GEOTECHNICAL ENGINEERING REPORT
ARTERIAL STREET MAINTENANCE
NORTH SHERIDAN ROAD
E. PINE STREET TO E. APACHE STREET
TULSA, OKLAHOMA

PROJECT NO. G2016021

April 28, 2016

April 28, 2016
Project No.: G2016021

AAB Engineering, LLC
Attention: Mr. Alan Betchan, P.E.
P.O. Box 2136
Sand Springs, Oklahoma 74063

Subject: **Geotechnical Engineering Report**
Arterial Street Maintenance
North Sheridan Road
E. Pine Street to E. Apache Street
Tulsa, Oklahoma

Dear Mr. Betchan:

GFAC Engineering Inc. has completed the authorized subsurface exploration and geotechnical engineering evaluation for the above-referenced project in general accordance with our Proposal for Geotechnical Engineering Services and Terms and Conditions dated February 25, 2016. The purpose of the geotechnical study was to explore and evaluate the subsurface conditions at various locations on the site and develop geotechnical design and construction recommendations for the project. The attached GFAC Engineering Inc. report contains a description of the findings of our field exploration and laboratory testing program, our engineering interpretation of the results with respect to the project characteristics, and our geotechnical site development and foundation design recommendations as well as construction guidelines for the planned project.

Recommendations provided herein are contingent on the provisions outlined in the ADDITIONAL SERVICES and LIMITATIONS sections of this report. The project Owner should become familiar with these provisions in order to assess further involvement by GFAC Engineering Inc. and other potential impacts to the proposed project.

We appreciate the opportunity to be of service and are prepared to provide the recommended additional services. Please call us if you have any questions concerning this report.

Respectfully submitted,
GFAC ENGINEERING INC.
Certificate of Authorization #6389; Exp. 6/30/2016

Dale L. Kelley II, P.E.
Oklahoma: 21521

REGISTERED PROFESSIONAL ENGINEER
DALE L. KELLEY II
20 April 2016
21521
OKLAHOMA

Brian K. Marick, P.E
Principal Engineer

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TULSA, OKLAHOMA
GFAC ENGINEERING INC. PROJECT NO. G2016021
EXECUTIVE SUMMARY

Site:

- It is our understanding that North Sheridan Road will be rehabilitated from E. Pine Street to E. Apache Street in Tulsa, Oklahoma. The roadway will be rehabilitated in accordance with the City of Tulsa standards. Rehabilitation of the pavements is anticipated to consist of milling, patching, and overlaying the existing pavements. Full depth reconstruction may also be required in some areas. It is our understanding the final grades of the new pavements will be at or near the existing grades.

Site Development:

- All broken asphaltic concrete, concrete, and other debris from demolition should be removed from the site. Areas disturbed during demolition should be evaluated by the geotechnical engineer prior to placement of structural fill. All disturbed soils should be undercut prior to placement of structural fill.
- Prior to placement of any required structural fill, the moisture content of the exposed subgrade should be evaluated. The moisture content of the exposed grade should be adjusted to within the range recommended for structural fill. Extremely wet or unstable areas that hamper compaction of the subgrade may require undercutting and replacement with structural fill or other stabilization techniques.
- Following moisture conditioning, it is recommended that the exposed grade be Test Rolled. Test Rolling should be performed in accordance with Oklahoma Department of Transportation (ODOT) “Standard Specifications for Highway Construction (2009)” Section 203.
- Excavation and embankment construction procedures should be performed in accordance with Oklahoma Department of Transportation (ODOT) “Standard Specifications for Highway Construction (2009)” Section 202.
- Pavement subgrade preparation procedures should be performed as specified by the Oklahoma Department of Transportation (ODOT) “Standard Specifications for Highway Construction (2009)” Section 310.
- Depending upon site conditions at the time of construction and the construction schedule, the contractor may elect to expedite the subgrade preparation with chemical stabilization of unstable areas.
- The moisture content of a portion of the soils encountered in a portion of the borings appeared to be relatively high. It is anticipated that due to the relatively high moisture contents of the soils, unstable subgrade conditions will be encountered during/following demolition of the pavements.

Pavements

- A pavement thickness design was not performed.

- A portion of the pavement subgrade soils appears to have a lower consistency. Removal and replacement of a portion of these lower consistency soils is required to provide a subgrade suitable for adequate support for the proposed pavements.
- The pavement subgrade will consist of native soils, evaluated and approved existing/possible fill, and newly placed structural fill.

The information stated above is a brief summary of the recommendations presented within this report. The report should be reviewed in its entirety for proper implementation of the recommendations.

GEOTECHNICAL ENGINEERING REPORT
ARTERIAL STREET MAINTENANCE
NORTH SHERIDAN ROAD
E. PINE STREET TO E. APACHE STREET
TULSA, OKLAHOMA

1. INTRODUCTION

1.1 GENERAL

GFAC Engineering Inc. has completed the authorized subsurface exploration and geotechnical engineering evaluation for the proposed improvements to North Sheridan Road. The services provided were in general accordance with our Proposal for Geotechnical Engineering Services and Terms and Conditions dated February 25, 2016. This report includes our recommendations related to the geotechnical aspects of the project design and construction. Conclusions and recommendations presented in the report are based on the subsurface information encountered at the location of our exploration and the provisions and requirements outlined in the ADDITIONAL SERVICES and LIMITATIONS sections of this report.

1.2 PROPOSED CONSTRUCTION

It is our understanding that North Sheridan Road will be rehabilitated from E. Pine Street to E. Apache Street in Tulsa, Oklahoma. The roadway will be rehabilitated in accordance with the City of Tulsa standards. Rehabilitation of the pavements is anticipated to consist of milling, patching, and overlaying the existing pavements. The total length of the roadway to be improved is at least 5,280 feet. Full depth reconstruction may also be required in some areas. It is our understanding that minimal grade changes, less than 1 foot, will be required to achieve finish grades at the site.

A pavement distress survey, pavement overlay recommendations, and resilient modulus testing were beyond the scope of work of this study.

The scope of the exploration and engineering evaluation for this study, as well as the conclusions and recommendations in this report, were based on our understanding of the project as described above. If pertinent details of the project have changed or otherwise differ from our descriptions, we must be notified and engaged to review the changes and modify our recommendations, if needed.

2. SITE CONDITIONS

2.1 SITE DESCRIPTION

North Sheridan Road will be reconstructed and/or rehabilitated from East Pine Street to East Apache Street in Tulsa, Oklahoma. North Sheridan Road is a 4 lane street constructed of asphalt and concrete. The general location of the project site is indicated on Plate 1, Site Vicinity Map.

Existing utilities at the site included, but most likely are not limited to, water lines, gas lines, phone lines, electric lines, fiber optic lines, and sewer lines.

2.2 SUBSURFACE CONDITIONS

The following presents a general summary of the major strata encountered at the boring locations drilled for the proposed street reconstruction during our subsurface exploration and includes a discussion of the results of field and laboratory tests conducted. Specific subsurface conditions encountered at the boring locations are presented on the respective logs in APPENDIX A. The stratification lines shown on the logs represent the approximate boundaries between material types; in situ, the transitions may vary or be gradual.

Surficial Materials: The borings encountered either, Portland Cement Concrete (PCC) or Asphaltic concrete. Table 2.2.1 presents the type of pavement and thicknesses encountered at each boring location. It should be noted that these are the total thicknesses of asphaltic concrete or Portland cement concrete encountered in the borings. Numerous layers, including those that are broken and/or not bonded to previous layers, are included in the total thickness. Aggregate base with an approximate thickness of 12 and 3 inches was encountered in Borings B-2 and B-8, respectively.

Existing/Possible Fill: Existing/Possible Fill was encountered below the pavement in all the borings except Borings B-1, B-7, and B-8 and continued to approximate depths ranging from 1.8 to 5 feet. The Existing/Possible Fill consisted of various combinations of lean clay with varying amounts of shale fragments, sand, and gravel, limestone screenings, silt with varying amounts of sand, poorly graded sand, and silty clayey sand. The poorly graded sand materials were encountered in Boring B-6.

Native Soils: Native clay soils with varying amounts of sand were encountered below the Existing/Possible Fill in Borings B-2 and B-11 and below the pavement in Borings B-1, B-7, and B-8. The native soils continued to approximate depths ranging from 3.4 to 5 feet. Native soils were not encountered in Borings B-3, B-4, B-5, B-6, B-9, and B-10.

Bedrock: Weathered to relatively unweathered sandstone bedrock was encountered in Borings B-4, B-7, B-9, and B-11 at approximate depths ranging from 3.2 to 4.6 feet below the pavement surface and continued to the bottom of these borings at an approximate depth ranging from 3.6 to 5 feet. Hand auger refusal occurred on apparent sandstone bedrock at an approximate depth of 3.6 feet in Boring B-7.

Table 2.2.1 presents the boring number, pavement type and thickness, Atterberg Limits test results, percent passing the No. 200 sieve test results, moisture content test results, and classification of the soils:

TABLE 2.2.1 – GENERALIZED BORING INFORMATION

Boring	Pavement Type and Thickness (inches)*	Sample	Depth	USCS/AASHTO	Moisture Content	Percent Passing No. 200 Sieve	Liquid Limit	Plastic Limit	Plasticity Index
B-1	AC – 2 1/2 PCC – 7 1/2	AS-1	0.9-1.7	CL/A-6(9)	25	88	30	18	12
B-2	AC – 1 7/8 PCC – 8 1/8 Agg Base - 12	AS-1	3.4-5.0	CL/A-7-6(16)	26	76	44	23	21
B-3	AC – 1 3/4 PCC – 7 1/2	AS-2	3.0-5.0	CL/A-7-6(24)	25	92	47	23	24
B-4	AC – 1 3/4 PCC – 7 3/4	SS-1	0.9-2.4	CL/A-6(9)	27	87	30	19	11
B-5	AC – 1 7/8 PCC – 8 1/4	AS-1	1.3-3.2	ML/A-4(0)	23	70	23	20	3
B-6	AC – 1 1/2 PCC – 8 3/8	SS-1	0.9-2.4	SP-SM/A-2-4	13	12	NP	NP	NP
B-7	PCC – 8 1/8	AS-2	1.4-3.0	CH/A-7-6(36)	25	94	58	24	34
B-8	PCC – 8 1/8 Agg Base - 3	SS-1	1.2-2.7	CL/A-7-6(26)	27	95	47	22	25
B-9	PCC – 8 1/2	SS-1	0.7-2.2	ML/A-4(0)	15	75	NP	NP	NP
B-10	PCC – 8 1/2	SS-1	0.7-2.2	SC-SM/A-4(0)	15	36	22	16	6
B-11	PCC – 8 1/4	SS-1	0.7-2.2	CL/A-4(4)	17	65	27	18	9

AC – Asphaltic Concrete, PCC – Portland Cement Concrete *Total thickness, including broken layers.

Borings B-5, B-6, B-7, B-9, and B-10 were terminated prior to the planned termination depth of 5 feet. Table 2.2.2 presents the boring number, termination depth, and reason for early termination of the boring.

TABLE 2.2.2 – BORING TERMINATION DEPTH

Boring	Depth	Reason for Termination
B-5	3.2	Hand auger refusal – possible sandstone bedrock or utility
B-6	1.8	Concrete encountered during the sampling operations – possible utility
B-7	3.6	Hand auger refusal – apparent sandstone bedrock
B-9	4.5	SPT refusal encountered in final sample for boring
B-10	2.7	Concrete or possible limestone encountered while advancing the boring

Laboratory CBR testing conducted on the composite sample of the materials encountered in the borings yielded a saturated CBR value of 2.7. A standard Proctor test was also conducted on the composite sample collected at the site. The results of the Proctor test indicated a Maximum Dry Density of 106.8 pcf and an Optimum Moisture Content of 17.5 %. Results of the CBR and Proctor tests are included in APPENDIX C.

2.3 GENERAL SITE GEOLOGY

According to the "Engineering Classification of Geologic Materials – Division Eight" from the Oklahoma Highway Department, 1970, the project site appears to be located within area designated as the Seminole Unit (Psl).

Seminole Unit (Psl): This unit consists predominantly of shale and sandy shale and contains zones of sandstone. The sandstones are moderately hard to soft, mostly thin bedded and commonly brown in color. The shale in the middle 40-100 feet is mostly clayey. The shale in the upper and lower portions is silty to sandy.

2.4 GROUNDWATER OBSERVATIONS

Groundwater observations were made both during and after completion of drilling operations. The borings remained dry during the drilling and sampling operations. The types of materials encountered in the borings have a wide range of hydraulic conductivities and observations over an extended period of time may show the presence of groundwater. Piezometers would be required to better define current

groundwater conditions and groundwater level fluctuations with time. Fluctuations of groundwater levels can occur due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

3. ANALYSIS AND DISCUSSION

3.1 GENERAL

Based on the results of our evaluation, it is our professional opinion that the proposed project can be completed using standard earthwork and pavement construction techniques. Recommendations regarding geotechnical aspects of the project design and construction are presented below.

3.2 SITE DEVELOPMENT

The recommendations presented in this section are intended for those sections of the roadways that will be reconstructed.

3.2.1 Demolition

Initial site preparation for the proposed project should commence with demolition of the existing pavements. The pavement thickness ranged from 8 1/8 to 10 1/8 inches at the boring locations. All broken asphaltic concrete, concrete, and other debris resulting from the demolition of the pavements should be removed from the site. Areas disturbed during demolition should be thoroughly evaluated by the geotechnical engineer prior to placement of structural fill. All disturbed soils should be undercut prior to placement of structural fill.

3.2.2 Moisture Conditioning and Compaction

Prior to placement of any required structural fill, the moisture content of the exposed subgrade should be evaluated. Moisture conditioning of the exposed subgrade may be required prior to proofrolling and/or fill placement. The moisture content of the exposed grade in these fill areas should be adjusted to within the range recommended for structural fill, to allow the exposed material to be compacted to a minimum of 95 percent of the standard Proctor density. Wet or unstable areas that hamper compaction of the

subgrade may require undercutting and replacement with structural fill or other stabilization techniques.

3.2.3 Test Rolling (Proofrolling)

Following moisture conditioning, it is recommended that the exposed grade be Test Rolled. Test Rolling should be performed in accordance with Oklahoma Department of Transportation (ODOT) "Standard Specifications for Highway Construction (2009)" Section 203.

3.2.4 Excavation

Excavation procedures should be performed in accordance with Oklahoma Department of Transportation (ODOT) "Standard Specifications for Highway Construction (2009)" Section 202.

3.2.5 Pavement Subgrade

In areas where soft and unstable subgrade conditions are encountered, pavement subgrade preparation procedures should be performed in accordance with Oklahoma Department of Transportation (ODOT) "Standard Specifications for Highway Construction (2009)" Section 310.

Depending upon site conditions at the time of construction and the construction schedule, the contractor may elect to expedite the subgrade preparation with chemical stabilization of unstable areas. Additional information associated with chemical stabilization of the pavement subgrade is provided in Section 3.6.

3.2.6 Construction Considerations

The moisture content of a portion of the soils encountered in a portion of the borings appeared to be relatively high. It is anticipated that due to the relatively high moisture contents of the soils, unstable subgrade conditions will be encountered during/following

demolition of the pavements. Drying, chemical stabilization, or replacement of the soils with a high moisture content may be required to provide a stable subgrade for the pavements.

A portion of the pavement subgrade soils appears to have a lower consistency. Removal and replacement of the lower consistency soils is required to provide adequate and uniform support for the proposed pavements. The lower consistency soils may extend to deeper depths and into other areas of the site than what was encountered during the field exploration.

3.3 LANDSCAPING AND SITE GRADING CONSIDERATIONS

Provisions should be made to reduce the potential for large moisture changes within pavement subgrade soils located adjacent to landscape areas, to reduce the potential for subgrade movement. Positive drainage should be incorporated into the design plans. Ponding of water adjacent to the pavements could contribute to significant moisture increases in the subgrade soils and subsequent movement.

Consideration should also be given to limiting landscaping and irrigation adjacent to the pavements. Trees and large bushes can develop intricate root systems that can draw moisture from the subgrade soils, causing them to shrink during dry periods of the year. Desiccation of soils below pavements can result in settlement.

3.4 CLIMATIC CONDITIONS

Weather conditions will influence the site preparation required. In spring and late fall, following periods of rainfall, the moisture content of the near surface soils may be significantly above the optimum moisture content. These conditions could seriously impede grading by causing an unstable subgrade condition. Typical remedial measures include aerating the wet subgrade, removal of the wet materials and replacing them with dry materials, or treating the material with cement kiln dust or Class “C” fly ash.

If site grading commences during summer months, moisture contents may be low and higher plasticity clay soils could have a high swell potential. Typically discing and moisture conditioning of the exposed subgrade materials to the moisture content criteria outlined in the STRUCTURAL FILL section will reduce this swell potential of the dry materials. As an alternative, the dry materials could be undercut and replaced with structural fill.

3.5 STRUCTURAL FILL

All structural fill utilized within the roadway alignment should consist of approved materials, free of organic matter and debris. The lab testing completed in conjunction with this project indicates that the soils encountered at the site could be utilized as structural fill within the roadway alignment. Imported material should meet the requirements as outlined in Section 4.3. Additional testing of the on-site soils at the time of construction should be performed prior to use as structural fill.

3.6 PAVEMENT SUBGRADES

3.6.1 General

The pavement subgrade is anticipated to consist of native soils, evaluated and approved existing/possible fill, and newly placed structural fill.

The pavement subgrades should be prepared as outlined in Sections 3.2 and 4.2. Disturbance, desiccation, and/or wetting of the subgrade following completion of the grading operations and prior to commencement of the paving operations may result in deterioration of the subgrade. A non-uniform subgrade would likely result in poor pavement performance and pavement failures soon after paving operations are completed.

The pavement subgrades be proofrolled and the moisture content and density of the top 8 inches of subgrade be checked within two days prior to commencement of actual paving operations. If any significant event, such as precipitation, occurs after

proofrolling, the subgrade should be reviewed by qualified geotechnical engineering personnel immediately prior to placing the pavement. The subgrade should be in its finished form at the time of the final review.

3.6.2 Pavement Subgrade Chemical Stabilization/Modification

Depending upon site conditions at the time of construction and the construction schedule, the contractor may elect to expedite the subgrade preparation with chemical stabilization of unstable areas. The soils encountered at the site have an AASHTO Classification of A-2-4, A-4, A-6, and A-7-6. According to the Oklahoma Department of Transportation (ODOT) "OHD L-50 SOIL STABILIZATION MIX DESIGN PROCEDURE", A-7-6 soils should be stabilized with hydrated lime, A-6 soils can be stabilized with hydrated lime or fly ash, A-4 soils can be stabilized with fly ash, and A-2-4 soils can be stabilized with Portland Cement or Cement Kiln Dust.

A soil stabilization mix design should be performed during construction in accordance with Oklahoma Department of Transportation (ODOT) "OHD L-50 Soil Stabilization Mix Design Procedure".

3.6.3 Existing Utilities

Numerous below grade utilities are located within the roadway alignment. The density/consistency of the utility trench backfill is not known. A portion of the utility trench backfill material may not be suitable for support of pavements. In order to provide uniform and suitable support for the pavements one or a combination of the following may be needed.

Unsuitable/unstable areas identified by the proofrolling operation should be: 1) undercut and replaced with structural fill, 2) scarified, aerated, and recompacted, 3) stabilized in place with shot rock, or 4) spanned through the use of bi-axial geogrid. Proofrolling can be accomplished through use of a fully-loaded, tandem-axle dump truck or similar equipment providing an equivalent subgrade loading. The method of stabilizing soft/unstable areas will be dependent upon the location/final use/elevation.

4. RECOMMENDATIONS

4.1 GENERAL

Based on the results of our evaluation, it is our professional opinion that the proposed project can be completed using standard earthwork and pavement construction operations.

The recommendations submitted herein are based, in part, upon data obtained from our subsurface exploration. The nature and extent of subsurface variations that may exist at the proposed project site will not become evident until construction. If variations appear evident, then the recommendations presented in this report should be evaluated. In the event that any changes in the nature, design, alignment, or grades of the proposed street reconstruction, the conclusions and recommendations contained in this report will not be considered valid unless the changes are reviewed and our recommendations modified in writing.

4.2 SITE PREPARATION

We recommend the following for site preparation:

1. All concrete, asphaltic concrete, and other debris resulting from the demolition of the pavements should be removed from the site. Areas disturbed during demolition should be thoroughly evaluated by the geotechnical engineer prior to placement of structural fill. All disturbed soils should be undercut prior to placement of structural fill.

2. Following demolition and any undercutting of unsuitable materials, the exposed subgrade should be scarified, moisture conditioned, and compacted to the requirements of structural fill.

3. Following moisture conditioning and recompaction, it is recommended that the exposed subgrade be Test Rolled (Proof Rolled). Test Rolling should be performed in accordance with Oklahoma Department of Transportation (ODOT) “Standard Specifications for Highway Construction (2009)” Section 203.

4. Pavement subgrade preparation should be performed in accordance with Oklahoma Department of Transportation (ODOT) “Standard Specifications for Highway Construction (2009)” Section 310.

4.3 STRUCTURAL FILL

We recommend the following for structural fill:

1. All fill material should have a maximum particle size of 3 inches.

2. All fill should be placed in lifts having a maximum loose lift thickness of 9 inches.

3. All fill shall be compacted to a minimum of 95 percent of the material's maximum dry density as determined by AASHTO T99, standard Proctor compaction.

4. The moisture content of the clay fill (Plasticity Index > 10) at the time of compaction should be within a range of 0 to 4 percent above optimum moisture content as defined by the standard Proctor compaction procedure.

5. For clays and silts having lower plasticities (Plasticity Index < 10) and sand, it may be necessary to use a moisture range of 2 percent below to 2 percent above optimum moisture content.

5. ADDITIONAL SERVICES

5.1 PLANS AND SPECIFICATIONS REVIEW

GFAC Engineering, Inc. should be provided the opportunity to conduct a general review of the final plans and specifications to evaluate that our earthwork and pavement subgrade preparation recommendations have been properly interpreted and implemented during design. If GFAC Engineering, Inc. is not retained to perform this recommended review, we will assume no responsibility for misinterpretation of our recommendations.

5.2 CONSTRUCTION OBSERVATION AND TESTING

All site preparation, placement of engineered fill, and pavement subgrade preparation should be monitored by a representative of GFAC Engineering Inc. or other geotechnical engineering firm. The purpose of these services would be to provide GFAC Engineering, Inc. the opportunity to observe the subsurface conditions encountered during construction, evaluate the applicability of the recommendations presented in this report, and recommend appropriate changes in design or construction procedures if conditions differ from those described herein.

6. LIMITATIONS

Recommendations contained in this report are based on our field observations and subsurface explorations, limited laboratory tests, and our present knowledge of the proposed construction. It is possible that subsurface conditions could vary between or beyond the points explored. If subsurface conditions are encountered during construction that differ from those described herein, we should be notified immediately in order that a review may be made and any supplemental recommendations provided. If the scope of the proposed construction, including the proposed loads or structural locations, changes from that described in this report, our recommendations should also be reviewed.

This report was prepared in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the site area at the time of our study. No warranty is expressed or implied. Recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be conducted by GFAC Engineering Inc. during the construction phase in order to evaluate compliance with our recommendations. Our scope of services did not include any environmental assessment or exploration for the presence of hazardous or toxic materials in the soil, surface water, groundwater or air, on, below or around this site.

This report may be used only by owner and only for the purposes stated, within a reasonable time from its issuance, but in no event later than three years from the date of report. Land use, site conditions (both on-site and off-site), regulations, or other factors may change over time, and additional work may be required with the passage of time. Any party other than the client who wishes to use this report shall notify GFAC Engineering Inc. of such intended use. Based on the intended use of the report, GFAC Engineering Inc. may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release GFAC Engineering Inc. from any liability resulting from the use of this report by any unauthorized party and client agrees to defend, indemnify and hold harmless GFAC Engineering Inc. from any claim or liability associated with such unauthorized or non-compliance.

APPENDIX A

FIELD EXPLORATION PROGRAM
PLATE 1 – SITE VICINITY MAP
PLATES 2, 3, 4, 5 – BORING LOCATION PLAN
BORING LOGS
PAVEMENT CORE PHOTOGRAPHS

FIELD EXPLORATION PROGRAM

The fieldwork was completed by representatives of GFAC Engineering Inc. on March 22, 2016. The exploration consisted of eleven (11) borings and eleven (11) pavement cores. The borings extended to approximate depths ranging from 1.8 to 5 feet below the existing pavement surface levels. Representatives of GFAC Engineering Inc. established the boring locations in the field by measuring distances from existing site features. Boring locations should be considered accurate only to the degree implied by the methods used to obtain them. GFAC did not determine the ground surface elevations at the boring locations.

Where possible, the borings were drilled using a truck-mounted (CME-55), rotary drill rig using solid flight augers. Samples were obtained utilizing the split-barrel sampling procedure in general accordance with ASTM D 1586. The split-barrel sampling procedure uses a standard 2-inch O.D. split-barrel sampler that is driven into the bottom of the boring with a 140-pound auto-hammer falling a distance of 30 inches. The number of blows required to advance the sampler the last 12 inches of a normal 18 inch penetration is recorded as the Standard Penetration Resistance Value (N). These "N" values are indicated on the boring logs at their depth of occurrence and provide an indication of the consistency and hardness of the material. Boring locations which did not allow the use of a drilling rig due to the presence of overhead or below grade utilities were performed with a hand auger.

Boring logs included in this appendix, present such data as soil and bedrock descriptions, consistency, relative density, and bedrock hardness evaluations, depths, sampling intervals and observed groundwater conditions. Conditions encountered in each of the borings were monitored and recorded by the field engineer. Field logs included visual classification of the materials encountered during drilling, as well as drilling characteristics. The final boring logs represent the engineer's interpretation of the field logs combined with laboratory observation and testing of the samples. Stratification boundaries indicated on the boring logs were based on observations during our fieldwork, an extrapolation of information obtained by examining samples from the borings and comparisons of soils with similar engineering characteristics.

Locations of these boundaries are approximate, and the transitions between soil and bedrock types may be gradual rather than clearly defined.

SOURCE: ESRI

Not to Scale

Site Location Map
Arterial Street Maintenance
N. Sheridan Road – E. Pine to E. Apache
Tulsa, Oklahoma
Project G2016021 April 12, 2016

Plate 1

SOURCE: ESRI

Not to Scale

Boring Location Diagram
Arterial Street Maintenance
N. Sheridan Road – E. Pine to E. Apache
Tulsa, Oklahoma
Project G2016021 April 11, 2016

SOURCE: ESRI

Not to Scale

Boring Location Diagram
Arterial Street Maintenance
N. Sheridan Road – E. Pine to E. Apache
Tulsa, Oklahoma
Project G2016021 April 11, 2016

Plate 3

SOURCE: ESRI

Not to Scale

Boring Location Diagram
Arterial Street Maintenance
N. Sheridan Road – E. Pine to E. Apache
Tulsa, Oklahoma
Project G2016021 April 11, 2016

SOURCE: ESRI

Not to Scale

Boring Location Diagram
Arterial Street Maintenance
N. Sheridan Road – E. Pine to E. Apache
Tulsa, Oklahoma
Project G2016021 April 11, 2016

Plate 5

GFAC ENGINEERING INC.
8157 E. 46th Street
Tulsa, Oklahoma 74145
Telephone: 918-622-7021

BORING NUMBER B-1

CLIENT AAB Engineering, LLC
PROJECT NAME North Sheridan Road
PROJECT NUMBER G2016021
PROJECT LOCATION E. Pine Street to E. Apache Street, Tulsa, OK
DATE STARTED 3/22/15 **COMPLETED** 3/22/15
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GFAC Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Auger
AT TIME OF DRILLING --- Dry
LOGGED BY DLK **CHECKED BY** DLK
AT END OF DRILLING --- Dry
NOTES _____
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	Texas Cone Penetrometer	BLOW COUNTS (N VALUE)	Uncon. Strength (psf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		ASPHALT - 2-1/2 inches											
		CONCRETE - 7-1/2 inches											
		LEAN CLAY, moist, dark gray	AU 1	100					25	30	18	12	88
2.5		LEAN CLAY, moist, brown, tan, amber, and olive	AU 2	100					27				
		LEAN CLAY with sand, moist, tan and brown	AU 3	100					26				
5.0		Bottom of borehole at 5.0 feet.											

GFAC ENGINEERING INC.
8157 E. 46th Street
Tulsa, Oklahoma 74145
Telephone: 918-622-7021

BORING NUMBER B-2

CLIENT AAB Engineering, LLC
PROJECT NAME North Sheridan Road
PROJECT NUMBER G2016021
PROJECT LOCATION E. Pine Street to E. Apache Street, Tulsa, OK
DATE STARTED 3/22/15 **COMPLETED** 3/22/15
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GFAC Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Auger
AT TIME OF DRILLING --- Dry
LOGGED BY DLK **CHECKED BY** DLK
AT END OF DRILLING --- Dry
NOTES _____
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	Texas Cone Penetrometer	BLOW COUNTS (N VALUE)	Uncon. Strength (psf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0.0		ASPHALT - 1-7/8 inches											
		CONCRETE - 8-1/8 inches											
		AGGREGATE BASE - 12 inches											
		FILL - Limestone Screenings, moist, gray											
2.5													
		LEAN CLAY with sand, moist, orange and brown	AU 1	100					26	44	23	21	76
5.0													

Bottom of borehole at 5.0 feet.

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8157 E. 46th Street
Tulsa, Oklahoma 74145
Telephone: 918-622-7021

BORING NUMBER B-3

CLIENT AAB Engineering, LLC
PROJECT NAME North Sheridan Road
PROJECT NUMBER G2016021
PROJECT LOCATION E. Pine Street to E. Apache Street, Tulsa, OK
DATE STARTED 3/22/15 **COMPLETED** 3/22/15
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GFAC Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Auger
AT TIME OF DRILLING --- Dry
LOGGED BY DLK **CHECKED BY** DLK
AT END OF DRILLING --- Dry
NOTES _____
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	Texas Cone Penetrometer	BLOW COUNTS (N VALUE)	Uncon. Strength (psf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		ASPHALT - 1-3/4 inches CONCRETE - 7-1/2 inches											
		POSSIBLE FILL - Lean Clay, moist, tan, olive, and gray	AU 1	100					28				
		- olive, gray, and amber below 1.4 feet	AU 2	100					25				
2.5		- gray, amber, and tan below 3 feet	AU 3	100					25	47	23	24	92
5.0		Bottom of borehole at 5.0 feet.											

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BORING NUMBER B-4

CLIENT AAB Engineering, LLC
PROJECT NAME North Sheridan Road
PROJECT NUMBER G2016021
PROJECT LOCATION E. Pine Street to E. Apache Street, Tulsa, OK
DATE STARTED 3/22/15 **COMPLETED** 3/22/15
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR GFAC Engineering
GROUND WATER LEVELS:
DRILLING METHOD CFA 6"
AT TIME OF DRILLING --- Dry
LOGGED BY DLK **CHECKED BY** DLK
AT END OF DRILLING --- Dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	Texas Cone Penetrometer	BLOW COUNTS (N VALUE)	Uncon. Strength (psf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		ASPHALT - 1-3/4 inches											
		CONCRETE - 7-3/4 inches											
		FILL - Lean Clay with sandstone gravel, moist, brown, tan, and gray											
		POSSIBLE FILL - Lean Clay, moist, soft, dark brown and dark gray with orange, brown, and tan	SS 1	89		3-2-1 (3)			27	30	19	11	87
2.5													
			SS 2	100		1-3-11 (14)			28				
5.0		WEATHERED SANDSTONE, poorly cemented, yellowish tan, brown, and gray											

Bottom of borehole at 5.0 feet.

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BORING NUMBER B-5

CLIENT AAB Engineering, LLC
PROJECT NAME North Sheridan Road
PROJECT NUMBER G2016021
PROJECT LOCATION E. Pine Street to E. Apache Street, Tulsa, OK
DATE STARTED 3/22/15 **COMPLETED** 3/22/15
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GFAC Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Auger
AT TIME OF DRILLING --- Dry
LOGGED BY DLK **CHECKED BY** DLK
AT END OF DRILLING --- Dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	Texas Cone Penetrometer	BLOW COUNTS (N VALUE)	Uncon. Strength (psf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		ASPHALT - 1-7/8 inches CONCRETE - 8-1/4 inches											
		FILL - Limestone Screenings, moist, gray											
		POSSIBLE FILL - Sandy Silt, moist to wet, loose, brown and gray	AU 1	100					23	23	20	3	70
2.5		- dark olive gray below 2.5 feet - with sandstone gravel below 2.8 feet											

Boring terminated at 3.2 feet due to hand auger refusal on possible sandstone bedrock or utility.
Bottom of borehole at 3.2 feet.

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BORING NUMBER B-6

CLIENT AAB Engineering, LLC
PROJECT NAME North Sheridan Road
PROJECT NUMBER G2016021
PROJECT LOCATION E. Pine Street to E. Apache Street, Tulsa, OK
DATE STARTED 3/22/15 **COMPLETED** 3/22/15
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR GFAC Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Auger
AT TIME OF DRILLING --- Dry
LOGGED BY DLK **CHECKED BY** DLK
AT END OF DRILLING --- Dry
NOTES _____
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	Texas Cone Penetrometer	BLOW COUNTS (N VALUE)	Uncon. Strength (psf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		ASPHALT - 1-1/2 inches CONCRETE - 8-3/8 inches											
		FILL - Lean Clay, brown and tan							20	25	25	NP	12
		FILL - Poorly Graded Sand with silt, loose, tan	SS 1	78		7-32/ 3"							
		CONCRETE											

Boring terminated at 1.8 feet due to encountering concrete during the samping operations - possible utility.
Bottom of borehole at 1.8 feet.

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BORING NUMBER B-7

CLIENT AAB Engineering, LLC
PROJECT NAME North Sheridan Road
PROJECT NUMBER G2016021
PROJECT LOCATION E. Pine Street to E. Apache Street, Tulsa, OK
DATE STARTED 3/22/15 **COMPLETED** 3/22/15
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GFAC Engineering
GROUND WATER LEVELS:
DRILLING METHOD Hand Auger
AT TIME OF DRILLING --- Dry
LOGGED BY DLK **CHECKED BY** DLK
AT END OF DRILLING --- Dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	Texas Cone Penetrometer	BLOW COUNTS (N VALUE)	Uncon. Strength (psf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		CONCRETE - 8-1/8 inches											
		LEAN CLAY, moist, gray and brown	AU 1	100					20				
2.5		FAT CLAY, moist, tan, gray, and brown	AU 2	100					25	58	24	34	94
		LEAN CLAY with trace sandstone and siltstone gravel, moist, brown, gray, and amber	AU 3	100					27				
		WEATHERED SANDSTONE, poorly cemented, olive, gray, and tan											

Boring terminated at 3.6 feet due to hand auger refusal on apparent sandstone bedrock.
Bottom of borehole at 3.6 feet.

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BORING NUMBER B-8

CLIENT AAB Engineering, LLC
PROJECT NAME North Sheridan Road
PROJECT NUMBER G2016021
PROJECT LOCATION E. Pine Street to E. Apache Street, Tulsa, OK
DATE STARTED 3/22/15 **COMPLETED** 3/22/15
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR GFAC Engineering
GROUND WATER LEVELS:
DRILLING METHOD CFA 6"
AT TIME OF DRILLING --- Dry
LOGGED BY DLK **CHECKED BY** DLK
AT END OF DRILLING --- Dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	Texas Cone Penetrometer	BLOW COUNTS (N VALUE)	Uncon. Strength (psf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		CONCRETE - 8-1/8 inches											
		AGGREGATE BASE - 3 inches											
		LEAN CLAY, moist, soft to medium stiff, gray, olive, and tan	SS 1	89		1-2-3 (5)			27	47	22	25	95
2.5		LEAN CLAY, moist, stiff, gray, tan, and amber	SS 2	89		3-3-5 (8)			28				
5.0		- trace weathered sandstone below 4.9 feet											
		Bottom of borehole at 5.0 feet.											

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BORING NUMBER B-9

CLIENT AAB Engineering, LLC
PROJECT NAME North Sheridan Road
PROJECT NUMBER G2016021
PROJECT LOCATION E. Pine Street to E. Apache Street, Tulsa, OK
DATE STARTED 3/22/15 **COMPLETED** 3/22/15
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR GFAC Engineering
GROUND WATER LEVELS:
DRILLING METHOD CFA 6"
AT TIME OF DRILLING --- Dry
LOGGED BY DLK **CHECKED BY** DLK
AT END OF DRILLING --- Dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	Texas Cone Penetrometer	BLOW COUNTS (N VALUE)	Uncon. Strength (psf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		CONCRETE - 8-1/2 inches											
		FILL - Silt with sand, moist, brownish red FILL - Limestone Screenings, wet, gray	SS 1	100		4-2-2 (4)			15	25	25	NP	75
2.5		FILL - Lean Clay with shale fragments, moist, gray											
		WEATHERED SANDSTONE, poorly cemented, brown and orange	SS 2	100		30-50/ 5.5"			13				

SPT refusal encountered in final sample for the boring at 4.5 feet.

Bottom of borehole at 4.5 feet.

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BORING NUMBER B-10

CLIENT AAB Engineering, LLC
PROJECT NAME North Sheridan Road
PROJECT NUMBER G2016021
PROJECT LOCATION E. Pine Street to E. Apache Street, Tulsa, OK
DATE STARTED 3/22/15 **COMPLETED** 3/22/15
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR GFAC Engineering
GROUND WATER LEVELS:
DRILLING METHOD CFA 6"
AT TIME OF DRILLING --- Dry
LOGGED BY DLK **CHECKED BY** DLK
AT END OF DRILLING --- Dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	Texas Cone Penetrometer	BLOW COUNTS (N VALUE)	Uncon. Strength (psf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		CONCRETE - 8-1/2 inches											
		FILL - Silty Clayey Sand, moist, orange and brown FILL - Limestone Screenings, moist, gray POSSIBLE FILL- Lean Clay with sandstone gravel, moist, stiff, tan	SS 1			4-6-7 (13)			15	22	16	6	36
2.5		POSSIBLE FILL - Weathered/Broken Sandstone, poorly cemented, tan - dark red below 2.5 feet											

Boring terminated at 2.7 feet due to encountering concrete or possible limestone while advancing the boring with augers.

Bottom of borehole at 2.7 feet.

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BORING NUMBER B-11

CLIENT AAB Engineering, LLC
PROJECT NAME North Sheridan Road
PROJECT NUMBER G2016021
PROJECT LOCATION E. Pine Street to E. Apache Street, Tulsa, OK
DATE STARTED 3/22/15 **COMPLETED** 3/22/15
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR GFAC Engineering
GROUND WATER LEVELS:
DRILLING METHOD CFA 6"
AT TIME OF DRILLING --- Dry
LOGGED BY DLK **CHECKED BY** DLK
AT END OF DRILLING --- Dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	Texas Cone Penetrometer	BLOW COUNTS (N VALUE)	Uncon. Strength (psf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		CONCRETE - 8-1/4 inches											
		POSSIBLE FILL - Sandy Lean Clay, moist, medium stiff, dark brown, tan, brown, and orange	SS 1	89		4-2-3 (5)			17	27	18	9	65
2.5		LEAN TO FAT CLAY, moist, medium stiff, brown, gray, and amber	SS 2	89		2-2-24 (26)			26				
5.0		WEATHERED SANDSTONE, poorly cemented, tan, brown, and amber											

Bottom of borehole at 5.0 feet.

Boring B-1


Arterial Street Maintenance
North Sheridan Road
E. Pine Street to E. Apache Street
Tulsa, Oklahoma
Project No.: G2016021
Boring No.: B-1
Empire Model 403 Empire Level Mfg. Corp. Mukwonago, WI 53149

Boring B-2


Arterial Street Maintenance
North Sheridan Road
E. Pine Street to E. Apache Street
Tulsa, Oklahoma
Project No.: G2016021
Boring No.: B-2
Empire Model 403 Empire Level Mfg. Corp. Mukwonago, WI 53149


Arterial Street Maintenance
North Sheridan Road
E. Pine Street to E. Apache Street
Tulsa, Oklahoma
Project No.: G2016021
Boring No.: B-3
Empire Model 403 Empire Level Mfg. Corp.

Boring B-4


Arterial Street Maintenance
North Sheridan Road
E. Pine Street to E. Apache Street
Tulsa, Oklahoma
Project No.: G2016021
Boring No.: B-4
Empire Model 403 Empire Level Mfg. Corp. Mukwonago, WI

Boring B-5


Arterial Street Maintenance
North Sheridan Road
E. Pine Street to E. Apache Street
Tulsa, Oklahoma
Project No.: G2016021
Boring No.: B-5
Empire Model 403 Empire Level Mfg. Corp. Mukwonago, WI

Boring B-6


Arterial Street Maintenance
North Sheridan Road
E. Pine Street to E. Apache Street
Tulsa, Oklahoma
Project No.: G2016021
Boring No.: B-6
Empire Model 403 Empire Level Mfg. Corp. Mukwonago, WI

Boring B-7


Arterial Street Maintenance
North Sheridan Road
E. Pine Street to E. Apache Street
Tulsa, Oklahoma
Project No.: G2016021
Boring No.: B-7
Empire Model 403 Empire Level Mfg. Corp.

Boring B-8


Arterial Street Maintenance
North Sheridan Road
E. Pine Street to E. Apache Street
Tulsa, Oklahoma
Project No.: G2016021
Boring No.: B-8
Empire Model 403 Empire Level Mfg. Corp.

Boring B-9


Arterial Street Maintenance
North Sheridan Road
E. Pine Street to E. Apache Street
Tulsa, Oklahoma
Project No.: G2016021
Boring No.: B-9
Empire Model 403 Empire Level Mfg.Corp.

Boring B-10


Arterial Street Maintenance
North Sheridan Road
E. Pine Street to E. Apache Street
Tulsa, Oklahoma
Project No.: G2016021
Boring No.: B-10
Empire Model 403 Empire Level Mfg. Corp.

Boring B-11


Arterial Street Maintenance
North Sheridan Road
E. Pine Street to E. Apache Street
Tulsa, Oklahoma
Project No.: G2016021
Boring No.: B-11
Empire Model 403 Empire Level Mfg.Corp.

APPENDIX B

LABORATORY TESTING PROGRAM
STANDARD PROCTOR TEST RESULTS
PARTICLE SIZE DISTRIBUTION REPORT
BEARING RATIO TEST REPORT

LABORATORY TESTING PROGRAM

GENERAL

Laboratory tests were performed on select, representative samples to evaluate pertinent engineering properties of these materials. We directed our laboratory testing program primarily toward classifying the subsurface materials, and measuring index values of the on-site materials. Laboratory tests were performed in general accordance with applicable standards, and the results are presented on the respective boring logs. The laboratory testing program consisted of the following:

- **Moisture content tests** ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- **No. 200 sieve,** ASTM D 1140, Standard Test Methods for Amount of Material in Soils Finer Than the No. 200 Sieve
- **Sieve Analysis,** ASTM D 422, Standard Test Method for Particle Size Analysis of Soils
- **Atterberg limits tests** ASTM D 4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- **California Bearing Ratio** ASTM D 1883, Standard Test Method California Bearing Ratio (CBR) of Laboratory Compacted Soils Index of Soils
- **Visual classification** ASTM D 2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

CLASSIFICATION

All samples were examined in field by a geotechnical engineer using visual and manual procedures. The samples were classified in general accordance with the Unified Soil Classification System, and are shown on the boring logs.

Bedrock units encountered in the borings were described based on visual classification of disturbed auger cuttings and recovered samples, as well as drilling characteristics. Core samples may reveal other rock types.

Laboratory Compaction Characteristics of Soils

Curve No.: 1

Project No.: G2016021 **Date:** 04/08/2016

Project: NORTH SHERIDAN ROAD IMPROVEMENTS; E. PINE STREET TO E. APACHE STREET

Client: AAB ENGINEERING, LLC

Location: Composite Sample (B-1 through B-11)

Sample Number: 1

Remarks: NT - No Test

MATERIAL DESCRIPTION

Description: Lean Clay with sand, brown, tan, gray, orange

Classifications - **USCS:** CL **AASHTO:** A-6(18)

Nat. Moist. = NT %

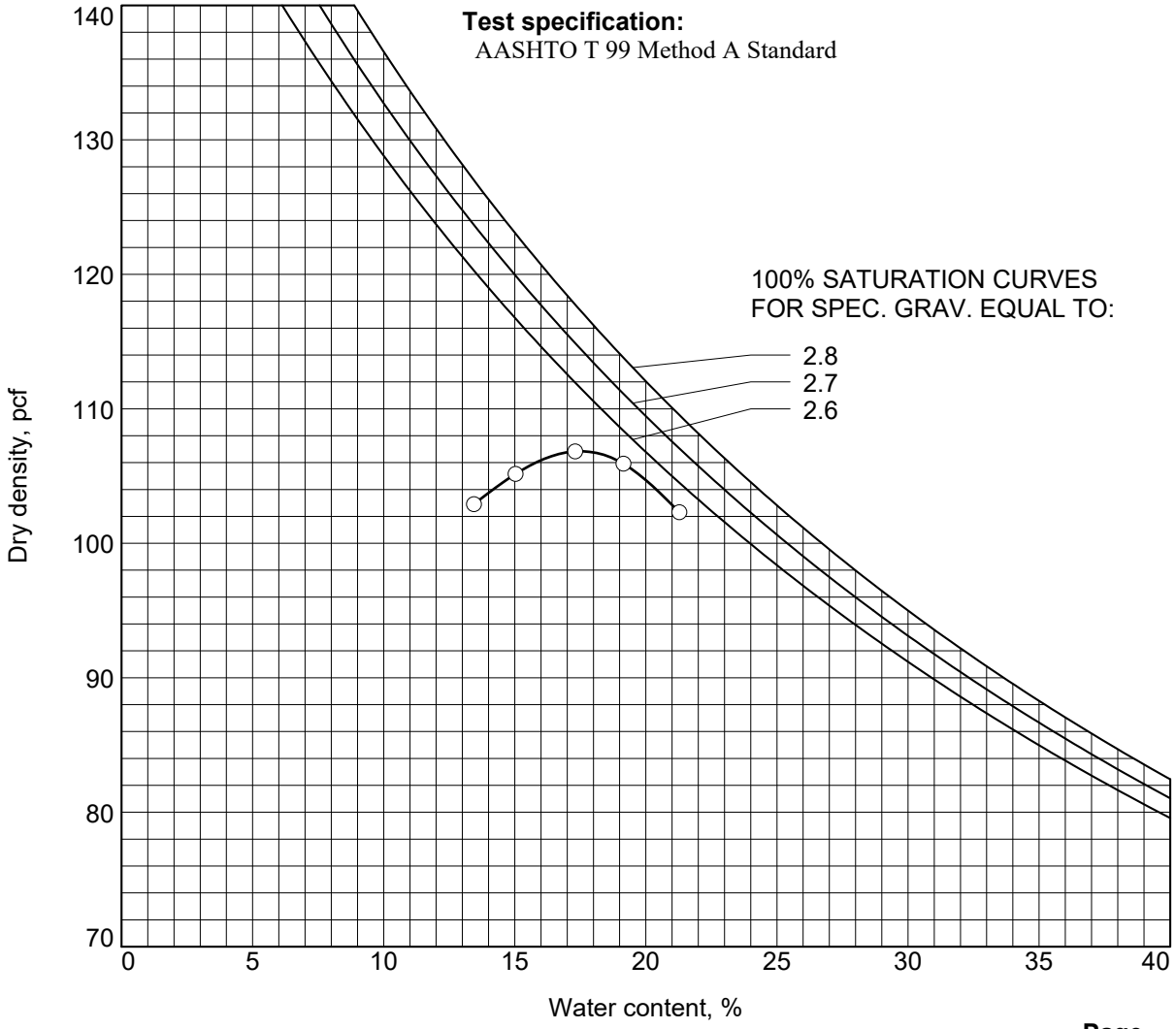
Sp.G. = NT

Liquid Limit = 38

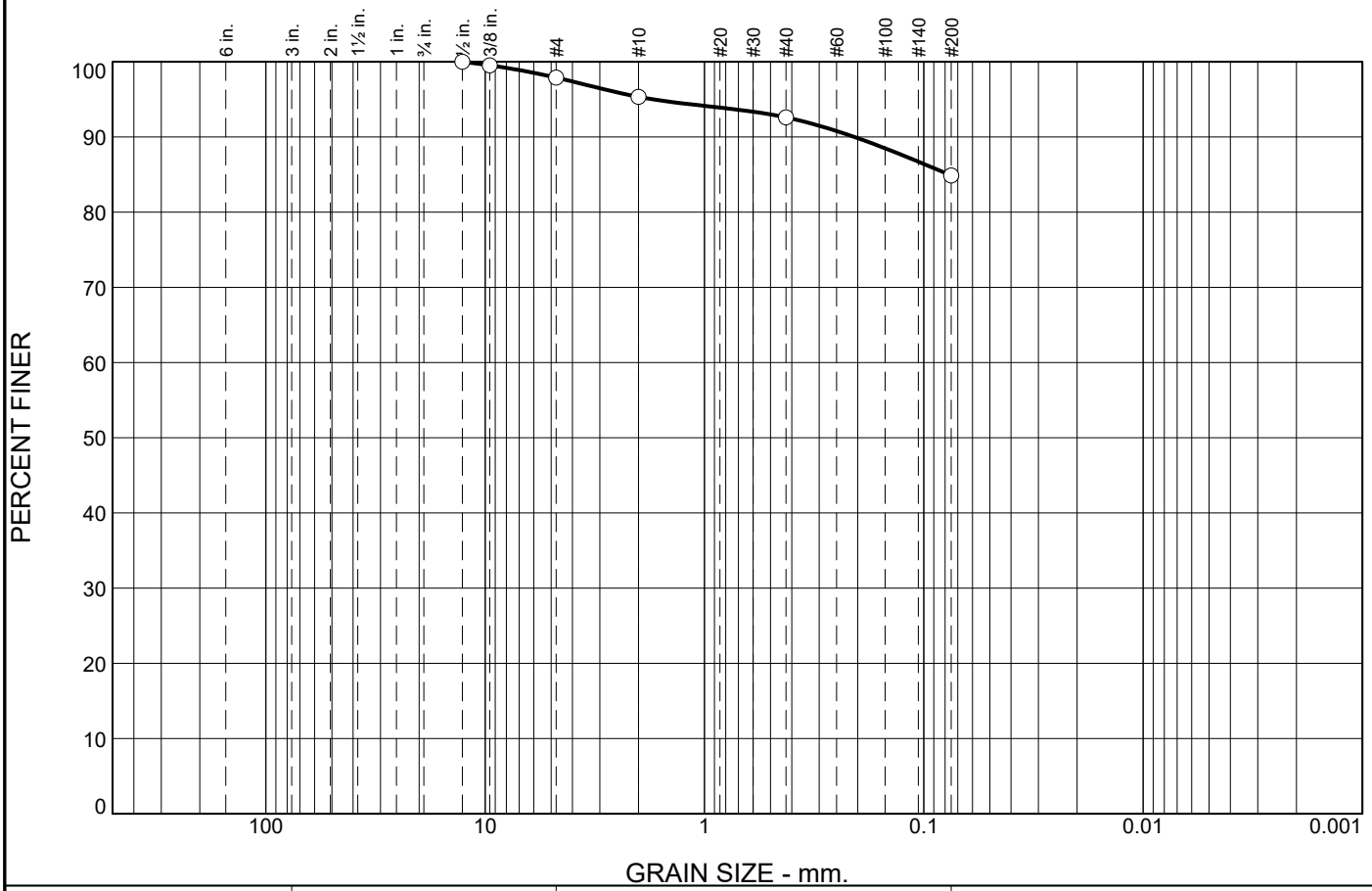
Plasticity Index = 22

% < No.200 = 84.9 %

TEST RESULTS
Maximum dry density = 106.8 pcf
Optimum moisture = 17.5 %



Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.1	2.6	2.7	7.7	84.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	99.5		
#4	97.9		
#10	95.3		
#40	92.6		
#200	84.9		

* (no specification provided)

Material Description

Lean Clay with sand, brown, tan, gray, orange

Atterberg Limits

PL= 16 LL= 38 PI= 22

Coefficients

D_{90}= 0.2070 D_{85}= 0.0766 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(18)

Remarks

Location: Composite Sample (B-1 through B-11)

Sample Number: 1 **Date:** 04/08/2016

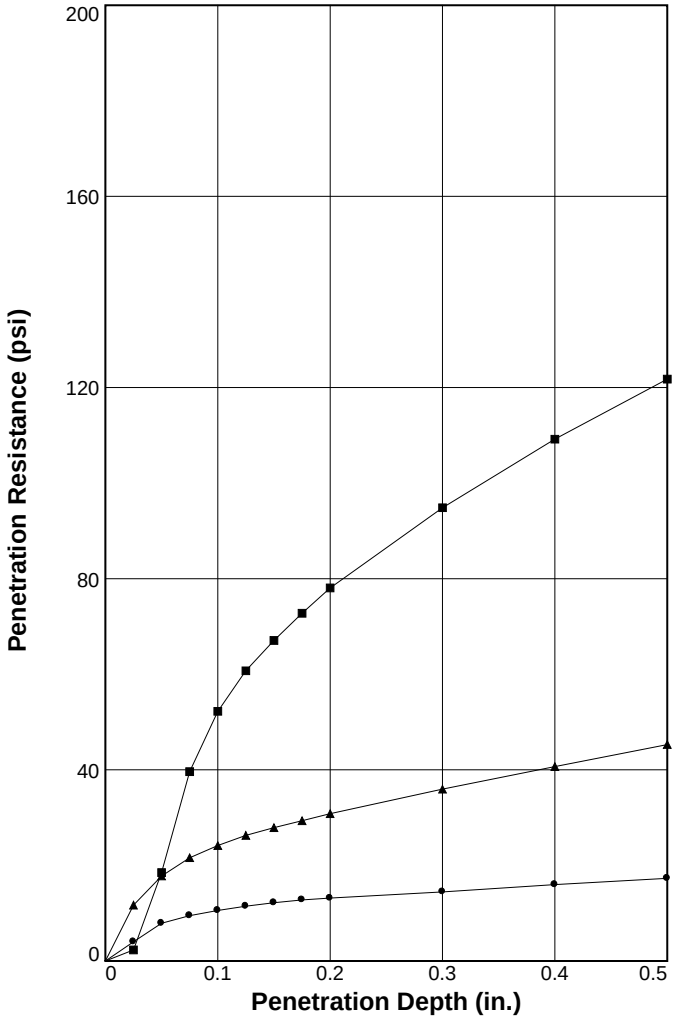
GFAC ENGINEERING
TULSA - MUSKOGEE
OFFICE 918.683.8600
GFACENG.COM

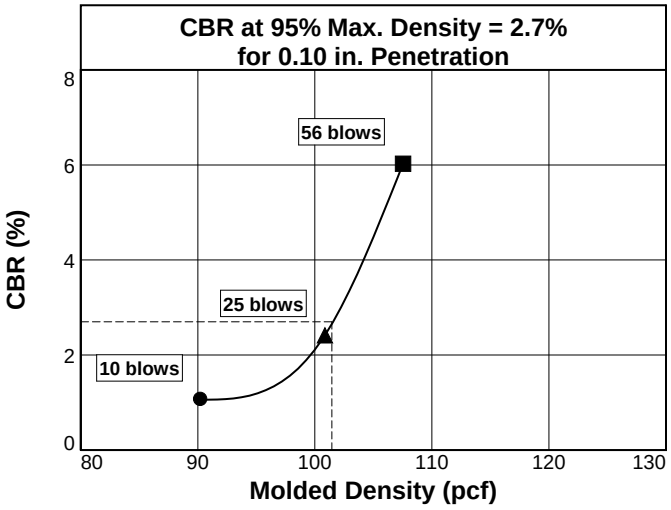
Client: AAB ENGINEERING, LLC

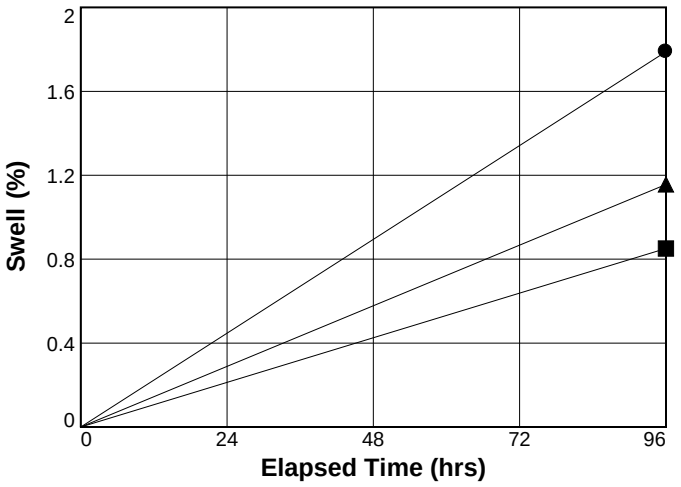
Project: NORTH SHERIDAN ROAD IMPROVEMENTS
E. PINE STREET TO E. APACHE STREET

Project No: G2016021

BEARING RATIO TEST REPORT
ASTM D 1883-07







	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ○	90.3	84.6	17.7	88.7	83	27.2	1.1	0.9	0.000	10	1.8
2 △	100.9	94.5	17.7	99.7	93.4	24.8	2.4	2.1	0.000	10	1.2
3 □	107.5	100.7	17.8	106.6	99.8	20.9	6.0	5.5	0.024	10	0.9

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Lean Clay, brown, tan, gray, orange	CL	106.8	17.5	38	22

Project No: G2016021

Project: NORTH SHERIDAN ROAD IMPROVEMENTS; PINE TO APACHE

Location: Composite Sample (B-1 through B-11)

Sample Number: 1

Date: 04/08/2016

Test Description/Remarks:

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