Eyncon ENGINEERING

Structural, Geotechnical, Forensic, Civil and MEP

PROJECT NO. 10424075

GEOTECHNICAL INVESTIGATION
FOR
PROPOSED BUILDING AT
805 NE 2ND STREET, KERENS
NAVARRO COUNTY, TEXAS

REPORTED TO

JEFF STAPLETON
POWELL, TEXAS

PREPARED BY

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MAY 15, 2024

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Project No: 10424075
Report No: 01
May 15, 2024

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Powell, Texas 75153

GEOTECHNICAL INVESTIGATION
FOR
PROPOSED BUILDING AT
805 NE 2ND STREET, KERENS
NAVARRO COUNTY, TEXAS

Eyncon, LLC (EL) has completed a geotechnical exploration for the above referenced project. This study was conducted per your authorization on April 15, 2024.

This report describes the field exploration and laboratory testing followed by our engineering analysis. The results were used to develop recommendations to aid in design and construction of the building foundation and roadway.

We appreciate and wish to thank you for this opportunity to assist you on this project. If we can be of further assistance, please contact our office.

Yours very truly,

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1.0 EXECUTIVE SUMMARY

It is planned to construct a building at 805 NE 2nd Street, Kerens, Navarro County, Texas. The proposed building will include roadways. Eyncon, LLC (EL) has completed the geotechnical exploration for this project. Our investigation and recommendations are summarized below:

- Six (6) boreholes to depths of 6-ft and 25-ft were drilled for this project. Boreholes BH1 through BH3 were drilled to a depth of 25-ft for the building while boreholes BH4 through BH6 were drilled to a depth of 6-ft for the roadway. Based on the information obtained from the field exploration and laboratory testing, the subsoils at the subject site can be summarized as follows:

Depth, ft.	Soil Description
0 – 6	LEAN CLAY (CL), stiff to very stiff, reddish brown, dark brown, dark gray, with root fibers, calcareous nodules, sands, moist.
0 – 15	FAT CLAY (CH), firm to stiff to very stiff, brown, reddish brown, dark brown, gray, greenish gray, olive gray, dark gray, brownish yellow, with root fibers to 8', ferrous and calcareous nodules, carbonate masses, gravels, moist.
13 – 25	LEAN CLAY (CL), stiff to very stiff, greenish gray, brownish yellow, with sands, moist.

- Groundwater was not encountered during our field exploration.

- The effective Plasticity Index (PI) of subsoils is 37. A potential vertical rise (PVR) of 3.5 inches is estimated with the existing site conditions. The PVR will be more than 3.5 inches, if deep seated swelling occurs.

- **Considering the presence of expansive soils and potential for deep seated swelling at the site, drilled shafts and structurally suspended grade beam and floor slab is the most suitable foundation system for the proposed building.** Slab-on-grade foundation system can be considered, only if potential movement can be tolerated by the structure.

- Recommendations for drilled shafts and post-tensioned slab are provided in Chapter 5.0 of this report. The drilled shafts should be seated at a minimum depth of 18-ft below existing grade. The actual depth of the drilled shafts may be deeper depending on the structural design including uplift forces. The design parameters for the post-tensioned slab are provided in Section 5.4 of this report.

- In order to reduce the PVR, recommendations on subgrade modification are provided in Section 4.3 of this report.

- We understand that roadway will be paved with concrete. Pavement recommendations for light weight and heavy weight traffic are provided in Chapter 6.0 of this report. **Pavement design is not within the scope of this study.**

This executive summary should be read in conjunction with the details given in the following report sections.

2.0 INTRODUCTION

2.1 Project Description

It is planned to construct a building at 805 NE 2nd Street, Kerens, Navarro County, Texas. The total footprint of the proposed building is approximately 8000 sq.-ft. The proposed building will include roadways. The roadways will be paved with concrete. The concrete paving will be subject to light/auto loading and heavy truck loading. Traffic information is not available at this time. Information regarding structural loads was made available at the time of this investigation. Drilled shafts or post-tensioned slab type foundation may be used to support the proposed building. Our investigation and recommendations are summarized below.

2.2 Scope of Work

The scope of this study are as follows:

- Subsurface soil, rock and groundwater conditions on site based on six (6) soil boreholes to depths of 6-ft and 25-ft from the existing ground elevation.
- Engineering characterization of the subsurface materials encountered.
- Design criteria for drilled shaft and post-tensioned slab foundation systems.
- Pavement recommendations for light and heavy weight traffic.
- Recommendations regarding site preparation and earthwork.

The scope of this study excludes any environmental assessment studies of soil, surface water and groundwater. Also, any slope stability analysis (for natural or constructed) and recommendations for retaining walls are not within the scope of this study. **Pavement design is not within the scope of this study.**

3.0 SITE GEOLOGY, FIELD EXPLORATION AND SUBSURFACE CONDITIONS

3.1 Site Geology

Information regarding depth and magnitude as well as anticipated features of the soil in this area is provided by the major soil formations. This information provides data for this area. Information provided is general information and should not be used to replace site specific engineering analysis.

The site is located in the Fluviatile Terrace Deposits Formation of the Pleistocene Age in the Quaternary Era as indicated on the Geologic Atlas of Texas; Dallas Sheet as published by the University of Texas at Austin. This formation is composed of gravels, sand, silt and clay with continuous terraces of different ages separated by solid line.

3.2 Site Description

At the time of the field exploration, the project site was covered with grass. The streets are concrete paved. The project site is generally level with elevation difference of less than 3-ft. In general, there is gradual residential and commercial development in the immediate vicinity of the project site. Project site pictures were taken during field exploration. These pictures are presented on PLATE 1.

3.3 Soil Boreholes

The soil conditions were explored by conducting six (6) soil boreholes. The borehole schedule is as follows:

Borehole Nos.	Depth, ft.	Facility
BH1 through BH3	25	Building
BH4 through BH6	6	Roadway

The approximate borehole locations are shown on PLATE 2. Boreholes were drilled using standard truck mounted rigs and equipment. The number of boreholes, depths and locations were specified by the project engineer.

Soil samples were obtained continuously at each borehole location from the ground surface to 10-ft and at five-ft intervals thereafter to the completion depth of the boreholes. Shelby tubes were used for fine grained materials according to ASTM D 1587.

Soil samples obtained were visually classified and logged during retrieval. Information on field observation, classification of the soils encountered and strata limits are presented on the borehole logs shown on PLATES 3 through 8. Lines delineating subsurface strata on the borehole logs are approximate and the actual transition between strata may be gradual. A key to the classification and symbols is presented on PLATE 9.

3.4 Groundwater Measurements

Boreholes were drilled without the aid of drilling water or fluid, to estimate the depth to perched or free-water conditions more accurately. Groundwater was not encountered during our field exploration.

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

The pressure and/or level of groundwater that might occur cannot be predicted accurately based upon short-term site investigation work. Most of the materials encountered in the boreholes are considered relatively impermeable and are anticipated to have a slow response to water movement.

The accurate evaluation of the hydrostatic water table requires long term observation of monitoring wells and/or piezometers. The installation of piezometers/monitoring wells was beyond the scope of our study. We recommend that EL be immediately notified if a noticeable change in groundwater occurs from that mentioned in this report. We would be pleased to evaluate the effect of any groundwater changes on the design and construction sections of this report.

3.5 Laboratory Tests

Laboratory tests were conducted on selected representative samples of the major strata obtained from boreholes to further classify the soils and to evaluate the engineering properties of soil. ASTM D-2487 was used for classification of soils for engineering purposes. The laboratory tests were performed in general accordance with relevant ASTM standards as follows:

Laboratory Test	ASTM Standard
Visual Soil Classifications	ASTM D 2488
Atterberg Limits	ASTM D 4318
Natural Moisture Content	ASTM D 4643
% Passing No. 200 Sieve	ASTM D 1140

Based on the test results, soils samples were classified according to ASTM D 2487. In addition, undrained shear strengths of the cohesive soils were verified by hand penetrometer tests. The test results are presented on the borehole logs at representative sample depth.

All soil samples in the laboratory are stored for a period of 7 days following the submission of this report. The samples will be discarded after this period, unless EL is instructed to retain samples.

3.6 Soil Stratigraphy and Properties

The subject site is located in the Fluviatile Terrace Deposits Formation. This type of formation is a result of soil deposited over time by streams or rivers. Hence, the type and depth of soil at each location may change dramatically within the project site. Based on the field exploration and laboratory testing for this investigation, the subsurface stratigraphy encountered at the borehole locations is relatively variable and consist of three (3) major strata: lean clay (CL) soils, fat clay (CH) soils and lean clay (CL) soils. Details of subsurface conditions at each borehole location are presented on the respective borehole logs. In general, the subsoils can be summarized as follows:

Depth, ft.	Soil Description	Plasticity Index	Shear Strength, tsf
0 – 6	LEAN CLAY (CL), stiff to very stiff, reddish brown, dark brown, dark gray, with root fibers, calcareous nodules, sands, moist.	18 – 27	0.62 – 1.50
0 – 15	FAT CLAY (CH), firm to stiff to very stiff, brown, reddish brown, dark brown, gray, greenish gray, olive gray, dark gray, brownish yellow, with root fibers to 8’, ferrous and calcareous nodules, carbonate masses, gravels, moist.	31 – 38	0.31 – 1.50
13 – 25	LEAN CLAY (CL), stiff to very stiff, greenish gray, brownish yellow, with sands, moist.	16 – 20	0.78 – 1.50

Soil Stratigraphy may vary between boring locations. **We recommend that EL be immediately notified, if a noticeable change in soil stratigraphy from that summarized above or presented in the borehole logs are encountered during construction.** We will evaluate the effect of any soil type and depth changes on the design and construction recommendations presented in this report. We may revise the recommendations based on the significance of the changed conditions.

4.0 FOUNDATIONS ON EXPANSIVE SOILS

4.1 Expansive Soils

Soil boreholes and laboratory tests indicates the presence of expansive soils at the subject site. The subsoil has an effective Plasticity Index (PI) of 37. Expansive soils shrink when water is removed and swell when water is added. Foundations constructed on expansive soils are subject to uplifting forces caused by the swelling, if environmental or man-made conditions cause a change in the moisture level of the soil. The potential heave is influenced by the soil properties, overburden pressures, and to a great extent by soil moisture levels at the time of construction.

4.2 Potential Vertical Rise (PVR)

Shrink and swell of foundation soils causes the foundation to move vertically. The potential vertical movement due to shrink/swell potential of the foundation soil is determined by the Texas Department of Transportation (TxDOT) Method 124-E in conjunction with engineering judgment and experience. The estimated movements were calculated assuming the moisture content of the in-situ soils, within the normal zone of seasonal moisture content change, varies between a ‘dry’ condition and a ‘wet’ condition as defined by TEX 124-E. The zone which has the potential for moisture variation due to seasonal changes is called as the active zone.

There is potential for deep seated swelling at the subject site. Considerably more movement will occur in areas where positive drainage of surface water is not maintained or if soils are subject to an outside water source, such as leakage from a utility line or subsurface migration from off-site locations.

Based on our calculations, the subsoil at the subject site has the Potential Vertical Rise (PVR) of about 3.5 inches. The PVR is calculated based on an active zone of 13-ft. The potential movement will be higher than 3.5 inches, if deep seated swelling occurs. Surcharge load of 1 psi from the slab is assumed for PVR calculations. Swell tests of onsite soils were not conducted. Swell tests are not within the scope of this study.

The PVR is estimated based on the current site grades and subsoil conditions. If cut and/or fill operations in excess of 6 inches are performed, the PVR value could change significantly.

4.3 Subgrade Modification

The expansive soils present at this site can cause foundation movement of floating slab type foundations. The anticipated soil movements should be reduced by removing several feet of on-site expansive soils and replacing with select fill or by chemical injection.

4.3.1 Alternative 1 – Removal and Replacement

We recommend to remove onsite expansive soils and replace with select fill to reduce the PVR. The amount of reduction in the PVR for various replacement thickness are tabulated below:

Thickness of Select Fill, ft	*PVR, in*
0	*3.5*
2	*2.5*
4	*2.0*
6	*1.5*
8	*1.0*

The select fill should extend 5-ft beyond the building footprint and all areas sensitive to soil movement. After the excavation of onsite soils is completed, scarify the bottom of the excavation to a minimum depth of 8-inch and add moisture (if required), 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 soils should be minimum of +3% of the Proctor optimum value. The specifications for select structural fill and procedure for compaction is provided in Section 7.1 of this report.

The degree of compaction and moisture in the fill soils shall 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. The fill moisture content and density must be maintained until floor slabs are completed.

Care should be taken to avoid the collection of water in the excavated area. Positive drainage should be provided in order to avoid any ponding water in and around removal and replacement area. Due to high permeability of cohesionless soils (sands), cohesionless soils should not be used as select fill material. Lack of positive drainage, improper fill material and insufficient compaction can cause bathtub effect in removal and replacement area.

4.3.2 Alternative 2 – Chemical Injection

Another option to reduce the PVR is chemical injection. Any reputable company with proven expertise and experience is recommended for chemical injection. After the chemical injection, the area should be covered with 1-ft of select fill to retain the moisture. The fill should be compacted according to the procedure outlined in Section 7.1 of this report. Moisture loss should not be allowed after the chemical injection. Construction of the foundation slab should start immediately after the completion of the chemical injection. The chemical injection area should be covered during the waiting period. We recommend to extend the chemical injection area to at least 5 feet beyond the building pad area and should cover all areas that are sensitive to soil movement such as canopy, sidewalk, etc.

The chemical injection shall be conducted by an experienced contractor. Equipment shall be suitable for the intended work. Injection equipment shall be self-propelled and constructed to provide straight pipe injection under pressure to the specific depth. Injection equipment shall be equipped with flow meter and pressure meter and control valve for monitoring and controlling the amount of chemical injected. The pump units shall have centrifugal pumps installed and shall be capable of injecting at least 7,500 gallons/hour at 200 to 250 pounds per square inch constant pressure. Injection rods shall be forced downward (not jetted or washed) in approximately 12-inch vertical intervals, to a specified depth. Spacing of the chemical injection holes shall not exceed 3 feet on center, each way.

The efficiency of the chemical injection should be tested through swell tests after the chemical injection. Undisturbed samples should be obtained at every one-foot interval to the total injected depth from two test holes per building pad or 1 test hole per 2,500 square feet, whichever is greater. The effect of chemical injection in reducing the PVR is tabulated below:

Chemical Injection Depth, ft	*PVR, in*
10	*1.5*

The PVR after the chemical injection is calculated based on the existing soil condition below the chemical injection depth and assuming that the chemical injection will reduce the swell potential of subsoils to less than 1%. The swell potential of soils after the chemical injection should be verified by swell test. If cut and/or fill operations in excess of 24 inches are performed, the chemical injection should be performed after the cut or placement of the fill to ensure uniform depth of chemical injection. The subgrade modification using chemical injection should include minimum 1-ft of select fill cap.

4.4 Foundation Maintenance

Long term performance of a 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 vegetation, trees, poor drainage or incorrectly controlled water sources, such as surface water, plumbing/sewer leaks, and excessive irrigation, water ponding near the foundation. Our general recommendations on foundation maintenance are presented in following sections of this report.

4.4.1 Site Drainage

It is recommended that positive site drainage is maintained throughout the life of the structure. The landscape and any sidewalk areas should be sloped away from the building (minimum of 10-ft) to direct surface water to suitable catch basins for disposal. A minimum of 6" for a distance of 10 ft away from the edge of foundation is recommended. If slope cannot be achieved when the exterior grade is above the floor grade or slopes toward the building, perimeter drains are required. The drains should be installed at a minimum of 12 inches below the bottom of the slab.

Excessive drying or excessive moisture should be avoided around the perimeter beams. The homeowners should be educated about the necessity of maintaining moist subgrade conditions throughout the year. For dryer months, a drip system can be added specifically for the foundation in order to maintain moisture around the foundation within 5-ft of foundation perimeter. The system should be on a timer and water uniformly around the foundation perimeter. If a drip system is cost prohibitive, soaker hoses can be used 12 inches-18 inches from the foundation. In the event that sprinkler systems are used, we recommend that the sprinkler system be placed all around the house to provide a uniform moisture condition throughout the year.

No ponding of surface water should be allowed near the structure and no area should allow entry of water under the slab.

Gutters are recommended to minimize water distributed near the foundation. Downspouts should either be extended a minimum of 5-ft from the foundation or connected to an underground drainage system away from the foundations. Due to mowing and aesthetics, running a drain pipe below grade to an exit grate or popup emitter is the best solution. This should be applied to all downspouts. If additional flower bed drains are added as part of a complete drainage plan, the downspouts could also connect to such drains.

Drains should be checked periodically to ensure that they remain functional and, if necessary, maintenance should be performed to improve drainage.

4.4.2 Vegetation Control

We recommend trees not be planted or existing trees left in place closer than the full height of the mature trees from the grade beams. Root barriers must be placed near the exterior grade beams to minimize tree root movements under the floor slab. Tree stumps should not be left under the slabs during site preparation. This may result in future settlement and termite infestation.

5.0 FOUNDATION DESIGN RECOMMENDATIONS

5.1 Foundations Type

Generally, lightly loaded foundations are designed and constructed on the basis of economics, risks, soil type, foundation shape and structural loading. The foundation systems are subdivided into two groups: deep support systems and shallow support systems. Each of these systems has an associated level of risk of damage that can occur to the building superstructure and architectural components due to differential foundation movements. The foundations typically used in the north central Texas, and their associated risks are generally described in Appendix A.

Building owners and/or developers need to be involved in the selection process of the foundation system. Most of the time, the foundation types are selected by the owner/builder, etc. Each of these systems also has an associated relative cost of construction. When comparing the various foundation systems, the level of risk is typically found to be inversely proportional to the level of cost. Many times, due to economic considerations, higher risks are accepted in foundation design. For example, shallow support systems typically have a relatively higher level of risk than deep support systems, but are often selected due to economics and affordability.

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 above recommendations, with respect to the best foundation types and risks, are general. The best type of foundation may vary as a function of structural loading and soil types. The proposed structural loads may be supported on either drilled shafts or post-tensioned slab type foundation. Our recommendations for these foundation types are presented in the following report sections.

5.2 Drilled Shafts Foundation

Drilled shaft foundations for the proposed building should satisfy three 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. Thirdly, the drilled shafts should resist uplift due to the presence of expansive soils. Drilled shafts should be anchored below the active zone. Depth of drilled shafts should be designed based on the above mentioned three criteria. In addition, the drilled shafts should be designed to sustain any potential lateral loads.

5.2.1 Axial Capacity

Depth: Based on the results of field exploration, laboratory testing and bearing capacity theory, we recommend to place the drilled shafts minimum at 18-ft below the existing grade. Actual depth of piers may be deeper and should be determined by Structural Engineer based on structural loading and uplift forces.

Bearing Pressure:

Minimum Drilled Shaft Depth, ft	Allowable Net Bearing Pressure, psf		Skin Friction Below 13-ft From Existing Grade, psf
	Dead Load	Total Load (Dead + Live)	
18	5000	7500	500

Foundations proportioned in accordance with these values will have a factor of safety of 3.0 and 2.0 with respect to shear failure for dead and total loading, respectively. Footing weight below final grade can be neglected in the determination of design loading. If bell bottom is used, bell to shaft diameter ratio should be limited to 3:1. The soil/rock strata at drilled shaft bearing depth should be verified at the time of construction.

Spacing: In order to attain the recommended bearing pressures and to control settlement, a minimum clearance of three (3) shaft diameters (or one bell diameter if bell bottom is used) should be provided between the drilled footings. Closer drilled shaft spacing should be evaluated by EL to determine if reductions in the allowable bearing pressures should be made to control settlement. If the piers are closer than 5-ft, it is recommended that the first shaft is drilled and concreted and the concrete has achieved its final set prior to drilling the adjacent pier.

Construction: Groundwater was not encountered during our field exploration. However, groundwater level can change due to seasonal variations. Any water inflow must be pumped out, using a sump pump, immediately. If necessary, adjustments in the depths and or diameter of drilled footings should be observed in the field by EL personnel. Due to potential variations in the subsoil stratigraphy and strengths and potential seasonal variations in groundwater depth, and corresponding potential soil caving issues, a slurry method of construction or casing may be required for the drilled footings installations. We recommend that the four corner piers be drilled first to better evaluate the constructability of the shafts. Once this information is field verified, all other shafts need to be constructed accordingly.

Within 8 hours of excavation, reinforcing steel and concrete should be placed. In no event should a pier excavation be allowed to remain open for more than 8 hours.

5.2.2 Soil Induced Uplift Loads

The drilled shaft should be designed to resist the uplift pressures due to post construction soil swell along the shaft and other uplift forces applied through the structural loadings. The magnitude of uplift pressures varies with the soil parameters, particularly the in-situ moisture levels at the time of construction. The uplift force due to soil swell can be calculated using the following equation:

$$Q_u = 0.79 \times D_s \times z_a \times \sigma_s$$

Where, Q_u = Uplift force in ton, D_s = Pier shaft diameter in feet, z_a = Depth of active zone in feet and σ_s = Swelling pressure in tsf. Based on the on-site soil properties, an active zone depth of 13-ft and a swell pressure of 1.0 tsf can be applied to estimate uplift force due to on-site expansive soils. The swell pressure can be ignored within select fill soils. Resistance to uplift load is a function of the dead weight of the pier, foundation load and skin friction below the active zone.

We recommend to place steel reinforcement to resist the net tensile load. A minimum percent steel A_s of 1 percent of the concrete area is recommended in design. Required steel percentage should be calculated by structural engineer. We recommend steel to meet ASTM 615 Grade 60 Reinforcing. The steel should extend from the bottom to the top of the drilled footings.

5.3 Floor Slabs Supported on Drilled Shafts

The floor slabs (grade beam system) may consist of a structural slab with void/crawl space or lifted slab with protective void or a floating (stiffened) structural slab supported on drilled shafts. The decision as to what type of floor slab to use is usually in accordance with our recommendations on different types of foundations, presented in Appendix A. Due to presence of expansive clay soils, the structural slab with void space is highly recommended for the subject site.

5.3.1 Structural Slab with Void/Crawl Space (Suspended Structural Slab)

The most positive floor system in areas with expansive soils consists of a floor system suspended completely above the existing ground surface. We recommend a minimum drained void space of about eight (8) inches between the bottom of the floor slab (/lowest suspended fixture/utility) and top surface of the underlying expansive soil. All grade beams should be supported by the drilled shafts. A minimum 8-inch void space should be provided beneath all grade beams to prevent contact with the swelling clay soils.

Void boxes (structural cardboard forms or cardboard carton forms) under the floor slabs and grade beams are used to create the minimum void space between the foundation and the on-site expansive soils. Void boxes should collapse when underlying expansive soils heave; therefore, the load from expansive soil heaving will not be transmitted to the foundation system. The cardboard carton forms should be allowed to crush or become wet prior to/during concrete placement operations.

We recommend that all access and entry slabs also be structurally supported on drilled shafts and suspended above the active clays by a minimum 8-inch drained void space. To prevent potential tripping hazards, these access and entry slabs should be elevated above adjacent sidewalks and pavement slabs and provided with transition slabs over an 8-inch drained void space that are hinged at grade beam connections and provided with toe beams at connections to adjacent flatwork.

The bottom of the void should be higher than adjacent grades. If it is lower, it should be shaped and drained to prevent the ponding of water. In the event that a crawl space is used, we recommend that positive drainage be maintained in the crawl space area at all times and the area in the crawl space be properly vented.

Backfill against the exterior face of grade beams or panels should be properly compacted using on-site clays to achieve 95 percent of the maximum Standard Proctor density. The moisture content at the time of compaction of soils should be minimum of +3% of the Proctor optimum value. This clay fill is intended to reduce surface water infiltration beneath the structure. Cohesionless soils should not be used to backfill exterior face of grade beams.

5.3.2 Lifted Floor Slabs Supported on Drilled Shafts

The lifted floor slabs, are an alternative to structural suspended system. The lifted slab is cost effective compare to structural suspended slab with void boxes/crawl space. A lifted floor slab system is achieved by constructing the slab at grade, then elevating it by using lifting system that uses jacks incorporated into the slab and placed atop the drilled shafts which then lifts the slab foundation to the desired elevation above surface grade. The lifting mechanisms are adjustable and may be realigned during the life of the foundation if necessary. However, the lifting elevation is limited to about 10-inches due to the limitations in lateral load carrying capacity.

If lifted floor slabs are used, we recommend eight (8) inches of protective void between the slab bottom and the soil. The lifted foundation system should be designed to perform similar to a pier-and-beam foundation system with void space. The foundation system should have required strength to carry vertical and lateral loading. The contractor/installer is responsible for maintaining proper quality control.

The backfill soils in the trench/underground utility and tree root excavation areas should consist of select fill materials, compacted to a minimum of 95% of standard proctor density (ASTM D 698). In the event of compaction difficulties, the trenches should be backfilled with cement-stabilized sand or other materials approved by the geotechnical engineer. Sandy soils (cohesionless soils) are not recommended for utility trench backfill within building slab area. Sandy soils (cohesionless soils) are highly permeable which can act as a pathway to water infiltration into subsoils. Water infiltration into expansive soils will lead to soil swelling. If sandy soils (cohesionless soils) are used for utility trench backfill, then we recommend minimum 4-ft of compacted clay cap at the ground surface in order to reduce the water infiltration and minimize subsequent soil swelling.

5.3.3 Floating (Stiffened) Structural Slab Supported on Drilled Shafts

Expansive soils can cause heave and structural distress. Potential movement of expansive soils must be considered to evaluate foundation requirements and subgrade preparation in floor slab areas that are supported at grade. The floor slabs can be supported on ground provided slab/structure is designed to sustain the movement due to expansive soils. However, the PVR should be reduced to tolerable limit.

Recommendation on subgrade modification to reduce the PVR to tolerable limit is provided in Section 4.3 of this report. In addition, drainage, landscaping and vegetation shall be maintained as recommended in Section 4.4 of this report. If proper drainage, landscape or vegetation control is not maintained, foundation movement will occur due to presence of expansive soils.

The subgrade modification presented section 4.3 are referenced as an alternative to the use of drilled shafts and structurally suspended grade beam/floor slab. The owner must fully understand that if the floor slab is placed on-grade, some movement and resultant cracking within the floor and interior wall partitions may occur. This upward slab movement and cracking usually is difficult and costly to repair, and may require continued maintenance expense. A greater risk of unsatisfactory foundation performance exists with a slab-on-grade design than for a drilled shaft with suspended slab/grade beam design.

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 between optimum and +3% of the Proctor optimum value.

5.4 Post-Tensioned Slab Foundation

The structural loads may be supported on a post-tensioned or concrete reinforced slab foundation. **In order to reduce the PVR, the subgrade should be modified in accordance with Section 4.3 of this report. In addition, drainage, landscaping and vegetation shall be maintained as recommended in Section 4.4 of this report.** If proper drainage, landscape or vegetation control is not maintained, foundation movement will occur due to presence of expansive soils.

Our recommendations for slab design parameters are based on the conditions encountered in the boreholes. Our recommendations for the design of post-tensioned slab or reinforced concrete slab-on-grade slabs are in general accordance with the PTI DC10.1-08, 3rd Edition with 2008 supplement. Our recommendations for post-tensioned slab or reinforced concrete slab-on-grade slabs are as follows:

Design Condition	**Bearing Capacity**
Effective Plasticity Index (PI) = 37 Thornthwaite Moisture Index = 6 Depth of Active Zone = 13-ft Climatic Rating = 22 Soil Support Index = 0.81 Design Suction Envelope = Post-Construction Required Subgrade Soil Shear Strength = 1000 psf Subgrade Preparation according to Chapter 7.0 of this report.	Allowable Net Bearing Capacity: Dead Loads Only = 1000 psf (FS = 3.0) Total Loads = 1500 psf (FS = 2.0) Minimum Grade Beam Depth Below the Final Grade = 18-inches Minimum Grade Beam Width = 10-inches
Slab Subgrade Friction Coefficient: Slab-on-Vapor Sheeting over Sand = 0.75; Slab without Vapor Sheeting = 1.0	

PTI Parameters					
Subgrade Condition	**PVR** inch	y_m, inch		e_m, ft	
		Center Lift	Edge Lift	Center Lift	Edge Lift
Existing Soil	3.5	2.1	3.1	8.3	4.2
2-ft of Fill Soils	2.5	1.8	2.4	8.3	4.2
4-ft of Fill Soils	2.0	1.5	2.1	8.5	4.3
6-ft of Fill Soils	1.5	1.3	1.9	8.5	4.3
8-ft of Fill Soils	1.0	1.2	1.8	8.5	4.4
10-ft of Chemical Injection	1.5	1.6	2.2	8.5	4.3

It should be understood by all parties that in the areas where expansive soils are present and trees have been removed prior to construction, lightly loaded floating slabs can still experience heave causing foundation distresses. However, the replacement of onsite expansive soils will reduce the anticipated differential movements to tolerable limit. If no movement can be tolerated by the client, a structural slab with drilled shafts is recommended.

It should also be noted that these foundations are not designed to resist soil and foundation movements as a result of non-climatic factors such as continued utility leaks, trees, slope, cut and fill sections, excessive irrigation, lack of maintenance, poor drainage and water ponding near the foundation system. Due to the presence of expansive soils on the site, we recommend the post-tensioned slab be stiffened such that minimum differential movements occur once a portion of the slab is lifted by the expansive soils.

The depth of perimeter beams can be increased to 3-ft below the final grade to further reduce the foundation movement.

A bedding layer of leveling sand, one- to two-inch in thickness, may be placed beneath the floor slab. A layer of vapor retardant 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.

Adjacent flatwork such as sidewalks and pavements should be designed in such a way as to allow for differential movements between flatwork and the exterior perimeter of the building foundation.

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 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, free of root organics, are suitable for use as structural fill under a post-tensioned slab foundation. Sands should not be used as structural fill materials at this site (with the exception of top two-inch of leveling sand under the slab).

5.5 Foundation Settlement

A detailed settlement analysis was not within the scope of this study. It is anticipated that drilled shafts 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 building.

6.0 PAVEMENT SECTIONS

6.1 General

We understand that concrete paving is planned for roadway subject to light/auto loading and heavy truck loading. Traffic information is not available at this time. **Pavement design is not within the scope of this study**. Recommendations on pavement structures are provided in the following sections.

The subgrade should be sufficiently stable to prevent excessive rutting and shoving during construction, provide good support for placement and compaction of pavement layers, limit pavement rebound deflections to acceptable limits, and restrict the development of excessive permanent deformation (rutting) in the subgrade during the service life of the pavement. Subgrade stabilization is intended to provide structural stability for improved long-term performance.

6.2 Roadway Areas

The results of our field and laboratory test data indicate that the surficial soils in the roadway areas generally consist of lean clay (CL) soils. These soils have subgrade moduli, k, ranging from 100 to 140 pci and CBR values ranging from 3 to 5. Based on the subgrade soil properties, the recommended minimum concrete thicknesses for roadway areas subject to auto/light traffic and heavy truck traffic loading are as follows:

Layers	Auto/Light Truck Traffic, in	Service Drive or Heavy Truck Traffic, in
Surface: Concrete Pavement	5	7
Subgrade: Lime-Stabilized	6	8

The subgrade should be stabilized with 4% of lime by dry weight TxDOT Specification Item 260 and 263. This results in application rates of 18 and 24 pounds of lime per square yard per six-inch and eight-inch of compacted thickness, respectively. The lime stabilized subgrade should be compact to 95% of Maximum Standard Proctor Density (ASTM D 698) at a moisture content between optimum and +3% of optimum.

Concrete compressive strength should be of 3500 psi at 28 days. The paving for the auto traffic should be reinforced with #4 bars at 20-inches on center-to-center each way. The paving for the heavy truck traffic should be reinforced with #4 bars at 18-inches center-to-center each way. Minimum Lab length shall be 22-inch. Suggested longitudinal and transverse joint spacing for concrete paving is 15-feet. The expansion joint spacing is approximately 80-feet. Steel used for reinforcements should be grade 60.

It should also be noted that these pavement recommendations are not designed to resist soil and pavement movements due to the presence of expansive soils. There is a potential for pavement movements and subsequent pavement cracks due to the expansive soils. If no movement is preferred, then soil remediation should be performed in accordance to the recommendations presented in Section 4.3 of this report. In addition, the pavement should be maintained in accordance to the recommendations presented in Section 4.4 of this report.

7.0 CONSTRUCTION GUIDELINES

Some construction problems, particularly their extent and magnitude, and including the depth of overburden across the site cannot be anticipated until the construction is in progress. The construction and maintenance of the proposed PTI slab, if used, should be in general accordance with the procedures presented in PTI Manual.

Information was not available on whether a fill will be used to raise site grade prior to slab construction. In the event that fill is placed on the site, specifications and placement should be in accordance with our recommendations given below. Lack of proper site preparation may result in additional stress and poor slab performance.

7.1 Select Structural Fill

The select fill materials beneath the building area may consist of inorganic sandy clay soils with a liquid limit of less than 40 and a plasticity index between 12 and 18. Other types of fills available locally, and acceptable to the geotechnical engineer, can also be used. Cohesionless soils should not be used as select structural fill. The select fill should extend 5-ft beyond the building footprint. The select fill thickness should be uniform over the entire building footprint. Bank sand should not be used for this purpose. Samples of the fill material should be submitted to the testing laboratory a minimum of 72 hours prior to commencing earthwork operations to allow for the materials evaluation, including the optimum moisture of the fill soils.

The select fill should be placed in loose lifts and uniformly compacted 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 between optimum and +3% of the Proctor optimum value. The lift thickness should not be more than eight inches in loose condition. The subgrade and fill moisture content and density must be maintained until floor slabs are completed. We recommend that these parameters be verified by field moisture and density tests at the time of construction.

7.2 Site Preparation

Our general recommendations for site preparations in the floor slab areas, based on our understanding of the subsurface conditions encountered in the boreholes, are summarized below or as otherwise required by the geotechnical engineer during construction site visits.

7.2.1 General

- Positive site drainage must be established at the beginning of the project to minimize ponding of surface water and limit construction difficulties with wet surface soils, or ingress into the foundation excavations. Standard sump pits and pumping may be adequate to control potential seepage into excavations.

- After completion of the necessary stripping, excavating and cleaning and prior to placing the required fill, the undesirable materials (organic wet, soft or loose materials) still in place should be removed. 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.

- The backfill soils in the trench/underground utility, pavement and tree root excavation areas should consist of select fill materials, compacted to a minimum of 95% of standard proctor density (ASTM D 698). In the event of compaction difficulties, the trenches should be backfilled with cement-stabilized sand or other materials approved by the geotechnical engineer. Sand and gravel should not be used for utility line bedding in expansive soils. If possible, all utility trenches should be sloped to drain away from the foundation. As a minimum, a four-foot-long clay plug or a concrete plug should be installed below the exterior grade beam where utility lines transition below the foundation.

- We recommend to follow quality control procedures during site preparation by a qualified engineer or engineer's representative during the construction of the foundations. This quality control procedures should include, observation of the site stripping and the extent of excavation, verification of the type, depth and amount of stabilizer, if used, evaluation of the quality of fill and monitor the fill placement for all lifts.

7.2.2 Slab on Grade and Pavement Area

- Any on-site fill soils encountered 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.

- The subgrade areas should then be proof rolled with a loaded dump truck or similar pneumatic-tired equipment with loads ranging from 25- to 50-ton. The proof rolling serves to compact surficial soils and to detect any soft or loose zones. The proof rolling 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 proof rolling is completed and approved by the geotechnical engineer. The proof rolling operations should be observed by an experienced geotechnician.

- After the proof rolling is completed and passed, 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 between optimum and +3% 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.

7.3 Construction Considerations

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, 3rd Edition, Post-Tensioning Institute, 2006". The drilled shaft installations must be in accordance with the American Concrete Institute (ACI) publication (ACI 336.1) and “Drilled Shafts: Construction Procedures and Design Methods”, U.S. Department of Transportation, Federal Highway Administration, Volumes I and II, August 1999.”

- Cut or fill slopes should not be steeper than 4(H):1(V). If the height of cut or fill is more than 5-ft, then slope stability analysis may be required. The crest or toe of cut/fill slopes should be no closer than height of the slope or 10 feet, whichever is greater, from any foundation and no closer than 5 feet from the edge of any pavement.

- Properly detailed and constructed moisture/vapor retardant should be placed between the slab and subgrade soils to retard moisture migration through the slab. If a bedding layer of leveling sand one- to two-inches in thickness is placed beneath the floor slab, the vapor sheeting consisting of minimum six- (6) mil Polyethylene should be used above the sands. The moisture barrier should be properly stretched to maximize soil-slab interaction.

- EL recommends that, prior to the concrete placement, the site and soil conditions used in the structural design of the foundation be verified during the engineer's site visit after all of the earthwork and site preparation have been completed.

- Stockpiles should be placed well away from the edge of the excavation and their heights should be controlled so they do not surcharge the sides of the excavation.

- Construction slopes should be closely observed for signs of mass movement, including tension cracks near the crest or bulges at the toe. Any potential stability problems should be reported to a geotechnical engineer promptly.

- Grade beams excavations should be free of all loose materials. The bottom of the excavations should be dry and hard. The exterior grade beams shall be extended about six-inches above the top soil (final grade).

- Minimum concrete strength should be 1,750 and 3,000 psi at 7 and 28 days, respectively, with a maximum slump of 5-inches. Concrete workability and durability can be improved by adding air to the concrete mix. The slump and strength values of the concrete should be verified by slump tests and compressive strength of concrete cylinder tests, respectively. We recommend four concrete cylinders be made for each slab. These cylinders should be tested after 7 and 28 days from placement date. Furthermore, these tests should be performed in accordance with the applicable ASTM test procedures.

- Construction site safety including means, methods and sequencing of construction operations are the sole responsibility of the contractor. The contractor is responsible for designing any excavation slopes, temporary sheeting or shoring. The slope height, inclination or excavation depths should in no case exceed those specified in the local, state and/or federal safety regulations, e.g. OSHA Health and Safety Standard for Excavations, 29, CFR Part 1926, or successor regulations.

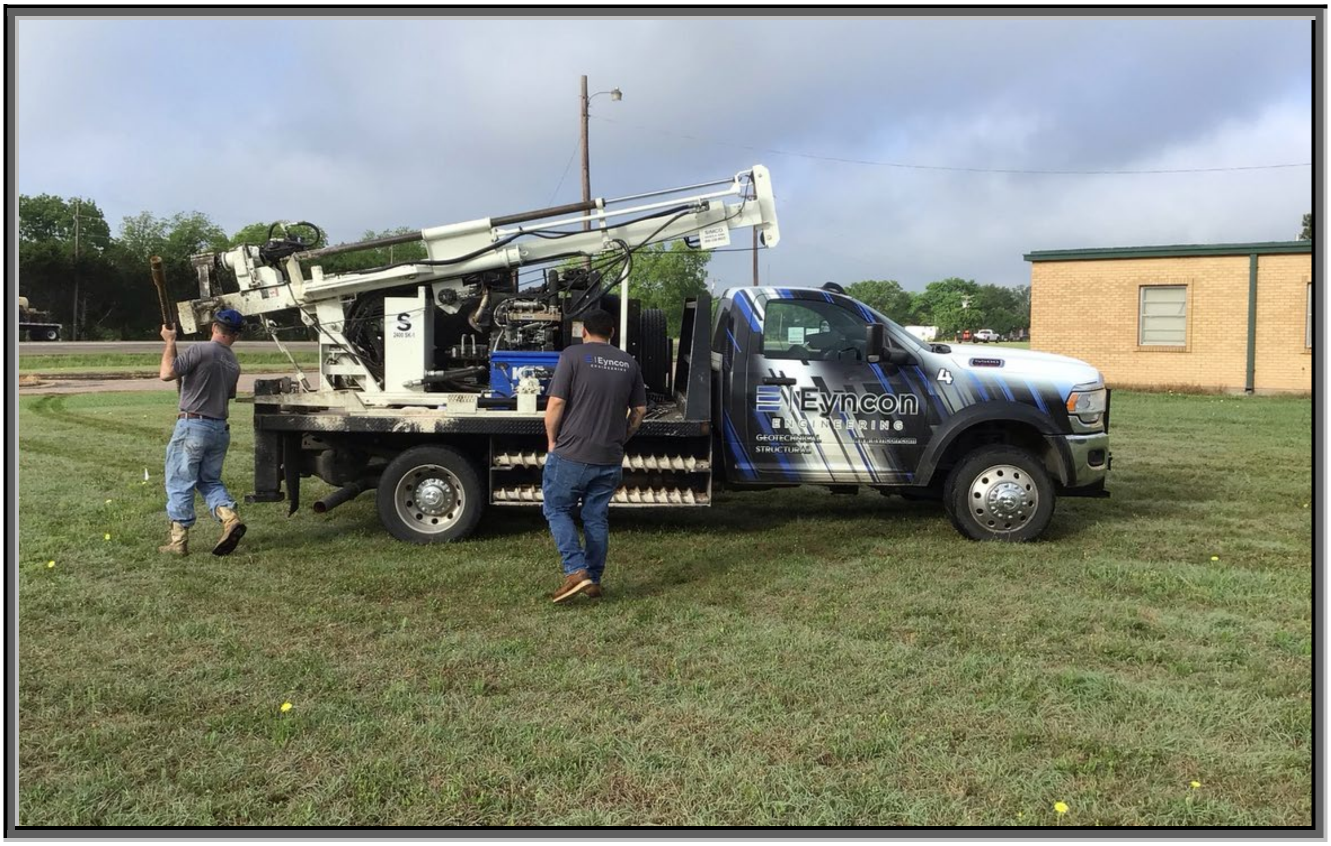
- Construction surveillance and quality control tests should be planned to verify materials and placement in accordance with the specifications and recommendations in this geotechnical report. We recommend the following quality control procedures be followed by a qualified engineer or engineer's representative during the construction of the foundations: Monitor the grade beam foundation cleanness, depth, size, etc., Observe the foundation make-up after all of the earthwork and site preparation have been completed and prior to the concrete placement, verify placement of the reinforcing steel/tendons, monitor concrete placement, conduct slump tests and make concrete cylinders, monitor installation of drilled shafts, verify the shear strength of the soil and strata at drilled shafts bearing depth at the time of construction, conduct post-pour observations, including post-tensioned slab cable stress monitoring, if applicable, and conduct a post-construction site visit to evaluate the site grading, drainage and the presence of trees/vegetation near the structure. It is the responsibility of the Client to notify EL when each phase of construction is taking place so that proper quality control and procedures are implemented.

8.0 LIMITATIONS

The recommendations described herein were conducted in a manner consistent with the generally accepted geotechnical engineering principles practiced contemporaneously under similar conditions in the locality of the project. Geotechnical engineering formulas and judgments are far from an exact science because of the multitude of unknown influential possibilities and the limitations of site investigation within an economical range. All recommendations in this report are interrelated and must be followed integrally. Any addendum to this report is valid only if in writing form and re-certified by EL. No other expressed or implied warranty and guarantee are made other than that the work was performed in a proper and workmanlike manner. EL is not responsible for damages resulting from workmanship of designers or contractors.

The recommendations presented in this report were developed from referenced samples obtained from a discrete number of soil test boreholes with limited cross sections. Soil type and properties across the site may vary at different times and may also differ from those observed at the borehole locations. The nature and extent of soil variations between the boreholes may not become evident until the time of construction. If these variations are noted during the construction, EL should be contacted to evaluate and revise the design and construction recommendations in order to minimize construction delays and cost overruns. Due to changes in technology, the project site conditions, seasonal moisture variations, etc., this report and its recommendations may need to be revised 5 months from the issuance date. We recommend that the Client contact EL to find out whether or not this report is applicable to the project after the above-mentioned time period.

This report was prepared for the sole and exclusive use by our Client for the property, specified on cover page and Plate 2, for which the investigation was conducted, based on the limited objectives and our understanding of information provided by the Client about the characteristics of the project. The data and recommendations provided in this report are applicable only for the design of the types of structure(s) described in the introduction section of this report and should not be used for any other structures, locations or for any other purposes. All reports, borehole logs, field data, laboratory test results, maps and other documents prepared by EL as instruments of service shall remain the property of EL. Reuse of these documents is not permitted without written approval by EL. Any such third party using this report after obtaining EL's written acceptance shall be bound by the limitations of this study including EL liability being limited to the fee paid to it for this report. EL assumes no responsibility for conclusions, opinions or recommendations made by others based on the data in this report or for the unauthorized use of this report by other parties and for purposes beyond the stated project objectives and work limitations.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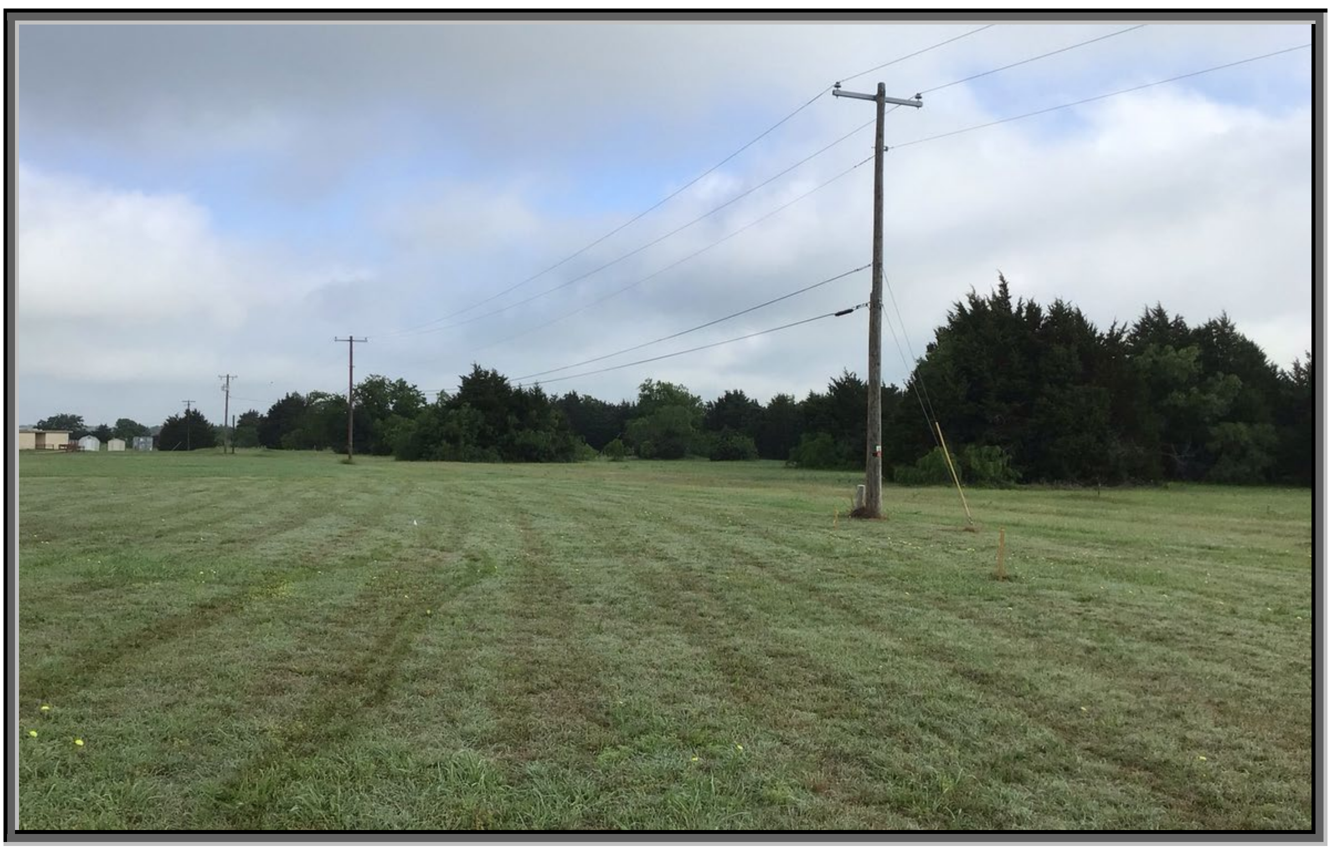

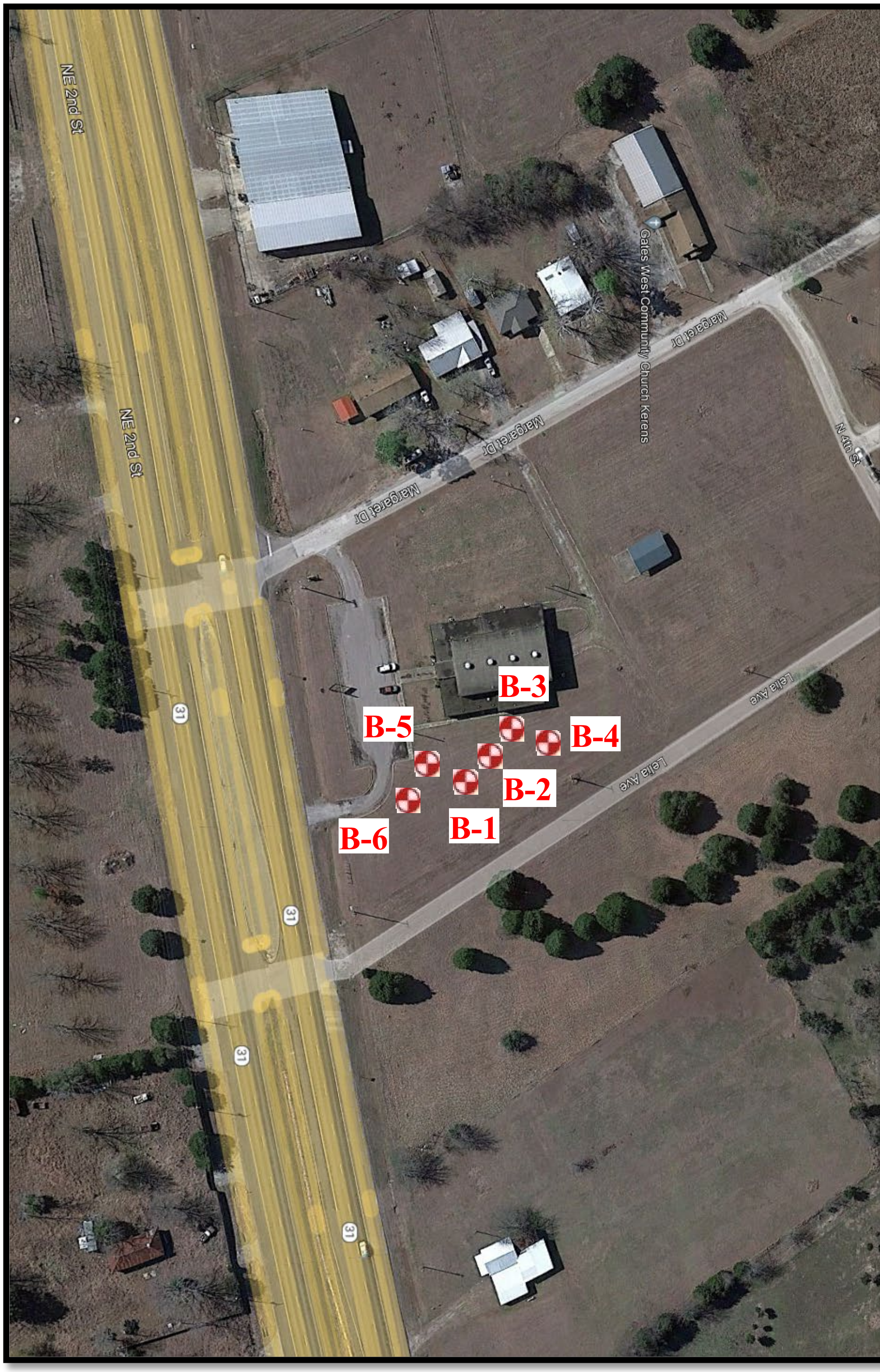

Eyncon ENGINEERING	PLAN OF BOREHOLES Locations are approximate		NOT TO SCALE
OFFICE: 1604 N. KAUFMAN ST. ENNIS, TX 75119 TELE: (469) 478-3033 EMAIL: info@eyncon.com www.eyncon.com	Project: Proposed Building at 805 NE 2nd Street, Kerens, Navarro County, TX		Approximate Site Location: 32° 08' 08.1", -96° 13' 06.7"
	Job No: 10424075	Date: May 15, 2024	PLATE 2

Eyncon ENGINEERING

Eyncon, LLC
1604 N. Kaufman Street
Ennis/Texas/75119
Telephone: 4694783033

BORING NUMBER BH1

CLIENT Jeff Stapleton
PROJECT NAME Proposed Building at 805 NE 2nd Street
PROJECT NUMBER 10424075
PROJECT LOCATION Kerens, Navarro County, Texas
DATE STARTED 4/30/24 **COMPLETED** 4/30/24
GROUND ELEVATION **HOLE SIZE** 3 inches
DRILLING CONTRACTOR Eyncon Engineering
GROUND WATER LEVELS:
DRILLING METHOD Shelby
AT TIME OF DRILLING ---
LOGGED BY Marshall **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		FAT CLAY (CH), firm, dark brown, dark gray, with root fibers, calcareous nodules, gravels, moist	ST			1.50		19	52	19	33	85
		- stiff 2' to 6'	ST			1.75						
5			ST			2.00						
		FAT CLAY (CH), very stiff, greenish gray, brownish yellow, with root fibers to 8', carbonate masses, moist	ST			4.00		20	58	20	38	
10			ST			4.00						
15			ST			3.50						
		LEAN CLAY (CL), greenish gray, brownish yellow, with sands moist										
		- stiff 18' to 25'	ST			2.50		16	34	16	18	
20												
25			ST			2.50						

Bottom of borehole at 25.0 feet.

Eyncon ENGINEERING

Eyncon, LLC
1604 N. Kaufman Street
Ennis/Texas/75119
Telephone: 4694783033

BORING NUMBER BH2

CLIENT Jeff Stapleton

PROJECT NAME Proposed Building at 805 NE 2nd Street

PROJECT NUMBER 10424075

PROJECT LOCATION Kerens, Navarro County, Texas

DATE STARTED 4/30/24 **COMPLETED** 4/30/24

GROUND ELEVATION **HOLE SIZE** 3 inches

DRILLING CONTRACTOR Eyncon Engineering

GROUND WATER LEVELS:

DRILLING METHOD Shelby

AT TIME OF DRILLING ---

LOGGED BY Marshall **CHECKED BY**

AT END OF DRILLING ---

NOTES

AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		FAT CLAY (CH), firm, dark brown, dark gray, with root fibers, calcareous nodules, gravels, moist	ST			1.50						
			ST			1.00		25	50	19	31	85
5			ST			1.25						
		FAT CLAY (CH), very stiff, greenish gray, brownish yellow, with root fibers to 8', carbonate masses, moist	ST			4.00						
10			ST			3.50		19	52	19	33	
15			ST			4.00						
		LEAN CLAY (CL), greenish gray, brownish yellow, with sands moist										
20		- stiff 18' to 20'	ST			2.50						
25		- very stiff 23' to 25'	ST			4.50		16	32	16	16	

Bottom of borehole at 25.0 feet.

Eyncon, LLC
1604 N. Kaufman Street
Ennis/Texas/75119
Telephone: 4694783033

BORING NUMBER BH3

CLIENT Jeff Stapleton
PROJECT NAME Proposed Building at 805 NE 2nd Street
PROJECT NUMBER 10424075
PROJECT LOCATION Kerens, Navarro County, Texas
DATE STARTED 4/30/24 **COMPLETED** 4/30/24
GROUND ELEVATION **HOLE SIZE** 3 inches
DRILLING CONTRACTOR Eyncon Engineering
GROUND WATER LEVELS:
DRILLING METHOD Shelby
AT TIME OF DRILLING ---
LOGGED BY Marshall **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		LEAN CLAY (CL), stiff, dark brown, dark gray, with root fibers, calcareous nodules, sands, moist	ST			2.00						
			ST			2.00						
5			ST			2.50		18	45	18	27	
		FAT CLAY (CH), very stiff, gray, greenish gray, brownish yellow, with root fibers to 8', moist	ST			3.50						
10			ST			3.50						
		LEAN CLAY (CL), very stiff, greenish gray, brownish yellow, with sands moist	ST			3.50		17	37	17	20	
15												
20			ST			3.50						
25			ST			3.50						

Bottom of borehole at 25.0 feet.

Eyncon ENGINEERING
Eyncon, LLC
1604 N. Kaufman Street
Ennis/Texas/75119
Telephone: 4694783033

BORING NUMBER BH4

CLIENT Jeff Stapleton
PROJECT NAME Proposed Building at 805 NE 2nd Street
PROJECT NUMBER 10424075
PROJECT LOCATION Kerens, Navarro County, Texas
DATE STARTED 4/30/24 **COMPLETED** 4/30/24
GROUND ELEVATION **HOLE SIZE** 3 inches
DRILLING CONTRACTOR Eyncon Engineering
GROUND WATER LEVELS:
DRILLING METHOD Shelby
AT TIME OF DRILLING ---
LOGGED BY Marshall **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		LEAN CLAY (CL), stiff, dark brown, with root fibers, calcareous nodules, sands, moist	ST			2.00		16	34	16	18	86
		FAT CLAY (CH), very stiff, brown, olive gray, brownish yellow, with root fibers, ferrous nodules, moist	ST			4.50						
5			ST			4.50						

Bottom of borehole at 6.0 feet.

Eyncon ENGINEERING

Eyncon, LLC
1604 N. Kaufman Street
Ennis/Texas/75119
Telephone: 4694783033

BORING NUMBER BH5

CLIENT Jeff Stapleton

PROJECT NAME Proposed Building at 805 NE 2nd Street

PROJECT NUMBER 10424075

PROJECT LOCATION Kerens, Navarro County, Texas

DATE STARTED 4/30/24 **COMPLETED** 4/30/24

GROUND ELEVATION **HOLE SIZE** 3 inches

DRILLING CONTRACTOR Eyncon Engineering

GROUND WATER LEVELS:

DRILLING METHOD Shelby

AT TIME OF DRILLING ---

LOGGED BY Marshall **CHECKED BY**

AT END OF DRILLING ---

NOTES

AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		LEAN CLAY (CL), stiff, dark brown, with root fibers, calcareous nodules, sands, moist	ST			2.00						
		- reddish brown 2' to 4'	ST			2.00		17	40	17	23	90
5		- very stiff 4' to 6'	ST			4.50						

Bottom of borehole at 6.0 feet.

Eyncon ENGINEERING
Eyncon, LLC
1604 N. Kaufman Street
Ennis/Texas/75119
Telephone: 4694783033

BORING NUMBER BH6

CLIENT Jeff Stapleton
PROJECT NAME Proposed Building at 805 NE 2nd Street
PROJECT NUMBER 10424075
PROJECT LOCATION Kerens, Navarro County, Texas
DATE STARTED 4/30/24 **COMPLETED** 4/30/24
GROUND ELEVATION **HOLE SIZE** 3 inches
DRILLING CONTRACTOR Eyncon Engineering
GROUND WATER LEVELS:
DRILLING METHOD Shelby
AT TIME OF DRILLING ---
LOGGED BY Marshall **CHECKED BY**
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		LEAN CLAY (CL), stiff, reddish brown, dark brown, with root fibers, calcareous nodules, sands, moist	ST			2.00						
		FAT CLAY (CH), stiff, reddish brown, dark brown, olive gray, with root fibers, calcareous nodules, moist	ST			2.50						
5			ST			3.00		19	51	19	32	

Bottom of borehole at 6.0 feet.

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
SHALE	FINE GRAINED, SEDIMENTARY ROCK OF MUD OR FLAKES OF CLAY MINERALS AND OTHER MINERALS
LIMESTONE	INORGANIC, SEDIMENTARY ROCK COMPOSED MAINLY OF CALCIUM CARBONATE
FILL	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 1/8-inch thick extending through the sample.
Seam	-	Inclusion 1/8- 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.

Relative Density	SPT, N-Value, blows/ft*
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

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.

Consistency	Standard Penetration, N-Value, blows/ft	Pocket Penetrometer Reading	Undrained Shear Strength tons/sf.
Very Soft	0-2	0-0.25	Less than 0.13
Soft	2-4	0.25-0.75	0.13 to 0.25
Firm	5-9	0.75-1.50	0.25 to 0.50
Stiff	10-19	1.50-3.00	0.50 to 1.00
Very Stiff	20-29	3.00-4.50	1.00 to 2.00
Hard	30 and higher	>4.50	2.00 and 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.

SOIL SAMPLERS

- SHELBY TUBE
- SPLIT SPOON
- AUGER

TERMS CHARACTERIZING ROCK PROPERTIES

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.

BEDROCK HARDNESS

Hardness	Approximate SPT Values
Soft	<50
Moderately Hard	51 to 100
Hard	5” to 11” per 100 blows
Very Hard	less than 5” per 100 blows)

APPENDIX A

Foundation Types and Risks

Foundation Types and Risks

The various types of foundation systems that are commonly used for residential and other low-rise buildings in the area are generally listed in the order of increasing levels of associated risk and decreasing levels of construction cost as described below:

	FOUNDATION TYPE	REMARKS
Deep Support Systems [1]	Structural Floor with Crawl Space and Piers aka: Post-and-Beam, Block and Beam, Suspended Floor Slab or Pier and Beam Foundation System (Structural slab designed per ACI 318) --- Structural Slab with Void Space and Piers aka: Structurally Suspended Slab (Structural slab designed per ACI 318)	This type of foundations is considered to be a low risk foundation in areas with expansive soils and the most positive floor system, provided a minimum space of 4" to 10" (or more than 18 inches for crawl space) is maintained under the slab and the piers are founded below the active zone. Using this foundation system, the floor slabs are not in contact with the subgrade soils. Usually no voids below grade beams. (In case of a crawl space, all grade beams can be raised completely above grade with nearly 100% void). The grade beams are designed to span between piers and the slabs to span between grade beams. Reduced maintenance requirements than other types of foundations. Fill can be comprised of expansive or non-expansive soil; however, termites can be attracted to moist cardboards. This type of foundation is particularly suited for the areas where expansive soils are present and where trees have been removed prior to construction. Depending on slab elevation, the water may be collected below slab and exposed below-grade plumbing in the crawl space can freeze. Crawl space requires ventilation. Grade beams that are in contact with soil can heave due to swelling of the expansive soil. The design and construction costs are usually higher than other systems below. In the areas where non-expansive soils are present, spread footings can be used instead of drilled footings.
	Floating (Stiffened) Structural Slab Supported on Piers. (Stiffened slabs designed per BRAB 33, WRI, ACI or PTI)	Due to presence of piers, the slab cannot move down reducing settlement. 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 fill need only be compacted to a density sufficient to support slab during concrete set up. The grade beams are designed to span between piers and the slabs to span between grade beams. The slab is more heavily reinforced that non-structural slab. Requires more design efforts and higher construction costs than other types of footings explained below. The structural loads can also be supported on spread footings if expansive soils are not present. The risk on this type of foundation system can be reduced sizably if it is built and maintained with positive drainage and vegetation control.
	Stiffened Slab-On-Fill Foundation Supported on Piers	This foundation system is also suited for the area where expansive soils are present. The system exhibits less settlement than the shallow support systems. The slab thickness and reinforcing is usually less and the system would be less expensive than the structurally isolated types explained above. The grade beams are laid out in a continuous grid-like pattern with sufficient stiffness to reduce the bending deflection due to soil volume changes. To resist potential uplift forces, grade beams may need to be deeper than those of a structurally isolated system. This system has some risks with respect to foundation distress and movements, where expansive soils are present. However, the non-expansive select structural 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.

FOUNDATION TYPE		REMARKS
***Shallow Support Systems** (No piers are used)*	Stiffened Structural Slab-on-Grade aka: Ribbed Mat or Super Slab Foundation	The grade beams should be supported directly by competent underlying soils. The foundation is designed utilizing continuous stiffening beams that form a grid like pattern. Many of the lightly loaded structures in the north central Texas region are built on this type of foundations and are performing satisfactorily. They rely on the builder and owner to follow soil moisture maintenance guidelines during and after construction. The advantage of this foundation system is that as long as the grade beams penetrate a minimum of 12 inches into the competent natural soils or properly compacted structural fill, no compaction of subgrade soils is required. Fill placed between the grade beams is only required to be compacted enough to support the concrete during placement. 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 between optimum and +3% of optimum moisture content. May experience more vertical movement than those supported on piers. The structural engineer should design the slabs (typically 4 to 6 inches) such that they can span in between the grade beams. More design efforts and more expensive than the following two types of foundations as it requires concrete and reinforcement. In the areas where trees have been removed prior to construction and where expansive clays exist, these foundations must be significantly stiffened to minimize the potential differential movements as a result of subsoil heave due to tree removal. The risk on this type of foundation system can be reduced significantly if it is built and maintained with positive drainage and vegetation control.
	Stiffened Slab-on-Fill aka: Floating or Waffle Slab (Grade supported stiffened slabs designed per WRI, ACI or PTI procedures)	The grade beams should be supported directly by competent underlying soils. The foundation is designed utilizing continuous stiffening beams that form a grid like pattern. Most economical system used where expansive soils are present. Faster to construct than slabs on piers but may experience more vertical movement. Many of the lightly loaded structures in the north central Texas are built on this type of foundations and are performing satisfactorily. They rely on the builder and owner to follow soil moisture maintenance guidelines during and after construction. In the areas where trees have been removed prior to construction and where expansive clays exist, these foundations must be significantly stiffened to minimize the potential differential movements as a result of subsoil heave due to tree removal. Foundation tilt can still occur. The risk on this type of foundation can be reduced significantly if it is built and maintained with positive drainage and vegetation control.
	Non-Stiffened Slab-on-Grade of uniform thickness aka: California Slab (Conventionally- Reinforced or Post-Tensioned Slab designed per BRAB 33, WRI, ACI or PTI)	Behaves similar to a mat foundation. Fast to construct. Eliminates digging of grade beams and easier to jack against if underpinning is required in a later stage. Potentially has more (differential) vertical movement than the above types of foundations. Risk of erosion and root penetration below the slab foundation unless they are bounded by perimeter grade beams. Flat slab can be supported on in-situ soils or compacted fill. Suitable for deep sandy soils. Can also be used for foundations having consistent subsoil formations with low propensity for heave. Foundation tilt can still occur even if the foundation system is designed rigid. The risk on this type of foundation can be reduced significantly if it is built and maintained with positive drainage and vegetation control.

[1] Deep support systems are defined as foundations having deep components such as drilled footings, piers or piles that extend well below the moisture active zone of the soils. They function to limit the vertical movements of the building by providing vertical support in a soil stratum that is not susceptible to downward movements caused by moisture fluctuations.

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. 1).