TETRA TECH

Report of Geotechnical Investigation

Weir Dewatering Treatment-Pump Stations, Nevada Environmental Response Trust, Henderson, Nevada

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TABLE OF CONTENTS

APPENDICES

EXECUTIVE SUMMARY

The Southern Nevada Water Authority (SNWA) is planning to construct two new weirs on land that is under the jurisdiction of the Bureau of Reclamation (BOR) and managed as Clark County Wetlands Park in the Las Vegas Wash. The groundwater generated from the weir construction dewatering operations is anticipated to be contaminated with low concentrations of perchlorate. Therefore, the combined water from the installation of the two weirs will be pumped from the two construction locations using dedicated pump stations via a buried 18-inch diameter, schedule 40, carbon steel pipeline and treated at the Central Treatment Plant before permitted discharge to the wash. The treatment process consists of using cyclones to remove large solid particles from the groundwater, then multi-media filters to remove the suspended solids, followed by ion exchange to remove the perchlorate from the water.

Construction of two pump stations, one for each weir location, to convey water to the treatment plant are required to treat the impacted water prior to discharge to the Las Vegas Wash in Henderson, Nevada. The Sunrise Mountain pump station will be located west of the central treatment plant in an existing area of barren undeveloped land with a footprint measuring about 100 by 130 feet in plan. The Historic Lateral pump station is located north of the West Galleria Court Subdivision in the vicinity of Pabco Road with a footprint measuring about 125 by 150 feet in plan. Equipment at the pump stations consists of four influent tanks and three pumps. Foundations will consist of Portland cement concrete mat foundations ranging in plan dimension from the smaller pump pads at approximately 11 x 27.3 ft. size to the larger compacted gravel influent water tank pads measuring 45 x 54 ft. The 18-inch diameter water pipeline will be buried with at least 2 feet of soil cover over the crown.

Five geotechnical borings were drilled for this investigation, borings B-3 through B-5, B-7 and B-8. Alignment modifications for the water pipeline or revised siting of the pump station locations precluded drilling borings B-1, B-2, B-6 and B-9 as per the initial investigation field plan. Borings drilled within the area of the proposed pump stations and pipeline alignment encountered a granular surface layer of generally medium dense to very dense sand or gravel with occasional interbedded but discontinuous clay seams to depths of 9.5 to 18 feet below existing grade. Soils classified as silty sand, silty clayey sand, poorly graded sand with silt and gravel; and poorly graded gravel with silt and sand. A low plasticity, stiff to very stiff, lean clay lies below the sand and gravel to the maximum depth explored, 23.0 feet. Subsurface water accumulated in borings B-3, B-4 and B-8 at depths of about 11 feet and 21.3 feet at the time of drilling, January 2017.

This executive summary has been prepared solely to provide a general overview and should not be used for any purpose except for that for which it was prepared. The full report must be referenced for information about findings, recommendations and other concerns.

PURPOSE AND SCOPE OF STUDY

The purpose of this study was to determine the subsurface conditions and provide recommendations for design and construction of foundations for the proposed Sunrise Mountain Pump Station, Historic Lateral Pump Station and earthwork construction guidelines for the buried water conveyance pipeline. The Nevada Environmental Response Trust (NERT) will construct and operate the two pump stations and a central water treatment plant to treat perchlorate-contaminated groundwater during Southern Nevada Water Authority's (SNWA) construction of the Sunrise Mountain Wear and Historic Lateral Weir in the Las Vegas Wash. According to SNWA, the system should have a capacity to treat intermittent flows on the order of 6,900 gallons per minute over the course of approximately 18 months until weir construction is complete. Tetra Tech conducted a field exploration program consisting of five (5) exploratory borings (B-3 through B-5, B-7 and B-8). The borings were drilled to obtain information on subsurface soil conditions for the proposed pipeline, equipment foundations and tanks, reference Drawing Nos. C-303 and C-304 of the "Issued for Permit" plan set (1/27/2017). The geotechnical study was performed in accordance with Tetra Tech's scope of work dated September 13, 2016, and Le Petomane Environmental Trusts Work Authorization with Tetra Tech dated February 18, 2015.

Samples obtained during the field investigation were tested in a Las Vegas, Nevada geotechnical engineering laboratory (Geotechnical & Environmental Services, Inc.) to determine the physical and engineering characteristics of on-site soils. This report summarizes the field data and presents conclusions and recommendations for design and construction of the L09 water conveyance pipeline, tanks and equipment foundations for the Historic and Sunrise Mountain Pump Stations and planned grading based on the proposed construction and subsurface conditions encountered. The report also includes design parameters and geotechnical engineering considerations related to construction.

PROPOSED CONSTRUCTION

The proposed Sunrise Mountain Pump Station will be located on property owned by Basic Environmental LLC, immediately west of the Central Treatment Plant, within a continuous earthen containment berm. The Historic Lateral Pump Station is located in Clark County Wetlands Park, on Bureau of Reclamation property north of the West Galleria Court Subdivision and is also surrounded by an earthen containment berm. Primary equipment for both pump stations will consist of four, 20,100 gallon capacity influent tanks and three, 2,300-gpm large 300 to 350 horsepower pumps. Water will be pumped to the central treatment plant for processing and clean water to three large treated water tanks prior to discharge to the Las Vegas Wash.

The earthen containment berms surrounding the pump stations will vary in height from about 2 to 9 feet above the surrounding topography and have a 15-foot wide top crest and 3:1 (H: V) side slopes. Interior freeboard ranges from approximately 2.5 to 4 feet from base of the containment area to the top of the berms at the two pump station sites. The containment area below the pump stations will be: 1) excavated 2 feet below finished grade, 2) lined with a 60-mil HDPE liner which is then, 3) covered by a 2-foot thick layer of drainage gravel to finished grade. The subgrade at both containments will be sloped down to a drainage sump for positive leak detection and collection of any lost intake waters.

The four influent tanks will be supported on a single compacted gravel pad foundation measuring about 45 x 54 feet in plan dimension. Waste water transfer pumps will be located on a single 11 x 27.3 foot, external concrete support pad positioned about 15 feet to the east or northwest of the four tank footprints, respectively. Proposed equipment/tank dimensions with estimated anticipated loading conditions were provided by Tetra Tech's structural design team, and are shown below in Table No. 1:

Table No. 1.

Equipment	Empty weight (lbs.)	Operating weight (lbs.)	Design Operating Weight (lbs.)	Notes
Transfer Pumps at Sunrise Mountain Weir 2,300 gpm at 360 ft. TDH	2,740	N/A	N/A	Est. weight per pump
Transfer Pump at Historic Lateral Weir 2,300 gpm at 460 ft. TDH	2,740	N/A	N/A	Est. weight per pump
Influent Tanks	28,000	196,036	232,560	Est. weight per tank

SITE DESCRIPTION

The project area is adjacent to the Las Vegas Wash on private land and on land that is under the jurisdiction of the BOR and managed as the Clark County Wetlands Park. Developed park infrastructure includes roadways and parking lot, picnic shelters and bathroom facilities, a paved bike path and unpaved trails. A high voltage transmission line crossed over the project area. At the time of the field investigation (January 2017), the pump station sites are undeveloped barren land adjacent to or contagious to the developed parkland. The topography is relatively flat-lying to rolling hills of open desert shrubland with a slope to the north-northeast. The water conveyance pipeline alignment skirts north of the southern boundary of the parkland and Russell road across similar rolling topography.

Vegetation consists of pockets of scattered brush and dense growths of mesquite, salt cedar and creosote. The riparian corrido along the outfall channels and the wash to the north contains communities comprised of cottonwood, willow and salt cedar with some inclusions of cattail wetlands. The pump station sites are currently undeveloped ground with several small stockpiles of soil and random wood debris scattered across the surface in the general project area. Future grading is anticipated to excavate for the planned foundations and for construction of the bermed containment with underlying HDPE liner.

Photos 1 through 5 show the site features at the general boring locations.

Photo 1. Borehole B-8, View looking west in location of the Historic Lateral Pump Station.

Photo 2. Borehole B-5, View looking east along water conveyance pipeline alignment.

Photo 3. Borehole B-3, View looking north along pipeline alignment.

Photo 4. Borehole B-4, View looking east along pipeline alignment and GWETS lift Station.

Photo 5, View looking east along water conveyance pipeline alignment north of Russell Road.

FIELD EXPLORATION

Geotechnical exploratory borings were drilled at the noted locations for the future water conveyance pipeline, pump equipment and influent tanks based on Drawing Nos. C-304 and C-401 of the L095 Weir Dewatering Treatment Project, Historic Lateral Pump Station and the Sunrise Mountain Pump Station and Central Water Treatment Plant Site Plan Drawings dated January 27, 2017, provided by Tetra Tech.

All work on the project site was performed under the conditions outlined in Tetra Tech's most recent project specific Health and Safety Plan, dated May 10, 2016. Tetra Tech's personnel and subcontractor personnel performed the field investigation in Level D PPE, which included at a minimum:

- Hard Hat, ANSI Z89.1-2003 Type 1, Class E approved.
- ASTM Compliant and/or CSA Grade Steel-toed boots (minimum of 6-inch ankle support)
- Safety Glasses with side-shields, or goggles as determined appropriate.
- Gloves for drilling tasks and cut resistant gloves if needed.
- Hearing protection worn when noise is generated where equipment is running.
- High visibility apparel, ANSI Class II approved.
- Additional PPE as identified during completion of JSAs and spot hazard analysis in the field.

Locations of the exploration borings were staked in the field by Tetra Tech's project geologist by GPS equipment. Prior to mobilization, Eagle Drilling Services drilling company personnel contacted Nevada Dig Alert to request the location and clearance of public underground utilities before performing drilling. Site utilities were located and physically marked in the field at each respective boring location. Boring locations were reviewed with available data sources prior to drilling to avoid accidental encroachment into below-ground GWETS piping components to the adjacent lift station and other buried utilities.

The field exploration drilling was conducted on January 19, 2017. Five (5) exploratory borings were drilled for the proposed water pipeline and the two pump station, equipment and storage tank foundations to depths of 11 to 23.0 feet. Existing elevations and northing and easting coordinates at the boring locations were obtained by GPS hand held survey. The boring locations are noted on Drawing No. C-101 in the Appendix.

Tetra Tech's drilling subcontractor (Eagle Drilling Services) advanced the borings through the overburden soils with a track-mounted Dietrich D-50 drill rig equipped with 8-inch diameter hollow-stem augers. The borings were logged by Tetra Tech's field engineer. The borings were reclaimed by grouting using bentonite chips. Logs of the exploratory borings are presented in the Appendix.

Samples of the subsurface materials were obtained with 1⅜-inch inside diameter split-barrel samplers and by collecting disturbed bulk samples of auger cuttings. Split barrel samplers were driven into the various strata using a 140-pound hammer falling 30 inches. The number of blows required to advance the sampler each of three successive 6-inch increments was recorded. When using the split-spoon sampler, the total number of blows required to advance the sampler the second and third 6-inch increments is the penetration resistance (N value) as described by ASTM Method D1586. Penetration resistance values generally indicate the relative density or consistency of the subsurface soils. The penetration resistance values presented on the logs are not corrected for sampler depth. California ring samplers were driven or thin-wall Shelby tube samplers hydraulically pushed into fine-grained subsurface clay soils at select locations. Boring logs were prepared noting the borehole location and plan elevation, equipment and drill methods used, subsurface profile and descriptions per ASTM D2487, and groundwater conditions. Depths at which the samples were obtained along with the penetration resistance values are shown on the logs of exploration borings.

Multichannel Analysis of Surface Waves (MASW) Refraction Survey

The MASW data was collected from the Central Treatment Plant location and consists of two orthogonal 24-channel seismic lines located through borehole locations BH-L09-1 and BH-L09-3 (see Drawing C-401 in the appendix). The depth of investigation for the MASW method is 60 feet below ground surface. The geophone spacing interval was 5 feet. A 10-pound hammer and plate were used as a seismic source. Multiple shots were collected to facilitate high resolution data collection. Optimum shot geometry was determined in the field by Tetra Tech's qualified geophysicist to maximize data acquisition for processing of the MASW data. The data was collected using a multi-channel digital seismograph. SeisImager/Surface Wave was be used to process the shot gathers into one dimensional (1-D) shear wave velocity verses depth profiles. Two dimensional (2-D) cross sections of the 1-D shear wave velocities were constructed. Compressional-wave (P-wave) refraction data was also collected, processed and presented as 2-D cross sections. The data from this investigation is used to determine values of dynamic shear modulus and Poisson's ratio. The results from this geophysical survey are presented in the Appendix of this report and includes the 1-D and 2-D shear wave data from the MASW assessment and 2-D refraction cross sections presenting the P-wave velocity data.

LABORATORY TESTING

Samples obtained during the field exploration were transported to Geotechnical and Environmental Services, Inc., and relinquished via chain-of-custody for testing. The samples were observed and visually classified in accordance with ASTM Method D2487, which is based on the Unified Soil Classification System. Representative subsurface soil samples were selected for testing by Tetra Tech's geotechnical project engineer. The selected samples were tested to determine the physical properties of the soils in general accordance with ASTM or other approved procedures. A summary of the tests conducted and the purposes of those tests is presented below. A sample handling protocol was established per the Health and Safety Plan prepared by GES governing their laboratory personnel and submitted to Tetra Tech.

<u>Tests Conducted</u>:	<u>To Determine:</u>
Grain-size Distribution	Size and distribution of soil particles; that is, clay, silt, sand and gravel.
Atterberg Limits	The effect of varying water content on the consistency of fine-grained soils.
Natural Moisture Content	Moisture content representative of field conditions at the time samples were taken.
Natural Dry Density	Dry unit weight of samples, representative of in-place conditions.
Consolidation/ Swell	The amount a soil sample compresses with loading and the influence of wetting on its behavior. For use in settlement analysis, determining expansion potential and foundation design.
Direct Shear	Soil shearing strength under varying load and/or moisture conditions. For use in foundation design and slope stability evaluation.
Moisture-Density Relationship	The optimum moisture content for compacting soil and the maximum dry unit weight (density) for a given compactive effort.
Resistivity, chlorides and pH	The combination of these characteristics determines the potential of soil to corrode metal.
Soluble Sulfate Content	Potential of soil to deteriorate normal strength concrete.

Field and laboratory test results are presented on Figures 6 through 22 in the Appendix. These data, along with the field information, were used to prepare the exploration boring logs on Figures 1 through 5 in the Appendix.

SEISMIC ASSESSMENT OF PROJECT AREA

Seismic Design Parameters

The project site is located in a geographic region considered to have a low potential for strong ground motion in response to seismic events. The USGS US Seismic Design Maps web application (http://earthquake.usgs.gov/designmaps/us/application.php) provides seismic design parameter values for various design codes on a site specific basis. ASCE/SEI 7-10 design criteria referenced in API Standard 650 is based on a 2 percent probability of exceedance or in other words a 98 percent probability of not being exceeded in any 50 year period. Based on the USGS National Seismic Hazard Mapping on-line mapping tool, the peak ground acceleration at the Las Vegas Wash site having a 2 percent probability of exceedance in any 50 year period is 0.199g.

The USGS database presents spectral response acceleration data in bedrock for short (0.2 sec) periods (S_s) and for long (1 sec) periods (S_1) for similar probability and 50-year return periods. According to USGS design procedures, these acceleration data are then adjusted upward or amplified depending on soil classification to reflect magnification effects as the earthquake wave energies pass from bedrock into soil. The values are then reduced by a factor that accounts for partial damping of the wave energy by the structure. The final values obtained (known as S_{DS} and S_{D1}) become the basis for the structural design and in this case at the Las Vegas Wash site are estimated as 0.460 g ($S_{DS)}$ and 0.231 g (S_{D1}). The data is summarized in the table below.

The methods of ASCE/SEI 7-10 require the properties of the soil at proposed site be classified as one of several site classes. The seismic design parameters for this site include a seismic zone soil profile type of (D), in accordance with the above referenced standard. Site Class D corresponds to a soil profile having stiff soil with an undrained shear strength between 1,000 and 2,000 psf, shear wave velocity between 600 and 1,200 ft. /s and average standard penetration resistance values between 15 and 50 blows per foot. This classification is based on the laboratory test data, MASW survey data and exploration boring information.

Earthquake and Seismic Design Parameters

Site	Latitude (North)	Longitude (West)	PGA	S_s	S_1	Site Class	F_a	F_v
Las Vegas Wash site	36.08545	-114.98753	0.199g	0.490	0.161	D	1.41	2.15

Notes: **PGA** = Peak Ground Acceleration
S_s = 0.2 sec. Spectral Response Acceleration
S_1 = 1.0 sec. Spectral Response Acceleration
F_a = Short Period Seismic Design Factor
F_v = Long Period Seismic Design Factor
Return period = 2%
Time period = 50 years

EARTHQUAKE INDUCED LIQUEFACTION

In review of the subsurface information to determine the potential for liquefaction triggered by strong ground motion, consideration was given to the type and age of the sediment, soil classification and stratigraphy, groundwater conditions, relative soil density, and peak ground acceleration for the site location.

The pump stations will be constructed in a relatively flat area adjacent to and within the Las Vegas Wash property underlain by predominantly medium dense to very dense silty sand and poorly graded sand with gravel overlying clay soil to the maximum depth investigated, 23.0 feet. Groundwater accumulated in the deeper exploration borings at depths of 11 to 21.3 feet at the time of drilling (January 2017).

A review of published geologic information for the site location was performed. Mapping identifies the soils as “alluvium” deposits of Holocene age (Qa), Bingler, E.C., 1977. Youd and Perkins, (1978) published a paper which estimated the susceptibility of sedimentary soil deposits to liquefaction during strong seismic shaking based on geologic age and depositional environment. According to the referenced document, continental alluvial fan deposits such as this are classified as having a low potential for liquefaction.

The USGS U.S. Seismic Design Maps web application provides seismic design parameter values for various design codes on a site specific basis. Based on the USGS National Seismic Hazard Mapping on-line mapping tool, the peak ground acceleration at the Las Vegas Wash site having a 10 percent probability of exceedance in any 50 year period is 0.135g and a having a 2 percent probability of exceedance in any 50 year period is 0.199g. Therefore, the Las Vegas Wash project location is in a geographic region considered to have a low potential for strong ground motion in response to seismic events.

A quantitative liquefaction evaluation of the Las Vegas Wash Treatment Plant location subsurface soils below the groundwater level of 11.5 feet to a depth of 50 feet was performed using the subsurface information, MASW survey results and laboratory test data in conjunction with the *Simplified Method* per (Seed and Idris, 1971). Unsaturated soils located above the groundwater table will not liquefy and soils deeper than 50 feet generally do not liquefy due to the high confining pressures. The quantitative liquefaction analysis determined factors of safety of 2.0 against liquefaction for the depth interval and sand soil types evaluated. The clay soils are not liquefiable considering their plasticity and clay contents. Therefore, potential for seismically induced liquefaction of the soils at the project site is negligible.

SUBSURFACE CONDITIONS

Stratigraphy

Borings B-3 and B-4, drilled near the area of the proposed Sunrise Mountain Pump Station, encountered a granular surface layer of very loose silty sand to a depth of 3 to 4 feet overlying medium dense to very dense, silty sand, silty clayey sand and poorly graded sand with silt to depths of 13 to 18 feet below existing grade. Low plasticity, stiff to very stiff, lean clay was encountered below the sands and extend beyond the depths of the boreholes of 23.0 feet.

At the Historic Lateral Pump Station, Boring B-8 encountered medium dense to dense sand to a depth of 9.5 overlying lean clay. The sand classifies as silty sand and poorly graded sand with silt and gravel according to the ASTM D 2487. The clay layer contains thin interbedded sand seams throughout its depth investigated, 21.5 feet.

Sand and gravel were the two predominant soil types identified in borings B-5 and B-7 drilled along the water conveyance pipeline alignment. The sand classifies as silty sand with gravel and the gravel as poorly graded gravel with silt and sand. The gravel recovered from the bulk samples obtained from the hollowstem augers is generally less than 2-inch nominal size.

The boring logs should be referenced for complete descriptions of the soil types and their estimated depths. A characterization of the subsurface profile normally includes grouping soils with similar physical and engineering properties into a number of distinct layers. The representative subsurface layers at the site are presented below, starting at the ground surface.

Sand (SM), (SC-SM) & (SP-SM)

Standard penetration resistance (SPT) N-values obtained in the silty sand and poorly graded sand with silt and gravel ranged from a low of 3 blows per foot at the surface to greater than 50 blows per foot, averaging about 20, indicating a medium dense to very dense relative density. Natural moisture contents in the sands ranged from 5 to 12 percent in the upper eleven feet of the layer with the lower percentage values in the sands indicative of samples having a lower percentage of silt fines. Liquid and plastic limit tests indicate these soils have a liquid limit of granular non-plastic and a plasticity index of non-plastic. Gradation test results for samples of the sand are presented on Figures 6, 7, 8 and 11. A one-dimensional consolidation test performed on a sample of silty clayey sand (Figure 14) indicates the soil is compressible under conditions of wetting and normal loading. A friction angle of 32 degrees and cohesion of 186 pounds per square foot was determined by laboratory testing for a sample of the silty clayey sand (Figure 18).

Results of two moisture-density relationship tests (ASTM D1557) performed on bulk samples of the sand obtained from the borings indicate maximum dry densities ranging from 128.8 to 129.3 pcf and optimum moisture contents ranging from 8.6 to 9.4 percent (Figures 20, and 22).

Analytical chemical testing was performed on three representative samples of silty sand with gravel from B-3 and B-4 at depths of 5.0-6.5 feet and 0-5.0 feet, respectively. Samples were submitted for testing to Silver State Analytical Laboratories of Las Vegas Nevada. Analytical chemical data indicates the sand has pH values of 7.67 and 7.84 with minimum resistivity values ranging from 267 to 575 ohm-cm, respectively. Soluble chloride concentrations in soil of 1,100, and 2,900 mg/kg were determined for the sand. Based on soil resistivity and pH data, the subgrade soils encountered at the project site present a low potential for corrosion of steel and galvanized steel in contact with the soil.

Sulfate content tests determine the potential of soil to deteriorate normal strength concrete. The concentration of water soluble sulfates measured on these two samples typical of the silty sand stratum were 0.05 and 0.06 percent, respectively. This concentration of water soluble sulfates is indicative of a negligible exposure to sulfate attack in normal strength concrete when exposed to the sand. The degree of attack is based on a range of negligible, positive, severe and very severe as presented in the U.S. Bureau of Reclamation Concrete Manual and as referenced in Table 7-2 of standard ACI 318-11.

Gravel (GP-GM)

Standard penetration resistance (SPT) N-values obtained in the poorly graded gravel with silt and sand ranged from a low of 13 blows per foot at the surface to greater than 50 blows per foot, averaging about 40, indicating a medium dense to very dense relative density. Natural moisture contents in the gravel ranged from 3 to 6 percent in the upper eleven feet of the layer.

Liquid and plastic limit tests indicate these soils have a liquid limit of granular non-plastic and a plasticity index of non-plastic. Gradation test results for a sample of the gravel are presented on Figure 10.

Results of a moisture-density relationship test (ASTM D1557) performed on a bulk sample of the gravel obtained from the boring B-8 indicates a maximum dry density of 133.4 pcf and an optimum moisture content of 7.5 percent (Figure 21).

Lean Clay (CL)

The lean clay contains varying amounts of fine grained sand and interbedded sand seams throughout the layer. Standard penetration resistance (SPT) N-values obtained in the clay range from 10 to 30 blows per foot, averaging about 18, indicating a medium stiff to very stiff soil consistency. Natural moisture contents in the lean clay ranged from 21 to 36 percent. Liquid and plastic limit tests indicate the clay has a liquid limit of 43 percent and a plasticity index of 22. Gradation test results for a sample of the clay from boring B-4 are presented on Figure 9.

One-dimensional consolidation tests performed on samples of lean clay (Figures 16 and 17) indicates the soil is compressible under conditions of wetting and normal loading. A friction angle of 31 degrees and cohesion of 1,068 pounds per square foot was determined by laboratory testing for a sample of the clay with sand (Figure 19).

Groundwater

Subsurface water accumulated in borings BH-3 and B-4 at depths of about 11 feet and in B-8 at a depth of 21.3 feet at the time of drilling, January 2017. Typical fluctuations in groundwater elevations are attributed to seasonal variations in rainfall during a particular year. Numerous factors contribute to groundwater fluctuations, and evaluation of such factors is beyond the scope of this study.

ENGINEERING ANALYSIS AND RECOMMENDATIONS

Site Grading and Embankment Berm Construction

Sunrise Mountain Station: Grade at the Sunrise Mountain Pump Station containment area is relatively flat lying to gently sloping terrain down to the east/northeast, ranging in elevation from about 1,555 to 1,558 feet according to the site survey map. Topography will be graded to construct a sloping containment pad surrounded by an earthen containment berm having a crest width of 15 feet and a top elevation on the order of 1,560 ft. according to the elevations presented on Drawing C-402 (1/27/17). Based on the site contours and the proposed site grading indicated on the project drawings, earthen embankment fills up to 5.0 feet high are required for the berm construction.

It is anticipated that final site grading will consist of excavating and placing excavated structural sand fill to complete the above-grade embankment berms of the containment. Placement requirements for structural fill and built slope ratios for the cut and fill embankment slopes are discussed herein. In general, the containment area construction sequence below the pump station will consist of the following steps: 1) excavate 2 feet below finished grade to desired finished subgrade for the containment contours, 2) place and weld 60-mil HDPE liner on the prepared and rolled subgrade, and 3) cover the HDPE liner with a 2-foot thick layer of drainage gravel to finished grade. The subgrade at both containments will be sloped down to a drainage sump for positive leak detection and collection of any lost intake waters.

Historic Lateral Station: Surrounding natural topography at the Historical Lateral Pump Station consists of gently rolling to gently sloping terrain down to the east/northeast, ranging in elevation from about 1,545 to 1,537 feet according to the site survey map. Topography will be graded to construct a sloping containment pad surrounded by an earthen containment berm having a crest width of 15 feet and a top elevation on the order of 1,544 to 1,546 ft. according to the elevations presented on Drawing C-304 (1/27/17). Based on the site contours and the proposed site grading indicated on the project drawings, earthen embankment fills up to 9.0 feet high are required for the berm construction.

It is anticipated that final site grading will consist of excavating and placing excavated structural sand fill to complete the above-grade embankment berms of the containment. Placement requirements for structural fill and built slope ratios for the cut and fill embankment slopes are discussed herein. In general, the containment area construction sequence below the pump station will consist of the following steps: 1) excavate 2 feet below finished grade to desired finished subgrade for the containment contours, 2) place and weld 60-mil HDPE liner on the prepared and rolled subgrade, and 3) cover the HDPE liner with a 2-foot thick layer of drainage gravel to finished grade. The subgrade at both containments will be sloped down to a drainage sump for positive leak detection and collection of any lost intake waters.

General Foundation Grading: Based on the proposed site grading and results of this investigation, the influent tanks can be supported directly on the gravel fill subgrade and pumps supported on conventional reinforced concrete mat foundations.

Site grading plans must include drainage features to rapidly drain surface run-off away from the pumps, influent tanks and containment area. All grades must provide effective drainage away from the foundations during and after construction. Water permitted to pond next to foundations can result in greater soil movements than those discussed in this report. These greater movements can result in unacceptable differential settlement, piping connection problems and on-grade concrete slab movements for the tanks or pumps.

Drilling information indicates that natural moisture content in the excavated sand could be as much as 4 to 6% lower than optimum moisture content. Moisture conditioning the site soil to add moisture will be required to obtain moisture contents within +/-2% of optimum in order to achieve compaction. Proper mixing and moisture conditioning will be required to obtain a well-mixed uniform soil suitable for use in constructing compacted fill. Engineering properties of the site soils should be suitable for processing to adjust the moisture content and will require effort to disc and blend the silty sand to achieve uniform results.

Excavation of the site sand to subgrade depth can be accomplished with heavy-duty earth excavating equipment such as scrappers, loaders, and excavators. According to the information collected during the subsurface exploration, groundwater levels are expected to be below the anticipated excavation depths for this project. The on-site soils are suitable for use as structural fill. Shrinkage values of 5 to 10% should be anticipated for the sands.

Design and construction criteria presented below must be observed for site preparation purposes and when preparing project documents. If site grading significantly differs from what is described herein, the recommendations of this report must be reviewed and revised as necessary to reflect the final grading plan.

1. Any site surface fill, organics or site debris should be removed from the proposed construction areas.

2. Fill slopes should be constructed to 3H (horizontal):1V (vertical) or flatter. Fill slopes should be overbuilt beyond final line and grade and then cut back to develop an adequately compacted slope face. Where fill is placed on existing slopes steeper than 5H: 1V, benches should be cut into the existing slopes prior to fill placement. The benches should have a minimum vertical face height of 1 foot and a maximum vertical face height of 3 feet and should be cut wide enough to accommodate the compaction equipment. This benching will help provide a positive bond between the fill and natural soils and reduce the possibility of failure along the fill/natural soil interface.

3. Prior to placing new site fill, the stripped subgrade should be proof-rolled with a loaded dump truck or similar equipment. If loose or soft areas are encountered during the proof-rolling, the soft or loose soil should be over-excavated, replaced with structural fill and compacted to the specification noted below.

4. All fill and backfill should be approved by a geotechnical engineer, moisture-conditioned to within +/- 2% of optimum moisture content and placed in uniform maximum lifts of 6 inches in thickness. It should then be compacted to the following minimum dry densities as determined by ASTM D1557 or to the minimum percentage of the relative density determined by the combination of ASTM D4253 and D4254, whichever method is applicable for the material being compacted.

	ASTM D1557	ASTM D4253 & D4254
Roadway Areas	95%	75%
Embankment Fill	95%	75%
Below Foundations	100%	75%
Utility Trench Backfill	95%	70%
Spread Footing Foundations	100%	75%
Foundation Backfill	100%	75%

5. The on-site soils are suitable for use as structural fill for construction of the earthen containment berms and may be used as general site grading provided they are segregated and processed to within +/-2% of optimum moisture and are compacted in accordance with Item 4 above.

6. The contractor is responsible for providing safe working conditions in connection with underground excavations. Temporary construction excavations which workers will enter will be governed by OSHA guideline 1926.6542, Appendix B to subpart P. For planning purposes, the soils encountered in the exploratory borings classify as Type C.

7. Site grading must be developed and maintained during and after construction to rapidly drain surface run-off well away from the influent tank and pump foundations. The ground surface adjacent to the exterior foundations should be sloped to drain away from the foundation in all directions. A minimum slope of 6 inches in the first 10 feet should be used for site drainage requirements.

Foundations

Pump Station: Influent Tanks, Pumps

Estimated total settlement of the foundations will likely govern design rather than allowable bearing pressure. In consideration of the subsurface soil conditions and their engineering properties determined from the geotechnical investigation, a reinforced concrete mat foundation can be used to support the pump station pumps and the influent tanks can be supported on the gravel fill. Tetra Tech's analysis is based on an assumed minimum foundation embedment depth of 1 foot below grade and footing widths on the order of 2 to 3 feet for the smaller equipment and up to 11 feet or greater for and pumps. Calculations indicate typical small equipment footings bearing on the compacted gravel can be proportioned for an allowable bearing pressure of 2,000 pounds per square foot (psf). The larger foundations for the tanks or pumps can be proportioned for an allowable bearing pressure of 4,500 psf. Contact pressures from the largest dimension tanks are expected to be significantly less than the allowable bearing pressure according to the design information in Table No. 1.

Total settlement calculations were performed for the heavier structures/equipment listed in Table No.1. Based on a combination of elastic theory in the sand and one-dimensional consolidation for the underlying clay, and using an actual contact pressure of 500 psf for the influent water tank (Table No. 1 design calculations), the total settlement is estimated to be approximately 0.5 to 0.75 inches. Total settlement is estimated to be on the order of ¼ to ½ inch for the pump pad. A majority of the settlement will occur long term through the consolidation of the underlying clay layer throughout the duration of the project, while immediate elastic settlement is estimated to be less than ¼ inch in the sand and should occur during construction and hydrostatic loading of the influent tanks. Differential settlement will be approximately one half of the estimated total settlement.

Normal pump operations create dynamic foundation loads generated through vibration by unbalanced machine forces. Vibration analysis of the foundations requires input of soil properties of shear modulus and Poisson's ratio to describe the motion and determine the necessary spring constants and dampening ratios. The data from the MASW refraction survey investigation is used to determine values of dynamic shear modulus and Poisson's ratio. The location of the geophysical survey and results from this survey are presented in the Appendix. Values for shear wave velocity, soil density, Poisson's ratio, shear modulus, Young's modulus and Bulk modulus are present versus depth in summary tables generated for each seismic line.

The lateral resistance of mat foundations and spread footings is controlled by a combination of sliding resistance between the footing and the foundation materials and passive earth pressure against the side of the footing. Criteria for calculating the lateral resistance are presented below.

The following design and construction criteria should be observed. The construction details should be considered when preparing the project documents.

1. Temporary excavation slopes in the natural sand, gravel or gravel fill for the foundation construction should be sloped to 2H: 1V or flatter.

2. The influent tanks, and pumps should be supported on the gravel fill or a reinforced concrete mat foundation with a minimum thickness of 1 foot or greater based on structural requirements to support loading conditions.

3. The small concrete equipment footings supported on the gravel fill should be designed for an allowable contact pressure of 2,000 psf or less, with anticipated settlement on the order of 1/4 inch or less depending on the actual design loading. The large mat foundations supported on the gravel fill should be designed for an allowable contact pressure of 4,500 psf or less, with anticipated settlement in the range of ¼ to ¾ inches depending on actual contact pressures estimated from Table No. 1 for the anticipated equipment listed.

4. The minimum width of the spread footings should be at least 18 inches or in accordance with applicable building codes, whichever is more restrictive.

5. Footing lateral loads may be resisted by friction between the footing base and supporting soil, and lateral bearing pressure against the sides of footings. For design purposes, a friction coefficient of 0.42 for concrete on the natural sand or gravel fill and a lateral bearing pressure of 225 pcf per foot of depth for natural sand or gravel fill should be used. A Modulus of Subgrade reaction of 300 pci is applicable for the sand and gravel fill.

6. Compacted sand or gravel should be placed as backfill around all exterior foundations. The natural sand and natural gravel should be moisture-conditioned to within +/- 2% of optimum moisture content and placed in uniform maximum lifts of 6 inches in thickness. It should then be compacted to the maximum dry density as determined by ASTM D1557 in accordance with *Site Grading,* Item 4 and the surfaced sloped to drain per *Site Grading,* Item 7. Gravel fill placed inside the containment berms over the HDPE liner is free draining and therefore will not require moisture conditioning to achieve compaction.

7. A representative of the geotechnical engineer should observe and test the placement of all fill and observe all foundation excavations prior to placement of concrete forms.

Ancillary Equipment Foundations

Concrete spread footing foundations are suitable for support of ancillary structures such as pipe supports and pump equipment. Based on the subsurface conditions, concrete spread footing foundations should be placed on natural silty sand and be proportioned for a maximum contact pressure of 2,000 pounds per square foot. Settlements are estimated to be less than 1/4 inch. Tetra Tech's analysis is based on an assumed minimum foundation depth of at least 1 foot below grade and a minimum width of at least 2 feet.

Lateral Earth Pressures

Design for lateral earth pressures should be computed on the basis of the lateral earth pressure coefficients provided in the table below. Resistance to overturning and sliding can be provided by passive earth pressure and sliding friction. Passive earth pressure should be computed on the basis of the passive lateral earth pressure coefficients presented in the table below. Compacted fill placed against the sides of the mat to resist lateral loads should be compacted in accordance with *Site Grading, Item 4* and the surfaced sloped to drain per *Site Grading, Item 7.* Conventional safety factors used in structural analysis for items such as overturning moments and sliding should be used in the design.

Lateral Earth Parameters

DESIGN PARAMETER	SOIL TYPE
	Silty Sand
Lateral Earth Pressure Ko (at-rest) Ka[1] (active) Kp[1] (passive)	 0.47 0.31 3.25
Unit Weight (pcf)	110
Coefficient of Friction[2]	0.42
Soil Friction Angle	32

Notes:

Assumptions: Wall slope = vertical

Friction angle between concrete wall and sand = 24 degrees

[1] Wall rotation or translation

Translation or Wall Rotation* (Horizontal or Sloping Backfill)	
Active	Passive
-0.002H	+0.02H

*Wall rotation of translation = δ/H where δ is horizontal deformation of the wall and H is the wall height. (Negative values indicate movement away from backfill; positive values indicate movement toward backfill.)

[2] Factor of Safety = 1.5 applied

Piping

All piping including tank attachments will need to be designed to account for the range of settlements discussed in this report. The design of the connections to the tanks and pumps should consider the estimated range of settlement (up to ½ to 3/4-inches) anticipated.

Containment Embankments

It is anticipated that containment embankments will consist of primarily fill slopes. The on-site soils are suitable to construct earthen containment embankments. The fill slopes should be designed with side slopes of 3H: 1V or flatter. In addition, embankments will be subject to some settlement over time. Embankments will need to be constructed to account for this settlement and an over-build of at least 1-inch should be considered.

Water Conveyance Pipeline

Trench Excavation and Backfill

According to the limited drilling information, subsurface conditions along the water conveyance pipeline consist of alluvial deposits of silty sand with gravel and poorly graded gravel with silt and sand. Excavation of the referenced granular soils can be accomplished to depths on the order of 5 to 10 feet with most heavy duty earth excavating equipment. Based on groundwater levels encountered while drilling, excavations for the pipeline should be above the water table and not require construction dewatering. The sand and gravel are suitable for use as trench backfill around the pipeline. Place trench backfill in maximum 8-inch compacted lifts within 3 percent of optimum moisture content, and compact to at least 90 percent of the maximum dry density as determined by ASTM D 1557.

The natural sands are often loose at the surface and may not support wheeled, heavy construction vehicle traffic especially during and after precipitation events. The use of low ground pressure tracked construction equipment is normally recommended since tracks will exert lower contact pressures than pneumatic tires.

Trench Stability

Trench stability is very important for worker safety, as well as protection of nearby utilities and/or private property. The contractor is responsible for maintaining excavations for worker safety. This procedure will be governed by OSHA Regulation 1926.652, Appendix B to Subpart P. The route for the water line installation will generally be through areas where trench excavations can be sloped to meet requisite OSHA regulations. As an aid to preliminary evaluation of OSHA trench slope requirements, subsoils encountered within the borings were classified as Type C, in accordance with Appendix A of the referenced standard. The classification is based on data obtained from the exploration of borings at the time of the investigation.

During pipe installation, various construction practices (e.g., stockpiling excavated soil immediately adjacent to the excavation or operating equipment next to the trench walls) may contribute to trench instability. These construction procedures create a surcharge load to the sides of the excavation that the soil might not be capable of supporting. Consequently, attention should be paid to construction practices.

Pipe Bedding

In consideration of the soil types encountered along the alignment and the fact that installation of steel pipe will be used for construction, bedding material other than the compacted natural soil is not recommended for the pipeline. The compacted density of the sand and gravel encountered at anticipated bedding depths should provide adequate soil consistency for supporting buried pipe. Backfill of all utility excavations should be compacted to at least 90 percent of the maximum dry density as determined by ASTM D1557.

Soil Resistivity

Soil Resistivity testing indicated the sand soils present in the upper 11 feet are slightly deleterious to buried metals in contact with the soils and should be considered to have a low corrosive potential. Laboratory testing of representative samples had resistivity results ranging from 267 to 575 ohm-cm.

CONTINUING SERVICES

Two additional elements of geotechnical engineering service are important to the successful completion of this project.

1. **Consultation with Tetra Tech during the design phase.** This is essential to ensure that the intent of our recommendations is incorporated in design decisions related to the project and that changes in the design concept consider geotechnical aspects.

2. **Observation and monitoring during construction.** Tetra Tech should be retained to observe the earthwork phases of the project, including the site grading and excavations, to determine that the subsurface conditions are compatible with those described in our

analysis. In addition, if environmental contaminants or other concerns are discovered in the subsurface, our personnel are available for consultation.

LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering practices in the region where the work was conducted. The conclusions and recommendations submitted in this report are based upon project information provided to Tetra Tech, data obtained from the exploratory borings drilled at the locations indicated. The nature and extent of subsurface variations across the site may not become evident until construction. Tetra Tech should be on site during construction to verify that actual subsurface conditions are consistent with those described herein.

This report has been prepared exclusively for our client. This report and the data included herein shall not be used by any third party without the express written consent of both the client and Tetra Tech. Tetra Tech is not responsible for technical interpretations by others. As the project evolves, we should provide continued consultation and field services during construction to review and monitor the implementation of our recommendations, and verify that our recommendations have been appropriately interpreted. Significant design changes may require additional analysis or modifications of the recommendations presented herein. Tetra Tech recommends on-site observation of excavations and foundation bearing strata and testing of fill by a representative of the geotechnical engineer.

Prepared by: ______________________
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Reviewed by: ______________________
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2/14/17

APPENDIX

IMPORTANT INFORMATION

ABOUT YOUR

GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE/The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the Geotechnical-related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A Geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include: the general nature of the structure involved, its size and configuration; the location of the structure on the site and its orientation; physical concomitants such as access roads, parking lots, and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program. To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting Geotechnical engineer indicates otherwise, *your Geotechnical engineer report should not be used:*

- When the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified:
- when there is a change of ownership, or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their reports' development have changed.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by Geotechnical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no Geotechnical engineer, no matter how qualified, and not subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be fare more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact.* For this reason, *most experienced owners retain their Geotechnical consultants through the construction stage*, to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

SUBSURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly-changing natural forces. Because a Geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a Geotechnical engineering report whose adequacy may have been affected by time.* Speak with the Geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as flood, earthquakes or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

GEOTECHNICAL SERVICES ARE PREFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems. *No individual other than the client should apply this report for its intended purpose without first conferring with the* *geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.*

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plants based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evalution of field samples. Only final boring logs customarily are included in geotechnical engineering reports. *These logs should not under any circumstances be redrawn* for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, *give contractors ready access to the complete geotechnical engineering report* prepared or authorized for their use. Those who do not provide such access may proceed under the *mistaken* impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are *not* exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE as developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publications directory.

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Tetra Tech Boring Log Descriptive Terminology
Key to Soil Symbols and Terms

12/06/12

TETRA TECH

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	Well-graded gravels, gravel sand mixtures, little or no fines.
				GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	Silty gravels, gravel-sand-silt mixtures.
				GC	Clayey gravels, gravel-sand-clay mixtures.
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	Well-graded sands, gravelly sands, little or no fines.
				SP	Poorly graded sands, gravelly sands, little or no fines.
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	Silty sands, sand-silt mixtures.
				SC	Clayey sands, sand-clay mixures.
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
				OL	Organic silts and organic silty clays of low plasticity.
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
				CH	Inorganic clays of high plasticity, fat clays.
				OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS				PT	Peat and other highly organic soils.

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

Order of Descriptors

- Group Name
- Consistency or Relative Density
- Moisture Condition
- Color
- Particle size descriptor(s) (coarse grained soils only)
- Angularity of coarse grained soils
- Other relevant notes

Criteria For Descriptors

Consistency of Fine Grained Soils

Consistency	N-Value (uncorrected)
Very Soft	< 2
Soft	2 - 4
Medium Stiff	5 - 8
Stiff	9 - 15
Very Stiff	16 - 30
Hard	> 30

Apparent Density of Coarse Grained Soils

Relative Density	N-Value (uncorrected)
Very Loose	< 4
Loose	4 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

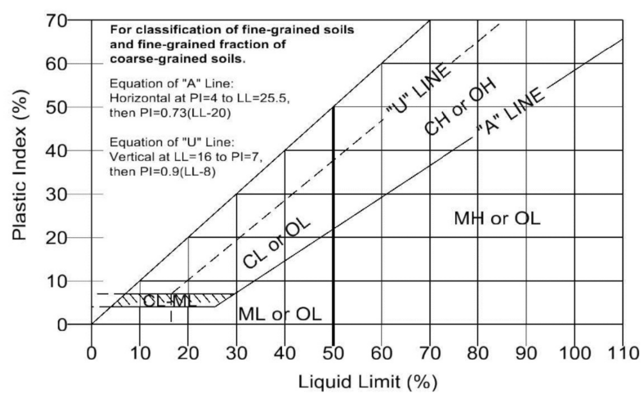
Moisture Condition

Dry	-Absence of moisture, dusty, dry to the touch.
Moist	-Damp, but no visible water.
Wet	-Visible free water.

Definition of Particle Size Ranges

Soil Component	Size Range
Boulder	> 12 in (300 mm)
Cobble	3 in (75 mm) - 12 in (300 mm)
Gravel	No. 4 Sieve (4.75 mm) to 3 in (75 mm)
Sand	No. 200 (0.075 mm) to No. 4 Sieves (4.75 mm)
Silt	< No. 200 Sieve (0.075 mm)*
Clay	< No. 200 Sieve (0.075 mm)*

*Atterberg limits and chart below to differentiate between silt and clay.



Notes

See Soil Boring Information Special Provision.

SPT (Standard Penetration Test-ASTM D1586):
The number of blows of a 140 lb (63.6 kg) hammer falling 2.5 ft (750 mm) used to drive a 2 in (50 mm) O.D. Split Spoon sampler for a total of 1.5 ft (0.45 m) of penetration.
Written as follows:
first 0.5 ft (0.15 m) - second 0.5 ft (0.15 m) - third 0.5 ft (0.15 m) (ex: 1-3-9)
Note: if the number of blows exceeds 50 before 0.5 ft (0.15 m) of penetration is achieved, the actual penetration rounded to the nearest 0.1 ft (0.03 m) follows the number of blows in parentheses (ex: 12-24-50 (0.09 m), 34-50 (0.4 ft), or 100 (0.3 ft)).WR denotes a zero blow count with the weight of the rods only.
WH denotes a zero blow count with the weight of the rods plus the weight of the hammer.

MC=Moisture Content, LL=Liquid limit, PL=Plastic Limit
-200%=percent soil passing 200 sieve, DD=Dry Density

Soil Classifications are Based on the Unified Soil Classification System, ASTM D2487 and D2488. Also included are the AASHTO group classifications (M145). Descriptions are based on visual observation, except where they have been modified to reflect results of laboratory tests as deemed appropriate.

Angularity of Coarse-Grained Particles

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

Example soil description: Sandy FAT CLAY (CH), soft, wet, brown. (A-7)

TETRA TECH

Tetra Tech Boring Log Descriptive Terminology
Key to Rock Symbols and Terms

Rock Type	Symbol	Rock Type	Symbol	Rock Type	Symbol
Argillite		Dolomite		Quartzite	
Basalt		Gneiss		Rhyolite	
Bedrock (other)		Granitic		Sandstone	
Breccia		Limestone		Schist	
Claystone		Siltstone		Shale	
		Conglomerate			

Order of Descriptors

- Rock Type
- Color
- Grain size (if applicable)
- Stratification/Foliation (as applicable)
- Field Hardness
- Other relevant notes

Criteria For Descriptors

Grain Size

Description	Characteristic
Coarse Grained	-Individual grains can be easily distinguished by eye
Fine Grained	-Individual grains can be distinguished with difficulty

Stratum Thickness

Thickly Bedded	3-10 ft (1-3 m)
Medium Bedded	1-3 ft (300 mm - 1 m)
Thinly Bedded	2-12 in (50-300 mm)
Very Thinly Bedded	< 2 in (50 mm)

Rock Field Hardness

Very Soft	-Can be carved with knife. Can be excavated readily with point of rock hammer. Can be scratched readily by fingernail.
Soft	-Can be grooved or gouged readily by knife or point of rock hammer. Can be excavated in fragments from chips to several inches in size by moderate blows of the point of a rock hammer.
Medium	-Can be grooved or gouged 0.05 in (2 mm) deep by firm pressure of knife or rock hammer point. Can be excavated in small chips to pieces about 1 in (25 mm) maximum size by hard blows of the point of a rock hammer.
Moderately hard	-Can be scratched with knife or pick. Gouges or grooves to 0.25 in (6 mm) can be excavated by hard blow of rock hammer. Hand specimen can be detached by moderate blows.
Hard	-Can be scratched with knife or pick only with difficulty. Hard hammer blows required to detach hand specimen.
Very Hard	-Cannot be scratched with knife or sharp rock hammer point. Breaking of hand specimens requires several hard blows of a rock hammer.

Notes:

UCS = Unconfined Compressive Strength obtained from laboratory testing at the given depth.

See Soil Boring Information Special Provision.

Miscellaneous Soil/Rock Symbols and Terms

- Concrete
- Asphalt
- Water
- Boulders and Cobbles
- Coal
- Fill
- Millings
- Topsoil

Explanation of Text Fields in Boring Logs:

Material Description: Lithologic Description of soil or rock encountered.

Remarks: Comments on drilling, including method, bit type, and problems encountered.

Unless stated on logs as being surveyed by district survey, all locations are considered approximate.

General Notes

- Descriptions on these boring logs apply only at the specific boring, and at the time the time the borings were made. These logs are not warranted to be representative of subsurface conditions at other locations or times.
- Water level observations apply only at the specific boring, and at the time the borings were made. Due to the variability of groundwater measurements given the type of drilling used, and the stratification of the soil in the boring, these logs are not warranted to be representative of groundwater conditions at other locations or times.
- Other terms may be used as descriptors, as defined by the profession.

-Soil and Rock descriptions are based on visual observation, except where they have been modified to reflect results of laboratory tests as deemed appropriate.

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sample Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Cone Penetrometer; Vane Shear; Special Samplers; Testpit

Example Rock Log

SANDSTONE, gray, fine grained, thickly bedded, hard field hardness.

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation: D 2487 – 83

(Based on Unified Soil Classification System)

MAJOR DIVISIONS				GROUP SYMBOL	GROUP NAME
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines	Cu ≥ 4 and 1 ≤ Cc ≤ 3[E]	GW	Well graded gravel [F]
			Cu < 4 and/or 1 > Cc > 3[E]	GP	Poorly graded gravel [F]
		Gravels with Fines More than 12% fines	Fines classify as ML or MH	GM	Silty gravel [F G H]
			Fines classify as CL or CH	GC	Clayey gravel [F G H]
	Sands 50% or more of coarse faction passes No. 4 sieve	Clean Sands Less than 5% fines	Cu ≥ 6 and 1 ≤ Cc ≤ 3[E]	SW	Well-graded sand [I]
			Cu < 6 and/or 1 > Cc > 3[E]	SP	Poorly graded sand [I]
		Sands with Fines More than 12% fines	Fines classify as ML or MH	SM	Silty Sand [G H I]
			Fines classify as CL or CH	SC	Clayey sand [G H I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line	CL	Lean clay [K L M]
			PI < 4 or plots below "A" line	ML	Silt [K L M]
		Organic	Liquid limit – oven dried / Liquid limit – not dried < 0.75	OL	Organic clay [K L M N] Organic silt [K L M O]
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [K L M]
			PI plots below "A" line	MH	Elastic silt [K L M]
		Organic	Liquid limit – oven dried / Liquid limit – not dried < 0.75	OH	Organic clay [K L M O] Organic silt [K L M O]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $Cc = (D_{30})^2 / (D_{10} \times D_{90})$

[F] If soil contains ≥15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥15% gravel, add "with gravel" to group name.
If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K]. If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

[L] If solid contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.

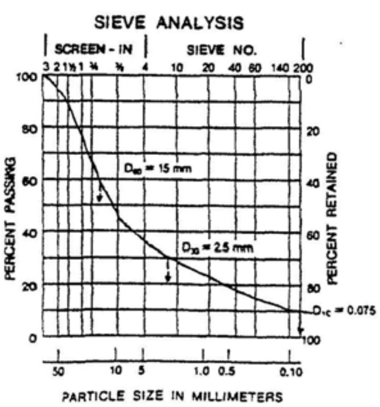
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

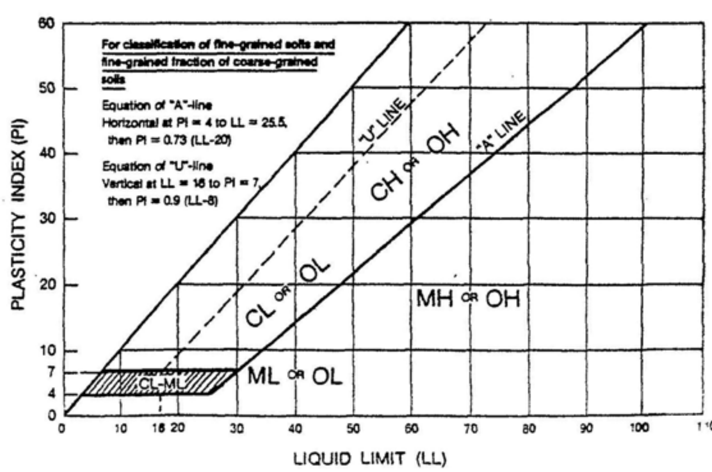
[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A: line.

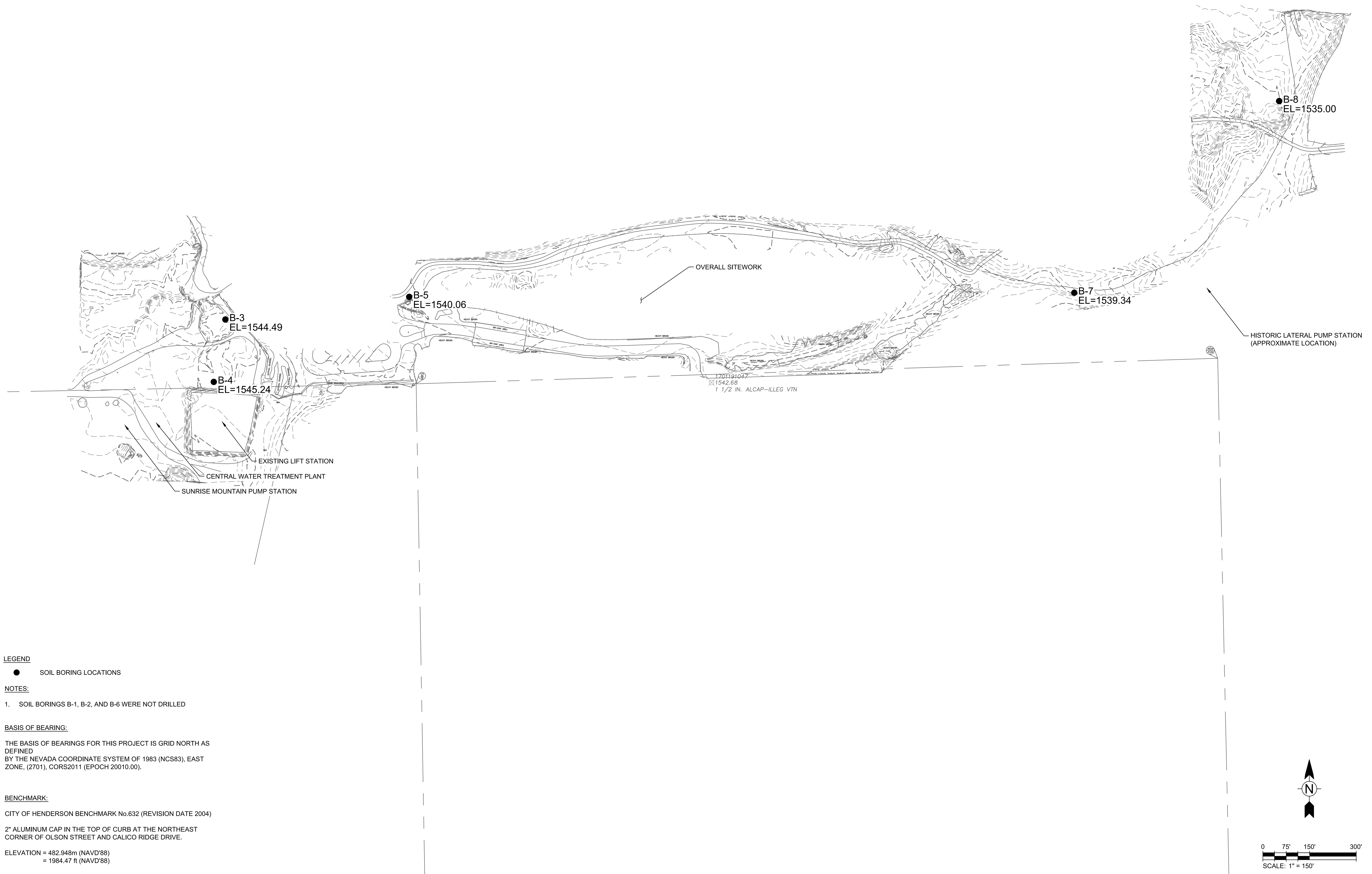
[P] PI plots on or above "A: line.

[Q] PI plots below "A: line.





$C_u = \frac{D_{50}}{D_{1e}} = \frac{15}{0.075} = 200$ $C_c = \frac{(D_{30})2}{D_{12} \times 10_{36}} + \frac{(2.5)\text{-}}{0.075 \times 15} = 5.6$



LEGEND

● SOIL BORING LOCATIONS

NOTES:

1. SOIL BORINGS B-1, B-2, AND B-6 WERE NOT DRILLED

BASIS OF BEARING:

THE BASIS OF BEARINGS FOR THIS PROJECT IS GRID NORTH AS DEFINED
BY THE NEVADA COORDINATE SYSTEM OF 1983 (NCS83), EAST ZONE, (2701), CORS2011 (EPOCH 20010.00).

BENCHMARK:

CITY OF HENDERSON BENCHMARK No.632 (REVISION DATE 2004)

2" ALUMINUM CAP IN THE TOP OF CURB AT THE NORTHEAST CORNER OF OLSON STREET AND CALICO RIDGE DRIVE.

ELEVATION = 482.948m (NAVD'88)
= 1984.47 ft (NAVD'88)

TETRA TECH
www.tetratech.com
1489 West Warm Springs Road, Suite 110
Henderson, NV 89014
Phone: 702.946.6700 Fax: 702.997.7140

MARK	DATE	DESCRIPTION	BY
A	02/13/17	ISSUED FOR REVIEW	SEF

NEVADA ENVIRONMENTAL RESPONSE TRUST
HENDERSON, NEVADA

WIER DEWATERING TREATMENT

LOCATION OF EXPLORATORY BORINGS

Project No.:	114-571048X
Designed By:	R. DOMBROUSKI
Drawn By:	S. FIELD
Checked By:	R. DOMBROUSKI

GEOTECH DRAWING

C-101

2/13/2017 3:33:19 PM - O:\T-Z\TTMISSOULA\114-571148X NERT 2017 OPS SUPPORT\CAD\SHEETFILES\C-101-LOCATION OF EXPLORATORY BORINGS.DWG - FIELD, STEVE

2525 Palmer St, Suite 2
Missoula, Montana 59808
Phone: 406.543.3045
Fax: 406.543.3088

Figure No. 1

LOG OF BORING

Boring B-3

TETRA TECH

Project: NERT - Weir Dewatering Treatment		**Rig:** Deidrich D-50 **Hammer:** Auto	**Boring Location Coordinates** N: 36.08641 E: -114.98679
Project Number: 114-571148X		**Boring Diameter:** 6 in	**System:** Local Coordinates **Datum:** NAD83 **Top of Boring Elevation:** 1544.5 ft
Date Started: 1/19/17	**Date Finished:** 1/19/17	**Drilling Fluid:** None	**Abandonment Method:** Bentonite
Driller: Eagle Drilling **Logger:** Luke Michels		**Location:**	

Depth (ft) / *Elev. (ft)*	Recovery (%)	RQD (%)	Blow Count	Material Description	Depth (ft) / *Elev. (ft)*	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
0 / *1544.5*	83		1 - 1 - 2	Silty SAND (SM), very loose, moist, light brown, coarse grained, surface soil disturbed from vegetation removal.		12					
2 / *1542.5*						17					
	83		3 - 1 - 3	Silty, Clayey SAND (SC-SM), very loose, moist, light brown to tan, Interbedded Lean Clay with Sand and Silt with Sand, fine grained sand.	3.0 / *1541.5*						
4 / *1540.5*						15	27	20	40	95 98	c=186 psf Phi=32 degrees
6 / *1538.5*	100					6					
	83		8 - 9 - 10								
8 / *1536.5*				Silty SAND with gravel (SM), medium dense to very dense, moist to wet, brown to gray, medium to coarse grained, subrounded to subangular.	7.5 / *1537.0*						
10 / *1534.5*	61		8 - 50/0.4ft			13					
12 / *1532.5*				Silty SAND (SM), very stiff, wet, light brown, non plastic.	12.0 / *1532.5*						
14 / *1530.5*							NV	NP	47	96	
16 / *1528.5*	78		9 - 13 - 17								
18 / *1526.5*				Lean CLAY (CL), stiff, wet, light brown, low plasticity.	18.0 / *1526.5*						
20 / *1524.5*	100		4 - 4 - 6			36					
					21.5 / *1523.0*						

Boring Depth: 21.5 ft, *Elevation: 1523.0 ft*

Water Level Observations	During Drilling: 11.0 ft *(1533.5 ft)*	Remarks:
After Drilling: Not Recorded	After Drilling: Not Recorded	

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Figure No. 2

LOG OF BORING

Boring B-4

TETRA TECH

Project: NERT - Weir Dewatering Treatment		**Rig:** Deidrich D-50 **Hammer:** Auto	**Boring Location Coordinates** N: 36.08586 E: -114.98692
Project Number: 114-571148X		**Boring Diameter:** 6 in	**System:** Local Coordinates **Datum:** NAD83 **Top of Boring Elevation:** 1545.2 ft
Date Started: 1/19/17	**Date Finished:** 1/19/17	**Drilling Fluid:** None	**Abandonment Method:** Bentonite
Driller: Eagle Drilling **Logger:** Luke Michels		**Location:**	

Depth (ft) / *Elev. (ft)*	Recovery (%)	RQD (%)	Blow Count	Material Description	Depth (ft) / *Elev. (ft)*	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
0–1	0		8 - 7 - 8	FILL, Poorly-Graded SAND with silt and gravel (SP-SM), medium dense, moist, light brown, fine to coarse grained, subrounded to angular, soil disturbed from vegetation removal.	1.0 / *1544.2*		NV	NP	11		
2 / *1543.2*				Poorly-Graded SAND with silt and gravel (SP-SM), loose to medium dense, moist to wet, light brown, fine to coarse grained, subrounded to angular.		5					
3–4	89		6 - 6 - 4								
4 / *1541.2*						9					
6 / *1539.2*	72		9 - 8 - 7								
8 / *1537.2*						10					
8–9	89		4 - 6 - 13								
10 / *1535.2*						10					
11	94		6 - 6 - 4								
12 / *1533.2*											
14 / *1531.2*				Lean CLAY (CL), stiff to very stiff, wet, light brown to tan, low plasticity, Interbedded Lean Clay and Silt, fine grained sand.	13.0 / *1532.2*	28					
16 / *1529.2*	28		5 - 8 - 10								
18 / *1527.2*											
20 / *1525.2*						35	43	21	77	84 81	
21	100					21					
22 / *1523.2*	100		4 - 6 - 6		23.0 / *1522.2*						

Boring Depth: 23.0 ft, *Elevation: 1522.2 ft*

Water Level Observations		
After Drilling: Not Recorded	**During Drilling:** 11.0 ft *(1534.2 ft)* **After Drilling:** Not Recorded	Remarks:

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Fax: 406.543.3088

Figure No. 3

LOG OF BORING

Boring B-5

TETRA TECH

Project: NERT - Weir Dewatering Treatment	**Rig:** Deidrich D-50 **Hammer:** Auto	**Boring Location Coordinates** N: 36.0866 E: -114.98479	
Project Number: 114-571148X	**Boring Diameter:** 6 in	**System:** Local Coordinates **Datum:** NAD83	**Top of Boring Elevation:** 1540.1 ft
Date Started: 1/19/17	**Date Finished:** 1/19/17	**Drilling Fluid:** None	**Abandonment Method:** Bentonite
Driller: Eagle Drilling **Logger:** Luke Michels		**Location:**	

Depth (ft) / *Elev. (ft)*	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / *Elev. (ft)*	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
			83		8 - 12 - 15		Silty SAND with gravel (SM), medium dense, moist, light brown, fine to coarse grained, subrounded to angular.		7					
2 / *1538.1*									5					
			67		11 - 12 - 15									
4 / *1536.1*									5					
6 / *1534.1*			67		9 - 9 - 12									
									6					
8 / *1532.1*			78		9 - 6 - 13									
									6					
10 / *1530.1*			72		9 - 14 - 10									
							Boring Depth: 11.5 ft, *Elevation: 1528.6 ft*	11.5 / *1528.6*						

Water Level Observations	**During Drilling:** Not Encountered	Remarks:
After Drilling: Not Recorded	**After Drilling:** Not Recorded	

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Figure No. 4

LOG OF BORING

Boring B-7

TETRA TECH

Project: NERT - Weir Dewatering Treatment	**Rig:** Deidrich D-50 **Hammer:** Auto	**Boring Location Coordinates** N: 36.0866 E: -114.97756	
Project Number: 114-571148X	**Boring Diameter:** 6 in	**System:** Local Coordinates **Datum:** NAD83	**Top of Boring Elevation:** 1539.3 ft
Date Started: 1/19/17 / **Date Finished:** 1/19/17	**Drilling Fluid:** None	**Abandonment Method:** Bentonite	
Driller: Eagle Drilling **Logger:** Luke Michels	**Location:**		

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
			72		2 - 6 - 7		Poorly-Graded GRAVEL with silt and sand (GP-GM), medium dense to very dense, moist, brown, fine to coarse grained, subrounded to angular.		4	NV	NP	12		
2 / 1537.3									3					
4 / 1535.3			61		8 - 8 - 23									
									3					
6 / 1533.3			83		24 - 25 - 28									
8 / 1531.3			0		16 - 19 - 23									
10 / 1529.3									6					
			44		16 - 25 - 33			11.5 / 1527.8						

Boring Depth: 11.5 ft, *Elevation: 1527.8 ft*

Water Level Observations	During Drilling: Not Encountered	Remarks:
After Drilling: Not Recorded	After Drilling: Not Recorded	

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Figure No. 5

LOG OF BORING

Boring B-8

TETRA TECH

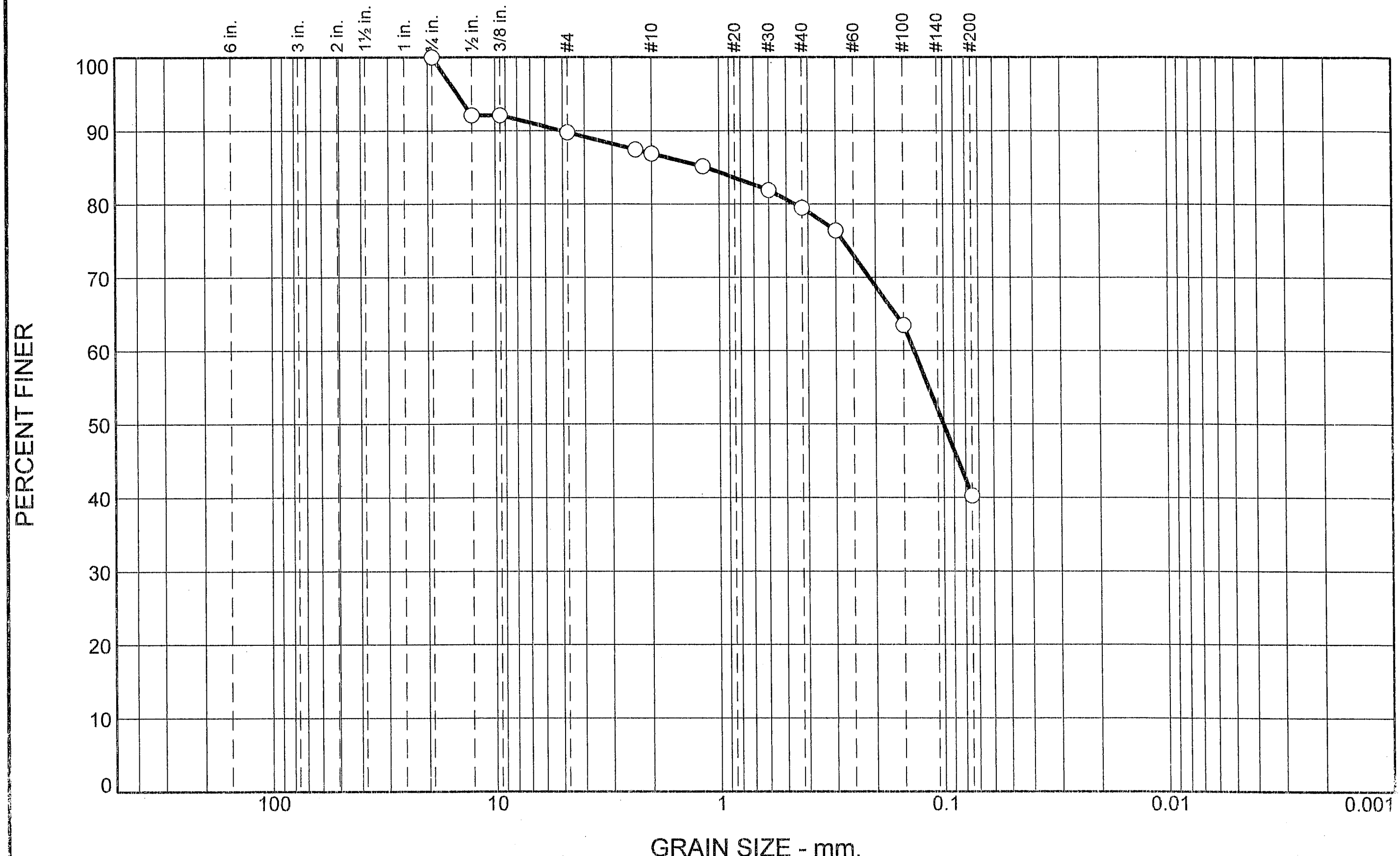
Project: NERT - Weir Dewatering Treatment	**Rig:** Deidrich D-50 **Hammer:** Auto	**Boring Location Coordinates** N: 36.08828 E: -114.97532	
Project Number: 114-571148X	**Boring Diameter:** 6 in	**System:** Local Coordinates **Datum:** NAD83	**Top of Boring Elevation:** 1535.0 ft
Date Started: 1/19/17	**Date Finished:** 1/19/17	**Drilling Fluid:** None	**Abandonment Method:** Bentonite
Driller: Eagle Drilling **Logger:** Luke Michels		**Location:**	

Depth (ft) / *Elev. (ft)*	Recovery (%)	RQD (%)	Blow Count	Material Description	Depth (ft) / *Elev. (ft)*	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
				Silty SAND (SM), medium dense, moist, light brown, fine to coarse grained, subrounded to angular, Trace small gravel..		6					
	89		3 - 6 - 11				NV	NP	37		
2 / *1533.0*						12					
	100		6 - 6 - 5								
4 / *1531.0*				Lean CLAY (CL), stiff, moist, tan.	4.5 / *1530.5*	18					
6 / *1529.0*	100		6 - 5 - 7								
				Poorly-Graded SAND with silt and gravel (SP-SM), dense, moist, tan, fine to coarse grained, subrounded to angular.	6.5 / *1528.5*	5					
8 / *1527.0*	100		12 - 24 - 18								
10 / *1525.0*				Lean CLAY (CL), very stiff, moist to wet, tan, occasional thin seams of silt and fine grained sand interbedded throughout.	9.5 / *1525.5*	20				72	Phi=32 degrees c= 420 psf
	100		7 - 9 - 10			19				102	
12 / *1523.0*											
14 / *1521.0*						21					
16 / *1519.0*	100		9 - 12 - 18								
18 / *1517.0*											
20 / *1515.0*						21					
	83		11 - 12 - 15		21.5 / *1513.5*						

Boring Depth: 21.5 ft, *Elevation: 1513.5 ft*

Water Level Observations		Remarks:
After Drilling: Not Recorded	During Drilling: 21.3 ft *(1513.7 ft)* After Drilling: Not Recorded	

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	10	3	8	39	40	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100		
.5	92		
.375	92		
#4	90		
#8	87		
#10	87		
#16	85		
#30	82		
#40	79		
#50	76		
#100	63		
#200	40		

* (no specification provided)

Material Description

Silty, clayey sand

Atterberg Limits

PL= 20 LL= 27 PI= 7

Classification

USCS= SC-SM AASHTO= A-4(0)

Remarks

Sampled by NERT. Tested using ASTM D6913.

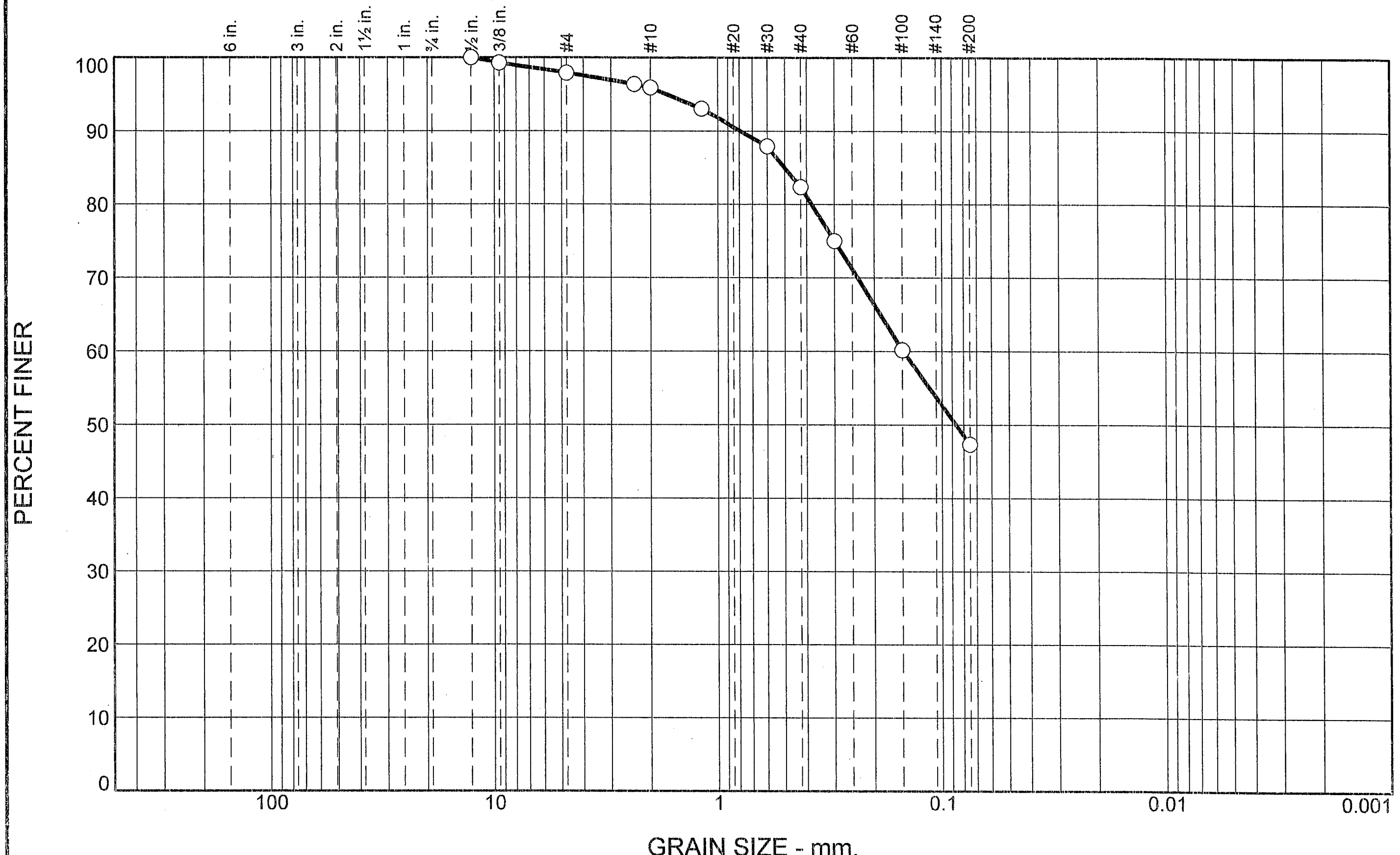
Location: BORING B-3 @ 5.0'-6.5'
Sample Number: B-3 **Depth:** 5.0'-6.5' **Date:** 01/20/17

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

Client: NEVADA ENVIRONMENTAL RESPONSE TRUST
Project: LAS VEGAS WASH WEIR
Project No: 20153663E402 **Figure** 6

Tested By: A. Sanders

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	2	2	14	35	47	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.5	100		
.375	99		
#4	98		
#8	96		
#10	96		
#16	93		
#30	88		
#40	82		
#50	75		
#100	60		
#200	47		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NV PI= NP

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Sampled by NERT. Tested using ASTM D6913.

Location: BORING B-3 @ 15.0'-16.5'
Sample Number: B-3 **Depth:** 15.0'-16.5' **Date:**

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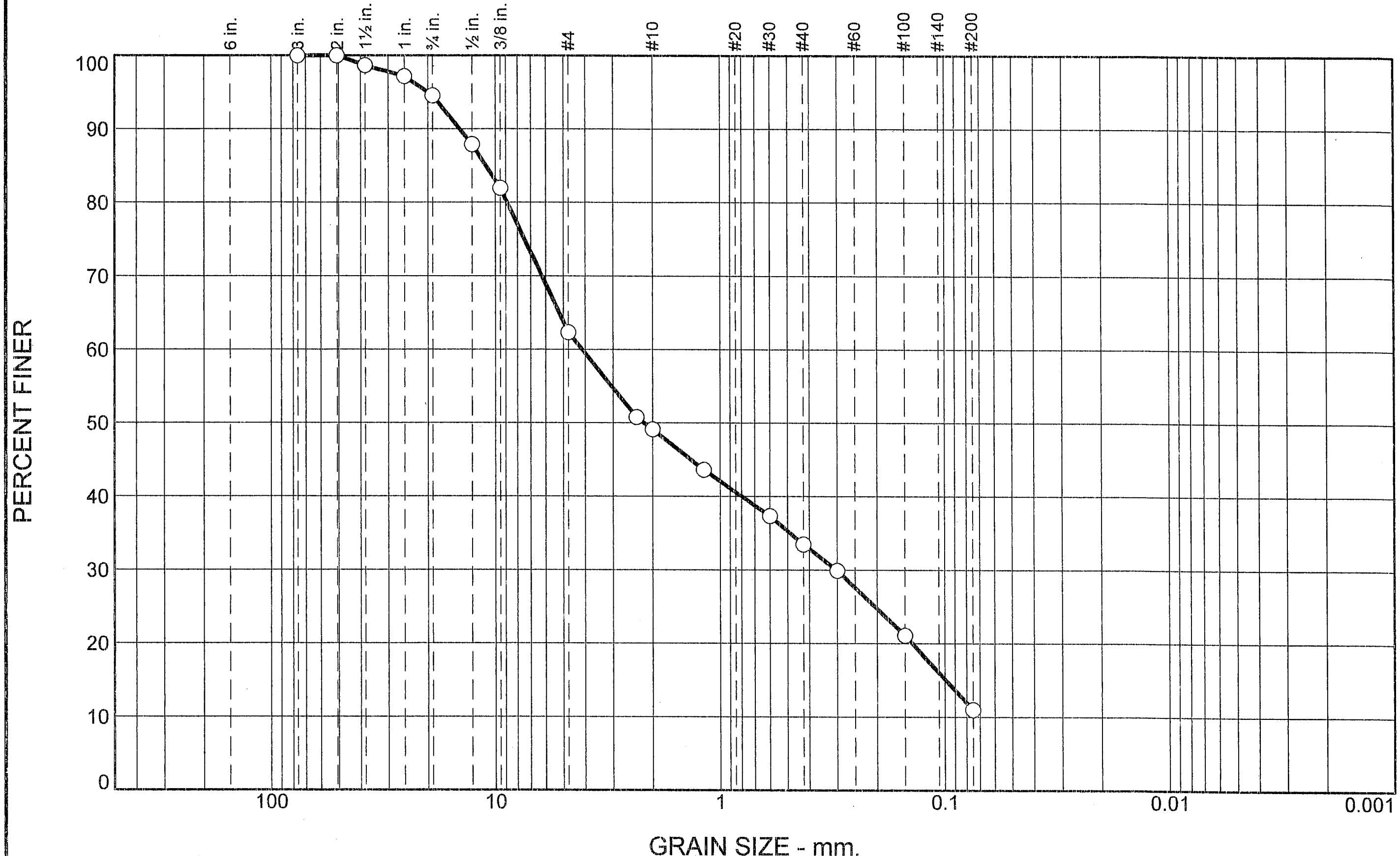
Client: NEVADA ENVIRONMENTAL RESPONSE TRUST
Project: LAS VEGAS WASH WEIR
Project No: 20153663E402 **Figure** 7

Tested By: L. Thomas

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	5	33	13	16	22	11	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100		
2	100		
1.5	99		
1	97		
.75	95		
.5	88		
.375	82		
#4	62		
#8	51		
#10	49		
#16	44		
#30	37		
#40	33		
#50	30		
#100	21		
#200	11		

* (no specification provided)

Material Description

Poorly graded sand with silt and gravel

Atterberg Limits

PL= NP LL= NV PI= NP

Classification

USCS= SP-SM AASHTO= A-1-b

Remarks

Sampled by NERT. Tested using ASTM D6913.

Location: BORING B-4 @ 0.0'-5.0'
Sample Number: B-4 **Depth:** 0.0'-5.0'

Date:

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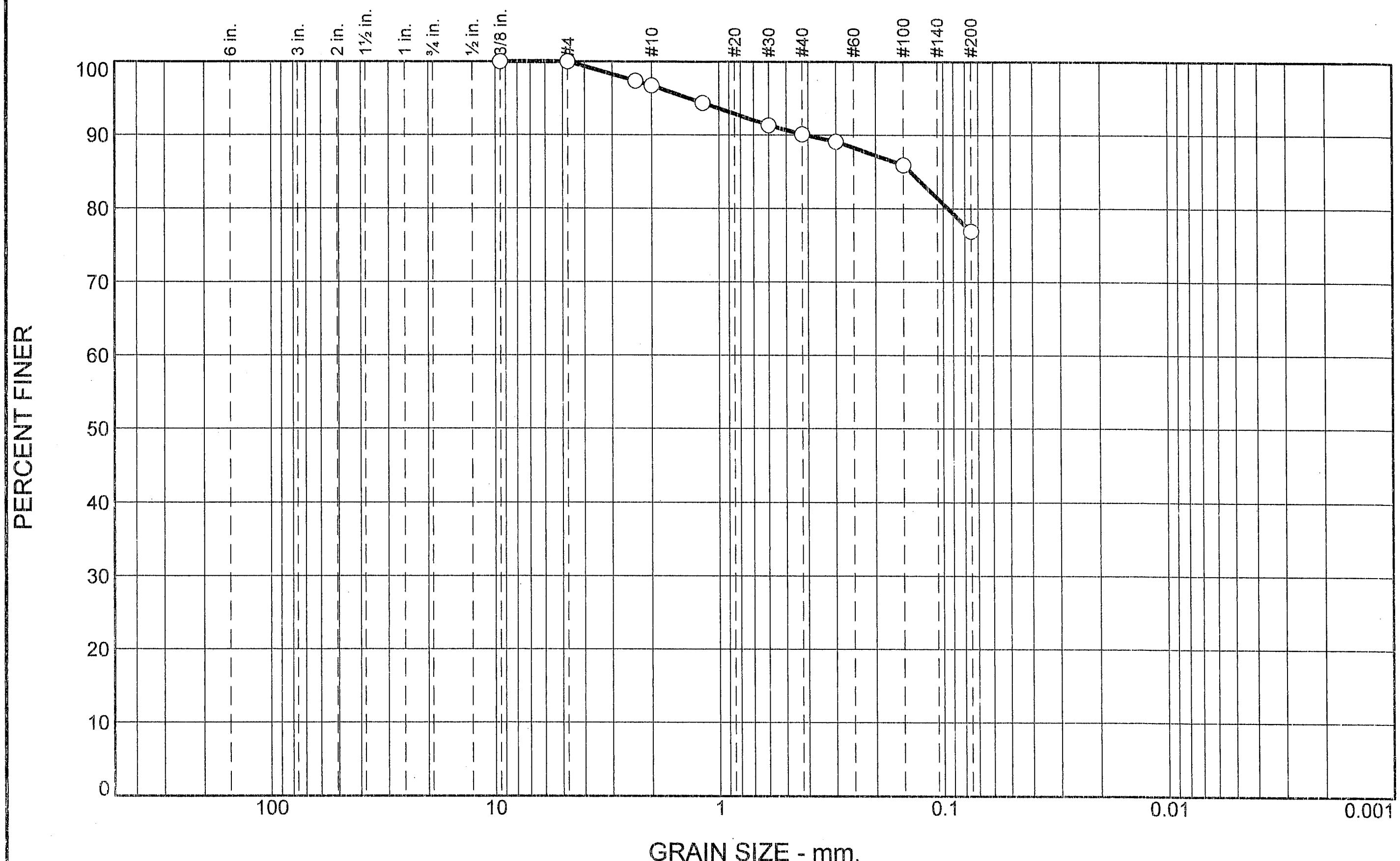
GES

Client: NEVADA ENVIRONMENTAL RESPONSE TRUST
Project: LAS VEGAS WASH WEIR

Project No: 20153663E402 **Figure** 8

Tested By: L. Thomas

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	3	7	13	77	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100		
#4	100		
#8	97		
#10	97		
#16	94		
#30	91		
#40	90		
#50	89		
#100	86		
#200	77		

* (no specification provided)

Material Description

Lean clay with sand

Atterberg Limits

PL= 21 LL= 43 PI= 22

Classification

USCS= CL AASHTO= A-7-6(16)

Remarks

Sampled by NERT. Tested using ASTM D6913.

Location: BORING B-4 @ 20.0'-21.5'
Sample Number: B-4 **Depth:** 20.0'-21.5' **Date:**

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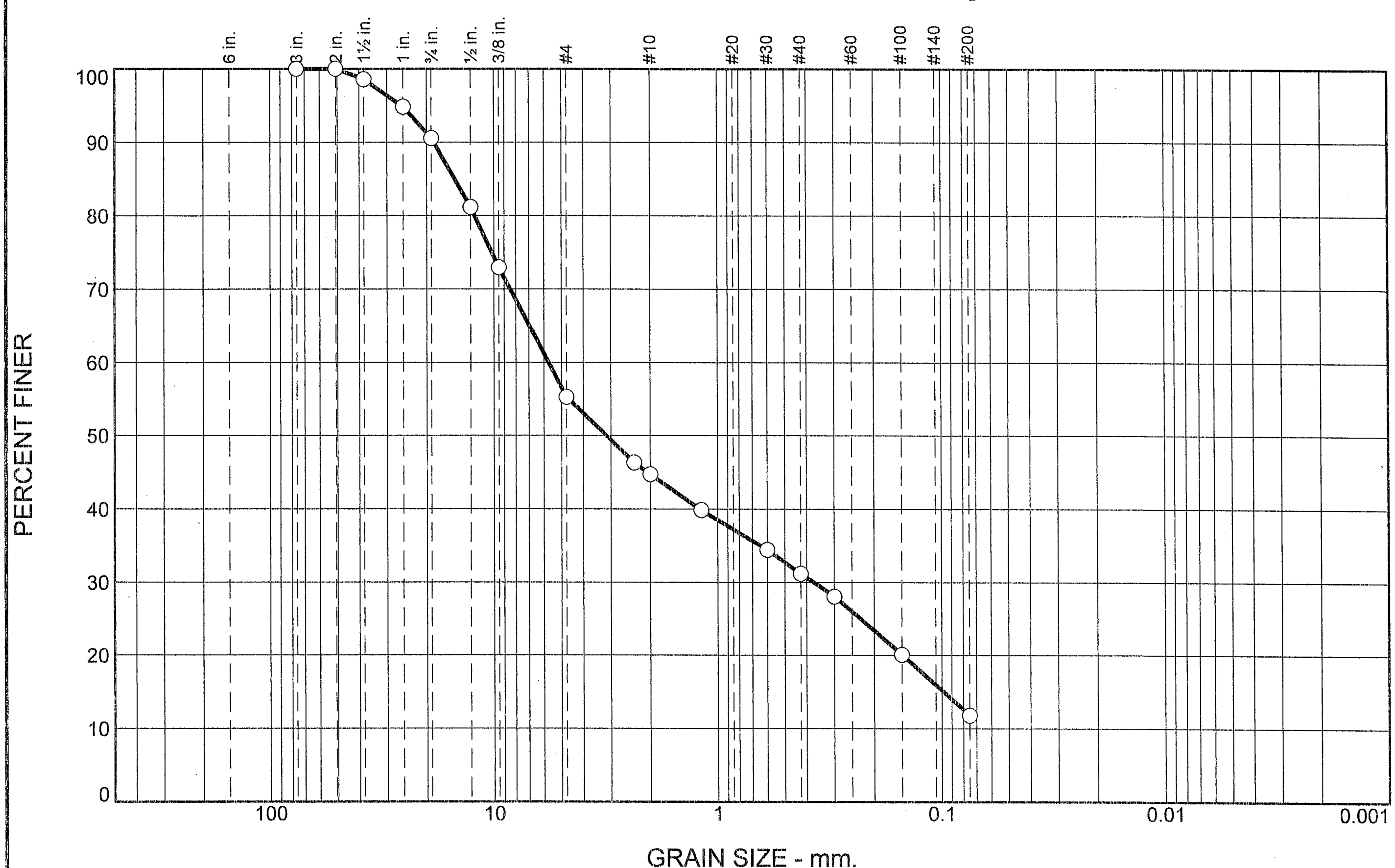
Client: NEVADA ENVIRONMENTAL RESPONSE TRUST
Project: LAS VEGAS WASH WEIR
Project No: 20153663E402 **Figure** 9

Tested By: A. Sanders

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	9	36	10	14	19	12	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100		
2	100		
1.5	99		
1	95		
.75	91		
.5	81		
.375	73		
#4	55		
#8	46		
#10	45		
#16	40		
#30	34		
#40	31		
#50	28		
#100	20		
#200	12		

* (no specification provided)

Material Description

Poorly graded gravel with silt and sand

Atterberg Limits

PL= NP LL= NV PI= NP

Classification

USCS= GP-GM AASHTO= A-1-b

Remarks

Sampled by NERT. Tested using ASTM D6913.

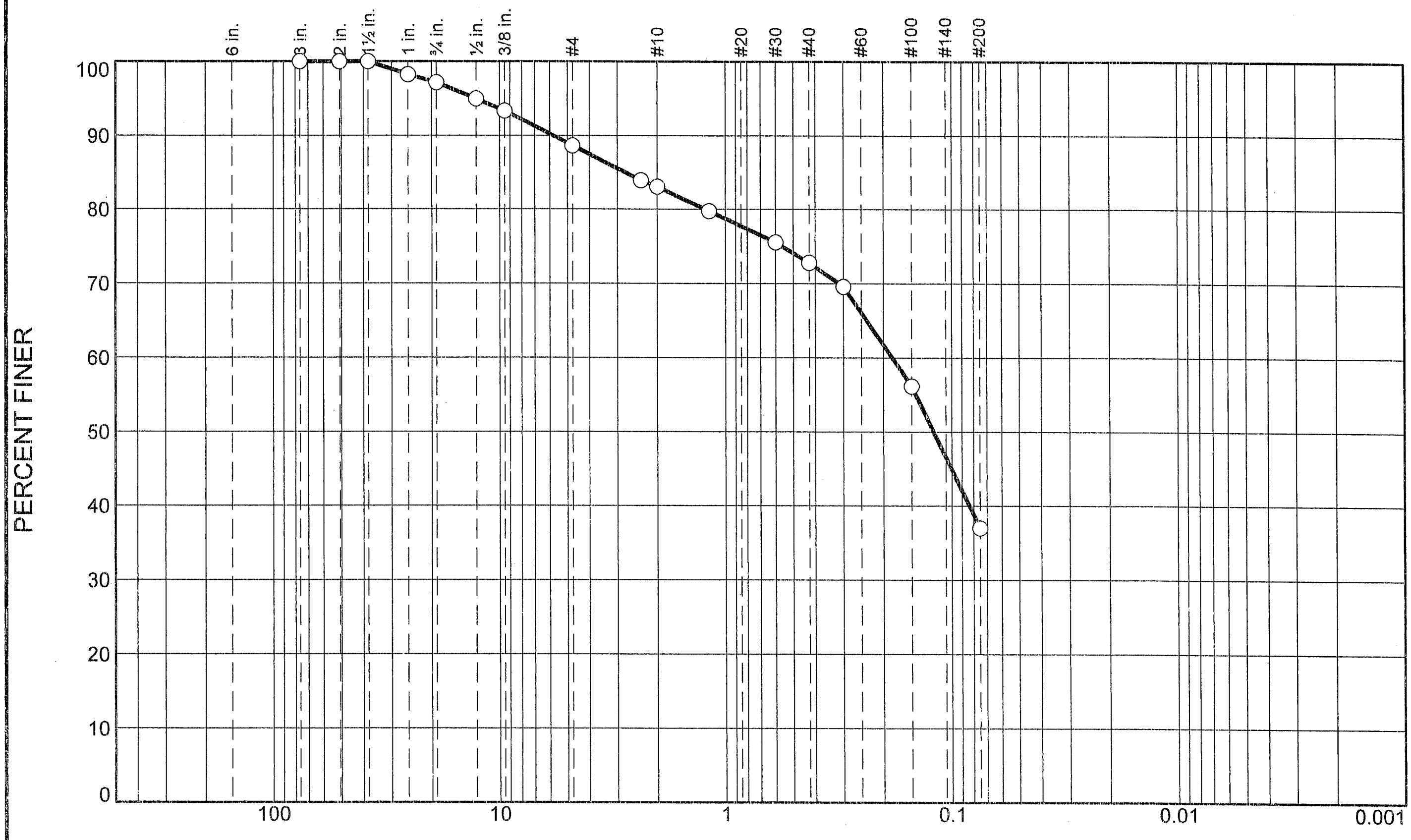
Location: BORING B-7 @ 0.0'-5.0'
Sample Number: B-7 **Depth:** 0.0'-4.5' **Date:**

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

Client: NEVADA ENVIRONMENTAL RESPONSE TRUST
Project: LAS VEGAS WASH WEIR
Project No: 20153663E402 **Figure** 10

Tested By: L. Thomas

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	3	8	6	10	36	37	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100		
2	100		
1.5	100		
1	98		
.75	97		
.5	95		
.375	93		
#4	89		
#8	84		
#10	83		
#16	80		
#30	76		
#40	73		
#50	70		
#100	56		
#200	37		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NV PI= NP

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Sampled by NERT. Tested using ASTM D6913.

Location: BORING B-8 @ 0.0'-4.5'
Sample Number: B-8 **Depth:** 0.0'-4.0' **Date:**

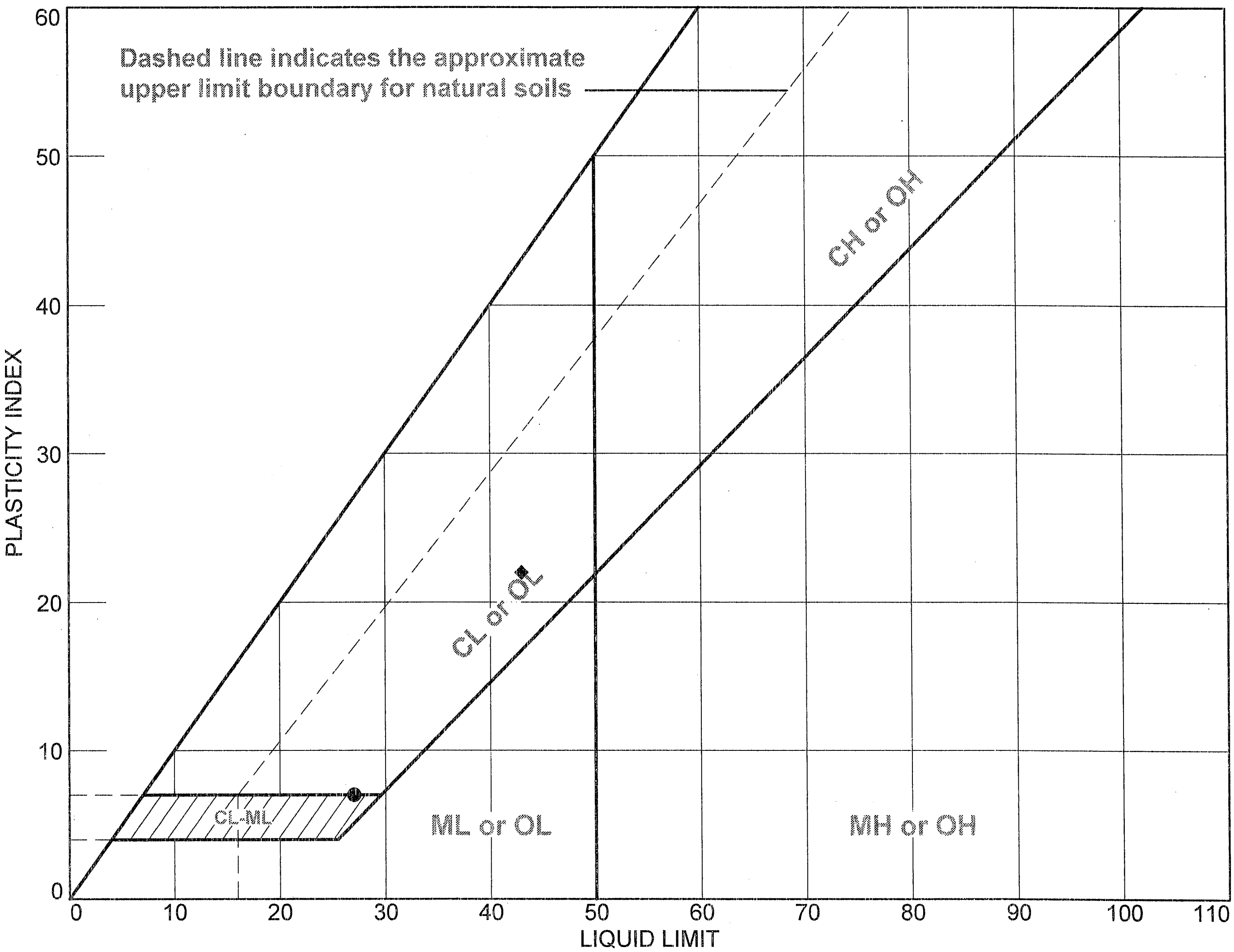
GES GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Client: NEVADA ENVIRONMENTAL RESPONSE TRUST
Project: LAS VEGAS WASH WEIR

Project No: 20153663E402 **Figure** 11

Tested By: L. Thomas

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	LAB#17-026	B-3	5.0'-6.5'		20	27	7	SC-SM
■	LAB#17-026	B-3	15.0'-16.5'		NP	NV	NP	SM
▲	LAB#17-026	B-4	0.0'-5.0'		NP	NV	NP	SP-SM
◆	LAB#17-026	B-4	20.0'-21.5'		21	43	22	CL
▼	LAB#17-026	B-7	0.0'-4.5'		NP	NV	NP	GP-GM

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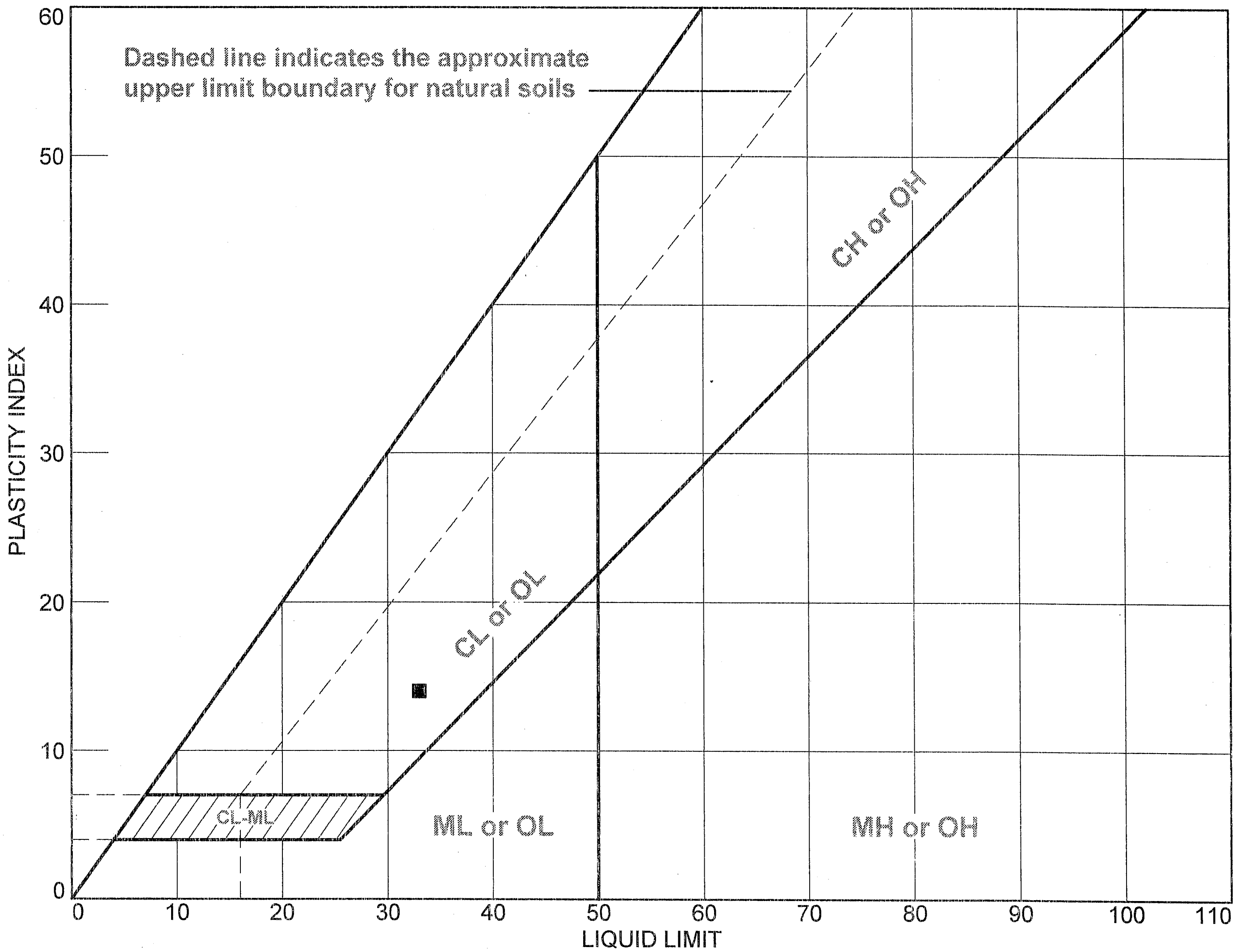
GES

Client: NEVADA ENVIRONMENTAL RESPONSE TRUST
Project: LAS VEGAS WASH WEIR

Project No.: 20153663E402 **Figure** 12

Tested By: ○ C. BYER □ C. Byer △ C. Byer ◇ T. FULLER ▽ C. Byer

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	LAB#17-026	B-8	0.0'-4.0'		NP	NV	NP	SM
■	LAB#17-026	B-8	10.0'-11.5'		19	33	14	

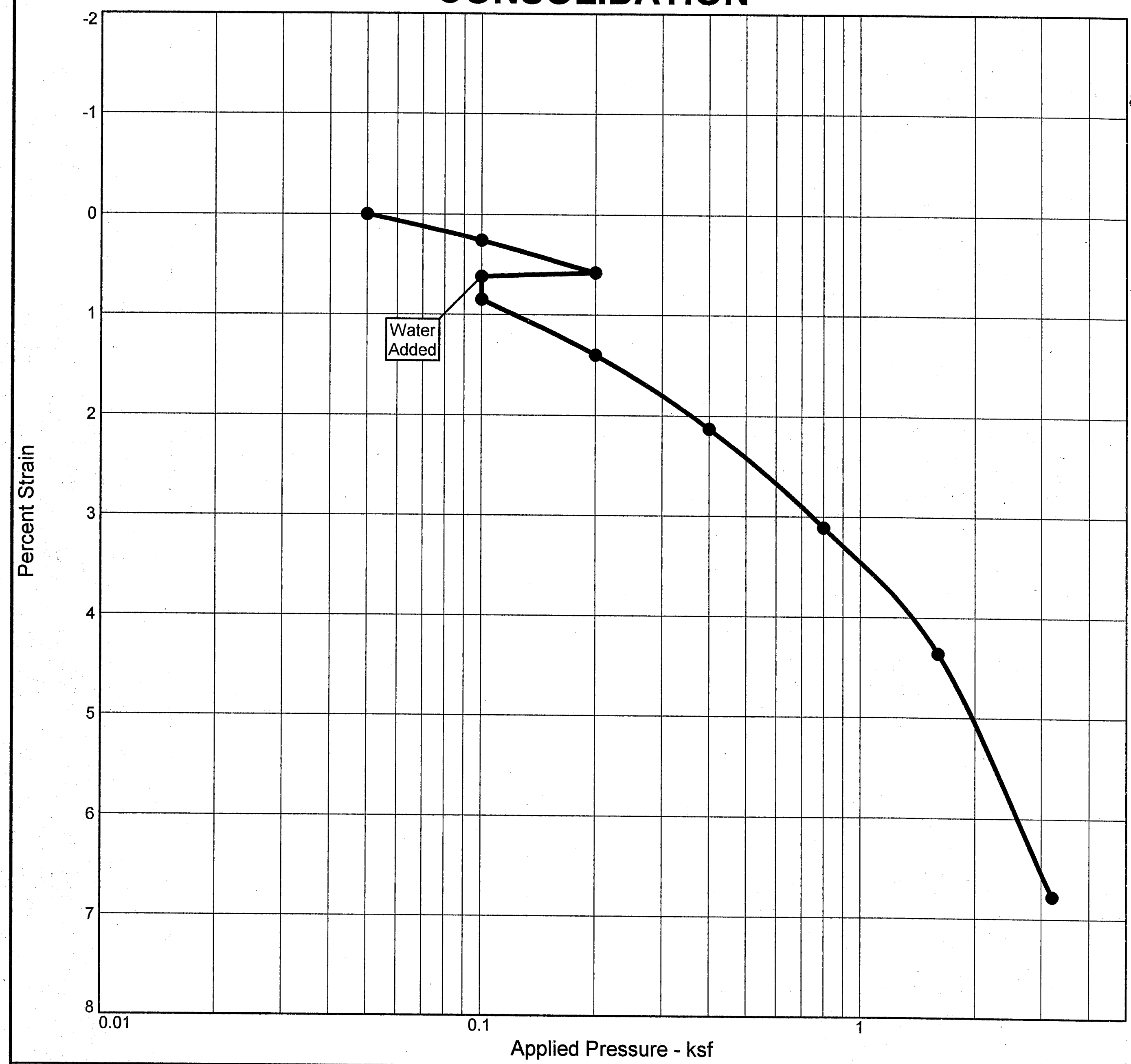
GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

Client: NEVADA ENVIRONMENTAL RESPONSE TRUST
Project: LAS VEGAS WASH WEIR

Project No.: 20153663E402 **Figure** 13

Tested By: ● C. Byer ■ C. BYER

CONSOLIDATION



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
65.3 %	15.0 %	98.3	27	7	2.65	SC-SM	A-4(0)	0.609

MATERIAL DESCRIPTION

Silty, clayey sand

Project No. 20153663E402 **Client:** NEVADA ENVIRONMENTAL RESPONSE TRUST

Project: LAS VEGAS WASH WEIR

Location: BORING B-3 @ 5.0'-6.5' **Depth:** 5.0'-6.5' **Sample Number:** B-3

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

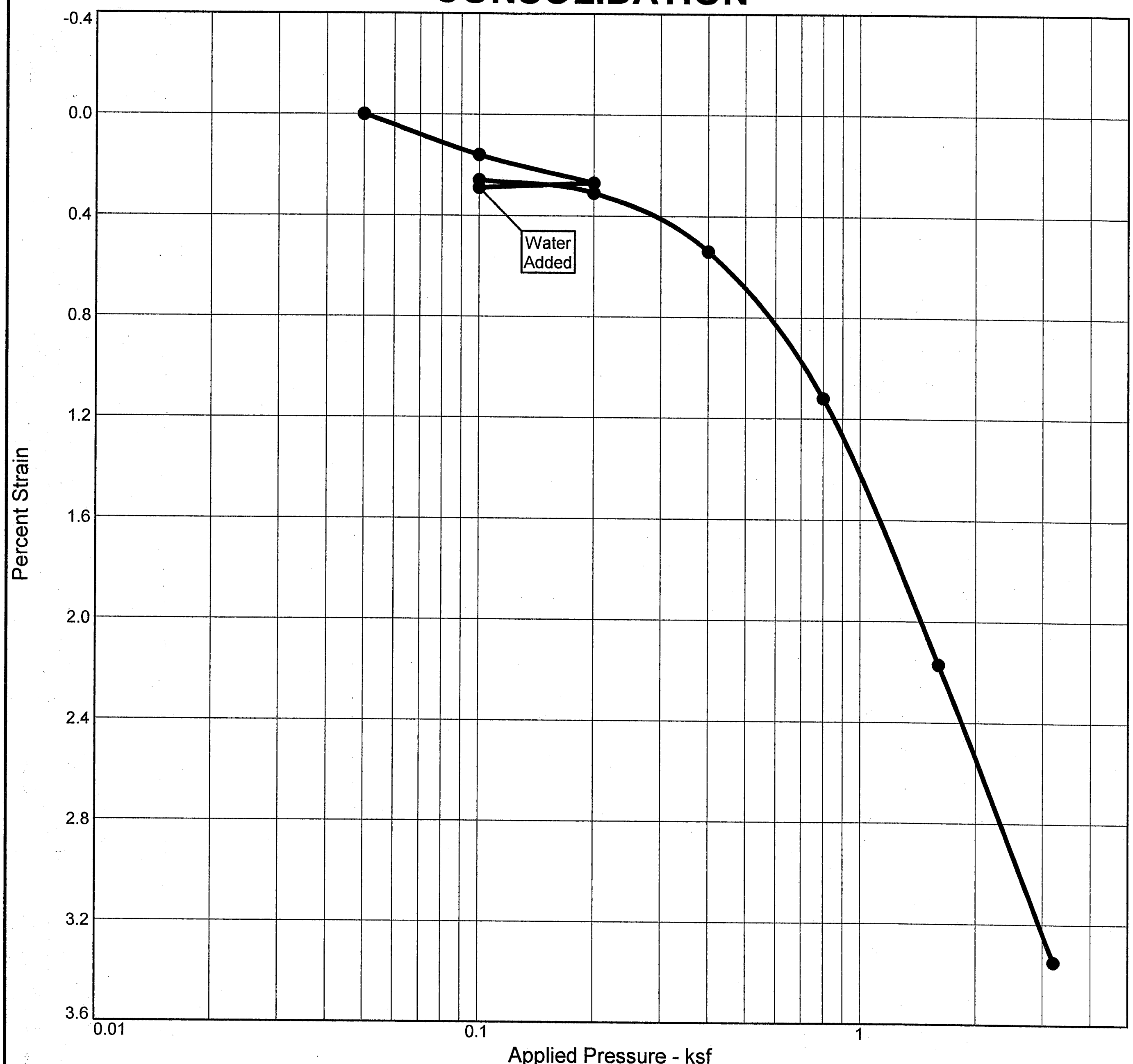
GES

Remarks:

Figure 14

Tested By: A. SANDERS

CONSOLIDATION



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
88.1 %	24.6 %	96.4	NV	NP	2.65	SM	A-4(0)	0.739

MATERIAL DESCRIPTION

Silty sand

Project No. 20153663E402 **Client:** NEVADA ENVIRONMENTAL RESPONSE TRUST

Project: LAS VEGAS WASH WEIR

Loc.: BORING B-3 @ 15.0'-16.5' **Depth:** 15.0'-16.5' **Sample No.:** B-3

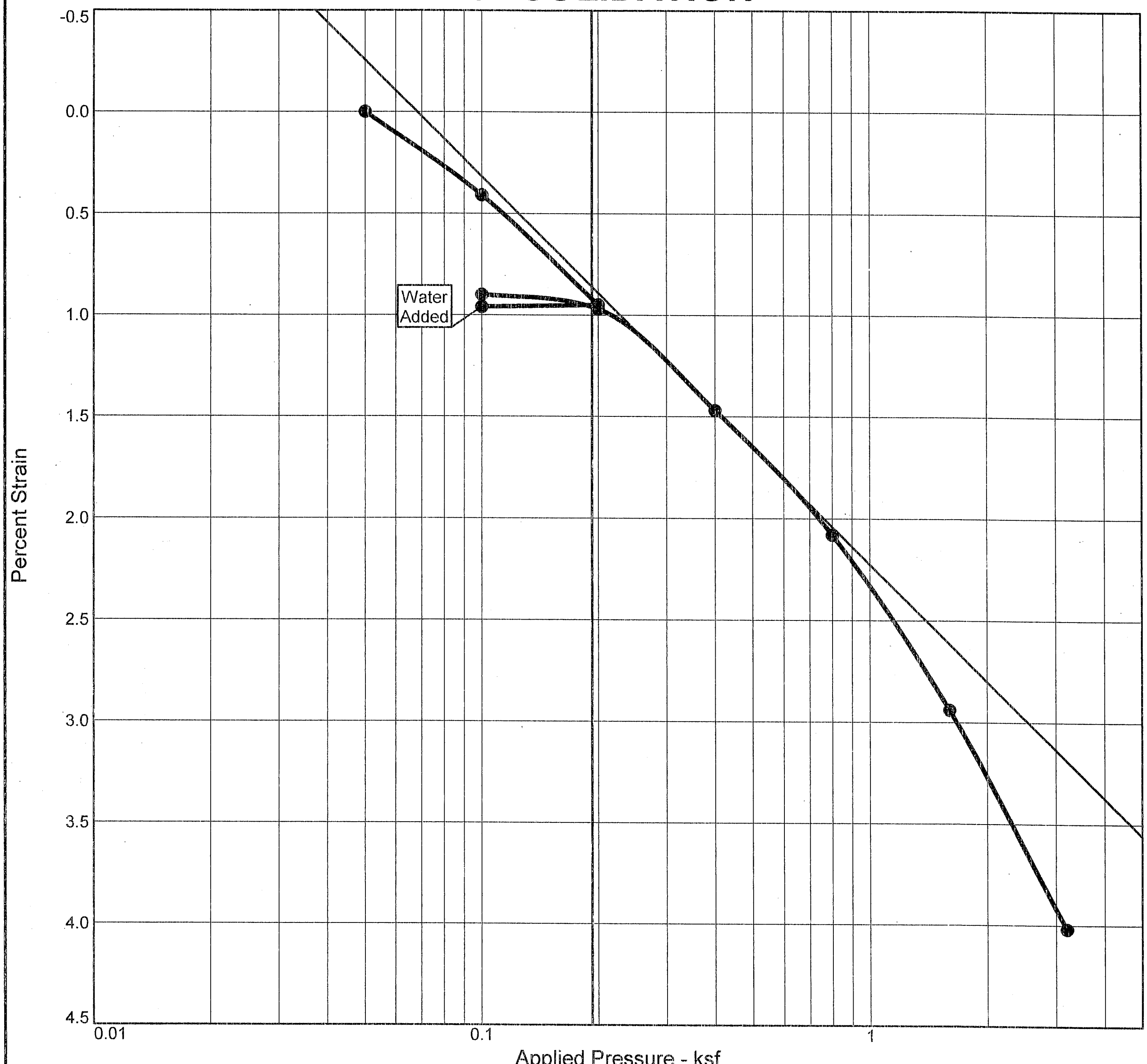
GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

Remarks:

Figure 15

Tested By: A. SANDERS

CONSOLIDATION



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
90.0 %	35.3 %	80.8	43	22	2.65	CL	A-7-6(16)	1.039

MATERIAL DESCRIPTION

Lean clay with sand

Project No. 20153663E402 **Client:** NEVADA ENVIRONMENTAL RESPONSE TRUST

Project: LAS VEGAS WASH WEIR

Loc.: BORING B-4 @ 20.0'-21.5' **Depth:** 20.0'-21.5' **Sample No.:** B-4

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

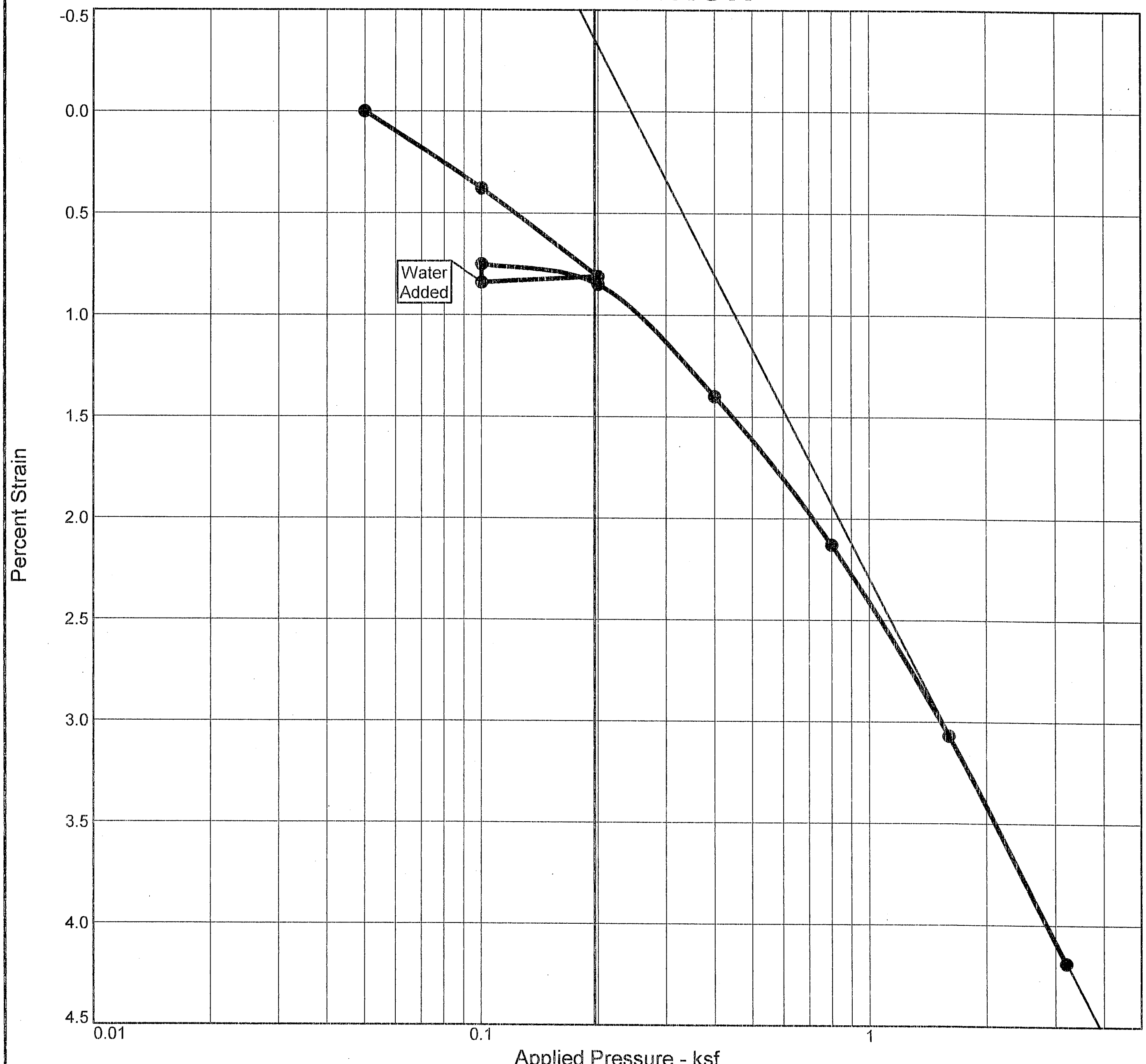
GES

Remarks:

Figure 16

Tested By: A. SANDERS

CONSOLIDATION



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
88.0 %	19.4 %	101.5	33	14	2.65			0.585

MATERIAL DESCRIPTION

Project No. 20153663E402 **Client:** NEVADA ENVIRONMENTAL RESPONSE TRUST

Project: LAS VEGAS WASH WEIR

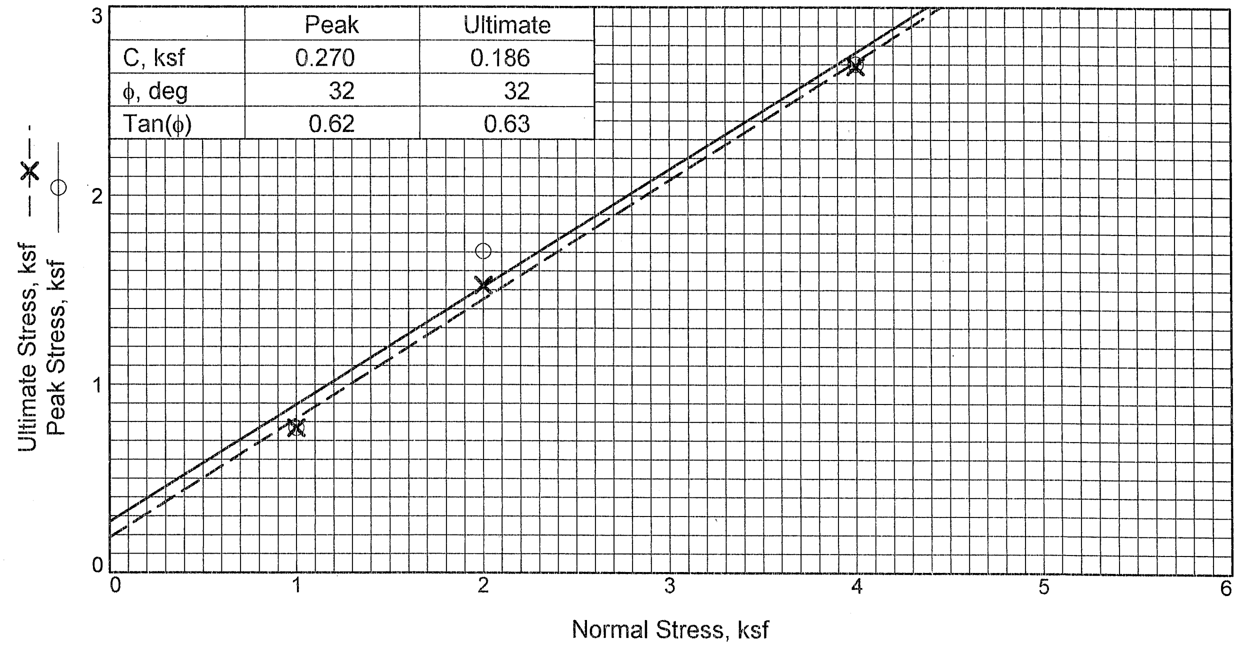
Loc.: BORING B-8 @ 10.0'-11.5' **Depth:** 10.0'-11.5' **Sample No.:** B-8

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

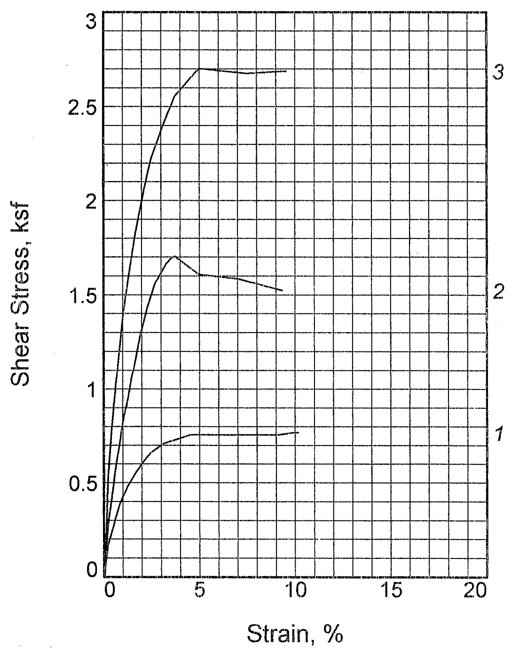
Remarks:

Figure 17

Tested By: A. SANDERS



	Peak	Ultimate
C, ksf	0.270	0.186
ϕ, deg	32	32
Tan(ϕ)	0.62	0.63



Sample No.		1	2	3
Initial	Water Content, %	15.0	15.0	15.0
	Dry Density, pcf	95.2	96.9	90.2
	Saturation, %	54.0	56.3	47.8
	Void Ratio	0.7373	0.7075	0.8333
	Diameter, in.	2.416	2.416	2.416
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	15.0	15.0	15.0
	Dry Density, pcf	95.2	96.9	90.2
	Saturation, %	54.0	56.3	47.8
	Void Ratio	0.7373	0.7075	0.8333
	Diameter, in.	2.416	2.416	2.416
	Height, in.	1.000	1.000	1.000
Normal Stress, ksf		1.000	2.000	4.000
Peak Stress, ksf		0.768	1.704	2.700
Strain, %		9.9	3.7	5.2
Ultimate Stress, ksf		0.768	1.524	2.688
Strain, %		10.1	9.3	9.5
Strain rate, in./min.		0.002	0.002	0.002

Sample Type: IN-SITU
Description: Silty, clayey sand

LL= 27 **PL=** 20 **PI=** 7
Assumed Specific Gravity= 2.65
Remarks:

Figure 18

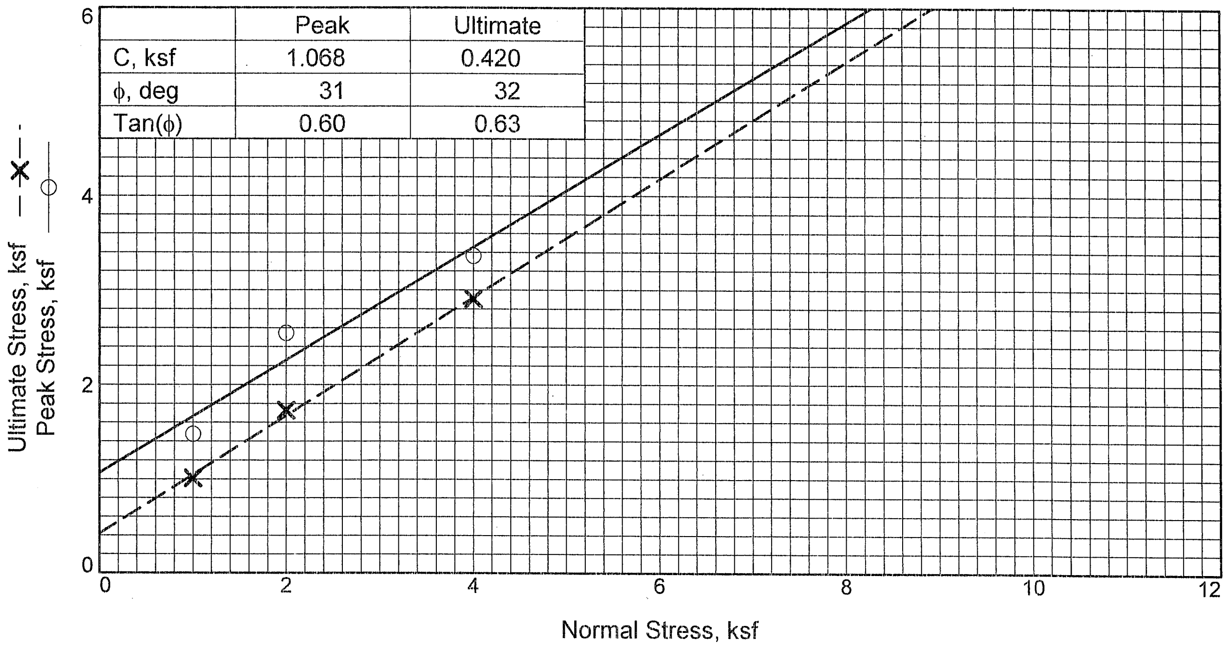
Client: NEVADA ENVIRONMENTAL RESPONSE TRUST

Project: LAS VEGAS WASH WEIR

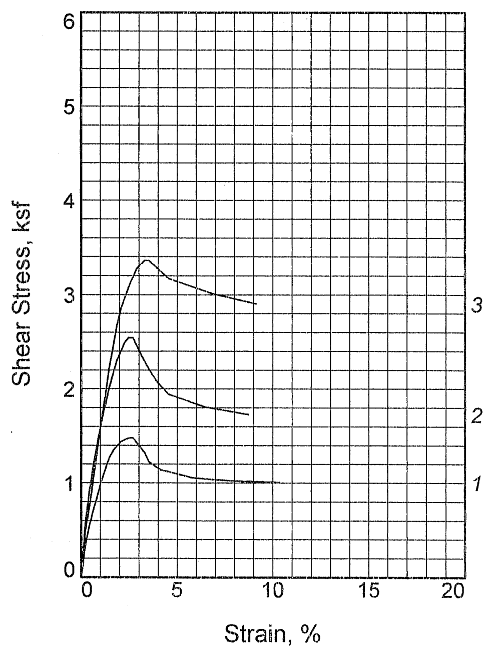
Location: BORING B-3 @ 5.0'-6.5'
Sample Number: B-3 **Depth:** 5.0'-6.5'
Proj. No.: 20153663E402 **Date Sampled:** 01/20/17

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

Tested By: A. SANDERS



	Peak	Ultimate
C, ksf	1.068	0.420
ϕ, deg	31	32
Tan(ϕ)	0.60	0.63



Sample No.		1	2	3
Initial	Water Content, %	19.4	19.4	19.4
	Dry Density, pcf	101.1	100.6	105.2
	Saturation, %	80.9	79.7	89.9
	Void Ratio	0.6361	0.6452	0.5723
	Diameter, in.	2.416	2.416	2.416
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	19.4	19.4	19.4
	Dry Density, pcf	101.1	100.6	105.2
	Saturation, %	80.9	79.7	89.9
	Void Ratio	0.6361	0.6452	0.5723
	Diameter, in.	2.416	2.416	2.416
	Height, in.	1.000	1.000	1.000
Normal Stress, ksf		1.000	2.000	4.000
Peak Stress, ksf		1.476	2.544	3.360
Strain, %		2.7	2.7	3.5
Ultimate Stress, ksf		1.008	1.728	2.904
Strain, %		10.3	8.7	9.1
Strain rate, in./min.		0.002	0.020	0.020

Sample Type:
Description:

Assumed Specific Gravity= 2.65
Remarks:

Figure 19

Client: NEVADA ENVIRONMENTAL RESPONSE TRUST

Project: LAS VEGAS WASH WEIR

Location: BORING B-8 @ 10.0'-11.5'
Sample Number: B-8 **Depth:** 10.0'-11.5'
Proj. No.: 20153663E402 **Date Sampled:**

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

Tested By: A. SANDERS

PROCTOR TEST REPORT

Project No.: 20153663E402 **Date:** 1/26/17
Project: LAS VEGAS WASH WEIR
Client: NEVADA ENVIRONMENTAL RESPONSE TRUST
Location: BORING B-4 @ 0.0'-5.0'
Sample Number: B-4 **Depth:** 0.0'-5.0'
Remarks: Sampled by NERT. Tested in accordance with ASTM D1557.

MATERIAL DESCRIPTION

Description: Poorly graded sand with silt and gravel

Classifications - **USCS:** SP-SM **AASHTO:** A-1-b
Nat. Moist. = **Sp.G. =**
Liquid Limit = NV **Plasticity Index =** NP
% < No.200 = 11 %

ROCK CORRECTED TEST RESULTS
Maximum dry density = 128.8 pcf
Optimum moisture = 8.6 %

Test specification:
ASTM D 1557-12 Method C Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

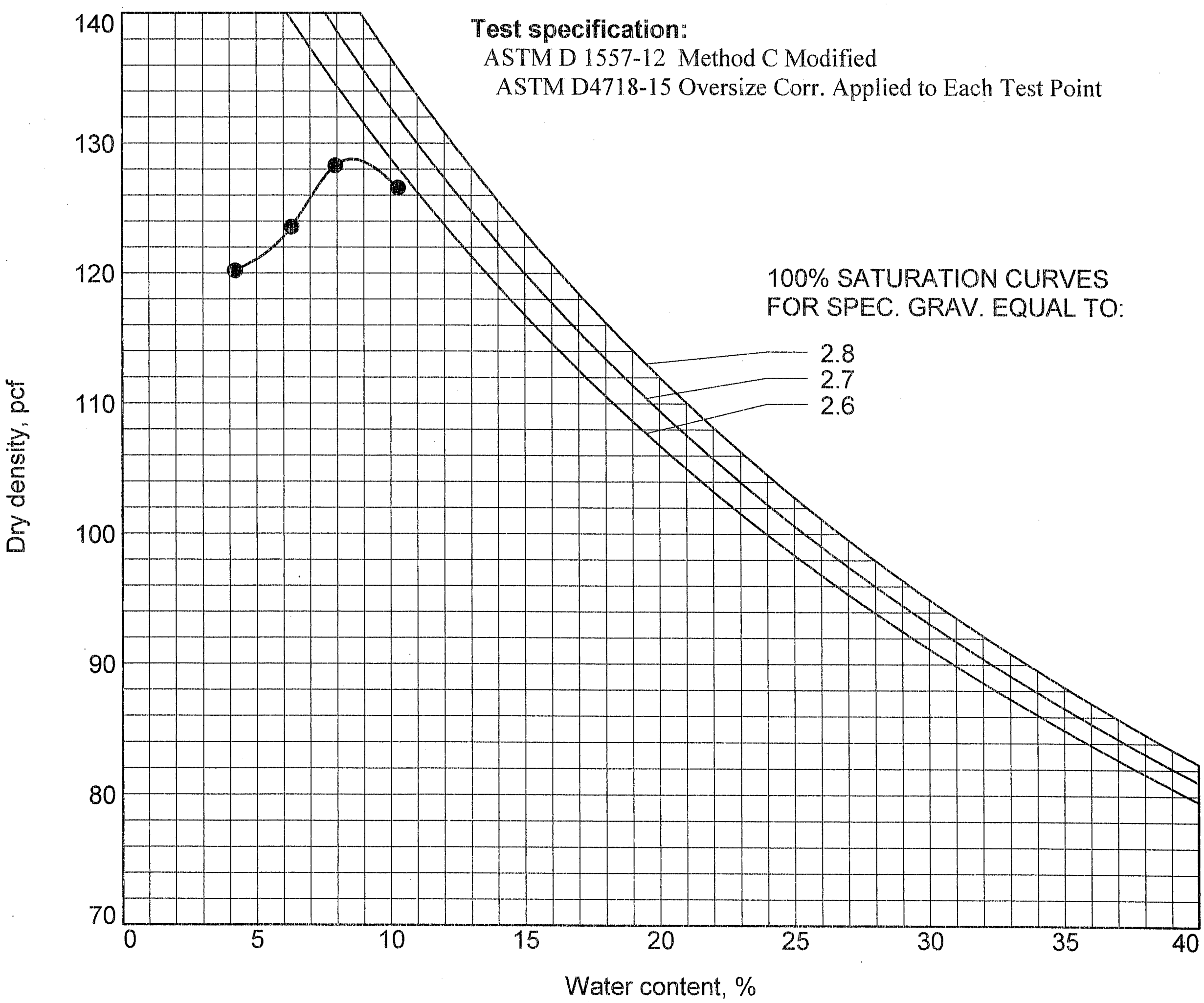


Figure 20

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Tested By: A. Sanders

PROCTOR TEST REPORT

Project No.: 20153663E402 **Date:** 1/31/17
Project: LAS VEGAS WASH WEIR
Client: NEVADA ENVIRONMENTAL RESPONSE TRUST
Location: BORING B-7 @ 0.0'-5.0'
Sample Number: B-7 **Depth:** 0.0'-5.0'
Remarks:

MATERIAL DESCRIPTION

Description: Poorly graded gravel with silt and sand

Classifications - **USCS:** GP-GM **AASHTO:** A-1-b
Nat. Moist. = **Sp.G. =** 2.65
Liquid Limit = NV **Plasticity Index =** NP
% < No.200 = 12 %

ROCK CORRECTED TEST RESULTS
Maximum dry density = 133.4 pcf
Optimum moisture = 7.5 %

Test specification:
ASTM D 1557-12 Method C Modified
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

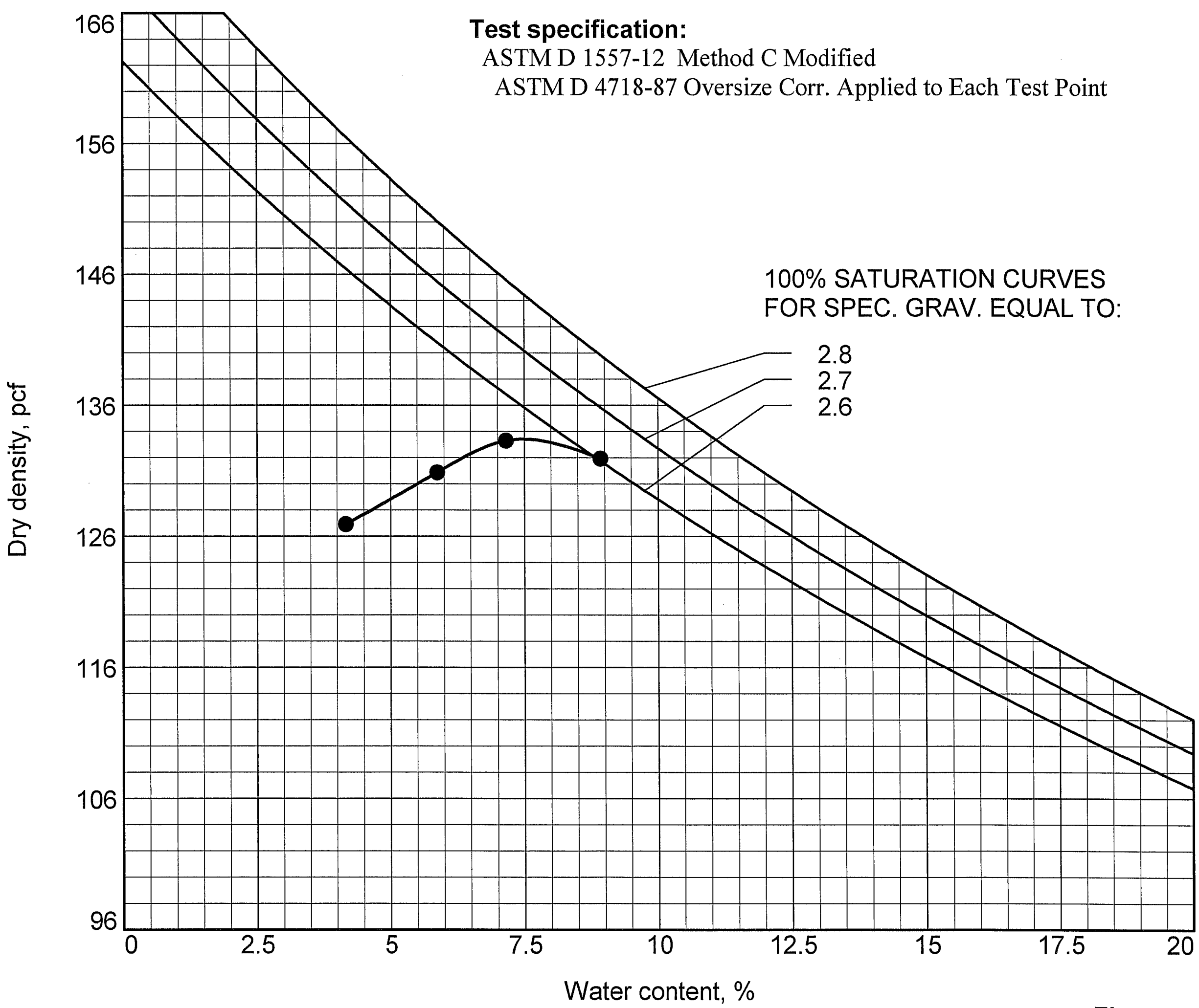


Figure 21

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Tested By: T. READ

PROCTOR TEST REPORT

Project No.: 20153663E402 **Date:** 1/26/17
Project: LAS VEGAS WASH WEIR
Client: NEVADA ENVIRONMENTAL RESPONSE TRUST
Location: BORING B-8 @ 0.0'-4.5'
Sample Number: B-8 **Depth:** 0.0'-4.0'
Remarks: Sampled by NERT. Tested in accordance with ASTM D1557 method A.

MATERIAL DESCRIPTION

Description: Silty sand

Classifications - **USCS:** SM **AASHTO:** A-4(0)
Nat. Moist. = **Sp.G. =**
Liquid Limit = NV **Plasticity Index =** NP
% < No.200 = 37 %

ROCK CORRECTED TEST RESULTS
Maximum dry density = 129.3 pcf
Optimum moisture = 9.4 %

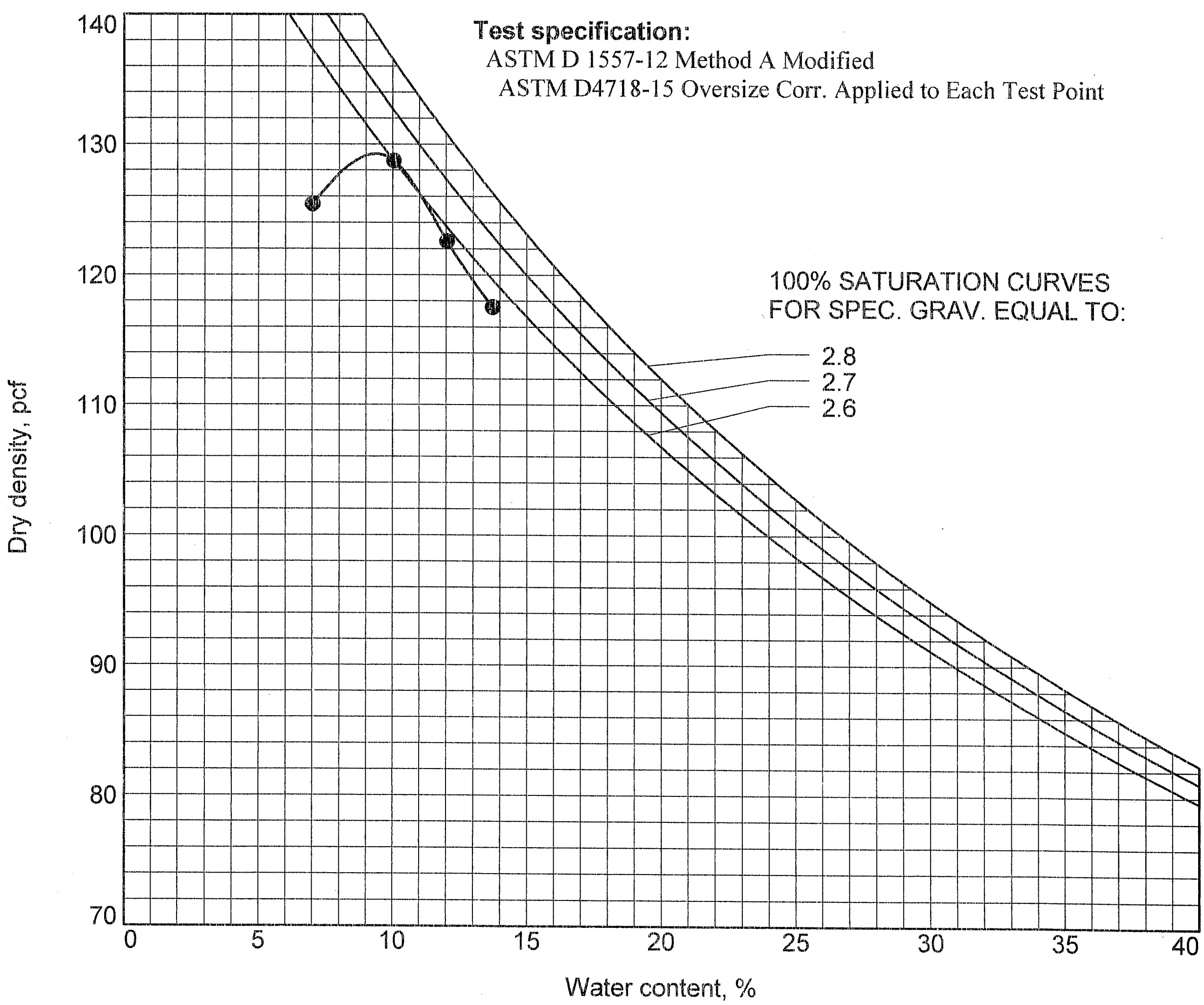
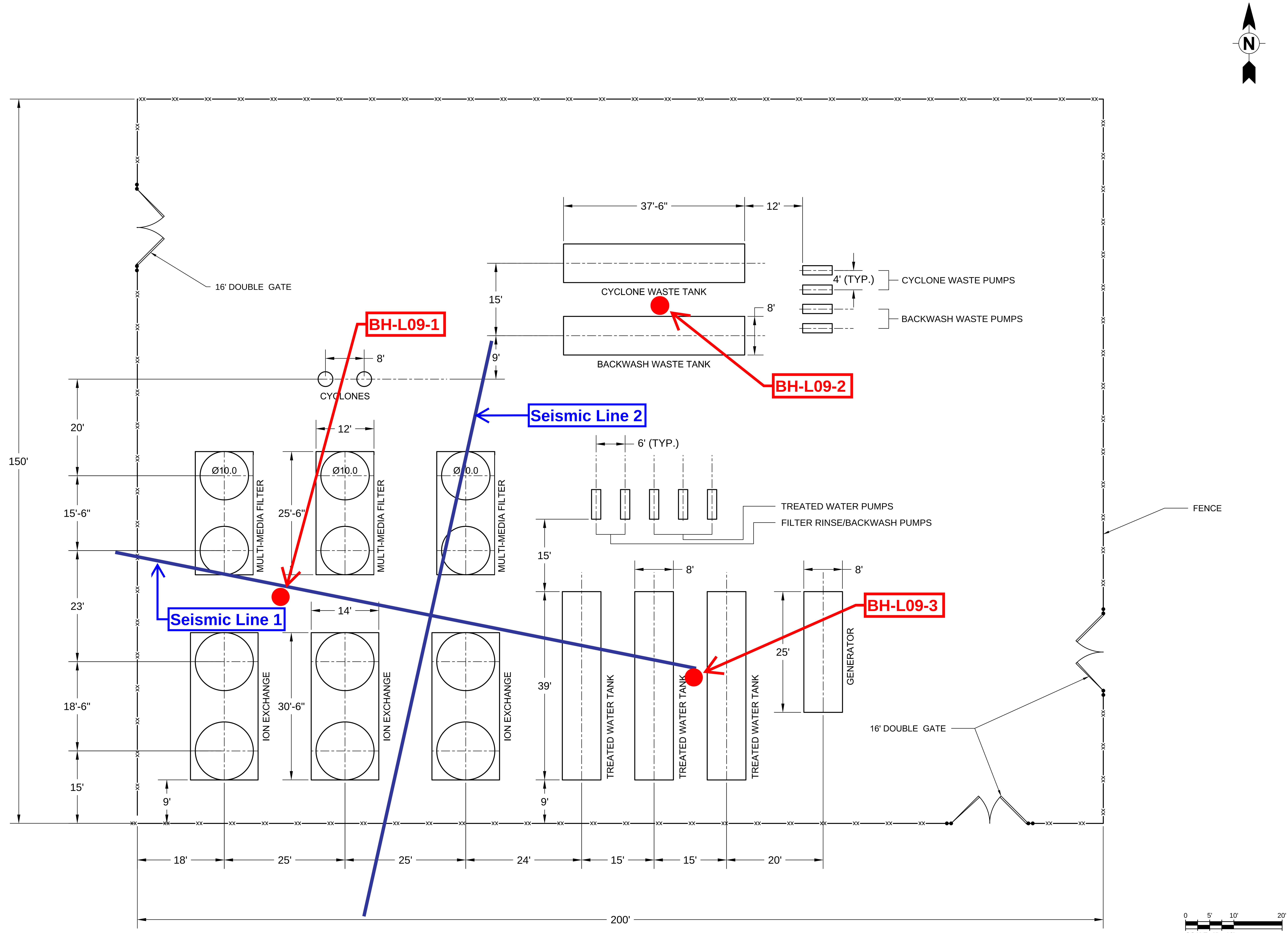


Figure 22

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Tested By: A. Sanders



DRAFT - FOR INTERNAL REVIEW ONLY

TETRA TECH
www.tetratech.com
1489 West Warm Springs Road, Suite 110
Henderson, NV 89014
Phone: 702.946.6700 Fax: 702.997.7140

MARK	DATE	DESCRIPTION	BY
1	10/14/16	ISSUED FOR 30% SUBMITTAL	CG

NEVADA ENVIRONMENTAL RESPONSE TRUST
HENDERSON, NEVADA

WEIR DEWATERING TREATMENT

CENTRAL WATER TREATMENT PLANT GENERAL ARRANGEMENT

Project No.:	200-01299-16015
Designed By:	JG
Drawn By:	CG
Checked By:	JG

C-401

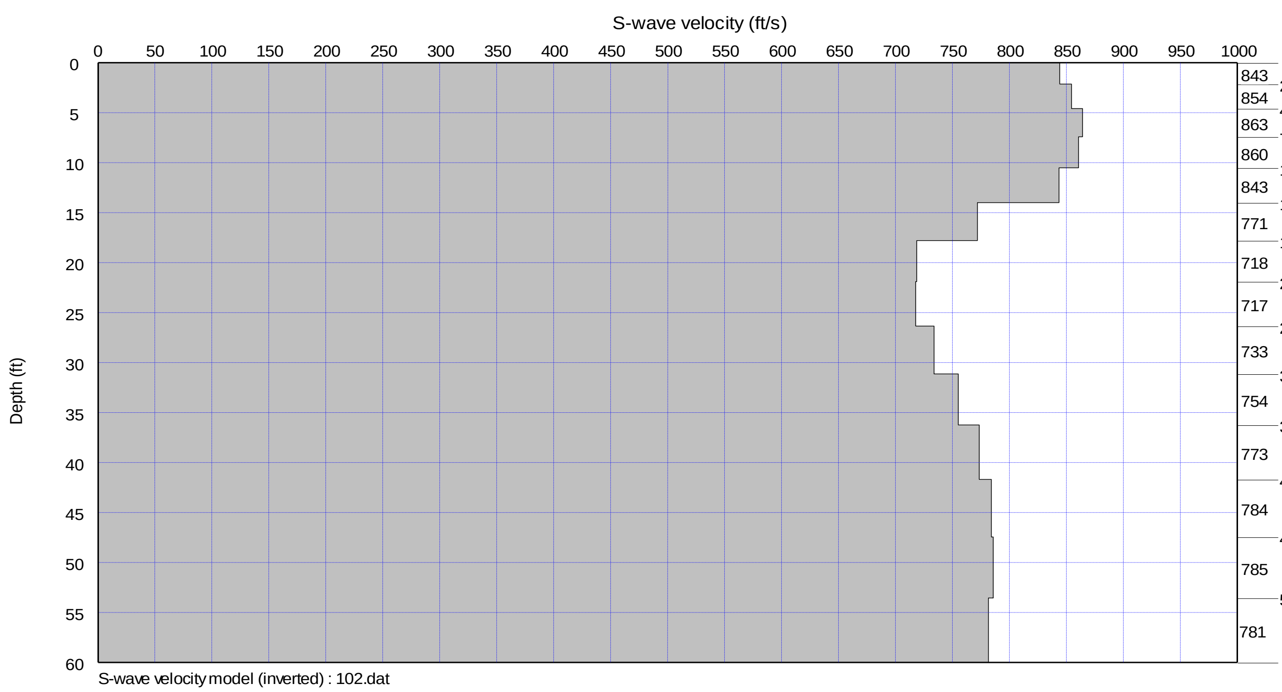
10/19/2016 11:02:47 AM - P:\IER\01299\200-01299-16015\CAD\SHEETFILES\C-401 - PLANT LAYOUT.DWG - GULMIRE, CALEB

MASW S and P Wave Seismic Testing
NERT L-09, Proposed Water Treatment Plant Site
Seismic Line 1

Summary Table of S and P Wave Data at Depth with Dynamic Modulus

Depth (ft)	S-Wave Velocity (ft/sec)	P-Wave Velocity (ft/sec)	Density (pcf)	Poisson's Ratio $\sigma p=[(Vp/Vs)^2-2]/[2(Vp/Vs)^2-2]$	Shear Modulus $G = dVs^2$ (psi)	Young's Modulus $E = 2G(1+\sigma p)$	Bulk Modulus $K = 1/3(E/(1-2\sigma_p))$
0.00	844	5180	113	0.49	17365	51622	631134
2.14	855	5189	113	0.49	17802	52910	632797
4.62	864	5197	113	0.49	18195	54068	634203
7.42	860	5192	113	0.49	18046	53629	633246
10.55	843	5175	113	0.49	17345	51561	629836
14.01	772	5097	113	0.49	14475	43086	612267
17.80	719	5038	112	0.49	12525	37314	598742
21.92	717	5032	112	0.49	12480	37182	597168
26.37	734	5042	112	0.49	13048	38861	598882
31.15	755	5057	112	0.49	13819	41142	601627
36.26	773	5071	112	0.49	14503	43163	604200
41.70	784	5080	112	0.49	14905	44351	605837
47.47	786	5082	112	0.49	14966	44531	606225
53.57	781	5079	112	0.49	14801	44043	605773
72.86	888	5201	113	0.48	19246	57159	633726

One-Dimensional MASW Analysis

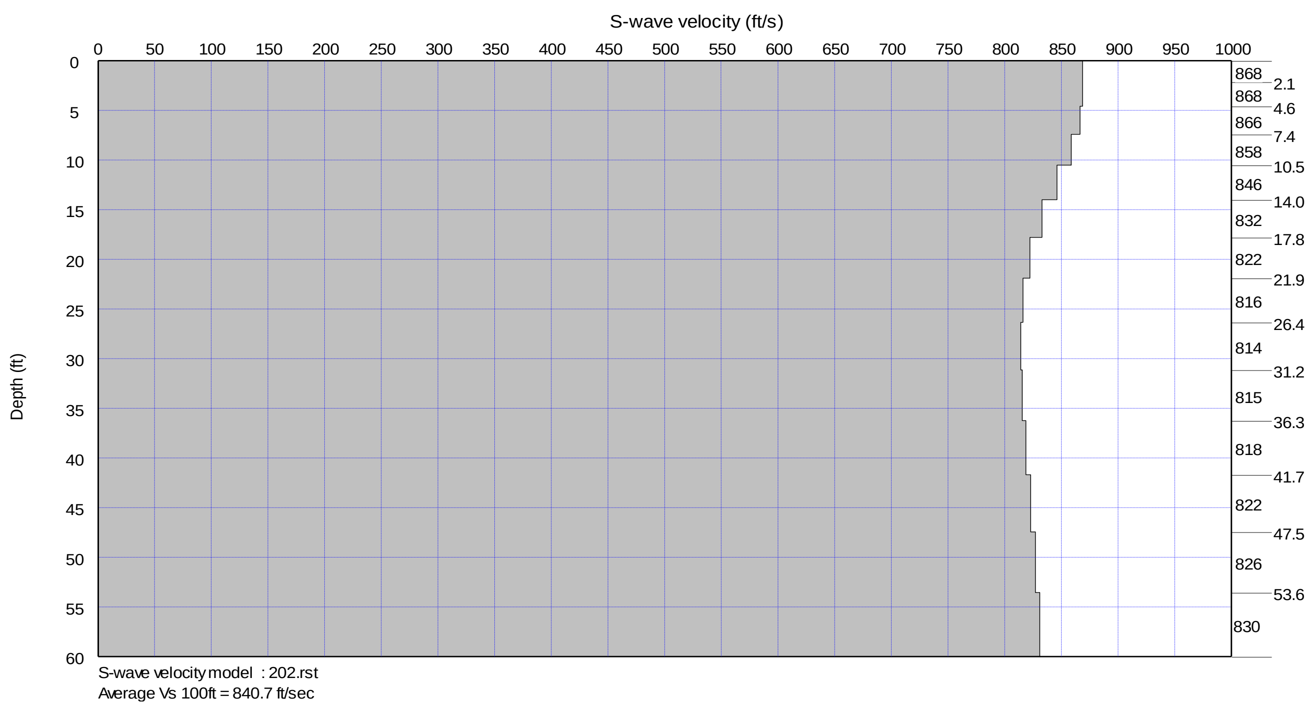


MASW S and P Wave Seismic Testing
NERT L-09, Proposed Water Treatment Plant Site
Seismic Line 2

Summary Table of S and P Wave Data at Depth with Dynamic Modulus

Depth (ft)	S-Wave Velocity (ft/sec)	P-Wave Velocity (ft/sec)	Density (pcf)	Poisson's Ratio $\sigma p=[(Vp/Vs)^2-2]/[2(Vp/Vs)^2-2]$	Shear Modulus $G = dVs^2$ (psi)	Young's Modulus $E = 2G(1+\sigma p)$	Bulk Modulus $K = 1/3(E/(1-2\sigma_p))$
0.00	869	5196	113	0.49	18421	54734	634851
2.14	869	5196	113	0.49	18424	54742	634868
4.62	866	5194	113	0.49	18327	54455	634280
7.42	858	5185	113	0.49	17988	53456	632218
10.55	846	5171	113	0.49	17457	51891	628953
14.01	833	5157	113	0.49	16903	50256	625491
17.80	822	5145	113	0.49	16464	48959	622707
21.92	816	5138	113	0.49	16211	48214	621090
26.37	814	5136	113	0.49	16129	47972	620563
31.15	815	5137	113	0.49	16179	48120	620884
36.26	818	5141	113	0.49	16311	48510	621732
41.70	823	5145	113	0.49	16480	49008	622812
47.47	827	5150	113	0.49	16656	49529	623933
53.57	831	5154	113	0.49	16815	49995	624934
72.86	869	5196	113	0.49	18424	54742	634868

One-Dimensional MASW Analysis



SilverState Analytical Laboratories

Silver State Labs-Las Vegas
3626 E. Sunset Road, Suite 100
Las Vegas, NV 89120
(702) 873-4478 FAX: (702) 873-7967
www.ssalabs.com

Analytical Report

WO#: 17010671
Date Reported: 1/30/2017

CLIENT: GES
Project: 20133663E402
Lab ID: 17010671-01
Client Sample ID 17-026, B-3 @ 5.0'-6.5'

Collection Date:

Matrix: SOIL

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
SOIL-CORROSION SUITE PLUS SOLUBILITY SULFIDE - SOILS				**SM 4500S2 F**		Analyst: **NM**
Sulfide	ND	1.00		mg/L	1	1/27/2017 2:55:39 PM
SOIL-CORROSION SUITE PLUS SOLUBILITY CHLORIDE - SOILS				**SM 4500 CL-B**		Analyst: **NM**
Chloride	2900	130	D	mg/Kg	125	1/26/2017 11:22:00 AM
SOIL-CORROSION SUITE PLUS SOLUBILITY SODIUM SULFATES - CALCULATION 0NLY.				**CALCULATION**		Analyst: **NM**
Sodium Sulfate as Na2SO4	0.0670	0		%	1	1/26/2017 11:49:00 AM
SOIL-CORROSION SUITE PLUS SOLUBILITY PH - SOILS				**SM 4500H+ B**		Analyst: **NM**
pH	7.84	0		pH Units	1	1/27/2017 2:54:25 PM
SOIL-CORROSION SUITE PLUS SOLUBILITY REDUCTION - OXIDATION POTENTIAL - SOILS				**SM 2580 B**		Analyst: **NM**
Oxidation-Reduction Potential	237	1.00		mV	1	1/26/2017 8:24:00 AM
SOIL-CORROSION SUITE PLUS SOLUBILITY WATER SOLUBLE SULFATE (SO4)				**SM 4500 SO4 E**		Analyst: **NM**
Sulfate	0.0500	0.0100		%	1	1/26/2017 3:07:36 PM
SOIL-CORROSION SUITE PLUS SOLUBILITY WATER SOLUBLE SODIUM (NA)				**ASTM D2791**		Analyst: **NM**
Sodium	0.150	0.0100		%	1	1/26/2017 11:23:00 AM
SOIL-CORROSION SUITE PLUS SOLUBILITY TOTAL SALTS (SOLUBILITY)				**SM 2540 C**		Analyst: **NM**
Solubility	0.720	0.0100		%	1	1/26/2017 11:21:00 AM

Qualifiers: (Qual)

*	Value exceeds Maximum Contaminant Level.	C	Value is below Minimum Compound Limit.
DF	Dilution Factor.	H	Holding times for preparation or analysis exceeded.
MCL	Maximum Contaminant Level.	ND	Not Detected at the PQL.
PQL	Practical Quantitation Limit.	U	Sample was analyzed for, but not detected.

Original

Silver State Analytical Laboratories

Silver State Labs-Las Vegas
3626 E. Sunset Road, Suite 100
Las Vegas, NV 89120
(702) 873-4478 FAX: (702) 873-7967
www.ssalabs.com

Analytical Report

WO#: 17010771
Date Reported: 1/30/2017

CLIENT:	GES	**Collection Date:**	
Project:	20153663E402		
Lab ID:	17010771-01	**Matrix:**	
Client Sample ID	17-026, B-4@0.0'-5.0'		

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
SOIL-CORROSION SUITE (CLARK COUNTY BD) SULFIDE - SOILS				**SM 4500S2 F**		Analyst: **NM**
Sulfide	ND	1.00		mg/L	1	1/27/2017 2:55:39 PM
SOIL-CORROSION SUITE (CLARK COUNTY BD) CHLORIDE - SOILS				**SM 4500 CL-B**		Analyst: **NM**
Chloride	1100	25	D	mg/Kg	25	1/27/2017 9:59:00 AM
SOIL-CORROSION SUITE (CLARK COUNTY BD) SODIUM SULFATES - CALCULATION 0NLY.				**CALCULATION**		Analyst: **NM**
Sodium Sulfate as Na2SO4	0.0850	0		%	1	1/27/2017 10:01:00 AM
SOIL-CORROSION SUITE (CLARK COUNTY BD) PH - SOILS				**SM 4500H+ B**		Analyst: **NM**
pH	7.67	0		pH Units	1	1/27/2017 2:54:25 PM
SOIL-CORROSION SUITE (CLARK COUNTY BD) REDUCTION - OXIDATION POTENTIAL - SOILS				**SM 2580 B**		Analyst: **NM**
Oxidation-Reduction Potential	238	1.00		mV	1	1/27/2017 10:02:00 AM
SOIL-CORROSION SUITE (CLARK COUNTY BD) WATER SOLUBLE SULFATE (SO4)				**SM 4500 SO4 E**		Analyst: **NM**
Sulfate	0.0600	0.0100		%	1	1/27/2017 9:58:29 AM
SOIL-CORROSION SUITE (CLARK COUNTY BD) WATER SOLUBLE SODIUM (NA)				**ASTM D2791**		Analyst: **NM**
Sodium	0.0400	0.0100		%	1	1/27/2017 10:01:00 AM

Qualifiers: (Qual)

*	Value exceeds Maximum Contaminant Level.	C	Value is below Minimum Compound Limit.
DF	Dilution Factor.	H	Holding times for preparation or analysis exceeded.
MCL	Maximum Contaminant Level.	ND	Not Detected at the PQL.
PQL	Practical Quantitation Limit.	U	Sample was analyzed for, but not detected.

Original