GEOTECHNICAL ENGINEERING REPORT

US-181 SEWER EXTENSION AND ARBOR FIELDS LIFT STATION

Floresville, Texas
UES Project No. A252627
September 16, 2025

Prepared for:

M&S ENGINEERING
376 Landa Street
New Braunfels, Texas 78130
Attention: Brady Kosub, P.E.

Prepared by:

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September 16, 2025

M&S Engineering
376 Landa Street
New Braunfels, Texas 78130

Attention: Brady Kosub, P.E.

Re: Geotechnical Engineering Report
US-181 Sewer Extension and Arbor Fields Lift Station
Floresville, Texas
UES Project No. A252627

UES has performed a geotechnical exploration for the project referenced above. This study was authorized by Brady Kosub, P.E. with M&S Engineering and performed in accordance with UES Proposal No. P24-2391 dated November 26, 2024 and M&S Engineering Subcontract Agreement, dated May 29, 2025.

The results of this exploration, together with our recommendations, are presented in the accompanying report, an electronic copy of which is being transmitted herewith.

UES appreciates the opportunity to be of service on this project. If we can be of further assistance, such as providing materials testing services during construction, please contact our office.

Sincerely,

Emanuel Diaz, E.I.T.
Geotechnical Project Manager

Lee E. Gurecky, P.E.
Geotechnical Department Manager

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APPENDICES

1.0 INTRODUCTION

Purpose and Scope. The purpose of this geotechnical study was to evaluate some of the physical and engineering properties of subsurface materials at selected locations on the subject site to develop geotechnical engineering design parameters and recommendations for the proposed project. To accomplish this, the scope of this study included field exploration consisting of drilling test borings and collecting samples of the subsurface materials, performing laboratory testing on selected samples obtained during the field exploration, performing engineering analysis and evaluation of the subsurface conditions with respect to the project characteristics, and development of geotechnical recommendations suitable for the proposed project. The scope of services did not include an environmental assessment of the site.

Limitations. Recommendations provided in this report were developed from information obtained in test borings depicting subsurface conditions only at the specific boring locations and at the particular time designated on the logs. Subsurface conditions at other locations may differ from those observed at the boring locations, and subsurface conditions at boring locations may vary at different times of the year. The scope of work may not fully define the variability of subsurface materials and conditions that are present on the site. The nature and extent of variations between borings may not become evident until construction. If significant variations then appear evident, our office should be contacted to re-evaluate our recommendations after performing on-site observations and possibly other tests.

Project Location. The project consists of the construction of new lift station and placement of a sanitary sewer utility line extending to an existing gravity main running parallel to US-181 in Floresville, Texas. The general location and orientation of the site is provided in Appendix A – Project Location Diagram.

Project Description. It is understood that this project consists of the construction of a new lift station with the installation of a fiber glass wet well. The bottom of the bottom of the wet well will be located at an approximate depth of 23½ feet below existing ground surface and with a wet well diameter of 8 feet. In addition, the placement of approximately 450 linear feet of underground sanitary sewer utility line is proposed to extend from the new lift station to an existing gravity main located off US-181.

Loading Information. Structure loading information was not available at the time of this report. However, it is anticipated the well will be supported on a mat/footing foundation system. It is expected the lift station excavation will be backfilled with excavated on-site soil. *Structural loading information should be brought to our attention once available to review the design and assess the suitability of the recommendations provided in this report herein.*

Site Grading. The site grading plans were not available at the time of writing this report. Our recommendations provided herein are on the basis that cuts and fills of less than 2 foot will be required to bring the lift station site to grade. When the site grading plan is available, we should be notified and allowed to review the site grading plan to assess and modify our recommendations, as necessary.

2.0 FIELD EXPLORATION

Test Borings. The field exploration for this project included performing a total of two (2) test borings as summarized in the following table. Boring depths were measured from the existing ground surface at the respective boring location at time of the field exploration.

Summary of Boring Depths and Locations		
Boring Identification	Depth, feet	Location
B-01	30	Lift Station Area
B-02	20	Gravity Sewer Main Extension

Test borings were advanced using standard rotary drilling equipment at the approximate locations as shown in APPENDIX B – Boring Location Diagram. The boring locations were not surveyed. UES located the borings in the field using a hand-held GPS unit with lateral accuracy of ± 20 ft. Therefore, the boring locations should be considered approximate.

Disturbed Soil Sampling. Disturbed soil samples were generally obtained using split-barrel sampling procedures in general accordance with ASTM D1586. In the split-barrel procedure, a disturbed sample is obtained in a standard 2-inch outside diameter (OD) split barrel sampling spoon driven 18 inches into the ground using a 140-pound (lb) hammer falling freely 30 inches. The number of blows for the last 12 inches of a standard 18-inch penetration is recorded as the Standard Penetration Test resistance (N-value). The N-values are recorded on the boring logs at the depth of sampling. Samples were sealed and returned to the laboratory for further evaluation and possible testing.

Groundwater Observations. A summary of groundwater observations is provided in Section 3.3.

Borehole Backfilling and Plugging. Upon completion of the borings, the boreholes were backfilled and plugged with on-site soil cuttings.

3.0 SUBSURFACE CONDITIONS

3.1 Geology

Geologic Formation. Based on our experience and a review of the **San Antonio Sheet of the Geologic Atlas of Texas,** the project site appears to be located within the **Queen**

City Sand (Eqc). The Bureau of Economic Geology describes the Queen City Sand formation generally consists of clays, sands, siltstones, and sandstones.

3.2 Subsurface Lithology

Stratigraphy. Descriptions of the various strata and their approximate depths and thickness per the Unified Soil Classification System (USCS) are provided on the boring logs included in APPENDIX C – Boring Logs and Laboratory Results. Terms and symbols used in the USCS are presented in APPENDIX C following the Boring Logs. The subsurface conditions encountered generally consist of medium dense to very dense coarse-grained soils with plasticity index (PI) values ranging from non-plastic to 17. Depths referenced in this report and in the tables below are measured from the existing ground surface at the respective boring location at time of the field exploration.

Soil Profile Table – B-01 (Lift Station Area)								
Depth	Description	LL	PI	C	Φ	γ_e	-#200	N
0-4	Silty, Clayey SAND	20	5	---	30	110	21	16-43
4-6	Clayey SAND	30	17	---	30	110	38	23
6-8	Silty, Clayey SAND	25	6	---	30	110	26	22
8-18	Poorly Graded SAND with Silt	21	2	---	30	110	6	11-21
18-30	Silty SAND	NP	NP	---	30	110	37	21-50/3”

Soil Profile Table – B-02 (Gravity Sewer Utility Line Area)								
Depth	Description	LL	PI	C	Φ	γ_e	-#200	N
0-4	Silty, Clayey SAND	23	7	---	30	110	18	29-42
4-13	Silty SAND	NP	NP	---	30	110	43	14-24
13-20	Silty, Clayey SAND	22	5	---	30	110	29	26-50/4”

Where: D = Depth below existing grade, ft
LL = Liquid Limit (%)
PI = Plasticity Index
C = Average Soil Cohesion, psf (undrained)
Φ = Average Angle of Internal Friction, deg. (undrained)
γ_e = Effective Soil Unit Weight, pcf
-#200 = Percent Material Finer than a #200 sieve
N = Standard Penetration value range
NP = Non-Plastic

It should be noted that the depths provided in the above tables and on the boring logs are based on our Field Technician’s and Engineer’s interpretation of conditions believed to exist between actual samples retrieved. Therefore, information on the boring logs contains both factual and interpretive information. Lines delineating subsurface strata are approximate and the actual transition between strata may be gradual or not clearly defined. In addition, variations may occur between or beyond the boring locations.

3.3 Groundwater Observations

Groundwater Levels. Groundwater was not encountered during the drilling operations nor was free water present in the open borings upon completion of the drilling operations.

Long-term Groundwater Monitoring. Groundwater observations in this report are those that were present at the time the borings were drilled. The depth and amount of water encountered in an open borehole largely depends on the permeability of the soils encountered at the boring location. In relatively permeable soils, such as sands and gravels, a rapid response to water movement is anticipated. In relatively impervious soils, such as clayey soils, a suitable estimate of the groundwater depths generally requires long-term monitoring. Long-term monitoring of groundwater conditions via piezometers or groundwater monitoring wells was not performed during this study and was beyond the scope of this study. Long-term monitoring can reveal groundwater levels materially different than those measured in the borings.

Groundwater Fluctuations. Subsurface groundwater fluctuations can occur. Future construction activities can alter the surface and subsurface drainage characteristics of this site. Seasonal variations, temperature, land-use, proximity to water bodies, and rainfall can also influence groundwater levels. UES recommends that the contractor verifies the groundwater elevation before construction starts.

3.4 Seismic Site Classification

The Site Class assigned for seismic design considers various factors, such as the soil profile (whether it's soil or rock), shear wave velocity, and strength, averaged over a depth of 100 feet. Since the borings didn't reach depths of 100 feet, UES made determinations under the assumption that the subsurface materials beneath the borehole bottoms resembled those encountered at the termination depth. Following the guidelines outlined in Section 1613.2.2 of the 2024 International Building Code and Table 20.2-1 in the 2022 ASCE-7, UES recommends using Site Class D (very dense soil) for seismic design purposes at this location.

4.0 LABORATORY TESTING

UES performs visual classification and laboratory tests, as appropriate, to define pertinent engineering characteristics of the soils encountered. Laboratory tests are performed in general accordance with ASTM or other applicable standards. Test results are included at the respective sample depths on the boring logs or separately tabulated herewith, as appropriate, or as included in APPENDIX C – Boring Logs and Laboratory Results. Laboratory tests and procedures performed for this geotechnical study are summarized in the following table.

Summary of Laboratory Tests and Procedures	
Test Procedure	**Description**
ASTM D4220	Standard Practices for Preserving and Transporting Soil Samples
ASTM D2487	Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D1140	Standard Test Methods for Amount of Material in Soils Finer than the No. 200 (75-µm) Sieve

5.0 RECOMMENDATIONS

5.1 Potential Movement of Expansive Soil

Estimated Potential Movement. Our findings indicate grade supported structures and movement sensitive flat work supported within 2 ft of existing ground surface could experience post construction movements up to approximately one inch due to shrinking and swelling of expansive soils (active clays) at the lift station site. For the purpose of this report, movement due to shrinking and swelling of active clays will be referred to as potential vertical movement (PVR).

Method of Estimation. PVR was estimated in general accordance with methods outlined by Texas Department of Transportation (TxDOT) Test Method Tex-124-E and engineering judgment and experience. Estimated PVR calculated assuming the moisture content of the in-situ soil within the normal zone of seasonal moisture content change varies between as defined by Tex-124-E. Also, it was assumed a 1 psi surcharge load from the floor slab acts on the subgrade soils. Movements exceeding our estimates could occur if positive drainage of surface water is not maintained or if soils are subject to an outside water source, such as leakage from a utility line or subsurface moisture migration from off-site locations.

5.2 Earthwork

Variations in subsurface conditions could be encountered during construction. To permit correlation between test boring data and actual subsurface conditions encountered during construction, it is recommended a registered Professional Engineering firm be retained to observe construction procedures and materials.

Some construction problems, particularly degree or magnitude, cannot be reasonably anticipated until the course of construction. The recommendations offered in the following paragraphs are intended not to limit or preclude other conceivable solutions, but rather to provide our observations based on our experience and understanding of the project characteristics and subsurface conditions encountered in the borings.

5.2.1 Excavation and Slopes

Geotechnical Parameters. From our experience, excavation methods for the lift station and placement of new underground utilities may include (but not limited to) open cuts and braced cuts. The geotechnical parameters provided in the tables below may be used for the design of braced excavation. The trench protection should be designed to provide the most conservative design.

Geotechnical Parameters for Braced Excavations - Boring B-01 (Lift Station Area)								
Depth	Description	C	Φ	C’	Φ’	Ka	Kp	OSHA
0-4	Silty, Clayey SAND	---	30	---	30	0.33	3.0	C
4-6	Clayey SAND	---	30	---	30	0.33	3.0	C
6-8	Silty, Clayey SAND	---	30	---	30	0.33	3.0	C
8-18	Poorly Graded SAND with Silt	---	30	---	30	0.33	3.0	C
18-30	Silty SAND	---	30	---	30	0.33	3.0	C

Geotechnical Parameters for Braced Excavations - Boring B-02 (Gravity Sewer Main)								
Depth	Description	C	Φ	C’	Φ’	Ka	Kp	OSHA
0-4	Silty, Clayey SAND	---	30	---	30	0.33	3.0	C
4-13	Silty SAND	---	30	---	30	0.33	3.0	C
13-20	Silty, Clayey SAND	---	30	---	30	0.33	3.0	C

Where: D = Depth below existing grade (ft)
C= Undrained Shear Strength (psf)
Φ = Undrained Angle of Internal Friction (degrees)
C’= Drained Shear Strength (psf)
Φ’= Drained Angle of Internal Friction (degrees)
Ka= Active Earth Pressure Coefficient
Kp= Passive Earth Pressure Coefficient
OSHA= OSHA Soil Type

5.2.2 Excavation Safety Considerations

Excavation Safety. The contractor is responsible for designing any excavation slopes, temporary sheeting or shoring. Design of these structures should include any imposed surface surcharges. Construction site safety is the sole responsibility of the contractor, who shall also be solely responsible for the means, methods and sequencing of construction operations. The contractor should also be aware that slope height, slope inclination or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state and/or federal safety regulations, such as OSHA Health and Safety Standard for Excavations, 29 CFR Part 1926, or successor regulations. Stockpiles should be placed well away from the edge of the excavation and their heights should be controlled so they do not surcharge the sides of the excavation. Surface drainage should be carefully controlled to prevent flow of water over the slopes and/or into the excavations. Construction slopes should be closely observed for signs of mass movement, including tension cracks near the crest or bulging at the toe. If potential stability problems are observed, a geotechnical engineer should be contacted immediately. Shoring, bracing or underpinning required for the project (if any) should be designed by a professional engineer registered in the State of Texas.

Applicability. Recommendations in this section apply to short-term construction-related excavations for this project with excavation depth less than 20 feet. Recommendations provided herein are not valid for any long-term or permanent slopes on-site. Stability of long-term unprotected slopes will require much flatter slopes. Slope protection for excavations greater than 20 feet should be designed and sealed by a professional engineer registered in the State of Texas.

Short-Term Sloped Excavations. All short-term sloped construction excavations on-site should be designed in accordance with Occupational Safety and Health Administration (OSHA) excavation standards. The following table provides a summary of the OSHA Soil Type Classification based on the soils encountered at the boring location.

Soil Type Classification Table		
Depth (feet, bgs)	**Soi Description**	**OSHA Soil Type Classification**
0 to 20	Non-Cohesive Soil Above Water Table	Type C

The contractor's "competent person" shall make the final determination of the OSHA Soil Type during excavation of the soils at the jobsite. The maximum allowable slopes during construction for soil OSHA soil types are provided in the following table.

Guidelines for Maximum Allowable Slopes Less Than 20-feet Deep	
Soil Type	**Max. Allow. Slopes for Excavations**
Type C	1.5 Horizontal : 1 Vertical

Shored Excavations. As an alternative to sloped excavations, vertical short-term construction excavations may be used in conjunction with trench boxes or other shoring systems. Surcharge pressures at the ground surface due to dead and live loads should be added to the lateral earth pressures where they may occur. Surcharge loads set back behind the excavation at a horizontal distance equal to or greater than the excavation depth may be ignored. We recommend that no more than 200 feet of unshored excavation should be open at any one time to prevent the possibility of failure and excessive ground movement to occur. We also recommend that unshored excavations do not remain open for a period of time longer than 24 hours.

Limitations. Recommendations provided herein assume there are no nearby structures or other improvements which might be detrimentally affected by the construction excavation. Before proceeding, we should be contacted to evaluate construction excavations with the potential to affect nearby structures or other improvements.

Excavation Monitoring. Construction excavations and their related safety are the responsibility of the Contractor. Excavations should be monitored and documented by a competent professional to confirm site soil conditions consistent with those encountered in the borings drilled as part of this study. Discrepancies in soil conditions should be brought to the attention of UES for review and revision of recommendations, as appropriate.

5.2.3 Site Preparation and Proof-roll

Site Clearing. In the area of improvements, all trees, stumps, brush, abandoned structures, roots, vegetation, rubbish and any other undesirable matter should be removed and properly disposed.

Proof-roll. Building pad and paving subgrades should be proof-rolled in accordance TX-DOT Specification Item 216 with a fully loaded tandem axle dump truck or similar pneumatic-tire equipment weighing at least 20 tons to locate areas of loose subgrade. In areas to be cut, the proof-roll should be performed after the final grade is established. In areas to be filled, the proof-roll should be performed prior to fill placement. Areas of loose or soft subgrade encountered in the proof-roll should be removed and replaced with engineered fill, moisture conditioned (dried or wetted, as needed) and compacted in place. Prior to placement of any fill, the exposed soil subgrade should then be scarified to a minimum depth of 6 inches and re-compacted as outlined in Section 5.2.7.

5.2.4 Construction Considerations

Maintenance of Subgrade during Construction. While the exposed subgrade is expected to remain relatively stable initially, unstable conditions may arise during general construction activities, particularly if the soil is exposed to wet weather conditions and repetitive construction traffic. The use of lighter construction equipment can help minimize disturbance to the subgrade. In the event of unstable conditions, stabilization measures will be necessary. After grading is completed, it's crucial to maintain the moisture content of the subgrade before proceeding with pavement construction. Minimizing construction traffic over the finished subgrade is advisable. If the subgrade becomes frozen, desiccated, saturated, or disturbed, the affected material should either be removed or treated by scarification, moisture conditioning, and re-compaction before pavement construction begins. UES should be retained to observe earthwork and to perform necessary tests and observations during subgrade preparation.

Wet Weather/Soft Subgrade. Soft and/or wet surface soils may be encountered during construction, especially following periods of wet weather. Wet or soft surface soils can present difficulties for compaction and other construction equipment. If specified compaction cannot be achieved due to soft or wet surface soils, one of the following corrective measures will be required:

1. Removal of the wet and/or soft soil and replacement with select fill,
2. Chemical treatment of the wet and/or soft soil with Lime-fly ash or cement to improve the subgrade stability, or
3. If allowed by the schedule, drying by natural means.

Chemical treatment is usually the most effective way to improve soft and/or wet surface soils. UES should be contacted for additional recommendations if chemical treatment is planned due to wet and/or soft soils.

Fill on Existing Slopes. If fill is to be placed on existing slopes (natural or constructed) steeper than six horizontal to one vertical (6:1), the fill materials should be benched into the existing slopes in such a manner as to provide a minimum bench-key width of five (5) ft. This should provide a good contact between the existing soils and new fill materials, reduce potential sliding planes, and allow relatively horizontal lift placements.

5.2.5 Grading, Drainage and Other Considerations

Efforts should be made to minimize the excessive wetting or drying of the underlying soil, as it can lead to swelling and shrinkage of these soil layers. Standard construction practices of providing good surface water drainage should be used. A positive slope of the ground away from any foundation should be provided. Ditches or swales should be provided to carry the run-off water both during and after construction. Stormwater runoff should discharge away from the structure.

In areas with pavement or sidewalks adjacent to the structure, a positive seal must be maintained between the structure and the pavement or sidewalk to minimize seepage of water into the underlying supporting soils. Post-construction movement of pavement and flatwork is common. Normal maintenance should include inspection of all joints in paving and sidewalks, etc. as well as re-sealing where necessary.

Since granular bedding backfill is used for most utility lines, the backfilled trench should not become a conduit and allow access for surface or subsurface water to travel toward the new structures. Concrete cut-off collars or clay plugs should be provided where utility lines cross building lines to prevent water from traveling in the trench backfill and entering beneath the structures.

Root systems from trees and shrubs can draw a substantial amount of water from the clay soils at this site, causing the clays to dry and shrink in excess of our estimates. This could cause settlement beneath grade-supported slabs such as floors, walks and paving. Trees and large bushes should be located a distance equal to at least one-half their anticipated mature height away from grade slabs. Lawn areas, if applicable, should be watered moderately, without allowing the clay soils to become too dry or too wet.

5.2.6 Groundwater Control

Groundwater was not encountered during drilling operations at this site. However, from our experience, shallow groundwater seepage could be encountered in excavations for foundations, utilities and other general excavations at this site. The risk of seepage increases with depth of excavation and during or after periods of precipitation. The risk of seepage is also increased where limestone is exposed in excavations and slopes or is near final grade. Standard sump pits and pumping may be adequate to control seepage on a local basis.

If groundwater is encountered during excavation, dewatering to bring the groundwater below the bottom of excavations may be required. Dewatering could consist of standard sump pits and pumping procedures, which may be adequate to control seepage on a local basis during excavation. Supplemental dewatering will be required in areas where standard sump pits and pumping are not effective. Supplemental dewatering could include submersible pumps in slotted casings, well points, or eductors. For supplemental dewatering, the contractor should submit a groundwater control plan, prepared by a licensed engineer experienced in that type of work.

5.2.7 Fill Compaction

<u>General Fill</u>. General fill may be placed in improved areas outside of the structure pad area. General fill should consist of material approved by the Geotechnical Engineer with a liquid limit less than 50. General fill should be placed in loose lifts not exceeding 8 inches and should be uniformly compacted to a minimum of 95 percent maximum dry density (per ASTM D-698) and within ±2 percent of the optimum moisture content. The subgrade to receive general fill should be scarified to a depth of 6 inches and compacted to at least 95 percent maximum dry density (per ASTM D-698) and at a moisture content between optimum and 4 percent above optimum moisture content.

<u>Fill Restrictions</u>. Select fill and general fill should consist of those materials meeting the requirements stated. Fill soils should not contain material greater than 4 inches in any direction, debris, vegetation, waste material, environmentally contaminated material, or any other unsuitable material.

<u>Fill Compaction Testing Guidelines</u>. Field compaction and classification tests should be performed by UES. Compaction tests should be performed in each lift of the compacted material. We recommend the following minimum soil compaction testing be performed: one test per lift per 2,500 SF (with a minimum of two tests per lift) in the area of the structure pad, one test per lift per 5,000 SF outside the structure pad, and one test per lift per 100 linear feet of utility backfill. If the materials fail to meet the density or moisture content specified, the course should be reworked as necessary to obtain the specified compaction. Classification confirmation inspection/testing should be performed daily on select fill materials (whether on-site or imported) to confirm consistency with the project requirements. The testing frequency recommended herein can be altered (increased or decreased) at the discretion of the geotechnical engineer of record.

5.2.8 Utilities

Bedding. Pipe bedding and pipe-zone backfill for underground utilities should meet the requirements of the pipe manufacturer. If no manufacturer requirement exists, then pipe bedding should be placed in accordance with applicable municipal or TxDOT requirements. Unless specified otherwise, the pipe-zone generally consists of all materials surrounding the pipe in the trench from six (6) inches below the pipe to 12 inches above the pipe. Since granular bedding backfill is used for most utility lines, the backfilled trench should not become a conduit and allow access for surface or subsurface water to travel toward the new structure. Concrete cut-off collars or clay plugs should be provided where utility lines cross building lines to prevent water from traveling in the trench backfill and entering beneath the structure. At least 1 ft of soil cover should exist between concrete plugs and structural elements. Local municipality or jurisdiction take precedence over pipe bedding recommendations herein.

Backfill. The trench backfill for utilities should be properly placed and compacted as outlined in Section 5.2.7 and in accordance with requirements of local City standards. Utility backfill in the building pad should be placed in accordance with applicable requirements for the building pad.

Trench Settlement. Even if fill is properly compacted, fills in excess of about 10 ft are still subject to settlements over time of up to about 1 to 2 percent of the total fill thickness. This should be considered when designing pavement over utility lines and/or other areas with deep fill. Where utility lines are deeper than 10 ft, the fill/backfill below 10 ft should be compacted to at least 100 percent of standard Proctor maximum dry density (ASTM D 698) and within –2 to +2 percentage points of the material's optimum moisture content. The portion of the fill/backfill shallower than 10 ft should be compacted as previously outlined. Density tests should be performed on each lift (maximum 12-inch thick) and should be performed as the trench is backfilled. Local municipality or jurisdiction take precedence over trench backfill recommendations herein.

Trench Excavation. If utility trenches or other excavations extend to a depth of 5 ft or more below construction grade, the contractor or others shall be required to develop an excavation safety plan to protect personnel entering the excavation or excavation vicinity. The collection of specific geotechnical data and the development of such a plan, which could include designs for sloping and benching or various types of temporary shoring, is beyond the scope of this study. Any such designs and safety plans shall be developed in accordance with current OSHA guidelines and other applicable industry standards.

5.2.9 Deep Fill Considerations

Deep Fill Compaction. Fills placed deeper than 10 ft should be compacted to at least 100 percent of standard Proctor maximum dry density (ASTM D 698) and within –2 to +2 percentage points of the material's optimum moisture content. The portion of the fill/backfill shallower than 10 ft should be compacted as previously outlined. Density tests should be performed on each lift (maximum 12-inch thick) and should be performed as the trench is backfilled.

Deep Fill Settlement. Even if fill is properly placed and compacted as recommended herein, fills more than about 10 ft deep can still settle about 1 to 2 percent of its thickness due to its own weight, independent of external loads. This settlement generally begins as soon as lift placement begins. However, settlement can still occur for a period of time after completion of fill placement. The time required for settlement to occur is a function of soil type, pore water, and drainage path conditions and can vary widely. As a result, some fill-related settlement should be expected before and after final lifts are placed. Movement of grade supported structures (foundations, flatwork, etc.) related to settling fill can be reduced by allowing as much time as possible between the time the fill placement is completed and construction of the grade supported structure. If this risk of post construction settlement of deep fills is not acceptable, survey monitoring of constructed fills can be performed to evaluate the rate and magnitude of settlement prior to construction of structures on the fill. UES can provide this service if desired.

5.3 Foundation System for the Proposed Wet Well

Appropriate Foundation Types. A non-stiffened slab or mat foundation is generally appropriate to the project and site based on the geotechnical conditions encountered.

Foundation Determination. Foundation loading assumptions used in preparation of the following recommendations are summarized in Section 1.0. Final determination of the foundation type to be utilized for this project should be made by the Structural Engineer based on loading, economic factors and risk tolerance.

Foundations Adjacent to Slopes. Foundations placed too close to adjacent slopes steeper than 5H:1V may experience reduced bearing capacities and/or excessive settlement. Recommendations provided herein assume foundations are not close enough to adjacent slopes in excess of 5H:1V to be detrimentally affected. Therefore, foundations closer than 5 times the depth of adjacent slopes, pits, or excavations in excess of 5H:1V should be brought to UES's attention to review the appropriateness of our recommendations.

Design Applicability. The following foundation design recommendations are based on project information discussed in Section 1.0.

Foundation Plan Review. UES should be provided with final foundation plans, details and related structural loads, with adequate time to review, prior to finalizing the design to verify conformance with recommendations presented herein.

Foundation Depth. Based upon current project information, the depth of excavation for the wet well will be approximately 23½ feet below existing grades. Native, medium dense to very dense course-grained soils are anticipated at the foundation bearing level for the wet well.

Bearing Capacity. The mat should be analyzed using a soil-structure interaction program to identify areas of high contact stresses, excessive movements, and large moments. If a Winkler-type subgrade modulus model is utilized to model the mat response to load, a subgrade modulus (k) of 150 pounds per cubic inch (pci) can be utilized. Contact pressures should not exceed 2,500 psf. The indicated bearing pressure includes a factor of safety against a bearing capacity failure of at least 3. Contact stresses should be distributed so that yield does not occur.

Buoyancy Design Considerations. Due to the depth of the wet well below final grades and the assumed lack of perimeter drainage, the structure, and foundation should be designed for *full buoyancy*. The buoyant forces will be resisted primarily by the weight of the structure. The structure walls, the mat foundation, and the connections between these components should be structurally sufficient to resist upward forces and bending moments induced by the hydrostatic pressure.

Frictional Forces. Frictional forces between the fiber glass walls and the supporting soils should be neglected for the top 5 ft of native soils due to the zone of moisture variation. As such, the only resistance to potential uplift forces in this zone will be the self-weight of the wet well fiber glass shell. An allowable friction value 200 psf may be used below a depth of 5 feet along the walls, assuming competent surrounding soils and proper contact with these soils. The slab can be extended at the base to provide a lip or other measures considered to provide the required uplift resistance. As an alternative, soil anchors installed vertically beneath the slab may be considered to provide the required uplift resistance. If desired, our office should be contacted for additional design information. We recommend using a buoyant unit weight of 60 pcf for the soil to compute uplift resistance.

Construction and Observation. During construction of the wet well, care should be taken to keep the excavation free of water to prevent movement of the wet well. In addition, backfill around the walls should be placed as soon as practical.

It is estimated the resulting total foundation movement should be limited and not exceed 1 inch for the wet well due to the anticipated depth (23½ ft below existing site grade) of the wet well foundation and the encountered subgrade conditions. Careful field inspection of the mat excavation will contribute substantially to reducing foundation movements.

UES should observe and test the mat foundation subgrade soils during foundation construction to locate unsuitable materials that could be encountered in excavations for the mat and to verify conditions are as anticipated in this report. Unsuitable materials encountered at the foundation bearing level should be removed and replaced with lean concrete (about 2,000 psi strength at 28 days). Clay soils present at the foundation bearing level are prone to rapid deterioration after they are exposed. A lean concrete mud slab should be placed in the base of the foundation excavation to prevent deterioration of the foundation bearing surface and provide a firm base for workers constructing the foundation. A mud slab could consist of a lean concrete mixture (about 2,000 psi strength at 28 days) with a thickness of about 3 to 5 inches.

Settlement. Settlement of backfill behind the wet well walls should be anticipated. Even backfill that is properly compacted as recommended in Section 7.3 is subject to settlement due to its own self-weight over time. Our experience with similar soils indicates the magnitude of this settlement could be about 1 to 2 percent of the total fill thickness. This settlement should be considered when designing pavements, flatwork and piping within the backfill zone around the wet well. If this potential settlement is not tolerable, consideration can be given to using excavatable flowable fill (TxDOT Item 401) as backfill around the wet well.

5.4 Lateral Earth Pressures

It is expected that on-site coarse-grained soils will be used as backfill against the underground structures, and that drainage of the backfill materials will not be provided. Below-grade walls for the underground structures should be designed to resist combined at-rest lateral earth pressure and hydrostatic pressure. For such materials and conditions, we recommend a combined at-rest lateral earth pressure and hydrostatic pressure of 95 psf per ft of depth. This lateral pressure is based on a final ground surface slope behind the wall of not steeper than 1 vertical to 5 horizontal. Wall backfill should be compacted as described in Section 5.2.7 of this report.

The combined lateral earth pressure and hydrostatic pressure presented herein does not include the effects of vertical surcharge loads at the ground surface adjacent to the lift station. Surcharge loads should be multiplied by an at-rest earth pressure coefficient of 0.8 and applied as a uniform lateral pressure over the full depth of the wall.

Lightweight, hand-controlled vibrating plate compactors are recommended for compaction of backfill adjacent to walls to reduce the possibility of increases in lateral pressures due to over-compaction. Heavy compaction equipment should not be operated near the walls. Also, compaction of backfill soils behind walls should not exceed 100 percent standard Proctor maximum dry density (ASTM D 698) to further limit lateral earth pressures against walls.

5.5 Buried Structures and Pipe

5.5.1 Buried Structures

Uplift. Buried water-tight structures are subjected to uplift forces caused by differential water levels adjacent to and within the structure. Soils with any appreciable silt or sand content will likely become saturated during periods of heavy rainfall and the effective static water level will be at the ground surface. For design purposes, we recommend the groundwater level be assumed at the ground surface. Resistance to uplift pressure is provided by soil skin friction and the dead weight of the structure. Skin friction should be neglected for the upper 5 feet of soil. A skin friction of 200 pounds per square foot (psf) may be used below a depth of 3 feet.

Lateral Pressure. Lateral pressures on buried structures due to soil loading can be determined using an equivalent fluid weight of 95 pounds per cubic foot (pcf). This includes hydrostatic pressure but does not include surcharge loads. The lateral load produced by a surcharge may be computed as 50 percent of the vertical surcharge pressure applied as a constant pressure over the full depth of the buried structure. Surcharge loads located a horizontal distance equal to or greater than the buried structure depth may be ignored.

Vertical Pressure. Vertical pressures on buried structures due to soil loading can be determined using an equivalent fluid weight of 125 pcf. This does not include surcharge loads. The vertical load produced by a surcharge may be computed as 100 percent of the vertical surcharge pressure applied as a constant pressure over the full width of the buried structure.

5.5.2 Buried Pipe

Applicability. Recommendations in this section are applicable to the design of buried piping placed by open cut methods associated with this project.

Pressure on Buried Pipe. Design recommendations provided in Section 5.5.1 of this report apply to buried piping.

Thrust Restraints. Resistance to lateral forces at thrust blocks will be developed by friction developed along the base of the thrust block and passive earth pressure acting on the vertical face of the block. We recommend a coefficient of base friction of 0.25 along the base of the thrust block. Passive resistance on the vertical face of the thrust block may be calculated using the allowable passive earth pressures presented in the following table.

Allowable Passive Earth Pressure by Material Type	
Material	Allowable Passive Pressure (psf)
Sand	100 x Depth in Feet
Clayey Sand	2,000
Compacted Clay Fill	1,500

Note:

1. Passive resistance should be neglected for any portion of the thrust block within 3 feet of the final site grade. The allowable passive resistance for clayey sand is based on the thrust block bearing directly against vertical, undisturbed cuts in these materials.

Bedding and Backfill. Pipe bedding and pipe-zone backfill for the water and sanitary sewer piping should be in accordance with TxDOT standard specification Item 400 or the local equivalent. The pipe-zone consists of all materials surrounding the pipe in the trench from six (6) inches below the pipe to 12 inches above the pipe.

Trench Backfill. Excavated site soils will be utilized to backfill the trenches above the pipe-zone. Backfilled soil should be placed in loose lifts not exceeding 8-inches and should be compacted to at least 95 percent maximum dry density (per ASTM D-698) and at a moisture content between optimum and 4 percent above optimum moisture content.

Trench Settlement. Settlement of backfill should be anticipated. Even for properly compacted backfill, fills are still subject to settlements over time of up to 2 percent of the total fill thickness. This level of settlement can be significant for fills beneath streets. Therefore, close coordination and monitoring should be performed to reduce the potential for future movement.

6.0 LIMITATIONS/GENERAL COMMENTS

As with any geotechnical engineering report, this report presents technical information and provides detailed technical recommendations for civil and structural engineering design and construction purposes. UES, by necessity, has assumed the user of this document possesses the technical acumen to understand and properly utilize the information and recommendations provided herein. UES strives to be clear in its presentation and, like the user, does not want potentially detrimental misinterpretation or misunderstanding of this report. Therefore, we encourage any user of this report with questions regarding its content to contact UES for clarification. Clarification will be provided verbally and/or issued by UES in the form of a report addendum, as appropriate.

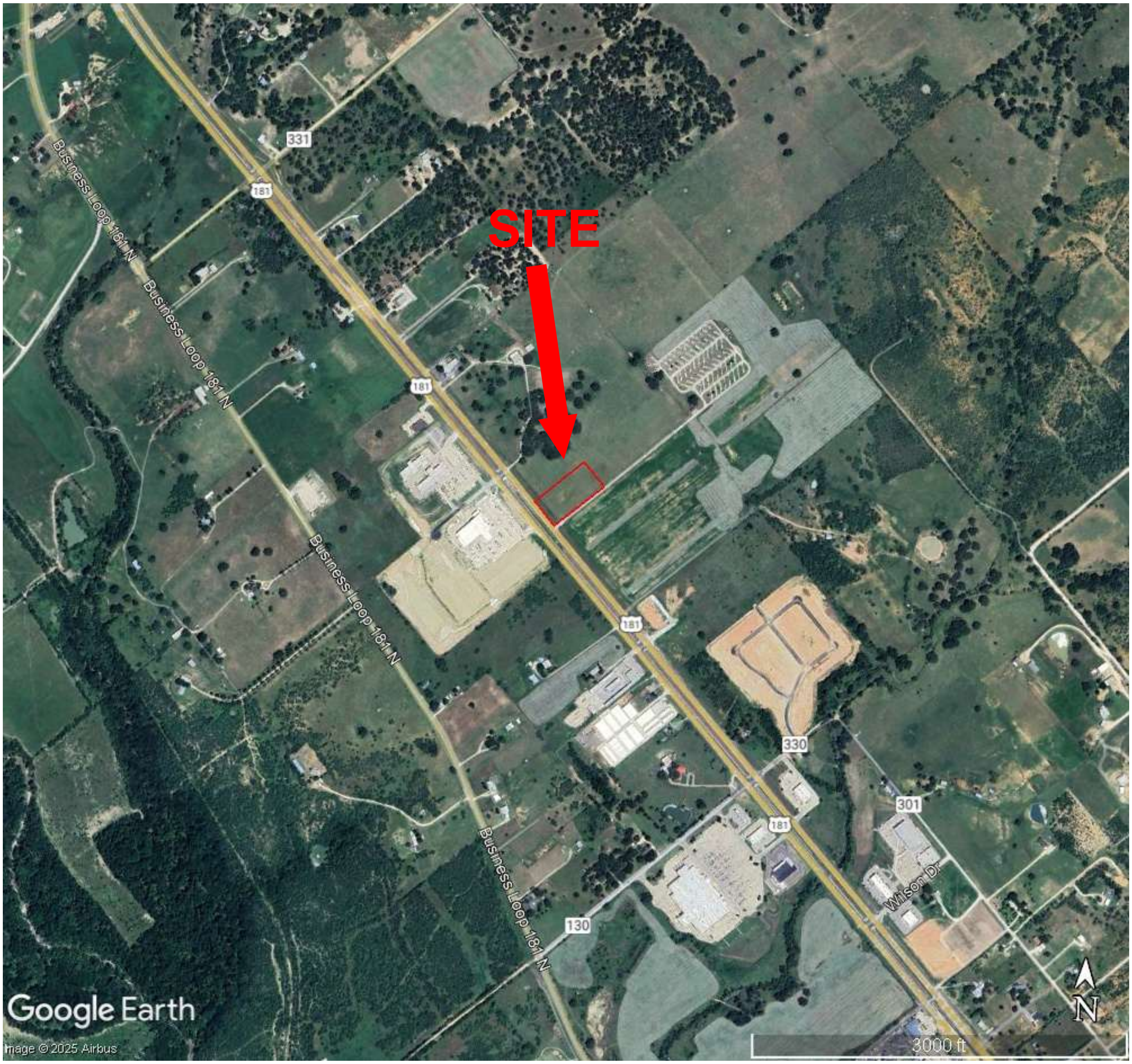
Professional services provided in this geotechnical exploration were performed, findings obtained, and recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. The scope of services provided herein does not include an environmental assessment of the site or investigation for the presence or absence of hazardous materials in the soil, surface water or groundwater. UES, upon written request, can be retained to provide these services.

UES is not responsible for conclusions, opinions or recommendations made by others based on this data. Information contained in this report is intended for the exclusive use of the Client (and their designated design representatives), and is related solely to design of the specific structures outlined in Section 1.0. No party other than the Client (and their designated design representatives) shall use or rely upon this report in any manner whatsoever unless such party shall have obtained UES's written acceptance of such intended use. Any such third party using this report after obtaining UES's written acceptance shall be bound by the limitations and limitations of liability contained herein, including UES's liability being limited to the fee paid to it for this report. Recommendations presented in this report should not be used for design of any other structures except those specifically described in this report. In all areas of this report in which UES may provide additional services if requested to do so in writing, it is presumed that such requests have not been made if not evidenced by a written document accepted by UES. Further, subsurface conditions can change with passage of time. Recommendations contained herein are not considered applicable for an extended period of time after the completion date of this report. It is recommended our office be contacted for a review of the contents of this report for construction commencing more than one (1) year after completion of this report. Non-compliance with any of these requirements by the Client or anyone else shall release UES from any liability resulting from the use of, or reliance upon, this report.

Recommendations provided in this report are based on our understanding of information provided by the Client about characteristics of the project. If the Client notes any deviation from the facts about project characteristics, UES should be contacted immediately since this may materially alter the recommendations. Further, UES is not responsible for damages resulting from workmanship of designers or contractors. It is recommended the Owner retain qualified personnel, such as a Geotechnical Engineering firm, to verify construction is performed in accordance with plans and specifications.

APPENDIX A - Project Location Diagram

PROJECT LOCATION DIAGRAM



US-181 SEWER EXTENSION AND ARBOR FIELDS LS

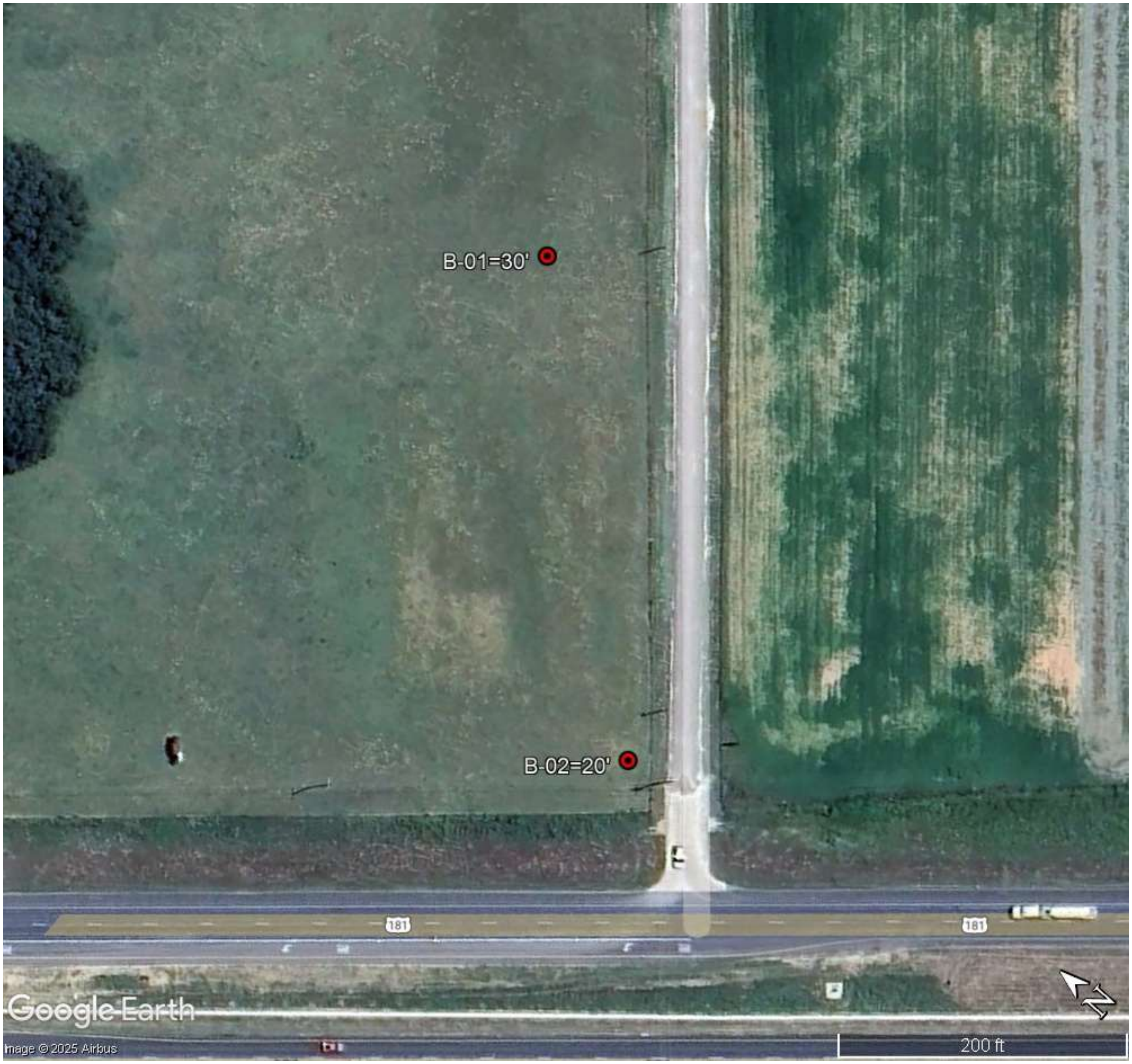
M&S Engineering
UES Project No.: A252627

US-181 & TX-331
Floresville, Texas

APPENDIX B - Boring Location Diagram

BORING LOCATION DIAGRAM

LOCATIONS ARE APPROXIMATE



US-181 SEWER EXTENSION AND ARBOR FIELDS LS

M&S Engineering
UES Project No.: A252627

US-181 & TX-331
Floresville, Texas

APPENDIX C - Boring Logs and Laboratory Results

SOIL BORING NUMBER: B-01

PROJECT NAME US-181 Sewer Extension
DATE STARTED 08/07/2025 **COMPLETED** 08/07/2025
CLIENT M&S Engineering
DRILLING METHOD Solid Flight Auger
NOTES

PROJECT NUMBER A252627
PROJECT LOCATION US-181 & TX-331, Floresville, Texas
LATITUDE / LONGITUDE 29.171466, -98.183092
BORING ELEVATION N/A
HAMMER WEIGHT - **HAMMER DROP** -

Groundwater Data	
During Drilling (ft):	N/A
After Drilling (ft):	N/A
After __ Hours (ft):	N/A

Depth (ft)	Material Description	Samples: Sample Graphic	REC (%) / RQD (%)	N-Value / Refusal / TCP	Pocket Pen (TSF)	Lab: Compressive Strength (TSF)	Confining Pressure (PSI)	Dry Density (PCF)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Swell	% Fines	Sulfate (PPM)
0.0–4.0	SILTY, CLAYEY SAND, medium dense to dense, brown. (SC-SM)			16					2	20	15	5		21	
				43					9						
4.0–6.0	CLAYEY SAND, medium dense, brown, with some gravel. (SC)			23					10	30	13	17		38	
6.0–8.0	SILTY, CLAYEY SAND, medium dense, light brown. (SC-SM)			22					6	25	19	6		26	
8.0–18.0	POORLY GRADED SAND WITH SILT, medium dense, light brown. (SP-SM)			11					4						
				21					2	21	19	2		6	
18.0–30.0	SILTY SAND, medium dense to very dense, reddish brown and gray. (SM)			26					6						
				21					7	NP	NP	NP		37	
				35-50/3"					4						
30.0	Boring terminated at a depth of 30-feet.														

SOIL BORING NUMBER: B-02

PROJECT NAME US-181 Sewer Extension
PROJECT NUMBER A252627
DATE STARTED 08/07/2025 **COMPLETED** 08/07/2025
PROJECT LOCATION US-181 & TX-331, Floresville, Texas
CLIENT M&S Engineering
LATITUDE / LONGITUDE 29.170714, -98.183814
DRILLING METHOD Solid Flight Auger
BORING ELEVATION N/A
NOTES
HAMMER WEIGHT - **HAMMER DROP** -

Groundwater Data	
During Drilling (ft):	N/A
After Drilling (ft):	N/A
After __ Hours (ft):	N/A

Depth (ft)	Material Description	Sample Graphic	REC (%) / RQD (%)	N-Value / Refusal / TCP	Pocket Pen (TSF)	Compressive Strength (TSF)	Confining Pressure (PSI)	Dry Density (PCF)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Swell	% Fines	Sulfate (PPM)
0.0–4.0	SILTY, CLAYEY SAND, medium dense to dense, brown. (SC-SM)	X		29					2	23	16	7		18	
		X		42					2						
4.0–13.0	SILTY SAND, medium dense, brown and reddish brown. (SM)	X		24					12	NP	NP	NP		43	
		X		19					14						
		X		14					13						
13.0–20.0	SILTY, CLAYEY SAND, medium dense to very dense, reddish brown to light brown. (SC-SM)	X		26					10						
		X		21-50/4"					9	22	17	5		29	
20.0	Boring terminated at a depth of 20-feet.														

KEY TO SOIL CLASSIFICATION AND SYMBOLS

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		SYMBOL	NAME
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well Graded Gravels or Gravel-Sand mixtures, little or no fines
		GP	Poorly Graded Gravels or Gravel-Sand mixtures, little or no fines
		GM	Silty Gravels, Gravel-Sand-Silt mixtures
		GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SAND AND SANDY SOILS	SW	Well Graded Sands or Gravelly Sands, little or no fines
		SP	Poorly Graded Sands or Gravelly Sands, little or no fines
		SM	Silty Sands, Sand-Silt Mixtures
		SC	Clayey Sands, Sand-Clay mixtures
	SILTS AND CLAYS LL < 50	ML	Inorganic Silts and very fine Sands, Rock Flour, Silty or Clayey fine Sands or Clayey Silts
		CL	Inorganic Clays of low to medium plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		OL	Organic Silts and Organic Silt-Clays of low plasticity
	SILTS AND CLAYS LL > 50	MH	Inorganic Silts, Micaceous or Diatomaceous fine Sandy or Silty soils, Elastic Silts
		CH	Inorganic Clays of high plasticity, Fat Clays
		OH	Organic Clays of medium to high plasticity, Organic Silts
NON USCS MATERIALS			Limestone
			Marl/Claystone
			Sandstone

TERMS CHARACTERIZING SOIL STRUCTURE

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 (VARVED) - composed of thin layers of varying color and texture, usually grading from sand or silt at the bottom to clay at the top

CRUMBLY - cohesive soils which break into small blocks or crumbs on drying

CALCAREOUS - containing appreciable quantities of calcium carbonate, generally nodular

WELL GRADED - having wide range in grain sizes and substantial amounts of all intermediate particle sizes

POORLY GRADED - predominantly of one grain size uniformly graded) or having a range of sizes with some intermediate size missing (gap or skip graded)

SYMBOLS FOR TEST DATA

— Groundwater Level (Initial Reading)

— Groundwater Level (Final Reading)

— Shelby Tube Sample

— SPT Samples

— Auger Sample

— Rock Core

— Texas Cone Penetrometer

— Grab Sample

TERMS DESCRIBING CONSISTENCY OF SOIL

COARSE GRAINED SOILS		FINE GRAINED SOILS		
DESCRIPTIVE TERM	NO. BLOWS/FT. STANDARD PEN. TEST	DESCRIPTIVE TERM	NO. BLOWS/FT. STANDARD PEN. TEST	UNCONFINED COMPRESSION TONS PER SQ. FT.
Very Loose	0 - 4	Very Soft	< 2	< 0.25
Loose	4 - 10	Soft	2 - 4	0.25 - 0.50
Medium Dense	10 - 30	Firm	4 - 8	0.50 - 1.00
Dense	30 - 50	Stiff	8 - 15	1.00 - 2.00
Very Dense	over 50	Very Stiff	15 - 30	2.00 - 4.00
		Hard	over 30	over 4.00

Field Classification for "Consistency" of Fine Grained Soils is determined with a 0.25" diameter penetrometer