FARGO

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FARGO Report of Geotechnical Exploration

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Proposed:

Mixed-Use Development
West 7th Street
Fort Worth, Texas

www.fargotexas.com

Prepared for:

GOLDENROD COMPANIES, LLC
Omaha, Nebraska

TBPE Firm Registration No.
F-7270

FARGO Report No. G21-3751
July 2021

Geotechnical ■ Materials
Environmental ■ Engineering

Fargo Consultants, Inc.
Since 1999

July 22, 2021

Goldenrod Companies, LLC
10340 N. 84th Street
Omaha, Nebraska 68122

Attention: Mr. Zachary A. Wiegert

Re: Geotechnical Exploration
Proposed Mixed-Use Development
2816 West 7th Street
Fort Worth, Texas

FARGO Report No. G21-3751

Presented herein is the report of a geotechnical exploration performed at the location referenced above in general accordance with our proposal No. PG21-3751, dated May 26, 2021.

This report provides geotechnical related recommendations, within the scope of this study, for the proposed project. This report also presents subsurface conditions encountered in the borings advanced at the time of field exploration and data obtained in the field and laboratory.

We appreciate the opportunity to provide our geotechnical services. We would also appreciate the opportunity to be considered for providing the materials testing and observation services during the construction phase of this project.

If you have any questions, or if we may be of further service, please contact our office at 214-352-4100.

STATE OF TEXAS
MOHAMMED MUNIM
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LICENSED
PROFESSIONAL ENGINEER

Sincerely,

FARGO CONSULTANTS, INC.
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INTRODUCTION

Purpose and Scope

The primary purpose of this study was to provide geotechnical information and recommendations related to earthwork, foundation and pavement.

Previously, Fargo performed a geotechnical study (Fargo Report No. G19-3272-1, dated July 24, 2019) for a proposed hotel tower within the western portion of the study area. Referenced study included a total of 4 borings (Boring B-1 through B-4) advanced in 2018 and additional 2 borings (Borings B-5 and B-6) advanced in 2019. These borings were advanced based on the project information provided to us at those times.

Recent information provided to us indicates that the project scope has been updated to include office and multifamily towers atop at-grade garage/retail podium. Additionally, the project area has been extended to the east (the existing parking area) of the previous project area.

With reference to the aforesaid, and as authorized by the previous developer, subsurface information obtained during the previous study were utilized for the present study. Also, two additional borings (Borings B-7 and B-8) were advanced at the eastern/northeastern area of the subject site. The borings were advanced to the depths shown on the Log of Borings included in the report Illustrations.

Data obtained from the borings advanced to date during this study and interpretation of data have been used as the basis for the recommendations provided in this report and are specific to the building pad at the specific location noted in this report. Use of these data, information, and/or recommendations for other purposes, other structures (existing or to be constructed), or evaluations of other locations, will be at the risk and responsibility of the user.

We are available, at any time, to discuss the recommendations, information, and concepts provided herein with the owner's design and construction team.

Site and Project General Information

General site conditions noted at the time of this study are presented below:

Subject Site	
Location	2816 West 7th Street in Fort Worth, Texas
Prior developments	Google Earth aerial photographs show indications that the northern area of the site previously was developed with structures. The referenced structures were not present at the time of this study.
Ground surface conditions	The southwestern area of the site was developed with existing buildings and its associated asphalt drives and parking. Northeastern area of the site was developed with concrete parking. Asphalt paving was present in the northern area of the site. Remainder of the study area was generally covered with vegetation. Dense trees were present in the northwestern area of the site. Based on visual observation, the study area was generally flat.
Site layout and boring locations	Site Vicinity Map, (Plate A) Location Plan, (Plate A-1) (Referenced plates are presented in report Illustrations section).

General project information provided to us at the time of this study are presented below:

Proposed Development	
General Building type	**Office and apartment towers atop at-grade podium garage and retail:** Levels 1, 2: Parking garage, retail and lobby Levels 3, 4: Parking garage Levels 5-9: Office, apartment Level 10: Apartment
Maximum column loads	Office area: 2,600 kips Apartment area: 2,100 kips Plaza area: 1,400 kips
Grading plan	Not available at the time of this study
Cut and fill slopes	No steeper than 4H:1V – (Assumed)
Other information	It is our understanding that the proposed building, in general, will encompass the entire site.

GENERAL SUBSURFACE CONDITIONS

General subsurface conditions presented in this section are based on the information obtained within the depths explored at the boring locations. Soil strata shown on the logs were classified based on evaluation of the results of laboratory tests performed on predominant materials in each stratum and visual examination of samples. Classifications were performed in general accordance with the Unified Soil Classification System (USCS).

Geological maps indicate that the near surface materials consist of Terrace deposits underlain by Duck Creek limestone formation. Subsurface conditions based on the results of the borings advanced can be generalized as follow:

Stratum	Material Encountered	Approximate Depth to Bottom of Stratum	Consistency and/or Relative Density
Pavement	Asphalt	2 and 6 inches in Borings B-4 and B-5, respectively	--
	Concrete	6 inches in Borings B-7 and B-8	
Fill	Brown and tan intermixed sandy clays with limestone	2 feet in Borings B-4 and B-5	Stiff
1	Reddish and tannish brown (SC) clayey sand	6 to 15 feet	Very stiff to hard
2	Tan gravelly (SP) sand with intermittent clayey sand	18 to 24 feet	Medium dense
3	Tan alternating limestone and calcareous gravelly clay	22 to 27 feet in Borings B-1 through B-6	--
4	Tan limestone	28 feet in Boring B-6	--
5	Medium gray shaley limestone	Termination depths of the borings	--

Remarks:

- Fill thickness and its composition may vary in areas beyond the locations where borings were advanced.
- Bottom stratum maybe deeper than the termination depths of borings.

Groundwater

Subsurface seepage water was encountered in the borings. Approximate depths to water seepage encountered during drilling and depths to the top of the water in the borings upon completion of the field operation are presented below:

Boring No.	Depth to Water Seepage (feet)	Depth to Top of Water (feet)
B-1	13	13
B-2	13	15
B-3	13	14
B-4	13	15
B-5	17	18
B-6	18	12
B-7	14	14
B-8	20	12

These observations represent only groundwater and seepage water conditions at the time of field operation and may not be indicative of other times or at other locations. Groundwater levels can be different at the time of construction. Seasonal variations in the amount of rainfall, runoff or landscape irrigation from nearby properties, or future construction activities can cause changes to groundwater levels.

Seismic Considerations

Based on the guidelines provided in the International Building Code (IBC) 2012 edition and ASCE Standard SEI 7-10, the site is classified as Seismic Site Class C.

Standards referenced above, require characterization of the upper 100 feet of the subsurface materials. Subsurface exploration to a depth of 100 feet was beyond the scope of the current study. Therefore, site classification noted above considered the subsurface information obtained from the borings and estimated soil properties based on general area geology of the site, as permitted by the referenced standards.

ANALYSES AND RECOMMENDATIONS

Existing Fill

In the absence of documented density control, the possibility of under-compacted zones, voids or presence of objectionable materials within the fill exists. Prior to placement of additional fill or construction of ground-supported improvements in areas containing fill, removal of the existing fill is recommended. On-site clean materials may be used as fill in areas where placement of fill is required. Placement and compaction of fill following the compaction guidelines provided in this report are recommended to minimize the risk of unusual settlement.

Potential Soil Vertical Movement

The following were considered in our estimation of soil potential vertical movement at the boring locations:

- Evaluation of data obtained at the location of borings.
- Existing surface conditions.
- Assuming movements occur only due to normal seasonal moisture fluctuations.
- Results of absorption swell test.
- Assuming all existing uncontrolled fill is removed prior to the grading of the site.
- Assuming dry subgrade condition at the time of construction.
- Texas Department of Transportation (TxDOT) Test Method Tex-124-E.
- Engineering experience judgment.

Regarding the aforesaid, magnitude of potential for vertical movements is not anticipated to exceed about 1 ½ inches below (June 2021) grade.

If significant cut and fill (greater than 1 ½ feet) are required to achieve finished pad elevations, our office should be contacted for reevaluation of the potential movement referenced above and recommendations provided in this report.

Geotechnical Related Design Recommendations

The following recommendations and criteria were developed based on subsurface conditions encountered in the borings and previously noted project characteristic.

As indicated, grading plan was not available at the time of this study. The recommendations were developed assuming foundation is constructed exclusively within the building pad depicted on the site plan (as shown on Plate A-1) and constructed within 1 ½ feet of existing (June 2021) grade. We highly recommend that our office be provided with a copy of the final grading plan for evaluation and applicability of the recommendations provided in this report.

Please Note – At the time of this study, the site was developed with various structures. It is our understanding that the existing structures will be removed prior to the construction of the new structure. To avoid interference between the new foundation and the existing foundation, all elements of the existing foundations in construction areas should be removed.

In the case of shallow foundation, as a minimum, the upper portion of the existing foundation needs to be removed. Removal should be to the extent as to provide a minimum of 2 feet or more separation between the bottom of the new foundation and the top of the existing foundations.

If the existing foundation consists of piers, then the piers should be removed using a jackhammer or other cutting tools without disturbance to the materials surrounding the piers, under supervision by qualified geotechnical personnel.

All areas disturbed should be backfilled with thoroughly-mixed on-site soils that are free of any objectionable materials or imported select fill. Fill should be placed and compacted following the guideline recommendations presented under the Earthwork section of this report. Qualified geotechnical personnel should be retained to perform moisture and compaction testing during backfilling operation.

Straight-Shaft Pier Foundation

Structural loads can be supported by straight-shaft pier foundation system. Piers should be founded into the underlying gray limestone stratum (bearing material). Geotechnical related guidelines and parameters for the design of piers are outlined below:

Bearing Stratum	Gray limestone
End Bearing Pressure	35 ksf – At or below minimum 3-foot penetration into bearing stratum 60 ksf – At or below minimum 8-foot penetration into bearing stratum
Skin Friction in Compression	4.5 ksf – Below minimum 3-foot penetration into bearing stratum 6 ksf – Below minimum 8-foot penetration into bearing stratum
Uplift Pressure Due to Soil Swell	0.8 ksf – Acting on the upper average 8 feet of pier, dry soil condition
Negative Skin Friction to Resist Uplift	3.5 ksf – Below minimum 3-foot penetration into bearing stratum 5 ksf – Below minimum 8-foot penetration into bearing stratum
Anticipated Elastic Settlement	About ½ inch
Differential Settlement	50% to 75% of total settlement
Minimum Clear Pier Spacing	1.5 times the larger shaft diameter. Reduction in pier load carrying capacity will apply for closer spacing. For closer spacing, Fargo should be contacted for case-by-case evaluation.
Use of Casing	Anticipated (assuming groundwater conditions at the time of pier drilling to be same or similar to conditions during boring advancement)
Remarks: 1) In view of the presence of occasional shale seams within the gray limestone stratum, and from the perspective of monitoring and verification of the pier shafts during drilling, designed pier diameter for the piers with heavy loading conditions should not be less than 36 inches. 2) Contractor should refer to structural plans for designed pier diameters and penetrations into bearing material.	

No portion of the pier surface area above the minimum penetration referenced above should be considered in providing skin friction resistance in compression or resistance to uplift pressures.

We highly recommend that upon completion of the interim structural design of the piers, our office be provided with the referenced information to determine if advancing deeper additional borings will be required for evaluation and applicability of the pier-related design values provided in this report.

Casing – As indicated, subsurface seepage water was encountered in the borings. Assuming same or similar subsurface water condition at the time of construction, installation of temporary casing during pier drilling operation will be required.

Casing must be installed a sufficient depth into the bearing stratum to ensure an adequate seal. The required penetration into the bearing material can then be achieved by excavating through the casing. Reinforcing steel and concrete should then be placed immediately after the excavation has been completed and observed.

Where casing is used, extreme care should be exercised to ensure that the head of the plastic concrete is higher than the groundwater level outside of the casing at all times during the removal of the casing. Removal of the casing should be slow and without rotation while additional concrete is elevated to the top of the casing.

Additional recommendations and considerations, pier foundation system

- Piers should be constructed within appropriate vertical tolerance and without overspill at the surface. Horizontal projections (overspill at the top of piers) can result in excess uplift pressure and therefore, it should be removed from the piers prior to backfill operations.
- The weight of the pier concrete below final grade may be neglected in determining foundation loads.
- The piers should contain adequate reinforcing steel throughout the pier shaft to resist the tensile uplift forces including uplift forces associated with swelling and expansion of the upper clays.
- In no event should a pier excavation be allowed to remain open for more than 5 hours.
- The bottom of a pier excavation should be clean and free of standing water prior to concrete placement.
- Concrete placed in a pier excavation should be placed through a tremie to avoid segregation of the aggregates.
- FARGO should be retained to perform continuous observation during construction of the piers. Observation is recommended to verify:
    - proper pier depth,
    - bearing stratum,
    - minimum depth and/or penetration,
    - pier shafts are within acceptable vertical tolerance, and
    - bottom of the pier hole is clean prior to placement of concrete.
- The contractor should clearly understand that the references made to pier diameter noted in this report are not the designed diameters. The contractor must refer to construction plans for the pier diameter(s) and penetration depth(s) into bearing material as designed by structural engineer.
- Bid for pier depths should be adjusted based on final site grades.

Pier Lateral Load Capacity – The following estimated soil and rock parameters may be used in calculation for lateral load capacity of piers.

Depth below June 2021 grade (feet)	Total unit weight (pcf)	Modulus of subgrade reaction (pcf)	Strain at 50% of failure stress (%)
0 to 22	110	--	--
22 to 28	125	2.0×10^6	0.5
28+	140	5.5×10^6	0.5

Grade Beams and Pier Caps – All grade beams should be supported by piers. A minimum vertical void space of 4 inches is recommended between the bottom of grade beams, pier cap extensions and the top of subgrade.

The void is recommended to limit potential foundation movements associated with swelling of the underlying soils. The void beneath cast-in-place elements can be created by use of waxed cardboard forms with sufficient strength to hold concrete without collapsing during construction. Rectangular boxes are recommended.

The grade beams should be formed (rather than cast against earth trenches) to control the beam excavation width. Retainer boards along the grade beam will be necessary to maintain the void.

Floor System, Pier Foundation

In areas where movement of the floor slab can be tolerated, an interior "floating" slab constructed on subgrade that is prepared following the guideline recommendations presented in this report may be considered. Regarding the interior slab, the level of acceptable movement will vary with the user; however, a goal of about one inch is typical.

A structurally suspended floor system supported on piers is recommended in areas where movement of floor is to be limited to less than 1 inch. This type of floor system does not require modification of existing subgrade below suspended slab.

Structurally-Suspended Floor System, Pier Foundation – A minimum vertical void space of 8 inches is recommended below floor system. The surface of subgrade below the floor should preferably be higher than adjacent exterior grades in order to provide and facilitate drainage.

If subgrade is lower, provisions should be made to provide drainage for the bottom of the void area, covering the entire area of the structural floor system. Interior drainage should consist of sloped surfaces draining by gravity to a central location where accumulated water can be removed by gravity or by a sump pump.

Void space for a structurally-suspended floor system can be provided using cardboard carton forms or a deeper crawl space. A ventilated and drained crawl space is preferred for several reasons, including the following:

- Utility lines can be hung from the structural floor with sufficient void below the utility lines. This condition is considered most positive because it minimizes the effect of soil vertical movements in breaking the lines.
- Provides easier access for periodic inspections to check for proper drainage and possible repairs.
- Provides for installation of a venting system to allow circulation of air within the void space if high humidity is not acceptable.

With reference to the structurally-suspended floor system, consideration should be given to the development of appropriate details in the plans to address the following items:

- Entrances including areas with features that are considered as sensitive to soil-related movements should be structurally suspended.
- The ground surface within a minimum distance of 10 feet from the foundation should slope down with a minimum of 10 inches of drop to provide proper drainage and to allow for post-construction movement.
- The perimeter slabs should not be structurally connected to the foundation to allow free upward movements without stressing the foundation system.

Ground-Supported Interior "Floating" Slab, Pier Foundation – Ground-supported interior floor slab may consist of a conventionally reinforced floor slab system. It is recommended that the slab be designed to conform to the current requirements of the American Concrete Institute (ACI) "Building Code Requirements for Reinforced Concrete", ACI 318. The interior floor slab should not be rigidly connected to the foundation. A flexible joint should be provided between the floor slab and the foundation to allow independent movements of the two systems.

In areas where differential movements between the interior slab and grade beam cannot be tolerated, consideration may be given to providing a leave out (about 5 to 7 feet from grade beam) to provide a keyway between the slab and the concrete placed in the leave out. In this case, the leave out slab section may be dowelled into the grade beam.

If the risk associated with the movement of the slab is not acceptable, serious consideration should be given to pier foundation with a suspended floor system as noted in this report.

As noted, various structures existed within the study area. Also, fill materials were encountered in some of the borings. In view of the above, and regarding the ground-supported slab, subgrade preparation by excavation is recommended primarily, to provide a subgrade that consist of somewhat homogeneous materials (that is beneficial in reduction of differential movements) and that is properly placed and compacted under controlled conditions. This method entails excavation, mixing during placement and compaction at proper moisture as presented below.

Subgrade Preparation

Preparation of subgrade with a goal of reducing movement to about 1 inch is typical. It should be noted that even slab movement of up to 1 inch can result in distress to floor coverings, interior partitions, and finishes. In general, use of a slab constructed on grade is feasible, provided the risk of some post-construction floor movement due to the presence of overall expansive soils is acceptable.

Subgrade preparation should be performed prior to installation of any plumbing, utilities, ditches, or any foundations.

Recommended procedure is as follows:

- Remove existing improvements and strip vegetation and dispose of construction debris and the organic materials in accordance with project specifications.
- Excavate subgrade within the building pad, extending at least 5 feet beyond the building lines, to 3 feet below the finished pad elevation or to 3 feet below existing (June 2021) grade, whichever is greater.
- As noted previously under the Design Recommendations section, any existing foundation elements within the depth of subgrade preparation needs to be removed.
- Site-excavated materials are expected to consist of various types of soils including clayey sand, sand and sandy clay. Therefore, thorough mixing of the site-excavated clean soils during moisture conditioning and placement before compaction is highly recommended to provide somewhat homogeneous materials, throughout the building pad, to minimize differential movements.
- Scarify exposed subgrade at the bottom of the excavation to a depth of 8 inches and recompact from 95 to 100 percent of the maximum dry density, as determined by ASTM D 698, “Standard Proctor” at or above optimum moisture content.
- Place site-excavated clean soils in loose lifts no greater than 8-inch thick and compact to the moisture and density requirements outlined above.
- Grade finished pad elevation following the steps noted above.

Upon completion of satisfactory subgrade preparation following the procedures presented above, magnitude of potential for heave of soils is anticipated to be reduced to about 1 inch.

Overall movements exceeding the magnitude predicted in this report may occur if soils below ground-supported improvements are subject to excessive moisture as result of poor drainage conditions around the foundation, subsurface moisture migration from off-site locations, or water leakage from utility lines.

We highly recommend that FARGO be retained to perform density testing and observation during fill placement and moisture conditioning process.

Ground-Supported First-Level Parking Slab

The floor slab may consist of an interior slab (not to be rigidly connected to any foundation elements) and should consist of a minimum 5-inch-thick reinforced concrete constructed on prepared subgrade.

It is recommended that slab be designed to conform to the current requirements of the American Concrete Institute (ACI) “Building Code Requirements for Reinforced Concrete”, ACI 318.

Vapor Retarder

The use of a vapor retarder should be considered beneath ground-supported slabs that will be covered with wood, tile, paint, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer and slab contractor should refer to **ACI 302** and/or **ACI 360** for procedures and cautions regarding the use and placement of a vapor retarder. Care should be taken during placement of poly to provide sufficient slack (particularly at the bottom of grade beam excavations) to avoid resistance of poly during and after concrete placement and to avoid formation of voids below poly.

Other Considerations

Regarding subgrade preparation, excavation to proper elevation, vertical depth, the lateral extent of excavation beyond the building lines, should be surveyed by the contractor. Verification of the referenced items will be the responsibility of the contractor.

Regarding any rigid canopy that will be rigidly connected to the main building and also partially supported beyond the building, a pier type foundation is the most positive foundation for supporting the type of canopy referenced above.

A shallow foundation, if desired, for supporting the canopy should be constructed in subgrade that has been prepared to reduce potential movement following the same procedures and guidelines as presented in this report.

Other than what was observed at the time of drilling and within the depths explored at the locations of the borings, detailed groundwater seepage studies (installation of piezometer, etc.), were beyond the scope of our services.

Finished floor elevation should be set high enough above the final exterior grades around the perimeter of the building to assure a positive flow of water away from the structure. The ground surface should slope away from the perimeter of the structure, preferably at a minimum of 5 percent grade to 10 feet beyond the building perimeter.

Positive drainage of surface water away from the buildings must be provided during construction and maintained after construction. The flatwork abutting the foundation should be sloped downward from the structure at a minimum 5 percent grade. The slope in areas of ADA should be performed as per regulations. The joint between the flatwork and foundation should be sealed.

Proper backfilling around the building perimeter will reduce the potential for water seepage beneath the structures. Fill against the perimeter of the foundations should consist of sandy clay to clay soils placed and compacted in accordance with the recommendations outlined under the report's Earthwork section. If bedding soils must be used adjacent to the perimeter of the building, provisions should be made not to allow water to be accumulated next to the foundation.

Lateral Pressure, Retaining Walls

It is our understanding that the proposed project may include construction of site retaining walls (yielding walls). The walls should be provided with adequate reinforcement and designed to resist lateral earth pressures. These pressures are dependent on the type of backfill material and quality of drainage provided behind the walls. Considering the presence of active soils at the subject site, walls with the flexibility to accommodate soil related movements are recommended.

The walls should be designed with a drainage system to prevent hydrostatic pressures from developing. Retaining walls that are not part of any structure (yielding walls) may be founded on a footing type foundation system. Footings may be proportioned using the following parameters.

Allowable bearing pressure on undisturbed subgrade or on compacted and tested fill (ksf)	2
Footing minimum width (inches)	36
Minimum embedment depth from top of adjacent grade to bottom of footing (inches)	24
Estimated coefficient of friction at footing base.	0.3
Estimated soil unit weight (pcf)	115
Estimated passive resistance (equivalent fluid pressure), neglecting the upper 18 inches (pcf)	200

Providing a key beneath the footing, constructed on a stable slope, can develop additional sliding resistance. The heel of the footing is an effective location for constructing the key. An allowable passive pressure of 150 psf/ft (rectangular distribution) may be considered against the face of the key. In plastic soils, however, unless the key is quite deep, the sliding zone may bridge over the key in taking the path of least resistance.

For yielding walls, active earth pressure can be used for design. For walls that are considered as rigid (no movement is allowed), at-rest earth pressure is recommended for design. Earth pressures in terms of Equivalent Fluid Pressures, for various types of backfill placed behind the rigid double-formed walls and yielding walls with non-surcharged level backfill, are presented below:

Backfill	**Unit Weight (pcf)**	**Equivalent Fluid Pressure (pcf)**		
		Yielding Walls (Active Pressure)	**Rigid Walls** (At-Rest Pressure)	
		Drained Condition	Drained Condition	Without Drainage
<u>Free Draining Granular Materials</u> Less than 3% passing No. 200 sieve Less than 30% passing No. 40 sieve Friction angle: At least 35 degrees	115	35	50	85
<u>Select Fill or On-Site Clean Soils</u> Liquid Limit: 35 or less Plasticity Index (PI): 6 to 15 Percent passing a No. 200 sieve: 15 to 40	125	50	65	95

1) The limits of select fill or granular backfill should extend outward at least 2 feet from the wall footing and then upward on 1H:2V slope or flatter.
2) Surcharge loads should be considered if they apply at the surface behind the wall within areas defined by an angle of 45 degrees from the base of the wall.
3) Active earth pressure can be used where the top of the wall is allowed to deflect on the order of 0.5 percent of the wall height.
4) Materials meeting the requirements of ASTM C 33 Size 57 or 67 are acceptable as granular backfill.

Wall Backfill – The following is recommended for placement of backfill behind the wall:

Backfill Material	**Compaction**	**Moisture Range**
Free Draining Granular Soils/crushed stone/gravel	To be determined depending on the type of granular material	
Select Fill or On-Site clean soils	From 95 to 100 percent of maximum dry density (ASTM D-698)	At or above optimum moisture

1) Backfill should be placed in loose lifts no greater than 8-inch thick during placement and compaction. Heavy equipment should not be used to compact the backfill or clay cap soils.
2) Placement of backfill in thinner lifts during compaction will be helpful for achieving the recommended compaction noted above.
3) Backfill consisting of granular materials should not be water jetted.
4) To minimize surface water infiltration, the top of the backfill should be protected by flatwork or paving. Granular backfill should be covered with a minimum of 18 inches of compacted clay cap with a PI of 25 or greater that is placed and compacted atop backfill.

In general, settlement of the wall backfill on order of 1 to 2 percent of the fill thickness should be considered. Piping and conduits through the fill should be designed for potential soil loading due to fill settlement.

Wall Drainage – The following is recommended for providing drainage behind the wall to prevent the development of hydrostatic pressures:

- In the case of backfill consisting of site excavated soils or select fill a vertical drain behind the wall is recommended. The drain may consist of manufactured products such as "Enka-Drain", "Miradrain" or other similar systems.
- In the case of the aggregate drain, a filter fabric (Mirafi 140N, Geotex 401, or approved equivalent) should be placed between the aggregate and the retained soils and also placed below clay cap.
- The drain behind the wall should be connected to a permanent perimeter drainage system.
- For walls associated with the structure, the perimeter drainage system should be located at least 24 inches lower than the bottom of the adjacent slab.
- The perimeter drain should be a perforated or slotted drain with a minimum pipe diameter of 4 inches. The pipe should be surrounded by at least 6 inches of drainage rock. The drainage rock should be wrapped with an effective geotextile filter fabric for protection against infiltration of finer materials. Accessible clean-outs should be provided.
- Below grade walls in occupied space should be waterproofed.

UTILITIES

The following is recommended regarding construction of utilities:

- Care should be taken that utility trenches are not left open for extended periods and that they are properly backfilled.
- Backfilling should be accomplished with on-site soils that are placed in loose lifts and compacted in accordance with the requirements of local City/County standards or following recommendations provided under the Earthwork section of this report, whichever governs.
- Backfill should not contain rock pieces greater than 5 inches in maximum dimension.
- A positive cut-off at the building line is recommended for utility trenches that slope downward toward the building, to help in preventing water from migrating in the utility trench backfill to below the foundation.
- Movement of the active soils can impact utilities. Storm drains should be designed with adequate slope considering the effect of soil movement.
- Utilities passing under grade beams should be placed below void box to prevent breaking of the lines due to the potential for upward movement of soils.

EARTHWORK

All vegetation and topsoil containing organic material should be cleared and grubbed at the beginning of earthwork construction. In all areas where improvements are planned, existing trees, if any, should be removed well before the construction. Care should be taken that root balls and near surface roots are removed. Disturbed areas should be backfilled following the guidelines provided in this section.

Site-excavated soils, that are free of any objectionable materials, are suitable to be used as fill. Imported soils should be clean clayey sand to sandy clay soils with plasticity indices from 6 to 25.

Areas subject to subgrade preparation – Preparation of the building pad and subgrade preparation should be performed following the guideline recommendations provided previously in this report.

Areas not subject to subgrade preparation – Guideline recommendations for proof rolling, fill placement and compaction are presented below:

Proof rolling:

- Prior to placement of any fill, and after removal of the existing fill, the exposed subgrade should be proof-rolled. Qualified geotechnical personnel should be retained to observe the proof rolling operation.
- Use heavy rubber-tired equipment (loaded dump truck or water truck) weighing not less than 20 tons for proof rolling.
- Remove areas that exhibit pumping action or are excessively soft/compressible.
- Backfill with on-site suitable materials.

Fill placement and compaction:

- Prior to fill placement, scarify subgrade to a depth of 8 inches.
- Compact from 95 to 100 percent of the maximum dry density, as determined by ASTM D 698, "Standard Proctor" at or above optimum moisture.
- Place fill in loose lifts no greater than 8-inch thick.
- Compact to the moisture and density requirements outlined above.

Additional recommendations related to earthwork:

- Regarding the placement of fill, the surface of each lift should be kept moist prior to placing a subsequent lift particularly when work needs to be resumed the next day.
- Surface desiccation should not be allowed and if noted the lift should be reworked and compacted to the moisture and density criteria outlined above.
- Crushed stone utilized for the drainage system should consist of durable gravel meeting ASTM C 33 Size 67 or coarser. Gravel should be placed in loose lifts no greater than 8-inch thick and compacted to a minimum of 65 percent of the relative density as determined by ASTM D 4254.
- All constructed slopes should be vegetated as soon as possible. Use of erosion control fabric is recommended during vegetation of the slopes.
- Earth slopes greater than eight feet in height should be evaluated for slope stability. This also applies to slopes combined with retaining walls that have a combined height in excess of eight feet.
- Global slope stability analyses were not within the scope of the present study. Our office can assist in the analyses if desired.

All excavations should be braced or cut at stable slopes in accordance with **Occupational Safety and Health Administration (OSHA)** requirements or other applicable building codes. Consideration should also be given to erosion protection on exposed slopes.

Existing Fill – Removal of all existing fill (particularly, where construction of flatwork or other improvements are planned), is recommended. Removed fill that is free of any objectionable material, may be placed and compacted in general areas of the site requiring fill, following the compaction criteria provided above.

Existing Structures – It is our understanding that the referenced structures will be removed before the start of the proposed construction. Prior to the grading of the site, all foundation elements of the previous structures, including all abandoned utility lines, should be removed. If removal of deeper drain lines is not considered economically feasible, then as a minimum these lines should be filled with lean concrete to prevent the flow of water through the pipes and possible seepage conditions. Nature and compaction condition of backfill for existing below-grade utility lines (lines crossing proposed structures in particular), should be checked prior to filling the lines with lean concrete, unless records are available to indicate that backfill was placed under controlled conditions. All areas disturbed should be reworked, compacted, and prepared as per recommendations provided in this report.

PAVEMENT

Considering the nature of the project, area pavement beyond the parking garage is expected to be limited. In at-grade areas where surface paving is planned, removal of existing fill is recommended. Removed fill that is free of any objectionable material, may be placed and compacted, following the compaction criteria presented previously in the Earthwork section.

The pavement subgrade in general is anticipated to consist of clayey sand soils. These soils are subject to loss in support with an increase in moisture that can occur beneath the pavement. They react with Portland cement, which serves to improve and maintain their support value. Treatment of subgrade with Portland cement below rigid pavement will provide for less maintenance and related cost during the design life of the pavement. However, subgrade treatment below rigid pavement in light-duty traffic areas (areas subject to passenger vehicles and occasional light delivery trucks) would not necessarily be required.

For estimation purposes, the following may be considered for cement quantity.

Estimated percent cement to treat subgrade	6 percent by dry soil weight
Estimated amount of cement to treat the upper 6-inch of subgrade	30 pounds per square yard **NCTCOG, 2017, Item 301.3** or latest version or as per city, county specification
The actual percent cement required to treat subgrade should be verified by further laboratory tests after completion of grading and installation of utility lines in the streets.	

Subgrade treatment should extend a minimum of 1 foot beyond the edge of pavement on both sides. Portland cement concrete sections are presented below:

Portland Cement Concrete Pavement – The specific pavement sections will be dependent upon the type and frequency of traffic. At the time of this study, vehicle traffic studies were not available. Therefore, several pavement sections are presented below for a 20-year design life based on assumed traffic types and loading conditions and our experience with similar projects:

General Traffic Conditions	Estimated Annual ESAL	Portland Cement Concrete Pavement Thickness (inches)	28-Day Minimum Compressive Strength (psi)
Light-Duty Passenger Cars and Occasional Light Trucks	10,000	5	3,000
Medium-Duty Passenger Cars, Light Trucks, Tractor Trailer	40,000	6 *	3,600

* In areas where subgrade treatment economically is not feasible, then in lieu of subgrade treatment, pavement thickness may be increased by 1 inch or as per city/county requirements, whichever is greater. In this case, concrete with a minimum compressive strength of 4,000 psi is recommended.

Pavements should be reinforced to control shrinkage cracks. Reinforcing steel should consist of the approximate equivalent of #3 bars at 18 inches on center. The specific amount of steel should be determined based on the spacing of expansion, construction, and contraction (saw) joints.

The pavement section should be saw cut at an approximate spacing of 20-foot squares. Recommended jointing techniques are discussed in detail in "Joint Design for Concrete Highway and Street Pavements," published by the Portland Cement Association.

Dumpster Pad – Recommended pavement section for the dumpster pad area is presented below:

Portland cement concrete pavement thickness (inches):	7
28-Day Minimum Compressive Strength (psi)	3,600

The dumpster pad area should be designed as per the above criteria or as per city/county requirements, whichever is greater.

The dumpster pad area should be designed so that the wheels of the collection truck are supported on the concrete while the dumpster is being lifted. Dumpster areas that are not designed in this manner often experience localized failures due to large wheel loading imposed during waste collection.

Other Pavement Related Recommendations and Considerations

Treated subgrade should be uniformly compacted from 95 to 100 percent of maximum dry density as determined by ASTM D698 at a moisture content between –1 and +3 percentage points of the optimum moisture. Untreated subgrade should be scarified to a depth of 6 inches and compacted to the moisture and density requirements outlined in the report's Earthwork section. Treated or untreated prepared subgrade should be protected and maintained in moist condition until the pavement is placed.

The need for a thicker pavement section will depend on the traffic mix, frequency and traffic speed. We will reevaluate pavement thickness if provided with traffic information. All pavement materials and construction procedures should conform to applicable TxDOT, NCTCOG, or city, county specification requirements.

To achieve design life of the pavement, normal periodic maintenance (sealing of cracks and joints) will be required for all pavements to minimize infiltration of surface water into subgrade soils, to minimize weakening of the subgrade.

The pavement subgrade should be carefully evaluated prior to construction of pavement for signs of excessive disturbance due to utility excavations, construction traffic, desiccation, rainfall, or rutting. Areas with excessive disturbance should immediately be reworked, moisture conditioned, and properly compacted prior to paving, following the recommendations provided in this report.

Mechanical treatment of the pavement subgrade will not prevent normal seasonal movements of the underlying untreated soils. Pavement and other flatwork generally will have the same potential for movement as slabs constructed directly on the existing soils. Poor drainage conditions and ponding of water along the pavement should not be allowed. Backfilling of curbs should be accomplished as soon as practical to prevent ponding of water.

Openings in the pavement, such as landscape islands, are sources for collection of water. Collected water in the islands can migrate into the surrounding subgrade soils thereby degrading support of the pavement and/or causing heave of adjacent foundation soils. This is especially applicable for islands with raised concrete curbs, irrigated foliage, and low permeability near-surface soils. The civil design for pavement with these conditions should include features to restrict or to collect and discharge excess water from the islands. Examples of features are edge drains connected to the storm water collection system or other suitable outlet and impermeable barriers preventing lateral migration of water such as a cutoff wall installed to a depth below the pavement structure.

LANDSCAPING AND DRAINAGE CONSIDERATIONS

To reduce potential for excessive heave of soils below improvements, good surface drainage should be established and maintained. The open ground should be sloped preferably at a minimum of 5 percent grade 10 feet beyond the building perimeter. Paving and flatwork should be sloped as much as is practical to prevent areas where water can pond. Where paving or flatwork abuts the structure, care should be taken that joints are properly sealed and maintained to prevent the infiltration of surface water.

Trees, existing or to be planted, will draw water from the soil and, as a result, can cause the active soil below ground-supported improvements to become dry and shrink. This could cause settlement beneath grade-supported slabs such as floors, walkways, and paving. To reduce this risk, trees and large bushes should be located a distance of at least one-half of the mature height away from the foundation and other grade slabs sensitive to movements.

Sprinkler mains should be located a minimum 5 feet away from the building line. If sprinkler heads must be located adjacent to the structure, then the service extension lines off the main should be provided. Roof drains should discharge on pavement or be extended away from the structure. Ideally, roof drains should discharge to storm sewers via solid pipes.

CONSTRUCTION OBSERVATION AND TESTING FREQUENCY

It is recommended that the following items, as a minimum, be observed and tested by a representative of FARGO during construction.

Observation:

- Fill placement and compaction.
- Foundation construction and concrete placement.

Field Compaction Testing:

- Building pads, one test per 2,500 square feet per lift within fills (minimum of 2 tests per lift).
- Area paving, one test per 3,000 square feet per lift within fills (minimum of 2 tests per lift).
- Utilities, one test per 100 linear feet per lift or as per city/county requirements.
- Fill placed next to grade beams, one test per 100 linear feet per lift.

REPORT CLOSURE

The boring logs included in the report Illustrations show subsurface conditions at specific boring locations. These logs also contain interpretations made by our field drilling representatives of conditions that are believed to exist between sampling intervals during drilling and sampling. Therefore, the boring logs contain both factual and interpretive information, and the lines delineating the subsurface strata are approximate. It is not implied that these logs are representative of subsurface conditions at other locations within the site.

The design recommendations in general, are based on the information obtained from the borings and laboratory testing and are specific to the referenced proposed project at the specific location(s) noted in this report. The engineer's initial analyses, conclusions, and recommendations are based on the data obtained from the borings. However, during construction, quite often anomalies in the subsurface conditions are revealed and cannot be fully predicted by mere soil samples, sample borings or test pits. If during construction, different subsurface conditions from those encountered in our borings are observed, we must be advised promptly so that we can review these conditions and reconsider our recommendations where necessary.

Unexpected conditions during excavation, observation, and testing frequently require that additional expenditures be made by the owner to attain a properly designed and constructed project. Therefore, provision for some contingency funds is recommended to accommodate such potential extra cost.

Subsurface conditions can change with the passage of time. Recommendations contained herein are not considered applicable for an extended period from the date of this report. It is recommended that our office be contacted for a review of the contents of this report in the case of any changes to project scope (e.g. grading plan, building layout, structural framing etc.) or for construction commencing more than 1 ½ year after completion of this report.

Further, it is urged that FARGO be retained to review those portions of the plans and specifications for this project that pertain to earthwork and foundation as a means to determine whether the plans and specifications are consistent with recommendations contained in this report.

The scope of our services did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater or air, on or below or around the site. In addition, slope stability analyses (localized and/or global) for ground slopes, retaining walls, or embankment slopes (existing or to be constructed) were beyond the scope of this service. Referenced studies, where needed, should be performed separately. Upon written request, FARGO may be retained to perform referenced studies. FARGO is not responsible for conclusions, opinions or recommendations made by others based on the data presented in this report.

This report has been prepared for the exclusive use of the entity and/or person to whom this report is addressed for specific application to the design of this project. The only warranty made by us in connection with the service provided is that we have used that degree of care and skill ordinarily exercised under similar conditions by reputable members of our profession practicing in the same or similar locality. No other warranty, expressed or implied, is made or intended.

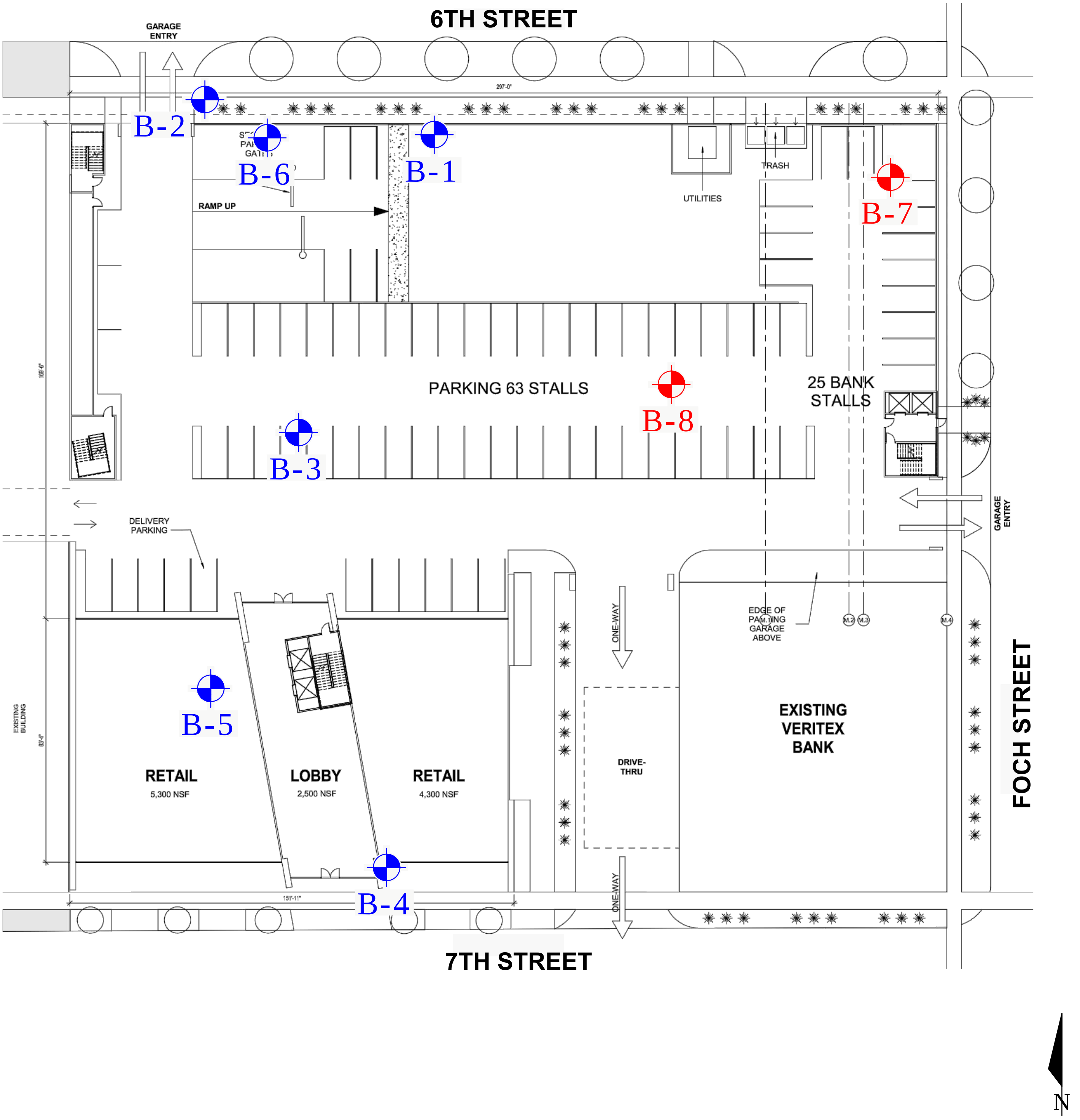
Verification of the subsurface conditions for purposes of determining the difficulty of excavation, trafficability, site safety, excavation support, etc. is the responsibility of others. FARGO is not responsible for damages resulting from the workmanship of designers or contractors.

In the event that information provided to us did not include final grading plans, then these recommendations should be reviewed once a grading plan is finalized. We recommend that FARGO be retained to observe earthwork and perform material evaluation and testing during the construction phase of the project. This enables the geotechnical engineer to be readily available to evaluate unanticipated conditions and, if required, to conduct additional tests and to recommend alternative solutions to unanticipated conditions. Until these construction phase services are performed by the project geotechnical engineer, the recommendations contained in this report on such items as final foundation bearing elevations, undercut depths, proper soils moisture conditioning, and other such subsurface related recommendations should be considered as preliminary.

ILLUSTRATIONS

Site Vicinity Map

FARGO	Project: **Proposed Mixed-Use Development** Location: **7th Street, Fort Worth, Texas** FARGO Report No.: **G21-3751**	PLATE A



Not To Scale

Location Plan

FARGO

Project: **Proposed Mixed-Use Development**

Location: **7th Street, Fort Worth, Texas**

FARGO Report No.: **G21-3751**

Approximate Location:

Boring Advanced in 2021

Boring Advanced in 2018 and 2019

PLATE A-1

LOG OF BORING NO. B-1

Report No: G21-3751

Reference: Proposed Mixed-Use Development
Fort Worth, Texas

Date Sampled: 11/30/2018

Location: See Plate A-1

Surface Elevation: N/A

Sampling Type: Intermittent

GROUNDWATER INFORMATION:

Seepage Encountered During Drilling (feet): 13
Depth to Top of Water Upon Completion (feet): 13

DEPTH (ft.)	P: HAND PEN., TSF / T: THD, NO. OF BLOWS / N: SPT, NO. OF BLOWS	STRATUM DEPTH (FT.)	DESCRIPTION OF STRATUM	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIT DRY WEIGHT (PCF)	UNCONFINED STRENGTH (TSF)	% PASSING NO. 200 SIEVE
	P2.0		Reddish brown CLAYEY SAND (SC) with a trace of gravel	13						
	P2.0			15						
5	P4.0			15	30	16	14			
	P3.5		- tannish brown below 6 feet	12	24	14	10	112	2.2	
10	P4.5	11	- with intermittent sand seams below 8 feet	14						
15	N23	19	Tan gravelly SAND (SP) with occasional intermittent clayey sand seams	9						21
20	N50/5.5"	24	Tan alternating Limestone and calcareous gravelly Clay with occasional dark gray shale seams							
25	T100/3"		Medium gray shaley LIMESTONE							
30	T100/ 3.5"		- with dark gray shale seams to 30 feet							
35	T100/2"									
40	T100/2"	40	BORING TERMINATED AT 40 FEET							
45										
50										
55										
60										

REMARKS:

TUBE SAMPLE	AUGER SAMPLE	SPLIT-SPOON	ROCK CORE	THD CONE PEN.	NO RECOVERY

FARGO

LOG OF BORING NO. B-2

Report No: G21-3751
Reference: Proposed Mixed-Use Development
Fort Worth, Texas

Date Sampled: 11/30/2018
Location: See Plate A-1
Surface Elevation: N/A

Sampling Type: Intermittent

GROUNDWATER INFORMATION:

Seepage Encountered During Drilling (feet): 13
Depth to Top of Water Upon Completion (feet): 15

FIELD DATA				DESCRIPTION OF STRATUM	LABORATORY DATA						
DEPTH (ft.)	SAMPLE TYPE	P: HAND PEN., TSF T: THD, NO. OF BLOWS N: SPT, NO. OF BLOWS	STRATUM DEPTH (FT.)		WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIT DRY WEIGHT (PCF)	UNCONFINED STRENGTH (TSF)	% PASSING NO. 200 SIEVE
	Tube	P2.0		Tannish brown CLAYEY SAND (SC)	16						
	Tube	P3.5			15						
5	Tube	P4.5			14	30	15	15			
	Tube	P3.5			11						
	Tube	P3.5			11	24	15	9			
10			10	- with sand seams below 9 feet							
				Tan gravelly SAND (SP) with occasional intermittent clayey sand seams							
15	Split-spoon	N18			14						
			18								
20	Split-spoon	N50/1.5"		Tan alternating Limestone and calcareous gravelly Clay with occasional dark gray shale seams							
			22								
				Medium gray shaley LIMESTONE							
25	THD	T100/3"		- with dark gray shale seams to 25 feet							
30	THD	T100/ 1.5"									
35	THD	T100/ 1.5"									
40	THD	T100/1"	40								
				BORING TERMINATED AT 40 FEET							
45											
50											
55											
60											

REMARKS:

TUBE SAMPLE	AUGER SAMPLE	SPLIT-SPOON	ROCK CORE	THD CONE PEN.	NO RECOVERY

FARGO

LOG OF BORING NO. B-3

Report No: G21-3751
Reference: Proposed Mixed-Use Development
Fort Worth, Texas

Date Sampled: 12/3/2018
Location: See Plate A-1
Surface Elevation: N/A

Sampling Type: Intermittent

GROUNDWATER INFORMATION:

Seepage Encountered During Drilling (feet): 13
Depth to Top of Water Upon Completion (feet): 14

FIELD DATA: DEPTH (ft.)	SAMPLE TYPE / P: HAND PEN., TSF / T: THD, NO. OF BLOWS / N: SPT, NO. OF BLOWS	STRATUM DEPTH (FT.)	DESCRIPTION OF STRATUM	LABORATORY DATA: WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIT DRY WEIGHT (PCF)	UNCONFINED STRENGTH (TSF)	% PASSING NO. 200 SIEVE
	P2.0		Reddish brown CLAYEY SAND (SC)	13						
	P4.5			16	33	18	15			
5	P4.5			13	30	16	14			
	N14		- with tannish brown sand seams below 6 feet	12						
10	N11	11		12						
			Tan gravelly SAND (SP) with occasional intermittent clayey sand seams							
15	N19	18		13						
20	N50/2.5"	24	Tan alternating Limestone and calcareous gravelly Clay with occasional dark gray shale seams	11						
25	N50/2.5"		Medium gray shaley LIMESTONE							
30	T100/2"		- with dark gray shale seams to 30 feet							
35	T100/2"									
40	T100/ 1.5"	40	BORING TERMINATED AT 40 FEET							
45										
50										
55										
60										

REMARKS:

TUBE SAMPLE | AUGER SAMPLE | SPLIT-SPOON | ROCK CORE | THD CONE PEN. | NO RECOVERY

Plate 3

LOG OF BORING NO. B-4

Report No: G21-3751
Reference: Proposed Mixed-Use Development
Fort Worth, Texas

Date Sampled: 12/3/2018
Location: See Plate A-1
Surface Elevation: N/A

Sampling Type: Intermittent

GROUNDWATER INFORMATION:

Seepage Encountered During Drilling (feet): 13
Depth to Top of Water Upon Completion (feet): 15

FIELD DATA						LABORATORY DATA						
DEPTH (ft.)	SAMPLE (P: HAND PEN., TSF; T: THD, NO. OF BLOWS; N: SPT, NO. OF BLOWS)	STRATUM DEPTH (FT.)	DESCRIPTION OF STRATUM	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIT DRY WEIGHT (PCF)	UNCONFINED STRENGTH (TSF)	% PASSING NO. 200 SIEVE		
0–0.2		0.2	Approximately 2-inch of Asphalt - PAVING									
0.2–2	P2.0	2	Brown and tan intermixed sandy clays with limestone - FILL	14								
2–6	P2.5	6	Reddish brown CLAYEY SAND (SC) with a trace of gravel	15								
5				12	31	16	15					
6–20	N12	20	Tan gravelly SAND (SP) with occasional intermittent clayey sand seams	10								
10	N14			10								
15	N21			13								
20	N26			14								
20–27	T100/3"	27	Tan alternating Limestone and calcareous gravelly Clay with occasional dark gray shale seams									
27–40	T100/2"	40	Medium gray shaley LIMESTONE									
35	T100/ 1.5"											
40	T100/ 1.5"		BORING TERMINATED AT 40 FEET									

REMARKS:

TUBE SAMPLE	AUGER SAMPLE	SPLIT-SPOON	ROCK CORE	THD CONE PEN.	NO RECOVERY

FARGO

LOG OF BORING NO. B-5

Report No: G21-3751
Reference: Proposed Mixed-Use Development
Fort Worth, Texas

Date Sampled: 6/20/2019
Location: See Plate A-1
Surface Elevation: N.A.

Sampling Type: Intermittent

GROUNDWATER INFORMATION:

Seepage Encountered During Drilling (feet): 17
Depth to Top of Water Upon Completion (feet): 18

DEPTH (ft.)	P: HAND PEN., TSF / T: THD, NO. OF BLOWS / N: SPT, NO. OF BLOWS	STRATUM DEPTH (FT.)	DESCRIPTION OF STRATUM	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIT DRY WEIGHT (PCF)	UNCONFINED STRENGTH (TSF)	% PASSING NO. 200 SIEVE
		0.5	Approximately 6-inch Asphalt - PAVING	10						
		2	Dark brown and gray intermixed sandy clays - FILL							
5	N16		Reddish brown CLAYEY SAND (SC) with sandy clay seams and a trace of gravel	14						
10	N22	11		9	23	14	9			
15	N18	18	Tan gravelly SAND (SP) with occasional intermittent clayey sand seams	15						
20	N36	22	Tan alternating Limestone and calcareous gravelly Clay with occasional dark gray shale seams	9						
25	T100/1"		Medium gray shaley LIMESTONE							
30	T100/ 0.5"									
35	T100/ 2.5"		- with dark gray shale seams to 35 feet							
40	T100/1"									
45	T100/ 0.5"									
50	T100/1"									
55	T100/ 1.5"	55	BORING TERMINATED AT 55 FEET							
60										

REMARKS:

TUBE SAMPLE	AUGER SAMPLE	SPLIT-SPOON	ROCK CORE	THD CONE PEN.	NO RECOVERY

FARGO

LOG OF BORING NO. B-6

Report No: G21-3751
Date Sampled: 6/20/2019
Sheet 1 of 2
Reference: Proposed Mixed-Use Development
Fort Worth, Texas
Location: See Plate A-1
Surface Elevation: N.A.

Sampling Type: Intermittent

GROUNDWATER INFORMATION:

Seepage Encountered During Drilling (feet): 18
Depth to Top of Water Upon Completion (feet): 12

DEPTH (ft.)	SAMPLE TYPE / P: HAND PEN., TSF; T: THD, NO. OF BLOWS; N: SPT, NO. OF BLOWS	STRATUM DEPTH (FT.)	DESCRIPTION OF STRATUM	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIT DRY WEIGHT (PCF)	UNCONFINED STRENGTH (TSF)	% PASSING NO. 200 SIEVE
0			Tannish brown CLAYEY SAND (SC) with gravel and calcareous nodules							
5	N14			11	28	16	12			
10	N16	12		12						
15	N28	19	Tan gravelly SAND (SP) with occasional intermittent clayey sand seams	12						21
20	N32	23	Tan alternating Limestone and calcareous gravelly Clay with occasional dark gray shale seams							
25	T100/3"	28	Tan LIMESTONE							
30	T100/1.5"		Medium gray shaley LIMESTONE							
35	T100/0"									
40	T100/1.5"		- with dark gray shale seams to 40 feet							
45	T100/1"									
50	T100/0.5"									
55	T100/0.5"									
60	T100/1"									

REMARKS:

TUBE SAMPLE | AUGER SAMPLE | SPLIT-SPOON | ROCK CORE | THD CONE PEN. | NO RECOVERY

FARGO

LOG OF BORING NO. B-6

Report No: G21-3751
Date Sampled: 6/20/2019

Reference: Proposed Mixed-Use Development
Fort Worth, Texas
Location: See Plate A-1
Surface Elevation: N.A.

Sampling Type: Intermittent

GROUNDWATER INFORMATION:

Seepage Encountered During Drilling (feet): 18
Depth to Top of Water Upon Completion (feet): 12

FIELD DATA						LABORATORY DATA						
DEPTH (ft.)	SOIL & ROCK SYMBOL	SAMPLE TYPE	P: HAND PEN., TSF T: THD, NO. OF BLOWS N: SPT, NO. OF BLOWS	STRATUM DEPTH (FT.)	DESCRIPTION OF STRATUM	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIT DRY WEIGHT (PCF)	UNCONFINED STRENGTH (TSF)	% PASSING NO. 200 SIEVE
				62	Medium gray shaley LIMESTONE							
65			T100/0"	65								
					BORING TERMINATED AT 65 FEET							
70												
75												
80												
85												
90												
95												
100												
105												
110												
115												
120												

REMARKS:

TUBE SAMPLE	AUGER SAMPLE	SPLIT-SPOON	ROCK CORE	THD CONE PEN.	NO RECOVERY

FARGO

LOG OF BORING NO. B-7

Report No: G21-3751
Reference: Proposed Mixed-Use Development
Fort Worth, Texas

Date Sampled: 6/21/2021
Location: See Plate A-1
Surface Elevation: N.A.

Sampling Type: Intermittent

GROUNDWATER INFORMATION:

Seepage Encountered During Drilling (feet): 14
Depth to Top of Water Upon Completion (feet): 14

DEPTH (ft.)	SAMPLE TYPE	P: HAND PEN., TSF / T: THD, NO. OF BLOWS / N: SPT, NO. OF BLOWS	STRATUM DEPTH (FT.)	DESCRIPTION OF STRATUM	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIT DRY WEIGHT (PCF)	UNCONFINED STRENGTH (TSF)	% PASSING NO. 200 SIEVE
			0.5	Approximately 6-inch of Concrete - PAVING							
	Tube	P4.5+		Tannish and reddish brown CLAYEY SAND (SC) - with a trace of gravel to 2 feet	15						
	Tube	P4.5+			10	22	15	7			
5	Tube	P4.5+			12	30	16	14			
	Tube	P4.5+			12						
10	Tube	P4.5			8	23	17	6			
				- with a trace of gravel below 13 feet							
15	Split-spoon	N29	15								
				Tannish brown CLAYEY SAND (SC) with gravel (caliche) and sandy clay seams							
20	Split-spoon	N50/2.5"									
			24								
25	THD	T100/ 2.5"		Medium gray shaley LIMESTONE							
30	THD	T100/ 1.5"									
35	THD	T100/2"		- with occasional dark gray shale seams to 35 feet							
40	THD	T100/ 2.5"									
45	THD	T100/ 1.5"		- with dark gray shale seams from 42 to 50 feet							
50	THD	T100/ 0.5"									
55	THD	T100/2"									
60	THD	T100/2"	60								

BORING TERMINATED AT 60 FEET

REMARKS:

TUBE SAMPLE	AUGER SAMPLE	SPLIT-SPOON	ROCK CORE	THD CONE PEN.	NO RECOVERY

FARGO

LOG OF BORING NO. B-8

Report No: G21-3751
Reference: Proposed Mixed-Use Development
Fort Worth, Texas

Date Sampled: 6/21/2021
Location: See Plate A-1
Surface Elevation: N.A.

Sampling Type: Intermittent

GROUNDWATER INFORMATION:

Seepage Encountered During Drilling (feet): 20
Depth to Top of Water Upon Completion (feet): 12

FIELD DATA						LABORATORY DATA						
DEPTH (ft.)	SAMPLE: P: HAND PEN., TSF / T: THD, NO. OF BLOWS / N: SPT, NO. OF BLOWS	STRATUM DEPTH (FT.)	DESCRIPTION OF STRATUM	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIT DRY WEIGHT (PCF)	UNCONFINED STRENGTH (TSF)	% PASSING NO. 200 SIEVE		
0		0.5	Approximately 6-inch of Concrete - PAVING									
1	P4.5+		Brown to tannish brown CLAYEY SAND (SC) - with a trace of gravel to 2 feet	12								
2.5	P4.5+			11	23	16	7					
4.5	P4.5+			13				117	3.4			
6.5	P4.5+			11	25	16	9					
8.5	P4.5+			10								
12		14	- with occasional caliche below 12 feet									
15	N36		Tannish brown CLAYEY SAND (SC) with gravel (caliche) and sandy clay seams									
20	N50/3"	24										
25	T100/3"		Medium gray shaley LIMESTONE									
30	T100/2"											
35	T100/ 2.5"		- with intermittent dark gray shale seams to 35 feet									
40	T100/1"											
45	T100/1"		- with occasional dark gray shale seams below 45 feet									
50	T100/ 2.5"											
55	T100/1"	55	BORING TERMINATED AT 55 FEET									

REMARKS:

TUBE SAMPLE	AUGER SAMPLE	SPLIT-SPOON	ROCK CORE	THD CONE PEN.	NO RECOVERY

FARGO

TERMS AND SYMBOLS USED ON BORING LOGS

Consistency of Fine-Grained Soils

Descriptive Term (Consistency)	Unconfined Compressive Strength (tsf)
VERY SOFT	Less than 0.25
SOFT	0.25 to 0.5
FIRM	0.5 to 1
STIFF	1 to 2
VERY STIFF	2 to 4
HARD	Greater than 4

Relative Density of Coarse-Grained Soils

Standard Penetration (Blows/Foot)	Descriptive Term (Relative Density)
0-4	Very Loose
4-10	Loose
10-30	Medium
30-50	Dense
Over 50	Very Dense

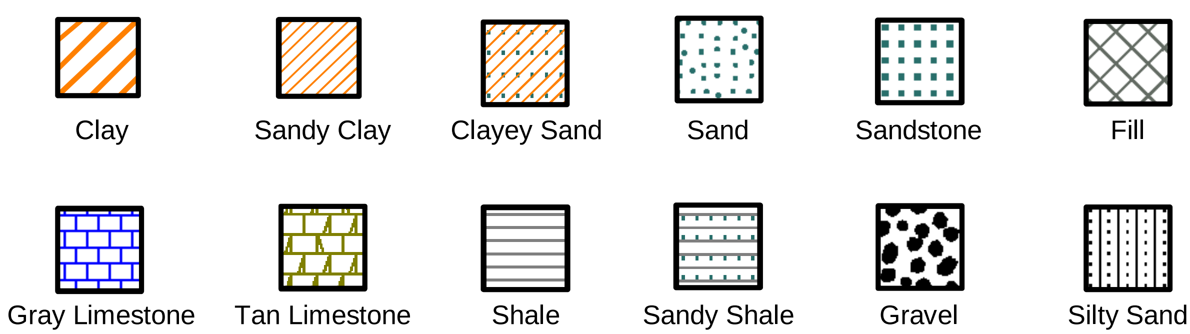
Grain Size Terminology

Major Component of Sample	Particle Size
BOULDERS:	12 in. diameter or larger
COBBLES:	3 in. to 12 in. diameter
GRAVEL:	Coarse 0.75 in. to 3 in.
	Fine 0.2 in. to 0.75 in.
SAND:	Coarse 2 mm to 4.75 mm
	Medium 0.4 mm to 2 mm
	Fine 0.07 mm to 0.4 mm
SILT:	0.002 mm to 0.07 mm
CLAY:	0.002 mm or smaller

Relative Proportion of Fines

Descriptive Term	Percent by Dry Weight
TRACE	1-10
LITTLE	11-20
SOME	21-35
AND	36-50

Soil and Rock Symbols



REFERENCES:
ASTM D 2487
Peck, Hanson, and Thornburn, (1974), Foundation Engineering

APPENDIX

FIELD EXPLORATION

A total of 8 sample borings were advanced in the subject study area to the depths shown on the Log of Borings (Plates 1 through 8), in the report Illustrations. Borings were advanced at approximate locations shown on the Location Plan (Plate A-1).

A hand-held GPS along with general landmarks, which could be identified in the field and as shown on the provided site plan was used to mark the borings. Therefore, the boring locations shown on Plate A-1 should be considered accurate only to the degree implied by the methods used to mark their locations. Surveying services to determine coordinates and surface elevations of the borings were beyond the scope of this study.

Because of difficulties in accessing the locations of Borings B-5 and B-6 with the drilling equipment, some adjustments to the locations of the referenced borings were made in the field to provide access.

Borings were advanced between sampling intervals using continuous flight augers. The following sampling and field testing were performed during field operation.

- Shelby tube sampler (ASTM D-1587).
- Split-spoon sampler/Standard Penetration Test (ASTM D 1586).
- TxDOT Cone Penetration Test.

One representative portion of each sample was sealed in a plastic bag and transported to our laboratory in waxed core boxes for further visual examination and testing. Water observations were made during and at the completion of field operations. Boreholes were backfilled with on-site soils at the completion of field operations.

A record of field observations was maintained in the form of field logs by the drill crew visually describing the subsurface materials encountered, interpretation of the subsurface materials transition, and other pertinent field data. Subsurface conditions encountered at each of the boring locations and boring depths are shown on Log of Borings. Material's descriptions presented on the logs are based on evaluation of the laboratory test results, visual examination of the samples in our laboratory, and data and information obtained in the field. Descriptions of terms and symbols used on the logs are presented on Plate B after the Log of Borings.

LABORATORY TESTING

Samples obtained from the borings were visually examined in the laboratory by a geotechnical engineer and tests were assigned on selected samples. Tests presented below, were performed by laboratory technicians under the direction of the engineer, in general accordance with the applicable ASTM procedures.

- Hand Penetrometer Resistance
- Moisture Content
- Liquid and Plastic Limits
- Dry Unit Weight
- Unconfined Compressive Strength
- Absorption Swell
- Percent Passing a No. 200 sieve

Absorption swell test was performed on selected samples of cohesive soils to further evaluate volume change potential at in-situ soil moisture levels. The results of routine laboratory tests are presented on the individual Log of Borings. The results of absorption swell test are presented below:

Boring No.	Sample Depth (feet)	Initial Moisture (%)	Final Moisture (%)	Swell (%)
B-1	4-6	15	17	0
B-2	4-6	14	16	0
B-7	4-6	12	15	0.1
B-8	2-4	11	14	0.1