APPENDIX C

GEOTECHNICAL EXPLORATION

PROPOSED CADDO WARD II
INDUSTRIAL PARK – PHASE 1
VIVIAN, CADDO PARISH, LOUISIANA
FILE NO. G18-12-153

Prepared for

MR. JOHN FRENCH, PE, PLS
KSA ENGINEERS, INC.
1111 HAWN AVENUE
SHREVEPORT, LOUISIANA 71107

AMERICAN TESTING LAB, LLC
GEOTECHNICAL ENGINEERING & CONSTRUCTION SERVICES CONSULTANTS

American Testing Lab, LLC
Geotechnical Engineering and Construction Services Consultants
1317 Canyon Court ♦ Bossier City, Louisiana 71111 ♦ Phone: 318-752-6605 ♦ Fax: 318-752-6617

February 8, 2019

Mr. John French, PE, PLS
KSA Engineers, Inc.
1111 Hawn Avenue
Shreveport, Louisiana 71107

RE: Geotechnical Exploration
Proposed Caddo Ward II Industrial Park – Phase 1
Vivian, Caddo Parish, Louisiana
File No. G18-12-153

Dear Mr. French:

This office is pleased to transmit our geotechnical engineering services report for the above referenced project. The attached report presents the results of site investigations, laboratory testing, and engineering analysis and recommendations.

We appreciate the opportunity to provide our services to you and look forward to serving as your geotechnical consultant throughout this project. Please do not hesitate to contact this office if you have any questions regarding the information presented or if we may be of further service.

Sincerely,

AMERICAN TESTING LAB, LLC

Taylor M. Goldman, PE
Project Engineer

STATE OF LOUISIANA
TAYLOR M. GOLDMAN
License No. 39999
PROFESSIONAL ENGINEER
IN
CIVIL ENGINEERING
2/8/19

Distribution: 2 – Above (EM & HC)

GEOTECHNICAL EXPLORATION
PROPOSED CADDO WARD II
INDUSTRIAL PARK – PHASE 1
VIVIAN, CADDO PARISH, LOUISIANA

PROJECT DESCRIPTION

This report presents the results of the geotechnical exploration performed for the proposed commercial development of a large tract of land located on the north and south sides of Roy "Hoppy" Hopkins Drive in Vivian, Caddo Parish, Louisiana. The area for the development begins approximately 2400 feet east of the intersection of Roy "Hoppy" Hopkins Drive and Louisiana Highway 1 and extends east to Louisiana Highway 170. It is anticipated by this writer that the development will consist of construction of multiple commercial properties within this development. However, plans for the development have not been finalized to the knowledge of this writer. This office is of the opinion that this investigation was completed to gain a preliminary understanding of on-site soil conditions and develop general recommendations for potential foundation systems, pavement sections and subgrade preparation. The approximate locations of the borings are illustrated on the attached Boring Location Diagram.

Final grading plan was unavailable at the time of the field operations. However, topography of the site indicates site grading will vary significantly across the industrial park. There is a variation in elevation visually observed to be on the order of ninety (90) to one hundred (100) feet from the lowest area of the investigation to the highest. The recommendations provided in the following paragraphs are based

off the field investigations, assumptions made by this writer and are of a generalized nature. It is recommended that an additional field investigation be completed upon finalization of site grading and final building plans being developed to provide a more project specific geotechnical report.

GENERAL

The study was authorized by KSA Engineers, Inc., on December 28, 2018. The executed contract (CPW.007.3) was received by this office on January 3, 2019. The purpose of the investigation was to evaluate the general subsurface conditions and develop general recommendations for the safe and economical design of potential foundation system(s), pavement sections and subgrade preparation.

The study included drilling sample borings, performing laboratory testing, and engineering analysis of the subsurface conditions. The field and laboratory investigations included in this report have been conducted in accordance with applicable standards and procedures set forth in ASTM Standards.

SITE DESCRIPTION

The property for the proposed development is located on the north and south sides of Roy "Hoppy" Hopkins Drive between Louisiana Highway 1 and Louisiana Highway 170 in Vivian, Caddo Parish, Louisiana. The area of the investigation began approximately 2400 feet east of the intersection of Roy "Hoppy" Hopkins Drive and Louisiana Highway 1 and extends east approximately one and a half (1.5)

miles. Approximately sixty-five (65) percent of the property was either previously cleared land or was pasture type land. The remaining percentage of the property is heavily wooded. The surrounding areas are also heavily wooded. The site has significant elevation variations but generally slopes to the east and west away from a hill located around boring B-17 (See attached Boring Location Diagram). There is approximately 100 feet of elevation relief from boring B-17 to boring B-12, though there are undulations between the two points. Additionally, the site tends to slope from the north to the south. There are multiple natural drainage swales throughout the investigation area. Surface drainage conditions are considered to be fair to good.

FIELD OPERATIONS

The subsurface conditions were evaluated by advancing eight (8) sample borings between January 14 and 16, 2019. The approximate locations of the borings are indicated on the attached Boring Location Diagram. The number and depth of the borings performed were specified by the design professional. The boring locations were selected by the design professional and staked and/or altered in the field by representatives of American Testing Lab, LLC. Descriptive terms and symbols used on the boring logs are in accordance with the Unified Soil Classification System. Surface elevations at the borehole locations were not supplied at the time of the field operations.

A track mounted auger drill rig was used to advance the test borings. Intermittent undisturbed samples were obtained in the following manner. Standard penetration tests were performed in accordance with ASTM procedures. This test is conducted by recording the number of blows required for a one hundred forty (140) pound hammer falling thirty (30) inches to drive a split spoon sampler eighteen (18) inches into the substrata. Depths at which split spoon samples were taken are indicated by two (2) crossed lines in the "Samples" column on the Log of Boring. The number of blows required to drive the sampler for each 6-inch increment were recorded. The penetration resistance is the number of blows required to drive the split spoon sampler the final twelve (12) inches of penetration. Information related to the penetration resistance is presented under the "Field Data" head of the Log of Boring. All samples were extruded in the field, sealed to maintain in-situ conditions, and packaged for transport to the laboratory for additional testing.

Water observations were recorded during the drilling operations and again in the open boreholes upon completion of the field services to evaluate groundwater conditions. All borings were backfilled at completion of the field operations.

LABORATORY TESTING

Upon return to the laboratory all samples were visually logged in accordance with the Unified Soils Classification System. Selected samples were subjected to standard laboratory tests under the supervision of a geotechnical engineer to verify classification and to determine pertinent engineering properties of the substrata.

The results of laboratory testing and soil classifications are tabulated on the attached Logs of Boring.

Samples obtained during our field studies and not consumed by laboratory testing procedures will be retained for a period of thirty (30) days. Arrangements for storage beyond that period of time must be made in writing to this office.

SUBSURFACE CONDITIONS

The subsurface stratigraphy encountered during this investigation varies somewhat significantly across the entirety of the site, which is expected over such a large area with substantial variations in elevation. The majority of the materials encountered are clay type soils varying between sandy and silty lean clay and fat clay. The lean clay soils exhibit low to moderate plasticity and generally exhibit moderate shear strength in upper twenty (20) to twenty-five (25) feet of the borings. When this material was encountered at greater depths, the shear strength exhibited was moderately high to high with the compressibility being considered as moderate to low. The fat clay soils encountered exhibit moderately high to high plasticity and is classified as volumetrically unstable, possessing moderately high susceptibility to shrink and swell with variations in moisture content. The fat clay generally exhibited moderate to moderately high shear strength and moderate to low compressibility. There were seemingly sporadic lignite layers encountered in multiple borings within the clay soils at depths ranging between seventeen (17) feet and thirty-three (33) feet depth. Additionally there were granular soils encountered, including loose to

very dense silty sand and clayey sand; however, these strata were generally less substantially in thickness than the clay soils encountered during this investigation. A large majority of the granular soils encountered were on the northern side of Roy "Hoppy" Hopkins Drive. The silty and clayey sand soils generally exhibit no to moderate plasticity.

The subsurface description provided in this section is of a generalized nature to highlight the major stratification features and material characteristics. For a detailed description of the subsoil, refer to the soil profiles located on the attached Logs of Boring.

No groundwater was encountered in boring B-14 during the field investigation. Groundwater was encountered in borings B-9, B-13, and B-15 through B-18 at depths ranging between five (5) feet and thirteen (13) feet depths during drilling operations. Perched groundwater was encountered in boring B-12 at six (6) feet during drilling operations but was light seepage that stopped as the boring was advanced. The actual groundwater in boring B-12 was not encountered until forty-six (46) feet depth. The water levels were recorded at depths ranging between one (1) foot and twenty (20) feet depths upon completion of field operations. It is anticipated that high groundwater elevations were significantly influenced by numerous precipitation events in the weeks preceding the field operations. Based on site topography, subsurface stratigraphy, and anticipated construction techniques required for this project, groundwater is not anticipated to present any

significant problems during the construction phase of the project. However, the depth of perched water and shallow groundwater is influenced by seasonal moisture variations in the climatic cycle. Consequently, the depth to shallow subsurface water should be verified prior to the start of construction of the project.

SEISMIC DESIGN CONSIDERATIONS

The International Building Code, 2009 edition requires the design of structures must consider dynamic forces resulting from seismic events. These forces are dependent upon the magnitude of the earthquake event as well as the properties of the soils that underlie the site. As part of the procedure to evaluate seismic forces, the code requires the evaluation of the Seismic Site Class, which categorizes the site based upon the characteristic of the subsurface profile within the upper 100 feet of the ground surface.

To define the Site Class for this project, we have interpreted the results of the test borings drilled within the project site and estimated appropriate soil properties below the base of the borings to a depth of 100 feet as permitted by the code. The estimated soil properties were based upon our experience with subsurface conditions in the general site area. Based upon this evaluation, the subsurface conditions within the site are consistent with the characteristics of a Site Class "D" (stiff soil profile) as defined in Table 1613.5.2 of the building code.

ANALYSIS AND RECOMMENDATIONS

Shallow Foundation Systems

Based on the site topography and visual observations, it is anticipated that site grading will likely vary significantly across the entire development. It is anticipated that some areas will likely be built up with significant amounts of fill material while others will either be at grade or in a cut. Therefore, with the analysis of the field and laboratory program and potential site grading, it is anticipated that shallow foundation systems can be utilized for support of the proposed structures in areas significant thicknesses of select fill material will be placed or in the areas of borings B-12, B-13, and B-16 through B-18, unless significant excavation operations are planned for those areas that would have footings bearing in the volumetrically unstable fat clay soils. Either continuous footings and/or isolated spread footings appear feasible in the areas described. The base of the footings should be placed in properly prepared select fill material or in-situ silty clay, sandy clay, clayey sand or silty sand strata at a depth of approximately two (2) feet below the final adjacent grade. It is recommended that all footings per structure be founded in the same stratum, e.g. all in select fill or all in in-situ soils. If site grading requires a wedge of fill material to establish final subgrade elevation, it is recommended that the footprint is excavated as such to place a uniform thickness of fill material equal to the greatest thickness of planned fill or four (4) feet, whichever is less. The limits of the select fill placement should extend a minimum of five (5) feet beyond the perimeter of the structures.

However, it must be noted that earth forming of footings founded through the in-situ silty sand stratum may require formwork to complete footing construction due to the non-plastic and potentially moisture-sensitive nature of this stratum. Existing soils may be undercut to allow for placement of select fill to allow for earth forming of footings, if desired or necessary. Select fill material should meet the general requirements discussed in the Site Preparation section of this report. Footing undercut should be equal to the width of the footing plus two (2) feet. Select fill material should meet the general requirements as stated in the Site Preparation section of this report.

Additionally, it must be noted that the silty sands and some silty lean clays encountered on site have a silt fraction that may have them act as moisture-sensitive materials. This classification of soil is subject to extreme changes in strength with varying moisture conditions. Saturation of silty soils generally results in a "quick" or "pumping" condition upon application of vibratory or dynamic loads typically associated with construction equipment. Consequently, if the in-situ soils begin to "pump" or yield, it generally becomes necessary to undercut the saturated soil and replace it with select fill.

An allowable bearing pressure range of 1600 to 2500 psf, depending on the bearing stratum and condition of said stratum at the time of construction, can be used for the design of continuous footings placed in the previously described strata. The bearing value contains a factor of safety on the order of two (2). A minimum footing

width of eighteen (18) inches should be maintained for all steel reinforced continuous footings as protection against isolated shear failure or isolated consolidation of the previously constructed select fill.

Isolated spread footings may be considered for support of interior columns or other areas of concentrated load. The base of the spread footings should be placed in the previously described strata. An allowable bearing pressure range of 2000 to 2800 psf would likely be acceptable to be utilized to proportion all spread footings depending on the bearing stratum and condition of said stratum at the time of construction. The bearing value contains a factor of safety on the order of two (2). All spread footings should be designed with a minimum base width of twenty-four (24) inches.

The base of all foundation excavations should be free of water and loose soil prior to placing concrete. The concrete should be placed as soon as possible after excavation to minimize bearing soil disturbance. Should the soils at the bearing elevation become excessively dry, disturbed, or saturated, the affected soils should be removed prior to placement of concrete.

The recommended select fill material and/or the in-situ lean clay, clayey sand or silty sand strata possess a low susceptibility to shrink and swell with variations in moisture content. Subsequently, the slab for the proposed structure can be placed directly on the properly prepared subgrade. Slabs, which are placed at grade,

should be stiffened and reinforced to tolerate potential differential movements between the periphery and the interior portions of the slabs associated with consolidation of select fill material or isolated soft strata. It is recommended that if there is to be variable amounts of fill material across a building footprint that the construction area be excavated as such to provide a minimum thickness of select fill of twelve (12) inches below the slab bearing elevation. The limits of the select fill placement should extend a minimum of five (5) feet beyond the perimeter of the structures.

Care should be taken to shape the site such that water does not pond around the structure during construction. When the structure is complete, the ground surface should slope away from the structure and all roof runoff should be collected in a gutter system and piped away from the structure, preferably onto paved areas or into subsurface drainage systems before discharging.

Deep Foundation Systems

Alternatively, if the design loads become too large for shallow foundations to be feasible or site grading plans put the footing bearing elevation at or near the volumetrically fat clay, especially in the areas of borings B-9, B-14 and B-15, a deep foundation alternative has been provided. The deep foundation option is also acceptable in lieu of uniformly cutting significant amounts of in-situ soils in footprint areas a fill wedge is required to establish grade. It is the opinion of this writer that the most positive means of minimizing distress in the structure is to support the

building with drilled and cast in place concrete piers in conjunction with a uniform thickness of select fill material placed directly beneath the top of subgrade elevation. Provided in the following table are minimum allowable loads for various diameter shafts. The depths provided are the minimum shaft lengths below ground elevation at the time of the geotechnical investigation or lengths below the bottom of anticipated grade beam or pier cap elevations, whichever is greater. It is recommended that project specific geotechnical explorations be performed per construction site to analyze potential allowable loads once building and grading plans have been developed.

Diameter (in)	Depth (ft)	Allowable Loads (kips)
18	10	12
	15	20
	20	28
	25	38
	30	47
24	10	17
	15	27
	20	39
	25	53
	30	65
30	10	22
	15	36
	20	50
	25	68
	30	84
36	10	28
	15	44
	20	62
	25	85
	30	105

The bearing values provided contain a factor of safety on the order of two (2). All shafts should be installed at the same tip elevation. Casing of the shafts should not be required to install the caissons to the depths indicated based on the soil types encountered. However, perched and shallow groundwater levels vary during periods of the climatic cycle. It is recommended that test shafts be drilled and installed prior to construction to establish an installation procedure. All pier excavations should be essentially dry and clean prior to concrete placement. Limited seepage into drilled pier excavations can probably be controlled by close coordination of drilling, cleanup and concrete placement. If pier excavations cannot be dewatered, underwater concrete placement techniques may be warranted. It is recommended that test shafts should be drilled prior to construction to establish an installation procedure. All test shafts should be of similar size of the production caissons.

The recommended select fill materials possess a low susceptibility to shrink and swell with variations in moisture content. Consequently, the slabs for the structures can be placed directly on the properly prepared select fill material. A minimum of two (2) feet of select fill material below the final subgrade elevation will be required. If desired, a combination of removal of volumetrically unstable clay and replacement with select fill is acceptable to obtain the desired final elevation. The limits of the select fill placement should extend a minimum of five (5) feet beyond the perimeter of the structures. Slabs placed at grade in the proposed select fill material should be stiffened and reinforced to tolerate potential differential movements between the

periphery and interior portions of the slab associated with consolidation of select fill material or isolated undiscovered soft strata.

Alternately, success has been achieved in this general area by supporting non-load bearing floor slabs due to expansion and contraction of the volumetrically unstable clay soils is to structurally suspend the floor system. A minimum void of four (4) inches should be provided between the bottom of all grade beams and the underlying clay soils. Forms manufactured for this purpose can be utilized to provide these voids. Suitable rigid protection should be installed along the outer edges of the grade beams to prevent backfill from infiltrating the void.

Prior to placement of any select fill, the subgrade should be prepared as specified the Site Preparation section of this report. Care should be taken to shape the site such that water does not pond around the structure during constructions. When the structure is complete the ground surface should slope away from the structure. All roof runoff should be collected by a gutter system and piped away from the structure, preferably onto pavement areas or into sewers prior to discharging.

PAVEMENT SECTIONS

The design of pavement sections for this site is based upon the upper twelve (12) inches of subgrade meeting the requirements of compaction and material type for select fill as presented in the Site Preparation section of this report or in-situ lean clays meeting the liquid limit and plasticity indices recommended for select fill,

clayey sand and silty sand encountered across the site. Anticipated select fill and appropriate in-situ materials should have Unified Soil Classifications of CL, CLS, SC or SM and should yield a CBR value on the order of five (5) if properly prepared.

Volumetrically unstable clay soils should not serve as pavement subgrade. Consequently, in the areas this material is encountered at the pavement subgrade elevation, the subgrade should be undercut as such to provide placement of a minimum of one (1) foot of select fill material beneath the designed top of subgrade elevation. Select fill material properties and placement should be as described in the Site Preparation section of this report.

Alternatively, in lieu of the select fill material, the in-situ fat clay soils may be lime stabilized to produce a mixture exhibiting a plasticity index of fifteen (15) or less. The lime and soil shall be thoroughly mixed, cured and compacted to a minimum of ninety-five (95) percent of the Standard Proctor Density (ASTM D-698). Lime treated subgrade should be constructed in accordance with the requirements presented in the latest addition of the Louisiana Standard Specifications for Roads and Bridges. Lime application rates should be based upon representative tests obtained directly from the prepared subgrade. However, based on the information obtained from the test borings, an application rate of approximately thirty (30) pounds per square yard for twelve (12) inches of treatment may be used for bid purposes.

It is strongly recommended that rigid pavement sections be given the highest priority for this site. For the benefit of comparing the first costs of construction, alternative flexible pavement sections have been provided. However, it is entirely likely that Portland cement concrete sections will cost less over the life of the pavement than equivalent asphaltic concrete and base course sections.

The following rigid pavement sections are recommended for this project:

Automobile Parking and Drive Area

6 inches Portland Cement Concrete
over
12 inches Density Controlled Low Plasticity In-Situ Subgrade
OR
12 inches Density Controlled Select Fill Material
OR
12 inches Density Controlled Lime Stabilized In-Situ Subgrade

Channelized Heavy Truck Traffic

8 inches Portland Cement Concrete
over
4 inches Density Controlled Crushed Aggregate Base
over
12 inches Density Controlled Low Plasticity In-Situ Subgrade
OR
12 inches Density Controlled Select Fill Material
OR
12 inches Density Controlled Lime Stabilized In-Situ

Portland cement concrete, with air entrainment admixture should possess a minimum compressive strength of 3500 pounds per square inch at twenty-eight (28)

days and should have weakened planes installed at maximum spacing of fifteen (15) feet.

The following flexible pavement sections are provided for this site:

Automobile Parking and Drive Area

2 inches Hot Mixed Asphaltic Concrete
over
6 inches Density Controlled Crushed Aggregate Base
over
12 inches Density Controlled Low Plasticity In-Situ Subgrade
OR
12 inches Density Controlled Select Fill Material
OR
12 inches Density Controlled Lime Stabilized In-Situ

Channelized Heavy Truck Traffic

4 inches Hot Mixed Asphaltic Concrete
over
8 inches Density Controlled Crushed Aggregate Base
over
12 inches Density Controlled Low Plasticity In-Situ Subgrade
OR
12 inches Density Controlled Select Fill Material
OR
12 inches Density Controlled Lime Stabilized In-Situ

Hot Mixed Asphaltic Concrete shall consist of Type 3 Asphaltic concrete or equivalent as defined by The Louisiana Standard of Specifications for Roads and Bridges issued by the Louisiana Department of Transportation and Development. For thickness requirements greater than two (2) inches, the total section shall

consist of a minimum of two (2) inches of wearing course over the remaining thickness of base course asphaltic concrete.

SITE PREPARATION

Site preparation should begin with the clearing and grubbing of any mature trees and associated clearing debris and stripping of any organic laden soils in the construction areas. A stripping depth on the order of six (6) to twelve (12) inches is expected across the site. Additional excavation and backfill may be required due to undiscovered soft strata or the removal of stumps and/or root systems from previously cleared trees. Once all deleterious matter has been removed, provide drainage of the exposed subgrade by sloping grades and ditching.

Following stripping and cutting and prior to any fill placement, the exposed surface of areas to receive select fill or to bear foundation elements or the pavement structure should be scarified to a minimum depth of twelve (12) inches and compacted to a minimum of ninety-five (95) percent of the maximum dry density determined by ASTM D-698. The low to moderate plasticity in-situ soils should be moisture controlled to within one (1) percent below to three (3) percent above optimum, while the fat clay in-situ soils should be moisture controlled to within one (1) percent to three (3) percent above optimum.

The subgrade should then be proof-rolled with a loaded tandem-wheel dump truck or equivalent equipment. Proof-rolling should be observed by a representative of the

Geotechnical Engineer to verify stable subgrade conditions. All soft or loose soils encountered within the construction areas should be undercut, stabilized, processed and recompacted or excavated and replaced with select fill, whichever is appropriate.

Place lifts of select fill in thin, essentially horizontal layers not exceeding eight (8) inches in loose thickness and compact to a minimum of ninety-five (95) percent of the maximum density established by ASTM D-698 with the moisture content adjusted and maintained to within two (2) percent below to three (3) percent above optimum moisture content. All select fill should be sandy clay or clayey sand possessing a liquid limit no greater than thirty-five (35), a plasticity index ranging between five (5) and eighteen (18), and not greater than sixty (60) percent passing the No. 200 mesh sieve. Soils possessing a plasticity index less than five (5) or a percent passing the No. 200 sieve greater than sixty (60) shall not be utilized as structural fill at this site. It should be noted that any in-situ material to be excavated that meet the requirements for select fill could be stockpiled separately from other excavated soils and utilized as select fill material.

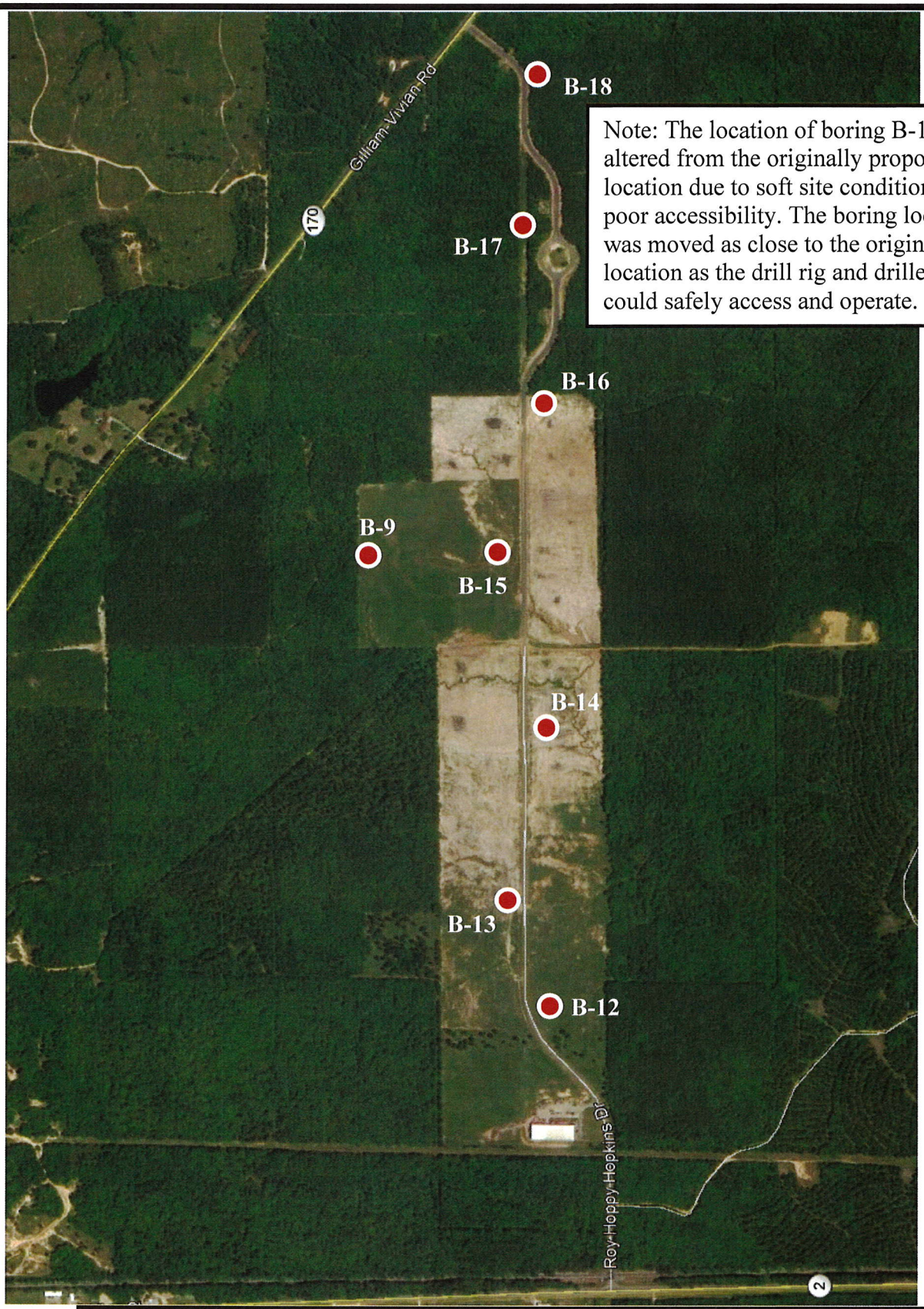
LIMITATIONS

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from any other information discussed in the report and are of a preliminary nature and should be verified through an additional geotechnical exploration following the completion

of site specific plans and site grading.. This report does not reflect any variations, which may occur across the site. The nature and extent of such variations may not become evident until construction. If variations appear evident it will be necessary to reevaluate the recommendations of this report.

It is recommended the Geotechnical Engineer be given the opportunity to review the plans and specifications so comments can be made regarding the interpretation and implementation of our geotechnical recommendations in the design and specifications. Sound engineering judgement must be followed when applying the recommendations to designs, plans, and also during the construction monitoring.

This report has been prepared for the exclusive use of our client for specific applications to the project discussed, and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied are intended or made. In the event any changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report are verified in writing by the Geotechnical Engineer.



Note: The location of boring B-18 was altered from the originally proposed location due to soft site conditions and poor accessibility. The boring location was moved as close to the original location as the drill rig and drillers could safely access and operate.

N
W E
S

American Testing Lab, LLC
Geotechnical Engineering and
Construction Services Consultants

BORING LOCATION DIAGRAM
PROPOSED CADDO WARD II
INDUSTRIAL PARK – PHASE 1
VIVIAN, CADDO PARISH, LOUISIANA

February 8, 2019

Project: G18-12-153

LOG OF BORING B-9

American Testing Lab, LLC
1317 Canyon Court
Bossier City, LA 71111
Telephone: 318-752-6605
Fax: 318-752-6617

CLIENT: KSA Engineers, Inc.
PROJECT: Caddo Ward II Industrial Park - Phase 1
LOCATION: Vivian, Caddo Parish, Louisiana
NUMBER: G18-12-153
DATE(S) DRILLED: 1/15/19

DRILLING METHOD(S):
Continuous Flight Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 8 ft during drilling operations.
Water level recorded at 4 ft upon completion.

SURFACE ELEVATION: Unknown

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 3	20									Soft tan and gray silty lean clay (CL)
			N = 9	21									Stiff gray and red lean-to-fat clay (CL-CH) with sand
	5		P = 4.25	23	41	22	19	99	1.77	4.24		75	
			P = 2.0	31	51	24	27	90	1.97	5.77			-- Medium stiff below 6 ft
	10		P = 4.5+	31	38	24	14	**				39	Firm gray and tan clayey sand (SC)
	15		P = 4.5+	28	47	24	23	**				75	Very stiff dark gray lean clay (CL) with silt partings
	20		P = 4.5+	33				78	7.13	4.94			-- with occasional lignite layers below 17 ft
	25		P = 4.5+	24				103	9.31	9.06			
	30		P = 4.5+	28	41	22	19	**					Boring Terminated 30 ft

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS Coordinates: 32* 50' 33.24" N, -93* 57' 48.54" W

** Sample disturbed upon extrusion.

LOG OF BORING B-12

American Testing Lab, LLC
1317 Canyon Court
Bossier City, LA 71111
Telephone: 318-752-6605
Fax: 318-752-6617

CLIENT: KSA Engineers, Inc.
PROJECT: Caddo Ward II Industrial Park - Phase 1
LOCATION: Vivian, Caddo Parish, Louisiana
NUMBER: G18-12-153
DATE(S) DRILLED: 1/14/19

DRILLING METHOD(S):
Continuous Flight Auger

GROUNDWATER INFORMATION:
Perched water encountered at 6 ft during drilling operations.
Groundwater encountered at 46 ft during drilling operations.
Water level recorded at 20 ft after 36 hours.

SURFACE ELEVATION: Unknown

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 2	24	24	16	8					73	Soft tan and gray silty lean clay (CL) with sand
			N = 6	22									Medium stiff gray and red lean clay (CL) with sand
	5		P = 2.5	22	40	20	20	99	1.83	8.92		75	-- Stiff below 4 ft
			P = 1.5	22				**					-- Gray and tan with no sand below 6 ft
			P = 2.5	21	49	18	31	109	2.22	7.98			
	10												
			P = 2.5	22				**					
	15												
	20		N = 50	19	34	21	13					72	Hard tan and gray silty lean clay (CL) with silty sand seams and layers
	25		N = 51	19									
	30		N = 66	13									Very dense gray and tan silty sand (SM) with occasional clay layers
	35		N = 58	20	NP	NP	NP					24	
	40		N = 50@4"	21	32	23	9						Very hard dark gray sandy lean clay (CLS) with silt seams and partings
	45		N = 25	31									-- Very stiff below 43 ft
													Auger Refusal 47 ft

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS Coordinates: 32* 50' 18.80" N, -93* 58' 31.45" W

** Sample disturbed upon extrusion.

LOG A GNNL01 - LOG A GNNL01.GDT - 2/11/19 09:19 - \\ATLLINKSYS\ATL LLC SHARE DRIVE\CURRENT JOBS\A FINAL REPORTS - GEO ETC\GINT GEOTECHNICAL\2018\G18-12-153 KSA - CADDO WARD II INDUSTRIAL PARK.GPJ

LOG OF BORING B-13

American Testing Lab, LLC
1317 Canyon Court
Bossier City, LA 71111
Telephone: 318-752-6605
Fax: 318-752-6617

CLIENT: KSA Engineers, Inc.
PROJECT: Caddo Ward II Industrial Park - Phase 1
LOCATION: Vivian, Caddo Parish, Louisiana
NUMBER: G18-12-153
DATE(S) DRILLED: 1/14/19

DRILLING METHOD(S):
Continuous Flight Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 13 ft during drilling operations.

SURFACE ELEVATION: Unknown

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													Stiff red and tan sandy lean clay (CLS)
			N = 10	16									
			P = 3.0	20	42	19	23	106	3.20	5.01		57	
	5		P = 3.0	18				**					
			N = 23	13	31	20	11					42	Firm tan, reddish tan and gray clayey sand (SC)
			N = 19	18									
	10		N = 20	17	29	19	10					38	
													Firm light gray clayey sand (SC)
	15		N = 24	23									
	20		N = 12	26	36	20	16					26	
			N = 25	30									Very stiff dark gray and gray fat clay (CH) with silt seams and partings
	25												
			N = 50	28	63	28	35					98	-- Hard below 29 ft
	30												
			N = 50@5"	37									-- with lignite layers below 33 ft
	35												
			N = 59	25	51	23	28					97	-- Very hard below 39 ft
	40												
			N = 63	20									
	45												
			N = 69	19	57	23	34					97	
	50												Boring Terminated 50 ft

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS Coordinates: 32* 50' 21.56" N, -93* 58' 20.26" W

** Sample disturbed upon extrusion.

LOG OF BORING B-14

American Testing Lab, LLC
1317 Canyon Court
Bossier City, LA 71111
Telephone: 318-752-6605
Fax: 318-752-6617

CLIENT: KSA Engineers, Inc.
PROJECT: Caddo Ward II Industrial Park - Phase 1
LOCATION: Vivian, Caddo Parish, Louisiana
NUMBER: G18-12-153
DATE(S) DRILLED: 1/15/19

DRILLING METHOD(S):
Continuous Flight Auger

GROUNDWATER INFORMATION:
No groundwater encountered during drilling operations.

SURFACE ELEVATION: Unknown

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 6	16	NP	NP	NP					45	Loose brown and gray silty sand (SM)
			N = 7	25									Medium stiff gray and red fat clay (CH)
	5		P = 4.5+	20	59	23	36	98	3.13	9.25		89	-- Very stiff gray and tan below 5 ft
			P = 4.5+	23				**					
			P = 4.5+	25	67	29	38	**				98	
	10												
			N = 33	26	62	27	35					96	-- Hard, gray, dark gray and tan with silt seams and partings and ferrous stains below 13 ft
	15												
			N = 47	26									
	20												
	25		N = 54	23	47	34	13					86	Very hard gray, dark gray and tan lean clay (CL) with silt and occasional sand seams
	30		N = 69	21	42	24	18					47	Dense gray, dark gray and tan clayey sand (SC)
	35		N = 65	21	38	23	15					74	Very hard gray and dark gray lean clay (CL) with sand
	40		N = 50@5"	19									
	45		N = 50@5"	20	41	21	20						-- Dark gray below 43 ft
	50		N = 50@4"	16	NP	NP	NP					34	Very dense gray silty sand (SM)
													Boring Terminated 50 ft

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS Coordinates: 32* 50' 19.58" N, -93* 58' 3.48" W

** Sample disturbed upon extrusion.

LOG OF BORING B-15

American Testing Lab, LLC
1317 Canyon Court
Bossier City, LA 71111
Telephone: 318-752-6605
Fax: 318-752-6617

CLIENT: KSA Engineers, Inc.
PROJECT: Caddo Ward II Industrial Park - Phase 1
LOCATION: Vivian, Caddo Parish, Louisiana
NUMBER: G18-12-153
DATE(S) DRILLED: 1/15/19

DRILLING METHOD(S):
Continuous Flight Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 13 ft during drilling operations.
Water level recorded at 9 ft upon completion.

SURFACE ELEVATION: Unknown

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 6	21	41	19	22						Medium stiff reddish tan lean clay (CL)
	5		P = 2.25	21									Stiff gray and tan fat clay (CH) with occasional silt seams
			P = 4.5+	22	69	24	45	96				98	-- Very stiff below 4 ft
			P = 4.5+	24				**					
	10		P = 2.5 ▼	22	86	29	57	97	2.43	4.25			-- Stiff below 8 ft
			N = 28 ▽	21	NP	NP	NP					28	Firm brown and gray silty sand (SM)
	15												
	20		P = 4.5+	20	54	22	32	89				100	Very stiff dark gray fat clay (CH) with silt partings
	25		P = 3.5	19									-- with lignite layers below 23 ft
	30		P = 4.5+	14	69	26	43	**				99	
	35		N = 69	15	50	22	28					98	Very hard dark gray lean-to-fat clay (CL-CH) with silt laminations
	40		N = 50@3"	14									
	45		N = 75	20	48	22	26					93	
	50		N = 50@4"	15									
													Boring Terminated 50 ft

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS Coordinates: 32* 50' 22.12" N, -93* 57' 49.50" W

** Sample disturbed upon extrusion.

LOG OF BORING B-16

American Testing Lab, LLC
1317 Canyon Court
Bossier City, LA 71111
Telephone: 318-752-6605
Fax: 318-752-6617

CLIENT: KSA Engineers, Inc.
PROJECT: Caddo Ward II Industrial Park - Phase 1
LOCATION: Vivian, Caddo Parish, Louisiana
NUMBER: G18-12-153
DATE(S) DRILLED: 1/16/19

DRILLING METHOD(S):
Continuous Flight Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 5 ft during drilling operations.
Water level recorded at 1 ft upon completion.

SURFACE ELEVATION: Unknown

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 3	17								53*	Loose gray and tan slightly clayey silty sand (SM)
			N = 4	17	31	18	13						Medium stiff gray, tan and red sandy lean clay (CLS)
	5		P = 0.5	14	32	16	16	**				52	
			N = 13	14	34	15	19						Firm gray, tan and red clayey sand (SC)
	10		P = 3.75	12								45	
	15		P = 4.5+	18	59	24	35	104	1.91	4.75			Very stiff gray, tan and red fat clay (CH) with occasional sandy silt partings
	20		P = 4.5+	21									
	25		P = 3.75	17	28	21	7	107	0.77	2.75		49	Firm dark gray clayey sand (SC)
	30		P = 4.5+	15	56	23	33	108	5.74	8.91		100	Very stiff dark gray fat clay (CH) with silt partings
	35		P = 4.5+	21									-- with lignite layers below 32 ft
	40		P = 4.5+	17	63	24	39	105	0.81	0.93		99	-- Very hard below 38 ft
	45		N = 50@3"	19									
	50		N = 50@3"	18	42	21	21						Very hard dark gray lean clay (CL) with silt laminations
													Boring Terminated 50 ft

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS Coordinates: 32* 50' 19.83" N, -93* 57' 34.14" W
* %Clay & Colloids 14, %Silt 39, %Sand 47
** Sample disturbed upon extrusion.

LOG OF BORING B-17

American Testing Lab, LLC
1317 Canyon Court
Bossier City, LA 71111
Telephone: 318-752-6605
Fax: 318-752-6617

CLIENT: KSA Engineers, Inc.
PROJECT: Caddo Ward II Industrial Park - Phase 1
LOCATION: Vivian, Caddo Parish, Louisiana
NUMBER: G18-12-153
DATE(S) DRILLED: 1/16/19

DRILLING METHOD(S):
Continuous Flight Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 12.5 ft during drilling operations.
Water level recorded at 8.5 ft upon completion.

SURFACE ELEVATION: Unknown

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 19	15	NP	NP	NP					27	Firm brown silty sand (SM)
			N = 23	12									
	5		N = 10	16	29	18	11					61	Stiff reddish brown and brown sandy lean clay (CLS)
			N = 6	17	20	14	6					49	Loose gray and tan silty clayey sand (SC-SM)
			N = 12	15									-- Firm below 7 ft
	10		N = 20	15	NP	NP	NP					40	Firm gray and tan silty sand (SM)
	15		N = 16	22									Very stiff gray, tan and red sandy lean clay (CLS) with silt partings
			P = 2.5	24	44	21	23	103	2.07	9.03		50	
	20		P = 2.25	28	66	29	37	92	2.03	5.27		100	Very stiff gray, tan and red fat clay (CH) with silt partings
	25		P = 3.0	19									
	30		N = 50	21								42	Dense gray and tan clayey sand (SC)
													Boring Terminated 30 ft

FIELD DATA | LABORATORY DATA

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS Coordinates: 32* 50' 19.97" N, -93* 57' 19.53" W

LOG OF BORING B-18

American Testing Lab, LLC
1317 Canyon Court
Bossier City, LA 71111
Telephone: 318-752-6605
Fax: 318-752-6617

CLIENT: KSA Engineers, Inc.
PROJECT: Caddo Ward II Industrial Park - Phase 1
LOCATION: Vivian, Caddo Parish, Louisiana
NUMBER: G18-12-153
DATE(S) DRILLED: 1/16/19

DRILLING METHOD(S):
Continuous Flight Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 7 ft during drilling operations.
Water level recorded at 5.5 ft upon completion.

SURFACE ELEVATION: Unknown

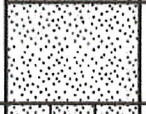
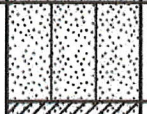
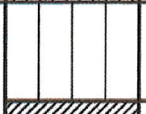
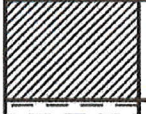
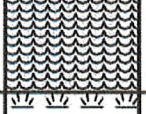
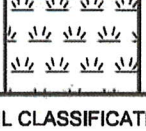
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 6	27									Medium stiff gray, tan and red sandy lean clay (CLS)
			P = 2.0	21	44	23	21					60	
	5		P = 2.0	14	21	16	5	**				40	Firm gray, tan and red clayey sand (SC)
			N = 23	17									
			P = 3.0	20	43	24	19	106	2.35	4.22		60	Very stiff gray, tan and red sandy lean clay (CLS)
	10												
			P = 2.25	23	54	23	31	102	1.39	6.31		87	Stiff gray and tan fat clay (CH) with occasional sandy silt seams
	15												
			P = 4.5+	37	45	26	19	81	0.85	3.39			Very stiff dark brown lean clay (CL) with silt partings
	20												
			P = 3.0	23	34	21	13					63	Very stiff dark gray sandy lean clay (CLS) with silty sand seams and layers
	25												-- with iron ore seams and layers below 27 ft
			P = 4.5+	21	40	25	15						
	30												Boring Terminated 30 ft

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS Coordinates: 32* 50' 19.78" N, -93* 57' 5.30" W

** Sample disturbed upon extrusion.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS