GEOTECHNICAL ENGINEERING REPORT

Tres Laurels
Units 2 and 3

Grosenbacher Road
San Antonio, Bexar County, Texas

Prepared for:

Lennar
San Antonio, Texas

Prepared by:
TTL, Inc.
San Antonio, Texas

Project No. 000230902935.02
April 24, 2025

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April 24, 2025

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RE: Pavement Design Report
Tres Laurels Units 2 and 3
Grosenbacher Road
San Antonio ETJ, Bexar County, Texas
TTL Project No.000230902935.02

Dear Mr. Mott:

TTL, Inc., (TTL) is pleased to submit this pavement design report for the above-referenced project. If you have 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 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. Our scope for this project included a Phase I Environmental Site Assessment. Results of that service are presented under separate cover.

Respectfully submitted,

TTL, Inc.

Rakshith P C Gowda, P.E.
Project Professional

STATE OF TEXAS
RAKSHITH PADMINI CHIKKE GOWDA
145415
LICENSED
PROFESSIONAL ENGINEER

04/24/2025

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1.0 PROJECT INFORMATION

Project information was provided by Mr. Richard Mott, P.E., and Ms. Taylor Hagg with Lennar in email conversations since August 31, 2023. We received the following file:

- Tres Laurels MDP

The conclusions and recommendations in this report are based on our understanding of the project. We should be provided additional information as it is developed if it could change or clarify our understanding of the project.

1.1 Project Description

Item	Description
Project Location	The project site is located on Grosenbacher Road southwest of its intersection with Marbach Road in the San Antonio ETJ, Bexar County, Texas. A Site Location Map is provided in Appendix A.
Proposed Development	Units 2 and 3 of the subdivision will consist of approximately 86.3 acres of land. We understand Units 2 and 3 of this subdivision will involve the construction of about 381 single-family homes and approximately 12,220 linear feet of streets.
Proposed Street Construction	The streets are expected to consist of Local Type A, Local Type B, and Collector streets designed per Bexar County and City of San Antonio (COSA) design criteria.
Pavements	The pavements will only consist of flexible pavements; concrete pavements are not planned in the proposed subdivision.

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

1.2 Scope of Services and Authorization

The purposes of our services were to explore the subsurface conditions at the project site and develop geotechnical recommendations for design and construction of subdivision streets. The scope did not include addressing earthwork for grading of residential lots, stability of slopes, foundation support of residential or amenity structures, driveways for individual lots, or other civil and structural design aspects of the project. The scope of work included 10 borings to 10 feet below existing grade. This Project was authorized on October 23, 2023, by Mr. Richard Mott with Lennar by acceptance of our Agreement for Services, No. P00230902935.00, dated September 7, 2023. Our scope was increased after the start of the project to include clearing through the wooded site to access boring locations.

2.0 EXPLORATION FINDINGS

2.1 Site Conditions

Item	Description
Existing Conditions	Based on Google Earth aerial imagery and site reconnaissance, the site consists of undeveloped ranchland covered with brush and trees. A pond, approximately 0.21 acres in area present about 300 feet northwest from the northwest corner of Unit 2, and Potranca Creek meanders south from the northeastern corner along the eastern property boundary.

Existing Topography	Topographic information was not provided to TTL. The ground surface appears to slope down to the south and east towards Potranca Creek from a hill in the northwest corner of the property. Publicly available information suggests more than 130 feet of elevation difference between the top of the hill and the majority of the site. Unit 2 is in the southeast part of the property where there appears to be less than about 20 feet of ground elevation difference. Unit 3 is located in the northwest part of the site where the ground slopes down from the hill.
Flood Zones	Review of Federal Emergency Management Agency (FEMA) flood maps shows most of the site is located within Zone X, an area determined to be outside the 100-year floodplain. However, the eastern portion of the site associated with Potranca Creek lies within Zone A, which is an area subject to a 100-year flood event.
Water Wells	TTL identified five monitoring wells on the property during our exploration. Two water wells were identified in Unit 3 project area.

2.2 Site Geology

The Geologic Atlas of Texas indicated Unit 2 is located over the Navarro Group and Marlbrook Marl (Kknm) of Cretaceous geologic age. The lower part of this formation typically consists of montmorillonitic clays, which typically have high plasticity, and is approximately 400 feet in thickness. This formation is known to contain expansive clays within the project area. Our review indicated Unit 3 is located over the Anacacho Limestone (Kac) of the late cretaceous geologic age. The formation typically contains alternating beds of limestone and marl. The formation is approximately 500 ft thick. The marl and limestone weather in-place to produce residual (left over) soil overburden typically consisting of lean clays, fat clays, clayey sands, and clayey gravels, depending on the parent bedrock.

2.3 Subsurface Stratigraphy

Subsurface conditions within the limits of the project were evaluated by drilling ten exploratory borings. Additionally, soil bulk samples were collected to test for the California Bearing Ratio (CBR) value to be used for our pavement design recommendations. The locations at which the borings were performed and CBR bulk samples were taken are indicated on the Boring Location Plan in Appendix A. Samples obtained during our field exploration were transported to our laboratory where they were reviewed by a geotechnical professional. Representative samples were selected and tested to determine pertinent engineering properties and characteristics for use in our evaluation of the project site.

Based on visual observations and laboratory testing, the following types of subsurface materials were encountered:

Stratum	Approximate Thickness of Stratum	Material Description	Material Properties[1]
Residuum (Borings B 01 to B-07)	0 to 10 feet	Fat Clay, Fat Clay with Sand, Fat Clay with Gravel and Sandy Fat Clay (USCS – CH), firm to very stiff, dark brown, light brown, brown and olive brown, calcareous OR Lean Clay with Sand, Sandy Lean Clay and Sandy Lean Clay with Gravel (USCS – CL), firm to very stiff, dark brown, brown, light brown, olive brown, yellowish-brown, calcareous, cemented OR Clayey Sand and Clayey Sand with Gravel (USCS – SC), medium dense to dense, light brown and brown, calcareous OR Silty Sand (USCS – SM), very dense, light brown and brown, calcareous, cemented OR Clayey Gravel with Sand (USCS – GC), dense, light brown, calcareous	N-value: 5 bpf to 50/0” bpf. MC: 5% to 24%, with most results between 10% and 20% LL: 30 to 97 PI: 14 to 75 <200: 33% to 98%
Limestone, Limestone with Interbedded Marl and Chalk (Borings B 08 to B-10)	2 to 10 feet	Limestone, Limestone with Interbedded Marl, Chalk, soft to hard rock, olive brown, tan, and light brown, completely to highly weathered	N-value: 50/0” bpf.
Termination	At depths of 10 feet below existing grade		

[1] Includes N-values of applicable samples in bpf = blows per foot, MC = Moisture Content, LL = Liquid Limit, PI = Plasticity Index, <200 = Percent of material passing number 200 sieve

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, classification of the soil samples by a geotechnical engineer in general accordance with the Unified Soil Classification System (USCS), which is defined by ASTM D2487 and D2488, and laboratory tests conducted on the retrieved soil samples. 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. Conditions can vary and may be different at locations between borings.

2.4 Subsurface Water Conditions

Subsurface water was not encountered during drilling or upon completion of the soil borings. The presence or absence of subsurface water during a geotechnical exploration may not be indicative of long-term subsurface water conditions at the project site. Subsurface water may exist as a continuous water surface (sometimes called the “water table”) present below the ground surface year-round resulting from long-term accumulation of water above or between relatively impervious subsurface strata. The water level can fluctuate up or down throughout the year due to seasonal changes in climate, precipitation, vegetation, surface runoff, water levels in nearby water bodies, and other factors. The groundwater 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.

Sometimes shallow temporary subsurface water conditions can develop as a result of above-normal rates of precipitation or surface runoff that exceed the rate at which the infiltration can pass through the subsurface strata. These temporary water levels are called “perched” or “trapped” water levels, and they can change rapidly over short horizontal distances and short durations of time. It is often not possible to distinguish between a temporary perched water level or the groundwater table based on one-time observations of water levels in open boreholes.

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 Expansive Soils

Many of the soils at the site are expansive and can shrink and swell in response to seasonal changes in soil moisture content. The expansive potential of a given soil profile may be characterized using the Potential Vertical Rise (PVR) methodology as described in the Texas Department of Transportation (TxDOT) Method TEX-124-E. This methodology is used to estimate how much a given point located on the ground surface may move due to volumetric changes in the soil resulting from fluctuations in soil moisture content. Based on our laboratory test results, we estimate the PVR of some site soils ranges from about 6 inches to 7 inches in its present condition.

In pavement areas, volumetric changes in the expansive clay subgrade may cause vertical and horizontal movements that result in undulating surface effects. These movements may eventually lead to curb and pavement cracking (both transverse and longitudinal). Remedial methods to address this issue include:

- removing the expansive soils and replacing them with a non-expansive soil;
- reducing the expansive potential of the soil by chemical injection; or,
- moisture-conditioning, lime stabilizing, and installing a vertical moisture barrier.

Other subgrade preparation methods are also available.

The City of San Antonio requires the pavement subgrade to be treated with hydrated lime regardless of other subgrade preparation methods. The purpose of lime treatment of an expansive clay pavement subgrade is to 1) improve the strength of the clayey soil, 2) make the soil more resistant to water absorption, which reduces the potential for soil softening, and 3) lower the plasticity index (PI) of the treated zone to reduce the potential for volume changes resulting from moisture content changes. However, the lime treatment is limited to the upper 6 to 12 inches of the pavement subgrade. This depth of treatment is not sufficient to prevent expansive soil movements associated with the “active zone” (i.e., the zone of seasonal moisture variation), which extends to a depth of about 10 feet below the ground surface based on our borings. Consequently, one of the remedial measures mentioned above will be needed to reduce the potential for pavement movements even though the pavement subgrade will be treated with lime. TTL needs to be contacted if any of the aforementioned remedial measures is implemented to facilitate the provision of suitable recommendations.

Utility trenches that traverse beneath the pavements are potential avenues for subsurface water to migrate beneath the pavements. We recommend a ‘clay soil plug’ should be used for the bedding and backfill where utilities cross below pavements.

3.2 Shallow Bedrock

Bedrock was encountered in borings B-08 to B-10 at depths ranging between 2 feet and 8 feet below existing grade. Excavations into bedrock would require blasting or hoe-ramming to remove the rock material. Conventional grading and excavation equipment should be capable of excavating the soil overburden above the bedrock. We recommend the project budget include a contingency for rock excavation.

4.0 EARTHWORK RECOMMENDATIONS

4.1 Subgrade Preparation and Treatment

The intended performance of earth supported elements such as pavements 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 observing and testing fill and backfill soils placed.

If possible, site development should be performed during seasonably dry weather, 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 fill subgrade 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 reduce the potential for further degradation. 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 should 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 pavement construction areas.

- Stripping should extend at least 5 feet (horizontal) beyond the construction limits or to the property lines, whichever is less. Experience suggests the stripping depth may need to be 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.
- Strippings should not be used as fill below pavements, utilities, or structures, and strippings should not be used to construct slopes or permanent berms.

4.1.2 Proof-rolling

After stripping and excavating to the design subgrade elevation, the stability of exposed subgrades should be evaluated by proof-rolling according to the following recommendations.

- 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).
- 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.

4.1.3 Subgrade Treatment

Depending on final grading and time of year construction takes place, some area of weak or unstable subgrade could be encountered. The following methods are options for producing stable subgrade conditions depending on the nature of the unstable conditions, the location and size of the unstable area, and the time available to address the unstable condition.

- Undercut soft, weak, and unstable soils by excavating below subgrade level to expose stable soils. Place and compact backfill meeting requirements outlined in Section 4.2 of this report to restore the design subgrade level. Contact TTL if undercutting deeper than about 3 feet is needed.
- Soil subgrade areas requiring fill placement should be scarified to a depth of about 8 inches and moisture-conditioned to between the optimum moisture content and 4 percentage points above 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 D698. The subgrade should be moisture conditioned immediately prior to fill placement so the subgrade maintains its compaction moisture content and does not have time to dry out.

Subgrades damaged by construction equipment should be promptly repaired. Our geoprofessional should provide recommendations for treatment if the subgrade materials become wet, dry, or frozen. Near-surface soils will degrade and will need to be undercut if they are subjected to freeze/thaw.

4.1.4 Pavement Earthwork

The intended performance of roadway pavement is contingent upon following the earthwork recommendations and guidelines outlined in this section

- After proof-rolling and replacing any weak yielding zones, the clay subgrade should be treated with hydrated lime to a depth of at least 6 inches in accordance with TxDOT Item 260. The lime should be in slurry form. It is anticipated that approximately 6 percent hydrated lime by weight will be required (approximately 35 pounds per square yard). The soil-lime mixture should be placed between optimum moisture content and +4 percentage points of the optimum moisture content and shall be compacted to at least 95 percent of the maximum dry density determined in accordance with standard Proctor compaction effort (ASTM D 698).
- For pavement subgrades the earthwork described here should result in approximately 6 inches of lime treated soil below the design pavement subgrade elevation.
- **For pavements located in natural drainage path areas, one of the following additional measures should be constructed beneath the soil subgrade level:**
    - Prepare the subgrade with 12 inches of moisture conditioned soils beneath 6 to 8 inches of lime treated soils, or
    - Prepare the subgrade with at least 12 inches of lime-treated soil.

4.1.5 Existing Pond

The identified area of the existing pond lies outside the development zones of Unit 2 and Unit 3. Should any development occur at this location, specific measures need to be taken to enhance stability and suitability for construction. The existing pond should be drained and wet, unstable soils within the pond (muck) should be removed and disposed of at on-site areas located outside the limits of current or future development or they should be disposed of off-site. The de-mucked subgrade should be proof-rolled according to Section 4.1.2 to assess stability of the subgrade, and unstable areas should be stabilized according to Section 4.1.3. Additional recommendations and measures may be necessary. Notification of the proposed construction should be extended to TTL, who should be authorized to furnish further recommendations.

4.2 Compacted Fill

Compacted fill materials may consist of general or select fill depending upon its intended use. The general fill material may consist of onsite soils or select fill materials. General fill material should possess good compaction characteristics that will provide uniform support for pavements or other facilities not extremely sensitive to moments. Select fill materials are typically selected for specific engineering characteristics and performance criteria. These characteristics and criteria are typically dependent on the requirements of the pavement 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. The following table provides more specific requirements for general and select fill materials.

Material Type	Characteristics	Compaction Procedures	Compaction Control $^{1, 2}$
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.	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, 2, or 3; Crushed or uncrushed gravel meeting Type B, Grades 1, 2, or 3; Crushed concrete meeting Type D, Grades 1, 2, or 3; 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. Moisture content at time of compaction: within minus 2 to plus 3 percent of the material's optimum moisture content.	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.

Material Type	Characteristics	Compaction Procedures	Compaction Control [1, 2]
	Clayey gravel (may locally be referred to as "pit-run" material) or caliche • CBR > 3 • Liquid Limit (LL): No greater than 40 • PI: Between 7 and 20 • Maximum particle size: 3 inches. • At least 50 percent of total material (by weight) retained on the No. 200 sieve • 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. • CBR > 3 • Liquid Limit (LL): No greater than 40 • PI: Less than 20 • Passing 3/4 Sieve: 100% • Passing 3/8 Sieve: 50%-75% • Passing #4 Sieve: 30%-60% • Passing #200: 5%-12%		

[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. In the event that the on-site soils cannot be compacted due to wet weather the on-site soils would need to dry out before continuing. If time does not allow for the on-site soils to dry out naturally then lime treatment or removal and replacement with select fill can be considered to continue earthwork operations. This operation should be observed and evaluated by qualified geotechnical personnel experienced in earthwork operations.

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) requires 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 if workers will enter an excavation. The contractor's 'competent 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 excavations deeper than 4 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 "Maximum Allowable Slopes" 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°
Type A	¾:1	53°
Type B	1:1	45°
Type C	1½:1	34°

1. Slopes or benching for excavations that exceed 20 feet shall be designed by a licensed professional engineer and may not use these tabulated values.
2. 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 the site soils appear to be OSHA Type B and C soils. Bedrock may classify as Type A or Stable Rock, depending on condition and degree of fracturing from blasting or excavation. 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 is not responsibile 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

The near-surface clayey soils can likely be excavated with conventional earthmoving equipment. However, Chalk, Marl, and Limestone may be difficult to excavate with conventional earthmoving equipment and will likely need heavy-duty rock excavation equipment and techniques, like blasting or hoe-ramming, to excavate them.

4.3.3 Drainage During Construction

Water should not be allowed to collect in roadway excavations or on prepared subgrades within the construction area. Excavated areas should be sloped toward designated drainage points to facilitate removal of any collected rainwater, subsurface water, or surface runoff. Positive surface drainage 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 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 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, if any, 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 pavements and utilities. We recommend site drainage be developed to prevent ponding of water on completed pavements. When establishing final grades, the ground surface around pavements should have sufficient slope to promote rapid surface drainage away from pavements.

5.0 INFRASTRUCTURE RECOMMENDATIONS

5.1 Utilities

We recommend the following installation guidelines for buried utilities.

- The bottoms of the utility trench excavations should be clean of loose soils and debris prior to placement of the utility pipe or cable.
- Recommendations for utility trench bedding and backfill are provided in Section 4.2 of this report.
- As an alternate, utility trenches may be backfilled with flowable fill materials that terminate at a depth sufficient to allow for the construction of pavements. Flowable fill should have a minimum 28-day compressive strength of 100 pounds per square inch (psi). The flowable fill should have a 28-day compressive strength low enough (not more than 400 psi) that it can readily be excavated. Flowable fill is defined as materials complying with Item 401 of the 2014 TxDOT Standard Specifications.
- Where granular bedding is used for pipe bedding, consideration should be given to the placement of non-woven filter fabric (Mirafi 140N, or equal) around the bedding materials within the trench to reduce the potential for piping fines through the bedding material. Piping of fines within utility trenches often results in pronounced subsidence of the ground surface over time that could affect pavements constructed over the utility trenches. The filter fabric should be overlapped at ends and edges per manufacturer’s recommendations and should wrap over the top of the crushed stone.

5.2 Landscape Considerations

TTL realizes 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 pavements may contribute to future distress as the vegetation can cause changes to the moisture content of the pavement subgrade. Landscape beds should not be closer than 5 feet to the edge of the pavement and should not contain plants or shrubs that will exceed a mature height of about 3 to 4 feet. Large bushes and trees that will generally exceed these heights should be planted away from the pavements so their canopy or “drip line” does not extend over the pavement when the tree reaches maturity.

Excessive watering should be avoided as excessive irrigation of landscaped areas adjacent to, near, or up-gradient from pavements can contribute to water migration into pavement sections. This migration could cause moisture fluctuations in the underlying clay subgrade which could in turn result in excessive soil movements and loss of subgrade strength.

5.3 Pavement Design Considerations

Based on the Bexar County and COSA design guidelines, the following design parameters were used for design of the pavement sections:

Acceptable Pavement Structural Sections

	Local Type A	Local Type B	Collector Street
Reliability, %	70	90	90
Standard Deviation, So	0.45	0.45	0.45
Initial Serviceability Index, po	4.2	4.2	4.2
Terminal Serviceability Index, pt	2.0	2.0	2.5
Design Life, years	20	20	20
18-kip ESALs	100,000	2,000,000	2,000,000
Minimum Structural Number	2.02	2.92	2.92
Maximum Structural Number	3.18	5.08	5.08

We performed CBR tests at three compaction levels (i.e., 90%, 95% and 100%) on the bulk samples. Based on laboratory test results, CBR values of about 2.0 and 3.2 percent were obtained for the existing untreated subgrade compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D 698. TTL recommends a CBR value of 2.0 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). In accordance with the COSA and Bexar County design guidelines, we used MR = 1,500 times the CBR to estimate the MR in psi. Pavement design methods are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support.

The COSA pavement guidelines require lime treatment of clay subgrades with a PI greater than 20. CBR and the boring samples obtained from this subdivision indicates a PI value over 20. Therefore, the subgrade at this site shall be treated with hydrated lime in accordance with TxDOT Item 260. Based on our experience we anticipate approximately 6 percent hydrated lime will be required (approximately 33 pounds per square yard to treat a 6-inch-thick layer of clay). However, the actual percentage should be determined by laboratory tests on samples of the subgrade materials prior to construction.

The index properties of the actual subgrade soils exposed after site grading should be checked to determine whether or not lime treatment is required because mass grading operations may alter the subgrade conditions compared to those used in our design analyses.

5.3.1 Final Pavement Sections

Following are the recommended pavement sections for Local Type A, Local Type B, and Collector.

Component	Local Type A without Bus Traffic	
	Pavement Material Thickness, inches	
Hot Mixed Asphaltic Concrete – Type D	3 inches	2 inches
Prime Coat	Yes	Yes
Granular Base Course (Type A, Grade 1 or 2)	12 inches	9 inches
Tensar TX Type-3 Geogrid	No	Yes
Lime Treated Subgrade[1]	6 inches	6 inches
Required Structural Number	2.88	2.88
Provided Structural Number[1]	3.00	3.06
Required 18-kip ESALs	100,000	100,000
Estimated Provided 18-kip ESALs	107,500	120,700

[1]Structural Number for Lime Treated Subgrade was not used in the Pavement Section Calculations.

Component	Local Type B		
	Pavement Material Thickness, inches		
Hot Mixed Asphaltic Concrete – Type D	2 inches	2 inches	3½ inches
Hot Mixed Asphaltic Concrete – Type C	2 inches	4 inches	4 inches[2]
Dense-Grade Hot-Mix Asphaltic Concrete Base Course (Type B, Item- 341)	4½ inches	None	None
Prime Coat	Yes	Yes	Yes
Granular Base Course (Type A, Grade 1 or 2)	11 inches	10 inches	12 inches
Tensar TX Type-3 Geogrid	No	Yes	No
Lime Treated Subgrade[1]	6 inches	6 inches	6 inches
Required Structural Number	4.97	4.97	4.97
Provided Structural Number[1]	5.01	4.98	4.98
Required 18-kip ESALs	2,000,000	2,000,000	2,000,000

Component	Local Type B		
	Pavement Material Thickness, inches		
Estimated Provided 18-kip ESALs	2,149,400	2,055,500	2,055,500

[1] Structural Number for Lime Treated Subgrade was not used in the Pavement Section Calculations.

Component	Collector		
	Pavement Material Thickness, inches		
Hot Mixed Asphaltic Concrete – Type D	2 inches	3 inches	4 inches
Hot Mixed Asphaltic Concrete – Type C	2 inches	4 inches	4 inches
Dense-Grade Hot-Mix Asphaltic Concrete Base Course (Type B, Item- 341)	5 inches	None	None
Prime Coat	Yes	Yes	Yes
Granular Base Course (Type A, Grade 1 or 2)	12 inches	10 inches	14 inches
Tensar TX Type-3 Geogrid	No	Yes	No
Lime Treated Subgrade[1]	6 inches	6 inches	6 inches
Required Structural Number	5.34	5.34	5.34
Provided Structural Number[1]	5.34	5.42	5.48
Required 18-kip ESALs	2,000,000	2,000,000	2,000,000
Estimated Provided 18-kip ESALs	2,018,200	2,247,400	2,434,800

[1] Structural Number for Lime Treated Subgrade was not used in the Pavement Section Calculations.

5.3.2 General Guidelines for Pavements

Pavement construction shall conform to the latest edition of Bexar County/ City of San Antonio Design and Construction guidelines.

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 evaluated by proof-rolling according to Section 4.1.2 and observed by TTL immediately prior to pavement construction. This is particularly important in and around utility trench cuts. Unstable areas should be reworked and compacted at that time.

Adequately designed pavements may still experience cracking and deformation from shrink/swell movements of the subgrade. 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;
- Provide drainage from areas anticipated for frequent wetting (e.g., landscape beds, discharge area, collection areas, etc.).
- Promptly place joint sealant to seal cracks;
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration into pavement subgrade soils; and
- Place compacted, clay backfill against the exterior side of curb and gutter.

Preventive maintenance should be planned and provided through an on-going pavement management program. These activities are intended to slow the rate of pavement deterioration. 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. Prior to implementing any maintenance, additional engineering observation is recommended to assess the need for the type and extent of preventive maintenance.

5.3.3 Drainage Adjacent to Pavements

The performance of the pavement system will depend, in part, on the stability of the moisture content of the soils and base underlying the pavement surface. The subgrade soils located near the edge of pavement structure are more susceptible to changes in moisture that occur due to natural seasonal moisture fluctuations. The edges can dry and shrink during drought conditions relative to the center of the pavement. During wet climate periods, the edges can swell relative to the center of the pavement. The shrinking and swelling of subgrade soils near the edge of pavements can result in longitudinal surface cracking parallel to the pavement. To help reduce the chances for moisture content variations of the subgrade soils, backfill behind the curbs should consist of compacted lean clay. The use of landscape mulch or topsoil could provide an easy avenue for surface water to infiltrate behind and beneath curbs and adversely impact curb and pavement performance. Consideration should also be given to locating sidewalks immediately adjacent to the curbs as an added measure to reduce moisture changes below the pavement.

Proper drainage along or adjacent to the pavement edge or curbs is ***very important***. The Project Civil Engineer should design final grades so there is rapid, positive drainage away from the pavement/curb edge. Also, asphaltic concrete pavement areas should be sloped to reduce the potential for ponding of water on the asphaltic concrete surface. The importance of proper runoff and drainage cannot be overemphasized and should be thoroughly considered by the Project Civil Engineer.

5.3.4 Pavement Section Materials

Pavement materials should conform to the latest edition of City of San Antonio/ Bexar County design and construction guidelines. 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 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 paving mixture and construction methods should conform to Item 340, "Hot Mix Asphaltic Concrete, Type C or D" of the Standard Specifications by TxDOT. The mix should be compacted between 91 and 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 asphalt cement grades should conform to the table shown below.

<table>
<tr><th colspan="4">Asphalt Cement Grades</th></tr>
<tr><th rowspan="2">Street Classifications</th><th colspan="3">Minimum PG Asphalt Cement Grade</th></tr>
<tr><th>Surface Courses</th><th>Binder and Level up courses</th><th>Base Courses</th></tr>
<tr><td>Arterials</td><td>PG 76-22</td><td rowspan="2">PG 70-22</td><td rowspan="4">PG 64-22</td></tr>
<tr><td rowspan="2">Collector and Local Type B Streets</td><td rowspan="2">PG 70-22</td></tr>
<tr><td rowspan="2">PG 64-22</td></tr>
<tr><td>Local Type A Street</td><td>PG 64-22</td></tr>
</table>

Aggregates known to be prone to stripping (i.e. loss of adhesion between the aggregate surface and the asphalt cement) should not be used in the hot mix. 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, should 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 may be used when approved by a registered 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.

Hot Mix Asphaltic Concrete Base – The paving mixture and construction methods shall conform to Item 340, "Hot Mix Asphaltic Concrete, Type B" of the standard specifications by TxDOT. The mix should be compacted between 95 and 98 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 77 to 87 percent of the VMA are filled with asphalt cement.

Prime Coat - The prime coat should consist of sealing the base with an oil such as MC-30 or AE-P asphalt cement. The prime coat should be applied at a rate not to exceed 0.35 gallon per square yard with materials that meet TxDOT Item 300. The prime coat is intended to improve the bond between the granular base and asphalt layers to reduce the potential for shear slipping along the interface. It may also reduce the penetration of rainfall and other moisture into the base.

Granular Base Material - Base material should be composed of crushed limestone base meeting the requirements of 2014 TxDOT Item 247, Type A, Grade 1 or 2; and should have no more than 15 percent of the material passing the No. 200 sieve. The base should be compacted to at least 95 percent of the maximum dry density determined in accordance with test method TEX-113-E at moisture contents ranging between 2 percent below and 3 percent above the optimum moisture content.

Lime Treatment - Lime treatment is required by COSA/Bexar County. only on the clay subgrade. The subgrade should be treated with hydrated lime in accordance with TxDOT Item 260. We estimate approximately 6 percent hydrated lime will be required (approximately 33 pounds per square yard to treat a 6-inch-thick layer of clay). However, the actual percentage should be determined by laboratory tests. The optimum hydrated lime content should result in a soil-lime mixture with a pH of at least 12.4 when tested in accordance with ASTM C 977, Appendix XI. The contractor should perform lime series tests of the specific subgrade conditions to evaluate the appropriate amount of lime required.

The hydrated lime should initially be blended with a mixing device such as a pulvermixer. After sufficient moisture conditioning, the treated soil mixture should be compacted to at least 95 percent of the maximum dry density as determined in accordance with the standard Proctor (ASTM D 698) method at moisture contents from optimum moisture content to 4 percentage points above the optimum moisture content.

5.4 Concrete Durability

According to the 2021 IBC, concrete exposed to sulfate-containing solutions should be selected for sulfate resistance in accordance with ACI 318, which defines four levels of exposure (S0 to S4) based on the concentration of sulfate in soil. Laboratory testing was conducted on soil samples recovered during the field exploration to assess the sulfate content within site soil. The results of the laboratory tests are presented in the following table.

Summary of Laboratory Test Results			
Boring No.	Sample Depth (ft.)	% Sulfate by Mass	ACI 318-19 Exposure Class
B-01	½ - 2	<0.02	S0

Summary of Laboratory Test Results			
Boring No.	Sample Depth (ft.)	% Sulfate by Mass	ACI 318-19 Exposure Class
B-08	2½ - 4	<0.02	S0

The sulfate test results indicate the tested samples have sulfate concentrations within limits for ACI 318 exposure level S0.

6.0 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 this geotechnical engineering report will be used by the Client and various designers and contractors involved with 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.

This geotechnical engineering report is based upon the information provided to us by the Client and other entities associated with the Project, results of the field exploration, laboratory testing, and engineering analyses and evaluations performed by TTL as described in this report. The Client and readers of this report should realize 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 and authorized to immediately evaluate such variations and, if necessary, 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, 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 <u>not</u> final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

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

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

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

Give Constructors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

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

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

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

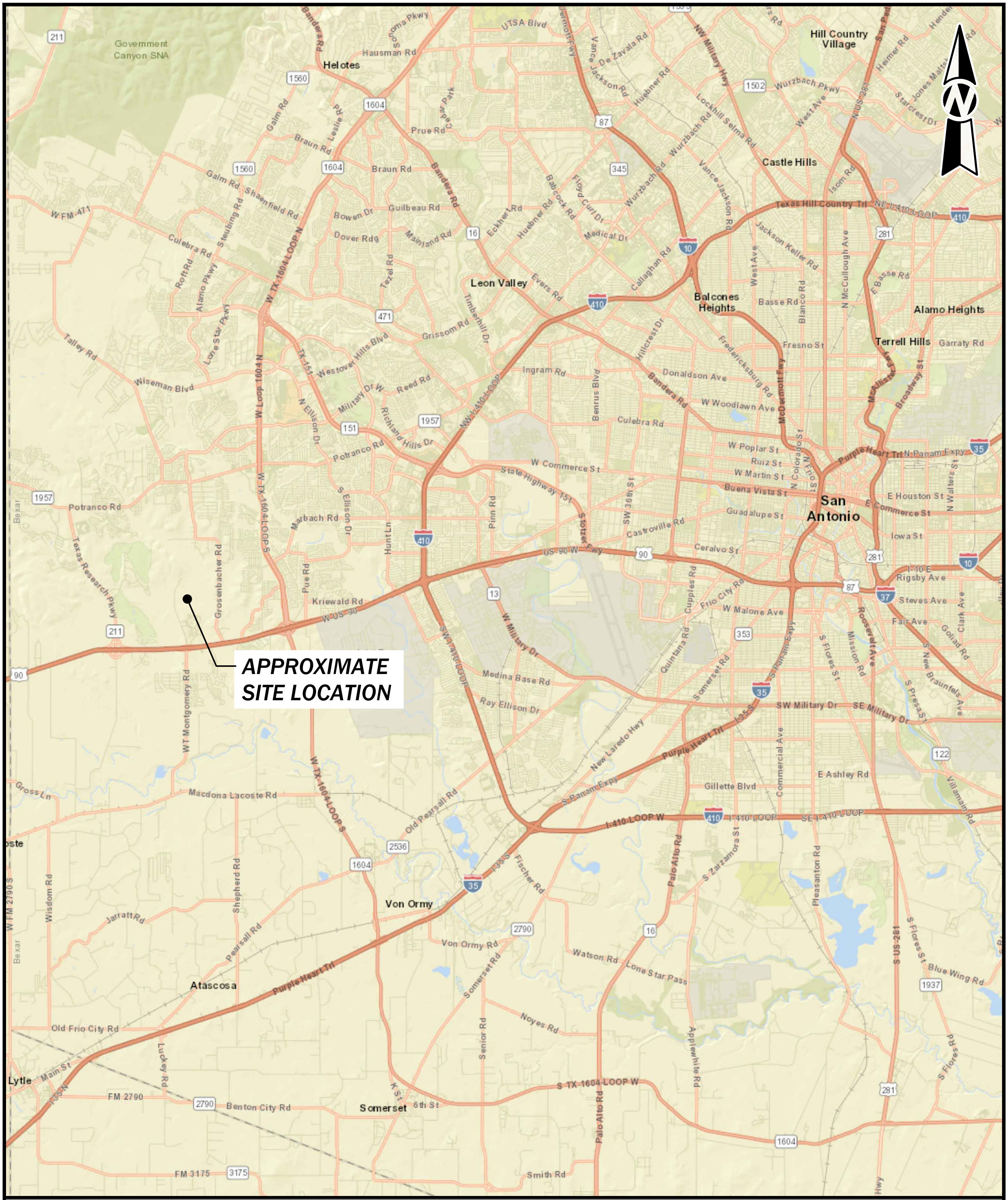
Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

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

GEOPROFESSIONAL
BUSINESS
ASSOCIATION

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

APPENDIX A
ILLUSTRATIONS



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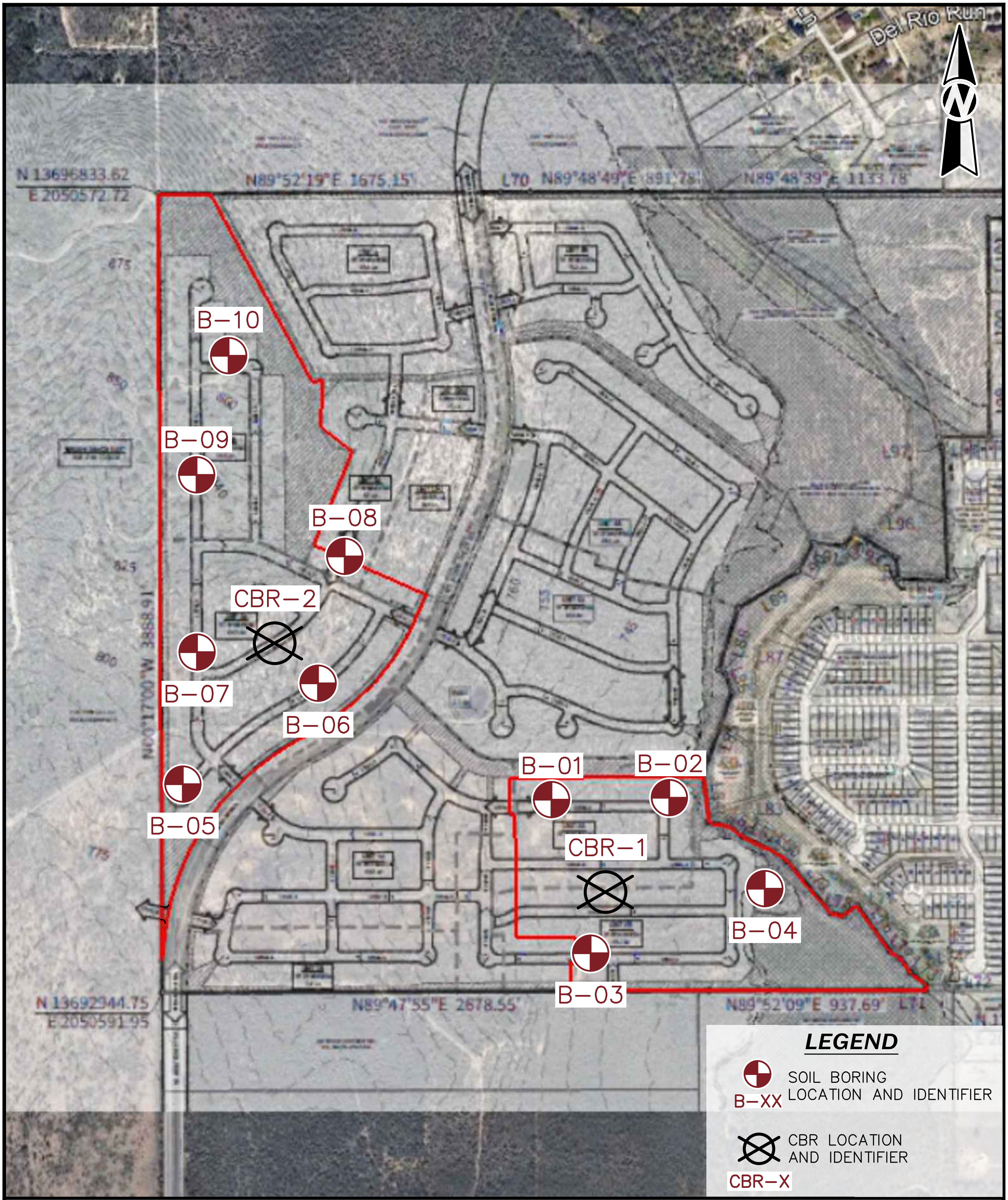
TBPELS Firm Registration No. F-12622 | TBPG Firm Registration No. 50456

TRES LAURELS UNITS 2 AND 3

GROSENBACHER ROAD
SAN ANTONIO ETJ, BEXAR COUNTY, TEXAS

Drawn By: RG
Checked By: DB
Date: 02/20/2024
Scale: NOT TO SCALE
Proj. No.: 000230902935.02
File Name:
Exhibits.dwg

SITE LOCATION MAP



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BORING AND CBR LOCATION PLAN

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

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UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

COARSE GRAINED SOILS (>50% of the material is larger than the #200 sieve)	GRAVELS (>50% of coarse fraction is larger than the #4 sieve)	CLEAN GRAVEL WITH <5% FINES	Cu > 4 Cc = 1-3	▨	GW	Well-graded gravels, gravel-sand mixtures with trace or no fines
			Cu ≤ 4 and/or Cc < 1 Cc > 3	▨	GP	Poorly-graded gravels, gravel-sand mixtures with trace or no fines
		GRAVEL WITH 5% TO 12% FINES	Cu > 4 Cc = 1-3	▨	GW-GM	Well-graded gravels, gravel-sand mixtures with silt fines
				▨	GW-GC	Well-graded gravels, gravel-sand mixtures with clay fines
			Cu ≤ 4 and/or Cc < 1 Cc > 3	▨	GP-GM	Poorly-graded gravels, gravel-sand mixtures with silt fines
				▨	GP-GC	Poorly-graded gravels, gravel-sand mixtures with clay fines
		GRAVEL WITH MORE THAN 12% FINES		▨	GM	Silty gravels, gravel-silt-sand mixtures
				▨	GC	Clayey gravels, gravel-sand-clay mixtures
				▨	GC-GM	Clayey gravels, gravel-sand-clay-silt mixtures
	SANDS (>50% of coarse fraction is smaller than the #4 sieve)	CLEAN SAND WITH <5% FINES	Cu > 6 Cc = 1-3	▨	SW	Well-graded sands, sand-gravel mixtures with trace or no fines
			Cu ≤ 6 and/or Cc < 1 Cc > 3	▨	SP	Poorly-graded sands, sand-gravel mixtures with trace or no fines
		SAND WITH 5% TO 12% FINES	Cu > 6 Cc = 1-3	▨	SW-SM	Well-graded sands, sand-gravel mixtures with silt fines
				▨	SW-SC	Well-graded sands, sand-gravel mixtures with clay fines
			Cu ≤ 6 and/or Cc < 1 Cc > 3	▨	SP-SM	Poorly-graded sands, sand-gravel mixtures with silt fines
				▨	SP-SC	Poorly-graded sands, sand-gravel mixtures with clay fines
		SAND WITH MORE THAN 12% FINES		▨	SM	Silty sands, sand-gravel-silt mixtures
				▨	SC	Clayey sands, sand-gravel-clay mixtures
				▨	SC-SM	Clayey sands, sand-gravel-clay-silt mixtures
FINE GRAINED SOILS (>50% of material is smaller than the #200 sieve)		SILTS & CLAYS (Liquid Limit less than 50)		▨	ML	Inorganic silts with low plasticity
				▨	CL	Inorganic clays of low plasticity, gravelly or sandy clays, silty clays, lean clays
				▨	CL-ML	Inorganic clay-silts of low plasticity, gravelly clays, sandy clays, silty clays, lean clays
				▨	OL	Organic silts and organic silty clays of low plasticity
		SILTS & CLAYS (Liquid Limit more than 50)		▨	MH	Inorganic silts of high plasticity, elastic silts
				▨	CH	Inorganic clays of high plasticity, fat clays
				▨	OH	Organic clays and organic silts of high plasticity

USCS - HIGHLY ORGANIC SOILS

Primarily organic matter, dark in color, organic odor

▨	PT	Peat, humus, swamp soils with high organic contents

OTHER MATERIALS

■	BITUMINOUS CONCRETE (ASPHALT)
▨	CONCRETE
▨	CRUSHED STONE/AGGREGATE BASE
▨	TOPSOIL
▨	FILL
▨	UNDIFFERENTIATED ALLUVIUM
▨	UNDIFFERENTIATED OVERBURDEN
▨	BOULDERS AND COBBLES

UNIFORMITY COEFFICIENT

$$C_u = D_{60}/D_{10}$$

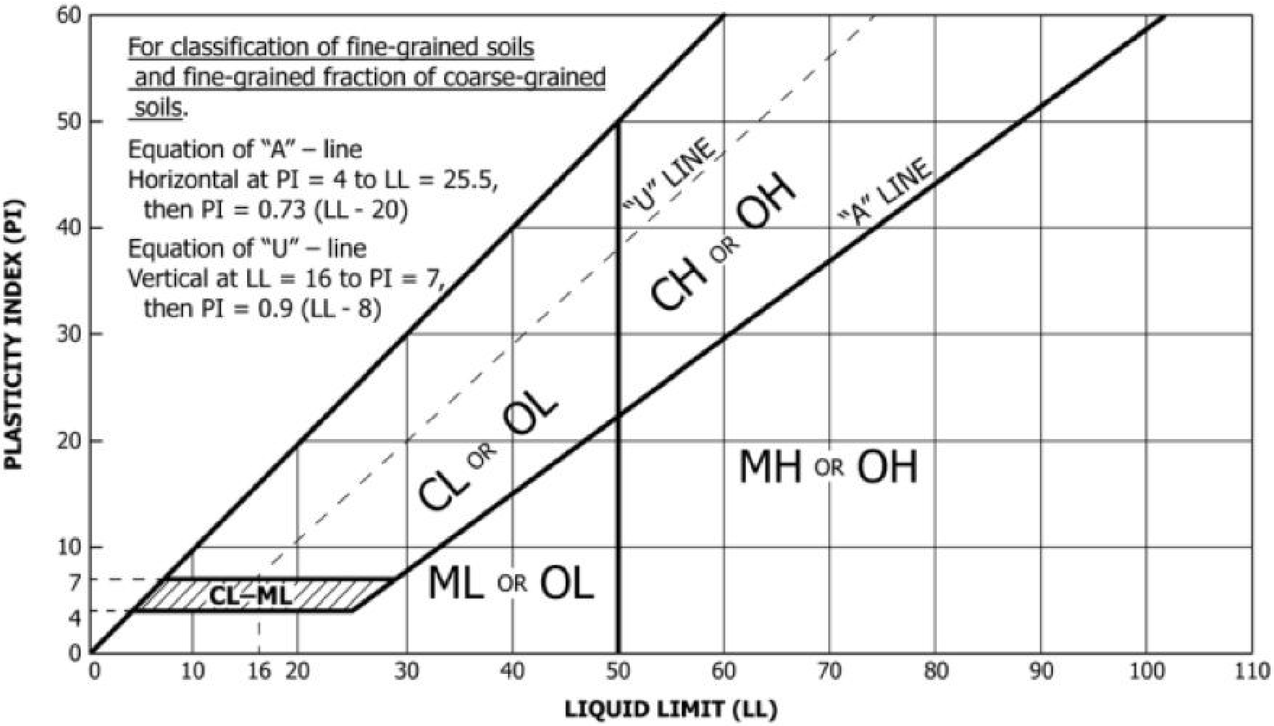
COEFFICIENT OF CURVATURE

$$C_C = (D_{30})^2/(D_{60}xD_{10})$$

Where:

D_{60} = grain diameter at 60% passing
D_{30} = grain diameter at 30% passing
D_{10} = grain diameter at 10% passing

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"

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Log of B-01

Page 1 of 1

Drilling Co.:	*TTL, Inc.*	**TTL** Project No.:	*000230902935.02*
Driller:	*T. Timmermann*	Date Drilled:	*12/18/2023*
Logged by:	*M. Green*	Boring Depth:	*10 feet*
Equipment:	*CME 550X*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.7374 Latitude: 29.3957*
Drilling Method:	*Solid 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 (pcf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	1		RESIDUMM: FAT CLAY; firm and stiff, dark brown, moist (CH)	☒	2 - 2 - 3 N = 5			18								
	3			☒	4 - 5 - 6 N = 11			18								92.7
	5		- calcareous between 4½ and 6 feet	☒	2 - 3 - 5 N = 8			21	73	31	42					
	7		FAT CLAY WITH SAND; very stiff, light brown, calcareous, with gypsum seams, moist (CH)	☒	8 - 12 - 17 N = 29			18								81.1
	9		CLAYEY GRAVEL WITH SAND; dense, light brown, calcareous, dry (GC)	☒	14 - 17 - 15 N = 32			5								42.4
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Log of
B-02

Page 1 of 1

Drilling Co.:	*TTL, Inc.*	**TTL** Project No.:	*000230902935.02*
Driller:	*T. Timmermann*	Date Drilled:	*12/18/2023*
Logged by:	*M. Green*	Boring Depth:	*10 feet*
Equipment:	*CME 550X*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.7356 Latitude: 29.3958*
Drilling Method:	*Solid 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	BORE/CORE DATA: P: TONS/SQFT	BORE/CORE DATA: % RQD / % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT LL	ATTERBERG LIMITS (%): PLASTIC LIMIT PL	ATTERBERG LIMITS (%): PLASTICITY INDEX PI	DRY DENSITY (pcf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
		▨	RESIDUMM: FAT CLAY; stiff to very stiff, dark brown, moist (CH)													
	1	▨		☒	4 - 4 - 7 N = 11			14								85.4
	2	▨	- calcareous between 2½ and 4 feet													
	3	▨		☒	8 - 11 - 15 N = 26			13	58	25	33					
	4	▨	LEAN CLAY WITH SAND; very stiff, light brown, calcareous, dry (CL)													
	5	▨		☒	9 - 11 - 12 N = 23			9								73.8
	6	▨														
	7	▨		☒	8 - 8 - 14 N = 22			8	36	21	15					
	8	▨														
	9	▨		☒	10 - 13 - 14 N = 27			7								76.3
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Log of B-03

Page 1 of 1

Drilling Co.:	*TTL, Inc.*	**TTL** Project No.:	*000230902935.02*
Driller:	*T. Timmermann*	Date Drilled:	*12/18/2023*
Logged by:	*M. Green*	Boring Depth:	*10 feet*
Equipment:	*CME 550X*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.7368 Latitude: 29.3938*

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

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

▽ 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 (pcf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0 – 2	▨	RESIDUMM: FAT CLAY; stiff, dark brown, calcareous, moist (CH)	⊠	5 - 6 - 8 N = 14			17								
	2 – 4	▨	CLAYEY GRAVEL; medium dense, dark brown, calcareous, dry (GC)	⊠	9 - 10 - 16 N = 26			4								
	4 – 6	▨	FAT CLAY; very stiff to hard, light brown, calcareous, with trace of gravel to 6 feet, moist (CH)	⊠	4 - 10 - 15 N = 25			17	69	27	42					88.6
	6 – 8	▨	- with gypsum seams between 6½ and 8 feet	⊠	11 - 18 - 27 N = 45			16								89.8
	8 – 10	▨		⊠	6 - 10 - 11 N = 21				57	17	40					
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Log of B-04
Page 1 of 1

Drilling Co.:	*TTL, Inc.*	**TTL** Project No.:	*000230902935.02*
Driller:	*T. Timmermann*	Date Drilled:	*12/18/2023*
Logged by:	*M. Green*	Boring Depth:	*10 feet*
Equipment:	*CME 550X*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.7341 Latitude: 29.3946*
Drilling Method:	*Solid 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 (pcf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0		RESIDUMM: FAT CLAY WITH SAND; stiff to very stiff, dark brown, moist (CH)													
	1			☒	4 - 5 - 8 N = 13			14	56	16	40					
	2		- calcareous between 2½ and 6 feet													
	3			☒	7 - 8 - 12 N = 20			13								84.8
	4		- WITH GRAVEL between 4½ and 6 feet													
	5			☒	4 - 8 - 13 N = 21			15								
	6		CLAYEY SAND WITH GRAVEL; dense, brown to light brown, calcareous, dry (SC)													
	7			☒	10 - 17 - 19 N = 36			9								33.0
	8															
	9			☒	17 - 22 - 19 N = 41			4								33.2
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Log of
B-05

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Drilling Co.:	*TTL, Inc.*	**TTL** Project No.:	*000230902935.02*
Driller:	*T. Timmermann*	Date Drilled:	*12/14/2023*
Logged by:	*S. Aleti*	Boring Depth:	*10 feet*
Equipment:	*CME 550X*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.743 Latitude: 29.3959*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	▽ Water Level at Time of Drilling: Cave-In at Time of Drilling:	*Not Encount.* *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 (pcf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
		▨	RESIDUMM: FAT CLAY; very stiff to stiff, dark brown to olive brown, calcareous, moist (CH)													
	1	▨		☒	7 - 8 - 9 N = 17			15	70	18	52					
	2	▨														
	3	▨		☒	10 - 9 - 11 N = 20			15								90.5
	4	▨	- with interbedded CHALK seams between 4½ and 6 feet													
	5	▨		☒	9 - 8 - 8 N = 16			11	65	17	48					
	6	▨	- becomes olive brown and brown below 6½ feet													
	7	▨		☒	8 - 9 - 10 N = 19			11								94.4
	8	▨														
	9	▨		☒	5 - 6 - 6 N = 12			21	78	26	52					
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Log of B-06
Page 1 of 1

Drilling Co.:	*TTL, Inc.*	**TTL** Project No.:	*000230902935.02*
Driller:	*T. Timmermann*	Date Drilled:	*12/14/2023*
Logged by:	*S. Aleti*	Boring Depth:	*10 feet*
Equipment:	*CME 550X*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.7411 Latitude: 29.3974*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	▽ 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*

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

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 (pcf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
		▨	RESIDUMM: FAT CLAY; stiff to very stiff, dark brown to olive brown, calcareous, moist (CH)													
	1	▨		☒	3 - 4 - 6 N = 10			26								
	2	▨	- with interbedded LIMESTONE seams between 2½ and 4 feet													
	3	▨		☒	8 - 7 - 9 N = 16			16	88	21	67					
	4	▨														
	5	▨		☒	5 - 8 - 10 N = 18			22								96.7
	6	▨														
	7	▨		☒	11 - 14 - 16 N = 30			23								96.2
	8	▨	- becomes olive brown and gray below 8½ feet													
	9	▨		☒	4 - 9 - 10 N = 19			24	97	22	75					
	10		Boring terminated at 10 feet.													
	11															
	12															
	13															
	14															

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Log of B-07

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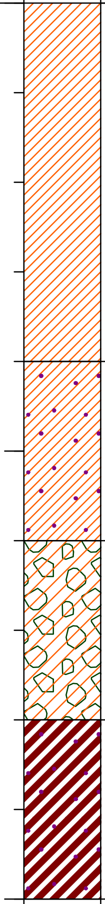
Drilling Co.:	*TTL, Inc.*	**TTL** Project No.:	*000230902935.02*
Driller:	*T. Timmermann*	Date Drilled:	*12/14/2023*
Logged by:	*S. Aleti*	Boring Depth:	*10 feet*
Equipment:	*CME 550X*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.7428 Latitude: 29.3976*
Drilling Method:	*Solid 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)	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA 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 (pcf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	1 2	RESIDUMM: LEAN CLAY WITH SAND; firm to stiff, dark brown, calcareous, moist (CL)	☒	2 - 3 - 4 N = 7			17								
	3		☒	6 - 7 - 8 N = 15			13								82.7
	4 5	SANDY LEAN CLAY WITH GRAVEL; very stiff, olive brown and brown, calcareous, dry (CL)	☒	7 - 7 - 10 N = 17			8								59.0
	6 7	CLAYEY GRAVEL WITH SAND; dense, light brown, calcareous, dry (GC)	☒	13 - 13 - 18 N = 31			6								33.3
	8 9	SANDY FAT CLAY; very stiff, olive brown, dry (CH)	☒	6 - 6 - 10 N = 16			9	71	17	54					
	10	Boring terminated at 10 feet.													
	11 12 13 14														

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Log of B-08

Page 1 of 1

Drilling Co.: *TTL, Inc.*

Driller: *T. Timmermann*

Logged by: *S. Aleti*

Equipment: *CME 550X*

Hammer Type: *Automatic*

Drilling Method: *Air Rotary w/SPT Sampling*

TTL Project No.: *000230902935.02*

Date Drilled: *12/14/2023*

Boring Depth: *10 feet*

Boring Elevation: *Ground Surface*

Coordinates: *Longitude: -98.7406 Latitude: 29.399*

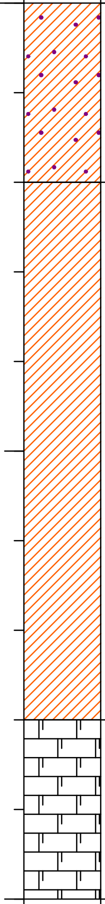
Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

▽ 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)	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA 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 (pcf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
		SANDY LEAN CLAY; hard, light brown, calcareous, moist (CL)	☒	5 - 10 - 21 N = 31			5								67.3
	2	LEAN CLAY WITH SAND; hard, light brown to yellowish-brown, calcareous, with interbedded CHALK seams, moist (CH)	☒	25 - 34 - 50/5 N = 84/11"			4	30	16	14					
			☒	50/5 N = 50/5"			4								
			☒	34 - 50/2 N = 50/2"			7								
	8	CHALK; soft rock, tan and light brown, weathered (ROCK)	☒	50/6 N = 50/6"			5								
	10	Boring terminated at 10 feet.													

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Log of B-09

Page 1 of 1

Drilling Co.: *TTL, Inc.*

Driller: *T. Timmermann*

Logged by: *S. Aleti*

Equipment: *CME 550X*

Hammer Type: *Automatic*

Drilling Method: *Solid Flight Augers (0'-6') and Air Rotary (6'-10'), w/SPT Sampling*

TTL Project No.: *000230902935.02*

Date Drilled: *12/14/2023*

Boring Depth: *10 feet*

Boring Elevation: *Ground Surface*

Coordinates: *Longitude: -98.7428 Latitude: 29.3999*

▽ 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*

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

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 (pcf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	1		RESIDUMM: CLAYEY SAND; medium dense, brown, calcareous, with trace of gravel, dry (SC)	☒	6 - 9 - 14 N = 23			8								49.0
	2 3		SILTY SAND; very dense, light brown, calcareous, cemented, with trace of gravel, dry (SM)	☒	50/4 N = 50/4"			5								
	4 5		CHALK; soft rock, tan, weathered (ROCK)	☐	50/0 N = 50/0"											
	6 7		LEAN CLAY WITH SAND; hard, olive brown, calcareous, cemented, dry (CL)	☒	40 - 50/4 N = 50/4"			7								
	8 9		CHALK; soft rock, tan and light brown, weathered (ROCK)	☐	50/0 N = 50/0"											
	10 11 12 13 14		Boring terminated at 10 feet.													

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.

Lennar
Tres Laurels Units 2 and 3
Grosenbacher Road
San Antonio ETJ, Bexar County, Texas

Log of B-10

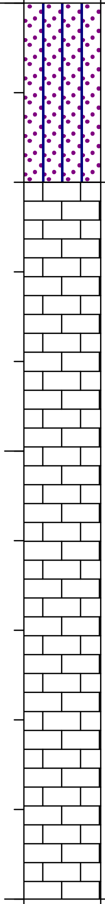
Page 1 of 1

Drilling Co.:	*TTL, Inc.*	**TTL** Project No.:	*000230902935.02*
Driller:	*T. Timmermann*	Date Drilled:	*12/14/2023*
Logged by:	*S. Aleti*	Boring Depth:	*10 feet*
Equipment:	*CME 550X*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.7423 Latitude: 29.4016*
Drilling Method:	*Air Rotary 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)	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 (pcf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
		RESIDUUM: SILTY SAND; very dense, light brown and brown, calcareous, dry (SM)													
	1			15 - 50/0 N = 50/0"			7								
	2	LIMESTONE; moderately hard to hard rock, olive brown, weathered (ROCK)													
	3			50/1 N = 50/1"											
	4														
	5			50/0 N = 50/0"											
	6														
	7			50/2 N = 50/2"											
	8	- with MARL (ROCK) seams below 8½ feet													
	9			50/0 N = 50/0"			7								
	10	Boring terminated at 10 feet.													
	11														
	12														
	13														
	14														

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Sheet 1 of 1

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	2.5 - 4	---	18	---	---	---	---	---	0.075	92.7	---
B-01	4.5 - 6	---	21	73	31	42	---	---	---	---	---
B-01	6.5 - 8	---	18	---	---	---	---	---	0.075	81.1	---
B-01	8.5 - 10	---	5	---	---	---	30.5	27.1	38.1	42.4	0.242
B-02	0.5 - 2	---	14	---	---	---	---	---	0.075	85.4	---
B-02	2.5 - 4	---	13	58	25	33	---	---	---	---	---
B-02	4.5 - 6	---	9	---	---	---	---	---	0.075	73.8	---
B-02	6.5 - 8	---	8	36	21	15	---	---	---	---	---
B-02	8.5 - 10	---	7	---	---	---	---	---	0.075	76.3	---
B-03	4.5 - 6	CH	17	69	27	42	---	---	0.075	88.6	---
B-03	6.5 - 8	---	16	---	---	---	---	---	0.075	89.8	---
B-03	8.5 - 10	---	---	57	17	40	---	---	---	---	---
B-04	0.5 - 2	---	14	56	16	40	---	---	---	---	---
B-04	2.5 - 4	---	13	---	---	---	---	---	0.075	84.8	---
B-04	6.5 - 8	---	9	---	---	---	28.1	38.9	38.1	33.0	0.458
B-04	8.5 - 10	---	4	---	---	---	25.9	40.9	38.1	33.2	0.411
B-05	0.5 - 2	---	15	70	18	52	---	---	---	---	---
B-05	2.5 - 4	---	15	---	---	---	---	---	0.075	90.5	---
B-05	4.5 - 6	---	11	65	17	48	---	---	---	---	---
B-05	6.5 - 8	---	11	---	---	---	---	---	0.075	94.4	---
B-05	8.5 - 10	---	21	78	26	52	---	---	---	---	---
B-06	2.5 - 4	---	16	88	21	67	---	---	---	---	---
B-06	4.5 - 6	---	22	---	---	---	---	---	0.075	96.7	---
B-06	6.5 - 8	---	23	---	---	---	---	---	0.075	96.2	---
B-06	8.5 - 10	---	24	97	22	75	---	---	---	---	---
B-07	2.5 - 4	---	13	---	---	---	---	---	0.075	82.7	---
B-07	4.5 - 6	---	8	---	---	---	15.5	25.5	38.1	59.0	---
B-07	6.5 - 8	---	6	---	---	---	48.2	18.5	38.1	33.3	3.192
B-07	8.5 - 10	---	9	71	17	54	---	---	---	---	---
B-08	0.5 - 2	---	5	---	---	---	---	---	0.075	67.3	---
B-08	2.5 - 3.9	---	4	30	16	14	---	---	---	---	---
B-09	0.5 - 2	---	8	---	---	---	12.3	38.7	38.1	49.0	0.083

Summary of Laboratory Test Results

Client: Lennar
Project: Tres Laurels Units 2 and 3
Location: San Antonio ETJ, Bexar County, Texas
Project Number: 000230902935.02

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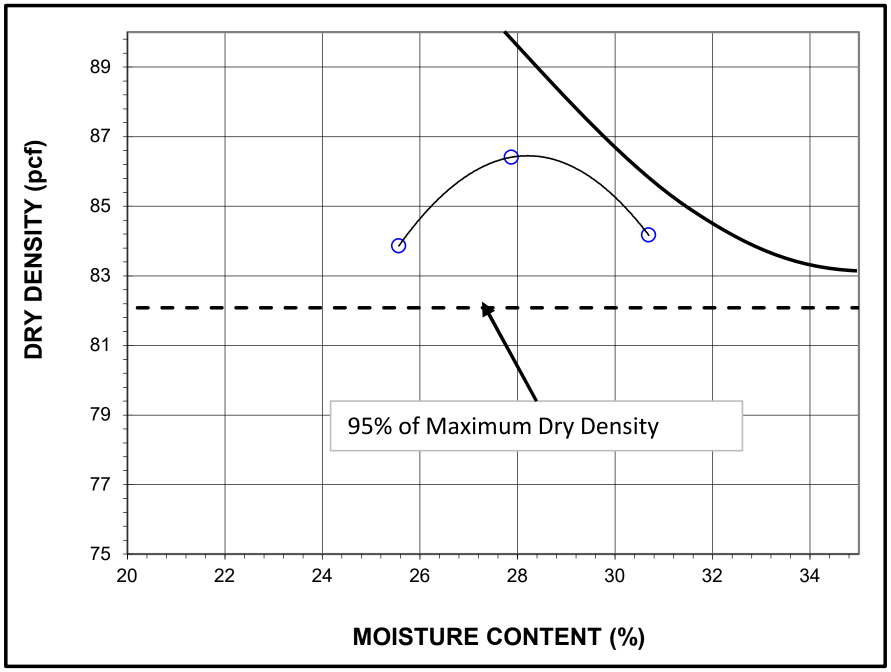

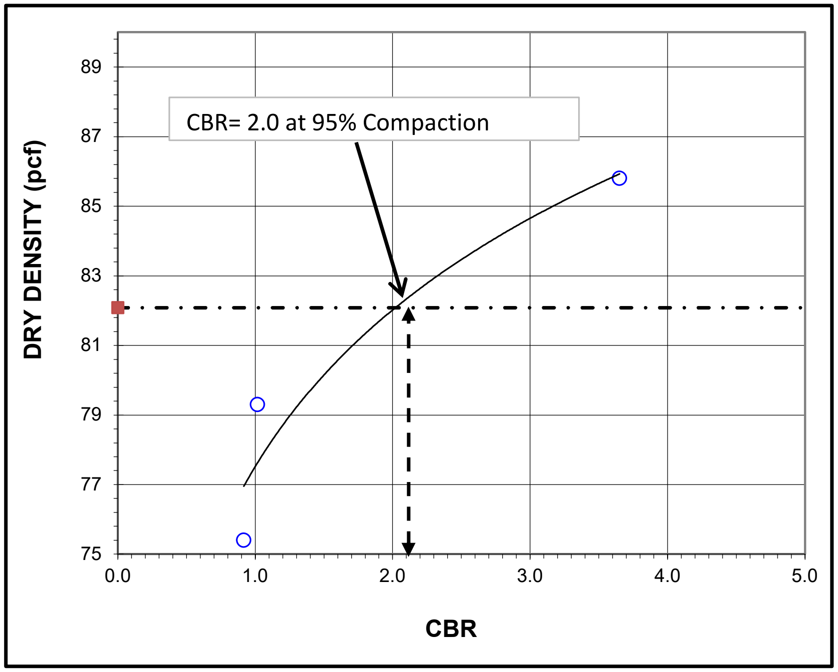

Sample Depth: Between 0 and 5 feet below existing ground surface

Sample: **CBR Sample No. 1**
Proctor Test Method: Standard Proctor (ASTM D-698)
CBR Test Method: California Bearing Ratio (ASTM D-1883)
Material: Fat Clay (CH)

Optimum Moisture Content: 28.2 %
Maximum Dry Unit Weight: 86.4 pcf
% Passing # 200 Sieve 91.9 %
Atterberg Limits: LL= 55 ; PL = 23 , PI = 32

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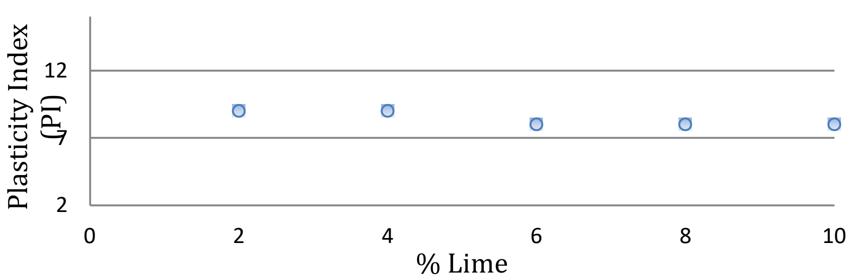
TRES LAURELS UNITS 2 AND 3
GROSENBACHER ROAD

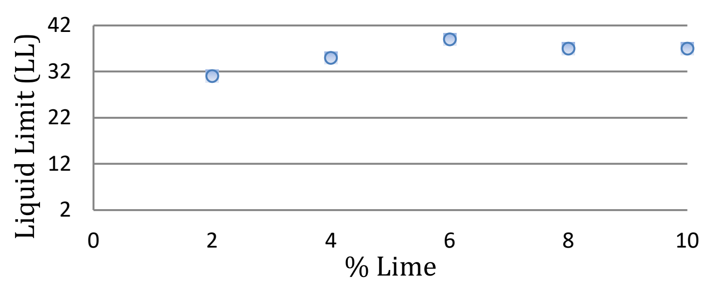
SAN ANTONIO ETJ, BEXAR COUNTY, TEAXS

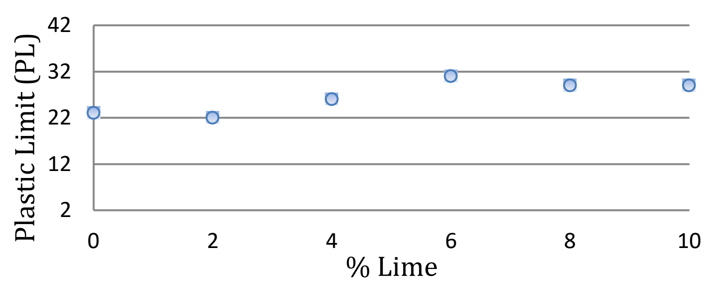
Drawn By: RG
Checked By: DB
Proj No:000230902935.02
File Name

CBR PLOT



% Lime	Plasticity Index (PI)	pH	Liquid Limit (LL)	Plastic Limit (PL)
0	32	7.41	55	23
2	9	12.37	31	22
4	9	12.41	35	26
6	8	12.43	39	31
8	8	12.43	37	29
10	8	12.43	37	29





Test Location:	**CBR Sample 1**
Material:	SANDY LEAN CLAY (CL); dark brown
Test Method:	TxDOT Item 260, Lime Treatment
Test Method:	ASTM C 977, Appendix XI; pH:Lime Saturation Content

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TRES LAURELS UNITS 2 AND 3
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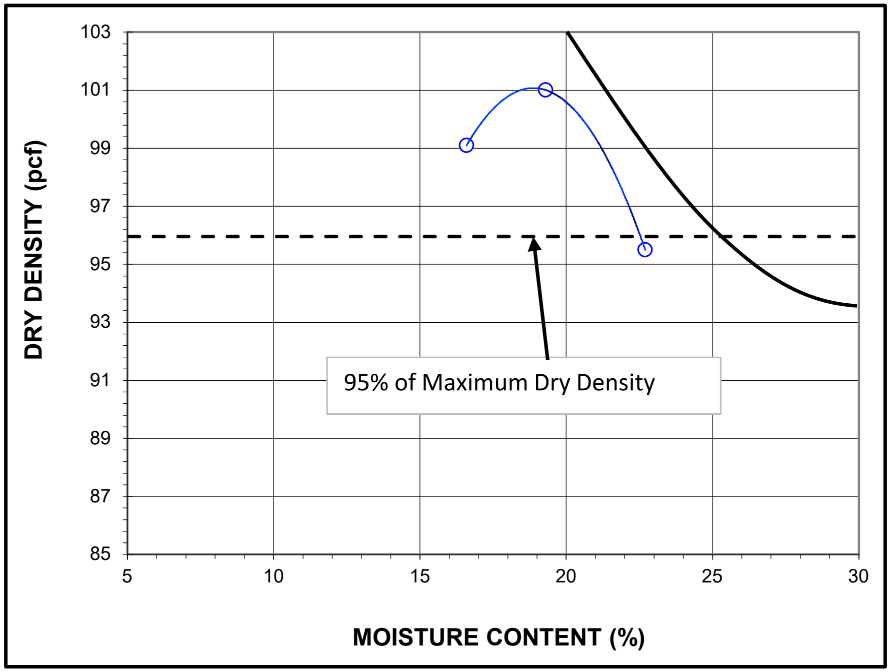
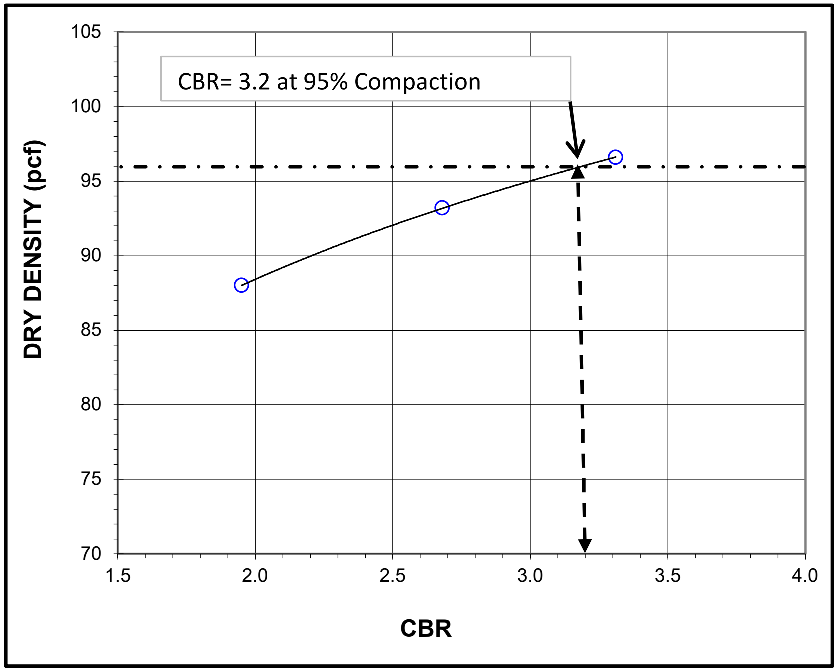
SAN ANTONIO ETJ, BEXAR COUNTY, TEAXS

Drawn By: RG
Checked By: DB
Proj No:000230902935.02
File Name

LIME SERIES



95% of Maximum Dry Density



CBR= 3.2 at 95% Compaction

Sample: **CBR Sample No. 2**
Proctor Test Method: Standard Proctor (ASTM D-698)
CBR Test Method: California Bearing Ratio (ASTM D-1883)
Material: SANDY LEAN CLAY (CL); dark brown

Sample Depth: Between 0 and 5 feet below existing ground surface

Optimum Moisture Content:	19.5 %
Maximum Dry Unit Weight:	101 pcf
% Passing # 200 Sieve	67.6 %

Atterberg Limits: LL = 35 , PL = 22 , PI = 13

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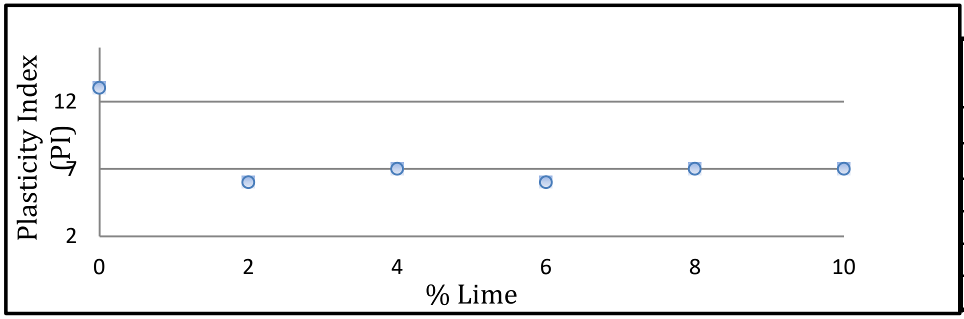
TRES LAURELS UNITS 2 AND 3
GROSENBACHER ROAD

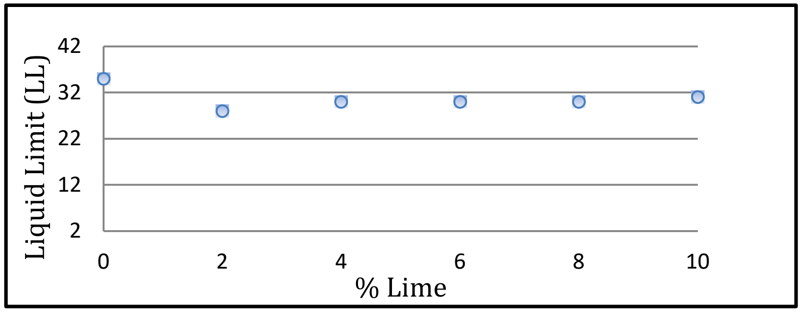
SAN ANTONIO ETJ, BEXAR COUNTY, TEAXS

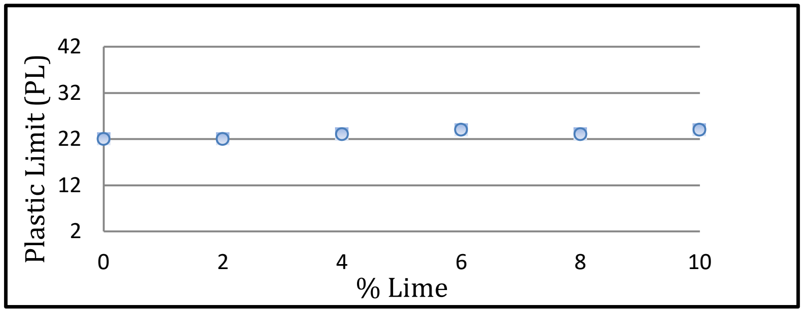
Drawn By: RG
Checked By: DB
Proj No:000230902935.02
File Name

CBR PLOT



% Lime	Plasticity Index (PI)	pH	Liquid Limit (LL)	Plastic Limit (PL)
0	13	8.15	35	22
2	6	11.63	28	22
4	7	12.28	30	23
6	6	12.36	30	24
8	7	12.40	30	23
10	7	12.44	31	24





Test Location:	**CBR Sample No. 2**
Material:	SANDY LEAN CLAY (CL); dark brown
Test Method:	TxDOT Item 260, Lime Treatment
Test Method:	ASTM C 977, Appendix XI; pH:Lime Saturation Content

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SAN ANTONIO ETJ, BEXAR COUNTY, TEAXS

Drawn By: RG
Checked By: DB
Proj No:000230902935.02
File Name

LIME SERIES

APPENDIX B
REFERENCE MATERIALS

EXPLORATION PROCEDURES

Field Locating of Exploratory Borings

Exploratory borings were located in the field by a TTL professional using a handheld GPS and should not be considered more accurate than implied by the methods used. Surveying the test locations for vertical and horizontal control was beyond the scope of this exploration.

Soil Borings

The borings were drilled using air rotary drilling methods by an all-terrain drill rig. Soil samples were obtained at selected depths in general accordance with the Standard Penetration Test (SPT) described in ASTM D1586. For this test, a split-barrel sampler is driven into the soil through three increments of 6 inches with blows from a 140-pound hammer falling 30 inches. The number of hammer blows required to advance the split-barrel sampler through each increment is recorded, and the sum of the final two blow counts is called the "N-value," with units of blows per foot (bpf). Where it was not possible to advance the sampler through a full 6-inch increment with 50 hammer blows, driving the sampler was terminated and the sampler penetration was measured. N-values for this condition are reported as "50/x," where x is the sampler penetration in inches. The N- values recorded during the sampling process provide an index to the strength and compressibility of the soil. These N-values and other data are shown at the depths of occurrence on boring logs in Appendix A.

Subsurface Water Measurements

Each borehole was checked for the presence of groundwater after removing the drill tools by lowering a measuring tape down the open borehole. The depth to subsurface water level and/or cave-in depth, if encountered, was recorded. Measurements are reported on the boring logs in Appendix A.

Backfilling Boreholes

After completion of drilling, each borehole was backfilled utilizing the drill cuttings. Auger cuttings sometimes consolidate after backfilling causing the top of the backfill column to settle and leaving an open hole at the ground surface. Return trips to the site to top-off backfill that may settle were not part of our scope of services.

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),
- Amount of Material Finer than N0.200 Sieve in Soils by Washing (ASTM D1140),
- Particle-Size Distribution of Soils using Sieve Analysis (ASTM D6913);
- Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (ASTM D698);
- Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils ASTM (D1883);
- Standard Test Method for Using pH to Estimate the Soil-Lime Proportion Requirement for Soil Stabilization (ASTM D6276); and
- Water Soluble Sulfate in Soil (ASTM C1580).

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