ADDENDUM NO. #3

DATE: May 10, 2019

PROJECT: FOUNDATION SCIENCES BUILDING
BALL STATE UNIVERSITY
MUNCIE, INDIANA

PROJECT NUMBER: RATIO #17099 / BSU# 2017-085.01 FS

OWNER: Ball State University
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Muncie, Indiana 47306
Phone: (765) 289-1241

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Phone: (317) 810-4141

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(619) 297-0159

05/10/2019
This Addendum is issued in accordance with the provisions of Contract Documents, and becomes a part of the Contract Documents as provided therein. The information contained herein modifies the original Bidding Documents dated April 16, 2019 and all prior Addenda as applicable. Requirements of the original Bidding Documents and previous Addenda remain in effect except as modified by this Addendum. Acknowledge receipt of this Addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.

PART 1 – GENERAL CLARIFICATIONS
NONE

PART 2 - PROJECT MANUAL CHANGES
NONE

PART 3 - DRAWING CHANGES
1. SHEET A-133-B THIRD LEVEL REFLECTED CEILING PLAN – EAST
   a. Room 366 - Remove tag for PT-08 and Level 5 finish keynote
   b. Room 366 - Remove Level 5 finish keynote
   c. Room 360 – Add note 5700D1 to window pocket at sink chase
2. SHEET A-133-B FIFTH LEVEL REFLECTED CEILING PLAN – WEST
   a. Room 519 – Add note 5700D1 to window pocket at sink chase

PART 4 – GENERAL QUESTIONS
1. QUESTION: Laboratory HVAC Heat Recovery System, should the alternate bid delete the complete system, pumps, heat exchanger, piping, LEF’s, subs, etc.? Also, what about the heat recovery coils in the AHUs? Please clarify extent. 
   RESPONSE: The heat recovery coils in the AHU’s are to be deleted. The heat recovery coils in the Laboratory exhaust fans are to be deleted. Heating coils in AHU’s shall be changed to Internal face and by-pass coils. Please see SHEET M-506 attached to Addendum # 2 for details.

PART 5 – ATTACHMENTS
A. Geotech Report
   1. Previously issued report was for a different location - Replace previously issued Geotech Report entirely with attached report.

END OF ADDENDUM NO. 3
GEOTECHNICAL ENGINEERING INVESTIGATION

PROPOSED FOUNDATIONAL SCIENCES BUILDING
BALL STATE UNIVERSITY
MUNCIE, INDIANA

ATC PROJECT NO. 170GC00624

MAY 15, 2018

PREPARED FOR:

MR. BROCK ROSEBERRY, AIA, LEED AP
PRINCIPAL
RATIO ARCHITECTS, INC.
101 SOUTH PENNSYLVANIA STREET
INDIANAPOLIS, INDIANA 46204
May 15, 2018

Mr. Brock Roseberry, AIA, LEED AP
Principal
Ratio Architects, Inc.
101 South Pennsylvania Street
Indianapolis, Indiana 46204

Re: Geotechnical Engineering Investigation
Proposed Foundational Sciences Building
Ball State University
Muncie, Indiana
ATC Project No. 170GC00624

Dear Mr. Roseberry:

Submitted herewith is the report of the geotechnical engineering investigation performed by ATC Group Services LLC (ATC) for the referenced project. This investigation was authorized in accordance with ATC Proposal-Agreement No. PE-18-1022 dated February 5, 2018.

This report contains the results of our field and laboratory testing program and an engineering interpretation of this data with respect to the available project characteristics. We wish to remind you that we will store the samples for 30 days after which time they will be discarded unless you request otherwise.

We appreciate the opportunity to be of service to you on this project. If we can be of any further assistance, or if you have any questions regarding this report, please do not hesitate to contact either of the undersigned.

Sincerely,

Stephen Rushfeldt, P.E.
Senior Project Engineer

Thomas J. Struwing, P.E.
Principal Engineer
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Appendix
1 PURPOSE AND SCOPE

The purpose of this study was to characterize the general subsurface conditions at the project site by drilling fourteen test borings and to evaluate this data with respect to the earth-supported elements associated with the proposed Foundational Sciences Building on the campus of Ball State University in Muncie, Indiana. Also included is an evaluation of the site with respect to potential construction problems and recommendations dealing with quality control during construction.

2 PROJECT CHARACTERISTICS

Ball State University is planning the construction of a new Foundational Sciences Building to be located northeast of the intersection of Martin Street and Ashland Street on the southeast side of the Ball State University campus in Muncie, Indiana. West Beechwood Avenue borders the project site to the north and North Dicks Street is located along the east side of the site. The general location of the proposed project on the campus is shown on the Vicinity Map (Figure 1 in the Appendix).

The site proposed for construction of the Foundational Sciences Building is currently composed of several existing lots including residential houses and apartments, various aggregate and asphalt surfaced parking areas, sidewalks and yard areas. Additionally, North Dill Street currently bisects the project site from north to south and is an asphalt surfaced roadway. North-south oriented alleyways are parallel to North Dill Street to the east and west of the roadway. We understand that previous generations of residential structures have existed throughout the property and have since been demolished. The existing topography at the site is relatively flat and the current ground surface is about 2 ft above the surrounding street elevations. Current ground surface elevations vary across the project site from about El 945 in the southeast portion of the site to about El 951 in the western portion of the site.

It is our understanding that the proposed building will be a five-story structure with a basement level located underneath only the southwest portion of the building. The remainder of the building area will be constructed with the ground floor level as a slab-on-grade floor at or near the current site elevation. We understand that the basement will extend approximately 18 ft below the proposed ground floor level and that the finished floor elevation of the ground floor level will be at or slightly above the existing site grade. Based on preliminary information provided by Ratio, we understand that the finished floor elevation of the ground level will be at about El 950.75. Therefore, it is estimated that the finished floor elevation of the basement level will be at about El 932.75 and spread footing foundations in the basement area will bear at about El 930 or lower. The building will be either a steel-framed structure with slab-on-metal decks or constructed as a cast-in-place concrete structure. The new building will have an approximate plan area of about 44,500 sq.ft. We understand that the maximum column and wall loads will not exceed about 1,600 kips/column and 2 kips/lin.ft, respectively. We further understand that floor loads will not exceed about 150 lbs/sq.ft.
In addition to the proposed building, the project is also planned to incorporate a chamber or pipe-type underground stormwater detention system north of the building for the on-site management of stormwater. New asphalt and/or concrete parking lots and driveways will be constructed adjacent to the proposed building, including a circular drive off of Ashland Street near the southeast corner of the proposed building. Retaining walls and site walls may be required at various locations. The location of the proposed building and other site features, along with existing facilities at the project site are shown on the Boring Plan (Figure 2 in the Appendix).

3 GENERAL SUBSURFACE CONDITIONS

The general subsurface conditions at the project site were investigated by drilling fourteen test borings to depths of 15 ft to 60 ft below the existing ground surface at the approximate locations shown on the Boring Plan (Figure 2 in the Appendix). The subsurface conditions disclosed by the field investigation are summarized in the following paragraphs. Detailed descriptions of the subsurface conditions encountered in each test boring are presented on the “Test Boring Logs” in the Appendix. The letters in parentheses following the soil descriptions are the soil classifications in general accordance with the Unified Soil Classification System. It should be noted that the stratification lines shown on the soil boring logs represent approximate transitions between material types. In-situ stratum changes could occur gradually or at slightly different depths.

The test borings were drilled in areas with varying surface materials including yard and parking areas. A summary of the surficial materials and approximate thicknesses is presented in the table below.

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Underlying the surface materials, the test borings generally encountered brown and/or gray, moist to slightly moist, stiff to hard silty clay (CL), sandy clay (CL) and sandy silty clay (CL) to depths of about 13.5 ft to 40.0 ft below the existing ground surface. The silty and/or sandy clay encountered in Borings B-1, B-2, B-3, B-4, B-6, B-7, B-8, B-9, B-10, B-12 and B-13 was identified as fill material to depths of about 3.5 ft to 14.0 ft below the existing ground surface. These shallow soils were classified as fill due to the unusual texture, coloration and stratification of the soil samples and occasional inclusion of unnatural material, organic material and/or gravel. Standard Penetration Test N-values within the natural silty clay (CL), sandy clay (CL) and sandy silty clay (CL) generally varied from about 12 to 80 blows/ft, although occasionally lower N-values were recorded within the shallower depths of the test borings. Moisture contents of the natural cohesive layers generally varied from as high as about 29 percent in the shallower silty clay to as low as about 5 percent in the deeper sandy clay glacial till.

Each of the building area borings encountered medium dense to very dense, wet sand and gravel layers with varying amounts of silt (SP, SM, SW, SP-SM, SC, SW-SM) at varying depths from as shallow as about 13 ft below the existing ground surface. Relatively thin sand seams were also interbedded within the cohesive glacial till soils at varying depths and locations. Standard Penetration Test N-values in the sands varied from about 20 to 95 blows/ft, although occasional looser sand layers were encountered at shallower depths within the test borings.

Free ground water was observed in each of the test borings, except B-13, at depths varying from about 2 ft to 32 ft below the existing ground surface, although in most cases ground water was encountered in the depth zone of about 12 to 22 ft below the existing grade. It must be noted that short term ground water observations made in cohesive glacial till soils are not necessarily a reliable indication of the ground water level. Shallow ground water in Central Indiana glacial till deposits is typically contained (or "perched") within discontinuous sand layers within the clayey glacial till soils. Therefore, the amount of ground water that is encountered in a test boring or excavation is often dependent upon the depth, thickness, lateral extent and saturation of granular zones or seams that are intersected by the test boring or excavation. In some cases, the ground water in confined sand layers within glacial till deposits can be under significant hydrostatic pressure and the actual hydrostatic ground water level within the confined sand layers may be well above the level at which free ground water is first encountered in a test boring or excavation (i.e., free ground water may not be encountered within the relatively impervious cohesive glacial till soils above a confined sand layer until the confined sand layer is penetrated, at which point the free ground water level rises well above the top of the sand layer). This appears to be the case in Borings B-4, B-5, B-10, B-11 and B-14 where free ground water was initially encountered deeper than the free ground water level that was encountered within the open borehole at completion of drilling.

Ground water may be encountered at varying depths and locations across the site and fluctuations in the level of the ground water should be expected due to variations in rainfall and other factors not evident at the time of our investigation. It is also possible that shallow "perched" ground water may be encountered at various depths and locations across the site as water is often trapped within old miscellaneous fill materials, abandoned utilities, utility trenches, etc. Ground water observations in the deeper sands that underlie the site may be impacted by the flow level of the nearby White River.
4 FINDINGS, CONCLUSIONS AND DESIGN RECOMMENDATIONS

The following findings, conclusions and design recommendations are based on the previously described project characteristics (Section 2) in conjunction with the subsurface conditions (Section 3) that were investigated for this project. If there is any change in the project criteria, including proposed locations and elevations of the project elements, loading conditions, structure types, etc., a review should be made by this office. The design recommendations presented herein are contingent upon the assumption that all earth related elements of the project will be carefully and continuously observed, tested and evaluated by a representative of ATC Group Services LLC working under direction of the geotechnical engineer of record to confirm that the earth related elements of the project are compatible and consistent with the conditions upon which the design recommendations are based. The careful and thorough field testing and observations of the soil related aspects of the project are a critical and essential component of the design recommendations.

4.1 General Foundation Concepts

The test borings drilled for this project revealed an upper stratum of cohesive silty clay soil with frequent layers of apparently uncontrolled and/or undocumented fill. The undocumented fill materials are not suitable for the reliable support of the proposed structure without the risk of unacceptable settlements. The natural cohesive soil is generally stiff to very stiff within the zone of influence of the foundations and is considered suitable for support of the proposed structure, along with the medium dense to very dense sand and gravel encountered at varying depths and thicknesses within the cohesive soils.

The following table summarizes the depths and estimated elevations at which soils that are judged to be suitable for reliable support of conventional spread footings were encountered in the test borings. It is important to note that the depths to suitable bearing soils will vary across the site and may be deeper at other locations. Additionally, existing houses with basement foundations and underground utility structures will require deeper undercutting and replacement with engineered fill.
In order to support the proposed structure on conventional spread footings, it will be necessary to first remove all existing fill materials, remnants from previous structures and all very moist or weaker natural soils at the footing locations in order to reach the very stiff to hard natural silty clay or the medium dense to very dense natural sand and gravel that is judged to be suitable for reliable support of conventional spread footings without excessive settlement.

We understand that the building foundations in some cases will be heavily loaded and therefore conventional spread footings may not be practical at some column locations due to the necessary corresponding size of the spread footings based on allowable bearing capacity and settlement considerations of the existing soils. Therefore, alternate foundation systems should be considered for support of the more heavily loaded building foundations. Aggregate columns, or another specialty ground improvement technique, could be used on this site to improve the bearing capacity and settlement characteristics of the existing soil within the slab-on-grade portion of the building. Information regarding ground improvement measures are provided in Section 4.2.1.

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Estimated Ground Surface Elevation, ft*</th>
<th>Estimated Depth to Suitable Bearing Soil, ft</th>
<th>Estimated Elevation of Suitable Bearing Soil, ft*</th>
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*Ground surface elevations estimated from topographic mapping provided by Ratio.
The shallow soils encountered at this site are generally cohesive in nature and the deeper layers of sand and gravel are generally relatively dense. It is therefore concluded that liquefaction (or any significant loss of strength during ground shaking) of the soils underlying the project site during earthquake ground motions is extremely unlikely. To our knowledge, there are no recorded cases of liquefaction of subsurface materials similar to those at this project site. Therefore, no special design measures relative to soil liquefaction appear to be warranted.

Based on geologic mapping and the results of the test borings drilled for this project, it is our opinion that the subsurface conditions at this site meet the criteria for Site Class “C” based on Section 1613.3.2 of the 2012 International Building Code (Chapter 20, Table 20.3-1 of ASCE 7-10 “Minimum Design Loads for Buildings and Other Structures”). Based on the USGS hazard data available for latitude 40.199° N and longitude -85.404° W, $S_{OS} = 0.107$ g and $S_{D1} = 0.082$ g should be used as the seismic design parameters for the proposed structure.

### 4.2 Conventional Spread Footings

Our findings show that the proposed building can be constructed on shallow spread footings bearing on the natural very stiff to hard silty and/or sandy clay or on the medium dense to dense sand and gravel generally encountered below the depths and elevations presented in the table in Section 4.1. All existing fill materials as well as remnants of previous structures and the weaker natural soils must be removed from beneath the spread footings. It is extremely important that the soil at the bases of all shallow foundation excavations (e.g., spread footings) be carefully observed, tested and evaluated as described in Section 5.4 in order to identify unsuitable materials that must be removed and replaced, such as old utilities, utility trench backfill, old foundations, construction debris, etc. and to verify that the footings will bear on the natural very stiff to hard silty and/or sandy clay or on the medium dense to dense sand and gravel. The careful and thorough field testing and observations of the soils at the bases of the foundation excavations are a critical and essential component of the foundation design. It appears that undercutting will be required at most foundation locations in order to expose suitable bearing soils. It is recommended that the contract documents include provisions for the removal and replacement of unsuitable materials as determined to be necessary based on field observations.

Spread footings that bear on natural very stiff to hard silty clay or medium dense to dense sand and gravel (or on lean concrete that is placed over such soils after first removing any unsuitable materials as described above) can be designed for a maximum allowable soil pressure 4,000 lbs/sq.ft for column and wall footings provided that all unsuitable materials (e.g., undocumented fill, softer cohesive soil, remnants from previous construction, subsurface utilities, etc.) are removed and replaced with lean concrete. The glacial till soil and sand and gravel at the estimated basement foundation bearing elevation of about El 931 is capable of supporting somewhat higher allowable design bearing pressures for spread footings. Spread footings that bear at or below El 931 can be designed for a maximum allowable soil pressure of 6,000 lbs/sq.ft for column and wall footings provided that any isolated pockets of looser sand or weaker cohesive soils are identified, removed and replaced with well compacted granular fill or lean concrete. The allowable bearing capacities can be increased by a factor of 1.33 for transient loading conditions such as wind gusts and earthquake loads. It is important that the soil at the base of each spread footing excavation be carefully observed and evaluated as described in Section 5.4 to determine whether the actual bearing materials are consistent with those upon which the recommendations are based. All remnants from previous construction, such as old foundations, utilities, etc. should be removed from beneath the spread footings. It is recommended that the contract
documents include provisions for the removal and replacement of unsuitable materials as determined to be necessary based on field observations.

Provided that the spread footings are designed as prescribed herein and the soils at the bases of the foundation excavations are observed and evaluated as outlined in Section 5.4, it is estimated that the total and differential foundation settlements should not exceed about 1½ in. and 1 in., respectively. Careful field control will contribute substantially to minimizing the settlements. All foundations should be located at a depth of at least 3 ft below the final exterior grade for frost protection.

Care must be exercised when excavating near existing facilities (e.g., pavements, utilities, etc.) to protect the integrity of the existing site features, foundations and project elements. Bracing or underpinning may be required if it becomes necessary to excavate below the bottom elevation of the existing pavements, utilities and project elements.

Uplift forces on the spread footings can be resisted by the weight of the footings and the soil material that is placed over the footings. It is recommended that the soil weight considered to resist uplift loads be limited to that immediately above and within the perimeter of the footings (unless a much higher factor of safety is used). A submerged soil unit weight of 65 lbs/cu.ft can be used for the backfill material placed above the footings, provided it is compacted as recommended in Section 5.3. It is also recommended that a factor of safety of at least 1.3 be used for calculating uplift resistance from the footings (provided only the weight of the footing and the soil immediately above it are used to resist uplift forces).

Lateral loads imparted upon shallow spread footings can be resisted by the passive lateral earth pressure against the sides of the footings and by friction between the subgrade soil and the bases of the footings. If passive lateral earth pressure is to be used to resist lateral loads imparted on the spread footings, it is essential that the soil that is relied upon to provide the passive lateral earth pressure resistance cannot be excavated or otherwise disturbed at any time in the future. If it is possible that disturbance or an excavation could be made in any portion of the passive zone (including not only soils beside the footings but soils above the tops of the footings), then passive lateral earth pressure resistance should not be considered. An allowable passive earth pressure ("Equivalent Fluid Pressure") of 80 lbs/sq.ft./ft of depth below the basement floor level can be used for the footings. An allowable coefficient of friction (between the base of the footing and the underlying soil) of 0.2 (based on a factor of safety of 1.5) can be used in conjunction with the minimum downward load on the base of the footing.

All footings should be located so that the least lateral clear distance between any two footings will be at least equal to the difference in their bearing elevations. Please note that this does not define the slope at which excavations can safely be made, which is flatter, but rather the geometric arrangement necessary to prohibit overstressing foundation soils due to stress interference between footings. New footings should not be located within a lateral distance (edge-to-edge) of 2 times the difference in their bearing elevations. If this distance cannot be maintained, the lower footing should be designed to account for the load imparted by the upper footing. If this condition occurs adjacent to a below-grade wall, the wall should be designed for additional lateral surcharge load that will be imparted upon the wall by the upper footing.
Proposed Foundational Sciences Building
Ball State University, Muncie, Indiana

Geotechnical Engineering Investigation
ATC Project No. 170GC00624

Lightly loaded project elements that are not settlement sensitive (such as site retaining walls, lightly loaded canopies, etc.) can be supported on shallow spread footings bearing at nominal depths provided that the soils at the bases of these footings are carefully observed and evaluated and any clearly unsuitable materials (i.e., fill that contains collapsible objects or degradable materials, concentrations of rubble and debris, old utilities such as sewers, wells, etc. and soft or loose soils) are removed and replaced with engineered fill. However, it must be recognized that there is some risk of greater-than-normal settlement in this case since undocumented fills, such as those noted in the upper 3.5 ft to 14.0 ft at this site, are not as reliable as the natural cohesive soils and the fill could contain compressible or collapsible materials not detected by the test borings or revealed by the field observations at the time of construction. If this risk is unacceptable, then these project elements should be supported on footings bearing on firm natural soils in a manner similar to the building foundations.

Provided that the risk of greater than normal settlement of the project elements is acceptable, spread footings that bear on firm existing soil (or on well-compacted engineered fill that is placed over firm existing soil) can be designed for a net allowable soil pressure of 1,500 lbs/sq.ft for column (square type) and wall (strip type) footings. Wall footings should be at least 2 ft wide and column footings should be at least 3 ft wide for bearing capacity considerations. All exterior footings and footings in unheated areas should be located at a depth of at least 3 ft below the final exterior grade for frost protection.

4.2.1 Aggregate Columns
It may be possible and cost effective to use a proprietary in-place soil modification or ground improvement technique such as aggregate columns to modify and improve the existing subsurface materials such that spread footings could be designed with a higher allowable bearing pressure and used without the need for complete removal and replacement of the unsuitable materials as described in Sections 4.1 and 4.2. In this case, consideration must be given to the aggregate columns relative to the existing underground utilities that will remain in service (e.g., storm sewers, tunnels and other subsurface utilities); along with other site elements. If aggregate columns are to be used, the specialty geotechnical contractor selected to improve the existing subsurface materials in-place must be consulted regarding the installation of such elements adjacent to existing facilities such as pavements, tunnels, utilities, etc. to ensure that existing features are not adversely affected due to the installation of the aggregate columns. Consideration must also be given to the sequencing of aggregate column installation with respect to the construction of the basement such that the installation process does not adversely affect the new basement walls or foundations, or that excavation for the basement does not compromise the integrity of previously installed aggregate columns.

It is recommended that a specialty geotechnical contractor be consulted to confirm the compatibility of the proprietary ground improvement system with the subsurface conditions and the project requirements (e.g., loading conditions and settlement criteria). Due to the variability in the type and condition of the existing subsurface materials at this site, which includes miscellaneous uncontrolled fill, zones of weaker cohesive soils, looser granular soils and remnants from previous construction that extend to varying depths below the existing ground surface and at various locations; the ground improvement system selected must be able to suitably improve the existing subsurface materials within the depth zone required for proper bearing of spread footings. Because of the variability in the depth to the stronger natural bearing soils over relatively short lateral distances, and thus uncertainty of the condition of the existing subsurface materials at any specific foundation location, it is recommended that the specialty geotechnical contractor consider...
aggregate columns to be installed such that soils to a depth within the zone of influence of the foundation are modified to enhance the reliability of the ground improvement measures.

Aggregate columns are proprietary techniques whereby dense-graded crushed limestone is placed in holes in thin lifts and densified using a specially designed dynamic energy source. The result is a pre-stressing of the existing material around the aggregate "columns", inclusion of stiff reinforcement elements within the existing matrix materials and a partial transfer of foundation loads to the deeper, more competent stratum. After the "in-place" reinforcement/modification, spread footings can be used without undercutting and replacement of the existing unsuitable materials. If such a system is to be used, consideration by the specialty geotechnical contractor must be given to potential issues regarding ground vibrations during installation of the aggregate columns and potential impact on adjacent structures, operations and functions; as well as potential obstructions that may exist within the existing fill materials. It will be necessary to remove any abandoned foundations, floor slabs or utilities and any large debris within the existing fill to prevent obstruction of the aggregate columns. The specialty geotechnical contractor should be consulted regarding the type of equipment and method of aggregate compaction used to determine the magnitude of ground vibrations and potential adverse impacts on the surrounding existing facilities and operations within the surrounding buildings. Consideration must also be given to the sequencing of aggregate column installation with regards to construction of the basement level, which will not require ground improvement techniques for support of the spread footings at this elevation.

Ground improvement techniques such as aggregate column soil modification and improvement systems are proprietary specialty geotechnical design/build procedures that are designed by a registered engineer with the specialty geotechnical foundation contractor and installed by a specialty geotechnical contractor. Therefore, the aggregate column contractor should be contacted regarding specific applicability to this project, development of the specific program to meet the project requirements (i.e., bearing capacity and settlement limitations) as well as costs and scheduling requirements. Spread footings that bear on reinforced, modified and improved subsurface materials as described above can usually be designed for an allowable bearing pressure in the range of about 4,000 to 6,000 lbs/sq.ft while limiting settlement within required project tolerances without the need for undercutting and replacing the existing soils or the use of deep foundations. The actual design bearing pressure must be determined by the specialty geotechnical contractor based on the specific criteria of the system, the expected loading conditions and required settlement tolerances. It is recommended that the ground improvement system be designed to limit the maximum total settlement to 1 in., or less. Since aggregate column systems are proprietary specialty geotechnical systems that result in modified subgrade soils, the ground improvement plan and final spread footing design criteria shall be developed and prepared by an engineer registered in the State of Indiana from the specialty geotechnical contractor who shall be entirely responsible for the design, installation, performance and warranty of the system.
4.3 Slab-On-Grade Floors

It appears that it may be possible to support the slab-on-grade floors on the existing soils provided the slab subgrade is prepared and observed as described in Section 5.2 of this report and any clearly unsuitable fill materials (i.e., fill that contains collapsible objects or degradable materials, concentrations of rubble and debris, old utilities such as sewers, cisterns, wells, etc. and softer or looser natural soils) are removed and replaced with engineered fill. Although some of the existing near surface materials are not suitable for support of the more heavily loaded spread footings, it may be possible to support the slab-on-grade floors on the existing soils. Based on the type of fill materials encountered in the test borings, in conjunction with the anticipated relatively light floor slab loading, the cost of complete removal and replacement of the existing uncontrolled fill materials beneath the floor slab areas (or the cost of ground improvement) may not be justified in order to completely eliminate the relatively small risk of greater-than-normal floor slab settlement that could occur at some locations if the existing fill and softer soils are not completely removed. However, the owner must recognize that there is some risk of greater-than-normal floor slab settlement in this case since uncontrolled fill materials are not as reliable as naturally deposited soils and the fill could contain compressible, degradable or collapsible materials not detected by the test borings or revealed by the field observations at the time of construction and settlement can occur without regard to changes in loading conditions (e.g., settlement can be caused by changes in the ground water regime, changes in the moisture content of the soils due to drying or increase in moisture, degradation of fill materials, etc.).

Alternatively, the slab-on-grade floors may be supported on materials improved with aggregate columns in a manner similar to the support of spread footings as described in Section 4.2.1.

It is recommended that all slab-on-grade floors be "floating", that is, fully ground supported and not structurally connected to walls or foundations. This is to minimize the possibility of cracking and displacement of the floor slabs because of differential movements between the slab and the foundation. Although the movements are estimated to be within the tolerable limits for structural safety, such movements could be detrimental to the slabs if they were rigidly connected to the foundations.

It is recommended that the ground floor level slab-on-grade floors be supported on a 4 in. thick (minimum) layer of clean granular material such as sand and gravel or crushed stone. This is to help distribute concentrated loads and equalize moisture conditions beneath the slab. Any granular materials imported for this purpose should conform to INDOT Standard Specifications Section 904.05 Structure Backfill, except that only sand and gravel or crushed limestone shall be used and the 2 in., 1½ in. and No. 30 size materials shall not be used. Provided that a minimum of 4 in. of clean granular material is placed below the floor slab, a modulus of subgrade reaction value ($k_{30}$) of 125 lbs/cu.in. can be used for design of the slab-on-grade floors. Recommendations regarding underslab drainage below the basement level floor slab are presented in Section 4.4.

4.4 Below-Grade Walls and Permanent Dewatering

The magnitude of the lateral earth pressure against the basement walls is dependent on the method of backfill placement, the type of backfill soil and drainage provisions. When a wall is held rigidly against horizontal movement (such as a basement wall that is braced by the floors, structural framing and the other walls), the lateral earth pressure against the wall is greater than the "active" lateral earth pressure that is typically used in the design of free-standing retaining walls. Therefore, the basement walls (including those that may be designed as cantilever walls) must be designed for higher, "at-rest" lateral earth pressures (using an at-rest lateral earth pressure coefficient, $K_0$). A design illustration to aid in computing lateral earth pressures against basement walls is included as Figure 3 in the Appendix.
It is recommended that only well-graded, free-draining granular material be used for backfill behind the basement walls within a zone defined by a plane extending upward and outward on a 1 to 1 slope from the base of the wall footing as shown in Figure 3. Any granular materials that are imported for this purpose should conform to INDOT Standard Specifications Section 211.03.1(c) Structure Backfill Type 3, except that No. 30 gradation material shall not be used and only natural sand, gravel or crushed limestone shall be used. The upper 24 to 36 in. of the backfill should be a cohesive soil in order to limit infiltration of surface water into the perimeter drainage system. Provided that well-graded, free-draining granular materials are used for backfill behind the basement walls, a total soil unit weight of 130 lbs/cu.ft and a coefficient of lateral earth pressure at-rest \(K_o\) of 0.45 can be used to calculate the lateral earth pressure against the basement walls using Figure 3 in the Appendix.

The pressure diagram and method of computation illustrated in Figure 3 in the Appendix presumes that there will be no hydrostatic pressure due to water build-up against the walls. Ground water was encountered as shallow as approximately 12 ft below the existing ground surface in some of the test borings for the proposed building (perched ground water was encountered higher in some isolated cases). Therefore, it is recommended that permanent dewatering measures be provided for the basement. The basement walls should be water-proofed and perforated drainage pipes should be placed along the bases of the walls to drain surface water and ground water that will enter the backfill around the walls. The drain pipes should be 8 in. (minimum) diameter (e.g., Contech A-2000 perforated PVC pipe). It is also recommended that a 12 in. thick (minimum) layer of free-draining aggregate (e.g., Indiana Department of Transportation coarse aggregate size No. 5 or No. 8 crushed limestone) should be placed beneath the basement floor slab and that 6 in. (minimum) diameter perforated drain pipes (e.g., Contech A-2000 perforated PVC pipe) set in trenches below the drainage layer and filled with the same free-draining aggregate as used beneath the floor slab (i.e., INDOT No. 5 or No. 8 crushed limestone) should be installed beneath the basement floor level to provide for drainage of water from beneath the floor. All of the drain pipes should drain to a sump pit from which water can be pumped or to a suitable gravity outfall. The perimeter drains and subfloor drains should be designed such that cleaning of the entire piping system can be performed. It is also recommended that the subfloor drains be sloped. The drain pipes and trenches beneath the basement floor drainage layer should be spaced about 25 ft apart (+/-). It is also recommended that a non-woven geotextile filter fabric be placed between the free-draining aggregate and the natural soils to prevent clogging of the drainage layer. The subfloor pipe inverts should be at a minimum depth of 24 in. below the bottom of the basement level floor slab. The pipes should be positioned within the trenches as shown in Figures 4 and 5 in the Appendix and should drain to header pipes and eventually to sumps with suitable pumping capacities for the projected flows noted below, or gravity drain to a suitable outfall.

It is imperative that the drainage material within the drainage blanket and trenches be kept clean and free of debris. It is therefore recommended that the completion of the drainage layer system be just prior to installation of the slab so that the exposure to construction traffic is minimized. If it should become necessary to place the drainage material earlier than immediately before placing the floor, the drainage blanket should be inspected and any contaminated zones replaced. It is also important that all drain pipes be located as far as possible from footings and that the pipes should be located outside the zone of influence of the footings. If the pipes are installed after the footings are installed, special care will need to be exercised to prevent undermining the existing footings due to excavation for the pipes.
Unless permanent dewatering measures are included around the elevator pit to maintain the ground water level below the base of the pit walls (which is often considered undesirable or impractical for elevator pit applications), the pit walls must be made watertight and designed for hydrostatic pressures and the pits designed to counteract buoyancy. Ground water was observed as shallow as 12 ft below the existing ground surface in the test borings. It is not possible to accurately predict the future high ground water level at the pit locations; however, based upon the general regional geology and our experience, we recommend using a design high ground water level for the elevator pits no lower than approximately 1 ft below the finished floor elevation of the basement floor slab. This is based upon the assumption that permanent dewatering measures are installed as described above that maintains the ground water level below the basement level. The buoyancy of the pit can be resisted by increasing the weight of the pit structure and a “lip” can be added to the pit bottom so that the soil above the lip can be utilized to resist the uplift forces acting on the base of the pit. Figure 7 in the Appendix can be used in the analysis and design for resistance of buoyancy of the elevator pit.

It is not possible to determine with complete certainty the amount of ground water that will be required to be pumped for soils such as those at this site because the soil stratigraphy is not uniform and ground water is generally contained in discontinuous saturated sand and gravel layers and seams interbedded within the cohesive soils. Furthermore, the recharge mechanisms of the subsurface soils are not well defined and can only be evaluated with an extensive hydrogeologic study over a prolonged period. However, based on a permanent dewatering system that includes subfloor trench drains and perimeter wall drains, in conjunction with our experience; it has been estimated that the maximum pumping rate for this project likely will not exceed approximately 1,000 gal./min. It is extremely important that multiple pumps of varying capacity be installed to handle variations in flow rate from periods of no ground water flow up to the maximum of 1,000 gal./min., as well as any volume in between for any length of time (it is possible that there could be extended periods of little or no ground water flow).

It is recommended that the project specifications require the temporary construction dewatering contractor to carefully monitor the construction dewatering and provide details of the system used to dewater the excavation along with the pumping rates of the system. This information should be evaluated to determine if additional pumping capacity is needed for the permanent dewatering system that will be installed.

For relatively short site retaining walls that are designed as cantilever retaining walls that are free to rotate sufficiently to develop the active lateral earth pressure condition, an active lateral earth pressure coefficient \( K_a \) of 0.33 and a total soil unit weight of 130 lbs/cu.ft. can be used to calculate the lateral earth pressures on the walls and footings provided that well-graded granular backfill material is used behind these walls. An allowable coefficient of friction between the base of the retaining wall footings and the foundation soils of 0.20 can be used to resist lateral forces based on a factor of safety of 1.5 relative to lateral resistance of the retaining wall footings. Lateral forces can also be resisted by the passive lateral earth pressure against the sides of the wall footings. An allowable passive pressure of 100 lbs/sq.ft per foot of depth below the ground surface can be used for that portion of the footing that is below a depth of 2 ft below the final exterior grade (no portion of the footing above this depth should be used for lateral resistance). If passive earth pressure is to be used to resist lateral forces, it is essential that the earth that is relied upon to provide the passive pressure cannot be excavated in the future.
4.5 Pavement
Generally cohesive fill materials were encountered within the upper 3.5 ft to 14.0 ft below the existing ground surface within the vicinity of the proposed pavements and, depending upon specific grading requirements and seasonal conditions, it is likely that the pavement subgrade in most areas will be wet, soft or yielding at the time of construction. It must be noted that undocumented fill materials are not as reliable as natural soil and there is a relatively small risk of greater than normal settlement of pavements supported on undocumented fill material.

It is possible that areas of uncontrolled miscellaneous fill materials (e.g., rubble, debris, remnants from previous construction, such as floor slabs, foundations, walls, pits, wells, cisterns, utility lines, etc.) may be encountered within pavement areas based on the results of the test borings drilled for the project. Our experience on projects with similar subsurface conditions as those encountered on this project site indicates that settlement can occur due to future consolidation of the existing miscellaneous fill and rubble materials without regard to loading. Changes in grading and surface water infiltration can initiate settlement along with degradation or collapse of materials within the fill. Therefore, in order to completely eliminate the risk of unacceptable differential settlement of the pavements it would be necessary to completely remove any existing uncontrolled fill materials that may be encountered and to replace them with well-compacted engineered fill. Although uncontrolled fill materials are not as reliable as naturally deposited soils, the cost of complete removal and replacement of uncontrolled fill materials, where encountered, beneath pavement areas does not appear to be justified in order to completely eliminate the risk of greater-than-normal settlement that could occur at some locations if the existing fill is not completely removed. However, if the fill is not completely removed and replaced where encountered, the owner must recognize that there is some risk of greater-than-normal settlement in this case since uncontrolled fill materials are not as reliable as naturally deposited soils and the fill could contain compressible or collapsible materials not detected by the test borings or revealed by the field observations at the time of construction.

In any case, it is recommended that the soils exposed at the pavement subgrade level should be carefully observed, tested and evaluated, including proofroll testing, to determine if there are any materials that need to be improved. Any remnants of previous construction that are exposed at the pavement subgrade level (such as foundations, walls, pits, vaults, etc.) should be removed to a depth of at least 2 ft below the base or bottom of the proposed pavement section and replaced with well-compacted engineered fill to provide uniform support directly beneath the pavement sections. Furthermore, any collapsible objects, pockets of “nested” debris or rubble, any soft/loose or otherwise unsuitable materials that are identified beneath the pavement subgrade level should also be removed and replaced with well-compacted engineered fill material.

The pavement subgrade surface should be uniformly sloped to facilitate drainage through the granular base and to avoid any ponding of water beneath the pavement. The storm water catch basins in pavement areas should be designed to allow water to drain from the aggregate base into the catch basins. At a minimum, subsurface trench drains should be included that extend out at least 20 ft from the catchbasins in at least four directions.
Based on the results of classification tests and our experience with similar soils, a resilient modulus value of 4,000 lbs/sq.in. has been estimated for use in pavement design for the clayey subgrade soils encountered at this site. The subgrade soils should be prepared and inspected as described in Sections 5.2 and 5.3.

The following report sections outline recommendations for asphalt and concrete pavements for automobile parking areas and truck zones. It is important to note that the recommendations for the automobile parking areas are based on the assumption that these areas will not be subject to any heavy truck traffic. Therefore, in areas where truck traffic cannot be controlled (i.e., driveways), it is suggested that the thicker pavement section be utilized. Since these recommendations are based on estimated traffic loading conditions, it is recommended that they be verified when the actual anticipated traffic conditions become available.

4.6.1 Asphalt Pavement
The table below summarizes recommended asphalt pavement section thicknesses based upon the assumed traffic volume. If significantly different traffic volume is expected or other assumed pavement characteristics are different, the pavement recommendations should be re-evaluated based upon the new information. Based on the results of laboratory tests, our experience with similar types of soils and engineering judgment, a resilient modulus value of 4,000 lbs/sq.in. was estimated for use in pavement section analyses. The pavement section thickness calculations are based on the estimated resilient modulus value as stated above using the AASHTO “Guide for Design of Pavement Structures - 1993”. Based on this method; a reliability value of 85 percent, an overall standard deviation value of 0.45, an initial serviceability value of 4.2, a final serviceability value of 2.0 and structural layer coefficients of 0.42 for asphalt surface, 0.40 for asphalt base and 0.12 for crushed limestone aggregate base material have been assumed for use in the pavement section calculations.
### Recommended Asphalt Pavement Sections

<table>
<thead>
<tr>
<th>Pavement Type</th>
<th>Standard-Duty</th>
<th>Heavy-Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Period</td>
<td>15 years</td>
<td>15 years</td>
</tr>
<tr>
<td>Minimum 15 Year Design Life Total ESALs</td>
<td>15,000</td>
<td>75,000</td>
</tr>
<tr>
<td>Estimated Resilient Modulus of Subgrade Soils, lbs/sq.in.</td>
<td>4,000</td>
<td>4,000</td>
</tr>
<tr>
<td>Initial Serviceability</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Terminal Serviceability</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Reliability, %</td>
<td>85.0</td>
<td>85.0</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.45</td>
<td>0.45</td>
</tr>
<tr>
<td>Recommended Minimum Asphalt Surface Thickness, inches</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Recommended Minimum Asphalt Base Thickness, inches</td>
<td>2.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Recommended Minimum Aggregate Base Thickness, inches</td>
<td>6.0</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Note: The parameters for ESALs, initial serviceability, terminal serviceability, reliability, standard deviation are based upon the AASHTO “Guide for Design of Pavement Structures - 1993”.

The aggregate base should consist of well-compacted crushed limestone that meets the requirements for coarse aggregate size No. 53 in accordance with Indiana Department of Transportation-INDOT-Standard Specifications (aggregates that are locally referred to as “commercial grade” No. 53 crushed stone should not be used as pavement base material). The hot mix asphalt (HMA) pavement should be constructed in accordance with the 2018 INDOT Standard Specifications Section 400 – Asphalt Pavements. The HMA mix design should be in accordance with INDOT Standard Specifications Section 402-Hot Mix Asphalt, HMA, Pavement.

It should be expected that normal maintenance compatible with asphalt pavement and the design period selected will be required during the life of the pavement. Furthermore, overlaying the pavement surface may be desirable at an intermediate time period to extend the life of the pavement and improve serviceability.

#### 4.6.2 Concrete Pavement

Concrete pavement thicknesses were determined from methods developed by the American Association of State Highway and Transportation Officials (AASHTO). These methods are based on the subgrade being firm, well-compacted and non-pumping and all joints being properly designed, located and sealed to minimize moisture seepage into the subgrade. It is also important that proper concrete curing practices be employed and that traffic will not be allowed until the concrete has had sufficient time to cure.
For design calculation purposes, the compressive strength of the concrete was assumed to be at least 4,000 lbs/sq.in. (or a modulus of rupture of at least 600 lbs/sq.in.) and the modulus of subgrade reaction ($k_{30}$) was estimated to be 100 lbs/cu.in. The table below summarizes the assumed design parameters and recommended concrete pavement sections.

### Recommended Concrete Pavement Sections

<table>
<thead>
<tr>
<th>Pavement Type</th>
<th>Standard-Duty</th>
<th>Heavy-Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Period</td>
<td>15 years</td>
<td>15 years</td>
</tr>
<tr>
<td>Minimum 15 Year Design Period Total ESALs</td>
<td>15,000</td>
<td>75,000</td>
</tr>
<tr>
<td>Initial Serviceability</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Terminal Serviceability</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Reliability, %</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.35</td>
<td>0.35</td>
</tr>
<tr>
<td>Estimated Modulus of Rupture of Concrete, lbs/sq.in.</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Estimated Modulus of Elasticity of Concrete, lbs/sq.in.</td>
<td>3,600,000</td>
<td>3,600,000</td>
</tr>
<tr>
<td>Load Transfer Factor ($J$)</td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>Estimated Modulus of Subgrade Reaction, lbs/cu.in.</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Drainage Coefficient</td>
<td>1.10</td>
<td>1.10</td>
</tr>
<tr>
<td>Recommended Minimum Concrete Thickness, inches</td>
<td>5.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Recommended Minimum Aggregate Base Thickness, inches</td>
<td>4.0</td>
<td>4.0</td>
</tr>
</tbody>
</table>

The performance of the concrete paving section is highly dependent on controlling the pumping of the subgrade soils. Although no wet surface soils were noted at the time of this study, it is important that surface drainage be controlled to prevent water from ponding in pavement areas, particularly in areas of existing high moisture content.

### 4.6 Site Grading and Drainage

Proper surface drainage should be provided at the site to minimize any increase in moisture content of the foundation soils or the below-grade wall backfill soils. The exterior grade should be sloped away from the structure to prevent ponding of water. Any roof drains or down spouts should be channeled or piped well away from the structure.

The soils encountered in the test borings at the Foundational Sciences Building project site generally consist of cohesive very stiff natural and fill soils that are relatively impervious, along with miscellaneous uncontrolled fill materials in the upper approximately 13.0 ft to 20.0 ft. These materials generally have relatively low permeability or are highly unreliable for purposes of storm water infiltration. Therefore, the reliable disposal of significant amounts of storm water by infiltration measures at this site will not be feasible. Based on the results of the test borings, field infiltration testing and in conjunction with published literature, it is recommended that a design infiltration rate for the natural cohesive soils above the ground water level should be limited to a maximum of approximately 0.1 in./hr. Since the ground
water level at the time of this investigation was typically at a depth of about 12 ft below the existing
ground surface, it is recommended that all infiltration measures be designed to discharge at least 4 ft
above the ground water level in order for the water to discharge above the ground water level. This will
likely required the removal and replacement of unsuitable materials as described above.

It must be noted that subsurface soil and ground water conditions change through time (such as a
seasonal rise in the ground water level and a decrease in the permeability of the subgrade soils due to
intrusion of fines transported by the storm water into the granular soils). Therefore, it is recommended
that any storm water infiltration system include measures for cleaning as well as a suitable alternate
outfall should the system performance be diminished or impaired. It is also recommended that any
storm water infiltration elements be located as far away from any structure (current or potential future
structures) as possible and locating the discharge level of an infiltration element below adjacent
basement levels is recommended.

5 GENERAL CONSTRUCTION PROCEDURES
AND RECOMMENDATIONS

Since this investigation identified actual subsurface conditions only at the test boring locations, it was
necessary for our geotechnical engineers to extrapolate these conditions in order to characterize the
entire project site. Even under the best of circumstances, the conditions encountered during
construction can be expected to vary somewhat from the test boring results and may, in the extreme
case, differ to the extent that modifications to the foundation recommendations become necessary.
Therefore, we recommend that ATC be retained as geotechnical consultant throughout the earth-related
phases of this project to correlate actual soil conditions with test boring data, identify variations, conduct
additional tests that may be needed and recommend solutions to earth-related problems that may
develop.

5.1 Mass Excavation
It will be necessary to make a mass excavation for the basement area to depths of at least 20 ft below the
existing ground surface. Based on the basement location, it is anticipated that an open-cut excavation
will be possible to the north and east of the basement and an earth retention system may be necessary
along North Martin Street and Ashland Avenue to the west and south, respectively. It is recommended
that the temporary excavation sideslopes be made no steeper than 2 (horizontal) to 1 (vertical). The
actual slope configurations must be determined by the contractor responsible for the temporary
excavation, construction means and methods and site safety. Some sloughing of loose material should
be expected with such slopes and the slopes should be continuously monitored for detection of
instabilities that may require remediation. All federal, state and local safety regulations should be
followed in regard to open-cut excavations.
It is recommended that a baseline survey be made of all pertinent surrounding site features before construction is initiated. This will include establishing benchmarks and initial elevations on buildings, sidewalks and streets adjacent to the proposed excavation. It is also recommended that a thorough investigation of the existing nearby structures precede any construction to document any existing defects (such as cracks, ground depressions, etc.) in the existing site features. Periodic monitoring of horizontal and vertical movement of the walls of nearby structures should be incorporated into the retention system program to monitor any movement of the nearby structures that could give an indication of the performance of the retention system or possible pending failure.

5.2 Site Preparation
All areas that will support slab-on-grade floors and pavements should be properly prepared. After rough grade has been established, the exposed subgrade should be carefully observed by an engineer or a qualified soils technician by probing and testing as needed. Any organic material still in place, frozen, wet, soft or loose soil, construction material and other undesirable materials should be removed. The exposed subgrade should furthermore be evaluated by probing to check for pockets of soft or loose material beneath a thin crust of better soil. Any unsuitable materials thus exposed should be removed and replaced with well-compacted, engineered fill as outlined in Section 5.3.

Care should be exercised during the grading operations at the site. Due to the nature of the near surface soils, the traffic of construction equipment may create pumping and general deterioration of the shallower soils, especially if excess surface water is present. The grading, therefore, should be done during a dry season, if at all possible.

5.3 Fill Compaction
All engineered fill beneath pavements and slabs-on-grade should be compacted to a dry density of at least 98 percent of the standard Proctor maximum dry density (ASTM D-698). Any engineered fill that is placed beneath a spread footing should be compacted to 100 percent of the standard Proctor. The compaction should be accomplished by placing the fill in about 8 in. (or less) loose lifts and mechanically compacting each lift to at least the specified minimum dry density. Field density tests should be performed on each lift as necessary to document moisture conditions and the actual compaction that is being achieved.

It is recommended that only well-graded granular material, such as pit-run sand and gravel or INDOT No. 53 crushed limestone, should be used to fill undercut excavations below spread footings and any other excavations of limited lateral dimensions where proper compaction of cohesive materials is difficult and compaction can only be accomplished with small vibratory equipment. Lean concrete (2,000 lbs./sq.in. minimum compressive strength) can also be used as fill beneath spread footings.

5.4 Foundation Excavations
It is essential that the soil at the base of each spread footing excavation should be observed and evaluated by an engineer or a qualified geotechnical field technician working under the direction of the geotechnical engineer-of-record (ATC) to verify that each spread footing will bear on very stiff to hard natural silty clay or sandy clay or on the medium dense to dense natural sand and gravel as described in Sections 4.1 and 4.2 and to identify any unsuitable materials that must be removed and replaced. All existing fill materials, remnants from previous construction, softer natural cohesive soils, loose granular soils and any otherwise undesirable materials must be removed at footing locations so that the footings will bear on satisfactory material compatible with the design of the footing as described in Sections 4.1 and 4.2. It appears likely
that it will be necessary to remove and replace unsuitable materials at some footing locations on this project. At the time of such observation, it will be necessary to make hand auger borings, use a hand penetration device or perform a small test pit in the base of the foundation excavation to evaluate the soils below the base of the footing. The necessary depth of penetration will be established by the geotechnical engineer or technician.

Where undercutting is required to remove unsuitable materials, the proposed footing elevation may be re-established by backfilling after all undesirable materials have been removed. The undercut excavation beneath each footing should extend to suitable bearing soils. If granular fill materials (such as pit-run sand and gravel, crushed limestone, etc.) are to be used to backfill the undercut excavations, the dimensions of the excavation base should be determined by imaginary planes extending outward and downward on a 2 (vertical) to 1 (horizontal) slope from the base perimeter of the footing (see Figure 8 in the Appendix). The entire excavation should then be refilled with engineered fill. The engineered fill should be limited to well-graded sand and gravel or crushed stone (e.g., Indiana Department of Transportation coarse aggregate size No. 53 crushed stone) compacted to 100 percent of the standard Proctor maximum dry density. In cases where lean concrete will be used to fill an undercut excavation (rather than enlarging the base of the undercut excavation as recommended above and placing compacted granular fill materials in 8 in. thick lifts), the dimensions of the base of the undercut excavation can be made the same dimensions as the footings. Special care should be exercised to remove any sloughed, loose or soft materials near the base of the excavation slopes. In addition, special care should be taken to “tie-in” the compacted fill with the excavation slopes with benches as necessary so that no pockets of loose or soft materials will be left in place along the excavation slopes below the foundation bearing level. The undercut excavation beneath each footing should extend to suitable bearing soils as described in Sections 4.1 and 4.2.

All existing facilities (e.g., utilities, pavements, etc.) should be suitably protected from undermining due to excavation for the new structure. Depending on the relative depths and locations of the new excavations and the need to remove unsuitable soils at footing locations, bracing or underpinning will likely be needed to protect some of the existing facilities. All federal, state and local safety regulations should be followed in this regard.

Soils exposed in the bases of all satisfactory foundation excavations should be protected against any detrimental change in condition such as from disturbance, rain and freezing. Surface run-off water should be drained away from the excavation and not allowed to pond. If possible, all footing concrete should be placed the same day the excavation is made. If this is not practical, the footing excavations should be adequately protected. It is recommended that a concrete “mud mat” be placed at the bases of the footing excavations to protect the subgrade soils from deterioration due to seepage of water, construction activity, etc., and to aid in the proper placement of reinforcing steel.
5.5 Construction Dewatering

At the time of our investigation, free ground water appeared to generally be below the shallow footing excavation depths in non-basement areas but well above the basement excavation depth. Depending on the seasonal conditions and the depths of undercutting required, some seepage into shallow footing excavations in non-basement areas may be experienced due to “perched” ground water that may be encountered in the cohesive soils or wet sand layers; or that which is trapped within old miscellaneous fill materials, abandoned utilities, utility trenches, etc. It is anticipated that such seepage can likely be handled by conventional dewatering methods such as by pumping from sumps in most cases.

Significant seepage of ground water into the basement excavation, the basement footing excavations and the elevator pit excavation should be expected. In some areas it may be possible to use conventional dewatering methods such as by pumping from trenches and sumps. However, in cases where saturated sand and gravel layers are encountered at the base or sides of the excavation, it will not be possible to pump water directly from the base of the excavation without causing deterioration of the subgrade soil. In these cases, more significant dewatering measures will be required to prevent caving or sliding of excavation slopes, heaving of the base of the excavation and/or causing a quick condition in the base of the excavation. In these cases, it may be necessary to depress the ground water level using multiple wells or well points. In some cases, the ground water in a confined sand layer within glacial till soils can be under significant hydrostatic pressure and the actual hydrostatic ground water level within the confined sand layer may be well above the level at which free ground water is first encountered in an excavation (i.e., free ground water may not be encountered within the relatively impervious cohesive glacial till soils above a confined sand layer until the confined sand layer is penetrated, at which point the free ground water level rises well above the top of the sand layer). This appears to be the case in Borings B-4, B-5, B-10, B-11 and B-14 where free ground water was initially encountered at depths below those observed within the open borehole at completion of drilling.

The contractor should be prepared for variable ground water conditions, including cases as described above, and variable temporary dewatering conditions. Because of the variability and complexity of the ground water conditions at this site, it is suggested that an experienced specialty dewatering contractor be retained to provide temporary dewatering measures for the excavations at the basement level. The ground water level should be maintained at least 3 ft below the deepest excavation and dewatering measures should be implemented before excavation begins to prevent destabilizing the subsurface soils.

6 FIELD INVESTIGATION

Fourteen test borings were drilled at the approximate locations shown on the Boring Plan (Figure 2 in the Appendix). The test borings drilled for this project were extended to depths of 15 ft to 60 ft below the existing grade. Split-barrel samples were obtained by the Standard Penetration Test procedures (ASTM D-1586) at 2.5 ft to 5 ft intervals. The test borings were backfilled with auger cuttings and plugged with concrete at completion of drilling.
Logs of all borings, which show visual descriptions of all soil strata encountered using the Unified Soil Classification System, have been included in numerical order in the Appendix. Ground water observations, sampling information and other pertinent field data and observations are also included. In addition, a “Field Classification System for Soil Exploration” document defining the terms and symbols used on the logs and explaining the Standard Penetration Test procedure is provided immediately following the boring logs.

7 LABORATORY INVESTIGATION

The disturbed samples were inspected by a geotechnical engineer and classified in accordance with the Unified Soil Classification System and the boring logs were edited as necessary. To aid in classifying the soils and to determine general soil characteristics, natural moisture content tests, Atterberg limits tests, particle size distribution tests and calibrated hand penetrometer (“pocket penetrometer”) tests were performed on selected samples. The results of these tests are included on the Test Boring Logs and summary sheets in the Appendix.

8 LIMITATIONS OF STUDY

An inherent limitation of any geotechnical engineering study is that conclusions must be drawn on the basis of data collected at a limited number of discrete locations. The recommendations provided in this report were developed from the information obtained from the test borings that depict subsurface conditions only at these specific locations and at the particular time designated on the logs. Soil and ground water conditions at other locations may differ from conditions occurring at these boring locations. The nature and extent of variations between the borings may not become evident until the course of construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations of this report after performing on-site observations during the excavation period and noting the characteristics of any variation.

Any comments or recommendations made herein regarding construction related issues are solely for the purpose of planning the design of the earth related elements of the proposed building. The scope of this investigation is not sufficient to identify all potential construction related issues, variations, anomalies, etc. or all factors that may affect construction means, methods and costs.

Our professional services have been performed, our findings obtained and our recommendations prepared in accordance with customary principles and practices in the field of geotechnical engineering at the time when the services were performed and at the location where the services were performed. This warranty is in lieu of all other warranties either express or implied. This company is not responsible for the independent conclusions, opinions or recommendations made by others based on the field exploration and laboratory test data presented in this report.

The scope of our services does not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in the soil, ground water or surface water within or beyond the site studied.
ATC assumes no responsibility for any construction procedures, temporary excavations (including utility trenches), temporary dewatering or site safety during or after construction. The contractor shall be solely responsible for all construction procedures, construction means and methods, construction sequencing and for safety measures during construction as well as the protection of all existing facilities. All applicable federal, state and local laws and regulations regarding construction safety must be followed, including current Occupational Safety and Health Administration (OSHA) Regulations including OSHA 29 CFR Part 1926 “Safety and Health Regulations for Construction”, Subpart P “Excavations”, and/or successor regulations. The Contractor shall be solely responsible for designing and constructing stable, temporary excavations and should brace, shore, slope, or bench the sides of the excavations as necessary to maintain stability of the excavation sides and bottom and to protect the integrity of all existing facilities (i.e., existing foundations, floor slabs, equipment, utilities, streets, etc.).
Appendix

Figure 1: Vicinity Map
Figure 2: Boring Plan
Figure 3: Design Illustration – Lateral Earth Pressure Against Basement Wall
Assuming Drained Backfill with No Hydrostatic Pressure
Figure 4: Typical Profile Along Sub-Floor Drainage Trench
Figure 5: Typical Cross-Section Through Sub-Floor Drainage Trench
Figure 6: Typical Drainage Pipe Placement Adjacent to Footing
Figure 7: Design Illustration – Uplift Consideration of Submerged Below-Grade Structure
Figure 8: Design Illustration – Footings in Undercut Area

Test Boring Logs
“Field Classification System for Soil Exploration”
Particle Size Distribution Test Reports
“Important Information About Your Geotechnical Engineering Report”
\[ \sigma_s = \text{TOTAL SOIL UNIT WEIGHT, lbs./cu. ft.} \]

\[ K_0 = \text{AT-REST LATERAL EARTH PRESSURE COEFFICIENT} \]
TYPICAL PROFILE ALONG SUB-FLOOR DRAINAGE TRENCH

PROPOSED FOUNDATIONAL SCIENCES BUILDING
BALL STATE UNIVERSITY
MUNCIE, INDIANA

FLOOR SLAB

INDOT No. 5 OR No. 8 CRUSHED STONE

FLOW (SLOPING PIPE)

3" MIN.

6" DIAMETER (MIN.) PERFORATED DRAINAGE PIPING (e.g., CONTECH A-2000 PERFORATED PVC PIPE) SLOPING

NON-WOVEN GEOTEXTILE

NATURAL GROUND

Project Number: 1706000624

Attn. By: JG

Drawing File: SEE LOWER LEFT

Cert. By: SR

Date: 5/18

Scale: NOT TO SCALE

Figure: 4

ATC
TYPICAL CROSS-SECTION THROUGH SUB-FLOOR DRAINAGE TRENCH

PROPOSED FOUNDATIONAL SCIENCES BUILDING
BALL STATE UNIVERSITY
MUNCIE, INDIANA

FLOOR SLAB

INDOT No. 5 OR No. 8 CRUSHED STONE

6" DIAMETER (MIN.) PERFORATED DRAINAGE PIPING (e.g., CONTECH A-2000 PERFORATED PVC PIPE SLOPING)

NON-WOVEN GEOTEXTILE FILTER FABRIC

NATURAL GROUND

12" MIN.

12" MIN.

3" MIN.

18" MIN.
NOTE: FOR THIS DESIGN APPROACH, TOTAL (NOT BUOYANT) WEIGHTS OF SOIL AND STRUCTURE MATERIALS WITHIN THE DASHED LINES SHOULD BE USED.

\[ U = \sigma_w HBL \]

\[ H = \text{DEPTH FROM DESIGN HIGH GROUND WATER LEVEL TO BOTTOM OF STRUCTURE (ft.)} \]
\[ \sigma_w = \text{UNIT WEIGHT OF WATER (lbs./ cu. ft.)} \]
\[ U = \text{TOTAL UPLIFT FORCE (lbs.)} \]
\[ W_T = \text{WEIGHT OF STRUCTURE (lbs.)} \]
\[ W_S = \text{WEIGHT OF SOIL OVER FOUNDATION SLAB (lbs.)} \]
\[ B = \text{WIDTH OF STRUCTURE BASE (ft.)} \]
\[ L = \text{LENGTH OF STRUCTURE BASE (ft.)} \]
PROPOSED GRADE

FOOTING

EXCAVATION LIMIT

COMPACTED ENGINEERED FILL

SUITABLE BEARING MATERIAL

EXCAVATION LIMIT

DESIGN ILLUSTRATION
FOOTINGS IN UNDERCUT AREA

PROPOSED FOUNDATIONAL SCIENCES BUILDING
BALL STATE UNIVERSITY
MUNCIE, INDIANA
### Test Boring Log

**Client:** Ratio Architects, Inc.  
**Project Name:** Proposed Foundational Sciences Building  
**Project Location:** Ball State University  
**Muncie, Indiana**

#### Drilling and Sampling Information

**Date Started:** 4/5/18  
**Date Completed:** 4/5/18  
**Drill Foreman:** W. Bates  
**Inspector:** S. Rushfeldt  
**Boring Method:** HSA

#### Soil Classification

<table>
<thead>
<tr>
<th>Stratum Description</th>
<th>Stratum Elevation</th>
<th>Depth, ft</th>
<th>Scale, ft</th>
<th>Sample No.</th>
<th>Sample Type</th>
<th>Sample Graphics</th>
<th>Water Table</th>
<th>Groundwater Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 in. Crushed stone</td>
<td>949.7</td>
<td>0.3</td>
<td></td>
<td>1</td>
<td>SS</td>
<td>X</td>
<td></td>
<td>Ground surface elevation estimated from topographic mapping provided by client.</td>
</tr>
<tr>
<td>Brown and gray, moist, sandy silty clay with trace gravel (FILL)</td>
<td>944.0</td>
<td>6.0</td>
<td></td>
<td>2</td>
<td>SS</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown and gray, moist, silty sand with brick fragments, concrete fragments, and trace cinders (FILL)</td>
<td>941.5</td>
<td>8.5</td>
<td></td>
<td>3</td>
<td>SS</td>
<td>X</td>
<td></td>
<td>Possible foundation or concrete slab encountered at 7.5 ft.</td>
</tr>
<tr>
<td>Brown, moist, sandy silty clay with trace gravel (FILL)</td>
<td>939.0</td>
<td>11.0</td>
<td></td>
<td>4</td>
<td>SS</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown, slightly moist, very stiff to hard, SANDY CLAY (CL) with trace gravel</td>
<td>931.5</td>
<td>18.5</td>
<td></td>
<td>5</td>
<td>SS</td>
<td>X</td>
<td></td>
<td>Borehole backfilled with auger cuttings and plugged with concrete.</td>
</tr>
<tr>
<td>Gray, slightly moist, hard, SANDY CLAY (CL) with trace gravel</td>
<td>916.5</td>
<td>33.5</td>
<td></td>
<td>13</td>
<td>SS</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gray, wet, very dense, SAND and GRAVEL (SW)</td>
<td>910.0</td>
<td>40.0</td>
<td></td>
<td>14</td>
<td>SS</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Bottom of Test Boring at 40.0 ft**

#### Test Data

**Sample Type**  
- SS - Driven Split Spoon  
- ST - Pressed Shelby Tube  
- CA - Continuous Flight Auger  
- RC - Rock Core  
- CU - Cuttings  
- CT - Continuous Tube

**Depth to Groundwater:**

- **Noted on Drilling Tools:** 32.0 ft.
- **At Completion:** None ft.
- **After** -- hours -- ft.
- **Cave Depth:** 18.0 ft.

**Boring Method**  
- HSA - Hollow Stem Augers  
- CFA - Continuous Flight Augers  
- CA - Casing Advancer  
- MD - Mud Drilling  
- HA - Hand Auger
### Ground Surface Elevation
Estimated from topographic mapping provided by client.

### Borehole Backfilled
- Auger cuttings
- Plugged with concrete.

### Soil Classification

<table>
<thead>
<tr>
<th>Stratum Description</th>
<th>Depth, ft</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 in. Asphalt over 4 in. crushed stone</td>
<td>950.4</td>
<td>-</td>
</tr>
<tr>
<td>Brown, moist, sandy silty clay with trace gravel (FILL)</td>
<td>947.5</td>
<td>-</td>
</tr>
<tr>
<td>Brown, moist, stiff to hard, SANDY SILTY CLAY (CL) with trace gravel</td>
<td>937.5</td>
<td>-</td>
</tr>
<tr>
<td>Gray, moist, stiff, SANDY CLAY (CL) with trace gravel</td>
<td>935.0</td>
<td>-</td>
</tr>
<tr>
<td>Brown, moist, hard, SANDY CLAY (CL) with interbedded sand seams</td>
<td>932.5</td>
<td>-</td>
</tr>
<tr>
<td>Gray, slightly moist, hard, SANDY CLAY (CL) with interbedded sand seams</td>
<td>923.0</td>
<td>-</td>
</tr>
<tr>
<td>Gray, wet, very dense, SAND (SP-SM) with trace silt and gravel</td>
<td>917.5</td>
<td>-</td>
</tr>
<tr>
<td>Gray, slightly moist, hard, SANDY CLAY (CL) with trace gravel</td>
<td>912.5</td>
<td>-</td>
</tr>
<tr>
<td>Gray, wet, very dense, SAND (SP-SM) with trace silt and gravel</td>
<td>911.0</td>
<td>-</td>
</tr>
</tbody>
</table>

### Test Data

- **Sample Type:**
  - SS - Driven Split Spoon
  - ST - Pressed Shelby Tube
  - CA - Continuous Flight Auger
  - RC - Rock Core
  - CU - Cuttings
  - CT - Continuous Tube

- **Depth to Groundwater:**
  - 28.0 ft.

- **Cave Depth:**
  - 23.0 ft.

- **Remarks:**
  - Ground surface elevation estimated from topographic mapping provided by client.
  - Borehole backfilled with auger cuttings and plugged with concrete.
**Ground surface elevation estimated from topographic mapping provided by client.**

Sample No. 3: LL=31, PL=15, PI=16

Borehole backfilled with auger cuttings and plugged with concrete.
Ground surface elevation estimated from topographic mapping provided by client. Drove rock with splitspoon between 6-7.5 ft.

Drove rock with splitspoon between 6-7.5 ft.

Drove rock with splitspoon between 6-7.5 ft.

Drove rock with splitspoon between 6-7.5 ft.

Drove rock with splitspoon between 6-7.5 ft.

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Drove rock with splitspoon between 6-7.5 ft.

Drove rock with splitspoon between 6-7.5 ft.

Drove rock with splitspoon between 6-7.5 ft.
## Test Boring Log

### General Information
- **Client:** Ratio Architects, Inc.
- **Project Name:** Proposed Foundational Sciences Building
- **Project Location:** Ball State University
- **Job #:** 170GC00624

### Drilling and Sampling Information
- **Date Started:** 4/9/18
- **Date Completed:** 4/9/18
- **Hammer Wt.:** 140 lbs.
- **Hammer Drop:** 30 in.
- **Drill Foreman:** W. Bates
- **Inspector:** S. Rushfeldt
- **Boring Method:** HSA

### Soil Classification

<table>
<thead>
<tr>
<th>Stratum Description</th>
<th>Stratum Elevation</th>
<th>Depth, ft</th>
<th>Sample No.</th>
<th>Sample Type</th>
<th>Standard Penetration Test, Blows per 6 in. Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 in. Topsoil</td>
<td>944.4</td>
<td>0.6</td>
<td>1</td>
<td>SS</td>
<td>2-3-3</td>
</tr>
<tr>
<td>Brown, moist, medium stiff, SILTY CLAY (CL) with trace sand and gravel</td>
<td>941.5</td>
<td>3.5</td>
<td>2</td>
<td>SS</td>
<td>4-5-6</td>
</tr>
<tr>
<td>Brown, moist, stiff to hard, SANDY SILTY CLAY (CL) with trace sand and gravel</td>
<td>931.5</td>
<td>13.5</td>
<td>5</td>
<td>SS</td>
<td>3-6-7</td>
</tr>
<tr>
<td>Gray, moist, stiff to very stiff, SANDY CLAY (CL) with trace gravel</td>
<td>926.5</td>
<td>18.5</td>
<td>7</td>
<td>SS</td>
<td>3-7-8</td>
</tr>
<tr>
<td>Brown, wet, medium dense, SILTY SAND and GRAVEL (SM)</td>
<td>921.5</td>
<td>23.5</td>
<td>10</td>
<td>SS</td>
<td>47-50/0.4</td>
</tr>
<tr>
<td>Gray, slightly moist, hard, SANDY CLAY (CL) with trace gravel and interbedded sand seams</td>
<td>906.5</td>
<td>38.5</td>
<td>13</td>
<td>SS</td>
<td>15-20-28</td>
</tr>
<tr>
<td>Gray, wet, medium dense to dense, SAND (SP) with trace gravel</td>
<td>891.0</td>
<td>43.0</td>
<td>16</td>
<td>SS</td>
<td>8-9-11</td>
</tr>
</tbody>
</table>

### Test Data
- **Sample No. 3:** LL=27, PL=14, PI=13
- **Sample No. 8:** Finer than No. 200 sieve = 22.5%

### Remarks
- Ground surface elevation estimated from topographic mapping provided by client.
- Sample No. 3: Borehole backfilled with auger cuttings and plugged with concrete.

---

### Testing Tools
- **Strata:** 7988 Centerpoint Drive, Suite 100
  - Indianapolis, IN 46256
  - Phone: (317) 849-4990
  - Fax: (317) 849-4278

---

### Boring Method
- **HSA:** Hollow Stem Augers
- **CFA:** Continuous Flight Augers
- **CA:** Casing Advancer
- **MD:** Mud Drilling
- **HA:** Hand Auger
**Client:** Ratio Architects, Inc.  
**Project Name:** Proposed Foundational Sciences Building  
**Project Location:** Ball State University  
**Job #:** 170GC00624

### Test Boring Log

| Date Started | 4/9/18 | Hammer Wt. | 140 lbs. |  
| Date Completed | 4/9/18 | Hammer Drop | 30 in.  
| Drill Foreman | W. Bates  
| Inspector | S. Rushfeldt  
| Boring Method | HSA  

#### Drilling and Sampling Information

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Depth</th>
<th>Sample No.</th>
<th>Sample Type</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray, wet, medium dense, SAND (SP) with trace gravel</td>
<td>891.5</td>
<td>16</td>
<td>SS</td>
<td>11-11-18</td>
</tr>
<tr>
<td>Gray, moist, hard, SANDY CLAY (CL) with trace to little gravel</td>
<td>885.0</td>
<td>18</td>
<td>SS</td>
<td>26-35-45 7.6 4.0</td>
</tr>
</tbody>
</table>

- **SOIL CLASSIFICATION**
  - **Sample Type:** SS, ST, CA, RC, CU, CT
  - **Depth to Groundwater:**
    - **Noted on Drilling Tools:** 18.5 ft.
    - **At Completion:** 18.0 ft.
    - **After ____ hours:** ____ ft.
    - **Cave Depth:** 25.1 ft.

#### Boring Method
- **HSA:** Hollow Stem Augers
- **CFA:** Continuous Flight Augers
- **CA:** Casing Advancer
- **MD:** Mud Drilling
- **HA:** Hand Auger

---

**Address:** 7988 Centerpoint Drive, Suite 100, Indianapolis, IN 46256  
**Phone:** (317) 849-4990  
**Fax:** (317) 849-4278

---

**Ratio Architects, Inc.**  
**Proposed Foundational Sciences Building**  
**Ball State University**  
**Muncie, Indiana**
Ground surface elevation estimated from topographic mapping provided by client.

Sample No. 7: Finer than No. 200 sieve = 31.6%

Borehole backfilled with auger cuttings and plugged with concrete.

---

**SOIL CLASSIFICATION**

<table>
<thead>
<tr>
<th>Stratum Elevation</th>
<th>Stratum Depth (ft)</th>
<th>Stratum (ft)</th>
<th>Sample No.</th>
<th>Sample Type</th>
<th>Sample Graphics</th>
<th>Sample Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>949.7</td>
<td>0.3</td>
<td>1</td>
<td>SS</td>
<td>9-4-3</td>
<td>23.6</td>
<td>Ground surface elevation estimated from topographic mapping provided by client.</td>
</tr>
<tr>
<td>946.5</td>
<td>3.5</td>
<td>2</td>
<td>SS</td>
<td>4-5-6</td>
<td>22.9</td>
<td></td>
</tr>
<tr>
<td>936.0</td>
<td>14.0</td>
<td>3</td>
<td>SS</td>
<td>5-5-5</td>
<td>24.9</td>
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<tr>
<td>934.0</td>
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<td>SS</td>
<td>4-4-4</td>
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<td></td>
</tr>
<tr>
<td>931.5</td>
<td>18.5</td>
<td>5</td>
<td>SS</td>
<td>5-4-4</td>
<td>15.0</td>
<td></td>
</tr>
<tr>
<td>929.5</td>
<td>20.5</td>
<td>6</td>
<td>SS</td>
<td>3-3-3</td>
<td>13.5</td>
<td></td>
</tr>
<tr>
<td>926.0</td>
<td>22.0</td>
<td>7</td>
<td>SS</td>
<td>9-10-12</td>
<td></td>
<td>Sample No. 7: Finer than No. 200 sieve = 31.6%</td>
</tr>
<tr>
<td>924.5</td>
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<td>8</td>
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<td>16-26-36</td>
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<tr>
<td>922.5</td>
<td>26.0</td>
<td>9</td>
<td>SS</td>
<td>14-25-25</td>
<td>6.7</td>
<td>Borehole backfilled with auger cuttings and plugged with concrete.</td>
</tr>
<tr>
<td>921.0</td>
<td>28.0</td>
<td>10</td>
<td>SS</td>
<td>6-6-14</td>
<td>10.6</td>
<td>4.5+</td>
</tr>
<tr>
<td>919.5</td>
<td>30.0</td>
<td>11</td>
<td>SS</td>
<td>7-17-21</td>
<td>12.9</td>
<td>4.5+</td>
</tr>
<tr>
<td>917.5</td>
<td>32.0</td>
<td>12</td>
<td>SS</td>
<td>12-26-28</td>
<td>9.8</td>
<td>4.5+</td>
</tr>
<tr>
<td>915.0</td>
<td>34.0</td>
<td>13</td>
<td>SS</td>
<td>17-21-30</td>
<td>8.0</td>
<td>4.5+</td>
</tr>
<tr>
<td>912.5</td>
<td>36.0</td>
<td>14</td>
<td>SS</td>
<td>20-30-33</td>
<td>7.6</td>
<td>4.5+</td>
</tr>
<tr>
<td>910.0</td>
<td>38.0</td>
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<td>SS</td>
<td>18-20-27</td>
<td>14.6</td>
<td>4.5+</td>
</tr>
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</table>

**TEST DATA**

<table>
<thead>
<tr>
<th>Depth to Groundwater</th>
<th>Sample Type</th>
<th>Boring Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5 ft.</td>
<td>SS - Driven Split Spoon</td>
<td>HSA - Hollow Stem Augers</td>
</tr>
<tr>
<td>4.5 ft.</td>
<td>ST - Pressed Shelby Tube</td>
<td>CFA - Continuous Flight Augers</td>
</tr>
<tr>
<td>4.5 ft.</td>
<td>CA - Continuous Flight Auger</td>
<td>CA - Casing Auger</td>
</tr>
<tr>
<td>4.5 ft.</td>
<td>RC - Rock Core</td>
<td>MD - Mud Drilling</td>
</tr>
<tr>
<td>4.5 ft.</td>
<td>CU - Cuttings</td>
<td>HA - Hand Auger</td>
</tr>
<tr>
<td>4.5 ft.</td>
<td>CT - Continuous Tube</td>
<td></td>
</tr>
</tbody>
</table>
### SOIL CLASSIFICATION

<table>
<thead>
<tr>
<th>Stratum Description</th>
<th>Depth, ft</th>
<th>Sample No.</th>
<th>Sample Type</th>
<th>Moisture Content, %</th>
<th>Pocket Penetrometer PP-tsf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray, slightly moist, hard, SANDY CLAY (CL) with trace gravel</td>
<td>896.5</td>
<td>16</td>
<td>SS</td>
<td>14.3</td>
<td>4.5+</td>
</tr>
<tr>
<td>Gray, wet, dense to very dense, SAND (SP)</td>
<td>890.0</td>
<td>18</td>
<td>SS</td>
<td>16-21-28</td>
<td>15-21-26</td>
</tr>
</tbody>
</table>

**Bottom of Test Boring at 60.0 ft**
# TEST BORING LOG

## CLIENT
Ratio Architects, Inc.

## PROJECT NAME
Proposed Foundational Sciences Building

## PROJECT LOCATION
Ball State University

## BORING #
B-7

## JOB #
170GC00624

### DRILLING and SAMPLING INFORMATION

| Date Started | 4/4/18 |
| Date Completed | 4/4/18 |
| Drill Foreman | W. Bates |
| Inspector | S. Rushfeldt |
| Boring Method | HSA |

### SOIL CLASSIFICATION

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Depth, ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 in. Crushed stone</td>
<td>0.3</td>
</tr>
<tr>
<td>Brown, moist, silty sandy clay with trace gravel and organics (FILL)</td>
<td>3.5</td>
</tr>
<tr>
<td>Brown, slightly moist, sandy clay with little gravel (FILL)</td>
<td>6.0</td>
</tr>
<tr>
<td>Brown, slightly moist, hard to very stiff, SANDY SILTY CLAY (CL) with trace gravel</td>
<td>13.5</td>
</tr>
<tr>
<td>Brown, moist, medium dense, SILTY SAND (SM) with trace gravel</td>
<td>16.0</td>
</tr>
<tr>
<td>Brown, slightly moist, hard, SANDY CLAY (CL) with trace gravel</td>
<td>18.5</td>
</tr>
<tr>
<td>Gray, slightly moist, hard, SANDY CLAY (CL) with trace gravel and interbedded sand seams</td>
<td>23.5</td>
</tr>
<tr>
<td>Brown, wet, dense, SAND and GRAVEL (SP-SM) with trace silt</td>
<td>26.0</td>
</tr>
<tr>
<td>Gray, moist, hard, SANDY CLAY (CL) with trace gravel and interbedded sand seams</td>
<td>30.0</td>
</tr>
</tbody>
</table>

### SURFACE ELEVATION

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Depth, ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 in. Crushed stone</td>
<td>0.3</td>
</tr>
<tr>
<td>Brown, moist, silty sandy clay with trace gravel and organics (FILL)</td>
<td>3.5</td>
</tr>
<tr>
<td>Brown, slightly moist, sandy clay with little gravel (FILL)</td>
<td>6.0</td>
</tr>
<tr>
<td>Brown, slightly moist, hard to very stiff, SANDY SILTY CLAY (CL) with trace gravel</td>
<td>13.5</td>
</tr>
<tr>
<td>Brown, moist, medium dense, SILTY SAND (SM) with trace gravel</td>
<td>16.0</td>
</tr>
<tr>
<td>Brown, slightly moist, hard, SANDY CLAY (CL) with trace gravel</td>
<td>18.5</td>
</tr>
<tr>
<td>Gray, slightly moist, hard, SANDY CLAY (CL) with trace gravel and interbedded sand seams</td>
<td>23.5</td>
</tr>
<tr>
<td>Brown, wet, dense, SAND and GRAVEL (SP-SM) with trace silt</td>
<td>26.0</td>
</tr>
<tr>
<td>Gray, moist, hard, SANDY CLAY (CL) with trace gravel and interbedded sand seams</td>
<td>30.0</td>
</tr>
<tr>
<td>Bottom of Test Boring at 40.0 ft</td>
<td></td>
</tr>
</tbody>
</table>

### TEST DATA

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Sample Type</th>
<th>Standard Penetration Test, Blows per 6 in. increments</th>
<th>Moisture Content, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SS</td>
<td>7-3-4</td>
<td>18.8</td>
</tr>
<tr>
<td>2</td>
<td>SS</td>
<td>9-15-20</td>
<td>12.1</td>
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<tr>
<td>3</td>
<td>SS</td>
<td>20-24-25</td>
<td>12.3</td>
</tr>
<tr>
<td>4</td>
<td>SS</td>
<td>6-10-12</td>
<td>14.6</td>
</tr>
<tr>
<td>5</td>
<td>SS</td>
<td>10-14-16</td>
<td>3.5</td>
</tr>
<tr>
<td>6</td>
<td>SS</td>
<td>7-6-8</td>
<td>6.7</td>
</tr>
<tr>
<td>7</td>
<td>SS</td>
<td>7-16-45</td>
<td>6.7</td>
</tr>
<tr>
<td>8</td>
<td>SS</td>
<td>50/0.4</td>
<td>4.9</td>
</tr>
<tr>
<td>9</td>
<td>SS</td>
<td>50/0.4</td>
<td>5.0</td>
</tr>
<tr>
<td>10</td>
<td>SS</td>
<td>12-25-19</td>
<td>8.4</td>
</tr>
<tr>
<td>11</td>
<td>SS</td>
<td>13-24-24</td>
<td>8.4</td>
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<td>12</td>
<td>SS</td>
<td>50-0.4</td>
<td>8.8</td>
</tr>
<tr>
<td>13</td>
<td>SS</td>
<td>25-36-39</td>
<td>8.6</td>
</tr>
<tr>
<td>14</td>
<td>SS</td>
<td>28-36-35</td>
<td>8.5</td>
</tr>
</tbody>
</table>

### Remarks
- Ground surface elevation estimated from topographic mapping provided by client.
- Sample No. 6: Finer than No. 200 sieve = 22.4%.
- Borehole backfilled with auger cuttings and plugged with concrete.

---

**Sample Type**
- SS - Driven Split Spoon
- ST - Pressed Shelby Tube
- CA - Continuous Flight Auger
- RC - Rock Core
- CT - Continuous Tube

**Depth to Groundwater**
- @ Noted on Drilling Tools: 19.0 ft.
- @ At Completion: 22.0 ft.
- @ After ____ hours: ____ ft.
- @ Cave Depth: 27.8 ft.

**Boring Method**
- HSA - Hollow Stem Augers
- CFA - Continuous Flight Augers
- CA - Casing Advance
- MD - Mud Drilling
- HA - Hand Auger
## BORING LOG

### CLIENT
Ratio Architects, Inc.

### PROJECT NAME
Proposed Foundational Sciences Building

### PROJECT LOCATION
Ball State University

### BORING #
B-8

### JOB #
170GC00624

## DRILLING and SAMPLING INFORMATION

<table>
<thead>
<tr>
<th>Depth to Groundwater</th>
<th>Sample Type</th>
<th>Sample No.</th>
<th>Sample Graphics</th>
<th>Stratum Elevation</th>
<th>Stratum Depth, ft</th>
<th>Depth, ft</th>
<th>Scale, ft.</th>
<th>Sample</th>
<th>Standard Penetration Test, Blows per 6 in. Increments</th>
<th>Moisture Content, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 in. Topsoil</td>
<td>SS</td>
<td>1</td>
<td></td>
<td>945.2</td>
<td>0.8</td>
<td>1</td>
<td></td>
<td>SS</td>
<td>4-4-4</td>
<td>12.3</td>
</tr>
<tr>
<td>Brown and gray, moist, sandy silty clay with little gravel and trace root material (FILL)</td>
<td>SS</td>
<td>2</td>
<td>4-5-8</td>
<td>13.9</td>
<td>3.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown, slightly moist, stiff to hard, SANDY CLAY (CL) with trace gravel</td>
<td>SS</td>
<td>3</td>
<td>12-11-17</td>
<td>13.0</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Brown, slightly moist, hard, SANDY CLAY (CL) with trace gravel and interbedded sand seams</td>
<td>SS</td>
<td>4</td>
<td>6-9-13</td>
<td>4.0</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Gray, slightly moist, stiff, SANDY CLAY (CL) with trace gravel</td>
<td>SS</td>
<td>5</td>
<td>18-20-17</td>
<td>15.0</td>
<td>4.0</td>
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<td></td>
</tr>
<tr>
<td>Brown, very dense, SAND and GRAVEL (SW-SM) with trace silt</td>
<td>SS</td>
<td>6</td>
<td>27-50/0.4</td>
<td>6.0</td>
<td>3.5</td>
<td></td>
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<tr>
<td>Gray, very dense, CLAYEY SAND (SC) with trace gravel</td>
<td>SS</td>
<td>7</td>
<td>50/0.3</td>
<td>5.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gray, slightly moist, hard, SANDY CLAY (CL) with trace gravel</td>
<td>SS</td>
<td>8</td>
<td>5-4-9</td>
<td>3.0</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Brown, slightly moist, hard, SANDY CLAY (CL) with trace gravel and interbedded sand seams</td>
<td>SS</td>
<td>9</td>
<td>30-50/0.4</td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gray, very dense, SANDY CLAY (CL) with trace gravel</td>
<td>SS</td>
<td>10</td>
<td>50/0.4</td>
<td>5.6</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Gray, very dense, CLAYEY SAND (SC) with trace gravel</td>
<td>SS</td>
<td>11</td>
<td>50/0.2</td>
<td>5.0</td>
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<td></td>
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<td>Gray, slightly moist, hard, SANDY CLAY (CL) with trace gravel</td>
<td>SS</td>
<td>12</td>
<td>28-35-30</td>
<td>8.2</td>
<td>4.0</td>
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<tr>
<td>Bottom of Test Boring at 40.0 ft</td>
<td>SS</td>
<td>13</td>
<td>10-18-22</td>
<td>8.2</td>
<td>4.0</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>SS</td>
<td>14</td>
<td>13-17-21</td>
<td>7.0</td>
<td>4.5+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Sample Type**
  - SS - Driven Split Spoon
  - ST - Pressed Shelby Tube
  - CA - Continuous Flight Auger
  - RC - Rock Core
  - CU - Cuttings
  - CT - Continuous Tube

- **Boring Method**
  - HSA - Hollow Stem Augers
  - CFA - Continuous Flight Augers
  - CA - Casing Advancer
  - MD - Mud Drilling
  - HA - Hand Auger

- **Remarks**
  - Noted on Drilling Tools 20.0 ft.
  - At Completion 22.0 ft.
  - After -- hours -- ft.
  - Cave Depth 29.0 ft.

## TEST DATA

- **Surface Elevation** 946
- **Groundwater**

---

7988 Centerpoint Drive, Suite 100
Indianapolis, IN 46256
(317) 849-4990
Fax (317) 849-4278
**SOIL CLASSIFICATION**

<table>
<thead>
<tr>
<th>Stratum Description</th>
<th>Depth, ft</th>
<th>Stratum Elevation</th>
<th>Stratum Depth, ft</th>
<th>Depth, Scale, ft</th>
<th>Sample No.</th>
<th>Sample Type</th>
<th>Sample Graphics</th>
<th>Groundwater</th>
<th>Standard Penetration Test, Blows per 6 in. Increments</th>
<th>Moisture Content, %</th>
<th>Pocket Penetrometer Post</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 in. Crushed stone</td>
<td>0.5</td>
<td>944.5</td>
<td>1</td>
<td>SS</td>
<td></td>
<td>6</td>
<td>6-3-3</td>
<td>20.0</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Brown and gray, moist, sandy silty clay with trace gravel and cinders (FILL)</td>
<td>3.5</td>
<td>941.5</td>
<td>2</td>
<td>SS</td>
<td></td>
<td>2-3-3</td>
<td>26.1</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown, slightly moist, medium stiff to stiff, SANDY CLAY (CL) with trace gravel</td>
<td>8.5</td>
<td>936.5</td>
<td>3</td>
<td>SS</td>
<td></td>
<td>7-7-8</td>
<td>15.5</td>
<td>4.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown and gray, very moist, medium stiff to stiff, SANDY CLAY (CL) with trace gravel</td>
<td>13.0</td>
<td>932.0</td>
<td>4</td>
<td>SS</td>
<td></td>
<td>4-3-3</td>
<td>14.9</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown, wet, medium dense, SAND (SP-SM) with trace gravel and silt</td>
<td>18.5</td>
<td>926.5</td>
<td>5</td>
<td>SS</td>
<td></td>
<td>3-6-7</td>
<td>13.5</td>
<td>0.5</td>
<td></td>
<td></td>
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<tr>
<td>Brown, moist, hard, SANDY CLAY (CL) with trace gravel</td>
<td>21.0</td>
<td>924.0</td>
<td>6</td>
<td>SS</td>
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<td>7-13-14</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Brown, wet, very dense, GRAVEL (GW-GM) with trace sand and silt</td>
<td>23.5</td>
<td>921.5</td>
<td>7</td>
<td>SS</td>
<td></td>
<td>7-10-19</td>
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<td></td>
</tr>
<tr>
<td>Gray, moist, hard to very stiff, SANDY CLAY (CL) with trace gravel and interbedded sand seams</td>
<td>35.0</td>
<td>905.0</td>
<td>8</td>
<td>SS</td>
<td></td>
<td>18-34-50/0.4</td>
<td>8.0</td>
<td></td>
<td></td>
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<tr>
<td>Bottom of Test Boring at 40.0 ft</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TEST DATA**

**Depth to Groundwater**
- 13.0 ft
- 15.0 ft
- 20.0 ft

**Boring Method**
- HSA - Hollow Stem Augers
- CFA - Continuous Flight Augers
- CA - Casing Advancer
- MD - Mud Drilling
- HA - Hand Auger

**Remarks**
- Ground surface elevation estimated from topographic mapping provided by client.
- Cobbles encountered at 18 ft
- Borehole backfilled with auger cuttings and plugged with concrete.

**Surface Elevation**

945
<table>
<thead>
<tr>
<th>Stratum Description</th>
<th>Stratum Elevation</th>
<th>Stratum Depth, ft</th>
<th>Depth, Scale, ft</th>
<th>Sample No.</th>
<th>Sample Type</th>
<th>Standard Penetration Test, Blows per 6 in. Increments</th>
<th>Moisture Content, %</th>
<th>Pocket Penetrometer, Pastr.</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 in. Asphalt over 10 in. No. 2 stone</td>
<td>950.0</td>
<td>1.0</td>
<td></td>
<td>1</td>
<td>SS</td>
<td>5-4-6</td>
<td>19.3</td>
<td>19.3</td>
<td>Ground surface elevation estimated from topographic mapping provided by client.</td>
</tr>
<tr>
<td>Brown, very moist, silty clay with trace sand and gravel (FILL)</td>
<td>947.5</td>
<td>3.5</td>
<td></td>
<td>2</td>
<td>SS</td>
<td>6-9-14</td>
<td>14.5</td>
<td>14.5</td>
<td>Sample No. 4: LL=30, PL=14, PI=16</td>
</tr>
<tr>
<td>Brown, slightly moist, stiff to hard, SANDY CLAY (CL) with trace gravel</td>
<td>937.5</td>
<td>13.5</td>
<td></td>
<td>3</td>
<td>SS</td>
<td>8-9-11</td>
<td>14.1</td>
<td>14.1</td>
<td>Sample No. 7: Finer than No. 200 sieve = 26.1%</td>
</tr>
<tr>
<td>Gray, moist, stiff, SANDY CLAY (CL) with trace gravel</td>
<td>935.0</td>
<td>16.0</td>
<td></td>
<td>4</td>
<td>SS</td>
<td>4-5-10</td>
<td>15.4</td>
<td>15.4</td>
<td>Sample No. 8: LL=22, PL=12, PI=10</td>
</tr>
<tr>
<td>Brown, wet, medium dense, SILTY SAND (SM)</td>
<td>932.5</td>
<td>18.5</td>
<td></td>
<td>5</td>
<td>SS</td>
<td>15-22-28</td>
<td>13.8</td>
<td>13.8</td>
<td>Borehole backfilled with auger cuttings and plugged with concrete.</td>
</tr>
<tr>
<td>Brown, wet, very dense, CLAYEY SAND (SC) with trace gravel</td>
<td>931.0</td>
<td>20.0</td>
<td></td>
<td>6</td>
<td>SS</td>
<td>5-7-8</td>
<td>13.9</td>
<td>13.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>7</td>
<td>SS</td>
<td>8-10-15</td>
<td>13.9</td>
<td>13.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15</td>
<td>8</td>
<td>SS</td>
<td>50/0.5</td>
<td>13.9</td>
<td>13.9</td>
<td></td>
</tr>
<tr>
<td>Bottom of Test Boring at 20.0 ft</td>
<td></td>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sample Type

- SS - Driven Split Spoon
- ST - Pressed Shelby Tube
- CA - Continuous Flight Auger
- RC - Rock Core
- CU - Cuttings
- CT - Continuous Tube

Depth to Groundwater

- Noted on Drilling Tools: 12.8 ft.
- At Completion: 12.0 ft.
- After -- hours: -- ft.
- Cave Depth: 16.0 ft.
**SOIL CLASSIFICATION**

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Depth, ft.</th>
<th>Sample No.</th>
<th>Sample Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 in. Topsoil</td>
<td>950.4</td>
<td>1</td>
<td>SS</td>
</tr>
<tr>
<td>Brown, moist, soft, SILTY CLAY (CL) with trace sand and root material</td>
<td>947.5</td>
<td>2</td>
<td>SS</td>
</tr>
<tr>
<td>Brown, moist, very stiff to hard, SANDY SILTY CLAY (CL) with trace gravel</td>
<td>937.5</td>
<td>4</td>
<td>SS</td>
</tr>
<tr>
<td>Gray, moist, very stiff, SILTY CLAY (CL) with trace gravel and sand</td>
<td>935.0</td>
<td>6</td>
<td>SS</td>
</tr>
<tr>
<td>Brown, moist, medium dense, SAND and GRAVEL (SP-SPM) with trace silt</td>
<td>932.5</td>
<td>8</td>
<td>SS</td>
</tr>
<tr>
<td>Brown, slightly moist, hard, SANDY CLAY (CL) with trace gravel</td>
<td>927.5</td>
<td>10</td>
<td>SS</td>
</tr>
<tr>
<td>Gray, moist, hard, SANDY CLAY (CL) with trace gravel</td>
<td>926.0</td>
<td>12</td>
<td>SS</td>
</tr>
<tr>
<td>Gray, wet, very dense, SAND (SP-SPM) with little gravel and trace silt</td>
<td>922.5</td>
<td>14</td>
<td>SS</td>
</tr>
<tr>
<td>Gray, wet, medium dense, GRAVEL (GW) with trace sand</td>
<td>917.5</td>
<td>16</td>
<td>SS</td>
</tr>
<tr>
<td>Gray, slightly moist, hard to very stiff, SANDY CLAY (CL) with trace gravel and interbedded sand seams</td>
<td>907.5</td>
<td>18</td>
<td>SS</td>
</tr>
</tbody>
</table>

**Groundwater Remarks**

- Ground surface elevation estimated from topographic mapping provided by client.
- Borehole backfilled with auger cuttings and plugged with concrete.

**Boring Method**

- HSA - Hollow Stem Augers
- CFA - Continuous Flight Augers
- CA - Casing Advance
- MD - Mud Drilling
- HA - Hand Auger

---

**Sample Type**

- SS - Driven Split Spoon
- ST - Pressed Shelby Tube
- CA - Continuous Flight Auger
- RC - Rock Core
- CU - Cuttings
- CT - Continuous Tube

---

**TEST DATA**
### Test Boring Log

**Client:** Ratio Architects, Inc.
**Project Name:** Proposed Foundational Sciences Building
**Project Location:** Ball State University, Muncie, Indiana

**Drilling and Sampling Information**

<table>
<thead>
<tr>
<th>Date Started</th>
<th>4/4/18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Completed</td>
<td>4/4/18</td>
</tr>
<tr>
<td>Drill Foreman</td>
<td>W. Bates</td>
</tr>
<tr>
<td>Inspector</td>
<td>S. Rushfeldt</td>
</tr>
<tr>
<td>Boring Method</td>
<td>HSA</td>
</tr>
</tbody>
</table>

**SOIL CLASSIFICATION**

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Elevation</th>
<th>Depth, ft</th>
<th>Scale, ft</th>
<th>Depth, ft</th>
<th>Scale, ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray, wet, dense, CLAYEY SAND (SC) with trace gravel</td>
<td>902.5</td>
<td>48.5</td>
<td>50</td>
<td>16</td>
<td>SS</td>
</tr>
<tr>
<td>Gray, moist, hard, SANDY CLAY (CL) with trace gravel</td>
<td>897.5</td>
<td>53.5</td>
<td>55</td>
<td>17</td>
<td>SS</td>
</tr>
<tr>
<td>Gray, wet, dense, SAND and GRAVEL (SP-SM) with trace silt</td>
<td>892.5</td>
<td>58.5</td>
<td>60</td>
<td>18</td>
<td>SS</td>
</tr>
</tbody>
</table>

- **Depth to Groundwater:** 25.0 ft
- **Pocket Penetrometer:**
  - After **--** hours, **--** ft.
- **Cave Depth:** 27.0 ft

**Sample Type**

- SS - Driven Split Spoon
- ST - Pressed Shelby Tube
- CA - Continuous Flight Auger
- RC - Rock Core
- CU - Cuttings
- CT - Continuous Tube

**Remarks:**

- Cobble encountered at 53 ft

---

**At Completion:**

- **Hammer Wt.:** 140 lbs.
- **Hammer Drop:** 30 in.
- **Spoon Sampler OD:** 2.0 in.
- **Rock Core Dia.:** -- in.
- **Shelby Tube OD:** -- in.

---

**Contact:**

7988 Centerpoint Drive, Suite 100
Indianapolis, IN 46256
(317) 849-4990
Fax (317) 849-4278
## Soil Classification

<table>
<thead>
<tr>
<th>Stratum Description</th>
<th>Stratum Elevation</th>
<th>Stratum Depth, ft</th>
<th>Depth, Scale, ft</th>
<th>Scale, ft.</th>
<th>Sample No.</th>
<th>Sample Type</th>
<th>Standard Penetration Test, Blows per 6 in. Incr.</th>
<th>Moisture Content, %</th>
<th>Pocket Penetrometer</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 in. Crushed stone</td>
<td>948.5</td>
<td>0.5</td>
<td></td>
<td></td>
<td>1</td>
<td>SS</td>
<td>8-4-3</td>
<td>14.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown and gray, moist, silty clay with little sand and trace gravel (FILL)</td>
<td>945.5</td>
<td>3.5</td>
<td></td>
<td></td>
<td>2</td>
<td>SS</td>
<td>4-5-6</td>
<td>14.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown, moist, stiff to very stiff, SANDY SILTY CLAY (CL) with trace gravel</td>
<td>940.5</td>
<td>8.5</td>
<td></td>
<td></td>
<td>3</td>
<td>SS</td>
<td>9-9-9</td>
<td>13.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown, moist, very loose, CLAYEY SAND (SC)</td>
<td>935.5</td>
<td>13.5</td>
<td></td>
<td></td>
<td>4</td>
<td>SS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown, wet, very loose, SILTY SAND (SM)</td>
<td>934.0</td>
<td>15.0</td>
<td></td>
<td></td>
<td>5</td>
<td>SS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bottom of Test Boring at 15.0 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>SS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Ground surface elevation estimated from topographic mapping provided by client.
- Sample No. 4:
  - LL = 31, PL = 14, PI = 17
- Sample No. 6:
  - Finer than No. 200 sieve = 35.7%

## Drilling and Sampling Information

- **Date Started**: 4/5/18
- **Date Completed**: 4/5/18
- **Hammer Wt.**: 140 lbs.
- **Hammer Drop**: 30 in.
- **Spoon Sampler OD**: 2.0 in.
- **Rock Core Dia.**: -- in.
- **Shelby Tube OD**: -- in.
- **Drill Foreman**: W. Bates
- **Inspector**: S. Rushfeldt
- **Boring Method**: HSA

## Test Data

- **Standard Penetration Test**: 13.5 ft.
- **Pocket Penetrometer**: None ft.
- **Cave Depth**: 10.5 ft.

**Remarks**

- Borehole backfilled with auger cuttings and plugged with concrete.
Ground surface elevation estimated from topographic mapping provided by client.

Borehole backfilled with auger cuttings and plugged with concrete.

**SOIL CLASSIFICATION**

<table>
<thead>
<tr>
<th>Stratum Elevation</th>
<th>Stratum Depth, ft</th>
<th>Depth, Scale, ft</th>
<th>Stratum Depth, ft</th>
<th>Depth, Scale, ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 in. Crushed stone</td>
<td>949.8 0.2</td>
<td>1 SS</td>
<td>6-6-5</td>
<td>18.8</td>
</tr>
<tr>
<td>Dark gray, moist, sandy clay with trace gravel, cinders and organics (FILL)</td>
<td>946.5 3.5</td>
<td>2 SS</td>
<td>6-9-12</td>
<td>12.7</td>
</tr>
<tr>
<td>Brown, slightly moist, very stiff to hard, SANDY SILTY CLAY (CL) with trace gravel</td>
<td>935.0 15.0</td>
<td>6 SS</td>
<td>8-13-13</td>
<td>14.7</td>
</tr>
</tbody>
</table>

**TEST DATA**

- **Sample Type**: SS - Driven Split Spoon, ST - Pressed Shelby Tube, CA - Continuous Flight Auger, RC - Rock Core, CU - Cuttings, CT - Continuous Tube
- **Depth to Groundwater**: None ft.
- **Boring Method**: HSA - Hollow Stem Augers, CFA - Continuous Flight Augers, CA - Casing Advancer, MD - Mud Drilling, HA - Hand Auger
- **Cave Depth**: 7.4 ft.

Borehole backfilled with auger cuttings and plugged with concrete.
### SOIL CLASSIFICATION

<table>
<thead>
<tr>
<th>Stratum Description</th>
<th>Surface Elevation</th>
<th>Depth, ft</th>
<th>Sample No.</th>
<th>Sample Type</th>
<th>Sample Graphics</th>
<th>Standard Penetration Test, Blows per 6 in. Increments</th>
<th>Moisture Content, %</th>
<th>Pocket Penetrometer</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 in. Topsoil</td>
<td>944.7</td>
<td>0.3</td>
<td>1</td>
<td>SS</td>
<td>X</td>
<td>5-6-7</td>
<td>25.0</td>
<td>2.5</td>
<td>Ground surface elevation estimated from topographic mapping provided by client.</td>
</tr>
<tr>
<td>Brown, moist, stiff, SILTY CLAY (CL) with trace sand and gravel</td>
<td>941.5</td>
<td>3.5</td>
<td>2</td>
<td>SS</td>
<td>X</td>
<td>5-5-8</td>
<td>14.6</td>
<td></td>
<td>Sample No. 3: LL=31, PL=15, PI=16</td>
</tr>
<tr>
<td>Brown, slightly moist, stiff to hard, SANDY CLAY (CL)</td>
<td>931.5</td>
<td>13.5</td>
<td>5</td>
<td>SS</td>
<td>K</td>
<td>10-28-39</td>
<td>15.0</td>
<td></td>
<td>Sample No. 6: Finer than No. 200 sieve = 9.0%</td>
</tr>
<tr>
<td>Brown, slightly moist, very dense, SAND (SP-SM) with trace silt</td>
<td>930.0</td>
<td>15.0</td>
<td>6</td>
<td>SS</td>
<td>X</td>
<td>12-28-37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bottom of Test Boring at 15.0 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Sample Type
- SS - Driven Split Spoon
- ST - Pressed Shelby Tube
- CA - Continuous Flight Auger
- RC - Rock Core
- CU - Cuttings
- CT - Continuous Tube

### Depth to Groundwater
- **None** ft.

### Boring Method
- HSA - Hollow Stem Augers
- CFA - Continuous Flight Augers
- CA - Casing Advance
- MD - Mud Drilling
- HA - Hand Auger

---

**Ratio Architects, Inc.**

**Proposed Foundational Sciences Building**

**Ball State University**

**Muncie, Indiana**

---

**Drilling and Sampling Information**

- **Date Started**: 3/3/18
- **Date Completed**: 3/30/18
- **Drill Foreman**: W. Bates
- **Inspector**: S. Rushfeldt
- **Boring Method**: HSA

---

**Groundwater**

- **Remarks**

---

**At Completion** 2.0 ft.

---

**After** -- hours -- ft.

---

**Cave Depth** 11.3 ft.
FIELD CLASSIFICATION SYSTEM FOR SOIL EXPLORATION

NON-COHESIVE SOILS
(Silt, Sand, Gravel and Combinations)

Density

<table>
<thead>
<tr>
<th>Classification</th>
<th>Blows/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Loose</td>
<td>5 or less</td>
</tr>
<tr>
<td>Loose</td>
<td>6 to 10</td>
</tr>
<tr>
<td>Medium Dense</td>
<td>11 to 30</td>
</tr>
<tr>
<td>Dense</td>
<td>31 to 50</td>
</tr>
<tr>
<td>Very Dense</td>
<td>51 or more</td>
</tr>
</tbody>
</table>

Particle Size Identification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulders</td>
<td>8 inch</td>
</tr>
<tr>
<td>Cobbles</td>
<td>3 to 8 inch</td>
</tr>
<tr>
<td>Gravel</td>
<td>1 to 3 inch</td>
</tr>
<tr>
<td>Medium</td>
<td>½ to 1 inch</td>
</tr>
<tr>
<td>Fine</td>
<td>¼ to ½ inch</td>
</tr>
<tr>
<td>Sand</td>
<td>Coarse 2.00mm to ¼ inch (dia. of pencil lead)</td>
</tr>
</tbody>
</table>

Relative Proportions

<table>
<thead>
<tr>
<th>Descriptive Term</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>1 to 10</td>
</tr>
<tr>
<td>Little</td>
<td>11 to 20</td>
</tr>
<tr>
<td>Some</td>
<td>21 to 35</td>
</tr>
<tr>
<td>And</td>
<td>36 to 50</td>
</tr>
</tbody>
</table>

COHESIVE SOILS
(Clay, Silt and Combinations)

Consistency

<table>
<thead>
<tr>
<th>Classification</th>
<th>Blows/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Soft</td>
<td>3 or less</td>
</tr>
<tr>
<td>Soft</td>
<td>4 to 5</td>
</tr>
<tr>
<td>Medium Stiff</td>
<td>6 to 10</td>
</tr>
<tr>
<td>Stiff</td>
<td>11 to 15</td>
</tr>
<tr>
<td>Very Stiff</td>
<td>16 to 30</td>
</tr>
<tr>
<td>Hard</td>
<td>31 or more</td>
</tr>
</tbody>
</table>

Degree of Plasticity

<table>
<thead>
<tr>
<th>Plasticity</th>
<th>Plasticity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0 - 4</td>
</tr>
<tr>
<td>Slight</td>
<td>5 - 7</td>
</tr>
<tr>
<td>Medium</td>
<td>8 - 22</td>
</tr>
<tr>
<td>High to Very High</td>
<td>over 22</td>
</tr>
</tbody>
</table>

Classification on the logs are made by visual inspection of samples.

Standard Penetration Test — Driving a 2.0" O.D. 1-3/8" I.D. sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30 inches. It is customary for ATC to drive the spoon 6 inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the test are recorded for each 0.5 feet of penetration on the drill log (Example — 6-8-9). The standard penetration test result can be obtained by adding the last two figures (i.e., 8 + 9 = 17 blows/ft). (ASTM D-1586-11).

Strata Changes — In the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes. A solid line (______) represents an actually observed change. A dashed line (_ _ _ _) represents an estimated change.

Ground Water observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs.
Material Description
Brown Sandy Silty Clay with trace Gravel

Atterberg Limits
PL = 15
LL = 31
Pl = 16

Coefficients
D90 = 1.0792
D85 = 0.4014
D50 = 0.0103
D30 = 0.0026
D10 =
C15 =
C30 =

Classification
USCS = CL

Remarks

Source of Sample: 10058
Sample Number: B-3; S-3

Depth: 6.0'-7.5'

Date:

ATC Group Services LLC
Indianapolis, Indiana

Client: BSU Foundational Sciences
Project No: 170GC00624
Figure
**Material Description**

Brown Sandy Silty Clay with trace Gravel

**Atterberg Limits**

- PL = 14
- LL = 27
- PI = 13

**Coefficients**

- $D_{10} = 0.0300$
- $D_{50} = 0.0055$
- $D_{15} = 0.0520$
- $C_u = \text{no specification provided}$
- $C_c = \text{no specification provided}$

**Classification**

- USCS = CL
- AASHTO =

**Remarks**

- (no specification provided)

**Source of Sample:** 10059

**Sample Number:** B-5; S-3

**Depth:** 6.0'-7.5'

**Date:**
### Material Description

Brown Silty Sand and Gravel

### Atterberg Limits

- $PL = NP$
- $LL = NP$
- $PI = NP$

### Coefficients

- $D_{90} = 27.1261$
- $D_{85} = 23.5580$
- $D_{50} = 1.7823$
- $D_{30} = 0.3086$
- $D_{15} = 0.0225$
- $CU = 359.07$
- $CC = 2.65$

### Classification

- USCS = SM
- AASHTO =

### Remarks


### Particle Size Distribution Report

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>PERCENT FINER</th>
<th>SPEC.* PERCENT</th>
<th>PASS? (X=NO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2&quot;</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1&quot;</td>
<td>21.7</td>
<td>14.1</td>
<td></td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>78.3</td>
<td>12.7</td>
<td>18.9</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>75.7</td>
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<td>10.1</td>
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<td>3/8&quot;</td>
<td>72.4</td>
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<tr>
<td>#4</td>
<td>64.2</td>
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<td>#8</td>
<td>53.6</td>
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<td>#10</td>
<td>51.5</td>
<td></td>
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<tr>
<td>#20</td>
<td>39.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#30</td>
<td>32.6</td>
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<td></td>
</tr>
<tr>
<td>#40</td>
<td>28.6</td>
<td></td>
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* (no specification provided)

Source of Sample: 10059  
Depth: 18.5'-20.0'  
Sample Number: B-5; S-8  

---

**ATC Group Services LLC**  
Indianapolis, Indiana  

**Client:** Ratio  
**Project:** BSU Foundational Sciences  
**Project No:** 170GC00624  
**Date:** 
### Material Description
Brown Silty Sand with little Gravel

### Atterberg Limits

<table>
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<tr>
<th>Coefficient</th>
<th>Value</th>
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<tr>
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### Classification
AASTHO= SM

### Remarks

---

**Source of Sample:** 10060  
**Depth:** 16.0'-17.5'  
**Sample Number:** B-6; S-7  
**Date:**

---

**ATC Group Services LLC**  
**Indianapolis, Indiana**

**Client:** Ratio  
**Project:** BSU Foundational Sciences  
**Project No:** 170GC00624  
**Figure**
### Particle Size Distribution Report

#### Material Description
Brown Silty Sand with trace Gravel

#### Atterberg Limits

- PL: NP
- LL: NP
- PI: NP

#### Coefficients

- D90 = 4.0609
- D85 = 3.0731
- D50 = 0.7572
- D30 = 0.1859
- D15 = 0.0346
- Cu = 96.63
- Cc = 2.73

#### Classification
USCS = SM

#### Remarks
AASHTO =

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<th>SPEC. * PERCENT</th>
<th>PASS? (X=NO)</th>
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* (no specification provided)

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Source of Sample: 10060  
Depth: 13.5'-15.0'

Sample Number: B-7; S-6  
Date: 

ATC Group Services LLC  
Indianapolis, Indiana  

Client: Ratio  
Project: BSU Foundational Sciences  
Project No: 170GC00624  
Figure
### Particle Size Distribution Report

#### Source of Sample:
- 10061
- Depth: 21.0’-22.5’
- Sample Number: B-8; S-9

#### Material Description:
Brown Sand and Gravel with trace Silt

#### Atterberg Limits
- **PL=** NP
- **LL=** NP
- **Pl=** NP

#### Coefficients
- **D90=** 16.0022
- **D85=** 13.5354
- **D60=** 5.8731
- **D50=** 3.7982
- **D30=** 1.1838
- **D15=** 0.3328
- **Cu=** 38.66
- **Cc=** 1.57

#### Classification
- USCS= SW-SM
- AASHTO=

#### Remarks

### Particle Size Distribution

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<th>Pass?</th>
<th>(X=NO)</th>
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</table>

* (no specification provided)

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**PL =** Plastic Limit
**LL =** Liquid Limit
**Cu =** Coefficient of Uniformity
**Cc =** Coefficient of Curvature

**PL =** Plastic Limit
**LL =** Liquid Limit
**Cu =** Coefficient of Uniformity
**Cc =** Coefficient of Curvature

**D90 =** 90th percentile of fines passing
**D85 =** 85th percentile of fines passing
**D60 =** 60th percentile of fines passing
**D50 =** 50th percentile of fines passing
**D30 =** 30th percentile of fines passing
**D15 =** 15th percentile of fines passing

**CU =** Coefficient of Uniformity
**CC =** Coefficient of Curvature

**USCS =** Unified Soil Classification System

---

**Source of Sample:** 10061  
**Depth:** 21.0’-22.5’  
**Sample Number:** B-8; S-9  
**Date:**
Particle Size Distribution Report

Material Description
Brown Sandy Clay with trace Gravel

Atterberg Limits
PL = 14
LL = 30
Pl = 16

Coefficients
D90 = 1.8035
D50 = 0.0101

Classification
USCS = CL

Remarks
AASHTO=

Source of Sample: 10062
Depth: 8.5'-10.0'
Sample Number: B-10; S-4

ATC Group Services LLC
Indianapolis, Indiana

Client: Ratio
Project: BSU Foundational Sciences
Project No: 170GC00624

Date:
Particle Size Distribution Report

<table>
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Material Description
Brown Silty Sand

Atterberg Limits
PL = NP
LL = NP
Pl = NP

Coefficients
D90 = 0.2454
D50 = 0.2253
D10 = 0.0307
D95 = 0.1399
D30 = 0.0877
D15 = 0.0438
Cu = 5.27
Cc = 1.55

Classification
USCS = SM
AASHTO =

Remarks

Source of Sample: 10062
Sample Number: B-10; S-7
Depth: 16.0'-17.5'

ATC Group Services LLC
Indianapolis, Indiana

Client: BSU Foundational Sciences
Project No: 170GC00624
Date: Figure
Material Description
Brown Clayey Sand with trace Gravel

Atterberg Limits
PL = 12
LL = 22
PI = 10

Coefficients
D_90 = 2.4469
D_85 = 1.6682
D_50 = 0.5789
D_30 = 0.0294
D_15 = 0.0041
C_u = 388.32
C_c = 1.00

Classification
USCS = SC
AASHTO =

Remarks

Source of Sample: 10062
Sample Number: B-10; S-8
Depth: 18.5'-20.0'

Client: Ratio
Project: BSU Foundational Sciences
Project No: 170GC00624

ATC Group Services LLC
Indianapolis, Indiana

Date:
Particle Size Distribution Report

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</table>

**Material Description**
Brown Clayey Sand

**Atterberg Limits**
- PL = 14
- LL = 31
- PI = 17

**Coefficients**
- D90 = 0.7747
- D50 = 0.5116
- D10 = 0.0136
- Cu = Cc =

**Classification**
- USCS = SC
- AASHTO = A-6(2)

**Remarks**

Source of Sample: 10063
Sample Number: B-12; S-4

ATC Group Services LLC
Indianapolis, Indiana

Client: Ratio
Project: BSU Foundational Sciences
Project No: 170GC00624

Depth: 8.5’-10.0’
Date:
### Particle Size Distribution Report

**Material Description**
Brown Silty Sand

**Atterberg Limits**
- **PL (Plastic Limit):** NP
- **LL (Liquid Limit):** NP

**Coefficients**
- **D_{90}:** 0.8530
- **D_{50}:** 0.5911
- **D_{30}:** 0.1932
- **D_{10}:** 0.0060
- **Cu:** 44.57
- **Cc:** 1.43

**Classification**
- USCS: SM
- AASHTO:

**Remarks**

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Source of Sample: 10063
Sample Number: B-12; S-6

**Source of Sample:**
- Depth: 13.5'-15.0'

**Client:** ATC Group Services LLC
**Project:** BSU Foundational Sciences
**Project No:** 170GC00624

Indianapolis, Indiana
### Particle Size Distribution Report

**Material Description**

Brown Sandy Clay

**Atterberg Limits**

- **PL**: 15
- **LL**: 31
- **Pl**: 16

**Coefficients**

- **D90**: 0.5146
- **D85**: 0.2707
- **D50**: 0.0107
- **D30**: 0.0023
- **D10**: 0.0023
- **C_U**:
- **C_C**:

**Classification**

- USCS: CL
- AASHTO:

**Remarks**

---

**Source of Sample:** 10063  
**Depth:** 6.0'-7.5'

**Sample Number:** B-14; S-3

**Client:** Ratio  
**Project:** BSU Foundational Sciences  
**Project No.:** 170GC00624  
**ATC Group Services LLC**  
**Indianapolis, Indiana**  
**Date:**
Particle Size Distribution Report

Material Description
Brown Sand with trace Silt

Atterberg Limits
PL = NP
LL = NP
Pl = NP

Coefficients
D90 = 0.8550
D85 = 0.7357
D60 = 0.4456

D50 = 0.3785
D30 = 0.2682
D15 = 0.1660

D10 = 0.0995
C_u = 4.48
C_c = 1.62

Classification
USCS = SP-SM
AASHTO = A-3

Remarks

SIEVE SIZE
3/4"
1/2"
3/8"
#4
#8
#10
#20
#40
#60
#100
#200
#270

PERCENT FINER
100.0
99.1
99.1
99.1
98.9
98.7
89.8
57.2
26.7
13.5
9.0
7.7

SPEC.* SPEC.*
PERCENT PASS? (X=NO)

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0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.0

% Coarse % Fine Coarse % Medium % Fine Silt Clay
PERCENT
0.9
0.4
41.5
48.2
6.7
2.3

* (no specification provided)

Source of Sample: 10063
Sample Number: B-14; S-6

Depth: 13.5'-15.0'

Date:

Client: Ratio
Project: BSU Foundational Sciences

Project No: 170GC00624

ATC Group Services LLC
Indianapolis, Indiana

Figure
Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared solely for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. And no one — not even you — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client’s goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it’s changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, always inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. Do not rely on a geotechnical-engineering report whose adequacy may have been affected by: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. Contact the geotechnical engineer before applying this report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report’s Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. Confirmation-dependent recommendations are not final, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members’ misinterpretation of geotechnical-engineering reports has resulted in costly
problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team’s plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer’s Logs
Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

Give Constructors a Complete Report and Guidance
Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, but preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report’s accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. Be sure constructors have sufficient time to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely
Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered
The equipment, techniques, and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated environmental problems have led to numerous project failures. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. Do not rely on an environmental report prepared for someone else.

Obtain Professional Assistance To Deal with Mold
Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the express purpose of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold-prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical-engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance
Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.