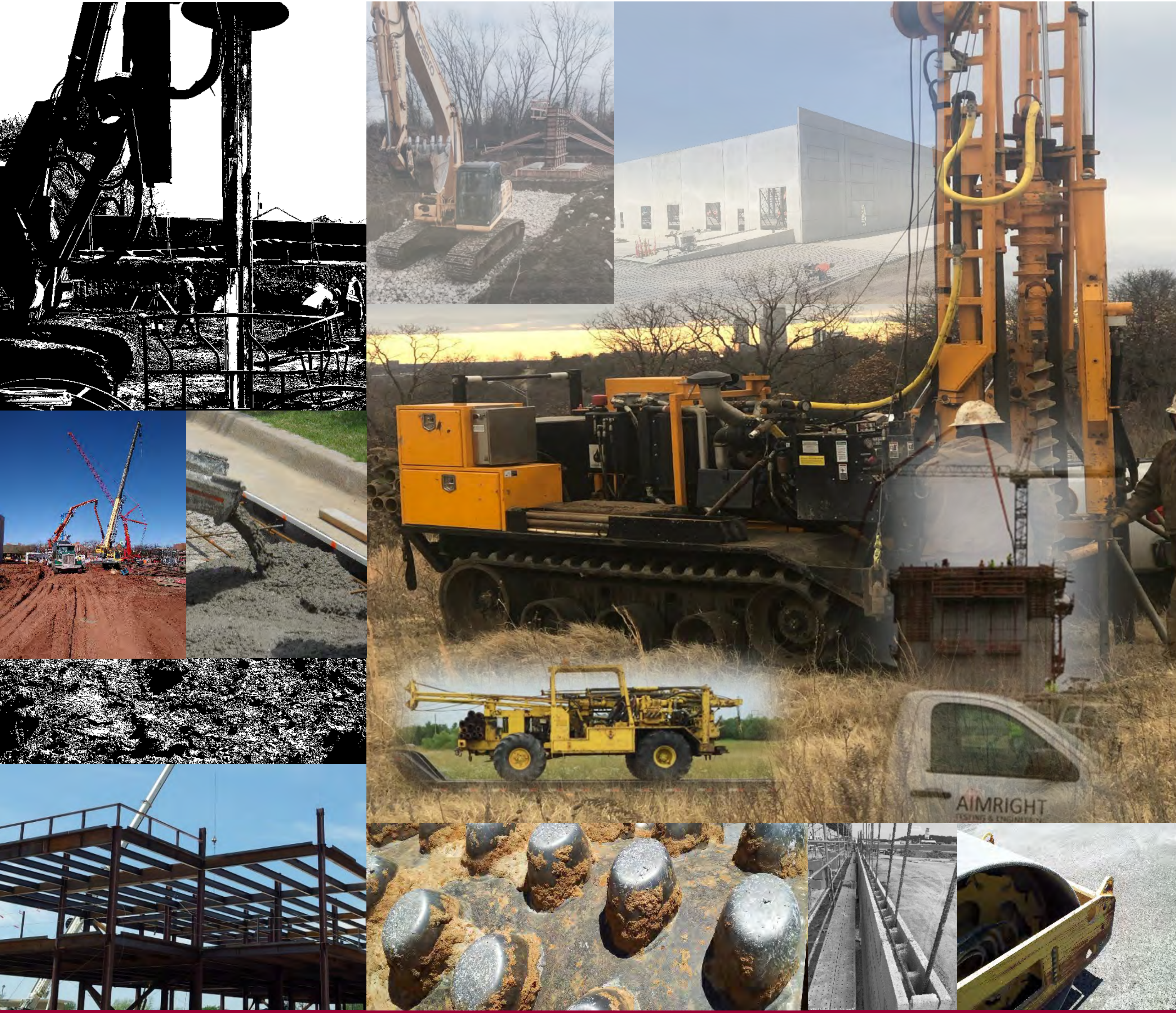

GEOTECHNICAL ENGINEERING REPORT

AIMRIGHT Project No. 17141124
December 30, 2024

City of Tulsa
Stormwater Maintenance & Operations Building

Prepared for:
BKL, Inc.

AIMRIGHT
TESTING & ENGINEERING

Construction Materials Testing • Special Inspections • Geotechnical Engineering

December 30, 2024

BKL, Inc.
1623 E 6th St
Tulsa, OK 74120
(918) 835-9588

Attn: Stacy Loeffler, PE, SE, Principal
loeffler@bklinc.com

Re: Geotechnical Engineering Report (Revised)
Project No. 17141124
City of Tulsa (CoT) Stormwater Maintenance and Ops Building
SEC of W 45th St & S Elwood Ave, Tulsa, OK 74107

It has been a pleasure serving you on this project. AIMRIGHT is pleased to submit this Geotechnical Engineering Report for the proposed construction planned at the referenced site. This report presents the findings of the geotechnical exploration and presents recommendations for design for the project.

We appreciate the opportunity to provide geotechnical consultation services for the subject project. We look forward to serving as your geotechnical engineer and construction materials testing laboratory for the remainder of this and future projects. Please do not hesitate to contact us with any concerns or questions regarding this report.

Respectfully submitted,

AIMRIGHT Testing & Engineering, LLC
CA No. 5794 (exp. 6/30/26)
Shon J. Jessee, PE
Senior Engineer
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REGISTERED PROFESSIONAL ENGINEER
SHON JESSEE
30 Dec 2024
27819
OKLAHOMA

Project Description

We understand that a new one-story structure (~17,000 sf) and associated parking/drive areas will be constructed on the referenced site. The final site design has not been completed. The proposed construction site is generally undeveloped with existing above/below-grade infrastructure, sidewalks/pavements along the perimeter, and grass/soil covered areas with few trees or shrubbery.

Cut and/or fill depths have not been finalized; however, we understand that cut/fill of approximately 6 to 18 inches will be required to reach the general final site elevations.

The structure is anticipated to be steel framed with brick veneer and supported by a concrete slab-on-ground and shallow foundations. Information regarding estimated structural loading conditions was not provided; however, we utilized maximum column loads of 20 to 60 kip and wall loads of 1 to 3 kip per linear foot in our engineering analyses

The new parking/drive areas will more than likely be constructed with an asphalt and/or concrete surface and aggregate base course overlying a properly prepared subgrade. Information regarding estimated traffic loading conditions was not provided; however, we utilized an estimated 20-year traffic volume to be equal to 25,000 (standard duty) and 50,000 (heavy duty) equivalent 18-kip single-axle loads (ESALs).

Scope of Services

The primary purpose of this report is to provide geotechnical engineering recommendations for the proposed site development. Our Scope of Services consisted of the following:

1. Drilling eight (8) soil test borings (borings) to depths of approximately 5 to 40 feet.

2. Performing laboratory testing of selected soil samples obtained from the borings.

3. Providing engineering analysis and preparation of this report discussing, in general, project description, our scope, exploration, testing, analysis, and recommendations.

The Boring Location Plan, Boring Logs, and other supporting data are presented in the Appendices to this report. Our Scope of Services did not include a survey of boring locations and elevations, rock coring, quantity estimates, preparation of plans or specifications, slope stability analysis, or the identification and evaluation of environmental aspects of the project site.

AIMRIGHT located the borings in the field by making measurements from known existing site features. No claim is made as to the accuracy of the locations shown on the Boring Location Plans, and they should be considered approximate.

The borings were advanced using an ATV-mounted drill rig equipped with an automatic hammer and rotary continuous flight augers. Representative soil samples were obtained using a standard 2-inch outside diameter split-barrel sampler in general compliance with the Standard Penetration Testing (SPT) method of the American Society of Testing and Materials (ASTM) D1586 standard to evaluate the consistency and general engineering properties of the subsurface soils.

The number of blows required to drive the split-barrel sampler three (3) consecutive 6-inch increments is recorded, and the blows of the last two 6-inch increments are added to obtain the SPT N-value in blows per foot (bpf) representing the penetration resistance of the soil. Upon encountering 50 blows within any 6-inch increment, N-values are recorded as 50/measured penetration in inches. At regular intervals within the borings, split-spoon samples were visually classified based on texture and plasticity.

During the drilling process, all encounters with groundwater, if any, were recorded. Upon completion of drilling, all borings were backfilled per OWRB requirements and topped with concrete and/or asphalt patch compound, if applicable.

The samples obtained from the geotechnical exploration were transported to the AIMRIGHT laboratory where representative samples were selected for testing. Testing consisted of Atterberg limits, sieve analysis, and determination of moisture content in general accordance with the ASTM testing procedures.

Laboratory Testing

Laboratory tests were conducted on selected samples in general accordance with ASTM standards. The laboratory testing performed for this project consisted of Atterberg Limits (ASTM D4318), Sieve Analysis – No. 200 Sieve Wash Method (ASTM D1140), and Moisture Content (ASTM D2216) testing. The test results are presented on the Boring Logs and the results are summarized below.

Boring No.	**Depth Interval (ft)**	**Moisture Content (%)**	**Finer than No. 200 Sieve (%)**	**Liquid Limit (%)**	**Plastic Limit (%)**	**Plasticity Index**
B-1	0 to 1.5	17.1	85.3	31	15	16
	1.5 to 3	10.8				
	3.5 to 5	15.6				
	8.5 to 10	7.4				
B-2	0 to 1.5	6.2	35.7	19	11	8
	1.5 to 3	12.6				
	3.5 to 5	15.7				
	6 to 7.5	16.2				
B-3	0 to 1.5	11.2	26.7	29	16	13
	1.5 to 3	13.8				
	3.5 to 5	19.2				
	6 to 7.5	14.7				
B-4	0 to 1.5	6.9				
	1.5 to 3	5.0	25.8	25	15	10
	6 to 7.5	8.6				
	8.5 to 10	2.3				
P-1	0 to 1.5	5.4	18.6	18	15	3
	1.5 to 3	13.4				
	3.5 to 5	13.2				
P-2	0 to 1.5	13.8				
	1.5 to 3	19.2				
	3.5 to 5	21.6	97.2	26	15	11
P-3	0 to 1.5	4.9				
	1.5 to 3	11.3				
	3.5 to 5	16.2	93.2	17	11	6
P-4	0 to 1.5	5.8				
	1.5 to 3	31.3				
	3.5 to 5	15.3	55.4	Non-plastic	Non-plastic	Non-plastic

Subsurface Conditions

The subsurface conditions outlined below represent a general interpretation of the boring data using normally accepted geotechnical engineering judgments. The transitions between soil strata are usually less distinct than shown on the Boring Logs.

Stratum	Depth to Bottom of Stratum	General Description of Materials
Surface	2 to 24 inches	medium dense to very dense aggregate base
Native Soils	33.5 feet	medium stiff to hard lean clay with varying amounts of silt, sand, and gravel; and loose to very dense sand with varying amounts of gravel, silt, and clay
Weathered Rock	(greater than 40 feet)	soft to moderately hard shale

Groundwater

Groundwater was encountered while drilling in borings B-1 and B-3 at depths of 24 and 23 feet, respectively. Groundwater was not encountered during or at the completion of drilling in any of the remaining borings. Water traveling through soil and rock is often unpredictable and may be present at shallow depths. Due to the seasonal changes in groundwater and the unpredictable nature of groundwater paths, groundwater levels will fluctuate. As such, groundwater levels at other times of the year may be different than those described in this report.

Generally, the highest groundwater levels occur in late winter and early spring and the lowest levels in late summer and fall. Therefore, it is necessary during construction to be observant for groundwater seepage in excavations to assess the situation and make necessary changes. Where applicable, the contractor should determine the actual groundwater levels at the time of construction.

Site Preparation and Earthwork

Before proceeding with construction, AIMRIGHT recommends conducting a pre-grading meeting to discuss recommendations as outlined in this report. Where appropriate, existing utilities beneath the construction footprints should be properly abandoned; or, should be removed and backfilled with properly compacted engineered fill as outlined in this report.

Any existing structures, pavements, site elements, foreign stockpiles, topsoil/vegetation, wet, soft, or loose soils and any other deleterious non-soil materials should be removed to a minimum distance of 2 and 5 feet beyond the parking/drive area and structure footprints, respectively.

Upon completion of required excavations, proof-rolling of the subgrade with a 20 to 30-ton loaded truck or other pneumatic-tired vehicle of similar size and weight should then be performed. Proof-rolling should be performed during a time of good weather and not while the site is wet, frozen, or severely desiccated. The proof-rolling observation is an opportunity for the geotechnical engineer to locate inconsistencies intermediate of our boring locations in the existing subgrade.

All unsuitable materials observed during the evaluation and proof-rolling operations should be over-excavated and replaced with compacted fill or stabilized in place. The possible need for, and extent of over-excavation and/or in-place stabilization required can best be determined by the geotechnical engineer at that time.

The upper 8 inches of the existing subgrade in construction areas shall then be scarified, moisture-conditioned and re-compacted to at least ninety-five percent (95%) of the maximum dry density and within ±2 percentage points of the optimum moisture content as determined by a Standard Proctor (ASTM D698). The moisture content and compaction shall be maintained prior to beginning any fill or aggregate placement and/or construction. Depending on weather conditions prior to and during construction, the near surface soils may need moisture-conditioning to sufficiently enable adequate scarifying and compaction.

We note that some of the near surface materials (i.e., silty clayey sand, sandy silt, silty clay, silt, etc.) will often exhibit shearing as open subgrades under wheel loads and will not hold up well to construction activities, especially during wet periods. A layer of aggregate base or crushed stone quickly placed after subgrade preparation and verification will help confine the subgrade soils and reduce imminent disturbance from construction activities.

Excavation Difficulties

Highly to moderately weathered, soft to moderately hard shale was encountered in the borings beginning at depths of approximately 33.5 feet and extending down to the termination depths.

We anticipate the near-surface soils above these depths at the site can be excavated with pans, scrapers, backhoes, and front-end loaders using conventional means and methods.

Our experience indicates rock in a weathered, boulder, and/or massive form may vary erratically in location and depth within the referenced site. Therefore, there is always a potential that these materials could be encountered at shallower depths between the boring locations, and should be anticipated during construction.

Installation or excavation of proposed subgrade, foundations, or underground utilities (depending on layout and planned bottom elevations) within some portions may potentially require jackhammering, coring, ripping, or other suitable methods to remove these materials.

Site Drainage

An important aspect to consider during development of this site is surface water control. During the initiation of grading operations, we recommend that the grading contractor take those steps necessary to enhance surface flow and promote rapid clearing of rainfall and runoff water following rain events.

It should be incumbent on the contractor to maintain favorable site drainage during construction to minimize deterioration of otherwise stable subgrades.

Permanent positive drainage should be provided around the perimeter of the structures to minimize moisture infiltration into the foundation and/or subgrade soils. We recommend areas adjacent to the structures be provided with a fall of at least 6 inches for the first 10 feet outward from the structure areas.

All grades must provide effective drainage away from the structures during and after construction. Water permitted to pond next to the structures can result in unacceptable differential floor slab movements and cracked slabs and/or walls.

After construction, AIMRIGHT recommends verifying final grades to document that effective drainage has been achieved. Grades around the structures should also be periodically inspected and adjusted as necessary, as part of the structure's maintenance program.

Sprinkler mains and spray heads should be located a minimum of 5 feet away from the structure lines. Low-volume, drip style landscape irrigation should not be used near the structures.

Roof runoff should be collected in drains or gutters. Roof drains and downspouts should be discharged onto pavements which slope away from the structures or downspouts should be extended a minimum of 10 feet away from the structures.

Cut and Fill Slopes

From a general slope stability standpoint, we recommend that unreinforced fill slopes (where required to raise site grades) be sloped at 3(H):1(V) or flatter. The tops and bases of all slopes should extend at least 10 feet horizontally beyond the building limits before sloping.

Fill slopes placed over existing slopes should be adequately benched or keyed into the existing slopes so that fill is not placed and/or compacted on a sloping subgrade or vertical wall excavation. The benches will help facilitate compaction, reduce the potential for high differential settlements over short distances, and increase the overall global stability of the constructed fill.

Slopes should be protected with silt fencing during construction, stabilized and hydro-seeded or similarly seeded for permanent protection. We note that surficial sloughing/erosion of the slope face soils is most likely to occur until the face of the slopes are completely stabilized with vegetation.

Similarly, to reduce sloughing/erosion, surface water should be diverted away from the slope crest and face for both temporary and permanent slopes. It may be necessary to utilize stabilization materials (turf-reinforcement mat or similar), depending on the conditions encountered during the slope construction.

All fill materials should be placed under the full-time control and supervision of a qualified geotechnical engineer. All fill materials should be adequately compacted, as outlined in this report, and where applicable, all slopes should be seeded and maintained as soon as possible after construction.

Fill Material

A sample of each material type should be submitted to the geotechnical engineer for evaluation. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

All fill material in structural areas (including utility backfill) should be placed in continuous, horizontal lifts having a maximum pre-compacted thickness of 9 inches. Aggregate base should have a maximum pre-compacted thickness of 6 inches; and fill compacted with hand-held or smaller-sized equipment having a maximum pre-compacted thickness of 4 to 6 inches.

Each lift should be compacted to at least ninety-five percent (95%) of the maximum dry density and within ±2 percentage points of the optimum moisture content as determined by a Standard Proctor (ASTM D698), unless noted otherwise and maintained throughout construction activities.

A minimum of two (2) field tests to determine in-place density and moisture content should be performed per lift for each 2,000 and 5,000 sf within structural and parking/drive footprints, respectively.

Engineered Fill

Engineered fill should consist of approved materials that are free of organic matter and debris, exhibit a maximum plasticity index (PI) of 18, maximum liquid limit (LL) of 40, and a maximum rock size of 3.0 inches.

Native Soils

Native soils could be used as fill; whereby, upon re-use, the soils meet the requirements for engineered fill as stated in this report. Soils that do not meet engineered fill requirements may be exposed during earthwork activities. AIMRIGHT recommends conducting additional soil sampling and laboratory testing of any excavated or cut native soils during completion of grading activities to determine characteristics prior to beginning placement in structural areas.

Aggregate Base

Aggregate base shall meet the requirements for ODOT Type A, may be utilized as engineered fill, and beneath pavements shall be compacted to at least ninety-five percent (95%) of the maximum dry density and within ±2 percentage points of the optimum moisture content as determined by a Modified Proctor (ASTM D1557).

Lateral Earth Pressures

Lateral earth pressures vary as a function of construction sequence, type of backfill and retained soil, the rigidity of the retaining structure and the magnitude of any surface loading, if any, including stresses induced by adjacent building or wall loads on the retained soils. Adjacent footings or other surcharge loads may also exert appreciable additional lateral pressures. The effect of surcharge loads should be added to the recommended earth pressures to determine total lateral stresses.

Excavated in-situ or imported soils should be approved, placed, and compacted as outlined in this report. The values provided for soil types encountered at the site that are prepared in accordance with this report are illustrated, however, actual parameters are dependent on bearing material exposed and/or placed during construction. Values are provided for guidance and should only be utilized by experienced engineers and designers.

Material Type	γ	Φ	K_a	K_o	K_p
Clay w/ trace sand	90 to 110	5	0.84	0.91	1.19
Sandy Clay or Clayey Sand	110 to 115	15	0.58	0.74	1.69
Silty Sand or Sand w/ Silt	115 to 125	30	0.33	0.50	3.00
Washed Aggregate	90 to 105	35	0.27	0.43	3.69

γ - total unit weight (pcf)
Φ - angle of friction (°)
K_a - Rankine active earth pressure coefficient
K_o - Rankine at-rest earth pressure coefficient
K_p - Rankine passive earth pressure coefficient

All material to be considered retained backfill should extend a minimum distance of 0.5 times the wall height laterally from the heel of cantilever wall footings. In backfilling against the walls, care should be taken to prevent the backfill from being over compacted, as this could result in excessive lateral stresses against the walls. Heavy equipment should not operate within 5 feet of walls to prevent excess lateral earth pressures.

All retaining walls should be provided with a positive drainage system, so they are not subject to hydrostatic pressures. We recommend that a minimum one-foot-wide zone of free-draining washed aggregate be constructed adjacent to the back of the walls and extend down to a foundation drain (perforated drainpipe).

Washed aggregate should be placed in lifts no greater than 2 feet in thickness and compacted with a backhoe bucket or similar method. The washed aggregate should be placed using a separation geotextile at the interface between the remaining backfill material. The foundation drain should be positively graded to allow drainage of any water that may collect in the wall backfill.

Slab-on-ground Design

The structure subgrades should be prepared as described in this report. Four (4) inches or more of granular base should be placed over the final soil subgrade and shall meet the requirements outlined below.

Minimum Finer than 1.5-in Sieve	100%
Maximum Finer than No. 200 Sieve	15%
Maximum Plasticity Index	6

The modulus of subgrade reaction, k, values illustrated below are based on a 30-inch diameter plate load test.

k, at soil subgrade	100 psi/in
k, w/ 4 inches of Granular Base	125 psi/in

At the time of concrete placement, the granular base should be moist, but free of any self-draining water. If floor coverings are susceptible to moisture damage by moist floor conditions (capillary moisture), a vapor retarder should be placed below the slab-on-ground in accordance with the most recent addendum to ACI 302.1R-04 / 302.2R-06 and other current industry recommendations for use and placement of vapor retarders.

Shallow Foundation Design

The project structural engineer should determine the final foundation sizes based on the actual design loads, building code requirements, and other structural considerations. Structure foundations may be designed utilizing the following parameters.

Maximum Wall Loads	1 to 3 kip/ft
Maximum Column Loads	20 to 60 kip
Approved Bearing Material	engineered fill or native soils
Net Allowable Bearing Pressure (FS ≥ 2.5)	2,600 psf
Total Unit Weight, γ	100 to 115 pcf
Coefficient of Sliding Friction, μ	0.27 to 0.38
Angle of Friction, ø	5°
Rankine Passive Earth Pressure Coefficient, K_p	1.19
Minimum Footing Embedment	24 inches
Minimum Wall Footing Width	18 inches
Minimum Column Footing Width	30 inches
Estimated Total Settlement	≤ 1 inch
Estimated Differential Settlement	≤ ½ inch
2018 IBC Earthquake Loads Site Class	D

The recommended net allowable bearing pressure is based on foundations within approved bearing materials and is the pressure more than the minimum surrounding overburden pressure at the footing base elevation.

Values provided for material encountered at the site and/or anticipated import material that are prepared in accordance with this report are illustrated, however, actual parameters are dependent on bearing material placed and/or exposed during construction. Values are provided for guidance and should only be utilized by experienced engineers and designers. Exclude total passive pressure resistance within 2 feet of the adjacent lowest final site elevation.

Minimum depth applies to both perimeter footings and foundations in unheated areas. Minimum depth will provide frost protection and reduce the potential for moisture variation below the bearing level. Interior foundations should extend at least 12 inches below the final adjacent subgrade to provide minimum confinement.

The magnitude of the settlements will be highly influenced by the variation in excavation requirements across the structure footprint, the distribution of loads, and the variability of underlying soils.

Shallow Foundation Construction

All exposed foundation subgrades should be re-compacted, observed, evaluated, and verified for the design soil bearing pressure by the geotechnical engineer after excavation and prior to concrete placement. This evaluation should include, as a minimum, Dynamic Cone Penetrometer (DCP) testing at the planned bearing elevations at intervals of no less than 35 feet and extending to depths of at least 3 feet below the bearing elevations.

If unsuitable material is encountered during foundation bearing grade testing and inspections (DCP Testing), foundations should; 1) extend deeper to a more suitable bearing material and bear directly on this material; 2) extend deeper to a more suitable bearing material and backfill with lean concrete to the designed bottom of footing elevation (see Figure 1); 3) extend deeper to a more suitable bearing material and backfilled with engineered fill (see Figure 2). If option 3 is selected, the over-excavation should extend laterally to a minimum of ⅔ of the total depth of excavation.

To reduce differential settlement, it is imperative to ensure that all shallow foundations bear on a minimum of 12 inches of similar material. Where applicable, to prevent a "point-load" bearing condition where the newly placed engineered fill or native soils adjoins weathered rock within wall/column footings, we recommend over-excavating the weathered rock to a minimum depth of 12 inches within the entire length of the wall/column footing and backfilling with properly compacted engineered fill. Alternatively, the engineered fill and/or native soils may be over-excavated down to the weathered rock and backfilled with lean concrete to the designed bearing elevation as illustrated in Figure 1.

Foundation excavations must be maintained in a drained/de-watered condition throughout the foundation construction process and water should not be allowed to pond in any excavation. Excavations for footings should be made in such a way as to provide bearing surfaces that are firm and free of loose, soft, wet, or otherwise disturbed soils.

Foundations should be concreted as soon as practical after they are excavated, and concrete should also not be placed on frozen or saturated subgrades. When applicable, it is recommended that a 2 to 4-inch-thick "mud mat" of lean concrete be placed on the bearing soils to help protect the bearing surface from rainfall or adverse construction activities.

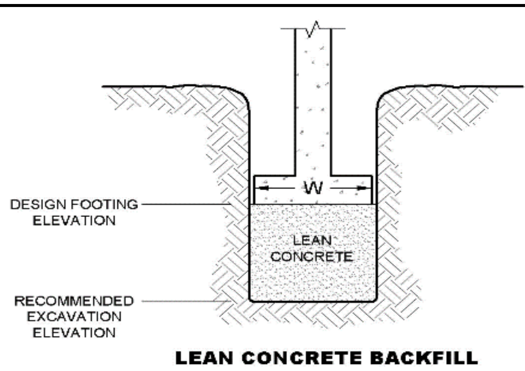

Figure 1

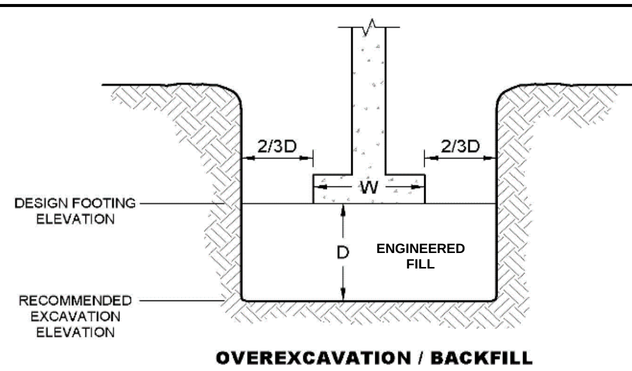

Figure 2

Note: Figures are shown for convenience and excavations shall be conducted with appropriate safety requirements.

Pavement Design

These recommendations are based on our discussions with you, interpretation of the field and laboratory data, assumed traffic loading conditions, review of the provided documents, our experience with similar projects and utilization of the 1993 AASHTO Pavement Design Guidelines.

AIMRIGHT recommends that governing authorities (i.e., city, county, or other recognized officials) be contacted to discuss appropriate pavement section requirements with respect to this project. The project architect or engineer of record should design the final pavement section. We utilized the design parameters as illustrated below. It is our opinion the tabulated minimum sections overlying a properly prepared subgrade as outlined in this report may be utilized for construction.

Estimated 20-yr Traffic ESALs, Standard	25,000
Estimated 20-yr Traffic ESALs, Heavy Duty	50,000
Subgrade Resilient Modulus, M_r	3,000 psi
Modulus of Subgrade Reaction, K	100 psi/in
Concrete Modulus of Rupture, R	650 psi
Load Transfer Coefficient	3.2
Drainage Coefficient	1.0
Reliability	85%
Overall Standard Deviation, Asphalt	0.40
Overall Standard Deviation, Concrete	0.35
Serviceability, Initial, Asphalt	4.2
Serviceability, Initial, Concrete	4.5
Serviceability, Terminal	2.0
Layer Coefficient, Asphalt Wearing	0.44
Layer Coefficient, Asphalt Base	0.40
Layer Coefficient, Aggregate Base	0.14

	Depth (inches)	
Concrete Pavement Section	**Standard**	**Heavy Duty**
Concrete (≥ 4,000 psi, air-entrained)	4.0	6.0
ODOT Type A Aggregate Base	4.0	4.0

Asphalt Pavement Section	Standard	Heavy Duty
ODOT Type B (S4) or C (S5)	2.0	2.0
ODOT Type A (S3)	2.0	4.0
ODOT Type A Aggregate Base	8.0	8.0

Pavements should be constructed in accordance with Oklahoma Department of Transportation (ODOT) and city or county governing specifications and applicable American Concrete Institute (ACI) guidelines.

A minimum thickness of 7 inches of concrete and 6 inches of aggregate base should be provided in front of and beneath dumpster areas or any other areas subjected to continuous concentrated truck wheel loading.

Pavement Construction

The parking/drive areas generally consist of near surface conditions that are generally suitable for support of the anticipated loads. However, soft, wet surface, or other unsuitable conditions may be encountered within some areas of the footprint. Remediation of these soils shall be required during site preparation and earthwork while following the recommendations outlined in this report.

AIMRIGHT recommends conducting additional soil sampling and laboratory testing of the final soil subgrades upon completion of the grading activities to determine characteristics and stabilization requirements prior to beginning pavement construction.

Where soils with PI greater than 18 are encountered, to provide the parking/drive areas with a more stable subgrade, at minimum, the upper 8 inches of the final soil subgrade plus an additional 2 feet beyond the footprint be constructed with properly compacted engineered fill or native soils stabilized with a lime or other appropriate additive.

The actual amounts of additive should be determined in the field and the modification/stabilization procedure shall be performed and monitored in general accordance with current ODOT Standard Specifications for Highway Construction Section 307 Subgrade Treatment.

In general, long-term pavement performance requires good drainage, performance of periodic maintenance activities, and attention to subgrade preparation. We emphasize that good base course drainage is essential for successful pavement performance and should always be maintained in a drained condition. Consideration for proper drainage design should be carefully evaluated where unequal minimum pavement sections meet (i.e., light, or standard to heavy duty). Depending on drainage flow design, it may be necessary to deepen the aggregate base course for the thinner section requirement.

Water build-up in the base course could result in premature pavement failures. Sub-drains are typically utilized beneath a pavement where water may enter the pavement from below or above. Based on the results of the borings, we do not anticipate that sub-drains are required for this site. However, site drainage problems may be revealed during construction that requires sub-drains.

Proper drainage may be aided by grading the site such that surface water is directed away from pavements and by construction of swales adjacent to the pavements. All pavements should be graded such that surface water is directed towards the outer limits of the paved areas or to catch basins located such that surface water does not remain on the pavement.

Construction Monitoring

We recommend that all earthwork construction be monitored by an experienced engineering technician at AIMRIGHT. Monitoring should include site preparation, subgrade earthwork, engineered fill earthwork, structure foundation systems, conventional and/or structural slabs.

Monitoring will allow AIMRIGHT to confirm the soil conditions on site and evaluate the recommendations presented within this report. If at the time of construction, our recommendations are inappropriate for the project, monitoring will allow us to remediate the recommendations at that time to better serve the project.

Monitoring during construction will also allow for the testing of all construction materials for the project. This includes but is not limited to:

✓subgrade inspection and density testing,
✓structural area fill placement density testing,
✓foundation bearing grade observations and testing,
✓structural and reinforcing steel inspection,
✓concrete testing, and
✓asphaltic concrete testing, as applicable.

We recommend that AIMRIGHT be retained to provide these services based upon our current familiarity with the project subsurface conditions, and the provided intent of the geotechnical recommendations pertaining to the proposed development.

Limitations

The recommendations are based on our observations at the site, interpretation and analysis of the field and laboratory data obtained during this exploration, assumed loads, and our experience with previous exploration and testing with similar projects. Soil penetration data have been used to estimate an allowable bearing pressure and associated settlement using established correlations. Subsurface conditions in unexplored locations may vary from those encountered.

Determination of an appropriate foundation system for a given structure is dependent on the proposed structural loads, soil conditions, and construction constraints such as proximity to other structures, etc. The subsurface exploration aids the geotechnical engineer in determining the soil stratum appropriate for structural support. This determination includes considerations regarding both allowable bearing pressure and compressibility of the soil strata. In addition, since the method of construction greatly affects the soils intended for structural support, consideration must be given to the implementation of suitable methods of site preparation, fill compaction, and other aspects of construction.

The recommendations provided are based in part on project information provided to us and they only apply to the specific project and site discussed in this report. If our statements or assumptions concerning the location and design of this project contain incorrect information, or if additional information is available, you should convey the correct or additional information to us and retain us to review our recommendations. We can then modify our recommendations if they are inappropriate for the proposed project. In the event changes are made in the proposed design/construction plans, the recommendations presented in this report shall not be considered valid unless reviewed by AIMIRIGHT and modified or verified in writing.

Regardless of the thoroughness of the geotechnical exploration, there is always a possibility that subsurface conditions will be different from those at a specific boring location and that conditions will not be as anticipated by the designers or contractors. In addition, the construction process may itself alter soil conditions. Therefore, experienced geotechnical personnel should observe and document the construction procedures used and the conditions encountered. Unanticipated conditions and inadequate procedures should be reported to the design team along with timely recommendations to solve the problems created. The conclusions and recommendations presented in this report were derived in accordance with standard geotechnical engineering practices and no other warranty is expressed or implied.

APPROXIMATE BORING LOCATIONS

BORING LOCATION PLAN

PROJECT NO.: 17141124
SOURCE: Aerial Imagery/Provided Plan

PROJECT: CoT Stormwater Maintenance and Ops Building
CLIENT: BKL, Inc.

AIMRIGHT TESTING & ENGINEERING

APPROXIMATE BORING LOCATIONS

BORING LOCATION PLAN

PROJECT NO.: 17141124

SOURCE: Aerial Imagery

PROJECT: CoT Stormwater Maintenance and Ops Building

CLIENT: BKL, Inc.

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LOG OF BORING B-1

AIMRIGHT TESTING & ENGINEERING

PROJECT: City of Tulsa (CoT) Stormwater Maintenance and Ops Building
CLIENT: BKL, Inc. **PROJECT NO.:** 17141124
PROJECT LOCATION: SEC of W 45th St & S Elwood Ave, Tulsa, OK 74107
LOCATION: see Boring Location Plan **ELEVATION:** N/A
DRILLER: B. Baxter **LOGGED BY:** C. Hale **DRILLING RIG:** D-50
DRILLING METHOD: Rotary Continuous Flight Auger **DATE:** 12/6/2024
DEPTH TO WATER> INITIAL: 24 **AT COMPLETION:** N/A **CAVING>** None

Depth (feet)	Description	Graphic	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
0	AGGREGATE BASE - 6 inches									
.5	LEAN CLAY w/ trace sand and gravel very stiff, brown mottled light grayish brown, moist		CL	15		17.1	85.3	31	15	16
1.5	SANDY LEAN CLAY w/ trace gravel hard, brown			40		10.8				
3.5	SANDY LEAN CLAY very stiff, dark brown, moist			12		15.6				
6	SANDY LEAN CLAY medium stiff, light brown, moist									
8.5	POORLY GRADED SAND, fine-grained, w/ trace clay medium dense, light reddish brown, moist			11		7.4				
13.5	POORLY GRADED SAND, fine-grained medium dense, light reddish brown, moist			14						
18.5	POORLY GRADED SAND, coarse-grained, w/ trace clay medium dense, light brown, moist			22						

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

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AIMRIGHT TESTING & ENGINEERING

LOG OF BORING B-1

PROJECT: City of Tulsa (CoT) Stormwater Maintenance and Ops Building
CLIENT: BKL, Inc. **PROJECT NO.:** 17141124
PROJECT LOCATION: SEC of W 45th St & S Elwood Ave, Tulsa, OK 74107
LOCATION: see Boring Location Plan **ELEVATION:** N/A
DRILLER: B. Baxter **LOGGED BY:** C. Hale **DRILLING RIG:** D-50
DRILLING METHOD: Rotary Continuous Flight Auger **DATE:** 12/6/2024
DEPTH TO WATER> INITIAL: 24 **AT COMPLETION:** N/A **CAVING>** None

Depth (feet)	Sampler Type	Description	Graphic	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
21											
22											
23											
24		POORLY GRADED SAND, coarse-grained, w/ trace clay loose, light brown, moist to wet			9	▽					
25–28											
29		POORLY GRADED SAND, fine-grained loose, medium reddish brown, moist to wet			8						
30–33											
33.5		SHALE w/ trace sand, moderately weathered moderately hard, dark gray, moist to wet			50/3.0						
35–38											
38.8					50/4.0						
		Boring terminated at 38.8 ft.									

AIMRIGHT TESTING & ENGINEERING

LOG OF BORING B-2

PROJECT: City of Tulsa (CoT) Stormwater Maintenance and Ops Building

CLIENT: BKL, Inc. **PROJECT NO.:** 17141124

PROJECT LOCATION: SEC of W 45th St & S Elwood Ave, Tulsa, OK 74107

LOCATION: see Boring Location Plan **ELEVATION:** N/A

DRILLER: B. Baxter **LOGGED BY:** C. Hale **DRILLING RIG:** D-50

DRILLING METHOD: Rotary Continuous Flight Auger **DATE:** 12/6/2024

DEPTH TO WATER> INITIAL: Dry **AT COMPLETION:** Dry **CAVING>** None

Depth (feet)	Description	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
0	AGGREGATE BASE - 24 inches - classifies as "CLAYEY GRAVEL w/ SAND" dense, light grayish brown, moist	GC	46		6.2	35.7	19	11	8
1.5		SC	35		12.6				
2	SANDY LEAN CLAY w/ trace gravel hard, brown								
3.5	LEAN CLAY w/ SAND, trace gravel very stiff, reddish brown, moist		19		15.7				
6	POORLY GRADED SAND, fine-grained, w/ trace clay medium dense, light reddish brown, moist		11		16.2				
8.5	POORLY GRADED SAND, fine-grained medium dense, light reddish brown, moist		14						
13.5			17						
18.5	POORLY GRADED SAND, coarse-grained medium dense, light reddish brown, moist		20						
20	Boring terminated at 20 ft.								

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

AIMRIGHT TESTING & ENGINEERING

LOG OF BORING B-3

PROJECT: City of Tulsa (CoT) Stormwater Maintenance and Ops Building
CLIENT: BKL, Inc. **PROJECT NO.:** 17141124
PROJECT LOCATION: SEC of W 45th St & S Elwood Ave, Tulsa, OK 74107
LOCATION: see Boring Location Plan **ELEVATION:** N/A
DRILLER: B. Baxter **LOGGED BY:** C. Hale **DRILLING RIG:** D-50
DRILLING METHOD: Rotary Continuous Flight Auger **DATE:** 12/6/2024
DEPTH TO WATER> INITIAL: 23 feet **AT COMPLETION:** N/A **CAVING>** None

Depth (feet)	Description	Graphic	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
0	AGGREGATE BASE - 24 inches - classifies as "CLAYEY GRAVEL w/ SAND" very dense, grayish brown, moist		GC	61		11.2	26.7	29	16	13
1.5				26		13.8				
1.5	CLAYEY SAND w/ gravel medium dense, brown, moist									
3.5	SANDY LEAN CLAY medium stiff, reddish brown, moist			6		19.2				
6	SANDY LEAN CLAY stiff, light reddish brown, moist			9		14.7				
8.5	POORLY GRADED SAND, fine-grained, w/ trace clay loose, light reddish brown, moist			6						
13.5	POORLY GRADED SAND, fine-grained, w/ trace clay medium dense, light reddish brown, moist			23						
18.5	POORLY GRADED SAND, fine-grained, w/ trace clay medium dense, light reddish brown, moist			13						

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AIMRIGHT TESTING & ENGINEERING

LOG OF BORING B-3

PROJECT: City of Tulsa (CoT) Stormwater Maintenance and Ops Building
CLIENT: BKL, Inc. **PROJECT NO.:** 17141124
PROJECT LOCATION: SEC of W 45th St & S Elwood Ave, Tulsa, OK 74107
LOCATION: see Boring Location Plan **ELEVATION:** N/A
DRILLER: B. Baxter **LOGGED BY:** C. Hale **DRILLING RIG:** D-50
DRILLING METHOD: Rotary Continuous Flight Auger **DATE:** 12/6/2024
DEPTH TO WATER> INITIAL: 23 feet **AT COMPLETION:** N/A **CAVING>** None

Depth (feet)	Sampler Type	Description	Graphic	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
21											
22											
23						▽					
24		POORLY GRADED SAND, coarse-grained, w/ trace clay loose, light brown, wet			8						
25–28											
29		POORLY GRADED SAND w/ trace gravel loose, brown, wet			6						
30–33											
33.5–34		SHALE w/ trace sand, highly weathered soft, dark gray, wet			50/5.0						
35–38											
39					50/5.0						
40		Boring terminated at 40 ft.									

AIMRIGHT TESTING & ENGINEERING

LOG OF BORING B-4

PROJECT: City of Tulsa (CoT) Stormwater Maintenance and Ops Building

CLIENT: BKL, Inc. **PROJECT NO.:** 17141124

PROJECT LOCATION: SEC of W 45th St & S Elwood Ave, Tulsa, OK 74107

LOCATION: see Boring Location Plan **ELEVATION:** N/A

DRILLER: B. Baxter **LOGGED BY:** C. Hale **DRILLING RIG:** D-50

DRILLING METHOD: Rotary Continuous Flight Auger **DATE:** 12/6/2024

DEPTH TO WATER> INITIAL: Dry **AT COMPLETION:** Dry **CAVING>** None

Depth (feet)	Description	Graphic	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
0	AGGREGATE BASE - 18 inches very dense, grayish brown, moist			55		6.9				
1.5	CLAYEY SAND w/ gravel dense, brown, moist		SC	48		5	25.8	25	15	10
3.5	CLAYEY SAND reddish brown, moist									
6	POORLY GRADED SAND, fine-grained, w/ trace clay medium dense, light reddish brown, moist			14		8.6				
8.5	POORLY GRADED SAND, fine-grained, w/ trace clay loose, light brown, dry to moist			10		2.3				
13.5	POORLY GRADED SAND, fine-grained, w/ trace clay medium dense, light brown, moist			15						
18.5				15						
20	Boring terminated at 20 ft.									

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

AIMRIGHT TESTING & ENGINEERING

LOG OF BORING P-1

PROJECT: City of Tulsa (CoT) Stormwater Maintenance and Ops Building
CLIENT: BKL, Inc. **PROJECT NO.:** 17141124
PROJECT LOCATION: SEC of W 45th St & S Elwood Ave, Tulsa, OK 74107
LOCATION: see Boring Location Plan **ELEVATION:** N/A
DRILLER: B. Baxter **LOGGED BY:** C. Hale **DRILLING RIG:** D-50
DRILLING METHOD: Rotary Continuous Flight Auger **DATE:** 12/6/2024
DEPTH TO WATER> INITIAL: Dry **AT COMPLETION:** Dry **CAVING>** None

Depth (feet)	Sampler Type	Description	Graphic	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
-1		CONCRETE - 14 inches									
0		AGGREGATE BASE - 18 inches - classifies as "SILTY GRAVEL and SAND" medium dense, reddish brown, moist	0	GM-SM	17		5.4	18.6	18	15	3
2		SILTY SAND w/ trace gravel medium dense, reddish brown, moist	1.5		14		13.4				
4		SILTY SAND medium dense, reddish brown, moist			8		13.2				
		Boring terminated at 5 ft.									

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

AIMRIGHT TESTING & ENGINEERING

LOG OF BORING P-2

PROJECT: City of Tulsa (CoT) Stormwater Maintenance and Ops Building

CLIENT: BKL, Inc. **PROJECT NO.:** 17141124

PROJECT LOCATION: SEC of W 45th St & S Elwood Ave, Tulsa, OK 74107

LOCATION: see Boring Location Plan **ELEVATION:** N/A

DRILLER: B. Baxter **LOGGED BY:** C. Hale **DRILLING RIG:** D-50

DRILLING METHOD: Rotary Continuous Flight Auger **DATE:** 12/6/2024

DEPTH TO WATER> INITIAL: Dry **AT COMPLETION:** Dry **CAVING>** None

Depth (feet)	Sampler Type	Description	Graphic	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
0		TOPSOIL - 6 inches									
.5–2		LEAN CLAY w/ sand, trace gravel hard, dark brown, moist			27		13.8				
1.5–3.5		SANDY LEAN CLAY very stiff, reddish brown, moist			18		19.2				
3.5–5		LEAN CLAY stiff, reddish brown, moist		CL	8		21.6	97.2	26	15	11

Boring terminated at 5 ft.

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

AIMRIGHT TESTING & ENGINEERING

LOG OF BORING P-3

PROJECT: City of Tulsa (CoT) Stormwater Maintenance and Ops Building
CLIENT: BKL, Inc. **PROJECT NO.:** 17141124
PROJECT LOCATION: SEC of W 45th St & S Elwood Ave, Tulsa, OK 74107
LOCATION: see Boring Location Plan **ELEVATION:** N/A
DRILLER: B. Baxter **LOGGED BY:** C. Hale **DRILLING RIG:** D-50
DRILLING METHOD: Rotary Continuous Flight Auger **DATE:** 12/6/2024
DEPTH TO WATER> INITIAL: Dry **AT COMPLETION:** Dry **CAVING>** None

Depth (feet)	Sampler Type	Description	Graphic	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
0		AGGREGATE BASE - 24 inches medium dense, grayish brown, moist			25		4.9				
1					49		11.3				
2		SILTY SAND w/ trace gravel dense, reddish brown, moist									
3.5		SILTY CLAY stiff, dark brown, moist		CL-ML	10		16.2	93.2	17	11	6
		Boring terminated at 5 ft.									

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

AIMRIGHT TESTING & ENGINEERING

LOG OF BORING P-4

PROJECT: City of Tulsa (CoT) Stormwater Maintenance and Ops Building
CLIENT: BKL, Inc. **PROJECT NO.:** 17141124
PROJECT LOCATION: SEC of W 45th St & S Elwood Ave, Tulsa, OK 74107
LOCATION: see Boring Location Plan **ELEVATION:** N/A
DRILLER: B. Baxter **LOGGED BY:** C. Hale **DRILLING RIG:** D-50
DRILLING METHOD: Rotary Continuous Flight Auger **DATE:** 12/6/2024
DEPTH TO WATER> INITIAL: Dry **AT COMPLETION:** Dry **CAVING>** None

Depth (feet)	Description	Layer Depth	USCS Symbol	SPT N-value (bpf)	Groundwater	Moisture Content	% < #200	Liquid Limit	Plastic Limit	Plasticity Index
0	AGGREGATE BASE - 2 inches	0.2								
1	CLAYEY SAND w/ gravel medium dense, light grayish brown, moist	1.5		27		5.8				
2	SILTY CLAY w/ trace gravel very stiff, dark brown, moist	3.5		19		31.3				
4	SANDY SILT medium stiff, dark reddish brown, moist		ML	6		15.3	55.4	NP	NP	NP

Boring terminated at 5 ft.

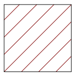
This information pertains only to this boring and should not be interpreted as being indicitive of the site.

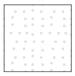
KEY TO SYMBOLS

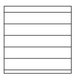
Symbol **Description**

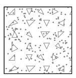
Strata Symbols

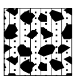
 **Clayey Gravel**

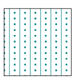
 **Low Plasticity Clay**

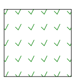
 **Poorly Graded Sand**

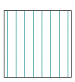
 **Shale**

 **Concrete**

 **Silty gravel and sand**

 **Silty Sand**

 **Topsoil**

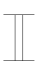
 **Silt**

Misc. Symbols

 Water Table during Drilling

Soil Samplers

 **Standard Penetration Test**

 **3-inch dia Shelby Tube**