REPORT OF DETAILED GEOTECHNICAL EXPLORATION

THE LEARNING EXPERIENCE
CROSSOVER BOULEVARD
WINCHESTER, VIRGINIA

TRIAD PROJECT NO. 07-23-0213

PREPARED FOR:

MR. MANOJ GANDHI
GANGES PROPERTIES GROUP
21671 BRONTE PLACE
ASHBURN, VIRGINIA 20147

PREPARED BY:

TRIAD ENGINEERING, INC.

200 AVIATION DRIVE
WINCHESTER, VIRGINIA 22602
WWW.TRIADENG.COM

JULY 11, 2023

TRIAD ENGINEERING, INC. TRIAD Listens, Designs & Delivers

July 11, 2023

Mr. Manoj Gandhi
Ganges Property Group
21671 Bronte Place
Ashburn, Virginia 20147

RE: Report of Detailed Geotechnical Exploration
The Learning Experience – Crossover Boulevard
Winchester, Virginia
Triad Project No. 07-23-0213

Dear Mr. Gandhi:

Triad Engineering, Inc. (Triad) has completed preparation of a detailed geotechnical exploration report for the proposed new Learning Experience project located in Winchester, Virginia. The work was completed in substantial conformance with our scope of services outlined in our proposal dated May 16, 2023 and authorized by signing and returning the Professional Services Agreement on May 16, 2023. This report includes the results of the field exploration and laboratory testing, and it presents our recommendations related to the geotechnical design and construction elements of the project.

The subsurface exploration was performed to evaluate the subsurface conditions encountered in the planned building areas for the limited purposes of preparing design and construction recommendations for geotechnical aspects of the project. It is emphasized that subsurface conditions may vary dramatically between test boring locations, and Triad makes no representations as to subsurface conditions other than those encountered at the specific test locations.

This report has been prepared for the exclusive use of Ganges Property Group for specific application to the proposed Learning Experience to be located in Winchester, Virginia. Triad's responsibilities and liabilities are limited to our Client and apply only to their use of our report for the purposes described above. To observe compliance with design concepts and specifications, and to facilitate design changes in the event that subsurface conditions differ from those anticipated prior to construction, it is recommended that Triad be retained to provide continuous engineering and testing services during the earthwork and foundation construction phases of the work.

We appreciate the opportunity to provide our services during the design phase of the project. If you should have any questions concerning this report, or if you require any additional information, please do not hesitate to contact us.

Sincerely,

TRIAD ENGINEERING, INC.

Kevin Benecki

Kevin T. Benecki
Staff Engineer

Mark Clippinger

Mark E. Clippinger, P.E.
Senior Engineer

COMMONWEALTH OF VIRGINIA
MARK E. CLIPPINGER
Lic. No. 040719
PROFESSIONAL ENGINEER

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REPORT OF DETAILED GEOTECHNICAL EXPLORATION

THE LEARNING EXPERIENCE – CROSSOVER BOULEVARD
WINCHESTER, VIRGINIA
TRIAD PROJECT NO. 07-23-0213

FOREWORD

This report has been prepared for the exclusive use of Ganges Property Group for specific application to the design of the Learning Experience to be located in Winchester, Virginia. The work has been performed in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

This report should not be used for estimation of construction quantities and/or costs, and contractors should conduct their own exploration of site conditions for these purposes. Please note that Triad is not responsible for any claims, damages or liability associated with any other party's interpretation of the data or re-use of these data or engineering analyses without the express written authorization of Triad. Additionally, this report must be read in its entirety. Individual sections of this report may cause the reader to draw incorrect conclusions if considered in isolation from each other.

The conclusions and recommendations contained in this report are based, in part, upon our field observations and data obtained from the field work at the site. The nature and extent of variations may not become evident until construction. If variations then appear evident, it may be necessary to re-evaluate the recommendations presented herein. Similarly, in the event that any changes in the nature, design or location of the facilities are planned, the conclusions and recommendations contained herein shall not be considered valid unless the changes are reviewed and the conclusions are modified or verified in writing by Triad.

It is recommended that we be provided the opportunity to review the final grading plan, overall foundation design, and specifications so that earthwork and foundation recommendations may be properly interpreted and implemented. If we are not afforded the privilege of making this review, we will not assume responsibility for misinterpretation of our recommendations, as our recommendations are strictly limited to conditions represented to Triad at the time this report was issued.

PROJECT DESCRIPTION

We understand that the project will involve construction of a new Learning Experience facility on the southern side of Crossover Boulevard, east of the intersection with South Pleasant Valley Avenue in Winchester, Virginia. Based on information provided by the architect, the new building will be a single-story structure with wood framing and slab-on-grade foundation. A cast-in-place concrete retaining wall is indicated along the southern and eastern sides of the new building. The retaining wall at the southeastern corner of the building will encompass the planned day care play area. The site location is shown on Figure A-1 in Appendix A.

As indicated above, the planned structure will be a single-story building with wood framing, isolated columns and a concrete floor slab supported on grade. Estimates of loads to be supported by the foundations were not provided. However, we assume that maximum structural loads will be less than 80 kips for isolated foundations and less than 3 kips per foot for continuous foundations.

Based on the site grading plan provided by Pennoni Associates, Inc., the new structure will have plan dimensions of 80 feet by 125 feet and a finished floor elevation (FFE) of EL. 727.30 feet. Based on the existing site conditions and the proposed grading plan, we anticipate that cuts and fills will be less than 3 feet except for some possible deeper utility excavations.

GEOLOGIC SETTING

Based on our review of the Geologic Map of the Winchester Quadrangle, Virginia (2004), the project site is located within an area of karst terrain. The project site is underlain by the undivided Edinburg, Lincolnshire and New Market Limestone Formations of Ordovician Age. These formations are generally characterized as interbedded medium-gray to dark-gray or black limestone which may contain shale partings, chert and calcite. Residual soils weathered from the parent bedrock generally consist of low to high plasticity silty clay and clayey silt with varying amounts of rock fragments. The project site is also located directly east of the Beekmantown Group of the Ordovician Age, comprised of the Pinesburg Station Dolomite, Rockdale Run and Stonehenge Limestone formations.

FIELD EXPLORATION

The field exploration included drilling five (5) soil borings at the approximate locations shown on Figure No. A-2 in Appendix A. The boring locations were selected by Triad based on the provided floor plans, and the boring locations were established in the field by Triad geotechnical personnel utilizing a hand-held GPS device. The surface elevations of the borings were estimated from Google Earth® imagery.

The test borings included Standard Penetration Testing (SPT) and split barrel sampling (ASTM D 1586) at regular intervals until or very near the planned termination depths or auger refusal on hard rock, whichever occurred first. Geotechnical engineering personnel from our office were present full time during the drilling to direct the drill crews, log all recovered soil and rock samples, and observe groundwater and rock conditions. The recovered soil and rock samples were transported to our laboratory for further testing. Detailed descriptions of materials encountered in the test borings are contained on the boring logs in Appendix B. Figure No. B-1 contains a description of the classification system and terminology utilized.

SUBSURFACE CONDITIONS

Auger refusal was encountered in borings B-1 and B-3 through B-5 at depths ranging from 10.5 feet to 12.5 feet below existing grades in the test locations. Boring B-2 reached a termination depth of 15 feet below existing grade. The materials encountered in the test borings are generally described below. Stratification lines indicated on the logs represent the approximate boundaries between material types, and the actual transitions may be gradual.

Surface Materials: Topsoil was encountered at the surface of all the borings. The topsoil thickness ranged from 2 to 5 inches. The topsoil generally consisted of dark brown organic clayey silt and silty clay with a surface grass root mat and minor amounts of sand and gravel. It should be anticipated that some low-lying zones may contain larger amounts of topsoil.

Existing Fill: Existing fill was encountered at the existing ground surface in all the borings, extending to depths ranging from 2 to 4 feet below existing grades. Most of the fill consisted of brown-orange, high-plasticity clay with varying amounts of sand and gravel, or gray-brown-orange gravel with varying amounts of clay and sand. SPT N-values obtained in the coarse-grained fill ranged from 19 to greater than 50 blows per foot indicating medium dense to very dense relative densities. The higher N-values were generally obtained in zones containing a greater proportion of rock fragments and gravel.

Residual Soils: Residual soil (residuum) was encountered below the existing fill in all the borings, with the exception of boring B-1. The residual soils extended to the weathered rock or termination depths noted on the logs. In general, the majority of the residual soils consisted of brown-orange FAT CLAY with gravel (CH), GRAVEL with some sand (GP) or clayey SAND AND GRAVEL (SC).

Bedrock: Weathered to unweathered (hard) rock was encountered in all the borings with the exception of boring B-2 at approximate depths ranging from 4 to 12.5 feet below existing grades. Specific refusal depths obtained in the borings are noted on the logs in Appendix B.

Groundwater Observations: The borings were checked for the presence of groundwater both during and upon completion of the drilling. No groundwater was encountered during the drilling exploration. It is important to note that fluctuations in perched water and groundwater levels may occur due to variations in environmental conditions, surface drainage and other factors which may not have been evident at the time measurements were made and reported herein.

LABORATORY TESTING

Laboratory tests were performed to supplement the field classifications, assess potential volume change characteristics and establish geotechnical design criteria. All laboratory tests were completed in accordance with appropriate ASTM standard test methods.

Detailed results of the laboratory tests are contained in Appendix C. A summary of the test results is presented below.

TEST TYPE	TEST RESULTS
Natural Moisture Contents	0.3 to 32.5%
Atterberg Limits: Liquid Limit Plasticity Index	37 to 62 16 to 39
Percent Passing No. 200 Sieve	14 to 76%
USCS Soil Classification	CH, GC

DISCUSSION

Karst Conditions

Based on our site reconnaissance, we did not observe any sinkholes or depressions within the bounds of the project. However, previous construction activities at the property may have disturbed any surface features that were present. It is important to note that there are certain risks that an owner must accept when developing in karst areas. These risks can include groundwater contamination, subsidence and flooding. In all these instances, water is the primary cause of the problem. The level of these risks, however, cannot be clearly defined since they are partially controlled by nature.

Additional explorations can be performed to help better define the level of risk at the planned building location. These can include geophysical studies combined with additional drilling work within the proposed construction areas. Certain design and construction measures can and should be implemented to help minimize potential risks associated with future sinkhole development within the site. All of these suggested measures are associated with implementing proper site drainage, minimizing water infiltration, and reducing groundwater fluctuation during and after construction. These additional measures include the following:

- Positive slopes should be maintained away from the building, any structures and pavement areas.

- Utility trenches are common routes along which subsurface water can travel, and this can increase the risk of future subsidence. Do not locate any new deep utilities within the building areas, if possible. Also, new utility trenches along the perimeters of the buildings should be located outside the zone of influence of new foundations.

- All utility lines located within the building footprint should be bedded in well-graded crushed aggregate (VDOT 21B dense graded aggregate or similar) to reduce the potential for accumulation of water.

- All downspout drains should be contained in solid pipes and routed to discharge points away from the buildings. Roof leaders should be connected to underground drain lines immediately upon installation such that water from precipitation events is not allowed to discharge along foundation walls

- Maintain positive slopes around footing excavations and the building footprint prior to and after placement of concrete.

- All buried liquid supply lines should be pressure tested prior to being placed in service to identify any leaks that may require repair.

General

The results of the exploration indicated that the site is generally underlain by a variable layer of existing fill and residual soil. The soil types and consistencies of the overburden materials are generally within typical ranges for limestone derived residual materials within the general geographic area. These soils typically do not exhibit adverse shrink-swell characteristics provided that compaction criteria and proper construction drainage measures, grading and sloping away from the structure is maintained both during and after construction.

Existing Fill

The borings encountered existing fill materials which extended to depths of 2 feet to 4 feet below existing grades. Although the fill did not contain significant amounts of organics or other unacceptable materials, we cannot confirm if the fill was originally placed in a controlled manner. We requested copies of compaction records documenting placement of the existing fill, but they were not available for review, and may not exist. Accordingly, we recommend that the existing fill materials be removed from the new building footprint to a minimum depth of 3 feet below the design bearing elevation, extending at least 5 feet beyond the footprint and be replaced with new controlled fill. The existing fill can be re-used for new fill if organics are excluded, and the material is moisture conditioned to achieve the required compaction. Upon completion of the partial over-excavation, the remaining material should be heavily proof-rolled with appropriate equipment to re-densify the fill as well as help identify any unstable areas. New fill within the building footprint should be placed and compacted in accordance with the recommendations contained in the **Controlled Fill** section of this report. Foundations for the new building can then be supported on the new controlled fill and/or suitable residual soils.

DESIGN RECOMMENDATIONS

Foundations

We believe that the proposed structure can be supported on conventional spread foundations bearing on approved residual materials or new controlled fill at shallow depths provided the recommendations herein are strictly maintained. The FFE for the proposed slab-on-grade structure is EL. 727.3 feet and, consequently, the design bearing elevation would be approximately EL. 724.3 feet. Based on the data obtained from the test borings and the planned site grading, we recommend that a maximum allowable bearing pressure of 2,500 psf be utilized for design of spread footings bearing on approved residuum or new controlled fill. Minimum dimensions of 2 feet and 3 feet should be observed for continuous and isolated footings, respectively. Exterior foundations should bear at least 30 inches below the final outside grade for frost protection. Footings within permanently heated areas can bear at minimum depths below the finished floor.

Hard rock may be encountered during foundation construction in isolated areas. The top of hard rock is impossible to predict between exploration points in karst terrain. Any hard rock which is encountered above the planned bearing elevation should be over-excavated to at least 12 inches below bearing levels and should be replaced with controlled soil fill. This measure typically reduces the magnitude of differential settlement resulting from partial rock and partial soil bearing.

Based on the above design recommendations and the various types and consistencies of bearing materials, it is estimated that total settlements for foundations bearing on approved materials will be on the order of one (1) inch or less. Total settlements for foundations bearing entirely on hard rock, if applicable, will be negligible. Differential settlements are anticipated to be half of the total settlements or in this case one-half (½) inch. Differential settlements could be in the same range as total settlements between interior columns bearing entirely on either soil or rock. Differential settlements along continuous wall footings are not expected to exceed an angular distortion of 0.0015 inch/inch.

Seismic Site Classification

The site soils were evaluated and classified according to the 2018 International Building Code Section 1613 - Earthquake Loads - Site Ground Motion. This building code establishes the criteria for project site evaluation. Section 1613.3.2 and 2010 ASCE-7 Standard-Table 20.3-1 defines the parameters for determining the seismic site class based on N-values. The seismic site class may be determined by calculating an average N-value of subsurface materials to a depth of 100 feet. For the determination, the N-values recorded in test borings are used for overburden soil, and then, typically, materials below the depth that auger refusal or hard rock is encountered (to a depth of 100 feet) are assigned an N-value of 100. Based on the results of the test borings, the site has an average N-value greater than 50. Using this information along with knowledge of the site geologic setting, the seismic site class and additional seismic information is as follows:

SEISMIC PARAMETERS	
Seismic Site Class	**C**
Soil Profile Name	**Very Dense Soil and Soft Rock**
Site Amplification Factor at 0.2 second, F_a	**1.3**
Site Amplification Factor at 1.0 second, F_v	**1.5**
$MCER_R$ Ground Motion (for 0.2 second period), S_s	**0.125**

MCER$_R$ Ground Motion (1.0 second period), S$_1$	**0.044**

Based on results from the test borings, published regional geologic information and the probable maximum strength of earthquake, it is our opinion that liquefaction potential for the on-site soils during seismic activity is low. Seismic coefficients and other seismic information to be considered for structural design of the project are provided in Appendix D of this report.

Floor Slabs

The structures will include concrete slabs supported on grade and bearing on new controlled fill and/or approved residual materials. We recommend that a modulus of subgrade reaction, "k," of 110 pci be adopted for analysis and design of the slabs-on-grade. Slabs should be underlain by a minimum 4-inch thick layer of open-graded aggregate such as ASTM designation No. 57 stone and should be underlain by a conventional polyethylene vapor barrier.

Lateral Earth Pressures

We recommend that the following lateral earth pressure coefficients be used to evaluate earth pressures for the design of the planned retaining walls for the project. It is noted that the coefficients are based on the angle of internal friction of the material, and these coefficients do not include a factor of safety. Accordingly, the designer should include a factor of safety appropriate for the specific design approach and/or codes.

BACKFILL MATERIAL	**MOIST UNIT WEIGHT (pcf)**	**FRICTION ANGLE (degrees)**	**LATERAL EARTH PRESSURE COEFFICIENTS (LEVEL BACK SLOPE)**		
			Active (K_a)	**At-Rest (K_o)**	**Passive (K_p)**
On site cohesive on-site soils (clays, silts)	115	28	0.36	0.53	2.77
On site granular soils (SM or more granular)	120	32	0.31	0.47	3.25
AASHTO #57 stone	110	38	0.24	0.38	4.20
Well-graded crushed aggregate (VDOT 21B)	140	40	0.21	0.36	4.60

The coefficient of friction which can be used for determination of sliding resistance on the base of foundation elements can be computed as 0.58 times the total vertical load on the foundation. This is based on a friction angle of 30° for the base soil, and it does not include a factor of safety.

Surcharge loads anticipated at the surface should be multiplied by the active earth pressure coefficient (for flexible walls) and superimposed as a uniform horizontal pressure on the recommended design lateral loading. Surcharge loads anticipated at the surface should be multiplied by the at-rest earth pressure coefficient (for rigid walls) and superimposed as a uniform horizontal pressure on the recommended design lateral loading.

It is emphasized that the designer must carefully consider the rigidity of the retaining system to select either an active or at-rest condition. To use an active earth pressure, the wall(s) must undergo a slight amount of rotation which will result in some translation at the top of the wall. Typically, for well-compacted granular backfill, the translation may be on the order of 0.001 to 0.002H, where H is the height of the wall. Similarly, for compacted cohesive soils, the translation may be on the order of 0.01 to 0.02H. If the retaining system is extremely rigid and/or upper levels are constructed over the wall to provide additional horizontal resistance, an at-rest pressure will be more appropriate.

The lateral pressure values recommended above are based on adequate drainage behind the walls without build-up of hydrostatic pressures. Consequently, a permanent backwall drainage system should be constructed along exterior retaining walls or below grade walls. The permanent backwall drainage should include a 4-inch diameter Schedule 40 PVC or HDPE perforated pipe surrounded by an 18-inch wide zone of free draining gravel such as ASTM Size No. 57, and separated from the general site backfill by a non-woven geofabric, such as TC Mirafi 140-N or an approved equal. Backwall drains should be sloped such that water will flow by gravity to a sump or an appropriate drain and day-light beyond the structures.

CONSTRUCTION RECOMMENDATIONS

Site Preparation

Initial site clearing and grubbing should include removal of the topsoil and any other deleterious materials within the new structure footprint and pavement areas and extending ten (10) feet beyond their perimeters. After removal of the unsuitable surface materials and old fill as recommended in the **DISCUSSION** section of the report, the subgrade soils should be heavily proof-rolled with approved construction equipment to locate isolated soft spots or areas of excessive "pumping" which are too wet to accommodate compacted fill or building construction. These areas should be either scarified, air-dried to a sufficient moisture content and re-compacted prior to fill placement or excavated to the level of stable soils. The exposed subgrade should be examined and verified by a representative from our office prior to placement of compacted fill.

Excavation Areas

The carbonate bedrock present beneath the site generally weathers differentially to produce a very irregular top of rock profile. Consequently, it is impossible to predict where rock will be encountered at locations between specific exploration points. In general, the existing fill and residual soils present can be excavated with conventional earth moving equipment such as backhoes and tracked loaders. Decomposed rock encountered can possibly be removed to a very limited extent with a ripper. This layer, however, is typically thin, and the transition from soil to hard rock is somewhat abrupt. Hard bedrock or large boulders will require hoe-ram chipping or hydraulic splitting for effective removal. Contractors should be required to submit unit prices for unanticipated unsuitable materials, should they be encountered during the project.

During excavation operations, dry conditions should be maintained within the cut areas at all times in order to reduce the need for additional undercutting or aeration of soils. The contractor should be prepared to implement, if necessary, temporary de-watering measures in these areas during construction. These measures can include sloping the cut areas to appropriate sump pit(s) and pumping accumulated surface runoff from precipitation. All cut areas should be sealed at the end of each day, to the extent which construction practicality will permit, to help prevent infiltration of precipitation and subsequent unsuitable soil conditions.

Controlled Fill

Satisfactory Soils

On-site residual materials and old fill excavated from cut areas can generally be used for fill provided that compaction criteria are strictly maintained. We anticipate that the on-site materials may have to be dried or wetted to attain a moisture content that is within a satisfactory level to obtain proper compaction. Due to the fine-grained soils at the site, construction during the winter and spring months is often futile. This will be very dependent upon seasonal conditions at the time of earthwork construction. Also, the fine-grained soils are relatively sensitive to moisture fluctuations and typically can be effectively placed and compacted only during drier seasons.

Fill materials should not contain any debris, waste, or frozen materials and they should contain less than two (2) percent vegetation-organic materials by weight. Also, materials classified as OL, OH, or Pt are not suitable for use as structural fill. The on-site clayey soils are generally suitable for re-use as structural fill provided that proper drainage, grading and sloping away from the structure is maintained both during and after construction.

Broken rock that is excavated from the site can be utilized for fill provided that certain construction procedures are observed. These procedures include maintaining the maximum particle size of the rock, prohibiting nesting of boulders and mixing sufficient amounts of soil fines with the rock to fill in open voids between the rock particles. Satisfactory materials placed from final building subgrade level to a depth of 1 foot below foundation bearing levels, from the subgrade to a depth of 1 foot below utility invert levels and in the top one (1) foot of pavement subgrade should be free of rock or gravel larger than six (6) inches in any dimension. Satisfactory materials placed below these levels should be free of rock larger than nine (9) inches in any dimension.

Placement and Compaction

Before compaction, each layer should be moistened or aerated as necessary to obtain the required compaction. Each layer should be compacted to the required percentage of maximum dry density. Fill should not be placed on surfaces that are muddy or frozen or have not been approved by testing and/or proof-rolling. Free water should be prevented from appearing on the surface during or subsequent to compaction operations.

Soil material which is removed because it is too wet to permit proper compaction can be spread and allowed to dry. Drying can be facilitated by discing or harrowing until the moisture content is reduced to an acceptable level. When the soil is too dry, water should be applied uniformly to the subgrade surface or to the layer to be compacted. Results of the moisture content testing indicate in-situ moisture contents ranging from 0.3 to 32.5 percent. Therefore, the contractor should be prepared to aerate or moisten the on-site soils on the order of 10 to 15% by weight.

All fill material compacted by heavy compaction equipment should be placed in maximum 9-inch loose lifts. All fill material compacted by hand-operated tampers or light compaction equipment should be placed in maximum 4-inch loose lifts.

Fill material placed below and extending five (5) feet beyond the foundations for the structure should be compacted to at least 98 percent of the laboratory maximum dry density as determined by the Standard Proctor method (ASTM D 698). Fill placed within the pavement subgrade areas should also be compacted to 98 percent of the maximum dry density as determined by ASTM D 698. The moisture content of the soils should be at or within two (2) percentage points of the optimum moisture content.

Foundations

We anticipate that conventional earth excavation equipment such as a backhoe or trackhoe can be utilized to excavate the residual soils or controlled fill for foundation construction. Hard rock removal typically requires hoe-ram chipping or hydraulic splitting. We recommend that any loose materials present at the bottom of footing excavations as a result of excavation work be recompacted or completely removed by hand in order to reduce differential settlements. In any areas where hard rock is encountered at the bottom of proposed footing levels, the recommendations presented in the **Foundation Design** section of this report should be strictly followed.

Foundation concrete should be placed the same day that excavations are completed to reduce the potential for softening due to precipitation and/or runoff. In areas where backfill adjacent to wall construction has not been placed prior to precipitation events, any ponded water that accumulates in these areas should be pumped out immediately to help prevent softening and deterioration of the surrounding soils. In addition, all rough grades around the structure should be sloped away from the structure both during and after construction such that water from precipitation does not build up or pond adjacent to the perimeter.

Any underground utilities which are located below or adjacent to new foundations should be backfilled with approved, well-graded crushed aggregate, lean mix concrete or flowable fill grout to grades which are at or above the design bearing levels. In addition, minimal thicknesses of bedding stone should be utilized beneath the utility lines in order to help prevent significant accumulation of water from precipitation developing within the utility trench area.

Floor Slabs

Prior to placement of crushed stone for the floor slabs, the subgrade soil within the limits of the structure should be proof-rolled in order to detect any soft, wet "pumping" areas. Any unsuitable areas should be either scarified, aerated to an approved moisture content, and re-compacted or undercut and replaced with controlled fill. The subgrade should be properly sloped to allow water from precipitation to drain from the stone prior to slab placement. Water should not be allowed to pond within the stone prior to placement of concrete. We recommend that the sequence and timing of floor construction be coordinated such that slab concrete will be placed within a very short time, i.e., within a few days or less, after placement and compaction of the aggregate base course.

Utilities

Locations and invert elevations for proposed utilities were not provided. In general, we anticipate that conventional excavation equipment such as a backhoe or trackhoe can be used for utility excavations in the residual soils and controlled fill. Any excavations which encounter large rock will require hoe-ram chipping or hydraulic splitting to attain scheduled invert elevations.

In areas where excavated rock and soil fill has been placed during mass earthwork construction, an acceptable substitute backfill material should be used for new utility trench backfill. This is recommended because of the inherent difficulty in re-compacting larger excavated rock materials in trenches using small, hand-operated equipment. The substitute material should comply with the maximum particle size restrictions specified for the particular utility. Trenches below structure and pavement areas should be backfilled in accordance with the Controlled Fill section of this report.

Construction Observations

We recommend that the geotechnical engineering firm of record, Triad, be retained to observe the construction activities to verify that the field conditions are consistent with the findings of our exploration. Construction observation services should be performed on a full-time and/or intermittent basis, as required, to:

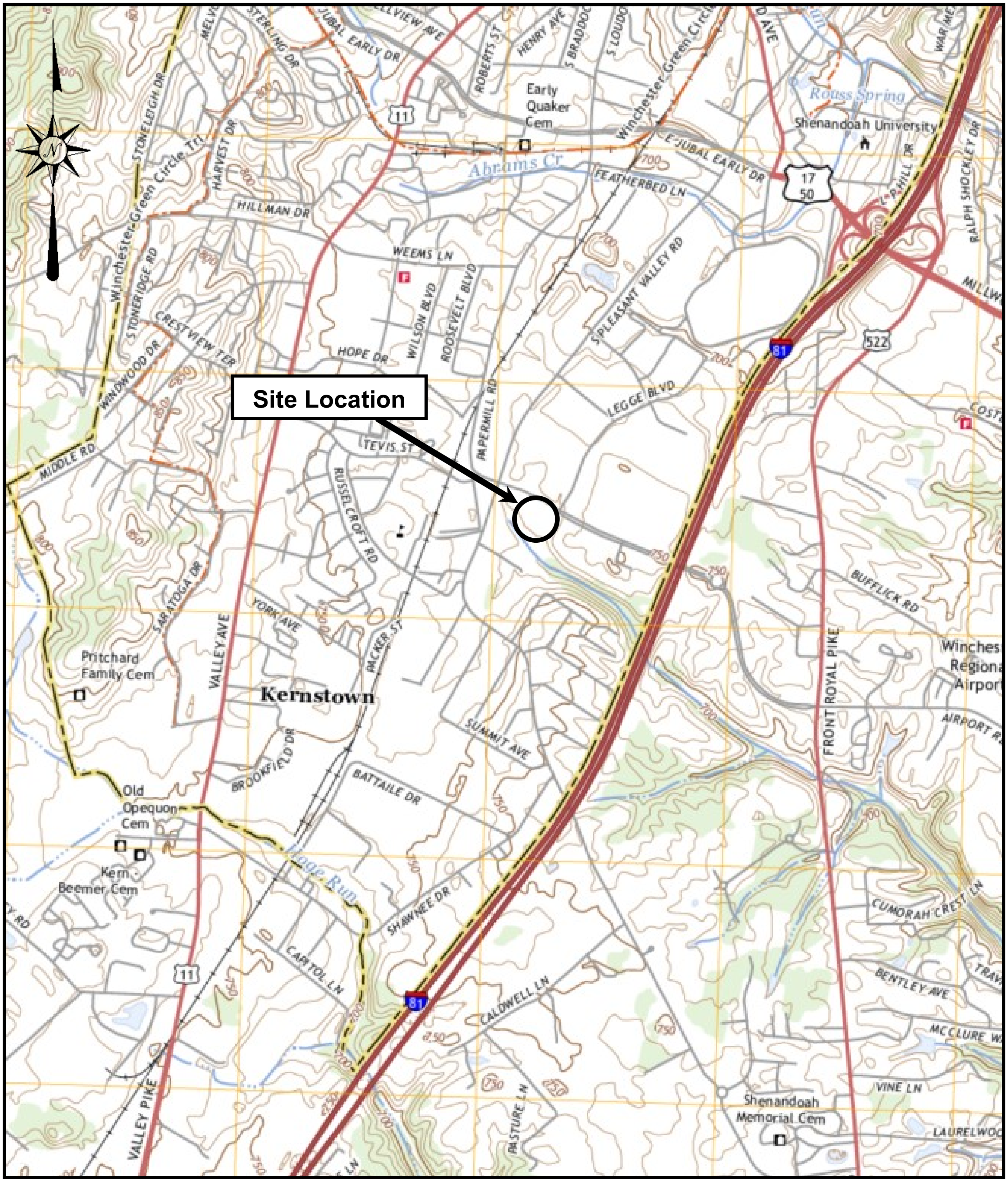
- observe removal of all old fill, organics and any deleterious materials and observe proof-rolling of original subgrade material prior to initial fill placement.

- observe and test controlled fill construction. Field density tests should be performed in accordance with ASTM D 6938 (nuclear method). A minimum of three field density tests should be performed for each lift of fill placed or at a frequency determined to be sufficient by the testing agency based on the amount of fill being placed to confirm the required soil compaction.

- examine all foundation bearing levels and slab subgrade, foundation depths, and reinforcing steel size, amount, and placement for the proposed structures. The inspection should be performed by a professional engineer or qualified representative working under the direct supervision of the professional engineer from our office. All foundation bearing levels should be tested immediately prior to placing reinforcing steel and concrete to confirm that the required bearing support is available.

APPENDIX A

Illustrations



SOURCE: USGS 7.5
WINCHESTER (VA) 2022;
Topographic Maps

THE LEARNING EXPERIENCE – CROSSOVER BOULEVARD
FREDERICK COUNTY, VIRGINIA

TRIAD ENGINEERING, INC.
www.triadeng.com

DRAWN BY: KTB

CHECKED BY: RAS

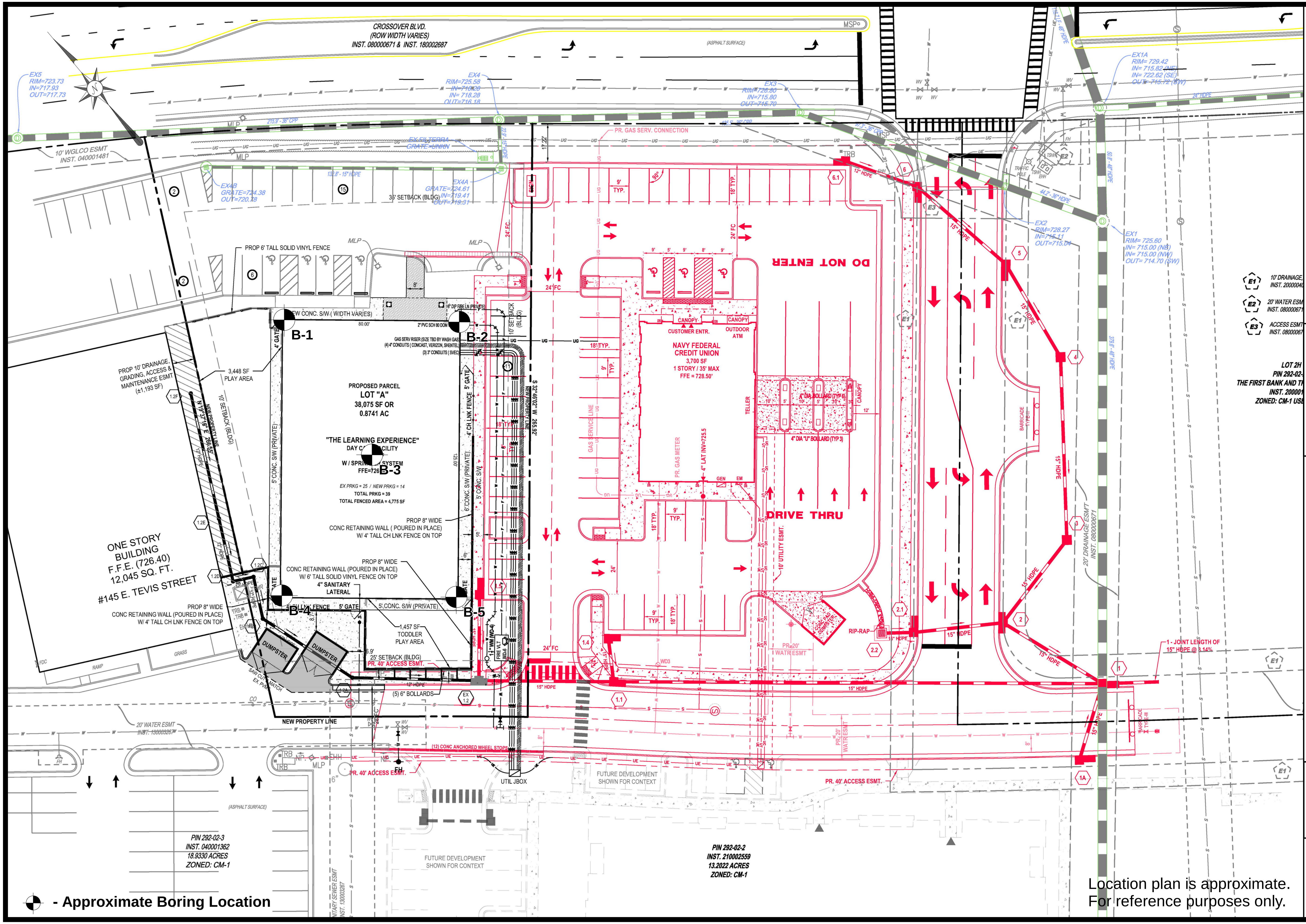
SITE VICINITY PLAN

DATE: 05-31-2023

SCALE: 1"= 2000'

TRIAD PROJECT NO. 07-23-0213

FIGURE NO.: A-1



- Approximate Boring Location

Location plan is approximate.
For reference purposes only.

TRIAD ENGINEERING, INC.
200 AVIATION DRIVE
WINCHESTER, VA 22602
PH: 540.667.9300 FAX: 540.667.2260
OFFICE LOCATIONS:
MARYLAND - OHIO - PENNSYLVANIA
VIRGINIA - WEST VIRGINIA

BASE MAP PROVIDED BY:
PENNONI

PROJECT NO:
07-23-0213

DRAWN BY:
KTB

CHECKED BY:
RAS

DATE:
05-31-2023

SCALE:
1"=40'

THE LEARNING EXPERIENCE -
CROSSOVER BOULEVARD
FREDERICK COUNTY, STATE

BORING LOCATION PLAN

TRIAD ENGINEERING, INC.
www.triadeng.com

FIGURE NUMBER:
A-2
PROJECT NO: 07-23-0213

TRIAD ENGINEERING, INC.

APPENDIX B

Field Exploration

KEY TO IDENTIFICATION OF SOIL AND WEATHERED BEDROCK SAMPLES

Descriptor Sequence

1	Color
2	Primary Component
3	Fractions
4	Moisture
5	Descriptors
6	Plasticity
7	Consistency/ Relative Density
8	Deposition Type

1. Color

Gray	Tan
Brown	Black
Orange	Red
Green	Yellow
Purple	Blue

Modifiers

Light	Lighter side of color range
Dark	Darker side of color range
Mottled	Irregularly marked with spots of different colors
Banded	Alternating shades or colors

2. Primary Component

Component	Grain Size
Boulders	≥ 12 inches
Cobbles	3 to 12 inches
Coarse Gravel	1 to 3 inches
Medium Gravel	$^{3}/_{8}$ to 1 inch
Fine Gravel	$^{5}/_{64}$ to $^{3}/_{8}$ inch
Coarse Sand	#40 to #10
Fine Sand	#200 to #40
Silt/Clay	≤ #200

3. Fractions

And	≥ 35%
Some	20 to 35%
Little	10 to 20%
Trace	< 10%

4. Moisture

Dry	Dry to touch
Damp	Slightly moist
Moist	No visible free water
Wet	Visible free water

5. Descriptors

Fissile	Splits easily along closely spaced parallel planes (breaks into plates)
Hackly	Jagged or irregular fracture planes
Slickenside	Polished and striated surface that results from friction along a fault plane
Laminated	Alternating thin layers of varying material or colors less than ¼” thick
Lensed	Inclusion of small pockets of different soils
Saprolitic	Completely weathered rock that retains the appearance of the original rock structure but has only a trace of the original bond strength
Micaceous	Containing mica minerals
Varved	Laminated sediment consisting of alternating layers of fine sand and silt or clay deposited in still water

6. Plasticity of Fine-Grained Soils

Fine-Grained Component	Plasticity	Estimated Plasticity Index (PI)	Smallest Thread Diameter	Thread Characteristics	Dilatancy
Predominately Silt Silt ↑ More Silt ↑	Non-Plastic	0 - 2%	Ball cracks	Dries rapidly; a 1/8-inch thread cannot be rolled at any water content	Moist ball sheds water when shaken giving a glossy appearance
	Low Plasticity	3 - 10%	$^{1}/_{8}$ to $^{1}/_{4}$ inch	Feels powdery when drying out during rolling; thread can barely be rolled	Moist ball retains water or sheds water slowly when shaken
Predominately Clay ↓ More Clay ↓ Clay	Medium Plasticity	> 10 - 20%	$^{1}/_{16}$ inch	Thread cannot be rerolled after reaching plastic limit	
	Highly Plastic	> 20%	$^{1}/_{32}$ inch	Thread can be rerolled after reaching plastic limit	Moist ball retains water when shaken

7a. Relative Density of Granular Coarse-Grained Soils

Descriptor	N-Value
Very Loose	≤ 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

7b. Consistency of Fine-Grained Soils

Descriptor	Pocket Penetrometer (tons/ft^2)	N-Value
Very Soft	≤ 0.25	≤ 2
Soft	≥ 0.25 - 0.5	3 - 4
Medium Stiff	> 0.5 - 1.0	5 - 8
Stiff	> 1.0 - 2.0	9 - 15
Very Stiff	> 2.0 - 4.0	16 - 30
Hard	> 4	≥ 31

8. Type of Deposit

Alluvium	Sediment deposited by moving water
Colluvium	Sediment deposited by gravity
Fill	Manmade deposit
Fluviomarine	Stratified materials formed by the combined action of river and sea processes
Glacial Outwash	Sediment deposited by glacial meltwater; commonly sand and gravel
Glacial Till	Unsorted sediment deposited by glacier
Glacial Lake Deposit	Sediment deposited in glacial lake; commonly silt and clay
Residuum	Insoluble material remaining from weathered rock
Weathered Bedrock	Bedrock that has been weathered

FIGURE B-1

TEST BORING LOG

Sheet 1 of 1

Project Number: 07-23-0213
Project Name: The Learning Experience
Boring No.: **B-1**
Logger: KTB
Boring Location: See Figure No. A-2
Date Started: 6/2/23
Drill/Method: DIEDRICH D-50 TURBO
Date Completed: 6/2/23
Driller: CONNELLY
Ground Elev.: 726

■ Shelby Tube
☒ Standard Split Spoon
◧ Core Sample
◩ Auger Probe

Depth (feet)	Sample No.	Sample Type	Blow Counts	Recovery (%)	RQD (RUN)	Strata Depth (ft)	MATERIAL DESCRIPTION	RQD (Strata)	Water Level	Graphic Log	Strata Elevation
	S-1	☒	4-23-27-23	67%		2.0	5" TOPSOIL Gray-tan **GRAVEL**, some sand, little clay, dry, dense -FILL-			▨	724.0
	S-2	☒	9-9-14-20	50%		4.0	Brown-orange-gray clayey **GRAVEL and SAND**, damp, medium dense -FILL-			▨	722.0
5.0 10.0	S-3 S-4 S-5	☒ ☒ ☒	9-50/5" 40-50/6" 50/3"	45% 83% 100%		11.5	Gray-brown-tan weathered **LIMESTONE**, some clay and sand, moist, very dense -difficult augering 5'-8.5' -little clay, damp -trace clay, dry to damp -very difficult augering 8.5'-11.5' -WEATHERED ROCK-			▦	714.5
15.0 20.0							-AUGER REFUSAL AT 11.5 FEET- (possible top of bedrock)				

TRIAD ENGINEERING, INC.

200 Aviation Drive
Winchester, VA 22602
P: 540.667.9300
F: 540.667.2260

Remarks: No groundwater encountered during or upon completion of drilling.

TEST BORING LOG

Sheet 1 of 1

Project Number: **07-23-0213**
Project Name: **The Learning Experience**
Boring No.: **B-2**
Logger: KTB
Boring Location: See Figure No. A-2
Date Started: 6/2/23
Drill/Method: DIEDRICH D-50 TURBO
Date Completed: 6/2/23
Driller: CONNELLY
Ground Elev.: 726.5

■ Shelby Tube
☒ Standard Split Spoon
◧ Core Sample
▱ Auger Probe

Depth (feet)	Sample No.	Sample Type	Blow Counts	Recovery (%)	RQD (RUN)	Strata Depth (ft)	MATERIAL DESCRIPTION	RQD (Strata)	Water Level	Graphic Log	Strata Elevation
	S-1	☒	10-12-25	61%			2" TOPSOIL Gray-tan **GRAVEL**, some clay and sand, dry, dense			▩	
						2.5	-FILL-			▩	724.0
	S-2	☒	6-5-5 PP=2.0 tsf	44%			Brown-tan-orange **FAT CLAY**, some gravel, little sand, damp, stiff			▨	
5.0	S-3	☒	3-3-5 PP=3.25 tsf	67%			-trace to little sand, trace gravel, damp, very stiff			▨	
10.0	S-4	☒	3-6-9 PP>4.5 tsf	89%			-mottled orange-brown, black and gray, damp, hard			▨	
15.0	S-5	☒	3-5-7 PP=3.5 tsf	83%		15.0	-very stiff -RESIDUUM-			▨	711.5
							-BORING TERMINATED AT 15.0 FEET-				
20.0											

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200 Aviation Drive
Winchester, VA 22602
P: 540.667.9300
F: 540.667.2260

Remarks: No groundwater encountered during or upon completion of drilling.

TEST BORING LOG

Sheet 1 of 1

Project Number: 07-23-0213
Project Name: **The Learning Experience**
Boring No.: **B-3**
Logger: KTB
Boring Location: See Figure No. A-2
Date Started: 6/2/23
Drill/Method: DIEDRICH D-50 TURBO
Date Completed: 6/2/23
Driller: CONNELLY
Ground Elev.: 726

■ Shelby Tube ☒ Standard Split Spoon
▮ Core Sample ◪ Auger Probe

Depth (feet)	Sample No.	Sample Type	Blow Counts	Recovery (%)	RQD (RUN)	Strata Depth (ft)	MATERIAL DESCRIPTION	RQD (Strata)	Water Level	Graphic Log	Strata Elevation
	S-1	☒	8-22-15	89%			3" TOPSOIL Gray-tan **GRAVEL**, some sand, little clay, dry, dense -FILL-				
						2.5					723.5
	S-2	☒	50/6"	17%			Gray-orange-brown clayey **SAND and GRAVEL**, moist, very dense -difficult augering 2.5'-4.5'				
5.0	S-3	☒	11-7-9	6%			-medium dense				
	S-4	☒	8-7-7	11%			-medium dense				
	S-5	☒	8-6-6	17%			-medium dense				
10.0	S-6	☒	3-7-50/5"	56%			-loose to medium dense -RESIDUUM-				
						11.0	Gray weathered **LIMESTONE**, very dense -WEATHERED ROCK-				715.0
						11.5	-AUGER REFUSAL AT 11.5 FEET-				714.5
15.0											
20.0											

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200 Aviation Drive
Winchester, VA 22602
P: 540.667.9300
F: 540.667.2260

Remarks: No groundwater encountered during or upon completion of drilling.

TEST BORING LOG

Sheet 1 of 1

Project Number: **07-23-0213**
Project Name: **The Learning Experience**
Boring No.: **B-4**
Logger: KTB
Boring Location: See Figure No. A-2
Date Started: 6/2/23
Drill/Method: DIEDRICH D-50 TURBO
Date Completed: 6/2/23
Driller: CONNELLY
Ground Elev.: 726

■ Shelby Tube
☒ Standard Split Spoon
▯ Core Sample
⧄ Auger Probe

Depth (feet)	Sample No.	Sample Type	Blow Counts	Recovery (%)	RQD (RUN)	Strata Depth (ft)	MATERIAL DESCRIPTION	RQD (Strata)	Water Level	Graphic Log	Strata Elevation
	S-1	☒	7-9-10-15	88%			4" TOPSOIL Tan-brown-gray clayey **SAND and GRAVEL**, some sand, trace roots, dry, medium dense			▩	
	S-2	☒	4-8-25-10	38%			-no roots, moist, dense			▩	
						4.0	-FILL-			▩	722.0
5.0	S-3	☒	15-10-11-43	50%			Gray-brown-orange **GRAVEL**, some sand, little to some clay, moist, medium dense -difficult augering 5.5'-9.5'			⁘	
	S-4	☒	50/2"	100%			-gray, no clay, damp, very dense			⁘	
	S-5	☒	50/5"	100%			-dry, very dense			⁘	
						9.5	-RESIDUUM-			⁘	716.5
10.0	S-6	☒	6-5-6-8 PP=1.5 tsf	92%			Orange-brown **FAT CLAY**, little sand and gravel, moist, stiff			▨	
						12.5	-RESIDUUM-			▨	713.5
							-AUGER REFUSAL AT 12.5 FEET-				
15.0											
20.0											

Remarks: No groundwater encountered during or upon completion of drilling.

TEST BORING LOG

Sheet 1 of 1

Project Number: **07-23-0213**
Project Name: **The Learning Experience**
Boring No.: **B-5**
Logger: KTB
Boring Location: See Figure No. A-2
Date Started: 6/2/23
Drill/Method: DIEDRICH D-50 TURBO
Date Completed: 6/2/23
Driller: CONNELLY
Ground Elev.: 725.5

■ Shelby Tube
☒ Standard Split Spoon
▯ Core Sample
▧ Auger Probe

Depth (feet)	Sample No.	Sample Type	Blow Counts	Recovery (%)	RQD (RUN)	Strata Depth (ft)	MATERIAL DESCRIPTION	RQD (Strata)	Water Level	Graphic Log	Strata Elevation
	S-1	☒	9-50/6"	50%			3" TOPSOIL Gray-tan-brown **GRAVEL**, some clay and sand, dry, very dense			▩	
						2.0	-FILL-			▩	723.5
	S-2	☒	6-4-7-9 PP=2.5 tsf	58%			Tan-brown-orange-gray **FAT CLAY**, little sand and gravel, moist, very stiff			▨	
5.0	S-3	☒	4-5-4-7 PP=2.25 tsf	63%						▨	
	S-4	☒	5-7-12-10	0%			-very stiff			▨	
	S-5	☒	6-8-12-14 PP>4.5 tsf	63%			-mottled orange-brown and black, damp, hard			▨	
10.0						10.5	-RESIDUUM-			▨	715.0
							-AUGER REFUSAL AT 10.5 FEET-				
15.0											
20.0											

Remarks: No groundwater encountered during or upon completion of drilling.

TRIAD ENGINEERING, INC.

APPENDIX C

Laboratory Testing

LABORATORY TESTING

The soil samples obtained during the field exploration were visually classified in the field by geotechnical engineering personnel from Triad. The recovered soils were further evaluated by laboratory testing. Laboratory soil tests were conducted in accordance with applicable ASTM and AASHTO Standards as listed below:

1) Moisture content tests were performed in accordance with ASTM D 2216.

2) Atterberg Limits tests, consisting of the liquid limit, plastic limit, and plasticity index, were performed in accordance with ASTM D 4318.

3) Sieve analyses with washed No. 200 sieve tests were performed in accordance with ASTM D 422.

A summary and details of the laboratory tests are included on the following pages of this appendix.

TRIAD ENGINEERING, INC.

SOIL DATA SUMMARY

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMPLE TYPE	NATURAL MOISTURE (%)	ATTERBERG LIMITS			GRADATION			USCS SOIL CLASS.	PROCTOR		ADDITIONAL TESTS CONDUCTED
				LL	PL	PI	% GRAVEL	% SAND	% FINES		MAX. DD (pcf)	OPT. M (%)	
B-1	0-2	SS	7.6										
B-1	2-4	SS	15.9	37	21	16	50	36	14	GC			
B-1	4-4.9	SS	12.3										
B-1	6-7	SS	12.5										
B-2	0-1.5	SS	13.9										
B-2	2.5-4	SS	16.5										
B-2	5-6.5	SS	32.3										
B-2	8.5-10	SS	30.0	62	23	39	0	24	76	CH			
B-2	13.5-15	SS	26.8										
B-3	0-1.5	SS	0.3										
B-3	7-8.5	SS	24.6										
B-3	8.5-10	SS	24.9										
B-3	10-11.4	SS	22.4										
B-4	0-2	SS	15.6										
B-4	2-4	SS	20.4	Combined with B-1 (2-4 ft.) for classification testing.									
B-4	4-6	SS	12.5										
B-4	10-12	SS	29.9										
B-5	2-4	SS	27.4										

TRIAD ENGINEERING, INC.

Notes:
1) Soil tests performed in accordance with recognized ASTM testing standards.
2) SS = Split Spoon;

PROJECT NUMBER: 07-23-0213
PROJECT NAME: The Learning Experience

LOCATION: Winchester, VA

FIGURE
C-1

TRIAD ENGINEERING, INC.

SOIL DATA SUMMARY

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMPLE TYPE	NATURAL MOISTURE (%)	ATTERBERG LIMITS			GRADATION			USCS SOIL CLASS.	PROCTOR		ADDITIONAL TESTS CONDUCTED
				LL	PL	PI	% GRAVEL	% SAND	% FINES		MAX. DD (pcf)	OPT. M (%)	
B-5	4-6	SS	32.5	Combined with B-2 (8.5-10 ft.) for classification testing.									
B-5	6-8	SS	25.2										

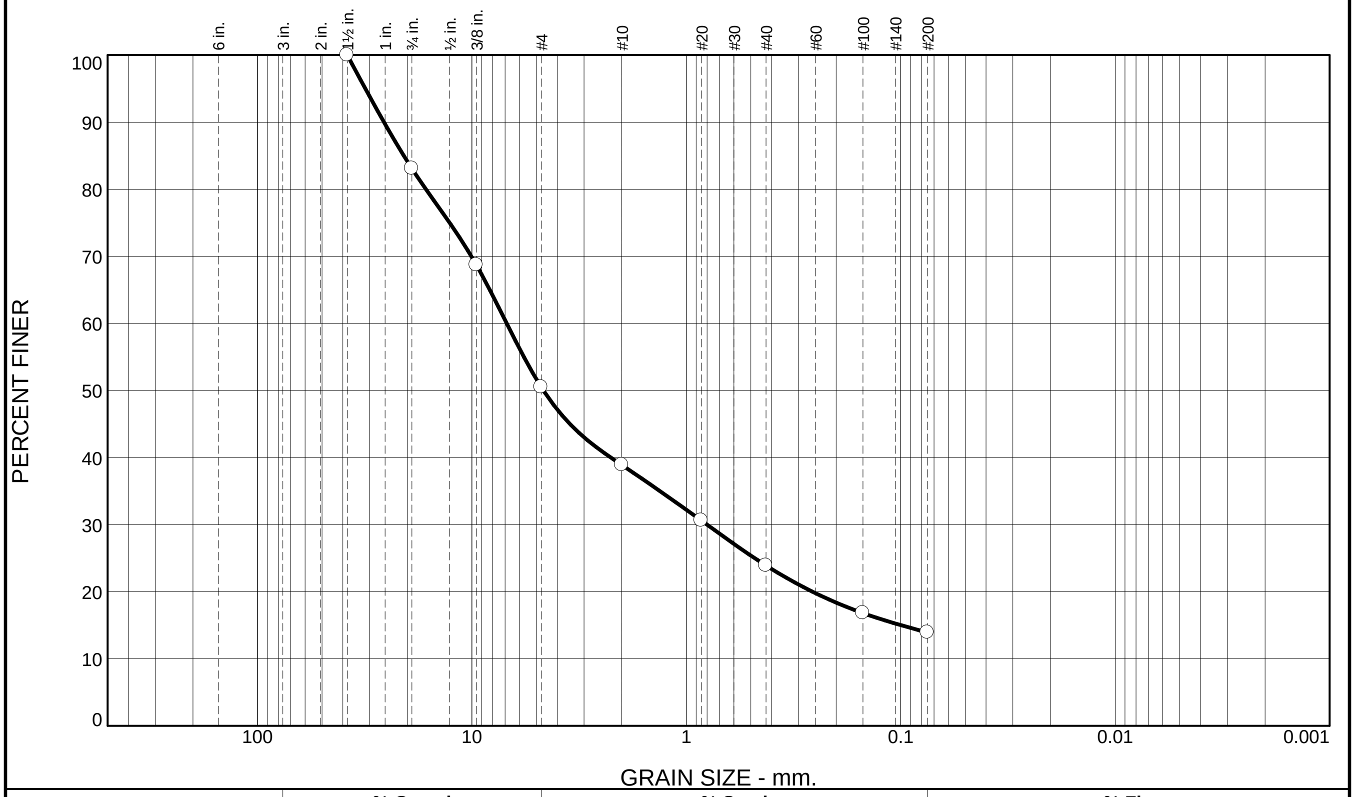
TRIAD ENGINEERING, INC.

Notes:
1) Soil tests performed in accordance with recognized ASTM testing standards.
2) SS = Split Spoon;

PROJECT NUMBER: 07-23-0213
PROJECT NAME: The Learning Experience
LOCATION: Winchester, VA

FIGURE C-2

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	16.9	32.6	11.6	15.0	10.0	13.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
3/4"	83.1		
3/8"	68.7		
#4	50.5		
#10	38.9		
#20	30.6		
#40	23.9		
#100	16.8		
#200	13.9		

* (no specification provided)

Material Description

Orange-brown-gray clayey GRAVEL & SAND

Atterberg Limits

PL= 21 LL= 37 PI= 16

Coefficients

D_{90}= 25.7134 D_{85}= 20.7813 D_{60}= 6.8789
D_{50}= 4.6409 D_{30}= 0.8005 D_{15}= 0.0997
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

Source of Sample: B-1 & B-4 **Depth:** 2.0' - 4.0'

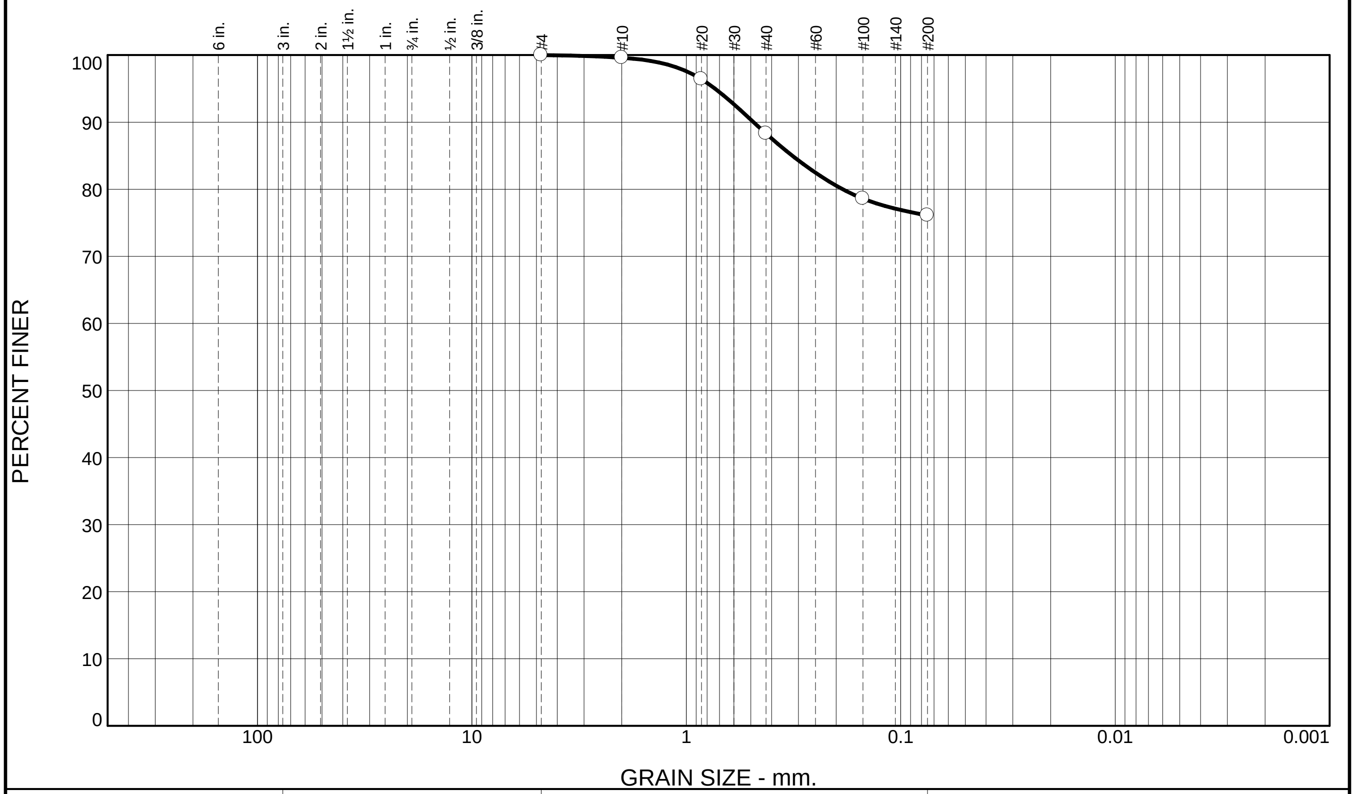
Date: 6-19-2023

Triad Engineering, Inc.

Client: Ganges Properties Group
Project: The Learning Experience
Winchester, VA
Project No: 07-23-0213 **Figure** C-3

Tested By: KBA **Checked By:** RAS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.4	11.3	12.2	76.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.6		
#20	96.4		
#40	88.3		
#100	78.6		
#200	76.1		

* (no specification provided)

Material Description

Orange-brown fat CLAY, some sand

Atterberg Limits

PL= 23	LL= 62	PI= 39

Coefficients

D_{90}= 0.4861	D_{85}= 0.3207	D_{60}=
D_{50}=	D_{30}=	D_{15}=
D_{10}=	C_u=	C_c=

Classification

USCS= CH

AASHTO= A-7-6(30)

Remarks

Source of Sample: B-2 & B-5 **Depth:** 4.0' - 10.0'

Date: 6-19-2023

Triad Engineering, Inc.

Client: Ganges Properties Group

Project: The Learning Experience
Winchester, VA

Project No: 07-23-0213 **Figure** C-4

Tested By: KBA **Checked By:** RAS

APPENDIX D

Seismic Information

07-23-0213 The Learning Experience

Latitude, Longitude: 39.15210131, -78.17436235

Date	7/3/2023, 2:29:34 PM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	C - Very Dense Soil and Soft Rock

Type	Value	Description
S_S	0.125	MCE_R ground motion. (for 0.2 second period)
S_1	0.044	MCE_R ground motion. (for 1.0s period)
S_{MS}	0.163	Site-modified spectral acceleration value
S_{M1}	0.066	Site-modified spectral acceleration value
S_{DS}	0.109	Numeric seismic design value at 0.2 second SA
S_{D1}	0.044	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	A	Seismic design category
F_a	1.3	Site amplification factor at 0.2 second
F_v	1.5	Site amplification factor at 1.0 second
PGA	0.064	MCE_G peak ground acceleration
F_{PGA}	1.3	Site amplification factor at PGA
PGA_M	0.083	Site modified peak ground acceleration
T_L	12	Long-period transition period in seconds
SsRT	0.125	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	0.133	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.044	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.048	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.5	Factored deterministic acceleration value. (Peak Ground Acceleration)
PGA_{UH}	0.064	Uniform-hazard (2% probability of exceedance in 50 years) Peak Ground Acceleration
C_{RS}	0.94	Mapped value of the risk coefficient at short periods

Type	Value	Description
C_{R1}	0.926	Mapped value of the risk coefficient at a period of 1 s
C_V	0.7	Vertical coefficient

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