GEOTECHNICAL ENGINEERING STUDY

# CLEARWATER CREEK SUBDIVISION MARION, TEXAS PAVEMENT DESIGN

FROST GEOSCIENCES, INC. PROJECT NO.: FGS-G 20020 OCTOBER 2, 2020

Prepared Exclusively for:

Mr. Allen Hoover Mosiac Land Development 6812 West Avenue, Suite 100 San Antonio, Texas 78213



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Frost GeoSciences Construction Materials • Forensics Environmental • Geotechnical

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October 2, 2020

Mr. Allen Hoover Mosiac Land Development 6812 West Avenue, Suite # 100 San Antonio, Texas 78213

SUBJECT: Geotechnical Engineering Services Clearwater Subdivision San Antonio, Texas FGS Project No: FGS-G20020

Dear Mr. Hoover;

Frost GeoSciences, Inc. (FGS) is a geotechnical engineering company registered with the Texas Board of Professional Engineers, with registration No. F-9227, and is pleased to submit the results of our Geotechnical Engineering Study for the above referenced project. This report includes the results of field and laboratory testing along with our recommendations for use in preparation of the appropriate design and construction documents for this project.

We appreciates the opportunity to be of service to you in this phase of your project and future projects . If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Respectfully submitted,

Frost GeoSciences, Inc.

F. J. Caballero, P.E. Project Engineer JOT - FGS-G20020

Copies Submitted:

- i. One (1) Electronic: Mr. Allen Hoover, Mosiac Land Development, San Antonio, Texas
- ii. One (1) File



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#### **PROJECT INFORMATION**

#### **Project Authorization:**

Frost GeoSciences, Inc. (FGS) has completed a geotechnical engineering study for new pavements to be constructed in the Clearwater Creek Subdivision, in Bexar County Texas. This project was authorized by Mr. Allen Hoover of Mosiac Land Development, through acceptance of Frost GeoSciences Proposal No.: FGS-P-G20043 dated July 8, 2020. Our scope of services for this project is as outlined in that proposal.

#### **Project Description:**

We understand that the CLEARWATER SUBDIVISION development involves the design and construction of both Type "A" and Type "B" residential streets and ARTERIAL streets. The pavement section design will be in accordance with the Bexar County Flexible Pavement Design Criteria. A Vicinity Map showing the location of the project is included in the section of this report entitled Illustrations.

#### **Purpose and Scope of Services:**

The purpose of the geotechnical investigation is to evaluate the subsurface conditions at the project site and develop geotechnical engineering recommendations and guidelines for use in preparing the appropriate design and other related construction documents for this project. Therefore, our scope of services for this project include the following:

- Drill borings and excavate test pits at selected locations within the project limits to evaluate subsurface conditions and to observe the potential presence of subsurface water;
- Perform geotechnical engineering laboratory tests on selected samples recovered during our field activities to evaluate their physical and engineering properties;
- Perform Engineering analyses to develop the appropriate geotechnical engineering recommendations and guidelines, to include:
  - Appropriate pavement section thickness recommendations;
  - Pavement section material requirements and specifications;
  - General site and subgrade preparation within the construction limits; and

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- General comments regarding construction methods, sequences and potential difficulties that may arise during overall construction as it relates to the geotechnical engineering aspects of this project.
- Prepare a written report that includes a boring location plan, boring log at each bore site, and results of the laboratory testing program, descriptions of the subsurface conditions encountered and our geotechnical engineering recommendations and guidelines developed for this project.

Our scope of services for this project did not include the assessment of any potential environmental concerns at this site. Therefore, such concerns are not addressed in this report.

#### SITE AND SUBSURFACE CONDITIONS

#### Site Description:

The site conditions were assessed using a combination of aerial photography and observations made by the FGS personnel during our field operations. The following site conditions were noted:

• The site is the **Clearwater Creek Subdivision**, located on the southwest side of I-10, off of Trainer Hale Road in Marion, Texas.

### Site Geology:

According to the Bureau of Economic Geology, and The University of Texas at Austin Geologic Atlas of Texas – San Antonio Sheet (1982), the Site is located on the following Geological Groups:

• The Leona Formation (Qle) - is fine calcareous silt that begins grading down into coarse gravel.

#### Soil Description:

According to the United States Department of Agricultural (USDA) Natural Resources Conservation Service (NRCS) Soil Survey of Bexar County (1966), the Site is located on the following soils:

• Lewisville silty clay, 0 to 1 percent slopes (LvA) – The Lewisville Silty Clay, 0-1% slopes (LvA) consists of moderately deep, dark colored, nearly level alluvial

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soils. These soils occur mainly on terraces bordering the San Antonio and Medina Rivers and their main tributaries. The surface layer is very dark grayish brown to brown silty clay and is about 24 inches thick. It has fine sub-angular blocky or blocky structure, and is firm and crumbly when moist. This layer contains a few fine concretions of lime carbonate. The subsurface layer is brown silty clay and is about 20 inches thick. It has fine, sub-angular blocky or blocky structure and is very firm but crumbly when moist. This layer is limy. The underlying material is reddish yellow silty clay. It has weak, blocky structure, is very firm when moist, and contains large amounts of lime. Beneath this layer there may be deep beds of water rounded limestone gravel. Lewisville soils have slow or medium surface drainage and medium internal drainage. Permeability is slow to moderate. The capacity to hold water is good. Natural fertility is high. The hazard of water erosion is serious on the more sloping parts but is very slight on the nearly level areas.

• The Houston Black Clay, terrace, 1-3% slopes (HtB) - This soil occurs as long, narrow slopes, generally adjacent to the larger drainage-ways. It is mainly in the southcentral and southwestern parts of the county. The surface layer is dark gray, about 34" thick. The subsurface layer is gray, approximately 20" thick, and has a blocky, crumbly structure. This layer may have a few lime concretions. Water erosion is a hazard, water intake is slow, and a plow-pan is likely to form.

#### Subsurface Conditions:

Subsurface conditions at the site were evaluated by drilling a total of THIRTEEN (13) soil borings to a depth of FIFTEEN (15) feet and THREE (3) test pits to approximately two (2) feet depth were excavated to obtain soil samples to determine the California Bearing Ratio (CBR) of the soil samples. The number of borings and test pits, their locations and their depths were selected by FGS. The borings and test pits were located in the field by FGS personnel using Global Positioning System (GPS) technology. The borings were advanced using solid flight auger drilling methods and soil samples were routinely obtained during the drilling process; the test pits are routinely excavated to the appropriate depth. Drilling and sampling techniques were accomplished in general accordance with ASTM procedures. Logs of the borings are presented in the Appendix section at the end of the report. A Borehole Location Plan with the location of each boring is presented in the Illustrations section of this report.

The soil samples obtained during our field exploration were transported to our laboratory where they were reviewed by qualified geotechnical engineering personnel. Representative samples were selected and tested to determine pertinent engineering properties and characteristics for use in evaluating the project site. Laboratory testing and soil classification were accomplished in general accordance with ASTM procedures.

Based on the field and laboratory data, it is determined that the stratigraphy of the site is generally as follows:

Stratum	Range of Depth, (feet)	Stratum Description and Classification
Ι	0.0 to 3.0	Fat Clay (CH), Dark Brown
II	3.0 to 15.0	Chalky Clay (CL), Light Tan

The subsurface descriptions shown above are general in nature and highlight major subsurface stratification features and material types. The boring logs included in Appendix A should be reviewed for specific information such as soil or rock material descriptions, stratifications, sampling depths and intervals, field test data and laboratory test data. The stratifications shown on each boring log only represent the conditions and approximate boundaries between strata at that actual boring location. The actual transitions between strata may be gradual. Variations will occur and should be expected at locations away from each boring location. Subsurface water level observations made during field operations are also shown on the boring logs. The indicated stratum depths and any subsurface water levels are measured from the ground surface and are estimated to the nearest one-half (½) foot. Portions of any samples that are not altered or consumed by laboratory testing will be retained for 30 days from the date of issuance of this report. Unless otherwise requested by the client and/or depending upon project requirements, all soil samples will be discarded after that retention period.

The P.I. values obtained from the soil samples taken near the surface ranged from **37 to 46** in the CLAY subgrade soil. Due to the characteristics of the materials found in the area, FGS is of the opinion that the sulfate contents of the materials will pose a problem if not treated with lime. In the case where the P.I. value of the material near the surface is greater than 20 the PI could be reduced if lime is applied to the subgrade material or the native Clay material is replaced with a more suitable material.

#### Subsurface Water Information:

The borings were advanced using dry drilling techniques to their full depths in an attempt to detect the potential presence of subsurface water in the material. Subsurface water was not encountered either during or upon completion of drilling or sampling operations. The boreholes were backfilled with soil cuttings upon completion of drilling and sampling operations. Short-term field observations generally do not provide accurate subsurface water levels for evaluation at most

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sites. Subsurface water levels are generally influenced by seasonal and climatic conditions that result in fluctuations of subsurface water levels over time. The earthwork contractor should check for subsurface water during excavation activities especially when sand and/or gravel are encountered. No specific notations concerning subsurface water are indicated on the boring logs in Appendix A since **no subsurface water was observed**.

#### ENGINEERING ANALYSIS AND RECOMMENDATIONS

#### **Pavement Design:**

Flexible pavements should be designed and constructed in accordance with the requirements established by local municipalities and the American Association of State Highway and Transportation Officials (AASHTO) "Guide for Design of Pavement Structures", for this project, the Bexar County Flexible Pavement Design Criteria was used.

Below is a table which outlines the Bexar County Flexible Pavement Design Criteria, which was used in the design of the proposed street sections for this project:

	San Antonio Pavement Specifications														
	Primary and Secondary ArterialsLocal Type "B" &Local Type "A" Streets withLocal Type "A" Streets withCollector StreetsBus TrafficNO Bus Traffic														
W18	ESAL = 3,000,000         ESAL = 2,000,000         ESAL = 1,000,000         ESAL = 100,000														
R	95	%	90%	6	70	%	70%								
So	Flexible	Rigid	Flexible	Rigid	Flexible	Rigid	Flexible	Rigid							
50	0.45	0.35	0.45	0.35	0.45	0.35	0.45	0.35							
Ро	4.2	4.5	4.2	4.5	4.2	4.5	4.2	4.5							
Pt	2.5	2.5	2.0 / 2.5	2.5	2.0	2.5	2.0	2.0							
ΔPSI	1.7	2.0	2.2 / 1.7	2.0	2.2	2.0	2.2	2.5							
Т	20	)	20		20	0		20							
GNI	Min.	Max	Min.	Max.	Min.	Max.	Min.	Max.							
SN	3.80	5.76	2.92	5.05	2.58	4.20	2.02	3.18							

#### Input Parameters used in Asphalt Pavement Section Calculation

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In addition to the parameters shown above, the soil resilient modulus,  $M_R$ , of the subgrade soil, must be determined. Typically, this value is obtained through California Bearing Ratio (CBR) testing. Field investigations show that all the soil samples obtained within the subgrade at the site are very similar with very similar (CBR) values. These soils are Dark Brown Fat Clay (CH) with CBR values ranging between 1.9 and 2.1. We will use the 2.0 CBR value to design our pavement sections.

Information regarding the moisture density relationships of the bulk samples of subgrade soil collected at this site and the CBR test results are presented in the Appendix section of this report.

The Pavement Sections for Clay soils with a CBR value of 2.0 are presented in the tables below.

It should be noted, the P.I. value of the Clay subgrade at this site varies between 37 and 46. The Clay soils may have areas with a P.I. value of 20 or more. While the Chalk soils will generally have a P.I. value of 20 or less. The subgrade soils with a P.I. value greater than 20 should be treated with lime to reduce their P.I. value or be replaced with better material approved by the Project Engineer. It will be important that once the field work starts, personnel from FGS be present to identify the areas where lime should be applied to reduce the P.I. value of the subgrade soil.

For the purposes of developing layer thicknesses for the pavement sections shown below, we have used the following structural coefficients in the calculation of pavement structural numbers:

Material Type	Structural Coefficient	Drainage Coefficient
TXDOT Item 340, Hot Mixed Asphaltic Concrete	0.44	1.00
TXDOT Items 292 or 340, Asphalt Treated Base	0.38	1.00
TXDOT Item 247, Flexible Base - Crushed Limestone	0.14	1.00
TXDOT Item 247, Flexible Base	0.08	1.00
Lime Stabilized Subgrade, (6 inch Min.)	0.08	1.00

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Based on the design parameters and the structural coefficients discussed above, the minimum required Structural Number, SN, for the existing soil conditions may be determined using equation found in Appendix CC-1 of the Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures prepared for the National Cooperative Highway Research Program

0.64

MR = 2555 (CBR)

Where: MR = the DESIGN Resilient Modulus 0.64 MR = 2555 (2.0) MR = 3,981.53 psi

#### WE WILL USE MR=3,980 PSI FOR OUR PAVEMENT DESIGNS

In accordance with Bexar County design parameters we have developed the following flexible pavement recommendations for Local "A" Streets with bus Traffic on a Clay subgrade.

COMPONENT	FLEXIBLE DESIGN SECTION (inches)								
COMPONENT	Local "A" Streets with Bus Traffic								
	Option # 1	Option # 2	Option # 3	Option # 4					
Type D HMAC Surface	2.0 inches	2.0 inches	2.75 inches	2.0 inches					
Type B HMAC Base	N/A	N/A	N/A	N/A					
Flexible Base, (Type B, Grade 2), Pit Run	16.75 inches	11.0 inches	18.0 inches	13.75 inches					
Lime Treated Subgrade (6 inch Min.)	YES	YES	NO	NO					
3 X 5 Rock									
Wrapped in Mirafi 180N Filter Fabric	NO	NO	YES	YES					
TENSAR GEOGRID (TX-5)	NO	YES	NO	YES					
Design ESAL Value	1,000,000	1,000,000	1,000,000	1,000,000					
Actual ESAL Value	1,054,000	1,016,000	1,104,000	1,069,000					

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In accordance with Bexar County design parameters we have developed the following flexible pavement recommendations for Local "B" Streets on a Clay subgrade.

	FLEXIBLE DESIGN SECTION (inches)							
COMPONENT	Local "B" Streets							
	Option # 1	Option # 2	Option # 3	Option # 4				
Type D HMAC Surface	3.0 inches	3.0 inches	3.0 inches	3.0 inches				
Type B HMAC Base	4.0 inches	4.0 inches	4.0 inches	4.0 inches				
Flexible Base, (Type B, Grade 2), Pit Run	8.75 inches	6.0 inches	12.25 inches	6.75 inches				
Lime Treated Subgrade (6 inch Min.)	YES	YES	NO	NO				
3 X 5 Rock								
Wrapped in Mirafi 180N Filter Fabric	NO	NO	YES	YES				
TENSAR GEOGRID (TX-5)	NO	YES	NO	YES				
Design ESAL Value	2,000,000	2,000,000	2,000,000	2,000,000				
Actual ESAL Value	2,025,000	3,256,000	2,058,000	2,015,000				

In accordance with Bexar County design parameters we have developed the following flexible pavement recommendations for Arterial Streets on a Clay subgrade.

COMPONENT	FLEXIBLE DESIGN SECTION (inches)							
COMPONENT	Arterial Streets							
	Option # 1	Option # 2	Option # 3	Option # 4				
Type D HMAC Surface	4.0 inches	4.0 inches	4.0 inches	4.0 inches				
Type B HMAC Base	4.0 inches	N/A	4.0 inches	4.0 inches				
Flexible Base, (Type B, Grade 2), Pit Run	12.0 inches	17.50 inches	15.50 inches	9.25 inches				
Lime Treated Subgrade (6 inch Min.)	YES	YES	NO	NO				
3 X 5 Rock								
Wrapped in Mirafi 180N Filter Fabric	NO	NO	YES	YES				
TENSAR GEOGRID (TX-5)	NO	YES	NO	YES				
Design ESAL Value	3,000,000	3,000,000	3,000,000	3,000,000				
Actual ESAL Value	3,052,000	3,022,000	3,093,000	3,147,000				

Note: Asterisk (\*) If the P.I. value of the Clay Subgrade is 20 or less, than Moisture Conditioning may be substituted for Lime Treatment, see Pavement Analysis section for additional details.

Double Asterisk (\*\*) the design was calculated using Tensar Spectra Pave4 PRO software.



#### **Pavement Analysis:**

The pavement designs presented in the previous paragraphs include designs for lime stabilized subgrade and lime treated subgrade, to be used on pavement sections with a Clay subgrade and a P.I. value greater than 20. The Bexar County pavement design criteria requires that a minimum of six (6) inches of subgrade soil below the pavement structure be treated or stabilized if the subgrade has a P.I. value greater than 20. If a Geogrid fabric is used to reduce the base course thickness, treatment or stabilization of the underlying high P.I. soil is still required, although The City and County could allow 3 X 5 Rock wrapped in a Filter Fiber.

In the case that subgrade fill is required to bring the subgrade elevation up to final grade, fills should be made with flexible base, on-site Chalk millings or other material approved by the Project Engineer. Fill material compaction shall be in accordance with subgrade compaction requirement for Bexar County.

#### **Pavement Material Specifications:**

The following guidelines have been prepared for use in the selection and preparation of various materials that may be used to construct the pavement sections. Submittals should be made for each pavement material and should be reviewed by the Geotechnical Engineer and other appropriate members of the design team. The submittals should provide the test information necessary to verify full compliance of the materials with the recommended or specified material properties.

**Fill Material** - If fill is used to raise the grade, approved fill material underneath the pavement should be used. The fill should be free of deleterious material with a minimum CBR value of 4.5 and preferably a Plastic Index below 20. If the material has a PI greater than 20 the lime application rates should be reevaluated and sulfate content tested for the fill material. The material should be placed as per applicable city or county guidelines.

Hot-Mix Asphaltic Surface Course – Asphaltic concrete should be plant mixed, hot laid, Type D meeting the 2014 TX DOT Standard Specification Item 340. Mix should be compacted to between 92 and 97 percent of the maximum theoretical density as determined by TEX-227-F.

Asphalt Treated Base – Asphalt treated base should be placed in maximum six (6) inch compacted lifts. These materials should conform to the requirements of the 2014 TX DOT Standard Specification Item 292, Grade 1 or Item 340, Type A or B.

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**Flexible Base Course** – Flexible base materials should be placed in maximum eight (8) inch compacted lifts. The base materials should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557. Flexible base materials should be moisture conditioned to between plus or minus two (+-2) percentage points of the optimum moisture content. Flexible base materials should meet all requirements specified in 2014 TX DOT Standard Specification Item 247, Type A or B, Grade 1 or 2.

Lime Treated Subgrade – Clay subgrade (with P.I. values greater than 20) should be treated with hydrated lime to reduce its plasticity and improve its strength and load carrying ability. Hydrated lime should be mixed with the subgrade soils in accordance with Bexar County Specifications for Lime Treatment to reduce the P.I. value to 20 or less.

Lime Stabilized Subgrade – Clay subgrade (with P.I. values greater than 20) should be stabilized with hydrated lime to reduce its plasticity and improve its strength and load carrying ability. Hydrated lime should be mixed with the subgrade soils in accordance with Bexar County Specifications for Lime Stabilization. We estimate that approximately six (6) percent (by weight) hydrated lime will be required to properly stabilize these soils. This is equivalent to about 27 pounds of hydrated lime per square yard for a six (6) inch depth. The optimum lime content should result in a soil-lime mixture with a pH of at least 12.4 when tested in accordance with ASTM C 977, Appendix XI and should reduce the P.I. to 20 or less.

**3 X 5 Rock Wrapped in Filter Fabric** – The County may allow 3 X 5 rock wrapped in Filter Fabric instead of lime stabilization. However the wrapping fabric must be Mirafi 180N Filter Fabric or equal, and prior approval must be obtained.

**Geogrid** – Tensar TX5 geogrid may be used to provide additional structural support to flexible base materials. The geogrid should be placed as per manufacturer's recommendations at the interface between the flexible base and subgrade.

**Moisture Conditioned Subgrade** – Exposed subgrade soils that do not need to be stabilized or treated should be scarified and moisture conditioned to between plus or minus three (+-3) percentage points of optimum to a depth of at least six (6) inches. The soils should then be compacted to at least 95 percent of the maximum dry density as determined by ASTM D 698.



#### Lime Series Curve and Unconfined Compressive Strength:

A Lime Series Curve was developed for the project to determine the optimum amount of hydrated lime required to stabilize the subgrade in accordance with Bexar County criteria. The optimum lime content should result in a soil-lime mixture with a pH of at least 12.4 when tested in accordance with ASTM C 977 and should reduce the Plasticity Index to 20 or less. The lime series curve depicts the percent lime added to the subgrade and the resulting pH/P.I. A strength verification test was performed on the lime stabilized subgrade to determine the Unconfined Compressive Strength (UCS) of the soil-lime mixture. **Bexar County requires an UCS** of 160 psi, a pH of 12.4 or greater and a P.I. of 20 or less. Results of the Lime Series Curve and the Unconfined Compressive Strength test are presented in the Appendix section of this report. Additional field verification testing will be required during the subgrade stabilization process once the project has started.

#### Subgrade Preparation:

The pavement alignment should be stripped of topsoil, vegetation, roots, loose or soft soils and any other deleterious materials. The stripped materials should be removed from the site and properly disposed of or used elsewhere on site. Upon completion of stripping operations, the alignment may be either excavated or filled as necessary to achieve the desired pavement elevation. Prior to the placement of any fill for grade adjustments or the construction of the pavement section, the exposed subgrade should be proof rolled with appropriate construction equipment weighing at least 20 tons. Unstable or non-uniform areas should be removed to expose stable soils and may be replaced with clean, properly compacted flexible base material or other more suitable material approved by the Project Engineer. All fill placed within the paved areas should be free of any deleterious materials and should not contain stones larger than the maximum lift thickness. The fill materials should be placed on prepared surfaces in lifts not to exceed eight (8) inches compacted measure. All fill materials placed in paved areas should be moisture conditioned to between plus or minus three (+-3) percentage points of the optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined by ASTM D 698.

#### Drainage:

Proper pavement perimeter drainage should be provided and maintained to minimize the infiltration of surface water into the pavement section from surrounding unpaved areas. The infiltration of water into the pavement section typically results in the accelerated degradation of the section with time as vehicular

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traffic traverses the infiltrated area. Curbs used in paved areas should extend at least three (3) inches into the base materials to help reduce the potential for water infiltration into the pavement section. Prefabricated strip drains or small "French" drains may also be installed behind curbs to intercept and remove water from the pavement perimeter before water infiltrates the pavement section. Furthermore, all concrete and asphalt interfaces should be sealed using a sealant that is compatible with both asphalt and concrete.

Proper pavement drainage is a critical component in the long-term performance of a pavement section. The pavement section recommendations shown above are based on generally recognized structural coefficients. These coefficients reflect the relative strength of each pavement material type and their contribution to the structural integrity of the pavement. The infiltration of water into these pavement materials will generally weaken the materials and result in the degradation of the pavement's performance. Therefore, proper drainage of the pavement should be carefully considered by the project design team to ensure that water rapidly drains from the pavement and does not pond on or around the pavement.

### **Utilities:**

Care should be exercised to make sure that utility lines do not serve as conduits that transmit water beneath foundations or pavements at this site. Secondary backfill for utility lines that are located beneath pavement, sidewalk and building areas should consist of lean clay (CL), flowable fill or other material in accordance with local municipality or utility provider specifications. Proper compaction of trench backfill is essential in pavement areas where settlement of the trench backfill can cause significant distress to the overlaying pavement. Flowable fill materials should be as described in the American Concrete Institute ACI 229R. Granular materials such as sand or gravel are not recommended as secondary backfill in utility trenches located in building pad or pavement areas.

#### **Excavations:**

As was discussed previously, these materials that are penetrated by geotechnical augers can generally be excavated with conventional earthmoving equipment. It should be noted that excavation equipment varies and field conditions may vary. Generally, geologic processes (such as faulting, weathering, etc.) are erratic and large variations can occur in small lateral distances. Details regarding "means and methods" to accomplish the work (such as excavation equipment and technique selection) are the sole responsibility of the project contractor.



The Occupational Safety and Health Administration (OSHA) Safety and Health Standards (29 CFR Part 1926, Revised October 1989), require that excavations be constructed in accordance with the current OSHA guidelines. Furthermore, the State of Texas requires that detailed plans and specifications meeting OSHA standards be prepared for trench and excavation retention systems used during construction. 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. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavation as part of the contractor's safety procedures.

In no case should slope height, slope inclination or excavation depth exceed those specified in local, state and Federal safety regulations. OSHA addresses the construction of slopes in large excavations that are less than 20 feet deep on OSHA Table B-1. We have provided this information solely as a service to our client. The OSHA regulations and OSHA Table B-1 should be consulted prior to any excavations that would be subject to OSHA regulations. FGS does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state and Federal safety or other regulations.

#### **QUALITY CONTROL**

#### **Document Review:**

Due to the uniqueness of each project and construction site, it is important that all engineering reports, drawings, specifications, change orders and other related documents accurately reflect the recommendations intended by the respective design professionals involved in the project. The performance of the pavements planned for this project will depend on the correct interpretation and implementation of our geotechnical engineering report and guidelines. We should be provided the opportunity to review the final design and construction documents to check that our geotechnical recommendations are properly interpreted and implemented in these documents. This review is not a part of our scope of services for this project and would be an additional service. We cannot be responsible for misinterpretation of our geotechnical recommendations if we have not had an opportunity to review these documents.



#### **Construction Materials Testing:**

As the Geotechnical Engineer of Record, we recommend that Frost GeoSciences be retained to monitor the pavement installation and earthwork related activities for this project. Due to our familiarity with this project, it is important that FGS provide these services to make certain that our geotechnical recommendations are interpreted properly and to make certain that actual field conditions are those described in our geotechnical report. We believe this technical overview and on-site surveillance during these activities is essential to provide well-constructed pavements and to check that the intent of these geotechnical recommendations is met.

#### **REPORT LIMITATIONS**

The recommendations and guidelines submitted in this report are based on the available subsurface information developed by FGS and project information provided by the client. If there are any changes in the nature, design or location of the project, the opinions, conclusions, recommendations and guidelines submitted in this report should not be used until we are able to review the changes and respond in writing as to whether the information contained within this report remains applicable.

Subsurface conditions at this site have been observed and interpreted at the Boring Locations only. Substantial variations in subsurface materials resulting from local geologic conditions or previous site use may occur away from the boring locations. These variations may not become evident until construction begins. Therefore, any conditions that vary significantly from those described in our report should be reported to FGS immediately. FGS will then determine whether our conclusions, opinions and recommendations remain valid or whether additional investigation and/or engineering analysis is required.

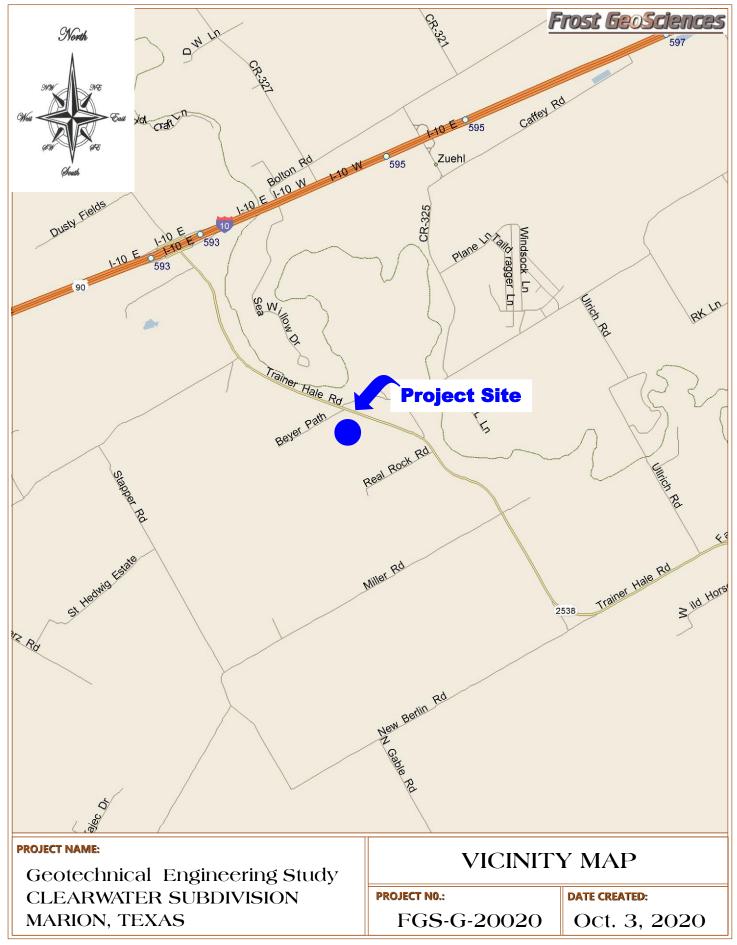
This study has been performed in accordance with accepted geotechnical engineering practice using the standard of care and skill currently exercised by geotechnical engineers practicing in this area. No warranty, expressed or implied, is made or intended. This report has been prepared exclusively for the specified client; project and client's authorized project team for use in preparing the appropriate design and construction documents for this project. This report may be included in the construction documents for this project provided the report is reproduced in its entirety. This report shall not be reproduced or used for any other purpose without the express written consent of Frost GeoSciences, Inc.

## **ILLUSTRATIONS**

Vicinity Map Boring Location Plan

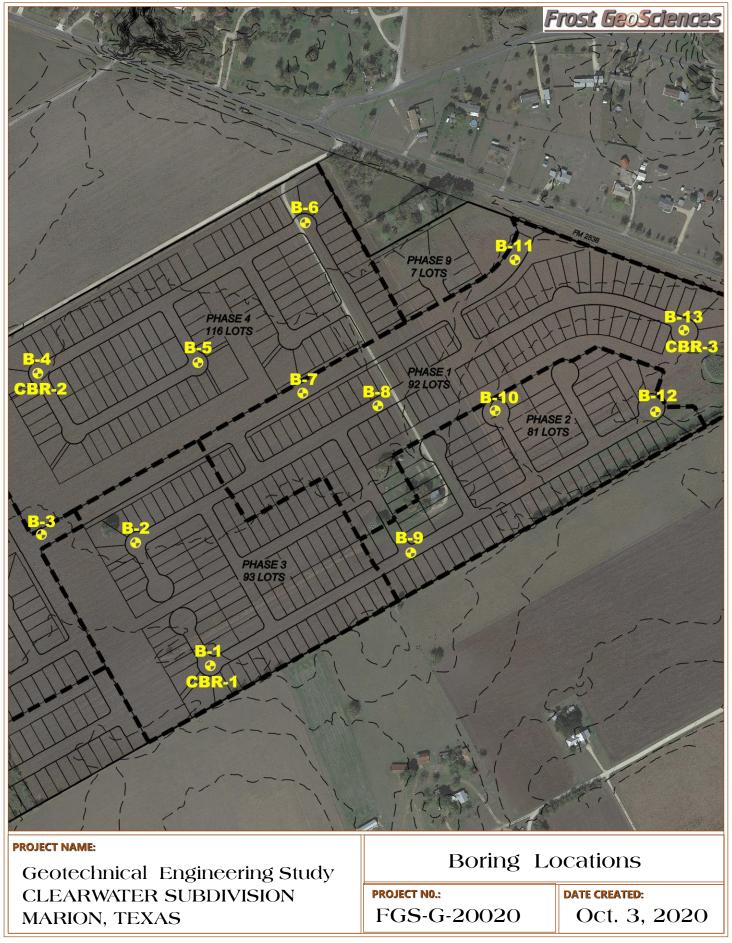
FGS Project No: FGS-G20020

# VICINITY MAP



Geotechnical • Construction Materials • Geologic • Environmental

# **BORING PLAN**



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## **APPENDIX "A"**

Boring Logs

Symbol Key Sheet

FGS Project No.: FGS-G20020

# **BORING LOGS**

													BORING
					PR	OJE	ECT:	Clea	arwater	Cre	ek Sı	ıbdiv	
				/				Mari	ion				BORING NO.: <u>B-01</u>
			aoSalan					Mari	ion, Tx				DRILLING DATE: 7/20/2020
	Geolog	gic = Geol	Environment technical	ar									SURFACE ELEVATION:
		-			CL	IEN	T:	Mos	iac Lar	nd De	evelo	pme	ent PAGE 1 of 1
	FIF		DATA			14	BO	RATC	DRY DA	ATA			DRILLING METHOD(S):
	1 11				ATT	ERBI							Dry auger drilling techniques were used to the termination depth of the boring.
				(%)	Ĺ	IMIT	S					(%)	
				MOISTURE CONTENT (%)			Ш			(	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	SUBSURFACE WATER INFORMATION:
				ITE <sup>N</sup>		늘	ND ND			%) Z	ESSI (	SIE	Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.
3			LE	COL	IMI		È	ΣË	E (L	RAI	D PRI	200	
MB(	(FT)	S	ISU SQ	JRE	רומחום רושוב	PLASTIC LIMIT	PLASTICITY INDEX	DRY DENSITY POUNDS/CU.FT	STH STH SO F	FAILURE STRAIN (%)	S/S	ġ	
SY	ОЕРТН (FT)	IPLE	% CONS	ISTL	LIQL	PLA	PLA	BON	NS/S	-UR	UND	SU	
SOIL SYMBOL	DEP	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MO	LL	PL	PI	POL	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAII	00 POG	MIN	DESCRIPTION OF STRATUM
		ÌŃ		10	58	14	44						Dark Brown Clay
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110												_	
	- 5												
	J			2	26	0	07						Light Tap Challey Clay at 5
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	78	11											
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	_			7	35	10	25						
11	- 15	-14											Boring Terminated at 15 feet of Depth
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070-													
N - STANDARD PENETRATION TEST RESISTANCE											REMARKS:		
2	P - PO	CKE	ET PENETF	ROME	ETER	RES	SISTA	NCE					
2	T - TXDOT CONE PENETRATION RESISTANCE R - ROCK CORE RECOVERY												
	R - ROCK CORE RECOVERY RQD - ROCK QUALITY DESIGNATION											12	

										LO	G C	)FE	BORING			
					PR	OJE	CT:	Clea	arwater	Cree	ek Su	ıbdiv		FGS-G20020		
				/				Mari					BORING NO.: DRILLING DATE:	<u>B-02</u>		
			20501270 Environment					Mari	ion, Tx				SURFACE ELEVATION:	7/20/2020		
	Deolog	Geol	echnical													
L_		-			CL	IEN	T:	Mos	iac Lar	nd De	evelo	pme		PAGE 1 of 1		
	FIE	LD	DATA			LÆ	BO	RATC	DRY DA	ATA			DRILLING METHOD(S): Dry auger drilling techniques were used to the termination depth of the boring.			
						ERB							by adjer onling teamiques note acce to the termine			
				MOISTURE CONTENT (%)							RE	200 SIEVE (%)	SUBSURFACE WATER INFORMATION: Subsurface water was not encountered either during or upon completion of dri			
				TEN.		E	PLASTICITY INDEX			FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	SIEV	Subsurface water was not encountered either during or operations and subsurface water observations.	upon completion of drilling		
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5	P - PU	JUK	DARD PEN ET PENET	RUN	CIC	/ UE	01017	ANUL					REMARKS:			
	T - TX	DO	T CONE PE	NET	RATI	ON F	RESIS	STANC	E							
FROS	R - R	- RC	CORE RE	TY D	ESIG	NAT	ION									
	log is not	alid if	separated from the	report										1		

										LO	GC	)F I	BORING			
		-			PF	ROJI	ECT		arwater	Cre	ek Sı	ıbdi		FGS-G20020		
	Bene	e IE	ಎಂ೯ಲೆಎಂ	202				Mar					BORING NO.: DRILLING DATE:	B-03		
			<u>20501271</u> Environment technical					Mar	ion, Tx				SURFACE ELEVATION:	7/20/2020		
		Geo	technical		CL	IEN	T:	Mos	iac Lai	nd D	evelo	pme	-	PAGE 1 of 1		
	FIE	ELD	DATA			L/	АВО	RATO	DRY D	ATA			DRILLING METHOD(S):			
						ERB	ERG						Dry auger drilling techniques were used to the termination	on depth of the boring.		
				۲ (%)			1 2				ш	(%)	SUBSURFACE WATER INFORMATI	ON:		
				TEN.		E	PLASTICITY INDEX			(%) N	NSS:	SIEVE	Subsurface water was not encountered either during or operations and subsurface water observations.	upon completion of drilling		
Ы			ե	CON			Ę	₹ Fu	BVIC (-	<b>FRAII</b>	PREN	200				
YMB	H (FT)	ES	WS/F S/SO WS	URE	רוסחום רושוב	PLASTIC LIMIT	ASTIC	ENSI DS/C	RESS VGTH	S ES.	S/SQI	Ň.				
SOIL SYMBOL	ОЕРТН (FT)	SAMPLES	N: BLOWS/F P: TONS/SG T: BLOWS R: % R: %	MOISTURE CONTENT	_			DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)				
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	Ŭ			6	34	9	25						Light Tan Chalky Clay at 5'			
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	N - ST.		ARD PENE						NCE				REMARKS:			
	T - TXDOT CONE PENETRATION RESISTANCE															
	R - ROCK CORE RECOVERY RQD - ROCK QUALITY DESIGNATION															

										LO	GC	)F I	BORING			
					PF	ROJI	ЕСТ		arwater	Cre	ek Sı	ubdi		FGS-G20020		
	Sene	2 /E	aacelaa	202				Mar					BORING NO.: DRILLING DATE:	B-04		
			1205C1271. Environment Intechnical					Mar	ion, Tx				SURFACE ELEVATION:	7/20/2020		
		Geo	technical				angle -		•	1.5			-			
H						IEN			iac Lai		evelo	pme		PAGE 1 of 1		
	FIE	ELC	DATA					RATC	DRY DA	ATA			DRILLING METHOD(S):	on depth of the boring		
						ERB							Dry auger drilling techniques were used to the termination depth of the boring.			
BOL	F		/FT Q FT	MOISTURE CONTENT (%)	רוסחום רושוב	PLASTIC LIMIT	PLASTICITY INDEX	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	<ol> <li>200 SIEVE (%)</li> </ol>	SUBSURFACE WATER INFORMATI Subsurface water was not encountered either during or operations and subsurface water observations.			
SYN	H (F	PLES	S/SNC S/SNC	STUR	Indui	LAS.	LAS'	DEN NDS/	PRE S/SC	JRE	NDS	S NG				
SOIL SYMBOL	ОЕРТН (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ F T: BLOWS R: % RQD: %	NOIS		PL	PI	PORY OUN	STRE	-AILI	POUL	MINUS NO.	DESCRIPTION OF ST			
111			20,700	-		1.2		uu	0000	ш.	00	2	Description of Str Dark Brown Clay	AT UN		
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	Geol	S D	2050120. Environmen	<u>085</u> tal				Mar	ion, Tx				DRILLING DATE: 	7/20/2020			
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	FI	ELD	DATA			L	АВО	RATC	RY D	ATA			DRILLING METHOD(S):				
							ERG						Dry auger drilling techniques were used to the termination depth of the borin				
				(%)	<b>–</b>	_IMIT 	1 20	-			щ	(%)	SUBSURFACE WATER INFORMATI	ON <sup>.</sup>			
				ENT		F	NDE)			(%)	SUF	200 SIEVE (%)	Subsurface water was not encountered either during or				
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SOIL SYMBOL	ОЕРТН (FT)	SAMPLES	S CONSI	MOISTURE CONTENT	רומחום רושוד	PLASTIC LIMIT	PLASTICITY INDEX	DRY DENSITY POUNDS/CU.FT	NPRI NS/S	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO.					
SOIL	DEP	SAN	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MO	LL	PL	PI	POL	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAIL	DO POOL	MIN	DESCRIPTION OF STR	RATUM			
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										LO	GC	)F I	BORING			
					PF	ROJE	ECT:	Clea	arwater	Cre	ubdiv		FGS-G20020			
		. /2	(P-#	/				Mari					BORING NO.:	B-06		
	Geolo	g (b) aic =	20SCI270 Environment	195 al				Mari	ion, Tx				DRILLING DATE: 	7/20/2020		
		Geo	Environment technical										-			
		-			CL	IEN			iac Lar		evelo	pme		PAGE 1 of 1		
	FIE	ELD	DATA			1122.0	- 100 - 100	RATC	DRY DA	ATA			DRILLING METHOD(S): Dry auger drilling techniques were used to the termination depth of the boring.			
						ERB	ERG S						by auger unning teeriniques were used to the terminate	ar depart of and borning.		
				MOISTURE CONTENT (%)						~	RE	MINUS NO. 200 SIEVE (%)	SUBSURFACE WATER INFORMATI			
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SOIL SYMBOL	ОЕРТН (FT)	SAMPLES	N: BLOWS/F P: TONS/SC T: BLOWS R: % ROD: %	IOIS		ਕ PL		DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	INU				
Ŭ,	0	10	ZCHCC	2	LL	PL	PI	04	ONC	щ	06	2	DESCRIPTION OF STE Dark Brown Clay			
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1				~				Mar	ion				BORING NO.:	<u>B-07</u>		
			eoScien					Mar	ion; Tx				DRILLING DATE: SURFACE ELEVATION:	7/20/2020		
1	Beolo	Geo	Environmen technical	a									SURFACE ELEVATION:			
		-			CL	.IEN	T:	Mos	iac La	nd D	evelo	pme	ent	PAGE 1 of 1		
	FIELD DATA LABORATORY DATA									ATA			DRILLING METHOD(S):			
					ATT	ERB	ERG						Dry auger drilling techniques were used to the termination	on depth of the boring.		
				(%)		<u>_IMIT</u>		-			щ	(%)	SUBSURFACE WATER INFORMATION:			
				MOISTURE CONTENT (%)		F	PLASTICITY INDEX			(%)	CONFINING PRESSURE (POUNDS/SQ IN)	200 SIEVE (%)	Subsurface water was not encountered either during or operations and subsurface water observations.			
_			F	LNO:	TIM	PLASTIC LIMIT	₹	、臣	J CE	FAILURE STRAIN (%)	N)	S 00				
SOIL SYMBOL	E	S	SO B	RE (	ום רו	STIC	STIC	VSIT S/CU	NTH NH	ST	NG I	0.2				
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	Sanc	¢ R	eoScien	200				Mar					BORING NO.: DRILLING DATE:	<u>B-08</u> 7/20/2020		
			Environment technical					Mar	ion, Tx				SURFACE ELEVATION:	112012020		
		Beor	lecimical		CL	.IEN	T:	Mos	iac La	nd D	evelo	pme	ent	PAGE 1 of 1		
	FIE	ELD	DATA			LA	٩ВО	RATC	DRY D	٩ΤΑ			DRILLING METHOD(S):			
						ERB							Dry auger drilling techniques were used to the termination	a depth of the boring.		
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				MOISTURE CONTENT	E	TIM	PLASTICITY INDEX	E	m	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	) SIE/	operations and subsurface water observations.	por completion of draining		
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00 FG	N - STANDARD PENETRATION TEST RESISTANCE REMARKS: P - POCKET PENETROMETER RESISTANCE															
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			205dien Environmen					Mar	ion, Tx				DRILLING DATE: SURFACE ELEVATION:	7/20/2020		
		Geo	technical										-			
		-			CL	.IEN	T:	Mos	iac Lai	nd De	evelo	pme	ent	PAGE 1 of 1		
	FIE	ELD	DATA			L	ABO	RATO	DRY D	ATA			DRILLING METHOD(S):			
						ERB	ERG						Dry auger drilling techniques were used to the termination	on depth of the boring.		
				(%)			1 333				ĥ	(%)	SUBSURFACE WATER INFORMATI	ON:		
				MOISTURE CONTENT		⊢⊢	PLASTICITY INDEX			(%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	Subsurface water was not encountered either during or operations and subsurface water observations.			
2			. 15	NOC	IMIT	PLASTIC LIMIT	Ε	노토	ш с	FAILURE STRAIN (%)	PRE ()	5 00 S				
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SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % ROD: %	ISTU	רומחום רושוב	PLA	PLA	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	LUR	NFIN	INS				
SOI	DEI	SAN	ZAHAR ZAHAR		LL	PL	PI	POR 104	055 DEF	FAI	CO DO	MIN	DESCRIPTION OF ST	RATUM		
				6	55	14	41						Dark Brown Clay			
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		1														
	Ī	T														
		1														
	-	-														
	- 5	- 5 -														
	0			5	36	10	26						Light Top Challey Clay at 5			
	<u> </u>	-		5	30	10	20						Light Tan Chalky Clay at 5'			
	-															
	7	-														
		T														
	-															
	- 10 -	1														
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	-															
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		T		5	34	9	25									
	- 15 -												Boring Terminated at 15 fee	t of Denth		
													Borning reminiated at 10 lee	r or Doput		
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	-															
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0.64																
70020																
ğ	- 20			TDA				SISTA	NCE				DEMADIZE			
S F	- PO	CKE	ARD PENE	OME	TER	RES	ISTA	NCE					REMARKS:			
	R - RO	CK	CONE PEN CORE REC	OVE	RY			IANCE								
ž F	RQD -	ROO	CK QUALIT	Y DE	SIGN	ATIO	NC									

										LO	GC	)FI	BORING			
					PF	ROJE	ECT:	Clea	arwater	Cre	ek Sı	ubdiv				
				~				Mari	on				BORING NO.: B-10	-		
			eoSalen					Mari	ion, Tx				DRILLING DATE:			
	Beolo	Geol	Environmeni technical	al							2		SURFACE ELEVATION:			
					CL	IEN	T:	Mos	iac Lar	nd De	evelo	pme	ent PAGE 1 of 1	ľ		
	FIE	ELD	DATA			LA	٩ΒΟ	RATC	RY D	٩ΤΑ			DRILLING METHOD(S):			
					ATT	ERB	ERG				1		Dry auger drilling techniques were used to the termination depth of the boring.			
				(%)	<u> </u>	IMIT:					щ	(%)	SUBSURFACE WATER INFORMATION:			
				MOISTURE CONTENT (%)		L_	PLASTICITY INDEX			(%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	Subsurface water was not encountered either during or upon completion of drilli operations and subsurface water observations.	ng		
			H	LNO	Ъ	LIMI	Ě	노토	ш с	SAIN	N)	00 S	operations and subsurface water observations.			
MBO	E	S	SO P SO P	REO	םרו	STIC	STICI	NSIT S/CU	SSI NH NH NH	STF	NG I	10.2				
SOIL SYMBOL	ОЕРТН (FT)	SAMPLES	NONS/	STU	רומחום רושוב	PLASTIC LIMIT	PLAS	NDO	APRI ENG	FAILURE STRAIN (%)	UND	NS N				
SOIL	DEP	SAN	N: BLOWS/I P: TONS/SG T: BLOWS R: % ROD: %	MO	ււ	PL	PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAII	00 DO	MIN	DESCRIPTION OF STRATUM			
		Ì											Dark Brown Clay			
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	- 15						_						Boring Terminated at 15 feet of Depth			
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FROSTLOG FGS-G20020.GPJ FROST.GDT 9/8/20	- 20 N - ST		ARD PENE	TRA		I TES	ST RE	SISTA	NCE				REMARKS:			
Pol F	Γ - TXI	DOT	T PENETR	NETF	RATIO				Ē							
ROS1	R - RC	CK	CORE REC	OVE	RY											
<u> </u>	KQD -	RUG	JK QUALIT	T DE	SIG	VATIC	NC									

										LO	GC	)F I	BORING			
	Frost GeoSciences PROJECT: Clearwater Creek Subdiv												FGS-G20020			
	Bane	è /B	ออริสโลล	ROC									BORING NO.: DRILLING DATE:	B-11 7/20/2020		
			Environment technical					Mar	ion, Tx				SURFACE ELEVATION:	112012020		
		Geo	technical		CL	.IEN	T:	Mos	iac Lai	nd De	evelo	pme	ent -	PAGE 1 of 1		
	FIE	ELD	DATA			L	ABO	RATC	RY D	ATA			DRILLING METHOD(S):			
					ATT	ERB	ERG S						Dry auger drilling techniques were used to the termination depth of the boring.			
				T (%)			1			0	JRE	MINUS NO. 200 SIEVE (%)	SUBSURFACE WATER INFORMATI			
				VTEN	F	Ę	PLASTICITY INDEX			N (%	I)	SIEV	Subsurface water was not encountered either during or operations and subsurface water observations.	upon completion of drilling		
ğ	6		L L	CO	LIQUID LIMIT	PLASTIC LIMIT	E S	F ⊐	SIVE FT)	TRA	SQ IN	. 200				
SYME	н Г	LES	NNS/NS/	TURE	aup	AST	AST	DS/C	NGTI S/SQ	RE S	NINI.	S NO				
SOIL SYMBOL	ОЕРТН (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % R: % R: %	MOISTURE CONTENT	E LL	ਕ PL	ਕ Pl	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	INN	DESCRIPTION OF ST			
			Zupuu	5	56	14	42		0000	u.	00	~	Dark Brown Clay			
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<u></u>	- 15 -	-14-										_	Boring Terminated at 15 fee	t of Depth		
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9/8/2																
1.GDT	ā	-														
FROSTLOG FGS-G20020.GPJ FROST.GDT 9/8/20	-															
SPJF																
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SS-G2	- 20 -															
S F	N - STANDARD PENETRATION TEST RESISTANCE REMARKS: P - POCKET PENETROMETER RESISTANCE															
STLC	- TXI	TOC	CONE PEN	NETR	RATIC											
E F	RQD -	ROC	CK QUALIT	YDE	SIGN	ATIC	N									

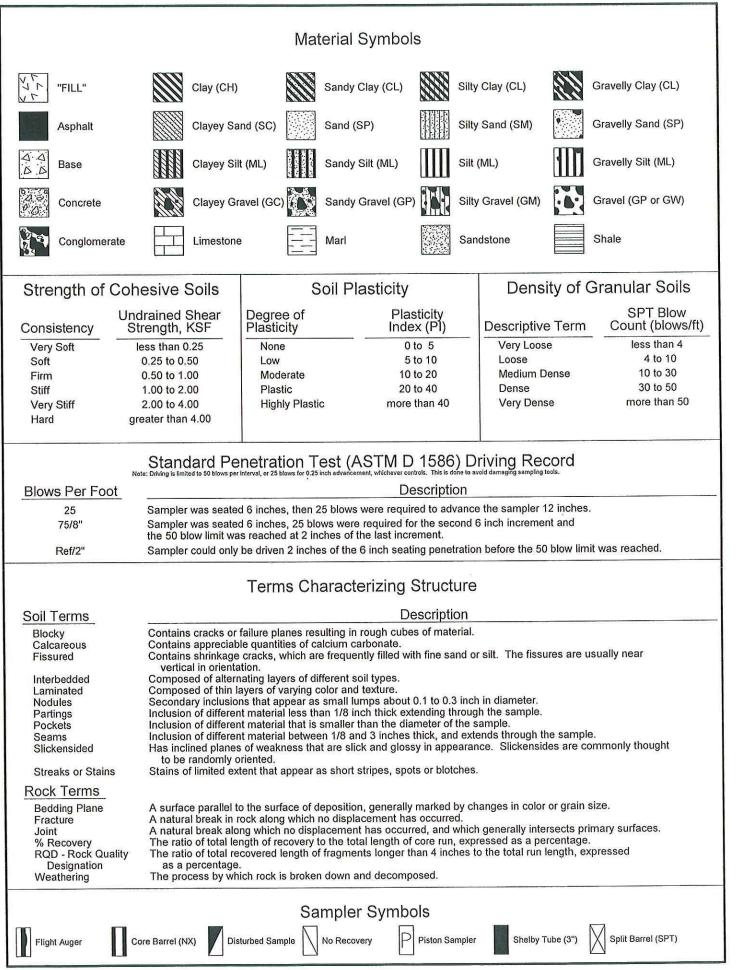
										LO	GC	)F I	BORING			
		Frost GeoSciences PROJECT: Clearwater Creek Subd											-	FGS-G20020		
	Pape	s P	n . Polan										BORING NO.: DRILLING DATE:	B-12		
	Geolo	gic =	20361211 Environmeni technical	tal				Mar	ion, Tx				SURFACE ELEVATION:	7/20/2020		
		Geol	technical													
		_		-	CL	.IEN	-		iac Lar		evelo	pme				
	FIE	LD	DATA					RATC	DRY DA	ATA			DRILLING METHOD(S): Dry auger drilling techniques were used to the termination depth of the boring.			
				()		ERB						0				
SOIL SYMBOL	ОЕРТН (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RDD: %	MOISTURE CONTENT (%)	ב רומחום רואוד	PLASTIC LIMIT	D PLASTICITY INDEX	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	SUBSURFACE WATER INFORMATI Subsurface water was not encountered either during or operations and subsurface water observations.	upon completion of drilling		
00	6		ZUHUU	2		PL.	PI		000	u.	08	2	DESCRIPTION OF STR Dark Brown Clay	KA I UIVI		
				5	53	14	39									
	- 5 -			1	19	9	10						Light Tan Chalky Clay at 5'			
	- 15 -												Boring Terminated at 15 fee	t of Depth		
	N - STANDARD PENETRATION TEST RESISTANCE P - POCKET PENETROMETER RESISTANCE								NCE	REMARKS:						
FROST LOC	P - POCKET PENETROMETER RESISTANCE T - TXDOT CONE PENETRATION RESISTANCE R - ROCK CORE RECOVERY RQD - ROCK QUALITY DESIGNATION															

				_	<u> </u>								BORING	
				_	PF	<b>SO</b>	ECT		arwatei	Cre	ek Sı	ubdi		FGS-G20020
	ISTOC	i II	an Celan	POR				Mar					BORING NO.: DRILLING DATE:	B-13
	Frost GeoScience: Geologic - Environmental				Marion, Tx					SURFACE ELEVATION:	7/20/2020			
		Geo	otechnical											
	CLIENT: Mosiac Land Develop						iac La	nd D	pme	ent	PAGE 1 of 1			
	FIE	ELC	DATA			L	АВО	RATO	DRY D	ATA			DRILLING METHOD(S):	
					ATT	ERB	ERG						Dry auger drilling techniques were used to the termination	on depth of the boring.
				(%)	- ·		1.00				ш	(%)	SUBSURFACE WATER INFORMAT	ON.
				ENT		-	NDE			(%)	SUF	EVE	Subsurface water was not encountered either during or	
			F	INO	TIN	IMI	ž	LE	۳	AIN	NH S	IS 00	operations and subsurface water observations.	
ABOI	E	0	F Q G	U U U U	DLI	TIC	LICI	CU.	SSIV TH D FT	STR	NG P	0.20		
SYA	TH (F	PLE	NSNO NSNO	STUF	רומחום רושוד	PLASTIC LIMIT	PLASTICITY INDEX	DEN	PRE IS/S(	URE	FINIT	N SI		
SOIL SYMBOL	ОЕРТН (FT)	SAMPLES	N: BLOWS/FT P: TONS/SG FT T: BLOWS R: % ROD: %	MOISTURE CONTENT		PL	PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STI	
		Ì	24744	7	60	14	46		000		00	2	Dark Brown Clay	AT UM
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R	- RO	CK	CORE REC	OVE	RY			THOL						
	RQD - I	ROC	CK QUALITY	Y DE	SIGN	IATIC	N							

This log is not valid if separated from the report

## SYMBOL KEY

## Symbol Key Sheet



### **APPENDIX "B"**

Moisture Density Relationship CBR Test Results Lime Series Curve & Unconfined Compressive Strength Chart Spectra Pave Design Analysis

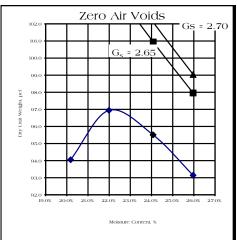
FGS Project No.: FGS-G20020

# **MOISTURE DENSITY**

F	rost GeoSciences	(210) 372-1315 phone	Helotes	Vestern Oak s, TX 78023 372-1318 fax
Loi	nstruction Materials - Forensics Environmental - Geotechnical	Project #: FGS-G20020		
		Project: Clearwater Creek Subdivision		
		Report Sample		8/27/2020 7/22/2020
Client:	Mosaic Land Development			
Report:	ASTM - Standard Proctor	LAB NO	:	4102

•		
Report:	ASTM - Standard Proctor	LAB NO:
Material:	Subgarde	Report #:

#### Moisture-Density Relationship -Subgrade Soil



Desc of Rammer: Mechanical Preparation Method: Dry Remarks: No comments at this time.

Test Method (As Applicable):	AST
	٨QT

<u>TM D-698 A</u> ASTM D-4318

**Test Results** 

S1

		<u>% Moisture</u>		Dry Dens	ity Lbs./ft <sup>3</sup>
		20.2%			94.1
0		22.0%			96.9
		24.1%			95.5
		26.0%			93.1
	Optimum =	= 22.3%		Maximum =	97
	Sieve	% Passing	-		
	3 inch	100.0%	Color:	Dark Brown	
	3/4 inch	100.0%	Description:	Clay	
	3/8 inch	100.0%		-	
	No. 4	100.0%	Liquid Limit:	58	
	No.10	58.2%	Plastic Limit:	14	
5	No. 40	29.0%	Plasticity Index:	44	
	No.100	4.1%			
	No.200	0.7%			

Location: Project Site

Respectfully Submitted, Frost GeoSciences, Inc.

M

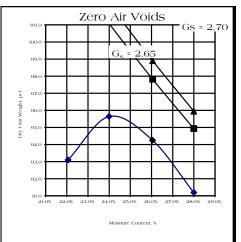
F.J.Caballero, P. E., Project Manager

THIS REPORT APPLIES ONLY TO THE STANDARDS OR PROCEDURES INDICATED AND TO THE SAMPLE(S) TESTED AND/OR OBSERVED AND ARE NOT NECESSARILY INDICATIVE OF THE QUALITIES OF APPARENTLY IDENTICAL OR SIMILAR PRODUCTS OR PROCEDURES, NOR DO THEY REPRESENT AN ONGOING QUALITY ASSURANCE PROGRAM UNLESS SO NOTED. THESE REPORTS ARE FOR THE EXCLUSIVE USE OF THE ADDRESSED CLIENT AND ARE NOT TO BE REPRODUCED WITHOUT PERMISSION.

Cor	TOST GEOSCIENCES	Helote (210) 372-1315 phone (210) 3	Vestern Oak s, TX 78023 i72-1318 fax
		Project: Clearwater Creek Subdivision	
		Report Date: Sample Date:	8/27/2020 7/22/2020
Client:	Mosaic Land Development		
Report:	ASTM - Standard Proctor	LAB NO:	4102

•		
Report:	ASTM - Standard Proctor	LAB NO:
Material:	Subgrade	Report #:

#### Moisture-Density Relationship -Subgrade Soil



Desc of Rammer: Mechanical Preparation Method: Dry Remarks: No comments at this time.

Test Method (As Applicable):	<u>AS</u>
	٨٥

<u>STM D-698 A</u> ASTM D-4318

#### **Test Results**

S2

		% Moisture		Dry Dens	ity Lbs./ft <sup>3</sup>
		22.1%			93.1
= 2.70		24.0%			95.6
_		26.1%			94.2
_		28.0%			91.2
	Optimum	= 24.1%		Maximum =	95.6
			_		
	Sieve	% Passing			
	3 inch	100.0%	Color:	Dark Brown	
	3/4 inch	100.0%	Description:	Clay	
	3/8 inch	100.0%			
	No. 4	100.0%	Liquid Limit:	56	
	No.10	56.8%	Plastic Limit:	10	
% 29.0%	No. 40	28.6%	Plasticity Index:	46	
	No.100	5.3%			
	No.200	2.1%			

Location: Project Site

Respectfully Submitted, Frost GeoSciences, Inc.

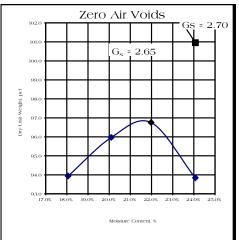
F.J.Caballero, P. E., Project Manager

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Cor	TOST GEOSCIENCES	Helote (210) 372-1315 phone (210) 3	Vestern Oak s, TX 78023 i72-1318 fax
		Project: Clearwater Creek Subdivision	
		Report Date: Sample Date:	8/27/2020 7/22/2020
Client:	Mosaic Land Development		
Report:	ASTM - Standard Proctor	LAB NO:	4102

0.001.00	
Report:	ASTM - Standard Proctor
Material:	Subgrade

#### Moisture-Density Relationship -Subgrade Soil



Desc of Rammer: Mechanical Preparation Method: Dry Remarks: No comments at this time.

Test Method (As Applicable):	4

ASTM D-698 A ASTM D-4318

#### **Test Results**

Report #:

S3

		% Moisture		Dry Dens	ity Lbs./ft <sup>3</sup>
		18.1%			93.9
70		20.1%			96.0
		22.0%			96.8
		24.0%			93.8
	Optimum =	= 21.5%		Maximum =	96.8
	Sieve	% Passing	-		
	3 inch	100.0%	Color:	Dark Brown	
	3/4 inch	100.0%	Description:	Clay	
	3/8 inch	100.0%			
	No. 4	100.0%	Liquid Limit:	54	
	No.10	65.3%	Plastic Limit:	14	
1%	No. 40	35.4%	Plasticity Index:	40	
	No.100	7.6%			
	No.200	2.6%			

Location: Project Site

Respectfully Submitted, Frost GeoSciences, Inc.

M.

F.J.Caballero, P. E., Project Manager

THIS REPORT APPLIES ONLY TO THE STANDARDS OR PROCEDURES INDICATED AND TO THE SAMPLE(S) TESTED AND/OR OBSERVED AND ARE NOT NECESSARILY INDICATIVE OF THE QUALITIES OF APPARENTLY IDENTICAL OR SIMILAR PRODUCTS OR PROCEDURES, NOR DO THEY REPRESENT AN ONGOING QUALITY ASSURANCE PROGRAM UNLESS SO NOTED. THESE REPORTS ARE FOR THE EXCLUSIVE USE OF THE ADDRESSED CLIENT AND ARE NOT TO BE REPRODUCED WITHOUT PERMISSION.

## **CBR RESULTS**

#### Frost GeoSciences, Inc. 13406 Western Oak Helotes, Texas 78023

·····, · ····	CBR (California Bearing Ratio)									
		AS	TM D188	<u>33</u>						
Project Name:	<b>Claerwater Creek Sub</b>	divison		Project #: FGS-G20020						
Soil Desc. Dark Brown Clay CBR #1						-		-		
Tested By: Miguel Gonzalez Jr						Test Date:	08/27/20			
								-		
Compaction Er	nergy: Rammer		os.		# layers:	3	Blows:	56		
w at compaction		Mold Dia.	6	in.		Soil Ht.	4.584	in.		
Volume	0.075 ft. <sup>3</sup>			_			Opt. M.C.	22.3	3	
	Initial	<u>Fina</u>	al		<u>%S</u>	Opt	Dry Unit wt.	97	7	
Date/Time	8/21/20 1:30pm	8/27/20 2	2:30pm							
Swell Data	0.000	0.6	5		14.18	_	Mold #	1	1	
						Su	rcharge, lbs.	10	)	
					Initial mas	s of wet soi	l + mold, lbs.	26.502	2	
					Final mas	s of wet soi	l + mold, lbs.	26.546	3	
						Mass	of Mold, lbs.	18.064	1	
					Init	ial mass of	wet soil, lbs.	8.438	3	
Dry density =	97.0 Comp	0.99998				-			_	
Moisture =	22.1 Points Opt	-0.2427								

#### ASTM D2216 Moisture Content

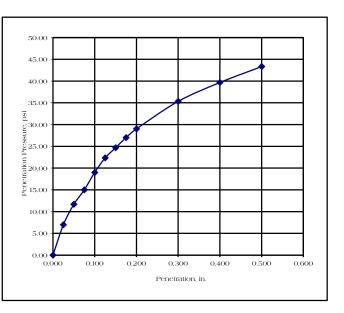
<u>Compaction</u>	Project #	Can No.	Wet Wt. (1)	Dry Wt. (2)	Tare Wt. (3)	(1) - (2) = A	(2) - (3) = B	%MC = A/B*100
Before	GS-G2002	0	670.95	662.33	176.29	8.62	486.04	1.773517
After	GS-G2002	0	691.07	537.41	174.5	153.66	362.91	42.34108

ASTM D1883

Date: 8/27/2020 Time: 2:45pm

Strain, in.	Load, lbs	Stress, psi	CBR
0.000	0.00	0.00	
0.025	21.00	7.00	
0.050	35.00	11.67	
0.075	45.00	15.00	
0.100	57.00	19.00	1.9
0.125	67.00	22.33	
0.150	74.00	24.67	
0.175	81.00	27.00	
0.200	87.00	29.00	1.9
0.300	106.00	35.33	
0.400	119.00	39.67	
0.500	130.00	43.33	

Used=TexDot Sieves



#### Frost GeoSciences, Inc. 13406 Western Oak Helotes, Texas 78023

,	CBR (California Bearing Ratio)										
			<u>A</u>	STM D18	<u>83</u>						
Project Name:	Clearwater	Creek Subo	division		Project #: FGS-G20020						
Soil Desc. Dark Brown Clay CBR #2											
Tested By: Miguel Gonzalez Jr			-		Test Date:	08/27/20					
-							•				
Compaction Er	nergy:	Rammer:	5.5	lbs.		# layers:	3	Blows:	56		
w at compaction	on:	24.10%	Mold Dia.	6	in.	-	Soil Ht.	4.584	in.		
Volume	0.075	ft. <sup>3</sup>	•		-			Opt. M.C.	24.1		
	Ini	<u>tial</u>	<u>Fi</u>	nal		<u>%S</u>	Opt	. Dry Unit wt.	95.6		
Date/Time	8/21/20	1:45pm	8/27/20	2:00pm				-			
Swell Data	0.0	000	0.	.07		1.53		Mold #	2		
			•		-		Su	rcharge, lbs.	10		
						Initial mass	s of wet soi	I + mold, lbs.	26.605		
						Final mass	s of wet soi	I + mold, lbs.	26.645		
							Mass	of Mold, lbs.	18.102		
						Init	ial mass of	wet soil, lbs.	8.503		
Dry density =	95.5	Comp.	0.99895				•				
Moisture =	24.1	Points Opt.	0.01782								

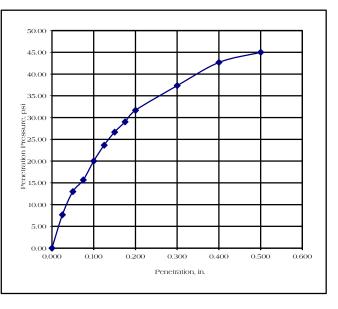
#### ASTM D2216 Moisture Content

<u>Compaction</u>	Project #	Can No.	Wet Wt. (1)	Dry Wt. (2)	Tare Wt. (3)	(1) - (2) = A	(2) - (3) = B	%MC = A/B*100
Before	GS-G2002	0	625.18	562.33	173.15	62.85	389.18	16.14934
After	GS-G2002	0	642.12	528.65	175.01	113.47	353.64	32.0863

ASTM D1883

Date: 8/27/2020 Time: 2:15pm

Strain, in.	Load, lbs	Stress, psi	CBR
0.000	0.00	0.00	
0.025	23.00	7.67	
0.050	39.00	13.00	
0.075	47.00	15.67	
0.100	60.00	20.00	2.0
0.125	71.00	23.67	
0.150	80.00	26.67	
0.175	87.00	29.00	
0.200	95.00	31.67	2.1
0.300	112.00	37.33	
0.400	128.00	42.67	
0.500	135.00	45.00	



Used=TexDot Sieves

#### Frost GeoSciences, Inc. 13406 Western Oak Helotes, Texas 78023

neioles, reza	neioles, Texas 70025											
		CBR (Cali	iornia Bearin	ng Ratio)								
		Α	STM D1883									
Project Name:				Project #: FGS-G20020								
Soil Desc.	Dark Brown Clay			_								
Tested By:					est Date:	08/27/20						
					_							
Compaction Er	nergy: Rar	mmer: 5.5	lbs.	# layers:	3	Blows:	56					
w at compaction	on: 21.5	50% Mold Dia.	6 in	ו. <u>–</u>	Soil Ht.	4.584 i	n.					
Volume	0.075 ft. <sup>3</sup>					Opt. M.C.	21.5					
	Initial	<u>Fi</u>	nal	<u>%S</u>	Opt.	Dry Unit wt.	96.8					
Date/Time	8/21/20 3:00p	om 8/27/202	0 3:15pm									
Swell Data	0.000	0.	75	16.36	_	Mold #	3					
					Sur	charge, lbs.	10					
				Initial mass	of wet soil	+ mold, lbs.	26.423					
				Final mass	of wet soil	+ mold, lbs.	26.518					
					Mass	of Mold, lbs.	18.15					
				Initia	al mass of <u>v</u>	wet soil, lbs.	8.273					
Dry density =	<u>96.7</u> (	Comp. 0.99897										
Moisture =	21.6 Point	s Opt. 0.07675										

#### ASTM D2216 Moisture Content

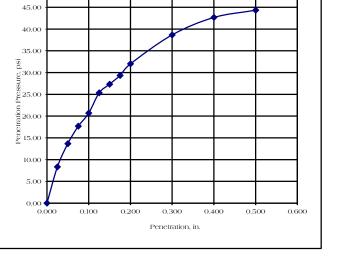
<u>Compaction</u>	Project #	Can No.	Wet Wt. (1)	Dry Wt. (2)	Tare Wt. (3)	(1) - (2) = A	(2) - (3) = B	%MC = A/B*100
Before	GS-G2002	0	722.22	680	176.66	42.22	503.34	8.387968
After	GS-G2002	0	765.35	613.15	175.36	152.2	437.79	34.76553

50.00

ASTM D1883

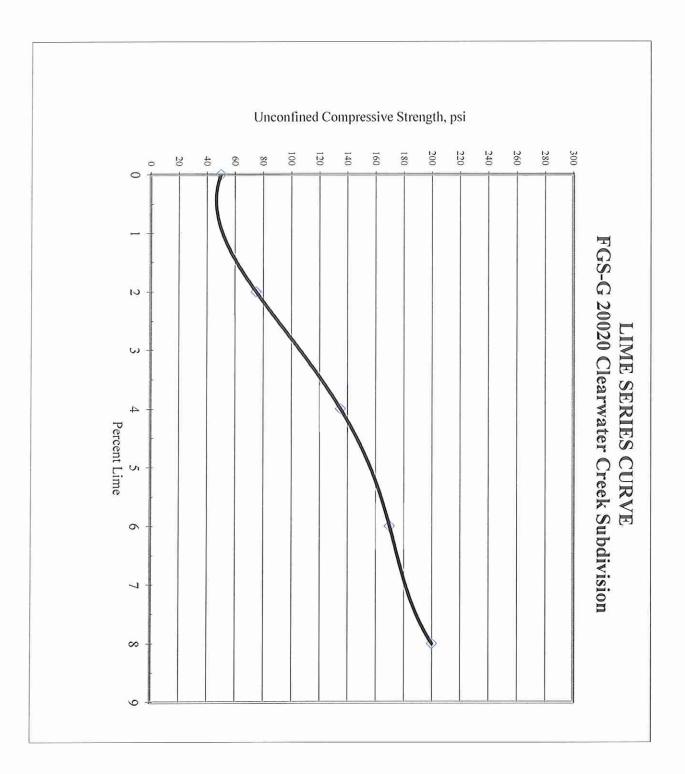
Date: 8/27/2020 Time: 3:30pm

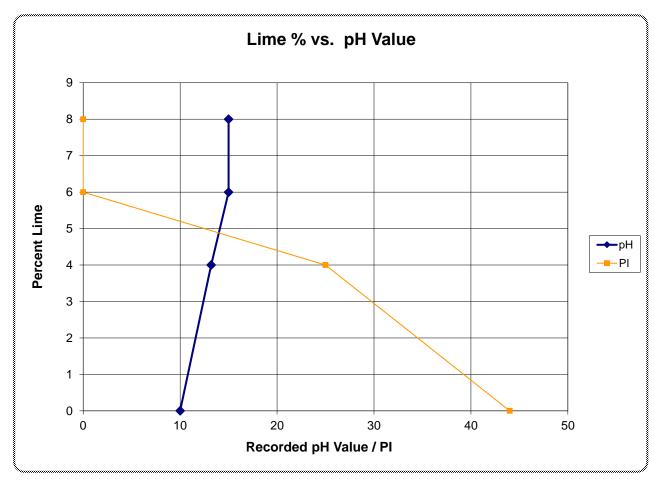
Strain, in.	Load, lbs	Stress, psi	CBR
0.000	0.00	0.00	
0.025	25.00	8.33	
0.050	41.00	13.67	
0.075	53.00	17.67	
0.100	62.00	20.67	2.1
0.125	76.00	25.33	
0.150	82.00	27.33	
0.175	88.00	29.33	
0.200	96.00	32.00	2.1
0.300	116.00	38.67	
0.400	128.00	42.67	
0.500	133.00	44.33	



Used=TexDot Sieves

# LIME SERIES CURVE

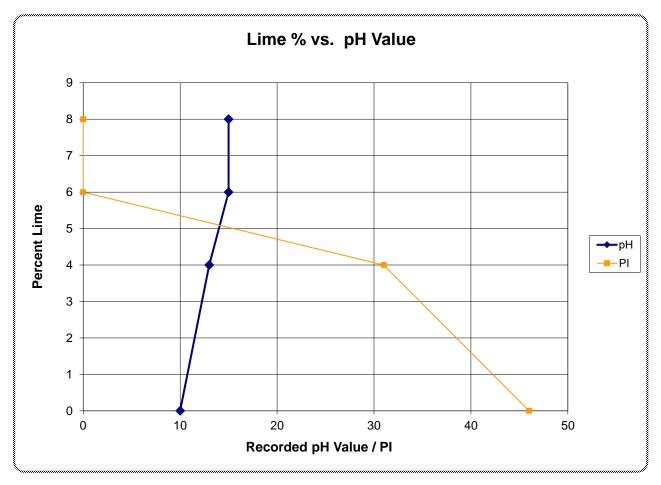




Project Name: Project Number: Soil Description:

Clearwater Creek Subdivision FGSG20020 (Proctor # 1) Dark Brown Clay

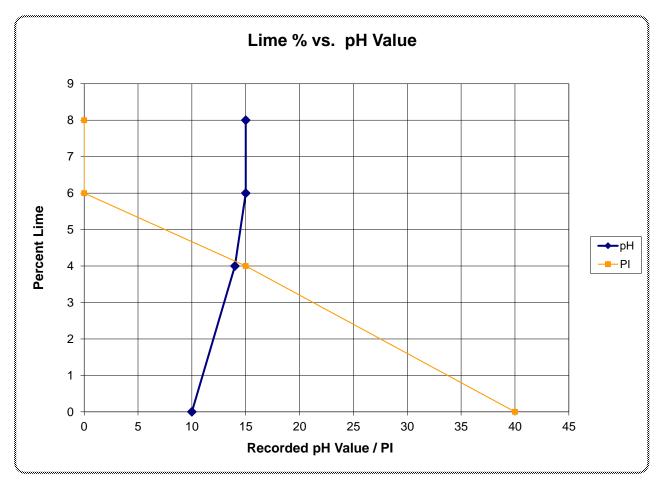
				6`/.	8`/.
%Lime	рН	PI	1	LIME	LIME
0	10	44	SET #1	165 psi	205 psi
4	13.2	25			
6	15	0	SET #2	170 psi	200 psi
8	15	0			



Project Name: Project Number: Soil Description:

Clearwater Creek Subdivision FGSG20020 (Proctor # 2) Dark Brown Clay

					6`/.	8`/.
ſ	%Lime	рН	PI	1	LIME	LIME
ſ	0	10	46	SET #1	170 psi	200 psi
	4	13	31			
	6	15	0	SET #2	170 psi	200 psi
	8	15	0			



Project Name: Project Number: Soil Description:

Clearwater Creek Subdivision FGSG20020 (Proctor # 3) Dark Brown Clay

				6`/.	8`/.
%Lime	рН	PI	]	LIME	LIME
0	10	40	SET #1	175 psi	220 psi
4	14	15			
6	15	0	SET #2	170 psi	200 psi
8	15	0			

## **SPECTRA PAVE**

# LOCAL "A"

### SpectraPave™ Pavement Optimization Design Analysis



Reliability (%)	= 70	Initial Serviceability	= 4.2
Standard Normal Deviate	=524	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

#### Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

#### **Unstabilized Section Material Properties**

Tensar

Layer	Description	Cost (\$/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0
SBC	Subbase Course	16.00	0.080	1.0

#### **Stabilized Section Material Properties**

Layer	Description	Cost (\$/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.215	1.0
SBC	Subbase Course	16.00	0.080	1.0



#### Unstabilized Pavement



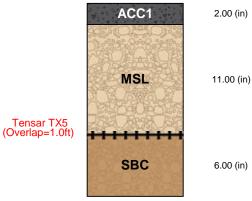
16.75 (in)

2.00 (in)

#### 6.00 (in)

Subgrade Modulus = 3,980 (psi) Structural Number = 3.705 Calculated Traffic (ESALs) = 1,054,000

## Stabilized Pavement



Subgrade Modulus = 3,980 (psi) Structural Number = 3.685 Calculated Traffic (ESALs) = 1,016,000

#### LIMITATIONS OF THE REPORT

The designs, illustrations, information and other content included in this report are necessarily general and conceptual in nature, and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops.				
Project Name				
Company Name FROST GEOSCIENCES				
Designer F. J. CABALLERO, P. E. Date October 2, 2020				

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# SpectraPave™TensafPavement Optimization Design Analysis



Reliability (%)	= 70	Initial Serviceability	= 4.2
Standard Normal Deviate	=524	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

#### Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

#### **Unstabilized Section Material Properties**

Layer	Description	Cost (\$/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0

#### **Stabilized Section Material Properties**

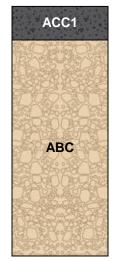
Layer	Description	Cost (\$/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.206	1.0



#### **Unstabilized Pavement**

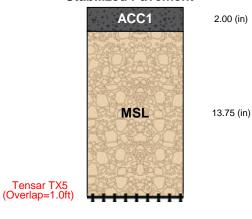
2.75 (in)

18.00 (in)



Subgrade Modulus = 3,980 (psi) Structural Number = 3.730 Calculated Traffic (ESALs) = 1,104,000

#### **Stabilized Pavement**



Subgrade Modulus = 3,980 (psi) Structural Number = 3.712 Calculated Traffic (ESALs) = 1,069,000

#### LIMITATIONS OF THE REPORT

The designs, illustrations, information and other content included in this report are necessarily general and conceptual in nature, and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops.				
Project Name	Project Name Clearwater Creek (Local A), Opt. 3 & 4, ROCK			
Company Name	pmpany Name FROST GEOSCIENCES			
Designer F. J. CABALLERO, P. E. Date October 2, 2020				

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LOCAL "B"

### SpectraPave™ Special aveTensalPavement Optimization Design Analysis



Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

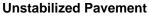
#### **Unstabilized Section Material Properties**

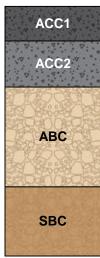
Layer	Description	Cost (\$/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.380	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0
SBC	Subbase Course	16.00	0.080	1.0

Layer	Description	Cost (\$/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.380	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.265	1.0
SBC	Subbase Course	16.00	0.080	1.0

#### **Stabilized Section Material Properties**

Layer	Description	Cost (\$/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.380	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.265	1.0
SBC	Subbase Course	16.00	0.080	1.0





4.00 (in)

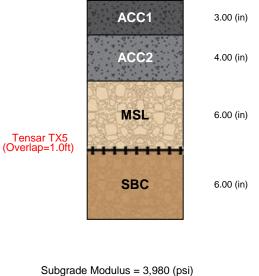
3.00 (in)

8.75 (in)

### 6.00 (in)

Subgrade Modulus = 3,980 (psi) Structural Number = 4.545 Calculated Traffic (ESALs) = 2,025,000

## **Stabilized Pavement**



Structural Number = 4.850 Calculated Traffic (ESALs) = 3,256,000

#### LIMITATIONS OF THE REPORT

nature, and do not cor	The designs, illustrations, information and other content included in this report are necessarily general and conceptual in nature, and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops.				
Project Name	CEARWATER CREEK ( Local "B" ) Opt. 1 & 2, LIME				
Company Name FROST GEOSCIENCES					
Designer	F. J. CABALLERO, P. E. Date October 2, 2020				

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# SpectraPave™TensafPavement Optimization Design Analysis



Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

#### Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

#### **Unstabilized Section Material Properties**

Layer	Description	Cost (\$/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.380	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0

#### **Stabilized Section Material Properties**

Layer	Description	Cost (\$/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.380	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.261	1.0

#### **Unstabilized Pavement**



3.00 (in) 4.00 (in)

12.25 (in)

Subgrade Modulus = 3,980 (psi) Structural Number = 4.555 Calculated Traffic (ESALs) = 2,058,000

# ACC1 3.00 (in) ACC2 4.00 (in) MSL 6.75 (in)

**Stabilized Pavement** 

Tensar TX5 (Overlap=1.0ft)

> Subgrade Modulus = 3,980 (psi) Structural Number = 4.542 Calculated Traffic (ESALs) = 2,015,000

#### LIMITATIONS OF THE REPORT

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Project Name	Clearwater Creek (Local "B") Opt. 3 & 4, ROCK			
Company Name	FROST GEOSCIENCES			
Designer	F. J. CABALLERO, P. E. Date October 2, 2020			

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## ARTERIAL

# SpectraPave™TensafPavement Optimization Design Analysis



Reliability (%)	= 95	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

#### Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

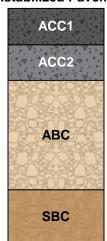
#### **Unstabilized Section Material Properties**

Layer	Description	Cost (\$/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.380	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0
SBC	Subbase Course	16.00	0.080	1.0

#### **Stabilized Section Material Properties**

Layer	Description	Cost (\$/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.187	1.0
SBC	Subbase Course	16.00	0.080	1.0





Subgrade Modulus = 3,980 (psi)

Structural Number = 5.440 Calculated Traffic (ESALs) = 3,052,000

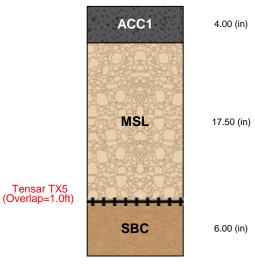
4.00 (in)

4.00 (in)

12.00 (in)

6.00 (in)

#### **Stabilized Pavement**



Subgrade Modulus = 3,980 (psi) Structural Number = 5.432 Calculated Traffic (ESALs) = 3,022,000

#### LIMITATIONS OF THE REPORT

The designs, illustrations, information and other content included in this report are necessarily general and conceptual in nature, and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops.					
Project Name	Clearwater Creek (ARTERIAL) Opt. 1 & 2, LIME				
Company Name	FROST GEOSCIENCES				
Designer	Designer F. J. CABALLERO, P. E. Date October 2, 2020				

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Thick Asphalt Pavement - TWH Edition - 20200626



# SpectraPave™TensafPavement Optimization Design Analysis



Reliability (%)	= 95	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

### Aggregate fill shall conform to following requirement:

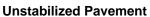
D50 <= 27mm (Base course)

#### **Unstabilized Section Material Properties**

Layer	Description	Cost (\$/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.380	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0

#### **Stabilized Section Material Properties**

Layer	Description	Cost (\$/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.400	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.236	1.0





Subgrade Modulus = 3,980 (psi)

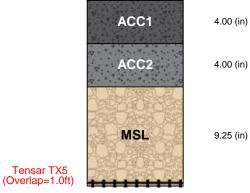
Structural Number = 5.450 Calculated Traffic (ESALs) = 3,093,000

4.00 (in)

4.00 (in)

15.50 (in)

## Stabilized Pavement



Subgrade Modulus = 3,980 (psi) Structural Number = 5.463 Calculated Traffic (ESALs) = 3,147,000

#### LIMITATIONS OF THE REPORT

The designs, illustrations, information and other content included in this report are necessarily general and conceptual in nature, and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops.						
Project Name	Clearwater Creek (ARTERIAL) Opt. 3 & 4, ROCK					
Company Name	FROST GEOSCIENCES					
Designer	F. J. CABALLERO, P. E.	Date	October 2, 2020			

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