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November 12, 2020
Project No. 20210161.001A

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**Subject:** **Geotechnical Investigation Report**
**Proposed Natural Gas Pipeline Replacement Project**
**ILI Retrofit of Line 021A, MP 12.12-31.95**
**Horizontal Directional Drill Under Napa River**
**Napa County, California**

Dear Mr. Ganji:

Kleinfelder is pleased to present the results of our geotechnical investigation for the proposed Pacific Gas and Electric Company (PG&E) pipeline replacement project for the Line 021A crossing in two locations. One is the Napa River crossing and the other is the nearby Suscol Creek crossing in Napa County, California. It is our understanding that replacement of the gas pipeline is intended to be implemented using potentially two different trenchless methods under Napa River and Suscol Creek in the areas south of Highway 29.

The purpose of this study was to evaluate the subsurface conditions near the two proposed trenchless crossings in order to characterize the subsurface soil and groundwater likely to be encountered during trenchless and open cut pipeline construction activities.

It is Kleinfelder's professional opinion that the proposed HDD crossing of the Napa River is feasible using horizontal directional drilling (HDD). The Suscol creek crossing appears feasible using jack and bore methods above groundwater. However, if the crossing is constructed below groundwater, jack and bore may not be practical and pipe ramming could be used instead to better control groundwater inflows at the heading. Both methods would require similar pits. Seasonal and daily tidal impacts on the groundwater table should be considered and monitored prior to construction activities. Specific recommendations regarding the geotechnical and hydrogeological aspects of project design and construction are presented in the following report.

We appreciate the opportunity to provide our services for this project. If you have questions regarding this report or if we may be of further assistance, please contact the undersigned.

Respectfully submitted,
**KLEINFELDER, INC.**

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# GEOTECHNICAL INVESTIGATION REPORT
# PROPOSED NATURAL GAS PIPELINE REPLACEMENT
# ILI RETROFIT OF LINE 021A, MP 12.12-31.95
# HORIZONTAL DIRECTIONAL DRILL UNDER NAPA RIVER
# NAPA COUNTY, CALIFORNIA

**NOVEMBER 12, 2020**

**ONLY THE CLIENT OR ITS DESIGNATED REPRESENTATIVES MAY USE THIS DOCUMENT AND ONLY FOR THE SPECIFIC PROJECT FOR WHICH THIS REPORT WAS PREPARED.**

A Report Prepared for:

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**Proposed Natural Gas Pipeline Replacement Project**
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November 12, 2020
Project No. 20210161.001A

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# 1 INTRODUCTION

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## 1.1 GENERAL

This report presents the results of a geotechnical investigation conducted for the proposed PG&E L-021A natural gas pipeline replacement project crossing the Napa River and Suscol Creek, and for decommissioning the existing pipeline on the west side of the Napa river. The purpose of this investigation was to characterize the subsurface conditions near the two proposed trenchless crossings along the alignment for the purpose of evaluating appropriate trenchless pipeline construction methods. Additionally, an exploration was performed in the area of the existing L-021A pipeline on the west side of the river in support of pipeline decommissioning. Dewatering analyses were performed near the Suscol Creek crossing and near the pipeline decommissioning location west of the Napa River to aid in project design and construction. The approximate location of the proposed pipeline alignment, existing pipeline alignment, and the pertinent project elements are shown on Figure 2, Site Plan.

This report includes our recommendations related to the geotechnical aspects of project planning, design and construction of the proposed HDD crossing and the Suscol Creek trenchless crossing. It also includes dewatering analyses related to the Suscol Creek crossing and the pipeline decommission location. Conclusions and recommendations presented in this report are based on the subsurface conditions encountered in seven (7) exploratory borings drilled for this investigation and our review of published geologic data referenced in this report. Recommendations presented herein should not be extrapolated to other areas or used for other projects without our prior review. The approximate locations of our exploratory borings are shown on Figure 2.

## 1.2 PROJECT DESCRIPTION

It is our understanding that the Napa River HDD crossing will consist of a 26-inch-diameter, steel, natural gas transmission pipeline constructed just south of Highway 29, roughly between Stanly Lane and Soscol Ferry Road. From the east end of the HDD alignment, the pipeline will continue south across Suscol Creek. The creek crossing is planned to consist of a Jack and Bore installation (auger bore, guided auger bore or alternative ‘slick bore’ method). An approximate 300-foot-long section of the old L-021A pipeline on the west side of the Napa River, south of the proposed replacement alignment, will be retired via excavation and removal. The project alignment and the pertinent project elements related to this study are shown on Figure 2.

## 1.3 SCOPE OF SERVICES

As authorized by PG&E, the scope of our services was outlined in our proposal dated March 30, 2020 and included the following items:

- Review of existing geologic and geotechnical data for the site vicinity
- Drilling and sampling of seven borings to explore subsurface conditions and to obtain samples for laboratory testing
- Installation, development, and slug testing of two test wells
- Laboratory testing of selected samples to assess pertinent geotechnical properties
- Evaluation of the available data to develop conclusions and recommendations to guide geotechnical aspects of design and construction
- Dewatering analyses
- Trenchless method analysis
- Preparation of this report which includes:
    - A description of the proposed project including a site vicinity map and site plan showing the crossing alignment, exploration locations, proposed HDD entry and exit points, Jack and Bore pits and old pipeline decommissioning pits.
    - A discussion of historical and geological research pertinent to the proposed alignment
    - A summary of the surficial and subsurface site conditions encountered during our field investigation
    - Liquefaction and seismic settlement analysis and discussion
    - Recommendations related to the geotechnical aspects of HDD under the Napa River including:

  - Anticipated drilling conditions
  - Soil and rock characteristics with regard to drill tooling selection and separation plant considerations
  - Drilling fluid considerations
  - Solids and fluid volume guidelines
  - Borehole and fluidic drag coefficients for pipe pullback load estimating
  - Recommendations for control of inadvertent fluid releases and related contingency planning
  - Equipment support
- Recommendations regarding trenchless crossing of Suscol Creek
- Recommendations for pipeline excavations including dewatering and temporary shoring
- Recommendations for Contractor selection and pre-bid services
- Appendices with logs of borings and laboratory test results

Environmental evaluations and analyses, including detailed review of possible contaminants in the investigated soils, are outside of our scope of services.

# 2 FIELD INVESTIGATION AND LABORATORY TESTING

## 2.1 SITE DESCRIPTION

The proposed pipeline alignment is located south of Highway 29 in Napa, California. Two (2) trenchless crossings are planned along the alignment under the Napa River, spanning from Stanly Lane on the west side of the Napa River past Soscol Ferry Road on the East side of the river, and a crossing under the Suscol Creek.

The alignment area on the west side of the Napa river consists of open, slightly sloping agricultural land from the levee at the riverbank to a drainage channel near the end of the trenchless crossing. The Napa River is approximately 300 feet wide and 18 feet deep in the area of this project. The east side of the alignment consists of wetland and agricultural land is surrounded by rural agricultural land with slightly sloping topography broken up by a rail line, paved and unpaved roads, and various drainages.

The Napa Sanitation District facility is located just south of the project location, east of the Napa River. Suscol Creek is thickly wooded at the crossing location, spanning approximately 20 feet across and 6 feet deep, and currently bridged by a simple concrete span along an unpaved road.

The Napa River experiences daily and seasonal tidal fluctuations high enough to flood the field on the West side of the River. The tidal fluctuations can be as high as 8 ft above sea level. In addition, the area is subject to seasonal flooding which has been a frequent issue during times on heavy winter rains.

## 2.2 PREVIOUS EXPLORATIONS

Kleinfelder reviewed available geotechnical data in the site vicinity. The following data was reviewed and considered during the development of our conclusions and recommendations for this study.

- "Geotechnical Engineering Investigation Report, Stanly Ranch HDD Project, Napa California," by Jacobs Associates, dated May 10, 2013.

- Log of Test Borings, Highway 29 Bridge over Napa River, Caltrans, 1971

Logs of borings from Napa Sanitation's Stanly Ranch HDD project are included in Appendix D, as they show subsurface information in the area of the proposed L-021A pipeline decommissioning and in the eastern portion of the proposed HDD alignment. The approximate Stanly Ranch HDD boring locations are presented on Figure 2. Due to their distance from the proposed alignment, the Caltrans borings were not relied upon for our HDD analysis and have not been included in this report.

## 2.3 FIELD EXPLORATION

The subsurface conditions at the site were explored between August 20th and August 27th, 2020 by drilling seven (7) borings (B-1A/B through B-6) to depths ranging from approximately 41½ to 101½ feet below the ground surface. The borings were drilled using a modified Mobile B-53, truck-mounted drill rig equipped with hollow-stem auger and mud rotary drilling capabilities.

The borings were located in the field by visual sighting and/or pacing from existing site features. Therefore, the locations of the borings shown on Figure 2 should be considered approximate and may vary slightly from those indicated.

A Kleinfelder professional maintained logs of the borings, visually classified the soils encountered according to the Unified Soil Classification System (American Society for Testing and Materials International [ASTM] D2488 visual-manual procedure) and obtained both disturbed and relatively undisturbed samples of the subsurface materials. A Graphics Key with the Unified Soil Classification System descriptive criteria is presented on Figure A-1 in Appendix A. Following laboratory testing, the field visual classifications were revised, as appropriate, based on ASTM D2487. Soil and Rock Description Keys are provided on Figures A-2 and A-3 in Appendix A. Logs of Borings are presented on Figures A-4 through A-10.

## 2.4 SAMPLING PROCEDURES

Samples were obtained from the borings at selected depths by driving a 2.5-inch inside diameter (I.D.), split-barrel, California sampler containing stainless steel liners into undisturbed soil with a 140-pound automatic hammer free-falling a distance of 30 inches. The California sampler was in general conformance with ASTM D3550. Soil sampled using this method may have experienced some minor disturbance due to hammer impact, retrieval, and handling.

Disturbed samples were also obtained at selected depths by driving a 1.4-inch I.D. Standard Penetration Test (SPT) sampler into undisturbed soil with a 140-pound automatic hammer free-falling a distance of 30 inches. The SPT sampler was used in sandy and gravelly soils and when sufficient recovery could not be achieved with the California sampler. The SPT sampler was in general conformance with ASTM D1586.

Blow counts were recorded at 6-inch depth intervals for each driven sample attempt and are reported on the logs. Blow counts shown on the boring logs have not been corrected for the effects of overburden pressure, rod length, sampler size, or hammer efficiency. Sampler size correction factors were applied to estimate the sample apparent density noted on the boring logs. The consistency terminology used in soil descriptions for cohesive soils is based on field observations (see Figure A-2). Soil samples obtained from the borings were packaged and sealed in the field to reduce moisture loss and disturbance and returned to our laboratory for further testing. After the borings were completed, with the exception of Borings B-5 and B-6, they were backfilled with neat cement grout. Test wells were installed in Borings B-5 and B-6.

## 2.5 TEST WELL INSTALLATIONS

Following drilling, test wells were installed and developed in Borings B-5 and B-6. The wells were constructed with a 2-inch-diameter, schedule 40 PVC casing with 0.020-inch mill slotted screen. A sand pack was placed in the annulus of each well to an approximate depth of 1 to 2 feet above the top of the well screen. An approximate 2-foot-thick bentonite seal was placed on top of the sand pack and hydrated, followed by placement of neat cement grout to the surface. The wells were completed with an 8-inch-diameter, flush mount well box that was set in concrete. The complete well construction log for each boring is presented in Appendix A. Key well details are summarized below in Table 2.1.

**Table 2.1**
**Test Well Construction Summary**

| Test Well ID | Total Depth (ft bgs) | Screened Interval (ft bgs) | Static Groundwater Depth at time of construction (ft bgs) | Static Groundwater Depth post-development (ft bgs) |
|---|---|---|---|---|
| B-5 | 40 | 15-40 | 15 | 3.5 |
| B-6 | 19 | 10-19 | 15 | 3.2 |

*Total depth, screened interval and static groundwater depths below ground surface (bgs) are approximate values*

The test wells were developed by Kleinfelder. The wells were purged of a minimum of ten well volumes with a portable submersible pump. Purge water was contained in drums and temporarily stored at the PG&E construction yard on Old Adobe Road in Petaluma, California prior to receiving analytical test results.

Several key test well construction factors can influence the effectiveness of hydraulic conductivity values estimated from aquifer testing. These factors include the filter pack gradation, the screen slot size, the drilling method and technique, and the quality of well development. The drilling, installation and development of the test wells were conducted in a manner to reduce borehole smear and increase the effectiveness of the hydrologic connection between the test wells and the in-situ (natural) soil and groundwater conditions.

## 2.6 AQUIFER/SLUG TESTING

Aquifer testing, in the form of slug tests, was performed on September 9, 2020, on the newly installed test wells. A slug test is a relatively cost-effective and efficient manner to estimate hydraulic conductivity within the immediate vicinity of the test well. The solid-slug test is conducted when a solid object of known volume (a slug) is quickly lowered into (slug-in) or pulled out (slug-out) of a water column within a well, causing the water level inside the well to rise or fall, respectively. The water level is monitored and recorded over time until it returns to equilibrium or the original observed level. The aquifer response and recovery data are used to estimate aquifer properties and provide the hydraulic conductivity estimates.

For our slug testing, the solid slug was alternately lowered into the wells (falling head test) and removed (rising head test) from the wells to create a condition of groundwater disequilibrium. The groundwater level was monitored with a pressure transducer over time as water level returned to equilibrium. A minimum of three slug-in and three slug-out tests were performed in each well. Depth to groundwater was measured at a depth of 3.5 feet (B-5) and 3.2 feet (B-6) feet below the ground surface at the time of slug testing.

## 2.7 LABORATORY TESTING

Laboratory tests were performed on selected samples recovered from the borings to evaluate their physical and engineering properties. The geotechnical laboratory testing included the following tests:

- Unit Weight (ASTM D2937)
- Moisture Content (ASTM D2216)
- Atterberg Limits (ASTM D4318)
- Sieve Analysis (ASTM D422)
- Unconsolidated-Undrained Triaxial Compression (ASTM D2850)

Unit weight, moisture content, sieve analysis, and Atterberg Limits results are summarized on the boring logs presented in Appendix A. The results of all laboratory tests are included in Appendix B.

# 3 SITE CONDITIONS

## 3.1 REGIONAL GEOLOGY

The crossing location transects the Napa River in southern Napa Valley, within the Coast Range Geomorphic Province of Northern California. This province is generally characterized by northwest-trending mountain ranges and intervening valleys, which are a reflection of the dominant northwest structural trend of the bedrock in the region. The basement rock in the northern portion of this province consists predominantly of the Franciscan Complex, a subduction complex of diverse groups of igneous, sedimentary and metamorphic rocks of Cretaceous to Upper Jurassic age (65 to 160 million years old), and to the east, the Coast Range Ophiolite and the Great Valley Complex, an Upper to Middle Jurassic age (approximately 145 to 175 million years old) volcanic ophiolite sequence with associated Lower Cretaceous to Upper Jurassic (approximately 100 to 160 million years old) sedimentary rocks. The Coast Range Ophiolite and the Great Valley Complex was tectonically juxtaposed with the Franciscan Complex (most likely during subduction accretion of the Franciscan Complex), and these ancient fault boundaries are truncated by a modern right-lateral fault system that includes the San Andreas, Hayward-Rodgers Creek and West Napa faults. Located approximately 30.6 miles southwest of the site, the San Andreas fault defines the westernmost boundary of the local bedrock. In the site vicinity, the Great Valley Sequence and Franciscan Complex are unconformably overlain by Tertiary age (approximately 2.6 to 65 million years old) continental and marine sedimentary and volcanic rocks. These Tertiary age rocks are locally overlain by younger Quaternary (approximately 2.6 million years old to present day) alluvial, colluvial, estuarine and landslide deposits.

## 3.2 SITE GEOLOGY

The geology at the site has been mapped by Bezore et al. (2002) and Witter et al. (2006) among others. Bezore et al. (2002) indicate the Napa River is confined by artificial levee fill that is underlain by Holocene age (approximately 11,700 years old to present day) estuarine deposits (bay mud). According to the authors, the estuarine deposits consist of silt, fine sand, peat and clay. The low ridge located adjacent to the east bank of the river is shown by Bezore et al. (2002) to be underlain by undivided bedrock of the Pliocene age (approximately 5 to 2.6 million years old) Sonoma Volcanics Group, comprised of basalt, agglomerate and tuff. Bezore et al. (2002) indicate the ridge west of the river is underlain by fluvial gravel, sand silt and clay of the Pliocene age Huichica Formation. Witter et al. (2006) are in general agreement and also indicate the Napa River is confined by artificial levee fill, underlain by Holocene age San Francisco Bay mud, consisting of silt, clay peat and fine sand. Witter et al. (2006) show the low ridges east and west of the river to be underlain by pre-Quaternary deposits and/or bedrock. According to Witter et al. (2006), the levee fill and bay mud deposits are moderately susceptible to liquefaction, while the bedrock forming the ridges to the east and west have very low susceptibility. The mapped geology in the area of the site is presented on Figure 3.

## 3.3 SEISMICITY AND FAULTING

The crossing location is not located within an Earthquake Fault Zone as defined by the California Geological Survey (CGS, 2020) in accordance with the Alquist-Priolo Earthquake Fault Zone Act of 1972. The nearest zoned active fault is the West Napa, which, according to the CGS (2020), is located approximately 0.4 miles southwest of the site. Moderate to major earthquakes generated on the West Napa and other faults in the region can be expected to cause strong ground shaking at the crossing location.

The proximities and seismic parameters of significant faults in the vicinity of the crossing locations are listed in Table 3.1. For faults with multiple segmentation scenarios we have only listed parameters for the scenario rupturing the most segments (i.e., the most severe scenario). The locations of the faults and associated parameters presented on Table 3.1 are based on Petersen et al. (2008). The maximum earthquake magnitudes presented in this table are based on the moment magnitude scale developed by Kanamori (1977). Felzer (2008) details calculations of California seismicity rates including correction for magnitude rounding and error, Gutenberg-Richter b value and seismicity rates.

**Table 3.1**
**Significant Faults**

| Fault Name | Closest Distance to Site* (mi) | Magnitude of Characteristic Earthquake** | Slip Rate (millimeters/year) |
|---|---|---|---|
| West Napa | 0.4 | 6.7 | 1 |
| Green Valley Connected | 7.7 | 6.8 | 4.7 |
| Hayward-Rodgers Creek-SH+NH+RC | 12.4 | 7.3 | 9 |
| Hunting Creek-Berryessa | 15.3 | 7.1 | 6 |

| **Fault Name** | **Closest Distance to Site* (mi)** | **Magnitude of Characteristic Earthquake**** | **Slip Rate (millimeters/year)** |
|---|---|---|---|
| Great Valley 5, Pittsburg Kirby Hills | 17.1 | 6.7 | 1 |
| Great Valley 4b Gordon Valley | 18.2 | 6.8 | 1.3 |
| Great Valley 4a Trout Creek | 25.3 | 6.6 | 1.3 |
| Mount Diablo Thrust | 28.5 | 6.7 | 2.0 |
| San Andreas-SAS+SAP+SAN+SAO | 30.6 | 8.1 | 17-24 |
| Maacama-Garberville | 31.9 | 7.4 | 9 |

* Closest distance to the potential rupture.
** *Moment magnitude*: An estimate of an earthquake's magnitude based on the seismic moment (measure of an earthquake's size utilizing rock rigidity, amount of slip, and area of rupture).

According to Petersen et al. (2008), characterizations of the Hayward-Rodgers Creek and the San Andreas faults are based on the following fault rupture segments and fault rupture scenarios:

- The Hayward-Rodgers Creek fault has been characterized by three segments and six rupture scenarios plus a floating earthquake. The three segments are the Rodgers Creek fault (RC), the Hayward North (HN), and the Hayward South (HS).
- The San Andreas fault has been characterized by four segments and nine rupture scenarios, plus a floating earthquake. The four segments are Santa Cruz Mountains (SAS), Peninsula (SAP), North Coast (SAN), and Offshore (SAO).

A number of large earthquakes have occurred within this region in the historic past. Some of the significant nearby events include two 1969 Santa Rosa earthquakes (M5.6, 5.7), the 2000 Yountville earthquake (M5.2), the 1869 Ukiah earthquake (M5.6), the 1906 San Francisco earthquake (M8+), and the 2014 South Napa earthquake (M6.0). Future seismic events in this region can be expected to produce strong seismic ground shaking at these locations. The intensity of future shaking will depend on the distance from the site to the earthquake focus, magnitude of the earthquake, and the response of the underlying soil and bedrock.

## 3.4 SUBSURFACE CONDITIONS

The following descriptions provide a general summary of the subsurface conditions encountered during the field exploration program. For more detailed descriptions of the actual conditions encountered at specific crossing locations, refer to the Anticipated Boring Condition sections for each crossing presented in Section 4 of this report, and the boring logs contained in Appendix A.

The primary soil units encountered varied between borings and from the east to west side of the Napa River, but generally consisted of alluvial lean and fat clays and silts with interbedded sand and gravel. The apparent density of the coarse-grained soils encountered ranged from loose to very dense and the consistency of the fine-grained soils ranged from very soft to hard. Very soft shallow lean and fat clay was encountered in Borings B-2 and B-6 to depths of 25 to 30 feet below ground surface. These densities/consistencies are based on sampler blow counts and field observations. Conditions encountered throughout all exploratory borings revealed similar trends in soil densities/consistencies, with looser/softer upper materials underlain by more hard/dense materials typically with small gravels.

Weak sandstone bedrock was encountered in Boring B-3 at a depth of about 80 feet below the ground surface. Uncorrected SPT blow counts within the sampled sandstone ranged from about 50 blows per 4 to 6 inches of penetration.

### 3.5 GROUNDWATER CONDITIONS

Groundwater was encountered between depths of about 8 and 16½ feet during the field investigation for this study. Subsequent slug testing and groundwater measurements in test wells installed as described in Section 5 indicated groundwater levels as shallow as 3.2 feet below the ground surface.

It is possible that groundwater conditions at the site could change due to variations in rainfall, groundwater withdrawal or recharge, construction activities, well pumping, Napa River stage, tidal influences, or other factors that may not have been apparent at the time the explorations were performed.

# 4 CONCLUSIONS AND DESIGN CONSIDERATIONS

## 4.1 GENERAL CONCLUSIONS

Based on our geotechnical evaluation of the data discussed in this report, it is our professional opinion that the proposed trenchless crossings are feasible provided the geotechnical data presented in this report is incorporated into design and construction. Table 4.1 below provides a general summary of the proposed trenchless crossings and construction methods.

**Table 4.1**
**Summary of Proposed Trenchless Crossings**

| Crossing | Borings | Approximate Length of Crossing (ft) | Approximate Maximum Depth of Channel (ft) | Recommended Trenchless Construction Method |
|---|---|---|---|---|
| Suscol Creek Crossing | B-4 & B-5 | 100-120 | 6 | Jack and Bore or Pipe Ram |
| Napa River Crossing | B-1, B-2, B-3 & B-4 | 3,600 | 18 | HDD |

Presented in the following sections of this report are descriptions of the anticipated subsurface conditions along with our conclusions and recommendations regarding the geotechnical aspects of the proposed trenchless installations.

## 4.2 LIQUEFACTION POTENTIAL AND SEISMIC SETTLEMENT

Liquefaction describes a condition in which saturated soil loses shear strength and deforms as a result of increased pore water pressure induced by strong ground shaking during an earthquake. Dissipation of the excess pore water pressures will produce volume changes within the liquefied soil layer, which causes settlement. Factors known to influence liquefaction include soil type, structure, grain size, relative density, confining pressure, depth to groundwater and the intensity and duration of ground shaking. Soils most susceptible to liquefaction are saturated, loose sandy soils, and low plasticity clays and silts. If liquefaction occurs, structures above the liquefiable layers may undergo settlement.

The soils sampled during this study were reviewed for liquefaction susceptibility in general accordance with the procedure developed by Boulanger and Idriss (2006). Based on conditions encountered in the borings drilled for this study with respect to relative density, soil type, and groundwater levels, the potential for liquefaction and seismically-induced ground failure is considered low.

## 4.3 SUSCOL CREEK CROSSING

### 4.3.1 Anticipated Boring Conditions

The trenchless crossing located across Suscol Creek is anticipated to be constructed between a depth of 16 and 18 feet below the ground surface with a length of about 100-120 feet. Groundwater was encountered at a depth of about 13 to 16 feet below the ground surface in Borings B-4 and B-5, and later test well measurement showed groundwater at approximately 3 feet below the ground surface in Boring B-5. In Boring B-4, at the anticipated bore depth of about 16 feet, the bore path would penetrate lightly cemented silty sand and hard, sandy lean clay. Provided the sands do not transmit water rapidly, jack and bore could be feasible. However, if uncemented sands were present, flowing ground conditions could result. The cemented materials may not be conducive to guided auger bore methods, as advancement of a typical slant-faced pilot tube may be difficult. In Boring B-5, stiff to soft fat clay soils are present that generally have low groundwater inflow rates and significant soil cohesion, which may be suitable for jack and bore or guided auger bore construction.

Presented below are tunnelman's ground classifications that are typically used to describe anticipated ground behavior for tunneling.

**Table 4.2**
**Tunnelman's Ground Classifications and Generalized Ground Behavior**

| Classification | | Behavior |
|---|---|---|
| Firm | | Heading can be advanced without initial support |
| Raveling | Slow raveling | Chunks or flakes of material begin to drop out of the arch or walls sometime after the ground has been exposed, due to loosening or to overstress and "brittle" fracture (ground separates or breaks along distinct surfaces, opposed to squeezing ground). In fast raveling ground the process starts within a few minutes, otherwise the ground is slow raveling. |
| | Fast raveling | |

| | | |
|---|---|---|
| Squeezing | | Ground squeezes or extrudes plastically into tunnel without visible fracturing or loss of continuity, and without perceptible increase in water content. Ductile, plastic yield and flow due to overstress |
| Running | Cohesive running | Granular materials above the water table without cohesion are unstable at slopes greater than their angle of repose (±30-35 degrees). When exposed at steeper slopes they run like granulated sugar or dune sand until the slope flattens to the angle of repose. Material that has sufficient apparent cohesion due to moisture or weak cementation to stand for a brief period of raveling before it breaks down and flows as a mixture of soil and water is cohesive running. |
| | Running | |
| Flowing | | A mixture of soil and water flows into the tunnel like a viscous fluid. The material can enter the tunnel from the invert as well as from the face, crown, and walls, and can flow great distances, completely filling the tunnel in some cases. |
| Swelling | | Ground absorbs water, increases in volume, and expands slowly into the tunnel. |

Based on the logs of Borings B-4 and B-5, it appears that the soils along the anticipated bore path would meet the description of “Firm” ground. If any zones of cohesionless sands are present, a “Flowing” ground condition could result.

Based on our groundwater level measurements, groundwater is likely to be above the bore path at the time of construction. If more than about 3 feet of groundwater head is present above the bore crown at the time of construction, and the contractor is concerned about excessive groundwater flows at the heading, pipe ramming methods could be used to install the pipe if “Flowing” ground or groundwater inflow conditions dictate. Pipe ramming can be done in the sands in a manner to reduce the risk of flowing soils and overmining of the heading. Mixed face conditions (i.e., boring at a transition between soil types/rock) appear to be present but do not appear to be severe. Mixed face conditions should normally be avoided where possible, as they represent difficulty maintaining the bore profile. This crossing may benefit from using pipe ramming if it must be constructed below groundwater, as less water will enter the shafts from the bore since the soil plug is generally left inside the pipe during ramming. This could reduce the need for dewatering outside shaft areas.

Dependent on the depth of planned excavation of the jack and bore pits, the expected soils should range from silty and clayey sand to lean and fat clay with various sand content, as described above and on the Boring Logs. Encountering groundwater is considered likely, and plans should be put in place to handle such conditions. Tidal impacts on the groundwater table should be anticipated.

### 4.3.2 Bore Instability

Over-mining of the headings in cohesionless soils can cause sink holes to develop at the ground surface. This should be considered when selecting the bore path and in the installation of the pipeline. Where a cohesive or cemented soil overlies cohesionless materials, the upward propagation of caving sand in a sink hole may be retarded. However, a cavity may still remain below the cohesive layer that could lead to a future sink hole if not mitigated during construction.

In jack and bore applications it is preferable to avoid cohesionless soils when selecting the bore path to reduce the risk of post-construction settlement or sinkhole development. In cohesionless soils, it is best to have the cutter head extend as little as possible in front of the lead casing to reduce the risk of over-mining. Although clayey and cemented silty sand soils are anticipated for this crossing, it is within alluvial deposits that can vary. If jack and bore methods are used below the groundwater level, the Contractor should be prepared to fill excessive voids that may develop around the pipe and near the headings if fast-raveling or flowing cohesionless materials are encountered.

### 4.3.3 Bore Monitoring

At a minimum, we recommend the jack and bore spoil volumes recovered from the Suscol Creek bore be monitored during construction to evaluate whether the excavated volume is consistent with the theoretical hole volume. Bulking of the excavated soils must be considered when comparing the jack and bore spoil volumes to the theoretical hole volume. If spoil quantities (adjusted for bulking) exceed the theoretical hole volume, over-mining of the heading may be occurring. This can result in voids along the bore path that can lead to settlement and/or sinkholes at the ground surface. If excessive voids occur that require mitigation, provisions should be made to fill those voids with cement grout or other suitable material to prevent distortion of the ground surface. If pipe ramming is used as an alternate to jack and bore, monitoring of the spoil volumes is usually not needed.

## 4.4 PIPELINE EXCAVATIONS

### 4.4.1 Temporary Excavations

#### 4.4.1.1 General Considerations

All excavations should comply with applicable local, state, and federal safety regulations including the current Occupational Safety & Health Administration (OSHA) Excavation and Trench Safety Standards. Construction site safety generally is the responsibility of the Contractor, who is responsible for the means, methods, and sequencing of construction operations. Kleinfelder is providing the information below solely as a service to the client. Under no circumstances should the information provided be interpreted to mean that Kleinfelder is assuming responsibility for construction site safety or the Contractor's activities. Such responsibility is not being implied and should not be inferred.

#### 4.4.1.2 Excavations and Slopes

Excavated slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, and/or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations). Such regulations are strictly enforced and, if they are not followed, the Owner, Contractor, and/or earthwork and utility subcontractors could be liable for substantial penalties.

Heavy construction equipment, building materials, excavated soil, and vehicular traffic should be kept sufficiently away from the top of any excavation to prevent any unanticipated surcharging. Alternatively, excavation slopes and shoring systems can be designed to accommodate surcharge loadings, if necessary. Shoring, bracing, or underpinning required for the project (if any), should be designed by a professional engineer registered in the State of California.

### 4.4.2 Temporary Shoring

#### 4.4.2.1 General Considerations

The site soils include varied alluvium composed of stiff to hard silts and clays and medium dense to very dense sands and gravels underlain by siltstone and claystone. In areas where Standard

Penetration test sampler blow counts exceed about 20 blows per foot and California Sampler blow counts exceed 30 blows per foot, as in the hard silts and clays, very dense gravels, and siltstone and claystone encountered, driving of steel sheet piles may not be feasible without pre-drilling or pre-trenching. The Contractor and designers should be aware of this condition and select appropriate shoring systems for the soil and rock conditions present in those areas.

In the event that driven sheet piles are not appropriate, drilled solutions such as soldier piles, secant pile walls or similar methods should be considered for shoring. The selection of these systems will depend on the presence of groundwater and/or cohesionless soils.

If soldier piles are to be used, continuous lagging will be required to retain potentially caving materials. Where voids exist behind the lagging following shoring installation, the surrounding ground will tend to yield towards the shoring and settlement can result in the areas adjacent to the excavation. Equipment and stockpiled materials adjacent to the trench will exacerbate this condition. These ground movements behind the shoring generally occur within a horizontal distance equal to the excavation depth. Excessive ground movement/settlement can cause damage to adjacent buried utilities and pavement sections. Therefore, it is important to backfill the lagging panels as the shoring progresses. It may also be necessary to repair cracked and/or settled pavement sections following construction where they area adjacent to the excavations.

Discontinuous or trench box shoring systems are generally not suitable in cohesionless soils and where positive support for the excavation side walls is needed.

Since selection of appropriate shoring systems will be dependent on construction methods and scheduling, we recommend the Contractor be solely responsible for the design, installation, maintenance, and performance of temporary shoring systems.

#### 4.4.2.2 Jacking and Receiving Pits

Where there is insufficient space to lay back the slopes for the planned excavations at the Suscol Creek jacking and receiving pits, shoring will be required. For design of cantilevered shoring, a triangular distribution of lateral earth pressure may be used. For design of braced shoring, a uniform distribution of earth pressure is recommended. Table 4.3 provides approximate lateral earth pressures for use in preliminary shoring design, assuming drained conditions without groundwater pressures. If the shoring will be installed to depths below anticipated groundwater, then groundwater pressures need to be taken into consideration. Final design of shoring systems should be performed by the contractor based on their review of the trench wall soil conditions. Design of shoring systems for the project should be performed by a state registered professional engineer.

**Table 4.3**
**Lateral Earth Pressures for Shoring**

| **Condition** | **Level Backfill** | | | |
|---|---|---|---|---|
| | **Drained Conditions** | | **Submerged Conditions** | |
| | **Sand and Gravel** | **Silt and Clay** | **Sand and Gravel** | **Silt and Clay** |
| Active Pressure (psf/ft) | 38 | 60 | 82 | 92 |
| Braced Pressure (psf) | 25H(1) | 39H(1) | 44H(1) | 51H(1) |
| Passive Pressure (psf/ft) | 400 | 250 | 200 | 125 |

Notes: 1. H is shored height in feet.

### 4.4.2.3 Lateral Deflections

Lateral deflection of a shored excavation is heavily dependent on the relative stiffness of the shoring system, the amount of bracing and/or tiebacks, and the quality of workmanship during installation. The limiting condition of maximum active earth pressure is generally reached when the shoring tilts or deflects laterally about 0.05 percent of the shoring wall height in dense sands and gravels and 1 percent of the shoring wall height in stiff cohesive material. If the shoring tilts or deflects less than the limiting condition, the lateral earth pressure will lie between the active and at-rest earth pressures. This soil movement can extend horizontally from 1H to 2H back from the top of cantilever retaining structures, with vertical movements approximately equal to the horizontal. The movement tends to be greatest close to the excavation and becomes less with increasing distance away. Backfilling void spaces behind shoring with sand or pea gravel may reduce the potential for vertical and lateral movements around the excavation.

The shoring designer should perform a deflection analysis of the shoring system. If movements are greater than the tolerance of existing project features (buried utilities, pavements, structures, etc.) tiebacks, dead-man anchors, or cross bracing may be needed to reduce deflections. Design using the at-rest pressure and/or more stringent tie-back or bracing systems may be required in the vicinity of improvements that cannot withstand lateral movements.

#### 4.4.2.4 Lateral Resistance

All soldier or sheet piles should extend to a sufficient depth below the excavation bottom to provide the required lateral resistance. Embedment depths should be determined using methods based on the principles of force and moment equilibrium. To account for three-dimensional effects on a soldier pile, the passive pressure may be assumed to act on an area 2 times the width of the embedded portion of the pile, provided adjacent piles are spaced at least 3 diameters, center-to-center. A minimum factor of safety of 1.2 should be applied to the calculated embedment depth and to determine the allowable passive pressure. The shoring professional should evaluate the final design conditions and shoring type to select the appropriate factor of safety for design.

The passive earth pressure, similar to active earth pressures, is mobilized when the shoring below the excavation bottom tilts or deflects laterally. The limiting condition of maximum passive earth pressure is generally reached when the shoring deflects laterally below the base of the excavation about 0.2 percent of the embedment depth below the bottom of the excavation in dense sands and gravels and about 2 percent of the embedment depth below the bottom of the excavation in stiff cohesive material. If the shoring system is restrained against movement, the lateral resistance below the base of the excavation will lie somewhere between the passive and at-rest earth pressure conditions. Accordingly, if lateral deflection at the base of the excavation is objectionable, the at-rest earth pressure should be used in design for lateral resistance.

#### 4.4.2.5 Surcharge Pressures

Shoring systems should be designed to resist lateral pressures due to hydrostatic forces, if present, and surface loads adjacent to excavations. We anticipate surface loads will be imposed by construction equipment, foundations, railroads, roadways, etc. Actual surcharge pressures will depend upon the geometry (i.e., point-, strip- or rectangular-shaped loaded area), the size of the loaded area, the position of the loaded area relative to the shoring, and the magnitude of the load. It is common in shoring design to use an appropriate Boussinesq theory solution to evaluate surcharge load pressures. Caltrans typically uses a traffic surcharge pressure of up to 250 psf for highway traffic.

#### 4.4.2.6 Existing Trench Backfill Conditions

In areas where existing trench backfills are exposed in or located adjacent to excavations for the proposed pipeline, the guideline trench side slope and shoring design criteria presented above may not be valid. The shoring designer should consider the presence of existing utility trenches in and near the proposed excavation areas as well as methods to protect the utilities. If existing trench backfill materials are encountered in excavations on the site, the shoring designer should be notified immediately to observe and address the encountered conditions. It should be noted that trench wall collapses have occurred where these conditions were not recognized and addressed during construction.

#### 4.4.2.7 Monitoring

Where lateral deflection of shoring elements can cause damage to existing, adjacent improvements, horizontal and vertical movements of the shoring system should be monitored by establishing survey points, installation of inclinometers, or a combination of both prior to excavation. The results should be reviewed by a qualified Geotechnical Engineer from Kleinfelder on a daily basis for a period of at least one week during excavation and following construction of the shoring system. Measurements should be obtained on a weekly basis thereafter. Detailed recommendations for monitoring should be provided by a qualified Geotechnical Engineer from Kleinfelder after a review of the planned shoring system.

#### 4.4.2.8 Construction Vibrations

The Contractor should use means and methods that will limit vibrations where adjacent structures/facilities are present. As a guide, the peak particle velocity of construction vibrations in adjacent structures/facilities should be limited to less than 1 inch/second when measured using an accelerometer.

#### 4.4.2.9 Shoring Removal

Shoring systems typically are removed as part of the excavation backfill process. Depending on the shoring system used, the removal process may create voids along the sides of the excavation. If these voids are left in place and are significantly large, backfill may shift laterally into the voids resulting in settlement of the backfill and overlying improvements. Therefore, care should be taken to remove the shoring system and backfill the trench in such a way as to not create these voids. If the shoring system requires removal after backfill is in place, resulting voids should be filled with cement slurry or grout.

## 4.5 NAPA RIVER CROSSING

### 4.5.1 General Evaluation

The Napa River HDD crossing is presently shown to run approximately 35 feet below the bottom of the river channel, as indicated on the 60% plans provided by GTS. The HDD crossing plan length at the Napa River crossing is anticipated to be approximately 3600 feet. It is likely that the design HDD depth under the river will need to be deeper (on the order of 70 feet) to help avoid hydraulic fracturing and inadvertent fluid releases to the surface during pilot hole drilling and reaming. The anticipated depths and lengths should be adjusted as appropriate in final design. This information is based on our review of the proposed 60% bore profile drawings and our experience with similar installations.

It is recommended that the proposed HDD installation be designed and constructed in general accordance with the fourth edition of the “Horizontal Directional Drilling (HDD) Good Practices Guidelines” by the north American Society of Trenchless Technologies (NASTT) dated 2017.

### 4.5.2 Anticipated HDD Drilling Conditions

Borings B-1 through B-4 represent the geotechnical conditions at the Napa River crossing. Soil conditions encountered in the exploratory borings generally consisted of interlayered alluvial deposits composed of lean and fat clay, clayey and silty sand, and well- and poorly-graded sand and gravel. Sedimentary sandstone bedrock was encountered below the alluvial soils in Boring B-3 at a depth of approximately 80 feet. Uncorrected SPT blow counts within the sampled sandstone ranged from about 50 blows per 4 to 6 inches of penetration. Refer to the Cross Section on Figure 4 and the boring logs in Appendix A for more detailed information.

### 4.5.3 Steering

The soils encountered within the exploratory borings appear to consist of relatively soft surficial soils underlain by stiff to hard clays and silts along with medium dense to dense sands with varying amounts of fines and gravels to the total depths explored. The exception is at Boring B-3 where sandstone was found at a depth of about 80 feet. Surface soils may be soft and require surface casing. In the underlying stiffer soils, the variations in density/consistency do not appear severe with respect to steering difficulty along the bore path. However, if the bore path extends into bedrock at a shallow angle, the drill bit may tend to skip on the harder materials and wander off the bore path. It is best to steer vertical curves either in the soil or rock but not across both to avoid this issue.

In dense/hard soils and rock with SPT sampler blow counts over 50 and California Sampler blow counts over 70, a mud motor drill will likely be necessary to penetrate the formations during pilot hole drilling. Mud motors are generally limited to a turning radius of 1,000 feet or more. Reaming to enlarge the hole for the pipe may require hole openers suitable for soft rock rather than soft soil reamers.

### 4.5.4 Borehole Instability

Sand and gravel layers that were encountered in all of the borings at various depths may be prone to instability in an HDD borehole. Hole collapse was observed in Boring B-1 at depths of approximately 10 feet and 23 feet, and in Boring B-4 at a depth of approximately 33 feet. If such sands and gravels are encountered during drilling, proper drilling fluid makeup or use of conductor casing can reduce the potential for borehole caving and stuck pipe during pullback. Use of loss of circulation materials and special drilling fluid formulation for sands and gravels may be needed in these soils.

### 4.5.5 Inadvertent Returns of Drilling Fluid

Hydraulic fracturing occurs when borehole pressure causes plastic deformation of the soil surrounding the borehole, initiating and propagating fractures in the soil mass. The resistance to plastic deformation and fracturing is a function of soil strength, overburden pressure, and pore water pressure. Hydraulic fracturing can result in drilling fluid inadvertently returning to the ground surface or running horizontally away from the borehole.

Borehole instability issues and/or the contactor not maintaining a clean borehole can result in poor drilling returns and partial or complete plugging of the borehole. This will result in higher fluid pressures within the bore and can lead to hydraulic fracturing and inadvertent fluid returns to the ground surface. Furthermore, at shallow depths, hydraulic fracturing is likely and is expected to occur near the bore exit point as the drill bit approaches the ground surface. Provisions should be in place to mitigate the effects of hydraulic fracturing and inadvertent fluid returns. Exit pits, containment areas, and similar countermeasures to contain drilling fluid releases should be considered.

Loss of drilling fluid returns typically occurs when the drill bit encounters rock fractures or large interstitial pore spaces in coarse materials (i.e. gravels and cobbles). Loss of returns is recognized by a decrease of drilling fluid returns, or a drop in drilling fluid pressure.

If fractures or interstitial pore spaces are small or discontinuous, they may fill with solids contained in the drilling fluid returns as drilling progresses beyond them. Once the fractures or pore spaces are filled, fluid will return up the bore hole again and fluid pressure will increase until another fracture or gravel layer is encountered. Based on the soil conditions encountered in the borings, the risk of significant drilling fluid losses is considered to be relatively high. Loss of circulation was noted in Borings B-1 at 23 feet and B-2 at 7 to 20 feet and 72 feet below the ground surface.

It is recommended that a hydraulic fracturing analysis be performed during final bore path design to confirm a safe depth of cover. The analysis should be performed in accordance with the recommendations contained in the above-referenced Horizontal Directional Drilling (HDD) Good Practices Guidelines. Kleinfelder is currently under contract to provide this analysis and will work with GTS after the date of this report to complete the analysis.

### 4.5.6 Drilling Fluid Program

#### 4.5.6.1 General

The drilling contractor should develop a Drilling Fluid Program (DFP) as part of the HDD Bore Plan. A properly designed drilling fluid program can substantially reduce losses due to frac-out, stuck product pipe, or loss of tooling. The drilling fluid program should take into account anticipated soil and rock conditions, fluid selection, drill bit and reamer selection, and volume calculations.

#### 4.5.6.2 Borehole Slurry Density

The density of the slurry in the borehole directly affects the buoyancy force and therefore the normal force between the pipe and the wall of the borehole. The density of drilling returns is a function of ground conditions, penetration rate, mud flow rate, drilling fluid composition, and efficiency of the mud cleaning system. In general, drilling return density varies between 10 and 12 pounds per gallon. In coarse gravel and cobbles, drilling fluid densities may approach 13 pounds per gallon.

For this project we anticipate drilling fluid return density will be on the order of 10 to 12 pounds per gallon where good returns are achieved, and drilling is performed in accordance with the HDD Good Practices Guidelines.

#### 4.5.6.3 Soil Conditions for Drilling Fluid Design

For the purpose of drilling fluid design, earth materials are divided into two categories: Inert, including sand and gravel; and reactive, including clay. Both soil types are present on the site. Information regarding subsurface conditions likely to be encountered at the site is provided in the Subsurface Conditions section of this report as well as in the boring logs contained in Appendix A and laboratory testing results presented in Appendix B.

#### 4.5.6.4 Drilling Fluid Selection

Drilling fluid program base fluid should be designed for site specific soil conditions. The base fluid may consist of either a bentonite or polymer and water, with additives to achieve specific fluid properties. Salt (chloride) is detrimental to base fluid performance and should not be present in make-up water. Bore hole stability and positive pressure should be maintained to minimize infiltration in formations containing saltwater.

The drilling contractor should submit a base fluid design with a list of additives, loss of circulation materials, and grouting materials that may be used on the project and MSD sheets for approval at least two weeks prior to mobilization. Assistance with drilling fluid selection can be obtained from reputable drilling fluid suppliers.

#### 4.5.6.5 Drill Bit and Reamer Selection

Drill bits and reamers should be selected based on anticipated subsurface conditions and past experience. The drilling contractor should be prepared with a variety of bits and reamers that have worked well in similar soil conditions.

### 4.5.6.6 Soil and Fluid Volume

The volume of soil or rock to be removed can be estimated as follows:

$$\frac{(\text{Hole Diameter in Inches})^2}{25} = \text{Volume in Gallons per Foot}$$

Sufficient fluid should be pumped during drilling and reaming operations to maintain flow. Drilling rates and drilling fluid flow rates may be adjusted in the field to match varying site conditions. However, an estimate of drilling fluid demand is useful when sizing drilling equipment, mud pumps, and solids removal systems, and can be particularly helpful in determining realistic drilling rates. Drilling fluid demand can be estimated based on the bore hole volume and the following ratios:

| Fluid Volume: Soil Volume | Ratio |
|---|---|
| Sand, Gravel, Cobble, Rock | 1:1 |
| Above, mixed with Clay | 2:1 |
| Clay or reactive Shale | 3-5:1 |

Drilling rates can be estimated based on the drilling fluid demand and the pump output at the design base fluid viscosity.

### 4.5.6.7 Solids Separation Plant

Fine-grained silts and clays are generally the most difficult to remove from drilling fluids. Depending on their extent, the presence of these soils along the proposed bore paths may require use of de-silters/centrifuge equipment in order to remove the fine soils from the drilling fluids.

### 4.5.6.8 Fluidic Drag Coefficient

A fluidic drag coefficient of 0.050 psi (345 Pa) was recommended in the original Pipeline Research Council International (PRCI) design guidelines and is still routinely used by pipeline designers. Recently it has been suggested the coefficient could be decreased to 0.025 psi (172 Pa) for a stable borehole with good solids removal (Puckett 2003). The higher value (0.050 psi) is recommended for routine calculations. The lower value (0.025 psi) may be appropriate for long bores in stable formations where significant cost saving could be realized by using a lower grade of steel or thinner pipe wall.

### 4.5.7 Borehole Friction Factor and Abrasion

A large portion of the pullback load is generated from friction between the pipe and the wall of the borehole. The pipe rubs against the borehole as it goes around corners and is pushed against the top of the borehole by buoyancy and capstan forces. The friction factor is an expression of the ratio of the normal force between the pipe and the borehole wall and the axial force needed to drag the pipe along the wall. The PRCI Guidelines recommend friction factors of 0.2 to 0.3 for steel pipe. ASTM Standard F1962-99 recommends a friction factor of 0.3. Due to the presence of gravels and rock, an abrasion resistant coating is recommended for steel pipes and generally required for natural gas pipelines. Recommended friction factors for abrasion resistant polymer concrete coating were not found in the above literature. The coating material is similar in texture to smooth, formed concrete. NAVFAC DM 7.02, Chapter 3, Table 1 reports friction factors for formed concrete against various soils types as presented in Table 4.4 below. The friction factors reported below do not account for the presence of a drilling fluid filter cake, as is normally present in HDD application using bentonite-based drilling fluids.

**Table 4.4**
**Ultimate Friction Factors**

| **Interface Material** | **Friction Factor (tanδ)** | **Friction angle δ (deg.)** |
|---|---|---|
| Clean gravel, sandy gravel, coarse sand, highly fractured rock | 0.55 to 0.60 | 29 to 31 |
| Clean fine to medium sand, silty medium to coarse sand, silty or clayey gravel | 0.45 to 0.55 | 24 to 29 |
| Clean fine sand, silty or clayey fine to medium sand | 0.35 to 0.45 | 19 to 24 |
| Fine sandy silt, non-plastic silt | 0.30 to 0.35 | 17 to 19 |
| Very stiff and hard residual or pre-consolidated clay | 0.40 to 0.50 | 22 to 26 |
| Medium stiff and stiff clay and silty clay | 0.30 to 0.35 | 17 to 19 |

### 4.5.8 Drill Pad support

Surface soils in the vicinity of our exploratory borings generally consist of clays and are not likely to provide adequate support for HDD drilling equipment, especially when they are wet. When these soils become wet, they may also be slippery and unstable. If rig set up is not planned for a paved surface, soil stabilization is likely to be required to provide a stable platform for the HDD drill rig and surrounding area. Use of a gravel surface course underlain by a geotextile is recommended where heavy truck and equipment traffic is planned. This may also be needed for a storm water pollution prevention plan (SWPPP).

### 4.5.9 Contractor Selection

The success of the project will be substantially dependent on the experience and performance of the specialty contractor retained to perform the work. We recommend the use of a specialty contractor with a minimum of 3 years construction experience in the field of horizontal directional drilling in similar drilling conditions on projects of similar scope (i.e., diameter, length, and depth). The contractor should be familiar with the use of drilling mud and additives, rock tools, and conductor casings and should provide examples of projects they have successfully completed installing similar utilities in similar conditions.

## 4.6 PIPELINE DESIGN CONSIDERATIONS

### 4.6.1 Trenchless Installations

The dead load imparted to a buried pipe may be calculated using the prism load (soil load applied over the pipe width. For a flexible pipe installed using trenchless methods such as jack and bore or pipe ramming, the American Lifelines Alliance (2001) recommends soil cohesion be incorporated into the pipe loading analysis, as described below:

$$P_{DL} = \gamma \cdot H - 2 \cdot c \cdot (H/B_t)$$

Where: $\gamma$ = total unit weight of soil - $\gamma$ = 130 pcf
$H$ = backfill height above the pipe crown
$B_t$ = width of bore, and
$c$ = allowable soil cohesion – $c$ = 500 psf

If the bore crown is in gravel, the cohesion value should be taken as zero.

### 4.6.2 Design Values for Buried Flexible Pipes

Flexible pipes typically derive part of their resistance to ring deflection from the stiffness of initial backfill and trench wall soils. In a trenchless application, the amount of overcut used to install the pipe will not provide resistance to ring deflection. Once the pipe deflects enough to engage the borehole walls, the evaluation of further ring deflection under soil and live loads may be determined using the Iowa Formula or Reclamation Formula. The elastic modulus of the soil surrounding the pipe, E'n (also termed Constrained Modulus) should be taken as 1,500 psi.

## 4.7 UTILITIES AND WELL CLEARANCE

The location of existing utilities and water wells was beyond the scope of this report. There should be a concerted attempt to locate any and all underground utilities near the alignment during the design phase and certainly prior to construction and these utilities should be protected by the Contractor so as not to be impacted by the trenchless crossings. The bore profiles should be designed to allow sufficient clearance from all underground utilities to avoid entering into the utility trench or pipe zone materials or causing excessive settlement of the utilities above the bore. If existing utilities are within about 25 feet of the bore entry and exit pits, conductor casings should be used to help contain HDD drilling fluids and keep them out of adjacent utility areas.

Nearby water wells may exist and must be located, and protected if possible, to prevent being impacted by HDD construction. The HDD bore profile should be designed to allow sufficient clearance from nearby wells to avoid drilling fluid releases into them. In general, we recommend wells be located at least 100 feet from the HDD bore path for this type of HDD installation. If a well becomes impacted with drilling fluid, the well may need to be re-developed or replaced.

# 5 HYDROGEOLOGIC ANALYSES

This section presents the findings of Kleinfelder's analysis of aquifer testing and soil grain size results for the trenchless crossing of Suscol Creek. Hydraulic conductivity is the measure of the rate at which water can pass through a permeable medium. It serves as the primary parameter governing flow through a dewatering system. Clays and silts generally have a lower hydraulic conductivity than sands and gravels.

## 5.1 AQUIFER TESTING ANALYSIS

Hydraulic conductivity of the soils in the area of the proposed Suscol Creek trenchless crossing was estimated by evaluating slug test data from the well borings B-5 and B-6. The software program AQTESOLV (by HydroSOLVE of Reston, Virginia) was used to evaluate slug test data using the Bouwer-Rice (1976) straight line method in order to estimate hydraulic conductivity. The expanded slug test evaluations are included in Appendix C. The resulting hydraulic conductivity estimates are summarized below in Table 5.1.

**Table 5.1**
**Hydraulic Conductivity Estimates from Slug Testing**

| Test Well ID | SLUG IN-1 | SLUG IN-2 | SLUG IN-3 | SLUG OUT-1 | SLUG OUT-2 | SLUG OUT-3 | GEOMETRIC MEAN |
|---|---|---|---|---|---|---|---|
| B-5 | 1.18E-03 | 1.29E-03 | 1.23E-03 | 1.15E-03 | 1.26E-03 | 1.24E-03 | 1.22E-03 |
| B-6 | 1.00E-03 | 8.86E-04 | 8.01E-04 | 1.30E-03 | 1.19E-03 | 1.08E-03 | 1.03E-03 |

*Hydraulic conductivity estimates in feet/minute*

Estimated hydraulic conductivity values from test well B-5 ranged from 1.15 x $10^{-3}$ feet/minute (ft/min) to 1.29 x $10^{-3}$ ft/min with a geometric mean of 1.22 x $10^{-3}$ ft/min. From Test Well B-6, the values ranged from 8.01 x $10^{-4}$ ft/min to 1.30 x $10^{-3}$ ft/min with a geometric mean of 1.03 x $10^{-3}$ ft/min.

## 5.2 GRAIN SIZE DISTRIBUTION ANALYSIS

Kleinfelder performed grain size analyses on select samples collected from the saturated, screened zone in the test wells. Hydraulic conductivity can be estimated from an analysis of grain size distribution. The grain size distribution results were analyzed using the program HydrogeoSieveXL (Devlin, 2016). The program computes estimated hydraulic conductivity using 15 published methods. The expanded grain size analysis evaluations are included in Appendix C. The resulting conductivity estimates (only reported for the methods which met the qualification criteria, with the Zunker method results excluded) are summarized in Table 5.2. The HydrogeoSieveXL program identified the Zunker method as meeting the qualification criteria for reporting. However, the reported estimate for this method was orders of magnitude higher than other methods. Based on our judgement, we have removed the Zunker method results from the estimates provided below.

**Table 5.2**
**Hydraulic Conductivity Estimates from Grain Size Analysis**

| Test Well ID | Sample Depth (ft) | Sample Description (USCS) | Percent Fines* (Passing #200) | Hydraulic Conductivity Range (ft/min) | | |
|---|---|---|---|---|---|---|
| | | | | Low | High | Geometric Mean |
| B-5 | 30.5 | Poorly Graded Sand with Silt and Gravel (SP-SM) | 9.4 | 1.85E-03 | 1.58E-01 | 2.51E-02 |
| B-6 | 8.5 | Fat Clay (CH) | 96 | 1.80E-06 | 1.20E-04 | 2.09E-05 |

**Fines are defined as silt and clay particles passing the #200 (0.074 millimeters) sieve*

Estimated hydraulic conductivity values from Test Well B-5 at a depth of 30.5 feet ranged from $1.85 \times 10^{-3}$ ft/min to $1.58 \times 10^{-1}$ ft/min with a geometric mean of $2.51 \times 10^{-2}$ ft/min. From Test Well B-6, the values at a depth of 8.5 feet ranged from $1.80 \times 10^{-6}$ ft/min to $1.20 \times 10^{-4}$ ft/min with a geometric mean of $2.09 \times 10^{-5}$ ft/min.

## 5.3 RESULTS

The mean hydraulic conductivity from analysis of aquifer testing (slug testing) resulted in values of $1.22 \times 10^{-3}$ ft/min (B-5) and $1.03 \times 10^{-3}$ ft/min (B-6). The mean hydraulic conductivity from the analysis of grain size samples resulted in values of $2.51 \times 10^{-2}$ ft/min (at depth of 30.5 feet) for B-5 and $5.36 \times 10^{-4}$ ft/min (at depth of 8.5 feet) for B-6.

The hydraulic conductivity values for Test Well B-5 are similar to the range of published, typical, hydraulic conductivity values for silty sand of 1.97 x $10^{-4}$ ft/min to 1.97 x $10^{-2}$ ft/min (Fetter, 2001).

The hydraulic conductivity values for B-6 are approximately one to two orders of magnitude higher than the range of published typical hydraulic conductivity values for clay of 1.97 x $10^{-8}$ ft/min to 1.97 x $10^{-5}$ ft/min (Powers et al, 2007 and Fetter, 2001).

## 5.4 DEWATERING EVALUATION

Hydraulic conductivity is the primary parameter governing groundwater flow through a dewatering system. Using the hydraulic conductivity, depth to water, excavation depth and dimensions, and other estimated aquifer parameters, an estimate can be made for anticipated flow and radius of influence of the dewatering system.

Presented in the following sections is our assessment of groundwater and aquifer conditions and estimated dewatering parameters based on a limited data set.

## 5.5 DEWATERING FLOW CALCULATION

Kleinfelder employed the following formula (Powers et al) for estimating dewatering flow to an open excavation in an unconfined aquifer of specified thickness, where:

$$Q = 7.48\left[\frac{\pi K(H^2 - h^2)}{ln\frac{R_0}{r_s}}\right]$$

And: Q = Flow in gallons per minute (gpm)
K = Hydraulic Conductivity in feet/minute
H = Aquifer thickness in feet
h = Dewatered aquifer thickness in feet
$R_o$ = Radius of influence in feet
$r_s$ = Effective radius of the dewatering system

This calculation is an analytical model used to approximate flow to a system with the following assumptions:

- The system is in equilibrium, meaning the pumping has continued until it has recharge equal to the discharge
- The system is approximated as flow from one source (single point)
- The aquifer is unconfined, homogenous, isotropic, of uniform thickness and extends horizontally in all directions
- The dewatering system is frictionless and fully penetrates the aquifer

Although the model treats the flow from a dewatered excavation as a single source, typical large dewatering systems will consist of multiple flow sources.

Actual dewatering flows will vary from the theoretical calculations based on several parameters, including but not limited to:

- Depth to groundwater and amount of drawdown required
- Variations in aquifer lithology, thickness, isotropy, lateral extent and confinement
- Hydraulic conductivity
- Distance to recharge source
- Hydraulic boundaries: Positive (infiltration from precipitation, inundation or landscaping, seepage from surface bodies of water, etc.) or negative (leakage to surface bodies of water or connecting aquifers, aquitards [artificial or naturally occurring], etc.)

## 5.6 DEWATERING EVALUATION

This evaluation is based upon our understanding of soil conditions, groundwater observations, and data analysis from aquifer testing as described above. The evaluation is made from a limited set of data. Excavation details were provided by GTS and reviewed in the 60% drawings prepared by GTS.

The values for dewatering flow and radius of influence presented are shown for estimating purposes based on the limited data and are likely vary from actual construction conditions. Actual dewatering flows will depend upon the actual groundwater levels at the time of construction, the actual soil conditions encountered during excavation, and the actual size and depth of the excavations. Discharge rates are expected to be higher at the start of dewatering activities and decrease over time as pumping continues and the target water level is reached.

In addition, our evaluation also did not factor in potential effects of a positive or negative recharge boundary since our scope of work did not include pumping tests or advanced groundwater modeling. A positive recharge boundary within the radius of influence of the dewatering system, such as infiltrating water or a nearby water source could increase flow rates.

It is assumed that the radius of influence extends evenly from the center of the excavation in all directions. The radius of influence of the dewatering system is a rough approximation made from several estimated and non-empirical aquifer parameters. If refinement of radius of influence is desired at sensitive locations, a pumping test can be conducted to more accurately define its extent.

### 5.6.1 Entry Pit HDD Tie In - Conceptual Dewatering Model

For our conceptual dewatering model(s), the following values were used:

- Unconfined aquifer thickness of 75 feet (assumed)
- Excavation size: 10 feet wide by 40 feet long by 9 feet deep (assumed)
- Water table depth of 3.5 feet below ground surface (assumed)
- A required drawdown of the water table of 7.5 feet (2 feet below the bottom of excavation) (assumed)
- Mean hydraulic conductivity of 1.22 x $10^{-3}$ ft/min (from slug test analysis of B-5)
- Specific yield of 0.1 (assumed)
- Time required to reach equilibrium conditions is 1 day (assumed)
- No positive or negative hydraulic boundaries

#### 5.6.1.1 Entry Pit HDD Tie In - Estimated Dewatering Flow

Using the parameters stated in our conceptual dewatering model, estimates for dewatering flow and dewatering induced radius of influence are summarized Table 5.3 below.

**Table 5.3**
**Entry Pit HDD Tie In - Dewatering Estimates**

| Assumed Depth to Groundwater (ft) | Hydraulic Conductivity (ft/min) | Assumed Drawdown Required (ft) | Flow Estimate (gallons per minute) | Daily Flow (gallons per day) | Radius of Influence Estimate (feet) |
|---|---|---|---|---|---|
| 3.5 | $1.22 \times 10^{-3}$ | 7.5 | 25 | 36,000 | 54 |

### 5.6.2 Suscol Creek Crossing Jack and Bore Pit - Conceptual Dewatering Model

For our conceptual dewatering model(s), the following values were used:

- Unconfined aquifer thickness of 75 feet (assumed)
- Excavation size: 25 feet wide by 50 feet long by 22 feet deep (assumed)
- Water table depth of 3.5 feet below ground surface (assumed)
- A required drawdown of the water table of 20.5 feet (2 feet below the bottom of excavation) (assumed)
- Mean hydraulic conductivity of $1.22 \times 10^{-3}$ ft/min (from slug test analysis from B-5)
- Specific yield of 0.1 (assumed)
- Time required to reach equilibrium conditions is 1 day (assumed)
- No positive or negative hydraulic boundaries

#### 5.6.2.1 Suscol Creek Crossing Jack and Bore Pit - Estimated Dewatering Flow

Using the parameters stated in our conceptual dewatering model, estimates for dewatering flow and dewatering induced radius of influence are summarized Table 5.4 below.

**Table 5.4**
**Dewatering Estimates**
**Suscol Creek Crossing Jack and Bore Pit**

| Assumed Depth to Groundwater (ft) | Hydraulic Conductivity (ft/min) | Assumed Drawdown Required (ft) | Flow Estimate (gallons per minute) | Daily Flow (gallons per day) | Radius of Influence Estimate (feet) |
|---|---|---|---|---|---|
| 3.5 | $1.22 \times 10^{-3}$ | 20.5 | 93 | 133,920 | 153 |

### 5.6.3 Existing Pipeline Decommissioning Vault Bell Hole - Conceptual Dewatering Model

For our conceptual dewatering model(s), the following values were used:

- Unconfined aquifer thickness of 75 feet (assumed)
- Excavation size: 10 feet wide by 20 feet long by 8 feet deep (assumed)
- Water table depth of 3.2 feet below ground surface (assumed)
- A required drawdown of the water table of 6.8 feet (2 feet below the bottom of excavation) (assumed)
- Mean hydraulic conductivity of $1.03 \times 10^{-3}$ ft/min (from slug test analysis from B-6)
- Specific yield of 0.01 (assumed)
- Time required to reach equilibrium conditions is 1 day (assumed)
- No positive or negative hydraulic boundaries

#### 5.6.3.1 Decommissioning Vault Bell Hole - Estimated Dewatering Flow

Using the parameters stated in our conceptual dewatering model, estimates for dewatering flow and dewatering induced radius of influence are summarized Table 5.5 below.

**Table 5.5**
**Dewatering Estimates**
**Pipeline Decommissioning Vault Bell Hole**

| Assumed Depth to Groundwater (ft) | Hydraulic Conductivity (ft/min) | Assumed Drawdown Required (ft) | Flow Estimate (gallons per minute) | Daily Flow (gallons per day) | Radius of Influence Estimate (feet) |
|---|---|---|---|---|---|
| 3.2 | $1.03 \times 10^{-3}$ | 6.8 | 9 | 12,960 | 158 |

### 5.7 DEWATERING APPROACH

Groundwater may be present within the project limits at depths as shallow as about 3 feet below the ground surface, seasonally. During our explorations in the Summer of 2020, the groundwater level was found to be between about 8 and 16½ feet deep at the time of our explorations. Test well water level readings during this study were found to be as shallow as about 3 feet below the ground surface. We anticipate groundwater control methods will be required for the proposed pipeline tie-in excavations that extend below site groundwater levels.

Hydraulic conductivity is the primary soil parameter governing the rate of flow of groundwater through a dewatering system. The mean hydraulic conductivity from analysis of aquifer testing resulted in values of $1.22 \times 10^{-3}$ ft/min (B-5) and $1.03 \times 10^{-3}$ ft/min (B-6). The mean hydraulic conductivity from analysis of grain size resulted in values of $2.51 \times 10^{-2}$ ft/min (B-5 at a depth of 30.5 feet), and $5.36 \times 10^{-4}$ ft/min (B-6 at a depth of 8.5 feet). These values generally fall within the range of published values for similar soil type.

Given the stated assumptions and parameters in the conceptual dewatering models stated in the previous section we anticipate the flow rate to reach a dewatered condition suitable for excavation work to be up to approximately 25 gallons per minute (36,000 gallons per day) with a radius of influence of up to 54 feet at the entry pit HDD tie in; approximately 93 gallons per minute (133,920 gallons per day) with a radius of influence of up to 153 feet at the jack and bore pit; and approximately 9 gallons per minute (12,960 gallons per day) with a radius of influence of up to 158 feet at the decommissioning vault bell hole.

Flows are likely to be higher at the inception of dewatering and decrease until a stable dewatered condition is achieved. Variations in hydraulic conductivity of the soils excavated may lead to changes in time to achieve equilibrium, radius of influence, and rate of expected flow estimations.

The character of the soil and relatively moderate flow rates expected in the open excavations derived from the testing indicate dewatering may reasonably be accomplished using pumped wells for faster drainage, and a sump, drains and open pumping methods, or a combination of each to control groundwater. Dewatering wells should be deep enough to create overlapping cones of depression at an elevation that coincides with at least two-feet below the planned excavation. For a sump system we recommend the pump be placed at least 2 feet below the bottom of the planned excavation depth. The sump ditch or hole should be larger than the pump size to accommodate the pump and a gravel filter pack. The sump pump should be placed a least six inches from the bottom of the drainage ditch and utilize a gravel filter and/or geotextile fabric to minimize the pumping of fine sediment and sand.

Poorly-constructed sumps, drains and open pumping methods of dewatering have a high risk of pumping fine soil material which can lead to erosion, slope instability, settlement of structures, and boils and blowouts.

Other groundwater control methods may be feasible. Groundwater control systems should be selected after careful assessment of safety, cost, efficiency, time and work-space concerns.

# 6 LIMITATIONS

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This report presents information for planning, permitting, design, and excavation for the proposed Pacific Gas and Electric Company I-195E, L-021A Natural Gas Pipeline Replacement project in Napa County, California. This report was prepared in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions and recommendations are based on a limited number of observations and data. Recommendations contained in this report are based on materials encountered in Borings B-1 through B-6, evaluation of existing geotechnical data, geologic interpretation based on published articles and geotechnical data, hydrogeologic evaluation based on testing conducted using test wells installed in Borings B-5 and B-6, and our present knowledge of the proposed construction.

The groundwater data used in the preparation of this evaluation were obtained from borings and monitoring wells installed at the project and a series of slug tests. It is likely that variations in soil and groundwater conditions will exist throughout the wet and dry seasons and due to river stage and tidal fluctuations. The nature and extent of these variations may not be evident until construction occurs. If soil or groundwater conditions are encountered at this site that are different from those described in this memorandum, our firm should be immediately notified so that we may make any necessary revisions to our recommendations.

This report may be used only by PG&E and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report. Kleinfelder offers various levels of investigative and engineering services to suit the varying needs of different clients. It should be recognized that definition and evaluation of geologic and environmental conditions are a difficult and inexact science. Judgments leading to conclusions and recommendations are generally made with incomplete knowledge of the subsurface conditions present due to the limitations of data from field studies. Although risk can never be eliminated, more detailed and extensive studies yield more information, which may help understand and manage the level of risk. Since detailed study and analysis involves greater expense, our clients participate in determining levels of service that provide adequate information for their purposes at acceptable levels of risk. Acceptance of this report will indicate that PG&E has reviewed the document and determined that it does not need or want a greater level of service than provided.

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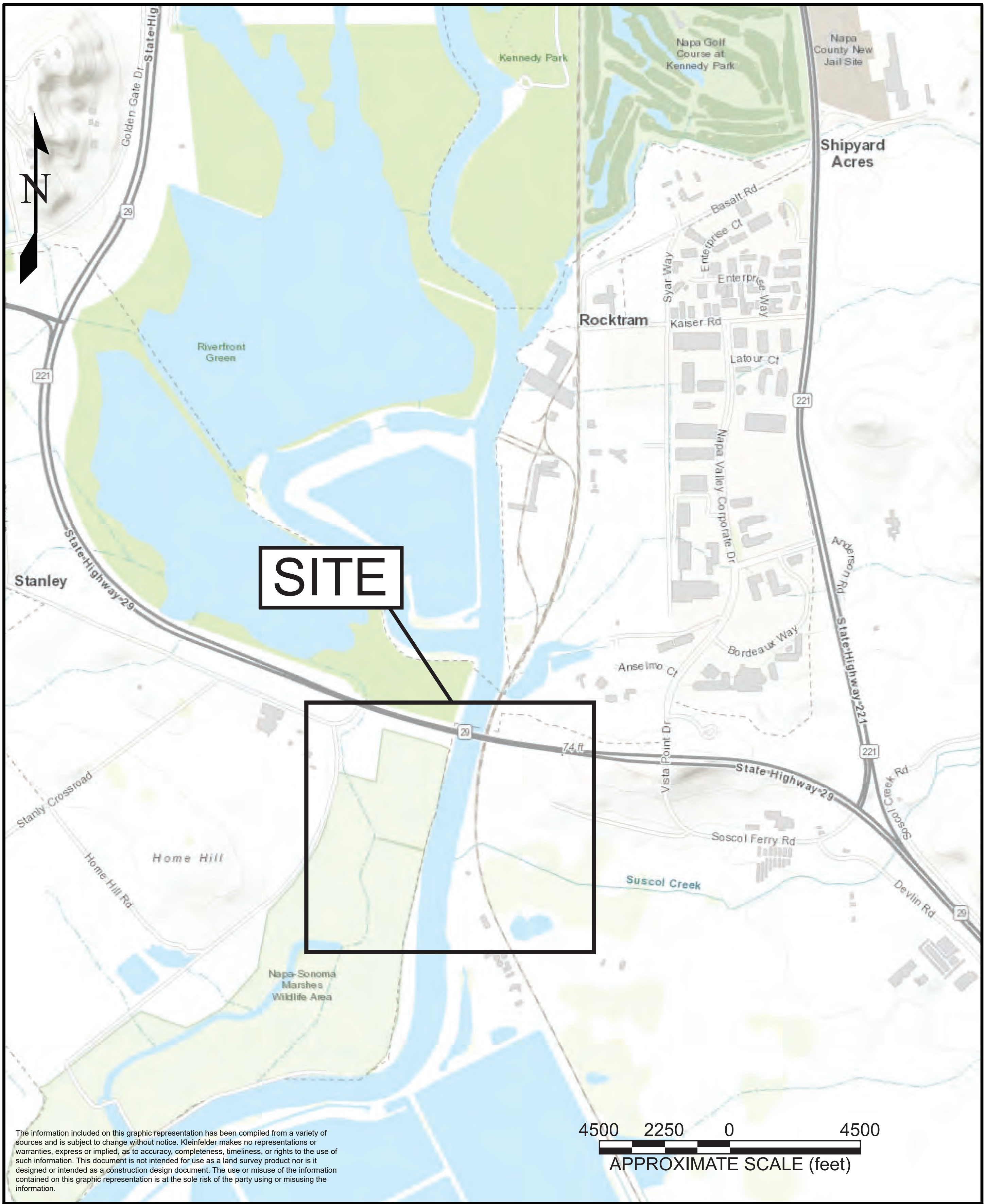
# Figures



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| | |
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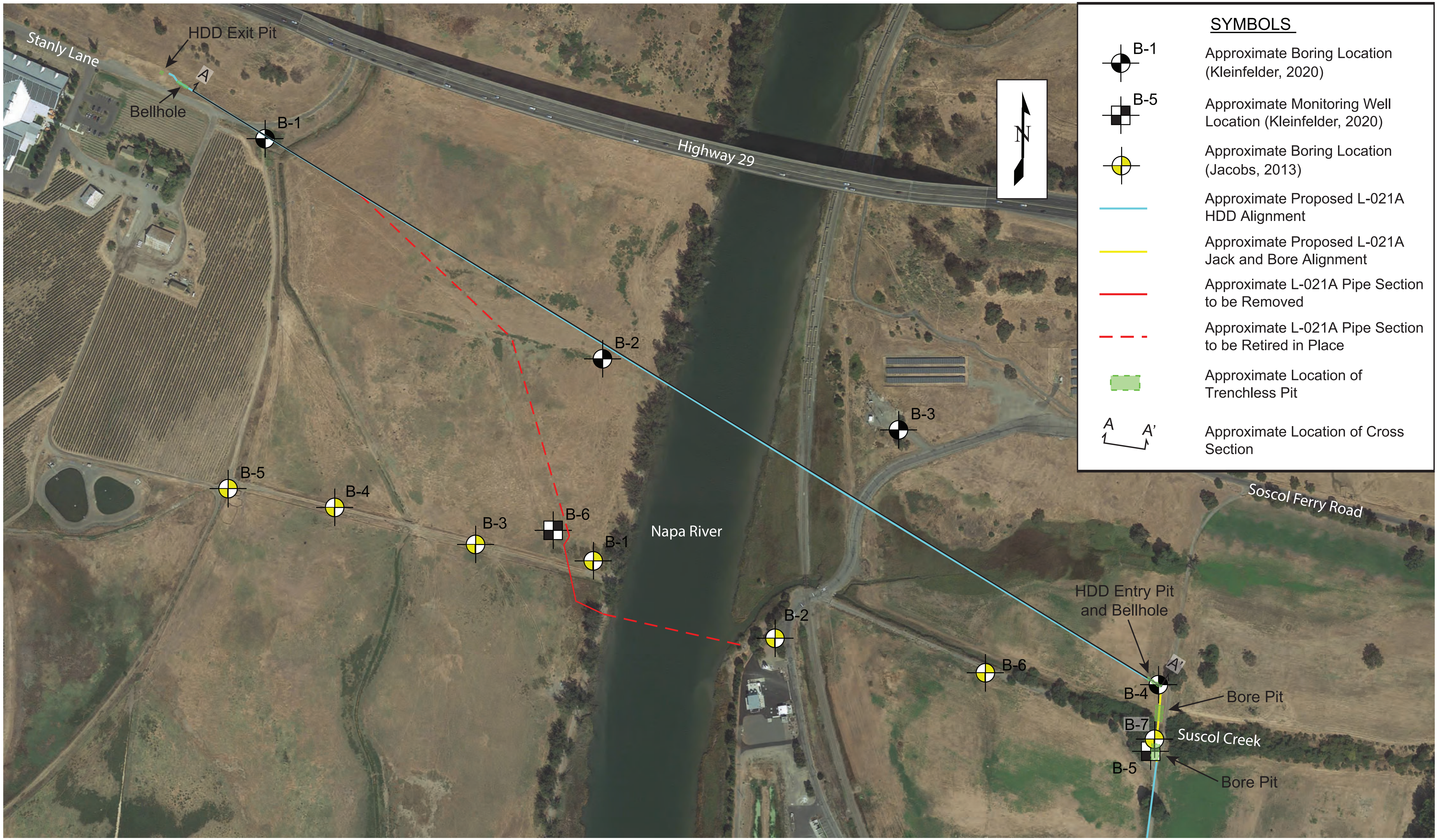
| PROJECT NO. | 20210161 |
| DRAWN | AUG 2020 |
| DRAWN BY | DJS |
| CHECKED BY | MJP |
| FILE NAME | Figure 1 Site Location.ai |

## SITE LOCATION

PG&E L-021A HDD
NATURAL GAS PIPELINE REPLACEMENT
NAPA COUNTY, CALIFORNIA

FIGURE

1



Proposed L-021A Alignment source: “L-021A, MP 12.05-16.16 ILI Upgrade, Segment 1 Napa” (60% Issued for Review), GTS, 8/14/20

300 150 0 300
APPROXIMATE SCALE (feet)

Santa Rosa

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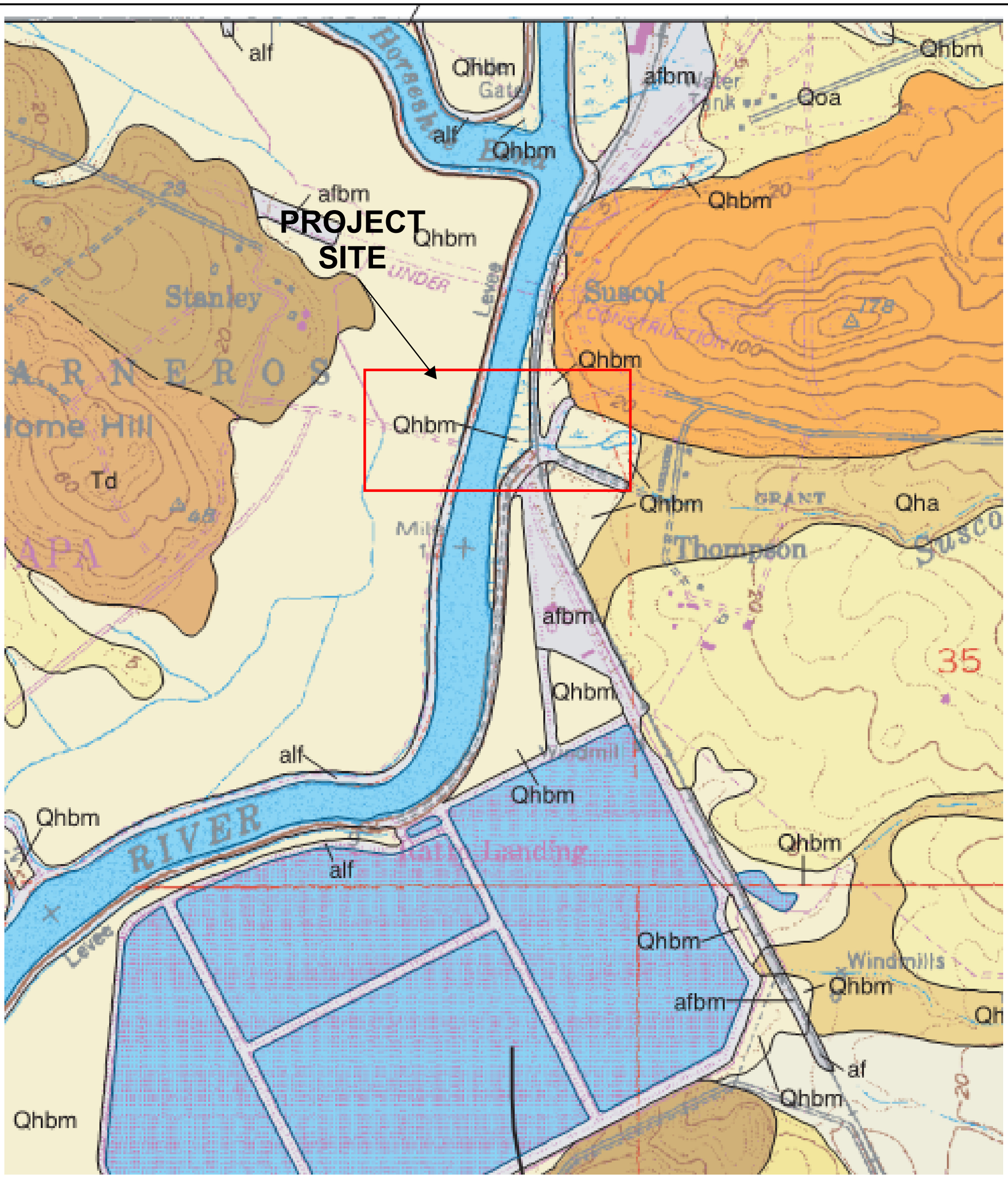
| DRAWN | OCT 2020 |
| DRAWN BY | DJS |
| CHECKED BY | MJP |
| FILE NAME | Figure 2 Site Plan.ai |

SITE PLAN

PG&E L-021A HDD
NATURAL GAS PIPELINE REPLACEMENT
NAPA COUNTY, CALIFORNIA

FIGURE
2



# LEGEND

Unit Explanation

(See Knudsen and others, 2000, for more information on Quaternary units).

| | |
|---|---|
| af | Artificial fill |
| afbm | Artificial fill on bay mud (Qhbm). |
| alf | Artificial levee fill |
| Qhbm | Holocene estuarine deposits (bay mud). Holocene sediments deposited in a tidal marsh, estuary, delta, or lagoon. Sediments are silts, fine sands, peats, and clays. |
| Qhc | Modern stream channel deposits. Channel bed and bank deposits of the major present- day creeks and streams. Deposits are late Holocene to modern in age and consist of loose fluvial sand, gravel, and silt. |
| Qhf | Holocene fan deposits. Holocene alluvial fan sediments, deposited by streams emanating from the mountains as debris flows, hyperconcentrated mudflows, or braided stream flows. Sediments include sand, gravel, silt and clay, that are moderately to poorly sorted, and moderately to poorly bedded |
| Qha | Holocene alluvium, undifferentiated. Alluvium of Holocene age, deposited in fan, terrace, or basin environments. The unit is mapped where separate types of deposits could not be delineated either due to complex interfingering of depositional environments or the limited size of the area. |
| Qf | Late Pleistocene to Holocene fan deposits. Gently sloping, fan-shaped, relatively undissected alluvial surfaces where late Pleistocene or Holocene age was uncertain or where the deposits of different age interfinger such that they could not be delineated at the map scale. Sediments include sand, gravel, silt, and clay, that are moderately to poorly sorted, and moderately to poorly bedded. |
| Qa | Late Pleistocene to Holocene alluvium, undifferentiated. Alluvium deposited in small valleys where separate fan, basin, and terrace units could not be delineated at the map scale, and where Holocene or Pleistocene age was uncertain. The unit includes flat, relatively undissected fan, terrace, and basin deposits, and small active stream channels. |
| Qpf | Late Pleistocene fan deposits. Gently sloping, fan-shaped alluvial surfaces where late Pleistocene age is indicated by slight dissection and/or the development of alfisols. |
| Qoa | Early to middle Pleistocene fan or terrace deposits. Moderately to deeply dissected alluvial deposits capped by alfisols, ultisols, or soils containing a silica or calcic hardpan. |
| Qls | Landslide deposits. Holocene and Pleistocene landslides. |
| Th | Huichica Formation (Pliocene). Fluvial gravel, sand, silt, and clay. Sediments are derived mostly from the Sonoma Volcanics. A tuff interbed yields a K/Ar date of 4.09 + 0.19 [Andre Sarna, written communication, 1981, reported in Kelly (1982)]. |
| Tsv | Sonoma Volcanics, undivided (Pliocene). Basalt to rhyolite flows, agglomerates, and tuffs. |
| Td | Domingene Formation (Eocene). Light gray to light brown quartz sandstone, commonly crossbedded with minor shale and conglomerate; locally contains serpentinite sandstone and conglomerate with gabbro clasts. |
| Tc | Capay Shale (Eocene). Grayish-brown sandy shale. |
| Kgv | Great Valley Sequence (Cretaceous). Sandstone, siltstone, shale, and minor conglomerate. |

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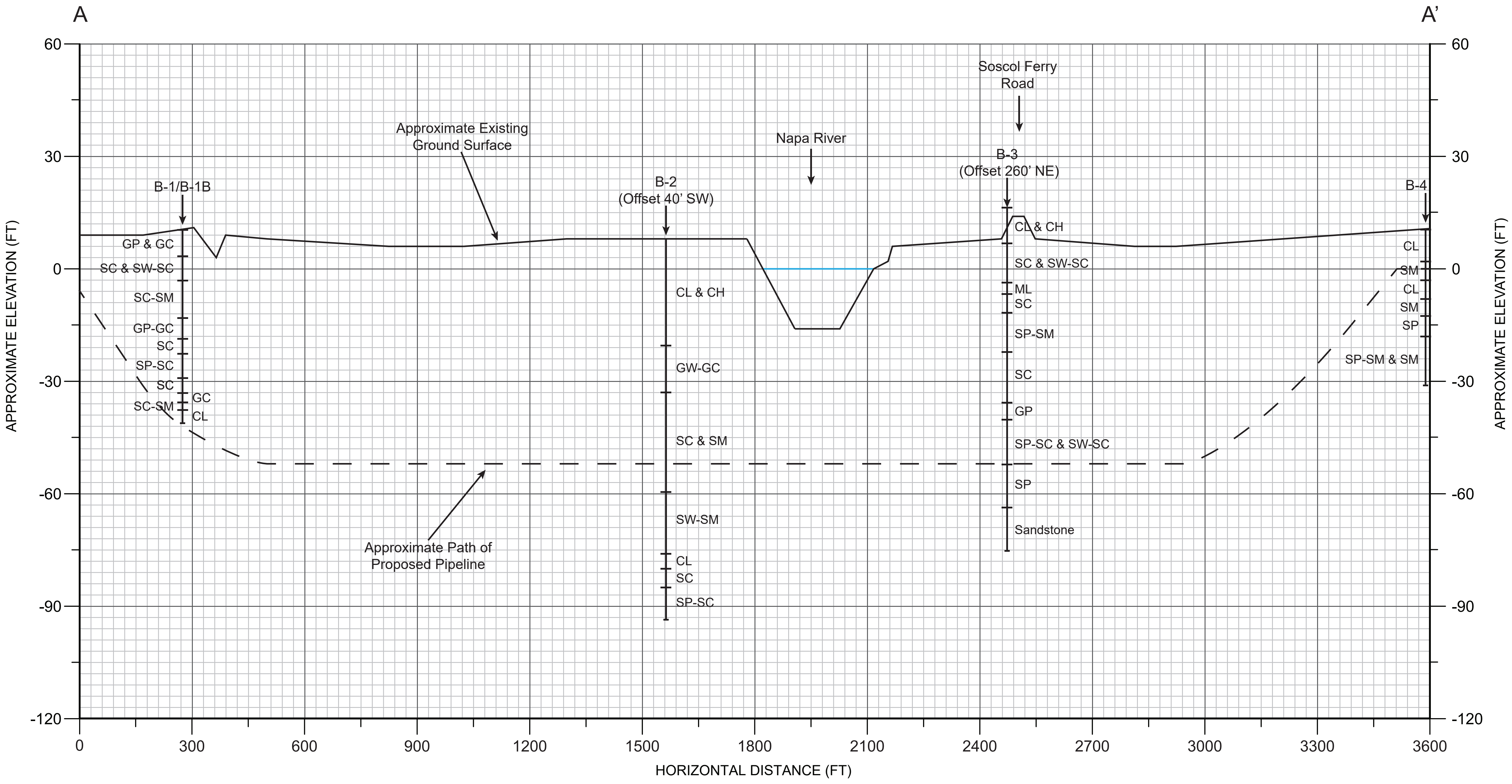
| DRAWN BY: | T.CISNEY |
| CHECKED BY: | R.SHIPLEE |
| FILE NAME: | GEOLOGY FIGURES |

## GEOLOGIC MAP

PG&E L-021A HDD
NATURAL GAS PIPELINE REPLACEMENT
NAPA COUNTY, CALIFORNIA

FIGURE:
3



Topography and Proposed Pipeline source:
"L-021A, MP 12.05-16.16 ILI Upgrade, Segment 1
Napa" (60% Issued for Review), GTS, 8/14/20

Horizontal Scale= 1":300'
Vertical Scale= 1":30'

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| PROJECT NO. | 20210161 |
| DRAWN | OCT 2020 |
| DRAWN BY | SDC |
| CHECKED BY | MJP |
| FILE NAME | Geo Cross Section A_A.ai |

CROSS SECTION
A-A'

PG&E L-021A HDD
NATURAL GAS PIPELINE REPLACEMENT
NAPA COUNTY, CALIFORNIA

FIGURE
4

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# Appendix A

## SAMPLE/SAMPLER TYPE GRAPHICS

| | |
|---|---|
| ☒ | BAG SAMPLE |
| ☒ | BULK SAMPLE |
| ◨ | CALIFORNIA SAMPLER<br>(3 in. (76.2 mm.) outer diameter) |
| ◫ | CORE SAMPLER |
| ◩ | STANDARD PENETRATION SPLIT SPOON SAMPLER<br>(2 in. (50.8 mm.) outer diameter and 1-3/8 in. (34.9 mm.) inner diameter) |

## GROUND WATER GRAPHICS

| | |
|---|---|
| ▽ | WATER LEVEL (level where first observed) |
| ▼ | WATER LEVEL (level after exploration completion) |
| ▼ | WATER LEVEL (additional levels after exploration) |
| ≋ | OBSERVED SEEPAGE |

## NOTES

- The report and graphics key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.

- Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown.

- No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.

- Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.

- In general, Unified Soil Classification System designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.

- Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing the No. 200 sieve require dual USCS symbols, ie., GW-GM, GP-GM, GW-GC, GP-GC, GC-GM, SW-SM, SP-SM, SW-SC, SP-SC, SC-SM.

- If sampler is not able to be driven at least 6 inches then 50/X indicates number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

**ABBREVIATIONS**

**WOH -** Weight of Hammer
**WOR -** Weight of Rod

## UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

| | | | | | | |
|---|---|---|---|---|---|---|
| **COARSE GRAINED SOILS** (More than half of material is larger than the #200 sieve) | **GRAVELS** (More than half of coarse fraction is larger than the #4 sieve) | CLEAN GRAVEL WITH <5% FINES | Cu≥4 and 1≤Cc≤3 | ▨ | **GW** | WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES |
| | | | Cu<4 and/ or 1>Cc>3 | ▨ | **GP** | POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES |
| | | GRAVELS WITH 5% TO 12% FINES | Cu≥4 and 1≤Cc≤3 | ▨ | **GW-GM** | WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES |
| | | | | ▨ | **GW-GC** | WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES |
| | | | Cu<4 and/ or 1>Cc>3 | ▨ | **GP-GM** | POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES |
| | | | | ▨ | **GP-GC** | POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES |
| | | GRAVELS WITH > 12% FINES | | ▨ | **GM** | SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES |
| | | | | ▨ | **GC** | CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES |
| | | | | ▨ | **GC-GM** | CLAYEY GRAVELS, GRAVEL-SAND-CLAY-SILT MIXTURES |
| | **SANDS** (Half or more of coarse fraction is smaller than the #4 sieve) | CLEAN SANDS WITH <5% FINES | Cu≥6 and 1≤Cc≤3 | ▨ | **SW** | WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES |
| | | | Cu<6 and/ or 1>Cc>3 | ▨ | **SP** | POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES |
| | | SANDS WITH 5% TO 12% FINES | Cu≥6 and 1≤Cc≤3 | ▨ | **SW-SM** | WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES |
| | | | | ▨ | **SW-SC** | WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES |
| | | | Cu<6 and/ or 1>Cc>3 | ▨ | **SP-SM** | POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES |
| | | | | ▨ | **SP-SC** | POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES |
| | | SANDS WITH > 12% FINES | | ▨ | **SM** | SILTY SANDS, SAND-GRAVEL-SILT MIXTURES |
| | | | | ▨ | **SC** | CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES |
| | | | | ▨ | **SC-SM** | CLAYEY SANDS, SAND-SILT-CLAY MIXTURES |

| | | | | |
|---|---|---|---|---|
| **FINE GRAINED SOILS** (Half or more of material is smaller than the #200 sieve) | SILTS AND CLAYS (Liquid Limit less than 50) | ▨ | **ML** | INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, SILTS WITH SLIGHT PLASTICITY |
| | | ▨ | **CL** | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS |
| | | ▨ | **CL-ML** | INORGANIC CLAYS-SILTS OF LOW PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS |
| | | ▨ | **OL** | ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY |
| | SILTS AND CLAYS (Liquid Limit 50 or greater) | ▨ | **MH** | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT |
| | | ▨ | **CH** | INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS |
| | | ▨ | **OH** | ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY |

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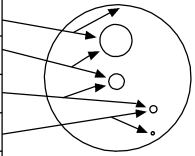
| | | |
|---|---|---|
| PROJECT NO.: | GRAPHICS KEY | FIGURE |
| DRAWN BY:<br>CHECKED BY:<br>DATE: | PG&E L-021A<br>NATURAL GAS PIPELINE REPLACEMENT<br>NAPA, CALIFORNIA | A-1 |

## GRAIN SIZE

| DESCRIPTION | | SIEVE SIZE | GRAIN SIZE | APPROXIMATE SIZE |
|---|---|---|---|---|
| Boulders | | >12 in. (304.8 mm.) | >12 in. (304.8 mm.) | Larger than basketball-sized |
| Cobbles | | 3 - 12 in. (76.2 - 304.8 mm.) | 3 - 12 in. (76.2 - 304.8 mm.) | Fist-sized to basketball-sized |
| Gravel | coarse | 3/4 -3 in. (19 - 76.2 mm.) | 3/4 -3 in. (19 - 76.2 mm.) | Thumb-sized to fist-sized |
| | fine | #4 - 3/4 in. (#4 - 19 mm.) | 0.19 - 0.75 in. (4.8 - 19 mm.) | Pea-sized to thumb-sized |
| Sand | coarse | #10 - #4 | 0.079 - 0.19 in. (2 - 4.9 mm.) | Rock salt-sized to pea-sized |
| | medium | #40 - #10 | 0.017 - 0.079 in. (0.43 - 2 mm.) | Sugar-sized to rock salt-sized |
| | fine | #200 - #40 | 0.0029 - 0.017 in. (0.07 - 0.43 mm.) | Flour-sized to sugar-sized |
| Fines | | Passing #200 | <0.0029 in. (<0.07 mm.) | Flour-sized and smaller |



## SECONDARY CONSTITUENT

| | AMOUNT | |
|---|---|---|
| Term of Use | Secondary Constituent is Fine Grained | Secondary Constituent is Coarse Grained |
| Trace | <5% | <15% |
| With | ≥5 to <15% | ≥15 to <30% |
| Modifier | ≥15% | ≥30% |

## MOISTURE CONTENT

| DESCRIPTION | FIELD TEST |
|---|---|
| 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 |

## CEMENTATION

| DESCRIPTION | FIELD TEST |
|---|---|
| Weakly | Crumbles or breaks with handling or slight finger pressure |
| Moderately | Crumbles or breaks with considerable finger pressure |
| Strongly | Will not crumble or break with finger pressure |

## CONSISTENCY - FINE-GRAINED SOIL

| CONSISTENCY | SPT - $N_{60}$ (# blows / ft) | Pocket Pen (tsf) | UNCONFINED COMPRESSIVE STRENGTH ($Q_u$)(psf) | VISUAL / MANUAL CRITERIA |
|---|---|---|---|---|
| Very Soft | <2 | PP < 0.25 | <500 | Thumb will penetrate more than 1 inch (25 mm). Extrudes between fingers when squeezed. |
| Soft | 2 - 4 | 0.25 ≤ PP <0.5 | 500 - 1000 | Thumb will penetrate soil about 1 inch (25 mm). Remolded by light finger pressure. |
| Medium Stiff | 4 - 8 | 0.5 ≤ PP <1 | 1000 - 2000 | Thumb will penetrate soil about 1/4 inch (6 mm). Remolded by strong finger pressure. |
| Stiff | 8 - 15 | 1 ≤ PP <2 | 2000 - 4000 | Can be imprinted with considerable pressure from thumb. |
| Very Stiff | 15 - 30 | 2 ≤ PP <4 | 4000 - 8000 | Thumb will not indent soil but readily indented with thumbnail. |
| Hard | >30 | 4 ≤ PP | >8000 | Thumbnail will not indent soil. |

FROM TERZAGHI AND PECK, 1948; LAMBE AND WHITMAN, 1969; FHWA, 2002; AND ASTM D2488

## REACTION WITH HYDROCHLORIC ACID

| DESCRIPTION | FIELD TEST |
|---|---|
| None | No visible reaction |
| Weak | Some reaction, with bubbles forming slowly |
| Strong | Violent reaction, with bubbles forming immediately |

## APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

| APPARENT DENSITY | SPT-$N_{60}$ (# blows/ft) | MODIFIED CA SAMPLER (# blows/ft) | CALIFORNIA SAMPLER (# blows/ft) | RELATIVE DENSITY (%) |
|---|---|---|---|---|
| Very Loose | <4 | <4 | <5 | 0 - 15 |
| Loose | 4 - 10 | 5 - 12 | 5 - 15 | 15 - 35 |
| Medium Dense | 10 - 30 | 12 - 35 | 15 - 40 | 35 - 65 |
| Dense | 30 - 50 | 35 - 60 | 40 - 70 | 65 - 85 |
| Very Dense | >50 | >60 | >70 | 85 - 100 |

FROM TERZAGHI AND PECK, 1948

## PLASTICITY

| DESCRIPTION | LL | FIELD TEST |
|---|---|---|
| Non-plastic | NP | A 1/8-in. (3 mm.) thread cannot be rolled at any water content. |
| Low (L) | < 30 | The thread can barely be rolled and the lump or thread cannot be formed when drier than the plastic limit. |
| Medium (M) | 30 - 50 | The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump or thread crumbles when drier than the plastic limit. |
| High (H) | > 50 | It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump or thread can be formed without crumbling when drier than the plastic limit. |

## STRUCTURE

| DESCRIPTION | CRITERIA |
|---|---|
| Stratified | Alternating layers of varying material or color with layers at least 1/4-in. thick, note thickness. |
| Laminated | Alternating layers of varying material or color with the layer less than 1/4-in. thick, note thickness. |
| Fissured | Breaks along definite planes of fracture with little resistance to fracturing. |
| Slickensided | Fracture planes appear polished or glossy, sometimes striated. |
| Blocky | Cohesive soil that can be broken down into small angular lumps which resist further breakdown. |
| Lensed | Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness. |

## ANGULARITY

| DESCRIPTION | CRITERIA |
|---|---|
| Angular | Particles have sharp edges and relatively plane sides with unpolished surfaces. |
| Subangular | Particles are similar to angular description but have rounded edges. |
| Subrounded | Particles have nearly plane sides but have well-rounded corners and edges. |
| Rounded | Particles have smoothly curved sides and no edges. |

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PROJECT NO.:

DRAWN BY:

CHECKED BY:

DATE:

SOIL DESCRIPTION KEY

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE
A-2

PLOTTED: 10/24/2019 11:18 AM BY: SDCain
OFFICE FILTER: SANTA ROSA
PROJECT NUMBER: 20200789.001A
gINT FILE: Klf_gint_master_2020
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2020.GLB [_KLF_GEO-LEG 2 (SOIL DESC KEY)]

## INFILLING TYPE

| NAME | ABBR | NAME | ABBR |
|---|---|---|---|
| Albite | Al | Muscovite | Mus |
| Apatite | Ap | None | No |
| Biotite | Bi | Pyrite | Py |
| Clay | Cl | Quartz | Qz |
| Calcite | Ca | Sand | Sd |
| Chlorite | Ch | Sericite | Ser |
| Epidote | Ep | Silt | Si |
| Iron Oxide | Fe | Talc | Ta |
| Manganese | Mn | Unknown | Uk |

## DENSITY/SPACING OF DISCONTINUITIES

| DESCRIPTION | SPACING CRITERIA |
|---|---|
| Unfractured | >6 ft. (>1.83 meters) |
| Slightly Fractured | 2 - 6 ft. (0.061 - 1.83 meters) |
| Moderately Fractured | 8 in - 2 ft. (203.20 - 609.60 mm) |
| Highly Fractured | 2 - 8 in (50.80 - 203.30 mm) |
| Intensely Fractured | <2 in (<50.80 mm) |

## ADDITIONAL TEXTURAL ADJECTIVES

| DESCRIPTION | RECOGNITION |
|---|---|
| Pit (Pitted) | Pinhole to 0.03 ft. (3/8 in.) (>1 to 10 mm.) openings |
| Vug (Vuggy) | Small openings (usually lined with crystals) ranging in diameter from 0.03 ft. (3/8 in.) to 0.33 ft. (4 in.) (10 to 100 mm.) |
| Cavity | An opening larger than 0.33 ft. (4 in.) (100 mm.), size descriptions are required, and adjectives such as small, large, etc., may be used |
| Honeycombed | If numerous enough that only thin walls separate individual pits or vugs, this term further describes the preceding nomenclature to indicate cell-like form. |
| Vesicle (Vesicular) | Small openings in volcanic rocks of variable shape and size formed by entrapped gas bubbles during solidification. |

## ADDITIONAL TEXTURAL ADJECTIVES

| DESCRIPTION | CRITERIA |
|---|---|
| Unweathered | No evidence of chemical / mechanical alternation; rings with hammer blow. |
| Slightly Weathered | Slight discoloration on surface; slight alteration along discontinuities; <10% rock volume altered. |
| Moderately Weathered | Discoloring evident; surface pitted and alteration penetration well below surface; Weathering "halos" evident; 10-50% rock altered. |
| Highly Weathered | Entire mass discolored; Alteration pervading most rock, some slight weathering pockets; some minerals may be leached out. |
| Decomposed | Rock reduced to soil with relic rock texture/structure; Generally molded and crumbled by hand. |

## RELATIVE HARDNESS / STRENGTH DESCRIPTIONS

| GRADE | | UCS (Mpa) | FIELD TEST |
|---|---|---|---|
| R0 | Extremely Weak | 0.25 - 1.0 | Indented by thumbnail |
| R1 | Very Weak | 1.0 - 5.0 | Crumbles under firm blows of geological hammer, can be peeled by a pocket knife. |
| R2 | Weak | 5.0 - 25 | Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer. |
| R3 | Medium Strong | 25 - 50 | Cannot be scraped or peeled with a pocket knife, specimen can be fractured with a single firm blow of a geological hammer. |
| R4 | Strong | 50 - 100 | Specimen requires more than one blow of geological hammer to fracture it. |
| R5 | Very Strong | 100 - 250 | Specimen requires many blows of geological hammer to fracture it. |
| R6 | Extremely Strong | > 250 | Specimen can only be chipped with a geological hammer. |

## ROCK QUALITY DESIGNATION (RQD)

| DESCRIPTION | RQD (%) |
|---|---|
| Very Poor | 0 - 25 |
| Poor | 25 - 50 |
| Fair | 50 - 75 |
| Good | 75 - 90 |
| Excellent | 90 - 100 |

## APERTURE

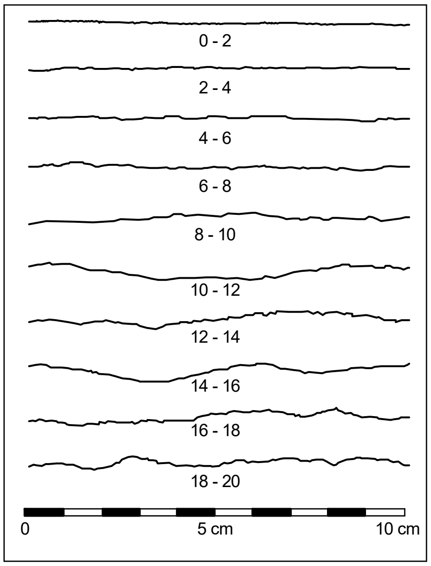
| DESCRIPTION | CRITERIA [in (mm)] |
|---|---|
| Tight | <0.04 (<1) |
| Open | 0.04 - 0.20 (1 - 5) |
| Wide | >0.20 (>5) |

## BEDDING CHARACTERISTICS

| DESCRIPTION | Thickness [in (mm)] |
|---|---|
| Very Thick Bedded | >36 (>915) |
| Thick Bedded | 12 - 36 (305 - 915) |
| Moderately Bedded | 4 - 12 (102 - 305) |
| Thin Bedded | 1 - 4 (25 - 102) |
| Very Thin Bedded | 0.4 - 1 (10 - 25) |
| Laminated | 0.1 - 0.4 (2.5 - 10) |
| Thinly Laminated | <0.1 (<2.5) |

| | |
|---|---|
| Bedding Planes | Planes dividing the individual layers, beds, or stratigraphy of rocks. |
| Joint | Fracture in rock, generally more or less vertical or traverse to bedding. |
| Seam | Applies to bedding plane with unspecified degree of weather. |

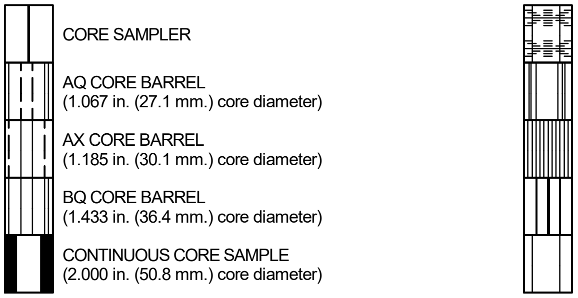
## JOINT ROUGHNESS COEFFICIENT (JRC)



From Barton and Choubey, 1977

RQD Rock-quality designation (RQD) Rough measure of the degree of jointing or fracture in a rock mass, measured as a percentage of the drill core in lengths of 10 cm. or more.

## CORE SAMPLER TYPE GRAPHICS



CORE SAMPLER

AQ CORE BARREL
(1.067 in. (27.1 mm.) core diameter)

AX CORE BARREL
(1.185 in. (30.1 mm.) core diameter)

BQ CORE BARREL
(1.433 in. (36.4 mm.) core diameter)

CONTINUOUS CORE SAMPLE
(2.000 in. (50.8 mm.) core diameter)

EX CORE BARREL
(0.846 in. (21.5 mm.) core diameter)

HQ CORE SAMPLE
(2.500 in. (63.5 mm.) core diameter)

NQ CORE SAMPLE
(1.874 in. (47.6 mm.) core diameter)

NO RECOVERY CORE SAMPLE

NX CORE SAMPLE
(2.154 in. (54.7 mm.) core diameter)

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PROJECT NO.:
DRAWN BY:
CHECKED BY:
DATE:
REVISED: -

ROCK DESCRIPTION KEY

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE
A-3

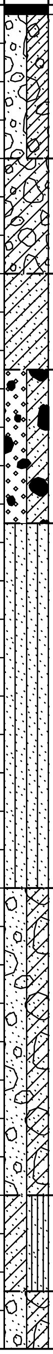
## BORING LOG B-1A

| | | | |
|---|---|---|---|
| **Date Begin - End:** | 8/24/2020 | **Drilling Co.-Lic.#:** | Gregg Drilling - #1044456 |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry, Manuel |
| **Hor.-Vert. Datum:** | WGS84 - NAD83 | **Drilling Equipment:** | Modified Mobile B-53 |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger/Mud Rotary |
| **Weather:** | Cloudy/Smoky | **Exploration Diameter:** | 6"/4" in. O.D. |

**Hammer Type - Drop:** 140 lb. Auto - 30 in.
**Hammer Efficiency:** 85%
**Hammer Cal. Date:** 9/04/2019

FIELD EXPLORATION / LABORATORY RESULTS

Latitude: 38.24415°
Longitude: -122.29120°
Approximate Ground Surface Elevation (ft.): 11
Surface Condition: Asphalt



| Approximate Elevation (feet) | Depth (feet) | Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in. Push Tube(PT)= psi Pocket Pen(PP)= tsf Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | | Asphalt: 3"<br>**Poorly Graded GRAVEL with Clay and Sand (GP-GC)**: low plasticity, brown, dry, medium dense to dense, fine to coarse grained sand, angular gravel to 6" (fill)<br>dry to moist, fines increasing with depth | ☒ | | | | | | | | | | Hand auger to 5' |
| 5 | 5 | **Clayey GRAVEL with Sand (GC)**: medium plasticity, brown, moist, medium dense, fine to coarse grained sand, angular to subangular gravel to 2" | ▮ | BC=40<br>15<br>15 | 83% | | 8.9 | 113.4 | | | | | |
| | | **Clayey SAND (SC)**: brown, yellow brown, moist, medium dense, fine to coarse grained sand, trace gravel | ◣ | BC=10<br>9<br>18 | 72% | | | | | 19 | | | |
| 0 | ∇ 10 | **Well-Graded SAND with Clay and Gravel (SW-SC)**: brown, moist to wet, dense, fine to coarse grained sand, angular to subrounded gravel to 1.5" | ▮ | BC=10<br>17<br>23 | 100% | SW-SM | 10.7 | 117.6 | 60 | 9.7 | | | Auger dry, sampler wet, swtich to Mud Rotary, hole collapsed, no additional gw reading |
| -5 | 15 | **Silty SAND (SM)**: non-plastic, olive, moist, loose, fine to medium grained sand | ◣ | BC=4<br>4<br>3 | 55% | SM | | | | 22 | NP | NP | |
| -10 | 20 | medium dense, fine to coarse grained sand, subangular to subrounded gravel to 1.5" | ▮ | BC=5<br>8<br>15 | 33% | | | | | | | | |
| -15 | 25 | **Poorly Graded SAND with Clay and Gravel (SP-SC)**: grayish brown, moist to wet, dense, fine to coarse grained sand, subangular to subrounded gravel to 1" | ◣ | BC=5<br>17<br>17 | 33% | | | | | | | | Hole collapsing, minor ciruclation loss, driller notes gravel, increased coarse material in fluid returns, minimal grinding |
| -20 | 30 | **Silty/Clayey SAND (SC)**: non-plastic to low plasticity, yellowish brown to olive, moist, medium dense, fine to medium grained sand | ◣ | BC=6<br>6<br>6 | 22% | | | | | | | | Washed gravel in most of sampler |

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| | |
|---|---|
| PROJECT NO.: | 20210161.001A |
| DRAWN BY: | DJS |
| CHECKED BY: | MJP |
| DATE: | |

BORING LOG B-1A

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE
A-4

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 8/24/2020 | **Drilling Co.-Lic.#:** | Gregg Drilling - #1044456 | | |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry, Manuel | | |
| **Hor.-Vert. Datum:** | WGS84 - NAD83 | **Drilling Equipment:** | Modified Mobile B-53 | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger/Mud Rotary | **Hammer Efficiency:** | 85% |
| **Weather:** | Cloudy/Smoky | **Exploration Diameter:** | 6"/4" in. O.D. | **Hammer Cal. Date:** | 9/04/2019 |

**BORING LOG B-1A**

Latitude: 38.24415°
Longitude: -122.29120°
Approximate Ground Surface Elevation (ft.): 11
Surface Condition: Asphalt

| Approximate Elevation (feet) | Depth (feet) | Graphical Log | FIELD EXPLORATION: Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in. Push Tube(PT)= psi Pocket Pen(PP)= tsf Torvane(TV)= tsf | Recovery (NR=No Recovery) | LABORATORY RESULTS: USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -25 | | | **Poorly Graded SAND with Clay and Gravel (SP-SC)**: grayish brown, wet, dense, fine to coarse grained sand, angular to subangular gravel to 1" | | BC=7<br>10<br>23 | 22% | | | | | | | | |
| -30 | 40 | | | | BC=8<br>5<br>4 | 22% | | | | | | | | |
| | | | **Clayey SAND (SC)**: low plasticity, brown to grayish brown, moist to wet, loose, fine to medium grained sand, trace coarse grained sand | | | | | | | | | | | |
| | | | **Clayey GRAVEL with Sand (GC)**: grayish brown, moist, medium dense, fine to coarse grained sand, angular to subangular gravel to 1" | | | | | | | | | | | |
| -35 | 45 | | **Silty/Clayey SAND (SC-SM)**: non-plastic to low plasticity, light grayish olive, moist, hard, fine to medium grained sand, light oxidation staining | | BC=10<br>14<br>28 | 100% | | 23.5 | 101.4 | | | | | |
| | | | **Sandy Lean CLAY (CL)**: low plasticity, light grayish olive, orange, moist, very stiff, fine grained sand, local black mottling | | | | | | | | | | | |
| -40 | 50 | | | | BC=12<br>15<br>23 | 89% | | | | | | | | |
| -45 | 55 | | | | | | | | | | | | | |
| -50 | 60 | | | | | | | | | | | | | |
| -55 | 65 | | | | | | | | | | | | | |

The boring was terminated at approximately 51.5 ft. below ground surface. Boring was backfilled with neat cement grout.

GROUNDWATER LEVEL INFORMATION:
⊻ Groundwater was observed at approximately 10 ft. below ground surface during drilling.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder using plans provided by GTS.

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| | | | |
|---|---|---|---|
| PROJECT NO.: 20210161.001A | | BORING LOG B-1A | FIGURE |
| DRAWN BY: | DJS | PG&E L-021A<br>NATURAL GAS PIPELINE REPLACEMENT<br>NAPA, CALIFORNIA | A-4 |
| CHECKED BY: | MJP | | |
| DATE: | | | PAGE: 2 of 2 |

PLOTTED: 11/10/2020 11:04 PM BY: TCisney

OFFICE FILTER: SANTA ROSA

PROJECT NUMBER: 20210161.001A [__KLF_BORING/TEST PIT SOIL LOG]

gINT FILE: Klf_gint_master_2021
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2021.GLB

# BORING LOG B-1B

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 8/24/2020 - 8/25/2020 | **Drilling Co.-Lic.#:** | Gregg Drilling - #1044456 | | |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry, Manuel | | |
| **Hor.-Vert. Datum:** | WGS84 - NAD83 | **Drilling Equipment:** | Modified Mobile B-53 | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger | **Hammer Efficiency:** | 85% |
| **Weather:** | Cloudy/Smoky | **Exploration Diameter:** | 6" in. O.D. | **Hammer Cal. Date:** | 9/04/2019 |

Latitude: 38.24415°
Longitude: -122.29120°
Approximate Ground Surface Elevation (ft.): 11
Surface Condition: Asphalt

| Approximate Elevation (feet) | Depth (feet) | FIELD EXPLORATION<br>Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in.<br>Push Tube(PT)= psi<br>Pocket Pen(PP)= tsf<br>Torvane(TV)= tsf | Recovery (NR=No Recovery) | LABORATORY RESULTS<br>USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10<br>5<br>0<br>-5 | 5<br>10<br>15 | Drilled straight to 20 ft. without sampling, see Boring Log B-1 for lithology in upper 20 ft. | | | | | | | | | | | |
| -10 | 20 | **Silty Clayey SAND with Gravel (SC-SM)**: brown and light olive, moist, loose, fine to coarse grained sand, subangular to subrounded gravel to 1.5" | ■ | BC=4<br>4<br>5<br>4 | 100% | SM | | | 76 | 13 | | | (California sampler w/o liners) |
| -15 | 25 | **Poorly Graded GRAVEL with Clay and Sand (GP-GC)**: medium plasticity, brown to yellow brown, moist to wet, very dense, fine to coarse grained sand, subrounded gravel to 1" | ■ | BC=23<br>25<br>26<br>28 | 100% | GP-GM | | | 47 | 7.1 | | | Auger clogged by sands, unable to proceed, resume drilling next day after placing 5" casing to 25' (California sampler w/o liners) |
| -20 | 30 | **Clayey SAND (SC)**: olive, moist, medium dense, fine to medium grained sand | ■ | BC=6<br>7<br>9<br>11 | 100% | | | | | | 30 | 12 | 5" casing to 30' (California sampler w/o liners) |
| | | **Poorly Graded SAND with Clay and Gravel (SP-SC)**: olive, moist, dense, fine to coarse grained sand, subangular to subrounded gravel to 2" | | | | | | | | | | | |

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| | | | |
|---|---|---|---|
| PROJECT NO.:<br>20210161.001A | | BORING LOG B-1B | FIGURE |
| DRAWN BY: | DJS | PG&E L-021A<br>NATURAL GAS PIPELINE REPLACEMENT<br>NAPA, CALIFORNIA | A-5 |
| CHECKED BY: | MJP | | |
| DATE: | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 8/24/2020 - 8/25/2020 | **Drilling Co.-Lic.#:** | Gregg Drilling - #1044456 | | **BORING LOG B-1B** |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry, Manuel | | |
| **Hor.-Vert. Datum:** | WGS84 - NAD83 | **Drilling Equipment:** | Modified Mobile B-53 | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger | **Hammer Efficiency:** | 85% |
| **Weather:** | Cloudy/Smoky | **Exploration Diameter:** | 6" in. O.D. | **Hammer Cal. Date:** | 9/04/2019 |

| | | | FIELD EXPLORATION | | | | LABORATORY RESULTS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Approximate Elevation (feet) | Depth (feet) | Graphical Log | Latitude: 38.24415°<br>Longitude: -122.29120°<br>Approximate Ground Surface Elevation (ft.): 11<br>Surface Condition: Asphalt<br>Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in.<br>Push Tube(PT)= psi<br>Pocket Pen(PP)= tsf<br>Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
| -25 | | | **Poorly Graded SAND with Clay and Gravel (SP-SC)**: olive, moist, dense, fine to coarse grained sand, subangular to subrounded gravel to 2" | | BC=10<br>18<br>23<br>30 | 100% | SP-SM | | | 67 | 6.6 | | | 5" casing to 35' (California sampler w/o liners)<br>no difficulty advancing casing |
| | 40 | | **Clayey SAND (SC)**: medium plasticity, olive, moist, medium dense, fine to medium grained sand, trace subangular to subrounded gravel to 1.5" | | BC=11<br>11<br>15<br>18 | 100% | | | | | | 30 | 10 | 5" casing to 40' (California sampler w/o liners) |
| -30 | | | | | | | | | | | | | | |
| | 45 | | | | | | | | | | | | | |
| -35 | | | | | | | | | | | | | | |
| | 50 | | | | | | | | | | | | | |
| -40 | | | | | | | | | | | | | | |
| | 55 | | | | | | | | | | | | | |
| -45 | | | | | | | | | | | | | | |
| | 60 | | | | | | | | | | | | | |
| -50 | | | | | | | | | | | | | | |
| | 65 | | | | | | | | | | | | | |
| -55 | | | | | | | | | | | | | | |

The boring was terminated at approximately 42 ft. below ground surface. Boring was backfilled with neat cement grout

GROUNDWATER LEVEL INFORMATION:
Groundwater was not measured during drilling or after completion due to drilling method.
GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder using plans provided by GTS.

| | | | |
|---|---|---|---|
| KLEINFELDER<br>Bright People. Right Solutions. | PROJECT NO.:<br>20210161.001A | BORING LOG B-1B | FIGURE |
| | DRAWN BY: DJS | PG&E L-021A<br>NATURAL GAS PIPELINE REPLACEMENT<br>NAPA, CALIFORNIA | A-5 |
| | CHECKED BY: MJP | | |
| | DATE: | | PAGE: 2 of 2 |

# BORING LOG B-2

| | | | |
|---|---|---|---|
| **Date Begin - End:** | 8/26/2020 - 8/27/2020 | **Drilling Co.-Lic.#:** | Greg Drilling - #1044456 |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry |
| **Hor.-Vert. Datum:** | WGS84 - NAD83 | **Drilling Equipment:** | Modified Mobile B-53 |
| **Plunge:** | -90 degrees | **Drilling Method:** | Mud Rotary |
| **Weather:** | Cloudy/Smoky | **Exploration Diameter:** | 4" in. O.D. |

**Hammer Type - Drop:** 140 lb. Auto - 30 in.
**Hammer Efficiency:** 85%
**Hammer Cal. Date:** 9/04/2019

Latitude: 38.24226°
Longitude: -122.28753°
Approximate Ground Surface Elevation (ft.): 8
Surface Condition: Grass

| Approximate Elevation (feet) | Depth (feet) | Graphical Log | Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in.<br>Push Tube(PT)= psi<br>Pocket Pen(PP)= tsf<br>Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | ▨ | **Sandy Lean CLAY (CL)**: low plasticity, brown, dry, medium stiff, fine to coarse grained sand | ☒ | | | | | | | | | | Hand auger to 5' |
| 5 | | | **Sandy Fat CLAY with Organics (OH)**: low plasticity, dark gray to gray with orange mottling, dry, stiff, fine to medium grained sand, white speckling | ☒ | | | | | | | | | | |
| | 5 | | becoming fatter<br>oxidation veining throughout sample | ■ | BC=5<br>5<br>6<br>PP=4.5+ | 61% | | 39.2 | 63.0 | | | 88 | 53 | Set up for Mud Rotary after sample at 5', immediate loss of circulation, likely due to pressure buildup forcing water into weak surrounding soils<br>5" casing to 10' |
| 0 | | | | | | | | | | | | | | |
| | 10 | ▧ | **Fat CLAY (CH)**: high plasticity, bluish gray and black, moist to wet, very soft, rootlets and organics present (Bay Mud) | ■ | BC=0<br>0<br>0<br>PP=0.25 | 100% | | 78.3 | 56.9 | | | | | |
| -5 | | | | | | | | | | | | | | |
| | 15 | | bluish gray, trace fine sand | ▥ | PT=0 | | | 48.4 | 73.3 | | | | | 5" casing to 15'<br>TXUU: c = 0.44 ksf |
| -10 | | | | | | | | | | | | | | |
| | | ▨ | **Sandy Lean CLAY (CL)**: low plasticity, brown to orange brown, moist, very stiff, fine to medium grained sand | | | | | | | | | | | |
| | 20 | | | ■ | BC=7<br>8<br>14<br>PP=3.0 | 94% | | 23.2 | 103.3 | | | 28 | 12 | 5" casing to 20'<br>TXUU: c = 1.76 ksf<br>Refill water, ~800 gal lost so far, very little circulation loss past this depth |
| -15 | | | | | | | | | | | | | | |
| | 25 | | low to medium plasticity, olive brown to light grayish olive, sand content increasing | ■ | BC=7<br>11<br>14<br>PP=3.5 | 89% | | 22.7 | 102.9 | | | | | |
| -20 | | ● | **Well-Graded GRAVEL with Clay and Sand (GW-GC)**: olive to grayish olive, moist to wet, dense, orange brown fines, fine to coarse grained sand, angular to subangular gravel to 1" | | | | | | | | | | | |
| | 30 | | | ■ | BC=15<br>24<br>39 | 66% | GW-GM | 18.1 | 111.7 | 49 | 10 | | | No noticeable chatter/grinding |
| -25 | | | | | | | | | | | | | | |
| | 35 | | sampler plugged by gravel at 35' | ◣ | BC=15<br>21<br>30 | 11% | | | | | | | | |
| -30 | | | | | | | | | | | | | | |

KLEINFELDER
Bright People. Right Solutions.

PROJECT NO.: 20210161.001A
DRAWN BY: DJS
CHECKED BY: MJP
DATE:

BORING LOG B-2

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE
A-6

|  |  |  |  |  |  |
|---|---|---|---|---|---|
| **Date Begin - End:** | 8/26/2020 - 8/27/2020 | **Drilling Co.-Lic.#:** | Greg Drilling - #1044456 |  | **BORING LOG B-2** |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry |  |  |
| **Hor.-Vert. Datum:** | WGS84 - NAD83 | **Drilling Equipment:** | Modified Mobile B-53 | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Mud Rotary | **Hammer Efficiency:** | 85% |
| **Weather:** | Cloudy/Smoky | **Exploration Diameter:** | 4" in. O.D. | **Hammer Cal. Date:** | 9/04/2019 |

FIELD EXPLORATION

Latitude: 38.24226°
Longitude: -122.28753°
Approximate Ground Surface Elevation (ft.): 8
Surface Condition: Grass

LABORATORY RESULTS

| Approximate Elevation (feet) | Depth (feet) | Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in. Push Tube(PT)= psi Pocket Pen(PP)= tsf Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | **Clayey SAND (SC)**: low plasticity, grayish olive with mottled orange, moist, very dense, fine to coarse grained sand |  | BC=29<br>30<br>41<br>PP=4.5+ | 61% |  |  |  |  | 40 |  |  |  |
| -35 |  | **Clayey SAND (SC)**: non-plastic to low plasticity, olive to grayish olive, moist, dense, fine to coarse grained sand (dominantly fine), some clay fines |  |  |  |  |  |  |  |  |  |  |  |
|  | 45 |  |  | BC=17<br>21<br>32 | 83% | SC | 33.6 | 89.8 |  | 30 | 40 | 16 | Consistent smooth drilling |
| -40 |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 50 | localized oxidation in bottom of sample |  | BC=20<br>18<br>25 | 83% |  |  |  |  |  |  |  |  |
| -45 |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 55 | sand content increasing |  | BC=28<br>29<br>33<br>PP=4.5+ | 94% |  | 31.1 | 91.2 |  |  |  |  | TXUU: c = 3.52 ksf |
| -50 |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 60 | clay content increasing (borderline ML/CL), occasional oxidized layers throughout sample, trace calcium carbonate |  | BC=17<br>22<br>25 | 77% |  | 27.1 |  |  |  |  |  |  |
| -55 |  | **Silty SAND (SM)**: olive to grayish olive, moist, very dense, fine to medium grained sand, oxidation staining, very weakly cemented |  |  |  |  |  |  |  |  |  |  |  |
|  | 65 |  |  | BC=25<br>35<br>50/5"<br>PP=4.5+ | 83% |  | 27.2 | 97.1 |  |  | 28 | 8 |  |
| -60 |  | **Well-Graded SAND with Silt (SW-SM)**: grayish brown, moist to wet, very dense, fine to coarse grained sand, subangular to subrounded gravel to 1.5", trace fines |  |  |  |  |  |  |  |  |  |  | Rounded to subrounded gravel to 1.5" in returns |
|  | 70 |  |  | BC=31<br>50/6" | 58% | SW-SM |  |  | 71 | 10 |  |  | Minor circulation loss |
| -65 |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 75 | infill fines are light yellow, sample is weakly cemented, trace subrounded gravel to 1" |  | BC=36<br>50/6" | 75% |  |  |  |  |  |  |  |  |
| -70 |  |  |  |  |  |  |  |  |  |  |  |  |  |

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PROJECT NO.:
20210161.001A

DRAWN BY: DJS

CHECKED BY: MJP

DATE:

BORING LOG B-2

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

A-6

PLOTTED: 11/10/2020 11:05 PM BY: TCisney

OFFICE FILTER: SANTA ROSA

PROJECT NUMBER: 20210161.001A

gINT FILE: Klf_gint_master_2021

gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2021.GLB [_KLF_BORING/TEST PIT SOIL LOG]

## BORING LOG B-2

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 8/26/2020 - 8/27/2020 | **Drilling Co.-Lic.#:** | Greg Drilling - #1044456 | | |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry | | |
| **Hor.-Vert. Datum:** | WGS84 - NAD83 | **Drilling Equipment:** | Modified Mobile B-53 | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Mud Rotary | **Hammer Efficiency:** | 85% |
| **Weather:** | Cloudy/Smoky | **Exploration Diameter:** | 4" in. O.D. | **Hammer Cal. Date:** | 9/04/2019 |

FIELD EXPLORATION

Latitude: 38.24226°
Longitude: -122.28753°
Approximate Ground Surface Elevation (ft.): 8
Surface Condition: Grass

LABORATORY RESULTS

| Approximate Elevation (feet) | Depth (feet) | Graphical Log | Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in.<br>Push Tube(PT)= psi<br>Pocket Pen(PP)= tsf<br>Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -75 | | | **Well-Graded SAND with Silt (SW-SM)**: grayish brown, moist to wet, very dense, fine to coarse grained sand, subangular to subrounded gravel to 1.5", trace fines | ◣ | BC=44<br>50/6" | 44% | | | | | 11 | | | |
| | 85 | | **Sandy Lean CLAY (CL)**: low plasticity, olive gray with orange, moist, hard, fine to medium grained sand, pervasive oxidation throughout | ◣ | BC=17<br>23<br>34<br>PP=4.5+ | 77% | | | | | | | | Driller notes increased drilling difficulty at 84' |
| -80 | 90 | | **Clayey SAND (SC)**: low plasticity, olive to dark olive, moist, very dense, fine to medium grained sand, weakly cemented | ▮ | BC=37<br>50/3" | 50% | | | | | | | | |
| -85 | 95 | | **Poorly Graded SAND with Clay (SP-SC)**: non-plastic to low plasticity, dark olive to dark olive brown, moist, very dense, fine to coarse sand, trace fine rounded gravel | ◣ | BC=34<br>34<br>50/6" | 61% | | | | | | | | |
| -90 | 100 | | decreasing clay content | ◣ | BC=31<br>33<br>50/4" | 72% | | | | | | | | |
| -95 | 105 | | | | | | | | | | | | | |
| -100 | 110 | | | | | | | | | | | | | |
| -105 | 115 | | | | | | | | | | | | | |
| -110 | | | | | | | | | | | | | | |

The boring was terminated at approximately 101.5 ft. below ground surface. Boring was backfilled with neat cement grout.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not measured during drilling or after completion due to drilling method.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder using plans provided by GTS.

KLEINFELDER
Bright People. Right Solutions.

PROJECT NO.: 20210161.001A

DRAWN BY: DJS

CHECKED BY: MJP

DATE:

BORING LOG B-2

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

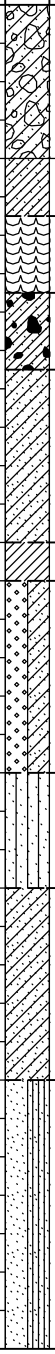
A-6

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 8/20/2020 | **Drilling Co.-Lic.#:** | Gregg Drilling - #1044456 | | **BORING LOG B-3** |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry, Jonathan | | |
| **Hor.-Vert. Datum:** | WGS84 | **Drilling Equipment:** | Modified Mobile B-53 | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger/Mud Rotary | **Hammer Efficiency:** | 85% |
| **Weather:** | Cloudy/Smoky | **Exploration Diameter:** | 6"/4" in. O.D. | **Hammer Cal. Date:** | 9/04/2019 |

FIELD EXPLORATION

Latitude: 38.24162°
Longitude: -122.28422°
Approximate Ground Surface Elevation (ft.): 11
Surface Condition: Gravel

LABORATORY RESULTS



| Approximate Elevation (feet) | Depth (feet) | Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in. Push Tube(PT)= psi Pocket Pen(PP)= tsf Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | | **Clayey GRAVEL with Sand (GC)**: low to medium plasticity, brown, dry to moist, medium dense to dense, fine to coarse grained sand, angular gravel to 3" (fill) | ☒ | | | | | | | | | | Hand auger to 5' |
| | | **Lean CLAY with Sand (CL)**: medium plasticity, grayish brown, moist, medium stiff, fine to coarse grained sand, rootlets present (fill/reworked colluvium) | ☒ | | | | | | | | | | |
| 5 | 5 | | ■ | BC=5<br>4<br>5<br>PP=1.5 | 100% | | 45.3 | 78.8 | | | 56 | 31 | |
| | ▽ | **Fat CLAY with Organics (OH)**: high plasticity, black, moist, medium stiff, trace fine to coarse grained sand, rootlets present, weak organci decay odor, locally oxidized | ◣ | BC=8<br>10<br>16 | 50% | | | | | | | | |
| 0 | 10 | **Sandy Lean CLAY with Gravel (CL)**: low plasticity, grayish blue to bluish gray, moist, very stiff, fine to coarse grained sand, rounded to subrounded gravel to 1.5" | ■ | BC=17<br>50/6"<br>PP=4.5+ | 91% | | 28.9 | 72.5 | | 18 | | | |
| | | **Clayey SAND (SC)**: yellowish brown to bluish gray, moist, very dense, fine to coarse grained sand, moderately cemented (fractured), slickensides present | | | | | | | | | | | |
| | ▽ 15 | **Lean CLAY (CL)**: high plasticity, yellowish brown, moist, stiff | | | | | | | | | | | Driller observes change in drilling at 14'<br>Switch to Mud Rotary |
| -5 | | **Well-Graded SAND with Clay (SW-SC)**: yellowish brown to greenish gray, moist to wet, medium dense, fine to coarse grained sand | ■ | BC=13<br>13<br>21 | 100% | | 28.9 | 92.8 | | 8.2 | | | |
| -10 | 20 | **Sandy SILT (ML)**: olive to light olive, moist, hard, localized black veining, moderately cemented, slickensides present | ◣ | BC=15<br>43<br>50/4"<br>PP=4.5+ | 83% | | | | | | 39 | 7 | |
| | | **Clayey SAND (SC)**: light grayish olive, moist, very dense to hard, fine to coarse grained sand, subangular to subrounded gravel to 1.5" | | | | | | | | | | | |
| -15 | 25 | | ■ | BC=34<br>50/3" | 50% | | 29.2 | 91.6 | | 31 | | | |
| | | **Poorly Graded SAND with Silt (SP-SM)**: olive, moist, very dense, fine to coarse grained sand, localized weak cementation | | | | | | | | | | | |
| -20 | 30 | increasing silt and fine sand content with depth | ◣ | BC=15<br>33<br>39 | 100% | | | | | | | | |

| | | | |
|---|---|---|---|
| KLEINFELDER<br>Bright People. Right Solutions. | PROJECT NO.:<br>20210161.001A | BORING LOG B-3 | FIGURE |
| | DRAWN BY: DJS<br>CHECKED BY: MJP<br>DATE: | PG&E L-021A<br>NATURAL GAS PIPELINE REPLACEMENT<br>NAPA, CALIFORNIA | A-7 |
| | | | PAGE: 1 of 3 |

gINT FILE: Klf_gint_master_2021 PROJECT NUMBER: 20210161.001A OFFICE FILTER: SANTA ROSA PLOTTED: 11/10/2020 11:05 PM BY: TCisney
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2021.GLB [__KLF_BORING/TEST PIT SOIL LOG]

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| **Date Begin - End:** | 8/20/2020 | **Drilling Co.-Lic.#:** | Gregg Drilling - #1044456 |  |  | **BORING LOG B-3** |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry, Jonathan |  |  |  |
| **Hor.-Vert. Datum:** | WGS84 | **Drilling Equipment:** | Modified Mobile B-53 | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |  |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger/Mud Rotary | **Hammer Efficiency:** | 85% |  |
| **Weather:** | Cloudy/Smoky | **Exploration Diameter:** | 6"/4" in. O.D. | **Hammer Cal. Date:** | 9/04/2019 |  |

FIELD EXPLORATION

Latitude: 38.24162°
Longitude: -122.28422°
Approximate Ground Surface Elevation (ft.): 11
Surface Condition: Gravel

LABORATORY RESULTS

| Approximate Elevation (feet) | Depth (feet) | Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in. Push Tube(PT)= psi Pocket Pen(PP)= tsf Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -25 |  | **Poorly Graded SAND with Silt (SP-SM)**: olive, moist, very dense, fine to coarse grained sand, localized weak cementation | ■ | BC=50/6" | 83% |  | 30.7 | 90.5 |  |  |  |  |  |
|  |  | **Clayey SAND (SC)**: olive, moist, very dense, fine to medium grained sand |  |  |  |  |  |  |  |  |  |  |  |
| -30 | 40 |  | ◣ | BC=37<br>50/4" | 83% |  |  |  | 99 | 17 |  |  | No circulation loss |
|  |  | **Clayey SAND (SC)**: bluish gray, moist, very dense, fine grained sand, weakly cemented, local slickensides and moderate cementation |  |  |  |  |  |  |  |  |  |  |  |
| -35 | 45 |  | ■ | BC=32<br>50/4" | 75% |  | 28.0 | 93.8 |  | 19 |  |  | TXUU: c = 8.69 ksf |
| -40 | 50 | increasing fines content | ◣ | BC=30<br>50/3" | 83% | SM |  |  |  | 14 |  |  |  |
|  |  | **Poorly Graded GRAVEL (GP)**: black, wet, dense, subangular to subrounded gravel to 1" |  |  |  |  |  |  |  |  |  |  | Driller notes gravelly feeling |
| -45 | 55 |  | ■ | BC=8<br>12<br>38 | 11% |  |  |  |  |  |  |  |  |
|  |  | **Sandy Lean CLAY (CL)**: dark gray and bluish gray, moist, hard, fine to medium grained sand, trace coarse grained sand and subrounded gravel to 0.75" |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **Poorly Graded SAND with Clay and Gravel (SP-SC)**: dark gray, wet, very dense, fine to coarse grained sand, subangular to subrounded gravel to 0.5" |  |  |  |  |  |  |  |  |  |  |  |
| -50 | 60 |  | ◣ | BC=50/6" | 100% | SP-SM |  |  | 66 | 6.1 |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  | No excessive circulation loss |
|  |  | **Well-Graded SAND with Clay and Gravel (SW-SC)**: dark gray, wet, very dense, fine to coarse grained sand, subangular to subrounded gravel to 0.75" |  |  |  |  |  |  |  |  |  |  |  |
| -55 | 65 |  | ■ | BC=26<br>41<br>50 | 11% | SW-SM |  |  | 62 | 6.9 |  |  | Logged from intact shoe |

|  |  |  |  |
|---|---|---|---|
| KLEINFELDER<br>Bright People. Right Solutions. | PROJECT NO.:<br>20210161.001A | BORING LOG B-3 | FIGURE |
|  | DRAWN BY: DJS<br>CHECKED BY: MJP<br>DATE: | PG&E L-021A<br>NATURAL GAS PIPELINE REPLACEMENT<br>NAPA, CALIFORNIA | A-7 |

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 8/20/2020 | **Drilling Co.-Lic.#:** | Gregg Drilling - #1044456 | | **BORING LOG B-3** |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry, Jonathan | | |
| **Hor.-Vert. Datum:** | WGS84 | **Drilling Equipment:** | Modified Mobile B-53 | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger/Mud Rotary | **Hammer Efficiency:** | 85% |
| **Weather:** | Cloudy/Smoky | **Exploration Diameter:** | 6"/4" in. O.D. | **Hammer Cal. Date:** | 9/04/2019 |

FIELD EXPLORATION

Latitude: 38.24162°
Longitude: -122.28422°
Approximate Ground Surface Elevation (ft.): 11
Surface Condition: Gravel

LABORATORY RESULTS

| Approximate Elevation (feet) | Depth (feet) | Graphical Log | Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in. Push Tube(PT)= psi Pocket Pen(PP)= tsf Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -60 | | | **Poorly Graded SAND (SP)**: dark gray, wet, very dense, fine to coarse grained sand, possible weathered rock | | BC=50/4" | 100% | | | | | | | | |
| | 75 | | | | BC=50/3" | NR | | | | | | | | |
| -65 | | | | | | | | | | | | | | |
| | 80 | | **SANDSTONE**: black and dark gray, coarse-grained, intensely fractured to 1.5" gravel | | BC=24<br>50/5" | 50% | | | | | | | | |
| -70 | | | | | | | | | | | | | | |
| | 85 | | | | BC=50/6" | 100% | | | | | | | | |
| -75 | | | | | | | | | | | | | | |
| | 90 | | Bluish gray lean clay infill | | BC=31<br>50/4" | 89% | | | | | | | | |
| -80 | | | | | | | | | | | | | | |
| | 95 | | | | | | | | | | | | | |
| -85 | | | | | | | | | | | | | | |
| | 100 | | | | | | | | | | | | | |
| -90 | | | | | | | | | | | | | | |

The boring was terminated at approximately 91 ft. below ground surface. Boring was backfilled with neat cement grout.

GROUNDWATER LEVEL INFORMATION:
- Groundwater was observed at approximately 8 ft. below ground surface before switching to mud rotary.
- Groundwater was initially observed at approximately 15.5 ft. below ground surface.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder using Google Earth.

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| | | | |
|---|---|---|---|
| PROJECT NO.: 20210161.001A | | BORING LOG B-3 | FIGURE |
| DRAWN BY: | DJS | PG&E L-021A<br>NATURAL GAS PIPELINE REPLACEMENT<br>NAPA, CALIFORNIA | A-7 |
| CHECKED BY: | MJP | | |
| DATE: | | | PAGE: 3 of 3 |

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 8/20/2020 - 8/21/2020 | **Drilling Co.-Lic.#:** | Gregg Drilling - #1044456 | | |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry, Jonathan | | |
| **Hor.-Vert. Datum:** | WGS84 - NAD83 | **Drilling Equipment:** | Modified Mobile B-53 | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger/Mud Rotary | **Hammer Efficiency:** | 85% |
| **Weather:** | Cloudy | **Exploration Diameter:** | 6"/4" in. O.D. | **Hammer Cal. Date:** | 9/04/2019 |

FIELD EXPLORATION

Latitude: 38.23942°
Longitude: -122.28133°
Approximate Ground Surface Elevation (ft.): 7
Surface Condition: Grass

LABORATORY RESULTS

| Approximate Elevation (feet) | Depth (feet) | Graphical Log | Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in. Push Tube(PT)= psi Pocket Pen(PP)= tsf Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | ▨ | **Sandy Lean CLAY (CL)**: low to medium plasticity, brown, dry to moist, medium stiff, fine to medium grained sand | ☒ | | | | | | | | | | Hand auger to 5' |
| 5 | | | moist, stiff | | | | | | | | | | | |
| | | | increasing sand size and content | | | | | | | | | | | |
| | 5 | | very stiff, fine to coarse grained sand | ▮ | BC=6<br>7<br>8<br>PP=4.0 | 100% | CL | 20.4 | 97.2 | 95 | 54 | 27 | 10 | |
| 0 | | ▨ | **Sandy Lean CLAY (CL)**: low plasticity, gray, moist, hard, fine grained sand, black rootlets present | ▮ | BC=7<br>7<br>13<br>PP=4.5 | 100% | | | | | | | | |
| | | ▥ | **Silty SAND (SM)**: non-plastic, olive, moist, dense, fine to medium grained sand, local orange or red oxidation | | | | | | | | | | | |
| | 10 | | locally weakly cemented | ▮ | BC=19<br>27<br>38<br>PP=4.5+ | 100% | SM | 30.2 | 91.8 | 99 | 39 | NP | NP | |
| -5 ▽ | | | | | | | | | | | | | | |
| | | ▨ | **Sandy Lean CLAY (CL)**: low plasticity, light olive, moist, hard, fine grained sand | | | | | | | | | | | |
| ▽ | 15 | | | ◣ | BC=20<br>42<br>38 | 77% | CL | | | | 54 | 32 | 12 | Sampler wet |
| -10 | | | | | | | | | | | | | | Resume 8/21 with Mud Rotary |
| | | ▥ | **Silty SAND (SM)**: olive, moist, very dense, fine to medium grained sand, moderately cemented | | | | | | | | | | | |
| | 20 | | | ▮ | BC=26<br>50/5"<br>PP=4.5+ | 75% | | 34.3 | 84.0 | | 28 | | | |
| -15 | | | | | | | | | | | | | | |
| | | ⁘ | **Poorly Graded SAND with Gravel (SP)**: grayish brown, wet, dense, fine to coarse grained sand, gravel fragments to 2.5" | | | | | | | | | | | |
| | 25 | | | ▮ | BC=13<br>27<br>30 | 66% | SP | 18.1 | 111.5 | 66 | 4.4 | | | Very light chatter/grinding |
| -20 | | | | | | | | | | | | | | |
| | | ⁘ | **Poorly Graded SAND with Silt and Gravel (SP-SM)**: grayish brown, wet, dense, fine to coarse grained sand, gravel fragments to 1.5" | | | | | | | | | | | |
| | 30 | | | ◣ | BC=4<br>8<br>28 | 33% | | | | 74 | 16 | | | BC likely not representative, lots of slough in sample |
| | | ⁘ | **Silty SAND with Gravel (SM)**: non-plastic, grayish olive, moist, dense, fine to medium grained sand | | | | | | | | | | | |
| -25 | | | | | | | | | | | | | | |
| | | ▨ | | | | | | | | | | | | Hole partially collapsed |

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PROJECT NO.:
20210161.001A

DRAWN BY: DJS

CHECKED BY: MJP

DATE:

BORING LOG B-4

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

A-8

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 8/20/2020 - 8/21/2020 | **Drilling Co.-Lic.#:** | Gregg Drilling - #1044456 | | **BORING LOG B-4** |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry, Jonathan | | |
| **Hor.-Vert. Datum:** | WGS84 - NAD83 | **Drilling Equipment:** | Modified Mobile B-53 | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger/Mud Rotary | **Hammer Efficiency:** | 85% |
| **Weather:** | Cloudy | **Exploration Diameter:** | 6"/4" in. O.D. | **Hammer Cal. Date:** | 9/04/2019 |

Latitude: 38.23942°
Longitude: -122.28133°
Approximate Ground Surface Elevation (ft.): 7
Surface Condition: Grass

| | | FIELD EXPLORATION | | | | | LABORATORY RESULTS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Approximate Elevation (feet) | Depth (feet) | Graphical Log | Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in. Push Tube(PT)= psi Pocket Pen(PP)= tsf Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
| | | | **Lean CLAY with Sand and Gravel (CL)**: medium plasticity, light olive, moist to wet, hard, fine to medium grained sand, rounded to subrounded gravel to 0.5" | | BC=7<br>36<br>50/5"<br>PP=4.5 | 72% | | | | | | | | |
| -30 | | | | | | | | | | | | | | |
| | | | **Silty SAND (SM)**: olive to light olive, moist, very dense, fine grained sand, moderately cemented | | | | | | | | | | | |
| | 40 | | olive, weakly cemented | | BC=13<br>37<br>50 | 72% | | | | | | | | |
| -35 | | | | | | | | | | | | | | |
| | 45 | | | | | | | | | | | | | |
| -40 | | | | | | | | | | | | | | |
| | 50 | | | | | | | | | | | | | |
| -45 | | | | | | | | | | | | | | |
| | 55 | | | | | | | | | | | | | |
| -50 | | | | | | | | | | | | | | |
| | 60 | | | | | | | | | | | | | |
| -55 | | | | | | | | | | | | | | |
| | 65 | | | | | | | | | | | | | |
| -60 | | | | | | | | | | | | | | |

The boring was terminated at approximately 41.5 ft. below ground surface. Boring was backfilled with neat cement grout.

GROUNDWATER LEVEL INFORMATION:

⊻ Groundwater was observed at approximately 13 ft. below ground surface before switching to mud rotary.

⊻ Groundwater was initially observed at approximately 15 ft. below ground surface.

GENERAL NOTES:

The exploration location and elevation are approximate and were estimated by Kleinfelder using plans provided by GTS.

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| | | | |
|---|---|---|---|
| PROJECT NO.: 20210161.001A | | BORING LOG B-4 | FIGURE |
| DRAWN BY: | DJS | PG&E L-021A<br>NATURAL GAS PIPELINE REPLACEMENT<br>NAPA, CALIFORNIA | A-8 |
| CHECKED BY: | MJP | | |
| DATE: | | | PAGE: 2 of 2 |

## BORING LOG B-5

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 8/21/2020 | **Drilling Co.-Lic.#:** | Gregg Drilling - #1044456 | | |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry, Robert | | |
| **Hor.-Vert. Datum:** | WGS84 - NAD83 | **Drilling Equipment:** | Modified Mobile B-53 | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger | **Hammer Efficiency:** | 85% |
| **Weather:** | Cloudy | **Exploration Diameter:** | 8" in. O.D. | **Hammer Cal. Date:** | 9/04/2019 |

FIELD EXPLORATION

Latitude: 38.23883°
Longitude: -122.28143°
Approximate Ground Surface Elevation (ft.): 12
Surface Condition: Grass

Approximate Elevation (feet): 10, 5, 0, -5, -10, -15, -20
Depth (feet): 5, 10, 15 ▽, 20, 25, 30

Lithologic Description

**Silty SAND with Gravel and Organics (SM)**: low plasticity, brown, dry, medium dense, fine to coarse grained sand, subangular gravel to 3", rootlets present (native)
increasing fines content and plasticity with depth

**Clayey SAND (SC)**: high plasticity, brown to dark brown, moist to wet, loose, medium to coarse grained sand, trace fine grained sand, trace rootlets

**Fat CLAY with Sand and Organics (CH)**: high plasticity, black, moist to wet, stiff, trace fine grained sand
medium plasticity

**Fat CLAY (CH)**: high plasticity, dark gray, moist to wet, soft to medium stiff, trace organics

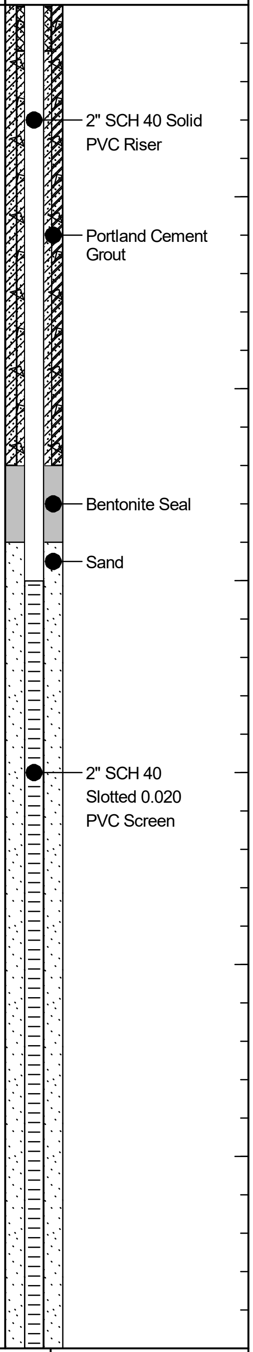
**Clayey SAND (SC)**: low plasticity, dark brown to dark gray, wet, loose, medium to coarse grained sand, trace fine grained sand

**Poorly Graded SAND with Silt (SP-SM)**: low to medium plasticity, brown, moist to wet, very dense, fine to coarse grained sand, subangular to subrounded gravel to 0.75"

| Blow Counts(BC)= Uncorr. Blows/6 in. Push Tube(PT)= psi Pocket Pen(PP)= tsf Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) |
|---|---|---|---|---|---|---|---|---|
| | | | | | 79 | 49 | | |
| BC=7<br>4<br>4<br>PP=3.0 | 100% | | 32.9 | 85.5 | | 47 | | |
| BC=5<br>4<br>7<br>PP=1.5 | 100% | | 67.9 | 64.5 | | | | |
| BC=2<br>2<br>4<br>PP=1.5 | 72% | CH | | | | 83 | 59 | 33 |
| BC=0<br>3<br>5<br>PP=0.5 | 66% | CH | 51.7 | 70.4 | | 93 | 60 | 34 |
| BC=push | 100% | SC | | | | 42 | 46 | 26 |
| BC=push<br>1<br>2 | 22% | | | | | | | |
| BC=19<br>50 | 42% | SP-SM | | | 75 | 9.4 | | |

MONITORING WELL CONSTRUCTION*

Completion Method: Flush mount cap in concrete



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PROJECT NO.: 20210161.001A
DRAWN BY: DJS
CHECKED BY: MJP
DATE:

BORING LOG B-5

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE
A-9

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 8/21/2020 | **Drilling Co.-Lic.#:** | Gregg Drilling - #1044456 | | **BORING LOG B-5** |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry, Robert | | |
| **Hor.-Vert. Datum:** | WGS84 - NAD83 | **Drilling Equipment:** | Modified Mobile B-53 | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger | **Hammer Efficiency:** | 85% |
| **Weather:** | Cloudy | **Exploration Diameter:** | 8" in. O.D. | **Hammer Cal. Date:** | 9/04/2019 |

FIELD EXPLORATION

Latitude: 38.23883°
Longitude: -122.28143°
Approximate Ground Surface Elevation (ft.): 12
Surface Condition: Grass

LABORATORY RESULTS

MONITORING WELL CONSTRUCTION*

Completion Method: Flush mount cap in concrete

| Approximate Elevation (feet) | Depth (feet) | Graphical Log | Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in. Push Tube(PT)= psi Pocket Pen(PP)= tsf Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -25 | | | **Poorly Graded SAND with Silt (SP-SM)**: low to medium plasticity, brown, moist to wet, very dense, fine to coarse grained sand, subangular to subrounded gravel to 0.75" | | BC=50/5" | 83% | | | | | | | |
| | 40 | | **Sandy CLAY with Gravel (CL)**: medium to high plasticity, olive gray, moist, stiff, fine to coarse grained sand, angular to subrounded gravel/gravel fragments to 1" | | BC=22<br>10<br>13<br>PP=1.0 | 94% | | | | | | | |
| -30 | | | | | | | | | | | | | |
| | 45 | | The boring was terminated at approximately 41.5 ft. below ground surface. Monitoring Well installed to a depth of 40'. | | | | | | | | | | |
| -35 | | | | | | | | | | | | | |
| | 50 | | | | | | | | | | | | |
| -40 | | | | | | | | | | | | | |
| | 55 | | | | | | | | | | | | |
| -45 | | | | | | | | | | | | | |
| | 60 | | | | | | | | | | | | |
| -50 | | | | | | | | | | | | | |
| | 65 | | | | | | | | | | | | |
| -55 | | | | | | | | | | | | | |

GROUNDWATER LEVEL INFORMATION:

∑ Groundwater was observed at approximately 15.5 ft. below ground surface during drilling.

GENERAL NOTES:

The exploration location and elevation are approximate and were estimated by Kleinfelder using plans provided by GTS.

| | | | |
|---|---|---|---|
| KLEINFELDER<br>Bright People. Right Solutions. | PROJECT NO.:<br>20210161.001A | BORING LOG B-5 | FIGURE |
| | DRAWN BY: DJS | PG&E L-021A<br>NATURAL GAS PIPELINE REPLACEMENT<br>NAPA, CALIFORNIA | A-9 |
| | CHECKED BY: MJP | | |
| | DATE: | | PAGE: 2 of 2 |

PLOTTED: 11/10/2020 11:05 PM BY: TCisney

OFFICE FILTER: SANTA ROSA

PROJECT NUMBER: 20210161.001A

gINT FILE: Klf_gint_master_2021

gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2021.GLB [_KLF_BORING/TEST PIT SOIL LOG]

| | | | |
|---|---|---|---|
| **Date Begin - End:** | 8/25/2020 | **Drilling Co.-Lic.#:** | Gregg Drilling - #1044456 |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry, Manuel |
| **Hor.-Vert. Datum:** | WGS84 | **Drilling Equipment:** | Modified Mobile B-53 |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger |
| **Weather:** | Cloudy/Smoky | **Exploration Diameter:** | 8" in. O.D. |

# BORING LOG B-6

**Hammer Type - Drop:** 140 lb. Auto - 30 in.
**Hammer Efficiency:** 85%
**Hammer Cal. Date:** 9/04/2019

FIELD EXPLORATION

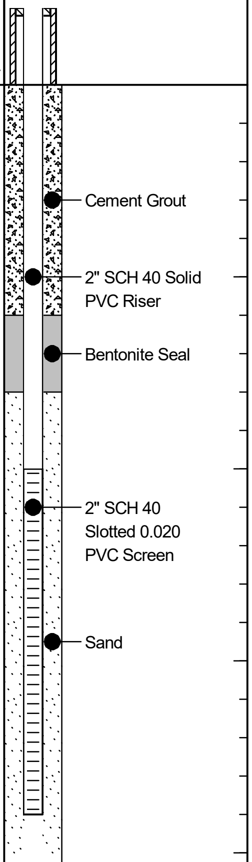
Latitude: 38.24074°
Longitude: -122.28804°
Approximate Ground Surface Elevation (ft.): 4
Surface Condition: Grass

LABORATORY RESULTS

| Approximate Elevation (feet) | Depth (feet) | Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in. Push Tube(PT)= psi Pocket Pen(PP)= tsf Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Lean CLAY with Sand (CL)**: low plasticity, olive to light olive, dry, medium stiff, fine grained sand, rootlets present | ☒<br>☒ | | | | | | | | | |
| 0 | | low to medium plasticity, becomes gray and orange, pervasive oxidation staining, sand content increasing with depth | ☒ | | | | | | | | | |
| | 5 | **Fat CLAY (CH)**: high plasticity, gray and orange, moist, stiff, pervasive oxidation staining, rootlets | ■ | BC=0<br>0<br>0<br>TV=0.15 | 100% | | | | | | | |
| | | **Fat CLAY (CH)**: high plasticity, dark gray and black, moist, very soft, high organics content, strong organic decay odor (Bay Mud) | | | | | 86.2 | 51.7 | | | 98 | 68 |
| -5 | | becomes bluish gray, reduced organic decay odor, inclusions of brown to olive brown lean clay w/ high organic content, low plasticity | ■ | BC=0<br>0<br>0<br>TV=0.25 | 100% | | | | 100 | 96 | | |
| | 10 | reduced inclusion size and frequency, increased sand content | ■ | BC=0<br>0<br>0<br>TV=0.1 | 89% | | 48.0 | 74.9 | | | 53 | 32 |
| -10 | | | | | | | | | | | | |
| | 15 | no inclusions, trace organic content | ■ | BC=0<br>0<br>0<br>TV=0.1 | 83% | | | | | | | |
| ∇ | | | ▥ | PT=0 | | | 56.3 | 69.7 | | | | |
| -15 | | | | | | | | | | | | |
| | 20 | moist to wet, becoming leaner | ■ | BC=3<br>3<br>4<br>TV=0.1 | 77% | | 41.8 | 83.3 | | | | |
| -20 | | | | | | | | | | | | |
| | 25 | moist, trace brown inclusions | ■ | BC=5<br>5<br>11<br>PP=1.25 | 100% | | 33.8 | 88.2 | | | | |
| | | **Clayey SAND with Gravel (SC)**: low to medium plasticity, grayish brown, moist, medium dense, fine to coarse grained sand, dominantly coarse grained | | | | | | | | | | |
| -25 | | | | | | | | | | | | |
| | 30 | high plasticity, becomes gray | ■ | BC=4<br>17<br>19 | 89% | | | | | | | |
| | | low to medium plasticity, becomes brown, trace angular gravel to 0.75" | | | | SC | 16.1 | 114.4 | | 19 | 50 | 31 |
| -30 | | | | | | | | | | | | |

MONITORING WELL CONSTRUCTION*

Completion Method: Locking Stand Pipe - 3 feet above grade



KLEINFELDER
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PROJECT NO.: 20210161.001A
DRAWN BY: DJS
CHECKED BY: MJP
DATE:

BORING LOG B-6

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE
A-10

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 8/25/2020 | **Drilling Co.-Lic.#:** | Gregg Drilling - #1044456 | | **BORING LOG B-6** |
| **Logged By:** | S. Cain | **Drill Crew:** | Angel, Henry, Manuel | | |
| **Hor.-Vert. Datum:** | WGS84 | **Drilling Equipment:** | Modified Mobile B-53 | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger | **Hammer Efficiency:** | 85% |
| **Weather:** | Cloudy/Smoky | **Exploration Diameter:** | 8" in. O.D. | **Hammer Cal. Date:** | 9/04/2019 |

Latitude: 38.24074°
Longitude: -122.28804°
Approximate Ground Surface Elevation (ft.): 4
Surface Condition: Grass

MONITORING WELL CONSTRUCTION*
Completion Method: Locking Stand Pipe - 3 feet above grade

| FIELD EXPLORATION | | | | | | | LABORATORY RESULTS | | | | | | | MONITORING WELL CONSTRUCTION* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Approximate Elevation (feet) | Depth (feet) | Graphical Log | Lithologic Description | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in.<br>Push Tube(PT)= psi<br>Pocket Pen(PP)= tsf<br>Torvane(TV)= tsf | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | |
| | | ▨ | **Clayey SAND (SC)**: low to medium plasticity, brown, moist, dense, fine to coarse grained sand | ◣ | BC=19<br>20<br>28 | 83% | SC | | | | 16 | 37 | 18 | |
| | 40 | ▨ | | ◣ | BC=13<br>22<br>21 | 72% | | | | | | | | |

| Approximate Elevation (feet) | Depth (feet) |
|---|---|
| -35 | 40 |
| -40 | 45 |
| -45 | 50 |
| -50 | 55 |
| -55 | 60 |
| -60 | 65 |
| -65 | |

The boring was terminated at approximately 41.5 ft. below ground surface. Monitoring Well installed to a depth of 19'.

GROUNDWATER LEVEL INFORMATION:
▽ Groundwater was observed at approximately 16.5 ft. below ground surface during drilling.
GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder using Google Earth.

KLEINFELDER
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| | | | |
|---|---|---|---|
| PROJECT NO.: 20210161.001A | | BORING LOG B-6 | FIGURE |
| DRAWN BY: | DJS | PG&E L-021A<br>NATURAL GAS PIPELINE REPLACEMENT<br>NAPA, CALIFORNIA | A-10 |
| CHECKED BY: | MJP | | |
| DATE: | | | PAGE: 2 of 2 |

KLEINFELDER

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# Appendix B

| Exploration ID | Depth (ft.) | Sample Description | Water Content (%) | Dry Unit Wt. (pcf) | Sieve Analysis (%) | | | Atterberg Limits | | | Additional Tests |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Passing 3/4" | Passing #4 | Passing #200 | Liquid Limit | Plastic Limit | Plasticity Index | |
| B-1 | 6.0 | CLAYEY GRAVEL WITH SAND (GC) | 8.9 | 113.4 | | | | | | | |
| B-1 | 7.5 | CLAYEY SAND WITH GRAVEL (SC) | | | | | 19 | | | | |
| B-1 | 11.0 | WELL GRADED SAND WITH CLAY AND GRAVEL (SW-SC) | 10.7 | 117.6 | 85 | 60 | 9.7 | | | | |
| B-1 | 15.0 | SILTY SAND (SM) | | | | | 22 | NP | NP | NP | |
| B-1 | 46.0 | SILTY CLAYEY SAND (SC-SM) | 23.5 | 101.4 | | | | | | | |
| B-1B | 20.0 | SILTY CLAYEY SAND WITH GRAVEL (SC-SM) | | | 94 | 76 | 13 | | | | |
| B-1B | 25.0 | POORLY GRADED GRAVEL WITH CLAY AND SAND (GP-GC) | | | 93 | 47 | 7.1 | | | | |
| B-1B | 30.0 | CLAYEY SAND (SC) | | | | | | 30 | 18 | 12 | |
| B-1B | 35.0 | POORLY GRADED SAND WITH CLAY AND GRAVEL (SP-SC) | | | 93 | 67 | 6.6 | | | | |
| B-1B | 40.0 | CLAYEY SAND (SC) | | | | | | 30 | 20 | 10 | |
| B-2 | 6.0 | SANDY FAT CLAY WITH ORGANICS (OH) | 39.2 | 63.0 | | | | 88 | 35 | 53 | |
| B-2 | 11.0 | FAT CLAY (CH) | 78.3 | 56.9 | | | | | | | |
| B-2 | 16.0 | FAT CLAY (CH) | 48.4 | 73.3 | | | | | | | TXUU: c = 0.44 ksf |
| B-2 | 21.0 | SANDY LEAN CLAY (CL) | 23.2 | 103.3 | | | | 28 | 16 | 12 | TXUU: c = 1.76 ksf |
| B-2 | 26.0 | SANDY LEAN CLAY (CL) | 22.7 | 102.9 | | | | | | | |
| B-2 | 31.0 | WELL GRADED GRAVEL WITH CLAY AND SAND (GW-GC) | 18.1 | 111.7 | 68 | 49 | 10 | | | | |
| B-2 | 40.0 | CLAYEY SAND (SC) | | | | | 40 | | | | |
| B-2 | 46.0 | CLAYEY SAND (SC) | 33.6 | 89.8 | | | 30 | 40 | 24 | 16 | |
| B-2 | 56.0 | CLAYEY SAND (SC) | 31.1 | 91.2 | | | | | | | TXUU: c = 3.52 ksf |
| B-2 | 60.0 | CLAYEY SAND (SC) | 27.1 | | | | | | | | |
| B-2 | 66.0 | SILTY SAND (SM) | 27.2 | 97.1 | | | | 28 | 20 | 8 | |
| B-2 | 70.0 | WELL GRADED SAND WITH SILT (SW-SM) | | | | 71 | 10 | | | | |
| B-2 | 80.0 | WELL GRADED SAND WITH CLAY AND GRAVEL (SW-SC) | | | | | 11 | | | | |
| B-3 | 6.0 | FAT CLAY WITH ORGANICS (CH) | 45.3 | 78.8 | | | | 56 | 25 | 31 | |
| B-3 | 10.5 | CLAYEY SAND (SC) | 28.9 | 72.5 | | | 18 | | | | |
| B-3 | 16.0 | WELL GRADED SAND WITH CLAY (SW-SC) | 28.9 | 92.8 | | | 8.2 | | | | |

Refer to the Geotechnical Evaluation Report or the supplemental plates for the method used for the testing performed above.
NP = NonPlastic

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20210161.001A

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DATE:

LABORATORY TEST
RESULT SUMMARY

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

B-1

| Exploration ID | Depth (ft.) | Sample Description | Water Content (%) | Dry Unit Wt. (pcf) | Sieve Analysis (%) | | | Atterberg Limits | | | Additional Tests |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Passing 3/4" | Passing #4 | Passing #200 | Liquid Limit | Plastic Limit | Plasticity Index | |
| B-3 | 20.0 | SANDY SILT (ML) | | | | | | 39 | 32 | 7 | |
| B-3 | 25.5 | CLAYEY SAND (SC) | 29.2 | 91.6 | | | 31 | | | | |
| B-3 | 35.0 | POORLY GRADED SAND WITH SILT (SP-SM) | 30.7 | 90.5 | | | | | | | |
| B-3 | 40.0 | CLAYEY SAND (SC) | | | | 99 | 17 | | | | |
| B-3 | 45.5 | CLAYEY SAND (SC) | 28.0 | 93.8 | | | 19 | | | | TXUU: c = 8.69 ksf |
| B-3 | 50.0 | CLAYEY SAND (SC) | | | | | 14 | | | | |
| B-3 | 60.0 | POORLY GRADED SAND WITH CLAY AND GRAVEL (SP-SC) | | | 97 | 66 | 6.1 | | | | |
| B-3 | 66.0 | WELL GRADED SAND WITH CLAY AND GRAVEL (SW-SC) | | | 86 | 62 | 6.9 | | | | |
| B-4 | 6.0 | SANDY LEAN CLAY (CL) | 20.4 | 97.2 | | 95 | 54 | 27 | 17 | 10 | |
| B-4 | 11.0 | SILTY SAND (SM) | 30.2 | 91.8 | | 99 | 39 | NP | NP | NP | |
| B-4 | 15.0 | SANDY LEAN CLAY (CL) | | | | | 54 | 32 | 20 | 12 | |
| B-4 | 20.5 | SILTY SAND (SM) | 34.3 | 84.0 | | | 28 | | | | |
| B-4 | 26.0 | POORLY GRADED SAND WITH GRAVEL (SP) | 18.1 | 111.5 | | 66 | 4.4 | | | | |
| B-4 | 30.0 | SILTY SAND WITH GRAVEL (SM) | | | | 74 | 16 | | | | |
| B-5 | 0.5 - 5.0 | SILTY SAND WITH GRAVEL AND ORGANICS (SM) | | | | 79 | 49 | | | | |
| B-5 | 6.0 | CLAYEY SAND (SC) | 32.9 | 85.5 | | | 47 | | | | |
| B-5 | 8.5 | FAT CLAY (CH) | 67.9 | 64.5 | | | | | | | TXUU: c = 1.21 ksf |
| B-5 | 10.0 | FAT CLAY WITH SAND AND ORGANICS (CH) | | | | | 83 | 59 | 26 | 33 | |
| B-5 | 16.0 | FAT CLAY (CH) | 51.7 | 70.4 | | | 93 | 60 | 26 | 34 | TXUU: c = 0.75 ksf |
| B-5 | 20.0 | CLAYEY SAND (SC) | | | | | 42 | 46 | 20 | 26 | |
| B-5 | 30.5 | POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM) | | | | 75 | 9.4 | | | | |
| B-6 | 6.0 | FAT CLAY (CH) | 86.2 | 51.7 | | | | 98 | 30 | 68 | |
| B-6 | 8.5 | FAT CLAY (CH) | | | | 100 | 96 | | | | |
| B-6 | 11.0 | FAT CLAY WITH SAND (CH) | 48.0 | 74.9 | | | | 53 | 21 | 32 | |
| B-6 | 18.0 | FAT CLAY (CH) | 56.3 | 69.7 | | | | | | | TXUU: c = 0.23 ksf |
| B-6 | 21.0 | FAT CLAY (CH) | 41.8 | 83.3 | | | | | | | |
| B-6 | 25.5 | FAT CLAY (CH) | 33.8 | 88.2 | | | | | | | TXUU: c = 0.51 ksf |

Refer to the Geotechnical Evaluation Report or the supplemental plates for the method used for the testing performed above.
NP = NonPlastic

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LABORATORY TEST
RESULT SUMMARY

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

B-2

| Exploration ID | Depth (ft.) | Sample Description | Water Content (%) | Dry Unit Wt. (pcf) | Sieve Analysis (%) | | | Atterberg Limits | | | Additional Tests |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Passing 3/4" | Passing #4 | Passing #200 | Liquid Limit | Plastic Limit | Plasticity Index | |
| B-6 | 31.0 | CLAYEY SAND WITH GRAVEL (SC) | 16.1 | 114.4 | | | 19 | 50 | 19 | 31 | |
| B-6 | 35.0 | CLAYEY SAND WITH GRAVEL (SC) | | | | | 16 | 37 | 19 | 18 | |

Refer to the Geotechnical Evaluation Report or the supplemental plates for the method used for the testing performed above.
NP = NonPlastic

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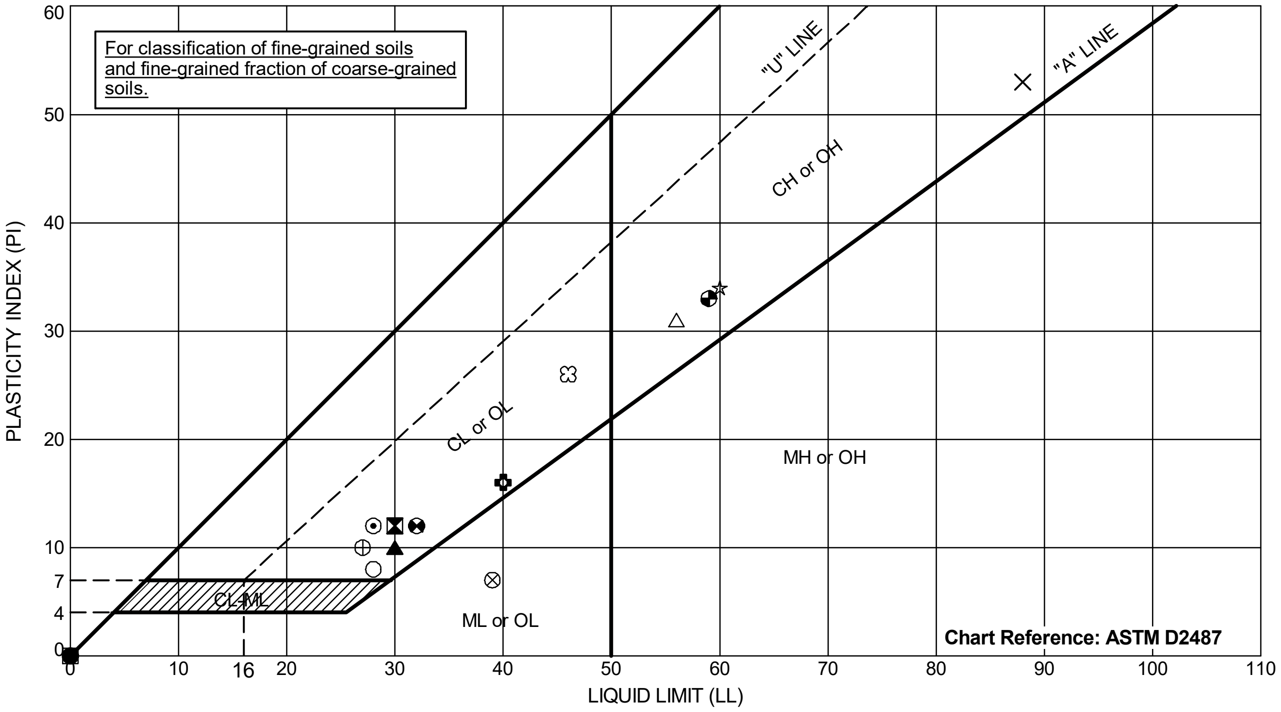
DATE:

LABORATORY TEST
RESULT SUMMARY

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

B-3



| | Exploration ID | Depth (ft.) | Sample Description | Passing #200 | LL | PL | PI |
|---|---|---|---|---|---|---|---|
| ● | B-1 | 15 | SILTY SAND (SM) | 22 | NP | NP | NP |
| ⧗ | B-1B | 30 | CLAYEY SAND (SC) | NM | 30 | 18 | 12 |
| ▲ | B-1B | 40 | CLAYEY SAND (SC) | NM | 30 | 20 | 10 |
| × | B-2 | 6 | SANDY FAT CLAY WITH ORGANICS (OH) | NM | 88 | 35 | 53 |
| ⊙ | B-2 | 21 | SANDY LEAN CLAY (CL) | NM | 28 | 16 | 12 |
| ✤ | B-2 | 46 | CLAYEY SAND (SC) | 30 | 40 | 24 | 16 |
| ○ | B-2 | 66 | SILTY SAND (SM) | NM | 28 | 20 | 8 |
| △ | B-3 | 6 | FAT CLAY WITH ORGANICS (CH) | NM | 56 | 25 | 31 |
| ⊗ | B-3 | 20 | SANDY SILT (ML) | NM | 39 | 32 | 7 |
| ⊕ | B-4 | 6 | SANDY LEAN CLAY (CL) | 54 | 27 | 17 | 10 |
| ☐ | B-4 | 11 | SILTY SAND (SM) | 39 | NP | NP | NP |
| ◍ | B-4 | 15 | SANDY LEAN CLAY (CL) | 54 | 32 | 20 | 12 |
| ◑ | B-5 | 10 | FAT CLAY WITH SAND AND ORGANICS (CH) | 83 | 59 | 26 | 33 |
| ☆ | B-5 | 16 | FAT CLAY (CH) | 93 | 60 | 26 | 34 |
| ✥ | B-5 | 20 | CLAYEY SAND (SC) | 42 | 46 | 20 | 26 |

Testing performed in general accordance with ASTM D4318.
NP = Nonplastic
NM = Not Measured

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20210161.001A

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DATE:

# ATTERBERG LIMITS

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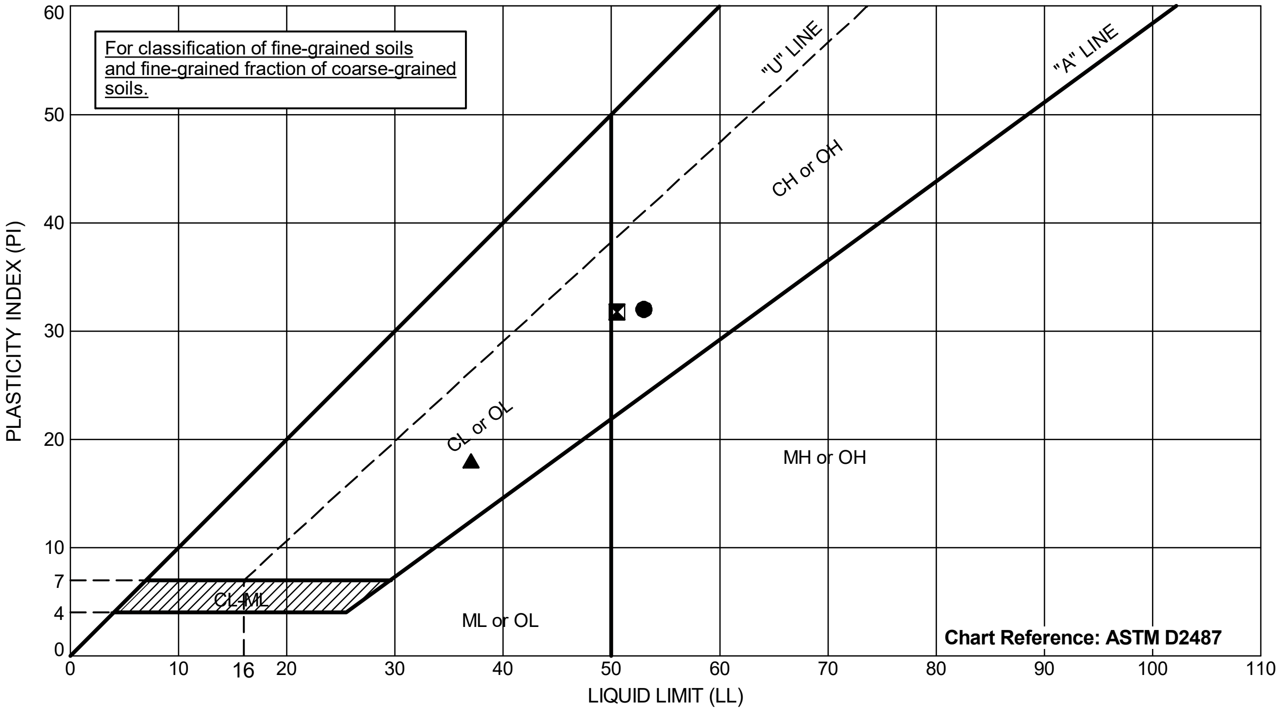
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

B-4



| | Exploration ID | Depth (ft.) | Sample Description | Passing #200 | LL | PL | PI |
|---|---|---|---|---|---|---|---|
| ● | B-6 | 11 | FAT CLAY WITH SAND (CH) | NM | 53 | 21 | 32 |
| ☒ | B-6 | 31 | CLAYEY SAND WITH GRAVEL (SC) | 19 | 50 | 19 | 31 |
| ▲ | B-6 | 35 | CLAYEY SAND WITH GRAVEL (SC) | 16 | 37 | 19 | 18 |
| | | | | | | | |
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Testing performed in general accordance with ASTM D4318.
NP = Nonplastic
NM = Not Measured

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# ATTERBERG LIMITS

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NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

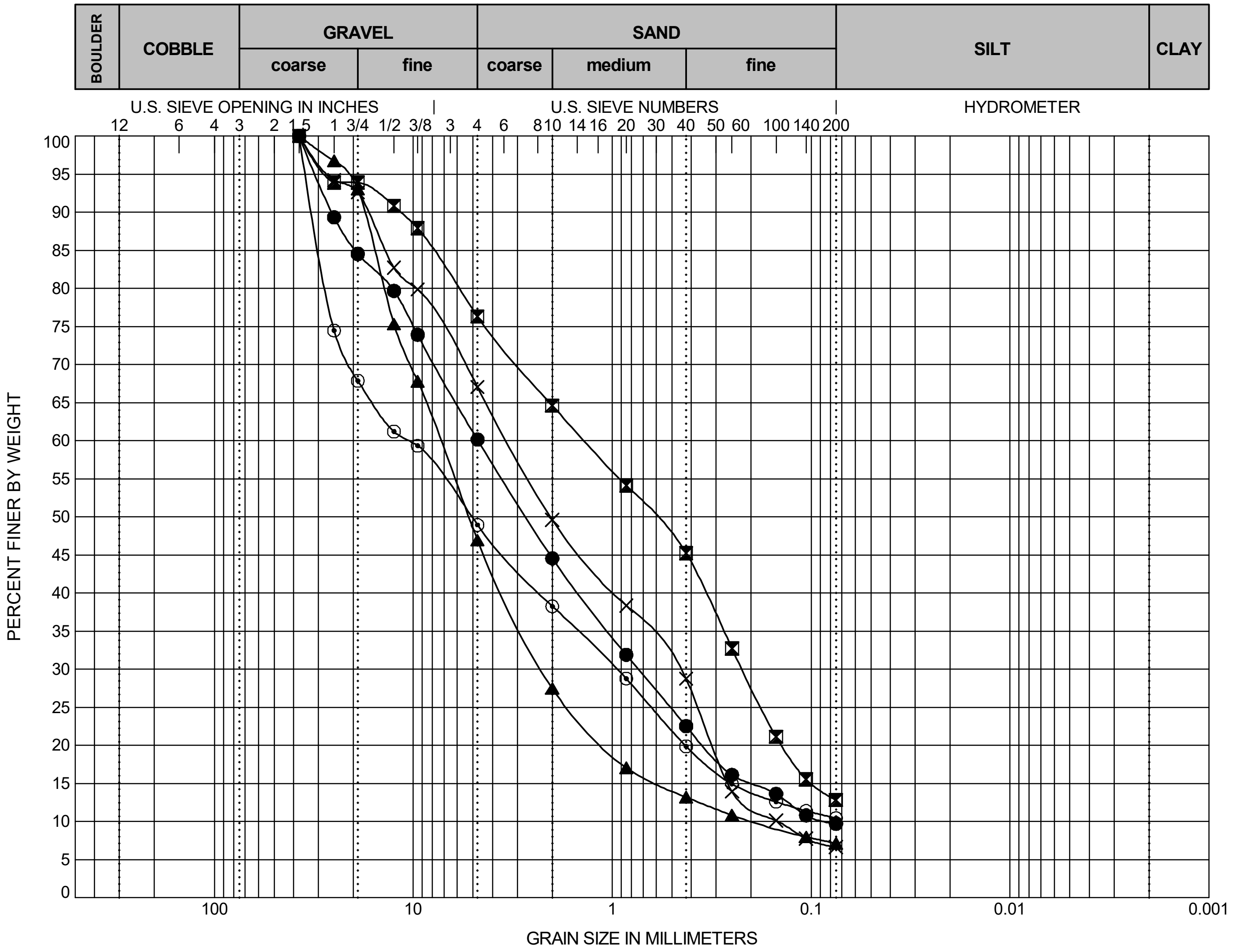
B-5

PLOTTED: 09/24/2020 01:11 PM BY: SDCain

OFFICE FILTER: SANTA ROSA

PROJECT NUMBER: 20210161.001A

gINT FILE: Klf_gint_master_2021
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2021.GLB [_KLF_ATTERBERG (ASTM)]



| | Exploration ID | Depth (ft.) | Sample Description | LL | PL | PI |
|---|---|---|---|---|---|---|
| ● | B-1 | 11 | WELL GRADED SAND WITH CLAY AND GRAVEL (SW-SC) | NM | NM | NM |
| ⧗ | B-1B | 20 | SILTY CLAYEY SAND WITH GRAVEL (SC-SM) | NM | NM | NM |
| ▲ | B-1B | 25 | POORLY GRADED GRAVEL WITH CLAY AND SAND (GP-GC) | NM | NM | NM |
| ✕ | B-1B | 35 | POORLY GRADED SAND WITH CLAY AND GRAVEL (SP-SC) | NM | NM | NM |
| ⊙ | B-2 | 31 | WELL GRADED GRAVEL WITH CLAY AND SAND (GW-GC) | NM | NM | NM |

| | Exploration ID | Depth (ft.) | $D_{100}$ | $D_{60}$ | $D_{30}$ | $D_{10}$ | Cc | Cu | Passing 3/4" | Passing #4 | Passing #200 | %Silt* | %Clay* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | B-1 | 11 | 37.5 | 4.716 | 0.74 | 0.082 | 1.41 | 57.22 | 85 | 60 | 9.7 | NM | NM |
| ⧗ | B-1B | 20 | 37.5 | 1.374 | 0.222 | NM | NM | NM | 94 | 76 | 13 | NM | NM |
| ▲ | B-1B | 25 | 37.5 | 7.333 | 2.242 | 0.196 | 3.49 | 37.37 | 93 | 47 | 7.1 | NM | NM |
| ✕ | B-1B | 35 | 37.5 | 3.35 | 0.466 | 0.147 | 0.44 | 22.72 | 93 | 67 | 6.6 | NM | NM |
| ⊙ | B-2 | 31 | 37.5 | 10.503 | 0.951 | NM | 1.35 | 164.08 | 68 | 49 | 10 | NM | NM |

*These numbers represent silt-sized and clay-sized content but may not indicate the percentage of the material with the engineering properties of silt or clay. Sieve Analysis and Hydrometer Analysis testing performed in general accordance with ASTM D6913(Sieve Analysis) and ASTM D7928 (Hydrometer Analysis).
NP = Nonplastic
NM = Not Measured

Coefficients of Uniformity - $C_u = D_{60} / D_{10}$
Coefficients of Curvature - $C_C = (D_{30})^2 / D_{60} D_{10}$
$D_{60}$ = Grain diameter at 60% passing
$D_{30}$ = Grain diameter at 30% passing
$D_{10}$ = Grain diameter at 10% passing

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PROJECT NO.:
20210161.001A

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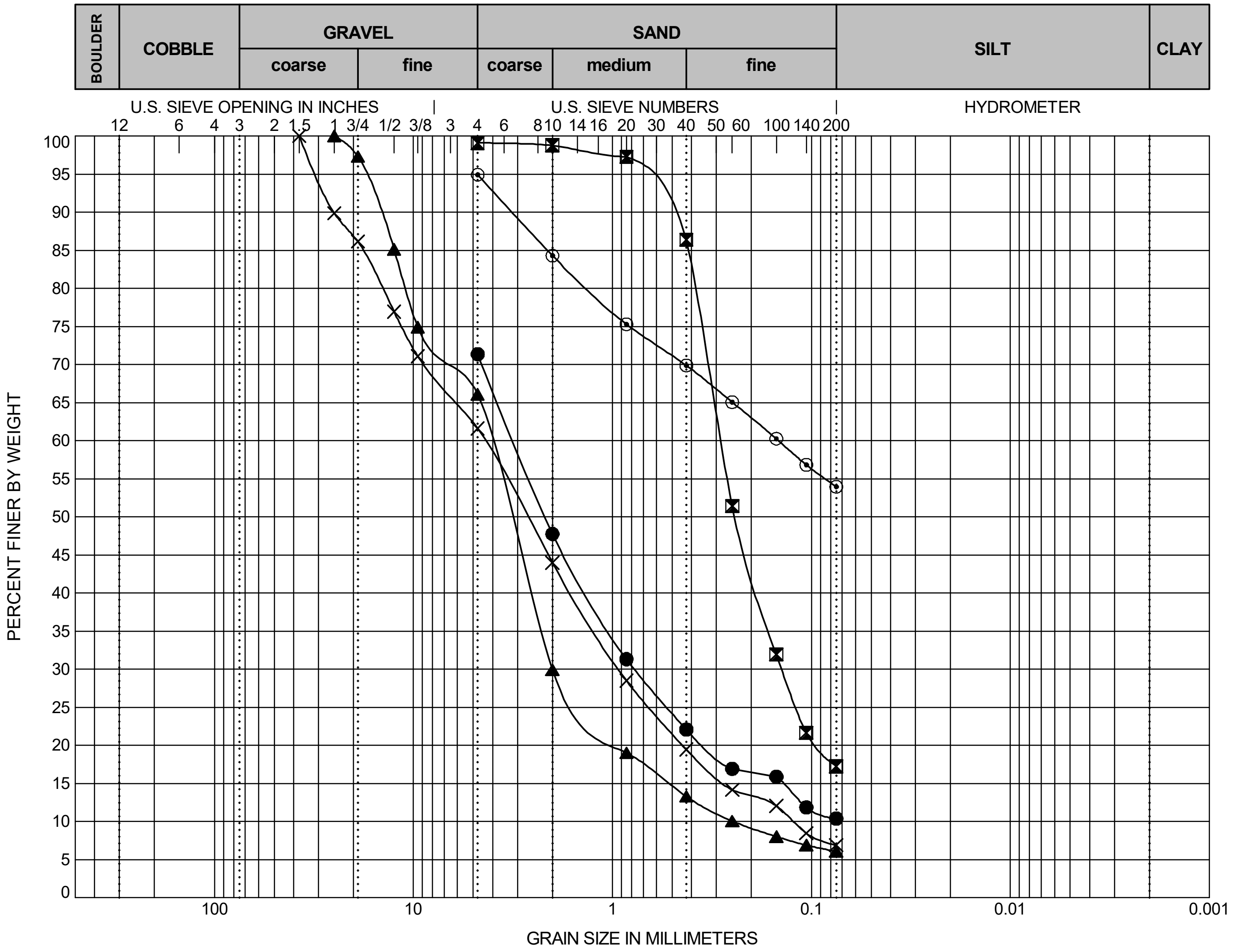
CHECKED BY: MJP
DATE:

## SIEVE ANALYSIS

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

B-6



| Exploration ID | | Depth (ft.) | Sample Description | LL | PL | PI |
|---|---|---|---|---|---|---|
| ● | B-2 | 70 | WELL GRADED SAND WITH SILT (SW-SM) | NM | NM | NM |
| ☒ | B-3 | 40 | CLAYEY SAND (SC) | NM | NM | NM |
| ▲ | B-3 | 60 | POORLY GRADED GRAVEL WITH CLAY AND SAND (GP-GC) | NM | NM | NM |
| ✕ | B-3 | 66 | WELL GRADED SAND WITH CLAY AND GRAVEL (SW-SC) | NM | NM | NM |
| ⊙ | B-4 | 6 | SANDY LEAN CLAY (CL) | 27 | 17 | 10 |

| Exploration ID | | Depth (ft.) | $D_{100}$ | $D_{60}$ | $D_{30}$ | $D_{10}$ | Cc | Cu | Passing 3/4" | Passing #4 | Passing #200 | %Silt* | %Clay* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | B-2 | 70 | 4.75 | 3.134 | 0.771 | NM | 2.76 | 45.60 | | 71 | 10 | NM | NM |
| ☒ | B-3 | 40 | 4.75 | 0.285 | 0.141 | NM | NM | NM | | 99 | 17 | NM | NM |
| ▲ | B-3 | 60 | 25 | 4.108 | 2.006 | 0.247 | 3.96 | 16.61 | 97 | 66 | 6.1 | NM | NM |
| ✕ | B-3 | 66 | 37.5 | 4.391 | 0.924 | 0.123 | 1.58 | 35.68 | 86 | 62 | 6.9 | NM | NM |
| ⊙ | B-4 | 6 | 4.75 | 0.146 | NM | NM | NM | NM | | 95 | 54 | NM | NM |

*These numbers represent silt-sized and clay-sized content but may not indicate the percentage of the material with the engineering properties of silt or clay. Sieve Analysis and Hydrometer Analysis testing performed in general accordance with ASTM D6913(Sieve Analysis) and ASTM D7928 (Hydrometer Analysis).
NP = Nonplastic
NM = Not Measured

Coefficients of Uniformity - $C_u = D_{60} / D_{10}$
Coefficients of Curvature - $C_C = (D_{30})^2 / D_{60} D_{10}$
$D_{60}$ = Grain diameter at 60% passing
$D_{30}$ = Grain diameter at 30% passing
$D_{10}$ = Grain diameter at 10% passing

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20210161.001A

DRAWN BY: DJS
CHECKED BY: MJP
DATE:

## SIEVE ANALYSIS

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE
B-7

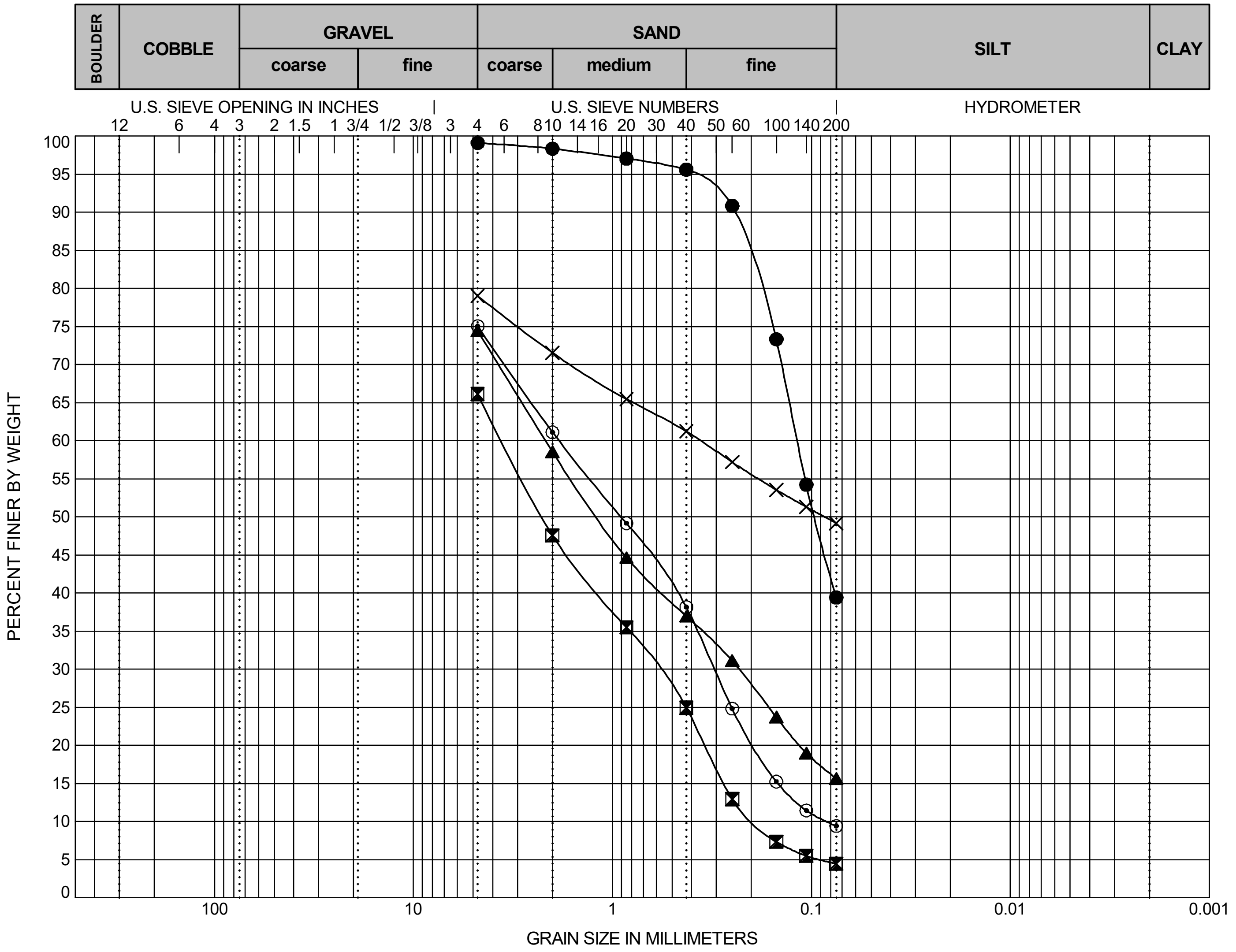
PLOTTED: 09/24/2020 01:14 PM BY: SDCain

OFFICE FILTER: SANTA ROSA

PROJECT NUMBER: 20210161.001A

gINT FILE: Klf_gint_master_2021

gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2021.GLB [_KLF_SIEVE ANALYSIS]



| | Exploration ID | Depth (ft.) | Sample Description | LL | PL | PI |
|---|---|---|---|---|---|---|
| ● | B-4 | 11 | SILTY SAND (SM) | NP | NP | NP |
| ☒ | B-4 | 26 | POORLY GRADED SAND WITH GRAVEL (SP) | NM | NM | NM |
| ▲ | B-4 | 30 | SILTY SAND WITH GRAVEL (SM) | NM | NM | NM |
| × | B-5 | 0.5 - 5 | SILTY SAND WITH GRAVEL AND ORGANICS (SM) | NM | NM | NM |
| ⊙ | B-5 | 30.5 | POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM) | NM | NM | NM |

| | Exploration ID | Depth (ft.) | $D_{100}$ | $D_{60}$ | $D_{30}$ | $D_{10}$ | Cc | Cu | Passing 3/4" | Passing #4 | Passing #200 | %Silt* | %Clay* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | B-4 | 11 | 4.75 | 0.118 | NM | NM | NM | NM | | 99 | 39 | NM | NM |
| ☒ | B-4 | 26 | 4.75 | 3.574 | 0.593 | 0.191 | 0.51 | 18.68 | | 66 | 4.4 | NM | NM |
| ▲ | B-4 | 30 | 4.75 | 2.168 | 0.232 | NM | NM | NM | | 74 | 16 | NM | NM |
| × | B-5 | 0.5 - 5 | 4.75 | 0.362 | NM | NM | NM | NM | | 79 | 49 | NM | NM |
| ⊙ | B-5 | 30.5 | 4.75 | 1.85 | 0.307 | 0.083 | 0.62 | 22.26 | | 75 | 9.4 | NM | NM |

*These numbers represent silt-sized and clay-sized content but may not indicate the percentage of the material with the engineering properties of silt or clay. Sieve Analysis and Hydrometer Analysis testing performed in general accordance with ASTM D6913(Sieve Analysis) and ASTM D7928 (Hydrometer Analysis).

NP = Nonplastic

NM = Not Measured

Coefficients of Uniformity - $C_u = D_{60} / D_{10}$

Coefficients of Curvature - $C_C = (D_{30})^2 / D_{60} D_{10}$

$D_{60}$ = Grain diameter at 60% passing

$D_{30}$ = Grain diameter at 30% passing

$D_{10}$ = Grain diameter at 10% passing

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PROJECT NO.:
20210161.001A

DRAWN BY: DJS

CHECKED BY: MJP

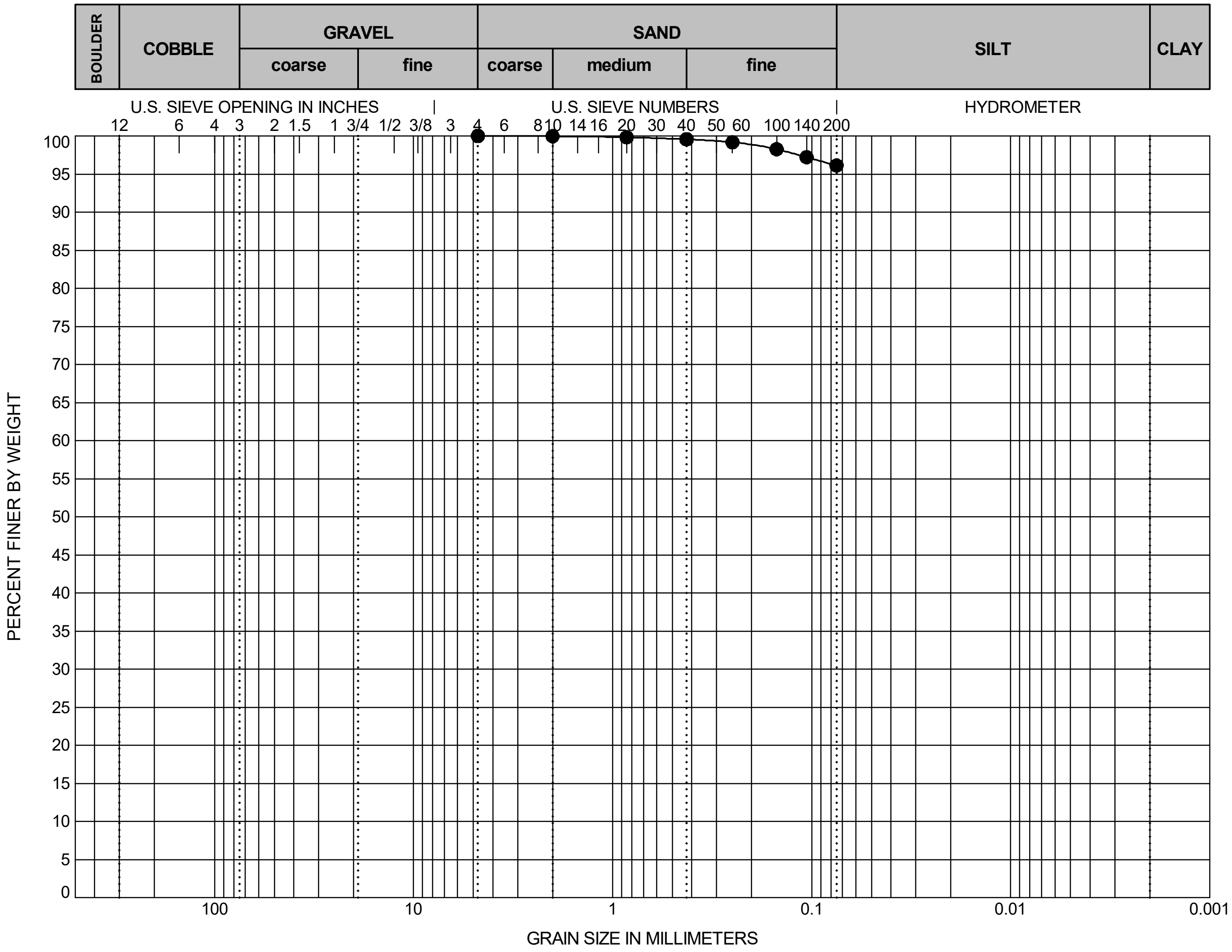
DATE:

SIEVE ANALYSIS

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

B-8



| Exploration ID | | Depth (ft.) | Sample Description | LL | PL | PI |
|---|---|---|---|---|---|---|
| ● | B-6 | 8.5 | FAT CLAY (CH) | NM | NM | NM |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

| Exploration ID | | Depth (ft.) | $D_{100}$ | $D_{60}$ | $D_{30}$ | $D_{10}$ | Cc | Cu | Passing 3/4" | Passing #4 | Passing #200 | %Silt* | %Clay* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | B-6 | 8.5 | 4.75 | NM | NM | NM | NM | NM | | 100 | 96 | NM | NM |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

*These numbers represent silt-sized and clay-sized content but may not indicate the percentage of the material with the engineering properties of silt or clay. Sieve Analysis and Hydrometer Analysis testing performed in general accordance with ASTM D6913(Sieve Analysis) and ASTM D7928 (Hydrometer Analysis).
NP = Nonplastic
NM = Not Measured

Coefficients of Uniformity - $C_u = D_{60} / D_{10}$
Coefficients of Curvature - $C_C = (D_{30})^2 / D_{60} D_{10}$
$D_{60}$ = Grain diameter at 60% passing
$D_{30}$ = Grain diameter at 30% passing
$D_{10}$ = Grain diameter at 10% passing

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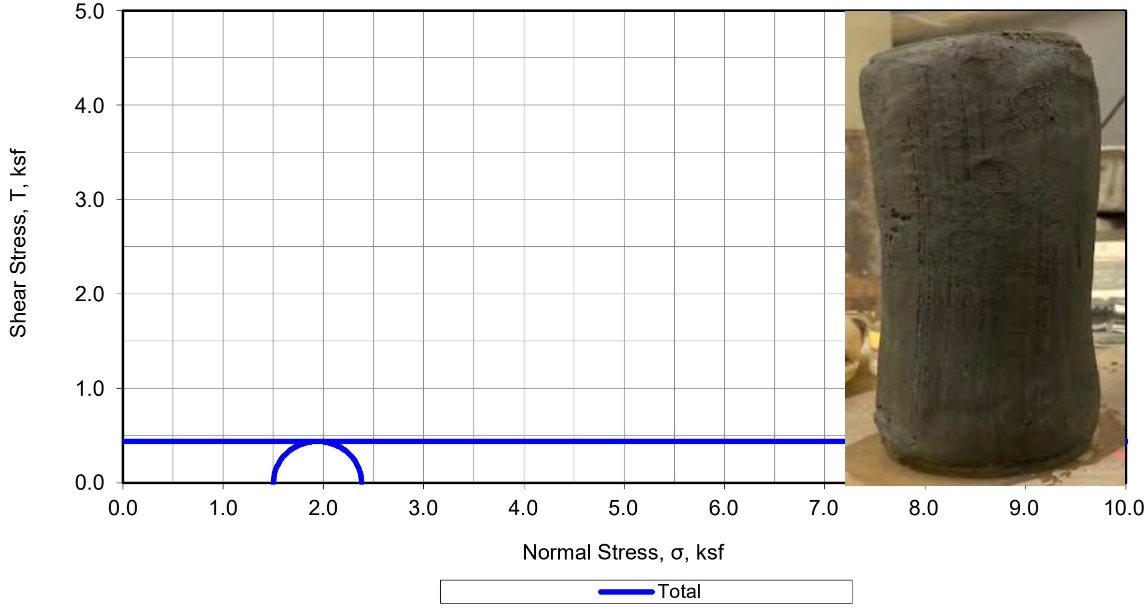
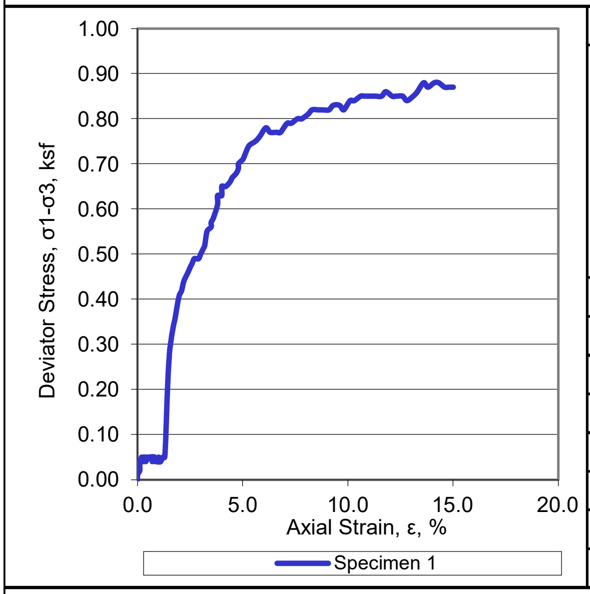
| | | | |
|---|---|---|---|
| PROJECT NO.:<br>20210161.001A | | SIEVE ANALYSIS | FIGURE |
| DRAWN BY: | DJS | PG&E L-021A<br>NATURAL GAS PIPELINE REPLACEMENT<br>NAPA, CALIFORNIA | B-9 |
| CHECKED BY: | MJP | | |
| DATE: | | | |

| Total | |
|---|---|
| c = 0.44 | ksf |

Specimen Shear Picture





| | | | |
|---|---|---|---|
| Specimen No. | | | 1 |
| Initial | Diameter, in | $D_O$ | 2.85 |
| | Height, in | $H_O$ | 5.99 |
| | Water Content, % | $\omega_O$ | 48.4 |
| | Dry Density, lbs/ft$^3$ | $\gamma_{d_o}$ | 73.3 |
| | Saturation, % | $S_O$ | 102 |
| | Void Ratio | $e_O$ | 1.257 |
| Minor Principal Stress, ksf | | $\sigma_3$ | 1.50 |
| Maximum Deviator Stress, ksf | | $(\sigma1-\sigma3)_{max}$ | 0.88 |
| Time to $(\sigma_1-\sigma_3)_{max}$, min | | $t_f$ | 14.32 |
| Deviator Stress @ 15% Axial Strain, ksf | | $(\sigma_1-\sigma_3)_{15\%}$ | 0.87 |
| Ultimate Deviator Stress, ksf | | $(\sigma_1-\sigma_3)_{ult}$ | na |
| Rate of strain, %/min | | $'\varepsilon$ | 1.00 |
| Axial Strain at Failure, % | | $\varepsilon_f$ | 14.32 |

Description of Specimen: Fat Clay (CH)

Amount of Material Finer than the No. 200, %: nm

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LL: nm | PL: nm | PI: nm | $G_S$: 2.65 Assumed | Specimen Type: | Undisturbed | Test Method: ASTM D2850 | |

**Membrane correction applied**

| | |
|---|---|
| Boring: | B-2 |
| Sample: | S-5 |
| Depth, ft: | 16.0 |
| Test Date: | 9/18/20 |

Remarks: nm= not measured, na = not applicable

KLEINFELDER
Bright People. Right Solutions.

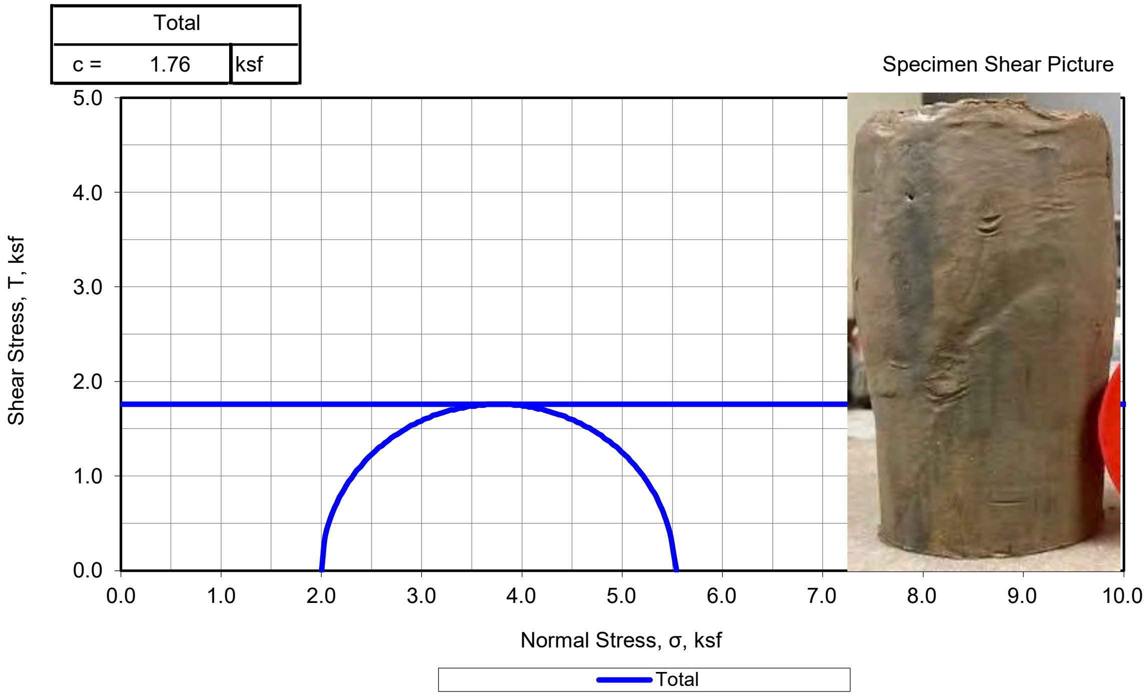
PROJECT NO.: 20210161
DRAWN BY: CP
CHECKED BY: CP
DATE: 9/22/2020
REVISED: -

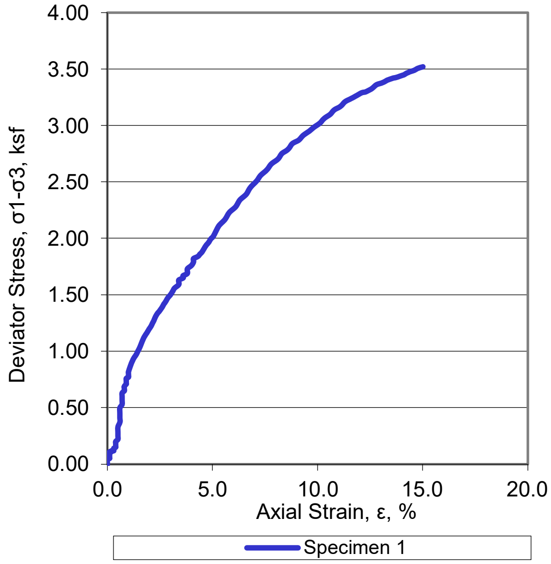
# TRIAXIAL COMPRESSION TEST (UU)

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

B-10





| Specimen No. | | | 1 |
|---|---|---|---|
| Initial | Diameter, in | $D_O$ | 2.40 |
| | Height, in | $H_O$ | 5.42 |
| | Water Content, % | $\omega_O$ | 23.2 |
| | Dry Density, lbs/ft$^3$ | $\gamma_{d_o}$ | 103.3 |
| | Saturation, % | $S_O$ | 102 |
| | Void Ratio | $e_O$ | 0.602 |
| Minor Principal Stress, ksf | | $\sigma_3$ | 2.00 |
| Maximum Deviator Stress, ksf | | $(\sigma 1-\sigma 3)_{max}$ | 3.52 |
| Time to $(\sigma_1\text{-}\sigma_3)_{max}$, min | | $t_f$ | 15.03 |
| Deviator Stress @ 15% Axial Strain, ksf | | $(\sigma_1-\sigma_3)_{15\%}$ | 3.52 |
| Ultimate Deviator Stress, ksf | | $(\sigma_1-\sigma_3)_{ult}$ | na |
| Rate of strain, %/min | | 'ε | 1.00 |
| Axial Strain at Failure, % | | $\varepsilon_f$ | 15.03 |

Description of Specimen: Sandy Lean Clay (CL)

Amount of Material Finer than the No. 200, %: nm

| LL: 28 | PL: 16 | PI: 12 | $G_S$: 2.65 Assumed | Specimen Type: Undisturbed | Test Method: ASTM D2850 |
|---|---|---|---|---|---|

**Membrane correction applied**

| | |
|---|---|
| Boring: | B-2 |
| Sample: | 6C |
| Depth, ft: | 21.0 |
| Test Date: | 9/18/20 |

Remarks: nm= not measured, na = not applicable

KLEINFELDER
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PROJECT NO.: 20210161
DRAWN BY: CP
CHECKED BY: CP
DATE: 9/22/2020
REVISED: -

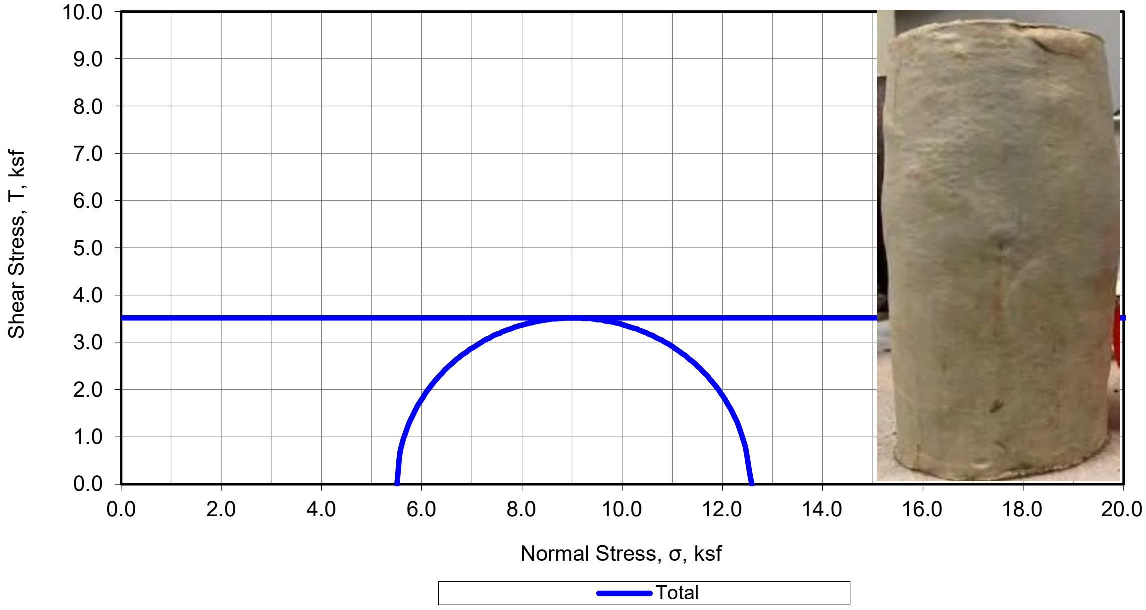
TRIAXIAL COMPRESSION TEST (UU)

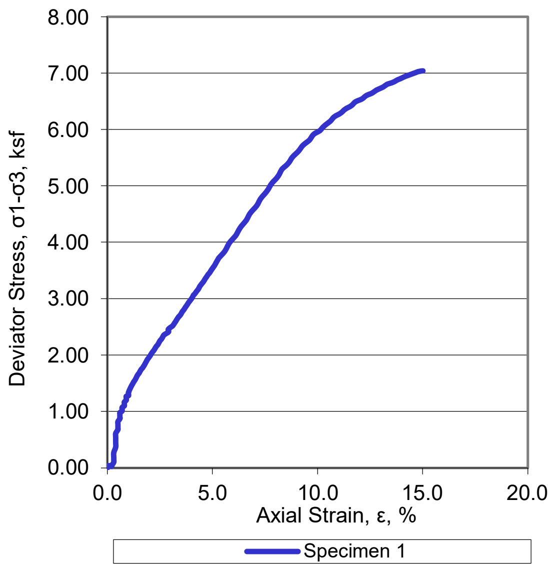
PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

B-11

| Total | | |
|---|---|---|
| c = | 3.52 | ksf |





| Specimen No. | | | 1 |
|---|---|---|---|
| Initial | Diameter, in | $D_O$ | 2.41 |
| | Height, in | $H_O$ | 5.82 |
| | Water Content, % | $\omega_O$ | 31.1 |
| | Dry Density, lbs/ft$^3$ | $\gamma_{d_o}$ | 91.2 |
| | Saturation, % | $S_O$ | 101 |
| | Void Ratio | $e_O$ | 0.812 |
| Minor Principal Stress, ksf | | $\sigma_3$ | 5.50 |
| Maximum Deviator Stress, ksf | | $(\sigma1-\sigma3)_{max}$ | 7.04 |
| Time to $(\sigma_1$-$\sigma_3)_{max}$, min | | $t_f$ | 15.02 |
| Deviator Stress @ 15% Axial Strain, ksf | | $(\sigma_1-\sigma_3)_{15\%}$ | 7.04 |
| Ultimate Deviator Stress, ksf | | $(\sigma_1-\sigma_3)_{ult}$ | na |
| Rate of strain, %/min | | 'ε | 1.00 |
| Axial Strain at Failure, % | | $\varepsilon_f$ | 15.02 |

Description of Specimen: Clayey Sand (SC)

Amount of Material Finer than the No. 200, %: nm

LL: nm | PL: nm | PI: nm | $G_S$: 2.65 Assumed | Specimen Type: Undisturbed | Test Method: ASTM D2850

**Membrane correction applied**

| | |
|---|---|
| Boring: | B-2 |
| Sample: | 13C |
| Depth, ft: | 56.0 |
| Test Date: | 9/18/20 |

Remarks: nm= not measured, na = not applicable

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DRAWN BY: CP
CHECKED BY: CP
DATE: 9/22/2020
REVISED: -

TRIAXIAL COMPRESSION TEST (UU)

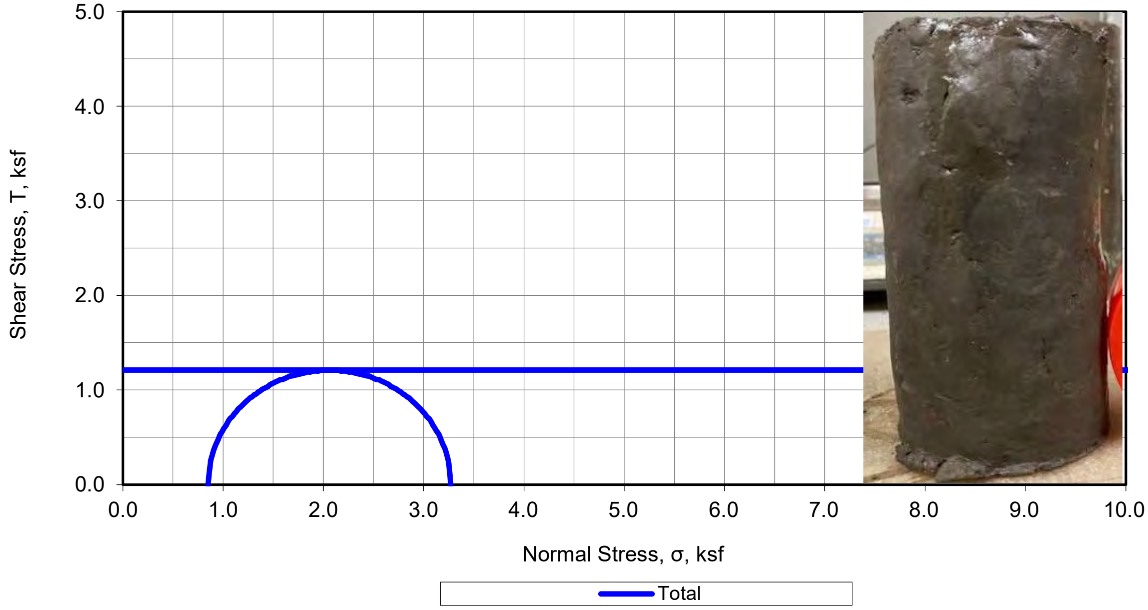
PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

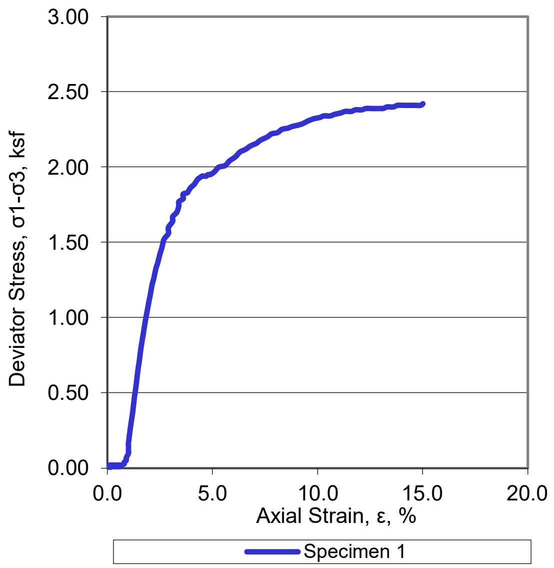
FIGURE

B-12

| Total | |
|---|---|
| c = 1.21 | ksf |

Specimen Shear Picture





| Specimen No. | | | 1 |
|---|---|---|---|
| Initial | Diameter, in | $D_O$ | 2.41 |
| | Height, in | $H_O$ | 5.58 |
| | Water Content, % | $\omega_O$ | 67.9 |
| | Dry Density, lbs/ft$^3$ | $\gamma_{d_o}$ | 64.5 |
| | Saturation, % | $S_O$ | 115 |
| | Void Ratio | $e_O$ | 1.565 |
| Minor Principal Stress, ksf | | $\sigma_3$ | 0.85 |
| Maximum Deviator Stress, ksf | | $(\sigma1-\sigma3)_{max}$ | 2.42 |
| Time to $(\sigma_1-\sigma_3)_{max}$, min | | $t_f$ | 15.02 |
| Deviator Stress @ 15% Axial Strain, ksf | | $(\sigma_1-\sigma_3)_{15\%}$ | 2.42 |
| Ultimate Deviator Stress, ksf | | $(\sigma_1-\sigma_3)_{ult}$ | na |
| Rate of strain, %/min | | 'ε | 1.00 |
| Axial Strain at Failure, % | | $\varepsilon_f$ | 15.02 |

Description of Specimen: Fat Clay (CH)

Amount of Material Finer than the No. 200, %: nm

| LL: nm | PL: nm | PI: nm | $G_S$: 2.65 Assumed | Specimen Type: Undisturbed | Test Method: ASTM D2850 |
|---|---|---|---|---|---|

**Membrane correction applied**

| | |
|---|---|
| Boring: | B-5 |
| Sample: | 3C |
| Depth, ft: | 8.5 |
| Test Date: | 9/18/20 |

Remarks: nm= not measured, na = not applicable

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PROJECT NO.: 20210161
DRAWN BY: CP
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DATE: 9/22/2020
REVISED: -

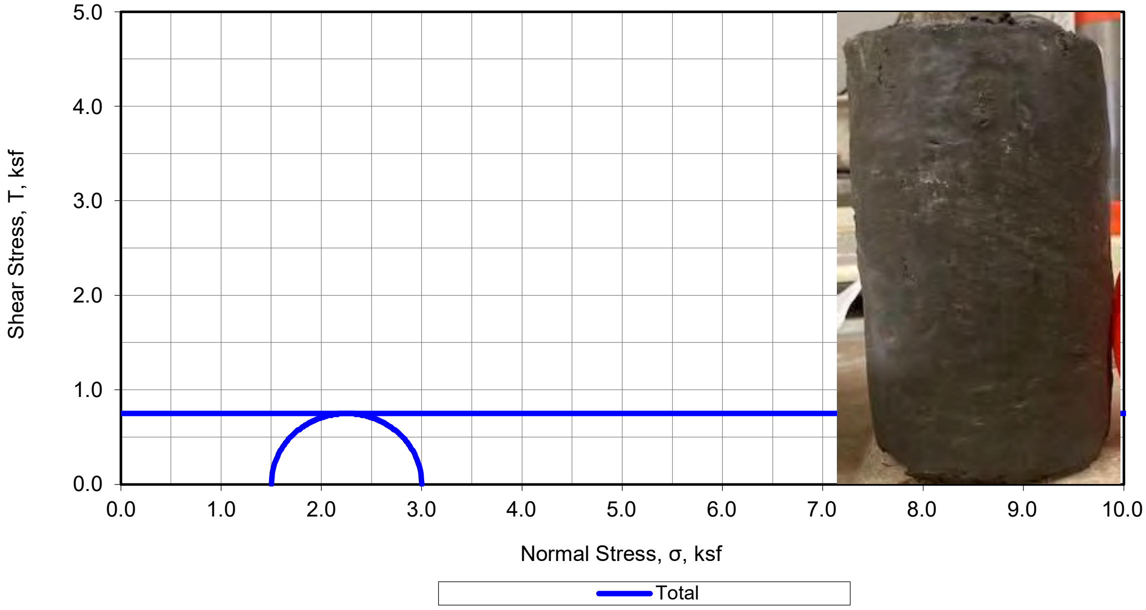
## TRIAXIAL COMPRESSION TEST (UU)

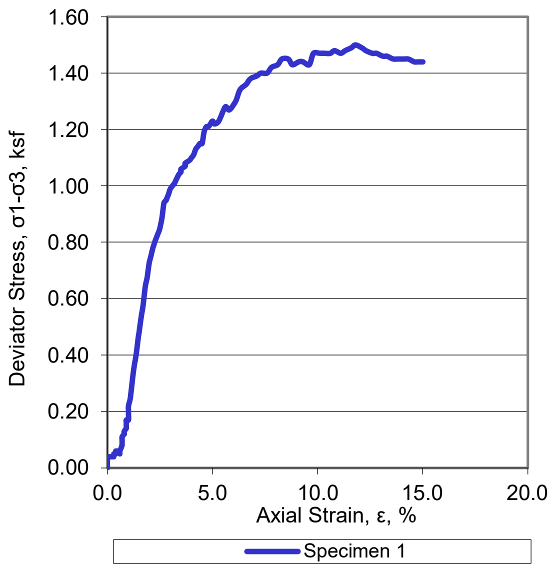
PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

B-13

| Total | |
|---|---|
| c = 0.75 | ksf |





| | Specimen No. | | 1 |
|---|---|---|---|
| Initial | Diameter, in | $D_O$ | 2.39 |
| | Height, in | $H_O$ | 5.22 |
| | Water Content, % | $\omega_O$ | 51.7 |
| | Dry Density, lbs/ft$^3$ | $^{\gamma}d_o$ | 70.4 |
| | Saturation, % | $S_O$ | 102 |
| | Void Ratio | $e_O$ | 1.349 |
| Minor Principal Stress, ksf | | $\sigma_3$ | 1.50 |
| Maximum Deviator Stress, ksf | | $(\sigma1-\sigma3)_{max}$ | 1.50 |
| Time to $(\sigma_1\text{-}\sigma_3)_{max}$, min | | $t_f$ | 11.82 |
| Deviator Stress @ 15% Axial Strain, ksf | | $(\sigma_1-\sigma_3)_{15\%}$ | 1.44 |
| Ultimate Deviator Stress, ksf | | $(\sigma_1-\sigma_3)_{ult}$ | na |
| Rate of strain, %/min | | 'ε | 1.00 |
| Axial Strain at Failure, % | | $\varepsilon_f$ | 11.82 |

Description of Specimen: Fat Clay (CH)

Amount of Material Finer than the No. 200, %: 93

| LL: 60 | PL: 26 | PI: 34 | $G_S$: 2.65 Assumed | Specimen Type: Undisturbed | Test Method: ASTM D2850 |
|---|---|---|---|---|---|

**Membrane correction applied**

| | |
|---|---|
| Boring: | B-5 |
| Sample: | 5C |
| Depth, ft: | 16.0 |
| Test Date: | 9/18/20 |

Remarks: nm= not measured, na = not applicable

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| | |
|---|---|
| PROJECT NO.: | 20210161 |
| DRAWN BY: | CP |
| CHECKED BY: | CP |
| DATE: | 9/22/2020 |
| REVISED: | - |

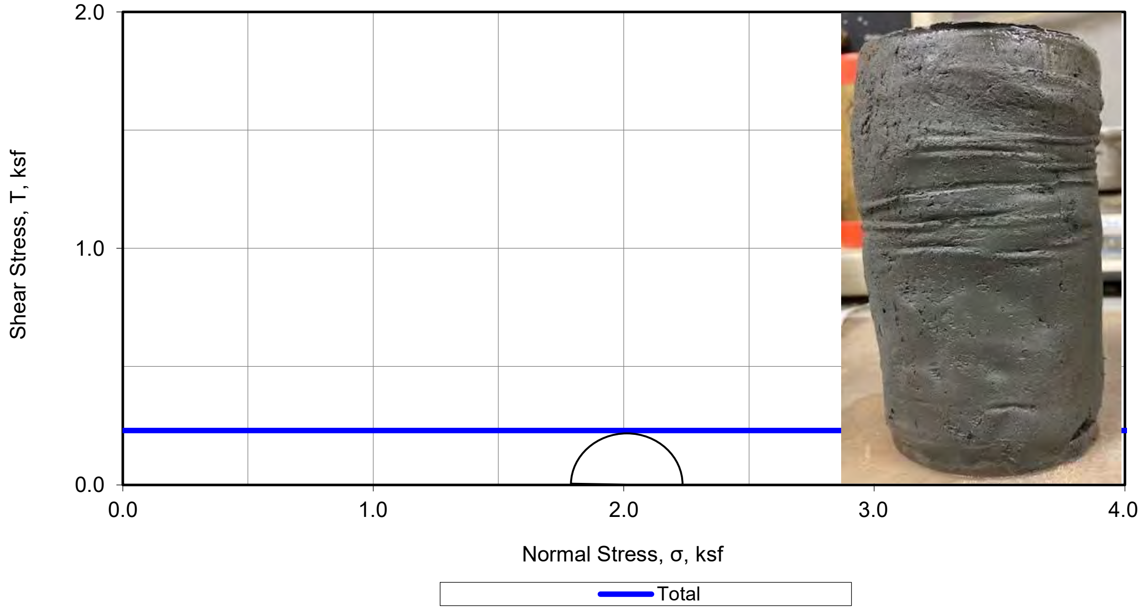
TRIAXIAL COMPRESSION
TEST (UU)

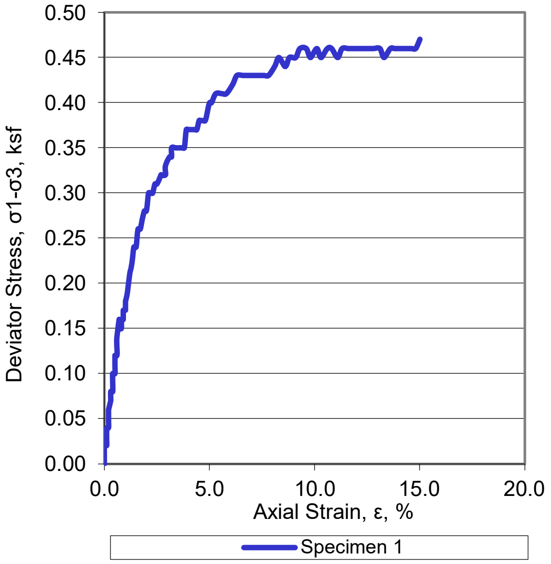
PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

B-14

| Total | |
|---|---|
| c = 0.23 | ksf |





| | | | |
|---|---|---|---|
| Specimen No. | | | 1 |
| Initial | Diameter, in | $D_O$ | 2.89 |
| | Height, in | $H_O$ | 6.11 |
| | Water Content, % | $\omega_O$ | 56.3 |
| | Dry Density, lbs/ft$^3$ | $\gamma_{d_o}$ | 69.7 |
| | Saturation, % | $S_O$ | 109 |
| | Void Ratio | $e_O$ | 1.371 |
| Minor Principal Stress, ksf | | $\sigma_3$ | 1.80 |
| Maximum Deviator Stress, ksf | | $(\sigma1-\sigma3)_{max}$ | 0.47 |
| Time to $(\sigma_1$-$\sigma_3)_{max}$, min | | $t_f$ | 15.02 |
| Deviator Stress @ 15% Axial Strain, ksf | | $(\sigma_1-\sigma_3)_{15\%}$ | 0.47 |
| Ultimate Deviator Stress, ksf | | $(\sigma_1-\sigma_3)_{ult}$ | na |
| Rate of strain, %/min | | 'ε | 1.00 |
| Axial Strain at Failure, % | | $\varepsilon_f$ | 15.02 |

Description of Specimen: Fat Clay (CH)

Amount of Material Finer than the No. 200, %: nm

| | | | | | |
|---|---|---|---|---|---|
| LL: nm | PL: nm | PI: nm | $G_S$: 2.65 Assumed | Specimen Type: Undisturbed | Test Method: ASTM D2850 |

**Membrane correction applied**

| | |
|---|---|
| Boring: | B-6 |
| Sample: | S-8 |
| Depth, ft: | 18.0 |
| Test Date: | 9/18/20 |

Remarks: nm= not measured, na = not applicable

KLEINFELDER
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DRAWN BY: CP
CHECKED BY: CP
DATE: 9/22/2020
REVISED: -

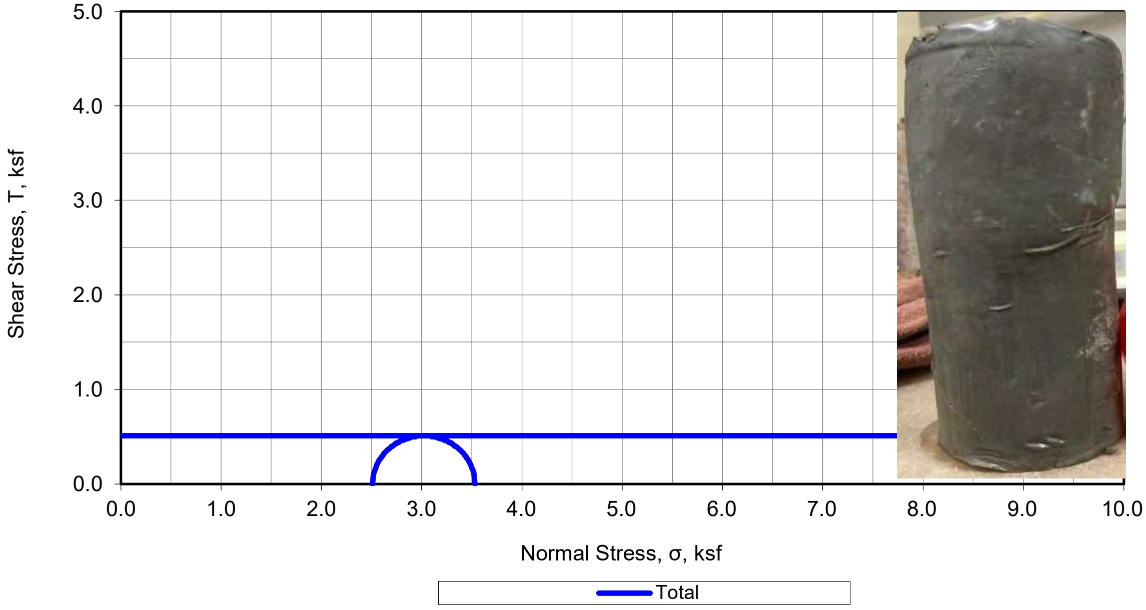
# TRIAXIAL COMPRESSION TEST (UU)

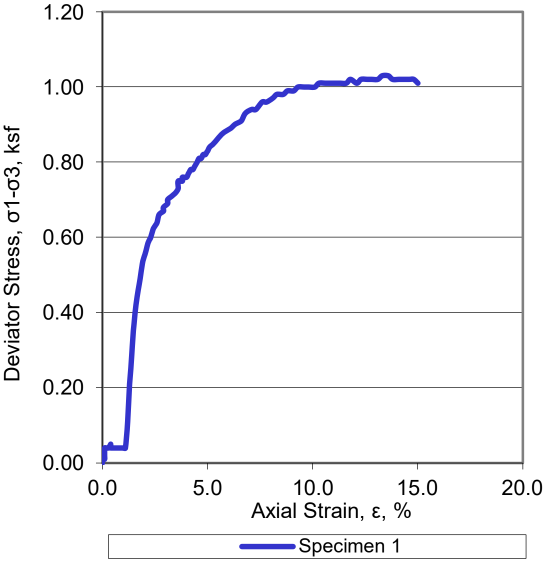
PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE
B-15

| Total | |
|---|---|
| c = 0.51 | ksf |

Specimen Shear Picture





| | | | |
|---|---|---|---|
| Specimen No. | | | 1 |
| Initial | Diameter, in | $D_O$ | 2.42 |
| | Height, in | $H_O$ | 5.98 |
| | Water Content, % | $\omega_O$ | 33.8 |
| | Dry Density, lbs/ft$^3$ | $^{\gamma}d_o$ | 88.2 |
| | Saturation, % | $S_O$ | 102 |
| | Void Ratio | $e_O$ | 0.875 |
| Minor Principal Stress, ksf | | $\sigma_3$ | 2.51 |
| Maximum Deviator Stress, ksf | | $(\sigma1-\sigma3)_{max}$ | 1.03 |
| Time to $(\sigma_1$-$\sigma_3)_{max}$, min | | $t_f$ | 13.33 |
| Deviator Stress @ 15% Axial Strain, ksf | | $(\sigma_1-\sigma_3)_{15\%}$ | 1.01 |
| Ultimate Deviator Stress, ksf | | $(\sigma_1-\sigma_3)_{ult}$ | na |
| Rate of strain, %/min | | 'ε | 1.00 |
| Axial Strain at Failure, % | | $\varepsilon_f$ | 13.33 |

Description of Specimen: Fat Clay (CH)

Amount of Material Finer than the No. 200, %: nm

| | | | | | |
|---|---|---|---|---|---|
| LL: nm | PL: nm | PI: nm | $G_S$: 2.65 Assumed | Specimen Type: Undisturbed | Test Method: ASTM D2850 |

**Membrane correction applied**

| | |
|---|---|
| Boring: | B-6 |
| Sample: | 10b |
| Depth, ft: | 25.5 |
| Test Date: | 9/18/20 |

Remarks: nm= not measured, na = not applicable

KLEINFELDER
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PROJECT NO.: 20210161
DRAWN BY: CP
CHECKED BY: CP
DATE: 9/22/2020
REVISED: -

TRIAXIAL COMPRESSION
TEST (UU)

PG&E L-021A
NATURAL GAS PIPELINE REPLACEMENT
NAPA, CALIFORNIA

FIGURE

B-16

KLEINFELDER

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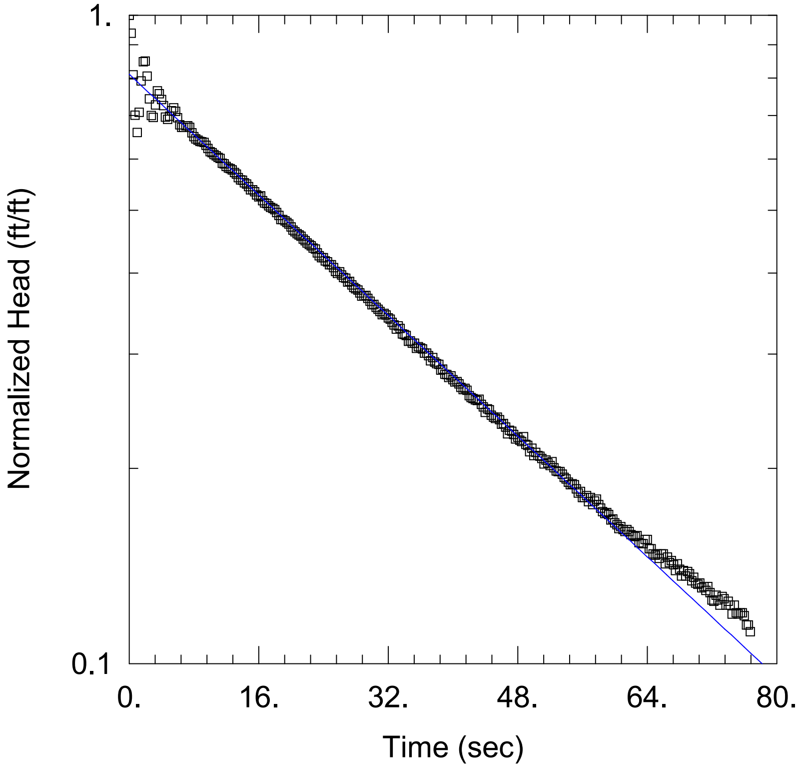
# Appendix C



## PG&E L-021A B-5 IN-1

Data Set: U:\1-Projects-HYDRO\20210161 - PG&E L-021A\L-021A Slug Testing\B-5\B-5 IN-1.aqt
Date: 09/16/20 Time: 13:37:07

## PROJECT INFORMATION

Company: Kleinfelder
Client: PG&E
Project: 20210161
Location: Napa, CA
Test Well: B-5
Test Date: 9-9-2020

## AQUIFER DATA

Saturated Thickness: 75. ft
Anisotropy Ratio (Kz/Kr): 0.01

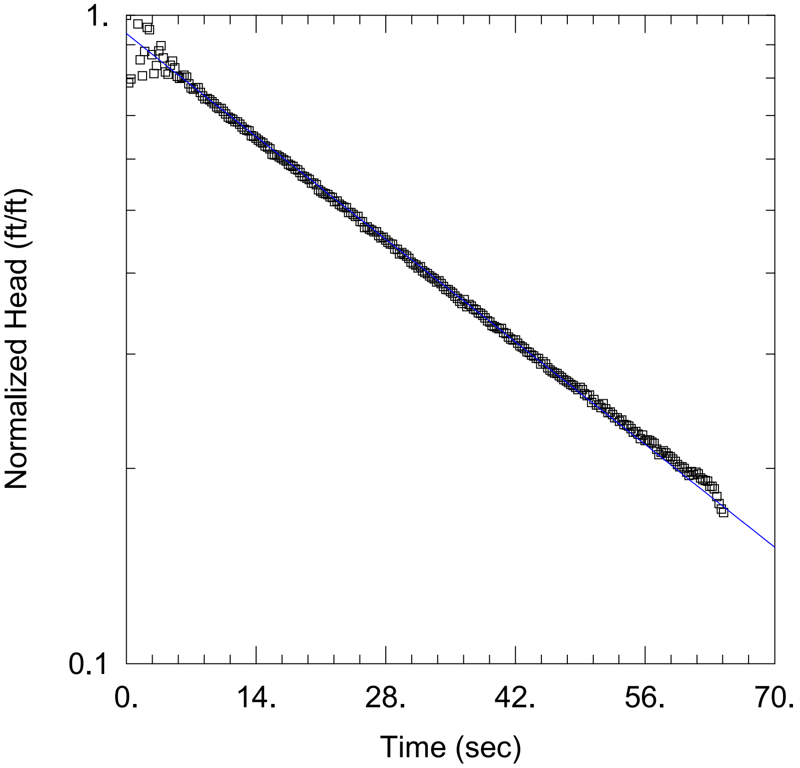
## WELL DATA (B-5)

Initial Displacement: 1.796 ft
Static Water Column Height: 36.5 ft
Total Well Penetration Depth: 36.5 ft
Screen Length: 25. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3333 ft

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.001178 ft/min
y0 = 1.456 ft



PG&E L-021A B-5 OUT-1

Data Set: U:\1-Projects-HYDRO\20210161 - PG&E L-021A\L-021A Slug Testing\B-5\B-5 OUT-1.aqt
Date: 09/16/20
Time: 14:02:18

PROJECT INFORMATION

Company: Kleinfelder
Client: PG&E
Project: 20210161
Location: Napa, CA
Test Well: B-5
Test Date: 9-9-2020

AQUIFER DATA

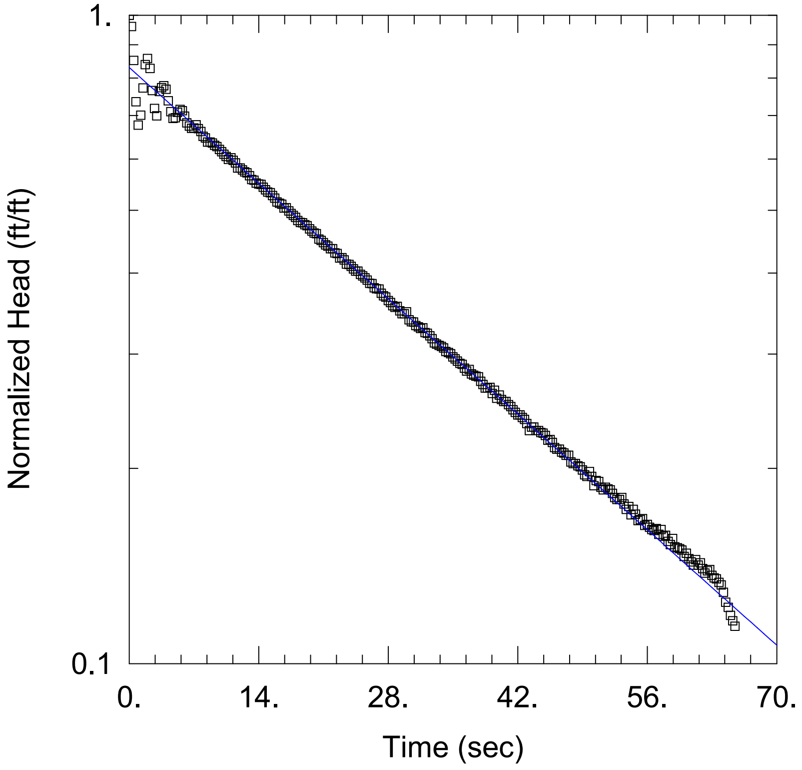
Saturated Thickness: 75. ft
Anisotropy Ratio (Kz/Kr): 0.01

WELL DATA (B-5)

Initial Displacement: 1.785 ft
Static Water Column Height: 36.5 ft
Total Well Penetration Depth: 36.5 ft
Screen Length: 25. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.001146 ft/min
y0 = 1.671 ft



## PG&E L-021A B-5 IN-2

Data Set: U:\1-Projects-HYDRO\20210161 - PG&E L-021A\L-021A Slug Testing\B-5\B-5 IN-2.aqt
Date: 09/16/20
Time: 13:43:05

## PROJECT INFORMATION

Company: Kleinfelder
Client: PG&E
Project: 20210161
Location: Napa, CA
Test Well: B-5
Test Date: 9-9-2020

## AQUIFER DATA

Saturated Thickness: 75. ft
Anisotropy Ratio (Kz/Kr): 0.01

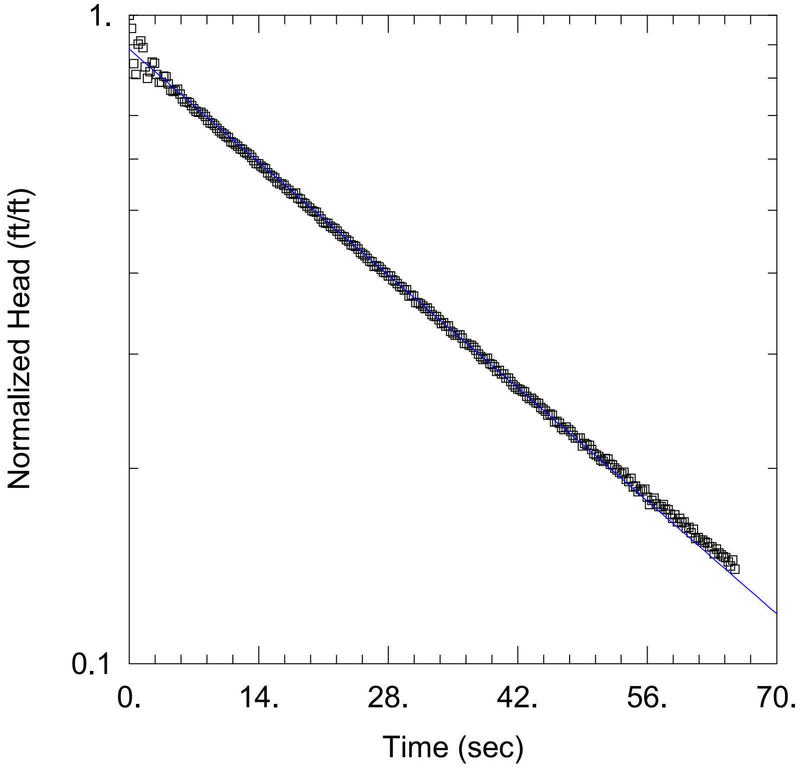
## WELL DATA (B-5)

Initial Displacement: 1.77 ft
Static Water Column Height: 36.5 ft
Total Well Penetration Depth: 36.5 ft
Screen Length: 25. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3333 ft

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00129 ft/min
y0 = 1.47 ft



## PG&E L-021A B-5 OUT-2

Data Set: U:\1-Projects-HYDRO\20210161 - PG&E L-021A\L-021A Slug Testing\B-5\B-5 OUT-2.aqt
Date: 09/16/20 Time: 14:24:55

## PROJECT INFORMATION

Company: Kleinfelder
Client: PG&E
Project: 20210161
Location: Napa, CA
Test Well: B-5
Test Date: 9-9-2020

## AQUIFER DATA

Saturated Thickness: 75. ft
Anisotropy Ratio (Kz/Kr): 0.01

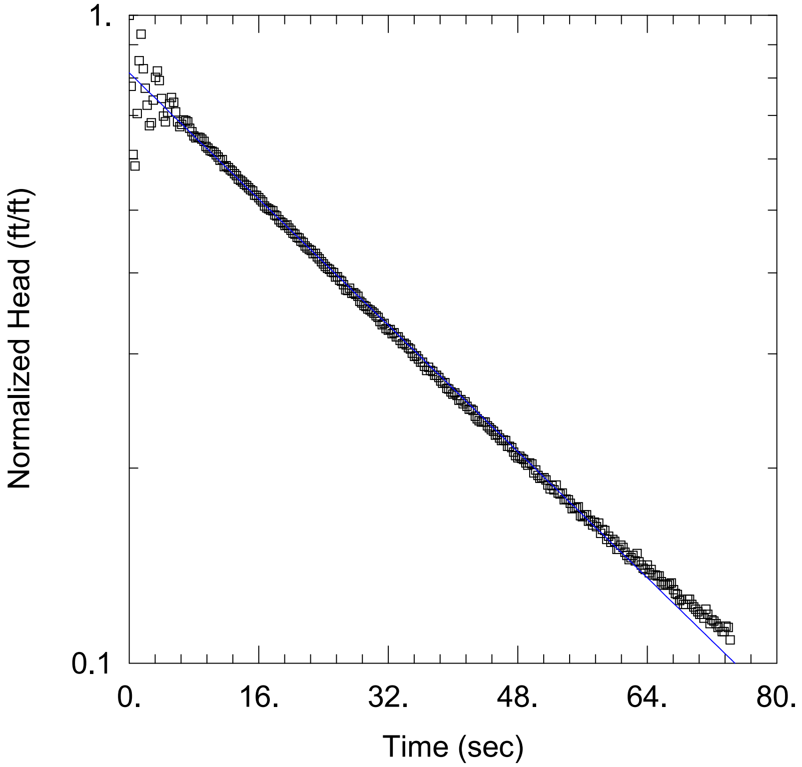
## WELL DATA (B-5)

Initial Displacement: 1.917 ft
Static Water Column Height: 36.5 ft
Total Well Penetration Depth: 36.5 ft
Screen Length: 25. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3333 ft

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.001261 ft/min
y0 = 1.699 ft



## PG&E L-021A B-5 IN-3

Data Set: U:\1-Projects-HYDRO\20210161 - PG&E L-021A\L-021A Slug Testing\B-5\B-5 IN-3.aqt
Date: 09/16/20 Time: 13:51:16

## PROJECT INFORMATION

Company: Kleinfelder
Client: PG&E
Project: 20210161
Location: Napa, CA
Test Well: B-5
Test Date: 9-9-2020

## AQUIFER DATA

Saturated Thickness: 75. ft
Anisotropy Ratio (Kz/Kr): 0.01

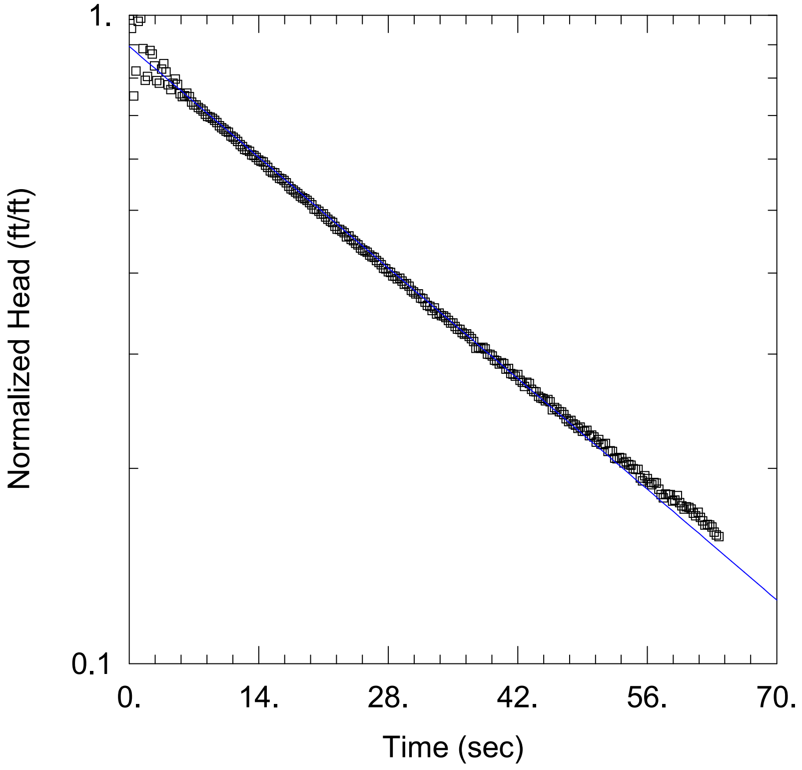
## WELL DATA (B-5)

Initial Displacement: 1.842 ft
Static Water Column Height: 36.5 ft
Total Well Penetration Depth: 36.5 ft
Screen Length: 25. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3333 ft

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.001233 ft/min
y0 = 1.501 ft



## PG&E L-021A B-5 OUT-3

Data Set: U:\1-Projects-HYDRO\20210161 - PG&E L-021A\L-021A Slug Testing\B-5\B-5 OUT-3.aqt
Date: 09/16/20 Time: 14:29:54

## PROJECT INFORMATION

Company: Kleinfelder
Client: PG&E
Project: 20210161
Location: Napa, CA
Test Well: B-5
Test Date: 9-9-2020

## AQUIFER DATA

Saturated Thickness: 75. ft
Anisotropy Ratio (Kz/Kr): 0.01

## WELL DATA (B-5)

Initial Displacement: 1.982 ft
Total Well Penetration Depth: 36.5 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 36.5 ft
Screen Length: 25. ft
Well Radius: 0.3333 ft

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

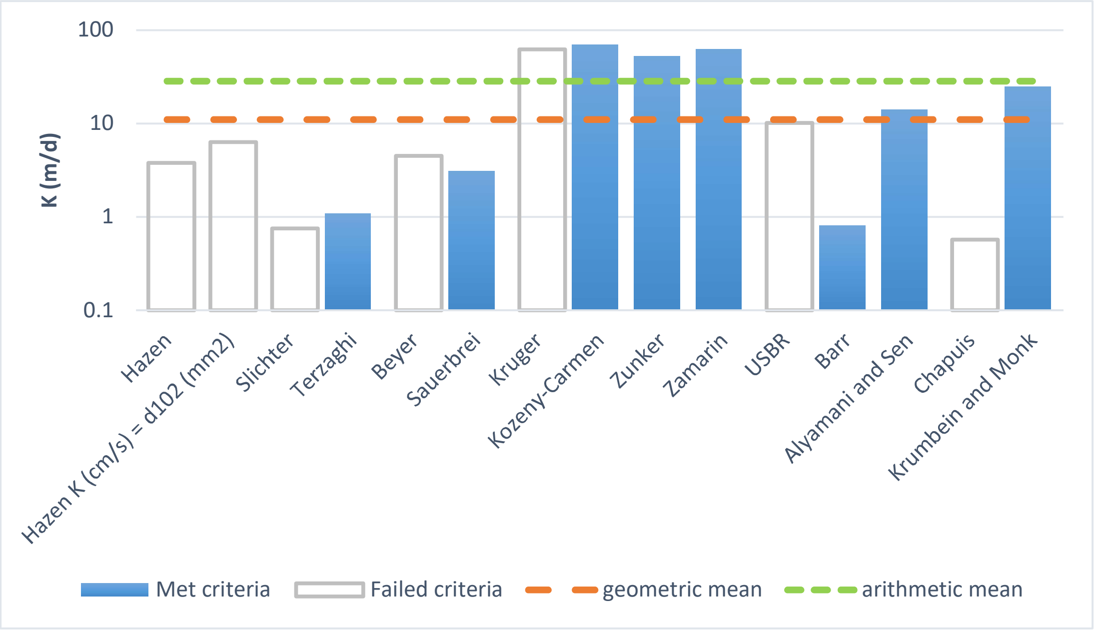
K = 0.001236 ft/min
y0 = 1.774 ft

*K* from Grain Size Analysis Report     Date: 9/23/2020

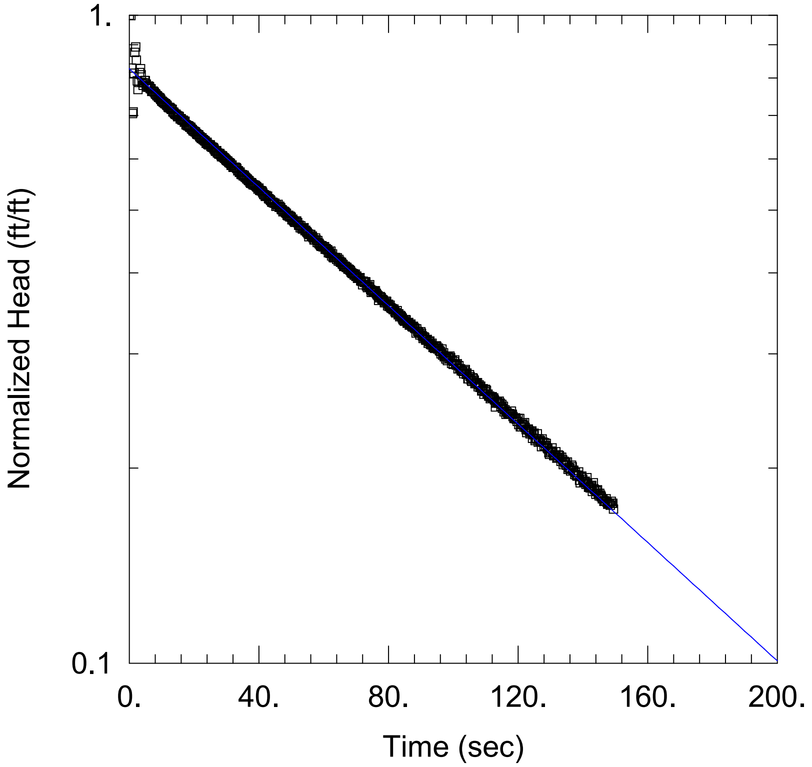
Sample Name: PG&E L-021A B-5 at 30.5 ft

Mass Sample (g): 100     T (oC) 20

## Poorly sorted gravelly sand low in fines



| Estimation of Hydraulic Conductivity | cm/s | m/s | m/d |
|---|---|---|---|
| Hazen | .436E-02 | .436E-04 | 3.77 |
| Hazen K (cm/s) = $d_{10}$ (mm) | .733E-02 | .733E-04 | 6.33 |
| Slichter | .868E-03 | .868E-05 | 0.75 |
| Terzaghi | .126E-02 | .126E-04 | 1.09 |
| Beyer | .519E-02 | .519E-04 | 4.49 |
| Sauerbrei | .360E-02 | .360E-04 | 3.11 |
| Kruger | .720E-01 | .720E-03 | 62.18 |
| Kozeny-Carmen | .804E-01 | .804E-03 | 69.50 |
| Zunker | .606E-01 | .606E-03 | 52.38 |
| Zamarin | .723E-01 | .723E-03 | 62.44 |
| USBR | .117E-01 | .117E-03 | 10.11 |
| Barr | .937E-03 | .937E-05 | 0.81 |
| Alyamani and Sen | .164E-01 | .164E-03 | 14.17 |
| Chapuis | .661E-03 | .661E-05 | 0.57 |
| Krumbein and Monk | .287E-01 | .287E-03 | 24.76 |
| geometric mean | .128E-01 | .128E-03 | 11.03 |
| arithmetic mean | .330E-01 | .330E-03 | 28.53 |



## PG&E L-021A B-6 IN-1

Data Set: U:\1-Projects-HYDRO\20210161 - PG&E L-021A\L-021A Slug Testing\B-6\B-6 IN-1.aqt
Date: 09/17/20 Time: 10:23:59

## PROJECT INFORMATION

Company: Kleinfelder
Client: PG&E
Project: 20210161
Location: Napa, CA
Test Well: B-5
Test Date: 9-9-2020

## AQUIFER DATA

Saturated Thickness: 75. ft
Anisotropy Ratio (Kz/Kr): 0.01

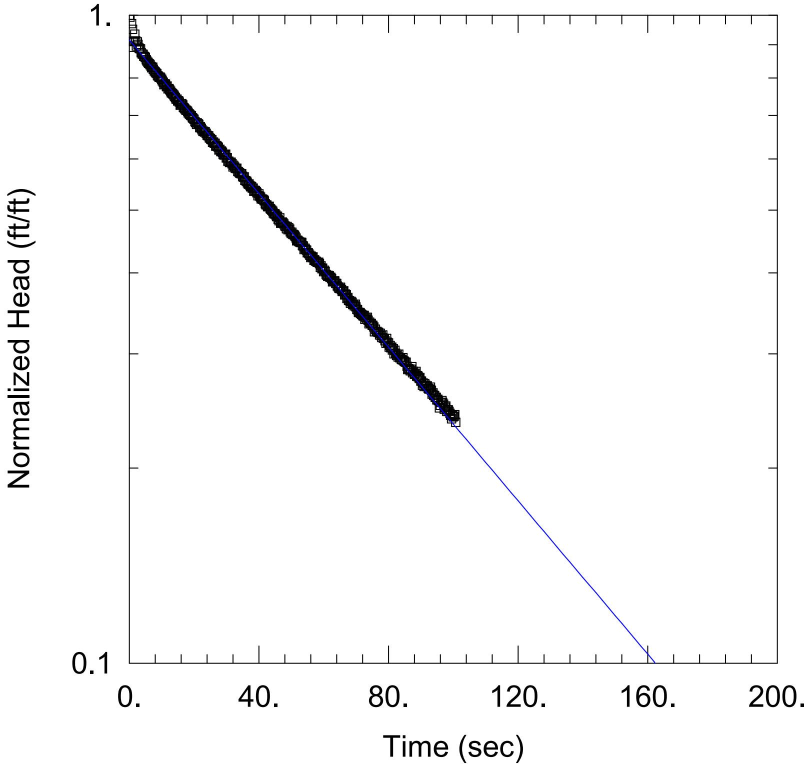
## WELL DATA (B-6)

Initial Displacement: 1.723 ft
Static Water Column Height: 12.6 ft
Total Well Penetration Depth: 12.6 ft
Screen Length: 9. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3333 ft

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.001004 ft/min
y0 = 1.424 ft



## PG&E L-021A B-6 OUT-1

Data Set: U:\1-Projects-HYDRO\20210161 - PG&E L-021A\L-021A Slug Testing\B-6\B-6 OUT-1.aqt
Date: 09/17/20
Time: 11:19:54

## PROJECT INFORMATION

Company: Kleinfelder
Client: PG&E
Project: 20210161
Location: Napa, CA
Test Well: B-5
Test Date: 9-9-2020

## AQUIFER DATA

Saturated Thickness: 75. ft
Anisotropy Ratio (Kz/Kr): 0.01

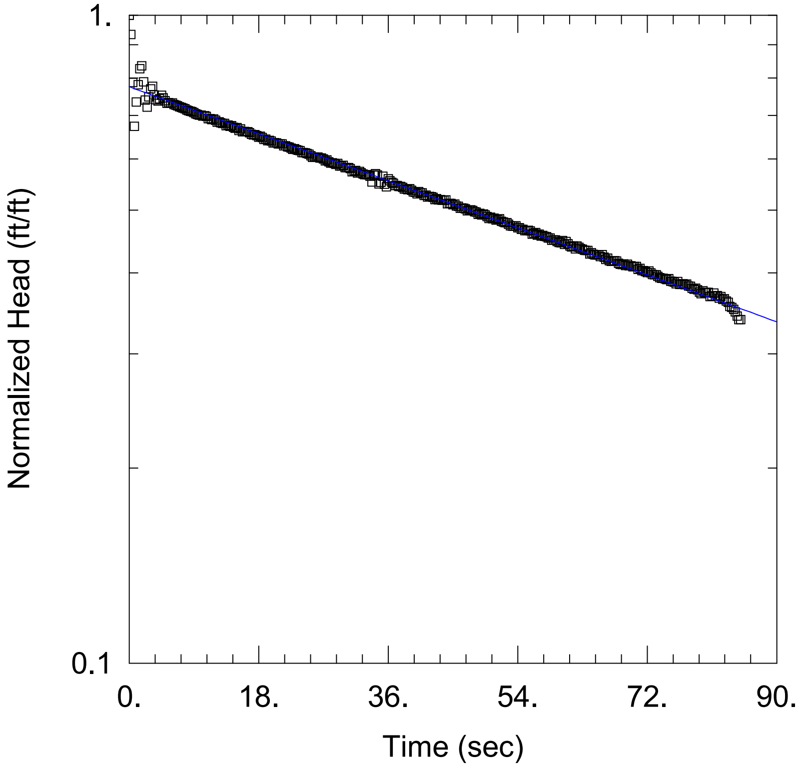
## WELL DATA (B-6)

Initial Displacement: 1.692 ft
Static Water Column Height: 12.6 ft
Total Well Penetration Depth: 12.6 ft
Screen Length: 9. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3333 ft

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.001303 ft/min
y0 = 1.55 ft



## PG&E L-021A B-6 IN-2

Data Set: U:\1-Projects-HYDRO\20210161 - PG&E L-021A\L-021A Slug Testing\B-6\B-6 IN-2.aqt
Date: 09/17/20 Time: 10:35:48

## PROJECT INFORMATION

Company: Kleinfelder
Client: PG&E
Project: 20210161
Location: Napa, CA
Test Well: B-5
Test Date: 9-9-2020

## AQUIFER DATA

Saturated Thickness: 75. ft
Anisotropy Ratio (Kz/Kr): 0.01

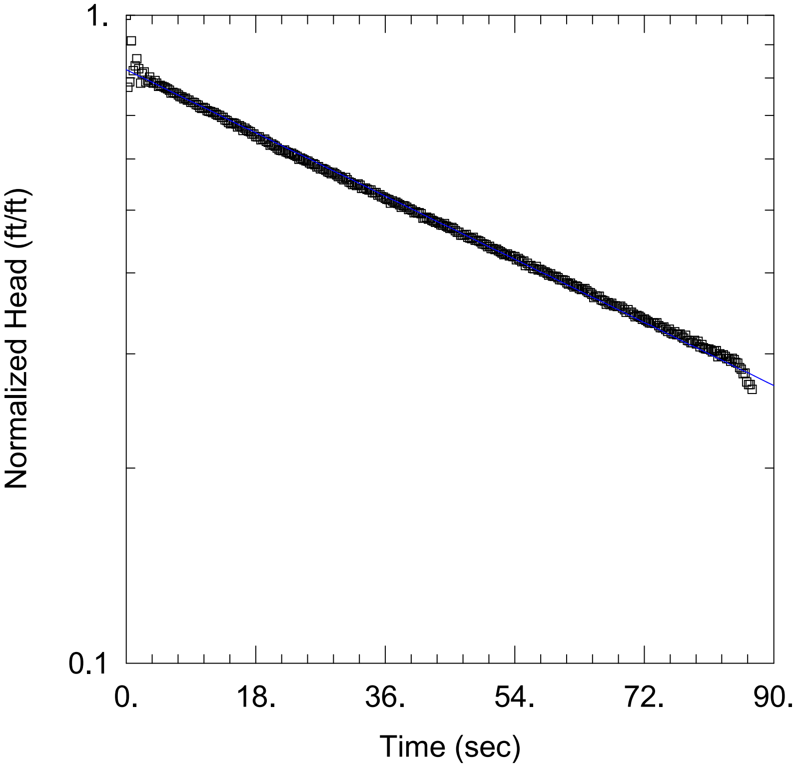
## WELL DATA (B-6)

Initial Displacement: 1.864 ft
Static Water Column Height: 12.6 ft
Total Well Penetration Depth: 12.6 ft
Screen Length: 9. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3333 ft

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.0008862 ft/min
y0 = 1.445 ft



PG&E L-021A B-6 OUT-2

Data Set: U:\1-Projects-HYDRO\20210161 - PG&E L-021A\L-021A Slug Testing\B-6\B-6 OUT-2.aqt
Date: 09/17/20 Time: 11:33:19

PROJECT INFORMATION

Company: Kleinfelder
Client: PG&E
Project: 20210161
Location: Napa, CA
Test Well: B-5
Test Date: 9-9-2020

AQUIFER DATA

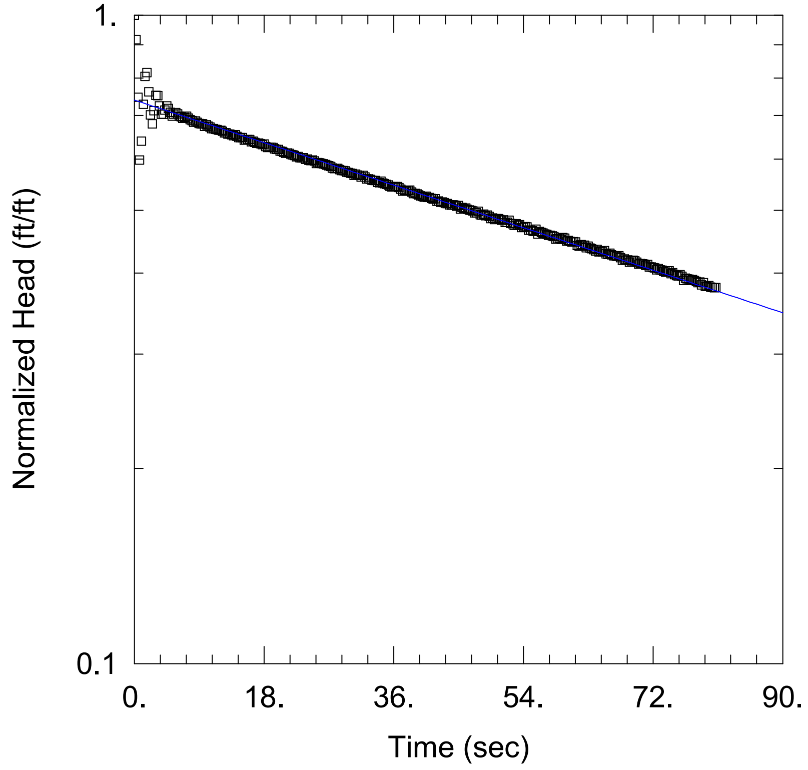
Saturated Thickness: 75. ft
Anisotropy Ratio (Kz/Kr): 0.01

WELL DATA (B-6)

Initial Displacement: 1.963 ft
Static Water Column Height: 12.6 ft
Total Well Penetration Depth: 12.6 ft
Screen Length: 9. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.001191 ft/min
y0 = 1.617 ft



PG&E L-021A B-6 IN-3

Data Set: U:\1-Projects-HYDRO\20210161 - PG&E L-021A\L-021A Slug Testing\B-6\B-6 IN-3.aqt
Date: 09/17/20 Time: 10:39:47

PROJECT INFORMATION

Company: Kleinfelder
Client: PG&E
Project: 20210161
Location: Napa, CA
Test Well: B-5
Test Date: 9-9-2020

AQUIFER DATA

Saturated Thickness: 75. ft
Anisotropy Ratio (Kz/Kr): 0.01

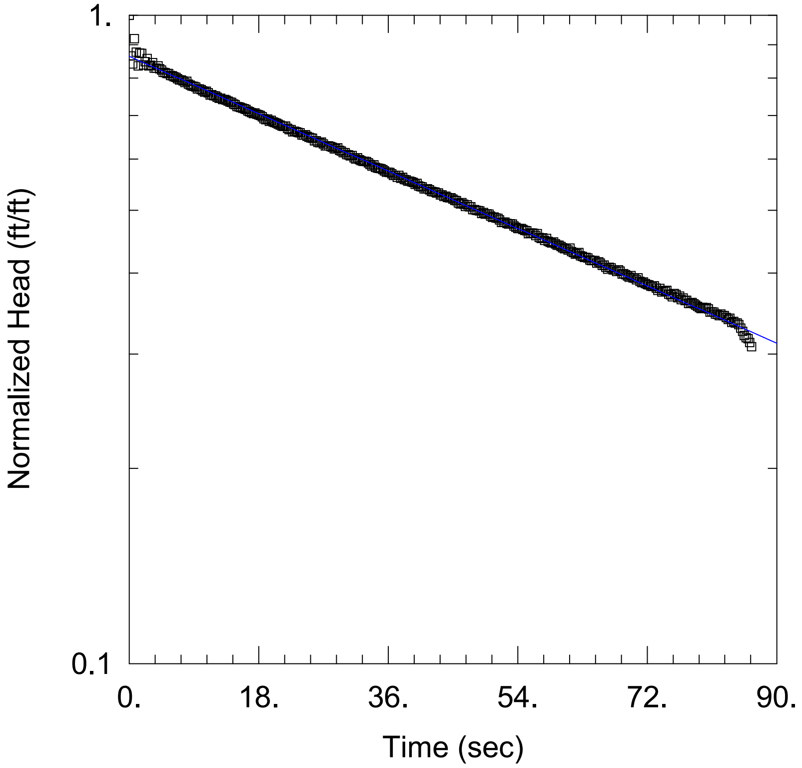
WELL DATA (B-6)

Initial Displacement: 1.946 ft
Static Water Column Height: 12.6 ft
Total Well Penetration Depth: 12.6 ft
Screen Length: 9. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.0008013 ft/min
y0 = 1.439 ft



PG&E L-021A B-6 OUT-3

Data Set: U:\1-Projects-HYDRO\20210161 - PG&E L-021A\L-021A Slug Testing\B-6\B-6 OUT-3.aqt
Date: 09/17/20 Time: 11:37:39

PROJECT INFORMATION

Company: Kleinfelder
Client: PG&E
Project: 20210161
Location: Napa, CA
Test Well: B-5
Test Date: 9-9-2020

AQUIFER DATA

Saturated Thickness: 75. ft
Anisotropy Ratio (Kz/Kr): 0.01

WELL DATA (B-6)

Initial Displacement: 1.893 ft
Static Water Column Height: 12.6 ft
Total Well Penetration Depth: 12.6 ft
Screen Length: 9. ft
Casing Radius: 0.08333 ft
Well Radius: 0.3333 ft

SOLUTION

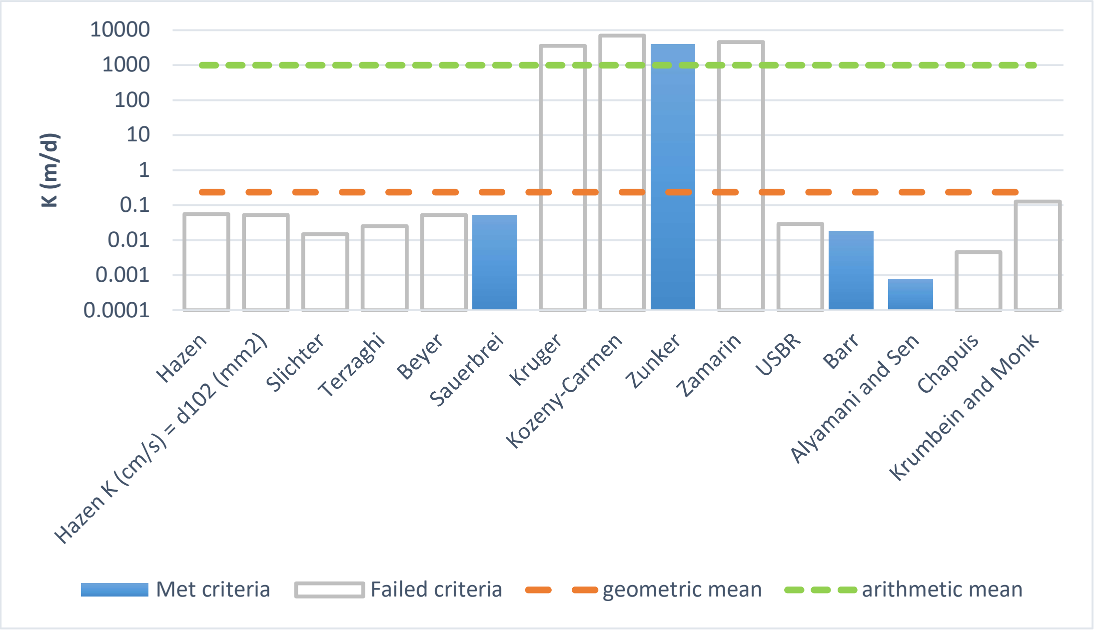
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.001081 ft/min
y0 = 1.636 ft

*K* from Grain Size Analysis Report Date: 9/23/2020

Sample Name: PG&E L-021A B-6 at 8.5 ft

Mass Sample (g): 100 T (oC) 20

## Poorly sorted silt low in fines



| Estimation of Hydraulic Conductivity | cm/s | m/s | m/d |
|---|---|---|---|
| Hazen | .645E-04 | .645E-06 | 0.06 |
| Hazen K (cm/s) = $d_{10}$ (mm) | .607E-04 | .607E-06 | 0.05 |
| Slichter | .171E-04 | .171E-06 | 0.01 |
| Terzaghi | .289E-04 | .289E-06 | 0.03 |
| Beyer | .602E-04 | .602E-06 | 0.05 |
| Sauerbrei | .609E-04 | .609E-06 | 0.05 |
| Kruger | .407E+01 | .407E-01 | 3520.17 |
| Kozeny-Carmen | .812E+01 | .812E-01 | 7019.46 |
| Zunker | .462E+01 | .462E-01 | 3993.75 |
| Zamarin | .530E+01 | .530E-01 | 4579.99 |
| USBR | .332E-04 | .332E-06 | 0.03 |
| Barr | .214E-04 | .214E-06 | 0.02 |
| Alyamani and Sen | .913E-06 | .913E-08 | 0.00 |
| Chapuis | .522E-05 | .522E-07 | 0.00 |
| Krumbein and Monk | .147E-03 | .147E-05 | 0.13 |
| geometric mean | .272E-03 | .272E-05 | 0.24 |
| arithmetic mean | .116E+01 | .116E-01 | 998.45 |

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# Appendix D

# LOG OF BORING B-1①

④ LOCATION: 15' n/o Station 22+00 (Figure 2)

④ GROUND SURFACE: Approx. El. 5'

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER ③ | DESCRIPTION ② | % MOISTURE % | DRY DENSITY lbs./ft.$^3$ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE | | | UNCONFINED COMPRESSIVE STRENGTH kips/ft.$^2$ | DIRECT SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Gravel (>#4 sieve) % | Sand (#4 to #200 sieve) % | Fines (<#200 sieve) % | | Cohesion p.s.f. | Internal Friction Angle |
| | | | | | **LEAN CLAY (CL) - FILL**<br>- dark brown<br>- trace sand, few silt<br>- moist | | | | | | | | | | |
| 5 | 1 | ■ | 2 | | **ORGANIC CLAY (OH) - FILL and BAY MUD**<br>- black and very dark yellowish brown<br>- very soft<br>- moist | 73 | 55 | | | | | | | | |
| 10 | 2 | □ | pushed | | **FAT CLAY (CH) - BAY MUD**<br>- dark gray<br>- few organics<br>- very soft<br>- moist | 43 | 78 | | | | | | | 240 | 25° |
| 15 | 3 | ■ | 3 | | **ORGANIC CLAY (OH) - BAY MUD**<br>- black and very dark brown<br>- very soft<br>- moist | 36 | 84 | 43 | 22 | | CORROSION TEST<br>Sample B-1-3<br>See Figure C-6 | | | | |
| | | | | | **SANDY LEAN CLAY (CL) - BAY MUD**<br>- very dark bluish gray<br>- trace to few organics<br>- very soft to soft<br>- moist | | | | | | | | | | |
| 20 | 4 | □ | pushed | | **FAT CLAY (CH) and ORGANIC CLAY (OH) - BAY MUD**<br>- dark greenish gray<br>- few silt<br>- trace to few organics<br>- very soft to soft<br>- moist<br>CONSOLIDATION TEST<br>SAMPLE B-1-4<br>$C_C$ = 0.36<br>$P_C$ = 1.15 ksf | 41 | 85 | | | | | | | | |
| 25 | 5 | □ | pushed | | | 34 | 89 | | | | | | 1.06 | | |

**BORING CONTINUED AT 28 FEET ON FIGURE B-1, 2 OF 4**

NOTES

① Drilled 8/12/10 with a Fraste Multidrill XL track rig using a 5-inch tri-cone bit and mud rotary with a 30" drop by 140 lb. hydraulic sampling hammer.
② See report text and plates in Appendices A and C for definitions, lab test results, and additional soil descriptions.
③ Boring drilled with a water-added method, therefore the static equilibrium groundwater depth is unknown to us at this time.
④ Surface elevation and stationing approximated from plans by GHD (print dated 4/24/13).

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## Log of Boring B-1

Figure
**B-1**
(1 of 4)

# LOG OF BORING B-1 (Continued) ①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **BORING CONTINUED FROM 28 FEET ON FIGURE B-1, 1 OF 4** | | | | | | | | | | |
| 30 | 6 | ◤ | 12 | | **LEAN/FAT CLAY (CL/CH)**<br>- dark gray and dark olive brown<br>- trace silt<br>- trace organics<br>- stiff<br>- moist | | | | | | | | | | |
| | | | | | **LEAN CLAY (CL)**<br>- dark gray and dark yellowish brown<br>- some silt<br>- stiff<br>- moist | | | | | | | | | | |
| 35 | 7 | ■ | 32 | | | 14 | 120 | | | | | | | | |
| | | | | | **POORLY-GRADED GRAVEL WITH SILT AND SAND (GP-GM) and SILTY/CLAYEY SAND WITH GRAVEL (SM/SC)**<br>- dark yellowish brown clay; varicolored sand<br>- trace cobble<br>- medium dense to dense<br>- wet | | | | | | | | | | |
| 40 | 8 | ■ | 68 | | | 11 | 132 | | | | | | | | |
| 45 | 9 | ◤ | 27 | | | | | | | 60 | 34 | 6 | | | |
| | | | | | **WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM)**<br>- olive brown fines, varicolored sand<br>- medium dense<br>- wet | | | | | | | | | | |
| 50 | 10 | ■ | 38 | | | 26<br>21 | 95<br>105 | | | <br>29 | <br>64 | <br>7 | | | |
| | | | | | **BORING CONTINUED AT 53 FEET ON FIGURE B-1, 3 OF 4** | | | | | | | | | | |
| 55 | | | | | | | | | | | | | | | |

NOTES

① See Notes on Figure B-1, 1 of 4.

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**Log of Boring B-1**

Figure
**B-1**
(2 of 4)

## LOG OF BORING B-1 (Continued) ①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | Sand (#4 to #200 sieve) % | Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **BORING CONTINUED FROM 53 FEET ON FIGURE B-1, 2 OF 4** | | | | | | | | | | |
| 55 | 11 | ◤ | 23 | | **LEAN CLAY (CL)**<br>- light yellowish brown<br>- trace sand and silt<br>- very stiff<br>- moist | | | | | | | | | | |
| 60 | 12 | ■ | 30 | | **LEAN/FAT CLAY WITH SAND (CL/CH)**<br>- reddish brown<br>- very stiff<br>- moist | 43 | 78 | | | | | | | | |
| 65 | 13 | ◤ | 18 | | **ELASTIC SILT (MH)**<br>- dark yellowish brown<br>- trace sand<br>- very stiff | | | 61 | 27 | | | | | | |
| 70 | 14 | ■ | 68 | | **LEAN CLAY (CL) and LEAN CLAY WITH SAND (CL)**<br>- light yellowish brown<br>- few to some silt<br>- hard<br>- moist/dry | 27 | 98 | | | | | | 6.67 | | |
| 75 | 15 | ◤ | 53 | | **POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) and CLAYEY SAND (SC)**<br>- varicolored<br>- mostly medium sand<br>- very dense<br>- moist/dry<br>**BORING CONTINUED AT 78 FEET ON FIGURE B-1, 4 OF 4** | | | | | 43 | 47 | 10 | | | |
| 80 | | | | | | | | | | | | | | | |

NOTES

①See Notes on Figure B-1, 1 of 4.

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**Log of Boring B-1**

Figure
**B-1**
(3 of 4)

# LOG OF BORING B-1 (Continued) ①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | % MOISTURE % | DRY DENSITY lbs./ft.$^3$ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.$^2$ | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **BORING CONTINUED FROM 78 FEET ON FIGURE B-1, 3 OF 4** | | | | | | | | | | |
| 80 | 16 | ■ | 58 | | **WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM)**<br>- varicolored<br>- dense<br>- moist/dry | | | | | 15 | 78 | 7 | | | |
| 85 | 17 | ■ | 85/11½ | | **SILTY SAND (SM) and SANDY LEAN CLAY/SILT (CL/ML)**<br>- pale yellowish brown<br>- very dense and hard<br>- moist/dry | 32 | 89 | | | | | | | | |
| 90 | 18 | ◤ | 39 | | **POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM)**<br>- varicolored<br>-gravel up to 1½-inch size<br>- dense<br>- moist/dry | | | | | 23 | 66 | 11 | | | |
| 95 | 19 | ◤ | 44 | | **POORLY-GRADED SAND (SP)**<br>- varicolored<br>- few silt<br>- dense<br>- moist/dry | | | | | | | | | | |
| 100 | 20 | ◤ | 50/5½ | | **WELL-GRADED SAND WITH GRAVEL (SW)**<br>- very dark gray and varicolored<br>- very dense<br>- moist/dry | | | | | | | | | | |
| | | | | | **BOTTOM OF BORING AT 101 FEET** | | | | | | | | | | |
| 105 | | | | | | | | | | | | | | | |

NOTES

① See Notes on Figure B-1, 1 of 4.

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**Log of Boring B-1**

**Figure**

**B-1**

(4 of 4)

## LOG OF BORING B-2①

④ LOCATION: 100' s/o Station 27+50 (Figure 2)

GROUND SURFACE: Approx. El. ~6'

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER ③ | DESCRIPTION ② | % MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **LEAN CLAY (CL) and CLAYEY GRAVEL (GC) - FILL**<br>- yellowish brown and dark yellowish brown<br>- few sand, trace cobbles, some silt<br>- very stiff/medium dense<br>- moist | | | | | | | | | | |
| 5 | 1 | ■ | 32 | | CORROSION TEST<br>Sample B-2-1<br>See Figure C-6 | | | | | | | | | | |
| | | | | | **LEAN CLAY (CL) - FILL**<br>- black and greenish gray<br>- few sand, trace gravel<br>- stiff<br>- moist | | | | | | | | | | |
| 10 | 2 | ■ | 12 | | | | | | | | | | | | |
| | | | | | **FAT CLAY (CH) - BAY MUD**<br>- black<br>- trace gravel, trace roots<br>- moist<br>- sulfurous odor | 47 | 73 | | | | | | | | |
| 15 | 3 | □ | pushed | | **FAT CLAY (CH) and ORGANIC CLAY (OH) - BAY MUD**<br>- very dark bluish gray and black<br>- very soft to soft<br>- moist | 66 | 64 | 83 | 48 | | | | 0.95 | | |
| 20 | 4 | □ | pushed | | | | | | | | | | | | |
| 25 | 5 | ■ | 5 | | - trace fine to coarse gravel | 44 | 76 | | | | | | 0.60 | | |

**BORING CONTINUED AT 28 FEET ON FIGURE B-2, 2 OF 4**

NOTES
① Drilled 8/13/10 with a Fraste Multidrill XL track rig using a 5-inch tri-cone bit and mud rotary with a 30" drop by 140 lb. hydraulic sampling hammer.
② See report text and plates in Appendices A and C for definitions, lab test results, and additional soil descriptions.
③ Boring drilled with a water-added method, therefore the static equilibrium groundwater depth is unknown to us at this time.
④ Surface elevation and stationing approximated from plans by GHD (print dated 4/24/13).

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**Log of Boring B-2**

Figure
**B-2**
(1 of 4)

## LOG OF BORING B-2 (Continued) ①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | % MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE | | | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Gravel (>#4 sieve) % | Sand (#4 to #200 sieve) % | Fines (<#200 sieve) % | | Cohesion p.s.f. | Internal Friction Angle |
| | | | | | **BORING CONTINUED FROM 28 FEET ON FIGURE B-2, 1 OF 4** | | | | | | | | | | |
| 30 | 6 | □ | pushed | | | | | | | | | | | | |
| | | | | | **FAT CLAY (CH) - BAY MUD**<br>- very dark greenish gray<br>- trace sand<br>- trace to few organics<br>- soft to medium stiff<br>- moist | | | | | | | | | | |
| 35 | 7 | ■ | 7 | | | 36 | 86 | | | | | | 0.82 | | |
| | | | | | - gravel at 37 feet | | | | | | | | | | |
| 40 | 8 | ◣ | 4 | | | | | | | | | | | | |
| 45 | 9 | ■ | 15 | | | 34 | 88 | | | | | | 2.23 | | |
| | | | | | **LEAN/FAT CLAY (CL/CH)**<br>- dark yellowish brown and dark gray mottled<br>- trace silt<br>- stiff<br>- moist | | | | | | | | | | |
| 50 | 10 | ◣ | 11 | | - sandy at 50'<br>CORROSION TEST<br>Sample B-2-10<br>See Figure C-6 | | | | | | | | | | |
| | | | | | **BORING CONTINUED AT 53 FEET ON FIGURE B-2, 3 OF 4** | | | | | | | | | | |
| 55 | | | | | | | | | | | | | | | |

NOTES

① See Notes on Figure B-2, 1 of 4.

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**Log of Boring B-2**

**Figure**

**B-2**

(2 of 4)

## LOG OF BORING B-2 (Continued) ①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **BORING CONTINUED FROM 53 FEET ON FIGURE B-2, 2 OF 4** | | | | | | | | | | |
| 55 | 11 | ■ | 24 | | **SANDY LEAN/FAT CLAY (CL/CH)**<br>- dark yellow brown<br>- few silt<br>- stiff<br>- moist | 27 | 98 | | | | | | 1.29 | | |
| 60 | 12 | ◪ | 13 | | **SILTY SAND (SM)**<br>- very dark gray<br>- medium dense<br>- moist<br>CORROSION TEST<br>Sample B-2-12<br>See Figure C-6 | | | | | | | | | | |
| 65 | 13 | ■ | 39 | | **POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) and SILTY/CLAYEY SAND (SM/SC)**<br>- varicolored<br>- rounded gravel<br>- dense<br>- moist | 20 | 111 | | | 45 | 50 | 5 | | | |
| 70 | 14 | ◪ | 30 | | | | | | | | | | | | |
| 75 | 15 | ■ | 89/11½" | | **SILTY LEAN CLAY WITH SAND (CL)**<br>- yellowish brown<br>- weakly cemented<br>- hard<br>- moist/dry | 33 | 89 | | | | | | 2.59 | | |
| | | | | | **BORING CONTINUED AT 78 FEET ON FIGURE B-2, 3 OF 4** | | | | | | | | | | |
| 80 | | | | | | | | | | | | | | | |

NOTES

① See Notes on Figure B-2, 1 Of 4.

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**Log of Boring B-2**

Figure
**B-2**
(3 of 4)

# LOG OF BORING B-2 (Continued) ①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **BORING CONTINUED FROM 78 FEET ON FIGURE B-2, 3 OF 4** | | | | | | | | | | |
| 80 | 16 | ◤ | 64 | | | | | | | | | | | | |
| 85 | 17 | ◤ | 44 | | **POORLY-GRADED SAND WITH SILT (SP-SM)**<br>- varicolored<br>- dense<br>- moist | | | | | | | | | | |
| 90 | 18 | ◤ | 50/5" | | **POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) and WELL-GRADED SAND WITH GRAVEL (SW)**<br>- varicolored<br>- very dense<br>- moist/dry | | | | | | | | | | |
| 95 | 19 | ◤ | 86 | | | | | | | 32 | 56 | 12 | | | |
| | | | | | **SILTY LEAN CLAY (CL/ML)**<br>- yellowish brown<br>- hard<br>- dry | | | | | | | | | | |
| 100 | 20 | ◤ | 50 | | **CLAYEY SAND (SC)**<br>- yellowish brown<br>- dense<br>- moist/dry | | | | | | | | | | |
| | | | | | **BOTTOM OF BORING AT 101½ FEET** | | | | | | | | | | |
| 105 | | | | | | | | | | | | | | | |

NOTES

① See Notes on Figure B-2, 1 Of 4.

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**Log of Boring B-2**

**Figure**
**B-2**
(4 of 4)

## LOG OF BORING B-3①

④ LOCATION: 10' n/o Station 18+70 (Figure 2)

GROUND SURFACE: Approx. El. 2.5'

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER ③ | DESCRIPTION ② | % MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **LEAN CLAY WITH SAND (CL) - FILL**<br>- dark brown<br>- fine sand<br>- moist<br>Note:<br>40 feet of conductor casing was required starting at the ground surface and during the drilling of this borehole to prevent the loss of excessive amounts of drilling fluid into the ground. | | | | | | | | | | |
| 5 | 1 | ■ | 10 | | **LEAN/FAT CLAY (CL/CH) - BAY MUD**<br>- dark gray<br>- trace sand<br>- little organics<br>- medium stiff<br>- moist | 51 | 64 | | | | | | | | |
| 10 | 2 | ■ | 2 | | **FAT CLAY (CH) - BAY MUD**<br>- black/dark bluish gray<br>- few to trace organics<br>- very soft<br>- moist | | | 73 | 39<br>LL RATIO $\frac{\text{O.D.}}{\text{N.D.}}$ =0.79 | | | | | | |
| | 3 | ▯ | | | - little silt<br>CONSOLIDATION TEST<br>SAMPLE B-3-3<br>$C_C$ = 0.65<br>$P_C$ = 1.42 ksf | 59 | 65 | | | | | | | | |
| 15 | | | | | | | | | | | | | | | |
| | 4 | ■ | 4 | | **FAT CLAY (CH) and ORGANIC CLAY (OH) - BAY MUD**<br>- dark grayish blue<br>- some silt, few organics<br>- soft<br>- moist | 44 | 76 | | | | | | 0.65 | | |
| 20 | | | | | | | | | | | | | | | |
| | 5 | ▯ | | | | | | | | 0 | 5 | 95<br>FINES<br>38% Silt<br>57% Clay | | | |
| | | | | | **FAT CLAY WITH SAND (CH)**<br>- dark grayish brown with granular bluish green/olive yellow<br>- coarse sand, few angular gravel<br>- stiff<br>- moist | | | | | | | | | | |
| 25 | 6 | ■ | 15 | | | 19 | 109 | | | | | | | | |

**BORING CONTINUED AT 27 FEET ON FIGURE B-3, 2 OF 4**

NOTES
① Drilled 8/08/12 with a Fraste Multidrill XL track rig using a 5-inch tri-cone bit and mud rotary with a 30" drop by 140 lb. hydraulic sampling hammer.
② See report text and figures in Appendices A and C for definitions, lab test results, and additional soil descriptions.
③ Boring drilled with a water-added method, therefore the static equilibrium groundwater depth is unknown to us at this time.
④ Surface elevation and stationing approximated from plans by GHD (print dated 4/24/13).

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**Log of Boring B-3**

Figure
**B-3**
(1 of 4)

# LOG OF BORING B-3 (Continued) ①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | % MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE |  |  | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  | Gravel (>#4 sieve) % | Sand (#4 to #200 sieve) % | Fines (<#200 sieve) % |  | Cohesion p.s.f. | Internal Friction Angle |
|  |  |  |  |  | **BORING CONTINUED FROM 27 FEET ON FIGURE B-3, 1 OF 4** |  |  |  |  |  |  |  |  |  |  |
| 30 | 7 | ◤ | 30 |  | **SILTY/CLAYEY SAND WITH GRAVEL (SM/SC)**<br>- olive brown/yellow/green/orange<br>- very stiff<br>- moist |  |  |  |  | 34 | 50 | 16 | FINES<br>8% Silt<br>8% Clay |  |  |
|  |  |  |  |  | **WELL-GRADED GRAVEL WITH SILT (GW-GM)**<br>- brownish gray<br>- fine to coarse gravel, few coarse sand<br>- wet |  |  |  |  |  |  |  |  |  |  |
| 35 | 8 | ■ | 21 |  | **SILTY/CLAYEY SAND WITH GRAVEL (SM/SC)**<br>- pale brown with yellowish brown/orange/dark brown<br>- medium dense<br>- wet | 22 | 104 |  |  | 17 | 68 | 15 |  |  |  |
| 40 | 9 | ◤ | 10 |  | **SANDY FAT CLAY WITH GRAVEL (CH)**<br>- pale brown<br>- medium to coarse sand, fine gravel<br>- stiff<br>- moist |  |  | 56 | 28 |  |  |  |  |  |  |
| 45 | 10 | ■ | 38 |  | **SILTY/CLAYEY SAND WITH GRAVEL (SM/SC)**<br>- yellowish/orangish brown<br>- medium dense<br>- wet | 19 | 110 |  |  | 40 | 46 | 14 |  |  |  |
| 50 | 11 | ◤ | 32 |  | **FAT CLAY WITH SAND (CH)**<br>- dark brown with yellowish/reddish brown mottling<br>- trace gravel, some silt<br>- hard<br>- moist/dry |  |  |  |  | 4 | 24 | 72 | FINES<br>28% Silt<br>44% Clay |  |  |
|  |  |  |  |  | **BORING CONTINUED AT 52 FEET ON FIGURE B-3, 3 OF 4** |  |  |  |  |  |  |  |  |  |  |
| 55 | 12 | ▒ | 55 |  |  |  |  |  |  |  |  |  |  |  |  |

NOTES

① See Notes on Figure B-3, 1 of 4.

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**Log of Boring B-3**

**Figure**
**B-3**
(2 of 4)

## LOG OF BORING B-3 (Continued)①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | % MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **BORING CONTINUED FROM 52 FEET ON FIGURE B-3, 2 OF 4** | | | | | | | | | | |
| 55 | 12 | ■ | 55 | | **SILTY/CLAYEY GRAVEL WITH SAND (GM/GC) and SANDY LEAN CLAY WITH GRAVEL (CL)**<br>- dark brown/yellowish brown<br>- angular olive-green gravel<br>- hard<br>- moist | 19 | 111 | | | 35 | 32 | 33<br>FINES<br>14% Silt<br>19% Clay | | | |
| 60 | 13 | ◤ | 22 | | **FAT CLAY (CH)**<br>- light olive brown to olive brown with grayish blue mottling<br>- trace sand, little silt<br>- very stiff to hard<br>- moist/dry | | | | | | | | | | |
| 65 | 14 | ■ | 50 | | | 33 | 92 | | | 0 | 2 | 98<br>FINES<br>21% Silt<br>77% Clay | 5.00 | | |
| 70 | 15 | ◤ | 52 | | **SANDY FAT CLAY (CH)**<br>- grayish brown to olive brown/reddish brown<br>- fine sand<br>- hard<br>- dry | | | | | | | | | | |
| 75 | 16 | ■ | 60 | | **FAT CLAY WITH SAND (CH)**<br>- olive brown/reddish orange<br>- fine sand, trace cemented<br>- hard<br>- moist/dry | 32 | 90 | | | 0 | 27 | 73 | | | |
| | | | | | **BORING CONTINUED AT 77 FEET ON FIGURE B-3, 4 OF 4** | | | | | | | | | | |
| 80 | 17 | ◤ | 31 | | | | | | | | | | | | |

NOTES

① See Notes on Figure B-3, 1 of 4.

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**Log of Boring B-3**

**Figure**

**B-3**

(3 of 4)

# LOG OF BORING B-3 (Continued)①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | % MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **BORING CONTINUED FROM 77 FEET ON FIGURE B-3, 3 OF 4** | | | | | | | | | | |
| 80 | 17 | ◩ | 31 | | **SANDY FAT CLAY (CH)**<br>- olive brown/reddish orange<br>- fine sand, trace cemented<br>- hard<br>- moist/dry | | | | | | | | | | |
| 85 | 18 | ■ | 50/5" | | **SILTY/CLAYEY SAND (SM/SC)**<br>- reddish orange/olive brown/grayish green<br>- angular hard gravel<br>- very dense<br>- moist to dry | 27 | 97 | | | 2 | 63 | 35 | | | |
| 90 | 19 | ◩ | 95 | | - yellowish brown/reddish orange/light purple | | | | | | | | | | |
| 95 | 20 | ◩ | 75 | | **SILTY/CLAYEY SAND WITH GRAVEL (SM/SC)**<br>- yellowish brown/black/red<br>- very dense<br>- moist | 20 | | | | 28 | 57 | 15 | | | |
| | 21 | ◣ | 50/5" | | | | | | | | | | | | |
| 100 | | | | | **BOTTOM OF BORING AT 100 FEET** | | | | | | | | | | |
| 105 | | | | | | | | | | | | | | | |

NOTES

① See Notes on Figure B-3, 1 of 4.

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## Log of Boring B-3

Figure
**B-3**
(4 of 4)

# LOG OF BORING B-4①

④ LOCATION: 5' n/o Station 13+80 (Figure 2)

GROUND SURFACE: Approx. El. 4'

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER ③ | DESCRIPTION ② | MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **SANDY LEAN/FAT CLAY (CL/CH) - FILL**<br>- brown<br>- fine sand<br>- some organics<br>- dry | | | | | | | | | | |
| 5 | 1 | ■ | 14 | | **LEAN/FAT CLAY WITH SAND (CL/CH) - FILL**<br>- dark grayish brown<br>- fine to coarse sand, trace gravel<br>- few organics<br>- stiff<br>- dry to moist | 22 | 93 | | | | | | | | |
| 10 | 2 | ▯ | pushed | | **PEAT (PT) and ORGANIC CLAY (OH) - BAY MUD**<br>- black/very dark bluish gray/dark greenish gray<br>- trace organics, trace silt<br>- very soft<br>- wet | 234 | 22 | | | | | | 1.03 | | |
| 15 | 3 | ▯ | pushed | | **FAT CLAY WITH SAND (CH)**<br>- greenish gray<br>- fine to coarse sand, few fine angular gravel<br>- wet | 18 | 117 | | | | | | 0.81 | | |
| 20 | 4 | ■ | 41 | | **WELL-GRADED GRAVEL WITH CLAY AND SAND (GW-GC)**<br>- gray/brown<br>- few coarse sand, fine to coarse gravel<br>- medium dense<br>- wet | 14 | 121 | | | | | | | | |
| | | | | | **WELL-GRADED SAND WITH CLAY AND GRAVEL (SW-SC)**<br>- gray/brown<br>- medium to coarse sand, fine gravel<br>- medium dense<br>- wet | | | | | | | | | | |
| 25 | 5 | ◩ | 34 | | **SILTY/CLAYEY SAND WITH GRAVEL (SM/SC)**<br>- olive brown/yellowish brown<br>- fine to coarse sand, fine to coarse gravel<br>- dense<br>- moist | | | | | 40 | 44 | 16 | | | |

Note:
45 feet of conductor casing was required starting at the ground surface and during the drilling of this borehole to prevent the loss of excessive amounts of drilling fluid into the ground.

BORING CONTINUED AT 27 FEET ON FIGURE B-4, 2 OF 4

NOTES

① Drilled 8/09/12 with a Fraste Multidrill XL track rig using a 5-inch tri-cone bit and mud rotary with a 30" drop by 140 lb. hydraulic sampling hammer.
② See report text and figures in Appendices A and C for definitions, lab test results, and additional soil descriptions.
③ Boring drilled with a water-added method, therefore the static equilibrium groundwater depth is unknown to us at this time.
④ Surface elevation and stationing approximated from plans by GHD (print dated 4/24/13).

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**Log of Boring B-4**

Figure
**B-4**
(1 of 4)

# LOG OF BORING B-4 (Continued) ①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | % MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **BORING CONTINUED FROM 27 FEET ON FIGURE B-4, 1 OF 4** | | | | | | | | | | |
| 30 | 6 | ◤ | 17 | | **SILTY/CLAYEY SAND (SM/SC)**<br>- dark yellowish brown<br>- fine to coarse sand, few fine gravel<br>- medium dense<br>- moist | 20 | | | | | | | | | |
| 35 | 7 | ■ | 34 | | **FAT CLAY (CH) and LEAN/FAT CLAY (CL/CH)**<br>- yellowish brown/olive brown<br>- trace fine sand<br>- very stiff<br>- moist | | | 52 | 29 | | | | | | |
| 40 | 8 | ◤ | 63 | | **SILTY/CLAYEY GRAVEL WITH SAND (GM/GC)**<br>- grayish blue with orange/grayish green/light brown<br>- fine to coarse sand, fine to coarse gravel<br>- very dense<br>- moist to dry | | | | | 44 | 31 | 25 | FINES<br>12% Silt<br>13% Clay | | |
| | | | | | **WELL-GRADED GRAVEL WITH COBBLES (GW)**<br>- based on drill rig reaction | | | | | | | | | | |
| 45 | 9 | ◤ | 26 | | **ELASTIC SILT (MH) and LEAN/FAT CLAY (CL/CH)**<br>- very dark brownish gray to reddish brown<br>- trace to few fine sand<br>- very stiff<br>- moist | 37 | | 55 | 21 | | | | | | |
| 50 | 10 | ◤ | 29 | | | 35 | | | | 0 | 13 | 87 | FINES<br>47% Silt<br>40% Clay | | |
| | | | | | **BORING CONTINUED AT 52 FEET ON FIGURE B-3, 3 OF 4** | | | | | | | | | | |
| 55 | 11 | ▨ | 58 | | | | | | | | | | | | |

NOTES

① See Notes on Figure B-4, 1 of 4.

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## Log of Boring B-4

Figure
**B-4**
(2 of 4)

# LOG OF BORING B-4 (Continued)①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **BORING CONTINUED FROM 52 FEET ON FIGURE B-4, 2 OF 4** | | | | | | | | | | |
| 55 | 11 | ■ | 58 | | **ELASTIC SILT/FAT CLAY WITH SAND (MH/CH)**<br>- very dark gray<br>- hard<br>- moist | 34 | 87 | | | | | | | 380 | 35° |
| 60 | 12 | ◤ | 38 | | - trace fine rounded black gravel | 27 | | | | 3 | 19 | 78 | FINES<br>41% Silt<br>37% Clay | | |
| 65 | 13 | ■ | 45 | | **SANDY ELASTIC SILT/FAT CLAY (MH/CH)**<br>- grayish blue/green and olive brown<br>- fine sand<br>- hard<br>- moist/dry | 26 | 100 | | | | | | 6.64 | | |
| 70 | 14 | ◤ | 31 | | **ELASTIC SILT/FAT CLAY WITH SAND (MH/CH)**<br>- light olive brown/orangish brown<br>- hard<br>- moist | 27 | | | | 0 | 17 | 83 | FINES<br>53% Silt<br>30% Clay | | |
| 75 | 15 | ■ | 92/11" | | **SILTY SAND (SM)**<br>- yellowish/reddish brown<br>- fine to coarse sand (slightly cemented)<br>- few gravel<br>- very dense<br>- moist/dry | 18 | 111 | | | 14 | 67 | 19 | | | |
| | | | | | **BORING CONTINUED AT 77 FEET ON FIGURE B-4, 4 OF 4** | | | | | | | | | | |
| 80 | 16 | ◤ | 75 | | | | | | | | | | | | |

NOTES

① See Notes on Figure B-4, 1 of 4.

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**Log of Boring B-4**

Figure
**B-4**
(3 of 4)

## LOG OF BORING B-4 (Continued)①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | % MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **BORING CONTINUED FROM 77 FEET ON FIGURE B-4, 3 OF 4** | | | | | | | | | | |
| 80 | 16 | ◤ | 75 | | **SILTY SAND (SM)**<br>- reddish/yellowish brown<br>- fine to coarse sand, few fine gravel<br>- very dense<br>- moist | 22 | | | | | | | | | |
| 85 | 17 | ◤ | 50/6" | | **SILTY SAND WITH GRAVEL (SM)**<br>- grayish brown, varicolored<br>- fine to coarse white gravel<br>- very dense<br>- moist | 14 | | | | 38 | 49 | 13 | | | |
| 90 | 18 | ◤ | 85/11" | | **WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM)**<br>- olive brown/yellow/orange/red/blue/green<br>- fine to coarse sand<br>- fine gravel<br>- very dense<br>- moist/dry | 19 | | | | | | | | | |
| 95 | 19 | ◤ | 95/11" | | **SILT WITH SAND AND GRAVEL (ML)**<br>- grayish blue/green<br>- very dense<br>- moist/dry | 25 | | | | 18 | 27 | 55 | | FINES<br>33% Silt<br>22% Clay | |
| 100 | 20 | ◤ | 75 | | **SILTY SAND WITH GRAVEL (SM) and LEAN CLAY WITH SAND (CL)**<br>- dark grayish/greenish blue<br>- fine to coarse sand, fine to coarse gravel<br>- very dense and hard<br>- moist | 15 | | | | | | | | | |
| | | | | | **BOTTOM OF BORING AT 100 ½ FEET** | | | | | | | | | | |
| 105 | | | | | | | | | | | | | | | |

NOTES

① See Notes on Figure B-4, 1 of 4.

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**Log of Boring B-4**

Figure
**B-4**
(4 of 4)

# LOG OF BORING B-5①

④ LOCATION: Station 10+10 (Figure 2)

GROUND SURFACE: Approx. El. 4'

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER ③ | DESCRIPTION ② | % MOISTURE % | DRY DENSITY lbs./ft.$^3$ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.$^2$ | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  | **SANDY LEAN CLAY (CL) - FILL**<br>- brown/grayish brown<br>- fine to coarse sand<br>- dry |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | **LEAN CLAY WITH SAND (CL) - FILL**<br>- dark brown<br>- fine to coarse sand<br>- dry |  |  |  |  |  |  |  |  |  |  |
| 5 | 1 | ■ | 14 |  | **FAT CLAY (CH) and LEAN/FAT CLAY (CL/CH)**<br>- olive brown<br>- trace fine sand<br>- few silt<br>- stiff<br>- moist | 25 | 97 |  |  |  |  |  |  |  |  |
| 10 | 2 | ■ | 16 |  |  |  |  | 51 | 25 |  |  |  |  |  |  |
|  |  |  |  | ▼ | **POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM)**<br>- brown/yellowish brown<br>- medium dense<br>- wet | 23 | 103 |  |  |  |  |  | 0.91 |  |  |
| 15 | 3 | ◩ | 28 |  |  |  |  |  |  | 34 | 54 | 12 → FINES<br>6% Silt<br>6% Clay |  |  |  |
| 20 | 4 | ■ | 51 |  | **LEAN/FAT CLAY (CL/CH)**<br>- olive brown/olive gray<br>- little to some silt<br>- hard<br>- dry/moist | 27 | 96 |  |  |  |  |  | 11.6 |  |  |
| 25 | 5 | ■ | 75/9" |  | **SILT/ELASTIC SILT (ML/MH) and LEAN/FAT CLAY (CL/CH)**<br>- reddish brown/reddish gray<br>- varicolored sand<br>- hard<br>- dry |  |  |  |  | 0 | 11 | 89 → FINES<br>47% Silt<br>42% Clay |  |  |  |

**BORING CONTINUED AT 27 FEET ON FIGURE B-5, 2 OF 2**

NOTES
① Drilled 8/10/12 using a CME 75, 8" diameter hollow stem augers, and a 30" drop by 140 lb. automatic sampling hammer.
② See report text and figures in Appendices A and C for definitions, lab test results, and additional soil descriptions.
③ Groundwater seepage measured at 12' at end of drilling. Static equilibrium groundwater depth is unknown to us at this time.
④ Surface elevation and stationing approximated from plans by GHD (print dated 4/24/13).

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**Log of Boring B-5**

Figure
**B-5**
(1 of 2)

# LOG OF BORING B-5 (Continued) ①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | % MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **BORING CONTINUED FROM 27 FEET ON FIGURE B-5, 1 OF 2** | | | | | | | | | | |
| | | | | | **SILT/ELASTIC SILT (ML/MH) and LEAN/FAT CLAY (CL/CH)**<br>- reddish brown/reddish gray<br>- varicolored sand<br>- hard<br>- dry | | | | | | | | | | |
| 30 | 6 | ◤ | 32 | | | 21 | | | | | | | | | |
| | | | | | **BOTTOM OF BORING AT 31 ½ FEET** | | | | | | | | | | |
| 35 | | | | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | | | | |
| 45 | | | | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | | | | |

NOTES

① See Notes on Figure B-5, 1 of 2.

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**Log of Boring B-5**

**Figure**
**B-5**
(2 of 2)

## LOG OF BORING B-6①

④ LOCATION: 5' s/o Station 35+00 (Figure 2)

GROUND SURFACE: Approx. El. 5'

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER ③ | DESCRIPTION ② | % MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **SANDY LEAN CLAY (CL) - FILL**<br>- brown<br>- fine to coarse sand<br>- dry to moist | | | | | | | | | | |
| 5 | NSR | ■ | 14 | ▼ | | | | | | | | | | | |
| 10 | 1 | ■ | 14 | | **ORGANIC/FAT CLAY (OH/CH) - BAY MUD**<br>- very dark bluish gray<br>- trace to few fine sand<br>- little silt, little to few organics<br>- medium stiff<br>- moist | 46 | 75 | | | | | | 2.46 | | |
| 15 | 2 | ■ | 7 | | | 56 | 64 | | | | | | | 300 | 28° |
| 20 | 3 | ◩ | 6 | | **ELASTIC SILT WITH SAND (MH) and FAT CLAY (CH) - BAY MUD**<br>- black<br>- fine to coarse sand<br>- medium stiff<br>- moist | | | 54 | 23 | | | | | | |
| 25 | 4 | ■ | 8 | | **SANDY SILT/ELASTIC SILT (ML/MH) - BAY MUD**<br>- very dark grayish brown<br>- few gravel<br>- little clay<br>- medium stiff<br>- moist | 31 | 90 | | | 9 | 39 | 52 | FINES<br>31% Silt<br>21% Clay | | |

**BORING CONTINUED AT 27 FEET ON FIGURE B-6, 2 OF 3**

NOTES
① Drilled 8/10/12 using a CME 75, 8" diameter hollow stem augers, and a 30" drop by 140 lb. automatic sampling hammer.
② See report text and figures in Appendices A and C for definitions, lab test results, and additional soil descriptions.
③ Groundwater seepage measured at 7' at end of drilling. Static equilibrium groundwater depth is unknown to us at this time.
④ Surface elevation and stationing approximated from plans by GHD (print dated 4/24/13).

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**Log of Boring B-6**

**Figure**
**B-6**
(1 of 3)

# LOG OF BORING B-6 (Continued) ①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | % MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE | | | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Gravel (>#4 sieve) % | Sand (#4 to #200 sieve) % | Fines (<#200 sieve) % | | Cohesion p.s.f. | Internal Friction Angle |
| | | | | | **BORING CONTINUED FROM 27 FEET ON FIGURE B-6, 1 OF 3** | | | | | | | | | | |
| 30 | 5 | ◤ | 38 | | **SILT (ML)**<br>- pale brown to reddish/yellowish brown<br>- trace to few fine sand, slightly cemented<br>- hard to very stiff<br>- moist | | | 33 | 5 | | | | | | |
| 35 | 6 | ■ | 26 | | **SILTY/CLAYEY SAND (SM/SC)**<br>- grayish/yellowish brown<br>- trace gravel<br>- medium dense to dense<br>- wet | 28 | 94 | | | | | | | | |
| 40 | 7 | ◤ | 32 | | | | | | | 2 | 71 | 27 | FINES<br>15% Silt<br>12% Clay | | |
| 45 | 8 | ■ | 80 | | **WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM)**<br>- reddish orange/pale brown/olive gray<br>- little gravel<br>- very dense to dense<br>- wet to moist<br>- poorly graded sand (SP) from 49' to 50 ½' | 16 | 114 | | | 25 | 63 | 12 | | | |
| 50 | 9 | ◤ | 51 | | | | | | | | | | | | |
| | | | | | **BORING CONTINUED AT 52 FEET ON FIGURE B-6, 3 OF 3** | | | | | | | | | | |

NOTES

① See Notes on Figure B-6, 1 of 3.

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## Log of Boring B-6

**Figure**

**B-6**

(2 of 3)

## LOG OF BORING B-6 (Continued) ①

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER | DESCRIPTION | % MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE Gravel (>#4 sieve) % | GRAIN SIZE Sand (#4 to #200 sieve) % | GRAIN SIZE Fines (<#200 sieve) % | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR Cohesion p.s.f. | DIRECT SHEAR Internal Friction Angle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **BORING CONTINUED FROM 52 FEET ON FIGURE B-6, 2 OF 3** | | | | | | | | | | |
| 55 | 10 | ■ | 50/4" | | **SILTY/CLAYEY GRAVEL WITH SAND (GM/GC)**<br>- reddish orange/olive brown/black/gray<br>- very dense<br>- moist | 11 | 126 | | | 44 | 39 | 17 | | | |
| 60 | 11 | ◤ | 90/9" | | | | | | | | | | | | |
| 65 | 12 | ■ | 50/4" | | **SILTY/CLAYEY SAND (SM/SC)**<br>- olive yellowish brown<br>- trace gravel<br>- slightly cemented<br>- very dense<br>- moist | 25 | 97 | | | 2 | 65 | 33 | | | |
| 70 | 13 | ◤ | 94/10" | | - interlayered poorly graded sand (SP) and well-graded sand (SW) | | | | | | | | | | |
| | | | | | **BOTTOM OF BORING AT 71 ½ FEET** | | | | | | | | | | |
| 75 | | | | | | | | | | | | | | | |

NOTES

① See Notes on Figure B-6, 1 of 3.

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**Log of Boring B-6**

**Figure**
**B-6**
(3 of 3)

## LOG OF BORING B-7①

④ LOCATION: 20' n/o Station 40+90 (Figure 2)

GROUND SURFACE: Approx. El. ~10'

| DEPTH feet | SAMPLE NO. | TYPE | PENETRATION RESISTANCE blows/ft. | GROUNDWATER ③ | DESCRIPTION ② | % MOISTURE % | DRY DENSITY lbs./ft.³ | LIQUID LIMIT | PLASTICITY INDEX | GRAIN SIZE | | | UNCONFINED COMPRESSIVE STRENGTH kips/ft.² | DIRECT SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Gravel (>#4 sieve) % | Sand (#4 to #200 sieve) % | Fines (<#200 sieve) % | | Cohesion p.s.f. | Internal Friction Angle |
| | | | | | **SANDY LEAN CLAY (CL) and LEAN CLAY WITH SAND (CL) - FILL**<br>- brown to dark brown<br>- fine to coarse sand<br>- dry to moist | | | | | | | | | | |
| | | | | | **SANDY FAT CLAY/ELASTIC SILT (CH/MH) and CLAYEY SAND (SC)**<br>- very dark gray<br>- fine to coarse sand<br>- medium stiff and loose<br>- moist | | | | | | | | | | |
| 5 | 1 | ■ | 6 | | | 34 | 85 | | | | | | 0.37 | | |
| 10 | 2 | ■ | 11 | | | 47 | 74 | 63 | 30 | | | | | | |
| | | | | | **ELASTIC SILT (MH) and FAT CLAY (CH) - BAY MUD**<br>- black/very dark gray<br>- few fine sand<br>- few organics<br>- medium stiff to soft<br>- moist | | | | | | | | | | |
| 15 | 3 | ◣ | 2 | | | | | | | 0 | 9 | 91 → | FINES<br>50% Silt<br>41% Clay | | |
| | | | | ▼ | | | | | | | | | | | |
| 20 | 4 | ■ | 12 | | | 41 | 81 | | | | | | 0.71 | | |
| | | | | | **SILTY/CLAYEY SAND WITH GRAVEL (SM/SC)**<br>- reddish brown<br>- loose<br>- wet | | | | | | | | | | |
| 25 | 5 | ◣ | 8 | | | | | | | 16 | 55 | 29 | | | |
| | | | | | **BOTTOM OF BORING AT 26 ½ FEET** | | | | | | | | | | |

NOTES

① Drilled 8/10/12 using a CME 75, 8" diameter hollow stem augers, and a 30" drop by 140 lb. automatic sampling hammer.
② See report text and figures in Appendices A and C for definitions, lab test results, and additional soil descriptions.
③ Groundwater seepage measured at 18' at end of drilling. Static equilibrium groundwater depth is unknown to us at this time.
④ Surface elevation and stationing approximated from plans by GHD (print dated 4/24/13).

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**Log of Boring B-7**

**Figure**
**B-7**

# Appendix E

# Important Information about This

# Geotechnical-Engineering Report

**Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.**

**While you cannot eliminate all such risks, you can manage them. The following information is provided to help.**

**The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.**

## Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

## Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

## You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

## This Report May Not Be Reliable

*Do not rely on this report* if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

## Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

## This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

## This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

## Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

## Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

## Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

## Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

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