

GEOTECHNICAL ENGINEERING INVESTIGATION REPORT PROPOSED CITY OF COLUSA WASTEWATER TREATMENT PLANT INFRASTRUCTURE IMPROVEMENTS COLUSA, CALIFORNIA

September 27, 2023

Prepared For:

City of Colusa

425 Webster Street
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Mr. Jesse Cain, City Manager



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125623-0071343.00.001

September 27, 2023
Project No. 71343.00.001

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Via PDF: citymanager@cityofcolusa.com

**Reference: Geotechnical Engineering Investigation Report
Proposed City of Colusa Wastewater Treatment Plant Infrastructure Improvements
1480 and 2820 Will S. Green Avenue
Colusa, Colusa County, California**

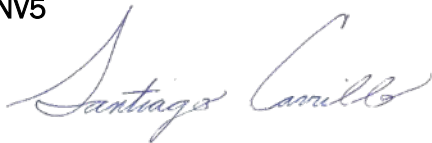
Dear Mr. Cain,

NV5 conducted a geotechnical engineering investigation for the proposed infrastructure improvements to be constructed at the existing City of Colusa Wastewater Treatment Plant (WWTP) located at 1480 and 2820 Will S. Green Avenue, Colusa, Colusa County, California.. NV5's geotechnical engineering investigation of the site was performed consistent with the scope of services presented in the May 10, 2023 proposal (PC23.104).

The findings, conclusions and recommendations presented in this report are based on the following relevant information collected and evaluated by NV5: literature review, surface observations, subsurface exploration, laboratory test results, and experience with similar projects, sites and conditions in the area. The proposed project will include sewer infrastructure improvements at the existing wastewater treatment facility. There were no seismic hazards or geotechnical engineering hazards identified on the site or in the immediate area that require design mitigation. Undocumented fills were encountered in the area of the proposed maintenance building and concrete lined aeration basin and are not considered suitable for support of the proposed improvements. However, it is NV5's opinion that the site is suitable for the proposed construction provided the geotechnical engineering recommendations presented in this report are incorporated into the earthwork and structural improvements. This report should not be relied upon without review by NV5 if a period of 24 months elapses between the issuance report date shown above and the date when construction commences.

NV5 appreciates the opportunity to provide geotechnical engineering services for this important project. If you have questions or need additional information, please do not hesitate to contact the undersigned at 530-894-2487.

Sincerely,
NV5



Santiago Carrillo, EIT
Staff Engineer



Dominic J. Potestio, PE 69299
Senior Engineer

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ACRONYMS

AB	aggregate base
AC	asphalt concrete
ACI	American Concrete Institute
ASCE	American Society of Civil Engineers
ASTM	ASTM International
bgs	below ground surface
Cal/EPA	California Environmental Protection Agency
CAT	Caterpillar
CBC	California Building Code
CGS	California Geological Survey
CQA	Construction Quality Assurance
DTSC	Department of Toxic Substances Control
EFP	equivalent fluid pressure
FS	factor of safety
ft/sec	feet per second
H:V	horizontal to vertical ratio
H&K	Holdrege & Kull
MCE	maximum considered earthquake
msl	mean sea level
mybp	million years before present
OSHA	Occupational Safety and Hazards Administration
PCA	Portland Cement Association
PI	plasticity index
psf	pounds per square foot
psi	pounds per square inch
R-value	resistance value
SSD	saturated surface dry
TI	traffic index
USCS	Unified Soils Classification System
USGS	United States Geological Survey
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

NV5 performed a geotechnical engineering investigation and prepared a geotechnical engineering investigation report for the proposed sewer infrastructure improvements project at the existing City of Colusa Wastewater Treatment Plant (WWTP) located at 1480 & 2820 Will S. Green Avenue in Colusa, California, consistent with the scope of services presented in NV5's *Proposal for Geotechnical Engineering Services* (PC23.104), dated May 8, 2023. NV5's findings, conclusions and recommendations are presented herein.

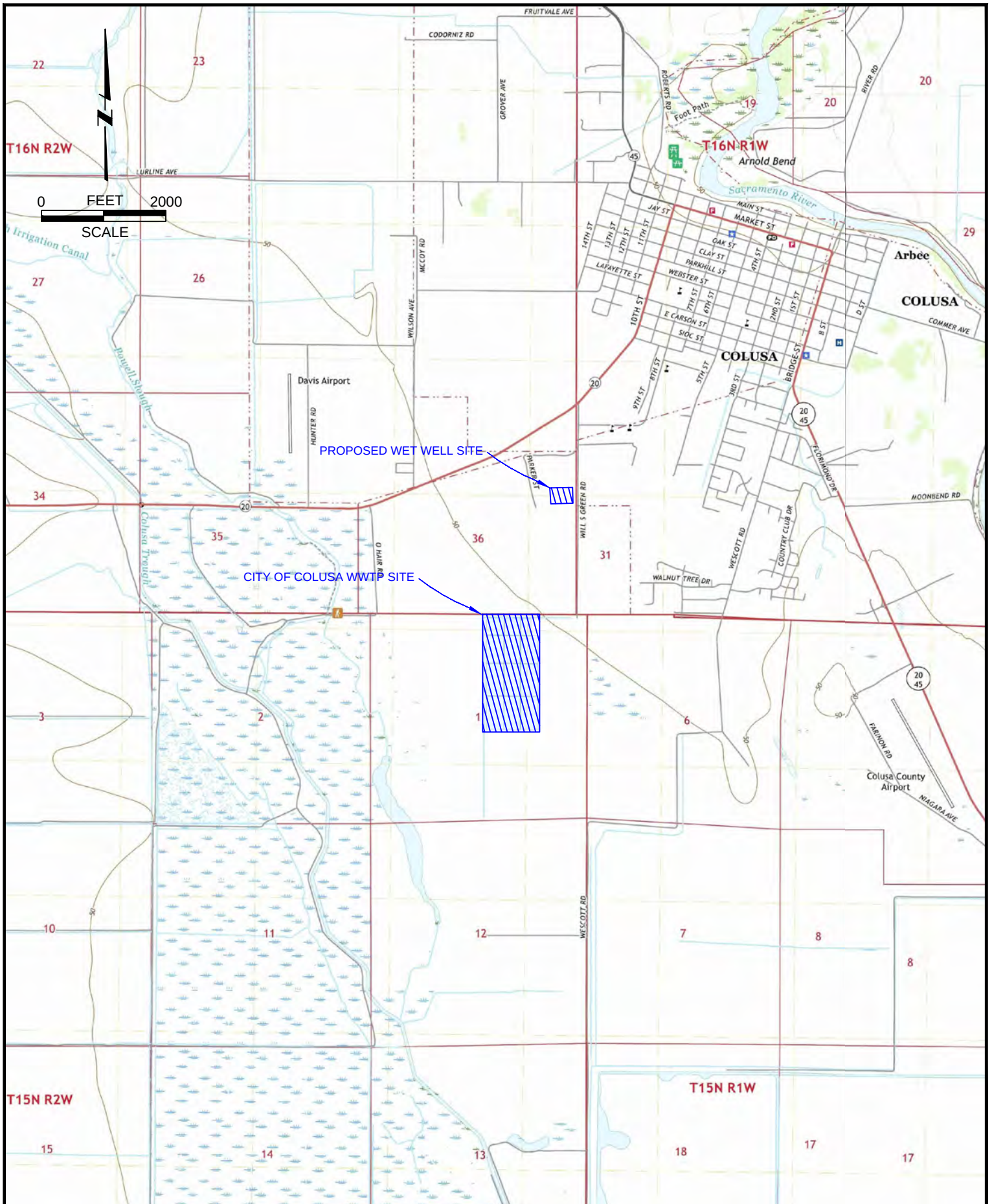
1.1 SCOPE-OF-SERVICES

NV5 performed a specific scope-of-services to develop geotechnical engineering design recommendations for earthwork and structural improvements. Brief description of each work scope task is presented below. A detailed description of each work scope task is presented in Section 2 (Site Investigation) of this report.

- **Task 1 Site Investigation:** NV5 performed a site investigation to characterize the existing surface and subsurface soil, rock and groundwater conditions encountered to the maximum depth excavated. NV5's field engineer/geologist made observations, collected representative soil samples, conducted seismic refraction surveys, and performed field tests at a limited number of subsurface exploratory locations. NV5 performed laboratory tests on selected soil samples to evaluate their engineering material properties.
- **Task 2 Data Analysis and Engineering Design:** NV5 evaluated the field and laboratory site data and the proposed site improvements and used this information to develop geotechnical engineering design recommendations for earthwork and structural improvements. NV5 used engineering judgment to extrapolate NV5's observations and conclusions regarding the field and laboratory data to other onsite areas located between and beyond the locations of NV5's subsurface exploratory excavations.
- **Task 3 Report Preparation:** NV5 prepared this report to present the findings, conclusions and recommendations for this geotechnical engineering investigation.

1.2 SITE LOCATION AND DESCRIPTION

The Colusa WWTP is located at 2820 Will South Green Avenue, Colusa County, California. The WWTP site consists of two locations which are referenced as Colusa County Assessor Parcel Numbers 017-020-007 & 002-090-001. The WWTP is accessed from the north via Will S. Green Avenue. The site is centered at approximately latitude 39.1873 north and longitude -122.0290 west on the United States Geological Survey's (USGS), 7.5 minute Colusa Quadrangle topographic map (2022). The average elevation of the site is approximately 45 feet above mean sea level (msl), based on review of the topographic information presented on the USGS 7.5 minute Colusa Quadrangle topographic map. Figure 1 shows the site location and vicinity.

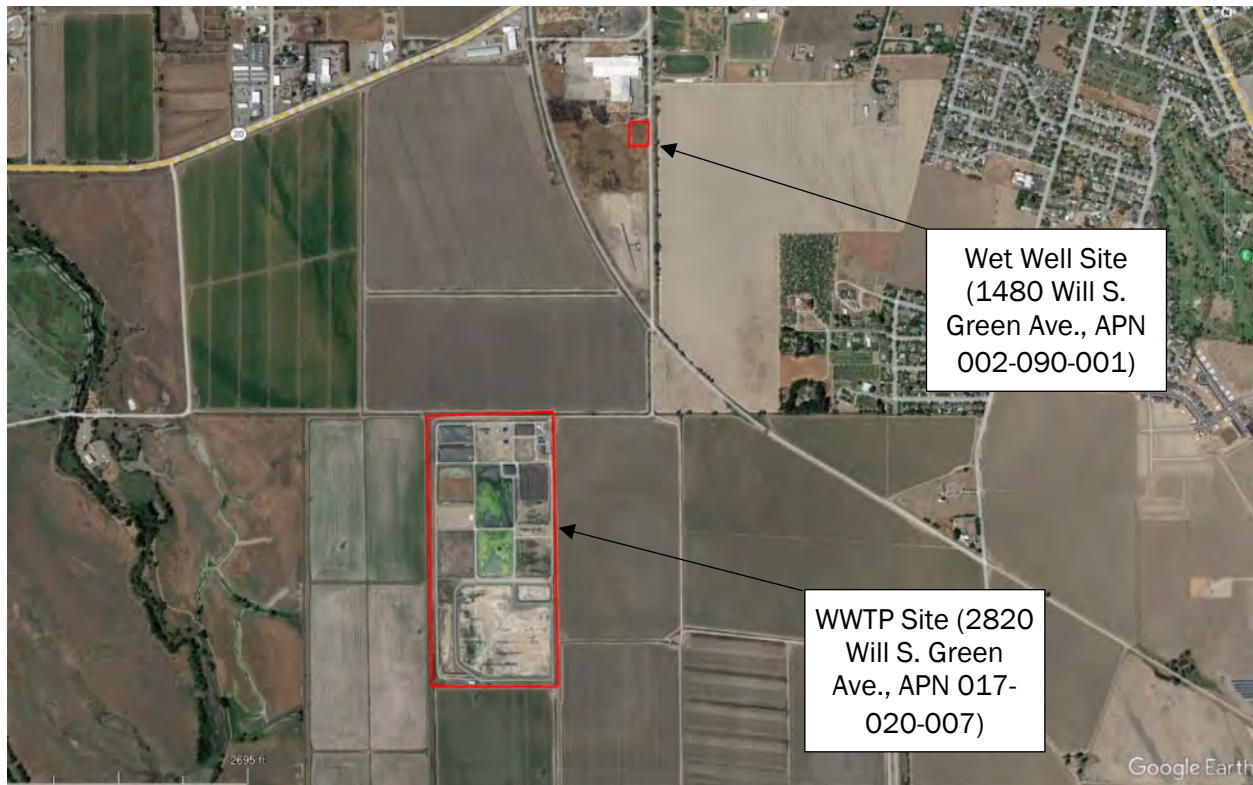


SITE LOCATION MAP

CITY OF COLUSA WWTIP INFRASTRUCTURE IMPROVEMENTS
COLUSA, COLUSA COUNTY, CALIFORNIA

DRAWN BY:	SC
CHECKED BY:	DJP
PROJECT:	71343.00.001
DATE:	SEPTEMBER 2023

FIGURE
1



At the time the site investigation was performed on August 1, 2023, the following conditions were observed and are shown in the inset image:

- Wet Well Site (1480 Will S. Green Avenue): The site consists of flat undeveloped land with moderate concentration of weeds and grasses. A yellow groundwater monitoring well stand pipe present. A mature tree was present to the northeast. The site was relatively rolling and uneven along the west boundary.
- WWTP Site (2820 Will S. Green Avenue): The site consists of an existing WWTP facility comprised of sewer infrastructure, office buildings, earthen soil berms, solar arrays, paved and unpaved access roads and wastewater holding ponds. Surrounding land use is agricultural and there are high power transmission lines transecting the southwest corner of the site.

1.3 PROPOSED IMPROVEMENTS

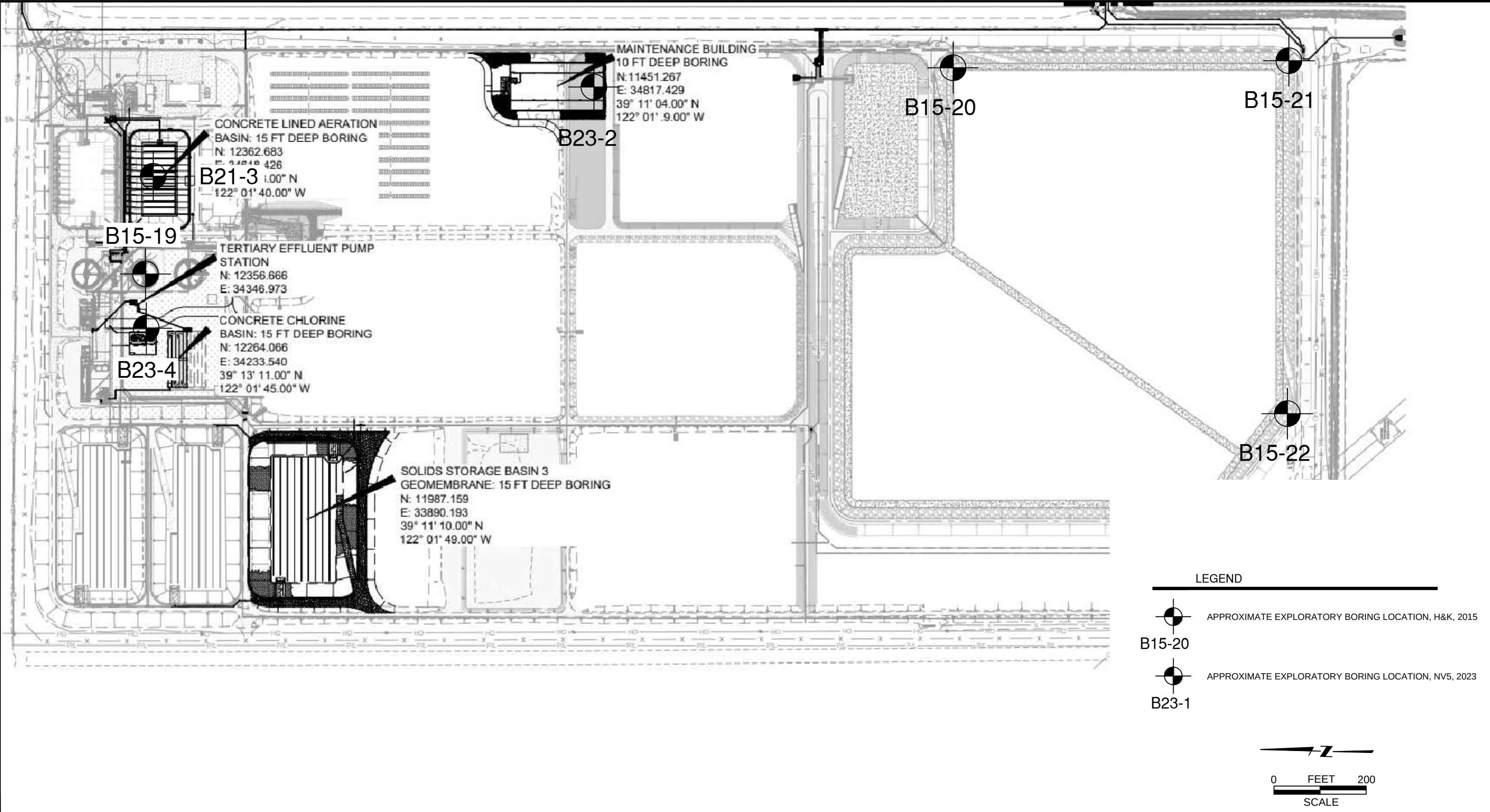
Based on recent correspondence and review of the March 8, 2023, Key Map and April 10, 2023, Site Piping Plan, both prepared by NexGen Utility Management, NV5 understands the proposed City of Colusa Sewer Infrastructure project will consist of construction of a Wet Well, a Control Building, a Maintenance Building, Concrete Lined Aeration and Chlorine Basins, and a Solid Stabilization Basin Geomembrane Liner. The improvements are proposed be constructed at the existing City of Colusa Wastewater Treatment Plant. NV5 understands the proposed maintenance and control buildings will be single-story wood and/or light-gauge steel framed buildings supported on shallow continuous spread and isolated foundations with an interior concrete slab-on-grade floor.

Associated site improvements may include construction of asphalt concrete and rigid concrete pavements, underground utilities, and landscaping.

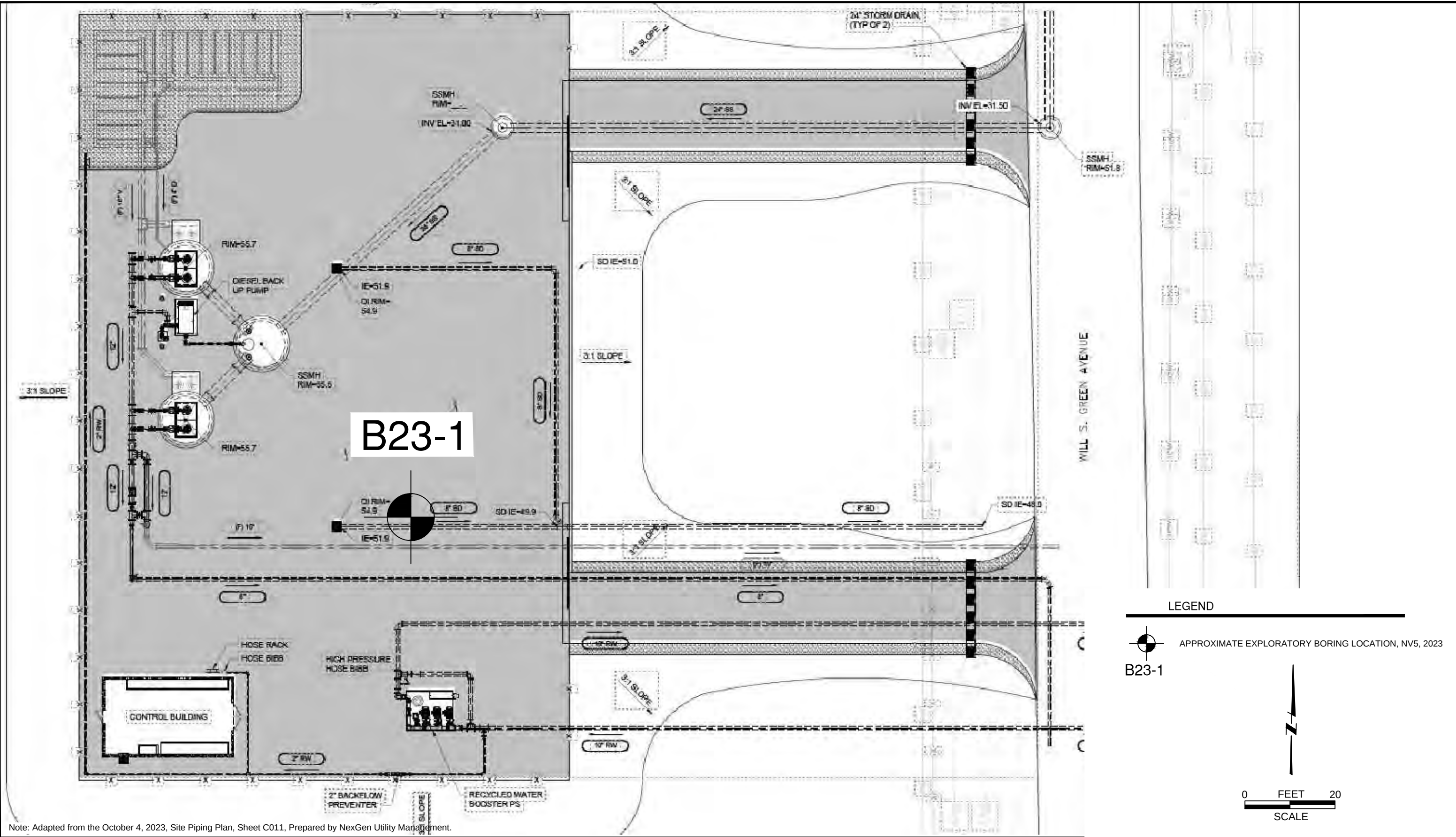
Earthwork grading may include general site preparation and minor cuts and fills required to balance the site to meet the proposed grades, with deeper cuts required for the effluent ponds. Figures 2 and 2a show the approximate site boundaries and exploratory boring locations.

1.4 INVESTIGATION PURPOSE

The purpose of the geotechnical investigation was to obtain sufficient on-site information about the soil, rock and groundwater conditions to provide geotechnical engineering recommendations for the proposed earthwork and structural improvements. As part of this contract, NV5 did not evaluate the site for the presence of hazardous waste, mold, asbestos and radon gas. Therefore, the presence and removal of these materials are not discussed in this report.



Note: Adapted from the July 27, 2023, Boring Locations and Depth Plan, Prepared by NexGen Utility Management.



Note: Adapted from the October 4, 2023, Site Piping Plan, Sheet C011, Prepared by NexGen Utility Management.

2.0 SITE INVESTIGATION

NV5 performed a site investigation to characterize the existing surface and subsurface conditions beneath the proposed improvements. The site investigation included a literature review of published and unpublished geologic documents and maps, a surface reconnaissance investigation, and a subsurface exploratory investigation using a truck-mounted drill rig to excavate exploratory borings. Each component of the site investigation is presented below.

2.1 LITERATURE REVIEW

NV5 performed a limited review of available literature that was pertinent to the project site. The following summarizes NV5's findings:

2.1.1 Site Improvement Plans

Improvement plans were not available for review at the time this report was prepared.

2.1.2 Previous Site Investigation Reports

- Holdrege & Kull (H&K), 2016, *Geotechnical Engineering Investigation Report, City of Colusa Waste Water System Improvements, Colusa, California, Project No. 70508-01*, dated January 8.

In 2015 H&K performed a geotechnical investigation to support ongoing improvements to the WWTP and construction of a new collection system pipeline extending from the WWTP to the City of Colusa. The results of the investigation are documented in the *Geotechnical Engineering Investigation Report for City of Colusa Wastewater System Improvements* dated January 8, 2016 (H&K, 2016). Twenty-one exploratory boreholes were drilled on and offsite during the geotechnical investigation to total depths ranging from 20 to 50 feet below ground surface (bgs). Of the 21 boreholes four boreholes (B15-19, B15-20, B15-21 and B15-22) were drilled at the WWTP. The depths of the boreholes ranged from 21.5 to 40 feet bgs. Due to the close proximity of Boring B15-19 to the proposed improvements, previous laboratory testing of soil samples collected from that boring were referenced in this investigation.

- NV5, 2018, *Work Plan for Groundwater Monitoring Well Installation, Colusa Waste Water Treatment Plant, Colusa, California*, dated May 2.

NV5 prepared a work plan for detailing procedures for drilling and construction of five new groundwater monitoring wells and video and geophysical logging of existing wells for the referenced site in Colusa County, California. This work plan was prepared pursuant to the California Regional Water Quality Control Board (RWQCB) NPDES Permit Order No. R5-2016-0062.

2.2 REGIONAL GEOLOGY

The project site is in the Great Valley geomorphic province. The Great Valley province is generally bordered on the north by the Klamath Mountains and Cascade Range, to the east by the Sierra Nevada Mountain Range, and to the west by the Coast Ranges geomorphic provinces. The Great Valley or central valley of California is a large, relatively flat lying northwest to southeast trending area that is approximately 40 to 60 miles (60 to 100 kilometers [km]) wide (east-west) and approximately

450 miles (720 km) long (north-south). The northern one-third of the valley drains to the south by the Sacramento River and the southern two-thirds of the valley drains north by the San Joaquin River, thus the portions of the great valley drained by these rivers are called the Sacramento Valley and San Joaquin Valley, respectively. These rivers join to form a large delta on the eastern edge of the San Francisco Bay and eventually flow westward into the Pacific Ocean.

The Great Valley is originated during the late Jurassic Period (164 to 145 million years before present [mybp]) through Cretaceous Period (145 to 66 mybp) below sea level as a depressed offshore area caused by subduction of the Farallon Oceanic Plate consisting predominantly of heavier mafic rocks beneath the North American Continental Plate consisting predominantly of lighter salic rocks. The resulting depression was subsequently filled with approximately 40,000 feet (12 km) of sediments referred to as the Great Valley Sequence derived from the ancient Sierra Nevadan volcanoes, followed by sediments eroded from the rapidly rising Sierra Nevada mountain range. The deeper sediments deposited during the late Jurassic and Cretaceous Periods generally consist of inter-layered coarse and fine grained marine sediments associated with mountain building events. The shallower sediments deposited during the Pleistocene Epoch (2.6 to 0.01 mybp) and Holocene Epoch (0.01 mybp to present) generally consist of marginal marine to non-marine, predominantly coarser grained sediments that represent the final stage of infilling of the basin.

2.3 SITE GEOLOGY

Based on review of the *Geologic Map of California, Ukiah Sheet*, published by the California Division of Mines and Geology (Jennings, C.W., and Strand, R.G.), the site is underlain predominantly of stream channel deposits (Qsc). The stream channel deposits generally consist of unconsolidated clay, silt, sand, and gravel reworked from older formations by streams.

2.4 REGIONAL FAULTING AND SEISMIC SOURCES

Based on review of the California Geological Society (CGS) *Fault Activity Map of California and Adjacent Areas*, (Jennings, C.W., 2010) there are no known active faults located within the near vicinity of the site. However, regional faulting and historic seismicity within the vicinity of the site is generally associated with the northern extension of the Calaveras Fault (i.e., Green Valley Fault, and Maacama Fault) and the San Andreas Fault all situated greater than approximately 25 miles to the west of the site and the Foothills Fault Systems (i.e., Spencerville Faults, Maidu Fault, Bear Mountain, Cleveland Hills Fault and Melones Fault) all situated greater than 10 miles to the east of the site.

Additionally, the California Geological Survey Special Publication 42, *Fault Rupture Hazard Zones in California published in 1994 and revised in 1997 with Supplement No's 1 and 2 added in 1999 and Supplement No. 3 added in 2003*, describes active faults and fault zones (activity within last 11,000 years) as part of the Alquist-Priolo Earthquake Fault Zoning Act (E.W. Hart and W.A. Bryant, 1999). The CGS Special Publication 42 and its supplements shows that the site is not located within an Alquist-Priolo Earthquake Fault Zone and that no known active or potentially active faults are known to cross the site.

2.5 FIELD INVESTIGATION

NV5 performed a field investigation of the site on August 1, 2023. NV5's field engineer/geologist described the surface and subsurface soil, rock and groundwater conditions observed at the site using the procedures cited in the ASTM International (ASTM), Volume 04.08, *Soil and Rock; Dimension Stone; and Geosynthetics* as general guidelines. The field geologist described the soil color using the general guideline procedures presented in the Munsell® Soil-Color Chart. Engineering judgment was used to extrapolate the observed surface and subsurface soil, rock and groundwater conditions to areas located between and beyond the subsurface exploratory locations. The surface, subsurface and groundwater conditions observed during the field investigation are summarized below.

2.5.1 Surface Conditions

NV5 observed the following surface conditions during the field investigation of the property. Figures 2 and 2a show the approximate project site boundaries and the approximate exploratory boring locations.

- **Wet Well Site (1480 Will S. Green Avenue):** The site consists of flat undeveloped land with moderate concentration of weeds and grasses. A yellow groundwater monitoring well stand pipe present. A mature tree was present to the northeast. The site was relatively rolling and uneven along the west boundary.
- **WWTP Site (2820 Will S. Green Avenue):** The site consists of an existing WWTP facility comprised of sewer infrastructure, office buildings, earthen soil berms, solar arrays, paved and unpaved access roads and wastewater holding ponds. Surrounding land use is agricultural and there are high power transmission lines transecting the southwest corner of the site.

2.5.2 Subsurface Conditions

The subsurface soil, rock and groundwater conditions were investigated by excavating exploratory borings across the site. The subsurface information obtained from this investigation method is described in the following subsections.

2.5.2.1 Exploratory Boring Information

NV5 provided engineering oversight for the advancement of a total of 4 exploratory soil borings across the site. The borings were advanced with a truck-mounted CME-55 drill rig equipped with 7.00-inch outside diameter, continuous flight, hollow stem augers. Figures 2 and 2a show the approximate locations of the subsurface exploratory borings. The borings were excavated to a maximum depth of 36.5 feet below ground surface (bgs). Engineering judgment was used to extrapolate the observed soil, rock and groundwater conditions to areas located between and beyond the subsurface exploratory excavations performed in the area.

NV5's field engineer/geologist logged each exploratory boring using the ASTM D2487 Unified Soils Classification System (USCS) as guidelines for soil descriptions and the American Geophysical Union guidelines for rock descriptions. Relatively undisturbed soil samples were collected with a 2.5-inch

inside diameter split-spoon sampler equipped with stainless steel liner sampler tubes. The sampler was driven into the soil using an automatic trip hammer weighing 140 pounds with a 30-inch free-fall. The stainless-steel liner samples were sealed with labeled plastic caps. All of the representative soil samples were transported to the NV5 Chico office soil laboratory facility.

Detailed descriptions of the soil, rock and groundwater conditions that were encountered in the subsurface exploratory location are presented on the exploratory boring logs included in Appendix A. The soil and rock descriptions include: visual field estimates of the particle size percentages (by dry weight), color, relative density or consistency, moisture content and cementation that comprise each soil material encountered.

A generalized profile of the soil, rock and groundwater conditions encountered to the maximum depth explored (36.5 feet) for the proposed building areas is presented below. The soil and/or rock units encountered in the subsurface exploratory excavations were generally stratigraphically continuous across the sites with some variations in gradations and thicknesses. The units encountered in general stratigraphic sequence during the subsurface investigation of the sites are described below.

- **ML, Low Plasticity Silt Soil:** This native soil consists of the following field estimated particle size percentages: 60 percent low plastic silt and clay fines and 40 percent fine sand. This soil is predominantly brown with a Munsell® Soil-Color Chart designation of (10YR, 4/3). This soil was soft and damp to moist at the time of our subsurface investigation.
- **CL, Low Plasticity Clay Soil:** This soil is comprised of undocumented fill and native soil that consists of the following field estimated particle size percentages: 85 percent low plastic silt and clay fines and 15 percent fine sand. This soil is predominantly dark brown with a Munsell® Soil-Color Chart designation of (10YR 3/3). This soil was medium stiff and damp to moist at the time of our subsurface investigation.
- **SM, Silty Sand Soil:** This native soil consists of the following field estimated particle size percentages: 60 percent fine sand and 40 percent low plastic silt and clay fines. This soil is predominantly grayish brown with a Munsell® Soil-Color Chart designation of (10YR, 5/2). This soil was dense and wet at the time of our subsurface investigation.

2.5.2.2 Groundwater Conditions

Groundwater was initially encountered in exploratory borings B23-1, B23-3 and B23-4 at depths of approximately 18.0, 12.0, and 13.5 feet bgs at the time of this subsurface investigation. The moisture content of each soil unit described on the exploratory boring logs is considered the natural moisture within the vadose soil zone (soil situated above the groundwater table).

As reported in H&K, 2016, the local groundwater table was generally encountered under unconfined conditions from approximately 5 (B15-20) to 8 (B15-17) feet below the existing ground surface. Based on groundwater monitoring data provided by the City of Colusa, and presented in the NV5, 2018 report, the groundwater flow direction appears to be in all directions depending on the time of year, adjacent ditch operations, adjacent agricultural operations, stage of Sacramento River and potentially other unknown influencing factors.

Review of the Department of Water Resources online Groundwater Information Center Interactive Map Application (URL: <https://gis.water.ca.gov/app/gicima/>), depth to groundwater at the site is mapped between 10 and 40 feet bgs. The regional flow direction in the vicinity of the WWTP is shown to vary in all directions from the spring and fall data sets; and during some time periods the flow pattern appears to be radial.

3.0 LABORATORY TESTING

NV5 performed laboratory tests on selected soil samples taken from the subsurface exploratory excavations to determine their geotechnical engineering material properties. These engineering material properties were used to develop geotechnical engineering design recommendations for earthwork and structural improvements. The following laboratory tests were performed using the cited ASTM guideline procedures:

- ASTM D2166 Unconfined Compressive Strength
- ASTM D2216 Moisture Content of Soil
- ASTM D2487 Soil Classification by the USCS
- ASTM D2850 Unconsolidated-Undrained Triaxial Compressive Strength
- ASTM D2937 Density of Soil In-Place
- ASTM D422 Particle Size Gradation (Sieve Only)
- ASTM D4318 Atterberg Limits (Dry Method)

Table 3.0-1 presents a summary of the geotechnical engineering classification and laboratory test results. Based on review of the H&K soils investigation, soil boring B15-19 is located near B23-4. To supplement our lab testing, NV5 used test results from soil boring B15-19. Appendix C presents the laboratory test data sheets.

Table 3.0-1, Laboratory Test Results

Boring		Sample		ASTM Test Results ⁽¹⁾							
No.	No.	Depth	D2487 D2488	D2216	D2937	D422		D4318		D2850	D2166
			USCS	Moisture Content	Dry Density	Passing No. 4 Mesh Sieve (%)	Passing No. 200 Mesh Sieve (%)	Plasticity Index	Liquid Limit	UU Compressive Strength ⁽²⁾	Unconfined Compressive Strength
		(ft)	(sym)	(%)	(pcf)	(%)	(%)	(%)	(%)	(psf)	(psf)
B23-2	BLK-2	1-3	CL	--	--	92.5	69.4	--	--	--	--
B23-4	BLK-4	1-3	CL	--	--	99.3	87.7	15	35	--	--
B15-19	L1-1- 2/L1- 2-2	5.0	CL	18.1	110.8	--	--	--	--	2449.4	1857.2

Notes:

(1) Laboratory test forms are presented in Appendix B
(2) UU Shear Strength equals ½ UU compressive strength
% percent
ASTM ASTM International
ft feet
No. number
sym symbol
pcf pounds per cubic foot
psf pounds per square foot
USCS Unified Soils Classification System
UU Unconsolidated Undrained

4.0 LIQUEFACTION AND SEISMIC SETTLEMENT

NV5 did not perform a detailed evaluation of the potential for seismically induced soil liquefaction at the site. However, NV5 believes that the site has a very low potential for soil liquefaction. The following supports our assessment.

4.1 LIQUEFACTION

Soil liquefaction results when the shear strength of a saturated soil decreases to zero during cyclic loading that is generally caused by machine vibrations or earthquake shaking. Generally, saturated, clean, loose, uniformly graded sand and loose, silty sand soils of Holocene age are the most prone to undergo liquefaction; however, saturated, gravelly soil, and some clay-rich soil may be prone to liquefaction under certain conditions

As reported in 2016, H&K performed an evaluation of the potential for liquefaction occurring at this site based on the subsurface information obtained from the exploratory borings drilled at the project site, and the results of the probabilistic seismic analysis performed by the USGS's 2008 PSHA Interactive Deaggregation software. The results of this analysis indicates that the soil underlying the project site and vicinity have a very low potential for liquefaction when subjected to the peak ground accelerations expected at the site resulting from the design MCE. The results of the liquefaction analysis of the project site are presented in the H&K report in Appendix D.

4.2 SEISMIC SETTLEMENT AND LATERAL SPREADING

The estimated seismically induced settlement expected at the site is considered to be negligible. Since, the potential for liquefaction at the site is very low and the site is relatively flat the potential for seismically induced lateral spreading is also considered to be negligible.

5.0 CONCLUSIONS

The conclusions presented in this section are based on information developed from the field and laboratory investigations.

1. It is NV5's opinion that the site is suitable for the proposed construction improvements provided that the geotechnical engineering design recommendations presented in this report are incorporated into the earthwork and improvement project plans. Prior to construction, NV5 should be allowed to review the proposed final earthwork grading and improvement plans to determine if the geotechnical engineering recommendations have been properly incorporated, are still applicable or need modifications.
2. Undocumented fills were observed in exploratory borings B23-2 and B23-3 in the areas of the proposed maintenance building and concrete lined aeration basin that extended from the surface to depths of approximately 6.5 and 8.0 feet bgs. These undocumented fills cannot be relied upon for support of the proposed structural improvements due to their unknown quality, unknown method of placement, and potential for settlement. Recommendations for mitigating the undocumented fills are presented in Section 6.1 of this report.
3. Based on the site geology, the observations within the exploratory borings, the site soil profile can be modeled, according to the 2022 CBC, Chapter 16, and ASCE 7-16, Chapter 20, as a Site Class D (Stiff Soil Profile) designation for the purposes of establishing seismic design loads for the proposed improvements.
4. Based on the relatively stiff and dense subsurface soil conditions encountered in the exploratory borings, other field data, and literature review, NV5 believes that the site soil and groundwater conditions make the probability of liquefaction occurring during a nearby earthquake to be very low.
5. At the time of our investigation, the site included two properties which are described below:
 - Wet Well Site (1480 Will S. Green Avenue): The site consists of flat undeveloped land with moderate concentration of weeds and grasses. A yellow groundwater monitoring well stand pipe present. A mature tree was present to the northeast. The site was relatively rolling and uneven along the west boundary.
 - WWTP Site (2820 Will S. Green Avenue): The site consists of an existing WWTP facility comprised of sewer infrastructure, office buildings, earthen soil berms, solar arrays, paved and unpaved access roads and wastewater holding ponds. Surrounding land use is agricultural and there are high power transmission lines transecting the southwest corner of the site.
6. The soil conditions observed to a maximum depth of 36.5 feet below the existing ground surface in the subsurface exploratory excavations (described relative to the existing ground surface) generally consisted of brown to dark brown, soft to stiff, low plasticity, sandy silt (ML) and lean clay (CL), underlain by dark brown, lean clay with sand (CL) and grayish brown, dense, silty sand (SM).
7. NV5's field and laboratory test data indicate that the sandy silt (ML) and lean clay (CL) soil units encountered beneath the site have the following general geotechnical engineering properties: soft to stiff, low plasticity; and, a low to moderate bearing capacity that is suitable for supporting shallow foundations.

8. Groundwater was initially encountered in exploratory borings B23-1, B23-3 and B23-4 at depths of approximately 18.0, 12.0, and 13.5 feet bgs at the time of this subsurface investigation. Based on the above average rainfall, subsurface geologic conditions and review of monitoring well data near the site, NV5 assumes that for design and evaluation purposes, the historically high groundwater table is located 10 to 40 feet bgs or deeper. The regional flow direction in the vicinity of the WWTP is shown to vary in all directions from the spring and fall data sets; and during some time periods the flow pattern appears to be radial.

6.0 RECOMMENDATIONS

NV5 identified undocumented fills in exploratory borings B23-2 and B23-3 in the areas of the proposed maintenance building and concrete lined aeration basin that are not considered suitable for support of the proposed structural improvements. Based on the field data, the undocumented fills should be completely removed and the areas restored to grade with engineered fill constructed in accordance with the recommendations presented in this section.

NV5 developed geotechnical engineering design recommendations for earthwork and structural improvements from the field and laboratory investigation data. NV5's recommendations are presented below.

6.1 EARTHWORK GRADING

NV5's earthwork grading recommendations include import fill soil, temporary excavations, stripping and grubbing, native soil preparation for engineered fill placement, engineered fill construction with testable earth materials, pond engineered fill construction, fill slope grading, cut slope grading, erosion controls, underground utility trenches, construction dewatering, soil corrosion potential, subsurface groundwater drainage, surface water drainage, grading plan review and construction monitoring.

6.1.1 Import Fill Soil

Import fill soil should meet the geotechnical engineering material properties described in Section 6.1.5.1 (Engineered Fill Construction with Non-Expansive Soil) of this report. Prior to importation to the site, the source generator should document that the import fill meets the guidelines set forth by the California Environmental Protection Agency (CalEPA) Department of Toxic Substances Control (DTSC) in their 2001 "Information Advisory, Clean Imported Fill Material." This advisory represents the best practice for characterization of soil prior to import for use as engineered fill. The project engineer should approve all proposed import fill soil for use in constructing engineered fills at the site.

6.1.2 Temporary Excavations

All temporary excavations must comply with applicable local, state and federal safety regulations, including the current Occupational Safety and Hazards Administration (OSHA) excavation and trench safety standards. Construction site safety is the responsibility of the contractor, who is solely responsible for the means, methods and sequencing of construction operations. Under no circumstances should the findings, conclusions and recommendations presented herein be inferred to mean that NV5 is assuming any responsibility for temporary excavations, or for the design, installation, maintenance and performance of any temporary shoring, bracing, underpinning or other similar systems. NV5 could provide temporary cut slope gradients, if required.

6.1.3 Demolition and Abandonment of Existing Site Improvements

NV5 anticipates that the existing site improvements within the proposed building areas will need to be demolished and removed from the site as described below.

1. The existing asphalt concrete (AC) and aggregate base (AB) rock pavement materials within the proposed building areas should be excavated and disposed off site. However, it may be possible to use some of this demolition material to construct engineered fills provided they meet the gradation requirements specified for either “testable fill” or “non-testable fill” materials presented in this report. The project geotechnical engineer should approve the use of both AC and AB rock demolition materials for use in constructing engineered fills.
2. All foundations, underground utilities and other existing site improvements that are encountered during construction within the proposed building area should be demolished and removed from the site. These demolition materials should be disposed off-site in compliance with applicable regulatory requirements.
3. All undocumented fills as encountered in our exploratory borings should be completely removed. The NV5 project engineer or their representative should approve the reuse and placement of all undocumented fill materials prior to constructing compacted engineered fills. Recommendations for engineered fill construction to restore areas of removed undocumented fills to design grades are presented in Sections 6.1.5 and 6.1.6 of this report.
4. Abandonment of any underground utilities within the construction area that will not interfere with the proposed site improvements should be plugged with cement grout to reduce migration of soil and/or water.

6.1.4 Stripping and Grubbing

The site should be stripped and grubbed of vegetation and other deleterious materials, as described below.

1. Strip and remove the top 4 to 6 inches of soil from the landscaping areas containing shallow vegetation roots and other deleterious materials. This highly organic topsoil can be stockpiled on-site and used for surface landscaping but should not be used for constructing compacted engineered fills. Grub the underlying 6 to 8 inches of soil to remove any large vegetation roots or other deleterious material while leaving the soil in place. The project geotechnical engineer or their representative should approve the use of any soil materials generated from the clearing and grubbing activities.
2. Remove all large shrub and tree roots, tree stumps, and underground utilities. Excavate the remaining cavities or holes to a sufficient width so that an approved backfill soil can be placed and compacted in the cavities or holes. Sufficient backfill soil should be placed and compacted in order to match the surrounding elevations and grades. The project geotechnical engineer or their representative should observe and approve the preparation of the cavities and holes prior to placing and compacting engineered fill soil in the cavities and holes.
3. Remove all rocks greater than 6 inches in greatest dimension from the top 12 inches of the soil. Rocks with a greatest dimension larger than 6 inches will be referred to in this report as “oversized” rock materials. Oversized rock materials can be stockpiled on-site and used to construct engineered fills; however, they must be placed at or near the bottom of deep fills but not shallower than 3 feet from the finished subgrade surface. The oversized rocks should be placed with enough space between them to avoid clustering and the creation of void space. The project geotechnical engineer or their representative should approve the use and placement of all oversized rock materials prior to constructing compacted engineered fills.

4. Excessively large amounts of vegetation, other deleterious materials and oversized rock materials should be removed from the site.

6.1.5 Native Soil Preparation for Engineered Fill Placement

After completing site stripping and grubbing activities, the exposed native soil should be prepared for placement and compaction of non-expansive engineered fills, as described below.

1. The native soil should be scarified to a minimum depth of 8 inches below the existing land surface or stripped and grubbed surface and then uniformly moisture conditioned. If the soil is classified as a coarse-grained soil by the USCS (i.e., GP, GW, GC, GM, SP, SW, SC or SM) then it should be moisture conditioned within ± 3 percentage points of the ASTM D1557 optimum moisture content. If the soil is classified as a low plasticity fine-grained soil by the USCS (i.e., CL, ML), then it should be moisture conditioned between 2 and 4 percentage points greater than the ASTM D1557 optimum moisture content. If soil classified as a high plasticity fine-grained soil by the USCS (i.e., CH, MH) is encountered, the soil should be removed from the building pad area or contact NV5 for further recommendations.
2. The native soil should then be compacted to achieve a minimum relative compaction of 90 percent of the ASTM D1557 maximum dry unit weight (density). The moisture content, density and relative percent compaction should be tested by the project geotechnical engineer or their field representative to evaluate whether the compacted soil meets or exceeds the minimum percent compaction and moisture content requirements. The earthwork contractor shall assist the project geotechnical engineer or their field representative by excavating test pads with the on-site earth moving equipment. Native soil preparation beneath AC pavement should be prepared as specified in Section 6.2 (Structural Improvements).
3. The prepared native soil surface should be proof-rolled with a fully-loaded 4,000-gallon-capacity water truck with the rear of the truck supported on a double-axle, tandem-wheel undercarriage or approved equivalent. The proof-rolled surface should be visually observed by the project geotechnical engineer or their field representative to be firm, competent and relatively unyielding. The project geotechnical engineer or their field representative may also evaluate the surface material by hand probing with a ¼-inch-diameter steel probe; however, this evaluation method should not be performed in place of proof-rolling as described above.
4. Construction Quality Assurance (CQA) tests should be performed using the minimum testing frequencies presented in Table 6.1.5-1 or as modified by the project geotechnical engineer to better suit the site conditions.
5. The native soil surface should be graded to minimize ponding of water and to drain surface water away from the building foundations and associated structures. Where possible, surface water should be collected, conveyed and discharged into natural drainage courses, storm sewer inlet structures, permanent engineered storm water runoff percolation/evaporation basins or engineered infiltration subdrain systems.

Table 6.1.5-1, Minimum Testing Frequencies

ASTM No.	Test Description	Minimum Test Frequency ⁽¹⁾
D1557	Modified Proctor Compaction Curve	1 per 1,500 CY or Material Change ⁽²⁾
D6938	Nuclear Density and Nuclear Moisture Content	1 per 250 CY
Notes: (1) These are minimum testing frequencies that may be increased or decreased at the project geotechnical engineer's discretion based on the site conditions encountered during grading. (2) Whichever criteria provide the greatest number of tests. ASTM = ASTM International CY = cubic yards No. = number		

6.1.6 Engineered Fill Construction with Testable Earth Materials

Engineered fills are constructed to support structural improvements. Engineered fills should be constructed using non-expansive soil as described in Section 6.1.5.1. If possible, the use of expansive soil for constructing engineered fills should be avoided. If the use of expansive soil cannot be avoided, then engineered fills should be constructed as described in Section 5.1.5.2 or as modified by the NV5 project engineer. If soil is to be imported to the site for constructing engineered fills, then NV5 should be allowed to evaluate the suitability of the borrowed soil source by taking representative soil samples for laboratory testing. Testable earth materials are generally considered to be soils with gravel and larger particle sizes retained on the No. 4 mesh sieve that make up less than 30 percent by dry weight of the total mass. The relative percent compaction of testable earth materials can be readily determined by the following ASTM test procedures: laboratory compaction curve (D1557), field moisture and density (D6938). Construction of engineered fills with non-expansive and expansive testable earth materials is described below.

6.1.6.1 Engineered Fill Construction with Non-Expansive Soil

Construction of engineered fills with non-expansive soil should be performed as described below.

1. Non-expansive soil used to construct engineered fills should consist predominantly of materials less than ½-inch in greatest dimension and should not contain rocks greater than 3 inches in greatest dimension (oversized material). Non-expansive soil should have a plasticity index (PI) of less than or equal to 15, as determined by ASTM D4318 Atterberg Indices testing. Oversized materials should be spread apart to prevent clustering so that void spaces are not created. The project geotechnical engineer or their field representative should approve the use of oversized materials for constructing engineered fills.
2. Non-expansive soil used to construct engineered fills should be uniformly moisture conditioned. If the soil is classified by the USCS as coarse grained (i.e., GP, GW, GC, GM, SP, SW, SC or SM), then it should be moisture conditioned to within ± 3 percentage points of the ASTM D1557 optimum moisture content. If the soil is classified by the USCS as fine grained (i.e., CL, ML), then it should be moisture conditioned to between 2 and 4 percentage points greater than the ASTM D1557 optimum moisture content.
3. Engineered fills should be constructed by placing uniformly moisture conditioned soil in maximum 8-inch-thick loose lifts (layers) prior to compacting.

4. The soil should then be compacted to achieve a minimum relative compaction of 90 percent of the ASTM D1557 maximum dry density.
5. The earthwork contractor should compact each loose soil lift with a tamping foot compactor such as a Caterpillar (CAT) 815 Compactor or equivalent as approved by NV5's project geotechnical engineer or their field representative. A smooth steel drum roller compactor should not be used to compact loose soil lifts for construction of engineered fills.
6. The field and laboratory CQA tests should be performed consistent with the testing frequencies presented in Table 6.1.6.1-1 or as modified by the project geotechnical engineer to better suit the site conditions.

Table 6.1.6.1-1, Minimum Testing Frequencies for Non-Expansive Soil

ASTM No.	Test Description	Minimum Test Frequency ⁽¹⁾
D1557	Modified Proctor Compaction Curve	1 per 1,500 CY or Material Change ⁽²⁾
D6983	Nuclear Moisture and Density	1 per 250 CY
Notes: (1) These are minimum testing frequencies that may be increased or decreased at the project geotechnical engineer's discretion based on the site conditions encountered during grading. (2) Whichever criteria provide the greatest number of tests. ASTM = ASTM International CY = cubic yards No. = number		

7. The moisture content, density and relative percent compaction of all engineered fills should be tested by the project geotechnical engineer's field representative during construction to evaluate whether the compacted soil meets or exceeds the minimum compaction and moisture content requirements. The earthwork contractor shall assist the project geotechnical engineer's field representative by excavating test pads with the on-site earth-moving equipment.
8. The prepared finished grade or finished subgrade soil surface should be proof-rolled, as mentioned above in Section 6.1.5, Paragraph 3.

6.1.6.2 Engineered Fill Construction with Expansive Soil

NV5 did encounter potentially expansive soil within the shallow soil, or zones within the foundation loads and slab-on-grade floors that would be influenced by shrinking or swelling conditions. NV5 recommends removing expansive soil from below the building footprint to avoid the potential damage that may be caused by soil heave.

If expansive soils are encountered during grading of the site and if the property owner desires to use the expansive soil to construct engineered fills, or have the building foundations or concrete-slab-on-grade floors bear directly upon the expansive soil, then the following three options should be considered. Each option has inherent risks and associated costs relative to future problems associated with expansive soil including shrinking and settlement (downward movement) and/or and swell and heave (upward movement) of foundations and concrete slab-on-grade floors. The options are presented in the general order of decreasing cost but increasing risk with regards to future problems related to soil shrink-swell behavior. Prior to implementing any of these options, NV5

should be notified so that further evaluation of the potentially expansive soil can be completed and these recommendations confirmed or modified as appropriate, if necessary.

Option 1 Remove and Replace with Non-Expansive Soil (NV5 Preferred Option-Lowest Shrink-Swell Behavior Risk):

This mitigation option has the lowest inherent risk of incurring future problems regarding settlement and/or heave of foundations and concrete slab-on-grade floors. This option consists of removing the expansive soil to a depth to be determined by the project geotechnical engineer. NV5 estimates that expansive soil, if encountered at the site, should be removed completely or removed to a minimum depth of 1 foot below the bottom of the building foundations and concrete slab-on-grade floors, whichever creates the greater depth below the adjacent finished grade surface. The actual removal depth or depths should be evaluated by the project geotechnical engineer's field representative during grading and may be either increased or decreased depending upon the site conditions observed.

Non-expansive soil should then be placed, moisture conditioned and compacted to achieve the finished grades as described in Section 6.1.6.1 of this report. This option, when compared to the other two options, generally incurs the greatest upfront costs to the project but has the least risk for future problems arising from the high shrink-swell behavior of the soil. Repair of future problems due to soil shrink-swell behavior is generally from 10 to 100 times costlier than the cost of removing and replacing with non-expansive soil during initial grading.

Option 2 Expansive Soil Treatment with High Calcium Lime and Fly-Ash (Moderate Shrink-Swell Behavior Risk):

This mitigation option has an intermediate (moderate) inherent risk of incurring future problems regarding settlement and/or heave of foundations and concrete slab-on-grade floors. This option consists of mixing high calcium lime and/or cement with the on-site expansive soil to reduce the expansive shrink-swell behavior of the soil. This option, when compared to the other two options, generally incurs an intermediate upfront cost to the project with an intermediate risk for future problems arising from the high shrink-swell behavior of the soil. NV5 did not evaluate as part of the geotechnical engineering investigation work scope the percent of high calcium lime and/or cement to be mixed with on-site expansive soil. If this option is selected by the owner to mitigate the on-site expansive soils, then NV5 should be consulted to prepare a proposed work scope to evaluate and develop construction specifications for lime and/or cement treatment of the onsite expansive soil.

Option 3 Reworking Expansive Soil with Use of Post-Tensioned Concrete Slab-On-Ground Surface Reinforced Floors (Highest Shrink-Swell Behavior Risk):

This mitigation option has the highest inherent risk of incurring future problems with settlement and/or heave of foundations and concrete slab-on-grade floors. This option consists of reworking the existing on-site expansive soil to reduce its expansive shrink-swell behavior and the construction of post-tensioned concrete slab-on-ground surface reinforced floors. The post-tensioned reinforced slab-on-ground surface floors should be designed by a California-licensed civil engineer. This option, when compared to the other two options, generally incurs the lowest upfront cost to the project with the highest risk for future problems arising from the high shrink-swell behavior of the soil. Construction of engineered fills with expansive soil should be performed as described below; however, these recommendations may need to be revised by the project geotechnical engineer

during grading depending upon the actual site conditions encountered. The project geotechnical engineer should be notified prior to implementing this expansive soil mitigation approach to determine if alternative foundation and concrete slab-on-grade floor designs will be necessary (i.e., pier and grade-beams, post-tension slabs, among others).

1. Expansive soil used to construct engineered fills should consist predominantly of materials less than 1/2-inch in greatest dimension and should not contain rocks greater than 3 inches in greatest dimension (oversized material). Expansive soil will have a PI greater than PI > 20 as determined by ASTM D4318 Atterberg Indices test. Oversized materials can be placed at or near the bottom of deep fills, but not within 3.0 feet of the finished subgrade surface or within 2.0 feet of the foundation bottom. Deep fills are defined as fills that are greater than 10 feet in vertical thickness. Oversized materials should be spread apart to prevent clustering so that void spaces are not created. The project geotechnical engineer or project geotechnical engineer's field representative should approve the use of oversized materials for constructing engineered fills.
2. Expansive soil used to construct engineered fills should be uniformly moisture conditioned to within 2 to 4 percentage points greater than the ASTM D1557 optimum moisture content. The actual moisture content should be reviewed by the project geotechnical engineer to determine if this preliminary moisture content range is appropriate or should be modified.
3. Engineered fills should be constructed by placing uniformly moisture-conditioned expansive soil in maximum 8-inch-thick loose lifts (layers) prior to compacting.
4. The expansive soil should then be compacted to achieve a minimum relative compaction of 88 percent and a maximum relative compaction of 92 percent of the ASTM D1557 maximum dry density. The actual percent relative compaction should be reviewed by the project geotechnical engineer to determine if this preliminary relative percent compaction range is appropriate or should be modified.
5. Field and laboratory CQA tests should be performed consistent with the testing frequencies presented in Table 6.1.6.2-1 or as modified by the project geotechnical engineer to better suit the site conditions.

Table 6.1.6.2-1, Minimum Testing Frequencies for Expansive Soil

ASTM No.	Test Description	Minimum Test Frequency ⁽¹⁾
D1557	Modified Proctor Compaction Curve	1 per 1,500 CY or Material Change ⁽²⁾
D6983	Nuclear Moisture and Density	1 per 100 CY
Notes: (1) These are minimum testing frequencies that may be increased or decreased at the project engineer's discretion based on the site conditions encountered during grading. (2) Whichever criteria provide the greatest number of tests. ASTM = ASTM International CY = cubic yards No. = number		

6. The earthwork contractor should compact each loose soil lift with a tamping foot compactor such as a CAT 815 Compactor or equivalent as approved by the project geotechnical engineer. A smooth steel drum roller compactor should not be used to compact loose soil lifts of engineered

fills with expansive soil, however, it may be used at the finished subgrade to finish the surface following the completion of compaction.

7. The moisture content, density and relative percent compaction of all engineered fills constructed with expansive soil should be tested by the project geotechnical engineer's field representative during construction to evaluate whether the compacted soil meets or exceeds the minimum compaction and moisture content requirements. The earthwork contractor shall assist the project geotechnical engineer's field representative by excavating test pads with the onsite earth moving equipment.
8. The prepared finished grade or finished subgrade soil surface constructed with expansive soil should be proof-rolled with a fully-loaded 4,000-gallon capacity water truck with the rear of the truck supported on a double-axle, tandem-wheel, undercarriage or approved equivalent. The minimum tire pressure should be 65 pounds per square inch (psi). The proof-rolled surface should be visually observed by the project geotechnical engineer or the project geotechnical engineer's field representative to be firm, competent and relatively unyielding. The project geotechnical engineer or the project geotechnical engineer's field representative may also evaluate the surface material by hand probing with a ¼-inch-diameter steel probe; however, this evaluation method should not be performed in place of proof-rolling as described in the preceding.

6.1.7 Pond Engineered Fill Construction

Engineered fills placed for, or adjacent to, wastewater treatment ponds should be constructed using low-permeability soil as described in Section 6.1.7.1. If soil is to be imported to the site for constructing engineered fills, then NV5 should be allowed to evaluate the suitability of the borrow soil source by taking representative soil samples for laboratory testing. Construction of engineered fills with low-permeability soils are described below.

6.1.7.1 Engineered Fill Construction with Low-Permeability Soil

Construction of engineered fills with low-permeability soil should be performed as described below.

1. Low-permeability soil used to construct engineered fills should consist of relatively homogeneous, fine grained soil with a maximum particle size of 1-inch and shall have a USCS classification as either Clayey Sand (SC) Low-plastic Clay (CL), or High Plastic Clay (CH), with a minimum PI of greater than or equal to $PI \geq 15$ as determined by ASTM D4318 Atterberg Indices test, a maximum permeability of 1.0×10^{-6} centimeters per second as measured by ASTM D5084 at a confining pressure of 5 pounds per inch squared, and a minimum of 30 percent of the fine particle material capable of passing a No. 200 mesh sieve determined by using ASTM D422.
2. Low-permeability soil used to construct engineered fills should be uniformly moisture conditioned to within 2 to 4 percentage points greater than the optimum moisture content of the ASTM D1557 modified compaction curve.
3. Engineered fills should be constructed by placing uniformly moisture-conditioned soil in maximum 8-inch-thick loose lifts (layers) prior to compacting.
4. The soil should then be compacted to achieve a minimum relative compaction of 90 percent of the ASTM D1557 maximum dry density.
5. Field and laboratory QA/QC tests should be performed consistent with the testing frequencies presented in Table 6.1.7.1-1:

Table 6.1.7.1-1, Minimum Testing Frequencies for Low-Permeability Soil

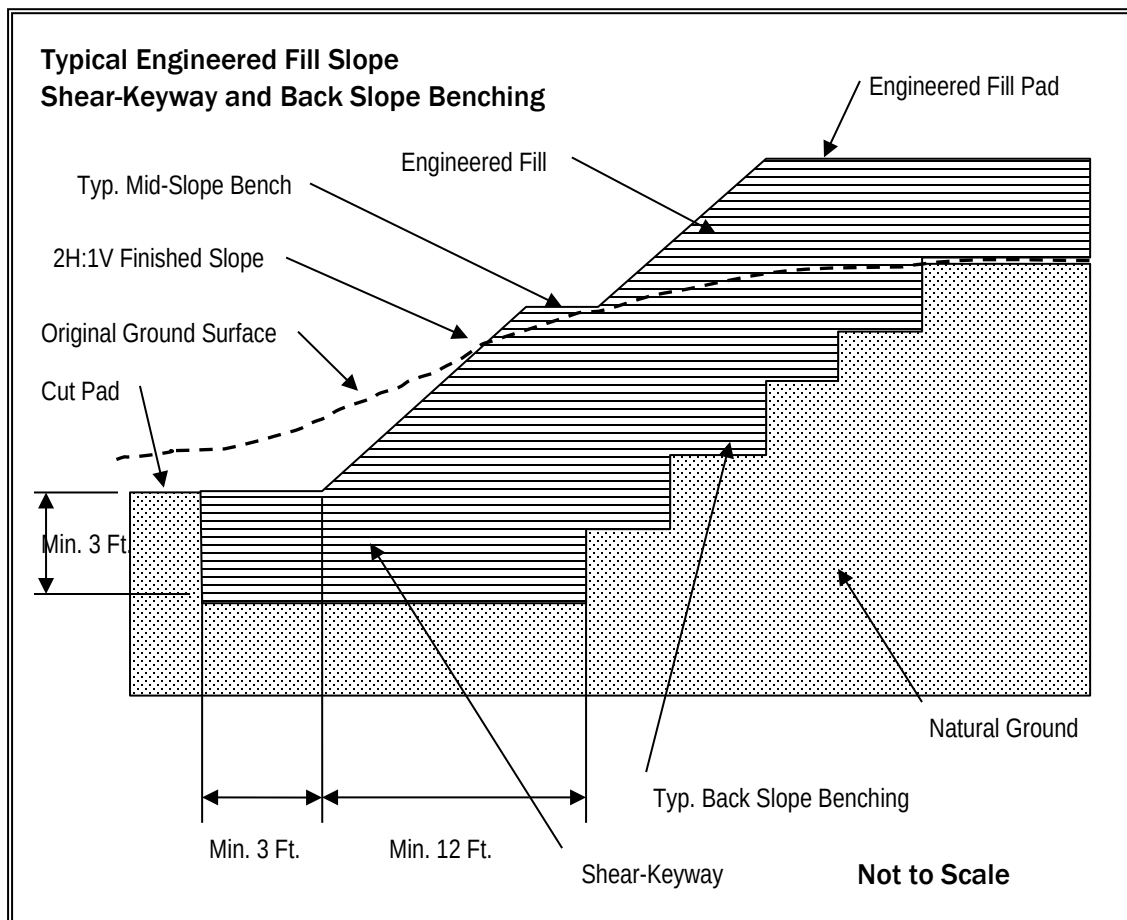
ASTM No.	Test Description	Minimum Test Frequency ⁽¹⁾
D1557	Modified Proctor Compaction Curve	1 per 1,500 CY or Material Change ⁽²⁾
D2487/2488	USCS	Each Material Type
D2922	Nuclear Moisture Content	1 per 250 CY
D3017	Nuclear Density	1 per 250 CY
D2216/D4643	Moisture Content	As Necessary to Check Gauge
D422	Particle Size	1 per 1,500 CY or Material Change ⁽²⁾
D4318	Atterberg Limits	1 per 1,500 CY or Material Change ⁽²⁾
D5084	Permeability	1 per 1,500 CY or Material Change ⁽²⁾
Notes: (1) These are minimum testing frequencies that may be increased or decreased at the project geotechnical engineer's discretion based on the site conditions encountered during grading. (2) Whichever criteria provide the greatest number of tests. ASTM = ASTM International CY = cubic yards No. = number USCS = Unified Soil Classification System		

- The earthwork contractor should compact each loose soil lift with a tamping foot compactor such as a CAT 815 Compactor or equivalent as approved by NV5's Project Engineer.
- The moisture content, density, and relative percent compaction of all engineered fills should be verified by our CQA monitor during construction. The earthwork contractor should assist our CQA monitor by excavating test pads with the on-site earth moving equipment.

6.1.8 Fill Slope Grading

Fill slopes should be graded as described below.

- Fill slopes should be graded with a maximum slope gradient of 2H:1V, and with a maximum vertical height of 20 feet. If fill slopes are to be graded steeper than 2H:1V and/or with a vertical height greater than 20 feet, then NV5 should be notified so that slope stability analysis of the proposed slope configuration can be performed, and revised recommendations provided.
- A shear-keyway should be graded at the base of the fill slope prior to constructing the fill slope. The shear-keyway should be a minimum of 15-feet wide and extend to a minimum depth of 3 feet below the finished subgrade surface, or deeper as determined by the project engineer during grading. The shear-keyway base should be graded with a minimum slope gradient of 2 percent toward the inside fill slope surface.



3. Fill slopes should be graded in horizontal lifts to the lines and grades shown on the grading plans. The design-finished grade of a fill slope should be achieved by overbuilding the slope face and then cutting it back to the design-finished grade. Fill slopes should not be graded (extended horizontally) by compacting moisture conditioned, loose soil lifts on the slope face as thin veneer layers. In other words, do not construct engineered fill slopes by placing and compacting successive thin layers (veneers) of soil over the fill slope face at an inclination that is roughly coincident with the final fill slope horizontal to vertical slope ratio. The in-slope edge of each horizontal lift should be benched into the firm, competent and relatively unyielding soil of the natural ground slope.
4. If groundwater seepage from the slope and/or shear-keyway areas is encountered during grading, or if the site conditions indicate that groundwater seepage does occur during the wet winter season, then NV5 should be notified so that NV5 can assess the conditions and provide a design for installation of permanent dewatering subdrains.
5. Surface benches should be graded into the finished fill slope with a minimum width of 10 feet and with maximum vertical intervals of 15 feet between benches, or at mid-slope height if the total vertical slope height is between 15 feet and 30 feet.

6. Benches should be graded with a minimum slope gradient of 2 percent toward the inside fill slope surface. In other words, the bench slope gradient should cause surface water to drain toward the fill slope side of the bench (not over and down the fill slope face).
7. Fill soils used to construct slopes should be uniformly moisture conditioned, placed in loose lifts, and compacted as described in Sections 6.1.5 through 6.1.7.

6.1.9 Cut Slope Grading

Cut slopes should be graded as described below.

1. Cut slopes should be graded with a maximum slope gradient of 2H:1V and with a maximum vertical height of 20 feet. If cut slopes are to be graded steeper than 2H:1V and/or with a vertical height greater than 20 feet, then NV5 should be notified so that NV5 can perform a slope stability analysis of the proposed slope configurations and provide revised recommendations, if necessary.
2. Surface benches should be graded into the finished cut slope with a minimum width of 10 feet and with maximum vertical intervals of 20 feet between benches, or at the mid-slope height if the total vertical slope height is greater than 20 feet but less than 30 feet.
3. The benches should be graded with a minimum slope gradient of 2 percent toward the cut. In other words, the bench slope gradient should cause surface water to drain toward the cut slope side of the bench (not over and down the cut slope face).

6.1.10 Erosion Controls

Erosion controls should be installed as described below.

1. Erosion controls should be installed on all cut and fill slopes to minimize erosion caused by surface water runoff.
2. Install on all slopes either an appropriate hydroseed mixture compatible with the soil and climate conditions of the site, as determined by the local United States Soil Conservation District or apply an appropriate manufactured erosion control mat.
3. Install surface water drainage ditches at the top of cut and fill slopes (as necessary) to collect and convey both sheet flow and concentrated flow away from the slope face.
4. The intercepted surface water should be discharged into a natural drainage course or into other collection and disposal structures.

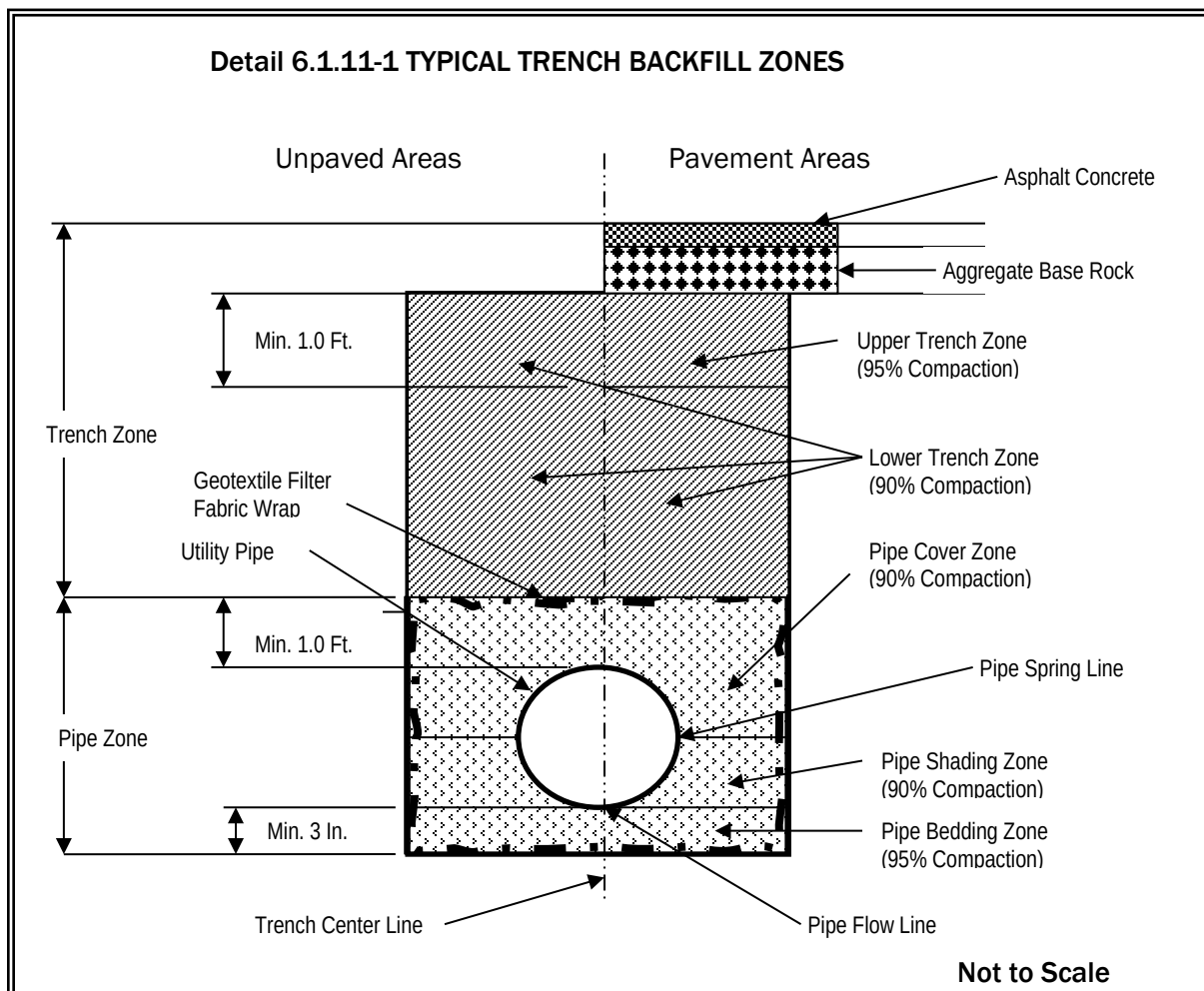
6.1.11 Underground Utility Trenches

Underground utility trenches should be excavated and backfilled as described below for each trench zone shown in the figure below.

1. **Trench Excavation Equipment:** NV5 anticipates that the contractor will be able to excavate all near-surface underground utility trenches with a Case 580 Backhoe or equivalent, however,

deeper utility trenches (4-feet or greater), or those encountering dense, slightly weathered, tuff, claystone, or sandstone, may require larger equipment.

2. **Trench Shoring:** All utility trenches that are excavated deeper than 4 feet bgs are required by California OSHA to be shored with bracing equipment or sloped back to an appropriate slope gradient prior to being entered by any individuals.
3. **Trench Dewatering:** NV5 does not anticipate that the proposed underground utility trenches will encounter shallow groundwater. However, if the utility trenches are excavated during the winter rainy season, then shallow or perched groundwater may be encountered. The earthwork contractor may need to employ dewatering methods as discussed in Section 6.1.12 in order to excavate, place and compact the trench backfill materials.
4. **Pipe Zone Backfill Type and Compaction Requirements:** The backfill material type and compaction requirements for the pipe zone, which includes the bedding zone, the shading zone and the cover zone, are described in Detail 6.1.11-1 below.



- **Pipe Zone Backfill Material Type:** Trench backfill used within the pipe zone, which includes the bedding zone, the shading zone and the cover zone, should consist of imported sand, Class 2 Aggregate Base or ¾-inch-minus, washed, crushed rock. The crushed rock particle

size gradation should meet the following requirements (percentages are expressed as dry weights using ASTM D422 test method): 100 percent passing the $\frac{3}{4}$ -inch sieve, 80 to 100 percent passing the $\frac{1}{2}$ -inch sieve, 60 to 100 percent passing the $\frac{3}{8}$ -inch sieve, 0 to 30 percent passing the No. 4 sieve, 0 to 10 percent passing the No. 8 sieve, and 0 to 3 percent passing the No. 200 sieve. If groundwater is encountered within the trench during construction, or if groundwater is expected to rise during the rainy season to an elevation that will infiltrate the pipe zone within the trench, then the pipe zone material should be wrapped with a minimum 6 ounce per square yard, non-woven geotextile filter fabric such as TenCate® Mirafi N140 or an approved equivalent. The geotextile seam should be located along the trench centerline and have a minimum 1-foot overlap. If the utility pipes are coated with a corrosion protection material, then the pipes should be wrapped with a minimum 6 ounce per square yard, non-woven, geotextile cushion fabric such as TenCate® Mirafi N140 or an approved equivalent. The geotextile cushion fabric should have a minimum 6-inch seam overlap. The geotextile cushion fabric will protect the pipe from being scratched by the crushed rock backfill material.

- **Pipe Bedding Zone Compaction:** Trench backfill soil placed in the pipe bedding zone (beneath the utilities) should be a minimum of 3 inches thick, moisture conditioned to within ± 3 percentage points of the ASTM D1557 optimum moisture content and compacted to achieve a minimum relative compaction of 95 percent of the ASTM D1557 maximum dry density. Crushed rock should be mechanically consolidated under the observation of NV5.
 - **Pipe Shading Zone Compaction:** Trench backfill soil placed within the pipe shading zone (above the bedding zone and to a height of one pipe radius above the pipe spring line) should be moisture conditioned to within ± 3 percentage points of the ASTM D1557 optimum moisture content and compacted to achieve a minimum relative compaction of 90 percent of the ASTM D1557 maximum dry density. Crushed rock should be mechanically consolidated under the observation of NV5. The pipe shading zone backfill material should be shovel-sliced to remove voids and to promote compaction.
 - **Pipe Cover Zone Compaction:** Trench backfill soil placed within the pipe cover zone (above the pipe shading zone to 1 foot over the pipe top surface) should be moisture conditioned to within ± 3 percentage points of the ASTM D1557 optimum moisture content and compacted to achieve a minimum relative compaction of 90 percent of the ASTM D1557 maximum dry density. Crushed rock should be mechanically consolidated under the observation of NV5.
5. **Trench Zone Backfill and Compaction Requirements:** The trench zone backfill materials consist of both lower and upper zones, as discussed below.
- **Trench Zone Backfill Material Type:** Soil used as trench backfill within the lower and upper intermediate zones, as shown on the preceding figure, should consist of non-expansive soil with a PI of less than or equal to 15 (based on ASTM D4318) and should not contain rocks greater than 3 inches in greatest dimension.
 - **Lower Trench Zone Compaction:** Soil used to construct the lower trench zone backfills should be uniformly moisture conditioned to within 0 and 4 percentage points of the ASTM D1557 optimum moisture content, placed in maximum 12-inch-thick loose lifts prior to compacting and compacted to achieve a minimum relative compaction of 90 percent of the ASTM D1557 maximum dry density.

- **Upper Trench Zone Compaction (Road and Parking Lot Areas):** Soil used to construct the upper trench zone backfills should be uniformly moisture conditioned to within 0 and 4 percentage points greater than the ASTM D1557 optimum moisture content, placed in maximum 8-inch-thick loose lifts (layers) prior to compacting and compacted to achieve a minimum relative compaction of 95 percent of the ASTM D1557 maximum dry density.
- **Upper Trench Zone Compaction (Non-Road and Non-Parking Lot Areas):** Soil used to construct the upper trench zone backfills should be uniformly moisture conditioned to within 0 and 2 percentage points greater than the ASTM D1557 optimum moisture content, placed in maximum 6-inch-thick loose lifts (layers) prior to compacting and compacted to achieve a minimum relative compaction of 90 percent of the ASTM D1557 maximum dry density.
- 6. **CQA Testing and Observation Engineering Services:** The moisture content, dry density and relative percent compaction of all engineered utility trench backfills should be tested by the project geotechnical engineer's field representative during construction to evaluate whether the compacted trench backfill materials meet or exceed the minimum compaction and moisture content requirements presented in this report. The earthwork contractor shall assist the project geotechnical engineer's field representative by excavating test pads with the on-site earth moving equipment.
- **Compaction Testing Frequencies:** The field and laboratory CQA tests should be performed consistent with the testing frequencies presented in Table 6.1.11-1 or as modified by the project geotechnical engineer to better suit the site conditions.

Table 6.1.11-1, Minimum Testing Frequencies for Utility Trench Backfill

ASTM No.	Test Description	Minimum Test Frequency ⁽¹⁾
D1557	Modified Proctor Compaction Curve	1 per 500 CY ⁽²⁾ Or Material Change
D6983	Nuclear Moisture and Density	1 per 100 LF per 24-Inch-Thick Compacted Backfill Layer ⁽²⁾ The maximum loose lift thickness shall not exceed 12-inches prior to compacting.
Notes: (1) These are minimum testing frequencies that may be increased or decreased at the project geotechnical engineer's discretion based on the site conditions encountered during grading. (2) Whichever criteria provide the greatest number of tests. ASTM = ASTM International CY = cubic yards No. = number		

- **Final Proof Rolling:** The prepared finished grade AB rock surface and/or finished subgrade soil surface of utility trench backfills should be proof-rolled, as mentioned above in Section 6.1.5, Paragraph 3.

6.1.12 Construction Dewatering

NV5 does anticipate the need to perform dewatering of the site during earthwork grading, the earthwork contractor should be prepared to dewater the utility trench excavations and any other excavations if perched water or the groundwater table is encountered during winter or spring grading. The following recommendations are preliminary and are not based on performing a groundwater flow analysis. A detailed dewatering analysis was not a part of the proposed work

scope. It should be understood that it is the earthwork contractor's sole responsibility to select and employ a satisfactory dewatering method for each excavation.

1. NV5 anticipates that dewatering of utility trenches can be performed by constructing sumps to depths below the trench bottom and removing the water with sump pumps.
2. Additional sump excavations and pumps should be added as necessary to keep the excavation bottom free of standing water and relatively dry when placing and compacting the trench backfill materials.
3. If groundwater enters the trench faster than it can be removed by the dewatering system, thereby allowing the underlying compacted soil to become unstable while compacting successive soil lifts, then it may be necessary to remove the unstable soil and replace it with free-draining, granular drain rock. Native backfill soil can again be used after placing the granular rock to an elevation that is higher than the groundwater table.
4. If granular rock is used, it should be wrapped in a non-woven geotextile fabric, such as TenCate® Mirifi® N140 or an approved equivalent. The geotextile filter fabric should have minimum 1-foot overlapped seams. The granular rock should meet or exceed the following gradation specifications (all percentages are expressed as dry weights using ASTM D422 test method): 100 percent passing the ¾-inch sieve, 80 to 100 percent passing the ½-inch sieve, 60 to 100 percent passing the 3/8-inch sieve, 0 to 30 percent passing the No. 4 sieve, 0 to 10 percent passing the No. 8 sieve, and 0 to 3 percent passing the No. 200 sieve.
5. NV5 recommends that the utility trench excavations be performed as late in the summer months as possible to allow the groundwater table to reach its lowest seasonal elevation.

6.1.13 Soil Corrosion Potential

The California Department of Transportation (Caltrans) Corrosion Guidelines (Version 3.2, dated March 2021) considers a site to be corrosive to structural elements "if one or more of the following conditions exist for the representative soil and/or water samples taken at the site: Chloride concentration is 500 ppm or greater, sulfate concentration of 1,500 ppm or greater, or the pH of 5.5 or less". Minimum resistivity in soil or water is considered an indicator parameter and is not used to define a corrosive soil environment. Caltrans' Guidelines state that a "minimum resistivity value for soil and/or water less than 1,500 Ohm-cm indicates the presence of high quantities of soluble salts and a higher propensity for corrosion".

A representative sample of the near surface site soils obtained from the borings was tested to evaluate the corrosion potential. The tests include pH, electrical resistivity, and soluble chloride and sulfate concentrations. Results of the corrosivity tests performed are summarized in Table 6.1.13-1 below and presented in *Appendix B – Laboratory Test Results*.

Table 6.1.13-1, Corrosivity Test Results

Boring Location and Sample Depth	Soil Type	pH	Minimum Resistivity (Ohm-cm)	Water Soluble Sulfate Content (ppm)	Water Soluble Chloride Content (ppm)
B23-2 @ 1 - 3 ft	LEAN CLAY WITH SAND (CL)	8.27	540	98.7	548.4

General recommendations to address the corrosion potential of the on-site soils are provided below. If additional recommendations are desired, it is recommended that a corrosion specialist be consulted.

Based on experience and the Caltrans Corrosion Guidelines, the site soils are not considered to be corrosive to steel based on the soluble chloride test concentrations. The sulfate test results do not suggest the potential for site soils to be corrosive to steel and concrete foundations.

6.1.13.1 ACI Criteria

Based on a review of the American Concrete Institute (ACI) 318, Section 19.3, the following is noted:

- Per Table 19.3.1.1 and Table 19.3.2.1 – Sulfate Content Test Results
 - o The tested site soils in a “Class S0” Exposure Category. A minimum concrete compressive strength of 2,500 psi would be required with no specific requirement for water cement ratio.
- Per Table 19.3.2.1 – Per Chloride Content Test Results
 - o The tested site soils are in a “Class C1” Exposure Category (assuming some moisture exposure is likely). A minimum concrete compressive strength of 2,500 psi would be required with no specific requirement for water cement ratio. The maximum water-soluble ion content in non-prestressed concrete is 0.30 percent by weight of cement.

6.1.13.2 Ferrous Pipes Criteria

As indicated in the 2006 edition (second edition) of “Corrosion Basics - An Introduction”, a general guideline for soil resistivity and corrosion-severity ratings is presented in Table 6.1.13.2-1 below:

Table 6.1.13.2-1, Soil Resistivity Versus Corrosion Severity

Soil Resistivity	Corrosivity
<1,000 ohm-cm	Extremely Corrosive
1,000 to 3,000 ohm-cm	Highly Corrosive
3,000 to 5,000 ohm-cm	Corrosive
5,000 to 10,000 ohm-cm	Moderately Corrosive

Soil Resistivity	Corrosivity
10,000 to 20,000 ohm-cm	Mildly Corrosive
>20,000 ohm-cm	Essentially Noncorrosive

Soil resistivity is not the only parameter affecting the risk of corrosion damage; and a high soil resistivity will not guarantee the absence of serious corrosion. For example, the American Water Works Association (AWWA) has developed a numerical soil-corrosivity scale, applicable to cast-iron alloys. The test results indicate the potential for soils to be extremely corrosive to ferrous metal pipes.

Any imported soils should be evaluated for corrosion characteristics if they will be in contact with buried or at-grade structures and appropriate mitigation measures should be included in the design. It is recommended that a corrosion specialist be contacted to determine if mitigation measures are necessary.

6.1.14 Subsurface Groundwater Drainage

NV5 does anticipate encountering perched groundwater during the wet weather construction season. If groundwater is encountered during grading, then NV5 should be allowed to observe the conditions and provide site-specific dewatering recommendations.

6.1.15 Grading Plan Review and Construction Monitoring

CQA includes review of plans and specifications and performing construction monitoring, as described below.

1. NV5 should be allowed to review the final earthwork grading improvement plans prior to commencement of construction to determine whether the recommendations have been implemented and, if necessary, to provide additional and/or modified recommendations.
2. NV5 should be allowed to perform CQA monitoring of all earthwork grading performed by the contractor to determine whether the recommendations have been implemented and, if necessary, to provide additional and/or modified recommendations.
3. NV5's experience, and that of the engineering profession, clearly indicates that during the construction phase of a project the risks of costly design, construction and maintenance problems can be significantly reduced by retaining a design geotechnical engineering firm to review the project plans and specifications and to provide geotechnical engineering observation and CQA testing services. Upon your request NV5 will prepare a geotechnical engineering CQA testing services proposal that will present a work scope, a tentative schedule and a fee estimate for your consideration and authorization. If NV5 is not retained to provide geotechnical engineering CQA services during the construction phase of the project, then NV5 will not be responsible for geotechnical engineering CQA services provided by others nor any aspect of the project that fails to meet your or a third party's expectations in the future.

6.2 STRUCTURAL IMPROVEMENTS

NV5's structural improvement design criteria recommendations include seismic design parameters, shallow continuous strip and isolated foundations for buildings, retaining walls entirely above the groundwater table, retaining wall backfill, concrete slab-on-grade interior floors, sidewalk and patio construction, rigid concrete pavement for heavy truck traffic areas and fire lanes and flexible pavement design. These recommendations are presented hereafter.

6.2.1 Seismic Design Parameters

NV5 developed the code-based seismic design parameters in accordance with Section 1613 of the 2022 California Building Code (CBC) and the Structural Engineers Association of California (SEAOC), *Seismic Design Maps* web application. The internet based application (www.seismicmaps.org) is used for determining seismic design values from the 2016 ASCE-7 Standard (erratum released February 2019). The spectral acceleration, site class, site coefficients and adjusted maximum considered earthquake spectral response acceleration, and design spectral acceleration parameters are presented in Table 6.2.1-1. The Seismic Design Parameter detailed report from the SEAOC analysis is provided in Appendix C.

6.2.1.1 Long-Period Seismic Site Coefficient (F_v)

Using Table 1613.2.3(2) of the 2022 CBC, NV5 calculated the long-period site coefficient (F_v) using $S_1=0.320$ and linear interpolation of the values presented in the table. Linear interpolating the values resulted in the following equations for calculating F_v :

- $F_v = (-2 \times S_1) + 2.6$ (S_1 is less than 0.3)
- $F_v = (-1 \times S_1) + 2.3$ (S_1 is greater than 0.3)

$$F_v = (-1 \times S_1) + 2.3 = (-1 \times 0.320) + 2.3 = 1.980$$

6.2.1.2 Seismic Design Category

Based on the short period response acceleration ground motion parameters ($S_{DS} = 0.606$), the 1-S period response acceleration ground motion parameters ($S_{D1} = 0.422$), and the Risk Category of I through III, the Seismic Design Category is D.

6.2.1.3 Geometric Mean Peak Ground Acceleration

NV5 used the SEAOC *Seismic Design Maps* web application to determine the seismic design parameters for the site, including the geometric mean peak ground acceleration (PGA_M). The PGA_M is calculated by using the Site Coefficient (F_{PGA}) multiplied by the PGA mapped values found on Figure 22-9 from ASCE 7-16. The PGA_M was calculated using the following equation:

$$PGA_M = F_{PGA}PGA = 1.273 \times 0.327 = 0.416 \text{ g}$$

The Seismic Design Maps report from the SEAOC analysis is provided in Appendix C.

6.2.1.4 Site-Specific Ground Motion Hazard Analysis

Based on the preliminary information provided to NV5 on the proposed building sizes and types, NV5 anticipates a ground motion hazard analysis is not required for the site provided the Long (1.0 sec) MCE Spectral Response, S_{M1} parameter as determined by ASCE 7-16 Equation 11.4-2 is increased by 50% for all applications of S_{M1} in accordance with Exception 2 found in Section 11.4.8 of ASCE 7-16, Supplement 3. The resulting value of the Long (1.0 sec) Design Spectral Response, S_{D1} parameter determined by ASCE 7-16, Equation 11.4-4 (using the increased value of S_{M1}) should be used for all applications of S_{D1} .

- **S_{M1} increased by 50%:** $(1.5 \times S_{M1}) = (1.5 \times 0.634) = 0.951$
- **Resulting S_{D1} :** $(^{2/3} \times S_{M1}) = (^{2/3} \times 0.951) = 0.634$

Table 6.2.1-1 2022 CBC Seismic Design Parameters

Description	Value	Reference
Latitude North (degrees)	39.1873	Google Earth
Longitude West (degrees)	-122.0290	Google Earth
Site Coefficient, F_A	1.196	2022 CBC, Table 1613.2.3(1), SEAOC Seismic Design Maps
Site Coefficient, F_V	1.980	2022 CBC, Table 1613.2.3(2), SEAOC Seismic Design Maps
Site Class	D = Stiff Soil	ASCE 7-16 Chapter 20, Table 20.3-1
Short (0.2 sec) Spectral Response, S_s (g)	0.760	ASCE 7-16, Section 11.4.2, SEAOC Seismic Design Maps
Long (1.0 sec) Spectral Response, S_1 (g)	0.320	ASCE 7-16, Section 11.4.2, SEAOC Seismic Design Maps
Short (0.2 sec) MCE Spectral Response, S_{MS} (g)	0.909	ASCE 7-16, Section 11.4.4, SEAOC Seismic Design Maps
Long (1.0 sec) MCE Spectral Response, S_{M1} (g)	0.634	ASCE 7-16, Section 11.4.4, SEAOC Seismic Design Maps
Short (0.2 sec) Design Spectral Response, S_{DS} (g)	0.606	ASCE 7-16, Section 11.4.5, SEAOC Seismic Design Maps
Long (1.0 sec) Design Spectral Response, S_{D1} (g)	0.422	ASCE 7-16, Section 11.4.5, SEAOC Seismic Design Maps
Seismic Design Category (Risk Category I, II or III)	D	ASCE 7-16, Section 11.6, SEAOC Seismic Design Maps
Geometric Mean Peak Ground Acceleration (PGA_M) (g)	0.416	ASCE 7-16, Section 11.8.3, SEAOC Seismic Design Maps
CBC = California Building Code MCE = Maximum Considered Earthquake g = gravitational acceleration (9.81 meters per second ² = 32.2 feet per second ²) sec = second		

6.2.2 Shallow Foundations

Shallow continuous and isolated spread foundations that will support load bearing walls shall be designed as follows:

1. The base of all shallow foundations should bear on firm, competent, non-expansive native soil, or non-expansive engineered fill compacted consistent with the earthwork recommendations of Section 6.1.
2. Continuous strip foundations should be constructed with the following dimensions:

- a. Minimum Width = 12 Inches
- b. Minimum Embedment Depth below the lowest adjacent exterior surface grade as shown in Table 6.2.2-1.
3. The bearing capacities to be used for structural design of shallow foundations embedded in either non-expansive native soil or non-expansive engineered fill are presented in Table 6.2.2-1.
 - The calculated factor of safety (FS) for allowable bearing pressures including live plus dead loads is 3.0 for all foundation embedment depths.
 - The allowable bearing pressure capacities were increased by a factor of 1.33 to include wind or seismic short-term loads.
 - The project structural engineer of record should review the factor of safety and confirm that it is not less than the over-strength factor for this structure.

Table 6.2.2-1, Foundation Bearing Pressures for Shallow Continuous Strip and Isolated Spread Foundations

Minimum Foundation Embedment Depth	Maximum Ultimate Bearing Pressures For Live + Dead Loads	Maximum Allowable Bearing Pressures For Live + Dead Loads	Maximum Allowable Bearing Pressures For Live + Dead + Wind or Seismic Loads	Allowable Safety Factor (Ultimate/Total)
(in)	(psf)	(psf)	(psf)	(dim.)
12	4,500	1,500	1,995	3.0
18	6,000	2,000	2,660	3.0
24	7,500	2,500	3,325	3.0
30	9,000	3,000	3,990	3.0
36	10,500	3,500	4,655	3.0
psf = pounds per square foot in = inches dim = dimensionless				

4. Foundation lateral resistance may be computed from passive pressure along the side of the foundation and sliding friction/cohesion resistance along the foundation base; however, the larger of the two resistance forces should be reduced by 50 percent when combining these two forces. The passive pressure can be assumed to be equal to an equivalent fluid pressure (EFP) per foot of depth. The passive pressure force and sliding friction coefficient for computing lateral resistance are as follows:
 - a. Passive pressure = 275 (H), pounds per square foot (psf), where H = foundation embedment depth (feet) below lowest adjacent soil surface.
 - b. Foundation bottom sliding friction coefficient = 0.35 (dimensionless).
5. Minimum steel reinforcement for continuous strip foundations should consist of two No. 4 bars with one bars placed near the top and one bars placed near the bottom of each foundation or as designated by a California licensed professional engineer.
6. The concrete should have a minimum 3,000 pounds per square inch (psi) compressive break strength after 28 days of curing, have a water-to-cement ratio from 0.40 to 0.45, and should be placed with minimum and maximum slumps of 3 and 5 inches, respectively. Since water is often added to uncured concrete to increase workability, it is important that strict quality control

measures be employed during placement of the foundation concrete to ensure that the water-to-cement ratio is not altered prior to or during placement.

7. Concrete coverage over steel reinforcements should be a minimum of 3 inches as recommended by the American Concrete Institute (ACI).
8. Prior to placing concrete in any foundation excavations, the contractor shall remove all loose soil, rock, wood debris or other deleterious materials from the foundation excavations.
9. Foundation excavations should be saturated prior to placing concrete to aid the concrete curing process; however, concrete should not be placed in standing water.
10. Total settlement of individual foundations will vary depending on the plan dimensions of the foundation and actual structural loading. Based on the anticipated foundation dimensions and loads, we estimate that the total post-construction settlement of foundations designed and constructed in accordance with the recommendations will be on the order of 1/2 inch. Differential settlement between similarly loaded, adjacent foundations is expected to be about 1/4 inch, provided the foundations are founded into similar materials (e.g., all on competent and firm engineered fill, native soil or rock).
11. Prior to placing concrete in any foundation excavation, the project geotechnical engineer or his/her field representative should observe the excavations to document that the following requirements have been achieved: minimum foundation dimensions, minimum reinforcement steel placement and dimensions, removal of all loose soil, rock, wood debris or other deleterious materials, and that firm and competent native or engineered fill soil is exposed along the entire foundation excavation bottom. Strict adherence to these requirements is paramount to the satisfactory behavior of a building foundation. Minor deviations from these requirements can cause the foundations to undergo minor to severe amounts of settlement which can result in cracks developing in the foundation and adjacent structural members, such as concrete slab-on-grade floors.

6.2.3 Retaining Walls Entirely Above the Groundwater Table

A California licensed professional engineer should design all retaining walls situated above the groundwater table with drained backfill using the following geotechnical engineering design criteria:

1. The retaining wall recommendations for static loading conditions are based on Rankine earth pressure theory published by W.J.M. Rankine (1857). The retaining wall recommendations for seismic loading conditions are based on the published work by Geraili and Sitar, *Seismic Earth Pressures on Retaining Structures in Cohesionless Soils*, (2013).
2. Retaining walls should be founded on firm competent native soil or engineered fill consistent with the requirements of Section 6.1.
3. The retaining wall should be designed using the geotechnical engineering design parameters presented in Table 6.2.3-1.
4. The retaining wall backfill soil should be free draining material that meets or exceeds the material requirements of and is placed and compacted consistent with the requirements of Section 6.2.4.

5. The static lateral earth pressures exerted on the retaining walls may be assumed to be equal to an equivalent fluid pressure per foot of depth below the top of the wall. The lateral pressures presented in the table below are ultimate values and, therefore, do not include a safety factor, and assumes a free draining backfill (no hydrostatic forces acting on the wall) and no surcharge loads applied within a distance of $0.50H$, where H equals the total vertical wall height.
6. The retaining wall backfill slope shall have a horizontal slope gradient for a minimum horizontal distance of $0.50H$, where H equals the total vertical wall height. If a steeper backfill slope ratio is desired, then NV5 should be notified and contracted to perform additional retaining wall designs.
7. The retaining wall foundation excavations should be saturated prior to placing concrete to aid the concrete curing process. However, concrete should not be placed in standing water.

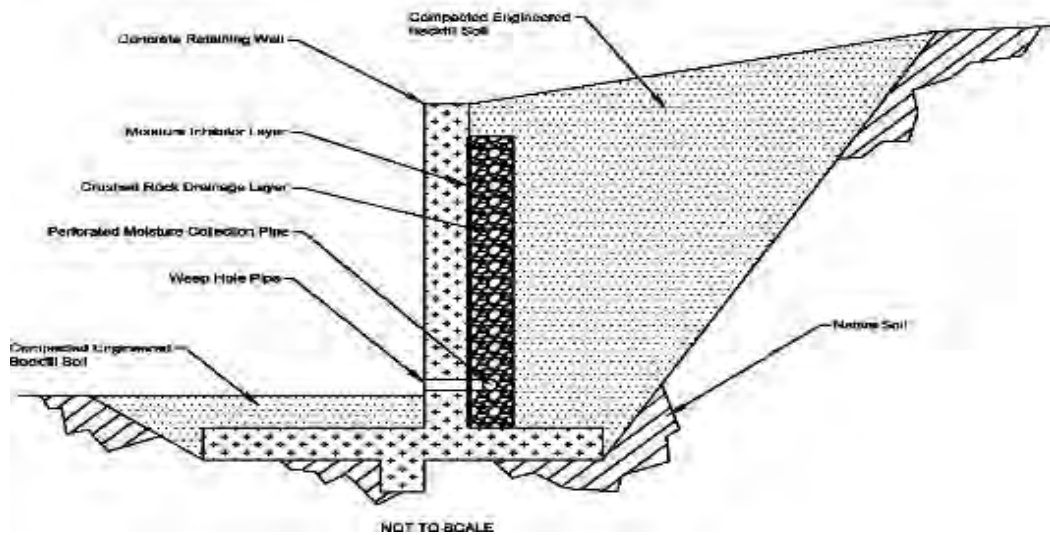
Table 6.2.3-1, Design Parameters for Retaining Walls

Design Parameters for Retaining Walls		
Loading Conditions	Static Loads On Retaining Wall With Horizontal Backfill Slope	Seismic Load On Retaining Wall With Horizontal Backfill Slope
Wall Active Condition Pressures (psf)/ft ⁽¹⁾	50 (H) ⁽⁵⁾	4 (H ²)
Wall Passive Condition Pressures (psf)/ft ⁽²⁾	275 (H)	4 (H ²)
Wall At-Rest Condition Pressure (psf)/ft ⁽³⁾	60 (H)	10 (H ²)
P _{active} Force Located Above Foundation Base	0.33 (H)	Not Applicable
P _{passive} Force Located Above Foundation Base	0.33 (H)	Not Applicable
P _{at-rest} Force Located Above Foundation Base	0.33 (H)	Not Applicable
P _{earthquake} Force Located Above Foundation Base	Not Applicable	0.33(H)
Maximum Allowable Foundation Bearing Capacity (psf), (Live + Dead Loads)	2,000	2,000
Maximum Allowable Foundation Bearing Capacity (psf) (Live + Dead + Wind or Seismic Loads)	2,660	2,660
Minimum Foundation Embedment Depth (in)	18	18
Foundation Bottom Friction Coefficient (dim.) ⁽⁴⁾	0.35	0.35
Notes: (1) The active pressure condition applies to a retaining wall with an unrestrained top (deflection allowed). (2) The passive pressure condition applies to a retaining wall with soil resistance at the base. If passive pressures are used, then NV5 recommends that the top 1.0 feet of soil weight be ignored. (3) The At-Rest pressure condition applies to a retaining wall with the top restrained (no deflection allowed). (4) If the design horizontal resistance force acting on the wall foundation is computed by combining both the sliding friction force and passive soil pressure force, then the larger of the two forces should be reduced by 50 percent. (5) H = The distance to a point in the backfill soil where the pressure is desired. The H distance is measured from the top of the wall for active and at-rest conditions and from one foot below the soil height at the toe of the wall for the passive condition (See Note 2 for passive condition).		

6.2.4 Retaining Wall Backfill

Place and compact all retaining wall backfill and drainage layer materials as described below. NV5 did not review the final improvement plans for the site. If sub-structure retaining walls for below grade rooms, basements, garages, etc., are designed for this project, then these structures should also incorporate a water proofing sealant as described below. The water proofing sealant products should be installed by a qualified waterproofing contractor according to the manufacturer's directions. A typical retaining wall and backfill material zones figure is shown below.

TYPICAL CANTILEVER RETAINING WALL AND BACKFILL MATERIALS



1. **Waterproofing:** Waterproofing materials should be installed behind retaining walls prior to backfilling if retaining walls will be constructed for below grade rooms, basements, garages, elevator shafts, etc. The waterproofing materials should be installed by a qualified waterproofing contractor according to the manufacturer's directions.
2. **Drainage Layer:** A drainage layer should be placed between the wall and backfill material to prevent buildup of hydrostatic pressures behind the wall. Additionally, care should be taken during placement of the drainage layer materials so as not to crush, tear, or damage the waterproofing materials. The drainage layer can be constructed from drain rock, geosynthetic drain nets or a combination of both as described below.
 - a. **Caltrans Class II Permeable Material Method:** Place a minimum 12-inch thick layer of Caltrans Class II Permeable Material directly against the wall or waterproofing system (as described below) without a geotextile wrapping to separate the backfill soil from the wall. The drainage material should extend from the wall bottom to within 12 inches of the wall top.
 - b. **Geotextile Wrapped Drain Rock Method:** Place a minimum 12-inch-thick layer of drain rock wrapped in a geotextile filter fabric directly against the wall or waterproofing system (as described below) to separate the backfill soil from the wall. The drain rock should extend from the wall bottom to within 12 inches of the wall top. A minimum 6-oz/sy non-woven geotextile fabric, such as TenCate® Mirafi N140 manufactured by TenCate Geosynthetics or equivalent should be used.
 - c. **Geosynthetic Composite Drainnet (Geonet) Method:** Place a geosynthetic composite drain-net (geonet) directly against the wall or waterproofing system (as described below) to separate the backfill soil from the wall. The composite geonet should extend from the wall bottom to within 12 inches of the wall top. A geosynthetic composite drainnet such as Hydroduct 200 or Hydroduct 220 distributed by Grace Construction Products or equivalent should be used.

3. **Drainage Layer Collection and Discharge Pipes:** A minimum 4-inch diameter schedule 40, polyvinylchloride (PVC) perforated drainpipe should be placed at the wall base inside the geotextile wrapped drain rock or wrapped by the composite geonet. ¼-inch diameter perforations should be drilled into the pipe. The perforations should be oriented in cross section view at 90 degrees to one another and along the pipe length on 6-inch centers. The pipe should be placed such that the perforations are oriented 45 degrees from the vertical. A minimum of 3 inches of drain rock should be placed below the perforated PVC pipe. The pipe should direct water away from the wall by gravity with a minimum 1 percent slope. The pipe should collect groundwater collected by the drainage layer discharged to the surface at the end of the wall or through weep-hole penetrations through the wall.
4. **Backfill Placement and Compaction Equipment:** Heavy conventional motorized compaction equipment should not be used directly adjacent to a retaining wall unless the wall is designed with sufficient steel reinforcements and/or bracing to resist the additional lateral pressures. Compaction of backfill materials within 5 feet of the retaining wall should be accomplished by lightweight, hand-operated, walk-behind, vibratory equipment. Additionally, care should be taken during placement of the general backfill materials so as not to crush, tear or damage the waterproofing and/or drainage layer materials.
5. **Backfill Materials and Compaction:** The backfill material should be free draining and classified by the USCS as a coarse-grained material (i.e., GP, GW, GC, GM, SP, SW, SC, and SM). Materials classified by the USCS as a fine-grained material (i.e., CL, CH, ML, or MH) should not be used as retaining wall backfill. The retaining wall backfill material placed between the drainage layer and temporary cut-slope should be moisture conditioned to between ± 3 percentage points of the ASTM D1557 optimum moisture content and then compacted to a minimum of 90 percent and a maximum of 95 percent of the ASTM D1557 maximum dry density.

6.2.5 Concrete Slab-On-Grade Interior, Sidewalk and Patio Construction

In general, NV5 recommends that subgrade elevations on which the concrete slab-on-grade floors are constructed be a minimum of 6 inches above the elevation of the surrounding parking lots, driveways and landscaped areas. Elevating the building will reduce the potential for subsurface water to enter beneath the concrete slab-on-grade floors and exterior surfaces and underground utility trenches.

The concrete slab-on-grade building floors, patios, sidewalks and driveway areas should be evaluated by a California-licensed civil engineer for expected live and dead loads to determine if the minimum slab thickness and steel reinforcement recommendations presented in this report should be increased or redesigned.

NV5 recommends using the guideline procedures, methods and material properties that are presented in the following ASTM and ACI documents for construction of concrete slab-on-grade floors:

- ACI 302.1R-15, Guide for Concrete Floor and Slab Construction, reported by ACI Committee 302.
- ASTM E1643-18a, Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

- ASTM E1745-17, Standard Specifications for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
- ASTM F710-22, Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.

The interior building concrete slab-on-grade floor and exterior slab-on-grade concrete components are described below from top to bottom. If static or intermittent live floor loads greater than 250 psf are anticipated, then a California-licensed professional engineer should design the necessary concrete slab-on-grade floor thickness and steel reinforcements.

6.2.5.1 Interior Floor Slabs

1. **Minimum 5-Inch-Thick Concrete Slab:** The concrete slab should be installed with a minimum 3,000 psi compressive strength after 28 days of curing. NV5 recommends that the concrete design use a water-to-cement ratio between 0.40 and 0.45 and should be placed with minimum and maximum slumps of 3 and 5 inches, respectively. The concrete mix design is the responsibility of the concrete supplier.
2. **Steel Reinforcement:** Reinforcement should be used to improve the load-carrying capacity, to reduce cracking caused by shrinkage during curing and from both differential and repeated loadings. It should be understood that it is nearly impossible to prevent all cracks from development in concrete slabs; in other words, it should be expected that some cracking will occur in all concrete slabs no matter how well they are reinforced. Concrete slabs that will be subjected to heavy loads should be designed with steel reinforcements by a California-licensed professional engineer.

Rebar: As a minimum, use No. 4 rebar (ASTM A615/A 615M-22 Grade 60), tied and placed with 18-inch centers in both directions (perpendicular) and supported on concrete “dobies” to position the rebar in the center of the slab during concrete pouring. NV5 does not recommend that the steel reinforcements of the concrete slab-on-grade floor be tied into the perimeter or interior continuous strip foundations or interior isolated column foundations. In other words, we recommend that the concrete slab-on-grade floors be constructed as independent structural members so that they can move (float) independently from the foundation structures.

3. **Underslab Vapor-Moisture Retarder Membrane:** The underslab retarder membrane should be placed in areas with moisture sensitive floor coverings as a floor component that will minimize transmission of both liquid water and water vapor transmission through the concrete slab-on-grade floor. NV5 recommends using at a minimum a Class A (ASTM E1745-17), minimum 10-mil-thick, plastic, vapor-moisture, retarder membrane material such as Stego Wrap® underslab vapor retarder membranes or equivalents. Additionally, the following materials are recommended: Stego® Tape and Stego® Mastic or equivalents to seal membrane joints and any utility penetrations.

Regardless of the type of moisture-vapor retarder membrane used, moisture can wick up through a concrete slab-on-grade floor. Excessive moisture transmission through a concrete slab floor can cause adhesion loss, warping and peeling of resilient floor coverings, deterioration of adhesive, seam separation, formation of air pockets, mineral deposition beneath flooring, odor and both fungi and mold growth. Slabs can be tested for water transmissivity in areas that are moisture sensitive. Commercial sealants, polymer additives to the concrete at the batch plant, entrained air, flyash, and a reduced water-to-content ratio can be incorporated into the concrete

slab-on-grade floor mix design to reduce its permeability and water-vapor transmissivity properties. A waterproofing consultant should be contacted to provide detailed recommendations if moisture sensitive flooring materials will be installed on the concrete slab-on-grade floors.

4. Minimum 4-Inch-Thick Crushed Rock or Class II Aggregate Base Rock Layer: Interior floors should be underlain by clean crushed rock. Crushed rock should be mechanically consolidated under the observation of NV5. The crushed rock should be washed to produce a particle size distribution of 100 percent (by dry weight) passing the $\frac{3}{4}$ inch sieve and 5 percent passing the No. 4 sieve and 0 to 3 percent passing the No. 200 sieve. An alternative rock material for slab-on-grade concrete surfaces would include AB rock meeting the specification of Caltrans Class II AB. AB rock layers should be placed and compacted to a minimum of 95 percent of the ASTM D1557 dry density with a moisture content of ± 3 percentage points of the ASTM D1557 optimum moisture content. Just prior to pouring the concrete slab, the rock layer should be moistened to a saturated surface dry (SSD) condition. This measure will reduce the potential for water to be withdrawn from the bottom of the concrete slab while it is curing and will help minimize the development of shrinkage cracks.

If the current property owner elects to eliminate the crushed rock or AB rock layer beneath the interior concrete slabs-on-grade for economic reasons, then there will be an inherent greater risk assumed by the developer for the development of both shrinkage and bearing-related cracks in the associated slabs.

5. Subgrade Soil Preparation: All concrete slab-on-grade subgrade soil should be prepared and compacted consistent with the recommendations of Section 6.1. The top 12 inches of the non-expansive soil should be compacted to a minimum of 90 percent of the ASTM D1557 dry density with a moisture content within ± 3 percentage points of the ASTM D1557 optimum moisture content.
6. Crack Control: Crack control grooves should be installed during placement or saw cuts should be made in accordance with the ACI and Portland Cement Association (PCA) specifications. Generally, NV5 recommends that expansion joints be provided between the slab and perimeter footings, and that crack control grooves or saw cuts are installed on 10-foot-centers in both directions (perpendicular).
7. Field Observations: All concrete slab-on-grade surfaces and installed steel reinforcements should be observed and inspected by an NV5 construction monitor prior to pouring concrete.
8. Field Curing of Concrete: Prior to applying construction loads, all exposed concrete slab-on-grade floors should be moisture cured for a minimum of 7 days following placement of the concrete. If concrete is placed during the hot summer months when the ambient air temperatures may be as low as 50 to 60 degrees Fahrenheit ($^{\circ}$ F) in the early morning and in excess of 90 $^{\circ}$ F in the afternoon, then the contractor may need to implement special curing measures to reduce the development of shrinkage cracks. The concrete contractor is responsible for determining the appropriate curing process to be applied to the slab-on-grade floor.

6.2.5.2 Exterior Sidewalks and Patios

1. Minimum 4-Inch-Thick Concrete Slab: should be installed with a minimum 2,500 psi compressive strength after 28 days of curing. NV5 recommends that the concrete design uses a water to cement ratio between 0.40 and 0.50 and should be placed with minimum and maximum slumps

of 4 and 6 inches, respectively. The concrete mix design is the responsibility of the concrete supplier.

2. Concrete Slabs In Contact With Isolated Concrete Foundations: NV5 does not recommend that concrete slab-on-grade floors be placed in direct contact with the top surface of isolated column concrete foundations. Our experience is that during curing period of the concrete slab-on-grade floor a significant thermal gradient may develop between the portions of the slab placed directly on the typically more massive isolated column concrete foundations and the portions of the slab placed over a vapor-moisture retarder membrane and crushed rock layers. The development of adverse thermal gradients may cause the development of significant orthogonal and/or circular shrinkage cracks around the isolated column foundations.
3. Steel Reinforcement: should be used to improve the load carrying capacity and to reduce cracking caused by shrinkage during curing and from both differential and repeated loadings. It should be understood that it is nearly impossible to prevent all cracks from development in concrete slabs; in other words, it should be expected that some cracking will occur in all concrete slabs no matter how well they are reinforced or cured. Concrete slabs that will be subjected to heavy loads should be designed with steel reinforcements by a California licensed professional engineer.

If the current property owner (developer) elects to eliminate the steel reinforcements from the exterior concrete slabs-on-grade for economic reasons, then there will be an inherent greater risk assumed by the developer for the development of both shrinkage and bearing related cracks in the associated slabs.

4. Minimum 4-Inch-Thick Crushed Rock Layer: Exterior concrete slabs-on-grade should be underlain by clean crushed rock. Crushed rock should be mechanically consolidated under the observation of NV5. The crushed rock should be washed to produce a particle size distribution of 100 percent (by dry weight) passing the $\frac{3}{4}$ inch sieve and 5 percent passing the No. 4 sieve and 0 to 3 percent passing the No. 200 sieve. An alternative rock material for slab-on-grade concrete surfaces would include AB rock meeting the specification of Caltrans Class II AB. AB rock layers should be placed and compacted to a minimum of 95 percent of the ASTM D1557 dry density with a moisture content of ± 3 percentage points of the ASTM D1557 optimum moisture content. Just prior to pouring the concrete slab, the rock layer should be moistened to a SSD condition. This measure will reduce the potential for water to be withdrawn from the bottom of the concrete slab while it is curing and will help minimize the development of shrinkage cracks.

If the current property owner elects to eliminate the crushed rock or AB rock layer beneath the interior concrete slabs-on-grade for economic reasons, then there will be an inherent greater risk assumed by the developer for the development of both shrinkage and bearing-related cracks in the associated slabs.

5. Subgrade Soil Preparation: All concrete slab-on-grade subgrade soil should be prepared and compacted consistent with the recommendations of Section 6.1. The top 12 inches of the non-expansive soil should be compacted to a minimum of 90 percent of the ASTM D1557 dry density with a moisture content within ± 3 percentage points of the ASTM D1557 optimum moisture content.
6. Crack Control: Crack control grooves should be installed during placement or saw cuts should be made in accordance with the ACI and PCA specifications. Generally, NV5 recommends that expansion joints be provided between the slab and perimeter footings, and that crack control grooves or saw cuts are installed on 10-foot-centers in both directions (perpendicular).

7. Field Observations: All concrete slab-on-grade surfaces and installed steel reinforcements should be observed and inspected by an NV5 construction monitor prior to pouring concrete.

6.2.6 Rigid Concrete Pavement for Heavy Truck Traffic Areas and Fire Lanes

The rigid concrete pavement components are described below from top to bottom. If static or intermittent live floor loads greater than 250 psf are anticipated, then a California-licensed professional engineer should design the necessary concrete slab-on-grade floor thickness and steel reinforcements.

1. The recommended modulus of subgrade value of 200 kips/cubic foot should be used if the site subgrade is prepared in accordance with the recommendations presented in Section 6.1 above.
2. Minimum 5-Inch-Thick Concrete Slab: The rigid concrete pavement should be installed with a minimum 3,500 pounds psi compressive strength after 28 days of curing. NV5 recommends that the concrete design uses a water-to-cement ratio between 0.40 and 0.45 and should be placed with minimum and maximum slumps of 4 and 6 inches, respectively. The concrete mix design is the responsibility of the concrete supplier.
3. Steel Reinforcements: The rigid concrete pavement sections should include steel reinforcement to improve the load carrying capacity and to minimize cracking caused by shrinkage during curing and from both differential and repeated loadings. It should be understood that it is nearly impossible to prevent all cracks from development in concrete slabs; in other words, it should be expected that some cracking will occur in all concrete slabs no matter how well they are reinforced. Rigid concrete pavement that will be subjected to heavy loads should be designed with steel reinforcements by a California-licensed professional engineer.

If the owner elects to eliminate the steel reinforcements from the exterior concrete slabs-on-grade for economic reasons, then there will be an inherent greater risk assumed by the developer for the development of both shrinkage and bearing related cracks in the associated slabs.

4. Steel Rebar: Use No. 4 steel rebar (ASTM A615/A 615M-04 Grade 60 reinforcement), tied and placed with 12-inch centers in both directions (perpendicular) and supported on concrete “dobies” to position the rebar in the center of the slab during concrete pouring.
5. Minimum 6-Inch Caltrans Class II AB Layer: The rigid concrete pavement should be underlain by Class II AB placed and compacted to a minimum of 95 percent of the ASTM D1557 dry density with a moisture content of ± 3 percentage points of the ASTM D1557 optimum moisture content.
6. Subgrade Soil Preparation: The subgrade soil below the rigid concrete pavement sections designed for vehicle traffic should be prepared and compacted consistent with the recommendations of Section 6.1. The top 12 inches of the non-expansive soil should be compacted to a minimum of 95 percent of the ASTM D1557 dry density with a relatively uniform moisture content of 0 to 4 percentage points greater than the ASTM D1557 optimum moisture content.
7. Crack Control Grooves: The rigid concrete pavement should include crack control and expansion joint grooves installed during placement, or saw cuts should be made in accordance with the ACI and PCA specifications. Generally, NV5 recommends that expansion joints be provided between the slab and perimeter footings, and that crack control grooves or saw cuts are installed on no greater than 10-foot-centers in both directions (perpendicular).

Field Observations: Field observations should be made by an NV5 construction monitor of all concrete slab-on-grade subgrade surfaces and installed steel reinforcements prior to placing concrete.

6.2.7 Flexible Pavement

NV5 used the procedures presented in the latest edition of the Caltrans Highway Design Manual to develop several AC and AB rock pavement design alternatives to allow for different traffic loading conditions. NV5 used a Traffic Index (TI) of 4 to 8 which represents typical vehicle traffic for light vehicle and truck traffic, industrial/commercial roads, and agricultural truck routes. The actual TI for the project pavement areas should be determined by the project civil engineer in accordance with Chapter 600 of the Caltrans Highway Design Manual.

Our experience with previous laboratory testing performed on samples of the anticipated pavement subgrade soils within the vicinity of the Waste Water Treatment Plant site indicates that these materials generally possess an R-Value of 5. The actual subsurface soil conditions exposed at the finished subgrade surface of the proposed pavement areas may be different from this R-Value based on site grades, or the use of imported fill materials. The actual finished subgrade materials should be evaluated during construction to confirm the design recommendations below. Please note that the Caltrans design method requires that the maximum R-Value of the subgrade soil not exceed 50.

NV5 assumed that the pavement layers will be constructed with Class 2 AB Rock (Minimum R-Value = 78) and Type A Asphalt Concrete in accordance with the requirements of Section 26 of the Caltrans Standard Specifications. Table 6.2.7-1 presents the road, driveway, and parking pavement design section. NV5 recommends that the AB rock layer be constructed with a minimum thickness of 6-inches for constructability issues and to achieve a higher level of confidence that the road will achieve the expected service life.

Table 6.2.7-1, Flexible Pavement Design

Parameters	Design Values				
Traffic Description (approximate)	Light Automobiles	Light to Medium Autos and Trucks	Medium to Heavy Trucks	Heavy Trucks	Very Heavy Trucks
Traffic Index (TI)	4	5	6	7	8
Design R-Values					
Class II AB Rock	78	78	78	78	78
Subgrade Soil	5	5	5	5	5
AC Thickness (inch) ⁽¹⁾	2.5	3.0	3.5	4.0	5.0
AB Rock Thickness (inch) ⁽²⁾ (95% Relative Compaction)	7.5	11.0	13.0	16.0	18.0
Subgrade Soil Thickness (inch) (95% Relative Compaction)	12.0	12.0	12.0	12.0	12.0
Notes: (1) The asphalt concrete thickness includes the Caltrans safety factor. (2) NV5 recommends that the minimum thickness of AB rock should be 6 inches regardless of what the Caltrans design method indicates. This minimum thickness is necessary for constructability issues and will increase the level of confidence that the roads will achieve the expected service life.					

The subgrade soil and AB rock should be placed and compacted as described below.

1. The subgrade soil to a depth of 12 inches from the finished grade surface should be compacted to a minimum relative compaction of 95 percent of the ASTM D1557 maximum dry density with a moisture content of 2 to 4 percentage points of the ASTM D1557 optimum moisture content. The compacted sub-grade soil shall be graded to achieve the design grades and tolerances.
2. The stability of the compacted subgrade soil should be evaluated by wheel rolling prior to placing the overlying AB rock layer. Wheel rolling should be performed with a fully loaded water truck with tire pressures between 60 and 95 psi. The subgrade soil surface should exhibit only minor deflections as the wheel load passes by. Any unstable areas should be reworked and then retested for percent relative compaction and percent moisture content and then proof rolled again. This process should be repeated until the area appears to be relatively stable.
3. The Caltrans Class II AB rock should be compacted to a minimum relative compaction of 95 percent of the ASTM D1557 maximum dry density with a moisture content of ± 3 percentage points of the ASTM D1557 optimum moisture content.
4. The stability of the compacted AB rock should be evaluated by wheel rolling prior to placing the overlying AC layer. Wheel rolling should be performed with a fully loaded water truck with tire pressures between 60 and 95 psi. The AB rock surface should exhibit only minor deflections as the wheel load passes by. Any unstable areas should be reworked and then retested for percent

relative compaction and percent moisture content and then proof rolled again. This process should be repeated until the area appears to be relatively stable.

5. Concrete cut-off curbs should be constructed around all landscaped areas that are adjacent to AC paved driveways and parking areas. The curbs should extend to a minimum depth of 8 inches into the underlying subgrade soil. The extended curbs will reduce migration of irrigation and rain waters originating in the landscaped areas from entering the AB rock materials underlying the AC pavement material. This design is intended to minimize failures of the paved areas due to saturation of the underlying AB rock and subgrade soils.

7.0 REFERENCES

- American Society of Civil Engineers, 2016. *Minimum Design Loads for Buildings and Other Structures* (ASCE 7-10).
- ASTM International (ASTM), 2023. *Soil and Rock; Dimension Stone; and Geosynthetics*. Volume 04.08.
- Geraili and Sitar, *Seismic Earth Pressures on Retaining Structures in Cohesionless Soils*, (2013)
- Rankine, W.J.M., 1857, *On the Stability of Loose Earth*, Philosophical Transactions of the Royal Society, London, Vol. 147.
- CGS, 1997. *Fault Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps*. Special Publication 42. Interim Revision.
- Jennings, C.W., 2010. *Fault Activity Map of California and Adjacent Areas*, California Geological Survey.
- United States Geological Survey, 2022. *Colusa Quadrangle, California-Colusa Co. 7.5 Minute Series* (Topographic).
- Jennings, C.W., and Strand, R.G., 1960. *Geologic Map of California, Ukiah Sheet*. Department of Conservation, Division of Mines and Geology, Geologic Atlas of California GAM-24

8.0 LIMITATIONS

The following limitations apply to the findings, conclusions and recommendations presented in this report:

1. This report should not be relied upon without review by NV5 if a period of 24 months elapses between the issuance report date shown above and the date when construction commences.
2. NV5's professional services were performed consistent with the generally accepted geotechnical engineering principles and practices employed in Northern California. No warranties are either expressed or implied.
3. NV5 provided engineering services for the site project consistent with the work scope and contract agreement presented in the proposal and agreed to by the client. The findings, conclusions and recommendations presented in this report apply to the conditions existing when NV5 performed the services and are intended only for the client, purposes, locations, timeframes and project parameters described herein. NV5 is not responsible for the impacts of any changes in environmental standards, practices or regulations subsequent to completing the services. NV5 does not warrant the accuracy of information supplied by others, or the use of segregated portions of this report. This report is solely for the use of the client unless noted otherwise. Any reliance on this report by a third party is at the party's sole risk.
4. If changes are made to the nature or design of the project as described in this report, then the conclusions and recommendations presented in this report should be considered invalid by all parties. The validity of the conclusions and recommendations presented in this report can only be made by NV5; therefore, NV5 should be allowed to review all project changes and prepare written responses with regards to their impacts on the conclusions and recommendations. However, additional fieldwork and laboratory testing may be required for NV5 to develop any modifications to the recommendations. The cost to review project changes and perform additional fieldwork and laboratory testing necessary to modify the recommendations is beyond the scope-of-services presented in this report. Any additional work will be performed only after receipt of an approved scope-of-work, budget and written authorization to proceed.
5. The analyses, conclusions and recommendations presented in this report are based on the site conditions as they existed at the time NV5 performed the surface and subsurface field investigations. NV5 has assumed that the subsurface soil and groundwater conditions encountered at the location of the exploratory excavations are generally representative of the subsurface conditions throughout the entire project site; however, if the actual subsurface conditions encountered during construction are different than those described in this report, then NV5 should be notified immediately so that NV5 can review these differences and, if necessary, modify the recommendations.
6. The elevation or depth to the groundwater table underlying the project site may differ with time and location; therefore, the depth to the groundwater table encountered in the exploratory excavations is only representative of the specific time and location where it was observed.
7. The project site map shows approximate exploratory excavation locations as determined by pacing distances from identifiable site features; therefore, their locations should not be relied upon as being exact nor located with the accuracy of a California-licensed land surveyor.

8. NV5's geotechnical investigation scope-of-services did not include an evaluation of the project site for the presence of hazardous materials. Although NV5 did not observe the presence of hazardous materials at the time of the field investigation, all project personnel should be careful and take the necessary precautions in the event hazardous materials are encountered during construction.
9. NV5's geotechnical investigation scope-of-services did not include an evaluation of the project site for the presence of mold nor for the future potential development of mold at the project site. If an evaluation of the presence of mold and/or for the future potential development of mold at the site is desired, then the property owner should contact a consulting firm specializing in these types of investigations. NV5 does not perform mold evaluation investigations.
10. NV5's experience and that of the civil engineering profession clearly indicates that during the construction phase of a project the risks of costly design, construction and maintenance problems can be significantly reduced by retaining a design geotechnical engineering firm to review the project plans and specifications and to provide geotechnical engineering CQA observation and testing services. Upon your request NV5 will prepare a CQA geotechnical engineering services proposal that will present a work scope, a tentative schedule and fee estimate for your consideration and authorization. If NV5 is not retained to provide geotechnical engineering CQA services during the construction phase of the project, then NV5 will not be responsible for geotechnical engineering CQA services provided by others nor any aspect of the project that fails to meet your or a third party's expectations in the future.

APPENDIX A:

Exploratory Boring Logs

N|V|5

EXPLORATORY BORING LOG

48 BELLARMINE COURT, SUITE 40, CHICO, CA., 95928
PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B23-1

Project Name: City of Colusa WWTP Infrastructure Improvements

Project No.: 71343.00

Task: 001

Start Date: 8-1-2023

Location: 1480 and 2820 Will S. Green Ave., Colusa, California

Estimated Ground Surface

Elevation (Ft. AMSL):

45.00

Finish Date: 8-1-2023

Sheet: 1 Of 2

Logged By: Santiago Carrillo

Drilling Cmpny: V&W Drilling

Drill Rig Type: CME-55

Driller: Anthony Castillo

Drilling Method: Hollow Stem Auger (HSA)

Hammer Type: 140 Pound Auto Trip Hammer

Boring Dia. (In.): 7.00

Total Depth (Ft.): 36.50

Backfill or Well Design: Neat Cement Grout

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Graphic Log	Ground Water Information				
									Date	08-01-2023			
									Time (24 Hour)	09:49			
									Depth (Ft.)	18.00			
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
08:48			HSA			0			(ML) SANDY SILT, Fld. Est.: 60% Low Plastic Clay-Silt Fines and 40% Fine Sand; Brown (10YR 4/3); Soft; Damp to Moist.				
					BLK-1	1							
08:53		2	2.5SS			2							
		2			L1-2-2	3							
	1.0	3		1.5/1.5	L1-1-2								
			HSA			4							
						5							
09:04		1	2.5SS			6							
		2			L2-2-2	7							
	1.0	2		1.4/1.5	L2-1-2	8							
			HSA			9							
						10							
						11			(CL) LEAN CLAY WITH SAND, Fld. Est.: 85% Low Plastic Clay-Silt Fines and 15% Fine Sand; Dark Brown (10YR, 3/3); Stiff; Damp to Moist.				
09:07		1	2.5SS			12							
		7			L3-2-2	13							
	2.25	10		1.1/1.5	L3-1-2	14							
			HSA			15							
						16							
09:15		6	2.5SS			17							
		13			L4-2-2	18							
	4.00	19		1.2/1.5	L4-1-2	19							
			HSA			20							

NOTES: HSA - Hollow Stem Augers

2.5SS - 2.5" Split Spoon Sampler



EXPLORATORY BORING LOG

48 BELLARMINE COURT, SUITE 40, CHICO, CA., 95928
PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B23-1

Project Name: City of Colusa WWTP Infrastructure Improvements

Project No.: 71343.00

Task: 001

Start Date: 08-01-23

Location: 1480 and 2820 Will S. Green Ave., Colusa, California

Estimated Ground Surface

Elevation (Ft. AMSL):

45.00

Finish Date: 08-01-23

Sheet: 2 Of 2

Logged By: Santiago Carrillo

Drilling Cmpny: V&W Drilling

Drill Rig Type: CME-55

Driller: Anthony Castillo

Drilling Method: Hollow Stem Auger (HSA)

Hammer Type: 140 Pound Auto Trip Hammer

Boring Dia. (In.): 7.00

Total Depth (Ft.): 36.50

Backfill or Well Design: Neat Cement Grout

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Graphic Log	Ground Water Information				
									Date	08-01-2023			
									Time (24 Hour)	09:23			
									Depth (Ft.)	18.00			
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
09:22		4	2.5SS			20			(CL) LEAN CLAY WITH SAND, Fld. Est.: 85% Low Plastic Clay-Silt Fines and 15% Fine Sand; Dark Brown (10YR, 3/3); Stiff; Moist.				
		5			L5-2-2	21							
	3.0	12		1.3/1.5	L5-1-2								
			HSA			22							
						23							
						24							
09:29		6	2.5SS			25			(SM) SILTY SAND, Fld. Est.: 60% Fine Sand and 40% Low Plastic Clay-Silt Fines; Grayish Brown (10YR, 5/2); Dense; Wet.				
		9			L6-2-2	26							
	2.50	9		1.1/1.5	L6-1-2	27							
			HSA			28							
						29							
						30							
09:34		6	2.5SS			30			(SM) SILTY SAND, Fld. Est.: 60% Fine Sand and 40% Low Plastic Clay-Silt Fines; Grayish Brown (10YR, 5/2); Dense; Wet.				
		13			L7-2-2	31							
		30		1.0/1.5	L7-1-2	32							
			HSA			33							
						34							
						35							
09:48		4	2.5SS			35			(SM) SILTY SAND, Fld. Est.: 60% Fine Sand and 40% Low Plastic Clay-Silt Fines; Grayish Brown (10YR, 5/2); Dense; Wet.				
		7			L8-2-2	36							
09:49	2.00	11		1.0/1.5	L8-1-2								
						37							
						38							
						39							
						40							
						41							

NOTES: HSA - Hollow Stem Augers

2.5SS - 2.5" Split Spoon Sampler

N|V|5

EXPLORATORY BORING LOG

48 BELLARMINE COURT, SUITE 40, CHICO, CA., 95928
PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B23-2

Project Name: City of Colusa WWTP Infrastructure Improvements	Project No.: 71343.00	Task: 001	Start Date: 8-1-2023
Location: 1480 and 2820 Will S. Green Ave., Colusa, California	Estimated Ground Surface Elevation (Ft. AMSL): 45.00	Finish Date: 8-1-2023	Sheet: 1 Of 1

Logged By: Santiago Carrillo	Drilling Cmpny: V&W Drilling	Drill Rig Type: CME-55
Driller: Anthony Castillo	Drilling Method: Hollow Stem Auger (HSA)	Hammer Type: 140 Pound Auto Trip Hammer
Boring Dia. (In.): 7.00	Total Depth (Ft.): 11.50	Backfill or Well Design: Neat Cement Grout

										Ground Water Information				
24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Graphic Log						
									Date	08-01-2023				
									Time (24 Hour)	12:16				
Depth (Ft.)	None					Soil And/Or Rock Material Descriptions								
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														
12:00			HSA			0			(CL) LEAN CLAY WITH SAND (UNDOCUMENTED FILL), Fld. Est.: 70% Low Plastic Clay-Silt Fines, 20% Fine Sand, and 10% Gravel; Dark Brown (10YR, 3/3); Medium Stiff; Dry.					
					BLK-2	1								
						2								
12:05		7	2.5SS			3								
		9			L1-2-2	4								
	4.0	10		1.0/1.5	L1-1-2	5								
			HSA			6								
						7								
						8								
						9								
12:09		3	2.5SS			10								
		6			L2-2-2	11								
		5		1.1/1.5	L2-1-2	12								
			HSA			13			(CL) LEAN CLAY WITH SAND, Fld. Est.: 85% Low Plastic Clay-Silt Fines and 15% Fine Sand; Dark Brown (10YR, 3/3); Soft to Stiff; Moist.					
						14								
						15								
						16								
						17								
						18								
						19								
						20								
12:15		4	2.5SS			21								
		6			L3-2-2	22								
12:16		10		1.5/1.5	L3-1-2	23								
						24								
						25								
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						29								
						30								
						31								
						32								

NOTES: HSA - Hollow Stem Augers
2.5SS - 2.5" Split Spoon Sampler



EXPLORATORY BORING LOG

48 BELLARMINE COURT, SUITE 40, CHICO, CA., 95928
PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B23-3

Project Name: City of Colusa WWTP Infrastructure Improvements

Project No.:

Task: 001

Start Date: 8-1-2023

Location: 1480 and 2820 Will S. Green Ave., Colusa, California

Estimated Ground Surface
Elevation (Ft. AMSL):

45.00

Finish Date: 8-1-2023

Sheet: 1 Of 1

Logged By: Santiago Carrillo

Drilling Cmpny: V&W Drilling

Drill Rig Type: CME-55

Driller: Anthony Castillo

Drilling Method: Hollow Stem Auger (HSA)

Hammer Type: 140 Pound Auto Trip Hammer

Boring Dia. (In.): 7.00

Total Depth (Ft.): 15.00

Backfill or Well Design: Neat Cement Grout

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Graphic Log	Ground Water Information				
									Date	08-01-2023			
									Time (24 Hour)	13:18			
									Depth (Ft.)	12.00			
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
12:55			HSA			0			(CL) LEAN CLAY WITH SAND (UNDOCUMENTED FILL), Fld. Est.: 70% Low Plastic Clay-Silt Fines, 20% Fine Sand, and 10% Gravel; Dark Brown (10YR, 3/3); Medium Stiff; Dry.				
12:59		3	2.5SS		L1-2-2	1							
		4				2							
	0.5	5		1.2/1.5	L1-1-2	3							
			HSA			4							
13:03		3	2.5SS			5							
		5			L2-2-2	6							
		11		1.3/1.5	L2-1-2	7							
			HSA			8							
						9							
						10							
						11							
						12							
						13							
						14							
13:11		11	2.5SS		L3-2-2	15							
	4.5	50/6"		0.7/1.5	L3-1-2	16							
			HSA			17							
						18							
						19							
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						172							

NOTES: HSA - Hollow Stem Augers
2.5SS - 2.5" Split Spoon Sampler
SPT - Standard Penetration Test



EXPLORATORY BORING LOG

48 BELLARMINE COURT, SUITE 40, CHICO, CA., 95928
PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B23-4

Sheet: 1 Of 1

Project Name: City of Colusa WWTP Infrastructure Improvements	Project No.: 71343.00	Task: 001	Start Date: 8-1-2023
Location: 1480 and 2820 Will S. Green Ave., Colusa, California	Estimated Ground Surface Elevation (Ft. AMSL): 45.00	Finish Date: 8-1-2023	
Logged By: Santiago Carrillo	Drilling Cmpny: V&W Drilling	Drill Rig Type: CME-55	
Driller: Anthony Castillo	Drilling Method: Hollow Stem Auger (HSA)	Hammer Type: 140 Pound Auto Trip Hammer	
Boring Dia. (In.): 7.00	Total Depth (Ft.): 36.50	Backfill or Well Design: Neat Cement Grout	

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Graphic Log	Ground Water Information				
									Date	08-01-2023			
									Time (24 Hour)	15:06			
									Depth (Ft.)	13.50			
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
14:49			HSA			0			(CL) LEAN CLAY, Fld. Est.: 90% Low Plastic Clay-Silt Fines and 10% Fine Sand; Dark Brown (10YR 3/3); Stiff; Damp to Moist.				
			↓			1							
			↓			2							
14:53		3	2.5SS		L1-2-2	2							
		4	↓			3							
	0.25	6	HSA	1.5/1.5	L1-1-2	3							
			↓			4							
			↓			5							
14:55		3	2.5SS		L2-2-2	5							
		8	↓			6							
		7	HSA	1.0/1.5	L2-1-2	6							
			↓			7							
			↓			8							
			↓			9							
			↓			10							
15:02		7	2.5SS		L3-2-2	10			(CL-ML) SILTY LEAN CLAY WITH SAND, Fld. Est.: 80% Low Plastic Clay-Silt Fines and 20% Fine Sand; Dark Brown (10YR 3/3); Stiff; Damp to Moist.				
		13	↓			11							
	4.0	19	HSA	1.1/1.5	L3-1-2	11							
			↓			12							
			↓			13							
			↓			14							
			↓			15							
15:06		6	2.5SS		L4-2-2	15							
		13	↓			16							
15:06	4.00	19	↓	1.2/1.5	L4-1-2	16							
						17			(SM) SILTY SAND, Fld. Est.: 60% Fine Sand and 40% Low Plastic Clay-Silt Fines; Grayish Brown (10YR, 5/2); Dense; Wet.				
						18							
						19							
						20							
						21							

NOTES: HSA - Hollow Stem Augers
2.5SS - 2.5" Split Spoon Sampler

APPENDIX B:

Soil Laboratory Test Results



PARTICLE SIZE DISTRIBUTION TEST WORK SHEET

ASTM D422, C136

DSA LEA No. 284

DSA File No. 0

DSA App No. 0

Sieve Only Analysis Worksheet

Project No.	71343.00.001	Project Name:	Proposed City of Colusa WWTP Improvements GEI		Date:	08/11/23
Sample No.	BLK-2	Boring/Trench:	B23-2	Depth, (ft.):	1-3'	Tested By: DOC
Description:	(CL) Lean Clay with Sand, Dark Brown (10YR, 3/3)					Checked By: DJP
Sample Location:	0					Lab. No. C23-252

Moisture Content Data:			Total Material Sample Data:		
Pan ID			Pan ID		
Pan Weight		(gm)	Pan Weight		(gm)
Wet Soil + Pan		(gm)	Wet Soil + Pan Wt.	6,480.00	(gm)
Dry Soil + Pan		(gm)	Total Wet Weight	6,480.00	(gm)
Water Weight	0.00	(gm)	Total Dry Weight	6,480.00	(gm)
Dry Soil Weight	0.00	(gm)	Total Dry Wt. >#4 Sieve	484.90	(gm)
Moisture Content	0.0	(%)	Total Dry Wt. <#4 Sieve	5,995.10	(gm)
			Total Dry Wt. <#200 Sieve	4,497.26	(gm)
			Total Percent <#200 Sieve	69.40	(%)

GRAVEL PORTION SIEVE ANALYSIS (Portion Retained On > #4 Sieve)

Sieve Size	Particle Diameter		Wet Weight Retained On Sieve (gm)	Dry Weight			
	Inches (in.)	Millimeter (mm)		Retained On Sieve (gm)	Accum. On Sieve (gm)	Passing Sieve (gm)	Percent Passing (%)
6 Inch	6.0000	152.40	0.00	0.00	0.00	6,480.00	100.0
3 Inch	3.0000	76.20	0.00	0.00	0.00	6,480.00	100.0
2 Inch	2.0000	50.80	0.00	0.00	0.00	6,480.00	100.0
1.5 Inch	1.5000	38.10	0.00	0.00	0.00	6,480.00	100.0
1.0 Inch	1.0000	25.40	0.00	0.00	0.00	6,480.00	100.0
3/4 Inch	0.7500	19.05	25.40	25.40	25.40	6,454.60	99.6
1/2 Inch	0.5000	12.70	81.10	81.10	106.50	6,373.50	98.4
3/8 Inch	0.3750	9.53	80.00	80.00	186.50	6,293.50	97.1
#4	0.1875	4.75	298.40	298.40	484.90	5,995.10	92.5
PAN			5,995.10	5,995.10			

SAND PORTION SIEVE ANALYSIS (Portion Retained On < #4 Sieves)

Representative Sample Data:			#200 Wash Data:		
Pan ID			Portion >#200 Sieve:	79.70	(gm)
Pan Weight		(gm)	Portion <#200 Sieve:	239.30	(gm)
Wet Soil + Pan	319.00	(gm)	Percent <#200 Sieve	75.02	(%)
Wet Soil	319.00	(gm)	Total Wt. <#200 Sieve	4497.26	(gm)
Dry Soil	319.00	(gm)			

Sieve Size	Particle Diameter		Dry Weight Rep. Sample		Total Sample Weight Retained (gm)	Accum. Grand Total On Sieve (gm)	Total Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Percent Retained (%)			
#10	0.075	2.000	17.2	5.39	323.25	808.15	87.5
#20	0.033	0.850	10.70	3.35	201.09	1,009.24	84.4
#40	0.017	0.425	9.70	3.04	182.30	1,191.53	81.6
#60	0.010	0.250	14.30	4.48	268.75	1,460.28	77.5
#100	0.006	0.150	8.10	2.54	152.23	1,612.51	75.1
#200	0.003	0.075	19.70	6.18	370.23	1,982.74	69.40
PAN			Discard				

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CONSTRUCTION QUALITY ASSURANCE - INFRASTRUCTURE - ENERGY - PROGRAM MANAGEMENT - ENVIRONMENTAL



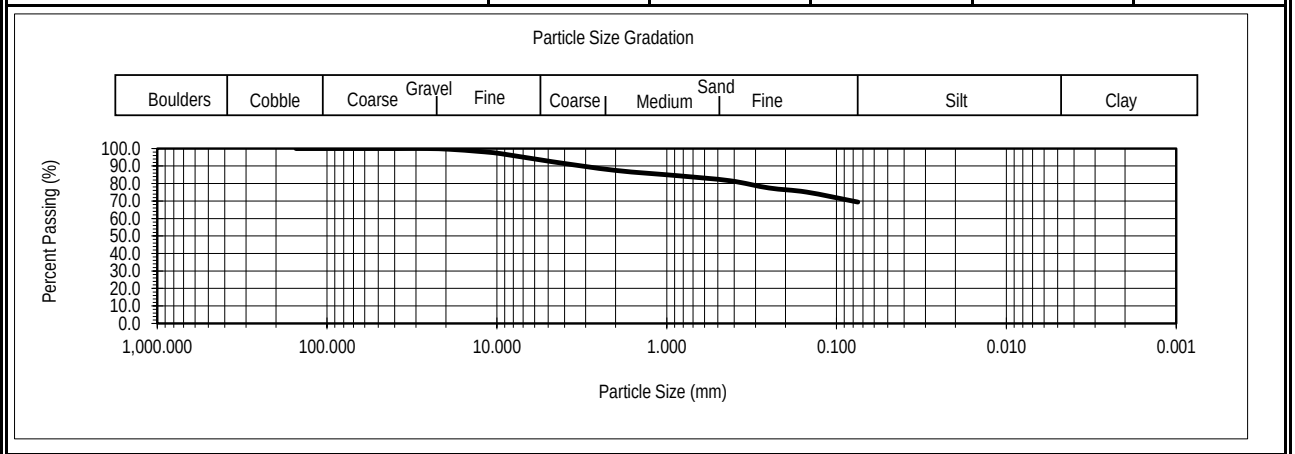
DSA LEA No.: 284

PARTICLE SIZE DISTRIBUTION

ASTM D422, C136

Project No.	71343.00.001	Project Name:	Proposed City of Colusa WWTP Improvements		Date:	8/11/2023
Sample No.	BLK-2	Boring/Trench:	B23-2	Depth, (ft.):	1-3'	Tested By: DOC
Description:	(CL) Lean Clay with Sand, Dark Brown (10YR, 3/3)				Checked By:	DJP
Sample Location:	0				Lab. No.	C23-252

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4	0.00	0.0	6,480.0	100.0
3 Inch	3.0000	76.2	0.00	0.0	6,480.0	100.0
2 Inch	2.0000	50.8	0.00	0.0	6,480.0	100.0
1.5 Inch	1.5000	38.1	0.00	0.0	6,480.0	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	6,480.0	100.0
3/4 Inch	0.7500	19.1	25.40	25.4	6,454.6	99.6
1/2 Inch	0.5000	12.7	81.10	106.5	6,373.5	98.4
3/8 Inch	0.3750	9.5	80.00	186.5	6,293.5	97.1
#4	0.1875	4.7500	298.40	484.9	5,995.1	92.5
#10	0.0790	2.0066	323.25	808.1	5,671.9	87.5
#20	0.0335	0.8500	201.09	1,009.2	5,470.8	84.4
#40	0.0167	0.4250	182.30	1,191.5	5,288.5	81.6
#60	0.0098	0.2500	268.75	1,460.3	5,019.7	77.5
#100	0.0059	0.1500	152.23	1,612.5	4,867.5	75.1
#200	0.0030	0.0750	370.23	1,982.7	4,497.3	69.4
Hydrometer						



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CONSTRUCTION QUALITY ASSURANCE - INFRASTRUCTURE - ENERGY - PROGRAM MANAGEMENT - ENVIRONMENTAL

D60	D30	D10



PARTICLE SIZE DISTRIBUTION TEST WORK SHEET

ASTM D422, C136

DSA LEA No. 284

DSA File No. 0

DSA App No. 0

Sieve Only Analysis Worksheet			
Project No.	71343.00.001	Project Name:	Proposed City of Colusa WWTP Improvements GEI
Sample No.	BLK-4	Boring/Trench:	B23-4
Description:	(CL) Lean Clay, Dark Brown (10YR, 3/3)		Depth, (ft.): 1-3'
Sample Location:	0		Date: 08/11/23
			Tested By: DOC
			Checked By: DJP
			Lab. No. C23-252

Moisture Content Data:		Total Material Sample Data:	
Pan ID		Pan ID	
Pan Weight	(gm)	Pan Weight	(gm)
Wet Soil + Pan	(gm)	Wet Soil + Pan Wt.	2,502.30 (gm)
Dry Soil + Pan	(gm)	Total Wet Weight	2,502.30 (gm)
Water Weight	0.00 (gm)	Total Dry Weight	2,502.30 (gm)
Dry Soil Weight	0.00 (gm)	Total Dry Wt. >#4 Sieve	18.60 (gm)
Moisture Content	0.0 (%)	Total Dry Wt. <#4 Sieve	2,483.70 (gm)
		Total Dry Wt. <#200 Sieve	2,193.19 (gm)
		Total Percent <#200 Sieve	87.65 (%)

GRAVEL PORTION SIEVE ANALYSIS (Portion Retained On > #4 Sieve)							
Sieve Size	Particle Diameter		Wet Weight Retained On Sieve (gm)	Dry Weight			
	Inches (in.)	Millimeter (mm)		Retained On Sieve (gm)	Accum. On Sieve (gm)	Passing Sieve (gm)	Percent Passing (%)
6 Inch	6.0000	152.40	0.00	0.00	0.00	2,502.30	100.0
3 Inch	3.0000	76.20	0.00	0.00	0.00	2,502.30	100.0
2 Inch	2.0000	50.80	0.00	0.00	0.00	2,502.30	100.0
1.5 Inch	1.5000	38.10	0.00	0.00	0.00	2,502.30	100.0
1.0 Inch	1.0000	25.40	0.00	0.00	0.00	2,502.30	100.0
3/4 Inch	0.7500	19.05	0.00	0.00	0.00	2,502.30	100.0
1/2 Inch	0.5000	12.70	7.60	7.60	7.60	2,494.70	99.7
3/8 Inch	0.3750	9.53	2.20	2.20	9.80	2,492.50	99.6
#4	0.1875	4.75	8.80	8.80	18.60	2,483.70	99.3
PAN			2,483.70	2,483.70			

SAND PORTION SIEVE ANALYSIS (Portion Retained On < #4 Sieves)							
Representative Sample Data:				#200 Wash Data:			
Pan ID				Portion >#200 Sieve:	36.40	(gm)	
Pan Weight	(gm)			Portion <#200 Sieve:	274.80	(gm)	
Wet Soil + Pan	311.20	(gm)		Percent <#200 Sieve	88.30	(%)	
Wet Soil	311.20	(gm)		Total Wt. <#200 Sieve	2193.19	(gm)	
Dry Soil	311.20	(gm)					
Sieve Size	Particle Diameter		Dry Weight Rep. Sample		Total Sample Weight Retained (gm)	Accum. Grand Total On Sieve (gm)	Total Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Percent Retained (%)			
#10	0.075	2.000	1.7	0.55	13.57	32.17	98.7
#20	0.033	0.850	0.50	0.16	3.99	36.16	98.6
#40	0.017	0.425	1.90	0.61	15.16	51.32	97.9
#60	0.010	0.250	1.60	0.51	12.77	64.09	97.4
#100	0.006	0.150	5.00	1.61	39.91	104.00	95.8
#200	0.003	0.075	25.70	8.26	205.11	309.11	87.65
PAN			Discard				



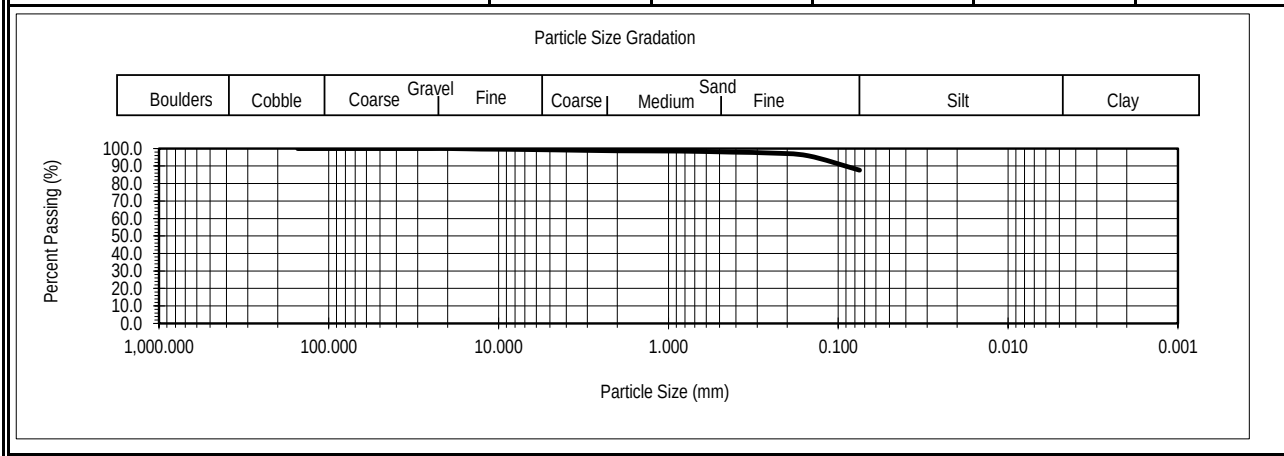
DSA LEA No.: 284

PARTICLE SIZE DISTRIBUTION

ASTM D422, C136

Project No.	71343.00.001	Project Name:	Proposed City of Colusa WWTP Improvements		Date:	8/11/2023	
Sample No.	BLK-4	Boring/Trench:	B23-4	Depth, (ft.):	1-3'	Tested By:	DOC
Description:	(CL) Lean Clay, Dark Brown (10YR, 3/3)				Checked By:	DJP	
Sample Location:	0				Lab. No.	C23-252	

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4	0.00	0.0	2,502.3	100.0
3 Inch	3.0000	76.2	0.00	0.0	2,502.3	100.0
2 Inch	2.0000	50.8	0.00	0.0	2,502.3	100.0
1.5 Inch	1.5000	38.1	0.00	0.0	2,502.3	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	2,502.3	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	2,502.3	100.0
1/2 Inch	0.5000	12.7	7.60	7.6	2,494.7	99.7
3/8 Inch	0.3750	9.5	2.20	9.8	2,492.5	99.6
#4	0.1870	4.7500	8.80	18.6	2,483.7	99.3
#10	0.0790	2.0066	13.57	32.2	2,470.1	98.7
#20	0.0335	0.8500	3.99	36.2	2,466.1	98.6
#40	0.0167	0.4250	15.16	51.3	2,451.0	97.9
#60	0.0098	0.2500	12.77	64.1	2,438.2	97.4
#100	0.0059	0.1500	39.91	104.0	2,398.3	95.8
#200	0.0030	0.0750	205.11	309.1	2,193.2	87.6
Hydrometer						





DSA LEA No. 284

ATTERBERG INDICES

ASTM D4318

DSA File No. 0

DSA App No. 0

Project No.	71343.00.001	Project Name	Proposed City of Colusa WWTP Improvements GEI	Date:	08/11/23
Sample No.	BLK-4	Boring/Trench	B23-4	Depth, (ft.):	1-3'
Description:	(CL) Lean Clay, Dark Brown (10YR, 3/3)				Tested By: DOC
Sample Location:	0				Checked By: DJP
					Lab. No. C23-252

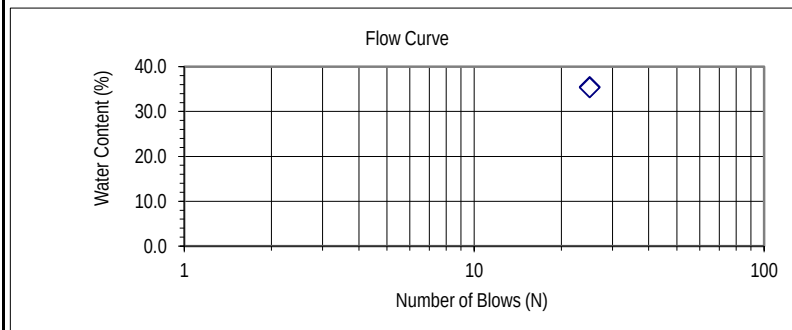
Estimated % of Sample Retained on No. 40 Sieve:

Sample Air Dried: yes

Test Method A or B:

B

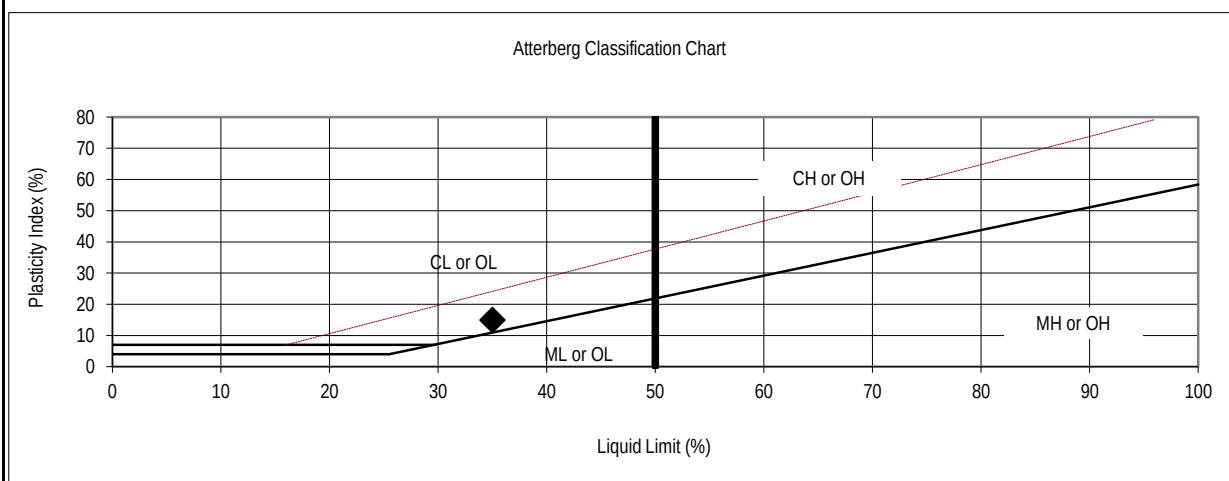
LIQUID LIMIT:						PLASTIC LIMIT:		
Sample No.:	1	2	3	4	5	1	2	3
Pan ID:	B	C				A2	B2	C2
Wt. Pan (gr)	38.98	38.27				18.52	18.38	18.52
Wt. Wet Soil + Pan	57.78	54.63				25.17	25.07	25.23
Wt. Dry Soil + Pan (g)	52.86	50.36				24.08	23.98	24.13
Wt. Water (gr)	4.92	4.27				1.09	1.09	1.10
Wt. Dry Soil (gr)	13.88	12.09				5.56	5.60	5.61
Water Content (%)	35.4	35.3				19.6	19.5	19.6
Number of Blows, N	25	25						
LIQUID LIMIT = 35						PLASTIC LIMIT = 20		

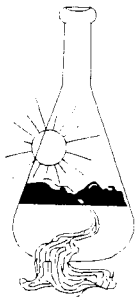


Plasticity Index = 15

Non-Plastic ☐

Group Symbol = CL





Sunland Analytical

11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 08/16/2023
Date Submitted 08/10/2023

To: Santiago Carrillo
NV5-Chico
48 Bellarmine Ct.
Chico, CA 95928

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 71343.00 Site ID : B23-2 & BLK-2.
Thank you for your business.

* For future reference to this analysis please use SUN # 90302-187404.

EVALUATION FOR SOIL CORROSION

Soil pH	8.27		
Minimum Resistivity	0.54	ohm-cm (x1000)	
Chloride	98.7 ppm	00.00987	%
Sulfate	548.4 ppm	00.05484	%

METHODS

pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422m

APPENDIX C:

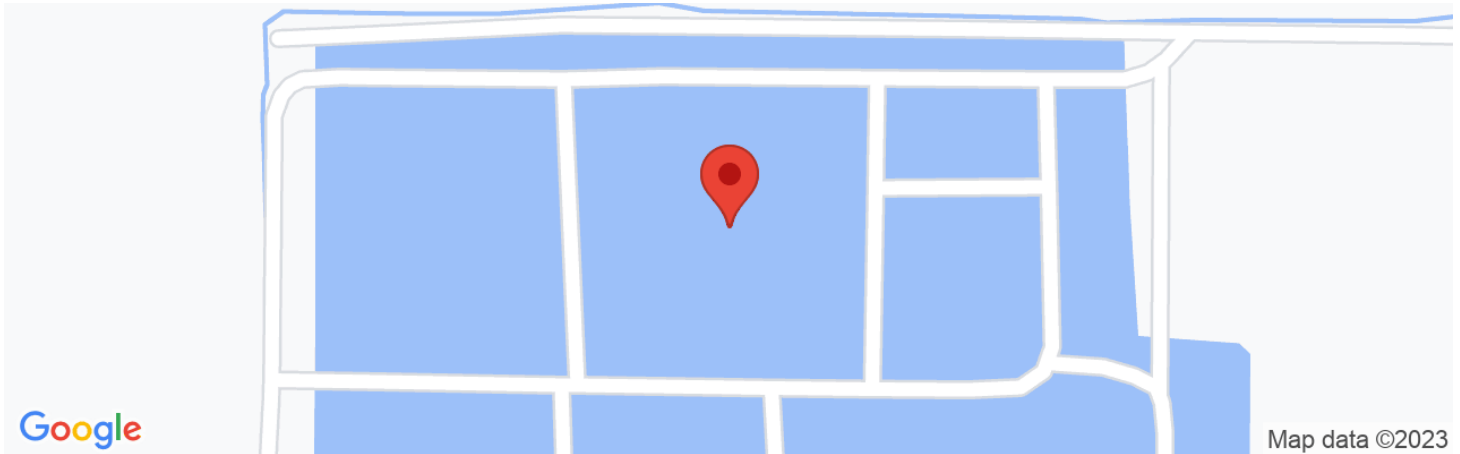
Seismic Design Parameters

USGS web services were down for some period of time and as a result this tool wasn't operational, resulting in *timeout* error.
USGS web services are now operational so this tool should work as expected.



City of Colusa WWTP

Latitude, Longitude: 39.18725804, -122.02897348



Date	8/22/2023, 4:31:36 PM
Design Code Reference Document	ASCE7-16
Risk Category	III
Site Class	D - Stiff Soil

Type	Value	Description
S_S	0.76	MCE_R ground motion. (for 0.2 second period)
S_1	0.32	MCE_R ground motion. (for 1.0s period)
S_{MS}	0.909	Site-modified spectral acceleration value
S_{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S_{DS}	0.606	Numeric seismic design value at 0.2 second SA
S_{D1}	null -See Section 11.4.8	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	null -See Section 11.4.8	Seismic design category
F_a	1.196	Site amplification factor at 0.2 second
F_v	null -See Section 11.4.8	Site amplification factor at 1.0 second
PGA	0.327	MCE_G peak ground acceleration
F_{PGA}	1.273	Site amplification factor at PGA
PGA_M	0.416	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
$SsRT$	0.76	Probabilistic risk-targeted ground motion. (0.2 second)
$SsUH$	0.826	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
$S1RT$	0.32	Probabilistic risk-targeted ground motion. (1.0 second)
$S1UH$	0.349	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
$S1D$	0.6	Factored deterministic acceleration value. (1.0 second)
$PGAd$	0.5	Factored deterministic acceleration value. (Peak Ground Acceleration)

Type	Value	Description
PGA_{UH}	0.327	Uniform-hazard (2% probability of exceedance in 50 years) Peak Ground Acceleration
C_{RS}	0.92	Mapped value of the risk coefficient at short periods
C_{R1}	0.917	Mapped value of the risk coefficient at a period of 1 s
C_V	1.18	Vertical coefficient

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APPENDIX D:

Previous Geotechnical Engineering Investigation, H&K, 2016

**GEOTECHNICAL ENGINEERING
INVESTIGATION REPORT
for
CITY OF COLUSA WASTE WATER SYSTEM
IMPROVEMENTS
City of Colusa, Colusa County, California**

**Prepared for:
City of Colusa
425 Webster Street
Colusa, Colusa County, California, 95932
Phone: 530-458-4740
Fax: 530-458-8674**

**Prepared by:
Holdrege & Kull
8 Seville Court, Suite 100
Chico, California, 95928
Phone: 530-894-2487
Fax: 530-894-2737**

**Project No. 70508-01
January 8, 2016**



January 8, 2016
Project No.: 70508-01

Jesse Cain
City of Colusa Department of Public Works
425 Webster Street
Colusa, Colusa County, California, 95932
Phone: 530-458-4740
Fax: 530-458-8674
Email: publicworks@cityofcolusa.com

Reference: *City of Colusa Waste Water System Improvements*
Colusa, Colusa County, California

Subject: *Geotechnical Engineering Investigation Report*

Dear Mr. Cain,

Holdrege & Kull (H&K) is pleased to have had this opportunity to provide geotechnical engineering services for improvements to the waste water system located throughout the city. H&K's geotechnical engineering investigation of the site was performed consistent with the scope of services presented in H&K's December 7, 2014 proposal PC14.118.

The findings, conclusions, and recommendations presented in this report are based on the following relevant information collected and evaluated by H&K: literature review, surface observations, subsurface exploration, laboratory test results, and H&K's experience with similar conditions in the area. It is H&K's opinion that the site is suitable for the proposed construction provided the geotechnical engineering design recommendations presented in this report are incorporated into the earthwork and structural improvements. This report should not be relied upon without review by H&K if a period of 24 months elapses between the issuance report date shown above and the date when construction commences.

H&K's experience and that of the civil engineering profession indicates that during the construction phase of a project the risks of costly design, construction and maintenance problems can be significantly reduced by retaining the design geotechnical engineering firm to review the project plans and specifications and to provide geotechnical engineering construction quality assurance (CQA) observation and testing services. Upon your request H&K will prepare a CQA geotechnical engineering services proposal that will present a work scope, tentative schedule and fee estimate for your consideration and authorization. If H&K is not retained to provide

(530) 894-2487 • FAX (530) 894-2437 • 8 Seville Court, Suite 100 • Chico, CA 95928 • A California Corporation

geotechnical engineering CQA services during the construction phase of the project, then H&K will not be responsible for geotechnical engineering CQA services provided by others nor any aspect of the project that fails to meet your or a third party's expectations in the future.

H&K appreciates the opportunity to provide geotechnical engineering services for this important project. Please call the undersigned at 530-894-2487 if you have questions or need additional information.

Sincerely,

Holdrege & Kull



Handwritten signature of Donald M. Olsen in blue ink.

Donald M. Olsen, PE 49514
Principal Engineer/Geologist



Kirk J. Keoster
Staff Engineer/Geologist

Copies To:

Addressee (4 bound copies by mail and 1 PDF formatted copy by email)

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- Appendix B, Important Information About YH&K's Geotechnical Investigation Report (Included with permission of ASFE, Copyright 2004), 2 pages
- Appendix C, Exploratory Boring Logs, 47 pages.
- Appendix D, Soil Laboratory Test Sheets, 84 pages.
- Appendix E, Soil Field Permeability Test Sheets, 5 pages.
- Appendix F, Seismic Design Parameters, 10 pages.
- Appendix G, Soil Liquefaction Analyses, 2 pages.

1 INTRODUCTION

Holdrege & Kull (H&K) performed a geotechnical engineering investigation of the City of Colusa Waste Water System located at the waste water treatment facility and along portions of the sewer pipeline through the City of Colusa, Colusa County, California. Figure 1 shows the approximate location of the City of Colusa. Figures 2 and 3 show the approximate alignment of the sewer pipeline to be replaced, the proposed pump station, and the proposed clarifier tank and the associated exploratory borings and surrounding vicinities. The geotechnical engineering investigation was performed consistent with the scope of services presented in H&K's Geotechnical Engineering Investigation Proposal (PC14.118), dated December 7, 2014. A copy of the proposal, excluding the fee and contract sections, is included in Appendix A. H&K's findings, conclusions, and recommendations are presented herein. Appendix B presents, for your review, a document prepared by ASFE entitled *"Important Information About Your Geotechnical Engineering Report."* This document summarizes project specific factors, limitations, content interpretation, responsibilities, and other pertinent information. Please read this document carefully. The information presented in this report is organized into the following sections: introduction, site investigation, laboratory testing, conclusions, recommendations, limitations, figures, and appendices.

1.1 SCOPE-OF-SERVICES

H&K performed a specific scope-of-services to develop geotechnical engineering design recommendations for the proposed earthwork and structural improvements. A brief description of each work scope task is presented below. A detailed description of each work scope task is presented in Section 2 (Site Investigation) of this report.

- **Task 1, Site Investigation:** H&K performed a site investigation to characterize the existing surface and subsurface soil, rock, and groundwater conditions encountered to the maximum depth excavated. H&K's field engineer/geologist made observations, took representative soil and/or rock samples, and performed field tests at a limited number of subsurface exploratory locations. H&K performed laboratory tests on selected soil and/or rock samples to evaluate their geotechnical engineering material properties.
- **Task 2, Data Analysis and Engineering Design:** H&K evaluated the field and laboratory site data, proposed site improvements, and used this information to develop geotechnical engineering design recommendations for earthwork and structural improvements. H&K used engineering judgment to extrapolate H&K's observations and conclusions regarding the field and laboratory data to other onsite areas located between and beyond the locations of H&K's subsurface exploratory excavations.
- **Task 3, Report Preparation:** H&K prepared this report to present H&K's findings, conclusions, and recommendations.

1.2 PROPOSED IMPROVEMENTS

H&K has not been provided with the approved construction plans to review as of the date of this report, however, H&K understands that the proposed site construction will include the following earthwork grading and structural improvements:

- Sewer Pipelines: Improvements include replacing approximately 14,265 linear feet (LF) of sewer pipeline to depths ranging from 12 to 15 feet below the surface (bgs). The sewer pipeline replacements include: Will S. Green Avenue = 4,659 LF, Colusa Avenue = 1,558 LF, 8th Street = 2,012 LF, Harris Street = 424 LF, Sioc Street = 1,165 LF, 5th Street = 318 LF, 6th Street = 1,588 LF, and Parkhill Street = 2,541 LF.
- Pump Station: Improvements include constructing a new pump station to a depth of approximately 26 feet bgs located on Will S. Green Avenue.
- Clarifier Tank: Improvements include constructing a new below grade clarifier tank with a 55 foot diameter to a depth of approximately 22 feet bgs.
- 20 Acre Treated Water Storage Pond: Improvements include grading to increase the perimeter berms heights to enclose approximately 34,000,000 gallons to, and install erosion protection on the interior slopes.

1.3 PROJECT DOCUMENTS

H&K was provided with the following project documents:

- City of Colusa Sewer System Plans, dated August 13, 2010.
- City of Colusa Project Report Screens Pump Station and Collection System Improvements, SRF Funding Application Attachment T1, prepared by Nexgen Utility Management, dated August 2014.
- Geotechnical Investigation Report Proposed Colusa Wastewater Treatment Plant Upgrades, Colusa, California, prepared by Kleinfelder & Associates, dated April 5, 2006.

1.4 INVESTIGATION PURPOSE

The purpose of H&K's investigation is to obtain sufficient on-site information about the soil, rock and groundwater conditions at the site to allow H&K to prepare geotechnical engineering design recommendations for construction of the proposed earthwork and structural improvements described in the preceding. H&K did not evaluate the site for the presence of hazardous waste, mold, asbestos, and radon gas. Therefore, the presence and removal of these materials are not discussed in this report.

2 SITE INVESTIGATION

H&K performed a site investigation to characterize the existing site conditions and to develop geotechnical engineering design recommendations for earthwork and structural improvements. Each component of H&K's site investigation is presented below.

2.1 GEOLOGY AND SEISMICITY

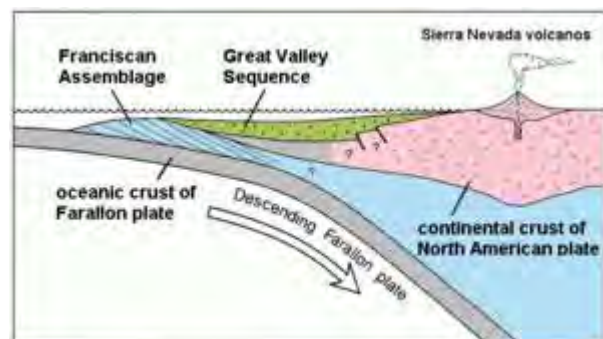
The regional and site geology, and seismicity associated with earthquake faulting is described below.

2.1.1 Regional Geology

The project site is located near the northeastern boundary of the Great Valley geomorphic province as shown on the inset figure. The Great Valley province is generally bordered on the north by the Klamath Mountains and Cascade Range, to the east by the Sierra Nevada Mountain Range, and to the west by the Coast Ranges geomorphic provinces. The Great Valley or central valley of California is a large, relatively flat lying northwest to southeast trending area that is approximately 40 to 60 miles (60 to 100 km) wide (east-west) and approximately 450 miles (720 km) long (north-south). The northern one-third of the valley is drained to the south by the Sacramento River and the southern two-thirds of the valley is drained to the north by the San Joaquin River, thus the portions of the great valley drained by these rivers are called the Sacramento Valley and San Joaquin Valley, respectively. These rivers join to form a large delta on the eastern edge of the San Francisco Bay and eventually flow westward into the Pacific Ocean.



The Great Valley is thought to have originated during the late Jurassic Period (164 to 145 million years before present [mybp]) through Cretaceous Period (145 to 66 mybp) below sea level as a depressed offshore area caused by subduction of the Farallon Oceanic Plate consisting predominantly heavier mafic rocks beneath the North American Continental Plate consisting predominantly of lighter salic rocks as shown in the inset figure. The theory of plate



tectonics refers to this geologic environment as either a forearc basin, arc-trench gap, outer arc trough or island arc phenomenon, because a chain of volcanoes defined the east boundary, and an ancient subduction zone associated with a deep-sea oceanic trench defined the west boundary.

The resulting depression was subsequently filled with approximately up to 40,000 feet (12 kilometers) of sediments referred to as the Great Valley Sequence derived from the ancient Sierra Nevadan volcanoes, followed by sediments eroded from the rapidly rising Sierra Nevada mountain range. The deeper sediments deposited during the late Jurassic and Cretaceous Periods generally consist of inter-layered coarse and fine grained marine sediments associated with mountain-building events. The shallower sediments deposited during the Pleistocene Epoch (2.6 to 0.01 mybp) and Holocene Epoch (0.01 mybp to present) generally consist of marginal-marine to non-marine, predominantly coarser-grained sediments that represent the final stage of infilling of the basin.

2.1.2 Site Geology

H&K reviewed the *Geologic Maps of California, Ukiah Sheet (1960) and Chico Sheet (1962 and revised 1989)* of California published by the California Department of Conservation, Division of Mines and Geology which is now known as the California Geological Survey (CGS) which describes the geology beneath and surrounding the project site. Figure 4 shows a portion of the Ukiah Sheet Geologic Map and the location of the project site. The geologic map indicates that the site is underlain alluvial deposits of the Holocene Epoch (last 11,000 years before present). These terrestrial alluvial deposits consist of varying thickness of inter-bedded sand, gravel, clay and silt that have been deposited during flood stages on the Sacramento River to the west, and the Feather River and Yuba River to the east.

2.1.3 Regional Faulting And Seismicity

Regional faulting and seismicity potentially impacting the site are generally associated with the northern extensions of the Calaveras Fault (i.e., Green Valley Fault, Hunting Creek Fault, Bartlett Springs Fault), Hayward Fault (i.e., Rogers Creek Fault, and Maacama Fault) and the San Andreas Fault all situated greater than approximately 25 miles to the west of the site and the Foothills Fault System (i.e., Spencerville Faults, Maidu Fault, Bear Mountain, Cleveland Hills Fault and Melones Fault) all situated greater than 10 miles to the east of the site. Figure 5 shows the approximate location of the property on the CGS *Fault Activity Map of California and Adjacent Areas that was prepared by C.W. Jennings (1994)*, and on the CGS 2010 Fault Activity Map of California. This map and the California Geological Survey Open File Report 96-08, *Probabilistic Seismic Hazard Assessment for the State of California*, and the 2002 update entitled *California Fault Parameters* indicate that no known active, potentially active, or inactive faults traces have been identified on or in the near vicinity of the project site. The closest known active fault to the site is the Cleveland Hills Fault situated about 20 miles to the northeast of the site.

The California Geological Survey Special Publication 42, *Fault Rupture Hazard Zones in California published in 1994 and revised in 1997 with Supplement No.s 1 and 2 added in 1999 and Supplement No. 3 added in 2003*, describes active faults and fault zones with seismic activity occurring during the Holocene Epoch (last 11,000 years) as part of the Alquist-Priolo Earthquake Fault Zoning Act (E.W. Hart and W.A. Bryant, 1999). The CGS Special Publication 42 and its supplements shows that the site is not located within an Alquist-Priolo Earthquake Fault Zone and that no known active or potentially active faults are known to cross the site.

2.2 FIELD INVESTIGATION

H&K performed a field investigation of the site from March 9 to 13, 2015. H&K's Field Engineer/Geologist described the surface and subsurface soil, rock, and groundwater conditions observed at the site using the procedures cited in the American Society for Testing and Materials (ASTM), Volume 04.08, *"Soil and Rock; Dimension Stone; and Geosynthetics"* as general guidelines for H&K's field and laboratory procedures. The Field Engineer/Geologist described the soil color using the general guideline procedures presented in the Munsell Soil Color Chart. Engineering judgment was used to extrapolate the observed surface and subsurface to areas located between and beyond H&K's subsurface exploratory locations. The surface and subsurface conditions observed during H&K's field investigation are described below.

2.2.1 Surface Conditions

H&K observed the following surface conditions during H&K's field investigation of the property. Figures 2 and 3 show the project sewer pipeline alignment, new pump station, new clarifier tank and existing storage pond locations. The proposed sanitary sewer alignment situated to the north and east of the intersection of Will S. Green Avenue and Colusa Ave is paved with asphalt concrete (AC). Will S. Green Avenue is paved for approximately 1000 feet to the south of this intersection and then becomes an unpaved gravel surfaced road for its remaining length as it extends to the south and terminates at the waste water treatment plant.

2.2.2 Subsurface Conditions

The subsurface soil, rock and groundwater conditions were investigated by excavating exploratory borings along the proposed sewer pipeline alignment, the new pump station, new clarifier tank and at the storage pond areas. The information obtained from the subsurface investigation is described herein.

H&K provided engineering oversight for the excavation of a total of 21 exploratory soil borings at the project site and are identified on Figures 2 and 3 as B15-1 through B15-22 with the exception of B15-10, which was not drilled due to sufficient information that had been previously obtained from the close boring locations. All of the exploratory borings were drilled with a truck mounted drillrig outfitted with hollow-stem-augers (HSA) and mud rotary (MR) drilling equipment. Exploratory borings B15-1 through

B15-9, B15-11 through B15-15, B15-17, B15-18, and B15-20 through B15-22 were all drilled to target depths of approximately 20 feet below the ground surface (bgs). Exploratory borings B15-16B and B15-19 were drilled to maximum depths of 50 and 40 feet bgs at the new pump station and new clarifier tank locations. Exploratory boring B15-19 was terminated at a depth of 40 feet, because the sandy soil encountered collapsed into the boring even when drilled with stabilizing mud, which prevented further sampling and advancement of the bore hole.

Refusal on bedrock or refusal within competent to highly weather rock, cobbles or cemented, hard-consolidated soil did not occur in any of the subsurface exploratory excavations. The soil, rock and groundwater conditions below these depths are unknown. Engineering judgment was used to extrapolate the observed soil, rock, and groundwater conditions to areas located between and beyond H&K's subsurface exploratory excavation locations.

Borings B15-1, B15-4 and B15-16A were converted into temporary monitoring wells. The well construction details are shown on the associated exploratory boring log and on well construction detail forms included in Appendix C.

H&K's field Engineer/Geologist logged each exploratory boring using the Unified Soils Classification System (USCS) guideline procedures. Representative soil samples were collected generally from the following depth intervals below the ground surface in each boring: at 2.5 feet, 5 feet and continued at 5 feet depth intervals for the remainder of the boring. Relatively undisturbed soil samples were collected with a 2.5-inch inside-diameter split-spoon sampler denoted by (2.5-SS) equipped with brass liner sample tubes. Relatively disturbed representative soil samples were also collected with a Standard Penetration Test sampler denoted by SPT was not equipped with liner tubes. The 2.5-SS and SPT samplers were driven into the soil at the specified sampling depth intervals using a 140-pound slide hammer with a 30-inch free fall to the striking anvil. The relatively undisturbed liner tube samples were all sealed with labeled, end-caps. The disturbed soil samples were placed in labeled, sealed plastic bags, sacks or buckets with lids. All of the samples were transported to the H&K Chico office laboratory.

Selected soil samples were tested in H&K's laboratory to determine their engineering material properties using the standardize testing procedures developed by the American Society for Testing and Materials (ASTM). These soil engineering material properties are used to develop geotechnical engineering design recommendations that may include but not be limited to: earthwork grading, foundations, retaining walls, concrete slab-on-grade floors, access road pavements, and groundwater drainage systems.

The generalized soil and rock conditions underlying the sanitary sewer pipeline alignments, new pump station, new clarifier tank, and at the existing storage pond areas are described below. Detailed descriptions of the soil, rock and groundwater

conditions that were encountered at each subsurface exploratory location are presented on the exploratory boring logs included in Appendix C. The particle size percentages described for the materials listed below and on the exploratory logs are based on visual field estimates of each material's dry weight and are estimated to the nearest 5 percentage point interval basis. The exploratory logs also show the particle size percentages descriptions for selected samples that were tested by standardized procedures in the laboratory. The laboratory determined particle size distribution percentages for selected samples are shown on the logs preceded by "LAB DATA" and then reported to the nearest tenth of a percent. The soil and/or rock units encountered in H&K's subsurface exploratory excavations were generally stratigraphically continuous or successive along the sewer pipeline alignment; however, the units varied in thickness. The units encountered during H&K's subsurface investigation of the sites are described below.

2.2.2.1 Sewer Pipeline Alignment:

Exploratory borings B15-1 through B15-18 generally were underlain by the following units:

- **Unit A, ML, Low Plasticity Silt Soil:** This soil unit was generally encountered along the sewer pipeline alignment site from approximately 0 to 13 feet bgs. This soil unit consists of the following field estimated particle size percentages: 65% low plasticity clay and silt, and 35% fine sand. This soil is predominantly brown with a Munsel Color Chart designation of (10YR4/3). This soil was firm to very stiff and damp to saturated at the time of H&K's subsurface investigation.
- **Unit B, CL, Low Plasticity Clay Soil:** This soil unit was generally encountered along the sewer pipeline alignment from approximately 13 to 20 feet bgs. This soil unit consists of the following field estimated particle size percentages: 85% low plastic clay and silt, 15% fine sand. This soil is predominantly dark brown with a Munsel Color Chart designation of (10YR,5/6). This soil was stiff to hard and wet to saturated at the time of H&K's subsurface investigation.

2.2.2.2 Pump Station:

Exploratory boring B15-16B was underlain by the following units:

- **Unit A, ML, Low Plasticity Silt Soil:** This soil unit was generally encountered from approximately 0 to 11 feet bgs. This soil unit consists of the following field estimated particle size percentages: 80% low plasticity clay and silt, and 20% fine sand. This soil is predominantly brown with a Munsel Color Chart designation of (10YR4/3). This soil was firm to stiff and damp to saturated at the time of H&K's subsurface investigation.
- **Unit B, CL, Low Plasticity Clay Soil:** This soil unit was generally encountered from approximately 11 to 31 feet bgs. This soil unit consists of the following field

estimated particle size percentages: 85% low plastic clay and silt, 15% fine sand. This soil is predominantly dark brown with a Munsel Color Chart designation of (10YR,5/6). This soil was stiff to hard and wet to saturated at the time of H&K's subsurface investigation.

- **Unit C, SM, Silty Sand Soil:** This soil unit was generally encountered across the entire site from approximately 31 to 33.5 feet bgs. This soil consists of the following field estimated particle size percentages: 80% low plasticity clay and silt, and 20 fine sand. This soil is predominantly dark yellowish brown with a Munsel Color Chart designation of (10YR,3/4). This soil was very stiff and saturated at the time of H&K's subsurface investigation.

2.2.2.3 Clarifier Tank:

Exploratory boring B15-19 was underlain by the following units:

- **Unit B, CL, Low Plasticity Clay Soil:** This soil unit was generally encountered from approximately 0 to 19 feet bgs. This soil unit consists of the following field estimated particle size percentages: 90% low plastic clay and silt, 10% fine sand. This soil is predominantly brown with a Munsel Color Chart designation of (10YR,4/3). This soil was firm to very stiff and moist to saturated at the time of H&K's subsurface investigation.
- **Unit C, SM, Silty Sand Soil:** This soil unit was generally encountered from approximately 19 to 24 feet bgs. This soil consists of the following field estimated particle size percentages: 35% low plasticity clay and silt, and 65% fine sand. This soil is predominantly yellowish brown with a Munsel Color Chart designation of (10YR,5/6). This soil was very dense and saturated at the time of H&K's subsurface investigation.
- **Unit B, CL, Low Plasticity Clay Soil:** This soil unit was generally encountered from approximately 24 to 29 feet bgs. This soil unit consists of the following field estimated particle size percentages: 90% low plastic clay and silt, 10% fine sand. This soil is predominantly brown with a Munsel Color Chart designation of (10YR,4/3). This soil was firm to very stiff and wet to saturated at the time of H&K's subsurface investigation.
- **Unit D, SP, Poorly Graded Sand Soil:** This soil unit was generally encountered from approximately 29 to 40 feet bgs. This soil unit consists of the following field estimated particle size percentages: 5% low plasticity clay and silt, and 95% fine sand. This soil is predominantly brown with a Munsel Color Chart designation of (10YR,5/3). This soil was very dense and saturated at the time of H&K's subsurface investigation. This soil collapsed into the borehole even when drilled with mud rotary equipment, which prevented further sampling and advancement of the borehole.

2.2.2.4 Existing Storage Pond:

Exploratory boring B15-20 through B15-22 was underlain by the following units:

- **Unit B, CL, Low Plasticity Clay Soil:** This soil unit was generally encountered from approximately 0 to 8 feet bgs. This soil unit consists of the following field estimated particle size percentages: 95% low plastic clay and silt, 5% fine sand. This soil is predominantly dark grayish brown with a Munsel Color Chart designation of (10YR,4/2). This soil was firm to very stiff and wet to saturated at the time of H&K's subsurface investigation.
- **Unit C, SM, Silty Sand Soil:** This soil unit was generally encountered from approximately 8 to 16 feet bgs. This soil consists of the following field estimated particle size percentages: 25% low plasticity clay and silt, and 75% fine sand. This soil is predominantly yellowish brown with a Munsel Color Chart designation of (10YR,5/4). This soil was medium dense and saturated at the time of H&K's subsurface investigation.
- **Unit E, SW, Well Graded Sand Soil:** This soil unit was generally encountered from approximately 16 to 20+ feet bgs. This soil consists of the following field estimated particle size percentages: 5% low plasticity clay and silt, and 75% fine sand and 20% medium sand. This soil is predominantly dark brown with a Munsel Color Chart designation of (10YR,4/3). This soil was medium dense and saturated at the time of H&K's subsurface investigation.

2.2.3 Groundwater Conditions

The local groundwater table was generally encountered from approximately 8 to 17 feet below the existing ground surface. The depth to the groundwater table when encountered is noted on each boring log. H&K used the State Water Resources Control Board's database (<http://geotracker.waterboards.ca.gov/gama/>) to review historical groundwater elevation data in the within the near vicinity of the project site. Based on review of the available groundwater data indicates that the depth to the local groundwater table ranges from approximately 11 to 19 feet bgs. Seasonal fluctuations in the local groundwater table at the project site are unknown at this time; however it is generally understood that the groundwater table elevation is highest at the end of the winter rainy season and lowest at the end of the summer dry season. H&K recommends that for planning and design purposes that the depth to the local groundwater table should be assumed to be 5 feet below the existing ground surface.

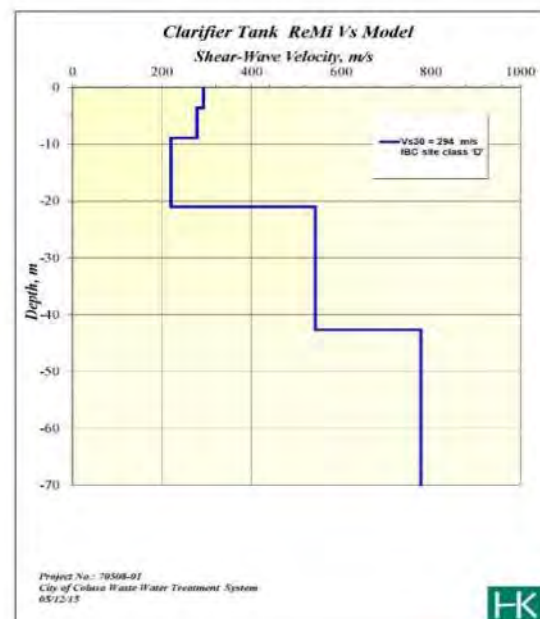
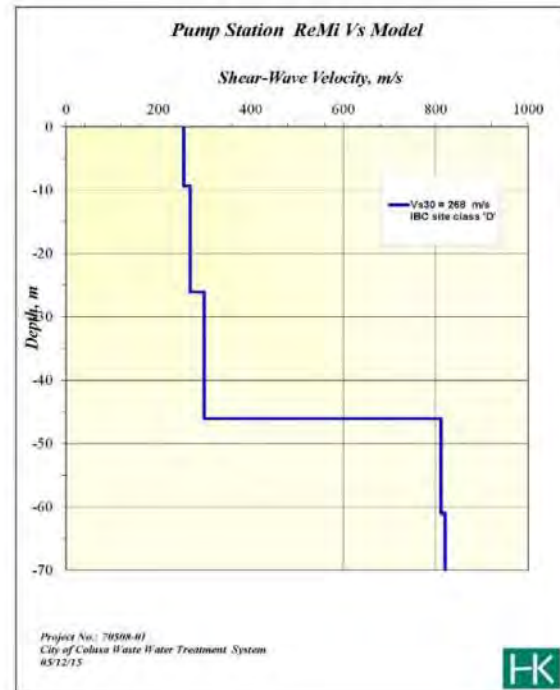
2.2.3.1 Remi Seismic Survey Site Class Determination

H&K performed a seismic refraction microtremor survey at the proposed pump station and at the proposed clarifier tank using the SeisOpt® ReMi™ Vs30 method to determine the in-situ shear-wave (S-wave) velocity profile of the first 100-feet (30 meters) of soil beneath the site. Based on the known subsurface geologic conditions at the site, this evaluation was selected to determine design soil Site Class in accordance with the 2013 California Building Code (CBC), Chapter 16A,

Section 1613A.3.2 and American Society of Civil Engineers (ASCE) publication ASCE 7-10, Chapter 20.

The seismic refraction survey is performed at the surface using a conventional seismograph and P-wave geophones used for refraction surveys. The seismic source consists of ambient seismic microtremors which are constantly being generated by cultural activities and natural noise in the area. H&K recorded the near site seismic vibrations generated by vehicle traffic along Will S. Green Avenue which is situated along the sewer pipeline alignment. The data was collected during a series of 24 recording periods that were each 30 seconds in duration. The Vs Model, included in the inset figures, shows the subsurface shear-wave velocity profile that was developed for each site from the SeisOpt® ReMi™ data.

The resulting subsurface shear wave model for both sites indicates that the harmonic mean seismic shear wave velocity for the upper 100 feet of the subsurface at the pump station and clarifier tank sites are 268 and 294 feet per second (ft/sec), respectively. These weighted shear wave velocities corresponds indicate that both sites are classified as soil Site Class D (Siff Soil Profile), as described in ASCE 7-10, Chapter 20, Table 20.3-1.



3 LABORATORY TESTING

H&K performed laboratory tests on selected soil samples taken from the subsurface exploratory excavations to determine their engineering material properties. These engineering material properties were used to develop geotechnical engineering design recommendations for earthwork and structural improvements. The following laboratory tests were performed using the cited ASTM guideline procedures:

- ASTM D422, Particle Size Gradation (Sieve Only, Hydrometer Only or Both)
- ASTM D2166, Unconfined Compressive Strength
- ASTM D2216, Soil Moisture Content
- ASTM D2487, Soil Classification by the USCS
- ASTM D2488, Soil Description (Visual Manual Method)
- ASTM D2850, Unconsolidated, Undrained, Triaxial Shear Strength
- ASTM D2937, Drive Tube Density-Moisture Determination
- ASTM D4318, Atterberg Plasticity Indices
- ASTM D4327, Chlorides and Sulfates
- ASTM D4829, Expansion Index (UBC Expansion Index)
- ASTM D4972, pH
- ASTM D6391, Two Stage Borehole Infiltrimeter
- ASTM G57, Electricity Resistivity

Table 3.1 presents a summary of the laboratory test results and Appendix D presents the laboratory test data sheets.

Table 3.1, Laboratory Test Results

Boring No./Trench No.	B15-1	B15-1	B15-1	B15-2	B15-2	B15-3	B15-3	B15-4	B15-4	B15-5
Sample No.	B2-1-1	L2-1-3 L2-2-3	L3-1-2	L1-1-2 L1-2-2	L2-1-2	L1-1-2	L2-1-2	B2-1-1	L2-1-1	B2-1-1
Sample Depth (ft)	5.0	10.0	20.0	5.0	15.0	5.0	15.0	5.0	10	10
D422 Coarse Gravel = 3 Inch (%)										
Particle Gradation (%)	Fine Gravel = 3/4 Inch (%)							100.0		100.0
	Coarse Sand = No. 4 Sieve (%)							99.9		99.9
	Med. Sand = No. 10 Sieve (%)		100.0	100.0	100.0			99.8		99.5
	Fine Sand = No. 40 Sieve (%)		99.5	99.6	99.7		100.0	98.1		99.0
	Silt & Clay = No. 200 Sieve (%)		68.3	79.7	49.8		55.5	84.7		31.0
D2166 Unconfined Shear Strength (psf)		1045	382	607	2554	1816	508			
D2937 Dry Density (pcf)									57.9	
Moisture Content (%)									68.2	
D4327 Chloride/Sulfate	48/110									
D4972 pH	9.05									
G57 Resistivity (ohms-cm)	860									

Table 3.1, Laboratory Test Results Continued

Boring No./Trench No.	B15-5	B15-6	B15-7	B15-7	B15-7	B15-8	B15-8	B15-11	B15-11	B15-11
Sample No.	L1-1-2	B2-1-1	B2-1-1	L1-1-2 L1-2-2	L2-1-2	L1-1-2 L1-2-2	L2-1-2 L2-2-2	B3-1-1	L1-1-2	L2-1-2
Sample Depth (ft)	5.0	10.0	10.0	5.0	15.0	5.0	15.0	15.0	5.0	10.0
D422 Coarse Gravel = 3 Inch (%)										
Particle Gradation (%)	Fine Gravel = 3/4 Inch (%)		100.0	100.0						
	Coarse Sand = No. 4 Sieve (%)			98.0	98.5					
	Med. Sand = No. 10 Sieve (%)	100.0		97.9	97.5		100.0	100.0	100.0	
	Fine Sand = No. 40 Sieve (%)	99.8		96.9	95.9		99.7	99.8	99.8	100.0
	Silt & Clay = No. 200 Sieve (%)	60.3		79.7	71.6		72.4	89.8	56.0	21.7
D2166 Unconfined Shear Strength (psf)	1191			NA	2772	907	2094		1463	NA
D2937 Dry Density (pcf)	101.0						103.0		100.4	
Moisture Content (%)	19.0						21.4		12.6	
D4318 Atterberg Liquid Limit (LL)							36.0	36.0		
Atterberg Plasticity Index (PI)							18.0	18		
D4327 Chloride/Sulfate (mg/kg)		16/47								
D4972 pH		8.90								
G57 Resistivity (lumhos.cm)		770								

Table 3.1, Laboratory Test Results Continued

Boring No./Trench No.	B15-12	B15-12	B15-12	B15-13	B15-14	B15-14	B15-16A	B15-16B	B15-16B	B15-16B
Sample No.	B1-1-1	L1-1-2	L2-1-1	B2-1-1	B1-1-1	L2-1-1	B3-1-1	B2-1-1	B5-1-1	B6-1-1
Sample Depth (ft)	5.0	2.0	10.0	15.0	5.0	10.0	10.0	6.5	21.5	25.0
D422 Coarse Gravel = 3 Inch (%)										
Fine Gravel = 3/4 Inch (%)					100.0				100.0	
Coarse Sand = No. 4 Sieve (%)			100.0		98.1			100.0	99.8	
Med. Sand = No. 10 Sieve (%)			99.3		96.9			98.8	99.6	100.0
Fine Sand = No. 40 Sieve (%)			98.0		94.5			97.9	99.4	97.8
Silt & Clay = No. 200 Sieve (%)			87.5		57.0			82.8	98.1	55.3
D2166 Unconfined Shear Strength (psf)			1008			2355				
D2216 Moisture Content (%)		582								
D2937 Dry Density (pcf)		95.2	100.4			102.7				
Moisture Content (%)		16.6	23.4			23.2				
D4318 Atterberg Liquid Limit (LL)	30.0					50.0		28.0	40.0	
Atterberg Plasticity Index (PI)	11.0					31.0		9.0	16.0	
D4327 Chloride/Sulfate (mg/kg)				19/16			ND/ND			
D4972 pH				8.84			8.63			
G57 Resistivity (ohms-cm)				870			1700			

Table 3.1, Laboratory Test Results Continued

Boring No./Trench No.	B15-16B	B15-16B	B15-16B	B15-16B	B15-16B	B15-16C	B15-16C	B15-18
Sample No.	B8-1-1	L2-1-2 L2-2-2	L3-1-2	L4-1-1	L5-1-1	B1-1-1	B2-1-1	B1-1-1
Sample Depth (ft)	35.0	5.0	10	15.0	20.0	45.0	50.0	5.0
D422 Coarse Gravel = 3 Inch (%)								
Particle Gradation (%)	Fine Gravel = 3/4 Inch (%)	100.0		100.0			100.0	
	Coarse Sand = No. 4 Sieve (%)	80.3		99.6		100.0	61.5	
	Med. Sand = No. 10 Sieve (%)	55.3		99.3		40.7	41.1	
	Fine Sand = No. 40 Sieve (%)	41.7		96.9		25.0	27.2	
	Silt & Clay = No. 200 Sieve (%)	20.0		86.5		7.1	10.2	
D2166 Unconfined Shear Strength (psf)		299.3						
D2850 UU Triaxial Strength (psf)		549.3			740.4			
D2937 Dry Density (pcf)		90.4	93.9		87.1			
Moisture Content (%)		30.9	28.5		35.2			
D4318 Atterberg Liquid Limit (LL)								43.0
Atterberg Plasticity Index (PI)								25.0

Table 3.1, Laboratory Test Results Continued

Boring No./Trench No.	B15-18	B15-18	B15-19	B15-19	B15-19	B15-19	B15-19	B15-19	B15-20
Sample No.	L1-1-2	L2-1-1	B2-1-1	B8-1-1	B10-1-1	L1-1-2 L1-2-2	L2-1-2 B3-1-1	L4-1-1	L1-1-2
Sample Depth (ft)	2.0	10.0	7.5	21.5	26.5	5.0	10.0	20.0	2.0
D422 Coarse Gravel = 3 Inch (%)				100.0					
Particle Gradation (%)									
Fine Gravel = 3/4 Inch (%)		100.0		98.1					
Coarse Sand = No. 4 Sieve (%)		99.9	100.0	87.7					
Med. Sand = No. 10 Sieve (%)		98.1	99.8	80.0			100.0		100.0
Fine Sand = No. 40 Sieve (%)		96.4	99.3	62.9	100.0		99.9		99.6
Silt & Clay = No. 200 Sieve (%)		93.6	89.5	36.0	87.2		98.8		95.6
D2166 Unconfined Shear Strength (psf)	488.2	2510.9				1857.2	2359.9	1752.4	
D2850 UU Triaxial Strength (psf)						2449.4			
D2937 Dry Density (pcf)	98.4	105.2				110.8	101.2	96.3	
Moisture Content (%)	22.2	21.2				18.1	25.5	26.6	
D4318 Atterberg Liquid Limit (LL)			37.0						48.0
Atterberg Plasticity Index (PI)			18.0						31.0
D4327 Chloride/Sulfate							19/45		
D4829 Expansion Index									
D4972 pH							8.53		
D5084 Falling Head Permeability (cm/s)									4.1E-09
G57 Resistivity (ohms-cm)							870		

Table 3.1, Laboratory Test Results Continued

Boring No./Trench No.	B15-21	B15-22							
Sample No.	L1-1-2	L1-1-2							
Sample Depth (ft)	2.0	2.0							
D422 Coarse Gravel = 3 Inch (%)									
Particle Gradation (%)									
Fine Gravel = 3/4 Inch (%)	100.0								
Coarse Sand = No. 4 Sieve (%)	99.8								
Med. Sand = No. 10 Sieve (%)	99.7	100.0							
Fine Sand = No. 40 Sieve (%)	99.5	99.5							
Silt & Clay = No. 200 Sieve (%)	96.0	97.5							
D4318 Atterberg Liquid Limit (LL)	60.0	50.0							
Atterberg Plasticity Index (PI)	43.0	31.0							
D5084 Falling Head Permeability (fps)	1.2E-08	7.0E-09							

4 TREATMENT POND FIELD PERMEABILITY TESTING

H&K performed four separate ASTM D6391 field infiltrometer tests to measure the vertical permeability of the native soil exposed on the bottom of the treatment pond. The infiltrometers were installed near the four corners of the roughly square shaped treatment pond. The vertical permeability of the soil averaged approximately $8.09 \text{ E-}08$ centimeters per second (cm/s) and ranged from $1.15 \text{ E-}07$ cm/s to $5.28 \text{ E-}08$ cm/s. The D6391 field test data and a plot of the test results for each infiltrometer are presented in Appendix E.

5 SEISMICALLY INDUCED SOIL LIQUEFACTION POTENTIAL

H&K performed an analyses of the potential for seismically induced liquefaction to occur at the project site as described below.

5.1 GEOMETRIC MEAN PEAK GROUND ACCELERATION

H&K used the USGS, *U.S. Seismic "Design Maps" Web Application, Version 3.1.0* to determine the seismic design parameters for the site, including the geometric mean peak ground acceleration (PGA_M). The PGA_M is calculated by using the Site Coefficient ($F_{PGA} = F_a$) multiplied by the PGA mapped values found on ASCE 7-10 Figure 22-7. The geometric mean peak ground acceleration was calculated using the following equation:

$$PGA_M = F_{PGA}PGA = 1.197 \times 0.303 = 0.362 \text{ g}$$

where g = gravitational acceleration ($32.2 \text{ feet/second}^2 = 9.80 \text{ meters/second}^2$)

The Seismic Design Parameter detailed report from the USGS analysis is included in Appendix F.

5.2 DEAGGREGATED SEISMIC SOURCE PARAMETERS

H&K used the USGS's 2008 Probabilistic Seismic Hazard Assessment (PSHA) Interactive Deaggregation software to estimate seismic parameters for the project site. The software uses probabilistic methods to evaluate the expected seismic ground motions, performs a probabilistic seismic hazard deaggregation of the available seismic data according to the following parameters for each earthquake occurrence relative to the project site location: earthquake moment magnitude, closest distance to the causative fault, and percent contribution to hazard. The seismic hazard deaggregation analysis was performed for the project site for a maximum credible earthquake (MCE) defined by a 5 percent damped spectral response ground acceleration with a 2 percent probability of being exceeded within a 50 year period, which represents a 2,475 year return period. The results of the probabilistic seismic hazard deaggregation analyses for the project site are summarized in Table 5.2.1 and the deaggregation data plots are included in Appendix F. The USGS's 2008 PSHA Interactive Deaggregation software can be accessed at (<https://geohazards.usgs.gov/deaggint/2008/>).

Table 5.2.1 Probabilistic Seismic Hazard Deaggregation				
Probability Of Exceedance With 5 Percent Damping And A 2,475 Year Return Period	Modal Magnitude (M _w)	Modal Distance to Fault		Peak Horizontal Ground Acceleration (g)
		Km	Miles	
2 percent in 50 years	6.42	32.6	19.6	0.3024

5.3 SEISMIC SOIL LIQUEFACTION ANALYSIS

Soil liquefaction results when the shear strength of a saturated soil decreases to zero during cyclic loading that is generally caused by machine vibrations or earthquake shaking. Liquefaction generally occurs in saturated, loose, poorly graded sand (SP), saturated, loose, well graded sand (SW), and saturated, loose, silty sand (SM) soils. However, gravels, and some clay-rich soils have been observed to have experienced liquefaction during earthquakes.

H&K performed soil liquefaction analysis of the project site consistent with the requirements of the 2013 CBC using the procedures presented in the Engineering Research Institute (EERI) Monograph authored by I. M. Idriss and R.W. Boulanger which was published in 2008. The California Geological Society (CGS) Special Publication 117A recommends a minimum liquefaction safety factor (FS) of FS = 1.3. Thus, for analytical purposes liquefaction is assumed to occur at the project site if the computed safety factor is less than FS < 1.3.

H&K's evaluation of the potential for liquefaction occurring at this site is based on the subsurface information obtained from the exploratory borings drilled at the project site, and the results of the probabilistic seismic analysis performed by the USGS's 2008 PSHA Interactive Deaggregation software. The results of this analysis indicates that the soil underlying the project site and vicinity have a very low potential for liquefaction when subjected to the peak ground accelerations expected at the site resulting from the design MCE. The results of the liquefaction analysis of the project site are presented in Appendix G.

5.4 SEISMICALLY INDUCED SETTLEMENT AND LATERAL SPREADING ANALYSIS

The estimated seismically induced settlement expected at the site is considered to be negligible. Since, the potential for liquefaction at the site is very low and the site is relatively flat the potential for seismically induced lateral spreading is also considered to be negligible.

6 SOIL CORROSION POTENTIAL

H&K obtained five representative soil samples to perform preliminary tests to estimate the corrosion potential of the soil for metal and concrete infrastructure materials. H&K does not provide corrosion engineering services. Therefore, the tests performed by H&K and the conclusions presented herein should be considered preliminary only. H&K recommends that the City of Colusa contract with a corrosion engineering firm to provide design recommendations for protecting all proposed metal, and/or concrete infrastructure improvements. Table 6.1 presents the results of four preliminary corrosion potential tests. Caltrans defines a corrosive area as an area where the soil and/or water contains more than 500ppm of chlorides, more than 2000 ppm of sulfates, has a minimum resistivity or of less than 1000 ohm-centimeters or has a pH of less than 5.5.

Table 6.1 Soil Corrosion Potential							
Boring No.	Sample No.	Depth (ft)	ASTM Tests				Comments
			D4972 pH (dim)	G57 Resistivity (ohms-cm)	D4327 Chlorides (mg/kg)	D4327 Sulfates (mg/kg)	
B15-1	B2-1-1	5	9.05	860	48	110	Mild to Low Potential
B15-6	B2-1-1	10	8.90	770	16	47	Mild to Low Potential
B15-13	B2-1-1	15	8.84	870	19	16	Mild to Low Potential
B15-16A	B3-1-1	10	8.63	1700	ND	ND	Mild to Low Potential
B15-19	B3-1-1	10	8.53	870	19	45	Mild to Low Potential.

7 CONCLUSIONS

The conclusions presented below are based on information developed from H&K's field and laboratory investigations of the site.

1. It is H&K's opinion that the sites are suitable for the proposed construction improvements provided that the geotechnical engineering design recommendations presented in this report are incorporated into the earthwork and structural improvement project plans.
2. Prior to construction, H&K should be allowed to review the proposed earthwork grading plans and structural improvement plans to determine if H&K's geotechnical engineering recommendations have been properly incorporated or if they need to be modified.
3. Based on the site geology, the observations made in the exploratory excavations, and ReMi™ seismic refraction survey the soil profile at the pump station and clarifier tank can both be modeled, according to the 2013 CBC, Chapter 16, Table 1613.5.2, and Section 1613.5.5, as a Site Class D (Stiff Soil Profile), designation for the purposes of establishing seismic design loads for the proposed improvements.
4. Based on the subsurface soil/rock and groundwater conditions observed during H&K's site investigation, literature review, and H&K's experience with subsurface conditions in the area, it is H&K's opinion that a very low probability exists for liquefaction to occur at the site during an earthquake on a nearby fault.
5. The laboratory test data indicates the near surface soil beneath the project sites are a low plasticity silt (ML) to clay (CL) soil with low expansion potential, low to moderate bearing capacity for foundations, retaining walls and concrete slab-on-grade floors. The soils also have a low corrosion potential.
6. At the time of H&K's subsurface site investigation, H&K encountered the local groundwater table at a depth of approximately 8 to 17 feet bgs, which is in reasonably close agreement with the range of 11 to 19 feet bgs reported for nearby monitoring wells. However, the depth to the ground water table may vary at these and other on-site locations as a result of both seasonal fluctuations and local soil conditions.
7. The average vertical permeability of the native soil exposed in the bottom of the treatment pond to be rehabilitated is approximately 8.09×10^{-8} cm/s.

8 RECOMMENDATIONS

H&K developed geotechnical engineering design recommendations for earthwork and structural improvements from H&K's field and laboratory investigation data. H&K's recommendations are presented hereafter.

8.1 EARTHWORK GRADING

H&K's earthwork grading recommendations include: clearing and grubbing, native soil preparation, fill construction, erosion controls, underground utility trenches, construction de-dewatering, soil corrosion potential, retaining wall back-fill, subsurface drainage, surface water drainage, review of construction plans, and construction quality assurance/quality control (QA/QC) monitoring. H&K's earthwork grading recommendations are presented below.

8.1.1 Demolition and Abandonment of Existing Site Improvements

H&K anticipates that the existing site improvements within the proposed building areas will need to be demolished and removed from the site as described below.

1. The existing asphalt concrete (AC) and aggregate base (AB) rock pavement materials within the proposed building areas should be excavated and disposed off site. However, it may be possible to use some of this demolition material to construct engineered fills provided they meet the gradation requirements specified for either "testable fill" or "non-testable fill" materials presented in this report. The project geotechnical engineer should approve the use of both AC and AB rock demolition materials for use in constructing engineered fills.
2. All foundations, underground utilities and other existing site improvements that are encountered during construction within the proposed building area should be demolished and removed from the site. These demolition materials should be disposed off-site in compliance with applicable regulatory requirements.
3. Abandonment of any underground utilities within the construction area that will not interfere with the proposed site improvements should be plugged with cement grout to reduce migration of soil and/or water.

8.1.2 Stripping and Grubbing

The site should be stripped and grubbed of vegetation and other deleterious materials as described below.

1. Strip and remove the top 2 to 4 inches of soil containing shallow vegetation roots and other deleterious materials. This highly organic topsoil can be stockpiled on-site and used for surface landscaping, but should not be used for constructing compacted engineered fills. Grub the underlying 6 to 8 inches of soil to remove any large vegetation roots or other deleterious material while leaving the soil in place.

The project geotechnical engineer or his/her representative should approve the use of any soil materials generated from the clearing and grubbing activities.

2. Remove all large shrub and tree roots and tree stumps. Excavate the remaining cavities or holes to a sufficient width so that an approved backfill soil can be placed and compacted in the cavity or holes. Sufficient backfill soil should be placed and compacted in order to match the surrounding elevations and grades. The project geotechnical engineer or his/her representative should observe and approve the preparation of the cavities and holes prior to placing and compacting engineered fill soil in the cavities and holes.
3. Remove all rocks greater than 3 inches in greatest dimension from the top 12 inches of the soil. Rocks with a greatest dimension larger than 3 inches will be referred to in this report as "oversized" rock materials. Oversized rock materials can be stockpiled on-site and used to construct engineered fills; however they must be placed at or near the bottom of deep fills but not shallower than 3 feet from the finished subgrade surface. The oversized rock should be placed with enough space between them to avoid clustering and the creation of void space. The project geotechnical engineer or his/her representative should approve the use and placement of all oversized rock materials prior to constructing compacted engineered fills.
4. Excessively large amounts of vegetation, other deleterious materials, and oversized rock materials should be removed from the site.

8.1.3 Native Soil Preparation For Engineered Fill Placement

After completing site clearing and grubbing activities, the exposed native soil should be prepared for placement and compaction of engineered fills as described below.

1. The native soil should be scarified to a minimum depth of 6 inches below the cleared and grubbed surface and then uniformly moisture conditioned. If the soil is classified as a coarse-grained soil by the USCS (i.e., GP, GW, GC, GM, SP, SW, SC or SM) then it should be moisture conditioned to within ± 3 percentage points of the ASTM D1557 optimum moisture content. If the soil is classified as a fine grained soil by the USCS (i.e., CL or ML) then it should be moisture conditioned between 0 to 4 percentage points greater than the ASTM D1557 optimum moisture content.
2. The native soil should then be compacted to achieve a minimum relative compaction of 90 percent of the ASTM D1557 maximum dry unit weight (density). The moisture content, density, and relative percent compaction should be tested by the project geotechnical engineer or the project geotechnical engineer's field representative to evaluate whether the compacted soil meets or exceeds this minimum percent compaction and moisture content requirements. The earthwork contractor shall assist the project geotechnical engineer or the project geotechnical engineer's field representative by excavating test pads with the on-site earth moving equipment. Native soil preparation beneath concrete slab-on-grade

structures (i.e., floors, sidewalks, patios, etc.), asphalt concrete (AC) pavement should be prepared as specified in Section 5.2 (Structural Improvements).

3. The prepared native soil surface should be proof rolled with a fully loaded 4,000 gallon capacity water truck with the rear of the truck supported on a double-axel, tandem-wheel, undercarriage or approved equivalent. The minimum tire pressure should be 65 pounds per square inch (psi). The proof rolled surface should be visually observed by the project geotechnical engineer or the project geotechnical engineer's field representative to be firm, competent and relatively unyielding. The project geotechnical engineer or the project geotechnical engineer's field representative may also evaluate the surface material by hand probing with a 1/4-inch-diameter steel probe; however, this evaluation method should not be performed in place of proof rolling as described in the preceding.
4. Construction quality assurance tests should be performed using the minimum testing frequencies presented in Table 8.1.3 or as modified by the project geotechnical engineer to better suit the site conditions.

Table 8.1.3, Minimum Testing Frequencies		
ASTM No.	Test Description	Minimum Test Frequency ⁽¹⁾
D1557	Modified Proctor Compaction Curve	1 per 10,000 SF ⁽²⁾ Or Material Change ⁽³⁾
D6938	Nuclear Moisture Content and Density	1 per 2,000 SF
Notes: (1) These are minimum testing frequencies that may be increased or decreased at the project geotechnical engineer's discretion on the basis of the site conditions encountered during grading. (2) SF = square feet (3) Whichever criteria provide the greatest number of tests.		

5. The native soil surface should be graded to minimize ponding of water and to drain surface water away from the building foundations and associated structures. Where possible surface water should be collected, conveyed, and discharged into natural drainage courses, storm sewer inlet structures, permanent engineered storm water runoff percolation/evaporation basins, or engineered infiltration subdrain systems.

8.1.4 Engineered Fill Construction With Testable Non-Expansive Earth Materials

Engineered fills are constructed to support structural improvements. H&K did not encounter highly expansive soil at the site during H&K's surface and subsurface investigation. If highly expansive soil is encountered at the site during earthwork grading, then H&K or the project geotechnical engineer should be contacted immediately to access the site conditions and provide recommendations to mitigate the highly expansive soil. If soil is to be imported to the site for constructing engineered fills, then H&K should be allowed to evaluate the suitability of the borrow soil source by taking representative soil samples for laboratory testing. Non-testable earth materials, as defined by ASTM D4718, are generally soil and soil-rock mixtures in which less than or equal 40 percent of the material is retained on the No. 4 sieve and/or

less than or equal to 30 percent of the material is retained on the No. 3/4 inch sieve. The relative percent compaction of testable earth materials can readily be determined by the following ASTM test procedures: laboratory compaction curve (D1557), and field moisture-density (D6983). Construction of engineered fills with non-expansive testable earth materials are described below.

1. Non-expansive soil used to construct engineered fills should consist predominantly of materials less than 3 inch in greatest dimension and should not contain rocks greater than 6 inches in greatest dimension (oversized material). Non-expansive soil should have a plasticity index (PI) of less than or equal to $PI \leq 40$ and a liquid limit (LL) that is less than or equal to $LL \leq 50$ as determined by ASTM D4318 Atterberg Indices test. Oversized materials can be placed at or near the bottom of deep fills, but not within 3.0 feet of the finished subgrade surface or within 2.0 foot of the foundation bottom. Deep fills are defined as fills that are greater than 10 feet in vertical thickness. Oversized materials should be spread apart to prevent clustering so that void spaces are not created. The project geotechnical engineer or project geotechnical engineer's field representative should approve the use of oversized materials for constructing engineered fills and should observe their placement and compaction.
2. Non-expansive soil used to construct engineered fills should be uniformly moisture conditioned. If the soil is classified by the USCS as coarse grained (i.e., GP, GW, GC, GM, SP, SW, SC or SM), then it should be moisture conditioned to within ± 3 percentage points of the ASTM D1557 optimum moisture content. If the soil is classified by the USCS as fine grained (i.e., CL or ML), then it should be moisture conditioned to between 0 to 4 percentage points greater than the ASTM D1557 optimum moisture content. Soil classified by the USCS as high plasticity and fine grained (i.e., CH or MH) should not be used to construct engineered fills without the approval of the project geotechnical engineer.
3. Engineered fills should be constructed by placing uniformly moisture-conditioned soil in maximum 8-inch-thick loose lifts (layers) prior to compacting.
4. The soil should then be compacted to achieve a minimum relative compaction of 90 percent of the ASTM D1557 maximum dry density.
5. The earthwork contractor should compact each loose soil lift with a tamping foot compactor such as a Caterpillar (CAT) 815 Compactor or equivalent as approved by H&K's project geotechnical engineer or the project geotechnical engineer's field representative. A smooth steel drum roller compactor should not be used to compact loose soil lifts for construction of engineered fills.
6. The field and laboratory CQA tests should be performed consistent with the testing frequencies presented in Table 8.1.4 or as modified by the project geotechnical engineer to better suit the site conditions.

Table 8.1.4, Minimum Testing Frequencies For Non-Expansive Soil

ASTM No.	Test Description	Minimum Test Frequency ⁽¹⁾
D1557	Modified Proctor Compaction Curve	1 per 1,500 CY ⁽²⁾ Or Material Change ⁽³⁾
D6938	Nuclear Moisture Content And Density	1 per 100 CY = 8-In. Loose Lift By 60-Ft. x 60-Ft.
Notes: (1) These are minimum testing frequencies that may be increased or decreased at the project geotechnical engineer's discretion on the basis of the site conditions encountered during grading.		
(2) CY = cubic yards		
(3) .Whichever criteria provide the greatest number of tests.		

7. The moisture content, density, and relative percent compaction of all engineered fills should be tested by the project geotechnical engineer's field representative during construction to evaluate whether the compacted soil meets or exceeds the minimum compaction and moisture content requirements. The earthwork contractor shall assist the project geotechnical engineer's field representative by excavating test pads with the on-site earth moving equipment.
8. The prepared finished grade or finished subgrade soil surface should be proof rolled with a fully loaded 4,000 gallon capacity water truck with the rear of the truck supported on a double-axel, tandem-wheel, undercarriage or approved equivalent. The minimum tire pressure should be 65 pounds per square inch (psi). The proof rolled surface should be visually observed by the project geotechnical engineer or the project geotechnical engineer's field representative to be firm, competent and relatively unyielding. The project geotechnical engineer or the project geotechnical engineer's field representative may also evaluate the surface material by hand probing with a ¼-inch-diameter steel probe; however, this evaluation method should not be performed in place of proof rolling as described in the preceding.

8.1.5 Erosion Controls

Erosion controls should be installed as described below.

1. Erosion controls should be installed on all cut and fill slopes to minimize erosion caused by surface water runoff.
2. Install on all slopes either an appropriate hydroseed mixture compatible with the soil and climate conditions of the site as determined by the local U.S. Soil Conservation District or apply an appropriate manufactured erosion control mat.
3. Install surface water drainage ditches at the top of all cut and fill slopes to collect and convey both sheet flow and concentrated flow away from the slope face.
4. Install surface water drainage ditches on the inside of all cut and fill slope benches to collect and convey both sheet flow and concentrated flow away from the slopes and to designed over side drain structures.
5. The drainage swales and over side drain structures should be lined with a minimum 2-inch-thick gunite concrete surface, erosion mats, or other suitable materials. Over side drains can also be designed with corrugated metal pipe that are anchored

to the slope. If over side drains are deemed necessary, then H&K should be allowed to perform both hydraulic and structural analyses for design of these surface water drainage control structures.

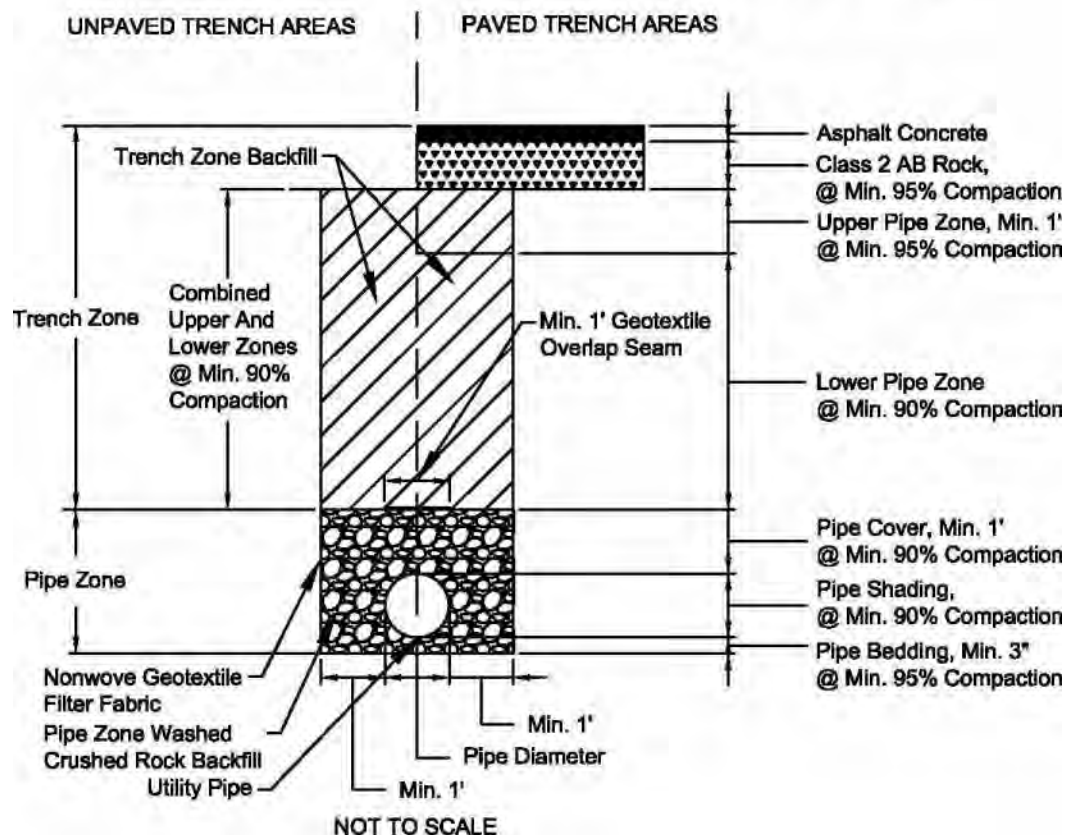
6. The intercepted surface water should be discharged into natural drainage course or into other collection and disposal structures.

8.1.6 Underground Utility Trenches

Underground utility trenches should be excavated and backfilled as described below for each trench zone as shown in the inset figure below.

1. **Trench Excavation Equipment:** H&K anticipate that the contractor will be able to excavate all underground utility trenches with a Case 580 Extend-A-Backhoe or equivalent.
2. **Trench Shoring:** All utility trenches that are excavated deeper than 4 feet below the surrounding ground surface are required by the California Occupational Safety and Health Administration (OSHA) to be shored with bracing equipment prior to being entered by any individuals, whether or not they are associated with the project.
3. **Trench Dewatering:** H&K does not anticipate that the proposed underground utility trenches will encounter shallow groundwater. However, if the utility trenches are excavated during the winter rainy season, then shallow or perched groundwater may be encountered. The earthwork contractor may need to employ de-watering methods as discussed in Section 8.1.8 in order to excavate, place and compact the trench backfill materials.
4. **Pipe Zone Backfill Type And Compaction Requirements:** The backfill material type and compaction requirements for the pipe zone which includes the bedding zone, shading zone and cover zone as shown on the inset figure below are described in the following:

TYPICAL UTILITY TRENCH BACKFILL



- Pipe Zone Backfill Material Type:** Trench backfill used within the pipe zone which includes the bedding zone, shading zone and cover zone should consist of $\frac{3}{4}$ -inch minus, washed, crushed rock. The crushed rock particle size gradation should meet the following requirements (percents are expressed as dry weights using ASTM D422 test method): 100 percent passing the $\frac{3}{4}$ inch sieve, 80 to 100 percent passing the $\frac{1}{2}$ inch sieve, 60 to 100 percent passing the $\frac{3}{8}$ inch sieve, 0 to 30 percent passing the No. 4 sieve, 0 to 10 percent passing the No. 8 sieve, and 0 to 3 percent passing the No. 200 sieve. If groundwater is encountered within the trench during construction or if it is expected to rise during the rainy season to an elevation that will infiltrate the pipe zone within the trench, then the pipe zone material should be wrapped with a minimum 6 ounce per square yard, non-woven, geotextile filter fabric such as Amoco 4506 manufactured by Amoco Fabrics and Fibers Company or equivalent should be used.. The geotextile seam should be located along the trench centerline and have a minimum 1-foot overlap. If the utility pipes are coated with a corrosion protection material, then the pipes should be wrapped with a minimum 6 ounce per square yard, non-woven, geotextile cushion fabric such as Amoco 4506 manufactured by Amoco Fabrics and Fibers Company or

equivalent should be used. The geotextile cushion fabric should have a minimum 6 inch seam overlap. The geotextile cushion fabric will protect the pipe from being scratched by the crushed rock backfill material.

- **Pipe Bedding Zone Compaction:** Trench backfill soil placed in the pipe bedding zone (beneath the utilities) should be a minimum 3-inches thick, moisture conditioned to within ± 3 percentage points of the ASTM D1557 optimum moisture content and compacted to achieve a minimum relative compaction of 95 percent of the ASTM D1557 maximum dry density.
 - **Pipe Shading Zone Compaction:** Trench backfill soil placed within the pipe-shading zone (above the bedding zone and to a height of one pipe radius length above the pipe spring line) should be moisture conditioned to within ± 3 percentage points of the ASTM D1557 optimum moisture content and compacted to achieve a minimum relative compaction of 90 percent of the ASTM D1557 maximum dry density. The pipe shading zone backfill material should be **shovel sliced** to remove voids and to promote compaction.
 - **Pipe Cover Zone Compaction:** Trench backfill soil placed within the pipe cover zone (above the pipe shading zone to one foot over the pipe top surface) should be moisture conditioned to within ± 3 percentage points of the ASTM D1557 optimum moisture content and compacted to achieve a minimum relative compaction of 90 percent of the ASTM D1557 maximum dry density.
5. **Trench Zone Backfill And Compaction Requirements:** The trench zone backfill materials consists of both lower and upper zones as discussed below.
- **Trench Zone Backfill Material Type:** Soil used as trench backfill within the lower and upper intermediate zones as shown on the preceding inset figure should consist of non-expansive soil with a plasticity index (PI) of less than or equal to $PI \leq 15$ (based on ASTM D4318) and should not contain rocks greater than 3 inches in greatest dimension.
 - **Lower Trench Zone Compaction:** Soil used to construct the lower trench zone backfills should be uniformly moisture conditioned to within 0 to 4 percentage points of the ASTM D1557 optimum moisture content, placed in maximum 12-inch-thick loose lifts (layers) prior to compacting and compacted to achieve a minimum relative compaction of 90 percent of the ASTM D1557 maximum dry density.
 - **Upper Trench Zone Compaction (Road And Parking Lot Areas):** Soil used to construct the upper trench zone backfills should be uniformly moisture conditioned to within 0 to 4 percentage points greater than the ASTM D1557 optimum moisture content, placed in maximum 8-inch-thick loose lifts (layers) prior to compacting and compacted to achieve a minimum relative compaction of 95 percent of the ASTM D1557 maximum dry density.

- **Upper Trench Zone Compaction (Non-Road And Non Parking Lot Areas):** Soil used to construct the upper trench zone backfills should be uniformly moisture conditioned to within 0 to 4 percentage points greater than the ASTM D1557 optimum moisture content, placed in maximum 8-inch-thick loose lifts (layers) prior to compacting and compacted to achieve a minimum relative compaction of 90 percent of the ASTM D1557 maximum dry density.
6. **CQA Testing And Observation Engineering Services:** The moisture content, dry density, and relative percent compaction of all engineered utility trench backfills should be tested by project geotechnical engineer's field representative during construction to evaluate whether the compacted trench backfill material meet or exceed the minimum compaction and moisture content requirements presented in this report. The earthwork contractor shall assist the project geotechnical engineer's field representative by excavating test pads with the on-site earth moving equipment.
- **Compaction Testing Frequencies:** The field and laboratory CQA tests should be performed consistent with the testing frequencies presented in Table 8.1.6 or as modified by the project geotechnical engineer to better suit the site conditions.

Table 8.1.6, Minimum Testing Frequencies For Utility Trench Backfill		
ASTM No.	Test Description	Minimum Test Frequency ⁽¹⁾
D1557	Modified Proctor Compaction Curve	1 per 500 CY ⁽²⁾ Or Material Change ⁽³⁾
D6938	Nuclear Moisture Content And Density	1 per 100 LF per 24-Inch-Thick Compacted Backfill Layer The maximum loose lift thickness shall not exceed 12-inches prior to compacting.
Notes: (1) These are minimum testing frequencies that may be increased or decreased at the project geotechnical engineer's discretion on the basis of the site conditions encountered during grading. (2) CY = cubic yards. (3) Whichever criteria provide the greatest number of tests		

- **Final Proof Rolling:** The prepared finished grade aggregate base (AB) rock surface and/or finished subgrade soil surface of utility trench backfills should be proof rolled with a fully loaded minimum 4,000 gallon capacity water truck with the rear of the truck supported on a double-axel, tandem-wheel, undercarriage or approved equivalent. The minimum tire pressure should be 65 pounds per square inch (psi). The proof rolled surface should be visually observed by the project geotechnical engineer or the project geotechnical engineer's field representative to be firm, competent and relatively unyielding. The project geotechnical engineer or the project geotechnical engineer's field representative may also evaluate the surface material by hand probing with a ¼-inch-diameter steel probe; however, this evaluation method should not be performed as a substitute for proof rolling as described in the preceding.

8.1.7 Utility Trench Seepage Cut-Off Walls

Utility trench seepage cut-off walls should be constructed beneath the building foundations where utilities penetrate beneath the building perimeter shallow foundations for trenches that are not sloped away from the building. The cut-off walls should be constructed with a slurry mixture consisting of 180 pound Portland cement (two sacks) with one cubic yard of clean sand. The cut-off walls should be a minimum of two feet thick in the direction of the utility trench alignment. The seepage cut-off wall should extend perpendicular to the trench alignment a minimum of 0.5 feet in all directions into the surrounding native soil and into the general trench backfill soil placed above the trench pipe zone materials. The bottoms of all utility trenches should be graded with a minimum of 1 percent slope away from the building foundations. Where possible bleed-off subdrains should be installed to drain by gravity any water collected in the main subdrains to the surface where it can be discharged into a natural drainage or graded drainage swale, or into a storm drain. The bleed-off subdrains should be constructed with the same materials and manner as the main utility trench.

8.1.8 Groundwater Table And Construction De-watering

H&K does anticipate the need to perform construction de-watering of sewer pipeline alignments, pump station and clarifier tank sites. The local groundwater table was encountered from approximately 7 to 15 feet below the ground surface. The actual depth of the local groundwater table encountered at each exploratory boring location is shown on each of the exploratory borings. The following recommendations are preliminary and are not based on performing a groundwater flow analysis. A detailed de-watering analysis was not a part of H&K's proposed work scope. It should be understood that it is the earthwork contractor's sole responsibility to select and employ a satisfactory de-watering method for each excavation.

1. **Sewer Pipeline:** The groundwater table when encountered along the sewer pipeline in exploratory borings B15-1 through B15-15 and at borings B15-17 and B-18 was at a depth of approximately 7 to 17 feet bgs. H&K recommends using a groundwater depth of about 10 feet bgs for design and planning purposes along those portions of the sewer pipeline. The soil along these section of the sewer pipeline are generally low permeability silts and clays which should allow the trenches to be dewatered by sump pump methods.
2. **Pump Station:** The local groundwater table was encountered in exploratory boring B15-16A and B located at the pump station at depth of about 8 feet bgs. The soil encountered from the surface to a depth of about 24 feet bgs generally consists of saturated, low permeability, silts and clay soils. The soil encountered from depths of about 24 to 45 feet bgs generally consist of moderately permeable clayey sands and silty sands. If the excavation for the pump station can be kept above a depth of about 20 feet bgs then sump pump dewatering may be adequate to maintain a safe and relatively dry working condition. If the excavation is greater than a depth

of about 20 feet bgs, then use of either individual pumping wells and/or cofferdam dewatering methods may be necessary.

3. **Clarifier Tank Site:** The local groundwater table was encountered in exploratory boring B15-19 located at the clarifier tank at a depth of about 7 feet bgs. The soil encountered from the surface to a depth of about 19 feet bgs generally consists of saturated, low permeability, clay soils. The soil encountered from depths of about 19 to 40 feet bgs generally consisted of moderately to high permeable clayey sands and sands. If the excavation for the pump station can be kept above a depth of about 15 feet bgs then sump pump dewatering may be adequate to maintain a safe and relatively dry working condition. If the excavation is greater than a depth of about 15 feet bgs, then use of either individual pumping wells and/or cofferdam dewatering methods may be necessary.
4. **Water Storage Pond:** The local groundwater table was encountered in exploratory borings B15-20 through B15-22 located at the water storage pond clarifier tank at a depth of about 4 feet bgs. The soil encountered from the surface to a depth of about 8 feet bgs generally consists of saturated, low permeability, clay soils. The soil encountered from depths of about 8 to 20 feet bgs generally consisted of moderately to high permeable clayey sands and sands. H&K recommends that the pond bottom should not be lowered (excavated) by more than 2 feet so that the local ground water table has a minimum separation from the bottom surface of the pond.

8.1.9 Soil Corrosion Potential

The selected materials used for constructing underground utilities should be evaluated by a corrosion engineer for compatibility with the onsite soil and groundwater conditions. H&K did not perform a through and extensive corrosion potential evaluation of the onsite soil and groundwater as part of H&K's scope-of-services. However, based on the limited tests of pH, resistivity, chloride content and sulfate content of representative soil samples, H&K believes that the onsite soils have a low to mild corrosion potential for metal and concrete structures.

8.1.10 Surface Water Drainage

H&K recommends the following surface water drainage mitigation measures:

1. Grade all slopes drain away from building areas with a minimum 2 percent slope for a distance of not less than 10 feet from the building foundations. An increased slope gradient of 4 percent should be used where interior slab-on-grade floors are proposed.
2. Grade all building footprint finished subgrade surfaces a minimum of 6 inches higher than the surrounding building pad finished subgrade surface, for a minimum distance of 10 feet from the building foundations.

3. Grade all landscape areas near and adjacent to buildings to prevent ponding of water.
4. Direct all building downspouts to solid (non-perforated) pipe collectors which discharge to natural drainage courses, storm sewers, catchment basins, infiltration subdrains, or other drainage facilities.

8.1.11 Grading Plan Review And Construction Monitoring

Construction quality assurance includes review of plans and specifications and performing construction monitoring as described below.

1. H&K should be allowed to review the final earthwork grading improvement plans prior to commencement of construction to determine whether H&K's recommendations have been implemented, and if necessary, to provide additional and/or modified recommendations.
2. H&K should be allowed to perform construction quality assurance (CQA) monitoring of all earthwork grading performed by the contractor to determine whether H&K's recommendations have been implemented, and if necessary, to provide additional and/or modified recommendations.
3. H&K's experience and that of H&K's profession clearly indicates that during the construction phase of a project the risks of costly design, construction and maintenance problems can be significantly reduced by retaining the design geotechnical engineering firm to review the project plans and specifications and to provide geotechnical engineering construction quality assurance (CQA) observation and testing services. Upon your request we will prepare a CQA geotechnical engineering services proposal that will present a work scope, tentative schedule and fee estimate for your consideration and authorization. If H&K is not retained to provide geotechnical engineering CQA services during the construction phase of the project, then H&K will not be responsible for geotechnical engineering CQA services provided by others nor any aspect of the project that fails to meet your or a third party's expectations in the future.

8.2 STRUCTURAL IMPROVEMENTS

H&K's structural improvement design criteria recommendations include: seismic design parameters, shallow continuous strip and stepped foundations, isolated spread foundations, retaining walls, and concrete slab-on-grade floors, patios and sidewalks. These recommendations are presented here after.

8.2.1 Seismic Design Parameters

H&K used Section 1613 of the 2013 California Building Code (CBC) and the United States Geological Survey (USGS), *Java Ground Motion Parameter Calculator, Earthquake Ground Motion Tools, Version 5.0.9a*, to develop the code-based seismic design parameters presented in Table 8.2.1:

Table 8.2.1, 2013 CBC Seismic Design Parameters		
Description	Value	Reference
Latitude-North	39.21471 deg	Google Earth version 5.2.1.1588
Longitude-West	122.00951 deg	Google Earth version 5.2.1.1588
Site Coefficient, F_A	1.183	2013 CBC, Table 1613.5.3(1), USGS, USSDM, v 3.1.0, 2013
Site Coefficient, F_V	1.738	2013 CBC, Table 1613.5.3(2), USGS, USSDM, v 3.1.0, 2013
Site Class: D (Siff Soil Profile)	D	2013 CBC, Section 1613.3.2, ASCE 7-10 Chapter 20, Table 20.3-1
Short (0.2 sec) Spectral Response, S_s	0.793g	2013 CBC, Figure 1613.5(3), USGS, USSDM, v 3.1.0, 2013
Long (1.0 sec) Spectral Response, S_l	0.331g	2013 CBC, Figure 1613.5(4), USGS, USSDM, v 3.1.0, 2013
Short (0.2 sec) MCE ⁽²⁾ Spectral Response, S_{MS}	0.793g	2013 CBC, Section 1613.5.3, USGS, USSDM, v 3.1.0, 2013
Long (1.0 sec) MCE Spectral Response, S_{M1}	0.575g	2013 CBC, Section 1613.5.3, USGS, USSDM, v 3.1.0, 2013
Short (0.2 sec) Design Spectral Response, S_{DS}	0.626g	2013 CBC, Section 1613.5.4, USGS, USSDM, v 3.1.0, 2013
Long (1.0 sec) Design Spectral Response, S_{D1}	0.384g	2013 CBC, Section 1613.5.4, USGS, USSDM, v 3.1.0, 2013
Notes: (1) UHRS = Uniform Hazard Response Spectra (2) MCE = Maximum Considered Earthquake		
CBC = California Building Code USGS = United States Geological Survey		

8.2.2 Shallow Continuous Strip And Stepped Foundations

Shallow continuous strip and stepped foundations for load bearing walls should be designed as follows:

1. The base of all shallow foundations should bear on firm competent non-expansive native soil, or either non-expansive engineered fill or expansive engineered fill compacted consistent with the earthwork recommendations of Section 8.1.
2. Continuous strip foundations should be constructed with the following dimensions:
 - a. Minimum Width = 12 Inches
 - b. Minimum Embedment Depth below the lowest adjacent exterior surface grade as shown in Table 8.2.2.
3. The allowable bearing capacities to be used for structural design of all shallow foundations founded in either non-expansive native soil or non-expansive engineered fill are presented in Table 8.2.2.

Table 8.2.2, Foundation Maximum Allowable Bearing Pressures		
Minimum Foundation Embedment Depth (inches)	Maximum Bearing Pressures For Live + Dead Loads (psf)	Maximum Bearing Pressures For Live + Dead + Wind or Seismic Loads (psf)
12	1,500	1,995
18	2,000	2,660
24	2,500	3,325
30	3,000	3,990
36	3,500	4,655

4. Foundation lateral resistance may be computed from passive pressure along the side of the foundation and sliding friction resistance along the foundation base; however the larger of the two resistance forces should be reduced by 50 percent when combining these two forces. The passive pressure can be assumed to be equal to an equivalent fluid pressure per foot of depth. The passive pressure force and sliding friction coefficient for computing lateral resistance are as follows:
 - a. Passive pressure = $275 (H)$, where H = foundation depth below lowest adjacent soil surface.
 - b. Foundation bottom sliding friction coefficient = 0.40 (dimensionless).
5. Minimum steel reinforcement for continuous strip foundations should consist of two No. 4 bars (ASTM A615 Grade 60 billet steel) with one bar placed near the top and one bar placed near the bottom of each foundation or as designated by a California licensed civil engineer.
6. The concrete should have a minimum 2,500 pounds per square inch compressive break strength after 28-days of curing and have a water to cement ratio from 0.40 to 0.45, and should be placed with minimum and maximum slumps of 3 and 5 inches, respectively. Since, water is often added to uncured concrete to increase workability, it is important that strict quality control measures be employed during placement of the foundation concrete to insure that the water to cement ratio is not altered prior to or during placement.

7. Concrete coverage over steel reinforcements should be a minimum of 3 inches as recommended by the American Concrete Institute (ACI).
8. Prior to placing concrete in any foundation excavations the contractor shall remove all loose soil, rock, wood, and debris, or other deleterious materials from the foundation excavations.
9. Foundation excavations should be saturated prior to placing concrete to aid the concrete curing process; however, concrete should not be placed in standing water.
10. Total settlement of individual foundations will vary depending on the plan dimensions of the foundation and actual structural loading. Based on the anticipated foundation dimensions and loads, we estimated that the total post-construction settlement of foundations designed and constructed in accordance with H&K's recommendations will be on the order of 1/2 inch. Differential settlement between similarly loaded, adjacent foundations is expected to be about 1/4 inch, provided the foundations are founded into similar materials (e.g., all on competent and firm engineered fill, native soil or rock). Differential settlement between adjacent foundations founded on dissimilar materials (e.g., one foundation on soil and one on rock) may approach the maximum estimated total settlement of 1/2 inch. Settlement of all foundations are expected to occur rapidly and should be essentially complete shortly after the total design load has been applied.
11. Prior to placing concrete in any foundation excavation the project geotechnical engineer or his/her field representative should observe the excavations to document that the following requirements have been achieved: minimum foundation dimensions, minimum reinforcement steel placement, and dimensions, removal of all loose soil, rock, wood, and debris, or other deleterious materials, and that firm and competent native soil or engineered fill soil is exposed along the entire foundation excavation bottom. Strict adherence to these requirements is paramount to the satisfactory behavior of a building foundation. Minor deviations of these requirements can cause the foundations to undergo minor to severe amounts of settlement which can result in cracks developing in the foundation and adjacent structural members such as concrete slab-on-grade floors.

8.2.3 Shallow Isolated Spread Foundations

Shallow isolated spread foundations (i.e., square, rectangular, trapezoidal and circular) for column loads should be designed as follows:

1. The base of all shallow foundations should bear on firm competent non-expansive native soil or either non-expansive engineered fill or expansive engineered fill compacted consistent with the earthwork recommendations presented in Section 5.1.
2. Shallow isolated square, rectangular and circular spread foundations should be designed by a California licensed civil engineer with the following dimensions:

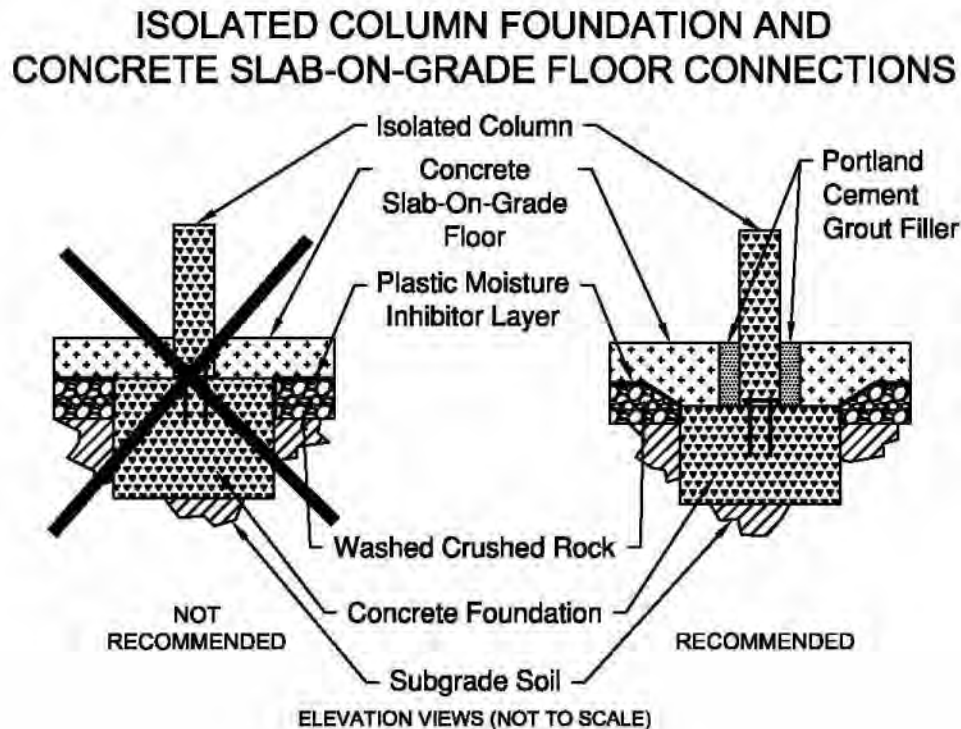
- a. Minimum Width and Length or Radius = dimensions should be determined such that the allowable bearing capacities presented herein are not exceeded.
- b. Minimum Embedment Depth below the lowest adjacent exterior surface grade as shown in Table 8.2.3.
3. The allowable bearing capacities to be used for structural design of all shallow isolated square, rectangular, trapezoidal or circular foundations founded in either non-expansive native soil or non-expansive engineered fill are presented in Table 8.2.3.

Table 8.2.3, Foundation Maximum Allowable Bearing Pressures		
Minimum Foundation Embedment Depth (inches)	Maximum Bearing Pressures For Live + Dead Loads (psf)	Maximum Bearing Pressures For Live + Dead + Wind or Seismic Loads (psf)
12	1,500	1,995
18	2,000	2,660
24	2,500	3,325
30	3,000	3,990
36	3,500	4,655

4. Foundation lateral resistance may be computed from passive pressure along the side of the foundation and sliding friction resistance along the foundation base; however the larger of the two resistance forces should be reduced by 50 percent when combining these two forces. The passive pressure can be assumed to be equal to an equivalent fluid pressure per foot of depth. The passive pressure force and sliding friction coefficient for computing lateral resistance are as follows:
 - a. Foundation bottom sliding friction coefficient = 0.40 (dimensionless).
 - b. Passive pressure = 275 (H), where H = foundation depth below lowest adjacent soil surface.
5. Minimum steel reinforcement of all isolated square, rectangular and circular foundations should be designed by a California licensed civil engineer using ASTM A615 Grade 60 billet steel.
6. The concrete should have a minimum 2,500 pounds per square inch compressive break strength after 28-days of curing and have a water to cement ration from 0.40 to 0.45, and should be placed with minimum and maximum slumps of 3 and 5 inches, respectively. Since, water is often added to uncured concrete to increase workability, it is important that strict quality control measures be employed during placement of the foundation concrete to insure that the water to cement ratio is not altered prior to or during placement.
7. Concrete coverage over steel reinforcements should be a minimum of 3 inches as recommended by the American Concrete Institute (ACI);

8. Prior to placing concrete in any foundation excavations the contractor shall remove all loose soil, rock, wood, and debris, or other deleterious materials from the foundation excavations.
9. Foundation excavations should be saturated prior to placing concrete to aid concrete curing process; however, concrete should be not placed in standing water.
10. Total settlement of individual foundations will vary depending on the plan dimensions of the foundation and actual structural loading. Based on the anticipated foundation dimensions and loads, we estimated that the total post-construction settlement of foundations designed and constructed in accordance with H&K's recommendations will be on the order of 1/2 inch. Differential settlement between similarly loaded, adjacent foundations is expected to be about 1/4 inch, provided the foundations are founded into similar materials (e.g., all on competent and firm engineered fill, native soil or rock). Differential settlement between adjacent foundations founded on dissimilar materials (e.g., one foundation on soil and one on rock) may approach the maximum estimated total settlement of 1/2 inch. Settlement of the all foundations are expected to occur rapidly and should be essentially complete shortly after the total design load has been applied.
11. Prior to placing concrete in any foundation excavation the project geotechnical engineer or his/her field representative should observe the excavations to document that the following requirements have been achieved: minimum foundation dimensions, minimum reinforcement steel placement, and dimensions, removal of all loose soil, rock, wood, and debris, or other deleterious materials, and that firm and competent native soil or engineered fill soil is exposed along the entire foundation excavation bottom. Strict adherence to these requirements is paramount to the satisfactory behavior of a building foundation. Minor deviations of these requirements can cause the foundations to undergo minor to severe amounts of settlement which can result in cracks developing in the foundation and adjacent structural members such as concrete slab-on-grade floors.
12. H&K does not recommend that concrete slab-on-grade floors be placed in direct contact with the top surface of isolated column concrete foundations. H&K's experience is that during the curing period of the concrete slab-on-grade floors, a significant thermal gradient may develop between the portions of the slab placed directly on the typically more massive isolated column concrete foundations and the portions of the slab placed over the vapor-moisture retarder membrane and crushed rock of the slab support layers. The development of adverse thermal gradients beneath portions of the slab may cause the development of significant orthogonal and/or circular shrinkage cracks in the floor slab around the isolated column foundations.

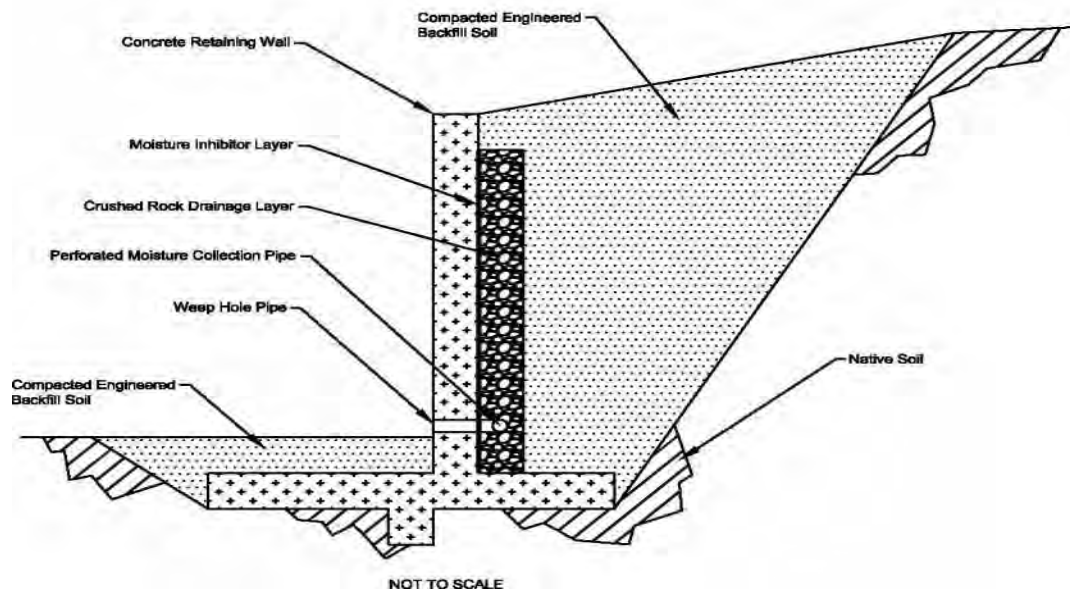
13. H&K's opinion is that the slab can be cast over the footing by providing a block out of the slab around the footing, casting the slab, and then filling the block out void with concrete after the slab has cured. Another option would be to cast the footing and slab as shown on the detail and provide felt or an expansion joint between the entire steel column and slab. The slab should be cured so that temperature and shrinkage are controlled. We recommend that the slab be moisture cured for a period of seven days after casting.



8.2.4 Retaining Wall Backfill

Place and compact all retaining wall backfill and drainage layer materials as described below. H&K did not review the final improvement plans for the site. If sub-structure retaining walls for below grade rooms, basements, garages, elevator shafts, etc. are designed for this project, then these structures should also incorporate a water proofing sealant as described below. The water proofing sealant products should be installed by a qualified waterproofing contractor according to the manufacturer's directions. A typical retaining wall and backfill material zones is shown below.

TYPICAL CANTILEVER RETAINING WALL AND BACKFILL MATERIALS



1. **Water Proofing:** Water proofing materials should be installed behind retaining walls prior to backfilling if retaining walls will be constructed for below grade rooms, basements, garages, elevator shafts, etc. The water proofing materials should be installed by a qualified waterproofing contractor according to the manufacturer's directions.
2. **Drainage Layer:** A drainage layer should be placed between the wall and backfill material in order to prevent buildup of hydrostatic pressures behind the wall. Additionally, care should be taken during placement of the drainage layer materials so as not to crush, tear, or damage the water proofing materials. The drainage layer can be constructed from drain rock, geosynthetic drain nets or a combination of both as described below.
 - a. **Caltrans Class II Permeable Material Method:** Place a minimum 12-inch-thick layer of Caltrans Class II Permeable Material directly against the wall or water proofing system (as described below) without a geotextile wrapping to separate the backfill soil from the wall. The drainage material should extend from the wall bottom to within 12 inches of the wall top.
 - b. **Geotextile Wrapped Drain Rock Method:** Place a minimum 12-inch-thick layer of drain rock wrapped in a geotextile filter fabric directly against the wall or water proofing system (as described below) to separate the backfill soil from the wall. The drain rock should extend from the wall bottom to within 12 inches of

the wall top. A minimum 6-ounce per square yard (oz/sy) non-woven geotextile fabric such as Amoco 4506 manufactured by Amoco Fabrics and Fibers Company or equivalent should be used.

- c. **Geosynthetic Composite Drainnet (Geonet) Method:** Place a geosynthetic composite drain-net (geonet) directly against the wall or water proofing system (as described below) to separate the backfill soil from the wall. The composite geonet should extend from the wall bottom to within 12 inches of the wall top. A geosynthetic composite drainnet such as Hydroduct 200 or Hydroduct 220 distributed by Grace Construction Products or equivalent should be used.
3. **Drainage Layer Collection And Discharge Pipes:** A minimum 4-inch-diameter schedule 40, polyvinylchloride (PVC) perforated drainpipe should be placed at the wall base inside the geotextile wrapped drain rock or wrapped by the composite geonet. 1/4-inch-diameter perforations should be drilled into the pipe. The perforations should be orientated in cross section view at 90 degrees to one another and along the pipe length on 6-inch-centers. The pipe should be placed such that the perforations are orientated at 45 degrees from the vertical. A minimum of 3 inches of drain rock should be placed below the perforated PVC pipe. The pipe should direct water away from the wall by gravity with a minimum 1 percent slope. The pipe should collect groundwater collected by the drainage layer discharge to the surface at the end of the wall or through weep-hole penetrations through the wall.
4. **Backfill Placement And Compaction Equipment:** Heavy conventional motorized compaction equipment should not be used directly adjacent to the retaining walls unless the wall is designed with sufficient steel reinforcements and/or bracing to resist the additional lateral pressures. Compaction of backfill materials within 5 feet of the retaining wall should be accomplished by light-weight hand operated, walk behind, and vibratory equipment. Additionally, care should be taken during placement of the general backfill materials so as not to crush, tear, or damage the water proofing and/or drainage layer materials.
5. **Backfill Materials And Compaction:** The backfill material should be free draining and classified by the USCS as a coarse-grained material (i.e., GP, GW, GC, GM, SP, SW, SC, and SM) then it. Materials classified by the USCS as a fine-grained material (i.e., CL, CH, ML, or MH) should not be used as retaining wall backfill. The retaining wall backfill material placed between the drainage layer and temporary cut-slope should be moisture conditioned to between ± 3 percentage points of the ASTM D1557 optimum moisture content and then compacted to a minimum of 90 percent and a maximum of 95 percent of the ASTM D1557 maximum dry density.

8.2.5 Retaining Walls Entirely Above The Groundwater Table

A California licensed civil engineer should design all retaining walls situated above the groundwater table with drained backfill using the following geotechnical engineering design criteria:

1. The retaining wall recommendations for static loading conditions are based on Rankine earth pressure theory published by W.J.M. Rankine (1857). The retaining wall recommendations for seismic loading conditions are based on the published work by Mononobe, N. and Matsuo, H. (1929).
2. Retaining walls should be founded on firm competent bedrock or engineered fill consistent with the requirements of Section 8.1.
3. The retaining wall should be designed using the geotechnical engineering design parameters presented in Table 8.2.5.
4. The retaining wall backfill soil should be free draining material that meets or exceeds the material requirements of and is placed and compacted consistent with the requirements of Section 8.1.
5. The static lateral earth pressures exerted on the retaining walls may be assumed to be equal to an equivalent fluid pressure per foot of depth below the top of the wall. The lateral pressures presented below are ultimate values and therefore do not include a safety factor, and assumes a free draining backfill (no hydrostatic forces acting on the wall) and no surcharge loads applied within a distance of $0.75H$, where H equals the total vertical wall height.
6. The retaining wall backfill slope shall have a horizontal slope gradient for a minimum horizontal distance of $0.75H$, where H equals the total vertical wall height. If a steeper backfill slope ratio is desired then H&K should be notified and contracted to perform additional retaining wall designs.
7. The retaining wall foundation excavations should be saturated prior to placing concrete to aid the concrete curing process. However, concrete should not be placed in standing water.

**Table 8.2.5, Design Parameters For Retaining Walls
Entirely Above The Groundwater Table**

Loading Conditions	Static Loads On Retaining Wall With Horizontal Backfill Slope	Seismic Load On Retaining Wall With Horizontal Backfill Slope
Wall Active Condition Pressures (psf) ⁽¹⁾	40 (H) ⁽⁵⁾	9 (H)
Wall Passive Condition Pressures (psf) ⁽²⁾	350 (H)	9 (H)
Wall At-Rest Condition Pressure (psf) ⁽³⁾	50 (H)	9 (H)
P _{active} Force Located Above Foundation Base	0.33 (H)	Not Applicable
P _{passive} Force Located Above Foundation Base	0.33 (H)	Not Applicable
P _{at-rest} Force Located Above Foundation Base	0.33 (H)	Not Applicable
P _{earthquake} Force Located Above Foundation Base	Not Applicable	0.60(H)
Maximum Allowable Foundation Bearing Capacity (psf), (Live + Dead Loads)	2,000	2,000
Maximum Allowable Foundation Bearing Capacity (psf) (Live + Dead + Wind or Seismic Loads)	2,660	2,660
Minimum Foundation Embedment Depth (in)	18	18
Foundation Bottom Friction Coefficient (dim.) ⁽⁴⁾	0.35	0.35
Notes: (1) The active pressure condition applies to a retaining wall with an unrestrained top (deflection allowed). (2) The passive pressure condition applies to a retaining wall with soil resistance at the base. If passive pressures are used then H&K recommends that the top 1.0 feet of soil weight be ignored. (3) The At-Rest pressure condition applies to a retaining wall with the top restrained (no deflection allowed). (4) If the design horizontal resistance force acting on the wall foundation is computed by combining both the sliding friction force and passive soil pressure force, then the larger of the two forces should be reduced by 50 percent. (5) H = The distance to a point in the backfill soil where the pressure is desired. The H distance is measured from the top of the wall for active and at-rest conditions and from one foot below the soil height at the toe of the wall for the passive condition. (See Note 2 for passive condition).		

8.2.6 Retaining Walls Partially or Fully Submerged Below The Groundwater Table

A California licensed civil engineer should design all retaining walls situated below the groundwater table with undrained backfill using the following geotechnical engineering design criteria:

1. The retaining wall recommendations for static loading conditions are based on Rankine earth pressure theory published by W.J.M. Rankine (1857). The retaining wall recommendations for seismic loading conditions are based on the published work by Mononobe, N. and Matsuo, H. (1929).
2. Retaining walls should be founded on firm competent bedrock or engineered fill consistent with the requirements of Section 8.1.
3. The retaining wall should be designed using the geotechnical engineering design parameters presented in Table 8.2.6.

4. The retaining wall backfill soil should be free draining material that meets or exceeds the material requirements and is placed and compacted consistent with the requirements of Section 8.1.
5. The static lateral earth pressures exerted on the retaining walls may be assumed to be equal to an equivalent fluid pressure per foot of depth below the top of the wall. The lateral pressures presented below are ultimate values and therefore do not include a safety factor, and assumes a free draining backfill (no hydrostatic forces acting on the wall) and no surcharge loads applied within a distance of $0.75 H$, where H equals the total vertical wall height.
6. The retaining wall backfill slope shall have a horizontal slope gradient for a minimum horizontal distance of $0.75H$, where H equals the total vertical wall height. If a steeper backfill slope ratio is desired then H&K should be notified and contracted to perform additional retaining wall designs.
7. The retaining wall foundation excavations should be saturated prior to placing concrete to aid the concrete curing process. However, concrete should not be placed in standing water.

**Table 8.2.6, Design Parameters For Retaining Walls
Partially Or Fully Submerged Below The Groundwater Table**

Loading Conditions	Static Loads On Retaining Wall With Horizontal Backfill Slope	Seismic Loads On Retaining Wall With Horizontal Backfill Slope
Wall Active Condition Pressures (psf) ⁽¹⁾	40 (H) + 62.4 (H _w) ⁽⁵⁾⁽⁶⁾	9 (H)
Wall Passive Condition Pressures (psf) ⁽²⁾	350 (H)	9 (H)
Wall At-Rest Condition Pressure (psf) ⁽³⁾	50 (H) + 62.4 (H _w)	9 (H)
P _{active} Force Located Above Foundation Base	0.33 (H)	Not Applicable
P _{passive} Force Located Above Foundation Base	0.33 (H)	Not Applicable
P _{at-rest} Force Located Above Foundation Base	0.33 (H)	Not Applicable
P _{earthquake} Force Located Above Foundation Base	Not Applicable	0.60(H)
Maximum Allowable Foundation Bearing Capacity (psf) (Live + Dead Loads)	2,000	2,000
Maximum Allowable Foundation Bearing Capacity (psf) (Live + Dead + Wind or Seismic Loads)	2,660	2,660
Minimum Foundation Embedment Depth (in)	18	18
Foundation Bottom Friction Coefficient (dim.) ⁽⁴⁾	0.35	0.35
Notes: (1) The active pressure condition applies to a retaining wall with an unrestrained top (deflection allowed). (2) The passive pressure condition applies to a retaining wall with soil resistance at the base. If passive pressures are used then H&K recommends that the top 1.0 feet of soil weight be ignored. (3) The At-Rest pressure condition applies to a retaining wall with the top restrained (no deflection allowed). (4) If the design horizontal resistance force acting on the wall foundation is computed by combining both the sliding friction force and passive soil pressure force, then the larger of the two forces should be reduced by 50 percent. (5) H = The distance to a point in the backfill soil where the pressure is desired. The H distance is measured from the top of the wall for active and at-rest conditions and from one foot below the soil height at the toe of the wall for the passive condition (See Note 2 for passive condition). (6) H _w = The distance to a point in the backfill soil below the groundwater table where the pressure is desired.		

8.2.7 Concrete Slab-On-Grade Floors

In general, H&K recommends that subgrade elevations on which the concrete slab-on-grade floors are constructed be a minimum of 6 inches above the elevation of the surrounding parking and landscaped areas. Elevating the building will reduce the potential for both surface and subsurface water to enter beneath the concrete slab-on-grade floors and exterior surfaces and underground utility trenches.

The concrete slab-on-grade building floors, patios, sidewalks and garbage collection dumpster areas should be evaluated by a California licensed civil engineer for expected live and dead loads to determine if the minimum slab thickness and steel reinforcement recommendations presented in this report should be increased or redesigned.

H&K recommends using the guideline procedures, methods and material properties that are presented in the following ASTM and American Concrete Institute (ACI) documents for construction of concrete slab-on-grade floors:

- ACI 302.1R-04, Guide For Concrete Floor And Slab Construction, reported by ACI Committee 302.
- ASTM E1643-98 (Reapproved 2005), Standard Practice For Installation Of Water Vapor Retarders Used In Contact With Earth Or Granular Fill Under Concrete Slabs.
- ASTM E1745-97 (Reapproved 2004), Standard Specifications For Plastic Water Vapor Retarders Used In Contact With Soil Or Granular Fill Under Concrete Slabs.
- ASTM F710-5, Standard Practice For Preparing Concrete Floors To Receive Resilient Flooring.

8.2.7.1 Interior Floors

The interior concrete slab-on-grade floor components are described below from top to bottom. If static or intermittent live floor loads greater than 250 psf are anticipated, then a California licensed civil engineer should design the necessary concrete slab-on-grade floor thickness and steel reinforcements.

1. Minimum 4-Inch-Thick Concrete Slab: The concrete should have a minimum 2,500 pounds per square inch compressive break strength after 28-days of curing and have a water to cement ratio from 0.40 to 0.45, and should be placed with minimum and maximum slumps of 3 and 5 inches, respectively. Since, water is often added to uncured concrete to increase workability, it is important that strict quality control measures be employed during placement of the foundation concrete to insure that the water to cement ratio is not altered prior to or during placement.
2. Prior to applying construction loads all exposed concrete slab-on-grade floors should be moisture cured for a minimum of 7 days following placement of the concrete. If concrete is placed during the hot summer months when the ambient air temperatures may be as low as 50 to 60 degrees Fahrenheit (F) in the early morning and in excess of 90 degrees F in the afternoon, then the contractor may need to implement special curing measures to minimize the development of shrinkage cracks. The concrete contractor is responsible for determining the appropriate curing process to be applied to the slab-on-grade floor.

Concrete Slabs In Contact With Isolated Concrete Foundations: H&K does not recommend that concrete slab-on-grade floors be placed in direct contact with the top surface of isolated column concrete foundations. H&K's experience is that during curing period of the concrete slab-on-grade floors a significant thermal gradient may develop between the portions of the slab placed directly on the typically more massive isolated column concrete foundations and the portions of the slab placed

over the vapor-moisture retarder membrane and crushed rock of the slab support layers. The development of adverse thermal gradients beneath portions of the slab may cause the development of significant orthogonal and/or circular shrinkage cracks around the isolated column foundations.

3. Steel Reinforcements: should be used to improve the load carrying capacity and to minimize cracking caused by shrinkage during curing and from both differential and repeated loadings. It should be understood that it is nearly impossible to prevent all cracks from development in concrete slabs; in other words, it should be expected that some cracking will occur in all concrete slabs no matter how well they are reinforced. Concrete slabs that will be subjected to heavy loads should be designed with steel reinforcements by a California licensed civil engineer.

Steel Rebar: Use No. 3 ribbed steel rebar (ASTM A615 Grade 60 billet steel), tied and placed with 18-inch centers in both directions (perpendicular) and supported on concrete "dobies" to position the rebar in the center of the slab during concrete pouring. H&K does not recommend that the steel reinforcements of the concrete slab-on-grade floor be tied into the perimeter or interior continuous strip foundations or interior isolated column foundations. In other words, we recommend that the concrete slab-on-grade floors be constructed as independent structural members so that they can move (float) independently from the foundation structures.

4. Underslab Vapor-Moisture Retarder Membrane: should be placed as a floor component that will minimize transmission of both liquid water and water vapor transmission through the concrete slab-on-grade floor. H&K recommends using at a minimum a Class A (ASTM E1745-97 [Reapproved 2004]), minimum 10-mil-thick, vapor-moisture, retarder membrane material such as: Stego Wrap® underslab vapor retarder membranes or equivalents. Additionally, the following materials are recommended: Stego® Tape and Stego® Mastic or equivalents to seal membrane joints and any utility penetrations.

Regardless of the type of moisture-vapor retarder membrane used, moisture can wick up through a concrete slab-on-grade floor. Excessive moisture transmission through a concrete slab floor can cause adhesion loss, warping and peeling of resilient floor coverings, deterioration of adhesive, seam separation, formation of air pockets, mineral deposition beneath flooring, odor and both fungi and mold growth. Slabs can be tested for water transmissivity in areas that are moisture sensitive. Commercial sealants, polymer additives to the concrete at the batch plant, entrained air, flyash, and a reduced water to content ratio can be incorporated into the concrete slab-on-grade floor to reduce its permeability and water-vapor transmissivity properties. A waterproofing consultant should be contacted to provide detailed recommendations if moisture sensitive flooring materials will be installed on the concrete slab-on-grade floors.

5. Minimum 6-Inch-Thick Crushed Rock Layer: should be placed and compacted to a minimum of 95 percent of the ASTM D1557 dry density with a moisture content of

± 3 percentage points of the ASTM D1557 optimum moisture content. The crushed rock should be washed to produce an ASTM D422 test particle size distribution of 100 percent (by dry weight) passing the ¾ inch sieve and 0 to 5 percent passing the No. 4 sieve and 0 to 3 percent passing the No. 200 sieve. This relatively clean (washed) crushed rock will act as a capillary break for free water moisture transmission, as well as, provide a uniform bearing surface for the concrete slab-on-grade floor.

6. Subgrade Soil Preparation: The subgrade soil should be prepared and compacted consistent with the recommendations of Section 5.1. The top 12 inches of the non-expansive soil should be compacted to a minimum of 90 percent of the ASTM D1557 dry density with a relatively uniform moisture content of from 0 to 4 percentage points greater than the ASTM D1557 optimum moisture content.
7. Crack Control Grooves: should be installed during placement or saw cuts should be made in accordance with the American Concrete Institute (ACI) and Portland Cement Association (PCA) specifications. Generally, H&K recommend that expansion joints be provided between the slab and perimeter footings, and that crack control grooves or saw cuts are installed on 10-foot-centers in both directions (perpendicular).
8. Field Observations: should be made by an H&K construction monitor of all concrete slab-on-grade subgrade surfaces and installed steel reinforcements prior to placing concrete.

8.2.7.2 Exterior Sidewalks, And Patios

The exterior concrete slab-on-grade surfaces components are described below from top to bottom. If static or intermittent live loads greater than 250 psf are anticipated, or if heavy traffic loads are anticipated then a California licensed civil engineer should design the necessary concrete slab-on-grade floor thickness and steel reinforcements.

1. Minimum 4-Inch-Thick Concrete Slab: The concrete should have a minimum 2,500 pounds per square inch compressive break strength after 28-days of curing and have a water to cement ration from 0.40 to 0.45, and should be placed with minimum and maximum slumps of 4 and 6 inches, respectively. Since, water is often added to uncured concrete to increase workability, it is important that strict quality control measures be employed during placement of the foundation concrete to insure that the water to cement ratio is not altered prior to or during placement.
2. Prior to applying construction loads all exposed concrete slab-on-grade floors should be moisture cured for a minimum of 7 days following placement of the concrete. If concrete is placed during the hot summer months when the ambient air temperatures may be as low as 50 to 60 degrees Fahrenheit (F) in the early morning and in excess of 90 degrees F in the afternoon, then the contractor may need to implement special curing measures to minimize the development of shrinkage cracks. The concrete contractor is responsible for determining the appropriate curing process to be applied to the slab-on-grade floors.

Concrete Slabs In Contact With Isolated Concrete Foundations: H&K does not recommend that concrete slab-on-grade floors be placed in direct contact with the top surface of isolated column concrete foundations. H&K's experience is that during curing period of the concrete slab-on-grade floor a significant thermal gradient may develop between the portions of the slab placed directly on the typically more massive isolated column concrete foundations and the portions of the slab placed over the vapor-moisture retarder membrane and crushed rock layers. The development of adverse thermal gradients beneath portions of the slab may cause the development of significant orthogonal and/or circular shrinkage cracks around the isolated column foundations.

3. Steel Reinforcements: should be used to improve the load carrying capacity and to minimize cracking caused by shrinkage during curing and from both differential and repeated loadings. It should be understood that it is nearly impossible to prevent all cracks from development in concrete slabs; in other words, it should be expected that some cracking will occur in all concrete slabs no matter how well they are reinforced. Concrete slabs that will be subjected to heavy loads should be designed with steel reinforcements by a California licensed civil engineer.

If the current property owner (developer) elects to eliminate the steel reinforcements from the exterior concrete slabs-on-grade for economic reasons, then there will be an inherent greater risk assumed by the developer for the development of both shrinkage and bearing related cracks in the associated slabs.

Steel Rebar: Use No. 3 ribbed steel rebar (ASTM A615 Grade 60 billet steel), tied and placed with 24-inch centers in both directions (perpendicular) and supported on concrete "dobies" to position the rebar in the center of the slab during concrete pouring. We do not recommend that the steel reinforcements of the concrete slab-on-grade floor be tied into adjacent building perimeter or isolated column foundations. In other words, we recommend that the concrete slab-on-grade floors be constructed as independent structural members so that they can move (float) independently from the foundation structures.

4. Minimum 4-Inch-Thick Crushed Rock Layer: should be placed and compacted to a minimum of 95 percent of the ASTM D1557 dry density with a moisture content of ± 3 percentage points of the ASTM D1557 optimum moisture content. The crushed rock should be washed to produce a particle size distribution of 100 percent (by dry weight) passing the $\frac{3}{4}$ inch sieve and 5 percent passing the No. 4 sieve and 0 to 3 percent passing the No. 200 sieve. This relatively clean (washed) crushed rock will act as a capillary break for free water moisture transmission, as well as, provide a uniform bearing surface for the concrete slab-on-grade floor. However, just prior to pouring the concrete slab the crushed rock layer should be moistened to a saturated surface dry (SSD) condition. This measure will reduce the potential for

water to be withdrawn from the bottom of the concrete slab while it is curing and will help minimize the development of shrinkage cracks.

If the current property owner (developer) elects to eliminate the crushed rock layer beneath the exterior concrete slabs-on-grade for economic reasons, then there will be an inherent greater risk assumed by the developer for the development of both shrinkage and bearing related cracks in the associated slabs.

5. Subgrade Soil Preparation: The subgrade soil should be prepared and compacted consistent with the recommendations of Section 8.1. The top 12 inches of the non-expansive soil should be compacted to a minimum of 90 percent of the ASTM D1557 dry density with a moisture content of from 0 to 4 percentage points greater than the ASTM D1557 optimum moisture content.
6. Crack Control Grooves: should be installed during placement or saw cuts should be made in accordance with the American Concrete Institute (ACI) and Portland Cement Association (PCA) specifications. Generally, H&K recommend that expansion joints be provided between the slab and perimeter footings, and that crack control grooves or saw cuts be installed on 10-foot-centers in both directions (perpendicular).
7. Field Observations: should be made by an H&K construction monitor of all concrete slab-on-grade surfaces and installed steel reinforcements prior to pouring concrete.

8.2.7.3 Loading Docks, Heavy Truck Traffic And Garbage Bin Areas

The concrete slab-on-grade floor components are described below from top to bottom. If static or intermittent live floor loads greater than 250 psf are anticipated, then a California licensed civil engineer should design the necessary concrete slab-on-grade floor thickness and steel reinforcements.

1. Minimum 8-Inch-Thick Concrete Slab: The concrete should have a minimum 3,500 pounds per square inch compressive break strength after 28-days of curing and have a water to cement ration from 0.40 to 0.45, and should be placed with minimum and maximum slumps of 4 and 6 inches, respectively. Since, water is often added to uncured concrete to increase workability, it is important that strict quality control measures be employed during placement of the foundation concrete to insure that the water to cement ratio is not altered prior to or during placement.
2. Prior to applying construction loads all exposed concrete slab-on-grade floors should be moisture cured for a minimum of 7 days following placement of the concrete. If concrete is placed during the hot summer months when the ambient air temperatures may be as low as 50 to 60 degrees Fahrenheit (F) in the early morning and in excess of 90 degrees F in the afternoon, then the contractor may need to implement special curing measures to minimize the development of shrinkage cracks. The concrete contractor is responsible for determining the appropriate curing process to be applied to the slab-on-grade floors.

Concrete Slabs In Contact With Isolated Concrete Foundations: We do not recommend that concrete slab-on-grade floors be placed in direct contact with the top surface of isolated column concrete foundations. H&K's experience is that during curing period of the concrete slab-on-grade floor a significant thermal gradient may develop between the portions of the slab placed directly on the typically more massive isolated column concrete foundations and the portions of the slab placed over the vapor-moisture retarder membrane and crushed rock layers. The development of adverse thermal gradients beneath portions of the slab may cause the development of significant orthogonal and/or circular shrinkage cracks around the isolated column foundations.

3. Steel Reinforcements: should be used to improve the load carrying capacity and to minimize cracking caused by shrinkage during curing and from both differential and repeated loadings. It should be understood that it is nearly impossible to prevent all cracks from development in concrete slabs; in other words, it should be expected that some cracking will occur in all concrete slabs no matter how well they are reinforced. Concrete slabs that will be subjected to heavy loads should be designed with steel reinforcements by a California licensed civil engineer.

If the current property owner (developer) elects to eliminate the steel reinforcements from the exterior concrete slabs-on-grade for economic reasons, then there will be an inherent greater risk assumed by the developer for the development of both shrinkage and bearing related cracks in the associated slabs.

Steel Rebar: Use No. 4 ribbed steel rebar (ASTM A615 Grade 60 billet steel), tied and placed with 12-inch centers in both directions (perpendicular) and supported on concrete "dobies" to position the rebar in the center of the slab during concrete pouring. We do not recommend that the steel reinforcements of the concrete slab-on-grade floor be tied into adjacent building perimeter or isolated column foundations. In other words, we recommend that the concrete slab-on-grade floors be constructed as independent structural members so that they can move (float) independently from the foundation structures.

4. Minimum 8-Inch-Thick Crushed Rock Layer: should be placed and compacted to a minimum of 95 percent of the ASTM D1557 dry density with a moisture content of ± 3 percentage points of the ASTM D1557 optimum moisture content. The crushed rock should be washed to produce a particle size distribution of 100 percent (by dry weight) passing the $\frac{3}{4}$ inch sieve and 5 percent passing the No. 4 sieve and 0 to 3 percent passing the No. 200 sieve. This relatively clean (washed) crushed rock will act as a capillary break for free water moisture transmission, as well as, provide a uniform bearing surface for the concrete slab-on-grade floor. However, just prior to pouring the concrete slab the crushed rock layer should be moistened to a saturated surface dry (SSD) condition. This measure will reduce the potential for water to be withdrawn from the bottom of the concrete slab while it is curing and will help minimize the development of shrinkage cracks.

If the current property owner (developer) elects to eliminate the crushed rock layer beneath the exterior concrete slabs-on-grade for economic reasons, then there will be an inherent greater risk assumed by the developer for the development of both shrinkage and bearing related cracks in the associated slabs.

5. Subgrade Soil Preparation: The subgrade soil should be prepared and compacted consistent with the recommendations of Section 8.1. The top 12 inches of the non-expansive soil should be compacted to a minimum of 90 percent of the ASTM D1557 dry density with a moisture content of from 0 to 4 percentage points greater than the ASTM D1557 optimum moisture content.
6. Crack Control Grooves: should be installed during placement or saw cuts should be made in accordance with the American Concrete Institute (ACI) and Portland Cement Association (PCA) specifications. Generally, H&K recommend that expansion joints be provided between the slab and perimeter footings, and that crack control groves or saw cuts be installed on 10-foot-centers in both directions (perpendicular).
7. Field Observations: should be made by an H&K construction monitor of all concrete slab-on-grade surfaces and installed steel reinforcements prior to pouring concrete.

9 REFERENCES

The following presents the references cited in this report:

- American Society for Testing and Materials (ASTM), Volume 04.08, "Soil and Rock; Dimension Stone; and Geosynthetics" 1992.
- Andrus and Stokoe, 2000, Liquefaction Resistance of Soils from Shear-Wave Velocity, Journal of Geotechnical and Geoenvironmental Engineering, November
- ASFE, Important Information About Your Geotechnical Engineering Report, copyright 2004.
- Blake, M.C., Harwood, D.S., Helley, J.H., Irwin, W.P., Jayko, A.S., Jones, D.L., 1999, Geologic map of the Red Bluff 30' x 60' quadrangle, California: U.S. Geological Survey Geologic Investigations Series Map I-2542, 1 sheet, scale 1:100,000, pamphlet 15 p., and database, available at <http://pubs.usgs.gov/imap/2542/>.
- Bryant, A., Martin, R., Wong, P., Maldonado, D., Wampole, J., and Dixon, D., 2002, GIS Files of Official Alquist-Priolo Earthquake Fault Zones Northern and Eastern Region, California Geological Survey, California Department of Conservation, CD 2001-06, May 31.
- Bryant, W.A. and Hart, E.H., 1994, California Geological Survey, Special Publication 42, Fault Rupture Hazard Zones in California, revised in 1997 with Supplement No.s 1 and 2 added in 1999, and Supplement No. 3 added in 2003.
- California Geological Survey (CGS) Open File Report 96-08, 1996, Probabilistic Seismic Hazard Assessment for the State of California.
- Day, H. W., 1992 *Tectonic Setting and Metamorphism of the Sierra Nevada, California*, California Department of Conservation, Divisions of Mines and Geology, Special Publication 114.
- Dixon, T.H., Miller, M., Farina, F., Wang, H., and Johnson, D., 2000, Present Day motion of the Sierra Nevada block and some tectonic implications for the Basin and Range province, North American Cordillera: Tectonics, v 19. p. 1-24.
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- Jennings, C.W., 1994, Fault Activity Map of California and Adjacent Areas with Locations and Ages of Recent Volcanic Eruptions, California Department of Conservation, Division of Mines and Geology.
- Oakeshott, G.B., 1971, California's Changing Landscapes, McGraw-Hill Company.
- Wagner, D.L., Jennings, C.W., Bedrossian, T.L., and Bortugno, E.J., 1987, Geology Map of the Sacramento Quadrangle.

Wakabayashi, J., and Sawyer, T., 2000, Neotectonics of the Sierra Nevada and the Sierra Nevada-Basin and Range Transition, California, with field trip stop descriptions for the northeastern Sierra Nevada: in Brooks, E.R., and Dida, L.T., eds., field guide to the geology and tectonics of the northern Sierra Nevada, California division of Mines and Geology Special Publication 122, p. 173-212.

Mononobe, N. and Matsuo, H., 1929, *Determination of Earth Pressures During Earthquakes*, Proceedings of the World Engineering Congress, Tokyo, Japan, Vol. 9, paper 388.

Rankine, W.J.M., 1857, *On the Stability of Loose Earth*, Philosophical Transactions of the Royal Society, London, Vol. 147.

10 LIMITATIONS

The following limitations apply to the findings, conclusions and recommendations presented in this report:

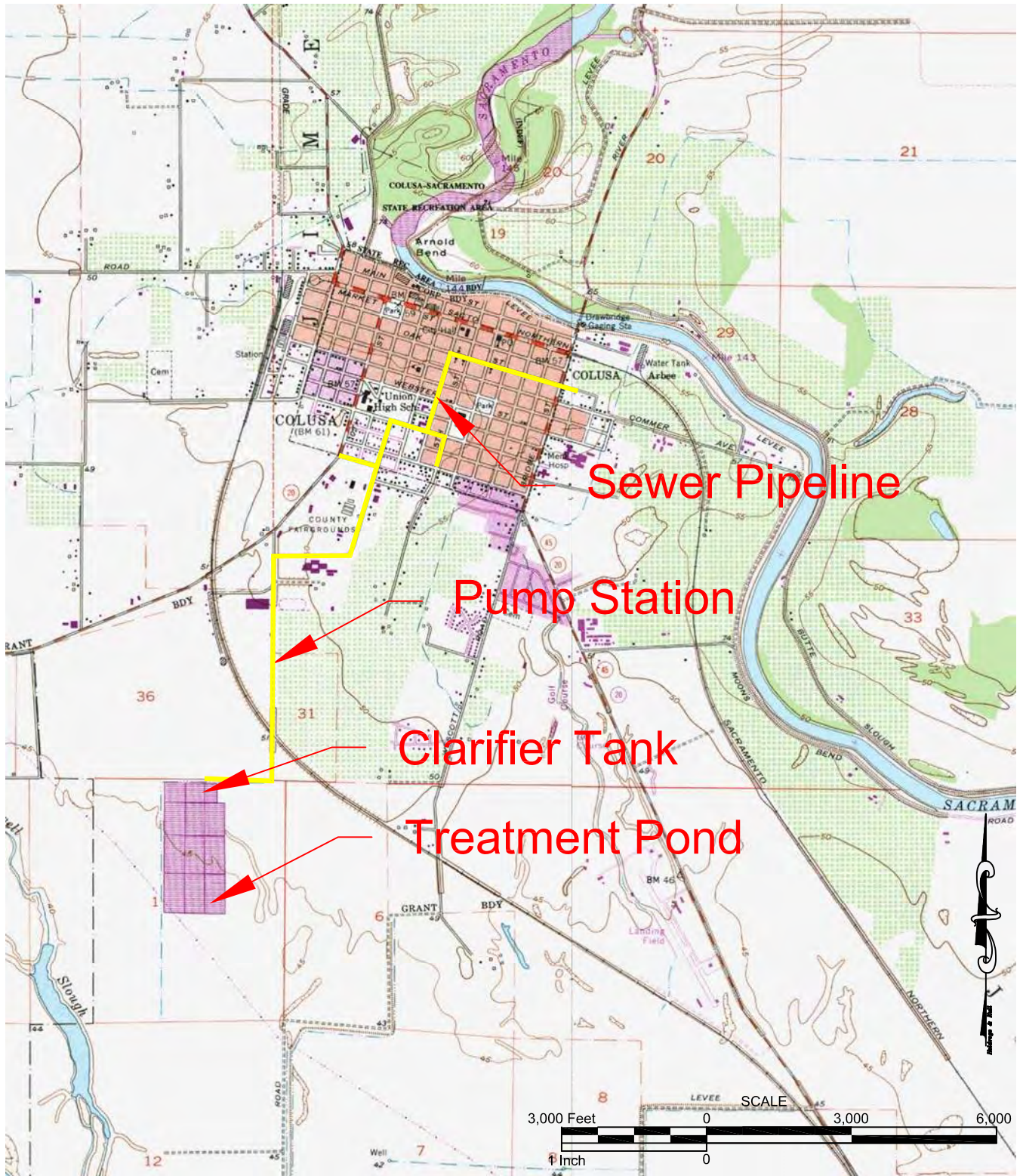
1. H&K's professional services were performed consistent with the generally accepted geotechnical engineering principles and practices employed in northern California. No warranty is either expressed or implied.
2. H&K provided engineering services for the site project consistent with the work scope and contract agreement presented in H&K's proposal and agreed to by H&K's client. The findings, conclusions and recommendations presented in this report apply to the conditions existing when H&K performed H&K's services and are intended only for H&K's client, purposes, locations, time frames, and project parameters described herein. H&K is not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to completing H&K's services. H&K does not warrant the accuracy of information supplied by others, or the use of segregated portions of this report. This report is solely for the use of H&K's client unless noted otherwise. Any reliance on this report by a third party is at the party's sole risk.
3. If changes are made to the nature or design of the project as described in this report, then the conclusions and recommendations presented in this report should be considered invalid by all parties. The validity of the conclusions and recommendations presented in this report can only be made by H&K's firm; therefore, H&K should be allowed to review all project changes and prepare written responses with regards to their impacts on H&K's conclusions and recommendations. However, additional fieldwork and laboratory testing may be required for us to develop any modifications to H&K's recommendations. The cost to review project changes and perform additional fieldwork and laboratory testing necessary to modify H&K's recommendations is beyond the scope-of-services presented in this report. Any additional work will be performed only after receipt of an approved scope-of-work, budget and written authorization to proceed.
4. The analyses, conclusions and recommendations presented in this report are based on the site conditions as they existed at the time H&K performed the surface and subsurface field investigations. H&K have assumed that the subsurface soil and groundwater conditions encountered at the location of the exploratory trenches and/or trenches are generally representative of the subsurface conditions throughout the entire project site. However, if the actual subsurface conditions encountered during construction are different than those described in this report, then H&K should be notified immediately so that we can review these differences and, if necessary, modify H&K's recommendations.
5. The elevation or depth to the groundwater table underlying the project site may differ with time and location. Therefore, the depth to the groundwater table

encountered in H&K's subsurface exploratory locations are only representative of the specific time and location where it was observed.

6. The project site map shows approximate subsurface exploratory locations as determined by pacing distances from identifiable site features; therefore, their locations should not be relied upon as being exact nor located with the accuracy of a California licensed land surveyor.
7. H&K's geotechnical investigation scope-of-services did not include an evaluation of the project site for the presence of hazardous materials. Although, H&K did not observe the presence of hazardous materials at the time of H&K's field investigation all project personnel should be careful and take the necessary precautions should hazardous materials be encountered during construction.
8. H&K's geotechnical investigation scope-of-services did not include an evaluation of the project site for the presence of mold nor for the future potential development of mold at the project site. If an evaluation of the presence of mold and/or for the future potential development of mold at the site is desired, then the property owner should contact a consulting firm specializing in these types of investigations. Holdrege & Kull does not perform mold evaluation investigations.
9. H&K's experience and that of the civil engineering profession clearly indicates that during the construction phase of a project the risks of costly design, construction and maintenance problems can be significantly reduced by retaining the design geotechnical engineering firm to review the project plans and specifications and to provide geotechnical engineering construction quality assurance (CQA) observation and testing services. Upon your request we will prepare a CQA geotechnical engineering services proposal that will present a work scope, tentative schedule and fee estimate for your consideration and authorization. If H&K is not retained to provide geotechnical engineering CQA services during the construction phase of the project, then H&K will not be responsible for geotechnical engineering CQA services provided by others nor any aspect of the project that fails to meet your or a third party's expectations in the future.

FIGURES:

- | | |
|-----------|--|
| Figure 1, | Site Location Map. |
| Figure 2, | Sewer Pipeline Boring Location Map. |
| Figure 3, | Waste Water Treatment Facility Boring Location Map |
| Figure 4, | Regional Geology Map. |
| Figure 5, | Regional Fault Seismicity Map. |



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SITE LOCATION MAP

City of Colusa
Waste Water Treatment System
Colusa, Colusa County, California

DRAWN BY: DMO

CHECKED BY: DMO

PROJ. NO.: 70508-01

DATE: 05-12-15

FIGURE NO.:

1



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Chico, California, 95928
Phone 530-894-2487, Fax 530-894-2437

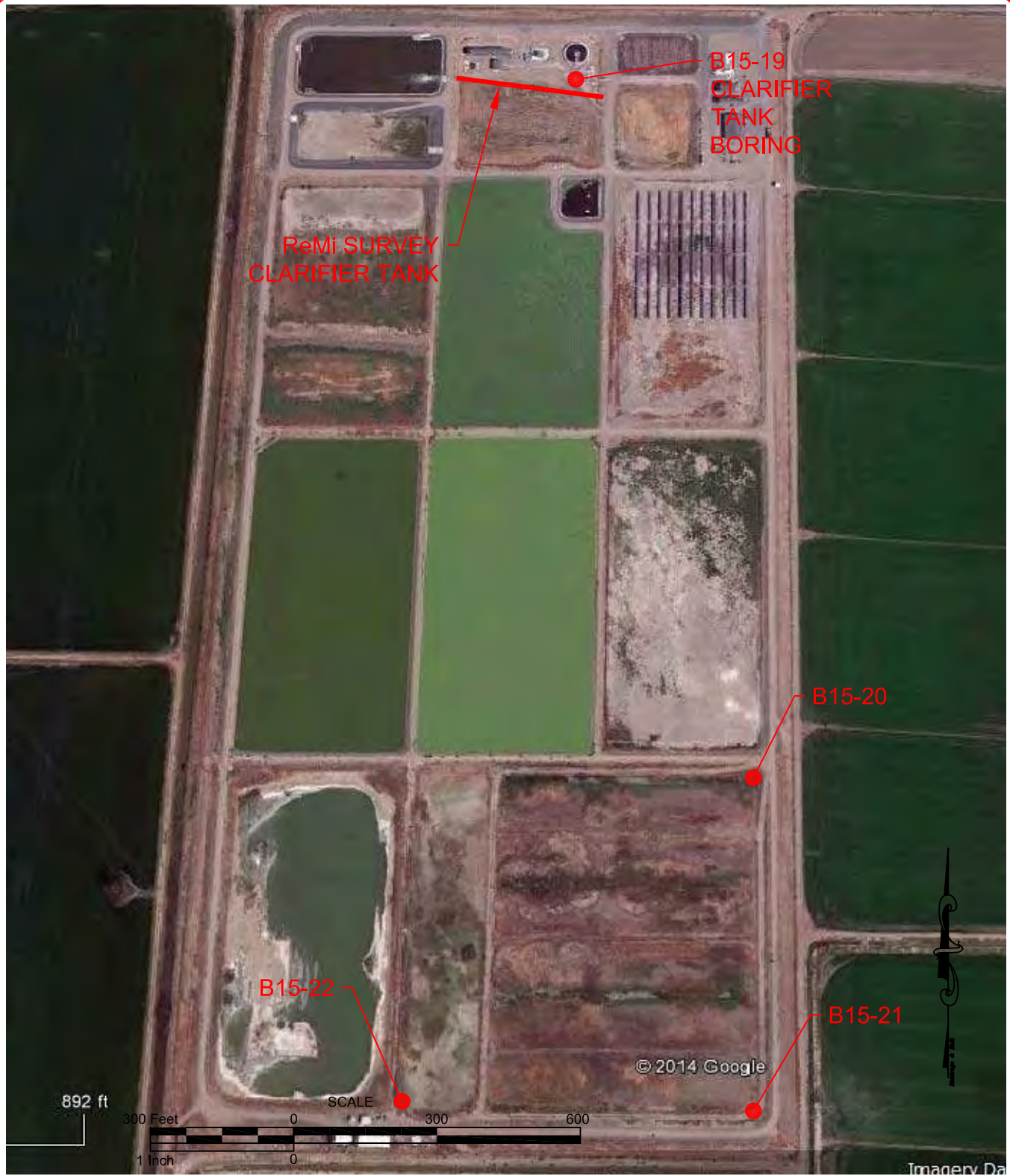
SEWER PIPELINE BORING LOCATIONS

City of Colusa
Waste Water Treatment System
Colusa, Colusa County, California

DRAWN BY: DMO
CHECKED BY: DMO
PROJ. NO.: 70508-01
DATE: 04-01-15

FIGURE NO.:

2



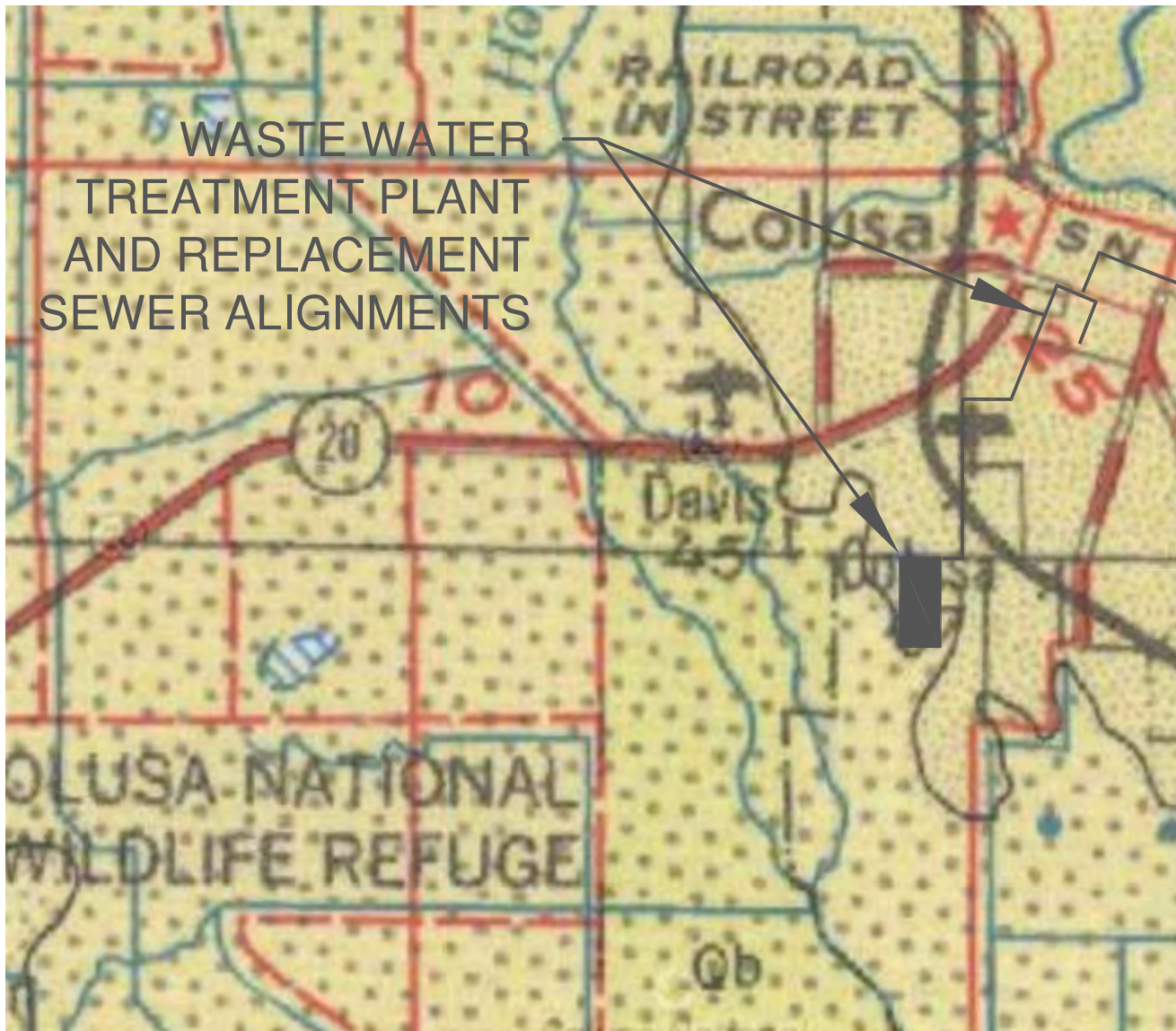
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Phone 530-894-2487, Fax 530-894-2437

SEWER PLANT BORING LOCATIONS
City of Colusa
Waste Water Treatment System
Colusa, Colusa County, California

DRAWN BY: DMO
CHECKED BY: DMO
PROJ. NO.: 70508-01
DATE: 05-12-15

FIGURE NO.:

3



PERTINENT GEOLOGIC UNITS LEGEND



Qm, Modesto Formation
(Pleistocene Alluvium: Sand,
Gravel, Clay, Silt)



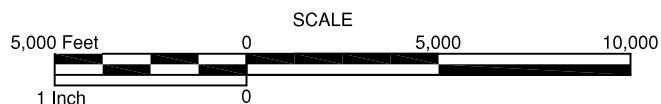
Qr, Riverbank Formation
(Pleistocene Alluvium: Sand,
Gravel, Clay and Silt)



Qa, Natural Levee and Channel
Deposits (Holocene Sand,
Gravel, Clay and Silt)



Qb, Basin Deposits
(Holocene Sand, Clay
and Silts)



Base Map: CGS Ukiah Quadrangle Geologic Map, 1960.



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GEOLOGIC MAP
City of Colusa
Waste Water System Improvements
Colusa, Colusa County, California

DRAWN BY: DMO
CHECKED BY: DMO
PROJ. NO.: 70500-01
DATE: 05-31-15

FIGURE NO.:

4



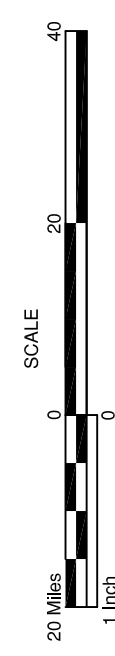
Compilation and Interpretation by:
Charles W. Jennings and William A. Bryant

Graphics by: Milind Patel, Ellen Sander, Jim Thompson, Barbara Wanish and Milton Fonseca

Explanation

- Fault traces on land are indicated by solid lines, where well located, by dashed lines where approximately located or inferred, and by dotted lines where contoured by younger rocks or by lakes or bays. If fault traces are queried where correlation or evidence is uncertain.
- FAULT CLASSIFICATION COLOR CODE**
(indicating frequency of movement)
- Fault along which historic (last 200 years) displacement has occurred
 - Holocene fault displacement (during past 11,700 years) without historic record
 - Late Quaternary fault displacement (during past 700,000 years)
 - Quaternary fault (age undifferentiated)
 - Pre-Quaternary fault (older than 1.6 million years) or fault without recognized Quaternary displacement
- ADDITIONAL FAULT SYMBOLS**
- Bar and half on downthrown side (relative or apparent)
 - Arrows along fault indicate relative or apparent direction of lateral movement
 - Arrow on fault indicating direction of dip

Base Map: CGS, Fault Activity Map of California And Adjacent Areas, Scale 1:750,000, Compiled by Charles W. Jennings, 1994 and the CGS 2010 Fault Activity Map of California (online source).



HK HOLDREGE & KULL CONSULTING ENGINEERS • GEOLOGISTS 8 Seville Court, Suite 100 Chico, California, 95928 Phone 530-894-2487, Fax 530-894-2437	CALIFORNIA FAULT ACTIVITY MAP		DRAWN BY: DMO	FIGURE NO.:
	City of Colusa		CHECKED BY: DMO	5
	Waste Water Treatment System Improvements		PROJ. NO.: 70508-01	
	Colusa, Colusa County, California		DATE: 05-31-15	

APPENDIX A:

Geotechnical Engineering Investigation Proposal for the City of Colusa Waste Water System Improvements, City of Colusa, Colusa County, California (fee and contract agreement sections excluded), 9 pages.



December 7, 2014
Proposal No. PC14.118

Mark Cocke
Nexgen Utility Management
4010 Lennane Drive
Sacramento, California, 95834
Phone: 916-564-8000, Fax: 916-564-8030
Email: mcocke@nexgenum.com

REFERENCE: ***City of Colusa Waste Water System Improvements***
City of Colusa, Colusa County, California

SUBJECT: ***Geotechnical Engineering Investigation Proposal***

Dear Name,

In accordance with your request as a representative of Nexgen Utility Management (NUM) on behalf of the City of Colusa (City), Holdrege & Kull (H&K) prepared this proposal to provide geotechnical engineering services for the City of Colusa Waste Water System Improvements at several locations within the confines of the City. With the preceding in mind H&K organized this proposal into the following sections: project description, project documents, investigation purpose, work scope, schedule, fee, assumptions, professional service agreement, and closing statement.

1 PROJECT DESCRIPTION

H&K understands that the proposed project improvements to be constructed at the site include the following:

- Sewer Pipelines: Improvements include replacing approximately 14,265 linear feet (LF) of sewer pipeline to depths ranging from 12 to 15 feet below the surface (bgs). The sewer pipeline replacements include: Will S. Green Avenue = 4,659 LF, Colusa Avenue = 1,558 LF, 8th Street = 2,012 LF, Harris Street = 424 LF, Sioc Street = 1,165 LF, 5th Street = 318 LF, 6th Street = 1,588 LF, and Parkhill Street = 2,541 LF.
- Pump Station: Improvements include constructing a new pump station to a depth of approximately 26 feet bgs located on Will S. Green Avenue.
- Clarifier Tank: Improvements include constructing a new below grade clarifier tank with a 55 foot diameter to a depth of approximately 22 feet bgs.

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- 20 Acre Treated Water Storage Pond: Improvements include grading to increase the perimeter berm heights to enclose approximately 34,000,000 gallons to, and install erosion protection on the interior slopes.

2 PROJECT DOCUMENTS

H&K was not provided with any project documents for the purpose of preparing this proposal.

- City of Colusa Sewer System Plans, dated August 13, 2010.
- City of Colusa Project Report Screens Pump Station and Collection System Improvements, SRF Funding Application Attachment T1, prepared by Nexgen Utility Management, dated August 2014.
- Geotechnical Investigation Report Proposed Colusa Wastewater Treatment Plant Upgrades, Colusa, California, prepared by Kleinfelder & Associates, dated April 5, 2006.

3 INVESTIGATION PURPOSE

The purpose of this site investigation is to identify the subsurface soil, rock and ground water information at the proposed site improvement locations and to develop geotechnical engineering design recommendations for use in designing and constructing the proposed improvements.

4 WORK SCOPE

H&K will perform a geotechnical engineering site investigation to characterize the soil, rock and ground water conditions encountered at the surface and beneath the site to the maximum depth excavated. Based on H&K's knowledge of the soil and rock conditions and experience from geotechnical and engineering geology investigations performed in the general vicinity of the project site, H&K, proposes to perform the following tasks as basic services with no other additional services included: Task 1 Geotechnical Site Investigation, Task 2 Storage Pond Permeability Investigation, Task 3 Analyses, Design and Review Contract Documents, and Task 4 Report Preparation.

Our work scope is intended for purely engineering purposes and does not address the following issues: mold, fungi, hazardous waste, radon gas, and asbestos. Prior to conducting our site investigation, H&K will need the AutoCAD files that show the conceptual development plans of the proposed structural improvement areas (if available). With the preceding in mind, H&K prepared the following work scope task descriptions for the proposed site improvements:

TASK 1 GEOTECHNICAL SITE INVESTIGATION

H&K will use the state-of-the-practice geotechnical engineering methods to perform the site investigation. The geotechnical engineering site investigation will include Subtask 1.1 Surface Reconnaissance Investigation, Subtask 1.2 Subsurface Investigation, and Subtask 1.3 Laboratory Testing Investigation as described below.

Subtask 1.1 Surface Reconnaissance

H&K will perform a surface reconnaissance of the project site to identify surface conditions that may impact the proposed site development plans. In general, we will observe and describe surface exposures of the following existing site conditions: Site and surrounding land uses, surface soil conditions existing site improvements including earthwork grading and structures, site topography and drainage, and vegetation.

Subtask 1.2 Subsurface Investigation

H&K will perform a subsurface investigation to obtain an understanding of the soil, rock and ground water conditions underlying the project site to the maximum depth excavated. Our subsurface investigation will include the following:

Underground Services Alert Notification: Prior to performing the subsurface investigation, H&K will mark all of our proposed subsurface exploration locations with white paint and will notify Underground Services Alert (USA) as required by California state law. USA will inspect each proposed subsurface exploratory location to determine if any underground utilities are present at these locations. If USA identifies the presence of underground utilities at any of the proposed exploratory locations then H&K will move the excavation location to an area that is clear of underground utilities. USA requires a minimum of 48 hours advanced notification prior to excavating.

Exploration Borings: H&K will perform geotechnical engineering oversight for excavation of a maximum of 25 exploratory borings at the approximate locations shown on Figures 1 and 2 to the anticipated depths described below.

- Sewer Pipeline: 18 exploratory boring all to an anticipated maximum depth of 20 feet bgs.
- Clarifier Tank: 1 exploratory boring to an anticipated maximum depth of 50 feet bgs.
- Pump Lift Station: 1 exploratory boring to an anticipated depth of 50 feet bgs.
- Storage Pond: 5 exploratory borings all to an anticipated depth of 20 feet bgs.



Figure 1, Sewer Pipeline Alignment And Pump Station Boring Locations

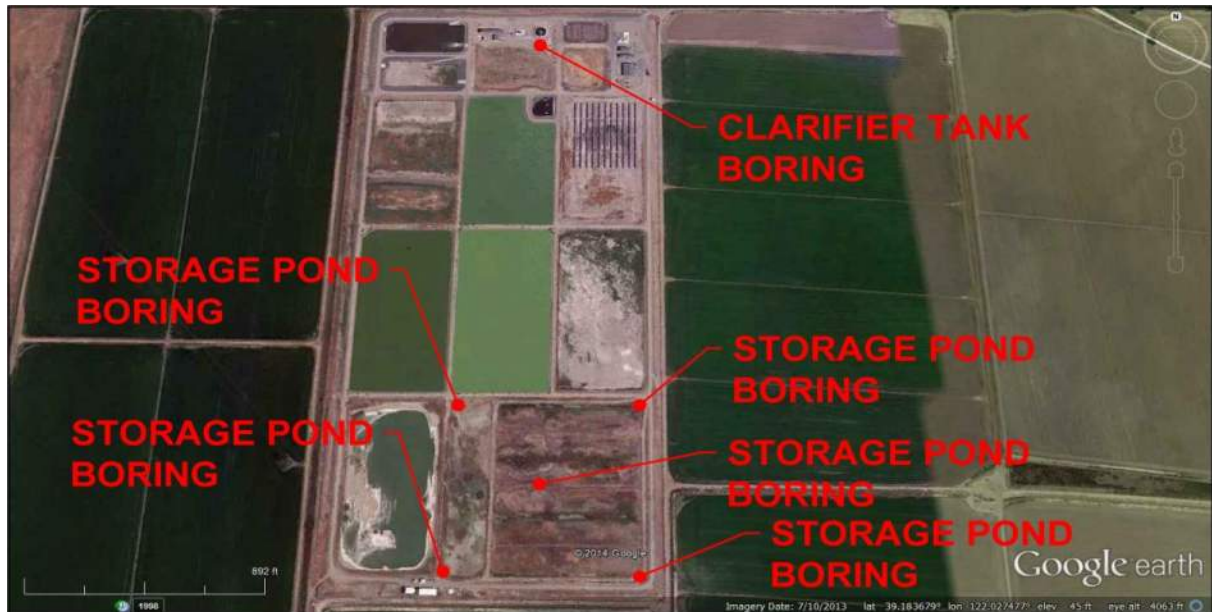


Figure 2, Clarifier Tank And Storage Pond Boring Locations

H&K will subcontract to a drilling contractor to provide a truck mounted drill rig and operator. H&K will prepare logs of the soil, rock and ground water conditions encountered at each subsurface exploratory location. The soil materials will be described consistent with the American Society for Testing and Materials (ASTM) D2487 Unified Soils Classification System (USCS) guideline procedures and D2487 USCS Visual Manual guideline procedures. The rock materials will be described consistent with the American Geophysical Union (AGU) guideline procedures.

An H&K geologist or engineer will take both relatively undisturbed and disturbed representative soil and/or rock samples from the exploratory excavations. When possible relatively undisturbed soil samples will be taken with a 2.5-inch-diameter (inside diameter) split-barrel sampler equipped with brass liner tubes. Generally, relatively undisturbed soil samples will be taken at the following depth intervals below the existing ground surface: 1 foot, 2 feet and then at 5-foot intervals for the remainder of the exploratory excavation depth. The brass liner tube samples will be sealed with plastic caps and labeled. H&K will also take disturbed bulk sample from the drill cutting returns from each exploratory location and place them in separate sealed and labeled containers. Additional material samples may be taken and/or the sample intervals may be changed depending upon the soil and/or rock conditions encountered. The soil and/or rock samples will be transported to our laboratory facility where selected samples will be tested to determine their engineering material properties. If the ground water table is encountered, then H&K will measure its depth below the existing ground surface prior to backfilling each exploratory borings. H&K will only be able to provide measurements of the depth to groundwater table at the time of our site investigation.

Each exploratory boring will be backfilled with a Portland cement-bentonite grout mixture to within 1 foot of the surface and then completed with asphalt concrete to the surface. The approximate location of the exploratory will be shown on the site plan map.

Dynamic Cone Penetrometer Testing: H&K will perform a maximum of five dynamic cone penetrometer tests (DCPT) at the storage pond site. The DCPT is performed by driving a cone that is mounted on the end of a steel rod into the ground with a 35-pound slide hammer with a 15-inch free fall. The steel cone has 1.38-inch diameter with a 60-degree angle pointed driving face. The steel rods have a 1-inch diameter and are 1-meter long and are scribed every 10 centimeters. The DCPT is performed by recording the number of hammer blows per every 10-centimeters of penetration (blow count). This continuous record of the penetration resistance with depth is then evaluated to determine estimates of the engineering properties of the penetrated soil.

Soil Classification Using ReMi™ Seismic Survey: H&K will perform one seismic survey at the clarifier tank site and one seismic survey at the pump station site to

develop an in-situ shear-wave velocity profile of the upper 30 meters (100 feet) of soil and/or rock materials that underlie the property using SeisOpt® ReMi™ Vs30 Method for shear-wave profiling. The shear wave velocity data will be used to determine a Site Class and seismic design parameters in accordance with Chapter 16 of the 2013 CBC and for evaluating the liquefaction potential of the subsurface soil. Each seismic survey line will include 12 geophones on approximate 8-meter spacing, for a total seismic line length of 88 meters. A microprocessor control signal enhancement seismograph will be used to record ambient seismic noise, or micro-tremors, which are constantly being generated by cultural and natural noise. Additional ambient noise will be initiated from vehicles and during exploratory excavations on site.

Subtask 1.3 Laboratory Testing Investigation

H&K will perform laboratory tests on selected soil samples to determine their geotechnical engineering material properties for earthwork and structural improvements. All soil samples will be stored until construction of the project is completed. All laboratory tests will be performed consistent with the guideline procedures of the American Society for Testing and Materials (ASTM) and Caltrans Test Methods (CTM). The laboratory soil characterization tests may include the following:

- D422, Particle Size Gradation (Sieve Only).
- D2166, Unconfined Compression Shear Strength.
- D2435, Consolidation Test
- D2487, Unified Soil Classification System.
- D2488, Soil Description Visual Manual Method.
- D2850, Unconsolidated, Undrained (UU) Triaxial Shear Strength.
- D2937, Density-Moisture By Drive Tube Method
- D4318, Atterberg Plasticity Indices.
- D4767, Falling Head Permeability.
- G51, Soil pH.
- G57, Electrical Resistivity.
- CTM 417, Sulfates.
- CTM 422, Chlorides.

TASK 2 OPTIONAL STORAGE POND PERMEABILITY INVESTIGATION

This task may be considered to be optional, depending upon the need to know the in place permeability of the soil for containment design purposes. H&K will perform a

maximum of 10 in place permeability tests on the bottom area of the treated waste water storage pond. The in place permeability will be measured using the ASTM D6391 two-stage borehole infiltrometer (TSBI). H&K will perform the following TSBI testing services:

- Transport all materials and testing equipment associated with the TSBI to the site from our Chico, California office.
- Install TSBI testing equipment into the surface of the storage pond bottom area.
- Provide data collection and equipment servicing for the duration of testing.
- Remove all TSBI testing equipment and transport back to the Chico H&K office.
- Stages 1 and 2 of the TSBI test both generally run for continuous periods of from 5 to 7 days for a total continuous period of from 10 to 14 days.
- Analyze the TSBI test data for each measurement period (usually daily).
- Compute the in situ permeability of the tested soil from the TSBI test field data.

TASK 3 ANALYSES, DESIGN AND REVIEW CONTRACT DOCUMENTS

H&K will use the state-of-the-practice geotechnical engineering analyses and design methods to evaluate the permeability of the water storage ponds, stability of the proposed water storage pond slopes, evaluate the potential for soil liquefaction and resulting settlement at the clarifier tank and pump station locations, provide earth work and foundation design recommendations for the clarifier tank and pump station structures, evaluate dewatering, excavating and backfilling of the proposed sewer pipeline trenches, and perform a review of the contract documents for compliance with the geotechnical report design recommendation. Each subtask is described below.

Subtask 3.1 Water Storage Pond Slope Stability Analyses

H&K understands that the existing water storage pond earth berms will need to be raised in order to achieve the desired storage capacity. H&K will perform slope stability analyses of the proposed slopes for the purposes of determining a stable configuration when subject to both static and seismic (earthquake) loading conditions. H&K anticipates that the maximum vertical heights of the berms will be approximately 15 feet and the slopes may range from 3H:1V to 2H to 1V (horizontal to vertical slope ratio). H&K will perform the both the static and seismic slope stability analyses using limit equilibrium analyses methods. The seismic slope stability analyses will be performed consistent with the California Geological Survey (CGS) Special Publication (SP) 117A *"Guidelines for Evaluating and Mitigating Seismic Hazards in California,"* Revised September 11, 2008, and the California Division of Mines and Geology (DMG) *"Recommended Procedures for Implementation of DMG*

Special Publication 117, Guidelines for Analyzing and Mitigating Landslide Hazards in California.", June 2002 and the 2013 California Building Code (2013 CBC).

Subtask 3.2 Clarifier Tank And Pump Station Liquefaction And Settlements Analyses

H&K will perform seismic liquefaction analyses of the soils underlying the new clarifier tank and the pump station sites for the purpose of estimating liquefaction induced settlements at each site. The seismic soil liquefaction and associated settlement analyses will be performed consistent with the procedures presented in the American Society of Civil Engineers (ASCE) and Structural Engineering Institute (SEI) publication ASCE/SEI 7-10, *"Minimum Design Loads for Buildings and Other Structures,"* and the requirements of the 2013 CBC.

Subtask 3.3 Clarifier Tank And Pump Station Foundation Designs

H&K will perform bearing capacity and consolidation analyses of the soil underlying the new clarifier tank and pump stations for the purpose of developing geotechnical engineering recommendations for earthwork grading, construction dewatering, and design of the foundation and retaining wall to be constructed at each site. The earthwork and structural improvements will be developed consistent with the requirements of the 2013 CBC. H&K will perform limited soil corrosion potential analyses and recommendations.

Subtask 3.4 Sewer Pipeline Trench Dewatering, Excavating And Backfilling Analyses

H&K will perform analyses of the soil underlying the replacement sewer pipeline alignment for the purpose of developing geotechnical engineering recommendations for construction dewatering, trench backfills, and pipeline design. The geotechnical engineering recommendations will be developed consistent with the requirements of the 2013 CBC. H&K will perform limited soil corrosion potential analyses and recommendations.

Subtask 3.5 Review Contract Documents

H&K will review the contract documents consisting of the construction plans and specifications for compliance with the earthwork and structural recommendations presented the final geotechnical engineering investigation report.

TASK 4 REPORT PREPARATION

H&K will prepare a geotechnical engineering report that will present our findings, conclusions and recommendations. The geotechnical engineering investigation report will meet or exceed the requirements of the 2013 California Building Code and the accepted geotechnical engineering principals and practices performed in northern

California. This report will include descriptions of the site conditions, field investigation, laboratory testing, and geotechnical engineering design recommendations for the proposed earthwork and structural improvements. The report will also include a site plan showing proposed improvements, and the approximate subsurface exploratory boring locations. The report appendices will present the subsurface exploratory logs, laboratory test data, and seismicity data.

H&K will deliver four bound copy by US mail and one portable document formatted (PDF) electronic file copy by email of the final report to the addressee.

5 SCHEDULE

H&K's proposed work schedule is based on our present and expected workload. Presently, H&K is prepared to commence the site investigation field work within 10 working days after receipt of a signed contract and retainer fee. H&K anticipates that the geotechnical engineering investigation report will be completed within 55 working days from the commencement of the site investigation field work. Our proposed schedule uses normal 8 hours per day workdays from Monday through Friday, excluding holidays. Table 5.1 summarizes our anticipated work schedule.

Table 5.1 Anticipated Schedule		
Task No.	Description	Anticipated Schedule (working days)
1	Geotechnical Site Investigation	20
2	Optional Storage Pond Permeability Investigation	15
3	Analyses, Design, And Contract Document Review	15
4	Report Preparation	5
TOTAL		55

The time required to complete our geotechnical investigation fieldwork may be increased as a result of encountering unforeseen subsurface conditions, adverse weather conditions, property access problems, and scheduling of exploratory equipment.

6 FEE

H&K will perform the work scope presented in the preceding consistent with our 2014 Fee Schedule or fee schedule applicable at the time the work is performed. H&K's 2014 Fee Schedule is included as Attachment No. 1. H&K prepared two lump sum fee estimates. Fee Estimate A includes Optional Task 2 and Fee Estimate B excludes Optional Task 2. Optional Task 2 is the Storage Pond In Place Soil Permeability Testing. The costs to perform the work scope described in this proposal are summarized in Table 6.1 and are itemized in Attachment 2 (Project Cost Summary).

Invoices for this project will be generated on a monthly basis with the terms of payment being net 30 days after the date of each invoice. H&K will stop work on the project if more than 30 calendar days have elapsed from the date of any invoice without having received full payment for the invoice. Full payment is due upon completion of the proposed work scope and issuance of our report. This cost quotation for the work scope described in this proposal is valid for a period of 60 days following the date of this proposal. H&K reserves the right to move funds between tasks provided that we do not exceed the total fee estimate for the project. We will make every reasonable effort to keep our costs to a minimum.

Table 6.1 Cost Estimate Summary			
Task No.	Description	Cost Estimate A	Cost Estimate B
1	Geotechnical Site Investigation	\$XXXX	\$XXXX
2	Optional Storage Pond Permeability Investigation	\$XXXX	\$XXXX
3	Analyses, Design, And Contract Document Review	\$XXXX	\$XXXX
4	Report Preparation	\$XXXX	\$XXXX
TOTAL		\$XXXX	\$XXXX

This fee estimate may require modification if unusual or unexpected site conditions are encountered which significantly change the work scope and increase the associated costs, if the client requests an expansion of the work scope, or if the County and/or City require the purchase of other unforeseen permits. H&K will not perform any additional work until we receive a written authorization to proceed and an approved budget augmentation.

7 ASSUMPTIONS

H&K made the following assumptions during preparation of this proposal:

- All site visits will originate and conclude from the H&K Chico office.
- H&K anticipates that the geotechnical engineering investigation report will be completed within 55 working days from the commencement of the site investigation field work.
- Our proposed schedule uses normal 8 hours per day workdays from Monday through Friday, excluding holidays.
- The City of Colusa and Colusa County encroachment permits for the purpose of drilling the exploratory boring in the streets or drilling permits for drilling the exploratory borings will be a maximum total of \$800.
- The maximum depths of the replacement sewer pipeline will be 13 to 15 feet bgs.
- The existing storage pond earth berms will be regraded to achieve a maximum vertical height of 15 feet with maximum 3H:1V to 2H:1V slope gradients.

- A total of 25 exploratory borings will be drilled for the site investigations as follows: eighteen 20 foot borings along the sewer replacement pipeline alignment, one 50 foot deep boring at the new clarifier tank, one 50 foot deep boring at the pump station, and five 20 foot deep borings at the storage pond.

8 PROFESSIONAL SERVICES AGREEMENT FORM

Please sign the first page of the professional services agreement form (PSAF) included as Attachment 3 to indicate your acceptance of this proposed work scope, schedule, and lump sum fixed fee. Your signature indicates that you accept the terms and conditions of this professional services agreement and is a written authorization for us to proceed with the work scope presented in this proposal. Please sign PSAF contract and mail, fax or scan and email to:

Office Fax: 530-894-2437
Office Address: 8 Seville Court, Suite 100, Chico, Ca., 95928
Email Address: dolsen@handk.net

Upon receipt of the signed PSAF and retainer fee we will mail you a counter signed copy of the PSAF for your records.

9 CLOSING STATEMENT

Please call me at 530-894-2487 if you have any questions or need additional information. Thank you for selecting Holdrege & Kull to prepare a proposal to provide geotechnical engineering services for this important project.

Sincerely,

Holdrege & Kull



Donald M. Olsen, R.C.E. 49514
Principal

Copies:
1 PDF Copy to: Addressee

Attachments:
Attachment 1, H&K 2014 Fee Schedule, 2 pages.
Attachment 2, H&K Itemized Cost Estimate, 2 pages.
Attachment 3, H&K Professional Services Agreement, 7 pages.

APPENDIX B:

Important Information About Your Geotechnical Engineering Investigation Report (Presented with permission of ASFE, Copyright 2004), 2 pages.

Important Information About Your Geotechnical Engineering Report

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

The following information is provided to help you manage your risks.

Geotechnical 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 civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you — should apply the report for any purpose or project except the one originally contemplated.*

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- 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,

- elevation, configuration, location, orientation, or weight of the proposed structure,
- 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. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that

have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of 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 equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely on Your ASFE-Member Geotechnical Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.



8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

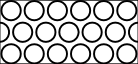
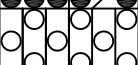
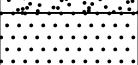
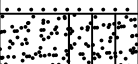
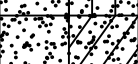
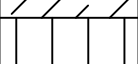
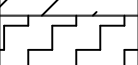
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APPENDIX C:

Exploratory Boring Logs, 47 pages.

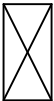
ASTM D2487 AND D2488

UNIFIED SOILS CLASSIFICATION SYSTEM

MAJOR CATEGORY	SUB CATEGORY	MINOR CATEGORY	GRAPHIC LOG	SYMBOL	SOIL TYPE DESCRIPTIONS
COARSE GRAINED SOIL >=50% Particle Size Larger Than 200 Mesh Sieve Size	GRAVELS >=50% Coarse Particle Size Larger Than 4 Mesh Sieve Size	GRAVELS With $\leq 5\%$ Silt And Clay Size Particles		GW	WELL-GRADED GRAVEL
				GP	POORLY-GRADED GRAVEL
		GRAVELS With $> 5\%$ To $< 12\%$ Silt And Clay Size Particles		GW-GM	WELL GRADED TO SILTY GRAVEL MIXTURES
				GW-GC	WELL GRADED TO CLAYEY GRAVEL MIXTURES
				GP-GM	POORLY GRADED TO SILTY GRAVEL MIXTURES
				GP-GC	POORLY GRADED TO CLAYEY GRAVEL MIXTURES
	SANDS >=50% Coarse Particle Size Smaller Than 4 Mesh Sieve Size	GRAVELS With $\geq 12\%$ Silt And Clay Size Particles		GM	SILTY GRAVEL
				GC	CLAYEY GRAVEL
		SANDS With $\leq 5\%$ Silt And Clay Size Particles		SW	WELL-GRADED SAND
				SP	POORLY-GRADED SAND
		SANDS With $> 5\%$ To $< 12\%$ Silt And Clay Size Particles		SW-SM	WELL GRADED TO SILTY SAND MIXTURES
				SW-SC	WELL GRADED TO CLAYEY SAND MIXTURES
				SP-SM	POORLY GRADED TO SILTY SAND MIXTURES
				SP-SC	POORLY GRADED TO CLAYEY SAND MIXTURES
		SANDS With $\geq 12\%$ Silt And Clay Size Particles		SM	SILTY SAND
				SC	CLAYEY SAND
FINE GRAINED SOIL >=50% Particle Size Smaller Than 200 Mesh Sieve Size	IDENTIFICATION FEATURES FOR SAMPLE PORTION SMALLER THAN A NO. 40 MESH SIEVE				
	DRY STRENGTH	DILATANCY	TOUGHNESS	GRAPHIC	SYMBOL
	None To Slight	Quick To Slow	None		ML
	Medium To High	None To Very Slow	Medium		CL
	Slight To Medium	Slow	Slight		OL
	Slight To Medium	None To Slow	Slight To Medium		MH
	High To Very High	None	High		CH
	Medium To High	None To Very Slow	Slight To Medium		OH
HIGHLY ORGANIC SOILS	Identified by: Spongy, Fibrous Texture, Organic Odor, Etc.			Pt	PEAT

EXPLORATORY LOG LEGEND

SAMPLER TYPES AND LABELING

SAMPLER SYMBOLS		LINER NUMBERING	LINER CAP AND BULK TAG SAMPLE LABELING
	BULK BAG SAMPLE		STANDARD PENETRATION TEST (SPT) SAMPLER
	MODIFIED CALIFORNIA SAMPLER (2.5 INCH INSIDE DIAMETER [ID])		SHELBY TUBE SAMPLE
	CALIFORNIA SAMPLER (2.0 INCH INSIDE DIAMETER [ID])		ROCK CORE SAMPLE
		Liner Drive Top L1-3-3 L1-2-3 L1-1-3 Liner Drive Bottom	PROJECT NO. BORING OR TRENCH NO. SAMPLE NO. SAMPLE DEPTH (START OF DRIVE) DATE SAMPLED

GROUNDWATER

SAMPLE NUMBERING

	FIRST ENCOUNTERED WATER LEVEL	LINER TUBES: L1-1-2	PLASTIC BAGGIES: B1-1-2	LARGE BULK SACKS: Bk1-1-2
	STABILIZED WATER LEVEL AT COMPLETION	SHELBY TUBES: S1	ROCK CORES: RC1	ASPHALT CONCRETE CORES: AC1-1-2

RELATIVE DESCRIPTIONS

MATERIAL DESCRIPTION	U.S. SIEVE MESH SIZE	RELATIVE SIZE	RELATIVE MOISTURE CONTENT DESCRIPTIONS Dry, Damp, Moist, Wet, Saturated				
Clay & Silt Fines	< #200	Smaller than Flour	RELATIVE DENSITY (Cohesionless Soils)		RELATIVE CONSISTENCY (Cohesive Soils)		
Fine Sand	#200 to < #40	Flour to Sugar	DESCRIPTION	SPT N60 BLOWS/FOOT	DESCRIPTION	SPT N60 BLOWS/FOOT	TSF
Medium Sand	#40 to < #10	Sugar to Rocksalt					
Coarse Sand	#10 to < #4	Rocksalt to Pea	Very Loose	0 to 4	Very Soft	0 to 2	0 to 0.25
Fine Gravel	#4 to < 3/4 Inch	Pea to Walnut	Loose	5 to 10	Soft	3 to 4	>0.25 to 0.50
Coarse Gravel	3/4 Inch to < 3 Inch	Walnut to Orange	Medium Dense	11 to 30	Firm	5 to 8	>0.50 to 1.0
Cobbles	3 Inch to < 12 Inch	Orange to Basketball	Dense	31 to 50	Stiff	9 to 16	>1.0 to 2.0
Boulders	=> 12 Inches	Greater than Basketball	Very Dense	> 50	Very Stiff	17 to 32	>2.0 to 4.0
					Hard	> 32	>4.0

GENERAL NOTES

- INFORMATION PRESENTED:** No warranty is expressed or implied by Holdrege & Kull as to the continuity of the soil, rock and groundwater conditions described on the exploratory logs which represent the general subsurface soil, rock and groundwater conditions at the locations and depths on the date indicated on the exploratory logs. Holdrege & Kull uses experience and judgement to extrapolate the observed conditions at the finite number of subsurface exploratory locations to other locations that are situated between and beyond.
- CONTACTS:** Lines separating strata on the exploratory logs represent approximate boundaries which actually may be abrupt or gradual (transitional). Solid lines indicate an observed boundary and dashed lines indicate an estimated boundary location that was determined by drill rig behavior or other information. However, if the boundary is not observed in a retrieved sample and no other information is available, then the boundary will be shown on the exploratory log as equidistant between the nearest samples retrieved above and below the material change.
- SOIL CLASSIFICATIONS:** The soil descriptions presented on the exploratory logs are consistent with ASTM D2487 (Unified Soils Classification System). The field estimated particle size percentages shown on the logs preceded by "Fld.Est.:" are based on visual estimates, to the nearest 5% interval, of the dry weights of each particle size described. If laboratory test data is available for a soil sample, then the actual lab test particle size percentages are presented on the exploratory log preceded by "LAB DATA:."
- SOIL DESCRIPTION ORDER:** USCS Symbol, Name (one adjective, one noun), Field Estimated Particle Size Gradation Percents; Munsell Color Name (name number); Density (cohesionless soil) or Consistency (cohesive soil); Relative Moisture Content; Other significant features (e.g., fill soil, concrete, asphalt concrete, odor, organics, cementation, structure, texture, refuse, etc.)
 EXAMPLE: (GC) CLAYEY GRAVEL, Fld. Est.: 20% Low Plastic Fines, 10% Fine Sand, 15% Medium Sand, 50% Fine Gravel, and 5% Coarse Gravel; Yellowish Brown (10YR, 5/8); Dense; Damp to Moist; Slight CaCO₃ Cementation.
- ROCK CLASSIFICATIONS:** The rock classifications and descriptions presented on the exploratory logs were determined by the methods published by the American Geophysical Union and American Geological Institute.
- ROCK DESCRIPTION ORDER:** Unit Name (i.e., Formation and/or Member); Rock Type (i.e., igneous, metamorphic, sedimentary); Lithology (i.e., minerals, crystal size, particle size, cementation, fabric, fossils, etc.); Munsell Color Name (name number); Bedding/Foliation; Weathering; Hardness; Fracture/Joint Spacing; Fracture/Joint Roughness; Moisture Content; Rock Quality Designation (RQD); Other significant features.
 EXAMPLE: TUSCAN Formation; Volcanic Lahars; Tuff Breccia w/ fine to coarse crystals; Grayish Brown (10YR 5/2); Very Thick Foliation; Slightly Weathered; Very Hard; Very Wide Fracture/Joint Spacing; Moderate Fracture/Joint Roughness; Moist; Good RQD.
- ABBREVIATIONS:** LP = Low Plasticity, HP = High Plasticity, F = Fine, M = Medium, C = Coarse, Fines = Clay + Silt, Sd = Sand, Gr = Gravel, Cb = Cobbles, Bd = Boulders, HSA = Hollow Stem Augers, SSA = Solid Stem Augers, MR = Mud Rotary, AP = Air Percussion, DCB = Diamond Core Barrel, SPT = Standard Penetration Test Sampler, 2.0-S = 2.0 Inch ID Split Spoon Sampler, 2.5-S = 2.5 Inch ID Split Spoon Sampler, S = Shelby Tube, RC = Rock Core, GWT = Groundwater Table, AMSL = Above Mean Sea Level; AB Rock = Aggregate Base Rock, AC = Asphalt Concrete, BGS = Below Ground Surface, Ft. = Feet. and In. = Inch, TSF = Tons/Square Foot, and Fm. = Geologic Formation.

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-1
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-09-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-09-15

Sheet: 1 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Temporary Monitoring Well Construction.

										Ground Water Information									
24 Hour Clock Time (HH:MM)		Pocket Penetrometer (TSF)		Uncorrected Blow Counts (Blows / 6-inch)		Drilling Method and/or Sampler Type		Sample Recovery (Ft./Ft.)		Sample No.		Depth B.G.S. (Ft.)		Sample Interval And Symbol		Well Construction Details		Graphic Log	
Date		03-09-15		03-31-15															
Time (24 Hour)		08:35		10:00															
Depth (Ft.)		18.0		16.85															
Soil And/Or Rock Material Descriptions																			
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuser; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; ROD; Moisture.																			
(AC) ASPHALT CONCRETE, 4 INCHES.																			
(AB) AGGREGATE BASE ROCK, 6 INCHES.																			
(ML) SANDY SILT; FLD. EST.: 80% LOW PLASTIC CLAY AND SILT, 20% FINE SAND; YELLOWISH BROWN (10YR, 5/4); FIRM; MOIST.																			

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-1

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-09-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL):

NA

Date Finish: 03-09-15

Sheet: 2 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 Lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Temporary Monitoring Well Construction

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-Inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
										Date				
										Time (24 Hour)				
										Depth (Ft.)				
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuser; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture														
08:23		5	2.5SS	1.3/1.5		20				(ML) SANDY SILT CONTINUED; LAB TESTS: D422 = 79.7% CLAY AND SILT, 19.9% FINE SAND, 0.4% MEDIUM, SAND., D2166 = 382 PSF.				
		6	↓		L3-2-2	21								
		11	↓		L3-1-2 B5-1-1	22								
						23								
						24								
						25								
						26								
						27								
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						29								
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						33								
						34								
						35								
						36								
						37								
						38								
						39								
						40								

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-2
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-12-15

Sheet: 1 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information												
24 Hour Clock Time (HH:MM)		Pocket Penetrometer (TSF)		Uncorrected Blow Counts (Blows / 6-inch) Drilling Method and/or Sampler Type		Sample Recovery (Ft./Ft.)		Sample No.		Depth B.G.S. (Ft.)		Sample Interval And Symbol		Well Construction Details (NA)		Graphic Log		Soil And/Or Rock Material Descriptions				
Date		03-12-15																SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.				
Time (24 Hour)		14:16																				
Depth (Ft.)		NONE																				
13:48				HSA							0							(AC) ASPHALT CONCRETE, 3 INCHES.				
											1							(AB) AGGREGATE BASE ROCK, 4 INCHES.				
											2							(SM) SILTY SAND; FLD. EST.: 45% LOW PLASTIC CLAY AND SILT, 55% FINE SAND; BROWN (10YR, 4/3); MEDIUM DENSE; MOIST.				
											3											
											4											
											5							@5': LAB TESTS: D422 = 49.8% LOW P;ASTIC CLAY AND SILT, 49.9% FINE SAND, 0.3% MEDIUM SAND; BROWN (10YR, 4/3); MEDIUM DENSE; MOIST.				
13:58		4	2.5SS	1.4/1.5							6											
		5									7											
		6									8											
			HSA								9											
											10							@10': YELLOWISH BROWN (10YR, 4/4); LOOSE.				
13:55		2	SPT	1.4/1.5	B2-1-1						11											
		5									12											
		5									13											
			HSA								14											
											15							(CL) CLAY: FLD. EST.: 85% LOW PLASTIC CLAY AND SILT,155% FINE SAND; DARK BROWN (10YR, 4/3); VERY STIFF; MOIST.				
14:07	2.75	5	2.5SS	1.3/1.5							16							@15': LAB TESTS: D2166 = 2554 PSF.				
		12			L2-2-2						17											
		18			L2-1-2						18											
			HSA		B3-1-1						19											
											20											

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-2
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-12-15

Sheet: 2 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
										Date				
										Time (24 Hour)				
										Depth (Ft.)				
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														
14:15		3	SPT	1.5/1.5	B4-1-1	20				(CL) CLAY CONTINUED; STIFF.				
		4	↓			21								
		5												
						22								
						23								
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						38								
						39								
						40								

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-3
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-12-15

Sheet: 1 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information							
24 Hour Clock Time (HH:MM)		Pocket Penetrometer (TSF)		Uncorrected Blow Counts (Blows / 6-Inch) Drilling Method and/or Sampler Type		Sample Recovery (Ft./Ft.)		Sample No.		Depth B.G.S. (Ft.)		Sample Interval And Symbol		Well Construction Details (NA)		Graphic Log	
Date		03-12-15															
Time (24 Hour)		13:21															
Depth (Ft.)		14.9															
Soil And/Or Rock Material Descriptions																	
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.																	
12:50				HSA						0						(AC) ASPHALT CONCRETE, 3 INCHES.	
										1						(AB) AGGREGATE BASE ROCK, 4 INCHES.	
										2						(ML) SANDY SILT; LAB TESTS: D422 = 55.5% LOW PLASTIC CLAY AND SILT, 44.5 %, FINE SAND, D2166 = 1816 PSF; BROWN (10YR, 4/3); VERY STIFF; MOIST.	
										3							
										4							
12:55		6		2.5SS		1.5/1.5				5							
		9						L1-2-2		6							
		11						L1-1-2		7							
				HSA				B1-1-1		8							
										9							
										10							
13:01		4		SPT		1.5/1.5		B2-1-1		11							
		5								12							
		6								13							
				HSA						14							
										15							
13:07		3		2.5SS		1.4/1.5				16						@15': LAB TESTS: D2166 = 508 PSF; FLD. EST.: 70% LOW PLASTICITY CLAY AND SILT, 30% FINE SAND; DARK YELLOWISH BROWN (10YR, 4/3); SATURATED.	
		4						L2-2-2		17							
		10						L2-1-2		18							
				HSA				B3-1-1		19							
										20							
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NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-3

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-12-15

Sheet: 2 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-Inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
										Date				
										Time (24 Hour)				
										Depth (Ft.)				
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														
13:18	>4.50	10	SPT	1.5/1.5	B4-1-1	20				(CL) CLAY CONTINUED.				
		16	↓			21								
		20				22								
						23								
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NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-4
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-09-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-09-15

Sheet: 1 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Temporary Monitoring Well Construction.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
										Date	03-09-15	03-31-15		
										Time (24 Hour)	15:27	10:16		
										Depth (Ft.)	17.10	15.17		
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuser; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														
14:50			HSA			0	0.25'			(AC) ASPHALT CONCRETE, 3 INCHES.				
						1				(AB) AGGREGATE BASE ROCK, 4 INCHES.				
						2				(ML) SANDY SILT; FLD. EST.: 55% LOW PLASTICITY CLAY AND SILT, 45 % FINE SAND; BROWN (10YR, 4/3); VERY STIFF; MOIST.				
						3								
						4								
15:00		4	2.5SS	0.9/1.5		5				@5': LAB TESTS.: D422 = 60.3% LOW PLASTICITY CLAY AND SILT, 39.5 % FINE SAND, 0.2% MEDIUM SAND; D2166 = 1191 PSF.				
		7			L1-2-2	6								
		16			L1-1-2	7								
			HSA		B1-1-1	8								
						9								
						10				(SM) SILTY SAND; LAB TESTS.: D422 = 31.0% LOW PLASTICITY CLAY AND SILT, 68.4 % FINE SAND, 0.5% MEDIUM SAND, 0.1% COARSE SAND; BROWN (10YR, 4/3); LOOSE; DAMP.				
15:08		4	SPT	1.5/1.5	B2-1-1	11								
		4				12								
		5				13								
			HSA			14								
						15								
15:13	3.50	5	2.5SS	1.5/1.5		16				@15.2'SATURATED.				
		12			L2-2-2	17								
		20			L2-1-2	18								
			HSA		B3-1-1	19				(CL) CLAY; FLD. EST: 85% LOW PLASTICITY CLAY AND SILT, 15%, FINE SAND; DARK BROWN (10YR, 5/3); VERY STIFF; MOIST.				
						20								

NOTES: ENTER NOTES



EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-5
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-12-15

Sheet: 1 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information							
24 Hour Clock Time (HH:MM)		Pocket Penetrometer (TSF)		Uncorrected Blow Counts (Blows / 6-inch) Drilling Method and/or Sampler Type		Sample Recovery (Ft./Ft.)		Sample No.		Depth B.G.S. (Ft.)		Sample Interval And Symbol		Well Construction Details (NA)		Graphic Log	
Date		03-12-15															
Time (24 Hour)		10:38															
Depth (Ft.)		NONE															
Soil And/Or Rock Material Descriptions																	
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.																	
10:00				HSA						0						(AC) ASPHALT CONCRETE, 2.5 INCHES.	
				↓						1						(AB) AGGREGATE BASE ROCK, 8.5 INCHES.	
10:05		>4.50		5 8 8		2.5SS ↓ HSA		1.1/1.5				2 3				(ML) SILT; FLD. EST: 70% LOW PLASTICITY CLAY AND SILT, 30%, FINE SAND; DARK BROWN (10YR, 4/3); HARD; MOIST.	
				↓								4				L1-1-1 B1-1-1	
10:13				2 4 5		2SPT ↓ HSA		0.45/1.5		B2-1-1		5				@5': LAB TEST DATA: 84.7% LOW PLASTICITY CLAY AND SILT, 13.4% FINE SAND, 1.7% MEDIUM SAND, 0.2% COARSE SAND; FIRM.	
				↓								6					
						↓						7					
						↓						8					
						↓						9					
10:20		1.50		4 7 7		2.5SS ↓ HSA		1.2/1.5				10				@10': STIFF.	
				↓								11					
						↓						12					
						↓						13					
						↓						14					
10:28		2.50		4 6 9		SPT ↓ HSA		0.5/1.5		B4-1-1		15				(CL) CLAY; FLD. EST: 85% LOW PLASTICITY CLAY AND SILT, 15%, FINE SAND; DARK BROWN (10YR, 5/3); VERY STIFF; MOIST.	
				↓								16					
						↓						17					
						↓						18					
						↓						19					
						↓						20					

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-5

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL):

NA

Date Finish: 03-12-15

Sheet: 2 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-Inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information						
										Date						
										Time (24 Hour)						
										Depth (Ft.)						
Soil And/Or Rock Material Descriptions																
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.																
10:38	2.50	4	2.5SS	1.1/1.5		20					(CL) CLAY CONTINUED..					
		16	↓			21										
		24			L3-1-1 B5-1-1	22										
						23										
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NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-6
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-12-15

Sheet: 1 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information									
24 Hour Clock Time (HH:MM)		Pocket Penetrometer (TSF)		Uncorrected Blow Counts (Blows / 6-Inch)		Drilling Method and/or Sampler Type		Sample Recovery (Ft./Ft.)		Sample No.		Depth B.G.S. (Ft.)		Sample Interval And Symbol		Well Construction Details (NA)		Graphic Log	
Date		03-12-15																	
Time (24 Hour)		16:20																	
Depth (Ft.)		14.9																	
Soil And/Or Rock Material Descriptions																			
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.																			
15:50						HSA						0						X.X Ft.	
												1							
												2							
												3							
												4							
												5							
15:55				4		2.5SS		1.1/1.5				6							
				7						L1-2-2		7							
				11						L1-1-2		8							
						HSA				B1-1-1		9							
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												13							
												14							
16:01		>4.50		6		SPT		1.1/1.5		B2-1-1		15							
				16								16							
				22								17							
						HSA						18							
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												149							
												150							

(AC) ASPHALT CONCRETE, 3 INCHES.

(AB) AGGREGATE BASE ROCK, 4 INCHES.

(ML) SANDY SILT; FLD. EST.: 55% LOW PLASTICITY CLAY AND SILT, 45 % FINE SAND; BROWN (10YR, 4/3); STIFF; MOIST.

@10': HARD.

(CL) CLAY; FLD. EST.: 85% LOW PLASTICITY CLAY AND SILT, 15%, FINE SAND; DARK BROWN (10YR, 5/3); SOFT; MOIST.

@15': SATURATED.

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-6
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-12-15

Sheet: 2 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

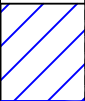
Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-Inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
										Date				
										Time (24 Hour)				
										Depth (Ft.)				
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														
16:18		5	2.5SS	0.0/1.5		20					(CL) CLAY CONTINUED; HARD.			
		17	↓			21								
		25				22								
						23								
						24								
						25								
						26								
						27								
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						37								
						38								
						39								
						40								

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-7
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-12-15

Sheet: 1 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details (NA)	Graphic Log	Ground Water Information			
										Date	03-12-15		
										Time (24 Hour)	12:12		
										Depth (Ft.)	17.10		
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture													
11:33			HSA			0				(ML) SANDY SILT; FLD. EST.:70% LOW PLASTICITY CLAY AND SILT, 30% FINE SAND; BROWN (10YR, 4/3); STIFF; MOIST.			
						1							
						2							
						3							
						4							
						5							
11:45		5	2.5SS	1.3/1.5		5				@5': LAB TESTS.: D422 = 71.6% LOW PLASTICITY CLAY AND SILT, 24.3% FINE SAND, 1.6% MEDIUM SAND, 2.5% COARSE SAND.			
		6			L1-2-2	6							
		7			L1-1-2	7							
			HSA		B1-1-1	7							
						8							
						9							
						10				@10': LAB TESTS.:D422 = 79.7% LOW PLASTICITY CLAY AND SILT, 17.2% FINE SAND, 1.0% MEDIUM SAND, 0.1% COARSE SAND, 2.0% FINE GRAVEL..			
11:52	4.50	4	SPT	1.5/1.5	B2-1-1	10							
		6				11							
		10				11							
			HSA			12							
						13							
						14							
						15				(CL) CLAY; FLD. EST: 85% LOW PLASTICITY CLAY AND SILT, 15%, FINE SAND; YELLOWISH BROWN (10YR, 5/4); VERY STIFF; MOIST.			
12:01	2.75	3	2.5SS	1.4/1.5		15				@15': LAB TESTS.:D2166 = 2772 PSF.			
		13			L2-2-2	16				@17': SATURATED			
		21			L2-1-2	16							
			HSA		B3-1-1	17							
						18							
						19							
						20							

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-7
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-12-15

Sheet: 2 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
										Date				
										Time (24 Hour)				
										Depth (Ft.)				
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														
12:11		4	SPT	1.3/1.5	B4-1-1	20				(CL) CLAY CONTINUED; HARD.				
		15				21								
		22				22								
						23								
						24								
						25								
						26								
						27								
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NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-8
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-12-15

Sheet: 1 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information							
24 Hour Clock Time (HH:MM)		Pocket Penetrometer (TSF)		Uncorrected Blow Counts (Blows / 6-inch) Drilling Method and/or Sampler Type		Sample Recovery (Ft./Ft.)		Sample No.		Depth B.G.S. (Ft.)		Sample Interval And Symbol		Well Construction Details (NA)		Graphic Log	
Date		03-12-15															
Time (24 Hour)		10:50															
Depth (Ft.)		13.30															
Soil And/Or Rock Material Descriptions																	
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.																	
10:20				HSA						0						(AC) ASPHALT CONCRETE, 4 INCHES.	
										1						(AB) AGGREGATE BASE ROCK, 4 INCHES.	
										2						(ML) SANDY SILT; FLD. EST.: 70% LOW PLASTICITY CLAY AND SILT, 30% FINE SAND; BROWN (10YR, 4/3); STIFF; MOIST.	
										3							
										4							
										5							
10:29		6		2.5SS		1.3/1.5				5						@5': LAB TESTS.: D422 = 72.4% LOW PLASTICITY CLAY AND SILT, 27.3% FINE SAND, 0.3% MEDIUM SAND, D2166 = 907 PSF; VERY STIFF.	
		9						I1-2-2		6							
		13						I1-1-2 B1-1-1		7							
				HSA						8							
										9							
										10							
10:32		4.50		13		SPT		1.5/1.5		10						(CL) CLAY; FLD. EST: 85% LOW PLASTICITY CLAY AND SILT, 15% FINE SAND; DARK ELLOWISH BROWN (10YR, 4/4); HARD; MOIST.	
				13						11							
				19						12							
				HSA						13						@13.2': SATURATED	
										14							
										15							
10:45		3.50		5		2.5SS		1.3/1.5		15						@15': LAB TESTS.: D422 = 89.8% LOW PLASTICITY CLAY AND SILT, 10.0% FINE SAND, 0.2% MEDIUM SAND, D2166 = 2094 PSF, D4318 = LIQUID LIMIT = 36 AND PLASTICITY INDEX = 18; VERY STIFF.	
				11						16							
				13						17							
				HSA						18							
										19							
										20							

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-8

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-12-15

Sheet: 2 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
										Date				
										Time (24 Hour)				
										Depth (Ft.)				
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														
10:55	3.50	12	SPT	1.4/1.5	B4-1-1	20				(CL) CLAY CONTINUED.				
		10	↓			21								
		10				22								
						23								
						24								
						25								
						26								
						27								
						28								
						29								
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						31								
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						33								
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						35								
						36								
						37								
						38								
						39								
						40								

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-9

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-12-15

Sheet: 1 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information									
24 Hour Clock Time (HH:MM)		Pocket Penetrometer (TSF)		Uncorrected Blow Counts (Blows / 6-inch)		Drilling Method and/or Sampler Type		Sample Recovery (Ft./Ft.)		Sample No.		Depth B.G.S. (Ft.)		Sample Interval And Symbol		Well Construction Details (NA)		Graphic Log	
Date		03-12-15																	
Time (24 Hour)		09:45																	
Depth (Ft.)		17.00																	
Soil And/Or Rock Material Descriptions																			
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.																			
09:00				4		HSA						0						X.X Ft.	
												1							
												2							
												3							
												4							
09:10		3.00		4		2.5SS		1.4/1.5				5							
				5						L1-2-2		6							
				8						L1-1-2		7							
						HSA				B1-1-1		8							
												9							
												10							
09:18		4.25		8		SPT		1.5/1.5		B2-1-1		11							
				14								12							
				15								13							
						HSA						14							
												15							
09:27				8		2.5SS		1.5/1.5				16							
				12						L2-2-2		17							
				30						L2-1-2		18							
						HSA				B3-1-1		19							
												20							
												21							
												22							

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-9
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL):

NA

Date Finish: 03-12-15

Sheet: 2 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
										Date				
										Time (24 Hour)				
										Depth (Ft.)				
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														

09:35		12	SPT	1.1/1.5	B4-1-1	20				(CL) CLAY CONTINUED; VERY STIFF.
		12	↓			21				
		13				22				
						23				
						24				
						25				
						26				
						27				
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NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-11
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-12-15

Sheet: 1 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information									
24 Hour Clock Time (HH:MM)		Pocket Penetrometer (TSF)		Uncorrected Blow Counts (Blows / 6-Inch)		Drilling Method and/or Sampler Type		Sample Recovery (Ft./Ft.)		Sample No.		Depth B.G.S. (Ft.)		Sample Interval And Symbol		Well Construction Details (NA)		Graphic Log	
Date		03-12-15																	
Time (24 Hour)		08:35																	
Depth (Ft.)		NONE																	
Soil And/Or Rock Material Descriptions																			
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.																			
07:20						HSA								0				X.X Ft.	
														1					
														2					
														3					
														4					
														5					
07:30				4		2.5SS		09/1.5						5					
				5										6					
				6															
						HSA								7					
														8					
														9					
														10					
07:40				4		2.5SS		1.0/1.5						10					
				6										11					
				8															
						HSA								12					
														13					
														14					
														15					
07:49		2.75		2		SPT		1.0/1.5		B3-1-1				15					
				3										16					
				5															
						HSA								17					
														18					
														19					
														20					

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-11

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-12-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL):

NA

Date Finish: 03-12-15

Sheet: 2 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-Inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
										Date				
										Time (24 Hour)				
										Depth (Ft.)				
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														
08:15		8	2.5SS	1.4/1.5	B4-2-2	20				(CL) CLAY CONTINUED; HARD.				
		20			L3-2-2	21								
		30			L3-1-2									
					B4-1-2	22								
						23								
						24								
						25								
						26								
						27								
						28								
						29								
						30								
						31								
						32								
						33								
						34								
						35								
						36								
						37								
						38								
						39								
						40								

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-12

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-11-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-11-15

Sheet: 1 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information																			
24 Hour Clock Time (HH:MM)		Pocket Penetrometer (TSF)		Uncorrected Blow Counts (Blows / 6-inch)		Drilling Method and/or Sampler Type		Sample Recovery (Ft./Ft.)		Sample No.		Depth B.G.S. (Ft.)		Sample Interval And Symbol		Well Construction Details (NA)		Graphic Log		Date		03-11-15		03-11-15		03-11-15		03-11-15	
Time (24 Hour)																				Time (24 Hour)		15:12		15:32		15:42		15:52	
Depth (Ft.)																				Depth (Ft.)		18.50		16.30		15.20		14.60	
Soil And/Or Rock Material Descriptions																													
SOLL: USCS Symbol; Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.																													
14:27						HSA								0						(ML) SANDY SILT; FLD. EST.: 55% LOW PLASTICITY CLAY AND SILT, 45% FINE SAND; BROWN (10YR, 4/3); STIFF; MOIST.									
						↓								1															
14:29		1.25		3		2.5SS		1.5/1.5						2						@2': LAB TESTS.: D2166 = 582 PSF.									
				5		↓								3															
				5		↓								4															
						HSA								5															
						↓								6															
14:33		1.75		3		SPT		0.7/1.5		B1-1-1				5						@5': LAB TESTS.: D4318 = LIQUID LIMIT = 30 AND PLASTICITY INDEX = 11.									
				5		↓								6															
				6		↓								7															
						HSA								8															
						↓								9															
														10															
14:40		2.00		6		X.XXX		1.0/1.5						10						@10': LAB TESTS.: D2166 = 1008 PSF.									
				9		↓								11															
				10		↓								12															
						HSA								13															
						↓								14															
														15															
14:45		2.50		4		SPT		1.0/1.5		B2-1-1				15						(CL) CLAY; FLD. EST.: 85% LOW PLASTICITY CLAY AND SILT, 15%, FINE SAND; DARK ELLOWISH BROWN (10YR, 4/4); VERY STIFF; MOIST.									
				8		↓								16						@14.6': SATURATED.									
				10		↓								17															
						HSA								18															
						↓								19															
														20															

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-12

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-11-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-11-15

Sheet: 2 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch) Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
									Date				
									Time (24 Hour)				
									Depth (Ft.)				
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
14:57	4.25	7 12 15	2.5SS ↓	1.5/1.5	20								(CL) CLAY CONTINUED; HARD.
				L3-1-1	21								
					22								
					23								
					24								
					25								
					26								
					27								
					28								
					29								
					30								
					31								
					32								
					33								
					34								
					35								
					36								
					37								
					38								
					39								
					40								

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

8 SEVILLE CT., SUITE 100, CHICO, CA 95928
PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-13

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-11-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL):

NA

Date Finish: 03-11-15

Sheet: 1 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

						Ground Water Information			
24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details (NA)	Graphic Log
						Date			
						Time (24 Hour)			
						Depth (Ft.)			
						Soil And/Or Rock Material Descriptions			
						SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; ROD; Moisture.			
16:11			HSA			0			(AC) ASPHALT CONCRETE, 2 INCHES.
						1			(AB) AGGREGATE BASE ROCK, 9 INCHES.
16:14	2.25	9	2.5SS	1.3/1.5		2			(CL) CLAY, FLD. EST.: 85% LOW PLASTICITY CLAY AND SILT, 15% FINE SAND; VERY DARK GRAY (10YR, 3/1); VERY STIFF; MOIST
		14				3			
		15	HSA		L1-1-1	4			
						5			
16:21	0.75	4	SPT	0.5/1.5	B1-1-1	6			(ML) SILT, FLD. EST.: 85% LOW PLASTICITY CLAY AND SILT, 15% FINE SAND; DARK GRAY (10YR, 4/3); VERY STIFF; MOIST
		3				7			
		4	HSA			8			
						9			
						10			(CL) CLAY, FLD. EST.: 85% LOW PLASTICITY CLAY AND SILT, 15% FINE SAND; VERY DARK GRAY (10YR, 3/1); VERY STIFF; MOIST
16:27	2.75	9	2.5SS	1.5/1.5		11			
		12				12			
		13	HSA		L2-1-1	13			
						14			
						15			@15': DARK YELLOWISH BROWN (10YR, 4/4).
16:33	3.00	6	SPT	0.8/1.5	B2-1-1	16			
		14				17			
		21	HSA			18			
						19			
						20			

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-13
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-10-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-10-15

Sheet: 2 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch) Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
									Date				
									Time (24 Hour)				
									Depth (Ft.)				
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
16:45	2.50	6 16 24	2.5SS ↓	1.5/1.5					(CL) CLAY CONTINUED.				
				L3-1-1									
							</						

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-14

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-11-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-11-15

Sheet: 1 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information				
24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details (NA)	Graphic Log	Date	03-11-15	03-11-15		
										Time (24 Hour)	13:37	14:07		
										Depth (Ft.)	11.50	9.10		
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														
12:45			HSA			0				(ML) SILT, FLD. EST.: 85% LOW PLASTICITY CLAY AND SILT, 15% FINE SAND; DARK GRAY (10YR, 4/3); HARD; MOIST				
			↓			1								
12:47	4.25	6	2.5SS	1.2/1.5		2								
		8	↓			3								
		9	HSA		L1-1-1	4								
			↓			5								
12:50	1.0	2	SPT	0.5/1.5		6				@5': LAB TESTS.: D422 = 57.0% LOW PLASTICITY CLAY AND SILT, 37.5% FINE SAND, 2.4% MEDIUM SAND, 1.2% COARSE SAND, 1.9% FINE GRAVEL; D2166 = 2355 PSF.				
		3	↓			7								
		3	HSA		B1-1-1	8								
			↓			9								
						10				(CL) CLAY, FLD. EST.: 85% LOW PLASTICITY CLAY AND SILT, 15% FINE SAND; VERY DARK GRAY (10YR, 3/1); VERY STIFF; MOIST				
			↓			11				@9': SATURATED.				
12:09	3.25	4	2.5SS	1.2/1.5		12				@10': LAB TESTS.: D2166 = 2355 PSF; D4318 = LIQUID LIMIT = 50 AND PLASTICITY INDEX = 31..				
		12	↓			13								
		16	HSA		L2-1-1	14								
			↓			15								
						16								
13:07	2.75	7	SPT	0.7/1.5		17								
		11	↓			18								
		15	HSA		B2-1-1	19								
			↓			20								
						21								
						22								

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-14
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-11-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-11-15

Sheet: 2 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch) Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
									Date				
									Time (24 Hour)				
									Depth (Ft.)				
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
13:17	2.75	9	2.5SS	1.5/1.5	20				(CL) CLAY CONTINUED.				
		11	↓	L3-1-1	21								
		15			22								
					23								
					24								
					25								
					26								
					27								
					28								
					29								
					30								
					31								
					32								
					33								
					34								
					35								
					36								
					37								
					38								
					39								
					40								

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-15
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-11-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-11-15

Sheet: 1 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

						Ground Water Information			
24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details (NA)	Graphic Log
10:49			HSA			0			
						1			
10:52	0.75	3	2.5SS	1.2/1.5		2			
		4				3			
		5	HSA		L1-1-1	4			
						5			
		1	SPT	1.1/1.5		6			
		1				7			
		1	HSA		B1-1-1	8			
						9			
						10			
	2.25	2	2.5SS	1.4/1.5		11			
		4			L2-2-2	12			
		8	HSA		L2-1-2	13			
						14			
						15			
11:10		4	SPT	1.5/1.5		16			
		9				17			
		12	HSA		B2-1-1	18			
						19			
						20			

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-15

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-11-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-11-15

Sheet: 2 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-Inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information					
										Date					
										Time (24 Hour)					
										Depth (Ft.)					
Soil And/Or Rock Material Descriptions															
SOIL: USCS Symbol Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.															
11:16	4.25	15	2.5SS	1.4/1.5		20					(CL) CLAY CONTINUED.				
		27	↓			21									
		39			L3-1-1										
						22									
						23									
						24									
						25									
						26									
						27									
						28									
						29									
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						31									
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						34									
						35									
						36									
						37									
						38									
						39									
						40									

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-16A
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-09-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL):

NA

Date Finish: 03-10-15

Sheet: 1 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Temporary Monitoring Well Constructed.

										Ground Water Information				
24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-Inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details (NA)	Graphic Log	Date	03-09-15	03-10-15	3-31-15	
										Time (24 Hour)	13:35	10:45	10:30	
										Depth (Ft.)	7.60	7.80	8.82	
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuser; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														
12:10			HSA			0	0.28'			(AB) AGGREGATE BASE ROCK, 8.5 INCHES.				
						1								
						2								
12:18	0.50	2	SPT	0.5/1.5	B1-1-1	3				(ML) SILT, FLD. EST.: 60% LOW PLASTICITY CLAY AND SILT, 40% FINE SAND; DARK BROWN (10YR, 4/3); SOFT; MOIST.				
		3				4								
		3				5								
			HSA			6								
						7								
	0.50	1	SPT	1.3/1.5	B2-1-1	8				@5.0': VERY SOFT.				
		1				9								
		1				10				@8.8': SATURATED.				
			HSA			11								
						12								
						13								
						14								
12:30	0.25	1	SPT	1.5/1.5	B3-1-1	15				@10': MOTTLED REDDISH BROWN.				
		1				16								
		1				17								
			HSA			18								
						19								
						20								
						21								
						22								
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						25								
						26								
						27								
						28								
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EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-16A

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-09-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL):

NA

Date Finish: 03-10-15

Sheet: 2 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Temporary Monitoring Well Construction.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
										Date				
										Time (24 Hour)				
										Depth (Ft.)				
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														
12:43	4.0	4	SPT	1.4/1.5	B5-1-1	20				(CL) CLAY CONTINUED.				
		8	↓			21								
		9				22								
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NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-16B
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-09-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-09-15

Sheet: 1 Of 3

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 51.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-Inch) Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details (NA)	Graphic Log	Ground Water Information				
									Date	03-09-15			
									Time (24 Hour)	16:30			
									Depth (Ft.)	7.60			
Soil And/OR Rock Material Descriptions													
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
13:55		HSA			0			X.X	(AB) AGGREGATE BASE ROCK.				
					1								
14:00		14	2.5SS	1.1/1.5	2								
		16			3								
		18			4								
		3	SPT	0.5/1.5	5								
		4			6								
		5			7								
14:24	0.75	5	2.5SS	1.2/1.5	8								
		2			9								
		2			10								
		1	SPT	1.5/1.5	11								
		1			12								
		1			13								
			HSA		14								
					15								
					16								
	1.00	1	2.5SS	1.5/1.5	17								
		2			18								
		2			19								
		4	SPT	1.1/1.5	20								
		5			21								
		8			22								
			HSA		23								
					24								
					25								
					26								
14:49		8	2.5SS	0.4/1.5	27								
		10			28								
		12			29								
		5	SPT	1.3/1.5	30								
		6			31								
		7			32								
			HSA		33								
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(ML) SILT, LAB TESTS: D422 = 82.8% LOW PLASTIC CLAY AND SILT, 15.1% FINE SAND, 0.9% MEDISUM SAND, 1.2% COARSE SAND; D2166 = 299 PSF; D2850 = 549 PSF; D4318 = LIQUID LIMIT = 28 AND PLASTICITY INDEX = 9; DARK BROWN (10YR, 4/3); FIRM; MOIST..

@6.5': VERY SOFT.

@8.7': SATURATED.

@10': FIRM

(CL) CLAY, FLD. EST.: 85% LOW PLASTICITY CLAY AND SILT, 15% FINE SAND; BROWN (10YR, 5/3); STIFF; SATURATED.

@15': LAB TESTS: D422 = 86.5% LOW PLASTICITY CLAY AND SILT, 10.4% FINE SAND, 2.4% MEDIUM SAND, 0.3% COARSE SAND, 0.4% FINE GRAVEL; STIFF.

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-16B
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-09-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-09-15

Sheet: 2 Of 3

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 51.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
										Date				
										Time (24 Hour)				
										Depth (Ft.)				
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														
15:02		4	2.5SS	0.5/1.5		20				@20': CLAY CONTINUED, LAB TESTS: D422 = 98.1% LOW PLASTICITY CLAY AND SILT, 1.3% FINE SAND, 0.2% MEDIUM SAND, 0.2% COARSE SAND, 0.2% FINE GRAVEL; D2850 = 1480 PSF; D4318 = LIQUID LIMIT = 40 AND PLASTICITY INDEX = 16; VERY STIFF.				
		5				21								
	4.00	12	SPT	0.7/1.5	L5-1-1 B5-1-1	22								
		16				23								
		18								@25': LAB TESTS: D422 = 55.3% LOW PLASTICITY CLAY AND SILT, 42.5% FINE SAND, 2.2% MEDIUM SAND..				
			HSA			24								
15:29	3.75	8	SPT	1.5/1.5	B6-1-1	25								
		9				26								
		10								(SM): SILTY SAND, FLD. EST.: 30% LOW PLASTICITY CLAY AND SILT, 70% FINE SAND; DARK GRAYISH BROWN (2.5Y, 4/2); DENSE; SATURATED.				
			HSA			27								
						28								
						29								
15:45	2.25	12	SPT	1.5/1.5	B7-2-2	30				@35': LAB TESTS: D422 = 20.0% LOW PLASTICITY CLAY AND SILT, 21.7% FINE SAND, 13.6% MEDIUM SAND, 25.0% COARSE SAND, 19.7% FINE GRAVEL; PALE BROWN (10YR,6/3); VERY DENSE.				
		18				31								
		25			B7-1-2	32								
			HSA			33								
						34								
15:57		20	SPT	1.5/1.5	B8-1-1	35								
		47				36								
		32				37								
			HSA			38								
						39								
						40								

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-16B
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-09-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-09-15

Sheet: 3 Of 3

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 51.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information					
										Date					
										Time (24 Hour)					
										Depth (Ft.)					
Soil And/Or Rock Material Descriptions															
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.															
16:12		9 34 42	SPT ↓ HSA	1.5/1.5	B9-1-1	40									(SM) SILTY SAND CONTINUED.
						41									
						42									
						43									
						44									
10:02		20 22 32	SPT ↓ HSA	1.5/1.5	B10-1-1	45									@45': LAB TESTS: D422 = 7.1% LOW PLASTICITY CLAY AND SILT, 17.9% FINE SAND, 15.7% MEDIUM SAND, 16.9% COARSE SAND, 42.4% FINE GRAVEL.
						46									.
						47									
						48									
						49									
10:40		30 32 50/2.5"	SPT ↓		B11-1-1 XX-X-X XX-X-X	50									@50': LAB TESTS: D422 = 10.2% LOW PLASTICITY CLAY AND SILT, 17.0% FINE SAND, 13.9% MEDIUM SAND, 20.4% COARSE SAND, 38.5% FINE GRAVEL.
						51									.
						52									
						53									
						54									
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						59									
						60									

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-17

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-11-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-11-15

Sheet: 1 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information			
Date		03-11-15		03-11-15									
Time (24 Hour)		10:23		10:31									
Depth (Ft.)		7.80		7.80									
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
09:30			HSA			0			(AB) AGGREGATE BASE ROCK.				
						1							
09:35	2.50	9	2.5SS	1.3/1.5		2							
		11				3							
		14	HSA		L1-1-1	4							
						5							
	0.500	2	SPT	0.9/1.5		6							
		2			B1-1-1	7							
		2	HSA			8							
						9							
						10							
09:48		9	2.5SS	0.3/1.5		11							
		16			B2-1-1	12							
		19	HSA			13							
						14							
						15							
09:57		7	SPT	0.8/1.5		16							
		12			B3-1-1	17							
		17	HSA			18							
						19							
						20							

(@15': VERY STIFF.

(CL) CLAY, FLD. EST.: 70% LOW PLASTICITY CLAY AND SILT, 30% FINE SAND; DARK GRAYISH BROWN (10YR, 4/3); HARD; SATURATED.

(ML) SILT, FLD. EST.: 85% LOW PLASTICITY CLAY AND SILT, 15% FINE SAND; DARK GRAYISH BROWN (10YR, 4/2); VERY STIFF; MOIST.

NOTES: ENTER NOTES



EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-18

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-11-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-11-15

Sheet: 1 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information			
Date		03-11-15											
Time (24 Hour)		08:52											
Depth (Ft.)		7.30											
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-18
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-11-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-11-15

Sheet: 2 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch) Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
									Date				
									Time (24 Hour)				
									Depth (Ft.)				
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol: Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
08:42		9 12 12	2.5SS ↓	1.5/1.5	20				(CL) CLAY CONTINUED				
				L3-1-1	21								
					22								
					23								
					24								
					25								
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					38								
					39								
					40								

NOTES: ENTER NOTES



EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-19

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-13-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-13-15

Sheet: 2 Of 2

Logged By: Don Olsen

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 40.0

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
										Date				
										Time (24 Hour)				
										Depth (Ft.)				
Soil And/Or Rock Material Descriptions														
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.														
09:18		16	2.5SS	1.4/1.5	B7-1-1	20								(SM) SILTY SAND CONTINUED. @20': LAB TESTS: ; D2166 = 1752 PSF. @21': LAB TESTS: ; D422 = 36.0% LOW PLASTICITY CLAY AND SILT, 26.9% FINE SAND, 17.1% MEDIUM SAND, 7.7% COARSE SAND, 12.3% FINE GRAVEL.
		24	↓		L4-2-2	21								
		35	↓		L4-1-2									
		13	SPT	1.35/1.5	B8-1-1	22								
		21	↓											
		22	↓											
			MR			23								
			↓			24								
			↓											
09:43		33	2.5SS	1.5/1.5	B9-1-1	25								(CL) CLAY, FLD. EST.: 90% LOW PLASTICITY CLAY AND SILT, 10% FINE SAND; BROWN (10YR, 3/4); HARD; SATURATED..
		38	↓		L5-2-2									
		50/2"	↓		L5-1-2	26								
		44	SPT	1.0/1.0	B10-1-1	27								@26.5': LAB TESTS: ; D422 = 87.2% LOW PLASTICITY CLAY AND SILT, 12.8% FINE SAND.
		50	↓											
			MR			28								
			↓			29								
			↓											
10:14		6	SPT	1.5/1.5	B11-3-3	30								(SP) POORLY GRADED SAND, FLD. EST.: 5% LOW PLASTICITY CLAY AND SILT, 90% FINE SAND; BROWN (10YR, 5/3); VERY DENSE; SATURATED.
		28	↓		B11-2-3	31								
		32	↓		B11-1-3									
			MR			32								@31': FLD. EST.: 5% LOW PLASTICITY CLAY AND SILT, 50% FINE SAND, 25% MEDIUM SAND, 15% COARSE SAND, 5% FINE GRAVEL.
			↓			33								
			↓			34								
			↓											
11:40		8	SPT	0/1.5		35								@34': SAND BEGAN TO FLOW INTO AND OVER THE TOP OF THE DRILL BIT MAKING IT DIFFICULT TO PULL THE DRILL BIT UP AND OUT OF THE BOREHOLE. COULD NOT RECOVER MATERIAL FROM SAMPLE INTERVAL STARTING AT 35 FEET. THICKENED DRILLING MUD AND ATTEMPTED TO DRILL TO 40 FEET FOR SAMPLE. WHEN PULLED DRILL BIT OUT OF THE BOREHOLE AND PLACED SAMPLER INTO BOREHOLE THE BOREHOLE HAD COLLAPSED AND WAS ONLY OPEN TO A DEPTH OF 34 FEET BELOW THE SURFACE. TERMINATED BORING.
		12	↓			36								
		16	↓											
			MR			37								
			↓			38								
			↓			39								
			↓			40								

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

8 SEVILLE CT., SUITE 100, CHICO, CA 95928
PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-20

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-10-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL):

NA

Date Finish: 03-10-15

Sheet: 1 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

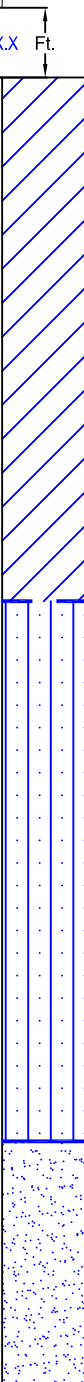
Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information			
24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-inch)	Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details (NA)	Graphic Log	Date	03-10-15		
										Time (24 Hour)	13:28		
										Depth (Ft.)	4.90		
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
12:20			HSA			0				(CL) CLAY, FLD. EST.: 90% LOW PLASTICITY CLAY AND SILT, 10% FINE SAND; DARK GRAYISH BROWN (10YR, 4/2); VERY STIFF; WET.			
						1							
12:26	2.25	7	2.5SS	1.4/1.5		2				@2': LAB TESTS.: D422 = 95.6% LOW PLASTICITY CLAY AND SILT, 4.0% FINE SAND, 0.4% MEDIUM SAND; D4318 = LIQUID LIMIT = 48 AND PLASTICITY INDIX = 31; D5084 = 4.1E-09 cm./sec..			
		12			L1-2-2	3							
		14			L1-1-2	4							
			HSA			5				@4.7': STIFF; SATURATED.			
12:30	1.75	3	SPT	0.7/1.5	B1-1-1	6							
		6				7							
		7				8							
			HSA			9							
						10				(SM) SILTY SAND, FLD. EST.: 25% LOW PLASTICITY CLAY AND SILT, 75% FINE SAND; YELLOWISH BROWN (10YR, 5/4); MEDIUM DENSE; SATURATED.			
12:38	4.00	8	SPT	1.5/1.5	B2-1-1	11							
		12				12							
		18				13							
			HSA			14							
						15							
132:46		24	SPT	1.0/1.5	B3-2-2	16							
		24			B3-1-2	17				(SW) WELL GRADED SAND, FLD. EST.: 5% LOW PLASTICITY CLAY AND SILT, 75% FINE SAND, 20% MEDIUM SAND; DARK BROWN (10YR, 4/3); MEDIUM DENSE; SATURATED.			
		25				18							
			HSA			19							
						20							

NOTES: ENTER NOTES



EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-21
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-10-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-10-15

Sheet: 1 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information											
24 Hour Clock Time (HH:MM)		Pocket Penetrometer (TSF)		Uncorrected Blow Counts (Blows / 6-Inch)		Drilling Method and/or Sampler Type		Sample Recovery (Ft./Ft.)		Sample No.		Depth B.G.S. (Ft.)		Sample Interval And Symbol		Well Construction Details (NA)		Graphic Log			
Date		03-10-15																			
Time (24 Hour)		14:40																			
Depth (Ft.)		4.60																			
Soil And/Or Rock Material Descriptions																					
SOIL: USCS Symbol Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.																					
13:55						HSA								0						(CH) CLAY, FLD. EST.: 90% HIGH PLASTICITY CLAY AND SILT, 10% FINE SAND; DARK GRAYISH BROWN (10YR, 4/2); VERY STIFF; WET.	
						↓								1							
13:59		1.75		4		2.5SS		1.3/1.5						2						@2': LAB TESTS.: D422 = 96.0% LOW PLASTICITY CLAY AND SILT, 3.5% FINE SAND, 0.2% MEDIUM SAND, 0.1% COARSE SAND, 0.2% FINE GRAVEL; D4318 = LIQUID LIMIT = 60 AND PLASTICITY INDIX = 43; D5084 = 1.2E-08 cm./sec..	
				7						L2-2-2				3							
				9		↓				L1-1-2				4							
						HSA								5						@4.7': STIFF; SATURATED.	
14:04		2.75		4		X.XXX		0.9/1.5		B1-1-1				6							
				6										7							
				6		↓								8							
						HSA								9							
						↓								10							
14:11		0.50		7		SPT		1.3/1.5		B2-1-1				11						(SM) SILTY SAND, FLD. EST.: 25% LOW PLASTICITY CLAY AND SILT, 75% FINE SAND; YELLOWISH BROWN (10YR, 5/4); MEDIUM DENSE; SATURATED.	
				8		↓								12							
				9										13							
						HSA								14							
						↓								15							
14:17				5		SPT		1.5/1.5		B3-1-1				16						(SW) WELL GRADED SAND, FLD. EST.: 5% LOW PLASTICITY CLAY AND SILT, 75% FINE SAND, 20% MEDIUM SAND; DARK BROWN (10YR, 4/3); MEDIUM DENSE; SATURATED.	
				8		↓								17							
				7										18							
						HSA								19							
						↓								20							

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.

B15-21

Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-10-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-10-15

Sheet: 2 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-Inch) Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
									Date				
									Time (24 Hour)				
									Depth (Ft.)				
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol: Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
14:25		1 1 1	SPT ↓	0.0/1.5	20				(SW) WELL GRADED SAND CONTINUED.				
					21								
					22								
					23								
					24								
					25								
					26								
					27								
					28								
					29								
					30								
					31								
					32								
					33								
					34								
					35								
					36								
					37								
					38								
					39								
					40								

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-22
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-10-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-10-15

Sheet: 1 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

										Ground Water Information			
Date		03-10-15											
Time (24 Hour)		16:05											
Depth (Ft.)		5.90											
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsell Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsell Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
15:15			HSA			0				(CH) CLAY, FLD. EST.: 90% HIGH PLASTICITY CLAY AND SILT, 10% FINE SAND; DARK GRAYISH BROWN (10YR, 4/2); VERY STIFF; WET.			
			↓			1							
15:18	1.25	4	2.5SS	1.2/1.5		2				@2': LAB TESTS.: D422 = 97.5% LOW PLASTICITY CLAY AND SILT, 2.0% FINE SAND, 0.5% MEDIUM SAND, 0.1% COARSE SAND, 0.2% FINE GRAVEL; D4318 = LIQUID LIMIT = 50 AND PLASTICITY INDEX = 31; D5084 = 7.0E-09 cm./sec..			
		6			L1-2-2	3							
		8	↓		L1-1-2	4							
			HSA			5							
			↓			6				@5.7': STIFF; SATURATED.			
15:25	2.25	4	SPT	1.1/1.5	B1-1-1	7				(ML) SILT, FLD. EST.: 25% LOW PLASTICITY CLAY AND SILT, 75% FINE SAND; YELLOWISH BROWN (10YR, 5/4); HARD; SATURATED.			
		7				8							
		9	↓			9							
			HSA			10							
			↓			11							
15:29	>4.50	16	SPT	1.1/1.5	B2-1-1	12							
		43				13							
		70	↓			14							
			HSA			15				@15': YELLOWISH BROWN (10YR, 4/4).			
			↓			16							
15:39		9	SPT	1.4/1.5	B3-1-1	17				(SW) WELL GRADED SAND, FLD. EST.: 5% LOW PLASTICITY CLAY AND SILT, 75% FINE SAND, 20% MEDIUM SAND; DARK BROWN (10YR, 4/3); VERY DENSE; SATURATED.			
		14				18							
		24	↓			19							
			HSA			20							
			↓										

NOTES: ENTER NOTES

EXPLORATORY BORING LOG

 8 SEVILLE CT., SUITE 100, CHICO, CA 95928
 PHONE: 530-894-2487, FAX: 530-894-2437

Boring No.
B15-22
Project Name: Colusa Waste Water System Improvements

Project No.: 70508-01

Task: 01

Date Start: 03-10-15

Location: Parkhill St. and Bridge St., Colusa, Ca.

Ground Elev. (Ft. AMSL): NA

Date Finish: 03-10-15

Sheet: 2 Of 2

Logged By: Chad Borean

Drilling Cmpny: PC Exploration, Inc.

Drill Rig Type: CME

Driller: Nate

Drilling Method: Hollow Stem Augers (HSA)

Hammer Type: 140 lbf. Automatic Trip Hammer

Boring Dia. (In.): 8

Total Depth (Ft.): 21.5

Backfill or Well Casing: Backfilled with Portland cement and 5% bentonite grout.

24 Hour Clock Time (HH:MM)	Pocket Penetrometer (TSF)	Uncorrected Blow Counts (Blows / 6-Inch) Drilling Method and/or Sampler Type	Sample Recovery (Ft./Ft.)	Sample No.	Depth B.G.S. (Ft.)	Sample Interval And Symbol	Well Construction Details	Graphic Log	Ground Water Information				
									Date				
									Time (24 Hour)				
									Depth (Ft.)				
Soil And/Or Rock Material Descriptions													
SOIL: USCS Symbol; Name; Particle Size Gradation %; Munsel Color; Density/Consistency; Moisture; Odor; Organics; Cementation; Texture; Refuse; Etc. ROCK: Unit Name; Lithology; Munsel Color; Cementation; Weathering; Competency; Bedding/Foliation; Fracture/Joint Spacing & Roughness; RQD; Moisture.													
		30	SPT	1.3/1.3	B4-1-1	20			(SW) WELL GRADED SAND CONTINUED.				
		36	↓			21							
		50/4"											
						22							
						23							
						24							
						25							
						26							
						27							
						28							
						29							
						30							
						31							
						32							
						33							
						34							
						35							
						36							
						37							
						38							
						39							
						40							

NOTES: ENTER NOTES

APPENDIX D:

Soil Laboratory Test Sheets, 84 pages.

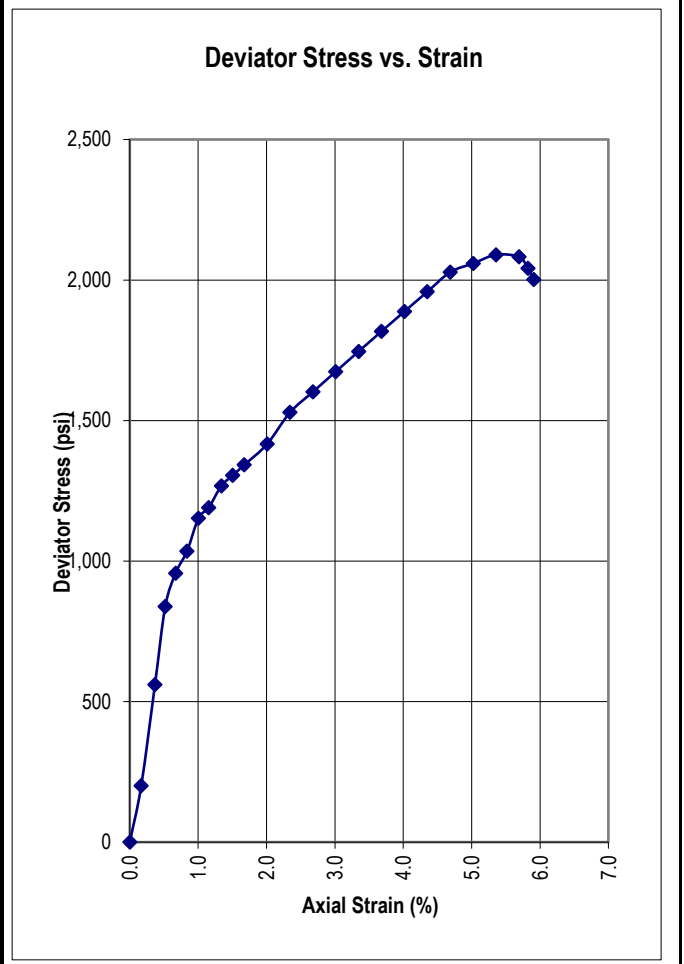
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/02/15
Boring/Trench No.:	B15-1	Sample No.:	L2-1-3	Depth (ft.)	10
Soil Description:	(CL) Sandy Lean CLAY: Vi.s Est. Clay 68%, Sand 32%; Dark Greyish Brown (10YR 4/2)				Tested By: CHB
Sample Location:					Check By: DMO
					Lab No.:

Sample Data			Sample Sketch At Failure		
Tare Tube Number	I.D.	C2			
Tare Weight	(gm)	769.70			
Wet Soil + Tare	(gm)	1613.30			
Dry Soil + Tare	(gm)	1482.50			
Weight of Water	(gm)	130.80			
Dry Soil Weight	(gm)	712.80			
Moisture Content	(%)	18.35			
Soil Height	(cm)	15.17			
Sample Diameter	(cm)	6.02			
Wet Unit Weight	(pcf)	121.94			
Dry Unit Weight	(pcf)	103.04			
Specific Gravity	(dim)	2.60			
Saturation	(%)	83.04	Comments: Maximum Shear Strength, Su = 1,044.9 psf = 7.26 psi Maximum Unconfined Compressive Strength, qu = 2,089.8 psf = 14.51 psi		
Strain Rate	(%/min.)	1.24			
Proving Ring Constant	(lbs/unit)	1.230			

Elapsed Time (Sec)	Strain		Area (cm²)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
8	10	0.17	28.51	5	6.15	200.4
18	22	0.37	28.57	14	17.22	560.0
27	31	0.52	28.61	21	25.83	838.7
34	40	0.67	28.66	24	29.52	957.1
42	50	0.84	28.70	26	31.98	1035.1
51	60	1.00	28.75	29	35.67	1152.6
58	69	1.16	28.80	30	36.90	1190.5
67	80	1.34	28.85	32	39.36	1267.5
75	90	1.51	28.90	33	40.59	1304.9
82	100	1.67	28.95	34	41.82	1342.1
98	120	2.01	29.05	36	44.28	1416.3
115	140	2.34	29.15	39	47.97	1529.0
131	160	2.68	29.25	41	50.43	1601.9
147	180	3.01	29.35	43	52.89	1674.3
163	200	3.35	29.45	45	55.35	1746.1
179	220	3.68	29.55	47	57.81	1817.4
195	240	4.02	29.65	49	60.27	1888.2
211	260	4.35	29.76	51	62.73	1958.4
228	280	4.69	29.86	53	65.19	2028.1
243	300	5.02	29.97	54	66.42	2059.1
259	320	5.36	30.07	55	67.65	2089.8
275	340	5.69	30.18	55	67.65	2082.4
281	348	5.83	30.22	54	66.42	2041.6
285	353	5.91	30.25	53	65.19	2002.1





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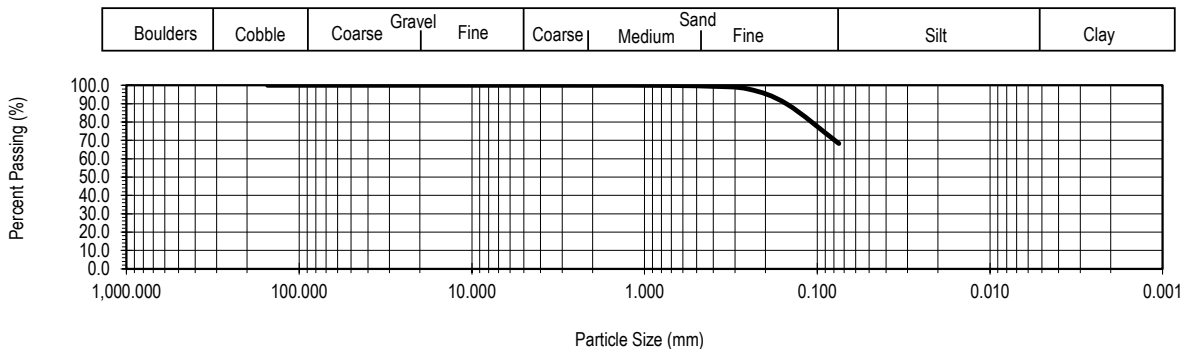
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/2/2015**
Sample No.: **L2-2-3** Boring/Trench: **B15-1** Depth, (ft.): **10** Tested By: **CHB**
Description: **(CL) Sandy Lean CLAY: Lab Data Clay 68%, Sand 32%; Dark Greyish Brown (1** Checked By: **DMO**
Sample Location: Lab. No.: **0**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	685.6	100.0
3 Inch	3.0000	76.2		0.0	685.6	100.0
2 Inch	2.0000	50.8		0.0	685.6	100.0
1.5 Inch	1.5000	38.1		0.0	685.6	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	685.6	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	685.6	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	685.6	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	685.6	100.0
#4	0.1875	4.7500	0.00	0.0	685.6	100.0
#10	0.0787	2.0000	0.10	0.1	685.5	100.0
#20	0.0335	0.8500	0.29	0.4	685.2	99.9
#40	0.0167	0.4250	3.10	3.5	682.1	99.5
#60	0.0098	0.2500	10.64	14.1	671.5	97.9
#100	0.0059	0.1500	55.82	69.9	615.7	89.8
#200	0.0030	0.0750	147.52	217.5	468.2	68.3
Hydrometer						

Particle Size Gradation



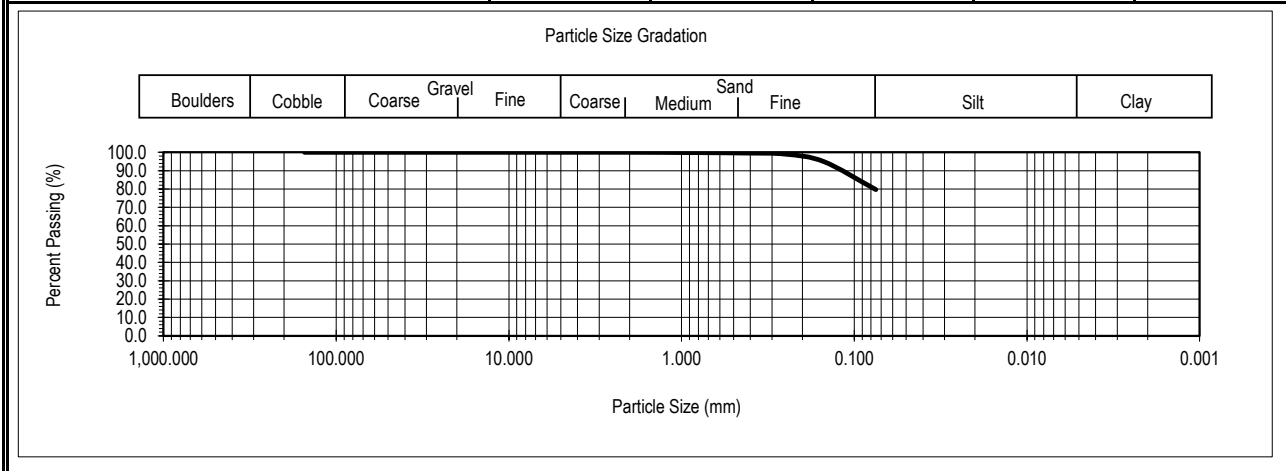
(530) 894-2487 - Fax (530) 894-2437 - 8 Seville Ct., Suite 100 - Chico, CA 95928 - A California Corporation

Particle Size Distribution

ASTM D422, C136

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	4/2/2015
Sample No.:	L3-1-2	Boring/Trench:	B15-1	Depth, (ft.):	20
Description:	(CL) Sandy Lean CLAY; Lab Data Clay 80%, fine Sand 20%; Dark Yellowish Br				
Sample Location:					Lab. No.:
					C15-035

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	685.7	100.0
3 Inch	3.0000	76.2		0.0	685.7	100.0
2 Inch	2.0000	50.8		0.0	685.7	100.0
1.5 Inch	1.5000	38.1		0.0	685.7	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	685.7	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	685.7	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	685.7	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	685.7	100.0
#4	0.1875	4.7500	0.00	0.0	685.7	100.0
#10	0.0787	2.0000	0.00	0.0	685.7	100.0
#20	0.0335	0.8500	1.14	1.1	684.5	99.8
#40	0.0167	0.4250	1.71	2.9	682.8	99.6
#60	0.0098	0.2500	4.00	6.9	678.8	99.0
#100	0.0059	0.1500	27.98	34.8	650.8	94.9
#200	0.0030	0.0750	104.50	139.3	546.3	79.7
Hydrometer						



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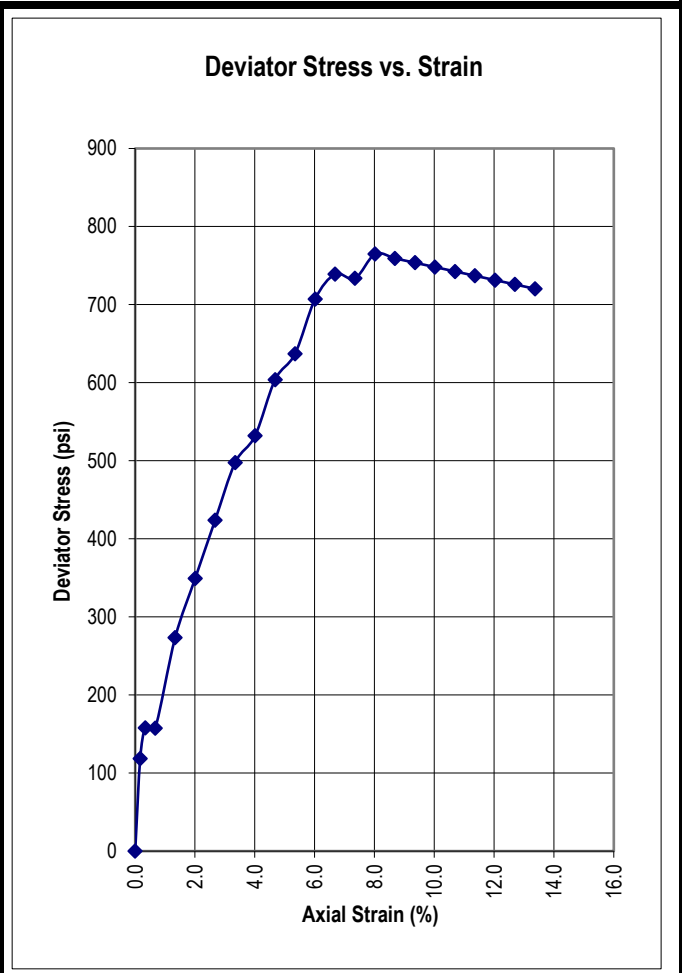
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/02/15
Boring/Trench No.:	B15-1	Sample No.:	L3-1-2	Depth (ft.):	20
Soil Description:	(CL) Sandy Lean CLAY; Lab Data Clay 80%, fine Sand 20%; Dark Yellowish Brown (10YR 3/4)				Tested By: CHB
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure	
Tare Tube Number	I.D.	C15		
Tare Weight	(gm)	765.30		
Wet Soil + Tare	(gm)	1632.00		
Dry Soil + Tare	(gm)	1454.80		
Weight of Water	(gm)	177.20		
Dry Soil Weight	(gm)	689.50		
Moisture Content	(%)	25.70		
Soil Height	(cm)	15.21		
Sample Diameter	(cm)	6.06		
Wet Unit Weight	(pcf)	123.29		
Dry Unit Weight	(pcf)	98.08		
Specific Gravity	(dim)	2.80		
Saturation	(%)	92.09	Comments: Maximum Shear Strength, Su = 382.4 psf = 2.66 psi Maximum Unconfined Compressive Strength, qu = 764.8 psf = 5.31 psi	
Strain Rate	(%/min.)	1.30		
Proving Ring Constant	(lbs/unit)	1.230		

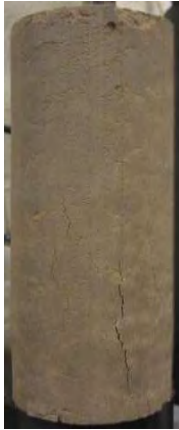
Elapsed Time (Sec)	Strain		Area (cm^2)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
8	10	0.17	28.91	3	3.69	118.6
16	20	0.33	28.96	4	4.92	157.8
32	40	0.67	29.06	4	4.92	157.3
63	80	1.34	29.25	7	8.61	273.4
93	120	2.00	29.45	9	11.07	349.2
125	160	2.67	29.65	11	13.53	423.9
155	200	3.34	29.86	13	15.99	497.5
187	240	4.01	30.07	14	17.22	532.1
218	280	4.68	30.28	16	19.68	603.9
248	320	5.34	30.49	17	20.91	637.1
279	360	6.01	30.71	19	23.37	707.0
309	400	6.68	30.93	20	24.60	738.9
340	440	7.35	31.15	20	24.60	733.7
370	480	8.02	31.38	21	25.83	764.8
401	520	8.69	31.61	21	25.83	759.2
432	560	9.35	31.84	21	25.83	753.7
463	600	10.02	32.08	21	25.83	748.1
494	640	10.69	32.32	21	25.83	742.6
525	680	11.36	32.56	21	25.83	737.0
555	720	12.03	32.81	21	25.83	731.5
585	760	12.69	33.06	21	25.83	725.9
617	800	13.36	33.31	21	25.83	720.3
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0

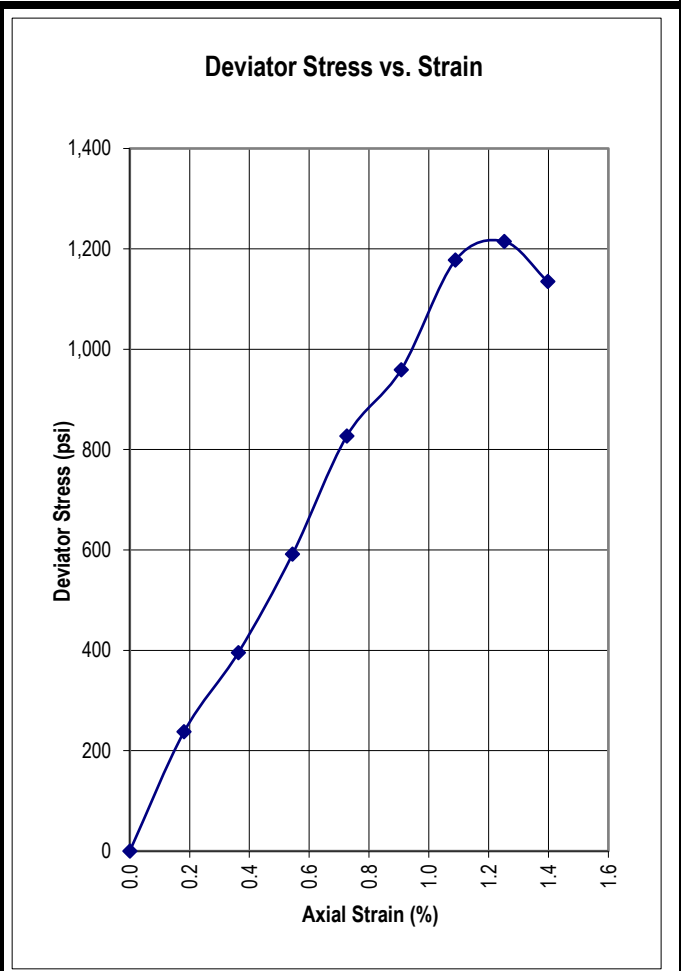


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ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project				Date:	04/08/15
Boring/Trench No.:	B15-2	Sample No.:	L1-1-2	Depth (ft.)	5		Tested By:	JFH
Soil Description:	(SM) Silty SAND, Vis.Est., 50%, Silt 50%, Dark Olive Brown (2.5Y 3/3)						Check By:	DMO
Sample Location:							Lab No.:	C15-035

Sample Data			Sample Sketch At Failure		
Tare Tube Number	I.D.	G8			
Tare Weight	(gm)	766.90			
Wet Soil + Tare	(gm)	1420.00			
Dry Soil + Tare	(gm)	1364.40			
Weight of Water	(gm)	55.60			
Dry Soil Weight	(gm)	597.50			
Moisture Content	(%)	9.31			
Soil Height	(cm)	14.00			
Sample Diameter	(cm)	6.06			
Wet Unit Weight	(pcf)	101.16			
Dry Unit Weight	(pcf)	92.55	Comments: Maximum Shear Strength, S_u = 607.4 psf = 4.22 psi Maximum Unconfined Compressive Strength, q_u = 1,214.8 psf = 8.44 psi		
Specific Gravity	(dim)	2.60			
Saturation	(%)	32.13			
Strain Rate	(%/min.)	1.23			
Proving Ring Constant	(lbs/unit)	1.230			

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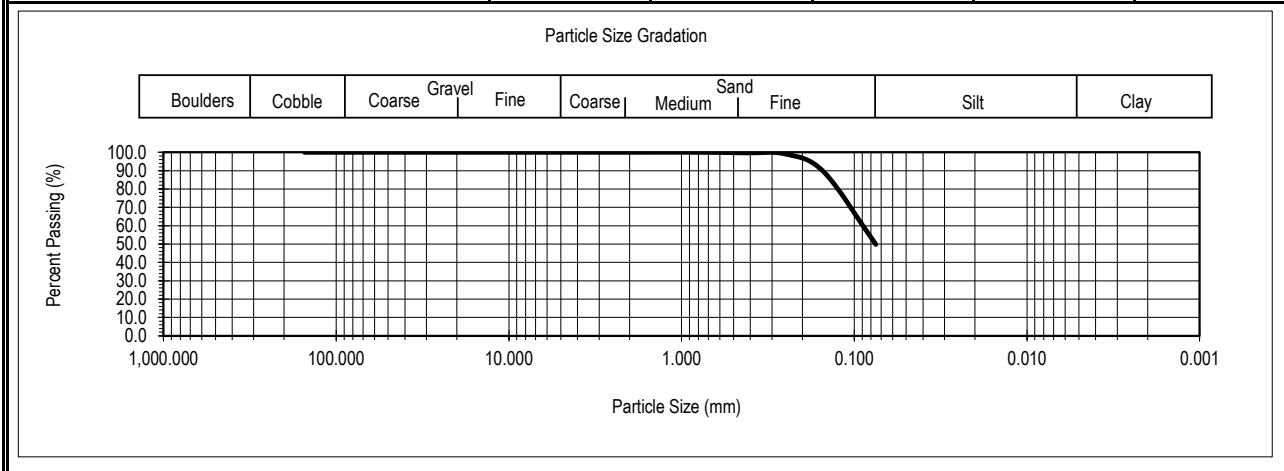
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Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/8/2015**
Sample No.: **L1-2-2** Boring/Trench: **B15-2** Depth, (ft.): **5** Tested By: **JFH**
Description: **(SM) Silty SAND; Lab Data Sand 50%, Silt 50%; Dark Olive Brown (2.5Y 3/3)** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4	0.00	0.0	608.1	100.0
3 Inch	3.0000	76.2	0.00	0.0	608.1	100.0
2 Inch	2.0000	50.8	0.00	0.0	608.1	100.0
1.5 Inch	1.5000	38.1	0.00	0.0	608.1	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	608.1	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	608.1	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	608.1	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	608.1	100.0
#4	0.1875	4.7500	0.00	0.0	608.1	100.0
#10	0.0787	2.0000	0.00	0.0	608.1	100.0
#20	0.0335	0.8500	0.00	0.0	608.1	100.0
#40	0.0167	0.4250	1.89	1.9	606.2	99.7
#60	0.0098	0.2500	3.78	5.7	602.5	99.1
#100	0.0059	0.1500	59.56	65.2	542.9	89.3
#200	0.0030	0.0750	240.13	305.4	302.8	49.8
Hydrometer						



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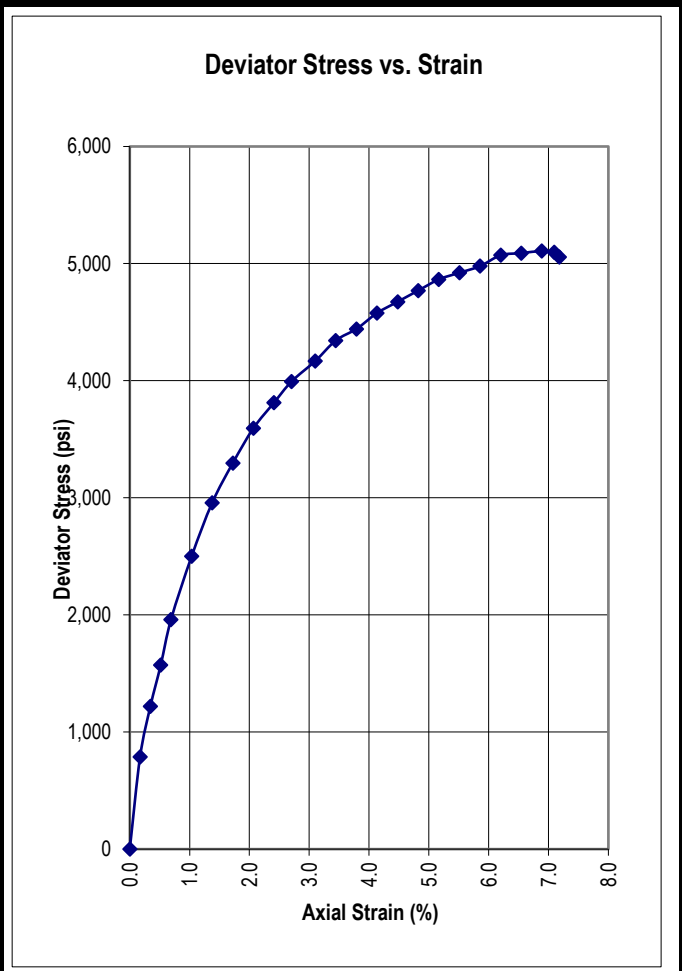
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/08/15
Boring/Trench No.:	B15-2	Sample No.:	L2-1-2	Depth (ft.):	15
Soil Description:	(CL) CLAY; Vis. Est. Clay 90%, Fine Sand 10%, Brown (10YR 4/3)				Tested By: JFH
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure	
Tare Tube Number	I.D.	G3		
Tare Weight	(gm)	765.40		
Wet Soil + Tare	(gm)	1639.60		
Dry Soil + Tare	(gm)	1493.10		
Weight of Water	(gm)	146.50		
Dry Soil Weight	(gm)	727.70		
Moisture Content	(%)	20.13		
Soil Height	(cm)	14.75		
Sample Diameter	(cm)	6.07		
Wet Unit Weight	(pcf)	127.78		
Dry Unit Weight	(pcf)	106.37		
Specific Gravity	(dim)	2.70		
Saturation	(%)	93.09	Comments: Maximum Shear Strength, Su = 2,553.7 psf = 17.73 psi Maximum Unconfined Compressive Strength, qu = 5,107.4 psf = 35.47 psi	
Strain Rate	(%/min.)	1.25		
Proving Ring Constant	(lbs/unit)	1.230		

Elapsed Time (Sec)	Strain		Area (cm²)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
9	10	0.17	29.01	20	24.60	787.9
19	20	0.34	29.06	31	38.13	1219.1
28	30	0.52	29.11	40	49.20	1570.3
37	40	0.69	29.16	50	61.50	1959.5
54	60	1.03	29.26	64	78.72	2499.5
71	80	1.38	29.36	76	93.48	2957.8
87	100	1.72	29.46	85	104.55	3296.5
104	120	2.07	29.57	93	114.39	3594.1
119	140	2.41	29.67	99	121.77	3812.6
134	157	2.70	29.76	104	127.92	3993.1
152	180	3.10	29.88	109	134.07	4168.1
168	200	3.44	29.99	114	140.22	4343.8
184	220	3.79	30.10	117	143.91	4442.2
201	240	4.13	30.21	121	148.83	4577.6
217	260	4.48	30.31	124	152.52	4674.2
232	280	4.82	30.42	127	156.21	4770.1
248	300	5.17	30.53	130	159.90	4865.1
264	320	5.51	30.65	132	162.36	4922.0
281	340	5.85	30.76	134	164.82	4978.3
296	360	6.20	30.87	137	168.51	5071.2
312	380	6.54	30.98	138	169.74	5089.4
328	400	6.89	31.10	139	170.97	5107.4
337	412	7.09	31.17	139	170.97	5096.1
341	417	7.18	31.20	138	169.74	5054.7



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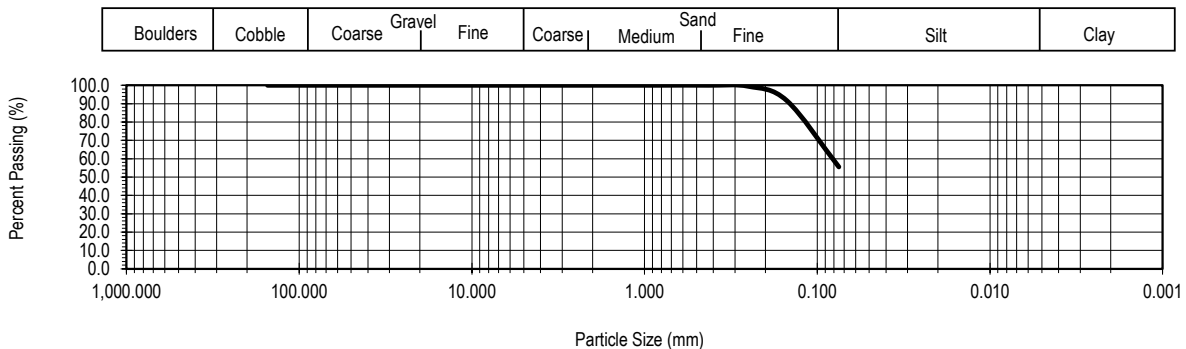
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/8/2015**
Sample No.: **L1-1-2** Boring/Trench: **B15-3** Depth, (ft.): **5** Tested By: **JFH**
Description: **(CL) Sandy Lean Clay, Lab Data Clay 55%, Sand 45%, Dark Greyish Brown (2.** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	678.5	100.0
3 Inch	3.0000	76.2		0.0	678.5	100.0
2 Inch	2.0000	50.8		0.0	678.5	100.0
1.5 Inch	1.5000	38.1		0.0	678.5	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	678.5	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	678.5	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	678.5	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	678.5	100.0
#4	0.1875	4.7500	0.00	0.0	678.5	100.0
#10	0.0787	2.0000	0.00	0.0	678.5	100.0
#20	0.0335	0.8500	0.00	0.0	678.5	100.0
#40	0.0167	0.4250	0.00	0.0	678.5	100.0
#60	0.0098	0.2500	3.83	3.8	674.7	99.4
#100	0.0059	0.1500	53.14	57.0	621.5	91.6
#200	0.0030	0.0750	244.87	301.8	376.7	55.5
Hydrometer						

Particle Size Gradation



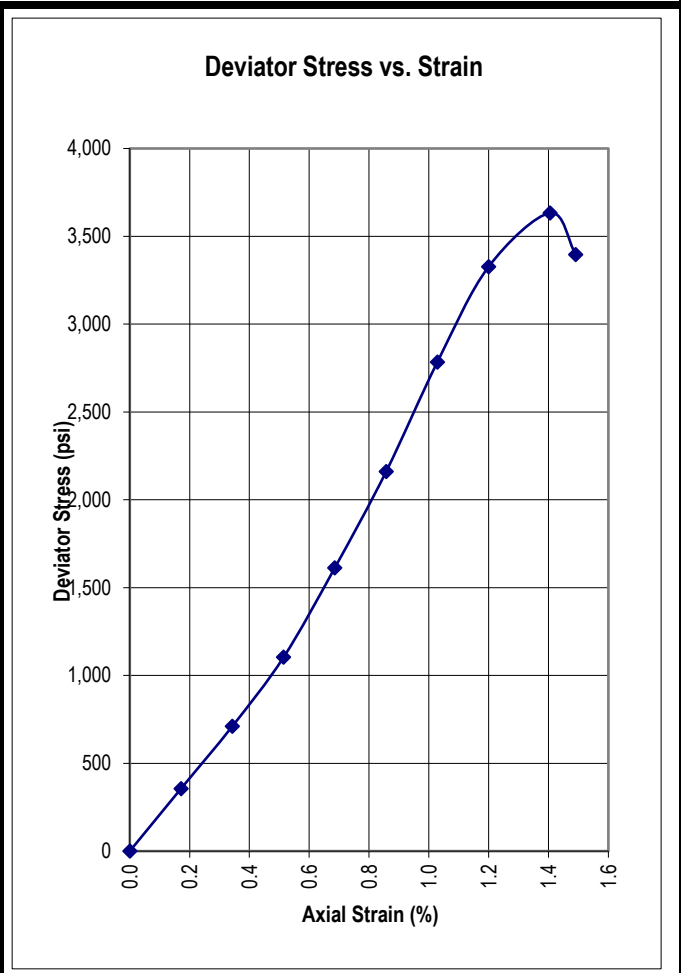
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UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project				Date:	04/08/15
Boring/Trench No.:	B15-3	Sample No.:	L1-1-2	Depth (ft.)	5		Tested By:	JFH
Soil Description:	(CL) Sandy Lean Clay, Lab Data Clay 55%, Sand 45%, Dark Greyish Brown (2.5YR 4/2)						Check By:	DMO
Sample Location:							Lab No.:	C15-035

Sample Data			Sample Sketch At Failure	
Tare Tube Number	I.D.	G4		
Tare Weight	(gm)	766.40		
Wet Soil + Tare	(gm)	1495.00		
Dry Soil + Tare	(gm)	1443.80		
Weight of Water	(gm)	51.20		
Dry Soil Weight	(gm)	677.40		
Moisture Content	(%)	7.56		
Soil Height	(cm)	14.82		
Sample Diameter	(cm)	6.06		
Wet Unit Weight	(pcf)	106.42		
Dry Unit Weight	(pcf)	98.94	Comments:	Maximum Shear Strength, Su = 1,816.4 psf = 12.61 psi Maximum Unconfined Compressive Strength, qu = 3,632.8 psf = 25.23 psi
Specific Gravity	(dim)	2.70		
Saturation	(%)	29.04		
Strain Rate	(%/min.)	1.09		
Proving Ring Constant	(lbs/unit)	1.230		

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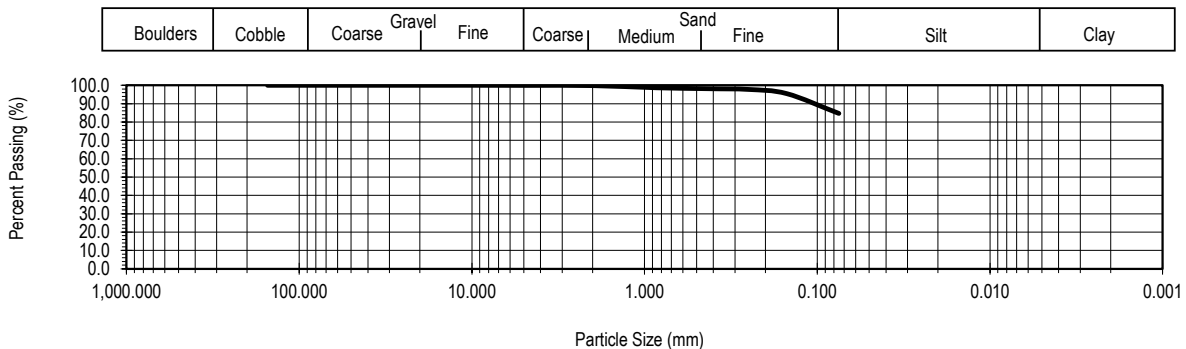
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/2/2015**
Sample No.: **B2-1-1** Boring/Trench: **B15-4** Depth, (ft.): **5'** Tested By: **JFH**
Description: **(CL) Sandy Lean CLAY; Lab Data Clay 85%, Fine Sand 15%; Dark Olive Brown** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	320.6	100.0
3 Inch	3.0000	76.2		0.0	320.6	100.0
2 Inch	2.0000	50.8		0.0	320.6	100.0
1.5 Inch	1.5000	38.1		0.0	320.6	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	320.6	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	320.6	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	320.6	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	320.6	100.0
#4	0.1875	4.7500	0.20	0.2	320.4	99.9
#10	0.0787	2.0000	0.30	0.5	320.1	99.8
#20	0.0335	0.8500	3.84	4.3	316.3	98.6
#40	0.0167	0.4250	1.60	5.9	314.7	98.1
#60	0.0098	0.2500	1.28	7.2	313.4	97.7
#100	0.0059	0.1500	7.36	14.6	306.0	95.5
#200	0.0030	0.0750	34.55	49.1	271.5	84.7
Hydrometer						

Particle Size Gradation



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Moisture & Density

ASTM D2216, D2937, C566

DSA File No.: n/a

DSA App No.: n/a

Project No.: 70508		Project Name: Colusa Waste Water Project		Date: 04/02/15	
				Tested By: JFH	
				Checked By: DMO	
				Lab. No.: C15-035	
SAMPLE LOCATION DATA					
Boring/Trench No.	Units	B15-4			
Sample No.		L2-1-1			
Depth Interval	(ft.)	10'			
Sample Description		Silty SAND, Vis. Est. Sand 65%, Silt 35%, Very Dark Greyish Brown (2.5 Y 3/2)			
USCS Symbol		(SM)			
SAMPLE DIMENSION AND WEIGHT DATA					
Sample Length	(in)	5.919			
Sample Diameter	(in)	2.395			
Sample Volume	(cf)	0.0154			
Wet Soil + Tube Wt.	(gr)	968.30			
Tube Wt.	(gr)	286.60			
Wet Soil Wt.	(gr)	681.70			
MOISTURE CONTENT DATA					
Tare No.		G4			
Tare Wt.	(gr)	766.60			
Wet Soil + Tare Wt.	(gr)	1260.70			
Dry Soil + Tare Wt.	(gr)	1060.30			
Water Wt.	(gr)	200.40			
Dry Soil Wt.	(gr)	293.70			
Moisture Content	(%)	68.2			
TEST RESULTS					
Wet Unit Wt.	(pcf)	97.4			
Moisture Content	(%)	68.2			
Dry Unit Wt.	(pcf)	57.9			
MOISTURE CORRECTION DATA					
Gauge Moisture	(%)				
K Value Correction Factor					
COMPACTION CURVE DATA (ASTM D698, ASTM D1557, or CAL216)					
Test Method					
Curve No.					
Max Wet Unit Wt.	(pcf)				
Max Dry Unit Wt.	(pcf)				
Optimum Moisture	(%)				
Wet Relative Comp.	(%)				
Dry Relative Comp.	(%)				

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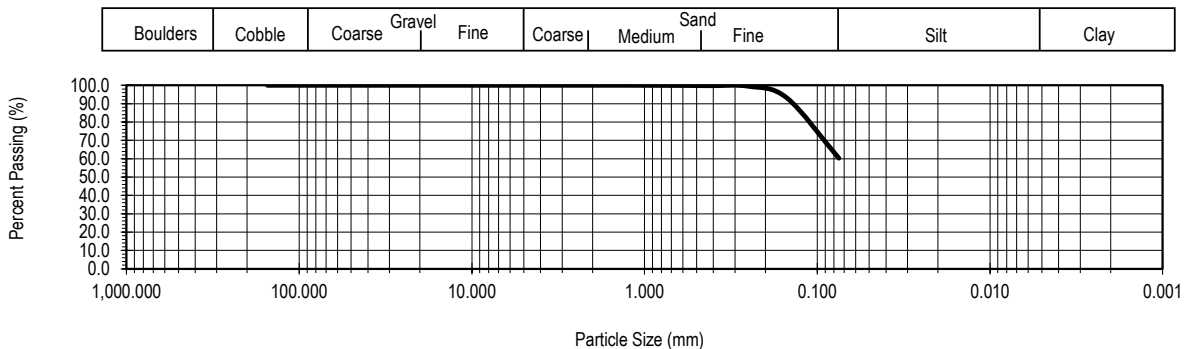
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/2/2015**
Sample No.: **L1-1-2** Boring/Trench: **B15-5** Depth, (ft.): **5'** Tested By: **JFH**
Description: **(ML) Sandy SILT, Lab Data Silt 60%, Sand 40%, Dark Brown, (10YR, 3/3)** Checked By: **0**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	701.6	100.0
3 Inch	3.0000	76.2		0.0	701.6	100.0
2 Inch	2.0000	50.8		0.0	701.6	100.0
1.5 Inch	1.5000	38.1		0.0	701.6	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	701.6	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	701.6	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	701.6	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	701.6	100.0
#4	0.1875	4.7500	0.00	0.0	701.6	100.0
#10	0.0787	2.0000	0.00	0.0	701.6	100.0
#20	0.0335	0.8500	0.31	0.3	701.3	100.0
#40	0.0167	0.4250	1.23	1.5	700.1	99.8
#60	0.0098	0.2500	2.15	3.7	697.9	99.5
#100	0.0059	0.1500	44.54	48.2	653.4	93.1
#200	0.0030	0.0750	230.39	278.6	423.0	60.3
Hydrometer						

Particle Size Gradation



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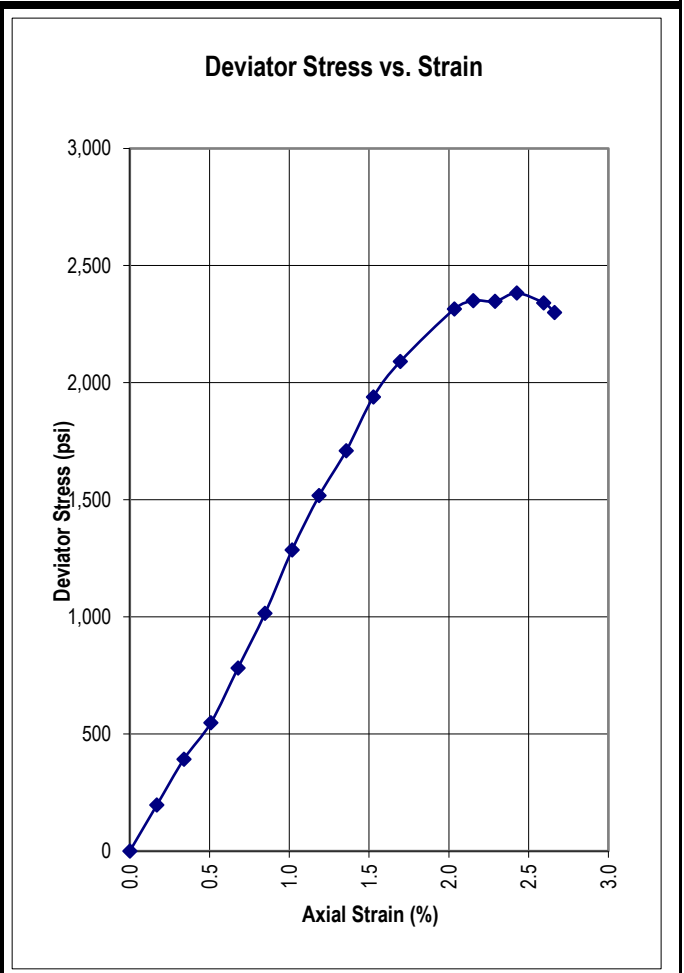
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/08/15
Boring/Trench No.:	B15-5	Sample No.:	L1-1-2	Depth (ft.):	5
Soil Description:	(ML) Sandy SILT, Lab Data Silt 60%, Sand 40%, Dark Brown, (10YR, 3/3)				Tested By: JFH
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure		
Tare Tube Number	I.D.	G3			
Tare Weight	(gm)	765.20			
Wet Soil + Tare	(gm)	1601.00			
Dry Soil + Tare	(gm)	1467.80			
Weight of Water	(gm)	133.20			
Dry Soil Weight	(gm)	702.60			
Moisture Content	(%)	18.96			
Soil Height	(cm)	14.98			
Sample Diameter	(cm)	6.08			
Wet Unit Weight	(pcf)	120.09			
Dry Unit Weight	(pcf)	100.95			
Specific Gravity	(dim)	2.60			
Saturation	(%)	81.19	Comments: Maximum Shear Strength, Su = 1,191.3 psf = 8.27 psi Maximum Unconfined Compressive Strength, qu = 2,382.6 psf = 16.55 psi		
Strain Rate	(%/min.)	1.29			
Proving Ring Constant	(lbs/unit)	1.230			

Elapsed Time (Sec)	Strain		Area (cm²)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
5	10	0.17	29.06	5	6.15	196.6
13	20	0.34	29.11	10	12.30	392.5
21	30	0.51	29.16	14	17.22	548.6
30	40	0.68	29.21	20	24.60	782.3
38	50	0.85	29.26	26	31.98	1015.3
46	60	1.02	29.31	33	40.59	1286.5
55	70	1.19	29.36	39	47.97	1517.8
63	80	1.36	29.41	44	54.12	1709.4
71	90	1.53	29.46	50	61.50	1939.2
79	100	1.70	29.51	54	66.42	2090.7
95	120	2.04	29.62	60	73.80	2315.0
101	127	2.15	29.65	61	75.03	2350.7
107	135	2.29	29.69	61	75.03	2347.4
113	143	2.43	29.74	62	76.26	2382.6
120	153	2.59	29.79	61	75.03	2340.1
124	157	2.66	29.81	60	73.80	2300.1
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0



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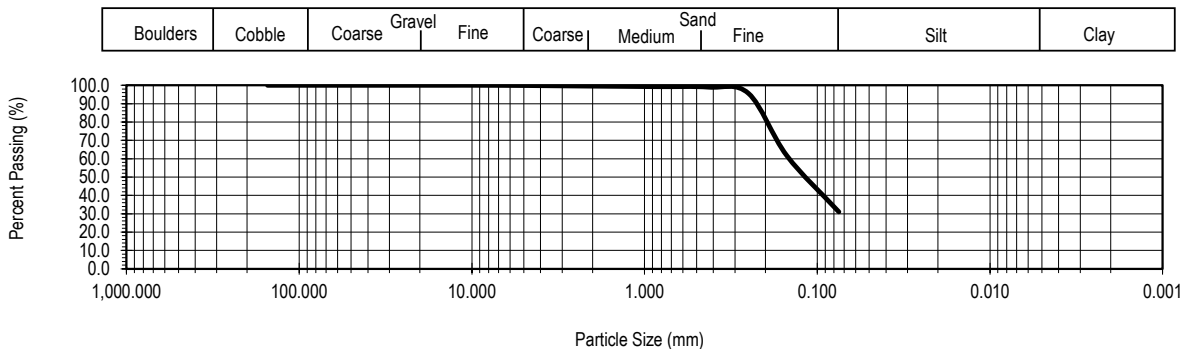
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/2/2015**
Sample No.: **B2-1-1** Boring/Trench: **B15-5** Depth, (ft.): **10'** Tested By: **JFH**
Description: **(SC) Clayey SAND; Lab Data Sand 69%, Clay 31%; Dark Greyish Brown (2.5Y 4** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	504.4	100.0
3 Inch	3.0000	76.2		0.0	504.4	100.0
2 Inch	2.0000	50.8		0.0	504.4	100.0
1.5 Inch	1.5000	38.1		0.0	504.4	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	504.4	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	504.4	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	504.4	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	504.4	100.0
#4	0.1875	4.7500	0.70	0.7	503.7	99.9
#10	0.0787	2.0000	1.60	2.3	502.1	99.5
#20	0.0335	0.8500	1.42	3.7	500.7	99.3
#40	0.0167	0.4250	1.42	5.1	499.3	99.0
#60	0.0098	0.2500	17.27	22.4	482.0	95.6
#100	0.0059	0.1500	171.25	193.7	310.7	61.6
#200	0.0030	0.0750	154.22	347.9	156.5	31.0
Hydrometer						

Particle Size Gradation

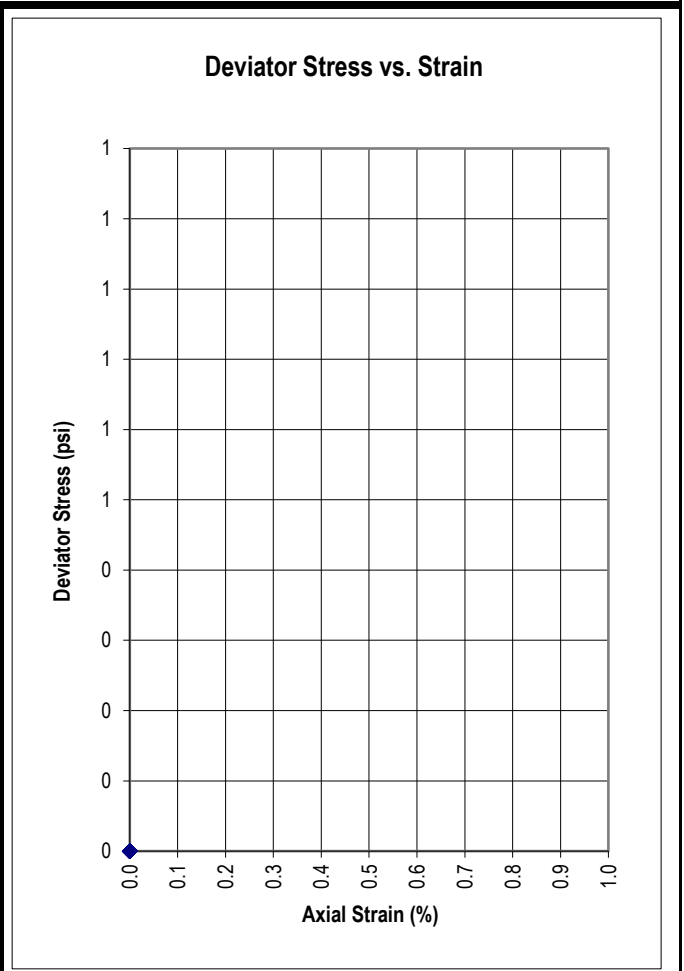


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ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project				Date:	04/20/15
Boring/Trench No.:	B15-7	Sample No.:	L1-1-2	Depth (ft.)	15		Tested By:	CHB
Soil Description:							Check By:	DMO
Sample Location:							Lab No.:	C15-035

Sample Data			Sample Sketch At Failure		
Tare Tube Number	I.D.				
Tare Weight	(gm)				
Wet Soil + Tare	(gm)				
Dry Soil + Tare	(gm)				
Weight of Water	(gm)				
Dry Soil Weight	(gm)				
Moisture Content	(%)				
Soil Height	(cm)				
Sample Diameter	(cm)				
Wet Unit Weight	(pcf)				
Dry Unit Weight	(pcf)		Comments: Sample broke when extruding		
Specific Gravity	(dim)	2.30			
Saturation	(%)				
Strain Rate	(%/min.)	#DIV/0!			
Proving Ring Constant	(lbs/unit)	1.230	Maximum Shear Strength, Su = 0.0 psf = 0.00 psi Maximum Unconfined Compressive Strength, qu = 0.0 psf = 0.00 psi		

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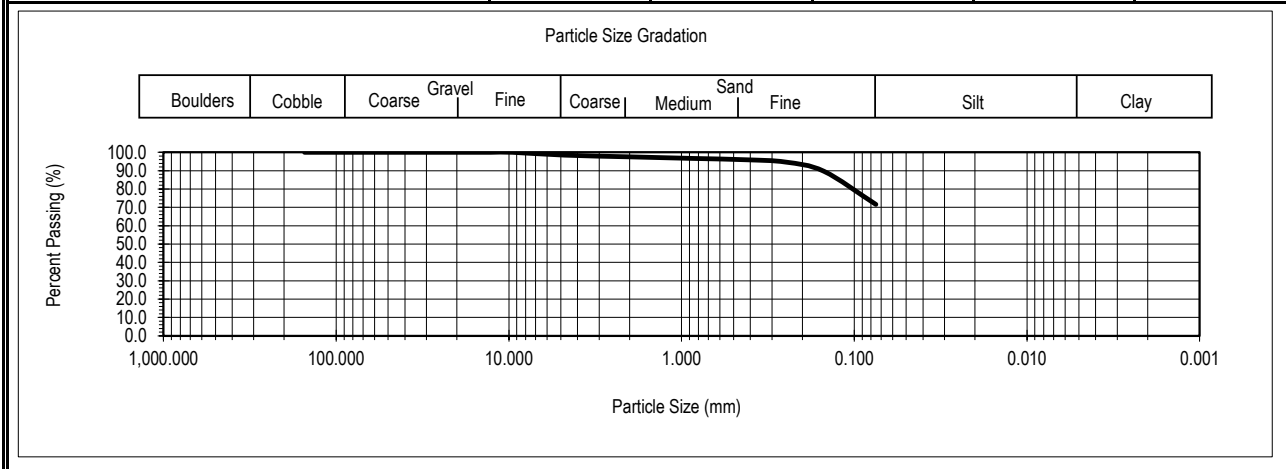
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Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/2/2015**
 Sample No.: **L1-2-2** Boring/Trench: **B15-7** Depth, (ft.): **5'** Tested By: **JFH**
 Description: **(CL) Lean CLAY w/ Sand; Lab Data Clay 72%, fine Sand 28%; dark Brown (10Y** Checked By: **DMO**
 Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	672.3	100.0
3 Inch	3.0000	76.2		0.0	672.3	100.0
2 Inch	2.0000	50.8		0.0	672.3	100.0
1.5 Inch	1.5000	38.1		0.0	672.3	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	672.3	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	672.3	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	672.3	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	672.3	100.0
#4	0.1875	4.7500	10.40	10.4	661.9	98.5
#10	0.0787	2.0000	6.20	16.6	655.7	97.5
#20	0.0335	0.8500	5.86	22.5	649.8	96.7
#40	0.0167	0.4250	4.80	27.3	645.0	95.9
#60	0.0098	0.2500	8.53	35.8	636.5	94.7
#100	0.0059	0.1500	33.58	69.4	602.9	89.7
#200	0.0030	0.0750	121.54	190.9	481.4	71.6
Hydrometer						



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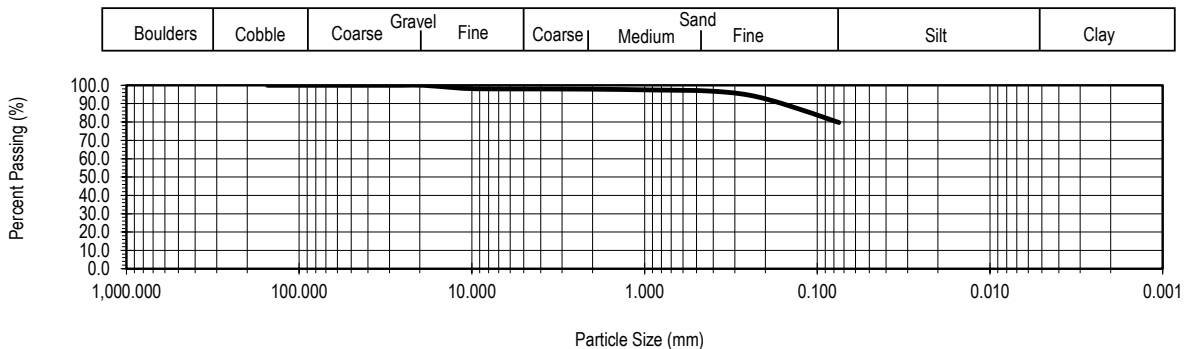
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/2/2015**
Sample No.: **B2-1-1** Boring/Trench: **B15-7** Depth, (ft.): **10'** Tested By: **JFH**
Description: **(CL) Lean CLAY w/ Sand; Lab Data Clay 80%, Sand 18%; Dark Greyish Brown** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	606.9	100.0
3 Inch	3.0000	76.2		0.0	606.9	100.0
2 Inch	2.0000	50.8		0.0	606.9	100.0
1.5 Inch	1.5000	38.1		0.0	606.9	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	606.9	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	606.9	100.0
1/2 Inch	0.5000	12.7	7.70	7.7	599.2	98.7
3/8 Inch	0.3750	9.5	3.70	11.4	595.5	98.1
#4	0.1875	4.7500	0.60	12.0	594.9	98.0
#10	0.0787	2.0000	0.80	12.8	594.1	97.9
#20	0.0335	0.8500	2.83	15.6	591.3	97.4
#40	0.0167	0.4250	3.23	18.9	588.0	96.9
#60	0.0098	0.2500	13.32	32.2	574.7	94.7
#100	0.0059	0.1500	33.11	65.3	541.6	89.2
#200	0.0030	0.0750	57.74	123.0	483.8	79.7
Hydrometer						

Particle Size Gradation



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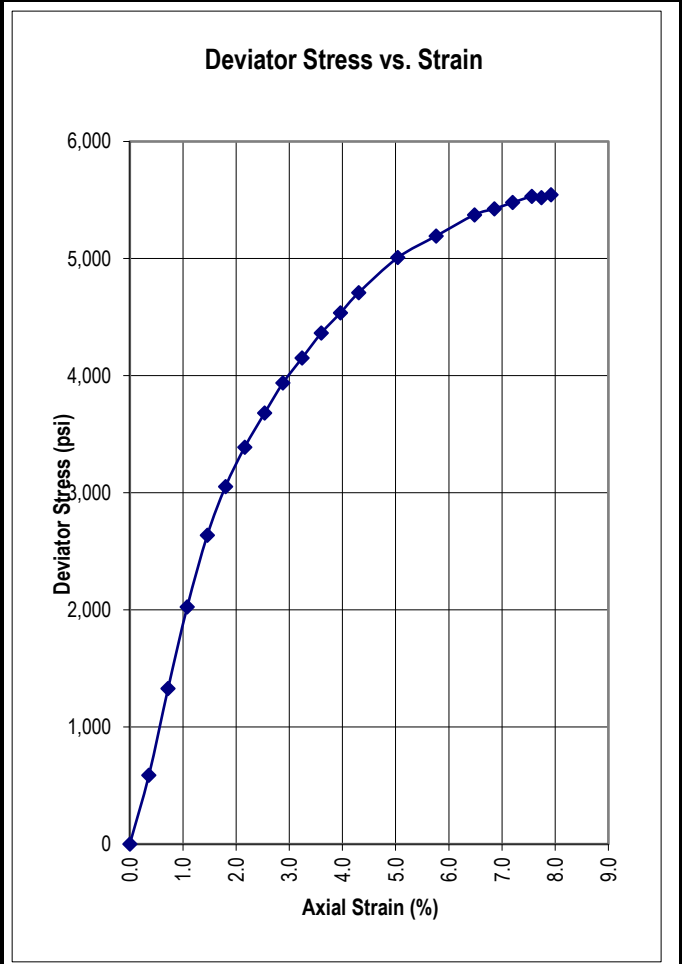
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/20/15
Boring/Trench No.:	B15-17	Sample No.:	L2-1-2	Depth (ft.)	15
Soil Description:	(CL) Lean CLAY; Dark Yellowish Brown (10YR 4/4)				Tested By: CHB
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure		
Tare Tube Number	I.D.	ZZ2			
Tare Weight	(gm)	169.10			
Wet Soil + Tare	(gm)	993.20			
Dry Soil + Tare	(gm)	835.80			
Weight of Water	(gm)	157.40			
Dry Soil Weight	(gm)	666.70			
Moisture Content	(%)	23.61			
Soil Height	(cm)	14.11			
Sample Diameter	(cm)	6.08			
Wet Unit Weight	(pcf)	125.59			
Dry Unit Weight	(pcf)	101.61			
Specific Gravity	(dim)	2.30			
Saturation	(%)	131.63	Comments: Maximum Shear Strength, Su = 2,772.4 psf = 19.25 psi Maximum Unconfined Compressive Strength, qu = 5,544.9 psf = 38.51 psi		
Strain Rate	(%/min.)	1.34			
Proving Ring Constant	(lbs/unit)	1.230			

Elapsed Time (Sec)	Strain		Area (cm²)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
16	20	0.36	29.14	15	18.45	588.3
33	40	0.72	29.24	34	41.82	1328.6
50	60	1.08	29.35	52	63.96	2024.5
67	81	1.46	29.46	68	83.64	2637.4
83	100	1.80	29.57	79	97.17	3053.3
98	120	2.16	29.67	88	108.24	3388.7
119	141	2.54	29.79	96	118.08	3682.5
130	160	2.88	29.89	103	126.69	3937.2
146	180	3.24	30.01	109	134.07	4151.1
163	200	3.60	30.12	115	141.45	4363.3
177	220	3.96	30.23	120	147.60	4536.0
192	239	4.30	30.34	125	153.75	4708.1
224	280	5.04	30.57	134	164.82	5008.2
254	320	5.76	30.81	140	172.20	5192.8
286	360	6.48	31.05	146	179.58	5373.9
302	381	6.86	31.17	148	182.04	5425.5
316	400	7.20	31.29	150	184.50	5478.7
331	420	7.56	31.41	152	186.96	5530.2
339	430	7.74	31.47	152	186.96	5519.4
347	440	7.92	31.53	153	188.19	5544.9
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0



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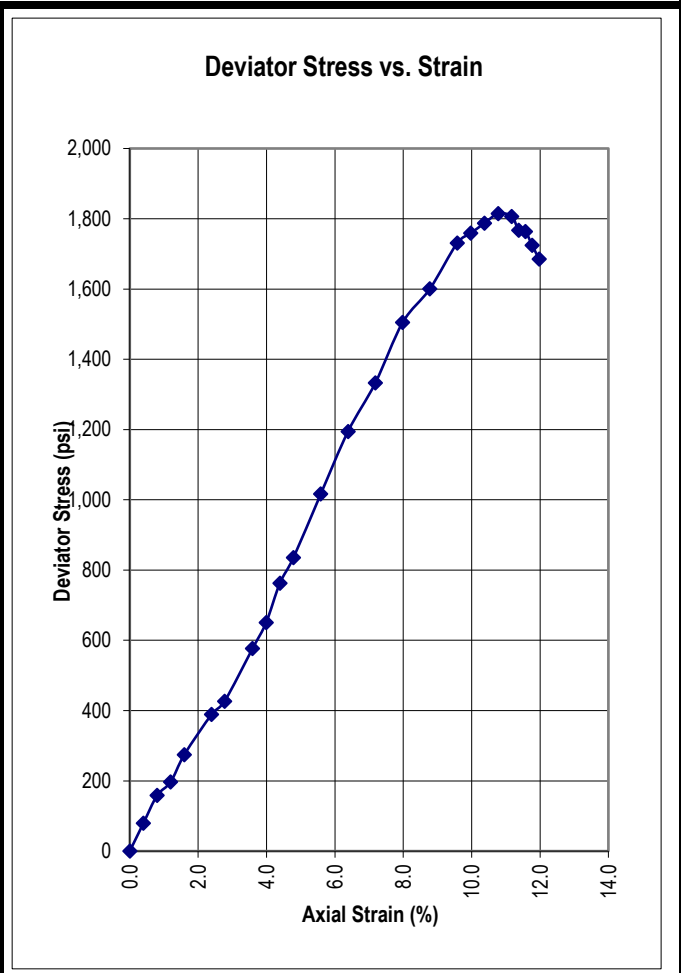
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/21/15
Boring/Trench No.:	B15-8	Sample No.:	L1-1-2	Depth (ft.):	5
Soil Description:	(CL) CLAY; Vis. Est. Clay 85%, Fine Sand 15%; Dark Greyish Brown (10YR 4/2)				Tested By: CHB
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure		
Tare Tube Number	I.D.	ZZ5			
Tare Weight	(gm)	171.00			
Wet Soil + Tare	(gm)	908.50			
Dry Soil + Tare	(gm)	781.20			
Weight of Water	(gm)	127.30			
Dry Soil Weight	(gm)	610.20			
Moisture Content	(%)	20.86			
Soil Height	(cm)	12.73			
Sample Diameter	(cm)	6.04			
Wet Unit Weight	(pcf)	126.24			
Dry Unit Weight	(pcf)	104.45			
Specific Gravity	(dim)	2.30	Comments: Maximum Shear Strength, Su = 907.4 psf = 6.30 psi Maximum Unconfined Compressive Strength, qu = 1,814.8 psf = 12.60 psi		
Saturation	(%)	128.26			
Strain Rate	(%/min.)	1.33			
Proving Ring Constant	(lbs/unit)	1.230			

Elapsed Time (Sec)	Strain		Area (cm²)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
15	20	0.40	28.77	2	2.46	79.4
31	40	0.80	28.88	4	4.92	158.3
46	60	1.20	29.00	5	6.15	197.0
62	80	1.60	29.12	7	8.61	274.7
92	120	2.39	29.36	10	12.30	389.3
106	139	2.77	29.47	11	13.53	426.5
138	180	3.59	29.72	15	18.45	576.7
153	200	3.99	29.84	17	20.91	650.9
169	220	4.39	29.97	20	24.60	762.6
184	240	4.79	30.09	22	27.06	835.4
215	280	5.59	30.35	27	33.21	1016.6
246	320	6.38	30.61	32	39.36	1194.7
277	360	7.18	30.87	36	44.28	1332.6
308	400	7.98	31.14	41	50.43	1504.6
339	440	8.78	31.41	44	54.12	1600.7
371	480	9.58	31.69	48	59.04	1731.0
385	500	9.98	31.83	49	60.27	1759.2
401	520	10.38	31.97	50	61.50	1787.2
416	540	10.77	32.11	51	62.73	1814.8
432	560	11.17	32.26	51	62.73	1806.7
439	570	11.37	32.33	50	61.50	1767.3
447	580	11.57	32.40	50	61.50	1763.3
455	590	11.77	32.48	49	60.27	1724.1
462	600	11.97	32.55	48	59.04	1685.1



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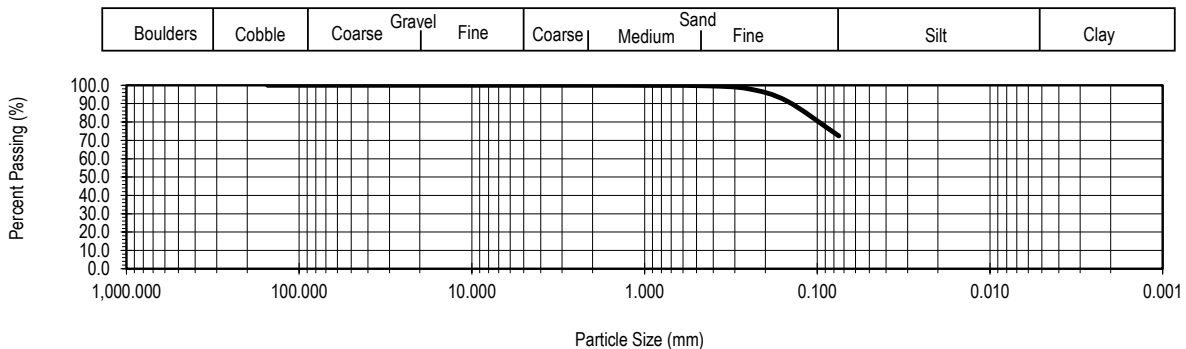
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/2/2015**
Sample No.: **L1-2-2** Boring/Trench: **B15-8** Depth, (ft.): **5'** Tested By: **JFH**
Description: **(CL) Lean CLAY w/ Fine Sand; Lab Data Clay 78%, Fine Sand 18%; Dark Grey;** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	687.9	100.0
3 Inch	3.0000	76.2		0.0	687.9	100.0
2 Inch	2.0000	50.8		0.0	687.9	100.0
1.5 Inch	1.5000	38.1		0.0	687.9	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	687.9	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	687.9	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	687.9	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	687.9	100.0
#4	0.1875	4.7500	0.00	0.0	687.9	100.0
#10	0.0787	2.0000	0.00	0.0	687.9	100.0
#20	0.0335	0.8500	0.55	0.6	687.3	99.9
#40	0.0167	0.4250	1.65	2.2	685.7	99.7
#60	0.0098	0.2500	11.00	13.2	674.7	98.1
#100	0.0059	0.1500	45.67	58.9	629.0	91.4
#200	0.0030	0.0750	130.95	189.8	498.1	72.4
Hydrometer						

Particle Size Gradation



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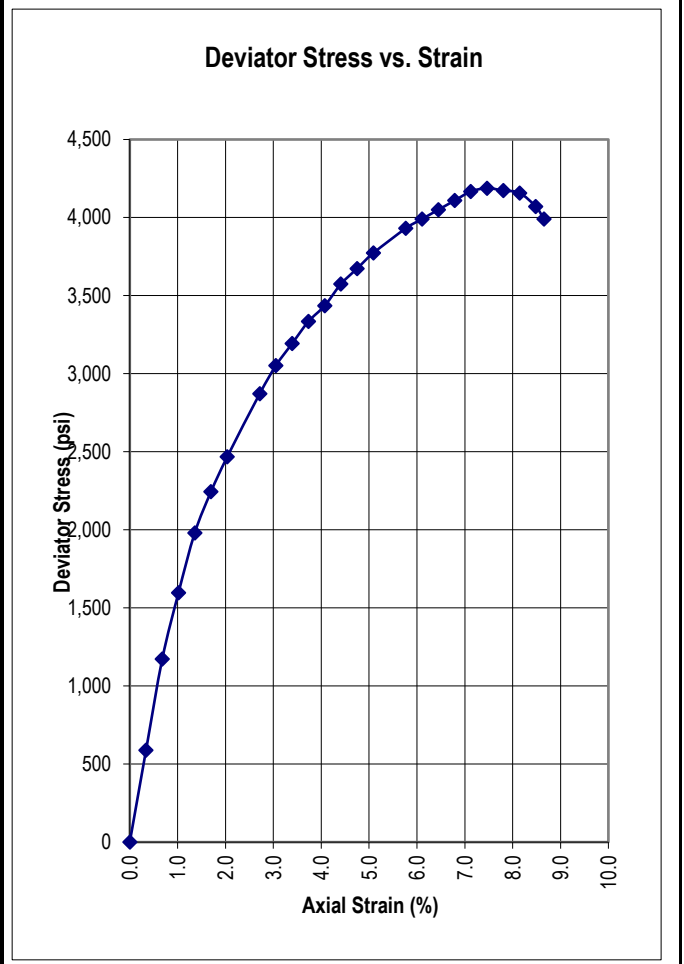
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/22/15
Boring/Trench No.:	B15-8	Sample No.:	L2-1-2	Depth (ft.)	15
Soil Description:	(CL) Lean CLAY; Brown (10YR 4/3)				Tested By: CHB
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure		
Tare Tube Number	I.D.	ZZ11			
Tare Weight	(gm)	175.70			
Wet Soil + Tare	(gm)	1046.20			
Dry Soil + Tare	(gm)	892.50			
Weight of Water	(gm)	153.70			
Dry Soil Weight	(gm)	716.80			
Moisture Content	(%)	21.44			
Soil Height	(cm)	14.97			
Sample Diameter	(cm)	6.08			
Wet Unit Weight	(pcf)	125.04			
Dry Unit Weight	(pcf)	102.96			
Specific Gravity	(dim)	2.30			
Saturation	(%)	125.21	Comments: Maximum Shear Strength, Su = 2,094.2 psf = 14.54 psi Maximum Unconfined Compressive Strength, qu = 4,188.3 psf = 29.09 psi		
Strain Rate	(%/min.)	1.33			
Proving Ring Constant	(lbs/unit)	1.230			

Elapsed Time (Sec)	Strain		Area (cm²)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
12	20	0.34	29.13	15	18.45	588.4
29	40	0.68	29.23	30	36.90	1172.7
46	60	1.02	29.33	41	50.43	1597.3
63	80	1.36	29.43	51	62.73	1980.0
79	100	1.70	29.53	58	71.34	2244.1
95	120	2.04	29.64	64	78.72	2467.7
127	160	2.71	29.84	75	92.25	2871.7
144	180	3.05	29.95	80	98.40	3052.5
159	200	3.39	30.05	84	103.32	3193.9
174	220	3.73	30.16	88	108.24	3334.3
190	240	4.07	30.27	91	111.93	3435.8
206	260	4.41	30.37	95	116.85	3574.1
222	280	4.75	30.48	98	120.54	3673.9
237	300	5.09	30.59	101	124.23	3772.9
269	340	5.77	30.81	106	130.38	3931.3
285	360	6.11	30.92	108	132.84	3991.1
300	380	6.45	31.03	110	135.30	4050.3
316	400	6.79	31.15	112	137.76	4109.0
331	420	7.13	31.26	114	140.22	4167.1
347	440	7.47	31.38	115	141.45	4188.3
363	460	7.80	31.49	115	141.45	4173.0
378	480	8.14	31.61	115	141.45	4157.6
393	500	8.48	31.72	113	138.99	4070.2
402	510	8.65	31.78	111	136.53	3990.7



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Atterberg Indices

ASTM D4318

DSA File No.: n/a

DSA App No.: n/a

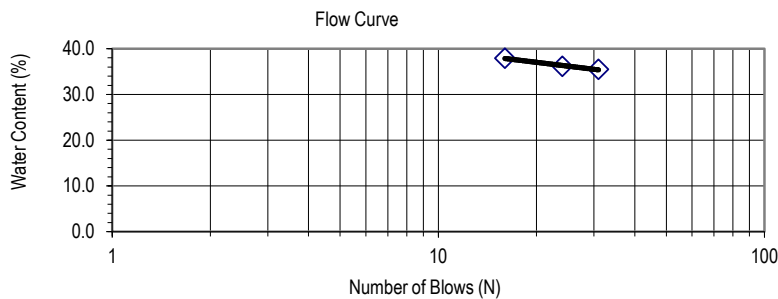
Project No.:	70508	Project Name:	Colusa Waste Water Project	Date:	04/02/15
Sample No.:	L2-2-2	Boring/Trench:	B15-8	Depth, (ft.):	15'
Description:	(CL) Lean CLAY; Lab Data Clay 90%; Brown (10YR 4/3)				Tested By:
Sample Location:					Checked By:
					Lab. No.:
					C15-035

Estimated % of Sample Retained on No. 40 Sieve:	0	Sample Air Dried:	yes
Test Method A or B:	A		

LIQUID LIMIT:						PLASTIC LIMIT:		
Sample No.:	1	2	3	4	5	1	2	3
Pan ID:	B	C	B			E	D	
Wt. Pan (gr)	38.97	38.46	38.45			36.45	38.27	
Wt. Wet Soil + Pan (gr)	55.27	52.73	53.83			47.91	47.40	
Wt. Dry Soil + Pan (gr)	51.00	48.94	49.60			46.15	46.01	
Wt. Water (gr)	4.27	3.79	4.23			1.76	1.39	
Wt. Dry Soil (gr)	12.03	10.48	11.15			9.70	7.74	
Water Content (%)	35.5	36.2	37.9			18.1	18.0	
Number of Blows, N	31	24	16					

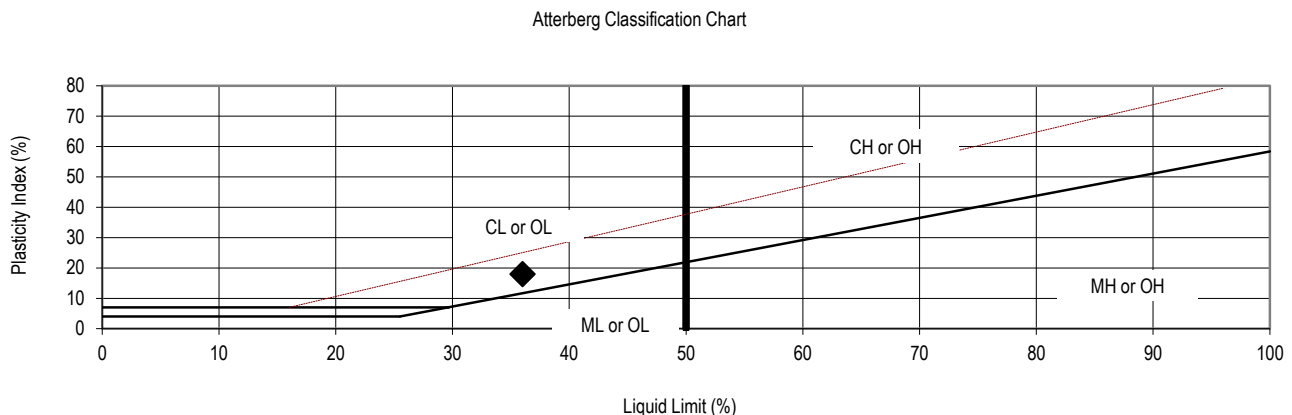
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PLASTIC LIMIT = 18



Plasticity Index = 18

Group Symbol = CL



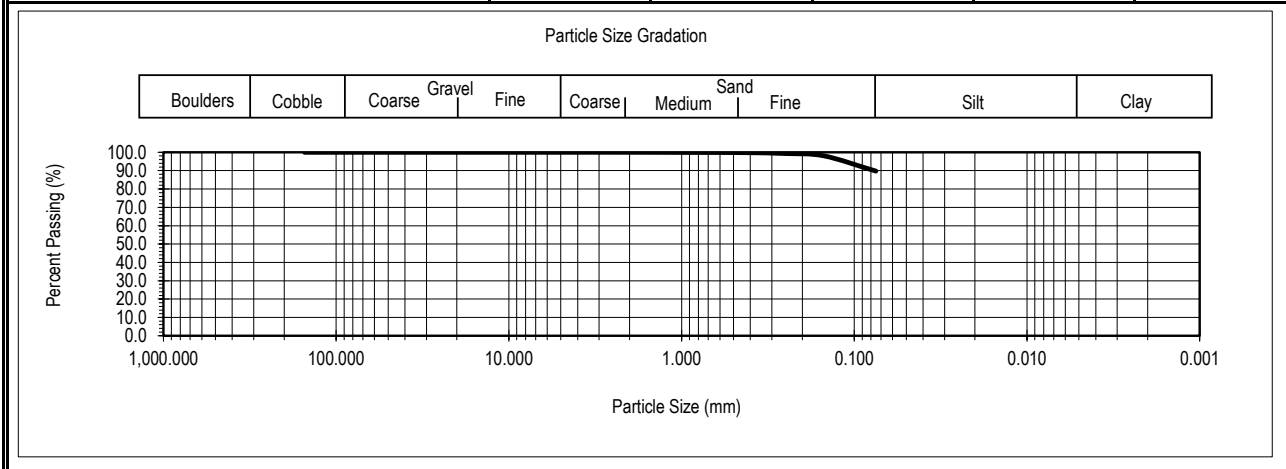
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Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/2/2015**
Sample No.: **L2-2-2** Boring/Trench: **B15-8** Depth, (ft.): **15'** Tested By: **JFH**
Description: **(CL) Lean CLAY; Lab Data Clay 90%; Brown (10YR 4/3)** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	581.5	100.0
3 Inch	3.0000	76.2		0.0	581.5	100.0
2 Inch	2.0000	50.8		0.0	581.5	100.0
1.5 Inch	1.5000	38.1		0.0	581.5	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	581.5	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	581.5	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	581.5	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	581.5	100.0
#4	0.1875	4.7500	0.00	0.0	581.5	100.0
#10	0.0787	2.0000	0.00	0.0	581.5	100.0
#20	0.0335	0.8500	0.56	0.6	580.9	99.9
#40	0.0167	0.4250	0.56	1.1	580.4	99.8
#60	0.0098	0.2500	2.81	3.9	577.6	99.3
#100	0.0059	0.1500	7.30	11.2	570.3	98.1
#200	0.0030	0.0750	48.30	59.5	522.0	89.8
Hydrometer						



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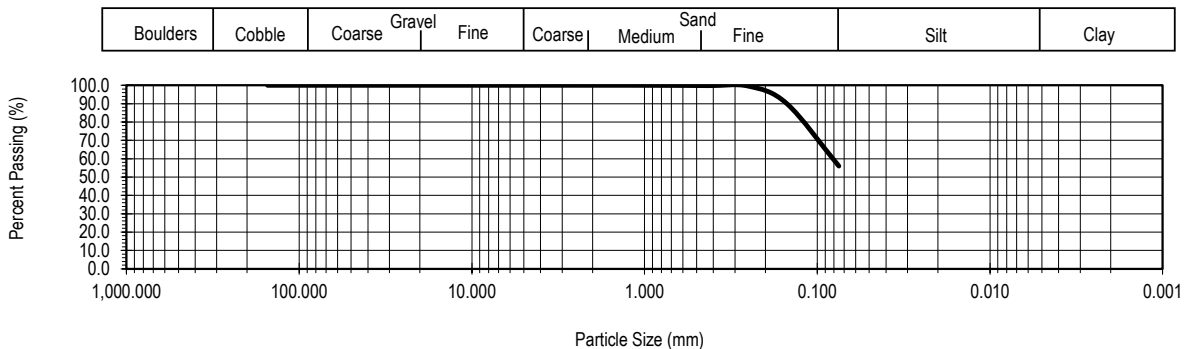
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/20/2015**
Sample No.: **L1-1-2** Boring/Trench: **B15-11** Depth, (ft.): **5'** Tested By: **JFH**
Description: **(CL) Sandy Lean CLAY Lab Data Clay 56%, Sand 44%; Dark Olive Brown (2.5Y** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	664.7	100.0
3 Inch	3.0000	76.2		0.0	664.7	100.0
2 Inch	2.0000	50.8		0.0	664.7	100.0
1.5 Inch	1.5000	38.1		0.0	664.7	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	664.7	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	664.7	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	664.7	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	664.7	100.0
#4	0.1875	4.7500	0.00	0.0	664.7	100.0
#10	0.0787	2.0000	0.00	0.0	664.7	100.0
#20	0.0335	0.8500	0.26	0.3	664.4	100.0
#40	0.0167	0.4250	1.05	1.3	663.4	99.8
#60	0.0098	0.2500	1.83	3.1	661.6	99.5
#100	0.0059	0.1500	63.38	66.5	598.2	90.0
#200	0.0030	0.0750	226.02	292.5	372.2	56.0
Hydrometer						

Particle Size Gradation



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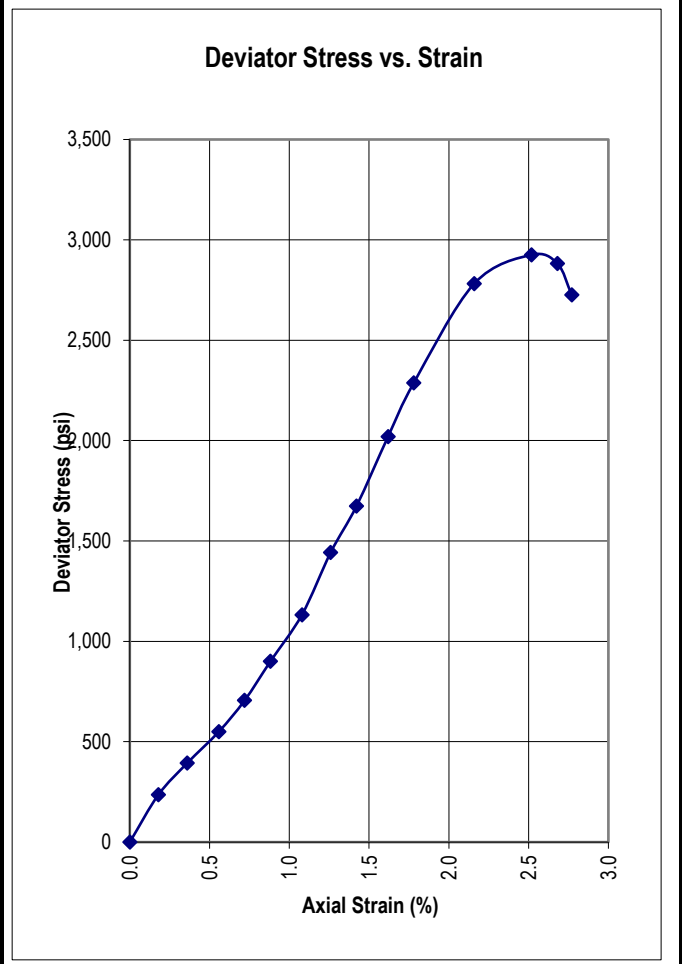
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/23/15
Boring/Trench No.:	B15-11	Sample No.:	L1-1-2	Depth (ft.)	5
Soil Description:	(CL) Sandy Lean CLAY Lab Data Clay 56%, Sand 44%; Dark Olive Brown (2.5Y 3/3)				Tested By: CHB
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure		
Tare Tube Number	I.D.	ZZ8			
Tare Weight	(gm)	172.30			
Wet Soil + Tare	(gm)	912.40			
Dry Soil + Tare	(gm)	829.70			
Weight of Water	(gm)	82.70			
Dry Soil Weight	(gm)	657.40			
Moisture Content	(%)	12.58			
Soil Height	(cm)	14.12			
Sample Diameter	(cm)	6.07			
Wet Unit Weight	(pcf)	113.08			
Dry Unit Weight	(pcf)	100.45			
Specific Gravity	(dim)	2.30			
Saturation	(%)	67.47	Comments: Maximum Shear Strength, Su = 1,462.8 psf = 10.16 psi Maximum Unconfined Compressive Strength, qu = 2,925.5 psf = 20.32 psi		
Strain Rate	(%/min.)	1.32			
Proving Ring Constant	(lbs/unit)	1.230			

Elapsed Time (Sec)	Strain		Area (cm^2)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
8	10	0.18	28.99	6	7.38	236.5
16	20	0.36	29.04	10	12.30	393.5
25	31	0.56	29.10	14	17.22	549.8
33	40	0.72	29.15	18	22.14	705.7
40	49	0.88	29.20	23	28.29	900.2
49	60	1.08	29.25	29	35.67	1132.8
58	70	1.26	29.31	37	45.51	1442.7
66	79	1.42	29.36	43	52.89	1673.9
75	90	1.62	29.41	52	63.96	2020.1
82	99	1.78	29.46	59	72.57	2288.3
100	120	2.16	29.58	72	88.56	2781.8
115	140	2.52	29.69	76	93.48	2925.5
122	149	2.68	29.73	75	92.25	2882.2
125	154	2.77	29.76	71	87.33	2726.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0



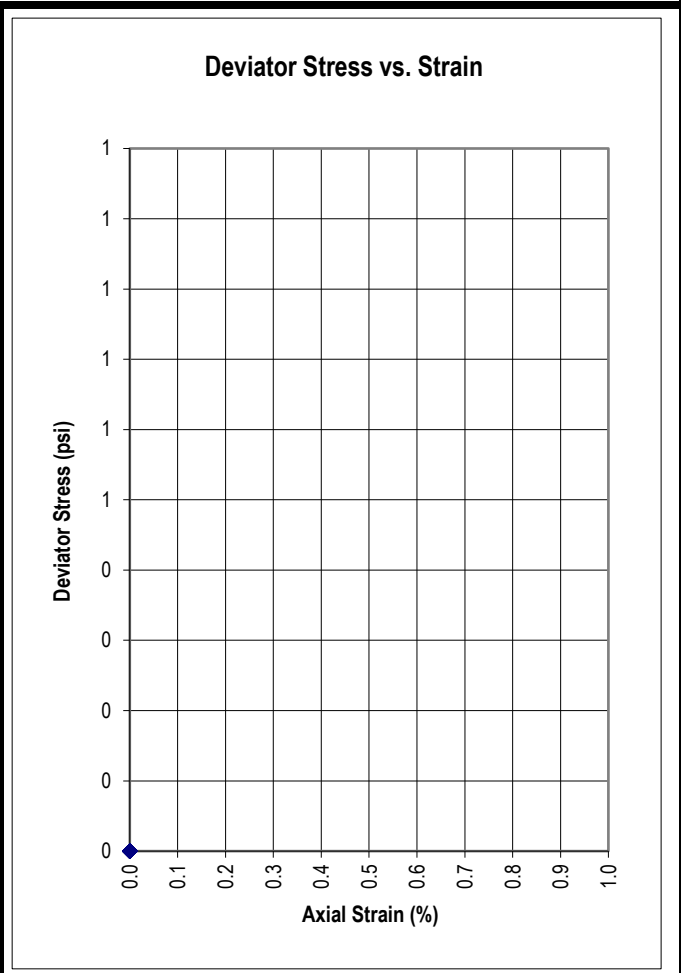
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UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project				Date:	04/23/15
Boring/Trench No.:	B15-11	Sample No.:	L2-1-2	Depth (ft.)	10		Tested By:	CHB
Soil Description:	(CL) Clayey SAND, Lab Data Sand 78%, Clay 22%; Dark Olive Brown (2.5Y 3/3)						Check By:	DMO
Sample Location:							Lab No.:	C15-035

Sample Data			Sample Sketch At Failure		
Tare Tube Number	I.D.	ZZ7			
Tare Weight	(gm)	171.40			
Wet Soil + Tare	(gm)	835.90			
Dry Soil + Tare	(gm)	782.40			
Weight of Water	(gm)	53.50			
Dry Soil Weight	(gm)	611.00			
Moisture Content	(%)	8.76			
Soil Height	(cm)	15.12			
Sample Diameter	(cm)	6.05			
Wet Unit Weight	(pcf)	95.44			
Dry Unit Weight	(pcf)	87.76	Comments: BROKE DURING EXTRUSION Maximum Shear Strength, Su = 0.0 psf = 0.00 psi Maximum Unconfined Compressive Strength, qu = 0.0 psf = 0.00 psi		
Specific Gravity	(dim)	2.30			
Saturation	(%)	31.70			
Strain Rate	(%/min.)	#DIV/0!			
Proving Ring Constant	(lbs/unit)	1.230			

[illegible]

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Atterberg Indices

ASTM D4318

DSA File No.: n/a

DSA App No.: n/a

Project No.:	70508	Project Name:	Colusa Waste Water Project	Date:	04/02/15	
Sample No.:	B3-1-1	Boring/Trench:	B15-11	Depth, (ft.):	15'	
Description:	(CL) Lean CLAY; Vis. Est. Clay 90%, Fine Sand 10%; Dark Yellowish Brown (10YR 4/4)				Tested By:	JFH
Sample Location:					Checked By:	DMO
					Lab. No.:	C15-035

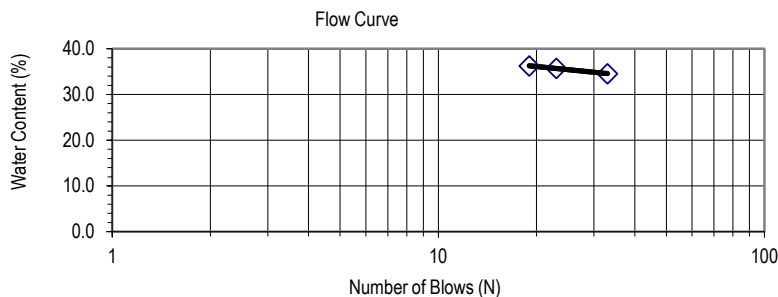
Estimated % of Sample Retained on No. 40 Sieve: 0 Sample Air Dried: yes

Test Method A or B: A

LIQUID LIMIT:						PLASTIC LIMIT:		
Sample No.:	1	2	3	4	5	1	2	3
Pan ID:	E1	A1	C1			B1	18.57	
Wt. Pan (gr)	17.05	18.49	18.72			18.60	18.57	
Wt. Wet Soil + Pan (gr)	32.86	33.54	34.24			28.75	28.60	
Wt. Dry Soil + Pan (gr)	28.80	29.58	30.11			27.20	27.08	
Wt. Water (gr)	4.06	3.96	4.13			1.55	1.52	
Wt. Dry Soil (gr)	11.75	11.09	11.39			8.60	8.51	
Water Content (%)	34.6	35.7	36.3			18.0	17.9	
Number of Blows, N	33	23	19					

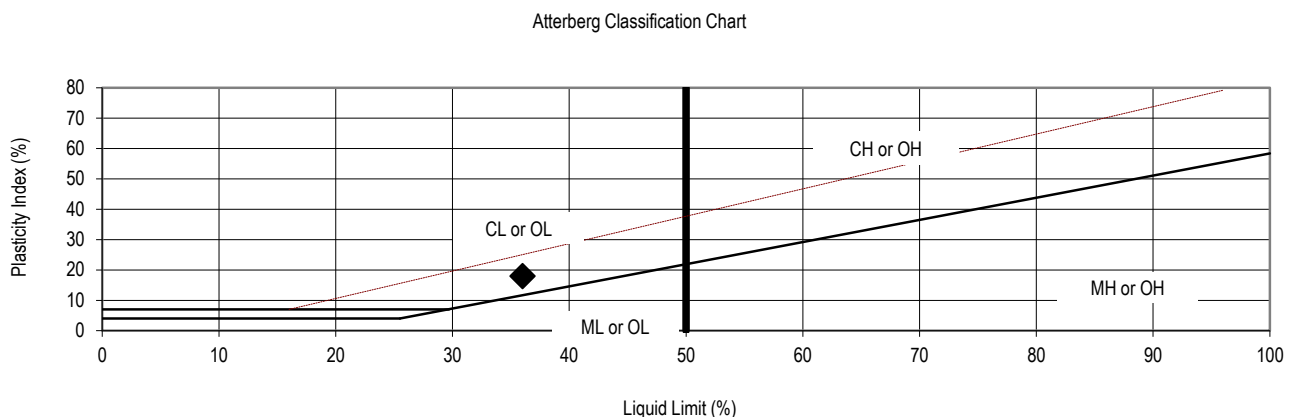
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PLASTIC LIMIT = 18



Plasticity Index = 18

Group Symbol = CL



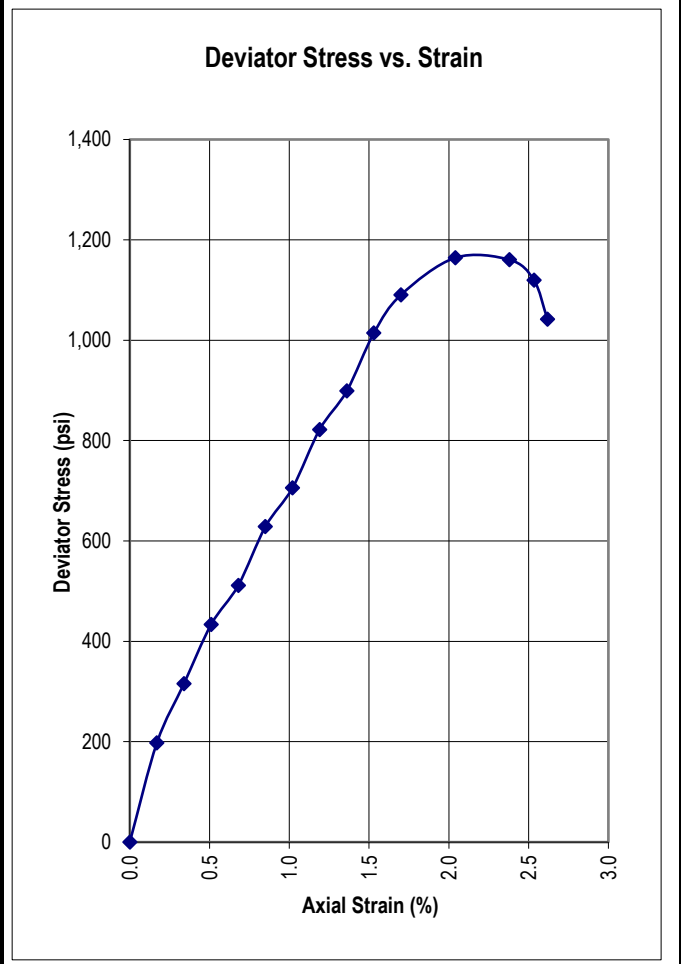
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/24/15
Boring/Trench No.:	B15-12	Sample No.:	L1-1-1	Depth (ft.):	2
Soil Description:	(CL) Lean CLAY; Vis. Est. Clay 90%, Fine Sand 10%; Very Dark Brown (10YR 2/3)				Tested By: CHB
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure
Tare Tube Number	I.D.	ZZ6	
Tare Weight	(gm)	171.50	
Wet Soil + Tare	(gm)	937.70	
Dry Soil + Tare	(gm)	828.80	
Weight of Water	(gm)	108.90	
Dry Soil Weight	(gm)	657.30	
Moisture Content	(%)	16.57	
Soil Height	(cm)	14.94	
Sample Diameter	(cm)	6.06	
Wet Unit Weight	(pcf)	111.01	
Dry Unit Weight	(pcf)	95.23	Comments: Maximum Shear Strength, Su = 582.2 psf = 4.04 psi Maximum Unconfined Compressive Strength, qu = 1,164.3 psf = 8.09 psi
Specific Gravity	(dim)	2.30	
Saturation	(%)	75.15	
Strain Rate	(%/min.)	1.28	
Proving Ring Constant	(lbs/unit)	1.230	

Elapsed Time (Sec)	Strain		Area (cm²)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
8	10	0.17	28.89	5	6.15	197.8
16	20	0.34	28.94	8	9.84	315.9
24	30	0.51	28.99	11	13.53	433.6
32	40	0.68	29.04	13	15.99	511.5
41	50	0.85	29.09	16	19.68	628.5
48	60	1.02	29.14	18	22.14	705.9
56	70	1.19	29.19	21	25.83	822.1
64	80	1.36	29.24	23	28.29	898.8
72	90	1.53	29.29	26	31.98	1014.3
81	100	1.70	29.34	28	34.44	1090.5
97	120	2.04	29.44	30	36.90	1164.3
101	140	2.38	29.55	30	36.90	1160.3
119	149	2.53	29.59	29	35.67	1119.8
123	154	2.62	29.62	27	33.21	1041.7
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0
		0.00	0.00		0.00	0.0



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Atterberg Indices

ASTM D4318

DSA File No.: n/a

DSA App No.: n/a

Project No.:	70508	Project Name: Colusa Waste Water Project	Date: 04/27/15
Sample No.:	B1-1-1	Boring/Trench: B15-12	Depth, (ft.): 5'
Description:	(CL) Lean CLAY; Vis. Est. Clay 90%, Fine Sand 10%; Very Dark Brown (10YR 2/3)		Tested By: JFH
Sample Location:			Checked By: DMO
			Lab. No.: C15-035

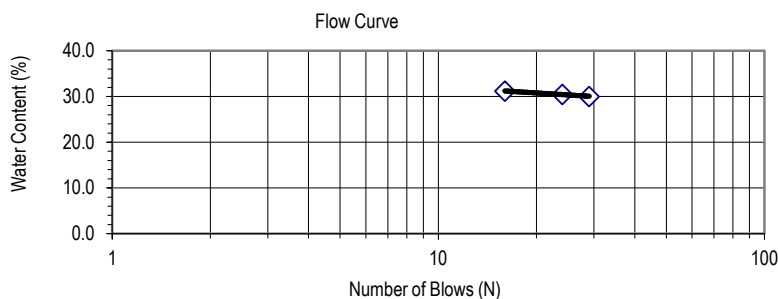
Estimated % of Sample Retained on No. 40 Sieve: 0 Sample Air Dried: yes

Test Method A or B: A

LIQUID LIMIT:						PLASTIC LIMIT:		
Sample No.:	1	2	3	4	5	1	2	3
Pan ID:	A	D	C			E	B	
Wt. Pan (gr)	38.44	38.27	38.45			36.45	38.96	
Wt. Wet Soil + Pan (gr)	52.69	50.09	55.19			47.77	50.18	
Wt. Dry Soil + Pan (gr)	49.40	47.33	51.21			45.98	48.34	
Wt. Water (gr)	3.29	2.76	3.98			1.79	1.84	
Wt. Dry Soil (gr)	10.96	9.06	12.76			9.53	9.38	
Water Content (%)	30.0	30.5	31.2			18.8	19.6	
Number of Blows, N	29	24	16					

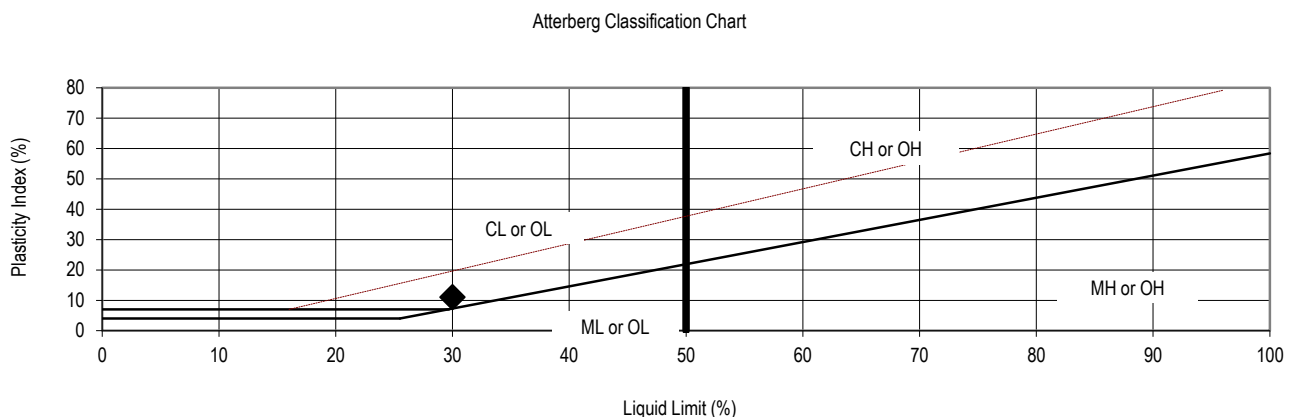
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PLASTIC LIMIT = 19



Plasticity Index = 11

Group Symbol = CL





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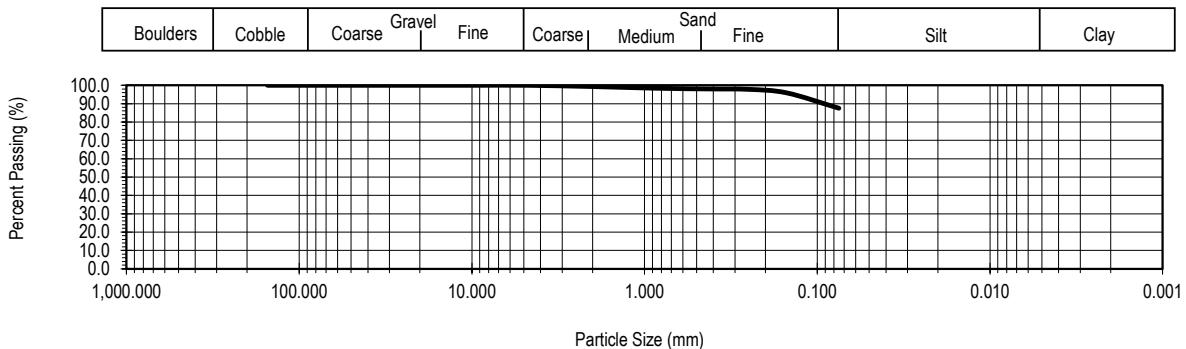
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/29/2015**
Sample No.: **L2-1-2** Boring/Trench: **B15-11** Depth, (ft.): **10'** Tested By: **CHB**
Description: **(CL) Lean CLAY; Lab Data Clay 88%, Fine Sand 12%; Very Dark Brown (10YR** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	667.4	100.0
3 Inch	3.0000	76.2		0.0	667.4	100.0
2 Inch	2.0000	50.8		0.0	667.4	100.0
1.5 Inch	1.5000	38.1		0.0	667.4	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	667.4	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	667.4	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	667.4	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	667.4	100.0
#4	0.1875	4.7500	0.00	0.0	667.4	100.0
#10	0.0787	2.0000	4.50	4.5	662.9	99.3
#20	0.0335	0.8500	6.16	10.7	656.7	98.4
#40	0.0167	0.4250	2.58	13.2	654.2	98.0
#60	0.0098	0.2500	1.49	14.7	652.7	97.8
#100	0.0059	0.1500	12.91	27.6	639.7	95.9
#200	0.0030	0.0750	55.73	83.4	584.0	87.5
Hydrometer						

Particle Size Gradation



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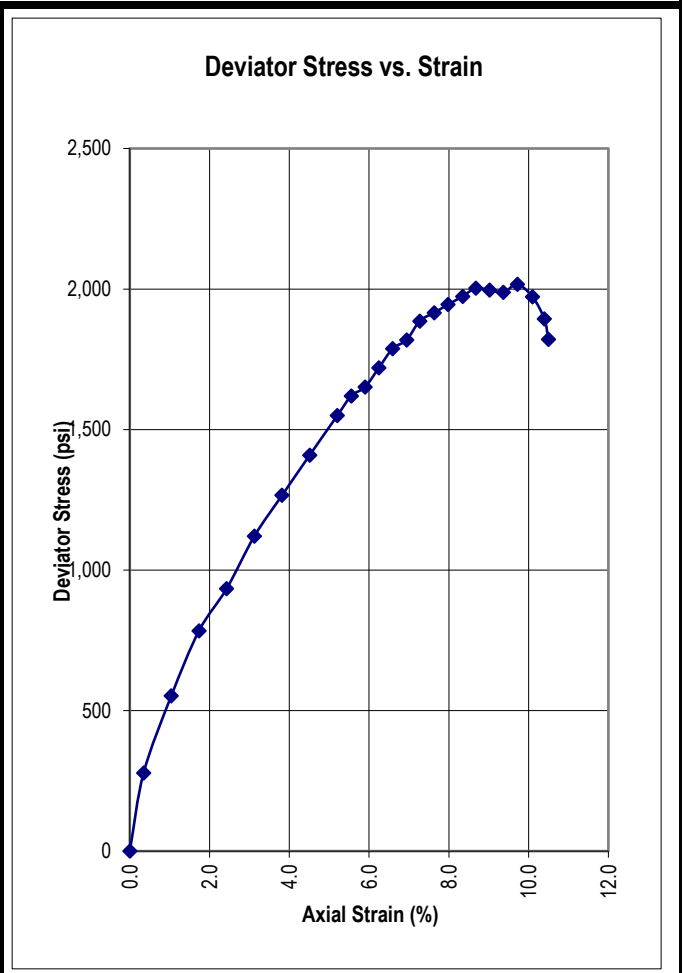
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/24/15
Boring/Trench No.:	B15-12	Sample No.:	L2-1-1	Depth (ft.)	10
Soil Description:	(CL) Lean CLAY; Lab Data Clay 88%, Fine Sand 12%; Very Dark Brown (10YR 2/3)				Tested By: CHB
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure
Tare Tube Number	I.D.	ZZ11	
Tare Weight	(gm)	175.60	
Wet Soil + Tare	(gm)	1007.80	
Dry Soil + Tare	(gm)	850.20	
Weight of Water	(gm)	157.60	
Dry Soil Weight	(gm)	674.60	
Moisture Content	(%)	23.36	
Soil Height	(cm)	14.64	
Sample Diameter	(cm)	6.04	
Wet Unit Weight	(pcf)	123.86	
Dry Unit Weight	(pcf)	100.40	Comments: Maximum Shear Strength, Su = 1,008.2 psf = 7.00 psi Maximum Unconfined Compressive Strength, qu = 2,016.4 psf = 14.00 psi
Specific Gravity	(dim)	2.30	
Saturation	(%)	125.13	
Strain Rate	(%/min.)	1.31	
Proving Ring Constant	(lbs/unit)	1.230	

Elapsed Time (Sec)	Strain		Area (cm²)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
16	20	0.35	28.75	7	8.61	278.2
48	60	1.04	28.95	14	17.22	552.5
80	100	1.73	29.16	20	24.60	783.8
111	140	2.43	29.37	24	29.52	933.9
143	180	3.12	29.58	29	35.67	1120.4
175	220	3.82	29.79	33	40.59	1265.9
207	260	4.51	30.01	37	45.51	1409.1
229	300	5.20	30.23	41	50.43	1550.0
251	320	5.55	30.34	43	52.89	1619.7
271	340	5.90	30.45	44	54.12	1651.3
287	360	6.25	30.56	46	56.58	1720.0
303	380	6.59	30.67	48	59.04	1788.1
318	400	6.94	30.79	49	60.27	1818.6
333	419	7.27	30.90	51	62.73	1886.1
349	440	7.63	31.02	52	63.96	1915.5
366	460	7.98	31.14	53	65.19	1945.0
382	481	8.35	31.26	54	66.42	1973.9
398	500	8.67	31.37	55	67.65	2003.2
413	520	9.02	31.49	55	67.65	1995.6
429	540	9.37	31.61	55	67.65	1988.0
445	560	9.72	31.74	56	68.88	2016.4
462	582	10.10	31.87	55	67.65	1972.0
475	599	10.39	31.98	53	65.19	1894.1
480	605	10.50	32.01	51	62.73	1820.5



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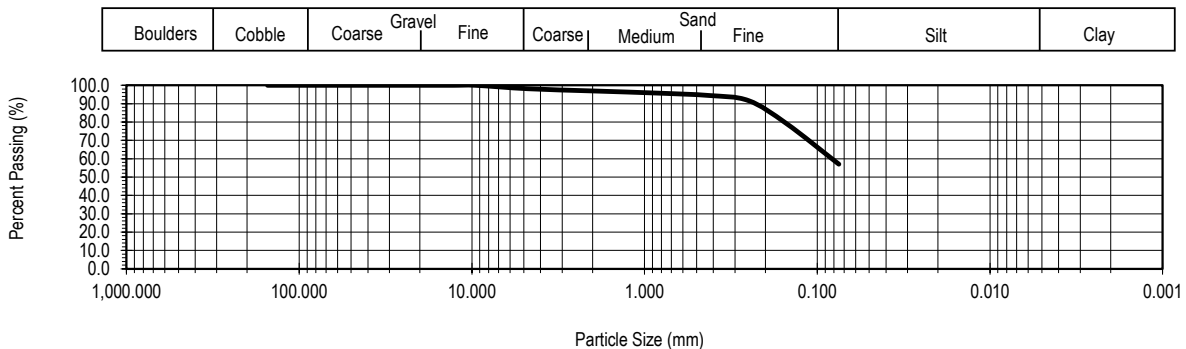
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/27/2015**
Sample No.: **B1-1-1** Boring/Trench: **B15-14** Depth, (ft.): **5'** Tested By: **JFH**
Description: **(CL) Sandy Lean CLAY, Lab Data Clay 58%, Sand 40%: Dark Olive Brown (2.5)** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	165.9	100.0
3 Inch	3.0000	76.2		0.0	165.9	100.0
2 Inch	2.0000	50.8		0.0	165.9	100.0
1.5 Inch	1.5000	38.1		0.0	165.9	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	165.9	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	165.9	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	165.9	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	165.9	100.0
#4	0.1875	4.7500	3.10	3.1	162.8	98.1
#10	0.0787	2.0000	2.00	5.1	160.8	96.9
#20	0.0335	0.8500	1.93	7.0	158.9	95.8
#40	0.0167	0.4250	2.16	9.2	156.8	94.5
#60	0.0098	0.2500	4.66	13.8	152.1	91.7
#100	0.0059	0.1500	21.02	34.9	131.1	79.0
#200	0.0030	0.0750	36.47	71.3	94.6	57.0
Hydrometer						

Particle Size Gradation



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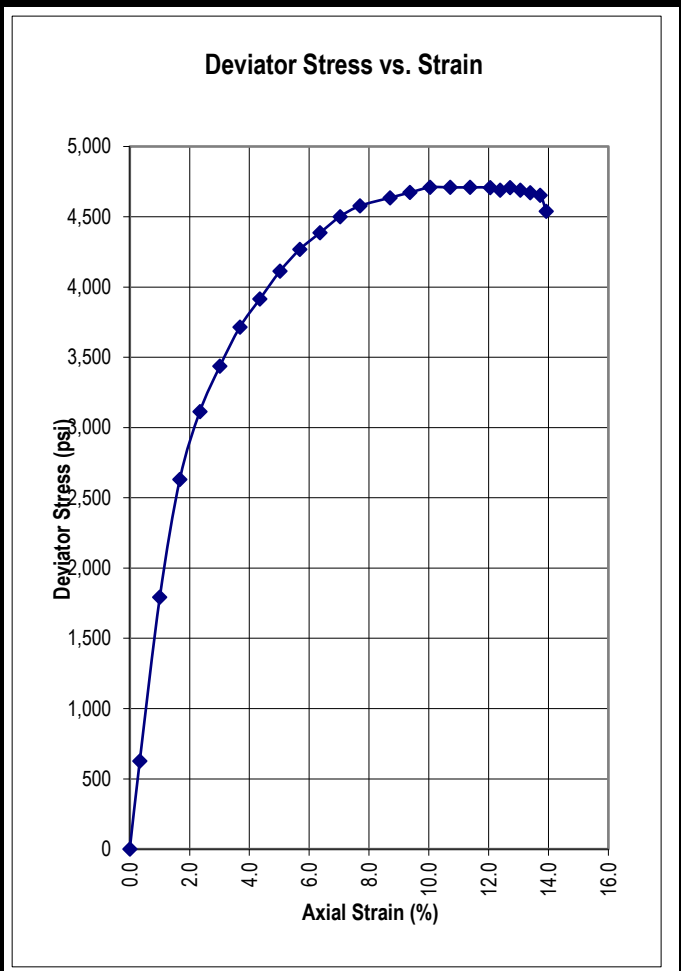
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/27/15
Boring/Trench No.:	B15-14	Sample No.:	L2-1-1	Depth (ft.):	10
Soil Description:	(CH) CLAY; Brown (10YR 4/3)				Tested By: CHB
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure		
Tare Tube Number	I.D.	G8			
Tare Weight	(gm)	766.80			
Wet Soil + Tare	(gm)	1659.50			
Dry Soil + Tare	(gm)	1491.60			
Weight of Water	(gm)	167.90			
Dry Soil Weight	(gm)	724.80			
Moisture Content	(%)	23.17			
Soil Height	(cm)	15.18			
Sample Diameter	(cm)	6.08			
Wet Unit Weight	(pcf)	126.46			
Dry Unit Weight	(pcf)	102.67			
Specific Gravity	(dim)	2.30			
Saturation	(%)	133.93	Comments: Maximum Shear Strength, Su = 2,354.6 psf = 16.35 psi Maximum Unconfined Compressive Strength, qu = 4,709.2 psf = 32.70 psi		
Strain Rate	(%/min.)	1.22			
Proving Ring Constant	(lbs/unit)	1.230			

Elapsed Time (Sec)	Strain		Area (cm²)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
18	20	0.33	29.13	16	19.68	627.6
53	60	1.00	29.33	46	56.58	1792.3
88	100	1.67	29.53	68	83.64	2631.6
119	140	2.34	29.73	81	99.63	3113.4
152	180	3.01	29.93	90	110.70	3435.6
182	220	3.68	30.14	98	120.54	3715.1
214	260	4.35	30.35	104	127.92	3915.2
247	300	5.02	30.57	110	135.30	4112.1
277	340	5.69	30.78	115	141.45	4268.7
310	380	6.36	31.00	119	146.37	4385.9
340	420	7.03	31.23	123	151.29	4500.9
372	460	7.70	31.45	126	154.98	4577.5
419	520	8.70	31.80	129	158.67	4635.5
451	560	9.37	32.04	131	161.13	4672.8
483	600	10.04	32.27	133	163.59	4709.1
513	640	10.71	32.52	134	164.82	4709.2
546	680	11.38	32.76	135	166.05	4708.8
576	720	12.05	33.01	136	167.28	4707.9
592	740	12.38	33.14	136	167.28	4690.0
608	760	12.72	33.26	137	168.51	4706.4
624	780	13.05	33.39	137	168.51	4688.4
639	800	13.39	33.52	137	168.51	4670.3
655	820	13.72	33.65	137	168.51	4652.3
666	832	13.92	33.73	134	164.82	4539.8



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Atterberg Indices

ASTM D4318

DSA File No.: n/a

DSA App No.: n/a

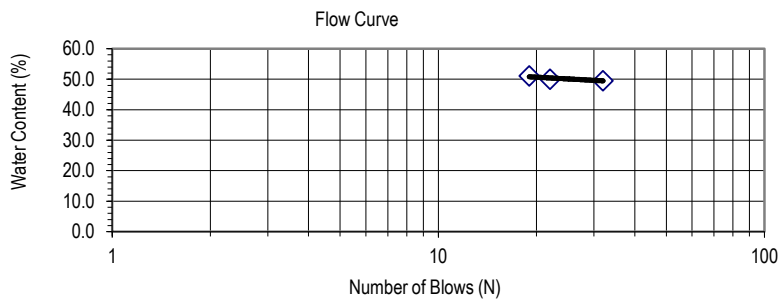
Project No.:	70508	Project Name:	Colusa Waste Water Project	Date:	04/27/15
Sample No.:	L2-1-1	Boring/Trench:	B15-14	Depth, (ft.):	10'
Description:	(CH) CLAY; Brown (10YR 4/3)				Tested By:
Sample Location:					Checked By:
					Lab. No.:
					C15-035

Estimated % of Sample Retained on No. 40 Sieve:	0	Sample Air Dried:	yes
Test Method A or B:	A		

LIQUID LIMIT:						PLASTIC LIMIT:		
Sample No.:	1	2	3	4	5	1	2	3
Pan ID:	C1	A1	B1			D1	E1	
Wt. Pan (gr)	18.72	18.49	18.60			18.56	17.05	
Wt. Wet Soil + Pan (gr)	33.23	31.15	33.74			30.70	27.48	
Wt. Dry Soil + Pan (gr)	28.42	26.93	28.62			28.79	25.85	
Wt. Water (gr)	4.81	4.22	5.12			1.91	1.63	
Wt. Dry Soil (gr)	9.70	8.44	10.02			10.23	8.80	
Water Content (%)	49.6	50.0	51.1			18.7	18.5	
Number of Blows, N	32	22	19					

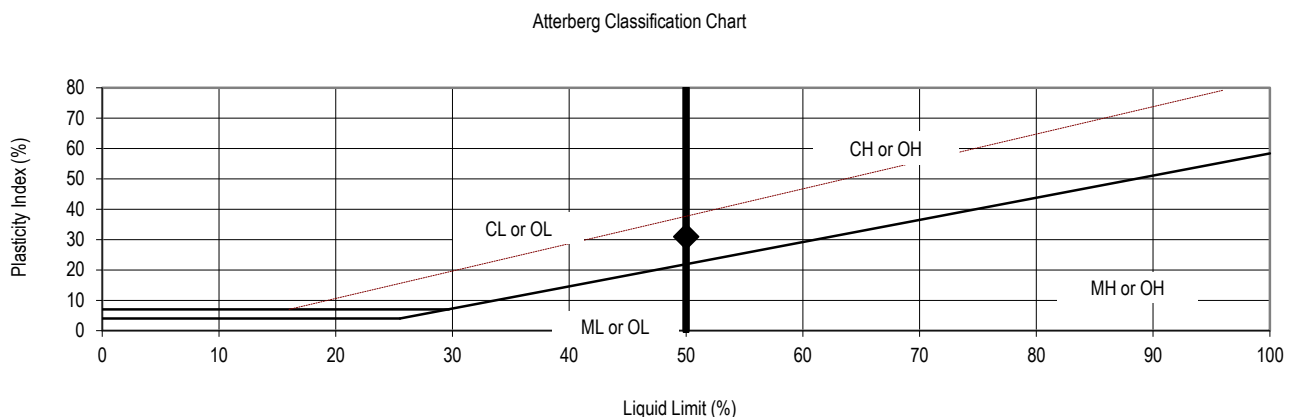
LIQUID LIMIT = 50

PLASTIC LIMIT = 19



Plasticity Index = 31

Group Symbol =



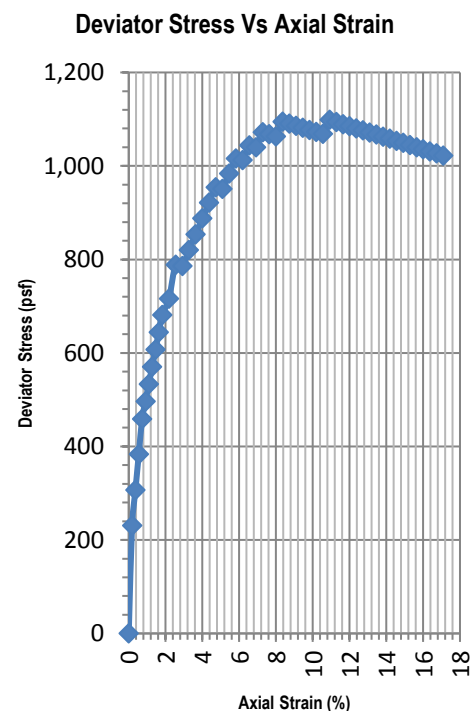
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TRIAXIAL COMPRESSION SHEAR TEST UNCONSOLIDATED UNDRAINED (UU) WITH PORE WATER PRESSURE ASTM D2850

Project No:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/07/15
Sample No:	L2-1-2	Boring/Trench No:	B15-16B	Tested By:	JFH
Soil Description:	(CL) Lean CLAY; Vis. Est. Clay 85%, Sand 15%; Dark Brown (10YR 3/3)			Checked By:	DMO
				Lab No:	C15-035

SAMPLE PREPERATION DATA

PARAMETERS			INITIAL	FINAL
Equations	Tare I.D. No.	Units		G14
a	Wt. Tare	(gr)	0.00	767.80
b	Wt Wet Soil + Tare	(gr)	768.00	1529.40
c	Wt Dry Soil + Tare	(gr)	586.70	1354.50
d = b - a	Wt. Wet Soil	(gr)	768.00	761.60
e = c - a	Wt. Dry Soil	(gr)	586.70	586.70
f = b - c	Wt. Water	(gr)	181.30	174.90
w = f / e	Moisture Content	(%)	30.90	29.81
	Wet Density	(pcf)	118.4	117.4
	Dry Density	(pcf)	90.4	90.4
	void ratio	(dim.)	0.7255	
	Saturation	(%)	106.48	
	Diameter	(in)	2.392	
	Area	(in ²)	4.494	
	Height	(in)	5.499	
	Volume	(in ³)	24.711	
	B Parameter	(dim.)		1.000



TEST SETUP PARAMETERS

G _s	Specific Gravity	2.500	(dimensionless)
Y _w	Unit Weight of Water	62.428	(pcf)
D	Deformation Dial Constant	0.001	(inch / unit)
H _c	Sample Height	5.499	(inch)
A _c	Sample Cross-Sectional Area	4.494	(in ²)
C ₁	Primary Load Ring Constant	1.2025	(lbs/unit)
U _{CH}	Chamber Cell Pressure	63	(psi)
U _{TB}	Sample Top and Bottom Back Pressure	58	(psi)
U _{CN}	Confining Pressure	5	(psi)
R	Strain Rate	0.084	(inch / minute)
F _{dmax}	Maximum Failure Deviator Stress	1,098.52	(psf)
T _{max}	Maximum Failure Shear Stress	549.26	(psf)

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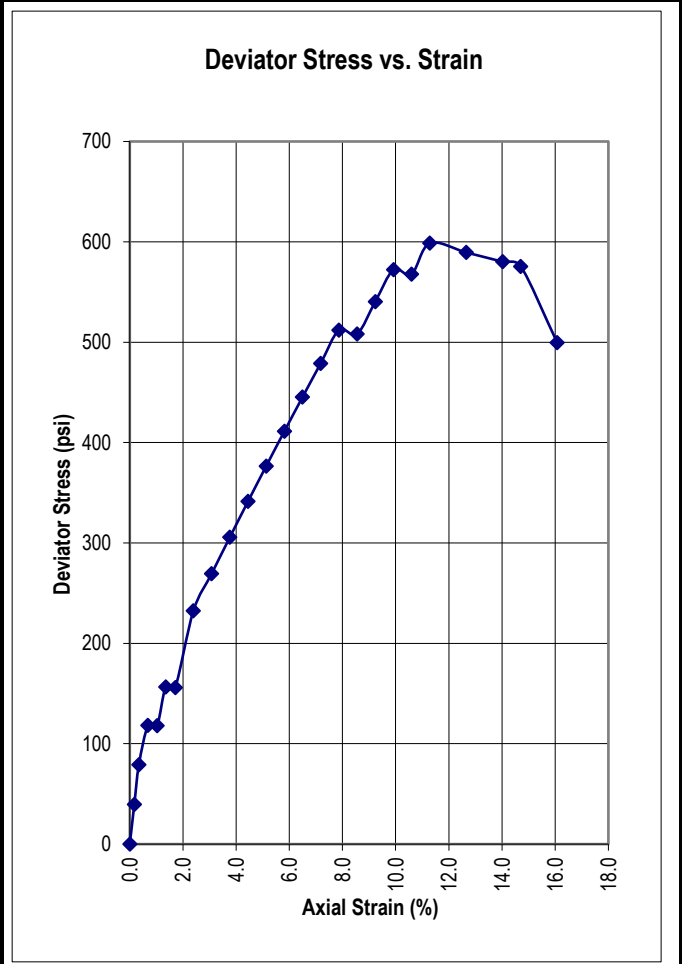
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/08/15
Boring/Trench No.:	B15-16B	Sample No.:	L2-2-2	Depth (ft.)	5
Soil Description:	(CL) Lean CLAY; Vis. Est. Clay 85%, Sand 15%; Dark Brown (10YR 3/3)				Tested By: JFH
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure		
Tare Tube Number	I.D.	G7			
Tare Weight	(gm)	769.60			
Wet Soil + Tare	(gm)	1575.10			
Dry Soil + Tare	(gm)	1387.60			
Weight of Water	(gm)	187.50			
Dry Soil Weight	(gm)	618.00			
Moisture Content	(%)	30.34			
Soil Height	(cm)	14.86			
Sample Diameter	(cm)	6.05			
Wet Unit Weight	(pcf)	117.61			
Dry Unit Weight	(pcf)	90.23			
Specific Gravity	(dim)	2.30			
Saturation	(%)	118.15	Comments: Maximum Shear Strength, Su = 299.3 psf = 2.08 psi Maximum Unconfined Compressive Strength, qu = 598.7 psf = 4.16 psi		
Strain Rate	(%/min.)	1.33			
Proving Ring Constant	(lbs/unit)	1.230			

Elapsed Time (Sec)	Strain		Area (cm²)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
6	10	0.17	28.83	1	1.23	39.6
14	20	0.34	28.88	2	2.46	79.1
29	40	0.68	28.98	3	3.69	118.3
46	60	1.03	29.08	3	3.69	117.9
60	79	1.35	29.18	4	4.92	156.6
76	100	1.71	29.29	4	4.92	156.1
107	140	2.39	29.49	6	7.38	232.5
138	180	3.08	29.70	7	8.61	269.3
169	220	3.76	29.91	8	9.84	305.6
200	260	4.45	30.12	9	11.07	341.4
231	300	5.13	30.34	10	12.30	376.6
262	340	5.81	30.56	11	13.53	411.3
293	380	6.50	30.79	12	14.76	445.4
324	420	7.18	31.01	13	15.99	479.0
355	460	7.87	31.24	14	17.22	512.0
386	500	8.55	31.48	14	17.22	508.2
417	540	9.23	31.71	15	18.45	540.5
449	580	9.92	31.95	16	19.68	572.2
479	620	10.60	32.20	16	19.68	567.8
510	660	11.29	32.45	17	20.91	598.7
573	740	12.65	32.96	17	20.91	589.5
634	820	14.02	33.48	17	20.91	580.2
665	860	14.70	33.75	17	20.91	575.6
727	940	16.07	34.30	15	18.45	499.8



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Atterberg Indices

ASTM D4318

DSA File No.: n/a

DSA App No.: n/a

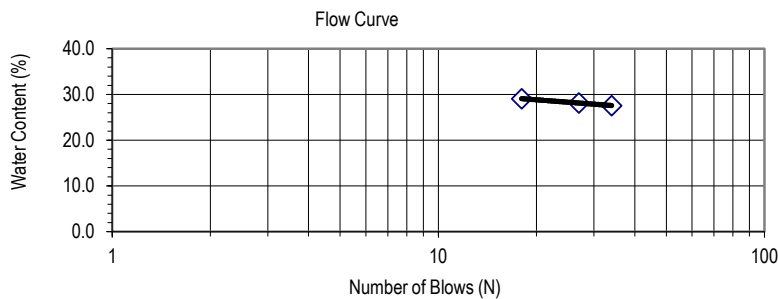
Project No.:	70508	Project Name:	Colusa Waste Water Project	Date:	04/02/15
Sample No.:	B2-1-1	Boring/Trench:	B15-16B	Depth, (ft.):	6.5'
Description:	(CL) Lean CLAY; Lab Data Clay 83%, Sand 17%; Dark Brown (10YR 3/3)				Tested By:
Sample Location:					Checked By:
					Lab. No.:
					C15-035

Estimated % of Sample Retained on No. 40 Sieve:	99	Sample Air Dried:	yes
Test Method A or B:	A		

LIQUID LIMIT:						PLASTIC LIMIT:		
Sample No.:	1	2	3	4	5	1	2	3
Pan ID:	H	J	L			F	M	
Wt. Pan (gr)	61.60	63.31	61.22			62.04	60.89	
Wt. Wet Soil + Pan (gr)	79.41	77.02	78.22			70.89	69.96	
Wt. Dry Soil + Pan (gr)	75.56	74.01	74.39			69.45	68.49	
Wt. Water (gr)	3.85	3.01	3.83			1.44	1.47	
Wt. Dry Soil (gr)	13.96	10.70	13.17			7.41	7.60	
Water Content (%)	27.6	28.1	29.1			19.4	19.3	
Number of Blows, N	34	27	18					

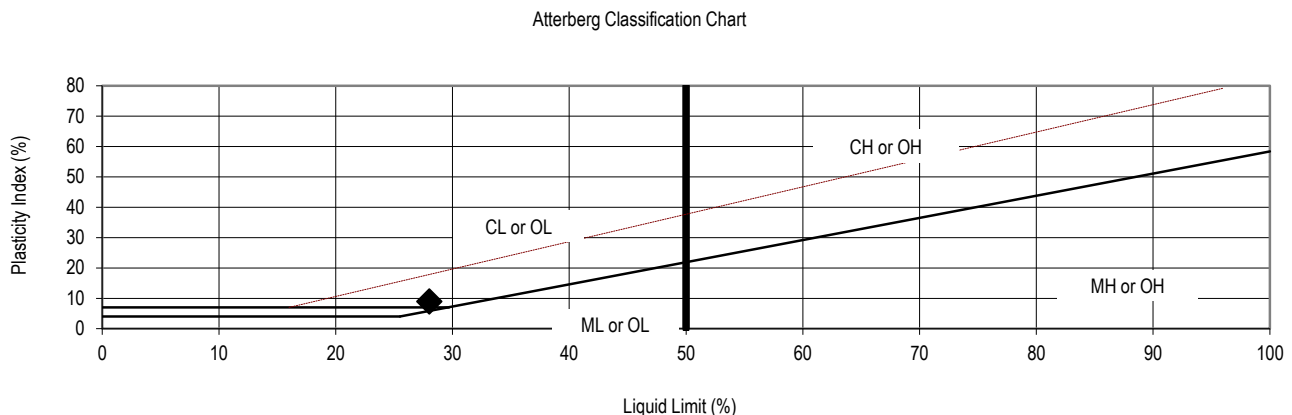
LIQUID LIMIT = 28

PLASTIC LIMIT = 19



Plasticity Index = 9

Group Symbol = CL



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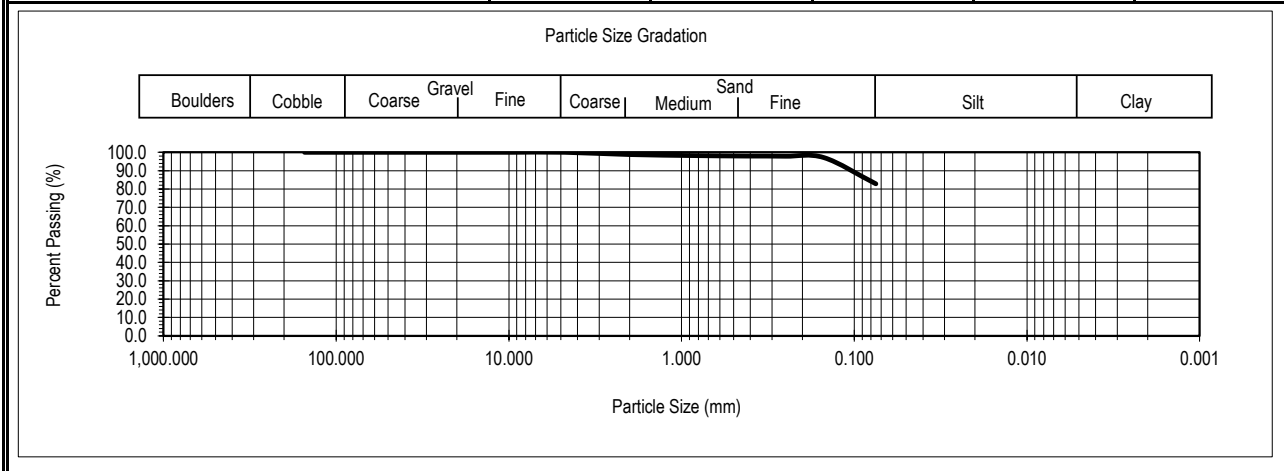
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Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/2/2015**
Sample No.: **B2-1-1** Boring/Trench: **B15-16B** Depth, (ft.): **6.5'** Tested By: **JFH**
Description: **(CL) Lean CLAY; Lab Data Clay 83%, Sand 17%; Dark Brown (10YR 3/3)** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	1,908.5	100.0
3 Inch	3.0000	76.2		0.0	1,908.5	100.0
2 Inch	2.0000	50.8		0.0	1,908.5	100.0
1.5 Inch	1.5000	38.1		0.0	1,908.5	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	1,908.5	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	1,908.5	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	1,908.5	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	1,908.5	100.0
#4	0.1875	4.7500	0.00	0.0	1,908.5	100.0
#10	0.0787	2.0000	23.30	23.3	1,885.2	98.8
#20	0.0335	0.8500	10.84	34.1	1,874.4	98.2
#40	0.0167	0.4250	5.00	39.1	1,869.4	97.9
#60	0.0098	0.2500	1.67	40.8	1,867.7	97.9
#100	0.0059	0.1500	14.17	55.0	1,853.5	97.1
#200	0.0030	0.0750	272.64	327.6	1,580.9	82.8
Hydrometer						



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Moisture & Density

ASTM D2216, D2937, C566

DSA File No.: n/a

DSA App No.: n/a

Project No.: 70508		Project Name: Colusa Waste Water Project		Date: 04/27/15	
				Tested By: JFH	
				Checked By: 0	
				Lab. No.: C15-035	
SAMPLE LOCATION DATA					
Boring/Trench No.	Units	B15-16B			
Sample No.		L3-1-2			
Depth Interval	(ft.)	10			
Sample Description		Lean CLAY; Vis. Est. Clay 90%, Fine Sand 10%; Olive Brown (2.5Y 4/3)			
USCS Symbol		CL			
SAMPLE DIMENSION AND WEIGHT DATA					
Sample Length	(in)	5.821			
Sample Diameter	(in)	2.402			
Sample Volume	(cf)	0.0153			
Wet Soil + Tube Wt.	(gr)	1109.80			
Tube Wt.	(gr)	273.90			
Wet Soil Wt.	(gr)	835.90			
MOISTURE CONTENT DATA					
Tare No.		G6			
Tare Wt.	(gr)	767.70			
Wet Soil + Tare Wt.	(gr)	1603.10			
Dry Soil + Tare Wt.	(gr)	1417.70			
Water Wt.	(gr)	185.40			
Dry Soil Wt.	(gr)	650.00			
Moisture Content	(%)	28.5			
TEST RESULTS					
Wet Unit Wt.	(pcf)	120.7			
Moisture Content	(%)	28.5			
Dry Unit Wt.	(pcf)	93.9			
MOISTURE CORRECTION DATA					
Gauge Moisture	(%)				
K Value Correction Factor					
COMPACTION CURVE DATA (ASTM D698, ASTM D1557, or CAL216)					
Test Method					
Curve No.					
Max Wet Unit Wt.	(pcf)				
Max Dry Unit Wt.	(pcf)				
Optimum Moisture	(%)				
Wet Relative Comp.	(%)				
Dry Relative Comp.	(%)				

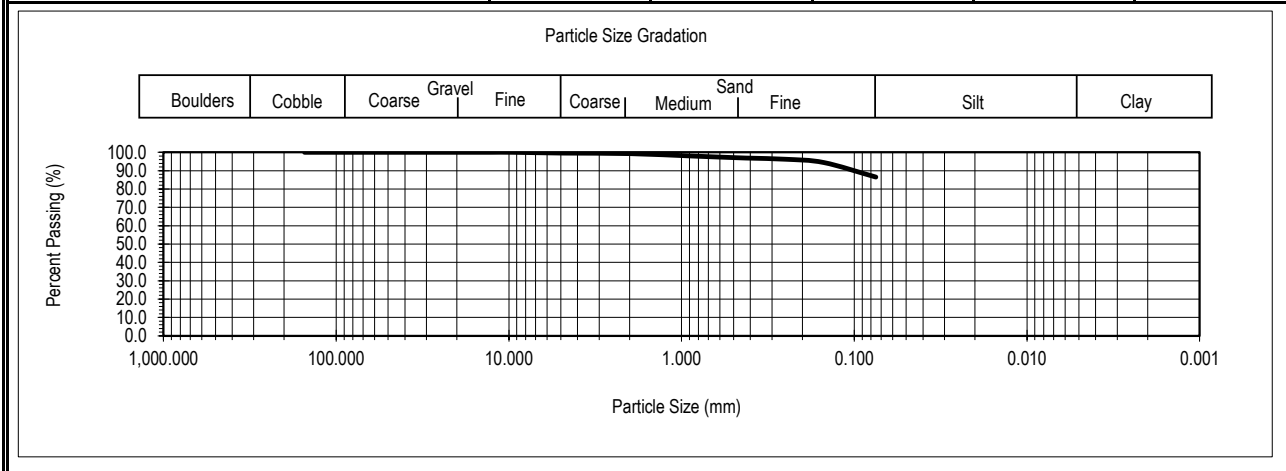
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Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/2/2015**
Sample No.: **L4-1-1** Boring/Trench: **B15-16B** Depth, (ft.): **15'** Tested By: **JFH**
Description: **(CL) Lean CLAY; Lab Data Clay 87%, Sand 13%; Olive Brown (2.5Y 4/3)** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	550.0	100.0
3 Inch	3.0000	76.2		0.0	550.0	100.0
2 Inch	2.0000	50.8		0.0	550.0	100.0
1.5 Inch	1.5000	38.1		0.0	550.0	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	550.0	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	550.0	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	550.0	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	550.0	100.0
#4	0.1875	4.7500	2.40	2.4	547.6	99.6
#10	0.0787	2.0000	1.50	3.9	546.1	99.3
#20	0.0335	0.8500	7.50	11.4	538.6	97.9
#40	0.0167	0.4250	5.78	17.2	532.8	96.9
#60	0.0098	0.2500	3.64	20.8	529.2	96.2
#100	0.0059	0.1500	9.86	30.7	519.3	94.4
#200	0.0030	0.0750	43.49	74.2	475.8	86.5
Hydrometer						



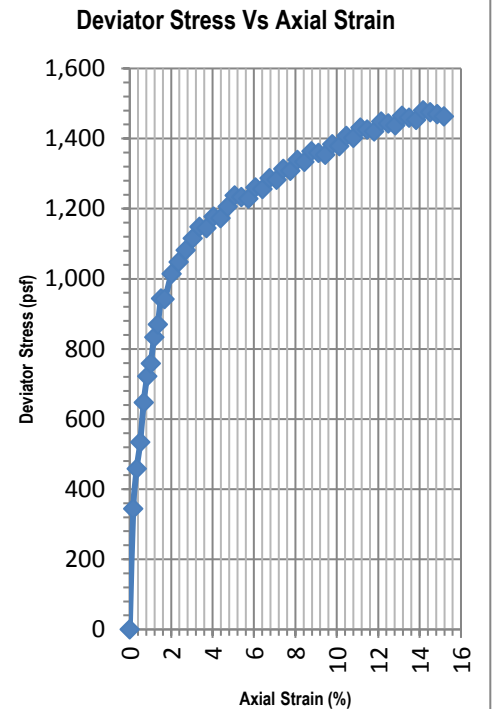
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TRIAXIAL COMPRESSION SHEAR TEST UNCONSOLIDATED UNDRAINED (UU) WITH PORE WATER PRESSURE ASTM D2850

Project No:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/07/15
Sample No:	L5-1-1	Boring/Trench No:	B15-16B	Tested By:	JFH
Soil Description:	Clay (CL) Light Olive Brown (2.5YR 5/3)			Checked By:	DMO
				Lab No:	C15-035

SAMPLE PREPERATION DATA

PARAMETERS			INITIAL	FINAL
Equations	Tare I.D. No.	Units		G2
a	Wt. Tare	(gr)	0.00	768.30
b	Wt Wet Soil + Tare	(gr)	827.10	1592.70
c	Wt Dry Soil + Tare	(gr)	611.80	1380.10
d = b - a	Wt. Wet Soil	(gr)	827.10	824.40
e = c - a	Wt. Dry Soil	(gr)	611.80	611.80
f = b - c	Wt. Water	(gr)	215.30	212.60
w = f / e	Moisture Content	(%)	35.19	34.75
	Wet Density	(pcf)	117.7	117.3
	Dry Density	(pcf)	87.1	87.1
	void ratio	(dim.)	0.7928	
	Saturation	(%)	110.97	
	Diameter	(in)	2.398	
	Area	(in ²)	4.516	
	Height	(in)	5.928	
	Volume	(in ³)	26.773	
	B Parameter	(dim.)		0.970



TEST SETUP PARAMETERS

G _s	Specific Gravity	2.500	(dimensionless)
Y _w	Unit Weight of Water	62.428	(pcf)
D	Deformation Dial Constant	0.001	(inch / unit)
H _c	Sample Height	5.928	(inch)
A _c	Sample Cross-Sectional Area	4.516	(in ²)
C ₁	Primary Load Ring Constant	1.2025	(lbs/unit)
U _{CH}	Chamber Cell Pressure	73	(psi)
U _{TB}	Sample Top and Bottom Back Pressure	58	(psi)
U _{CN}	Confining Pressure	15	(psi)
R	Strain Rate	0.084	(inch / minute)
F _{dmax}	Maximum Failure Deviator Stress	1,480.85	(psf)
T _{max}	Maximum Failure Shear Stress	740.42	(psf)

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Atterberg Indices

ASTM D4318

DSA File No.: n/a

DSA App No.: n/a

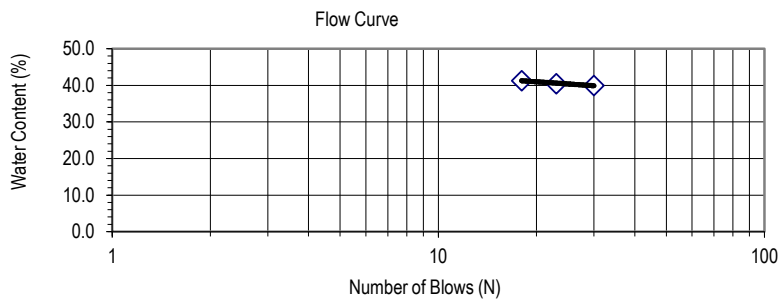
Project No.:	70508	Project Name:	Colusa Waste Water Project	Date:	04/02/15
Sample No.:	B5-1-1	Boring/Trench:	B15-16B	Depth, (ft.):	21.5'
Description:	(CL) Lean CLAY, Olive Brown, (2.5YR, 4/5)				Tested By:
Sample Location:					Checked By:
					Lab. No.:
					C15-035

Estimated % of Sample Retained on No. 40 Sieve:	0	Sample Air Dried:	yes
Test Method A or B:	A		

LIQUID LIMIT:						PLASTIC LIMIT:		
Sample No.:	1	2	3	4	5	1	2	3
Pan ID:	C	D	E			B	A	
Wt. Pan (gr)	38.47	38.27	36.44			38.46	38.44	
Wt. Wet Soil + Pan (gr)	54.66	53.50	52.93			49.18	48.20	
Wt. Dry Soil + Pan (gr)	50.04	49.11	48.11			47.15	46.33	
Wt. Water (gr)	4.62	4.39	4.82			2.03	1.87	
Wt. Dry Soil (gr)	11.57	10.84	11.67			8.69	7.89	
Water Content (%)	39.9	40.5	41.3			23.4	23.7	
Number of Blows, N	30	23	18					

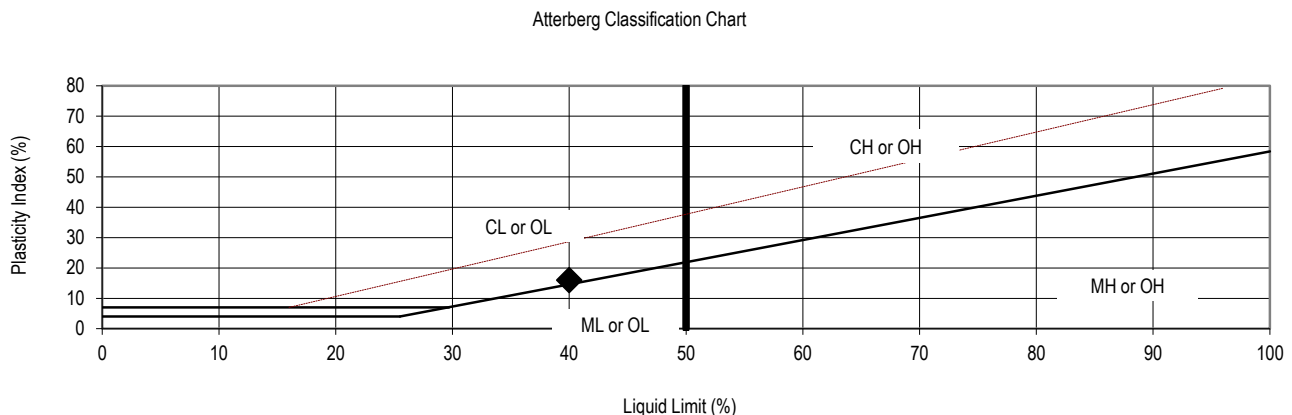
LIQUID LIMIT = 40

PLASTIC LIMIT = 24



Plasticity Index = 16

Group Symbol = CL



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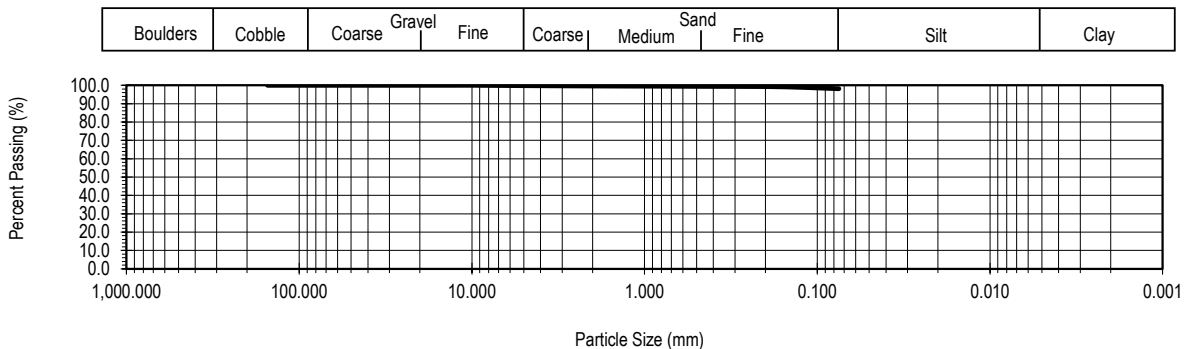
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/2/2015**
Sample No.: **B5-1-1** Boring/Trench: **B15-16B** Depth, (ft.): **21.5'** Tested By: **JFH**
Description: **(CL) Lean CLAY, Olive Brown, (2.5YR, 4/5)** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	1,014.3	100.0
3 Inch	3.0000	76.2		0.0	1,014.3	100.0
2 Inch	2.0000	50.8		0.0	1,014.3	100.0
1.5 Inch	1.5000	38.1		0.0	1,014.3	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	1,014.3	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	1,014.3	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	1,014.3	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	1,014.3	100.0
#4	0.1875	4.7500	2.10	2.1	1,012.2	99.8
#10	0.0787	2.0000	1.70	3.8	1,010.5	99.6
#20	0.0335	0.8500	1.12	4.9	1,009.4	99.5
#40	0.0167	0.4250	1.12	6.0	1,008.3	99.4
#60	0.0098	0.2500	0.56	6.6	1,007.7	99.4
#100	0.0059	0.1500	2.23	8.8	1,005.5	99.1
#200	0.0030	0.0750	10.05	18.9	995.5	98.1
Hydrometer						

Particle Size Gradation



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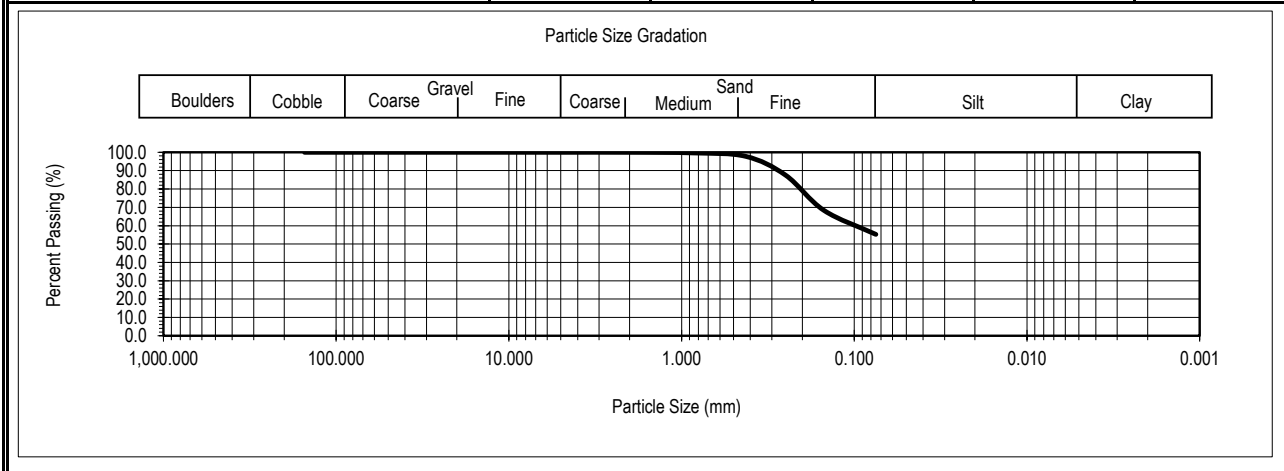
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Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/27/2015**
Sample No.: **B6-1-1** Boring/Trench: **B15-16B** Depth, (ft.): **25** Tested By: **JFH**
Description: **(CL) Sandy Lean CLAY; lab Data Clay 55%, fine sand 45%; Olive Brown (2.5Y 4/6)** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	665.4	100.0
3 Inch	3.0000	76.2		0.0	665.4	100.0
2 Inch	2.0000	50.8		0.0	665.4	100.0
1.5 Inch	1.5000	38.1		0.0	665.4	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	665.4	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	665.4	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	665.4	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	665.4	100.0
#4	0.1875	4.7500	0.10	0.1	665.3	100.0
#10	0.0787	2.0000	0.10	0.2	665.2	100.0
#20	0.0335	0.8500	2.10	2.3	663.1	99.7
#40	0.0167	0.4250	12.40	14.7	650.7	97.8
#60	0.0098	0.2500	68.10	82.8	582.6	87.6
#100	0.0059	0.1500	127.70	210.5	454.9	68.4
#200	0.0030	0.0750	87.10	297.6	367.8	55.3
Hydrometer						



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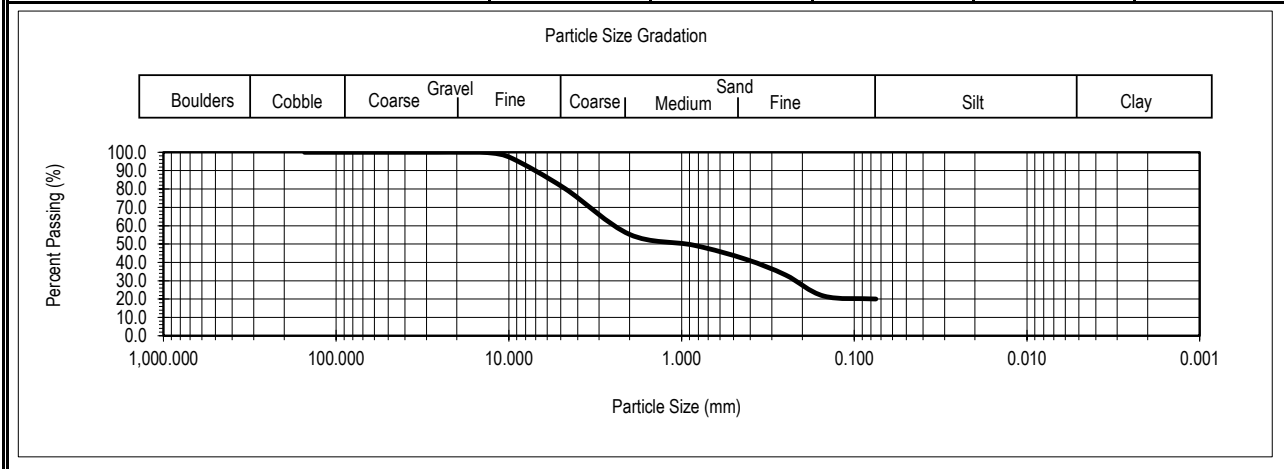
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Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/27/2015**
 Sample No.: **B8-1-1** Boring/Trench: **B15-16B** Depth, (ft.): **35** Tested By: **JFH**
 Description: **(SC) Clayey SAND w/ Gravel; Lab Data Sand 60% Gravel 20%; Olive Brown (2.4)** Checked By: **DMO**
 Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	846.6	100.0
3 Inch	3.0000	76.2		0.0	846.6	100.0
2 Inch	2.0000	50.8		0.0	846.6	100.0
1.5 Inch	1.5000	38.1		0.0	846.6	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	846.6	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	846.6	100.0
1/2 Inch	0.5000	12.7	3.00	3.0	843.6	99.6
3/8 Inch	0.3750	9.5	26.00	29.0	817.6	96.6
#4	0.1875	4.7500	137.50	166.5	680.1	80.3
#10	0.0787	2.0000	212.30	378.8	467.8	55.3
#20	0.0335	0.8500	49.95	428.7	417.8	49.4
#40	0.0167	0.4250	64.84	493.6	353.0	41.7
#60	0.0098	0.2500	72.48	566.1	280.5	33.1
#100	0.0059	0.1500	97.34	663.4	183.2	21.6
#200	0.0030	0.0750	13.51	676.9	169.7	20.0
Hydrometer						



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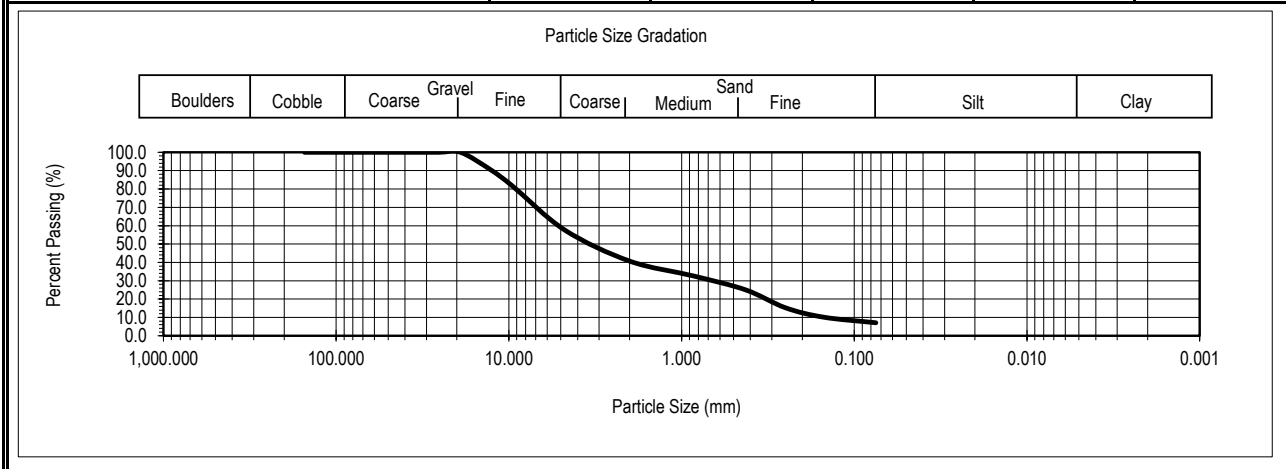
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Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/2/2015**
 Sample No.: **B1-1-1** Boring/Trench: **B15-16C** Depth, (ft.): **45'** Tested By: **CHB**
 Description: **(SW-SM) SAND w/ Silt and Gravel; Lab Data Sand 50%, Gravel 42%; Dark Yellow** Checked By: **DMO**
 Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	633.5	100.0
3 Inch	3.0000	76.2		0.0	633.5	100.0
2 Inch	2.0000	50.8		0.0	633.5	100.0
1.5 Inch	1.5000	38.1		0.0	633.5	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	633.5	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	633.5	100.0
1/2 Inch	0.5000	12.7	61.00	61.0	572.5	90.4
3/8 Inch	0.3750	9.5	55.50	116.5	517.0	81.6
#4	0.1875	4.7500	151.80	268.3	365.2	57.6
#10	0.0787	2.0000	107.30	375.6	257.9	40.7
#20	0.0335	0.8500	51.60	427.2	206.3	32.6
#40	0.0167	0.4250	47.96	475.2	158.3	25.0
#60	0.0098	0.2500	61.80	537.0	96.5	15.2
#100	0.0059	0.1500	32.51	569.5	64.0	10.1
#200	0.0030	0.0750	19.18	588.7	44.8	7.1
Hydrometer						



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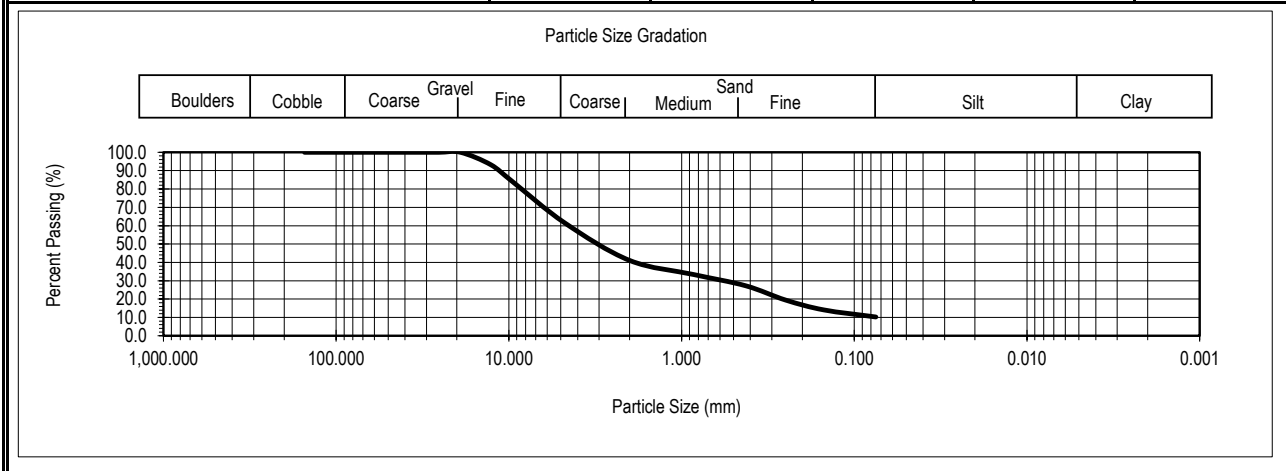
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Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/28/2015**
 Sample No.: **B2-1-1** Boring/Trench: **B15-16C** Depth, (ft.): **50'** Tested By: **JFH**
 Description: **(SW-SM) SAND w/ Silt and Gravel; Lab Data Sand 51%, Gravel 39%; Dark Yellow** Checked By: **DMO**
 Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	768.2	100.0
3 Inch	3.0000	76.2		0.0	768.2	100.0
2 Inch	2.0000	50.8		0.0	768.2	100.0
1.5 Inch	1.5000	38.1		0.0	768.2	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	768.2	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	768.2	100.0
1/2 Inch	0.5000	12.7	52.30	52.3	715.9	93.2
3/8 Inch	0.3750	9.5	70.60	122.9	645.3	84.0
#4	0.1875	4.7500	172.70	295.6	472.6	61.5
#10	0.0787	2.0000	157.10	452.7	315.5	41.1
#20	0.0335	0.8500	59.20	511.9	256.3	33.4
#40	0.0167	0.4250	47.00	558.9	209.3	27.2
#60	0.0098	0.2500	59.70	618.6	149.6	19.5
#100	0.0059	0.1500	41.40	660.0	108.2	14.1
#200	0.0030	0.0750	29.50	689.5	78.7	10.2
Hydrometer						



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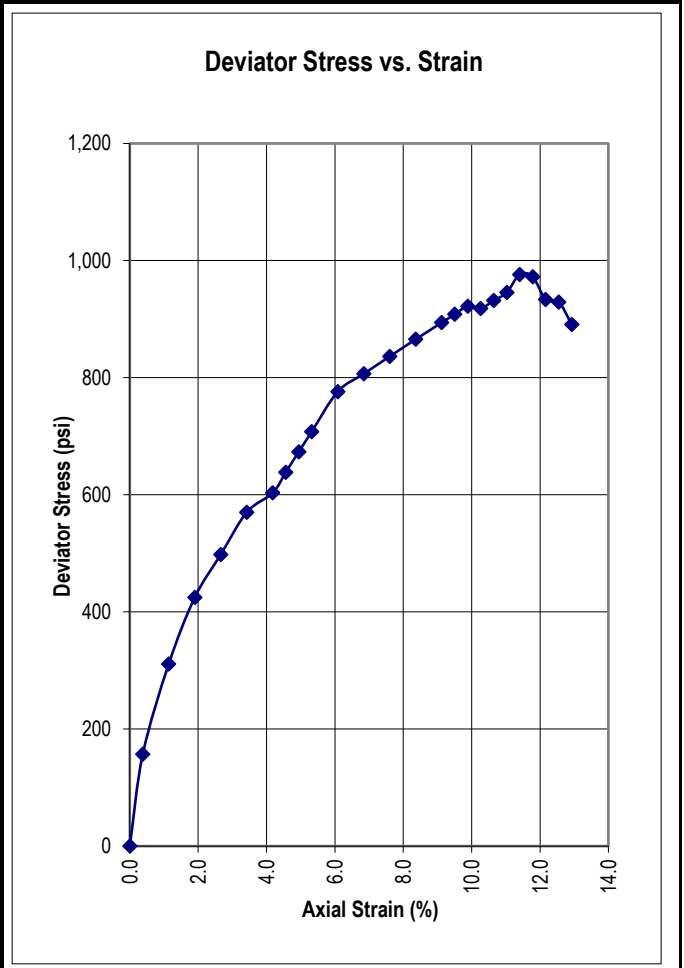
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/22/15
Boring/Trench No.:	B15-18	Sample No.:	L1-1-1	Depth (ft.):	2
Soil Description:	(CL) Lean CLAY; Very Dark Greyish Brown (10YR 3/2)				Tested By: CHB
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure
Tare Tube Number	I.D.	ZZ8	
Tare Weight	(gm)	172.40	
Wet Soil + Tare	(gm)	919.70	
Dry Soil + Tare	(gm)	784.00	
Weight of Water	(gm)	135.70	
Dry Soil Weight	(gm)	611.60	
Moisture Content	(%)	22.19	
Soil Height	(cm)	13.36	
Sample Diameter	(cm)	6.08	
Wet Unit Weight	(pcf)	120.28	
Dry Unit Weight	(pcf)	98.44	
Specific Gravity	(dim)	2.30	
Saturation	(%)	111.44	Comments: Maximum Shear Strength, Su = 488.2 psf = 3.39 psi Maximum Unconfined Compressive Strength, qu = 976.3 psf = 6.78 psi
Strain Rate	(%/min.)	1.33	
Proving Ring Constant	(lbs/unit)	1.230	

Elapsed Time (Sec)	Strain		Area (cm²)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
18	20	0.38	29.14	4	4.92	156.8
49	60	1.14	29.37	8	9.84	311.3
80	100	1.90	29.60	11	13.53	424.7
111	140	2.66	29.83	13	15.99	498.0
143	180	3.42	30.06	15	18.45	570.2
173	220	4.18	30.30	16	19.68	603.4
189	240	4.56	30.42	17	20.91	638.6
204	260	4.94	30.54	18	22.14	673.4
220	280	5.32	30.67	19	23.37	708.0
251	320	6.08	30.91	21	25.83	776.2
282	360	6.84	31.17	22	27.06	806.6
313	400	7.60	31.42	23	28.29	836.4
345	440	8.37	31.68	24	29.52	865.6
376	480	9.13	31.95	25	30.75	894.2
391	500	9.51	32.08	26	31.37	908.2
407	520	9.89	32.22	26	31.98	922.2
423	540	10.27	32.36	26	31.98	918.3
439	560	10.65	32.49	27	32.60	932.0
454	580	11.03	32.63	27	33.21	945.5
469	600	11.41	32.77	28	34.44	976.3
485	620	11.79	32.91	28	34.44	972.1
500	640	12.17	33.06	27	33.21	933.4
516	660	12.55	33.20	27	33.21	929.3
531	680	12.93	33.34	26	31.98	891.0



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Atterberg Indices

ASTM D4318

DSA File No.: n/a

DSA App No.: n/a

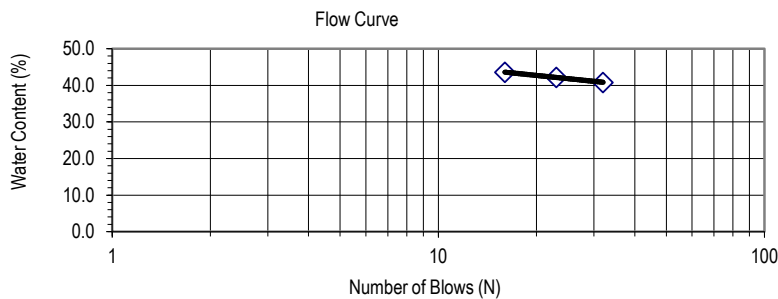
Project No.:	70508	Project Name:	Colusa Waste Water Project	Date:	04/28/15
Sample No.:	B1-1-1	Boring/Trench:	B15-18	Depth, (ft.):	5'
Description:	(CL) Clay; Dark Olive Brown (2.5Y 3/3)				Tested By:
Sample Location:					Checked By:
					Lab. No.:
					C15-035

Estimated % of Sample Retained on No. 40 Sieve:	0	Sample Air Dried:	yes
Test Method A or B:	A		

LIQUID LIMIT:						PLASTIC LIMIT:		
Sample No.:	1	2	3	4	5	1	2	3
Pan ID:	M	F	H			L	J	
Wt. Pan (gr)	60.88	62.04	61.60			61.22	63.31	
Wt. Wet Soil + Pan (gr)	75.58	78.11	78.11			69.97	73.94	
Wt. Dry Soil + Pan (gr)	71.32	73.34	73.10			68.61	72.28	
Wt. Water (gr)	4.26	4.77	5.01			1.36	1.66	
Wt. Dry Soil (gr)	10.44	11.30	11.50			7.39	8.97	
Water Content (%)	40.8	42.2	43.6			18.4	18.5	
Number of Blows, N	32	23	16					

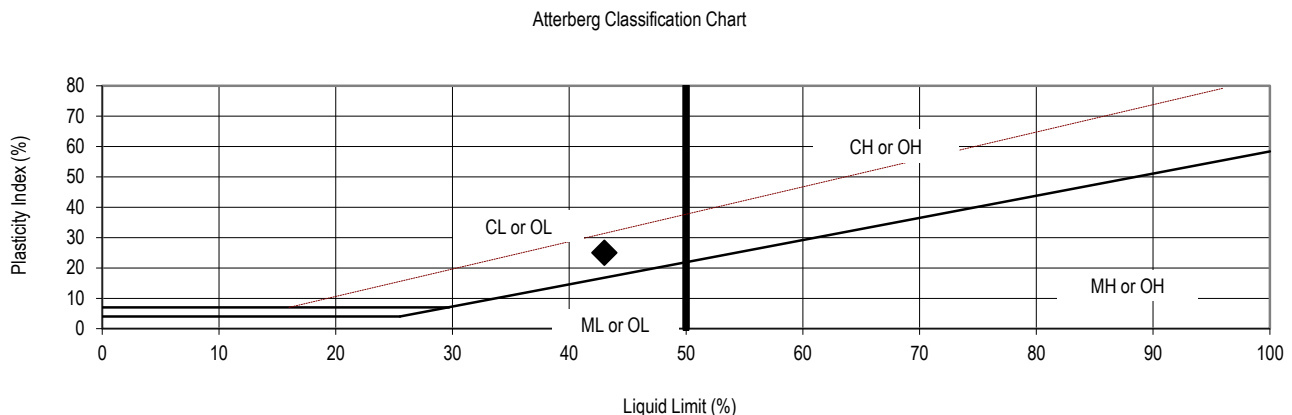
LIQUID LIMIT = 43

PLASTIC LIMIT = 18



Plasticity Index = 25

Group Symbol = CL



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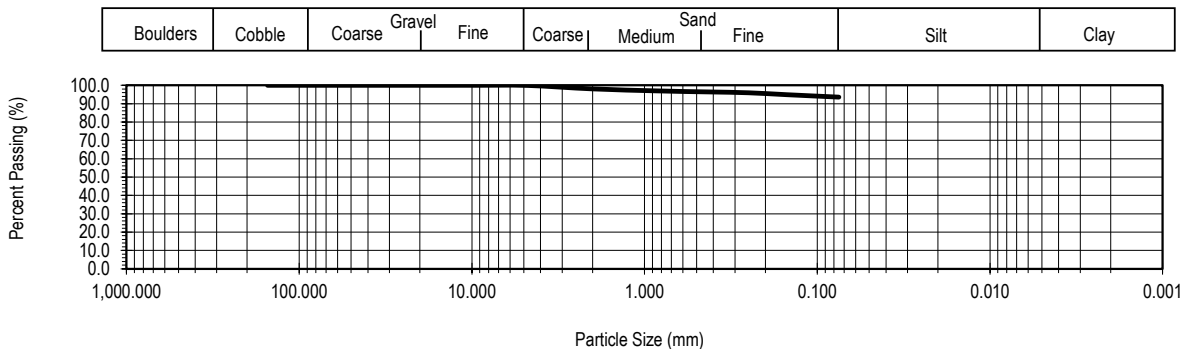
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/29/2015**
Sample No.: **L2-1-1** Boring/Trench: **B15-18** Depth, (ft.): **10'** Tested By: **CHB**
Description: **=Project info!\$B\$5** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	730.2	100.0
3 Inch	3.0000	76.2		0.0	730.2	100.0
2 Inch	2.0000	50.8		0.0	730.2	100.0
1.5 Inch	1.5000	38.1		0.0	730.2	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	730.2	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	730.2	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	730.2	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	730.2	100.0
#4	0.1875	4.7500	0.60	0.6	729.6	99.9
#10	0.0787	2.0000	13.60	14.2	716.0	98.1
#20	0.0335	0.8500	8.04	22.2	707.9	97.0
#40	0.0167	0.4250	4.12	26.4	703.8	96.4
#60	0.0098	0.2500	3.34	29.7	700.5	95.9
#100	0.0059	0.1500	7.65	37.4	692.8	94.9
#200	0.0030	0.0750	9.71	47.1	683.1	93.6
Hydrometer						

Particle Size Gradation



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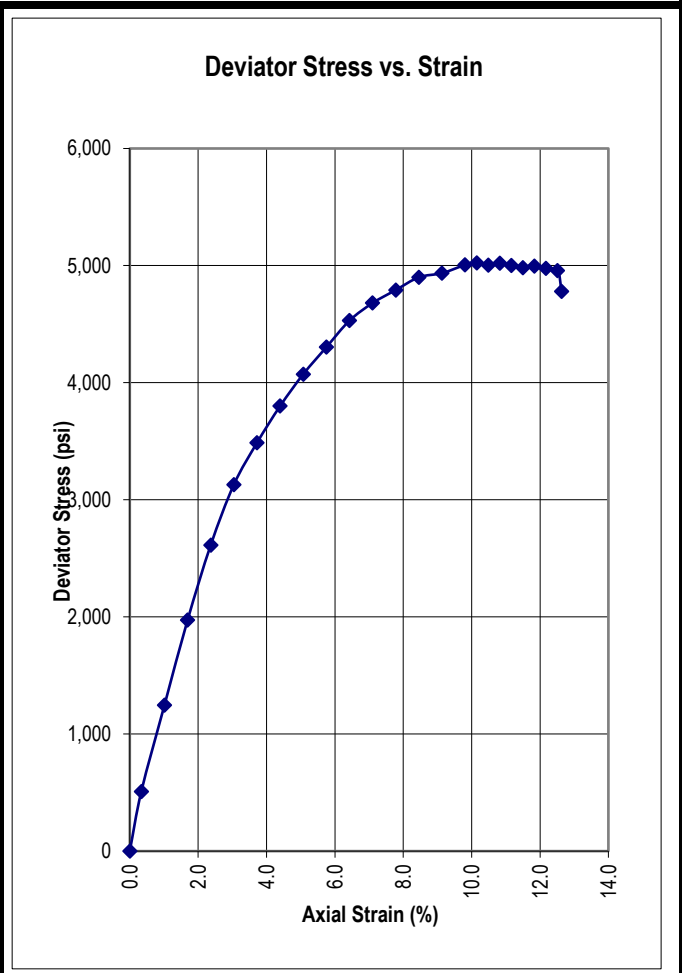
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/27/15
Boring/Trench No.:	B15-14	Sample No.:	L2-1-1	Depth (ft.)	10
Soil Description:	(CL) Lean Clay; Olive Brown (2.5Y 4/3)				Tested By: CHB
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure		
Tare Tube Number	I.D.	G2			
Tare Weight	(gm)	768.60			
Wet Soil + Tare	(gm)	1658.90			
Dry Soil + Tare	(gm)	1503.50			
Weight of Water	(gm)	155.40			
Dry Soil Weight	(gm)	734.90			
Moisture Content	(%)	21.15			
Soil Height	(cm)	15.02			
Sample Diameter	(cm)	6.08			
Wet Unit Weight	(pcf)	127.46			
Dry Unit Weight	(pcf)	105.21			
Specific Gravity	(dim)	2.30			
Saturation	(%)	133.58	Comments: Maximum Shear Strength, Su = 2,510.9 psf = 17.44 psi Maximum Unconfined Compressive Strength, qu = 5,021.8 psf = 34.87 psi		
Strain Rate	(%/min.)	1.22			
Proving Ring Constant	(lbs/unit)	1.230			

Elapsed Time (Sec)	Strain		Area (cm²)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
15	20	0.34	29.13	13	15.99	509.9
48	60	1.01	29.33	32	39.36	1246.7
81	100	1.69	29.53	51	62.73	1973.3
114	140	2.37	29.74	68	83.64	2613.0
148	180	3.04	29.94	82	100.86	3129.2
178	220	3.72	30.16	92	113.16	3486.3
212	260	4.40	30.37	101	124.23	3800.4
243	300	5.07	30.58	109	134.07	4072.4
274	340	5.75	30.80	116	142.68	4303.1
308	380	6.43	31.03	123	151.29	4530.0
338	420	7.10	31.25	128	157.44	4680.1
371	460	7.78	31.48	132	162.36	4791.2
402	500	8.46	31.71	136	167.28	4900.2
4334	540	9.13	31.95	138	169.74	4935.5
467	580	9.81	32.19	141	173.43	5005.2
482	600	10.15	32.31	142	174.66	5021.8
498	620	10.48	32.43	142	174.66	5002.9
513	640	10.82	32.56	143	175.89	5019.1
529	660	11.16	32.68	143	175.89	5000.1
546	680	11.50	32.81	143	175.89	4981.0
560	700	11.84	32.93	144	177.12	4996.7
576	720	12.18	33.06	144	177.12	4977.5
592	740	12.51	33.19	144	177.12	4958.4
599	747	12.63	33.23	139	170.97	4779.7



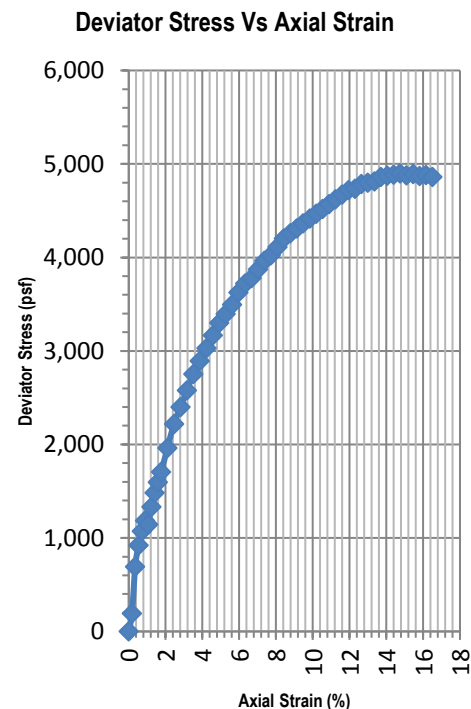
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TRIAXIAL COMPRESSION SHEAR TEST UNCONSOLIDATED UNDRAINED (UU) WITH PORE WATER PRESSURE ASTM D2850

Project No:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/13/15
Sample No:	L1-1-2	Boring/Trench No:	B15-19	Tested By:	JFH
Soil Description:	(CL) Lean CLAY, Vis. Est. Clay 90%, Fine Sand 10%; Very Dark Brown (10YR 2/2)			Checked By:	DMO
				Lab No:	C15-035

SAMPLE PREPERATION DATA

PARAMETERS			INITIAL	FINAL
Equations	Tare I.D. No.	Units		G11
a	Wt. Tare	(gr)	0.00	765.70
b	Wt Wet Soil + Tare	(gr)	878.30	1652.70
c	Wt Dry Soil + Tare	(gr)	743.60	1509.30
d = b - a	Wt. Wet Soil	(gr)	878.30	887.00
e = c - a	Wt. Dry Soil	(gr)	743.60	743.60
f = b - c	Wt. Water	(gr)	134.70	143.40
w = f / e	Moisture Content	(%)	18.11	19.28
	Wet Density	(pcf)	130.8	132.1
	Dry Density	(pcf)	110.8	110.8
	void ratio	(dim.)	0.4090	
	Saturation	(%)	110.72	
	Diameter	(in)	2.391	
	Area	(in ²)	4.490	
	Height	(in)	5.696	
	Volume	(in ³)	25.575	
	B Parameter	(dim.)		0.990



TEST SETUP PARAMETERS

G _s	Specific Gravity	2.500	(dimensionless)
Y _w	Unit Weight of Water	62.428	(pcf)
D	Deformation Dial Constant	0.001	(inch / unit)
H _c	Sample Height	5.696	(inch)
A _c	Sample Cross-Sectional Area	4.490	(in ²)
C ₁	Primary Load Ring Constant	1.2025	(lbs/unit)
U _{CH}	Chamber Cell Pressure	63	(psi)
U _{TB}	Sample Top and Bottom Back Pressure	58	(psi)
U _{CN}	Confining Pressure	5	(psi)
R	Strain Rate	0.084	(inch / minute)
F _{dmax}	Maximum Failure Deviator Stress	4,898.84	(psf)
T _{max}	Maximum Failure Shear Stress	2,449.42	(psf)

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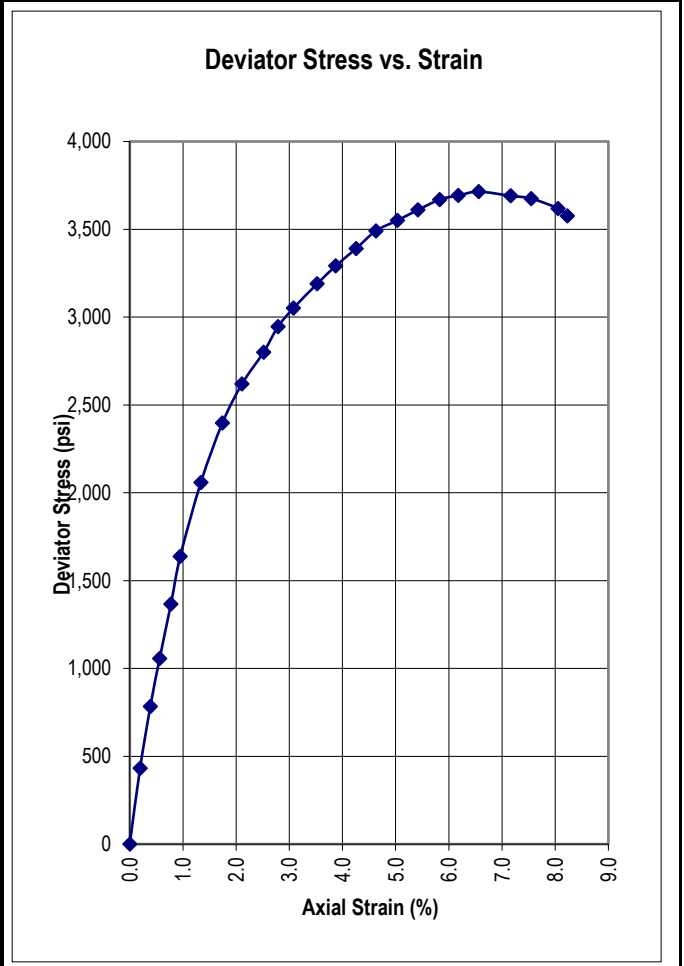
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/17/15
Boring/Trench No.:	B15-19	Sample No.:	L1-2-2	Depth (ft.):	5
Soil Description:	(CL) Lean CLAY, Vis. Est. Clay 90%, Fine Sand 10%; Very Dark Brown (10YR 2/2)				Tested By: CHB
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure
Tare Tube Number	I.D.	G7	
Tare Weight	(gm)	769.40	
Wet Soil + Tare	(gm)	1513.40	
Dry Soil + Tare	(gm)	1384.60	
Weight of Water	(gm)	128.80	
Dry Soil Weight	(gm)	615.20	
Moisture Content	(%)	20.94	
Soil Height	(cm)	13.12	
Sample Diameter	(cm)	6.08	
Wet Unit Weight	(pcf)		
Dry Unit Weight	(pcf)	100.83	Comments: Maximum Shear Strength, Su = 1,857.2 psf = 12.90 psi Maximum Unconfined Compressive Strength, qu = 3,714.3 psf = 25.79 psi
Specific Gravity	(dim)	2.30	
Saturation	(%)	113.74	
Strain Rate	(%/min.)	1.36	
Proving Ring Constant	(lbs/unit)	1.230	

Elapsed Time (Sec)	Strain		Area (cm^2)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
11	10	0.19	29.09	11	13.53	432.1
20	20	0.39	29.15	20	24.60	784.1
28	29	0.56	29.20	27	33.21	1056.7
37	40	0.77	29.26	35	43.05	1366.9
45	49	0.95	29.31	42	51.66	1637.4
62	69	1.34	29.43	53	65.19	2058.1
79	90	1.74	29.55	62	76.26	2397.7
94	109	2.11	29.66	68	83.64	2619.9
101	130	2.52	29.78	73	89.79	2800.9
123	144	2.79	29.87	77	94.71	2946.1
135	159	3.08	29.96	80	98.40	3051.8
152	182	3.52	30.09	84	103.32	3189.6
166	200	3.87	30.20	87	107.01	3291.6
183	220	4.26	30.32	90	110.70	3391.4
198	239	4.63	30.44	93	114.39	3491.0
215	260	5.03	30.57	95	116.85	3550.8
231	280	5.42	30.70	97	119.31	3610.8
247	301	5.83	30.83	99	121.77	3669.4
261	319	6.18	30.94	100	123.00	3692.8
277	339	6.56	31.07	101	124.23	3714.3
301	370	7.16	31.27	101	124.23	3690.5
316	390	7.55	31.40	101	124.23	3675.1
336	416	8.05	31.58	100	123.00	3618.9
343	425	8.23	31.64	99	121.77	3575.9





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Atterberg Indices

ASTM D4318

DSA File No.: n/a

DSA App No.: n/a

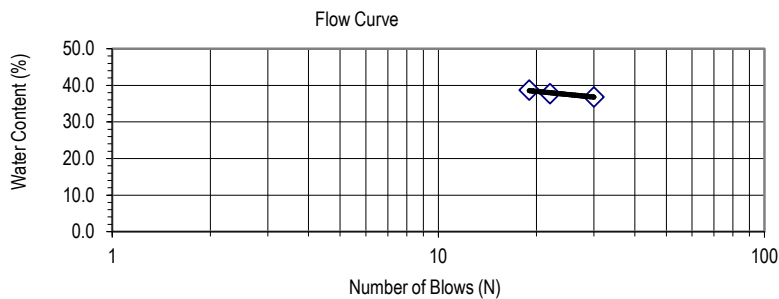
Project No.:	70508	Project Name:	Colusa Waste Water Project	Date:	04/20/15
Sample No.:	B2-1-1	Boring/Trench:	B15-19	Depth, (ft.):	7.5'
Description:	(CL) Lean CLAY, Lab Data Clay 90%, Fine Sand 10%; Very Dark Grey, (10YR, 3/1)				Tested By:
Sample Location:					Checked By:
					Lab. No.:
					C15-035

Estimated % of Sample Retained on No. 40 Sieve:	100	Sample Air Dried:	yes
Test Method A or B:	A		

LIQUID LIMIT:						PLASTIC LIMIT:		
Sample No.:	1	2	3	4	5	1	2	3
Pan ID:	C1	D1	B1			E1	A1	
Wt. Pan (gr)	18.72	18.57	18.60			17.05	18.49	
Wt. Wet Soil + Pan (gr)	32.16	33.86	32.97			26.75	28.62	
Wt. Dry Soil + Pan (gr)	28.54	29.67	28.96			25.20	27.02	
Wt. Water (gr)	3.62	4.19	4.01			1.55	1.60	
Wt. Dry Soil (gr)	9.82	11.10	10.36			8.15	8.53	
Water Content (%)	36.9	37.7	38.7			19.0	18.8	
Number of Blows, N	30	22	19					

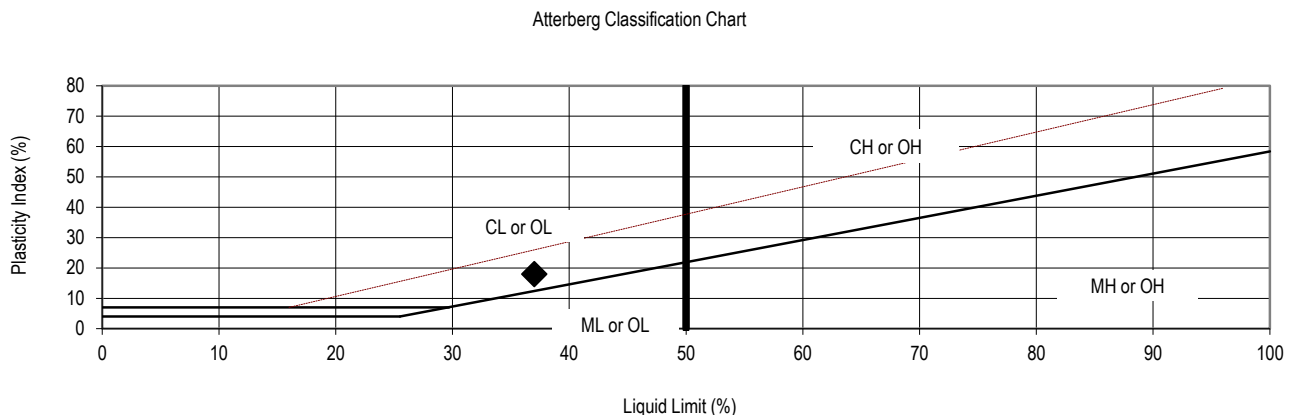
LIQUID LIMIT = 37

PLASTIC LIMIT = 19



Plasticity Index = 18

Group Symbol = CL



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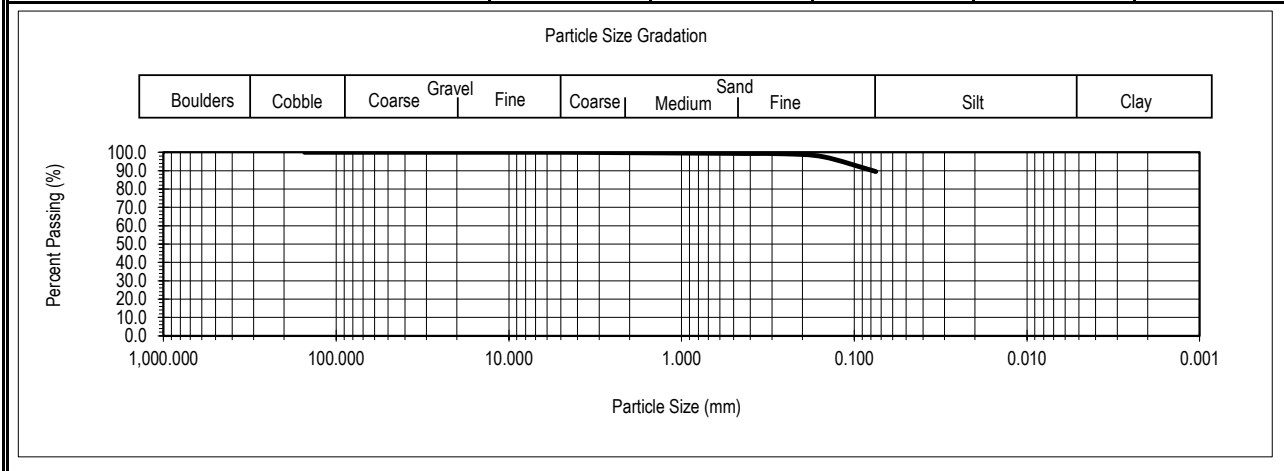
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Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/20/2015**
Sample No.: **B2-1-1** Boring/Trench: **B15-19** Depth, (ft.): **7.5'** Tested By: **JFH**
Description: **(CL) Lean CLAY, Lab Data Clay 90%, Fine Sand 10%; Very Dark Grey, (10YR, 5/6)** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	1,856.4	100.0
3 Inch	3.0000	76.2		0.0	1,856.4	100.0
2 Inch	2.0000	50.8		0.0	1,856.4	100.0
1.5 Inch	1.5000	38.1		0.0	1,856.4	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	1,856.4	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	1,856.4	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	1,856.4	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	1,856.4	100.0
#4	0.1875	4.7500	0.40	0.4	1,856.0	100.0
#10	0.0787	2.0000	3.90	4.3	1,852.1	99.8
#20	0.0335	0.8500	4.47	8.8	1,847.6	99.5
#40	0.0167	0.4250	3.58	12.4	1,844.0	99.3
#60	0.0098	0.2500	3.58	15.9	1,840.4	99.1
#100	0.0059	0.1500	30.42	46.3	1,810.0	97.5
#200	0.0030	0.0750	148.51	194.9	1,661.5	89.5
Hydrometer						



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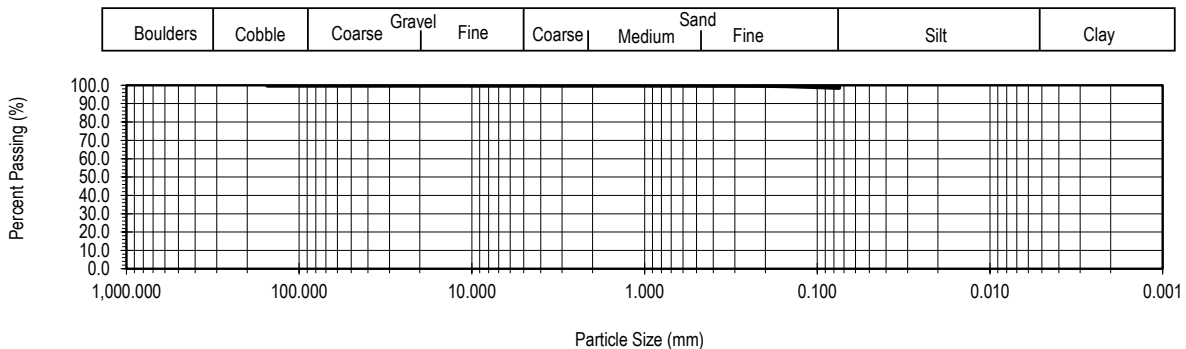
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/20/2015**
Sample No.: **L2-1-2** Boring/Trench: **B15-19** Depth, (ft.): **10'** Tested By: **JFH**
Description: **(CL) CLAY; Olive Brown (2.5Y 4/4)** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	714.9	100.0
3 Inch	3.0000	76.2		0.0	714.9	100.0
2 Inch	2.0000	50.8		0.0	714.9	100.0
1.5 Inch	1.5000	38.1		0.0	714.9	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	714.9	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	714.9	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	714.9	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	714.9	100.0
#4	0.1875	4.7500	0.00	0.0	714.9	100.0
#10	0.0787	2.0000	0.00	0.0	714.9	100.0
#20	0.0335	0.8500	0.00	0.0	714.9	100.0
#40	0.0167	0.4250	0.40	0.4	714.5	99.9
#60	0.0098	0.2500	0.40	0.8	714.1	99.9
#100	0.0059	0.1500	1.19	2.0	712.9	99.7
#200	0.0030	0.0750	6.75	8.7	706.2	98.8
Hydrometer						

Particle Size Gradation



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Moisture & Density

ASTM D2216, D2937, C566

DSA File No.: n/a

DSA App No.: n/a

Project No.: 70508		Project Name: Colusa Waste Water Project		Date: 04/20/15	
				Tested By: CHB	
				Checked By: DMO	
				Lab. No.: C15-035	
SAMPLE LOCATION DATA					
Boring/Trench No.	Units	B15-19			
Sample No.		L2-1-2			
Depth Interval	(ft.)	10			
Sample Description		CLAY; Olive Brown (2.5Y 4/4)			
USCS Symbol		CL			
SAMPLE DIMENSION AND WEIGHT DATA					
Sample Length	(in)	5.979			
Sample Diameter	(in)	2.384			
Sample Volume	(cf)	0.0154			
Wet Soil + Tube Wt.	(gr)	1168.50			
Tube Wt.	(gr)	274.70			
Wet Soil Wt.	(gr)	893.80			
MOISTURE CONTENT DATA					
Tare No.		G2			
Tare Wt.	(gr)	768.40			
Wet Soil + Tare Wt.	(gr)	1659.60			
Dry Soil + Tare Wt.	(gr)	1478.70			
Water Wt.	(gr)	180.90			
Dry Soil Wt.	(gr)	710.30			
Moisture Content	(%)	25.5			
TEST RESULTS					
Wet Unit Wt.	(pcf)	127.6			
Moisture Content	(%)	25.5			
Dry Unit Wt.	(pcf)	101.7			
MOISTURE CORRECTION DATA					
Gauge Moisture	(%)				
K Value Correction Factor					
COMPACTION CURVE DATA (ASTM D698, ASTM D1557, or CAL216)					
Test Method					
Curve No.					
Max Wet Unit Wt.	(pcf)				
Max Dry Unit Wt.	(pcf)				
Optimum Moisture	(%)				
Wet Relative Comp.	(%)				
Dry Relative Comp.	(%)				

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Moisture & Density

ASTM D2216, D2937, C566

DSA File No.: n/a

DSA App No.: n/a

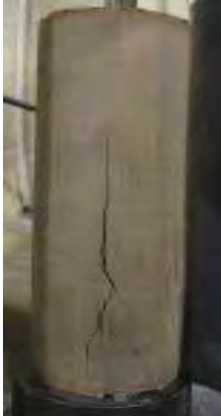
Project No.: 70508		Project Name: Colusa Waste Water Project		Date: 04/20/15	
				Tested By: CHB	
				Checked By: DMO	
				Lab. No.: C15-035	
SAMPLE LOCATION DATA					
Boring/Trench No.	Units	B15-19			
Sample No.		L2-1-2			
Depth Interval	(ft.)	10			
Sample Description		CLAY; Olive Brown (2.5Y 4/4)			
USCS Symbol		CL			
SAMPLE DIMENSION AND WEIGHT DATA					
Sample Length	(in)	5.979			
Sample Diameter	(in)	2.384			
Sample Volume	(cf)	0.0154			
Wet Soil + Tube Wt.	(gr)	1168.50			
Tube Wt.	(gr)	274.70			
Wet Soil Wt.	(gr)	893.80			
MOISTURE CONTENT DATA					
Tare No.		G2			
Tare Wt.	(gr)	768.40			
Wet Soil + Tare Wt.	(gr)	1659.60			
Dry Soil + Tare Wt.	(gr)	1478.70			
Water Wt.	(gr)	180.90			
Dry Soil Wt.	(gr)	710.30			
Moisture Content	(%)	25.5			
TEST RESULTS					
Wet Unit Wt.	(pcf)	127.6			
Moisture Content	(%)	25.5			
Dry Unit Wt.	(pcf)	101.7			
MOISTURE CORRECTION DATA					
Gauge Moisture	(%)				
K Value Correction Factor					
COMPACTION CURVE DATA (ASTM D698, ASTM D1557, or CAL216)					
Test Method					
Curve No.					
Max Wet Unit Wt.	(pcf)				
Max Dry Unit Wt.	(pcf)				
Optimum Moisture	(%)				
Wet Relative Comp.	(%)				
Dry Relative Comp.	(%)				

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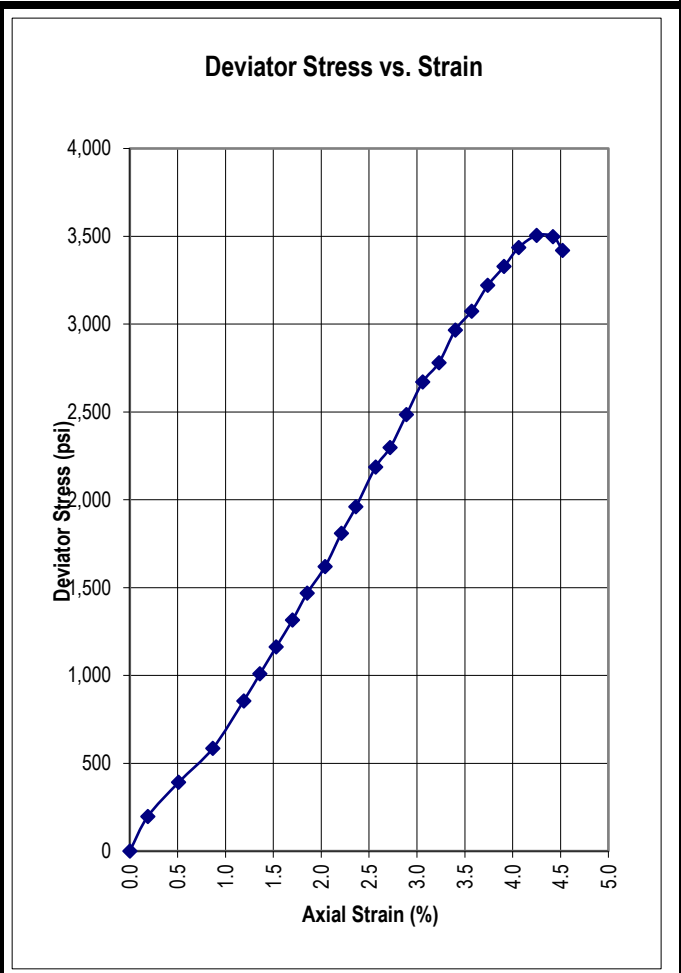
UNCONFINED COMPRESSION

ASTM D2166

Project No.:	70508-01	Project Name:	Colusa Waste Water Project	Date:	04/27/15
Boring/Trench No.:	B15-19	Sample No.:	L4-1-2	Depth (ft.)	20
Soil Description:	(CL) Lean Clay, Vis. Est Clay 85%, Fine Sand 15%; Brown (2.5Y 4/3)				Tested By: CHB
Sample Location:					Check By: DMO
					Lab No.: C15-035

Sample Data			Sample Sketch At Failure
Tare Tube Number	I.D.	G5	
Tare Weight	(gm)	768.00	
Wet Soil + Tare	(gm)	1614.80	
Dry Soil + Tare	(gm)	1437.10	
Weight of Water	(gm)	177.70	
Dry Soil Weight	(gm)	669.10	
Moisture Content	(%)	26.56	
Soil Height	(cm)	14.94	
Sample Diameter	(cm)	6.08	
Wet Unit Weight	(pcf)	121.88	
Dry Unit Weight	(pcf)	96.31	Comments: Maximum Shear Strength, Su = 1,752.4 psf = 12.17 psi Maximum Unconfined Compressive Strength, qu = 3,504.8 psf = 24.34 psi
Specific Gravity	(dim)	2.30	
Saturation	(%)	124.60	
Strain Rate	(%/min.)	1.27	
Proving Ring Constant	(lbs/unit)	1.230	

Elapsed Time (Sec)	Strain		Area (cm²)	Load		Deviator Stress (psf)
	Units (0.001in/unit)	Percent (%)		Dial (units)	Force (lbs)	
0	0	0.00	0.00	0	0.00	0.0
8	11	0.19	29.09	5	6.15	196.4
23	30	0.51	29.18	10	12.30	391.6
40	51	0.87	29.29	15	18.45	585.3
53	70	1.19	29.38	22	27.06	855.6
65	80	1.36	29.43	26	31.98	1009.4
73	90	1.53	29.48	30	36.90	1162.7
81	100	1.70	29.54	34	41.82	1315.4
89	109	1.85	29.58	38	46.74	1467.9
97	120	2.04	29.64	42	51.66	1619.3
105	130	2.21	29.69	47	57.81	1809.0
113	139	2.36	29.74	51	62.73	1959.8
123	151	2.57	29.80	57	70.11	2185.8
130	160	2.72	29.85	60	73.80	2297.3
139	170	2.89	29.90	65	79.95	2484.4
148	180	3.06	29.95	70	86.10	2670.8
155	190	3.23	30.00	73	89.79	2780.4
164	200	3.40	30.06	78	95.94	2965.6
171	210	3.57	30.11	81	99.63	3074.2
180	220	3.74	30.16	85	104.55	3220.3
182	230	3.91	30.21	88	108.24	3328.1
195	239	4.06	30.26	91	111.93	3436.1
204	250	4.25	30.32	93	114.39	3504.8
212	260	4.42	30.38	93	114.39	3498.5
217	266	4.52	30.41	91	111.93	3419.6



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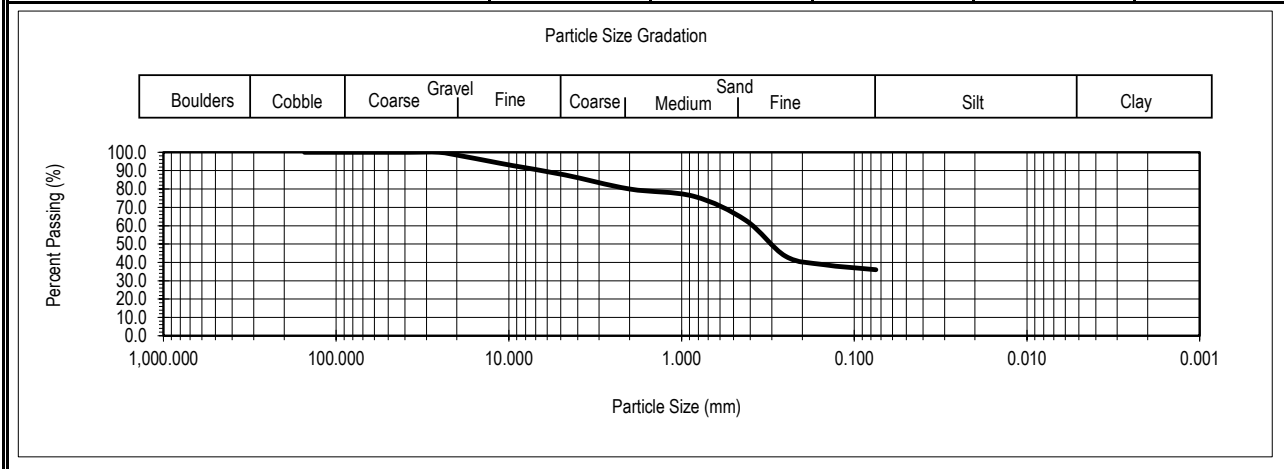
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Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/28/2015**
 Sample No.: **B8-1-1** Boring/Trench: **B15-19** Depth, (ft.): **21.5** Tested By: **CHB**
 Description: **(SM) Silty SAND; Lab Data Sand 52%, Silt 36%; Dark Olive Brown (2.5Y 3/3)** Checked By: **DMO**
 Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	752.7	100.0
3 Inch	3.0000	76.2		0.0	752.7	100.0
2 Inch	2.0000	50.8		0.0	752.7	100.0
1.5 Inch	1.5000	38.1		0.0	752.7	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	752.7	100.0
3/4 Inch	0.7500	19.1	14.20	14.2	738.5	98.1
1/2 Inch	0.5000	12.7	23.60	37.8	714.9	95.0
3/8 Inch	0.3750	9.5	16.60	54.4	698.3	92.8
#4	0.1875	4.7500	38.20	92.6	660.1	87.7
#10	0.0787	2.0000	58.00	150.6	602.1	80.0
#20	0.0335	0.8500	29.82	180.4	572.2	76.0
#40	0.0167	0.4250	98.71	279.1	473.5	62.9
#60	0.0098	0.2500	147.28	426.4	326.3	43.3
#100	0.0059	0.1500	34.51	460.9	291.7	38.8
#200	0.0030	0.0750	20.83	481.7	270.9	36.0
Hydrometer						



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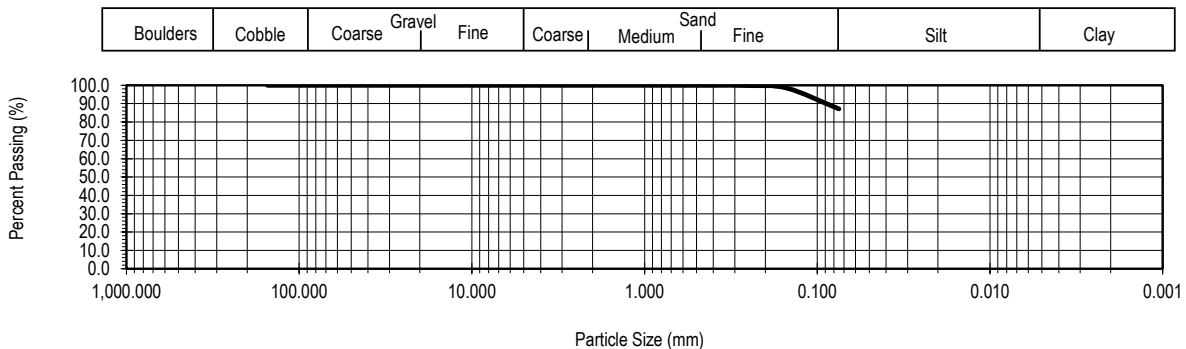
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/28/2015**
Sample No.: **B10-1-1** Boring/Trench: **B15-19** Depth, (ft.): **26.5** Tested By: **CHB**
Description: **(CL) Lean Clay; Lab Data Clay 87%, Fine Sand 13%; Brown (2.5Y 4/3)** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	519.8	100.0
3 Inch	3.0000	76.2		0.0	519.8	100.0
2 Inch	2.0000	50.8		0.0	519.8	100.0
1.5 Inch	1.5000	38.1		0.0	519.8	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	519.8	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	519.8	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	519.8	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	519.8	100.0
#4	0.1875	4.7500	0.00	0.0	519.8	100.0
#10	0.0787	2.0000	0.00	0.0	519.8	100.0
#20	0.0335	0.8500	0.00	0.0	519.8	100.0
#40	0.0167	0.4250	0.20	0.2	519.6	100.0
#60	0.0098	0.2500	0.60	0.8	519.0	99.8
#100	0.0059	0.1500	7.10	7.9	511.9	98.5
#200	0.0030	0.0750	58.80	66.7	453.1	87.2
Hydrometer						

Particle Size Gradation



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Atterberg Indices

ASTM D4318

DSA File No.: n/a

DSA App No.: n/a

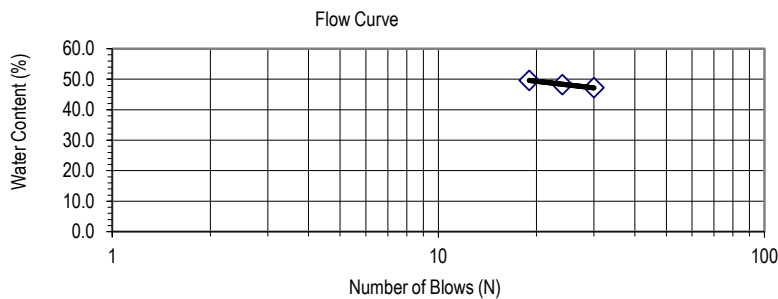
Project No.:	70508	Project Name:	Colusa Waste Water Project	Date:	04/08/15
Sample No.:	L1-1-2	Boring/Trench:	B15-20	Depth, (ft.):	2
Description:	(CL) Lean Clay, Very Dark Greyish Brown (2.5YR, 3/2)				Tested By:
Sample Location:					Checked By:
					Lab. No.:
					C15-035

Estimated % of Sample Retained on No. 40 Sieve:	0	Sample Air Dried:	yes
Test Method A or B:	A		

LIQUID LIMIT:						PLASTIC LIMIT:		
Sample No.:	1	2	3	4	5	1	2	3
Pan ID:	B	E	A			D	C	
Wt. Pan (gr)	38.97	36.44	38.45			38.27	38.46	
Wt. Wet Soil + Pan (gr)	58.61	53.53	56.74			45.69	51.30	
Wt. Dry Soil + Pan (gr)	52.31	47.97	50.67			44.63	49.44	
Wt. Water (gr)	6.30	5.56	6.07			1.06	1.86	
Wt. Dry Soil (gr)	13.34	11.53	12.22			6.36	10.98	
Water Content (%)	47.2	48.2	49.7			16.7	16.9	
Number of Blows, N	30	24	19					

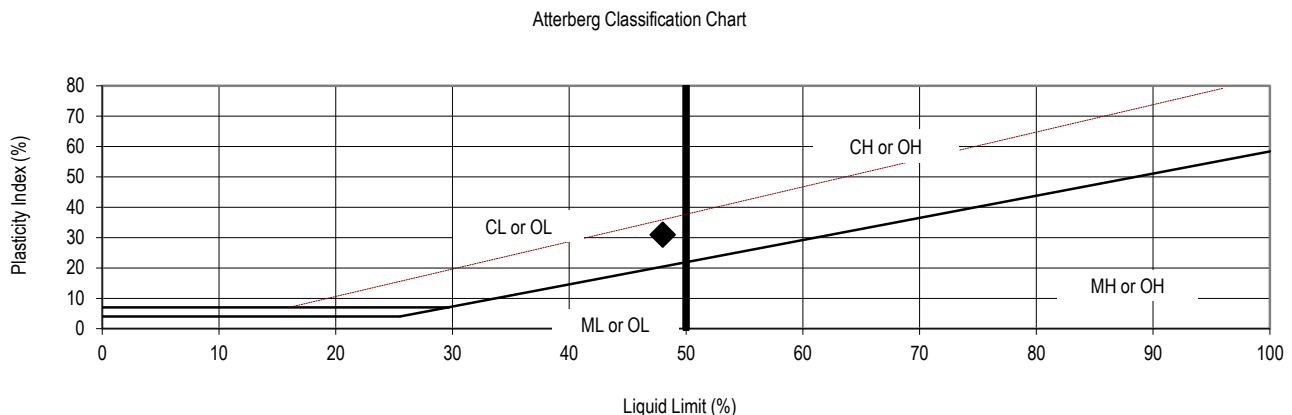
LIQUID LIMIT = 48

PLASTIC LIMIT = 17



Plasticity Index = 31

Group Symbol = CL



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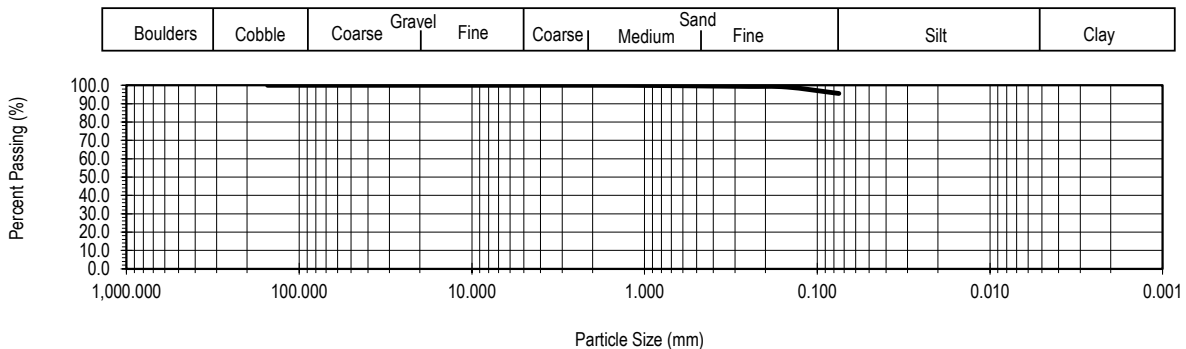
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/8/2015**
Sample No.: **L1-1-2** Boring/Trench: **B15-20** Depth, (ft.): **2** Tested By: **JFH**
Description: **(CL) Lean Clay, Very Dark Greyish Brown (2.5YR, 3/2)** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	339.3	100.0
3 Inch	3.0000	76.2		0.0	339.3	100.0
2 Inch	2.0000	50.8		0.0	339.3	100.0
1.5 Inch	1.5000	38.1		0.0	339.3	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	339.3	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	339.3	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	339.3	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	339.3	100.0
#4	0.1875	4.7500	0.00	0.0	339.3	100.0
#10	0.0787	2.0000	0.00	0.0	339.3	100.0
#20	0.0335	0.8500	0.46	0.5	338.8	99.9
#40	0.0167	0.4250	0.91	1.4	337.9	99.6
#60	0.0098	0.2500	0.76	2.1	337.2	99.4
#100	0.0059	0.1500	1.07	3.2	336.1	99.1
#200	0.0030	0.0750	11.88	15.1	324.2	95.6
Hydrometer						

Particle Size Gradation



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PERMEABILITY TEST

ASTM D5084 (Method C)

Project No.: 70508-01

Project Name: Colusa Waste Water Project

Boring/Trench No.: B15-20

Sample No.: L1-1-2

Sample Depth (ft): 2

Sample Description: (CL) Lean Clay, Very Dark Greyish Brown (2.5YR, 3/2)

Date Tested: 4/3/2015

Tested By: JFH

Checked By: DMO

Special Notes:

TEST SPECIMEN INFORMATION**Initial and Final Specimen Test Conditions**

Property	Units	Initial	final
Diameter	(cm)	6.060	6.114
Area	(cm ²)	28.843	29.359
Height	(cm)	6.880	6.953
Volume	(cm ³)	198.437	204.133
Wet Soil Weight	(gr)	413.70	421.30
Dry Soil Weight	(gr)	343.90	343.90
Water Weight	(gr)	69.80	77.40
Moisture Content	(%)	20.3	22.5
Dry Density	(pcf)	108.2	105.2
Void Ratio	(dim)	0.616	0.662
Saturation	(%)	92.3	95.2
Porosity	(%)	38.1	39.8
Relative Compaction	(%)		

End of Test Oven Dried Sample Information

Item	Unit	Final
Tare Number	na	G13
Tare Weight	(gr)	769.30
Wet Soil + Tare Weight	(gr)	1190.60
Dry Soil + Tare Weight	(gr)	1113.20
Water Weight	(gr)	77.40
Dry Soil Weight	(gr)	343.90
Moisture Content	(%)	22.5
Lab Maximum Dry Density	(pcf)	
Optimum Moisture Content	(%)	
Specific Gravity	(dim)	2.80

Avg. Permeability (Last Four Readings), K= 4.1E-09 cm/s

SAMPLE PREPARATION AND TEST CONDITIONS:**Back Pressure Saturation Test Phase:**

Chamber (psi) = 60.0

Sample Top and Bottom (psi) = 58.0

Skempton "B" Parameter = 0.90

Chamber (psi) =

Sample Top and Bottom (psi) =

Skempton "B" Parameter =

Consolidation Test Phase:

Chamber (psi) = 60.0

Sample Top and Bottom (psi) = 55.0

Average Consol. Pressure (psi) = 5.0

Permeation Test Phase:

Permeant = Deaired tap water

Initial Hydraulic Gradient (cm/cm) = 34.69

Chamber (psi) = 60.0

Sample Top (psi) = 55.0

Sample Bottom (psi) = 58.0

PERMEATION TEST DATA

Time Data			Burrett Readings			Temp. Degree Celcius (C)	Permeability (cm/s)	Restart Test (Yes or No)	Comments
Date (mm/dd/yy hh:mm)	Clock Time (hh:mm)	Elapsed Time (sec)	Bottom (Inflow) (cm)	Top (Outflow) (cm)	Chamber (cm)				
4/7/15 9:37	9:37	0	44.20	15.80	41.00	23.20		Yes	
4/8/15 7:22	7:22	78,300	43.70	16.60	39.90	21.50	7.9E-09		
4/9/15 8:11	8:11	89,340	43.30	17.00	39.50	24.70	4.2E-09		
4/10/15 7:39	7:39	84,480	42.90	17.40	39.30	22.30	4.4E-09		
4/11/15 19:25	19:25	128,760	42.40	17.90	38.70	22.30	3.7E-09		
4/13/15 7:47	7:47	130,920	41.80	18.40	38.20	22.20	4.1E-09		
		0							
		0							
		0							
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Atterberg Indices

ASTM D4318

DSA File No.: n/a

DSA App No.: n/a

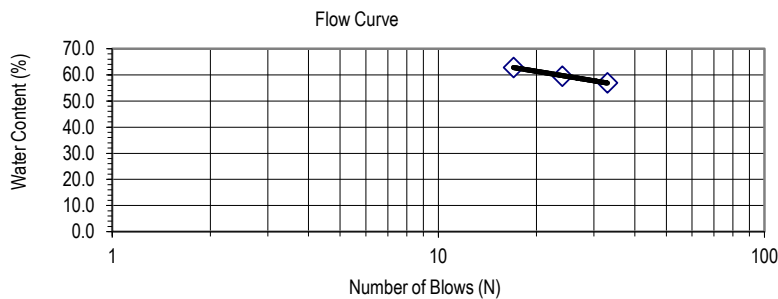
Project No.:	70508	Project Name:	Colusa Waste Water Project	Date:	04/08/15
Sample No.:	L1-1-2	Boring/Trench:	B15-21	Depth, (ft.):	2
Description:	(CH) Clay, Olive Brown (2.5YR, 4/3)			Tested By:	JFH
Sample Location:				Checked By:	DMO
				Lab. No.:	C15-035

Estimated % of Sample Retained on No. 40 Sieve:	0	Sample Air Dried:	yes
Test Method A or B:	A		

LIQUID LIMIT:						PLASTIC LIMIT:		
Sample No.:	1	2	3	4	5	1	2	3
Pan ID:	E	B	D			A	C	
Wt. Pan (gr)	36.45	38.97	38.27			38.45	38.46	
Wt. Wet Soil + Pan (gr)	52.57	53.14	52.18			45.37	47.90	
Wt. Dry Soil + Pan (gr)	46.72	47.85	46.81			44.35	46.52	
Wt. Water (gr)	5.85	5.29	5.37			1.02	1.38	
Wt. Dry Soil (gr)	10.27	8.88	8.54			5.90	8.06	
Water Content (%)	57.0	59.6	62.9			17.3	17.1	
Number of Blows, N	33	24	17					

LIQUID LIMIT = 60

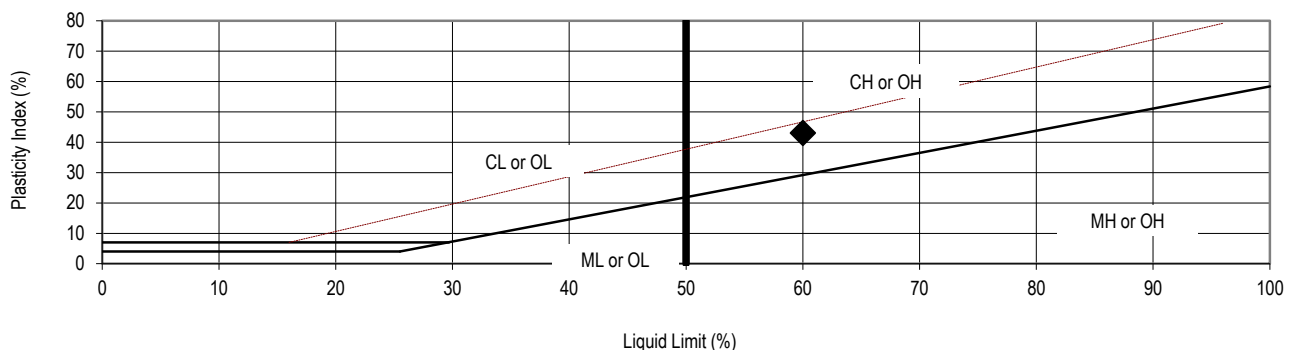
PLASTIC LIMIT = 17



Plasticity Index = 43

Group Symbol = CH

Atterberg Classification Chart



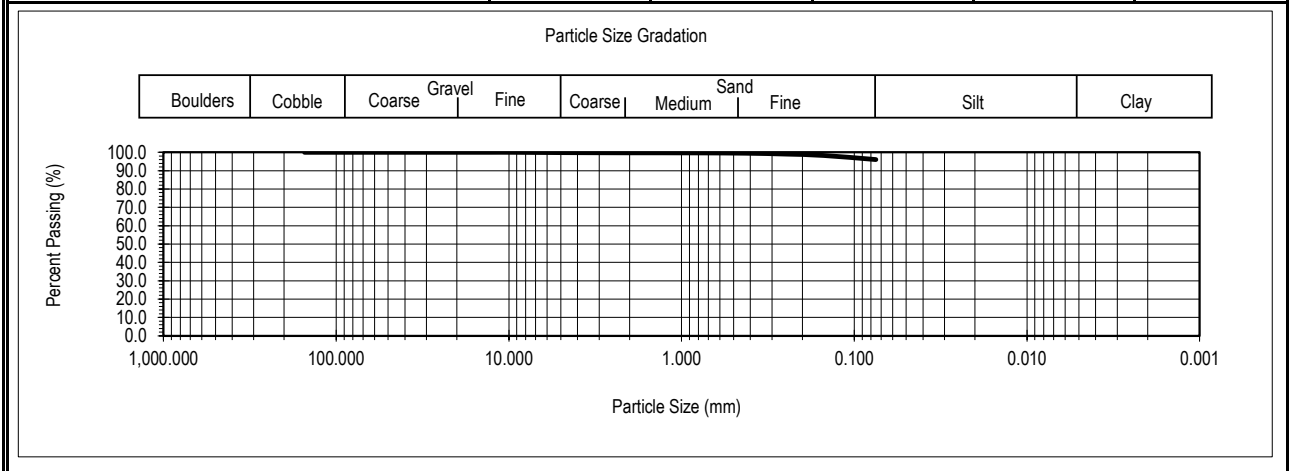
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Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/8/2015**
Sample No.: **L1-1-2** Boring/Trench: **B15-21** Depth, (ft.): **2** Tested By: **JFH**
Description: **(CH) Clay, Olive Brown (2.5YR, 4/3)** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	729.8	100.0
3 Inch	3.0000	76.2		0.0	729.8	100.0
2 Inch	2.0000	50.8		0.0	729.8	100.0
1.5 Inch	1.5000	38.1		0.0	729.8	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	729.8	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	729.8	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	729.8	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	729.8	100.0
#4	0.1875	4.7500	1.30	1.3	728.5	99.8
#10	0.0787	2.0000	0.70	2.0	727.8	99.7
#20	0.0335	0.8500	0.33	2.3	727.4	99.7
#40	0.0167	0.4250	1.33	3.7	726.1	99.5
#60	0.0098	0.2500	3.32	7.0	722.8	99.0
#100	0.0059	0.1500	5.65	12.6	717.1	98.3
#200	0.0030	0.0750	16.28	28.9	700.9	96.0
Hydrometer						



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PERMEABILITY TEST

ASTM D5084 (Method C)

Project No.: 70508-01

Project Name: Colusa Waste Water Project

Boring/Trench No.: B15-21

Sample No.: L1-1-2

Sample Depth (ft):	2
--------------------	---

Sample Description: (CH) Clay, Olive Brown (2.5YR, 4/3)

Date Tested: 4/3/2015

Tested By: JFH

Checked By: DMO

Special Notes:

TEST SPECIMEN INFORMATION

Initial and Final Specimen Test Conditions

Property	Units	Initial	final
Diameter	(cm)	6.070	6.080
Area	(cm^2)	28.938	29.033
Height	(cm)	6.153	6.132
Volume	(cm^3)	178.055	178.032
Wet Soil Weight	(gr)	353.40	359.40
Dry Soil Weight	(gr)	284.60	284.60
Water Weight	(gr)	68.80	74.80
Moisture Content	(%)	24.2	26.3
Dry Density	(pcf)	99.8	99.8
Void Ratio	(dim)	0.752	0.752
Saturation	(%)	90.0	97.9
Porosity	(%)	42.9	42.9
Relative Compaction	(%)		

End of Test Oven Dried Sample Information

Item	Unit	Final
Tare Number	na	G11
Tare Weight	(gr)	765.70
Wet Soil + Tare Weight	(gr)	1125.10
Dry Soil + Tare Weight	(gr)	1050.30
Water Weight	(gr)	74.80
Dry Soil Weight	(gr)	284.60
Moisture Content	(%)	26.3
Lab Maximum Dry Density	(pcf)	
Optimum Moisture Content	(%)	
Specific Gravity	(dim)	2.80

Avg. Permeability(Last Four Readings), K= 1.2E-08 cm/s

SAMPLE PREPARATION AND TEST CONDITIONS:

Back Pressure Saturation Test Phase:

Chamber (psi) = 60.0

Sample Top and Bottom (psi) = 58.0

Skempton "B" Parameter = 1.00

Chamber (psi) =

Sample Top and Bottom (psi) =

Skempton "B" Parameter =

Consolidation Test Phase:

Chamber (psi) = 60.0

Sample Top and Bottom (psi) = 55.0

Average Consol. Pressure (psi) = 5.0

Permeation Test Phase:

Permeant = Deaired tap water

Initial Hydraulic Gradient (cm/cm) = 37.34

Chamber (psi) = 60.0

Sample Top (psi) = 55.0

Sample Bottom (psi) = 58.0

PERMEATION TEST DATA

[illegible]



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Atterberg Indices

ASTM D4318

DSA File No.: n/a

DSA App No.: n/a

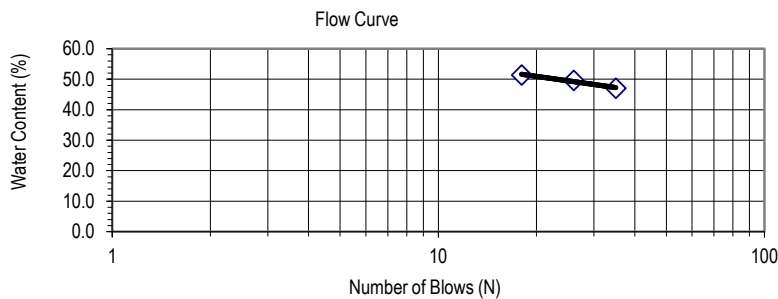
Project No.:	70508	Project Name:	Colusa Waste Water Project	Date:	04/08/15
Sample No.:	L1-1-2	Boring/Trench:	B15-22	Depth, (ft.):	2
Description:	(CH) Clay; Very Dark Greyish Brown (2.5y 3/2)				Tested By:
Sample Location:					Checked By:
					Lab. No.:

Estimated % of Sample Retained on No. 40 Sieve:	0	Sample Air Dried:	yes
Test Method A or B:	A		

LIQUID LIMIT:						PLASTIC LIMIT:		
Sample No.:	1	2	3	4	5	1	2	3
Pan ID:	D	A	B			C	E	
Wt. Pan (gr)	38.27	38.45	38.97			38.46	36.45	
Wt. Wet Soil + Pan (gr)	55.90	54.19	56.16			47.21	43.64	
Wt. Dry Soil + Pan (gr)	50.26	48.97	50.32			45.83	42.50	
Wt. Water (gr)	5.64	5.22	5.84			1.38	1.14	
Wt. Dry Soil (gr)	11.99	10.52	11.35			7.37	6.05	
Water Content (%)	47.0	49.6	51.5			18.7	18.8	
Number of Blows, N	35	26	18					

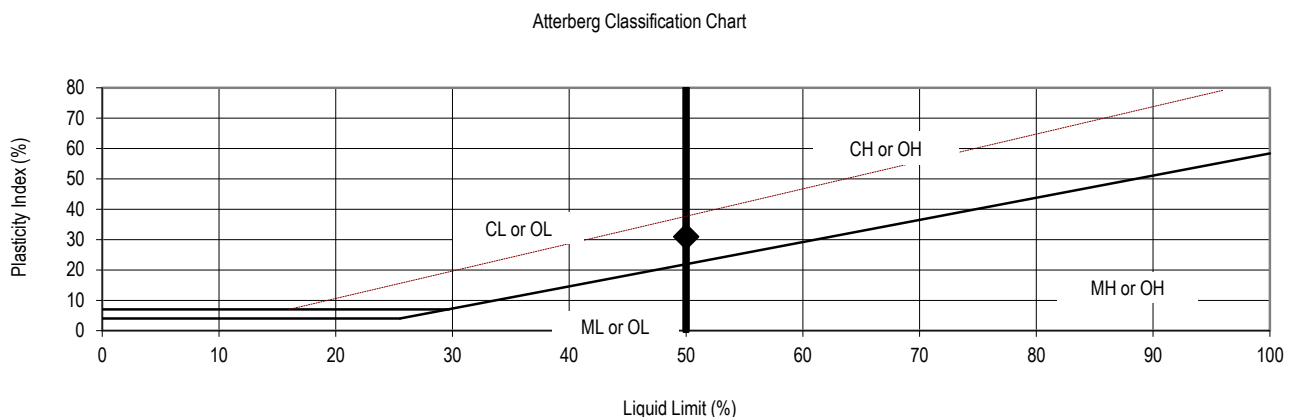
LIQUID LIMIT = 50

PLASTIC LIMIT = 19



Plasticity Index = 31

Group Symbol = CH



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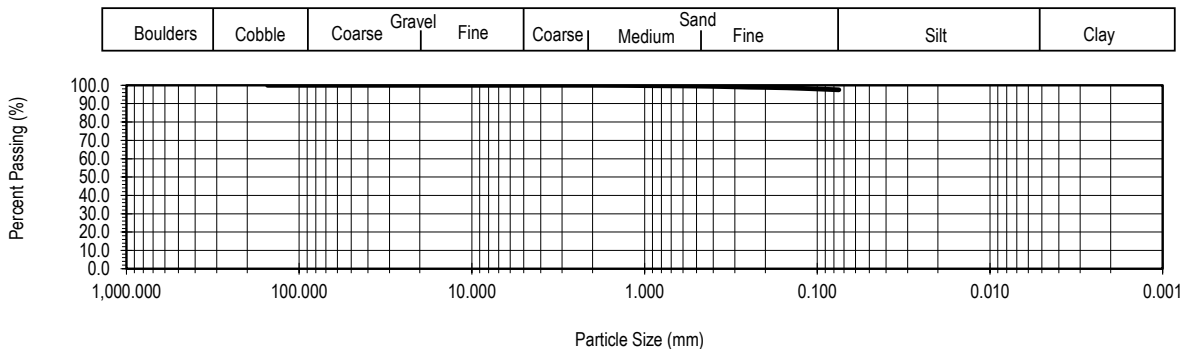
Particle Size Distribution

ASTM D422, C136

Project No.: **70508** Project Name: **Colusa Waste Water Project** Date: **4/8/2015**
Sample No.: **L1-1-2** Boring/Trench: **B15-22** Depth, (ft.): **2** Tested By: **JFH**
Description: **(CH) Clay; Very Dark Greyish Brown (2.5y 3/2)** Checked By: **DMO**
Sample Location: Lab. No.: **C15-035**

Sieve Size (U.S. Standard)	Particle Diameter		Dry Weight on Sieve			Percent Passing (%)
	Inches (in.)	Millimeter (mm)	Retained On Sieve (gm)	Accumulated On Sieve (gm)	Passing Sieve (gm)	
6 Inch	6.0000	152.4		0.0	665.7	100.0
3 Inch	3.0000	76.2		0.0	665.7	100.0
2 Inch	2.0000	50.8		0.0	665.7	100.0
1.5 Inch	1.5000	38.1		0.0	665.7	100.0
1.0 Inch	1.0000	25.4	0.00	0.0	665.7	100.0
3/4 Inch	0.7500	19.1	0.00	0.0	665.7	100.0
1/2 Inch	0.5000	12.7	0.00	0.0	665.7	100.0
3/8 Inch	0.3750	9.5	0.00	0.0	665.7	100.0
#4	0.1875	4.7500	0.00	0.0	665.7	100.0
#10	0.0787	2.0000	0.00	0.0	665.7	100.0
#20	0.0335	0.8500	1.53	1.5	664.2	99.8
#40	0.0167	0.4250	1.91	3.4	662.3	99.5
#60	0.0098	0.2500	3.43	6.9	658.8	99.0
#100	0.0059	0.1500	2.29	9.2	656.5	98.6
#200	0.0030	0.0750	7.24	16.4	649.3	97.5
Hydrometer						

Particle Size Gradation



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PERMEABILITY TEST**ASTM D5084 (Method C)**

Project No.: 70508-01

Project Name: Colusa Waste Water Project

Boring/Trench No.: B15-22

Sample No.: L1-1-2

Sample Depth (ft): 2

Sample Description: (CH) Clay; Very Dark Greyish Brown (2.5y 3/2)

Date Tested: 4/3/2015

Tested By: JFH

Checked By: DMO

Special Notes:

TEST SPECIMEN INFORMATION**Initial and Final Specimen Test Conditions**

Property	Units	Initial	Final
Diameter	(cm)	6.020	6.051
Area	(cm ²)	28.463	28.757
Height	(cm)	7.840	7.845
Volume	(cm ³)	223.151	225.599
Wet Soil Weight	(gr)	447.40	453.20
Dry Soil Weight	(gr)	364.30	364.30
Water Weight	(gr)	83.10	88.90
Moisture Content	(%)	22.8	24.4
Dry Density	(pcf)	101.9	100.8
Void Ratio	(dim)	0.715	0.734
Saturation	(%)	89.3	93.1
Porosity	(%)	41.7	42.3
Relative Compaction	(%)		

End of Test Oven Dried Sample Information

Item	Unit	Final
Tare Number	na	G6
Tare Weight	(gr)	767.80
Wet Soil + Tare Weight	(gr)	1221.00
Dry Soil + Tare Weight	(gr)	1132.10
Water Weight	(gr)	88.90
Dry Soil Weight	(gr)	364.30
Moisture Content	(%)	24.4
Lab Maximum Dry Density	(pcf)	
Optimum Moisture Content	(%)	
Specific Gravity	(dim)	2.80

Avg. Permeability (Last Four Readings), K= 7.0E-09 cm/s**SAMPLE PREPARATION AND TEST CONDITIONS:****Back Pressure Saturation Test Phase:**

Chamber (psi) = 60.0

Sample Top and Bottom (psi) = 58.0

Skempton "B" Parameter = 0.90

Chamber (psi) =

Sample Top and Bottom (psi) =

Skempton "B" Parameter =

Consolidation Test Phase:

Chamber (psi) = 60.0

Sample Top and Bottom (psi) = 55.0

Average Consol. Pressure (psi) = 5.0

Permeation Test Phase:

Permeant = Deaired tap water

Initial Hydraulic Gradient (cm/cm) = 30.30

Chamber (psi) = 60.0

Sample Top (psi) = 55.0

Sample Bottom (psi) = 58.0

PERMEATION TEST DATA

Time Data			Burrett Readings			Temp. Degree Celcius (C)	Permeability (cm/s)	Restart Test (Yes or No)	Comments
Date (mm/dd/yy hh:mm)	Clock Time (hh:mm)	Elapsed Time (sec)	Bottom (Inflow) (cm)	Top (Outflow) (cm)	Chamber (cm)				
4/7/15 9:47	9:47	0	44.00	16.50	44.60	23.30		Yes	
4/8/15 7:23	7:23	77,760	43.50	17.80	43.50	21.70	1.3E-08		
4/9/15 8:13	8:13	89,400	43.00	18.40	43.30	24.70	6.6E-09		
4/10/15 7:40	7:40	84,420	42.40	19.00	43.20	22.30	7.7E-09		
4/11/15 19:24	19:24	128,640	41.50	19.70	42.70	22.30	7.0E-09		
4/13/15 7:48	7:48	131,040	40.70	20.50	42.40	22.20	6.9E-09		
		0							
		0							
		0							
		0							
		0							
		0							
		0							
		0							
		0							
		0							
		0							
		0							
		0							
		0							
		0							



7 May 2015

Job No.1 1505011
Cust. No.12277

1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax. 925 462 2775
www.cercoanalytical.com

Mr. Don Olsen
Holdrege & Kull
792 Searls Avenue
Nevada City, CA 95959

Subject: Project No.: 70508-01
Project Name: Boring B15-13 @ 15'
Corrosivity Analysis – ASTM Test Methods with Brief Evaluation

Dear Mr. Olsen:

Pursuant to your request, CERCO Analytical has analyzed the soil samples submitted on May 04, 2015. Based on the analytical results, a brief corrosivity evaluation is enclosed for your consideration.

Based upon the resistivity measurement, the sample is classified as "corrosive". All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.

The chloride ion concentration is 19 mg/kg. Because the chloride ion concentration is less than 300 mg/kg, it is determined to be insufficient to attack steel embedded in a concrete mortar coating.

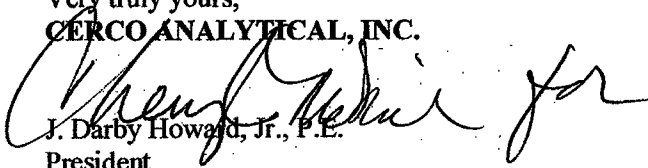
The sulfate ion concentrations is 16 mg/kg and is determined to be insufficient to damage reinforced concrete structures and cement mortar-coated steel at these locations.

The pH of the soil is 8.84 which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

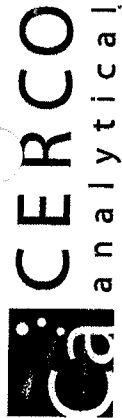
This corrosivity evaluation is based on general corrosion engineering standards and is non-specific in nature. For specific long-term corrosion control design recommendations or consultation, please call *JDH Corrosion Consultants, Inc.* at (925) 927-6630.

We appreciate the opportunity of working with you on this project. If you have any questions, or if you require further information, please do not hesitate to contact us.

Very truly yours,
CERCO ANALYTICAL, INC.


J. Darby Howard, Jr., P.E.
President

JDH/jdl
Enclosure



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Concord, CA 94520-1006
925 462 2771 Fax: 925 462 2775
www.cercoanalytical.com

Date of Report: 7-May-2015

Client:	Holdrege & Kull
Client's Project No.:	70508-01
Client's Project Name:	Boring B15-13 @ 15'
Date Sampled:	Not Indicated
Date Received:	4-May-15
Matrix:	Soil
Authorization:	Signed Chain of Custody

[illegible]

Method:	ASTM D1498	ASTM D4972	ASTM D1125M	ASTM G57	ASTM D4638M	ASTM D4327	ASTM D4327
Detection Limit:	-	-	10	-	50	15	15
Date Analyzed:	-	6-May-2015	-	5-May-2015	-	6-May-2015	6-May-2015

* Results Reported on "As Received" Basis
N.D. = None Detected

Cheryl McMillen

Cheryl McMillen
Laboratory Director

Quality Control Summary - All laboratory quality control parameters were found to be within established limits



8 May 2015

Job No. 1505012
Cust. No. 12277

1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax. 925 462 2775
www.cercoanalytical.com

Mr. Don Olsen
Holdrege & Kull
792 Searls Avenue
Nevada City, CA 95959

Subject: Project No.: 70508-01
Project Name: Boring B15-6 @ 10'
Corrosivity Analysis – ASTM Test Methods with Brief Evaluation

Dear Mr. Olsen:

Pursuant to your request, CERCO Analytical has analyzed the soil samples submitted on May 04, 2015. Based on the analytical results, a brief corrosivity evaluation is enclosed for your consideration.

Based upon the resistivity measurement, the sample is classified as "corrosive". All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.

The chloride ion concentration is 16 mg/kg. Because the chloride ion concentration is less than 300 mg/kg, it is determined to be insufficient to attack steel embedded in a concrete mortar coating.

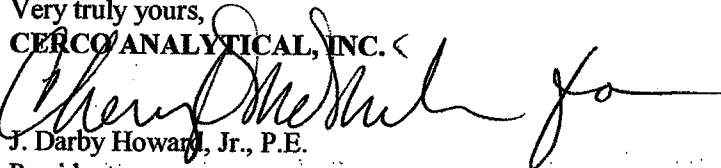
The sulfate ion concentration is 47 mg/kg and is determined to be insufficient to damage reinforced concrete structures and cement mortar-coated steel at these locations.

The pH of the soil is 8.90 which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

This corrosivity evaluation is based on general corrosion engineering standards and is non-specific in nature. For specific long-term corrosion control design recommendations or consultation, please call JDH Corrosion Consultants, Inc. at (925) 927-6630.

We appreciate the opportunity of working with you on this project. If you have any questions, or if you require further information, please do not hesitate to contact us.

Very truly yours,
CERCO ANALYTICAL, INC. <


J. Darby Howard, Jr., P.E.
President

JDH/jdl
Enclosure



8 May 2015

Job No. 1505013
Cust. No. 12277

1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax. 925 462 2775
www.cercoanalytical.com

Mr. Don Olsen
Holdrege & Kull
792 Searls Avenue
Nevada City, CA 95959

Subject: Project No.: 70508-01
Project Name: Boring B15-16A @ 10'
Corrosivity Analysis – ASTM Test Methods with Brief Evaluation

Dear Mr. Olsen:

Pursuant to your request, CERCO Analytical has analyzed the soil samples submitted on May 04, 2015. Based on the analytical results, a brief corrosivity evaluation is enclosed for your consideration.

Based upon the resistivity measurement, the samples is classified as "corrosive". All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.

The chloride ion concentration is none detected to 15 mg/kg.

The sulfate ion concentration is none detected to 15 mg/kg.

The pH of the soil is 8.63 which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

This corrosivity evaluation is based on general corrosion engineering standards and is non-specific in nature. For specific long-term corrosion control design recommendations or consultation, please call *JDH Corrosion Consultants, Inc.* at (925) 927-6630.

We appreciate the opportunity of working with you on this project. If you have any questions, or if you require further information, please do not hesitate to contact us.

Very truly yours,
CERCO ANALYTICAL, INC.


J. Darby Howard, Jr., P.E.
President

JDH/jdl
Enclosure

Date of Report: 8-May-2015

[illegible]

Method:	ASTM D1498	ASTM D4972	ASTM D1125M	ASTM G57	ASTM D4658M	ASTM D4327	ASTM D4327
Detection Limit:	-	-	10	-	50	15	15
Date Analyzed:	-	6-May-2015	-	5-May-2015	-	6-May-2015	6-May-2015

* Results Reported on "As Received" Basis
N.D. - None Detected

Cheryl McMillen
Laboratory Director



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13 May 2015

Job No. 1505015
Cust. No. 12830

Mr. Don Olsen
Holdrege & Kull
8 Seville Court, Suite 100
Chico, CA 95928

Subject: Project No.: 70508-01
Project Name: Colusa Waste Water Project
Boring B15-19 @ 10' Below Ground Surface
Corrosivity Analysis – ASTM Test Methods with Brief Evaluation

Dear Mr. Olsen:

Pursuant to your request, CERCO Analytical has analyzed the soil sample submitted on May 04, 2015. Based on the analytical results, a brief corrosivity evaluation is enclosed for your consideration.

Based upon the resistivity measurement, the sample is classified as "corrosive". All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.

The chloride ion concentration is 19 mg/kg and is determined to be insufficient to attack steel embedded in a concrete mortar coating.

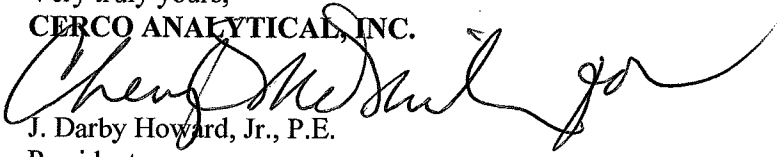
The sulfate ion concentration is 45 mg/kg and is determined to be insufficient to damage reinforced concrete structures and cement mortar-coated steel at this location.

The pH of the soil is 8.53, which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

This corrosivity evaluation is based on general corrosion engineering standards and is non-specific in nature. For specific long-term corrosion control design recommendations or consultation, please call *JDH Corrosion Consultants, Inc.* at (925) 927-6630.

We appreciate the opportunity of working with you on this project. If you have any questions, or if you require further information, please do not hesitate to contact us.

Very truly yours,
CERCO ANALYTICAL, INC.


J. Darby Howard, Jr., P.E.
President

JDH/jdl
Enclosure



Contract No.:	Holdrege & Kull
Contract's Project No.:	70508-01
Contract's Project Name:	Colusa Waste Water Project - Boring B15-19 @ 10' Below Ground Surface
Contract's Sampled:	Not Indicated
Contract's Received:	4-May-05
Contract's Price:	Soil
Contract's Authorization:	Signed Chain of Custody

Date of Report: 13-May-2015

[illegible]

Mod:	ASTM D1498	ASTM D4972	ASTM D1125M	ASTM G57	ASTM D4658M	ASTM D4327
ction Limit:	-	-	10	-	50	15
Analyzed:	-	11-May-2015	-	7-May-2015	-	11-May-2015

* Results Reported on "As Received" Basis

Cheryl McMillen

McMillen

Laboratory Director

Control Summary - All laboratory quality control parameters were found to be within established limits



1100 Willow Pass Court, Suite A

Concord, CA 94520-1006

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www.cercoanalytical.com

13 May 2015

Job No. 1505014

Cust. No. 12277

Mr. Don Olsen
Holdrege & Kull
8 Seville Court, Suite 100
Chico, CA 95928

Subject: Project No.: 70508-01
Project Name: Colusa Waste Water Project
Boring B15-1 @ 5' Below Ground Surface
Corrosivity Analysis – ASTM Test Methods with Brief Evaluation

Dear Mr. Olsen:

Pursuant to your request, CERCO Analytical has analyzed the soil sample submitted on May 04, 2015. Based on the analytical results, a brief corrosivity evaluation is enclosed for your consideration.

Based upon the resistivity measurement, the sample is classified as "corrosive". All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.

The chloride ion concentration is 48 mg/kg and is determined to be insufficient to attack steel embedded in a concrete mortar coating.

The sulfate ion concentration is 110 mg/kg and is determined to be insufficient to damage reinforced concrete structures and cement mortar-coated steel at this location.

The pH of the soil is 9.05, which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

This corrosivity evaluation is based on general corrosion engineering standards and is non-specific in nature. For specific long-term corrosion control design recommendations or consultation, please call *JDH Corrosion Consultants, Inc.* at (925) 927-6630.

We appreciate the opportunity of working with you on this project. If you have any questions, or if you require further information, please do not hesitate to contact us.

Very truly yours,

CERCO ANALYTICAL, INC.


J. Darby Howard, Jr., P.E.
President

JDH/jdl
Enclosure

nt:	Holdrege & Kull
nt's Project No.:	70508-01
nt's Project Name:	Colusa Waste Water Project - Boring B15-1 @ 5' Below Ground Surface
Sampled:	Not Indicated
Received:	4-May-05
ix:	Soil
orization:	Signed Chain of Custody

Date of Report: 13-May-2015

[illegible]

od:	ASTM D1498	ASTM D4972	ASTM D1125M	ASTM G57	ASTM D4658M	ASTM D4327	ASTM D4327
ation Limit:	-	-	10	-	50	15	15
Analyzed:	-	11-May-2015	-	7-May-2015	-	11-May-2015	11-May-2015

* Results Reported on "As Received" Basis

August 2001.

Henry McMillen

/s/ McMillen

atory Director

v Control Summary - All laboratory quality control parameters were found to be within established limits

APPENDIX E:

Field Permeability Test Sheets, 5 pages.

ASTM D6391-06

Infiltrometer Geometry And Geometry Coefficients													
Units	Ra	z1	b1	D1	a	D2	L	b2	F	G3	G4	G5	Note: a = +1 for impermeable base at b1 a = 0 for infinite depth of test material (b1 >= 20D1) a = -1 for permeable base at b1
in	5.50	6.00	80.00	4.00	0.00	4.00	6.00	77.00	0.94632	2.38953	3.30278	1.03973	
cm	13.97	15.24	203.20	10.16	0.00	10.16	15.24	195.58	2.40365	6.06940	8.38905	2.64092	

TSBI Stage 1 Test Data

[illegible]

Average Last Three Readings = 7.59E-08

TSBI Stage 2 Test Data

[illegible]

Average Last Three Readings =

ASTM D6391-06

Infiltrometer Geometry And Geometry Coefficients													
Units	Ra	z1	b1	D1	a	D2	L	b2	F	G3	G4	G5	Note: a = +1 for impermeable base at b1 a = 0 for infinite depth of test material (b1 >= 20D1) a = -1 for permeable base at b1
in	5.50	6.00	80.00	4.00	0.00	4.00	6.00	77.00	0.94632	2.38953	3.30278	1.03973	
cm	13.97	15.24	203.20	10.16	0.00	10.16	15.24	195.58	2.40365	6.06940	8.38905	2.64092	

TSBI Stage 1 Test Data

[illegible]

Average Last Three Readings = 7.98E-08

TSBI Stage 2 Test Data

[illegible]

Average Last Three Readings = #DIV/0!

ASTM D6391-06

Infiltrometer Geometry And Geometry Coefficients													
Units	Ra	z1	b1	D1	a	D2	L	b2	F	G3	G4	G5	Note: a = +1 for impermeable base at b1 a = 0 for infinite depth of test material (b1 >= 20D1) a = -1 for permeable base at b1
in	5.50	6.00	80.00	4.00	0.00	4.00	6.00	77.00	0.94632	2.38953	3.30278	1.03973	
cm	13.97	15.24	203.20	10.16	0.00	10.16	15.24	195.58	2.40365	6.06940	8.38905	2.64092	

TSBI Stage 1 Test Data

[illegible]

Average Last Three Readings = 1.15E-07

TSBI Stage 2 Test Data

[illegible]

Average Last Three Readings = #DIV/0!

ASTM D6391-06

ASTM D5091-05												
Infiltrometer Geometry And Geometry Coefficients												
Units	Ra	z1	b1	D1	a	D2	L	b2	F	G3	G4	G5
in	5.50	6.00	80.00	4.00	0.00	4.00	6.00	77.00	0.94632	2.38953	3.30278	1.03973
cm	13.97	15.24	203.20	10.16	0.00	10.16	15.24	195.58	2.40365	6.06940	8.38905	2.64092
Note: a = +1 for impermeable base at b1 a = 0 for infinite depth of test material (b1 >= 20D1) a = -1 for permeable base at b1												

TSBI Stage 1 Test Data

[illegible]

Average Last Three Readings = 5.28E-08

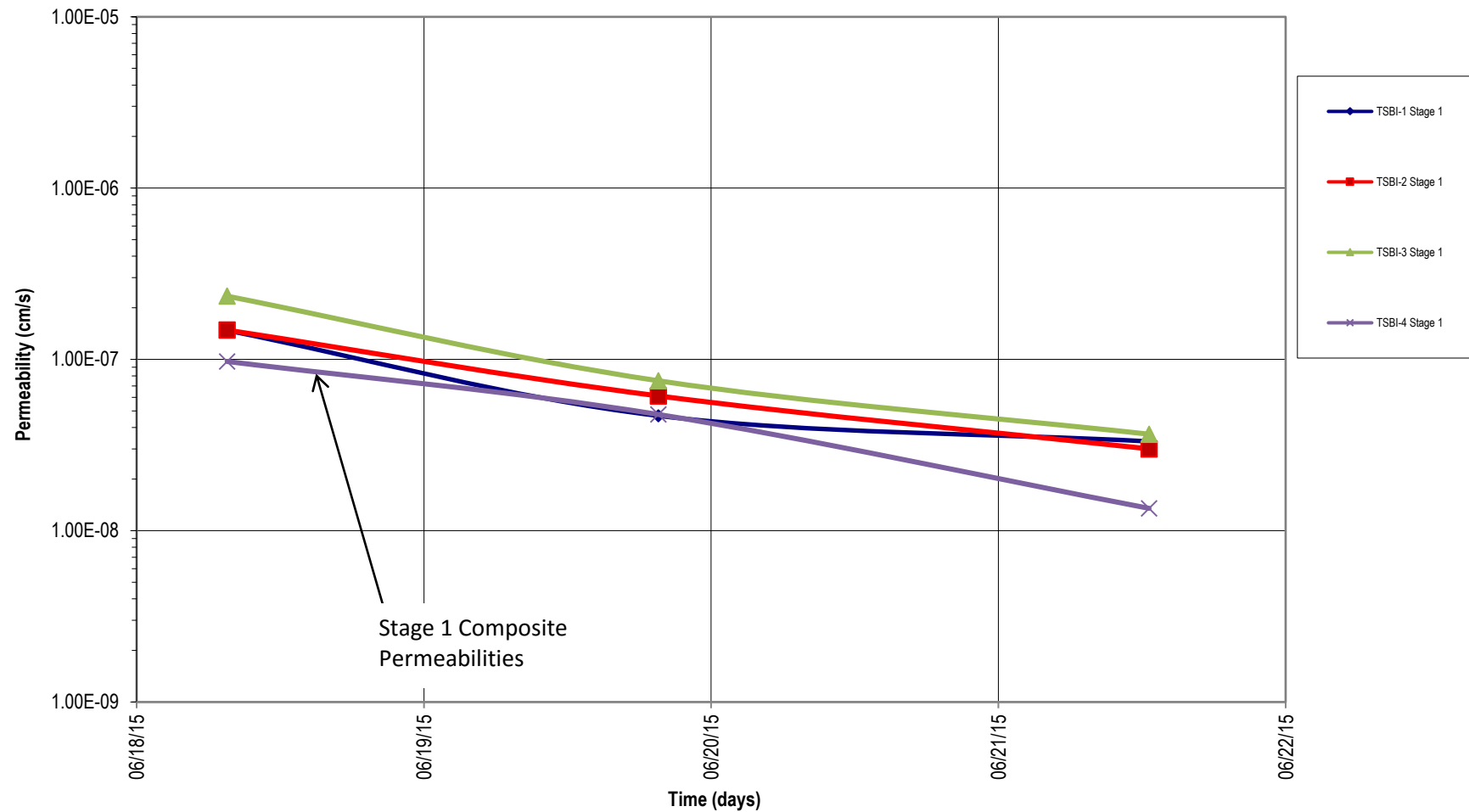
TSBI Stage 2 Test Data

[illegible]

Average Last Three Readings = #DIV/0!

FIGURE TSBI-1
City of Colusa Waste Water Treatment System Upgrade, Colusa, California
Treatment Pond Native Soil Permeability Testing

ASTM D6391-06 TSBI Composite Permeability Test Results



APPENDIX F:

Seismic Design Parameters, 10 pages.

USGS Design Maps Summary Report

User-Specified Input

Report Title 70508-01, City of Colusa

Mon June 1, 2015 05:02:34 UTC

Building Code Reference Document ASCE 7-10 Standard

(which utilizes USGS hazard data available in 2008)

Site Coordinates 39.21471°N, 122.00951°W

Site Soil Classification Site Class D – “Stiff Soil”

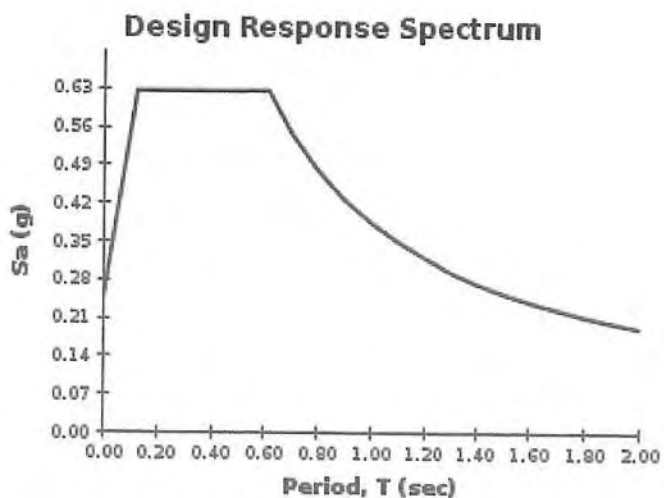
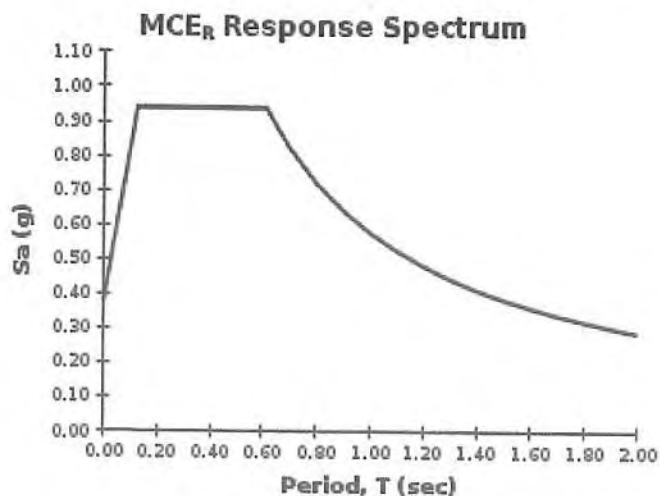
Risk Category I/II/III



USGS-Provided Output

$S_s = 0.793 \text{ g}$	$S_{MS} = 0.938 \text{ g}$	$S_{DS} = 0.626 \text{ g}$
$S_1 = 0.331 \text{ g}$	$S_{M1} = 0.575 \text{ g}$	$S_{D1} = 0.384 \text{ g}$

For information on how the S_s and S_1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the “2009 NEHRP” building code reference document.



For PGA_w , T_L , C_{RS} , and C_{R1} values, please [view the detailed report](#).



Design Maps Detailed Report

ASCE 7-10 Standard (39.21471°N, 122.00951°W)

Site Class D – “Stiff Soil”, Risk Category I/II/III

Section 11.4.1 — Mapped Acceleration Parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_s) and 1.3 (to obtain S_1). Maps in the 2010 ASCE-7 Standard are provided for Site Class B.

Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

From **Figure 22-1** ^[1]

$$S_s = 0.793 \text{ g}$$

From **Figure 22-2** ^[2]

$$S_1 = 0.331 \text{ g}$$

Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Chapter 20.

Table 20.3-1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
Any profile with more than 10 ft of soil having the characteristics:			
• Plasticity index $PI > 20$, • Moisture content $w \geq 40\%$, and • Undrained shear strength $\bar{s}_u < 500$ psf			
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 11.4.3 — Site Coefficients and Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Table 11.4-1: Site Coefficient F_a

Site Class	Mapped MCE _R Spectral Response Acceleration Parameter at Short Period				
	$S_s \leq 0.25$	$S_s = 0.50$	$S_s = 0.75$	$S_s = 1.00$	$S_s \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight-line interpolation for intermediate values of S_s

For Site Class = D and $S_s = 0.793$ g, $F_a = 1.183$

Table 11.4-2: Site Coefficient F_v

Site Class	Mapped MCE _R Spectral Response Acceleration Parameter at 1-s Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight-line interpolation for intermediate values of S_1

For Site Class = D and $S_1 = 0.331$ g, $F_v = 1.738$

Equation (11.4-1):

$$S_{MS} = F_a S_s = 1.183 \times 0.793 = 0.938 \text{ g}$$

Equation (11.4-2):

$$S_{M1} = F_v S_1 = 1.738 \times 0.331 = 0.575 \text{ g}$$

Section 11.4.4 — Design Spectral Acceleration Parameters

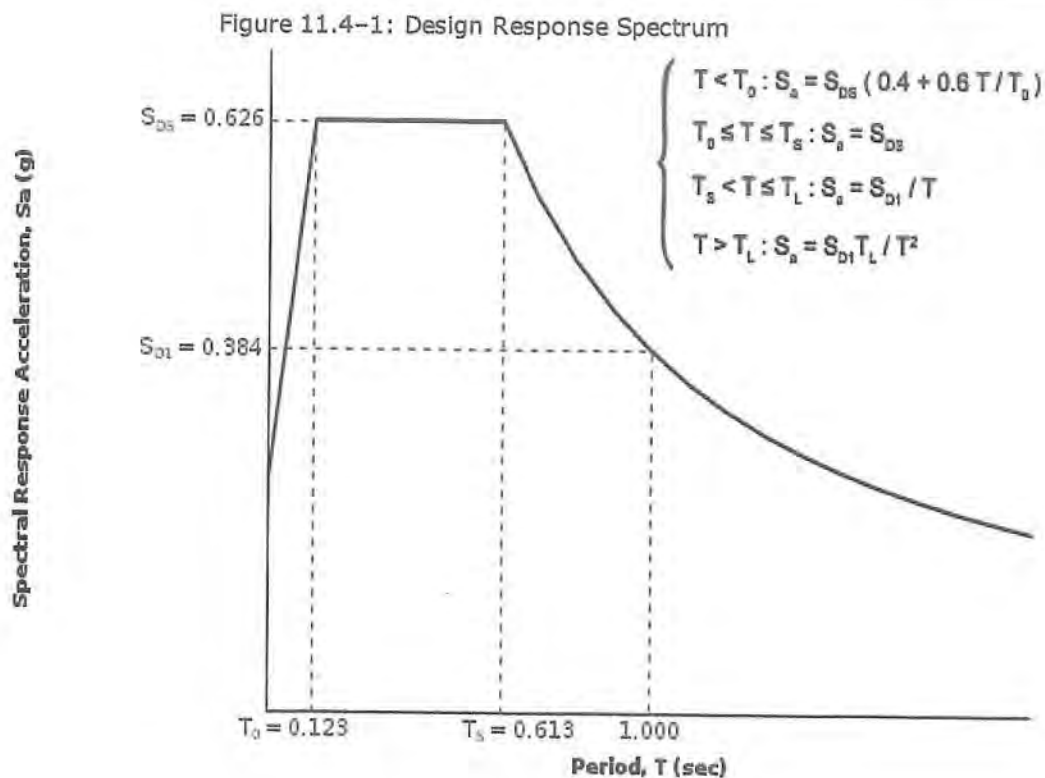
Equation (11.4-3):

$$S_{DS} = \frac{2}{3} S_{MS} = \frac{2}{3} \times 0.938 = 0.626 \text{ g}$$

Equation (11.4-4):

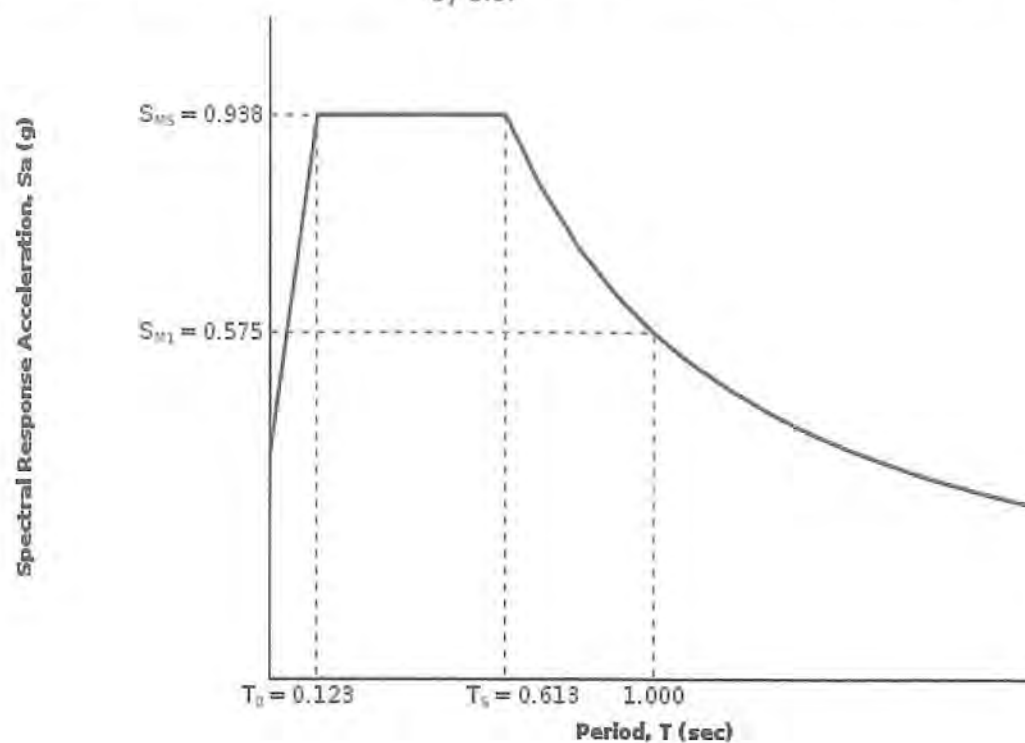
$$S_{D1} = \frac{2}{3} S_{M1} = \frac{2}{3} \times 0.575 = 0.384 \text{ g}$$

Section 11.4.5 — Design Response Spectrum

From **Figure 22-12** ^[3] $T_L = 8 \text{ seconds}$ 

Section 11.4.6 — Risk-Targeted Maximum Considered Earthquake (MCE_R) Response Spectrum

The MCE_R Response Spectrum is determined by multiplying the design response spectrum above by 1.5.



Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

From [Figure 22-7](#) ^[4]

$$PGA = 0.303$$

Equation (11.8-1):

$$PGA_M = F_{PGA} PGA = 1.197 \times 0.303 = 0.362 \text{ g}$$

Table 11.8-1: Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight-line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.303 g, $F_{PGA} = 1.197$

Section 21.2.1.1 — Method 1 (from Chapter 21 – Site-Specific Ground Motion Procedures for Seismic Design)

From [Figure 22-17](#) ^[5]

$$C_{RS} = 1.014$$

From [Figure 22-18](#) ^[6]

$$C_{R1} = 1.042$$

Section 11.6 — Seismic Design Category

Table 11.6-1 Seismic Design Category Based on Short Period Response Acceleration Parameter

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \leq S_{DS} < 0.33g$	B	B	C
$0.33g \leq S_{DS} < 0.50g$	C	C	D
$0.50g \leq S_{DS}$	D	D	D

For Risk Category = I and $S_{DS} = 0.626 g$, Seismic Design Category = D

Table 11.6-2 Seismic Design Category Based on 1-S Period Response Acceleration Parameter

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \leq S_{D1} < 0.133g$	B	B	C
$0.133g \leq S_{D1} < 0.20g$	C	C	D
$0.20g \leq S_{D1}$	D	D	D

For Risk Category = I and $S_{D1} = 0.384 g$, Seismic Design Category = D

Note: When S_1 is greater than or equal to $0.75g$, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category $\equiv$ "the more severe design category in accordance with Table 11.6-1 or 11.6-2" = D

Note: See Section 11.6 for alternative approaches to calculating Seismic Design Category.

References

1. Figure 22-1: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-1.pdf
2. Figure 22-2: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-2.pdf
3. Figure 22-12: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-12.pdf
4. Figure 22-7: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-7.pdf
5. Figure 22-17: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-17.pdf
6. Figure 22-18: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-18.pdf

PSH Deaggregation on NEHRP BC rock 70508-01, City 122.009° W, 39.215 N.

Peak Horiz. Ground Accel. ≥ 0.1641 g

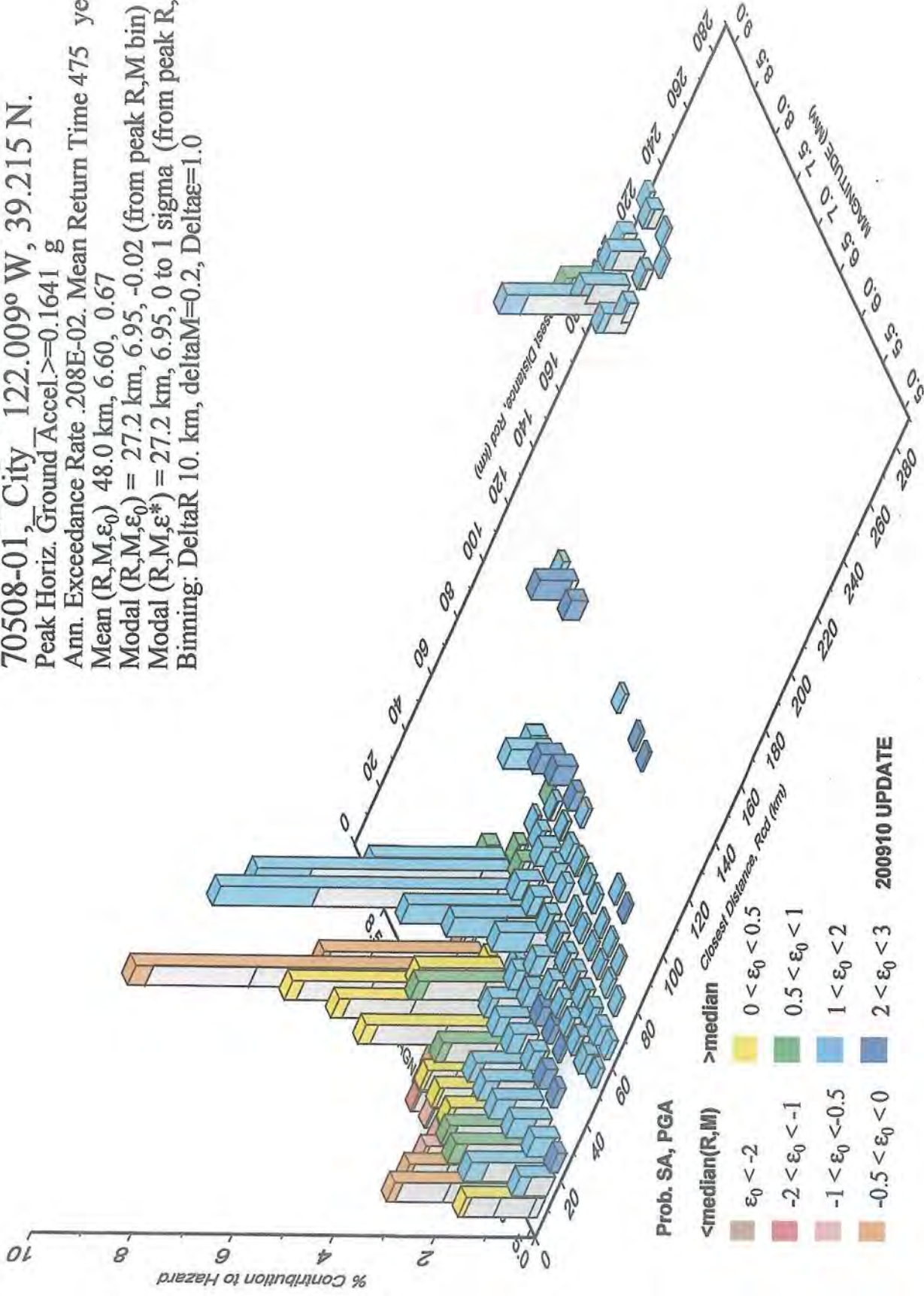
Ann. Exceedance Rate .208E-02. Mean Return Time 475 years

Mean (R, M, ϵ_0) 48.0 km, 6.60, 0.67

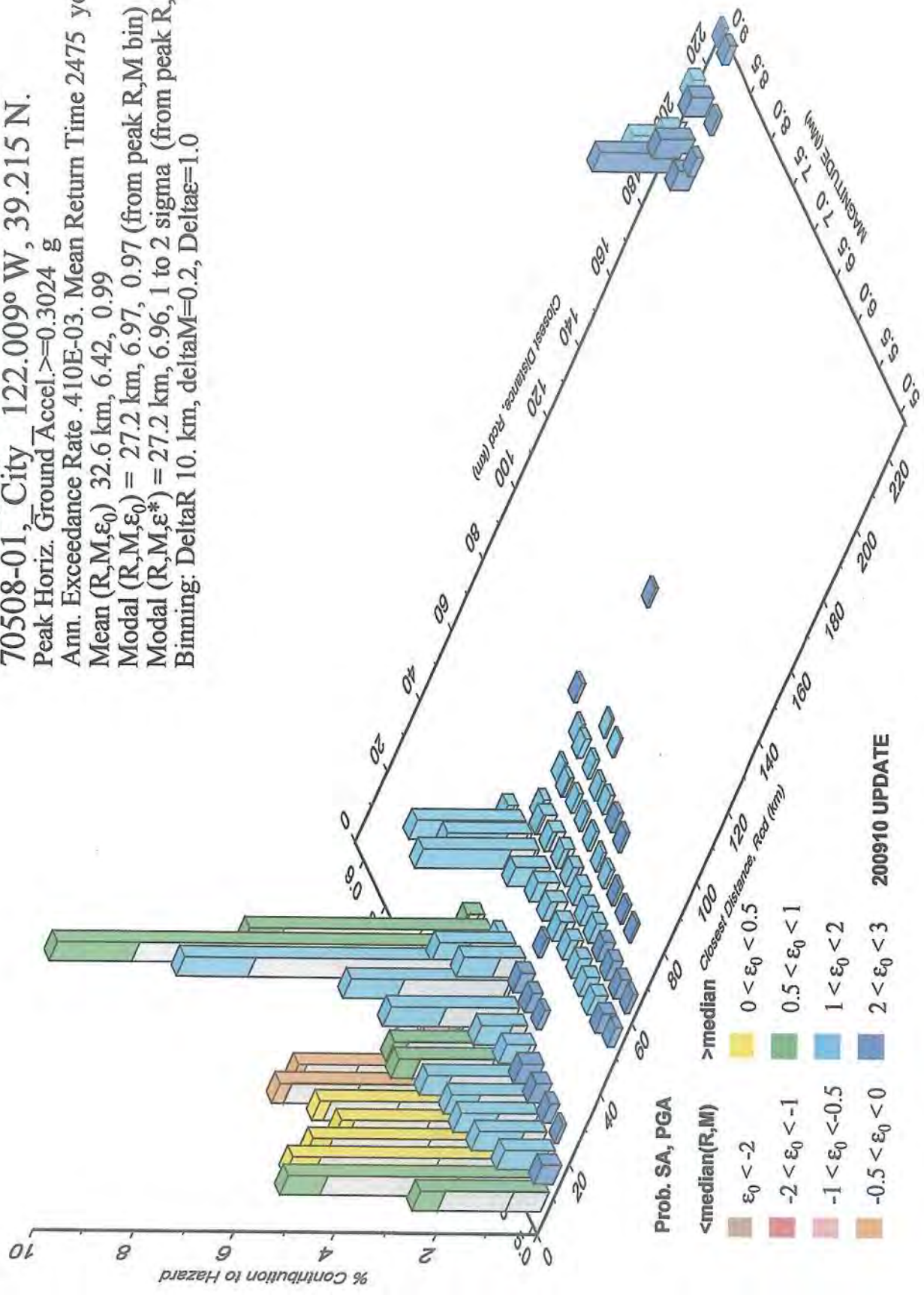
Modal (R, M, ϵ_0) = 27.2 km, 6.95, -0.02 (from peak R, M bin)

Modal (R, M, ϵ^*) = 27.2 km, 6.95, 0 to 1 sigma (from peak R, M, ϵ bin)

Binning: DeltaR 10. km, deltaM=0.2, Delta ϵ =1.0



PSH Deaggregation on NEHRP BC rock
 70508-01, City 122.009° W, 39.215 N.
 Peak Horiz. Ground Accel. ≥ 0.3024 g
 Ann. Exceedance Rate .410E-03. Mean Return Time 2475 years
 Mean (R_M, ϵ_0) 32.6 km, 6.42, 0.99
 Modal (R_M, ϵ_0) = 27.2 km, 6.97, 0.97 (from peak R_M bin)
 Modal (R_M, ϵ^*) = 27.2 km, 6.96, 1 to 2 sigma (from peak R_M, ϵ bin)
 Binning: DeltaR 10. km, deltaM=0.2, Delta ϵ =1.0



APPENDIX G:

Soil Liquefaction Analysis, 2 pages.

Project Number:

70508-01

Project Name:

City of Colusa Waste Water System Improvements (Pump Station at Boring Location B15-16A, B)

Input parameters:

Peak ground accel (g) =

0.362
6.60
2.38

Earthquake magnitude, M =

7.82 (ft)

** multiply depth in feet by 0.3048 to obtain meters

*multiply unit weight in pcf by 0.16026 to obtain kN/m³

Average γ above water table (kN/m³) =

19.2
20.8

120 (pcf)

130 (pcf)

Average γ below water table (kN/m³) =

203.2

8.00 (in)

*** multiply diameter in inches by 25.4 to obtain mm

Borehole Diameter (mm) =

NO

Requires correction for sampler liners (YES/NO)

Rod lengths assumed equal to the depth plus 1.5m (for the above ground extension).

SPT sample number	Depth (m)	Measured N	Soil type (USCS)	Flad "Clay" "Unsaturated" "Unreliable"	Fines content (%)	Energy ratio, ER (%)	C _E	C _B	C _R	C _S	N ₆₀	α _{vc} (kPa)	α _{vc} ' (kPa)	C _N	(N ₁) ₆₀	Δn for fines content	(N ₁) _{60-ss}	Stress reduct. Coeff, r _d	CSR	MSF for sand	K _c for sand	corr FOR m=7.5 & α _{vc} =1atm	CRR	Factor of Safety	Limiting shear strain γ _{lin}	Para- meter Fα	Maximum shear strain γ _{max}	Δh _i (m)	ΔLD _i (m)	Vertical reconsol. Strain ε _v	ΔS _i (m)	Depth (ft)
1	0.61	6	ML	Clay		75	1.25	1.15	0.75	1.00	6.5	12	12	1.70	n.a.	n.a.	n.a.	1.00	0.235	1.27	1.10	n.a.	n.a.	n.a.	0.000	0.000	0.000	0.914	0.000	0.000	0.000	2.00
2	1.52	2	ML	Clay		75	1.25	1.15	0.80	1.00	2.3	29	29	1.38	n.a.	n.a.	n.a.	0.99	0.233	1.27	1.10	n.a.	n.a.	n.a.	0.000	0.000	0.000	0.762	0.000	0.000	0.000	5.00
3	3.05	2	CL	Clay		75	1.25	1.15	0.85	1.00	2.4	60	53	1.18	n.a.	n.a.	n.a.	0.97	0.256	1.27	1.10	n.a.	n.a.	n.a.	0.000	0.000	0.000	0.762	0.000	0.000	0.000	10.00
4	4.57	16	CL	Clay		75	1.25	1.15	0.95	1.00	21.9	91	70	1.10	n.a.	n.a.	n.a.	0.94	0.290	1.27	1.10	n.a.	n.a.	n.a.	0.000	0.000	0.000	0.762	0.000	0.000	0.000	15.00
5	6.10	17	CL	Clay		75	1.25	1.15	0.95	1.00	23.2	123	87	1.04	n.a.	n.a.	n.a.	0.92	0.306	1.27	1.04	n.a.	n.a.	n.a.	0.000	0.000	0.000	0.762	0.000	0.000	0.000	20.00
6	7.62	19	CL	Clay		75	1.25	1.15	0.95	1.00	25.9	155	104	0.99	n.a.	n.a.	n.a.	0.89	0.312	1.27	0.99	n.a.	n.a.	n.a.	0.000	0.000	0.000	0.762	0.000	0.000	0.000	25.00
7	9.14	43	SM		30	75	1.25	1.15	1.00	1.00	61.8	187	120	0.95	59.0	5.4	64.39	0.85	0.312	1.27	0.95	2.000	2.000	2.00	0.000	-2.802	0.000	0.762	0.000	0.000	0.000	30.00
8	10.67	79	SM		20	75	1.25	1.15	1.00	1.00	113.6	218	137	0.92	104.8	4.5	109.25	0.82	0.308	1.27	0.91	2.000	2.000	2.00	0.000	-6.958	0.000	0.762	0.000	0.000	0.000	35.00
9	12.19	76	SM		20	75	1.25	1.15	1.00	1.00	109.3	250	154	0.90	97.8	4.5	102.26	0.79	0.302	1.27	0.88	2.000	2.000	2.00	0.000	-6.284	0.000	0.762	0.000	0.000	0.000	40.00
10	13.72	54	SM		7.1	75	1.25	1.15	1.00	1.00	77.6	282	171	0.87	67.6	0.2	67.75	0.76	0.295	1.27	0.84	2.000	2.000	2.00	0.000	-3.096	0.000	0.762	0.000	0.000	0.000	45.00
11	15.24	82	SM		10.2	75	1.25	1.15	1.00	1.00	117.9	314	188	0.85	100.2	1.2	101.40	0.73	0.287	1.27	0.82	2.000	2.000	2.00	0.000	-6.202	0.000	0.762	0.000	0.000	0.000	50.00
LDI=																	0.000		S=													

Project Number: 70508-01
Project Name: City of Colusa Waste Water System Improvements (Clarifier Tank at Boring Location B15-19)

Input parameters:

Peak ground accel (g) = 0.362
Earthquake magnitude, M = 6.60
Water table depth (m) = 2.38
Average γ above water table (kN/m³) = 19.2 120 (pcf)
Average γ below water table (kN/m³) = 20.8 130 (pcf)
Borehole Diameter (mm) = 203.2 8.00 (in)
Requires correction for sampler liners (YES/NO) NO
Rod lengths assumed equal to the depth plus 1.5m (for the above ground extension).

** multiply depth in feet by 0.3048 to obtain meters
*multiply unit weight in pcf by 0.16026 to obtain kN/m³
*** multiply diameter in inches by 25.4 to obtain mm

SPT sample number	Depth (m)	Measured N	Soil type (USCS)	Flad "Clay" "Unsaturated" "Unreliable"	Fines content (%)	Energy ratio, ER (%)	C _E	C _B	C _R	C _S	N ₆₀	α _{vc} (kPa)	α _{vc} ' (kPa)	C _N	(N ₁) ₆₀	Δn for fines content	(N ₁) _{60-ss}	Stress reduct. Coeff, r _d	CSR	MSF for sand	K _c for sand	corr FOR m=7.5 & α _{vc} '=1atm	CRR	Factor of Safety	Limiting shear strain γ _{lin}	Para-meter Fα	Maximum strain γ _{max}	Δh _i (m)	ΔLD _i (m)	Vertical reconsol. Strain ε _v	ΔS _i (m)	Depth (ft)
1	1.98	11	CL	Clay		75	1.25	1.15	0.80	1.00	12.7	38	38	1.29	n.a.	n.a.	n.a.	0.98	0.231	1.27	1.10	n.a.	n.a.	n.a.	0.000	0.000	0.000	0.914	0.000	0.000	0.000	6.50
2	3.51	19	CL	Clay		75	1.25	1.15	0.85	1.00	23.2	69	58	1.16	n.a.	n.a.	n.a.	0.96	0.269	1.27	1.10	n.a.	n.a.	n.a.	0.000	0.000	0.000	0.762	0.000	0.000	0.000	11.50
3	5.03	44	CL	Clay		75	1.25	1.15	0.95	1.00	60.1	101	75	1.08	n.a.	n.a.	n.a.	0.93	0.296	1.27	1.09	n.a.	n.a.	n.a.	0.000	0.000	0.000	0.762	0.000	0.000	0.000	16.50
4	6.55	43	SM	Clay	36	75	1.25	1.15	0.95	1.00	58.7	133	92	1.03	n.a.	n.a.	n.a.	0.91	0.308	1.27	1.03	n.a.	n.a.	n.a.	0.000	0.000	0.000	0.762	0.000	0.000	0.000	21.50
5	8.08	94	CL	Clay		75	1.25	1.15	0.95	1.00	128.4	164	109	0.98	n.a.	n.a.	n.a.	0.88	0.312	1.27	0.98	n.a.	n.a.	n.a.	0.000	0.000	0.000	0.762	0.000	0.000	0.000	26.50
6	9.14	60	SP		5	75	1.25	1.15	1.00	1.00	86.3	187	120	0.95	82.4	0.0	82.37	0.85	0.312	1.27	0.95	2.000	2.000	2.00	0.000	-4.413	0.000	0.762	0.000	0.000	0.000	30.00
7	10.67	28	SP		5	75	1.25	1.15	1.00	1.00	40.3	218	137	0.91	36.5	0.0	36.50	0.82	0.308	1.27	0.91	1.548	1.790	2.00	0.017	-0.544	0.000	0.762	0.000	0.000	0.000	35.00
8	12.19	28	SP		5	75	1.25	1.15	1.00	1.00	40.3	250	154	0.87	35.0	0.0	35.03	0.79	0.302	1.27	0.89	1.116	1.258	2.00	0.022	-0.438	0.000	0.762	0.000	0.000	0.000	40.00
																	LDI=		0.000		S=											