#### VOLUME I RESOURCE REPORTS

APPENDIX 6A HDD BORING REPORT

Report of Subsurface Exploration and Geotechnical Engineering Services

Proposed Tie-in-Facility, 6493 – Eastern Panhandle Expansion, Fulton County, Pennsylvania

Prepared for

EnSiteUSA 109 Fieldview Drive, P.O. Box 1007 Versailles, KY 40383

Prepared by

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February 1, 2017

PSI Project No. 0512713

Naveen S. Thakur, P.E. Project Manager



Karl Suter, P.E. Chief Engineer



February 1, 2017

EnSiteUSA 109 Fieldview Drive P.O. Box 1007 Versailles, KY 40383

Attention: Jacob Shams, P.E.

Reference: Report for Geotechnical Exploration and Assessment Proposed Tie-in-Facility 6493 – Eastern Panhandle Expansion Fulton County, Pennsylvania PSI Project Number: 0512713

Dear Mr. Shams:

Thank you for choosing Professional Service Industries, Inc. (PSI) as your geotechnical consultant for the proposed Tie-in-Facility in Fulton County, Pennsylvania. This facility is planned as part of the Eastern Panhandle Expansion (Pipeline) Project.

As per your authorization, we have completed a subsurface exploration for this project. The findings of the exploration and our recommendations for the proposed development are discussed in the accompanying report. As requested, one electronic and three original hard copies of the report will be provided to you.

The soil samples obtained during this exploration will be retained in our laboratory for sixty days. Should there be any questions, please do not hesitate to contact our office. PSI would be pleased to continue providing geotechnical services throughout the implementation of the project, and we look forward to working with you and your organization on this and future projects.

Respectfully submitted, **Professional Service Industries, Inc.** 

Naveen S. Thakur Project Manager

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Karl Suter, P.E Chief Engineer

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## 1 EXECUTIVE SUMMARY

PSI has completed a subsurface exploration and geotechnical evaluation for the proposed Tie-in-Facility project in Fulton County, Pennsylvania. One soil test boring was drilled within the footprint of the proposed facility. Competent residual soils underlain by Partially Weathered Rock was encountered within the boring.

The proposed Tie-in-Facility can be supported on shallow foundations bearing on the underlying competent residual soils, provided the recommendations in this report are followed. Shallow foundations can be proportioned using a net allowable bearing pressure of 2,000 pounds per square foot (psf) bearing on compacted structural fill.

The designer should not rely solely upon the executive summary and must read and evaluate the entire contents of this report, prior to utilizing our engineering recommendations in the preparation of design and construction documents.



## 2 PROJECT INFORMATION

## 2.1 PROPOSAL AND PROJECT AUTHORIZATION

This report presents the findings and recommendations related to the geotechnical exploration program performed by Professional Service Industries, Inc. (PSI) for the proposed Tie-in-Facility in Fulton County, Pennsylvania. These services were planned and performed in general accordance with scope and services outlined in PSI Proposal No 0512-187947, dated August 17, 2016.

## 2.2 PROJECT DESCRIPTION

Initial project information was provided by Mr. Jacob Shams with EnSiteUSA. We also reviewed the RFP document titled, "Facility Geotechnical Investigation, for Eastern Panhandle Expansion, Fulton County, PA" dated July 27, 2016. The project involves the construction of a Tie-in-Facility, which will support the pipes above grade. Based on the drawings provided to us, the pipes will be supported on isolated concrete and these columns will be approximately 2 to 3 feet, above the finished grade. We anticipate very minimal cut and fill grading activities of less than 1 foot.

As of the preparation of this report, no structural loading information was provided. However, we anticipate the maximum load on the column to be less than 50 kips.

If any of the noted information is incorrect or has changed, please inform PSI so that we may review the geotechnical data and amend the recommendations presented in this report, if deemed appropriate.

## 2.3 PURPOSE AND SCOPE OF WORK

The scope of services for this study included a site reconnaissance of the project area and the assessment of subsurface conditions through field exploration and laboratory testing. The study included an assessment of the site and subsurface conditions relative to the proposed development, engineering studies and the preparation of this report. The subsurface exploration was developed to provide the following:

- Geologic review of the project site.
- Subsurface conditions encountered including pertinent soil properties including water levels and drainage.
- Soil data review and analysis as it relates to the proposed site development.
- Civil site recommendations for site preparation, placement and compaction of fill.



- Structural recommendations to support foundation and construction.
- Comments relating to observed geotechnical conditions such as soft material or groundwater which could impact development.
- Determination of the Seismic Site Class and seismic design parameters per IBC 2009 based on the SPT N-values obtained during field exploration.

The scope of our services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, groundwater, or air, on or below or around this site. Any statement in this report or on the boring logs regarding odors, colors, unusual or unexpected items or conditions are strictly for the information of our client.

PSI did not provide nor was it requested to provide any service to investigate or detect the presence of moisture, mold or other biological contaminants in or around any structure, or any service that was designed or intended to prevent or lower the risk of the occurrence of the amplification of the same. Client acknowledges that mold is ubiquitous to the environment with mold amplification occurring when building materials are impacted by moisture. Client further acknowledges that site conditions are outside of PSI's control, and that mold amplification will likely occur, or continue to occur, in the presence of moisture. As such, PSI cannot and shall not be held responsible for the occurrence or recurrence of mold amplification.

## 2.4 SUBSURFACE EXPLORATION

PSI subcontracted Connelly Drilling Inc. to provide drilling services for the exploration program at the site. PSI in the proposal, recommended for two soil test borings to be drilled for the proposed facility. However, as per the client's request, only one soil test boring designated as GO-10 was drilled to a depth of 20 feet, below the existing grade.

Our drilling subcontractor used an ATV drill rig, equipped with an automatic hammer. Standard Penetration Tests were performed at selected depths within the boring regardless of the drilling methods as detailed in ASTM D1586. The penetration resistance, in conjunction with soil classifications, provides an indication of engineering characteristics of a soil.

Soil samples recovered during the drilling operations were transported to the PSI laboratory in Fairfax, Virginia for visual classification and further evaluation. Groundwater when encountered was noted. Descriptions of the soils encountered during our subsurface exploration are provided in the attached Boring Log. Groundwater conditions, penetration resistances, and other pertinent information are also included in the Boring Log in Appendix C.



The ground surface elevation at the boring location shown on the boring log was estimated from the google earth.

Drilling and soil sampling were conducted in accordance with the procedures generally recognized and accepted as standard methods of exploration of subsurface conditions related to earthwork and foundation engineering projects at this time.

The location of the boring is shown on the Boring Location Plan, in Appendix **B**. The findings of the PSI boring are presented on the Test Boring Log also included in Appendix **C**.

## 2.5 LABORATORY TESTING

A PSI geotechnical engineer visually-manually classified the soil samples obtained for this geotechnical report in general accordance with the Unified Soil Classification System (USCS) (ASTM D2487 and D2488). Selected samples were tested for natural water content (ASTM D2216). Atterberg limits tests (ASTM D4318), grain size analyses (ASTM D6913).

The laboratory test results are presented in Appendix **D**, as well as shown on the boring log.



## 3 SITE AND SUBSURFACE CONDITIONS

## 3.1 SITE LOCATION AND DESCRIPTION

The proposed project site is located on the east side of the intersection of Green Lane Road and Ravenwood Drive in Fulton County, Pennsylvania. Based on the google earth, the existing grade within the limits of the proposed Tie-in-Facility is relatively flat and varies from EL. 580 to EL. 582 feet. The surface cover within the limits of the proposed facility consists of grass. The location of the site is shown on the Boring Location Plan attached as **Appendix B**.

## 3.2 AREA GEOLOGY

The site is geologically located in the Piedmont Physiographic Province. A study of the area geology from the available literature shows that the site is underlain by McKenzie Formation (Maryland) or Willis Creek Formation (Pennsylvania) of Silurian age. The Formation in general consists of gray, thin-bedded shale, siltstone and argillaceous limestone.

## 3.3 SUBSURFACE CONDITIONS

The stratification of the soil conditions at the actual soil test boring location is described in this section. The log of the boring is provided in Appendix C.

<u>Surface Cover:</u> At the surface, test boring encountered approximately four inches of topsoil.

<u>Residual Soils:</u> Beneath the surface cover, residual soils, described as sandy silt or silty gravel were encountered to a depth of 5 feet, below the existing grade. The consistency of the sandy silt material can be described as stiff, while the relative density of the silty gravel material can be described as medium dense. Based on the Standard Penetration Testing (SPT), the N-values of these residual soils varied from 14 to 22 blows per foot (bpf), with moisture content values varying from 16 to 19 percent. Sieve analysis and Atterberg Limits were performed within the residual soils at a depth of 2.5 feet, below the existing grade. Based on the above tests, the soil was classified as silty gravel (GM) as per USCS and exhibited a liquid limit value of 39, with plasticity index value as 13. Approximately 19 percent of the test sample passed through the No. 200 Sieve (fines).

<u>Partially Weathered Rock:</u> Beneath the residual soils, Partially Weathered Rock (PWR) was encountered to the boring termination depth. The PWR can be described as very hard, clayey gravel material. The SPT-N values of this stratum varied from 50 blows for 5 inches of penetration to 50 blows for 2 inches of penetration, with natural moisture content values varying from 2 to 9 percent. Atterberg and Sieve analysis was performed within this stratum at a depth 8.5 feet below the existing grade. Based on the test



results, the sample was classified as silty gravel with sand (GM) as per USCS with a liquid limit value of 31 and plasticity index of 12. Approximately 15 percent of the test sample passed through the No. 200 Sieve (fines).

The above subsurface description is of a generalized nature provided to highlight the major soil strata encountered. The boring logs included in the appendices should be reviewed for specific information as to individual test boring locations. The stratification lines shown on the test boring logs represent the conditions only at the actual test boring locations. The stratification lines represent the approximate boundaries between subsurface materials and the actual transition may be gradual.

## 3.4 GROUNDWATER CONDITIONS

During and upon completion of drilling, no groundwater infiltration was observed in the test boring. Water level, if any, at the test boring location is shown on the respective log provided in Appendix D.

The groundwater observations presented in this report and the attached boring log reflect those observed at the time of our field activities. We recommend that the Contractor determine the actual groundwater levels at the time of construction to determine groundwater impact on the proposed construction procedure.



## 4 GEOTECHNICAL ASSESMENT AND RECOMMENDATIONS

The following recommendations are based on the information available on the proposed construction, the data obtained from the boring, and our experience with soils and subsurface conditions similar to those encountered at this site. Because the borings represent a very small statistical sampling of the subsurface materials, conditions encountered during construction may be substantially different from those encountered in our borings. In these instances, adjustments to the design and construction may be necessary depending on the actual conditions encountered.

As indicated earlier, very minimal cut and fill (less than a foot) is anticipated within the proposed construction limits of the Tie-in-Facility. Based on the review of the test boring, competent residual soils will likely be encountered at the design foundation bearing level of the isolated columns, assumed to be below the frost penetration depth, which is 36 inches below the existing grade. Since weathered rock was shallow, it is possible that very dense weathered rock, intact rock or boulders will be encountered in foundation excavations.

Groundwater was not encountered in the boring. However, groundwater seepage or surface runoff may be encountered within the excavation and in which case, sump pumps can be used for temporary dewatering.

## 4.1 SEISMIC CONSIDERATIONS

The project site is located within a municipality that employs the International Building Code (IBC), 2009 edition. As part of this code, the design of structures must consider dynamic forces resulting from seismic events. These forces are dependent upon the magnitude of the earthquake event as well as the properties of the soils that underlie the site.

Part of the IBC code procedure to evaluate seismic forces requires the evaluation of the Seismic Site Class, which categorizes the site based upon the characteristics of the subsurface profile within the upper 100 feet of the ground surface.

To define the Seismic Site Class for this project, and in accordance with your requested level of assessment, we have interpreted the results of our soil test borings drilled within the project site per Section 1613.5 of the code. Material properties were estimated below the depth of the borings based upon data available in published geologic reports as well as our experience with subsurface conditions in the general site area.

Based upon our assessment, it is our opinion that the subsurface conditions within the areas of the site planned for building construction are consistent with the characteristics of **Site Class C** as defined in Table 1613.5.2 of the building code.



The associated IBC probabilistic ground motion values for latitude 39.723099° and longitude -78.20648° obtained from the *Java Ground Motion Parameter Calculator – Version 5.1.0* on the USGS Earthquake Hazards Program – Seismic Design for Buildings web page (http://earthquake.usgs.gov/designmaps/us/application.php) are as follows:

Table 1: Seismic Design Parameters*									
Period (seconds)	Ma F Ace	apped MCE Spectral Response celeration** (g)	Site Coefficients		Adju Sl Re Accel	sted MCE pectral sponse eration (g)	Design Spectral Response Acceleration (g)		
0.2	0.2 S <sub>s</sub> 0.129		Fa	1.2	SMs	0.155	SDs	0.103	
1.0	S <sub>1</sub>	0.053	Fv	1.7	SM <sub>1</sub>	0.091	SD <sub>1</sub>	0.060	
* 2% Probability of exceedance in 50 years. ** At B-C interface (i.e. top of bedrock). MCE= Maximum Considered Earthquake									

The Site Coefficients,  $F_a$  and  $F_v$  presented in the above table were also obtained from the USGS calculator, but can be interpolated from IBC Tables 1613.5.3(1) and 1613.5.3(2) as a function of the site classification and mapped spectral response acceleration at the short (S<sub>s</sub>) and 1 second (S<sub>1</sub>) periods.

For Seismic Design Category designations of C, D, E or F, which are contingent on the structure "Occupancy Category", the Code also requires an assessment of liquefaction, slope stability and surface rupture due to faulting or lateral spreading. Detailed evaluations of these factors were beyond the scope of this study. However, the following table presents a qualitative assessment of these issues considering the site class, the subsurface soil properties, the groundwater elevation and probabilistic ground motions.

Table 2: Seismic Hazards						
Hazard Relative Risk Comments						
Liquefaction	Low	Site soils are dense, and the seismicity is low.				
Slope Stability	Low	The site is relatively level and does not incorporate significant cut or fill slopes				
Surface Rupture	Low	The site is not underlain by a mapped Holocene-aged fault				

## 4.2 SITE PREPARATION AND EARTHWORK

We anticipate site preparation and earthwork for the proposed Tie-in-Facility to consist primarily of foundation excavation and backfilling.

• Utilities, if any, encountered within the proposed tower footprint should be removed or relocated. The utility excavations shall be backfilled and compacted as per the fill requirements provided in the subsequent paragraphs.



- All loose or wet soils or any debris encountered at the footing subgrade elevation shall be undercut and replaced with structural fill.
- Material satisfactory for structural fill may include clean soil or bankrun sand and gravel (SW, SP, SM, GW, and GM). CL, ML, GC, and SC material can be used in engineered fills, subject to the following limitations:

Maximum Dry Density (per ASTM D698)	$\geq$ 105 pcf
Liquid Limit	$\leq 40$
Plasticity Index	$\leq 20$

Organic soils and high plasticity clays and silts (CH, MH, OL, OH, PT) should not be used as engineered fill. The fill materials should be free from topsoil and debris, have less than 3 percent organics and should not contain rock fragments having a major dimension greater than 3 inches. The use of the excavated fill soils for controlled structural fill will be subject to approval of the Geotechnical Engineer of Record and moisture adjustments at the time of construction, and the plasticity and maximum dry density requirement specified in this section.

The onsite existing fill material can be reused as a structural fill provided it meets the above indicated requirements.

- Fill placement should be in loose horizontal lifts no greater than 8 inches thick compacted uniformly with the proper equipment.
- Fill required to support the footings and the slab-on-grade should be compacted to at least 98 percent of the maximum dry density as per ASTM D698 (Standard Proctor) test method. The moisture content of the fill should be within plus or minus two (±2) percentage points of the optimum moisture content.

For proper site preparation, the earthwork should be performed under the observation of and to the satisfaction of the Geotechnical Engineer of Record or his authorized representative.

It will be important to maintain positive site drainage during construction. Stormwater runoff should be diverted around the excavated areas. The site should be graded at all times such that water is not allowed to pond. If any surface soils become wet due to rains, they should be removed or dried prior to further site work operations and/or fill placement.



## 4.3 FOUNDATION DISCUSSION

Our recommendations for subsurface preparation for foundation support are detailed in the following sections.

#### 4.3.1 GENERAL SHALLOW FOUNDATION RECOMMENDATIONS

The isolated columns for the pipes of Tie-in-Facility can be supported on isolated spread foundations bearing on the underlying competent residual soils. The bottom of the column foundations should be below the frost penetration depth, which is assumed to be 36 inches, below the existing grade.

Spread foundations can be proportioned using a net allowable soil bearing pressure of 2,000 pounds per square foot (psf). Utilizing this allowable bearing pressure, we estimated the total settlement to be less than 1 inch with differential settlement being less than ½ inch over a horizontal distance of 25 feet. Column footings should have minimum widths of 24 inches, regardless of the actual bearing pressure.

Because of possible variations in subsurface conditions and related bearing capacity, all footing excavations and trenches should be observed and approved by the Geotechnical Engineer of Record or his qualified representative. Water and possibly some loose soil may collect in the footing excavations as a result of surface precipitation and near ground surface seepage. Therefore:

- Water, loose soil and soil softened by water should be removed from the bottom of the footing excavations before placing concrete.
- Footing excavations should not be left open for long periods. If the concrete cannot be placed due to inclement weather conditions or any other unforeseen circumstances, the bottom of the footing excavations and trenches should be protected by undercutting 3 inches and placing a 3-inch thick lean-mix concrete (2,000 psi) work mat immediately upon approval and before reinforcing steel is placed.

Where unsuitable bearing conditions are encountered as determined by the PSI Geotechnical Engineer or designated representative, these soils should be undercut and replaced with controlled structural fill. If backfilled up to the design bearing elevation, the over-excavation should extend laterally from all foundation edges a minimum of one half the depth of the undercut. The backfill should consist of the materials described earlier in this section. If the overexcavation is filled with concrete or flowable fill, the widening of the excavation will not be required.

Backfill around and above the footing should satisfy the controlled fill requirements described in Section 4.1 'Site Preparation and Earthwork'.



## 4.4 CONSTRUCTION DEWATERING

During our investigation, no groundwater was encountered in the test boring. As such, groundwater may not be encountered during the foundation excavation. However, additional water may be introduced into excavations due to surface runoff, temporary perched water and local precipitation during construction. Our past experience indicates that the foundation and subgrade bearing soils encountered on-site will soften considerably when exposed to free water. The contractor should keep excavations dry to prevent the softening of these materials. Methods such as sloping, ditching, and berming should be used to control surface water at the site.

Groundwater at this site can be handled by using sump pumps and pits may be utilized to direct and remove the water both during and after construction.

For the purposes of managing water that may enter an excavation, we recommend that collection pits with pumps be used to remove the water from the excavation. The sump pits should be backfilled with open graded stone (AASHTO #57 recommended) and should be surrounded by a properly graded filter medium. The purpose of the filter medium is to prevent clogging of the drainage system by the infiltration of fine-grained soils.

Pumping from the sump pits should be done with care to prevent the loss of soil fines, development of soil boils, or instability of slopes. We must emphasize that dewatering requirements will be dictated by groundwater conditions at the time of construction and may require more aggressive techniques than pumping from a sump pit. The contractor should use a technique or combination of techniques which achieve the desired results under actual field conditions.



## 5 CONSTRUCTION CONSIDERATIONS

To assess that the in-situ soil conditions or those conditions developed during the construction are as anticipated during the design stage, construction control, continuous observation and testing are recommended as follows:

- Structural fill placement, if any, should be monitored by a qualified soils technician working under the supervision of the geotechnical engineer of record.
- All footing excavations should be carried out under the observation of the geotechnical engineer of record or authorized representative.

## 5.1 EXCAVATION AND SAFETY

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, Part 1926, Subpart P". This document was issued to better allow for the safety of workers entering trenches or excavations. It is mandated by this federal regulation that excavations, whether they be utility trenches, basement excavations or footing excavations, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the Contractor could be liable for substantial penalties.

The Contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The Contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the Contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in all local, state, and federal safety regulations.

We are providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the Contractor's or other parties' compliance with local, state, and federal safety or other regulations.



## 6 RECOMMENDED ADDITIONAL SERVICES

Additional foundation engineering, testing, and consulting services recommended for this project are summarized below:

- Footing Evaluations: It is recommended that footing for this project be evaluated by PSI. The purpose of these evaluations will be to verify that the design soil bearing pressure is available and that subgrade areas are properly prepared.
- Earthwork & Compaction Testing: It is recommended that an experienced engineering technician witness the required filling operations and take sufficient in-place density tests to verify that the specified degree of compaction has been achieved. Soil engineering judgments will be involved and should be made by the geotechnical engineer of record with information provided by the engineering technician.
- Soils Laboratory Testing: Testing to aid in the classification and verification of use of the on-site soils for structural fill and/or embankment material should be performed by PSI. Testing includes, but is not limited to, Atterberg Limits, Grain Size Analysis, California Bearing Ratio, Standard Moisture Density Relationship, and Moisture Content.



## 7 REPORT LIMITATIONS

The recommendations submitted in this report are based upon the available subsurface information obtained by PSI and design details furnished by **EnSiteUSA** for the proposed project. If there are any revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine whether the recommendations provided herein must be changed. If PSI is not retained to perform these functions, we will not be responsible for the impact of those conditions on the geotechnical recommendations for the project.

PSI warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area at the date of this report. No other warranties are implied or expressed.

No entity can be as familiar with the design concepts inherent in these recommendations as PSI. Accordingly, only observations by PSI can permit PSI to finalize its recommendations and enhance the likelihood of the design concept being adequately considered during implementation of its recommendations.

After the plans and specifications are more complete, PSI should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use of **EnSiteUSA** and its clients for the specific application to construction of the proposed **Tie-in-Facility Project**, located in Fulton County, Pennsylvania.

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# APPENDIX A: IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL REPORT

# Important Information about Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

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

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

#### **Read the Full Report**

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

#### A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

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

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

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

 the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,

- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

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

#### **Subsurface Conditions Can Change**

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

#### Most Geotechnical Findings Are Professional Opinions

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

### A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

#### A Geotechnical Engineering Report Is Subject to Misinterpretation

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

#### **Do Not Redraw the Engineer's Logs**

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.* 

#### Give Contractors a Complete Report and Guidance

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

#### **Read Responsibility Provisions Closely**

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that

have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

#### **Geoenvironmental Concerns Are Not Covered**

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

#### **Obtain Professional Assistance To Deal with Mold**

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

#### Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/THE BEST PEOPLE ON EARTH exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.



8811 Colesville Road/Suite G106, Silver Spring, MD 20910 Telephone: 301/565-2733 Facsimile: 301/589-2017 e-mail: info@aste.org www.aste.org

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## **APPENDIX B – VICINITY MAP AND BORING LOCATION PLAN**



LEGEND:

B-1 - PROPOSED BORING (10 FT) - BORING DEPTH

NOTES:

1. ALL BORINGS WILL BE ADVANCED WITH HOLLOW-STEM AUGERS.

2. SPT SAMPLING WILL BE PERFORMED IN ALL BORINGS.

3. BORING DEPTHS ARE AS SHOWN

4. BORING SPOILS WILL USED TO BACKFILL THE BORE HOLES.



BORING LOCATION PLA PROPOSED TIE-IN FACIL

FULTON COUNTY, PA

N.T.

N.T.S.

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	REVISIONS
AN	
JTY	
	FEBRUARY 1, 2017
	0512-715

#### **APPENDIX C: BORING LOGS**

				12/21/16			DRILL COMPANY: Connelly Drilling, Inc.						BORING GO-10					
COMPLETION DEPTH				<u>12/21/16</u> 20.0 ft			DRILLER: Josh Lewis LOGGED BY: Philip Daute						► V While Drilling Dry feet					
BENC		RK:		-		N/A	ι <u> </u>	DRILLING METHOD: Hollow Stem Auger					ate	L Upo	n Com	pletion	Dry feet	
ELEV	ATION	l:			58	31 ft		SAMPLING METHOD:2-in SS1.874-in Core Standard					Dela	ay		N/A feet		
LATITUDE: <u>39.723074°</u>					HAMMER TY	/PE:	A	utoma	itic		BORIN	G LOCA	ATION:					
LONG	LONGITUDE: 78.206551°				EFFICIENCY			N/A										
	ION:_	N	J/A		OFFS	SET:	N/A	REVIEWED E	BY:	Lubor	nir Pey	/tchev						
												ΩŶ		STAN			ΔΤΙΟΝ	
Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)		MATEF	RIAL DESC	RIPTION		USCS Classification	T Blows per 6-inch (S 2D & Recovery % (N	Moisture, %		TEST N in blo Moisture	DATA ws/ft © P 25 GTH, tsf	PL LL 50	Additional Remarks
												SP- RG			Qu	*	Qp	
580-	- 0 - 	· · · · · · · · · · · · · · · · · · ·		1	18	Appro Stiff, r <b>ML)</b> so	ximately 4 noist, light ome gravel	inches of Tops brown <b>sandy</b> , roots.	soil SILT (USCS	5	Top Soil ML	3-6-8 N=14	16		R		4.0	
				2	14	GRAV shale	m dense, r /EL (USCS fragments.	noist, light bro GM) with sand Residuum	wn <b>silty</b> d, trace		GM	3-8-14 N=22	19				•	LL = 39 PL = 26 Fines=19.3%
575—	- 5 -  			3	2	Weath sampl brown <b>sand</b> , Forma	nered Rock ed as very clayey G Silurian [B ation]	, SHALE and I hard, moist, re <b>RAVEL (USC</b> loomsburg and	LIMESTONI ed, dark <b>S GC) with</b> d Mufflintow	E, /n		50/2"	2	×			>>@	)
570-	 - 10 - 		X	4	10							7-50/5"	9	×		•	>>@	LL = 31 PL = 19 Fines=15.7%
											тисс							
			X	5	3					VVEF S	HALE	50/3"	9	×			>>@	٥
565—	- 15 - 																	
	  - 20 -		X	6	2							50/2"	4	×			>>@	<b>)</b>
	20					Bottor	n of test bo	ring at 20 feet	dustries	Inc		PI					051271	3-1
	F			J	]	293 Fai Tel	80 Eskrid rfax, VA ephone:	ge Rd 22031 (703) 698-	9300			PI L(	ROJE	CT: _	 6493-Еа Р	astern F otomac Washi Ha	Panhano c River ( ington C ncock, I	C I Crossing County MD



## **GENERAL NOTES**

#### SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

#### DRILLING AND SAMPLING SYMBOLS

- SFA: Solid Flight Auger typically 4" diameter flights, except where noted.
- HSA: Hollow Stem Auger typically 3<sup>1</sup>/<sub>4</sub>" or 4<sup>1</sup>/<sub>4</sub> l.D. openings, except where noted.
- M.R.: Mud Rotary Uses a rotary head with Bentonite or Polymer Slurry
- R.C.: Diamond Bit Core Sampler
- H.A.: Hand Auger
- P.A.: Power Auger Handheld motorized auger

#### SOIL PROPERTY SYMBOLS

- SS: Split-Spoon 1 3/8" I.D., 2" O.D., except where noted.
  - ST: Shelby Tube 3" O.D., except where noted.
- RC: Rock Core
- TC: Texas Cone
- 🕅 BS: Bulk Sample
- PM: Pressuremeter
- CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings
- N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
- N<sub>60</sub>: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
- Q<sub>u</sub>: Unconfined compressive strength, TSF
- Q.: Pocket penetrometer value, unconfined compressive strength, TSF
- w%: Moisture/water content, %
- LL: Liquid Limit, %
- PL: Plastic Limit, %
- PI: Plasticity Index = (LL-PL),%
- DD: Dry unit weight, pcf
- ▼,,,, Ž, Ž Apparent groundwater level at time noted

#### RELATIVE DENSITY OF COARSE-GRAINED SOILS ANGULARITY OF COARSE-GRAINED PARTICLES

Relative Density	N - Blows/foot	Description	Criteria
Very Loose	0 - 4	Angular	Particles have sharp edges and relatively plane sides with uppolished surfaces
Loose Medium Dense	4 - 10 10 - 30	Subangular:	Particles are similar to angular description, but have
Dense Verv Dense	30 - 50 50 - 80	Subrounded:	Particles have nearly plane sides, but have
Extremely Dense	80+	Rounded:	well-rounded corners and edges Particles have smoothly curved sides and no edges

#### **GRAIN-SIZE TERMINOLOGY**

#### PARTICLE SHAPE

Modifier:

>12%

Component	Size Range	<u>Description</u>	Criteria
Boulders:	Over 300 mm (>12 in.)	Flat:	Particles with width/thickness ratio > 3
Cobbles:	75 mm to 300 mm (3 in. to 12 in.)	Elongated:	Particles with length/width ratio > 3
Coarse-Grained Gravel:	19 mm to 75 mm (¾ in. to 3 in.)	Flat & Elongated:	Particles meet criteria for both flat and
Fine-Grained Gravel:	4.75 mm to 19 mm (No.4 to 3/4 in.)		elongated
Coarse-Grained Sand:	2 mm to 4.75 mm (No.10 to No.4)		
Medium-Grained Sand:	0.42 mm to 2 mm (No.40 to No.10)	RELATIVE	PROPORTIONS OF FINES
Fine-Grained Sand:	0.075 mm to 0.42 mm (No. 200 to No.	40) Descripti	ve Term % Dry Weight
Silt:	0.005 mm to 0.075 mm		Trace: < 5%
Clay:	<0.005 mm		With: 5% to 12%

Page 1 of 2



## **GENERAL NOTES**

(Continued)

#### **CONSISTENCY OF FINE-GRAINED SOILS**

<u>Q<sub>U</sub> - TSF</u>	<u>N - Blows/foot</u>	Consistency
0 - 0.25	0 - 2	Very Soft
0.25 - 0.50	2 - 4	Soft
0.50 - 1.00	4 - 8	Firm (Medium Stiff)
1.00 - 2.00	8 - 15	Stiff
2.00 - 4.00	15 - 30	Very Stiff
4.00 - 8.00	30 - 50	Hard
8.00+	50+	Very Hard

#### **MOISTURE CONDITION DESCRIPTION**

<b>Description</b>	Criteria
Dry:	Absence of moisture, dusty, dry to the touch
Moist:	Damp but no visible water
Wet:	Visible free water, usually soil is below water table

#### **RELATIVE PROPORTIONS OF SAND AND GRAVEL**

Descriptive Term% Dry WeightTrace:< 15%</td>With:15% to 30%Modifier:>30%

#### STRUCTURE DESCRIPTION

<b>Description</b>	Criteria	<b>Description</b>	Criteria
Stratified:	Alternating layers of varying material or color with	n Blocky:	Cohesive soil that can be broken down into small
	layers at least ¼-inch (6 mm) thick		angular lumps which resist further breakdown
Laminated:	Alternating layers of varying material or color with	n Lensed:	Inclusion of small pockets of different soils
	layers less than ¼-inch (6 mm) thick	Layer:	Inclusion greater than 3 inches thick (75 mm)
Fissured:	Breaks along definite planes of fracture with little	Seam:	Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick
	resistance to fracturing		extending through the sample
Slickensided:	Fracture planes appear polished or glossy, sometimes striated	Parting:	Inclusion less than 1/8-inch (3 mm) thick

#### SCALE OF RELATIVE ROCK HARDNESS

<u>Q<sub>U</sub> - TSF</u>	<u>Consistency</u>
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
,050 - 2,600	Hard
>2,600	Very Hard

#### **ROCK VOIDS**

<u>Voids</u>	Void Diameter
Pit	<6 mm (<0.25 in)
Vug	6 mm to 50 mm (0.25 in to 2 in)
Cavity	50 mm to 600 mm (2 in to 24 in)
Cave	>600 mm (>24 in)

#### **ROCK QUALITY DESCRIPTION**

Rock Mass Description	RQD Value
Excellent	90 -100
Good	75 - 90
Fair	50 - 75
Poor	25 -50
Very Poor	Less than 25

#### **ROCK BEDDING THICKNESSES**

<b>Description</b>	Criteria
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	<sup>1</sup> / <sub>2</sub> -inch to 1 <sup>1</sup> / <sub>4</sub> -inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to 1/2-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

#### **GRAIN-SIZED TERMINOLOGY**

(Typically Sedi <u>Component</u>	mentary Rock) <u>Size Range</u>		
Very Coarse Grained	>4.76 mm		
Coarse Grained	2.0 mm - 4.76 mm		
Medium Grained	0.42 mm - 2.0 mm		
Fine Grained	0.075 mm - 0.42 mm		
Very Fine Grained	<0.075 mm		

#### **DEGREE OF WEATHERING**

Slightly Weathered: Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.
 Weathered: Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.
 Highly Weathered: Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

## SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS		SYMBOLS		TYPICAL	
		GRAPH	LETTER	DESCRIPTIONS	
	GRAVEL AND	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
GI	GRAVELLY SOILS	(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
COARSE GRAINED SOILS	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50%	MORE THAN 50% AND	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
LARGER THAN NO. 200 SIEVE SIZE SOILS	SANDY SOILS	(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
FRACTION PASSING ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES	
		LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
FINE SILTS AND GRAINED CLAYS SOILS			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE SILTS AND CLAYS			МН	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS	
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		СН	INORGANIC CLAYS OF HIGH PLASTICITY
				ОН	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS	


### APPENDIX D: LABORATORY TESTING RESULTS







July 12, 2016 Revised August 15, 2016

EnSite USA, Inc. 109 Fieldview Drive Versailles, KY, 40383 Attn: Grace Northcutt, P.E.

Re: Draft Report for Geotechnical Subsurface Exploration & Engineering Services 6493 – Eastern Panhandle Expansion I-68 Crossing, Preliminary Investigation Washington County, Maryland PSI Project Number 0512719-1

Dear Ms. Northcutt:

Thank you for choosing Professional Service Industries, Inc. (PSI) as your consultant for the referenced project. Authorization to perform services was provided through PSI Proposal No. 0512-182516 dated June 21, 2016. The proposal was executed by Ms. Northcutt, P.E. representing EnSite USA, Inc.

This letter report presents the results of borings performed by PSI at five locations along the proposed HDD alignment at I-68 Crossing. Approximate boring locations are presented in the Appendix, Sections 1A: Site Plan and 1B: Boring Location Plans.

#### Scope of Services

PSI's services consisted of field exploration, laboratory testing, and preparation of a geotechnical engineering report for the proposed HDD location. Field work included drilling 2 test borings (Borings GO-4, and GO-5) utilizing hollow-stem (HSA) auger drilling, wash rotary drilling, and rock coring in conformance with ASTM standards.

Laboratory testing included unit weight, moisture content, Atterberg limits, grain size distribution tests, pH and resistivity testing, unconfined compressive strength and slake durability testing. All tests were performed in with ASTM standards.

#### Summary of Field Exploration and Laboratory Testing

The borings were completed with a track-mounted drill rig with hollow-stem augers in conformance with ASTM standards. Standard Penetration Testing (SPT) and split-spoon sampling of overburden soils was performed at 2.5 foot intervals for the first 10 feet and at 5-foot intervals thereafter to the termination depths to evaluate the strength and relative consistency of the soils encountered. Below auger refusal depth, rock coring was performed using NQ coring equipment. All recovered soil and rock samples were visually classified by a PSI geotechnical engineer and a graphical log developed for each boring. Boring depths and depths at which auger refusal were encountered are summarized in Table 1 below.

Table 1 – Summary of E	Boring Depths
------------------------	---------------

Boring	Approximate Termination Depth (feet)	Ground Surface Elevation (feet, NAVD)	Approximate Depth/Elevation of Top of Weathered Rock	Approximate Depth/Elevation of Auger Refusal
GO-4	60	435	7 feet, EL ±428 MSL	10 feet, EL ±425 MSL
GO-5	70	447	8.5 feet, EL ±438.5 MSL	13.5 feet, EL ±433.5 MSL

The Boring Logs included in the Appendix approximate depths and visual descriptions of overburden soil and underlying rock materials encountered, soil SPT test results, rock core recovery and quality designation (RQD) values, and measurements of groundwater where encountered. The total length of recovered rock core, divided by the length of the run, is referred to as rock core recovery, and is expressed as a percentage. The Rock Quality Designation (RQD) is a measure of the rock mass quality, and is defined as the total length of sound, intact rock core pieces 4 inches or more in length, divided by the length of the rock core run, also expressed as a percentage. The rock core recovery and RQD values are indicated on the Boring Logs included with this report.

#### **Geotechnical Investigation Results**

A brief summary of subsurface stratigraphies as encountered at the various borings are presented as follows:

<u>Surficial Materials</u>: Approximately 3 inches of surficial topsoil were encountered at the ground surface of Borings GO-4 and GO-5.

<u>Alluvium with shallow tilled surface (10 to 12 inches)</u> with thickness from 2 feet to 5 feet consisting of soft to medium stiff lean clay (Unified Classification CL) and loose to dense clayey sand (SC)

<u>Residuum:</u> Residual soil classified as clayey SAND (SC) was encountered to depths ranging from approximately 7 to 8.5 feet below existing surface grades at both borings. The residual soil was between 3.5 to 5 feet thick at the boring locations. Standard Penetration Test (SPT) N-values in this layer ranged from approximately 17 to 34 blows per foot (BPF).

<u>Weathered Rock:</u> Typically consisting of weathered shale, weathered rock was encountered at both boring locations. The weathered rock samples consisted of soft shale with Limestone floaters. SPT N-values were typically in excess of 50 blows per foot. Auger refusal was encountered within the weathered rock at depths ranging from approximately 7 to 8.5 feet below existing grades.

<u>Bedrock:</u> Bedrock materials encountered below the auger refusal depths consisted primarily of cyclic sequences of Limestone and shale, with occasional layers of sandy shale and sandstone. Voids were not encountered in the borings. Core recoveries ranged from 33 to 100 percent. RQD values ranged from 0 to 97 percent.

The above subsurface descriptions are of a generalized nature provided to highlight the major



strata encountered. The boring logs included in the Appendix should be reviewed for specific information as to individual boring locations. The stratification lines shown on the boring logs represent the conditions only at the actual boring locations. The stratification lines represent the approximate boundaries between subsurface materials and the actual transition may be gradual.

		Sample		Moisture	A	tterberg L	imits.	Grain-S	ize Distri	bution				
Boring	Sample No.	Depth (feet)	USCS Classification <sup>(1)</sup>	Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Gravel (%)	Sand (%)	Fines (%)				
GO-4	S-1	0.0 – 1.5	CL	CL 19 35		5 21 14		35 21 14		35 21 14		0.6	21.5	77.9
GO-4	S-2	2.5 – 4.0		9										
GO-4	S-3	5.0 – 6.5	SC	28.1	51.8	20.1								
GO-4	S-4	S-4 7.0 – 7.3		2										
GO-5	S-1	0.0 – 1.5	SC	22	45	26	19	12.3	58.3	29.4				
GO-5	S-2	2.5 – 4.0		41										
GO-5	S-3	5.0 – 6.5	SC	21	41 25 16			14.8	61.2	23.9				
GO-5	S-4	8.5 – 8.9		4										
GO-5	S-5	9.5 – 9.8		5										
GO-5	S-6	13.5 – 13.8		3										
(1)	For USCS	Soil Classifica	ation definitions, re	fer to the C	General N	lotes in At	tachment							

 Table 2 – Classification and Strength of Overburden Soil Test Results

Table 3 – Elevation, Rock Recovery and RQD Test Results

Boring	Depth (feet)	Elevation (feet)	Run Length (feet)	Recovery (%)	RQD (%)
GO-4	7.0 – 10.0	428 - 425	3	37	0
GO-4	10.0 – 15.0	425 - 420	5	83	10
GO-4	15.0 – 20.0	420 – 415	5	100	66
GO-4	20.0 - 25.0	415 – 410	5	100	80
GO-4	25.0 - 30.0	410 – 405	5	100	80
GO-4	30.0 - 35.0	405 – 400	5	100	75
GO-4	35.0 - 40.0	400 – 395	5	97	66
GO-4	40.0 - 45.0	395 – 390	5	100	80
GO-4	45.0 - 50.0	390 – 385	5	83	0



Boring	Depth (feet)	Elevation (feet)	Run Length (feet)	Recovery (%)	RQD (%)
GO-4	50.0 - 55.0	385 - 380	5	100	86
GO-4	55.0 - 60.0	380 – 375	5	98	86
GO-5	13.5 – 15.0	433.5 – 432.0	1.5	100	61
GO-5	15.0 – 20.0	432 - 427	5	100	80
GO-5	20.0 – 25.0	427 – 422	5	100	68
GO-5	25.0 - 30.0	422 – 417	5	100	95
GO-5	30.0 - 35.0	417 - 412	5	100	57
GO-5	35.0 - 40.0	412 - 407	5	100	93
GO-5	40.0 - 45.0	407 - 402	5	100	83
GO-5	45.0 - 50.0	402 - 397	5	100	97
GO-5	50.0 - 55.0	397 - 392	5	100	67
GO-5	55.0 - 60.0	392 - 387	5	100	90
GO-5	60.0 - 65.0	387 - 382	5	100	93
GO-5	65.0 - 70.0	382 - 377	5	100	93

Table 4 – Rock Unconfined Compressive Strength Test Results

Boring	Approximate Sample Depth	Rock	Unit Weight	Uncor Compressiv	nfined /e Strength
	(feet)	Classification	(pcf)	(psi)	(tsf)
GO-4	36.0-36.5	Shale	173.96	2140	154.1
GO-4	57.0-57.5	Shale	170.49	2100	151.2
GO-5	21.5-22.0	Shale	170.61	4680	337.0
GO-5	45.5-46.0	Shale	169.67	1500	108.0
GO-5	55.6-56.0	Shale	163.74	3230	232.6



Boring	Approximate Sample Depth (feet)	Rock Classification	Slake Durability Index First Cycle (%)	Slake Durability Index Second Cycle (%)
GO-4	38.5 – 39.0	Shale	99.4	98.4
GO-4	54.0 - 54.5	Shale	99.5	98.9
GO-5	22.0 - 22.6	Shale	99.3	98.8
GO-5	44.0 - 44.5	Shale	99.7	99.5
GO-5	64.5 - 65.0	Shale	99.5	99.0

Table 5 – Slake Durability Test Results

One (1) representative soil sample was selected by PSI for soil resistivity testing. Table 6 below presents a summary of the test results. A detailed report is included in the Appendix.

#### Table 6 - Soil Resistivity Test Results

Boring No.	GO-4
Depth	1.0' – 5.0'
pH - AASHTO T289	5.8
Soil Resistivity – AASHTO T-288	8950 Ohm-cm

Should there be any questions, please do not hesitate to contact our office at (703) 698-9300. PSI would be pleased to continue providing geotechnical services throughout the implementation of the project, and we look forward to working with you on this and future projects.

Respectfully submitted, *PROFESSIONAL SERVICE INDUSTRIES, INC.* 

dubonine Stepfclew

Lubomir D. Peytchev, P.E. Senior Geotechnical Engineer

Nan

Naseer Nayeem, P.E. Vice President/Principal Consultant



## Appendix:

Figure 1A Site Vicinity Map and Figure 1B – Boring Location Plan Boring Logs and General Notes Cross Section Showing the General Stratigraphy Laboratory Test Results Slake Durability Test Results Soil Resistivity Test Results Important Information About Your Geotechnical Report



Figure 1A Site Vicinity Map and Figure 1B – Boring Location Plan







REVISIONS	
FION PLAN	
JUNE 29, 2016	
0512-713	

Boring Logs and General Notes



DATE	STAF	RTED:			6	6/23/16		Conr	nelly Dr	illing, Inc.	_		BC	DRIN	G (	GO-4
		PLE II	ED: EPT	н		6/23/16 60.0 ft	DRILLER: Tom Chew DRILL RIG:	_ LOGO Died	rich D-	<b>r:<u>J. Thonnte</u> 50</b>	end I	ŗ	⊠ Whi	le Drillir	ng	Dry feet
BENC		RK:				N/A	DRILLING METHOD:	Ho	llow St	em Auger	_	ate	– Vpo	n Comp	oletion	Dry feet
ELEV	ATIO	N:			43	35 ft	SAMPLING METHOD:2	2-in SS	1.874-ii	n Core Stan	dard	3	Dela	ау		N/A feet
LATI	UDE:				39.709	9278°	HAMMER TYPE:		Automa	atic		BORIN	IG LOCA	ATION:		
LONG	SITUD	E:			78.20	84611°	EFFICIENCY		N/A							
	ION:	N	I/A			SET: <u>N/A</u>	REVIEWED BY:	Lubo	mir Pe	ytchev						
					<u> </u>					ο Q		ST A				
<u> </u>					(sc				5	N) (N)			TEST	DATA		
feet	set)	DO-	ype	ġ	che				îcati	ry %	%		N in blo	ws/ft ⊚		
) uc	, (fe	lic L	e T	le N	y (in	MATE	RIAL DESCRIPTION	N	assif	Der 6 Ovel	ure,	×	Moisture		PL LL	Additional
vati	epth	rapt	dm	amp	Ver				S CI	Rec	Aoist	0	2	25	50	Remarks
Ele	ă	U U	ŝ	S	l cc				lsc	en de la constante de la const	2		STRENG	GTH, tsf		
										RQR			Qu	Ж	Qp	
	- 0 -		М		40	Approximately 3	inches of Topsoil		Top /	101		0	2	.0	4.0	LL = 35
			Д	1	18	Soft to medium s	stiff, moist, brown, sandy	/	Soil	N=7	19		╲╨	+		PL = 21 Fines=77.9%
							Some gravel, roots	s. [		1	0					11103-11.570
			М	2	18	Dense to mediur	n dense, moist, brown, o	live	~~~	11-18-16 N=34	9		`			
430-	- 5 -					SC) some grave	I, trace shale fragments.		SC				<b> </b> ,			
			X	3	18	Residuum	_			4-10-11	9	×	: ⊿∽	+		LL = 29 PL = 17
			X	4	3	Weathered Rock	k, gray, dark gray, soft Sl TONE, Silurian (Wills Cro	HALE		50/3"	4	×			>>@	Fines=20.1%
			IH	5	12	Shale and Bloom	sburg Formation]	CON WE	ATHEF SHALE	RQD=0						
425_				•						Rec=37%						
425-						Interbedded, slig	htly weathered, medium	fino								
						grained to mediu	im grained, soft SHALE a	and	Shale							
		E	1	6	50	hard LIMESTON	E, dip of 35 degrees, (R Vills Creek Shale and	QD = I i	and mestor	RQD=10						
						Bloomsburg For	mation]									
420-	- 15 -		H			Interbedded, slig	htly weathered, medium			-						
						bedded to thin be	edded, gray, dark gray , t im grained, soft SHALE ;	fine and	Shale							
				7	60	hard LIMESTON	E, dip of 50 degrees, (R	QD =	and	RQD=66						
		Ē				Bloomsburg For	Vills Creek Shale and mation	LI	mesto	<b>Heec=100%</b>						
415-	- 20 -					Interbedded slig	htly weathered medium			-						
						bedded to thin be	edded, gray, dark gray , t	fine								
			1	8	60	hard LIMESTON	IM grained, soπ SHALE a	and QD =		RQD=80						
			1			80 %) Silurian [V	Vills Creek Shale and		<u> </u>	Rec=100%						
410-	- 25 -					BIODITISDUIG FOIL	nationj		and				_			
		Ē						Li	mesto	he						
				q	60					ROD=80						
				Ũ						Rec=100%						
405-		ËĿ														
405-	_ 30 -					Interbedded, slig	htly weathered, medium	nd								
						gray, fine graine	ed to medium grained, ha	ard								
			1	10	60	LIMESTONE and	d soft SHALE, dip of 40 of 75 % and 66 %) Siluria	n		RQD=75 Rec=100%						
			1			[Wills Creek Sha	le and Bloomsburg	al I	Shale							
400-	- 35 -					Formation]		1 :	and							
		ĒE	1					LI	mesto	le						
				11	58					RQD=66						
										Rec=97%						
395-	- 40 -	Ē	IJ				Continued Next Dags			-						
		I							l							
					57	2930 Febrid	ii Service Industries Ige Rd	, INC.		PR			).: 6403-⊑∕	( astern D	<u>151271</u> anhar/	9-1 Ne Expansion
		75	5		;/	Fairfax, VA	22031			LC	CAT	ION:	<u></u>	I-68 H	DD Cro	ssing
📕					"	Telephone:	(703) 698-9300							Washi	ngton C	County
														Har	icock, I	MD

DATE COMPLETED:       02216       DBILLER: Ton Chew. LOGGED BYJ. Thordnedt         DENDECONFLICTION:       VINIA       DBILLING METHOD:       Holdwissen Auger         DENDECONFLICTION:       307020773       SAMELING METHOD:       Holdwissen Auger         LATITUDE:       307020773       MARKET VPE:       Automate         VINIA       0PFSET:       NA       REVIEWED BY       Latomate         MARKET VPE:       Automate       MA       REVIEWED BY       Latomate         MARKET VPE:       Automate       MA       REVIEWED BY       Latomate         MARKET VPE:       MA       REVIEWED BY       Latomate       MARKET VPE:         MARKET VPE:       MA       REVIEWED BY       Latomate       MARKET VPE:         MARKET VPE:       MA       REVIEWED BY       Latomate       MARKET VPE:         MARKET VPE:       MARKET VPE:       Automate       MARKET VPE:       MARKET VPE:         MARKET VPE:       MARKET VPE:       Automate       MARKET VPE:       MARKET VPE:         MARKET VPE:       MARKET VPE:       Automate       MARKET VPE:       MARKET VPE:         MARKET VPE:       MARKET VPE:       MARKET VPE:       MARKET VPE:       MARKET VPE:         MARKET VPE:       MARKET VPE:	DATE	STAF	RTED:			6	6/23/16	DRILL COMPANY:	Conr	nelly Dr	illing, Inc.				BC	RIN	IG (	30-4
Definition user in the body of the	DATE			ED:	—		6/23/16	DRILLER: Tom Chew	LOG	GED B	<b>1:</b> <u>J. Thonn</u>	fend			Whi	Drilli		Dry feet
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385       50       granied to medium grained; soft SHALE and hard LMRSTONE; dip of Softgress, (ROD 9%) Slurian [Wills Creek Shale and Bloomsburg Formation]       Entrebedded; sliphly weathered; medium hedded to this bedded; gray; disk gray; fine grained to medium grained; soft SHALE and hard LMRSTONE; dip of 45 degress, (ROD=86 Rec=100%)       ROD=86 Rec=100%         380       55       59         15       59       ROD=86 Rec=98%       ROD=86 Rec=98%         375       60       To feessional Service Industries, Inc. 2305 Eskridge Rd Earlaw, VA 22031 Telephone; (703) 698-9300       PROJECT NO:012719-1 PROJECT NO:0			Ē				bedded to thin be	edded, gray, dark gray,	fine									
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380       30       14       60       Interbedded, sightly weathered, medium pained, soft SHALE and hard LIMESTONE, dip of 36 degrees, (ROD = 86 %) Siturian (Wills Creek Shale and Biomsburg Formation)       ROD=86 Rec=100% Shale and Limestone         380       55       60       15       59         375       60       15       59       RoD=86 Rec=86%         Bottom of test boring at 60 feet       Image: Shale and Limestone       RoD=86 Rec=86%         Professional Service Industries, Inc. 2930 Eskridge Rd Fair(X, VA 22031)       Professional Service Industries, Inc. 2930 Eskridge Rd Fair(X, VA 22031)         Telephone: (703) 698-9300       Image: Comparison of the	005						Bloomsburg For	mation]										
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2930 Eskridge Rd       PROJECT:       6493-Eastern Panhandle Expansion         Fairfax, VA 22031       LOCATION:       I-68 HDD Crossing         Telephone:       (703) 698-9300       Washington County							Professiona	I Service Industries	s, Inc.	-	F	ROJ	СТ	NO.:			051271	9-1
Fairfax, VA 22031     LOCATION:     I-68 HDD Crossing       Telephone:     (703) 698-9300     Washington County				Ē			2930 Eskrid	lge Rd	, <b></b>		F	ROJE	ECT:	6	493-Ea	astern F	Panhanc	lle Expansion
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DATE	ATE STARTED: 6/22/16 DRILL COMPANY: Connelly Drilling, Inc.											BC	RIN	IG (	GO-5		
			ED: דרי			6/22/16		DRILLER: Tom C	Chew LOG	GED B	<b>Y:</b> J. Thonni	end		V Whi	Drillir		Dry feet
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STAT	ION:	N	J/A		OFFS	ET:	N/A	REVIEWED BY:	Lubo	omir Pe	vtchev						
REMARKS:																	
set)	et)	D	be	ö	ches)						inch (SS) / % (NX)	%	STA	NDARD P TEST N in blo	ENETRA DATA ws/ft ⊚	TION	
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445-	- 0 - 		X	1	6	Approx Dense sandy	timately 3 i to medium clayey SA	nches of Topsoil n dense, moist, bro . <b>ND (USCS SC)</b> sor	wn, me	Top Soil	1-31-18 N=49	22		×		<b>*</b> ®	LL = 45 PL = 26 Fines=29.4%
			X	2	4	gravel,	roots. All	uvium		SC	17-18-9 N=27	41			0	×	
440-	- 5 -  		Х	3	18	Mediur dark br some g <b>Residu</b>	n dense, n rown <b>clay</b> gravel, trac <b>ium</b>	noist, brown, olive ey SAND (USCS S eshale fragments.	brown, <b>C)</b>	SC	3-7-10 N=17	21		×		+	LL = 41 PL = 25 Fines=23.9%
	 - 10 -		X	4 5	5 3	Weath and ha Shale a	ered Rock, rd LIMEST and Bloom	, gray, dark gray, s ONE, Silurian [Wil sburg Formation]	oft SHALE Ils Creek WE		50/5" 50/3"	4 5	× ×			>>@ >>@	
435—	 								VVL	SHALE							
	 - 15 - 			6	18	Interbe beddeo graineo hard Ll	edded, sligh d to thin be d to mediu IMESTON	ntly weathered, me edded, gray, dark g m grained, soft SH E, dip of 55 degree	dium ray , fine ALE and s, (RQD =	Shale	RQD=61 Rec=100%	3 6	×				
430—	 			7	60	80 %) Blooms	Silurian [W sburg Forn	/ills Creek Shale ar nation]	nd L	and imesto	neRQD=80 Rec=100%	6					
425—	- 20 -  			8	60	Interbe beddeo graineo hard Ll 68 %) Bloom	edded, sligh d to thin be d to mediuu IMESTONE Silurian [W sburg Forn	ntly weathered, me edded, gray, dark g m grained, soft SH E, dip of 48 degree /ills Creek Shale an nation]	dium ray , fine ALE and s, (RQD = nd L	Shale and imesto	RQD=68	6					-
420—	- 25 -   			9	60	Interbe beddeo graineo hard Ll 95 %) Blooms	edded, sligh d to thin be d to mediuu IMESTONE Silurian [W sburg Forn	ntly weathered, me edded, gray, dark g m grained, soft SH E, dip of 50 degree /ills Creek Shale an nation]	dium ray , fine ALE and s, (RQD = nd L	Shale and imestor	RQD=95	6					•
415—	- 30 -   			10	60	Interbe beddeo graineo hard Ll 57 %) Blooms	edded, sligh d to thin be d to mediuu IMESTONE Silurian [W sburg Forn	ntly weathered, me edded, gray, dark g m grained, soft SH E, dip of 50 degree fills Creek Shale an nation]	dium ray , fine ALE and s, (RQD = nd L	Shale and imesto	RQD=57	6					*
410—	- 35 -    - 40 -			11	60	Interbe beddeo graineo hard Ll 93 %) Blooms	edded, sligh d to thin be d to mediuu IMESTONE Silurian [W sburg Forn	htly weathered, me edded, gray, dark g m grained, soft SH E, dip of 50 degree /ills Creek Shale an nation]	dium ray , fine ALE and es, (RQD = nd L	Shale and imesto	RQD=93	<i>,</i> 0					*
							С	ontinued Next Page	9								
						Prof	fessional	Service Indus	tries, Inc.		Р	ROJE	ECT NO	D.:		051271	9-1
						293	0 Eskrid	ge Rd			Р	ROJE	CT:	6493-Ea	stern F	anhand	dle Expansion
			2			Fair	Tax, VA	22031	0		L	UCAT	ION:		1-68 H	DD Cro	ossing
						reie	priorie:	(103) 090-930	U						vvasni Har	ngion C ncock	MD
															i idi	IJUUUA, I	VI ()

DATE STARTED:					6/22/16		DRILL COM	IPANY:	Conr	nelly Dr	illing, Inc.				B		JG (	GO-5	
			ED:	u—	6/22/16 70.0.ft			DRILLER:	Tom Chew	_ LOGO	SED BY	<b>1:</b> <u>J. Thonr</u>	nfend			7 Wh	ile Drilli	ina	Drv feet
BENCHMARK					70.0 IL				Died	IIOW St			ate	Ī		on Com	pletion	Dry feet	
ELEVATION: 447 ft					SAMPLING	METHOD:	-in SS	1 874-ir	n Core St	andaro	Š	Ī	Del	ay	protion	N/A feet			
LATITUDE: 39.7117556°				HAMMER T	YPE:		Automa	atic		BOF	RINC	G LOC	ATION:						
LONG	ITUD	E:			78.20	86167°		EFFICIENC	Y		N/A								
STAT	ON:_	N	I/A		OFFS	SET:	N/A	REVIEWED	BY:	Lubo	mir Pe	ytchev							
REMA	RKS:											<u> </u>							
vation (feet)	epth, (feet)	iraphic Log	ample Type	ample No.	overy (inches)		MATER	RIAL DESC	CRIPTION	N	S Classification	ws per 6-inch (SS Recovery % (NX	Moisture, %	×	TAN K	DARD I TEST N in bl	PENETR DATA ows/ft © 25 1	PL LL 50	Additional Remarks
Εle		U	š	0	Rec						nsc	SPT BIC RQD 8		0	: •	STREN Qu	GTH, tsf Ж 2.0	Qp 4.0	
405-	- 40 -   			12	60	Interbe beddeo graineo hard LI 83 %) \$ Blooms	dded, sligl d to thin be d to mediu MESTONI Silurian [W sburg Forn	htly weathere edded, gray, m grained, s E, dip of 43 c /ills Creek SI nation]	ed, medium dark gray , f oft SHALE a degrees, (RC nale and	fine and QD = Li	Shale and mestor	RQD=8 Rec=100	3 %						
400-	- 45 -   			13	60	Interbe bedded grained hard LI 97 %) \$ Blooms	dded, sligl d to thin be d to mediu MESTONI Silurian [W sburg Forn	htly weathere edded, gray, m grained, s E, dip of 38 c /ills Creek SI nation]	ed, medium dark gray , f oft SHALE a degrees, (RC nale and	fine and QD = Li	Shale and mestor	RQD=9 Rec=100	7 %						
395—	- 50 -   			14	60	Interbe beddeo graineo hard LI 67 %) s Blooms	dded, sligl d to thin be d to mediu MESTONI Silurian [W sburg Forn	htly weathere edded, gray, m grained, s E, dip of 40 c /ills Creek SI nation]	ed, medium dark gray , f oft SHALE a degrees, (RC nale and	fine and QD = Li	Shale and mestor	RQD=6 netec=100	7 %						
390-	- 55 -   			15	60	Interbe beddeo graineo hard Ll 90 %) \$ Blooms	dded, sligl d to thin be d to mediu MESTONI Silurian [W sburg Forn	htly weathere edded, gray, m grained, s E, dip of 50 c /ills Creek SI nation]	ed, medium dark gray , f oft SHALE a degrees, (RC nale and	fine and QD = Li	Shale and mestor	RQD=9 Rec=100	0 %						
385—	- 60 -   			16	60	Interbe beddeo graineo hard Ll 93 %) Blooms	dded, sligl d to thin be d to mediu MESTONI Silurian [W sburg Forn	htly weathere edded, gray, m grained, s E, dip of 53 c /ills Creek SI nation]	ed, medium dark gray , f oft SHALE a degrees, (RC nale and	fine and QD =	Shale	RQD=9 Rec=100	3 %						
380-				17	60					Li	mestor	RQD=9	3						
-	 - 70 -					Bottom	of test bo	ring at 70 fe	et			Rec=100	%	-					
	F			Ż		Prof 293 Fair Tele	essiona 0 Eskridg fax, VA ephone:	i Service I ge Rd 22031 (703) 698	ndustries, 8-9300	, Inc.		l	PROJI PROJI LOCA <sup>-</sup>	ECT   ECT: FION	NO. _6  : _	: 6493-E	astern I I-68 F Wash Ha	051271 Panhano IDD Cro ington C ncock	9-1 dle Expansion ossing county MD



## **GENERAL NOTES**

#### SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

#### DRILLING AND SAMPLING SYMBOLS

- SFA: Solid Flight Auger typically 4" diameter flights, except where noted.
- HSA: Hollow Stem Auger typically 3<sup>1</sup>/<sub>4</sub>" or 4<sup>1</sup>/<sub>4</sub> l.D. openings, except where noted.
- M.R.: Mud Rotary Uses a rotary head with Bentonite or Polymer Slurry
- R.C.: Diamond Bit Core Sampler
- H.A.: Hand Auger
- P.A.: Power Auger Handheld motorized auger

#### SOIL PROPERTY SYMBOLS

- SS: Split-Spoon 1 3/8" I.D., 2" O.D., except where noted.
  - ST: Shelby Tube 3" O.D., except where noted.
- RC: Rock Core
- TC: Texas Cone
- 🕅 BS: Bulk Sample
- PM: Pressuremeter
- CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings
- N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
- N<sub>60</sub>: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
- Q<sub>u</sub>: Unconfined compressive strength, TSF
- Q.: Pocket penetrometer value, unconfined compressive strength, TSF
- w%: Moisture/water content, %
- LL: Liquid Limit, %
- PL: Plastic Limit, %
- PI: Plasticity Index = (LL-PL),%
- DD: Dry unit weight, pcf
- ▼,,,, Ž, Ž Apparent groundwater level at time noted

#### RELATIVE DENSITY OF COARSE-GRAINED SOILS ANGULARITY OF COARSE-GRAINED PARTICLES

Relative Density	N - Blows/foot	Description	Criteria
Very Loose	0 - 4	Angular	Particles have sharp edges and relatively plane sides with uppolished surfaces
Loose Medium Dense	4 - 10 10 - 30	Subangular:	Particles are similar to angular description, but have
Dense Verv Dense	30 - 50 50 - 80	Subrounded:	Particles have nearly plane sides, but have
Extremely Dense	80+	Rounded:	well-rounded corners and edges Particles have smoothly curved sides and no edges

#### **GRAIN-SIZE TERMINOLOGY**

#### PARTICLE SHAPE

Modifier:

>12%

Component	Size Range	<u>Description</u>	Criteria
Boulders:	Over 300 mm (>12 in.)	Flat:	Particles with width/thickness ratio > 3
Cobbles:	75 mm to 300 mm (3 in. to 12 in.)	Elongated:	Particles with length/width ratio > 3
Coarse-Grained Gravel:	19 mm to 75 mm (¾ in. to 3 in.)	Flat & Elongated:	Particles meet criteria for both flat and
Fine-Grained Gravel:	4.75 mm to 19 mm (No.4 to 3/4 in.)		elongated
Coarse-Grained Sand:	2 mm to 4.75 mm (No.10 to No.4)		
Medium-Grained Sand:	0.42 mm to 2 mm (No.40 to No.10)	RELATIVE	PROPORTIONS OF FINES
Fine-Grained Sand:	0.075 mm to 0.42 mm (No. 200 to No.	40) Descripti	ve Term % Dry Weight
Silt:	0.005 mm to 0.075 mm		Trace: < 5%
Clay:	<0.005 mm		With: 5% to 12%

Page 1 of 2



## **GENERAL NOTES**

(Continued)

#### **CONSISTENCY OF FINE-GRAINED SOILS**

<u>Q<sub>U</sub> - TSF</u>	<u>N - Blows/foot</u>	Consistency
0 - 0.25	0 - 2	Very Soft
0.25 - 0.50	2 - 4	Soft
0.50 - 1.00	4 - 8	Firm (Medium Stiff)
1.00 - 2.00	8 - 15	Stiff
2.00 - 4.00	15 - 30	Very Stiff
4.00 - 8.00	30 - 50	Hard
8.00+	50+	Very Hard

#### **MOISTURE CONDITION DESCRIPTION**

<b>Description</b>	Criteria
Dry:	Absence of moisture, dusty, dry to the touch
Moist:	Damp but no visible water
Wet:	Visible free water, usually soil is below water table

#### **RELATIVE PROPORTIONS OF SAND AND GRAVEL**

Descriptive Term% Dry WeightTrace:< 15%</td>With:15% to 30%Modifier:>30%

#### STRUCTURE DESCRIPTION

<b>Description</b>	Criteria	<b>Description</b>	Criteria
Stratified:	Alternating layers of varying material or color with	n Blocky:	Cohesive soil that can be broken down into small
	layers at least ¼-inch (6 mm) thick		angular lumps which resist further breakdown
Laminated:	Alternating layers of varying material or color with	n Lensed:	Inclusion of small pockets of different soils
	layers less than ¼-inch (6 mm) thick	Layer:	Inclusion greater than 3 inches thick (75 mm)
Fissured:	Breaks along definite planes of fracture with little	Seam:	Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick
	resistance to fracturing		extending through the sample
Slickensided:	Fracture planes appear polished or glossy, sometimes striated	Parting:	Inclusion less than 1/8-inch (3 mm) thick

#### SCALE OF RELATIVE ROCK HARDNESS

<u>Q<sub>U</sub> - TSF</u>	<u>Consistency</u>
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
,050 - 2,600	Hard
>2.600	Verv Hard

#### **ROCK VOIDS**

<u>Voids</u>	Void Diameter
Pit	<6 mm (<0.25 in)
Vug	6 mm to 50 mm (0.25 in to 2 in)
Cavity	50 mm to 600 mm (2 in to 24 in)
Cave	>600 mm (>24 in)

#### **ROCK QUALITY DESCRIPTION**

Rock Mass Description	RQD Value	
Excellent	90 -100	
Good	75 - 90	
Fair	50 - 75	
Poor	25 -50	
Very Poor	Less than 25	

#### **ROCK BEDDING THICKNESSES**

<b>Description</b>	Criteria
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	<sup>1</sup> / <sub>2</sub> -inch to 1 <sup>1</sup> / <sub>4</sub> -inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to 1/2-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

#### **GRAIN-SIZED TERMINOLOGY**

(Typically Sedi <u>Component</u>	mentary Rock) <u>Size Range</u>			
Very Coarse Grained	>4.76 mm			
Coarse Grained	2.0 mm - 4.76 mm			
Medium Grained	0.42 mm - 2.0 mm			
Fine Grained	0.075 mm - 0.42 mm			
Very Fine Grained	<0.075 mm			

#### **DEGREE OF WEATHERING**

Slightly Weathered: Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.
 Weathered: Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.
 Highly Weathered: Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

# SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

м	ONS	SYM	BOLS	TYPICAL	
			GRAPH	LETTER	DESCRIPTIONS
	GRAVEL AND	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	GRAVELLY SOILS	(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
COARSE GRAINED SOILS	MORE THAN 50% OF COARSE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
	RETAINED ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50%	SAND AND	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
LARGER THAN NO. 200 SIEVE SIZE	SANDY SOILS	(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
	PASSING ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
				ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE				MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		СН	INORGANIC CLAYS OF HIGH PLASTICITY
				ОН	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
н	HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS







Cross Section Showing the General Stratigraphy





Laboratory Test Results



# Laboratory Summary Sheet

Sheet 1 of 1 Dry Density Satur-Water Approx. Liquid Plastic Plasticity Qu %<#200 Est. Specific Void Borehole Content ation Sieve Depth Limit Limit Index (tsf) Ratio Gravity (pcf) (%) (%) GO-4 21 77.9% 19 1 35 14 GO-4 3 9 9 GO-4 6 29 17 12 20.1% GO-4 4 7.15 GO-5 1 45 26 19 29.4% 22 GO-5 3 41 GO-5 5.5 41 25 16 23.9% 21 GO-5 8.7 4 GO-5 5 9.65 GO-5 13.7 3



Professional Service Industries 2930 Eskridge Rd Fairfax, VA 22031 Telephone: (703) 698-9300 Fax: (703) 560-7931

### Summary of Laboratory Results

PSI Job No.:	0512719-1
Project:	6493-Eastern Panhandle Expansion
_ocation:	I-68 HDD Crossing
	Washington County
	Hancock, MD




Slake Durability Test Results



EnSite USA Project Number 6493 Eastern Panhandle Expansion, I-68 Crossing, PSI Project Number 0512719-1 July 12, 2016

Client Client Project Project No.	Professional Service In Proposed Eastern Par 37538	Boring Depth Sample Lab Sample No.	
	6493 Eastern Pannar	Idle Expansion, I-68 HDD Crossing	Lab Sample No.
Visual Description:	Dark Reddish Gray Sil	tstone	
Initial Wa	ter Content		
Drum ID		А	
Drum + Wet Shale,	gm	1772.14	1
Drum + Dry Shale, g	m	1767.93	
Drum Wt., gm		1244.86	
Water Content, %		1%	
Initial Dry Shale We	ight, gm	523.07	
Water Temerature	Before Cycle 1, *C	21.4	
Water Temerature	After Cycle 1, *C	21.6	
Average Temp durir	ng Cycle 1, *C	21.5	1000
Drum + Dry Shale at	fter Cycle 1, gm	1764.73	-
Dry Shale after Cycl	e 1	519.87	
Slake Durability Ind	lex (First cycle)	99.4%	_
Water Temerature	Before Cycle 2, *C	21	
Water Temerature	After Cycle 2, *C	21.6	
Average Temp during Cycle 2, *C		21.3	ALC: NO
			all and a second
Drum + Dry Shale at	fter Cycle 2, gm	1759.78	
Dry Shale after Cycl	e 2	514.92	
Slake Durability Ind	lex (Second cycle)	98.4%	

Type II—Retained specimen consist of large and small fragments.



GO-4 38.0'-39.0' RC-11 37538002

**Final Photograph** 



Date Tested:

Input Validation: tmp

Reviewed By: SVG

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Client	Professional Service Industries, Inc. (PSI)	Boring	GO-4
Client Project	Proposed Eastern Panhandle Expansion I-68 Crossing	Depth	54.0'-55.0'
Project No.	37538	Sample	RC-14
	6493 Eastern Panhandle Expansion, I-68 HDD Crossing	Lab Sample No.	37538003

Visual Description: Gray Shale

#### **Initial Water Content**

Drum ID	В
Drum + Wet Shale, gm	1769.99
Drum + Dry Shale, gm	1767.23
Drum Wt., gm	1244.29
Water Content, %	1%
Initial Dry Shale Weight, gm	522.94
Water Temerature Before Cycle 1, *C	21.6
Water Temerature After Cycle 1, *C	21.7
Average Temp during Cycle 1, *C	21.65
Drum + Dry Shale after Cycle 1, gm	1764.46
Dry Shale after Cycle 1	520.17
Slake Durability Index (First cycle)	99.5%
Water Temerature Before Cycle 2, *C	21.6
Water Temerature After Cycle 2, *C	21.9
Average Temp during Cycle 2, *C	21.75
Drum + Dry Shale after Cycle 2, gm	1761.47
Dry Shale after Cycle 2	517.18
Slake Durability Index (Second cycle)	98.9%

Type II—Retained specimen consist of large and small fragments.



**Final Photograph** 



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Date Tested:

Client	Professional Service Industries,	GO-5			
Client Project	Proposed Eastern Panhandle Ex	22.0'-23.0'			
Project No.	37538	Sample	RC-9		
		Lab Sample No.	37538004		
	6493 Eastern Panhandle Expansion, I-68 HDD Crossing				
Visual Description:	Gray Shale				

#### **Initial Water Content**

Drum ID	D
Drum + Wet Shale, gm	1779.82
Drum + Dry Shale, gm	1777.53
Drum Wt., gm	1260.98
Water Content, %	0.44%
Initial Dry Shale Weight, gm	516.55
Water Temerature Before Cycle 1, *C	21.2
Water Temerature After Cycle 1, *C	21.5
Average Temp during Cycle 1, *C	21.35
Drum + Dry Shale after Cycle 1, gm	1774.11
Dry Shale after Cycle 1	513.13
Slake Durability Index (First cycle)	99.3%
Water Temerature Before Cycle 2, *C	21.2
Water Temerature After Cycle 2, *C	21.5
Average Temp during Cycle 2, *C	21.35
Drum + Dry Shale after Cycle 2, gm	1771.28
Dry Shale after Cycle 2	510.3
Slake Durability Index (Second cycle)	98.8%

Type II—Retained specimen consist of large and small fragments.



**Final Photograph** 



Input Validation: tmp

Reviewed By: SVG Date T COPYRIGHT © 2012 GEOTECHNICAL TESTING SERVICES, INC. 1-800-853-7309

Date Tested: 6/

Client Client Project Project No.	Professional Service Industries, Inc. (PSI) Proposed Eastern Panhandle Expansion I-68 Crossing 37538		Boring Depth Sample	GO-5 44.0'-45.0' RC-13
Visual Description:	6493 Eastern Panł Gray Shale	nandle Expansion, I-68 HDD Crossing	Lab Sample No.	37338003
Initial Wa	ter Content			
Drum ID		С	_	Init
Drum + Wet Shale, g	gm	1755.36		Project No. Boring Depth
Drum + Dry Shale, g	m	1753.65		Sample Lab Sample No
Drum Wt., gm		1257.69		
Water Content, %		0.34%		
Initial Dry Shale We	ight, gm	495.96		
Water Temerature I	Before Cycle 1, *C	21.4		
Water Temerature	After Cycle 1, *C	21.6	1.0	
Average Temp durir	ng Cycle 1, *C	21.5		
				2753800
Drum + Dry Shale af	ter Cycle 1, gm	1752.4	•	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Dry Shale after Cycl	e 1	494.71		
Slake Durability Ind	ex (First cycle)	99.7%		Client Project
				Project No. Boring Depth
Water Temerature I	Before Cycle 2, *C	21.6		Sample Lab Sample No
Water Temerature	After Cycle 2, *C	22		

21.8

1751.12

493.43

99.5%





Type I—Retained specimen remain virtually unchanged

Average Temp during Cycle 2, \*C

Drum + Dry Shale after Cycle 2, gm

Slake Durability Index (Second cycle)

Dry Shale after Cycle 2

Input Validation: tmp

Reviewed By: SVG

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Date Tested:

Client Client Project Project No.	Professional Service Ind Proposed Eastern Panha 37538	ustries, Inc. (PSI) andle Expansion I-68 Crossing	Boring Depth Sample Lab Sample No.	GO-5 64.0'-65.0' RC-17 37538006
Visual Description:	6493 Eastern Panhand Gray Shale	le Expansion, I-68 HDD Crossing	)	
Initial Wa	ater Content			
Drum ID		D		Initial Photograph
Drum + Wet Shale,	gm	1759.33		Client Project 0 Project No. 0 Boring GO-5
Drum + Dry Shale, g	şm	1757.69		Depth 64.0-63.0 Sample RC-17 Sample No 37538006
Drum Wt., gm		1260.82		
Water Content, %		0.33%		
Initial Dry Shale We	ight, gm	496.87		
Water Temerature	Before Cycle 1, *C	19.7		
Water Temerature	After Cycle 1, *C	20		
Average Temp durir	ng Cycle 1, *C	19.85		27538006
Drum + Dry Shale at	fter Cycle 1, gm	1755.39		51550000
Dry Shale after Cycl	e 1	494.57		
Slake Durability Inc	dex (First cycle)	99.5%		Test Name: Final Photograph
Water Temerature	Before Cycle 2, *C	21	1	Project No. 0 Boring Beach
Water Temerature	After Cycle 2, *C	21.6		Sample
Average Temp durir	ng Cycle 2, *C	21.3	6	
Drum + Dry Shale at	fter Cycle 2, gm	1752.69		
Dry Shale after Cycl	e 2	491.87		
Slake Durability Inc	lex (Second cycle)	99.0%		ULA
Type II—Retained s	specimen consist of large	and small fragments.	3	7538006

Date Tested:

6/30/2016

Input Validation: tmp

Reviewed By: SVG

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Soil Resistivity Test Results



EnSite USA Project Number 6493 Eastern Panhandle Expansion, I-68 Crossing, PSI Project Number 0512719-1 July 12, 2016

ClientProfessional Service Industries, Inc. (PSI)Client Project6493 - Proposed Eastern Panhandle Expansion I-68 CrossingProject No.37538

						pH AASHTO T289		Soil Resistivity AASHTO T-288		3	
Lab Sample ID	Boring	Depth	Sample	Sample Received	Matrix	Result	Date Tested	Tested By	Result, Ohm- cm	Date Tested	Tested By
37538001	GO-4	1.0'-5.0'	SS: 1,2	6/27/2016	Soil	5.8	6/29/2016	ΤX	8950	6/29/2016	ΤX

Important Information About Your Geotechnical Report



EnSite USA Project Number 6493 Eastern Panhandle Expansion, I-68 Crossing, PSI Project Number 0512719-1 July 12, 2016

# Important Information about Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

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

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

### **Read the Full Report**

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

#### A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

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

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

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

 the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,

- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

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

# **Subsurface Conditions Can Change**

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

### Most Geotechnical Findings Are Professional Opinions

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

# A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

#### A Geotechnical Engineering Report Is Subject to Misinterpretation

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

#### **Do Not Redraw the Engineer's Logs**

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.* 

#### Give Contractors a Complete Report and Guidance

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

### **Read Responsibility Provisions Closely**

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that

have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

#### **Geoenvironmental Concerns Are Not Covered**

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

# **Obtain Professional Assistance To Deal with Mold**

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

#### Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/THE BEST PEOPLE ON EARTH exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.



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July 22, 2016 Revised September 9, 2016

EnSite USA, Inc. 109 Fieldview Drive Versailles, KY, 40383 Attn: Grace Northcutt, P.E.

Re: Report for Geotechnical Subsurface Exploration & Engineering Services 6493 – Eastern Panhandle Expansion Potomac River Crossing, Preliminary Investigation Washington County, Maryland and Morgan County, West Virginia. PSI Project Number 0512713-1

Dear Ms. Northcutt:

Thank you for choosing Professional Service Industries, Inc. (PSI) as your consultant for the referenced project. Authorization to perform services was provided through PSI Proposal No. 0512-182348 dated June 13, 2016. The proposal was executed by Ms. Northcutt, P.E. representing EnSite USA, Inc.

This letter report presents the results of borings performed by PSI at two locations along the proposed HDD alignment at Potomac River Crossing. Approximate boring locations are presented in the Appendix Figures: 1A Site Vicinity Map and 1B: Boring Location Plans.

#### Scope of Services

PSI's services consisted of field exploration, laboratory testing, and preparation of a geotechnical engineering report for the proposed HDD location. Field work included drilling 2 test borings (Borings GO-1 and GO-2R), utilizing hollow-stem auger (HSA) drilling, wash rotary drilling, and rock coring in conformance with ASTM standards.

Laboratory testing determined unit weight, moisture content, Atterberg limits, grain size distribution tests, pH and resistivity testing, unconfined compressive strength and slake durability testing. All tests were performed per ASTM standards.

#### Summary of Field Exploration and Laboratory Testing

The borings were completed with a track-mounted drill rig with HSA in conformance with ASTM standards. Standard Penetration Testing (SPT) and split-spoon sampling of overburden soils was performed at 2.5 foot intervals for the first 10 feet and at 5-foot intervals thereafter to the termination depths to evaluate the strength and relative consistency of the soils encountered. Below auger refusal depth, rock coring was performed using NQ coring equipment. All recovered soil and rock samples were visually classified by a PSI geotechnical engineer and a graphical log developed for each boring. Boring depths and depths at which auger refusal were encountered are summarized in Table 1 below.

Boring	Approximate Termination Depth (feet)	Ground Surface Elevation (feet, NAVD)	Approximate Depth/Elevation of Top of Weathered Rock	Approximate Depth/Elevation of Auger Refusal	
GO-1	305	624	23 feet, EL ±601MSL	24 feet, EL ±600MSL	
GO-2R	154	411	20 feet, EL ±391MSL	24 feet, EL ±387MSL	

#### Table 1 – Summary of Boring Depths

The boring logs included in the Appendix approximate depths and visual descriptions of overburden soil, underlying rock materials encountered, soil SPT test results, rock core recovery and quality designation (RQD) values, and measurements of groundwater depth where encountered. The total length of recovered rock core, divided by the length of the run, is referred to as rock core recovery and is expressed as a percentage. The Rock Quality Designation (RQD) is a measure of the rock mass quality and is defined as the total length of sound, intact rock core pieces 4 inches or more in length divided by the length of the rock core run, also expressed as a percentage. The rock core recovery and RQD values are indicated on the Boring Logs included with this report.

# **Geotechnical Investigation Results**

A brief summary of subsurface stratigraphy as encountered at the various borings are presented below. All soil is classified per the Unified Soil Classification System (ASTM D-2487):

<u>Surficial Materials</u>: Approximately 3 inches of surficial topsoil were encountered at the ground surface of Borings GO-1 and GO-2R.

<u>Alluvium</u> with thickness from 2 feet to 16 feet consisting of soft to very stiff lean clay (CL) and fat clay (CH).

<u>Residuum:</u> Residual soil classified as clayey silt (ML) and lean clay (CL) were encountered to depths ranging from approximately 2 to 17 feet below existing surface grades at both borings. The residual soil was between 3 to 21 feet thick in the boring locations. SPT N-values in this layer ranged from approximately 6 to 30 blows per foot (BPF).

<u>Weathered Rock:</u> Typically consisting of weathered shale, weathered rock was encountered at both boring locations. The weathered rock samples consisted of soft shale with limestone floaters. SPT N-values were typically in excess of 50 BPF. Auger refusal was encountered within the weathered rock at depths ranging from approximately 23 to 24 feet below existing grades.

<u>Bedrock:</u> Bedrock materials encountered below the auger refusal depths consisted primarily of cyclic sequences of Limestone, and shale, with occasional layers of sandy shale, cherty limestone and sandstone. Voids were encountered in Boring GO-2R. Core recoveries ranged from 13 to 100 percent. RQD values ranged from 0 to 100 percent.

The above subsurface descriptions are of a generalized nature provided to highlight the major strata encountered. The boring logs included in the Appendix should be reviewed for specific information as to individual boring locations. The stratification lines shown on the boring logs



represent the conditions only at the actual boring locations. The stratification lines represent the approximate boundaries between subsurface materials and the actual transition may be gradual.

		Sample		Moisture	Att	erberg Li	mits	Grain-Size Distribution			
Boring Sample No.	Sample No.	Depth (feet)	USCS Classification <sup>(1)</sup>	Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Gravel (%)	Sand (%)	Fines (%)	
GO-1	S-1	0.0 – 1.5		14							
GO-1	S-2	2.5 – 4.0	СН	21	55	27	28	0.0	2.6	97.4	
GO-1	ST-1	2.0 - 4.0	CL	17	41	24	17				
GO-1	S-3	5.0 - 6.5		23							
GO-1	S-4	8.5 – 10.0	ML	25	39	27	12	0.0	0.2	99.8	
GO-1	ST-2	11.0 – 11.5	ML	26	45	29	16	0.0	0.4	99.6	
GO-1	S-5	13.5 – 15.0		21							
GO-1	ST-3	18.3 – 18.8	CL	21	44	26	18	0.0	10.0	90.0	
GO-1	S-6	18.5 – 20.0		25							
GO-2R	S-1	0.0 – 1.5		21							
GO-2R	ST-1	1.5 – 2.0	CL	19	38	22	16	0.0	24.9	75.1	
GO-2R	S-2	2.5 – 4.0	СН	30	65	25	38				
GO-2R	ST-2	2.0 - 4.0	СН	24	55	22	33				
GO-2R	S-3	5.0 - 6.5	СН	27	59	23	36	0.0	10.7	89.3	
GO-2R	ST-3	8.5 - 9.0	CL	20	33	18	15	0.0	9.2	90.8	
GO-2R	S-4	8.5 – 10.0		18							
GO-2R	S-5	13.5 – 15.0	CL	17				0.0	40.2	55.8	
GO-2R	S-6	18.5 – 20.0		14							
(1) (2)	For USCS	Soil Classifica	ation definitions, re	fer to the G	eneral No	otes in Atta	achment				

Table 2 – Overburden Soil Classification Test Results

<sup>2)</sup> ST – Shelby Tube soil sample

<sup>(3)</sup> S – Split spoon soil sample

# Table 3 – Rock Recovery and RQD Field Coring Test Results

Boring	Depth (feet)	Elevation (feet)	Run Length (feet)	Recovery (%)	RQD (%)	Hardness (Moh,s)
GO-1	24 - 29	600 - 595	5	100	89	3
GO-1	29- 34	595 – 590	5	100	90	3
GO-1	34 - 39	590 – 585	5	100	100	3
GO-1	39 - 44	585 – 580	5	100	78	3
GO-1	44 - 49	580 – 575	5	100	88	3



Table 3 – Rock Recovery and RQD Field Coring Test Results Continued								
Boring	Depth (feet)	Elevation (feet)	Run Length (feet)	Recovery (%)	RQD (%)	Hardness (Moh,s)		
GO-1	49 - 54	575 – 570	5	100	90	3		
GO-1	54 - 59	570 – 565	5	87	45	3		
GO-1	59 - 64	565 – 560	5	100	83	3 - 4		
GO-1	64 - 69	560 – 555	5	100	95	3 - 4		
GO-1	69 - 74	555 – 550	5	100	92	3 - 4		
GO-1	74 – 79	550 – 545	5	100	97	3 - 4		
GO-1	79 – 84	545 – 540	5	100	94	3 - 4		
GO-1	84 – 89	540 – 535	5	100	95	3 - 4		
GO-1	89 – 94	535 – 530	5	100	95	3 - 4		
GO-1	94 – 99	530 – 525	5	100	88	3 - 4		
GO-1	99 – 104	525 – 520	5	100	67	3 - 4		
GO-1	104 – 109	520 – 515	5	100	50	3 - 4		
GO-1	109 – 114	515 – 510	5	100	47	3 - 4		
GO-1	114 – 119	510 – 505	5	100	64	3 - 4		
GO-1	119 – 124	505 – 500	5	100	53	3 - 4		
GO-1	124 – 129	500 – 495	5	100	59	3 - 4		
GO-1	129 – 134	495 – 490	5	100	100	3 - 4		
GO-1	134 – 139	490 – 485	5	100	96	3 - 4		
GO-1	139 – 144	485 – 480	5	100	93	3 - 4		
GO-1	144 – 149	480 – 475	5	97	95	3 - 4		
GO-1	149 – 154	475 – 470	5	100	98	3 - 4		
GO-1	154 – 159	470 – 465	5	100	91	3 - 4		
GO-1	159 – 164	465 – 460	5	98	96	3 - 4		
GO-1	164 – 169	460 – 455	5	100	100	3 - 4		
GO-1	169 – 174	455 – 450	5	100	73	3 - 4		
GO-1	174 – 179	450 – 445	5	90	75	3 - 4		
GO-1	179 – 184	445 - 440	5	100	75	3 - 4		
GO-1	184 – 189	440 – 435	5	100	83	3 - 4		





Table 3 – Rock Recovery and RQD Field Coring Test Results Continued									
Boring	Depth (feet)	Elevation Run Length (feet) (feet)		Recovery (%)	RQD (%)	Hardness (Moh,s)			
GO-1	189 – 194	435 – 430	5	100	55	3 - 4			
GO-1	194 – 199	430 – 425	5	100	63	3 - 4			
GO-1	199 – 204	425 – 420	5	100	88	3 - 4			
GO-1	204 - 209	420 – 415	5	100	88	3 - 4			
GO-1	209 - 214	415 – 410	5	100	93	3 - 4			
GO-1	214 - 219	410 – 405	5	100	88	3 - 4			
GO-1	219 - 224	405 – 400	5	100	93	3 - 4			
GO-1	224 - 229	400 – 395	5	100	51	3 - 4			
GO-1	229 – 234	395 – 390	5	93	70	3 - 4			
GO-1	234 – 239	390 – 385	5	100	65	3 - 4			
GO-1	239 – 244	- 244 385 - 380 5		100	75	3 - 4			
GO-1	244 – 249	380 – 375	5	97	68	3 - 4			
GO-1	249 – 254	375 – 370	5	95	85	3 - 4			
GO-1	254 – 259	370 – 365 5		95	83	3 - 4			
GO-1	259 – 264	365 – 360 5		100 46		3 - 4			
GO-1	264 – 269	360 – 355	- 355 5		0	0			
GO-1	269 – 274	355 – 350	5	13	0	0			
GO-1	274 – 279	350 – 345	5	87	13	3			
GO-1	279 – 284	345 – 340	5	87	30	3			
GO-1	284 – 289	340 – 335	5	82	25	7 - 8			
GO-1	289 – 294	335 – 330	5	100	58	7 - 8			
GO-1	294 – 299	330 – 325	5	100	62	7 - 8			
GO-1	299 – 304	325 - 320	5	100	78	7 - 8			
GO-1	304 – 305	320 – 319	1	100	100	7 - 8			
GO-2R	24 – 29	387 – 382	5	90	35	3 - 4			
GO-2R	29 – 34	382 – 377	5	100	40	3 - 4			
GO-2R	34 – 39	377 – 372	5	100	95	3			



Table 3 – Rock Recovery and RQD Field Coring Test Results Continued									
Boring	Depth (feet)	Elevation (feet)	Run Length (feet)	Recovery (%)	RQD (%)	Hardness (Moh,s)			
GO-2R	39 – 44	372 – 367	5	100	52	3			
GO-2R	44 – 49	367 – 362	5	100	82	3			
GO-2R	49 – 54	362 – 357	5	88	70	3			
GO-2R	54 – 59	357 – 352	5	95	93	3			
GO-2R	59 – 64	352 – 347	5	100	78	3			
GO-2R	64 – 69	347 – 342	5	95	52	3			
GO-2R	69 – 74	342 – 337	5	100	42	3			
GO-2R	74 – 79	337 – 332	5	100	98	3			
GO-2R	79 – 84	79 - 84 332 - 327 5		100	72	3			
GO-2R	84 – 89	327 – 322	5	5 100		3			
GO-2R	89 – 94	322 – 317	5	98	83	2.5 - 3			
GO-2R	94 – 99	317 – 312	5	95	70	2.5 - 3			
GO-2R	99 – 104	312 – 307 5		100	66	2.5 - 3			
GO-2R	104 – 109	307 – 302	5	85	62	2.5 - 3			
GO-2R	109 – 114	109 – 114 302 – 297 5		82	18	2.5 - 3			
GO-2R	114 – 119	114 – 119 297 – 292		5 100		2.5 - 3			
GO-2R	119 – 124	292 – 287	5	93	85	2.5 - 3			
GO-2R	124 – 129	287 – 282	5	100	95	2.5 - 3			
GO-2R	129 – 134	282 – 277	5	55	23	2.5 - 3			
GO-2R	134 – 139	277 – 272	5	87	58	2.5 - 3			
GO-2R	139 – 144	272 – 267	5	100	60	2.5 - 3			
GO-2R	144 – 149	267 – 262	5	87	17	4 - 5			
GO-2R	149 – 154	262 – 257	5	100	75	4 - 5			



Boring	Approximate Sample	Rock	Unit Weight	Unconfined Compressive Strength						
Bonng	Depth (feet)	Classification	(pcf)	(psi)	(tsf)					
GO-1	43.0 - 43.5	Shale	162.33	1310	94.3					
GO-1	64.0 - 64.5	Shale	163.90	510	36.7					
GO-1	98.0 - 98.5	Shale	160.29	1950	140.4					
GO-1	149.5 - 150.0	Shale	165.00	2720	195.8					
GO-1	195.0 - 195.5	Shale	158.80	1560	112.3					
GO-1	233.0 - 233.5	Sandstone	130.92	970	69.8					
GO-1	287.5 - 288.0	Limestone-Cherty	*	11570	833.1					
GO-1	290.0 - 290.5	Shale	155.46	5680	408.9					
GO-2R	27.0 - 27.5	Shale	167.27	6870	494.6					
GO-2R	50.0 - 50.5	Shale	156.14	4210	303.1					
GO-2R	84.0 - 84.5	Shale	172.74	3870	278.6					
GO-2R	85.0 - 85.5	Shale	172.51	4340	312.5					
GO-2R	116.0 - 116.5	Shale	169.63	3630	261.4					
GO-2R	131.0 - 131.5	Shale	160.46	4400	316.8					
* Test could no	* Test could not be performed									

 Table 4 – Rock Unconfined Compressive Strength Test Results

# Table 5 – Soil Unconfined Compressive Strength Test Results

Borina	Approximate Sample Depth	Water Content	Dry Unit Weight	Soil	Unconfined Compressive Strength		
· · · · g	(feet)	(%)	(pcf)	Classification	(psf)	(tsf)	
GO-1	4.0 - 6.0	16.7	116.8	ML	5530	2.76	
GO-1	11.0 – 11.5	26.4	94.5	ML	2780	1.39	
GO-1	18.3 – 18.8	21.2	97.2	CL	2300	1.15	
GO-2R	1.5 – 2.0	13.8	100.3	CL	1440	0.72	
GO-2R	4.0 - 6.0	24.4	101.5	СН	4464	2.23	
GO-2R	8.5 - 9.0	20.2	104.0	CL	2180	1.09	



The **durability** of the shale is a measurement of its deterioration over time interaction with the water weathering properties. The durability of the shale was determined on selected samples of shales per Slake Durability of Shales and Similar Weak Rocks, ASTM D-4644 Standard.

Boring	Approximate Sample Depth (feet)	Rock Classification	Slake Durability Index First Cycle (%)	Slake Durability Index Second Cycle (%)
GO-1	51.0 - 52.0	Shale	99.5	99.3
GO-1	64.5 – 65.5	Shale	99.5	99.2
GO-1	95.0 - 96.0	Shale	94.8	90.0
GO-1	129.0 – 130.0	Shale	99.2	98.7
GO-1	203.0 - 204.0	Shale	66.1	42.9
GO-1	255.0 – 256.0	Shale	60.5	29.4
GO-2R	43.0 - 44.0	Shale	99.9	99.8
GO-2R	58.0 - 59.0	Shale	99.4	99.1
GO-2R	70.5 – 71.5	Shale	99.9	99.9
GO-2R	100.0 - 101.0	Shale	99.6	99.3
GO-2R	122.0 - 123.0	Shale	99.6	99.4
GO-2R	151.5 – 152.5	Shale	99.8	99.6

Table 6 – Slake Durability Test Results

Two (2) representative soil samples were selected by PSI for soil resistivity testing. Table 7 below presents a summary of the test results. A detailed report is included in the Appendix.

Table 7 – Soil Resistivity 7	<b>Fest Results</b>
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Location	GO-1	GO-2R		
Depth (Foot)	4.0' to 6.0'	4.0' to 6.0'		
pH - AASHTO T289	4.6	7.1		
Soil Resistivity – AASHTO T-288	4200 Ohm-cm	1500 Ohm-cm		



Should there be any questions, please do not hesitate to contact our office at (703) 698-9300. PSI would be pleased to continue providing geotechnical services throughout the implementation of the project, and we look forward to working with you on this and future projects.

Respectfully submitted, **PROFESSIONAL SERVICE INDUSTRIES, INC.** 

dubonine Sterfelew

Lubomir D. Peytchev, P.E. Senior Geotechnical Engineer

Nam

Naseer Nayeem, P.E. Vice President/Principal Consultant

Appendix: Figure 1A: Site Vicinity Map and Figure 1B: Boring Location Plan Boring Logs and General Notes Cross Section Showing the General Stratigraphy Laboratory Test Results Slake Durability Test Results Soil Resistivity Test Results



Figure 1A Site Vicinity Map and Figure 1B – Boring Location Plan



EnSite USA Project Number 6493 Eastern Panhandle Expansion, Potomac River Crossing PSI Project Number 0512713-1 Revised September 9, 2016





(10 FT) - BORING DEPTH

#### NOTES:

1. ALL BORINGS WILL BE ADVANCED WITH HOLLOW-STEM AUGERS. 2. SPT SAMPLING WILL BE PERFORMED IN ALL BORINGS.

3. BORING DEPTHS ARE AS SHOWN 4. BORING SPOILS WILL USED TO BACKFILL THE BORE HOLES.

**BORING LOCATION PLAN (FIGURE 1B)** 6493- EASTERN PANHANDLE EXPANSION POTOMAC RIVER CROSSING

WASHINGTON COUNTY, MD AND MORGAN COUNTY, WV

N.T.S.

# JULY 21, 2016 0512-713-1

Boring Logs and General Notes



EnSite USA Project Number 6493 Eastern Panhandle Expansion, Potomac River Crossing PSI Project Number 0512713-1 Revised September 9, 2016

DATE	STAR	TED:	_		6	6/29/16		DRILL COMP	PANY:	Conn	elly Dr	illing, Inc.	_		BO	RING	G	 D-1
			ED: PTI			7/7/16 305.01	 ft		om Chew		ED B1	<b>r:</b> J. Thonnfe	nd		While	Drilling		Drv feet
			FII	' -		 N/Δ			ETHOD.	Hol	_ <u>55 L</u>		_	∎	Upon	Completic	n	Dry feet
		l: _			62	24 ft		SAMPLING N	METHOD:2-	in SS1	.874-ii	n Core Stan	 dard	Ŝ <b>⊉</b>	Delay			N/A feet
LATIT	UDE:			:	39.680	3639°		HAMMER TY	PE:	A	utoma	atic		BORING	LOCAT	ION:		
LONG	SITUDE	:			78.19	52222°		EFFICIENCY			N/A							
STAT	ION:	N	/A		OFFS	ET:	N/A	REVIEWED B	BY:	Lubor	nir Pe	ytchev						
REM/	ARKS:																	
Elevation (feet)	o Depth, (feet)	r Graphic Log	Sample Type	Sample No.	Recovery (inches)		MATER	RIAL DESC	RIPTION	I	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %		DARD PEN TEST D/ N in blows loisture 25 STRENGTI Qu 2.0	VETRATION ATA %ft © PL • LL H, tsf * Qp	<u>50</u> 4.0	Additional Remarks
			Д	1	18	$\Delta Soft to$	stiff. mois	t. light brown.		,/ <u>`</u>	Soil	1-6-5 N=11	14		×			
			X	2	18		CH) some	gravel, roots.	Alluvium	/ [	\CH∕	2-6-8	21		b × ⊿	$\mapsto$	⇒‡₽L	= 55 _ = 27
620-	- 5 -					Stiff to	very stiff, SII T (USC	moist, brown, <b>S MI )</b> some a	red, trace		ML	N=14	22				-Fir	1es=97.4%
			Д	3	18	Resid	uum	e me, como g				6-8-10 N=18	23		$\mathcal{P}$			
045			×	4	16	Stiff to	verv stiff.	moist. dark bro	own. brown			2-5-6	05	6			LL	= 39
615-	- 10 -			-		SILT (	USCS ML)	some gravel,	trace shale	·		N=11	25				PL Fir	. = 27 nes=99.8%
					24	tragme	ents <b>Resid</b>	luum			МІ		26		×			= 45
610			×	5	18							7-14-16	01		$\sim$	o	Fir	nes=99.6%
010-	- 15 -		4	Ū								N=30	21				$ \rightarrow $	
					24	Mediu	m stiff to st	iff, very moist,	, dark brow	n,		-				>		= 44
605						olive b	rown, blac gravel sha	k lean CLAY (	(USCS CL)				21		×		PL	= 26
005	- 20 -		ΔĄ	6	12	Resid	uum	lio naginonio,	nood ompe		CL	1-4-2 N=6	25		$ \rightarrow $			1es=90.0%
															$\uparrow$			
600				7	0	Weath	ered Rock	, gray, dark gr	ay, soft SH	ALNE/E/	THEF	RED50/0"				>		
600-	- 25 -					\and ha	ard LIMES	ſŎŊĖ			\$HAL∕Ĕ						_	
		IIII 1H		8	60	bedde	d to thin be	ntly weathered	i, medium ark grav . fi	ne		RQD=89						
505						graine	d to mediu	m grained, ver	ry soft to so	oft		Rec=100%						
595	- 30 -					45 dec	= and hard	LIMESTONE, D from 45% to	, dip of 25 t 100 %)	0							_	
		ШН	H	9	60	Devon	ian [Marce	Ilus Formation	and and			RQD=90						
500						Needn	nore Shale	]				Rec=100%						
590-	- 35 -																_	
				10	60							RQD=100						
585-												Rec=100%						
505	- 40 -	HII									Chala						-	
			H	11	60						and	RQD=78						
580-										Lir	nesto	le le						
	- 45 -	H	H														-	
				12	60							RQD=88						
575-												Rec=100%						
010	- 50 -	HH H															-	
				13	60							RQD=90						
570-												Rec=100%						
	- 55 -																$\dashv$	
	$\mid$ $\mid$			14	52							RQD=45						
565-			H									1100-07 70						
	- 60 -						C	ontinued Next	Page								$\neg$	
				/		Pro	fessiona	Service In	dustriae	Inc		DD			•	0512	71२_^	1
					77	293	0 Eskrid	ge Rd	3030103,			PR	OJE	CT: 6	493-East	tern Panh	andle	Expansion
		75			i //	Fair	fax, VA	22031				LO	CAT	10N: _	Pot	omac Rive	er Cro	ossing
						Tele	ephone:	(703) 698-	9300					_	V	Vashingto	n Cou	unty
																Hancoc	k, MD	)

DATE STARTED:	6/29/16	DRILL COMPANY: Conn		BORING GO-1															
DATE COMPLETED:	///16 305.0.ft	DRILLER: <u>I om Chew</u> LOGG	ED BY:J. Thonnfend		While Drilling	Drv feet													
BENCHMARK	N/A	DRILLING METHOD: Hol	llow Stem Auger	∎ ate	Upon Completion	Dry feet													
ELEVATION:	624 ft	SAMPLING METHOD:2-in SS1	.874-in Core Standard	<u>V</u> ×	Delay	N/A feet													
LATITUDE:	39.6803639°	HAMMER TYPE:	Automatic	BORING	LOCATION:														
LONGITUDE:	78.1952222°	EFFICIENCY	N/A																
STATION: N/A	OFFSET:N/A	REVIEWED BY: Lubor	mir Peytchev																
REMARKS:																			
n (feet) (feet) c Log Type	(inches)		isification r 6-inch (SS very % (NX)	STAND	DARD PENETRATION TEST DATA N in blows/ft bisture	A -1-141													
evatior Depth, Graphi	Sample Sovery	NAL DESCRIPTION	CS Clas lows pe & Reco Moistu	0	25 LL 50	Remarks													
	Rec. 1		SPT BI RQD	S <sup>−</sup>	TRENGTH, tsf tu X Qp														
	Interbedded, slig	htly weathered, medium	DOD-02		2.0 4.0														
	grained to thin b grained to media SHALE and hard 45 degrees, (RC	added, gray, dark gray, tine im grained, very soft to soft d LIMESTONE, dip of 25 to D from 45% to 100 %),	Rec=100%																
	16 60 Devonian [Marca Needmore Shale	ellus Formation and e]	RQD=95 Rec=100% and																
	17 60	Li	RQD=92 Rec=100%																
	18 60		RQD=97 Rec=100%																
	19 60 Slightly weather bedded, black, o grained to mediu coal seams din	ed, medium bedded to thin lark gray, trace white , fine um grained, soft SHALE, trace of 20 to 60 degrees (ROD	RQD=94 Rec=100%																
540	from 47% to 95 Formation and N	%), Devonian [Marcellus leedmore Shale]	POD-05																
535			Rec=100%																
530	21 60		RQD=95 Rec=100%																
- 95	22 60		RQD=88 Rec=100%																
	23 60		Shale RQD=67 Rec=100%																
520-105-	24 60		RQD=50																
515			Rec=100%																
510	25 60		RQD=47 Rec=100%																
505	26 60		RQD=64 Rec=100%																
-120-		Continued Next Page																	
ps	Professiona 2930 Eskric Fairfax, VA Telephone:	al Service Industries, Inc. Ige Rd 22031 (703) 698-9300	PROJI PROJI LOCA	ECT NO.: ECT: <u>64</u> TION:	0512713 193-Eastern Panhand Potomac River C Washington Co Hancock M	-1 le Expansion rossing punty													
DATE STARTED: 6/29/16						6/29/16		DRILL COMPANY: Connelly Drilling, Inc.					BORING GO-1						
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	COMPLETION DEPTH 305.0 ft							DRILLER: 10	<u>om Cnew</u> LC	CME 55 L	<b>Y:</b> J <u>Inonn</u> C	tena	□         □						
BENC	HMAF	RK:				N/A		DRILLING ME	THOD:	Hollow S	tem Auger		ate 1	Upc	on Com	pletion	Dry feet		
ELEV	ATION	1:			62	24 ft		SAMPLING M	IETHOD:2-in S	SS1.874-i	n Core Sta	indarc	≥   ⊻	Dela	ay		N/A feet		
LATIT	UDE:			;	39.680	)3639°		HAMMER TY	PE:	Autom	atic		BORIN	IG LOCA	ATION:				
LONG	SITUDI	E:			78.19	52222°		EFFICIENCY		N/A									
STAT	ION:	N	I/A		OFFS	SET:	N/A	REVIEWED B	SY:L	ibomir Pe	eytchev								
REM/	ARKS:																		
(feet)	eet)	Log	-ype	No.	nches)					ification	6-inch (SS ery % (NX)	%	STA	NDARD F TEST N in blo	PENETR DATA ws/ft ©	ATION			
vation	epth, (1	raphic	ample 7	ample	overy (i		MATEF	RIAL DESCF	RIPTION	S Class	ws per Recover	Moisture	0		25	LL 50	Additional Remarks		
Ele	D	0	ŝ	S	Reco				nso	SPT Blo RQD &			STRENO Qu	GTH, tsf 米	Qp				
	-120-					Slight	v weathere	d medium bec	Ided to thin			_	0	2	2.0	4.0			
500-	   -125-			27	60	bedde graine coal se from 4	d, black, d d to mediu eams, dip o 7% to 95 %	ark gray, trace m grained, soft of 20 to 60 deg %), Devonian [	white , fine SHALE, trac rees, (RQD Marcellus	e Shale	RQD=53 Rec=100	3 %							
			I	28	60	Forma	ition and N	eedmore Shale	9]		RQD=59 Rec=100	9 %							
495-	-130- - 130- 			29	60	Interbe bedde graine hard L	edded, slig d to thin be d to mediu IMESTON	htly weathered, edded, gray, da m grained, soft E, dip of 25 to 9	, medium irk gray , fine t SHALE and 50 degrees,		RQD=10 Rec=100 <sup>6</sup>	0							
490-	-135- -			30	60	(RQD [Marce	ellus Forma	ation and Need	more Shale]		RQD=96	6							
485—	  -140-										Rec=100 <sup>6</sup>	%							
480-	  - 145-			31	60						RQD=93 Rec=1009	3 %							
475-				32	58						RQD=9 Rec=97%	5							
470-	-150-  			33	60					Shale	RQD=98 Rec=100	3 %							
470	-155-  			34	60					and Limesto	ne RQD=9 <sup>-</sup> Rec=100 <sup>0</sup>	1 %							
465—	 _160 			35	59						RQD=96	6							
460—	 -165- 			36	60						RQD=10	0							
455—											Rec=100	%							
450-	  -175-			37	60						RQD=73 Rec=100 <sup>6</sup>	3 %							
445-				38	54						RQD=75 Rec=90%	5							
	-180-						C	Continued Next	Page										
						Dro	fessiona	I Service Inc	- Hustries In	<u> </u>						051271	3_1		
			1		77	293	0 Eskrid	ge Rd		<i>.</i>	F	ROJE	ECT:	 6493-Ea	astern l	Panhand	lle Expansion		
	Ē.	73			i //	Fai	fax, VA	22031			Ĺ	OCA1	ION:	P	otoma	c River C	Crossing		
						Tel	ephone:	(703) 698-9	9300						Wash	ington C	ounty		
															Ha	ncock, N	/ID		

DATE STARTED: 6/29/16						5/29/16	DRILL COMPANY: Connelly Drilling, Inc.					BORING GO-1					
	COMPLETION DEPTH 305.0 ft						DRILLER: Tom Chew LOGGED BY:J. Thonnfend					₩ While Drilling Drv feet					
BENC			.r 11	' -		 N/A	DRILLING METHOD: Hollow Stem Auger					ate	Ť	Upo	on Com	pletion	Dry feet
		l:			62	<u>4</u> ft	SAMPLING METHOD:	2-in SS	.874-i	n Core Stan	 dard	Š	$\bar{\mathbf{v}}$	Del	ay		N/A feet
LATIT	UDE:			:	39.680	)3639°	HAMMER TYPE:		Autom	atic		BOF	RING		ATION:		
LONG	SITUDI	E:			78.19	52222°	EFFICIENCY N/A										
STAT	ION:_	N	I/A		OFFS	ET: <u>N/A</u>	REVIEWED BY:	Lubo	mir Pe	ytchev							
REMA	ARKS:																
ı (feet)	(feet)	: Log	Type	No.	(inches)			N 1	sification	r 6-inch (SS /ery % (NX)	e, %	S <sup>-</sup>	TANI M	DARD F TEST N in blo loisture	PENETR DATA ws/ft ©	ATION PL	
evation	epth,	òraphio	ample	ample	overy	MATER	VIAL DESCRIPTIO	IN	S Clas	ows pe	Moistur	0		:	25	LL 50	Remarks
Ele		U	ű	0)	Rec				nsc	SPT BIG			s ▲ (	GTREN( Qu	GTH, tsf 米	Qp	
	-180-	<u> </u>				Interbedded slid	htly weathered medium	<u> </u>		0)		0		2	2.0	4.0	
440—	   -185-			39	60	bedded to thin be grained to mediu hard LIMESTON (RQD from 55%	edded, gray, dark gray , m grained, soft SHALE E, dip of 25 to 50 degre to 100 %), Devonian	fine and es,		RQD=75 Rec=100%							
435—	   - 190-		_	40	60	[Marcellus Forma	ation and Needmore Sha	ale]	Shale and	RQD=83 Rec=100%							
430-	   			41	60			LI	mesto	RQD=55 Rec=100%							
			I	42	60					RQD=63 Rec=100%							
425—	 _200_ 			43	60	Interbedded, slig bedded to thin be SHALE and hard 45 degrees (RO	htly weathered, medium edded, red, fine grained, LIMESTONE, dip of 25 D from 88% to 93 %)	, soft 5 to		RQD=88 Rec=100%							
420—	 _205 			44	60	Devonian [Marce Needmore Shale	llus Formation and			RQD=88							
415—	 -210- 			45	60				Shale and	RQD=93							
410—	-215-			46	60			LI	mesto	RQD=88							
405—	 -220-			47	60					Rec=100%							
400-	-225-			40	50	Interbedded, slig bedded to thin be	htly weathered, medium edded, white, gray, trace	ı e red,		Rec=100%							
395—	  -230-			48	90	yellow, fine grain SANDSTONE an 25 degrees, (RQ Devonian [Marce	ed to medium grained, s id soft SHALE, dip of 10 D from 46% to 75 %), lus Formation and	soft ) to		Rec=93%							
390-	  -235-			49	60	Needmore Shale		SAI	NDSTO	Rec=100%							
385—	   -240-			50	60					RQD=65 Rec=100%							
						C	ontinued Next Page										
	F			Ż		Professiona 2930 Eskrid Fairfax, VA Telephone:	I Service Industries ge Rd 22031 (703) 698-9300	s, Inc.		PR PR LO	OJE OJE CAT	CT I CT: ION	NO.: _ <u>6</u> :	: 493-E: P	astern l Potomae Wash Ha	0512713 Panhanc c River C ington C ncock, N	3-1 Ile Expansion Crossing county /D

DATE STARTED:         6/29/16           DATE COMPLETED:         7/7/16						3/29/16	DRILL COMPANY: Connelly Drilling, Inc. DRILLER: Tom Chew LOGGED BY:J. Thonnfenc					BORING GO-1					
СОМ	PLETIC	N DE	PTI	н		305.0 ft	DRILL RIG:	DRILL RIG: CME 55 LC					$\overline{\Delta}$	While	e Drillir	ng	Dry feet
BENC	HMAR	K: _				N/A	DRILLING METHOD:	Ho	llow St	em Auger		Vat	Ţ	Upon	n Com	pletion	Dry feet
ELEV	ATION	:			62	<u>24 ft</u>	SAMPLING METHOD:2	2- <u>in SS</u>	1.874-ii	n Core Stan	darc	>	<u> </u>	Delay	y		N/A feet
	UDE:				39.680	<u>)3639°</u> )52222°	HAMMER TYPE: Automatic					BOR	ING L	.OCA	TION:		
			/Δ		0FFS	<u>52222</u> SET· Ν/Δ		Lubo	mir Pe	vtchev							
REMA	ARKS:				_0110			Lubo		ytonev							
(feet)	feet)	Log	<b>Type</b>	No.	nches)				sification	6-inch (SS) ery % (NX)	, %	ST	ANDA T N	RD PE FEST E in blow	ENETRA DATA vs/ft ⊚	ATION PL	
Elevation	Depth, (1	Graphic	Sample <sup>-</sup>	Sample	ecovery (i	MATE	RIAL DESCRIPTIO	N	SCS Class	Blows per 8 Recov	Moisture	0			Additional Remarks		
	240				Å				5	SPT I RQC		0	Qu	2.0	тп, isi Ж	Qp 4.0	
380-	-240-   - 245-			51	60	Interbedded, slig bedded to thin b yellow, fine grain SANDSTONE a 25 degrees, (RC	ghtly weathered, medium bedded, white, gray, trace ned to medium grained, s nd soft SHALE, dip of 10 QD from 46% to 75 %),	e red, soft to		RQD=75 Rec=100%							
375-				52	58	Devonian [Marc Needmore Shale	ellus Formation and e]			RQD=68 Rec=97%							
370-	-250-	· · · · · · · · · · · · · · · · · · ·		53	57			SAI	NDSTO	Rec=95%							
010	-255-  			54	57					RQD=83 Rec=95%							
365—	-260-			55	60					RQD=46 Rec=100%							
360-	-265- -  			56	26	Loose wet brow (USCS SP) trace Devonian [Marc Needmore Shal	n poorly-graded <b>SAND</b> e limestone floaters, ellus Formation and e]			RQD=0 Rec=43%							
355-	-270-			57	8				SP	RQD=0 Rec=13%							
350—	-275-			58	52	Interbedded, slig bedded to thin b grained to mediu SANDSTONE a	ghtly weathered, medium bedded, white, gray, fine um grained, medium haro nd sand seams, dip of 10	d ) to		RQD=13 Rec=87%							
345-	-280-			59	52	35 degrees, (RC Devonian [Marc Needmore Shale	DD from 13% to 30 <sup>°</sup> %), ellus Formation and e]	SAI	NDSTO	NEQD=30 Rec=87%							
340—	 -285- 			60	49					RQD=25							
335—	-290-5 	· · · · · · · · · · · · · · · · · · ·		61	60	Interbedded, slig bedded to thin b grained, mediun	ghtly weathered, medium bedded, white, gray, fine n hard LIMESTONE -			RQD=58							
330-	 -295-	0 0 0		62	60	CHERTY and sa (RQD from 58% [Marcellus Form	and seams, dip of 45 deg to 100 %), Devonian nation and Needmore Sha	<sup>irees</sup> LIN ale] C	IESTO - HERT	RQD=62							
325-	 -300-	0					Continued Next Page			Rec=100%							
						Drofocala		Inc	1			· · · ·					
					57	2930 Eskrid	ai Service industries dae Rd	, INC.		PR		CT N	1 <b>U.:</b> 649	3-Fag	stern F	051271 Panhanc	<u>3-1</u> Ile Expansion
		75	5		;/	Fairfax, VA	22031			LO		ION:		Po	tomac	River C	Crossing
📕					<b>'</b>	Telephone:	(703) 698-9300							1	Washi	ngton C	ounty
															Har	ncock, N	ΛD

	BORING GO-1						
DATE COMPLETED: 7/7/16 DRILLER: Tom Chew LOGGED BY: J. Thonnfend							
COMPLETION DEPTH $305.0 \text{ ft}$ DRILL RIG:       CME 55 LC $brack       brack       brack bra brack $	While Drilling Dry feet						
BENCHMARK:N/ADRILLING METHOD: Hollow Stem Auger	Upon Completion Dry feet						
ELEVATION: 624 ft SAMPLING METHOD:2-in SS1.874-in Core Standard > ½	Delay N/A feet						
LATITUDE: <u>39.6803639°</u> HAMMER TYPE: <u>Automatic</u> BORING	LOCATION:						
LONGITUDE:EFFICIENCY							
REMARKS							
	TEST DATA						
	l in blows/ft ⊚						
	isture PL						
	IRENGTH, tsf						
	u # Qp 2.0 4.0						
-305 Bottom of test boring at 305 feet Rec=100%							
Professional Service Industries, Inc. PROJECT NO.:	0512713-1						
2930 Eskridge Rd PROJECT: 64	93-Eastern Panhandle Expansion						
Fairfax, VA 22031 LOCATION:	Potomac River Crossing						
Telephone: (703) 698-9300	Washington County						

<b>DATE STARTED:</b> 7/7/16							DRILL COMPANY: Connelly Drilling, Inc.					BORING GO-2R				
			ED:			7/11/16	DRILLER: Tom Chew I		<b>3Y:</b> J. Thor	nfend	5					
			:P11	-		<u>154.0 π</u>					ate		n Comple	ation	Dry feet	
		KK: _			I	N/A			in Coro S	er tondo	۳ ۲	T Dela	n compie	50011	N/A feet	
		·			30.68	3732°		Autor	natic	lanua	ROI					
		=			78 1	99167°	FEFICIENCY N/A						NION.			
			Ι/Δ		OFES				evtchev							
REMA	ARKS:				_0110			Lubonnin	cytonev							
									(in the second s		s	TANDARD P	ENETRAT	ION		
					(s			6	N (N			TEST	DATA			
eet	et)	ß	/pe	<u>o</u>	che			icati	∠ -inc	8	2	N in blo	ws/ft ©			
n (f	(fe		Ē	⊂ e	i)	MATE	RIAL DESCRIPTION	ssif	er 6 over	a	s   ×	Moisture	P P		Additional	
atio	pth,	aph	hple	mp	/er/			C	s p	icti	0	2	5	<b>5</b> 0	Remarks	
lev	De	Ū	Sar	Sa	0 S			scs	& Bow	ž						
ш					R B			S				STRENG	STH, tsf ⊮ ⊄	~		
									R R		0	▲ Qu 2	.0 × (	ېر 4.0		
410-	- 0 -	()////	$\mathbf{M}$	1	16	Approximately 3	inches of Topsoil		2-2-3	2	1 @				LL = 38	
_				•	24	A Medium stiff, mo	ist, brown, dark brown, S CL) some gravel roots		N=5	1	9			>>0	PL = 22 Fines=75.1%	
			Щ	2	18	Alluvium			/ 3-3-4 N=7	3	וי				LL = 63	
405-	- 5 -		$\mathbf{X}$	3	18	Medium stiff to s	tiff, moist, mottled brown	Сн	3-4-6	; 2	7		X	->>	LL = 59	
400						Alluvium	S CH) some sand.		N=10	)					PL = 23	
				4	24	Stiff, moist, mott	led brown, lean CLAY			2	5		-+		JL = 33	
	- 10 -			4	18	(USCS CL) trace	sand. Alluvium	CL	N=11	1	в				PL = 18 Fines=90.8%	
400-	E _								_			/			1 1103-00.070	
						Medium stiff, mo	st, mottled brown sandy				_   _					
	- 15 -		ЮĄ	5	14	Alluvium		CL	2-2-3	1	/ <u> </u> @				Fines=55.8%	
395-									C=N			$\mathbf{N}$				
						Stiff, moist, mott	led brown, lean CLAY	0				Ν				
			$\mathbb{N}$	6	12	(USCS CL) trace	shale fragments, sand,		18-11	.7   14	4	×`o				
390-	- 20 -					Weathered Rock	, gray, dark gray, soft SHA			3						
						and hard LIMES	TONE, Silurian [Wills Cree	K SHAL	_n_D .E							
			$\mathbf{X}$	7	2	Shale and Bloom	sburg Formation]		4-48-50	/2"						
385-	- 25 -					bedded to thin be	edded, gray, light gray, trac	ce								
000				8	54	brown, fine grain	ed to medium grained,	_	RQD=	35						
	L _					dip from 30 to 40	ALE and nard LIMESTON	E,   ⊃	INEC-3	, ,0						
200	- 30 -		1			95 %) Silurian [V	Vills Creek Shale and	-			-				i	
300-	F			9	60	Bloomsburg Forr	mation]		RQD=	40						
			11						Rec=Tu	0%						
	- 35 -							Shal	е						ſ	
375-	E _			10	60			and Limest	RQD=	95						
		ĒE						Lincot	Rec=10	0%						
	- 40 -														ł	
370-				11	60				RQD=	52						
									Rec=10	0%						
	 - 45 -														ļ	
365-				12	60				RQD=	82						
			1						_Rec=10	0%						
360-	- 50 -	ΗΓ		12	52				BOD-	70						
	L _			13	55			Shal	PRec=88	3%						
								and								
355-	- 55 -	ΗΓ						Limest	one							
000				14	57				RQD=	93						
			16						1100-3	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,						
	- 60 -		1.			C	Continued Next Page				-				í	
						Drofocoiona	l Sonvice Industrias		1	000			 ^^	1074	2 1	
					57	2930 Fekrid	a Service muustries, I ae Rd	IIIC.		PRO	IECT	6403-Er	Ut Instern Po	nhanr	<u>J-I</u> The Expansion	
				5/		Fairfax, VA	22031			LOCA		<u></u>  : P	otomac F	River (	Crossing	
					IJ	Telephone:	(703) 698-9300						Washing	ton C	County	
							,						Hanc	ock. N	MD	

<b>DATE STARTED</b> : 7/7/16					-	7/7/16	DRILL COMPANY: Connelly Drilling, Inc.					BORING GO-2R					
DATE	COM		ED:	.—		7/11/16	DRILLER: Tom Chew LOGGED BY:J. Thonnfend										
			PII	Η		<u>154.0 π</u>		CIME	: 55 L		_	ate	⊻ Wi ▼ Un		nletion	Dry feet	
		κκ: _			41	<u>N/A</u>		HOI in SS1		em Auger		Ň	V De	lav	pietion	N/A feet	
		N			39.68	111 3732°		<u>ا دی اا</u> ا۔ ۵	.074-1	atic	uaru	BORI					
	SITUD	E:			78.1	99167°		,	N/A		_	Dona					
STAT	ION:	N	I/A		OFFS	ET: N/A	REVIEWED BY:	Lubor	nir Pe	vtchev							
REMA	ARKS:				-		· · · · · · · · · · · · · · · · · · ·			,							
ieet)	et)	bo	/pe	lo.	ches)				ication	-inch (SS) y % (NX)	%	ST	ANDARD TES N in b	PENETR T DATA lows/ft ©	ATION		
ation (f	oth, (fe	tphic L	T aldu	nple N	ery (in	MATER	RIAL DESCRIPTION	١	Classif	s per 6 tecover	oisture,	× 0	Moisture	25	PL LL 50	Additional Remarks	
eva	Dep	Gra	San	Sai	SCO V				scs	80 80 8	M						
					Å				ő	SPT F RQD			Qu Qu	IGTH, tST ₩ 20	Qp		
350-	- 60 -   			15	60	Interbedded, slig bedded to thin be grained to mediu SHALE and hard	htly weathered, medium edded, brown and gray, fi Im grained, medium hard I LIMESTONE, dip from 3	ine 1 30 to		RQD=78 Rec=100%		-					
345—	- 65 -  			16	57	40 degrees, (RQ [Wills Creek Sha Formation]	D from 42 to 93 %) Siluri le and Bloomsburg	ian Lir	Shale and nestoi	RQD=52 Rec=95%							
340-	- 70 - 		I	17	60	Void from 51.3' to	o 51.4'			RQD=42							
	  - 75 -					Void from 53.1' to $\sqrt{100}$	o 53.2'			Rec=100%							
335—	  			18	60	Interbedded, slig bedded to thin be grained to mediu	htly weathered, medium edded, gray, trace brown, Im grained, medium hard	, fine		RQD=98 Rec=100%							
330—	- 80 -  			19	60	SHALE and hard 45 degrees, (RQ [Wills Creek Sha Formation]	I LIMESTONE, dip from 3 D from 66 to 98 %) Siluri le and Bloomsburg	30 to ian		RQD=72 Rec=100%							
325—	- 85 -  			20	60				Shale	RQD=85 Rec=100%							
320—	- 90 - - 90 - 			21	59			Lir	and nestoi	ne RQD=83 Rec=98%							
315—	- 95 - - 95 - 			22	57					RQD=70 Rec=95%							
310-	 _100		ľ	23	60					RQD=66							
	  - 105-			-		Interbedded, slig	htly weathered, medium			Rec=100%							
305—	  			24	51	bedded to thin be brown, fine grain medium hard SH dip from 30 to 45	edded, gray, trace yellow ed to medium grained, IALE and hard LIMESTO 5 degrees, (RQD from 17	NE, to		RQD=62 Rec=85%							
300-	-110-  			25	49	95 %) Silurian [W Bloomsburg Forr	Vills Creek Shale and mation]	Lir	Shale and nestor	RQD=18 Rec=82%							
295-	 -115- 			26	60	Sand seam from	131.6' to 134'			ROD=73							
						Sand seam from	136° to 136.7' 138.5' to 139'			Rec=100%							
	-120-					C	Continued Next Page										
	F			Ĵ		Professiona 2930 Eskrid Fairfax, VA	l Service Industries, ge Rd 22031 (703) 608 0300	, Inc.		PR PR LO	OJE OJE CAT	CT N CT: ION:	<b>0.:</b> 	Eastern I Potomae	051271: Panhanc River (	3-1 Ile Expansion Crossing	
						reiephone.	(100) 000-0000							Ha	ncock, N	MD	

DATE STARTED: 7/7/16 DF						7/7/16	DRILL COMPANY: Connelly Drilling, Inc.					BORING GO-2R					
DATE			ED:	—		7/11/16		DRILLER: Tom Chew LOGGED BY:J. Thonnfend					<b>-</b> 7		ila Drilli		
			:P11	н_		154.01	<u>t</u>						ate ,			nletion	Dry feet
		κκ: _ 				N/A				10110W 51	em Auger	dard	Š k	V Dela	av	piecion	N/A feet
		·			39.68	3732°			F.	Autom	atic	luaru					
LONG		E:			78.1	99167°		EFFICIENCY	<b>-</b> ·	N/A			Boran	10 200/			
STAT	ION:	N	I/A		OFFS	BET:	N/A	REVIEWED BY	/: Lu	bomir Pe	vtchev						
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set)	et)	b	be	o	ches)					cation	inch (SS) / % (NX)	%	STA	NDARD F TEST N in blo	PENETR/ DATA ws/ft ©	ATION	
/ation (f	epth, (fe	aphic Lo	mple Ty	ample N	very (inc		MATER	RIAL DESCR	IPTION	S Classifi	vs per 6- Recover	loisture, <sup>6</sup>	× 0	Moisture	25	PL LL 50	Additional Remarks
Elev	D	Ū	Sa	š	Reco					nsc	SPT Blov RQD &	2		STRENC Qu	GTH, tsf *	Qp 4 0	
290-	-120-  			27	56	Interbe bedde brown mediu	dded, sligi d to thin be fine grain m hard SH	htly weathered, edded, gray, trac ed to medium gr ALE and hard L	medium ce yellow and rained, IMESTONE,		RQD=85 Rec=93%						
285—	-125-  			28	60	dip fro 95 %) Bloom	m 30 to 45 Silurian [W sburg Forn	degrees, (RQD /ills Creek Shale nation]	from 17 to and		RQD=95 Rec=100%	R.					
280—	-130-  			29	33	Sand s	seam from	131.6' to 134' 136' to 136 7'			RQD=23 Rec=55%						
275—	 135			30	52	Sand	seam from	138.5' to 139'		Shale	RQD=58						
270-	 - 140- 			21	60					Limesto	Rec=87%						
	  -145-			31	60						Rec=100%						
265—				32	52						RQD=17 Rec=87%						
260—	-150-  			33	60						RQD=75 Rec=100%						
						Botton	ı of test bo	oring at 154 feet.									
					59	Pro	fessiona	l Service Ind	ustries, Inc		PF			).:	otorn [	051271	3-1
				5/		Fair	fax. VA	22031			LC		10N:	<u>0490-⊏</u> 8 P	otomac	River (	
Telephone: (703) 698-9300										Washi	ngton C	county					
							-								На	ncock, N	//D



## **GENERAL NOTES**

### SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

### DRILLING AND SAMPLING SYMBOLS

- SFA: Solid Flight Auger typically 4" diameter flights, except where noted.
- HSA: Hollow Stem Auger typically 3<sup>1</sup>/<sub>4</sub>" or 4<sup>1</sup>/<sub>4</sub> l.D. openings, except where noted.
- M.R.: Mud Rotary Uses a rotary head with Bentonite or Polymer Slurry
- R.C.: Diamond Bit Core Sampler
- H.A.: Hand Auger
- P.A.: Power Auger Handheld motorized auger

### SOIL PROPERTY SYMBOLS

- SS: Split-Spoon 1 3/8" I.D., 2" O.D., except where noted.
  - ST: Shelby Tube 3" O.D., except where noted.
- RC: Rock Core
- TC: Texas Cone
- 🕅 BS: Bulk Sample
- PM: Pressuremeter
- CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings
- N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
- N<sub>60</sub>: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
- Q<sub>u</sub>: Unconfined compressive strength, TSF
- Q.: Pocket penetrometer value, unconfined compressive strength, TSF
- w%: Moisture/water content, %
- LL: Liquid Limit, %
- PL: Plastic Limit, %
- PI: Plasticity Index = (LL-PL),%
- DD: Dry unit weight, pcf
- ▼,,,, Ž, Ž Apparent groundwater level at time noted

### RELATIVE DENSITY OF COARSE-GRAINED SOILS ANGULARITY OF COARSE-GRAINED PARTICLES

Relative Density	N - Blows/foot	Description	Criteria				
Very Loose	0 - 4	Angular	Particles have sharp edges and relatively plane sides with uppolished surfaces				
Loose Medium Dense	4 - 10 10 - 30	Subangular:	Particles are similar to angular description, but have				
Dense Verv Dense	30 - 50 50 - 80	Subrounded:	Particles have nearly plane sides, but have				
Extremely Dense	80+	Rounded:	well-rounded corners and edges Particles have smoothly curved sides and no edges				

### **GRAIN-SIZE TERMINOLOGY**

### PARTICLE SHAPE

Modifier:

>12%

Component	Size Range	<u>Description</u>	Criteria
Boulders:	Over 300 mm (>12 in.)	Flat:	Particles with width/thickness ratio > 3
Cobbles:	75 mm to 300 mm (3 in. to 12 in.)	Elongated:	Particles with length/width ratio > 3
Coarse-Grained Gravel:	19 mm to 75 mm (¾ in. to 3 in.)	Flat & Elongated:	Particles meet criteria for both flat and
Fine-Grained Gravel:	4.75 mm to 19 mm (No.4 to 3/4 in.)		elongated
Coarse-Grained Sand:	2 mm to 4.75 mm (No.10 to No.4)		
Medium-Grained Sand:	0.42 mm to 2 mm (No.40 to No.10)	RELATIVE	PROPORTIONS OF FINES
Fine-Grained Sand:	0.075 mm to 0.42 mm (No. 200 to No.	40) Descripti	ve Term % Dry Weight
Silt:	0.005 mm to 0.075 mm		Trace: < 5%
Clay:	<0.005 mm		With: 5% to 12%

Page 1 of 2



# **GENERAL NOTES**

(Continued)

### **CONSISTENCY OF FINE-GRAINED SOILS**

<u>Q<sub>U</sub> - TSF</u>	<u>N - Blows/foot</u>	Consistency
0 - 0.25	0 - 2	Very Soft
0.25 - 0.50	2 - 4	Soft
0.50 - 1.00	4 - 8	Firm (Medium Stiff)
1.00 - 2.00	8 - 15	Stiff
2.00 - 4.00	15 - 30	Very Stiff
4.00 - 8.00	30 - 50	Hard
8.00+	50+	Very Hard

### **MOISTURE CONDITION DESCRIPTION**

<b>Description</b>	Criteria
Dry:	Absence of moisture, dusty, dry to the touch
Moist:	Damp but no visible water
Wet:	Visible free water, usually soil is below water table

### **RELATIVE PROPORTIONS OF SAND AND GRAVEL**

Descriptive Term% Dry WeightTrace:< 15%</td>With:15% to 30%Modifier:>30%

### STRUCTURE DESCRIPTION

<b>Description</b>	Criteria	<b>Description</b>	Criteria
Stratified:	Alternating layers of varying material or color with	n Blocky:	Cohesive soil that can be broken down into small
	layers at least ¼-inch (6 mm) thick		angular lumps which resist further breakdown
Laminated:	Alternating layers of varying material or color with	n Lensed:	Inclusion of small pockets of different soils
	layers less than ¼-inch (6 mm) thick	Layer:	Inclusion greater than 3 inches thick (75 mm)
Fissured:	Breaks along definite planes of fracture with little	Seam:	Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick
	resistance to fracturing		extending through the sample
Slickensided:	Fracture planes appear polished or glossy, sometimes striated	Parting:	Inclusion less than 1/8-inch (3 mm) thick

### SCALE OF RELATIVE ROCK HARDNESS

<u>Q<sub>U</sub> - TSF</u>	<u>Consistency</u>
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
,050 - 2,600	Hard
>2.600	Verv Hard

### **ROCK VOIDS**

<u>Voids</u>	Void Diameter
Pit	<6 mm (<0.25 in)
Vug	6 mm to 50 mm (0.25 in to 2 in)
Cavity	50 mm to 600 mm (2 in to 24 in)
Cave	>600 mm (>24 in)

### **ROCK QUALITY DESCRIPTION**

Rock Mass Description	RQD Value	
Excellent	90 -100	
Good	75 - 90	
Fair	50 - 75	
Poor	25 -50	
Very Poor	Less than 25	

### **ROCK BEDDING THICKNESSES**

<b>Description</b>	Criteria
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	<sup>1</sup> / <sub>2</sub> -inch to 1 <sup>1</sup> / <sub>4</sub> -inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to 1/2-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

### **GRAIN-SIZED TERMINOLOGY**

(Typically Sedimentary Rock)					
<u>Component</u>	Size Range				
Very Coarse Grained	>4.76 mm				
Coarse Grained	2.0 mm - 4.76 mm				
Medium Grained	0.42 mm - 2.0 mm				
Fine Grained	0.075 mm - 0.42 mm				
Very Fine Grained	<0.075 mm				

### **DEGREE OF WEATHERING**

Slightly Weathered:Rock generally fresh, joints stained and discoloration<br/>extends into rock up to 25 mm (1 in), open joints may<br/>contain clay, core rings under hammer impact.Weathered:Rock mass is decomposed 50% or less, significant<br/>portions of the rock show discoloration and<br/>weathering effects, cores cannot be broken by hand<br/>or scraped by knife.Highly Weathered:Rock mass is more than 50% decomposed, complete<br/>discoloration of rock fabric, core may be extremely<br/>broken and gives clunk sound when struck by<br/>hammer, may be shaved with a knife.

# SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYM	BOLS	TYPICAL
			GRAPH	LETTER	DESCRIPTIONS
	GRAVEL AND	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	GRAVELLY SOILS	(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
COARSE GRAINED SOILS	MORE THAN 50% OF COARSE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
	RETAINED ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50%	SAND AND	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
LARGER THAN NO. 200 SIEVE SIZE	SANDY SOILS	(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
	PASSING ON NO. 4 SIEVE			SC	CLAYEY SANDS, SAND - CLAY MIXTURES
				ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE	MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE			МН	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		СН	INORGANIC CLAYS OF HIGH PLASTICITY
				ОН	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
н	IGHLY ORGANIC S	SOILS		PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS







Cross Section Showing the General Stratigraphy



EnSite USA Project Number 6493 Eastern Panhandle Expansion, Potomac River Crossing PSI Project Number 0512713-1 Revised September 9, 2016



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Laboratory Test Results



EnSite USA Project Number 6493 Eastern Panhandle Expansion, Potomac River Crossing PSI Project Number 0512713-1 Revised September 9, 2016

# Laboratory Summary Sheet

BoreholeApprox. Depti LimitLiquid LimitPlastictly IndexQu (tsf)%-#200 ServeEst. Specifi ServitWater ContentDry DensitySatur- ationYeddGO-111 <td< th=""><th></th><th></th><th></th><th></th><th></th><th>-</th><th></th><th>-</th><th></th><th></th><th>Sheet</th><th>1 of 1</th></td<>						-		-			Sheet	1 of 1
GO-11 $14$ $GO-1$ 355272897.4%21 $GO-1$ 5.599.8% $GO-1$ 939271299.8%<	Borehole	Approx. Depth	Liquid Limit	Plastic Limit	Plasticity Index	Qu (tsf)	%<#200 Sieve	Est. Specific Gravity	Water Content (%)	Dry Density (pcf)	Satur- ation (%)	Void Ratio
$GO-1$ 355272897.4%21 $\ldots$ $\ldots$ $GO-1$ 5.5 $\ldots$ $\ldots$ $\ldots$ $233$ $\ldots$ $\ldots$ $\ldots$ $GO-1$ 939271299.8%25 $\ldots$ $\ldots$ $\ldots$ $GO-1$ 1145291699.6%26 $\ldots$ $\ldots$ $\ldots$ $GO-1$ 14 $\ldots$ $\ldots$ $\ldots$ 99.6%26 $\ldots$ $\ldots$ $\ldots$ $GO-1$ 14 $\ldots$ $\ldots$ $\ldots$ $211$ $\ldots$ $\ldots$ $\ldots$ $GO-1$ 184442618 $90.0\%$ 21 $\ldots$ $\ldots$ $GO-1$ 19 $\ldots$ $\ldots$ $\ldots$ $\ldots$ $255$ $\ldots$ $\ldots$ $GO-1$ 19 $\ldots$ $\ldots$ $\ldots$ $\ldots$ $255$ $\ldots$ $\ldots$ $GO-1$ 184442618 $90.0\%$ $211$ $\ldots$ $\ldots$ $GO-1$ 19 $\ldots$ $\ldots$ $\ldots$ $\ldots$ $255$ $\ldots$ $\ldots$ $GO-2R$ 1 $\ldots$ $\ldots$ $\ldots$ $\ldots$ $211$ $\ldots$ $\ldots$ $GO-2R$ 3 $63$ 2538 $\ldots$ $300$ $\ldots$ $\ldots$ $\ldots$ $GO-2R$ 3.5592336 $89.3\%$ 20 $\ldots$ $\ldots$ $\ldots$ $GO-2R$ 8.5331815 $90.8\%$ 20 $\ldots$ $\ldots$ $\ldots$ $GO-2R$ 9 $\ldots$ $\ldots$ $\ldots$ $188$ $\ldots$ $\ldots$ $\ldots$ $\ldots$ $GO-2R$ 14	GO-1	1							14			
GO-1 $5.5$ $1$ $1$ $1$ $1$ $2$ $1$ $2$ $2$ $2$ $2$ $1$ $2$ $2$ $2$ $1$ $2$ $2$ $1$ $2$ $2$ $1$ $2$ $2$ $1$ $2$ $2$ $1$ $2$ $2$ $1$ $2$ $2$ $1$ $2$ $2$ $1$ $2$ $2$ $1$ $2$ $2$ $1$ $2$ $2$ $1$ $2$ $2$ $1$ $2$ $1$ $2$ $1$ $2$ $1$	GO-1	3	55	27	28		97.4%		21			
$GO-1$ 939271299.8%25 $\ldots$ $\ldots$ $GO-1$ 1145291699.6%26 $\ldots$ $\ldots$ $\ldots$ $GO-1$ 14 $\ldots$ $\ldots$ $\ldots$ $99.6\%$ $26$ $21$ $\ldots$ $\ldots$ $GO-1$ 14 $\ldots$ $\ldots$ $\ldots$ $90.0\%$ $21$ $\ldots$ $\ldots$ $\ldots$ $GO-1$ 18442618 $90.0\%$ $21$ $\ldots$ $\ldots$ $\ldots$ $GO-1$ 19 $\ldots$ $\ldots$ $\ldots$ $90.0\%$ $21$ $\ldots$ $\ldots$ $\ldots$ $GO-2$ R19 $\ldots$ $\ldots$ $\ldots$ $30.0$ $\ldots$ $\ldots$ $\ldots$ $GO-2$ R1.5382216 $$	GO-1	5.5							23			
GO-11145291699.6%26 $16$ $26$ $16$ $16$ $GO-1$ 14 $14$ $26$ $18$ $90.0$ $21$ $16$ $16$ $GO-1$ 1844 $26$ $18$ $90.0$ $21$ $16$ $25$ $16$ $GO-1$ 19 $16$ $16$ $16$ $25$ $16$ $16$ $GO-2R$ 1 $16$ $16$ $75.1$ $19$ $16$ $16$ $GO-2R$ 3.6325 $38$ $26$ $16$ $30$ $19$ $16$ $GO-2R$ $5.5$ $59$ $23$ $36$ $89.3$ $27$ $16$ $16$ $GO-2R$ $8.5$ $33$ $18$ $15$ $90.8$ $27$ $16$ $16$ $GO-2R$ $9$ $14$ $16$ $16$ $90.8$ $20$ $16$ $16$ $GO-2R$ $14$ $16$ $16$ $16$ $17$ $16$ $16$ $GO-2R$ $14$ $16$ $16$ $16$ $14$ $14$ $16$	GO-1	9	39	27	12		99.8%		25			
GO-114 $14$ $16$ $16$ $16$ $21$ $16$ $16$ $GO-1$ 18442618 $90.0%$ 21 $21$ $16$ $26$ $GO-1$ 19 $16$ $16$ $16$ $25$ $16$ $21$ $21$ $16$ $21$ $GO-2R$ 1.5382216 $75.1%$ $19$ $16$ $19$ $16$ $16$ $GO-2R$ 3.632538 $16$ $75.1%$ $19$ $16$ $16$ $GO-2R$ 3.632538 $16$ $27$ $10$ $16$ $16$ $GO-2R$ 5.5592336 $89.3%$ $27$ $16$ $16$ $16$ $GO-2R$ 8.5331815 $90.8%$ $20$ $16$ $16$ $16$ $GO-2R$ 9 $14$ $16$ $16$ $55.8%$ $17$ $16$ $16$ $16$ $GO-2R$ 19 $14$ $16$ $16$ $55.8%$ $17$ $16$ $16$ $16$	GO-1	11	45	29	16		99.6%		26			
GO-11844261890.0%21 $I$ $I$ $I$ $GO-1$ 19 $I$	GO-1	14							21			
GO-119	GO-1	18	44	26	18		90.0%		21			
GO-2R1	GO-1	19							25			
GO-2R1.538221675.1%191011GO-2R363253830301010GO-2R5.559233689.3%271010GO-2R8.533181590.8%201010GO-2R9161655.8%1810111011GO-2R14161655.8%11710111011GO-2R191616114101111	GO-2R	1							21			
GO-2R       3       63       25       38	GO-2R	1.5	38	22	16		75.1%		19			
GO-2R       5.5       59       23       36       89.3%       27           GO-2R       8.5       33       18       15       90.8%       20            GO-2R       9        18       15       90.8%       20             GO-2R       9            18            GO-2R       14            55.8%       17             GO-2R       19	GO-2R	3	63	25	38				30			
GO-2R       8.5       33       18       15       90.8%       20          GO-2R       9           18           GO-2R       14           55.8%       17           GO-2R       19            14	GO-2R	5.5	59	23	36		89.3%		27			
GO-2R         9            18              GO-2R         14            55.8%         17 </td <td>GO-2R</td> <td>8.5</td> <td>33</td> <td>18</td> <td>15</td> <td></td> <td>90.8%</td> <td></td> <td>20</td> <td></td> <td></td> <td></td>	GO-2R	8.5	33	18	15		90.8%		20			
GO-2R         14         Image: Constraint of the state	GO-2R	9							18			
GO-2R 19 14 14	GO-2R	14					55.8%		17			
	GO-2R	19							14			



Professional Service Industries 2930 Eskridge Rd Fairfax, VA 22031 Telephone: (703) 698-9300 Fax: (703) 560-7931

## Summary of Laboratory Results

PSI Job No.:	0512713-1
Project:	6493-Eastern Panhandle Expansion
_ocation:	Potomac River Crossing
	Washington County
	Hancock, MD







### UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL - ASTM D 2166

Sheet 3 of 3



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## UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL - ASTM D 2166

Sheet 3 of 3





Laboratories

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## **Unconfined Compression Test**

Date: 7/18/2016		Project:	EnsiteUSA-CPG Pipeline, Washington County, MD
Tested by: Redha K Hasan		Project No:	0512713-1
Client: CPG		Location:	Hancock, MD
Average Initial Height (in):	6.14	Boring :	GO1
Average Initial Diameter (in):	2.82	Sample Number:	ST-2
Water Content %:	26.4	Sample Depth:	11.0'-11.5'
Wet Density (pcf): Dry Density (pcf): LL - PL = PI:	119.4 94.5 45 - 26 = 16	Soil Description:	ML



This test was performed according to ASTM D2166 . Unconfined Compressive Strength of Cohesive Soil.

Average Rate of Strain to Failure (% Strain/min):

0.00% 0.00%



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Laboratories

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## Unconfined Compression Test

Date: 7/18/2016 Tested by: Redha K Hasan Client:		Project: Project No: Location:	EnsiteUSA-CPG Pipeline, Washington County, MD 0512713-1 Hancock. MD
Average Initial Height (in):	6.32	Boring :	GO1
Average Initial Diameter (in):	2.83	Sample Number:	ST3
Water Content %:	21.2	Sample Depth:	18.3'-18.8'
Wet Density (pcf):	117.7		
Dry Density (pcf):	97.2	Soil Description:	CL
LL - PL = PI:	44 - 26 = 18		



Unconfined Compression Strength q <sub>u</sub> (tsf):	1.15
Height to Diameter Ratio:	2.2
Percent Strain at Failure :	0.00%
Average Rate of Strain to Failure (% Strain/min):	0.00%
This test was performed according to ASTM D2166 . Unconfined Compressive Strength of Cohesive Soil.	



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## **Unconfined Compression Test**

Date: 7/18/2016 Tested by: Redha K Hasan Client: CPG		Project: Project No: Location:	EnsiteUSA-CPG Pipeline, Washington County, MD 0512713-1 Hancock, MD
Average Initial Height (in):	6.51	Boring :	GO2R
Average Initial Diameter (in):	2.82	Sample Number:	ST-3
Water Content %:	0.0	Sample Depth:	8.5'-9.0'
Wet Density (pcf):	125.0		
Dry Density (pcf):	104.0	Soil Description:	CL
LL - PL = PI:	33 - 18 = 15	•	



Unconfined Compression Strength q <sub>u</sub> (tsf):	1.09
Height to Diameter Ratio:	2.3
Percent Strain at Failure :	0.00%
Average Rate of Strain to Failure (% Strain/min):	0.00%
This test was performed according to ASTM D2166 . Unconfined Compressive Strength of Cohesive Soil.	



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Phone (703) 698-9300 Fax (703) 560-7931

## **Unconfined Compression Test**

Date: 7/18/2016 Tested by: Redha K Hasan Client: CPG		Project: Project No: Location:	EnsiteUSA-CPG Pipeline, Washington County, MD 0512713-1 Hancock. MD
Average Initial Height (in):	5.86	Boring :	GO2 R
Average Initial Diameter (in):	2.76	Sample Number:	ST-1
Water Content %:	13.8	Sample Depth:	1.5'-2.0'
Wet Density (pcf):	114.1		
Dry Density (pcf):	100.3	Soil Description:	CL
LL - PL = PI:	38 - 22 = 16	•	



Unconfined Compression Strength q <sub>u</sub> (tsf):	0.72
Height to Diameter Ratio:	2.1
Percent Strain at Failure :	0.00%
Average Rate of Strain to Failure (% Strain/min):	0.00%
This test was performed according to ASTM D2166 . Unconfined Compressive Strength of Cohesive Soil.	

Slake Durability Test Results



EnSite USA Project Number 6493 Eastern Panhandle Expansion, Potomac River Crossing PSI Project Number 0512713-1 Revised September 9, 2016

Client Client Project Project No.	Professional Service Proposed Eastern P 37622	rofessional Service Industries, Inc. (PSI) roposed Eastern Panhandle Expansion 7622		GO-1 51.0'-52.0' RC-13 37622003
Visual Description:	Gray Limestone			
Initial Wa	ter Content			
Drum ID		В		Client Project
Drum + Wet Shale,	gm	1723.59		Project No. Boring Depth Semple
Drum + Dry Shale, g	m	1714.96		Lab Sample No
Drum Wt., gm		1244.24		(
Water Content, %		1.83%		
Initial Dry Shale We	ight, gm	470.72		
Water Temerature I	Before Cycle 1, *C	19.5		
Water Temerature	After Cycle 1, *C	19.6	and the second second	
Average Temp durir	ng Cycle 1, *C	19.55	A COMPANY	
				97/9
Drum + Dry Shale af	ter Cycle 1, gm	1712.79		346Z
Dry Shale after Cycl	e 1	468.55		
Slake Durability Ind	ex (First cycle)	99.5%		Fin
				Depth 51 Sample F Lab Sample No 37
Water Temerature I	Before Cycle 2, *C	20.1		
Water Temerature	After Cycle 2, *C	21.1		
Average Temp durir	ng Cycle 2, *C	20.6		
Drum + Dry Shale af	ter Cycle 2, gm	1711.58	N	
Dry Shale after Cycl	e 2	467.34		
Slake Durability Ind	ex (Second cycle)	99.3%		

Type II—Retained specimen consist of large and small fragments.



**Final Photograph** 



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Date Tested:

Client Client Project Project No.	Professional Service Industries, Inc. (PSI) Proposed Eastern Panhandle Expansion 37622		Boring Depth Sample Lab Sample No.	GO-1 64.5'-65.5' RC-16 37622004
Visual Description:	Gray Limestone			
Initial Wa	ater Content			
Drum ID		А		Client Project 0
Drum + Wet Shale,	gm	1711.15		Project No. 0 Boring Depth 6
Drum + Dry Shale, §	gm	1703.49		Sample Lab Sample No 3
Drum Wt., gm		1244.85		-
Water Content, %		1.67%	6	
Initial Dry Shale We	ight, gm	458.64		
Water Temerature	Before Cycle 1, *C	19.9		
Water Temerature After Cycle 1, *C		20.1		
Average Temp duri	ng Cycle 1, *C	20	Here	
				27177
Drum + Dry Shale a	fter Cycle 1, gm	1700.98		31022
Dry Shale after Cycl	le 1	456.13		
Slake Durability Inc	dex (First cycle)	99.5%		Fina Project No.
				Boring
Water Temerature	Before Cycle 2, *C	21.2		10.403
Water Temerature	After Cycle 2, *C	21.6		
Average Temp duri	ng Cycle 2, *C	21.4		A
				1392
Drum + Dry Shale a	fter Cycle 2, gm	1699.6		ALA
Dry Shale after Cyc	le 2	454.75		RAN
Slake Durability Inc	dex (Second cycle)	99.2%	1	

Type II—Retained specimen consist of large and small fragments.



**Final Photograph** 



Date Tested:

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Client Client Project	Professional Service Industries, Inc. (PSI)	Boring	GO-1
Project No.	37622	Sample Lab Sample No.	RC-22 37622005

#### Visual Description: Gray Carbonaceous Shale

### **Initial Water Content**

Drum ID	В
Drum + Wet Shale, gm	1760.42
Drum + Dry Shale, gm	1756.59
Drum Wt., gm	1244.15
Water Content, %	0.75%
Initial Dry Shale Weight, gm	512.44
Water Temerature Before Cycle 1, *C	21.1
Water Temerature After Cycle 1, *C	21.5
Average Temp during Cycle 1, *C	21.3
Drum + Dry Shale after Cycle 1, gm	1729.77
Dry Shale after Cycle 1	485.62
Slake Durability Index (First cycle)	94.8%
Water Temerature Before Cycle 2, *C	22.1
Water Temerature After Cycle 2, *C	22.6
Average Temp during Cycle 2, *C	22.35
Drum + Dry Shale after Cycle 2, gm	1705.12
Dry Shale after Cycle 2	460.97
Slake Durability Index (Second cycle)	90.0%

Type II—Retained specimen consist of large and small fragments.







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Client Client Project Project No.	Professional Service Proposed Eastern Pa 37622	Industries, Inc. (PSI) anhandle Expansion	Boring Depth Sample Lab Sample No.	GO-1 129.0'-130.0' RC-29 37622006
Visual Description	n: Gray Limestone			
Initial V	Nater Content			
Drum ID		А	-	Client 0
Drum + Wet Shal	e, gm	1760.93		Client Project 0 Project No. 0 Boring GC
Drum + Dry Shale	e, gm	1754.3		Depth 129.0- Sample RC Lab Sample No 3762
Drum Wt., gm		1244.79		Ging Lineson
Water Content, %	6	1.30%		-
Initial Dry Shale V	Veight, gm	509.51	13	
Water Temeratur	re Before Cycle 1, *C	21.8		1
Water Temeratur	re After Cycle 1, *C	22		
Average Temp du	iring Cycle 1, *C	21.9	100	M
Drum + Dry Shale	after Cycle 1, gm	1749.97		376.
Dry Shale after Cy	ycle 1	505.18		
Slake Durability I	ndex (First cycle)	99.2%	_	Final
				Project No. 0 Boring GO.
Water Temeratu	re Before Cycle 2, *C	21.2	1000	Sample RC- Lab Sample No 37622
Water Temeratur	re After Cycle 2, *C	21.3		GENY LIVESTOND
Average Temp du	iring Cycle 2, *C	21.25		
				Pali
Drum + Dry Shale	after Cycle 2, gm	1747.9		76
Dry Shale after Cy	ycle 2	503.11		
Slake Durability I	ndex (Second cycle)	98.7%		

Type II—Retained specimen consist of large and small fragments.



**Final Photograph** 



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Client	Professional Service	e Industries, Inc. (PSI)	Boring	GO-1
Client Project	Proposed Eastern F	Panhandle Expansion	Depth	203.0'-204.0'
Project No.	37622		Sample Lab Sample No.	RC-43 37622007
Visual Description:	Brown Shale	(Sample Did Not Meet Mas	ss Requirements)	
Initial Wa	ter Content			
Drum ID		А		Initial Photograph
Drum + Wet Shale, g	gm	1685.07		Clent Project 0 Project No. 0 Boring GO-1
Drum + Dry Shale, g	m	1678.41		Dephi 203.0"-204.0" Sample RC-33 Lab Sample No 37522007
Drum Wt., gm		1244.75		
Water Content, %		1.54%		Han True
Initial Dry Shale Wei	ight, gm	433.66	1 Alexandre	
,				
Water Temerature B	Before Cycle 1, *C	20.9		and the second
Water Temerature A	After Cycle 1, *C	21.4		
Average Temp durir	ng Cycle 1, *C	21.15	0	
			Jample	Does Nor MEET MASS REQUIREMENTS
Drum + Dry Shale af	ter Cycle 1, gm	1531.42		37622007 (only 9 pieces)
Dry Shale after Cycle	e 1	286.67		
Slake Durability Ind	ex (First cycle)	66.1%		Final Photograph
				Project No. U Boring GO-1 Depth 203.0°-204.0°
Water Temerature	Before Cycle 2, *C	21.9		Sample RC-53 Lab Sama No 3722007
Water Temerature A	After Cycle 2, *C	22.3		- Antice Co
Average Temp durir	ng Cycle 2, *C	22.1		
Drum + Dry Shale af	ter Cycle 2, gm	1430.81	1	A STATEMENT
Dry Shale after Cycle	e 2	186.06	2	A STATISTICS
			2 C	K K B B C A
Slake Durability Ind	ex (Second cycle)	42.9%	The second secon	ACAL AL
			6.0	

Type III—Retained specimen is exclusively small fragments.

Date Tested:

Jample Does Nor Meet Mass RequiremENTS 37622007 (ONly 9 PIECES)

7/19/2016

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Client Client Project Project No.	ientProfessional Service Industries, Inc. (PSI)ient ProjectProposed Eastern Panhandle Expansionroject No.37622		Boring Depth Sample Lab Sample No.	GO-1 255.0'-256.0' RC-54 37622008
Visual Description:	Brown Sandstone			
Initial Wa	ater Content			
Drum ID		C		Initial
Drum + Wet Shale,	gm	1745.13		Boring GO Depth 255.0'- Sample RC-
Drum + Dry Shale, g	m	1732.73		Lab Sample No 37622
Drum Wt., gm		1257.63		Braun
Water Content, %		2.61%		X
Initial Dry Shale We	ight, gm	475.1		
Water Temerature	Before Cycle 1, *C	19.7		
Water Temerature After Cycle 1, *C		20		V
Average Temp durir	ng Cycle 1, *C	19.85	C.	
Drum + Dry Shale at	fter Cycle 1, gm	1545.18		37624
Dry Shale after Cycl	e 1	287.55		
Slake Durability Ind	lex (First cycle)	60.5%		Final
				Lab Sample No 3762200
Water Temerature	Before Cycle 2, *C	21.1	and a	Braun S.
Water Temerature	After Cycle 2, *C	21.4		
Average Temp durir	ng Cycle 2, *C	21.25		-
Drum + Dry Shale af	fter Cycle 2, gm	1397.53		i que
Dry Shale after Cycl	e 2	139.9		
Slake Durability Ind	lex (Second cycle)	29.4%		

Type III—Retained specimen is exclusively small fragments.





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Client Professional Servi Client Project Proposed Eastern Project No. 37622		ndustries, Inc. (PSI) nhandle Expansion	Boring Depth Sample Lab Sample No.	GO-2R 43.0'-44.0' RC-11 37622009
Visual Description	: Gray Sandstone			
Initial W	Vater Content			
Drum ID		D		Initial Photo
Drum + Wet Shale	e, gm	1782.91		Boring         GO-2R           Depth         43.0'-44.0'           Sample         RC-11           Lab Sample No         37622009
Drum + Dry Shale,	gm	1780.48		Sudding
Drum Wt., gm		1260.77		142 CA
Water Content, %		0.47%		1-1-1
Initial Dry Shale W	/eight, gm	519.71		L
Water Temerature	e Before Cycle 1, *C	20.4		No. 11
Water Temerature	e After Cycle 1, *C	21.2		1 Alexand
Average Temp du	ring Cycle 1, *C	20.8	All and a second	
Drum + Dry Shale	after Cycle 1, gm	1780.17	3	7622009
Dry Shale after Cy	cle 1	519.4		
Slake Durability Ir	ndex (First cycle)	99.9%	_	Final Photo
				Client Project         0           Project No.         0           Boring         GO-2R           Depth.         43.0'-44.0'           Sample         RC-11           Lab Sample No.         3762209
Water Temerature	e Before Cycle 2, *C	21.4		Istone
Water Temerature	e After Cycle 2, *C	22.2		
Average Temp dui	ring Cycle 2, *C	21.8		
Drum + Dry Shale	after Cycle 2, gm	1779.33		
Dry Shale after Cy	cle 2	518.56	CP 1	
Slake Durability Ir	ndex (Second cycle)	99.8%		17

Type I—Retained specimen remain virtually unchanged







Date Tested:

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Client Client Project Project No.	nt Professional Service Industries, li nt Project Proposed Eastern Panhandle Exp ect No. 37622		Boring Depth Sample Lab Sample No.	GO-2R 58.0'-59.0' RC-14 37622010
Visual Description:	Gray Shale			
Initial Wa	ter Content			
Drum ID		С		Initial Photograph
Drum + Wet Shale, ۽	gm	1769.7		Depth 58.0-59.0 Sample RC-14 Lab Sample No 37622010
Drum + Dry Shale, g	m	1767.32		Can Ship
Drum Wt., gm		1257.94		and survey
Water Content, %		0.47%	ATT A	6)00
Initial Dry Shale Wei	ight, gm	509.38		
Water Temerature B	Before Cycle 1, *C	21.7		
Water Temerature A	After Cycle 1, *C	21.9		1 mg
Average Temp durir	ng Cycle 1, *C	21.8		01193010
Drum + Dry Shale af	ter Cycle 1, gm	1764.24		31622010
Dry Shale after Cycle	e 1	506.3		
Slake Durability Ind	ex (First cycle)	99.4%		Final Photograph
				Boring GO-2R Depth 58.0'-59.0' Sample RC-14 Line Sample 376/22010
Water Temerature I	Before Cycle 2, *C	20.7		
Water Temerature A	After Cycle 2, *C	21.2		Shale
Average Temp durir	ng Cycle 2, *C	20.95	S	
Drum + Dry Shale af	ter Cycle 2, gm	1762.76	VA	
Dry Shale after Cycle	e 2	504.82	100	1916
Slake Durability Ind	ex (Second cycle)	99.1%		

Type I—Retained specimen remain virtually unchanged

Date Tested:

37622010

7/18/2016

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Client Client Project Project No.	Professional Service Ir Proposed Eastern Pan 37622	Professional Service Industries, Inc. (PSI) Proposed Eastern Panhandle Expansion 37622		GO-2R 70.5'-71.5' RC-11 37622011
Visual Description:	Brown Limestone			
Initial W	ater Content			
Drum ID		D	-	Init
Drum + Wet Shale	, gm	1736.6		Client Client Project Project No.
Drum + Dry Shale,	gm	1728.84		Boring Depth Sample Lab Sample No
Drum Wt., gm		1260.89		1
Water Content, %		1.7%	1	
Initial Dry Shale W	eight, gm	467.95		X
Water Temerature	e Before Cycle 1, *C	19.7	and the second s	13
Water Temerature	e After Cycle 1, *C	19.9	- Star	T
Average Temp dur	ing Cycle 1, *C	19.8	C.	1
				19.6
Drum + Dry Shale a	after Cycle 1, gm	1728.33	100	37622
Dry Shale after Cyc	cle 1	467.44		
Slake Durability In	dex (First cycle)	99.9%		Fin_
			1000	Boring 0 Depth 70 Sample
Water Temerature	Before Cycle 2, *C	20.4		
Water Temerature	e After Cycle 2, *C	21.2		
Average Temp dur	ing Cycle 2, *C	20.8		VIII)
			the second	M
Drum + Dry Shale a	after Cycle 2, gm	1728.34	Lan -	
Dry Shale after Cyc	cle 2	467.45	100	
Slake Durability In	dex (Second cycle)	99.9%		X

Type I—Retained specimen remain virtually unchanged

 Initial Photograph

 Image: Display initial provided initiprovided initial provided initial provided initial prov

**Final Photograph** 



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Client	Professional Service Industries, Inc. (PSI)	Boring	GO-2R
Client Project	Proposed Eastern Panhandle Expansion	Depth	100.0'-101.0'
Project No.	37622	Sample	RC-14
		Lab Sample No.	37622012

Visual Description: Gray Interbedded Shale and Siltstone

#### **Initial Water Content**

Drum ID	D
Drum + Wet Shale, gm	1794.64
Drum + Dry Shale, gm	1793.39
Drum Wt., gm	1260.89
Water Content, %	0.23%
Initial Dry Shale Weight, gm	532.5
Water Temerature Before Cycle 1, *C	21.4
Water Temerature After Cycle 1, *C	21.8
Average Temp during Cycle 1, *C	21.6
Drum + Dry Shale after Cycle 1, gm	1791.2
Dry Shale after Cycle 1	530.31
Slake Durability Index (First cycle)	99.6%
Water Temerature Before Cycle 2, *C	20.5
Water Temerature After Cycle 2, *C	20.9
Average Temp during Cycle 2, *C	20.7
Drum + Dry Shale after Cycle 2, gm	1789.45
Dry Shale after Cycle 2	528.56
Slake Durability Index (Second cycle)	99.3%

Type I—Retained specimen remain virtually unchanged



#### **Final Photograph**



Date Tested:

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Client Client Project Project No.	Professional Service Proposed Eastern P 37622	osed Eastern Panhandle Expansion		GO-2R 122.0'-123.0' RC-9 37622013
Visual Description:	Gray Shale			
Initial Wa	ter Content			
Drum ID		С	_	Initial Photograph
Drum + Wet Shale, §	gm	1787.6		Client Project         0           Project No.         0           Baring         GO-2R
Drum + Dry Shale, g	m	1783.77		Depth 122.0'-123.0' Sample RC-9 Lab Sample No 37622013
Drum Wt., gm		1257.52		Gry Shale
Water Content, %		0.73%		
Initial Dry Shale Wei	ight, gm	526.25		200
Water Temerature E	Before Cycle 1, *C	20.3		
Water Temerature A	After Cycle 1, *C	20.9		MERICA
Average Temp durin	ng Cycle 1, *C	20.6	100	
				27/22012
Drum + Dry Shale af	ter Cycle 1, gm	1781.8	100	57622013
Dry Shale after Cycle	e 1	524.28		
Slake Durability Ind	ex (First cycle)	99.6%		Final Photograph
				Project No. 0 Boring GO-2R Depth 122.0'-123.0'
Water Temerature	Before Cycle 2, *C	21.2		Sample No 37622013
Water Temerature A	After Cycle 2, *C	21.9		Shale
Average Temp durin	ng Cycle 2, *C	21.55		
Drum + Dry Shale af	ter Cycle 2, gm	1780.37		
Dry Shale after Cycle	e 2	522.85		1 - A
Slake Durability Ind	ex (Second cycle)	99.4%		
			ADDUCTOR	A STATE OF THE OWNER

Type I—Retained specimen remain virtually unchanged

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37622013

Date Tested:

7/19/2016

Input Validation: tmp

Client	Professional Service Industries, Inc. (PSI)	Boring	GO-2R
Client Project	Proposed Eastern Panhandle Expansion	Depth	151.5'-152.5'
Project No.	37622	Sample	RC-13
		Lab Sample No.	37622014

Visual Description: Gray Interbedded Shale and Siltstone

#### **Initial Water Content**

Drum ID	В
Drum + Wet Shale, gm	1723.44
Drum + Dry Shale, gm	1713.92
Drum Wt., gm	1244.29
Water Content, %	2.03%
Initial Dry Shale Weight, gm	469.63
Water Temerature Before Cycle 1, *C	21.4
Water Temerature After Cycle 1, *C	21.7
Average Temp during Cycle 1, *C	21.55
Drum + Dry Shale after Cycle 1, gm	1712.79
Dry Shale after Cycle 1	468.5
Slake Durability Index (First cycle)	99.8%
Water Temerature Before Cycle 2, *C	21.3
Water Temerature After Cycle 2, *C	21.5
Average Temp during Cycle 2, *C	21.4
Drum + Dry Shale after Cycle 2, gm	1712.16
Dry Shale after Cycle 2	467.87
Slake Durability Index (Second cycle)	99.6%

Type I—Retained specimen remain virtually unchanged



#### **Final Photograph**



Date Tested:

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Soil Resistivity Test Results



EnSite USA Project Number 6493 Eastern Panhandle Expansion, Potomac River Crossing PSI Project Number 0512713-1 Revised September 9, 2016

# **Corrosivity Testing**

ClientProfessional Service Industries, Inc. (PSI)Client ProjectProposed Eastern Panhandle ExpansionProject No.37622

						pH AASHTO T289			Soil Resistivity AASHTO T-288		
Lab Sample ID	Boring	Depth	Sample	Sample Received	Matrix	Result	Date Tested	Tested By	Result, Ohm- cm	Date Tested	Tested By
37622001 37622002	GO-1 GO-2R	4.0'-6.0' 4.0'-6.0'	ST-1 ST-2	7/14/2016 7/14/2016	Soil Soil	4.6 7.1	7/14/2016 7/14/2016	TX TX	4200 1500	7/19/2016 7/19/2016	TX TX

Input Validation: tmp

Reviewed By: SVG

Important Information About Your Geotechnical Report



EnSite USA Project Number 6493 Eastern Panhandle Expansion, Potomac River Crossing PSI Project Number 0512713-1 Revised September 9, 2016

# Important Information about Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

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

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

# **Read the Full Report**

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

# A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

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

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

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

 the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,

- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

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

# **Subsurface Conditions Can Change**

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

# Most Geotechnical Findings Are Professional Opinions

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

# A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

# A Geotechnical Engineering Report Is Subject to Misinterpretation

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

# **Do Not Redraw the Engineer's Logs**

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.* 

### Give Contractors a Complete Report and Guidance

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

# **Read Responsibility Provisions Closely**

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that

have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

# **Geoenvironmental Concerns Are Not Covered**

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

# **Obtain Professional Assistance To Deal with Mold**

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

# Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/THE BEST PEOPLE ON EARTH exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.



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February 8, 2017

EnSite USA, Inc. 109 Fieldview Drive Versailles, KY, 40383 Attn: Jacob Shams, P.E.

Re: Addendum to Report for Geotechnical Subsurface Exploration & Engineering Services 6493 – Eastern Panhandle Expansion Potomac River Crossing, Borings GO-3R and GO-7 Washington County, Maryland. PSI Project Number 0512713-2

Dear Mr. Shams:

Thank you for choosing Professional Service Industries, Inc. (PSI) as your consultant for the referenced project. Authorization to perform services was provided through PSI Proposal No. 0512-187239 dated August 9, 2016. The proposal was executed by Mr. Shams, P.E. representing EnSite USA, Inc.

This addendum letter to PSI geotechnical report presents the results of borings performed by PSI at two locations along the proposed HDD alignment at Potomac River Crossing. Approximate boring locations are presented in the Appendix Figures: 1A Site Vicinity Map and 1B: Boring Location Plan.

#### Scope of Services

PSI's services consisted of field exploration, laboratory testing, and preparation of a geotechnical engineering report for the proposed HDD location. Field work included drilling two test borings (Borings GO-3R and GO-7), utilizing hollow-stem auger (HSA) drilling, wash rotary drilling, and rock coring in conformance with ASTM standards.

Laboratory testing determined unit weight, moisture content, Atterberg limits, grain size distribution tests, pH and resistivity testing, unconsolidated undrained compressive strength and slake durability testing. All tests were performed per ASTM standards.

#### Summary of Field Exploration and Laboratory Testing

The borings were completed with a track-mounted drill rig with HSA in conformance with ASTM standards. Standard Penetration Testing (SPT) and split-spoon sampling of overburden soils was performed at 2.5 foot intervals for the first 10 feet and at 5-foot intervals thereafter to the termination depths to evaluate the strength and relative consistency of the soils encountered. Below auger refusal depth, rock coring was performed using NQ coring equipment. All recovered soil and rock samples were visually classified by a PSI geotechnical engineer and a graphical log developed for each boring. Boring depth and depth at which auger refusal was encountered are summarized in Table 1 below.

Boring	Approximate Termination Depth (feet)	Ground Surface Elevation (feet, NAVD)	Approximate Depth/Elevation of Top of Weathered Rock	Approximate Depth/Elevation of Auger Refusal		
GO-3R	277	591	5.5 feet, EL ±585.5MSL	20 feet, EL ±571MSL		
GO-7	134	402	6 feet, EL ±396MSL	14 feet, EL ±388MSL		

# Table 1 – Summary of Boring Depths

The boring logs included in the Appendix approximate depths and visual descriptions of overburden soil, underlying rock materials encountered, soil SPT test results, rock core recovery and quality designation (RQD) values, and measurements of groundwater depth where encountered. The total length of recovered rock core, divided by the length of the run, is referred to as rock core recovery and is expressed as a percentage. The Rock Quality Designation (RQD) is a measure of the rock mass quality and is defined as the total length of sound, intact rock core pieces 4 inches or more in length divided by the length of the rock core run, also expressed as a percentage. The rock core recovery and RQD values are indicated on the Boring Logs included with this report.

# **Geotechnical Investigation Results**

A brief summary of subsurface stratigraphy as encountered at the boring is presented below. All soil is classified per the Unified Soil Classification System (ASTM D-2487):

<u>Surficial Materials</u>: Approximately 3 inches of surficial **topsoil** were encountered at the ground surface of Boring GO-3R. Approximately 6 feet of **water** were encountered at Potomac river to the river bottom surface at Boring GO-7.

<u>Alluvium</u> with thickness up to 2 feet consisting of medium stiff lean Clay (CL) with gravel, roots. SPT N-values counted in this layer were 8 blows per foot of penetration (BPF).

<u>Residuum:</u> Residual soil classified as dense to very dense silty Gravel (GM) was encountered to depth of approximately 9 feet below existing surface grade at the Test Boring GO-3R. The residual soil was approximately 7 feet thick in the test boring location GO-3R. SPT N-values in this layer ranged from approximately 32 BPF to refusal of 50 blows per 0-inch of penetration.

<u>Weathered Rock:</u> Typically consisting of weathered shale, weathered rock was encountered at the test boring locations. The weathered rock samples consisted of soft shale with limestone floaters. SPT N-values in this layer ranged from approximately 50 blows per 5-inches of penetration to 50 blows per 2-inches of penetration. Auger refusal was encountered within the weathered rock at depths ranging from approximately 5.5 to 20 feet below existing grade at Boring GO-3R.

<u>Bedrock:</u> Bedrock materials encountered below the auger refusal depths consisted primarily of Shale and Limestone. Voids were encountered in Boring GO-7. At Boring GO-3R core recoveries ranged from 55 to 100 percent and RQD values ranged from 7 to 100 percent. At Boring GO-7 core recoveries ranged from 23 to 100 percent and RQD values ranged from 0 to 100 percent.



The above subsurface descriptions are of a generalized nature provided to highlight the major strata encountered. The boring logs included in the Appendix should be reviewed for specific information as to individual boring locations. The stratification lines shown on the boring logs represent the conditions only at the actual boring locations. The stratification lines represent the approximate boundaries between subsurface materials and the actual transition may be gradual.

Boring	Sampl	Sample	USCS	USCS Moisture Atterberg Limits Grain-Size Distributio			bution			
	e No.	Depth (feet)	Classification (1)	Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Gravel (%)	Sand (%)	Fines (%)
GO-3R	S-1	0.0 - 1.5	CL	10						
GO-3R	ST-1	0.0 - 2.0	GM	21.4	NP	NP	NP	39.7	28.0	32.3
GO-3R	S-2	2.5 – 4.0	GM	7	26	17	9	60.2	18.5	21.3
GO-3R	S-3	5.0 - 6.5	GM	6						
GO-3R	S-4	8.5 – 10.0	GM	6						
GO-3R	S-5	13.5 – 15.0	GM	4				36.7	36.0	27.3
GO-3R	S-6	18.5 – 20.0	GM	9						
(1)	<sup>(1)</sup> For USCS Soil Classification definitions, refer to the General Notes in Attachment									
(2)	<sup>(2)</sup> ST – Shelby Tube soil sample									
(3)	S – Split	spoon soil samp	le							

Table 2 – Overburden Soil Classification Test Results

Table 3 – Rock Recovery and RQD Field Coring Test Results

Boring	Depth (feet)	Elevation (feet)	Run Length (feet)	Recovery (%)	RQD (%)	Hardness (Moh,s)
GO-3R	20 - 22	571 - 569	2	92	29	3
GO-3R	22 – 27	569 - 564	5	55	25	3
GO-3R	27 – 32	564 – 559	5	97	53	3
GO-3R	32 – 37	559 – 554	5	100	60	3
GO-3R	37 – 42	554 – 549	5	100	75	3
GO-3R	42 – 47	549 – 544	5	100	76	3
GO-3R	47 – 52	544 – 539	5	95	58	3
GO-3R	52 – 57	539 – 534	5	100	65	3
GO-3R	57 – 62	534 – 529	5	80	20	2.5 - 3
GO-3R	62 – 67	529 – 524	5	57	7	2.5 - 3
GO-3R	67 – 72	524 – 519	5	100	70	2.5 - 3
GO-3R	72 – 77	519 – 514	5	92	77	2.5 - 3
GO-3R	77 – 82	514 – 509	5	100	77	2.5 - 3



Table 3 – Rock Recovery and RQD Field Coring Test Results - Continued												
Boring	Depth (feet)	Elevation (feet)	Run Length (feet)	Recovery (%)	RQD (%)	Hardness (Moh,s)						
GO-3R	82 – 87	509 - 504	5	100	73	2.5 - 3						
GO-3R	87 – 92	504 - 499	5	100	83	3						
GO-3R	92 – 97	499 – 494	5	100	93	3						
GO-3R	97 – 102	494 – 489	5	100	100	3 - 4						
GO-3R	102 – 107	489 – 484	5	100	77	3 - 4						
GO-3R	107 – 112	484 – 479	5	85	40	3 - 4						
GO-3R	112 – 117	479 – 474	5	100	70	3 - 4						
GO-3R	117 - 122	474 – 469	5	53	37	3 - 4						
GO-3R	122 – 127	469 – 464	5	72	27	3 - 4						
GO-3R	127 – 132	464 – 459	5	100	75	3 and 5 - 6						
GO-3R	132 – 137	459 – 454	5	60	7	3 and 5 - 6						
GO-3R	137 – 142	454 – 449	5	95	67	3 and 5 - 6						
GO-3R	142 – 147	449 – 444	5	100	97	3 and 5 - 6						
GO-3R	147 – 152	444 – 439	5	100	95	3 and 5 - 6						
GO-3R	152 – 157	439 – 434	5	100	100	3 and 5 - 6						
GO-3R	157 – 162	434 – 429	5	100	97	3						
GO-3R	162 – 167	429 – 424	5	95	92	3						
GO-3R	167 – 172	424 – 419	5	100	75	3						
GO-3R	172 -177	419 – 414	5	100	77	3						
GO-3R	177 – 182	414 – 409	5	100	83	3 and 5 - 6						
GO-3R	182 – 187	409 – 404	5	73	30	3 and 5 - 6						
GO-3R	187 – 192	404 – 399	5	100	93	3 and 5 - 6						
GO-3R	192 – 197	399 – 394	5	100	100	3 and 5 - 6						
GO-3R	197 – 202	394 – 389	5	100	97	3 and 5 - 6						
GO-3R	202 – 207	389 – 384	5	100	98	3 and 5 - 6						
GO-3R	207 – 212	384 – 379	5	100	100	3 and 5 - 6						
GO-3R	212 – 217	379 – 374	5	93	92	3 and 5 - 6						
GO-3R	217 – 222	374 – 369	5	93	86	3 and 5 - 6						
GO-3R	222 – 227	369 – 364	5	100	95	3 and 5 - 6						



Table 3 – Rock Recovery and RQD Field Coring Test Results - Continued												
Boring	Depth (feet)	Elevation (feet)	Run Length (feet)	Recovery (%)	RQD (%)	Hardness (Moh,s)						
GO-3R	227 – 232	364 – 359	5	100	95	3 and 5 - 6						
GO-3R	232 – 237	359 – 354	5	100	100	3 and 5 - 6						
GO-3R	237 – 242	354 – 349	5	100	3 and 5 - 6							
GO-3R	242 – 247	349 – 344	5	100	90	3 and 5 - 6						
GO-3R	247 – 252	344 – 339	5	100	97	3 and 5 - 6						
GO-3R	252 – 257	339 – 334	5	87	100	3 and 5 - 6						
GO-3R	257 – 262	334 – 329	5	97	50	3 and 4 - 5						
GO-3R	262 – 267	329 – 324	5	100	80	3 and 4 - 5						
GO-3R	267 – 272	324 – 319	5	100	78	3 and 4 - 5						
GO-3R	272 - 277	319 – 314	5	100	83	3 and 4 - 5						
GO-7	6 – 9	396 – 393	3	50	0	7.5 - 8						
GO-7	9 - 14	393 – 388	23	23 0								
GO-7	14 – 19	388 – 383	5	96	88	2.5 - 4						
GO-7	19 – 24	383 – 378	5	100 100 2.5 -								
GO-7	24 – 29	378 – 373	5	94	86	2.5 - 4						
GO-7	29 – 34	373 – 368	5	100	68	3						
GO-7	34 – 39	368 – 363	5	60	0	4						
GO-7	39 – 44	363 – 358	5	100	86	4						
GO-7	44 – 49	358 – 353	5	96	72	3						
GO-7	49 – 54	353 – 348	5	100	24	2.5 - 3						
GO-7	54 – 59	348 – 343	5	84	64	2.5 - 3						
GO-7	59 – 64	343 – 338	5	86	30	2.5 - 3						
GO-7	64 - 69	338 – 333	5	100	70	2.5 - 3						
GO-7	69 – 74	333- 328	5	72	60	2.5 - 3						
GO-7	74 – 79	328 – 323	5	94	60	3 - 4						
GO-7	79 – 84	323 – 318	5	100	74	3 - 4						
GO-7	84 – 89	318 – 313	5	100	92	3 - 4						
GO-7	89 – 94	313 – 308	5	100	82	3 - 4						
GO-7	94 – 99	308 – 303	5	96	24	3 - 4						



Table 3 – Rock Recovery and RQD Field Coring Test Results - Continued												
Boring	Depth (feet)	Elevation (feet)	Run Length (feet)	Recovery (%)	RQD (%)	Hardness (Moh,s)						
GO-7	99 – 104	303 -298	5	96	50	3 - 4						
GO-7	104 – 109	298 – 293	5	80	0	3 - 4						
GO-7	109 – 114	293 – 288	5	100	34	3 - 4						
GO-7	114 – 119	288 – 283	5	100	46	3						
GO-7	119 – 124	283 – 278	5	100	28	3						
GO-7	124 – 129	278 – 273	5	100	44	3						
GO-7	129 - 134	273 - 268	5	100	72	3						

Table 4 – Rock Unconfined Compressive Strength Test Results

Boring	Approximate Sample	Rock Classification	Unit Weight	Unconfined Compressive Strength			
• · · · · g	Depth (feet)		(pcf)	(psi)	(tsf)		
GO-3R	40.5 - 41.0	Limestone	163.9	3528	254		
GO-3R	101.0 – 101.5	Limestone	173.8	26,903	1937		
GO-3R	168.5 – 169.0	Shale	175.6	1597	115		
GO-3R	192.5 – 193.0	Shale	172.0	1569	113		
GO-3R	221.0 - 221.5	Shale	172.7	1556	112		
GO-3R	271.0 – 271.5	Shale	171.2	1556	112		
GO-7	19.9 – 20.4	Limestone	158.7	4722	340		
GO-7	42.1 – 42.6	Shale	158.3	1013	73		
GO-7	90.5 – 91.0	Shale	144	48	3		
GO-7	131.5 – 131.2	Limestone	168.5	7736	557		

# Table 5 – Soil, Unconfined Compressive Strength Test Results

Boring	Approximate Sample Depth	Water Content	Dry Unit Weight	Soil Classification	Confining Stress	Shear Strength		
g	(feet)	(%)	(pcf)		(psi)	(psf)	(tsf)	
The	ere were not availat	ble soil samp	oles to perfo	orm Soil Unconfine	d Compressive	Strength Te	sts	



The **durability** of the shale is a measurement of its deterioration over time interaction with the water weathering properties. The durability of the shale was determined on a selected sample of shales per Slake Durability of Shales and Similar Weak Rocks, ASTM D-4644 Standard.

Boring	Approximate Sample Depth (feet)	Rock Classification	Slake Durability Index First Cycle (%)	Slake Durability Index Second Cycle (%)
GO-3R	28.4 - 29.4	Siltstone	98.3	97.3
GO-3R	141.0 – 142.0	Shale	99.3	98.5
GO-3R	177.5 – 178.5	Shale	99.5	98.9
GO-3R	228.0 – 229.0	Shale	99.7	99.5
GO-3R	273.0 – 274.0	Shale	99.7	99.5
GO-7	14.9 - 15.9	Siltstone	95.9	90.7
GO-7	54.0 - 55.0	Siltstone	99.3	99.0
GO-7	81.5 - 82.5	Limestone	99.0	98.4
GO-7	129.0 – 130.0	Shale	99.2	98.9

 Table 6 – Slake Durability Test Results

One (1) representative soil sample was selected by PSI for soil resistivity testing. Table 7 below presents a summary of the test results. A detailed report is included in the Appendix.

Table 7 – Soil Resistivity Test Results

Location	GO-3R
Depth (Foot)	0.0 – 2.0'
pH - AASHTO T289	4.8
Soil Resistivity – AASHTO T-288	28500 Ohm-cm



Should there be any questions, please do not hesitate to contact our office at (703) 698-9300. PSI would be pleased to continue providing geotechnical services throughout the implementation of the project, and we look forward to working with you on this and future projects.

Respectfully submitted, **PROFESSIONAL SERVICE INDUSTRIES, INC.** 

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Lubomir D. Peytchev, P.E. Senior Geotechnical Engineer

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Naseer Nayeem, P.E. Vice President/Principal Consultant

Appendix: Figure 1A: Site Vicinity Map and Figure 1B: Boring Location Plan Boring Logs and General Notes Laboratory Test Results Slake Durability Test Results Soil Resistivity Test Results



# APPENDIX A: IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL REPORT

# Important Information about Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

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

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

# **Read the Full Report**

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

# A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

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

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

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

 the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,

- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

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

# **Subsurface Conditions Can Change**

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

# Most Geotechnical Findings Are Professional Opinions

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

# A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

# A Geotechnical Engineering Report Is Subject to Misinterpretation

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

# **Do Not Redraw the Engineer's Logs**

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.* 

### Give Contractors a Complete Report and Guidance

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

# **Read Responsibility Provisions Closely**

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that

have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

# **Geoenvironmental Concerns Are Not Covered**

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

# **Obtain Professional Assistance To Deal with Mold**

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

# Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/THE BEST PEOPLE ON EARTH exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.



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# **APPENDIX B – VICINITY MAP AND BORING LOCATION PLAN**





# **APPENDIX C: BORING LOGS**

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455   136   137   70   101   10	460-	-130- -130- 			29	60			L	-imestor	e RQD=75 Rec=100%	_							
450   140   31   57     450   140   10 thin bedded, gray, fine grained to medium pointed, wey soft to soft SHALE and hard Limeston/Rec=100%   RQD=67     445   146   32   60   Interbedded, slightly weathered, medium bedded to thin bedded, green, red, gray, fine grained to medium grained, wey soft to soft SHALE and hard Limeston/Rec=100%   RQD=95     440   155   60   Interbedded, slightly weathered, medium bedded to thin bedded, green, red, gray, fine grained to medium grained, wey soft to soft SHALE and hard Limeston/Rec=100%   RQD=100     435   160   11erbedded, slightly weathered, medium bedded to thin bedded, dreen, red, gray, fine grained to medium grained, wey soft to soft SHALE and hard Limeston/Rec=100%   RQD=100     430   160   57   Interbedded, slightly weathered, medium bedded to thin bedded, drak gray, fine grained to medium grained, wey soft to soft SHALE and hard Limeston/Rec=100%   RQD=97     425   160   100   Shale and Bloomsburg Formation]   Shale Rec=100%   Rec=100%     415   160   100   Silvia Riverses, fine grained to medium grained, wey soft to soft SHALE and hard Limestorie   RQD=92     110   100   36   60   Continued Next Page   RCD=97     140   100   38   60   Shale and Bloomsburg For	455-	-135-			30	36	Interbedded. slic	ahtly weathered. mediu	m bedded		RQD=7 Rec=60%	-					-		
445   145   132   60   Shate and Biomstores in structury   Shate RQD=97     440   150   33   60   RQD=95   Rec=100%   RQD=95     440   150   34   60   Interbedded, green, red, gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 45 degrees, (ROD from 97 to 100 %), Silurian (Wills Creek Shale and Biomsburg Formation)   RQD=97     425   160   Interbedded, dark gray, fine grained to medium bedded to thin bedded, dark gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 45 degrees, (ROD from 97 to 100 %), Silurian (Wills Creek Shale and Bioomsburg Formation)   RQD=97     425   166   Interbedded, dark gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 70 degrees, (ROD from 30 to 100 %), Silurian (Wills Creek Shale and Bioomsburg Formation)   RQD=92     426   170   38   60   Continued Next Page   RQD=77     415   39   60   Continued Next Page   RQD=77   Rec=100%     180   290   Eskridge Rd   RQD=83   RQD=77   Rec=100%     180   291   Continued Next Page   RQD=77   Rec=100%   RQD=77     180   291   Shale Rd Rce=100%   RQD=7	450-	- 140- - 140- 			31	57	to thin bedded, g grained, very so LIMESTONE, di from 67 to 97 % and Bloomsburg	(fine grained to me fit to soft SHALE and h ip of 35 to 60 degrees, b), Silurian [Wills Creek a Formation]	edium ard (RQD s Shale	Shalo	RQD=67 Rec=95%	_					-		
440   150   33   60   Interbedded, slightly weathered, medium bedded to thin bedded, green, red, gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, cip of 35 to 45 degrees, (RQD from 97 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation]   RQD=100   RQD=100     430   160   35   60   Interbedded, slightly weathered, medium bedded to thin bedded, clark gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 45 degrees, (RQD from 97 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation]   RQD=97     425   160   Interbedded, slightly weathered, medium bedded to thin bedded, clark gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 70 degrees, (RQD from 30 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation]   RQD=92     420   170   37   60   Interbedded, slightly weathered, medium bedded to thin bedded, to thin bedded, to thin bedded, slightly weathered, medium bedded to thin bedded, slightly mediate participarts, and RQD=92   RQD=92     420   170   38   60   Continued Next Page   RQD=77   Rec=100%   <	445-	 -145- 			32	60		, i onnetionj	L	and imestor	RQD=97 Rec=100%	-					-		
435   -155   34   60   in bit bedded, green, red, gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 45 degrees, (RQD from 97 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation]   RQD=100   RQD=100     430   -160   36   57   Interbedded, dark gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 45 degrees, (RQD from 97 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation]   RQD=97   Rcc=100%     425   -165   36   57   Interbedded, dark gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 70 degrees, (RQD from 10 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation]   RQD=92   Rcc=95%     420   -170   37   60   Interbedded, dark gray, fine grained to medium bedded to thin beddeed to 100 0%), Silurian [Wills Creek Shale and Bloomsburg Formation]   RQD=92   Rcc=95%     415   -170   38   60   Continued Next Page   RQD=75   Interstore     415   -170   38   60   Continued Next Page   RQD=83   RQD=75     180   Continued Next Page   RQD=83   RQD=83   RQD=75   Interstore     2930 Eskridge Rd   Fairfax, VA 22031   Rec=100%   RQD=75   Interstore	440-	 150			33	60	Interhedded slic	ntly weathered mediu	m bedded		RQD=95 Rec=100%	-					-		
430   160   35   60   Interbedded, slightly weathered, medium bedded to thin bedded, dark gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 70 degrees, (RQD from 30 to 100 %), Slutian [Wills Creek Shale and Bloomsburg Formation]   RQD=92     420   170   37   60   RQD=75   Rec=100%     415   38   60   Shale and Bloomsburg Formation]   Shale   RQD=77     180   60   Continued Next Page   RQD=83   PROJECT NO:   0512713-1     PROJECT NO:   2930 Eskridge Rd   Fairfax, VA 22031   PROJECT NO:   0512713-1     PROJECT ION:   Continued Next Page   Protemac River Crossing   Washington County     Washington County   Hancord MD   Washington County	435-	-155-			34	60	to thin bedded, g medium grained hard LIMESTON (RQD from 97 to Shale and Bloon	green, red, gray, fine g I, very soft to soft SHA NE, dip of 35 to 45 deg o 100 %), Silurian [Wil nsburg Formation]	rained to LE and rees, Is Creek	Shale and imestor	RQD=100 Rec=100%	-					-		
425   165   36   57   In thin bedded, dark gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 70 dogrees, (RQD From 30 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation]   RQD=92   Rec=95%     420   170   37   60   Shale and Bloomsburg Formation]   RQD=75     415   170   38   60   Continued Next Page   RQD=77   Rec=100%     180   Continued Next Page   RQD=83   RQD=83   RQD=83   RQD=83     Professional Service Industries, Inc. 2930 Eskridge Rd Fairfax, VA 22031 Telephone: (703) 698-9300   PROJECT NO.: 0512713-1   0512713-1     Protomac River Crossing   Vulnerooft MD   Vulnerooft MD   Vulnerooft MD	430-	-160-			35	60	Interbedded slic	ahtly weathered mediu	m bedded		RQD=97 Rec=100%	-					-		
420   170   37   60     420   175   Rec=100%   Rec=100%     175   38   60   RQD=77     180   60   Continued Next Page   RQD=83     PROJECT NO:   0512713-1     180   Professional Service Industries, Inc.   PROJECT NO:   0512713-1     2930 Eskridge Rd   Fairfax, VA 22031   PROJECT:   6493-Eastern Panhandle Expansion     Lineshone:   (703) 698-9300   Washington County   Washington County	425-	 165 			36	57	to thin bedded, o medium grained hard LIMESTON (RQD from 30 to Shale and Bloon	dark gray, fine grained d, very soft to soft SHA NE, dip of 35 to 70 deg o 100 %), Silurian [Wil nsburg Formation]	to LE and rees, Is Creek		RQD=92 Rec=95%	-					-		
415   175   38   60   RQD=77   Rec=100%     180   39   60   Continued Next Page   RQD=83   RQD=83     Professional Service Industries, Inc.     2930 Eskridge Rd   PROJECT NO.:   0512713-1     Fairfax, VA 22031   PROJECT:   6493-Eastern Panhandle Expansion     LOCATION:   Potomac River Crossing     Washington County   Washington County	420-	-170-			37	60			L	Shale and imestor	RQD=75 Rec=100% ne	-							
Image: Telephone:   RQD=83   RQD=83   Image: Telephone:   RQD=83     Image: Telephone:   Continued Next Page   PROJECT NO.:   0512713-1     Image: Telephone:   Professional Service Industries, Inc.   PROJECT NO.:   0512713-1     Image: Telephone:   Professional Service Industries, Inc.   PROJECT:   6493-Eastern Panhandle Expansion     Image: Telephone:   Telephone:   (703) 698-9300   Image: Telephone:   MD	415-	 -175- 			38	60					RQD=77 Rec=100%	_					-		
Professional Service Industries, Inc.   PROJECT NO.:   0512713-1     2930 Eskridge Rd   PROJECT:   6493-Eastern Panhandle Expansion     Fairfax, VA 22031   LOCATION:   Potomac River Crossing     Telephone:   (703) 698-9300   Washington County		-180-			39	60		Continued Next Page	I		RQD=83	_					-		
2930 Eskridge Rd   PROJECT:   6493-Eastern Panhandle Expansion     Fairfax, VA 22031   LOCATION:   Potomac River Crossing     Telephone:   (703) 698-9300   Washington County				_			Profession	al Service Industr	ies, Inc.	PROJE				JECT NO.: 0512713-1					
Fairfax, VA 22031 LOCATION: Potomac River Crossing   Telephone: (703) 698-9300 Washington County	2930 Eskridge				dge Rd	PROJE				CT: 6493-Eastern Panhandle Expansion									
I elephone: (703) 698-9300 Washington County	Fairfax, VA 220 Telephone: (70			x 22031		LOCAT				TION: Potomac River Crossing									
	Telephone: (70				. (703) 698-9300	1					Washington County Hancock, MD								

DATE	STAF	RTED:	_		1	2/15/16		DRILL COMPA	NY: Co	nnelly Dr	illing, Inc.			BO	RIN	G G	0-3R
DATE	DATE COMPLETED: 12/21/16				DRILLER: Kev	in Kersh LO	GGED B	Gunner Ingr	am	5		ilo Drillir					
			PII	H _		277.0 ft				1E 550 A		_	ate		n Comr	iy Netion	Dry feet
		KK: _			50	N/A				10110W St	em Auger	hard	Ň	⊥ Opc	av		N/A feet
		·			39.68	6351°		HAMMER TYPE: Automatic									
LONG		E:			78.2	0148°		EFFICIENCY		N/A		- '	borta				
STAT	ION:	N	J/A		OFFS	SET:	N/A	REVIEWED BY	: Lu	bomir Pe	vtchev						
REM/	ARKS:				-												
vation (feet)	epth, (feet)	raphic Log	ample Type	ample No.	overy (inches)		MATER	RIAL DESCR	IPTION	S Classification	ws per 6-inch (SS) Recovery % (NX)	Aoisture, %	STA ×	NDARD F TEST N in blo Moisture	PENETR DATA pws/ft @ 25	PL LL 50	Additional Remarks
Ele		U	Se	S	Reco					nsc	SPT Blo RQD &	2		STREN( Qu	GTH, tsf 米	Qp	
410-	-180-		Π			Interbe	dded, sligh	tly weathered, me	edium bedded		Rec=100%		0		2.0	4.0	
410	  -185-			40	44	to thin I mediun hard LI (RQD f Shale a	bedded, da n grained, v MESTONE rom 30 to r and Blooms	rk gray, fine grair very soft to soft S , dip of 35 to 70 100 %), Silurian   sburg Formation]	ned to HALE and degrees, Wills Creek		RQD=30 Rec=73%						-
100	  - 190-			41	60						RQD=93						-
400-																	
395—	-195-			42	60					Shale	RQD=100 Rec=100%						
390—	-200- -200- 			43	60					and Limestor	e RQD=97 Rec=100%						
385—	 -205- 			44	60						RQD=98 Rec=100%						-
380-	 _210- 			45	60						RQD=100 Rec=100%						-
375—	-215-			46	56						RQD=92 Rec=93%						
370-	 -220-  			47	56	to thin I mediun hard LI (RQD f Shale a	aded, slign bedded, da n grained, v MESTONE rom 50 to and Blooms	rk gray, fine grain very soft to soft S dip of 45 to 65 100 %), Silurian   sourg Formation]	edium bedded hed to HALE and degrees, Wills Creek		RQD=86 Rec=93%						-
365—	 -225- 			48	60					Shale	RQD=95 Rec=100%						-
360-	 -230- 			49	60					and Limestor	e RQD=95 Rec=100%						-
355—	-235- -235-			50	60						RQD=100 Rec=100%						-
	 -240-			51	60		С	Continued Next P	age		RQD=95						
	F			Ż		Prof 2930 Fair Tele	essional 0 Eskrido fax, VA phone:	Service Indu ge Rd 22031 (703) 698-93	stries, Inc. 800		PR PR LC	OJE OJE CAT	CTNC CT: ION:	D.:	astern I Potomac Wash Ha	051271 Panhanc River ( ington C ncock, N	3-1 Ile Expansion Crossing County MD

DATE STARTED:		12/15/16	DRILL COMPANY: Co	nnelly Dr	illing, Inc.			BO	RIN	G	0-3R
DATE COMPLETED	):	12/21/16	DRILLER: Kevin Kersh LOG	GED B	Gunner Ingr	ram					
COMPLETION DEPT	ГН	277.0 ft	DRILL RIG:CM	E 550 A	TV	_	ter	⊻ wni	le Drillin	g	Dry feet
BENCHMARK:		N/A		Iollow St	em Auger		S S		n Comp	etion	Dry feet
ELEVATION:	5	91 ft	SAMPLING METHOD: 2-in S	<u>51.874-i</u>	n Core Stand	<u>dar</u> d [			ay		N/A teet
	39.68	86351°		Automa	atic	E	BORIN	G LOCA	ATION:		
	/8.	20148		N/A							
REMARKS		SEI: <u>N/A</u>			ylchev						
	(Sa			tion	sh (SS) (NX)		STA	NDARD F TEST	PENETRA DATA	TION	
ion (feei h, (feet) hic Log	ple No.	MATER	RIAL DESCRIPTION	lassifica	per 6-inc covery %	iture, %	×	N in blo Moisture	ows/ft⊚ ⊿	PL LL	Additional
Dept Grap	Sam			USCS C	T Blows 2D & Re	Mois	0	STRENG	GTH, tsf		Remarks
					SP		•	Qu	*	Qp 4.0	
350-240		Interbedded, slight	tly weathered, medium bedded		Rec=100%		0			4.0	
		to thin bedded, da	rk gray, fine grained to								
345-245-	52 60	hard LIMESTONE (RQD from 50 to Shale and Blooms	E, dip of 45 to 65 degrees, 100 %), Silurian [Wills Creek sburg Formation]		RQD=90 Rec=100%						
-250	53 60				RQD=97 Rec=100%						
	-										
335-255-	54 52			Shale	Rec=87%						
330-260-	55 58			and Limestor	e RQD=50 Rec=97%						
-265-	56 60				RQD=80						
					Rec=100%						
320-270-	57 60				RQD=78 Rec=100%						
315-275-	58 60				RQD=83 Rec=100%						
		Bottom of test bor	ing at 277 feet								
			Opensional la desate '								
		Protessional	Service industries, Inc.		PR		CN TC	.: 6402 F	( actorn F	)512713	i-1
	533	Eairfay VA	22031 PROJE				- I :  ON+	0493-E	asiem F	River C	
		Telephone <sup>.</sup>	(703) 698-9300		20		<b>U</b> 11.	r	Washi	naton C	ountv
		i siopriorio.							Har	ncock, N	1D

DATE COMPLETED:   1/2017   DPLLERH-twice Roders D. Sol EXAMPLE   DPLLERH-twice Roders D. Sol Part (Section D. Sol Part (Sectin D. Sol Part (Section D. Sol Part (Sectin D. Sol	DATE	STAF	TED:			1	/17/17	DRILL COMPANY:	Connelly	' Dr	illing, Inc.		BORING GO-7						
COMPLETION DEPTH   134.0 ft.   DBUL RIS:   Decking DS:   Decking DS:   Decking DS:     LINGTUDE:   38.811827   HAMMER TYPE:   MA   DECLINE METHOD:   187.41 Coxe Standard     LINGTUDE:   38.811827   HAMMER TYPE:   MA   DECLINE METHOD:   187.41 Coxe Standard     REMARKS:   MA   OFFSET:   NA   REVEWED BY:   Lubran Potition:   No.1     REMARKS:   MA   OFFSET:   NA   REVEWED BY:   Lubran Potition:   No.1     Stream   MA   OFFSET:   NA   REVEWED BY:   Lubran Potition:   No.1   Revements     Stream   Stream   Stream   Stream   Stream   Stream   S	DATE	COM	PLETE	ED:	0: 1/20/17			DRILLER: Howie Roberts	LOGGED BY: Rob Stickley			ley					00-1		
BENCHMAR:     NA     OPELLING METROD:     1624 Cores     Status		PLETIC	ON DE	PTH	┥		134.0 ft		Diedrich	D-5	50		fel	⊥ V ▼ I	Vnile Dri	milling	0 feet		
LetAritor:     30/21     SAMPLIKE IPRO:     NA     Processor       1 Latitude:     30/21     PROCENCY     NA     PROCENCY     NA       2000     70107303*     PROCENCY     NA     PROCENCY     NA       2001     20107303*     PROCENCY     NA     PROCENCY     NA       2001     2010730*     PROCENCY     NA     PROCENCY     NA       2001     201070*     PROCENCY     Lubour Petricency     Procency     Procen	BENC	HMAF	RK: _				N/A	DRILLING METHOD:	Ro	<u>ck (</u>	Coring	<u> </u>	N S	⊥ U	Jpon Col	mpletion	U feet		
LAII TUDE:			:			40	12 ft	SAMPLING METHOD:	<u>1.874-ir</u>	$\frac{1}{1}$	ore Standard	<u> </u>					N/A Teel		
Source   NAL   OFESSIO   NAL   OFESSION   Statutor   Statutor   Statutor   Statutor   Anticipate   Participate   Nature   OFESSION   Nature <td></td> <td></td> <td></td> <td></td> <td></td> <td>39.68</td> <td>1887° 17552°</td> <td></td> <td><u>۲</u> ۸۱/</td> <td><u>v/A</u></td> <td></td> <td></td> <td>BOR</td> <td>NG LC</td> <td>CATION</td> <td>N:</td> <td></td>						39.68	1887° 17552°		<u>۲</u> ۸۱/	<u>v/A</u>			BOR	NG LC	CATION	N:			
PENANCKS     TOX     OFFELT     TOX     References     Couldin Peptides       00     0				1/ A					IN//	<del>۱</del> Doi	tobov								
get under get get under get get under get get under get get get get get get get get get get		ARKS:		NA.					Lubonnii	гe	runev								
egg of geg of	et)		 D	ø		hes)				allOII	(XN) %		ST	andar Te N in	D PENET	ration a ©			
B   B	tion (fe	th, (fee	ohic Lo	ple Typ	nple Nc	ery (incl	MATE	RIAL DESCRIPTION		JIISSUIC	scovery	sture, %	×	Moist	ure [	Z PL ▶ LL			
400   -	Eleva	Dep	Gra	Sam	San	Recove					D & D	Moi		STRI	ENGTH, 1	tsf			
400   6   Potomac River, approximately 6 feet of WATER     396   1   18   Medium dense to very dense, wel, while, red, reduced and Coobles (Alluvium)     300   2   14   Interbeddad, slightly weathered, medium beddad to thin beddad, gray, dark gray, trace trown and the soft SNALE and medium beddad to thin beddad, gray, dark gray, trace trown and the soft SNALE and medium beddad the Stone and Heiderberg Group]   RQD=0     300   4   60   Interbeddad, slightly weathered, medium beddad to thin beddad, gray, dark gray, trace trown and the soft SNALE and medium bard INESTONE   RQD=08     300   4   60   Interbeddad, slightly weathered, medium bedded to thin bedded, trown, gray, dark gray, trace white, fine Stone Rec=100%   RQD=08     300   4   60   Interbeddad, slightly weathered, medium bedded to thin bedded, trown, gray, dark gray, trace white, fine Stone Rec=100%   RQD=08     300   4   60   6   60   RQD=08   RQD=08     300   5   56   6   60   RQD=08   RQD=08     300   6   60   60   60   RQD=08   RQD=08     300   7   36   Interbedded, gray, dark gray, trace white, fine Stone Rec=100%   RQD=08   RQD=08     300   6							7				N N		0	Qu X Qp			0		
400- - 386- - 4   1   18   Medum dense to very dense, wel, while, red, brown, gray and black Sand, Gravel and Cobbles (Alluvium)   RQD=0 Rec=50%   RQD=0 Rec=50%     30- - 300- - 4   1   18   Medum dense to very dense, wel, while, red, Cobbles (Alluvium)   RQD=0 Rec=50%   RQD=0 Rec=50%     30- - 4   5   5   Interbeddet, signity weatheret, medum bedded to thin beddet, gray, dark gray, trace town and white, fire grained to medum grained, very soft to soft SHALE and medum hard LIMESTONE, dark gray, trace white, fire graned to medum grained, very soft to soft Shale and and and and and and and and and and		- 0 -					Potomac River, ap	oproximately 6 feet of WAT	ER				-						
395   4   1	400—								Wa	ater									
396   1		- 5 -					Madium dance to										_		
390   10   2   14   Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray, trace town and white, the grained to medium grained, very soft to soft SHALE and medium mark LIMESTONE, do r 20 to 45 degrees, (RQD from 68% to 100 %), Decominal (Diskary Sandstone and Hedderberg Group)   RQD=80 Rec=80% Rec=80%   RQD=80 Rec=80%     300   4   60   RQD=100 Hedderberg Group)   RQD=80 Rec=100% Shale   RQD=80 Rec=100%     300   5   5   56   February Sandstone and Hedderberg Group)   RQD=86 Rec=100%   Interbedded, weathered, medium bedded to thin bedded, brow, gray, dark gray, trace white, fine grained to medium grained, very soft to soft Shale   RQD=86 Rec=100%   Interbedded, sightly weathered, medium bedded to thin bedded, brow, gray, dark gray, trace white, fine grained to medium grained, very soft to soft Shale   RQD=86 Rec=100%   Interbedded, sightly weathered, medium bedded to thin bedded, sightly weathered, gray, dark gray, trace white, fine grained to medium grained, very soft to soft Shale   RQD=86 Rec=100%   Interbedded, sightly weathered, medium bedded graves, RQD=00   RQD=86 Rec=100%   Interbedded, sightly weathered, medium bedded graves, RQD=72 Rec=96%   Interbedded, gray, dark gray, trace white, fine grained to soft sightly weathered, gravy, dark gray, trace white, fine grained to medium grained, very soft to soft shale and and (Diskary Sandstone and Helderberg Group)   RQD=86 Rec=100%   RQD=86 Rec=100%   RQD=86 Rec=100%   RQD=86 Rec=100%   RQD=10 Rec=60%   RQD=10 Rec=60%   RQD=	395—				1	18	brown, gray and b Cobbles (Alluvi	lack Sand, Gravel and um)	ı, Cot	ble	RQD=0 Rec=50%								
390   Re=23%   Re=23%     385   11   Red     386   10   Red     376   5   6     4   60   Red     11   Red   Red     12   Red   Red     365   6   Red     4   60   Red     11   Red   Red     12   Red   Red     365   7   36     136   Red   Red		- 10 - 			2	14			Sto	nes	RQD=0								
15   10   10   Installing backed, gray, task track way soft to soft SPNE.     385   20   4   60     386   20   4   60     380   25   5   56     380   25   5   56     380   25   5   56     375   5   56   RQD=88     376   6   60   RQD=86     376   7   36   RQD=60     376   7   36   RQD=60     376   7   36   RQD=60     377   7   36   RQD=60     380   7   36   RQD=60     376   7   36   RQD of 0%, Devolation     380   7   36   RQD of 0%, Devolation     380   7   36   RQD of 0%, Devolation     381   RQD of 0%, Devolation   Shale   RQD=0     Rec=60%   Rec=100%   Rec=60%   Rec=60%     381   Rec=100%   Shale   RQD=0     Rec=60%   Rec=100%   Shale   RQD=26 <	390-						Interheddod oligh	thu waatharad madium ha	ddad		Rec=23%								
300   20   0 soft SHALE and medulum hard LIMES LONE. fig of 20 to 45 degrees. (ROD from 86% to 100 %). Devonian [Oriskany Sandstone and Heiderberg Group]   Rec=96%     300   25   5   5     375   5   56     376   5   56     376   6   60     377   7   36     365   7   36     365   7   36     365   7   36     40   1   Interbedded, weathered, medium bedded to thin beddet brown, gray, dark gray, trace while, fine grained to medium grained, very soft to soft Shale fine grained to medium grained, very soft to soft Shale and [Oriskany Sandstone and Heiderberg Group]   ROD=86 Rec=100% Shale and [Oriskany Sandstone and Heiderberg Group]     Professional Service Industries, Inc. 200 Estridge R d Fairfax, VA 22031 Telephone: (703) 698-9300   PROJECT NO:: 0512713-1 PROJECT: 6493-Eastern Panhandle Expansion LOCATTION: Potomac River Crossing     Washington County   Harcredk MD	385-	- 15 -			3	58	to thin bedded, slign white, fine grained	ay, dark gray, trace brown to medium grained, very	and soft		RQD=88						_		
380   4   60   RQD=100   Rec=100%     375   5   56   RQD=88   Rec=94%   Image: RQD=100     370   36   6   60   RQD=88   Rec=100%     365   7   36   1   Interbedded, brown, gray, dark gray, trace white, fine grained to medium grained, very soft to soft SHALE and hard LMESTONE, dip of 20 to 60   Shale Rc=100%   RQD=68     365   40   8   60   Interbedded, slightly weathered, medium bedded to thin bedded, gray, trace white, fine grained to medium grained, very soft to soft SHALE and hard LMESTONE, dip of 20 to 60   Shale Rc=100%   RQD=68     365   9   58   60   Oriskany Sandstone and Heiderberg Group)   RQD=86   Rec=100%     365   9   58   60   Oriskany Sandstone and Heiderberg Group)   Rec=100%   Rec=100%     365   9   58   60   Forferssional Service Industries, Inc.   Rec=96%   Rec=96%   Image: distance Rec=100%     365   50   70   50   50   Shale Rec=96%   Rec=100%     365   9   58   Forferssional Service Industries, Inc.   Rec=96%   Shale Rec=96%   Image: Rec=96%   Shale Rec=9	505						dip of 20 to 45 de %), Devonian [Ori	grees, (RQD from 68% to skany Sandstone and	NE, 100		Rec=96%								
375   5   56     376   30   6   60     370   6   60   Rec=94%   Rec=94%     370   7   36   Rec=94%   Rec=94%     370   7   36   Rec=94%   Image: 100%     365   7   36   Interbedded, weathered, medium bedded to thin bedded, brown, gray, dark gray, trace white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 60   Shale Rec=60%     360   40   8   60   Finiterbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray, trace white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 60   Shale Rec=100%     365   9   58   Continued Next Page   RQD=86     365   9   58   Continued Next Page   Shale Rec=100%     365   9   58   Continued Next Page   Shale and ard LIMESTONE, dip of 20 to 40     365   9   58   Forfersional Service Industries, Inc.   RQD=72     365   200   Shale graes, (ROD from 24% to 86 %), Devonian Brid and LIMESTONE, dip of 20 to 40   Brouest Rec=96%     365   9   58   Forofersional Service Industries, Inc.	380-				4	60	Tielderberg Group	1			RQD=100 Rec=100%								
375-   5   56   RQD=86   Rec=94%     370-   6   60   Rec=04%   RQD=68   Rec=04%     370-   36   Interbedded, weathered, medium bedded to thin bedded, brown, gray, dark gray, trace while, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 60   Shale   RQD=0     365-   7   36   Interbedded, gray, dark gray, trace while, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 60   Shale   RQD=0     360-   40   60   Interbedded, gray, dark gray, brown and white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 45   Shale   RQD=86     360-   40   9   58   60   Free=60%   Rec=100%     365-   50   7   36   Free=deal, sightly weathered, medium beddeded to soft SHALE and hard LIMESTONE, dip of 20 to 45   Shale   RQD=86     365-   50   7   58   7   7   7     365-   50   7   7   7   7   7     365-   50   7   7   7   7   7     365-   50   7   7   7 <td< td=""><td></td><td>- 25 -</td><td></td><td></td><td></td><td></td><td></td><td></td><td>ar Lime</td><td>ale Id stor</td><td>ie</td><td></td><td></td><td></td><td></td><td></td><td>_</td></td<>		- 25 -							ar Lime	ale Id stor	ie						_		
30   6   60   RQD=86     365   7   36   Interbedded, weathered, medium bedded to thin bedded, brown, gray, dark gray, trace while, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 60 degrees, clay seams (RQD of 0%), Devonian Interbedded, gray, dark gray, trown and white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 60 degrees, clay seams (RQD of 0%), Devonian Interbedded, gray, dark gray, trown and white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 40 degrees, (RQD from 24% to 86%), Devonian IOriskany Sandstone and Helderberg Group]   RQD=86     360   45   9   58   60   Rec=60%   RQD=72     7   7   7   7   7   7   7     8   60   fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 45   Shale and relearberg Group]   RQD=86     8   60   fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 45   Shale and and LIMESTONE, dip of 20 to 45   Shale and and LIMESTONE, dip of 20 to 45     9   58   60   for protection degrees, (RQD from 24% to 86 %), Devonian IOriskany Sandstone and Helderberg Group]   RQD=72   Rec=100%     2030 Eskridge Rd Fairfax, VA 22031   2930 Eskridge Rd Fairfax, VA 22031   Rec=000%   RQD=72   Macoreck MD <td>375—</td> <td></td> <td></td> <td></td> <td>5</td> <td>56</td> <td></td> <td></td> <td></td> <td></td> <td>RQD=86 Rec=94%</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	375—				5	56					RQD=86 Rec=94%								
370   360   1   Interbedded, weathered, medium bedded to thin bedded, brown, gray, dark gray, trace white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 60 degrees, clay seams (RQD of 0 %), Devonian Oriskany Sandstone and Helderberg Group]   Shale   RQD=0     360   40   8   60   Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray, brown and white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 45 degrees, (RQD from 24% to 86 %), Devonian (Oriskany Sandstone and Helderberg Group)   RQD=86   RQD=86     355   9   58   Professional Service Industries, Inc. 2930 Eskridge Rd Fairfax, VA 22031 Telephone: (703) 698-9300   PROJECT NO: 0512713-1   0512713-1     PROJECT NO:   0512713-1   Professional Service Industries, Inc. 2930 Eskridge Rd Fairfax, VA 22031 Telephone: (703) 698-9300   PROJECT NO: 0512713-1   PROJECT NO: 0512713-1     PROJECT MO:   0512713-1   Professional Service Industries, Inc. 2930 Eskridge Rd Fairfax, VA 22031 Telephone: (703) 698-9300   PROJECT NO: 0512713-1		 - 30 -			0						<b>DOD-00</b>						_		
365   -40   7   36   Interbedded, weathered, medium bedded to thin bedded, pray, dark gray, trace white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 60 degrees, clay seams (RQD of 0 %), Devonian Oriskany Sandstone and Helderberg Group]   Shale   RQD=0   RQD=0     40   40   60   degrees, clay seams (RQD of 0 %), Devonian Oriskany Sandstone and Helderberg Group]   Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray, brown and white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 45 degrees, (RQD from 24% to 86 %), Devonian [Oriskany Sandstone and Helderberg Group]   RQD=86   RQD=86     355   -50   Continued Next Page   Shale   RQD=72   Rec=96%     Professional Service Industries, Inc. 2930 Eskridge Rd Fairfax, VA 22031   Professional Service Industries, Inc. 2930 Eskridge Rd Fairfax, VA 22031   PROJECT NO: OS12713-1   0512713-1     PROJECT NO:   0512713-1   Protomac River Crossing   Washington County     Hancock MD   Hancock MD   Hancock MD   Hancock MD	370—				6	60					RQD=68 Rec=100%								
365   40   SHALE and hard LIMESTONE, dip of 20 to 60   Rec=60%   Rec=60%     360   40   10   Interbedded, slightly weathered, medium bedded to thin bedded, gray, dark gray, brown and white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 45 degrees, (RQD from 24% to 86 %), Devonian [Oriskany Sandstone and Helderberg Group]   RQD=86     355   50   50   Continued Next Page   RQD=72     Rec=96%   Continued Next Page   Shale and and Limestone   RQD=72     PROJECT NO::   0512713-1   0512713-1     PROJECT NO::   0512713-1   PROJECT NO::   0512713-1     PROJECT NO::   0512713-1   Protomac River Crossing   Washington County     Hancock MD   Hancock MD   Hancock MD   Hancock MD		- 35 - 			7	36	Interbedded, weat bedded, brown, gr grained to mediun	hered, medium bedded to ay, dark gray, trace white, n grained, very soft to soft	fine Sh	ale	ROD=0						_		
40   40 <td< td=""><td>365-</td><td></td><td></td><td></td><td></td><td></td><td>SHALE and hard degrees, clay sea ∖[Oriskany Sandsto</td><td>LIMESTONE, dip of 20 to ms (RQD of 0 %), Devonia one and Helderberg Group</td><td>60 61 an 1</td><td></td><td>Rec=60%</td><td></td><td></td><td></td><td></td><td></td><td></td></td<>	365-						SHALE and hard degrees, clay sea ∖[Oriskany Sandsto	LIMESTONE, dip of 20 to ms (RQD of 0 %), Devonia one and Helderberg Group	60 61 an 1		Rec=60%								
300   45   Integrained to medium grained, very sort to sort SHALE and hard LIMESTONE, dip of 20 to 45 degrees, (RQD from 24% to 86 %), Devonian [Oriskany Sandstone and Helderberg Group]   Shale and Limestone   Rec=100%     355   50   Continued Next Page   RQD=72 Rec=96%   Shale and Limestone   Shale and Limestone     Figure 1   Professional Service Industries, Inc. 2930 Eskridge Rd Fairfax, VA 22031 Telephone: (703) 698-9300   PROJECT NO.:   0512713-1 PROJECT:     6493-Eastern Panhandle Expansion UCCATION:   Potomac River Crossing Washington County Hancock MD	200	- 40 - 			8	60	Interbedded, sligh to thin bedded, gra	tly weathered, medium bed ay, dark gray, brown and w	dded /hite,		RQD=86						+		
355   45   45   10 <t< td=""><td>360-</td><td></td><td></td><td></td><td></td><td></td><td>SHALE and hard degrees, (RQD fro</td><td>Colum grained, very soft to LIMESTONE, dip of 20 to tom 24% to 86 %), Devonia</td><td>sont 45 In Sh</td><td>ale nd</td><td>Rec=100%</td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	360-						SHALE and hard degrees, (RQD fro	Colum grained, very soft to LIMESTONE, dip of 20 to tom 24% to 86 %), Devonia	sont 45 In Sh	ale nd	Rec=100%								
Image: Solution of the second seco	355-	- 45 -  			9	58	Unskany Sandsto	J Lime	stor	RQD=72									
Continued Next Page   PROJECT NO.:   0512713-1     PROJECT NO.:   0512713-1     2930 Eskridge Rd   PROJECT:   6493-Eastern Panhandle Expansion     Fairfax, VA 22031   LOCATION:   Potomac River Crossing     Telephone:   (703) 698-9300   Washington County																			
Professional Service Industries, Inc.   PROJECT NO.:   0512713-1     2930 Eskridge Rd   PROJECT:   6493-Eastern Panhandle Expansion     Fairfax, VA 22031   LOCATION:   Potomac River Crossing     Telephone:   (703) 698-9300   Washington County							C	Continued Next Page											
2930 Eskridge Rd PROJECT: 6493-Eastern Panhandle Expansion   Fairfax, VA 22031 LOCATION: Potomac River Crossing   Telephone: (703) 698-9300 Washington County							Professional	Service Industries, I	nc.	PROJECT N			CT N	NO.: 0512713-1					
Fairrax, VA 22031 Location: Potomac River Crossing   Telephone: (703) 698-9300 Washington County   Hancock MD		2930 Eskridge Rd					ge Rd		PROJECT: 6493-Eastern Pan			n Panhar	ndle Expansion						
Hancock MD						LOCATION: Potomac River Crossing													
		reiepnone: (703) 698-9300					Hancock. MD					MD							

	TE STARTED: 1/17/17					/17/17	DRILL COMPANY:	Conr	elly Dr	illing, Inc.		BORING GO-7					
		ON DE	PTH 134.0 ft			134.0 ft	DRILLER: Howie Roberts	DRILL RIG: Diedrich D-50					🛛 Whi	le Drillir	ng	0 feet	
BENC		RK:				N/A	DRILLING METHOD:		Rock	Coring		/ato	Upo	n Comp	oletion	0 feet	
ELEV	ATIO	N:			40	)2 ft	SAMPLING METHOD:	1.87	4-in Co	ore Standard	d	<b>S</b>	L Dela	ау		N/A feet	
	UDE:	-			39.68	1887°			<u>N/A</u>			BORIN	G LOCA	TION:			
		E:	1/ A		78.1	97553°		Luba	N/A	toboy							
REMA	ARKS:	N	I/A		0663			LUDO	nii Pe	ytchev							
Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATER	RIAL DESCRIPTION	I	USCS Classification	RQD & Recovery % (NX)	Moisture, %		NDARD F TEST N in blo Moisture	PENETR DATA ows/ft @ 4 25 CTH, tsf #	ATION PL LL 50 Qp	Additional Remarks	
	- 50 -											0	2	2.0	4.0		
350—	   - 55 -			10	60	Interbedded, sligh to thin bedded, gra fine grained to me SHALE and hard I degrees, (RQD fro [Oriskany Sandsto	tly weathered, medium ber ay, dark gray, brown and w dium grained, very soft to LIMESTONE, dip of 20 to om 24% to 86 %), Devonia one and Helderberg Group	dded vhite, soft 45 an		RQD=24 Rec=100%	)						
345—	 			11	50	Void approximatel	y from 58.2' to 59'	, Li	Shale and mestor	RQD=64 Rec=84%							
340—	- 60 -  			12	52					RQD=30 Rec=86%							
335—	- 65 -  			13	60	Interbedded, sligh to thin bedded, gra white, fine grained soft to soft SHALE 20 to 50 degrees, Devonian [Oriskar	tly weathered, medium ber ay, dark gray, trace brown d to medium grained, extre E and hard LIMESTONE, c (RQD from 24% to 92 %) ny Sandstone and Helderb	dded and mely dip of , erg		RQD=70 Rec=100%	)						
330—	- 70 -  			14	43	Group] Clay seam approx	imately from 72.6' to 74'			RQD=60 Rec=72%							
325—	- 75 -  			15	56					RQD=60 Rec=94%							
320—	- 80 -   			16	60			Li	Shale and mestor	RQD=74 Rec=100%	0						
315—	- 85 -   			17	60					RQD=92 Rec=100%	0						
310—	- 90 -  	- - - - - - - - - - - - - - - - - - -		18	60					RQD=82 Rec=100%	)						
305—	- 95 -  			19	58					RQD=24 Rec=96%							
	-100-					0	Continued Next Page										
						Professional 2930 Eskridg Fairfax, VA Telephone:	Service Industries, I ge Rd 22031 (703) 698-9300	Inc.		Pi Pi L(	ROJE ROJE DCA1	CT NO CT: 10N:	.: 6493-E F	astern I Potomao Wash Ha	0512713 Panhand c River C ington C ncock, M	}-1 lle Expansion rrossing ounty //D	

DATE	STAF	RTED:			1	/17/17		DRILL COM	PANY:	Conr	elly Dr	illing, Inc.		1		BC	RIN	IG (	30-7
DATE	COM	PLETE	ED:	.—		1/20/17		DRILLER:Ho	wie Roberts I	LOGO	ED BY	: Rob Stick	ley	5	$\nabla$	Whit	o Drillin		
			PIR	•_		134.0 ft		DRILL RIG:		Diedi	Deels	50 Denimen		ate	Ť	Upor	e Driill Dromr	Iletion	0 feet
		κη: _ 			40	11/A 12 ft		SAMPLING IN		1 87	4-in Co	ore Standar		Ň	Ī	Dela	v		N/A feet
	UDE:	•			39.68	1887°		HAMMER TY	истнов ФЕ:	1.07	<u>+-in cc</u> N/A		<u>u</u>	BOR		LOCA	, TION:		
LONG	ITUDI	E:			78.1	97553°		EFFICIENCY			N/A								
STAT	ION:_	Ν	I/A		OFFS	ET: 13	N/A	REVIEWED E	BY:	Lubo	mir Pey	/tchev							
REMA	ARKS:				1														
Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	I	MATEF	RIAL DESC	RIPTION		USCS Classification	QD & Recovery % (NX)	Moisture, %	ST.	AND/ N Mo	ARD PI TEST I in blov isture 29 20 20 20 20 20 20 20 20 20 20 20 20 20	ENETR/ DATA ws/ft © 4 5 5	PL LL 50	Additional Remarks
	100											<u>۲</u>		0	Q	u 2.	0 ★	Qp 4.0	
300-	-100-  			20	58					1 1	Shale and mestor	RQD=50 Rec=96%							
			H			Interbedd	ed, weat	nered, medium	bedded to th	nin		-							
295—	-105-  			21	48	bedded, b trace whit soft to sof 20 to 45 c	orown, da te, fine gr ft SHALE degrees, [Oriskar	rk gray, gray, or ained to mediu and hard LIM clay seams (F y Sandstone a	dark brown, um grained, v ESTONE, dij RQD of 0 %), und Helderbei	very p of	Shale	RQD=0 Rec=80%							
	-110-					Group]	LOUISKAI			9					+				
290-				22	60	Clay sear	n approxi ed. slight	mately from 10 lv weathered.	07' to 108.5' medium bedo	ded		RQD=34							
						to thin be	dded, gra	y, dark gray, ti	ace brown a	nd		Rec=100%	D						
	 -115-		Π			to soft SH	ALE and	I moderately h	anieu, very so ard	JIL					_				-
285				23	60	LIMESTC from 28%	0NE, dip	of 40 to 60 deg ) Devonian [O	grees, (RQD riskany			RQD=46							
205-						Sandston	e and He	Iderberg Grou	p]			Rec=100%	Ď						
	 -120-		H																_
				24	60						Shale	ROD=28							
280-				27						Li	mestor	Rec=100%	b						
	-125- 			~-															
275-				25	60							RQD=44 Rec=100%	b						
	-130-														+				
270-				26	60							RQD=72							
						Bottom of	test bori	ng at 134 feet											
						Profes	ssional	Service Inc	lustries, In	IC.		Р	ROJE	CT N	<b>O</b> .:			051271	3-1
2930 Eskridge Fairfax V/A 23				Je Kd 22031				P	ROJE		64	193-Ea	astern F		te Expansion				
Telephone: (70				(703) 698-9	9300			L	JUA			P	Washi	ington C	County				
								,									Ha	ncock, I	MD



# **GENERAL NOTES**

### SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

### DRILLING AND SAMPLING SYMBOLS

- SFA: Solid Flight Auger typically 4" diameter flights, except where noted.
- HSA: Hollow Stem Auger typically 3<sup>1</sup>/<sub>4</sub>" or 4<sup>1</sup>/<sub>4</sub> l.D. openings, except where noted.
- M.R.: Mud Rotary Uses a rotary head with Bentonite or Polymer Slurry
- R.C.: Diamond Bit Core Sampler
- H.A.: Hand Auger
- P.A.: Power Auger Handheld motorized auger

### SOIL PROPERTY SYMBOLS

- SS: Split-Spoon 1 3/8" I.D., 2" O.D., except where noted.
  - ST: Shelby Tube 3" O.D., except where noted.
- RC: Rock Core
- TC: Texas Cone
- 🕅 BS: Bulk Sample
- PM: Pressuremeter
- CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings
- N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
- N<sub>60</sub>: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
- Q<sub>u</sub>: Unconfined compressive strength, TSF
- Q.: Pocket penetrometer value, unconfined compressive strength, TSF
- w%: Moisture/water content, %
- LL: Liquid Limit, %
- PL: Plastic Limit, %
- PI: Plasticity Index = (LL-PL),%
- DD: Dry unit weight, pcf
- ▼,,,, Ž, Ž Apparent groundwater level at time noted

### RELATIVE DENSITY OF COARSE-GRAINED SOILS ANGULARITY OF COARSE-GRAINED PARTICLES

Relative Density	N - Blows/foot	Description	Criteria
Very Loose	0 - 4	Angular	Particles have sharp edges and relatively plane sides with uppolished surfaces
Loose Medium Dense	4 - 10 10 - 30	Subangular:	Particles are similar to angular description, but have
Dense Verv Dense	30 - 50 50 - 80	Subrounded:	Particles have nearly plane sides, but have
Extremely Dense	80+	Rounded:	well-rounded corners and edges Particles have smoothly curved sides and no edges

### **GRAIN-SIZE TERMINOLOGY**

### PARTICLE SHAPE

Modifier:

>12%

Component	Size Range	<u>Description</u>	Criteria
Boulders:	Over 300 mm (>12 in.)	Flat:	Particles with width/thickness ratio > 3
Cobbles:	75 mm to 300 mm (3 in. to 12 in.)	Elongated:	Particles with length/width ratio > 3
Coarse-Grained Gravel:	19 mm to 75 mm (¾ in. to 3 in.)	Flat & Elongated:	Particles meet criteria for both flat and
Fine-Grained Gravel:	4.75 mm to 19 mm (No.4 to 3/4 in.)		elongated
Coarse-Grained Sand:	2 mm to 4.75 mm (No.10 to No.4)		
Medium-Grained Sand:	0.42 mm to 2 mm (No.40 to No.10)	RELATIVE	PROPORTIONS OF FINES
Fine-Grained Sand:	0.075 mm to 0.42 mm (No. 200 to No.	40) Descripti	ve Term % Dry Weight
Silt:	0.005 mm to 0.075 mm		Trace: < 5%
Clay:	<0.005 mm		With: 5% to 12%

Page 1 of 2



# **GENERAL NOTES**

(Continued)

### **CONSISTENCY OF FINE-GRAINED SOILS**

<u>Q<sub>U</sub> - TSF</u>	<u>N - Blows/foot</u>	Consistency
0 - 0.25	0 - 2	Very Soft
0.25 - 0.50	2 - 4	Soft
0.50 - 1.00	4 - 8	Firm (Medium Stiff)
1.00 - 2.00	8 - 15	Stiff
2.00 - 4.00	15 - 30	Very Stiff
4.00 - 8.00	30 - 50	Hard
8.00+	50+	Very Hard

### **MOISTURE CONDITION DESCRIPTION**

<b>Description</b>	Criteria
Dry:	Absence of moisture, dusty, dry to the touch
Moist:	Damp but no visible water
Wet:	Visible free water, usually soil is below water table

### **RELATIVE PROPORTIONS OF SAND AND GRAVEL**

Descriptive Term% Dry WeightTrace:< 15%</td>With:15% to 30%Modifier:>30%

### STRUCTURE DESCRIPTION

<b>Description</b>	Criteria	<b>Description</b>	Criteria
Stratified:	Alternating layers of varying material or color with	n Blocky:	Cohesive soil that can be broken down into small
	layers at least ¼-inch (6 mm) thick		angular lumps which resist further breakdown
Laminated:	Alternating layers of varying material or color with	n Lensed:	Inclusion of small pockets of different soils
	layers less than ¼-inch (6 mm) thick	Layer:	Inclusion greater than 3 inches thick (75 mm)
Fissured:	Breaks along definite planes of fracture with little	Seam:	Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick
	resistance to fracturing		extending through the sample
Slickensided:	Fracture planes appear polished or glossy, sometimes striated	Parting:	Inclusion less than 1/8-inch (3 mm) thick

### SCALE OF RELATIVE ROCK HARDNESS

<u>Q<sub>U</sub> - TSF</u>	<u>Consistency</u>
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
,050 - 2,600	Hard
>2.600	Verv Hard

#### **ROCK VOIDS**

<u>Voids</u>	Void Diameter
Pit	<6 mm (<0.25 in)
Vug	6 mm to 50 mm (0.25 in to 2 in)
Cavity	50 mm to 600 mm (2 in to 24 in)
Cave	>600 mm (>24 in)

### **ROCK QUALITY DESCRIPTION**

Rock Mass Description	RQD Value	
Excellent	90 -100	
Good	75 - 90	
Fair	50 - 75	
Poor	25 -50	
Very Poor	Less than 25	

### **ROCK BEDDING THICKNESSES**

<b>Description</b>	Criteria
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	<sup>1</sup> / <sub>2</sub> -inch to 1 <sup>1</sup> / <sub>4</sub> -inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to 1/2-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

### **GRAIN-SIZED TERMINOLOGY**

(Typically Sedi	mentary Rock)
<u>Component</u>	Size Range
Very Coarse Grained	>4.76 mm
Coarse Grained	2.0 mm - 4.76 mm
Medium Grained	0.42 mm - 2.0 mm
Fine Grained	0.075 mm - 0.42 mm
Very Fine Grained	<0.075 mm

### **DEGREE OF WEATHERING**

Slightly Weathered:Rock generally fresh, joints stained and discoloration<br/>extends into rock up to 25 mm (1 in), open joints may<br/>contain clay, core rings under hammer impact.Weathered:Rock mass is decomposed 50% or less, significant<br/>portions of the rock show discoloration and<br/>weathering effects, cores cannot be broken by hand<br/>or scraped by knife.Highly Weathered:Rock mass is more than 50% decomposed, complete<br/>discoloration of rock fabric, core may be extremely<br/>broken and gives clunk sound when struck by<br/>hammer, may be shaved with a knife.

# SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYM	BOLS	TYPICAL
			GRAPH	LETTER	DESCRIPTIONS
	GRAVEL AND	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	GRAVELLY SOILS	(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
COARSE GRAINED SOILS	MORE THAN 50% OF COARSE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
	RETAINED ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50%	SAND AND	ID CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
LARGER THAN NO. 200 SIEVE SIZE	SANDY SOILS	(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
	PASSING ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
				ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
FINE GRAINED SOILS	SILTS AND LIQUID LIMIT LESS THAN 50 CLAYS			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE	MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50			МН	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
SIZE				СН	INORGANIC CLAYS OF HIGH PLASTICITY
				ОН	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
н	IGHLY ORGANIC S	SOILS		PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS



# APPENDIX D: LABORATORY TESTING RESULTS

# Laboratory Summary Sheet

Sheet 1 of 1 Dry Density (pcf) Water Satur-Approx. Depth Liquid Plastic Plasticity Qu %<#200 Est. Specific Void Borehole Content ation Ratio Limit Limit Index (tsf) Sieve Gravity (%) (%) 10 GO-3R 1 7 GO-3R 3 26 17 9 21.3% GO-3R 5.5 6 GO-3R 9 6 GO-3R 13.7 27.3% 4 GO-3R 18.6 9



Professional Service Industries 2930 Eskridge Rd Fairfax, VA 22031 Telephone: (703) 698-9300 Fax: (703) 560-7931

# Summary of Laboratory Results ob No.: 0512713-1

PSI Job No.: 0512713-1 Project: 6493-Eastern Panhandle Expansion Location: Potomac River Crossing Washington County Hancock, MD





#### PARTICLE-SIZE ANALYSIS OF SOILS - ASTM D422

Project

Specifications

Client	Professional Service Industries, Inc. (PSI)	Boring	GO-3R
Client Project	Proposed Eastern Panhandle Expansion I-68 Cross	sing V Depth	0.0'-2.0'
Project No.	38212	Sample	ST-1
		Lab Sample	38212001

#### Sample Color: DARK REDDISH BROWN USCS Group Name: SILTY GRAVEL WITH SAND USCS Group Symbol: GM USDA: AASHTO: A-2-4 (0) NA MECHANICAL SIEVE Total Sample Split Normalized Sieve Nominal Dry Total Sample Wet Wt, gm (-3") 930 Size Opening, mm Wt, gm % Retained % Finer Sample Split on Sieve No. 4 3" 0.0% 100.0% 0 75 Coarse Washed Dry Sample, gm 327 2-1/2" 0.0% 100.0% 63 0 603 2" 0.0% 100.0% Wet Wt Passing Split, gm 50 0 Dry Wt. Passing Split, gm 1-1/2" 83.0% 497 37.5 140.22 17.0% Total Sample Dry Wt, gm 824 1" 0.0% 83.0% 25 0

		3/4"	19	17.86	2.2%	80.8%	
Split Sample - Passing No.	4	1/2"	12.5	39.17	4.8%	76.1%	
Tare No.	2015	3/8"	9.5	44.08	5.3%	70.7%	
Tare + WS., gm	467.16	No. 4	4.75	85.8	10.4%	60.3%	
Tare + DS., gm	411.46	No. 10	2	33.47	7.8%	52.5%	
Tare, gm	151.26	No. 20	0.85	22.94	5.3%	47.2%	
Water Content of Split Sample	21.4%	No. 40	0.425	13.64	3.2%	44.1%	
Wt. of DS., gm	260.20	No. 60	0.25	9.81	2.3%	41.8%	
		No. 140	0.106	23.93	5.5%	36.2%	
Wt. of +#200 Sample, gm	120.86	No. 200	0.075	17 07	4.0%	32.3%	

#### USCS SOIL CLASSIFICATION

Corrected For 1	00% Passi	ng a 3" Sieve		U	SCS Description	า		
% Gravel (-3" & +#4)	39.7	Silt=NA Clay=NA		SILTY GRAVEL WITH SAND				
Coarse=19.2; Fine=20.5		D60, mm	NA	USCS Group Symbol	Atterber	g Limits Grou	p Symbol	
% Sand (-#4 & +#200)	28.0	D30, mm	NA	GM	NF	P - NON PLAS	ТІС	
Coarse=7.8; Medium=8.5; Fi	ne=11.8	D10, mm	NA	Auxiliary Information	Wt Ret, gm	% Retained	% Finer	
% Fines (-#200)	32.3	Сс	NA	12" Sieve - 300 mm	0	0.0	100.0	
% Plus #200 (-3")	67.7	Cu	NA	6" Sieve - 150 mm	0	0.0	100.0	
				3" Sieve - 75 mm	0	0.0	100.0	



## LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS ASTM D 4318

Client	Professional Service Industries, Inc. (PSI)	Boring	GO-3R
Client Project	Proposed Eastern Panhandle Expansion I-68 Crossing V	/ Depth	0.0'-2.0'
Project No.	38212	Sample	ST-1
		Lab Sample	38212001

Soil Description:

DARK REDDISH BROWN NON PLASTIC MATERIAL

(-#40 Fraction)

AS-RECEIVED W.C.	SAMPLE SUMMARY
Tare Number2015Wt. Tare & WS, gm467.16Wt. Tare & DS, gm411.46Wt. Tare, gm151.26Water Content, %21.4	C Liquid Limit (LL), % NA Plastic Limit (PL), % NA Plasticity Index (PI) NA USCS Group Symbol (-#40 Fraction ) NP USCS Group Name (-#40 Fraction ) NON PLASTIC Sample Color: DARK REDDISH BROWN LIQUID LIMIT
Points Run 0 Non-Plastic Tare Number Wt. Tare & WS, gm Wt. Tare & DS. gm	0 Non-Plastic
Wt. Tare, gm	
Water Content, %	# of Blows
PLASTICITY CHART	FLOW CURVE
60 50 40 40 40 20 20 10 CL-ML ML - Silt	25 20 15 10 5 10 10 10 10 10 10 10 10 10 10
0 10 20 30 40 50 60 70 80 90	
Liquid Limit	No. of Blows
Input Validation: MAK	Reviewed By: ALO Date Tested: 1/7/201

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### **DENSITY DETERMINATIONS**

ClientProfessional Service Industries, Inc. (PSI)ProjectProposed Eastern Panhandle Expansion I-68 Crossing Wash Co MDProject No.38212

Boring Number	GO-3R						
Depth	0.0'-2.0'						
Sample	ST-1						
Lab Sample No.	38212001						
			Water Cont	tents			
Tare Number	2015						
Wt. Tare & WS, gm	467.16						
Wt. Tare & DS, gm	411.46						
Wt. Tare, gm	151.26						
Water Content, %	21.4%						
		<b>Direct</b> 1	Measureme	ent Method	!		
Wt. of Wet Soil, gm	930						
Length 1, in	5.864						
Length 2, in	5.865						
Length 3, in	5.868						
Top Diameter, in	2.882						
Middle Diameter, in	2.879						
Bottom Diameter, in	2.88						
Sample Volume, cc	626.32						
Water Content ,%	21.4%						
Unit Wet Wt., gm/cc	1.48						
Unit Wet Wt., pcf	92.7						
Unit Dry Wt., pcf	76.3						
Unit Dry Wt., gm/cc	1.22						
Specific Gravity, Assumed	2.7						
Void Ratio,e	1.21						
Porosity, n	0.55						
Saturation, %	47.9%						

Input Validation: ALO



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Date: 1/5/2017		Project:	Potomac River Crossing
Tested by: Yamma Ershadi		Project No:	512713-2
Client: Ensite USA		Location:	Washington County, MD
Average Initial Height (in):	4.50	Boring :	GO-3R
Average Initial Diameter (in):	1.97	Sample Number:	RC-11
Water Content %:	0.5	Sample Depth:	40.5-41.0
Wet Density (pcf):	164.7	Dook	
Dry Density (pcf):	163.9	ROCK	live hard rod Limostono
LL - PL = PI:	NP - NP = NP	Description: Med	



		Failure Picture
Unconfined Compression Strength q <sub>u</sub> (tsf):	254	and a second sec
Height to Diameter Ratio:	2.3	
Percent Strain at Failure :	3.91%	
Average Rate of Strain to Failure (% Strain/min):	0.36%	
This test was performed according to ASTM D7012 - 14. Compressive Strength of Intact Rock Core Specimens.		E /



Phone (703) 698-9300 Fax (703) 560-7931

Date: 1/5/2017		Project:	Potomac River Crossing
Tested by: Yamma Ershadi		Project No:	512713-2
Client: Ensite USA		Location:	Washington County, MD
Average Initial Height (in):	4.00	Boring :	GO-3R
Average Initial Diameter (in):	1.95	Sample Number:	RC-23
Water Content %:	0.7	Sample Depth:	101.0-101.5
Wet Density (pcf):	175.0	Book	
Dry Density (pcf):	173.8		7 <b>T</b>
LL - PL = PI:	NP - NP = NP	Description: H	ard gray Limestone
		Stross Ve S	Strain



		Failure Picture
Unconfined Compression Strength q <sub>u</sub> (tsf):	1937	
Height to Diameter Ratio:	2.1	
Percent Strain at Failure :	13.20%	
Average Rate of Strain to Failure (% Strain/min):	1.20%	
This test was performed according to ASTM D7012 - 14.		
Compressive Strength of Intact Rock Core Specimens.		



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Date: 1/5/2017		Project:	Potomac River Crossing
Tested by: Yamma Ershadi		Project No:	512713-2
Client: Ensite USA		Location:	Washington County, MD
Average Initial Height (in):	4.80	Boring :	GO-3R
Average Initial Diameter (in):	: 1.93	Sample Number:	RC-37
Water Content %:	0.3	Sample Depth:	168.5-169
Wet Density (pcf):	176.1	Dook	
Dry Density (pcf):	175.6	RUCK	t grav Chalo
LL - PL = PI:	NP - NP = NP	Description: SOL	L YLAY SHALE



		Failure Picture
Unconfined Compression Strength q <sub>u</sub> (tsf):	115	
Height to Diameter Ratio:	2.5	
Percent Strain at Failure :	3.54%	a.
Average Rate of Strain to Failure (% Strain/min):	0.89%	10.00
This test was performed according to ASTM D7012 - 14.		
Compressive Strength of Intact Rock Core Specimens.		



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Date: 1/5/2017		Project:	Potomac River Crossing	
Tested by: Yamma Ershadi		Project No:	512713-2	
Client: Ensite USA		Location:	Washington County, MD	
Average Initial Height (in):	4.65	Boring :	GO-3R	
Average Initial Diameter (in):	. 1.95	Sample Number:	RC-42	
Water Content %:	0.4	Sample Depth:	192.5-193.0	
Wet Density (pcf):	172.6	Pook		
Dry Density (pcf):	172.0	ROCK Description:Sof	+ Gray Shale	
LL - PL = PI:	NP - NP = NP	Description.501	t Gray Share	
		Strees Vo. 6	Stroip	



		Failure Picture
Unconfined Compression Strength q <sub>u</sub> (tsf):	113	
Height to Diameter Ratio:	2.4	
Percent Strain at Failure :	3.70%	
Average Rate of Strain to Failure (% Strain/min):	0.92%	
This test was performed according to ASTM D7012 - 14.		
Compressive Strength of Intact Rock Core Specimens.		



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Date: 1/5/2017		Project:	Potomac River Crossing
Tested by: Yamma Ershadi		Project No:	512713-2
Client: Ensite USA		Location:	Washington County, MD
Average Initial Height (in):	4.50	Boring :	GO-3R
Average Initial Diameter (in):	1.96	Sample Number:	RC-47
Water Content %:	0.4	Sample Depth:	221.0-221.5
Wet Density (pcf):	173.5	Dook	
Dry Density (pcf):	172.7	RUCK	t grav Shale
LL - PL = PI:	NP - NP = NP	Description: 501	c gray plate



		Failure Picture
Unconfined Compression Strength q <sub>u</sub> (tsf):	112	
Height to Diameter Ratio:	2.3	and the second se
Percent Strain at Failure :	2.87%	Co
Average Rate of Strain to Failure (% Strain/min):	0.82%	
This test was performed according to ASTM D7012 - 14.		
Compressive Strength of Intact Rock Core Specimens.		and the second s



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Date: 1/5/2017		Project:	Potomac River Crossing
Tested by: Yamma Ershadi		Project No:	512713-2
Client: Ensite USA		Location:	Washington County, MD
Average Initial Height (in):	4.30	Boring :	GO-3R
Average Initial Diameter (in):	1.96	Sample Number:	: RC-57
Water Content %:	0.3	Sample Depth:	271.0-271.5
Wet Density (pcf):	171.8	Dool	
Dry Density (pcf):	171.2	RUCK	Et grave Chalo
LL - PL = PI:	NP - NP = NP	Description: SOL	LU GLAY SHALE
		-	



		Failure Picture
Unconfined Compression Strength q <sub>u</sub> (tsf):	112	
Height to Diameter Ratio:	2.2	
Percent Strain at Failure :	4.30%	
Average Rate of Strain to Failure (% Strain/min):	0.86%	2715
This test was performed according to ASTM D7012 - 14.		
Compressive Strength of Intact Rock Core Specimens.		A second



Tested by: YE Project No: 0512713-2	
Client: Ensite Location: Hancock MD	
Average Initial Height (in): 3.96 Boring : GO-7	
Average Initial Diameter (in): 1.98 Sample Number: RC-11	
Water Content %: 0.8 Sample Depth: 19.9' - 20.4'	
Wet Density (pcf): 159.9	
Dry Density (pcf): 158.7 Nock	
LL - PL = PI: NP - NP = NP	







Date: 1/30/2017		Project:	Easter Panhandle Expansion	
Tested by: YE		Project No:	0512713-2	
Client: Ensite		Location:	Hancock, MD	
Average Initial Height (in):	4.59	Boring :	GO-7	
Average Initial Diameter (in)	: 1.98	Sample Numbe	r: RC-16	
Water Content %:	0.5	Sample Depth:	42.1' - 42.6'	
Wet Density (pcf):	159.0	Deel		
Dry Density (pcf):	158.3	ROCK	ft mar Chalo	
LL - PL = PI:	NP - NP = NP	Description: SC	oll gray shale	



		Failure Picture
Unconfined Compression Strength q <sub>u</sub> (tsf):	73	
Unconfined Compression Strength q <sub>u</sub> (psf):	145007	the of the second s
Unconfined Compression Strength q <sub>u</sub> (psi):	1007	and the second s
Height to Diameter Ratio:	2.3	A CALL AND A CALL
Percent Strain at Failure :	0.22%	and the second sec
Average Rate of Strain to Failure (% Strain/min):	0.22%	42.1
Time to Failure (min):	1.0	42.6
This test was performed according to ASTM D7012 - 14 Me Compressive Strength of Intact Rock Core Specimens.	thod C.	



Date: 1/30/2017		Project:	Easter Panhandle Expansion
Tested by: YE		Project No:	0512713-2
Client: Ensite		Location:	Hancock, MD
Average Initial Height (in):	5.65	Boring :	GO-7
Average Initial Diameter (in)	: 1.98	Sample Number	:: RC-22
Water Content %:	0.2	Sample Depth:	90.5' - 91.0'
Wet Density (pcf):	144.3	Deel	
Dry Density (pcf):	144.0	ROCK	tremely soft gray Shale
LL - PL = PI:	NP - NP = NP	Description:	cremery sort gray share



Unconfined Compression Strength q <sub>u</sub> (tsf): Unconfined Compression Strength q <sub>u</sub> (psf): Unconfined Compression Strength q <sub>u</sub> (psi): Height to Diameter Ratio: Percent Strain at Failure : Average Rate of Strain to Failure (% Strain/min): Time to Failure (min): This test was performed according to ASTM D7012 - 14 Method C. Compressive Strength of Intact Rock Core Specimens.	3 6950 48 2.9 0.53% 1.06% 0.5	Failure Picture
Compressive Strength of Intact Rock Core Specimens. The H/D Ratio was not conforming to this method.		



Date: 1/30/2017		Project:	Easter Panhandle Expansion
Tested by: YE		Project No:	0512713-2
Client: Ensite		Location:	Hancock, MD
Average Initial Height (in):	5.88	Boring :	GO-7
Average Initial Diameter (in)	: 1.99	Sample Number	: RC-33
Water Content %:	0.7	Sample Depth:	131.5' - 132.0'
Wet Density (pcf):	169.6	Deel	
Dry Density (pcf):	168.5	ROCK	
LL - PL = PI:	NP - NP = NP	Description:MOC	lerately hard gray Limestone



		Failure Picture
Unconfined Compression Strength q <sub>u</sub> (tsf):	557	
Unconfined Compression Strength q <sub>u</sub> (psf):	1113319	
Unconfined Compression Strength q <sub>u</sub> (psi):	7731	
Height to Diameter Ratio:	3.0	
Percent Strain at Failure :	0.37%	
Average Rate of Strain to Failure (% Strain/min):	0.05%	Ny
Time to Failure (min):	7.0	0
This test was performed according to ASTM D7012 - 14 Me Compressive Strength of Intact Rock Core Specimens. The H/D Ratio was not conforming to this method.	ethod C.	

**Slake Durability Test Results** 

Client	Professional Service Industries,	Boring	GO-3R
Client Project	Proposed Eastern Panhandle Ex	Depth	28.4'-29.4'
Project No.	38212	Sample	RC-9
		Lab Sample No.	38212005

Visual Description: Red Siltstone

#### **Initial Water Content**

Drum ID	В
Drum + Wet Shale, gm	1786.7
Drum + Dry Shale, gm	1778.1
Drum Wt., gm	1221.4
Water Content, %	2%
Initial Dry Shale Weight, gm	556.7
Water Temerature Before Cycle 1, *C	22
Water Temerature After Cycle 1, *C	21.7
Average Temp during Cycle 1, *C	21.85
Drum + Dry Shale after Cycle 1, gm	1768.9
Dry Shale after Cycle 1	547.5
Slake Durability Index (First cycle)	98.3%
Water Temerature Before Cycle 2, *C	18.2
Water Temerature After Cycle 2, *C	18.1
Average Temp during Cycle 2, *C	18.15
Drum + Dry Shale after Cycle 2, gm	1763
Dry Shale after Cycle 2	541.6
Slake Durability Index (Second cycle)	97.3%

Type II—Retained specimen consist of large and small fragments.



#### **Final Photograph**



Input Validation: MAK Reviewed By: ALO Date Tested: 1/6/2017 COPYRIGHT © 2012 GEOTECHNICAL TESTING SERVICES, INC. 1-800-853-7309

Client	Professional Service Industries,	Boring	GO-3R
Client Project	Proposed Eastern Panhandle Ex	Depth	141'-142'
Project No.	38212	Sample	RC-31
		Lab Sample No.	38212006

Visual Description: Gray Phyllite/Slate

### **Initial Water Content**

Drum ID	A
Drum + Wet Shale, gm	1769.9
Drum + Dry Shale, gm	1765.4
Drum Wt., gm	1222.2
Water Content, %	1%
Initial Dry Shale Weight, gm	543.2
Water Temerature Before Cycle 1, *C	19.2
Water Temerature After Cycle 1, *C	19.9
Average Temp during Cycle 1, *C	19.55
Drum + Dry Shale after Cycle 1, gm	1761.4
Dry Shale after Cycle 1	539.2
Slake Durability Index (First cycle)	99.3%
Water Temerature Before Cycle 2, *C	22.5
Water Temerature After Cycle 2, *C	22.2
Average Temp during Cycle 2, *C	22.35
Drum + Dry Shale after Cycle 2, gm	1757.3
Dry Shale after Cycle 2	535.1
	00 <b>5</b> 51
Slake Durability Index (Second cycle)	98.5%

Type II—Retained specimen consist of large and small fragments.



#### **Final Photograph**



1/4/2017

Client	Professional Service Industries,	Boring	GO-3R
Client Project	Proposed Eastern Panhandle Ex	Depth	177.5'-178.5'
Project No.	38212	Sample	RC-39
		Lab Sample No.	38212007

Visual Description: Gray Phyllite/Slate

### **Initial Water Content**

Drum ID	В
Drum + Wet Shale, gm	1788.1
Drum + Dry Shale, gm	1784.7
Drum Wt., gm	1221.6
Water Content, %	1%
Initial Dry Shale Weight, gm	563.1
Water Temerature Before Cycle 1, *C	20.1
Water Temerature After Cycle 1, *C	20.6
Average Temp during Cycle 1, *C	20.35
Drum + Dry Shale after Cycle 1, gm	1782
Dry Shale after Cycle 1	560.4
Slake Durability Index (First cycle)	99.5%
Water Temerature Before Cycle 2, *C	23.2
Water Temerature After Cycle 2, *C	22.4
Average Temp during Cycle 2, *C	22.8
Drum + Dry Shale after Cycle 2, gm	1778.7
Dry Shale after Cycle 2	557.1
Slake Durability Index (Second cycle)	98.9%

Type II—Retained specimen consist of large and small fragments.



**Final Photograph** 



Input Validation: MAK

Reviewed By: ALO

Date Tested:

1/4/2017

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Client	Professional Service Industries,	Boring	G0-3R
Client Project	Proposed Eastern Panhandle Ex Depth		228'-229'
Project No.	38212	Sample	RC-49
		Lab Sample No.	38212008

#### Visual Description: Gray Phyllite/Slate

### **Initial Water Content**

Drum ID	С
Drum + Wet Shale, gm	1821.6
Drum + Dry Shale, gm	1820.2
Drum Wt., gm	1234.7
Water Content, %	0%
Initial Dry Shale Weight, gm	585.5
Water Temerature Before Cycle 1, *C	20
Water Temerature After Cycle 1, *C	20.2
Average Temp during Cycle 1, *C	20.1
Drum + Dry Shale after Cycle 1, gm Dry Shale after Cycle 1	1818.5 583.8
Slake Durability Index (First cycle)	99.7%
Water Temerature Before Cycle 2, *C Water Temerature After Cycle 2, *C	23.4 23
Average Temp during Cycle 2, *C	23.2
Drum + Dry Shale after Cycle 2, gm Dry Shale after Cycle 2	1817.1 582.4
Slake Durability Index (Second cycle)	99.5%

Type II—Retained specimen consist of large and small fragments.



#### Final Photograph



Input Validation: MAK

Reviewed By: ALO Date Tested: COPYRIGHT © 2012 GEOTECHNICAL TESTING SERVICES, INC. 1-800-853-7309 1/4/2017

Client	Professional Service Industries,	Boring	GO-3R
Client Project	Proposed Eastern Panhandle Ex	Depth	273'-274'
Project No.	38212	Sample	RC-58
		Lab Sample No.	38212009

Visual Description: Gray Phyllite/Slate

### **Initial Water Content**

Drum ID	D
Drum + Wet Shale, gm	1796.5
Drum + Dry Shale, gm	1794.9
Drum Wt., gm	1238.4
Water Content, %	0.3%
Initial Dry Shale Weight, gm	556.5
Water Temerature Before Cycle 1, *C	20.7
Water Temerature After Cycle 1, *C	20.7
Average Temp during Cycle 1, *C	20.7
Drum + Dry Shale after Cycle 1, gm	1793.4
Dry Shale after Cycle 1	555
Slake Durability Index (First cycle)	99.7%
Water Temerature Before Cycle 2, *C	23.8
Water Temerature After Cycle 2, *C	23.2
Average Temp during Cycle 2, *C	23.5
Drum + Dry Shale after Cycle 2, gm	1792.1
Dry Shale after Cycle 2	553.7
Slake Durability Index (Second cycle)	99.5%

Type II—Retained specimen consist of large and small fragments.



#### Final Photograph



Input Validation: MAK

Reviewed By: ALO Date Tested: COPYRIGHT © 2012 GEOTECHNICAL TESTING SERVICES, INC. 1-800-853-7309 1/4/2017

Client	Professional Service Industries,	Boring	GO-7
Client Project	Proposed Eastern Panhandle Ex	Depth	14.9' - 15.9'
Project No.	38298	Sample	RC-3
		Lab Sample No.	38298001

Visual Description: Gray Siltstone

### **Initial Water Content**

Drum ID	D
Drum + Wet Shale, gm	1755.2
Drum + Dry Shale, gm	1704.7
Drum Wt., gm	1238.4
Water Content, %	11%
Initial Dry Shale Weight, gm	466.3
Water Temerature Before Cycle 1, *C	20.1
Water Temerature After Cycle 1, *C	20
Average Temp during Cycle 1, *C	20.05
Drum + Dry Shale after Cycle 1, gm	1685.4
Dry Shale after Cycle 1	447
Slake Durability Index (First cycle)	95.9%
Water Temerature Before Cycle 2, *C	17.3
Water Temerature After Cycle 2, *C	17.5
Average Temp during Cycle 2, *C	17.4
Drum + Dry Shale after Cycle 2, gm	1661.2
Dry Shale after Cycle 2	422.8
Slake Durability Index (Second cycle)	90.7%

Type II—Retained specimen consist of large and small fragments.



#### Final Photograph


#### Slake Durability of Shales and Similar Weak Rocks - ASTM D4644

Client	Professional Service Industries,	GO-7	
Client Project	Proposed Eastern Panhandle Ex	Depth	54.0' - 55.0'
Project No. 38298		Sample	RC-11
		Lab Sample No.	38298002

Visual Description: Tan Siltstone with Interbedded Black Shale

#### **Initial Water Content**

Drum ID	А
Drum + Wet Shale, gm	1749.5
Drum + Dry Shale, gm	1720.1
Drum Wt., gm	1222.2
Water Content, %	6%
Initial Dry Shale Weight, gm	497.9
Water Temerature Before Cycle 1, *C	20.4
Water Temerature After Cycle 1, *C	20.1
Average Temp during Cycle 1, *C	20.25
Drum + Dry Shale after Cycle 1, gm	1716.6
Dry Shale after Cycle 1	494.4
Slake Durability Index (First cycle)	99.3%
Water Temerature Before Cycle 2, *C	17.6
Water Temerature After Cycle 2, *C	17.7
Average Temp during Cycle 2, *C	17.65
Drum + Dry Shale after Cycle 2, gm	1714.9
Dry Shale after Cycle 2	492.7
Slake Durability Index (Second cycle)	99.0%

Type II—Retained specimen consist of large and small fragments.



#### **Final Photograph**



#### Slake Durability of Shales and Similar Weak Rocks - ASTM D4644

Client	Professional Service Industries,	GO-7	
Client Project	Proposed Eastern Panhandle Ex	Depth	81.5' - 82.5'
Project No. 38298		Sample	RC-16
		Lab Sample No.	38298003

#### Visual Description: Gray Limestone

#### **Initial Water Content**

Drum ID	В
Drum + Wet Shale, gm	1761.2
Drum + Dry Shale, gm	1746.4
Drum Wt., gm	1221.6
Water Content, %	3%
Initial Dry Shale Weight, gm	524.8
Water Temerature Before Cycle 1, *C	20.1
Water Temerature After Cycle 1, *C	20
Average Temp during Cycle 1, *C	20.05
Drum + Dry Shale after Cycle 1, gm	1741
Dry Shale after Cycle 1	519.4
Slake Durability Index (First cycle)	99.0%
Water Temerature Before Cycle 2, *C	17.8
Water Temerature After Cycle 2, *C	17.9
Average Temp during Cycle 2, *C	17.85
Drum + Dry Shale after Cycle 2, gm	1737.9
Dry Shale after Cycle 2	516.3
Slake Durability Index (Second cycle)	98.4%

Type II—Retained specimen consist of large and small fragments.



#### **Final Photograph**



#### Slake Durability of Shales and Similar Weak Rocks - ASTM D4644

Client Client Project Project No.	Professional Servio Proposed Eastern 38298	ce Industries, Panhandle Ex	Boring Depth Sample	GO-7 129.0' - 130.0' RC-26
Visual Description:	Gray Shale		Lab Sample No.	38298004
Initial Wat	ter Content			
Drum ID		С		Initial Photograph
Drum + Wet Shale, g	ym	1749.7		
Drum + Dry Shale, gr	n	1741.5		(and the second s
Drum Wt., gm		1234.5		A A Per
Water Content, %		2%		
Initial Dry Shale Wei	ght, gm	507		000
Water Temerature B	Sefore Cycle 1, *C	20.5		ATTA ATTA
Water Temerature A	After Cycle 1, *C	20.1		
Average Temp durin	g Cycle 1, *C	20.3		
Drum + Dry Shale aft	ter Cycle 1, gm	1737.6		
Dry Shale after Cycle	21	503.1		
Slake Durability Inde	ex (First cycle)	99.2%		Final Photograph
Water Temerature B	Sefore Cycle 2, *C	17.6		
Water Temerature A	After Cycle 2, *C	17.8		
Average Temp durin	g Cycle 2, *C	17.7		DAR
Drum + Dry Shale af	ter Cycle 2, gm	1736.1		
Dry Shale after Cycle	2	501.6		
Slake Durability Inde	ex (Second cycle)	98.9%		

Type II—Retained specimen consist of large and small fragments.





**Soil Resistivity Test Results** 

# **Corrosivity Testing**

ClientProfessional Service Industries, Inc. (PSI)Client ProjectProposed Eastern Panhandle Expansion I-68 Crossing Wash Co MDProject No.38212

						pH AASHTO T289			Soil Resistivity AASHTO T-288		
Lab Sample ID	Boring	Depth	Sample	Sample Received	Matrix	Result	Date Tested	Tested By	Result, Ohm- cm	Date Tested	Tested By
38212001	GO-3R	0.0'-2.0'	ST-1	12/30/2016	Soil	4.8	1/9/2017	TX	28500	1/9/2017	ТХ

Input Validation:

ΤX

Reviewed By: ALO



Report of Subsurface Exploration and Geotechnical Engineering Services

Proposed Point-of-Delivery Facility, 6493 – Eastern Panhandle Expansion, Morgan County, West Virginia

Prepared for

EnSiteUSA 109 Fieldview Drive, P.O. Box 1007 Versailles, KY 40383

Prepared by

Professional Service Industries, Inc. 2930 Eskridge Road Fairfax, Virginia 22031 Phone: (703) 698-4414

February 2, 2017

PSI Project No. 0512713

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Lubomir D. Peytchev Project Manager



Karl Suter, P.E. Chief Engineer



February 2, 2017

EnSiteUSA 109 Fieldview Drive P.O. Box 1007 Versailles, KY 40383

Attention: Jacob Shams, P.E.

Reference: Report for Geotechnical Exploration and Assessment Proposed Point-of-Delivery(POD) Facility 6493 – Eastern Panhandle Expansion Morgan County, West Virginia PSI Project Number: 0512713

Dear Mr. Shams:

Thank you for choosing Professional Service Industries, Inc. (PSI) as your geotechnical consultant for the proposed Point-of-Delivery(POD) Facility for Eastern Panhandle Expansion in Morgan County, West Virginia. This facility is planned as part of the Eastern Panhandle Expansion (Pipeline) Project.

As per your authorization, we have completed a subsurface exploration for this project. The findings of the exploration and our recommendations for the proposed development are discussed in the accompanying report. As requested, one electronic and three original hard copies of the report will be provided to you.

The soil samples obtained during this exploration will be retained in our laboratory for sixty days. Should there be any questions, please do not hesitate to contact our office. PSI would be pleased to continue providing geotechnical services throughout the implementation of the project, and we look forward to working with you and your organization on this and future projects.

Respectfully submitted, **Professional Service Industries, Inc.** 

dubonine Stephclew

Lubomir D. Peytchev Project Manager

Kal & St

Karl Suter, P.E Chief Engineer

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## **APPENDICES**

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Boring Log	Appendix C
Laboratory Test Results	Appendix D



# 1 EXECUTIVE SUMMARY

PSI has completed the geotechnical assessment for Point-of-Delivery(POD) Facility for Eastern Panhandle Expansion in Morgan County, West Virginia. One soil test boring GO-6 was drilled to a depth of 40 feet below the existing grade.

The test boring encountered 3 inches of topsoil over the existing native soils described as loose to very dense silty sands over weathered shale and limestone bedrock to the boring termination depth of 40 feet.

As of the preparation of this report, limited structural loading information was provided. We anticipate the maximum load on the column to be less than 20 kips.

Existing residual soils will likely be encountered at the foundation bearing elevation. Based on the review of the test borings and taking into account the assumed structural loads, the proposed POD Facility can be supported on the existing medium dense to dense residual soils. Shallow foundations can be proportioned using an allowable bearing pressure value of 3,000 pounds per square foot (psf).

Groundwater was encountered in the boring GO-6 while drilling operations were performed, at approximately 29.5 feet below ground surface. As such, groundwater will not likely be encountered during the construction of the shallow foundations. However, there may be the groundwater seepage from the surface run off. In such case, the sump pumps can be used for temporary dewatering.

Recommendations relative to earthwork and foundation design are detailed in the report. The owner/designer should not rely solely upon the executive summary and must read and evaluate the entire contents of this report, prior to utilizing our engineering recommendations in the preparation of design and construction documents.



# 2 **PROJECT INFORMATION**

#### 2.1 PROPOSAL AND PROJECT AUTHORIZATION

This report presents the findings and recommendations related to the geotechnical exploration program performed by Professional Service Industries, Inc. (PSI) for the proposed POD Facility in Morgan County, West Virginia. These services were planned and performed in general accordance with scope and services outlined in PSI Proposal No 0512-182348 and Change Order CO#1 dated July 28, 2016.

#### 2.2 **PROJECT DESCRIPTION**

Initial project information was provided by Mr. Jacob Shams with EnSiteUSA. We also reviewed the RFP document titled, "Potomac River Crossing, Additional Investigation, for Eastern Panhandle Expansion, Washington County, Maryland and Morgan County West Virginia, dated July 26, 2016. The project involves the construction of a Point-of-Delivery Facility, which will support the pipes above grade. Based on the drawings provided to us, the pipes will be supported on isolated concrete columns that will extend approximately 3 feet, above the finished grade. We anticipate very minimal cut and fill grading activities of less than 1 foot.

As of the preparation of this report, limited structural loading information was provided. We anticipate the maximum load on the column to be less than 20 kips.

If any of the noted information is incorrect or has changed, please inform PSI so that we may review the geotechnical data and amend the recommendations presented in this report, if deemed appropriate.

#### 2.3 PURPOSE AND SCOPE OF WORK

The scope of services for this study included a site reconnaissance of the project area and the assessment of subsurface conditions through field exploration and laboratory testing. The study included an assessment of the site and subsurface conditions relative to the proposed development, engineering studies and the preparation of this report. The subsurface exploration was developed to provide the following:

- Geologic review of the project site.
- Subsurface conditions encountered including pertinent soil properties including water levels and drainage.
- Soil data review and analysis as it relates to the proposed site development.
- Civil site recommendations for site preparation, placement and compaction of fill.
- Structural recommendations to support foundation and construction.
- Comments relating to observed geotechnical conditions such as soft material or groundwater which could impact development.



• Determination of the Seismic Site Class and seismic design parameters per IBC 2015 based on the SPT N-values obtained during field exploration.

The scope of our services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, groundwater, or air, on or below or around this site. Any statement in this report or on the boring logs regarding odors, colors, unusual or unexpected items or conditions are strictly for the information of our client.

PSI did not provide nor was it requested to provide any service to investigate or detect the presence of moisture, mold or other biological contaminants in or around any structure, or any service that was designed or intended to prevent or lower the risk of the occurrence of the amplification of the same. Client acknowledges that mold is ubiquitous to the environment with mold amplification occurring when building materials are impacted by moisture. Client further acknowledges that site conditions are outside of PSI's control, and that mold amplification will likely occur, or continue to occur, in the presence of moisture. As such, PSI cannot and shall not be held responsible for the occurrence or recurrence of mold amplification.

## 2.4 SUBSURFACE EXPLORATION

PSI subcontracted Connelly Drilling Inc. to provide drilling services for the exploration program at the site. One soil test boring designated as GO-6 was drilled to a depth of 40 feet, below the existing grade.

The boring was completed with a track-mounted drill rig with HSA in conformance with ASTM standards. Standard Penetration Testing (SPT) and split-spoon sampling of overburden soils was performed at 2.5 foot intervals for the first 10 feet and at 5-foot intervals thereafter to the termination depths to evaluate the strength and relative consistency of the soils encountered. Below auger refusal depth, rock coring was performed using NQ coring equipment. All recovered soil and rock samples were visually classified by a PSI geotechnical engineer and a graphical log developed for each boring. Boring depth and depth at which auger refusal was encountered are summarized in Table 1 below.

Table 1 – Summary	of Boring Depths
-------------------	------------------

Boring	Approximate Termination Depth (feet)	Ground Surface Elevation (feet, NAVD)	Approximate Depth/Elevation of Top of Weathered Rock	Approximate Depth/Elevation of Auger Refusal
GO-6	40	590	23 feet, EL ±567MSL	30 feet, EL ±560MSL

The boring log included in the Appendix shows approximate depths and visual descriptions of overburden soil, underlying rock materials encountered, soil SPT test results, rock core recovery and quality designation (RQD) values, and measurements of groundwater depth where encountered. The total length of recovered rock core, divided by the length of the run, is referred to as rock core recovery and is expressed as a percentage. The Rock Quality Designation (RQD) is a measure of the rock mass quality and is defined as the total length of sound, intact rock core pieces 4 inches or more in length divided by the length of the rock core run, also



expressed as a percentage. The rock core recovery and RQD values are indicated on the Boring Log included with this report.

The location of the boring is shown on the Boring Location Plan, in Appendix **B**. The findings of the PSI boring are presented on the Test Boring Log included in Appendix **C**.

#### 2.5 LABORATORY TESTING

A PSI geotechnical engineer visually-manually classified the soil samples obtained for this geotechnical report in general accordance with the Unified Soil Classification System (USCS) (ASTM D2487 and D2488). Selected samples were tested for natural water content (ASTM D2216), Atterberg limits tests (ASTM D4318), grain size analyses (ASTM D6913), Soil Unconsolidated Undrained Compressive Strength Test (ASTM D2850), Slake Durability Test (ASTM D4644), Soil Resistivity Test (AASHTO T-288) and Soil pH Test (AASHTO T-289).

Boring	Sample	Sample	USCS	Moisture	A	Atterberg Limits			Atterberg Limits Grain-Size Distribut			bution
	No.	Depth (feet)	Classification (1)	Content (%)	Liquid Limit	Plastic Limit	Plasticit y Index	Gravel (%)	Sand (%)	Fines (%)		
GO-6	S-1	0.0 – 1.5	SM	16								
GO-6	ST-1	0.0 - 2.0	SM	16	37	25	12	7.9	63.4	28.7		
GO-6	ST-2	2.0 - 4.0	SM	16								
GO-6	S-2	2.5 - 4.0	SM	19								
GO-6	S-3	5.0 - 6.5	SM	19	41	27	14			34.5		
GO-6	S-4	8.5 – 10.0	SM	14								
GO-6	S-5	13.5 – 15.0	SM	13								
GO-6	S-6	18.5 – 20.0	GM	13								
GO-6	S-7	23.5 - 25.0	GM	5	26	19	7			13.3		
(1) (2) (3)	SO-0     S-7     23.5 - 23.0     GIVI     S     26     19     7       (1)     For USCS Soil Classification definitions, refer to the General Notes in Attachment       (2)     ST – Shelby Tube soil sample       (3)     S – Split spoon soil sample											

 Table 2 – Overburden Soil Classification Test Results

Boring	Depth (feet)	Elevation (feet)	Run Length (feet)	Recovery (%)	RQD (%)	Hardness (Moh,s)
GO-6	30 - 35	560 - 555	5	100	25	3
GO-6	35- 40	555 – 550	5	70	0	3



Boring	Approximate Sample	Bock Classification	Unit Weight	Unconfined C Strei	Compressive ngth		
209	Depth (feet)		(pcf)	(psi)	(tsf)		
Rock Compressive Strength Tests were not performed as the available rock core samples had cracks and fissures							

# Table 5 – Soil, Unconsolidated Undrained Triaxial Compression Test Results

Borina	Approximate Sample Depth Water Dry Unit Content Weight (%) Soil Classification		Confining Stress	Shear Str	ength, S <sub>u</sub>		
	(feet)	(%)	(per)		(psi)	(psf)	(tsf)
GO-6	0.0 - 4.0	17.9	112.5	SM	6.9	2966	1.5
GO-6	0.0 - 4.0	14.4	121.4	SM	13.9	4190	2.1
GO-6	0.0 - 4.0	18.4	112.8	SM	27.8	3643	1.8

The **durability** of the shale is a measurement of its deterioration over time interaction with the water weathering properties. The durability of the shale was determined on a selected sample of shales per Slake Durability of Shales and Similar Weak Rocks, ASTM D-4644 Standard.

# Table 6 – Slake Durability Test Results

Boring	Approximate Sample Depth (feet)	Rock Classification	Slake Durability Index First Cycle (%)	Slake Durability Index Second Cycle (%)
GO-6	31.5 – 32.5	Shale	98.9	98.3

One representative soil sample was selected by PSI for soil resistivity testing. Table 7 below presents a summary of the test results. A detailed report is included in the Appendix D.

|--|

	loot noodito
Location	GO-6
Depth (Foot)	0.0' to 4.0'
pH - AASHTO T289	4.4
Soil Resistivity – AASHTO T-288	18000 Ohm-cm



#### 3 SITE AND SUBSURFACE CONDITIONS

#### 3.1 SITE LOCATION AND DESCRIPTION

The proposed project site is located on the east side of the Hancock Road (WV SR 522), 0.9 mile south of the intersection of Hancock Road with River Road (WV SR 1) in Morgan County, West Virginia. Based on Google Earth, the existing grade within the limits of the proposed Tie-in-Facility is relatively level and varies from EL. 590 to EL. 592 feet. The surface cover within the limits of the proposed facility consists of grass, brush and young forest. The location of the site is shown on the Boring Location Plan attached as **Appendix B**.

#### 3.2 AREA GEOLOGY

The site is geologically located in the Ridge and Valley Province. A study of the area geology from the available literature shows that the site is underlain by Marcellus Formation and Needmore Shale of Devonian age. The Marcellus Formation in general consists of gray, thinbedded shale and argillaceous limestone.

#### 3.3 SUBSURFACE CONDITIONS

The stratification of the subsurface conditions at the soil test boring location is described in this section. The log of the boring is provided in Appendix C.

A brief summary of subsurface stratigraphy as encountered at the boring is presented below. The soil is classified per the Unified Soil Classification System (ASTM D-2487):

<u>Surficial Materials</u>: Approximately 3 inches of surficial topsoil were encountered at the ground surface of Boring GO-6.

<u>Alluvium:</u> Alluvium was observed with thickness up to 2 feet consisting of loose to medium dense silty sand (SM) with shale fragments, gravel, and roots. The SPT N-value in this layer was 9 blows per foot of penetration (BPF).

<u>Residuum:</u> Residual soil classified as medium dense to very dense silty SAND (SM) was encountered to depth of approximately 19 feet below existing surface grade at the test boring. The residual soil was approximately 17 feet thick in the test boring location. SPT N-values in this layer ranged from approximately 19 to 84 BPF and 50 blows per 4-inches of penetration.

<u>Weathered Rock:</u> Typically consisting of weathered shale, weathered rock was encountered at the test boring location. The weathered rock samples consisted of soft shale with limestone floaters. SPT N-values were typically in excess of 50 BPF. Auger refusal was encountered within the weathered rock at depth of 19 feet below existing grades.

<u>Bedrock:</u> Bedrock materials encountered below the auger refusal depths consisted primarily of Shale and Limestone. Voids were not encountered in Boring GO-6. Core recoveries were 70 and 100 percent. RQD values ranged from 0 to 25 percent.



The above subsurface descriptions are of a generalized nature provided to highlight the major strata encountered. The boring log included in the Appendix should be reviewed for specific information at the boring location. The stratification lines shown on the boring log represent the conditions only at the actual boring location. The stratification lines represent the approximate boundaries between subsurface materials and the actual transition may be gradual.

# 3.4 GROUNDWATER CONDITIONS

During drilling groundwater was encountered in the test boring GO-6 at approximate depth of 29.5 feet below the exisnig grade. Water level at the test boring location is shown on the boring log provided in Appendix C.

The groundwater observations presented in this report and the attached boring log reflect those observed at the time of our field activities. We recommend that the Contractor determine the actual groundwater levels at the time of construction to determine groundwater impact on the proposed construction procedure.



## 4 GEOTECHNICAL ASSESMENT AND RECOMMENDATIONS

The following recommendations are based on the information available on the proposed construction, the data obtained from the boring, and our experience with soils and subsurface conditions similar to those encountered at this site. Because the borings represent a very small statistical sampling of the subsurface materials, conditions encountered during construction may be substantially different from those encountered in our borings. In these instances, adjustments to the design and construction may be necessary depending on the actual conditions encountered.

As indicated earlier, very minimal cut and fill (less than a foot) is anticipated within the proposed construction limits of the POD Facility. Based on the review of the test boring, competent residual soils will likely be encountered at the design foundation bearing level of the isolated columns, assumed to be about 5 feet below grade and thus below the frost penetration depth, which is 36 inches below grade. If deleterious or incompetent soils are encountered the design foundation bearing level of the columns, then such soils shall be undercut to the competent stratum and replaced with compacted structural fill or lean concrete, placed up to the bottom of the design foundation level.

#### 4.1 SEISMIC CONSIDERATIONS

The project site is located within a municipality that employs the International Building Code (IBC), 2015 edition. As part of this code, the design of structures must consider dynamic forces resulting from seismic events. These forces are dependent upon the magnitude of the earthquake event as well as the properties of the soils that underlie the site.

Part of the IBC code procedure to evaluate seismic forces requires the evaluation of the Seismic Site Class, which categorizes the site based upon the characteristics of the subsurface profile within the upper 100 feet of the ground surface.

To define the Seismic Site Class for this project, and in accordance with your requested level of assessment, we have interpreted the results of our soil test borings drilled within the project site per Section 1613.5 of the code. Material properties were estimated below the depth of the borings based upon data available in published geologic reports as well as our experience with subsurface conditions in the general site area.

Based upon our assessment, it is our opinion that the subsurface conditions within the areas of the site planned for building construction are consistent with the characteristics of **Site Class C** as defined in Table 1613.5.2 of the building code.

The associated IBC probabilistic ground motion values for latitude 39.678878° and longitude - 78.194106° obtained from the *Java Ground Motion Parameter Calculator – Version 5.1.0* on the USGS Earthquake Hazards Program – Seismic Design for Buildings web page (http://earthquake.usgs.gov/designmaps/us/application.php) are as follows:



Table 8: Seismic Design Parameters*								
Period (seconds)	Марро Ас	ed MCE Spectral Response cceleration** (g)	Site Coe	efficients	Adjusted MCE Spectral Response Acceleration (g)		Design Spectral Response Acceleration (g)	
0.2	S₅	0.130	Fa	1.2	SMs	0.156	SDs	0.104
1.0 S <sub>1</sub> 0.053 F <sub>v</sub> 1.7 SM <sub>1</sub> 0.091 SD <sub>1</sub> 0.061								
* 2% Probability of exce ** At B-C interface (i.e. t MCE= Maximum Consid	edance in 5 top of bedro dered Earth	i0 years. ck). quake						

The Site Coefficients,  $F_a$  and  $F_v$  presented in the above table were also obtained from the USGS calculator, but can be interpolated from IBC Tables 1613.5.3(1) and 1613.5.3(2) as a function of the site classification and mapped spectral response acceleration at the short ( $S_s$ ) and 1 second ( $S_1$ ) periods.

For Seismic Design Category designations of C, D, E or F, which are contingent on the structure "Occupancy Category", the Code also requires an assessment of liquefaction, slope stability and surface rupture due to faulting or lateral spreading. Detailed evaluations of these factors were beyond the scope of this study. However, the following table presents a qualitative assessment of these issues considering the site class, the subsurface soil properties, the groundwater elevation and probabilistic ground motions.

Table 9: Seismic Hazards					
Hazard	Relative Risk	Comments			
Liquefaction	Low	The materials below the foundation bearng level are dense, and the seismicity is low.			
Slope Stability	Low	The site is relatively level and does not incorporate significant cut or fill slopes			
Surface Rupture	Low	The site is not underlain by a mapped Holocene-aged fault			

# 4.2 SITE PREPARATION AND EARTHWORK

We anticipate site preparation and earthwork for the proposed Tie-in-Facility to consist primarily of foundation excavation and backfilling.

- Utilities, if any, encountered within the proposed column pad footprints should be removed or relocated. The utility excavations shall be backfilled and compacted as per the fill requirements provided in the subsequent paragraphs.
- All loose or wet soils or any debris encountered at the footing subgrade elevation shall be undercut and replaced with structural fill.
- Material satisfactory for structural fill may include clean soil or bankrun sand and gravel (SW, SP, SM, GW, and GM). CL, ML, GC, and SC material can be used in engineered fills, subject to the following limitations:

Maximum Dry Density (per ASTM D698)	≥ 105 pcf
Liquid Limit	≤ 40
Plasticity Index	≤ 20



Organic soils and high plasticity clays and silts (CH, MH, OL, OH, PT) should not be used as engineered fill. The fill materials should be free from topsoil and debris, have less than 3 percent organics and should not contain rock fragments having a major dimension greater than 3 inches. The use of the excavated fill soils for controlled structural fill will be subject to approval of the Geotechnical Engineer of Record and moisture adjustments at the time of construction, and the plasticity and maximum dry density requirement specified in this section.

The onsite existing fill material can be reused as a structural fill provided it meets the above indicated requirements.

- Fill placement should be in loose horizontal lifts no greater than 8 inches thick compacted uniformly with the proper equipment.
- Fill required to support the footings and the slab-on-grade should be compacted to at least 98 percent of the maximum dry density as per ASTM D698 (Standard Proctor) test method. The moisture content of the fill should be within plus or minus two (±2) percentage points of the optimum moisture content.

For proper site preparation, the earthwork should be performed under the observation of and to the satisfaction of the Geotechnical Engineer of Record or his authorized representative.

It will be important to maintain positive site drainage during construction. Stormwater runoff should be diverted around the excavated areas. The site should be graded at all times such that water is not allowed to pond. If any surface soils become wet due to rains, they should be removed or dried prior to further site work operations and/or fill placement.

## 4.3 FOUNDATION DISCUSSION

The isolated columns supporting the pipes of POD Facility can be supported on isolated spread foundations bearing on the underlying competent residual soils. The bottom of the column foundations should be below the frost penetration depth, which is assumed to be 36 inches, below the existing grade. This is consistent with the design drawings provided to us showing the bearing level being about 5 feet below grade.

Spread foundations can be proportioned using a net allowable soil bearing pressure of 3,000 pounds per square foot (psf). Utilizing this allowable bearing pressure, we estimated the total settlement to be less than 1 inch with differential settlement being less than 1/2 inch over a horizontal distance of 25 feet.

Because of possible variations in subsurface conditions and related bearing capacity, all footing excavations and trenches should be observed and approved by the Geotechnical Engineer of Record or his qualified representative. Water and possibly some loose soil may collect in the footing excavations as a result of surface precipitation and near ground surface seepage. Therefore:

• Water, loose soil and soil softened by water should be removed from the bottom of the footing excavations before placing concrete.



• Footing excavations should not be left open for long periods. If the concrete cannot be placed due to inclement weather conditions or any other unforeseen circumstances, the bottom of the footing excavations and trenches should be protected by undercutting 3 inches and placing a 3-inch thick lean-mix concrete (2,000 psi) work mat immediately upon approval and before reinforcing steel is placed.

Where unsuitable bearing conditions are encountered as determined by the PSI Geotechnical Engineer or designated representative, these soils should be undercut and replaced with controlled structural fill. If backfilled up to the design bearing elevation, the over-excavation should extend laterally from all foundation edges a minimum of one half the depth of the undercut. The backfill should consist of the materials described earlier in this section. If the overexcavation is filled with concrete or flowable fill, the widening of the excavation will not be required. Backfill around and above the footing should satisfy the controlled fill requirements described in Section 4.1 'Site Preparation and Earthwork'.

Column footings should have minimum widths of 24 inches, regardless of the actual bearing pressure.

# 4.4 CONSTRUCTION DEWATERING

During our investigation groundwater was encountered in the Boring GO-6 at 29.5 feet. As such, groundwater may not be encountered during the foundation excavation. However, additional water may be introduced into excavations due to surface runoff and local precipitation during construction. Our past experience indicates that the foundation and subgrade bearing soils encountered on-site will soften considerably when exposed to free water. The contractor should keep excavations dry to prevent the softening of these materials. Methods such as sloping, ditching, and berming should be used to control surface water at the site.

Groundwater at this site can be handled by using sump pumps and pits may be utilized to direct and remove the water both during and after construction.

For the purposes of managing water that may enter an excavation, we recommend that collection pits with pumps be used to remove the water from the excavation. The sump pits should be backfilled with open graded stone (AASHTO #57 recommended) and should be surrounded by a properly graded filter medium. The purpose of the filter medium is to prevent clogging of the drainage system by the infiltration of fine-grained soils.

Pumping from the sump pits should be done with care to prevent the loss of soil fines, development of soil boils, or instability of slopes. We must emphasize that dewatering requirements will be dictated by groundwater conditions at the time of construction and may require more aggressive techniques than pumping from a sump pit. The contractor should use a technique or combination of techniques which achieve the desired results under actual field conditions.



# 5 CONSTRUCTION CONSIDERATIONS

To assess that the in-situ soil conditions or those conditions developed during the construction are as anticipated during the design stage, construction control, continuous observation and testing are recommended as follows:

- Structural fill placement, if any, should be monitored by a qualified soils technician working under the supervision of the geotechnical engineer of record.
- All footing excavations should be carried out under the observation of the geotechnical engineer of record or authorized representative.

## 5.1 EXCAVATION AND SAFETY

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, Part 1926, Subpart P". This document was issued to better allow for the safety of workers entering trenches or excavations. It is mandated by this federal regulation that excavations, whether they be utility trenches, basement excavations or footing excavations, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the Contractor could be liable for substantial penalties.

The Contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The Contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the Contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in all local, state, and federal safety regulations.

We are providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the Contractor's or other parties' compliance with local, state, and federal safety or other regulations.



# 6 RECOMMENDED ADDITIONAL SERVICES

Additional foundation engineering, testing, and consulting services recommended for this project are summarized below:

- Footing Evaluations: It is recommended that footing for this project be evaluated by PSI. The purpose of these evaluations will be to verify that the design soil bearing pressure is available and that subgrade areas are properly prepared.
- Earthwork & Compaction Testing: It is recommended that an experienced engineering technician witness the required filling operations and take sufficient in-place density tests to verify that the specified degree of compaction has been achieved. Soil engineering judgments will be involved and should be made by the geotechnical engineer of record with information provided by the engineering technician.
- Soils Laboratory Testing: Testing to aid in the classification and verification of use of the on-site soils for structural fill and/or embankment material should be performed by PSI. Testing includes, but is not limited to, Atterberg Limits, Grain Size Analysis, California Bearing Ratio, Standard Moisture Density Relationship, and Moisture Content.



# 7 REPORT LIMITATIONS

The recommendations submitted in this report are based upon the available subsurface information obtained by PSI and design details furnished by **EnSiteUSA** for the proposed project. If there are any revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine whether the recommendations provided herein must be changed. If PSI is not retained to perform these functions, we will not be responsible for the impact of those conditions on the geotechnical recommendations for the project.

PSI warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area at the date of this report. No other warranties are implied or expressed.

No entity can be as familiar with the design concepts inherent in these recommendations as PSI. Accordingly, only observations by PSI can permit PSI to finalize its recommendations and enhance the likelihood of the design concept being adequately considered during implementation of its recommendations.

After the plans and specifications are more complete, PSI should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use of **EnSiteUSA** and its clients for the specific application to construction of the proposed **POD Facility Project**, located in Morgan County, West Virginia.

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# APPENDIX A: IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL REPORT

# Important Information about Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

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

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

## **Read the Full Report**

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

#### A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

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

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

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

 the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,

- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

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

# **Subsurface Conditions Can Change**

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

## Most Geotechnical Findings Are Professional Opinions

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

# A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

#### A Geotechnical Engineering Report Is Subject to Misinterpretation

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

#### **Do Not Redraw the Engineer's Logs**

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.* 

#### Give Contractors a Complete Report and Guidance

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

## **Read Responsibility Provisions Closely**

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that

have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

#### **Geoenvironmental Concerns Are Not Covered**

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

# **Obtain Professional Assistance To Deal with Mold**

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

#### Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/THE BEST PEOPLE ON EARTH exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.



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# **APPENDIX B – VICINITY MAP AND BORING LOCATION PLAN**




## **APPENDIX C: BORING LOGS**

DATE STARTED:				12/14/16			DRILL COMPANY:	DRILL COMPANY: Connelly Drilling, Inc.		BORING GO-6							
DATE COMPLETED:					12/14/16			DRILLER: Kevin Kersl	DRILLER: Kevin Kersh LOGGED BYGunner Ingram			ram					
COMPLETION DEPTH				н_	40.0 ft		t	DRILL RIG:	DRILL RIG: CME 550 ATV		_	ter	⊻ wn	le Drillir	ng	29.5 feet	
					DRILLING METHOD:	Ho	llow St	tem Auger	<u> </u>	S Sa		on Comp	Dietion	N/A feet			
					SAMPLING METHOD:	2- <u>in SS1</u>	.8/4-I	n Core Stan	<u>da</u> rq					N/A leel			
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						Tele	ephone:	(703) 698-9300							Morga	n Coun	ty
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## **GENERAL NOTES**

#### SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

#### DRILLING AND SAMPLING SYMBOLS

- SFA: Solid Flight Auger typically 4" diameter flights, except where noted.
- HSA: Hollow Stem Auger typically 3<sup>1</sup>/<sub>4</sub>" or 4<sup>1</sup>/<sub>4</sub> l.D. openings, except where noted.
- M.R.: Mud Rotary Uses a rotary head with Bentonite or Polymer Slurry
- R.C.: Diamond Bit Core Sampler
- H.A.: Hand Auger
- P.A.: Power Auger Handheld motorized auger

#### SOIL PROPERTY SYMBOLS

- SS: Split-Spoon 1 3/8" I.D., 2" O.D., except where noted.
  - ST: Shelby Tube 3" O.D., except where noted.
- RC: Rock Core
- TC: Texas Cone
- 🕅 BS: Bulk Sample
- PM: Pressuremeter
- CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings
- N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
- N<sub>60</sub>: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
- Q<sub>u</sub>: Unconfined compressive strength, TSF
- Q.: Pocket penetrometer value, unconfined compressive strength, TSF
- w%: Moisture/water content, %
- LL: Liquid Limit, %
- PL: Plastic Limit, %
- PI: Plasticity Index = (LL-PL),%
- DD: Dry unit weight, pcf
- ▼,,,, Ž, Ž Apparent groundwater level at time noted

#### RELATIVE DENSITY OF COARSE-GRAINED SOILS ANGULARITY OF COARSE-GRAINED PARTICLES

Relative Density	N - Blows/foot	Description	Criteria
Very Loose	0 - 4	Angular	Particles have sharp edges and relatively plane sides with uppolished surfaces
Loose Medium Dense	4 - 10 10 - 30	Subangular:	Particles are similar to angular description, but have
Dense Verv Dense	30 - 50 50 - 80	Subrounded:	Particles have nearly plane sides, but have
Extremely Dense	80+	Rounded:	well-rounded corners and edges Particles have smoothly curved sides and no edges

#### **GRAIN-SIZE TERMINOLOGY**

### PARTICLE SHAPE

Modifier:

>12%

Component	Size Range	<u>Description</u>	Criteria		
Boulders:	Over 300 mm (>12 in.)	Flat:	Particles with width/thickness ratio > 3		
Cobbles:	75 mm to 300 mm (3 in. to 12 in.)	Elongated:	Particles with length/width ratio > 3		
Coarse-Grained Gravel:	19 mm to 75 mm (¾ in. to 3 in.)	Flat & Elongated:	Particles meet criteria for both flat and		
Fine-Grained Gravel:	4.75 mm to 19 mm (No.4 to 3/4 in.)		elongated		
Coarse-Grained Sand:	2 mm to 4.75 mm (No.10 to No.4)				
Medium-Grained Sand:	0.42 mm to 2 mm (No.40 to No.10)	RELATIVE	PROPORTIONS OF FINES		
Fine-Grained Sand:	0.075 mm to 0.42 mm (No. 200 to No.	40) Descripti	ve Term % Dry Weight		
Silt:	0.005 mm to 0.075 mm		Trace: < 5%		
Clay:	<0.005 mm		With: 5% to 12%		

Page 1 of 2



## **GENERAL NOTES**

(Continued)

#### **CONSISTENCY OF FINE-GRAINED SOILS**

<u>Q<sub>U</sub> - TSF</u>	<u>N - Blows/foot</u>	Consistency
0 - 0.25	0 - 2	Very Soft
0.25 - 0.50	2 - 4	Soft
0.50 - 1.00	4 - 8	Firm (Medium Stiff)
1.00 - 2.00	8 - 15	Stiff
2.00 - 4.00	15 - 30	Very Stiff
4.00 - 8.00	30 - 50	Hard
8.00+	50+	Very Hard

#### **MOISTURE CONDITION DESCRIPTION**

<b>Description</b>	Criteria
Dry:	Absence of moisture, dusty, dry to the touch
Moist:	Damp but no visible water
Wet:	Visible free water, usually soil is below water table

#### **RELATIVE PROPORTIONS OF SAND AND GRAVEL**

Descriptive Term% Dry WeightTrace:< 15%</td>With:15% to 30%Modifier:>30%

#### STRUCTURE DESCRIPTION

<b>Description</b>	Criteria	<b>Description</b>	Criteria
Stratified:	Alternating layers of varying material or color with	n Blocky:	Cohesive soil that can be broken down into small
	layers at least ¼-inch (6 mm) thick		angular lumps which resist further breakdown
Laminated:	Alternating layers of varying material or color with	n Lensed:	Inclusion of small pockets of different soils
	layers less than ¼-inch (6 mm) thick	Layer:	Inclusion greater than 3 inches thick (75 mm)
Fissured:	Breaks along definite planes of fracture with little	Seam:	Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick
	resistance to fracturing		extending through the sample
Slickensided:	Fracture planes appear polished or glossy, sometimes striated	Parting:	Inclusion less than 1/8-inch (3 mm) thick

#### SCALE OF RELATIVE ROCK HARDNESS

<u>Q<sub>U</sub> - TSF</u>	<u>Consistency</u>
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
,050 - 2,600	Hard
>2.600	Verv Hard

#### **ROCK VOIDS**

<u>Voids</u>	Void Diameter
Pit	<6 mm (<0.25 in)
Vug	6 mm to 50 mm (0.25 in to 2 in)
Cavity	50 mm to 600 mm (2 in to 24 in)
Cave	>600 mm (>24 in)

#### **ROCK QUALITY DESCRIPTION**

Rock Mass Description	RQD Value	
Excellent	90 -100	
Good	75 - 90	
Fair	50 - 75	
Poor	25 -50	
Very Poor	Less than 25	

### **ROCK BEDDING THICKNESSES**

<b>Description</b>	Criteria
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	<sup>1</sup> / <sub>2</sub> -inch to 1 <sup>1</sup> / <sub>4</sub> -inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to 1/2-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

#### **GRAIN-SIZED TERMINOLOGY**

(Typically Sedi <u>Component</u>	mentary Rock) <b>Size Range</b>			
Very Coarse Grained	>4.76 mm			
Coarse Grained	2.0 mm - 4.76 mm			
Medium Grained	0.42 mm - 2.0 mm			
Fine Grained	0.075 mm - 0.42 mm			
Very Fine Grained	<0.075 mm			

#### **DEGREE OF WEATHERING**

Slightly Weathered: Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.
 Weathered: Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.
 Highly Weathered: Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

# SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

м	ONS	SYM	BOLS	TYPICAL	
			GRAPH	LETTER	DESCRIPTIONS
	GRAVEL AND	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	GRAVELLY SOILS	(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
COARSE GRAINED SOILS	MORE THAN 50% OF COARSE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
	RETAINED ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50%	SAND AND	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
LARGER THAN NO. 200 SIEVE SIZE	SANDY SOILS	(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
	PASSING ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
				ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE				MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		СН	INORGANIC CLAYS OF HIGH PLASTICITY
				ОН	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
н	HIGHLY ORGANIC SOILS				PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS



## APPENDIX D: LABORATORY TESTING RESULTS

# Laboratory Summary Sheet

Sheet 1 of 1 Dry Density (pcf) Satur-Water Approx. Liquid Plastic Plasticity Qu %<#200 Est. Specific Void Borehole Content ation Depth Limit Limit Index (tsf) Sieve Ratio Gravity (%) (%) GO-6 37 25 12 16 1 GO-6 3 19 GO-6 5.5 27 14 19 41 34.5% 9.5 GO-6 14 GO-6 14 13 GO-6 17.5 13 7 5 GO-6 24 26 19 13.3% GO-6 29 7



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## **Summary of Laboratory Results**

PSI Job No.:	0512713-1	
Project:	6493-Easter	n Panhandle Expansion
Location:	Potomac Riv	ver Crossing
	Washington	County
	Hancock, M	D





#### PARTICLE-SIZE ANALYSIS OF SOILS - ASTM D422

Client	Professional Service Industries, Inc. (PSI)	Boring	GO-6
Client Project	Proposed Eastern Panhandle Expansion I-68 Cros	ssing V Depth	0.0'-4.0'
Project No.	38212	Sample	ST-1 & ST-2
		Lab Sample	38212002

#### Sample Color: **YELLOWISH BROWN USCS Group Name: SILTY SAND USCS Group Symbol:** SM USDA: A-2-6 (0) NA AASHTO: **MECHANICAL SIEVE** Total Sample Sieve Nominal Drv Split Normalized Project Total Sample Wet Wt, gm (-3") 1324 Size Opening, mm Wt, gm % Retained % Finer Specifications Sample Split on Sieve No. 4 3' 0.0% 100.0% 0 75 2-1/2" 0.0% 100.0% Coarse Washed Dry Sample, gm 91 63 0 2" 0.0% 100.0% Wet Wt Passing Split, gm 1233 50 0 1-1/2" Dry Wt. Passing Split, gm 1064 37.5 0.0% 100.0% 0 Total Sample Dry Wt, gm 1155 1" 0.0% 100.0% 25 0 3/4" 0.0% 100.0% 19 0 1/2" 100.0% 0.0% Split Sample - Passing No. 4 12.5 0 3/8" 0.7% 99.3% Tare No. 2073 9.5 8.3 839.29 No. 4 7.2% 92.1% Tare + WS., gm 4.75 82.72 Tare + DS., gm 744.86 No. 10 21.9% 70.3% 2 140.74 No. 20 50.3% Tare, gm 151.78 0.85 128.35 19.9% Water Content of Split Sample 15.9% No. 40 9.8% 40.5% 0.425 63.37 Wt. of DS., gm No. 60 35.5% 593.08 5.0% 0.25 32.25 No. 140 5.1% 30.3% 0.106 33.12 Wt. of +#200 Sample, gm No. 200 1.6% 28.7% 408.01 0.075 10.18 USCS SOIL CLASSIFICATION **USCS** Description Corrected For 100% Passing a 3" Sieve SILTY SAND % Gravel (-3" & +#4) 7.9 Silt=NA Clay=NA USCS Group Symbol **Atterberg Limits Group Symbol** Coarse=0; Fine=7.9 D60, mm NA **ML - SILT** % Sand (-#4 & +#200) 63.4 D30, mm NA SM Auxiliary Information NA Wt Ret, gm % Retained % Finer Coarse=21.9; Medium=29.8; Fine=11.7 D10, mm % Fines (-#200) 28.7 Сс NA 12" Sieve - 300 mm 0 0.0 100.0 % Plus #200 (-3") 71.3 6" Sieve - 150 mm 0.0 Cu NA 0 100.0 3" Sieve - 75 mm 0 0.0 100.0 100% 90% 80% 70% Percent Finer 60% 50% 40% 30% 20% 10%

0% 10 0.01 0.001 1 0.1 Diameter, mm Input Validation MAK Reviewed Bv: ALO Date Tested

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#### LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS **ASTM D 4318**

Client	Professional Service Industries, Inc. (PSI)	Boring	GO-6
Client Project	Proposed Eastern Panhandle Expansion I-68 Crossing \	/ Depth	0.0'-4.0'
Project No.	38212	Sample	ST-1 & ST-2
		Lab Sample	38212002

Soil Description:

YELLOWISH BROWN SILT

(-#40 Fraction)



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#### UNCONSOLIDATED UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOIL - ASTM D 2850

Sheet 3 of 3



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#### UNCONSOLIDATED UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOIL - ASTM D 2850

Sheet 3 of 3



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#### UNCONSOLIDATED UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOIL - ASTM D 2850 Sheet 3 of 3

Client Professional Service Industries, Inc. (PS Boring GO-6 Confining Stress (  $\sigma_3$  ), psi 27.8 Proposed Eastern Panhandle Expansion Depth Client No. 0.0'-4.0' UU Strength (q<sub>u</sub>), psi 50.7 ST-1 & ST-2 Project No. 38212 Sample Shear Strength (S<sub>u</sub>), psi 25.3 Lab ID No. 38212002 5.0% Strain at Failure ( $\varepsilon_f$ ), % Visual Description: YELLOWISH BROWN SILTY SAND Sample Condition Undisturbed STRESS VS. STRAIN 60 50 **Interbedded Shale** Deviator Stress (σ<sub>1</sub>-σ<sub>3</sub>), psi 40 30 20 10 0 0% 5% 10% 15% 20% Axial Strain (ε), % **MOHRS CIRCLE** STRESS PATHS 50 50 45 Mohrs Circle Radius (q), psi 45 40 40 Shear Strength, psi 35 35 30 30 25 25 20 20 15 15 10 10 5 5 0 0 20 0 40 60 80 0 20 40 60 80 Mohrs Circle Center (p), psi Normal Stress, psi

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**Slake Durability Test Results** 

#### Slake Durability of Shales and Similar Weak Rocks - ASTM D4644

Client	Professional Service Industries,	GO-6	
Client Project	Proposed Eastern Panhandle Ex	Depth	31.5'-32.5'
Project No.	38212	Sample	RC-9
		Lab Sample No.	38212004

#### Visual Description: Gray Phyllite/Slate

#### **Initial Water Content**

Drum ID	А
Drum + Wet Shale, gm	1733.9
Drum + Dry Shale, gm	1726.4
Drum Wt., gm	1221.9
Water Content, %	1%
Initial Dry Shale Weight, gm	504.5
Water Temerature Before Cycle 1, *C	21.9
Water Temerature After Cycle 1, *C	21.6
Average Temp during Cycle 1, *C	21.75
Drum + Dry Shale after Cycle 1, gm	1720.9
Dry Shale after Cycle 1	499
Slake Durability Index (First cycle)	98.9%
Water Temerature Before Cycle 2, *C	18.2
Water Temerature After Cycle 2, *C	18.3
Average Temp during Cycle 2, *C	18.25
Drum + Dry Shale after Cycle 2, gm	1717.8
Dry Shale after Cycle 2	495.9
Slake Durability Index (Second cycle)	98.3%

Type II—Retained specimen consist of large and small fragments.



#### Final Photograph



Input Validation: MAK

Reviewed By: ALO

Date Tested:

1/6/2017

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**Soil Resistivity Test Results** 

### **Corrosivity Testing**

ClientProfessional Service Industries, Inc. (PSI)Client ProjectProposed Eastern Panhandle Expansion I-68 Crossing Wash Co MDProject No.38212

						pH AASHTO T289			Soil Resistivity AASHTO T-288		
Lab Sample ID	Boring	Depth	Sample	Sample Received	Matrix	Result	Date Tested	Tested By	Result, Ohm- cm	Date Tested	Tested By
38212002	GO-6	0.0'-4.0'	ST-1 & ST-2	12/30/2016	Soil	4.4	1/9/2017	TX	18000	1/9/2017	TX

Input Validation:

ΤХ

Reviewed By: ALO