GEOTECHNICAL EXPLORATION

MULTI-FAMILY APARTMENTS
Off Belknap Street
Fort Worth, Texas
ALPHA Report No. W212888-rev1
January 27, 2022

Prepared for:

JGR ARCHITECTS
730 N. Ninth Street
Salina, KS 67401
Attention: Mr. Chris Gillam

Prepared By:

ALPHA TESTING

WHERE IT ALL BEGINS

ALPHA TESTING
WHERE IT ALL BEGINS

Geotechnical
Construction Materials
Environmental
TBPE Firm No. 813

5058 Brush Creek Road
Fort Worth, Texas 76119

Tel: 817-496-5600
Fax: 817-496-5608
www.alphatesting.com

January 27, 2022

JGR Architects
730 N. Ninth Street
Salina, KS 67401

Attention: Mr. Chris Gillam

Re: Geotechnical Exploration
Multi-Family Apartments
Off Belknap Street
Fort Worth, Texas
ALPHA Report No. W212888-rev1

Attached is the report of the geotechnical exploration performed for the project referenced above. This study was authorized by Mr. Chris Gillam on September 21, 2021 and performed in accordance with ALPHA Proposal No. 86387-rev1, dated September 21, 2021.

The purpose of this revision is to provide shallow footing recommendations per the Client's request.

This report contains results of field explorations and laboratory testing and an engineering interpretation of these with respect to available project characteristics. The results and analyses were used to develop recommendations to aid design and construction of foundations and pavement.

ALPHA TESTING, LLC appreciates the opportunity to be of service on this project. If we can be of further assistance, such as providing the final geotechnical exploration, please contact our office.

Sincerely,

ALPHA TESTING, LLC

STATE OF TEXAS
GREGORY S. FAGAN
116518
LICENSED
PROFESSIONAL ENGINEER

January 27, 2022

Antonio Franco, EIT
Geotechnical Project Manager

Gregory Fagan, P.E.
Geotechnical Sr. Project Engineer

AF/GSF-BJH/af
Copies: (1-PDF) Client

TABLE OF CONTENTS

ALPHA REPORT NO. W212888-REV1

1.0 PURPOSE AND SCOPE

The purpose of this geotechnical exploration is for ALPHA TESTING, LLC (ALPHA) to evaluate for JGR Architects (Client) some of the physical and engineering properties of subsurface materials at selected locations on the subject site with respect to formulation of appropriate geotechnical design parameters for the proposed construction. The field exploration was accomplished by securing subsurface samples from widely spaced test borings performed across the expanse of the site. Engineering analyses were performed from results of the field exploration and results of laboratory tests performed on representative samples.

Also included are general comments pertaining to reasonably anticipated construction problems and recommendations concerning earthwork and quality control testing during construction. This information can be used to evaluate subsurface conditions and to aid in ascertaining construction meets project specifications.

Recommendations provided in this report were developed from information obtained in test borings depicting subsurface conditions only at the specific boring locations and at the particular time designated on the logs. Subsurface conditions at other locations may differ from those observed at the boring locations, and subsurface conditions at boring locations may vary at different times of the year. The scope of work may not fully define the variability of subsurface materials and conditions that are present on the site.

The nature and extent of variations between borings may not become evident until construction. If significant variations then appear evident, our office should be contacted to re-evaluate our recommendations after performing on-site observations and possibly other tests.

2.0 PROJECT CHARACTERISTICS

It is proposed to construct a four-story apartment building on a site located on the southside of the intersection of U.S. Highway 377 and Oakhurst Scenic Drive in Fort Worth, Texas. A site plan illustrating the general outline of the property is provided as Figure 1, the Boring Location Plan, in the Appendix.

At the time the field exploration was performed, the site generally consisted of a developed tract of land with multiple buildings, distressed asphalt parking lots, and gravel parking lots. A slope is present at the western property line near the Trinity River. The existing buildings are located within the proposed footprint of the new structure. No information regarding previous development on the site was provided to us.

Grading plans prepared by MMA (Project Number 3402-00-02, Sheet C5.0 dated November 17, 2021) indicate the ground surface generally slopes down towards the southwest about 8 ft (Approximate Elevation 543 ft to 535 ft) and the structure is planned to have a finished floor elevation (FFE) of 539 ft.

We understand the building will be designed for about 1 inch of post-construction seasonal movement. No below grade slabs are planned. Pavement for the project will consist of portland cement concrete (PCC). The referenced grading plans indicate cuts of 1 ft and fills of 3 ft are required to achieve final grade within the building pad area will be required. Slope stability analysis of embankments (natural or constructed) was not within the scope of this study.

3.0 FIELD EXPLORATION

Subsurface conditions on the site were explored by drilling a total of seven (7) test borings. Four (4) borings were drilled to a depth of about 20 ft (Borings 1 through 4) for the building and three (3) borings were drilled to a depth of about 5 ft (Borings 5, 6 and 7) for the pavement. The test borings were drilled in general accordance with ASTM Standard D 420 using standard rotary drilling equipment. The approximate location of each test boring is shown on the Boring Location Plan, Figure 1, enclosed in the Appendix. Details of drilling and sampling operations are briefly summarized in Methods of Field Exploration, Section A-1 of the Appendix.

Subsurface types encountered during the field exploration are presented on Log of Boring sheets (boring logs) included in the Appendix. The boring logs contain our Field Technician's and Engineer's interpretation of conditions believed to exist between actual samples retrieved. Therefore, these boring logs contain both factual and interpretive information. Lines delineating subsurface strata on the boring logs are approximate and the actual transition between strata may be gradual.

4.0 LABORATORY TESTS

Selected samples of the subsurface materials were tested in the laboratory to evaluate their engineering properties as a basis in providing information for foundation design and earthwork construction. A brief description of testing procedures used in the laboratory can be found in Methods of Laboratory Testing, Section B-1 of the Appendix. Individual test results are presented on the Log of Boring sheets in the Appendix.

5.0 GENERAL SUBSURFACE CONDITIONS

Based on geological atlas maps available from the Bureau of Economic Geology, published by the University of Texas at Austin, the project site lies within the Terrace deposits overlying the Pawpaw, Weno Limestone, and Denton Clay formations, mapped as undivided. Terrace Deposits generally consist of clays, sands, and gravels. The clay soils associated with the Terrace Deposits are generally characterized with low to high shrink-swell potential. The undivided Pawpaw, Weno Limestone, and Denton Clay formation generally consist of limestone with alternating layers of marl (limey shale). Residual overburden soils associated with this formation generally consist of clay soils with low to high shrink/swell characteristics.

Subsurface conditions encountered in building borings (Borings 1and 2) consisted of silty, clayey sand, sand, and clayey sand to a depth of about 6 ft to 7 ft underlain by limestone extending to the 20 ft termination depth. Subsurface conditions encountered in building borings (Borings 3 and 4) consisted of sand, and clayey sand to extending to the 20 ft termination depth. Subsurface conditions encountered in the pavement borings (Borings 5 through 7) generally consisted of clayey sand extending to the 5 ft termination depths of the borings. The upper 2 ft to 4 ft of silty, clayey sand and sand encountered in the borings were visually classified as fill. About 3 to 4 inches of asphalt were encountered at the surface in Borings 1 through 5. About 2 feet of base material was encountered at the surface in Borings 6 and 7. Additional stratigraphic information is presented on the attached Log of Boring sheets.

The granular materials (silty, clayey sand, clayey sand, and sand) encountered in the borings are considered relatively permeable and are anticipated to have a relatively rapid response to water movement. However, the limestone are considered relatively impermeable and are anticipated to have a relatively slow response to water movement. Therefore, several days of observation would be required to evaluate actual groundwater levels within the depths explored. Also, the groundwater level at the site is anticipated to fluctuate seasonally depending on the amount of rainfall, prevailing weather conditions and subsurface drainage characteristics.

Free groundwater was encountered on drilling tools during drilling in Borings 2 at a depth of about 7 ft. Groundwater was observed in the open borehole immediately upon completion of drilling at depths of about 6 ft. No free groundwater was encountered in the remaining borings. However, it is common to encounter seasonal groundwater in granular soils, at the soil/rock (limestone) interface, or from fractures in the rock, particularly during or after periods of precipitation. If more detailed groundwater information is required, monitoring wells or piezometers can be installed.

Additional information concerning subsurface materials and conditions encountered can be obtained from the Log of Boring sheets in the Appendix.

6.0 DESIGN RECOMMENDATIONS

The following design recommendations were developed on the basis of the previously described Project Characteristics (Section 2.0) and General Subsurface Conditions (Section 5.0). If project criteria should change, our office should conduct a review to determine if modifications to the recommendations are required. Further, it is recommended our office be provided with a copy of the final plans and specifications for review prior to construction.

The following design criteria were developed based on our understanding that cuts of 1 ft and fills of 3 ft will be required to achieve final grade in the building pad area. Cutting or filling on the site more than 3 ft can alter the recommended foundation design parameters. Therefore, it is recommended our office be contacted before performing other cutting and filling on site to verify appropriate design parameters are utilized for final foundation design.

6.1 Demolition and Existing Fill

As discussed in Section 5.0, existing fill materials were encountered to a depth of about 4 ft below the existing ground surface in the borings. It is not known if this fill was placed under engineering supervision with compaction records. If compaction records for this fill cannot be obtained, the existing fill should be considered as uncontrolled fill. Uncontrolled fill is generally not considered suitable for support of foundations due to the risk of under-compacted zones resulting in failures of weak soil and/or indeterminate levels of settlement. Any existing uncontrolled fill should be removed from the building pad area and replaced with engineered fill as recommended in Section 7.3. Onsite soils with plasticity index of 15 or less can be used as discussed in Section 7.3. The excavated materials may be suitable for reuse as engineered fill provided they are free of organics, boulders, rubble, and other debris.

The lateral extent, depth and nature of the existing fill are not known. Test pits could be performed prior to construction to verify the presence, lateral extent, depth, and nature of the existing fill materials. ALPHA would be pleased to provide this service if desired.

As discussed in Section 2.0, it appears structures may have been or will be demolished on the site. Any soil disturbed due to removal of structures or foundations should be re-compacted in accordance with recommendations provided in Section 7.3. All foundation elements of the existing structures should be removed or cut off at least 1 ft below finished grade or 1 ft below the new structural elements, whichever is deeper. All abandoned utility lines should be either removed or positively sealed to prevent possible water seepage into subgrade soils.

6.2 Slab-on-Grade Foundation

Our findings indicate slab foundations constructed at final grades indicated on the referenced grading plans could experience soil-related potential movements of about 1 inch due to shrinking and swelling of active clayey soils. This estimate of potential movements is based on the assumption that any fill used to raise the grade consists of onsite or similar soils with a plasticity index of 15 or less. Use of fill material with a plasticity index higher than 15 can result in potential movements exceeding our estimates. Slab foundations supported on uncontrolled fill are also subject to indeterminate levels of settlement. Any existing fill should be removed and replaced as discussed in Section 6.1. Onsite soils with plasticity index of 15 or less can be used as discussed in Section 7.3.

Potential seasonal movements were estimated using results of absorption swell tests, in general accordance with methods outlined by the Texas Department of Transportation (TxDOT) Test Method Tex-124-E and engineering judgment and experience. Estimated movements were calculated assuming the moisture content of the in-situ soil within the normal zone of seasonal moisture content change varies between a "dry" condition and a "wet" condition as defined by Tex-124-E. Also, it was assumed a 1 psi surcharge load from the floor slab acts on the subgrade soils. Movements exceeding our estimates could occur if positive drainage of surface water is not maintained or if soils are subject to an outside water source, such as leakage from a utility line or subsurface moisture migration from off-site locations.

The slab foundations should be designed with exterior and interior grade beams adequate to provide sufficient rigidity to the foundation systems. A net allowable soil bearing pressure of 2.0 kips per sq ft may be used for design of grade beams bearing on undisturbed cuts in onsite soils or on fill material placed as recommended in Section 7.3. Grade beams should bear a minimum depth of 18 inches below final grade and should have a minimum width of 10 inches for bearing capacity considerations.

To reduce cracking as normal movements, occur in foundation soils, all grade beams and the floor slab should be adequately reinforced with steel (conventional reinforcing steel and/or post-tension reinforcement). It is common to experience some minor cosmetic distress to structures with slab-on-grade foundation systems due to normal ground movements. A properly designed and constructed moisture barrier should be placed between the slab and subgrade soils to retard moisture migration throughout the slab.

6.2.1 Post-Tensioned Slabs-on-Grade Design Criteria

Table A contains information for design of the post-tensioned, slab-on-grade foundations. Design parameters provided below were evaluated based on the conditions encountered in the boring and using information and correlations published by PTI Third Edition and VOLFLO 1.5 computer program provided by Geostructural Tool Kit, Inc. (GTI).

TABLE A Post-Tensioned Slab-on-Ground Design Criteria Potential Seasonal Movement = 1 inch		
	EDGE LIFT	**CENTER LIFT**
Edge Moisture Distance, ft (e_m)	4.3	9.0
Differential Soil Movement, inches (y_m)	1.2 (swell)	1.0 (shrink)

6.2.2 Wire Reinforcement Institute Design Criteria

The foundation could be designed using the Design of Slab-On-Ground Foundations published by the Wire Reinforcement Institute, Inc. (Aug., 1981). WRI parameters are provided in Table B.

TABLE B WRI Design Criteria: Potential Seasonal Movement = 1 inch	
Design Method	**WRI**
Climatic Rating (Cw)	18
Effective Plasticity Index	15
Soil Compressive Strength (tsf)	0.5

6.3 Spread Footings (Alternative)

Our findings indicate the proposed structures could be supported on spread footings. Spread footings are subject to potential movements of about 1 inch. Exterior footings should extend at least 2 ft below final grade. Interior footings should bear at a nominal depth below the floor slab. Any existing uncontrolled fill should be removed and replaced as discussed in Section 6.1. Onsite soils with plasticity index of 15 or less can be used as discussed in Section 7.3.

Spread footings bearing on undisturbed cuts in native soil or on fill placed and compacted as recommended in Section 7.3 can be designed using a net allowable bearing pressure of 2.0 kips per sq ft. Continuous footings should have a least dimension of 18 inches in width and spot footings should have a least dimension of 24 inches for bearing capacity considerations.

Careful monitoring during construction is necessary to locate any pockets or seams of unsuitable materials or clay layers which might be encountered in excavations for footings. Unsuitable materials encountered at the foundation bearing level should be removed and replaced with lean concrete (at least 200 psi strength at 28 days) or structural concrete.

Resistance to sliding will be developed by friction along the base of the footings and passive earth pressure acting on the vertical face of the footing and a (possible) key installed in the base of the footings, if required. We recommend a coefficient of base friction of 0.30 be used along the bottom of the footing. The available passive earth resistance on the vertical face of the foundation and a (possible) key constructed in the base of the footing may be calculated using a uniform allowable passive earth pressure of 500 psf for footings bearing against vertical cuts in native clay soils or against fill material placed as recommended in Section 7.3. The passive resistance along the vertical face of the footing should be neglected within 2 ft of the final site grade.

To reduce the risk of differential movement of footings, all footings should bear on limestone or all footings should bear on soil. It may be required to over-excavate limestone from some areas to provide a minimum 6 inch soil cushion below all footings.

6.4 Exterior Flatwork

Exterior flatwork supported within 8 ft of existing grade is subject to potential seasonal movements of up to about 1 inch as described in Section 6.2. If this level of movement is not acceptable, our office should be contacted. Flatwork supported on uncontrolled fill is also subject to indeterminate levels of settlement. If indeterminate settlement of flatwork or pavement is not acceptable, uncontrolled fill can be removed and replaced as discussed in Section 6.1.

6.5 Pavement

To permit correlation between information from test borings and actual subgrade conditions exposed during construction, a qualified Geotechnical Engineer should be retained to provide subgrade monitoring and testing during construction. If there is any change in project criteria, the recommendations contained in this report should be reviewed by our office.

Calculations used to determine the required pavement recommendations are based only on the physical and engineering properties of the materials used and conventional thickness determination procedures. Pavement joining buildings should be constructed with a curb and the joint between the building and curb should be sealed. Related civil design factors such as subgrade drainage, shoulder support, cross-sectional configurations, surface elevations, reinforcing steel, joint design and environmental factors will significantly affect the service life and must be included in preparation of the construction drawings and specifications, but all were not included in the scope of this study. Normal periodic maintenance will be required for all pavement to achieve the design life of the pavement system.

Please note, the recommended pavement sections provided below are considered the minimum necessary to provide satisfactory performance based on the expected traffic loading. In some cases, City minimum standards for pavement section construction may exceed those provided below.

6.5.1 Pavement Subgrade Improvement

Based on the soil profile encountered in the borings, we would expect the pavement subgrade could consist of sandy material or clayey material depending on where the pavement is located. In general, clayey soils with a plasticity index of 15 or greater should be lime stabilized. Clayey sands and clay soils with a plasticity index less than 15 should be cement modified. As an alternative, Cem-Lime™ could be used to improve either clayey or sandy soils. Provided below are subgrade improvement recommendations for lime, cement and Cem-Lime™

In areas where moderate to high plasticity clay soils (plasticity index of 15 or greater) are exposed after final subgrade elevation is achieved, the exposed surface of the pavement subgrade soil should be scarified to a depth of 6 inches and mixed with a minimum 6 percent hydrated lime (by dry soil weight) in conformance with TxDOT Standard

Specification Item 260. Assuming an in-place unit weight of 100 pcf for the pavement subgrade soils, this percentage of lime equates to about 27 lbs of lime per sq yard of treated subgrade. The actual amount of lime required should be confirmed by additional laboratory tests (ASTM C 977 Appendix XI) prior to construction. The soil-lime mixture should be compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of 0 to 4 percentage points above the mixture's optimum moisture content. In all areas where hydrated lime is used to stabilize subgrade soil, routine Atterberg-limit tests should be performed to verify the resulting plasticity index of the soil-lime mixture is at/or below 15.

Based on our borings, we expect the pavement subgrade to consist of sandy material. The exposed surface of the pavement subgrade soil should be scarified to a depth of 6 inches and mixed with a minimum 5 percent portland cement (by dry soil weight) in conformance with TxDOT Standard Specification Item 275. Assuming an in-place unit weight of 105 pcf for the pavement subgrade soils, this percentage of cement equates to about 24 lbs of cement per sq yard of treated subgrade. The soil-cement mixture should be compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of -1 to +3 percentage points above the mixture's optimum moisture content. Cement stabilization could also be utilized where subgrade consists of clay and sandy clay soils.

Cem-Lime™ is designed to serve the same purpose as both lime and cement for soil stabilization or modification in highly variable subgrade conditions similar to those encountered at the referenced project site. Cem-Lime™ is a proprietary product manufactured by Martin Marietta. Cem-Lime™ should be placed according to the manufacturer's specifications. After final subgrade elevation is achieved, the exposed surface of the pavement subgrade soils should be scarified to a depth of at least 6 inches and mixed with Cem-Lime™. For preliminary purposes, a minimum 5 percent (by dry soil unit weight) of Cem-Lime™ should be used. Unconfined compressive strength tests should be performed on laboratory molded specimens of representative onsite material mixed with Cem-Lime™ to evaluate the actual percent of required Cem-Lime™.

Subgrade improvement could also consist of a minimum 6-inch layer of flexible base material. Flexible base used for pavement subgrade should consist of material meeting the requirements of TxDOT Standard Specifications Item 247, Type A, Grade 1-2. The flexible base should be compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of 2 percentage points below to 2 percentage points above the material's optimum moisture content.

We recommend subgrade improvement procedures extend at least 1 ft beyond the edge of the pavement to reduce effects of seasonal shrinking and swelling upon the extreme edges of pavement.

Improvement of the pavement subgrade soil will not prevent normal seasonal movement of the underlying untreated materials. Pavement and other flatwork will have the same potential for movement as slabs constructed directly on the existing undisturbed soils. Good perimeter surface drainage with a minimum slope of 2 percent away from the pavement is recommended. The use of sand as a leveling course below pavement supported on expansive clays should be avoided. Normal maintenance of pavement should

be expected over the life of the structures.

6.5.2 PCC Pavement Section

Following subgrade improvement recommended in Section 6.4.1, PCC (reinforced) pavement sections are recommended in Table C.

TABLE C Recommended PCC Pavement Sections		
Paving Areas and/or Type	**Subgrade Thickness, Inches**	**PCC Thickness, Inches**
Parking Areas Subjected Exclusively to Passenger Vehicle Traffic	Scarified and Compacted (native), 6	5
Drive Lanes, Fire Lanes, Areas Subject to Light Volume Truck Traffic	See Section 6.4.1, 6	6
Dumpster Traffic Areas, Areas subject to Moderate Volume Truck Traffic	See Section 6.4.1, 6	7

Portland-cement concrete should have a minimum compressive strength of 3,000 lbs per sq inch (psi) at 28 days in light-duty traffic areas and 3,500 psi in drive lanes and truck traffic areas. Concrete should be designed with 4.5 +/- 1.5 percent entrained air. Joints in concrete paving should not exceed 15 ft. Reinforcing steel should consist of No. 3 bars placed at 18 inches on-center in two directions.

Improvement of the pavement subgrade is recommended for drive lanes, fire lanes, and pavement subject to truck traffic. Improvement of the pavement subgrade is not necessary for pavements subjected exclusively to passenger vehicle traffic, although improvement in these areas would be generally beneficial to the long-term performance of the pavement. Cement treatment of the subgrade is described in Section 6.4.1.

Alternately, improvement of the pavement subgrade could be eliminated by increasing the corresponding PCC thickness presented in the pavement sections in Table C by 1 inch. Prior to construction of pavement on unimproved subgrade soil, the exposed subgrade should be scarified to a depth of at least 6 inches and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of -1 to +3 percentage points above the material's optimum moisture content.

6.6 Drainage and Other Considerations

Adequate drainage should be provided to reduce seasonal variations in the moisture content of foundation soils. All pavement and sidewalks within 10 ft of the buildings should be sloped away from the structure to prevent ponding of water around the foundation. Final grades within 10 ft of the structure should be adjusted to slope away from the structure at a minimum slope of 2 percent. **Maintaining positive surface drainage throughout the life of the structures is essential.**

In areas with pavement or sidewalks adjacent to the new structure, a positive seal must be maintained between the structures and the pavement or sidewalk to minimize seepage of water

into the underlying supporting soils. Post-construction movement of pavement and flat-work is common. Normal maintenance should include inspection of all joints in paving and sidewalks, etc. as well as resealing where necessary.

Several factors relate to civil and architectural design and/or maintenance, which can significantly affect future movements of the foundation and floor slab systems:

- Preferably, a complete system of gutters and downspouts should carry runoff water a minimum of 5 feet from the completed structure.

- Large trees and shrubs should not be allowed closer to the foundation than a horizontal distance equal to roughly one-half of their mature height due to their significant moisture demand upon maturing.

- Moisture conditions should be maintained "constant" around the edge of the slab. Ponding of water in planters, in unpaved areas, and around joints in paving and sidewalks can cause slab movements beyond those predicted in this report.

- Planter box structures placed adjacent to the buildings should be provided with a means to assure concentrations of water are not available to the subsoil stratigraphy.

Trench backfill for utilities should be properly placed and compacted as outlined in Section 7.4 and in accordance with requirements of local City standards. Since granular bedding backfill is used for most utility lines, the backfilled trench should not become a conduit and allow access for surface or subsurface water to travel toward the new structures. Concrete cut-off collars or clay plugs should be provided where utility lines cross building lines to prevent water from traveling in the trench backfill and entering beneath the structures.

7.0 GENERAL CONSTRUCTION PROCEDURES AND GUIDELINES

Variations in subsurface conditions could be encountered during construction. To permit correlation between test boring data and actual subsurface conditions encountered during construction, it is recommended a registered Professional Engineering firm be retained to observe construction procedures and materials.

Some construction problems, particularly degree or magnitude, cannot be anticipated until the course of construction. The recommendations offered in the following paragraphs are intended not to limit or preclude other conceivable solutions, but rather to provide our observations based on our experience and understanding of the project characteristics and subsurface conditions encountered in the borings.

7.1 Site Preparation and Grading

Existing fill was encountered in borings to a depth of 2 ft to 4 ft at the site. Existing fill can also contain organics, boulders, rubble, and other debris which could be encountered during site grading and general excavation. The earthwork and excavation contracts should contain provision for removal of unsuitable materials in the existing fill. Test pit excavations performed prior to

construction can be used to evaluate the depth, extent, and composition of existing fill at this site. ALPHA would be pleased to provide this service if desired.

All areas supporting slab foundations, floor slabs, pavement, flatwork, or areas to receive new fill should be properly prepared.

- After completion of the necessary stripping, clearing, and excavating and prior to placing any required fill, the exposed soil subgrade should be carefully evaluated by probing and testing. Any undesirable material (organic material, wet, soft, or loose soil) still in place should be removed.

- The exposed soil subgrade should be further evaluated by proof-rolling with a heavy pneumatic tired roller, loaded dump truck or similar equipment weighing approximately 20 tons to check for pockets of soft or loose material hidden beneath a thin crust of possibly better soil.

- Proof-rolling procedures should be observed routinely by a Professional Engineer, or his designated representative. Any undesirable material (organic material, wet, soft, or loose soil) exposed during the proof-roll should be removed and replaced with well-compacted material as outlined in Section 7.3.

- Prior to placement of any fill, the exposed soil subgrade should then be scarified to a minimum depth of 6 inches and recompacted as outlined in Section 7.3.

If fill is to be placed on existing slopes (natural or constructed) steeper than six horizontal to one vertical (6:1), the fill materials should be benched into the existing slopes in such a manner as to provide a minimum bench-key width of five (5) ft. This should provide a good contact between the existing soils and new fill materials, reduce potential sliding planes, and allow relatively horizontal lift placements.

Even if fill is properly compacted as recommended in Section 7.3, fills in excess of about 10 ft are still subject to settlements over time of up to about 1 to 2 percent of the total fill thickness. This should be considered when planning or placing deep fills.

Slope stability analysis of embankments (natural or constructed) and global stability analysis for retaining walls was not within the scope of this study.

The contractor is responsible for designing any excavation slopes, temporary sheeting or shoring. Design of these structures should include any imposed surface surcharges. Construction site safety is the sole responsibility of the contractor, who shall also be solely responsible for the means, methods and sequencing of construction operations. The contractor should also be aware that slope height, slope inclination or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state and/or federal safety regulations, such as OSHA Health and Safety Standard for Excavations, 29 CFR Part 1926, or successor regulations. Stockpiles should be placed well away from the edge of the excavation and their heights should be controlled so they do not surcharge the sides of the excavation. Surface drainage should be carefully controlled to prevent flow of water over the slopes and/or into the excavations. Construction slopes should be closely observed for signs of mass movement, including tension

cracks near the crest or bulging at the toe. If potential stability problems are observed, a geotechnical engineer should be contacted immediately. Shoring, bracing or underpinning required for the project (if any) should be designed by a professional engineer registered in the State of Texas.

Due to the nature of the clayey and sandy soils found near the surface at the borings, traffic of heavy equipment (including heavy compaction equipment) may create pumping and general deterioration of shallow soils. Therefore, some construction difficulties should be anticipated during periods when these soils are saturated.

7.2 Foundation Excavations

All foundation excavations should be properly monitored to verify loose, soft, or otherwise undesirable materials are removed and foundations will bear on satisfactory material. Surface runoff should be drained away from excavations and not allowed to pond in the bottom of the excavation. The exposed foundation soils should not be allowed to become excessively dry or wet before placement of concrete. All concrete for foundations should be placed as soon as practical after the excavation is made.

The granular soils encountered near the surface in our study are prone to caving. Forming of the foundation will be required if neat excavations cannot be maintained.

Prolonged exposure of the bearing surface to air or water will result in changes in strength and compressibility of the bearing stratum. Therefore, if delays occur, excavations should be slightly deepened and cleaned, in order to provide a fresh bearing surface.

7.3 Fill Compaction

The following recommendations pertain to fill soils placed for general site grading. *Fill material placed in the building pad should consist of onsite or similar soil with plasticity index of 15 or less.*

Clayey and sandy soils with a plasticity index below 25 should be compacted to a dry density of at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of 1 percentage point below to 3 percentage points above the material's optimum moisture content. Clayey fill should be process and the largest particle or clod should be less than 6 inches prior to compaction.

Non-plastic granular materials (sand) should be compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698) and within the range of 2 percent below to 1 percentage points above the material's optimum moisture content. Compaction of these soils is very sensitive to moisture content and these soils are prone to pumping when too wet and rutting when too dry.

Where mass fills are deeper than 10 ft, the fill/backfill below 10 ft should be compacted to at least 100 percent of standard Proctor maximum dry density (ASTM D 698) and within – 2 to +2 percentage points of the material's optimum moisture content. The portion of the fill/backfill shallower than 10 ft should be compacted as outlined herein.

Compaction should be accomplished by placing fill in about 8-inch-thick loose lifts and compacting each lift to at least the specified minimum dry density. Field density and moisture content tests should be performed on each lift.

7.4 Utilities

Where utility lines are deeper than 10 ft, the fill/backfill below 10 ft should be compacted to at least 100 percent of standard Proctor maximum dry density (ASTM D 698) and within –2 to +2 percentage points of the material's optimum moisture content. The portion of the fill/backfill shallower than 10 ft should be compacted as previously outlined. Density tests should be performed on each lift (maximum 12-inch thick) and should be performed as the trench is being backfilled.

Even if fill is properly compacted, fills in excess of about 10 ft are still subject to settlements over time of up to about 1 to 2 percent of the total fill thickness. This should be considered when designing pavement over utility lines and/or other areas with deep fill.

If utility trenches or other excavations extend to or beyond a depth of 5 ft below construction grade, the contractor or others shall be required to develop an excavation safety plan to protect personnel entering the excavation or excavation vicinity. The collection of specific geotechnical data and the development of such a plan, which could include designs for sloping and benching or various types of temporary shoring, is beyond the scope of this study. Any such designs and safety plans shall be developed in accordance with current OSHA guidelines and other applicable industry standards.

7.5 Groundwater

Groundwater was encountered on drilling tools during drilling in Borings 2 at a depth of about 7 ft. Groundwater was observed in the open borehole immediately upon completion of drilling at a depth of about 6 ft. However, from our experience, shallower groundwater could be encountered during general excavation and grading at this site. The risk of encountering seepage is increased during or after periods of precipitation. Standard sump pit and pumping procedures should be adequate to control seepage on a local basis for relatively shallow excavations.

Where groundwater is encountered in granular soils, sump pits may not be adequate to control seepage and supplemental dewatering measures may be necessary to control groundwater seepage. Supplemental dewatering measures include (but are not limited to) submersible pumps in slotted casings and well points.

In any areas where cuts are made, attention should be given to possible seasonal water seepage that could occur through natural cracks and fissures in the newly exposed stratigraphy. In these areas, subsurface drains may be required to intercept seasonal groundwater seepage. The need for these or other de-watering devices should be carefully addressed during construction. Our office could be contacted to visually observe the final grades to evaluate the need for such drains.

8.0 LIMITATIONS

Professional services provided in this geotechnical exploration were performed, findings obtained, and recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. The scope of services provided herein does not include an environmental assessment of the site or investigation for the presence or absence of hazardous materials in the soil, surface water or groundwater. ALPHA, upon written request, can be retained to provide these services.

ALPHA is not responsible for conclusions, opinions or recommendations made by others based on this data. Information contained in this report is intended for the exclusive use of the Client (and their designated design representatives), and is related solely to design of the specific structures outlined in Section 2.0. No party other than the Client (and their designated design representatives) shall use or rely upon this report in any manner whatsoever unless such party shall have obtained ALPHA's written acceptance of such intended use. Any such third party using this report after obtaining ALPHA's written acceptance shall be bound by the limitations and limitations of liability contained herein, including ALPHA's liability being limited to the fee paid to it for this report. Recommendations presented in this report should not be used for design of any other structures except those specifically described in this report. In all areas of this report in which ALPHA may provide additional services if requested to do so in writing, it is presumed that such requests have not been made if not evidenced by a written document accepted by ALPHA. Further, subsurface conditions can change with passage of time. Recommendations contained herein are not considered applicable for an extended period of time after the completion date of this report. It is recommended our office be contacted for a review of the contents of this report for construction commencing more than one (1) year after completion of this report. Non-compliance with any of these requirements by the Client or anyone else shall release ALPHA from any liability resulting from the use of, or reliance upon, this report.

Recommendations provided in this report are based on our understanding of information provided by the Client about characteristics of the project. If the Client notes any deviation from the facts about project characteristics, our office should be contacted immediately since this may materially alter the recommendations. Further, ALPHA is not responsible for damages resulting from workmanship of designers or contractors. It is recommended the Owner retain qualified personnel, such as a Geotechnical Engineering firm, to verify construction is performed in accordance with plans and specifications.

APPENDIX

A-1 METHODS OF FIELD EXPLORATION

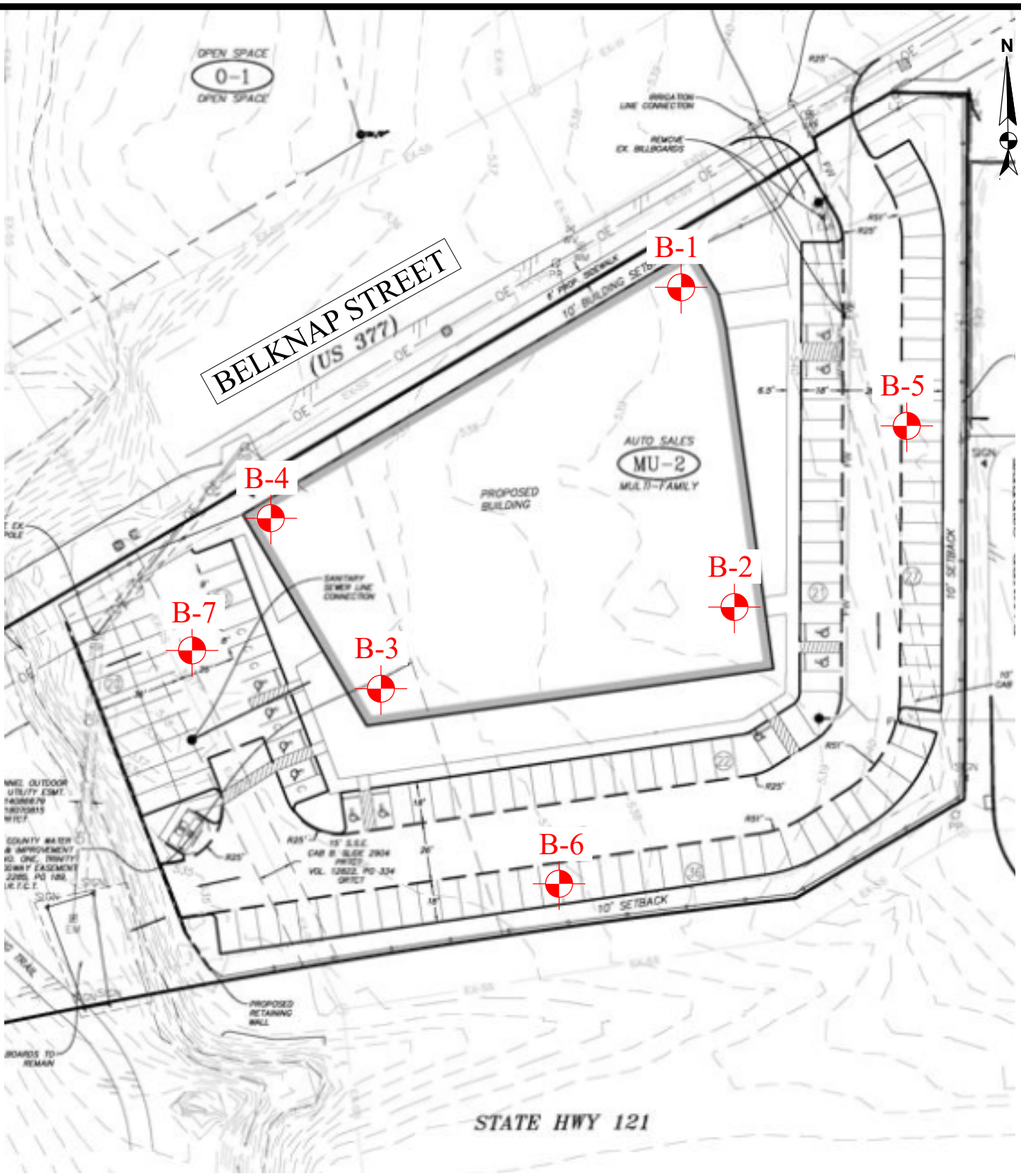
Using standard rotary drilling equipment, a total of seven (7) test borings were performed for this geotechnical exploration at the approximate locations shown on the Boring Location Plan, Figure 1. The boring locations were staked by using a handheld GPS device or by pacing/taping and estimating right angles from landmarks which could be identified in the field and as shown on the site plan provided during this study. The locations of the test borings shown on the Boring Location Plan are considered accurate only to the degree implied by the methods used to define them.

Disturbed soil samples were obtained using split-spoon sampling procedures in accordance with ASTM Standard D 1586. Disturbed samples were obtained at selected depths in the borings by driving a standard 2-inch O.D. split-spoon sampler 18 inches into the subsurface material using a 140-pound hammer falling 30 inches. The number of blows required to drive the split-spoon sampler the final 12 inches of penetration (N-value) is recorded in the appropriate column on the Log of Boring sheets.

Relatively undisturbed soil samples were obtained by hydraulically pressing 3-inch O.D. thin-wall sampling tubes into the underlying soils at selected depths (ASTM D 1587). These samples were removed from the sampling tubes in the field and evaluated visually. One representative portion of each sample was sealed in a plastic bag for use in future visual evaluation and possible testing in the laboratory.

Texas Cone Penetration (TCP) tests were completed in the field to determine the apparent in-place strength characteristics of the rock type materials. A 3-inch diameter steel cone driven by a 170-pound hammer dropped 24 inches is the basis for TxDOT strength correlations. Depending on the resistance (strength) of the materials, either the number of blows of the hammer required to provide 12 inches of penetration, or the inches of penetration of the cone due to 100 blows of the hammer are recorded on the field logs and are shown on the Log of Boring sheets as “TX Cone” (reference: TxDOT Test Method TEX 132-E, as modified).

The boring logs are included in this Appendix. The logs show visual descriptions of subsurface strata encountered in the borings using the Unified Soil Classification System. Sampling information, pertinent field data, and field observations are also included. Samples not consumed by testing will be retained in our laboratory for at least 14 days and then discarded unless the Client requests otherwise.



GEOTECHNICAL EXPLORATION
SWEETWATER STATION
OFF BELKNAP STREET
FORT WORTH, TEXAS
ALPHA PROJECT NO. W212888

ALPHA TESTING
WHERE IT ALL BEGINS

FIGURE 1

BORING LOCATION PLAN

APPROXIMATE BORING LOCATION

B-1 METHODS OF LABORATORY TESTING

Representative samples were evaluated and classified by a qualified member of the Geotechnical Division and the boring logs were edited as necessary. To aid in classifying the subsurface materials and to determine the general engineering characteristics, natural moisture content tests (ASTM D 2216), Atterberg-limit tests (ASTM D 4318), percent material passing the No. 200 sieve tests (ASTM D 1140) and dry unit weight determinations were performed on selected samples. In addition, unconfined compressive strength tests (ASTM D 2166) and pocket-penetrometer tests were conducted on selected soil samples to evaluate the soil shear strength. Results of these laboratory tests are provided on the Log of Boring sheets.

In addition to the Atterberg-limit tests, the expansive properties of the clay soils were further analyzed by absorption swell tests. The swell test is performed by placing a selected sample in a consolidation machine and applying either the approximate current or expected overburden pressure and then allowing the sample to absorb water. When the sample exhibits very little tendency for further expansion, the height increase is recorded and the percent free swell and total moisture gain calculated. Results of the absorption swell tests are provided on the attached boring logs.

ALPHA TESTING
WHERE IT ALL BEGINS

5058 Brush Creek Rd.
Fort Worth, Texas 76119
Phone: 817-496-5600
Fax: 817-496-5608
www.alphatesting.com

BORING NO.: 1
Sheet 1 of 1
PROJECT NO.: W212888

Client: JGR Architects
Project: Multi-Family Apartments
Start Date: 10/5/2021 **End Date:** 10/5/2021
Drilling Method: CONTINUOUS FLIGHT AUGER

Location: Fort Worth, Texas
Surface Elevation:
West:
North:
Hammer Drop (lbs / in): 170 / 24

GROUND WATER OBSERVATIONS
On Rods (ft): NONE
After Drilling (ft): DRY
After ____ Hours (ft): ____

Depth, feet	Graphic Log	MATERIAL DESCRIPTION		Sample Type	Recovery % RQD	TX Cone or Std. Pen. (blows/ft, in)	Pocket Penetrometer (tsf)	Unconfined Comp. Strength (tsf)	% Passing No. 200 Sieve	Unit Dry Weight (pcf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Swell, %
		3" ASPHALT	0.5												
		Brown SILTY CLAYEY SAND - FILL	2.0						19		8	16	10	6	
		Tan CLAYEY SAND with gravel					2.25				8				
5									27		10	21	12	9	
			7.0			66/ 9"					6				
		Tan LIMESTONE	9.0												
10		Gray LIMESTONE				100/ 1"					9				
15						100/ 1.75"									
20			20.0			100/ 0.75"									
		TEST BORING TERMINATED AT 20 FT													

ALPHA TESTING
WHERE IT ALL BEGINS

5058 Brush Creek Rd.
Fort Worth, Texas 76119
Phone: 817-496-5600
Fax: 817-496-5608
www.alphatesting.com

BORING NO.: 2
Sheet 1 of 1
PROJECT NO.: W212888

Client: JGR Architects
Project: Multi-Family Apartments
Start Date: 10/5/2021 **End Date:** 10/5/2021
Drilling Method: CONTINUOUS FLIGHT AUGER

Location: Fort Worth, Texas
Surface Elevation:
West:
North:
Hammer Drop (lbs / in): 170 / 24

GROUND WATER OBSERVATIONS
On Rods (ft): 7
After Drilling (ft): 6
After ____ Hours (ft): ____

Depth, feet	Graphic Log	MATERIAL DESCRIPTION		Sample Type	Recovery % RQD	TX Cone or Std. Pen. (blows/ft, in)	Pocket Penetrometer (tsf)	Unconfined Comp. Strength (tsf)	% Passing No. 200 Sieve	Unit Dry Weight (pcf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Swell, %
		3" ASPHALT	0.5												
		Reddish Brown SAND - FILL	2.0								6				
		Tan CLAYEY SAND							20		8	22	13	9	
5						39/ 12"					6				
			6.0												
		Tan LIMESTONE	8.0												
		Gray LIMESTONE													
10						100/ 0.50"					12				
15						100/ 2.75"									
20			20.0			100/ 1.25"									
		TEST BORING TERMINATED AT 20 FT													

ALPHA TESTING

WHERE IT ALL BEGINS

5058 Brush Creek Rd.
Fort Worth, Texas 76119
Phone: 817-496-5600
Fax: 817-496-5608
www.alphatesting.com

BORING NO.: 3

Sheet 1 of 1

PROJECT NO.: W212888

Client: JGR Architects
Project: Multi-Family Apartments
Start Date: 10/5/2021 **End Date:** 10/5/2021
Drilling Method: CONTINUOUS FLIGHT AUGER

Location: Fort Worth, Texas
Surface Elevation:
West:
North:
Hammer Drop (lbs / in): 170 / 24

GROUND WATER OBSERVATIONS
On Rods (ft): NONE
After Drilling (ft): DRY
After ____ Hours (ft):

Depth, feet	Graphic Log	MATERIAL DESCRIPTION		Sample Type	Recovery % RQD	TX Cone or Std. Pen. (blows/ft, in)	Pocket Penetrometer (tsf)	Unconfined Comp. Strength (tsf)	% Passing No. 200 Sieve	Unit Dry Weight (pcf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Swell, %
		4" AGGREGATE BASE	0.5												
		Tan SAND with gravel - FILL	2.0				4.5+				6				
		Brown CLAYEY SAND					3.0	1.2		109	13	29	13	16	0.5
5						5					14				
			6.0												
		Reddish Brown CLAYEY SAND				5					10				
10						5			48		17				
			12.0												
		Dark Brown CLAYEY SAND					3.5				12				
15			16.0												
		Gray CLAYEY SAND with gravel													
20			20.0			23					10				
		TEST BORING TERMINATED AT 20 FT													

ALPHA TESTING
WHERE IT ALL BEGINS

5058 Brush Creek Rd.
Fort Worth, Texas 76119
Phone: 817-496-5600
Fax: 817-496-5608
www.alphatesting.com

BORING NO.: 4
Sheet 1 of 1
PROJECT NO.: W212888

Client: JGR Architects
Project: Multi-Family Apartments
Start Date: 10/5/2021 **End Date:** 10/5/2021
Drilling Method: CONTINUOUS FLIGHT AUGER

Location: Fort Worth, Texas
Surface Elevation:
West:
North:
Hammer Drop (lbs / in): 170 / 24

GROUND WATER OBSERVATIONS
On Rods (ft): NONE
After Drilling (ft): DRY
After ____ Hours (ft):

Depth, feet	Graphic Log	MATERIAL DESCRIPTION		Sample Type	Recovery % RQD	TX Cone or Std. Pen. (blows/ft, in)	Pocket Penetrometer (tsf)	Unconfined Comp. Strength (tsf)	% Passing No. 200 Sieve	Unit Dry Weight (pcf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Swell, %
		3" ASPHALT	0.5												
		Tan SAND with gravel - FILL	2.0								10				
		Tan CLAYEY SAND					4.5				16				
5							3.5				13				
							2.75		33		15	27	13	14	0.0
10						4					15				
			13.0												
		Dark Brown CLAYEY SAND with gravel				9					15				
15			18.0												
		Brown CLAYEY SAND with gravel				4					8				
20			20.0												
		TEST BORING TERMINATED AT 20 FT													

ALPHA TESTING

WHERE IT ALL BEGINS

5058 Brush Creek Rd.
Fort Worth, Texas 76119
Phone: 817-496-5600
Fax: 817-496-5608
www.alphatesting.com

BORING NO.: 5

Sheet 1 of 1

PROJECT NO.: W212888

Client: JGR Architects
Project: Multi-Family Apartments
Start Date: 10/5/2021 **End Date:** 10/5/2021
Drilling Method: CONTINUOUS FLIGHT AUGER

Location: Fort Worth, Texas
Surface Elevation:
West:
North:
Hammer Drop (lbs / in): 170 / 24

GROUND WATER OBSERVATIONS
On Rods (ft): NONE
After Drilling (ft): DRY
After ____ Hours (ft):

Depth, feet	Graphic Log	MATERIAL DESCRIPTION		Sample Type	Recovery % RQD	TX Cone or Std. Pen. (blows/ft, in)	Pocket Penetrometer (tsf)	Unconfined Comp. Strength (tsf)	% Passing No. 200 Sieve	Unit Dry Weight (pcf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Swell, %
		3" ASPHALT	0.5												
		Reddish Brown CLAYEY SAND - FILL					4.5+				10				
							4.5+		31		10	24	14	10	
			4.0												
		Tan CLAYEY SAND					2.0				18				
5			5.0												
		TEST BORING TERMINATED AT 5 FT													
10															
15															
20															

ALPHA TESTING

WHERE IT ALL BEGINS

5058 Brush Creek Rd.
Fort Worth, Texas 76119
Phone: 817-496-5600
Fax: 817-496-5608
www.alphatesting.com

BORING NO.: 6

Sheet 1 of 1

PROJECT NO.: W212888

Client: JGR Architects
Project: Multi-Family Apartments
Start Date: 10/5/2021 **End Date:** 10/5/2021
Drilling Method: CONTINUOUS FLIGHT AUGER

Location: Fort Worth, Texas
Surface Elevation:
West:
North:
Hammer Drop (lbs / in): 170 / 24

GROUND WATER OBSERVATIONS
On Rods (ft): NONE
After Drilling (ft): DRY
After ____ Hours (ft):

Depth, feet	Graphic Log	MATERIAL DESCRIPTION	Sample Type	Recovery % RQD	TX Cone or Std. Pen. (blows/ft, in)	Pocket Penetrometer (tsf)	Unconfined Comp. Strength (tsf)	% Passing No. 200 Sieve	Unit Dry Weight (pcf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Swell, %
		AGGREGATE BASE 2.0								6				
		Brown CLAYEY SAND with gravel - FILL 4.0				4.5+				9				
5		Reddish Brown CLAYEY SAND 5.0				4.5+		26		9	31	17	14	
		TEST BORING TERMINATED AT 5 FT												
10														
15														
20														

ALPHA TESTING

WHERE IT ALL BEGINS

5058 Brush Creek Rd.
Fort Worth, Texas 76119
Phone: 817-496-5600
Fax: 817-496-5608
www.alphatesting.com

BORING NO.: 7

Sheet 1 of 1

PROJECT NO.: W212888

Client: JGR Architects
Project: Multi-Family Apartments
Start Date: 10/5/2021 **End Date:** 10/5/2021
Drilling Method: CONTINUOUS FLIGHT AUGER

Location: Fort Worth, Texas
Surface Elevation:
West:
North:
Hammer Drop (lbs / in): 170 / 24

GROUND WATER OBSERVATIONS
On Rods (ft): NONE
After Drilling (ft): DRY
After ____ Hours (ft):

Depth, feet	Graphic Log	MATERIAL DESCRIPTION	Sample Type	Recovery % RQD	TX Cone or Std. Pen. (blows/ft, in)	Pocket Penetrometer (tsf)	Unconfined Comp. Strength (tsf)	% Passing No. 200 Sieve	Unit Dry Weight (pcf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Swell, %
		AGGREGATE BASE 2.0								3				
		Tan CLAYEY SAND - FILL 4.0				4.5+		42		8	37	17	20	
5		Tan CLAYEY SAND with gravel 5.0			10					18				
		TEST BORING TERMINATED AT 5 FT												
10														
15														
20														

ALPHA TESTING

WHERE IT ALL BEGINS

KEY TO SOIL SYMBOLS AND CLASSIFICATIONS

SOIL & ROCK SYMBOLS

- (CH), High Plasticity CLAY
- (CL), Low Plasticity CLAY
- (SC), CLAYEY SAND
- (SP), Poorly Graded SAND
- (SW), Well Graded SAND
- (SM), SILTY SAND
- (ML), SILT
- (MH), Elastic SILT
- LIMESTONE
- SHALE / MARL
- SANDSTONE
- (GP), Poorly Graded GRAVEL
- (GW), Well Graded GRAVEL
- (GC), CLAYEY GRAVEL
- (GM), SILTY GRAVEL
- (OL), ORGANIC SILT
- (OH), ORGANIC CLAY
- FILL

SAMPLING SYMBOLS

- SHELBY TUBE (3" OD except where noted otherwise)
- SPLIT SPOON (2" OD except where noted otherwise)
- AUGER SAMPLE
- TEXAS CONE PENETRATION
- ROCK CORE (2" ID except where noted otherwise)

RELATIVE DENSITY OF COHESIONLESS SOILS (blows/ft)

VERY LOOSE	0 TO 4
LOOSE	5 TO 10
MEDIUM	11 TO 30
DENSE	31 TO 50
VERY DENSE	OVER 50

SHEAR STRENGTH OF COHESIVE SOILS (tsf)

VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
FIRM	0.50 TO 1.00
STIFF	1.00 TO 2.00
VERY STIFF	2.00 TO 4.00
HARD	OVER 4.00

RELATIVE DEGREE OF PLASTICITY (PI)

LOW	4 TO 15
MEDIUM	16 TO 25
HIGH	26 TO 35
VERY HIGH	OVER 35

RELATIVE PROPORTIONS (%)

TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	36 TO 50

PARTICLE SIZE IDENTIFICATION (DIAMETER)

BOULDERS	8.0" OR LARGER
COBBLES	3.0" TO 8.0"
COARSE GRAVEL	0.75" TO 3.0"
FINE GRAVEL	5.0 mm TO 3.0"
COURSE SAND	2.0 mm TO 5.0 mm
MEDIUM SAND	0.4 mm TO 5.0 mm
FINE SAND	0.07 mm TO 0.4 mm
SILT	0.002 mm TO 0.07 mm
CLAY	LESS THAN 0.002 mm