Geotechnical Report

Proposed Lift Station Replacements - Sunset (Lift Station #116), Sierra Crest (Lift Station #138) and Country Club (Lift Station #117) El Paso, El Paso County, Texas

Project # 2037192035

Prepared for:

El Paso Water
1154 Hawkins14, El Paso, Texas 79912

October 20, 2020

wood.

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October 20, 2020
Wood Project No. 2037192035

El Paso Water
1154 Hawkins
El Paso, Texas 79925

Attn.: Mr. Francisco J. Martinez, P.E.

RE: Geotechnical Study
Proposed Lift Station Replacements – Sunset (Lift Station #116), Sierra Crest (Lift Station #138) and Country Club (Lift Station #117)
El Paso, Texas

Dear Mr. Martinez:

Wood Environment & Infrastructure Solutions, Inc. (Wood) submits this Geotechnical Report for the above referenced project. The report includes the results of test drilling, laboratory analyses, and recommended criteria for foundation design and related earthwork.

Should any questions arise concerning this report, we would be pleased to discuss them with you.

Respectfully submitted,
Wood Environment & Infrastructure Solutions, Inc.
Texas Registered Engineering Firm F-0012
Texas Registered Geoscience Firm 50184

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The seal appearing on this document was authorized by Mark J. Breitnauer, P.E. on 10/20/2020

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Senior Engineer

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Ulises Estrada, P.E., CEA Group

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1.0 INTRODUCTION

This report is submitted pursuant to a geotechnical engineering study made by this firm for the proposed lift station replacements planned at the Sunset site (Lift Station #117) and Country Club site (Lift Station #116). The Sunset site is located at 9914 W. Sunset Road, west of the intersection of W. Sunset Road and Vista Del Monte Street, and the Country Club site is located at 249 Country Club Road, east of the intersection of Love Road and Country Club Road, both in west El Paso, Texas. The objective of this study was to evaluate the physical properties of the soils underlying the site to provide recommendations for equipment foundations, slab support, and related earthwork.

The Sierra Crest lift station located at 20 Hidden Hills Drive in central El Paso, Texas will also be replaced as part of the wastewater system improvements. Due to shallow rock at the Sierra Crest (Lift Station #138 site, a geophysical study will be conducted in lieu of geotechnical soil borings. The Sierra Crest report will be submitted under a separate cover.

We have attached for your review, in ***Appendix A***, important information prepared by the Geoprofessional Business Association (GBA) regarding geotechnical studies of the type performed for this project.

2.0 PROPOSED CONSTRUCTION

Details of the project were provided to Wood by Mr. Francisco J. Martinez, P.E. with El Paso Water and Ulises Estrada, P.E. of the CEA Group.

It is our understanding that the project will consist of the decommissioning and construction of two lift stations in west El Paso, Texas. The lift stations and Sunset, Country Club will also be constructed with an electrical control building at the ground surface. We understand that the depth of the individuals lift stations will generally match the existing elevations to limit changes to the existing piping systems in place. Based on this and the technical memorandum provided to Wood, the following wet well depths were used in our study.

Location	Estimated Wet Well Depth (feet)
Sunset (Lift Station #117)	22
Country Club (Lift Station #116)	21

Foundation loads for the proposed structures are not known at this time but are anticipated to be moderate.

Should final design details vary significantly from those outlined above, this firm should be notified for review and possible modification of recommendations.

3.0 SOIL STUDY

3.1 SUBSURFACE EXPLORATION

Our field exploration program consisted of performing a total of two (2) auger borings with standard penetration testing (SPT); one (1) boring was drilled at the Sunset site (Lift Station #117) to a depth of about thirty-five (35) feet, and one (1) boring was drilled at the Country Club site (Lift Station #116) to a depth of thirty-five (35) feet below existing grades. ***(Figure 1)***.

The test borings were completed using a CME 75 truck-mounted drill rig equipped with 3¼ inch I.D. hollow stem augers. The borings were conducted in accordance with methodology consistent with ASTM International Standard D1586, Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils. Standard penetration testing was completed at selected intervals in the borings. During the field study, the soils encountered were examined, visually classified, and logged. The locations of the borings are graphically depicted on the Boring Location Plan as shown in ***Appendix B***; they were located by measuring wheel from existing site features and should be considered accurate only to the extent implied by the limitation of the depiction. Results of the field study are presented in ***Appendix B***, which includes a brief description of drilling and sampling equipment and procedures, boring location plan, and logs of the test borings

The boring logs and related information included in this report are indicators of subsurface conditions only at the specific locations and times noted. subsurface conditions, including groundwater levels, at other locations on the subject site, may differ significantly from conditions, which exist at the sampling locations.

3.2 LABORATORY ANALYSIS

To aid in soil classification and evaluate the engineering properties of the soil, selected soil samples were tested for moisture content, Atterberg limits, and particle size distribution. Laboratory tests were performed in general accordance with test standards ASTM D2216, ASTM D4318, and ASTM D6913. The results of the moisture testing, Atterberg Limits, and Material Finer than No. 200 (75-µm) Sieve are shown on the boring logs presented in ***Appendix C***. Particle distribution test results are presented in ***Appendix C***.

The soil encountered during the field study was classified in general accordance with the Unified Soil Classification System. The soil classification symbols appear on the boring logs and are briefly described in ***Appendix B***.

4.0 SITE CONDITIONS & GEOTECHNICAL PROFILE

4.1 SITE CONDITIONS

The lift station replacement structures will be located within the existing Sunset (Lift Station #117) and Country Club (Lift Station #116) lift station facilities. At present, the sites have existing lift stations with associated pumps and electrical infrastructure.

4.2 GEOTECHNICAL PROFILE

The general subsurface conditions encountered during the field exploration conducted on October 7, 2020, are shown on the soil boring logs presented in ***Appendix B***. The lines of stratification shown on the logs are based upon examination of the recovered soil samples and interpretation of the field boring logs and represent the approximate boundaries between the soil types; the actual transitions may be gradual.

Sunset (Lift Station #117) (Boring B-1)
The upper stratum consists of silty sands (SM) that extend to a depth of about 7.5 feet below the ground surface. Based on standard penetration tests, the silty sands are generally medium dense to loose. Underlying the surficial silty soils consists of medium dense to loose silty sands (SM) to a depth of 23 feet. The final layer consists of medium dense, poorly graded sands with silt (SP-SM) that extend to the depth explored (36.5 feet).

Country Club (Lift Station #116) (Boring B-2)
Soils encountered at the project site generally consist of sandy, silty clays (CL-ML). Based on standard penetration tests, the clays are generally stiff. Laboratory testing indicates a liquid limit of 24 with a corresponding plasticity index of 6. Underlying the surficial slightly silty clay soils consists of sandy lean clays (CL) to a depth of 7 feet. Laboratory testing indicates a liquid limit of 25 with a corresponding plasticity index of 9. The next layer consists of loose, silty sands (SM) to a depth of 10 feet. The underlying layer consists generally of medium dense poorly graded sand with silt (SP-SM) to a depth of about 33 feet. The final layer consists of medium dense silty sands (SM) to the depth explored (36.5 feet).

The soil classification symbols shown above and elsewhere herein are derived from ASTM D2487, *Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)* and D2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*. The descriptions for relative density and firmness are based on grain size and standard penetration tests as detailed in "Terminology Used to Describe the Relative Density, Consistency or Firmness of Soil" in ***Appendix B*** of this report.

4.3 SOIL MOISTURE AND GROUNDWATER CONDITION

At the time of our field study, groundwater was encountered at the Sunset and Country Club test boring locations at depths of 13 feet and 10 feet below the existing ground surface, respectively. It should be noted that seasonal groundwater fluctuations of 2 to 4 feet are also known to exist within the project area due to changes in the river flow, irrigation, or after periods of heavy rainfall events.

Soil moisture contents were generally damp to wet with values ranging from 10.9 to 30.5 percent.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 ANALYSIS OF RESULTS

Based on the results of our field and laboratory study, the soil underlying the project site will provide reliable support for the proposed structures following minor soil improvements. The proposed at-grade structures can be safely supported on shallow spread and continuous type footings bearing on improved native soils or structural fill, provided guidelines concerning site preparation and moisture protection presented in Section 5.4 are completed. The proposed lift station structures may be supported on a mat-type foundation system bearing on improved soils. Based on the results of our study, localized dewatering will be required for the lift station locations.

It should be noted that a risk is involved with the use of a shallow foundation system. Should a broken water line or other sources of moisture occur, some movement of slabs and foundations is possible. As a result, the recommendations concerning site drainage and moisture protection presented in Section 5.4 are considered critical for the satisfactory performance of the structures.

5.2.1 SHALLOW FOUNDATIONS – AT GRADE

For the electrical control structures founded at or near existing grade, a shallow foundation system consisting of spread or continuous type footings bearing at uniform depths below finished grade is recommended. A shallow foundation system may be used provided the site preparation and moisture protection recommendations in this report are strictly followed.

Below the base of all foundation elements, the native soils should be excavated to a depth of 12 inches. The over excavations should extend a lateral distance of 1foott beyond the edge of all footings. The base of the excavation should then be scarified to a depth of 8 inches, brought to within plus or minus 2 percent of optimum moisture content, and compacted. Structural fill should then be placed in compacted lifts to final grade. Compaction of the soil should be accomplished by mechanical means to obtain a density of not less than 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined in accordance with ASTM D 1557.

For at grade structures, a net allowable soil bearing pressure of 2,500 pounds per square foot is recommended for the design of shallow spread and continuous type footings bearing on structural fill. This bearing pressure applies to full dead plus realistic live loads.

Minimum depths of footings should be 2 feet below the lowest adjacent finished grade for perimeter footings and 1.5 feet below finished floor slab elevation for interior footings. The minimum recommended width of spread and continuous type footings is 2.0 feet and 1.5 feet, respectively.

To minimize the sensitivity of the structures to differential movements, footings and stem walls should be reinforced to allow for a degree of load redistribution should a localized zone of supporting soil become saturated. Stem walls should be positively separated from slabs by the use of expansion joint material.

It is estimated that vertical movements of footings designed as recommended above will not exceed ¾ of an inch for moisture contents of the native soils encountered during test drilling or compaction moisture contents introduced during construction. Differential movements are expected to be less than 75 percent of the total movement. Significant moisture increases above these values could result in additional movements. As a result, recommendations presented in Section 5.4 concerning site drainage and moisture protection are considered critical for the satisfactory performance of the proposed structures.

5.2.2 SITE GRADING AND SLAB SUPPORT – AT GRADE STRUCTURES

All site grading and fill placement should be performed in accordance with the requirements presented in ***Appendix D*** of this report. Structural fill specifications as well as compaction requirements are also detailed in ***Appendix D***.

Below slabs on grade, the native soils should be scarified to a depth of 8 inches, brought to within 2 percent of optimum moisture content, and compacted. Structural fill should then be placed, as required, in compacted lifts to final grade. These recommendations will result in a subgrade preparation, which will provide adequate support for a lightly loaded slab-on-grade floor. Thus, the use of a granular base for structural support of lightly loaded slabs is not considered necessary. However, a 4-inch course can be placed below the slab to provide a working surface.

Heavily loaded slabs cast directly on prepared subgrade should be designed using a modulus of subgrade reaction value of 250 pounds per cubic inch. Where the granular base is used, it should meet the following grading requirements as determined in accordance with ASTM C-136:

Sieve Size (Square Openings)	Percent Passing by Dry Weight
1 inch	100
¾ inch	85-100
No. 4	45-95
No. 200	0-8

The granular base should have a plasticity index of no greater than 12 when tested in accordance with ASTM D 4318. The coarse aggregate should have a percent of wear, when subjected to the Los Angeles abrasion test (ASTM C 131), of no less than 50. The granular base should be compacted to at least 95 percent of ASTM D 1557 maximum dry density.

The granular base will tend to act as a capillary barrier to moisture but will not provide a positive barrier against the rise of moisture to the slab. If the moisture sensitivity of floor coverings is considered critical, an impervious membrane vapor barrier should be placed beneath the floor slab.

5.3 FOUNDATIONS – BELOW GRADE STRUCTURES

A mat foundation system is recommended for support of the proposed lift station structures founded at a depth of between 19 and 21 feet below existing grades. The mat type foundation system may be used provided the site preparation recommendations presented in this report are followed.

The recommended site preparation consists of over excavating the native soils to a depth of 12 inches below the base of all foundation elements. The base of the excavation should then be scarified to a depth of 8 inches, moisture conditioned as needed to bring the soil to within plus or minus 2 percent of the optimum moisture content, and compacted. Structural fill should then be placed in compacted lifts to final grade. Compaction of the soil should be accomplished by mechanical means to obtain a density of not less than 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined in accordance with ASTM D 1557.

A lean concrete mud-mat slab below the lift station may be constructed to seal the bottom of the excavation and protect it from disturbance during the placement of mat reinforcing steel and placement of foundation concrete. Adequate dewatering should be made to facilitate the construction of the structures.

An allowable soil bearing pressure of 2,500 pounds per square foot is recommended for the design of a mat type foundation bearing on structural fill. The bearing pressure applies to full dead plus realistic live loads.

It is estimated that vertical movements of footings designed as recommended above will not exceed 1 inch for moisture contents of the native soil encountered during test drilling or compaction moisture contents introduced during construction. Differential movements are expected to be less than 75 percent of the total movement.

5.3.1 FLOTATION FORCES

As discussed previously, groundwater was encountered at the Sunset and Country Club sites. Flotation forces should be accounted for in the design of the structures, which extend at or below the water table elevation. The design of the structures to resist uplift forces may be accomplished with gravity loads.

The structures designer must take this into account, or it may cause problems during construction and in the future. We recommend that a factor of safety of at least 2 be used against uplift due to hydrostatic pressure. Any structure founded below 10 feet should be designed to withstand the buoyant forces.

Uplift on the structures may be resisted by both the weight of the structure itself and the weight of the backfill placed over the foundation of the structure. For uplift calculations, the weight used for the structure should be the empty weight since this would represent a more conservative condition during the operation of the structures. The weight of the soil or flowable backfill above the top of the foundation within a prism bounded by a line projected up at a 30-degree angle from vertical from the top edge of the foundation may also be used to resist uplift forces. A soil unit weight of 115 pounds per cubic foot and a saturated, submerged soil unit weight of 65 pounds per cubic foot is recommended for use in this computation. A factor of safety of at least 2.0 should be applied to the ultimate uplift capacity computed by this method.

5.3.2 DEWATERING

Groundwater was encountered at the sites at about 10 to 13 feet below the ground surface, respectively with potential seasonal fluctuations of 2 to 4 feet. It is recommended that groundwater depths be monitored at the project area up to the time of construction to provide information for construction planning.

As a result of shallow groundwater elevations, dewatering may be required to complete the construction of the structures planned for the project. The dewatering system may consist of either a system of multiple well points or a single well to effectively dewater the site for construction. It is anticipated that a large volume of water may be required to be dewatered and discharged. The local aquifer has excellent transmissivity and permeability is reasonably high within the sand and silty sand stratum encountered at the boring locations. Dewatering should extend a minimum of 5 feet below the bottom of footing elevation(s). Wood recommends that the dewatering system to be used for the project to be designed by an individual with sufficient experience to perform the requirements needed for the project.

Since dewatering increases the effective stress on the sub-soil, there is a potential that dewatering could create settlement of the structures located adjacent to the project site. It is therefore recommended that the dewatering system be designed to limit the volume dewatered to that, which will be necessary for construction. Piezometers are recommended to be installed near the project site to monitor the dewatered depths and to ensure the adequacy of the dewatering system.

Following the construction of the structures below groundwater levels, the groundwater should be allowed to return to a stable level in a gradual manner. Pumping should not be terminated, but slowly decreased to allow for a slow, steady, and uniform rise of the groundwater.

Wood recommends that a pre-construction survey be completed before the start of the project to document the interior and exterior conditions of the adjacent structures.

5.4 SITE DRAINAGE AND MOISTURE PROTECTION

Moisture increases in the soil supporting foundations would reduce their support value and increase foundation movements. Therefore, positive site drainage should be provided during construction and carefully maintained for the life of the structures.

Where slabs or pavements do not immediately adjoin the proposed structures, the ground surface should be sloped away from the perimeter of the structures in a manner to allow flow along the drainage lines at a minimum grade of 5 percent to points at least 15 feet away. Positive drainage should be provided from these points to streets or natural watercourses. In no case should long-term ponding of water be allowed around the perimeter of the proposed structures.

Roof drains should be designed and constructed to discharge stormwater directly onto paved areas that will carry the water rapidly away from the building. No stormwater from roof drains should be allowed to discharge onto or accumulate in unpaved areas close to the structures.

The possibility of moisture infiltration beneath the proposed structures, in the event of plumbing leaks, should be considered in the design and inspection of underground conduits. All backfill behind footings and stem walls as well as utility trench backfill within 15 feet of the structures should be compacted as recommended for structural fill in ***Appendix D***.

5.5 LATERAL LOADS

The pressure exerted on retaining walls will depend on their degree of restraint. Rigid, restrained walls with horizontal backfill meeting structural fill requirements as presented in ***Appendix D*** of the geotechnical report should be designed using an “at rest” equivalent fluid pressure of 55 pounds per cubic foot (pcf) for drained condition and 90 pcf for undrained condition. Walls allowed to rotate around their bases at a distance of 0.001 times their height or more, at the top, should be designed using an “active” equivalent fluid pressure of 35 pcf for drained condition and 80 pcf for undrained condition.

The passive soil resistance against the edges of footings, stem walls, etc. with properly compacted backfill, should be considered as being equal to forces exerted by a fluid of 385 pcf unit weight for drained condition and 180 pcf for undrained condition. A coefficient of friction of 0.35 is recommended for computing lateral resistance between the bases of the footing and slabs and the soil in analyzing lateral loads.

The equivalent fluid pressures do not include any lateral component due to either hydrostatic or surcharge loads. Special care should be taken not to over compact the backfill material to reduce the potential for the buildup of residual compaction pressures against the retaining walls.

The equivalent fluid pressures provided above do not include a factor of safety, however, we recommend that a minimum factor of safety of 1.5 be used for the design of retaining walls against overturning and sliding. Surcharge loads, such as vehicular wheel loads, to the area adjacent to the retaining wall, can add additional horizontal components of lateral earth pressures to this wall. The magnitude of these components will depend on the loads and locations of these loads relative to the retaining wall.

5.6 EXCAVATIONS

Based on the results of the field study, excavations along the project alignment are not anticipated to be difficult using conventional earthwork equipment. However, earthwork contractors should verify the suitability of their equipment for use for the varied soil types and conditions observed at the project sites.

Based upon the results of our study, the soils encountered along the majority of the alignment classify as OSHA Type C soils and side slopes of the trench excavations should be no steeper than 1.5 to 1 (horizontal to vertical). Should the excavations remain open for periods longer than 72 hours, maximum slopes should not exceed 2H:1V and the proper use of barricades and fencing will be required. Shoring or other bracing methods may be used for excavations up to 20 feet deep. Excavations greater than 20 feet in depth will require a special design or approval from a registered engineer.

Based on the soil conditions encountered at each proposed lift station location, some caving and sloughing is anticipated during excavations. These conditions can reduce the overall stability of the excavations leading to slope failure. The contractor should be prepared to bench excavations beyond the 1.5:1 slope or provide alternate methods of soil support such as trench shields or shoring systems should unstable conditions exist.

It is anticipated that a shoring system may be required in several areas due to the limited space available. Although trench shields will probably be the preferred method of trench stabilization, sheet piles or other methods (such as pneumatic or hydraulic systems) approved by the geotechnical engineer could be used. All shoring, including trench shields, should be designed using lateral loads described in Section 5.5.

It is recommended that a representative of the geotechnical engineer periodically observe temporary cut slopes at the time of excavation to assess their stability. All excavations should be provided with berms or other installations to prevent surface runoff from entering the excavation or impacting the excavation slopes. Construction equipment and materials, including soil stockpiles, should not be placed within 5 feet or ½ of the total excavation depth, whichever is greater, from the crest of open excavations. The exception to this recommendation is the presence of small soil berms constructed for temporary drainage purposes.

The above recommendations for temporary excavation slopes are based on geotechnical considerations only. These recommendations do not consider requirements that might be imposed by OSHA, the State of Texas, or other governmental agencies. For all open excavations and trenches, OSHA, and other governing entities' regulations should be followed in the process of planning.

6.0 CONSTRUCTION OBSERVATION & TESTING

Recommendations presented in previous sections of this report are predicated on there being continuous observation and testing by the geotechnical engineer during earthwork operations. Verification of recommended excavation, site grading, and required degree of compaction should be performed in accordance with "Guide Specifications for Earthwork" in ***Appendix D.***

The recommendations presented in this report are based upon a limited number of subsurface samples obtained from one sampling location at each site. The samples may not fully indicate the nature and extent of the variations that exist between sampling locations. For that reason, among others, we recommend that Wood be retained to observe earthwork construction. It should be noted if variations or other latent conditions become evident during earthwork construction, it will be necessary for us to review these conditions and modify their recommendations.

APPENDIX A

Important Information about This

Geotechnical-Engineering Report

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

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

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

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will <u>not</u> likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will <u>not</u> be adequate to develop geotechnical design recommendations for the project.

Do <u>not</u> rely on this report if your geotechnical engineer prepared it:

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

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do <u>not</u> rely on an executive summary. Do <u>not</u> read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

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

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

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

This Report's Recommendations Are Confirmation-Dependent

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

This Report Could Be Misinterpreted

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

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

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

Give Constructors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are <u>Not</u> Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will <u>not</u> of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are <u>not</u> building-envelope or mold specialists.***

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APPENDIX B

TEST DRILLING EQUIPMENT & PROCEDURES

SAMPLING PROCEDURES - Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D-1586 procedures. In most cases, 2" O.D.samplers are used to obtain the standard penetration resistance. Undisturbed samples of firmer soil are often obtained with 3" O.D. samplers lined with 2.42" I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140 pound, 30-inch free fall drop hammer required to advance the samplers in 6-inch increments. However, in stratified soil, driving resistance is sometimes recorded in 2 or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per foot on the logs. Undisturbed sampling of softer soil is sometimes performed with thin walled Shelby tubes (ASTM D-1587). Where samples of rock are required, they are obtained in NX diamond core drilling (ASTM D-2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings.

CONTINUOUS PENETRATION TESTS - Continuous penetration tests are performed by driving a 2" O.D. blunt nosed penetrometer adjacent to or in the bottom of borings. The penetrometer is attached to 1-inch O.D. drill rods to provide clearance to minimize side friction so that penetration values are recorded as the number of blows of a 140 pound, 30-inch free fall drop hammer required to advance the penetrometer in one foot increments or less.

BORING RECORDS - Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares boring logs. Soil is visually classified in accordance with the Unified Soil Classification System (ASTM D-2487), with appropriate group symbols being shown on the logs.

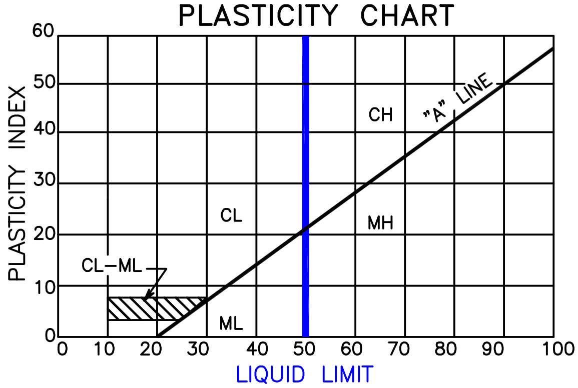
UNIFIED SOIL CLASSIFICATION SYSTEM

Soils are visually classified by the Unified Soil Classification System on the boring logs presented in this report. Grain–size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System", Corp of Engineers, US Army Technical Memorandum No. 3–357 (Revised April 1960) or ASTM Designation: D2487–93T.

MAJOR DIVISIONS				GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
COARSE–GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel–sand mixtures, or sand–gravel–cobble mixtures.
					GP	Poorly graded gravels, gravel–sand mixtures or sand–gravel–cobble mixtures
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line or hatched zone on plasticity chart		GM	Silty gravels, gravel–sand–silt mixtures
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel–sand–clay mixtures
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 seive)			SW	Well graded sands, gravelly sands
					SP	Poorly graded sands, gravelly sands
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line or hatched zone on plasticity chart		SM	Silty sands, sand–silt mixtures
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand–clay mixtures
FINE–GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS Limits plot below "A" line or hatched zone on plasticity chart	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50%)			ML	Inorganic silts, clayey silts with slight plasticity
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50%)			MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts
	CLAYS Limits plot above "A" line & hatched zone on plasticity chart	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50%)			CL	Inorganic clays of low to medium plasticity; gravelly clays, sandy clays, silty clays, lean clays
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50%)			CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity

NOTE: **Coarse grained soils with between 5% & 12% passing the No. 200 sieve and fine grained soils with limits plotting in the hatched zone on the plasticity chart to have double symbol.**

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
COBBLES	Above 3 inches
GRAVEL	3 inches to No. 4 sieve
Coarse Gravel	3 inches to 3/4 inch
Fine Gravel	3/4 inch to No. 4 sieve
SAND	No. 4 sieve to No. 200
Coarse	No. 4 sieve to No. 10
Medium	No. 10 sieve to No. 40
Fine	No 40 sieve to No. 200
FINES (SILT or CLAY)	Below No. 200 sieve

TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY CONSISTENCY, OR FIRMNESS OF SOIL

The terminology used on the boring logs to describe the relative density, consistency or firmness of soil relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blow per foot is obtained by ASTM D-1586 procedure using 2" O.D., 1-inch I.D. samplers.

RELATIVE DENSITY: Terms for description of relative density of cohesionless, uncemented sand and sand-gravel mixtures, and

RELATIVE CONSISTENCY: Terms for the description of fine-grained soils. Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance.

Granular Materials		
Relative Density	**Safety Hammer SPT N-Value (Blow/Foot {300 mm})**	**Automatic Hammer SPT N-Value (Blow/Foot {300 mm})**
Very Loose	Less than 4	Less than 3
Loose	4 – 10	3 – 7
Medium Dense	10 – 30	7 – 21
Dense	30 – 50	21 – 35
Very Dense	Greater than 50	Greater than 35
Silts and Clays		
Consistency	**Safety Hammer SPT N-Value (Blow/Foot {300 mm})**	**Automatic Hammer SPT N-Value (Blow/Foot {300 mm})**
Very Soft	Less than 2	Less than 1
Soft	2 – 4	1 – 3
Firm	4 – 8	3 – 6
Stiff	8 – 15	6 – 11
Very Stiff	15 – 30	11 – 21
Hard	Greater than 30	Greater than 21

If SPT data is not available, consistency can be estimated based on visual-manual examination of the material. Refer to ASTM D 2488 for consistency criteria.

RELATIVE FIRMNESS: Terms for the descriptions of partially saturated and/or cemented soil which commonly occurs in the Southwest including clay, cemented granular materials, silt and silty and clayey granular soil:

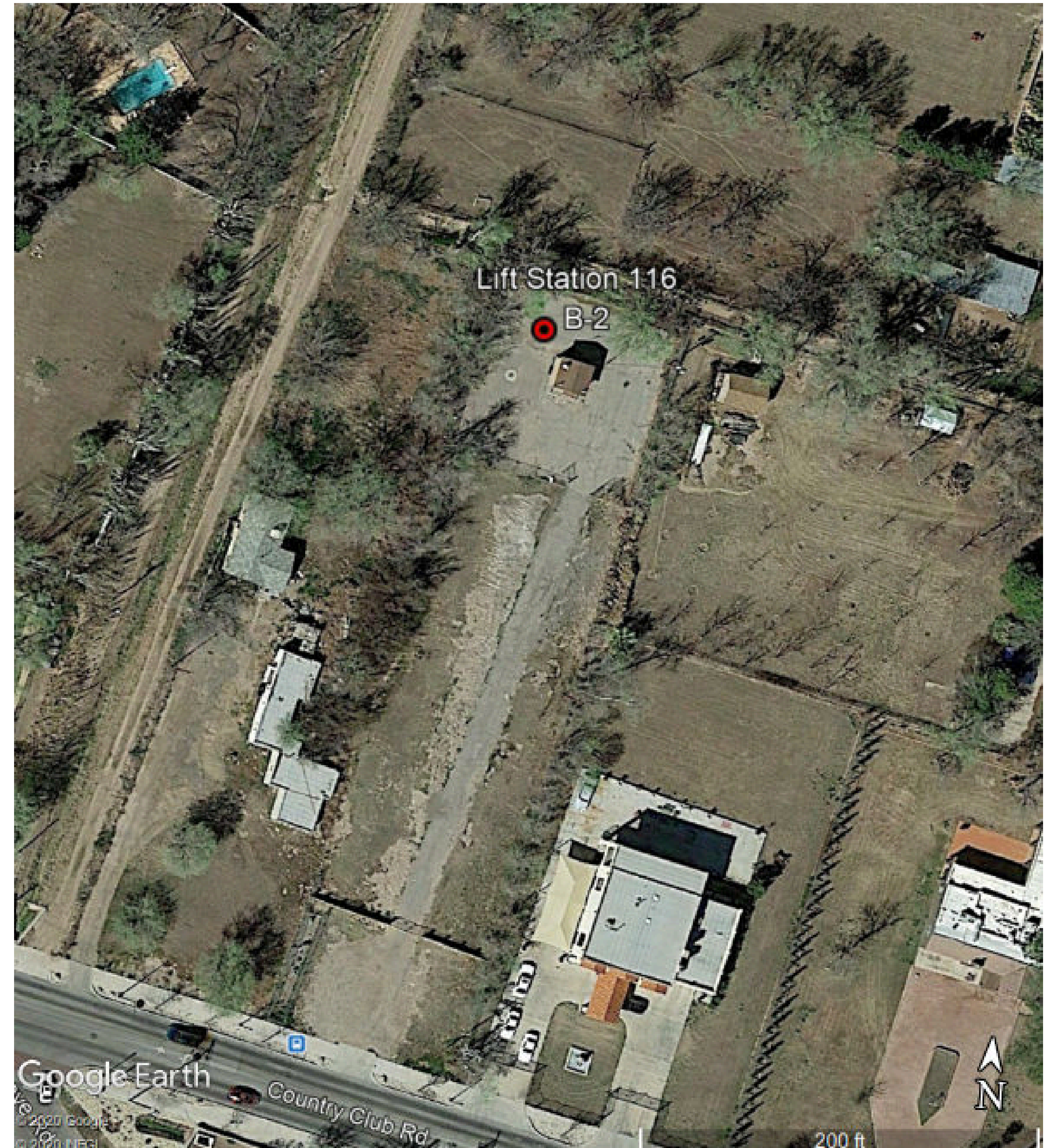
N	RELATIVE FIRMNESS
0-4	Very Soft
5-8	Soft
9-15	Moderately Firm
16-30	Firm
31-50	Very Firm
50+	Hard

SOIL MOISTURE CLASSIFICATION

MOISTURE CONDITION	FIELD IDENTIFICATION	ESTIMATED RANGE OF MOISTURE	
		Group A (%)	Group B (%)
Dry	Absence of moisture, dusty. Dry to the touch.	0-4	0-8
Damp	Grains appear slightly darkened, but no visible water. Silt/clay may clump. Sand will not bulk. Soils are below plastic limits.	4-8	8-16
Moist	Grains appear darkened, but no visible water. Silt/clay will clump. Sand will bulk. Soils are often at or near plastic limits.	8-16	16-30
Wet	Visible water on larger grain surfaces. Sand and cohesionless silt exhibit dilatancy. Cohesive silt/clay can be readily remolded. "Wet" indicates that the soil is much wetter than the optimum moisture content and above the plastic limit (APL).	>16	>30
Water Bearing	A water-producing formation.	N/A	N/A

Group A - Coarse Grained Soils, nonplastic to plasticity index <7.
Includes: SM, SP-SM, SP, SW, GM, GP, and GW.

Group B - Fine Grained Soils to clayey sands & gravels with a plasticity index >7.
Includes: GC, SC, ML, MH, CL, and CH.



CLIENT: El Paso Water Utility 1154 Hawkins El Paso, Texas 79925	LEGEND: ● Boring Approximate Location	DRAWN BY: MJB	PROJECT:	**Geotechnical Study** **Proposed Lift Stations Replacements: Country Club (Lift Station #116) & Sunset (Lift Station #117)** **El Paso, El Paso County, Texas**	REV NO. 0
		CHK'D BY: DAV			DATE 10/9/2020
wood. E & I S, INC. 125 MONTOYA ROAD EL PASO, TX 39932		PROJECTION:			PROJECT NO. **2037192035**
		SCALE: AS SHOWN		**BORING LOCATION PLAN**	FIGURE NO. 1

PROJECT **EPWU-Lift Station Replacements**
9914 Sunset (Lift Station #117) & 249 Country Cl
El Paso, El Paso County, Texas

Wood E&IS, Inc.
125 Montoya Road
El Paso, TX 79932
Telephone: 915-585-2472

JOB NO. 2037192035 **DATE** 10/7/20

LOCATION See Boring Location Plan
LOGGED BY E. Sosa
RIG TYPE Tierra Drilling - CME 75
BORING TYPE Hollow Stem Auger Method
SURFACE ELEV. Existing Ground Surface
DATUM Existing Ground Surface

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Sample Number	Blows Per Six Inches	SPT N-Value	Moisture Content Percent of Dry Weight	Percent Fines	Liquid Limit	Plastic Limit	Plasticity Index	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
0				S		5-6-5	11						SM	Medium Dense	Silty Sand - Reddish brown medium and fine SAND, little silt, nonplastic fines, damp.
													SM		Silty Sand - Brown fine SAND, little silt, nonplastic fines, damp.
				S		16-6-5	11	11.9	26					Medium Dense	Clay nodules
5				S		2-2-3	5	10.9	25					Loose	
				S		2-5-5	10						SM	Medium Dense	Silty Sand - Grayish brown fine SAND, little silt, nonplastic fines, moist.
10				S		4-7-7	14	22.4	17					Medium Dense	..., wet.
∇															
15				S		4-6-12	18							Medium Dense	
20				S		2-2-2	4							Loose	
													SP-SM		Poorly Graded Sand with Silt - Dark gray fine SAND, few silt, nonplastic fines, wet.
25				S		15-24-25/4"		19.1	5.5					Very Dense	
30															

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
∇	13	0	10/7/2020
▼			
∇			
∇			

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.375" I.D. Split-Barrel Sampler
U - 3" O.D. 2.375" I.D. Split-Barrel Sampler
SH - 3" O.D. Shelby Tube Sample
TC - Texas Cone
G - Grab Sample

LOG OF TEST BORING NO. B- 1

Wood E&IS, Inc.
125 Montoya Road
El Paso, TX 79932
Telephone: 915-585-2472

PROJECT EPWU-Lift Station Replacements
9914 Sunset (Lift Station #117) & 249 Country Cl
El Paso, El Paso County, Texas

JOB NO. 2037192035 **DATE** 10/7/20

LOCATION See Boring Location Plan
LOGGED BY E. Sosa
RIG TYPE Tierra Drilling - CME 75
BORING TYPE Hollow Stem Auger Method
SURFACE ELEV. Existing Ground Surface
DATUM Existing Ground Surface

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Sample Number	Blows Per Six Inches	SPT N-Value	Moisture Content Percent of Dry Weight	Percent Fines	Liquid Limit	Plastic Limit	Plasticity Index	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
30				S		8-11-12	23							Medium Dense	
															Poorly Graded Sand with Silt - Grayish brown fine SAND, few silt, nonplastic fines, wet.
35				S		3-5-13	18							Medium Dense	
															Auger terminated at 35 feet. Sampler terminated at 36.5 feet. NE - Not Encountered PP - Pocket Penetrometer tsf - tons per square foot
40															
45															
50															
55															
60															

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	13	0	10/7/2020
▼			
▽			
▽			

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.375" I.D. Split-Barrel Sampler
U - 3" O.D. 2.375" I.D. Split-Barrel Sampler
SH - 3" O.D. Shelby Tube Sample
TC - Texas Cone
G - Grab Sample

LOG OF TEST BORING NO. B- 1

PROJECT EPWU-Lift Station Replacements
9914 Sunset (Lift Station #117) & 249 Country Cl
El Paso, El Paso County, Texas

JOB NO. 2037192035 **DATE** 10/7/20

Wood E&IS, Inc.
125 Montoya Road
El Paso, TX 79932
Telephone: 915-585-2472

LOCATION See Boring Location Plan
LOGGED BY E. Sosa
RIG TYPE Tierra Drilling - CME 75
BORING TYPE Hollow Stem Auger Method
SURFACE ELEV. Existing Ground Surface
DATUM Existing Ground Surface

Depth in Feet	Sample Type	Blows Per Six Inches	SPT N-Value	Moisture Content Percent of Dry Weight	Percent Fines	Liquid Limit	Plastic Limit	Plasticity Index	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
0	S	2-4-4	8	15.9	73	24	18	6	CL-ML	Stiff	Silty Clay with Sand - Brown silty CLAY, low plastic fines, little sand, damp.
	S	1-2-1	3						CL	Soft	Sandy Lean Clay - Brown CLAY, low plastic fines, some sand, moist.
5	S	1-2-1	3	30.5	67	25	16	9		Soft	..., wet.
									SM		Silty Sand - Brown fine SAND, some silt, nonplastic fines, wet.
	S	2-4-4	8							Loose	
▽ 10	S	1-3-3	6						SP-SM	Loose	Poorly Graded Sand with Silt - Grayish brown fine SAND, few silt, nonplastic fines, wet.
15	S	4-6-9	15							Medium Dense	
20	S	2-4-4	8	22.8	8.6					Medium Dense	
25	S	4-9-20	29							Dense	
30											

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽	10	0	10/7/2020
▼			
▼			
▼			

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.375" I.D. Split-Barrel Sampler
U - 3" O.D. 2.375" I.D. Split-Barrel Sampler
SH - 3" O.D. Shelby Tube Sample
TC - Texas Cone
G - Grab Sample

LOG OF TEST BORING NO. B- 2

Wood E&IS, Inc.
125 Montoya Road
El Paso, TX 79932
Telephone: 915-585-2472

PROJECT EPWU-Lift Station Replacements
9914 Sunset (Lift Station #117) & 249 Country Cl
El Paso, El Paso County, Texas

JOB NO. 2037192035 **DATE** 10/7/20

LOCATION See Boring Location Plan
LOGGED BY E. Sosa
RIG TYPE Tierra Drilling - CME 75
BORING TYPE Hollow Stem Auger Method
SURFACE ELEV. Existing Ground Surface
DATUM Existing Ground Surface

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Sample Number	Blows Per Six Inches	SPT N-Value	Moisture Content Percent of Dry Weight	Percent Fines	Liquid Limit	Plastic Limit	Plasticity Index	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
30				S		1-2-3	5							Loose	
													SM		Silty Sand - Grayish brown fine SAND, little silt, nonplastic fines, wet.
35				S		3-6-7	13	17.0	18					Medium Dense	
															Auger terminated at 35 feet. Sampler terminated at 36.5 feet. NE - Not Encountered PP - Pocket Penetrometer tsf - tons per square foot
40															
45															
50															
55															
60															

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
∇	10	0	10/7/2020
▼			
∇			
∇			

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.375" I.D. Split-Barrel Sampler
U - 3" O.D. 2.375" I.D. Split-Barrel Sampler
SH - 3" O.D. Shelby Tube Sample
TC - Texas Cone
G - Grab Sample

LOG OF TEST BORING NO. B- 2

APPENDIX C

TABULATION OF TEST RESULTS

DATE: October 2020

Wood Project No.: 2037192035

PROJECT: EPWU Lift Station Replacements
Sunset (Lift Station #117) and Country Club (Lift Station #116)
El Paso, El Paso County, Texas

BORING NO.	DEPTH	UNIFIED CLASS.	LL	PL	PI	SIEVE ANALYSIS - ACCUM. % PASSING														MOISTURE %
						No.200	No.140	No.100	No.60	No.40	No.20	No.10	No.4	⅜″	¾″	1″	1½″	2″	3″	
B-1	2½′-4′	SM				16	25	33	70	89	94	96	97	99	100					11.9
B-1	5′-6½′	SM				25	32	40	76	95	98	100	100	100						10.9
B-1	10′-11½′	SM				17	19	31	86	96	97	98	98	98	100					22.4
B-1	25′-26½	SP-SM				5.5	22	19	59	89	98	99	100							19.1
B-2	0′-1½′	CL-ML	24	18	6	73	84	90	95	97	99	100	100							15.9
B-2	5′-6½′	CL	25	16	9	67	83	90	98	99	99	100	100	100						30.5
B-2	20′-21½	SP-SM				8.6	14	29	73	97	100	100								22.8
B-2	35′-36½	SM				18	25	32	78	97	100	100								17.0

APPENDIX D

GUIDE SPECIFICATIONS FOR EARTHWORK

1. SCOPE

Includes all clearing and grubbing, removal of obstructions, general excavating, filling and any related items necessary to complete the grading for the entire project in accordance with these specifications.

2. SUBSURFACE SOIL DATA

Subsurface soil studies have been made and the results are available for examination by the contractor. The contractor is expected to examine the site and determine for himself the character of materials to be encountered.

No additional allowance will be made for rock removal, site clearing and grading, filling, compaction, disposal or removal of any unclassified materials.

3. CLEARING AND GRUBBING

A. **General:** Clearing and grubbing will be required for all areas shown on the plans to be excavated or on which fill is to be constructed.

B. **Clearing:** Clearing shall consist of removal and disposal of the existing vegetation located within the areas to be cleared. Clearing shall also include the complete removal of the existing structures to be demolished prior to construction of the new facilities.

C. **Grubbing:** Stumps, matted roots and roots larger than 2 inches in diameter shall be removed from within 6 inches of the surface of areas on which fills are to be constructed except in roadways. Materials as described above within 18 inches of finished subgrade in either cut or fill sections shall be removed. Areas disturbed by grubbing will be filled as specified hereinafter for STRUCTURAL FILL.

4. EARTH EXCAVATION

A. Earth excavation shall consist of the excavation and removal of suitable soil for use as embankment as well as the satisfactory disposal of all vegetation, debris and deleterious materials encountered within the area to be graded and/or in a borrow area.

B. Excavated areas shall be continuously maintained such that the surface shall be smooth and have sufficient slope to allow water to drain from the surface.

5. STRUCTURAL FILL

A. **General:** Structural fill shall consist of a controlled fill constructed in areas indicated on the grading plans.

B. Materials:

(1) Physical Characteristics: Structural fill material shall consist of soil that conforms to the following physical characteristics:

Sieve Size (Square Openings)	Percent Passing by Weight
3 inch	100
3/4 inch	70 - 100
No. 4	40 - 100
No. 200	5 - 35

The plasticity index of the material, as determined in accordance with ASTM D 4318, shall not exceed 15. The structural fill material shall be free from roots, grass, other vegetable matter, clay lumps, rocks larger than 3 inches in any dimension, or other deleterious materials.

(2) Site Soil: Site soil from cuts may be used for structural fill provided they meet the requirements presented above. The results of this soil study indicate that some of the soils encountered at the project sites will meet the requirements for structural fill, except for the clay soils. Some blending of native materials may be required to meet the requirements for structural fill.

(3) Borrow: When the quantity of suitable material required for backfill or embankments are not available within the limits of the job site, the contractor shall provide sufficient materials to construct the fills and embankments to the lines, elevations and cross sections as shown on the drawings from borrow areas. The contractor shall obtain from owners of said borrow areas, the right to excavate material, shall pay all royalties and other charges involved, and shall pay all expenses in developing the source including the cost of right-of-way required for hauling the material.

C. Construction:

(1) Foundations – Lift Stations: Site preparation shall consist of over excavating the native soils below foundations to a depth of 12 inches. The base of the excavation shall be scarified to a depth of 8 inches, brought to within plus or minus 2 percent of optimum moisture content and compacted. Structural fill shall then be placed in compacted lifts to final grade.

In the event the excavations encounter loose or soft conditions, additional excavation or stabilization methods may be required and Wood shall be contacted to provide further recommendations.

Proper shoring shall be placed as needed for construction to protect existing structures located near the project site.

Due to shallow groundwater conditions encountered at the project site, dewatering will be required for the project. Dewatering shall extend a minimum of 5 feet below bottom of footing elevation. Adequate dewatering shall be performed to facilitate construction of the structure in the dry. Following construction of the structure, the groundwater shall be allowed to return to a stable level in a gradual manner. Pumping shall not be terminated, but slowly decreased to allow for a slow, steady and uniform rise of the groundwater.

(2) Compaction: All fill required beneath paved areas or fills required to support structural loadings shall be spread in layers not exceeding 8 inches, watered as necessary and compacted. Moisture content at the time of compaction shall be within plus or minus 2 percent of optimum moisture content. Compaction of the fill shall be accomplished by mechanical means only to obtain a density of not less than 95 percent of maximum dry density for fill placement and backfilling requirements. Optimum moisture content and maximum dry density for each soil type used shall be determined in accordance with ASTM D1557. Where vibratory compaction equipment is used, it shall be the contractor's responsibility to ensure that the vibrations do not damage nearby buildings or other adjacent property.

(3) Weather Limitations: Controlled fill shall not be constructed when the atmospheric temperature is below 35 degrees F. When the temperature falls below 35 degrees, it shall be the responsibility of the contractor to protect all areas of completed surface against any detrimental effects of ground freezing by methods approved by the geotechnical engineer. Any areas that are damaged by freezing shall be reconditioned, reshaped and compacted by the contractor in conformance with the requirements of this specification without additional cost to the owner.

D. **Slope Protection & Drainage:** The edges of the controlled fill embankments shall be graded to the contours shown on the drawings and compacted to the density required in paragraph 5.C.(3). Embankment slopes steeper than 1 vertical to 3 horizontal shall be protected from erosion.

6. INSPECTION & TESTS

A. **Field Inspection & Testing:** The owner shall employ the services of a registered, licensed geotechnical engineer for consultation during all controlled earthwork operations. The geotechnical engineer shall provide continuous on-site observation and testing by experienced personnel during construction of controlled earthwork. The contractor shall notify the engineer at least two working days in advance of any field operations of the controlled earthwork, or of any resumption of operations after stoppages. Tests of fill materials and embankments will be made at the following suggested minimum rates:

(1) One field density test for each 500 square feet of prepared subgrade and each 8-inch lift of structural fill below foundations and slabs.

(2) One moisture-density curve for each type of material used, as indicated by sieve analysis and plasticity index.

B. **Report of Field Density Tests:** The geotechnical engineer shall submit, daily, the results of field density tests required by these specifications.

C. **Costs of Tests & Inspection:** The costs of tests, inspection and engineering, as specified in this section of the specifications, shall be borne by the owner.