



February 2, 2017 Revised June 28, 2017

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

Re: Revised Report for Karst Topography Review Services

6493 – Eastern Panhandle Expansion Project Potomac River Crossing, Preliminary Investigation

Fulton County, Pennsylvania; Washington County, Maryland; and

Morgan County, West Virginia. 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. 0512-182348 dated June 13, 2016. The proposal was executed by Mr. Shams, P.E. representing EnSite USA, Inc.

This report was prepared to provide the public and Federal Energy Regulatory Commission (FERC) with information regarding the potential for Karst conditions along the Eastern Panhandle Expansion Project.

Project Description

PSI understands that the proposed project will consist of installation of natural gas transmission pipeline below portions of Fulton County, Pennsylvania; Washington County, Maryland; and Morgan County, West Virginia.

The Eastern Panhandle Expansion Project will consist of 3.37 miles of new greenfield 8-inch-diameter pipeline; three valves and two new tie-in assemblies. Two thirds of the pipeline will have ground cover of at-least 3 feet below the surface and about one third will be installed using Horizontal Directional Drilling (HDD) to lay the pipeline under the Potomac River and Interstate I-68.

EnSite USA is providing engineering services for Columbia Pipeline Partners for the proposed pipeline and requested that PSI perform an assessment of the potential for the presence of karstic limestone bedrock along the alignment.

Purpose and Scope Of Work

The purpose of this study was to obtain supplemental subsurface information in the area of the proposed natural gas transmission pipeline footprint in order to assess the potential for karst feature development. The following subsurface information was collected:

- Approximate bedrock depth and conditions at test borings performed along the proposed pipeline alignment
- Karst potential along the alignment based on a review of published geologic reports.

The following services were performed in order to achieve the objectives as outlined above:

- PSI reviewed readily available published topographic, geologic and soils information. This published information was obtained from the sources listed in the Bibliography, provided in the end of this report.
- PSI executed a limited subsurface exploration program consisting of drilling eight test borings, designated as PSI Borings GO-1, GO-2R, GO-3R, GO-4, GO-5, GO-6, GO-7 and GO-10 using a track mounted drill rig. The approximate locations of the test borings are shown on the Boring Location Plan in the Appendix B.
- Water level observations were made during the boring operations and are recorded on the boring logs in the Appendix C. Seasonal variations could influence the groundwater levels at the site; therefore, water levels could be different from those observed during the subsurface exploration.
- PSI prepared the geotechnical report, which summarizes the subsurface conditions encountered in the areas of potential Karst concern.

KARST TOPOGRAPHY

Karst is a special type of landscape that is formed by the dissolution of soluble carbonate rocks including limestone.

The development of karst occurs whenever acidic water starts to break down the surface of bedrock near its cracks, or bedding planes. Over geologic time, even very mildly acidic water can contribute to this weathering and dissolution of the bedrock. As the bedrock (typically limestone or dolostone) continues to degrade, its cracks tend to get bigger. As time goes on, these fractures will become wider, and eventually an internal drainage system of some sort may start to form underneath. If this underground drainage system does form, it will speed up the development of karst formations there because more water will be able to flow through the region.

The project site is located within a region which is prone to solution activity within the soluble carbonate bedrock. Karst is characterized by underground drainage systems with sinkholes and caves. Sinkhole development may result from raveling or movement of soil fines from the soil overburden by infiltrating water flowing downward to the poor-quality bedrock media where the rock mass has partially dissolved in the geologic past creating solution channels, clay-filled joints, and voids. Thus, a sinkhole may consist of a relatively localized weathered feature or a larger feature resulting from a collapse within a void formed in the overburden during migration of the soil fines. Solution activity could also be present along bedrock fracture zones or along geologic contacts. The mechanism of sinkhole development is illustrated schematically in Appendix D of this report. The following discussion outlines the findings of the study of the geology and subsurface exploration along the pipeline alignment as they relate to the potential for karst activity.



SITE AND SUBSURFACE CONDITIONS

SITE LOCATION AND DESCRIPTION

The project site is located in Fulton County, Pennsylvania; Washington County, Maryland; and Morgan County, West Virginia. The proposed Potomac river crossing has a steep eastern river bank and rolling hill terrain along the rest of the pipeline footprint. From the electronic plans provided, the elevations across the site range from about EL 402 to 691 feet.

SUBSURFACE CONDITIONS

LOCAL GEOLOGY

The Eastern Panhandle Expansion Project site is located in Ridge and Valley Province between South Mountain in Washington County and Dans Mountain in western Allegany County which contains strongly folded and faulted sedimentary rocks. The Potomac river flows in a valley called the Great Valley and is formed on Cambrian and Ordovician limestone and dolomite. Some of the valleys in this region are underlain by Silurian and Devonian limestones.

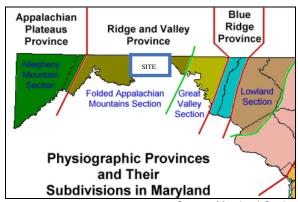


Figure 1. Physiographic Provinces and their Subdivisions in Maryland, Source: Maryland Geological Survey http://www.mgs.md.gov/geology/

A review of the Pennsylvania (PA), Maryland (MD) and West Virginia (WV) Geologic Maps, compiled by the United States Department of Interior Geologic Survey (USGS) indicates that the project site is underlain by the Marcellus Formation and Needmore Shale; Oriskany Sandstone and Helderberg Group; Wills Creek Shale and Bloomsburg Formation and Bloomsburg and Mifflintown Formations of the Ridge and Valley Physiographic Province of WV, MD and PA and are from the Silurian and Devonian Period.

Marcellus Formation and Needmore Shale, Devonian

Marcellus Formation (part of Millboro Shale) is predominantly gray-black to black thinly laminated non-calcareous pyritic shale. Contains one or more thin-bedded limestones, including the Purcell Member of Pennsylvania. Needmore Shale (part of Onesquethaw ("Onondaga") Group): predominantly dark grey or green, calcitic, mostly non-fissile shale. Gives strong "kick" on gamma ray logs. Tioga Bentonite near the top. Includes the black Beaver Dam Shale Member. Grades westward into the Huntersville Chert.



Oriskany Sandstone and Helderberg Group, Devonian

Oriskany Sandstone consists of White to brown coarse to fine grained, partly calcareous sandstone, locally pebbly or conglomeratic, and ridge-forming. May be white, nearly pure silica, and a source of glass sand, as at Berkeley Springs, Morgan County. *Helderburg Group* consists of mostly cherty limestone, with some sandstone and shale. Group contains several named stratigraphic units, including the Keyser Formation, which is partly Silurian and includes the Clifton Forge Sandstone and Big Mountain Shale Members.

Wills Creek Shale and Bloomsburg Formation, Silurian

Wills Creek Shale is olive to yellowish-gray, thin-bedded mudstone, calcareous shale, argillaceous limestone, and sandstone; thickness 450 feet in west, increases to 600 feet in east; Bloomsburg Formation is bright red, hematitic, thin to thick bedded sandstone and shale; some dark sandstone and green shale; Cedar Creek Limestone Member is dark gray, fine to medium grained argillaceous limestone, occurs in middle part of formation; total thickness 20 feet in west, increases to 200 feet in east.

Bloomsburg and Mifflintown Formations, Silurian

Bloomsburg and Mifflintown Formations - Includes, in descending order, the *Bloomsburg Formation* (Sb) and the *Mifflintown Formation* are interbedded dark-gray shale and mediumgray fossiliferous limestone;

Weathering in these formations is moderate to highly weathered to depths of 5 ft to 23 ft. Joints have a platy pattern, are steeply dipping, well developed, open and highly fractured. The interface between the bedrock and the soil mantle is pinnacled in most places. Some solution-channel openings as voids and caves can be expected in these formations and investigations for possible incipient sinkholes and sinkhole collapse areas are necessary.

Map showing the distribution of carbonate rocks in Pennsylvania. In Fulton County, folded carbonate rocks at the surface are shown along the eastern border of the county and at the center of the southern border. In the area of the proposed pipeline and tie-in facility we did not find mapped areas of karst activity nor did we observe exposed karst features at the surface.

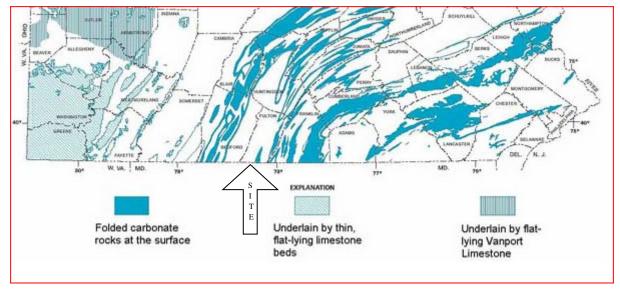


Figure 2. Pennsylvania Karst Map, Source: USGS, 2003 Pennsylvania Karst Map https://pubs.usgs.gov/of/2003/of03-471/graphics/reese/fig1.jpg



Map showing the distribution of carbonate rocks in Maryland. Those most associated with collapse sinkholes are the Hagerstown Valley (HV), the Frederick Valley (FV), and the Wakefield Valley (WV). To a lesser degree, collapse sinkholes are found in Green Spring Valley (gs), Worthington Valley (wo), and Long Green Valley (lg). In the area of the proposed pipeline and in Washington County mapping does not indicate karst activity.

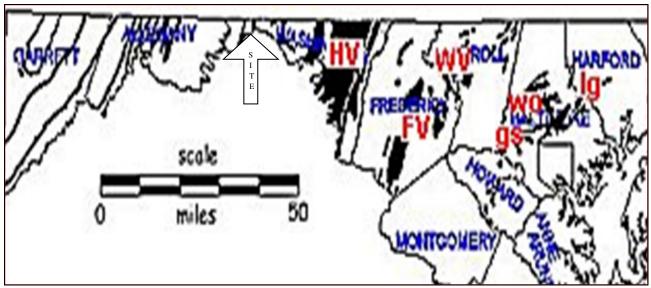


Figure 3. Maryland Sinkhole Map, Source: InspectAPedia®, Maryland Sinkhole Map http://inspectapedia.com/vision/Maryland_Karst.jpg

Map showing the distribution of carbonate rocks in Morgan County, West Virginia. The most prevalent carbonate rock outcrops are shown along the eastern 1/3 of West Virginia. In Morgan County, karst areas are shown to the south of the project site. In the area of the proposed pipeline and Point-of-Delivery facility in Morgan County mapping does not indicate karst activity. The map shows the distribution of caverns (blue triangles) in Berkeley, Jefferson and Hampshire Counties.

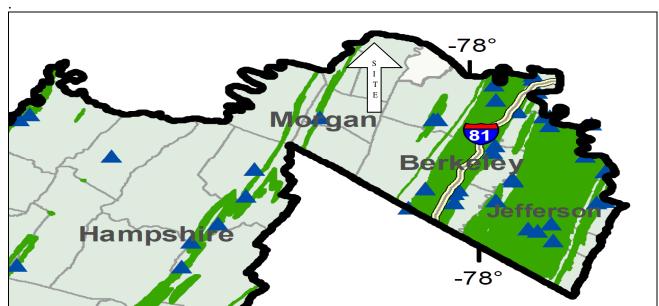


Figure 4. West Virginia Tax Districts with Karst Terrain, Source: Davies, William E., Caverns of West Virginia, (Volume 19A): http://www.wygs.wynet.edu/wyges2/publications/PubCat Details.aspx?PubCatID



Summary of Field Exploration and Laboratory Testing

Pennsylvania

Maryland

Maryland

West Virginia

Figure 5. Boring Plan, Source: Google Earth 2016

Eight borings were completed with a track-mounted drill rig in conformance with ASTM standards. Hollow stem augers were used to advance the boreholes through the upper overburden soils. Four borings were completed for the Potomac River crossing (GO-1, GO-7, GO-2R and GO-3R), two borings for the Interstate I-68 crossing (GO-4 and GO-5), one for the proposed Tie-in-Facility (GO-10) and one for the proposed Point-of-Delivery Facility (GO-6). 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 auger refusal 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.

The boring logs included in the Appendix indicate depths and visual descriptions of overburden soil, underlying rock materials encountered, soil SPT test results, rock core recovery and quality designation values, and 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.

The borings generally encountered five to twenty-three feet of overburden soil materials over the weathered rock and sound rock. The overburden deposits thicken toward the Potomac



river. Boring depths and bedrock 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-1	305	624	23 feet, EL ±601MSL	24 feet, EL ±600MSL
GO-2R	154	411	20 feet, EL ±391MSL	24 feet, EL ±387MSL
GO-3R	277	591	9 feet, EL ±582MSL	23 feet, EL ±568MSL
GO-4	60	435	6.5 feet, EL ±428.5 MSL	10 feet, EL ±425 MSL
GO-5	70	447	8.5 feet, EL ±438.5 MSL	13.5 feet, EL ±433.5 MSL
GO-6	40	590	19 feet, EL ±571MSL	30 feet, EL ±560MSL
GO-7	100	402	6 feet, EL ±396	6 feet, EL ±396MSL
GO-10	20	581	5 feet, EL ±576MSL	20 feet, EL ±561MSL

Weathered rock (WR) was encountered in all borings and is sufficiently dense or hard to result in SPT N-values of at least 100 bpf. Boring B-10 was terminated in weathered rock. Auger refusal **was** encountered in all test borings.

Rock discontinuities as voids as well as clay and sand seams which were encountered are summarized in Table 2 below.

Table 2 – Summary of Borings with Voids, Sand and Clay Seams

Boring	Approximate Termination Depth (feet)	Ground Surface Elevation (feet, NAVD)	Approximate Depth/Elevation of recorded VOIDS Depth/Elevation (Feet)	Approximate Depth/Elevation of recorded Sand Seams Depth/Elevation (Feet)	Material Washed Away During Coring Depth/Elevation (Feet)
GO-1	305	624	N/A	10-foot sand seam from 264feet, EL ±360MSL to 274feet, EL ±350MSL	N/A
GO-2R	154	411	1-inch void at 51.3 feet, EL ±359.7MSL 1-inch void at 53.1 feet, EL ±357.9MSL 7-inch void at 53.4 feet, EL ±357.6MSL	29-inch sand seam from 131.6 feet, EL ±279.4MSL to 134feet, EL ±277MSL 8-inch sand seam at 136 feet, EL ±275MSL 6-inch sand seam at 138.5 feet, EL ±272.5MSL	N/A
GO-3R	277	591	N/A	N/A	N/A
GO-4	60	435	N/A	N/A	N/A
GO-5	70	447	N/A	N/A	N/A
GO-6	40	590	N/A	N/A	N/A
GO-7	100	402	9-inch void at 58.2 feet, EL ±343.8MSL	N/A	17-inch clay seam from 72.6 feet, EL±329.4MSL to 74feet, EL ±328MSL 18-inch clay seam from 107feet, EL ±295MSL to 108.5feet, EL ±293.5MSL
GO-10	20	581	N/A	N/A	N/A



Groundwater Conditions

Groundwater was encountered only in one of eight borings while drilling operations were performed, at GO-6 at depth of approximately 29.5 feet below ground surface. The mud rotary and rock coring drilling processes introduced water into the boreholes, so the levels measured after drilling did not reflect the level of the saturated zone at the site. Borings were backfilled on completion for safety reasons; therefore, 24-hour water levels were not measured.

The rock coring process includes circulating water through the drilling rods to lubricate the core bit and to wash the cuttings up to the surface where the circulating water enters a small tank and the cuttings are allowed to settle out. The drilling crew did not observe excess return water that could indicate the presence of a confined aguifer containing groundwater under positive pressure, a so-called flowing artesian condition.

Conclusions

The results of the geologic literature review indicate that the rock formations along the project alignment are not mapped as having karst features. The borings did not encounter a soft soil, indicative of an active weathering zone just above the bedrock, which is a characteristic of sites with active karst feature development. In addition, the limestone encountered in the rock cores was interbedded with shale. Karst features are more likely to develop in massive limestone deposits than in more thinly bedded limestone that is interbedded with shale. Although some voids were observed in the rock cores, they were typically small and well above the expected depth of the pipeline.

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.

Lubomir D. Pevtchev. P.E.

Senior Geotechnical Engineer

Karl Suter, P.E.

Kal & Sit

Chief Engineer/Principal Consultant

Appendix:

Appendix A: Important Information About Your Geotechnical Report

Appendix B: Figure 1A: Site Vicinity Map and Figure 1B: Boring Location Plan

Appendix C: Boring Logs and Profiles

Appendix D: The mechanism of sinkhole development



BIBLIOGRAPHY

Cardwell, D.H., Erwin, R.B., and Woodward, H.P., 1968 (slightly revised 1986), Geologic Map of West Virginia: West Virginia Geological and Economic Survey, Map 1, East Sheet, scale 1: 250,000.

Cleaves, E.T., Edwards, J., Jr., Glaser, J.D., 1968, Geologic Map of Maryland: Maryland Geological Survey, Baltimore, Maryland, scale 1: 250,000.

Berg, T. M., Edmunds, W. E., Geyer, A. R., and others, compilers, 1980, Geologic map of Pennsylvania: Pennsylvania Geological Survey, 4th ser., Map 1, 2nd ed., 3 sheets, scale 1: 250,000.

David J. Weary and Daniel H. Doctor, Karst in the United States: A Digital Map Compilation and Database

David K. Brezinski and Bob Conkwright, Geologic and Karst Features Map of the Hagerstown Quadrangle, Washington County, Maryland, Hagerstown 7.5-minute quadrangle. 2013. Karst features mapped include sinkholes, closed depressions and springs. The map was compiled at a scale of 1:24,000

John D. Glaser, Geologic Map of Portions of the Hancock, Cherry Run, and Big Pool Quadrangles, Washington County, Maryland 2003, Scale 1: 24,000

Davies, William E., Caverns of West Virginia, (Volume 19A): Davies, William E., Caverns of West Virginia, (Volume 19A): http://www.wvgs.wvnet.edu/wvges2/publications/PubCat Details.aspx?PubCatID

Physiographic Provinces and their Subdivisions in Maryland: Maryland Geological Survey http://www.mgs.md.gov/geology/

Pennsylvania Karst Map: USGS, 2003 Pennsylvania Karst Map https://pubs.usgs.gov/of/2003/of03-471/graphics/reese/fig1.jpg

Maryland Sinkhole Map: InspectAPedia®, Maryland Sinkhole Map

West Virginia Tax Districts with Karst Terrain: Davies, William E., Caverns of West Virginia, (Volume 19A): http://www.wygs.wvnet.edu/wvges2/publications/PubCat Details.aspx?PubCatID

Mark T. Duigon and James R Dine, Water Resources of Washington County, Maryland, Bulletin 36, 1991, Maryland Geological Survey

Joseph T. Singewald, Jr. The Physical Features of Washington County; State of Maryland Board of Natural Resources Department of Geology, Mines and Water Resources, Baltimore, Maryland 1951

"What is Karst (and why is it important)?". Karst Waters Institute. http://karstwaters.org/educational-resources/what-is-karst-and-why-is-it-important/



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 confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your 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 *geoenvironmental* 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 conveved 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 conveved in this report will not of itself be sufficient to prevent mold from arowing in or on the structure involved.

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

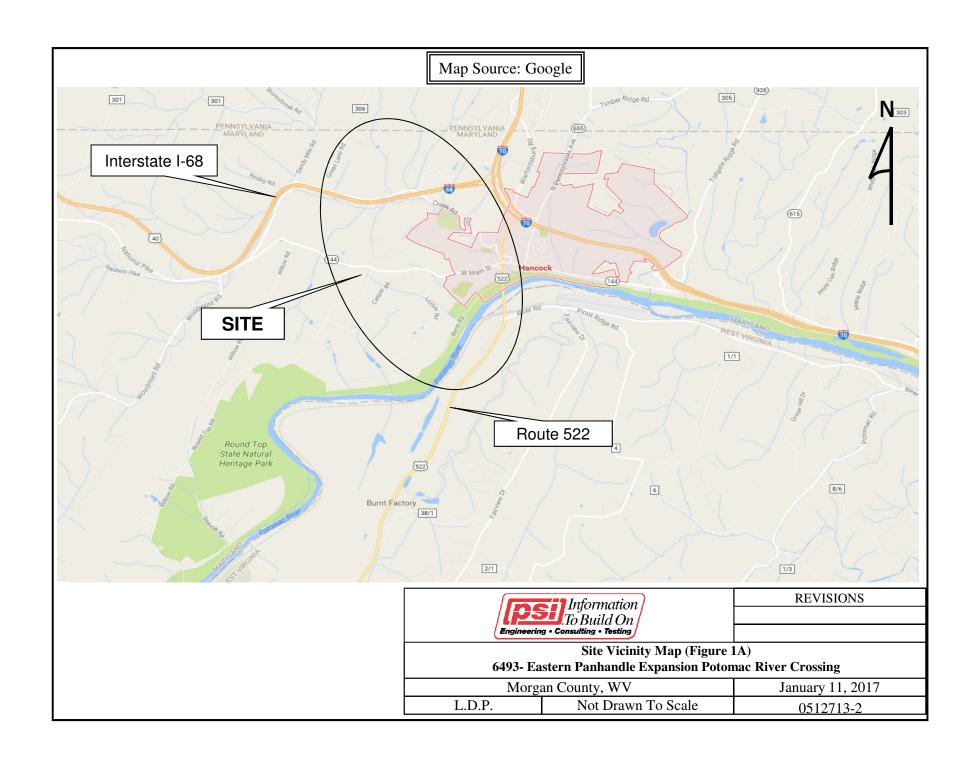
Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

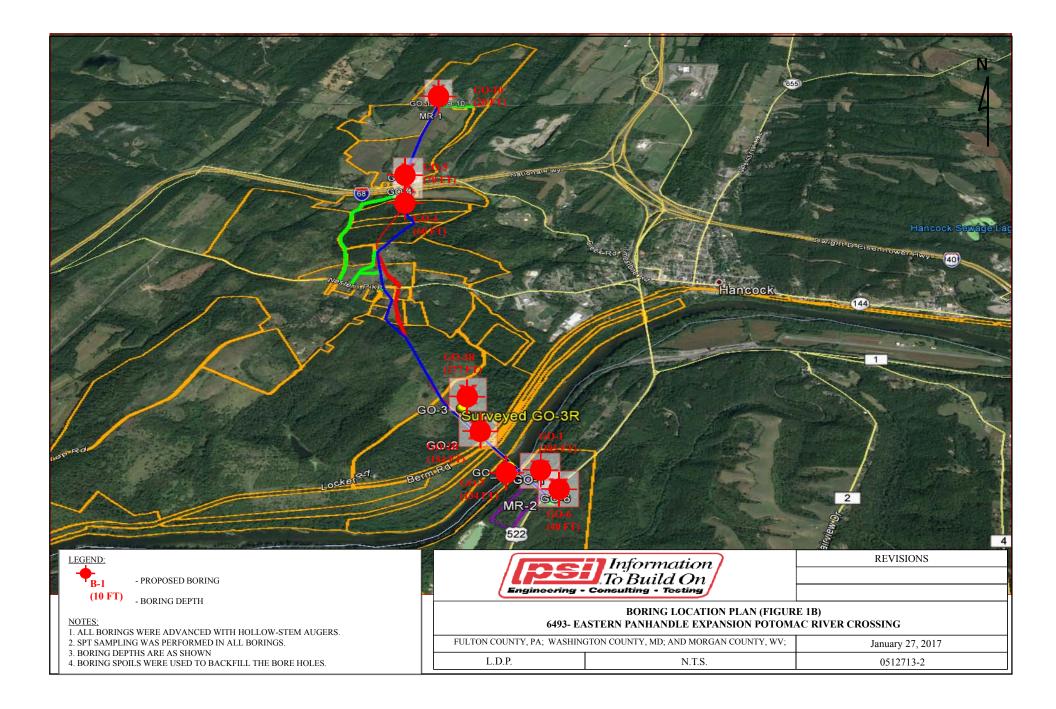


8811 Colesville Road/Suite G106, Silver Spring, MD 20910 Telephone: 301/565-2733 Facsimile: 301/589-2017 e-mail: info@asfe.org www.asfe.org

Copyright 2004 by ASFE, Inc. Duplication, reproduction, or copying of this document, in whole or in part, by any means whatsoever, is strictly prohibited, except with ASFE's specific written permission. Excerpting, quoting, or otherwise extracting wording from this document is permitted only with the express written permission of ASFE, and only for purposes of scholarly research or book review. Only members of ASFE may use this document as a complement to or as an element of a geotechnical engineering report. Any other firm, individual, or other entity that so uses this document without being an ASFE member could be committing negligent or intentional (fraudulent) misrepresentation.

APPENDIX B - VICINITY MAP AND BORING LOCATION PLAN





APPENDIX C: BORING LOGS

DATE STARTED:	6/29/16			rilling, Inc.	_ [BORIN	IG (3O-1
DATE COMPLETED:	7/7/16	DRILLER: Tom Chew LOG	GED B ` 1E 55 L		nd L		While Drilli		Dry feet
COMPLETION DEPTH	311.0 ft			- ;	water ĀĀĀ	Upon Com	-	Dry feet	
BENCHMARK:				tem Auger		<u>*</u> §	Delay	pietion	N/A feet
ELEVATION: LATITUDE:	624 ft 39.6803639°	SAMPLING METHOD:2-in SS HAMMER TYPE:	Autom				LOCATION:		TWA TOOL
LONGITUDE:	78.1952222°	EFFICIENCY	N/A	alic		JKING	LOCATION.		
STATION: N/A	OFFSET: N/A		omir Pe	vtchev					
REMARKS:			011111 1 0	ytonov					
Elevation (feet) Depth, (feet) Graphic Log Sample Type Sample No.	Recovery (inches)	RIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	× Md	TRENGTH, tsf		Additional Remarks
0 1	18 Approximately 3		Top	1-6-5	14	@			
2	18 (USCS CH) some	t, light brown, FAT CLAY gravel, roots. Alluvium	Soil/ CH/	N=11 2-6-8	21	\	, × —		LL = 55 PL = 27
620 - 5 - 1 2 2	Stiff to very stiff,	moist, brown, red, trace	ML	N=14					Fines=97.4%
3	18 gray, SILI (USC	S ML) some gravel.	IVIL	6-8-10	23		þΥ		
F 1111 .	Ctiff to your otiff	maiat dark brown brown		N=18			'		LL = 39
615 - 10 - 11 4		moist, dark brown, brown, some gravel, trace shale		2-5-6 N=11	25	9			PL = 27
├ [']	fragments Resid	luum			26		× 2	→	Fines=99.8% LL = 45
F 3 ■ <u>-</u>	24		ML	_ , , , ,				>>9	PL = 29 Fines=99.6%
610 - 15 - 1	18			7-14-16 N=30	21		\times		
	Medium stiff to st	iff, very moist, dark brown,							
	olive brown, black	(lean CLAY (USCS CL)			21		X		LL = 44 PL = 26
605+ 6	12 some gravel, sha	le fragments, wood chips.	CL	1-4-2	25	\otimes	*		Fines=90.0%
20	Residudiii			N=6					
<u> </u>		C OLIALITE		(all					
600 7	0 Weathered Rock	, gray, dark gray, soft SHAL\ E /E CONF	ATHEI NAH					>>@)
25 8	Interbedded, slight	ntly weathered, medium	D(11/19/	RQD=89					
t ‡ i i i i i i i i i i i i i i i i i i	pedded to thin be	edded, gray, dark gray , fine m grained, very soft to soft		Rec=100%					
595	SHALE and hard	LIMESTONE, dip of 25 to							
30 9	45 degrees, (RQI	D from 45% to 100 %),		RQD=90					
<u> </u>	Needmore Shale	llus Formation and		Rec=100%					
590		•							
35 10	60			RQD=100					
	00			Rec=100%					
585+									
11	60		Shale	RQD=78					
		ı	and imesto	Rec=100%					
580 - 45		-							
12	60			RQD=88					
□ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □				Rec=100%					
575									
F ³⁰	60			RQD=90					
<u> </u>				Rec=100%					
570 - 55 - 55									
14	52			RQD=45					
	-			Rec=87%					
565 - 60									
00		ontinued Next Page							
		Service Industries, Inc.		PR	OJEC	T NO.:		051271	9-1
Inc	2930 Eskrid	ge Rd			OJEC		Eastern Par		
IJJ	Fairfax, VA			LO	CATIC	ON: _		ington C	
	i eiepnone:	(703) 698-9300					ŀ	Hancock	•

DATE DATE			D:		6	5/29/16 7/7/1				L COMP	_			rilling, Inc. Y: J. Thonnfe				BC	RIN	IG G	O-1
COMP						311.0				LER L RIG:	JIII CHEW		E 55 L		znu	Ŀ	∇	While	e Drilli	ng	Dry feet
BENC	HMAF	RK:			I	N/A			DRILL	LING ME	ETHOD:			tem Auger		Water	Ţ			pletion	Dry feet
ELEV		l:				24 ft								n Core Star		-		Dela			N/A feet
LATIT	_					3639°				MER TY			Autom	atic		BOR	ING	LOCA	TION:		
LONG STATI			/A		78.19 OFFS	52222	N/A			CIENCY	 BY:	Lube	N/A	vtchov							
REMA	_	IN			OFFS	,E1.	IN/A		KEVIL	-WED B	,ı	Lubo	////// FE	ylcriev	_						
Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)		MAT	ΓER	IAL [DESCF	RIPTIO	·N	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	× 0	Moi	TEST [in blow sture	vs/ft © TH, tsf **		Additional Remarks
560	- 60 - - - - - 65 -		\blacksquare	15	60	bedd grain SHA 45 de	ed to thi ed to me LE and h egrees, (n be ediur nard (RQE	dded, g n grair LIMES) from	gray, daned, ven STONE, 45% to	, medium ark gray , y soft to : dip of 25 100 %),	fine soft 5 to		RQD=83 Rec=100%				2.0		4.0	
555	555 + 70 =										Shale and mesto	ne									
550	 - 75 -	——————————————————————————————————————	\blacksquare											RQD=92 Rec=100%							
545	 - 80 -		\blacksquare	18	60	bedd	ed, blac	k, da	rk gray	y, trace	dded to tl white , fi	ne		RQD=97 Rec=100% RQD=94							
540	 - 85 -		\blacksquare	20	60	coal from	seams, o	dip o 95 %	f 20 to 5). Dev	60 deg	t SHALE grees, (Ro [Marcellu e]	QD		Rec=100%			+				
535	90 -			21	60									Rec=100%			+				
530	 - 95 - 			22	60									Rec=100%							
525	- -100-		2	23	60								Shale	RQD=67							
520	 -105- 		2	24	60									Rec=100%							
515	 - 110- 		2	25	60									Rec=100%							
510	 -115- 		2	26	60									Rec=100% RQD=64			+				
505	 - -120-									ed Next I		<u> </u>		Rec=100%							
				#	7		ofessic 30 Esk				dustries	s, Inc.			ROJE	ECT N				0512719	-1 Expansion
		75	\$	Æ			oo ∟sr irfax, \									ION:				ington Co	
L							lephor				9300									Hancock	

	STAR		_		(6/29/16 7/7/1		_	RILL COMP				rilling, Inc. /: J. Thonnfe			В	BORI	NG G	O-1
	PLETIC			_		311.0			RILLER:	om chew		55 L		ilu I	ЭĽ	∑ w	/hile Dri	lling	Dry feet
BENC	HMAF	RK:				N/A		DR	RILLING MI	ETHOD:			em Auger			▼ U		npletion	Dry feet
	ATION	_				24 ft							n Core Stan			$\bar{\Lambda}$ D			N/A feet
LATIT				;		03639°		_	MMER TY	-		Automa	atic		BORI	NG LO	CATION	l:	
STAT			I/A		78.19 OFF S	52222 ET.	N/A	_	FICIENCY	 BY:		N/A	vtchov						
	ARKS:		N/A		OFF) - 1	IN/A	_	VIEVVED	··	LUDUI	IIII F C	ytchev						
Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)		MATE	ERIAL	L DESCI	RIPTION		USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	× 0	TES N in Moistu	25 ENGTH, ts	PL FO	Additional Remarks
500-	-120- - - - - - -125-			27	60	bedo grain coal	ed, black, ed to med seams, dir	dark g lium gr p of 20	gray, trace rained, sof to 60 deg	dded to thir white , fine t SHALE, tr grees, (RQE Marcellus	race	Shale	RQD=53 Rec=100%		0		2.0	4.0	
495—				28	60	Form	ation and	Needr	more Shale	e]			RQD=59 Rec=100%						
490-	130—130—130—130—130—130—130—130—130—130—									ark gray , fir t SHALE ar 50 degrees vonian	nd S,		RQD=100 Rec=100%						
485-	 			30	60	liviai	celius Fori	mation	and Need	imore Snak	ej		RQD=96 Rec=100%						
480-	-140- 			31	60								RQD=93 Rec=100%						
475—	-145- 			32	58								RQD=95 Rec=97%						
470-	-150- 			33	60							Shale and	RQD=98 Rec=100%						
465-	-155- 			34	60						Lir	mestoi	ne RQD=91 Rec=100%						
460-	-160- 			35	59								RQD=96 Rec=98%						
455-	-165- 			36	60								RQD=100 Rec=100%						
450-	-170- 			37	60								RQD=73 Rec=100%						
445-	-175- 	I I		38	54								RQD=75 Rec=90%						
	-180-							Contii	nued Next	Page								+ -	
4						Pr	ofession			dustries,	Inc		PE	O.IF	CT N	0.:		0512719	-1
			7		77	29	30 Eskri	idge l	Rd					OJE		_	stern Pa	anhandle E	
		7	J	Ì	i I	Fa	irfax, VA	4 220	031	0000			LC	CAT	ION:			hington Co	
L			\leq			Te	ephone	e: (70	03) 698-9	9300								Hancock	

	STAR		-D·		(6/29/16 7/7/1		-	COMPANY	': <u>Co</u> Chew LO (rilling, Inc				BC	RIN	IG G	iO-1
				н—		311.0					ME 55 L		illellu	er	∇	While	e Drilli	ng	Dry feet
BENC	NCHMARK: N/A DRILLING METHOD: Hollow Ste												r	/ater	$ar{f \Lambda}$			pletion	Dry feet
	'ATION	l:				24 ft		SAMPL	ING METH	IOD: 2- <u>in</u> S	S1.874-	in Core St	andar	$\overline{}$		Dela			N/A feet
	TUDE:	_ —				03639°		_	R TYPE:		Autom	atic		BOR	ING	LOCA	TION:		
STAT	SITUDE		I/A		78.19 OFF S	52222°	N/A	EFFICIE	ENCY VED BY:	11	N/A comir Pe	ov tobov.							
	ARKS:	IN	I/A		OFF)	IN/A	REVIEW	VED BI.	Lui	JOHN PE	eytonev							
Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)		MATEI	RIAL DE	ESCRIP [*]	TION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	× 0	Moi	TEST [I in blov isture 25 TRENG	ws/ft⊚ ⊿ ♣		Additional Remarks
440-	-180- - - -			39	60	bedd grain	pedded, slig ed to thin b ed to mediu LIMESTON	edded, gr um graine	ay, dark gi d, soft SH	ray , fine ALE and		RQD=7 Rec=100		0		2.0	0	4.0	
435-	-190									an	Shale	RQD=8 Rec=100	-						
430-	 			41	60						Limesto	RQD=5 Rec=100							
425-	-195 42 60 Interbedded, sligh											RQD=6 Rec=100							
420-	-205			43	60	SHA 45 de Devo	ed to thin b LE and hard egrees, (RC onian [Marce Imore Shale	d LIMEST D from 88 ellus Form	ONE, dip (3% to 93 %	of 25 to %),		RQD=8 Rec=100							
415-	-210-			44	60						Shale	RQD=8 Rec=100	-						
410-	-215-			45	60						and Limesto	RQD=9 n R ec=100	0%						
405-	-220-			46 47	60							RQD=8 Rec=100	0%						
400-	-225-				60	bedd	pedded, slig	edded, wł	nite, gray,	trace red,		RQD=9 Rec=100	0%						
395-	395—230—395—48 56 yellow, fine grained to med SANDSTONE and soft SH. 25 degrees, (RQD from 46 Devonian [Marcellus Formation 10 per								HALE, dip 6 6% to 75 %	of 10 to %),		RQD=5 Rec=93	%						
390-	-235					Need	unore Shale	=]		S	ANDST	ONEQD=7 Rec=100							
385-				50	60			<u>Cont</u> inued	Next Page	e		RQD=6 Rec=100	-						
					7	29 Fa	ofessiona 30 Eskrio irfax, VA	al Servic Ige Rd 22031	e Indust	tries, Inc			PROJI PROJI LOCA	ECT:			rn Par Wash	0512719 hhandle Eington Co	Expansion ounty

Septembar Sept		: STAR		=D·			7/7/16 7/7/16		DRILL COMPA			rilling, Inc. V : I Thonn				BO	RIN	1G G	O-1
DRILING METHOD: Hollow Stem Augert September December Dec					н—								ilenu	7	∇	While	e Drilli	ng	Dry feet
Authoriatic Street Stree					. –				_					ate	_			-	Dry feet
Authoratic Substitution Substi			_											d≥l		Delay	y	•	N/A feet
EASTATION: NA			_												ING L	OCA1	TION:		
STANDARD PENITRATION STANDARD PENITRATION Nin blower Nin blowe	LONG	SITUDE	E:			78.19	52222°												
STANDARD FINEMENT No. STEPHATE No. STANDARD FINEMENT No. STANDARD FINEMENT No. STEPHATE NO. STEPHAT	STAT	ION:_	N	I/A		OFFS	SET:	V/A	REVIEWED BY	:Lul	oomir Pe	eytchev							
1	REMA	ARKS:																	
Sample	Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	Λ	MATER	IIAL DESCRI	IPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)		× 0	Mois STF	TEST Din blow sture	DATA #s/ft # TH, tsf #	PL LL 50	Additional Remarks
Standard Standard		-240-					Interbedd	ded, sligt	ntly weathered, r	medium				10		2.0	1	4.0	
SANDSTO RCD=85 Rec=95% RCD=85 Rec=95% RCD=85 Rec=95% RCD=85 RCD=95 RCD=100 RCC=43% RCD=100 RCC=43% RCD=100 RCC=43% RCD=100 RCC=43% RCD=100 RCC=13% RCD=100 RCC=13% RCD=100	380-	-245-					bedded to yellow, fir SANDST 25 degree Devonian	o thin be ne graine ONE an es, (RQI n [Marcel	dded, white, gra ed to medium gr d soft SHALE, d D from 46% to 7 lus Formation a	y, trace red, ained, soft lip of 10 to 5 %),		Rec=100	%						
SANDSTO ROD=85 Rec=95% RQD=85 Rec=95% RQD=83 Rec=95% RQD=846 Rec=100% RQD=46 Rec=100% RQD=13	375-			Ш			Needmor	e Shale]				Rec=97%	%						
255	370-	-250- 			53	57				S	ANDST	NEQD=8: Rec=95%	5 %						
Section Sect	0.0	-255																	
Loose we to flow producy graded sAND (USCS SP) trace limestone floaters, Devonian (Marcellus Formation and Needmore Shale) 570 570 571 582 350 2775 583 350 2775 585 522 Interbedded, slightly weathered, medium bedded to thin bedded, white, gray, fine grained to medium grained, medium hard SANDSTONE and sand seams, dip of 10 to 35 degrees, (RQD from 13% to 30 %), Devonian [Marcellus Formation and Needmore Shale] 340 285 600 49 61 60 61 60 61 60 61 60 62 60 62 60 Frofessional Service Industries, Inc. 2930 Professional Service Industries, Inc. 2930 Eastern Panhandle Expansion		-260 -			55	60													
Interbedded, slightly weathered, medium bedded to thin bedded, white, gray, fine grained to medium grained, medium hard SANDSTONE and sand seams, dip of 10 to 35 degrees, (RQD from 13% to 30%), Devonian [Marcellus Formation and Needmore Shale] SANDSTONE and sand seams, dip of 10 to 35 degrees, (RQD from 13% to 30%), Devonian [Marcellus Formation and Needmore Shale] SANDSTONEQD=30 Rec=87% RQD=25 Rec=82% Interbedded, slightly weathered, medium bedded to thin bedded, white, gray, fine grained, medium hard LIMESTONE - CHERTY and sand seams, dip of 45 degrees_LIMESTONE (RQD from 58% to 100 %), Devonian [Marcellus Formation and Needmore Shale] Continued Next Page Professional Service Industries, Inc. PROJECT NO.: 0512719-1 PROJECT: Eastern Panhandle Expansion		-265 -			56	26	(USCS SI Devonian	P) trace in [Marcel	limestone floate lus Formation a	rs,	SP								
interbedded, slightly weathered, medium bedded to thin bedded, slightly weathered, medium bedded to thin bedded, slightly weathered, medium bedded to thin bedded, white, gray, fine grained, medium hard LIMESTONE - CHERTY and sand seams, dip of 45 degrees LIMESTONE (RQD from 58% to 100 %), Devonian [Marcellus Formation and Needmore Shale] Professional Service Industries, Inc. PROJECT NO: 0512719-1 Eastern Panhandle Expansion	050	-270- 			57	8													
Needmore Shale] Needmore Shale] SANDSTONEQD=30 Rec=87% RQD=25 Rec=82% Interbedded, slightly weathered, medium bedded to thin bedded, white, gray, fine grained, medium hard LIMESTONE - CHERTY and sand seams, dip of 45 degrees_LIMESTONE (RQD from 58% to 100 %), Devonian [Marcellus Formation and Needmore Shale] Continued Next Page Professional Service Industries, Inc. 2930 Eskridge Rd PROJECT NO.:		 			58	52	bedded to grained to SANDST 35 degree	o thin be o mediur ONE and es, (RQI	dded, white, gra m grained, medi d sand seams, o D from 13% to 3	y, fine um hard dip of 10 to 0 %),			-						
Interbedded, slightly weathered, medium bedded to thin bedded, white, gray, fine grained, medium hard LIMESTONE - CHERTY and sand seams, dip of 45 degrees LIMESTONE (RQD from 58% to 100 %), Devonian [Marcellus Formation and Needmore Shale] Continued Next Page Professional Service Industries, Inc. 2930 Eskridge Rd PROJECT NO.:	340-	 		H	59	52					ANDST		-						
190	335-	-285- 			60	49													
Professional Service Industries, Inc. 2930 Eskridge Rd PROJECT NO.:		 			61	60	bedded to grained, r CHERTY (RQD fro	o thin be medium and sar m 58% t	dded, white, gra hard LIMESTON nd seams, dip of o 100 %), Devo	iy, fine NE - f 45 degrees _l onian	IMESTO	RQD=50 Rec=100 NE	8 %						
Professional Service Industries, Inc. 2930 Eskridge Rd PROJECT NO.: 0512719-1 PROJECT: Eastern Panhandle Expansion	325-	 	0		62	60	[Marcellu			•	CHERT	RQD=6							
2930 Eskridge Rd PROJECT: Eastern Panhandle Expansion								С	ontinued Next Pa	age									
Telephone: (703) 698-9300 Hancock		E	Professional Service Industries, Inc. 2930 Eskridge Rd Fairfax, VA 22031										PROJ	ECT:	E		rn Par Washi	nhandle E	xpansion

DATE STARTED:	6/29/16	DRILL COMPANY:	Connelly Dr			BOR	ING G	O-1
DATE COMPLETED:	7/7/16	DRILLER: Tom Chew			! 			
COMPLETION DEPTH	311.0 ft	DRILL RIG:	CME 55 LO		. 털 -	While Dr Upon Co Upon Co While Dr While Dr	mpletion	Dry feet Dry feet
BENCHMARK:	N/A	DRILLING METHOD:	Hollow Sto		. > .		mpielion	N/A feet
ELEVATION: LATITUDE:	624 ft 39.6803639°	SAMPLING METHOD:2-i HAMMER TYPE:	I <u>n SS1.874-Ir</u> Automa			<u>v</u> Delay IG LOCATIO	N:	IN/A IEEL
LONGITUDE:	78.1952222°	EFFICIENCY	N/A	auc	DURIN	IG LOCATIO	N:	
STATION: N/A	OFFSET: N/A		Lubomir Pe	vtchev				
REMARKS:	OITOLI	KLVILWLD D1.	<u>Lubolilli i C</u>	ytoricv				
	nches)		ification	6-inch (SS) ary % (NX)	8	NDARD PENET TEST DATA N in blows/ft	Α	
Elevation (feet) Depth, (feet) Graphic Log Sample Type Sample No.	Recovery (inches)	RIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)		Moisture 25 STRENGTH, 1	♣ LL 50	Additional Remarks
				SPT		Qu 2.0	₩ Qp	
320 - 305 - 64		oring at 305 feet	- CHERT	NRQD=78 Rec=100% Y RQD=100 Rec=100%	0	2.0	4.0	
315—-310-								
	Dunfor and	I Complete Indicated	Inc			\	0510515	4
	2930 Eskrid	l Service Industries,	IIIC.	_	JECT NC JECT:		0512719 Panhandle E	
DS	Fairfax, VA	22031			ATION:		shington Co	
	Telephone:	(703) 698-9300		200			Hancock	· · · · · · ·

DATE	STAF	RTED:				7/7/16	DRILL COMPANY:			illing, Inc.			PODII	VIC.	CO 2P
	_					7/11/16	DRILLER: Tom Chew				end	• 7			GO-2R
COME			PT	н _		154.0 ft	DRILL RIG:		55 L			Water	While Drill	-	Dry feet
BENC		-				N/A	_ DRILLING METHOD: _			em Auger		\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	Upon Con	pletion	
ELEV		_				11 ft	SAMPLING METHOD:2-						Z Delay		N/A feet
LATIT						3456°	HAMMER TYPE:		Automa	atic		BORIN	G LOCATION	:	
LONG			1/4			9904°	_ EFFICIENCY		N/A						
STAT REMA	_		I/A		OFFS	SET: N/A	_ REVIEWED BY:	Lubor	nir Pe	ytchev					
IXEIVI										ଡି ଦ		CTA		ATION	
Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATE	RIAL DESCRIPTION	I	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	× 0	NDARD PENETF TEST DATA N in blows/ft @ Moisture	PL LL	Additional Remarks
410-	- 0 - 	11111	M	1	16		inches of Topsoil		Top	2-2-3	21	<u></u>	X	1	LL = 38
405—	 - 5 - 		X	2	24 18 18	lean CLAY (USC Alluvium Medium stiff to s	pist, brown, dark brown, CS CL) some gravel, roots. stiff, moist, mottled brown CS CH) some sand.		Soil/ CL/ CH	N=5 3-3-4 N=7 3-4-6 N=10	19 30 27	<u> </u>	X	>>	PL = 22 Fines=75.1% ILL = 63 PL = 25 ILL = 59 PL = 23 Fines=89.3%
400-	 - 10 -			4	24 18	Stiff, moist, mot	tled brown, lean CLAY e sand. Alluvium		CL	2-3-8 N=11	20 18		* •	***	LL = 33 PL = 18 Fines=90.8%
395-	 - 15 -			5	14	lean CLAY (USO Alluvium	oist, mottled brown sandy CS CL) trace gravel.	'	CL	2-2-3 N=5	17		×		Fines=55.8%
390-	 - 20 - 			6	12	(USCS CL) trace gravel. Residu Weathered Roc and hard LIMES	k, gray, dark gray, soft SH <i>i</i> TONE, Silurian [Wills Cree	ALE ek	CL ATHER SHALE	18-11-7 N=18 RED	14				
385-	 - 25 - 			7 8	2 54	Interbedded, slig bedded to thin b brown, fine grain	nsburg Formation] ghtly weathered, medium ledded, gray, light gray, tra ned to medium grained, HALE and hard LIMESTON	ace	JIIALL	4-48-50/2' RQD=35 Rec=90%					
380-	- 30 - - 30 - 			9	60	dip from 30 to 4	0 degrees, (RQD from 35 t Wills Creek Shale and			RQD=40 Rec=100%					
375-	- 35 - - 35 - 			10	60				Shale and nesto	RQD=95 Rec=100%	Ď				
370-	- 40 - 			11	60					RQD=52 Rec=100%					
365—	- 45 - 			12	60					RQD=82 Rec=100%					
360-	- 50 - 			13	53				Shale and	RQD=70 Rec=88%					
355—	- 55 - 			14	57			Lir	nesto	ne RQD=93 Rec=95%					
	- 60 -						Continued Next Page								<u> </u>
	K					2930 Eskrid Fairfax, VA		Inc.		P	ROJE ROJE DCAT	_	Eastern Pa Wash		e Expansion County

DATE STARTED:		7/7/16			rilling, Inc.	—		ı	ROI	RIN	ic c	0-2R
DATE COMPLETED		7/11/16 154.0 ft	DRILLER: Tom Chew LOC			end	_		While			Dry feet
COMPLETION DEP BENCHMARK:		N/A		ME 55 L	tem Auger	-	æ				oletion	Dry feet
ELEVATION:		11 ft	SAMPLING METHOD:F			— ndard	Water		Delay	001116	51011011	N/A feet
LATITUDE:		33456°	atic				OCATI	ION:				
LONGITUDE:		19904°	EFFICIENCY	N/A								
STATION: N/A	OFF:	SET: N/A	REVIEWED BY: Lub	omir Pe	ytchev							
REMARKS:	T 1	T										
Elevation (feet) Depth, (feet) Graphic Log	Sample No. Recovery (inches)	MATER	RIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %		Т	RD PEN EST DA n blows ture	ATA /ft ⊚	PL LL 50	Additional Remarks
ilev Del	Sa			SSS	Sow R F	ž						
ш	%			Š	PTE			SIR Qu	RENGTH	⊣, tsf Ж	Qp	
60					N. I.		0	Qu	2.0		4.0	
350	15 60	bedded to thin be grained to mediu SHALE and hard	htly weathered, medium edded, brown and gray, fine im grained, medium hard I LIMESTONE, dip from 30 to		RQD=78 Rec=100%							
345	16 57	40 degrees, (RQ [Wills Creek Sha Formation]	D from 42 to 93 %) Silurian lle and Bloomsburg	Shale and Limesto	RQD=52 Rec=95%							
340	17 60	Void from 51.3' to			RQD=42 Rec=100%							
335	18 60	bedded to thin be	htly weathered, medium edded, gray, trace brown, fine		RQD=98 Rec=100%							
330 - 80	19 60	SHALE and hard 45 degrees, (RQ	m grained, medium hard I LIMESTONE, dip from 30 to D from 66 to 98 %) Silurian lle and Bloomsburg		RQD=72 Rec=100%							
325 - 85	20 60				RQD=85 Rec=100%							
320 - 90 -	21 59			and Limesto	ne RQD=83 Rec=98%							
315	22 57				RQD=70 Rec=95%							
310	23 60				RQD=66 Rec=100%							
305	24 51	bedded to thin be brown, fine grain medium hard SH	htly weathered, medium edded, gray, trace yellow and ed to medium grained, IALE and hard LIMESTONE, degrees, (RQD from 17 to		RQD=62 Rec=85%							
300 - 110	25 49	95 %) Silurian [V Bloomsburg Form	Vills Creek Shale and mation]	Shale and Limesto	RQD=18 Rec=82%							
-115-		Sand seam from	131.6' to 134'					+				
295	26 60	Sand seam from	136' to 136.7'		RQD=73							
-120-		Sand seam from			Rec=100%							
			l Service Industries, Inc		PE	RO.IF	CT N	ω·	,		0512719	 -1
		2930 Eskrid	ge Rd	•		ROJE		_	astern			xpansion
	Sil	Fairfax, VA	22031			CAT					ngton Co	
		Telephone:	(703) 698-9300							-	lancock	

DATE STAR	_			7/7/16		DRILL COMPANY: _ DRILLER: Tom Chev			illing, Inc.			В	ORIN	IG G	0-2R
DATE COMPLETIC	PLETED: ON DEPT	н		7/11/10 154.0		DRILL RIG:		E 55 L		ilu I	ē		ile Drilli		Dry feet
BENCHMAR				N/A		DRILLING METHOD:		em Auger		at	▼ Upo	n Com	pletion	Dry feet	
ELEVATION	:			1 ft		SAMPLING METHOD						▼ Del			N/A feet
LATITUDE:			39.68			HAMMER TYPE:		Automa	atic		BORI	NG LOC	ATION:		
LONGITUDE STATION:	:: N/A		OFFS	9904°	N/A	EFFICIENCY REVIEWED BY:	Lube	N/A	vtchov						
REMARKS:	IN/A		OFFS	·	IN/A	REVIEWED B1.	Lubc	JIIII FE	ytchev						
Elevation (feet) Depth, (feet)	Graphic Log Sample Type	Sample No.	Recovery (inches)		MATEF	RIAL DESCRIPTIC	Ν	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	×	N in blo	DATA Dws/ft ©	ATION PL LL 50 Qp 4.0	Additional Remarks
290		27	56	bedde browr mediu	ed to thin be n, fine grain um hard SH	htly weathered, mediunedded, gray, trace yello ed to medium grained, IALE and hard LIMEST degrees, (RQD from 1	w and ONE,		RQD=85 Rec=93%						
285		28	60	95 %	Silurian [Vnsburg Forr	Vills Creek Shale and	7 10		RQD=95 Rec=100%						
280		29	33			131.6' to 134' 136' to 136.7'			RQD=23 Rec=55%						
275		30	52	Sand	seam from	138.5' to 139'	L	Shale and imestor	RQD=58 Rec=87%						
270		31	60						RQD=60 Rec=100%						
265		32	52						RQD=17 Rec=87%						
260		33	60						RQD=75 Rec=100%						
						oring at 154 feet.									
						I Service Industrie	s, Inc.				CT N	· · · · · · · · · · · · · · · · · · ·		0512719	
					30 Eskrid rfax, VA					OJE		East		ngton Co	Expansion
						(703) 698-9300			LC	CAI	ION:			ngton Co Hancock	Durity

COMPLETION DEPTH		STAR					2/15/16	DRILL COMPANY:			illing, Inc.	_		BC	PRINC	G	O-3R
Selection Sele					.—		12/21/16 277 0 ft					ramı	ı.				
Section Sect					• –						, lä			-	-		
Name			_									— dard	> □				•
STATION: NA OFFSET: NA REVIEWED BY: Lubomir Peytchev STATION: NA OFFSET: NA REVIEWED BY: Lubomir Peytchev STATION: NA OFFSET: NA REVIEWED BY: Lubomir Peytchev STATION: NA OFFSET: NA NA DECEMBER STATION: TISTION T	LATIT	UDE:												IG LOC	ATION:		
STRINGTH by	LONG	SITUDE	≣:			78.2	0148°	EFFICIENCY		N/A							
Section Sec		_	N	/A		OFFS	SET:N/A	REVIEWED BY:	Lubo	mir Pe	ytchev	_					
Section Sect	REMA	ARKS:											I				
Medium stiff, moist, red, lean CLAY (USCS Sol) N=6	Elevation (feet)		Graphic Log	Sample Type					DN				× 0 0	TEST N in ble Moisture STREN Qu	F DATA ows/ft ⊚ 25 GTH, tsf Ж	PL LL 50	
Section Sect	590-	Approximately 3 inches of Topsoli 10p 2-3-5 Nedium stiff, moist, red, lean CLAY (USCS N=8												4			11 - 00
Section 1				X	2	9	CL) some gravel,	roots.			8-14-18		×				PL = 17
Substitute		- 5 -			_	0	GRAVEL (USCS)	nse, moist, red silty GM) some sand.		GM				+		<u></u>	-
10	585—	_		즤	3	9	Residuum	,		Civi	14-50/0		×				
580 10 10 10 10 10 10 10 10 10 10 10 10 10		_		\forall	,	10					22 50/4"	9	1				
GRAVEL (USCS GM) with sand GR	E00	- 10 -		47	4	10			ONE,		23-30/4			1		<i>></i> >@	<i>y</i>
575 - 15	560		2														
575 - 15					5	5				014	50/5"					>>@	
570 - 20	575	_ 15 _			٦	5				GIVI	30/3						
The process of the	373		°Ď[C														
The process of the		- 1 - 1	3/1/3	\forall	6	2					50/2"					>>@	
Secure of this pediced of th	570-	_ 20 _	a v				Interbedded, sligh	ntly weathered, mediu	m		1						
25	370			H	<i>'</i>	22	bedded to thin be	edded, red, fine grained	d to								
Shale and Bloomsburg Formation] 9 58 Shale and Bloomsburg Formation] RQD=53 Rec=97% RQD=60 Rec=100% RQD=75 and RQD=75 and RQD=76 Rec=100% RQ		- 1		ш		22	hard LIMESTONE	E, dip of 20 to 70 degre	ees,		DOD-25						
30 9 58 RQD=53 Rec=97% RQD=60 RC=100% RQD=75 and RQD=75 RQD=76 Rec=100% RQD=76 Rec=100% R	565	- 25 -		П	8	33			Creek								
560 30 8 Rec=97% RQD=60 Rec=100% Shale and RQD=75 and Rec=100% Rec=100% Rec=100% RQD=75 Rec=100% Rec=100% Rec=100% Rec=100% RQD=76 Rec=100% Rec=100% RQD=76 Rec=100% Rec=100% RQD=76 Rec=100% RQD=76 Rec=100% Rec=100% RQD=76 RQD	505			н			Shale and bloom	sburg i ormation									
560 30 8 Rec=97% RQD=60 Rec=100% Shale and RQD=75 and Rec=100% Rec=100% Rec=100% RQD=75 Rec=100% Rec=100% Rec=100% Rec=100% RQD=76 Rec=100% Rec=100% RQD=76 Rec=100% Rec=100% RQD=76 Rec=100% RQD=76 Rec=100% Rec=100% RQD=76 RQD				ш	۵	50					DOD-53						
35	560-	- 30 -		ш	"	50											
555	000			H													
555				ш	10	60					ROD=60						
550 40 11 60 Limeston Rec=100% RQD=75 RQD=76 Rec=100% RQD=58 Rec=95% RQD=65 Rec=100% RQD=65 Rec=100% RQD=65 Rec=100% RQD=65 Rec=100% RQD=65 Rec=100%	555	- 35 - - -		ш		00											
550 40 11 60 Limeston Rec=100% RQD=75 RQD=76 Rec=100% RQD=58 Rec=95% RQD=65 Rec=100% RQD=65 Rec=100% RQD=65 Rec=100% RQD=65 Rec=100% RQD=65 Rec=100%				н													
Limeston Rec=100% RQD=76 Rec=100% RQD=58 Rec=95% 14 60 RQD=65 Rec=100% RQD=65 Rec=100% RQD=65 Rec=100% RQD=65 Rec=100%		- 40		ш	11	60					RQD=75						
12 60 RQD=76 Rec=100% RQD=58 Rec=95% RQD=65 Rec=100% RQD=65 Rec=100% RQD=65 Rec=100% RQD=65 Rec=100% RQD=65 Rec=100%	550-	- 4 0 -		ш					Li	mestoi	Rec=100%						
545				п													
545 - 50 - 50 - 50 - 50 - 50 - 50 - 50 -		 - 45 -		ш	12	60											
540—555—55—14 60 Rec=95% RQD=65 Rec=100% RQD=20 RQD=20	545-			ш							Rec=100%						
540—555—55—14 60 Rec=95% RQD=65 Rec=100% RQD=20 RQD=20		- 1 - 1		П													
540 Rec=95% RQD=65 Rec=100% RQD=20 RQD=20		- - 50 -		ш	13	57											
535 Rec=100% RQD=20 Continued Next Page	540-			Ш							Rec=95%						
535 Rec=100% RQD=20 Continued Next Page				П													
535 - Rec=100% RQD=20 RQD=20		- - 55 -			14	60								1			
Continued Next Page	535-			Ш							Rec=100%						
Continued Next Page																	
· · · · · · · · · · · · · · · · · · ·		60			15	48	_	and and Alexander			RQD=20			1			<u> </u>
Drafe acional Comine Industries Inc. BRO IFOT NO. 0540740.4																	
Professional Service Industries, Inc. 2930 Eskridge Rd PROJECT NO.: 0512713-1 PROJECT: 6493-Eastern Panhandle Expansion						77			es, Inc.								



Fairfax, VA 22031

Telephone: (703) 698-9300

LOCATION: Potomac River Crossing

DATE STAR			1	2/15/16	DRILL COMPANY:			illing, Inc.	_		B	ORII	NG (GO-3R
DATE COMP		_		12/21/16 277.0 ft	DRILLER: Kevin Kersh DRILL RIG:	_	550 A		am.	_		hile Dr		Dry feet
BENCHMAR		•••		N/A	DRILLING METHOD:			em Auger	-				mpletio	•
ELEVATION	_			91 ft	SAMPLING METHOD:2				— dard	≥ .		elay		N/A feet
LATITUDE:			39.68	6351°	HAMMER TYPE:		Automa			30RII	NG LO	CATIO	N:	
LONGITUDE	i:			20148°	EFFICIENCY		N/A							
STATION: REMARKS:	N/	Α	_OFF	SET: N/A	REVIEWED BY:	Lubor	mir Pe	ytchev						
KEIVIAKKS.		Т						$\widehat{\mathfrak{S}}_{\mathcal{C}}$		CT A	NDADE		DATION	
			s)				등	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)		517		ST DATA	RATION	
eet)	g	<u>s</u> <u>s</u>	che				catic	ind y %	%		N in	blows/ft		
n (f	i L		Ë	MATE	RIAL DESCRIPTION	N	ıssifi	er 6 over		×	Moistu	re -	I PL ▶ LL	Additional
levation (fee) Depth, (feet)	Graphic Log	Sample Type	_ .				SCIE	vs p Rec	Moisture,	0		25		50 Remarks
Elevation (feet) Depth, (feet)	ত ্ৰ	S S	Recovery (inches)				USCS Classification	Blov 0 & 1	Σ		STRE	NGTH, t	ef	
_			ď)	RAI		•	Qu	:чотт, t		
								Rec=80%		0		2.0		4.0
530								1100-00 /0						
					htly weathered, medium edded, gray, fine grained	to								
65		16	34	medium grained	, very soft to soft SHALE	and		RQD=7 Rec=57%						_
525	_	L			IE, dip of 40 to 50 degree 100 %), Silurian [Wills Cr			Nec-31 /0						
		II		Shale and Bloon	nsburg Formation]									
520 70		17	60					RQD=70 Rec=100%						
320														
		18	55					RQD=77						
515 75		10	5 33					Rec=92%						
		i .												
F		19	60					RQD=77						
510 + 80 +		. ``						Rec=100%						
		1					Chala							
85		20	60				Shale and	RQD=73						
505						Lir	mestor	Meec=100%						
90		21	60					RQD=83						
500								Rec=100%						
95		22	60					RQD=93 Rec=100%						
495								Rec-100%						
		١.												
100		23	60					RQD=100 Rec=100%						
490														
								DOD-77						
485		24	60					RQD=77 Rec=100%						
100		ł		Interbedded, slig	ahtly weathered, medium									
F=		25	5 51	bedded to thin b	edded, gray, fine grained , very soft to soft SHALE	to		RQD=40						
480 - 110-			, 0.	hard LIMESTON	, very soit to soit SHALE IE, dip of 35 to 60 degree	es,		Rec=85%						
					75 %), Silurian [Wills Cre nsburg Formation]	ek	Shale							
-		26	60	Griaic ariu Di0011	nooung i omnauonj	l ir	and mestor	neRQD=70					\perp	
475						-"	. 55(0)	Rec=100%						
120	=	27	32					RQD=37						
120				(Continued Next Page									
					al Service Industries,	, Inc.				CT NO	_		0512	
	74	=	5	2930 Eskrio Fairfax, VA	ige Ku 22031				OJE CAT		0493-			andle Expansion er Crossing

Telephone: (703) 698-9300

Washington County Hancock, MD

DATE COMPLETION EPPTH 27.0 ft DRILLER: Kern Kersh L OGGED BYSUNGER Ingrand Completion (Completion Depth 27.0 ft Drill State (No. 16.50 ATV Driller) (DATE						2/15/16 12/21/16	DRILL COMPANY:			illing, Inc.			BO	RIN	G G	0-3R
LONGITUDE: 78.20148* EFFCIENCY N/A					н—				_			ram L	<u> </u>				
LONGITUDE: 78.20148* EFFCIENCY N/A					_							_	Z at			-	•
EPROLEMOY N/A OFFSET: N/A REVIEWED BY: Lubomir Poytchev	ELEV	ATION	۱:									dard	<u> </u>	Z Dela	ay		N/A feet
STANDAN NA OFFSET: N/A REVIEWED BY: Lubomir Peytchev Lubomir Test Peytchev Lubomir Peytchev Lubomir Test Peytchev Lubomi											atic	E	BORIN	G LOC	ATION:		
## Additional Remarks		_															
## Additional Remains		_	N	I/A		OFFS	ET: <u>N/A</u>	_ REVIEWED BY:	Lubon	nır Pe	ytchev						
120	1 (2.11)										ŝŝ x		STAI	NDARD F	PENETRA	ATION	
120	t)			4		es)				ioi	S) (S) (S) (N) %			TEST	DATA		
120	(fee	eet)	Log	ype	Š	nch				ificat	6-ine ery %		~			PL	
120	ion	h, (f	hic	Je J	ple	ry (i	MATE	RIAL DESCRIPTION	N	lass	per	ture	n .		•	LL	
120	eval	ept	Эгар	ami	Sam	ove				SS	ows & Re	Mois	-		Ĭ		Remarks
120	Ш			0)	•	Rec				NS N	T BI						
## 125		100									S. S.		0				
March 125	470-	- 120-		П							Rec=53%						
125				П			medium grained	, very soft to soft SHALE	and								
Shale and Bloomsburg Formation RQD=75, Rec=60%		 -125-		Ш	28	43	(RQD from 7 to	IE, dip of 35 to 60 degree 75 %). Silurian [Wills Cre	es, ek								
130	465			Ш						a	Rec=72%						
135				Ш						and							
135	400	-130-		Ш	29	60			Lin	nestor	ieRQD=75 Rec=100%						
455 133 1 57 Interbedded, slightly weathered, medium bedded to thin bedded, gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 60 degrees, (RQD from 67 to 97 %), Silurian [Wills Creek Shale and Bloomsburg Formation] 32 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, dip of 35 to 045 degrees, (RQD from 97 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] 35 60 Interbedded, slightly weathered, medium bedded to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 045 degrees, (RQD from 97 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] 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 %), Silurian [Wills Creek Shale and Bloomsburg Formation] 170 37 60 Formation] 180 80 80 80 80 80 80 80 80 80 80 80 80 8	460	_		Н							. 100 10070						
455 133 1 57 Interbedded, slightly weathered, medium bedded to thin bedded, gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 60 degrees, (RQD from 67 to 97 %), Silurian [Wills Creek Shale and Bloomsburg Formation] 32 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, dip of 35 to 045 degrees, (RQD from 97 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] 35 60 Interbedded, slightly weathered, medium bedded to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 045 degrees, (RQD from 97 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] 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 %), Silurian [Wills Creek Shale and Bloomsburg Formation] 170 37 60 Formation] 180 80 80 80 80 80 80 80 80 80 80 80 80 8				Ш	30	36					POD-7						
Interbedded, slightly weathered, medium bedded to thin bedded, gray, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 35 to 60 degrees, (RQD from 67 to 97 %), Silurian (Wills Creek Shale and Bloomsburg Formation)	455	-135- -		П	30	30											
140				H													
Art IMESTONE, dip of 35 to 60 degrees, (RDD from 67 to 97 %), Silurian IWills Creek Shale and Bloomsburg Formation] RQD=97				Ш	31	57	bedded to thin b	edded, gray, fine grained very soft to soft SHALE	l to and		RQD=67						
Shale and Bloomsburg Formation] Shale and Bloomsburg Formation] Shale and RQD=97 LimestorRec=100% RQD=95 Rec=100% RQD=100 RQD=100 Shale and Bloomsburg Formation] A34 60 Interbedded, slightly weathered, medium bedded to thin bedded, green, red, gray, fine grained to medium grained, very soft on 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 Shale RQD=100 Shale Rec=100% Shale and Bloomsburg Formation RQD=100 Shale Rec=100% Shale and Bloomsburg Formation RQD=97 Rec=100% Interbedded, slightly weathered, medium bedded to thin bedded, dark gray, fine grained to medium grained, very soft is soft SHALE and hard LIMESTONE, dip of 35 to 70 degrees, (RQD from 30 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] RQD=97 Rec=100% RQD	450-	_ 140					hard LIMESTON	IE, dip of 35 to 60 degree	es,		Rec=95%						
145							(RQD from 67 to Shale and Bloor	o 97 %), Silurian [Wills Cr nsburg Formation]	I	Shale							
150 440 150 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, dip of 35 to 0 A5 degrees, (RQD from 97 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] 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 %), Silurian [Wills Creek Shale and Bloomsburg Formation] 37 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 %), Silurian [Wills Creek Shale and Bloomsburg Formation] Shale RQD=97 Rec=100% RQD=97 Rec=100% Limestone RQD=75 and RQD=75 and RQD=77 Rec=100% Limestone RQD=77 Rec=100% RQD=75 A15		 -145-		Ш	32	60				and							
Interbedded, slightly weathered, medium bedded to thin 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 Rec=100% and Limestone RQD=97 Rec=100% and Limestone RQD=97 Rec=100% linterbedded, 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 %), Silurian [Wills Creek Shale and Bloomsburg Formation] Shale RQD=92 Rec=95% degrees, (RQD from 30 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] Professional Service Industries Inc. PROJECT NO: 0512713-1	445			Ш					Lin	nestor	16: ec=100%						
Interbedded, slightly weathered, medium bedded to thin 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 Rec=100% and Limestone RQD=97 Rec=100% and Limestone RQD=97 Rec=100% linterbedded, 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 %), Silurian [Wills Creek Shale and Bloomsburg Formation] Shale RQD=92 Rec=95% degrees, (RQD from 30 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] Professional Service Industries Inc. PROJECT NO: 0512713-1				Ш							505.05						
Interbedded, slightly weathered, medium bedded to thin 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] 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 %), Silurian [Wills Creek Shale and Bloomsburg] 170 37 60 Formation] Shale RQD=92 Rec=95% Rec=100% Limestone RQD=77 Rec=100% Limestone RQD=83 Professional Service Industries Inc. PROJECT NO: 0512713-1	440	-150-		Ш	33	60											
435 435 436 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] 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 %), Silurian [Wills Creek Shale and Bloomsburg Formation] Shale RQD=92 Rec=95% degrees, (RQD from 30 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] RQD=92 Rec=95% degrees, (RQD from 30 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] RQD=77 Rec=100% Limestone RQD=77 Rec=100% RQD=77 Rec=100% Limestone RQD=77 Rec=100% RQD=77 Rec=100% RQD=77 Rec=100% RQD=83 RQD=83	440			Н			Interbedded, slid	ahtly weathered, medium									
SHALE and hard LIMESTONE, dip of 35 to 45 degrees, (RQD from 97 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] SHALE and hard LIMESTONE, dip of 35 to 45 degrees, (RQD from 97 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] 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 %), Silurian [Wills Creek Shale and Bloomsburg Formation] Shale RQD=92 Rec=95% dec=95% degrees, (RQD from 30 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] Shale RQD=75 and RQD=77 Rec=100% Limestone RQD=77 Rec=100% Limestone RQD=83 Professional Service Industries Inc. PROJECT NO: 0512713-1				Ш	34	60	bedded to thin b	edded, green, red, gray, t	fine		ROD=100						
Shale and Bloomsburg Limestone RQD=97 Rec=100%	435-	-155- 		Ш	•		SHALE and hard	d LIMESTONE, dip of 35	to S		Rec=100%						
160 35 60 Formation] RQD=97 Rec=100% 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 %), Silurian [Wills Creek Shale and Bloomsburg Formation] Shale RQD=75 Rec=100% Limestone RQD=77 Rec=100% RQD=77 Rec=100% RQD=77 Rec=100% RQD=77 Rec=100% RQD=77 Rec=100% RQD=77 Rec=100% RQD=78 Rec=100% RQD=78 Rec=100% RQD=79 Rec=100% RQD=75 Rec=100% RQD=75 Rec=100% RQD=75 Rec=100% Rec=100% RQD=75 Rec=100% Rec=10				П							ne						
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 %), Silurian [Wills Creek Shale and Bloomsburg Formation] Shale RQD=92 Rec=95% Rec=100% Limestone RQD=75 Rec=100% Limestone RQD=77 Rec=100% RQD=77 Rec=100% RQD=77 Rec=100% RQD=83 Professional Service Industries Inc. PROJECT NO: 0512713-1		 -160-		Ш	35	60					RQD=97						
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 %), Silurian [Wills Creek Shale and Bloomsburg Formation] Shale RQD=92 Rec=95% Shale RQD=75 Rec=100% Limestone RQD=77 Rec=100% RQD=77 Rec=100% RQD=77 Rec=100% RQD=77 Rec=100% RQD=78 RQD=77 Rec=100% RQD=78 RQD=77 Rec=100% RQD=83	430			Ш							Rec=100%						
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] Shale and RQD=75 Rec=100% Limestone RQD=77 Rec=100% RQD=77 Rec=100% RQD=77 Rec=100% RQD=77 Rec=100% RQD=83				Ш													
degrees, (RQD from 30 to 100 %), Silurian [Wills Creek Shale and Bloomsburg Formation] Shale and RQD=75 Rec=100% Limestone RQD=77 Rec=100% RQD=83 Professional Service Industries Inc. PROJECT NO: 0512713-1	405	-165-		Ш	36	57	to medium grain	ed, very soft to soft SHAL									
37 60 Formation] Shale and Limestone RQD=75 Rec=100% RQD=77 Rec=100% RQD=83 Professional Service Industries Inc. PROJECT NO: 0512713-1	425			H					an		1160-9570						
420—170—170—170—170—170—170—170—170—170—17				Ш	27	00		ale and Bloomsburg			DOD-75						
Limestone RQD=77 Rec=100% RQD=83 Professional Service Industries Inc. PROJECT NO: 0512713-1	420-	-170- -		Ш	31	60	Tomation		(
Rec=100% RQD=83 Professional Service Industries Inc. PROJECT NO: 0512713-1	.20			H					Lin		ne						
Rec=100% RQD=83 Professional Service Industries Inc. PROJECT NO: 0512713-1					38	60					RQD=77			L			
Continued Next Page Professional Service Industries Inc. PROJECT NO: 0512713-1	415	- 1/5			-												
Continued Next Page Professional Service Industries Inc. PROJECT NO: 0512713-1																	
Continued Next Page Professional Service Industries Inc. PROJECT NO: 0512713-1		 -180-			39	60		.			RQD=83						
Professional Service Industries, Inc. PROJECT NO.:								•									
						77			, inc.								



Fairfax, VA 22031

Telephone: (703) 698-9300

PROJECT NO.: 0512713-1

PROJECT: 6493-Eastern Panhandle Expansion

Potomac River Crossing

Washington County

Hancock, MD

	STAR		_			2/15/16	_ DRILL COMPANY:			rilling, Inc.				BOF	RIN	G G	O-3R
	COMI			_		12/21/16 277.0 ft	DRILLER: Kevin Kersh DRILL RIG:	_	∌ED Β` ∶550 Α		<u>igram</u>	_			e Drilli		Dry feet
	CHMAF		. F 1 I	' -		N/A	DRILLING METHOD:					ater				pletion	Dry feet
	ATION	_				91 ft	SAMPLING METHOD:			tem Auger		-		Delay		piotion	N/A feet
LATIT		. —				6351°	HAMMER TYPE:		Autom		<u>ariuu</u> r(┸			TION:		
	SITUDE	≣:				20148°	EFFICIENCY		N/A	<u> </u>							
STAT	ION:	N	/A		OFFS		REVIEWED BY:	Lubo	mir Pe	ytchev							
REM/	ARKS:					·											
Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATE	ERIAL DESCRIPTION	N	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %			TEST [in blow	vs/ft⊚ ⊿ ♣	PL LL 50	Additional Remarks
Ш)	S	0,	Rec)SN	SPT BI			ST Qu		*	Qp	
440	180					Interbedded, sli	ghtly weathered, medium			Rec=100	%	0		2.0)	4.0	
410-	- - -185- - -			40	44	bedded to thin lead to medium grain and hard LIMES degrees, (RQD)	bedded, dark gray, fine graned, very soft to soft SHA STONE, dip of 35 to 70 from 30 to 100 %), Siluria ale and Bloomsburg	ained LE		RQD=3 Rec=739							
400-	- -190-			41	60					RQD=9 Rec=100							
395—	- -195- -			42	60				Shale	RQD=10 Rec=100							
390-	-200-			43	60			L	and imesto	neRQD=9 Rec=100	7 %						
385-	-205 -			44	60					RQD=9 Rec=100							
380-	-210- 			45	60					RQD=10 Rec=100							
375—	 -215- 			46	56					RQD=9 Rec=939							
370—	- -220- -			47	56	bedded to thin l to medium grai and hard LIMES degrees, (RQD	ightly weathered, medium bedded, dark gray, fine graned, very soft to soft SHA STONE, dip of 45 to 65 from 50 to 100 %), Siluria lale and Bloomsburg	ained LE		RQD=8 Rec=939	-						
365-	- -225- -		Ц	48	60	Formation]	2.00000		Shale	RQD=9 Rec=100							
360-	- -230- - -			49	60			L	and imesto	neRQD=9 Rec=100	5 %						
355—	 -235- 			50	60					RQD=10 Rec=100	-						
	 -240-			51	60		Continued Next Page			RQD=9	5						
4						Profession	al Service Industries	, Inc.		ı	PROJI	ECT N	10.:			0512713	-1
			5		!/	2930 Eskri Fairfax, V <i>A</i>	dge Rd \ 22031				PROJI LOCA					Panhand River C	e Expansion rossing

Telephone: (703) 698-9300

Washington County Hancock, MD

DATE (_			2/15/16		DRILL COMPANY			rilling, Inc.			В	ORIN	IG G	0-3R
DATE (12/21/ 277.0		DRILLER: Kevin h		550 A		<u>rar</u> n	ř		/hile Dril		Dry feet
BENCH			•			N/A	<i>,</i>	DRILLING METHO			tem Auger	_	Water		pon Con	-	Dry feet
ELEVA		_				91 ft		SAMPLING METH				— dard		<u>1</u> D	elay		N/A feet
LATITU	JDE:					6351°		HAMMER TYPE:		Autom	atic		BOR	ING LO	CATION	:	
LONGI		<u> </u>				20148°		EFFICIENCY		N/A							
STATIC REMAR		N	1/A		OFFS	SET:	N/A	REVIEWED BY:	Lubo	omir Pe	ytchev	_					
KEWA	KNS:									T	<u> </u>		Τ				
					s)					<u> </u>	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)		SI		D PENETF ST DATA	RATION	
eet)	(F)	g	,pe	<u>o</u>	che					catic	y -inch	%		N in	blows/ft @		
Ē.	(fe	ic L	Ţ	e N	, (in		MATE	RIAL DESCRIP	TION	Issifi	er 6. over		×	Moistu	re	PL LL	Additional
Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)					USCS Classification	vs p Rec	Moisture,	0		25	50	Remarks
⊟	ے ا	Ō	Sal	Ss	eco					SCS	Blov 0 & L	Σ		STRE	NGTH, ts	:	
_					Ϋ́						PT RQI		1	N Qu	**************************************		
	240					Intor	hoddod elic	htly weathered, me	dium		Rec=100%		0		2.0	4.0	
350	-		Ш			bedo	ed to thin b	edded, dark gray, fil	ne grained		10070						
E	<u> </u>		Ш			to m	edium grain	ed, very soft to soft TONE, dip of 45 to	SHALE 65								
F:	245		Ш	52	60	degr	ees, (RQD f	from 50 to 100 %), S	Silurian		RQD=90 Rec=100%					+	
345—	-		Ш				s Creek Sha nation]	ale and Bloomsburg			Nec-10070						
L	1		Ш			' 0111	iationj										
	250		Ш	53	60						RQD=97 Rec=100%					+	
340—	-		Ш								100 10070						
F	1		Ш	- 4							DOD 400						
335	255		Ш	54	52						RQD=100 Rec=87%					+	
333	-		Н							Shale							
F	-		Ш	55	58					and	neRQD=50						
330	260		Ш	55	50				L	mesto	Rec=97%						
E	_		Н														
E.			Ш	56	60						RQD=80						
325	265		Ш								Rec=100%						
F	1		Ш														
Ŀ.	270 270		Ш	57	60						RQD=78						
320—	270		Ш								Rec=100%						
F	-		П														
E:	275		Ш	58	60						RQD=83					\perp	
315	‡		Ш								Rec=100%						
						Botto	om of test bo	oring at 277 feet									
							-f!	d Camila - II I	tudaa laa							05405	<u> </u>
			7		; 7		ofessiona 30 Eskric	al Service Indust lae Rd	uies, inc.			ROJE	CT N	_	Eastern	0512713 Panhand	3-1 le Expansion
		夫	5		ij	Fa	irfax, VA	22031					ION:			c River C	
					L	Te	lephone:	(703) 698-930	0						Wash	nington C	ounty

DATE	STAF	RTED:			6	6/23/16	DRILL COMPANY:			illing, Inc.			BC	RIN	G	3 0-4
		PLETE				6/23/16	DRILLER: Tom Chew	_			nd	•				
		ON DE	PT	н _		60.0 ft	DRILL RIG:		rich D-		_	Water Z		e Drillin	-	Dry feet
	HMAI	_				N/A	DRILLING METHOD:			em Auger	<u>. </u>	X A		n Compl	etion	Dry feet N/A feet
	ATIO	_				35 ft	SAMPLING METHOD:2							•		IN/A IEEL
LATIT						99278°	HAMMER TYPE:	-	Automa N/A	atic	_	BORING	LUCA	IION:		
STAT			I/A		OFFS	84611° SET: N/A	REVIEWED BY:	Lubo		ytchev	_					
-	ARKS:		I/A		OFFS	<u> </u>	REVIEWED B1.	Lubo	IIIII F C	ytchev	_					
												STAN	DARD DI	ENETRAT	LION	
					s)				5	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)		JIAN	TEST		11014	
eet	et)	g	ğ	o.	che				cati	y ind	%		N in blov			
ų) u	(feet)	C L	Ę	S S	(in	MATE	RIAL DESCRIPTIO	NI	ssifi	er 6.		× N	loisture			Additional
aţio	Ę,	Graphic Log)dc	Sample No.	ery	IVI/X I LI	THE DECORAL TION		Cla	s be	Moisture,	0	2	5	LL 50	
Elevation (feet)	Depth,	Gra	Sample Type	Sai	Recovery (inches)				USCS Classification	% ⊗ %	ĭ					
Ш			0		Re				S	L G			STRENG		_	
	_									유			Qu 2.		Qp 4.0	
	- 0 -	11/1/1	M	1	18	Approximately 3	inches of Topsoil		Top	1-3-4	40	(a)				LL = 35
	_			•	.0	Soft to medium s	stiff, moist, brown, sandy S CL) some gravel, roots	/	Soil/ CL	N=7	19		XZ+			PL = 21 Fines=77.9%
						Alluvium	S CL) Some graver, rook	s. /	UL.		_			_		111103-17.070
			XI	2	18		m dense, moist, brown, c			11-18-16	9	×		\gg		
430-							vn clayey SAND (USCS el, trace shale fragments.		SC	N=34						
430	_ 5 _		M	3	18	Residuum	ii, irace shale iraginlenis.	•		4-10-11	9	×		_		LL = 29
		11/1/				Weathered Rock	k, gray, dark gray, soft SI	HALE		N=21	-					PL = 17 Fines=20.1%
			Ň	4	3	and hard LIMES	TŎNÉ, Silurian [Wills Cr	eek _{WF}	ATHF	50/3" RED	4	×			>>@	
	L _		П	5	12	Shale and Bloom	nsburg Formation]	**-	SHALE	RQD=0						
425-	- 10 -		Ш							Rec=37%						
423	_ '0		Ш			Interbedded, slig	htly weathered, medium edded, gray,	fino								
	_		Ш			grained to mediu	im grained, soft SHALE a	and	Shale							
			Ш	6	50	hard LIMESTON	E, dip of 35 degrees, (Re	QD =	and	RQD=10						
	_		Ш				Vills Creek Shale and	Li	mestoi	ı €Rec=83%						
420-	 - 15 -		Ш			Bloomsburg Form	-									
720	_ ' _		Ш			Interbedded, slig	htly weathered, medium edded, gray, dark gray,	l fine								
			Ш			grained to mediu	ım grained, soft SHALE a	and	Shale							
			Ш	7	60	hard LIMESTON	E, dip of 50 degrees, (R	QD = . :	and	RQD=66						
		≡⊨	Ш			Bloomsburg For	Vills Creek Shale and `	LI	mestoi	Meec=100%						
415-	- 20 -		Ш			_	htly weathered, medium									
			Ш			bedded to thin be	edded, gray, dark gray ,	fine								
			Ш	_		grained to mediu	ım grained, soft SHALE a	and		505.00						
			Ш	8	60		E, dip of 50 degrees, (Re Vills Creek Shale and	QD =		RQD=80 Rec=100%						
			Ш			Bloomsburg For	mation]		Shale	100 10070						
410-	- 25 -		Н			Ü	•		and							
			Ш					Li	mesto	ie						
			Ш	9	60					RQD=80						
			Ш	9	00					Rec=100%						
			Ш													
405-	- 30 -		Н			Interbedded, slig	htly weathered, medium	1								-
		≡≡	Ш			bedded to thin be	edded, red, trace white a	and								
	-		Ш	10	60		ed to medium grained, ha d soft SHALE, dip of 40	ard		RQD=75						
	-		Ш			degrees, (RQD o	of 75 % and 66 %) Siluria	an		Rec=100%						
	-		Ш			[Wills Creek Sha	lle and Bloomsburg		Shale							
400-	- 35 -		Ш			Formation]		1:	and							
	-	E						LI	mestoi	ı.G						
	-			11	58					RQD=66						
	_									Rec=97%						
205																
395—	- 40 -		_			(Continued Next Page									
4						Professiona	I Service Industries	s, Inc.		PR	OJE	CT NO.	:	0	51271	9-1
			6			2930 Eskrid	lge Rd			PR	OJE	CT: _6	493-Ea	stern Pa	anhand	dle Expansion
		7	J	ĮĪ		Fairfax, VA				LO	CAT	ION:		I-68 HE		
			_			I elephone:	(703) 698-9300					_		Washin	gton C	county

DATE					6	/23/16		DRILL COM				illing, Inc.			B	ORIN	NG (30-4
DATE COMP				.—		6/23/16		DRILLER:_ DRILL RIG	Tom Chew	•	rich D-		ena i	<u></u>		ile Drilli		Dry feet
BENC				_	ı	V/A			METHOD:			em Auger	_		_		pletion	Dry feet
ELEVA	ATION	l:			43	5 ft		SAMPLING	METHOD:2				<u>da</u> rd	 	Del	ay		N/A feet
LATITU						9278°			YPE:		Automa	atic		BORIN	IG LOC	ATION:		
LONGI						84611°		EFFICIENC	-	Links	N/A	. 4 - 1	_					
STATION REMAIN		IN	l/A		OFFS	EI: _	N/A	REVIEWED	BY:	Lubc	omir Pe	ytchev	_					
Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)		MATEF	RIAL DES	CRIPTION	١	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	× 0	N in blo	DATA ows/ft ©	PL LL 50	Additional Remarks
300	40 -			12	60	bedde gray , LIMES degre Shale	ed to thin be fine graine STONE and es, (RQD = and Bloom	htly weathere edded, red, tr d to medium d soft SHALE : 80 %) Siluri asburg Forma	race white an grained, han E, dip of 40 an [Wills Creation]	rd	Shale and imestor	RQD=80						
390	45 -			13	50	bedde graine hard I 0 %) \$	ed to thin be ed to mediu IMESTON	htly weatheredded, gray, m grained, s E, dip of 50 c lls Creek Shanation]	dark gray , f oft SHALE a degrees, (RC	and QD =	Shale and imestor	RQD=0 neRec=83%						
	50 -			14	60	bedde graine hard I 86 %)	ed to thin be ed to mediu IMESTON	htly weathere edded, gray, m grained, s E, dip of 45 o /ills Creek Sl mation]	dark gray , f oft SHALE a degrees, (RC	and	Shale	RQD=86 Rec=100%						
380	55 -			15	59					L	and imestor	RQD=86 Rec=98%						
375	60							oring at 60 fe		Ina							051274	0.4
			5			293 Fai	30 Eskrid rfax, VA			inc.		PF	ROJE	CT NO CT: ION:		I-68 H	0512719 Panhand HDD Cro ington C	dle Expansion essing

	: STAF		-D·		6	6/22/16		DRILL CO	IMPANY: Tom Chev			illing, Inc.				BOF	RIN	G (SO-5
	PLETI(н		70.0		DRILL RIC			rich D-		ilu i	je.	∇	While [Orilling	g	Dry feet
BENC	CHMAF	RK:		_		N/A		DRILLING	METHOD:	Но	llow St	em Auger				Upon C	ompl	etion	Dry feet
ELEV	ATION	N:			44	17 ft		SAMPLIN	G METHOD	:2-in SS1	I.874-ii	n Core Star	<u>da</u> rd		Ā	Delay			N/A feet
	TUDE:			,		7556°		HAMMER		,	Automa	atic		BOR	ING L	OCATIO	ON:		
	SITUDI					86167°		EFFICIEN			N/A								
STAT	'ION:_ ARKS:		I/A		OFFS	SET:	N/A	REVIEWE	D BY:	Lubo	mir Pe	ytchev	_						
IXLIVIA												$\widehat{\omega}$			A N I D A			TION	
Elevation (feet)	o Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)				SCRIPTIC	DΝ	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	× 0	N Mois	25 RENGTH	TA ft ⊚		Additional Remarks
445-	 			1	6	Dens	oximately 3 se to mediur y clayey S A	n dense, m AND (USCS	oist, brown,		Top Soil	1-31-18 N=49	22			×		→	LL = 45 PL = 26 Fines=29.4%
	- 		X	2	4	grave	el, roots. Al	luvium			SC	17-18-9 N=27	41					×	
440-	- 5 - 		X	3	18	dark some	um dense, r brown clay e gravel, trad duum	ey SAND (vn,	sc	3-7-10 N=17	21		(-	•	LL = 41 PL = 25 Fines=23.9%
435—	 - 10 - 		X	4 5	5	and h	thered Rock nard LIMES and Bloom	TŎNĚ, Silu	gray, soft S rian [Wills C nation]	reek WE	ATHEF SHALE		4 5	×				>>© >>©	
430-	 - 15 - 			6 7	18	bedd grain hard 80 %	ed to thin be ed to mediu	edded, gray ım grained, E, dip of 55 Vills Creek S	red, mediun , dark gray , soft SHALE degrees, (F Shale and	, fine and RQD =	Shale and mestor	RQD=61 Rec=100% neRQD=80 Rec=100%		×					
425-	- 20 - 			8	60	bedd grain hard 68 %	ed to thin be ed to mediu	edded, gray ım grained, E, dip of 48 Vills Creek (ered, mediun r, dark gray , soft SHALE degrees, (F Shale and	, fine and ROD =	Shale and mestor	RQD=68 18ec=100%							
420—	- 25 - 			9	60	bedd grain hard 95 %	ed to thin be ed to mediu	edded, gray ım grained, E, dip of 50 Vills Creek (ered, mediun r, dark gray , soft SHALE degrees, (F Shale and	, fine and RQD =	Shale and mestor	RQD=95 Rec=100%							
415—	- 30 - 			10	60	bedd grain hard 57 %	ed to thin be ed to mediu	edded, gray ım grained, E, dip of 50 Vills Creek S	red, mediun , dark gray , soft SHALE degrees, (F Shale and	, fine and RQD =	Shale and mestor	RQD=57 Rec=100%							
410—	- 35 - 			11	60	bedd grain hard 93 %	ed to thin be ed to mediu	edded, gray ım grained, E, dip of 50 Vills Creek (red, mediun r, dark gray , soft SHALE degrees, (F Shale and	, fine and RQD =	Shale and mestor	RQD=93							
	- 40 -						C	Continued N	ext Page										
4						Pr			Industrie	s Inc		PF	O.IF	CT N	ο.		0	51271	— —— 9-1
			7		77	29	30 Eskrid	ge Rd		-,						3-Easte			lle Expansion
	=	<i>=</i> =	=	三声	i II	Fa	irfax VA	22031				10	СДТ	ION.		1_6	38 H	D Cro	ssina

Telephone: (703) 698-9300

DATE			_			/22/16 6/22/16	_ DRILL COMPANY:			illing, Inc.			E	30 F	RIN		3 O-5
COMP				н—		70.0 ft	DRILLER: Tom Chew DRILL RIG:	_	rich D-		<u>na</u>	<u></u>	∑ v	Vhile [Drillin	ng	Dry feet
BENCI				_	1	V/A	DRILLING METHOD:			em Auger	_					letion	Dry feet
ELEVA		_				7 ft	SAMPLING METHOD:2				<u>da</u> rd	>	Ā c	Delay			N/A feet
LATIT					39.711		HAMMER TYPE:		Automa	atic		BORI	NG LC	CATI	ON:		
LONG						86167°	_ EFFICIENCY		N/A								
STATION			I/A		OFFS	ET: <u>N/A</u>	_ REVIEWED BY:	Lubo	mir Pe	ytchev							
I LIVIA										(S) X		STA	ANDAR	D PEN	ETRA	TION	
Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATE	RIAL DESCRIPTIOI	N	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	× 0	TE N in Moiste	ST DA blows/	TA ft ⊚ ⊿ +		Additional Remarks
	40 -					Interhedded eli	ghtly weathered, medium			<i>S</i> –		0		2.0		4.0	
405	· -			12	60	bedded to thin to grained to medi hard LIMESTOI	oedded, gray, dark gray, t um grained, soft SHALE a NE, dip of 43 degrees, (Ro Wills Creek Shale and	fine and QD =	Shale and imestor	RQD=83 Meec=100%							
400	45 - 			13	60	bedded to thin to grained to medinard LIMESTOR	ghtly weathered, medium bedded, gray, dark gray, f um grained, soft SHALE a NE, dip of 38 degrees, (Ro Wills Creek Shale and rmation]	fine and QD =	Shale and imestor	RQD=97 nRec=100%							
395	· 50 - · - · -			14	60	bedded to thin to grained to medi hard LIMESTO	ghtly weathered, medium bedded, gray, dark gray, t um grained, soft SHALE a NE, dip of 40 degrees, (Ro Wills Creek Shale and rmation]	fine and QD =	Shale and imestor	RQD=67 Neec=100%							
390	55 - 			15	60	bedded to thin to grained to medi hard LIMESTOI	ghtly weathered, medium bedded, gray, dark gray, t um grained, soft SHALE a NE, dip of 50 degrees, (Ro Wills Creek Shale and rmation]	fine and QD =	Shale and imestor	RQD=90 Nec=100%							
385	60 - - 65 -			16	60	bedded to thin to grained to medi hard LIMESTOI	ghtly weathered, medium bedded, gray, dark gray, t um grained, soft SHALE a NE, dip of 53 degrees, (Ro Wills Creek Shale and rmation]	fine and	Shale and	RQD=93 Rec=100%							
380	· -			17	60			Li	imestor	RQD=93 Rec=100%							
	- 70 -					Bottom of test b	ooring at 70 feet										
						Profession	al Service Industries	, Inc.		PR	OJE	CT N	0.:		()512719	9-1
						2930 Eskri	dge Rd				OJE		6493				lle Expansion
			U			Fairfax, VA	. 22031 : (703) 698-9300			LO	CAT	ION:				DD Cro	
					4	reichinie	. (100) 000-0000							v v	اااان	igion O	Janey

	STAR				1	2/14/16 12/14/		DRILL CO	MPANY: Kevin Kersh		_	illing, Inc.			E	BORI	NG (30-6	
	PLETIC					40.0		DRILL RIG		CME 5			<u>al</u> III	7	∑ v	/hile Dril	ling	29.5	feet
	HMAF			_		N/A	-	DRILLING				em Auger	_	ate	▼ ∪	pon Cor	npletion	N/A	feet
	ATION	l:				90 ft		SAMPLING	METHOD:2-							elay		N/A	feet
LATIT						8878°		HAMMER 1			utoma	atic		BORI	NG LO	CATION	l:		
LONG			I/A		78.1 OFFS	94106° ET:	N/A	EFFICIENC			N/A	vtchev							
REMA	_		1 //~		_0110		14//	·	, DI	Lubon		ytoricv							
Elevation (feet)	o Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)				CRIPTION		USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	× 0	TE N in Moistu	D PENETF ST DATA blows/ft @ re	PL LL 50	Additiona Remarks	
	 			1	10	Loos	e to mediun O (USCS SN	inches of To n dense, moi / I) with shale	ist, brown, si l	lty /	Top Soil SM	2-3-6 N=9	16	(×		•	LL = 37 PL = 25	
585-	 - 5 -			2	18	Medi	SAND (USC	SSM) with	mottled brow gravel, shale	vn /		7-6-13 N=19	19		8			-LL = 41	
303				3	12	fragn	nents Resi	duum				10-13-17 N=30	19		×		•	PL = 27 Fines=34.5%	
580-	- 10 - - 10 -		M	4	18						SM	19-36-48 N=84	14		×		>>(
575—	 - 15 - 		X	5	10							25-50/4"	13		×		>>@		
570—	 - 20 - 			6	4	samp	led as very	hard, moist,	d LIMESTON dark gray, GM) with sand	,		50/4"	13		*		>>@	•	
565—	 - 25 - 			7	4						GM	50/4"	5	×		-	>>@	LL = 26 PL = 19 Fines=13.3%	
560-	- - 30 -			8	4 5	Intert			dium bedded t	to		50/4"	7				>>@))	
555—	 - 35 -			9	60	grain SHAI 45 de Devo	ed to mediu _E and hard egrees, (RQ	d LIMESTON D from 25% ellus Formation	very soft to so IE, dip of 30 to to 0 %),	0	Shale and nestor	RQD=25 Rec=100%							
550—	 - 40 -			10	42	Botto	m of test bo	oring at 40 fe	et			RQD=0 Rec=70%							
									Industries,	Inc.		PR	OJE	CT N	O.: _		051271	3-1	
		1			IJ		30 Eskric						OJE		6493			dle Expansion	<u>1</u>
	\mathbb{Z}		<u> </u>	7[irfax, VA lephone:	(703) 698	3-9300			LO	CAI	ION:			ac River hington (Crossing County	_

DATE COM		_			1/17/17 1/20/17		DRILL COMPANY:			illing, Inc.				BC	DRIN	IG (3 0-7
DATE COM COMPLETION			_		1/20/17 134.0 ft		DRILLER: Howie Robert DRILL RIG:	<u>s</u> LOGG Diedri			<u>ey</u>		∇		le Drillir		0 feet
BENCHMAR			٠ –		N/A		DRILLING METHOD:			Coring	_	Water	Ī		n Comp	-	0 feet
ELEVATION	_)2 ft		SAMPLING METHOD:				_	Š	$ar{ar{f Y}}$	Dela			N/A feet
LATITUDE:				39.68			HAMMER TYPE:		N/A			BOR			TION:		
LONGITUDI					97553°		EFFICIENCY		N/A								
STATION:		I/A		OFFS	SET:N/	A	REVIEWED BY:	Lubon	nir Pey	/tchev							_
REMARKS:										•							
Elevation (feet) Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	7		RIAL DESCRIPTION		USCS Classification	RQD & Recovery % (NX)	Moisture, %	× 0	N Moi	TEST in blow sture	STH, tsf		Additional Remarks
400				•	Potomac Ri	ver, ap	pproximately 6 feet of WA		Water								
395			1	18	brown, gray	and b	very dense, wet, white, re lack Sand, Gravel and	ed,		RQD=0							
- 10 -			2	14	Cobbles (Alluvi	um)		Cobble Stones								
390 15 -							tly weathered, medium be ay, dark gray, trace brown			Rec=23%							
385			3	58	white, fine g to soft SHAI to 45 degree	grained LE and es, (R0	It to medium grained, very thard LIMESTONE, dip of QD from 68% to 100 %), ny Sandstone and Helderk	soft of 20		RQD=88 Rec=96%							
380			4	60	Groupj			s	SHALE	RQD=100 Rec=100%							
375			5	56						RQD=86 Rec=94%							
370			6	60						RQD=68 Rec=100%							
365			7	36	bedded, bro grained to m SHALE and degrees, cla	own, gr nedium I hard I ay sear	hered, medium bedded to ay, dark gray, trace white n grained, very soft to soft LIMESTONE, dip of 20 to ms (RQD of 0 %), Devoni one and Helderberg Group	e, fine t s 60 ian	HALE	RQD=0 Rec=60%							
360			8	60	Interbedded to thin bedd fine grained SHALE and degrees, (R	I, slight led, gra I to me I hard I QD fro	tly weathered, medium be ay, dark gray, brown and v dium grained, very soft to LIMESTONE, dip of 20 to om 24% to 86 %), Devonione and Helderberg Group	edded white, o soft o 45 an	SHALE	RQD=86 Rec=100%							
355			9	58	-					RQD=72 Rec=96%							
""						С	Continued Next Page										
E					2930 Es Fairfax,	skrido VA 2		Inc.		PR	OJE	CT N CT: TION:			astern F Potomac	0512713 Panhand River C	lle Expansion Crossing

DATE			_		1	/1//1/ 1/20/17			COMPANY: R:Howie Robe			Illing, Inc. '• Pob Stickle				BC	PIN	IG G	SO-7
COME						134.0 f		DRILL R			Irich D-		<u> </u>	ē	∇	While	e Drillir	ng	0 feet
BENC				_	ı	V/A	<u> </u>		G METHOD:		Rock (Water	Ā	Upor	n Comp	letion	0 feet
ELEV	ATION	l:			40	2 ft			NG METHOD						Ā	Dela	у		N/A feet
LATIT					39.68				R TYPE:		N/A			BOR	ING	LOCA	TION:		
LONG		_				97553° 		EFFICIE			N/A		_						
STAT REMA	_		I/A		OFFS	ET:	N/A	REVIEW	ED BY:	Lubo	omir Pe	/tchev	_						
IXLIVIA												\$		ST	AND	ARD P	ENETR	ATION	
Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)		MATE	RIAL DE	SCRIPTIO	N	USCS Classification	RQD & Recovery % (NX)	Moisture, %		N	TEST	DATA ws/ft ⊚ ⊿ ♣		Additional Remarks
					Re						SN	RQD		0	ST Qı			Qp 4.0	
350-	- 50 - 			10	60	to thin fine gra SHALE	bedded, graained to me ained to me and hard	ay, dark gr edium grair LIMESTO	red, medium bay, brown and ned, very soft to NE, dip of 20 to 86 %), Devor	l white, to soft to 45		RQD=24 Rec=100%					<u> </u>	4.0	
345-	- 55 - 			11	50	[Oriska	any Sandsto	one and H	elderberg Gro	up]	SHALE	RQD=64 Rec=84%							
340-	- 60 - 			12	52							RQD=30 Rec=86%							
335—	- 65 - - 65 - 			13	60	to thin white, to soft to 50 d	bedded, grafine grained SHALE and legrees, (Ro ian [Oriska)	ay, dark gr d to mediu d hard LIM QD from 2	red, medium bay, trace brown grained, ver IESTONE, dip 4% to 92 %), one and Helde	n and y soft of 20		RQD=70 Rec=100%							
330-	- 70 - 			14	43	Group] Clay se	•	imately fro	om 72.6' to 74'	,		RQD=60 Rec=72%							
325-	- 75 - 			15	56							RQD=60 Rec=94%							
320-	- 80 - 			16	60						SHALE	RQD=74 Rec=100%							
315—	- 85 - 			17	60							RQD=92 Rec=100%							
310-	- 90 - 			18	60							RQD=82 Rec=100%							
305-	- 95 - 			19	58							RQD=24 Rec=96%							
	-100-		1 1				,	Continued	Next Page						+				
										lua -	I							0=46=6	
					77		tessional 0 Eskrid		Industries	, inc.				CT N		103 E		0512713 Panhand	
				5/	; [fax, VA							:C1: ΓΙΟΝ:				: River C	le Expansion rossing
			_		IJ		ephone:		98-9300				-					ington C	

COMPLETION DEPTH 134.0 ft DRILL RIG: Diedrich D-50 ▼ While Drilling 0 feet BENCHMARK: N/A DRILLING METHOD: Rock Coring ▼ Upon Completion 0 feet	DATE STARTED:	1/1 //1 / 1/20/17	DRILLER:Howie Roberts LOG		Illing, Inc. '• Rob Stickley	,		BOF	ring G	60-7
BENCHMARK: NA ORILLING METHOD: Rock Coring EVENT SAPPLING METHOD: 1574-In CORSUMBATE THE PRICE T	-							While D	rilling	0 feet
NA						_ ate	Ţ	Upon C	ompletion	0 feet
CANGED C	ELEVATION:	402 ft		74-in Co		_ 3	<u> </u>	Delay		N/A feet
STATURE NAME OFFSET: N/A REVIEWED BY: Lubomir Peytither REMARKS: Comparison C				N/A		_ BO	RING	LOCATIO	DN:	
STRINGTH, tsf Qu Stringth Qu Stringt						- —				
MATERIAL DESCRIPTION Section S		OFFSET:N/A	REVIEWED BY: Lub	omir Pey	/tchev					
100		Sample No. Recovery (inches)	RIAL DESCRIPTION	USCS Classification	& Recovery %	Moisture, %	N Mo	TEST DA I in blows/ isture 25 RENGTH	TA ft ⊚	
bedded, brown, dark gray, gray, dark brown, trace white, fine grained to medium grained, very soft to soft SHALE and hard LIMESTONE, dip of 20 to 46 degrees, day seams (RQD) of 0, becomian (Onskany Sandstone and Helderberg (Group) 220 600 221 600 222 600 233 600 23 600 24 600 24 600 25 600 26 600 275		20 58		SHALE		0		2.0	4.0	
22	295	bedded, brown, da trace white, fine g soft to soft SHALE 20 to 45 degrees, Devonian [Oriskar	ark gray, gray, dark brown, rained to medium grained, very E and hard LIMESTONE, dip of clay seams (RQD of 0 %),	SHALE		_				
23 60 bod degrees, (RQD from 28% to 72 %). 24 60 beyonian [Oriskany Sandstone and Helderberg Group] 24 60 Beyonian [Oriskany Sandstone and Helderberg Rec=100%] 25 60 RQD=44 Rec=100% 275 8 60 RQD=44 Rec=100% Bottom of test boring at 134 feet		Clay seam approx Interbedded, sligh to thin bedded, gra white, fine grained	tly weathered, medium bedded ay, dark gray, trace brown and to medium grained, very soft							
24 60 25 60 26 60 Bottom of test boring at 134 feet SHALE RQD=28 Rec=100% RQD=44 Rec=100% RQD=72 Rec=100%		to 60 degrees, (R0 Devonian [Oriskar	QD from 28% to 72 %),							
25 60 RQD=44 Rec=100% 26 60 Bottom of test boring at 134 feet		24 60		SHALE						
270		25 60								
	- I - I - I - I - I - I - I - I - I - I		ing at 134 feet							
Professional Service Industries, Inc. 2930 Eskridge Rd Fairfax, VA 22031 Telephone: (703) 698-9300 PROJECT NO.: 0512713-1 PROJECT: 6493-Eastern Panhandle Expansion LOCATION: Potomac River Crossing Washington County										
2930 Eskridge Rd PROJECT: 6493-Eastern Panhandle Expansion Fairfax, VA 22031 LOCATION: Potomac River Crossing Washington County		Professional	Service Industries, Inc.		PRO	JECT	NO.:		0512713	-1
Fairfax, VA 22031 LOCATION: Potomac River Crossing Telephone: (703) 698-9300 Washington County	Inc	2930 Eskridg	ge Rd					493-Easte		
		Fairfax, VA	22031 (703) 698-9300		LOC	OITA	N:			

DATE STARTED: 12/21/16 DATE COMPLETED: 12/21/16		DRILL COMPANY: Connelly Drilling, Inc. DRILLER: Josh Lewis LOGGED BY: Philip Daute			BORING GO-10														
COMF				_		20.0		DRILL RIG: CME 550 ATV			<u>-</u> 7		ile Drilli			feet			
BENC						N/A		DRILLING				em Auger	_			on Com	-		feet
ELEV		-				31 ft		SAMPLING METHOD:2-in SS1.874-in Core Standard			> \(\bar{2}\)	Z Del	ay		N/A	feet			
LATIT	UDE:					3074°		HAMMER 1	ΓΥΡ Ε :		utoma	tic		BORIN	G LOC	ATION:			
LONG		_				06551°		EFFICIENC			N/A								
STAT REMA	_		N/A		OFFS	SET:	N/A	REVIEWED	BY:	Lubor	nir Pey	rtchev							
KEIVIA	KKN5:				Ι						I	<u> </u>		T					
Elevation (feet)	o Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)			RIAL DES		١	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	× 0	TEST N in blo Moisture STRENG Qu	PENETRA DATA DWS/ft © 25 GTH, tsf #2.0	PL LL 50	Additior Remark	
580	 			1	18	Stiff,	moist, light some gravel	inches of To brown sand , roots. noist, light bi	y SILT (USC	s	Top Soil ML	3-6-8 N=14	16		X				
	 			2	14	GRA	VEL (USCS fragments.	GM) with sa	ind, trace		GM	3-8-14 N=22	19		$ \gamma$			LL = 39 PL = 26 Fines=19.3%	
575—	- 5 - 			3	2	samp brow Siluri	oled as very n silty GRA	, SHALE and hard, moist, VEL (USCS burg and Mu	red, dark GM) with sa			50/2"	2	×			>>@		
570	 - 10 - 		M	4	10							7-50/5"	9	×		•	>>@	LL = 31 PL = 19 Fines=15.7%	
	 		X.	5	3						ATHER SHALE	ED 50/3"	9	×			>>@)	
565	- 15 - 																		
	 - 20 -		XI	6	2	Botto	om of test bo	oring at 20 fe	et			50/2"	4	×			>>@		
	E				7	29	ofessiona 30 Eskrid irfax, VA		ndustries,	, Inc.		PF	ROJE	CT NO CT: ION:	6493-E	astern F		3-1 dle Expansio Crossing	<u></u> <u>n</u>
	Telephone: (703) 698-9300 Washington County																		



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 31/4" or 41/4 I.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

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

PM: Pressuremeter

CPT-U: Cone Penetrometer Testing with

Pore-Pressure Readings

SOIL PROPERTY SYMBOLS

N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.

N₆₀: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)

Q. Unconfined compressive strength, TSF

Q_o: 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

▼,▽,▼ Apparent groundwater level at time noted

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

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

GRAIN-SIZE TERMINOLOGY

PARTICLE SHAPE

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)		

Fine-Grained Sand: 0.075 mm to 0.42 mm (No. 200 to No.40)

Medium-Grained Sand: 0.42 mm to 2 mm (No.40 to No.10)

Silt: 0.005 mm to 0.075 mm

Clay: <0.005 mm

RELATIVE PROPORTIONS OF FINES

Descriptive Term % Dry Weight

Trace: < 5%
With: 5% to 12%
Modifier: >12%

Page 1 of 2



GENERAL NOTES

(Continued)

CONSISTENCY OF FINE-GRAINED SOILS

MOISTURE CONDITION DESCRIPTION

STRUCTURE DESCRIPTION

Description	Criteria	Description	<u>Criteria</u>
Stratified:	Alternating layers of varying material or color with	n Blocky:	Cohesive soil that can be broken down into small
	layers at least 1/4-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 1/4-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,	Parting:	Inclusion less than 1/8-inch (3 mm) thick
	sometimes striated		

SCALE OF RELATIVE ROCK HARDNESS

ROCK BEDDING THICKNESSES

Qu - TSF	Consistency	<u>Description</u>	<u>Criteria</u>
- 10	F () 0.0	Very Thick Bedded	Greater than 3-foot (>1.0 m)
2.5 - 10	Extremely Soft	Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
10 - 50	Very Soft	Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
50 - 250	Soft	Thin Bedded	11/4-inch to 4-inch (30 mm to 100 mm)
250 - 525	Medium Hard	Very Thin Bedded	1/2-inch to 11/4-inch (10 mm to 30 mm)
525 - 1,050	Moderately Hard	Thickly Laminated	1/8-inch to 1/2-inch (3 mm to 10 mm)
1,050 - 2,600 >2,600	Hard Very Hard	Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

ROCK VOIDS

Voids	Void Diameter	(Typically Sedir	mentary Rock)
	<6 mm (<0.25 in)	Component	Size Range
	6 mm to 50 mm (0.25 in to 2	Very Coarse Grained	>4.76 mm
•	•	Coarea Grained	2.0 mm - 4.76 mm
,	y 50 mm to 600 mm (2 in to 2 e >600 mm (>24 in)	Medium Grained	0.42 mm - 2.0 mm
Cave	>000 Hilli (>24 III)	Fine Grained	0.075 mm - 0.42 mm
		Very Fine Grained	<0.075 mm

ROCK QUALITY DESCRIPTION

DEGREE OF WEATHERING

Page 2 of 2

GRAIN-SIZED TERMINOLOGY

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

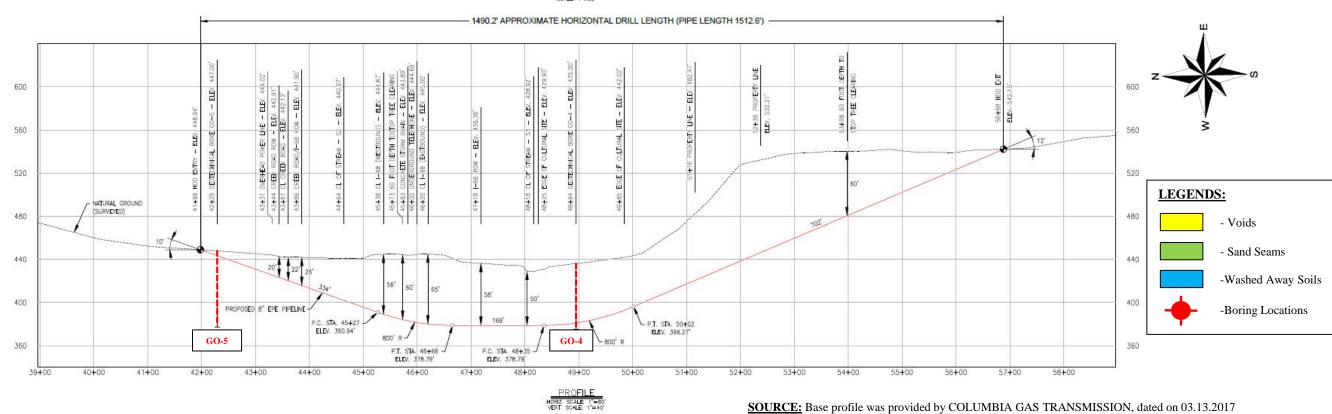
SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

		ONS	SYMI	BOLS	TYPICAL	
IVI	AJOR DIVISION		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	
	FRACTION 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	
OF MATERIAL IS 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	
	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 GRAINED SOILS	SILTS AND CLAYS			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	
COILO				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
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	
HI	GHLY ORGANIC S	SOILS	7/ 7/ 7/ 7/ 7/ 7/ 7/ 7/ 7/ 7/ 7/ 7/ 7/ 7/ 7/	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS	



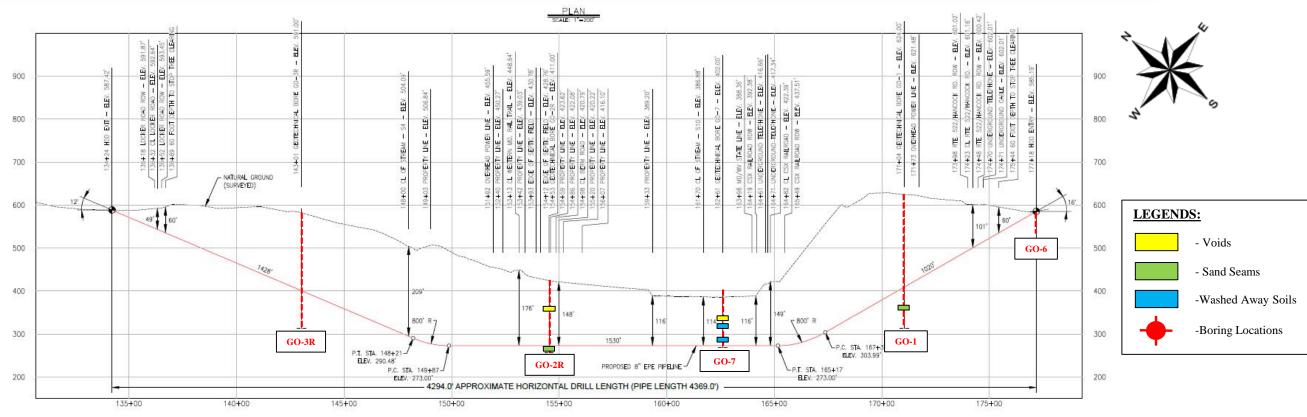




Boring	Approximate Depth/Elevation of recorded VOIDS Depth/Elevation (ft)	Approximate Depth/Elevation of recorded SAND SEAMS Depth/Elevation (ft)	Material Washed Away During Coring Depth/Elevation (ft)
GO - 4	N/A	N/A	N/A
GO – 5	N/A	N/A	N/A

		REVISIONS				
Interte	ek ps:					
6493 –	PROFILE 6493 – EASTERN PAN HANDLE EXPANSION INTERSTATE 68 CROSSING					
Washington County, I	MD – Morgan County, WV	June 15, 2017				
E.Q.S.	N.T.S.	0512713				





Boring	Approximate Depth/Elevation of recorded VOIDS Depth/Elevation (ft)	Approximate Depth/Elevation of recorded SAND SEAMS Depth/Elevation (ft)	Material Washed Away During Coring Depth/Elevation (ft)
GO - 1	N/A	10.0° / 360 to 350 MSL	N/A
GO – 2R	0.1' / 359.7 MSL 0.1' / 357.9 MSL 0.6' / 357.6 MSL	2.4' / 279.4 to 277 MSL 0.7' / 275 MSL 0.5' / 272.5 MSL	N/A
GO – 3R	N/A	N/A	N/A
GO – 6	N/A	N/A	N/A
GO – 7	0.8° / 343.8 MSL	N/A	1.4° / 329.4 to 328 MSL 1.5°/ 295 to 293.5 MSL

SOURCE: Base profile was provided by COLUMBIA GAS TRANSMISSION, dated on 03.13.2017



REVISIONS

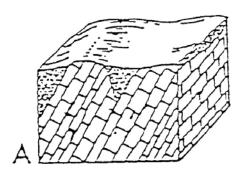
PROFILE

+	6493 – EASTERN PANHANDLE EXPANSION POTOMAC RIVER CROSSING		
	Washington County, I	MD – Morgan County, WV	June 15, 2017
	E.Q.S.	N.T.S.	0512713

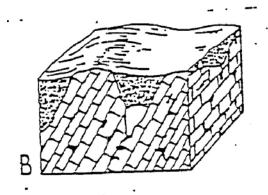
APPENDIX D: H<9'A97<5B=GA'C: 'G=B?<C@'89J9@CDA9BH'

THE MECHANISM OF SINKHOLE DEVELOPMENT

Limestone areas represent a potentially serious foundation problem. The solubility of these carbonate rocks often makes small fractures become larger channelways, intersecting fractures become huge chambers and the normally smooth soil-bedrock interface becomes pinnacled with almost unbelievable relief. Usually, these fractures are hidden from view beneath a gently rolling landscape with exceptionally rich looking soils.

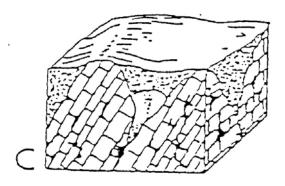


The character of the carbonate bedrock surface is usually pinnacled and covered with thick, weathered mantle. As this mantle dries out during periods of drought or lowering of the water table by man's activities, volume shrinkage due to compaction takes place.

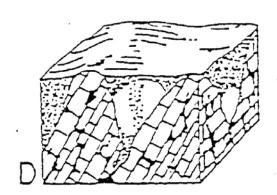


This compaction is irregular and may be expressed at the surface by the typical rolling topography of carbonate terrains. However, an open void may develop in this overlying debris and the roof of the void assumes the shape of an arch. The weight of the compacted soil would then be carried along the arch-bridge and absorbed by the soil abutments adjacent to the carbonate rock pinnacles.

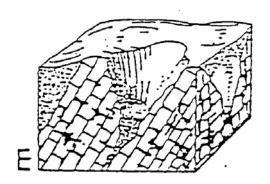




At the same time, the dried-out debris is slowly migrating downward into the existing openings, widened by solution, in the carbonate bedrock. A wide range of soil particle sizes encourages a sporadic but continuous process of roof spalling into the voids. This debris is then carried to great depths within the bedrock probably along interconnecting solution channels that have opened along joints, faults, and bedding planes in the limestone.



As the spalling continues and the debris moves downward, the open chambers gradually grow upward. At that point in time when the archbridge cannot hold the weight of the overlying materials, sudden collapse of the surface occurs, and a sinkhole is born.



The appearance of most sinkholes after a torrential rainfall is probably due to the sudden influx of water which adds weight to the overlying materials, flushes out much of the debris at the bottom of the voids, and softens the dried arch-bridge, causing collapse.

No simple solution is available for the detection of potential sinkholes or for determining the exact soil-bedrock interface. A combination of conventional soil borings and rock probes, fracture trace analyses, and electrical resistivity studies have proven successful in analyzing this precarious phenomenon.

