FEATHER
ENGINEERS

November 2024

PROJECT NO. 172215

MULTI-TENANT

N CORINTH ST, CORINTH, TEXAS

GEOTECHNICAL ENGINEERING REPORT

Prepared for:

Kairos Real Estate

FEATHER
ENGINEERS

Geotechnical & Foundation Engineering
Construction Material Testing
Laboratory Testing

11/15/2024

Kairos Real Estate
Attention: Mr. Braden Seegmiller
Email: braden@kairosrealestate.com

Geotechnical Engineering Report
Multi-Tenant
N Corinth St & W Shady Shore Rd, Corinth, Texas

The results of our geotechnical engineering study for the proposed project are presented in the following report. The geotechnical study has been conducted in general agreement with our proposal agreement.

We appreciate the opportunity to provide geotechnical engineering services. If you have any questions please let us know.

Sincerely,

JEREMY L. FEATHERSTON
126370

Jeremy Featherston

Jeremy L. Featherston, P.E. / Principal Geotechnical Engineer

Texas Board of Professional Engineers
Firm Registration No. F-18942

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1 INTRODUCTION

This report presents the results of a geotechnical engineering study for the proposed Commercial Building at N Corinth St & W Shady Shore Rd, Corinth, Texas. Braden Seegmiller authorized the project and aided in providing the project information summarized below.

1.1 Project Information

Item	Description
Location	See Plan of Borings for Site Vicinity Map
Existing Ground Conditions	The building location is on combined tracts of land; empty non-developed, open land with tall native grass, with some trees to be removed and some trees to remain near structure, generally slopes - 4% (B1 to B4). Historical Images indicate conditions similar to existing.
Site Layout	See Plan of Boring (A1) in Appendix A
Proposed Construction	Commercial Building
Finished Floor Elevation	Anticipated near existing grade
Assumed Maximum Loads	Point: 60 k
	Wall: 3.5 klf
	Slabs: 130 psf

1.2 Purpose and Scope

The purpose of this geotechnical study has been to determine the general subsurface conditions, evaluate the engineering characteristics of the subsurface materials encountered, and develop recommendations for the type of foundation suitable for support of the proposed building.

To accomplish its intended purposes, the study has been conducted in the following phases.

- Drill borings to determine the subsurface conditions and obtain samples;
- Laboratory testing to determine pertinent engineering properties;
- Engineering analyses and geotechnical recommendations for the proposed construction.

2 SUBSURFACE CONDITIONS

2.1 Area Geology

Based on area geology, prior borings in the area and experience the proposed building site is situated within the Woodbine Geological Formation. Sands, clays, sandstones and shales generally compose this formation. Iron oxides, lignite, gypsum, and pyrite are also found throughout the formation. Dense and irregular shaped masses or hard sandstone occur at random throughout the formation and are commonly referred to as "boulders." Structurally, the Woodbine is quite complex in that it contains numerous small faults, lenticular masses, and consequent divergent dips. It is often difficult, if not impossible, trace a particular bed for any distance. Water is found at various levels in the formation, some as perched tables in sand lenses.

2.2 Subsurface Stratification

Description	Approximate Depth Range of Stratum, Ft.	Material Encountered	Mc/LL	Soil Consistency/Density
Stratum 1	0-2 (B1, B2, B3)	SANDY LEAN CLAY, dark reddish brown	0.26	very stiff
Stratum 2	2-8.5 (B1, B2, B3)	SANDY LEAN CLAY, mottled reddish brown to tan & gray	0.37	hard
Stratum 3	6-17.5 (B1, B2)	SANDY SHALY CLAY, gray w/reddish brown	0.32	very stiff
Stratum 4	16-20 (B1)	CLAYEY SAND, tan & light gray	0.50	medium dense

Borings logs are presented in Appendix A and identify the conditions encountered at that specific location. Stratification boundaries represents the approximate location of changes in subsurface material. In situ transitions may be gradual. The "Mc/LL" column above represents the moisture content divided by the liquid limit as a relative measure of dryness of soil conditions; values greater than 0.5 can be classified with ideal moisture conditions with minimal swell potential, values 0.37-0.5 in a moderate moisture condition; values 0.25-0.37 in a dry condition; and values less than 0.25 in a severely dry condition. Highly expansive clay in a dry condition possess the greatest risk to foundation distress.

2.3 Groundwater

Shallow subsurface seepage was not observed during drilling operations on 11/7/2024 and the borings were dry at the completion of the day.

Fluctuations of the groundwater level can occur due to seasonal variations in the amount of rainfall; site topography and runoff; hydraulic conductivity of soil strata; and other factors not evident at the time the borings were performed. Water traveling through the soil (subsurface water) is often unpredictable. This could be due to seasonal changes in groundwater and due to the unpredictable nature of groundwater paths. Therefore, it is necessary during construction for the contractor to be observant for groundwater seepage in excavations in order to assess the situation and make necessary changes and/or recommendations.

2.4 Seismic Site Classification

Code Used	Site Class Designation
2018 International Building Code (IBC)	D

Note the IBC requires a site soil profile determination extending a depth of 100 feet for seismic site classification. However, our scope of services did not include a boring to 100 feet. The deepest boring only extended to 20 feet, and it can only be estimated that the soils encountered continues to a depth of 100 feet.

3 ANALYSIS AND DESIGN RECOMMENDATIONS

Subsurface conditions within the proposed building site consist of deeper expansive shaly clays with HIGH potential for volume change (shrink and swell) movements with variations in soil moisture content. Sandy layers can allow seepage to the highly expansive shaly clay. The expansive soils at this site can subject shallow foundation elements, slabs, flatwork, sidewalks and paving placed on the soil to differential post construction movements due to moisture fluctuations in the clay. Soil conditions vary considerably as the shaly clay is layered through out the site. It is recommended to consider every location capable of differential movement in the order of the full range of the PVR. In the area of Boring 2, the large trees have severely dried the shaly clay. The foundation performance will be additionally sensitive to proper earthwork to pre-swell the areas where trees have been removed, and drying where trees remain closer than their mature height to the foundation.

3.1 Potential Vertical Rise (PVR)

The Texas Department of Transportation (TxDOT) provides the test method (Tex-124-E) for determining Potential Vertical Rise (PVR). A PVR of approximately 2.8 to 3.5 inches has been estimated based on the subsurface conditions revealed by the borings and for seasonal moisture fluctuations. The larger PVR value accounts for the possibility that the soil will be in the dry condition at the time of construction. If efforts are made to protect the soil from drying the lower PVR value can be used for design considerations. The PVR values provided were calculated using a 15 foot depth and 1 psi surcharge. Soil movements larger than estimated could occur due to inadequate site grading, poor drainage, leaking water service lines and/or leaking irrigation lines and ponding of storm water.

3.2 Geotechnical Recommendations

Foundation types available for this project ranging from least risk to most risk with respect to expansive soil and/or variable water table are provided below to give the owner the full range of potential options; the remaining discussion in this section gives specific recommendations for the option that provides the most favorable value when comparing performance to cost.

Deep Foundation Options

- Auger excavated piers with floor system suspended above grade;
- Auger excavated piers with a raft slab-on-grade system on fully prepared subgrade;

Shallow Foundation Options

- Raft slab-on-grade placed on a fully prepared select fill subgrade;
- Raft slab-on-grade placed on a fully prepared moisture conditioned subgrade;
- Raft slab-on-grade placed on a fully prepared moisture injected subgrade;

Based on the field and laboratory data available, along with previous experience, a deep foundation that isolates the structure from shrink/swell movements would be the best choice if post-construction movement is desired to be negligible. When potential soil movements are less than four (4) inches (as is the case for this project), full subgrade preparation and a monolithic slab-on-grade system are typically suitable if some post-construction movement is acceptable. The slab-on-grade system should be designed to withstand the predicted shrink/swell movements from subsurface soils factoring in a fully prepared subgrade that removes the majority of the risk and movement associated with expansive clay. However, due to the depth of the shaly clay, full subgrade preparation may not have a good benefit versus cost compared to using a deep foundation system with a structural slab that isolates the effects of expansive clay.

The fully prepared subgrade can be constructed remediating the full depth of the shaly clay strata three. Moisture/chemical injections may be utilized to reach the full depth of strata three if proper injection penetration can be achieved. The hard ground conditions may limit the effectiveness of injections. Depending on the final grading and if cut is to remove some of the hard surface strata's, injections may be a suitable option. Over-excavation methods, replacing with select fill or moisture conditioning the shaly clay require the full depth of strata three and at least 1 foot of a select fill cap above grade. Extend subgrade preparation 5 feet beyond the edge of foundation. Strata three may extend beyond the area indicated by the borings. The limits of strata three should be confirmed during earthwork construction. See Section 3.7 Reduction of Soil Movement and Section 4 Earthwork.

The foundation type chosen should meet the owner's desired serviceability and risk tolerance for the proposed construction. The standard limit post-subgrade remediation is one (1) inch. The fully prepared subgrade option reduces the PVR to approximately 1 inch. The fully prepared subgrade recommendations considers cost practicality and unacceptable foundation distress is possible; however, with moisture maintenance around the perimeter the risk is low. If the owner desires to utilize landscaping practices with no regard to moisture control and desires little to no foundation movement, it is recommended to reduce the PVR further or use a structural slab supported by suspended grade beams on piers. Contact Feather Engineers if a specific utilization plan is required to further evaluate the reduction in PVR and when final grading is determined.

3.3 Monolithic Slab-On-Grade Foundation

Parameters are provided below for shallow foundation elements. If a monolithic slab-on-grade foundation (either conventional or post-tensioned) is selected for use at this site, the foundation should be designed by the structural engineer to resist the estimated differential movements as provided herein. The slab design parameters presented below are based on criteria published by the Prestressed Concrete Institute (PCI), the Wire Reinforcement Institute (WRI), the Building Research Advisory Board (BRAB), and the Post-Tensioning Institute (PTI) 3rd Edition.

Shallow Foundation Parameters

Minimum embedment of grade beams below final grade	18 Inches
Allowable Net Bearing Pressure (FS=3)	4500 psf; (2000 psf compacted select fill)
Subgrade Modulus (k)	150 pci
Potential Vertical Rise, in.	2.8 (1)
Passive Pressure	416 psf (300 psf)
Ultimate Coefficient of Base Friction	0.38 (0.25)

- Values in parenthesis represents the fully prepared subgrade option if applicable.

- Allowable net bearing pressure is provided for a minimum embedment depth of 18 inches and a factor of safety of three; controlled by the minimum of general bearing capacity and settlement. Contact FEATHER ENGINEERS if expected loading requires greater bearing pressure.

- Minimum embedment is to reduce surface water migration below foundation elements and is not based on structural considerations. Grade beams should bear on existing subgrade soils or compacted subgrade.

- The modulus of subgrade reaction (k) is provided for short-term loading and wide area long-term loading that could induce additional settlements; and depends on the type of soil, degree of compaction, and the moisture content of the subgrade.

BRAB/WRI/PCI Parameters

Effective Plasticity Index	28.5 (20)
Climatic Rating (Cw)	20
Soil Support Index (C) for BRAB	0.88 (0.95)

- Effective PI is the weighted average of the PI values in the upper 15 feet considering the slope and consolidation factors;

Post Tensioning Institute (PTI) Parameters

Edge moisture Variation Distance, em	Center Lift, ft.	8.78 (8.78)
	Edge Lift, ft.	4.46 (4.46)
Differential Soil Movement, ym	Center Lift, in.	-1.48 (-0.94)
	Edge Lift, in.	2.21 (1)

- The design parameters were computed using the Addendum to the 3rd addition of the Post-Tensioning Institute (PTI) method and VOLFLO v1.5 software. These general PTI design parameters only account for climatically controlled variables and represents a simplified design scenario. Accordingly, the final structural design should consider non-climatically controlled variables developed latter in the design phase. Non-climatically controlled variables include but are not limited to: pre-existing and post-construction vegetation, slopes, landscaping, groundwater, and irrigations.

- The values provided are for 'post-construction' conditions varying from extremes (wet/dry) and a 15 foot depth active zone. A fully prepared subgrade constructed using the moisture conditioning method and preserving the moisture in the subgrade until construction can use the 'post-equilibrium' conditions and corresponding values.

- The designer should consider using the final post-construction PVR for the edge lift ym.

Settlement of a slab foundation system designed and constructed as recommended in this report, should be less than one (1) inch. The settlement response on a compacted subgrade is influenced more by the quality of the construction than soil-structure interaction.

The slab designer and slab contractor should consider use of a vapor retarder beneath the slab to limit moisture migration. Consider ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

3.4 Slopes and Retaining Walls

All permanent cut slopes and fill slopes should be less than 3(H):1(V) unless further geotechnical analysis is preformed once future conditions are known. The building pad should extend at least 5 feet beyond the foundation. This may result in select-fill extending to the steep slope. Retaining walls can be used to retain the soil and increase usable space. The lateral earth pressure on the subsurface walls will depend on the restraint conditions of the wall (active (a), at rest (r), passive (p)), the type of backfill, surcharge pressure, and hydrostatic pressure potential.

Backfill Material	Equivalent Fluid Pressure, pcf	
	Above Water Table	Below Water Table
Non-Expansive, Select-Fill (Imported)	41 (a) 62 (r) 373 (p)	83 (a) 93 (r) 248 (p)
Granular Backfill	35 (a) 50 (r) 469 (p)	64 (a) 79 (r) 311 (p)
On site soil	45 (a) 65 (r) 316 (p)	65 (a) 84 (r) 212 (p)

- It is recommended to use free draining material as backfill, cutting the in-situ material back at a 1(H):1(V) slope.

- The above values do not include lateral pressures induced by surface loads or from inclined backfill, which must be taken into account by the design engineer.

- Granular backfill (Free Draining Gravel or Sand/Gravel Mix) should have less than 5% passing #200 mesh sieve and less than 30% passing #40 sieve, and be non-plastic. Maximum particle size is 1-1/2". ASTM C33, size #57 typically meets this requirement.

- Swelling soil can cause an additional lateral pressure as high as the overburden pressure especially if expansive soils is used as backfill behind the wall and become saturated. Compaction behind the retaining wall should be performed using hand tampers to avoid pressures larger than the equivalent fluid pressure.

An ultimate coefficient of base friction of 0.38 (0.25) can be used at the interface between the base of foundation and the underlying soil can be used to prevent sliding.

3.5 Consolidation Settlement

Consolidation settlements are anticipated to be negligible based on the anticipated loading configuration. Contact FEATHER ENGINEERS if conditions differ from the assumption in this report, especially if fill is used to raise grade significantly.

3.6 Pier and Beam Foundation

Design parameters are provided below for drilled piers. The depths provided are from the existing ground elevation at the time of our study.

Description	Belled Parameters	Straight Shaft Parameters
Minimum Depth	na	See note 1
Allowable Bearing Pressure	na	9 ksf (FS=3)
Allowable Side Friction	na	0.8 ksf (FS=2)
Total Settlement	< 1/2''	
Min. Spacing	2.5 Pier Diameter, Center to Center	
Soil Uplift Pressure	400 psf (non-strata 3) 1500 psf (strata 3)	
Uplift Bell Resistance (Ru), Kips	na	
Underream	na	

- The required depths depend on the critical scenarios of swelling soil in an uplift condition and shrinking soils in a downward loading condition. When using piers to resist uplift, the adjacent flatwork and/or shallow foundation elements can differentially move up to the appropriate PVR from seasonal moisture variations and potentially significantly higher for unforeseen sources of moisture.

- Reduce the skin friction resistance by 3/4 to account for the pier's elastic elongation in a pullout condition.

- **Casings are recommended due to sand layers and spatial variation. Seepage should be expected. Based on the borings, a test pier hole may indicate casings are not needed.**

3.7 Drilled Pier Construction

The construction of the drilled pier foundation should at a minimum observe the following: proper depth is achieved, base and shaft is clear from cuttings, and spacers are used on the reinforced steel.

Care should be taken to prevent loose excavated soil from falling into the excavation. Concrete should be placed as soon as possible within the day of drilling to prevent softening and inundation of the bearing surface.

It is recommended to design the concrete slump between 4'' to 6'' and allow the concrete to pour vertically down the center of the shaft. A minimum of 3'' protective cover, 2% plumbness, and 3"+ location should be achievable by the concrete design and construction methodology. Generally, shaft lengths should not be greater than 30 times the shaft diameter.

3.8 Grade Beams and Floor System

Grade beams should be tied into the tops of the piers. If cardboard carton forms are used they should be observed by the Contractor, prior to concrete placement, to determine that they are firm and capable of supporting the wet concrete and that they are placed the full width and length of the beam. Soil retainers should be used to prevent infilling of the void space below grade beams. The void box manufacturer typically also provides the soil retainers. Once the foundation concrete has cured the fill used as form work can be removed if desired. Ventilation should be provided in the crawlspace.

If grade beams are cast monolithically with the slab, the slab should be designed as a structural slab with the capacity to withstand the swelling pressure induced by the piers ability to resist uplift.

3.9 Reduction of Soil Movement

The following information is provided to help determine the appropriate subgrade preparation option to reduce the potential for differential expansive soil movement. This section provides general information for each applicable option and provides recommendations. However, the option chosen requires the Owner along with their consultants to evaluate each option and select the method that best compliments their construction and utilization plans for this facility. Further recommendations and updated parameters can be provided based on the specific subgrade preparation implemented. If the potential for expansive movement is not significant subgrade preparation may not be needed and, in some projects, it may not be cost-feasible to reduce the expansive potential and the foundation should be designed accordingly.

- The interior floor slab used with the pier and beam foundation;
- The slab-on-grade foundation;
- Sidewalks, main entry flatwork, patios and other flatwork were a reduction in soil movement is desired.

A reduction in soil movement can be achieved by the excavation of the clay soil and the replacement of the soil back in the excavation to a higher moisture content and lower uniform density. The replaced soil should be topped out with a 12-inch thick layer of select fill to protect the clay from loss of moisture.

This option (moisture conditioning) is most beneficial when the subgrade soils are near their dry cycle condition at the time of construction. By bringing the moisture content up and protecting the subgrade from moisture loss the PVR can be reduced greatly. Although this option does not remove the problematic clay, it limits the ability for clay soil to swell and lift the foundation; whereas shrinkage from clay soil is less likely to lead to movement of a properly designed raft foundation since only the perimeter of the structure experiences shrinkage. This option is also more cost effective than replacing in situ soils with off site select fill. However, the section 3.10 Secondary Considerations should be followed to avoid changes in moisture content.

If select fill is used to replace in situ soils care should be taken to avoid the "bath tub" effect that can result in supplying moisture to the deeper expansive clay. Limit the width of the excavation and use a non-permeable material to prevent infiltration. Provide a drainage outlet at the bottom of the excavation or use a sump to remove excess moisture. The benefit of full replacement with select fill is that the Section 3.10 Secondary Considerations is less critical particularly regarding trees and vegetation.

Moisture or chemical injections are typically the most cost effective option to reduce the swell potential, however, hard soil conditions can result in improper penetration and difficulties uniformly injecting the subgrade. This option can require increased construction time. Post injection swell test are recommended to verify the reduction in swell. Fill soils may be compromised by the injections and require drying back the moisture content and recompaction. Section 3.10 Secondary Considerations should be followed to avoid changes in moisture content. If appliable to this project Appendix B provides further moisture/chemical injection recommendations.

The fully prepared subgrade can be constructed remediating the full depth of the shaly clay strata three. Moisture/chemical injections may be utilized to reach the full depth of strata three if proper injection penetration can be achieved. The hard ground conditions may limit the effectiveness of injections. Depending on the final grading and if cut is to remove some of the hard surface strata's, injections may be a suitable option. Over-excavation methods, replacing with select fill or moisture conditioning the shaly clay require the full depth of strata three and at least 1 foot of a select fill cap above grade. Extend subgrade preparation 5 feet beyond the edge of foundation. Strata three may extend beyond the area indicated by the borings. The limits of strata three should be confirmed during earthwork construction.

3.10 Secondary Considerations

To reduce the potential for moisture induced soil movement (uplift) as well as shrinkage (when applicable based on the post-construction risk), it is very important that measures be taken to control moisture changes around and below the structure. The following recommendations/comments should be incorporated into the overall project design. Soil with greater expansive potential than determined by the borings could exist at the project site.

- Site grading should be designed to provide surface drainage so that water does not pond during or after construction.

- A slope of 5 to 10 percent should be provided, such that the soil slopes away from the structure, flatwork, etc. 10 to 15 feet beyond.

- Water from roof gutters should be collected and transmitted to the storm drain system, to a paved area, or to a sufficient distance from the foundation (approximately 10 to 15 feet). If downspouts discharge next to the structure onto flatwork or paved areas, the area should be watertight and sealed in order to eliminate infiltration next to the building.

- Utility ditches should be backfilled so that they do not become conduits that allow surface water to flow adjacent to or below the foundation. This can be accomplished by the use of clay or concrete plugs placed within the trench backfill.

- Landscape irrigation systems should be designed and located to prevent excessive moisture adjacent to the foundation. Systems should not be located where water will be sprayed onto building walls and subsequently drain downward and flow into the soils beneath foundations.

- Trees should not be planted within a distance equal to the mature tree height from the foundation. If it is desired to leave the trees within this proximity, then landscaping irrigation should be designed to not allow the trees to pull moisture out of the soil and cause excessive shrinkage. If require, use moisture barriers to attempt to isolate the effects.

- Flower beds and planting areas should not be constructed along foundation perimeters. Constructing sidewalks or pavements adjacent to foundations would be preferable. If required, flower beds and planting areas could be constructed beyond the sidewalks away from the structure. If it is desired to have flower beds and planting adjacent to the structure, the use of above grade concrete planter boxes or other methods such as moisture barriers which reduce the likelihood of large changes in moisture content of soils adjacent to or below structures should be considered.

- Utilities which project through floor slabs, particularly where expansive soils or soils subject to settlement are present, should be designed with some degree of flexibility and/or with a sleeve to reduce the potential for damage to the utilities should movement occur.

- Vertical movement should be accounted for between flat work and the suspended foundation option.

4 EARTHWORK

4.1 Site Preparation

The following recommendations apply to site grading and general fill placement at the site, if grading and fill material is required.

Any top soil and organic surface strata should be removed. The subgrade should be firm and able to support the construction equipment without displacement by PROOF ROLLING. Soft or yielding subgrade should be corrected and made stable before construction proceeds. Loose sands, uncontrolled fill, and/or softened subgrade below a demolish foundation may require soil stabilization, over-excavation, and recompaction as determined by proof rolling. Prior to fill placement, the subgrade should be scarified to a depth of approximately six (6) inches, its moisture content adjusted, and recompacted to the density specified herein for fill. Do not place fill or pour the foundation on a dry subgrade. A 6 inch desiccated surface layer can swell considerably and add unforeseen movement.

Any trees that are cut down must have their root systems removed. The area (excavation pits) should be flooded and allowed to absorb moisture (re-flood as needed); moisture condition and recompact fill. Time is beneficial before building to allow the soils to reach equilibrium. These areas will have the potential to swell.

All excavations must comply with applicable local, state and federal safety regulations. The responsibility for excavation safety and stability of temporary construction slopes lies solely on the contractor.

4.2 Non-Expansive Select Fill

Select fill used for this project should meet at minimum the following requirements.

Select Fill Requirements
Liquid limit less than 35
Plasticity index between 6 and 15
USCS Classification CL, SC, and/or GC

- Prior to placement of the select fill, the upper six (6) inches of the subgrade should be scarified and recompacted according to the requirements provided in the next section. The select fill should be placed as soon as possible after preparation of the subgrade soils.

- To prevent deep seated swelling, a properly graded excavation and a collector drain with natural outfall or a sump and pump system will be required to provide adequate drainage, in order to prevent water from ponding beneath the building.

- The owner must approve any soil hauled onto this project from off-site sources. The contractor must obtain a written, notarized certification from the landowner of each proposed off-site soil borrow source stating that to the best of the landowner's knowledge and belief there has never been contamination of the borrow source site with hazardous or toxic materials. The certification must be furnished to the owner prior to proceeding to furnish soils to the site. Soil materials derived from the excavation of underground petroleum storage tanks shall not be used as fill on this project.

4.3 Placement and Compaction

Compaction and moisture content criteria for engineering fill materials are as follows:

Material Type		Per the Standard Proctor Test (ASTM D 689)		
		Minimum Compaction Requirement (%)	Range of Moisture Content	
			Minimum	Maximum
Imported Select Fill		95	-2%	5%
Moisture Conditioned Subgrade	PI <= 25	95	-2%	5%
	PI >=25	95	3%	5%

- Fill material should be placed in loose lifts not exceeding eight (8) inches in uncompacted thickness. The fill material should be uniform with respect to material type and moisture content. Clods and chunks of material should be broken and the fill material mixed by disking, blading, or plowing, as necessary, so that a material of uniform moisture and density is obtained for each lift. Water required for sprinkling to bring the fill material to the proper moisture content should be applied evenly through each layer.

- The ranges in moisture content given herein are provided as recommended ranges. For some soils and under some conditions, the earthwork contractor may have to maintain a more narrow range of moisture content (within the recommended range) in order to consistently achieve the recommended density.

- Each lift should be compacted, tested, and approved before another lift is added on the frequency of every 5,000 square feet. The purpose of the field density tests is to provide some indication that uniform and adequate compaction is being obtained. The actual quality of the fill, as compacted, should be the responsibility of the contractor and satisfactory results from the tests should not be considered as a guarantee of the quality of the contractor's filling operations.

5 PAVEMENT RECOMMENDATIONS

Traffic loads are anticipated to be produced primarily by cars, pickups, SUV's, delivery and garbage trucks and an occasional fire truck once or twice a month. Light duty pavement sections are for parking areas expected to receive car, pickup, and SUV type traffic. Medium duty pavement sections are for drives with an occasional light truck. Heavy duty pavement sections assume one to five delivery and garbage trucks per week and one or two fire truck passes per month. In some cases, all types of vehicles will travel over the pavement, particularly driveways and fire lanes. If heavier loading conditions are expected, the pavement sections provided herein should be re-evaluated.

5.1 Pavement Sections

Pavement Section	Joint Reinforced Concrete Pavement Thickness	Compacted Subgrade
Light Duty (Parking Stalls)	6 inches	6 inches
Medium Duty (Drives Occ. Light Truck)	7 inches	6 inches
Heavy Duty (Truck Drives)	8 inches	6 inches

- The pavement thickness ban be reduced by 1 inch if the subgrade is properly treated with hydrated lime or cement for the 6 inch thickness.

- Local regulations may require subgrade stabilization.

5.2 Subgrade and Pavement Requirements

Since the soils at this site consist of expansive clays, some movements within the pavement section should be expected. Proper drainage should be provided both during and after construction, and a minimum slope of one (1) percent is recommended for the paved areas. Particular emphasis should be given to areas where the pavement is placed directly adjacent to entries. If the subgrade heaves, the pavement could result in sloping toward the building, causing problems with drainage, door opening and closing, etc. The pavement should be maintained properly, including the use of a flexible joint material to seal cracks which can occur during the life of the pavement. A proper testing and inspection program during construction is also vital to the overall long-term performance of the pavement.

Recommendations for subgrade and paving materials are provided as follows:

- Compacted Subgrade - Compact to a minimum of 95 percent of Standard Proctor at a moisture content between optimum and four (4) percentage points above optimum.

- Jointed Reinforced Concrete Pavement - Minimum compressive strength of 3,500 psi at 28 days. Joint spacing use 30 times the thickness. Joint depth one-fourth the thickness. Shrinkage reinforcement is optional with proper joint spacing. If desired use #3 bars on 18 inch spacing. Chairs should be used to position the steel.

Proper finishing of concrete pavement requires the use of sawed and sealed joints. Sawing of joints should begin as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling. All joints should be completed before uncontrolled shrinkage cracking occurs. Joints should be cleaned and sealed before opening to the traffic.

Pavement design methods are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support. The support characteristics of the subgrade for pavement design do not account for shrink/swell movements on an expansive clay subgrade such as the soils encountered on this project. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade. It is therefore important to minimize moisture changes in the subgrade both during construction and during the life of the pavement to reduce shrink/swell movements.

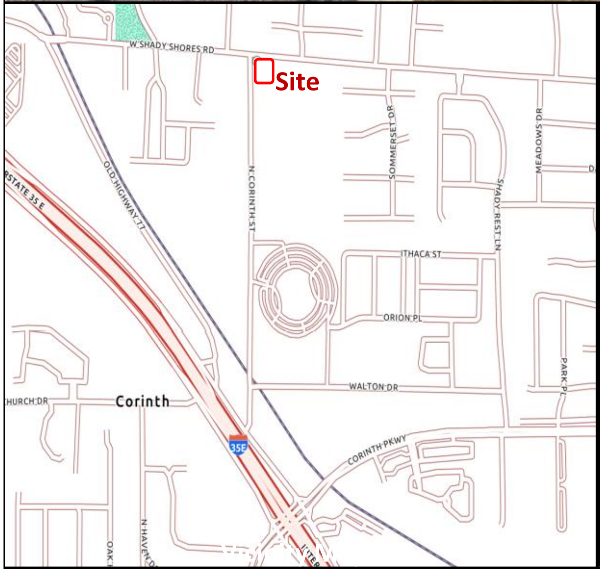
We recommend the concrete pavement details for joint spacing, joint reinforcement, and joint sealing be prepared in accordance with American Concrete Institute (ACI 330R 01 and ACI 325R.9.91). Control joints should be cut as soon as the slab can support the weight of the saw, usually 24 hours. Expansion (isolation) joints must be full depth and should only be used to isolate fixed objects abutting or within the paved area.

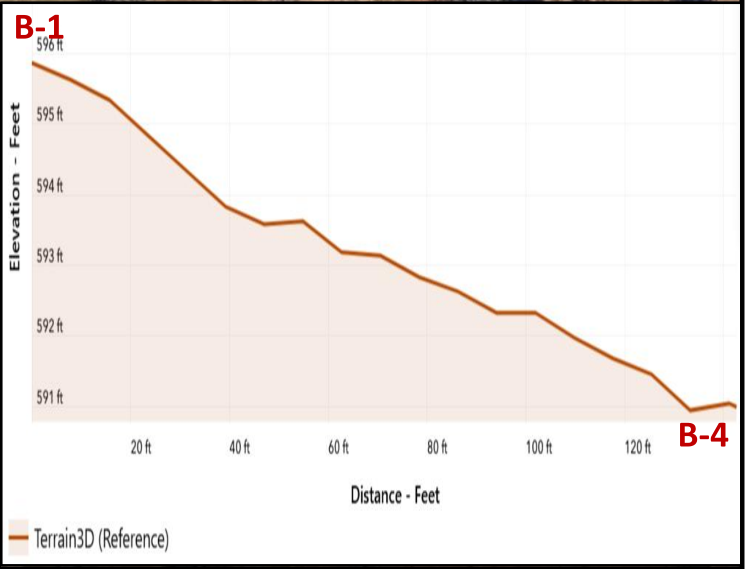
Surface drainage should be provided during construction and maintained throughout the life of the structure. Consideration should be given to the design and location of planting areas or other features which would produce moisture concentration adjacent to or beneath the paving. Joints should be sealed with a flexible joint sealer to prevent infiltration of surface water. Maintenance should include periodic inspection for open joints and cracks and resealing as necessary.

6 GENERAL COMMENTS

We have employed accepted geotechnical engineering, engineering geologic and hydrogeologic procedures, and our opinions and conclusions are made in accordance with generally accepted principles and practices of these professions. The contents of this report are valid as of the date of preparation. However, changes in the condition of the site can occur over time as a result or either natural processes or human activity. In addition, advancements in the practice of geotechnical engineering, engineering geology and hydrogeology and changes in applicable practice codes may affect the validity of this report. Consequently, this report should not be relied upon after an eclipsed period of six months without a review by this firm for verification of validity. This warranty is in lieu of all other warranties, either expressed or implied. Although not anticipated at this site, we should note that our investigation did not include the evaluation or assessment of any potential environmental hazards or groundwater contamination that may be present. The conclusions and recommendations in this report are invalid if the design loads are greater than assumed, the structure is relocated, the report is used for adjacent or other property or buildings, grades and/or ground-water levels change, and any other significant change that alters the project from that proposed when this report was prepared.

APPENDIX A





Not to Scale

LEGEND

⌖ Boring Location

Multi-Tenant

N Corinth St & W Shady Shore Rd, Corinth, Texas

PLAN OF BORINGS

Date: 11/7/2024

A1

Project: **Multi-Tenant**
N Corinth St & W Shady Shore Rd, Corinth, Texas

Project Number: 172215

BORING LOG B-1

Location: See Plan of Borings
Surface El.: na
Northing: na
Easting: na

Depth, Feet	Samples	Symbol / USCS	MATERIAL DESCRIPTION	Hand Penetrometer, tsf	Penetration Blows / Foot	Recovery %	Swell% @ Overburden	Moisture Content, %	Unit Dry Weight, pcf	Liquid Limit	Plactic Limit	Plasticity Index	% Passing No. 200 Sieve	Unc. Compressive Strength, tsf
	U	▨	SANDY LEAN CLAY, silty, dark reddish brown, very stiff, dry 2.0	2.50				5.6					60.5	
5	U	▨	SANDY LEAN CLAY, shaly seams, mottled reddish brown to tan & gray, hard, dry 6.0	4.5+				12.3						
10	S	▨	SANDY SHALY CLAY, sandy layers, gray w/reddish brown, very stiff, dry		50			23.0		60	22	38	91.2	
15	A		16.0				2.2	24.5		65	24	41		
20	S	▨	CLAYEY SAND, tan & light gray, medium dense, dry 20.0		30			13.0		26	15	11	47.8	
25 30 35 40														

Completion Depth: 20 ft.

Date: 11/7/2024

FEATHER ENGINEERS

Remarks: Seepage was not observed during drilling.

Dry @ completion.

Project: **Multi-Tenant**
N Corinth St & W Shady Shore Rd, Corinth, Texas

Project Number: 172215

BORING LOG B-2

Depth, Feet	Samples	Symbol / USCS	Location: See Plan of Borings Surface El.: na Northing: na Easting: na **MATERIAL DESCRIPTION**	Hand Penetrometer, tsf	Penetration Blows / Foot	Recovery %	Swell% @ Overburden	Moisture Content, %	Unit Dry Weight, pcf	Liquid Limit	Plactic Limit	Placticity Index	% Passing No. 200 Sieve	Unc. Compressive Strength, tsf
	U	▨	SANDY LEAN CLAY, silty, dark reddish brown, very stiff, dry 2.0	2.25				9.9		25	12	13	63.2	
	U	▨	SANDY LEAN CLAY, mottled reddish brown, tan, gray, hard, dry 5.0	4.5+				15.7		36	14	22	78.7	
5 10	S	▨	SANDY LEAN CLAY, shaly seams, tan w/gray & reddish brown, hard, dry w/some sandstone layers 11.0		63			14.3		32	16	16		
	U	▨	SANDY SHALY CLAY, sandy layers, gray w/reddish brown, hard, dry				4.1	14.6	104.1	62	26	36		2.2
15	S		17.5		32			16.5						
20 25 30 35 40														

Completion Depth: 17.5 ft.

Date: 11/7/2024

FEATHER ENGINEERS

Remarks: Seepage was not observed during drilling.

Dry @ completion.

Project: **Multi-Tenant**
N Corinth St & W Shady Shore Rd, Corinth, Texas

Project Number: 172215

BORING LOG B-3

Location: See Plan of Borings
Surface El.: na
Northing: na
Easting: na

Depth, Feet	Samples	Symbol / USCS	MATERIAL DESCRIPTION	Hand Penetrometer, tsf	Penetration Blows / Foot	Recovery %	RQD	Moisture Content, %	Unit Dry Weight, pcf	Liquid Limit	Plactic Limit	Placticity Index	% Passing No. 200 Sieve	Unc. Compressive Strength, tsf
	A	▨	SANDY LEAN CLAY, silty, reddish brown, very stiff, dry 2.0					5.1		26	12	14	54.5	
5	U	▨	SANDY LEAN CLAY, sandy w/shaly layers, orangish brown w/tannish brown & gray, hard, dry 6.0	4.5+				6.6		38	15	23		
	U	▨	SANDY LEAN CLAY, sandy w/shaly layers, tan w/light gray, hard, dry w/sandstone layes	4.5+				12.2		34	14	20	71.2	
10		▨												
	A	▨						12.5						
15	S	▨	15.0		50									
			, ,											
20														
25														
30														
35														
40														

Completion Depth: 15 ft.

Date: 11/7/2024

FEATHER ENGINEERS

Remarks: Seepage was not observed during drilling.
Dry @ completion.

Project: **Multi-Tenant**
N Corinth St & W Shady Shore Rd, Corinth, Texas

Project Number: 172215

BORING LOG B-4

Location: See Plan of Borings
Surface El.: na
Northing: na
Easting: na

Depth, Feet	Samples	Symbol / USCS	MATERIAL DESCRIPTION	Hand Penetrometer, tsf	Penetration Blows / Foot	Recovery %	RQD	Moisture Content, %	Unit Dry Weight, pcf	Liquid Limit	Plactic Limit	Placticity Index	% Passing No. 200 Sieve	Unc. Compressive Strength, tsf
	A	▨	SANDY LEAN CLAY, silty, reddish brown, very stiff, dry 2.0					6.7		26	14	12		
	U	▨	SANDY LEAN CLAY, sandy w/shaly layers, orangish brown w/tannish brown & gray, hard, dry	4.5+				8.5		29	13	16	63.3	
5														
	U	▨	6.5	4.5+				15.3						
10														
	A							12.2		35	14	21		
	S		15.0		50									
15			, ,											
20														
25														
30														
35														
40														

Completion Depth: 15 ft.

Date: 11/7/2024

Remarks: Seepage was not observed during drilling.

Dry @ completion.

Project: **Multi-Tenant**
N Corinth St & W Shady Shore Rd, Corinth, Texas

Project Number: 172215

BORING LOG B-5

Location: See Plan of Borings
Surface El.: na
Northing: na
Easting: na

Depth, Feet	Samples	Symbol / USCS	MATERIAL DESCRIPTION	Hand Penetrometer, tsf	Penetration Blows / Foot	Recovery %	RQD	Moisture Content, %	Unit Dry Weight, pcf	Liquid Limit	Plactic Limit	Placticity Index	% Passing No. 200 Sieve	Unc. Compressive Strength, tsf
	A	▨	SANDY LEAN CLAY, silty, reddish brown, very stiff, dry 2.0					4.9		28	12	16	59.4	
	U	▨	SANDY LEAN CLAY, sandy w/shaly layers, orangish brown w/tannish brown & gray, hard, dry	4.5+				13.4		38	14	24	72.5	
5		▨												
	U	▨	8.5	4.5+				8.5						
10		▨	SANDY LEAN CLAY, sandy w/shaly layers, reddish brown & gray, hard, dry w/sandstone layes											
	A	▨	15.0					10.4		34	14	20		
15			, ,											
20														
25														
30														
35														
40														

Completion Depth: 15 ft.

Date: 11/7/2024

Remarks: Seepage was not observed during drilling.

Dry @ completion.

FEATHER
ENGINEERS

GENERAL LOG NOTES

DRILLING AND SAMPLING SYMBOLS	
U	Thin-Walled Tube - 3" O.D.
A	Auger Sample
S	Split Spoon - 2" O.D. (140 lb, 30" drop)
W	Wash Sample
C	Core Barrel
T	TxDOT Cone Penetrometer (Modified), (140 lb, 30" drop)

RELATIVE DENSITY OF COARSE-GRAINED SOILS:		CONSISTENCY OF FINE-GRAINED SOILS:	
Penetration Resistance Blows/foot	Relative Density	Compressive Strength, Qu, tsf	Consistency
0-4	Very Loose	Less than 0.26	Very Soft
4-10	Loose	0.25 to 0.51	Soft
10-30	Medium Dense	0.50 to 1.01	Firm
30-50	Dense	1.00 to 2.01	Stiff
over 50	Very Dense	2.00 to 4.01	Very Stiff
		4.00 and higher	Hard

TERMS CHARACTERIZING SOIL STRUCTURE	
Slickensided:	Having inclined planes of weakness that are slick and glossy in appearance
Fissured:	Shrinkage cracks, frequently filled with sand or silt
Laminated:	Compsed of thin layers of varying color
Well Graded:	Having wide range of grain sizes
Poorly Graded:	Predomently one grain size or missing intermediate size
Interbedded:	Composed of alternate layers of different soil types
Calcareous:	Containing appreciable quantities of calcium carbonate

DEGREE OF WEATHERING	
Unweathered	Rock in its natural state before being exposed to atmospheric agents
Slightly Weathered	Noted predominantly by color change with no disintegrated zones
Severely Weathered	Color change with consistency and texture appearance approaching soil

Appendix B
Water Pressure Injection Recommendations

WATER PRESSURE INJECTION

1.00 GENERAL

1.01 SCOPE

The work covered by this recommendation consists of furnishing all plant, labor, equipment, and materials, and performing all operations in connection with the injection of water and other agents into the graded building pad. Approximately one (1) foot of select fill material shall be placed on the final approved water injected pad.

The basic work shall consist of water injection until the conditions stated herein are achieved. The average of all swell tests shall be equal to or less than one (1) percent swell with no single swell test exceeding two (2) percent. The injection will be performed until the swell requirements have been achieved. See Item 3.01, C for injection depths. Following the completion of injections, testing will be performed by the Owner to determine if the requirements have been accomplished.

The initial injections should consist of strata three 6-17.5 feet.

1.02 CHARACTER OF THE SOILS.

Interpretation of the character of the soil conditions through which the injection is to be performed is the responsibility of each prospective bidder and the Contractor.

Geotechnical studies, including borings, were performed at the site for use by the Owner in designing the project.

The geotechnical report is not a part of the Contract document, but is available from the Owner. Neither the Owner, FEATHER ENGINEERS, nor any of their consultants or agents guarantees the accuracy or adequacy of the information contained in the geotechnical reports or that they represent all subsurface conditions that may be encountered during construction. Any interpretation or use made of the geotechnical information is the sole responsibility of each prospective bidder and the Contractor.

No additional compensation will be made due to any subsurface condition or any material encountered in the work, of whatever nature.

2.00 MATERIALS

2.01 WATER

The water shall be clean, fresh, and potable and contain no deleterious materials such as high acidity, high sulfate content, etc. The sulfate/sulfite content of the water should not exceed 500 mg/l, and the acidity in the water, as measured by pH, should not be less than 6.5.

2.02 SURFACTANT

The non-ionic surfactant (wetting agent) shall be mixed according to the manufacturer's recommendations or at a rate of one part surfactant (undiluted) to 3,500 parts water, whichever is greater.

3.00 EXECUTION

3.01 PROSECUTION OF THE WORK

A. CONSTRUCTION OPERATIONS

The Contractor shall have experienced personnel (management, quality control operators, etc.), equipment, and materials to effectively perform the injection process. Supervisory personnel to be on site at all times during the work.

The Contractor shall at all times maintain the building pad, mixing areas, and access ways at such grades and elevations as provided by the Contractor. Equipment rutting and ponding of shall be prevented. The water shall be maintained within the immediate injection area and not be allowed to flow into ditches or other off-site areas.

B. LINES AND GRADES

The injection work shall be accomplished after the building pad subgrade has been established and prior to installation of any plumbing, ditches, utilities, or foundations. Allowance should be made for approximately 2 to 6 inches of heave that may occur as a result of the injection process, depending upon soil properties and in situ moisture contents.

The injection shall extent a minimum of five (5) feet outside the building line including entryways, sidewalks. The Contractor shall determine the building corners and stake five (5)-foot offsets to delineate the area to be injected. Offset stakes shall be placed not greater than 50 feet apart. Spacing for the injections shall not exceed five (5) feet on center each way.

C. INJECTION DEPTH

Injection pipes shall penetrate the soil in approximately twelve (12) to eighteen (18)-inch intervals, with a minimum of five (5) stops or intervals. Injection shall be to refusal at each interval point, for the total depth specified or impenetrable material, whichever occurs first. Impenetrable material is the maximum depth to which two injection pipes can be mechanically pushed into the soil using an injection rig having a minimum gross weight of five tons. The lower portion of the injection pipe shall consist of a perforated hole pattern that will uniformly disperse the slurryin a 360° pattern through the entire depth.

D. REFUSAL

Injections shall be continued to refusal. This is determined by observations where the maximum quantity of water has been injected intothe soil and water is running freely at the ground surface, either out of previous injection holes or from areas where the surface soils have fractured. The amount of water flowing at the surface shall be approximately equivalent to the volume of water being pumped into the soil.

Loss of water or blowback around the injector pipes does not constitute refusal and continued loss of water in this manner may indicate inadequate injection equipment, techniques, or, in some instances, surficial soils that will not form an adequate seal to contain the water. Scarification and light re-compaction to form a surface seal after completion of the three injections and prior to start of additional injections shall be required.

E. INJECTION PRESSURE

The injection pressure shall be adjusted to inject the greatest quantity of water possible (depending upon site conditions) within the pressure range of 50 to 200 psi. Pressures shall be adjusted based on field conditions to assure water penetration into soil fractures rather than returning to the surface around the injector pipe.

3.02 EQUIPMENT

A. INJECTION VEHICLE

The injection vehicle shall have a minimum gross weight of five (5) tons and shall be capable of making straight vertical penetrations to minimize pressure loss around the injector rods.

The injection vehicle shall have injection pipes spaced on five (5)-foot centers and each injection pipe shall be capable of exerting a minimum penetration force of 10,000 psi. The injection pipes shall be forced into the soil, not washed down by the scouring action of the fluid, and shall operate independently of each other, i.e. if one pipe refuses on impenetrable material, the other pipes shall advance.

The injection vehicle shall be equipped with a valve to cut-off the flow of slurry to all injection pipes during advancement to the next depth interval, as well as during horizontal travel of the injection vehicle.

3.03 INJECTION

Injections shall be made five (5) feet on center each way and spaced two and one-half (2.5) feet offset in two orthogonal directions from the previous injections. The minimum time between injections shall be 48 hours. The quantity of water injected shall be closely monitored on a daily basis by the Contractor in order to achieve uniform distribution.

Following the injections with water, the Project Geotechnical Engineer will obtain soil samples and perform tests. These tests will be used by the Engineer to determine if additional water injections are needed.

3.04 SUBGRADE PREPARATION

A. PROCESSING AND COMPACTION

Upon completion of all injection work, scarify and mix the top six (6) inches of the subgrade.

Compact the subgrade to a minimum of 95 percent of Standard Proctor density (ASTM D 698) at a moisture content ranging from optimum to five (5) percentage points above optimum (0 to +5). Perform compaction tests at the rate of one test per each 5,000 square feet with a minimum of 2 tests per building pad or section.

B. MAINTENANCE AND MONITORING

The moisture content at the end of the final injection shall be maintained until the concrete is placed and loss of moisture from the surface or sides of the building pad must be prevented by occasional watering or use of a membrane. Any open trenches should be sealed or kept wet to prevent loss of moisture. All trenches should be backfilled with the excavated material. Water should be added when required to bring moisture to approximately 2 percent above optimum.

Sufficient time must be given for the injected soil to heave prior to placement of the floor slab. The Contractor should monitor the heave and not place the floor slab until the soil heave has ended.

Excess moisture should be prevented from penetrating below the slab or ponding adjacent to the building. Moisture penetrating into the soils below the building can cause differential movements within the floor slab and other structural elements.

4.00 QUALITY CONTROL

4.01 GENERAL

The Owner shall arrange for and pay for the services of the Project Geotechnical Engineer to observe and perform tests and observations as specified, on a full time basis. The tests performed by the Owner's representative shall be the official tests of record. In the event of a conflict between the test results performed by the Owner's representative and the test results performed by the Contractor, the Owner's test results shall take precedence without exception.

The Owner's testing shall in no way relieve the Contractor of the responsibility of performing testing necessary to meet construction requirements.

4.02 SAMPLING AND TESTING

A. FIELD SAMPLING

After a minimum time of 48 hours following the most recent injection, the treated soils shall be continuously sampled with thin-walled Shelby tube samplers at a rate of not less than one boring for each 5,000 square feet (minimum of 2 borings) of treated area to a depth at least equal to the injection depth or deeper if directed by the Engineer. Samples are to be taken in one (1) foot intervals. Borings must be located on the treated pad by using a set of randomly selected points and a random number generator or as directed by the Engineer based on site observations and conditions.

B. LABORATORY TESTING

Approximately three (3) one-dimensional swell tests shall be performed on samples from each boring using surcharge loads as follows:

Sample Depth Interval	**Surcharge Load (psf)**
0 to 3 feet	250
>3 to 5 feet	500
>5 to 8 feet	750
>8 to 10 feet	1000*

* If injection depth is to 10 feet.

C. ACCEPTANCE CRITERIA

The average of all swell tests shall be equal to or less than one (1) percent swell with no single swell test exceeding two (2) percent. In addition, moisture content and hand penetrometer tests shall beperformed on each sample. Sufficient time must be allowed to perform the testing and provide results to the Owner. The pad will be reinjected until these requirements are met.

D. REPORT

Report to include boring number, sample depth, hand penetrometer reading (tsf), initial and final moisture content, percent swell and applied overburden pressure. Injection monitoring, field reports, field sampling, laboratory testing, and report to be under the direction of a registered professional engineer licensed in the State of Texas and the report must be signed by that engineer.