TERRADYNE
Engineers, Geologists & Environmental Scientists

Subsurface Exploration and Preliminary Foundation Recommendations
Stephens Towne Crossing
Sanger, Denton County, Texas

Terradyne Project No.: D211188

Ms. Liz Navarette
LGI Homes-Texas, LLC
5345 Towne Square Drive, Suite 145
Plano, Texas 75024

January 5, 2022

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Attn: **Ms. Liz Navarette**
Phone: 972-834-6109
Email: liz.navarette@lgihomes.com

Re: **Subsurface Exploration and Preliminary Foundation Recommendations**
Stephens Towne Crossing
Sanger, Denton County, Texas
Terradyne Project No.: D211188

Dear Ms. Navarette:

Terradyne Engineering, Inc. has completed a soil and foundation engineering report at the above referenced project site. The results of the exploration are presented in this report.

We appreciate and wish to thank you for the opportunity to service you on this project. Please do not hesitate to contact us if we can be of additional assistance during the Construction Materials Testing and Quality Control phases of construction.

Respectfully Submitted,

Terradyne Engineering, Inc.
Texas Firm Registration No. F-6799

Eva Pitman, P.E.
Senior Geotechnical Engineer

STATE OF TEXAS
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REGISTERED
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Chief Engineer

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EXECUTIVE SUMMARY

The soil conditions at the site of the proposed residential structures for Stephens Towne Crossing in Sanger, Denton County, Texas were explored by drilling 15 borings to a maximum depth of 15 feet below the existing ground surface elevation. Laboratory tests were performed on selected soil samples to evaluate the engineering characteristics of the soil strata encountered in our borings. This investigation is preliminary in nature and based on a very limited number of borings. The foundation design parameters presented in this report are for informational and comparative purposes only and should not be used for actual foundation design.

The results of our exploration, laboratory testing and engineering evaluation indicate the soils underlying this site have moderate to very high expansive characteristics. Following is a summary of our results:

1) The boring locations were selected by the geotechnical project manager and are shown on Figure 1-B. A potential vertical movement ranging between one and one-quarter (1¼) inches to five (5) inches was estimated at the existing grade level for average moisture conditions.
2) The Design Plasticity Index value ranges between 27 and 57.
3) Our borings generally encountered Fat Clay (CH), Fat Clay with Sand (CH), and Sandy Fat Clay (CH).
4) Groundwater was not encountered below the ground surface during or after completion of the drilling operations.

This report presents preliminary stiffened beam and slab foundation design parameters for the site prior to any cut and fill operations or soil modification procedures. Final design values after site work and grading has occurred can be expected to vary.

Detailed descriptions of subsurface conditions, engineering analysis and design recommendations are included in this report.

This summary does not contain all the information that is included in the full report. The report should be read in its entirety to obtain a more complete understanding of the information provided.

1.0 INTRODUCTION

This report presents the results of our preliminary subsurface exploration and foundation analysis for the proposed residential structures for Stephens Towne Crossing in Sanger, Denton County, Texas. This project was authorized by Ms. Liz Navarette, of LGI Homes-Texas, LLC.

2.0 PURPOSE AND SCOPE OF SERVICES

The purpose of our preliminary geotechnical investigation was to evaluate the subsurface materials and groundwater conditions of the site and provide geotechnical-engineering recommendations for the design and construction of proposed residential structures and pavement. Our scope of services includes the following:

1) Drilling and sampling of 15 borings to maximum depths of 15 feet below the existing ground depth for single family dwellings;
2) Observation of the groundwater conditions during drilling operations;
3) Performing laboratory tests such as Atterberg limits, passing #200 sieve tests, moisture content tests, and sulfate testing;
4) Review and evaluation of the field and laboratory test programs during their execution with modifications of these programs, when necessary, to adjust to subsurface conditions revealed by them;
5) Compilation, generalization and analysis of the field and laboratory data in relation to the project requirements;
6) Estimation of potential vertical movement;
7) Development of recommendations for the design, construction, and earthwork phases of project;
8) Consultations with the Prime Professional and members of the design team on findings and recommendations; and preparation of a written geotechnical engineering report for use by the members of the design team in their preparation of design, contract documents, and specifications.

The Scope of Services did not include any environmental assessment for the presence or absence of wetlands and/or hazardous or toxic materials in the soil, surface water, groundwater, or air, in the proximity of this site. Any statements in this report or on the bore hole logs regarding odors, colors or unusual or suspicious items or conditions are strictly for the information of the client.

2.1 Site Description

The subject property is located southeast of intersection of I-35 Frontage Road and Lois Road East. The site is currently undeveloped and is covered in grass and some trees. An aerial map of the site location is included in Figure 1-A.

3.0 GEOTECHNICAL INVESTIGATION

The field exploration to determine the engineering characteristics of the subsurface materials included a reconnaissance of the project site, drilling the borings, and recovering samples. 15 borings were advanced to a maximum depth of 15 feet at the project site.

The soil borings were performed with a drilling rig equipped with a rotary head. Conventional solid stem continuous augers were used to advance the hole and samples of the subsurface materials were sampled using split-barrel sampling (ASTM 1586). The samples were identified according to depth, encased in polyethylene plastic wrapping to protect against moisture loss, and transported to our laboratory in special containers.

3.1 Field Tests and Measurements

Penetration Tests: During the sampling procedures, standard penetration tests were performed in the borings in conjunction with split-barrel sampling (ASTM 1586). The standard penetration value (N) is defined as the number of blows of a 140-pound hammer, falling thirty inches, required to advance the split-spoon sampler one foot into the soil. The sampler is lowered to the bottom of the drill hole and the number of blows recorded for each of the two successive increments of six inches penetration. The "N" value is obtained by adding the second and third incremental numbers. The results of the standard penetration tests indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

Texas Cone Penetration Tests: During the sampling procedures TCP (Texas Cone Penetrometer) test were performed for each boring per Tex-132-E, TxDOT standardized test procedure. TCP value (N) is defined as the number of blows required to advance a three (3) inch diameter, 60º apex angle probe 24 inches into the soil with a 170-pound weight, with a force obtained from the kinetic energy of the weight falling twenty-four inches and striking the TCP drill steam connector rod. Once the desired depth is reached the sampler is lowered to the bottom of the borehole and hammered 12 times, or approximately six (6) inches, whichever comes first to properly seat probe into soil or rock. Two (2) reference marks are made on the drill steam at six (6) inch increments; the number of blows counts recorded for each of the two successive increments are added to compute the "N" value. The results of the Texas Cone Penetrometer indicate the relative density and comparative consistency of the soils, this provides a basis for estimating the relative strength and compressibility of the soil profile components.

Groundwater Information: Groundwater was not encountered below the ground surface during or after completion of the drilling operations. Groundwater levels fluctuate seasonally as a function of rainfall, proximity to creeks, rivers and lakes, the infiltration rate of the soil, seasonal and climatic variations and land usage. Therefore, at a time of the year different from the time of drilling, there is the possibility of a considerable change in the recorded levels or the occurrence of water where not

previously encountered. We recommend that the Contractor determine the actual groundwater levels at the site during construction activities.

3.2 Boring Logs

A field log was prepared for each boring. The logs include information concerning the samples attempted and recovered, indications of the presence of material (such as calcareous clays, sandy clay, etc.) and groundwater observations. It also includes an interpretation of the subsurface conditions between samples. Therefore, these logs include both factual and interpretive information.

The final logs represent our interpretation of the contents of the field logs for the purpose delineated by our client. The final logs are included on Figures 2 through 16 in the Illustration Section. A key to classification terms and symbols used on the logs is presented on Figure 17.

3.3 Laboratory Testing Program

In addition to field exploration, a supplemental laboratory-testing program was conducted to determine additional pertinent engineering characteristics of the subsurface materials necessary in evaluating the design parameters of the soil. All phases of the laboratory testing program were conducted in general accordance with the indicated applicable ASTM Specifications as presented in Table No. 1.

Table No. 1 - Lab Testing Summary

Laboratory Test	Applicable Test Standard
Liquid Limit, Plastic Limit, & Plasticity Index of Soil	ASTM D-4318
Moisture Content	ASTM D-2216
Passing #200 Sieve	ASTM D-1140

In the laboratory, each sample was examined and classified by a geotechnical engineer. As a part of this classification procedure, the natural water content of the soil samples was determined. Atterberg limit tests were performed on representative soil samples to determine the plasticity characteristics of the soil strata encountered. The results of these tests are presented on the appropriate boring logs and in the Illustrations.

3.4 General Subsurface Conditions

As shown on the Sherman sheet of the geological atlas of Texas, the site is located at the boundary of Denton Clay (Kd) and Pawpaw Formation, Weno Limestone, and Denton Clay undivided (Kpd). Denton Clay (Kd), mostly clay, calcareous, shaly; basal 5 feet marly, upper 3 to 5 feet

composed of impure limestone with abundant Gryphaea; some sandstone in Oklahoma. Thickness in Texas is approximately 45 feet. Pawpaw Formation, Weno Limestone, and Denton Clay undivided (Kpd), undifferentiated from northern Denton County southward.

The soils underlying this site may be grouped into generalized strata. The soil stratigraphy information and the engineering properties of the underlying soils, based on our professional engineering experience is presented on the Boring Logs, Figures 2 through 16.

Groundwater was not encountered below the ground surface during or after completion of the drilling operations. In addition, the soil samples were considered dry to moist. Based upon this information and past projects in the surrounding areas of the site, groundwater is not anticipated to be major concern during construction activities. However, groundwater condition can fluctuate due to seasonal and climatic variations and may be encountered at shallow depths during high precipitation seasons.

4.0 FOUNDATION DESIGN CONSIDERATIONS

Lot Drainage: How a lot is graded affects the accumulation of surface water around the slab. Most builders are aware of the importance of grading the soil away from structures so that rainwater does not collect and pond adjacent to the foundation. If allowed to accumulate next to the foundation, water may infiltrate the expansive soils underlying the foundation, which could cause the foundation to settle. Similarly, runoff from surface water drainage patterns and swales must not collect adjacent to foundation.

Topography: As it swells, soil heaves perpendicularly to the ground surface or slope, but as it shrinks, it recedes in the direction of gravity and gradually moves downslope in a sawtooth fashion over a number of shrink-swell cycles. In addition to this shrink-swell influence, soil will exhibit viscoelastic properties and creep downhill under the steady influence of the weight of the soil. Therefore, to avoid a structure constructed on a slope from moving downhill with the soil, it must be designed to compensate for this lateral soil influence.

Pre-Construction Vegetation: A large amount of vegetation, especially large trees, on a site prior to construction may have desiccation at the site. Constructing over a desiccated soil can produce some dramatic instances of heave and associated structural distress and damage as it becomes wet.

Post-Construction Vegetation: The type, amount, and location of vegetation that has grown since construction can cause localized desiccation. Planting trees or large shrubs near a building can result in the loss of foundation support as the vegetation robs moisture from the foundation soil. conversely, the opposite effect can occur if flowerbeds or shrubs are planted next to foundations and these beds are kept well-watered or flooded. This practice can result in swelling of the soil around the perimeter where the soil remains wet.

Summation: It is beyond the scope of this investigation to do more than point out the factors that may influence the amount and type of swell a slab-on-grade foundation may be subjected to during its lifetime. The design engineer must be aware of these factors in developing his design, using his engineering experience and judgment as a guide.

5.0 DESIGN ENGINEERING ANALYSIS

Foundation Design Considerations: Review of the borings and test data indicates that the following factors will affect the foundation designs and construction at this site:

1) The site at shallow depths is underlain by subsurface soils of moderate to very high expansiveness in character. Structures supported at shallow depths will be subjected to potential vertical movement ranging between one and one-quarter (1¼) inches to five (5) inches.
2) The strengths of the underlying soils are adequate to support the proposed structures.
3) Groundwater was not encountered below the ground surface during or after completion of the drilling operations.

Vertical Movements: The potential vertical movement (PVR) for slab-on grade construction at this site has been estimated using the general guidelines presented in a) the Texas Department of Transportation Test Method TXDOT-124-E and b) based on our experience with the swelling characteristics of the clays that are similar to those at the project site. The Texas Department of Transportation method utilizes the liquid limits and plasticity indices for soils in the seasonally active zone, estimated to be about 12 to 15 feet in the project area.

The estimated PVR value provided is based on the proposed floor system applying a sustained surcharge load of approximately one pound per square inch on the subgrade materials. Potential vertical movement ranging between one and one-quarter (1¼) inches to five (5) inches was estimated for average soil moisture conditions at the finish grade elevation. The PVR value is based on the current site grades. Higher PVR values than the above-mentioned value will occur in areas where water is allowed to pond for extended periods.

If the existing grade of the structures has to be raised to attain finish grade elevation, select structural fill should be used, placed in lifts and compacted as recommended under the section titled Select Structural Fill provided in this report.

6.0 FOUNDATION RECOMMENDATIONS

This investigation is a preliminary investigation and is based on a very limited number of borings. The design values provided in the report are for comparative purposes only and should not be used for actual design.

6.1 Stiffened Grid Type Beam and Slab Foundations

A stiffened grid type beam and slab foundation, either conventionally reinforced or post-tensioned, may be considered to support the proposed buildings provided the anticipated vertical movement will not impair the performance of the structures.

It is desirable to design the foundation systems using an assumption that the beams carry the loads. An allowable bearing pressure of 1,200 pounds per square foot should be used for beams founded at a minimum depth of 18 inches below the existing proof-rolled soils. Borings B-1, B-2, B-5, B-6 and B-9 **must** be properly recompacted and proofrolled to achieve the allowable bearing pressure. An allowable bearing pressure of 1,700 pounds per square foot should be used for beams bearing on a minimum of 12 inches of compacted non-expansive fill. Beams should be at least 18 inches deep and 10 inches wide to prevent local shear failure of the bearing soils. Design plasticity index values were evaluated at the boring locations and range between 27 and 57.

6.2 Post-Tensioned Beam and Slab Foundation

A post-tensioned slab-on-grade foundation may also be considered to support the structures provided the anticipated movement will not impair the performance of the structures. Differential vertical movements should be expected for shallow type foundations at this site due to the expansive soil conditions that were encountered. Refer to the Stiffened Grid Type Beam and Slab Foundation section for allowable bearing capacities.

Table No. 2 – PVR values

Boring #	PVR Value (inch)
B-1	3
B-2	1½
B-3	3
B-4	2¼
B-5	3
B-6	3½
B-7	3¾
B-8	2½

B-9	4
B-10	3¼
B-11	5
B-12	3½
B-13	1¼
B-14	1½
B-15	3

6.3 Utilities

Utilities, that project through slab-on-grade floors, should be designed with either some degree of flexibility or with sleeves in order to prevent damage to these lines should vertical movement occur.

6.4 Contraction, Control or Expansion Joints

Contraction, control and/or expansion joints should be designed and placed in various portions of the structure. Properly planned placement of these joints will assist in controlling the degree and location of material cracking that normally occurs due to soil movements, material shrinkage, thermal affects, and other related structural conditions.

6.5 Lateral Earth Pressure

Some retaining walls may be needed at the site. The equivalent fluid density values were evaluated for various backfill materials. These values are presented in Table No. 3.

Table No. 3 - Lateral Pressure Parameters

Backfill Material	Equivalent Fluid Density PCF		
	Active Condition	At Rest Condition	Passive Condition
a. Crushed Limestone	40	60	530
b. Clean Sand	40	60	360
c. Select Fill (PI ≤ 15)	65	85	265

These equivalent fluid densities do not include the effect of seepage pressures, surcharge loads such as construction equipment, vehicular loads or future storage near the walls.

If the basement wall or cantilever retaining wall can tilt forward to generate "active earth pressure" condition, the values under active condition should be used. For rigid non-yielding walls which are part of the buildings, the values "at rest condition" should be used. The compactive effort should be controlled during backfill operations. Over compaction can produce lateral earth pressures in excess of at rest magnitudes. Compaction levels adjacent to below-grade walls should be maintained between 95 and 98 percent of standard Proctor (ASTM D698) maximum dry density.

The backfill behind the wall should be drained properly. The simplest drainage system consists of a drain located near the bottom of the wall. The drain collects the water that enters the backfill and this may be disposed of through outlets along the base of the wall. To insure that the drains are not clogged by fine particles, they should be surrounded by a granular filter. In spite of a well-constructed toe drain, substantial water pressure may develop behind the wall if the backfill consists of clays or silts. A more satisfactory drainage system, consisting of a back drain of 12 inches to 24 inches width gravel may be provided behind the wall to facilitate to drainage.

The maximum toe pressure for wall footings founded a minimum depth of 18 inches into the existing soils should not exceed 900 pounds per square foot. An adhesion value of 300 pounds per square foot should be used to check against sliding for wall footings bearing on existing soils.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 Construction Monitoring

As Geotechnical Engineer of Record for this project, Terradyne, shall be involved in monitoring the foundation installation and earthwork activities. The performance of any foundation system is not only dependent on the foundation design but is strongly influenced by the quality of construction. Prior to construction, please contact our office so that a Foundation and Earthwork Monitoring Plan can be incorporated into the Project Quality Control Program.

7.2 Site Drainage

We recommend that an effective site drainage plan be devised by others prior to commencement of construction to provide positive drainage away from the foundation perimeters and off the site, both during and after construction. Groundwater was not encountered below the ground surface during or after completion of the drilling operations. Minor groundwater seepage may be encountered within the proposed building foundation and grading excavations at the time of construction, especially after periods of heavy precipitation. Small quantities of seepage may be removed by conventional sump and pump methods of dewatering.

7.3 Site Preparation

In any areas where soil-supported floor slabs are to be constructed, vegetation and all loose or organic material should be stripped and removed from the site. Subsequent to stripping operations, the subgrade should be proof-rolled to identify soft zones. Any soft zone detected should be removed to

expose firm soil or rock and replaced with compacted suitable soils to reach subgrade level. Upon the acceptance of proof-rolling operations the subgrade shall be scarified to a minimum depth of eight (8) inches, moisture conditioned and compacted to a minimum 95 percent of maximum dry density as determined by ASTM D 698, between optimum and four (4) percentage points above of optimum moisture content. The exposed subgrade shall not be allowed to dry out prior to placing structural fill. Any fill placed above the subgrade will need to be compacted in lifts approximately six (6) inches thick. The fill should be compacted to at least 95 percent of the maximum dry density as determined by TxDOT-113-E, within ± 2 percentage points of optimum moisture content.

7.4 Non-expansive Fill

Non-expansive fill material used at this site should be clayey sand (SC), lean clay with gravel (CL) or clayey gravel (GC) with maximum liquid limit of 35 percent and plasticity index (PI) between 5 and 15. The fill should be compacted to at least 95 percent of the maximum dry density as determined by TxDOT-113-E, within ± 2 percentage points of optimum moisture content.

7.5 Groundwater

In any areas where significant cuts (one foot or more) are made to establish final grades for building pads, attention should be given to possible seasonal water seepage that could occur through natural cracks and fissures in the newly exposed stratigraphy. Subsurface drains may be required to intercept seasonal groundwater seepage. The need for these, or other dewatering devices, on building pads should be carefully addressed during construction. Our office could be contacted to visually inspect final pads to evaluate the need for such drains.

Groundwater seepage may occur several years after construction if the rainfall rate or drainage changes in the vicinity of the project site. If seepage runoff occurs towards the residence, an engineer should be notified to evaluate its' effect and determine whether French Drains are required at the location.

7.6 Temporary Drainage Measures

Temporary drainage provisions shall be established to minimize water runoff into construction areas. If standing water does accumulate, it shall be removed by pumping as soon as possible. Adequate protection against sloughing of soils shall be provided for workers and inspectors entering the excavations. This protection shall meet OSHA and other applicable building codes.

7.7 Temporary Construction Slopes

Temporary slopes on the order of 1H to 1V may be provided for excavations through clays. Fill slopes on the order of 1H to 1V may be used provided a) the fill materials are compacted, as recommended, and b) the slopes are temporary. Fill slopes shall be compacted. Compacting operations shall be continued until the slopes are stable but not too dense for planting on the slopes. Compaction of the slopes may be done in increments of 4 to 6-feet in fill height or for shallow fills, until fill reaches its' total height.

7.8 Earthwork and Foundation Acceptance

Exposure to environment may weaken the soils at the foundation bearing level if the excavation remains open for long periods of time. Therefore, it is recommended that all foundation excavations are extended to final grade and the footings constructed as soon as possible to minimize potential damage to bearing soils or rock. The foundation bearing level should be free of loose soil; ponded water or debris and should be inspected and approved by the geotechnical engineer or his representative prior to concreting.

Foundation concrete should not be placed on soils that have been disturbed by rainfall or seepage. If the bearing soils are softened by surface water intrusion during exposure or by desiccation, the unsuitable soils must be removed from the foundation excavation and replaced prior to placement of concrete.

Subgrade preparation and fill placement operations should be monitored by the soils engineer or his representative. As a guideline, at least one in-place density test should be performed for each 2,500 square feet of compacted surface per lift. Any areas not meeting the required compaction should be re-compacted and retested until compliance is met.

8.0 DRAINAGE AND MAINTENANCE

Final drainage is very important for the performance of the structure. Landscaping, plumbing, and downspout drainage is also very important. It is vital that all roof drainage be transported away from the building so that no water ponds around the building which can result in soil volume change under the building. Plumbing leaks should be repaired as soon as possible in order to minimize the magnitude of moisture change under the slab. Large trees and shrubs should not be planted in the immediate vicinity of the structures, since root systems can cause a substantial reduction in soil volume in the vicinity of the trees during dry periods.

Adequate drainage should be provided to reduce seasonal variations in moisture content of foundation soils. All pavement and sidewalks within 10-feet of the structure should be sloped away from the structure to prevent ponding of water around the foundation. Final grades within 10-feet of the structure should be adjusted to slope away from structures preferably at a minimum slope of three (3) percent. Maintaining positive surface drainage throughout the life of the structure is essential.

In areas with pavement or sidewalks adjacent to the new structure, a positive seal must be provided and maintained between the structure and the pavement or sidewalk to minimize seepage of water into the underlain supporting soils. Post-construction movement of pavement and flat work is not uncommon. Maximum grades practical should be used for paving and flatwork to prevent areas where water can pond. In addition, allowances in final grades should take into consideration post construction movement of flatwork particularly if such movement would be critical. Normal

maintenance should include inspection of all joints in paving and sidewalks, etc. as well as re-sealing where necessary.

There are several factors, which relate to civil and architectural design and/or maintenance that can significantly affect future movements of the foundation and floor slab systems:

1. Where positive surface drainage cannot be achieved by sloping the ground surface adjacent to the building, a complete system of gutters and downspouts should carry runoff water a minimum of 10-feet from the completed structure.
2. Planters located adjacent to the structure should preferably be self contained. Sprinkler mains should be located a minimum of 5-feet from the building line.
3. Planter box structures placed adjacent to buildings should be provided with a means to assure concentrations of water are not available to the subsoil stratigraphy.
4. Large trees and shrubs should not be allowed closer to the foundation than a horizontal distance equal to roughly their mature height due to their significant moisture demand upon maturing.
5. Moisture conditions should be maintained "constant" around the edge of the slabs. Ponding of water in planters, in unpaved areas, and around joints in paving and sidewalks can cause slab movements beyond those predicted in this report.
6. Roof drains should discharge on pavement or be extended away from the structures. Ideally, roof drains should discharge to storm sewers by closed pipe.

Trench backfill for utilities should be properly places and compacted as outlined in this report and in accordance with requirements of local City Standards. Since granular bedding backfill is used for most utility lines, the backfilled trench should be prevented from becoming a conduit and allowing an access for surface or subsurface water to travel toward the new structure. Concrete cut-off collars or clay plugs should be provided where utility lines cross building lines to prevent water traveling in the trench backfill and entering beneath the structure.

The PVR values estimated and stated under "Vertical Movements" are based on the provision that positive drainage shall be maintained to divert water away from the building. If this drainage is not maintained, the wetted front may occur below the assumed fifteen feet depth, and the resulting PVR may be 2 to 3 times greater than the stated values shown in this report. Utility leaks may also cause similar high movements to occur.

9.0 SHORING

Shoring of excavations and design of shoring systems are governed by federal, state, and local regulations. The design of shoring systems on this project is beyond the scope of our services. The owner or the contractor should retain a shoring design professional to design shoring systems for excavations on this site.

10.0 LIMITATIONS

The analysis and recommendations submitted in this report are based upon the data obtained from the 15 borings drilled at the site. This report is preliminary, and the values presented are for planning purposes only and should not be used for design. This report may not reflect the exact variations of the soil conditions across the site. The nature and extent of variations across the site may not become evident until construction commences. If variations appear evident, it will be necessary to re-evaluate our recommendations after performing on-site observations and tests to establish the engineering significance of any variations. The project geotechnical engineer should review the final plan for the proposed building so that he may determine if changes in the foundation recommendations are required. The project geotechnical engineer declares that the findings, recommendations or professional advice contained herein have been made and this report prepared in accordance with generally accepted professional engineering practice in the fields of geotechnical engineering and engineering geology. No other warranties are implied or expressed.

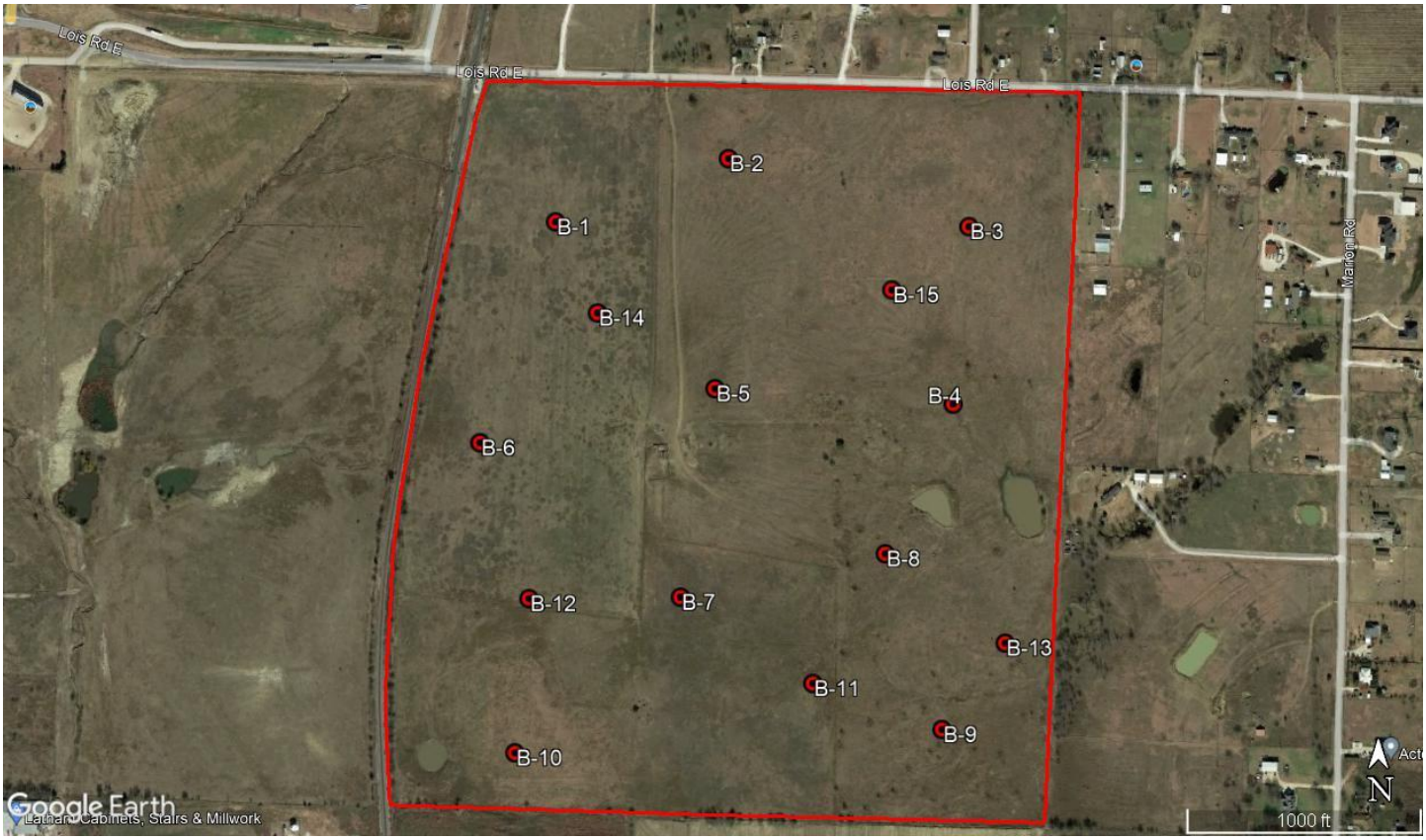
This report is valid until site conditions change due to disturbance (cut and fill grading) or changes to nearby drainage conditions or for 3 years from the date of this report, whichever occurs first. Beyond this expiration date, Terradyne shall not accept any liability associated with the engineering recommendations in the report, particularly if the site conditions have changed. If this report is desired for use for design purposes beyond this expiration date, we highly recommend drilling additional borings so that we can verify the subsurface conditions and validate the recommendations in this report.

This report has been prepared for the exclusive use of LGI Homes-Texas, LLC for the specific application of the proposed residential structures for Stephens Towne Crossing in Sanger, Denton County, Texas.

APPENDIX

*Terradyne drill rigs are equipped with a GPS tracking system which provides us with latitude and longitudinal co-ordinates of sites.

Site Location Proposed Development at Stephens Towne Crossing Sanger, Denton County, Texas	TERRADYNE Engineers, Geologists & Environmental Scientists	TERRADYNE EULESS, TEXAS	
	Prepared By: VM	Scale: See Scale Bar	Project # D211188
	Verified By: Google Earth	Date: January 2022	Figure # 1-A



*Boring locations are approximate.

Boring Location Plan Proposed Development at Stephens Towne Crossing Sanger, Denton County, Texas	TERRADYNE Engineers, Geologists & Environmental Scientists	TERRADYNE EULESS, TEXAS	
	Prepared By: VM	Scale: See Scale Bar	Project # D211188
	Base Plan By: Google Earth	Date: January 2022	Figure # 1-B

Project: **Proposed Development at Stephens Towne Crossing** Project Location: **Sanger, Denton County, Texas** Terradyne Project Number: **D211188**	Log of Boring B-1 **Sheet 1 of 1**

Date(s) Drilled **December 22, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **14 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT, TCP**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0		4			FAT CLAY, medium stiff to very stiff, dry to moist, dark grey, (CH)	27							
		18				20		94	64	22	42		
5		16				17							
		29				19							
10		T=0.25"			LIMESTONE, very hard								
					Auger Refusal at 14 feet BGS								
15													
20													

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Figure 2

Project: **Proposed Development at Stephens Towne Crossing**

Project Location: **Sanger, Denton County, Texas**

Terradyne Project Number: **D211188**

Log of Boring B-2

Sheet 1 of 1

Date(s) Drilled **December 22, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **15 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0		7			FAT CLAY, medium stiff to hard, dry to moist, dark grey, (CH)	22							
		22				20							
5		24				17							
		30				21		96	50	20	30		
10													
		54				18							
15					Boring Terminated at 15 Feet BGS								
20													

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Figure 3

Project: **Proposed Development at Stephens Towne Crossing** Project Location: **Sanger, Denton County, Texas** Terradyne Project Number: **D211188**	Log of Boring B-3 **Sheet 1 of 1**

Date(s) Drilled **December 22, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **15 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0					FAT CLAY WITH SAND, very stiff to hard, dry to moist, dark grey, (CH)								
		21				17							
		16				27							
5		29				24		77	63	21	42		
		40				20							
10													
		50/3"				9							
15					Boring Terminated at 15 Feet BGS								
20													

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Figure 4

Project: **Proposed Development at Stephens Towne Crossing** Project Location: **Sanger, Denton County, Texas** Terradyne Project Number: **D211188**	Log of Boring B-4 **Sheet 1 of 1**

Date(s) Drilled **December 22, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **15 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0					FAT CLAY, stiff to hard, dry to moist, dark grey, (CH)								
		10				18							
		15				25							
5		31				22							
		40				22							
10													
		50				18		95	62	26	36		
15					Boring Terminated at 15 Feet BGS								
20													

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Figure 5

Project: **Proposed Development at Stephens Towne Crossing** Project Location: **Sanger, Denton County, Texas** Terradyne Project Number: **D211188**	Log of Boring B-5 **Sheet 1 of 1**

Date(s) Drilled **December 22, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **15 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0					FAT CLAY, medium stiff to hard, dry to moist, dark grey, (CH)								
		7				26		89	63	21	42		
		38				18							
5		38				19							
		44				20							
10													
		50/1/2"				15							
15					Boring Terminated at 15 Feet BGS								
20													

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Figure 6

Project: **Proposed Development at Stephens Towne Crossing**

Project Location: **Sanger, Denton County, Texas**

Terradyne Project Number: **D211188**

Log of Boring B-6

Sheet 1 of 1

Date(s) Drilled **December 22, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **15 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0					FAT CLAY, medium stiff to very stiff, dry to moist, dark brown, (CH)								
		5				23							
		20				20							
5		24				17							
		20				20		97	65	19	46		
10													
		29				21							
15					Boring Terminated at 15 Feet BGS								
20													

Figure 7

Project: **Proposed Development at Stephens Towne Crossing** Project Location: **Sanger, Denton County, Texas** Terradyne Project Number: **D211188**	Log of Boring B-7 **Sheet 1 of 1**

Date(s) Drilled **December 22, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **15 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT, TCP**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0					FAT CLAY, stiff to hard, dry to moist, dark brown, (CH)								
		10				23							
		28				20		96	72	24	48		
5		45				18							
		50/2"				7							
10		T=0.25"			LIMESTONE, very hard	5							
15					Boring Terminated at 15 Feet BGS								
20													

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Figure 8

Project: **Proposed Development at Stephens Towne Crossing**

Project Location: **Sanger, Denton County, Texas**

Terradyne Project Number: **D211188**

Log of Boring B-8

Sheet 1 of 1

Date(s) Drilled **December 21, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **15 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0					SANDY FAT CLAY, stiff to hard, dry to moist, dark brown, (CH)								
		26				11		53	64	25	39		
		12				18							
5		14				16							
		27				23							
10													
		50/5"				11							
15					Boring Terminated at 15 Feet BGS								
20													

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Figure 9

Project: **Proposed Development at Stephens Towne Crossing**

Project Location: **Sanger, Denton County, Texas**

Terradyne Project Number: **D211188**

Log of Boring B-9

Sheet 1 of 1

Date(s) Drilled **December 21, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **15 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0					FAT CLAY, medium stiff to hard, dry to moist, dark brown, (CH)								
		7				34							
		24				20							
5		38				21							
		43				14							
10													
		52				26		98	72	22	50		
15					Boring Terminated at 15 Feet BGS								
20													

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Figure 10

Project: **Proposed Development at Stephens Towne Crossing**

Project Location: **Sanger, Denton County, Texas**

Terradyne Project Number: **D211188**

Log of Boring B-10

Sheet 1 of 1

Date(s) Drilled **December 21, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **15 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0					FAT CLAY, stiff to hard, dry to moist, dark brown, (CH)								
		9				26							
		17				20		93	67	23	44		
5		29				20							
		40				18							
10													
		52				18							
15					Boring Terminated at 15 Feet BGS								
20													

Figure 11

Project: **Proposed Development at Stephens Towne Crossing** Project Location: **Sanger, Denton County, Texas** Terradyne Project Number: **D211188**	Log of Boring B-11 **Sheet 1 of 1**

Date(s) Drilled **December 21, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **15 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0					FAT CLAY, stiff to hard, dry to moist, dark brown, (CH)								
		13				27							
		18				17							
5		21				12							
		28				25							
10													
		46				18		94	78	21	57		
15					Boring Terminated at 15 Feet BGS								
20													

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Figure 12

Project: **Proposed Development at Stephens Towne Crossing**

Project Location: **Sanger, Denton County, Texas**

Terradyne Project Number: **D211188**

Log of Boring B-12

Sheet 1 of 1

Date(s) Drilled **December 21, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **15 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0					FAT CLAY, stiff to hard, dry to moist, dark brown, (CH)								
		25				19							
		14				19		95	70	23	47		
5		17				21							
		35				9							
10													
		26				25							
15					Boring Terminated at 15 Feet BGS								
20													

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Figure 13

Project: **Proposed Development at Stephens Towne Crossing** Project Location: **Sanger, Denton County, Texas** Terradyne Project Number: **D211188**	Log of Boring B-13 **Sheet 1 of 1**

Date(s) Drilled **December 21, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **15 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0					FAT CLAY, stiff to hard, dry to moist, dark brown, (CH)								
		10				25							
		21				22							
5		20				21							
		16				27		97	50	23	27		
10													
		34				23							
15					Boring Terminated at 15 Feet BGS								
20													

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Figure 14

Project: **Proposed Development at Stephens Towne Crossing** Project Location: **Sanger, Denton County, Texas** Terradyne Project Number: **D211188**	Log of Boring B-14 **Sheet 1 of 1**

Date(s) Drilled **December 21, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **14 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT, TCP**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0					FAT CLAY, stiff to very stiff, dry to moist, dark brown, (CH)								
		10				24							
		16				19		87	54	23	31		
5		35				20							
		29				18							
10		T=0.25"			LIMESTONE, very hard	6							
					Auger Refusal at 14 feet BGS								
15													
20													

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Figure 15

Project: **Proposed Development at Stephens Towne Crossing**

Project Location: **Sanger, Denton County, Texas**

Terradyne Project Number: **D211188**

Log of Boring B-15

Sheet 1 of 1

Date(s) Drilled **December 21, 2021**		
Drilling Method **Continuous Flight Auger**		Total Depth of Borehole **15 feet bgs**
Drill Rig Type **Simco2**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT**	
Borehole Backfill **Natural Soils**	Location **See Figure 1-B**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0					FAT CLAY, very stiff to hard, dry to moist, dark brown, (CH)								
		30				27							
		21				17							
5													
		29				21		89	64	21	43		
		38				24							
10													
		43				22							
15					Boring Terminated at 15 Feet BGS								
20													

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Figure 16

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STANDARD REFERENCE NOTES FOR BORING LOGS

I. Sampling & Testing Symbols or Abbreviations:

ST Shelby Tube	**SS** Split-Spoon Sampler	**RC** Rock core	**TC** Texas Cone	**A** Auger	**SPT** Standard Penetration Test	**PT** Percussion Tube

II. Correlations of Penetration Resistance to Soil Properties:

Relative Density of Sand and Sandy Silt		Consistency of Clay and Clayey Silt		
Relative Density	SPT N-value	Stiffness	SPT N-value (qualitative measure)	Unconfined Compressive Strength (tsf)
Very loose	0 – 4	Very soft	0 – 2	0 – 0.25
Loose	4 – 10	Soft	2 – 4	0.25 – 0.5
Medium dense	10 – 30	Firm	4 – 8	0.5 – 1.0
Dense	30 – 50	Medium stiff	8 – 15	1.0 – 2.0
Very Dense	> 50	Stiff	15 – 30	2.0 – 4.0
		Hard	> 30	> 4.0 OR 4.0+

III. Unified Soil Classification Symbols:

GP - Poorly Graded Gravel
GW - Well Graded Gravel
GM - Silty Gravel
GC - Clayey Gravel
OH - High Plasticity Organics

SP - Poorly Graded Sand
SW - Well Graded Sand
SM - Silty Sand
SC - Clayey Sand
OL - Low Plasticity Organics

ML - Low Plasticity Silt
MH - High Plasticity Silt
CL - Low to Medium Plasticity Clay
CH - High Plasticity Clay

IV. Rock Quality Designation index (RQD):

RQD:	Description of Rock Quality: (if all natural fractures)
0-25 %	Very poor
25-50 %	Poor
50-75 %	Fair
75-90 %	Good
90-100%	Excellent

V. Natural moisture content:

"Dry" No apparent moisture, crumbles easily
"Moist" Damp but no visible water
"Wet" Visible water

VI. Grain size terminology:

Cobble: 3-inches to 12-inches
Gravel: #4 sieve size (4.75 mm) to 3-inches
Coarse sand: #10 to #4 sieve size
Medium sand: #40 to #10 sieve size
Fine sand: #200 to #40 sieve size
Silt or clay: smaller than #200 sieve size

VII. Descriptive terms for soil composition:

"Trace" . . . . . 1 to 9%
"Some" . . . . . 10 to 29%
(with suffix –y, e.g. sandy, clayey …) . . . . 30 to 49%

VIII. Descriptive terms or symbols:

"Mottled": occasional/spotted presence of that color
"- […]": identifies change in soil characteristics
LL: Liquid Limit (moisture content as % of dry weight)
PL: Plastic Limit (moisture content as % of dry weight)
WOH: Weight of hammer
"with […]": item identified within that sample only
"REC": Rock core recovery %

IX. Plasticity of cohesive soil:

(function of PI and clay mineral types)

Plasticity Index (PI):	*Plasticity*:
0 to 20	Low
20 to 30	Medium
30 +	High