ECS Southwest, LLP

Geotechnical Engineering Report
Van Buren Estates Roadways

NWC Weston Road and CR 170
Weston, Texas

ECS Project Number 19:7256

December 15, 2017

December 15, 2017

Mr. Andre Sutiono
John Thomas Engineering
800 N. Watters Road, Suite 170
Allen, TX 75013

ECS Project No. 19:7256

Reference: Geotechnical Engineering Report
Van Buren Estates Roadways
NWC Weston Road and CR 170
Weston, Texas

Dear Mr. Sutiono:

ECS Southwest (ECS) has completed the subsurface exploration, laboratory testing, and geotechnical engineering analyses for the referenced project. Our services were performed in general accordance with our Proposal No. 19:8268-GP, dated November 8, 2017. This report presents our understanding of the geotechnical aspects of the project along with the results of the field exploration and laboratory testing conducted. The report also contained our findings and recommendations for design and construction.

It has been our pleasure to be of service to you during design phase of this project. We would appreciate the opportunity to remain involved during the continuation of the design phase, and we would like to provide our services during construction phase operations as well to verify the assumptions of subsurface conditions made for this report. Should you have any questions concerning the information contained in this report, or if we can be of further assistance to you, please contact us.

Respectfully submitted,

ECS Southwest, LLP

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The electronic seal on this document was authorized by Michael P. Batuna No. 92147, on December 15, 2017

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EXECUTIVE SUMMARY

The following summarizes the main findings of the exploration, particularly those that may have a cost impact on the planned roadway improvements. Further, our principal pavement and subgrade improvement recommendations are summarized. Information gleaned from the executive summary should not be utilized in lieu of reading the entire geotechnical report.

- The geotechnical exploration performed for this study consisted of twelve (12) borings drilled for the roadways pavement to a depth of approximately 10 feet below the existing site grades.

- The borings encountered natural, FAT CLAY (CH) soils at the surface to approximate depths of 5 ½ to 10 feet below existing site grades. Tan weathered limestone was encountered in borings B-3 at a depth of 5 ½ feet below existing site grade. Groundwater was not encountered in any of the borings during drilling or at completion of drilling.

- The clay soils encountered at this site have high expansion potential of up to 5 inches. These potential movements reflect moisture changes in the soil that can occur over the life of the structure and after construction is complete.

- Pavement section for the planned residential roads should consist of at least 6 inches of Portland Cement Concrete over 6 inches of lime stabilized subgrade. Design values for the proposed pavement, subgrade preparation and stabilization, as well as materials specifications are provided in the report.

1.0 INTRODUCTION

1.1 GENERAL

The purpose of this study was to provide geotechnical information for the design and construction of the proposed six residential streets at Van Buren Estates Subdivision at the northwest corner of Westin Road and CR 170 in Weston, Texas.

The recommendations developed for this report are based on project information provided by the client. This report contains the results of our subsurface explorations and geotechnical laboratory testing programs, site characterization, engineering analyses, and recommendations for the design and construction of the planned pavement improvements.

1.2 SCOPE OF SERVICES

To obtain the necessary geotechnical information required for evaluation of subsurface soil conditions supporting the pavement, twelve (12) soil test borings were performed along the proposed roadways alignment as shown on the project Overall Site Plan (dated October 20, 2017 as prepared by John Thomas Engineering). A laboratory-testing program was also implemented to characterize the physical and geotechnical engineering properties of the subsurface soils.

This report discusses our exploratory and testing procedures, presents our findings and evaluations and includes the following:

- A brief review and description of our field and laboratory test procedures and the results of testing conducted.
- A review of surface topographical features and site conditions.
- A review of area and site geologic conditions.
- A review of subsurface soil stratigraphy with pertinent available physical properties.
- A final copy of our soil test borings.
- Recommendations for site preparation and construction of compacted fills for site grading.
- Recommendations for pavement section and preparation of pavement subgrades.

1.3 AUTHORIZATION

Our services were provided in accordance with our Proposal No. 19:8268-GP, dated November 8, 2017, and authorized by the client on November 16, 2017.

2.0 PROJECT INFORMATION

2.1 PROJECT LOCATION

The project is located at the northwest corner of Weston Road and CR 170 In Weston, Texas. The location is depicted in Figure 2.1.1 as shown below.

Figure 2.1.1. Site Location

2.2 CURRENT SITE CONDITIONS

The site is currently a vacant lot covered with grass and trees. Few detention ponds were observed in the area. The north half of the site topography slopes down from northeast to southeast maximum and minimum elevations of approximately EL 710 feet to EL 650 feet, respectively. The south half of the site topography slopes down from north/west to south/east maximum and minimum elevations of approximately EL 694 feet to EL 652 feet, respectively.

2.2 PROPOSED CONSTRUCTION

We understand that this project will consist of the devolvement of six residential streets within the future Van Buren Estates Subdivision in Weston, Texas.

3.0 FIELD EXPLORATION

3.1 FIELD EXPLORATION PROGRAM

The field exploration was planned with the objective of characterizing the project site in general geotechnical and geological terms and to evaluate subsequent field and laboratory data to assist in the determination of geotechnical recommendations.

The subsurface conditions were explored by drilling a total of twelve (12) borings to a depth of approximately 10 feet below the existing site grades. A truck-mounted drill rig with continuous flight augers was utilized to drill the borings. The subsurface exploration was completed under the general supervision of an ECS representative.

The boring locations were identified in the field by ECS personnel using the supplied diagram. The approximate as-drilled boring locations are shown on the Boring Location Diagram in Appendix A. The ground surface elevations noted in this report were obtained from NCTCOG (www.dfwmaps.com), which provided elevation contours in 2 foot intervals.

Representative soil samples were obtained by means of the Shelby tube sampling procedures in accordance with ASTM Specifications D-1587. In the Shelby tube sampling procedure, a thin walled, steel seamless tube with sharp cutting edges is pushed hydraulically into the soil, and a relatively undisturbed sample is obtained.

Texas Cone Penetrometer tests were performed to evaluate the load carrying capacity of the rock encountered. These tests were performed in general accordance with test method Tex-132-E in the Texas Department of Transportation (TxDOT) Manual of Testing Procedures. The results of these tests are shown on the attached boring logs at the depths of occurrence.

Field logs of the soils encountered in the borings were maintained by the drill crew. After recovery, each geotechnical soil sample was removed for the sampler and visually classified. Representative portions of each soil sample was then wrapped in plastic and transported to our laboratory for further visual examination and laboratory testing. After completion of the drilling operations, the boreholes were backfilled with auger cuttings to the existing ground surface.

3.2 REGIONAL GEOLOGY

The regional parent geologic mapping indicates that the site is underlain by the Austin Chalk (Kau) geologic formation. The parent rock of the Austin Chalk Formation Kau is a chalky massive limestone. This rock formation varies from 300 to 500 feet thick in full section. It can commonly be seen in the bottoms of creeks, and in some cliff-like outcrops as a bluish-gray rock. Upper portions of this limestone typically weather to form tan limestone containing more frequent fractures, joints, and clay layers.

Through chemical and mechanical weathering, the Austin Chalk forms highly plastic residual clay soils. These clays typically exhibit moderate to high shrink/swell with changes in moisture. The clays directly above the rock are typically tan in color and limy (calcareous). Clays progressively closer to the ground surface take on a darker brown appearance, have higher plasticity and contain less calcareous deposits and limestone fragments.

The location of the site on the geologic map is provided below on Figure 3.2.1.

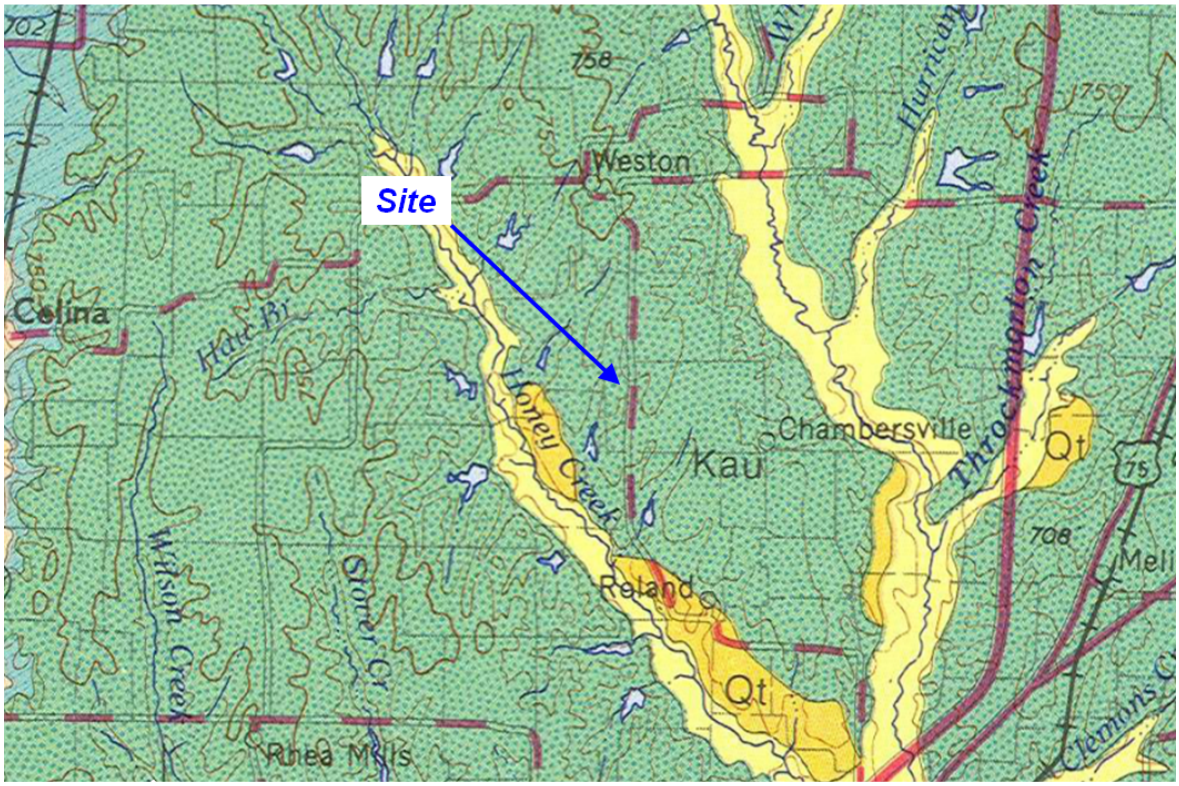


Figure 3.2.1
Geologic map for Figure 3.2.1 obtained from the Geologic Atlas of Texas, Sherman Sheet, 1991

3.3 SUBSURFACE CHARACTERIZATION

The soils described by the attached boring logs are generally consistent with the regional geology described previously. Soil materials encountered in the subsurface exploration are generally described below for the purpose of our discussion herein. These stratum designations do not imply continuity of the materials described, but give the general descriptions and characteristics of the materials at the site. For detailed information at specific boring locations, please refer to the boring logs provided in the Appendix of this report.

Table 3.3.1 Subsurface Stratigraphy

Approximate Bottom Depth Below Grade (ft)	Material Description	Material Description
5 ½ to 10*	FAT CLAY (CH), dark brown, light brown and light gray	Very Stiff to Hard
10* (Boring B-3)	LIMESTONE, tan	Soft Rock

* Depth to bottom of boring penetration

Please refer to the attached Boring Logs in Appendix B for a more detailed description of the subsurface conditions encountered in the borings.

3.4 SOIL SURVEY MAPPING

Based on the United States Department of Agriculture web soil survey, the site is underlain by the Houston Black Clay, Austin Silty Clay, Heiden Clay and Altoga Silty Clay. Typically, the Houston Black Clay is moderately well drained and has very low to moderately low permeability. The parent material of these soils is clayey residuum weathered from calcareous mudstone of upper cretaceous age. The Austin Silty Clay is well drained and has moderately low to moderately high permeability. The parent material of these soils is residuum weathered from chalk. The Heiden Clay is well drained and has very low to moderately high permeability. The parent material of these soils is clayey residuum weathered from mudstone. The Altoga Silty Clay is well drained and has moderately low to moderately high permeability. The parent material of these soils is calcareous clayey alluvium derived from mudstone.

3.5 GROUNDWATER OBSERVATIONS

Groundwater level observations were made in the borings during drilling operations. In auger drilling operations, water is not introduced into the borehole and the groundwater position can often be determined by observing water flowing into and out of the excavation. Furthermore, visual observation of soil samples retrieved can often be used in evaluating the groundwater conditions. Groundwater was not encountered in any of the borings during drilling or upon completion of drilling.

Any water encountered in borings within this geologic setting is generally referred to as a partially perched condition. Specifically, rainfall that enters the site, either directly from overland flow or from adjacent properties, begins to percolate through surficial soils and within clay seams and fissures. This ground water flow continues downhill with the water table occasionally surfacing to form wet springs and intermittent streams. Only in the lowest lying areas and adjacent to existing creeks is a shallow groundwater table in a continuous condition.

The highest groundwater observations are normally encountered in the late winter and early spring. Fluctuation in the location of the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff and other factors not immediately apparent at the time of his investigation. Therefore, the groundwater conditions at this site are expected to be significantly influenced by surface water runoff and rainfall.

4.0 LABORATORY TESTING

The laboratory testing was performed by ECS on selected samples obtained during our field exploration operations. Classification and index property tests were performed on representative soil samples obtained from the test borings in order to aid in classifying soils according to the Unified Soil Classification System and to quantify and correlate engineering properties. The soil samples were tested for moisture content, Atterberg Limits, percent passing No. 200 Sieve, one-dimensional swell and lime pH series.

An experienced geotechnical engineer visually classified each soil sample from the test borings on the basis of texture and plasticity in accordance with the Unified Soil Classification System (USCS) and ASTM D-2488 (Description and Identification of Soils-Visual/Manual Procedures). After classification, the geotechnical engineer grouped the various soil types into the major zones noted on the boring logs in Appendix B. The group symbols for each soil type are indicated in parentheses following the soil descriptions on the boring logs. The stratification lines designating the interfaces between earth materials on the boring logs are approximate; in situ, the transitions may be gradual.

The soil samples will be retained in our laboratory for a period of 60 days, after which, they will be discarded unless other instructions are received as to their disposition.

5.0 DESIGN RECOMMENDATIONS

The following recommendations have been developed on the basis of the previously described project characteristics and subsurface conditions. If there are any changes to the project characteristics or if different subsurface conditions are encountered during construction, ECS should be consulted so that the recommendations of this report can be reviewed. Site grading information was not provided during this report; however, we have assumed that the final pavement grade will be at or near the existing site elevations. If the final pavement subgrade elevation deviates from this assumed grade, the recommendations provided below should be evaluated by our office.

5.1 POTENTIAL VERTICAL MOVEMENTS

As previously discussed, it is anticipated the pavement will be constructed with only shallow cuts and fills, near existing grades. The soils encountered at this site are highly expansive. These soils are susceptible to shrink swell tendencies, occurring seasonally, throughout the life of the pavement with the changes in moisture content. Based on test method TEX-124-E in the Texas Department of Transportation (TxDOT) Manual of Testing Procedures, laboratory one-dimensional test and our experience with similar soils, we estimate potential vertical soil movements (PVM) will be about 5 inches. The actual movements could be greater if poor drainage, ponded water, and/or other unusual sources of moisture are allowed to saturate the soils beneath the pavement after construction. Subgrade treatment consisting of moisture conditioned soil should be considered to reduce the potential vertical movement.

If the above potential vertical movement (PVM) cannot be tolerated for the proposed road, ECS should be contacted for additional recommendations to reduce the PVM to the desired level. Positive drainage should be conducted during all phases of construction. Regular pavement maintenance should be performed by routinely sealing all cracks and joints in the pavement.

5.2 SOLUBLE SULFATES

Soluble sulfate tests were not performed during this study. Due to the potential presence of soluble sulfates in the soil, we recommend soluble sulfate testing be performed after final site grading prior to performing subgrade lime stabilization in order to verify that the soil soluble sulfate content is lower than 3,000 ppm.

5.3 PAVEMENT SECTIONS

We considered the proposed roadways to be residential street class. We considered an annual Equivalent Single-Axle Load (ESAL) of 35,000 based on our experience with similar roadway type and taking into considerations the traffic data from the 2014 updated Collin County Mobility Plan. We have used the following design parameters for our pavement design analyses.

Street Classification	Residential
Annual ESAL	35,000
Growth Factor	0.5%
Design Life	20 years
Reliability	90%
Overall Standard Deviation	0.39

Concrete Modulus of Rupture	570 psi
Concrete Modulus of Elasticity	4,000,000 psi
Drainage Coefficient	1.0
Load Transfer Coefficient	3.0
Initial Pavement Serviceability	4.5
Terminal Pavement Serviceability	2.0
Modulus of Subgrade Reaction (lime stabilized)	150 pci

Based on the results of our analysis and the minimum requirement set forth in Collin County Subdivision Regulations dated November 5, 2012, the roadways may be designed and installed using a PCC pavement section over an untreated natural subgrade or a PCC section over a lime stabilized subgrade as follows:

Table 5.3.1: Pavement Sections

Street Name	Material Thickness	
	Portland Cement Concrete	Lime Stabilized Subgrade
Garfield Court, Ford Court, Delano Court, Coolidge Court, Buchanan Court, and Adams Court	6 inches	6 inches

For the design and construction of exterior pavement, the subgrade should be prepared in accordance with the recommendations in the "Earthwork Operations" section of this report. An important consideration with the design and construction of pavements is surface and subsurface drainage. Where standing water develops, either on the pavement surface or within the base course layer, softening of the subgrade and other problems related to the deterioration of the pavement can be expected. Furthermore, good drainage should reduce the possibility of the subgrade materials becoming saturated during the normal service period of the pavement.

Please note, the recommended pavement sections provided above are considered the minimum necessary to provide satisfactory performance based on the provided traffic loading. In some cases, jurisdictional minimum standards for pavement section construction may exceed those provided above.

5.3.1 Pavement Materials

Pavement materials should be in strict accordance with the most current City of Waxahachie Pavement Design Standards, as well as the latest edition of North Central Texas Council of Governments (NCTCOG) Standard Specifications for Public Works Construction. Pavement should be specified, constructed and tested to meet the following requirements:

1. Portland Cement Concrete (NCTCOG Item 303.2.2): Specify a minimum compressive strength of 3,600 psi at 28 days.
2. Reinforcing Steel: #3 bars at 24" along centers each ways.
3. Concrete Pavement Joints:
    a. Transverse Joints shall be sawed on 15' centers.

b. Longitudinal Joints shall be sawed based on the following:
   25’ Width Street: Saw Joint 3” from the center
c. Expansion Joints to be constructed a maximum of 500’ apart on straight paving, and on all radii, PC, PT and CR or otherwise specified. Use 24”x1” (#8) dowels for paving 7” thick or greater.

4. Lime Stabilized Subgrade (NCTCOG Item 301.2): 7% (32 lbs/cy) hydrated lime by dry weight of soil, based on lime pH series.
5. Sidewalk should be a minimum of 4” thick with #3 bars at 18” on center each way and a minimum compressive strength of 3,600 psi at 28 days.
6. Sidewalk Concrete Pavement Joints:
   a. For 4’ Sidewalk; redwood expansion joints required at every 40’ and dummy joints every 4’.
   b. For 5’ Sidewalk; redwood expansion joints required at every 40’ and dummy joints every 5’.
   c. Install ½” slip dowels (smooth) along lead walks and at barrier free ramps.

6.0 SITE CONSTRUCTION RECOMMENDATIONS

6.1 SUBGRADE PREPARATION

In a dry and undisturbed state, the upper 1-foot of the majority of the soil at the site will provide good subgrade support for fill placement and construction operations. However, when wet, this soil will degrade quickly with disturbance from contractor operations. Therefore, good site drainage should be maintained during earthwork operations, which would help maintain the integrity of the soil.

The surface of the site should be kept properly graded in order to enhance drainage of the surface water away from the proposed building areas during the construction phase. We recommend that an attempt be made to enhance the natural drainage without interrupting its pattern.

The soils at the site are moisture and disturbance sensitive, and contain fines which are considered moderately erodible. Therefore, the contractor should carefully plan his operation to minimize exposure of the subgrade to weather and construction equipment traffic, and provide and maintain good site drainage during earthwork operations to help maintain the integrity of the surficial soils. All erosion and sedimentation shall be controlled in accordance with sound engineering practice and current jurisdictional requirements.

6.1.2 Proofrolling

After stripping and removing all unsuitable surface materials, cutting to the proposed grade, and prior to the placement of any structural fill, the exposed subgrade should be examined by the Geotechnical Engineer or authorized representative. The exposed subgrade should be thoroughly proofrolled with previously approved construction equipment having a minimum axle load of 10 tons (e.g. fully loaded tandem-axle dump truck). The areas subject to proofrolling should be traversed by the equipment in the same direction with overlapping passes of the vehicle under the observation of the Geotechnical Engineer or authorized representative. This procedure is intended to assist in identifying any localized yielding materials.

In the event that unstable or “pumping” subgrade is identified by the proofrolling, those areas should be marked for repair prior to the placement of any subsequent structural fill or other construction materials. Methods of repair of unstable subgrade, such as undercutting or moisture conditioning or chemical stabilization, should be discussed with the Geotechnical Engineer to determine the appropriate procedure with regard to the existing conditions causing the instability. If the area is deemed too small for a piece of equipment to traverse the excavated area it should be thoroughly probed by the Geotechnical Engineer or authorized representative.

6.2 EARTHWORK OPERATIONS

Prior to placement of any new fill, all subgrades should be scarified to a minimum depth of 6 inches, moisture conditioned and compacted to at least 95% of Maximum Dry Density as obtained by the Standard Proctor Method (ASTM D-698) moisture conditioned at least 3 percentage points above the optimum moisture content value. All fills should be benched into the existing soils. Imported soil used for general fill should not have a Plasticity Index (PI) of greater than the material encountered onsite.

Soil moisture levels should be preserved (by various methods that can include covering with plastic, watering, etc.) until new fill, or pavements are placed. All fill soils should be placed in 8 inch loose lifts for mass grading operations and 4 inches for trench type excavations where walk behind or "jumping jack" compaction equipment is used.

Upon completion of the filling operations, care should be taken to maintain the soil moisture content prior to construction of pavements. If the soil becomes desiccated, the affected material should be removed and replaced, or these materials should be scarified, moisture conditioned and recompacted.

Utility cuts should not be left open for extended periods of time and should be properly backfilled. Backfilling should be accomplished with properly compacted on-site soils, rather than granular materials. If granular materials are used, a utility trench cut-off at the building line is recommended to help prevent water from migrating through the utility trench backfill to beneath the proposed structure.

6.3 LIME STABILIZED ON SITE CLAY

Based on the lime pH series test results, lime application rate of 7% hydrated lime by dry weight of clay should be used for budgeting purposes. The actual amount of lime required should be confirmed by additional laboratory tests (lime series) during the construction phase.

Sulfate tests should be performed on the pavement subgrade after final site grading and before lime stabilization process. Special construction process should be followed when this sulfate content (>3,000 ppm) is encountered.

The lime stabilized clay should be thoroughly mixed and appropriately mellowed for at least 48 hours and tested for gradation and lime solubility (pH) prior to final placement and compaction. Once appropriately mixed and mellowed, this material may then be placed and compacted at workable moisture contents 3 percentage points above the optimum moisture content and compacted to at least 95% of the Maximum Dry Density as obtain using the Standard Proctor Method (ASTM D-698). Lime treatment should extend at least 1 foot beyond exposed pavement edges to reduce the effects of shrinkage and associated loss of subgrade support.

Please refer to the "General Recommendations for Quality Assurance (QA) Testing" table provided in the Appendix A of this report for specific requirements.

7.0 CLOSING

ECS has prepared this report of findings, evaluations, and recommendations to guide geotechnical-related design and construction aspects of the project.

The description of the proposed project is based on information provided to ECS by John Thomas Engineering. If any of this information is inaccurate, either due to our interpretation of the documents provided or site or design changes that may occur later, ECS should be contacted immediately in order that we can review the report in light of the changes and provide additional or alternate recommendations as may be required to reflect the proposed construction.

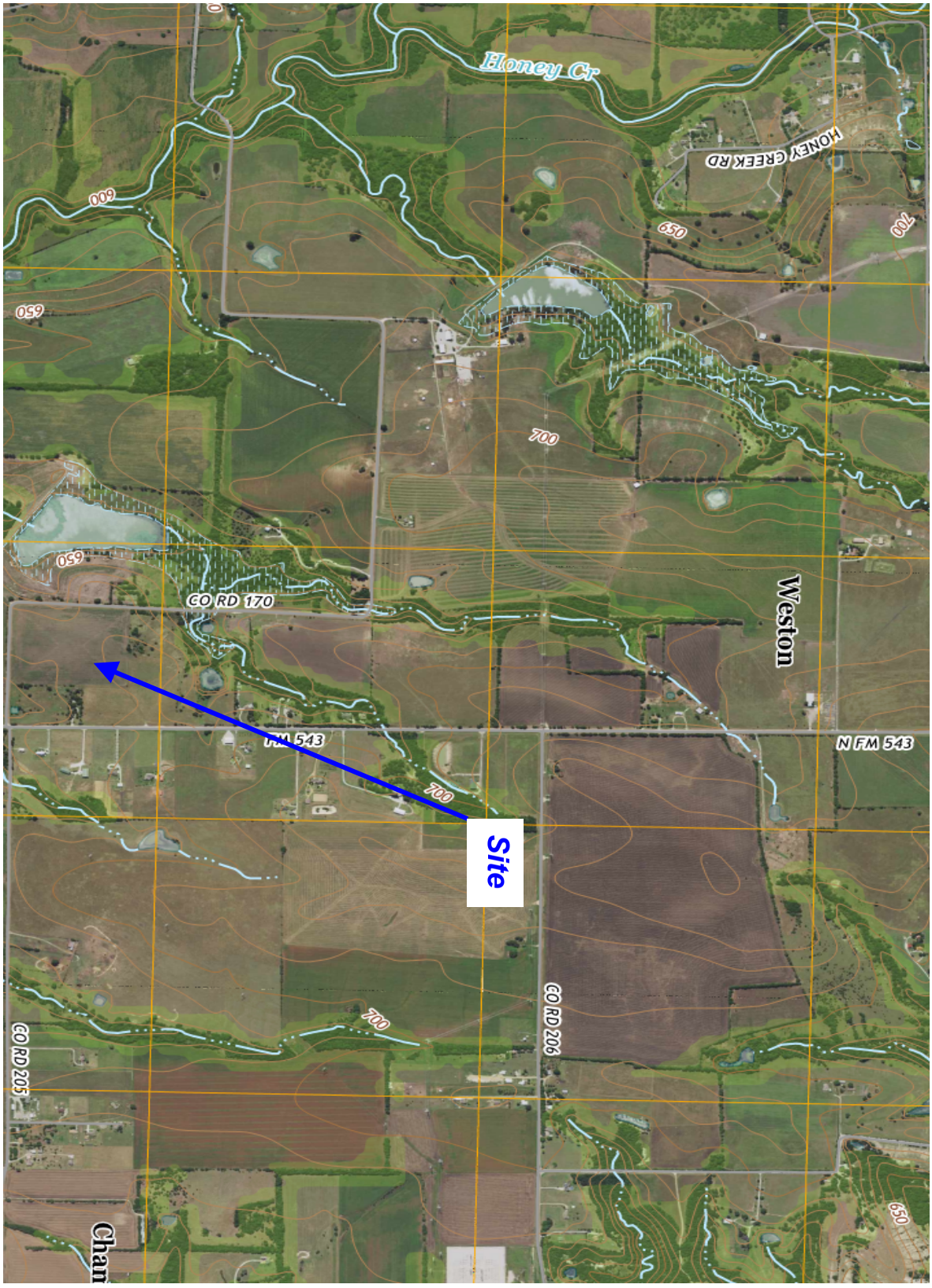
All construction activities should be conducted in accordance with the most recent City of Waxahachie Pavement Design Standards, as well as the latest edition of North Central Texas Council of Governments (NCTCOG) Standard Specifications for Public Works Construction.

We recommend that ECS be allowed to review the project's plans and specifications pertaining to our work so that we may ascertain consistency of those plans/specifications with the intent of the geotechnical report.

Field observations, monitoring, and quality assurance testing during earthwork and foundation installation are an extension of and integral to the geotechnical design recommendation. We recommend that the owner retain these quality assurance services and that ECS be allowed to continue our involvement throughout these critical phases of construction to provide general consultation as issues arise. ECS is not responsible for the conclusions, opinions, or recommendations of others based on the data in this report.

APPENDIX A – Figures

Site Location Map
Boring Location Diagram
Regional Geology
General Recommendations for Quality Assurance (QA) Testing

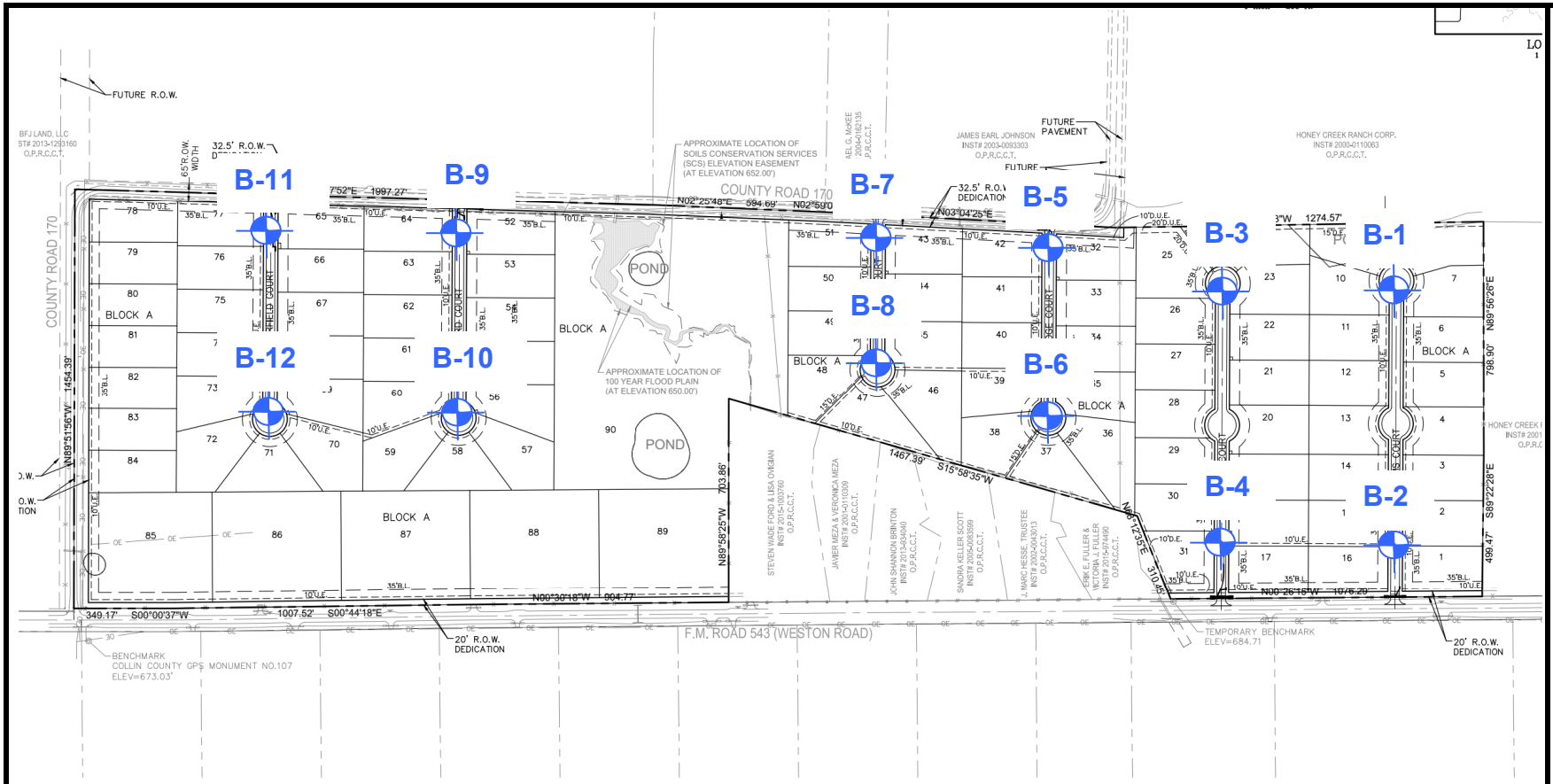


USGS Topographic Map, Weston, TX Quadrangle 2016

Site Location Map
Van Buren Estates Roadway
NWC Weston Road and CR 170
Weston, Texas

ECS Southwest, LLP
3033 Kellway Drive, Suite 110
Carrollton, Texas 75006

SCALE: NTS		PROJECT No.: 19-7256
PM:YWT	DATE: December 15, 2017	FIGURE: SLM



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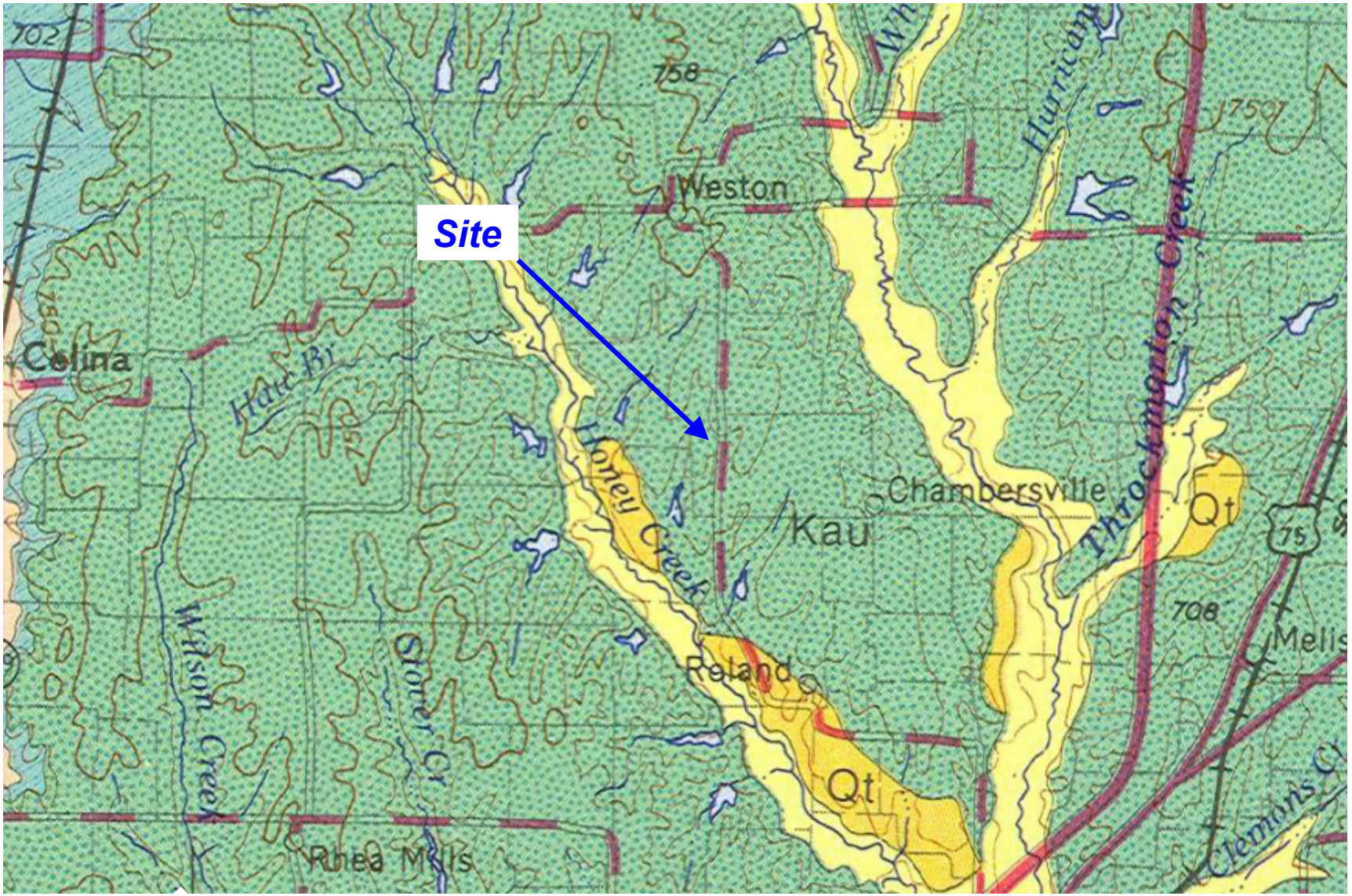
Approximate Boring Location

ECS Southwest, LLP
3033 Kellway Drive, Suite 110
Carrollton, Texas 75006

PROJECT No.: 19-7256
FIGURE: BLD
SCALE: NTS
DATE: December 15, 2017
PM:YWT

Boring Location Diagram
Van Buren Estates Roadways
NWC Weston Road and CR 170
Weston, Texas



Kau – Austin Chalk Formation
Geologic Atlas of Texas, Sherman Sheet, 1991

ECS Southwest, LLP
3033 Kellway Drive, Suite 110
Carrollton, Texas 75006

SCALE: NTS | PROJECT No.: 19-7256 | FIGURE: RG

PM: YWT | DATE: December 15, 2017

REGIONAL GEOLOGY
Van Buren Estates Roadway
NWC Weston Road and CR 170
Weston, Texas

General Recommendations for Quality Assurance (QA) Testing*

Item	Parameter	Test Method ASTM unless noted otherwise	Test Frequency or Observations	Requirements
General Earth Fill Below Paving & Structures	Standard Proctor Curve	D698	1 per soil type	--
	Atterberg Limits	D4318	1 per soil type	--
	-200 Mesh Sieve	D1140	1 per soil type	--
	In Situ Density/Moisture Nuclear Gauge	D2922 D3017	1 per each 250 ft. of lane direction per 6 inch lift (2 tests minimum per lift per section)	Density $\geq$ 95% Moisture: if PI < 20 (0 to +4) (+3) if PI > 20
Select Fill	Standard Protector Curve	D698	1 per soil type	Lean Sandy Clay or Clayey Sand
	Atterberg Limits	D4318	1 per soil type	LL $\leq$ 35; 6 $\leq$ PI $\leq$ 15
	-200 Mesh Sieve (P 200)	D1140	1 per soil type	P200 $\leq$ 50
	In Situ Density/Moisture Nuclear Gauge	D2922 D3017	1 per each 250 lf of lane direction per 6 inch lift (2 tests minimum per lift)	Density: $\geq$ 95% Moisture: (0 to +4)
Stabilized Subgrade	Standard Proctor Curve	D698	1 per soil type	--
	Atterberg Limits	D4318	1 per soil type	PI < 15
	In Situ Density/Moisture Nuclear Gauge	D2922 D3017	1 per 250 lf of lane direction (min. of 2 tests)	Density $\geq$ 100% Moisture: (+3)
	Gradation	D422	1 per 2 Density/Moisture test	100% Passing 1-3/4" Sieve 60% passing #4 Sieve
	Depth Check	Survey, drive probe or hand auger	1 per 2 Density/Moisture tests	Min. Specified

*Performed by the Construction Materials Engineering

Item	Parameter	Test Method ASTM unless noted otherwise	Test Frequency or Observations	Requirements
Trench Backfill Below Streets & Structures	Standard Proctor Curve	D698	1 per soil type	--
	Atterberg Limits	D4318	1 per soil type	--
	-200 Mesh Sieve	D1140	1 per soil type	--
	In Situ Density/Moisture Nuclear Gauge	D2922 D3017	1 per 150 linear feet of trench per 12-inch lift (minimum 2 tests per lift per section)	Density $\geq$ 95% Moisture: (+3)
Crushed Limestone Flexible Base (TxDOT Item 247)	Modified Proctor Curve	D1557	1 per material type	Type A, Grade 1 or better
	Atterberg Limits	D4318	1 per material type	LL $\leq$ 40 P < 12
	Sieve Analysis	D422	1 per material type	0-10% Passing 1-3/4 inch 45-75% Passing No. 4 60-85% Passing No. 40
	Wet Ball Mill	TxDOT	1 per material type	Max. 45
	In Situ Density/Moisture Nuclear Gauge	D2922 D3017	1 per 250 ft of lane direction (Streets/Roads)	Density $\geq$ 95% (Modified) Moisture: (-2 to +4)

Notes: 1. Table 1 is a guide for sampling and testing. Each of these items may not apply to the specified project.

2. Material changes, suspect areas, or other field conditions may require the engineer to increase testing and sampling frequencies.
3. Minimum of two tests per lift.
4. The moisture content ranges specified are to be considered as maximum allowable ranges. The contractor may have to maintain a more narrow range (within the maximum allowable) in order to consistently achieve the specified density for some soils or under some conditions.

APPENDIX B – Field Operations

Reference Notes for Boring Logs
Boring Logs B-1 to B-12

REFERENCE NOTES FOR BORING LOGS

MATERIAL[1,2]	
	ASPHALT
	CONCRETE
	GRAVEL
	TOPSOIL
	VOID
	Limestone
	AGGREGATE BASE COURSE
	FILL[3] MAN-PLACED SOILS
GW	**WELL-GRADED GRAVEL** gravel-sand mixtures, little or no fines
GP	**POORLY-GRADED GRAVEL** gravel-sand mixtures, little or no fines
GM	**SILTY GRAVEL** gravel-sand-silt mixtures
GC	**CLAYEY GRAVEL** gravel-sand-clay mixtures
SW	**WELL-GRADED SAND** gravelly sand, little or no fines
SP	**POORLY-GRADED SAND** gravelly sand, little or no fines
SM	**SILTY SAND** sand-silt mixtures
SC	**CLAYEY SAND** sand-clay mixtures
ML	**SILT** non-plastic to medium plasticity
MH	**ELASTIC SILT** high plasticity
CL	**LEAN CLAY** low to medium plasticity
CH	**FAT CLAY** high plasticity
OL	**ORGANIC SILT or CLAY** non-plastic to low plasticity
OH	**ORGANIC SILT or CLAY** high plasticity
PT	**PEAT** highly organic soils

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS			
SS	Split Spoon Sampler	PM	Pressuremeter Test
ST	Shelby Tube Sampler	RD	Rock Bit Drilling
WS	Wash Sample	RC	Rock Core, NX, BX, AX
BS	Bulk Sample of Cuttings	REC	Rock Sample Recovery %
PA	Power Auger (no sample)	RQD	Rock Quality Designation %
HSA	Hollow Stem Auger	CFA	Continuous Flight Auger

PARTICLE SIZE IDENTIFICATION		
DESIGNATION		**PARTICLE SIZES**
Boulders		12 inches (300 mm) or larger
Cobbles		3 inches to 12 inches (75 mm to 300 mm)
Gravel:	Coarse	¾ inch to 3 inches (19 mm to 75 mm)
	Fine	4.75 mm to 19 mm (No. 4 sieve to ¾ inch)
Sand:	Coarse	2.00 mm to 4.75 mm (No. 10 to No. 4 sieve)
	Medium	0.425 mm to 2.00 mm (No. 40 to No. 10 sieve)
	Fine	0.074 mm to 0.425 mm (No. 200 to No. 40 sieve)
Silt & Clay ("Fines")		<0.074 mm (smaller than a No. 200 sieve)

COHESIVE SILTS & CLAYS		
UNCONFINED COMPRESSIVE STRENGTH, Q_P[4]	**SPT[5] (BPF)**	**CONSISTENCY[7] (COHESIVE)**
<0.25	<3	Very Soft
0.25 - <0.50	3 - 4	Soft
0.50 - <1.00	5 - 8	Medium Stiff
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

GRAVELS, SANDS & NON-COHESIVE SILTS	
SPT[5]	**DENSITY**
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
>50	Very Dense

RELATIVE AMOUNT[7]	COARSE GRAINED (%)[8]	FINE GRAINED (%)[8]
Trace	≤5	≤5
Dual Symbol *(ex: SW-SM)*	10	10
With	15 - 20	15 - 25
Adjective *(ex: "Silty")*	≥25	≥30

WATER LEVELS[6]		
	WL	Water Level (WS)(WD) (WS) While Sampling (WD) While Drilling
	SHW	Seasonal High WT
	ACR	After Casing Removal
	WL	Water Level at Drilling Completion

[1] *Classifications and symbols per ASTM D 2488-09 (Visual-Manual Procedure) unless noted otherwise.*

[2] *To be consistent with general practice, "POORLY GRADED" has been removed from GP, GP-GM, GP-GC, SP, SP-SM, SP-SC soil types on the boring logs.*

[3] *Non-ASTM designations are included in soil descriptions and symbols along with ASTM symbol [Ex: (SM-**FILL**)].*

[4] *Typically estimated via pocket penetrometer or Torvane shear test and expressed in tons per square foot (tsf).*

[5] *Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). "N-value" is another term for "blow count" and is expressed in blows per foot (bpf).*

[6] *The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in granular soils. In clay and cohesive silts, the determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally employed.*

[7] *Minor deviation from ASTM D 2488-09 Note 16.*

[8] *Percentages are estimated to the nearest 5% per ASTM D 2488-09.*

CLIENT	Job #:	BORING #	SHEET
John Thomas Engineering	19:7256	B-1	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Van Buren Estates Roadways	John Thomas Engineering

SITE LOCATION: NWC Weston Road and CR 170, Weston, Texas

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

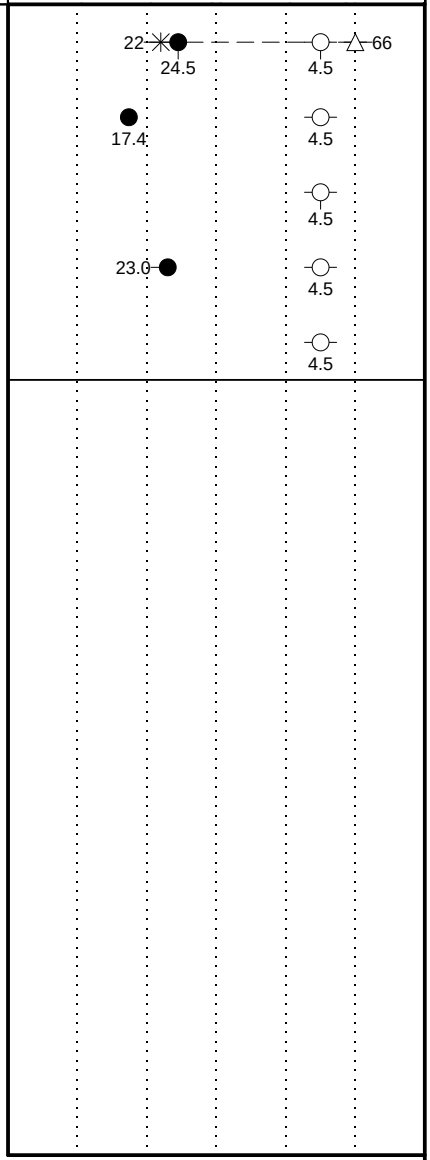
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 676

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CH) FAT CLAY, dark brown, moist, hard		675	
	S-2	ST	24	24	(CH) FAT CLAY, light brown, moist, hard, trace of gypsum deposits, blocky			
5	S-3	ST	24	24			670	
	S-4	ST	24	24				
	S-5	ST	24	24				
10					END OF BORING @ 10'		665	
15							660	
20							655	
25							650	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 11/22/17	CAVE IN DEPTH N/A
WL(SHW) WL(ACR)	BORING COMPLETED 11/22/17	HAMMER TYPE Manual
WL Dry Upon Completion	RIG Truck FOREMAN Miguel	DRILLING METHOD CFA

CLIENT	Job #:	BORING #	SHEET
John Thomas Engineering	19:7256	B-2	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Van Buren Estates Roadways	John Thomas Engineering

SITE LOCATION: NWC Weston Road and CR 170, Weston, Texas

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

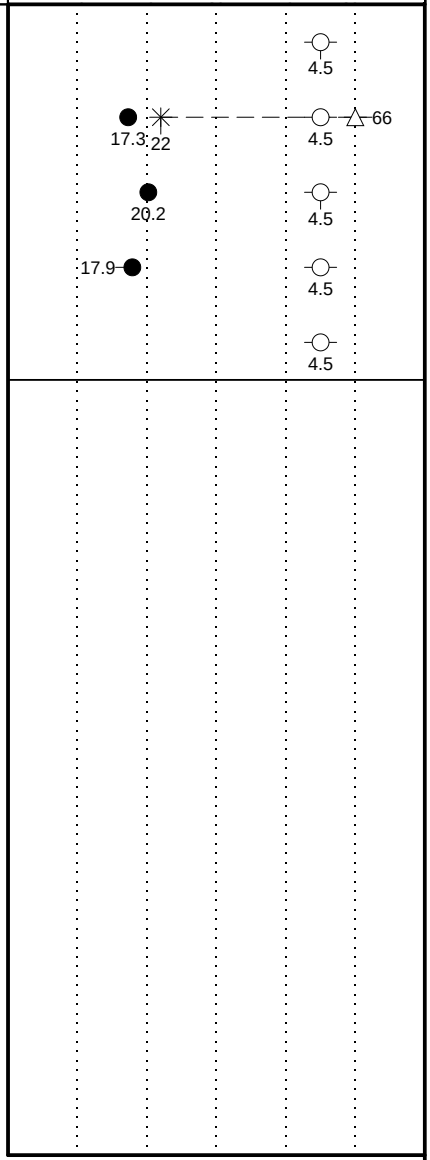
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 672

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CH) FAT CLAY, dark brown, moist, hard			
	S-2	ST	24	24	(CH) FAT CLAY, brown, moist, hard, trace gypsum deposit		670	
5	S-3	ST	24	24	(CH) FAT CLAY, light brown, moist, hard, trace gypsum deposit, blocky			
	S-4	ST	24	24			665	
	S-5	ST	24	24				
10					END OF BORING @ 10'		660	
15							655	
20							650	
25							645	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 11/22/17	CAVE IN DEPTH N/A
WL(SHW) WL(ACR)	BORING COMPLETED 11/22/17	HAMMER TYPE Manual
WL Dry Upon Completion	RIG Truck FOREMAN Miguel	DRILLING METHOD CFA

CLIENT	Job #:	BORING #	SHEET
John Thomas Engineering	19:7256	B-3	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Van Buren Estates Roadways	John Thomas Engineering

SITE LOCATION: NWC Weston Road and CR 170, Weston, Texas

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 686

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CH) FAT CLAY, dark brown, moist, very stiff to hard		685	
	S-2	ST	24	24	(CH) FAT CLAY, light brown, moist, hard, blocky			
5	S-3	ST	24	24	LIMESTONE, Tan		680	
	S-4	TCP	2.5					
10	S-5	TCP	2		END OF BORING @ 10'		675	
15							670	
20							665	
25							660	
30								

30.4 | 3.5 | 17.7 | 4.5 | 17.9 | 4.5 | 100 | 100

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WL Dry WS ☐ WD ☐	BORING STARTED 11/22/17	CAVE IN DEPTH N/A
WL(SHW) WL(ACR)	BORING COMPLETED 11/22/17	HAMMER TYPE Manual
WL Dry Upon Completion	RIG Truck FOREMAN Miguel	DRILLING METHOD CFA

CLIENT	Job #:	BORING #	SHEET
John Thomas Engineering	19:7256	B-4	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Van Buren Estates Roadways	John Thomas Engineering

SITE LOCATION: NWC Weston Road and CR 170, Weston, Texas

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

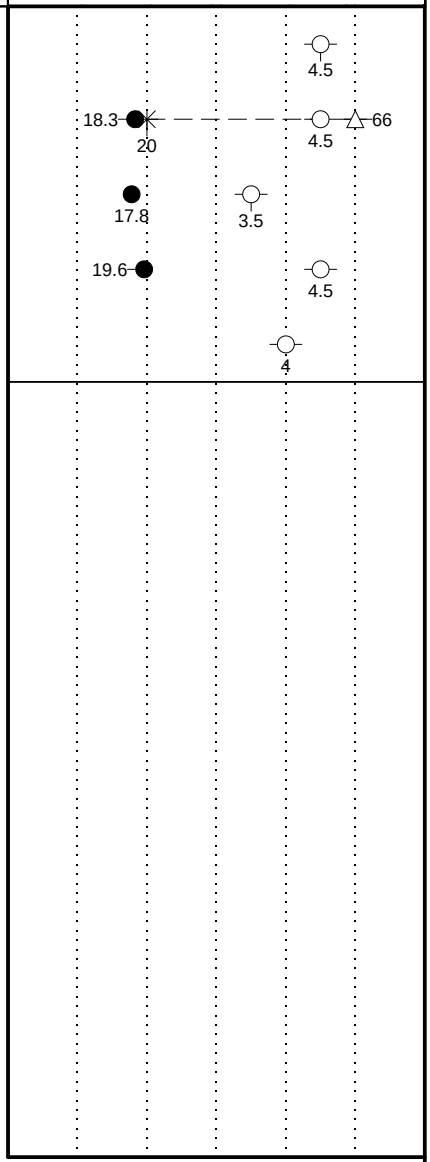
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 674

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CH) FAT CLAY, dark brown, moist, hard			
	S-2	ST	24	24	(CH) FAT CLAY, light brown, moist, very stiff to hard, trace gypsum deposit		670	
5	S-3	ST	24	24				
	S-4	ST	24	24				
	S-5	ST	24	24			665	
10					END OF BORING @ 10'			
							660	
15								
							655	
20								
							650	
25								
							645	
30								



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WL Dry WS ☐ WD ☐	BORING STARTED 11/22/17	CAVE IN DEPTH N/A
WL(SHW) WL(ACR)	BORING COMPLETED 11/22/17	HAMMER TYPE Manual
WL Dry Upon Completion	RIG Truck FOREMAN Miguel	DRILLING METHOD CFA

CLIENT	Job #:	BORING #	SHEET
John Thomas Engineering	19:7256	B-5	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Van Buren Estates Roadways	John Thomas Engineering

SITE LOCATION: NWC Weston Road and CR 170, Weston, Texas

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

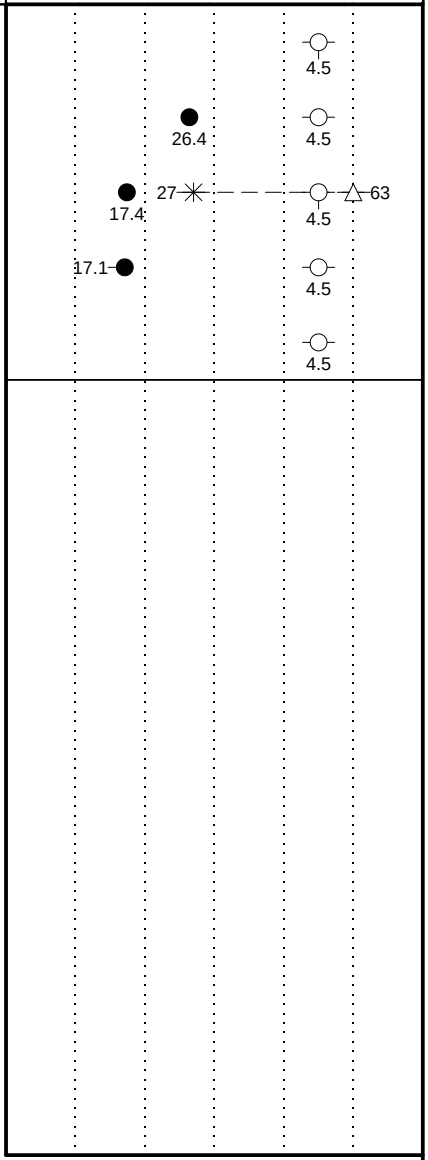
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 690

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CH) FAT CLAY, dark brown, moist, hard		690	
	S-2	ST	24	24	(CH) FAT CLAY, brown, moist, hard, blocky			
5	S-3	ST	24	24	(CH) FAT CLAY, light brown, moist, hard, blocky		685	
	S-4	ST	24	24				
	S-5	ST	24	24				
10					END OF BORING @ 10'		680	
15							675	
20							670	
25							665	
30							660	



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WL Dry WS ☐ WD ☐	BORING STARTED 11/22/17	CAVE IN DEPTH N/A
WL(SHW) WL(ACR)	BORING COMPLETED 11/22/17	HAMMER TYPE Manual
WL Dry Upon Completion	RIG Truck FOREMAN Miguel	DRILLING METHOD CFA

CLIENT	Job #:	BORING #	SHEET
John Thomas Engineering	19:7256	B-6	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Van Buren Estates Roadways	John Thomas Engineering

SITE LOCATION: NWC Weston Road and CR 170, Weston, Texas

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

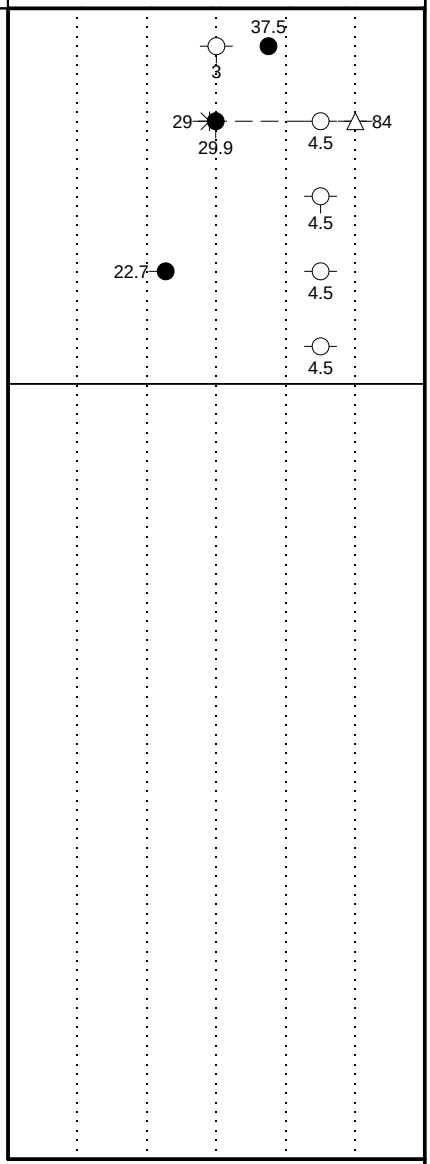
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 680

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CH) FAT CLAY, dark brown, moist, very stiff to hard		680	
	S-2	ST	24	24				
5	S-3	ST	24	24	(CH) FAT CLAY, light brown, moist, hard, trace gypsum deposit		675	
	S-4	ST	24	24				
	S-5	ST	24	24				
10					END OF BORING @ 10'		670	
15							665	
20							660	
25							655	
30							650	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 11/22/17	CAVE IN DEPTH N/A
WL(SHW) WL(ACR)	BORING COMPLETED 11/22/17	HAMMER TYPE Manual
WL Dry Upon Completion	RIG Truck FOREMAN Miguel	DRILLING METHOD CFA

CLIENT	Job #:	BORING #	SHEET
John Thomas Engineering	19:7256	B-7	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Van Buren Estates Roadways	John Thomas Engineering

SITE LOCATION: NWC Weston Road and CR 170, Weston, Texas

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

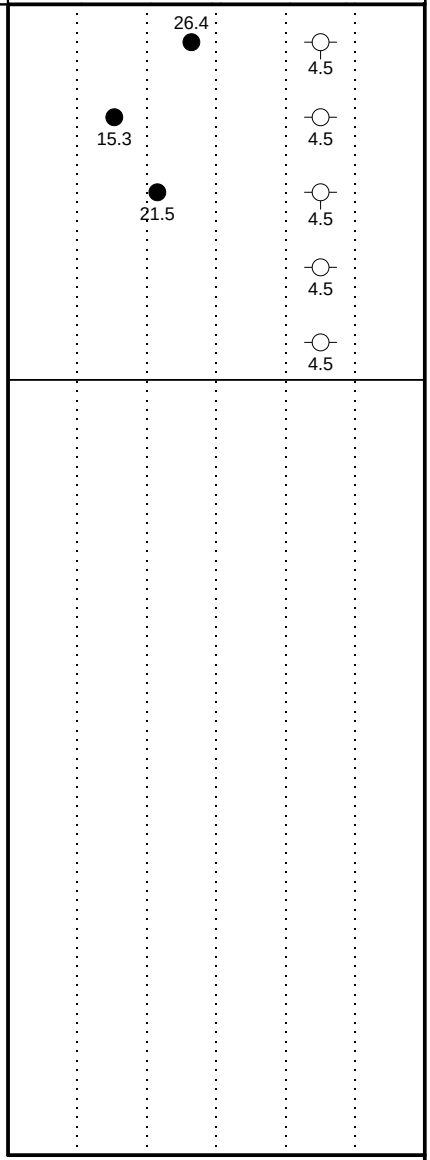
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 704

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CH) FAT CLAY, dark brown, moist, hard			
	S-2	ST	24	24	(CH) FAT CLAY, light brown and light gray, moist, hard, trace gypsum deposit, blocky		700	
5	S-3	ST	24	24				
	S-4	ST	24	24				
	S-5	ST	24	24			695	
10					END OF BORING @ 10'			
							690	
15								
							685	
20								
							680	
25								
							675	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 11/22/17	CAVE IN DEPTH N/A
WL(SHW) WL(ACR)	BORING COMPLETED 11/22/17	HAMMER TYPE Manual
WL Dry Upon Completion	RIG Truck FOREMAN Miguel	DRILLING METHOD CFA

CLIENT	Job #:	BORING #	SHEET
John Thomas Engineering	19:7256	B-8	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Van Buren Estates Roadways	John Thomas Engineering

SITE LOCATION: NWC Weston Road and CR 170, Weston, Texas

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

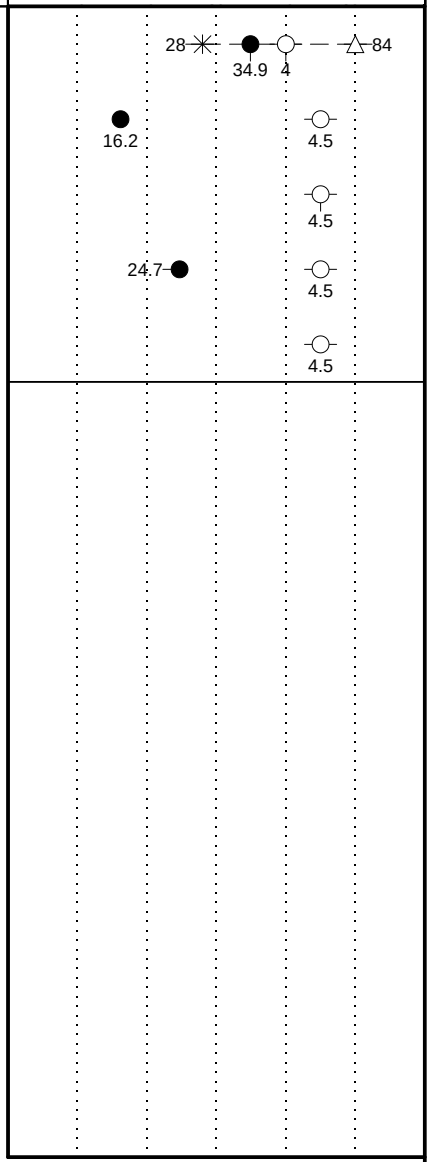
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 680

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CH) FAT CLAY, dark brown, moist, hard		680	
	S-2	ST	24	24	(CH) FAT CLAY, light brown and light gray, moist, hard, blocky			
5	S-3	ST	24	24			675	
	S-4	ST	24	24				
	S-5	ST	24	24				
10					END OF BORING @ 10'		670	
15							665	
20							660	
25							655	
30							650	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 11/22/17	CAVE IN DEPTH N/A
WL(SHW) WL(ACR)	BORING COMPLETED 11/22/17	HAMMER TYPE Manual
WL Dry Upon Completion	RIG Truck FOREMAN Miguel	DRILLING METHOD CFA

CLIENT	Job #:	BORING #	SHEET
John Thomas Engineering	19:7256	B-9	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Van Buren Estates Roadways	John Thomas Engineering

SITE LOCATION: NWC Weston Road and CR 170, Weston, Texas

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

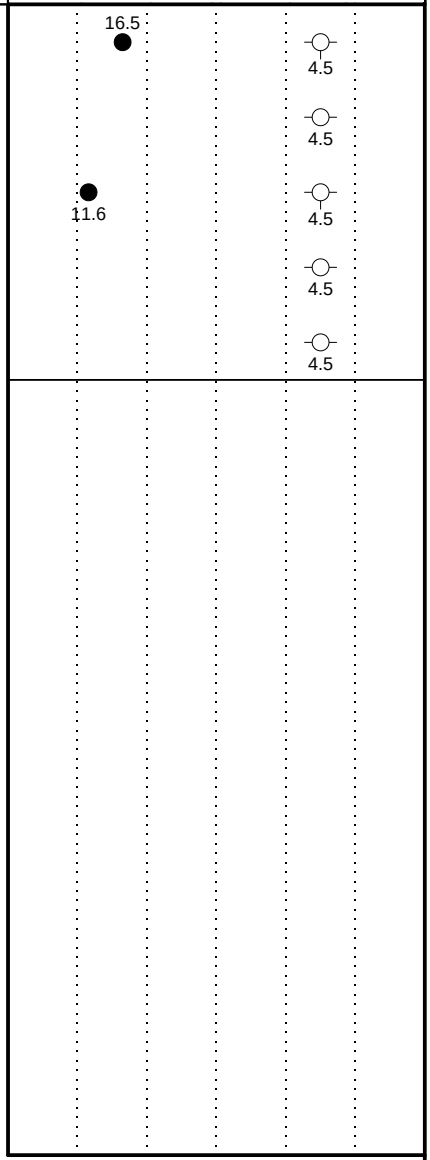
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 676

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CH) FAT CLAY, dark brown, moist, hard		675	
	S-2	ST	24	24	(CH) FAT CLAY, light brown, moist, hard, with calcareous nodules, blocky			
5	S-3	ST	24	24			670	
	S-4	ST	24	24				
	S-5	ST	24	24				
10					END OF BORING @ 10'		665	
15							660	
20							655	
25							650	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 11/22/17	CAVE IN DEPTH N/A
WL(SHW) WL(ACR)	BORING COMPLETED 11/22/17	HAMMER TYPE Manual
WL Dry Upon Completion	RIG Truck FOREMAN Miguel	DRILLING METHOD CFA

CLIENT	Job #:	BORING #	SHEET
John Thomas Engineering	19:7256	B-10	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Van Buren Estates Roadways	John Thomas Engineering

SITE LOCATION: NWC Weston Road and CR 170, Weston, Texas

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

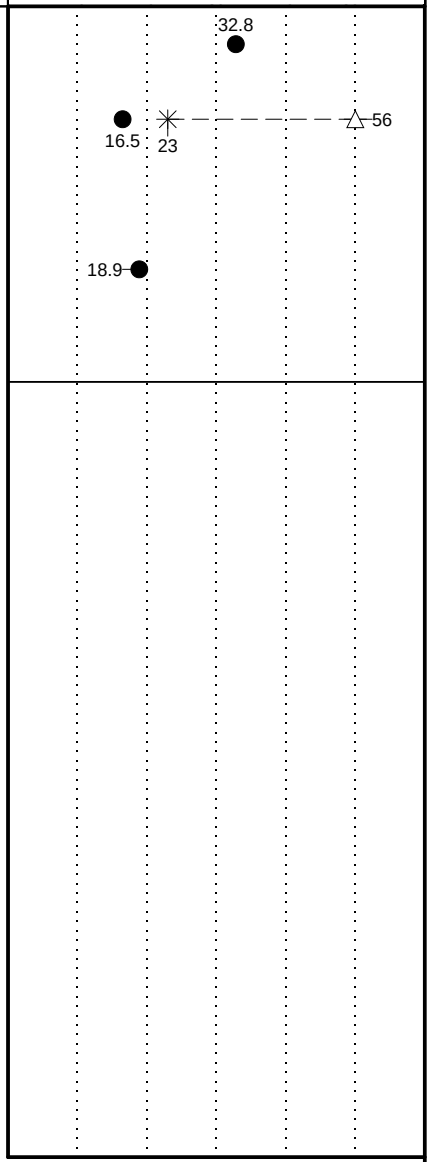
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 694

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CH) FAT CLAY, dark brown, moist, hard			
	S-2	ST	24	24	(CH) FAT CLAY, light brown, moist, hard, blocky			
5	S-3	ST	24	24			690	
	S-4	ST	24	24				
	S-5	ST	24	24			685	
10					END OF BORING @ 10'			
							680	
15								
							675	
20								
							670	
25								
							665	
30								



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WL Dry WS ☐ WD ☐	BORING STARTED 11/22/17	CAVE IN DEPTH N/A
WL(SHW) WL(ACR)	BORING COMPLETED 11/22/17	HAMMER TYPE Manual
WL Dry Upon Completion	RIG Truck FOREMAN Miguel	DRILLING METHOD CFA

CLIENT	Job #:	BORING #	SHEET
John Thomas Engineering	19:7256	B-11	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Van Buren Estates Roadways	John Thomas Engineering

SITE LOCATION: NWC Weston Road and CR 170, Weston, Texas

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

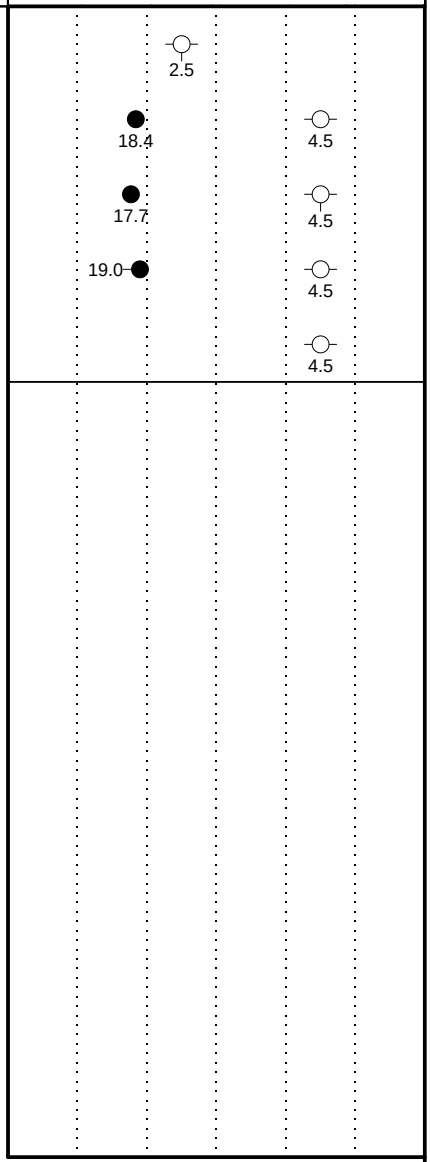
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 678

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CH) FAT CLAY, dark brown, moist, hard stiff to hard, trace of calcareous nodules			
	S-2	ST	24	24	(CH) FAT CLAY, light brown, moist, hard, with calcareous nodules		675	
5	S-3	ST	24	24				
	S-4	ST	24	24			670	
	S-5	ST	24	24				
10					END OF BORING @ 10'		665	
15							660	
20							655	
25							650	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 11/22/17	CAVE IN DEPTH N/A
WL(SHW) WL(ACR)	BORING COMPLETED 11/22/17	HAMMER TYPE Manual
WL Dry Upon Completion	RIG Truck FOREMAN Miguel	DRILLING METHOD CFA

CLIENT	Job #:	BORING #	SHEET
John Thomas Engineering	19:7256	B-12	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Van Buren Estates Roadways	John Thomas Engineering

SITE LOCATION: NWC Weston Road and CR 170, Weston, Texas

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

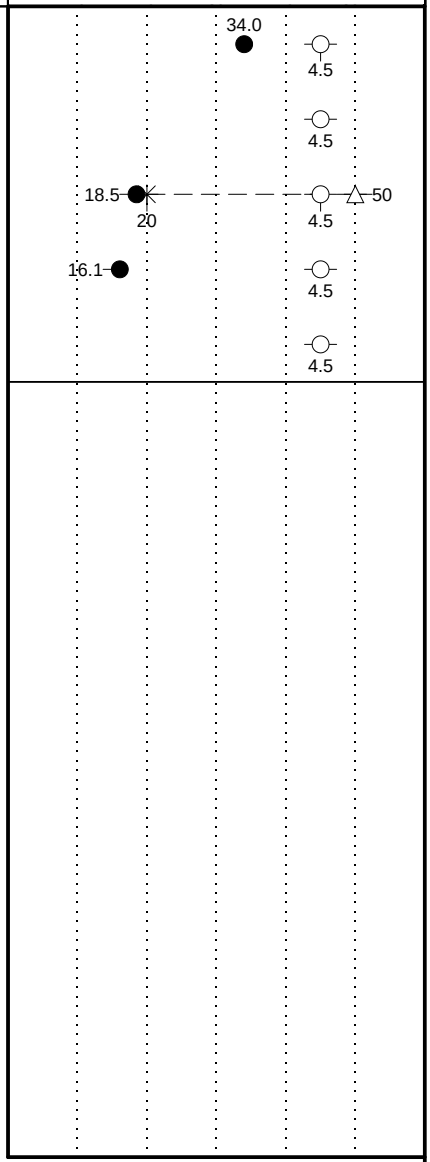
STANDARD PENETRATION BLOWS/FT

ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 682

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CH) FAT CLAY, dark brown, moist, hard			
	S-2	ST	24	24	(CH) FAT CLAY, light brown, moist, hard, trace gypsum deposits, blocky		680	
5	S-3	ST	24	24				
	S-4	ST	24	24			675	
	S-5	ST	24	24				
10					END OF BORING @ 10'		670	
15							665	
20							660	
25							655	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 11/22/17	CAVE IN DEPTH N/A
WL(SHW) WL(ACR)	BORING COMPLETED 11/22/17	HAMMER TYPE Manual
WL Dry Upon Completion	RIG Truck FOREMAN Miguel	DRILLING METHOD CFA

APPENDIX C – Laboratory Testing

Laboratory Testing Summary
Lime pH Series

ECS Southwest, LLP

Carrollton, Texas

Laboratory Testing Summary

Date: 12/13/2017

Project Number: 7256 **Project Name:** Van Buren Estates Roadways

Project Engineer: YWT **Principal Engineer:** MPB **Summary By:** YWT

Boring Number	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[5]	Dry Unit Weight (pcf)	One-Dimensional Swell[6]			Sulfate (ppm)
					LL	PL	PI			Final Moisture (%)	Surcharge (psf)	Swell (%)	
B-1													
	S-1	2 - 4	24.5		66	22	44						
	S-2	2 - 4	17.4										
	S-4	6 - 8	23.0										
B-2													
	S-2	2 - 4	17.3		66	22	44	88.4	106.3	33.3	360	4.0	
	S-3	4 - 6	20.2										
	S-4	6 - 8	17.9										
B-3													
	S-1	2 - 4	30.4										
	S-2	2 - 4	17.7										
	S-3	4 - 6	17.9										
B-4													
	S-2	2 - 4	18.3		66	20	46	85.7					
	S-3	4 - 6	17.8										
	S-4	6 - 8	19.6										
B-5													
	S-2	2 - 4	26.4										
	S-3	4 - 6	17.4		63	27	36						
	S-4	6 - 8	17.1										

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 7260, 5. ASTM D 1140, 6. ASTM D 4546

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, NP: Non Plastic

ECS Southwest, LLP
Carrollton, Texas
Laboratory Testing Summary

Date: 12/13/2017

Project Number: 7256 **Project Name:** Van Buren Estates Roadways

Project Engineer: YWT **Principal Engineer:** MPB **Summary By:** YWT

Boring Number	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[5]	Dry Unit Weight (pcf)	One-Dimensional Swell[6]			Unconfined Strength (tsf)
					LL	PL	PI			Final Moisture (%)	Surcharge (psf)	Swell (%)	
B-6													
	S-1	2 - 4	37.5										
	S-2	2 - 4	29.9		84	29	55	92.8	93.6	35.9	360	3.5	
	S-4	6 - 8	22.7										
B-7													
	S-1	2 - 4	26.4										
	S-2	2 - 4	15.3										
	S-3	4 - 6	21.5										
B-8													
	S-1	2 - 4	34.9		84	28	56						
	S-2	2 - 4	16.2										
	S-4	6 - 8	24.7										
B-9													
	S-1	2 - 4	16.5										
	S-3	4 - 6	11.6										
B-10													
	S-1	2 - 4	32.8										
	S-2	2 - 4	16.5		56	23	33	94.6	111.0	35.9	360	1.7	
	S-4	6 - 8	18.9										

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 7260, 5. ASTM D 1140, 6. ASTM D 4546

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, NP: Non Plastic

ECS Southwest, LLP
Carrollton, Texas
Laboratory Testing Summary

Date: 12/13/2017

Project Number: 7256 **Project Name:** Van Buren Estates Roadways

Project Engineer: YWT **Principal Engineer:** MPB **Summary By:** YWT

Boring Number	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[5]	Dry Unit Weight (pcf)	One-Dimensional Swell[6]			Unconfined Strength (tsf)
					LL	PL	PI			Final Moisture (%)	Surcharge (psf)	Swell (%)	
B-11													
	S-2	2 - 4	18.4										
	S-3	4 - 6	17.7										
	S-4	6 - 8	19.0										
B-12													
	S-1	2 - 4	34.0										
	S-3	4 - 6	18.5		50	20	30	73.3					
	S-4	6 - 8	16.1										

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 7260, 5. ASTM D 1140, 6. ASTM D 4546

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, NP: Non Plastic

ECS Southwest, LLP
Carrollton, Texas

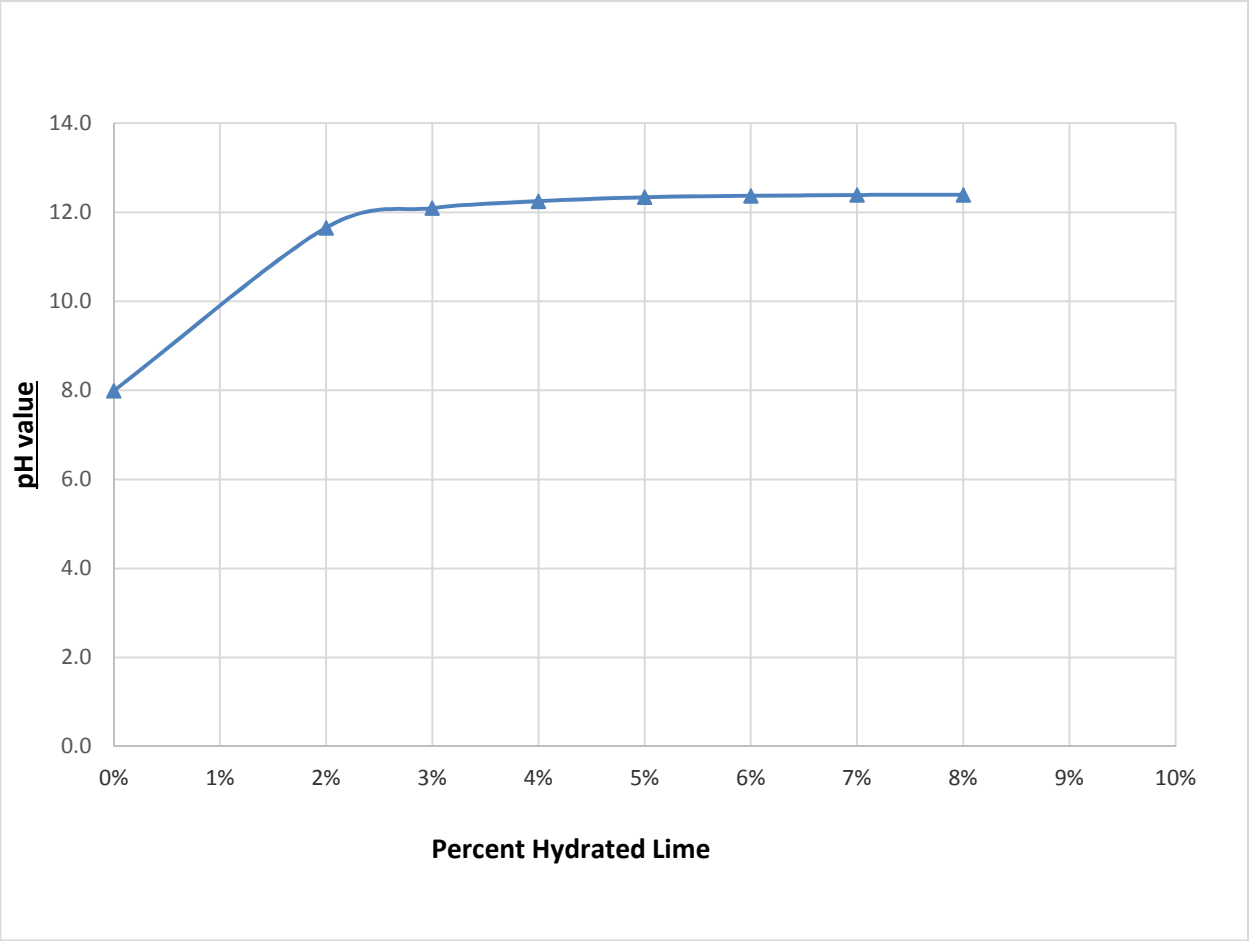
Lime Series By the pH Method ASTM 2976

Dark Brown CLAY (CH)

Date: 12/13/2017

Project Number: 7256 **Project Name: Van Buren Estates Roadways**

Project Engineer: YWT **Principal Engineer: MPB**



% of Lime	0%	2%	3%	4%	5%	6%	7%	8%
pH	8.0	11.7	12.1	12.2	12.3	12.4	12.4	12.4