Report of Geotechnical Exploration

Five Points Phase 4 Infrastructure Improvements
Knoxville, Tennessee

Prepared for:
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Prepared by:
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Project No. 1185073-01
December 13, 2018

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SHIELD
ENGINEERING, INC.

December 13, 2018

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Subject: **Report of Geotechnical Exploration**
Five Points Phase 4 Infrastructure Improvements
Knoxville, Tennessee
Shield Project No.: 1185073-01

Dear Ms. Floyd:

Shield Engineering, Inc. (Shield) has completed our geotechnical exploration for your proposed Five Points Phase 4 Infrastructure Improvements in Knoxville, Tennessee in general accordance with our proposal P2018-801 dated November 19, 2018. The scope of work authorized for this project included field activities, laboratory testing, and report preparation. Presented herein are the results of Shield's subsurface exploration, conclusions and geotechnical recommendations as they relate to our understanding of the proposed project.

1.0 EXECUTIVE SUMMARY

Shield was selected by you to perform a subsurface exploration for the proposed KCDC Five Points Phase 4 Development. The proposed project site is located in Knoxville, Tennessee. The objectives of our exploration were to determine general subsurface conditions, obtain data to evaluate the site for shallow foundation support, and recommend an appropriate soil bearing pressure.

The exploration consisted of drilling 20 test borings to 15 feet. The borings were drilled at locations as designated by you. The major findings and recommendations of our subsurface exploration are as follows:

- The subsurface drilling encountered topsoil, fill soils and residual soils. The fill soils were a heterogeneous mixture of brownish red to brown silty clay's with possible organic material, topsoil, bricks and asphalt. The underlying residual soil was a brown sandy clay material.

- Groundwater was not encountered at the time of drilling or completion, we do not expect groundwater to present a problem during construction.

- As the site currently exists it is not suitable for support of shallow foundations. It appears that following grading for the current site layout materials may have been wasted and spoiled outside of current building areas.

- Based on our observations and drilling data we believe that the site will require undercut and replacement prior to new fill placement or selective undercut and replacement in the building pad areas.

- Foundations may be designed for a maximum allowable so bearing pressure of 3,000 pounds per square foot (psf), provided our subsequent recommendations are followed for site preparation.

We recommend experienced geotechnical personnel observe subgrades, foundation excavations, fill placement, and other construction procedures. We recommend the owner retain Shield to provide these services based on our familiarity with the project, the subsurface conditions, the intent of the recommendations, and our experience in this area. This summary is only an overview and should not be used as a separate document or in place of reading the entire report, including the appendices.

2.0 PROJECT INFORMATION

Information has been provided to us in an email dated November 15, 2018. Included in the email was a drawing detailing the current site layout and proposed boring locations. The subject site currently the Walter P. Taylor homes development with multiple 2 story apartment buildings, pavement areas, and yard areas. The site is boarded to the north and east by Olive Street, south by Bethel Ave, and west by Connell Street.

No information regarding the construction of the building has been provided. We have assumed the new structure will be similar in construction and type to the surrounding development. Shield contacted Civil and Environmental Consultants, Inc. (CEC) and was provided the proposed site grading plans. Based on a review of the plans it appears cuts and fills will range from as little as 1 foot up to 5 feet.

No structural loading information for the proposed structure has been provided at this time. Shield has assumed that column and wall footings not exceeding maximum compressive loads of 75 kips and 4 kips per linear foot, respectively.

3.0 GEOLOGY & SOIL REVIEW

Knoxville, Tennessee is located in the Valley and Ridge Physiographic Province. This province is underlain by a continuous belt of well indurated (cemented) sedimentary bedrock that extends from central Alabama northward through Georgia, Tennessee, and Virginia into Pennsylvania. The formations that underlie the province consist of dolostone, limestone, shale, marble, and sandstone. These strata have been folded and faulted in the ancient past and are now inclined. The bedrock strata have been subjected to an extended period of erosion since their structural deformation and the erosion has produced a series of subparallel, alternating ridges and valleys

Based on a review of the Knoxville, Tennessee USGS Geologic Quadrangle the subject site is underlain by both the Ottossee Shale and Copper Ridge Dolomite. The Ottossee is mapped north of Bethel Ave and the Copper Ridge south of Bethel Avenue. The Ottossee is comprised mainly of gray to brown, calcareous, silty shale with occasional thin beds and lenses of limestone. The Ottossee weathers to a thin, light brown or tan residual soil with a "chippy" texture; this residuum generally grades progressively into weathered shale and "fresh" bedrock without a distinct soil-bedrock interface.

The Copper Ridge dolomite typically consists of dark, crystalline, siliceous dolomite interbedded with well-bedded, light gray, fine-grained dolomite and occasional sandstone. The coloration of the dark dolomite is caused by small amounts of asphaltic material. Upon weathering, the Copper Ridge dolomite produces a generally thick residual, silty, clay soil with abundant chert fragments and boulders.

3.1 Sinkhole Development and Risk Assessment

The dolomite bedrock underlying the southern portion of the site is of great geologic age and over time has undergone a natural weathering process that sometimes results in the formation of solution features (e.g. sinkholes). The formation of a sinkhole occurs from the loss of surrounding soil into a solution feature or void in the underlying bedrock and the eventual collapse of the overlying soil dome. The development of sinkholes is a natural and ongoing geologic process facilitated by the in-place weathering of the parent bedrock and movement of groundwater. However, the formation of sinkholes is often accelerated during the construction grading process by the downward seepage of surface water through freshly exposed fractures in the soil which remain from the geologic structure of the parent bedrock. Based on a review of the Knoxville, Tennessee USGS topographic quadrangle, it is Shield's opinion the property has a low risk for the development of future sinkholes affecting structures. It is important an owner understand and be made conscious of the risk associated with building in an area with sinkhole development in order to make a well informed decision regarding this risk. Shield has developed the three categories of "low risk," "moderate risk," and "high risk" to define the risk to the owner as follows:

- **Low Risk -** Less than one in ten thousand buildings built in a geologic setting underlain by bedrock susceptible to sinkhole development will undergo significant structural distress requiring demolition or significant repair.

- **Moderate Risk -** Between one in one thousand and one in ten thousand buildings built in a geologic setting underlain by bedrock susceptible to sinkhole development will undergo significant structural distress requiring demolition or significant repair.

- **High Risk -** More than one in one thousand buildings built in a geologic setting underlain by bedrock susceptible to sinkhole development will undergo significant structural distress requiring demolition or significant repair.

As mentioned previously, the exposed soils during grading often contain relic structures of the parent bedrock. During grading and stripping of topsoil, the soils are exposed to surface water from rainfall and will transport groundwater downward more rapidly resulting in a greater possibility of new sinkhole formation. This risk increases in areas where the underlying bedrock has been exposed. To reduce the risk of sinkhole formation, designing and creating positive drainage to maintain a well drained condition for the entire development area is imperative. The pooling or collection of standing water in areas other than designated and designed detention/retention ponds is discouraged.

The continued formation and development of sinkholes cannot be eliminated, but during site development there are several good practices that can be utilized to further reduce the potential for sinkhole formation. The four recommended practices are as follows:

1. In areas of cut, scarify and re-compact the exposed upper nine inches of soil to develop a less permeable layer of material.

2. In suspect areas, utilize a liner system for ditches and water collection systems such as asphalt, concrete or geo-membranes.

3. Prior to slab placement, pressure test all under-slab piping before beginning service.

4. Route roof drains away from structure and specifically not beneath the structure.

4.0 FIELD EXPLORATION PROCEDURES

Our subcontractor, Tri-State Drilling, performed the field exploration December 3, 2018. The soil borings were drilled with a Geoprobe® drill rig outfitted for geotechnical drilling.. The test borings were advanced utilizing continuous flight hollow stem augers, with Standard Penetration Test (SPT) and soil sampling performed by means of the split-barrel sampling procedure in general accordance with ASTM D 1586. In this procedure, a 2 inch O.D., split-barrel sampler is driven into the soil a distance of 18 inches by a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through the final 12 inches of penetration is termed the standard penetration resistance or N-value value and is indicated for each sample on the boring logs in Appendix B. This value can be used as a qualitative indication of the in-place relative density of cohesionless soils. In a less reliable way, it also indicates the consistency of cohesive soils. This indication is qualitative, because many factors can significantly affect the N-value and prevent direct correlation between samples obtained by various drill crews, drill rigs, drilling procedures, and hammer-rod-spoon assemblies.

A total of 20Standard Penetration Test (SPT) soil borings were extended to depths of 15 feet below the existing ground surface. The boring locations were determined in the field by Shield personnel using visual approximation methods and site features. The approximate location of each boring is shown on the Boring Location Plan (Figure 2, in Appendix A). Groundwater readings were observed upon completion of the drilling operations. The borings were backfilled for safety reasons after the drilling process; therefore 24-hour water level readings are not available.

The recovered soil samples were visually classified in the field by the driller. Collected soil samples were labeled according to boring number and sample depth, placed in air-tight containers, and transported to Shield's laboratory where they were re-examined by our geotechnical engineer to verify the field classifications, and subjected to further testing and analysis.

The soil samples and the field data collected during the field exploration were used to assist in the description of the subsurface conditions, and for engineering evaluation purposes. The subsurface conditions observed at each test boring location are detailed on the Geotechnical Boring Logs in Appendix B, at the end of this report.

5.0 LABORATORY TESTING PROGRAM

The purpose of the laboratory testing program was to evaluate the mechanical and index properties of the subsurface soils encountered, and to assist in soil classification and relative strength evaluations. The laboratory testing program was performed in general accordance with applicable American Society for Testing and Materials (ASTM) test procedures. The laboratory testing program included the following tests:

- Moisture Content of Soils — ASTM D 2216
- Atterberg Limits (Liquid Limit, Plastic Limit, and Plasticity Index) — ASTM D 4318

5.1 <u>Summary of Laboratory Testing:</u>

Atterberg Limit testing was performed to assist in the classification and characterization of the encountered soils. Testing reveals the selected samples have Liquid Limits of 50 and 58 and Plasticity Indices of 22 and 26. Indicating lean clays. Natural moisture content testing was performed on random samples and revealed natural moisture range from 20.1 percent to 40.1 percent.,.

6.0 <u>SUBSURFACE CONDITIONS</u>

The Test Boring Logs presented in Appendix B represent our interpretation of the subsurface conditions based on tests and observations performed during the drilling operations at the test boring locations and visual examination of the soil samples. The lines designating the interfaces between various strata on the Test Boring Logs represent the approximate strata boundary; however, the transition between strata may be more gradual than shown, especially where indicated by a broken line. All data should only be considered accurate at the exact test boring locations.

6.1 <u>Description of General Soil Profile</u>:

The following paragraphs provide a general description of the soil conditions encountered. For soil descriptions at a particular boring location and depth, the respective boring log should be reviewed in Appendix B. Soils encountered on site were typically composed of topsoil and residuum. Topsoil is the highly organic material that forms at the ground surface that supports vegetation. Fill soils are soils that have been transported to their present location by man. Residuum is composed of soil materials developed from the in place weathering of the underlying parent bedrock.

From the ground surface topsoil was encountered in all borings with the exception of Boring's B-7, B-8, B-10, B-11, B–13,B-14,B-15, B-16, B-17, and B-18 ranging in depth from 4 inches to 6 inches. Asphalt and basestone was encountered in Borings B-10, B-11 and B-16 and demolition debris was present in Borings B-13 and B-14. The asphalt and basestone were a total of 9 inches thick and the demolition debris was 1 foot to 1.5 feet thick.

Fill materials were encountered in all borings with the exception of boring B -1, B-3 to B-5, B-11, B-12, B-14, and B-19. The fill soils were a heterogeneous mixture of brownish red to brown silty clay with black oxide stains, construction debris such as bricks and asphalt as well as pockets of topsoil. The fill material ranged from soft to stiff in nature. Fill depths ranged from 1.5 to 5.5 feet in depth. Standard Penetration Test (SPT) resistance values for the fill materials ranged from 3 to 15 blows per foot, indicating a soft to stiff consistency soil range with most of the soil typically in the stiff range.

Underlying the topsoil, asphalt and fill material in all borings, residual soils were encountered to the boring termination depths. The residual soil was composed of light brown to brownish silty Clay with trace black oxide staining. Yellowish to brown materials also encountered. SPT resistance values for the residuum ranged from 6 to 25 bpf, indicating a firm to very stiff soil consistency with most of the soil in the stiff range.

Auger refusal material was not encountered during drilling. All borings were terminated at their respective predetermined depth of 15 feet below existing grade.

6.2 Groundwater Observations:

Groundwater was not observed in the borings at the time of drilling. However, it is important to note that fluctuations in the elevation of the static groundwater table may occur seasonally and are also influenced by variations in precipitation, evaporation, site grading activities, surface water run off and/or the nearby presence of surface water features. Groundwater springs and seeps are common in the site geology and typically occur in the bottoms of the hollows.

We do not anticipate ground water to be a concern during construction.

7.0 FOUNDATION AND SITE PREPERATION RECOMMENDATIONS

Based on a review of the information from the test borings, laboratory test results and project information, the site is not currently suitable for the support of shallow spread footing foundations using conventional construction methods. The existing fill soils do not appear suitable for support of shallow foundations and will require undercut and replacement. Additionally, the onsite materials do not appear suitable for use as structural fill. Imported fill soils for use beneath buildings should be placed in accordance with our subsequent "Structural Fill Recommendations" are followed. Newly compacted fill soil under building areas, paving and driveway areas should be composed of clay, silt or shale types of soils.

Once the site is prepared, we recommend sizing the footings for a design soil bearing pressure of 3,000 psf subject to a footing inspection by a geotechnical engineer at the time of construction. **It is important to note that if a footing inspection is not performed, then the design soil bearing pressure provided above should be considered invalid.** The following sections provide recommendations for the installation of foundations, site preparation and the control and placement of structural fill.

7.1 Site Preparation Recommendations:

As the site currently exists, fill materials are present throughout the proposed development footprint. Most likely the site was previously developed for residential houses that were then razed and removed for the existing structures. Deleterious materials that included brick, asphalt and topsoil were most likely wasted outside of the existing building footprints in yard areas. Based on these observations it is Shield's opinion that undercutting and replacement of these materials will be necessary for site develop As such as Shield proposes the two options below for site preparation:

Option One – Total Undercut – One possibility for site development would be totally undercut and remove the fill materials from the site down to residual materials. These materials should be wasted offsite or stockpiled for use in yard areas The replacement soil should meet the criteria and installation per our structural fill recommendations below. We realize this may not be the most economical given the size of the site and average depth of fill materials encountered throughout the site.

Option Two – Partial Undercut – A second option that would be to selectively undercut and replace the existing fill soils in the proposed building pad locations down to residual materials. The proposed building pads should be located by a surveyor and the undercut should extend a minimum 10 feet outside the perimeter of the proposed building pad. For buildings that sit far enough apart from others it may be possible to isolate and selectively remove the individual building pad materials directly beneath the footprint. Where other structures are in sequence and closer to one another it may be more reasonable to undercut and replace a swath continuously beneath the buildings.

The soil material removed from the building pad undercut areas can be stockpiled on site and reused in parking and yard areas if the material does not consist of construction demolition debris. Soil material containing construction debris should either be placed in deeper fill areas or depending on the amount and type of construction debris may need to be wasted off site. in deeper fill areas beneath parking lots. The soil material undercut from the building pads, if reused in yard areas, should not be placed closer than 2 feet from final subgrade in parking and yard areas unless it is clean of previous construction demolition debris.

We recommend that all topsoil, vegetation, debris, and surface soil containing organic material be stripped from areas to be graded. If suitable, topsoil can be reused in areas to be landscaped.

After the completion of stripping and excavation to design subgrade elevations in cut areas, the exposed soil subgrade in cut and fill areas should be proofrolled with a fully loaded, tandem-axle dump truck, or other similarly-loaded, pneumatic-tired construction equipment. Proofrolling should be done after a suitable period of dry weather to avoid degrading an otherwise acceptable subgrade. The proofrolling equipment should make at least four passes over each section, with the last two passes perpendicular to the first two, where accessible. Areas not accessible for proofrolling should be probed by the Shield geotechnical engineer or his representative.

Proofrolling should be observed and documented by the Shield geotechnical engineer or his representative. Soft, rutting or pumping soils should be undercut to stiffer, more competent soils and backfilled with structural fill or stabilized as recommended by Shield.

7.2 Structural Fill Recommendations:

Shield recommends after unsuitable materials identified during proofrolling or probing are removed and before filling operations begin, additional proofrolling or inspection should be performed.

Representative samples of each proposed fill material should be collected and tested to determine the compaction and classification characteristics. Soils which are found to contain deleterious material, including organics and topsoil, should not be used as structural fill for the support of structures or pavement. In addition, soils having a Plasticity Index (PI) in excess of 30 and/or a Standard Proctor (ASTM D 698) maximum dry density of less than 90 pcf should not be used without prior engineering evaluation and approval.

We recommend that fill placement be carefully observed by a Shield representative to determine if proper compaction is being achieved within the building and other structural fill areas. Improper compaction may result in premature deterioration of the pavement areas and/or differential foundation settlement. For structural fill placed within the confines of the proposed structures it may be necessary to separate pockets of high plasticity clay and/or provide moisture content control to ensure a suitable bearing surface for foundations and/or grade slabs.

The surface of the placed fill should be graded to provide positive drainage of surface water and prevent deterioration of the subgrade. We recommend that the contractor be responsible for maintaining a drained stable surface during and after the filling operations.

All controlled fill beneath footings, slab-on-grade and pavement areas should be placed in uniform lifts not exceeding 8 inch loose (un-compacted) thickness and compacted to at least 98 percent of the standard Proctor maximum dry density (ASTM D 698). The upper 2 feet of fill beneath paved areas and upper 1 foot beneath slab-on-grade should be compacted to at least 100 percent of standard Proctor maximum dry density. The density of each lift should be tested and approved by a qualified soils technician prior to the placement of additional fill. Fill surfaces should be gently sloped and sealed with rubber tired or smooth drummed equipment at the end of each day's operations and when precipitation is expected. This will improve surface run-off and minimize construction delays caused by the effects of ponding water. All sloped areas to receive fill with slopes steeper than 5H:1V should be properly benched. The horizontal limits of the areas subject to these recommendations should include a minimum 10 feet outside proposed building footprints, as well as other areas to receive additional fill.

7.3 Foundation Recommendations:

We recommend supporting the proposed foundations on shallow spread footings. Based on a review of the boring information and our previous experience, we recommend sizing the footings for a maximum allowable bearing pressure of 3,000 pounds per square foot (psf) when bearing on the stiff or better residual soils and/or newly compacted structural fill.

In order to avoid a local shear or "punching" failure of the footings, we recommend minimum widths of 24-inches for isolated column footings and 18-inches for wall strip footings. For areas in low to medium plasticity soils, the footings should be located a minimum of 18 inches below the final exterior ground surface to provide adequate frost protection.

If the footings are installed as recommended and with adequate supervision, we anticipate total settlement to be within 1 inch and differential settlement to be within ½ inch. These settlement tolerances represent the industry standard for shallow spread footing design, but if tighter tolerances and less settlement are required then Shield is able to provide a more conservative foundation recommendation upon request.

The suitability of foundation and/or slab bearing soils in areas between borings should be verified by qualified visual inspection and/or proofrolling as described in subsequent sections. In addition, the opened footing excavations should be examined for uniformity of soil properties and tested using a hand auger and a dynamic cone penetrometer (DCP). The footing evaluation should be performed by the geotechnical engineer and/or his representative prior to the placement of reinforcing steel or concrete. The purpose of the footing evaluation is to locate any unexpected soft soil areas or unsuitable soil areas which may require undercutting and backfilling. Areas in the foundation subgrade that are determined to be unsuitable should be repaired or modified as directed by the geotechnical engineer. **It is important to note that the foundation recommendations described above should not be considered valid unless a footing evaluation is conducted at the time of foundation installation.**

We recommend that the footings be poured as soon as possible after the geotechnical footing observation, in order to minimize potential disturbance of the bearing soil. The prepared foundation bearing soils should not be left exposed overnight or during inclement weather. If the subgrade soils are exposed overnight or during inclement weather, we recommend the placement of a two to four-inch thick "mud-mat" of lean concrete on the bearing soils. Saturation and subsequent disturbance of the foundation subgrade soils can result in a loss of strength and bearing capacity, leading to increased settlement.

7.4 Slab-on-Grade Recommendations:

After the near surface soils have been improved and prior to the placement of stone or concrete beneath the slab-on-grade, we recommend that the slab-on-grade subgrade be carefully proofrolled under the supervision of a Shield geotechnical engineer to check for soft areas. The proofrolling for structural fill should be performed as recommended in the site preparation section of this report. The slab-on-grade should be placed only on soils which proofroll successfully and should have an adequate thickness of granular base. The floor slab should be designed with an adequate number of joints to minimize cracking. The slab should be designed as a floating slab, not rigidly connected to bearing walls or foundations in order to accommodate differential settlement between the foundation and the slab. The slab should be nominally reinforced to maintain its integrity should minor differential movement occur. In addition, aggregate, such as ASTM D 448 No. 57 or No. 67 stone, should be densified and placed beneath the slab to allow for a suitable base on which to work as well as reduce damage/degradation of the prepared subgrade during construction. The aggregate layer should be at least 4 inches thick.

Subgrade soils to support floor slabs shall consist of suitable bearing natural soils and/or properly placed controlled structural fill and be firm and unyielding. Interior utility trenches should be properly backfilled and compacted as recommended herein. Proof rolling of the subgrade soils is recommended prior to placement of the recommended granular cushion to detect any possible soft or yielding areas which may be present. Any soft or unsuitable bearing subgrade areas which are detected during proof rolling should be removed and replaced with suitably compacted and controlled structural fill in accordance with the recommendations contained herein.

8.0 PAVEMENT RECOMMENDATIONS

Pavement design requires knowledge of the soil subgrade strength and anticipated traffic conditions. Soil strength is typically expressed in terms of a California Bearing Ratio (CBR) for flexible pavement design and a modulus of subgrade reaction (k) for rigid pavement design. For the design of flexible and rigid pavements, proposed single- and tandem-axle loads of varying weights are described in terms of an equivalent number of 18-kip single-axle loads, which would affect the same wear on a similar pavement. This is termed an equivalent axle loading (EAL).

We were not provided traffic loads for the anticipated pavement sections. In order to provide pavement thickness recommendations, we have estimated EALs for light-duty and heavy-duty pavement sections of 50,000 and 10,000, respectively. For comparison, an EAL value of 50,000 is typically used to design pavements in areas with light traffic with few or no loaded trucks such as a parking lot for a medium apartment complex. Finally, an EAL value of 100,000 is typically used to design pavements in areas having medium to heavy traffic with less than 30 percent loaded trucks such as a delivery lane for an apartment building or dumpster path.

No subgrade strength tests have been performed for this project. However, we have assumed a design CBR of 3 for flexible pavements and a modulus of subgrade reaction, k, of 100 pounds per cubic inch (pci) for rigid pavements. These recommended subgrade strength values are predicated on successful proofrolling in cut areas and in fill areas a compaction of the soil subgrade to at least 100 percent of standard Proctor maximum dry density (ASTM D 698) as previously recommended.

Thickness analyses for flexible and rigid pavements were performed in general accordance with American Association of State Highway and Transportation Officials (AASHTO) procedures. Based on the estimated EAL values, a terminal serviceability index of 2.0, a CBR value of 3, a k value of 100 psi/inch and our experience with similar projects, the following pavement sections are recommended:

Pavement Type	Material	Thickness (inches)
Light-Duty Flexible	Asphaltic Concrete Surface Bituminous Plant Mix Base Mineral Aggregate Base	1-1/2 2-1/2 5
Heavy-Duty Flexible	Asphaltic Concrete Surface Bituminous Plant Mix Base Mineral Aggregate Base	1-1/2 2-1/2 7

Our analysis and assumptions have been made based on the Tennessee Department of Highways Standard Specification for Road and Bridge Construction (1995). The asphaltic concrete should satisfy the following guidelines:

- Section 411, Grading D or E, for the surface course mix design.
- Section 903.11, aggregate grading, Grading E.
- Section 307, Grading B (with aggregate per Section 903.06B) for the base course.
- Sections 407 for crushed stone placement and compaction.
- 303 Section 903.05B for gradation.

The Tennessee department of Highways Standard Specification for Road and Bridge Construction Division II, Part 4, should be the basis for which concrete pavement is constructed and crushed stone compacted.

The success and long term use of pavement is a direct function of the soil subgrade. Poor subgrade preparation, protection and maintenance (typically in the form of poor drainage) of the subgrade are most often the causes of pavement failures. Shield stresses the need to compact the upper 24 inches of fill soils to 100 percent of the soil's standard Proctor maximum dry density as stated in our "Structural Fill Recommendations" section. A higher CBR value can be achieved by placing the fill at or below the soil's optimum moisture content determined from the standard Proctor compaction test. Shield recommends the exposed subgrade be proofrolled prior to basestone placement to detect areas softened by rainfall, or that have been degraded by construction traffic. Shield recommends positive drainage be maintained on the pavement subgrade to prevent ponding of surface water. In addition, should the basestone be placed well in advance of the asphalt, additional proofrolling should be performed to expose any softened areas.

Structural distress has often been a problem in flexible pavement near trash dumpsters, turning areas, braking areas, entrances, exits, and loading docks, it is highly recommended concrete pads and drives be utilized to reduce pavement distress in these areas.

We recommend that the geotechnical engineering firm of record (Shield) be retained to monitor the construction activities and to verify that the field conditions are consistent with the findings of our investigation. If significant variations are encountered or if the design is altered, Shield should be notified and given the opportunity to evaluate potential impacts on the geotechnical elements of the project. The geotechnical engineer of record should provide personnel full-time to monitor, test, and approve subgrades and fill layers before, during and after fill placement. The field density testing of the fill soils should be achieved by performing field density tests in accordance with either ASTM D-2937 (Drive-Cylinder Method), ASTM D 1556 (Sand-Cone Method) or ASTM D 6938 (Nuclear Method).

The contractor should provide at least 24 hours notice before starting operations and/or changing construction equipment or procedures. Regardless of notification, any fill placed by the contractor in the absence of the geotechnical engineer's representative shall be removed and replaced at the contractor's expense and under the full-time observation of the geotechnical engineer's representative. We recommend the use of the project specifications for the construction of the proposed development.

Prior to completion of final design, we recommend Shield have the opportunity to review the drawings and specifications to verify the recommendations contained within this report have been properly interpreted.

10.0 LIMITATIONS

This report has been prepared for the exclusive use of Knoxville Community Development Corporation for the subject site in Knoxville, Tennessee. The information and recommendations reported herein are presented to assist in the evaluation of the site for development. Any foundation recommendations would be based on specific location and data to be followed by footing evaluations at the time of excavation. In the event there are any significant changes in the size, design, or location of the project, changes in the planned construction from the concepts previously outlined, or changes of the design parameters stated in this report, the Shield geotechnical engineer should be consulted. The conclusions and recommendations contained in this report should not be considered valid unless all changes have been reviewed and our conclusions and recommendations reaffirmed or appropriately modified, in writing. If we are not accorded the privilege of making this recommended review, we can assume no responsibility for misinterpretation of our recommendations.

11.0 ADDITIONAL RECOMMENDATIONS

As of now the site has only been partially demolished and razed. It is Shield's recommendation following completion of demolition a series of test pits be performed to observe the soils in the specific building footprint locations to better characterize the condition of the fill materials. The results of study may confirm the need for undercut replacement or may result in a suggestion of other foundation options.

results of study may confirm the need for undercut replacement or may result in a suggestion of other foundation options.

If you have any questions regarding the contents of this report, please do not hesitate to contact the undersigned.

Sincerely,

SHIELD ENGINEERING, INC.

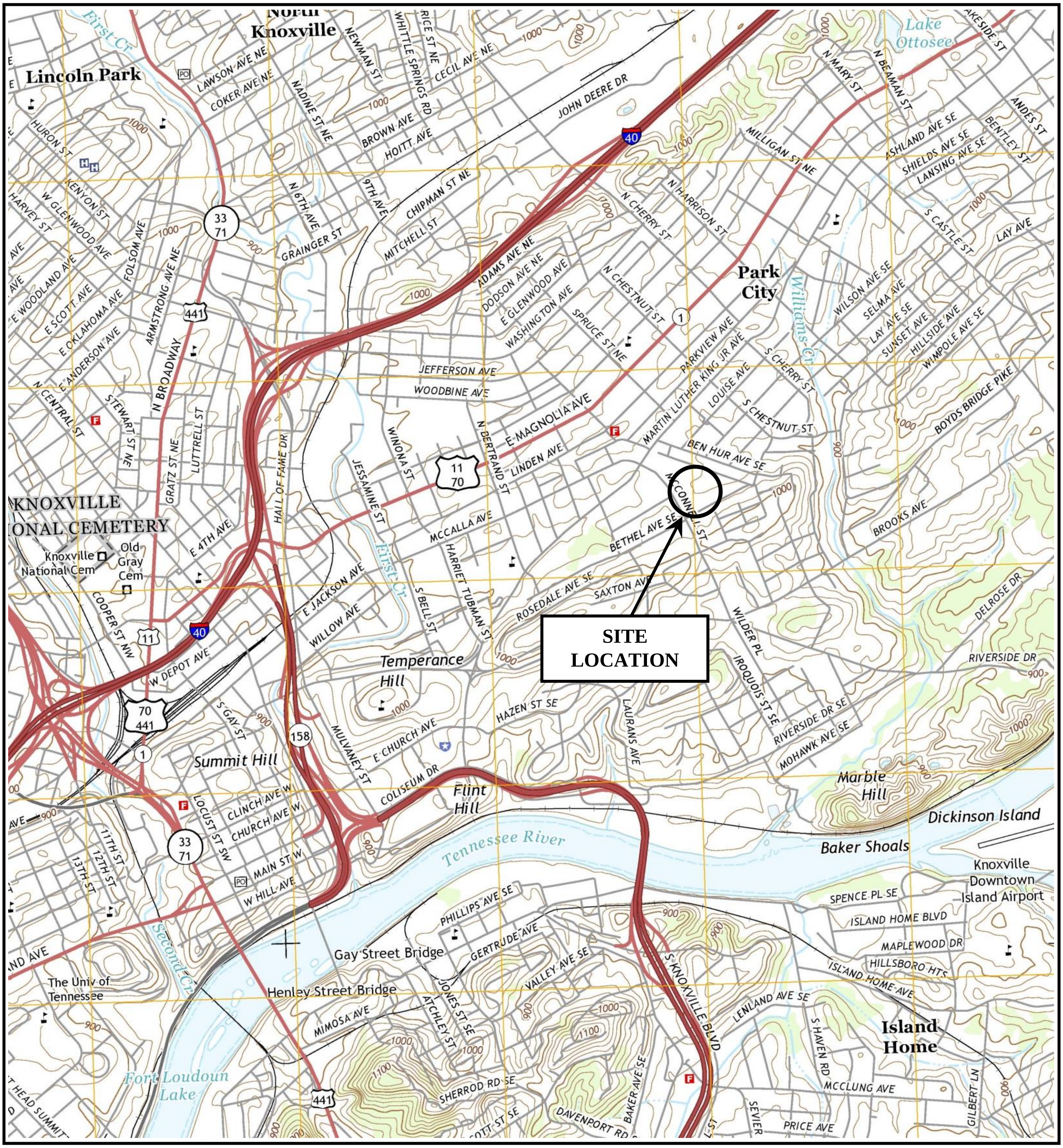
C. Raymond, P.E.
Principal Engineer

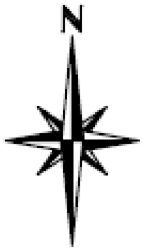
Justin A. Goss, P.E.
Senior Project Engineer

Attachments: Appendix A – Figures
Appendix B – Boring Logs
Appendix C – Laboratory Test Results

APPENDIX A

Figure 1 – Site Location Plan
Figure 2 - Boring Location Plan





SOURCE: USGS TOPO, 7.5 MINUTE MAP
KNOXVILLE, TENNESSEE - 2016

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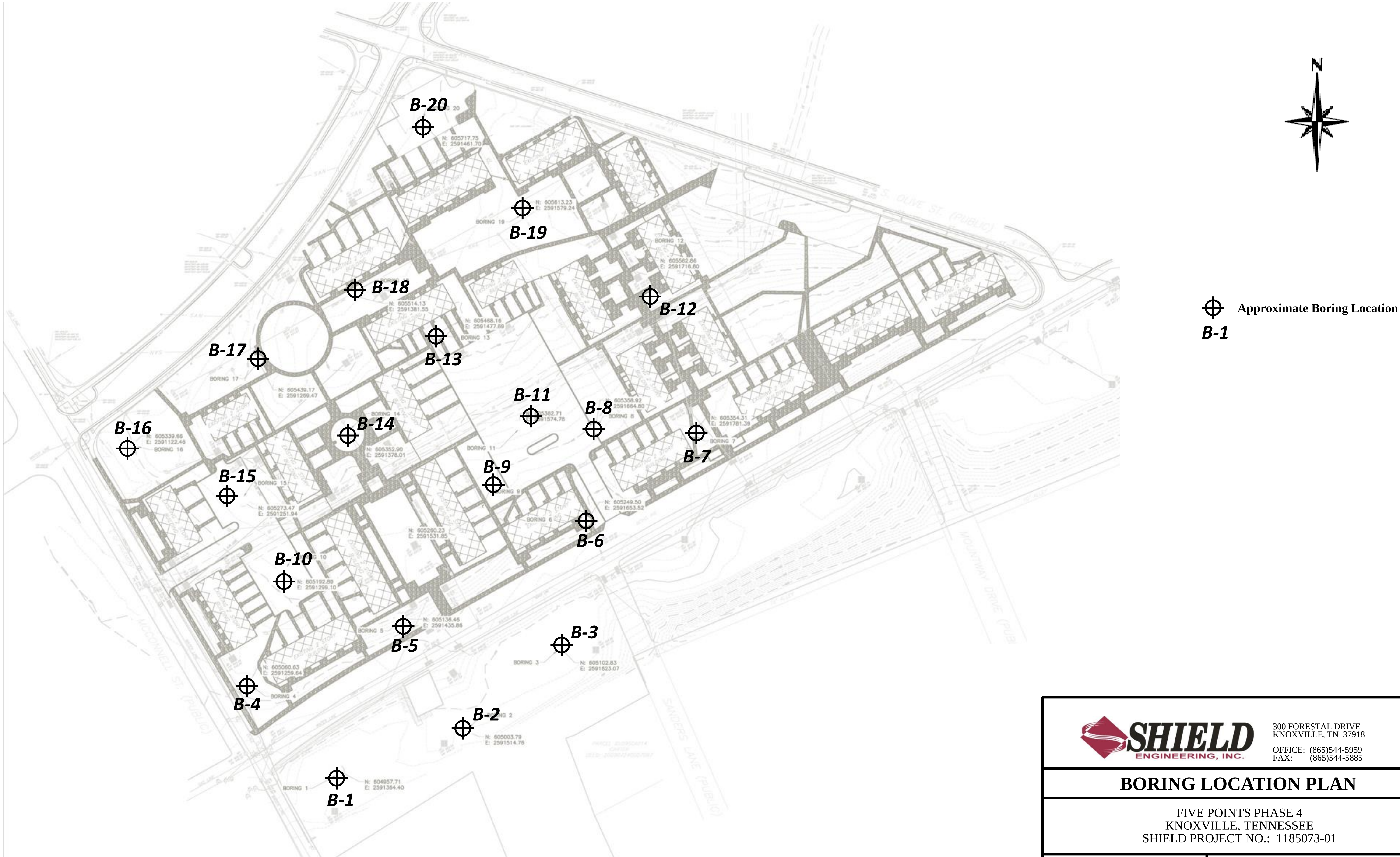
SITE VICINITY MAP

FIVE POINTS PHASE 4
KNOXVILLE, TENNESSEE
SHIELD PROJECT NO.: 1185073-01

DATE: 12/12/2018	DRAWN BY: JAG
SCALE: NTS	FIGURE: 1



SOURCE: "Knoxville's Community Development Corporation Five Points Phase 4 Infrastructure Improvements", Boring Plan; Civil & Environmental Consultants, Inc.: Drawing B100; Dated: August 15, 2018.

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BORING LOCATION PLAN

FIVE POINTS PHASE 4
KNOXVILLE, TENNESSEE
SHIELD PROJECT NO.: 1185073-01

DATE: 12/12/2018	DRAWN BY: JAG
SCALE: NTS	FIGURE: 2

APPENDIX B

Key to Soil Classification
Geotechnical Boring Logs

KEY TO SOIL CLASSIFICATION

Correlation of Standard Penetration Resistances with
Relative Density and Consistency

Sands and Gravels

Standard Penetration Resistance	Relative Density
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Medium
31 - 50	Dense
Over 50	Very Dense

Silts and Clays

Standard Penetration Resistance	Consistency
0 - 2	Very Soft
3 - 4	Soft
5 - 8	Firm
9 - 15	Stiff
16 - 30	Very Stiff
31 - 50	Hard
Over 50	Very Hard

Particle Size Identification
(Unified Soil Classification System)

Boulders – exceeds 12 inches diameter
Cobbles – greater than 3 inches to 12 inches diameter
Coarse gravel – greater than ¾ inch to 3 inches diameter
Fine gravel – greater than 4.75 mm to ¾ inch diameter
Coarse sand – greater than 2.0 mm to 4.75 mm diameter
Medium sand – greater than 0.425 mm to 2.0 mm diameter
Fine sand – greater than 0.075 mm to 0.425 mm diameter
Silt and clay – finer than 0.075 mm diameter
(particles cannot be seen with naked eye)

Secondary Modifiers

The second modifiers are generally included when a soil type comprises less than 35 percent of the entire sample.

Percent of Sample	Modifier
0 – 10	Trace
11 - 20	Little
21 - 35	Some

GEOTECHNICAL BORING LOG

Report Date: 12/3/18 | Boring No.: B-1
Boring Method: Hollow Stem Auger | Hammer Type: Automatic | Sheet: 1 of: 1
Logged By: JAG | Driller: Tri-State Drilling, Inc. | Date Started: 12/3/18
Boring Location: | Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
		1		1, 2, 2	4	Topsoil 5 inches (0.4)			29				
						Soft to stiff, brownish red to brown silty CLAY with trace to few black oxide staining, moist - Residuum							
		2		2, 2, 3	5				28				
		3		2, 5, 7	12				28				
	5					(5.5)							
		4		3, 4, 5	9	Stiff, brown sandy CLAY with black oxide staining, moist - Residuum			28				
		5		3, 4, 6	10								
	10												
		6		3, 5, 6	11				24				
	15					(15.0) Boring terminated at 15.0 Feet.							
	20												

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

SHIELD ENGINEERING, INC.

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Fax: 865-544-5885

Five Points Phase 4
Partners Development
Knoxville, TN
Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18 | Boring No.: B-2
Boring Method: Hollow Stem Auger | Hammer Type: Automatic | Sheet: 1 of: 1
Logged By: JAG | Driller: Tri-State Drilling, Inc. | Date Started: 12/3/18
Boring Location: | Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
	0.3					Topsoil 4 inches							
		1		3, 5, 7	12	Stiff, light brown to brown CLAY with trace fine rootlets, moist - Possible Fill							
	1.5	2		2, 3, 4	7	Firm, dark sandy CLAY, moist - Residuum							
		3		3, 2, 4	6								
	5.5					Firm to stiff, brown sandy SILT, moist - Residuum							
		4		3, 3, 5	8								
		5		4, 5, 6	11								
		6		4, 7, 7	14								
	15.0												

Depth scale: 5, 10, 15, 20

GENERAL REMARKS:	GPS DATA:	GROUNDWATER DATA:
	Datum:	During Drilling: Dry Feet
	North:	At Completion: Dry Feet
	East:	Caved: N/A Feet
		After 24 Hours: N/A Feet

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Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18
Boring Method: Hollow Stem Auger — Hammer Type: Automatic
Logged By: JAG — Driller: Tri-State Drilling, Inc.
Boring Location:

Boring No.: B-3
Sheet: 1 of: 1
Date Started: 12/3/18
Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
		1		2, 1, 3	4	Topsoil 4 inches (0.3)							
						Soft to stiff, brown to brownish red CLAY with black oxide staining, moist - Residuum							
		2		3, 4, 5	9	(3.0)							
		3		3, 4, 4	8	Firm to stiff, brown and yellowish brown and brownish red CLAY, moist - Residuum							
	5												
		4		2, 3, 4	7								
		5		2, 4, 5	9								
	10												
		6		2, 3, 6	9	(15.0)							
	15					Boring terminated at 15.0 Feet.							
	20												

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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GEOTECHNICAL BORING LOG

Report Date: 12/3/18 | Boring No.: B-4
Boring Method: Hollow Stem Auger | Hammer Type: Automatic | Sheet: 1 of: 1
Logged By: JAG | Driller: Tri-State Drilling, Inc. | Date Started: 12/3/18
Boring Location: | Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
		1		2, 3, 4	7	Topsoil 5 inches	0.4						
		2		4, 4, 5	9	Firm to stiff, brown to yellowish brown CLAY, moist - Residuum							
	5	3		3, 3, 5	8								
		4		3, 4, 5	9		8.0						
	10	5		2, 2, 4	6	Firm, brown to brownish red CLAY, moist to very moist - Residuum							
	15	6		2, 3, 4	7		15.0						
	20					Boring terminated at 15.0 Feet.							

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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GEOTECHNICAL BORING LOG

Report Date: 12/3/18 | Boring No.: B-5
Boring Method: Hollow Stem Auger | Hammer Type: Automatic | Sheet: 1 of: 1
Logged By: JAG | Driller: Tri-State Drilling, Inc. | Date Started: 12/3/18
Boring Location: | Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
	0.5					Topsoil 6 inches							
		1		3-5-6	11	Firm to stiff, light brown to yellowish brown CLAY, moist - Residuum							
		2		2-3-4	7								
		3		3-4-6	10								
	5.5												
		4		3-5-5	10	Stiff, brownish to light brown CLAY with black oxide staining, moist - Residuum							
		5		2-3-7	10								
	15.0	6		3-4-6	10								
						Boring terminated at 15.0 Feet.							

GENERAL REMARKS:	GPS DATA:	GROUNDWATER DATA:
	Datum:	During Drilling: Dry Feet
	North:	At Completion: Dry Feet
	East:	Caved: N/A Feet
		After 24 Hours: N/A Feet

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Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18
Boring Method: Hollow Stem Auger   Hammer Type: Automatic
Logged By: JAG   Driller: Tri-State Drilling, Inc.
Boring Location:

Boring No.: B-6
Sheet: 1 of: 1
Date Started: 12/3/18
Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
						Topsoil 5 inches	0.4						
		1		1, 3, 5	8	Firm, brown to dark brown silty CLAY with trace rock fragments and pockets of top soil and fine rootlets - Fill							
		2		3, 3, 4	7		3.3						
		3		4, 5, 9	14	Stiff, light brown to yellowish brown CLAY with trace black oxide staining, moist - Residuum							
	5												
		4		5, 6, 7	13								
		5		3, 5, 8	13								
	10												
		6		4, 4, 7	11								
	15						15.0						
	20												

GENERAL REMARKS:	GPS DATA:	GROUNDWATER DATA:
	Datum:	During Drilling: Dry Feet
	North:	At Completion: Dry Feet
		Caved: N/A Feet
	East:	After 24 Hours: N/A Feet

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GEOTECHNICAL BORING LOG

Report Date: 12/3/18 — Boring No.: B-7
Boring Method: Hollow Stem Auger — Hammer Type: Automatic — Sheet: 1 of: 1
Logged By: JAG — Driller: Tri-State Drilling, Inc. — Date Started: 12/3/18
Boring Location: — Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
		1		3, 4, 4	8	Firm, brown to dark brown CLAY with construction debris - Fill			25				
	1.5	2		4, 6, 7	13	Stiff, brown to brownish red silty CLAY, moist - Probable Fill			26				
		3		5, 7, 7	14				24				
	5												
	5.5	4		2, 3, 4	7	Firm to stiff, light brown silty CLAY with trace black oxide staining, moist - Residuum			30				
		5		3, 4, 4	8				34				
	10												
		6		4, 5, 5	10				32				
	15.0					Boring terminated at 15.0 Feet.							
	20												

GENERAL REMARKS:	GPS DATA:	GROUNDWATER DATA:
	Datum:	During Drilling: Dry Feet
	North:	At Completion: Dry Feet
		Caved: N/A Feet
	East:	After 24 Hours: N/A Feet

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Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18
Boring Method: Hollow Stem Auger — Hammer Type: Automatic
Logged By: JAG — Driller: Tri-State Drilling, Inc.
Boring Location:

Boring No.: B-8
Sheet: 1 of: 1
Date Started: 12/3/18
Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
		1		3, 4, 4	8	Firm to stiff, dark brown CLAY with chert and rock fragments - Fill							
		2		2, 4, 4	8								
		3		3, 5, 5	10								
	5						5.5						
		4		3, 4, 5	9	Stiff, light brown to brownish red CLAY, moist - Residuum							
		5		3, 5, 5	10								
	10												
		6		3, 4, 7	11								
	15					Boring terminated at 15.0 Feet.	15.0						
	20												

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18
Boring No.: B-9
Boring Method: Hollow Stem Auger
Hammer Type: Automatic
Sheet: 1 of: 1
Logged By: JAG
Driller: Tri-State Drilling, Inc.
Date Started: 12/3/18
Boring Location:
Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
		1		2, 3, 4	7	Topsoil 6 inches	0.5						
						Firm, brown to dark brown silty CLAY with chert and rock fragments - Fill							
		2		2, 3, 3	6		3.3						
	5	3		4, 5, 5	10	Stiff to very stiff, light brown to yellowish brown CLAY, moist - Residuum							
		4		6, 8, 12	20								
	10	5		3, 8, 12	20								
	15	6		4, 7, 6	13		15.0						
						Boring terminated at 15.0 Feet.							
	20												

GENERAL REMARKS:

GPS DATA:

Datum:
North:
East:

GROUNDWATER DATA:

During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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Knoxville, TN
Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18 — Boring No.: B-10
Boring Method: Hollow Stem Auger — Hammer Type: Automatic — Sheet: 1 of: 1
Logged By: JAG — Driller: Tri-State Drilling, Inc. — Date Started: 12/3/18
Boring Location: — Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum depth	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
						Asphalt 5 inches	0.4						
						Basestone 4 inches	0.7						
		2		4 / 5 / 9	14	Stiff, light brown to yellowish brown CLAY with trace asphalt and rock fragments - Fill	2.0						
		3		4 / 7 / 11	18	Firm to very stiff, light brown to brown silty CLAY to CLAY with trace black oxide staining, moist - Residuum							
	5												
		4		3 / 5 / 7	12								
		5		2 / 3 / 7	10								
	10												
		6		2 / 2 / 4	6		15.0						
	15					Boring terminated at 15.0 Feet.							
	20												

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18
Boring No.: B-11
Boring Method: Hollow Stem Auger
Hammer Type: Automatic
Sheet: 1 of: 1
Logged By: JAG
Driller: Tri-State Drilling, Inc.
Date Started: 12/3/18
Boring Location:
Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum depth	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
						Asphalt 4 inches	0.3						
						Basestone 5 inches	0.7						
		2		3, 2, 3	5	Firm, brown to brownish red silty CLAY with asphalt and rock fragments - Fill	2.5		31				
		3		3, 3, 6	9	Stiff, light brown to yellowish brown silty CLAY to CLAY with trace black oxide staining, moist - Residuum			31				
	5												
		4		3, 5, 6	11				33				
		5		4, 5, 4	9				32				
	10												
		6		2, 4, 8	12				32				
	15					Boring terminated at 15.0 Feet.	15.0						
	20												

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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Knoxville, TN
Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18
Boring Method: Hollow Stem Auger Hammer Type: Automatic
Logged By: JAG Driller: Tri-State Drilling, Inc.
Boring Location:

Boring No.: B-12
Sheet: 1 of: 1
Date Started: 12/3/18
Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
		1		1 / 1 / 2	3	Topsoil 5 inches (0.4); Soft to stiff, brown to brownish red silty CLAY to CLAY, moist - Residuum			24				
		2		3 / 3 / 5	8				34				
		3		4 / 5 / 6	11				30	50	22		
	5												
		4		3 / 5 / 7	12				31				
		5		4 / 5 / 6	11				34				
	10												
		6		3 / 6 / 6	12				29				
	15					15.0 Boring terminated at 15.0 Feet.							
	20												

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18	Boring No.: B-13
Boring Method: Hollow Stem Auger — Hammer Type: Automatic	Sheet: 1 of: 1
Logged By: JAG — Driller: Tri-State Drilling, Inc.	Date Started: 12/3/18
Boring Location:	Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
	0					Building Demo Debris 12 inches							
	1.0					Firm, brown to dark brown silty CLAY to sandy CLAY with trace fine rootlets - Probable Fill							
		2		3, 3, 5	8								
		3		2, 3, 4	7								
	5.5					Firm to stiff, light brown to brown silty CLAY to CLAY with trace black oxide staining, moist - Residuum							
		4		3, 3, 4	7								
		5		2, 5, 7	12								
		6		3, 5, 5	10								
	15.0					Boring terminated at 15.0 Feet.							

GENERAL REMARKS:

GPS DATA:

Datum:
North:
East:

GROUNDWATER DATA:

During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18
Boring No.: B-14
Boring Method: Hollow Stem Auger
Hammer Type: Automatic
Sheet: 1 of: 1
Logged By: JAG
Driller: Tri-State Drilling, Inc.
Date Started: 12/3/18
Boring Location:
Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
		1		2-1-3	4	Building Demo Debris 12 inches							
	1.5	2		4-5-7	12	Soft to very stiff, brown to brownish red silty CLAY with black oxide staining, moist - Residuum							
		3		5-9-13	22								
	5												
		4		4-4-6	10								
		5		9-11-13	24								
	10												
		6		2-3-8	11								
	15.0					Boring terminated at 15.0 Feet.							
	20												

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18
Boring Method: Hollow Stem Auger Hammer Type: Automatic
Logged By: JAG Driller: Tri-State Drilling, Inc.
Boring Location:

Boring No.: B-15
Sheet: 1 of: 1
Date Started: 12/3/18
Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum depth	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
						Asphalt 5 inches	0.4						
						Basestone 4 inches	0.7						
		1		4 / 4 / 5	9	Firm to stiff, dark brown to brownish gray silty CLAY to CLAY with traces of wood fragments and traces of red brick debris - Fill							
	5	2		3 / 2 / 6	8		5.5						
		3		4 / 7 / 11	18	Stiff to very stiff, light brown to brown silty CLAY to CLAY with trace black oxide staining, moist - Residuum							
	10	4		6 / 10 / 15	25								
	15	5		5 / 6 / 7	13		15.0						
	20					Boring terminated at 15.0 Feet.							

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

SHIELD ENGINEERING, INC.
300 Forestal Dr.
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Telephone: 865-544-5959
Fax: 865-544-5885

Five Points Phase 4
Partners Development
Knoxville, TN
Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18
Boring Method: Hollow Stem Auger   Hammer Type: Automatic
Logged By: JAG   Driller: Tri-State Drilling, Inc.
Boring Location:

Boring No.: B-16
Sheet: 1 of: 1
Date Started: 12/3/18
Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
		1		3 / 4 / 7	11	Topsoil 6 inches	0.5		20				
		2		3 / 4 / 4	8	Stiff, brown to dark brown silty CLAY with chert and rock fragments and asphalt debris - Fill	2.0		30				
		3		3 / 3 / 5	8	Firm to stiff, light brown to brown silty CLAY, moist - Residuum			38	58	26		
	5												
		4		4 / 5 / 5	10				35				
		5		3 / 3 / 5	8				30				
	10												
		6		3 / 4 / 5	9				41				
	15					Boring terminated at 15.0 Feet.	15.0						
	20												

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18
Boring No.: B-17
Boring Method: Hollow Stem Auger
Hammer Type: Automatic
Sheet: 1 of: 1
Logged By: JAG
Driller: Tri-State Drilling, Inc.
Date Started: 12/3/18
Boring Location:
Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
		1		2-2-3	5	Soft to firm, brown to dark brown and brownish red silty CLAY with chert and asphalt, brick and mortar debris - Fill							
		2		3-4-4	8								
	5	3		3-2-1	3								
	5.5					Stiff, light brown to brown silty CLAY with trace black oxide staining, moist - Residuum							
		4		3-4-7	11								
	10	5		4-5-4	9								
	15	6		3-5-6	11								
	15.0					Boring terminated at 15.0 Feet.							
	20												

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18 | Boring No.: B-18
Boring Method: Hollow Stem Auger | Hammer Type: Automatic | Sheet: 1 of: 1
Logged By: JAG | Driller: Tri-State Drilling, Inc. | Date Started: 12/3/18
Boring Location: | Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
	0	1		1-3-3	6	Soft to stiff, brown to dark brown CLAY with asphalt, brick and concrete debris - Fill							
		2		4-6-9	15								
		3		2-3-2	5								
	5.5					Stiff, light brown to brown silty CLAY with trace black oxide staining, moist - Residuum							
		4		3-4-6	10								
		5		5-5-6	11								
		6		3-6-8	14								
	15.0					Boring terminated at 15.0 Feet.							

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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Five Points Phase 4
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Knoxville, TN
Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18 | Boring No.: B-19
Boring Method: Hollow Stem Auger | Hammer Type: Automatic | Sheet: 1 of: 1
Logged By: JAG | Driller: Tri-State Drilling, Inc. | Date Started: 12/3/18
Boring Location: | Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
		1		2, 2, 3	5	Firm to stiff, brown to dark brown CLAY with asphalt, brick and concrete debris - Fill							
		2		3, 5, 10	15								
		3		3, 4, 4	8								
	5						5.5						
		4		3, 5, 7	12	Stiff, light brown to brown silty CLAY with trace black oxide staining, moist - Residuum							
		5		5, 6, 9	15								
	10												
		6		5, 6, 9	15								
	15						15.0						
						Boring terminated at 15.0 Feet.							
	20												

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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Five Points Phase 4
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Shield Project No.: 1185073-01

GEOTECHNICAL BORING LOG

Report Date: 12/3/18 | Boring No.: B-20
Boring Method: Hollow Stem Auger | Hammer Type: Automatic | Sheet: 1 of: 1
Logged By: JAG | Driller: Tri-State Drilling, Inc. | Date Started: 12/3/18
Boring Location: | Date Finished: 12/3/18

Surface Elevation: +/-

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum depth	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
	0–0.5					Topsoil 6 inches	0.5						
		1		2, 3, 5	8	Firm to stiff, brown to brownish red silty CLAY to CLAY with trace chert fragments and trace fine rootlets, moist - Residuum							
		2		3, 5, 10	15								
	5	3		3, 6, 8	14		5.5						
		4		4, 5, 9	14	Stiff to very stiff, brown to dark brown and brownish red silty CLAY to CLAY with trace black oxide staining, moist - Residuum							
	10	5		4, 5, 12	17								
	15	6		3, 6, 10	16		15.0						
						Boring terminated at 15.0 Feet.							
	20												

GENERAL REMARKS:

GPS DATA:
Datum:
North:
East:

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: N/A Feet

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Five Points Phase 4
Partners Development
Knoxville, TN
Shield Project No.: 1185073-01

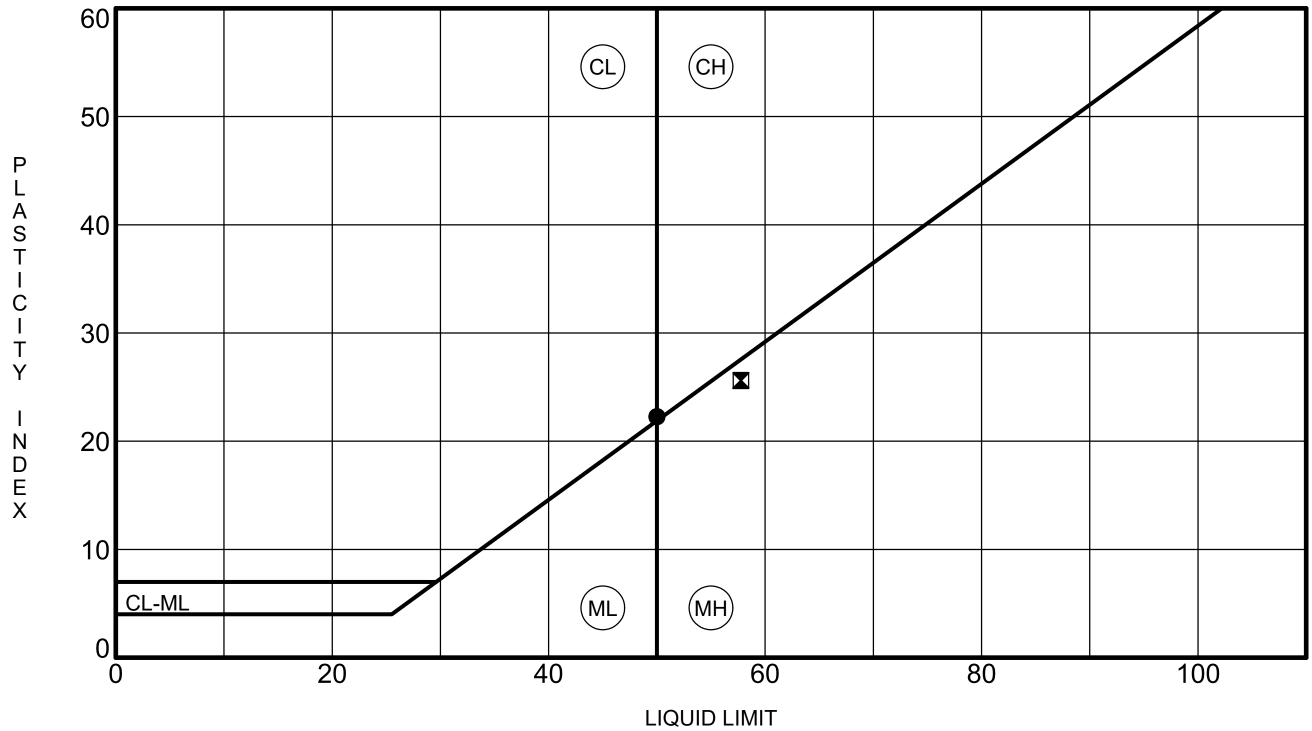
APPENDIX C

Laboratory Test Results

Report of Geotechnical Exploration
Five Points Phase 4 Infrastructure Improvements
Knoxville, Tennessee
Project No. 1185073-01

Laboratory Test Results					
				Atterberg Limits	
Boring	**Sample**	**Depth (feet)**	**Natural Moisture Content (%)**	**Liquid Limit (%)**	**Plasticity Index (%)**
B-1	1	0 – 1.5	28.8		
B-1	2	1.5 – 3.0	28.1		
B-1	3	3.5 – 5.0	28.0		
B-1	4	6.0 – 7.5	27.6		
B-1	6	13.5 – 15.0	23.9		
B-7	1	0 – 1.5	25.1		
B-7	2	1.5 – 3.0	25.6		
B-7	3	3.5 – 5.0	23.7		
B-7	4	6.0 – 7.5	29.5		
B-7	5	8.5 – 10.0	33.9		
B-7	6	13.5 – 15.0	31.7		
B-11	2	1.5 – 3.0	31.0		
B-11	3	3.5 – 5.0	31.4		
B-11	4	6.0 – 7.5	32.9		
B-11	5	8.5 – 10.0	32.3		
B-11	6	13.5 – 15.0	31.9		
B-12	1	0 – 1.5	23.7		
B-12	2	1.5 – 3.0	33.9		
B-12	3	3.5 – 5.0	30.5	50	22
B-12	4	6.0 – 7.5	31.3		
B-12	5	8.5 – 10.0	34.0		
B-12	6	13.5 – 15.0	29.1		
B-16	1	0 – 1.5	20.1		
B-16	2	1.5 – 3.0	30.0		
B-16	3	3.5 – 5.0	38.0	58	26
B-16	4	6.0 – 7.5	34.7		
B-16	5	8.5 – 10.0	30.4		
B-16	6	13.5 – 15.0	41.1		

ATTERBERG LIMITS' RESULTS



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**B-12**	**4.3**	**50**	**28**	**22**		**Brown to brownish red silty clay to clay**
⧗	**B-16**	**4.3**	**58**	**32**	**26**		**Light brown to brown silty clay**

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