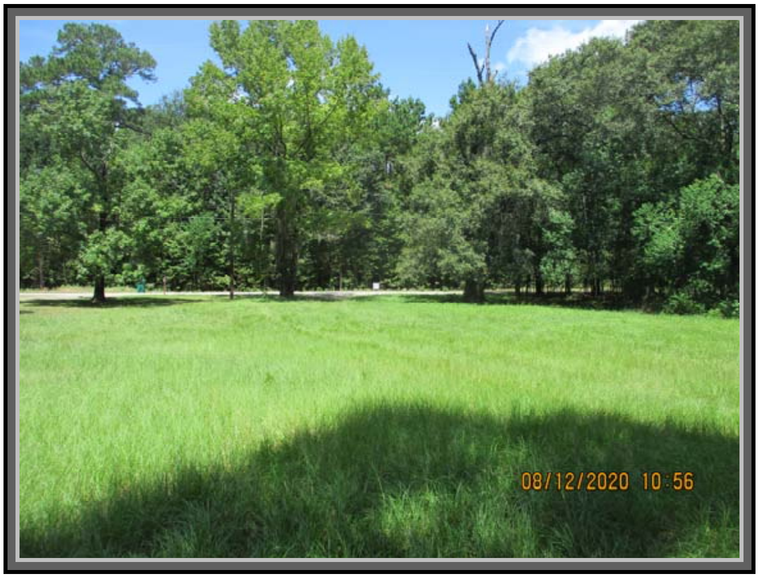
GEOTECHNICAL STUDY
PROPOSED RESIDENCE AT
3307 HAMILTON CIRCLE
MONTGOMERY, TEXAS

PROJECT NO. 20-640E



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TO

MR. GILBERTH GIRALDO
MONTGOMERY, TEXAS

BY

GEOTECH ENGINEERING AND TESTING

SERVICING

TEXAS, LOUISIANA, NEW MEXICO, OKLAHOMA

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Geotechnical, Environmental, Construction Materials, and Forensic Engineering

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GEOTECHNICAL STUDY
PROPOSED RESIDENCE AT
3307 HAMILTON CIRCLE
MONTGOMERY, TEXAS

Submitted here are the results of Geotech Engineering and Testing (GET) geotechnical study for the proposed residence at the above referenced location. This study was authorized by Mr. Gilberth Giraldo on July 27, 2020.

1.0 INTRODUCTION

It is planned to construct a residence at the above-referenced location. A geotechnical study was performed to evaluate the subsoils and groundwater conditions and to provide recommendations for suitable foundation type, depth and allowable loading. We understand that either drilled footings or a floating slab type foundation will be used on this project. Due to presence of cohesionless soils at the site, a helical pile foundation system is also recommended in this report.

The purpose of our study was to evaluate subsurface conditions at the site and using the information obtained, develop recommendations to guide design and construction of the proposed residence.

2.0 FIELD EXPLORATION

At the request of the client, the soil conditions were explored by two (2) soil borings (B-1 and B-2) located approximately as shown on Plate 1. The number of borings and depth were specified by the client. Soil samples were obtained continuously at the boring locations from the ground surface to 10-ft and at five-ft intervals thereafter to the completion depth of the borings at 20-ft.

Cohesionless soils were generally sampled with a split-spoon sampler driven in general accordance with the Standard Penetration Test (SPT), ASTM D 1586. This test is conducted by recording the number of blows required for a 140-pound weight falling 30 inches to drive the sampler 12 inches into the soil. Driving resistance for the SPT, expressed as blows per foot of sampler resistance (N), is tabulated on the boring logs.

Soil samples were examined and classified in the field. This data, together with a classification of the soils encountered and strata limits, is presented on the logs of borings, Plates 2 and 3. A key to the log terms and symbols is given on Plate 4.

The borings were drilled dry, without the aid of drilling fluids to more accurately estimate the depth to groundwater. Water level observations made during and after drilling are indicated at the bottom portion of the individual logs.

3.0 LABORATORY TESTS

3.1 General

Soil classifications and shear strengths were further evaluated by laboratory tests on representative samples of the major strata. The laboratory tests were performed in general accordance with ASTM Standards. Specifically, ASTM D 2487 is used for classification of soils for engineering purposes.

3.2 Classification Tests

As an aid to visual soil classifications, physical properties of the soils were evaluated by classification tests. These tests consisted of natural moisture content tests (ASTM D 4643) and percent passing No. 200 sieve tests (ASTM D 1140). Similarity of these properties is indicative of uniform strength and compressibility characteristics for soils of essentially the same geological origin. Results of these tests are tabulated on the boring logs at respective sample depths.

3.3 Soil Sample Storage

Soil samples tested or not tested in the laboratory will be stored for a period of seven days subsequent to submittal of this report. The samples will be discarded after this period, unless we are instructed otherwise.

4.0 GENERAL SOILS AND DESIGN CONDITIONS

4.1 Site Conditions

The project site and the surrounding areas are generally flat with a topographic variation of less than three-feet. Currently, the project site is vacant and covered with grass and some trees. Project site pictures were taken during our field exploration and are presented on the cover page and Plate 5.

4.2 Soil Stratigraphy

Subsurface soils appear to be uniform across the site. Details of subsurface conditions at each boring location are presented on the boring logs. In general, the soils can be grouped into one (1) major stratum with depth limits and characteristics as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
I	0 – 20	SILTY SAND (SM), loose to dense, light brown, brown, with root fibers to 10’

* Classification in general accordance with the Unified Soil Classification System (ASTM D 2487)

4.3 Soil Properties

Soil strength and index properties and how they relate to foundation are summarized below:

Stratum No.	Soil Type	SPT	Soil Expansivity	Soil Shear Strength, tsf	Remarks
I	Silty Sand (SM)	10 – 35	Non-Expansive	–	Moisture Sensitive

Legend: SPT = Standard Penetration Test

4.4 Water-Level Measurements

The soil borings were dry augered to evaluate the presence of perched or free-water conditions. The level where free water was encountered in the open boreholes during the time of our field exploration is shown on the boring logs. Our groundwater measurements are as follows:

Boring Number(s)	Groundwater Depth, ft. at the Time of Drilling	Groundwater Depth, ft. at 0.33-Hour Later
B-1	12	12
B-2	16	16

Fluctuations in groundwater generally occur as a function of seasonal moisture variation, temperature, groundwater withdrawal and future construction activities that may alter the surface drainage and subdrainage characteristics of this site.

An accurate evaluation of the hydrostatic water table in the relatively impermeable clay and low permeable sands/silts requires long term observation of monitoring wells and/or piezometers. It is not possible to accurately predict the pressure and/or level of groundwater that might occur based upon short-term site exploration. The installation of piezometers/monitoring wells was beyond the scope of our study. We recommend that the groundwater level be verified just before construction if any excavations such as construction of drilled footings/underground utilities, etc. are planned.

We recommend that GET be immediately notified if a noticeable change in groundwater occurs from that mentioned in our report. We would be pleased to evaluate the effect of any groundwater changes on our design and construction sections of this report.

5.0 POTENTIAL VERTICAL MOVEMENT

Vertical movement of expansive foundation soils is commonly referred to in terms of the Potential Vertical Rise (PVR, Ref. 1) that can occur due to changes in soil moisture content. Accepted methods of estimating PVR includes the use of empirical relationships and the results of laboratory Atterberg limits and moisture content tests.

We computed the Potential Vertical Rise at this site. A PVR of about 1.0-inch can be expected during the life of the structures.

6.0 FOUNDATION RECOMMENDATIONS

6.1 Foundations and Risks

Many lightly loaded foundations are designed and constructed on the basis of economics, risks, soil type, foundation shape and structural loading. Many times, due to economic considerations, higher risks are accepted in foundation design. We recommend that the builder and architect/designer discuss foundations and risks with the owner. The proper foundation system should then be selected by the owner after all risks are discussed. It should be noted that some levels of risk are associated with all types of foundations and there is no such thing as a zero risk foundation. All of these foundations must be stiffened in the areas where expansive soils are present, and trees have been removed prior to construction. It should be noted that these foundations are not designed to resist soil and foundation movements as a result of sewer/plumbing leaks, excessive irrigation, poor drainage and water ponding near the foundation system. The following are the foundation types typically used in the area with increasing levels of risk and decreasing levels of cost:

FOUNDATION TYPE	REMARKS
Structural Slab with Piers or Helical Piles	This type of foundation (which also includes a pier and beam foundation with a void/crawl space) is considered to be a low risk foundation, provided it is built and maintained with positive drainage and vegetation control. A minimum space of four-inch or larger is required. Using this foundation, the floor slabs are not in contact with the subgrade soils. This type of foundation is particularly suited for the areas where expansive soils are present and where trees have been removed prior to construction. The drilled footings must be placed below the potential active zone to reduce potential drilled footing upheaval due to expansive clays. In the areas where non-expansive soils are present, spread footings can be used instead of drilled footings.
Slab-On-Fill Foundation Supported on Piers or Helical Piles	This foundation system is also suited for the area where expansive soils are present. This system has some risks with respect to foundation distress and movements, where expansive soils are present. However, if positive drainage and vegetation control are provided, this type of foundation should perform satisfactorily. The fill thickness is evaluated such that once it is combined with environmental conditions (positive drainage, vegetation control) the potential vertical rise will be reduced. The structural loads can also be supported on spread footings if expansive soils are not present.
Floating (Stiffened) Slab Supported on Piers. The Slab can either be Conventionally-Reinforced or Post-Tensioned	The risk on this type of foundation system can be reduced if it is built and maintained with positive drainage and vegetation control. Due to presence of piers, the slab cannot move down. However, if expansive soils are present, the slab may move up, behaving like a floating slab. In this case, the steel from the drilled piers should not be dowelled into the grade beams. The structural loads can also be supported on spread footings if expansive soils are not present.

FOUNDATION TYPE	REMARKS
Floating Super-Structural Slab Foundation (Conventionally-Reinforced or Post-Tensioned Slab)	The risk on this type of foundation system can be reduced if it is built and maintained with positive drainage and vegetation control. No piers are used in this type of foundation. Many of the lightly-loaded structures in the state of Texas are built on this type of foundation and are performing satisfactorily. In the areas where trees have been removed prior to construction and where expansive clays exist, these foundations must be stiffened to reduce the potential differential movements as a result of subsoil heave due to tree removal. The advantage of this foundation system is that as long as the grade beams penetrate a minimum of six-inch into the competent natural soils or properly compacted structural fill, no compaction of subgrade soils is required. The subgrade soils should, however, be firm enough to support the floor slab loads during construction. The structural engineer should design the floor slabs such that they can span in between the grade beams. The subsoils within which the grade beams are placed must have a minimum shear strength of 1000 psf and a minimum degree of compaction of 95 percent standard proctor density (ASTM D 698) at a moisture content within ± 2% of optimum moisture content.
Floating Slab Foundation (Conventionally-Reinforced or Post-Tensioned Slab)	The risk on this type of foundation can be reduced if it is built and maintained with positive drainage and vegetation control. No piers are used in this type of foundation. Many of the lightly-loaded structures in the state of Texas are built on this type of foundation and are performing satisfactorily. In the areas where trees have been removed prior to construction and where expansive clays exist, these foundations must be stiffened to reduce the potential differential movements as a result of subsoil heave due to tree removal. However, foundation tilt can still occur even if the foundation system is designed stiff.

The above recommendations, with respect to the best foundation types and risks, are very general. The best type of foundation may vary as a function of structural loading and soil types. For example, in some cases, a floating slab foundation may perform better than a drilled footing type foundation. More information regarding foundations and risks can be found at the **Foundation Performance Association Document #FPA-SC-01-0** (Ref. 2).

6.2 Foundation Type

Foundations for the proposed structure should satisfy two independent design criteria. First, the maximum design pressure exerted at the foundation level should not exceed allowable net bearing pressure based on an adequate factor of safety with respect to soil shear strength. Secondly, the magnitude of total and differential settlements or heave under sustained foundation loads must be such that the structure is not damaged or its intended use impaired.

We understand that the proposed structural loads will be supported on either deep foundations or shallow foundations. The deep foundation may consist of driller footings or helical piles. The shallow foundation may consist of a floating slab foundation.

The use of drilled footings at this site may be expensive due to presence of cohesionless soils and groundwater. **Drilled footings should be constructed, using a slurry method of construction**. This may make drilled footings more expensive than helical piles. The structural engineer may want to design the foundation system using helical piles, in addition to the drilled footings. There should be cost comparison between drilled footings, using a slurry method of construction and helical piles.

The decision as to what foundation type to be used should be made by the structural engineer, homeowner or the builder. Our recommendations for these foundation types are presented in the following report sections.

6.3 Drilled Footings Type Foundation

6.3.1 Allowable Bearing Pressure

Based on the results of field exploration, laboratory testing and bearing capacity theory, allowable loads for drilled footings will be as follows:

Foundation Type	Depth, ft. (1)	Allowable Net Bearing Pressure, psf	
		Dead Load (2)	Total Load (Dead + Live)
Drilled Footings: Straight Shafts	10	3,500	5,250

Notes: 1. With respect to existing grade
2. Dead load + sustained live load

Foundations proportioned in accordance with these values will have a factor of safety of 3.0 and 2.0 with respect to shearing failure for dead and total loading, respectively. Footing weight below final grade can be neglected in the determination of design loading. The allowable skin friction includes a safety factor of 2.0. We recommend that straight shafts be founded at least three shaft diameters away from each other to minimize group effect.

Based on the field and laboratory testing data, it is our opinion that the drilled footings should be designed and constructed as follows:

- Use a straight shaft type foundation.
- Based on our current groundwater observations, the drilled footing excavations may encounter groundwater. Any water inflow must be pumped out immediately, using a pump.
- Due to (a) presence of cohesionless soils and groundwater, (b) potential seasonal variations in groundwater depth, (c) variations in the subsoils stratigraphy and strengths and (d) corresponding potential caving problems, **a slurry method of construction will be required for the drilled footings installations.**

Due to potential variability of the on-site soils and potential groundwater fluctuations, we recommend that the four corner piers be drilled first to better evaluate the constructability of the depth and bell to shaft ratios recommended herein. Once this information is field verified, all other piers need to be constructed accordingly.

6.4 Helical Pile

The structural loads can also be supported on a helical pile system founded below a minimum depth of 20-ft. The helical pile system should be designed on the basis of design procedure, outlined in the “Basic Helical Screw Pile Design,” (Ref. 3)

In general, the cost of Helical Pile System will be less than the cost of drilled footings, installed using casing or slurry method of construction. Furthermore, the construction time is significantly reduced. Further information on design of helical pile system can be obtained from Geotech Engineering and Testing web site (www.geotecheng.com), under "Publications, Guidelines".

The ultimate pile capacity can be computed from the following:

$P = \Sigma A_H (qN_q)$ Piles in Sands

Where: P = Ultimate Pile Capacity, lbs
ΣA_H = Sum of Helical Plate Areas, ft^2
$q = \gamma h/2$= Soil Overburden Pressure to Mid-Plate Depth, psf
γ = Soil Unit Weight of 60 pcf
h = Depth of Helical Piles, ft
N_q = Bearing Capacity Factor for Granular Soil

A factor of safety of 2.0 is recommended in calculating ultimate helical piles capacity. We recommend that the helical plates be separated at a distance of three plate diameters. Furthermore, the structural engineer should also check for buckling, using a soil modulus of subgrade reaction (k). Buckling can usually be a problem in soft soils. One way to reduce the potential for buckling is to install the helical shafts inside a 12-inch diameter, 10-ft deep hole which is backfilled with concrete after helical pile installation. The helical pile should be placed at a distance of at least five largest plate diameters between each other to reduce group action. Pile spacing that is closer than 5 largest plate diameters will result in axial capacity reduction.

We recommend the following design parameters (Ref. 4) for this project:

$N_q = 15$

The helical pile should be designed to resist the "punch-through" failure in areas where soft soils encounter below strong soils. We recommend a distance of greater than five times the diameter of the lowest helical plate exists from the soft soils to prevent the helical piles from puncturing through into the soft soil stratum.

Some of the helical pile contractors are as follows:

Company Name	Telephone No.	Contact Person
Ram Jack Foundations	713-599-0102	Mr. Brian Buchanan
R.L. Nelson Construction Foundation Repair	713-473-2382	Ms. Ann Nelson
Rock Solid Helical Pile, LLC	713-417-9053	Mr. Ward Taylor
Du-West Foundation Repair	713-473-7156	Mr. Jim Dutton

6.5 Floor Slabs Supported on Drilled Footings or Helical Piles

The project site has the potential for construction problems related to the surficial layer of silty sand soils encountered in the borings. The cohesionless soils may act as a pathway for water to travel under a foundation system. This condition may result in an increase in subsoil moisture contents and subsequently the cohesionless soils become extremely soft when wet. Sometimes this condition may result in moisture migration (vapor) through the foundation slab. We recommend one of the following remedial measures to mitigate the problem:

1. Remove the surficial two feet of silty sand soils from the floor slab areas, and five-ft beyond the building footprint and be replaced it with select structural fill in accordance with our “Site Preparation” section.

2. Leave the on-site silty sand soils in place. Place a high-performance polyethylene moisture barrier over the silty sand soils to reduce the problem.

It is our opinion that alternative No. 1 will provide a lower risk of potential issues. The decision as to what measure to use should be made by the owner(s) after risks and rewards of the issues are explained to them.

We recommend that the upper eight-inch of subgrade soils in the floor slab areas be compacted to at least 95% standard Proctor density (ASTM D 698) at a moisture content within ±2% of optimum.

A bedding layer of leveling sand, one- to two-inches in thickness, may be planned under the slab for leveling purposes only. A layer of high-performance polyethylene moisture barrier should be used above the sands to prevent moisture migration through the slab.

6.6 Floating Slab Foundation

We understand that the structural loads could be supported either on a post-tensioned slab foundation (Ref. 5) or a conventionally reinforced slab (Ref. 6). The subgrade at this site is considered to be non-expansive so the type II lightly reinforced slab (Ref. 7) can be used at this site. The design methods developed in PTI Design Manual (Ref. 5) for slabs are applicable for subgrade with Plasticity Index (PI) equal or greater than 15 in the upper five-feet. Therefore, the post-tensioned slab design in this project may not follow the PTI Design Manual. Our recommendations for conventionally reinforced slab as well as the post-tensioned slab are presented below:

Minimum Grade Beam Depth
  Below the Final Grade : 1.5-ft

Minimum Grade Beam Width : 12-inch

Allowable Net Bearing Capacity
  Total (Dead + Live) Loading : 1,500 psf
  Dead + Sustained Live Loads : 1,000 psf

Slab Subgrade Coefficient
  Slab-on-Vapor Sheeting over Sand : 0.75

Depth of Deepest Root Fibers : 10-ft

Edge Moisture Variation, e_m, feet
  Edge Lift : 4.8
  Center Lift : 9.0

Differential Swell, y_m, inches
  Edge Lift : 0.8
  Center Lift : 1.0

Effective Plasticity Index (PI) : 15

Structural Fill Type : See Site Preparation Section

The Required Minimum Fill Undrained Shear Strength : 1,000 psf

Support Index : 1

Climatic Rating : 26

Thornthwaite Moisture Index : 18

Design Suction Profile : Post-Equilibrium

Potential Vertical Rise (PVR) : 1.0 inch

Grade beams proportioned in accordance with the above bearing capacity values will have a factor of safety of 3.0 and 2.0 with respect to shearing failure for dead and total loading, respectively. Footing weight below final grade can be neglected in the determination of design loading.

The differential movement values presented in this report are based on climate controlled soil conditions and are not valid when influenced by significant other conditions, such as trees, poor drainage, slope, cut and fill sections, etc.

The project site has the potential for construction problems related to the surficial layer of silty sand soils encountered in the borings. The cohesionless soils may act as a pathway for water to travel under a foundation system. This condition may result in an increase in subsoil moisture contents and subsequently the cohesionless soils become extremely soft when wet. Sometimes this condition may result in moisture migration (vapor) through the foundation slab. We recommend one of the following remedial measures to mitigate the problem:

1. Remove the surficial two feet of silty sand soils from the floor slab areas, and five-ft beyond the building footprint and be replaced it with select structural fill in accordance with our “Site Preparation” section.

2. Leave the on-site silty sand soils in place. Place a high-performance polyethylene moisture barrier over the silty sand soils to reduce the problem.

It is our opinion that alternative No. 1 will provide a lower risk of potential issues. The decision as to what measure to use should be made by the owner(s) after risks and rewards of the issues are explained to them.

A bedding layer of leveling sand, one- to two-inch in thickness, may be placed beneath the floor slab. A layer of high-performance polyethylene moisture barrier should be used above the sands to prevent moisture migration through the slab. The excavations for the grade beams should be free of loose materials prior to concrete placement.

Information was not available on whether fill will be used to raise site grade prior to slab construction. In the event that fill is placed on the site, specifications should require placement in accordance with our recommendations given in the "Site Preparation" section. Lack of proper site preparation may result in additional stress and inferior slab performance. The on-site soils, with the exception of sands and silts, free of root organics, can be used as fill, under a floating slab foundation. Sands should not be used as fill materials at this site (with the exception of top two-inch of leveling sand under the slab).

6.7 Foundation Settlement

A settlement analysis was not within the scope of this study. It is anticipated that footings, grade beams and slabs designed using the recommended allowable bearing pressures will experience small settlements that will be within the tolerable limit for the proposed structure.

6.8 Vegetation Control

We recommend trees not be planted or left in place (existing trees) closer than half the canopy diameter of mature trees from the grade beams, typically a minimum of 20-ft. Alternatively, root barriers must be placed near the exterior grade beams to minimize tree root movements under the floor slab. This will minimize possible foundation movements as a result of tree root systems.

6.9 Foundation Maintenance

Long term performance of a residential structure depends not only on the proper design and construction, but also on the proper foundation maintenance program.

A properly designed and constructed foundation may still experience distress from the vegetation and expansive soil which will undergo volume change when correct drainage is not established or incorrectly controlled water source, such as plumbing/sewer leaks, excessive irrigation, water ponding near the foundation becomes available.

Our general recommendations on foundation maintenance are presented in the article at the end of this report. More foundation maintenance information can be found at **Foundation Performance Association Document #FPA-SC-07-0** (Ref. 2).

7.0 CONSTRUCTION CONSIDERATIONS

7.1 General

Our recommendations for the construction and maintenance of the post-tensioned slab foundations should be in accordance with the procedures presented in the publication "Construction and Maintenance Procedures Manual for Post-Tensioned Slabs-on-Ground" (Ref. 8).

7.2 Site Preparation

The project site has the potential for construction problems related to the surficial layer of silty sand soils. The surficial silty sand soils become extremely soft when wet, and must be stabilized, aerated, or replaced. In the event that surficial silty sand soils become wet, they will experience rutting and pumping. Therefore, these soils may have to be improved. Our recommendations on subgrade improvements are presented in the earthwork section of this report. Our site preparation recommendations are presented below:

1. In general, remove all vegetation, tree roots, organic topsoil, existing foundations, paved areas and any undesirable materials from the construction area. Tree trunks and tree roots under the floor slabs should be removed to a root size of less than 0.5-inch. We recommend that the stripping depth be evaluated at the time of construction by a soil technician.

2. Any on-site fill soils, encountered in the structure and pavement areas during construction, must have records of successful compaction tests signed by a licensed professional engineer that confirms the use of the fill and record of construction and earthwork testing. These tests must have been performed on all the lifts for the entire thickness of the fill. In the event that no compaction test results are available, the fill soils must be removed, processed and recompacted in accordance with our site preparation recommendations. Excavation should extend at least two-feet beyond the structure and pavement area. Alternatively, the existing fill soils should be tested comprehensively to evaluate the degree of compaction in the fill soils.

3. The subgrade areas should then be proofrolled with a loaded dump truck or similar pneumatic-tired equipment with loads ranging from 25- to 50-tons. The proofrolling serves to compact surficial soils and to detect any soft or loose zones. The proofrolling should be conducted in accordance with TxDOT Standard Specification Item 216. Any soils deflecting excessively under moving loads should be undercut to firm soils and recompacted. Any subgrade stabilization should be conducted after site proofrolling is completed and approved by the geotechnical engineer. The proofrolling operations should be observed by an experienced geotechnician.

4. Scarify the subgrade, add moisture, or dry if necessary, and recompact to 95% of the maximum dry density as determined by ASTM D 698 (standard Proctor). The moisture content at the time of compaction of subgrade soils should be within ±2% of the Proctor optimum value. We recommend that the degree of compaction and moisture in the subgrade soils be verified by field density tests at the time of construction. We recommend a minimum of four field density tests per lift or one every 2,500 square feet of floor slab areas, whichever is greater.

5. Structural fill beneath the structure area may consist of off-site inorganic lean clays with a liquid limit of less than 40 and a plasticity index between 12 and 20. Other types of structural fill available locally, and acceptable to the geotechnical engineer, can also be used.

   These soils should be placed in loose lifts not exceeding eight-inch in thickness and compacted to 95% of the maximum dry density determined by ASTM D 698 (standard Proctor). The moisture content of the fill at the time of compaction should be within ±2% of the optimum value. We recommend that the degree of compaction and moisture in the fill soils be verified by field density tests at the time of construction. We recommend that the frequency of density testing be as stated in Item 4.

6. The backfill soils in the trench/underground utility and root excavation areas should consist of select structural fill, compacted as described in Item 4. In the event of compaction difficulties, the trenches should be backfilled with cement-stabilized sand or other materials approved by the Geotechnical Engineer. Due to the high permeability of sands and potential surface water intrusion, bank sands should not be used as backfill material in the trench/underground utility and tree root excavation areas.

7. In cut areas, the soils should be excavated to grade and the surface soils proofrolled and scarified to a minimum depth of six-inch and recompacted to the previously mentioned density and moisture content.

8. The subgrade and fill moisture content and density must be maintained until paving or floor slabs are completed. We recommend that these parameters be verified by field moisture and density tests at the time of construction.

9. We recommend that the site and soil conditions used in the structural design of the foundation be verified by the engineer's site visit after all of the earthwork and site preparation has been completed and prior to the concrete placement.

7.3 Suitability of On-Site Soils for Use as Fill

7.3.1 General

The on-site soils can be used as fill. There are typically three types of fill at a site. These fills can be classified as described in the following report sections.

7.3.2 Select Structural Fill

This is the type of fill that can be used under the floor slab, paving, etc. These soils should consist of lean clays, free of root organics, with liquid limit of less than 40 and plasticity indices between 12 and 20.

7.3.3 Structural Fill

This type of fill does not meet the Atterberg limit requirements for select structural fill. This fill should consist of lean clays or fat clays. They can be used under a floating slab foundation or paving.

7.3.4 General Fill

This type of fill consists of sands and silts. These soils are moisture sensitive and are difficult to compact in a wet condition (they may pump). Furthermore, these soils erode easily. Their use is not recommended under the floor slabs or pavements. They can be used in the planter areas at least 5-ft away from the structure. They can also be used for site grading outside the structure and pavement areas.

7.3.5 Use of On-Site Soils as Fill

The on-site soils can be used as fill materials as described below:

		Use as Fill			
Stratum No.[1]	Soil Type	Select Structural Fill	Structural Fill	General Fill	Notes
I	Silty Sand (SM)	–	–	✓	2, 3

Notes:
1. See soil stratigraphy and design conditions sections of this report for strata description.
2. All fill soils should be free of organics, roots, etc.
3. The on-site cohesionless soils are moisture sensitive and erode easily. These soils will pump when they get wet. Compaction difficulties will occur in these soils in a wet condition.

7.4 Drilled Footings Installations

The drilled footings installations must be in accordance with the American Concrete Institute (ACI) Reference Specifications (Ref. 9) for the construction of drilled piers (ACI 336.1) and commentary (ACI 336.1R-98). Furthermore, it should comply with U.S. Department of Transportation, drilled shafts construction procedures and design methods (Ref. 10).

The drilled footing excavations should be free of loose materials and water prior to concrete placements, and concrete should be poured immediately after drilling the holes.

Due to the potential variability of the on-site soils and potential groundwater fluctuations, we recommend that the four corner piers be drilled first to better evaluate the constructability of the depth and bell to shaft ratios recommended herein. Once this information is field verified, all other piers need to be constructed accordingly.

Detailed observations of pier construction should be required by a qualified engineering technician to assure that the piers are (a) founded in the proper bearing stratum, (b) have the proper depth, (c) have the correct size, and (d) that all loose materials have been removed prior to concrete placement.

7.5 Helical Pile Installations

Experience indicates that torque required to install a helical pile can be used to estimate its compressive capacity (Ref. 11). The contractor should screw the pile into ground to desired torque. Do not over-torque. Furthermore, grout can be placed if specified in the design and brackets can also be installed.

In general, the ultimate compressive capacity of helical pile can be estimated in the field, using a value of 9 to 10 times the value of the torque, for square base products. The ultimate compressive capacity will be 6 to 9 times of the field torque, if tubular products are used. The structural engineer should consult with the helical pile manufacturers for piles that can resist corrosion.

7.6 Surface Water Drainage

In order to minimize ponding of surface water, site drainage should be established early in project construction so that this condition will be controlled.

Due to potential for presence of perched water table at this site, we recommend that a matrix for shallow channels be constructed throughout the site at the beginning of the project to accelerate draining of the surficial cohesionless soils. This will reduce potential subgrade pumping during the construction.

7.7 Earthwork

7.7.1 General

Difficult access and workability problems will most likely occur in the surficial silty sand soils due to poor site drainage, wet season, or site geohydrology. Considering the soils stratigraphy, the construction of this project should be conducted during the dry season to avoid major earthwork problems. The subgrade soils should be improved if they become wet and experience pumping problems. This condition can be improved by (a) improving drainage, (b) opening up to dry up, (c) soil mixing, (d) removing and replacing with dry cohesive soils, or (e) chemically modifying or stabilizing the soils. These alternatives are discussed in the following report sections.

7.7.2 Improving Drainage

The project site drainage in the pumping soils can be accomplished by placing several shallow bleeder ditches (about 18-inches ±) in the surficial cohesionless soils. These bleeder ditches should be directed to a low area, such as a hole (detention pond) or another ditch in the lowest elevation area of the site. This will allow the surficial cohesionless soils to drain the water and make the drying process faster. The hole/low area should not be under the building areas. The excess water can be pumped out of the hole and moved off-site.

7.7.3 Subgrade Drying

The on-site wet soils can be opened up so that it would dry up. However, opening up the surficial cohesionless soils for drying purposes may not be practical, due to cyclic rainfall in the Gulf-Coast area.

7.7.4 Soil Mixing

The on-site cohesionless (silty sands, Stratum I) soils can be mixed with off-site cohesive soils to reduce subgrade pumping. GET can do a mix design to come up with soil mix percentages, if this option is considered.

7.7.5 Removal and Replacement

The surficial cohesionless soils can be removed and replaced with select structural fill. The actual depth of removal and replacement should be evaluated in the field, but it should reach level of dry and stable subgrade. This procedure will include removal of the surficial cohesionless soils, proofrolling and compacting the subgrade soils to a minimum of 95 percent standard Proctor density (ASTM D 698). The site can then be backfilled with select structural fill, compacted to a minimum of 95 percent of standard Proctor density. The proofrolling should be in accordance with the site preparation section of this report. All of the fill soils should be placed and tested in accordance with the site preparation section of this report.

7.7.6 Modification/Stabilization

We recommend that the on-site cohesionless soils be modified (to dry up), using 5 to 10 percent fly ash by dry weight. The fly ash stabilization should be in accordance to Texas Department of Transportation (TxDOT) Specification, Item 265. The estimated amounts of fly ash per depth of modification are as follows:

Modification Depth, in.	Fly Ash Weight Range, lbs. per Square Yard	
	5%	10%
6	23	45
12	46	90
18	69	135
24	92	180

We recommend that five percent fly ash be used if the surficial soils are relatively moist at the time of application. Higher levels (10 percent) of fly ash should be used if wet and soggy subgrade soils are encountered.

The subgrade soils should be removed to a depth of 24-inches (or more) below existing grade. These soils should be stockpiled. The soils below a depth of 24-inches should be modified to a depth of 12-inches. These soils should be compacted to a minimum of 95 percent of standard Proctor density (ASTM D 698). The stockpiled soils should then be modified and replaced in six-inch lifts and compacted to 95 percent of maximum dry density as determined by ASTM D 698 at moisture contents within ±2 percent of optimum.

Due to poor drainage and the depth of the cohesionless soils, the depth of stabilization may be as deep as depth of cohesionless soils. A test section can be implemented for this purpose. The subgrade soils should be modified in six-inch lifts and compacted within four hours of mixing and placement. All of the subgrade soils should be compacted to a minimum of 95 percent of the standard Proctor density at the moisture content with optimum. The degree of compaction for the lifts, below a depth of 24-inches can be relaxed to 90 percent of maximum dry density to ease the construction procedures.

The subcontractor who will be doing the subgrade modification or stabilization should be experienced with stabilization procedures and methods. Furthermore, all of the earthwork at this project should be monitored by our geotechnician to assure compliance with the project specifications.

Once the subgrade is constructed, the soils at the top of subgrade should be slicked and the subgrade needs to be crowned such that the all surface water would drain away. No low areas should be left within the subgrade areas, since these areas would hold water and destroy the subgrade structure.

7.8 Construction Surveillance

Construction surveillance and quality control tests should be planned to verify materials and placement in accordance with the specifications. The recommendations presented in this report were based on a discrete number of soil test borings. Soil type and properties may vary across the site. As a part of quality control, if this condition is noted during the construction, we can then evaluate and revise the design and construction to minimize construction delays and cost overruns. We recommend the following quality control procedures be followed by a qualified engineer or technician during the construction of the facility:

- Observe the site stripping and proofrolling.
- Verify the type, depth, and amount of stabilizer.
- Verify the compaction of subgrade soils.
- Evaluate the quality of fill and monitor the fill compaction for all lifts.
- Monitor and test the foundation excavations for, strength, cleanness, depth, size, etc.
- Observe the foundation make-up prior to concrete placement.
- Monitor concrete placement, conduct slump tests and make concrete cylinders.
- Conduct after pour observations, including post-tensioned slab cable stress monitoring, if used.
- Monitor installation of drilled footings, or helical piles, if used.

- Conduct after construction site visit to evaluate the site landscaping, drainage and the presence of trees near the structure.

It is the responsibility of the client, to notify GET of when each phase of the construction is taking place so that proper quality control and procedures are implemented. More information regarding construction quality control can be found at the **Foundation Performance Association Documentation #FPA-SC-10-1** (Ref. 2).

8.0 RECOMMENDED ADDITIONAL STUDIES

We recommend the following additional studies be conducted:

1. This report has been based on assumed conditions/characteristics of the proposed development where specific information was not available. It is recommended that the architect, civil engineer and structural engineer along with any other design professionals involved in this project carefully review these assumptions to ensure they are consistent with the actual planned development. When discrepancies exist, they should be brought to our attention to ensure they do not affect the conclusions and recommendations provided herein. We recommend that GET be retained to review the plans and specifications to ensure that the geotechnical related conclusions and recommendations provided herein have been correctly interpreted as intended.

2. **Conduct site characterization studies.** These studies will include the following separate studies:

    - Phase I Geologic Fault Study to look for geologic faults at or near the site.
    - Phase I Environmental Site Assessment Study to evaluate the risk of contamination at the site.
    - Review previous aerial photos of the project site.
    - Review site topography.
    - Conduct a site visit to look for drainage features, slopes, seeps, trees and other vegetation; fence lines, ponds, stock tanks; areas of fill, etc.

3. We recommend obtaining baseline micro-elevations of the floor slabs after floor covering is installed. This information will be valuable in the event of future foundation movements.

9.0 STANDARD OF CARE

The recommendations described herein were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the geotechnical engineering profession practicing contemporaneously under similar conditions in the locality of the project. No other warranty or guarantee, expressed or implied, is made other than the work was performed in a proper and workmanlike manner.

10.0 REPORT DISTRIBUTION

This report was prepared for the sole and exclusive use by our client, based on specific and limited objectives. All reports, boring logs, field data, laboratory test results, maps and other documents prepared by GET as instruments of service shall remain the property of GET. Reuse of these documents is not permitted without written approval by GET. GET assumes no responsibility or obligation for the unauthorized use of this report by other parties and for purposes beyond the stated project objectives and work limitations.

We appreciate the opportunity to assist on this project. Please call if there should be any questions.

Very truly yours,

GEOTECH ENGINEERING AND TESTING
TBPE Registration Number F-001183

vincent yin

Vincent Yin, M.S. Geology
Project Manager

SHAILESH NAMEKAR
131521

James
Shailesh Namekar
8/28/20

James Namekar, Ph D., P.E.
Chief Engineer

VY/JN/DAE/vy

Copies Submitted: (1) Hard Copy – Mr. Gilberth Giraldo
(1) PDF Copy Email – Mr. Gilberth Giraldo

11.0 ILLUSTRATIONS

	Plate
Plan of Borings	1
Logs of Borings	2 – 3
Key to Log Terms and Symbols	4
Project Site Pictures	5
Foundation Maintenance Program	

12.0 REFERENCES

1. "Method for Determining the Potential Vertical Rise, PVR," State Department of Highways and Public Transportation, Test Method Tex 124-E, Austin, Texas.

2. Committee Papers from Foundation Performance Association (FPA), see FPA Website: http://www.foundationperformance.org/committee_papers.cfm.

3. “Basic Helical Screw Pile Design”, Donald J. Clayton, P.E., Earth Contac Products, February 2005.

4. “Basic Guidelines for Design Helical Piers for Underpinning,” A.B. Chance Company, January 1993 (Bulletin 01-9202).

5. “Design of Post-Tensioned Slab-on-Ground”, Post-Tensioning Institute, Phoenix, Arizona, Third Edition with 2008 Supplement, 2008.3

6. “Design of Slab-on-Ground Foundation”, Wire Reinforcement Institute, Findlay, Ohio, August 1981 and update March 1996.4

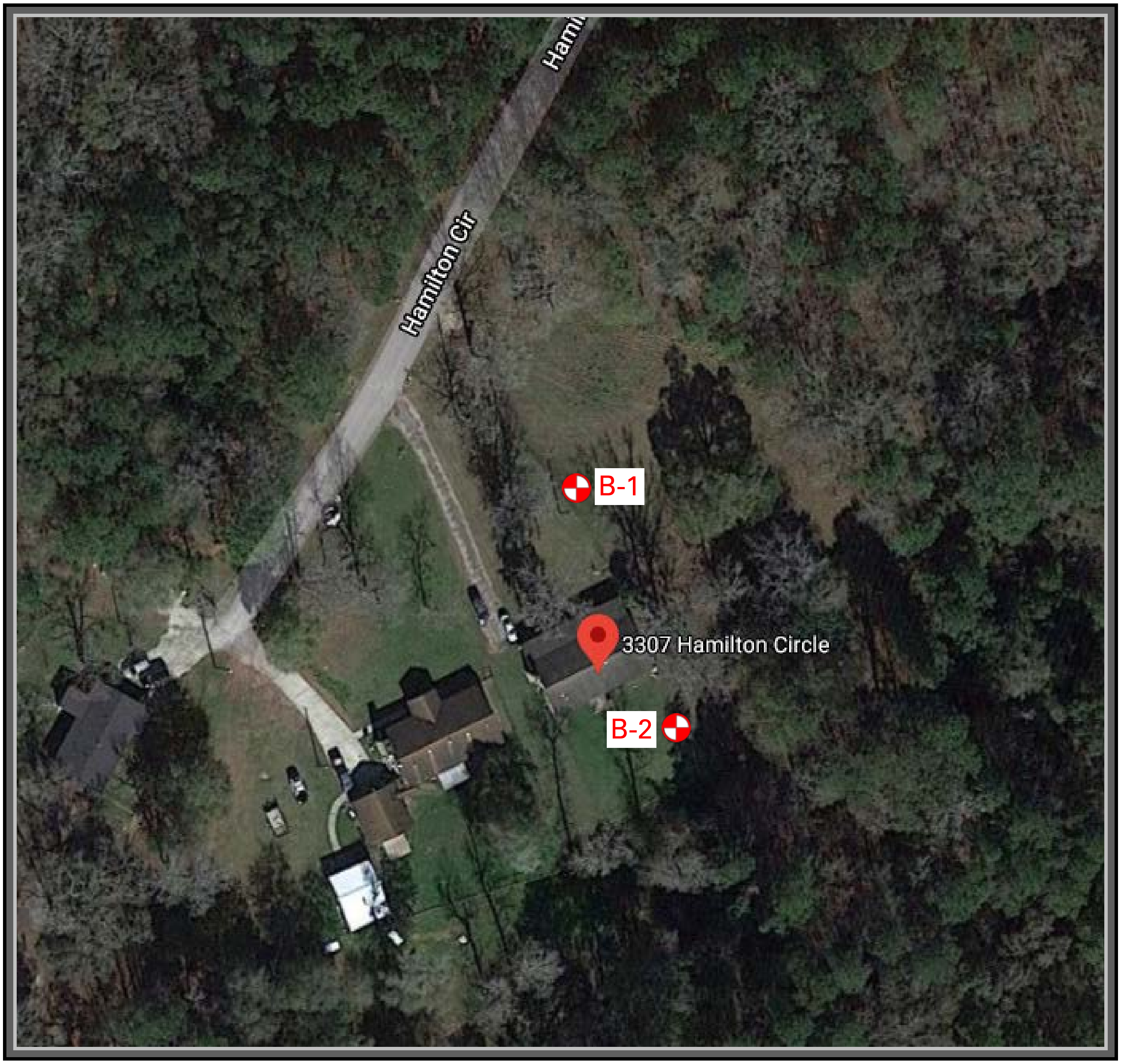
7. “Criteria for Selection and Design of Residential Slabs-on-Ground”, Building Research Advisory Board, Publication 1571, Report No. 33, Washington D.C., 1968.

8. “Construction and Maintenance Procedures Manual for Post-Tensioned Slabs-on-Ground”, 2nd Edition, Post-Tensioning Institute, Phoenix, Arizona, September 1998.

9. “Reference Specifications for the Construction of Drilled Piers (ACI 336.1) and Commentary (ACI 336.1R-98)”, American Concrete Institute, Farmington Hills, Michigan.

10. Federal Highway Administration, US-DOT “Drilled Shafts; Construction Procedures and Design Methods”, Publication FHWA-IF-99-025, 2010.

11. “Repairing Existing Structures, Using Steel Piers or Helical Piles,” Donald J. Clayton, P.E., Earth Contact Products, February 2005.



PLAN OF BORINGS (boring locations are approximate)

PROJECT: G/S for Proposed Residence at 3307 Hamilton Circle
Montgomery, Texas 77304

SCALE: NOT TO SCALE

DATE: AUGUST 2020

PROJECT NO.: 20-640E

NORTH

LOG OF BORING NO. B-1

Sheet 1 of 1

Geotech Engineering and Testing
17407 US Highway 59 North
Houston, Texas 77396
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: G/S for Proposed Residence at 3307 Hamilton Circle
LOCATION: Montgomery, TX 77304
PROJECT NO.: 20-640E STATION NO.:
DATE: 8-12-20 COMPLETION DEPTH: 20.0 ft.

NORTHING: 1
EASTING: 2
ELEVATION: Existing Grade

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
▮ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)	UNDRAINED SHEAR STRENGTH, tsf
0					SILTY SAND (SM), light brown, brown, with root fibers to 10'										
					- loose 2' to 4'										
	10														
					- medium dense 4' to 15'										
5	13					4				15					
	19														
	24														
10															
▼															
	28														
15															
					- dense 18' to 20'										
	33														
20															
25															

WATER OBSERVATIONS:
∇ : WATER ENCOUNTERED AT 12.0 ft. DURING DRILLING
▼ : WATER DEPTH AT 12.0 ft. AFTER 0.33-HOUR

DRY AUGER: 0 TO 20 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Alex

OVM2 20-640E.GPJ OVM.GDT 8/13/20

LOG OF BORING NO. B-2

Sheet 1 of 1

GET
GEOTECH ENGINEERING & TESTING

Geotech Engineering and Testing
17407 US Highway 59 North
Houston, Texas 77396
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: G/S for Proposed Residence at 3307 Hamilton Circle
LOCATION: Montgomery, TX 77304
PROJECT NO.: 20-640E STATION NO.:
DATE: 8-12-20 COMPLETION DEPTH: 20.0 ft.

NORTHING: 2
EASTING: 3
ELEVATION: Existing Grade

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0			SILTY SAND (SM), light brown, brown, with root fibers to 2'	4				17				
			- loose 2' to 4'									
	10											
			- medium dense 4' to 15'									
5	13											
	17											
	24			13				13				
10												
	28											
15												
			- dense 18' to 20'									
	35											
20												
25												

UNDRAINED SHEAR STRENGTH, tsf

▲ HAND PENETROMETER
▮ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
▽ : WATER ENCOUNTERED AT 16.0 ft. DURING DRILLING
▼ : WATER DEPTH AT 16.0 ft. AFTER 0.33-HOUR

DRY AUGER: 0 TO 20 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Alex

OVM2 20-640E.GPJ OVM.GDT 8/13/20

KEY TO LOG TERMS AND SYMBOLS

UNIFIED SOIL CLASSIFICATIONS

Symbol		Material Descriptions
GW	▚	WELL GRADED-GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GP	▢	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GM	▥	SILTY GRAVELS, GRAVEL-SAND SILT MIXTURES
GC	▩	CLAY GRAVELS, GRAVEL-SAND CLAY MIXTURES
SW	▓	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SP	░	POORLY GRADED SANDS, OR GRAVELLY SANDS, LITTLE OR NO FINES
SM	▒	SILTY SANDS, SAND-SILT MIXTURES a
SC	▨	CLAYEY SANDS, SAND-SILT MIXTURES b
ML	▥	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
CL	▨	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS
OL	▤	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
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
PT	▢	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT
	⊠	FILL SOILS

TERMS CHARACTERIZING SOIL STRUCTURE

Slickensided	-	Having incline planes of weakness that are slick and glossy in appearance.
Fissured	-	Containing shrinkage cracks frequently filled with fine sand or silt: usually vertical.
Laminated	-	Composed of thin layers of varying colors and soil sample texture.
Interbedded	-	Composed of alternate layers of different soil types.
Calcareous	-	Containing appreciable quantities of calcium carbonate.
Well Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Poorly Graded	-	Predominantly of one grain size, or having a range of sizes with some intermediate sizes missing.
Pocket	-	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	-	Inclusion less than ⅛-inch thick extending through the sample.
Seam	-	Inclusion ⅛- to 3-inch thick extending through the sample.
Layer	-	Inclusion greater than 3-inch thick extending through the sample.
Interlayered	-	Soils sample composed of alternating layers of different soil types.
Intermixed	-	Soil samples composed of pockets of different soil type and layered or laminated structure is not evident.

COARSE GRAINED SOILS (major portion retained on No. 200 Sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Conditions rated according to standard penetration test (SPT)* as performed in the field.

Descriptive Terms	Blows Per Foot*
Very Loose	0 – 4
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	over 50

* 140 pound weight having a free fall of 30-inch

SOIL SAMPLERS

■ SHELBY TUBE SAMPLER

☒ STANDARD PENETRATION TEST

◨ AUGER SAMPLING

FINE GRAINED SOILS (major portion passing No. 200 Sieve): Include (1) inorganic or organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength as indicated by hand penetrometer readings or by unconfined compression tests.

Descriptive Term	Undrained Shear Strength Ton/Sq. Ft.	Descriptive Term	Blows Per Foot*
Very Soft	Less than 0.13	Very Soft	< 2
Soft	0.13 to 0.25	Firm	2 – 8
Firm	0.25 to 0.50	Stiff	8 – 15
Stiff	0.50 to 1.00	Very Stiff	15 – 30
Very Stiff	1.00 to 2.00	Hard	> 30
Hard	2.00 or higher		

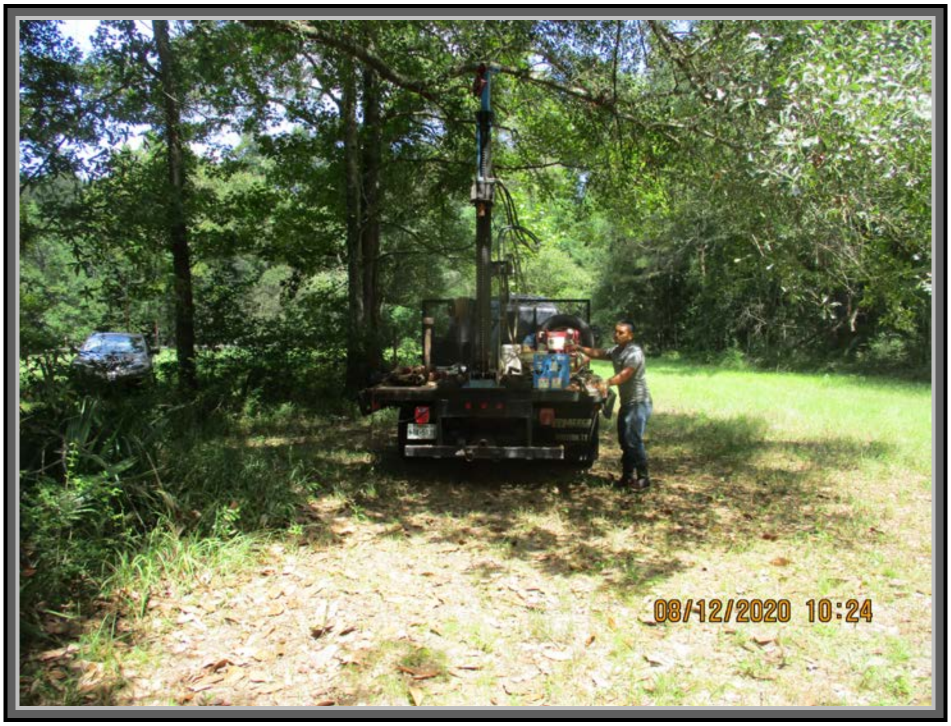
NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above because of weakness or cracks in the soil. The consistency ratings of such soils are based on hand penetrometer readings.

* 140 pound weight having a free fall of 30-inch

TERMS CHARACTERIZING ROCK PROPERTIES

VERY SOFT OR PLASTIC	Can be remolded in hand: corresponds in consistency up to very stiff in soils.
SOFT	Can be scratched with fingernail.
MODERATELY HARD	Can be scratched easily with knife; cannot be scratched with fingernail.
	Difficult to scratch with knife.
VERY HARD	Cannot be scratched with knife.
POORLY CEMENTED OR FRIABLE	Easily crumbled.
CEMENTED	Bounded Together by chemically precipitated materials.
UNWEATHERED	Rock in its natural state before being exposed to atmospheric agents.
SLIGHTLY WEATHERED	Noted predominantly by color change with no disintegrated zones.
WEATHERED	Complete color change with zones of slightly decomposed rock.
EXTREMELY WEATHERED	Complete color change with consistency, texture, and general appearance or soil.

PROJECT PICTURES
Project No. 20-640E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08/12/2020 10:25

Note: The above picture(s) indicate a snap shot of the project and the surroundings. We request that the client review the picture(s) and make sure that they represent the project area. We must be contacted immediately if any discrepancy exists.

GEOTECH ENGINEERING and TESTING

ACCREDITED
CERTIFICATE #0075-01
#0075-02

Geotechnical, Environmental, Construction Materials, and Forensic Engineering

RECOMMENDED HOMEOWNER FOUNDATION MAINTENANCE PROGRAM FOR RESIDENTIAL PROJECTS IN THE HOUSTON AREA

BY

DAVID A. EASTWOOD, P.E.

02-16

Introduction

Performance of residential structures depends not only on the proper design and construction, but also on the proper foundation maintenance program. Many residential foundations have experienced major foundation problems as a result of owner's neglect or alterations to the initial design, drainage, or landscaping. This has resulted in considerable financial loss to the homeowners, builders, and designers in the form of repairs and litigation.

A properly designed and constructed foundation may still experience distress from vegetation and expansive soil which will undergo volume change when correct drainage is not established or incorrectly controlled water source becomes available.

The purpose of this document is to present recommendations for maintenance of properly designed and constructed residential projects in Houston. It is recommended that the builder submit this document to his/her client at the time that the owner receives delivery of the house.

Typical Foundations

Foundations for support of residential structures in the Houston area consist of pier and beam type foundation, spread footing foundation, conventionally reinforced slab, or a post-tensioned slab. A soils exploration must be performed before a proper foundation system can be designed.

General Soil Conditions

Variable subsoil conditions exist in the Houston Metro area. Highly expansive soils exist in the West University, Bellaire, Southwest Houston, Clear Lake, Friendswood, Missouri City, and First Colony areas.

Sandy soils with potential for severe perched water table problems as a result of poor drainage are present in the North and West Houston, including portions of Piney Point, Hedwig Village, The Woodlands, Kingwood, Atascocita, Cypresswood, Fairfield, etc.

A perched water table condition can occur in an area consisting of surficial silty sands or clayey sands underlain by impermeable clays. During the wet (rainy) season, water can pond on the clays (due to poor drainage) and create a perched water table condition. The sands become extremely soft, wet, and lose their load carrying capacity.

Drainage

The initial builder/developer site grading (positive drainage) should be maintained during the useful life of the residence. In general, a civil engineer develops a drainage plan for the whole subdivision. Drainage sewers or other discharge channels are designed to accommodate the water runoff. These paths should be kept clear of debris such as leaves, gravel, and trash.

In the areas where expansive soils are present, positive drainage should be provided away from the foundations. Changes in moisture content of expansive soils are the cause of both swelling and shrinking. Positive drainage should also be maintained in the areas where sandy soils are present.

Positive drainage is extremely important in minimizing soil-related foundation problems.

The homeowner's berm the flowerbed areas, creating a dam between the berm and the foundation, preventing the surface water from draining away from the structure. This condition may be visually appealing but can cause significant foundation damage as a result of negative drainage.

The most commonly used technique for grading is a positive drainage away from the structure to promote rapid runoff and to avoid collecting ponded water near the structure which could migrate down the soil/foundation interface. This slope should be about 3 to 5 percent within 10-feet of the foundation.

Should the owner change the drainage pattern, he should develop positive drainage by backfilling near the grade beams with select fill compacted to 90 percent of the maximum dry density as determined by ASTM D 698-91 (standard proctor).

This level of compaction is required to minimize subgrade settlements near the foundations and the subsequent ponding of the surface water. The select fill soils should consist of silty clays and sandy clays with liquid limits less than 40 and plasticity index (PI) between 10 and 20. Bank sand or top soils are not a select fill. The use of Bank sand or top soils to improve drainage away from a house is discouraged; because, sands are very permeable. In the event that sands are used to improve drainage away from the structure, one should make sure the clay soils below the sands have a positive slope (3 - 5 Percent) away form the structure, since the clay soils control the drainage away from the house.

The author has seen many projects with an apparent positive drainage; however, since the drainage was established with sands on top of the expansive soils the drainage was not effective.

Depressions or water catch basin areas should be filled with compacted soil (sandy clays or silty clays not bank sand) to have a positive slope from the structure, or drains should be provided to promote runoff from the water catch basin areas. Six to twelve inches of compacted, impervious, non-swelling soil placed on the site prior to construction of the foundation can improve the necessary grade and contribute additional uniform surcharge pressure to reduce uneven swelling of underlying expansive soil.

Pets (dogs, etc.) sometimes excavate next to the exterior grade beams and created depressions and low spots in order to stay cool during the hot season. This condition will result in ponding of the surface water in the excavations next to the foundation and subsequent foundation movements. These movements can be in the form of uplift in the area with expansive soils and settlement in the areas with sandy soils. It is recommended as a part of the foundation maintenance program, the owner backfills all excavations created by pets next to the foundation with compacted clay fill.

Grading and drainage should be provided for structures constructed on slopes, particularly for slopes greater than 9 percent, to rapidly drain off water from the cut areas and to avoid ponding of water in cuts or on the uphill side of the structure. This drainage will also minimize seepage through backfills into adjacent basement walls.

Subsurface drains may be used to control a rising water table, groundwater and underground streams, and surface water penetrating through pervious or fissured and highly permeable soil. Drains can help control the water table in the expansive soils.

Furthermore, since drains cannot stop the migration of moisture through expansive soil beneath foundations, they will not prevent long-term swelling. Moisture barriers can be placed near the foundations to minimize moisture migration under the foundations. The moisture barriers should be at least five-feet deep in order to be effective.

Area drains can be used around the house to minimize ponding of the surface water next to the foundations. The area drains should be checked periodically to assure that they are not clogged.

The drains should be provided with outlets or sumps to collect water and pumps to expel water if gravity drainage away from the foundation is not feasible. Sumps should be located well away from the structure. Drainage should be adequate to prevent any water from remaining in the drain (i.e., a slope of at least 1/8 inch per foot of drain or 1 percent should be provided).

Positive drainage should be established underneath structural slabs with crawl space. This area should also be properly vented. Absence of positive drainage may result in surface water ponding and moisture migration through the slab. This may result in wood floor warping and tile unsticking.

It is recommended that at least six-inches of clearing be developed between the grade and the wall siding. This will minimize surface water entry between the foundation and the wall material, in turn minimizing wood decay.

Poor drainage at residential projects in North and West Houston can result in saturation of the surficial sands and development of a perched water table. The sands, once saturated, can lose their load carrying capacity. This can result in foundation settlements and bearing capacity failures. Foundations in these areas should be designed assuming saturated subsoil conditions.

In general, roof drainage systems, such as gutters or rain dispenser devices, are recommended all around the roof line when gutters and downspouts should be unobstructed by leaves and tree limbs. In the area where expansive soils are present, the gutters should be connected to flexible pipe extensions so that the roof water is drained at least 10-feet away from the foundations. Preferably the pipes should direct the water to the storm sewers. In the areas where sandy soils are present, the gutters should drain the roof water at least five-feet away from the foundations.

If a roof drainage system is not installed, rain-water will drip over the eaves and fall next to the foundations resulting in subgrade soil erosion, and creating depression in the soil mass, which may allow the water to seep directly under the foundation and floor slabs.

The home owner must pay special attention to leaky pools and plumbing. In the event that the water bill goes up suddenly without any apparent reason, the owner should check for a plumbing leak.

The introduction of water to expansive soils can cause significant subsoil movements. The introduction of water to sandy soils can result in reduction in soil bearing capacity and subsequent settlement. The home owner should also be aware of water coming from the air conditioning drain lines. The amount of water from the condensating air conditioning drain lines can be significant and can result in localized swelling in the soils, resulting in foundation distress.

Landscaping

General. A house with the proper foundation and drainage can still experience distress if the homeowner does not properly landscape and maintain his property. One of the most critical aspects of landscaping is the continual maintenance of properly designed slopes.

Installing flower beds or shrubs next to the foundation and keeping the area flooded will result in a net increase in soil expansion in the expansive soil areas. The expansion will occur at the foundation perimeter. It is recommended that initial landscaping be done on all sides, and that drainage away from the foundation should be provided and maintained. Partial landscaping on one side of the house may result in swelling on the landscaping side of the house and resulting differential swell of foundation and structural distress in a form of brick cracking, windows/door sticking, and slab cracking.

Landscaping in areas where sandy, non-expansive soils are present, with flowers and shrubs should not pose a major problem next to the foundations. This condition assumes that the foundations are designed for saturated soil conditions. Major foundation problems can occur if the planter areas are saturated as the foundations are not designed for saturated (perched water table) conditions. The problems can occur in a form of foundation settlement, brick cracking, etc.

Sprinkler Systems. Sprinkler systems can be used in the areas where expansive soils are present, provided the sprinkler system is placed all around the house to provide a uniform moisture condition throughout the year.

The use of a sprinkler system in parts of Houston where sandy soils are present should not pose any problems, provided the foundations are designed for saturated subsoil conditions with positive drainage away from the structure.

The excavations for the sprinkler system lines, in the areas where expansive soils are present, should be backfilled with impermeable clays. Bank sands or top soil should not be used as backfill. These soils should be properly compacted to minimize water flow into the excavation trench and seeping under the foundations, resulting in foundation and structural distress.

The sprinkler system must be checked for leakage at least once a month. Significant foundation movements can occur if the expansive soils under the foundations are exposed to a source of free water.

The homeowner should also be aware of damage that leaking plumbing or underground utilities can cause, if they are allowed to continue leaking and providing the expansive soils with the source of water.

Effect of Trees. The presence of trees near a residence is considered to be a potential contributing factor to the foundation distress. Our experience shows that the presence or removal of large trees in close proximity to residential structures can cause foundation distress. This problem is aggravated by cyclic wet and dry seasons in the area. Foundation damage of residential structures caused by the adjacent trees indicates that foundation movements of as much as 3- to 5-inches can be experienced in close proximity to residential foundations.

This condition will be more severe in the periods of extreme drought. Sometimes the root system of trees such as willow, elm, or oak can physically move foundations and walls and cause considerable structural damage. Root barriers can be installed near the exterior grade beams to a minimum depth of 60-inches, if trees are left in place in close proximity to foundations. It is recommended that trees not be planted closer than half the canopy diameter of the mature tree, typically 20-feet from foundations. Any trees in closer proximity should be thoroughly soaked at least twice a week during hot summer months, and once a week in periods of low rainfall. More frequent tree watering may be required.

Tree roots tend to desiccate the soils. In the event that the tree has been removed prior to house construction, during the useful life of the house, or if tree dies, subsoil swelling can occur for several years. Studies have shown that this process can last as much as 20 years in the area where highly expansive clays are present. In the areas where sandy soils are present this process does not occur.

In this case the foundation for the house should be designed for the anticipated maximum heave. Alternatively, the site should be left alone for several years so that the moisture regime in the desiccated area of the soils (where roots used to be) become equal/stabilized to the surrounding subsoil conditions.

Tree removal can be safe provided the tree is no older than any part of the house, since the subsequent heave can only return the foundation to its original level. In most cases there is no advantage to a staged reduction in the size of the tree and the tree should be completely removed at the earliest opportunity. The areas where expansive soils exist and where the tree is older than the house, or there are more recent extensions to the house, it is not advisable to remove the tree because the danger of inducing damaging heave; unless the foundation is designed for the total computed expected heave.

In the areas where non-expansive soils are present, no significant foundation distress will occur as a result of the tree removal.

In the areas where too much heave can occur with tree removal, some kind of pruning, such as crown thinning, crown reduction or pollarding should be considered. Pollarding, in which most of the branches are removed and the height of the main trunk is reduced, is often mistakenly specified, because most published advice links the height of the tree to the likelihood of damage. In fact, the leaf area is the important factor. Crown thinning or crown reduction, in which some branches are removed or shortened, is therefore generally preferable to pollarding. The pruning should be done in such a way as to minimize the future growth of the tree, without leaving it vulnerable to disease (as pollarding often does) while maintaining its shape. This should be done only by a reputable tree surgeon or qualified contractor working under the instructions of an arbor culturist.

You may find there is opposition to the removal or reduction of an offending tree; for example, it may belong to a neighbor or the local authority or have a Tree Preservation Order on it. In such cases there are other techniques that can be used from within your own property.

One option is root pruning, which is usually performed by excavating a trench between the tree and the damaged property deep enough to cut most of the roots. The trench should not be so close to the tree that it jeopardizes its stability. In time, the tree will grow new roots to replace those that are cut; however, in the short term there will be some recovery as the degree of desiccation in the soil under the foundations reduces.

Where the damage has only appeared in a period of dry weather, a return to normal weather pattern may prevent further damage occurring. Permission from the local authority is required before pruning the roots of a tree with preservation order on it.

Root barriers are a variant of root pruning. However, instead of simply filling the trench with soil after cutting the roots, the trench is either filled with concrete or lined with an impermeable layer to form a "permanent" barrier to the roots. Whether the barrier will be truly permanent is questionable, because the roots may be able to grow round or under the trench. However, the barrier should at least increase the time it takes for the roots to grow back.

Foundations/Flat Works

Every homeowner should conduct a yearly observation of foundations and flat works and perform any maintenance necessary to improve drainage and minimize infiltrations of water from rain and lawn watering. This is important especially during the first six years of a newly built home because this is usually the time of the most severe adjustment between the new construction and its environment. We recommend that all of the separations in the flat work and paving joints be immediately backfilled with joint sealer to minimize surface water intrusion and subsequent shrink/swell.

Some cracking may occur in the foundations. For example, most concrete slabs can develop hairline cracks. This does not mean that the foundation has failed. All cracks should be cleaned up of debris as soon as possible. The cracks should be backfilled with high-strength epoxy glue or similar materials. If a foundation experiences significant separations, movements, cracking, the owner must contact the builder and the engineer to find out the reason(s) for the foundation distress and develop remedial measures to minimize foundation.