

May 22, 2019

Via Electronic Mail

Mr. Scott R. Williamson
Program Manager, Waterways & Wetlands Program
Pennsylvania Department of Environmental Protection
Southcentral Regional Office
909 Elmerton Avenue
Harrisburg, PA 17110-8200

**Re: DEP Request for Additional Information
Blacklog Creek Crossing 16" Horizontal Directional Drill Location (S2-0154-16)
Permit No. E31-234
Shirley Township, Huntingdon County**

Dear Mr. Williamson:

In compliance with the Corrected Stipulated Order dated August 10, 2017 a Re-evaluation Report of the above-referenced horizontal directional drill (HDD) was submitted to the Pennsylvania Department of Environmental Protection (Department) on February 18, 2019. In a letter dated April 1, 2019, the Department requested additional information, please accept this letter as a response. Your requests are bolded below followed by Sunoco Pipeline, LP (SPLP) responses.

- 1. As required by Paragraph 4. and 5. of the Environmental Hearing Board's August 10, 2017 Corrected Stipulated Order (Order), SPLP failed to fully utilize information gathered during the HDD of the 20-inch bore as part of the HDD Re-evaluation for the 16-inch pipeline. Several inadvertent returns occurred during the HDD activities for the 20-inch bore. Please gather geologic and drilling information collected by various site personnel during the 20-inch bore which can be used to synthesize a comprehensive history of each or groupings of events. The HDD re-evaluation report should discuss the operational or geologic cause of each inadvertent return, the magnitude of the inadvertent return(s) (IRs) and associated loss of circulation, the best management practice used to contain and minimize the inadvertent return, and the drilling procedure or technique used to progress the boring. The re-evaluation should describe how the 20-inch "as-built" was used in determining the proposed 16-bore path.**

The type of information described above, and any other relevant data gained in the intervening time period since the 20-inch HDD began to present, should be used to describe and support why the chosen bore path for the 16-inch pipeline was determined and how such information has been used to minimize the potential for IRs or the potential for water supply impacts to occur. Part of the discussion of construction alternatives, including why HDD activity is still the preferred and chosen methodology for pipeline construction at this location should be included in the re-evaluation report.

SPLP utilized all information obtained during the drilling of the 20-inch HDD in our internal assessment and evaluation of the 16-inch HDD profile as revised. The IR information represented graphically on Figure 1 in Attachment 2 presents the plan and cross section views of the March 23, 2018 IR event. This figure presents the reality of events that occurred during the HDD operations in relation to the depth of profile and allowed for correlation to monitoring data collected during active drilling.

SPLP reviewed the daily drilling reports, geotechnical investigations, Incident Assessment Report, IR Restart Reports, and HDD Inspection Daily Reports, paying special attention to intervals/days in which a partial or full loss of returns or an IR occurred. Specifically, the depth of the bit was compared to the geotechnical investigations to determine if the pilot tool was advancing through a highly weathered or fractured interval of bedrock. Further, the annular pressure was reviewed to identify any sudden changes in pressure.

Based on a review of this information, it was determined that the three IRs resulted from the boring passing through intervals of jointed or fractured bedrock. The first IR occurred on October 10, 2017, while the original HDD profile was being drilled from west to east (high elevation to low) using a 400 Class HDD unit (high pressure/flow rig). The high to low drilling results in the circulation of drilling fluids at higher rates and pressures to induce the cuttings that were being generated to return to the entry pit. The increased pumping rates exceeded the hydrostatic pressure being exerted on the boring. Once the boring intersected an interval of weathered and/or fractured bedrock the “pressurized” drilling fluid migrated into the formation and eventually discharged to the ground surface. This IR volume was between 5-10,000 gallons. A review of the 2017 geotechnical investigation reveals that the rock quality designation (RQD) for the boring near the first IR location ranged from very poor to fair (0 to 66) for the upper 15 feet of the boring. To correct the cause of this IR, the original 20-inch HDD profile was closed with grout, and redesigned. A low pressure/flow drill rig mobilized to the eastern end of the boring to allow the reduced elevation along the redesigned profile to assist in transporting the cuttings back to the eastern entry/exit returns pit. Further, the entry/exit angles were modified (increased) on the redesigned profile to allow for quicker entry and exit into competent bedrock and to reduce the length of the boring in which the HDD would be advancing through shallow unconsolidated material and weathered bedrock.

The second IR occurred on March 10, 2018, when the pilot bit was located entirely within unconsolidated material and was classified as a “punch-in” release of 25-50 gallons. The IR was also located entirely within the limits of disturbance in an upland area. Immediately following the detection of this IR, a second eastern return pit was excavated that effectively recovered all the returning drilling fluids.

The third IR occurred on March 23, 2018, when the pilot bit was located at an approximate depth of 29 feet below ground surface (bgs), and was 10-12 ounces in volume. As with the first IR, the pilot bit was in an interval of bedrock that was likely weathered and less competent leading to the drilling fluid surfacing. To address the cause of this IR, the drilling contractor tripped the bottom hole assembly (i.e., mud motor, monel and bit/reamer) out of the borehole, installed a non-expandable packer assembly onto the drill string, tripped the drill string back into the boring at the interval in which the loss of circulation (LOC)/IR occurred, and pressure-grouted (with cement grout) the formation. The cement grout was allowed to cure prior to advancing the pilot bit through the plug and prior to advancing the

borehole. Since no additional losses of circulation or IRs occurred, this remedial method was deemed successful at sealing off the weathered and less competent portion of the bedrock.

This information was utilized, along with the hydrogeologic evaluation, to assess the potential for IRs to occur along the permitted 16-inch HDD profile during installation. Based on this review, it was determined that the permitted 16-inch HDD profile was susceptible to IRs. To reduce the potential for IRs to occur during completion of the 16-inch HDD, the profile was redesigned to increase the entry and exit angles and lower the total profile depth. By increasing the entry and exit angles, the redesigned 16-inch HDD will be advanced through the unconsolidated soils and weathered bedrock quicker and closer to the respective entry and exit points. This modification will minimize the distance the pilot bit and reamer will have to travel through these lower integrity, near-surface materials. Further, the overall depth of the profile has been increased from a maximum depth of 45 feet below ground surface (bgs) on the permitted 16-inch profile, to 70 feet bgs on the redesigned 16-inch profile. These design changes, along with best management drilling practices, will be used to reduce the risk of IRs from occurring during the 16-inch HDD operations. Should an IR occur, the drilling contractor will immediately stop all drilling activities, begin to construct a containment structure around the IR to minimize the surficial area impacted and begin recovery operations. The key items are to perform this drill with the entry on the low elevation side, and then monitor for significant losses of return. Monitoring by inspection staff (utility, geology, and environmental) will be increased as the pilot reaches HDD station 4+14 on the revised profile, since this was the location of the largest IR during drilling to install the 20-inch pipeline.

Additional adjustments of the drill profile are not possible, or would induce problems into the drilling program. The western exit point cannot be extended, since this would result in increasing the elevation at the exit point, which results in increased fluid injection and annulus pressure during operations, and the exit location is the limiting factor to additional depth of profile under the large volume IR point. The entry and exit radius to the profile bottom at 2,000 ft are below the pipeline stress allowance; however neither radius can be tightened without inducing an increase of the entry and exit angles, and these are already maximized.

As mentioned in the Alternative Analysis of the Re-Evaluation Report, the HDD methodology was confirmed to be the preferred installation method because it will result in the least amount of direct impact to the environment and land surface. Converting this HDD to open-cut would result in the direct disturbance to the forested wetlands and the stream that would need to be crossed. Open-cut installation would result in 1,600 square feet of state water bottom, 0.22 acres of floodway, and 0.99 acres of wetlands being directly impacted. Further, any dewatering required to maintain the open-cut trench could result in the potential discharge of cloudy water downstream regardless of the utilization of filtration bags and mitigation structures. Re-routing the pipeline is not a viable option because streams and wetlands would still need to be crossed, there would be additional direct impacts to scrub-shrub and/or forested wetlands, and a new "greenfield" corridor would need to be created. Based on these factors, the HDD technique remains the preferred construction method for this location.

2. Relating to the overall HDD Re-evaluation summary and the Geologic Report:

- a. There is no evaluation of the data and no data-based correlation for why the revised 16-inch pathway was chosen. Please provide a discussion of how the data presented was used in designing and as support for this proposed HDD bore path and profile.**

The response provided to Item 1 above presents information on the data utilized to redesign the 16-inch HDD profile, and limitations to further adjustments.

The bedrock qualities for the 20-inch profile were generally considered good; and are equal or better for the 16-inch profile. Based upon the 2017 geotechnical investigation translated to the HDD profile, competent rock will be encountered at 17-23 ft of depth bgs. There is some variation in recovery and rock hardness to 48 ft of depth bgs; recovery values range from 96-100, and RQD values range from 36-72. Below 48 ft of depth bgs, recovery values are generally in the 90-100 range, and RQD values range from 63-100.

- b. The root cause of the IRs is only discussed in the Executive Summary section in Attachment 1- "Geology and Hydrogeological Evaluation Report" of this HDD re-evaluation. The root cause of the IRs should be evaluated and discussed in detail from a geologic standpoint and addressed within the Conclusions section in Attachment 1.**

Section 8 Conceptual Hydrogeologic Model and Conclusion of the Geology and Hydrogeology Evaluation Report has been modified to discuss the root cause of the IRs. Additional details on the root cause of the IRs are presented above in the response to Item 1.

- c. Both the Geology and Hydrogeological Evaluation Report and Horizontal Directional Drill Analysis mention "... fractures or groups of fractures that can be sufficiently enlarged by dissolution of the bedrock". Dissolution of shale bedrock? Please explain.**

This language is not accurate based on the lack of carbonate lithology at this HDD location, and has been modified in the revised Hydrogeological Re-Evaluation Report, which is attached.

- d. It is unclear from the narrative discussions which direction the HDD will proceed. Please confirm the drilling direction is West to East, as is indicated in Figures 1-3.**

The 16-inch HDD will be drilled from east to west, or from low elevation to high elevation.

- e. The table Regional Geology Summary lists "depth to rock" as 18-59 ft BGS. The soil borings and core borings show auger refusal depths ranging from 15 ft to 22 ft. Please revise or explain.**

The depth to rock data is provided in the response to Item 2a above.

- f. Section 5.0 Geotechnical Evaluation presents a synopsis of the two core borings. The section ends with the statement "Skelly and Loy and RETTEW relied on these reports and incorporated their data into the general geologic and hydrogeologic framework of the analysis of the proposed 16-inch drill at HDD S2-0154-16 for this report." Please specify where this data was incorporated into the re-evaluation? The data is presented but is not further discussed.**

Additionally, this section of the report presents information and data but no evaluation of the data and information is made in relation to the re-design the proposed 16-inch bore path.

The results of the 2014 and 2017 geotechnical investigation were utilized to develop the conclusion that the permitted 16-inch HDD profile was susceptible to an IR during HDD operations. This conclusion was based on the potential presence of weathered and fractured bedrock along an extended portion of the permitted profile. As a result, the 16-inch HDD profile has been redesigned to increase the depth of the bore path to an elevation at which RQD values from the 2017 geotechnical investigation indicate the presence of more competent bedrock, thus decreasing the potential for IRs during the proposed HDD operations. Additional detail on how the results of the geotechnical investigation were used to redesign the 16-inch HDD profile are provided in the responses to Items 1 and 2a above.

- g. Analysis of geologic strength at profile depth:**

There is no analysis in the re-evaluation report specifically tying the revised drill path to any specific zones noted on the core boring logs as having high RQDs, or why the revised 16-inch path was chosen. Please provide a discussion addressing the use of this data in designing the bore path.

The rock quality data in relation to the HDD profile is provided in the response to Item 2a above.

- h. The table Rock Core Description Summary lists the rock classification as "limestone" while other references in the report identify the primary rock classification as Shale. Please confirm that the bedrock is Reedsville Shale. Is the site close enough to the shale's lower contact that the lower parts of the cores are limestone?**

If limestone was identified as part of the geology, in accordance with the Order, conduct appropriate geophysical testing/evaluations or provide a detailed justification of for why such geologic investigations was not done.

Based on a review of the lithology description from Soil Boring SB-02 from the 2014 geotechnical investigation, it appears that the entry of limestone in the Rock Core Description Summary was an error. The lithology described for both bedrock samples from boring SB-02 identified highly fractured dark gray weathered shale and no mention was made of the presence of limestone. This is further supported by the results of the 2017 geotechnical investigation, which was completed to greater depths than the 2014 investigation and did not encounter any limestone in the recovered core samples.

- i. If additional geophysical data is obtained, please submit additional plan/profile maps with superimposed geophysical data.**

As stated in Section 6.0 of the Geology and Hydrogeologic Evaluation Report, a geophysical survey would add little additional information to prevent IRs during the completion of the proposed 16-inch HDD profile based on the lack of carbonate geology at this HDD location.

- j. Attachment 3 Well Location Map contains a location labelled "GES Stream Testing Location", with GES well ID ST-09252017-614-01. Is this the same location described in Section 3.0 Hydrogeology of the Geologic Report as a spring? Was the spring sampled? If yes to either question, use and discuss any applicable and relevant data in the re-evaluation.**

The GES 'Stream Testing Location' and the "spring" identified in Section 3.0 of the Geology and Hydrogeologic Evaluation Report are the same location. With the exception of iron, none of the parameters typically identified in samples impacted by drilling fluids (i.e., turbidity, total suspended solids, iron and manganese) were identified in this sample at concentrations higher than the Department's established primary and secondary drinking water standards (MCLs/SMCLs). However, only the iron results from the pre-construction sampling event were detected at a concentration greater than the secondary drinking water standard.

- 3. Relating to the Analysis of well production zones and use of information obtained during construction of the 20-inch pipeline;**

The re-evaluation report fails to include evaluation of the information and any data collected for the one private water supply within 450 feet of the HDD, the two other nearby water supplies identified in the report, or the water supply complaint that was investigated during the construction of the 20-inch pipeline.

It is also unclear about whether the one water supply within 450 feet of the HDD or the water supply identified approximately 520 feet from the HDD is the same as the one water supply identified within 0.5 miles using the PaGWIS database

Any private or public water supply data obtained within 450 feet or otherwise obtained in the vicinity of the 20-inch or proposed 16-inch HDD should be used and discussed as part of this HDD re-evaluation. This data should include but not be limited to any applicable water supply sampling data and any water supply complaints that SPLP may have obtained and received for water supplies within 450 of the HDD or within the general vicinity during construction of the 20-inch pipeline. The results of the SPLP's water supply sampling program, investigation, disposition of the complaint, and any correlation or non-correlation to SPLP's construction activities should be evaluated and discussed in the HDD re-evaluation report and used to demonstrate that the proposed 16-inch HDD activity will minimize the potential for IR' s and impacts to water supplies. Please revise the re-evaluation report to include this information.

Per the Order, SPLP conducted a search for any water supply wells located within 450 feet of the Blacklog Creek HDD. A total of two water wells were located, neither of which were identified within the 0.5-mile radius search of the Pennsylvania Groundwater Information System, nor were they identified on parcels within 450 feet of the HDD. These water wells are represented on Attachment 3 of the Hydrogeologic Re-Evaluation Report. The second well that was identified is on a parcel within the 450-foot search radius, but is actually located approximately 520 feet from the HDD alignment. Water quality samples were collected from the identified locations prior to the initiation of HDD activities (i.e., during completion of the 20-inch HDD and following completion of the 20-inch HDD). A review of the analytical results from these two sampling events did not identify any changes, other than those attributed to minor seasonal fluctuations. Further, drilling fluid in the form of residual bentonite was not detected in any of the water quality samples. As a result of these findings, no impacts to groundwater quality were identified that could be attributed to the installation of the Blacklog Creek 20-inch HDD. Summary tables containing the analytical results from the various water quality sampling events are attached.

On March 15, 2018, a complaint was made for a loss of water production from the water well supplying the residence of Mr. and Mrs. Jerry Goshorn, located at 16443 Blacklog Valley Road, Orbisonia, Huntingdon County, Pennsylvania. Mr. Goshorn indicated that he first noticed a decrease in water pressure on March 10, 2018. An attempt to re-pressurize the pressure tank connected to the water well was able to temporarily increase the water pressure, but it would decrease quickly. Mr. Goshorn attempted to re-pressurize the pressure tank again on March 13, 2018, at which time the pressure would build up to 50 pounds per square inch, but once the pump was shut off, the pressure would drop quickly. Walters Well Drilling (Walters) was retained by the homeowners to evaluate the condition of the well pump. Walters determined that the submersible pump motor had failed. Walters installed a new submersible pump in the well and water production returned to normal levels. A water quality sample was going to be collected while Walters was installing the new pump; however, the sample was not collected because Walters chlorinated the well prior to installing the new pump. As discussed in the S2-0154 Blacklog Creek Goshorn Water Well Complaint Report submitted to the Department on August 3, 2018, it was concluded that no impacts associated with the Blacklog Creek HDD had impacted the water well. The Department's written concurrence with that determination was received on January 16, 2019.

4. Related to Pipe Stress Radius: Provide further explanation of how the following statement applies to this HDD re-evaluation: "Pipe stress allowances are an integral part of the design calculations performed for each HDD."

For steel pipe, the "pipe stress allowance" is the amount of curvature that a piece or length of pipeline can bend without resulting in damages such as a "kink" or "crimp" in the wall of the pipe. The innate curvature ability of pipe is termed the "free stress radius". The stress allowance of the pipe is determined by the ductility of the steel, wall thickness, and the diameter of the pipe. An HDD design is limited by the horizontal distance between the points of entry and exit and the free stress radius of the pipe.

Ductility of the steel used for pipelines is determined by the percentage of carbon within the steel. Generally, steel pipe is categorized as either “low carbon” having less than 0.3% carbon content within the steel, or “high carbon” having greater than 3% carbon within the steel. As the carbon content within the steel used to make the pipe increases, the flexibility (ductility) of the pipe is decreased. The X70 16-inch pipe utilized on the Mariner project is a low carbon (high ductility) steel pipe.

The design of an HDD profile accounts for the free stress radius of the pipeline segment to be pulled into the drilled entry, through the entry radius of curvature at maximum horizontal depth, out the exit radius leaving maximum depth, and out the drilled exit; therefore, each HDD has a minimum of four (4) points of pipeline curvature to assess for pipeline stress. Additionally, a horizontally drilled profile is not a “perfect” pathway, especially when drilled through rock formations. The pilot tool cutting into the rock face has a larger cutting face than the drill stem pushing the tool forward, which results in flexibility of the tooling within the pilot hole. As a result, the pilot tool will drift in orientation as proceeding forward because the cutting tool will proceed easier into softer material while cutting due to natural variances in hardness of the materials being cut, whether they are soils or rock. Steering of the pilot tool is used to correct drifting as it occurs. As a result of this natural drifting during completion of the pilot hole, the entire length of the drilled pilot hole is assessed for stress allowances at three (3) joint intervals before reaming of the annulus is permitted. If errors during pilot drilling or reaming occur and a mid-point is identified that would breach the pipe stress allowance, then the use of an over-reamed annulus is assessed for breach of the stress allowance. In cases where an over-reamed annulus will not correct the stress problem, the HDD must be re-drilled.

All the information and the stress assessment procedures discussed above are incorporated into the profile design and implemented in analysis of the drilling profile to ensure the integrity of the pipeline as installed.

SPLP submits that we have been, and are, in complete compliance with the agreed terms and analysis requirements of the Order, as agreed to by the Department, and that no further analysis is required for the Department to consent to the start of this HDD. SPLP requests that the Department approve the Re-evaluation Report for the Blacklog Creek Crossing Horizontal Directional Drill (S2-0154-16) as soon as possible.

Sincerely,



Larry J. Gremminger, CWB
Vice-President – Environmental, Health & Safety
Energy Transfer Partners
Mariner East 2 Pipeline Project

Mr. Scott Williamson
Response to DEP Comments on S2-0154-16
May 22, 2019
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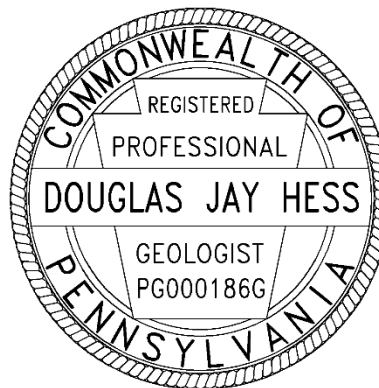
Pertaining to the practice of geology and information conveyed.



Douglas J. Hess, P.G.
License No. PG-000186-G
Skelly and Loy, Inc.
Director of Groundwater
and Site Characterization
Geo-Environmental Services

5/22/2019

Date



Attachments as stated.

February 13, 2019
Revised May 22, 2019

Mr. Matthew Gordon
Sunoco Pipeline, LP
535 Fritztown Road
Sinking Spring, PA 19608

Engineers

Environmental
Consultants

Surveyors

Landscape
Architects

Safety
Consultants

RE: Sunoco Pipeline, LP Pipeline Project - Mariner East II
SR 2017/Blacklog Creek HDD (S2-0154), PA-HU-0106.0000-RD-16
Hydrogeological Re-Evaluation Report for the 16-Inch Pipeline
Shirley Township, Huntingdon County, Pennsylvania
RETTEW Project No. 096302011

EXECUTIVE SUMMARY

1. This hydrogeologic re-evaluation report was prepared as a result of inadvertent returns (IRs) that occurred when the SR 2017/Blacklog Creek horizontal directional drill (HDD) location S2-0154 20-inch pilot boring was being advanced. A root cause analysis determined that the IRs were likely caused by the presence of jointed and fractured bedrock with low to high angle joints within the underlying geologic formation.
2. The site is underlain by clastic sedimentary rocks of the Ordovician-age Reedsville Formation (Or).
3. Water-bearing zones generally occur in secondary openings along bedding planes, joints, faults, and fractures. Most of the water-bearing zones occur in individual fractures or groups of interconnected fractures.
4. Reported median well depth in the Reedsville Formation is 130 feet below the ground surface (bgs). Based on published information, well yields range from 1 to 50 gallons per minute (gpm) with a median well yield of 12 gpm for domestic wells and 20 gpm for nondomestic wells.
5. The HDD profile for the proposed 16-inch HDD has been redesigned to increase its depth beneath the stream and wetland resources.
6. Based on the hydro-structural characteristics of the underlying geology, information obtained during installation of the 20-inch pipe, IRs that occurred during installation of the 20-inch HDD pilot boring, and the permitted SR 2017/Blacklog Creek 16-inch HDD profile within shallow unconsolidated soil materials and generally shallow bedrock, the proposed 16-inch HDD is susceptible to an IR of drilling fluids during HDD operations. A redesigned 16-inch HDD profile and proactive HDD best management practices (BMPs) will be used during drilling operations to reduce the risk of an IR.

1.0 INTRODUCTION

The purpose of this report is to describe the geologic and hydrogeologic setting of the SR 2017/Blacklog Creek S2-0154 horizontal directional drill (HDD) location on the Sunoco Pipeline, L.P. (SPLP) Pennsylvania Pipeline Project - Mariner East II (PPP-ME2) Project. The SR 2017/Blacklog Creek HDD is located in Shirley



Township, Huntingdon County, Pennsylvania as shown on **Figure 1**. The HDD was originally designed to be drilled under two wetlands (W-K69 and W-K70), Blacklog Creek (S-K94), and SR 2017/Blacklog Valley Road. The redesigned 16-inch HDD profile crosses beneath these same features. This Hydrogeologic Re-evaluation Report was prepared as a result of the inadvertent returns (IRs) that occurred as the SR 2017/Blacklog Creek HDD 20-inch pipeline pilot boring was being advanced.

The permitted 16-inch HDD profile was redesigned on January 24, 2019. The overall length of the HDD profile and the inclination of the entry and exit angles has been increased to increase the amount of cover under sensitive receptors and to install the boring into bedrock quicker than the original, shorter and shallower profile. The redesigned western HDD entry/exit is at a surface elevation of approximately 899 feet above mean sea level (AMSL) and the redesigned eastern HDD entry/exit is at an elevation of approximately 863 feet AMSL. The permitted HDD profile was extended 210 feet to the east and west resulting in a new horizontal length of 1,395 feet and a new boring/pipe length of 1,421 feet. The inclination of the western and eastern entry/exit angles has been increased to approximately 17° and 16°, respectively, to allow the pipe to be installed through the soils and bedrock in closer proximity to the entry and exit points, and to deepen the profile to approximately 67 feet below Blacklog Creek (this is approximately 20 feet deeper than the as-built 20-inch pipe). The locations of the as-built 20-inch and proposed 16-inch, SR 2017/Blacklog Creek HDD profiles are shown on **Figure 1**, and the redesigned 16-inch profile detail is included as **Attachment 1**.

2.0 GEOLOGY AND SOILS

Based upon publications by the Pennsylvania Bureau of Topographic and Geologic Survey (PABTGS) the site is in the Appalachian Mountain Section of the Ridge and Valley Physiographic Province of Pennsylvania, and is underlain by sedimentary rocks consisting of sandstone, siltstone, shale, conglomerate, limestone, and dolomite. Local topography is characterized by a northeast to southwest trending succession of long narrow ridges and broad to narrow valleys, with some karst terrain. Natural slopes are steep and geologic structure includes open and closed plunging folds with narrow hinges and planar limbs, and a variety of faults. These rocks generally have good surface drainage (Sevon, 2000). The SR 2017/Blacklog HDD site straddles the axis of a northeast-southwest trending anticline. Based on the United States Geologic Survey (USGS) 7.5-Minute Aughwick Topographic Quadrangle Map shown on **Figure 1**, the site is situated at an approximate elevation range of 900 to 860 feet AMSL. Surface topography at the site slopes to the east and west along the HDD profile toward Blacklog Creek. The major surface water feature proximate to the SR2017/Blacklog Creek HDD is Blacklog Creek which flows to the southwest before discharging into Shade Creek and ultimately into Aughwick Creek.

The site geology for the SR 2017/Blacklog Creek HDD profile is mapped as the Ordovician-age Reedsville Formation (Or) as shown on **Figure 2** (Berg and Dodge, 1981). The Reedsville Formation consists of moderately well bedded dark-gray shale containing thin sandy to silty shale interbeds and some siltstone and sandstone layers near the top of the formation. The sandstone layers near the top of the formation have graded beds and are very fossiliferous, while the shale beds tend to be fissile to thick bedded. The thickness of the Reedsville Formation ranges from 1,000 to 2,000 feet (Taylor et al., 1982). The formation is moderately well bedded with thin beds. The joints, which have a seamy to platy pattern, are well developed and highly abundant, are variably spaced with a close distance between fractures. The joints are open and steeply dipping. The joints, bedding and fracture-plane openings provide a secondary porosity of low magnitude and low permeability. This formation is slightly resistant to weathering and is typically moderately to highly weathered to a moderate to deep depth. Weathering results in loose rubble containing individual fragments with shapes ranging from pencil-like to rectangular plates with an

overlying thin soil mantle. From an engineering standpoint, excavation is classified as moderately easy, although slight rebound may be a special problem. Drilling rates are typically classified as fast; however, sandy shale interbeds could reduce the penetration rate. Cut-slope stability is fair due to rapid disintegration once the formation is exposed to moisture. Foundation stability is good, as long as the excavation reaches sound material. Surface drainage is good (Geyer and Wilshusen, 1982).

According to the United States Department of Agriculture (USDA) Soil Surveys of Huntingdon County, Pennsylvania, soils in the vicinity of the SR 2017/Blacklog Creek HDD consist of seven separate soil units. A USDA map that depicts the mapped area, along with the soil profile descriptions, is included as **Attachment 2**.

3.0 HYDROGEOLOGY

Groundwater at the site occurs in a fractured clastic sedimentary bedrock aquifer system within the geology described above. Water-bearing zones generally occur in secondary openings developed along bedding planes, joints, faults and fractures. Most of the water-bearing zones penetrated by wells occur in individual fractures or groups of interconnected fractures (Taylor et al., 1982).

A review of published data on water wells provided information on the hydrogeology underlying the HDD profile. Reported depths of domestic and nondomestic wells in the Reedsville Formation range from 31 to 435 feet below ground surface (bgs). The median depth reported for domestic and nondomestic wells was 130 feet. Well yields of 38 water wells ranged from 1 to 50 gallons per minute (gpm) with a median well yield of 12 gpm for domestic wells and 20 gpm for nondomestic wells. The limited data available regarding well yields indicates that abundant water-bearing zones are available in the 50- to 150-foot depth range bgs. A few water-bearing zones are present at depths below 200 feet bgs, with the deepest reported zone at 350 feet bgs (Taylor et al., 1982).

A water well records search of the Pennsylvania Groundwater Information System (PaGWIS, January 15, 2018) was completed within a 0.5-mile radius of the SR 2017/Blacklog Creek HDD. Only one well record was available within the 0.5 search radius and is summarized below. The well location is shown on **Figures 2 and 3**.

Well No.	Well Use	Casing Depth	Total Depth	Water Level	Yield
116609	Domestic	28 feet	112 feet	20 feet	100 gpm

In January 2019, other SPLP contractors researched private water supplies within a 450-foot radius of the SR 2017/Blacklog Creek HDD. One private water supply well was identified within the 450-foot buffer of the alignment; however, a second water supply well was located approximately 521 feet perpendicular to the HDD alignment. The reported depths for these wells range from 60 to 179 feet bgs. Information regarding depth to water and well yield was not known for either of these additional wells. In addition to the two water supply wells, a spring was identified 1,056 feet from the eastern HDD entry/exit. A map of these spring and well locations is included as **Attachment 3**.

4.0 FRACTURE TRACE ANALYSIS

Fracture traces underlying, or in close proximity to, the SR 2017/Blacklog Creek HDD were evaluated using historical aerial photographs from the years 1994 through 2015 (Google Earth, 2017), the Aughwick, PA USGS 7.5 Minute Quadrangle Topographic Map, the Frankstown 7.5 Minute Quadrangle Geologic Map

(Berg and Dodge, 1981), and the 2007 digital color orthophoto (PASDA, 2007-2008). The aerial photographs and maps were used to approximate the locations of natural linear features or lineaments expressed on the ground surface. The linear features may be the surficial representation of deeper fractures, joints, faults or bedding planes within the subsurface which can transmit groundwater through the fractured bedrock aquifer underlying the SR 2017/Blacklog HDD.

Figures 2 and **3** show the results of the fracture trace analysis overlain on the geologic map and aerial base map, respectively. Twelve fracture traces were identified in close proximity to the proposed SR 2017/Blacklog Creek HDD that are likely related to the primary geologic structure of the area. Due to the nature of the ridges and folded geology near the site, several of the fracture traces trend approximately northeast-southwest (NE-SW) and perpendicular to the HDD alignment. Additional fracture traces were identified in an approximately west-east (W-E) orientation crossing the prominent fracture traces and generally parallel to the HDD alignment. The W-E fracture lineaments are presumed to be stress-related joint sets. General surface drainage patterns near the site are characterized by linear stream reaches oriented NE-SW or W-E that also reflect the local geologic structure. Blacklog Creek flows generally NE-SW.

5.0 GEOTECHNICAL EVALUATION

Two geotechnical drilling investigations were performed at the site. The initial investigation was performed in October 2014 during the preliminary investigation of SR 2017/Blacklog Creek HDD and prior to initiating the 20-inch HDD operations. A second phase of geotechnical drilling was performed in September and October of 2017. The 2014 test borings were advanced by hollow-stem auger drilling methods to a maximum depth of approximately 30 feet bgs or until auger refusal. NQ-sized wireline rock coring methods were utilized in borings that were continued past auger refusal. These borings are designated as SB-01 and SB-02. The second phase test borings completed in 2017 were advanced using hollow-stem auger drilling and NQ-sized wireline rock coring methods. The 2017 borings were designated as B-01 and B-02. Soil, residual soil and weathered bedrock collected during both investigative phases were sampled using split-spoon samplers. Geotechnical boring logs are included in **Attachment 1**.

Boring SB-01 was located approximately 100 feet northeast of the western HDD entry/exit. Boring SB-02 was located approximately 375 feet northwest of the eastern entry/exit point. Boring B-01 was located approximately 80 feet to the northeast of the western HDD entry/exit, and Boring B-02 was located approximately 130 feet to the northwest of the eastern HDD entry/exit. The locations of these borings are depicted on **Figures 2** and **3**.

The generalized subsurface profile at the site, as observed in the borings, is described as follows:

- Variable and residual soil depths vary boring from boring; 26.3 feet bgs at SB-01, 15 feet bgs at SB-02, 15.2 feet bgs at B-01, and 15.4 feet bgs at B-02. The residual soils are described as follows:
 - **Boring SB-01:** Silty CLAY (CL) with some fine sand, trace fine gravel, partially weathered gray SHALE. Auger refusal was encountered at 26 feet bgs. Groundwater was not encountered.
 - **Boring SB-02:** Clayey fine to medium SAND (SC), with some silty clay and a little fine sandstone gravel, partially weathered gray to greenish-gray SHALE. Auger refusal was encountered at 15 feet bgs. Groundwater was encountered at 11 feet bgs.
 - **Boring B-01:** Stiff to very stiff, moist, lean CLAY (CL) with sand and trace shale fragments, medium dense, moist, clayey SAND (SC) with shale fragment, weathered sandy SHALE

- sampled as very dense, dry, poorly graded GRAVEL (GP). Auger refusal was encountered at approximately 15.2 feet bgs. Groundwater was not encountered.
- **Boring B-02:** Stiff, moist, sandy lean CLAY (CL) with trace shale fragments, weathered sandy SHALE sampled as very dense, dry, poorly graded GRAVEL (GP). Auger refusal occurred at approximately 15.4 feet bgs. Groundwater was not encountered.
 - From the initiation of coring operations to the total depth of the NQ cores, weathered bedrock and bedrock were encountered and are described as follows:
 - **Boring SB-01:** Rock coring was not completed at this location.
 - **Boring SB-02:** SB-02 was completed to a total depth of 25 feet bgs. A dark gray highly fractured shale with pyrite deposits was encountered from 15 to 25 feet bgs. Calcite deposits were identified at depths of 24.4, 24.5 and 24.7 feet bgs. Rock recoveries were between 70% to 80% and rock quality designations (RQD) were very poor (0).
 - **Boring B-01:** B-01 was completed to a depth of 150 feet. From 15.2 to 150 feet bgs, dark gray very fine to fine-grained, very thin to thickly bedded, weathered to slightly weathered, soft to moderately hard SHALE was observed. A complete loss of drill fluids occurred at 51 feet bgs. Vertical fractures were observed at the following intervals: 72.7-74.1 and 86-87 feet bgs. Broken and vertical fractures were observed between 121-131 feet bgs, while a highly broken interval was encountered between 136.4-137.2 feet bgs. Rock recoveries ranged from 97-100%. RQDs were very poor (0) to excellent (100). The weakest RQDs were in the weathered rock/competent rock transition zone (0) from 15.2 to 16 feet bgs and the broken and vertical fractured zone (27) between 121 and 131 feet bgs. RQDs were fair (62 to 66) from 16 to 31 feet bgs. Groundwater was observed at 45.5 feet bgs at the completion of coring operations.
 - **Boring B02:** B-02 was completed to a total depth of 150 feet bgs. From 15.4 to 150 feet bgs, a dark gray, very fine to fine-grained, very thinly to thickly bedded, weathered, medium to moderately hard, SHALE was observed. Vertical fractures were observed at the following intervals: 41-42.2 and 88.4-89.8 feet bgs. Broken intervals were observed from 44.1-46, 90.2-91, and 139.4-140.4 feet bgs. Rock recoveries ranged from 75-100%. RQDs were very poor (0) to excellent (100). The weakest RQDs were in the weathered rock/competent rock transition zone (0 to 13) from 15.4 to 23 feet bgs and the vertically fractured and broken interval (14) between 41 and 46 feet bgs. Groundwater was not encountered during coring operations.

Unconfined compressive strength testing was performed on core samples, and these testing results are summarized in the table below.

Boring	Sample Depth (feet bgs)	Compressive Strength (tons per square foot)
B-01	16.5	470.12
B-01	24.4	329.08
B-01	34.3	257.72
B-01	44.1	250.97
B-01	54	426.96

Boring	Sample Depth (feet bgs)	Compressive Strength (tons per square foot)
B-01	64.1	599.58
B-01	73	398.28
B-01	84	294.85
B-01	94.4	560.53
B-01	104.3	461.68
B-01	114	442.15
B-01	124	244.78
B-01	137	441.67
B-01	144	287.86
B-02	21.5	77.08
B-02	31.3	476.31
B-02	42.4	349.36
B-02	52.4	508.32
B-02	61.8	598.49
B-02	72.1	395.66
B-02	82.3	447.63
B-02	91.7	296.45
B-02	102.2	252.99
B-02	112.2	462.51
B-02	122.2	231.26
B-02	132	626.80
B-02	141.4	200.78

Please note that RETTEW Associates, Inc. or Skelly and Loy did not oversee or direct the geotechnical drilling program associated with HDD S2-0154 including, but not limited to, the selection of boring locations and target depths, observations of rock cores during drilling operations, or preparation of boring logs. The geotechnical reports, boring logs, and core photographs that resulted from these programs were generated by other Sunoco Pipeline, L.P. contractors. RETTEW and Skelly and Loy relied on these reports and incorporated the data into the general geologic and hydrogeologic framework included in this report.

6.0 GEOPHYSICAL SURVEY CONSIDERATIONS

The use of geophysical surveys during the site hydrogeologic re-evaluation was considered but was ultimately not implemented because the results of geophysical surveys would be unlikely to provide

additional information that would reduce the risk of an IR. Based on the lack of carbonate geology mapped at the site and site-specific geologic observations obtained during completion of the 20-inch HDD operations, the data generated from geophysical surveys will not reduce the risk of an IR.

7.0 FIELD OBSERVATIONS

Michels Directional Crossings (Michels) completed the drilling for the installation of the 20-inch pipeline. Michels initiated drilling on October 5, 2017, from the western entry/exit point utilizing the original HDD profile. From October 5 to October 10, 2017, Michels advanced the pilot hole to a trajectory of approximately 462 feet. On October 9, 2018, Michels reported a loss of returns (LOR) of 200 gallons when the pilot hole had been advanced approximately 360 feet from the western entry point and was 34 feet bgs. Michels swabbed the hole and was able to regain full returns. On October 10, 2017, with the pilot bit at approximately 462 feet from the western entry point, an IR of approximately 5,000 to 10,000 gallons was observed within Wetland K69. All drilling activities were stopped and Michels initiated cleanup and containment activities. On October 20, 2017, Michels injected approximately 7 cubic yards of cement grout into the existing pilot hole in an effort to seal the fracture(s) that had led to the IR and also as a means to abandon the pilot boring. Following the grouting operation, Michels demobilized their equipment from the site.

On March 9, 2018, Michels re-initiated pilot hole drilling, this time from the eastern entry exit point utilizing a revised profile, dated March 8, 2018, that was longer and deeper than the original profile. On March 10, 2018, an IR of approximately 25-50 gallons occurred within 10 feet of the eastern entry pit, completely within the limits of disturbance (LOD) and not impacting any Waters of the Commonwealth. The lead environmental inspector gave permission for Michels to construct a new returns pit at the location of the IR and continue drilling activities that day. From March 10, 2018 to March 23, 2018, Michels advanced the pilot hole to a trajectory of 955 feet from the eastern entry point. Sporadic LORs were observed on March 16, 17, 19, 20, 22, and 23, 2018, with the LORs ranging from 50 to 736 gallons per day on these dates. On March 23, 2018, a small 10 to 12 fluid ounce IR was observed within Wetland K69. All drilling activities were suspended until the Pennsylvania Department of Environmental Protection (PA DEP) approved the resumption of pilot hole advancement. SPLP's HDD team proposed the use of cement grout installed through a non-expanding packer to reduce the risk of further IRs. On May 3, 2018, following PA DEP approval to resume pilot hole activities, Michels pumped 2.5 cubic yards of cement grout through a non-expanding packer on the end of the drill string located 941 feet from the eastern entry point. No additional IRs occurred following the installation of the cement grout and the pilot hole was completed on May 18, 2018. Cuttings observed during the completion of the borehole consisted of overburden, weathered shale, dark gray to brown shale and trace calcite in the form of vein (fracture) filling.

Michels completed various ream and swab passes between May 21st and June 19th, 2018, and the 20-inch product line was pulled through the completed boring on June 19th, 2018.

8.0 CONCEPTUAL HYDROGEOLOGIC MODEL AND CONCLUSION

Based on published geologic and hydrogeologic information, results of the two geotechnical investigations and field observations during the completion of the 20-inch HDD, the SR 2017 HDD is underlain by clastic sedimentary rocks of the Reedsville Formation. The hydrogeologic setting is dominated by groundwater flow that occurs in secondary openings formed along geologic features that include bedrock bedding planes, joints, and fractures. Most of the water-bearing zones occur in individual fractures or groups of interconnected fractures. Median well depth in the Reedsville Formation is 130 feet bgs. Well yields

ranged from 1 to 50 gpm with a median well yield of 12 gpm for domestic wells and 20 gpm for nondomestic wells.

A root cause analysis was performed following the completion of the 20-inch HDD. This analysis identified the cause of the three IRs to be the result of the general shallow nature of the HDD profile and the presence of jointed and fractured bedrock with low to high angle joints within the underlying geologic formation. The first and third IRs occurred when the pilot tool was at a depth in which highly fractured and jointed bedrock was identified in the 2017 geotechnical investigation.

The originally designed 16-inch HDD profile was relatively shallow at the eastern and western entry/exit points in comparison to the land surface and surface streambed (Blacklog Creek, Stream K-94). Based on the hydro-structural characteristics of the underlying geology described in this report and geologic information obtained and utilized during installation of the 20-inch HDD, the SR 2017/Blacklog HDD is susceptible to an IR of drilling fluids during HDD operations. As a result, the permitted 16-inch HDD profile was redesigned to allow for a deeper crossing beneath the referenced stream and wetlands. The revised profile is approximately 67 feet below Blacklog Creek (this is approximately 20 feet deeper than the as-built 20-inch pipe). The inclination of the entry and exit angles has been increased to allow the pipe to be installed through protective soils, residual soils, and bedrock, and in closer proximity to the entry and exit points than the original, shorter and shallower profile. From a geologic perspective, the longer and deeper profile, in conjunction with the proposed engineering controls and/or drilling best management practices, will be used to reduce the risk of an IR and/or a loss of drilling fluid. Drilling BMPs are described in the Horizontal Directional Drill Analysis component of the overall re-evaluation package.

9.0 REFERENCES

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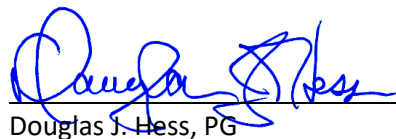
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W.D. Sevon, 2000, Map 13, Physiographic Provinces of Pennsylvania, Pennsylvania Bureau of Topographic and Geologic Survey, Harrisburg, Pennsylvania.

10.0 CERTIFICATION

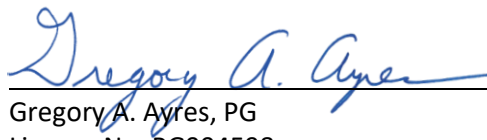
The studies and evaluations presented in this report (other than Section 5.0) were completed under the direction of a licensed professional geologist (PG) and are covered under the PG seals that follow.

By affixing my seal to this document, I am certifying that, to my knowledge and belief, the information herein is true and correct. I further certify, that I am licensed to practice in the Commonwealth of Pennsylvania and that it is within my professional expertise to verify the correctness of the information herein.



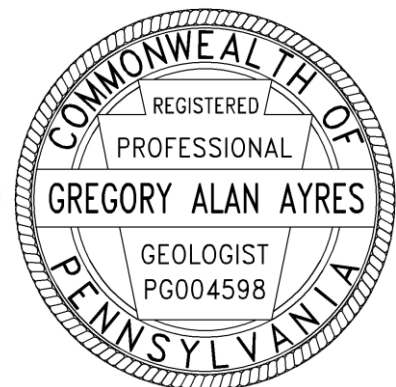
Douglas J. Hess, PG

License No. PG000186G



Gregory A. Ayres, PG

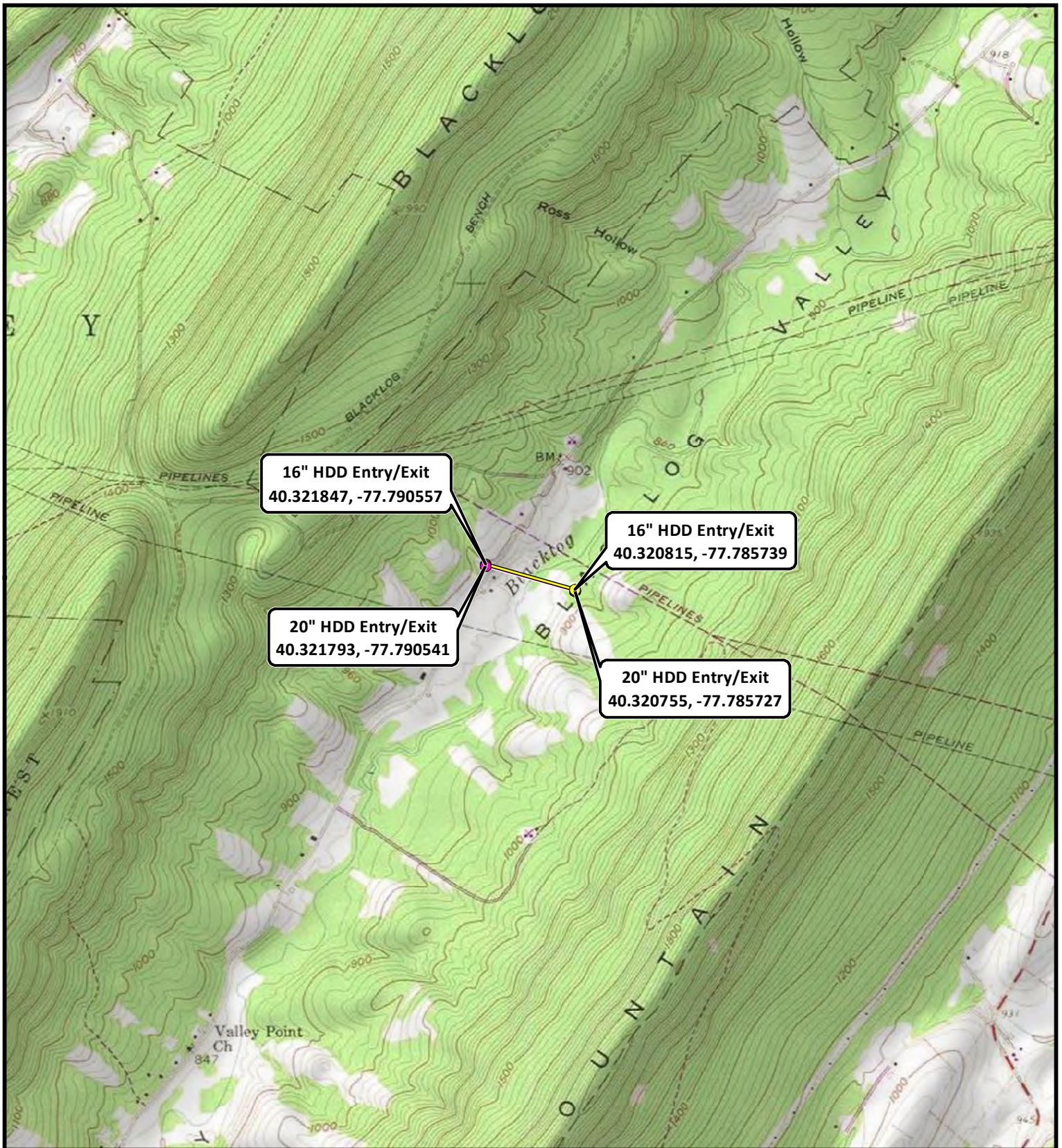
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Enclosures

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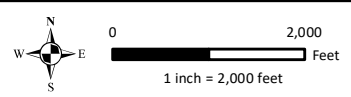
FIGURES

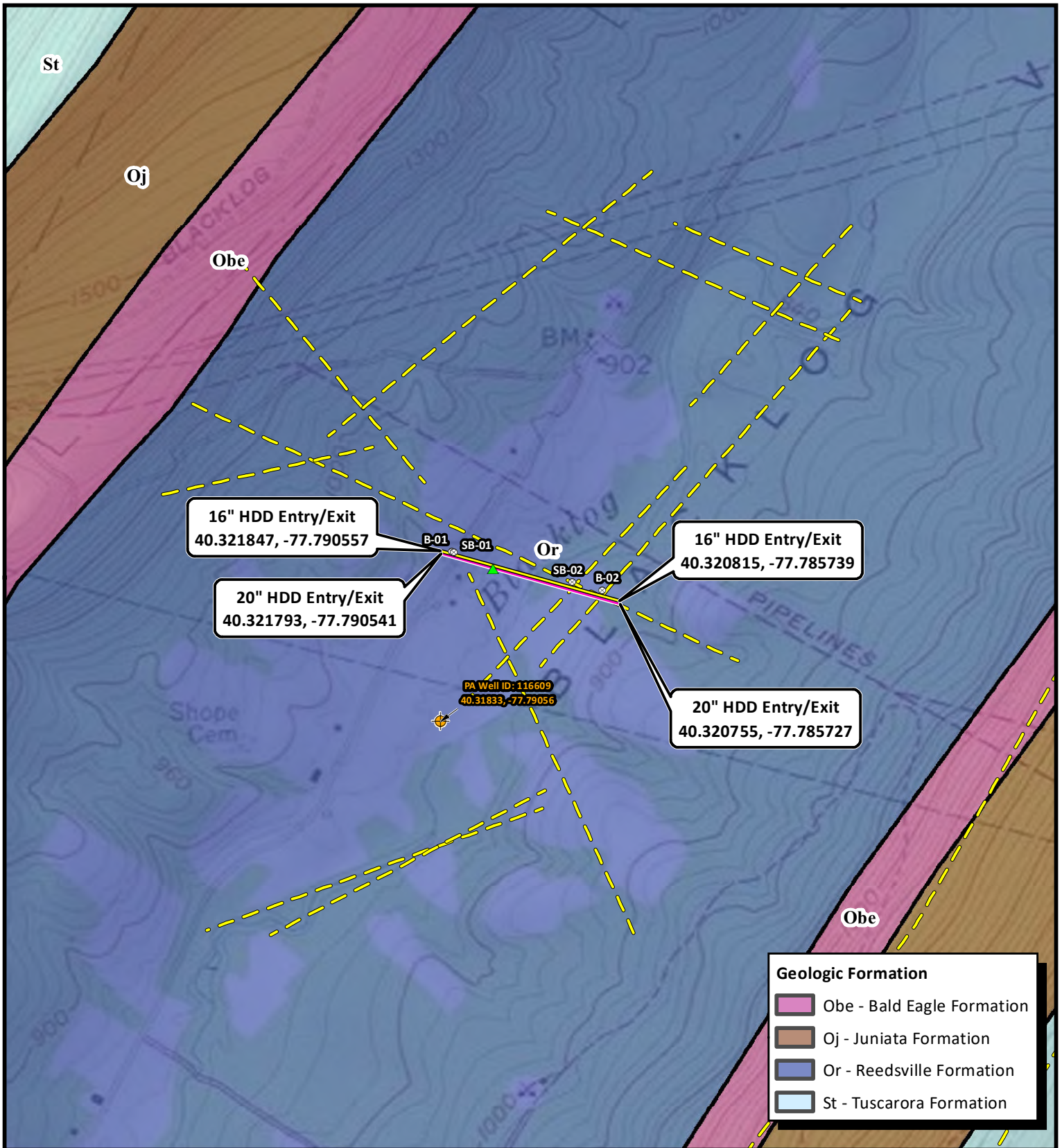


- 16" HDD Entry/Exit
- 20" HDD Entry/Exit
- 16" HDD Profile
- 20" HDD Profile

Sunoco Pipeline, L.P.
S.R. 2017

Figure 1 - Topographic Basemap
 Shirley Township, Huntingdon County, PA
 Project No. 096302011





16" HDD Entry/Exit
40.321847, -77.790557

20" HDD Entry/Exit
40.321793, -77.790541







PA Well ID: 116609
40.31833, -77.79056

16" HDD Entry/Exit
40.320815, -77.785739

20" HDD Entry/Exit
40.320755, -77.785727

Geologic Formation


- Obe - Bald Eagle Formation
- Oj - Juniata Formation
- Or - Reedsville Formation
- St - Tuscarora Formation

	Inadvertent Return		20" HDD Profile
	Soil Boring		Inferred Fracture Trace
	Residential Well		
	16" HDD Profile		


Aughwick, PA USGS 7.5' Topographic Quadrangle 5/17/2019

Sunoco Pipeline, L.P.
S.R. 2017

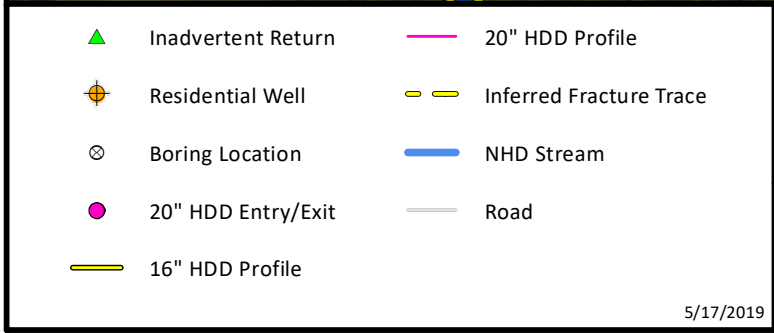
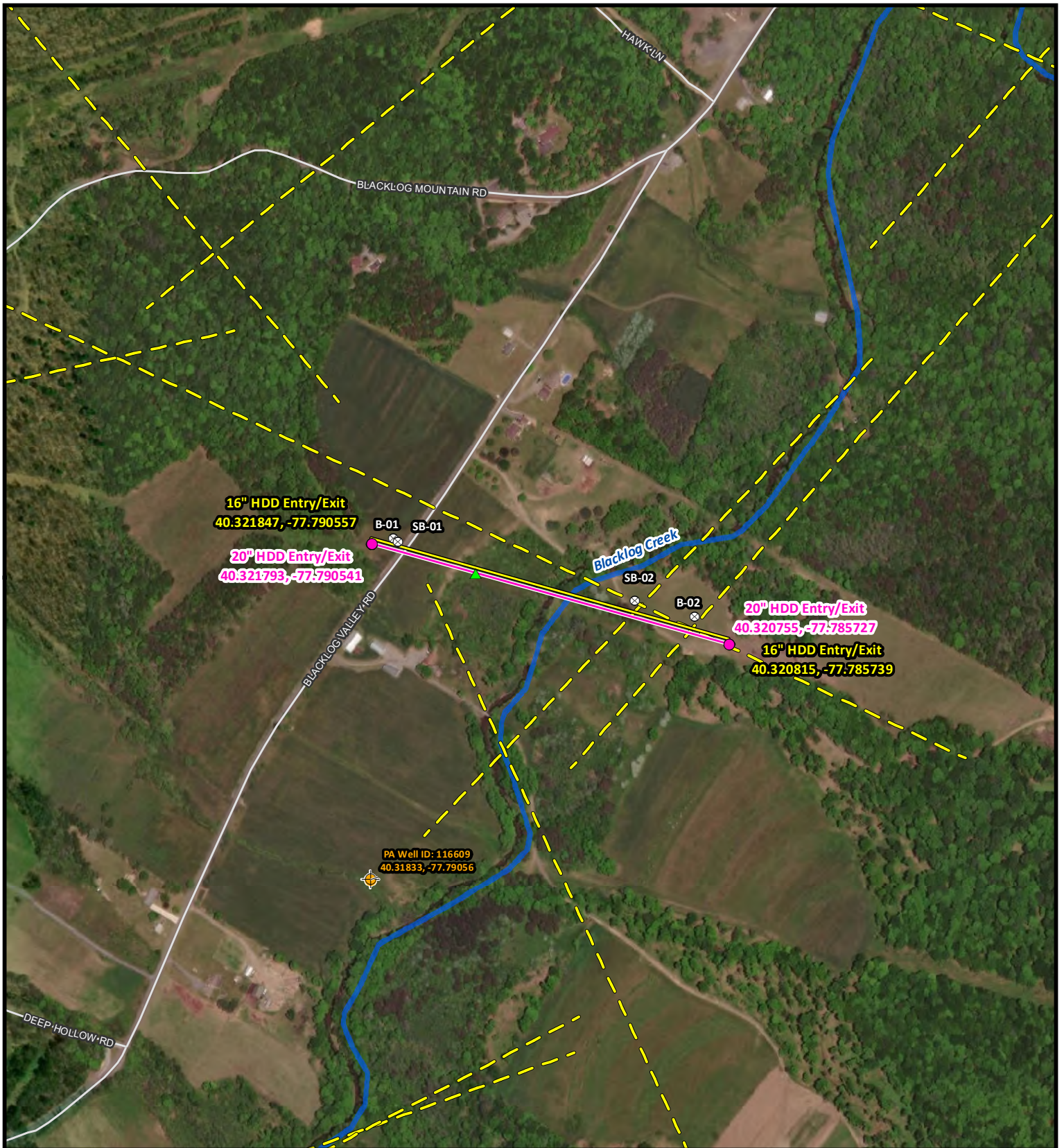
Figure 2 - Geologic Map
Shirley Township, Huntingdon County, PA
Project No. 096302011



0 1,000
Feet
1 inch = 1,000 feet



Service Layer Credits: Copyright: © 2013 National Geographic Society, i-cubed



Sunoco Pipeline, L.P.

S.R. 2017

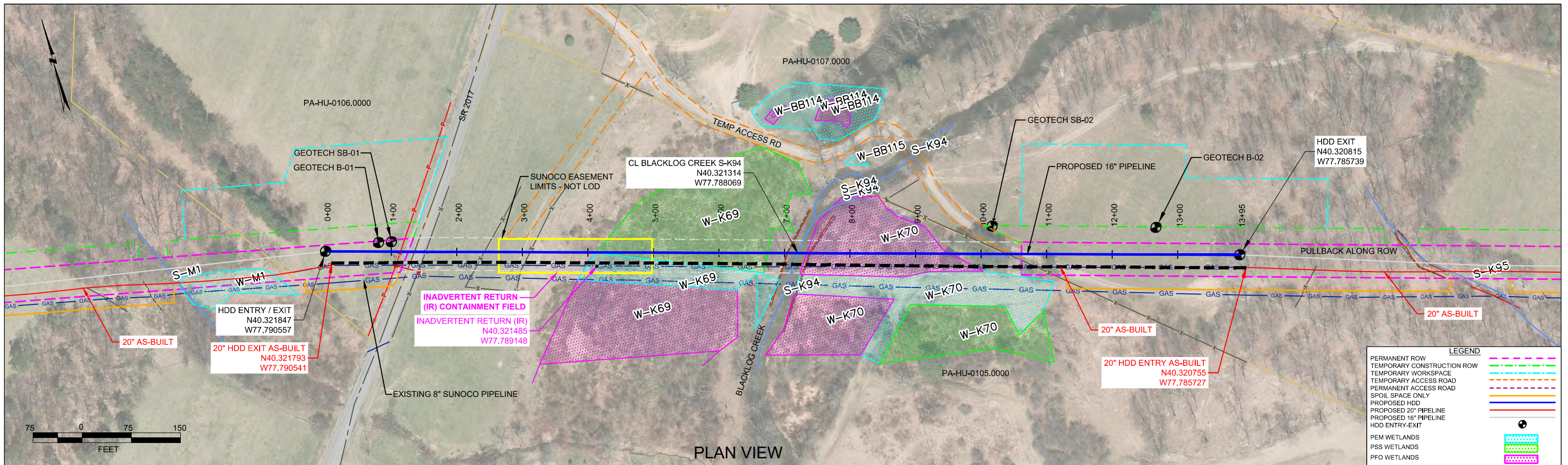
Figure 3 - Aerial Basemap
 Shirley Township, Huntingdon County, PA
 Project No. 096302011

0 500
Feet
1 inch = 500 feet

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REVIEW

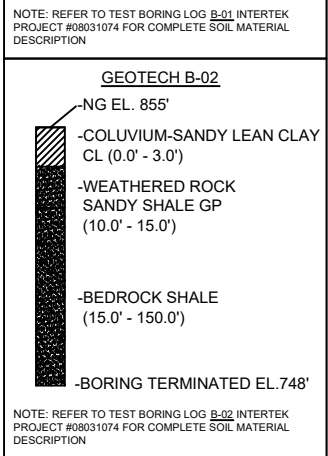
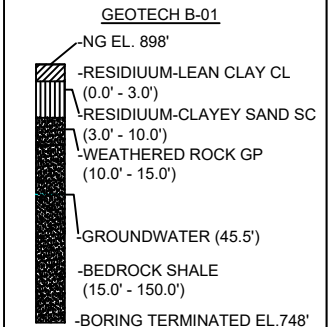
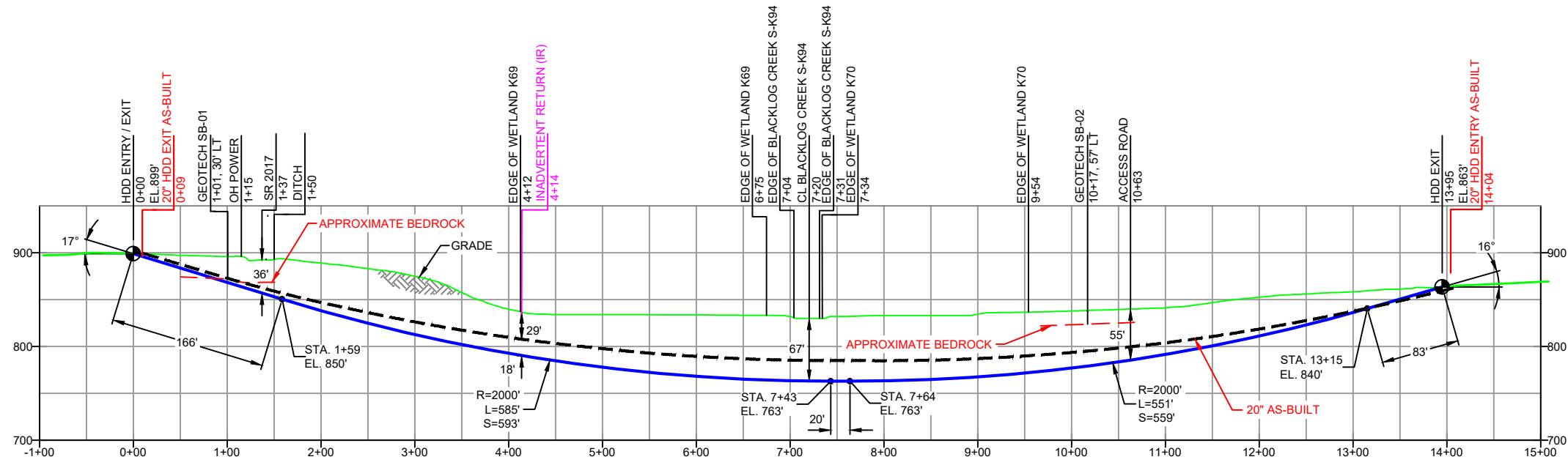
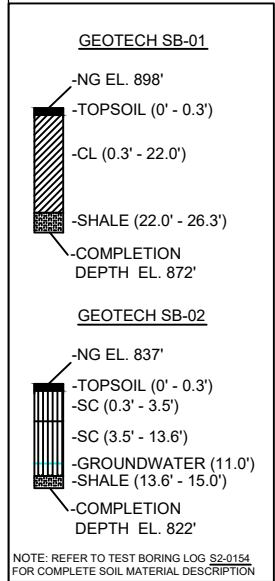
**ATTACHMENT 1
HDD PROFILES AND GEOTECHNICAL BORING LOGS**



PLAN VIEW

HUNTINGDON COUNTY PENNSYLVANIA, SHIRLEY TOWNSHIP
S2-0154-16

PROFILE VIEW



- DESIGN AND CONSTRUCTION:
- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
 - THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
 - DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
 - CROSSING PIPE SPECIFICATION:
HDD HORZ. LENGTH (L=): 1395'
HDD PIPE LENGTH (S=): 1421'
16" x 0.438" W.T., X-70, API6L, PSL2, ERW, BFW
COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
 - INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50).
 - INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
 - PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
 - CARRIER PIPE NOT ENCASED.
 - PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
 - CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 2625 PSIG.
 - SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
 - SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
 - SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

- ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
- STATIONING IS BASED ON HORIZONTAL DISTANCES.
- ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP. FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
- CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
- SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING		REVISIONS	
ES-3.73	TO	ES-3.73	DESCRIPTION
		EP7	DESIGN CHANGE PER DPS
		EP6	ADDED LOD IR CONTAINMENT FIELD BOUNDARY
		EP5	UPDATED NOTE 5 AND 10 PER INCREASED 16" MOP
		EP4	MODIFIED ATWS PER LAND ACQUISITION
		EP3	RELOCATED DRILL ENTRY/EXIT - DESIGN PER MICHELS
		EP2	REVISED PER PADEP COMMENTS RECIVED 09-06-16
DWG NO	DWG NO	NO.	DESCRIPTION

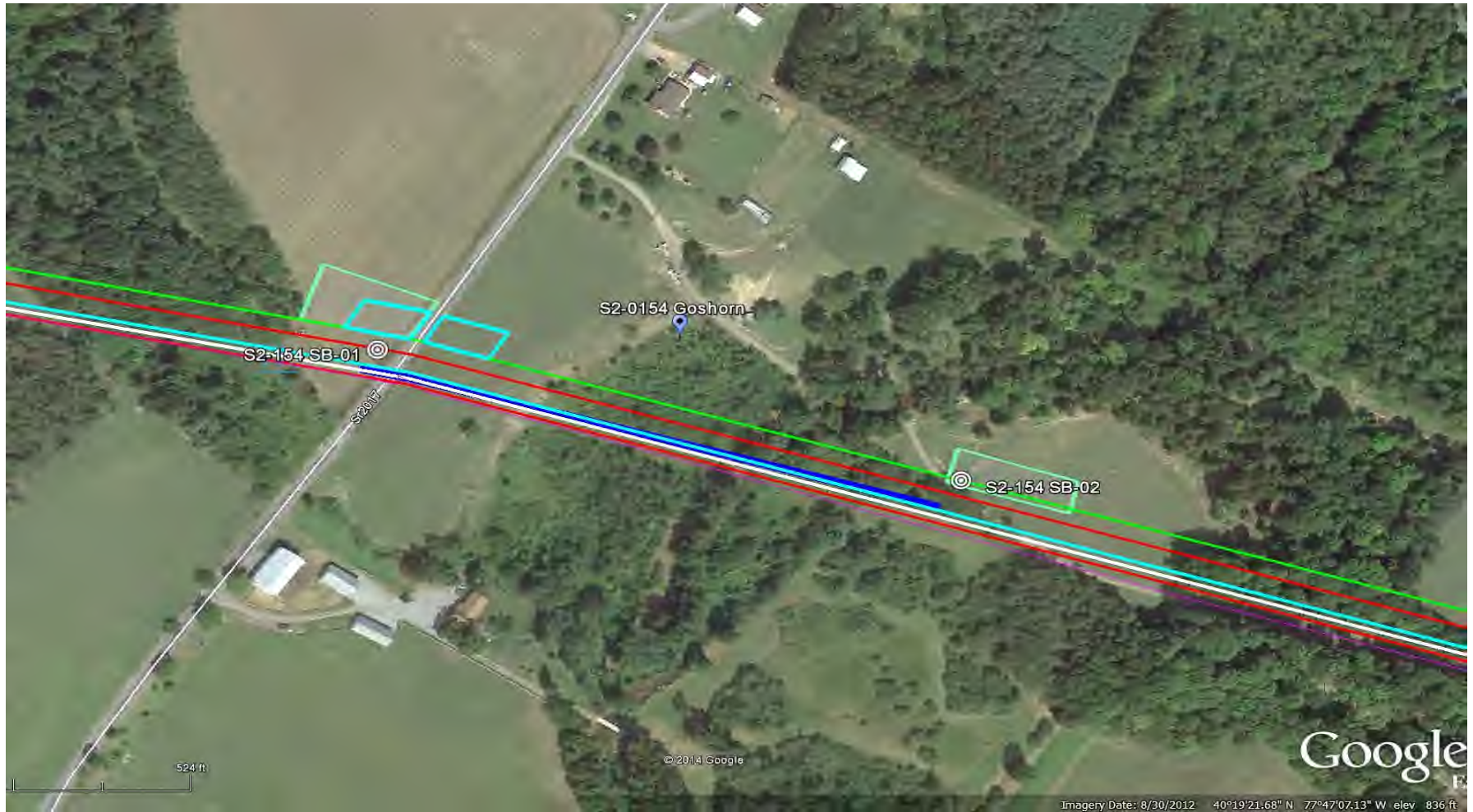
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
SR 2017
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'
DWG. NO. PA-HU-0106.0000-RD-16



LEGEND:

⊙ Geotechnical Soil Boring (SB) Locations



TETRA TECH

GEOTECHNICAL BORING LOCATIONS

HDD S2-0154

HUNTINGDON COUNTY, SHIRLEY TOWNSHIP, PA

SUNOCO PENNSYLVANIA PIPELINE PROJECT



TETRA TECH

240 Continental Drive, Suite 200
 Newark, Delaware 19713
 302.738.7551
 fax: 302.454.5988

TEST BORING LOG

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: 16443 BLACKLOG VALLEY ROAD, ORBISONIA, PA			Page 1 of 1		
HDD No.: S2-0154		Dates(s) Drilled: 10-12-14		Inspector: E. WATT	
Boring No.: SB-02		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 11.0		Total Depth (ft): 25.0	

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (ft)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
	From	To	From	To								
			0.0	0.3			TOPSOIL (4").					
1	3.0	5.0	0.3	3.5	21	SC	BROWN AND GRAY CLAYEY FINE TO MEDIUM SAND (USCS: SC).	5	10	14	16	24
2	8.0	10.0	3.5		17	SC	DR WEATHERED TO A VARI-COLORED FINE TO MEDIUM SAND, WITH	4	21	30	28	51
				13.6			SOME SILTY CLAY, AND A LITTLE FINE SANDSTONE GRAVEL.					
3	13.0	13.9	13.6	15.0	9		PARTIALLY WEATHERED GRAY TO GREENISH GRAY SHALE.	5	50/5"			>50
							AUGER REFUSAL AT 15.0'.					
							<u>ROCK CORING</u>					
RUN 1	15.0	20.0			42	ROCK	HIGHLY FRACTURED DARK GRAY SHALE WITH PYRITE DEPOSITS.	TCR: 70%, SCR: 2%, RQD: 0%				
RUN 2	20.0	25.0			48		HIGHLY FRACTURED DARK GRAY SHALE WITH PYRITE DEPOSITS,	TCR: 80%, SCR: 8%, RQD: 0%				
							WITH CALCITE DEPOSITS AT 24.4', 24.5', AND 24.7'.					
							WET TON SPOON AT 11'					
							WATER LEVELS THROUGH AUGERS AT 13.5'					
							CAVED AT 15'.					

Notes/Comments:
Pocket Pentrometer Testing DR: DECOMPOSED ROCK
 S1: .4 TSF

Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
 N: Number of blows to drive spoon from 6" to 18" interval.

**GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0154**

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.)		Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318)			USCS Classif. (ASTM D2487)
			From	To			Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	
S2-0154	SB-01	1	3.0	5.0	20.2	63.2	-	-	-	-
		2	8.0	10.0	14.3	74.0	31	20	11	CL
		3	13.0	14.5	13.4	72.8	32	21	10	CL
		6	26.0	26.3	3.8	23.6	-	-	-	-
	SB-02	1	3.0	5.0	11.2	41.9	28	18	10	SC
		2	8.0	10.0	14.4	28.6	-	-	-	-
		3	13.0	13.9	9.0	23.2	-	-	-	-

Notes:

- 1) Sample depths based on feet below grade at time of exploration.

**REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0154**

HDD No.	NAME	BORING NO.	REGIONAL GEOLOGY DESCRIPTION	GENERAL TOPOGRAPHIC SETTING	BEDROCK FORMATION	GENERAL ROCK TYPE	APPROX MAX FM THICKNESS (FT)	DEPTH TO ROCK (Ft bgs) based on nearby well drilling logs	NOTES / COMMENTS
S2-0154	Goshorn	SB-01	Reedsville Formation - consists of dark-gray shale containing thin sandy to silty shale and siltstone interbeds, and it has an upper fossiliferous sandstone.	Rolling hills (ridge & valley)	Reedsville Fm.	Shale-siltstone		18-59	
		SB-02							

Note : Source of well log data - <http://www.dcnr.state.pa.us/topogeo/groundwater/pagwis/records/index.htm>. All other sources as referenced in comments section.

**ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0154**

Location	Boring No.	Core Run	Core Depth (ft)		TCR (%)	SCR (%)	RQD (%)	Depth (ft)		Weathering	Classification	Bedding Thickness (ft)	Color	Discontinuity Data
			From	To				From	To					
S2-0154	SB-2	1	15	20	70	1.6	0	15	20	Slight	Limestone	Massive	Gray to Dark Gray	Heavily fractured, significant mechanical fracturing, wildly varying dip angles in range of 0° to 60°
S2-0154	SB-2	2	20	25	80	8	0	20	25	Slight	Limestone	Massive	Gray to Dark Gray	Heavily fractured, significant mechanical fracturing, Avg. Dip 45°, calcite filling of some thin fractures

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

<u>Density</u>	<u>N (blows)*</u>
Very Loose	5 or less
Loose	6 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	51 or more

Particle Size Identification

Boulders	8 in. diameter or more
Cobbles	3 to 8 in. diameter
Gravel	Coarse (C) 3 in. to ¾ in. sieve Fine (F) ¾ in. to No. 4 sieve
Sand	Coarse (C) No. 4 to No. 10 sieve (4.75mm-2.00mm) Medium (M) No. 10 to No. 40 sieve (2.00mm – 0.425mm) Fine (F) No. 40 to No. 200 sieve (0.425 – 0.074mm)
Silt/Clay	Less Than a No. 200 sieve (<0.074mm)

Relative Proportions

<u>Description Term</u>	<u>Percent</u>
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

COHESIVE SOILS

(Silt, Clay & Combinations)

<u>Consistency</u>	<u>N (blows)*</u>
Very Soft	3 or less
Soft	4 to 5
Medium Stiff	6 to 10
Stiff	11 to 15
Very Stiff	16 to 30
Hard	31 or more

Plasticity

<u>Degree of Plasticity</u>	<u>Plasticity Index</u>
None to Slight	0 - 4
Slight	5 - 7
Medium	8 - 22
High to Very High	> 22

ROCK

(Rock Cores)

<u>Rock Quality Designation (RQD), %</u>	<u>Rock Quality Description</u>
0-25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
90-100	Excellent

***N - Standard Penetration Resistance.** Driving a 2.0" O.D., 1-3/8" I.D. sampler a distance of 18 inches into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. The number of hammer blows to drive the sampler through each 6 inch interval is recorded; the number of blows required to drive the sampler through the final 12 inch interval is termed the Standard Penetration Resistance (SPR) N-value. For example, blow counts of 6/8/9 (through three 6-inch intervals) results in an SPR N-value of 17 (8+9).

Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

UNIFIED SOIL CLASSIFICATION SYSTEM [Casagrande (1948)]

Major Divisions		Group Symbols	Typical Descriptions	Laboratory Classifications			
Coarse Grained Soils (More than half of material is larger than No. 200 sieve)	Gravels More than half of coarse fraction is larger than No. 4 sieve size	Clean gravel (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3 Not meeting C_u or C_c requirements for GW		
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines			
		Gravel with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below A Line or I_p less than 4 Atterberg limits above A line with I_p greater than 7	Limits plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols	
			GC	Clayey gravels, gravel-sand-clay mixtures			
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Clean sands (Little or no fines)	SW	Well graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3 Not meeting C_u or C_c requirements for SW		
			SP	Poorly graded sands, gravelly sands, little or no fines			
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures	Atterberg limits below A Line or I_p less than 4 Atterberg limits above A line with I_p greater than 7	Limits Plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols	
			SC	Clayey sands, sand-clay mixtures			
		Determine Percentage of sand and gravel from grain size curve. Depending on Percentage of fines (fraction smaller than No. 200 sieve), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP More than 12 percent GM, GC, SM, SC 5 to 12 percent Borderline cases requiring dual symbols ⁽¹⁾					
		Major Divisions		Group Symbols	Typical Descriptions	For soils plotting nearly on A line use dual symbols i.e., $I_p = 29.5$, $w_L = 60$ gives CH-MH. When w_L is near 50 use CL-CH or ML-MH. Take near as ± 2 percent.	
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silt and clays (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				
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays				
		OL	Organic silts and organic silty clays of low plasticity				
	Silt and Clays (Liquid limit greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts				
		CH	Inorganic clays of high plasticity, fat clays				
		OH	Organic clays of medium to high plasticity, organic silts				
	Highly organic soils	Pt	Peat and other highly organic soils				

(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example GW-GC. well-graded gravel-sand mixture with clay binder.

Figure 1: Site Vicinity Plan

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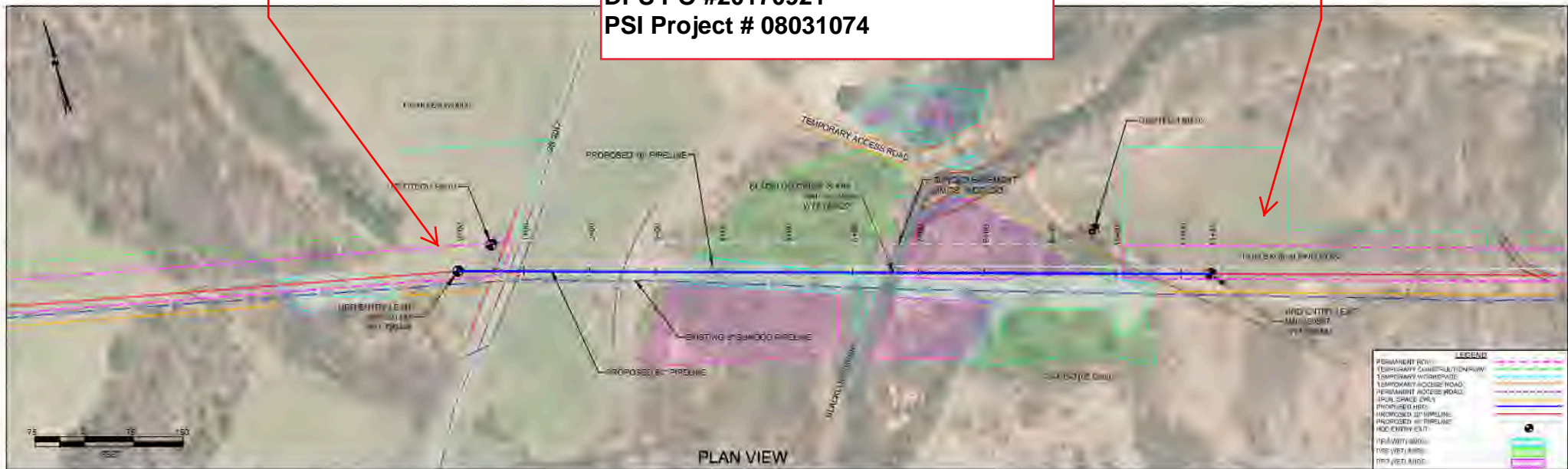
Visit us at <http://www.dcnr.state.pa.us>



**GEO BORE #1
(150 FT)**

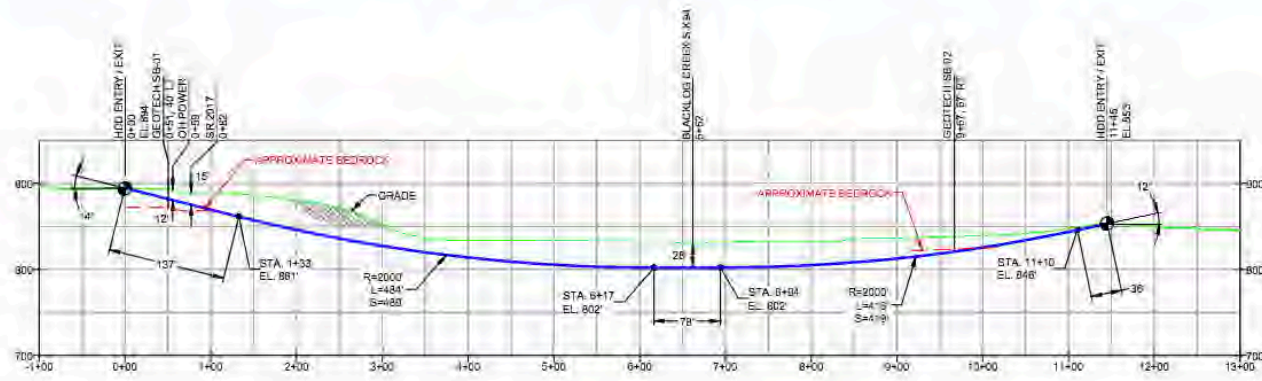
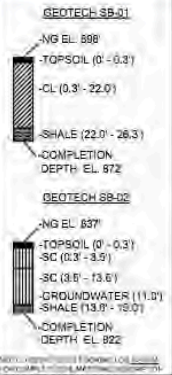
**FIGURE 2: Boring Location Plan
SR 2017 - PPP3
DPS PO #20170921
PSI Project # 08031074**

**GEO BORE #2
(150 FT)**



PLAN VIEW
PROFILE VIEW

HUNTINGDON COUNTY PENNSYLVANIA, SHIRELY TOWNSHIP
S22164



DESIGN AND CONSTRUCTION:
 1. CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE PENNSYLVANIA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION, LATEST EDITION.
 2. THE MINIMUM BERMATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET UNLESS OTHERWISE SPECIFIED BY THE DESIGNER.
 3. EXISTING UTILITIES SHALL BE PROTECTED AND MAINTAINED THROUGHOUT CONSTRUCTION.
 4. CROSSING PIPE BERMATION SHALL BE 12 INCHES WIDE AND 12 INCHES HIGH.
 5. THE PIPE SHALL BE PROTECTED BY A 12 INCH CONCRETE CURB AND 12 INCH GRANULAR FILL.
 6. THE PIPE SHALL BE PROTECTED BY A 12 INCH CONCRETE CURB AND 12 INCH GRANULAR FILL.
 7. THE PIPE SHALL BE PROTECTED BY A 12 INCH CONCRETE CURB AND 12 INCH GRANULAR FILL.
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 10. THE PIPE SHALL BE PROTECTED BY A 12 INCH CONCRETE CURB AND 12 INCH GRANULAR FILL.

REVISIONS:
 1. REVISION 1: REVISED PROFILE WITH 2017 LDR.
 2. REVISION 2: REVISED PERMITS/ENGINEERING COMMENTS.
 3. REVISION 3: REVISED PROPOSED CONSTRUCTION.

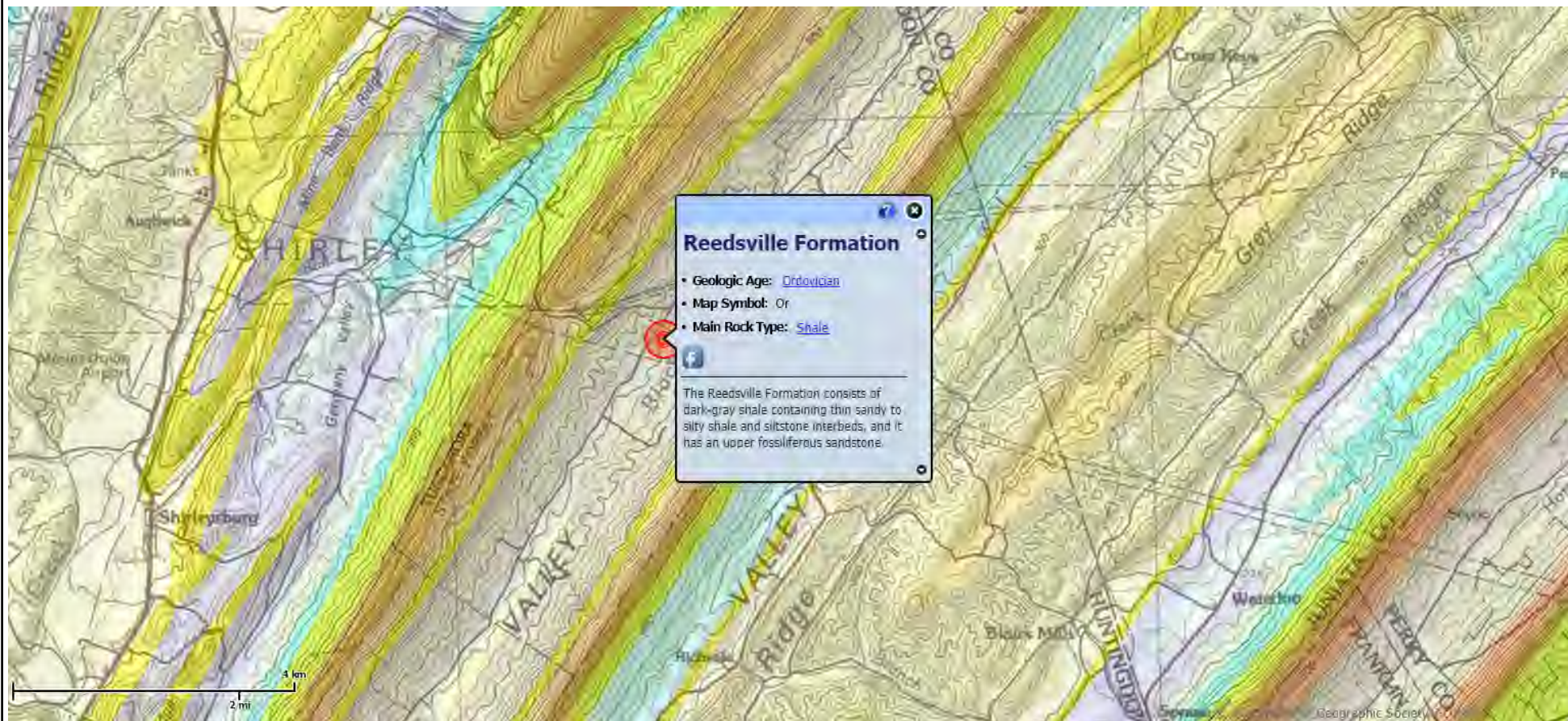
NOTES:
 1. ALL COORDINATES SHOWN ARE NAD 83 LATITUDE AND LONGITUDE (ALL IN FEET) UNLESS OTHERWISE NOTED.
 2. EXISTING UTILITIES SHOWN ARE BASED ON RECENT SURVEYS. THE INFORMATION SHOWN HEREON IS FOR INFORMATION ONLY AND IS NOT TO BE USED FOR CONSTRUCTION. ANY DAMAGE TO EXISTING UTILITIES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
 3. CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE PENNSYLVANIA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION, LATEST EDITION.
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NO.	DATE	BY	CHKD	APP	DATE	DESCRIPTION																													
1	02/21/17	RAM	QAD	QAD	02/21/17	REVISED PROFILE WITH 2017 LDR.																													
2	02/23/17	RAM	QAD	AW	02/23/17	REVISED PERMITS/ENGINEERING COMMENTS.																													
3	02/23/17	AW	QAD	AW	02/23/17	REVISED PROPOSED CONSTRUCTION.																													

Figure 3: Site Geology Plan

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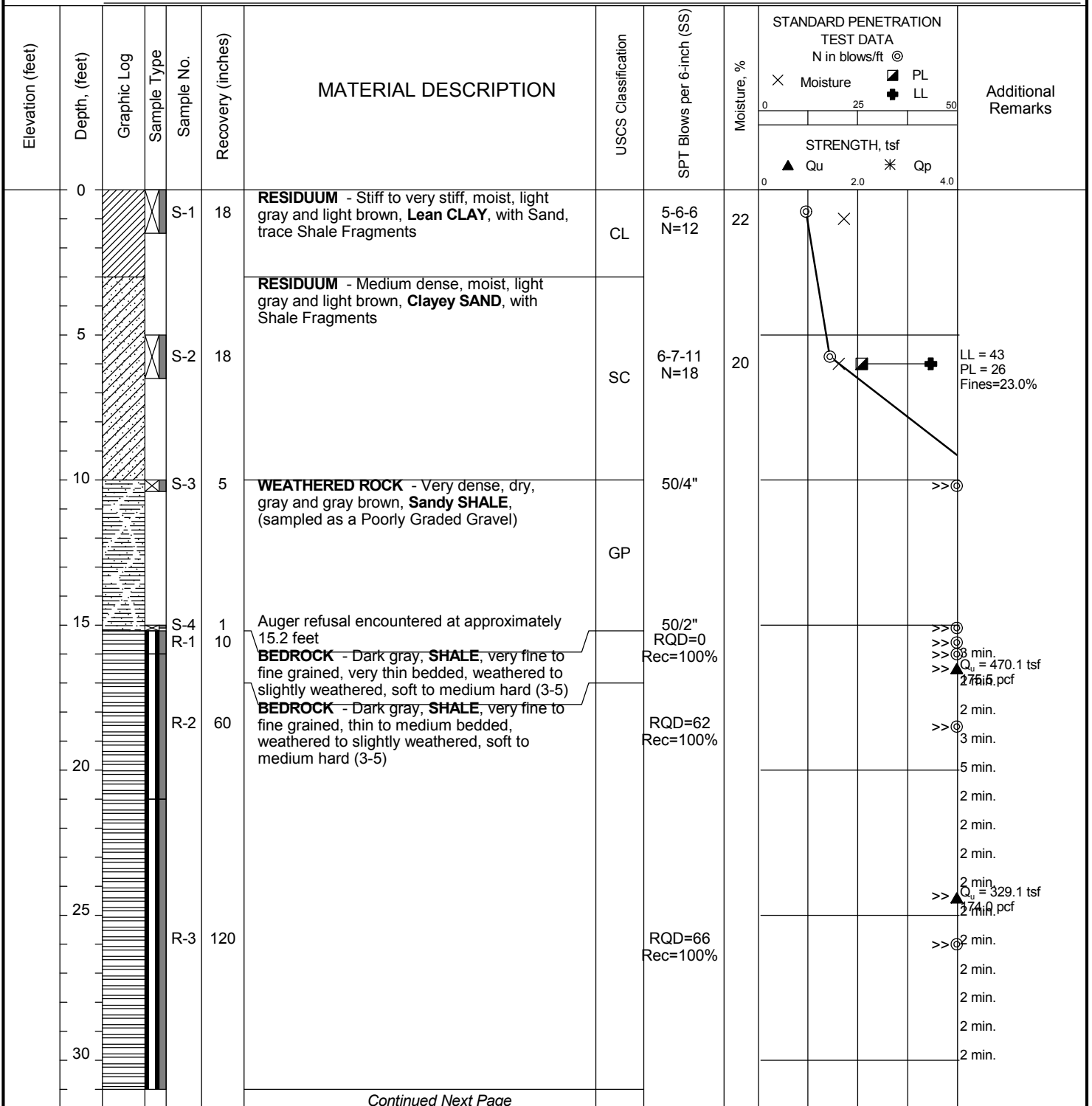


DATE STARTED: 9/27/17 **DRILL COMPANY:** PSI, Inc.
DATE COMPLETED: 9/28/17 **DRILLER:** R. Weaver **LOGGED BY:** C. Lehman
COMPLETION DEPTH: 150.0 ft **DRILL RIG:** CME 55x300
BENCHMARK: N/A **DRILLING METHOD:** Hollow Stem Auger
ELEVATION: N/A **SAMPLING METHOD:** SS, 3' Centers
LATITUDE: _____ **HAMMER TYPE:** Automatic
LONGITUDE: _____ **EFFICIENCY:** N/A
STATION: N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette
REMARKS: _____

BORING B-01

Water
 ▽ Pre-Core None Enc.
 ▽ Upon Completion 45.5 feet
 ▽

BORING LOCATION:
 Refer to Boring Location Plan



Continued Next Page

Professional Service Industries, Inc.
 850 Poplar Street
 Pittsburgh, PA 15220
 Telephone: (412) 922-4000

PROJECT NO.: 08031074
PROJECT: Energy Transfer HDD (DPS)
LOCATION: SR-2017 (PPP3)
 Huntingdon Co., PA
 PA-HU-0106.0000-RD/PO#20170921

DATE STARTED: 9/27/17 **DRILL COMPANY:** PSI, Inc.
DATE COMPLETED: 9/28/17 **DRILLER:** R. Weaver **LOGGED BY:** C. Lehman
COMPLETION DEPTH: 150.0 ft **DRILL RIG:** CME 55x300
BENCHMARK: N/A **DRILLING METHOD:** Hollow Stem Auger
ELEVATION: N/A **SAMPLING METHOD:** SS, 3' Centers
LATITUDE: _____ **HAMMER TYPE:** Automatic
LONGITUDE: _____ **EFFICIENCY:** N/A
STATION: N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette
REMARKS: _____

BORING B-01

Water	▽	Pre-Core	None Enc.
	▼	Upon Completion	45.5 feet
	▽		

BORING LOCATION:
 Refer to Boring Location Plan

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STRENGTH, tsf	Additional Remarks
						BEDROCK - Dark gray, SHALE , very fine to fine grained, thin to thick bedded, weathered to slightly weathered, soft to medium hard (3-5)					
65				R-7	120			RQD=92 Rec=100%			3 min. 2 min. >> $Q_u = 599.6$ tsf 176.2 pcf 2 min.
70						Vertical fracture from 72.7 to 74.1 feet					2 min. 2 min. 2 min. 2 min. 2 min. 2 min.
75				R-8	120			RQD=72 Rec=100%			>> $Q_u = 398.3$ tsf 176.7 pcf 2 min.
80											2 min. 2 min. 2 min. 2 min.
85				R-9	120	Vertical fracture from 86 to 87 feet		RQD=80 Rec=100%			>> $Q_u = 294.8$ tsf 174.4 pcf 2 min.
90											1 min. 2 min. 2 min. 2 min. 1 min. 2 min. 2 min.

Continued Next Page

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LOCATION: SR-2017 (PPP3)
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DATE STARTED: 9/27/17 **DRILL COMPANY:** PSI, Inc.
DATE COMPLETED: 9/28/17 **DRILLER:** R. Weaver **LOGGED BY:** C. Lehman
COMPLETION DEPTH: 150.0 ft **DRILL RIG:** CME 55x300
BENCHMARK: N/A **DRILLING METHOD:** Hollow Stem Auger
ELEVATION: N/A **SAMPLING METHOD:** SS, 3' Centers
LATITUDE: **HAMMER TYPE:** Automatic
LONGITUDE: **EFFICIENCY:** N/A
STATION: N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette
REMARKS:

BORING B-01

Water
 ▽ Pre-Core None Enc.
 ▼ Upon Completion 45.5 feet
 ▼

BORING LOCATION:
 Refer to Boring Location Plan

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STRENGTH, tsf	Additional Remarks
125			R-13	116		BEDROCK - Dark gray, SHALE , very fine to fine grained, very thin bedded, weathered to slightly weathered, medium to moderately hard (4-6)		RQD=27 Rec=97%		244.8 tsf 175.2 pcf 2 min. >> 6 min. 7 min. 2 min. 2 min. 2 min. 2 min. 2 min. 2 min. 5 min.	
130			R-14	120		Highly broken from 136.4 to 137.2 feet		RQD=63 Rec=100%		2 min. >> 2 min. 2 min. 2 min. 2 min. 2 min. 2 min. 2 min. 2 min. 2 min. 2 min. 2 min.	
135			R-15	108				RQD=100 Rec=100%		287.9 tsf 177.1 pcf 2 min. >> 1 min. 2 min. 2 min. 2 min. 2 min.	
140											
145											
150						Boring terminated at approximately 150 feet					

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PROJECT: Energy Transfer HDD (DPS)
LOCATION: SR-2017 (PPP3)
 Huntingdon Co., PA
 PA-HU-0106.0000-RD/PO#20170921

08031074
SR2017
PPPS
B-1

REF-CORE DRY

Box Lot -
912717

Run	Depth	Ree	R2D
R-1	15.2 - 16.0	0.8	0.0
2	16.0 - 21.0	5.0	3.1
3	21.0 - 31.0	10.0	6.6

TOP

16.0

16.0



2031074
SPAC
OPN-2
5
PAC-100

9-21-15

RUN	DEPTH	REC	LAB
3	31.0-41.0	10.0	G 6
4	31.0-41.0	10.0	B 8
5	41.0-51.0	10.0	97



00740711

7-28-17

5-1
FPP-3
SR 2017

RUN	DEPTH	QEC	ROD
5	41.0-51.0	10.0	9.7
6	51.0-61.0	10.0	9.6



08031074
SR 2097
PPPS
B-1
Box 4 of
9/29/17

Run	Depth	Rm.	R0D
R-6	51.0-61.0	10.0	9.6
R-7	61.0-71.0	10.0	9.2
R-8	71.0-81.0	10.0	7.2

TOP

61.0

0

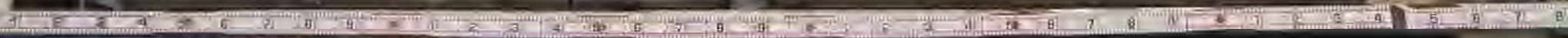


08031074
50207
P223
B-1
Box 5 of
9/25/17

Run	Depth	Rc	RQB
R-8	21.0 - 31.0	10.0	2.2
R-9	31.0 - 41.0	10.0	5.0

TOP

01B



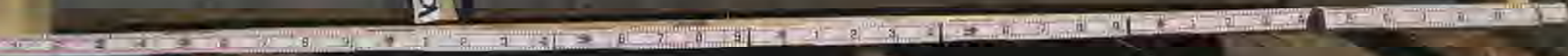
D8031074
SR2012
PPP3
B-1
Box 6 of 7
9/28/12

Run	Depth	R ₁	R ₂
R-9	81.0-91.0	10.0	9.0
R-10	91.0-101.0	10.0	9.6
R-11	101.0-111.0	10.0	9.4

TOP

91.0

101.0



08031024
SR 2017
PPP3
B-1
Box 3 of -
9/29/17

Run	Depth	Rec.	PROD.
R-11	101.0-111.0	10.0	9.4
R-12	111.0-121.0	10.0	9.4

TOP

111.0



06031074
SR2012
PPP3
B-1
Box 5 of 5
9/26/17

Run	Depth	Per	ROD
R-12	111.0-121.0	10.0	8.4
R-13	121.0-131.0	9.7	2.2
R-14	131.0-141.0	10.0	6.3

TOP

121.0

131.0



08031074
SR2017
PPP3
B-1
Box 9 of -
9/28/17

Run	Depth	Box	ACC
R-14	181.0-191.0	10.0	6.3
R-15	191.0-190.0	9.0	5.0

TOT

M10



08031074
SR 2017
PPF3
B-1
Box 2 of 10
9/23/17

Run	Dash	Run	Rad
R-15	141.0-150.0	9.0	9.0
EDB			

Top

150.0



DATE STARTED: 9/29/17
 DATE COMPLETED: 10/2/17
 COMPLETION DEPTH: 150.0 ft
 BENCHMARK: N/A
 ELEVATION: N/A
 LATITUDE:
 LONGITUDE:
 STATION: N/A OFFSET: N/A
 REMARKS:

DRILL COMPANY: PSI, Inc.
 DRILLER: R. Weaver LOGGED BY: C. Lehman
 DRILL RIG: CME 55x300
 DRILLING METHOD: Hollow Stem Auger
 SAMPLING METHOD: SS, 3' Centers
 HAMMER TYPE: Automatic
 EFFICIENCY: N/A
 REVIEWED BY: S. Simonette

BORING B-02
 Water: ▽ Pre-Core None Enc.
 ▽ Upon Completion feet
 ▽

BORING LOCATION:
 Refer to Boring Location Plan

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STRENGTH, tsf	Additional Remarks
0				S-1	18	COLLUVIUM - Stiff, moist, light brown, Sandy Lean CLAY , trace Shale Fragments	CL	6-6-8 N=14	15		LL = 49 PL = 33 Fines=51.8%
5				S-2	17		CL	6-8-15 N=23	18		
10				S-3	17	WEATHERED ROCK - Very dense, dry, light brown and gray brown, Sandy SHALE , (sampled as a Poorly Graded Gravel)	GP	16-36-50/4"			
15				S-4	5	WEATHERED ROCK - Very dense, dry, gray, Sandy SHALE , (sampled as a Poorly Graded Gravel)	GP	50/4"			>>⊙
				R-1	18	Auger refusal encountered at approximately 15.4 feet		RQD=0 Rec=75%			>>⊙ 2 min. >>⊙ 3 min.
				R-2	29	BEDROCK - Dark gray, SHALE , very fine to fine grained, very thin bedded, weathered, medium hard (3-4)		RQD=0 Rec=92%			>>⊙ 2 min. >>⊙ 3 min.
				R-3	28			RQD=13 Rec=77%			>>⊙ 2 min. >>⊙ 2 min. >>⊙ 2 min.
				R-4	36	BEDROCK - Dark gray, SHALE , very fine to fine grained, very thin to medium bedded, weathered, medium to moderately hard (4-6)		RQD=87 Rec=100%			>>⊙ 2 min. >>⊙ 2 min. >>⊙ 2 min.
				R-5	54			RQD=52 Rec=90%			>>⊙ 1 min. >>⊙ 1 min. >>⊙ 3 min.

Continued Next Page

Professional Service Industries, Inc.
 850 Poplar Street
 Pittsburgh, PA 15220
 Telephone: (412) 922-4000

PROJECT NO.: 08031074
 PROJECT: Energy Transfer HDD (DPS)
 LOCATION: SR-2017 (PPP3)
 Huntingdon Co., PA
 PA-HU-0106.0000-RD/PO#20170921



DATE STARTED: 9/29/17 **DRILL COMPANY:** PSI, Inc.
DATE COMPLETED: 10/2/17 **DRILLER:** R. Weaver **LOGGED BY:** C. Lehman
COMPLETION DEPTH: 150.0 ft **DRILL RIG:** CME 55x300
BENCHMARK: N/A **DRILLING METHOD:** Hollow Stem Auger
ELEVATION: N/A **SAMPLING METHOD:** SS, 3' Centers
LATITUDE: _____ **HAMMER TYPE:** Automatic
LONGITUDE: _____ **EFFICIENCY:** N/A
STATION: N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette
REMARKS: _____

BORING B-02

Water Pre-Core None Enc.
 Upon Completion feet

BORING LOCATION:
 Refer to Boring Location Plan

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STRENGTH, tsf	Additional Remarks	
						BEDROCK - Dark gray, SHALE , very fine to fine grained, very thin to medium bedded, weathered, medium to moderately hard (4-6)					N in blows/ft © X Moisture PL + LL 0 25 50 STRENGTH, tsf ▲ Qu * Qp 4.0 0 2.0 4.0	
	35			R-6	101			RQD=47 Rec=84%			>>▲ Q _u = 476.3 tsf 1 min. 169.8 pcf 1 min. 2 min. 1 min.	
	40					Vertical fracture from 41 to 42.2 feet						
	45			R-7	50	Broken from 44.1 to 46 feet		RQD=14 Rec=84%			>>▲ Q _u = 349.4 tsf 1 min. 169.8 pcf >>● 2 min. 2 min. 2 min. 2 min. 2 min.	
	50			R-8	60			RQD=92 Rec=100%			>>● 2 min. 2 min. 2 min.	
	55					BEDROCK - Dark gray, SHALE , very fine to fine grained, medium to very thick bedded, weathered, medium to moderately hard (4-6)					>>▲ Q _u = 508.3 tsf 1 min. 156.8 pcf 1 min.	
	60			R-9	120			RQD=100 Rec=100%			>>● 1 min. 1 min. 1 min. 1 min. 1 min.	
											>>▲ Q _u = 598.5 tsf	

Continued Next Page

Professional Service Industries, Inc.
 850 Poplar Street
 Pittsburgh, PA 15220
 Telephone: (412) 922-4000

PROJECT NO.: 08031074
PROJECT: Energy Transfer HDD (DPS)
LOCATION: SR-2017 (PPP3)
 Huntingdon Co., PA
 PA-HU-0106.0000-RD/PO#20170921

08031074
SR2077
PPP3
B-2
BOLL OF
9/27/77

Run	Depth	Rec	RSD
R-1	15.4 - 17.5	15	0.0
R-2	17.4 - 20.0	24	0.0
R-3	20.0 - 23.0	23	0.4
R-4	23.0 - 26.0	30	2.6
R-5	26.0 - 31.0	45	2.6
R-6	31.0 - 41.0	84	4.7

TOP

0.5
0.0



0.6

1.0

06031074
SR2017
PPP3
B-2
Box 2 of
10/2/17

Run	Depth	Rec.	ROD
R-6	31.0-41.0	8.4	4.7
R-7	41.0-46.0	4.2	0.7
R-8	46.0-51.0	5.0	4.6

TOP



41.0

46.0

06031074
SR2017
PPP3
B-2
Box 3 of _
10/21/17

Run	Depth	Rec	ROD
R-8	46.0-51.0	5.0	4.6
R-9	51.0-61.0	10.0	10.0
R-10	61.0-71.0	9.7	9.0

Top

510

610



08031074
SR2017
PPP3
B-2
Box 4 of -
101217

Run	Depth	R ₁₀	R ₂₀
R-10	61.0-71.0	9.7	9.0
R-11	71.0-81.0	10.0	10.0

TDP

71.0



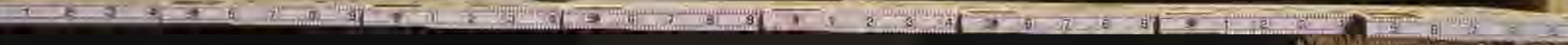
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SR 2017
DPP3
R-2
Box 5 of
10/3/17

Run	Depth	Rec.	RQD
R-11	21.0-81.0	10.0	10.0
R-12	81.0-91.0	9.8	3.6
R-13	91.0-101.0	10.0	9.9

TOP

018

019

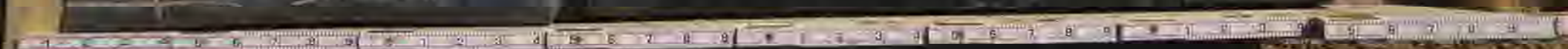


07031074
SR2013
PPP3
B-2
Box 6 of
1013117

Run	Depth	Res	RSD
R-13	91.0 - 101.0	10.0	9.9
R-14	101.0 - 111.0	10.0	10.0

TOP

101.0



09031074
SR 2017
PPP3
B-3
Box 3 of -
1093117

Run	Depth	Rec	RSD
R-14	101.0-111.0	10.0	10.0
R-15	111.0-121.0	10.0	10.0
R-16	121.0-131.0	9.9	7.9

TOP

110

110

121.0



080317H
SRS07
PPP3
B-2
Box 3 of 4
10/3/17

Run	Depth	Rec.	RQD
R-16	121.0-131.0	9.9	7.9
R-17	131.0-141.0	10.0	7.9

TOP



131.0



09031074
SE 22073
PP93
B-2
Box 2 of
10/117

Run	Depth	Rec	ROD
R-17	131.0 - 141.0	10.0	79
R-18	141.0 - 150.0	9.0	88

TOP

141.0

150.0



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. | ☒ SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted. |
| HSA: Hollow Stem Auger - typically 3¼" or 4¼ I.D. openings, except where noted. | ■ ST: Shelby Tube - 3" O.D., except where noted. |
| M.R.: Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry | ▮ RC: Rock Core |
| R.C.: Diamond Bit Core Sampler | ⬇ TC: Texas Cone |
| H.A.: Hand Auger | ☞ BS: Bulk Sample |
| P.A.: Power Auger - Handheld motorized auger | ☒ 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_u: Unconfined compressive strength, TSF
- Q_p: 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

<u>Relative Density</u>	<u>N - Blows/foot</u>
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	50 - 80
Extremely Dense	80+

<u>Description</u>	<u>Criteria</u>
Angular:	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular:	Particles are similar to angular description, but have rounded edges
Subrounded:	Particles have nearly plane sides, but have well-rounded corners and edges
Rounded:	Particles have smoothly curved sides and no edges

GRAIN-SIZE TERMINOLOGY

<u>Component</u>	<u>Size Range</u>
Boulders:	Over 300 mm (>12 in.)
Cobbles:	75 mm to 300 mm (3 in. to 12 in.)
Coarse-Grained Gravel:	19 mm to 75 mm (¾ in. to 3 in.)
Fine-Grained Gravel:	4.75 mm to 19 mm (No.4 to ¾ in.)
Coarse-Grained Sand:	2 mm to 4.75 mm (No.10 to No.4)
Medium-Grained Sand:	0.42 mm to 2 mm (No.40 to No.10)
Fine-Grained Sand:	0.075 mm to 0.42 mm (No. 200 to No.40)
Silt:	0.005 mm to 0.075 mm
Clay:	<0.005 mm

PARTICLE SHAPE

<u>Description</u>	<u>Criteria</u>
Flat:	Particles with width/thickness ratio > 3
Elongated:	Particles with length/width ratio > 3
Flat & Elongated:	Particles meet criteria for both flat and elongated

RELATIVE PROPORTIONS OF FINES

<u>Descriptive Term</u>	<u>% Dry Weight</u>
Trace:	< 5%
With:	5% to 12%
Modifier:	>12%



GENERAL NOTES

(Continued)

CONSISTENCY OF FINE-GRAINED SOILS

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

MOISTURE CONDITION DESCRIPTION

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

RELATIVE PROPORTIONS OF SAND AND GRAVEL

<u>Descriptive Term</u>	<u>% Dry Weight</u>
Trace:	< 15%
With:	15% to 30%
Modifier:	>30%

STRUCTURE DESCRIPTION

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

SCALE OF RELATIVE ROCK HARDNESS

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

ROCK BEDDING THICKNESSES

<u>Description</u>	<u>Criteria</u>
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	½-inch to 1¼-inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to ½-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

ROCK VOIDS

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

GRAIN-SIZED TERMINOLOGY

(Typically Sedimentary Rock)

<u>Component</u>	<u>Size Range</u>
Very Coarse Grained	>4.76 mm
Coarse Grained	2.0 mm - 4.76 mm
Medium Grained	0.42 mm - 2.0 mm
Fine Grained	0.075 mm - 0.42 mm
Very Fine Grained	<0.075 mm

ROCK QUALITY DESCRIPTION

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

DEGREE OF WEATHERING

Slightly Weathered:	Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.
Weathered:	Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.

Degree of Brokenness

<u>Characteristic</u>	<u>Description</u>
Less than 1 inch	Very Broken
1 inch to 3 inches	Broken
3 inches to 6 inches	Slightly Broken
Greater than 6 inches	Massive

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.
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SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS


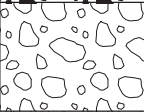
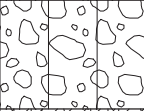
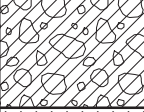
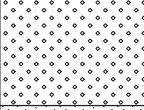
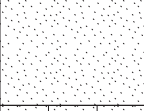
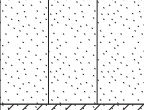
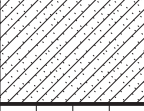
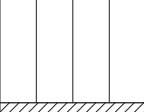
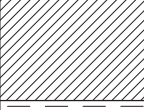
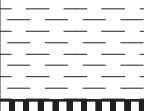


MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS		
			GRAPH	LETTER			
<p>COARSE GRAINED SOILS</p> <p>MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE</p>	<p>GRAVEL AND GRAVELLY SOILS</p>	<p>CLEAN GRAVELS</p> <p>(LITTLE OR NO FINES)</p>		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE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



Table 4-3 Hardness and unconfined compressive strength of rock materials

Hardness category	Typical range in unconfined compressive strength (MPa)	Strength value selected (MPa)	Field test on sample	Field test on outcrop
Soil*	< 0.60		Use USCS classifications	
Very soft rock or hard, soil-like material	0.60–1.25		Scratched with fingernail. Slight indentation by light blow of point of geologic pick. Requires power tools for excavation. Peels with pocket knife.	
Soft rock	1.25–5.0		Permits denting by moderate pressure of the fingers. Handheld specimen crumbles under firm blows with point of geologic pick.	Easily deformable with finger pressure.
Moderately soft rock	5.0–12.5		Shallow indentations (1–3 mm) by firm blows with point of geologic pick. Peels with difficulty with pocket knife. Resists denting by the fingers, but can be abraded and pierced to a shallow depth by a pencil point. Crumbles by rubbing with fingers.	Crumbles by rubbing with fingers.
Moderately hard rock	12.5–50		Cannot be scraped or peeled with pocket knife. Intact handheld specimen breaks with single blow of geologic hammer. Can be distinctly scratched with 20d common steel nail. Resists a pencil point, but can be scratched and cut with a knife blade.	Unfractured outcrop crumbles under light hammer blows.
Hard rock	50–100		Handheld specimen requires more than one hammer blow to break it. Can be faintly scratched with 20d common steel nail. Resistant to abrasion or cutting by a knife blade, but can be easily dented or broken by light blows of a hammer.	Outcrop withstands a few firm blows before breaking.
Very hard rock	100–250		Specimen breaks only by repeated, heavy blows with geologic hammer. Cannot be scratched with 20d common steel nail.	Outcrop withstands a few heavy ringing hammer blows but will yield large fragments.
Extremely hard rock	> 250		Specimen can only be chipped, not broken by repeated, heavy blows of geologic hammer.	Outcrop resists heavy ringing hammer blows and yields, with difficulty, only dust and small fragments.

Method used to determine consistency or hardness (check one):

Field assessment: _____ Uniaxial lab test: _____ Other: _____ Rebound hammer (ASTM D5873): _____

* See NEH631.03 for consistency and density of soil materials. For very stiff soil, SPT N values = 15 to 30. For very soft rock or hard, soil-like material, SPT N values exceed 30 blows per foot.

Laboratory Summary Sheet

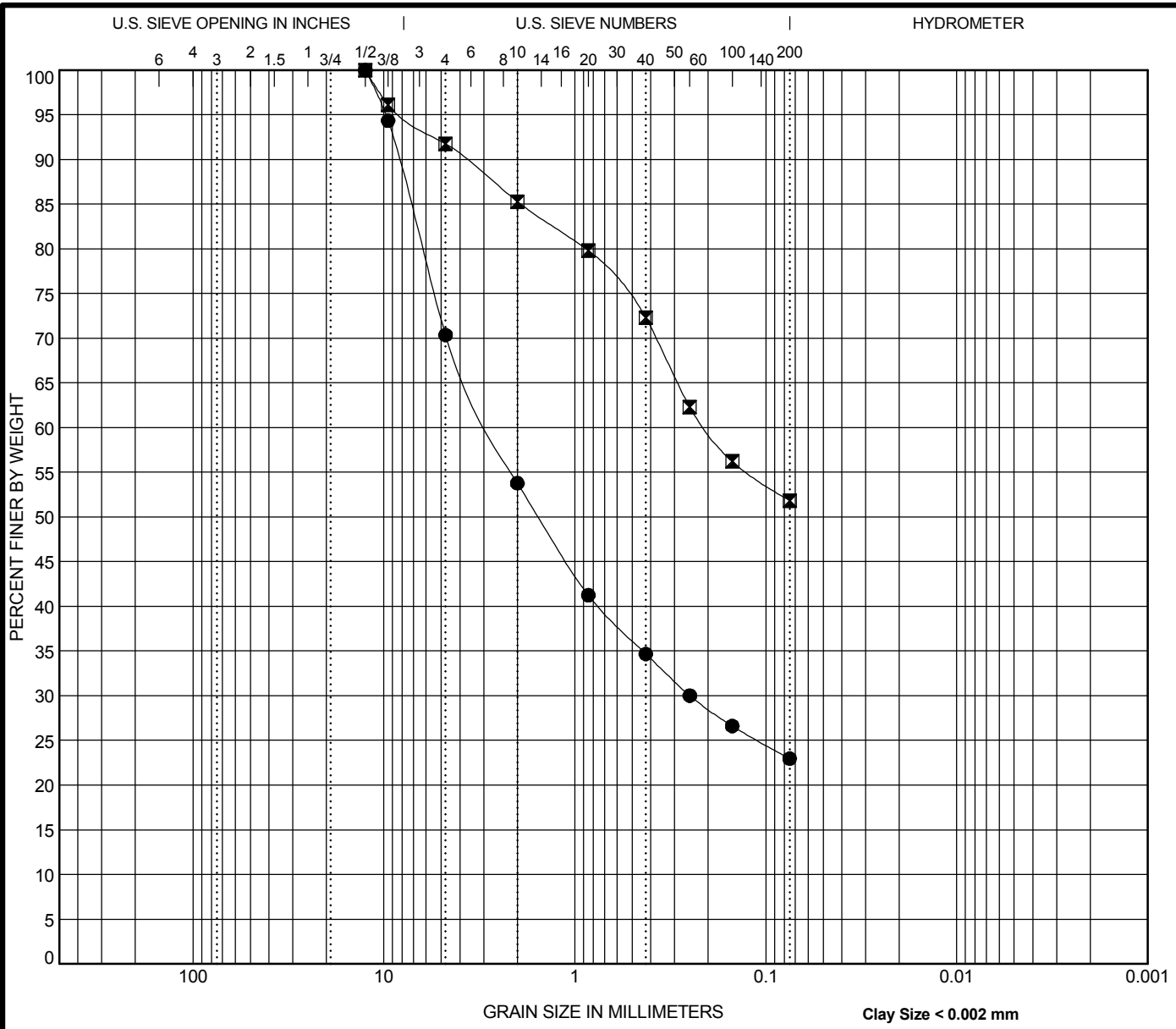
Sheet 1 of 1

Borehole	Approx. Depth	Liquid Limit	Plastic Limit	Plasticity Index	Qu (tsf)	%<#200 Sieve	Est. Specific Gravity	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-01	1							22			
B-01	6	43	26	17		23.0%		20			
B-01	16.5				470.12						
B-01	24.4				329.08						
B-01	34.3				257.72						
B-01	44.1				250.97						
B-01	54				426.96						
B-01	64.1				599.58						
B-01	73				398.28						
B-01	84				294.85						
B-01	94.4				560.53						
B-01	104.3				461.68						
B-01	114				442.15						
B-01	124				244.78						
B-01	137				441.67						
B-01	144				287.86						
B-02	1	49	33	16		51.8%		15			
B-02	6							18			
B-02	21.5				77.08						
B-02	31.3				476.31						
B-02	42.4				349.36						
B-02	52.4				508.32						
B-02	61.8				598.49						
B-02	72.1				395.66						
B-02	82.3				447.63						
B-02	91.7				296.45						
B-02	102.2				252.99						
B-02	112.2				462.51						
B-02	122.2				231.26						
B-02	132				626.80						
B-02	141.4				200.78						

Professional Service Industries
 850 Poplar Street
 Pittsburgh, PA 15220
 Telephone: (412) 922-4000
 Fax: (412) 922-4014

Summary of Laboratory Results

PSI Job No.: 08031074
 Project: SR2017 PPP3 Pipeline Huntingdon Co.
 Location: SR-2017
 Shirley Township
 Huntingdon Co., PA



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● B-01 6.0		43	26	17		
☒ B-02 1.0		49	33	16		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-01 6.0	12.5	2.767	0.25		29.6	47.4	23.0	
☒ B-02 1.0	12.5	0.206			8.2	39.9	51.8	

Professional Service Industries, Inc.
 850 Poplar Street
 Pittsburgh, PA 15220
 Telephone: (412) 922-4000
 Fax: (412) 922-4014

GRAIN SIZE DISTRIBUTION

Project: SR2017 PPP3 Pipeline Huntingdon Co.
 PSI Job No.: 08031074
 Location: SR-2017
 Shirley Township

Slake Test

08031074 B-1 R-2 17.1'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 5.06

Final Ph: 8.18

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-1 R-3 24.2'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 5.06

Final Ph: 7.95

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-1 R-4 34.0'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 5.06

Final Ph: 8.41

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-1 R-5 44.6'



Start



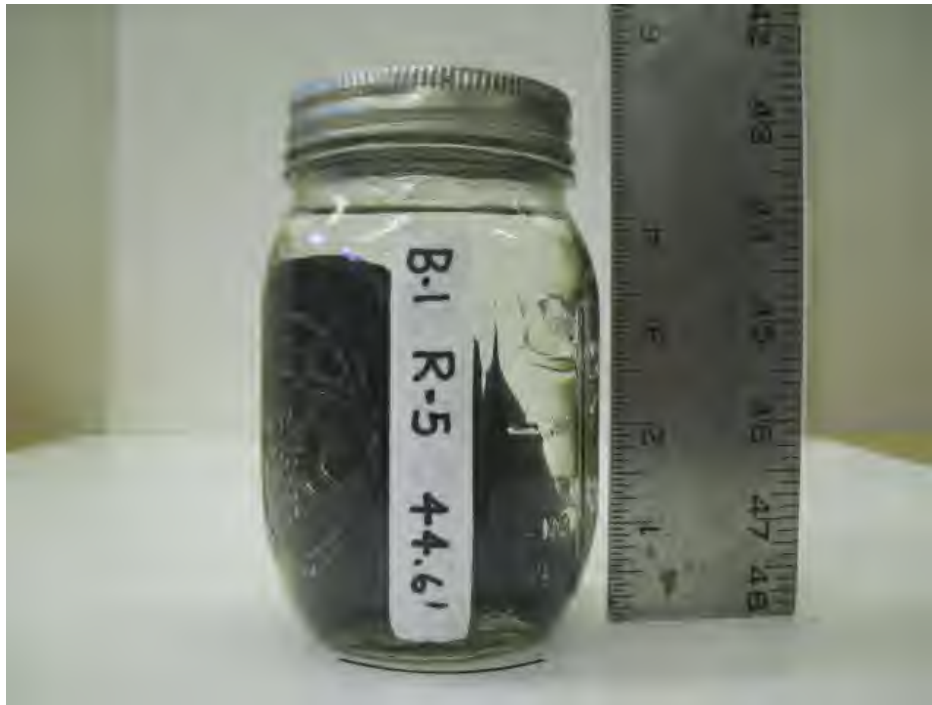
2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 5.06

Final Ph: 8.21

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-1 R-6 54.8'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 5.06

Final Ph: 8.48

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-1 R-7 64.0'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 5.06

Final Ph: 7.29

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-1 R-8 74.4'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 5.06

Final Ph: 7.55

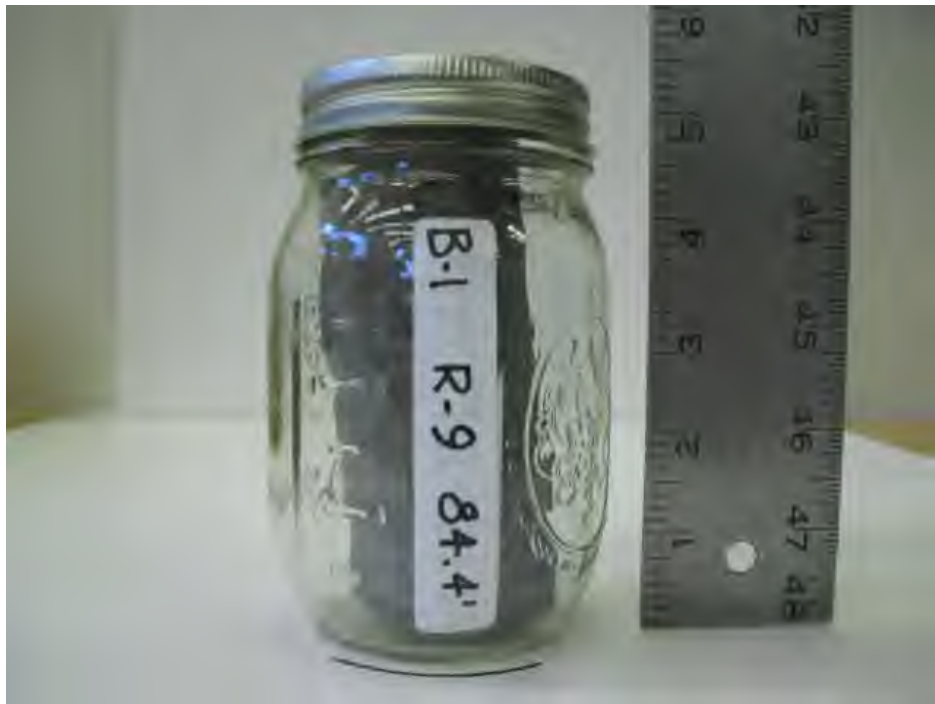
Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-1 R-9 84.4'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 5.06

Final Ph: 8.56

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-1 R-10 94.0'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 5.06

Final Ph: 8.59

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-1 R-11 104.0'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 5.06

Final Ph: 8.54

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-1 R-12 114.9'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 5.06

Final Ph: 8.21

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-1 R-13 124.4'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 5.06

Final Ph: 8.10

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-1 R-14 135.0'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 5.06

Final Ph: 6.86

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-1 R-15 144.4'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 3 & 4, 2017

Test Fluid: Distilled Water

Initial Ph: 4.96

Final Ph: 8.10

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-1 16.0'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.53

Final Ph: 6.30

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-3 22.1'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.53

Final Ph: 7.07

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-6 32.3'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.53

Final Ph: 8.03

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-7 42.9'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.53

Final Ph: 6.05

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-9 52.1'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.31

Final Ph: 8.26

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-10 62.3'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.31

Final Ph: 7.78

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-11 72.6'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.31

Final Ph: 8.41

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-12 82.7'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.31

Final Ph: 8.46

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-13 92.3'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.31

Final Ph: 8.31

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-14 101.7'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.31

Final Ph: 8.25

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-15 112.0'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.31

Final Ph: 8.13

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-16 122.7'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.31

Final Ph: 8.40

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-17 132.4'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.31

Final Ph: 8.43

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

Slake Test

08031074 B-2 R-18 142.3'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: October 10 & 11, 2017

Test Fluid: Distilled Water

Initial Ph: 5.31

Final Ph: 8.72

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

Jar Slake Index Descriptions

REVIEW

**ATTACHMENT 2
SOIL RESOURCES MAP AND PROFILE DESCRIPTIONS**



United States
Department of
Agriculture



Natural
Resources
Conservation
Service

A product of the National
Cooperative Soil Survey,
a joint effort of the United
States Department of
Agriculture and other
Federal agencies, State
agencies including the
Agricultural Experiment
Stations, and local
participants

Custom Soil Resource Report for Huntingdon County, Pennsylvania

SR 2017/Black Log HDD Soils



Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

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scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

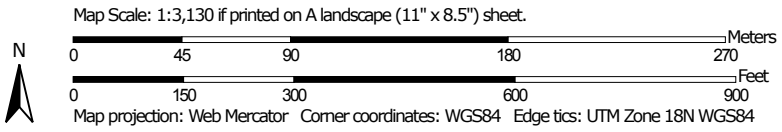
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identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map


The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report Soil Map (SR 2017/Black Log HDD Soils)





MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)




















Soils







 Soil Map Unit Polygons

 Soil Map Unit Lines


 Soil Map Unit Points

Special Point Features






-  Blowout
-  Borrow Pit
-  Clay Spot
-  Closed Depression
-  Gravel Pit
-  Gravelly Spot
-  Landfill
-  Lava Flow
-  Marsh or swamp
-  Mine or Quarry
-  Miscellaneous Water
-  Perennial Water
-  Rock Outcrop
-  Saline Spot
-  Sandy Spot
-  Severely Eroded Spot
-  Sinkhole
-  Slide or Slip
-  Sodic Spot

-  Spoil Area
-  Stony Spot
-  Very Stony Spot
-  Wet Spot
-  Other
-  Special Line Features


Water Features

 Streams and Canals

Transportation

-  Rails
-  Interstate Highways
-  US Routes
-  Major Roads
-  Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL:
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Huntingdon County, Pennsylvania
 Survey Area Data: Version 12, Sep 18, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 23, 2010—Mar 10, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend (SR 2017/Black Log HDD Soils)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
At	Atkins silt loam	6.9	36.4%
BkC	Berks channery silt loam, 8 to 15 percent slopes	3.9	20.5%
BID	Berks-Weikert channery silt loams, 15 to 25 percent slopes	0.0	0.0%
BoB	Blairton silt loam, 2 to 8 percent slopes	0.2	0.9%
BrB	Brinkerton silt loam, 3 to 8 percent slopes	0.5	2.8%
BxD	Buchanan extremely stony loam, 8 to 25 percent slopes	3.6	19.0%
WeD	Weikert channery silt loam, 15 to 25 percent slopes	3.8	20.3%
Totals for Area of Interest		18.9	100.0%

Map Unit Descriptions (SR 2017/Black Log HDD Soils)

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the

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scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Huntingdon County, Pennsylvania

At—Atkins silt loam

Map Unit Setting

National map unit symbol: 15yc
Elevation: 200 to 3,000 feet
Mean annual precipitation: 32 to 55 inches
Mean annual air temperature: 46 to 59 degrees F
Frost-free period: 120 to 214 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Atkins and similar soils: 85 percent
Minor components: 14 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Atkins

Setting

Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Acid alluvium derived from sedimentary rock

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 30 inches: silt loam
H3 - 30 to 60 inches: gravelly silty clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 60 to 99 inches to lithic bedrock
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high
(0.06 to 2.00 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: B/D
Hydric soil rating: Yes

Minor Components

Philo

Percent of map unit: 6 percent
Hydric soil rating: No

Barbour

Percent of map unit: 6 percent
Hydric soil rating: No

Saprists

Percent of map unit: 2 percent
Landform: Depressions
Hydric soil rating: Yes

BkC—Berks channery silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2sgcg
Elevation: 320 to 3,570 feet
Mean annual precipitation: 37 to 50 inches
Mean annual air temperature: 47 to 56 degrees F
Frost-free period: 148 to 192 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Berks and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Berks

Setting

Landform: Ridges, mountain slopes
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Upper third of mountainflank, side slope
Down-slope shape: Convex
Across-slope shape: Convex, linear
Parent material: Residuum weathered from shale and siltstone and/or fine grained sandstone

Typical profile

Ap - 0 to 8 inches: channery silt loam
Bw1 - 8 to 14 inches: very channery silt loam
Bw2 - 14 to 26 inches: very channery silt loam
C - 26 to 36 inches: extremely channery silt loam
R - 36 to 46 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 5.95 in/hr)
Depth to water table: More than 80 inches

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Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 1 percent
Gypsum, maximum in profile: 1 percent
Salinity, maximum in profile: Nonsaline (0.0 to 1.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Other vegetative classification: Dry Uplands (DU2), Dry Uplands (DU3)
Hydric soil rating: No

Minor Components

Weikert

Percent of map unit: 10 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Other vegetative classification: Droughty Shales (SD2)
Hydric soil rating: No

Brinkerton

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Hydric soil rating: Yes

BID—Berks-Weikert channery silt loams, 15 to 25 percent slopes

Map Unit Setting

National map unit symbol: 2sgbp
Elevation: 410 to 3,570 feet
Mean annual precipitation: 37 to 50 inches
Mean annual air temperature: 47 to 56 degrees F
Frost-free period: 148 to 192 days
Farmland classification: Not prime farmland

Map Unit Composition

Berks and similar soils: 50 percent
Weikert and similar soils: 35 percent
Minor components: 15 percent

Custom Soil Resource Report

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Berks

Setting

Landform: Ridges

Landform position (two-dimensional): Shoulder, backslope, summit

Landform position (three-dimensional): Side slope

Down-slope shape: Convex

Across-slope shape: Convex, linear

Parent material: Residuum weathered from shale and siltstone and/or fine grained sandstone

Typical profile

A - 0 to 7 inches: channery silt loam

Bw1 - 7 to 14 inches: channery silt loam

Bw2 - 14 to 21 inches: very channery silt loam

C - 21 to 36 inches: extremely channery silt loam

R - 36 to 46 inches: bedrock

Properties and qualities

Slope: 15 to 25 percent

Depth to restrictive feature: 20 to 40 inches to lithic bedrock

Natural drainage class: Well drained

Runoff class: High

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum in profile: 1 percent

Gypsum, maximum in profile: 1 percent

Salinity, maximum in profile: Nonsaline (0.0 to 1.0 mmhos/cm)

Sodium adsorption ratio, maximum in profile: 1.0

Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: B

Other vegetative classification: Dry Uplands (DU2)

Hydric soil rating: No

Description of Weikert

Setting

Landform: Ridges

Landform position (two-dimensional): Shoulder, backslope, summit

Landform position (three-dimensional): Side slope

Down-slope shape: Convex

Across-slope shape: Convex, linear

Parent material: Gray and brown acid residuum weathered from shale and siltstone and/or fine grained sandstone

Typical profile

A - 0 to 6 inches: channery silt loam

Bw - 6 to 12 inches: very channery silt loam

Custom Soil Resource Report

C - 12 to 15 inches: extremely channery silt loam

R - 15 to 25 inches: bedrock

Properties and qualities

Slope: 15 to 25 percent

Depth to restrictive feature: 10 to 20 inches to lithic bedrock

Natural drainage class: Somewhat excessively drained

Runoff class: High

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Salinity, maximum in profile: Nonsaline (0.0 to 1.0 mmhos/cm)

Available water storage in profile: Very low (about 1.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: D

Other vegetative classification: Droughty Shales (SD3)

Hydric soil rating: No

Minor Components

Ernest

Percent of map unit: 5 percent

Landform: Ridges

Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Head slope, base slope

Down-slope shape: Convex, concave

Across-slope shape: Convex, linear

Hydric soil rating: No

Blairton

Percent of map unit: 5 percent

Landform: Ridges

Landform position (two-dimensional): Shoulder, backslope, summit

Landform position (three-dimensional): Side slope

Down-slope shape: Concave

Across-slope shape: Concave

Hydric soil rating: No

Bedington

Percent of map unit: 4 percent

Landform: Ridges

Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Convex

Across-slope shape: Convex, linear

Hydric soil rating: No

Typic endoaquults

Percent of map unit: 1 percent

Landform: Ridges

Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Side slope

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Down-slope shape: Concave
Across-slope shape: Concave, linear
Hydric soil rating: Yes

BoB—Blairton silt loam, 2 to 8 percent slopes

Map Unit Setting

National map unit symbol: 15yr
Elevation: 300 to 1,300 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 120 to 214 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Blairton and similar soils: 90 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blairton

Setting

Landform: Depressions
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Head slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Local silty colluvium derived from shale and siltstone over acid silty residuum weathered from shale and siltstone

Typical profile

H1 - 0 to 9 inches: silt loam
H2 - 9 to 22 inches: channery silty clay loam
H3 - 22 to 26 inches: very channery loam
H4 - 26 to 30 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Somewhat poorly drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 6 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified

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Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Brinkerton

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

BrB—Brinkerton silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 15yv
Elevation: 300 to 3,000 feet
Mean annual precipitation: 30 to 65 inches
Mean annual air temperature: 46 to 59 degrees F
Frost-free period: 120 to 217 days
Farmland classification: Not prime farmland

Map Unit Composition

Brinkerton and similar soils: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Brinkerton

Setting

Landform: Depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Local fine-silty colluvium derived from sedimentary rock

Typical profile

H1 - 0 to 9 inches: silt loam
H2 - 9 to 18 inches: silty clay loam
H3 - 18 to 46 inches: silty clay loam
H4 - 46 to 65 inches: channery silt loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 15 to 34 inches to fragipan
Natural drainage class: Poorly drained
Runoff class: Very high

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Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)

Depth to water table: About 0 to 6 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 4w

Hydrologic Soil Group: D

Hydric soil rating: Yes

Minor Components

Ernest

Percent of map unit: 10 percent

Hydric soil rating: No

Laidig

Percent of map unit: 5 percent

Landform: Mountains

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Lower third of mountainflank

Down-slope shape: Concave

Across-slope shape: Concave

Hydric soil rating: No

Berks

Percent of map unit: 5 percent

Landform: Ridges, valleys

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Convex, linear

Across-slope shape: Convex, linear

Hydric soil rating: No

Atkins

Percent of map unit: 3 percent

Landform: Flood plains

Down-slope shape: Concave

Across-slope shape: Concave

Hydric soil rating: Yes

Philo

Percent of map unit: 2 percent

Hydric soil rating: No

BxD—Buchanan extremely stony loam, 8 to 25 percent slopes

Map Unit Setting

National map unit symbol: 15z0

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Elevation: 400 to 3,800 feet
Mean annual precipitation: 34 to 60 inches
Mean annual air temperature: 46 to 59 degrees F
Frost-free period: 120 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Buchanan, extremely stony, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Buchanan, Extremely Stony

Setting

Landform: Mountain slopes, valley sides
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Lower third of mountainflank, base slope
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Parent material: Mountain slope colluvium derived from sedimentary rock

Typical profile

A - 0 to 6 inches: very gravelly loam
Bt1 - 6 to 19 inches: channery clay loam
Bt2 - 19 to 29 inches: gravelly sandy clay loam
Bx - 29 to 49 inches: gravelly sandy clay loam
C - 49 to 60 inches: very gravelly loam

Properties and qualities

Slope: 8 to 25 percent
Percent of area covered with surface fragments: 9.0 percent
Depth to restrictive feature: 22 to 32 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 6 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Laidig

Percent of map unit: 12 percent
Hydric soil rating: No

Andover, extremely stony

Percent of map unit: 3 percent
Landform: Depressions
Landform position (two-dimensional): Footslope, toeslope

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Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

WeD—Weikert channery silt loam, 15 to 25 percent slopes

Map Unit Setting

National map unit symbol: 2v4vs
Elevation: 340 to 4,040 feet
Mean annual precipitation: 37 to 50 inches
Mean annual air temperature: 47 to 56 degrees F
Frost-free period: 148 to 192 days
Farmland classification: Not prime farmland

Map Unit Composition

Weikert and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Weikert

Setting

Landform: Ridges
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Gray and brown acid residuum weathered from shale and siltstone and/or fine grained sandstone

Typical profile

A - 0 to 6 inches: channery silt loam
Bw - 6 to 12 inches: very channery silt loam
C - 12 to 15 inches: extremely channery silt loam
R - 15 to 25 inches: bedrock

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Natural drainage class: Somewhat excessively drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.0 to 1.0 mmhos/cm)
Available water storage in profile: Very low (about 1.5 inches)

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Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: D

Other vegetative classification: Droughty Shales (SD3)

Hydric soil rating: No

Minor Components

Berks

Percent of map unit: 9 percent

Landform: Ridges

Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Convex

Across-slope shape: Convex, linear

Hydric soil rating: No

Ernest

Percent of map unit: 3 percent

Landform: Hillslopes

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Side slope

Down-slope shape: Concave

Across-slope shape: Linear

Hydric soil rating: No

Wharton

Percent of map unit: 2 percent

Landform: Ridges

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Interfluve, side slope, head slope

Down-slope shape: Concave

Across-slope shape: Concave

Hydric soil rating: No

Hartleton

Percent of map unit: 1 percent

Landform: Ridges

Landform position (two-dimensional): Shoulder, backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Linear, concave

Across-slope shape: Linear, concave

Hydric soil rating: No

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REVIEW



**ATTACHMENT 3
450-FOOT WELL SURVEY**

GES Well ID	Distance to HDD Perpendicular (Feet)	Distance to HDD Entry/Exit (Feet)	Well Information		
			Reported DTB (Feet)	Reported DTW (Feet)	Reported Pump Depth
WL-09222017-618-01	367	408	179	Unknown	Unknown
WL-09132017-614-01	521	661	60	Unknown	Unknown
ST-09252017-614-01	1,110	1,110	NA	NA	NA

Legend

-  LOD
-  Parcel
-  PPP Centerline
-  HDD
-  450 foot buffer of HDD alignment
-  Public Water Supply/Landowner Confirmed No Well

****Testing locations current as of 07/30/2018**

-  GES Testing Location
-  GES Stream Testing Location

Location



0 250 500
Feet

Well Location Map
HDD# PA-HU-0106.0000-RD
Huntingdon County, PA.

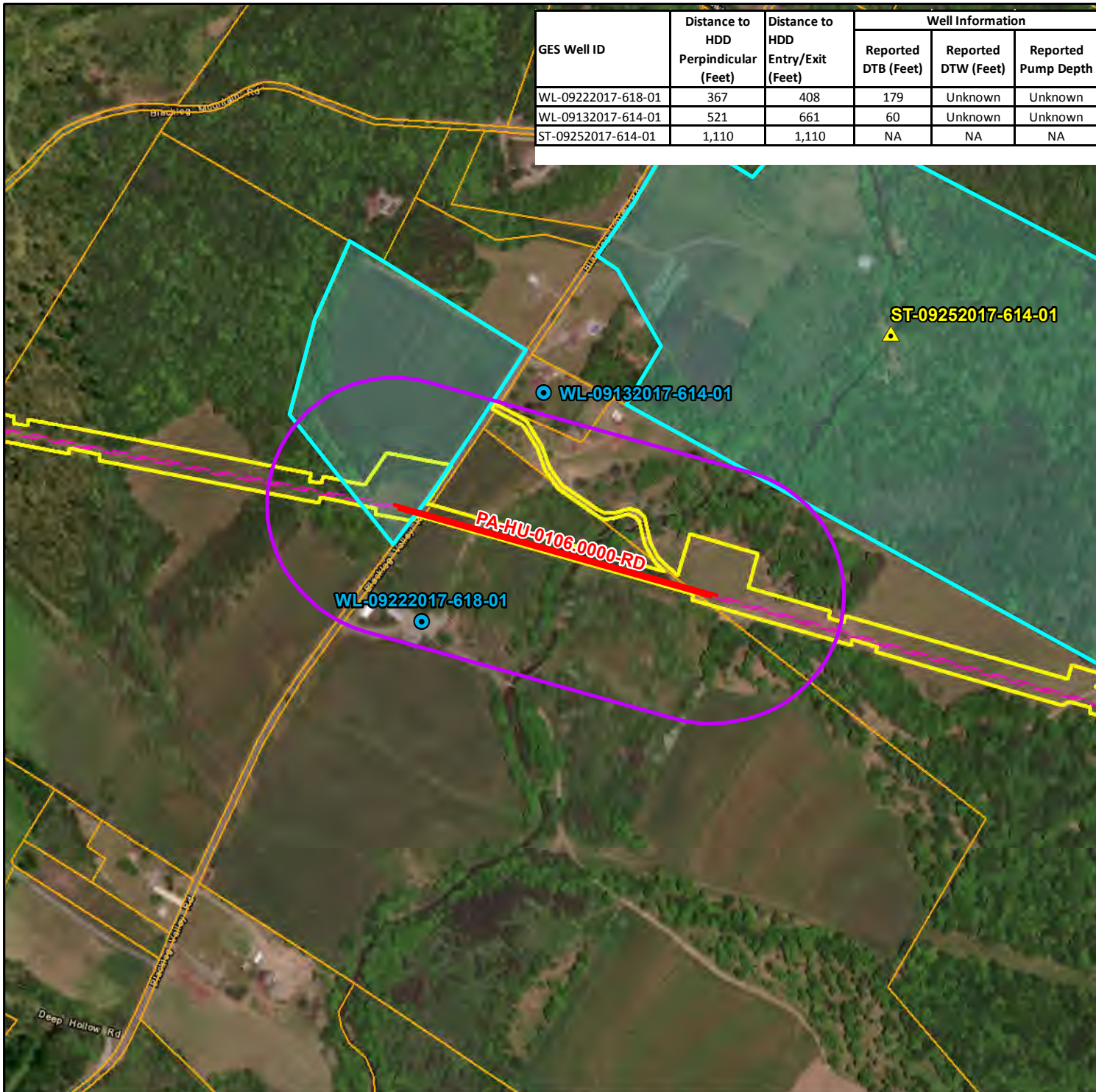
Prepared By:



Date:
1/10/2019

Base Map:
ESRI World Imagery, 09/24/2015

Coordinate System: NAD 83 Stateplane, PA South, Feet



E:\GIS\workspace\12\060558\FH\PA\WellLocations\WellLocation_PA_HU_0106_0000.mxd

Stream Sample Analytical Results Summary

Parcel ID: 42-18-03.3 (16387 Blacklog Valley Road)
 Stream Location Map ID: ST-09252017-614-01

Parameter	Units	Sample Date: 9/25/2017	Sample Date: 3/20/2018	PA DEP Drinking Water MCL/SMCL
		Sample I.D.: 09252017-614-01	Sample I.D.: 03202018-634-01	
Coliform, fecal	col/100ml	177	37.0	-
E. Coli	MPN/100ml	387	52.9	-
Coliform, total	MPN/100ml	> 2419.6	365	-
Dissolved Solids	mg/l	43.0	34.0	500
Suspended Solids	mg/l	ND	ND	-
Hardness (colorimetric) as CaCO ₃	mg/l	ND	ND	-
Turbidity	NTU	1.54	2.89	-
Alkalinity	mg/l	30.4	ND	-
pH	SU	7.48	7.30	-
Specific Conductance	umhos/cm	67.7	44.4	-
Bromide	mg/l	ND	ND	-
Chloride	mg/l	1.96	2.38	250
Sulfate	mg/l	ND	5.98	250
Barium	mg/l	0.0224	0.0158	2
Calcium	mg/l	6.33	3.59	-
Iron	mg/l	0.330	0.144	0.3
Magnesium	mg/l	2.54	1.78	-
Manganese	mg/l	0.0185	0.0111	0.05
Potassium	mg/l	1.97	ND	-
Sodium	mg/l	2.57	1.88	-
Methane	mg/l	ND	ND	-
Ethane	mg/l	ND	ND	-
Ethene	mg/l	ND	ND	-
Propane	mg/l	ND	ND	-
Benzene	mg/l	ND	ND	0.005
Toluene	mg/l	ND	ND	1
Ethylbenzene	mg/l	ND	ND	0.7
Total Xylenes	mg/l	ND	ND	10
Residual Bentonite	-	NA	NA	-

20-inch HDD construction dates: October 5, 2017 to October 10, 2017 and March 9, 2018 through June 19, 2018

16-inch HDD construction dates: Awaiting PA DEP authorization to start

Notes:

1. MCL - Maximum Primary Contaminant Level
2. SMCL - Maximum Secondary Contaminant Level
3. NA - Not Analyzed
4. ND - Not Detected
5. col/100ml - colonies per 100 milliliters
6. MPN/100ml - most probable number per 100 milliliters
7. mg/l - milligrams per liter
8. NTU - nephelometric turbidity units
9. SU - standard units
10. umhos/cm - micro ohms per centimeter

Concentrations that are bolded exceed or are equivalent to their respective PA DEP MCL/SMCL

Goshorn Water Sample Analytical Results Summary

Parcel ID: 42-18-05.1 (16443 Blacklog Valley Road)
Well Location Map ID: WL-09132017-614-01

Parameter	Units	9/13/2017 Pre-Construction	3/20/2018 During Construction	PA DEP Drinking Water MCL/SMCL
		Sample I.D.: 09132017-614-01	Sample I.D.: 03202018-631-01	
Coliform, fecal	col/100ml	< 1	< 1	-
E. Coli	MPN/100ml	< 1	< 1	-
Coliform, total	MPN/100ml	< 1	< 1	-
Dissolved Solids	mg/l	305	183	500
Suspended Solids	mg/l	10.8	ND	-
Hardness (colorimetric) as CaCO3	mg/l	179	132	-
Turbidity	NTU	5.29	1.55	-
Alkalinity	mg/l	69.7	58.6	-
pH	SU	7.07	7.30	-
Specific Conductance	umhos/cm	484	296	-
Bromide	mg/l	ND	ND	-
Chloride	mg/l	80.1	36.0	250
Sulfate	mg/l	29.0	25.4	250
Barium	mg/l	0.0489	0.0545	2
Calcium	mg/l	33.2	30.0	-
Iron	mg/l	0.229	ND	0.3
Magnesium	mg/l	11.9	11.7	-
Manganese	mg/l	0.0571	0.386	0.05
Potassium	mg/l	1.52	1.54	-
Sodium	mg/l	8.00	8.31	-
Methane	mg/l	ND	ND	-
Ethane	mg/l	ND	ND	-
Ethene	mg/l	ND	ND	-
Propane	mg/l	ND	ND	-
Benzene	mg/l	ND	ND	0.005
Toluene	mg/l	ND	ND	1
Ethylbenzene	mg/l	ND	ND	0.7
Total Xylenes	mg/l	ND	ND	10
Residual Bentonite	-	NA	NA	-

20-inch HDD construction dates: October 5, 2017 to October 10, 2017 and March 9, 2018 through June 19, 2018

16-inch HDD construction dates: Awaiting PA DEP authorization to start

Notes:

1. MCL - Maximum Primary Contaminant Level
2. SMCL - Maximum Secondary Contaminant Level
3. NA - Not Analyzed
4. ND - Not Detected
5. col/100ml - colonies per 100 milliliters
6. MPN/100ml - most probable number per 100 milliliters
7. mg/l - milligrams per liter
8. NTU - nephelometric turbidity units
9. SU - standard units
10. umhos/cm - micro ohms per centimeter

Concentrations that are bolded exceed or are equivalent to their respective PA DEP MCL/SMCL

Martin Water Sample Analytical Results Summary

Parcel ID: 42-18-05.4 (Blacklog Valley Road)
Well Location Map ID: WL-09222017-618-01

Parameter	Units	Sample Date: 9/22/2017	Sample Date: 3/22/2018	PA DEP Drinking Water MCL/SMCL
		Sample I.D.: 09222017-618-01	Sample I.D.: 03222018-613-01	
Coliform, fecal	col/100ml	< 1	< 1	-
E. Coli	MPN/100ml	< 1	< 1	-
Coliform, total	MPN/100ml	4.00	< 1	-
Dissolved Solids	mg/l	147	143	500
Suspended Solids	mg/l	ND	2.50	-
Hardness (colorimetric) as CaCO ₃	mg/l	114	121	-
Turbidity	NTU	0.415	1.82	-
Alkalinity	mg/l	111	103	-
pH	SU	8.00	7.99	-
Specific Conductance	umhos/cm	278	250	-
Bromide	mg/l	ND	ND	-
Chloride	mg/l	9.13	6.58	250
Sulfate	mg/l	20.0	17.9	250
Barium	mg/l	0.106	0.108	2
Calcium	mg/l	29.5	29.9	-
Iron	mg/l	0.244	0.360	0.3
Magnesium	mg/l	7.47	7.62	-
Manganese	mg/l	0.0977	0.102	0.05
Potassium	mg/l	1.83	6.90	-
Sodium	mg/l	9.69	14.5	-
Methane	mg/l	0.0287	0.0223	-
Ethane	mg/l	ND	ND	-
Ethene	mg/l	ND	ND	-
Propane	mg/l	ND	ND	-
Benzene	mg/l	ND	ND	0.005
Toluene	mg/l	ND	ND	1
Ethylbenzene	mg/l	ND	ND	0.7
Total Xylenes	mg/l	ND	ND	10
Residual Bentonite	-	NA	NA	-

20-inch HDD construction dates: October 5, 2017 to October 10, 2017 and March 9, 2018 through June 19, 2018
 16-inch HDD construction dates: Awaiting PA DEP authorization to start

Notes:

1. MCL - Maximum Primary Contaminant Level
2. SMCL - Maximum Secondary Contaminant Level
3. NA - Not Analyzed
4. ND - Not Detected
5. col/100ml - colonies per 100 milliliters
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7. mg/l - milligrams per liter
8. NTU - nephelometric turbidity units
9. SU - standard units
10. umhos/cm - micro ohms per centimeter

Concentrations that are bolded exceed or are equivalent to their respective PA DEP MCL/SMCL