GEOTECHNICAL ENGINEERING REPORT

Friendship Oaks Subdivision

Friendship Lane and South Creek Street
Fredericksburg, Gillespie County, Texas

Prepared for:

Lennar
San Antonio, Texas

Prepared by:
TTL, Inc.
San Antonio, Texas

Project No. 00210900833.00
April 16, 2021

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April 16, 2021

Mr. Richard Mott, P.E.
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RE: Preliminary Foundation and Pavement Design Report
Friendship Oaks Subdivision
Friendship Lane and South Creek Street
Fredericksburg, Gillespie County, Texas
TTL Project No.00210900833.00

Dear Mr. Mott:

TTL, Inc. (*TTL*) is pleased to submit this preliminary foundation and pavement section design report for the above-referenced project. If you have any questions regarding our report, or if additional services are needed, please do not hesitate to contact us.

The enclosed report contains a brief description of the site conditions and our understanding of the project. The pavement section design recommendations and preliminary foundations recommendations contained within this report are based on our understanding of the proposed development, the results of our field exploration and laboratory tests, and our experience with similar projects.

We appreciate the opportunity to provide these Geotechnical Services for your project and look forward to continuing participation during the design and construction phases of this project.

Respectfully submitted,
TTL, Inc.

June M. Potter, P.E.
Project Professional

AMIT BAKANE
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04/16/2021

Amit Bakane, P.E.
Senior Project Engineer
Geotechnical Services

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1.0 PROJECT INFORMATION

1.1 Project Description

Item	Description
Project Location	The project site is located in the southeast quadrant of the intersection of Friendship Lane and South Creek Street and runs southwest to Highway 87 in Fredericksburg, Gillespie County, Texas.
Proposed Development	Based on the plat for the Fredericksburg Subdivision prepared by TCG Engineering, we understand this subdivision will consist of approximately 85 acres of land to be developed as a residential subdivision. Associated streets will be constructed as well.
Proposed Construction	This geotechnical engineering study will pertain to the development of one (1) story and two (2) story single-family residences that will be supported using monolithic slab and grade beam foundations. Also, pavement design recommendations meeting the City of Fredericksburg pavement design criteria.
Pavements	The pavements constructed as a part of this project will consist of flexible pavements only. ***All street construction materials and methods shall comply the City of Fredericksburg Specifications for Water, Sanitary Sewer, Street, and Electric Construction.***

If the above information is not correct, please contact us so that we can make the necessary modifications to this document and our evaluation and recommendations, if needed.

1.2 Authorization

This Project was authorized by Mr. Richard Mott with Lennar on March 19, 2021 by acceptance of our Agreement for Services, No. P00200900833.00, dated March 19, 2021.

2.0 EXPLORATION FINDINGS

2.1 Site Conditions

The Site was historically utilized for agricultural purposes. Agricultural activities can result in environmental impacts as a result of the application of pesticides and herbicides and sometimes involve on-site store of significant quantities of hazardous materials, as well as maintenance, repair and operation of farm equipment. No direct evidence of these activities was identified at the Site; however, it would be unusual if pesticides and herbicides have not been applied at the Site. Such applications are permissible under applicable regulations, but can result in a build-up of contaminants over time. Redevelopment of the Site will likely result in redistribution of remaining near-surface soils, reducing the potential for hot spots of contamination to remain. In the absence of evidence of a significant release of agricultural chemicals, there is no regulatory requirement for sampling at the Site. The historical and current agricultural activities conducted at the Site are considered *de minimis*; therefore, no significant impact to the Site is expected

2.2 Site Geology

We reviewed the Geologic Atlas of Texas to determine the geologic setting of the project site and surrounding area. Our review indicated the Project Site is located primarily over Hensell Sand (Kh) of Early Cretaceous geologic age. This formation typically consists of sand, silt, and clay over conglomerate, siltstone, and/or claystone.

2.3 Subsurface Stratigraphy

Subsurface conditions within the limits of the project were evaluated by drilling fifteen (15) exploratory borings at the approximate locations shown on the Boring Location Plan in Appendix A. Samples obtained during our field exploration were transported to our laboratory where they were reviewed by geotechnical engineering personnel. Representative samples were selected and tested to determine pertinent engineering properties and characteristics for use in our evaluation of the project site. Based on the information developed during our field exploration and laboratory testing, we have determined the stratigraphy of the site is generally as shown on the logs of boring as shown in Appendix A.

The boring logs presented in Appendix A represent our interpretation of the subsurface conditions at each individual boring location. Our interpretation is based on tests and observations performed during drilling operations, visual examination of the soil samples by a geotechnical engineer, and laboratory tests conducted on the retrieved soil samples. The USCS classifications shown on the boring logs represent classifications based on either visual examination, laboratory testing, or both. The lines designating the interfaces between various strata on the boring logs represent the approximate strata boundary. The transition between strata may be more gradual than shown, especially where indicated by a broken line. All data should only be considered accurate at the exact boring locations.

2.4 Subsurface Water Conditions

Subsurface water was not detected either during or upon completion of our exploratory borings. Upon completion of subsurface water observations, the boreholes were backfilled with the spoils generated during drilling operations. It should be noted that clayey sand was encountered in most our borings at various depths. These materials are granular in nature and will transmit water easily.

Subsurface water is generally encountered as a ‘true’ or permanent continuous water source that is generally present year-round or as a discontinuous, isolated “‘perched”’ or temporary water source that is temporary. Permanent subsurface water is generally present year-round, which may or may not be influenced by seasonal changes in climate, precipitation, vegetation, surface runoff, water levels in nearby water bodies, and other factors. The subsurface water level below the site may fluctuate up or down in response to such changes and may be at different levels than indicated on the exploration logs at times after the exploration. Temporary subsurface water generally develops as a result of seasonal and climatic conditions.

3.0 GEOTECHNICAL CONSIDERATIONS

The following geotechnical considerations have been prepared based on the information developed during this Project, our experience with similar projects, and our knowledge of sites with similar surface and subsurface conditions.

3.1 Corrosion Considerations

According to the 2015 IBC, concrete that is exposed to sulfate-containing solutions should be selected for sulfate resistance in accordance with ACI 318. To evaluate if sulfate exposure was a concern at this site, laboratory testing was conducted on soil samples recovered during the field exploration to assess the risk of sulfate attack at the site. The soil samples were submitted to an analytical lab to determine the sulfate content. The results of the laboratory tests are presented in the following table.

Boring No.	Sample Depth (ft.)	Sulfate (ppm)	ACI 318-14 Exposure Class
B-1	4½ to 6	77	S0
B-7	2½ to 4	128	S0
B-10	4½ to 6	114	S0

The sulfate test results indicate that the sulfate exposure level is Class S0, which infers that sulfate exposure to concrete is not an issue. Therefore, Type I/II cement may be used.

4.0 EARTHWORK RECOMMENDATIONS

4.1 Subgrade Preparation and Stabilization

The intended performance of earth supported elements such as foundations and utilities are contingent upon following the earthwork recommendations and guidelines outlined in this section. Earthwork activities on the project should be observed and evaluated by TTL personnel. The evaluation of earthwork should include observation and testing of all fill and backfill soils placed at the site, along with subgrade preparation beneath the residential structures, pavements, and other areas to receive fill materials.

Please note that mass grading for the subdivision had not been performed before drilling of TTL exploratory borings at the site. Our <u>preliminary</u> foundation recommendations are based on the existing subsurface conditions we encountered during our drilling operations conducted at accessible locations within the project site. Further geotechnical field exploration consisting of additional test borings will need to be conducted after the mass grading is completed in order to characterize the actual bearing soils and their strength conditions. The final design foundation recommendations will be impacted by the modified site conditions.

If possible, site development should be performed during seasonably dry weather (typically May through October), and excavation and site preparation should not be performed during or immediately following periods of heavy precipitation or freezing temperatures. Positive surface drainage should be maintained during grading operations and construction to prevent water from ponding on the surface. Surface water run-off from off-site areas should be diverted around the site using berms or ditches. The surface can be rolled smooth to enhance drainage if precipitation is expected but should then be scarified prior to resuming fill placement operations. Subgrades damaged by construction equipment should be promptly repaired to avoid further degradation in adjacent areas and water ponding. Our geoprofessional should provide recommendations for treatment if the subgrade materials become wet, dry, or frozen. When work activities are interrupted by heavy rainfall, fill operations should not be resumed until the moisture content and density of the previously placed fill materials are as recommended in this report. The following earthwork recommendations must be performed prior to pavement and utility construction.

4.1.1 Stripping

Subgrade preparation should begin with stripping the existing vegetation and any otherwise unsuitable materials from planned construction areas.

- Stripping should extend at least 3 feet (horizontal) beyond the construction limits or to the property lines, whichever is less. Due to the tree and brush vegetation at the site, the stripping depth may need to be at least 12 to 18 inches to completely grub and remove the roots.
- Organic-laden strippings including root masses and loose topsoil should be removed from the site or disposed of at designated on-site areas located outside the limits of current or future development.

4.1.2 Subgrade Preparation

Undercut soft, weak, and unstable soils by excavating below subgrade level to expose stable soils. The excavated soil can be used to restore the excavation subgrade, provided that the soils are relatively free and clean of deleterious material or materials exceeding 3 inches in maximum dimension. The excavated soil, or imported fill soil, shall be placed in maximum 6-inch compacted lifts. Each lift of soil shall be moisture conditioned between -2 and +3 percentage points of the optimum moisture content and compacted to at least 95 percent of the maximum dry density determined in accordance with the Standard compaction effort (ASTM D 698) for non-roadways and TEX-114-E for roadway areas. Compaction should be at least 95 percent of the modified Proctor (ASTM D 1557) maximum dry density (non-roadways) and TEX-113-E (roadways) for fill bodies 5 feet or greater in thickness.

4.1.3 Proof-rolling

After stripping and excavating to the design subgrade elevation, the stability of exposed subgrades in areas to receive fill should be evaluated by proof-rolling. The stability of subgrades exposed by cutting to final grades should also be evaluated by proof-rolling.

- Perform proof-rolling with a rubber-tired vehicle having a gross vehicle weight of at least 20 tons (such as a loaded tandem-axle dump truck, or similar size/weight construction equipment), or as approved by the CoF.
- Proof-rolling equipment should make multiple closely-spaced overlapping passes in perpendicular directions over the subgrade at a walking pace.
- The subgrade should be relatively smooth and free of wheel ruts, sheepsfoot roller dimples, loose clods of soil, or loose gravel; and the subgrade should not be desiccated, cracked, wet, or frozen.
- A TTL geotechnical engineer or their representative should observe the proof-rolling to identify, document, and mark areas of unstable subgrade response, such as pumping, rutting, or shoving, if any.

4.1.4 Subgrade Stabilization

Unstable subgrades should be stabilized as recommended below.

- Undercut soft, weak, and unstable soils by excavating below subgrade level to expose stable soils. The excavated soil can be used to restore the excavation subgrade, provided that the soils are relatively free and clean of deleterious material or materials exceeding 3 inches in maximum dimension. The excavated soil, or imported fill soil, shall be placed in maximum 6-inch compacted lifts. Each lift of soil shall be moisture conditioned between plus or minus two (±2) percentage points of the optimum moisture content and compacted to at least 95 percent of the maximum dry density determined in accordance with the Standard compaction effort (ASTM D 698). If undercutting deeper than about 3 feet is needed, contact TTL.
- Soil subgrade areas requiring fill placement should be scarified to a depth of about eight (8) inches and moisture conditioned between plus or minus two (±2) points of the optimum moisture content. The moisture conditioned subgrade should then be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D 698. The subgrade should be moisture conditioned just prior to fill placement so the subgrade maintains its compaction moisture levels and does not dry out.
- On-site soils (general fill), Select Fill or Granular Select Fill soil should be placed to achieve the desired elevation as described in Section 4.2 of this report.

4.2 Compacted Fill Materials

Compacted fill materials may consist of select or general fill depending upon its intended use. General fill materials may consist of onsite soils, select fill materials or clean imported fill soils that possess good compaction characteristics that will provide suitable, uniform support for pavements and other non-habitable facilities that are not extremely sensitive to movements. General fill material may be used in open areas where such facilities will not be constructed. Select fill material, on the other hand, is selected based on specific engineering characteristics and performance criteria for the proposed purposes. These selection characteristics and criteria typically depend on the requirements of the pavements, structures, or other facilities they are intended to support.

General and select fill materials should be clean and free of any vegetation, roots, organic materials, trash or garbage, construction debris, or other deleterious materials. These materials should contain stones no larger than two and one-half (2½) inches in maximum dimension. The following table provides more specific requirements for general and select fill materials.

Material Type	Characteristics	Compaction Procedures	Compaction Control [1, 2]
GENERAL FILL	Shall consist of CH, CL, SM, SC, GM, GC, SW, or GW as defined by ASTM D 2487. Plasticity Index: Not more than 35. Maximum allowable organic content: 3 percent by weight. **This fill material type shall not be used in areas where select fill materials are specified. It is not the intent of this material to control differential soil movements and it shall not be used in areas where control of soil movements is required.**	Maximum loose lift thickness: 8 inches. Compaction requirement: Compaction should be at least 95 percent of the standard Proctor (ASTM D 698) maximum dry density for fill bodies less than 5 feet in thickness. Compaction should be at least 95 percent of the modified Proctor (ASTM D 1557) maximum dry density for fill bodies 5 feet or greater in thickness. Moisture content at time of compaction: within plus to minus 3 percent of the material's optimum moisture content.	General Fill Areas: One field test for every 10,000 square feet per lift, with a minimum of two tests per lift. Utility Trenches (in areas where Select Fill is not required): One field density test per every 100 linear feet, per lift.
SELECT LEAN CLAY FILL (COMPACTED FILL)	Maximum particle size: 3 inches. Maximum gravel and oversize particle content: 15 percent retained on a ¾-inch sieve. At least 70 percent of total material (by weight) passing the No. 200 sieve Maximum allowable organic content: 3 percent by weight, but large roots are not allowed. Liquid Limit: Not more than 40. Plasticity Index: Between 8 and 15. Designation as a CL in accordance with the Unified Soil Classification System (USCS).	Maximum loose lift thickness: 8 inches with compacted thickness of about 6 inches. Compaction requirement: Compaction should be to at least 95 percent of the standard Proctor maximum (ASTM D 698) dry density for non-roadway areas and TEX-114-E for roadway areas. Moisture content at time of compaction: within minus 2 to plus 3 percent of the material's optimum moisture content.	Building Area: One field density test every 5,000 square feet per lift, with a minimum of two tests per lift. Pavement Areas and Slopes: One field density test every 10,000 square feet per lift, with a minimum of two tests per lift. Utility Trenches: One field density test per structure or one test per every 100 linear feet, per lift.
SELECT GRANULAR FILL (COMPACTED FILL)	Crushed stone (limestone) meeting Type A, Grades 1 or 2; Crushed or uncrushed gravel meeting Type B, Grades 1 or 2; Crushed concrete meeting Type D, Grades 1 or 2; of the 2014 TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges. Designation as a GC or GM in accordance with the USCS	Maximum loose lift thickness: 8 inches. Compaction requirement: Compaction should be to at least 98 percent of the TEX-113-E dry density.	Building Area: One field density test every 5,000 square feet per lift, with a minimum of two tests per lift. Pavement Areas and Slopes: One field density test every

Material Type	Characteristics	Compaction Procedures	Compaction Control [1, 2]
	Clayey gravel (may locally be referred to as "pit-run" material) or caliche having no particle sizes greater than 3 inches in any dimension, at least 50 percent of total material retained on the No. 200 sieve, a Liquid Limit (LL) no greater than 40, and a PI between 7 and 20. Designation as a GC in accordance with the USCS. Commercial Grade Base (may locally be referred to as "three-quarters to dust" material) that is produced by some local/regional quarries having nothing retained on the 2-inch sieve, at least 60 percent retained on the No. 40 sieve, at least 80 percent retained on the No. 200 sieve, an LL no greater than 30, and a PI of 7 or less. Designation as a GM in accordance with the USCS.	Moisture content at time of compaction: within minus 2 to plus 3 percent of the material's optimum moisture content.	10,000 square feet per lift, with a minimum of two tests per lift. Utility Trenches: One field density test per structure or one test per every 100 linear feet, per lift.

[1] For preliminary planning only. Our technician/engineer should determine the actual test frequency.

[2] In addition, the fill must be stable under the influence of compaction equipment. Heavy construction traffic should not be allowed to travel on compacted fill areas, except on designated haul roads, to reduce the potential for damaging a previously compacted fill subgrade

If grading occurs during wet, cool weather, when drying soils is more difficult and time-consuming, the grading contractor may have difficulty achieving suitable moisture conditions for proper compaction of soil fill.

The surface of any filled area can experience settlement due to compression of the underlying soils, and sometimes additional settlement results from consolidation of thick soil fills due to their own self-weight.

4.3 Excavation Conditions

4.3.1 Temporary Slopes and OSHA Soil Types

The Occupational Safety and Health Administration (OSHA) Safety and Health Standards (29 CFR Part 1926) require that excavations be constructed in accordance with the current OSHA guidelines. The contractor is **solely** responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. To that end, the contractor's 'responsible person' as defined in 29 CFR Part 1926 should evaluate the required excavations and the soils exposed by those excavations and determine appropriate means as part of the contractor's safety procedures.

OSHA requires that excavations in excess of 5 feet be shored or appropriately sloped. Currently available and practiced methods for achieving excavation stability include sloping, benching, shoring, and the use of trench shields. In excavations that are less than 20 feet deep, OSHA addresses maximum allowable slopes on Table as reproduced below.

Soil or Rock Type	Maximum Allowable Slopes (H:V)[1] for Excavations Less Than 20 Feet Deep[2]	
Stable Rock	Vertical	90°

Soil or Rock Type	**Maximum Allowable Slopes (H:V)[1] for Excavations Less Than 20 Feet Deep[2]**	
Type A[3]	¾:1	53°
Type B	1:1	45°
Type C	1½:1	34°

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
2. Slopes or benching for excavations that exceed 20 feet shall be designed by a licensed professional engineer.
3. For Type A soils, a short-term maximum allowable slope of ½:1 (63°) is allowed in excavations that are 12 feet deep or less. For excavations deeper than 12 feet, the short-term allowable slope shown above applies. OSHA defines short-term as a period of 24 hours or less.

Based on the results of our field and laboratory testing, it is our opinion that the Lean and Fat CLAY (CL) soils encountered in our soil borings may be considered as Type B soils. If those clay soils become saturated or submerged, they should be downgraded to Type C soils. The CLAYEY SAND (SC) encountered in our soil borings may be considered Type C soils. We have provided this information solely as a service to our client. The actual OSHA regulations should be consulted prior to any excavations that would be subject to OSHA regulations. TTL does not assume responsibility for any construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations.

4.3.2 Anticipated Excavation Conditions

As is shown on the boring logs presented in Appendix A, clay and sand materials were encountered at this site. The soils encountered at the borings can generally be excavated by conventional earthmoving equipment.

4.3.3 Drainage During Construction

Water should not be allowed to collect on prepared subgrades within the construction area during or after construction. Excavated areas should be sloped toward designated drainage points to facilitate removal of any collected rainwater, subsurface water, or surface runoff. Positive surface drainage at the site should be provided to reduce infiltration of surface water into subgrades and fill bodies during construction and promote prompt removal of water from the project site.

Water should not be allowed to collect on completed pavement surfaces after construction. Excavated areas should be sloped to facilitate the removal of any collected water. Positive site surface drainage should be provided to reduce infiltration of surface water beneath the pavement surface. The grades should be sloped and surface drainage should be collected such that water is channeled to collection points and discharged away from the roadway or into storm sewers. In addition, curbs should be designed as full-depth curbs that extend through the base section and at least three (3) inches into the subgrade to help reduce the potential for water infiltration into the pavement section. Consideration may also be given to the installation of wick drains behind the curbs to intercept and remove water from the pavement perimeter before the water infiltrates the pavement section. All concrete/asphalt interfaces should be sealed using a sealant compatible with both materials.

4.4 Long-Term Drainage Considerations

Long-term drainage conditions can have a significant impact on the performance of structures, pavements, utilities, and other ancillary facilities on a project site. We recommend that site drainage be developed such that long-term ponding does not occur except in areas specifically designed for such purposes. When establishing final grades, the design team should be reminded that in expansive clay environments, it is common for ground surface movements to occur that could potentially cause reversal of site drainage patterns and unwanted ponding of surface water. We recommend that sufficient slope of the ground surface should be maintained around pavements and other ancillary facilities to ensure long-term positive drainage.

5.0 INFRASTRUCTURE RECOMMENDATIONS

5.1 Landscape Considerations

TTL realize landscaping is vital to the aesthetics of any project and is generally typical for residential construction. The owner and design team should be made aware that placing large bushes and trees adjacent to the structures and pavements may contribute to future distress. Vegetation placed in landscape beds adjacent to the structure should be limited to plants and shrubs that will not exceed a mature height of about 3 to 4 feet. Large bushes and trees that will generally exceed these heights should be planted at a reasonable distance away from structures and pavements so their canopy or “drip line” does not extend over the structure when the tree reaches maturity.

Watering of vegetation should be performed in a timely and controlled manner and in sufficient quantity to maintain healthy vegetative cover. Excessive watering should be avoided as excessive irrigation of landscaped areas adjacent to, near or up gradient from pavements can lead to water migration into building pads and base sections. This migration could cause moisture fluctuations in the underlying clay subgrade which could result in excessive soil movements and loss of subgrade strength.

5.2 Pavement Design Considerations

The following design parameters were used for the design of the pavement section:

	Residential Street	Residential Collector
Reliability, %	70	90
Initial Serviceability Index, po	4.2	4.2
Terminal Serviceability Index, pt	2.0	2.0
Standard Deviation, So	0.45	0.45
Design Life, years	20	20

Soil bulk samples were collected to determine the California Bearing Ratio (CBR) value to be used for our pavement design recommendations. The location at which the CBR bulk sample was taken is indicated on the Boring Location Plan in Appendix A. We performed two CBR tests at three compaction levels (i.e. 90%, 95% and 100%). Based on laboratory test results, CBR values of about 2.6 and 4.4 percent was obtained for the existing untreated subgrade compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D 698. Therefore, TTL recommends that am average CBR value of 3.5 percent be used to represent the pavement subgrade conditions at this site. There are a number of published correlations relating CBR to the Resilient Modulus (MR), we used a Resilient Modulus (MR) = 1,500 times the CBR in psi, to convert CBR to MR.

5.2.1 Pavement Section Recommendations

Presented below are the recommended pavement sections for a flexible pavement system for the proposed residential streets. The flexible pavement system is provided for the minimum and maximum traffic ADT values based on the Traffic Engineering Study prepared by AC Group and provided by Lennar.

Flexible Pavement System						
Component	Pavement Material Thickness, inches					
	Based on Minimum Traffic ADT (Residential)			Based on Maximum Traffic ADT (Residential Collector)		
Hot Mixed Asphaltic Concrete, inches	---	2	2	---	2½	2½
Two-Course Surface Treatment The Asphaltic Concrete Surface Course	Yes	---	---	Yes	---	---
Prime Coat	Yes	Yes	Yes	Yes	Yes	Yes
The Flexible Base Course, inches	17	10½	6	23½	16	8½
Tensar TriAx TX5 Geogrid	---	---	Yes	---	---	Yes
Moisture Conditioned Subgrade	Yes	Yes	Yes	Yes	Yes	Yes
Calculated Structural Number	2.38	2.35	2.68	3.29	3.34	3.36
Estimated ESAL Range for Pavement Section[1]	100,750	100,500	233,000	401,500	453,000	472,400

Notes Applicable to the Flexible Pavement Design:

[1] The ESALs are calculated based on the ADT values provided in the Traffic Engineering Study prepared by AC Group and estimating the projected ADT for residential homes and an occasional truck/bus within the subdivision.

5.2.2 General Guidelines for Pavements

All street construction materials and methods shall comply the City of Fredericksburg (CoF) Specifications for Water, Sanitary Sewer, Street, and Electric Construction.

On most projects, rough site grading is accomplished relatively early in the construction phase. However, as construction proceeds, excavations are made into these areas; dry weather may desiccate some areas; rainfall and surface water saturates some areas; heavy traffic from concrete and other delivery vehicles disturbs the subgrade; and many surface irregularities are filled in with loose soils to improve trafficability temporarily. As a result, the pavement subgrade should be carefully evaluated as the time for pavement construction approaches. This is particularly important in and around utility trench cuts.

Thorough proof-rolling of pavement areas using appropriate construction equipment weighing at least 20 tons should be performed no more than 24 hours prior to surface paving. Any problematic areas should be reworked and compacted at that time.

Long-term pavement performance will be dependent upon several factors, including maintaining subgrade moisture levels and providing for preventive maintenance. The following recommendations should be considered at a minimum:

- Maintain and promote proper surface drainage away from pavement edges;
- Consider appropriate edge drainage systems;
- Install drainage in areas anticipated for frequent wetting (e.g. landscape beds, discharge area, collection areas, etc.);
- Place joint sealant and seal cracks immediately;
- Seal all landscaped areas in, or adjacent to pavements, to minimize or prevent moisture migration to subgrade soils;
- Placing compacted, low permeability backfill against the exterior side of curb and gutter; and,
- Extending the base of the curb and gutter system through the pavement base material and at least 6 inches into subgrade soils.

Preventive maintenance should be planned and provided for through an on-going pavement management program. These activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. This consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventive maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements. Prior to implementing any maintenance, additional engineering observation is recommended to determine the type and extent of preventive maintenance.

5.2.3 Pavement Section Materials

Presented below are selection and preparation guidelines for various materials that may be used to construct the pavement sections. Submittals should be made for each pavement material. The submittals should be reviewed by TTL and any appropriate members of the Project Team. The submittals should provide test information necessary to verify full compliance with the recommended or specified material properties.

Hot Mix Asphaltic Concrete Surface – The asphaltic concrete surface course should be plant mixed, hot laid Type D or C Surface meeting the master specification requirements of 2014 TXDOT Standard Specifications Item 341, and specific criteria for the job mix formula. The mix should be compacted between 91and 95 percent of the maximum theoretical density as measured by TEX-227-F. The asphalt cement content by percent of total mixture weight should fall within a tolerance of ±0.3 percent asphalt cement from the specific mix. In addition, the mix should be designed so 75 to 85 percent of the voids in the mineral aggregate (VMA) are filled with asphalt cement. The grade of the asphalt cement should be PG 64-22 or higher performance grade. Aggregates known to be prone to stripping should not be used in the hot mix. If such aggregates are used, measures should be taken to mitigate this concern. The mix should have at least 70 percent strength retention when tested in accordance with TEX-531-C.

Pavement specimens, which shall be either cores or sections of asphaltic pavement, will be tested according to Test Method TEX-207-F. The nuclear-density gauge or other methods which correlate satisfactorily with results obtained from Project pavement specimens maybe used when approved by the Engineer. Unless otherwise shown on the plans, the Contractor shall be responsible for obtaining the required pavement specimens at their expense and in a manner and at locations selected by the Engineer.

Asphaltic Concrete Surface Course - The asphaltic concrete surface course shall conform to TxDOT Item 316 and as approved by the CoF. ***The first course*** shall be Grade 4 aggregate applied at a rate coverage of 105 SY/CY with an asphalt rate of 0.32 gal/SY and approved by the CoF. ***The second course*** shall be Grade 5 “trap rock” aggregate applied at a rate of coverage of 115 SY/CY with an asphalt rate of 0.32 gal/SY. The asphaltic material shall be HFRS-2P in accordance with the requirements of TxDOT Standard Specifications 2014 Edition. In the event of cool or windy weather, the contractor may use HFRS-2 in accordance with TxDOT Item 300.2 but under no circumstances shall surface treatment(s) be installed outside the TxDOT standard temperature limitations. It is important that positive drainage be provided.

Prime Coat - The prime coat shall consist of asphalt emulsion prime in accordance with TxDOT Item 314. The prime coat should be applied at a rate of about 0.2 gallons per square yard with materials which meet TxDOT Item 300. The prime coat will help to minimize penetration of rainfall and other moisture that penetrates the base.

The Flexible Base Course – The flexible base course shall be crushed limestone conforming to TxDOT (2014) Item 247, Type A, Grades 1 or 2. The base course shall be placed in lifts with a maximum thickness of 6 inches and a minimum thickness of 4 inches and shall be compacted to a minimum of 95 percent of the maximum density at a moisture content within plus or minus 2 percent of the optimum moisture content as determined by TEX-113-E.

Details regarding subgrade preparation are presented in Pavement Earthwork Section below.

5.2.4 Pavement Earthwork

The intended performance of roadway pavement is contingent upon following the earthwork recommendations and guidelines outlined in this section. Earthwork activities on the Project should be observed and evaluated by *TTL* personnel. The evaluation of earthwork should include observation and testing of all fill and backfill soils placed at the Site, and subgrade preparation beneath the streets.

The following earthwork recommendations must be performed prior to pavement construction.

- If applicable, strip vegetation, loose topsoil, existing pavements, vegetation and any otherwise unsuitable materials from the pavement area. The pavement area is defined as the area that extends at least 3 feet (horizontal) beyond the perimeter of the proposed pavement and any adjacent flatwork (sidewalks).
- Perform cut and fill to accommodate the design pavement subgrade elevation (also referenced as the bottom of the base course). Onsite soils can be used for grade adjustments in fill areas. Refer to Section 4.0 of this report for requirements for the placement of onsite soils and select fill materials.
- After achieving the required excavation depth, and before placing any fill, the exposed excavation subgrade should be proof-rolled with at least a 20-ton roller, or equivalent equipment, to evidence any weak yielding zones. A technical representative of our firm should be present to observe the proof-rolling operations. If any weak yielding zones are present, they should be over-excavated, both vertically and horizontally, until competent soils are exposed. The excavated soil can be used to restore the excavation subgrade, provided that the soils are relatively free and clean of deleterious material or materials exceeding 3 inches in maximum dimension. The excavated soil or imported fill soil shall be placed in maximum 6-inch compacted lifts. Each lift of soil shall be moisture conditioned and compacted as described in Section 4.0.
- No pavement may be installed until all loose material has been removed and base has been approved by the CoF.
- All street construction materials and methods shall comply with the latest TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges unless otherwise specified by the engineer and approved by the CoF Engineer or Public Works Department.

6.0 STRUCTURAL RECOMMENDATIONS

6.1 Seismic Design Parameters

Presented below are the seismic design criteria for the project site and immediate area.

Description	Value
2015 International Building Code Site Classification (IBC)[1]	C[2]
Site Latitude	30.25024°
Site Longitude	-98.86692°
Maximum Considered Earthquake 0.2 second Design Spectral Response Acceleration (S_{DS})	0.046 g
Maximum Considered Earthquake 1.0 second Design Spectral Response Acceleration (S_{D1})	0.033 g

[1] As per the requirements of Section R301.2.2.1.1 in the 2018 IRC and Section 1613.3.2 in the 2015 IBC, the site class definition was determined using SPT N-values in conjunction with Table 20.3-1 of the ASCE 7. The Spectral Acceleration values were determined using publicly available information provided on the United States Geological Survey (USGS) website. The above criteria can be used to determine the Seismic Design Category using Table R301.2.2.1.1 in the 2015 IRC.

[2] Note: Chapter 20 of ASCE 7 requires a site soil profile determination extending to a depth of 100 feet for seismic site classification. The current scope does not include the required 100-foot soil profile determination. The boring extended to a maximum depth of ***10 feet***, and this seismic site class definition considers that similar soils continues below the maximum depth of the subsurface exploration. Additional exploration to deeper depths would be required to confirm the conditions below the current depth of exploration.

6.2 Shallow Foundations

Please note that the foundation design recommendations and construction guidelines provided in this section are ***preliminary*** and shall *only* be used for planning and budgeting purposes. The recommendations and construction guidelines shall not be used for final foundation design.

6.2.1 Preliminary Monolithic Slab and Beam Foundation Recommendations

Slab foundations should be designed such that if the subsoils expand or contract, the entire slab foundation will move as one unit. ***Please note that such a foundation system does not eliminate potential foundation movement due to expansion or contraction of the subsoils. As stated previously, the subsoils may yield a PVR ranging from less than 1 inch to approximately 2 inches, thus foundation movement of less than 1 to approximately 2 inches should be expected.*** Should this range of potential foundation movement exceed the desired performance, earthwork operations may be required to reduce the PVR of subsoils. TTL can provide these recommendations once a desired PVR is provided to us.

The foundation system would consist of perimeter and interior concrete foundation beams poured monolithic with the slab. Based on subsurface conditions encountered at the site, without accounting for any cuts or fills, ***preliminary*** design parameters for this foundation type are provided below. The ***preliminary*** foundation parameters are provided for the observed soil conditions and are presented in the following table.

EXISTING CONDITIONS – Preliminary Parameters			
PTI Method; 3rd Edition[1,3,4,5]			
Vertical Moisture Barrier Depth (ft)[6,7]:	<2½	2½	3
Edge Moisture Variation Distance (e_m):			
Center Lift (ft):	8.5	8.1	7.9
Edge Lift (ft):	4.3	3.5	3.0
Maximum Unrestrained Differential Soil Movement or Swell (y_m):			
Center Lift (in):	1.5	1.0	1.0
Edge Lift (in):	2.3	1.6	1.5
Coefficient of Slab-Subgrade Friction (μ):	0.75	0.75	0.75
Net Allowable Bearing Pressures[2]:			
Total Load Conditions (psf):	2500	2500	2500
Dead Load Plus Gravity Live Load Conditions (psf):	1700	1700	1700
Maximum Allowable Deflection Ratio of Foundation Beam:	1/360	1/360	1/360

Notes Applicable to the PTI Slab Foundation Design:

1	Design parameters based on preparing the subgrade and constructing a residential pad as recommended in **EARTHWORK RECOMMENDATIONS SECTION 4.0** of this report.
2	Includes a factor of safety (FS) of at least 2 for total load conditions and at least 3 for dead load plus gravity live load conditions.
3	If the floor slab of the foundation is to be covered with wood, vinyl tile, carpet, or other moisture sensitive or impervious coverings, a vapor barrier should be placed beneath concrete slab foundations or concrete floor slabs if they are bearing directly on the ground. The designer should be familiar with the American Concrete Institute (ACI) 302 for procedures and cautions about the use and placement of a vapor barrier.
4	The width of foundation beams should not be less than 10 inches. The minimum bearing depth below the adjacent ground surface (also referred to as "final grade") should not be less than ***24 inches*** for perimeter and interior foundation beams. These foundation dimension recommendations are for the proper development of bearing capacity for the foundations and to reduce the potential for water to migrate beneath the foundation. These recommendations are not based on structural considerations of the applicable design method. Actual foundation depths and widths may need to be greater than the minimum recommended herein for structural considerations, which should be properly evaluated and designed by the Structural or Foundation Engineer.
5	This is essentially an empirical design method and the recommended design parameters are based on our understanding of the proposed project, our interpretation of the information and data collected as a part of this study, our area experience, and the criteria published in the PTI design manual.
6	According to the PTI 3rd Edition, a vertical barrier must extend at least ***24 inches*** below the adjacent ground surface to be considered as having any significant effect. Foundation beams bearing less than 30 inches below the adjacent ground surface ("final grade") are not considered a vertical moisture barrier.
7	According to the PTI 3rd Edition, once the foundation plan has been determined, the Shape Factor (SF) shall be calculated. If the SF exceeds 24, the designer should contact us to discuss additional geotechnical engineering recommendations to reduce the y_m and e_m values to recommended values.

At the time of the field exploration the site had not been cleared of vegetation and mass grading had not been conducted. Therefore, our recommendations for PTI design are based on the subsoil conditions that we encountered during our drilling operations at the Site and at existing grade.

6.2.2 Shallow Foundation Construction Considerations

Excavations for shallow foundations and grade beams shall be neat excavated with a smooth-mouthed bucket. If a toothed bucket is used, excavation with this bucket should be stopped 6 inches above the final foundation bearing surface and the excavation completed with a smooth-mouthed bucket or by hand labor. Debris in the bottom of the excavations should be removed prior to steel placement. If neat excavation is not possible, the foundation should be over-excavated and formed. All loose materials should be removed from the over-excavated areas and filled with lean concrete or flowable fill as described in ACI 229R.

Reinforcing steel should be placed and the foundation constructed as quickly as possible to avoid exposure of the foundation bottoms to wetting and drying. The excavations should be sloped sufficiently to create internal sumps for runoff collection and removal of water. If surface runoff or subsurface water seepage in excess of 1 inch accumulates at the bottom of the excavation, it should be collected and removed so that ponding water does not adversely affect the quality of the bearing surfaces. Special care should be taken to protect exposed bearing surfaces from disturbance or drying out prior to the placement of concrete.

6.3 Settlement of Grade Supported Foundations

Total settlement of grade supported foundations designed and constructed as recommended in this report is expected to be about 1 inch or less. The settlement of the foundations is expected to be elastic in nature with most of the observed settlement occurring during construction. Differential settlement approaching ½ to ¾ of the total foundation settlement should be expected to occur between load bearing foundation elements. The settlement response of grade supported foundations is impacted more by the quality of construction than by soil-structure interaction. The improper installation of foundation elements can result in differential settlements that are greater than we have estimated.

7.0 LIMITATIONS

This geotechnical engineering report has been prepared for the exclusive use of our Client for specific application to this Project. This geotechnical engineering report has been prepared in accordance with generally accepted geotechnical engineering practices using that level of care and skill ordinarily exercised by licensed members of the engineering profession currently practicing under similar conditions in the same locale. No warranties, express or implied, are intended or made.

TTL understands that this geotechnical engineering report will be used by the Client and various individuals and firms' designers and contractors involved with the preliminary design of the

Project. TTL should be invited to attend Project meetings (in person or teleconferencing) or be contacted in writing to address applicable issues relating to the geotechnical engineering aspects of the Project. The information provided in this report is intended for planning purposes only and should not be used for final design considerations.

This geotechnical engineering report is based upon the information provided to us by the Client and various other individuals and entities associated with the Project, along with the field exploration, laboratory testing, and engineering analyses and evaluations performed by TTL as described in this report. The Client and readers of this geotechnical engineering report should realize that subsurface variations and anomalies may exist across the site which may not be revealed by our field exploration. Furthermore, the Client and readers should realize that site conditions can change due to the modifying effects of seasonal and climatic conditions and conditions at times after our exploration may be different than reported herein.

The nature and extent of such site or subsurface variations may not become evident until construction commences or is in progress. If site and subsurface anomalies or variations exist or develop, TTL should be contacted immediately so that the situation can be properly evaluated and, if necessary, addressed with provide applicable recommendations.

Unless stated otherwise in this report or in the contract documents between TTL and Client, our scope of services for this Project did not include, either specifically or by implication, any environmental or biological assessment of the site or buildings, or any identification or prevention of pollutants, hazardous materials or conditions at the site or within buildings. If the Client is concerned about the potential for such contamination or pollution, TTL should be contacted to provide a scope of additional services to address the environmental concerns. In addition, TTL is not responsible for permitting, site safety, excavation support, and dewatering requirements.

Should the nature, design, or location of the Project, as outlined in this geotechnical engineering report be modified, the geotechnical engineering recommendations and guidelines provided in this document will not be considered valid unless TTL is authorized to review the changes and either verifies or modifies the applicable Project changes in writing.

Additional information about the use and limitations of a geotechnical report is provided within the Geoprofessional Business Association document included at the end of this report.

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 not 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 not be adequate to develop geotechnical design recommendations for the project.

Do not 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 not rely on an executive summary. Do not 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 not 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 Not 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.

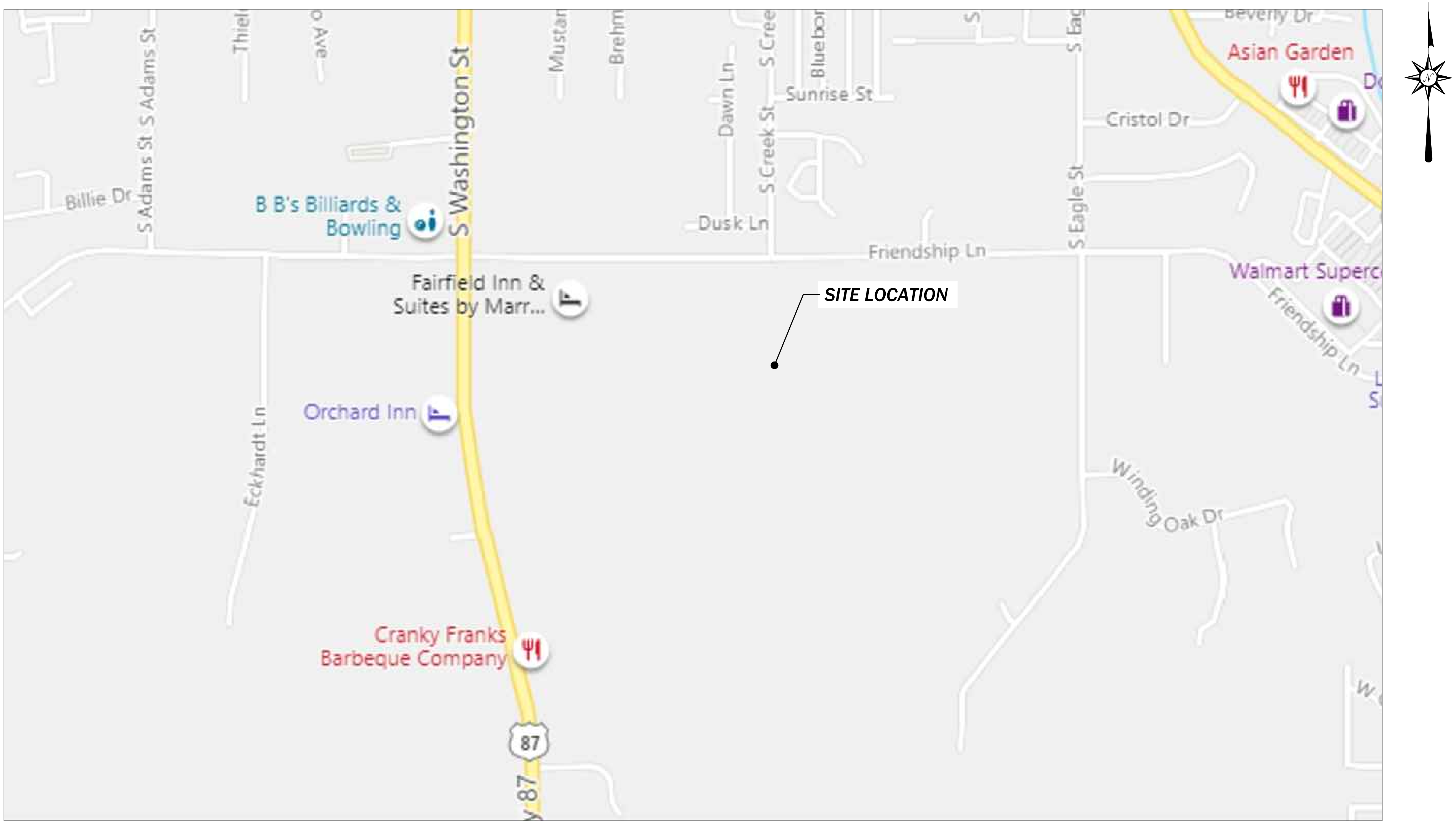
Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

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 not 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 not building-envelope or mold specialists.***

GEOPROFESSIONAL
BUSINESS
ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

APPENDIX A
ILLUSTRATIONS



Legend

BORING LOCATIONS

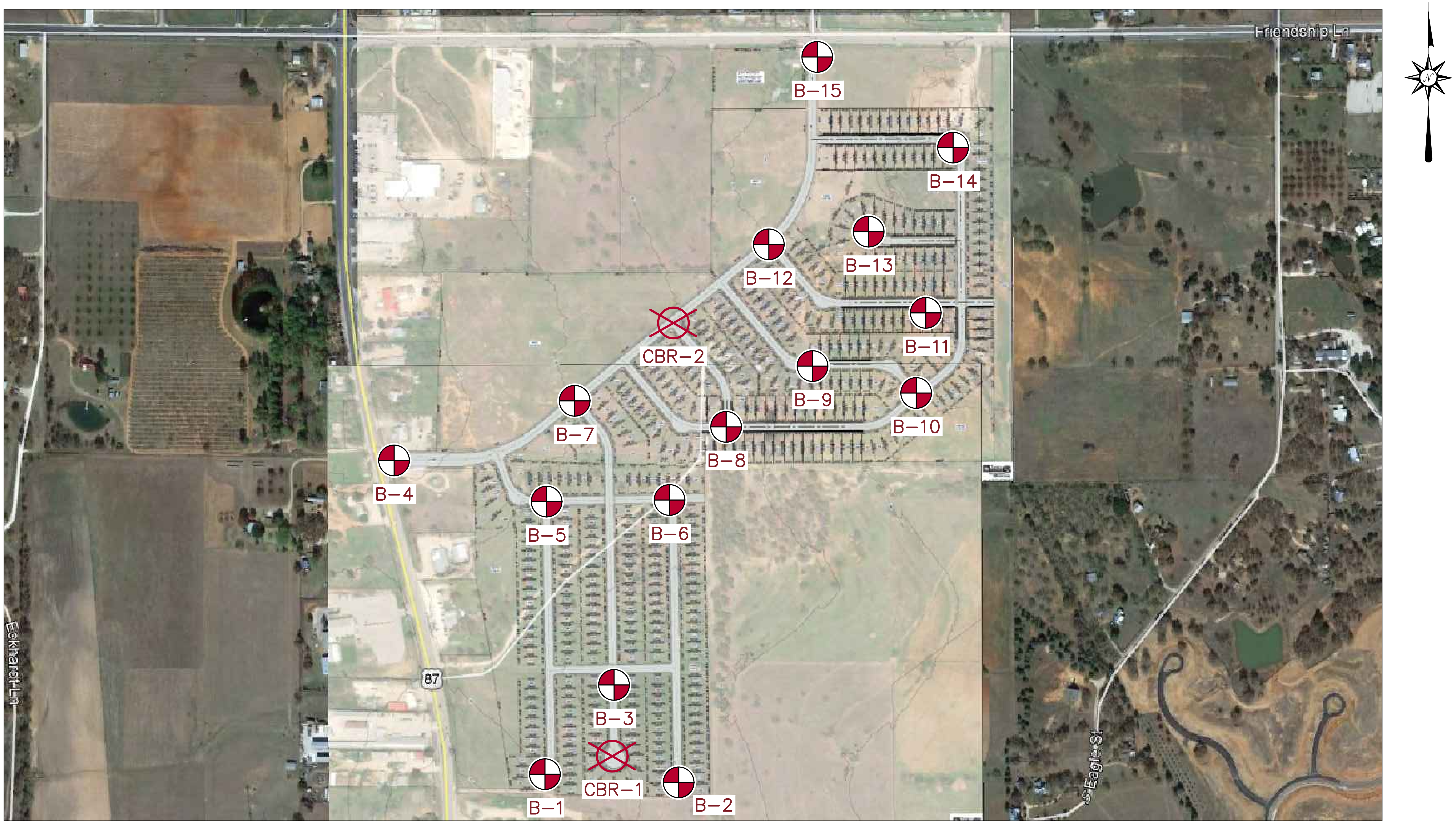
FRIENDSHIP OAKS SUBDIVISION – LENNAR

FRIENDSHIP LANE AND SOUTH CREEK STREET, FREDRICKSBURG, TEXAS

Date: 4/14/2021
Drawn By: SJ
Checked By: AB
Approved By: AD
Project No.: 00210900XXX.00

Exhibit 1

TTL
17215 Jones Maltsberger Rd.,
Suite 101 San Antonio, TX 78247
210.888.6100
TBPE Registration: F-12622
TBPG Registration: 50456



Legend

⊕ B–X Boring Location and Identifier

⊗ CBR–X California Bearing Ratio Location and Identifier

BORING LOCATIONS

FRIENDSHIP OAKS
SUBDIVISION – LENNAR

FRIENDSHIP LANE AND SOUTH CREEK STREET, FREDRICKSBURG, TEXAS

Date:	4/14/2021
Drawn By:	SJ
Checked By:	AB
Approved By:	AD
Project No.:	00210900XXX.00

Exhibit 2

TTL
17215 Jones Maltsberger Rd.,
Suite 101 San Antonio, TX 78247
210.888.6100
TBPE Registration: F–12622
TBPG Registration: 50456

SOIL LEGEND

FINE- AND COARSE-GRAINED SOIL INFORMATION

FINE-GRAINED SOILS (SILTS AND CLAYS)

SPT N-Value	Consistency	Estimated Q_u (TSF)
0 - 1	Very Soft	0 - 0.25
2 - 4	Soft	0.25 - 0.5
5 - 8	Firm	0.5 - 1.0
9 - 15	Stiff	1.0 - 2.0
16 - 30	Very Stiff	2.0 - 4.0
31+	Hard	4.0+

Q_u = Unconfined Compression Strength

COARSE-GRAINED SOILS (SANDS AND GRAVELS)

SPT N-Value	Relative Density
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
51+	Very Dense

PARTICLE SIZE

Name	Size (US Std. Sieve)
Boulders	>300 mm (>12 in.)
Cobbles	75 mm to 300 mm (3 - 12 in.)
Coarse Gravel	19 mm to 75 mm (3/4 - 3 in.)
Fine Gravel	4.75 mm to 19 mm (#4 - 3/4 in.)
Coarse Sand	2 mm to 4.75 mm (#10 - #4)
Medium Sand	0.425 mm to 2 mm (#40 - #10)
Fine Sand	0.075 mm to 0.425 mm (#200 - #40)
Silts and Clays	< 0.075 mm (< #200)

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Terms	Percent of Dry Weight
"Trace"	< 15
"With"	15 - 30
Modifier	> 30

RELATIVE PROPORTIONS OF CLAYS AND SILTS

Descriptive Terms	Percent of Dry Weight
"Trace"	< 5
"With"	5 - 12
Modifier	> 12

CRITERIA FOR DESCRIBING MOISTURE CONDITION

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp, but no visible water
Wet	Visible free water, usually soil is below water table

CRITERIA FOR DESCRIBING CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

CRITERIA FOR DESCRIBING STRUCTURE

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note the thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

ABBREVIATIONS AND ACRONYMS

WOH	Weight of Hammer	N-Value	Sum of the blows for last two 6-in increments of SPT
WOR	Weight of Rod		
Ref.	Refusal	NA	Not Applicable or Not Available
ATD	At Time of Drilling	OD	Outside Diameter
DCP	Dynamic Cone Penetrometer	PPV	Pocket Penetrometer Value
Elev.	Elevation	SFA	Solid Flight Auger
ft.	feet	SH	Shelby Tube Sampler
HSA	Hollow Stem Auger	SS	Split-Spoon Sampler
ID	Inside Diameter	SPT	Standard Penetration Test
in.	inches	USCS	Unified Soil Classification System
lbs	pounds		

SAMPLERS AND DRILLING METHODS

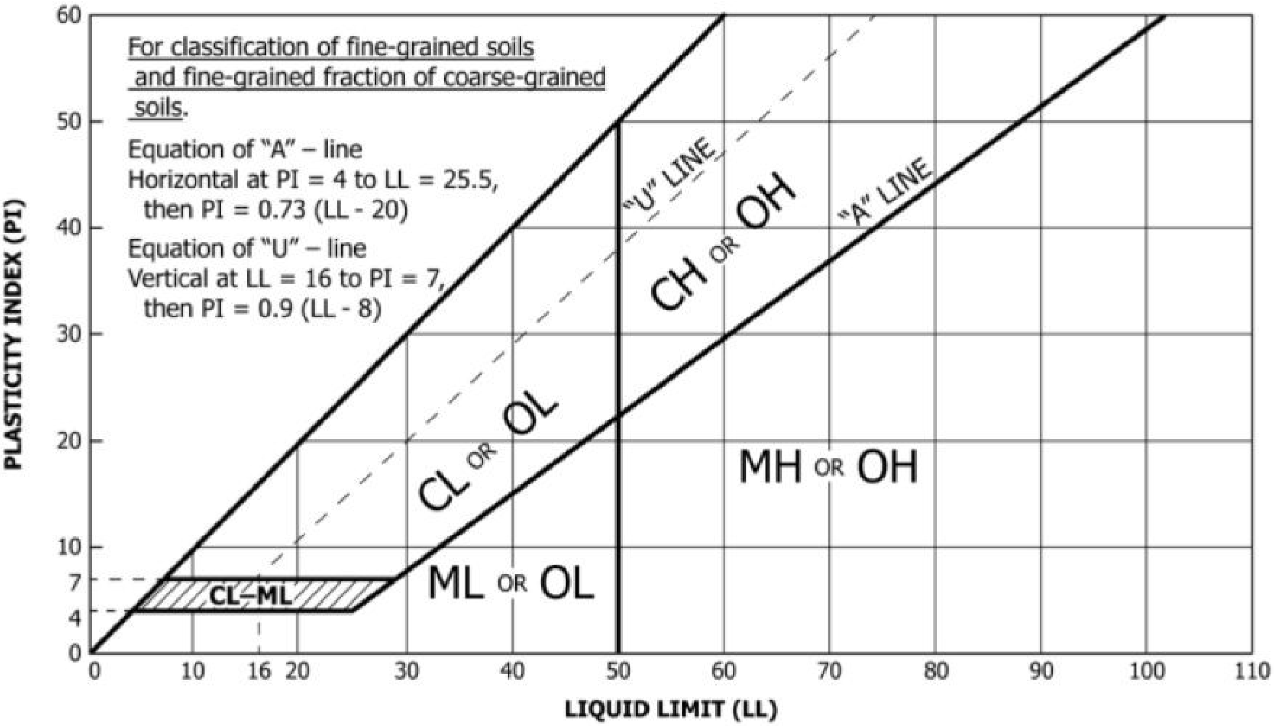
▮	AUGER CUTTINGS
◇	BAG/BULK SAMPLE
✋	GRAB SAMPLE
▤	CONTINUOUS SAMPLES
■	SHELBY TUBE SAMPLE
⧗	PITCHER SAMPLE
⊠	STANDARD PENETRATION SPLIT-SPOON SAMPLE
○	SPLIT-SPOON SAMPLE WITH NO RECOVERY
▼	DYNAMIC CONE PENETROMETER
▮	ROCK CORE

WATER LEVEL SYMBOLS

▽	WATER LEVEL AT TIME OF DRILLING
≡	PERCHED WATER OBSERVED AT DRILLING
▼	DELAYED WATER LEVEL OBSERVATION
▨	CAVE-IN DEPTH
≈	OBSERVED SEEPAGE

TTL

PLASTICITY CHART FOR USCS CLASSIFICATION OF FINE-GRAINED SOILS



IMPORTANT NOTES ON TEST BORING RECORDS

1) The report and graphics key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.

2) Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown. Solid lines are used to indicate a change in the material type, particularly a change in the USCS classification. Dashed lines are used to separate two materials that have the same material type, but that differ with respect to two or more other characteristics (e.g. color, consistency).

3) No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.

4) Logs represent general soil and rock conditions observed at the point of exploration on the date indicated.

5) In general, Unified Soil Classification System (USCS) designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.

6) Fine-grained soils that plot within the hatched area on the Plasticity Chart, and coarse-grained soils with between 5% and 12% passing the #200 sieve require dual USCS symbols as presented on the previous page.

7) If the sampler is not able to be driven at least 6 inches, then 50/X" indicates that the sampler advanced X inches when struck 50 times with a 140-pound hammer falling 30 inches.

8) If the sampler is driven at least 6 inches, but cannot be driven either of the subsequent two 6-inch increments, then either 50/X" or the sum of the second 6-inch increment plus 50/X" for the third 6-inch increment will be indicated.
Example 1: Recorded SPT blow counts are 16 - 50/4", the SPT N-value will be shown as N = 50/4"
Example 2: Recorded SPT blow counts are 18 - 25 - 50/2", the SPT N-value will be shown as N = 75/8"

Lennar
Friendship Oaks Subdivision
Friendship Lane and South Creek Street
Fredericksburg, Gillespie County, Texas

Log of B-01

Page 1 of 1

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00210900833.00*
Driller:	*J. Munoz*	Date Drilled:	*3/26/2021*
Logged by:	*E. Garcia*	Boring Depth:	*10 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.86872 Latitude: 30.24678*
Drilling Method:	*Straight Flight Auger w/SPT Sampling*	▽ Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA 1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SOFT	RQD / % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0	▨	CLAYEY SAND; very loose to dense, brown to reddish-brown (SC)													
	1	▨		☒	1 - 1 - 2 N = 3			6								28.9
	3	▨		☒	3 - 4 - 10 N = 14			16	42	16	26					44.1
	5	▨		☒	8 - 15 - 12 N = 27			7								
	7	▨		☒	9 - 8 - 8 N = 16			5								29.9
	8½	▨	- becomes light brown below 8½ feet													
	9	▨		☒	12 - 16 - 15 N = 31			14								
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Log of B-02

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Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00210900833.00*
Driller:	*J. Munoz*	Date Drilled:	*3/26/2021*
Logged by:	*E. Garcia*	Boring Depth:	*10 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.86678 Latitude: 30.24668*
Drilling Method:	*Straight Flight Auger w/SPT Sampling*	▽ Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	**MATERIALS DESCRIPTION**	TYPE	1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SQFT	RQD % REC	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
		▨	CLAYEY SAND; very loose to medium dense, brown to reddish-brown (SC)													
	1	▨		☒	2 - 2 - 2 N = 4			9								30.4
	2	▨														
	3	▨		☒	3 - 11 - 15 N = 26			9	65	19	46					
	4	▨	SANDY LEAN CLAY; very stiff to stiff, reddish-brown to brown (CL)													
	5	▨		☒	9 - 16 - 12 N = 28			10								
	6	▨														
	7	▨		☒	4 - 12 - 15 N = 27			9	35	16	19					
	8	▨	- becomes mottled reddish-brown and gray, calcareous below 8½ feet													
	9	▨		☒	8 - 7 - 8 N = 15			18								
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Log of B-03

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Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00210900833.00*
Driller:	*J. Munoz*	Date Drilled:	*3/26/2021*
Logged by:	*E. Garcia*	Boring Depth:	*10 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.86773 Latitude: 30.24791*
Drilling Method:	*Straight Flight Auger w/SPT Sampling*	▽ Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	**MATERIALS DESCRIPTION**	TYPE	BORE/CORE DATA: 1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SQFT	RQD % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
		▨	CLAYEY SAND; very loose, brown and gray (SC)													
	1	▨		☒	3 - 1 - 1 N = 2			18								31.0
	2	▨	SANDY LEAN CLAY; stiff, light brown (CL)													
	3	▨		☒	3 - 6 - 8 N = 14			13	44	14	30					
	4	▨														
	5	▨		☒	8 - 12 - 13 N = 25			9	37	15	22					
	6	▨	CLAYEY SAND; dense, reddish-brown to reddish-brown and gray, calcareous (SC)													
	7	▨		☒	14 - 19 - 23 N = 42			7								43.3
	8	▨														
	9	▨		☒	8 - 14 - 23 N = 37			15	44	16	28					
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00210900833.00*
Driller:	*J. Munoz*	Date Drilled:	*3/26/2021*
Logged by:	*E. Garcia*	Boring Depth:	*10 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.87092 Latitude: 30.25073*
Drilling Method:	*Straight Flight Auger w/SPT Sampling*	▽ Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	**MATERIALS DESCRIPTION**	TYPE	BORE/CORE DATA: 1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0 – 4	▨	SANDY LEAN CLAY; firm to very stiff, brown to reddish-brown, trace roots (CL)	☒	1 - 3 - 4 N = 7			19	49	16	33					
				☒	9 - 12 - 14 N = 26			11								
	4 – 6	▨	SANDY FAT CLAY; hard, reddish-brown (CH)	☒	11 - 17 - 18 N = 35			13	52	18	34					
	6 – 10	▨	CLAYEY SAND; very dense, red and brown to brown (SC)	☒	11 - 26 - 50/5 N = 76/11"			9	31	12	19					
				☒	20 - 27 - 32 N = 59			4								15.1
	10		Boring terminated at 10 feet.													

Depth scale (ft): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

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Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00210900833.00*
Driller:	*J. Munoz*	Date Drilled:	*3/26/2021*
Logged by:	*E. Garcia*	Boring Depth:	*10 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.86871 Latitude: 30.25021*
Drilling Method:	*Straight Flight Auger w/SPT Sampling*	▽ Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA: 1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0	▨	CLAYEY SAND; very loose to loose, brown (SC)													
	1	▨		☒	1 - 1 - 2 N = 3			7								30.9
	3	▨		☒	2 - 4 - 6 N = 10			9								
	4	▨	SANDY LEAN CLAY; hard, light reddish-brown (CL)													
	5	▨		☒	16 - 16 - 18 N = 34			10	31	15	16					
	6	▨	CLAYEY SAND; very dense to dense, light reddish-brown to light brown (SC)													
	7	▨		☒	8 - 21 - 32 N = 53			8	21	12	9					
	9	▨		☒	11 - 14 - 17 N = 31			7								24.3
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Log of B-06

Page 1 of 1

Drilling Co.: *Blue Hole Drilling*

Driller: *J. Munoz*

Logged by: *E. Garcia*

Equipment: *CME 75*

Hammer Type: *Automatic*

Drilling Method: *Straight Flight Auger w/SPT Sampling*

TTL Project No.: *00210900833.00*

Date Drilled: *3/25/2021*

Boring Depth: *10 feet*

Boring Elevation: *Ground Surface*

Coordinates: *Longitude: -98.86692 Latitude: 30.25024*

▽ Water Level at Time of Drilling: *Not Encount.*

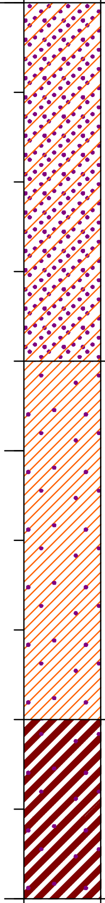
Cave-In at Time of Drilling: *N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA



ELEVATION (ft)	DEPTH (ft)	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA: 1st 6" - 2nd 6" - 3rd 6"; N-VALUE BLOWS/FT	P: TONS/SOFT	RQD / % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0	CLAYEY SAND; loose to medium dense, brown (SC)													
	1		☒	4 - 4 - 3 N = 7			6								25.5
	3		☒	3 - 4 - 7 N = 11			17								28.8
	4	SANDY LEAN CLAY; stiff to very stiff, mottled reddish-brown and gray (CL)													
	5		☒	5 - 7 - 7 N = 14			12	32	16	16					
	7		☒	3 - 8 - 11 N = 19			10								
	8	SANDY FAT CLAY; very stiff, reddish-brown and gray (CH)													
	9		☒	6 - 8 - 13 N = 21			17	60	20	40					
	10	Boring terminated at 10 feet.													
	11														
	12														
	13														
	14														

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B-07

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Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00210900833.00*
Driller:	*J. Munoz*	Date Drilled:	*3/26/2021*
Logged by:	*E. Garcia*	Boring Depth:	*10 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.8683 Latitude: 30.25148*
Drilling Method:	*Straight Flight Auger w/SPT Sampling*	▽ Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	**MATERIALS DESCRIPTION**	TYPE	BORE/CORE DATA 1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SQFT	RQD % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
		▨	FAT CLAY WITH SAND; stiff to hard, mottled red and brown, trace roots (CH)													
	1	▨		☒	1 - 3 - 6 N = 9			14	55	19	36					
	2	▨														
	3	▨		☒	10 - 15 - 19 N = 34			10								
	4	▨	SANDY LEAN CLAY; hard, mottled red and brown to gray, calcareous (CL)													
	5	▨		☒	8 - 14 - 20 N = 34			11	42	16	26					
	6	▨														
	7	▨		☒	7 - 18 - 25 N = 43			11								
	8	▨														
	9	▨		☒	16 - 22 - 25 N = 47			9	24	12	12					
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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B-08

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Drilling Co.: *Blue Hole Drilling*
Driller: *J. Munoz*
Logged by: *E. Garcia*
Equipment: *CME 75*
Hammer Type: *Automatic*
Drilling Method: *Straight Flight Auger w/SPT Sampling*

TTL Project No.: *00210900833.00*
Date Drilled: *3/25/2021*
Boring Depth: *10 feet*
Boring Elevation: *Ground Surface*
Coordinates: *Longitude: -98.866098 Latitude: 30.25115*
∇ Water Level at Time of Drilling: *Not Encount.*
Cave-In at Time of Drilling: *N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▼ Delayed Water Level: *N/A*
Delayed Water Observation Date: *N/A*

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	SAMPLE DATA TYPE	BORE/CORE DATA 1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SQFT	RQD % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
		▨	SANDY FAT CLAY; stiff to hard, brown to mottled red, brown and gray (CH)													
	1	▨		☒	4 - 6 - 7 N = 13			11								52.9
	2	▨														
	3	▨		☒	7 - 10 - 13 N = 23			12	55	18	37					
	4	▨														
	5	▨		☒	9 - 12 - 22 N = 34			10								
	6	▨														
	7	▨		☒	15 - 15 - 12 N = 27			13								
	8	▨	- becomes mottled red and gray, less sand below 8½ feet													
	9	▨		☒	11 - 19 - 34 N = 53			11								71.0
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Drilling Co.: *Blue Hole Drilling*

Driller: *J. Munoz*

Logged by: *E. Garcia*

Equipment: *CME 75*

Hammer Type: *Automatic*

Drilling Method: *Straight Flight Auger w/SPT Sampling*

TTL Project No.: *00210900833.00*

Date Drilled: *3/25/2021*

Boring Depth: *10 feet*

Boring Elevation: *Ground Surface*

Coordinates: *Longitude: -98.86483 Latitude: 30.25192*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▽ Water Level at Time of Drilling: *Not Encount.*

Cave-In at Time of Drilling: *N/A*

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	**MATERIALS DESCRIPTION**	TYPE	BORE/CORE DATA 1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SQFT	RQD % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
		▨	FAT CLAY WITH SAND; stiff to hard, brown to mottled red and brown (CH)													
	1	▨		⊠	5 - 7 - 8 N = 15			18	73	22	51					
	2	▨														
	3	▨		⊠	7 - 9 - 9 N = 18			13								
	4	▨	- becomes mottled red, brown, and gray below 4½ feet													
	5	▨		⊠	8 - 12 - 21 N = 33			10	51	17	34					
	6	▨	CLAYEY SAND; dense to very dense, reddish-brown (SC)													
	7	▨		⊠	17 - 24 - 20 N = 44			9								36.7
	8	▨														
	9	▨		⊠	15 - 27 - 47 N = 74			7								
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00210900833.00*
Driller:	*J. Munoz*	Date Drilled:	*3/26/2021*
Logged by:	*E. Garcia*	Boring Depth:	*10 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.86333 Latitude: 30.25159*
Drilling Method:	*Straight Flight Auger w/SPT Sampling*	▽ Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA: 1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SOFT	RQD / % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
		▨	CLAYEY SAND; very loose, reddish-brown (SC)													
	1	▨		☒	2 - 1 - 3 N = 4			16								39.0
	2	▨	SANDY FAT CLAY; very stiff, reddish-brown (CH)													
	3	▨		☒	5 - 8 - 8 N = 16			18	72	21	51					
	4	▨														
	5	▨		☒	7 - 11 - 15 N = 26			17								
	6	▨	SANDY LEAN CLAY; hard to very stiff, mottled red and brown (CL) - becomes hard between 6½ to 8 feet													
	7	▨		☒	8 - 12 - 20 N = 32			17								
	8	▨														
	9	▨		☒	8 - 9 - 15 N = 24			15	38	14	24					
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00210900833.00*
Driller:	*J. Munoz*	Date Drilled:	*3/26/2021*
Logged by:	*E. Garcia*	Boring Depth:	*10 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.86319 Latitude: 30.25259*
Drilling Method:	*Straight Flight Auger w/SPT Sampling*	▽ Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA 1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SQFT	RQD % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
		▨	SANDY LEAN CLAY; soft to very stiff, dark reddish-brown (CL)													
	1	▨		☒	2 - 2 - 2 N = 4			22	63	21	42					
	2	▨														
	3	▨		☒	6 - 9 - 7 N = 16			16								
	4	▨														
	5	▨		☒	5 - 13 - 15 N = 28			15								
	6	▨														
	7	▨		☒	10 - 10 - 15 N = 25			15								
	8	▨	- becomes reddish-brown, less sand below 8½ feet													
	9	▨		☒	7 - 7 - 10 N = 17			14								71.4
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

R:\GINT\TTL\PROJECTS\2021\00210900833.00 -- FRIENDSHIP OAKS SUBDIVISION - LENNAR.GPJ 4/15/21 Report:AEP-GEOTECH LOG - LAT LONG

Lennar
Friendship Oaks Subdivision
Friendship Lane and South Creek Street

Fredericksburg, Gillespie County, Texas

Log of B-12

Page 1 of 1

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00210900833.00*
Driller:	*J. Munoz*	Date Drilled:	*3/25/2021*
Logged by:	*E. Garcia*	Boring Depth:	*10 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.86547 Latitude: 30.25345*
Drilling Method:	*Straight Flight Auger w/SPT Sampling*	∇ Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA: 1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
			CLAYEY SAND; very loose to medium dense, mottled brown and dark brown (SC)													
	1				1 - 1 - 2 N = 3			20	40	17	23					
	2															
	3				3 - 6 - 8 N = 14			12								
	4		SANDY LEAN CLAY; very stiff to hard, mottled red and brown to mottled tan and red (CL)													
	5				8 - 11 - 16 N = 27			7								
	6															
	7				8 - 21 - 24 N = 45			9								
	8		CLAYEY SAND; dense, mottled red, brown, and gray (SC)													
	9				15 - 14 - 15 N = 29			15	46	14	32					
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

This boring log shall not be separated from the corresponding Instrument of Service; no third party may rely upon this boring log or the corresponding Instrument of Service absent a written TTL Secondary Client Agreement.

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Friendship Lane and South Creek Street
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Log of B-13

Page 1 of 1

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00210900833.00*
Driller:	*J. Munoz*	Date Drilled:	*3/25/2021*
Logged by:	*E. Garcia*	Boring Depth:	*10 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.86401 Latitude: 30.25361*
Drilling Method:	*Straight Flight Auger w/SPT Sampling*	▽ Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	**MATERIALS DESCRIPTION**	TYPE	BORE/CORE DATA 1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0	▨	SANDY FAT CLAY; stiff to hard, reddish-brown to dark brown, calcareous (CH)													
	1	▨		☒	2 - 4 - 5 N = 9			21	57	20	37					
	2	▨														
	3	▨		☒	10 - 8 - 9 N = 17			8								64.8
	4	▨	- becomes mottled red and brown between 4½ to 6 feet													
	5	▨		☒	6 - 9 - 15 N = 24			11								
	6	▨	- becomes mottled red, brown, and gray below 8½ feet													
	7	▨		☒	19 - 21 - 21 N = 42			12								52.4
	8	▨														
	9	▨		☒	11 - 23 - 40 N = 63			13	61	22	39					
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Friendship Lane and South Creek Street
Fredericksburg, Gillespie County, Texas

Log of B-14
Page 1 of 1

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00210900833.00*
Driller:	*J. Munoz*	Date Drilled:	*3/25/2021*
Logged by:	*E. Garcia*	Boring Depth:	*10 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.86277 Latitude: 30.25469*
Drilling Method:	*Straight Flight Auger w/SPT Sampling*	▽ Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA: 1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SOFT	RQD / % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
		▨	LEAN CLAY WITH SAND; stiff, dark brown (CL)													
	1	▨		☒	2 - 4 - 5 N = 9			16	43	13	30					
	2	▨	CLAYEY SAND; medium dense, mottled brown and gray to brown, gray and red (SC)													
	3	▨		☒	4 - 4 - 7 N = 11			14								34.2
	4	▨														
	5	▨		☒	8 - 9 - 7 N = 16			10	35	12	23					
	6	▨														
	7	▨		☒	8 - 9 - 16 N = 25			14								
	8	▨	SANDY LEAN CLAY; very stiff, mottled red and brown (CL)													
	9	▨		☒	7 - 9 - 13 N = 22			12								
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Friendship Oaks Subdivision
Friendship Lane and South Creek Street
Fredericksburg, Gillespie County, Texas

Log of B-15

Page 1 of 1

Drilling Co.: *Blue Hole Drilling*

Driller: *J. Munoz*

Logged by: *E. Garcia*

Equipment: *CME 75*

Hammer Type: *Automatic*

Drilling Method: *Straight Flight Auger w/SPT Sampling*

TTL Project No.: *00210900833.00*

Date Drilled: *3/26/2021*

Boring Depth: *10 feet*

Boring Elevation: *Ground Surface*

Coordinates: *Longitude: -98.86476 Latitude: 30.25581*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▽ Water Level at Time of Drilling: *Not Encount.*

Cave-In at Time of Drilling: *N/A*

▼ Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA 1st 6" 2nd 6" 3rd 6" N-VALUE BLOWS/FT	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0 – 2		SANDY FAT CLAY; firm, mottled red and brown (CH)	☒	2 - 3 - 5 N = 8			24	79	27	52					
	2 – 10		CLAYEY SAND; dense to very dense, mottled reddish-brown and gray to red (SC)	☒	7 - 17 - 17 N = 34			10								44.0
				☒	11 - 17 - 21 N = 38			10								36.5
			- becomes mottled red and gray below 6½ feet	☒	4 - 15 - 13 N = 28			11	30	12	18					
			- with gravel below 8½ feet	☒	13 - 36 - 50/4 N = 86/10"			10								
	10		Boring terminated at 10 feet.													

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Boring	Depth	USCS	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Gravel	% Sand	Maximum Size (mm)	% Passing #200 % Silt % Clay (If hydrometer data available)	D50 (mm)
B-01	0.5 - 2	---	6	---	---	---	0.0	0.0	0.075	28.9	---
B-01	2.5 - 4	SC	16	42	16	26	0.0	0.0	0.075	44.1	---
B-01	6.5 - 8	---	5	---	---	---	0.0	0.0	0.075	29.9	---
B-02	0.5 - 2	---	9	---	---	---	0.0	0.0	0.075	30.4	---
B-02	2.5 - 4	---	9	65	19	46	---	---	---	---	---
B-02	6.5 - 8	---	9	35	16	19	---	---	---	---	---
B-03	0.5 - 2	---	18	---	---	---	0.0	0.0	0.075	31.0	---
B-03	2.5 - 4	---	13	44	14	30	---	---	---	---	---
B-03	4.5 - 6	---	9	37	15	22	---	---	---	---	---
B-03	6.5 - 8	---	7	---	---	---	0.0	0.0	0.075	43.3	---
B-03	8.5 - 10	---	15	44	16	28	---	---	---	---	---
B-04	0.5 - 2	---	19	49	16	33	---	---	---	---	---
B-04	4.5 - 6	---	13	52	18	34	---	---	---	---	---
B-04	6.5 - 8	---	9	31	12	19	---	---	---	---	---
B-04	8.5 - 10	---	4	---	---	---	0.0	0.0	0.075	15.1	---
B-05	0.5 - 2	---	7	---	---	---	0.0	0.0	0.075	30.9	---
B-05	4.5 - 6	---	10	31	15	16	---	---	---	---	---
B-05	6.5 - 8	---	8	21	12	9	---	---	---	---	---
B-05	8.5 - 10	---	7	---	---	---	0.0	0.0	0.075	24.3	---
B-06	0.5 - 2	---	6	---	---	---	0.0	0.0	0.075	25.5	---
B-06	2.5 - 4	---	17	---	---	---	0.0	0.0	0.075	28.8	---
B-06	4.5 - 6	---	12	32	16	16	---	---	---	---	---
B-06	8.5 - 10	---	17	60	20	40	---	---	---	---	---
B-07	0.5 - 2	---	14	55	19	36	---	---	---	---	---
B-07	4.5 - 6	---	11	42	16	26	---	---	---	---	---
B-07	8.5 - 10	---	9	24	12	12	---	---	---	---	---
B-08	0.5 - 2	---	11	---	---	---	0.0	0.0	0.075	52.9	---
B-08	2.5 - 4	---	12	55	18	37	---	---	---	---	---
B-08	8.5 - 10	---	11	---	---	---	0.0	0.0	0.075	71.0	---
B-09	0.5 - 2	---	18	73	22	51	---	---	---	---	---
B-09	4.5 - 6	---	10	51	17	34	---	---	---	---	---
B-09	6.5 - 8	---	9	---	---	---	0.0	0.0	0.075	36.7	---
B-10	0.5 - 2	---	16	---	---	---	0.0	0.0	0.075	39.0	---
B-10	2.5 - 4	---	18	72	21	51	---	---	---	---	---
B-10	8.5 - 10	---	15	38	14	24	---	---	---	---	---
B-11	0.5 - 2	---	22	63	21	42	---	---	---	---	---
B-11	8.5 - 10	---	14	---	---	---	0.0	0.0	0.075	71.4	---
B-12	0.5 - 2	---	20	40	17	23	---	---	---	---	---
B-12	8.5 - 10	---	15	46	14	32	---	---	---	---	---
B-13	0.5 - 2	---	21	57	20	37	---	---	---	---	---
B-13	2.5 - 4	---	8	---	---	---	0.0	0.0	0.075	64.8	---
B-13	6.5 - 8	---	12	---	---	---	0.0	0.0	0.075	52.4	---

Summary of Laboratory Test Results

Client: Lennar
Project: Friendship Oaks Subdivision
Location: Fredericksburg, Gillespie County, Texas
Project Number: 00210900833.00

Sheet 2 of 2

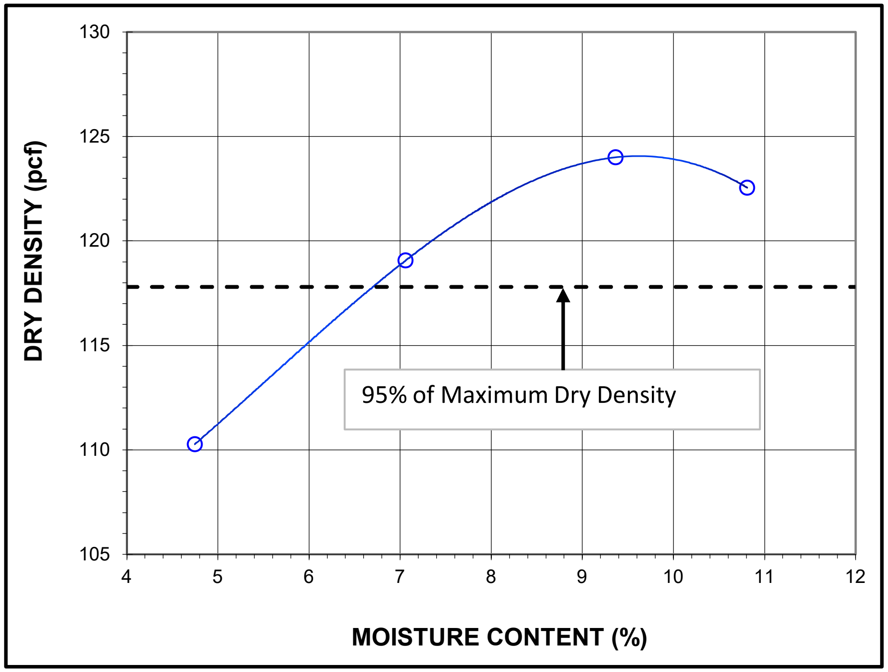
Boring	Depth	USCS	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Gravel	% Sand	Maximum Size (mm)	% Passing #200 % Silt % Clay (If hydrometer data available)	D50 (mm)
B-13	8.5 - 10	---	13	61	22	39	---	---	---	---	---
B-14	0.5 - 2	---	16	43	13	30	---	---	---	---	---
B-14	2.5 - 4	---	14	---	---	---	0.0	0.0	0.075	34.2	---
B-14	4.5 - 6	---	10	35	12	23	---	---	---	---	---
B-15	0.5 - 2	---	24	79	27	52	---	---	---	---	---
B-15	2.5 - 4	---	10	---	---	---	0.0	0.0	0.075	44.0	---
B-15	4.5 - 6	---	10	---	---	---	0.0	0.0	0.075	36.5	---
B-15	6.5 - 8	---	11	30	12	18	---	---	---	---	---

R:\GINT\TTL\PROJECTS\2021\00210900833.00 -- FRIENDSHIP OAKS SUBDIVISION - LENNAR.GPJ 4/15/21 Report:SOIL SUMMARY - GEOTECH

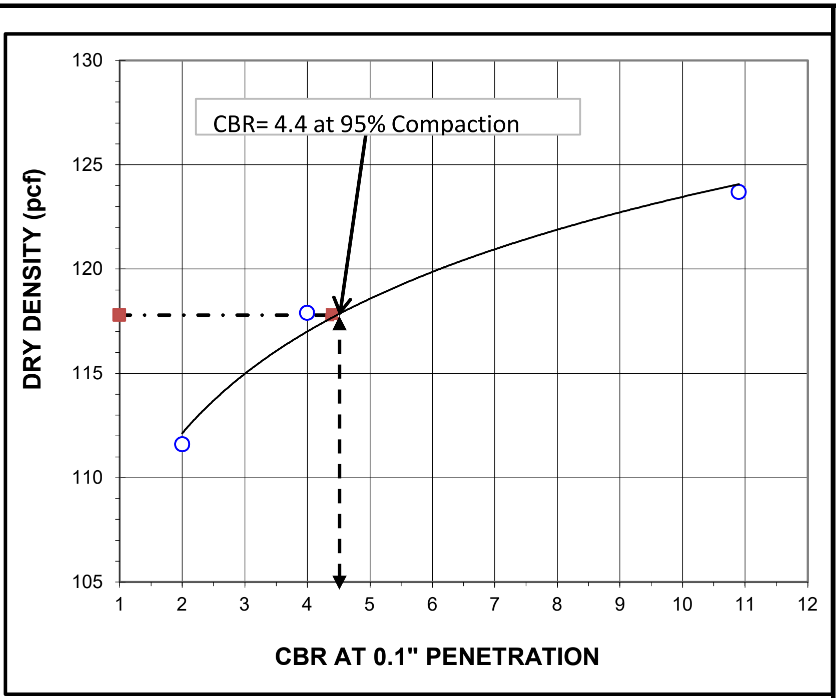
TTL

Summary of Laboratory Test Results

Client: Lennar
Project: Friendship Oaks Subdivision
Location: Fredericksburg, Gillespie County, Texas
Project Number: 00210900833.00



95% of Maximum Dry Density



CBR= 4.4 at 95% Compaction

Sample: **CBR Sample No. 1**
Proctor Test Method: Standard Proctor (ASTM D-698)
CBR Test Method: California Bearing Ration (ASTM D-1883)
Material: SILTY CLAYEY SAND (SC-SM), brown

CBR Sample Location: 30.24701°, -98.596568°
Sample Depth: Between 0 and 5 feet below existing ground surface
Optimum Moisture Content: 9.4 %
Maximum Dry Unit Weight: 124 pcf
% Passing # 200 Sieve 30.8 %
Atterberg Limits: LL= 17; PL = 12, PI = 5

TTL

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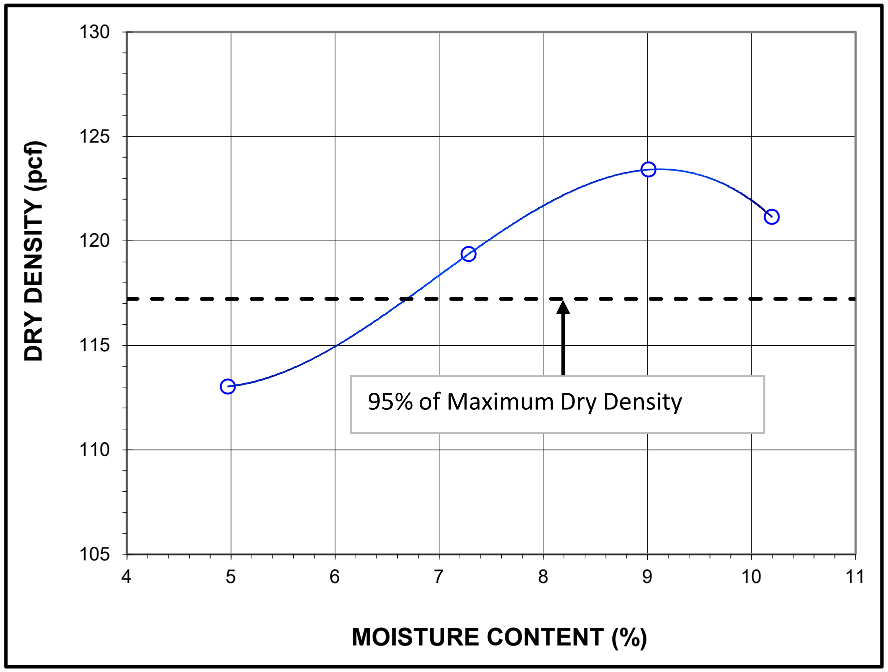
San Antonio, Texas 78247
T: 210-888-6100
WWW.TTLUSA.COM

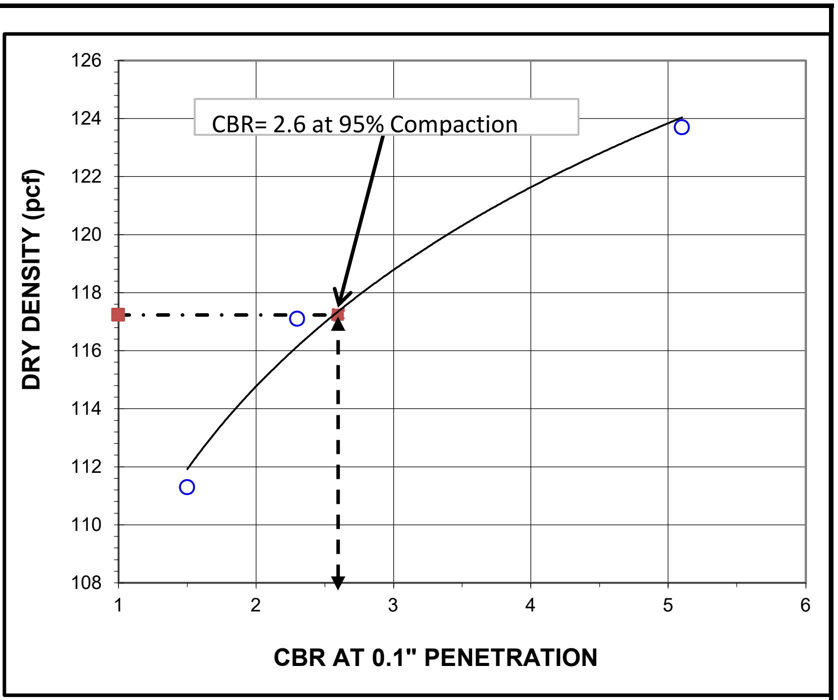
FRIENDSHIP OAKS SUBDIVISION
FRIENDSHIP LANE AND SOUTH CREEK STREET

FREDERICKSBURG, GILLESPIE COUNTY, TEXAS

Drawn By: SJ
Checked By: AB
Proj No:0021090833.00
File Name

CBR PLOT





Sample: **CBR Sample No. 2**
Proctor Test Method: Standard Proctor (ASTM D-698)
CBR Test Method: California Bearing Ration (ASTM D-1883)
Material: SILTY SAND (SM), Reddish-Brown

CBR Sample Location: 30.25247°, -98.86686°
Sample Depth: Between 0 and 5 feet below existing ground surface
Optimum Moisture Content: 9 %
Maximum Dry Unit Weight: 123.4 pcf
% Passing # 200 Sieve 34.1 %
Atterberg Limits: LL= 14; PL = 13, PI = 1

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FRIENDSHIP LANE AND SOUTH CREEK STREET

FREDERICKSBURG, GILLESPIE COUNTY, TEXAS

Drawn By: SJ
Checked By: AB
Proj No:0021090833.00
File Name

CBR PLOT

APPENDIX B
REFERENCE MATERIALS

EXPLORATION PROCEDURES

General

Various drill equipment and procedures are used to obtain soil or rock specimens during geotechnical engineering exploration activities. The drill equipment typically consists of fuel powered machinery that is mounted on a flat-bed truck or an all-terrain vehicle. The ground surface conditions at the site generally determine the type of vehicle to use.

Borings can be drilled either dry or wet. The drilling technique depends on the type of subsurface materials (clays, sands, silts, gravels, rock) encountered and whether or not subsurface water is present during the drilling operations. Sometimes a combination of both techniques is implemented.

The dry method can generally be employed when subsurface water or granular soils are not present. The dry method generally consists of advancing the augers without the use of water or drilling fluids. Air can be employed as necessary to remove cuttings from the borehole or cool the drilling bits during some drilling applications. The wet rotary process is generally used when subsurface water, rock or granular soils are present. The wet rotary process utilizes water or drilling fluids to advance the augers, remove cuttings from the borehole, and cool the drilling bits during drilling.

Sampling

Various sampling devices are available to recover soil or rock specimens during the geotechnical exploration program. The type of sampling apparatus to employ depends on the subsurface materials (clays, sands, silts, gravels, rock) encountered and on their consistency or strength. Most commonly used samplers are Shelby tubes, split-spoons or split-barrels, and NX core barrels. Depending on the subsurface conditions, sampling apparatus such as the Pitcher barrel, Osterberg sampler, Dennison barrel, or California sampler are sometimes used. The procedures for using and sampling subsurface materials with most of these samplers are described in detail by the American Society for Testing and Materials (ASTM). Sampling is generally performed on a two (2) foot continuous interval to a depth of about ten (10) feet, followed by five (5) foot intervals between the depths of about ten (10) to 50 feet, and on ten (10) foot intervals thereafter to the termination depth of the borings. However, sampling intervals may change depending on the project scope and actual subsurface conditions encountered.

If cohesive soils (clays and some silts) are present during drilling, samples are retrieved by using the Shelby tube sampler (ASTM D 1587) orthe split-barrel sampler (ASTM D 1586). The Shelby tube is used to recover "virtually" undisturbed soil specimens that can be returned to the laboratory for strength and compressibility testing. The Shelby tube is a three (3) inch nominal diameter, thin-walled tube that is advanced hydraulically into the soil by a single stroke of the drill equipment.

The split-barrel sampler is used when performing the Standard Penetration Test (SPT). There covered sample is considered to be a “disturbed” specimen due tothe SPT procedure. The split-barrel is advanced into the soil by driving the sampler with blows from a 140-pound hammer free falling 30 inches. The SPT procedure is performed to evaluate the strength or competency of the material being sampled. This evaluation is based on the material sampled, depth of the sample, and the number of blows required to obtain full penetration of the split-barrel sampler. This blow count or penetration resistance is referred to as the “N” value.

The split-barrel is typically used when cohesionless soils (sands, silts, gravels) are encountered or when good quality cohesive soils cannot be recovered with the Shelby tube sampler. The SPT procedure can be employed when rock or cemented zones are encountered. However, the split-barrel may not penetrate the rock or cemented zone if the layer is extremely hard, thus resulting in no sample recovery.

When rock or cemented zones are present, and depending on the type of project and engineering testing required, rock coring may be implemented to recover specimens of the particular layer. Typically, an NX double tube core barrel (ASTM D 2113) is used.

Logging

During the drilling activities, one of our geologists or engineering technicians is present to make sure that the appropriate sampling techniques are employed and to extrude or remove all materials from the samplers. The samples are then visually classified by our field representative who records the information on a field boring log. Our field representative may perform pocket penetrometer, hand torvane, or field vane tests on the subsurface materials recovered from the Shelby tube samplers. If the SPT procedure is employed, our field representative will record the N values or blow counts that are germane to that particular field test. If rock coring is utilized, our field representative will calculate the percent recovery and Rock Quality Designation (RQD). The test data for all the field tests will be noted on the appropriate field boring log. Upon completion of the logging activities and field testing of the recovered soil or rock samples, representative portions of the specimens were placed in appropriately wrapped and sealed containers to preserve their natural moisture condition and to minimize disturbance during handling and transporting to our laboratory for additional testing.

When subsurface water is observed during the drilling and sampling operations, drilling will be temporarily delayed so the subsurface water level can be monitored for a period of at least 15 to30 minutes. Depending on the rise of the subsurface water in the borehole and project requirements, subsurface water measurements may be monitored for periods of 24 hours or more. Generally, observation wells or piezometers are installed in the completed boreholes to monitor subsurface water levels for periods longer than 24 hours.

Following completion of drilling, sampling, and subsurface water monitoring, all boreholes are backfilled with soil cuttings from the completed borings unless the client requests or local ordinance requires special backfilling requirements. If there are not enough soil cuttings available, clean sand will be used to backfill the completed boreholes.

Details concerning the subsurface conditions are provided on each individual boring log presented in this Appendix. The terms and symbols used on each boring log are defined in the Legend Sheet which is also presented in this Appendix.

LABORATORY TESTING PROCEDURES

Classification and Index Testing

The recovered soil samples were classified in the laboratory by a geoprofessional using the USCS as a guide. Samples were tested for the following properties in general accordance with the applicable ASTM standards:

- Moisture content (ASTM D2216),
- Atterberg Limits (ASTM D4318),
- Percent material passing the No. 200 sieve (ASTM D1140),

Results of tests for moisture content, Atterberg Limits, and percent material passing the No. 200 sieve are presented on individual boring logs in Appendix A. The results are also tabulated on the Summary of Laboratory Results sheet in Appendix A.