

**HORIZONTAL DIRECTIONAL DRILL ANALYSIS  
AUGHWICK CREEK CROSSING  
PADEP SECTION 105 PERMIT NO.S:  
PA-HU-0078.000-WX & PA-HU-0078.000-WX-16  
(SPLP HDD# S2-0153)**

**AUGHWICK CREEK CROSSING  
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PA-HU-0078.000-WX & PA-HU-0078.000-WX-16  
(SPLP HDD# S2-0153)**

**HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 20-INCH**

- Horizontal length: 1,309 feet (ft)
- Entry angle: 13 degrees
- Maximum depth of cover: 40 ft
- Pipe design radius: 2,000 ft

**HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 16-INCH**

- Horizontal length: 1,260 ft
- Entry angle: 16 degrees
- Maximum depth of cover: 51 ft
- Pipe design radius: 1,260 ft

**GEOLOGIC AND HYDROGEOLOGIC ANALYSIS**

The crossing of Aughwick Creek is underlain by carbonate and sedimentary rocks of the Onondaga and Old Port Formations. Geologic mapping, reports, and field observations indicate near-vertical beds with jointing and fracturing in the bedrock, with some enhanced dissolution of the carbonate rocks.

Attachment 1 provides an extensive discussion on the geology, hydrogeology and results of the geotechnical investigation performed at this location.

**HYDROGEOLOGY, GROUND WATER, AND WELL PRODUCTION ZONES**

Water-bearing zones generally occur in secondary openings along bedding planes, joints, faults and fractures. Water-bearing zones in the Onondaga and Old Port Formations are reportedly evenly distributed in the first 300 feet of the subsurface.

Attachment 1 provides an extensive discussion on the geology, hydrogeology and results of the geotechnical investigation performed at this location.

**INADVERTENT RETURNS DISCUSSION**

The proposed HDD profile is relatively shallow compared to the land surface and the streambed of Aughwick Creek. Based on the hydro-structural characteristics of the underlying geology and the bore path through shallow soils and shallow bedrock, the crossing of Aughwick Creek by HDD is susceptible to the inadvertent return of drilling fluids during HDD operations.

An inadvertent return (IR) occurred during HDD operations on July 6, 2017 during the initial HDD attempt. The HDD entry is on the east side of Aughwick Creek, and a loss of drilling fluid circulation was observed prior to the IR event. Drilling fluids were observed discharging from a developed spring catchment approximately 200 feet southwest of the entry location. Observations made during the IR event noted weathered bedrock at the discharge location. Drilling operations were shut down while containment measures were implemented.

Project management voluntarily stopped this HDD until additional evaluations of the geology and drilling procedures were completed and could be utilized to prepare location specific HDD procedures.

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**ADJACENT FEATURES ANALYSIS**

The crossing of Aughwick Creek is located in rural Huntingdon County, approximately 0.55 miles north of the community of Aughwick, 13 miles southeast of Huntingdon, PA.

The pipeline route in this area of Huntingdon County follows parallel to a previously existing Sunoco Pipeline, L.P. (SPL) pipeline. At this location, on the east side of Aughwick Creek a residential home site and other secondary structures are immediately adjacent to the existing permanent utility easement. The presence of this home site and other structures necessitated a deviation (reroute) from the existing easement, resulting in the planned route being adjusted 135 ft north of the existing easement to avoid potential affects to this home site and other structures and significant disruption to the homeowner during construction.

Water well records indicate the presence of a water well 330 ft north of the horizontal directional drill (HDD) location. There are no records of a water well at the residence located 175 ft south of the HDD location; however given the rural setting; it is assumed this residence is provided potable water by a water well.

**ALTERNATIVES ANALYSIS**

The proposed HDD is an alternative route and plan of installation to a conventional open trench construction plan to bypass the existing encroachments on the permanent utility easement by primary and secondary residential structures.

This alternative route already creates a new permanent utility easement outside and separate from the existing utility easement, creating an additional encumbrance to the properties of the affected private landowners. Alternately to return to use of the existing easement would require direct disturbance of grounds immediate to an occupied residence.

**Open-cut Analysis**

At the proposed crossing of Aughwick Creek an open cut, or conventional construction crossing plan would require multiple channel closings and open trench crossings of the creek channels of the one (1) primary and two (2) secondary creek channels. To cross these, regardless of sequencing, an open cut crossing plan requires the damming and diversion using geotube dams of all water flows into the other channels, while completing the first or second channel crossings, and simultaneously pumping out of all produced groundwater discharge from the excavated shallow soil horizons and water seepage below the geotube dams installed in the channel(s) for the entire duration of the open cut crossing event.

SPLP specifications require a minimum of 48-inches of cover over the installed pipelines. To meet these cover requirements, during construction through the individual creek channels, an authorized open cut work space of 175 ft in width would be required to accommodate the 16 and 20-inch pipelines, allowing for each pipeline to be installed with sufficient separation between each pipeline for integrity management. The length of the creek crossing area is approximately 320 ft. The assessed area of impact by this open cut plan would directly affect 1.28 acres of state water bottoms and wooded riparian area.

The produced groundwater and seepage under the geotubes during the open cut process can be pumped to a discharge filtration structure; however the current technical capability of filtration does not exceed 50 microns, therefore, cloudy water (from suspended fine clay and silt particles) will be discharged downstream regardless of all control methods employed for the entire duration of the crossing until completion.

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**Re-Route Analysis**

No practicable re-route option lies to the north or south of the proposed route that would not transect the same roadways and waterways transected by the proposed route.

The current permitted route is a reroute from the existing permanent easement, and already creates a new utility easement encumbrance to the private property owners.

There are no other route adjustment that can considered that will eliminate or minimize the encumbrance of the proposed route's potential affects to natural resources.

**CONCLUSION**

As discussed above, the proposed route for the crossing of Aughwick Creek is the implementation of a reroute to avoid residential structures and is the shortest route possible that minimizes the extent of new permanent easement across private property.

HDD specialists employed by SPLP have investigated the initial HDD attempt and have concluded that poor drilling practices and lack of pressure monitoring technology are the root cause of the initial IR.

The completion of the crossing of Aughwick Creek by HDD is feasible and will minimize the effects to natural resources and waters of the state.

Upon the restart of this HDD, Sunoco will employ one or more HDD best management practices as follows:

- SPLP will mandate annular pressure monitoring during the drilling of the pilot hole, which assists in immediate identification of pressure changes indicative of loss of return flows or over pressurization of the annulus, managing development pressures that can induce an IR;
- SPLP will mandate short-tripping of the drilling tools to ensure an open annulus is maintained to manage the potential inducement of IRs;
- Required monitoring of the drilling fluid viscosity, such that fissures and fractures in the subsurface are sealed during the drilling process;
- During the reaming phase, the use of Loss Control Materials can be implemented if indications of a potential IR are noted or an IR is observed, and
- If necessary, the pilot hole and reaming phases of the HDD may utilize casing, hammered into the substrate down to structurally better rock, to prevent lateral movement of drilling fluids.

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**ATTACHMENT 1  
GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT**

September 7, 2017

Mr. Matthew Gordon  
Sunoco Pipeline, L.P.  
535 Fritztown Road  
Sinking Spring, Pennsylvania 19608

Engineers

Environmental  
Consultants

Surveyors

Landscape  
Architects

Safety  
Consultants

RE: Sunoco Pipeline, L.P. Pipeline Project - Mariner East II  
Aughwick Creek Horizontal Directional Drill Location (S2-0153)  
Hydrogeological Re-Evaluation Report  
Shirley Township, Huntingdon County, Pennsylvania  
RETTEW Project No. 096302011

## EXECUTIVE SUMMARY

1. The Stipulated Order dated August 8, 2017 requires a re-evaluation of the Aughwick Creek HDD location, including a geologic report.
2. The site is underlain by carbonate and sedimentary rocks of the Onondaga and Old Port Formations.
3. Geologic mapping, reports, and field observations indicate near-vertical beds with jointing and fracturing in the bedrock, and some enhanced dissolution of the carbonate rocks.
4. Water-bearing zones generally occur in secondary openings along bedding planes, joints, faults and fractures. Water-bearing zones in the Onondaga and Old Port Formations are reportedly evenly distributed in the first 300 feet of the subsurface.
5. The proposed HDD bore path is relatively shallow compared to the land surface and the streambed of Aughwick Creek.
6. Due to the hydro-structural characteristics of the underlying geology and the bore path through shallow soils and shallow bedrock, the Aughwick Creek HDD site is susceptible to the inadvertent return of drilling fluids during HDD operations.

## 1. INTRODUCTION

The purpose of this report is to describe the geologic and hydrogeologic setting of the Aughwick Creek (S2-0153) horizontal directional drilling (HDD) location (the site) on the Sunoco Pipeline, L.P. (SPLP) Pennsylvania Pipeline Project - Mariner East (PPP-ME2) Project. The site is located in Shirley Township, Huntingdon County, Pennsylvania. The site is located west of Cummings Road and was designed to be drilled under the three stream channels of Aughwick Creek (refer to **Figure 1**). This re-evaluation report is part of the response to the Stipulated Order dated August 8, 2017 related to the inadvertent return (IR) of drilling fluids that occurred during HDD operations at the site on July 6, 2017.



The site is situated in the Aughwick Creek valley. The HDD entry is on the east side of the stream at an elevation of approximately 557 feet. Along the profile of the HDD, the bore path crosses beneath the three channels of Aughwick Creek at depths ranging from 40 to 18 feet below the ground surface. The HDD exit is on the west side of the stream at an elevation of approximately 624 feet. Aughwick Creek flows southwest to northeast to its confluence with the Juniata River.

## 2. GEOLOGY

Based upon publications by the Pennsylvania Bureau of Topographic and Geologic Survey (BTGS)<sup>1</sup>, the site is in the Appalachian Mountain Section of the Ridge and Valley Physiographic Province of Pennsylvania, underlain by sandstone, siltstone, shale, conglomerate, limestone, and dolomite. Local topography is characterized by long, narrow ridges and broad to narrow valleys. 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.

The site geology is mapped<sup>2</sup> as the undivided Onondaga and Old Port (Doo) Formations of Devonian age. The Onondaga is described as an interbedded dark-gray limestone, shaley limestone, and calcareous and noncalcareous shale. The Old Port Formation is comprised of an upper unit of calcareous quartz sandstone and a lower unit of chert, cherty limestone and calcareous shale.

The Onondaga and Old Port Formations are well bedded and flaggy to thick in nature. Most joints are blocky to seamy; moderately abundant, open and vertical. Joints are moderately to closely spaced. These rocks are weathered moderately to a deep depth with deeper weathering in the shales. Weathering results in small- to medium sized blocks. The overlying mantle is thin. From an engineering standpoint, excavation of this Group is difficult but slope stability is good in the limestone member and fair in the shale member. Foundation stability is good, provided the excavation is to sound material and solution cavities are investigated and mitigated. Surface drainage is good. Secondary porosity of moderate magnitude is provided by joints and bedding plane fractures. Permeability is low to moderate<sup>3</sup>.

## 3. HYDROGEOLOGY

Groundwater in the area of the site occurs in a fractured carbonate/sedimentary bedrock aquifer system within the Onondaga and Old Port Formations. In these rock types of Huntingdon County, water-bearing zones generally occur in the secondary openings 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 that are sufficiently enlarged by solution that readily transport water.<sup>2</sup>

The depths of 168 reported domestic and non-domestic wells in the Onondaga and Old Port Formations range from 35 to 500 feet, with yields ranging from 0 to 1,400 gallons per minute (gpm). The median well depth for domestic wells is 141 feet and 215 feet for nondomestic wells. Median well yields are 10 gpm for domestic wells and 60 gpm for non-domestic wells. Water-bearing zones among the 88 wells reported are evenly distributed to a depth of 300 feet, and the deepest water-bearing zone is reported as 460 feet<sup>2</sup>.

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<sup>1</sup> D. Sevon, Map 13, 2000, Physiographic Provinces of Pennsylvania, Pennsylvania Bureau of Topographic and Geologic Survey, Harrisburg, Pennsylvania.

<sup>2</sup> L. Taylor et al, 1982, Groundwater Resources of the Juniata River Basin, Pennsylvania, Pennsylvania Department of Environmental Resources, Office of Resource Management, Bureau of Topographic and Geologic Survey.

<sup>3</sup> A.R. Geyer and J.P. Wilshusen, 1982, Engineering Characteristics of the Rocks of Pennsylvania, Pennsylvania Department of Environmental Resources, Office of Resource Management, Bureau of Topographic and Geologic Survey.

Well records reviewed within a 0.5-mile radius of the HDD location were obtained from the Pennsylvania Groundwater Information System (PaGWIS). Records from three wells in this radius were available and are summarized below. These well locations are shown on **Figures 2 and 3**.

Well No.	Well Use	Casing Depth	Total Depth	Water Level	Yield
507110	Domestic	Unknown	129 feet	32 feet	75 gpm
489068	Domestic	105 feet	279 feet	80 feet	25 gpm
488353	Domestic	105 feet	279 feet	80 feet	60 gpm

#### 4. FRACTURE TRACE ANALYSIS

Fracture traces underlying, or in close proximity to, the site were analyzed using historical aerial photographs from the years 1994 through 2015, Geologic and Surficial Materials Maps of Pennsylvania (1989, Commonwealth of Pennsylvania, DCNR & BTGS), the Aughwick Quadrangle Geologic Map (1976, Hoskins) and the United States Geological Survey (USGS) 7.5-minute Topographic Quadrangle Map. Since the area of the site is generally undeveloped in nature, the higher-resolution, more current photographs were used for fracture trace evaluation. The photographs were viewed to estimate lineaments or natural linear features 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 in the fractured bedrock aquifer at the site.

**Figures 2 and 3** show the results of the fracture trace analysis overlain on the geologic map of the site and an aerial basemap. A total of nine fracture traces were identified within approximately one-mile of the site (not including one to the west of the site, approximately 2.5 miles away, at the next ridge perpendicular to the Juniata River) that are likely related to the primary geologic structure of the area discussed above. Due to the nature of the ridges and folded geology near the site, several of the fracture traces trend approximately Northeast-Southwest (NE-SW), with likely perpendicular fracture traces manifested in the approximately West-East (W-E) fracture lineaments that could possibly be stress-related joint sets. General surface drainage patterns near the site are characterized by linear stream reaches in a NE-SW or W-E trend. Aughwick Creek flows generally SW-NE to the Juniata River, which at a larger scale is also structurally controlled in Huntingdon and Mifflin Counties.

#### 5. GEOTECHNICAL EVALUATION

Two geotechnical drilling evaluations were performed at the site by drilling contractors with the client's direction. Test borings were advanced by hollow-stem augers. An NQ core barrel/bit was used for rock coring. Geotechnical boring logs are presented in **Attachment 1**.

The first geotechnical drilling program was performed on January 22 and 23, 2015, prior to the initiation of HDD operations. Soil Boring 01 (SB-01) was located approximately 250 feet south of the HDD exit on the west side of Aughwick Creek and Soil Boring 02 (SB-02) was located approximately 250 feet south of mid-point of the bore path on the west side of the stream.

Five additional borings were advanced on July 19, 21, and 24, 2017, following initiation of the HDD operation and the IR that occurred on July 6, 2017. Borings B-1 and B-1A were installed near the HDD entry on the east side of the creek. Borings B-2, B-2A, and B-2B were installed near the HDD exit on the west side of the creek. B-2A was offset from B-2 due to difficult drilling conditions. B-2B was also offset



for the purpose of advancing the coring equipment. Soil and residual soil observations were recorded using the findings from B-2 and bedrock core descriptions were recorded using the core from B-2B.

In general, the subsurface profile at the site, as observed in the borings, was described as follows:

- Soil and residual soil depths varied from west to east; 15 feet at B-2, 21 feet at SB-02, and 65 feet at B-1A. The residual soils were described as follows:
  - **Boring B-2:** SAND (SM) with subordinate amounts of silt, GRAVEL (GM/GP) with subordinate amounts of silt and sand comprised of sandstone;
  - **Boring SB-02:** SAND (SC) with subordinate amounts of silt, clay and gravel, lean CLAY (SC) with subordinate amounts of sand and gravel. Gravel component was described as unweathered shale; and
  - **Boring B-1/B-1A:** SAND (SC/SM) with subordinate amounts of clay and silt. Coarser material was described as sandstone.
- Refusal, defined as naturally occurring rock that cannot be penetrated by standard soil sampling methods consisting of split-spoon samplers and augers, was encountered at 15.1 feet at B-2, 27.7 feet at SB-02, and 70 feet in B-1A.
- Beneath auger refusal to the total depth of the NQ cores, bedrock was encountered and was described as follows:
  - **Boring B-2B:** From 17 to 74 feet, a buff/light gray, fine-grained, massive sandstone. Rock recoveries were very poor to excellent (0% to 100%) and rock quality designations (RQD) were very poor to excellent (0% to 98%). The lowest RQDs were observed from 52 to 74.5 feet where voids and weathered sandstone were observed. A blue gray, fine grained limestone was observed from 74.5 feet to the completion of the core at 100 feet. Vertical fractures were observed in the limestone from 87 to 97 feet and the driller indicated a loss of circulation through this zone. Rock recoveries were fair to excellent (50% to 100%) and RQDs were very poor to fair (18% to 74%); and
  - **Boring SB-02:** A light to dark gray limestone was encountered from 27.7 to 36.9 feet. Rock recoveries were fair to good (55% to 83%) and RQDs were poor (27% to 44%). Fractures ranging from generally horizontal to high angle were recorded in the core logs.

Please note that RETTEW did not oversee or direct the geotechnical drilling programs associated with the Aughwick Creek HDD, 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 contractors. RETTEW relied on these reports and incorporated their data into the general geologic and hydrogeologic framework of the analysis of the Aughwick Creek HDD in this report.

## 6. FIELD OBSERVATIONS

RETTEW staff were on-site during HDD operations on July 6, 2017 when the IR occurred during the initial HDD. The HDD entry was on the east side of Aughwick Creek. An initial loss of fluid circulation was observed along the trajectory length of 200 feet while drilling through shale. Drilling fluids were observed discharging from a developed spring catchment approximately 200 feet southwest of the entry location which ultimately discharges into Aughwick Creek. Observations made during the IR noted weathered shale

bedrock near the discharge location. Drilling operations were shut down while containment measures were implemented.

A field investigation was performed by RETTEW staff on August 29, 2017 to identify rock outcrops for fracture fabric analysis, evaluation and ground-truthing of fracture traces identified during the desktop exercise, and to identify potential sensitive receptors to IRs. Readily accessible bedrock outcrops were limited to the stream bed of Aughwick Creek and are composed of the calcareous shale of the Onondaga Formation. Strike direction is generally to the northeast (23° to 30°), consistent with the mapped bedrock geology and fracture-trace analysis. Due to weathering and poor exposure, dip was difficult to measure at the exposed outcrops but appeared near vertical.

Based on the IR event and site reconnaissance, the primary sensitive receptors identified are the spring catchment and Aughwick Creek. A water well has not been observed at the residence near the HDD entry, but the property is likely served by a domestic water source for potable water use.

## **7. CONCEPTUAL HYDROGEOLOGIC MODEL AND CONCLUSION**

Based on published geologic and hydrogeologic information and the evaluation of geotechnical borings from the site, the Aughwick Creek HDD location is underlain by carbonate and sedimentary rocks of the Onondaga and Old Port Formations. The hydrogeologic setting is dominated by groundwater flow in secondary openings along geologic features including bedding planes, joints, faults, and fractures. The secondary openings may be enlarged or enhanced by dissolution in underlying carbonate rocks. This is supported by the observation of voids in the geotechnical cores, and may be indicative of the high yields reported from some nearby domestic and non-domestic wells. Field and geotechnical core observations and measurements also indicated that local bedrock is fractured with near vertical bedding planes. The proposed HDD profile is relatively shallow compared to the land surface and the streambed of Aughwick Creek, and passes through the soil overburden and the fractured bedrock. Based on the hydro-structural characteristics described in this report of the underlying geology, and the known profile through shallow soils and bedrock, the Aughwick Creek HDD site is susceptible to the inadvertent return of drilling fluids during HDD operations.

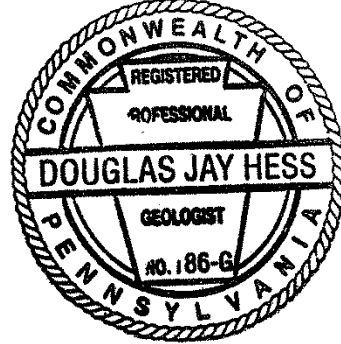
## 8. CERTIFICATION

The studies and evaluations presented in this report (other than Section 5) were completed under the direction of a licensed professional geologist (P.G.), and are covered under the P.G. seals that follow.

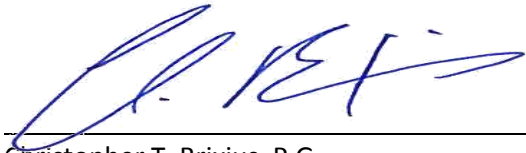
By affixing my seal to this document, I am certifying that, to my knowledge and belief, the information herein is true and correct. I further certify, that I am licensed to practice in the Commonwealth of Pennsylvania and that it is within my professional expertise to verify the correctness of the information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



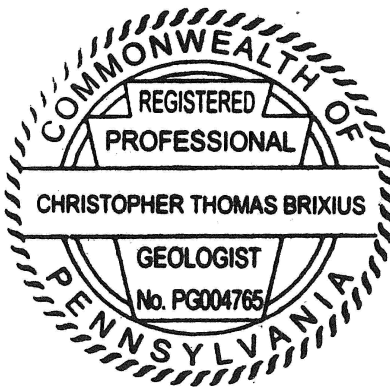
Douglas J. Hess, P.G.  
License No. PG000186G



Ethan E. Prout, P.G.  
License No. PG003884

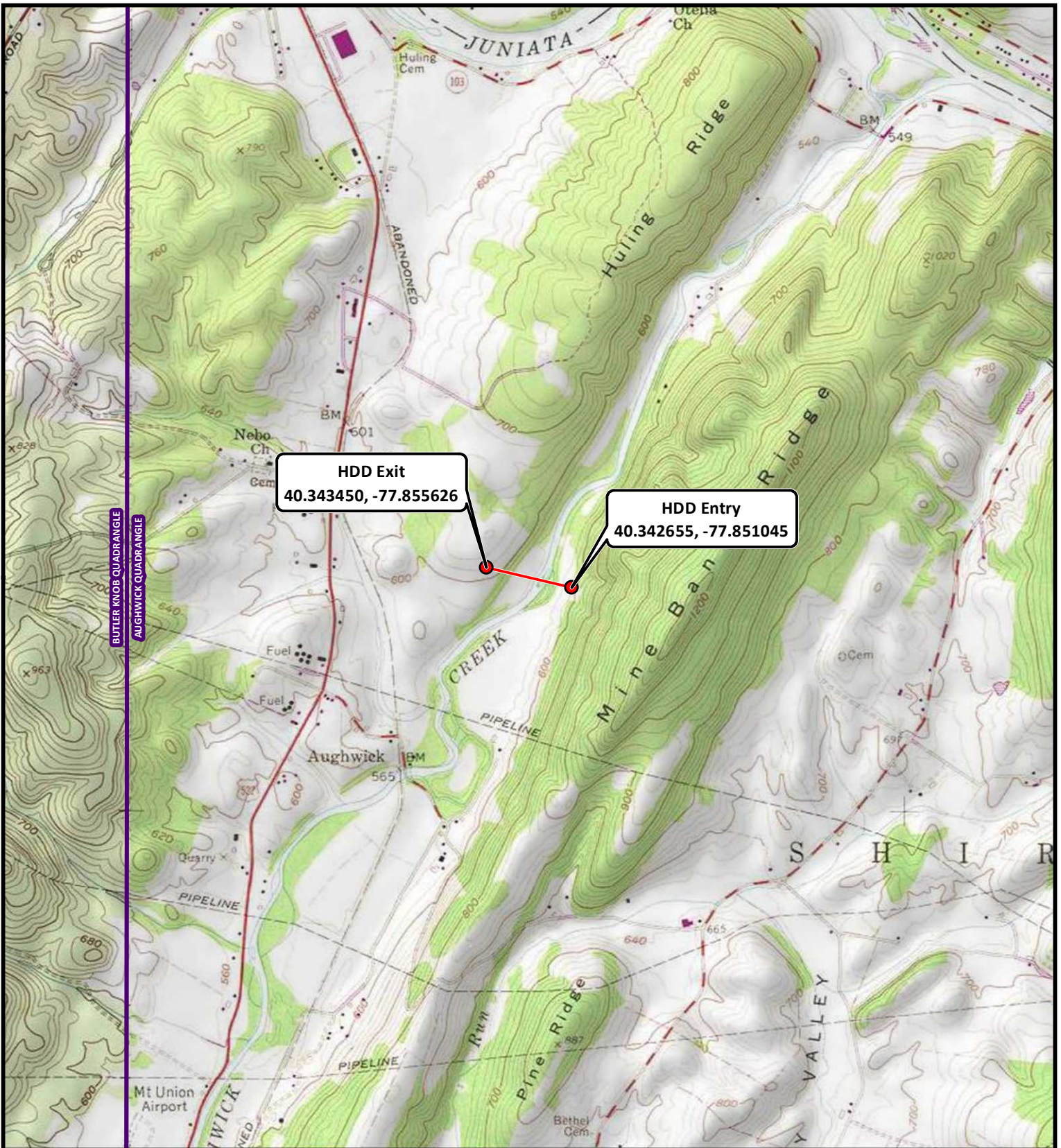


Christopher T. Brixius, P.G.  
License No. PG004765



**FIGURES**





BUTLER KNOB QUADRANGLE  
 AUGHWICK QUADRANGLE

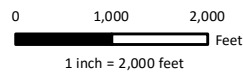
**HDD Exit**  
40.343450, -77.855626

**HDD Entry**  
40.342655, -77.851045

- HDD Entry/Exit
- HDD Profile

**Sunoco Pipeline, L.P.**  
**Aughwick Creek HDD Location**

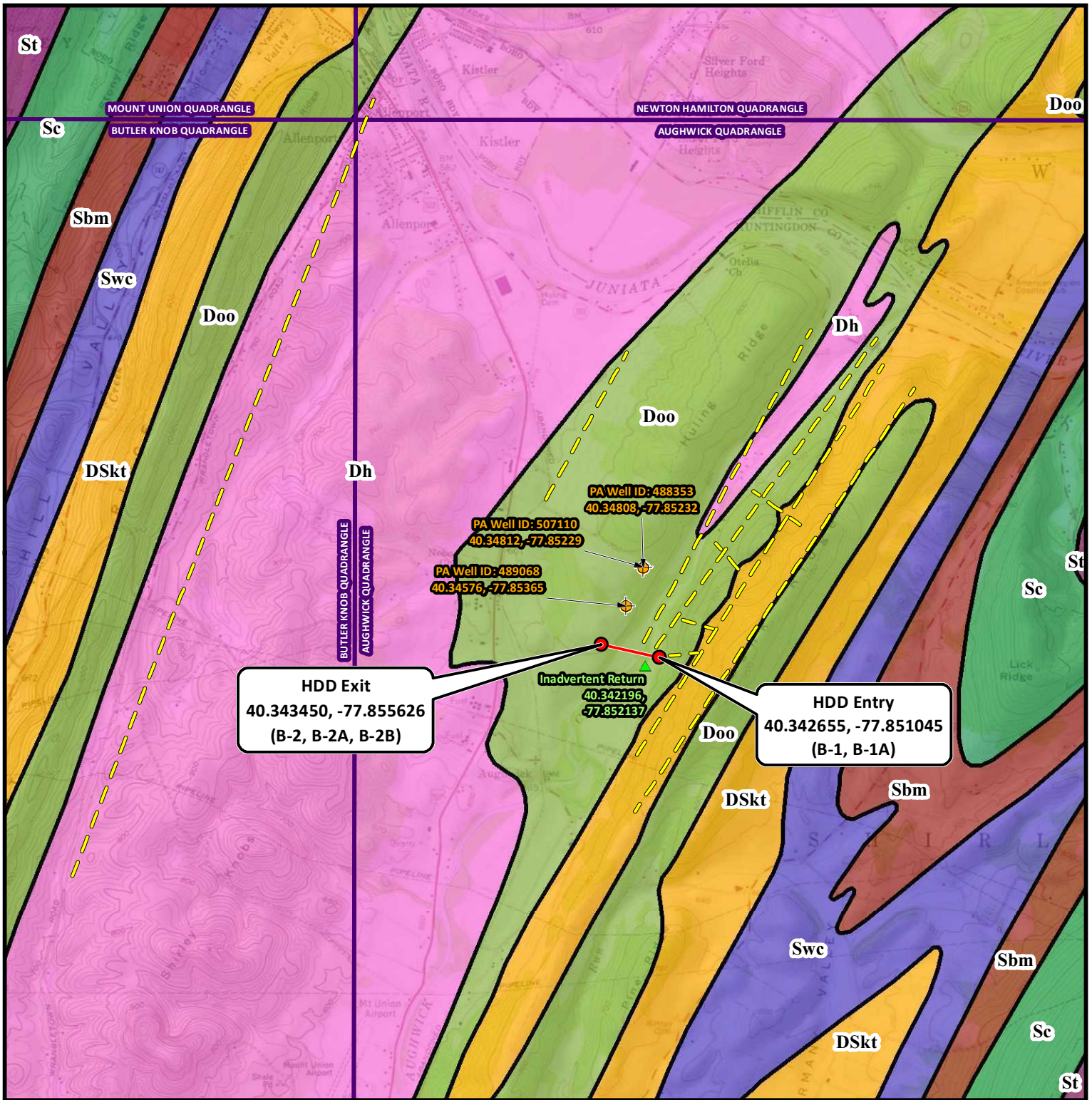
Figure 1 - Topographic Basemap  
 Shirley Township, Huntingdon County, PA  
 Project No. 096302011



**Sunoco Logistics Partners L.P.**

**RETTEW**





**HDD Exit**  
 40.343450, -77.855626  
 (B-2, B-2A, B-2B)

**Inadvertent Return**  
 40.342196, -77.852137

**HDD Entry**  
 40.342655, -77.851045  
 (B-1, B-1A)

PA Well ID: 507110  
 40.34812, -77.85229

PA Well ID: 489068  
 40.34576, -77.85365

PA Well ID: 488353  
 40.34808, -77.85232

- Inadvertent Return
  - Residential Well
  - HDD Profile
  - HDD Entry/Exit
  - Inferred Fracture Trace
- Geologic Formation**
- DSkt - Keyser and Tonoloway Formations, undivided
  - Dh - Hamilton Group
  - Doo - Onondaga and Old Port Formations, undivided
  - Sbm - Bloomsburg and Mifflintown Formations, undivided
  - Sc - Clinton Group
  - Swc - Wills Creek Formation

9/5/2017

**Sunoco Pipeline, L.P.**  
**Aughwick Creek HDD Location**  
**Figure 2 - Geologic Map**  
 Shirley Township, Huntingdon County, PA  
 Project No. 096302011

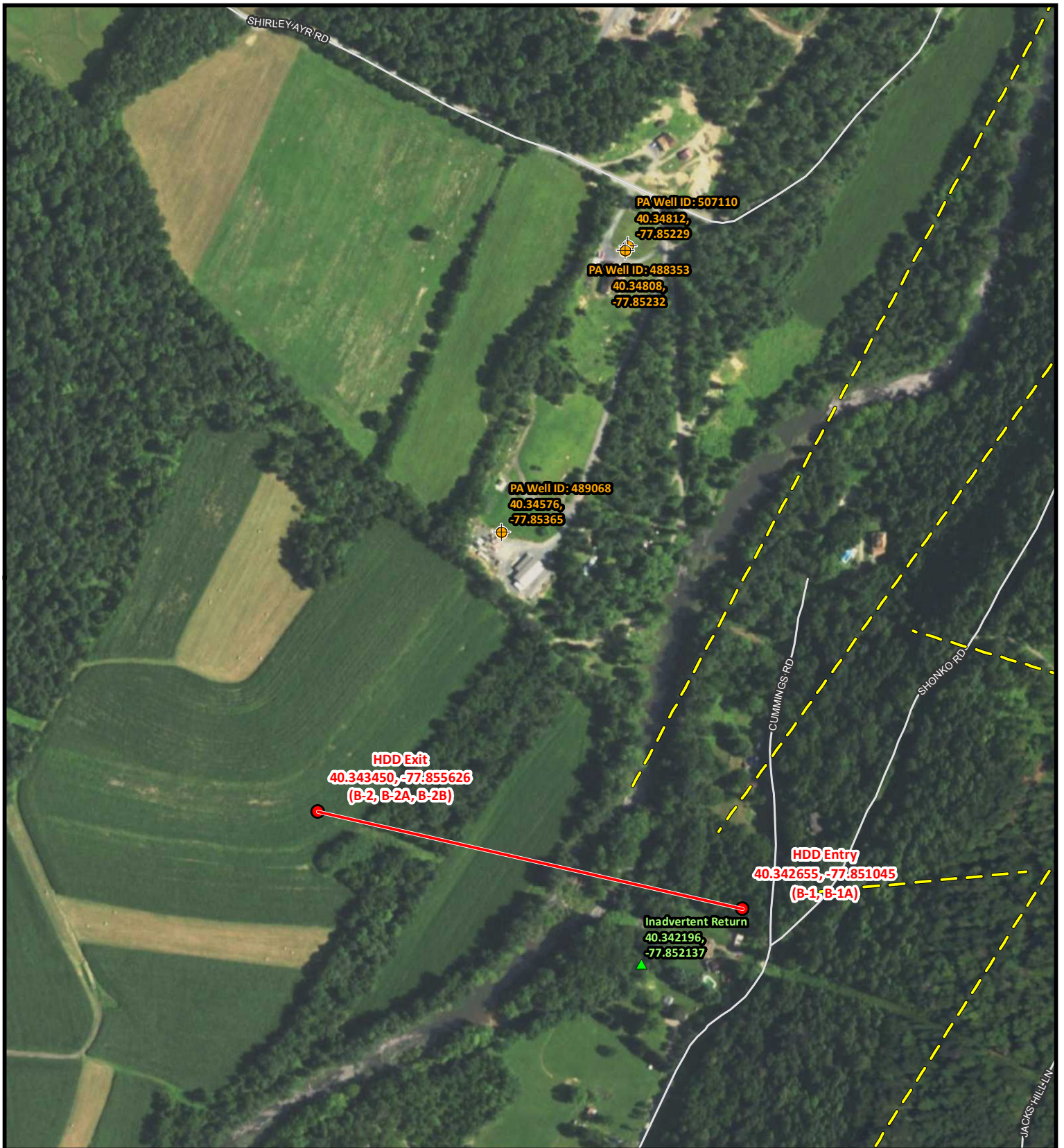








0 3,000  
 Feet  
 1 inch = 3,000 feet

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










	Inadvertent Return		HDD Profile
	Residential Well		Inferred Fracture Trace
	HDD Entry/Exit		Road

9/5/2017

**Sunoco Pipeline, L.P.**  
**Aughwick Creek HDD Location**  
**Figure 3 - Aerial Basemap**  
 Shirley Township, Huntingdon County, PA  
 Project No. 096302011



0 400  
Feet  
1 inch = 400 feet

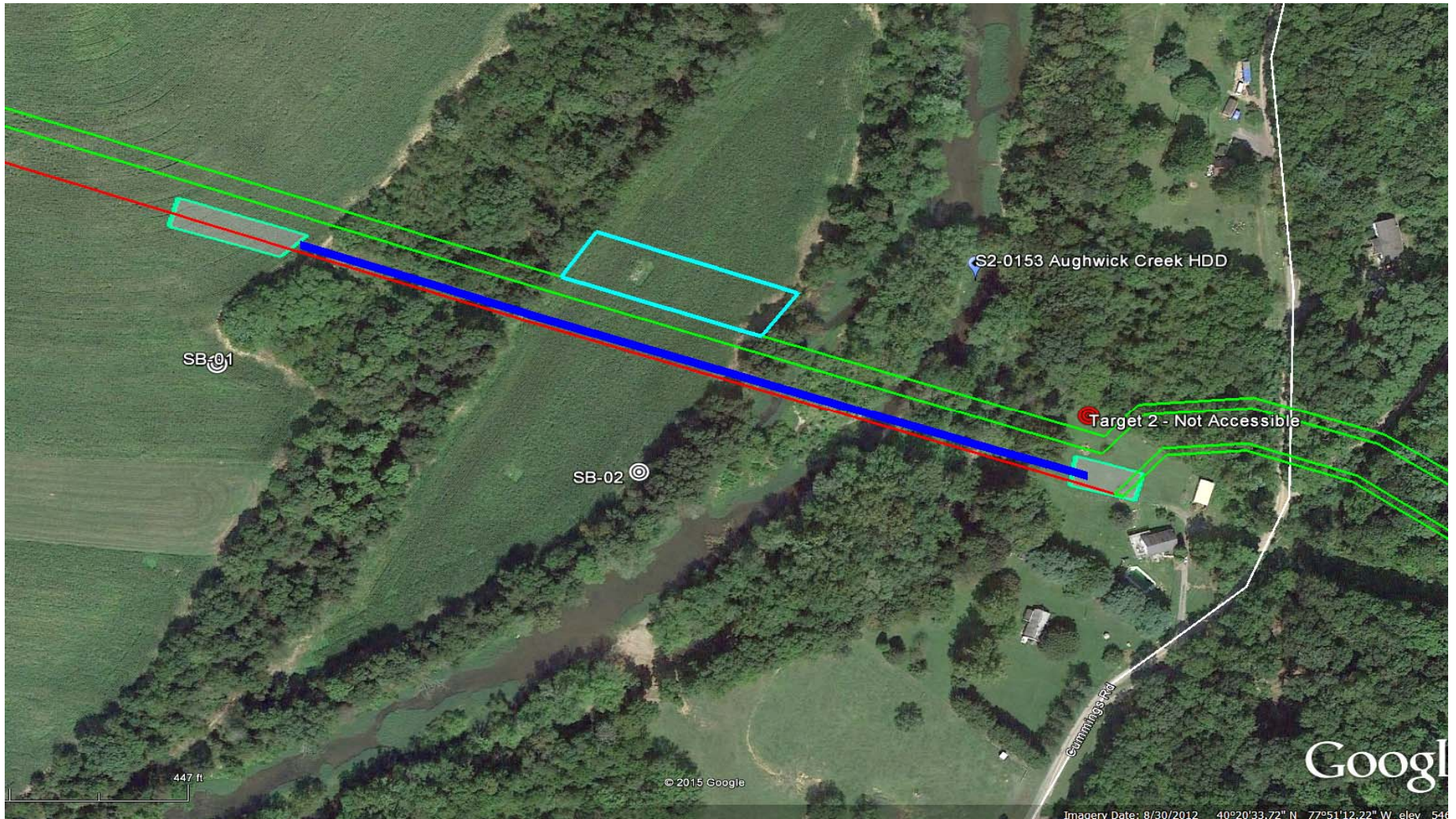
  


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



**ATTACHMENT 1  
GEOTECHNICAL BORING LOGS**





**LEGEND:**

⊙ Geotechnical Soil Boring (SB) Locations



**TETRA TECH**

GEOTECHNICAL BORING LOCATIONS

HDD S2-0153

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: US 522, SHIRLEYSBURG, PA		Page 1 of 1	
HDD No.: S2-0153	Dates(s) Drilled: 01-22-15	Inspector: E. WATT	
Boring No.: SB-01	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 6.7	
Boring Location Coordinates:		40°20'34.37"N	77°51'20.29"W

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
	From	To	From	To								
			0.0	0.4			TOPSOIL (5").					
1	3.0	5.0	0.4		24	CL	MOTTLED BROWN, ORANGE BROWN, RED BROWN AND YELLOW BRWN	5	12	10	15	22
2	6.5	6.7			1.5		SILTY CLAY WITH SOME F-SAND, A LITTLE F-GRAVEL. (USCS: CL).					
				6.7			ORANGE BROWN SILTY CLAY WITH SOME FINE SAND, AND	50/2"				>50
							SOME SANDSTONE GRAVEL.					
							AUGER REFUSAL AT 6.5'. OFF-SET 23' EAST AND CONTINUOUSLY					
							AUGERED TO REFUSAL AT 6.5'. OFF-SET CLOSER TO ORIGINAL					
							LOCATION AND CONTINUOUSLY AUGERED TO 6.2'.					
							CAVED AT 5'.					
							REFUSAL MATERIAL MAY BE DUE TO BOULDERY SUBSURFACE,					
							COULD NOT PENETRATE DEEPER.					
							SANDSTONE OUTCROPS OBSERVED AT SURFACE IN VICINITY OF					
							BORING.					

Notes/Comments:  
Pocket Penetrometer 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.



**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:	US 522, WEST SIDE OF AUGHWIZK CREEK, MOUNT UNION, PA			Page 1 of 1	
HDD No.:	S2-0153	Dates(s) Drilled:	01-23-15	Inspector:	E. WATT
Boring No.:	SB-02	Drilling Method:	SPT - ASTM D1586	Driller:	S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft):	NOT ENCOUNTERED	Total Depth (ft):	36.9
Boring Location Coordinates:	40°20'32.84"N		77°51'13.34"W		

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (in)	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		20	CL	ORANGE BROWN SILTY CLAY WITH A LITTLE FINE SAND.	3	6	7	8	13	
2	8.0	10.0			20		MOTTLED (BROWN AND DARK BROWN) SILTY CLAY WITH SOME FINE SAND. (USCS: CL).	3	10	12	22	22	
3	13.0	15.0	9.9		24	SC/CL	YELLOWISH BROWN FINE TO MEDIUM SAND AND SILTY CLAY, WITH SOME UNWEATHERED SHALE GRAVEL.	5	11	12	18	23	
4	18.0	18.9			12		YELLOWISH BROWN FINE TO MEDIUM SAND AND SILTY CLAY, WITH SOME UNWEATHERED SHALE GRAVEL. (USCS: SC/CL).	7	50/5"				>50
5	23.0	23.9	21.0		13	WEATHERED ROCK	GRAY AND GREENISH GRAY WEATHERED SHALE.	13	50/5"				>50
6	27.0	27.3			4		GRAY WEATHERED LIMESTONE.	50/4"					>50
							AUGER REFUSAL AT 27.7'.						
							<u>ROCK CORING</u>						
RUN 1	27.7	31.9	27.70		42	FRAGMENTED LIMESTONE ROCK	GRAY MODERATELY FRACTURED LIMESTONE. FRACTURES AT 28.24, 29.14, 29.5. OXIDATION LENSES THROUGHOUT.	TCR: 83%, SCR: 48%, RQD: 44%					
			29.50				GRAY INTENSELY FRACTURED LIMESTONE.						
			30.10				GRAY MODERATELY FRACTURED LIMESTONE.						
			30.70	31.90			GRAY VERY INTENSELY FRACTURED LIMESTONE.						
RUN 2	31.9	36.9	31.90	33.88	54		GRAY MODERATELY FRACTURED LIMESTONE.	TCR: 55%, SCR: 27%, RQD: 27%					
			33.88				GRAY VERY INTENSELY FRACTURED AND WEATHERED LIMESTONE.						
			36.90				FRACTURE BREAK AT 33.88 APPEARS TO BE VERTICAL.						
							<u>CORE TESTING RESULTS (RUN 1, DEPTH 30.2):</u>						
							COMPRESSIVE STRENGTH: 2,110 PSI						
							UNIT WEIGHT: 161.6 PCF						
							<u>CORE TESTING RESULTS (RUN 2, DEPTH 32.5):</u>						
							COMPRESSIVE STRENGTH: 840 PSI						
							UNIT WEIGHT: 160.2 PCF						

Notes/Comments:  
Pocket Pentrometer Testing CAVED AT 27".  
 S1: > 4 TSF  
 S2: > 4 TSF

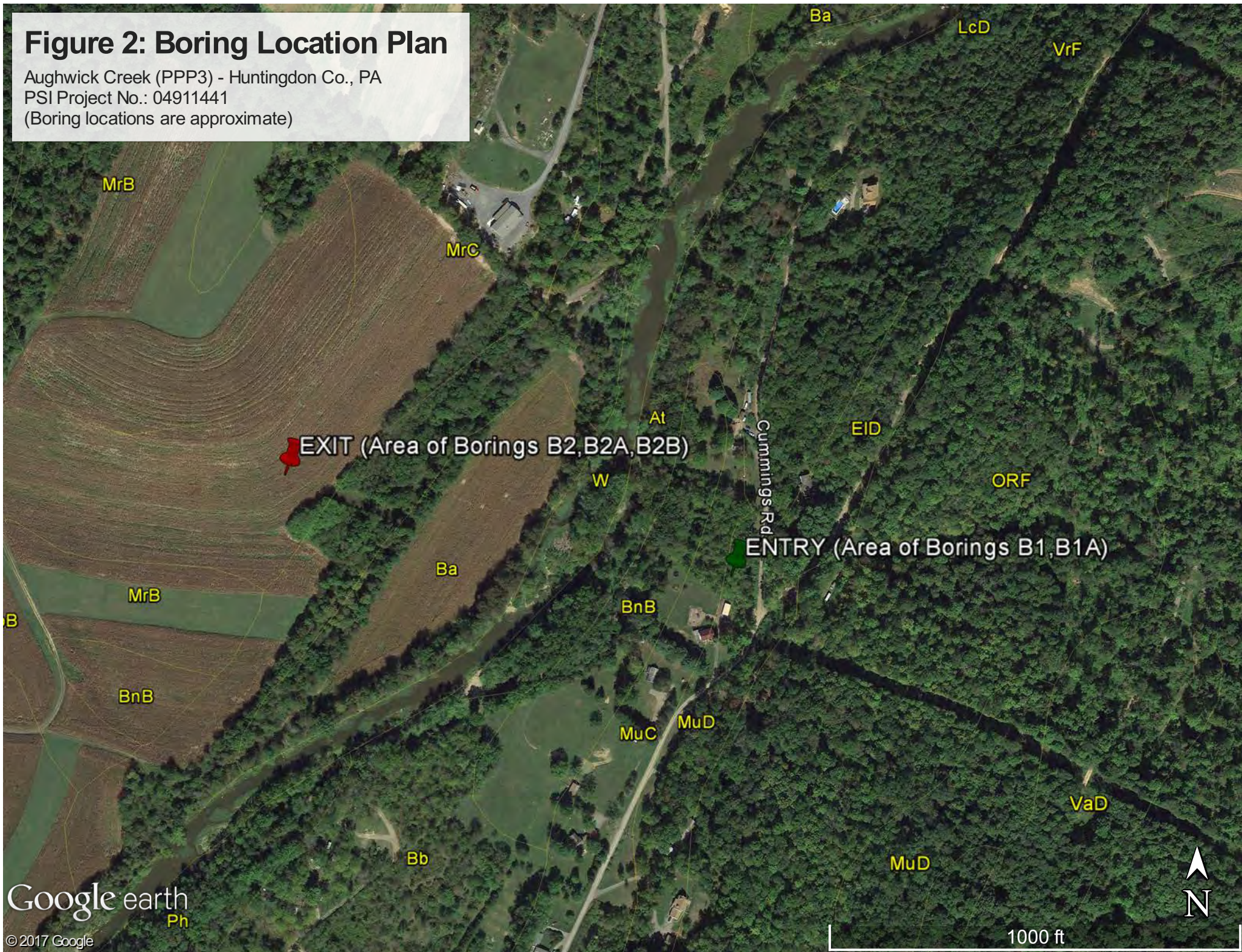
Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.

\* 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.



# Figure 2: Boring Location Plan

Aughwick Creek (PPP3) - Huntingdon Co., PA  
PSI Project No.: 04911441  
(Boring locations are approximate)





DATE STARTED: 7/19/17  
 DATE COMPLETED: 7/20/17  
 COMPLETION DEPTH: 55.0 ft  
 BENCHMARK: N/A  
 ELEVATION: N/A  
 LATITUDE: n/a°  
 LONGITUDE: n/a°  
 STATION: N/A    OFFSET: N/A  
 REMARKS:

DRILL COMPANY: Terra-Testing, Inc.  
 DRILLER: M. Schirra    LOGGED BY: P. McMichael  
 DRILL RIG: Diedrich D50  
 DRILLING METHOD: Hollow Stem Auger  
 SAMPLING METHOD: 2-in SS  
 HAMMER TYPE: Automatic  
 EFFICIENCY: N/A  
 REVIEWED BY: P. McMichael

**BORING B-1**  
 Water: While Drilling 30 feet  
 BORING LOCATION: See 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	15	<b>COLLUVIUM</b> - Very Stiff, Brown Lean CLAY with Sand, moist	CL	3-8-10-10 N=18	○		
5				S-2	24	<b>COLLUVIUM</b> - Very Stiff, Brown Sandy Lean CLAY, trace Gravel, moist	CL	4-6-10-12 N=16	○		
10				S-3	18	<b>COLLUVIUM</b> - Very Dense, Tan Silty SAND with Gravel, moist  NOTE: Below a depth of 7 feet moderately slow, difficult/"choppy" augering.	SM	5-27-24-24 N=51			>>○
15				S-4	8	<b>COLLUVIUM</b> - Very Dense, Buff/Light Brown Poorly Graded GRAVEL with Silt and Sand, moist	GP-GM	22-50/5"			>>○
20				S-5	5	<b>COLLUVIUM/DECOMPOSED SANDSTONE?</b> - Loose to Dense, White/Very Pale Gray Silty/Clayey SAND, varying amounts of gravel, moist to wet  Note: Possible cobble-sized rock based on auger reactions		50/5"			>>○
25				S-6	18	Sample S6: Soil Mottling	SC/SM	11-16-18-35 N=34			
30											

Continued Next Page



Professional Service Industries, Inc.  
 1707 S. Cameron Street, Suite B  
 Harrisburg, PA 17104  
 Telephone: (717) 230-8622

PROJECT NO.: 04911441  
 PROJECT: Energy Transfer HDD (DPS)  
 LOCATION: Aughwick Creek (PPP3)  
 Huntingdon Co., PA  
 PA-HU-0078.0000-WX/PO#20170724


DATE STARTED: 7/19/17  
 DATE COMPLETED: 7/20/17  
 COMPLETION DEPTH: 55.0 ft  
 BENCHMARK: N/A  
 ELEVATION: N/A  
 LATITUDE: n/a°  
 LONGITUDE: n/a°  
 STATION: N/A    OFFSET: N/A  
 REMARKS:

DRILL COMPANY: Terra-Testing, Inc.  
 DRILLER: M. Schirra    LOGGED BY: P. McMichael  
 DRILL RIG: Diedrich D50  
 DRILLING METHOD: Hollow Stem Auger  
 SAMPLING METHOD: 2-in SS  
 HAMMER TYPE: Automatic  
 EFFICIENCY: N/A  
 REVIEWED BY: P. McMichael

**BORING B-1**  
 Water: While Drilling 30 feet

**BORING LOCATION:**  
 See 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
30				S-7	18	<b>COLLUVIUM/DECOMPOSED SANDSTONE?</b> - Loose to Dense, White/Very Pale Gray Silty/Clayey SAND, varying amounts of gravel, moist to wet  Note: Possible cobble-sized rock based on auger reactions		8-10-11-4 N=21			
35				S-8	18	Sample S9: Loose/Medium Dense		5-5-5-5 N=10			
40				S-9	0		SC/SM	50/2"			
45				S-10	2	Sample S10: A collected piece of gravel-sized "rock" felt abrasive and appeared microcrystalline with a Moh's hardness between 7 and 8.		50/3"			
50				S-11	24	Sample S11: Very Loose/Loose		10-3-2-5 N=5			
55						Test Boring Terminated @ 55 ft  A string of augers (15 LF) broke of and remain in bottom of borehole.					

 <p><b>Intertek</b> <b>PSI</b> Total Quality. Assured.</p>	Professional Service Industries, Inc. 1707 S. Cameron Street, Suite B Harrisburg, PA 17104 Telephone: (717) 230-8622	<b>PROJECT NO.:</b> 04911441 <b>PROJECT:</b> Energy Transfer HDD (DPS) <b>LOCATION:</b> Aughwick Creek (PPP3) Huntingdon Co., PA PA-HU-0078.0000-WX/PO#20170724
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**DATE STARTED:** 7/21/17 **DRILL COMPANY:** Terra-Testing, Inc.  
**DATE COMPLETED:** 7/21/17 **DRILLER:** M. Schirra **LOGGED BY:** C. Lehman  
**COMPLETION DEPTH:** 70.0 ft **DRILL RIG:** Diedrich D50  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** N/A **SAMPLING METHOD:** 2-in SS  
**LATITUDE:** n/a° **HAMMER TYPE:** Automatic  
**LONGITUDE:** n/a° **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** P. McMichael  
**REMARKS:**

# BORING B-1A

Water

**BORING LOCATION:**  
See 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						Augered w/o sampling to depth of 60 ft. Below are soil descriptions based on augur cuttings:					
5						~0 to 10 ft: Brown/Red Brown Lean Clay with Sand					
10						10 to 15 ft: Light Red Brown Lean Clay with Sand					
15						15 to 20 ft: Light Red Brown Sandy Lean Clay, trace sandstone fragments					
20						20 to 30 ft: Light Red Brown Poorly Graded Sand with Gravel (sandstone?)					
25											
30						No auger cutting returns after 30 ft					
35											
40											
45											
50											
55											
60				S-1	12	<b>COLLUVIUM/DECOMPOSED SANDSTONE?</b> - Medium Dense, Tan & Light Gray Poorly Graded SAND with Gravel (sandstone?), wet		4-8-13-12 N=21			
65				S-2	4	<b>COLLUVIUM/DECOMPOSED SANDSTONE?</b> -Very Dense, Tan & Light Gray Poorly Graded SAND with Gravel (sandstone?), wet		50/4"			
70						Test Boring Terminated @ 70 ft A string of heavy duty augurs (15 LF) broke off and remain in bottom of borehole.					



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**PROJECT NO.:** 04911441  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Aughwick Creek (PPP3)  
 Huntingdon Co., PA  
 PA-HU-0078.0000-WX/PO#20170724

**DATE STARTED:** 7/24/17  
**DATE COMPLETED:** 7/24/17  
**COMPLETION DEPTH:** 15.1 ft  
**BENCHMARK:** N/A  
**ELEVATION:** N/A  
**LATITUDE:** n/a°  
**LONGITUDE:** n/a°  
**STATION:** N/A    **OFFSET:** N/A  
**REMARKS:**

**DRILL COMPANY:** Terra-Testing, Inc.  
**DRILLER:** M. Schirra    **LOGGED BY:** Driller  
**DRILL RIG:** CME-75  
**DRILLING METHOD:** Hollow Stem Auger  
**SAMPLING METHOD:** 2-in SS  
**HAMMER TYPE:** Automatic  
**EFFICIENCY:** N/A  
**REVIEWED BY:** P. McMichael

## BORING B-2

**Water**    ▽ While Drilling    Not Enc.  
               ▼  
               ▼

**BORING LOCATION:**  
 See 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		<b>RESIDUUM</b> - Dense, Brown Silty SAND with Gravel, moist	SM	5-15-16-33 N=31	X Moisture    ◻ PL ◼ LL	▲ Qu    * Qp	
5			S-2		<b>RESIDUUM</b> - Medium Dense, Brown Poorly Graded GRAVEL with Silt and Sand, moist	GP-GM	11-21-13-14 N=34				
10			S-3		<b>Weathered SANDSTONE Sample As:</b> - Very Dense, Buff/White Poorly Graded GRAVEL, dry  No Rx to 10%HCL	GP	22-9-11-50/3" N=20				
15			S-4		Boring Terminated @ 15.1 ft ("Burned-up" auger bit - Borehole backfilled with cuttings)		50/1"				



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**PROJECT NO.:** 04911441  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Aughwick Creek (PPP3)  
 Huntingdon Co., PA  
 PA-HU-0078.0000-WX/PO#20170724



**DATE STARTED:** 7/24/17 **DRILL COMPANY:** Terra-Testing, Inc.  
**DATE COMPLETED:** 7/24/17 **DRILLER:** M. Schirra **LOGGED BY:** Driller  
**COMPLETION DEPTH:** 14.0 ft **DRILL RIG:** CME-75  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** N/A **SAMPLING METHOD:** 2-in SS  
**LATITUDE:** n/a° **HAMMER TYPE:** Automatic  
**LONGITUDE:** n/a° **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** P. McMichael  
**REMARKS:**

## BORING B-2A

**Water**  While Drilling  Not Enc.

**BORING LOCATION:**  
 See 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, %	STANDARD PENETRATION TEST DATA				Additional Remarks
										N in blows/ft ©				
0						Augered to 14 ft w/o sampling								
5														
10														
						Boring Terminated @ 14 ft ("Burned-up" auger bit - Borehole backfilled with cuttings)								



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**PROJECT NO.:** 04911441  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Aughwick Creek (PPP3)  
Huntingdon Co., PA  
PA-HU-0078.0000-WX/PO#20170724

**DATE STARTED:** 7/24/17  
**DATE COMPLETED:** 7/28/17  
**COMPLETION DEPTH:** 100.0 ft  
**BENCHMARK:** N/A  
**ELEVATION:** N/A  
**LATITUDE:** n/a°  
**LONGITUDE:** n/a°  
**STATION:** N/A    **OFFSET:** N/A  
**REMARKS:**

**DRILL COMPANY:** Terra-Testing, Inc.  
**DRILLER:** M. Schirra    **LOGGED BY:** Driller  
**DRILL RIG:** CME-75  
**DRILLING METHOD:** Hollow Stem Auger  
**SAMPLING METHOD:** 2-in SS1.874-in Core  
**HAMMER TYPE:** Automatic  
**EFFICIENCY:** N/A  
**REVIEWED BY:** P. McMichael

## BORING B-2B

**Water**    ▽ While Drilling    Not Enc.  
 ▼  
 ▼

**BORING LOCATION:**  
 See 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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft © X Moisture    ▣ PL + LL  STRENGTH, tsf ▲ Qu            * Qp	Additional Remarks
0						Augered to 17 ft w/o sampling.  Field driller description of cuttings: "Brown Sand & Gravel, Medium to V. Dense, Dry"					
	5										
	10										
	15										
	20			R-1	59	<b>SANDSTONE-</b> Buff/Light Gray, Fine-Grained, Hard, Broken <b>SANDSTONE-</b> Buff/Light Gray, Fine-Grained, Hard, Slightly Broken to Massive  No Rx to 10%HCL		RQD=88 Rec=98%		7 min. 8 min. >>© 7 min.	
	25			R-2	60	<b>SANDSTONE-</b> Buff/Light Gray, Fine-Grained, Hard, Broken to Slightly Broken  <b>SANDSTONE-</b> Buff/Light Gray, Fine-Grained, Hard, Slightly Broken to Massive		RQD=56 Rec=100%		9 min. 9 min. 5 min. 5 min. 4 min.	
	30			R-3	59			RQD=88		6 min. 7 min. 8 min. 8 min.	

*Continued Next Page*



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**PROJECT NO.:** 04911441  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Aughwick Creek (PPP3)  
 Huntingdon Co., PA  
 PA-HU-0078.0000-WX/PO#20170724

**DATE STARTED:** 7/24/17 **DRILL COMPANY:** Terra-Testing, Inc.  
**DATE COMPLETED:** 7/28/17 **DRILLER:** M. Schirra **LOGGED BY:** Driller  
**COMPLETION DEPTH:** 100.0 ft **DRILL RIG:** CME-75  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** N/A **SAMPLING METHOD:** 2-in SS1.874-in Core  
**LATITUDE:** n/a° **HAMMER TYPE:** Automatic  
**LONGITUDE:** n/a° **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** P. McMichael  
**REMARKS:**

## BORING B-2B

**Water** ▽ While Drilling Not Enc.  
▼  
▼

**BORING LOCATION:**  
 See 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) RQD & Recovery % (NX)	Moisture, %	STRENGTH, tsf	Additional Remarks
30						<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Slightly Broken to Massive		Rec=98%			10 min.
						<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Broken to Very Broken					10 min.
				R-4	59	<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Massive		RQD=64 Rec=98%			11 min.
35						<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Massive					25 min.
						<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Slightly Broken to Massive					5 min.
				R-5	44	No Rx to 10%HCL		RQD=52 Rec=74%			5 min.
40						<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Slightly Broken to Massive					3 min.
						<b>VOID</b> (~1-foot)					20 min.
				R-6	50	<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Slightly Broken		RQD=76 Rec=84%			15 min.
45						<b>VOID</b> (~1-foot)					2 min.
						<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Slightly Broken					2 min.
						No Rx to 10%HCL					4 min.
				R-7	28	<b>VOID</b> (~1-foot)		RQD=42 Rec=46%			2 min.
50						<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Slightly Broken to Broken					2 min.
						<b>VOID</b> (~1-foot)					0 min.
						No Rx to 10%HCL					3 min.
						<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Slightly Broken to Broken		RQD=14 Rec=44%			0 min.
55				R-8	26	<b>VOID</b> (~1-foot)					5 min.
						No Rx to 10%HCL					5 min.
						<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Slightly Broken to Broken					1 min.
						No Rx to 10%HCL					1 min.
						<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Slightly Broken to Broken					2 min.
						No Rx to 10%HCL					2 min.
						<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Slightly Broken to Broken					3 min.
				R-9	40	<b>SANDSTONE</b> - Buff/Light Gray, Fine-Grained, Hard, Slightly Broken to Broken		RQD=36			3 min.
60											

*Continued Next Page*



Professional Service Industries, Inc.  
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 Telephone: (717) 230-8622

**PROJECT NO.:** 04911441  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Aughwick Creek (PPP3)  
 Huntingdon Co., PA  
 PA-HU-0078.0000-WX/PO#20170724

DATE STARTED: 7/24/17  
 DATE COMPLETED: 7/28/17  
 COMPLETION DEPTH: 100.0 ft  
 BENCHMARK: N/A  
 ELEVATION: N/A  
 LATITUDE: n/a°  
 LONGITUDE: n/a°  
 STATION: N/A    OFFSET: N/A  
 REMARKS:

DRILL COMPANY: Terra-Testing, Inc.  
 DRILLER: M. Schirra    LOGGED BY: Driller  
 DRILL RIG: CME-75  
 DRILLING METHOD: Hollow Stem Auger  
 SAMPLING METHOD: 2-in SS1.874-in Core  
 HAMMER TYPE: Automatic  
 EFFICIENCY: N/A  
 REVIEWED BY: P. McMichael

**BORING B-2B**  
 Water:  While Drilling     Not Enc.

**BORING LOCATION:**  
 See 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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft © X Moisture    PL LL + STRENGTH, tsf ▲ Qu    * Qp	Additional Remarks
60								Rec=66%			5 min.
						VOID (~1.5-foot)					1 min.
						Weathered SANDSTONE- Buff/Light Gray, Fine-Grained, Hard, Very Broken		RQD=0 Rec=24%			1 min.
65			R-10	14		No Rx to 10%HCL See Note 1 below VOID (~6-foot)					0 min.
											1 min.
											15 min.
											2 min.
											0 min.
											0 min.
70			R-11	0				RQD=0 Rec=0%			0 min.
											0 min.
											0 min.
						Weathered SANDSTONE- Buff/Light Gray, Fine-Grained, Hard, Broken to Very Broken					0 min.
						No Rx to 10%HCL					3 min.
						VOID (~0.5-foot)		RQD=44 Rec=88%			6 min.
75			R-12	53		LIMESTONE- Blue Gray, Very Fine-to-Fine-Grained, Hard, Broken to Slightly Broken					2 min.
						Moderate to High RX to 10%HCL					7 min.
						LIMESTONE- Blue Gray, Very Fine-to-Fine-Grained, Hard, Slightly Broken to Massive					10 min.
						Moderate to High RX to 10%HCL		RQD=66 Rec=100%			7 min.
											9 min.
											10 min.
											8 min.
											20 min.
											7 min.
											10 min.
85			R-14	50				RQD=74 Rec=84%			8 min.
											10 min.
											11 min.
											8 min.
											20 min.
90			R-15	30				RQD=0			

Continued Next Page



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 LOCATION: Aughwick Creek (PPP3)  
 Huntingdon Co., PA  
 PA-HU-0078.0000-WX/PO#20170724

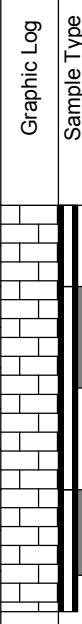
**DATE STARTED:** 7/24/17  
**DATE COMPLETED:** 7/28/17  
**COMPLETION DEPTH:** 100.0 ft  
**BENCHMARK:** N/A  
**ELEVATION:** N/A  
**LATITUDE:** n/a°  
**LONGITUDE:** n/a°  
**STATION:** N/A    **OFFSET:** N/A  
**REMARKS:**

**DRILL COMPANY:** Terra-Testing, Inc.  
**DRILLER:** M. Schirra    **LOGGED BY:** Driller  
**DRILL RIG:** CME-75  
**DRILLING METHOD:** Hollow Stem Auger  
**SAMPLING METHOD:** 2-in SS1.874-in Core  
**HAMMER TYPE:** Automatic  
**EFFICIENCY:** N/A  
**REVIEWED BY:** P. McMichael

## BORING B-2B

**Water**    ▽ While Drilling    Not Enc.  
 ▼  
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**BORING LOCATION:**  
 See 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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft © X Moisture    ▣ PL + LL	STRENGTH, tsf ▲ Qu            * Qp	Additional Remarks	
90						<b>LIMESTONE-</b> Blue Gray, Very Fine-to-Fine-Grained, Hard, Moderate to High RX to 10%HCL.  The recovered rock ranged from Broken to Massive with several vertical fractures with unweathered surfaces. The rock core recoveries for R-15 (87 to 92 ft) and R-16 (92 to 97 ft) were generally low. The driller indicated he believed the recovery losses were the result of "gravel" zones (very broken rock?).						6 min.	
			R-16	30			RQD=18 Rec=50%						10 min.
			R-17	25			RQD=53 Rec=70%						12 min.
						Test Boring Terminated @ 100 ft						10 min.	
						Note 1: Beginning at Core Runs R-10 (62-67 ft) and R-11 (67-72 ft), the rock core diameter changed from ~2-in to ~1-3/4-in. The driller indicated NQ-sized rock barrels were utilized throughout coring. However, due to core bit burns outs, several core bits were utilized in order to advance the rock coring, particularly through the limestone rock which appeared in Core Run R-12 (72-77 ft).  Note 1: Borehole tremie grouting was attempted on 07/29/2017; however, driller reported they were not able to raise the grout level above the bottom void or above an appx depth of 74.5 ft below grade (after introducing appx 110 gallons of grout). The driller returned after the weekend and through a combination of casing through voids (PVC pipe) and bentonite, was able to grout the balance of the borehoole.						12 min.	
												8 min.	
												10 min.	
												9 min.	
												10 min.	
												8 min.	



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 Telephone: (717) 230-8622

**PROJECT NO.:** 04911441  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Aughwick Creek (PPP3)  
 Huntingdon Co., PA  
 PA-HU-0078.0000-WX/PO#20170724