GEOTECHNICAL INVESTIGATION
CLEARWELL CONDITION ASSESSMENT AND REPLACEMENT OF SELECTED VALVES AND ACTUATORS AT EWPP
WBS NO. S-000056-0070-4
HOUSTON, TEXAS

REPORT NO. 1140209501

Reported to:

CAROLLO ENGINEERS, INC.

Houston, Texas

Reported by:

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Houston, Texas

Key Map No. 496 U & Y

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Report No. 1140209501
March 18, 2016

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Reference: **Geotechnical Investigation**
Clearwell Condition Assessment and
Replacement of Selected Valves and Actuators at EWPP
WBS No. S-000056-0070-4
Houston, Texas

Dear Ms. Berkey:

Presented herein is the final geotechnical investigation report for the referenced project. A preliminary report was submitted to you on December 14, 2015. A draft report was submitted to you on February 19, 2016. This final report supersedes all previously submitted reports, transmittals etc, for the referenced project. This study was performed in accordance with Agreement between Engineer and Subconsultant dated February 27, 2015 and Task Order No. 1 on February 27, 2015 and Task Order No. 2 on November 4, 2015.

We appreciate this opportunity to be of service to you. If you have any questions regarding this report or if you need any additional service, please call us.

Sincerely,
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EXECUTIVE SUMMARY

Geotest Engineering, Inc. (Geotest) has completed a geotechnical investigation for the proposed improvements at Clearwell Condition Assessment and Replacement of Selected Valves and Actuators in the East Water Purification Plant (EWPP) in Houston, Texas.

The project consists of design of the overflow structure and sodium bisulphate pad/building at the East Water Purification Plant (EWPP). The project also includes construction of box culvert, a large junction box, headwall and a detention pond. The proposed improvements are detailed in Section 1.3 of this report.

This geotechnical investigation included drilling and sampling ten (10) soil borings (B-1 through B-10) to depths ranging from 10 to 50 feet below the existing grade, installing one (1) piezometer, performing appropriate laboratory tests on samples recovered from the borings, performing engineering analyses and developing geotechnical recommendations for the design and construction of the proposed structures and preparation of a geotechnical report.

The principal findings developed from this investigation are summarized below:

1. As shown on boring logs B-1 through B-10, the subsurface soils encountered below the existing grade consists of predominantly cohesive soils to the termination depths of 10 to 50 feet. The cohesive soils consist of soft to hard yellowish brown, reddish brown, and gray and brown Fat Clay, Fat Clay with sand, Sandy Fat Clay, Lean Clay, Lean Clay with sand, Silty Clay with Sand and Sandy Lean Clay. Cohesionless soils consisting of loose to very dense brown and gray and reddish brown Silty Sand, Silt with sand and Silt were encountered in borings B-1, B-3, B-7, B-9 and B-10 between depths of 48.5 to 50 feet, 48 to 50 feet, 15 to 18.5 feet, 4 to 6 feet and 10 to 12.5 feet, respectively. Fill material consisting of medium stiff to hard, reddish brown and gray and brown and gray fat clay with sand and lean clay with sand and sandy lean clay with grass roots were encountered

to depths of 2 to 8 feet in all the borings with exception of boring B-5. The detailed subsurface conditions are presented in Section 4.0 "General Subsurface Conditions".

2. Groundwater was encountered during drilling in borings B-1, B-3, B-4, B-5, B-7 and B-8 at depths ranging from 10 to 20 feet and water levels measured 15 to 20 minutes after water first encountered ranged from 4.3 to 14.7 feet below the existing grade in these borings. The water level was measured at a depth of 10 feet in piezometer B-1P on April 28, 2015.

3. All excavation operations should be in accordance with OSHA Standards. Based on soil conditions revealed by soil borings, OSHA soil type "C" should be used for the determination of allowable maximum slope and/or the design of a shoring system.

4. The geotechnical recommendations for the proposed overflow structure, sodium bi-sulfate building, box culvert with large junction box, headwall and a detention pond are presented in Section 5.0 of this report.

5. The foundation excavation and groundwater control are provided under Construction Considerations in Section 6.0 of this report.

1.0 INTRODUCTION

1.1 General

Geotest Engineering, Inc. (Geotest) has completed a geotechnical investigation for the proposed improvements at Clearwell Condition Assessment and Replacement of Selected Valves and Actuators in the East Water Purification Plant (EWPP) in Houston, Texas

1.2 Authorization

This study was performed in accordance with Agreement between Engineer and Subconsultant dated February 27, 2015 and Task Order No. 1 on February 27, 2015 and Task Order No. 2 on November 4, 2015.

1.3 Location and Description of Project

The project is located at 2300 Federal Road in Houston, Texas, within the Key Map Page and Grids 496 U and Y.

The project consists of design of the overflow structure and sodium bisulphate pad/building at the East Water Purification Plant (EWPP). The proposed improvements are presented below.

- The overflow structure will have a footprint of approximately 17 ft. x 30 ft. The structure will be partially below grade and placed approximately 7 ft. below grade (EL 7.5 feet). Weight of overflow structure: Dry weight: ~350,000 lbs. Wet weight: ~480,000 lbs.
- The proposed Sodium Bisulfite Building, footprint will be approximately 20 ft. x 10 ft.
- The proposed box culvert adjacent to the proposed overflow structure will be 3 ft. H x 10 ft. W, and placed at a depth of 7 feet deep, with one junction box to transition to the 4 ft. H x 9 ft. W box culvert.

- Large junction box will be approximately 15 ft. W x 15 ft. L x 8 ft. H and the north south box culvert will be 4 ft. H x 9 ft. W.
- Headwall will be provided where box culvert daylights at the detention basin.
- Detention pond is 435 ft. long by 217 ft. wide at top and about 5 ft. deep.

A vicinity map is shown on Figure 1.

1.4 Purpose and Scope

The purposes of this investigation were to explore the subsurface conditions at the proposed site and to develop geotechnical recommendations for the design and construction of the proposed overflow structure, sodium bisulfate structure, large junction box with box culvert and the proposed detention pond. The scope of work is based on City of Houston Design Manual Geotechnical Requirements (July 2015) and consisted of the following tasks:

1. Drilled and sampled a total of ten (10) soil borings to depths ranging from 10 to 50 feet to explore soil stratigraphy and groundwater conditions.

   The borings B-1 and B-7 were drilled near the proposed overflow structure; boring B-8 was drilled near the sodium bisulfate building, large junction box and box culvert and borings B-9 and B-10 were drilled near the proposed detention pond and headwall.

2. Converted one (1) boring into piezometer to monitor long term ground water level.

3. Performed laboratory tests to determine the physical and engineering properties of subsurface soils at the site.

4. Performed engineering analyses to develop geotechnical recommendations for the proposed facilities.

5. Incorporated all of the above into a geotechnical engineering report.

2.0 FIELD EXPLORATION

2.1 General

Subsurface conditions were explored by drilling and sampling ten (10) borings (B-1 through B-10) to depths ranging from 10 to 50 feet. The borings B-1 through B-6 were drilled with a buggy mounted rig and borings B-7 through B-10 were drilled with a truck mounted drilling rig. All the drilling and sampling were performed in accordance with appropriate ASTM procedures. The approximate locations of all these borings are shown on Figure 2, Plan of Borings.

It should be noted that the scope of the project was changed after the initial field work. Six (6) borings (B-1 through B-6) were completed in March 2015 and additional four (4) borings (B-7 through B-10) were drilled in November 2015 for the changed scope.

2.2 Geotechnical Borings

Subsurface conditions were explored by drilling a total of ten (10) soil borings designated as B-1 through B-10. The borings B-1 and B-7 were drilled to a depth of 50 feet near the proposed overflow structure and boring B-8 was drilled to a depth of 50 feet near the proposed sodium bisulfate building, large junction box, box culvert and borings B-9 and B-10 were drilled to a depth of 15 feet near the proposed headwall and detention pond. The borings were drilled with buggy mounted and truck mounted drilling rigs. The approximate location of soil borings is shown on Plan of Borings, Figure 2. The survey information (Northing and Easting coordinates and ground surface elevations) of the completed boreholes is provided to us by Carollo Engineers, Inc. The summary of boring information is provided in Table 1.

Samples were obtained continuously to a 20-foot depth and at 5-foot intervals thereafter. Samples of cohesive soils were obtained with a 3-inch diameter thin-walled tube sampler in general accordance with ASTM Method D 1587. Samples of granular soils were obtained with a 2-inch diameter split-barrel sampler in general accordance with ASTM Method D 1586. Each sample was

removed from the sampler in the field, carefully examined and logged by an experienced soils technician. Suitable portions of each sample were sealed and packaged for transportation to Geotest's laboratory. The shear strength of cohesive soil samples was estimated by use of a calibrated pocket penetrometer in the field. Driving resistances for the split-barrel sampler were recorded as "blows per foot" on the boring logs. Water level measurements were made in the open boreholes at the time of drilling. All borings were backfilled with cement bentonite grout, except the boring converted to piezometer, after completion of the groundwater level measurements.

Detailed descriptions of the soils encountered in the borings drilled for this study are given on the boring logs presented on Figures A-1 through A-10 in Appendix A. A key to the symbols and terms used on the boring logs is given on Figure A-11 in Appendix A.

2.3 Piezometer Installation

During the field investigation, a piezometer was installed in the open borehole of boring B-1 to a depth of 50 feet. The location of the piezometer, designated as B-1P, is shown on Figure 2 (Plan of Borings). The piezometer installation report showing the details of the construction of the piezometer and water level measurements at different dates is provided on Figure A-12 in Appendix A. The piezometer installation report was submitted to Texas Department of Licensing and Regulations (TDLR).

After taking the final water level measurements, the piezometer was abandoned in place. The piezometer installation and abandonment report is presented in Appendix D.

3.0 LABORATORY TESTS

The laboratory testing program was designed to evaluate the pertinent physical properties and shear strength characteristics of the subsurface soils. Classification tests were performed on selected samples to aid in soil classification. All geotechnical tests were performed in accordance with appropriate ASTM procedures.

Undrained shear strengths of selected cohesive samples were measured by unconsolidated undrained (triaxial) (ASTM D2850) compression tests. Results of the unconsolidated undrained (triaxial) compression tests are plotted as solid squares on the boring logs. The shear strength of cohesive samples was measured in the field with a calibrated pocket penetrometer and also in the laboratory with a Torvane. The shear strength values obtained from the penetrometer and Torvane are plotted on the boring logs as open circles and triangles, respectively.

Measurements of moisture content (ASTM D2216) and dry unit weight were taken for each unconsolidated undrained triaxial test sample. Moisture content measurements were also made on other samples to define the moisture profile at each boring location. Atterberg limits tests (ASTM D4318) and Percent Passing No. 200 Sieve (ASTM D1140) were performed on selected cohesive soil samples for physical classification. Sieve analyses (ASTM D422) were performed on selected cohesionless soil samples to evaluate grain size distribution. The results of most of the laboratory tests are plotted or summarized on the boring logs B-1 through B-10 presented on Figures A-1 through A-10 in Appendix A. The results of the laboratory tests are tabulated and are presented on Figures B-1 through B-10 in Appendix B. Grain size distribution curves are presented on Figure B-11 and B-12 in Appendix B.

California Bearing Ratio (CBR) tests (ASTM D 1883) were performed on a composite sample of the surficial soils (0' - 6') obtained from the borings. The bearing ratios were measured at different compacted densities. The CBR tests results are presented on Figures B-13a through B-13c and the

relation between CBR versus dry density is presented on Figure B-13d.

One (1) one-dimensional swell test was performed. The result of the one dimensional swell test is presented on Figure B-14.

Due to the change in scope of the project, the included CBR and one dimensional swell tests are for information only.

The laboratory Corrosivity tests including pH, Chloride, Sulphate and resistivity tests were performed on selected samples at locations where the Cast Iron pipe is proposed. The test results are presented in Appendix C and also given below.

Boring No.	***Depth (ft)***	***pH***	***Resistivity (ohm-c)***	***Chloride (mg/kg)***	***Sulphate (mg/kg)***
B-1	*23-25*	*9.16*	*2060*	*<9.92*	*<11.3*
B-1	*28-30*	*9.02*	*1320*	*10.1*	*12.1*
B-3	*23-25*	*9.19*	*2630*	*<9.88*	*19.4*
B-4	*18-20*	*8.87*	*2240*	*23.3*	*63.5*

Based on the corrosivity test results, the degree of corrosivity of the subsurface soils is negligible in terms of pH. The degree of corrosivity is moderately to mildly corrosive in terms of resistivity, threshold in terms of chloride concentration and negligible in terms of sulfate concentration. The results of the Aggressivity tests are presented in Appendix C.

4.0 GENERAL SUBSURFACE CONDITIONS

4.1 Geology

The project site lies in the Beaumont Formation. The clays and sands of the Beaumont Formation are over-consolidated as a result of desiccation from frequent rising and lowering of the sea level and the groundwater table. Consequently, clays of this formation have moderate to high shear strength and relatively low compressibility. The sands of the Beaumont Formation are typically very fine and often silty. Further, there is occasional evidence in the Houston area of the occurrence of cemented material (sandstone and siltstone) deposits within the Beaumont Formation.

4.2 Existing Pavement

The boring B-1 was drilled in the existing concrete pavement and encountered 7.25 inches of concrete.

4.3 Soil Stratigraphy

Overflow Structure. As revealed by the boring logs B-1 and B-7 and as shown on boring log profile presented on Figure 3.1, the subsurface soils at the proposed overflow structure consists of medium stiff to hard dark gray and brown and reddish brown and gray Fat Clay, Sandy Fat Clay, Lean Clay with sand and Sandy Lean Clay to a depth of 50 feet. A stratum of loose brown Silt was encountered in boring B-7 between the depths of 15 to 18.5 feet and very dense reddish brown Silt was encountered between the depths of 48.5 to 50 feet in boring B-1. Fill material consisting of medium stiff to very stiff dark gray and brown fat clay and sandy lean clay was encountered to depths of 6 to 8 feet in borings B-1 and B-7.

The Fat Clay and Sandy Fat Clay are of high plasticity with liquid limits ranging from 52 to 61 and plasticity indices ranging from 31 to 37. The Sandy Lean Clay and Lean Clay with sand are of slight to medium plasticity with liquid limits ranging from 26 to 36 and plasticity indices ranging from 8 to 19. The fines content (percent passing No. 200 sieve) of Fat Clay ranges from 88 to 97 percent and the fines content Sandy Fat Clay and Sandy Lean Clay ranges from 60 to 63 percent. The fines content of Lean Clay with sand ranges from 80 to 81 percent. The fines content of Silt with sand is about 77 percent and the percent fines of silt is about 86 percent.

Sodium Bisulfate Building and Large Junction Box. As revealed by the boring log B-8 and as shown on boring log profile presented on Figure 3.2, the subsurface soils at the sodium bisulfate building and large junction box consists of medium stiff to hard reddish brown, gray and brown Fat Clay, Fat Clay with sand, Silty Clay with sand and Lean Clay to the explored depth of 50 feet. Fill material consisting of stiff to very stiff gray and brown lean clay with sand was encountered to a depth of 8 feet below the existing grade.

The Fat Clay with sand and Fat Clay are of high plasticity with a liquid limit of about 51 and plasticity indices ranging from 29 to 30. The Silty Clay with sand and Lean clay are of low to high plasticity with liquid limits ranging from 22 to 49 and plasticity indices ranging from 7 to 28. The fines content of Fat Clay and Lean clay ranges from 87 to 98 percent. The percent fines of Fat Clay with sand, Silty Clay with sand and Lean Clay with sand ranges from 77 to 83 percent.

Headwall and Detention Pond Area. As revealed by the boring logs B-9 and B-10 and as shown on boring log profile presented on Figure 3.3, the subsurface soils at the detention pond consists of stiff to hard reddish brown, gray and brown Fat Clay, Lean Clay, Fat Clay with sand and Sandy Fat Clay to the explored depth of 15 feet. A layer of loose to medium dense gray Sandy Silt and Silty Sand was encountered between the depths of 4 to 6 feet and 10 to 12.5 feet in these borings. Fill material consisting of stiff to very stiff gray fat clay with sand was encountered to depths of 4 to 6 feet below the existing grade.

The Fat Clay and Sandy Fat Clay are of high to very high plasticity with liquid limits ranging from 52 to 68 and plasticity indices ranging from 32 to 42. The Lean Clay is of high plasticity with liquid limit of about 46 and plasticity index of about 25. The fines content of Lean Clay is about 95 percent. The fines content of Fat Clay with sand ranges from 75 to 77 percent and the fines content of Sandy Fat Clay is about 66 percent. The fines content of Silty Sand is about 30 percent and the fines content of Sandy Silt is about 50 percent.

4.4 Range of Weak Soils Encountered in Borings

The range of loose cohesionless soils and/or soft cohesive soils as encountered in borings are given below:

Boring No.	**Range of Weak Soils Encountered, ft**		**Soil Type**
	From	**To**	
B-7	8	10	Soft Sandy Fat Clay
	15	18.5	Loose Silt with Sand
B-9	4	6	Loose Sandy Silt

4.5 Water Levels

Groundwater was encountered during drilling in borings B-1, B-3, B-4, B-5, B-7 and B-8. The groundwater level measured during drilling in each boring and after drilling in borings converted to piezometers is given below.

Boring	**Ground Water Depth Encountered During Drilling**	**Ground Water Depth Measured 24 Hours and More after Completion of Drilling**
B-1 (B-1P)	4.3	10 (4-28-15)*
B-3	9.0	--

Boring	Ground Water Depth Encountered During Drilling	Ground Water Depth Measured 24 Hours and More after Completion of Drilling
B-4	12	--
B-5	10.8	--
B-7	14.2	--
B-8	14.7	--

* Water level readings in piezometer.

However, it should be noted that various environmental and man-made factors, such as amount of precipitation, nearby subsurface construction activities, changes in area drainage, and water level in the nearby gully could substantially influence the groundwater levels.

4.6 Environmental Concerns

No environmental concerns were noticed during drilling in the borings B-1 through B-10 drilled for this study.

5.0 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

The project consists of design of the overflow structure and sodium bisulphate pad/building at the East Water Purification Plant (EWPP). The proposed improvements are presented below.

- The overflow structure will have a footprint of approximately 17 ft. x 30 ft. The structure will be partially below grade and placed approximately 7 ft. below grade (EL 7.5 feet). Weight of overflow structure: Dry weight: ~350,000 lbs. Wet weight: ~480,000 lbs.
- The proposed Sodium Bisulfite Building, footprint will be approximately 20 ft. x 10 ft.
- The proposed box culvert adjacent to the proposed overflow structure will be 3 ft. H x 10 ft. W, and placed at a depth of 7 feet deep, with one junction box to transition to the 4 ft. H x 9 ft. W box culvert.
- Large junction box will be approximately 15 ft. W x 15 ft. L x 8 ft. H and the north south box culvert will be 4 ft. H x 9 ft. W.
- Headwall will be provided where box culvert daylights at the detention basin.
- Detention pond is 435 ft. long by 217 ft. wide at top and about 5 ft. deep.

5.1 Overflow Structure

The overflow structure will have a footprint of approximately 17 ft x 30 ft. The structure will be partially below grade and placed approximately 7' below grade (EL 7.5 feet). Weight of overflow structure: Dry weight: ~350,000 lbs. Wet weight: ~480,000 lbs.

5.1.1 Foundation Type, Depth and Allowable Bearing Pressure. Based on the subsurface conditions revealed by borings B-1 and B-7 drilled near the proposed overflow structure area, the foundation of the overflow structure can be supported on drilled and underreamed footings. The drilled and underreamed footings should be placed at depths ranging from 13 to 18 feet below the

bottom of the structure at approximate elevations -1 to -11 feet (15 to 25 feet below existing grade) and proportioned for an allowable bearing pressures as given below.

Drilled Piers and/or Drilled and Underreamed Footing Depth Below the Structure, ft.	Depth Below Existing Grade (Footing Elevation), ft.	Allowable (Net) Bearing Pressure (psf)		Allowable Skin Friction, psf
		Total Dead and Live Loads	Dead and Sustained Live Loads	
8	15 (-1)	3,600	2,400	--
18	25 (-11)	4,800	3,200	260

These allowable bearing pressures contain safety factors of 2 for total load and 3 for sustained load conditions.

It is recommended that the drilled and underreamed footings be designed with a bell-to-shaft ratio of 2.5 to 1 for bell. If design bell size cannot be achieved due to excessive sloughing or caving-in, the ratio should be reduced. In extreme cases, a ratio of 1.1 (straight shaft) is required. Due to the presence of loose silt material encountered between the depths 15 to 18.5 feet, for footing placed at El. -1 feet, a straight shaft will be required. Due to cohesionless soils encountered between depths of 15 to 18.5 feet in boring B-7, casing may be required during installation of drilled shafts.

Pier reinforcement should be checked to ensure that design provides sufficient resistance to tensile loads imposed due to swell of near surface soils. Reinforcement should be sufficient to resist a tensile load of 30d kips and 90d kips, where "d" is the diameter of the shaft, in feet for shaft lengths of 8 feet and 18 feet, respectively.

Alternatively, the overflow structure can be supported on a mat foundation. Based on the borings B-1 and B-7, soft soils were encountered between the depths of 8 to 10 feet. Hence, it is recommended that the existing soft soils below the bottom of proposed structure to a minimum depth

of 3 feet should be over excavated and replaced with either compacted select fill or cement stabilized sand. The mat foundation supported on compacted select fill or cement stabilized sand should be designed for an allowable (net) bearing pressure of 3,000 psf for total dead and live loads or 2,000 psf for dead and sustained live loads, whichever results in a larger foundation area. These net allowable bearing pressures contain safety factors of 2 for total load and 3 for sustained load conditions.

5.1.2 Modulus of Subgrade Reaction. A modulus of subgrade reaction of 50 pci can be used for design of the mat foundation.

5.1.3 Lateral Pressures. The lateral pressure diagrams presented on Figures 7.1 and 7.2 are applicable for permanent wall.

5.1.4 Hydrostatic Uplift Resistance. Structures extending below the groundwater level should be designed to resist uplift pressure resulting from excess piezometric head. Design uplift pressures should be computed based on the assumption that the water table is at ground surface. To resist the hydrostatic uplift at the bottom of the structure, one of the following sources of resistance can be used in the design.

a. Dead weight of structure,
b. Weight of soil above base extensions plus weight of structure, or
c. Soil-wall friction plus dead weight of structure.

The uplift force and resistance to uplift should be computed as detailed on Figure 8. In determining the configuration and dimensions of the structure using one of the approaches presented on Figure 8, the following factors of safety are recommended.

a. Dead weight of concrete structure, $S_{f1} = 1.10$,
b. Weight of soil (backfill) above base extension, $S_{f2} = 1.5$, and
c. Soil-wall friction, $S_{f3} = 3.0$.

Friction resistance should be discounted for the upper 5 feet, since this zone is affected by seasonal moisture changes.

5.1.5 Foundation Settlement. The settlement of a foundation for any structure depends on its size, shape, depth, and more particularly on the magnitude of the sustained load imposed at the base of the footing and on the compressibility of the foundation soils. Based on a size of 17 ft x 30 ft and wet weight of 480,000 lbs, the contact pressure at the over flow structure bottom is about 1,000 psf. However, since the overflow structure is a below grade structure (about 7 below existing grade) and the estimated overburden pressure of the soils that will be removed in the overflow structure area is about 850 psf, therefore, the settlement induced from the net surcharge of the new overflow structure will be minimal.

5.2 Sodium Bisulfate Building

5.2.1 Foundation Type, Depth and Allowable Bearing Pressure. Based on the soil stratigraphy revealed from boring B-8, the foundation for Sodium Bisulfate building can be supported on a mat foundation placed at depth of 2 feet (into stiff lean clay fill) below existing grade and should be designed for an allowable (net) bearing pressure of 2,500 psf for total dead and live loads or 1,670 psf for dead and sustained live loads, whichever results in a larger foundation area. These net allowable bearing pressures contain safety factors of 2 for total load and 3 for sustained load conditions.

A modulus of subgrade reaction of 50 pci can be used for design of the mat foundation.

5.2.2 Site Preparation and Structural Fill Requirements. The site should be cleared of all debris, grubbed and stripped of all organic material, soft soils and foreign material from the building and paved areas. Stripped areas should be appropriately graded and shaped to prevent ponding of water on the site. **Existing fill was encountered in boring B-8. If any soft soils are encountered during preparation of building pad, then soft soils should be over excavated and replaced with structural fill material.**

Should any structural fill required to raise the grade or backfill grub holes should consist of lean clay with a liquid limit less than 40 and a plasticity index between 8 and 20 in building footprint. The structural fill should be compacted at moisture content within three percent above optimum to reduce swelling potential of the compacted fill. The fill material should be placed in loose lifts not exceeding eight inches and should be compacted to a minimum of 98 percent of the maximum dry density as determined by ASTM D 698 in building area and 95 percent of the maximum dry density as determined by ASTM D 698 in other area. The structural fill should extend at least five feet outside the building and paving area. The onsite surficial high plasticity fat clay soils (onsite material from the detention pond area) are not suitable for structural fill material unless stabilized sufficient lime (a minimum of 5% hydrated lime).

5.3 Box Culvert, Large Junction Box and Headwall

The proposed box culvert, large junction box and headwall will be placed at a depth of approximately 7 feet into stiff to very stiff fat clay.

5.3.1 Trench Excavation. The following subsections provide information for the design and construction of the proposed box culvert that will be by installed by open cut method of construction.

5.3.2 Geotechnical Parameters. Based on the soil conditions revealed by the borings B-8 and B-9, geotechnical parameters were developed for the design of open cut construction for proposed box culvert. The design parameters are provided in Table 2. For design, the groundwater level should be assumed to exist at the ground surface.

5.3.3 Excavation Stability. The open excavation may be shored or laid back to a stable slope or supported by some other equivalent means used to provide safety for workers and adjacent structures, if any. The excavating operations should be in accordance with OSHA Standards, OSHA 2207, Subpart P, latest revision and the City of Houston Standard Specification.

- Excavation Shallower Than 5 Feet - Excavations that are less than 5 feet deep **(critical height)** should be effectively protected when an indication of dangerous ground movement is anticipated.

- Excavations Deeper Than 5 Feet - Excavations that are deeper than 5 feet (if any) should be sloped, shored, sheeted, braced or laid back to a stable slope or supported by some other equivalent means or protection such that workers are not exposed to moving ground or cave-ins. The slopes and shoring should be in accordance with the trench safety requirements as per OSHA Standards. The following items provide design criteria for excavation stability.

(i) OSHA Soil Type. Based on the soil conditions revealed by borings drilled for this study and assumed groundwater level at surface, OSHA soil type "C" should be used for determination of allowable maximum slope and/or the design of shoring along the alignment for full proposed depth of open excavation. For shoring deeper than 20 feet (if needed), an engineering evaluation is required and deeper soil borings will be needed.

(ii) Excavation Support Earth Pressure. Based on the subsurface conditions indicated by our field investigation and laboratory testing results, excavation support earth pressure diagrams were developed and are presented on Figures 5.1 and 5.2. This pressure diagram can be used for the design of temporary trench bracing. For a trench box, a lateral earth pressure resulting from an equivalent fluid with a unit weight of 94 pcf can be used. The effects of any surcharge loads at the ground surface should be added to the computed lateral earth pressures. A surcharge load, q, will typically result in a lateral load equal to 0.5 q. The above value of equivalent fluid pressure is based on assumption that the groundwater level is near the ground surface, since these conditions may exist after a heavy rain or flooding.

(iii) Bottom Stability. In braced cuts, if tight sheeting is terminated at the base of the cut, the bottom of the excavation can become unstable. The parameters that govern the stability of the excavation base are the soil shear strength and the differential hydrostatic head between the groundwater level within the retained soils and the groundwater level at the interior of the trench excavation. For cut in cohesive soils as predominantly encountered for the proposed excavation depths, the bottom stability can be evaluated as outlined on Figure 6. However, due to presence of sandy silt at depths 4 feet to 6 feet in boring B-9, the excavation should be performed after dewatering to avoid bottom stability problems.

5.3.4 Groundwater Control. Excavations for the overflow structure and box culvert may encounter groundwater seepage to varying degrees depending upon the groundwater conditions at the time of construction and the location and depth of the trench. Based on the soil conditions identified in the borings, all the excavations will be in cohesive soils with interbedded cohesionless soils. In general for cohesive soils the groundwater if encountered may be managed by collection in excavation bottom sumps for pumped disposal. In cohesionless soils such as sandy silt as encountered between the depths of 4 to 6 feet in boring B-9 dewatering such as vacuum well points may be required to lower the ground water level at least 5 feet below the bottom of excavation. Due to the presence of relatively thin layer (2-foot thick) sandy silt layer, the groundwater may be controlled by using eductor well system if it can be successfully lowered 5 feet below the excavation bottom; otherwise, alternatively installing continuous interlock (water tight) sheet piling with trench bottom sumps for pumped disposal.

It is recommended that the actual groundwater conditions should be verified by the contractor at the time of construction and that groundwater control should be performed in general accordance with the City of Houston Standard Specifications, Section 01578.

5.3.5 Bedding and Backfill for Box Culvert. Excavations for the proposed structures should be backfilled in accordance with the City of Houston Standard Specifications, Section 02316, "Excavation and Backfill for Structures."

5.3.6 Allowable Bearing Pressure. Based on the soil stratigraphy revealed from borings B-8 and B-9, the box culvert, junction box and headwall placed at a depth of 7 feet below the existing grade into stiff to very stiff fat clay and may be designed for an allowable (net) bearing pressure of 2,500 psf for total loads. The net allowable bearing pressures contain safety factor of 2 for total loads.

5.3.7 Lateral Pressures. The lateral pressure diagrams presented on Figures 7.1 and 7.2 are applicable for permanent wall.

5.3.8 Hydrostatic Uplift Resistance. Structures extending below the groundwater level should be designed to resist uplift pressure resulting from excess piezometric head. Design uplift pressures should be computed based on the assumption that the water table is at ground surface. To resist the hydrostatic uplift at the bottom of the structure, one of the following sources of resistance can be used in the design.

a. Dead weight of structure,
b. Weight of soil above base extensions plus weight of structure, or
c. Soil-wall friction plus dead weight of structure.

The uplift force and resistance to uplift should be computed as detailed on Figure 8. In determining the configuration and dimensions of the structure using one of the approaches presented on Figure 6, the following factors of safety are recommended.

a. Dead weight of concrete structure, $S_{f1} = 1.10$,
b. Weight of soil (backfill) above base extension, $S_{f2} = 1.5$, and
c. Soil-wall friction, $S_{f3} = 3.0$.

Friction resistance should be discounted for the upper 5 feet, since this zone is affected by seasonal moisture changes.

5.3.9 Protection of Below Grade Structures. The design of the proper means for protection of below grade structures will depend upon the potential of the aggressivity or corrosivity of soil and groundwater properties. The aggressivity testing were conducted on borings B-1, B-3 and B-4 and the details were presented on Section 3.0 of this report. Based on the test results, no special corrosion measures are required for the below grade structures.

5.4 Detention Pond

The proposed detention pond is about 5 feet deep. It is recommended that the side slopes of the proposed detention pond should be no steeper than 4(H):1(V).

5.4.1 Slope Protection and Erosion Control. Attention should be given for the erosion protection of the detention pond to prevent over-bank runoff. Excessive erosion can cause substantial ground loss and progressive movement of soil that may cause slope failure. A properly installed and maintained grass cover can serve as a protection for the detention slope by reducing soil erosion. Furthermore, routine maintenance of the slope surface including removal of undesirable vegetation growth on or around the cover, repair minor cracks or spalling, regrade and repair eroded areas should also be performed on a regular basis to enhance the integrity of the slope protective system.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Foundation Excavation and Construction

Whenever practical, excavations should be performed during dry weather. All excavated areas should be adequately protected from surface run-off water with appropriate measures to prevent ponding of water in and around the excavation. Excavations should be properly sloped, shored, braced, or protected in accordance with OSHA's excavation safety standard, 29CFR Part 1926, Subpart P (Excavations and Trenches) Standards. It is recommended that temporary sides of the excavation be trimmed to slopes no steeper than 1 vertical to 1.5 horizontal.

It is recommended that the footing excavation be inspected by a geotechnical engineer or experienced engineering technician or an architect's or owner's representative prior to placing steel and concrete. The excavation should be checked to verify that (a) the footing has been constructed to the specified dimensions and is placed at the correct depth and into the appropriate stratum with adequate bearing capacity as recommended in this report, (b) the loose cuttings, and any soft-compressible materials have been removed from the bottom of the excavation, and (c) placement of concrete should be accomplished as soon as possible to prevent changes in the state of stress and caving of the foundation soils. A seal slab of lean concrete should be placed, if concrete placement is delayed for more than 6 hours after excavation or sooner if rain is forecasted. No footing concrete should be placed without the prior approval of the Project's Engineer, Architect or Owner's Representative. Due to presence of sandy silt material in boring B-7, a slurry displacement technique will be required during installation of drilled shafts.

Based on the available information, the excavation depth is about 7 feet for the Overflow structure, Large Junction box and box culvert. It is recommended that any existing structures within the close proximity of the proposed excavations should be monitored during construction. It is the contractor's responsibility to monitor any nearby structures during excavation.

6.2 Groundwater Control

Excavations for the overflow structure and box culvert may encounter groundwater seepage to varying degrees depending upon the groundwater conditions at the time of construction and the location and depth of the trench. Based on the soil conditions identified in the borings, all the excavations will be in cohesive soils with interbedded cohesionless soils. In general for cohesive soils the groundwater if encountered may be managed by collection in excavation bottom sumps for pumped disposal. In cohesionless soils such as sandy silt encountered between the depths of 4 to 6 feet in boring B-9 dewatering such as vacuum well points may be required to lower the ground water level at least 5 feet below the bottom of excavation.

It is recommended that the actual groundwater conditions should be verified by the contractor at the time of construction and that groundwater control should be performed in general accordance with the City of Houston Standard Specifications, Section 01578. Due to the presence of relatively thin layer (2-foot thick) sandy silt layer, the groundwater may be controlled by using eductor well system if it can be successfully lowered 5 feet below the excavation bottom; otherwise, alternatively installing continuous interlock (water tight) sheet piling with trench bottom sumps for pumped disposal.

7.0 PROVISIONS

The subsurface conditions and the design information contained in this report are based on the test borings made at the time of drilling at specific locations. However, some variation in soil conditions may occur between the boring locations. Should any subsurface conditions other than those described in our boring logs be encountered, Geotest should be immediately notified so that further investigation and supplemental recommendations can be provided. The depth of the groundwater level can be expected to vary with environmental variations such as frequency and magnitude of rainfall.

The analysis and recommendations submitted in this report are based upon the data obtained from subsurface explorations made at the time test borings were drilled at specific locations and the results of laboratory tests on selected soil samples from the test borings. The stratification lines on the log of borings represent the approximate boundaries between soil types, however, the transition between soil types may be more gradual than depicted.

This report has been prepared for the exclusive use of Carollo Engineers, Inc. or the City of Houston specifically for the design and construction of Clearwell Condition Assessment and Replacement of Selected Valves and Actuators at East Water Purification Plant in Houston, Texas. This report shall not be reproduced in whole or part without written permission of Geotest Engineering, Inc., Carollo Engineers, Inc. and the City of Houston.

ILLUSTRATIONS

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Symbols and Abbreviations Used on Boring Log Profile	4
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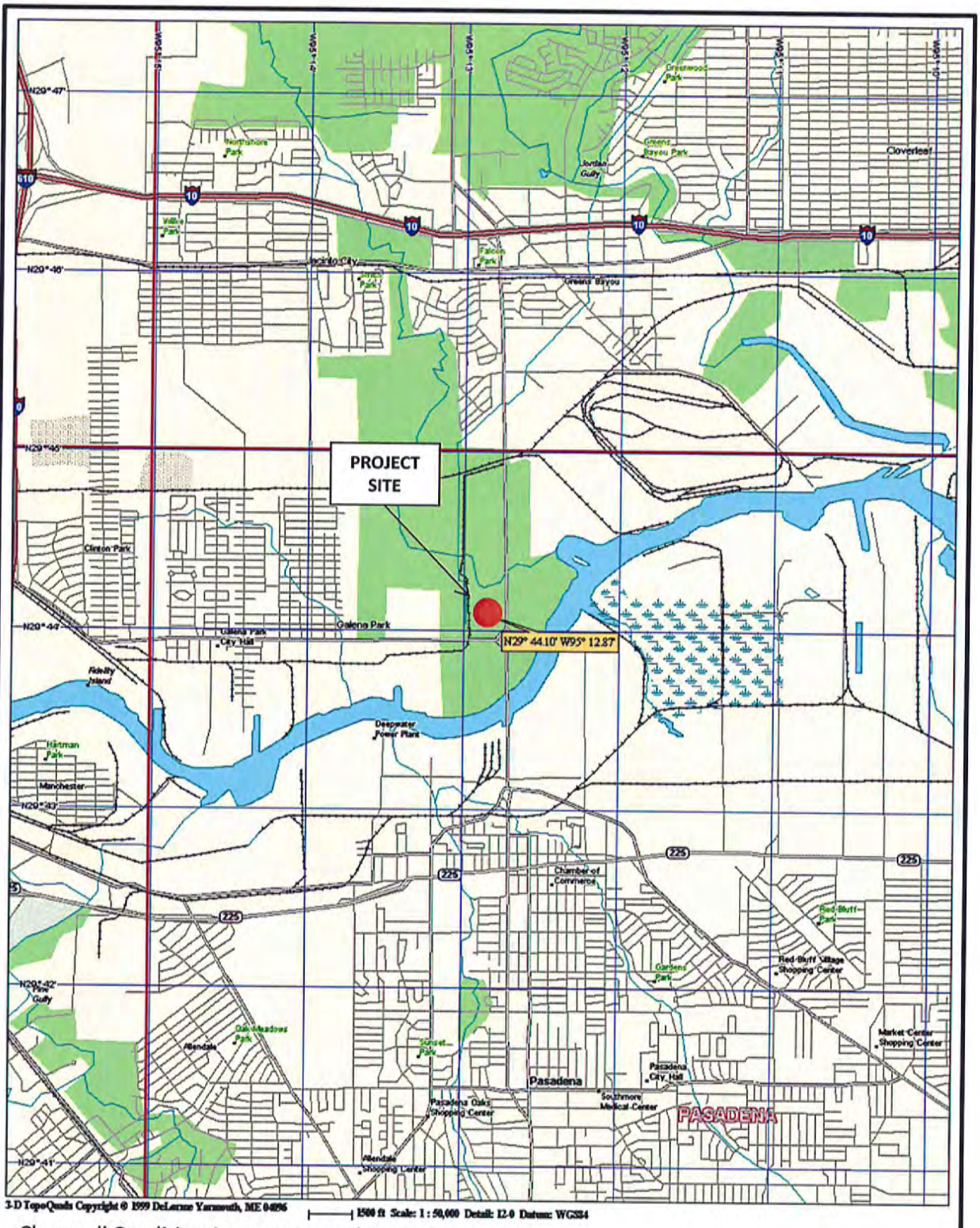
Stability of Bottom Braced Cut	6
Lateral Earth Pressure Diagram for Permanent Wall	7.1 and 7.2
Uplift Pressure and Resistance	8

Job No. 1140209501



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 — 1500 ft Scale: 1 : 50,000 Detail: 12.0 Datum: WGS84

Clearwell Condition Assessment and Replacement of
Selected Valves and Actuators
East Water Purification Plant (EWPP)
WBS No. S-000056-0070-3
Houston, Texas

VICINITY MAP

Geotest Engineering, Inc.

FIGURE 1

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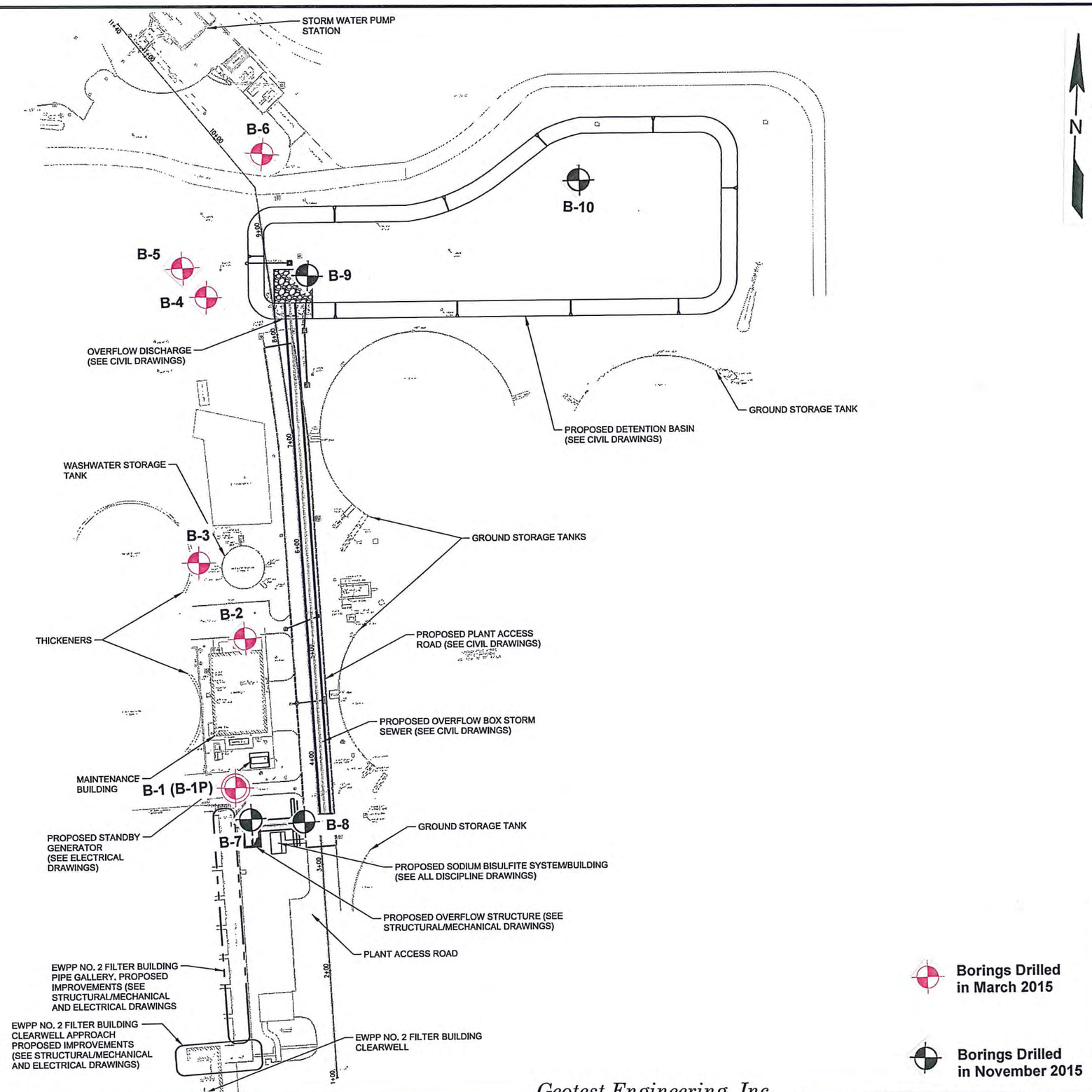


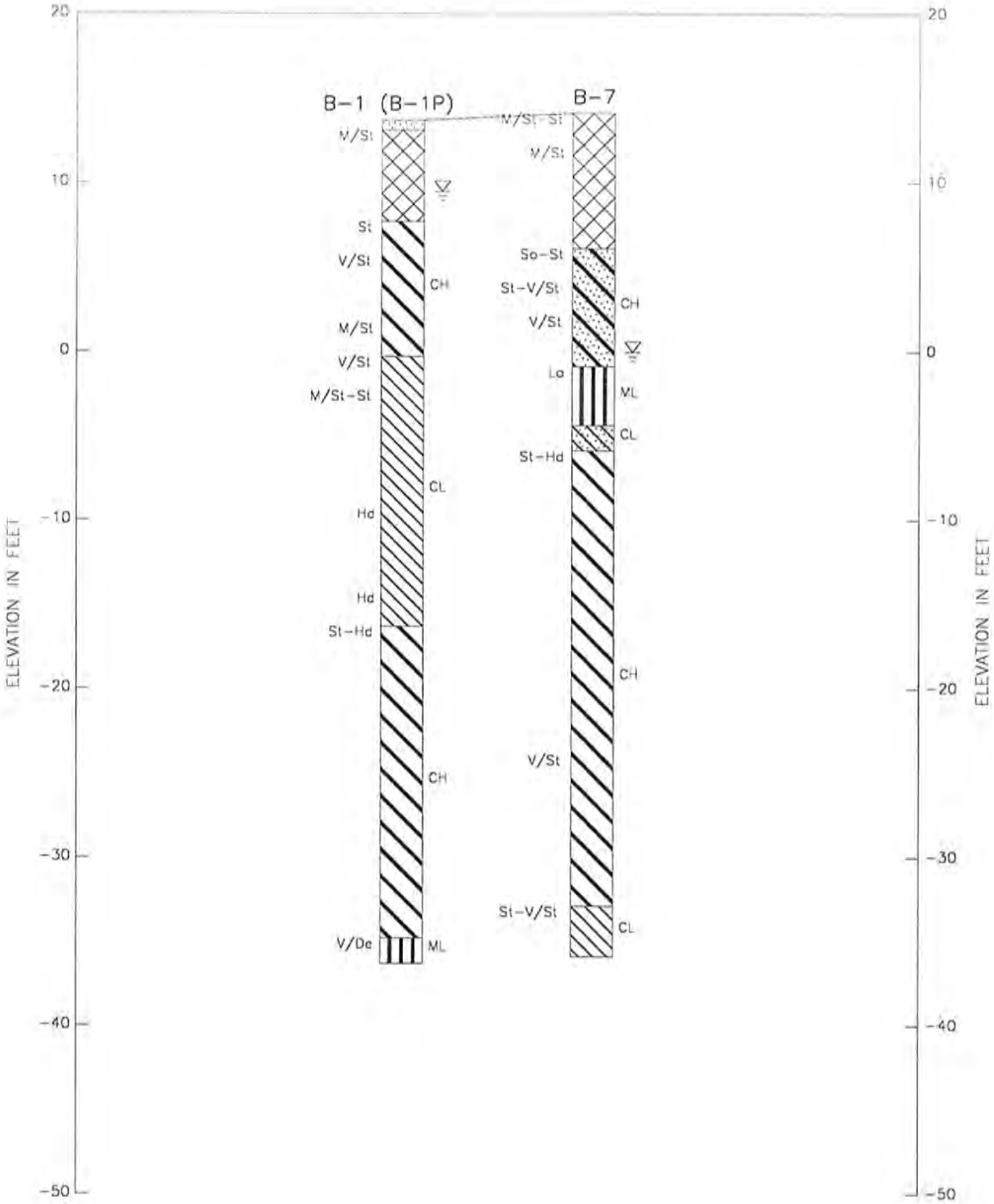
Borings Drilled in March 2015

Borings Drilled in November 2015

LEGEND	GEOTEST ENGINEERING, INC.
Boring Boring w/ Piezometer	CLEARWELL CONDITION ASSESSMENT & REPLACEMENT OF SELECTED VALVES & ACTUATORS; EAST WATER PURIFICATION PLANT (EWPP); WBS NO. S-000056-0070-4 HOUSTON, TEXAS **PLAN OF BORINGS** 0 50 100 SCALE IN FEET

Geotest Engineering, Inc.

FIGURE 2



GENERAL NOTES:

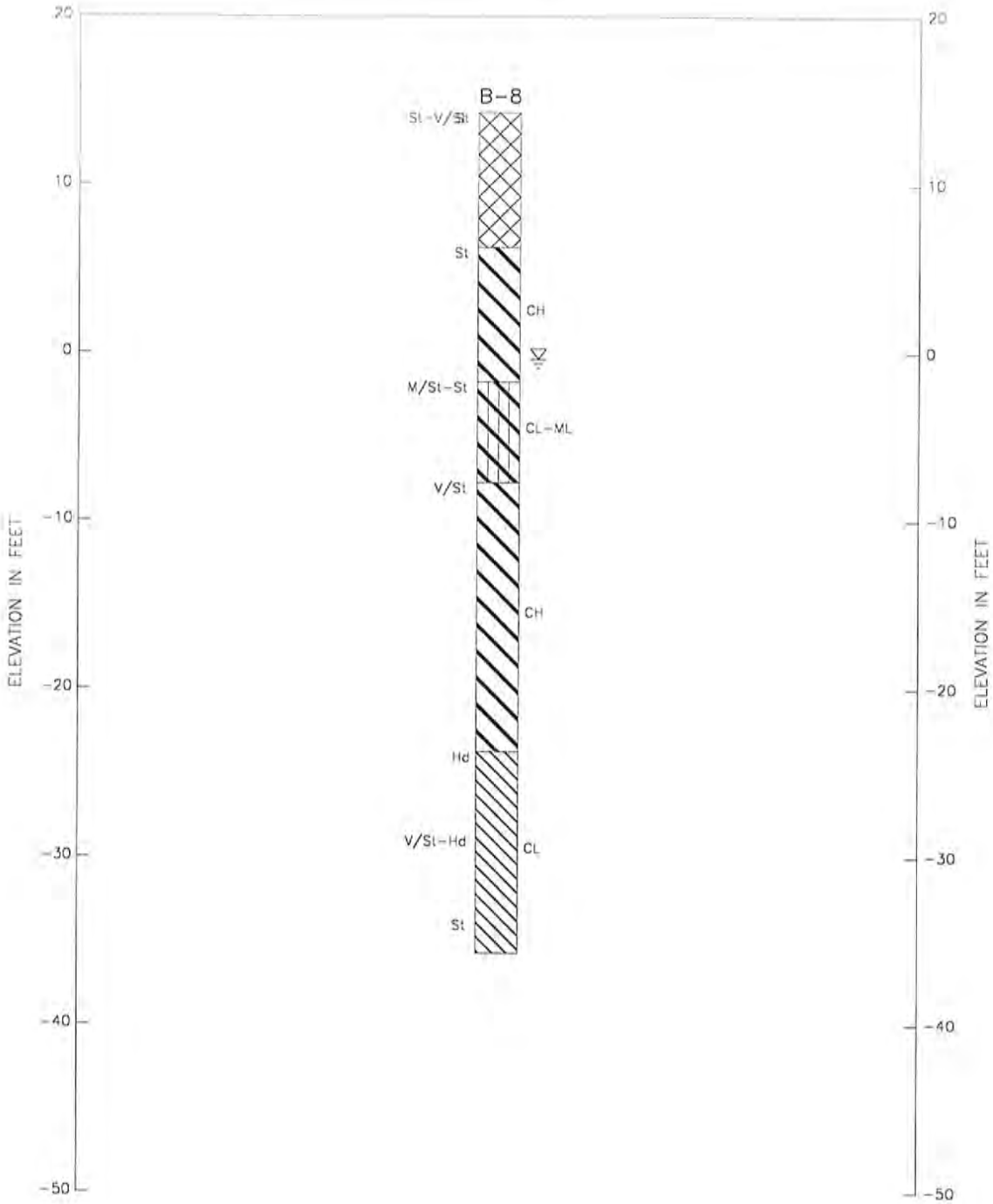
1. See Figure 2 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by Cerollo Engineers, Inc.

BORING LOG PROFILE

Proposed Overflow Structure

0 20 40 60 80

HORIZONTAL SCALE IN FEET



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5. Ground surface elevation at each boring location was based on survey data provided to us by Carollo Engineers, Inc.

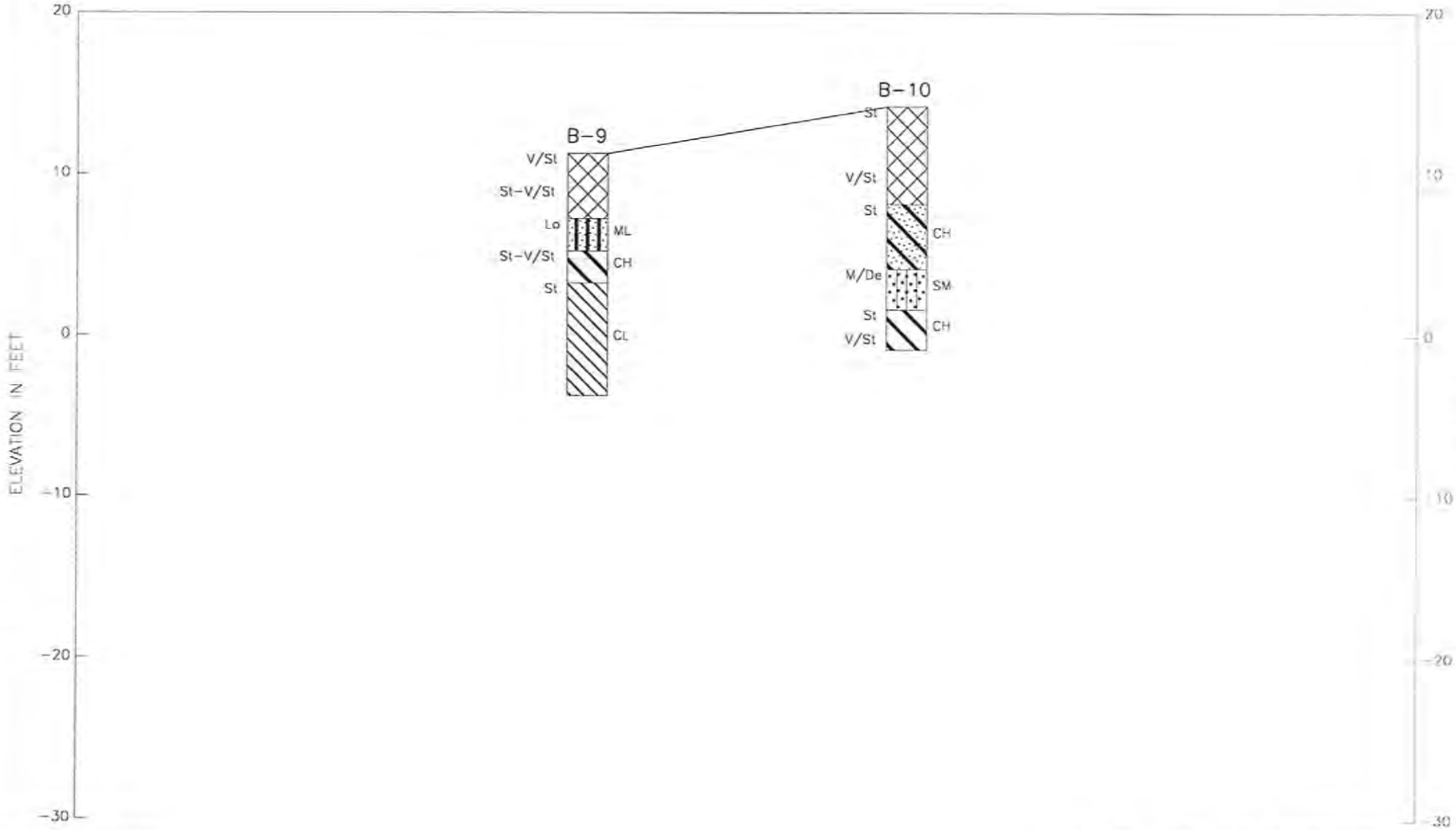
BORING LOG PROFILE

Sodium Bisulfate Building

0 15 30 45 60

HORIZONTAL SCALE IN FEET

Job No. 114020950



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3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by Carollo Engineers, Inc.

BORING LOG PROFILE

Detention Pond

0 25 50 75 100

HORIZONTAL SCALE IN FEET

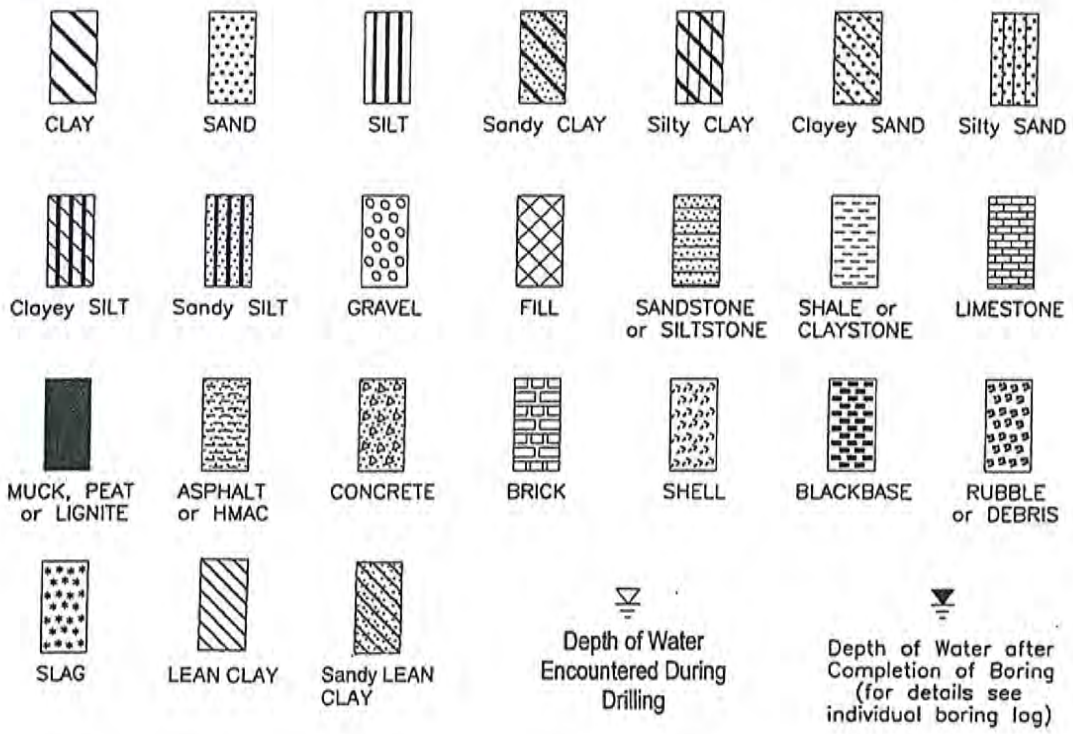
Geolest Engineering, Inc.

FIGURE 3.3

Job No. 1140209501

SYMBOLS AND ABBREVIATIONS USED ON BORING LOG PROFILE

LEGEND



ABBREVIATIONS USED FOR CONSISTENCY/DENSITY

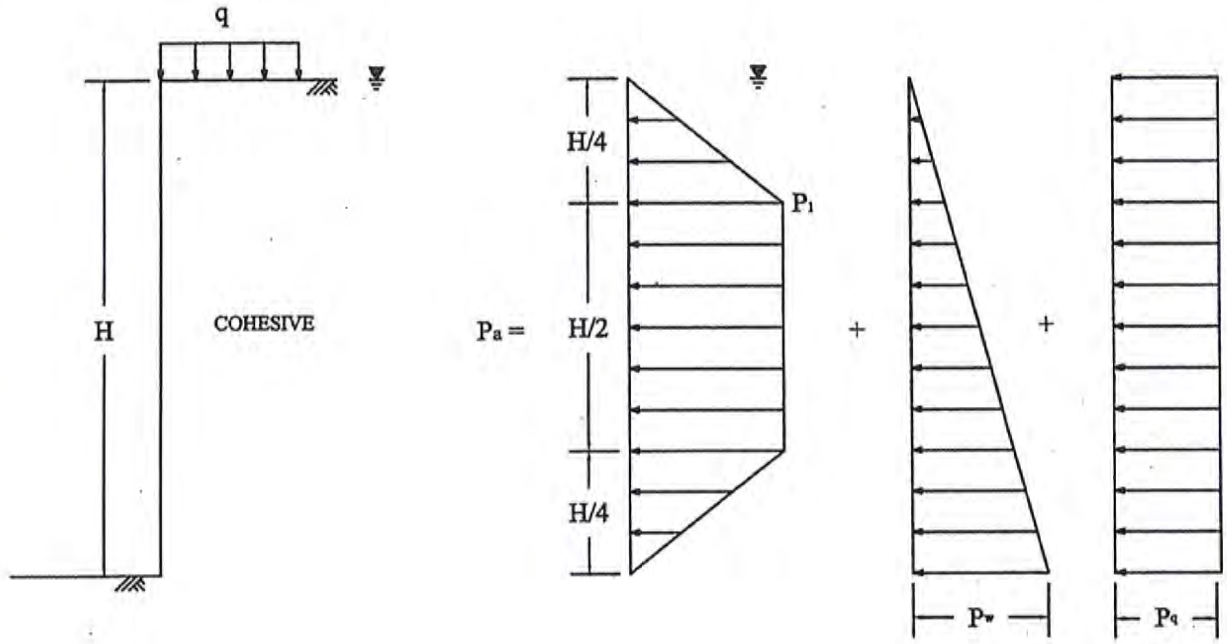
COHESIVE SOILS

V/So : Very Soft
So : Soft
Fm : Firm
M/St : Medium Stiff
St : Stiff
V/St : Very Stiff
Hd : Hard
V/Hd : Very Hard

COHESIONLESS SOILS

V/Lo : Very Loose
Lo : Loose
S/Co : Slightly Compact
Co : Compact
M/De : Medium Dense
De : Dense
V/De : Very Dense

Job No. 1140209501



TYPICAL SOIL PARAMETERS

See Table 2 for typical values of soil parameters

BRACED WALL

For $\gamma H/c \leq 4$

$P_1 = 0.3\ \gamma_c' H$
$P_w = \gamma_w H = 62.4\ H$
$P_q = 0.5\ q$

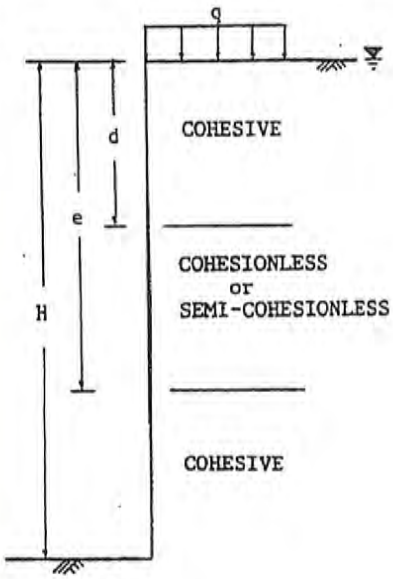
Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_a = Lateral pressure, psf;
P_1 = Active earth pressure, psf;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Depth of braced excavation, feet
c = Shear strength of cohesion soil, psf;

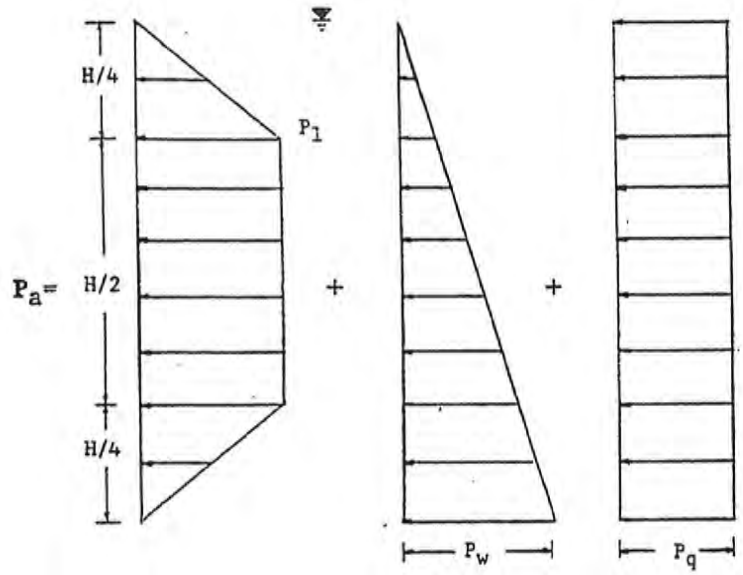
EXCAVATION SUPPORT EARTH PRESSURE

SUBMERGED COHESIVE SOIL

Job No. 1140209501



TYPICAL SOIL PARAMETERS



BRACED WALL

See Table 2 for typical values of soil parameters

$P_1 = 0.3\ \gamma'_{avg}\ H$

$P_w = \gamma_w\ H = 62.4\ H$

$P_q = 0.5q$

$$\gamma'_{avg} = \frac{\gamma_c'\ d + \gamma_s'\ (e-d) + \gamma_c'\ (H-e)}{H}$$

$\gamma_w = 62.4$ pcf

Where:

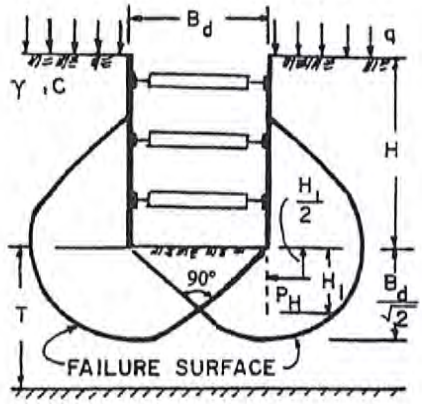
- γ_c' = Submerged unit weight of cohesive soil, pcf ;
- γ_s' = Submerged unit weight of cohesionless or semi-cohesionless soil, pcf ;
- γ_w = Unit weight of water, pcf;
- γ'_{avg} = Average submerged unit weight of soil, pcf ;
- q = Surcharge load at surface, psf;
- P_a = Lateral pressure, psf;
- P_1 = Active earth pressure, psf;
- P_q = Horizontal pressure due to surcharge, psf;
- P_w = Hydrostatic pressure due to groundwater, psf;
- H = Depth of braced excavation, feet

EXCAVATION SUPPORT EARTH PRESSURE

SUBMERGED COHESIVE SOIL INTERBEDDED WITH COHESIONLESS OR SEMI-COHESIONLESS SOIL

Job No. 1140209501

CUT IN COHESIVE SOIL,
DEPTH OF COHESIVE SOIL UNLIMITED ($T > 0.7\ B_d$)
L = LENGTH OF CUT



If sheeting terminates at base of cut:

$$\text{Safety factor, } F_S = \frac{N_C C}{\gamma H + q}$$

N_C = Bearing capacity factor, which depends on dimensions of the excavation : B_d, L and H (use N_C from graph below)

C = Undrained shear strength of clay in failure zone beneath and surrounding base of cut

γ = Wet unit weight of soil (see Table 2)

q = Surface surcharge (assumed q = 500 psf)

If safety factor is less than 1.5, sheeting or soldier piles must be carried below the base of cut to insure stability - (see note)

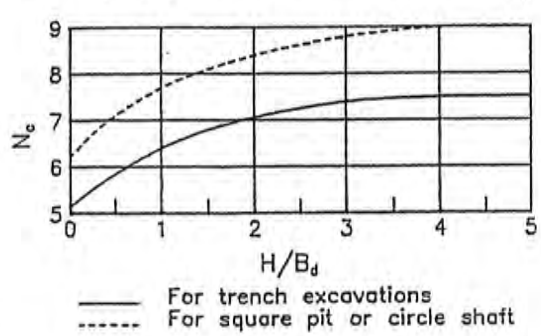
$$H_1 = \text{Buried length} = \frac{B_d}{2} \geq 5 \text{ feet}$$

Note : If soldier piles are used, the center to center spacing should not exceed 3 times the width or diameter of soldier pile .

Force on buried length, P_H:

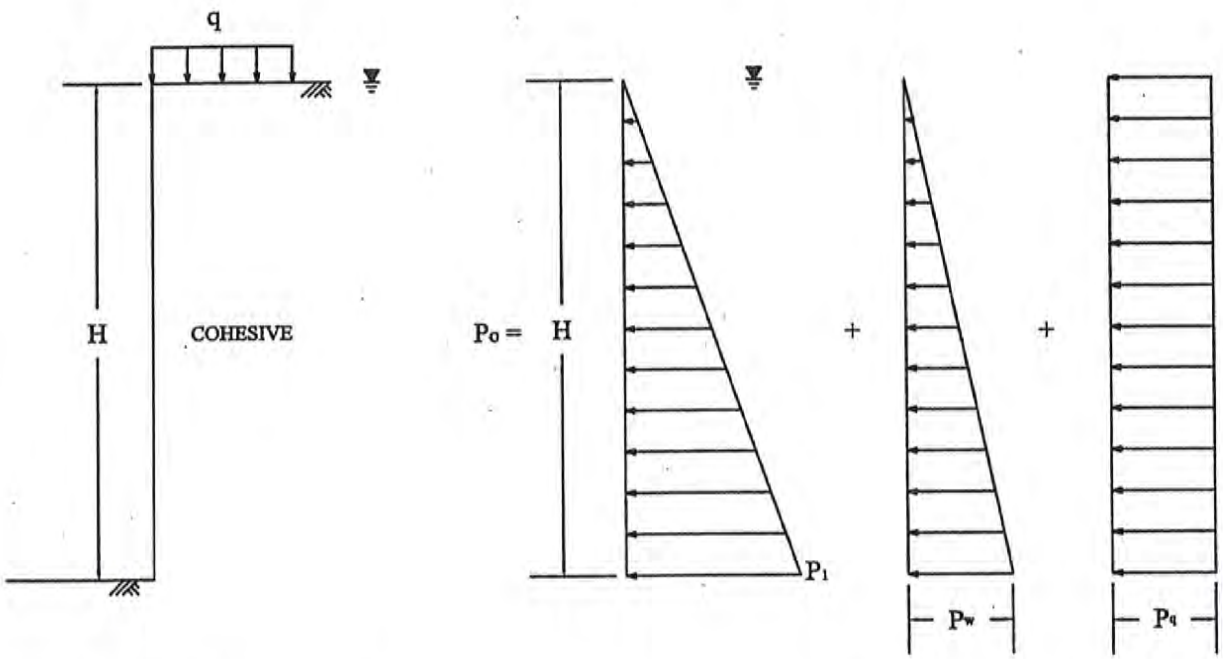
$$\text{If } H_1 > \frac{2}{3}\frac{B_d}{\sqrt{2}}, \quad P_H = 0.7\,(\gamma\, HB_d - 1.4CH - \pi CB_d) \text{ in lbs/ linear foot}$$

$$\text{If } H_1 < \frac{2}{3}\frac{B_d}{\sqrt{2}}, \quad P_H = 1.5H_1\,(\gamma\, H - \frac{1.4CH}{B_d} - \pi C) \text{ in lbs/ linear foot}$$



STABILITY OF BOTTOM
FOR
BRACED CUT

Job No. 1140209501



TYPICAL SOIL PARAMETERS

See Table 2 for typical values of soil parameters

$K_{oc} = 1.0$

PERMANENT WALL

$P_1 = K_{oc}\,\gamma_c'\,H$
$P_w = \gamma_w\,H = 62.4\,H$
$P_q = 0.5\,q$

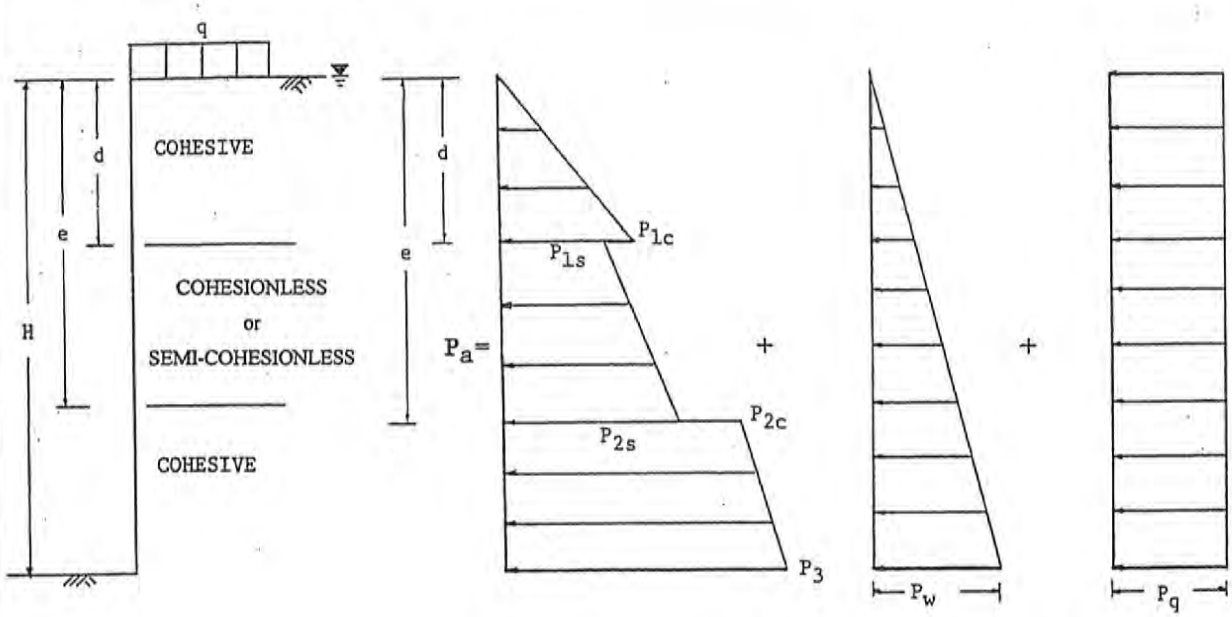
Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
K_{oc} = Coefficient of at-rest earth pressure in cohesive soil;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_o = Lateral pressure, psf;
P_1 = At-rest earth pressure, psf;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Depth of excavation, feet

LATERAL EARTH PRESSURE DIAGRAM FOR PERMANENT WALL

SUBMERGED COHESIVE SOIL

Job No. 1140209501



TYPICAL SOIL PARAMETERS

See Table 2 for typical values of soil parameters

$K_{oc} = 1.0$

$K_{os} = 1 - \sin\phi_s$

$\gamma_w = 62.4$ psf

PERMANENT WALL

$P_{1c} = \gamma'_c\, d\, K_{oc}$

$P_{1s} = \gamma'_c\, d\, K_{os}$

$P_{2s} = P_{1s} + \gamma'_s\, (e-d)\, K_{os}$

$P_{2c} = [\gamma'_c\, d + \gamma'_s\, (e-d)]\, K_{oc}$

$P_3 = [\gamma'_c\, d + \gamma'_s\, (e-d) + \gamma'_c\, (H-e)]\, K_{oc}$

$P_w = \gamma_w\, H = 62.4\, H$

$P_q = 0.5\, q$

Where:

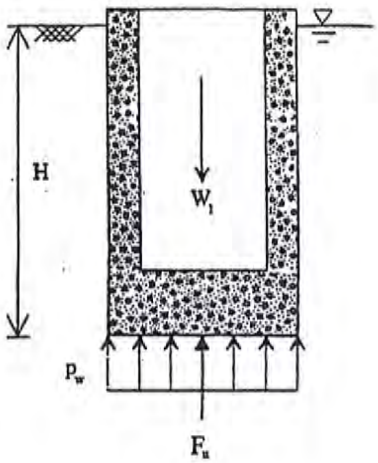
γ_c' = Effective unit weight of cohesive soil, pcf;
γ_s' = Effective unit weight of cohesionless or semi-cohesionless soil, pcf;
ϕ_s = Internal friction angle of cohesionless or semi-cohesionless soil, degree;
K_{oc} = Coefficient of earth pressure at rest in cohesive soils;
Ko_{as} = Coefficient of earth pressure at rest in cohesionless or semi-cohesionless soil;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_a = Lateral pressure, psf;
P_i, P_{ic}, P_{is} = Earth pressure at rest, psf; i = 1, 2, 3;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Height of wall, feet

LATERAL EARTH PRESSURE DIAGRAM FOR PERMANENT WALL

SUBMERGED COHESIVE SOIL INTERBEDDED WITH COHESIONLESS OR SEMI-COHESIONLESS SOIL

Job No. 1140209501

(a) DEAD WEIGHT OF STRUCTURE



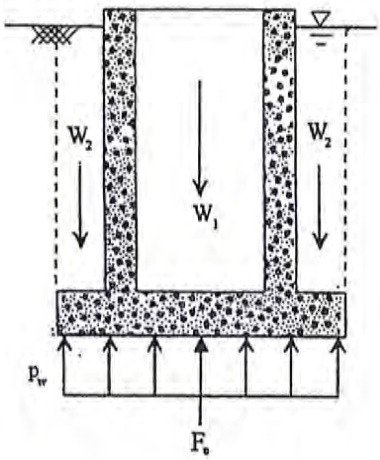
$p_w = H\gamma_w$

$F_u = A_b p_w$

$\frac{W_1}{Sf_1} = F_u$

See Table 2 for typical values of soil parameters

(b) WEIGHT OF SOIL ABOVE BASE EXTENSION PLUS DEAD WEIGHT OF STRUCTURE

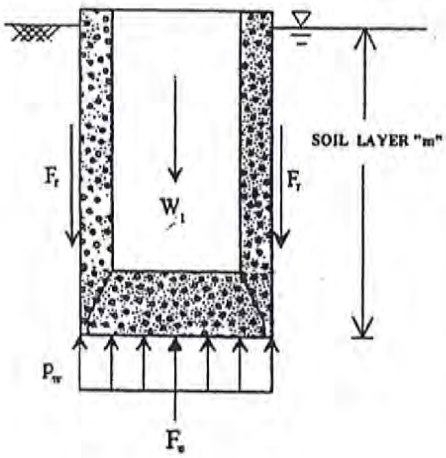


$p_w = H\gamma_w$

$F_u = A_b p_w$

$\frac{W_1}{Sf_1} + \frac{W_2}{Sf_2} = F_u$

(c) SOIL-WALL FRICTION PLUS DEAD WEIGHT OF STRUCTURE



$p_w = H\gamma_w$

$F_u = A_b p_w$

$\frac{W_1}{Sf_1} + \frac{F_r}{Sf_3} = F_u$

Predominantly Cohesive Soils, $F_r = \alpha c_m A_m$

Predominantly Cohesionless Soils, $F_r = p_m A_m K \tan \delta_m$

Where:

A_b	=	area of base, sq. ft.
A_m	=	cylindrical surface area of layer "m" , sq. ft.
c_m	=	undrained cohesion of soil layer "m", psf.
F_u	=	hydrostatic uplift force, lbs.
F_r	=	frictional resistance, lbs.
H	=	height of buried structure, ft.
K	=	coefficient of lateral pressure = 0.5.
p_m	=	average overburden pressure for layer "m," psf.
p_w	=	hydrostatic uplift pressure, psf.
$Sf_{1, 2, 3}$	=	factor of safety.
W_1	=	dead weight of concrete structure, lbs.
W_2	=	weight of backfill above base extension, lbs.
α	=	cohesion reduction factor = 0.5.
δ_m	=	friction angle between soil layer "m" and concrete wall, degrees = 0.75 ϕ_m
ϕ_m	=	internal angle of friction of soil layer "m", degrees.
γ_w	=	unit weight of water = 62.4 pcf.

UPLIFT PRESSURE AND RESISTANCE

TABLES

	Table
Summary of Boring Information	1
Geotechnical Design Parameter Summary – Open Cut Excavation	2

TABLE 1

SUMMARY OF BORING INFORMATION

Boring No.	Depth (feet)	Northing	Easting	Elevation (feet)
B-1 (B-1P)	50	13836146.42	3170043.14	13.68
B-2	15	13836271.70	3170094.86	14.47
B-3	50	13836363.88	3170027.31	14.73
B-4	50	13836543.03	3169985.77	16.38
B-5	50	13836570.61	3169982.59	16.43
B-6	10	13836764.47	3169964.15	14.34
B-7	50	13836114.25	3170075.04	14.08
B-8	50	13836116.67	3170117.39	14.27
B-9	15	13836599.59	3170126.88	11.24
B-10	15	13836691.19	3170165.52	14.14

TABLE 2

GEOTECHNICAL DESIGN PARAMETER SUMMARY
OPEN-CUT EXCAVATION

Boring Nos.	Stratigraphic Unit	Range of Depths, ft	Wet Unit Weight, γ, pcf	Submerged Unit Weight, γ', pcf	Undrained Cohesion, psf	Internal Friction Angle, φ, degree
B-1	Fill	0-6	124	62	600	--
	Cohesive	6-10	129	64	1,500	--
		10-14	130	65	1,400	--
		14-20	132	66	1,000	--
		20-30	132	66	3,000	--
		30-48.5	128	64	1,600	--
	Cohesionless	48.5-50	105	42	--	28
B-7	Fill	0-8	125	63	500	--
	Cohesive	8-15	125	63	1400	--
	Cohesionless	15-18.5	98	44	--	25
	Cohesive	18.5-35	132	66	1000	--
		35-50	130	65	1500	--
B-8	Fill	0-8	132	66	1000	--
	Cohesive	8-16	125	63	1000	--
		16-22	130	65	1000	--
		22-38	132	66	2800	--
		38-50	126	63	1000	--
B-9	Fill	0-6	127	64	1300	--
	Cohesionless	6-8	102	51	--	25
	Cohesive	8-15	126	63	1100	--

Note: 1) Fill Soils consists of lean clay, sandy lean clay and fat clay with sand
2) Cohesive soils include Sandy Lean Clay, Fat Clay with sand and Sandy Fat Clay.
3) Cohesionless soils include Silt with Sand and Sandy Silt.

APPENDIX A

	Figure
Log of Borings	A-1 thru A-10
Symbols and Terms Used on Boring Logs	A-11
Piezometer Installation Report	A-12

LOG OF BORING NO. B-1 (B-1P)

PROJECT : Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NO. : 1140209501

LOCATION : N 13836146.42, E 3170043.14
See Plan of Borings (Figure 2)

COMPLETION DEPTH : 50.0 FT.

SURFACE ELEVATION : 13.68 FT.

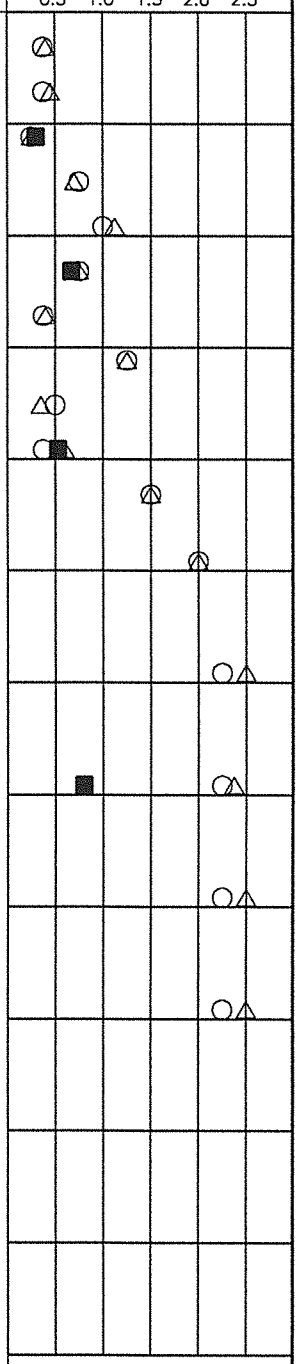
DATE : 03-26-15

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 10.0 FT.
WET ROTARY : 10.0 TO 50.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
13.7	0	7.25" Concrete				24.4			
13.1		FILL: medium stiff brown, gray and dark gray fat clay w/sand, silt seams, calcareous and ferrous nodules				25.4			
	5			81.3	97	27.7	55	22	33
7.7						25.9			
		Stiff reddish brown and gray FAT CLAY (CH) w/silt seams, ferrous nodules and ferrous stains				24.0			
	10			96.9	102	22.6	53	22	31
-0.3		-very stiff 8'-10'				24.8			
	15	-medium stiff 12'-14'				20.8			
		Very stiff gray and brown LEAN CLAY (CL) w/sand, ferrous nodules, and ferrous stains				17.8			
	20			80.5	118	16.9	26	18	8
		-medium stiff to stiff 16'-20'				16.3			
	25	-hard w/calcareous nodules 23'-30'				16.8			
		-hard 28'-30'							
-16.3	30					17.7			
		Stiff to hard yellowish brown and gray FAT CLAY (CH) w/calcareous nodules and ferrous stains							
	35	-w/clay stone 33'-40'		90.8	106	21.2	61	24	37
		-gray and reddish brown 38'-45'							
	40					24.7			
	45					22.0			
-34.8									
-36.3	50	Very dense reddish brown SILT (ML)	74	86.2		23.0			
	55								
	60								

NOTE :
Loss of circulotion between depths of 10'-20'. See Piezometer B-1P for water level measurements.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE



DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 10.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 4.3 FT.
HOLE OPEN TO 50.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-1

LOG OF BORING NO. B-2

PROJECT : Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NO. : 1140209501

LOCATION : N 13836271.70, E 3170094.86
See Plan of Borings (Figure 2)

COMPLETION DEPTH : 15.0 FT.

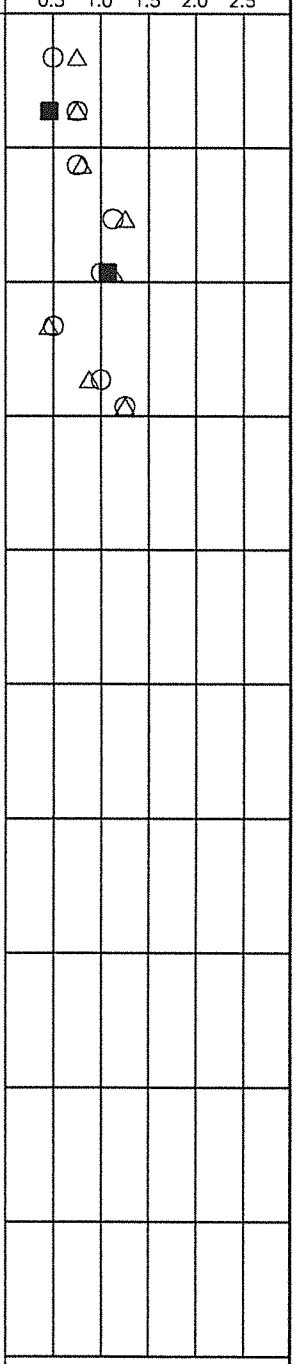
SURFACE ELEVATION : 14.47 FT.

DATE : 03-25-15

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 15.0 FT.
WET ROTARY : -- TO -- FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
14.5	0	FILL: stiff gray and brown fat clay w/sand, calcareous and ferrous nodules				13.9			
				84.6	105	21.0	51	21	30
	5	-w/limestone 0'-2' -medium stiff to stiff 2'-4'							
8.5						25.2			
		Very stiff brown and gray LEAN CLAY (CL) w/sand, ferrous nodules, and ferrous stains				19.9			
	10			85.0	109	21.1	44	19	25
		-medium stiff to stiff 10'-12'				20.3			
		-stiff to very stiff 12'-14'				19.7			
-0.5	15					23.0			
	20								
	25								
	30								
	35								
	40								
	45								
	50								



DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 15.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-2

LOG OF BORING NO. B-3

PROJECT : Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NO. : 1140209501

LOCATION : N 13836363.88, E 3170027.31
See Plan of Borings (Figure 2)

COMPLETION DEPTH : 50.0 FT.

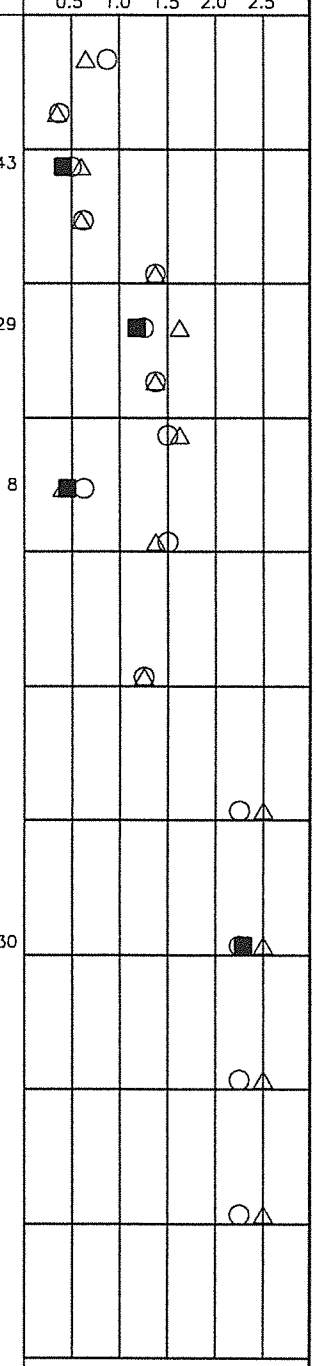
SURFACE ELEVATION : 14.73 FT.

DATE : 03-25-15

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 16.0 FT.
WET ROTARY : 16.0 TO 50.0 FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
14.7	0	FILL: stiff gray and brown sandy lean clay w/limestone				13.5			
12.7						26.2			
	5	Medium stiff brown and gray FAT CLAY (CH) w/ferrous nodules and ferrous stains		94.8	95	28.2	69	26	43
		-w/sand and calcareous nodules 2'-4'				28.8			
		-medium stiff to stiff 4'-6'				22.5			
4.7	10	-stiff 6'-8' -very stiff 8'-10'		88.5	103	21.8	49	20	29
		Very stiff gray and brown LEAN CLAY (CL) w/calcareous and ferrous nodules				23.7			
	15					26.0			
-1.3		-w/silt and sand seams 14'-16'		75.4	114	18.9	23	15	8
	20	Medium stiff to stiff brown and gray LEAN CLAY (CL) w/sand, ferrous nodules, and ferrous stains				15.2			
		-very stiff yellowish brown and gray 18'-25'							
	25	-w/calcareous nodules 23'-45'				18.8			
		-hard reddish brown and gray w/silt 28'-48'							
	30					20.8			
	35			71.6	104	16.1	48	18	30
	40					22.9			
	45					22.9			
-33.3									
-35.3	50	Very dense reddish brown SILT (ML) w/silt stone	95 / 2.0"			20.8			



DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 15.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 9.0 FT. HOLE OPEN TO 50.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-3

LOG OF BORING NO. B-4

PROJECT : Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NO. : 1140209501

LOCATION : N 13836543.03, E 3169985.77
See Plan of Borings (Figure 2)

COMPLETION DEPTH : 50.0 FT.

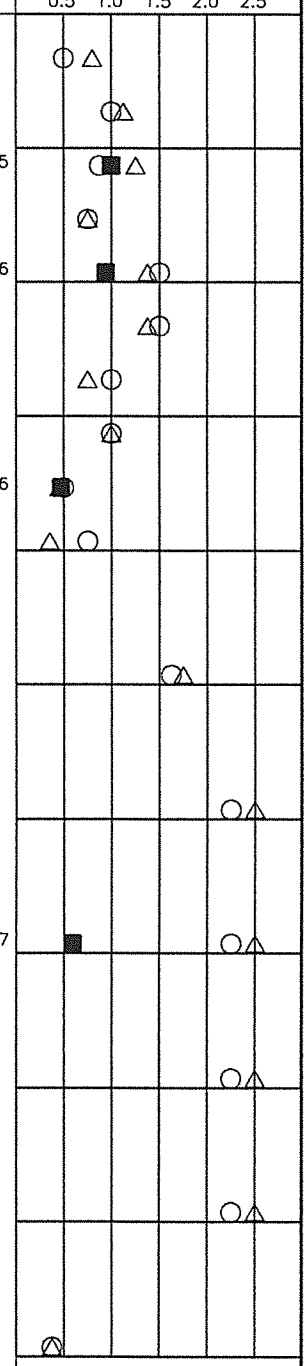
SURFACE ELEVATION : 16.38 FT.

DATE : 03-24-15

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 20.0 FT.
WET ROTARY : 20.0 TO 50.0 FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
16.4	0	FILL: stiff reddish brown and gray lean clay w/calcareous and ferrous nodules				17.3			
						17.0			
12.4	5	-very stiff 2'-4'		80.4	102	24.4	72	27	45
10.4		Stiff to very stiff yellowish brown and gray FAT CLAY (CH) w/sand, calcareous and ferrous nodules and ferrous stains				28.4			
6.4	10			90.1	105	24.6	73	27	46
		Stiff gray and yellowish brown FAT CLAY (CH) w/calcareous nodules and ferrous stains				19.0			
						19.0			
	15	-stiff to very stiff 8'-10'				19.0			
		Very stiff gray and yellowish brown SANDY LEAN CLAY (CL) w/ferrous nodules and ferrous stains		65.9		20.2	32	16	16
	20	-stiff to very stiff 12'-14'				20.1			
		-medium stiff to stiff 16'-20'							
	25	-w/calcareous nodules 23'-25'				18.1			
-11.6		Hard reddish brown and gray FAT CLAY (CH) w/calcareous and ferrous nodules and ferrous stains				19.7			
	30	-slickensided 33'-35'							
	35			90.4	109	19.5	61	24	37
		-w/sand stone 38'-40'							
	40					22.8			
	45					20.5			
-31.6		Medium stiff reddish brown LEAN CLAY (CL) w/sand							
-33.6	50					18.5			



DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 20.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 12.0 FT.
HOLE OPEN TO 50.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-4

LOG OF BORING NO. B-5

PROJECT : Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NO. : 1140209501

LOCATION : N 13836570.61, E 3169982.59
See Plan of Borings (Figure 2)

COMPLETION DEPTH : 50.0 FT.

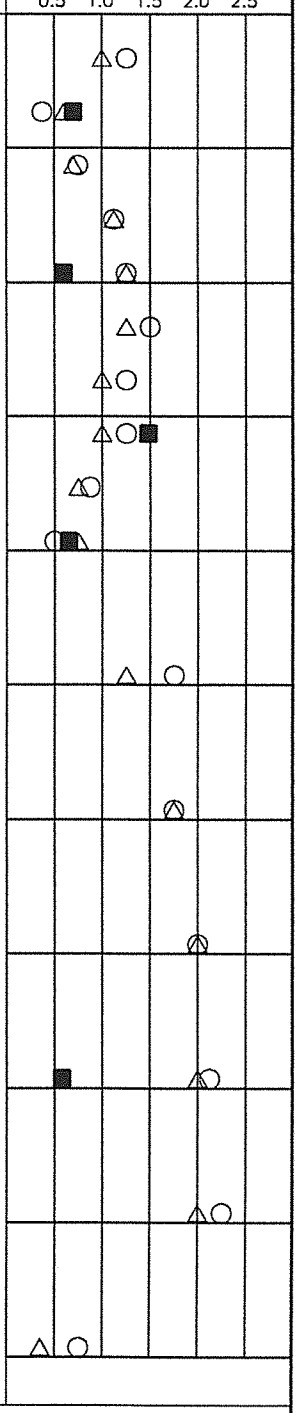
SURFACE ELEVATION : 16.43 FT.

DATE : 03-24-15

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 18.0 FT.
WET ROTARY : 18.0 TO 50.0 FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
16.4	0	Very stiff reddish brown LEAN CLAY (CL) w/sand, calcareous and ferrous nodules, and ferrous stains				16.3			
12.4	5	-medium stiff to stiff 2'-4'		77.3	118	17.5	39	15	24
						24.3			
		Stiff gray and brown FAT CLAY (CH) w/ferrous stains, calcareous and ferrous nodules				26.1			
	10	-very stiff w/sand seams 6'-8'		94.7	103	25.5	68	26	42
4.4		-stiff to very stiff 8'-10'				19.0			
		-very stiff w/sand seams 10'-12'				19.4			
	15			75.8	112	18.3	38	14	24
-1.6		Very stiff gray and brown LEAN CLAY (CL) w/sand, ferrous nodules, and ferrous stains				19.0			
	20	-stiff 16'-18'		61.0	109	19.6	31	14	17
		Stiff brown and gray SANDY LEAN CLAY (CL) w/ferrous stains and calcareous and ferrous stains				17.7			
	25	-very stiff 23'-25'							
-11.6		Very stiff reddish brown and gray FAT CLAY (CH) w/ferrous stains and calcareous and ferrous nodules				21.5			
	30	-hard 33'-35'							
	35					21.1			
		-stiff to hard 38'-40'							
	40			95.7	107	19.6	56	22	34
		-hard 43'-45'							
	45					19.3			
-31.6		Medium stiff to stiff reddish brown and gray LEAN CLAY (CL) w/sand							
-33.6	50					20.8			



DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 18.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 10.8 FT. HOLE OPEN TO 50.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-5

LOG OF BORING NO. B-6

PROJECT : Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NO. : 1140209501

LOCATION : N 13836764.47, E 3169964.15
See Plan of Borings (Figure 2)

COMPLETION DEPTH : 10.0 FT.

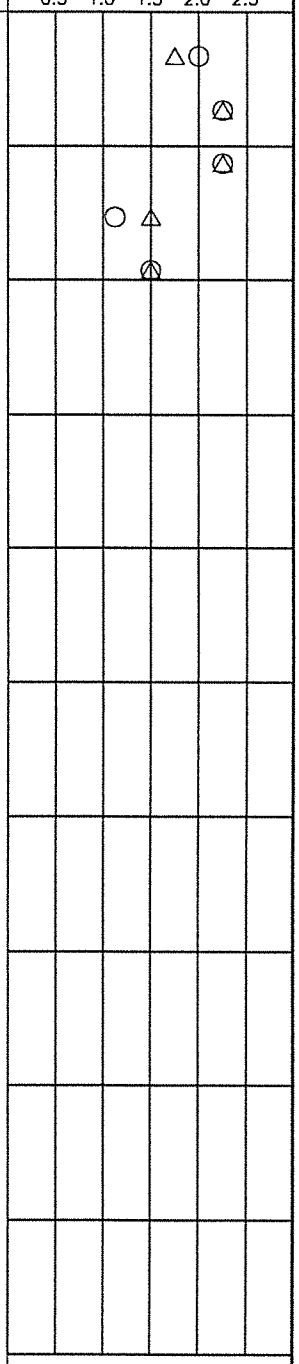
SURFACE ELEVATION : 14.34 FT.

DATE : 03-25-15

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 10.0 FT.
WET ROTARY : -- TO -- FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
14.3	0	FILL: very stiff to hard brown and gray lean clay -w/grass roots, ferrous stains, shell fragments and limestone 0'-2' -hard 2'-4'			114	17.6			
				89.3		11.1	40	16	24
10.3	5					21.2			
		Hard brown and gray FAT CLAY (CH) w/ferrous stains -very stiff 6'-10'		98.7		27.8	80	29	51
4.3	10					22.2			
	15								
	20								
	25								
	30								
	35								
	40								
	45								
	50								



DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 10.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-6

LOG OF BORING NO. B-7

PROJECT : Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NO. : 1140209501

LOCATION : N 13836114.25, E 3170075.04
See Plan of Borings (Figure 2)

COMPLETION DEPTH : 50.0 FT.

SURFACE ELEVATION : 14.08 FT.

DATE : 11-12-15

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 18.0 FT.
WET ROTARY : 18.0 TO 50.0 FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
14.1	0	FILL: medium stiff to stiff gray sandy lean clay -medium stiff 2'-8'				19.6			
				63.3	103	22.7	36	18	19
	5					25.8			
						22.3			
6.1		Soft to stiff brown and gray SANDY FAT CLAY (CH) w/calcareous and ferrous nodules -stiff to very stiff 10'-12' -very stiff 12'-15'		60.3	96	22.9	52	22	31
	10					20.6			
						23.3			
						23.6			
-0.9	15	Loose brown SILT (ML) w/sand				16.1			
			8	77.2		17.0			
-4.4		Gray SANDY LEAN CLAY (CL)	6			18.8			
-5.9	20	Stiff to hard reddish brown and gray FAT CLAY (CH) w/calcareous nodules							
	25			88.7	119	16.4	52	22	30
	30					18.1			
	35			91.5	109	20.6	59	24	35
		-very stiff 38'-40'							
	40					29.6			
	45			94.0	102	22.7	56	22	34
-32.9		Stiff to very stiff gray and brown LEAN CLAY (CL) w/sand							
-35.9	50					22.0			

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 18.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 14.2 FT. HOLE OPEN TO 50.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-7

LOG OF BORING NO. B-8

PROJECT : Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NO. : 1140209501

LOCATION : N 13836116.67, E 3170117.39
See Plan of Borings (Figure 2)

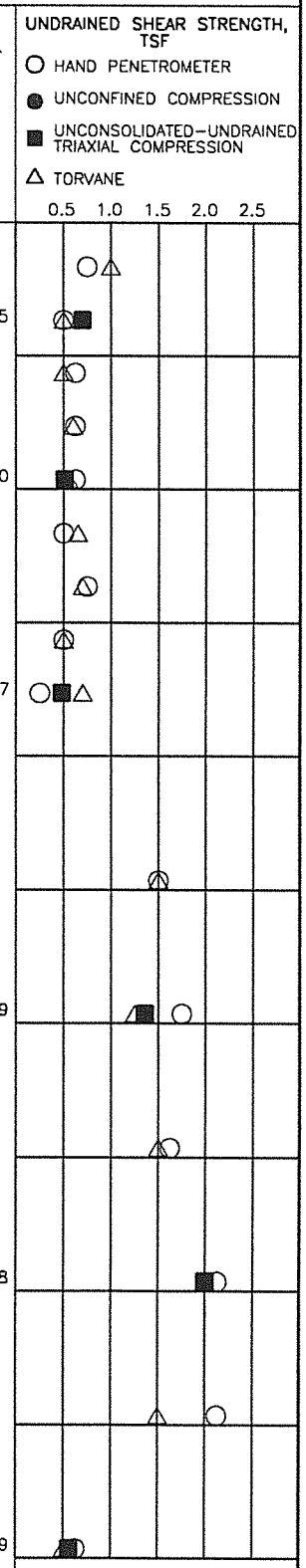
COMPLETION DEPTH : 50.0 FT.

SURFACE ELEVATION : 14.27 FT.

DATE : 11-12-15

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 20.0 FT.
WET ROTARY : 20.0 TO 50.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
14.3	0	FILL: stiff to very stiff gray and brown lean clay w/sand -stiff 0'-6'				16.3			
				77.0	113	20.5	44	19	25
	5					23.5			
6.3						21.6			
		Stiff dark gray and brown FAT CLAY (CH) w/sand and ferrous nodules		83.1	97	23.5	51	21	30
	10					28.4			
						28.0			
	15					26.0			
-1.7		Medium stiff to stiff gray SILTY CLAY (CL-ML) w/sand and ferrous nodules		81.1	112	17.8	22	15	7
	20		7	80.5		18.0			
-7.7		Very stiff gray and brown FAT CLAY (CH) w/calcareous and ferrous nodules							
	25					18.5			
	30			87.3	115	17.4	51	22	29
	35					20.3			
-23.7		Hard reddish brown and gray LEAN CLAY (CL) w/calcareous and ferrous nodules -very stiff to hard 43'-45'							
	40			97.8	105	20.4	49	21	28
	45					22.1			
		-stiff 48'-50'							
-35.7	50			97.3	104	21.2	29	21	9



DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 20.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 14.7 FT. HOLE OPEN TO 50.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-8

LOG OF BORING NO. B-9

PROJECT : Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Hauston, Texas

PROJECT NO. : 1140209501

LOCATION : N 13836599.59, E 3170126.88
See Plan of Borings (Figure 2)

COMPLETION DEPTH : 15.0 FT.

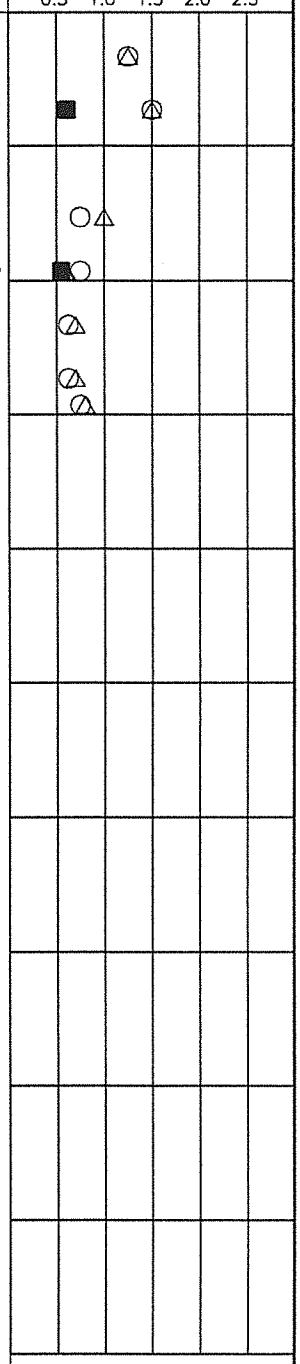
SURFACE ELEVATION : 11.24 FT.

DATE : 11-12-15

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 15.0 FT.
WET ROTARY : -- TO -- FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
11.2 (0)	FILL: very stiff gray fat clay w/sand, calcareous and ferrous nodules				19.5			
7.2	-stiff to very stiff 2'-4'		75.2	101	26.2	60	21	39
5.2 (5)	Loose gray SANDY SILT (ML) w/clay	8	50.4		26.9			
3.2	Stiff to very stiff gray FAT CLAY (CH) w/ferrous nodules				33.6			
(10)			94.8	99	30.8	46	21	25
	Stiff reddish brown and gray LEAN CLAY (CL) w/calcareous and ferrous nodules				25.0			
					27.8			
-3.8 (15)					22.0			



DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 15.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-9

LOG OF BORING NO. B-10

PROJECT : Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NO. : 1140209501

LOCATION : N 13836691.19, E 3170165.52
See Plan of Borings (Figure 2)

COMPLETION DEPTH : 15.0 FT.

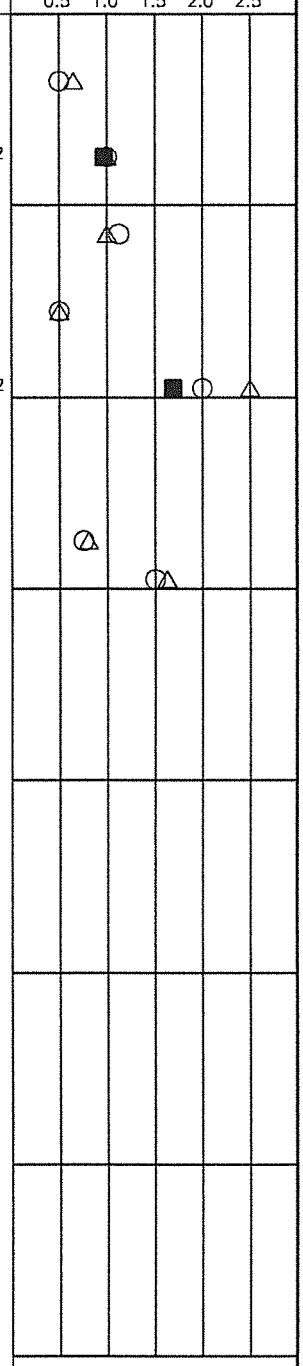
SURFACE ELEVATION : 14.14 FT.

DATE : 11-12-15

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 15.0 FT.
WET ROTARY : -- TO -- FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
14.1	0	FILL: stiff gray fat clay w/sand and ferrous stains				30.5			
		-very stiff 4'-6'		76.7	107	25.2	52	20	32
	5					22.5			
8.1		Stiff to hard gray SANDY FAT CLAY (CH) w/calcareous and ferrous nodules				28.3			
				65.7	107	22.7	68	26	42
4.1	10	Medium dense gray SILTY SAND (SM)	12	29.9		19.1			
1.6		Stiff to very stiff reddish brown FAT CLAY (CH) w/sand seams				32.0			
-0.9	15					25.4			
	20								
	25								
	30								
	35								



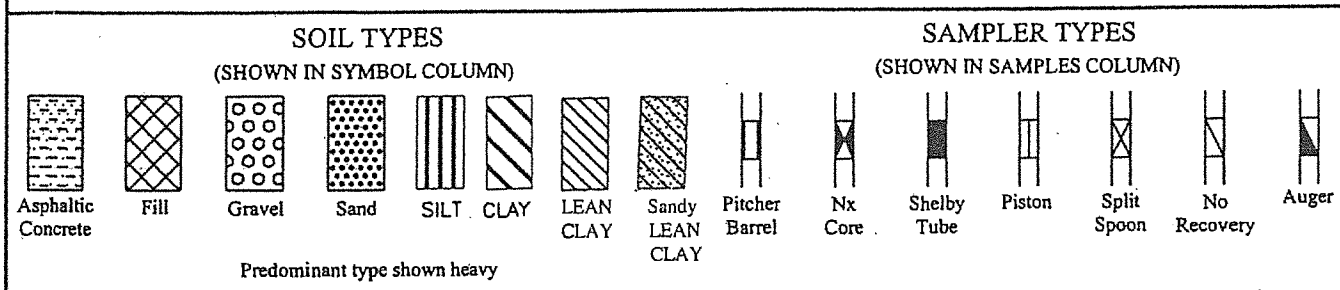
DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 15.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-10

Job No. 1140209501

SYMBOLS AND TERMS USED ON BORING LOGS



TERMS DESCRIBING CONSISTENCY OR CONDITION

Basic Soil Type	Density or Consistency	Standard Penetration Resistance, (1) Blows/ft.	Unconfined Compressive Strength (q_u), (2) Tons/sq. ft.
Cohesionless	Very loose	Less than 4	Not applicable
	Loose	4 to <10	Not applicable
	Medium dense	10 to <30	Not applicable
	Dense	30 to <50	Not applicable
	Very dense	50 or greater	Not applicable
Cohesive	Very soft	Less than 2	Less than 0.25
	Soft	2 to <4	0.25 to <0.5
	Firm/Medium stiff	4 to <8	0.5 to <1.0
	Stiff	8 to <15	1.0 to <2.0
	Very stiff	15 to <30	2.0 to <4.0
	Hard	30 or greater	4 or greater

(1) Number of blows from 140-lb. weight falling 30-in. to drive 2-in. OD, 1-3/8-in. ID, split barrel sampler (ASTM D1586)

(2) q_u may also be approximated using a pocket penetrometer

TERMS CHARACTERIZING SOIL STRUCTURE

Parting: -paper thin in size Seam: -1/8" to 3" thick Layer: -greater than 3"

Slickensided	- having inclined planes of weakness that are slick and glossy in appearance.
Fissured	- containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated	- composed of thin layers of varying color and texture.
Interbedded	- composed of alternate layers of different soil types.
Calcareous	- containing appreciable quantities of calcium carbonate.
Well graded	- having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Poorly graded	- predominantly of one grain size, or having a range of sizes with some intermediate size missing.
Flocculated	- pertaining to cohesive soils that exhibit a loose knit or flakey structure.

Job No. 1140209501

PIEZOMETER INSTALLATION REPORT

PROJECT NAME: CLEARWELL CONDITION ASSESSMENT AND REPLACEMENT OF SELECTED VALVES AND ACTUATORS; EWPP	PIEZOMETER NUMBER: B-1P

GEOTECHNICAL CONSULTANT GEOTEST ENGINEERING, INC.	DESIGN CONSULTANT CAROLLO ENGINEERS, INC	HOUSTON, TEXAS

COMPLETION DATE 03-26-15

DRY AUGERED 0 TO 10 FT

WASH BORED 10 TO 50 FT

DRILLING FLUID: WATER

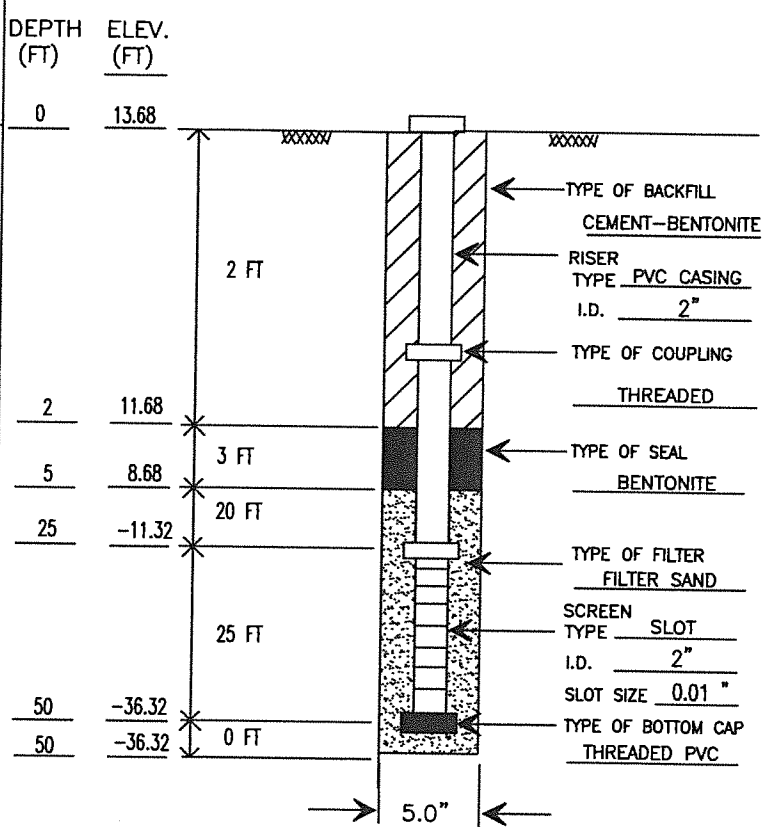
DEVELOPMENT DATE: 03-26-15

METHOD OF DEVELOPMENT:

BAILING

WATER LEVEL READINGS:

DATE	DEPTH (TOG)	ELEVATION
03-27-15	10	3.7
04-28-15	10	3.7



(NOT TO SCALE)

REMARKS:

NOTES:

1. DIMENSIONS NOMINAL UNLESS OTHERWISE NOTED
2. TOG = TOP OF GROUND

DRILLED BY: ET	STARTED: 03-25-15	NORTHING: 13836146.42 EASTING: 3170043.14
LOGGED BY: TM	COMPLETED: 03-26-15	GROUND LEVEL (MSL): 13.68
CHECKED BY: NK	APPROVED BY: MB	SHEET 1 OF 1

APPENDIX B

	Figure
Summary of Laboratory Test Data	B-1 thru B-10
Grain Size Distribution Curves	B-11 and B-12
California Bear Ratio Test Results	B-13a thru B-13c
Dry Density versus CBR	B-13d
One-Dimensional Swell Test Results	B-14

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NUMBER: 1140209501

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
B-1 (B-1P)	2	0.6	2.0	UD		24									0.40	0.38	Fill
	3	2.0	4.0	UD		25									0.45	0.38	Fill
	4	4.0	6.0	UD		28	97	55	22	33	81		0.30	0.43	0.25	0.25	Fill
	5	6.0	8.0	UD		26									0.70	0.75	Fat Clay
	6	8.0	10.0	UD		24									1.13	1.00	Fat Clay
	7	10.0	12.0	UD		23	102	53	22	31	97		0.67	0.86	0.75	0.75	Fat Clay
	8	12.0	14.0	UD		25									0.40	0.38	Fat Clay
	9	14.0	16.0	UD		21									1.25	1.25	Lean Clay
	10	16.0	18.0	UD		18									0.35	0.50	Lean Clay
	11	18.0	20.0	UD		17	118	26	18	8	81		0.53	1.44	0.60	0.38	Lean Clay
	12	20.0	22.0	UD		16									1.50	1.50	Lean Clay
	13	23.0	25.0	UD		17									2.00	2.00	Lean Clay
	14	28.0	30.0	UD		18									2.50	2.25	Lean Clay
	15	33.0	35.0	UD		21	106	61	24	37	91		0.80	2.52	2.38	2.25	Fat Clay
	16	38.0	40.0	UD		25									2.50	2.25	Fat Clay
	17	43.0	45.0	UD		22									2.50	2.25	Fat Clay
	18	48.5	50.0	SS	74	23					86						Silt

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-1

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NUMBER: 1140209501

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
B-2	1	0.0	2.0	UD		14									0.75	0.50	Fill
	2	2.0	4.0	UD		21	105	51	21	30	85		0.46	0.29	0.75	0.75	Fill
	3	4.0	6.0	UD		25									0.80	0.75	Fill
	4	6.0	8.0	UD		20									1.25	1.13	Lean Clay
	5	8.0	10.0	UD		21	109	44	19	25	85		1.07	0.72	1.13	1.00	Lean Clay
	6	10.0	12.0	UD		20									0.45	0.50	Lean Clay
	7	12.0	14.0	UD		20									0.88	1.00	Lean Clay
	8	14.0	15.0	UD		23									1.25	1.25	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-2

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NUMBER: 1140209501

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
B-3	1	0.0	2.0	UD		13									0.65	0.88	Fill
	2	2.0	4.0	UD		26									0.35	0.38	Fat Clay
	3	4.0	6.0	UD		28	95	69	26	43	95		0.41	0.43	0.60	0.50	Fat Clay
	4	6.0	8.0	UD		29									0.60	0.63	Fat Clay
	5	8.0	10.0	UD		23									1.38	1.38	Fat Clay
	6	10.0	12.0	UD		22	103	49	20	29	88		1.18	0.86	1.63	1.25	Lean Clay
	7	12.0	14.0	UD		24									1.38	1.38	Lean Clay
	8	14.0	16.0	UD		26									1.63	1.50	Lean Clay
	9	16.0	18.0	UD		19	114	23	15	8	75		0.45	1.30	0.40	0.63	Lean Clay
	10	18.0	20.0	UD		15									1.38	1.50	Lean Clay
	11	23.0	25.0	UD		19									1.25	1.25	Lean Clay
	12	28.0	30.0	UD		21									2.50	2.25	Lean Clay
	13	33.0	35.0	UD		16	104	48	18	30	72		2.29	2.52	2.50	2.25	Lean Clay
	14	38.0	40.0	UD		23									2.50	2.25	Lean Clay
	15	43.0	45.0	UD		23									2.50	2.25	Lean Clay
	16	48.5	50.0	SS	95/2.0"	21											Silt

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-3

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NUMBER: 1140209501

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
B-4	1	0.0	2.0	UD		17									0.80	0.50	Fill
	2	2.0	4.0	UD		17									1.13	1.00	Fill
	3	4.0	6.0	UD		24	102	72	27	45	80		1.00	0.43	1.25	0.88	Fat Clay
	4	6.0	8.0	UD		28									0.75	0.75	Fat Clay
	5	8.0	10.0	UD		25	105	73	27	46	90		0.94	0.72	1.38	1.50	Fat Clay
	6	10.0	12.0	UD		19									1.38	1.50	Sandy Lean Clay
	7	12.0	14.0	UD		19									0.75	1.00	Sandy Lean Clay
	8	14.0	16.0	UD		19									1.00	1.00	Sandy Lean Clay
	9	16.0	18.0	UD		20		32	16	16	66		0.47	1.30	0.45	0.50	Sandy Lean Clay
	10	18.0	20.0	UD		20									0.35	0.75	Sandy Lean Clay
	11	23.0	25.0	UD		18									1.75	1.63	Sandy Lean Clay
	12	28.0	30.0	UD		20									2.50	2.25	Fat Clay
	13	33.0	35.0	UD		20	109	61	24	37	90		0.59	2.52	2.50	2.25	Fat Clay
	14	38.0	40.0	UD		23									2.50	2.25	Fat Clay
	15	43.0	45.0	UD		21									2.50	2.25	Fat Clay
	16	48.0	50.0	UD		19									0.38	0.38	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-4

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NUMBER: 1140209501

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
B-5	1	0.0	2.0	UD		16									1.00	1.25	Lean Clay
	2	2.0	4.0	UD		18	118	39	15	24	77		0.70	0.29	0.60	0.38	Lean Clay
	3	4.0	6.0	UD		24									0.70	0.75	Fat Clay
	4	6.0	8.0	UD		26									1.13	1.13	Fat Clay
	5	8.0	10.0	UD		25	103	68	26	42	95		0.60	0.72	1.25	1.25	Fat Clay
	6	10.0	12.0	UD		19									1.25	1.50	Fat Clay
	7	12.0	14.0	UD		19									1.00	1.25	Lean Clay
	8	14.0	16.0	UD		18	112	38	14	24	76		1.48	1.15	1.00	1.25	Lean Clay
	9	16.0	18.0	UD		19									0.75	0.88	Lean Clay
	10	18.0	20.0	UD		20	109	31	14	17	61		0.65	1.44	0.75	0.50	Sandy Lean Clay
	11	23.0	25.0	UD		18									1.25	1.75	Sandy Lean Clay
	12	28.0	30.0	UD		22									1.75	1.75	Fat Clay
	13	33.0	35.0	UD		21									2.00	2.00	Fat Clay
	14	38.0	40.0	UD		20	107	56	22	34	96		0.58	2.88	2.00	2.13	Fat Clay
	15	43.0	45.0	UD		19									2.00	2.25	Fat Clay
	16	48.0	50.0	UD		21									0.35	0.75	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-5

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NUMBER: 1140209501

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
B-6	1	0.0	2.0	UD		18	114								1.75	2.00	Fill
	2	2.0	4.0	UD		11		40	16	24	89				2.25	2.25	Fill
	3	4.0	6.0	UD		21									2.25	2.25	Fat Clay
	4	6.0	8.0	UD		28		80	29	51	99				1.50	1.13	Fat Clay
	5	8.0	10.0	UD		22									1.50	1.50	Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-6

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NUMBER: 1140209501

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
B-7	1	0.0	2.0	UD		20									0.60	0.38	Fill
	2	2.0	4.0	UD		23	103	36	18	19	63		0.28	0.29	0.40	0.25	Fill
	3	4.0	6.0	UD		26									0.30	0.25	Fill
	4	6.0	8.0	UD		22									0.30	0.25	Fill
	5	8.0	10.0	UD		23	96	52	22	31	60		0.22	0.72	0.40	0.63	Sandy Fat Clay
	6	10.0	12.0	UD		21									0.70	1.00	Sandy Fat Clay
	7	12.0	14.0	UD		23									1.25	1.13	Sandy Fat Clay
	8	14.0	15.0	UD		24									1.25	1.00	Sandy Fat Clay
	9	15.0	16.0	UD		16											Silt
	10	16.5	18.0	SS	8	17					77						Silt
	11	18.5	20.0	SS	6	19											Sandy Lean Clay
	12	23.0	25.0	UD		16	119	52	22	30	89		2.10	1.80	0.80	2.25	Fat Clay
	13	28.0	30.0	UD		18									0.80	2.25	Fat Clay
	14	33.0	35.0	UD		21	109	59	24	35	92		0.51	2.52	0.80	2.25	Fat Clay
	15	38.0	40.0	UD		30									1.25	1.25	Fat Clay
	16	43.0	45.0	UD		23	102	56	22	34	94		2.05	3.24	0.70	1.75	Fat Clay
	17	48.0	50.0	UD		22									0.75	1.00	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-7

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NUMBER: 1140209501

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
B-8	1	0.0	2.0	UD		16									1.00	0.75	Fill
	2	2.0	4.0	UD		21	113	44	19	25	77		0.70	0.29	0.50	0.50	Fill
	3	4.0	6.0	UD		24									0.50	0.63	Fill
	4	6.0	8.0	UD		22									0.60	0.63	Fill
	5	8.0	10.0	UD		24	97	51	21	30	83		0.51	0.72	0.55	0.63	Fat Clay
	6	10.0	12.0	UD		28									0.65	0.50	Fat Clay
	7	12.0	14.0	UD		28									0.70	0.75	Fat Clay
	8	14.0	16.0	UD		26									0.50	0.50	Fat Clay
	9	16.0	18.0	UD		18	112	22	15	7	81		0.48	1.30	0.70	0.25	Silty Clay
	10	18.5	20.0	SS	7	18					81						Silty Clay
	11	23.0	25.0	UD		19									1.50	1.50	Fat Clay
	12	28.0	30.0	UD		17	115	51	22	29	87		1.36	2.16	1.25	1.75	Fat Clay
	13	33.0	35.0	UD		20									1.50	1.63	Fat Clay
	14	38.0	40.0	UD		20	105	49	21	28	98		2.00	2.88	2.00	2.13	Lean Clay
	15	43.0	45.0	UD		22									1.50	2.13	Lean Clay
	16	48.0	50.0	UD		21	104	29	21	9	97		0.56	3.60	0.50	0.63	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-8

SUMMARY OF LABORATORY TEST RESULTS

CEOTEST ENGINEERING, INC.

PROJECT NAME: Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NUMBER: 1140209501

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Tap	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
B-9	1	0.0	2.0	UD		19									1.25	1.25	Fill
	2	2.0	4.0	UD		26	101	60	21	39	75		0.61	0.29	1.50	1.50	Fill
	3	4.5	6.0	SS	8	27					50						Sandy Silt
	4	6.0	8.0	UD		34									1.00	0.75	Fat Clay
	5	8.0	10.0	UD		31	99	46	21	25	95		0.55	0.72	0.60	0.75	Lean Clay
	6	10.0	12.0	UD		25									0.70	0.63	Lean Clay
	7	12.0	14.0	UD		28									0.70	0.63	Lean Clay
	8	14.0	15.0	UD		22									0.80	0.75	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-9

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Clearwell Condition Assessment and Replacement of Selected Valves and Actuators; East Water Purification Plant (EWPP); WBS No. S-000056-0070-4; Houston, Texas

PROJECT NUMBER: 1140209501

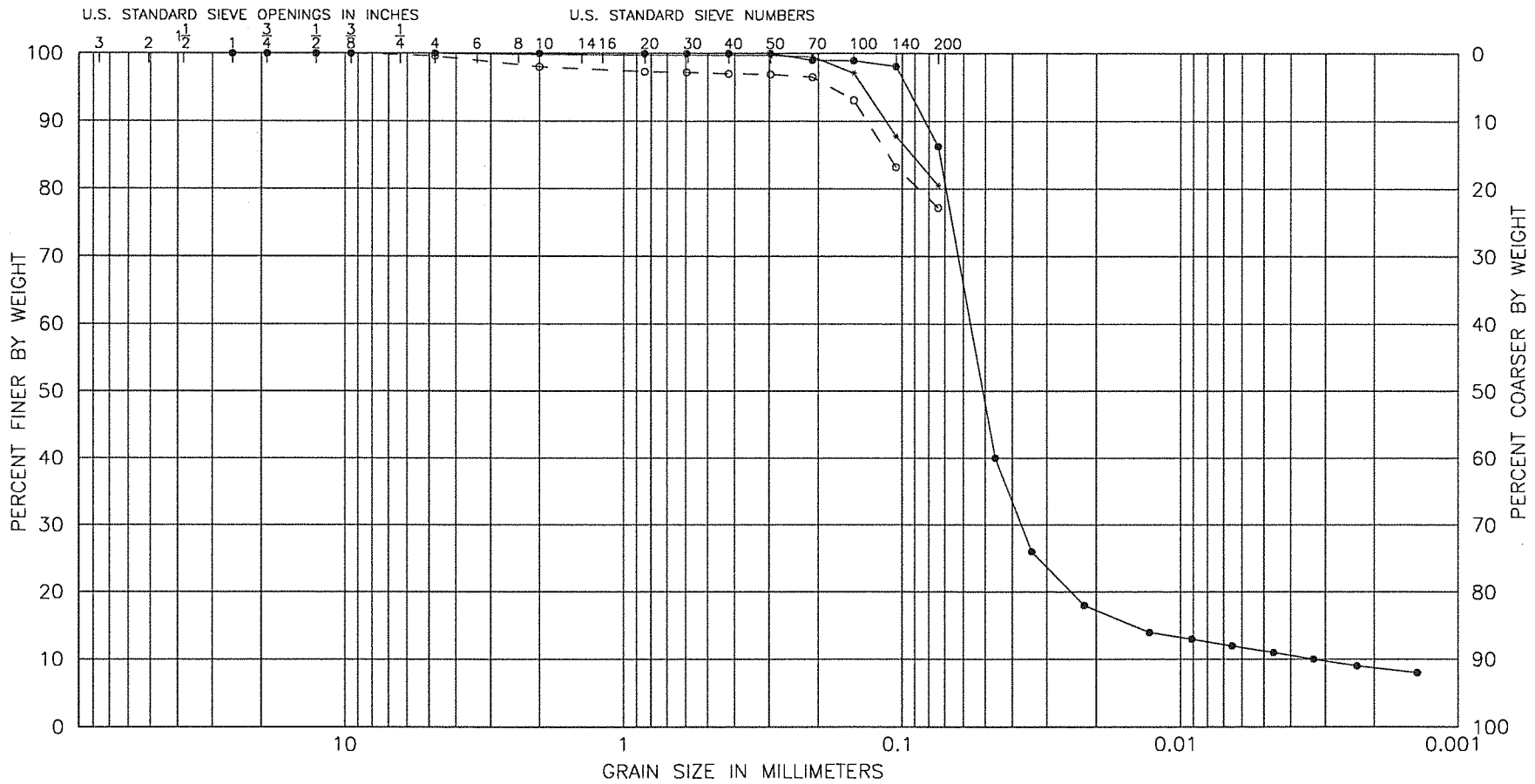
BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
B-10	1	0.0	2.0	UD		31									0.65	0.50	Fill
	2	2.0	4.0	UD		25	107	52	20	32	77		0.97	0.29	1.00	1.00	Fill
	3	4.0	6.0	UD		23									1.00	1.13	Fill
	4	6.0	8.0	UD		28									0.50	0.50	Sandy Fat Clay
	5	8.0	10.0	UD		23	107	68	26	42	66		1.69	0.72	2.50	2.00	Sandy Fat Clay
	6	10.5	12.0	SS	12	19					30						Silty Sand
	7	12.0	14.0	UD		32									0.80	0.75	Fat Clay
	8	14.0	15.0	UD		25									1.63	1.50	Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-10

Job No. 1140209501



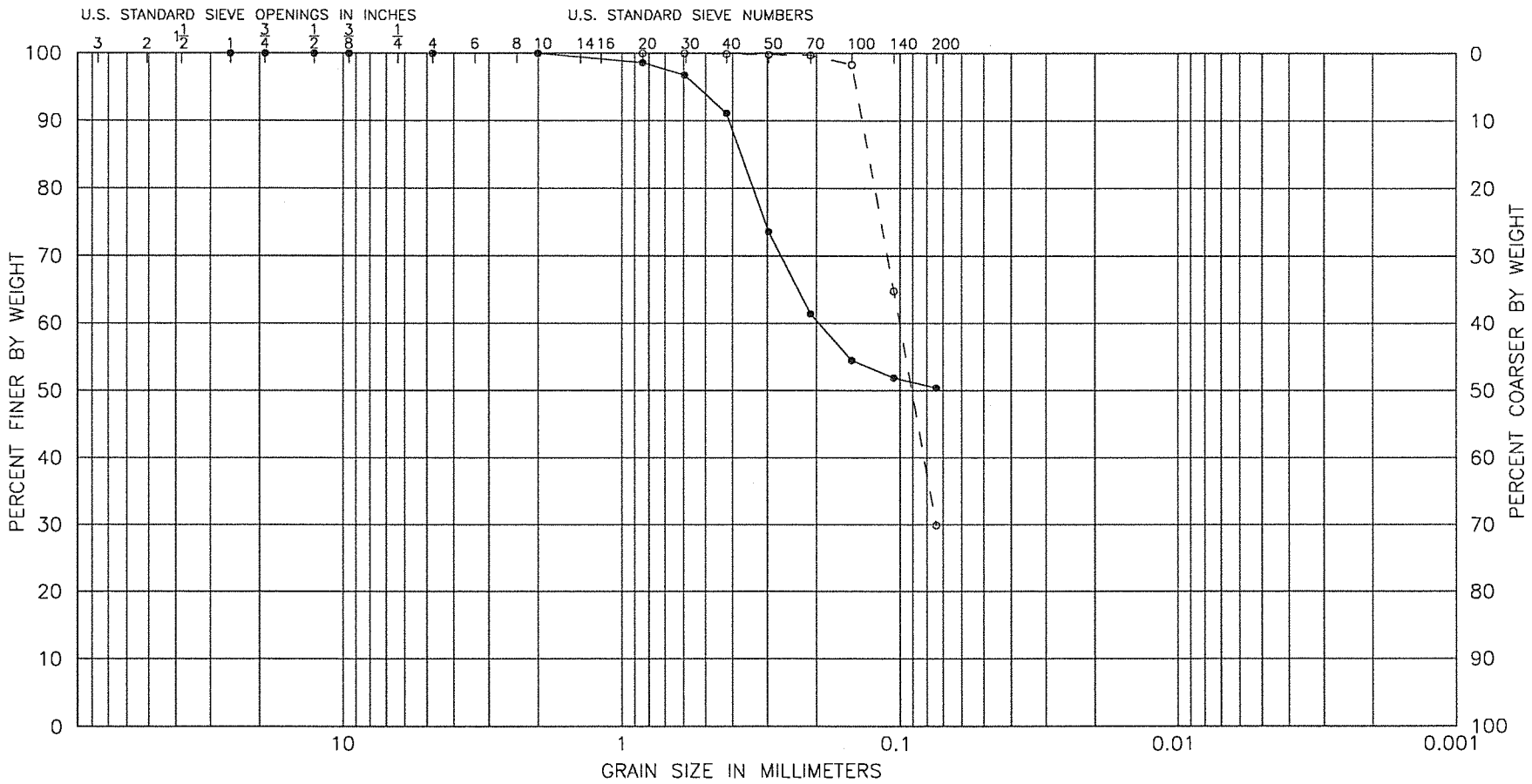
LEGEND	BORING NO.	SAMPLE NO.	DEPTH FT.	SAMPLE DESCRIPTION
●—●—●—●	B–1	S–17	48.5–50.0	Reddish brown silt
○—○—○—○	B–7	S–10	16.5–18.0	Brown silt w/sand
×—×—×—×	B–8	S–10	18.5–20.0	Gray silty clay w/sand

GRAIN SIZE DISTRIBUTION CURVES

Geotest Engineering, Inc.

FIGURE B–11

Job No. 1140209501



LEGEND	BORING NO.	SAMPLE NO.	DEPTH FT.	SAMPLE DESCRIPTION
●●●●●	B–9	S–3	4.5–6.0	Gray sandy silt w/clay
○○○○○	B–10	S–6	10.5–12.0	Gray silty sand

GRAIN SIZE DISTRIBUTION CURVES

Geotest Engineering, Inc.

FIGURE B–12

CALIFORNIA BEARING RATIO (CBR) OF LABORATORY-COMPACTED SOILS

ASTM D1883

Project: Clearwell Condition Assessment and Replacement of Selected valves and Actuators; East Water Purification Plant(EWPP)

Job No.: 1140209501

Sample Location: Composite sample from borings GB-4 to GB-6 (0'-4')

Sample Description: Grayish brown sandy clay(CL)

Liquid Limit: 43 **Plastic Limit:** 18 **Plasticity Index:** 25

Method of Compaction: ☒ ASTM D698
☐ ASTM D1557

Blows per layer: 10

Sample Condition: ☒ soaked ☐ unsoaked

Dry Density before soaking 86.7 pcf

Dry Density after soaking 83.1 pcf

Moisture Content:

Before compaction	14.6 %
After compaction	14.2 %
Top 1-in layer after soaking	26.2 %
Average after soaking	25.0 %

Swell 4.32 %

Bearing Ratio 0.10 % (☒ soaked ☐ unsoaked)

Surcharge 10 lbs

CALIFORNIA BEARING RATIO (CBR) OF LABORATORY-COMPACTED SOILS

ASTM D1883

Project: Clearwell Condition Assessment and Replacement of Selected valves and Actuators; East Water Purification Plant(EWPP)

Job No.: 1140209501

Sample Location: Composite sample from borings GB-4 to GB-6 (0'-4')

Sample Description: Grayish brown sandy clay(CL)

Liquid Limit: 43 **Plastic Limit:** 18 **Plasticity Index:** 25

Method of Compaction: ☒ ASTM D698
☐ ASTM D1557

Blows per layer: 25

Sample Condition: ☒ soaked ☐ unsoaked

Dry Density before soaking 98.8 pcf

Dry Density after soaking 95.5 pcf

Moisture Content:

Before compaction	14.4 %
After compaction	13.6 %
Top 1-in layer after soaking	24.6 %
Average after soaking	22.3 %

Swell 3.44 %

Bearing Ratio 0.43 % (☒ soaked ☐ unsoaked)

Surcharge 10 lbs

CALIFORNIA BEARING RATIO (CBR) OF LABORATORY-COMPACTED SOILS

ASTM D1883

Project: Clearwell Condition Assessment and Replacement of Selected valves and Actuators; East Water Purification Plant(EWPP)

Job No.: 1140209501

Sample Location: Composite sample from borings GB-4 to GB-6 (0'-4')

Sample Description: Grayish brown sandy clay(CL)

Liquid Limit: 43 **Plastic Limit:** 18 **Plasticity Index:** 25

Method of Compaction: ☒ ASTM D698
☐ ASTM D1557

Blows per layer: 56

Sample Condition: ☒ soaked ☐ unsoaked

Dry Density before soaking 108.9 pcf

Dry Density after soaking 105.7 pcf

Moisture Content:

Before compaction	14.2 %
After compaction	13.7 %
Top 1-in layer after soaking	23.8 %
Average after soaking	20.0 %

Swell 3.04 %

Bearing Ratio 1.61 % (☒ soaked ☐ unsoaked)

Surcharge 10 lbs

Job No. 11401209501

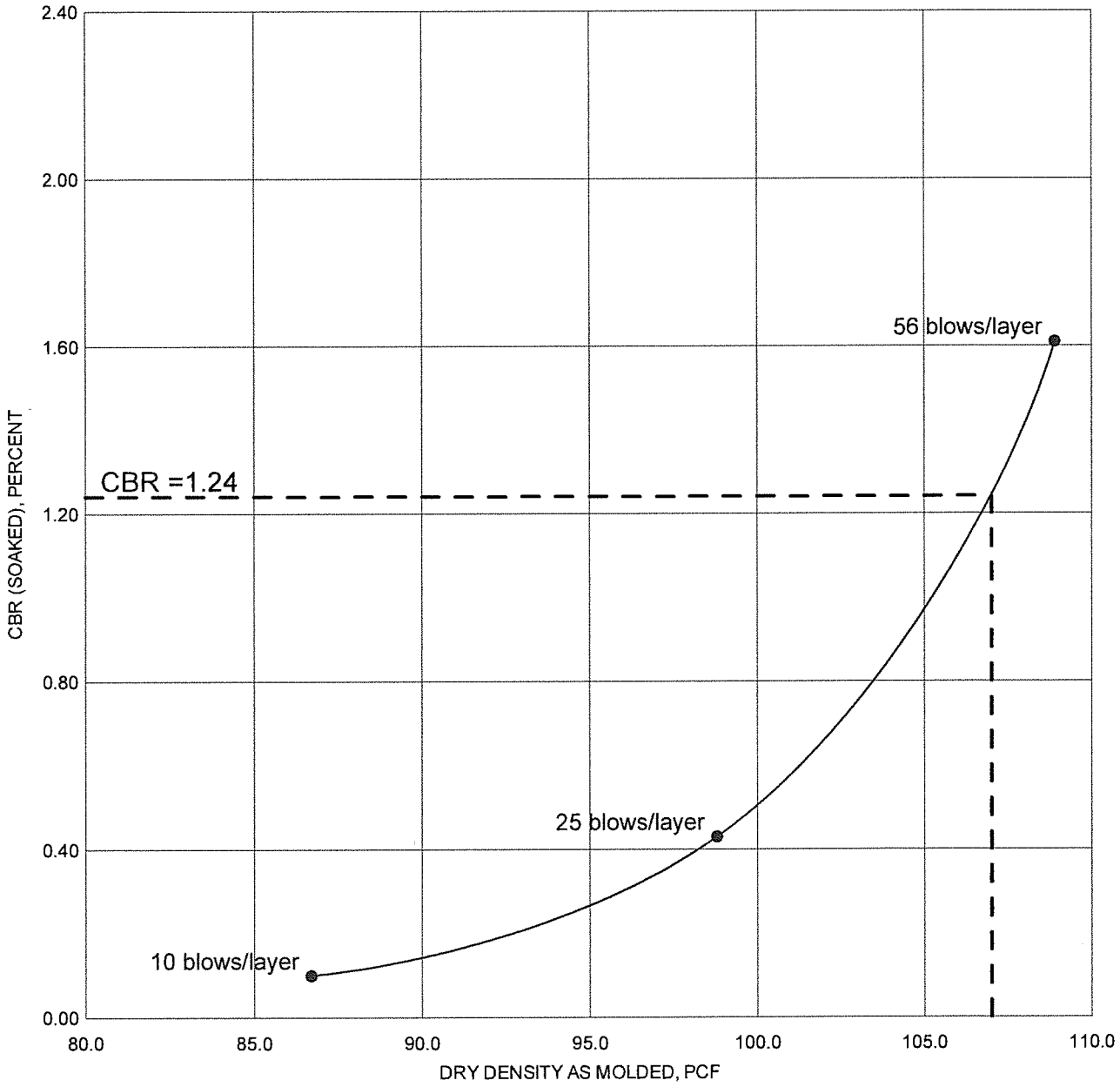
Project: Clearwell Condition Assessment and Replacement of Selected valves and Actuators;East Water Purification Plant(EWPP)

Sample Location: GB-4 to GB-6 (0'-4')

Sample Description: Grayish brown sandy clay(CL)

Liquid Limit: 43 **Plastic Limit:** 18 **Plasticity Index:** 25

Dry Density (pcf): 107



DRY DENSITY VERSUS CBR
(ASTM D 1883)

Geotest Engineering, Inc.

FIGURE B-13d

Report No. 1140209501

Project: Clearwell Condition Assessment & Replacement of Selected Valved and Actuators, Houston, Texas

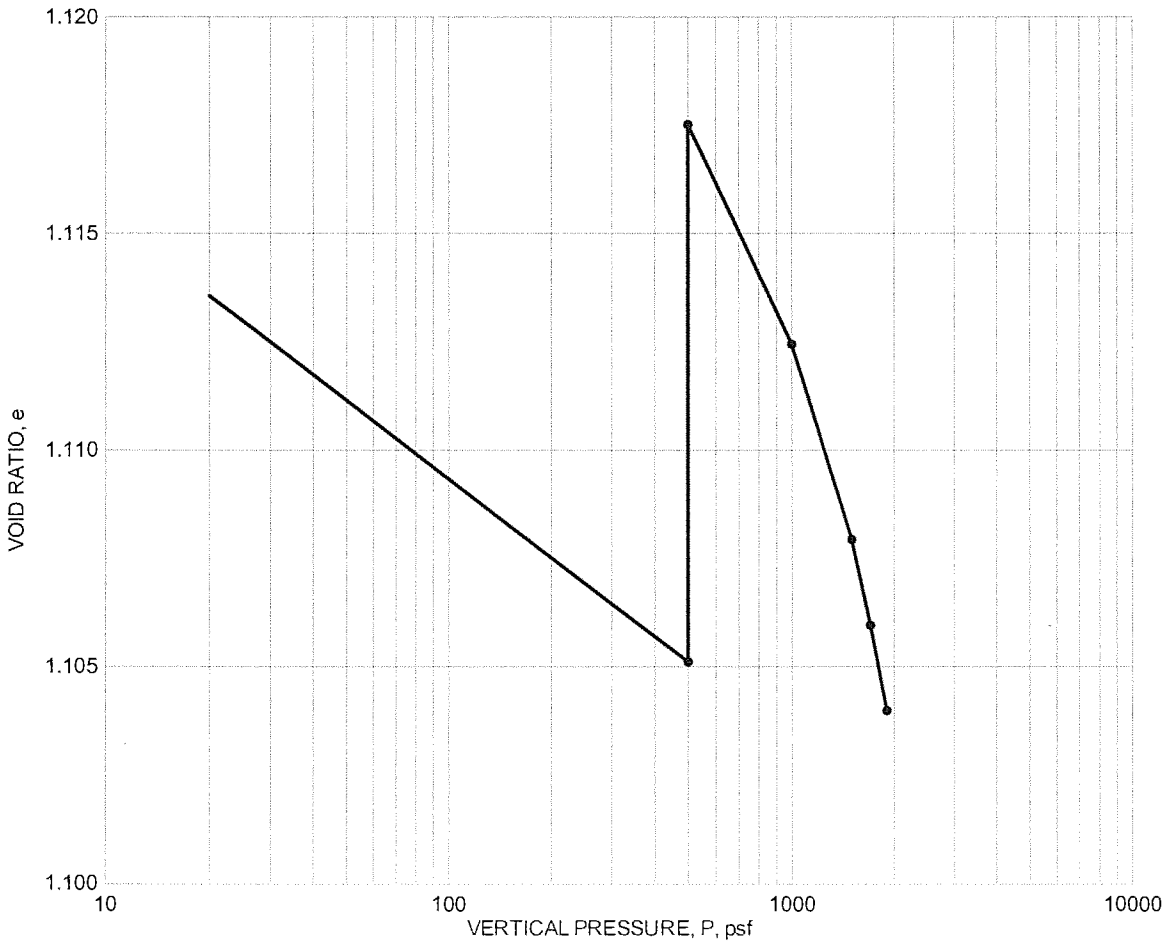
Boring No.: B-1 Sample No. 13 Depth (ft): 28-30

Description: Gray and brown Lean Clay w/sand

Dry Unit Weight (pcf): 105 Specific Gravity: 2.68

Initial Moisture Content (%): 18 Final Moisture Content (%): 26

Swell Pressure (ksf): 1.8



SWELL TEST RESULTS

Geotest Engineering, Inc.

FIGURE B-14

APPENDIX C

Aggressivity Test Report

Analytical Report 506929

for

Geotest Engineering, Inc.

Project Manager: Naresh Kolli

Clearwell Condition Assessment

1140209501

06-MAY-15

Collected By: Client

4143 Greenbriar Dr., Stafford, TX 77477

Xenco-Houston (EPA Lab code: TX00122):
Texas (T104704215-14-18), Arizona (AZ0765), Florida (E871002), Louisiana (03054)
New Jersey (TX007), North Carolina(681), Oklahoma (9218), Pennsylvania (68-03610)

Xenco-Atlanta (EPA Lab Code: GA00046):
Florida (E87429), North Carolina (483), South Carolina (98015), Kentucky (85), DoD (L10-135)
Texas (T104704477), Louisiana (04176), USDA (P330-07-00105)

Xenco-Lakeland: Florida (E84098)
Xenco-Odessa (EPA Lab code: TX00158): Texas (T104704400-TX)
Xenco-Dallas (EPA Lab code: TX01468): Texas (T104704295-TX)
Xenco Phoenix (EPA Lab Code: AZ00901): Arizona(AZ0757)
Xenco-Phoenix Mobile (EPA Lab code: AZ00901): Arizona (AZM757)
Xenco Tucson (EPA Lab code:AZ000989): Arizona (AZ0758)

06-MAY-15

Project Manager: **Naresh Kolli**
Geotest Engineering, Inc.
5600 Bintliff
Houston, TX 77036

Reference: XENCO Report No(s): **506929**
Clearwell Condition Assessment
Project Address:

Naresh Kolli:

We are reporting to you the results of the analyses performed on the samples received under the project name referenced above and identified with the XENCO Report Number(s) 506929. All results being reported under this Report Number apply to the samples analyzed and properly identified with a Laboratory ID number. Subcontracted analyses are identified in this report with either the NELAC certification number of the subcontract lab in the analyst ID field, or the complete subcontracted report attached to this report.

Unless otherwise noted in a Case Narrative, all data reported in this Analytical Report are in compliance with NELAC standards. The uncertainty of measurement associated with the results of analysis reported is available upon request. Should insufficient sample be provided to the laboratory to meet the method and NELAC Matrix Duplicate and Matrix Spike requirements, then the data will be analyzed, evaluated and reported using all other available quality control measures.

The validity and integrity of this report will remain intact as long as it is accompanied by this letter and reproduced in full, unless written approval is granted by XENCO Laboratories. This report will be filed for at least 5 years in our archives after which time it will be destroyed without further notice, unless otherwise arranged with you. The samples received, and described as recorded in Report No. 506929 will be filed for 60 days, and after that time they will be properly disposed without further notice, unless otherwise arranged with you. We reserve the right to return to you any unused samples, extracts or solutions related to them if we consider so necessary (e.g., samples identified as hazardous waste, sample sizes exceeding analytical standard practices, controlled substances under regulated protocols, etc).

We thank you for selecting XENCO Laboratories to serve your analytical needs. If you have any questions concerning this report, please feel free to contact us at any time.

Respectfully,

Debbie Simmons

Debbie Simmons
Project Manager

Recipient of the Prestigious Small Business Administration Award of Excellence in 1994.
Certified and approved by numerous States and Agencies.
A Small Business and Minority Status Company that delivers SERVICE and QUALITY

Houston - Dallas - Odessa - San Antonio - Tampa - Lakeland - Atlanta - Phoenix - Oklahoma - Latin America

Sample Cross Reference 506929

Geotest Engineering, Inc., Houston, TX

Clearwell Condition Assessment

Sample Id	Matrix	Date Collected	Sample Depth	Lab Sample Id
B-1 S# 12	S	03-26-15 00:00	23 - 25	506929-001
B-1 S# 13	S	03-26-15 00:00	28 - 30	506929-002
B-3 S# 11	S	03-26-15 00:00	23 - 25	506929-003
B-4 S# 10	S	03-26-15 00:00	18 - 20	506929-004

Sample receipt non conformances and comments:

Sample receipt non conformances and comments per sample:

None

Certificate of Analysis Summary 506929

Geotest Engineering, Inc., Houston, TX

Project Name: Clearwell Condition Assessment

Project Id: 1140209501
Contact: Naresh Kolli
Project Location:

Date Received in Lab: Wed Apr-29-15 12:51 pm
Report Date: 06-MAY-15
Project Manager: Debbie Simmons

Analysis Requested	*Lab Id:*	506929-001		506929-002		506929-003		506929-004			
	Field Id:	B-1 S# 12		B-1 S# 13		B-3 S# 11		B-4 S# 10			
	Depth:	23-25		28-30		23-25		18-20			
	Matrix:	SOIL		SOIL		SOIL		SOIL			
	Sampled:	Mar-26-15 00:00		Mar-26-15 00:00		Mar-26-15 00:00		Mar-26-15 00:00			
Inorganic Anions by SW 9056	*Extracted:*	May-02-15 10:25		May-02-15 10:25		May-02-15 10:25		May-02-15 10:25			
	Analyzed:	May-04-15 16:00		May-04-15 16:18		May-04-15 16:37		May-04-15 16:55			
	Units/RL:	mg/kg	RL	mg/kg	RL	mg/kg	RL	mg/kg	RL		
Chloride		BRL	9.92	10.1 K	9.88	BRL	9.88	23.3 K	9.84		
Sulfate		11.3 K	9.92	12.1 K	9.88	19.4 K	9.88	63.5 K	9.84		
Soil Resistivity (As Received) by NACE	*Extracted:*										
	Analyzed:	May-01-15 13:47		May-01-15 13:52		May-01-15 14:04		May-01-15 14:07			
	Units/RL:	Ohm-cm	RL	Ohm-cm	RL	Ohm-cm	RL	Ohm-cm	RL		
Soil Resistivity +		2060 K		1320 K		2630 K		2240 K			
Soil pH by EPA 9045C	*Extracted:*										
	Analyzed:	May-01-15 11:27		May-01-15 11:28		May-01-15 11:29		May-01-15 11:30			
	Units/RL:	SU	RL	SU	RL	SU	RL	SU	RL		
pH		9.16 K		9.02 K		9.19 K		8.87 K			

This analytical report, and the entire data package it represents, has been made for your exclusive and confidential use.
The interpretations and results expressed throughout this analytical report represent the best judgment of XENCO Laboratories.
XENCO Laboratories assumes no responsibility and makes no warranty to the end use of the data hereby presented.
Our liability is limited to the amount invoiced for this work order unless otherwise agreed to in writing.

Houston - Dallas - San Antonio - Atlanta - Tampa - Boca Raton - Latin America - Odessa - Corpus Christi

Debbie Simmons
Project Manager

Final 1.000

XENCO Laboratories
CHRONOLOGY OF HOLDING TIMES

Analytical Method : Soil pH by EPA 9045C

Client : Geotest Engineering, Inc.

Work Order #: **506929**

Project ID: 1140209501

Field Sample ID	Date Collected	Date Received	Date Extracted	Max Holding Time Extracted (Days)	Time Held Extracted (Days)	Date Analyzed	Max Holding Time Analyzed (Days)	Time Held Analyzed (Days)	Q
B-1 S# 13	Mar. 26, 2015	Apr. 29, 2015				May.1, 2015	28	36	F
B-3 S# 11	Mar. 26, 2015	Apr. 29, 2015				May.1, 2015	28	36	F
B-4 S# 10	Mar. 26, 2015	Apr. 29, 2015				May.1, 2015	28	36	F
B-1 S# 12	Mar. 26, 2015	Apr. 29, 2015				May.1, 2015	28	36	F

XENCO Laboratories
CHRONOLOGY OF HOLDING TIMES

Analytical Method : Inorganic Anions by SW 9056

Client : Geotest Engineering, Inc.

Work Order #: **506929**

Project ID: 1140209501

Field Sample ID	Date Collected	Date Received	Date Extracted	Max Holding Time Extracted (Days)	Time Held Extracted (Days)	Date Analyzed	Max Holding Time Analyzed (Days)	Time Held Analyzed (Days)	Q
B-1 S# 12	Mar. 26, 2015	Apr. 29, 2015	May. 2, 2015	28	37	May.4, 2015	28	2	F
B-4 S# 10	Mar. 26, 2015	Apr. 29, 2015	May. 2, 2015	28	37	May.4, 2015	28	2	F
B-1 S# 13	Mar. 26, 2015	Apr. 29, 2015	May. 2, 2015	28	37	May.4, 2015	28	2	F
B-3 S# 11	Mar. 26, 2015	Apr. 29, 2015	May. 2, 2015	28	37	May.4, 2015	28	2	F

F = These samples were analyzed outside the recommended holding time.
P = Samples analyzed within the recommended holding time.

Flagging Criteria

X In our quality control review of the data a QC deficiency was observed and flagged as noted. MS/MSD recoveries were found to be outside of the laboratory control limits due to possible matrix /chemical interference, or a concentration of target analyte high enough to affect the recovery of the spike concentration. This condition could also affect the relative percent difference in the MS/MSD.

B A target analyte or common laboratory contaminant was identified in the method blank. Its presence indicates possible field or laboratory contamination.

D The sample(s) were diluted due to targets detected over the highest point of the calibration curve, or due to matrix interference. Dilution factors are included in the final results. The result is from a diluted sample.

E The data exceeds the upper calibration limit; therefore, the concentration is reported as estimated.

F RPD exceeded lab control limits.

J The target analyte was positively identified below the quantitation limit and above the detection limit.

U Analyte was not detected.

L The LCS data for this analytical batch was reported below the laboratory control limits for this analyte. The department supervisor and QA Director reviewed data. The samples were either reanalyzed or flagged as estimated concentrations.

H The LCS data for this analytical batch was reported above the laboratory control limits. Supporting QC Data were reviewed by the Department Supervisor and QA Director. Data were determined to be valid for reporting.

K Sample analyzed outside of recommended hold time.

JN A combination of the "N" and the "J" qualifier. The analysis indicates that the analyte is "tentatively identified" and the associated numerical value may not be consistent with the amount actually present in the environmental sample.

** Surrogate recovered outside laboratory control limit.

BRL Below Reporting Limit.

RL Reporting Limit

MDL Method Detection Limit **SDL** Sample Detection Limit **LOD** Limit of Detection

PQL Practical Quantitation Limit **MQL** Method Quantitation Limit **LOQ** Limit of Quantitation

DL Method Detection Limit

NC Non-Calculable

+ NELAC certification not offered for this compound.

* (Next to analyte name or method description) = Outside XENCO's scope of NELAC accreditation

BS / BSD Recoveries

Project Name: Clearwell Condition Assessment

Work Order #: 506929 **Project ID:** 1140209501

Analyst: BHRE **Date Prepared:** 05/02/2015 **Date Analyzed:** 05/04/2015

Lab Batch ID: 967410 **Sample:** 692105-1-BKS **Batch #:** 1 **Matrix:** Solid

Units: mg/kg

BLANK /BLANK SPIKE / BLANK SPIKE DUPLICATE RECOVERY STUDY

Inorganic Anions by SW 9056 Analytes	Blank Sample Result [A]	Spike Added [B]	Blank Spike Result [C]	Blank Spike %R [D]	Spike Added [E]	Blank Spike Duplicate Result [F]	Blk. Spk Dup. %R [G]	RPD %	Control Limits %R	Control Limits %RPD	Flag
Chloride	<10.0	100	98.2	98	100	98.1	98	0	80-120	20	
Sulfate	<10.0	100	101	101	100	101	101	0	80-120	20	

Relative Percent Difference RPD = 200*|(C-F)/(C+F)|
Blank Spike Recovery [D] = 100*(C)/[B]
Blank Spike Duplicate Recovery [G] = 100*(F)/[E]
All results are based on MDL and Validated for QC Purposes

Form 3 - MS / MSD Recoveries

Project Name: Clearwell Condition Assessment

Work Order # : 506929 **Project ID:** 1140209501

Lab Batch ID: 967410 **QC- Sample ID:** 506929-001 S **Batch #:** 1 **Matrix:** Soil

Date Analyzed: 05/04/2015 **Date Prepared:** 05/02/2015 **Analyst:** BHRE

Reporting Units: mg/kg

MATRIX SPIKE / MATRIX SPIKE DUPLICATE RECOVERY STUDY

Inorganic Anions by SW 9056 Analytes	Parent Sample Result [A]	Spike Added [B]	Spiked Sample Result [C]	Spiked Sample %R [D]	Spike Added [E]	Duplicate Spiked Sample Result [F]	Spiked Dup. %R [G]	RPD %	Control Limits %R	Control Limits %RPD	Flag
Chloride <05/05/2015 09:20>	<9.92	99.2	107	108	99.2	106	107	1	80-120	20	
Sulfate <05/05/2015 09:20>	11.3	99.2	112	102	99.2	109	98	3	80-120	20	

Lab Batch ID: 967410 **QC- Sample ID:** 507047-001 S **Batch #:** 1 **Matrix:** Soil

Date Analyzed: 05/04/2015 **Date Prepared:** 05/02/2015 **Analyst:** BHRE

Reporting Units: mg/kg

MATRIX SPIKE / MATRIX SPIKE DUPLICATE RECOVERY STUDY

Inorganic Anions by SW 9056 Analytes	Parent Sample Result [A]	Spike Added [B]	Spiked Sample Result [C]	Spiked Sample %R [D]	Spike Added [E]	Duplicate Spiked Sample Result [F]	Spiked Dup. %R [G]	RPD %	Control Limits %R	Control Limits %RPD	Flag
Chloride	<9.90	99.0	103	104	99.0	103	104	0	80-120	20	
Sulfate	26.6	99.0	135	109	99.0	134	108	1	80-120	20	

Matrix Spike Percent Recovery [D] = 100*(C-A)/B
Relative Percent Difference RPD = 200*|(C-F)/(C+F)|

Matrix Spike Duplicate Percent Recovery [G] = 100*(F-A)/E

ND = Not Detected, J = Present Below Reporting Limit, B = Present in Blank, NR = Not Requested, I = Interference, NA = Not Applicable
N = See Narrative, EQL = Estimated Quantitation Limit, NC = Non Calculable - Sample amount is > 4 times the amount spiked.

Sample Duplicate Recovery

Project Name: Clearwell Condition Assessment

Work Order #: 506929

Lab Batch #: 967350 **Project ID:** 1140209501
Date Analyzed: 05/01/2015 13:04 **Date Prepared:** 05/01/2015 **Analyst:** KCS
QC- Sample ID: 506923-001 D **Batch #:** 1 **Matrix:** Soil
Reporting Units: Ohm-cm

Soil Resistivity (As Received) by NACE	SAMPLE / SAMPLE DUPLICATE RECOVERY				
Analyte	Parent Sample Result [A]	Sample Duplicate Result [B]	RPD	Control Limits %RPD	Flag
Soil Resistivity	9440	9320	1	20	

Lab Batch #: 967350
Date Analyzed: 05/01/2015 13:57 **Date Prepared:** 05/01/2015 **Analyst:** KCS
QC- Sample ID: 506929-002 D **Batch #:** 1 **Matrix:** Soil
Reporting Units: Ohm-cm

Soil Resistivity (As Received) by NACE	SAMPLE / SAMPLE DUPLICATE RECOVERY				
Analyte	Parent Sample Result [A]	Sample Duplicate Result [B]	RPD	Control Limits %RPD	Flag
Soil Resistivity	1320	1300	2	20	

Lab Batch #: 967249
Date Analyzed: 05/01/2015 11:22 **Date Prepared:** 05/01/2015 **Analyst:** JGT
QC- Sample ID: 506906-001 D **Batch #:** 1 **Matrix:** Soil
Reporting Units: SU

Soil pH by EPA 9045C	SAMPLE / SAMPLE DUPLICATE RECOVERY				
Analyte	Parent Sample Result [A]	Sample Duplicate Result [B]	RPD	Control Limits %RPD	Flag
pH	7.98	7.98	0	20	

Spike Relative Difference RPD 200 * | (B-A)/(B+A) |
All Results are based on MDL and validated for QC purposes.
BRL - Below Reporting Limit

CHAIN OF CUSTODY

XENCO LABORATORIES

Page 1 Of 1

Setting the Standard since 1990

Stafford,Texas (281-240-4200)

Dallas Texas (214-902-0300)

Service Center - San Antonio, Texas (210-509-3334)

www.xenco.com

Odessa, Texas (432-563-1800)

Norcross, Georgia (770-449-8800)

Lakeland, Florida (863-646-8526)

Tampa, Florida (813-620-2000)

Xenco Quote #

Xenco Job # 576929-11

Client / Reporting Information

Company Name / Branch: Geotest Engineering, Inc.,

Company Address: 5600 Bintliff Drive Houston Texas

Email: nkolli@geotesteng.com

Phone No: 713 266 0588

Project Contact: Naresh Kolli

Samplers's Name: Tiffany Murry

Project Information

Project Name/Number: Clearwell Condition Assessment / 1140209501

Project Location: Houston, Texas

Invoice To: Accounting

PO Number:

Matrix Codes

S = Soil/Sed/Solid
GW =Ground Water
DW = Drinking Water
P = Product
SW = Surface water
SL = Sludge
OW =Ocean/Sea Water
W = Wipe
O = Oil
WW= Waste Water
A = Air

No.	Field ID / Point of Collection	Collection: Sample Depth	Date	Time	Matrix	# of bottles	HCl	NaOH/Zn Acetate	HNO3	H2SO4	NaOH	NaHSO4	MEOH	NONE	Resistivity	pH	Sulfate	Chloride						Field Comments
1	B-1 S# 12	23-25	3/26/2015		S	1									X	X	X	X						
2	B-1 S# 13	28-30	3/26/2015		S	1									X	X	X	X						
3	B-3 S# 11	23-25	3/26/2015		S	1									X	X	X	X						
4	B-4 S# 10	18-20	3/26/2015		S	1									X	X	X	X						
5																								
6																								
7																								
8																								
9																								
10																								

Turnaround Time (Business days)

- [ ] Same Day TAT
- [x] 5 Day TAT
- [ ] Next Day EMERGENCY
- [ ] 7 Day TAT
- [ ] 2 Day EMERGENCY
- [ ] Contract TAT
- [ ] 3 Day EMERGENCY

TAT Starts Day received by Lab, if received by 3:00 pm

Data Deliverable Information

- [ ] Level II Std QC
- [ ] Level IV (Full Data Pkg /raw data)
- [ ] Level III Std QC+ Forms
- [ ] TRRP Level IV
- [ ] Level 3 (CLP Forms)
- [ ] UST / RG -411
- [x] TRRP Checklist

Notes:

FED-EX / UPS: Tracking #

SAMPLE CUSTODY MUST BE DOCUMENTED BELOW EACH TIME SAMPLES CHANGE POSSESSION, INCLUDING COURIER DELIVERY

Relinquished by Sampler:	Date Time:	Received By:	Relinquished By:	Date Time:	Received By:
1		1 CC 4/29/15 1233	2		2
Relinquished by:	Date Time:	Received By:	Relinquished By:	Date Time:	Received By:
3		3	4		4
Relinquished by: CC	Date Time: 4/29/15 1251	Received By: 5	Custody Seal #	Preserved where applicable	On Ice [X]

Temp: -20°C Temp Gun ID: IR-31
C/F:-1.2
Corrected Temp: 1.8°C

Note: Signature of this document and relinquishment of samples constitutes a valid purchase order from client company to XENCO Laboratories and its affiliates, subcontractors and assigns XENCO's standard terms and conditions of service unless previ

XENCO Laboratories

Prelogin/Nonconformance Report- Sample Log-In

Client: Geotest Engineering, Inc.

Date/ Time Received: 04/29/2015 12:51:00 PM

Work Order #: 506929

Acceptable Temperature Range: 0 - 6 degC
Air and Metal samples Acceptable Range: Ambient

Temperature Measuring device used :

Sample Receipt Checklist		Comments
#1 *Temperature of cooler(s)?	1.8	
#2 *Shipping container in good condition?	Yes	
#3 *Samples received on ice?	Yes	
#4 *Custody Seals intact on shipping container/ cooler?	No	
#5 Custody Seals intact on sample bottles?	No	
#6 *Custody Seals Signed and dated?	No	
#7 *Chain of Custody present?	Yes	
#8 Sample instructions complete on Chain of Custody?	Yes	
#9 Any missing/extra samples?	No	
#10 Chain of Custody signed when relinquished/ received?	Yes	
#11 Chain of Custody agrees with sample label(s)?	Yes	
#12 Container label(s) legible and intact?	Yes	
#13 Sample matrix/ properties agree with Chain of Custody?	Yes	
#14 Samples in proper container/ bottle?	Yes	
#15 Samples properly preserved?	Yes	
#16 Sample container(s) intact?	Yes	
#17 Sufficient sample amount for indicated test(s)?	Yes	
#18 All samples received within hold time?	No	Samples received outside recommended hold time.
#19 Subcontract of sample(s)?	N/A	
#20 VOC samples have zero headspace (less than 1/4 inch bubble)?	N/A	
#21 <2 for all samples preserved with HNO3,HCL, H2SO4? Except for samples for the analysis of HEM or HEM-SGT which are verified by the analysts.	N/A	
#22 >10 for all samples preserved with NaAsO2+NaOH, ZnAc+NaOH?	N/A	

*** Must be completed for after-hours delivery of samples prior to placing in the refrigerator**

Analyst: th

PH Device/Lot#:

Checklist completed by: Tanya Torres — Date: 04/29/2015

Checklist reviewed by: Debbie Simmons — Date: 04/29/2015

APPENDIX D

Piezometer Abandonment Report

STATE OF TEXAS PLUGGING REPORT for Tracking #156777

Owner:	**Clearwater Valve Actuator**	Owner Well #:	**GB-1**
Address:	**2300 Federal Road Pas, TX 77504**	Grid #:	**65-23-1**
Well Location:	**2300 Federal Road Pasadena, TX 77504**	Latitude:	**29° 44' 07" N**
		Longitude:	**095° 12' 52" W**
Well County:	**Harris**	Elevation:	**No Data**

Well Type: **Monitor**

Drilling Information

Company: **Envirotech Drilling Services, LLC** Date Drilled: **3/26/2015**

Driller: **Jaime Vasquez** License Number: **58171**

Well Report Tracking #391460

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	5	0	50

Plugging Information

Date Plugged: **4/24/2015** Plugger: **Jaime Vasquez**

Plug Method: **Pour in 3/8 bentonite chips when standing water in well is less than 100 feet depth, cement top 2 feet**

Casing Left in Well:			Plug(s) Placed in Well:		
Dia (in.)	*Top (ft.)*	*Bottom (ft.)*	*Top (ft.)*	*Bottom (ft.)*	*Description (number of sacks & material)*
	0	0	0	50	**Bentonite 6 Bags/Sacks**

Certification Data: The driller certified that the driller plugged this well (or the well was plugged under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the reports(s) being returned for completion and resubmittal.

Company Information: **Envirotech Drilling Services LLC**

PO BOX 19064
Houston, TX 77224

Driller Name: **Jaime Vasquez** License Number: **58171**

Comments: **No Data**

STATE OF TEXAS WELL REPORT for Tracking #391460

Owner:	**Clearwater Valve Actuator**	Owner Well #:	**GB-1**
Address:	**2300 Federal Road** **Pas , TX 77504**	Grid #:	**65-23-1**
Well Location:	**2300 Federal Road** **Pasadena , TX 77504**	Latitude:	**29° 44' 07" N**
Well County:	**Harris**	Longitude:	**095° 12' 52" W**
Elevation:	**No Data**	GPS Brand Used:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Date:	Started: **3/26/2015** Completed: **3/26/2015**
Diameter of Hole:	Diameter: **5 in From Surface To 50 ft**
Drilling Method:	**Mud Rotary**
Borehole Completion:	Gravel Packed From: **5 ft to 45 ft** Gravel Pack Size: **20/40**
Annular Seal Data:	1st Interval: **From 0 ft to 2 ft with Cmt grout (#sacks and material)** 2nd Interval: **From 2 ft to 5 ft with Bentonite (#sacks and material)** 3rd Interval: **No Data** Method Used: **Free Pour** Cemented By: **Envirotech Drilling Services** Distance to Septic Field or other Concentrated Contamination: **No Data** Distance to Property Line: **No Data** Method of Verification: **No Data** Approved by Variance: **No Data**
Surface Completion:	**Surface Sleeve Installed**

Water Level:	Static level: **No Data** Artesian flow: **No Data**
Packers:	**No Data**
Plugging Info:	Casing or Cement/Bentonite left in well: **No Data**
Type Of Pump:	**No Data**
Well Tests:	**No Data**

Water Quality:	Type of Water: **No Data** Depth of Strata: **No Data** Chemical Analysis Made: **No Data** Did the driller knowingly penetrate any strata which contained undesirable constituents: **No Data**
Certification Data:	The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.

Company Information:	**Envirotech Drilling Services, LLC** **2718 S. Brompton Dr.** **Pearland , TX 77584**
Driller License Number:	**58171**
Licensed Well Driller Signature:	**Jaime Vasquez**
Registered Driller Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Comments:	**No Data**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking number (Tracking **#391460**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

DESC. & COLOR OF FORMATION MATERIAL

From (ft) To (ft) Description
0-.75' Concrete
.75-6' Sandy Clay-brown/gray
6-11' Clay-red/brown
11-14' Silty Clay-brown
14-16' Clay-brown
16-18' Sandy Clay-brown
18-25' Clay-gray/blue
48-50' Silt-brown

CASING, BLANK PIPE & WELL SCREEN DATA

Dia. New/Used Type Setting From/To
2" New PVC Casing 0-15'
2" New PVC Screen 15-45' .010