REPORT OF GEOTECHNICAL EXPLORATION

PENNSYLVANIA AVENUE PUMP STATION
WINCHESTER, VIRGINIA

TRIAD PROJECT NO. 07-17-0167

PREPARED FOR:

MR. GLENN F. ROGERS III, PE, CCCA, ENV SP
HAZEN AND SAWYER
4807 HERMITAGE ROAD, SUITE 203
RICHMOND, VA 23227

PREPARED BY:

TRIAD ENGINEERING, INC.

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

APRIL 22, 2019

TRIAD Listens, Designs & Delivers

April 22, 2019

Mr. Glenn F. Rogers III, PE, CCCA, ENV SP
Hazen and Sawyer
4807 Hermitage Road, Suite 203
Richmond, VA 23227

RE: Report of Detailed Geotechnical Exploration
Pennsylvania Avenue Pump Station
Winchester, Virginia
Triad Proposal No. 07-17-0167

Dear Mr. Rogers:

Triad Engineering, Inc. (Triad) has completed a geotechnical exploration for the planned pump station to be constructed in Winchester, Virginia. Our scope of services was completed in substantial conformance with our proposal dated July 10, 2017 and authorized by issuance of the signed Subcontract Agreement for Professional Services dated September 5, 2017. This report outlines the results of our field exploration and laboratory tests, and presents our recommendations for design and construction of the geotechnical elements of the project.

The subsurface exploration was performed to evaluate the subsurface conditions encountered at the planned pump station location 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 in areas other than the specific boring locations, and Triad makes no representations as to subsurface conditions other than those encountered at the specific boring locations.

This report has been prepared for the exclusive use of Hazen and Sawyer for specific application to the design of the Pennsylvania Avenue Pump Station project 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.

Raymond A. Strother II, PE
Geotechnical Practice Leader

Randy L. Moulton, P.E.
Principal Engineer

COMMONWEALTH OF VIRGINIA
RANDY L. MOULTON
Lic. No. 019214
PROFESSIONAL ENGINEER

TABLE OF CONTENTS

Page

FOREWORD 1

SITE AND PROJECT DESCRIPTION 1

GEOLOGIC SETTING 2
- General 2
- Development in Karst Areas 2

FIELD EXPLORATION 4

SUBSURFACE CONDITIONS 4
- Subsurface Strata 4
- Groundwater Observations 4

LABORATORY TESTING 5

DISCUSSION 5

DESIGN RECOMMENDATIONS 5
- Foundations 5
- Slabs-on-Grade 6
- Below Grade Walls 6
- Seismic Activity 7

CONSTRUCTION RECOMMENDATIONS 7
- Site Preparation 7
- Site Excavations 8
- Structural Fill Material 8
- Fill Placement and Compaction 8
- Foundation Construction 9
- Quality Assurance and Control 9

APPENDIX A

Site Location Plan ..... Figure No. A-1
Boring Location Plan ..... Figure No. A-2
Revised Survey Site Plan ..... Figure No. A-3

APPENDIX B

Key to Identification of Soil and Weathered Rock Samples ..... Figure No. 1
Log of Test Borings ..... B-1 and B-2

APPENDIX C

Results of Laboratory Tests ..... Figures C-1 to C-2

Report of Detailed Geotechnical Exploration
Pennsylvania Avenue Pump Station
Winchester, Virginia

Triad Project No. 07-17-0167

FOREWORD

This report has been prepared for the exclusive use of Hazen and Sawyer for specific application to the design of the pump station which will be constructed in Winchester, Frederick County, 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 borings 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. 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.

SITE AND PROJECT DESCRIPTION

The subject site is located on a parcel of land owned by the City of Winchester situated between Star Fort Drive and Pennsylvania Avenue in Winchester, Virginia. The site consists of flat to gently sloping grass, gravel and densely wooden terrain. It is our understanding that a new pump station will be constructed in the open portions of the site. The location of the site is shown on Figure No. A-1 in Appendix A. Several underground and overhead utilities were noted at the site, and they include water, sewer and electric located as shown on Figure No. A-2 in Appendix A. In addition to the utilities shown on Figure No. A-2, another sewer line was marked in the vicinity of boring

B-1. The newly identified sewer line was marked exiting the northern manhole of the existing pump station and extending northwest just beyond boring B-1 and then immediately turning due west toward existing manhole MH-114-1. Triad survey personnel mobilized to the site to field locate the newly marked utility line. A revised site plan is provided as Figure No. A-3 in Appendix A for reference purposes.

Based on the provided drawings (dated April 2019), the pump station will include construction of the following precast structures: a wet well, a valve vault, a meter vault and concrete building. A new emergency generator with a subbase tank is planned. We understand that the valve and meter vaults will be situated adjacent to the wet well and extend to depth of about 7.5 feet below the finished exterior grade. It is our understanding that the bottom of the base slab for the electrical building will bear at elevation 722 MSL and have a footprint of 22 feet by 17 feet. We also understand that the floor elevation of the top slab will be at 727 MSL, and it will have a footprint of 20 by 15 feet. The electric building slab will house a new generator pad with a footprint of about 7.5 feet by 3.5 feet and a precast concrete structure with a footprint of 10 feet by 12 feet. Based on the provided information, we understand that maximum applied loads will be on the order of 1,600 psf for the wet well and 750 psf for the electric building slab. We assume that the applied loads for the remaining meters and generator components will be negligible. ***The structural engineer for the project should confirm the estimated loads are in accordance with the actual applied loads for the project.***

Based on the preliminary grading information, it appears that the overall ground surface at the site will be raised by about two feet. Therefore, an off site borrow source of material will be required to achieve final design grades.

GEOLOGIC SETTING

General

According to the Geologic Map of the Virginia Portion of the Winchester 30 x 60 Minute Quadrangle, published in 2001 by the Virginia Division of Mineral Resources, the site is underlain by the Pinesburg Station Dolomite and the Rockdale Run Formation. The Pinesburg Station Dolomite is generally described as gray, fine-grained, medium- to thick-bedded dolostone with sparse fossils and minor nodular chert throughout. The Rockdale Run Formation is described as gray, fine-grained, fossiliferous limestone, laminated dolomitic limestone and dolostone with mottled beds. Thin lenses of gray chert are common near the bottom of the formation. Residual overburden soils weathered from the parent bedrock generally consist of lean to fat clay and clayey silts with varying amounts of sand and rock fragments.

Development in Karst Areas

The project site and general geographic area is underlain by carbonate sedimentary bedrock which results in karst terrain. Karst terrain is characterized by caves, internal drainage, lack of surface streams and topographic features such as sinkholes. These

features are the result of the dissolution of soluble bedrock, such as limestone or dolomite, by groundwater and/or surface water infiltration. As water enters fractures and bedding planes in soluble carbonate bedrock, it slowly dissolves the rock and enlarges the fractures. This results in the formation of solution channels or underground streams or ravines. Sinkholes are created by the subsidence of unconsolidated materials (soils) into underlying voids such as solution channels or caves. Usually, subsidence occurs slowly and steadily over geologic time. Many sinkholes, however, are caused by a sudden collapse of a solution cave when the roof of the cave becomes too thin to support the overburden materials. Sinkholes recently created by such a collapse can usually be identified by the presence of freshly broken rock outcrops around the rim or throat of the sinkhole. Since water is the primary cause of the dissolution, the potential for sinkhole formation within stormwater management areas and in cut areas is increased due to the intensified water infiltration in these areas and removal of overburden soils, respectively.

The carbonate rock at the site is moderately solution-prone, highly calcareous and weathers differentially to produce a pinnacled or "sawtooth" top of rock profile. The degree of weathering or dissolution within the limestone bedrock is controlled by joint orientation and frequency and to some degree bedrock structure. Where joints intersect or where rock is highly fractured, dissolution is intensified typically creating topographically low areas and weathered rock seams that are generally filled with residual clay soils. Conversely, topographically high areas generally represent more competent, slightly to non-weathered rock that is often coarse grained and only slightly solution prone.

Based on our site reconnaissance, no sinkholes or apparent depressions were observed during our exploration. Therefore, we do not believe that additional investigations at the site are warranted at this time. It is important to note that there will always be some risk 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 levels of these risks can not be clearly or completely defined since they are partially controlled by nature. A geophysical study can be conducted to help better define the level of risk associated with potential future sinkhole activity, if desired.

It is important to note that alterations in the ground surface, particularly in cut areas, during construction can impact the natural drainage within the site, and it is common to have some solutioning features develop in these areas as a result of construction. Also, normal blasting required to remove hard rock can create micro-fractures within the bedrock that will allow greater surface water infiltration into areas that may normally not receive water and, in turn, disturb old solutioning features and/or possibly create new features. These features can develop during and/or after construction, and they will result in some minor construction delays and unanticipated costs for repairs. Certain design and construction measures can and should be implemented to help reduce 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.

FIELD EXPLORATION

As requested, the field exploration included two (2) borings drilled at the proposed wet well and precast concrete building locations. The boring locations were selected by Hazen and Sawyer and established in the field by Triad survey personnel. Surface elevations were also determined by Triad. The approximate boring locations are shown on Figure A-2 in Appendix A.

The test borings included Standard Penetration Testing (SPT) and split barrel sampling (ASTM D 1586) at regular intervals that extended beyond the planned termination depths due to soft soil conditions. Boring B-1 was terminated at a depth of 46.5 feet below existing grade due to a lack of additional augers to advance the drilling. Boring B-2 encountered a layer of stiff soils and was terminated at a depth of 31.5 feet below existing grade. A geotechnical engineer from our office was present full time during the drilling to direct the drill crew, log all recovered soil samples and observe groundwater and rock conditions. The recovered soil samples were transported to our laboratory for further testing. Detailed descriptions of materials encountered in the test borings are contained on the logs in Appendix B. Figure No. 1 in Appendix B contains a description of the classification system and terminology utilized.

SUBSURFACE CONDITIONS

Subsurface Strata

The materials encountered in the borings are generally described below. Stratification lines indicated on the logs represent the approximate boundaries between material types.

Topsoil: A 2-inch thick layer of topsoil was encountered at the ground surface in boring B-1. The topsoil layer generally consisted of brown silty clay with an appreciable root mat. A 3-inch thick layer of gravel was encountered at the ground surface in boring B-2

Residuum: Residual soils were encountered in the test borings below the topsoil or fill. The residuum extended to termination depths of 31.5 and 46.5 feet below existing grades. The residuum generally consisted of clay with varying amounts of sand and rock fragments. Standard Penetration Testing (SPT) N-values obtained in the residuum ranged from Weight of Hammer (WOH) to 18 blows per foot, which indicates a very soft to very stiff consistency. N-values exhibiting very soft to soft consistencies were isolated to samples obtained between 30 feet and 46.5 feet in boring B-1, and samples obtained between 15 feet and 30 feet in boring B-2. The majority of the residuum exhibited medium stiff to stiff consistencies.

Groundwater Observations

The test borings were checked for the presence of groundwater both during and upon completion of the drilling. A static groundwater level was detected at depths of 30 feet

and 15 feet upon completion of drilling in borings B-1 and B-2, respectively. It is emphasized that variations in groundwater levels are typical of the geologic region and may occur due to changes in environmental conditions, surface drainage and other factors not 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	13.0 % to 45.5 %
Atterberg Limits: Liquid Limit Plasticity Index	41 18
Percent Passing #200 Sieve	83 %
USCS Soil Classification	CL

DISCUSSION

Based on our estimated applied load for the wet well and results of the exploration, it is our opinion that the wet well can be supported by the planned spread foundation constructed at the design bearing elevation. We assume that excavations required for the wet well will be of sufficient size such that the adjacent valve pits will be supported on controlled backfill placed around the wet well. The concrete building and generator pad can be supported on conventional slabs-on-grade (mat foundations) without the need for extensive corrective measures to the existing site soils.

DESIGN RECOMMENDATIONS

The geotechnical engineering evaluation of the subsurface conditions at the site, as well as the recommendations for earthwork and foundation construction, are based on our site observations, the field data obtained, and our understanding of the project information as presented in this report. If any of the information is incorrect, please contact us so that we can review our recommendations. Also, the knowledge of any site or subsurface condition revealed during construction that deviates from the data obtained during the geotechnical exploration should be reported to us for our evaluation.

Foundations

We conclude that the proposed structures can be supported on conventional shallow spread foundations bearing on approved residual materials or new controlled fill. Based on data obtained from the field exploration and our experience with similar projects, we recommend that a maximum allowable bearing pressure of 2,000 psf be utilized for

design of shallow and mat foundations bearing on approved residual soil or new controlled fill. Minimum dimensions of 2 feet and 3 feet should be observed for continuous and isolated footings, respectively, as warranted. Exterior foundations should bear at least 30 inches below the final outside grade for frost protection.

Based on the assumed maximum loads, our experience with similar soils and the net change in pressure at the planned bearing level for the wet well prior to and upon completion of construction, we estimate that total settlements for foundations bearing on approved residual soils and/or new controlled fill will be one (1) inch or less. Differential settlements are anticipated to be one-half of the total settlements. Differential settlements along continuous wall footings are not expected to exceed an angular distortion of 0.0015 inch/inch.

Slabs-on-Grade

As mentioned previously, we assume that the concrete building and generator pad will include mat foundations supported at grade. For evaluation and design of slabs-on-grade, we recommend that a modulus of subgrade reaction, k, of 100 pci be utilized. The mats should include turned down edges extended to 30 inches below the finished grade for frost protection. Construction joints should be provided in accordance with criteria outlined by the American Concrete Institute (ACI) and/or Portland Cement Association (PCA).

Below-Grade Walls

The below grade walls of the wet well will be subject to lateral earth pressures. It is assumed that select on-site materials will be used as structural fill behind the below grade walls. For use of the fine grained on-site materials (CL or CH) as backfill, we recommend that an active equivalent fluid pressure (γK_a) of 65 pcf be utilized for design. We recommend that an at-rest equivalent fluid pressure (γK_o) of 95 pcf be used for design if the fine-grained on-site soils are used as backfill for below grade structures.

Reduced lateral pressures can be realized if select structural fill is used as backfill against the walls. For materials that are classified as SM or more granular, in accordance with the Unified Soil Classification System (USCS), we recommend that an active equivalent fluid pressure (γK_a) of 40 pcf and an at-rest equivalent fluid pressure (γK_o) of 65 pcf be utilized for design. A factor of safety of 1.5 has been incorporated into the above recommended equivalent fluid pressures. Sample(s) of off-site material to be utilized as structural backfill material should be tested to determine the appropriate USCS classification and corresponding active and at-rest pressures.

The designer should give careful consideration when evaluating active and at-rest lateral earth pressures against below grade walls. For example, if the below grade walls will be backfilled prior to placement of decking or lateral support, this suggests that an active lateral earth pressure should be utilized since the below grade walls would be free to translate. However, if lateral support is placed, such that the walls are fixed prior

to backfilling, this condition would more appropriately be analyzed using at-rest lateral earth pressures.

Adequate drainage, consisting of ASTM No. 57 limestone, a geosynthetic filter fabric between any stone/soil interface, and slotted drainage pipes should also be installed behind the retaining structure to help remove any water which may infiltrate behind them. We suggest that a solid piece of pipe be connected to any perforated foundation drain pipe and be routed to discharge away from the structure. Installing a permanent drainage system along the exterior of the wet well may not be feasible since the bearing elevations may be well below available discharge points. If a drainage system cannot be designed, the walls should be designed for full hydrostatic and soil pressures.

Below-ground tanks may be subject to floatation from uplift hydrostatic pressures during construction and when the structures are emptied after they are in service. Resisting these pressures may be accomplished by installing rock anchors along the bottom of the structures, providing thicker concrete walls to increase the dead weight of the structures or constructing a toe on the structure footings. Since the tanks will be empty during construction, and may have to be drained in the future, the fact that they will be filled with liquid should not be considered in the design of the walls. Each wall of the structure should be constructed prior to backfilling behind the subsurface walls. Any below-grade walls should also be sealed against water infiltration. Temporary shoring and bracing may be required to facilitate construction of foundation systems for the wet well. Sloping, benching and/or shoring of excavations required for construction should be designed and evaluated in accordance with OSHA 29 CFR Part 1926, titled "Occupational Safety and Health Standards - Excavations."

Seismic Activity

The project site is located in Winchester, Frederick County, Virginia which is considered to be a low seismic risk region. We recommend that Site Class "E" be utilized for seismic design of foundations. This recommendation is for the designer utilizing the International Building Code (IBC) 2015 guidelines. Liquefaction potential of the on-site soils is considered to be negligible.

CONSTRUCTION RECOMMENDATIONS

Site Preparation

Initial site preparation should include removal of trees, root mats, topsoil, and any other deleterious material from within the proposed structure footprints and extending at least five (5) feet beyond their perimeter. Any existing utilities should be re-located outside of the new construction area.

Any exposed subgrade which is to receive new fill or construction should be densified and proof-rolled, if feasible, or probed to identify soft, unstable areas. Any soft, unstable areas identified should be over-excavated to firm, stable material and should be

replaced with new controlled fill. A qualified representative from Triad should be present to observe the subgrade and verify that appropriate conditions are present.

Site Excavations

It is anticipated that the majority of the on-site soils can be effectively removed with conventional earth-moving equipment such as backhoes and dozers. It is assumed that that excavations required for the project will likely not extend to depths sufficient to encounter hard bedrock. However, hard bedrock that is encountered may require rock removal techniques such as hoe-ram chipping, heavy ripping, or blasting for effective removal.

Excavated materials should not be stockpiled and construction equipment should not be positioned beside open excavations, since the added load may cause a sudden collapse of the excavation side walls. The design and construction of all excavations should comply with applicable local, state and federal safety regulations, including the current requirements of the Occupational Safety and Health Administration (OSHA). In no case should slope height, slope inclination or excavation depth, including utility trench excavation depth, exceed those specified by OSHA or any other regulatory agencies or local authorities having jurisdiction at the construction site.

Structural Fill Material

Fill required to attain design grades should be placed as controlled, compacted fill. Satisfactory fill includes approved on-site excavated materials, off-site granular borrow material (residual soils, soil/rock mixtures, and soft weathered rock), or a well-graded commercial stone such as crusher run aggregate. The fill should be free of trash, wood, topsoil, organics, coal, coal mine refuse, pyritic material containing greater than 0.5 percent by weight of pyritic sulfur, frozen material, and pieces of rock greater than 6 inches in any dimension. New fill should be tested and approved prior to placement and compaction.

Fill Placement and Compaction

Before initiating fill placement, the exposed subgrade should be proof-rolled with appropriate construction equipment to locate any soft spots or areas of excessive "pumping." Any such areas should be scarified, aerated, and re-compacted prior to placing fill, or removed and replaced with other structural fill.

During placement, moisten or aerate each layer of fill, as necessary, to obtain the required compaction. Fill should not be placed on surfaces that are muddy or frozen, or have not been approved by prior 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 may be spread and allowed to dry. Drying can be facilitated by discing, harrowing, or by

pulverizing until the moisture content is reduced to an acceptable level. When the soil is too dry, water may be uniformly applied to the subgrade surface or to the layer to be compacted.

Fill material compacted by heavy compaction equipment should be placed in loose layers having a 9-inch maximum thickness. Fill compacted with lightweight equipment, such as hand-operated tampers or walk-behind rollers, should be placed in loose layers not exceeding 4 inches in thickness. Light compaction equipment should be used to compact fill adjacent to walls and formed foundations such that damage to these structural elements does not occur. Fill placed on sloping areas should be properly benched into the existing slope such that a smooth interface between the new fill and existing slope is not present.

Fill required within the structure footprints, any controlled fill slopes and 5 feet beyond their perimeters, should be compacted to at least 98 percent of the laboratory maximum dry density as determined by the Standard Proctor method (ASTM D 698). Granular materials, such as ASTM No. 57 stone, should be compacted to at least 85 percent of its relative density, as determined by ASTM D 4253 and D 4254 test methods. Fill for general site grading outside of structure areas should be compacted to at least 95 percent of the maximum Standard Proctor dry density. The placement moisture content of all fill should be within 3 percentage points of the optimum moisture content as determined by ASTM D 698. Fill placement should be observed and tested to verify that the fill areas are constructed as recommended in this report.

Foundation Construction

Foundation excavations should be compacted following excavation to densify loose or otherwise disturbed materials present in the base of the excavations. The excavations should be observed by a qualified representative from our office prior to base stone and/or concrete placement to verify that materials capable of providing the recommended bearing capacity are present. Materials exposed in the foundation excavations will be susceptible to softening and/or degradation if exposed to inclement weather. Consequently, foundation concrete should be placed in the excavation as soon as possible once the excavation has been observed and approved. It is also important that areas adjacent to foundations be adequately sloped to facilitate positive drainage away from the foundations both during and after construction.

Quality Assurance and Control

We recommend that the geotechnical engineer-of-record, Triad, be retained to observe the construction activities to verify that the field conditions are consistent with the findings of our exploration. If significant variations are encountered, or if the design is altered, we should be notified.

The geotechnical engineer should provide personnel full-time and/or intermittently, as necessary, to:

- observe final surface material removal and observe and verify proof-rolling of original subgrade prior to initial fill placement;

- observe and test material compaction during fill construction. Field density tests should be performed in accordance with ASTM D 6938 (nuclear method). At least three field density tests should be performed for each lift or at a frequency determined by the geotechnical engineer to be sufficient for the size of the fill area to verify the required soil compaction;

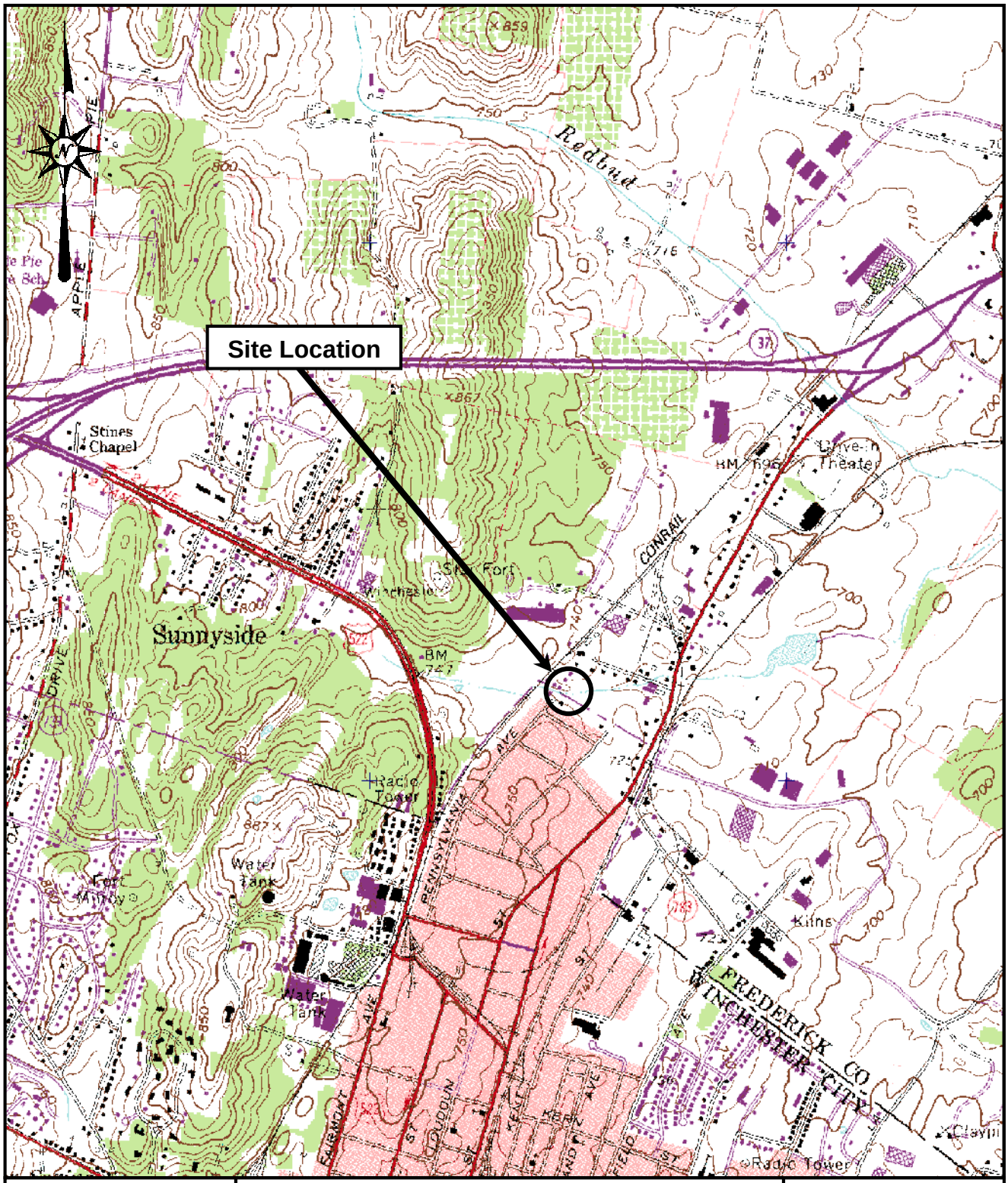
- examine foundation subgrade bearing levels to confirm compliance with our recommendations, and verify that adequate support is available, and;

- test structural concrete placed for the project.

TRIAD ENGINEERING, INC.

APPENDIX A

Illustrations



SOURCE: USGS 7.5 WINCHESTER (VA) 1987; Topographic Maps		PENNSYLVANIA AVENUE PUMP STATION WINCHESTER/FREDERICK COUNTY, VIRGINIA
DRAWN BY: DJM	CHECKED BY: RLM	SITE VICINITY PLAN
DATE: 02-12-2019	SCALE: 1" = 2000'	TRIAD PROJECT NO. 07-17-0167

TRIAD ENGINEERING, INC.
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FIGURE NO.: A-1

Location plan is approximate.
For reference purposes only.

Overhead Electric Line

PENNSYLVANIA AVENUE

GRAVEL ACCESS ROAD

MH-114-1

PROPOSED MH

YARD HYDRANT

6'x5' WASH DOWN AREA

12' PRECAST WET WELL

Bore #1

B-1

PRECAST VALVE VAULT

PRECAST METER VAULT

Existing Sewer

FENCE

PROPERTY

Existing Pump Station

GATE

B-2

Bore #2

7.6'x3.5' EMERGENCY GENERATOR (INCLUDING CONC PAD)

10'x12' PRECAST CONC BUILDING

EX 8" FORCE MAIN

BM #1
EL=725.45'

Existing Force-main

- Approximate Boring Location

10 5 0 10'

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: HAZEN AND SAWYER	PROJECT NO: 07-17-0167	CHECKED BY: RLM	SCALE: 1"=10'
		DRAWN BY: DJM	DATE: 04-02-2019

PENNSYLVANIA AVENUE PUMP STATION
WINCHESTER/FREDERICK COUNTY, VIRGINIA

BORING LOCATION PLAN

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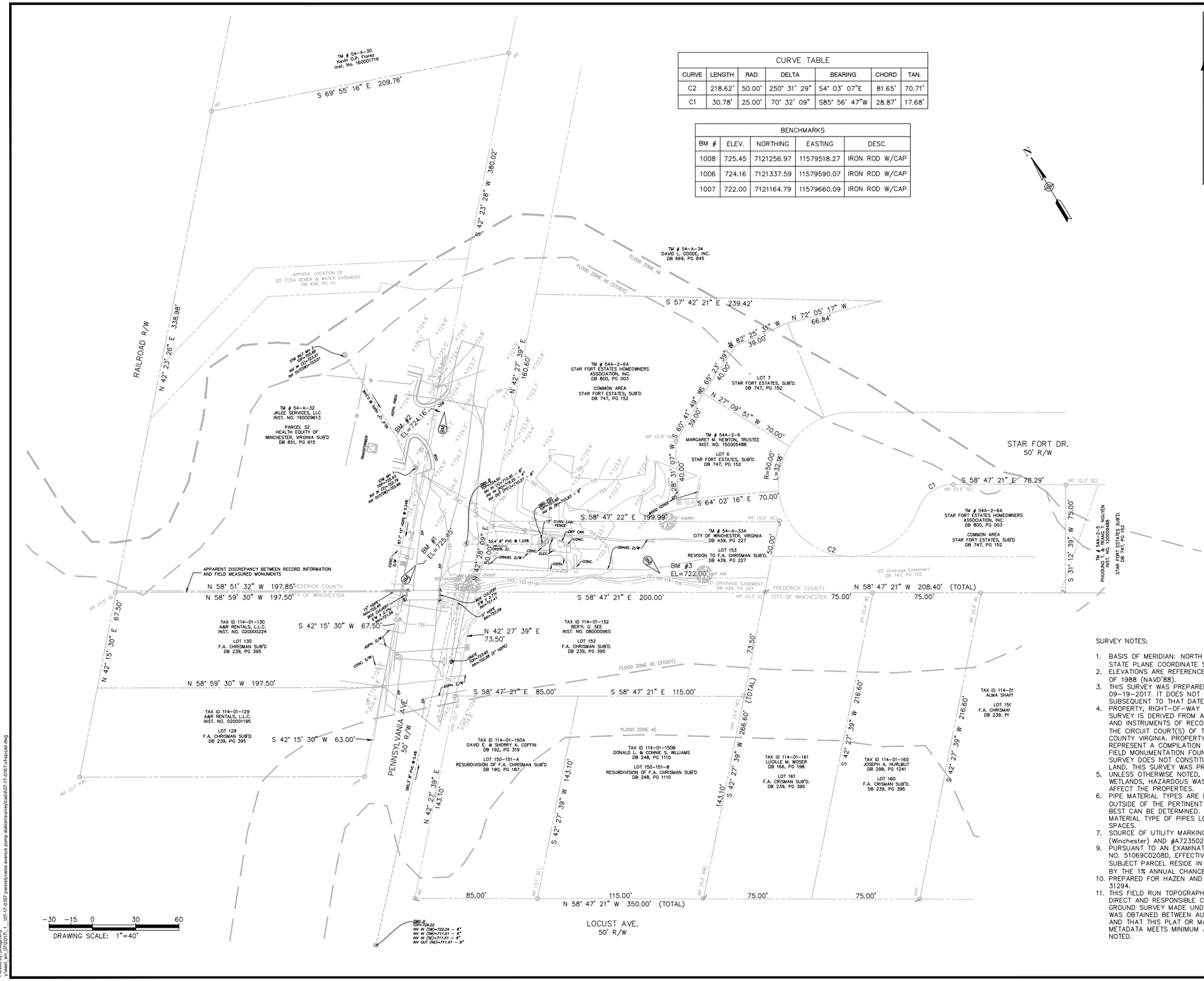
FIGURE NUMBER:
A-2
PROJECT NO: 07-17-0167

CURVE TABLE						
CURVE	LENGTH	RAD	DELTA	BEARING	CHORD	TAN.
C2	218.62'	50.00'	250° 31' 29"	S4° 03' 07"E	81.65'	70.71'
C1	30.78'	25.00'	70° 32' 09"	S85° 56' 47"W	28.87'	17.68'

BENCHMARKS				
BM #	ELEV.	NORTHING	EASTING	DESC.
1008	725.45	7121256.97	11579518.27	IRON ROD W/CAP
1006	724.16	7121337.59	11579590.07	IRON ROD W/CAP
1007	722.00	7121164.79	11579660.09	IRON ROD W/CAP



VICINITY MAP
SCALE: 1"=1000'

LEGEND

- UNDERGROUND ELECTRIC LINES — UGE
- UNDERGROUND GAS LINES
- UNDERGROUND WATER LINES — W
- STORM DRAIN PIPES
- SANITARY SEWER LINES
- SANITARY FORCE MAIN
- FENCES
- TREE DRIP LINE
- OVERHEAD ELECTRIC LINES — OHE
- WATER METER
- WATER VALVE
- FIRE HYDRANT
- LIGHT POST
- SIGN
- UTILITY POLE
- GUY ANCHOR
- HDPE HIGH DENSITY POLYETHYLENE
- D/W DRIVE WAY
- SMH SANITARY MANHOLE
- IRF IRON ROD FOUND
- IPF IRON PIPE FOUND
- PPF PINCH PIPE FOUND

SURVEY NOTES:

1. BASIS OF MERIDIAN: NORTH AMERICAN DATUM OF 1983 (NAD'83), VIRGINIA STATE PLANE COORDINATE SYSTEM (NORTH ZONE).
2. ELEVATIONS ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD'88).
3. THIS SURVEY WAS PREPARED TO SHOW EXISTING FEATURES AS OF 09-19-2017. IT DOES NOT CERTIFY TO CHANGES IN SITE CONDITIONS SUBSEQUENT TO THAT DATE.
4. PROPERTY, RIGHT-OF-WAY AND OWNERSHIP INFORMATION SHOWN ON THIS SURVEY IS DERIVED FROM ASSESSMENTS TAX RECORDS, DEEDS, PLATS AND INSTRUMENTS OF RECORD OBTAINED FROM THE LAND RECORDS OF THE CIRCUIT COURT(S) OF THE CITY OF WINCHESTER AND FREDERICK COUNTY VIRGINIA. PROPERTY AND RIGHT-OF-WAY LINES DEPICTED HEREON REPRESENT A COMPILATION OF RECORD INFORMATION SUBJECTIVELY FIT TO FIELD MONUMENTATION FOUND AND LOCATED DURING THE SURVEY. THIS SURVEY DOES NOT CONSTITUTE A BOUNDARY SURVEY OR SUBDIVISION OF LAND. THIS SURVEY WAS PREPARED WITHOUT BENEFIT OF A TITLE REPORT.
5. UNLESS OTHERWISE NOTED, THIS SURVEY IS NOT INTENDED TO DEPICT WETLANDS, HAZARDOUS WASTE OR ENVIRONMENTAL FEATURES THAT MAY AFFECT THE PROPERTIES.
6. PIPE MATERIAL TYPES ARE IDENTIFIED BY FIELD OBSERVATIONS FROM OUTSIDE OF THE PERTINENT STRUCTURES (MANHOLES, INLETS, ETC.) AS BEST CAN BE DETERMINED. THE SURVEYOR DOES NOT WARRANT THE MATERIAL TYPE OF PIPES LOCATED IN CONFINED OR INACCESSIBLE SPACES.
7. SOURCE OF UTILITY MARKINGS: MISS UTILITY DESIGN TICKETS #A723502620 (Winchester) AND #A723502623 (FREDERICK COUNTY).
9. PURSUANT TO AN EXAMINATION OF A FEMA FLOOD INSURANCE RATE MAP, NO. 51069C0208D, EFFECTIVE SEPTEMBER 2, 2009, PORTIONS OF THE SUBJECT PARCEL RESIDE IN ZONE AE (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD (100-YEAR FLOOD).
10. PREPARED FOR HAZEN AND SAWYER, HAZEN AND SAWYER PROJECT NO. 31294.
11. THIS FIELD RUN TOPOGRAPHIC SURVEY WAS COMPLETED UNDER THE DIRECT AND RESPONSIBLE CHARGE OF CORY M. HAYNES FROM AN ACTUAL GROUND SURVEY MADE UNDER MY SUPERVISION; THAT THE ORIGINAL DATA WAS OBTAINED BETWEEN AUGUST 23, 2017 AND SEPTEMBER 19, 2017; AND THAT THIS PLAT OR MAP, OR DIGITAL GEOSPATIAL DATA INCLUDING METADATA MEETS MINIMUM ACCURACY STANDARDS UNLESS OTHERWISE NOTED.

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

REV. #	DATE	DESCRIPTION	BY

CADD FILE: 07-17-0167-VF-SP-JAD.dwg
DRAWN BY: CJM
CHECKED BY: TEAM
DATE: 9/19/2017
SCALE: N.T.S.

PENNSYLVANIA AVE. PUMP STATION
CITY OF WINCHESTER & FREDERICK COUNTY, VA

TOPOGRAPHIC SURVEY
REVISED SURVEY SITE PLAN

TRIAD ENGINEERING, INC.
www.triadeng.com

FIGURE No.
A-3
PROJECT No.: 07-17-0167

Plotted by: jdougherty
y:\data_inc\07\0167_ _\07-17-0167 pennsylvania avenue pump station\survey\cad\07-17-0167-vf-sp-jad.dwg

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APPENDIX B

Field Exploration

FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling two (2) test borings with Standard Penetration Testing (SPT) and sampling. The borings were drilled by Triad Engineering utilizing a CME-45 drill rig equipped with hollow stem augers. The field exploration was supervised by a geotechnical engineer from our office.

SPT and sampling was performed in accordance with ASTM D 1586. The SPTs were performed to depths indicated on the attached boring logs using a split barrel sampler with an outside diameter of two (2) inches and an inside diameter of one and three-eighths (1-3/8) inches. The split barrel sampler was driven eighteen (18) inches with a hammer weighing approximately 140 pounds and falling thirty (30) inches. The number of blows required to drive the split barrel sampler at six (6) inch increments was recorded on the boring logs. The method utilized to classify the soils is defined in Figure No. 1, Key to Identification of Soils and Weathered Rock Samples.

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KEY TO IDENTIFICATION OF SOIL AND WEATHERED ROCK SAMPLES

The material descriptions on the logs indicate the visual identification of the soil and rock recovered from the exploration and are based on the following criteria. Major soil components are designated by capital letters and minor components are described by terms indicating the percentage by weight of each component. Standard Penetration Testing (SPT) and sampling was conducted in accordance with ASTM D1586. N-values in blows per foot are used to describe the *relative density* of coarse-grained soils or the *consistency* of fine-grained soils.

The MAJOR components constitute more than 50% of the sample and have the following size designation.		The MINOR components have the following percentage designation.	
COMPONENT	**PARTICLE SIZE**	**ADJECTIVE**	**PERCENTAGE**
Boulders	12 inches plus		
Cobbles	3 to 12 inches	and	35 - 50
Gravel -coarse	¾ to 3 inches		
-fine	#4 to ¾ inches	some	20 - 35
Sand -coarse	#10 to #4		
-medium	#40 to #10	little	10 - 20
-fine	#200 to #40		
Silt or Clay	Minus #200 (fine-grained soil)	trace	0 - 10

Relative Density – Coarse-grained Soils		**Consistency – Fine-grained Soils**	
Term	***N-Value***	***Term***	***N-Value***
Very Loose	≤4	ery Soft	≤ 2
Loose	5 to 10	Soft	3 to 4
Medium Dense	11 to 30	Medium Stiff	5 to 8
Dense	31 to 50	Stiff	9 to 16
Very Dense	>50	Very Stiff	>16

Soil Plasticity	**Plasticity Index (PI)**	**Rock Hardness**	
None	Nonplastic	***Term***	***N-Value***
Low	1 to 5	Very Weathered	≤50/.5
Medium	5 to 20	Weathered	50/.4
High	20 to 40	Soft	50/.3
Very High	over 40	Medium hard	50/.2 to 50/.1
Moisture Description		Hard	Auger Refusal
Dry - Dusty, dry to touch			
Slightly Moist - damp			
Moist - no visible free water			
Wet - visible free water, saturated			

FIGURE NO. 1

TRIAD ENGINEERING, INC.

TEST BORING LOG

Project Number: 07-17-0167 | Project Name: Pennsylvania Avenue Pump Station | Boring No.: B-1
Logger: DJM | Boring Location: See Figure No. A-2
Date Started: 3/26/19 | Drill/Method: CME 45
Date Completed: 3/26/19 | Driller: TRIAD | Ground Elev.: 723.9

Shelby Tube | Standard Split Spoon | Core Sample | Auger Probe | Water Level Upon Completion 30.0 ft.

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		2-3-4	67%			2" TOPSOIL Tan-brown lean **CLAY**, medium stiff, low to medium plasticity, some sand and rock fragments, moist PP=2.75 tsf				
	S-2		4-3-5	83%			-medium stiff, little topsoil in spoon PP=2.75 tsf				
5.0	S-3		7-7-7	100%			-red-brown, stiff PP=2.75 tsf				
	S-4		4-4-4	100%			-orange-brown, medium stiff, little sand and rock fragments PP=4.25 tsf				
10.0	S-5		3-3-4	100%			-medium stiff, trace sand and rock fragments PP=4.0 tsf				
15.0						15.0	-RESIDUUM-				708.9
	S-6		3-3-3	100%			Orange-brown fat **CLAY**, medium stiff, medium to high plasticity, trace sand and rock fragments, moist PP=2.50 tsf				
20.0						20.0					703.9

Remarks: Boring extended 20' due to low blow counts at planned termination depth.

TRIAD ENGINEERING, INC.
200 Aviation Drive
Winchester, VA
P: 540.667.9300
F: 540.667.2260

TRIAD_C 07-17-0167 BORINGS.GPJ TRIAD 3.GDT 4/18/19

TEST BORING LOG

Project Number: 07-17-0167 | Project Name: Pennsylvania Avenue Pump Station | Boring No.: B-1
Logger: DJM | Boring Location: See Figure No. A-2
Date Started: 3/26/19 | Drill/Method: CME 45
Date Completed: 3/26/19 | Driller: TRIAD | Ground Elev.: 723.9

Shelby Tube | Standard Split Spoon | Core Sample | Auger Probe | Water Level Upon Completion 30.0 ft.

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-7		2-2-3	100%			-medium stiff PP=2.0 tsf				
25.0	S-8		2-2-4	100%			-red-brown, medium stiff PP=1.75 tsf				
30.0	S-9		4-2-2	100%			-soft, high plasticity PP=1.25 tsf				
35.0	S-10		2-1-2	100%			-soft, high plasticity, little sand and rock fragments PP=1.25 tsf				
40.0						40.0					683.9

Remarks: Boring extended 20' due to low blow counts at planned termination depth.

TRIAD ENGINEERING, INC.
200 Aviation Drive
Winchester, VA
P: 540.667.9300
F: 540.667.2260

TRIAD_C 07-17-0167 BORINGS.GPJ TRIAD 3.GDT 4/18/19

TEST BORING LOG

Project Number: 07-17-0167 | Project Name: Pennsylvania Avenue Pump Station | Boring No.: B-1
Logger: DJM | Boring Location: See Figure No. A-2
Date Started: 3/26/19 | Drill/Method: CME 45
Date Completed: 3/26/19 | Driller: TRIAD | Ground Elev.: 723.9

Shelby Tube | Standard Split Spoon | Core Sample | Auger Probe | Water Level Upon Completion 30.0 ft.

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-11		WOH/12"-2	100%			-very soft, high plasticity, trace sand and rock fragments, very moist PP=1.0 tsf				
45.0	S-12		WOH/18"	100%			-very soft, little sand and rock fragments, very moist PP=1.0 tsf				
						46.5	-RESIDUUM-				677.4
							-BORING TERMINATED AT 46.5 FEET- (Boring terminated due to a lack of additional augers)				
50.0											
55.0											
60.0											

Remarks: Boring extended 20' due to low blow counts at planned termination depth.

TRIAD ENGINEERING, INC.
200 Aviation Drive
Winchester, VA
P: 540.667.9300
F: 540.667.2260

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TEST BORING LOG

Project Number: 07-17-0167 | Project Name: Pennsylvania Avenue Pump Station | Boring No.: B-2
Logger: DJM | Boring Location: See Figure No. A-2
Date Started: 3/25/19 | Drill/Method: CME 45
Date Completed: 3/25/19 | Driller: TRIAD | Ground Elev.: 723.4

Shelby Tube | Standard Split Spoon | Core Sample | Auger Probe | Water Level Upon Completion 15.0 ft.

Depth (feet)	Sample No.	Sample Type	Blow Counts	Recovery (%)	RQD (RUN)	Strata Depth (ft)	MATERIAL DESCRIPTION	RQD (Strata)	Water Level	Graphic Log	Strata Elevation
							3" GRAVEL				
	S-1		4-4-4	78%			Tan-brown fat **CLAY**, medium stiff, medium to high plasticity, some sand and rock fragments, moist PP=4.75 tsf				
	S-2		5-5-6	94%			-stiff PP=4.75 tsf				
5.0	S-3		5-8-10	100%			-red-brown, very stiff PP=4.0 tsf				
	S-4		4-4-5	50%			-stiff PP=3.25 tsf				
10.0	S-5		2-4-12	100%			-orange-brown, stiff, trace sand and rock fragments PP=4.0 tsf				
15.0	S-6		2-1-1	89%			-tan-brown, very moist, very soft PP=1.0 tsf				
20.0	S-7		1-1-1	100%		20.0	-very soft, very moist PP=1.50 tsf				703.4

Remarks: Boring extended 5' due to low blow counts at plannedtermination depth.

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

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TEST BORING LOG

Project Number: 07-17-0167 | Project Name: Pennsylvania Avenue Pump Station | Boring No.: B-2
Logger: DJM | Boring Location: See Figure No. A-2
Date Started: 3/25/19 | Drill/Method: CME 45
Date Completed: 3/25/19 | Driller: TRIAD | Ground Elev.: 723.4

Shelby Tube | Standard Split Spoon | Core Sample | Auger Probe | Water Level Upon Completion 15.0 ft.

Depth (feet)	Sample No.	Sample Type	Blow Counts	Recovery (%)	RQD (RUN)	Strata Depth (ft)	MATERIAL DESCRIPTION	RQD (Strata)	Water Level	Graphic Log	Strata Elevation
25.0	S-8		2-2-1	100%			-soft, high plasticity, very moist PP=1.25 tsf				
30.0	S-9		10-7-2	94%			-stiff, some sand and rock fragments, very moist PP=1.50 tsf				
						31.5	-RESIDUUM-				691.9
							-BORING TERMINATED AT 31.5 FEET-				
35.0											
40.0											

Remarks: Boring extended 5' due to low blow counts at plannedtermination depth.

TRIAD ENGINEERING, INC.
200 Aviation Drive
Winchester, VA
P: 540.667.9300
F: 540.667.2260

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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 Standards as listed below:

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

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

3) A sieve analysis with washed No. 200 sieve test was performed in accordance with ASTM D 422.

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

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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	7.5-9	SS	29.7	41	23	18	T	17	83	CL			
B-1	10-11.5	SS	33.1										
B-1	15-16.5	SS	45.5										
B-1	20-21.5	SS	42.0										
B-1	25-26.5	SS	40.5										
B-2	2.5-4	SS	20.6										
B-2	5-6.5	SS	13.0										

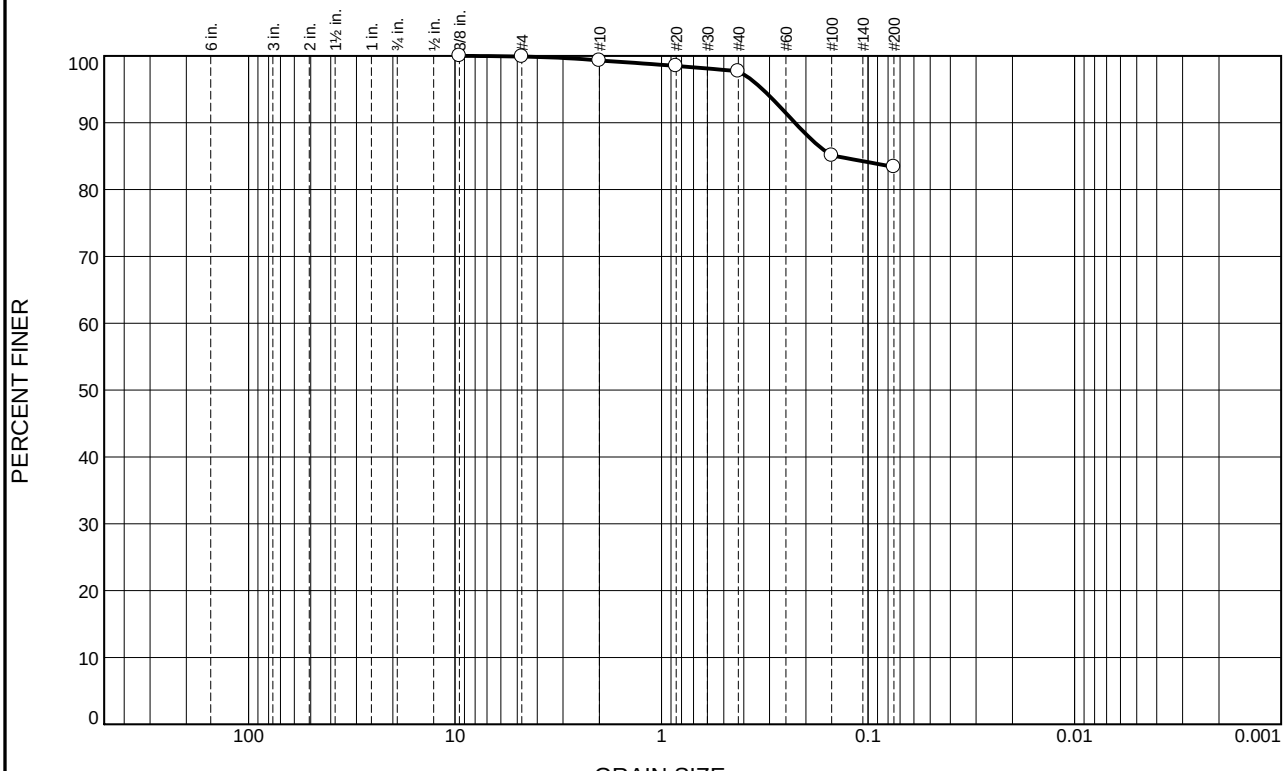
TRIAD ENGINEERING, INC.

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

PROJECT NUMBER: 07-17-0167
PROJECT NAME: Pennsylvania Avenue Pump Station
LOCATION: Winchester, VA

FIGURE C-1

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.6	1.6	14.3	83.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
#4	99.9		
#10	99.3		
#20	98.5		
#40	97.7		
#100	85.1		
#200	83.4		

* (no specification provided)

Material Description

Tan-brown lean CLAY, little sand, trace gravel

Atterberg Limits

PL= 23 LL= 41 PI= 18

Coefficients

D_{90}= 0.2261 D_{85}= 0.1440 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(15)

Remarks

Source of Sample: B-1 **Depth:** 7.5' - 11.5'

Date: 4-9-2019

Triad Engineering, Inc.

Client: Hazen and Sawyer
Project: Pennsylvania Avenue Pump Station
Winchester, VA
Project No: 07-17-0167 **Figure** C-2

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