Environmental
Geotechnical Engineering
Materials Testing
Field Inspections & Code Compliance
Geophysical Technologies

December 30, 2024

INK Civil
2021 SH 46 West, Suite 105
New Braunfels, Texas 78132

Attention: James Ingalls, P.E.

SUBJECT: **SUBSURFACE EXPLORATION, LABORATORY TESTING PROGRAM, AND FOUNDATION AND PAVEMENT RECOMMENDATIONS FOR THE PROPOSED BUCH TRACT SUBDIVISION ROADWAY AND LIFT STATION**
FM 725 AND BUCH LANE
NEW BRAUNFELS, TEXAS
UES Project Number: 24-1234

Dear Mr. Ingalls,

In accordance with our agreement, UES Professional Solutions 45, LLC (UES) performed a subsurface exploration and foundation and pavement evaluation for the referenced project. The results of this exploration, together with our recommendations, are presented in the accompanying report, an electronic copy of which is being transmitted herewith. UES will provide up to two (2) hard copies of this report at the request of the client.

Often, because of design and construction details that occur on a project, questions arise concerning soil conditions. UES would be pleased to continue its role as the Geotechnical Engineer during project implementation.

UES also has great interest in providing materials testing and special inspection services during the construction phase of this project. If you will advise us of the appropriate time to discuss these engineering services, we will be pleased to meet with you at your convenience.

Sincerely,

Lee E. Gurecky, P.E.
Geotechnical Department Manager - San Antonio

SUBSURFACE EXPLORATION, LABORATORY TESTING PROGRAM, AND FOUNDATION AND PAVEMENT RECOMMENDATIONS FOR THE PROPOSED BUCH TRACT SUBDIVISION ROADWAY AND LIFT STATION FM-725 AND BUCH LANE NEW BRAUNFELS, TEXAS

UES PROJECT NUMBER: 24-1234

PREPARED FOR:

INK CIVIL
2021 SH 46 WEST, SUITE 105
NEW BRAUNFELS, TEXAS 78132

DECEMBER 30, 2024

PREPARED BY:

UES PROFESSIONAL SOLUTIONS 45, LLC
4740 PERRIN CREEK, SUITE 480
SAN ANTONIO, TX 78217
PHONE: (210) 249-2100

TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NUMBER 2101

12/30/24

Kyle D. Hammock, P.E.
Vice President – San Antonio

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

UES ™

TABLE OF CONTENTS

INTRODUCTION

This report presents the results of a subsurface exploration and foundation and pavement evaluation for the proposed subdivision roadway and lift station to be constructed within the Buch Tract located at FM 725 and Buch Lane in New Braunfels, Texas. This study was conducted for INK Civil.

Authorization

The work for this project was performed in accordance with UES Proposal No. P24-2103 dated October 11, 2024. The proposal contained a scope of work, fee, and limitations. The proposal was approved and signed by James Ingalls on October 13, 2024 and returned to UES via email.

Purpose and Scope

The purpose of this study was to provide applicable foundation and pavement design recommendations for the proposed project. The scope of this study included the subsurface exploration, field and laboratory testing, engineering analysis and evaluation of the subsurface soils, development of foundation and pavement recommendations suitable for the proposed project, and preparation of this report.

The scope of services did not include an environmental assessment. Any statements in this report, or on the Logs of Boring, regarding odors, colors, unusual or suspicious items or conditions are strictly for the information of the client.

General

The exploration and analysis of the subsurface conditions reported herein are considered sufficient in detail and scope to form a reasonable basis for foundation and pavement designs. The recommendations submitted for the proposed project are based on the available soil information and the preliminary design details provided to UES by the client. If other design criteria are required for the structural and civil engineers to complete the foundation and pavement designs, and the requested information can be obtained from the agreed upon scope of work, UES will provide the requested information as a supplement to this report.

The Geotechnical Engineer states that the findings, recommendations, specifications or professional advice contained herein, have been presented after being prepared in a manner consistent with the level of care and skill ordinarily exercised by reputable members of the Geotechnical Engineer's profession practicing contemporaneously under similar conditions in the locality of the project.

UES operates in accordance with "*Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction*", (ASTM D3740). No other representations are expressed or implied, and no warranty or guarantee is included or intended.

FIELD EXPLORATION

Scope

The field exploration, completed in order to evaluate the engineering characteristics of the subsurface conditions, included a reconnaissance of the project site, drilling test borings and recovering disturbed and relatively undisturbed samples of the subsurface materials encountered at the test boring locations. UES performed a total of four (4) borings at the site. The table below provides the boring location, number, and depth:

SUMMARY OF BORING INFORMATION		
Boring Location	**Boring Identification**	**Boring Depth (ft)**
Lift Station	B-01	40
Paving	B-02 to B-04	15

During the sample recovery operations, the soils encountered were classified and recorded on Logs of Boring in accordance with "*Standard Guide for Field Logging of Subsurface Exploration of Soil and Rock*", (ASTM D5434). Upon completion of the drilling operations and obtaining the groundwater observations, the drilled holes were backfilled with excavated soils.

UES personnel determined the number, depth, and location of the borings. The borings were located in the field by UES personnel and UES completed the drilling operations. A Site Vicinity Map and a Boring Location Plan are provided in the Appendix of this report.

Drilling and Sampling Procedures

The test borings were performed using a drilling rig equipped with a rotary head and solid flight augers to advance the boreholes to the termination depths. Disturbed samples were obtained employing split-barrel sampling procedures in general accordance with the procedures for "*Penetration Test and Split-Barrel Sampling of Soils*" (ASTM D1586). Relatively undisturbed soil samples were obtained using thin-wall tube sampling procedures in accordance with the procedures for "*Thin-Walled Tube Sampling of Soils*" (ASTM D1587). The samples obtained by this procedure were extruded by a hydraulic ram in the field.

The samples obtained from the test borings were classified in the field, placed in plastic bags, marked according to boring number, depth and any other pertinent field data, and stored in special containers. The samples were delivered to the laboratory for testing at the completion of the drilling operations.

Field Tests and Measurements

Penetration Tests - During the sampling procedures, standard penetration tests (SPT) were performed to obtain the standard penetration value of the soil. The standard penetration value (N) is defined as the number of blows of a 140-pound hammer, falling 30-inches, required to advance the split-barrel sampler 1-foot into the soil. The sampler is lowered to the bottom of the previously cleaned drill hole and advanced by blows from the hammer. The number of blows is recorded for each of three successive 6-inch penetrations.

The "N" value is obtained by adding the second and third 6-inch increment number of blows from the hammer. The results of standard penetration tests indicate the relative density of cohesionless soils and comparative consistency of cohesive soils, thereby providing a basis for estimating the relative strength and compressibility of the soil profile components.

Groundwater Observations - Groundwater observations were made during the test boring operations and are noted on the Logs of Boring provided in the Appendix. The amount of water in an open borehole largely depends on the permeability of the soils encountered at the boring location. In relatively pervious soils, such as sandy soils, the indicated depth is usually a reliable groundwater level. In relatively impervious soils, a suitable estimate of the groundwater depth may not be possible, even after several days of observation. Seasonal variations, temperature, land-use, and recent rainfall conditions may influence the depth to groundwater.

Ground Surface Elevations - The ground surface elevations at the test boring locations were not provided. The depths referred to in this report are reported from the actual ground surface elevations at the boring locations during the time of our field investigation. A Grading Plan should be provided to UES for review prior to design finalization.

LABORATORY TESTING PROGRAM

In addition to the field investigation, a laboratory-testing program was conducted to determine additional pertinent engineering characteristics of the subgrade materials necessary in developing the pavement recommendations for the roadways.

The laboratory-testing program included supplementary visual classification (ASTM D2487) and water content tests (ASTM D2216) on all samples. In addition, selected samples were subject to Atterberg limits tests (ASTM D4318), percent material finer than the #200 sieve tests (ASTM D1140), one-dimensional swell tests (ASTM D4546), unconfined compressive strength tests (ASTM D2166), a moisture density relationship test (TEX Method 114), a California Bearing Ratio (CBR) test (ASTM D1883), pH tests (ASTM D4972), lime series (TEX Method 121E), and sulfate content determinations (TEX Method 145E). Estimated soil strengths were obtained in the field using a hand penetrometer. The shear strength of a selected soil sample was evaluated from unconsolidated, undrained strength test (ASTM D2850).

All phases of the laboratory-testing program were conducted in general accordance with applicable ASTM or TxDOT Specifications. The results of these tests are to be found in this report or on the accompanying boring logs provided in the Appendix.

SUBSURFACE CONDITIONS

General

The types of materials encountered in the test borings have been visually classified and are described in detail on the Logs of Boring. The results of the standard penetration tests, strength tests, water level observations and laboratory tests are presented on the Logs of Boring in numerical form. Representative samples of the soils were placed in polyethylene bags and are now stored in the laboratory for further analysis, if desired. Unless notified to the contrary, the samples will be disposed of three months after issuance of this report.

The stratification of the soil, as shown on the Logs of Boring, represents the conditions at the actual boring locations. Variations may occur between, or beyond, the boring locations. Lines of demarcation represent the approximate boundary between different soil types, but the transition may be gradual, or not clearly defined.

It should be noted that, whereas the test borings were drilled and sampled by experienced drillers, it is sometimes difficult to record changes in stratification within narrow limits. In the absence of foreign substances, it is also difficult to distinguish between discolored soils and clean soil fill.

Generalized Soil Conditions

The subsurface conditions encountered at Borings B-01 to B-03 generally consist of firm to hard fat clays extending to the boring termination depths of 15 and 40-feet. Boring B-04 consisted of stiff fat clay overlying loose to very dense clayey sands extending to the boring termination depth of 15-feet. The fat clays are very high in plasticity with plasticity index (PI) values ranging from 43 to 59 and the clayey sands low to moderate in plasticity with plasticity index (PI) values of 10 and 30.

Detailed descriptions of the soils encountered at the boring locations are provided on the Logs of Boring attached. Representative samples of the soils were placed in polyethylene bags and are now stored in the laboratory for further analysis, if desired. Unless notified to the contrary, the samples will be disposed of three months after issuance of this report.

Sulfate Test Result

The sulfate test result on a representative subgrade bulk sample is provided in the following table:

UPPER CLAY SUBGRADE SULFATE TEST RESULTS	
Boring No.	**Sulfate (ppm)**
B-03 (Bulk)	26.6

The TxDOT Treatment Guidelines for Soils and Base in Pavement Structures (August 2019) for soils containing sulfates indicates the following risk levels regarding heave associated with chemical reactions from lime treatment:

SULFATE RISK LEVELS	
Sulfate (ppm)	**Risk**
<3,000	Low (Normal Mix, 24 to 48-hour mellowing period)
3,000-7,000	Moderate to High (7-day or longer mellowing period with additional moisture)
>7,000	High and Unacceptable (do not lime-treat)

The negligible sulfate concentrations indicate the subgrade soils at the site are in a low risk level of using lime as a treatment method.

Lime Series and pH Test Results

The lime series and pH test results on the bulk subgrade sample are provided in the following table:

BORING B-03 BULK SUBGRADE SAMPLE LIME SERIES AND pH TEST RESULTS		
% Lime	**Plasticity Index (PI)**	**pH**
0	50	8.4
2	41	12.1
4	31	12.3
6	25	12.4
8	26	12.5
10	24	12.5

The results indicate the subgrade soils should be treated with a minimum of 6-percent lime to reduce the plasticity index (PI) and increase the pH to 12.4 or greater. Based on the results, it is not necessary to increase the lime concentration to greater than 6-percent.

Seismic Site Class

The field investigation did not include a 100-foot deep boring, therefore, the soil properties are not known in sufficient detail to determine the Site Class per ASCE 7 Chapter 20. This section states that where site-specific data are not available to a depth of 100-feet, appropriate soil properties are permitted to be estimated by the registered design professional preparing the soil investigation report based on known geologic conditions.

Table 20.3-1 Site Class Definitions of ASCE 7 Chapter 20, indicates that Site Class D materials should have soil undrained shear strengths between 1,000 and 2,000 psf and standard penetration resistances between 15 and 50 blows per foot. The on-site soils have strengths similar to Site Class D materials, therefore, UES recommends that Site Class D, “stiff soil profile” be assumed.

Groundwater Observations

Groundwater was not encountered during the drilling operations and the borings were dry upon completion of the drilling operations. It should be noted that water levels in open boreholes may require several hours to several days to stabilize depending on the permeability of the subsurface materials and that groundwater levels or zones of seepage may be subject to seasonal conditions, recent rainfall, drought or temperature effects.

PVR Discussion

The fat clays are high to very high in plasticity at this site. **The calculated total potential vertical rise (PVR) at this site is approximately 4 to 6-inches.** These PVR values were calculated using the Texas Department of Transportation Method TEX-124E and took into account the average depth of active zone, estimated to extend to a depth of approximately 15-feet, and the Atterberg limits test results of the soils encountered within the active zone.

It is important to note that the PVR values provided herein were calculated using the Texas Department of Transportation Method TEX-124E and represents the vertical rise that can be experienced by relatively dry subsoils subjected to increases in soil moisture content resulting from capillary effects or rainwater. The TEX-124E method is widely used in Texas for predicting expansive soil movements and has been found to be reasonably accurate for moisture variations resulting from normal seasonal and climatic controlled conditions (environmental conditions). The actual movement of the subsoils is dependent upon their change in moisture content.

Conditions that allow the soils to become saturated or significantly exceed typical moisture variations resulting from environmental conditions or exceed the dry and wet boundary conditions established by the TEX-124E method, such as poor drainage, broken utilities, and variations in subsurface groundwater sources, may result in higher magnitudes of moisture related soil movements than calculated by the PVR method provided herein and as shown

It is anticipated that when completely inundated with water and allowed to become saturated, the subgrade soils could swell 2 or more times or more the magnitude estimated by the TEX-124E PVR represented herein as confirmed by swell tests results ranging from 1.6 to 13.2 percent.

Reducing the PVR value in the pavement area by modification of the upper subgrade soils or replacement of a portion of the expansive soils with volumetrically stable materials will improve pavement performance. However, reduction of PVR is typically not economically feasible in pavement areas and is therefore not often performed. Instead, deepened curbs, edge drains or other pavement edge details are incorporated in an effort to reduce the moisture variations beneath the pavements and thereby reduce the full PVR from being realized. If PVR reduction will be considered by the owner for this project, UES should be contacted for the appropriate recommendations.

PAVEMENT RECOMMENDATIONS

Based on the information provided to UES, the proposed project will consist of the construction of approximately 2,500 linear feet of flexible hot-mixed asphaltic concrete pavements for the subdivision roadway. The new residential roadway will be classified as “Local A” street. In designing the proposed pavements, the existing subgrade conditions must be considered together with the expected traffic use and loading conditions.

The conditions that influence pavement design can be summarized as follows:

1. Bearing values of the subgrade. These values can be represented by a California Bearing Ratio (CBR) for the design of flexible asphalt pavements.
2. Vehicular traffic, in terms of the number and frequency of vehicles and their range of axle loads.
3. Probable increase in vehicular use over the life of the pavement.
4. The availability of suitable materials to be used in the construction of the pavement and their relative costs.

Specific laboratory testing to define the subgrade strength (i.e. CBR/K values) has been performed for this analysis. Based upon the CBR test result and the plasticity index and strengths of the natural fat clay subgrade soils, a CBR value of 2.0 has been selected for this design.

UES has utilized the design parameters and street classifications provided in “*City of New Braunfels – Street Design Guide (Draft)*”, dated August 2021 in the development of pavement sections for the proposed roadways. In addition, UES has evaluated the proposed new flexible pavement sections to ensure the minimum criteria for pavement sections are attained, as specified in the “*Guadalupe County Subdivision Regulations*” manual, dated January 9, 2024. The following pavement design parameters were selected for the “Local A” Street classification based on Equivalent Single Axle Loading (ESAL) for the specific roadway classification:

FLEXIBLE PAVEMENT DESIGN PARAMETERS "LOCAL A" STREET	
DESIGN PARAMETER	**DESIGN VALUE**
18-kip Equivalent Single Axle Loading (ESAL)	250,000
Reliability (R)	80%
Overall Deviation	0.45
Initial/Terminal Serviceability	4.2 / 2.0
Subgrade Design CBR	2.0
Subgrade Resilient Modulus (Mr)	3,000
Design Life	20 years

The following lime treated subgrade, limestone base, and hot mix asphaltic concrete layer coefficients were selected for the pavement design:

Pavement Constituent	Layer Coefficient (α)
Lime Treated Subgrade	0.08
Crushed Limestone Base	0.14
Mechanically Stabilized Limestone Base	0.17
Type D HMAC	0.44

The recommended hot mixed asphaltic concrete (HMAC) pavement sections are provided in the following tables:

"LOCAL A" STREET - FLEXIBLE PAVEMENT (Required AASHTO 18-KIP ESAL = 250,000)			
Hot Mix Asphaltic Concrete	3"	3"	3"
Limestone Base	---	11"	---
Mechanically Stabilized Limestone Base	13"	---	9"
TENSAR Geogrid	HX-5.5	---	HX-5.5
Lime Treated Subgrade	---	8"	8"
Compacted Subgrade	8"	---	---
Calculated AASHTO 18-kip ESAL	283,400	267,500	262,400

Pavement Material Recommendations

Compacted Subgrade - After all surface organics and deleterious materials have been removed and the desired subgrade elevation has been achieved, the upper 8-inches of exposed subgrade soils should be compacted to a minimum density of 95-percent of the maximum dry unit weight of the subgrade soils as determined by TEX 114E and at or above the optimum moisture content. Any embankment fill required to achieve the final subgrade elevation shall be placed in maximum 8-inch loose lifts and compacted as specified above.

Lime Treated Subgrade - Lime placement and mixing operations should be performed in accordance with TxDOT Item 260, *"LIME TREATMENT FOR MATERIALS USED AS SUBGRADE (ROAD MIXED)."* Lime shall be properly mixed at a rate of 6-percent of the maximum dry unit weight of the raw subgrade soils as determined by TEX 114E. This equates to 36 pounds of lime per square yard per 8-inch treated depth.

After proper curing time, usually 48 to 72 hours, the lime stabilized soils should be remixed and compacted to a minimum density of 95-percent of the maximum dry unit weight of the lime stabilized subgrade soils as determined by TEX 114E and at or above the optimum moisture content.

Geogrid - Geogrid should be placed beneath the base material and on top of the compacted subgrade. Geogrid should be Tensar HX-5.5 Triaxial Geogrid and should be placed and overlapped in accordance with the manufacturer's recommendations. Geogrid will significantly improve the long-term performance of the pavements and reduce cracking.

If alternate geogrid products are desired for use, additional base material thickness will apply, and UES should be contacted for the specific recommendations. If a direct substitution with an alternate geogrid is proposed by the local geogrid distributor, the geogrid should come with a pavement design specific for the site that is sealed by a licensed professional engineer in the state of Texas and that pavement design shall supersede the pavement recommendations provided herein.

Crushed Limestone Base - Limestone base materials should meet the requirements set forth in the Texas Department of Transportation (TxDOT) 2014 Standard Specifications for Construction of Highways, Streets and Bridges; Item 247, Type A, Grade 1-2. The base material should be placed in maximum 8-inch thick loose lifts and compacted to a minimum density of 100-percent of the maximum dry density as determined by TEX-113E within -2 to +2 percentage points of the optimum moisture content.

Hot Mix Asphalt - Hot mix asphaltic concrete should meet the requirements set forth in TxDOT Item 340 or Item 340 or 341; Type D surface course. The asphaltic concrete should be compacted to between 91.5 and 96.3-percent of the maximum theoretical density as determined by the Rice specific gravity.

Drainage

Proper drainage is very important for the adequate performance of asphaltic pavements. Ruts and birdbaths in asphalt pavements allow for quick deterioration of the pavement primarily due to saturation of the underlying base materials and subgrade soils.

The pavement design recommendations in this report are based on the assumption that the pavements will have good drainage. A minimum cross-slope of 2-percent in the pavement surface is recommended. In addition, full depth curbs extending through the base materials and at least 6-inches into the subgrade are recommended, If full depth curbs are not utilized, pavement edge drains or other moisture barriers are recommended.

LIFT STATION RECOMMENDATIONS

Mat/Footing Foundation Recommendations

In addition to the proposed roadway, it is understood that this project will include the construction of a new lift station with an approximate depth of 20-feet and a wet well diameter of 8-feet.

The foundation at the base of the lift station will behave as a mat or spread footing. Mat foundations and spread footing foundations are essentially the same foundation type with the major difference being that the size and loading of a mat foundation are generally larger and of higher magnitude than a conventional footing and require the structural engineer to assure that the loads are modelled using the modulus of subgrade reaction (K), a spring constant, to assure the mat has sufficient thickness and stiffness to support the proposed loads.

A spread footing or mat founded at a depth of approximately 20-feet on hard clays can be designed for a net allowable bearing pressure of **4,000 psf**. The net allowable bearing pressure includes a design safety factor of at least 3.

A modulus of subgrade reaction (K) of 125 pci can be used to model the subgrade soils. A footing or mat foundation designed using the net allowable unit soil pressure provided should experience total settlements of approximately 1-inch or less. In order to reduce the effects of any slight differential movement that may occur due to variations in the character of the supporting soils, it is recommended that the foundation be suitably reinforced to make it as rigid as possible.

Structures constructed at depths below the groundwater should be checked for buoyancy and, as necessary, the mat/footing foundations can be geometrically shaped to provide resistance to buoyancy utilizing the effective unit weights of the backfill materials.

Depending upon the soil and groundwater conditions at the time of construction, dewatering may be required during foundation excavation and for proper construction of the foundation. If groundwater is present at the time of construction, the exposed subgrade soils at the foundation bearing depth will likely be very soft and wet, and the contractor should stabilize the base of the excavation to improve the bottom condition at the foundation bearing level. The specific material types and quantities used to stabilize the soils at the bearing elevation can and should be at the contractor’s discretion and should be placed in a manner to achieve workability and a firm and stable subgrade surface. Examples of stabilizing materials include lean concrete, crushed limestone base structural fill, bull rock and dry Portland cement.

The prepared bearing surface shall be protected to prevent excessive wetting and desiccation of the subgrade soils. It will be beneficial to place a lean concrete seal slab in the foundation area to prevent disturbance of the subgrade soils at the bearing elevation for the foundation.

Below Grade Walls

The lift station will have walls constructed below grade that will act as retaining walls. Retaining walls must be designed to resist the loads imposed by the retained soil.

Backfill around the lift station wet well shall be properly compacted non-expansive select fill, or free draining gravel. Each lift shall be compacted beginning at the wall of the structure and work away from the structure in an attempt to maintain structural integrity and alignment. The soil properties in the following table can be used for the design of the below grade lift station wet well walls at this site.

BELOW GRADE WALL DESIGN PARAMETERS				
Backfill Material	**Active Earth Pressure Coefficient (Ka)**	**At Rest Earth Pressure Coefficient (Ko)**	**Moist Soil Unit Weight (pcf)**	**Effective Soil Unit Weight (pcf)**
Select Fill (CL-ML, CL, SC or SM-SC)	0.53	0.69	120	60
Free Draining Gravel (GW, GP or GM)	0.28	0.44	130	70

Retaining walls which are allowed to move slightly will develop an "active" earth pressure condition. If the wall is restrained from lateral movements such as when it is part of a fixed structure, which is expected to be the case for the lift station, the "at rest" earth pressure condition will be developed.

Moist soil unit weights should be used where the fill materials are above the groundwater elevation and will not become submerged. Where the fill materials will be located below the groundwater elevation, and where there is a possibility for submergence, the effective soil unit weight should be used to calculate the lateral earth pressures from the buoyant soils, and the pressure calculations should also include the hydrostatic loads.

It is very important to note that in designing below grade wall structures, the calculated equivalent fluid densities utilizing the design parameters provided in the above table will not include the effect of surcharge loads due to adjacent structures, equipment, vehicular loads or future storage near the walls.

Backfill for retaining walls shall be compacted in maximum 8-inch lifts, loose measure, to a minimum density of 95 percent of the maximum dry density as determined by the standard Proctor (ASTM D698) and the moisture content shall be maintained at, or above, the optimum moisture content. All compaction operations shall be performed in an attempt to minimize stress on the below grade walls. Compaction operations for each lift of fill soils shall begin at the wall and work back away from the wall in an effort to reduce the pressures on the wall due to construction activities.

Excavations and Slopes

The geotechnical parameters provided in the table below may be used for the design of braced excavations. The trench protection should be designed to provide the most conservative design.

GEOTECHNICAL PARAMETERS FOR SOILS IN BORINGS								
D	**Description**	**C**	**Φ**	**C’**	**Φ’**	**Ka**	**Kp**	**OSHA**
0-5	Fat **CLAY**	800	0	300	18	0.53	1.89	B
5-10	Fat **CLAY**	1,500	0	400	20	0.49	2.04	B
10-28	Fat **CLAY**	4,000	0	425	21.5	0.46	2.16	B
28-40	Fat **CLAY**	5,000	0	520	25	0.41	2.46	B

It should be noted that the values provided in the table above is based on the soil strengths and soil densities encountered in the field. Empirical formulas were used to correlate undrained shear strengths to drained shear strengths and the corresponding angle of internal friction for clay soils.

The active and passive earth pressure coefficients for the soils encountered were calculated using the drained angle of internal friction as recommended in “***FOUNDATION ANALYSIS AND DESIGN***”, written by Mr. Joseph Bowles where he states, “Drained soil parameters for stiff clays and Φ-C soils in general may be appropriate for lateral pressures behind braced walls where the excavation is open for a considerable length of time”.

It is highly recommended that the excavation operations be performed at an expeditious pace to reduce the time that the excavation is open without shoring. Exposure to the environment, vibrations, nearby or adjacent utility trenches, groundwater and sloughing soils can quickly create unstable excavation conditions. The contractor should thoroughly evaluate the soil and groundwater conditions at the excavation location.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. It is recommended that the contractor perform additional exploration including more closely spread borings, test pits or other means prior to construction as necessary to understand the subsurface conditions and groundwater elevations at the time of construction. All excavations should comply with applicable local, state and federal safety regulations including the current OSHA Excavation and Trench Safety Standards. We are providing this information solely as a service to our client. Under no circumstances should the information provided herein be interpreted to mean that UES is assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

In no case should slope height, slope inclination or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. Specifically, the current OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926 should be followed. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor's "competent person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. For excavations, including a trench, extending to a depth of more than 20-feet, it will be necessary to have the side slopes designed by a professional engineer licensed in the State of Texas. The contractor's "competent person" should establish a minimum lateral distance from the crest of the slope for all personnel, vehicles, and spoil piles. Likewise, the contractor's "responsible person" should establish protective measures for exposed slope faces.

The maximum allowable slopes during construction for various OSHA soil types are provided in the following table:

GUIDELINES FOR MAXIMUM ALLOWABLE SLOPES	
Soil or Rock Type	**Maximum Allowable Slopes for Excavations Less Than 20 Feet Deep**
Stable Rock (S.R.)	Vertical
Type A	¾ Horizontal : 1 Vertical
Type B	1 Horizontal : 1 Vertical
Type C	1 ½ Horizontal : 1 Vertical

Guidelines for maximum allowable slopes were obtained from OSHA documents, but do not take into account any recent revisions or the stability of long-term unprotected slopes. In addition, any soils that are encountered during construction for which water is freely seeping. The guidelines presented herein for slopes does not imply UES is taking responsibility for construction site safety, this responsibility falls entirely upon the contractor and his responsible person. UES is assuming that the contractor will comply with all rules, ordinances and other requirements to comply with safe construction practices.

CONSTRUCTION CONSIDERATIONS

Dewatering

Groundwater was not encountered in the borings at this site. However, if groundwater is encountered during excavation operations, dewatering will be required for the excavation at this site. It should be noted that the depth to the groundwater is subject to change due to climatic and site conditions, therefore, it should be made the responsibility of the contractor to verify depths to groundwater. A unit cost price for dewatering should be included in the contract documents.

Subsurface water that flows in an upward direction into an excavation area that is being dewatered imparts a seepage force that tends to loosen the soil, reducing the soil strength. The change in strength should be considered in designing excavation bracing and foundations. Where excavations are to extend more than a few feet below groundwater level, open ditches or pits may not be practical, and more advanced methods may be required.

For dewatering to intermediate depths (to about 30-feet but more if sufficient area is available for installing the necessary equipment) well-point systems are normally used. To dewater an area, a series of well points is installed around the perimeter of the area. The groundwater level within the perimeter will be lowered when the well-point system is put in operation. The spacing of the well points varies according to the soil type and depth of dewatering. Spacing conventionally varies between 3 and 10-feet.

With the type of pumping equipment conventionally used for well points, the depth of dewatering that can usually be achieved by a single line of well points located around the perimeter of an excavation is about 18 to 20-feet. This is due to the limit on the practical lifting, or suction, capacity of the pumping equipment. Lowering the water table through a greater distance may require the use of a two (or more) stage (multistage) installation. Where a two-stage installation is required, the well points for the first stage of drawdown are located near the extreme perimeter limits of the area that can be excavated, and are put into operation. Well points for the second stage are subsequently located within the area that has been excavated, near to the bottom elevation that has been dewatered by the first stage. The second stage well points then lower the water table to the additional depth necessary to complete the excavation in dry conditions.

Other methods of dewatering are available and may be more cost effective than those mentioned above. Additional information concerning dewatering may be obtained from a contractor whose specialty is dewatering.

GENERAL COMMENTS

If significant changes are made in the character or location of the proposed project, a consultation should be arranged to review any changes with respect to the prevailing soil conditions. At that time, it may be necessary to submit supplementary recommendations.

It is recommended that the services of UES be engaged to test and evaluate the soils in the undercut excavations prior to placing select fill and in the foundation excavations prior to concreting in order to verify that the bearing soils are consistent with those encountered in the borings. UES cannot accept any responsibility for any conditions that deviate from those described in this report, nor for the performance of the foundation and pavements if not engaged to also provide construction observation and testing for this project. If it is required for UES to accept any liability, then UES must agree with the plans and perform such observation during construction as we recommend.

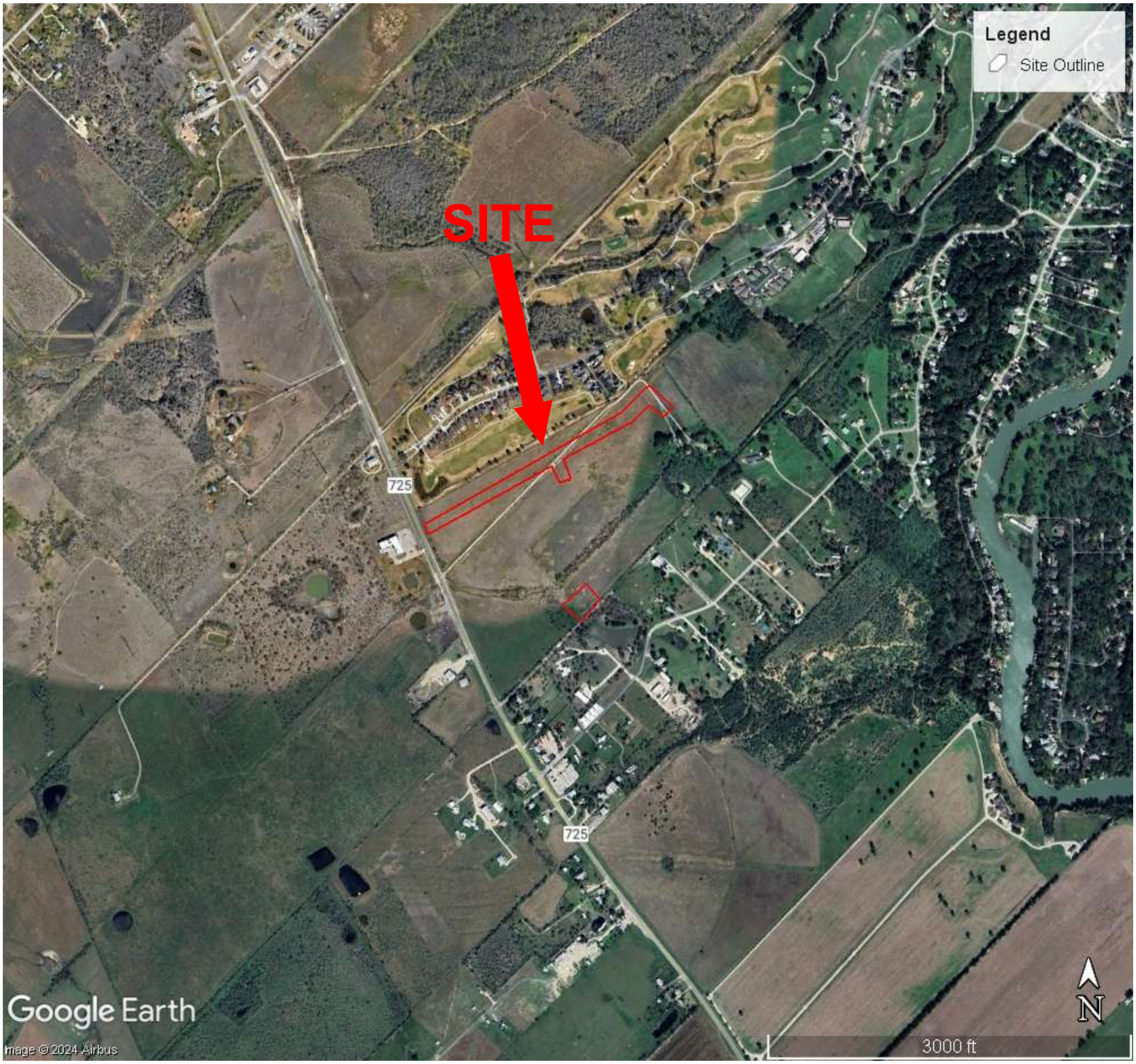
Sheeting, shoring and bracing of trenches, pits and excavations should be made the responsibility of the contractor and should comply with all current and applicable local, state and federal safety codes, regulations and practices, including the Occupational Safety and Health Administration.

APPENDIX

SITE VICINITY MAP

LOCATION IS APPROXIMATE

FIGURE 1A



BUCH TRACT SUBDIVISION ROADWAYS

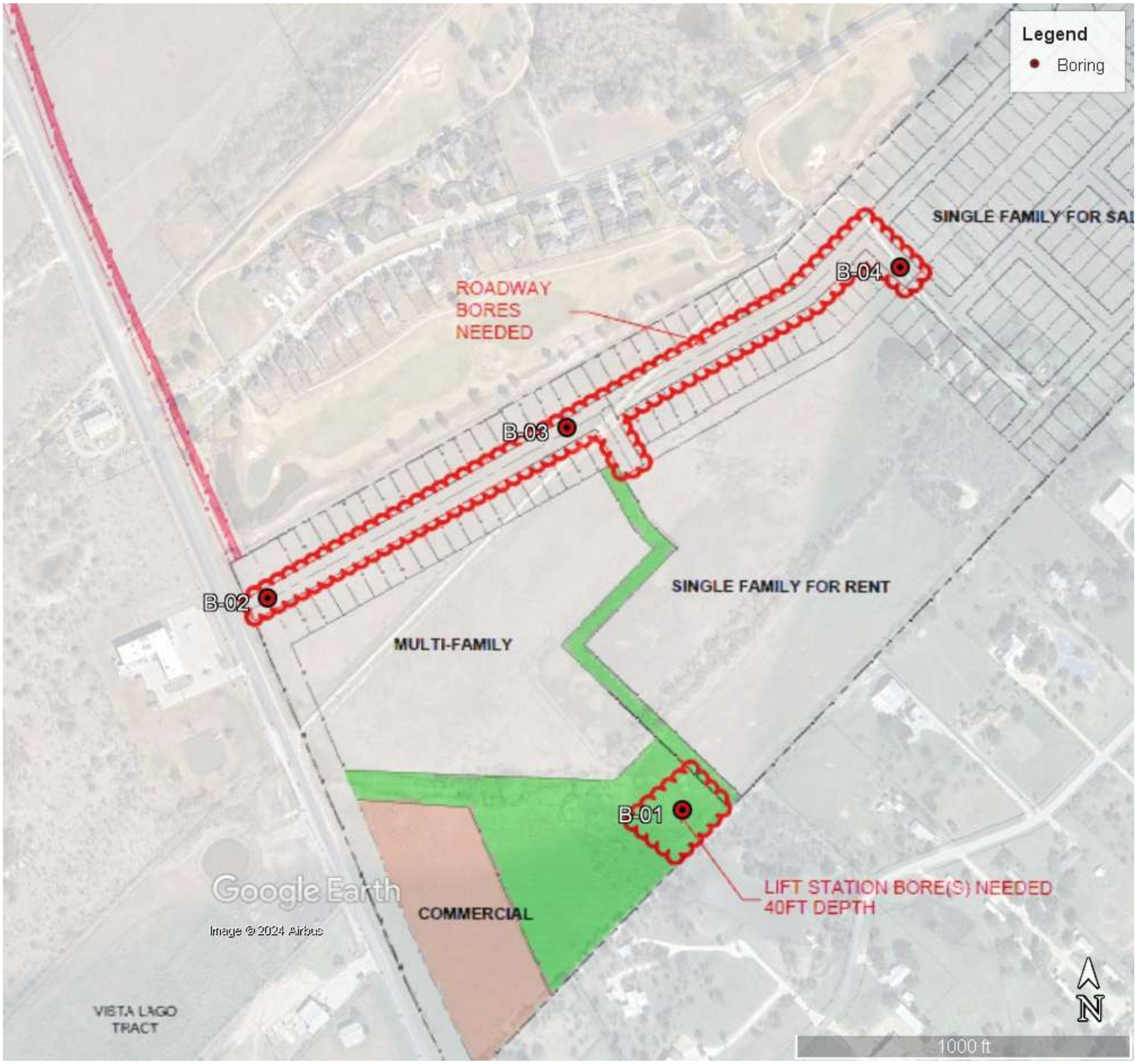
INK Civil
UES Project No.: 24-1234

Buch Lane
New Braunfels, Texas

BORING LOCATION PLAN

LOCATIONS ARE APPROXIMATE

FIGURE 1B



BUCH TRACT SUBDIVISION ROADWAYS

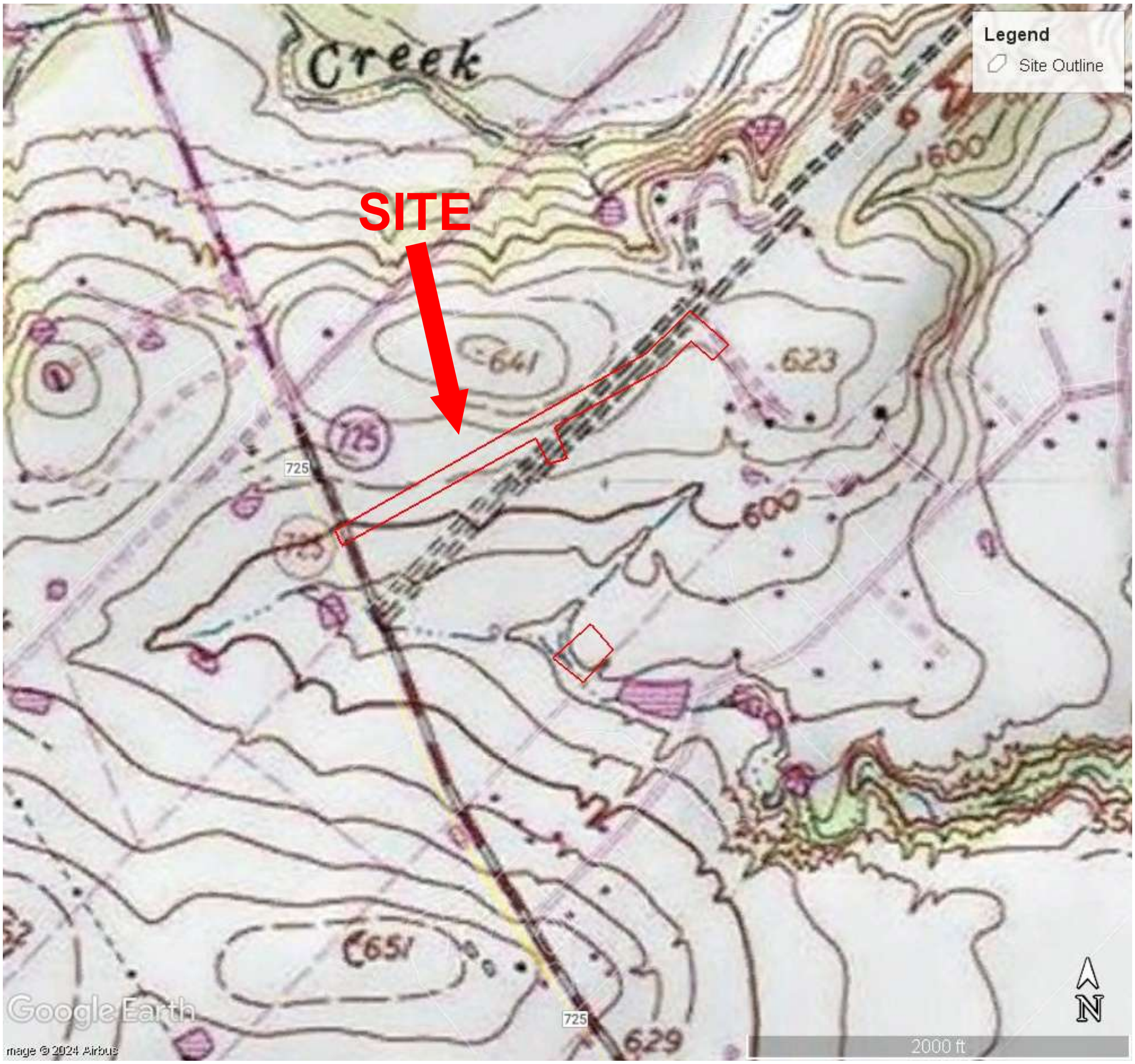
INK Civil
UES Project No.: 24-1234

Buch Lane
New Braunfels, Texas

TOPOGRAPHIC MAP

LOCATIONS ARE APPROXIMATE

FIGURE 2



BUCH TRACT SUBDIVISION ROADWAYS

Buch Lane

New Braunfels, Texas

INK Civil

UES Project No.: 24-1234

GEOLOGIC MAP

LOCATIONS ARE APPROXIMATE

FIGURE 3

BUCH TRACT SUBDIVISION ROADWAYS

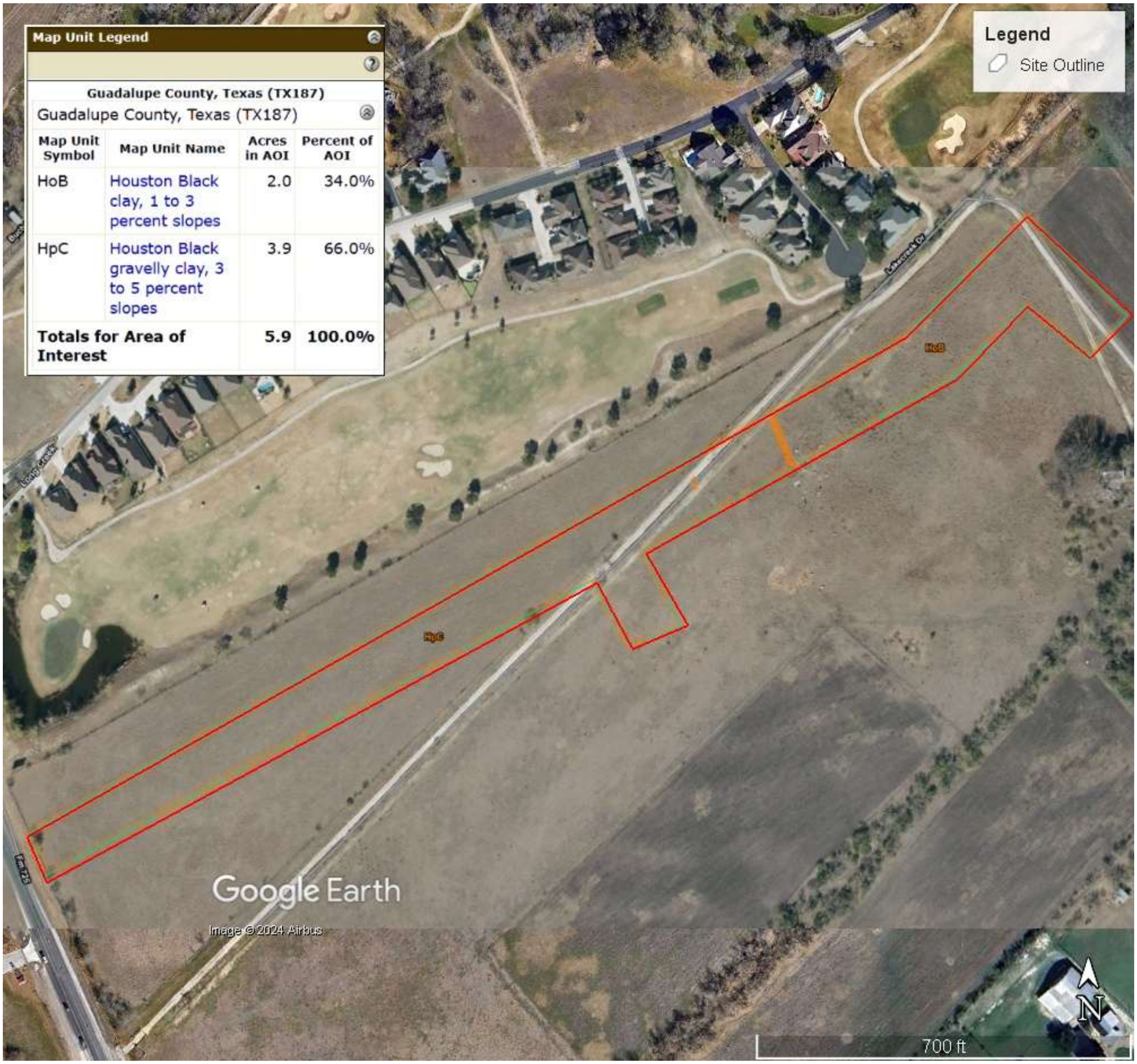
INK Civil
UES Project No.: 24-1234

Buch Lane
New Braunfels, Texas

SOIL MAP - ROADWAY

LOCATIONS ARE APPROXIMATE

FIGURE 4A



BUCH TRACT SUBDIVISION ROADWAYS

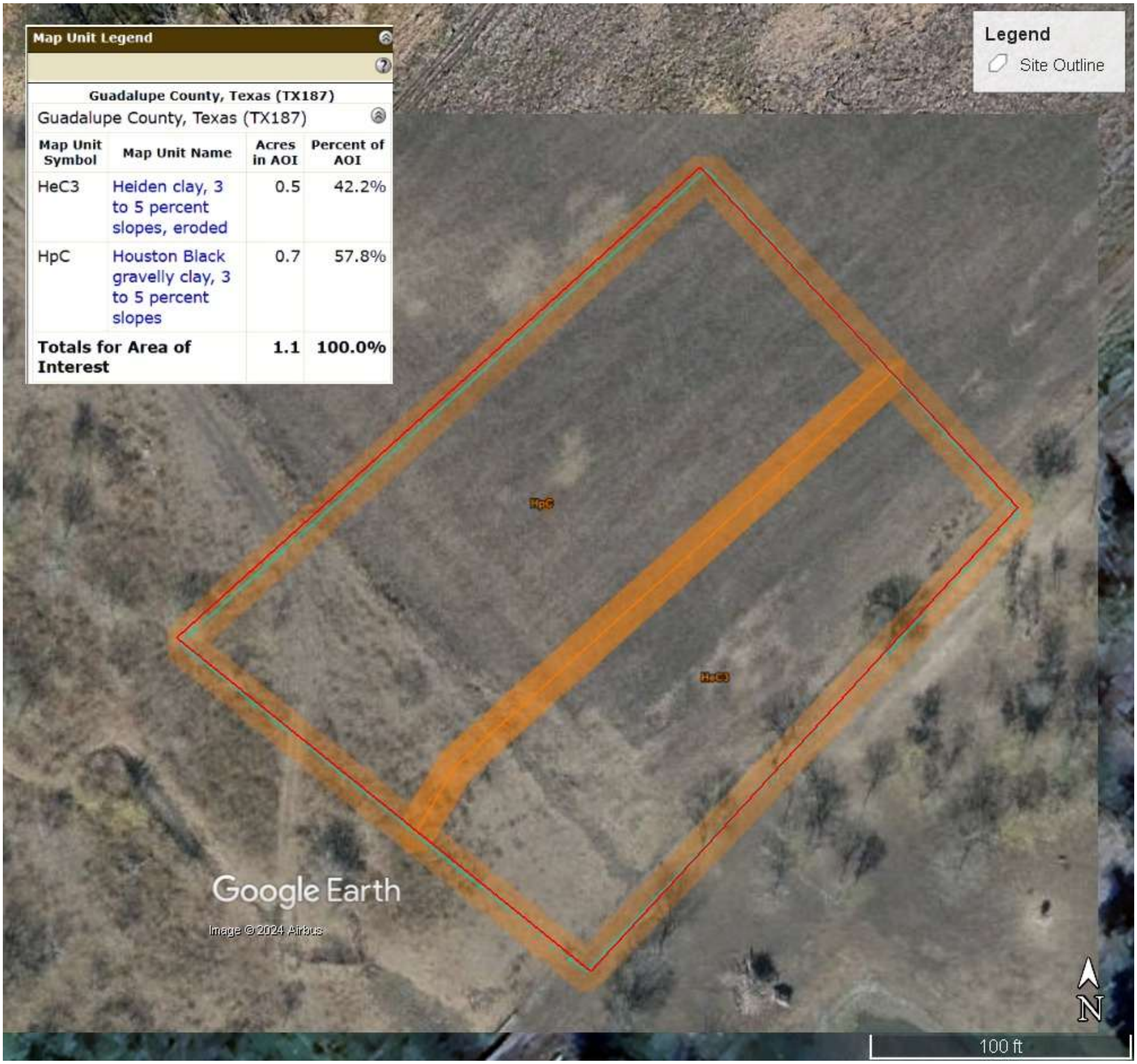
INK Civil
UES Project No.: 24-1234

Buch Lane
New Braunfels, Texas

SOIL MAP – LIFT STATION

LOCATIONS ARE APPROXIMATE

FIGURE 4B



BUCH TRACT SUBDIVISION ROADWAYS

INK Civil | Buch Lane
UES Project No.: 24-1234 | New Braunfels, Texas

UES REPORT NO.: 24-1234 DATE: 11/14/24

UES Professional Solutions, LLC
4740 Perrin Creek
San Antonio, Texas 78217
Geotechnical I Construction Materials I Environmental
www.TeamUES.com
TBPE Firm No. 813 / TBPG Firm No. 50341

TEST METHOD: ASTM D4546, Method B

TESTED FOR: INK Civil
New Braunfels, Texas

PROJECT: Buch Tract Subdivision Roadways
New Braunfels, Texas

TECHNICIAN: Alex Rosales

SWELL TEST RESULTS

Boring No.	**B-01**	**B-02**	**B-03**	**B-03**	**B-03**		
Average Depth (ft)	9	7	5	7	14		
Applied Overburden (psi)	7.8	6.1	4.3	6.1	12.2		
Liquid Limit (%)	70	79	71	84	71		
Plastic Limit (%)	24	23	19	25	45		
Plastic Index (%)	46	56	52	59	26		
Initial Moisture Content (%)	28	28	19	22	22		
Final Moisture Content (%)	34	32	30	32	27		
Unit Wet Weight (pcf)	123	118	127	126	127		
Unit Dry Weight (pcf)	96	92	106	104	104		
Swell (%)	5.4	1.6	13.2	12.1	3.2		

FIGURE 5

UES REPORT NO.: 24-1234 DATE: 11/27/24

UES Professional Solutions, LLC
4740 Perrin Creek
San Antonio, Texas 78217
Geotechnical I Construction Materials I Environmental
www.TeamUES.com
TBPE Firm No. 813 / TBPG Firm No. 50341

MATERIAL DESCRIPTION: Dark Brown Clay

CLASSIFICATION: FAT CLAY (CH)
SAMPLE LOCATION: NEAR BORING B-03

TEST METHOD: TEX-114-E

TESTED FOR: INK Civil
New Braunfels, Texas

PROJECT: Buch Tract Subdivision Roadway
New Braunfels, Texas

TECHNICIAN: Alex Rosales

SOIL ID NUMBER:	1	
MAXIMUM DRY UNIT WEIGHT:	92.1	PCF
OPTIMUM MOISTURE CONTENT:	26.1	%
LIQUID LIMIT:	68	
PLASTIC LIMIT:	19	
PLASTICITY INDEX:	49	
% FINER THAN NO. 200 SIEVE:	93	%

MOISTURE DENSITY RELATIONSHIP

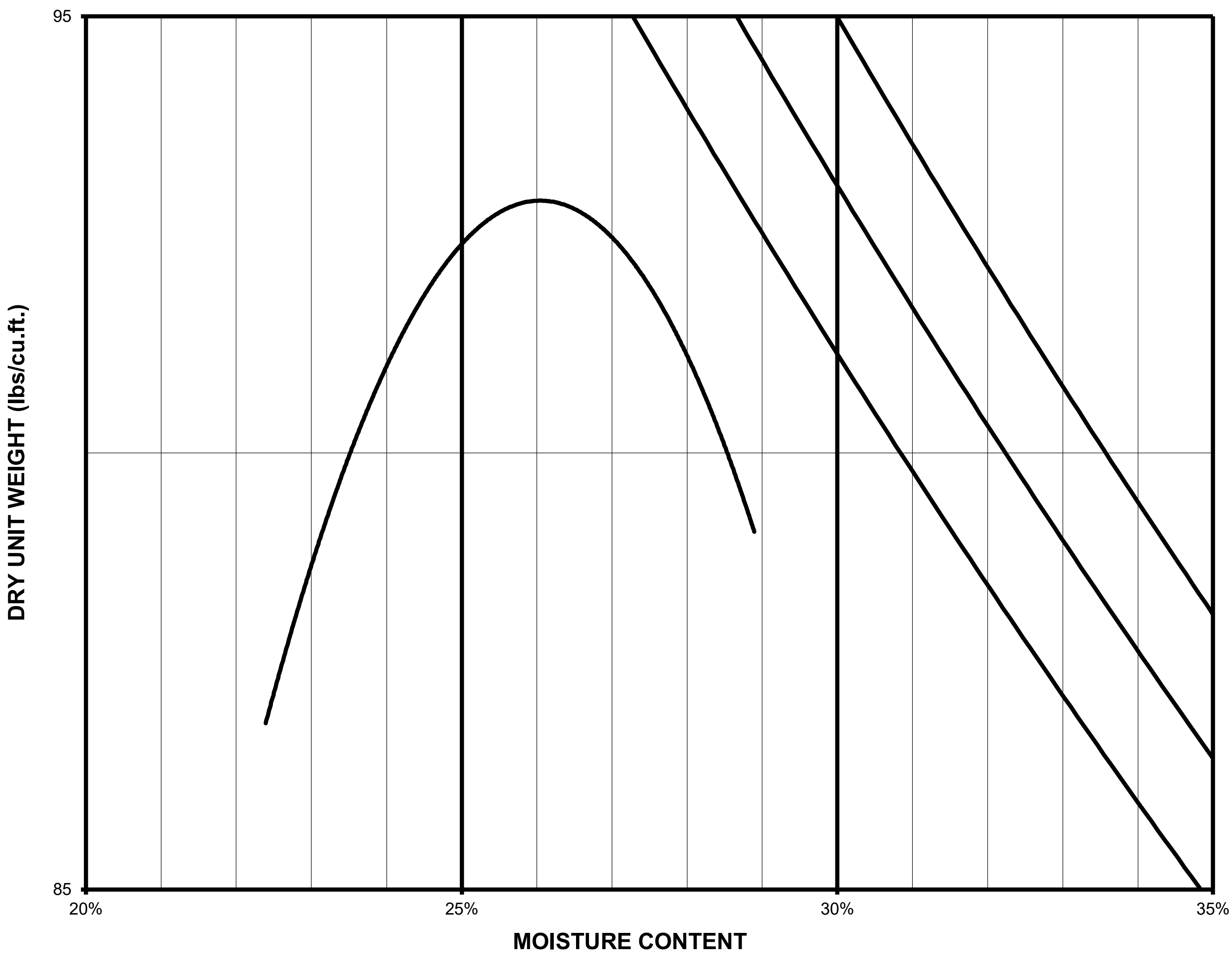


FIGURE 6

UES REPORT NO.: 24-1234 DATE: 11/27/24

UES Professional Solutions, LLC
4740 Perrin Creek
San Antonio, Texas 78217
Geotechnical I Construction Materials I Environmental
www.TeamUES.com
TBPE Firm No. 813 / TBPG Firm No. 50341

MATERIAL DESCRIPTION: Dark Brown Clay

CLASSIFICATION: FAT CLAY (CH)
SAMPLE LOCATION: NEAR BORING B-03

TEST METHOD: ASTM D1883-21

TESTED FOR: INK Civil
New Braunfels, Texas

PROJECT: Buch Tract Subdivision Roadway
New Braunfels, Texas

TECHNICIAN: Ronaldo Cristan

Percent of Maximum Density	80%	93%	98%
CBR Value at 0.1" deflection	0.8%	1.9%	4.4%
CBR Value at 0.2" deflection	0.6%	1.8%	2.9%
Compacted Dry Density, PCF	74	85.4	90.1
Compacted Moisture Content	31.5	33	31.1
Moisture Relative to Optimum	5.4	6.9	5

CBR DATA SHEET

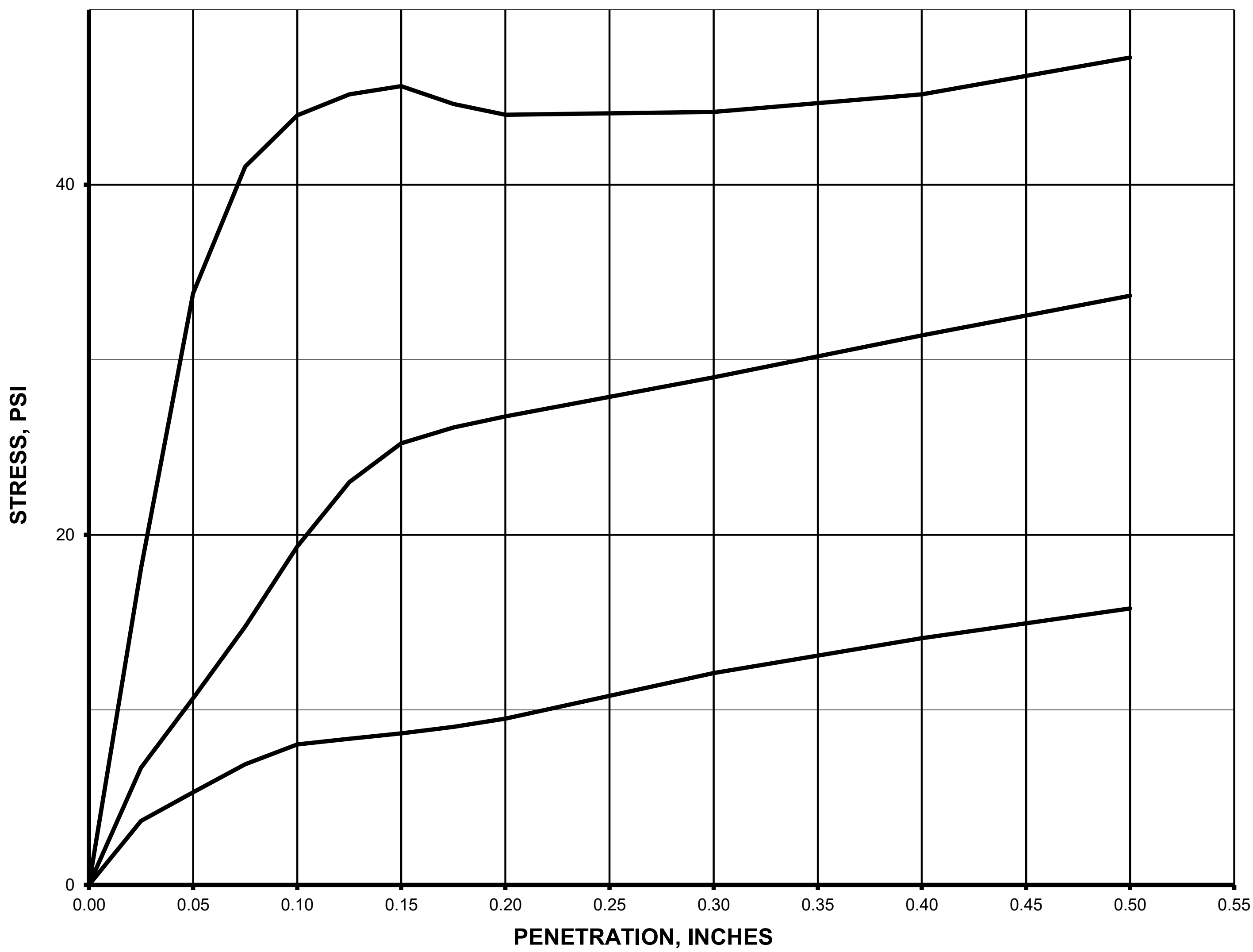


FIGURE 7

UES Professional Solutions, LLC
4740 Perrin Creek
San Antonio, Texas 78217
Geotechnical I Construction Materials I Environmental
www.TeamUES.com
TBPE Firm No. 813 / TBPG Firm No. 50341

UES REPORT NO.: 24-1234
DATE: 11/12/24

TEST METHOD: TEX-145-E PART II

TESTED FOR: INK Civil
New Braunfels, Texas

PROJECT: Buch Tract Subdivision Roadways
New Braunfels, Texas

TECHNICIAN: Ronaldo Cristan

DETERMINING SULFATE CONTENT IN SOILS

SAMPLE NO.	SAMPLE LOCATION AND MATERIAL DESCRIPTION	SOLUBLE SULFATE CONTENT
1	GRAY FAT CLAY (CH)	27 ppm

FIGURE 8

LOG OF BORING 01

UES Professional Solutions
4740 Perrin Creek
San Antonio, TX
Telephone: 210-249-2100
Fax: 210-249-2101

CLIENT: INK Civil
PROJECT: Buch Tract Subdivision Roadways
LOCATION: Buch Lane, New Braunfels, Texas
NUMBER: 24-1234

DATE(S) DRILLED: 10/23/2024 - 10/23/2024

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling, and the boring was dry upon completion of drilling.

SURFACE ELEVATION: N/A

FIELD DATA				LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE TYPE	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (POUNDS/CU.FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		SPT	N=6	14							**FAT CLAY**, firm, dark brown. (CH)
		SPT	N=8	23	69	22	47			93	
	5	ST	P=2.5	24							
		SPT	N=12	25							**FAT CLAY**, stiff to hard, light brown and gray. (CH)
		ST	P=2.5	27	70	24	46	96		100	- (swell result 5.4%, final moisture 34%)
	10										
		ST	P=4.5+	26	64	21	43			100	
	15										
		ST	P=4.5	25				102	6.1		- with gypsum deposits form 18 to 25-feet. - confining pressure (16.2 psi)
	20										
		ST	P=4.5	25							
	25										
		SPT	N=35	21				106	12.9		**FAT CLAY**, hard, dark gray, marly. (CH)
	30										
		ST	P=4.5+	21							
	35										
		SPT	N=48	19				110	17.2		
	40										Boring terminated at a depth of 40-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring location determined by UES. Drilling operations performed by UES.
GPS Coordinates: N 29.622799°, W -98.060289°

LOG OF BORING 02

UES Professional Solutions
4740 Perrin Creek
San Antonio, TX
Telephone: 210-249-2100
Fax: 210-249-2101

CLIENT: INK Civil
PROJECT: Buch Tract Subdivision Roadways
LOCATION: Buch Lane, New Braunfels, Texas
NUMBER: 24-1234

DATE(S) DRILLED: 10/23/2024 - 10/23/2024

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling, and the boring was dry upon completion of drilling.

SURFACE ELEVATION: N/A

FIELD DATA				LABORATORY DATA							
DEPTH (FT)	SAMPLE TYPE	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (POUNDS/CU.FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
0–4										**FAT CLAY**, firm to stiff, dark brown. (CH)
~0.75	SPT	N=6	17	74	25	49				
~3.25	SPT	N=14	20	76	17	59			97	
4–15										**FAT CLAY**, stiff to very stiff, light brown and gray. (CH)
~5	ST	P=2.0	27							
~7	ST	P=4.0	27	79	23	56	92		95	- (swell result 1.6%, final moisture 32%)
~9.25	SPT	N=13	27							
~14	ST	P=4.5+	23							- with calcareous materials at 14-feet.
15										Boring terminated at a depth of 15-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring location determined by UES. Drilling operations performed by UES.
GPS Coordinates: N 29.624525°, W -98.064174°

LOG OF BORING 03

UES Professional Solutions
4740 Perrin Creek
San Antonio, TX
Telephone: 210-249-2100
Fax: 210-249-2101

CLIENT: INK Civil
PROJECT: Buch Tract Subdivision Roadways
LOCATION: Buch Lane, New Braunfels, Texas
NUMBER: 24-1234

DATE(S) DRILLED: 10/23/2024 - 10/23/2024

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling, and the boring was dry upon completion of drilling.

SURFACE ELEVATION: N/A

DEPTH (FT)	SAMPLE TYPE	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (POUNDS/CU.FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
0										**FAT CLAY**, stiff to very stiff, dark brown. (CH)
1	SPT	N=12	18	77	23	54			97	
3	SPT	N=21	17							
5	ST	P=4.5+	20	71	19	52	106		94	- (swell result 13.2%, final moisture 31%)
6										**FAT CLAY**, very stiff, light brown and gray. (CH)
7	ST	P=4.5+	20	84	25	59	104		97	- (swell result 12.1%, final moisture 32%)
9	SPT	N=26	21							
14	ST	P=4.5+	23	71	26	45	104		100	- (swell result 3.2%, final moisture 27%)
15										Boring terminated at a depth of 15-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring location determined by UES. Drilling operations performed by UES.
GPS Coordinates: N 29.625913°, W -98.061371°

LOG OF BORING 04

UES Professional Solutions
4740 Perrin Creek
San Antonio, TX
Telephone: 210-249-2100
Fax: 210-249-2101

CLIENT: INK Civil
PROJECT: Buch Tract Subdivision Roadways
LOCATION: Buch Lane, New Braunfels, Texas
NUMBER: 24-1234

DATE(S) DRILLED: 10/23/2024 - 10/23/2024

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling, and the boring was dry upon completion of drilling.

SURFACE ELEVATION: N/A

Depth (ft)	Sample Type	N: Blows/ft; P: Tons/sq ft; T: Tons/sq ft; Qc: Tons/sq ft	Moisture Content (%)	LL	PL	PI	Dry Density (pounds/cu.ft)	Compressive Strength (tons/sq ft)	Minus No. 200 Sieve (%)	Description of Stratum
0–2	SPT	N=13	16	71	28	43			71	**FAT CLAY WITH SAND**, stiff, dark brown. (CH)
2–6	SPT	N=16	12							**CLAYEY SAND**, loose to medium dense, dark brown, with abundant calcareous materials. (SC)
	SPT	N=10	11	48	18	30			48	
6–15	SPT	N=59	4	26	16	10			26	**CLAYEY SAND WITH GRAVEL**, very dense, light brown, with chert fragments. (SC) (30% gravel)
	SPT	N=50/5"	3							
	SPT	N=56	1							
15										Boring terminated at a depth of 15-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring location determined by UES. Drilling operations performed by UES.
GPS Coordinates: N 29.627219°, W -98.058249°

UES™

KEY TO SOIL CLASSIFICATION AND SYMBOLS

UNIFIED SOIL CLASSIFICATION SYSTEM

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

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED - having inclined planes of weakness that are slick and glossy in appearance

FISSURED - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical

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

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

CALCAREOUS - containing appreciable quantities of calcium carbonate, generally nodular

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

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

SYMBOLS FOR TEST DATA

- ▽ — Groundwater Level (Initial Reading)
- ▼ — Groundwater Level (Final Reading)
- — Shelby Tube Sample
- — SPT Samples
- — Auger Sample
- — Rock Core
- — Texas Cone Penetrometer
- — Grab Sample

TERMS DESCRIBING CONSISTENCY OF SOIL

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

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