HORIZONTAL DIRECTIONAL DRILL ANALYSIS
YELLOW BREECHES CREEK CROSSING
PADEP SECTION 105 PERMIT NO.S: E21-449
PA-CU-0203.0000-WX & PA-CU-0203.0000-WX-16
(SPLP HDD No. S2-0250)

YELLOW BREECHES CROSSING
PADEP SECTION 105 PERMIT NO.S: E21-449
PA-CU-0203.0000-WX & PA-CU-0203.0000-WX-16
(SPLP HDD No. S2-0250)

This reanalysis of the horizontal directional drill (HDD) installation of a 16-inch and 20-inch diameter pipeline crossing under Yellow Breeches Creek, is in accordance with Stipulated Order issued under Environmental Hearing Board Docket No. 2017-009-L for HDDs listed on Exhibit 2 of the Stipulated Order. This HDD is number 14 on the list of HDDs included on Exhibit 2. This HDD was not initiated before the issuance of the Order.

PIPE INFORMATION

20-Inch: 0.456 wall thickness; X-65
16-Inch: 0.438 wall thickness; X-70

Pipe stress allowances are an integral part of the design calculations performed for each HDD.

ORIGINAL HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 20-INCH

- Horizontal length: 2,259 foot (ft)
- Entry/Exit angle: 12-15 degrees
- Maximum Depth of cover: 84 ft
- Depth under Yellow Breeches Creek: 32 ft
- Depth under wetland W-124: 42 ft
- Depth below Stream S-134: 20 ft
- Pipe design radius: 2,000 ft

ORIGINAL HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 16-INCH

- Horizontal length: 2,300 foot (ft)
- Entry/Exit angle: 12-15 degrees
- Maximum Depth of cover: 84 ft
- Depth under Yellow Breeches Creek: 36 ft
- Depth under wetland W-124: 46 ft
- Depth below Stream S-134: 25 ft
- Pipe design radius: 1,600 ft

GEOLOGIC AND HYDROGEOLOGIC ANALYSIS

This HDD is situated in the northern portion of the Gettysburg-Newark Lowland Section of the Piedmont Physiographic Province. In eastern Pennsylvania, this portion of the Gettysburg-Newark Lowland Physiographic Province is underlain by sedimentary and igneous rocks of the Newark Group. These sedimentary rocks were deposited in a fault-bounded rift basin, commonly referred to as the Newark Basin, during late Triassic through early Jurassic time (Root and MacLachlan, 1999). According to Berg and Dodge (1981), the area near HDD S2-0250 is underlain by both clastic rocks (i.e., conglomerate, siltstone/sandstone, and shale) that are mapped as the Gettysburg Formation of Triassic age (Trg) and crystalline igneous (intrusive) Diabase rocks of Jurassic age (Jd). Locally, the sedimentary sequence is interbedded with basaltic lava flows and is intruded by diabase dikes and sills. The dominant topography is rolling lowlands, shallow valley and isolated hills with low to moderate relief. The predominant rock type consists mainly of red shale, siltstone, and sandstone with some conglomerate and diabase. The

predominant geologic structure within this physiographic section consists of a half-graben having low, monoclinal, northwest-dipping beds. The drainage pattern is dendritic and trellis.

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

According to Low, et. al (2002), the depths of water-bearing zones in 322 wells completed in the Gettysburg Formation range from 5 to 900 feet bgs. Fifty percent (50%) of the water-bearing zones were penetrated at a depth of less than 115 feet with 90% of the water-bearing zones occurring at a depth of less than 288 feet. The greatest density of water-bearing zones (0.65 per 50 feet of well depth) is from 51 to 100 feet bgs.

The dense, uniform, crystalline, non-granular matrix of the Diabase lacks bedding planes or consistent foliation and therefore possesses very low primary porosity and hydraulic conductivity. Although abundant, joint openings within the Diabase provide very low secondary porosity (low permeability) and, combined with the corresponding low hydraulic conductivity, there is minimal pore space. As a result, the storage and transmission of groundwater in the Diabase are primarily dependent on the degree and extent of fracturing. Water levels in the Diabase show a strong seasonal influence. A thin mantle of stiff clay that is relatively impervious to moisture generally overlies Diabase bedrock. This results in poor drainage in low-lying areas underlain by Diabase (Low, et. al, 2002). Water levels from 191 inventoried wells within this unit range from flowing at the land surface to 155 feet bgs with a median water level of 14 feet bgs. The depths of water-bearing zones from 145 wells completed in the Diabase range from 4 to 583 feet bgs. Fifty percent (50%) of the 249 water-bearing zones reported were penetrated at a depth of less than 75 feet with 90% of the water-bearing zones occurring at a depth of less than 226 feet.

Well records from the Pennsylvania Department of Conservation and Natural Resources (PA DCNR) Pennsylvania Groundwater Information System (PaGWIS) database were reviewed to provide information on well depths and yields. The search identified 32 wells within the 0.5-mile radius of the HDD consisting of domestic private supply wells. The public well records indicate the majority of these wells were completed as 6-inch-diameter open-rock wells at depths ranging from 89 to 1,000 feet bgs. Based solely on the PaGWIS database, the depth to bedrock ranges from 0 to 107 feet, and well construction consists of 17 to 174 feet of steel casing with the open-rock portions of the wells extending from 17 feet to 1,000 feet bgs. Reported well yields range from 0 to 60 gpm. Static water level measurements were recorded and range from 17 to 300 feet bgs. Based on the PaGWIS database, the majority of the wells identified above were completed in the Gettysburg Formation. The production zone for waters wells within bedrock is from the well bottom to highest point of water inflow from the water bearing seams, joints, and fractures in the rock formation.

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

INADVERTENT RETURN (IR) DISCUSSION

HDD specialists for Sunoco Pipeline, L.P. (SPLP) reviewed the original design profiles for the 16 and 20-HDDs and determined there was an increased risk of an IR during the undercrossing of Yellow Breeches Creek and adjacent wetlands, and undercrossing of Stream S-134 due to the shallow depth of profile as summarized in the HDD design data above.

As presented and discussed in the conclusions section below, the profile for both the 16 and 20-inch pipelines have been redesigned longer in extent to allow for an increase in the profile depth below the creek, wetlands, and stream.

The new geotechnical data shows a transition from a diabase bedrock dominated subsurface profile west of Yellow Beeches Creek to a sandstone subsurface east of the creek. The west side of the HDD profile will encounter bedrock at 23 ft below ground surface (bgs) and pass through intact but only fair strength rock until 75 ft bgs, then passing through strata of intact and high strength rock, with recovery value of 100 and a RQD value of 75. As the profile deepens, the diabase rock continues to transition until sandstone is entered at 114 ft bgs having a recovery value of 100 and RQD value of 80, indicating high recovery and excellent strength. Where the HDD profile will be in the sandstone dominated subsurface, as shown by the new geotechnical data obtained east of Yellow Beeches Creek, the HDD profile will enter intact bedrock at 30 ft bgs, with the upper bedrock having a recovery value of 100 and RQD value of 100. As the profile deepens within the sandstone formation, rock quality values for recovery and RQD are consistently high, indicative of good to excellent integrity and excellent strength. The increase in the profile depth below resources, is by itself, a means to minimize the potential for IR's to occur during these HDDs.

Due to the approximate 70 ft of elevation difference between the HDD entry (west) side, and HDD exit (east) side, the potential for producing groundwater during the HDD exits. However, this difference in elevation is not extreme, and the produced water during the pilot and reaming phases will be utilized in the continuing HDD process and decrease the amount of water imported at the HDD rig, while simultaneously the drilling fluid viscosity is adjusted to account for produced water to ensure the returns are maintained as a flowable slurry.

ADJACENT FEATURES ANALYSIS

The crossing of Yellow Breeches Creek is located in Cumberland County, approximately 5.6 miles south of Harrisburg, PA. The pipeline route follows parallel to two (2) previously existing Sunoco pipelines.

This HDD location is within unmanaged deciduous woodlands and pasture. The HDD would cross under two (2) streams and one (1) wetland, none of which are designated as exceptional value. A 39 acre impoundment occurs approximately 440 ft north of the east HDD entry/exit point.

SPLP has identified all landowners with property located within 450 ft of the HDD alignment. There are seven (7) individual landowners with properties located within 450 ft of the HDD alignment. SPLP sent each of these landowners a notice letter via both certified and first-class mail on October 30, 2017, that included an offer to sample the landowner's private water supply/well in accordance with the terms of the Order and the Water Supply Assessment, Preparedness, Prevention and Contingency Plan. The letter also requested that each landowner contact the Right-of-Way agent for the local area and provide SPLP with information regarding: (1) whether the landowner has a well; (2) where that well is located, and its depth and size if known; and (3) whether the landowner would like to have the well sampled. In accordance with paragraph 10 of the Order, copies of the certified mail receipts for the letters sent to landowners have been provided to Karyn Yordy, Executive Assistant, Office of Programs at the Department's Central Office.

Through these communications and a ground investigation, SPLP has confirmed there are no private water wells within 450 ft of the HDD profile to the west of Yellow Breeches Creek. One landowner west of Yellow Breeches Creek, but more than 450 ft south of the HDD profile, has requested testing, and SPLP has completed this testing as requested. One landowner east of Yellow Breeches Creek within 450 ft of the HDD profile has requested testing, and SPLP intends to locate and sample the well on November 10, 2017. In addition, SPLP is currently investigating a second residence within 450 ft of the HDD profile east of Yellow Breeches Creek to determine whether a potable well is present. Both properties are east and

southeast of the east HDD entry/exit point, and therefore any water well located on these properties would be up gradient of the HDD profile and direction of groundwater movement. Because of the elevation difference between the west and east entry/exit of this HDD, there is the potential to create a drain for groundwater flows and temporarily lower the groundwater table on the east side of this HDD. The two wells in vicinity of the east HDD exit point will require monitoring for reduced water levels during the HDD.

Based on the response to the mailings and direct contact, the landowners with private water wells determined to be at risk during the HDD will be monitored and offered alternative water supplies until the HDD is complete.

ALTERNATIVES ANALYSIS

As required by the Order, the reanalysis of HDD S2-0250 includes an evaluation of open cut alternatives and a re-route analysis. As part of the PADEP Chapter 105 permit process for the Mariner II East Project, SPLP developed and submitted for review a project-wide Alternatives Analysis. During the development and siting of the Project, SPLP considered several different routings, locations, and designs to determine whether there was a practicable alternative to the proposed impact. SPLP performed this determination through a sequential review of routes and design techniques, which concluded with an alternative that has the least environmental impacts, taking into consideration cost, existing technology, and logistics. The baseline route provided for the pipeline construction was to cross every wetland and stream on the project by open cut construction procedures. The Alternatives Analysis submitted to PADEP conceptually analyzed the potential feasibility of any alternative to baseline route trenched resource crossings (e.g., reroute, conventional bore, HDD). The decision-making processes for selection of the HDD instead of an open cut crossing methodology is discussed thoroughly in the submitted alternatives analysis and was an important part of the overall PADEP approval of HDD plans as currently permitted. As described below, the open cut and re-route analyses have confirmed the conclusions reached in the previously submitted Alternatives Analysis.

The revised 20-inch and 16-inch HDDs are 2,600 ft and 2,580 ft in horizontal length respectively and includes the crossing of one significant stream channel, Yellow Breeches Creek, one minor stream channel, and approximately 440 ft of emergent and forested wetlands.

Open-cut Analysis

SPLP specifications require a minimum of 48-inches of cover over the installed pipelines. To meet these cover requirements, construction through the stream and wetlands would require a minimum authorized open cut work space 75 ft in width to accommodate the 16 and 20-inch pipelines, allowing for each pipeline to be installed with sufficient separation for integrity management. The assessed area of impact by this open cut plan would directly affect approximately 0.29 acres of state water bottoms, 0.58 acres of emergent wetland, and 0.10 acres of forested wetland.

The open cut crossing of the creek would require using geotube dams upstream and downstream of the crossing location. Water flows in the river would have to be pumped around the dammed section using a series of 8-inch pumps while a trench across the creek was excavated. While excavating the creek crossing, any consolidated rock in the creek bottom within the required depth of trench would have to be shattered using explosives, or if feasible, broken up for excavation using a rock hammer.

Due to the existing saturated ground conditions, a significant volume of produced groundwater would fill all the excavations during the open cut process. These water volumes could be pumped to a discharge filtration structure; however, the current feasible filtration ability does not exceed 50 microns, therefore,

cloudy water (from suspended fine clay and silt particles) would be discharged downstream regardless of all control methods employed for the entire duration of this crossing until completion.

The crossing distance of the emergent and forested wetlands, which are the most expansive natural features crossed by the HDDs, is beyond the technical limits of a conventional auger bore.

Re-Route Analysis

The pipeline route as currently permitted follows parallel to two (2) existing Sunoco pipelines.

There are no existing utility corridors to the north or south that provide a practical alternative route in near vicinity to this HDD. Any alternate route considered north or south of the existing utility corridor would require the clearing of a new "greenfield" corridor through existing woodlands and croplands or urban developments; would increase the number of stream crossings, and possibly encroach on additional private residences before it could rejoin the current route.

RECONSIDERATION OF THE HORIZONTAL DIRECTIONAL DRILL

SPLP HDD consultants reviewed the HDD designs and geotechnical data for this area. Based upon this review, it was determined that the risk of IRs to waters overlying the HDD could be reduced by increasing the depth of the original permitted HDD profile. Additional geologic investigations have been completed and utilized in the redesign of the planned HDD. The redesign adjusts the HDD profile deeper to place the HDD pathway through bedrock having better structural integrity than a shallower profile and increase the overall length of the HDD due to pipe design requirements. A summary of the redesign factors is provided below.

REVISED HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 20-INCH

- Horizontal length: 2,600 foot (ft)
- Entry/Exit angle: 12-15 degrees
- Maximum Depth of cover: 114 ft
- Depth under Yellow Breeches Creek: 61 ft
- Depth under wetland W-124: 71 ft
- Depth below Stream S-134: 62 ft
- Pipe design radius: 1,600 ft

REVISED HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 16-INCH

- Horizontal length: 2,580 foot (ft)
- Entry/Exit angle: 12-15 degrees
- Maximum Depth of cover: 94 ft
- Depth under Yellow Breeches Creek: 77 ft
- Depth under wetland W-124: 87 ft
- Depth below Stream S-134: 60 ft
- Pipe design radius: 1,600 ft

Upon the start of these HDDs, SPLP will employ the following HDD best management practices:

- 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 inspectors will ensure that an appropriate diameter pilot tool, relative to the diameter of the drilling pipe, is used to ensure adequate “annulus spacing” around the drilling pipe exits to allow good return flows during the pilot drilling;

- SPLP will mandate short-tripping of the reaming tools to ensure an open annulus is maintained to manage the potential inducement of IRs;

- SPLP will require monitoring of the drilling fluid viscosity, such that fissures and fractures in the subsurface are sealed during the drilling process; and

- 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.

CONCLUSION

It is SPLP’s intent to modify the original profile design and to pursue a deeper and longer HDD profile. Figures 1 and 3 in Attachment 2 presents the original HDD plan and profiles. Figures 2 and 4 presents the revised HDD plan and profiles.

YELLOW BREECHES CROSSING
PADEP SECTION 105 PERMIT NO.S: E21-449
PA-CU-0203.0000-WX & PA-CU-0203.0000-WX-16
(SPLP HDD No. S2-0250)

ATTACHMENT 1

GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT

RETTEW

We answer to you.

3020 Columbia Avenue, Lancaster, PA 17603 ● Phone: (800) 738-8395
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Engineers
Environmental Consultants
Surveyors
Landscape Architects
Safety Consultants

November 27, 2017

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

RE: Sunoco Pipeline, L.P. Pipeline Project - Mariner East II
Yellow Breeches Creek Horizontal Directional Drill Location (S2-0250)
Hydrogeological Re-Evaluation Report
Lower Allen Township, Cumberland County, Pennsylvania
RETTEW Project No. 096302011

Dear Mr. Gordon:

RETTEW Associates, Inc. is pleased to provide the enclosed Hydrogeological Re-Evaluation Report for the Yellow Breeches Creek Horizontal Directional Drill (HDD) Location (S2-0250). This HDD Re-Evaluation Report was performed as required by the Corrected Stipulated Order dated August 10, 2017. Please note that the HDD Re-Evaluation Report for S2-0250 was prepared by Skelly and Loy, Inc. (Skelly & Loy) under subcontract to RETTEW. Mr. Douglas Hess, Director of Groundwater and Site Characterization Services, was the Professional Geologist (PG) at Skelly and Loy that supervised the work for this report.

If you have any questions regarding the Hydrogeological Re-Evaluation Report for HDD S2-0250, please do not hesitate to call Mr. Hess at (717) 232-1799.

Sincerely,

Matthew T. Bruckner, PG
Project Manager

Enclosure

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November 27, 2017

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

Re: Sunoco PA Pipeline Project Mariner East II, Yellow Breeches Creek Horizontal Directional Drill (HDD) Location (S2-0250) Hydrogeological Re-Evaluation Report, Lower Allen Township, Cumberland County and Fairview Township, York County, Pennsylvania
Rettew Project No. 096302011

EXECUTIVE SUMMARY

1. The 20-inch S2-0250 Yellow Breeches Creek Horizontal Directional Drill (HDD) location is included in the Corrected Stipulated Order of August 10, 2017, requiring re-evaluation, including a geologic report.

2. The Yellow Breeches Creek HDD bore path is underlain by sedimentary rocks of the Triassic age Gettysburg Formation (Trg) and Triassic age Limestone Fanglomerate (Trfl) in addition to crystalline intrusive (igneous) rocks composed of Jurassic age Diabase (Jd).

3. Geologic mapping, published reports, and field observations indicate a moderate degree of bedrock fractures in the Gettysburg Formation that are characterized by a blocky joint pattern that is moderately to well-developed and open with low angle northwest dipping beds. Geologic mapping, published reports, and field observations indicate that the younger Diabase is characterized by moderately abundant, well-developed, and open joints exhibiting a blocky pattern that generally intruded along gently dipping bedding planes and fractures of older rock.

4. Water-bearing zones generally occur in secondary openings along bedding planes, joints, faults, and fractures. Water-bearing zones in the Gettysburg Formation are reported to be distributed within the first 5 to 900 feet of the subsurface, with the greatest density of water-bearing zones occurring within the upper 288 feet of the subsurface (half occur below 115 feet and 90% occur at depths of less than 288 feet). Water-bearing zones in the Diabase generally occur in the weathered zone at the top of the bedrock; however, half of these occur within the uppermost 75 feet of the subsurface, with the greatest density of water-bearing zones occurring within the upper 350 feet of the subsurface. As a result, the storage and transmission of groundwater in the Diabase is primarily dependent on the degree and extent of fracturing and joint development.

5. The proposed redesigned HDD bore path is relatively shallow compared with the land surface, wetlands, and streambeds of the Yellow Breeches Creek and unnamed tributary (Stream S-I34).

6. To date, no HDD operations for the proposed 20-inch pipeline have been initiated; therefore, no inadvertent returns (IRs) have occurred.

7. Based on the hydro-structural characteristics of the underlying geology and proposed redesigned bore paths through shallow unconsolidated soil materials and within shallow bedrock, the Yellow Breeches Creek proposed 20-inch and proposed 16-inch HDDs are susceptible to the inadvertent return of drilling fluids during HDD operations. The HDD profiles were redesigned to allow for deeper crossings beneath the streams. The inclination of the entry and exit angles has been increased as a means to install the pipe through protective soils, residual soils, and bedrock 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.

1.0 INTRODUCTION

The purpose of this report is to describe the hydrogeologic setting of the proposed Yellow Breeches Creek (S2-0250) HDD location on the Sunoco Pipeline, L.P. (SPLP) Pennsylvania Pipeline Project-Mariner East II (PPP-ME2) Project. The Yellow Breeches Creek HDD (the site) is located in Lower Allen Township, Cumberland County and Fairview Township, York County, Pennsylvania. The site is located approximately 0.5 mile south of the intersection of the Yellow Breeches Creek and the Pennsylvania Turnpike (I-76) and 1.6 miles northeast of the Village of Lisburn. The HDD was designed to be drilled under the Yellow Breeches Creek and the unnamed tributary stream channel S-I34 discharging to Yellow Breeches Creek (refer to **Figure 1**). This hydrogeologic report is part of the response to the Corrected Stipulated Order dated August 10, 2017, related to the potential for the inadvertent return of drilling fluids during proposed drilling operations.

HDD S2-0250 is located within the Gettysburg-Newark Lowland Section of the Piedmont Physiographic Province (Pennsylvania Department of Conservation and Natural Resources [DCNR], 2000). The dominant topography in areas underlain by the Gettysburg Formation is typified by undulating hills of low relief to small hills and ridges that are higher than the surrounding countryside. In areas underlain by Diabase, the topography is comprised of undulating hills of medium relief with moderately steep and stable natural slopes. Where the Diabase was formed as dikes, the topography is expressed as narrow ridges, whereas areas of larger intrusions or flows form hills of moderate relief. Local relief is low to moderate and ranges in the vicinity of the site from approximately 350 feet above mean sea level (AMSL) to 505 feet AMSL (GoogleEarth, 2017). The site is drained by wetland area I24 located adjacent to the west bank of Yellow Breeches Creek fed by the shallow unnamed tributary stream S-I34 which flows from west to east

through the western half of the proposed west-east HDD path. The area surrounding the HDD consists of mixed woodland and rural properties that include typical rural land uses (e.g., farming, ranching, agriculture).

The proposed HDD profile was lengthened and deepened on October 30, 2017, to provide additional cover beneath the stream crossings. The HDD entry point is at a surface elevation of 432 feet AMSL and forms a slightly concave HDD profile that slopes gently upward toward the east to an elevation of 505 feet AMSL at the HDD exit point for the proposed 20-inch pipe and 503 feet AMSL for the proposed 16-inch pipe. The 16-inch pipe will cross under the referenced unnamed tributary at a depth of 60 feet below ground surface (bgs), the wetland at a depth of 87 feet bgs, and Yellow Breeches Creek at a depth of 77 feet bgs. The 20-inch pipe will cross under the referenced unnamed tributary at a depth of 62 feet bgs, the wetland at a depth of 70 feet bgs, and Yellow Breeches Creek at 61 feet bgs. The HDD is located between Stations 10832+00 and 10857+50 on the pipeline, for overall horizontal lengths of 2,580 feet (16-inch) and 2,600 feet (20-inch). The inclination of the entry and exit angles has been increased to install the pipe through protective soils, residual soils, and bedrock and in closer proximity to the entry and exit points than the original shorter and shallower profile. Due to the approximate 70 feet of elevation difference between the HDD entry (west) point and HDD exit (east) point, the potential for produced groundwater exists. However, this difference in elevation is not extreme, and any water produced during the pilot and reaming phases will be utilized in the continuing HDD process to reduce the amount of water import required at the HDD rig while simultaneously allowing the drilling fluid viscosity to be adjusted to account for free water to ensure that the returns are maintained as a flowable slurry. The location of HDD S3-0250 is shown on **Figure 1**.

2.0 GEOLOGY AND SOILS

Thirteen available published and online references were reviewed to evaluate the hydrogeology and soils present in the vicinity of the Yellow Breeches Creek HDD location (S2-0250). Detailed descriptions of the soils and bedrock geology underlying S2-0250 are included in the following section.

According to the United States Department of Agriculture Soil Survey of York and Cumberland Counties, Pennsylvania, soils within approximately 500 to 600 feet of the drill path for HDD S2-0250 consist of 13 soils primarily composed of gravely silt loam and channery silt loam. A site map showing the spatial distribution of the various soils along with the soil profile descriptions is included as **Attachment 1**.

Low, et al. (2002) and the DCNR (2000) reported that the S2-0250 HDD site is situated in the northern portion of the Gettysburg-Newark Lowland Section of the Piedmont Physiographic Province. In eastern Pennsylvania, this portion of the Gettysburg-Newark Lowland Physiographic Province is underlain by sedimentary and igneous rocks of the Newark Group. These sedimentary rocks were deposited in a fault-bounded rift basin commonly referred to as the Newark Basin during late Triassic through early Jurassic time (Root and MacLachlan, 1999). According to Berg

and Dodge (1981), the area in the vicinity of HDD S2-0250 is underlain by both clastic rocks (i.e., conglomerate, siltstone/sandstone, and shale) that are mapped as the Gettysburg Formation of Triassic age (Trg) and crystalline igneous (intrusive) Diabase rocks of Jurassic age (Jd). Locally, the sedimentary sequence is interbedded with basaltic lava flows and is intruded by diabase dikes and sills. The dominant topography is rolling lowlands, shallow valley, and isolated hills with low to moderate relief. The predominant rock type consists mainly of red shale, siltstone, and sandstone with some conglomerate and diabase. The predominant geologic structure within this physiographic section consists of a half-graben having low, monoclinal, northwest-dipping beds. The drainage pattern is dendritic and trellis. Based on available mapping, the first 500 to 700 feet of HDD S2-0250 will be completed in the Diabase unit and the remainder of the HDD will be in the Gettysburg Formation. This geologic contact is identified on the geologic mapping included as **Figure 2**.

According to GoogleEarth, three geologic formations occur within a 0.5-mile radius of HDD S2-0250. These formations include the Gettysburg Formation, Limestone Fanglomerate, and Diabase. The Gettysburg Formation is composed of reddish-brown to maroon, silty mudstone and shale containing thin red sandstone interbeds with several thin beds of impure limestone. According to Geyer and Wilshusen (1982), the Gettysburg Formation underlying the HDD S2-0250 site is moderately to well-bedded with individual beds ranging from thin to flaggy (sandstone, siltstone, and shale) and thick to massive (conglomerate) with moderately developed, moderately abundant, closely spaced, naturally occurring fractures known as joints. These joints are typically blocky, open, and steeply dipping. Primary porosity occurs in the weathered portion of the formation. The joint and bedding plane openings collectively provide a secondary porosity in unweathered rock. The topography is characterized by undulating valleys of low relief. Natural slopes are moderately steep and stable, and cut slope stability is fair to poor due to rapid weathering when exposed to moisture. The overlying soil mantle is generally thin. The shales comprising the formation are also moderately weathered to a moderate depth, whereas areas underlain by sandstones and conglomerates exhibit much less weathering. The formation is moderately easy to excavate. The rock reportedly provides good foundation stability. Drilling rates are typically moderate to fast except in areas where rock is adjacent to diabase intrusions (rock is harder and drilling rate is slower).

The Limestone Fanglomerate consists of yellowish-gray to medium gray, angular limestone and dolomite pebbles, cobbles, and fragments set in a red, very fine-grained quartz matrix containing a few shale-clast interbeds. The Diabase is described as a medium- to coarse-grained, quartz-normative tholeiitic basalt; is composed of labradorite and various pyroxenes; and occurs as dikes, sheets, and a few small flows. The rocks of the Newark Basin generally dip an average of 20° to the north-northwest. The geologic structure of the Gettysburg-Newark Lowland Physiographic Province consists principally of a north-northwestward dipping homocline (Newport, 1971).

The igneous Diabase that occurs in the Gettysburg-Newark Lowland is dark gray to black with high silica content and a dense, very fine to coarsely crystalline, non-granular lithologic fabric

forming narrow dikes and sheets. The Diabase is highly resistant to weathering and commonly weathers to form large, massive, spheroidal boulders (Geyer and Wilshusen, 1982; Low, et. al., 2002). Joints are well-developed, abundant, and open providing a very low secondary porosity. The overlying soil is thin. Dikes typically form narrow ridges, and larger intrusions form hills of moderate relief. Excavation and/or drilling are slow due to the density and hardness of the rock.

3.0 HYDROGEOLOGY

Bedrock geology ultimately influences the storage, transmission, and use of groundwater. Geologic factors such as rock type, intergranular porosity, rock strata inclination, faults, joints, bedding planes, and solution channels affect groundwater movement and availability. According to Wood (1980) and Low (2002), groundwater within the clastic rocks of Cumberland and York Counties occurs under both unconfined (i.e., water table) and confined conditions. In general, groundwater generally occurs under unconfined conditions within the upper portion of the aquifer and under-confined or semiconfined conditions in the deeper portions of the aquifer. The groundwater flow system was conceptualized by Wood (1980) as a series of sedimentary beds with relatively high transmissivity separated by beds exhibiting lower transmissivities. This sequence of beds exhibits different hydraulic properties that collectively act as a series of alternating aquifers and confining or semi-confining units forming a leaky multi-aquifer system (LMAS). Groundwater flow paths within the clastic rocks have both local and regional components. Locally, shallow groundwater discharges to the gaining portions of nearby streams and deeper regional groundwater flow is toward points of regional groundwater discharge such as the Susquehanna River. Groundwater divides may be different for each zone of groundwater flow and therefore may not coincide with surface water divides. Based on our review of available reference sources, no regional water table mapping is available for the Yellow Breeches Creek HDD site or surrounding area. As a result, no water table mapping was available for review or inclusion with this HDD re-evaluation report. Based on the geotechnical report and boring logs included as **Attachment 2**, the depth to water is quite shallow proximate to the HDD path with depths ranging from 7 to 25 feet bgs.

The direction of groundwater flow within the clastic rocks of Cumberland and York Counties is largely controlled by the hydraulic gradient and spatial variability of hydraulic conductivity. The groundwater flow system in the clastic rocks is highly anisotropic with the predominant flow direction parallel to the strike of the rock beds. The potential for well interference related to pumping is generally greatest for wells aligned parallel to strike, rather than in wells drilled in the direction of bedding dip (i.e., perpendicular to strike). The presence of Diabase often acts as a barrier to flow (Becher and Root, 1981; and Wood, 1980). No groundwater modeling was performed for the area surrounding HDD S2-0250.

According to Low, et. al (2002), the depths of water-bearing zones in 322 wells completed in the Gettysburg Formation range from 5 to 900 feet bgs. Fifty percent (50%) of the 669 water-bearing zones reported were penetrated at a depth of less than 115 feet with 90% of the water-bearing zones occurring at a depth of less than 288 feet. The greatest density of water-bearing

zones (0.65 per 50 feet of well depth) is from 51 to 100 feet bgs. The density of water-bearing zones encountered at depths greater than 401 feet is based on the presence of 4 or fewer water-bearing zones per 50-foot interval. The overall density of water-bearing zones in the Gettysburg Formation is 0.41 per 50-feet of well depth.

The dense, uniform, crystalline, non-granular matrix of the Diabase lacks bedding planes or consistent foliation and therefore possesses very low primary porosity and hydraulic conductivity. Although abundant, joint openings within the Diabase provide very low secondary porosity (low permeability) and, combined with the corresponding low hydraulic conductivity, there is minimal pore space. As a result, the storage and transmission of groundwater in the Diabase are primarily dependent on the degree and extent of fracturing. Water levels in the Diabase show a strong seasonal influence. A thin mantle of stiff clay that is relatively impervious to moisture generally overlies Diabase bedrock. This results in poor drainage in low-lying areas underlain by Diabase (Low, et. al, 2002). Water levels from 191 inventoried wells within this unit range from flowing at the land surface to 155 feet bgs with a median water level of 14 feet bgs. Springs are common in ravines, draws, and other depressions crossed by Diabase dikes (Low, et. al, 2002).

According to Low, et. al (2002), the depths of water-bearing zones from 145 wells completed in the Diabase range from 4 to 583 feet bgs. Fifty percent (50%) of the 249 water-bearing zones reported were penetrated at a depth of less than 75 feet with 90% of the water-bearing zones occurring at a depth of less than 226 feet. The greatest density of water-bearing zones (0.57 per 50 feet of well depth) is from 301 to 350 feet bgs. The density of water-bearing zones encountered at depths greater than 301 feet are based on the presence of 4 or fewer water-bearing zones per 50-foot interval. The overall density of water-bearing zones in the Diabase is 0.41 per 50-feet of well depth.

Well records from the Pennsylvania Department of Conservation and Natural Resources (PA DCNR) Pennsylvania Groundwater Information System (PaGWIS) database were reviewed to identify domestic water supply wells located within a 0.5-mile radius of the proposed HDD right-of-way (ROW) boundary (PaGWIS, 2017). The search identified 32 wells within the 0.5-mile radius of the HDD. These wells consist of domestic private supply wells. A map showing the well locations relative to the proposed HDD location is included as **Figure 3**. Based on the PaGWIS database (**Figure 3**), it appears that the majority of the identified wells were completed as 6-inch-diameter open-rock wells at depths ranging from 89 to 1,000 feet bgs. Based solely on the PaGWIS database, the depth to bedrock ranges from 0 to 107 feet, and well construction consists of 17 to 174 feet of steel casing with the open-rock portions of the wells extending from 17 feet to 1,000 feet bgs. Reported well yields range from 0 to 60 gpm. Static water level measurements were recorded and range from 17 to 300 feet bgs. Based on the PaGWIS database, the majority of the wells identified above were completed in the Gettysburg Formation.

4.0 FRACTURE TRACE ANALYSIS

Fracture traces are defined as concentrated areas of high-angle bedrock fracturing forming linear features that can be identified using topographic mapping and aerial photography. The web-based GoogleEarth was used to access, download, and view aerial imagery of the HDD area. Eleven series of aerial photographs were reviewed that included photography dated April 7, 1993; April 12, 1999; December 31, 2002; February 26, 2004; March 15, 2006; February 28, 2007; May 27, 2008; May 9, 2010; August 30, 2012; September 6, 2013; and April 15, 2016 (GoogleEarth Pro, 2017). Given the extensive agricultural development and heavily forested areas in the vicinity of the HDD, no fracture traces were identified proximate to the HDD. However, general surface drainage patterns near the HDD are characterized by the linear stream reaches of the Yellow Breeches Creek in a NW-SE trend. No other fracture trace features were apparent on the photographs reviewed.

According to Wood (1980), two NW-SE trending fracture traces are mapped in the vicinity of the HDD path. One of these interpreted fracture traces crosses the HDD path approximately 1,000 feet east of the western end (entry point) of the HDD. The second trace terminates approximately 500 feet north of the central portion of the HDD path. These mapped fracture traces are shown on **Figures 2 and 3**.

5.0 GEOTECHNICAL EVALUATION

Five geotechnical borings were completed from October 25, 2014, through August 31, 2017, during the preliminary investigation of HDD S2-0250 and prior to initiating HDD operations. The five borings are located within the HDD limit of disturbance (LOD). The borings were completed to investigate soil, residual soil, and bedrock conditions using hollow-stem auger drilling methods for the soil investigation and core barrel/bit for the bedrock investigation. **Attachment 2** presents a map depicting the boring locations, boring logs, and a geotechnical report for the two studies.

The geotechnical investigation was performed in two phases. Three shallow borings, SB-01 through SB-03, were completed in October 2014, and two additional bedrock borings, B1 and B2, were completed in August 2017.

SB-01 was located near the western HDD entry/exit point, SB-02 was located just east of Yellow Breeches Creek and the wetland, and SB-03 was located near the easternmost entry/exit point. The generalized subsurface profile observed in SB-01 through SB-03 is described below.

- **SB-01**: Clays and silts from ground surface to 6.5 feet bgs; sandstone from 6.5 to the total depth of the boring at 7.2 feet bgs. Groundwater was not encountered.

- **SB-02**: Sand from ground surface to 25 feet bgs; sandstone with some conglomerate from 25 to the total boring depth of 43 feet. Groundwater was not encountered.
- **SB-03**: Sands, silts, and clays from ground surface to the total depth of the boring at 22.8 feet bgs. Groundwater was not encountered.

The boring logs indicate that the soil/bedrock interface ranges from approximately 7 feet (SB-01) to 25 feet (SB-03) bgs. The bedrock was described in SB-02 as fractured sandstone with lenses of conglomerate. The compressive strength of a portion of the bedrock core at a depth of 36.5 feet was 550 pounds per square inch (PSI) and its unit weight was 160.5 pounds per cubic feet (PCF).

Two additional borings (B-1 and B-2) were completed during August 2017 as part of the second phase of the geotechnical investigation. B-1 was drilled near the western HHD entry/exit point, and B-2 was drilled near the eastern entry/exit point. The generalized subsurface profile observed in B-1 and B-2 is described below.

- **B-1**: Clays, sands, and gravels were encountered from the ground surface to approximately 12 feet bgs; Diabase bedrock was encountered from 12 to 114 feet bgs; and sandstone and conglomerate were found from 114 to the total depth of the borehole at 180 feet bgs. Groundwater was encountered at approximately 7 to 8 feet bgs.
- **B-2**: Sands were encountered from the ground surface to 27 feet bgs; bedrock consisting of siltstone, sandstone, shale, and conglomerate was encountered between 27 feet bgs and the total borehole depth of 250 feet. Groundwater was encountered at approximately 18 to 25 feet bgs.

The bedrock in both borings was described as ranging from moderately hard to extremely hard and broken to massive. Photographs of the cores obtained from B-1 and B-2 are included in **Attachment 2**.

Please note that Skelly and Loy/RETTEW did not oversee or direct the geotechnical drilling programs associated with the S2-0250 HDD, including but not limited to the selection of boring locations, determination of location, determination of surface elevation, 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. Skelly and Loy/RETTEW relied on these reports and incorporated their data into the general geologic and hydrogeologic framework of the analysis of the proposed 20-inch and 16-inch S2-0250 HDD's for this report.

6.0 FIELD OBSERVATIONS

Based on a site reconnaissance performed by Skelly and Loy geologists on October 17, 2017, there were no bedrock exposures in the immediate vicinity of the HDD bore path; however, several outcrops were identified in a road cut located approximately 0.5 mile south of the HDD trace. These outcrops occurred in cut slopes near the intersection of Yellow Breeches Creek and Sheepford Road. The entire HDD trace on the west shore of Yellow Breeches Creek was not surveyed due to the presence of cattle in the field. At the cut slope locations, outcrops of shale, siltstone, and sandstone of the Gettysburg Formation and Limestone Fanglomerate were identified. Structural geologic measurements of these units indicate that the bedding strike ranges from north (N) 35° to 90° east (E) with dips ranging from 30° to 44° NW. Based on local topography and bedrock dip reported in the published literature (Newport 1971), bedrock strike is generally to the north-northeast (20° to 70°) which is also consistent with the field observations and geologic measurements of the Gettysburg Formation nearly 0.5 mile south of the HDD trace. Several joint sets were identified ranging from N15° west (W) with a dip angle of 60° northeast (NE) to N56°E dipping 45°NW.

Available geologic mapping indicates that the initial 500 to 800 feet of the HDD bore path are underlain by bedrock characterized as the Triassic age Gettysburg Formation. Although this published mapping is consistent with Skelly and Loy's field observations of Diabase bedrock 200 feet west of the HDD entry point (see **Figure 2**), geotechnical exploration Boring B-1 indicates Diabase bedrock is also present from a depth of 12 to 114 feet bgs in this area (**Attachment 2**). Based on the results of the site-specific geotechnical exploration, it appears likely that Diabase bedrock will be encountered during HDD drilling activities performed within 800 feet of the HDD entry point. With the exception of the unnamed tributary, wetland area, and Yellow Breeches Creek, a farm located approximately 600 feet south of the HDD entry point, but not identified in the PaGWIS data search, appears to be a likely additional environmental receptor of concern within the defined 0.5-mile HDD buffer area.

7.0 GEOPHYSICAL SURVEY CONSIDERATIONS

Although some thin-bedded limestone units and Limestone Fanglomerate occur within a 0.5-mile radius of the HDD, no karst geology is present at this HDD location. Although the Corrected Stipulated Order states that the use of geophysical surveys should be considered in karst areas, based on the lack of karst geologic features and extensively fractured bedrock, the use of geophysical surveys during re-evaluation was considered but ultimately not implemented at the Yellow Breeches Creek HDD location because the results of geophysical surveys would not likely provide additional information that would reduce the risk of an IR. In addition, results of geophysical surveys in karst terrains with the resolution necessary to image features that could affect the HDD are typically limited to the upper 20 to 50 feet of the ground surface. Based on our experience working in karst geology, the lack of mapped karst geology along the HDD trace, and lack of continuous thick-bedded limestone units, the Gettysburg Formation is not deemed susceptible to the solution activity present in other more thickly bedded carbonate geologic formations in

Pennsylvania. In our professional opinion, geophysical surveys would not provide additional information on the formational thickness, interbedded sandstone, shale, diabase, and thin beds of limestone fanglomerate at depths greater than 50 feet bgs along the HHD profile. Geophysical survey data would not enhance the evaluation or reduce the risk of an IR.

8.0 CONCEPTUAL HYDROGEOLOGIC MODEL

Groundwater occurring in the watershed occupied by the Yellow Breeches Creek HDD originates as precipitation or snowmelt that infiltrates through the overburden soils. As previously described, shallow groundwater generally occurs under unconfined conditions within the upper portion of the bedrock LMAS. Based on site-specific geotechnical data (Section 5.0), the groundwater table occurs within the overburden soils proximate to the HDD path and contributes flow to local shallow groundwater discharge zones supporting the unnamed tributary and Yellow Breeches Creek which cross above the HDD profile. The thickness of the regolith and saturated regolith varies according to the underlying geohydrologic unit and topographic setting (Low, et. al, 2002).

Logs of the five geotechnical borings drilled from October 25, 2014, through August 31, 2017, indicated that the soil thickness near HDD S2-0250 ranges from approximately 7 to 25 feet and consists predominantly of sand, silt, clay, and gravel. Recorded descriptions for the bedrock cores included sandstone, conglomerate, siltstone, shale, and Diabase. Data tabulated for supply wells found in the PaGWIS database (**Figure 3**) within a 0.5-mile radius of the HDD trace recorded measured water levels in the bedrock aquifer ranging from 17 to 300 feet bgs. Depth to water measurements obtained from the geotechnical bedrock core borings (B-1 and B-2) ranged from 7 to 25 feet bgs. Groundwater was not encountered in the three shallow geotechnical soil borings (SB-01, SB-02, and SB-03) completed within the soil regolith.

This formation is highly anisotropic with the predominant flow direction parallel to bedrock strike. As mentioned above, the local occurrence of an intrusive diabase sill or dike was identified proximate to the western HDD entry point. The transport of groundwater in the fractured bedrock is generally greatest within highly permeable fractures. Wells drilled to the same depths along bedrock strike generally penetrate the same water-bearing zones, whereas wells drilled to the same depth several hundred feet down dip of each other rarely intersect the same water-bearing zones. Within the LMAS of the Gettysburg Formation, most of the groundwater flow is semi-confined or confined by shale and poorly permeable sandstone and conglomerate units acting as confining layers. Some site-specific evaluation of the bedrock has been completed in areas proximate to the geotechnical borings completed along this HDD profile. No detailed characterization or groundwater flow modeling of the bedrock aquifer was performed as part of this hydrogeologic re-evaluation.

The groundwater flow direction in the overburden soils is presumed to mimic surface topography which variably slopes gently to steeply from the west and east toward the unnamed tributary and Yellow Breeches Creek. This shallow groundwater flow direction is supported by

the above-referenced depth to water measurements recorded during the geotechnical investigation of the unconsolidated regolith. The wetland is sustained by local shallow groundwater flow discharges. The wetland and unnamed tributary are both situated along the HDD path in the area immediately west of Yellow Breeches Creek. Flow in the unnamed tributary begins near the HDD entry point and flows eastward toward the center of the HDD trace and eventually discharging to the wetland and Yellow Breeches Creek, also near the center of the HDD trace. The geotechnical report and boring logs included as **Attachment 2** show that the depth to water can be quite shallow proximate to the HDD path with depths ranging from 7 to 25 feet bgs. Based on this information, the uppermost groundwater table is presumed to occur within the unconsolidated regolith under unconfined conditions.

9.0 CONCLUSIONS

Based on published geologic and hydrogeologic information, the S2-0250 Yellow Breeches Creek HDD location is underlain by clastic sedimentary rocks (conglomerate, siltstone, sandstone, and shale) of the Gettysburg Formation, Limestone Fanglomerate, and dense, very fine to coarsely crystalline intrusive Diabase. Groundwater movement within these rocks is primarily through a network of interconnected secondary openings (e.g., fractures, joints, and faults) that were developed by external forces following deposition of the beds and intrusion of the Diabase. Geotechnical rock core observations have confirmed that the local bedrock ranges from fractured and broken to massive sandstone, conglomerate, siltstone, shale, Limestone Fanglomerate, and Diabase comprised of well-developed thin to massive moderately to steeply dipping joint and bedding planes. All of the water supply wells identified in the vicinity of the HDD are constructed in the deeper bedrock portion of the LMAS indicating that none of the domestic wells relies on the shallow (uppermost) LMAS that provides a source of sustaining groundwater discharge to the surrounding wetlands and unnamed tributary to the Yellow Breeches Creek. The HDD profile extends entirely within both the shallow unconsolidated regolith materials and weathered to highly weathered bedrock. Based on the hydro-structural characteristics of the underlying geology described in this report and the proposed HDD profile, the S2-0250 Yellow Breeches Creek HDD is susceptible to the inadvertent return of drilling fluids during HDD operations. As a result, the HDD profile was redesigned to allow for deeper crossings beneath the streams and wetland. The inclination of the entry and exit angles has been increased as a means to install the pipe through protective soils, residual soils, and bedrock 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.

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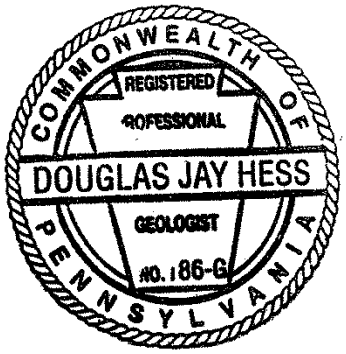
11.0 CERTIFICATION

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. seal that follows.

By affixing my seal to this document, I am certifying that the information 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.



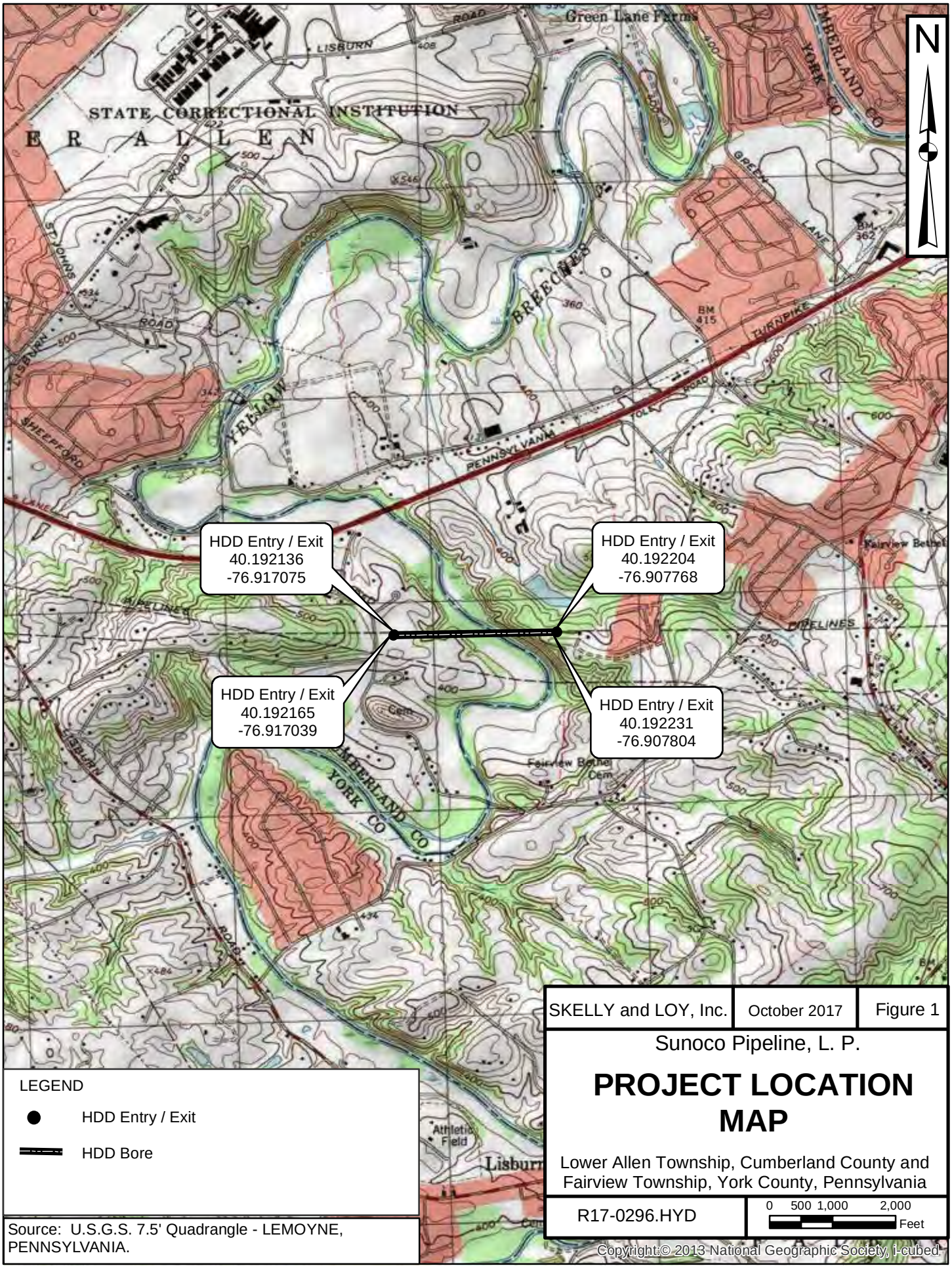
Douglas J. Hess, P.G.
License No. PG-000186-G

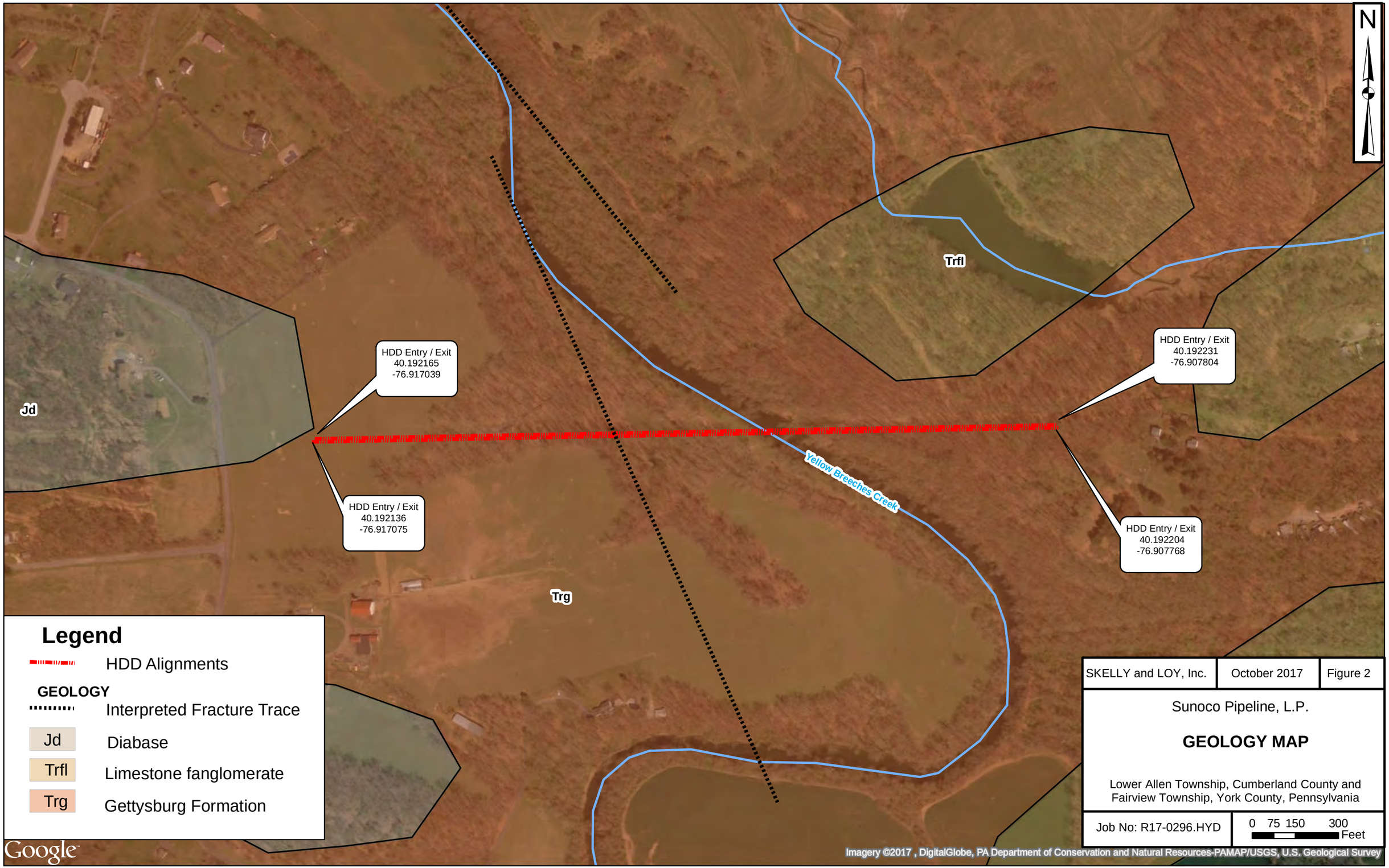
Sincerely yours,

SKELLY and LOY, Inc.

Douglas J. Hess, P.G.
Director of Groundwater
and Site Characterization
Geo-Environmental Services

cc: R17-0296.HYD
File: Yellow Breeches Creek.docx


N
HDD Entry / Exit
40.192136
-76.917075
HDD Entry / Exit
40.192204
-76.907768
HDD Entry / Exit
40.192165
-76.917039
HDD Entry / Exit
40.192231
-76.907804
STATE CORRECTIONAL INSTITUTION
E R A L L E N
Green Lane Farms
PENNSYLVANIA TURNPIKE
PIPELINES
YORK CO
CUMBERLAND CO
LISBURN ROAD
BREECHES
YELLOW
SHEEPFORD
Fairview Bethel Cem
Athletic Field
Lisburn
LEGEND
HDD Entry / Exit
HDD Bore
Source: U.S.G.S. 7.5' Quadrangle - LEMOYNE, PENNSYLVANIA.
SKELLY and LOY, Inc.
October 2017
Figure 1
Sunoco Pipeline, L. P.
PROJECT LOCATION MAP
Lower Allen Township, Cumberland County and Fairview Township, York County, Pennsylvania
R17-0296.HYD
0 500 1,000 2,000
Feet
Copyright© 2013 National Geographic Society, i-cubed



SKELLY and LOY, Inc.	October 2017	Figure 2

Sunoco Pipeline, L.P.

GEOLOGY MAP

Lower Allen Township, Cumberland County and
Fairview Township, York County, Pennsylvania

Job No: R17-0296.HYD	0 75 150 300 Feet

N

631900
156582
634063
156431
156357
96654
635992
621151
156450
156471
599907
HDD Entry / Exit
40.192165
-76.917039
156441
HDD Entry / Exit
40.192231
-76.907804
156440
96668
96666
96669
96670
96671
96667
422499
424001
HDD Entry / Exit
40.192136
-76.917075
HDD Entry / Exit
40.192204
-76.907768
156401
96661
418987
156692
156691
156638
96706
257263
17048

Legend

- Proposed HDD
- Interpreted Fracture Trace
- 0.5 Mile Radius of Proposed HDD
- PAGWIS Well ID
- Parcel Boundary

SKELLY and LOY, Inc.	October 2017	Figure 3

Sunoco Pipeline, L.P.

WELL LOCATION MAP

Lower Allen Township, Cumberland County and
Fairview Township, York County, Pennsylvania

Job No: R17-0296.HYD	0 175 350 700 Feet

Google

PAWellID	County	Municipali	QuadName	WellAddres	WellZipCod	DateDrille	TypeOfActi	LatitudeDD	LongitudeD	Driller	OriginalOw	WellUse	WaterUse
156692	YORK	FAIRVIEW TWP.	LEMOYNE			1992-05-01	NEW WELL	40.18694	-76.90333	JOHN THRAN	LEWIS MURICE	WITHDRAWAL	DOMESTIC
156691	YORK	FAIRVIEW TWP.	LEMOYNE			1992-05-01	NEW WELL	40.18694	-76.90306	JOHN THRAN	LEWIS MURICE	WITHDRAWAL	DOMESTIC
156638	YORK	FAIRVIEW TWP.	LEMOYNE			1991-12-01	NEW WELL	40.18694	-76.90194	HARRISBURG'S KOHL BROS INC	SPRENKEL JAY	WITHDRAWAL	DOMESTIC
156401	YORK	FAIRVIEW TWP.	LEMOYNE			1982-06-01	NEW WELL	40.18944	-76.90167	EICHELBERGERS INC.	REICHWEIN J	WITHDRAWAL	DOMESTIC
156440	YORK	FAIRVIEW TWP.	LEMOYNE			1977-02-15	NEW WELL	40.19333	-76.90417	EICHELBERGERS INC.	MEADOWBROOK TR PRK	WITHDRAWAL	DOMESTIC
156440	YORK	FAIRVIEW TWP.	LEMOYNE			1977-02-15	NEW WELL	40.19333	-76.90417	EICHELBERGERS INC.	MEADOWBROOK TR PRK	WITHDRAWAL	DOMESTIC
156441	YORK	FAIRVIEW TWP.	LEMOYNE			1977-02-14	NEW WELL	40.19333	-76.90278	EICHELBERGERS INC.	MEADOWBROOK TR PRK	WITHDRAWAL	DOMESTIC
156441	YORK	FAIRVIEW TWP.	LEMOYNE			1977-02-14	NEW WELL	40.19333	-76.90278	EICHELBERGERS INC.	MEADOWBROOK TR PRK	WITHDRAWAL	DOMESTIC
156471	YORK	FAIRVIEW TWP.	LEMOYNE			1985-05-15	NEW WELL	40.19444	-76.89944	EICHELBERGERS INC.	MCCONAUGHEY D	WITHDRAWAL	DOMESTIC
156450	YORK	FAIRVIEW TWP.	LEMOYNE			1976-07-28	NEW WELL	40.195	-76.90556	EICHELBERGERS INC.	MEADOWBROOK TR PRK	WITHDRAWAL	DOMESTIC
635992	YORK	FAIRVIEW TWP.		191 ROSE HILL DRIVE	17070	2003-03-18	NEW WELL	40.19583	-76.91083	EICHELBERGERS INC.	GENE B. SEITZ	WITHDRAWAL	DOMESTIC
621151	YORK	FAIRVIEW TWP.		189 ROSE HILL DRIVE	17070	2001-07-12	NEW WELL	40.19583	-76.90667	EICHELBERGERS INC.	DANIEL P. WAGNER	WITHDRAWAL	DOMESTIC
156357	YORK	FAIRVIEW TWP.	LEMOYNE			1978-04-05	NEW WELL	40.19639	-76.90083	EICHELBERGERS INC.	HARING G	WITHDRAWAL	DOMESTIC
156431	YORK	FAIRVIEW TWP.	LEMOYNE			1980-06-10	NEW WELL	40.19667	-76.90222	EICHELBERGERS INC.	REHM D	WITHDRAWAL	DOMESTIC
156582	YORK	FAIRVIEW TWP.	LEMOYNE			1988-04-01	NEW WELL	40.19694	-76.91028	EICHELBERGERS INC.	HEMPT FARMS	WITHDRAWAL	DOMESTIC
634063	YORK	FAIRVIEW TWP.	LEMOYNE	186 ROSE HILL ROAD	17070	2002-07-26	NEW WELL	40.19694	-76.90917	EICHELBERGERS INC.	S and A HOMES	WITHDRAWAL	DOMESTIC
631900	YORK	FAIRVIEW TWP.		ROSE HILL DRIVE	17070	2003-01-17	NEW WELL	40.19833	-76.91	EICHELBERGERS INC.	FOGARTY CUSTOM HOMES	WITHDRAWAL	DOMESTIC
17048	CUMBERLAND	LOWER ALLEN TWP.	LEMOYNE			1967-02-20		40.18556	-76.91472	HARRISBURG'S KOHL BROS INC	UNDERKOFF- LERMELVIN	WITHDRAWAL	DOMESTIC
257263	CUMBERLAND	LOWER ALLEN TWP.	LEMOYNE	2000 Sheepford Rd. Mechanicsburg Pa.		1989-08-01	NEW WELL	40.18611	-76.91639		Lumadue		DOMESTIC
96706	CUMBERLAND	LOWER ALLEN TWP.	LEMOYNE			1967-01-01	NEW WELL	40.18694	-76.91472	HARRISBURG'S KOHL BROS INC	UNDERKOFFLER M	WITHDRAWAL	DOMESTIC
418987	CUMBERLAND	LOWER ALLEN TWP.		1954 SHEEPFORD ROAD	17055	2006-12-21	NEW WELL	40.1875	-76.91833	EICHELBERGERS INC.	A. C. RIMMER HVAC		DOMESTIC
96661	CUMBERLAND	LOWER ALLEN TWP.	LEMOYNE			1977-10-27	NEW WELL	40.18778	-76.91861	EICHELBERGERS INC.	HARTLEY F	WITHDRAWAL	DOMESTIC
422499	CUMBERLAND	LOWER ALLEN TWP.		LIBERTY COVE	17055	2008-01-08	NEW WELL	40.18917	-76.92306	EICHELBERGERS INC.	ROLAND BUILDER INC	WITHDRAWAL	DOMESTIC
424001	CUMBERLAND	LOWER ALLEN TWP.		LIBERTY COVE	17055	2008-05-02	NEW WELL	40.18972	-76.92472	EICHELBERGERS INC.	ROLAND BUILDER INC	WITHDRAWAL	DOMESTIC
96671	CUMBERLAND	LOWER ALLEN TWP.	LEMOYNE			1983-08-01	NEW WELL	40.19028	-76.92472	EICHELBERGERS INC.	NEW PENN MOTOR EXP	WITHDRAWAL	DOMESTIC
96670	CUMBERLAND	LOWER ALLEN TWP.	LEMOYNE			1985-06-26	NEW WELL	40.19028	-76.92444	EICHELBERGERS INC.	NEW PENN MOTOR EXP	WITHDRAWAL	DOMESTIC
96666	CUMBERLAND	LOWER ALLEN TWP.	LEMOYNE			1984-05-17	NEW WELL	40.19028	-76.92417	EICHELBERGERS INC.	VANDENBURGH K	UNUSED	DOMESTIC
96667	CUMBERLAND	LOWER ALLEN TWP.	LEMOYNE			1984-05-24	NEW WELL	40.19028	-76.92389	EICHELBERGERS INC.	VANDENBURGH K	UNUSED	DOMESTIC
96668	CUMBERLAND	LOWER ALLEN TWP.	LEMOYNE			1984-02-10	NEW WELL	40.19028	-76.92361	EICHELBERGERS INC.	VANDENBURGH K	WITHDRAWAL	DOMESTIC
96669	CUMBERLAND	LOWER ALLEN TWP.	LEMOYNE			1985-06-24	NEW WELL	40.19028	-76.92333	EICHELBERGERS INC.	NEW PENN MOTOR EXP	WITHDRAWAL	DOMESTIC
599907	CUMBERLAND	LOWER ALLEN TWP.		1862 SHEEPFORD ROAD	17055	2001-09-10	NEW WELL	40.19389	-76.91694	EICHELBERGERS INC.	RONALD E. LEWIS	WITHDRAWAL	DOMESTIC
96654	CUMBERLAND	LOWER ALLEN TWP.	LEMOYNE			1982-12-01	NEW WELL	40.19611	-76.92056	EICHELBERGERS INC.	LEWIS R	WITHDRAWAL	DOMESTIC

PAWellID	WellDepth	TopOfCasin	BottomOfCa	CasingDiam	DepthToBed	BedrockNot	WellYield	StaticWate	WaterLevel	LengthOfTe	YieldMeasu	FormationN	Remark
156692	1000	0	60	6	35	False	2				VOLUMETRIC WATCH & BUCKET	GETTYSBURG FORMATION	
156691	375	0	60	6	0	False	30				VOLUMETRIC WATCH & BUCKET	GETTYSBURG FORMATION	
156638	240	0	80	6	40	False	6	45	240	1	ESTIMATED	GETTYSBURG FORMATION	
156401	275	0	40	6	34	False	8	110	265	0.5	VOLUMETRIC WATCH & BUCKET	NEW OXFORD FORMATION	RT=SILTSTONE W/SS
156440	150	0	17	0	0	False	0				ESTIMATED	HEIDLERSBURG MEM OF GETTY	DIA1=10";C M=ROTARY;WELL#5
156440	150	0	54	6	0	False	0				ESTIMATED	HEIDLERSBURG MEM OF GETTY	DIA1=10";C M=ROTARY;WELL#5
156441	600	0	17	0	0	False	0				ESTIMATED	HEIDLERSBURG MEM OF GETTY	WELL#4;DIA1=10";C M=ROTARY;RT=CGL W/FRACTURE
156441	600	0	100	6	0	False	0				ESTIMATED	HEIDLERSBURG MEM OF GETTY	WELL#4;DIA1=10";C M=ROTARY;RT=CGL W/FRACTURE
156471	175	0	30	6	9	False	40	37	165	0.5	VOLUMETRIC WATCH & BUCKET	GETTYSBURG FORMATION	RT=HORNFELS
156450	180	0	174	6	0	False	15	84	150		VOLUMETRIC WATCH & BUCKET	HEIDLERSBURG MEM OF GETTY	C M=ROTARY
635992	240	0	122	6	107	False	12	125	95	30	VOLUMETRIC WATCH & BUCKET		ROSE HILL FARM DEVELOPMENT LOT 24
621151	300	0	100	6	84	False	8	135	145	30	VOLUMETRIC WATCH & BUCKET		
156357	400	0	60	6	60	False	2				VOLUMETRIC WATCH & BUCKET	HEIDLERSBURG MEM OF GETTY	
156431	150	0	82	6	68	False	15	78			VOLUMETRIC WATCH & BUCKET	GETTYSBURG SHALE UPPER MEMBER	RT=LS CGL
156582	575	0	96	6	73	False	60	85	555	0.5	VOLUMETRIC WATCH & BUCKET	GETTYSBURG FORMATION	DWBZ = 1)30 2)1.25 3)3 4)549(60)
634063	220	0	120	6	105	False	40	50	150	30	VOLUMETRIC WATCH & BUCKET		ROSE HILL FARMS LOT 17 MOORE JOB
631900	150	0	100	6	82	False	50	45	75	30	VOLUMETRIC WATCH & BUCKET		REARICK JOB #02-09
17048	89	0	30	6	0	False	24	17	0	0		GETTYSBURG FORMATION	
257263	220	0	41	6	27	False	12	90	200	30	VOLUMETRIC WATCH & BUCKET		
96706	89	0	30	6	9	False	24	17	0	0	UNKNOWN	HEIDLERSBURG MEM OF GETTY	
418987	160	0	60	6	10	False	50	72	68	30	VOLUMETRIC WATCH & BUCKET		PIERCE JOB
96661	250	0	42	6	35	False	5	0	0	0	VOLUMETRIC WATCH & BUCKET	GATESBURG FORMATION	
422499	500	0	40	6	2	False	0	100	380	30	VOLUMETRIC WATCH & BUCKET		LIBERTY POINT DEVELOPMENT LOT 10
424001	500	0	40	6	5	False	0	300	180	30	VOLUMETRIC WATCH & BUCKET		LIBERTY POINT DEVELOPMENT LOT 4
96671	175	0	42	6	27	False	20	60	165	0.5		DIABASE DIKES AND SILLS	RT=HORNFELS
96670	250	0	40	0	10	False	3	205	240	0.5	VOLUMETRIC WATCH & BUCKET	DIABASE DIKES AND SILLS	LOT#11;DEV=HIGH MEADOWS II;DIA1=10;RT=BLUE GRAY
96666	560	0	60	6	49	False	1	0	0	0	VOLUMETRIC WATCH & BUCKET	DIABASE DIKES AND SILLS	RT=LS/CGL;LOT#6;DEV=HIGH MEADOWS
96667	500	0	40	6	18	False	2	0	490	0.5	VOLUMETRIC WATCH & BUCKET	DIABASE DIKES AND SILLS	LOT#5;DEV=HIGH MEADOWS;RT=HORNFELS
96668	300	0	52	6	17	False	4	23	290	0.5	VOLUMETRIC WATCH & BUCKET	DIABASE DIKES AND SILLS	LOT#3;DEV=HIGH MEADOWS;RT=LS/CGL
96669	175	0	40	0	3	False	6	34	165	0.5	VOLUMETRIC WATCH & BUCKET	DIABASE DIKES AND SILLS	WBZ4=163;RT=LS/CGL;DIA1=10
599907	500	0	60	6	48	False	0	42	438	30	VOLUMETRIC WATCH & BUCKET		
96654	400	0	80	6	70	False	3	29	390	0.5	VOLUMETRIC WATCH & BUCKET	HOLOCENE ALLUVIUM	RT=GRAY SS

ATTACHMENT 1

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 Cumberland County, Pennsylvania, and York County, Pennsylvania

Yellow Breeches HDD

September 27, 2017

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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Contents

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

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.

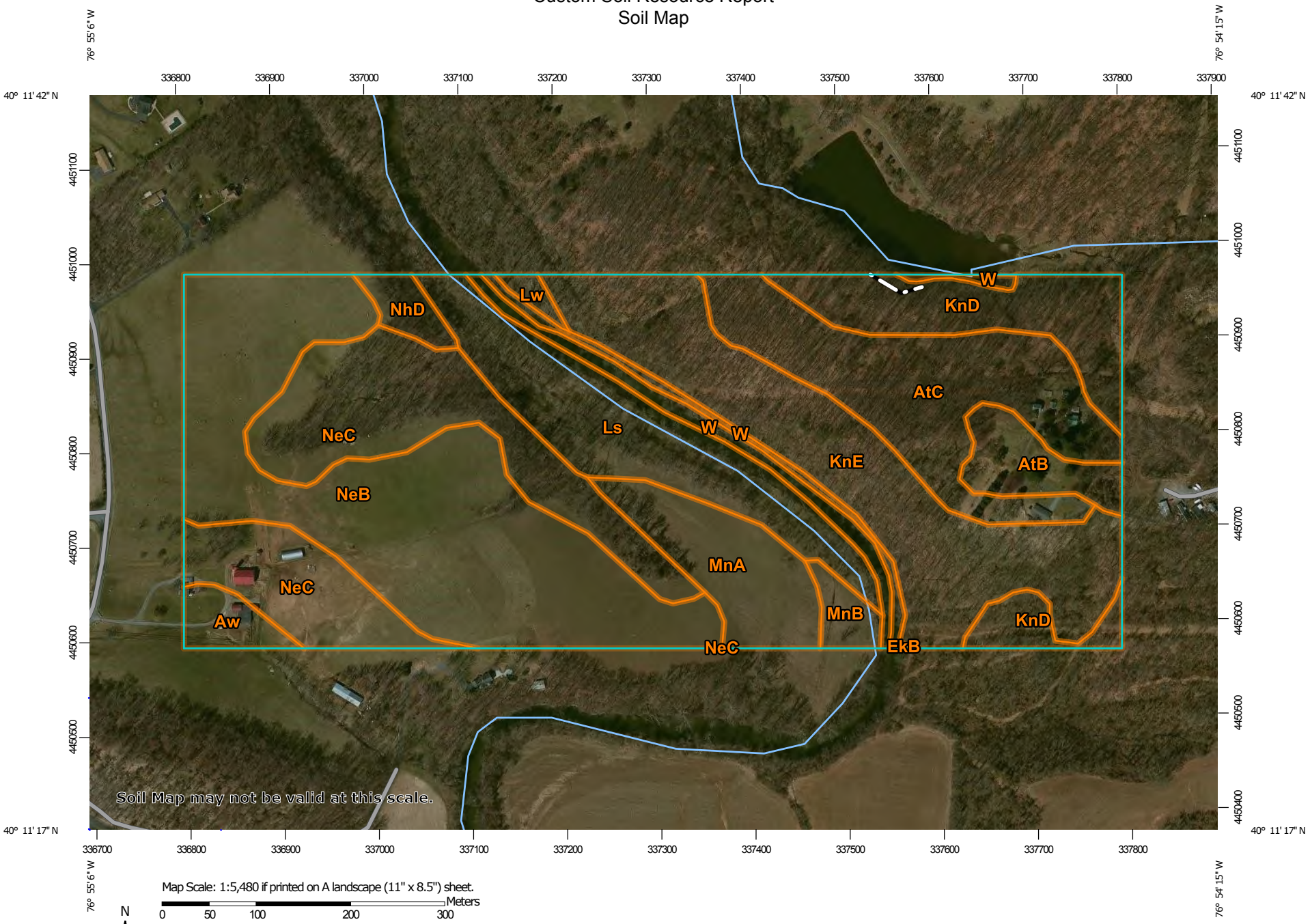
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

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



Map Scale: 1:5,480 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 250 500 1000 1500

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

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 scales ranging from 1:15,800 to 1:24,000.

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: Cumberland County, Pennsylvania
Survey Area Data: Version 8, Sep 19, 2016

Soil Survey Area: York County, Pennsylvania
Survey Area Data: Version 10, Sep 19, 2016

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

MAP LEGEND

MAP INFORMATION

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

Date(s) aerial images were photographed: Mar 29, 2011—Apr 14, 2011

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

Cumberland County, Pennsylvania (PA041)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Aw	Atkins silt loam	1.4	1.5%
Ls	Lindside silt loam	9.5	9.7%
MnA	Monongahela silt loam, 0 to 3 percent slopes	5.2	5.3%
MnB	Monongahela silt loam, 3 to 8 percent slopes	1.1	1.1%
NeB	Neshaminy gravelly silt loam, 3 to 8 percent slopes	22.9	23.4%
NeC	Neshaminy gravelly silt loam, 8 to 15 percent slopes	14.9	15.2%
NhD	Neshaminy very stony silt loam, 8 to 25 percent slopes	1.1	1.2%
W	Water	2.2	2.2%
Subtotals for Soil Survey Area		**58.3**	**59.5%**
Totals for Area of Interest		**97.9**	**100.0%**

York County, Pennsylvania (PA133)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AtB	Athol gravelly silt loam, 3 to 8 percent slopes	2.6	2.7%
AtC	Athol gravelly silt loam, 8 to 15 percent slopes	11.7	11.9%
EkB	Elk silt loam, 3 to 8 percent slopes	0.0	0.0%
KnD	Klinesville channery silt loam, 15 to 25 percent slopes	7.6	7.8%
KnE	Klinesville channery silt loam, 25 to 40 percent slopes	15.7	16.1%
Lw	Lindside silt loam	0.4	0.4%
W	Water	1.5	1.5%
Subtotals for Soil Survey Area		**39.6**	**40.5%**
Totals for Area of Interest		**97.9**	**100.0%**

Map Unit Descriptions

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 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.

Cumberland County, Pennsylvania

Aw—Atkins silt loam

Map Unit Setting

National map unit symbol: r8tq
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

Barbour

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

Philo

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

Saprists

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

Ls—Lindside silt loam

Map Unit Setting

National map unit symbol: r8xm
Elevation: 300 to 1,500 feet
Mean annual precipitation: 34 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 120 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Lindside

Setting

Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock

Typical profile

H1 - 0 to 13 inches: silt loam
H2 - 13 to 46 inches: silty clay loam
H3 - 46 to 65 inches: gravelly sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: High (about 11.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Melvin

Percent of map unit: 5 percent
Landform: Flood plains
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Clarksburg

Percent of map unit: 5 percent
Hydric soil rating: No

Monongahela

Percent of map unit: 5 percent
Hydric soil rating: No

MnA—Monongahela silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: r8xv
Elevation: 300 to 1,800 feet
Mean annual precipitation: 30 to 55 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 110 to 187 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Monongahela and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Monongahela

Setting

Landform: Stream terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Old alluvium derived from sedimentary rock

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 23 inches: silt loam

H3 - 23 to 48 inches: loam
H4 - 48 to 63 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 18 to 30 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Wheeling

Percent of map unit: 7 percent
Hydric soil rating: No

Unadilla

Percent of map unit: 5 percent
Landform: Outwash terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Holly

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

Lakin

Percent of map unit: 3 percent
Hydric soil rating: No

MnB—Monongahela silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: r8xw
Elevation: 300 to 1,800 feet
Mean annual precipitation: 30 to 55 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 110 to 187 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Monongahela and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Monongahela

Setting

Landform: Stream terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Old alluvium derived from sedimentary rock

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 23 inches: silt loam
H3 - 23 to 48 inches: loam
H4 - 48 to 63 inches: silt loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 18 to 30 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Unadilla
Percent of map unit: 7 percent
Landform: Outwash terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Lakin
Percent of map unit: 5 percent
Hydric soil rating: No

Wheeling
Percent of map unit: 5 percent
Hydric soil rating: No

Holly
Percent of map unit: 3 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

NeB—Neshaminy gravelly silt loam, 3 to 8 percent slopes

Map Unit Setting
National map unit symbol: r8y4
Elevation: 300 to 1,500 feet
Mean annual precipitation: 34 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 130 to 214 days
Farmland classification: All areas are prime farmland

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

Description of Neshaminy

Setting
Landform: Hillslopes
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, nose slope, interfluve
Down-slope shape: Linear, convex

Across-slope shape: Convex, linear
Parent material: Residuum weathered from diabase

Typical profile

H1 - 0 to 9 inches: gravelly silt loam
H2 - 9 to 60 inches: gravelly clay loam
H3 - 60 to 64 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 48 to 72 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 60 to 72 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Berks

Percent of map unit: 5 percent
Hydric soil rating: No

Chester

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Mount lucas

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear, concave
Across-slope shape: Concave, linear
Hydric soil rating: No

NeC—Neshaminy gravelly silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: r8y5
Elevation: 300 to 1,500 feet
Mean annual precipitation: 34 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 130 to 214 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

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

Description of Neshaminy

Setting

Landform: Hillslopes
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, side slope, nose slope
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Parent material: Residuum weathered from diabase

Typical profile

H1 - 0 to 9 inches: gravelly silt loam
H2 - 9 to 60 inches: gravelly clay loam
H3 - 60 to 64 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 48 to 72 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 60 to 72 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Berks
Percent of map unit: 5 percent
Hydric soil rating: No

Chester
Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Side slope, nose slope
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Mount lucas
Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear, concave
Across-slope shape: Concave, linear
Hydric soil rating: No

NhD—Neshaminy very stony silt loam, 8 to 25 percent slopes

Map Unit Setting
National map unit symbol: r8y7
Elevation: 400 to 1,600 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 155 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition
Neshaminy and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Neshaminy

Setting
Landform: Hillslopes
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, side slope, nose slope
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Parent material: Residuum weathered from diabase

Typical profile
H1 - 0 to 8 inches: channery silt loam

H2 - 8 to 49 inches: very gravelly clay loam
H3 - 49 to 53 inches: bedrock

Properties and qualities

Slope: 8 to 25 percent
Percent of area covered with surface fragments: 1.6 percent
Depth to restrictive feature: 36 to 72 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: C
Hydric soil rating: No

W—Water

Map Unit Setting

National map unit symbol: r8yh
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 59 degrees F
Frost-free period: 120 to 214 days
Farmland classification: Not prime farmland

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Setting

Parent material: Rivers streams ponds

Properties and qualities

Runoff class: Negligible
Frequency of ponding: Frequent

York County, Pennsylvania

AtB—Athol gravelly silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: l6tw
Elevation: 300 to 1,500 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 140 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Athol

Setting

Landform: Hillsides
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Red fine-loamy residuum weathered from calcareous conglomerate

Typical profile

H1 - 0 to 10 inches: gravelly silt loam
H2 - 10 to 52 inches: silty clay loam
H3 - 52 to 60 inches: gravelly silt loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 60 to 99 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Readington

Percent of map unit: 10 percent
Landform: Hillslopes

Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Base slope, head slope, side slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Hydric soil rating: No

Penlaw

Percent of map unit: 5 percent
Landform: Swales
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

AtC—Athol gravelly silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: l6tx
Elevation: 300 to 1,500 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 140 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

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

Description of Athol

Setting

Landform: Hillsides
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Red fine-loamy residuum weathered from calcareous conglomerate

Typical profile

H1 - 0 to 10 inches: gravelly silt loam
H2 - 10 to 52 inches: silty clay loam
H3 - 52 to 60 inches: gravelly silt loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 60 to 99 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Readington

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Base slope, head slope, side slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Hydric soil rating: No

Penlaw

Percent of map unit: 5 percent
Landform: Swales
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

EkB—Elk silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: l6wd
Elevation: 200 to 1,500 feet
Mean annual precipitation: 32 to 52 inches
Mean annual air temperature: 48 to 57 degrees F
Frost-free period: 133 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Elk

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and/or residuum weathered from limestone and siltstone

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 48 inches: silt loam
H3 - 48 to 60 inches: gravelly silt loam

Properties and qualities

Slope: 3 to 6 percent
Depth to restrictive feature: 60 to 99 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 11.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Chagrin

Percent of map unit: 7 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Glenville

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Side slope, head slope
Down-slope shape: Linear, concave
Across-slope shape: Concave, linear
Hydric soil rating: No

Penlaw

Percent of map unit: 2 percent
Landform: Swales

Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Stony areas

Percent of map unit: 1 percent
Hydric soil rating: No

KnD—Klinesville channery silt loam, 15 to 25 percent slopes

Map Unit Setting

National map unit symbol: l6wx
Elevation: 300 to 1,500 feet
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 120 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Klinesville and similar soils: 88 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Klinesville

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Parent material: Residuum weathered from siltstone

Typical profile

H1 - 0 to 6 inches: channery silt loam
H2 - 6 to 8 inches: very channery silt loam
H3 - 8 to 14 inches: very channery loam
H4 - 14 to 24 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 (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Available water storage in profile: Very low (about 1.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Hustontown

Percent of map unit: 10 percent
Hydric soil rating: No

Basher

Percent of map unit: 2 percent
Hydric soil rating: No

KnE—Klinesville channery silt loam, 25 to 40 percent slopes

Map Unit Setting

National map unit symbol: l6wy
Elevation: 250 to 1,400 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 130 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Klinesville

Setting

Landform: Ridges, valleys
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from siltstone

Typical profile

H1 - 0 to 8 inches: channery silt loam
H2 - 8 to 14 inches: very channery silt loam
H3 - 14 to 16 inches: extremely channery silt loam
H4 - 16 to 26 inches: bedrock

Properties and qualities

Slope: 25 to 35 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 (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.4 inches)

Interpretive groups

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

Minor Components

Brecknock

Percent of map unit: 5 percent
Landform: Ridges, hills
Landform position (two-dimensional): Shoulder, summit, backslope
Landform position (three-dimensional): Side slope, interfluve
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Penn

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope, nose slope
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Steinsburg

Percent of map unit: 5 percent
Landform: Hillsides
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Lw—Lindside silt loam

Map Unit Setting

National map unit symbol: l6xr
Elevation: 300 to 1,500 feet
Mean annual precipitation: 30 to 55 inches
Mean annual air temperature: 45 to 61 degrees F

Frost-free period: 133 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Lindside

Setting

Landform: Drainageways, valleys, flood plains
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Alluvium derived from limestone

Typical profile

Ap - 0 to 10 inches: silt loam
Bw - 10 to 50 inches: silty clay loam
C - 50 to 60 inches: stratified gravelly sandy loam to silty clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: High (about 11.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Holly

Percent of map unit: 12 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Newark

Percent of map unit: 1 percent
Landform: Depressions, flood plains
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Side slope, head slope

Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Hydric soil rating: No

Nolin

Percent of map unit: 1 percent
Landform: Flood plains, depressions
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, riser
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Hydric soil rating: No

Elk

Percent of map unit: 1 percent
Landform: Terraces
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

W—Water

Map Unit Setting

National map unit symbol: l6zv
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 59 degrees F
Frost-free period: 120 to 214 days
Farmland classification: Not prime farmland

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Setting

Parent material: Rivers streams ponds

Properties and qualities

Runoff class: Negligible
Frequency of ponding: Frequent

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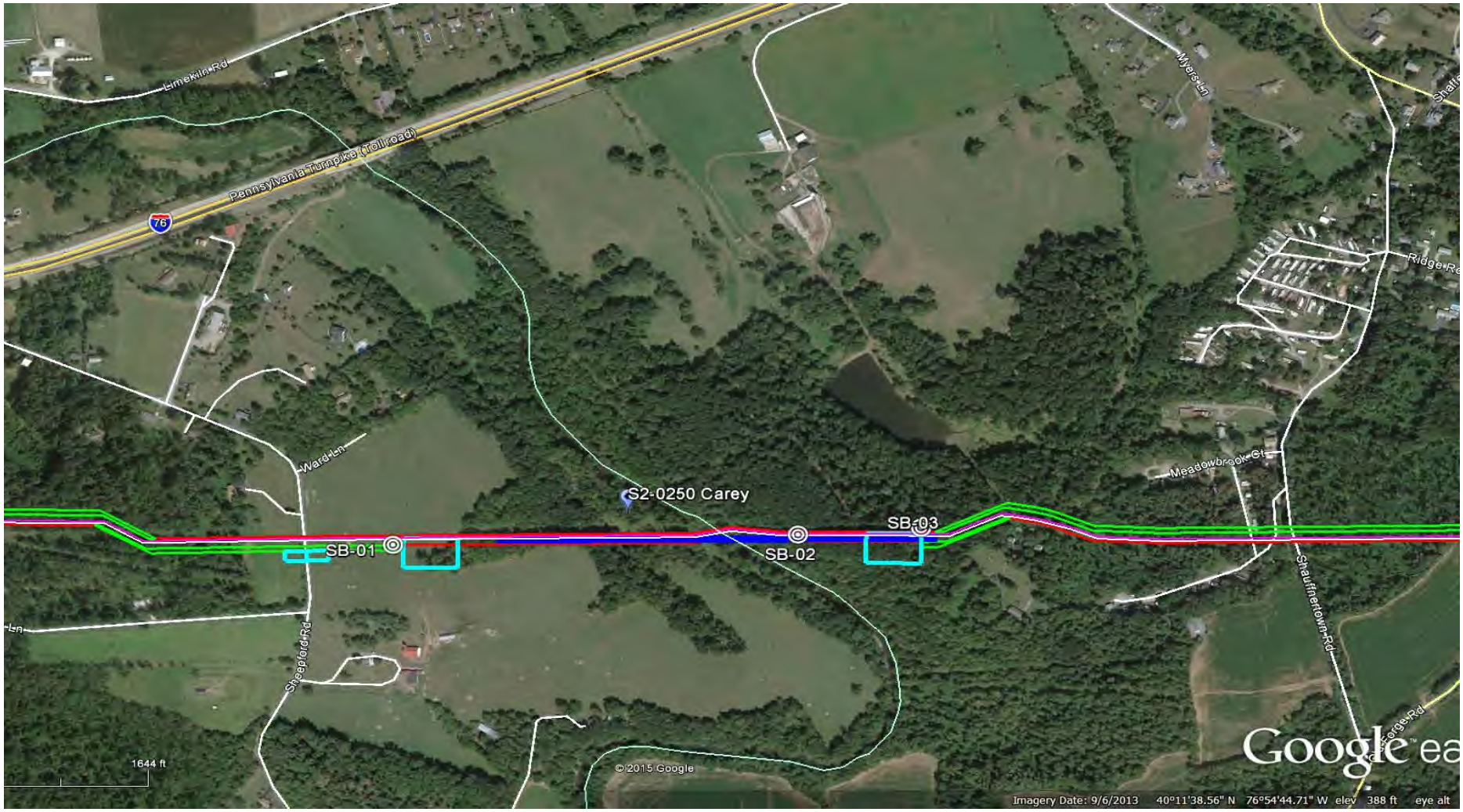

LEGEND:

Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S2-0250
CUMBERLAND COUNTY, LOWER ALLEN TOWNSHIP AND
YORK COUNTY, FAIRVIEW 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:	SHEEPFORD ROAD, MECHANICSBURG, PA		Page 1 of 1
HDD No.:	S2-0250	Dates(s) Drilled: 10-25-14	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): 7.2

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.5			TOPSOIL (6 ")					
1	3.0	5.0	0.5		11	CL/ ML	ORANGE BROWN CLAY/SILT WITH SOME F-C SAND, TRACE	2	4	9	8	**13**
				6.5			FINE SANDSTONE GRAVEL. (USCS: CL/ML)					
2	7.0	7.2	6.5	7.2	1		PARTIALLY WEATHERED GRAY SANDSTONE.	50/2"				**>50**
							AUGER REFUSAL AT 7'. 0FF-SET BORING TWICE AND AUGERED					
							TO REFUSAL, AS FOLLOWS:					
							OFF-SET 1: AUGER REFUSAL AT 5'.					
							OFF-SET 2: AUGER REFUSAL AT 6.5'.					

Notes/Comments:

Pocket Pentrometer Testing
S1: 2 TSF

DR: DECOMPOSED ROCK

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.

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TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	277 SHAUFFNERTOWN ROAD, MECHANICSBURG, PA		Page 1 of 1
HDD No.:	S2-0250	Dates(s) Drilled: 10-25/26-14	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): 43.0

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
							NO DISCERNABLE TOPSOIL					
1	3.0	5.0	0.0		20	SM	REDDISH BROWN FINE SAND WITH SOME SILT, TRACE FINE	1	8	8	10	**16**
							SANDSTONE GRAVEL.					
2	8.0	10.0			14		REDDISH BROWN FINE SAND WITH SOME SILT, TRACE FINE	3	5	9	11	**14**
							SANDSTONE GRAVEL.					
3	13.0	15.0			17		REDDISH BROWN FINE SAND WITH SOME SILT, WITH A LITTLE FINE	2	10	12	10	**22**
							SANDSTONE GRAVEL.					
4	18.0	20.0			15		REDDISH BROWN FINE SAND WITH SOME SILT, TRACE FINE	1	1	3	10	**4**
							SANDSTONE GRAVEL.					
5	23.0	25.0			16		REDDISH BROWN FINE SAND WITH SOME SILT, TRACE FINE	2	9	17	24	**26**
				25.0			SANDSTONE GRAVEL.					
6	28.0	28.1	25.0		1		PARTIALLY WEATHERED REDDISH BROWN SANDSTONE.	50/1"				**>50**
7	33.0	33.2		34.0	2		PARTIALLY WEATHERED REDDISH BROWN SANDSTONE.	50/2"				**>50**
							AUGER REFUSAL AT 34'.					
							ROCK CORING					
RUN 1	34.0	38.0	34.0		45	ROCK	REDDISH BROWN SANDSTONE. FRACTURE ZONE 34.1 TO 34.2,	TCR: 94%, SCR: 54%, RQD: 17%				
							FRACTURES AT 34.5 AND 34.6, 34.7 TO 35, 35.3, 35.6, 35.9, 36.3,					
							37.3, 37.7 AND 37.9. CONGLOMERATE LENS FROM 36.9 TO 37.45'.					
RUN 2	38.0	43.0			51		CONTINUE REDDISH BROWN SANDSTONE, FRACTURE AT 38.9,	TCR: 85%, SCR: 61%, RQD: 53%				
							40.5. CONGLOMERATE LENSE FROM 40.6 TO 41.0. SANDSTONE					
				43.0			FRACTURES ALSO AT 42.2 AND 42.5 TO 43.					
							CORE TESTING RESULTS (DEPTH 36.5'):					
							COMPRESSIVE STRENGTH: 550 PSI					
							UNIT WEIGHT: 160.5 PCF					
							CAVED AT 32'.					

Notes/Comments:
Pocket Pentrometer Testing

DR: DECOMPOSED ROCK

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.

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TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	SHAUFFNERTOWN ROAD, NEW CUMBERLAND, PA		Page 1 of 1
HDD No.:	S2-0250	Dates(s) Drilled: 10-25-14	Inspector: E. WATT
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 22.8

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.4			TOPSOIL (5")					
1	3.0	5.0	0.4		19	SM	REDDISH BROWN FINE SAND AND SILT (CONGLOMERATE IN	2	16	22	14	**38**
							SPOON SHOE).					
2	8.0	10.0			13		REDDISH BROWN FINE SAND AND SILT, WITH INTERMITTENT	5	8	7	6	**15**
				12.5			QUARTZ CONGLOMERATE LENSES.					
3	13.0	15.0	12.5		17	ML/ CL	REDDISH BROWN SILT AND CLAY WITH A LITTLE FINE SAND, TRACE	2	9	9	7	**18**
				18.5			MICA (USCS: ML/CL)					
4	18.0	18.8	18.5		8		REDDISH BROWN SILT/CLAY AND F-SAND, WITH A LITTLE F-GRAVEL.	10	50/3"			**>50**
5	22.5	22.8		22.8	2		REDDISH BROWN SILTY SAND, INDICATION OF QUARTZ CONGLOM.	50/3"				**>50**
							AUGER REFUSAL AT 22.5'. MAY BE DUE TO CONGLOMERATE.					
							(MAY NOT BE BEDROCK).					
							CAVED AND DRY AT 19'.					

Notes/Comments:
Pocket Pentrometer Testing

DR: DECOMPOSED ROCK

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 S2-0250

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.) From	Depth of Sample (ft.) To	Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318) Liquid Limit, %	Atterburg Limits (ASTM D4318) Plastic Limit, %	Atterburg Limits (ASTM D4318) Plasticity Index, %	USCS Classif. (ASTM D2487)
S2-0250	SB-01	1	3.0	5.0	35.9	77.3	35	24	11	CL/ML
	SB-02	1	3.0	5.0	7.6	37.3	-	-	-	-
		3	13.0	15.0	5.8	24.0	-	-	-	-
		4	18.0	20.0	14.8	36.6	-	-	-	-
		5	23.0	25.0	6.4	28.3	-	-	-	-
		6	28.0	28.1	4.8	9.1	-	-	-	-
	SB-03	1	3.0	5.0	5.7	30.9	-	-	-	-
		2	8.0	10.0	12.4	42.6	-	-	-	-
		3	13.0	15.0	14.9	88.3	27	22	5	ML/CL
		4	18.0	18.8	9.1	53.6	-	-	-	-
		5	22.5	22.8	8.4	71.5	-	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-02	1	36.5	550	160.5

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0250

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
S2-0250	Carey	SB-01 SB-02 SB-03	**Gettysburg Fm** - reddish-brown to maroon silty mudstone and shale and soft, red-brown, medium- to fine-grained sandstone, with minor amounts of yellowish-brown shale and sandstone and thin beds of impure limestone.	Steep sloping valley	Gettysburg Fm	Silty mudstone-shale-sandstone w/ some impure limestone		9-43	Very steep slope from SB02 to SB03. Limestone and voids noted on drilling logs. PWS well within 0.25-mi.

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 S2-0250

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					
S2-0250	SB-2	1	34	38	94	54	17	34	37	Slight	Siltstone to sandstone	Massive	Red	Slight fracturing, Avg. Dip 27° (2° - 75°)
								37	38	Slight	Sandstone grading to conglomerate	Massive	Red	Only one fracture in run, probably mechanical
S2-0250	SB-2	2	38	43	85	61	53	38	40	Slight	Siltstone to sandstone	Massive	Red	No fractures
								40	42	Slight	Coarse sandstone with gravel	Massive	Red	No fractures
								42	43	Slight	Siltstone	Massive	Red	Heavily fractured, appears to have been broken up by drilling

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

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

Relative Proportions

Description Term	*Percent*
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

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)	

COHESIVE SOILS

(Silt, Clay & Combinations)

Consistency	***N (blows)****
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

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

ROCK

(Rock Cores)

Rock Quality Designation (RQD), %	***Rock Quality Description***
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).

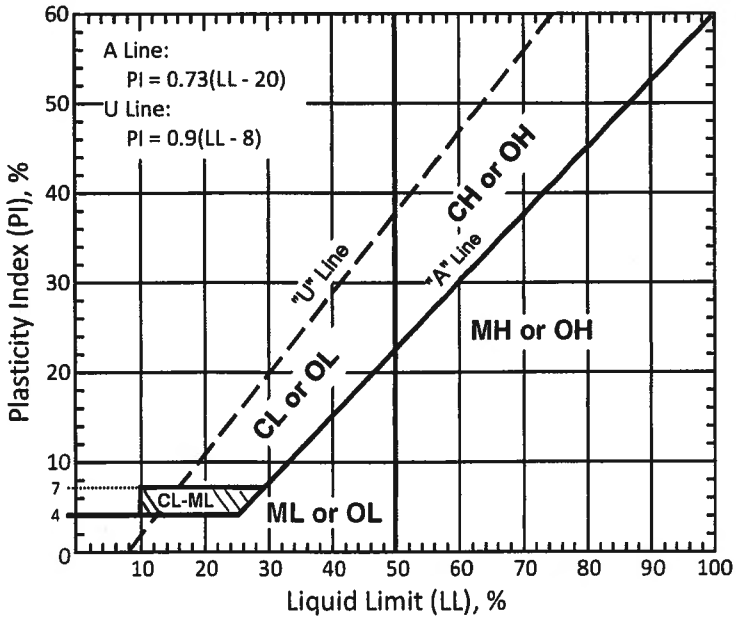
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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	Clean gravel (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	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]	$C_u=\frac{D_{60}}{D_{10}}$ greater than 4: $C_c=\frac{(D_{30})2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting C_u or C_c requirements for GW	
		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	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		Atterberg limits above A line with I_p greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Clean sands (Little or no fines)	SW	Well graded sands, gravely 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	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting C_u or C_c requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	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		Atterberg limits above A line with I_p greater than 7	

Major Divisions		Group Symbols	Typical Descriptions
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts 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
	Silts 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

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.



(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.

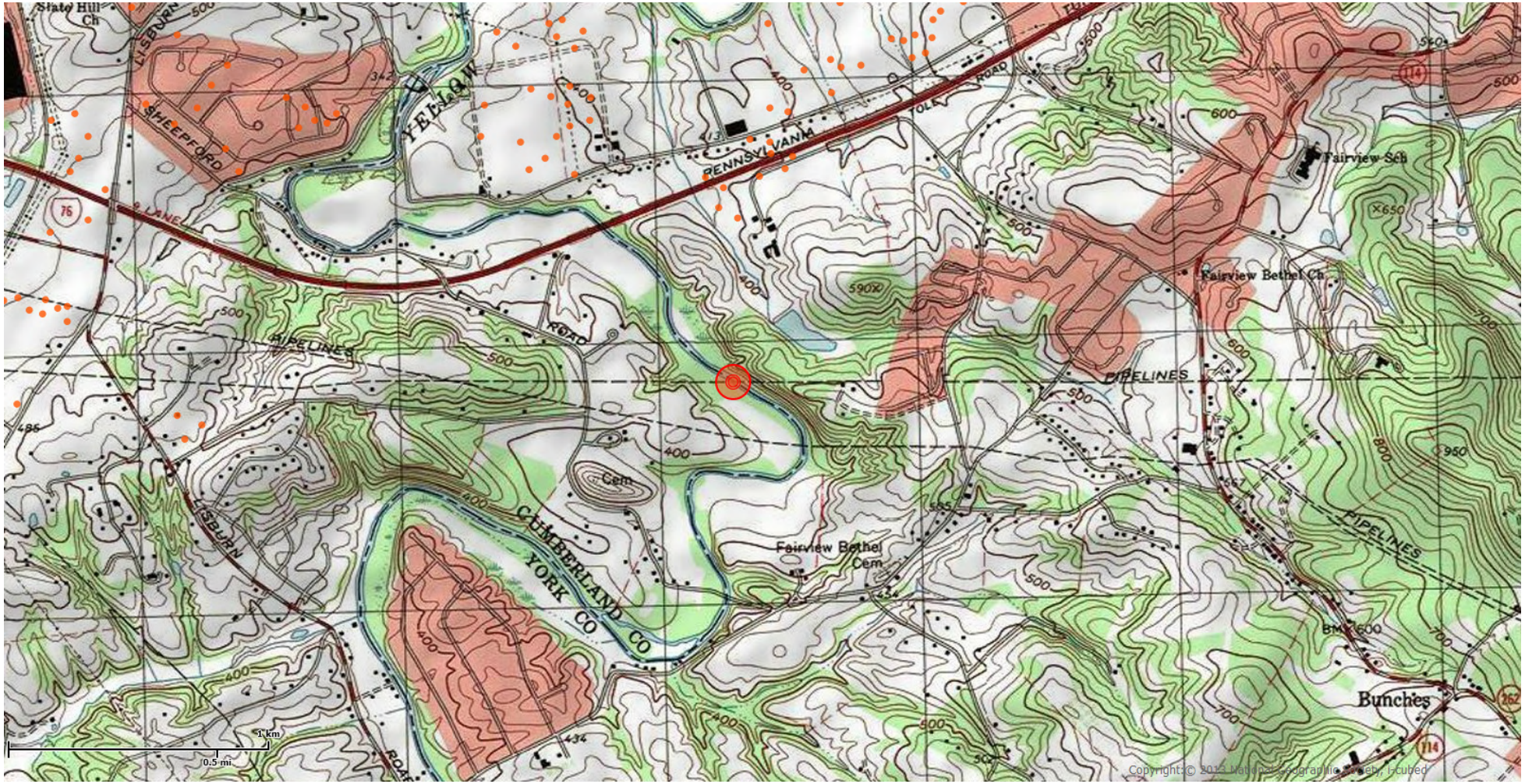
ATTACHMENT 2

pennsylvania
DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES

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

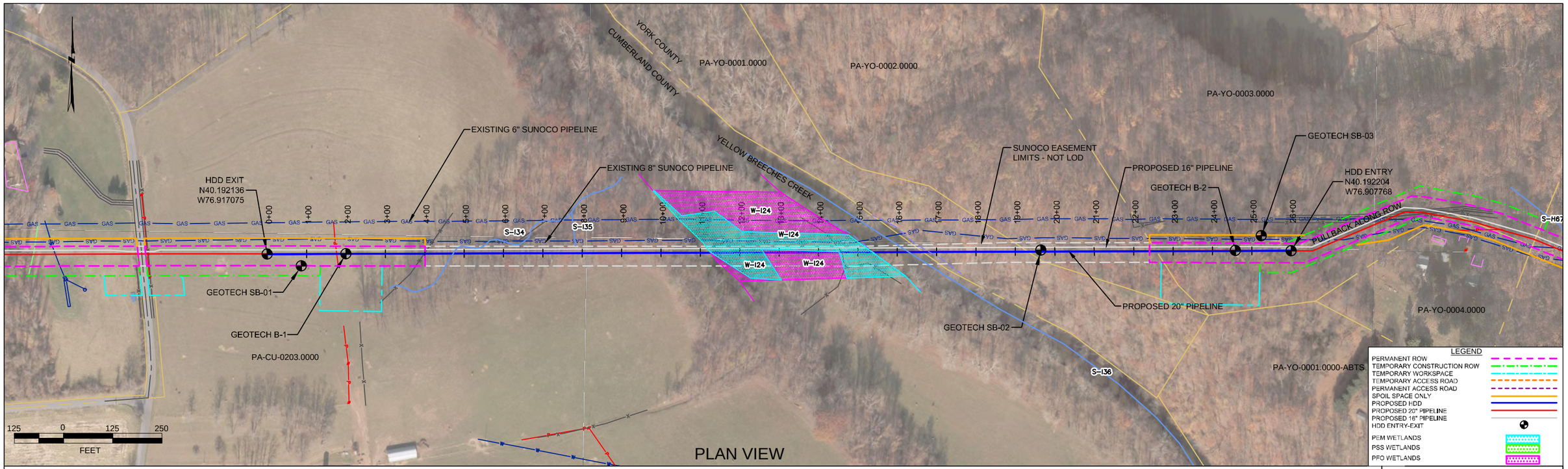
Figure 1: Site Vicinity Map

Make online reservations at
www.visitPAparks.com
or call toll-free 888-PA-PARKS



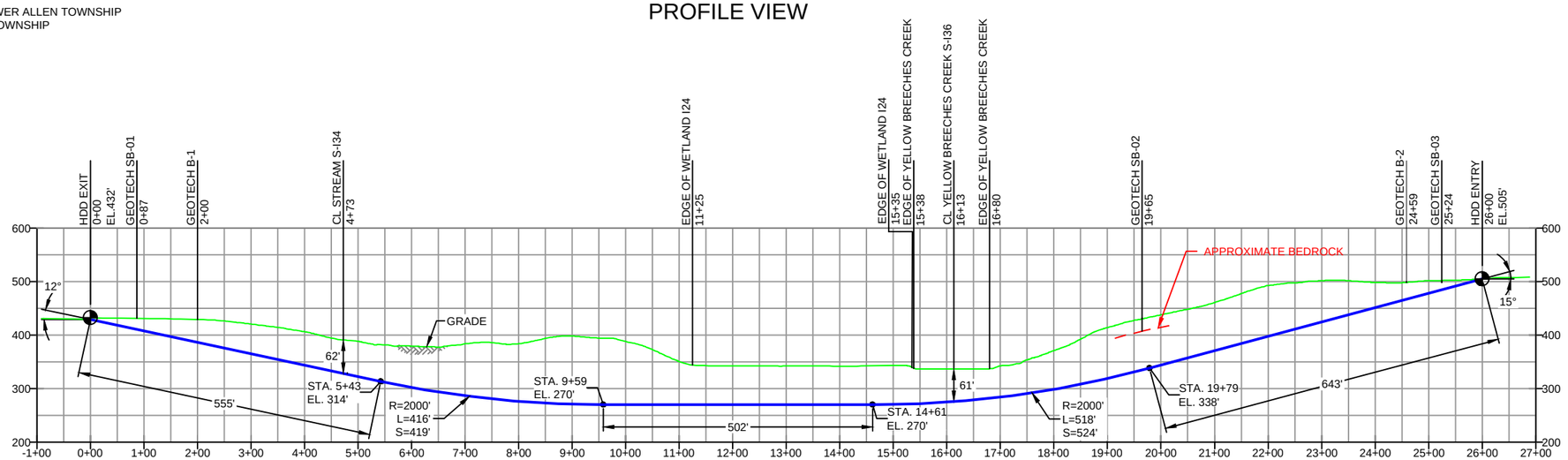
Created using PA DCNR Map Viewer

Map created on Sat Aug 12 2017



PLAN VIEW

PROFILE VIEW



CUMBERLAND COUNTY, PENNSYLVANIA - LOWER ALLEN TOWNSHIP
YORK COUNTY, PENNSYLVANIA - FAIRVIEW TOWNSHIP
S2-0250

GEOTECH SB-01

GEOTECH SB-02

GEOTECH SB-03

NOTE: REFER TO TEST BORING LOG S2-0250 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-1

NOTE: REFER TO TEST BORING LOG B-1 INTERTEK PROJECT # 04911455 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-2

NOTE: REFER TO TEST BORING LOG B-2 INTERTEK PROJECT # 04911455 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):2600'
   HDD PIPE LENGTH (S=): 2643'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. 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.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES-4.100	TO	ES-4.01	EROSION & SEDIMENT PLAN
SHEET 62	TO	SHEET 1	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP3	RELOCATED ENTRY/EXIT POINTS - DESIGN CHANGE BY DPS	MRS	10/30/17	RMB	10/30/17	CAG	10/30/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/17/16	RMB	05/17/16	AAW	05/17/16
EP		JTW	11/23/15	RMB	11/23/15	AAW	11/23/15
C	ADDED GEOTECH INFO	MRS	09/16/15	RMB	09/16/15	AAW	09/16/15
B	ISSUED FOR BID	DLM	7/31/15	RMB	7/31/15	AAW	7/31/15

Sunoco Logistics Partners L.P.

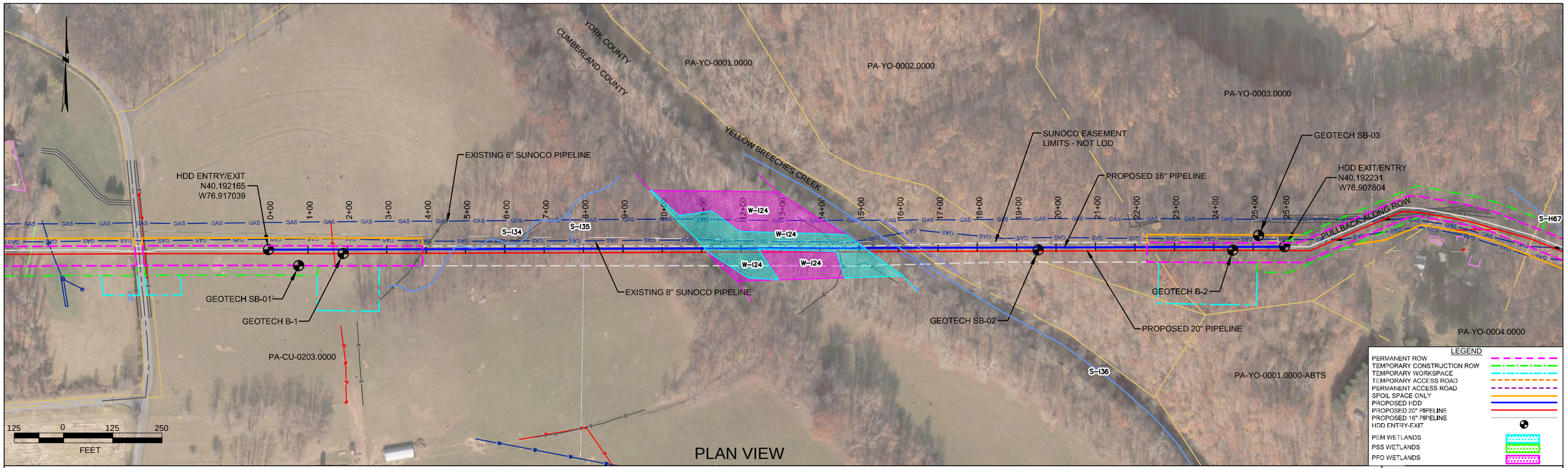
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
YELLOW BREECHES CREEK
PENNSYLVANIA PIPELINE PROJECT

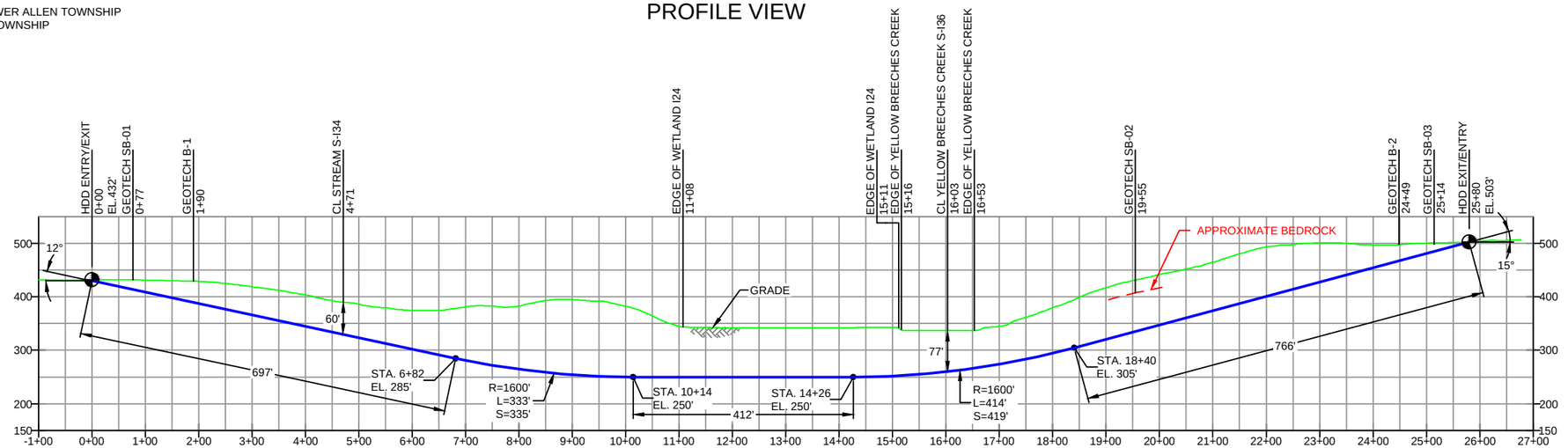
SCALE: 1"=250'

DWG. NUMBER: PA-CU-0203.0000-WX



PLAN VIEW

PROFILE VIEW



CUMBERLAND COUNTY, PENNSYLVANIA - LOWER ALLEN TOWNSHIP
YORK COUNTY, PENNSYLVANIA - FAIRVIEW TOWNSHIP
S2-0250-16

GEOTECH SB-01

-NG EL. 432'
-TOPSOIL (0.0'-0.5')
-CL/ML (0.5' - 6.5')
-SANDSTONE (6.5' - 7.2')
-AUGER REFUSAL (7.0')
-COMPLETION DEPTH EL. 425'

GEOTECH SB-02

-NG EL. 430'
-SM (0.0' - 25.0')
-SANDSTONE (25.0' - 34.0')
-AUGER REFUSAL (34.0')
-REDDISH BROWN SANDSTONE (34.0' - 43.0')
-COMPLETION DEPTH EL. 388'

GEOTECH SB-03

-NG EL. 498'
-TOPSOIL (0' - 0.4')
-SM (0.4' - 12.5')
-ML\CL (12.5' - 18.5')
-SILTY SAND (18.5' - 22.8')
-COMPLETION DEPTH EL. 475'

NOTE: REFER TO TEST BORING LOG S2-0250 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-1

-NG EL. 429'
-LEAN CLAY CL (0.0' - 2.0')
-CLAYEY GRAVEL GC GC (2.0' - 4.0')
-SILTY SAND SM (4.0' - 8.0')
-GROUNDWATER (7.0')
-SILTY SAND SM (8.0' - 12.0')
-DIABASE/SANDSTONE (12.0' - 180.0')
-COMPLETION DEPTH EL.249'

NOTE: REFER TO TEST BORING LOG B-1 INTERTEK PROJECT # 04911455 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-2

-NG EL. 498'
-CLAYEY SAND SC GC (0.0' - 2.0')
-SILTY SAND SM (2.0' - 6.0')
-GROUNDWATER (13.0')
-CLAYEY SAND SC GC (6.0' - 8.0')
-SILTY SAND SM (8.0' - 16.5')
-SILTY SAND SP-SM (16.5' - 27.0')
-CONGLOMERATE/SANDSTONE (27.0' - 250.0')
-COMPLETION DEPTH EL.248'

NOTE: REFER TO TEST BORING LOG B-2 INTERTEK PROJECT # 04911455 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. 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.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 2580'
   HDD PIPE LENGTH (S=): 2629'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. 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.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES 4.100	TO	ES 4.01	EROSION & SEDIMENT PLAN
SHT 62	TO	SHT 1	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP3	RELOCATED ENTRY/EXIT POINTS- DESIGN CHANGE BY DPS	MRS	10/30/17	RMB	10/30/17	CAG	10/30/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	DLM	05/17/16	RMB	05/17/16	AAW	05/17/16
EP		JTW	11/23/15	RMB	11/23/15	AAW	11/23/15
B	ADDED GEOTECH INFO	MRS	09/17/15	RMB	09/17/15	AAW	09/17/15
A	ISSUED FOR BID	MRS	08/31/15	RMB	08/31/15	AAW	08/31/15

Sunoco Logistics Partners L.P.

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SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
YELLOW BREECHES CREEK
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'

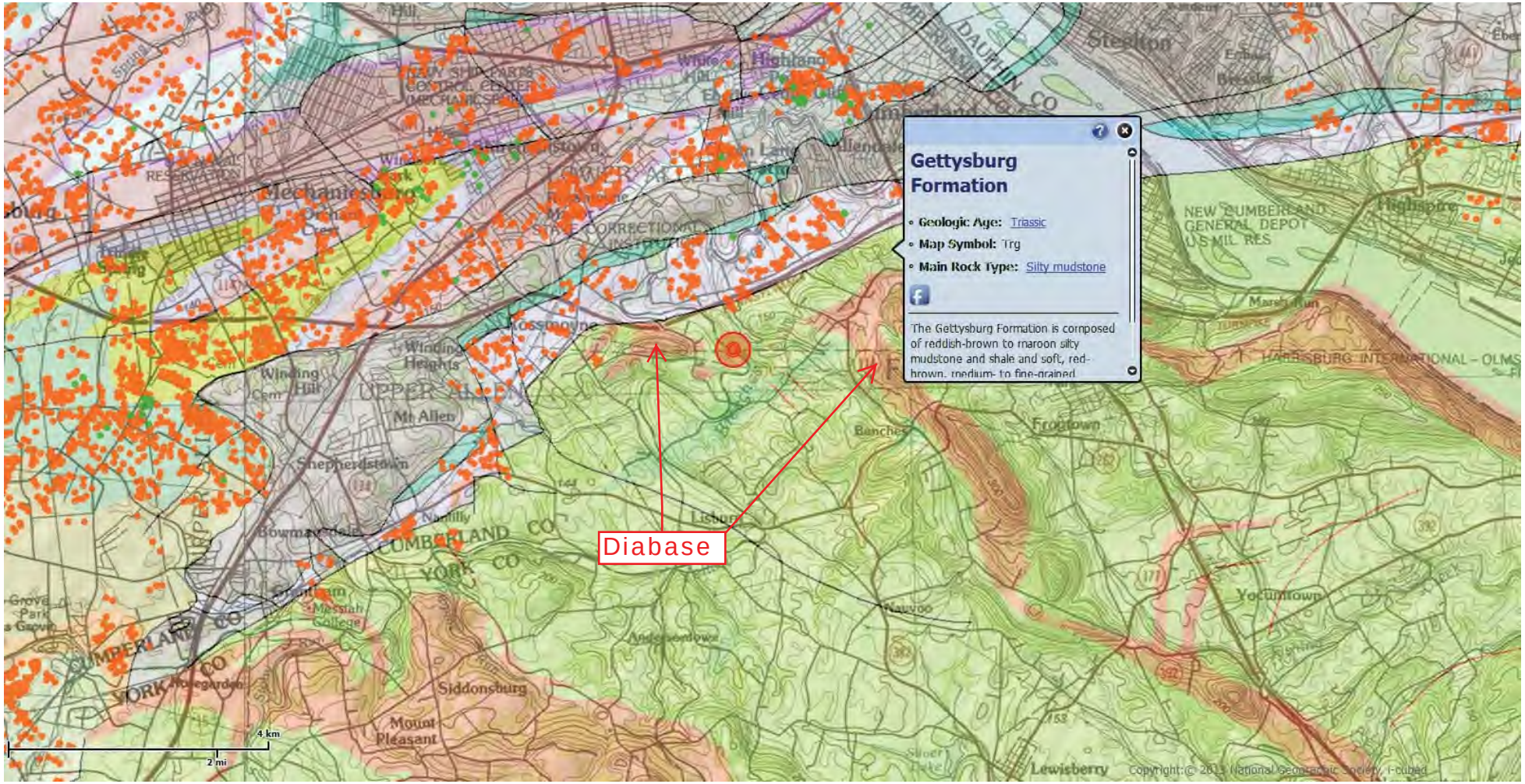
DWG. NO: PA-CU-0203.0000-WX-16

pennsylvania
DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES

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

Figure 3: Site Geology Map

Make online reservations at
www.visitPAparks.com
or call toll-free 888-PA-PARKS



Created using PA DCNR Map Viewer

Map created on Sat Aug 12 2017

BORING B-1

DATE STARTED:	8/23/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	8/25/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	180.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
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:**	F. Hoffman

REMARKS:

Water
- While Drilling — 8 feet
- 8/23/2017 @ 3:48 p.m. — 7 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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ / Moisture × / PL ◪ / LL ✚ (0, 25, 50) / STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	0			S-1	18	**Possible Disturbed Soils**-Brown to gray-brown, Lean CLAY with Sand, organic odor, moist	CL	2-4-5-5 N=9	37		Fines=74.7%
				S-2	16	**Possible Disturbed Soils**-Gray-brown, Clayey GRAVEL with Sand, organic odor, moist	GC	4-7-15-11 N=22	11		
	5			S-3	18	**RESIDUUM**-Medium Dense, Gray-brown, Silty SAND with Gravel, moist	SM	10-11-11-12 N=22	23		Fines=23.6%
				S-4	17	Trace Gravel from 6 to 8 feet.		10-11-16-10 N=27	14		
				S-5	17	**Highly Weathered DIABASE Sampled as Soil**-Very Dense, Gray-brown, Silty SAND, moist/wet	SM	10-34-36-50/5" N=70	24	>>◎	
	10			R-1	17	**DIABASE**-Gray to dark gray, Fine grained, Highly Weathered, very broken to broken, extremely hard		RQD=0 Rec=71%			
	15			R-2	6			RQD=0 Rec=17%			
				R-3	36	**DIABASE**-Gray to black, Fine grained, Weathered, broken to slightly broken, hard to very hard		RQD=0 Rec=100%			3 min. 3 min.
	20			R-4	60	**DIABASE**-Gray to black, Fine grained, Weathered to Slighty Weathered, very broken to massive, hard to very hard		RQD=64 Rec=100%			4 min. 4 min. 4 min. 2 min.
										>>▲ Q_u = 681.5 tsf 186.6 pcf	2 min.
	25										3 min.

Continued Next Page

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Professional Service Industries, Inc.
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Harrisburg, PA 17104
Telephone: (717) 230-8622

PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	8/23/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	8/25/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	180.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
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:**	F. Hoffman

REMARKS:

BORING B-1

Water
While Drilling 8 feet
8/23/2017 @ 3:48 p.m. 7 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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ / Moisture × / PL ◪ / LL ✚ (0, 25, 50) / STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
				R-5	60	**DIABASE**-Gray to black, Fine grained, Weathered to Slighty Weathered, very broken to massive, hard to very hard		RQD=53 Rec=100%			3 min. 3 min.
						DIABASE-Gray to black, Fine grained, Weathered to Highly Weathered, very broken to slightly broken, very hard					2 min. 2 min.
	30					**DIABASE**-Gray to black, Fine grained, Weathered to Slightly Weathered, broken to slightly broken, hard					2 min. 2 min.
				R-6	60			RQD=22 Rec=100%			3 min. 2 min.
						DIABASE-Gray to black, Fine grained, Weathered to Highly Weathered, very broken to broken, hard					2 min. 2 min.
	35					**DIABASE**-Gray to black, Fine grained, Weathered to Slightly Weathered, broken to massive, hard to very hard Weathered seam @ 35.9 feet (~ 1-3/4 inches thick) Weathered/Highly Weathered @ 37.2 feet (~ 5 inches thick)					3 min. 3 min.
				R-7	60			RQD=57 Rec=100%			3 min. 2 min. 2 min.
	40					**DIABASE**-Gray to black, Fine grained, Slightly Weathered, slightly broken to massive, hard				>> Q_u = 208.3 tsf	2 min.
				R-8	60			RQD=68 Rec=100%		181.4 pcf	2 min. 2 min. 3 min.
						DIABASE-Gray to black, Fine grained, Weathered, broken to massive, hard to very hard					3 min.
	45					**DIABASE**-Gray to black, Fine grained, Highly Weathered, very broken to slightly broken, hard to very hard					3 min. 2 min.
				R-9	60	**DIABASE**-Gray to black, Fine grained, Slightly Weathered, broken to massive, hard to very hard		RQD=43 Rec=100%			3 min. 3 min.
	50					**DIABASE**-Gray to black, Fine grained, Weathered to Slightly Weathered, very broken to massive, very hard				>> Q_u = 261.5 tsf	3 min. 2 min.
										186.3 pcf	

Continued Next Page

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PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED: 8/23/17 **DRILL COMPANY:** Allied Well Drilling
DATE COMPLETED: 8/25/17 **DRILLER:** R. Miller **LOGGED BY:** H. Patel
COMPLETION DEPTH 180.0 ft **DRILL RIG:** Diedrich D-50 Turbo
BENCHMARK: N/A **DRILLING METHOD:** Casing/Rock Coring
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:** F. Hoffman
REMARKS:

BORING B-1

Water
While Drilling 8 feet
8/23/2017 @ 3:48 p.m. 7 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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ Moisture × PL ◪ LL ✚ (0 25 50) STRENGTH, tsf Qu ▲ Qp ✳ (0 2.0 4.0)	Additional Remarks
				R-10	60	**DIABASE**-Gray to black, Fine grained, Weathered to Slightly Weathered, very broken to massive, very hard		RQD=58 Rec=100%			2 min. 2 min. 2 min.
	55			R-11	60			RQD=43 Rec=100%			3 min. 3 min. 2 min. 2 min. 2 min. 2 min.
	60					**DIABASE**-Gray to black, Fine grained, Slightly Weathered, broken to massive, very hard					2 min.
				R-12	60			RQD=45 Rec=100%			>> Q_u = 670.6 tsf 188.7 pcf 3 min. 3 min.
						DIABASE-Gray to black, Fine grained, Weathered, very broken to massive, very hard					3 min.
	65					**DIABASE**-Gray to black, Fine grained, Slightly Weathered, broken to massive, very hard					2 min. 2 min.
				R-13	60			RQD=48 Rec=100%			3 min. 2 min.
						DIABASE-Gray to black, Fine grained, Weathered to Highly Weathered, very broken to massive, very hard					2 min.
	70										3 min. 2 min. 2 min.
				R-14	60	**DIABASE**-Gray to black, Fine grained, Slightly Weathered, broken to massive, hard to very hard		RQD=47 Rec=100%			3 min. 3 min.
	75										3 min. 3 min.
				R-15	60			RQD=92			3 min. >> Q_u = 271.4 tsf

Continued Next Page

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PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED: 8/23/17 **DRILL COMPANY:** Allied Well Drilling
DATE COMPLETED: 8/25/17 **DRILLER:** R. Miller **LOGGED BY:** H. Patel
COMPLETION DEPTH 180.0 ft **DRILL RIG:** Diedrich D-50 Turbo
BENCHMARK: N/A **DRILLING METHOD:** Casing/Rock Coring
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:** F. Hoffman
REMARKS:

BORING B-1

Water
While Drilling 8 feet
8/23/2017 @ 3:48 p.m. 7 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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0 25 50) STRENGTH, tsf ▲ Qu ✳ Qp (0 2.0 4.0)	Additional Remarks
	80			R-16	60	**DIABASE**-Gray to black, Fine grained, Slightly Weathered, broken to massive, hard to very hard		Rec=100% RQD=68 Rec=100%			172.2 pcf 3 min. 3 min. 2 min. 3 min. 3 min. 2 min. 2 min.
	85			R-17	60	**DIABASE**-Gray to black, Fine grained, Weathered to Slightly Weathered, very broken to massive, hard to very hard		RQD=48 Rec=100%			3 min. 3 min. 2 min. 3 min. 2 min. >> Q_u = 182.4 tsf 182.8 pcf
	90			R-18	60	**DIABASE**-Gray to black, Fine grained, Slightly Weathered, broken to massive, hard to very hard		RQD=61 Rec=100%			3 min. 3 min. 2 min. 2 min. 2 min. 2 min.
	95			R-19	60	**DIABASE**-Gray to black, Fine grained, Weathered to Slightly Weathered, very broken to massive, very hard		RQD=23 Rec=100%			3 min. 2 min. 3 min. 3 min.
	100			R-20	60	**DIABASE**-Gray to black, Fine grained, Slightly Weathered, very broken to massive, hard to very hard		RQD=50 Rec=100%			2 min. >> Q_u = 134.7 tsf 179.3 pcf 2 min. 3 min.

Continued Next Page

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PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	8/23/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	8/25/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	180.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
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:**	F. Hoffman

REMARKS:

BORING B-1

Water
While Drilling 8 feet
8/23/2017 @ 3:48 p.m. 7 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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ / Moisture / PL / LL (0, 25, 50) / STRENGTH, tsf Qu / Qp (0, 2.0, 4.0)	Additional Remarks
	105			R-21	60	**DIABASE**-Gray to black, Fine grained, Weathered to Highly Weathered, very broken to slightly broken, hard		RQD=7 Rec=100%			3 min. 3 min. 4 min. 4 min. 3 min. 2 min.
	110			R-22	60	**DIABASE**-Gray to black, Fine grained, Slightly Weathered, very broken to massive, hard to very hard		RQD=80 Rec=100%		>> Q_u = 136.3 tsf 180.8 pcf	3 min. 2 min. 2 min. 2 min. 3 min.
	115			R-23	60	**Conglomeratic SANDSTONE**-Light gray to dark gray-brown to green-gray, Fine to very coarse grained, Slightly Weathered, very broken to massive, hard to extremely hard Very broken seam @ 119.5 feet (~ 2-1/4 inches thick)		RQD=82 Rec=100%		>> Q_u = 123.7 tsf 166.9 pcf >> Q_u = 289.7 tsf 159.1 pcf	4 min. 4 min. 3 min. 3 min.
	120			R-24	60			RQD=82 Rec=100%		>> Q_u = 282.9 tsf 164.2 pcf	3 min. 3 min. 4 min. 3 min. 3 min.
	125			R-25	60			RQD=93 Rec=100%		>> Q_u = 202.7 tsf 176.1 pcf	4 min. 5 min. 3 min. 4 min. 3 min.
	130					*Continued Next Page*					

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PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

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DATE STARTED:	8/23/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	8/25/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	180.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
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:**	F. Hoffman

REMARKS:

BORING B-1

Water
While Drilling 8 feet
8/23/2017 @ 3:48 p.m. 7 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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0 25 50) STRENGTH, tsf ▲ Qu ✳ Qp (0 2.0 4.0)	Additional Remarks
	130										3 min.
											4 min.
				R-26	60	**SANDSTONE**-Light gray-brown, Fine to coarse grained, Weathered to Slightly Weathered, very broken to massive, extremely hard		RQD=27 Rec=100%			3 min.
											1 min.
											2 min.
	135										2 min.
											4 min.
						Conglomeratic SANDSTONE-Light gray-brown to green-gray, Fine to very coarse grained, Slightly Weathered, broken to massive, hard to very hard					3 min.
				R-27	60			RQD=97 Rec=100%			3 min.
											3 min.
										>> ▲ Q_u = 241.4 tsf	172.3 pcf
	140										3 min.
											3 min.
											2 min.
				R-28	60	**SANDSTONE**-Light gray to black, Fine to very coarse grained, Slightly Weathered, very broken to massive, very hard to extremely hard		RQD=58 Rec=100%		>> ▲ Q_u = 596.6 tsf	155.0 pcf
											2 min.
	145										2 min.
											2 min.
											2 min.
				R-29	60	Weathered layer @ 147.8 feet (~ 4-1/4 inches thick)		RQD=37 Rec=100%			2 min.
						Conglomeratic SANDSTONE-Light gray to dark green-gray, Fine to very coarse grained, Slightly Weathered, broken to massive, very hard to extremely hard					3 min.
	150										2 min.
											3 min.
											3 min.
				R-30	60			RQD=95 Rec=100%		>> ▲ Q_u = 352.4 tsf	167.8 pcf
											3 min.
											3 min.
	155										2 min.

Continued Next Page

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PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	8/23/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	8/25/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	180.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
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:**	F. Hoffman

REMARKS:

BORING B-1

Water
While Drilling 8 feet
8/23/2017 @ 3:48 p.m. 7 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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ / Moisture × / PL ◪ / LL ✚ (0, 25, 50) / STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
				R-31	60	**SANDSTONE**-Light gray-brown to dark red-brown, Fine grained, Weathered to Slightly Weathered, very broken to slightly broken, extremely hard		RQD=28 Rec=100%			2 min. 2 min. 3 min. 3 min.
	160										3 min.
						Conglomeratic SANDSTONE-Light green-gray-brown, Fine to very coarse grained, Slightly Weathered, massive, extremely hard					2 min. >> ▲ Q_u = 647.5 tsf 149.6 pcf 4 min.
				R-32	60	**SANDSTONE**-Light gray to dark red-brown, Fine to medium grained, Weathered to Slightly Weathered, very broken to massive, extremely hard		RQD=67 Rec=100%			4 min. 3 min.
	165					**CONGLOMERATE**-Light gray to gray-brown to light brown, Fine to very coarse grained, Slightly Weathered, very broken to massive, very hard to extremely hard					3 min. 2 min. 2 min.
				R-33	60			RQD=93 Rec=100%			2 min. 3 min.
	170										3 min. 1 min. 3 min.
				R-34	58			RQD=97 Rec=97%			4 min. 4 min. >> ▲ Q_u = 199.1 tsf 168.3 pcf
	175										3 min. 4 min. 5 min.
				R-35	60			RQD=87 Rec=100%			4 min. 4 min.
	180					Test boring terminated @ 180 feet					4 min.

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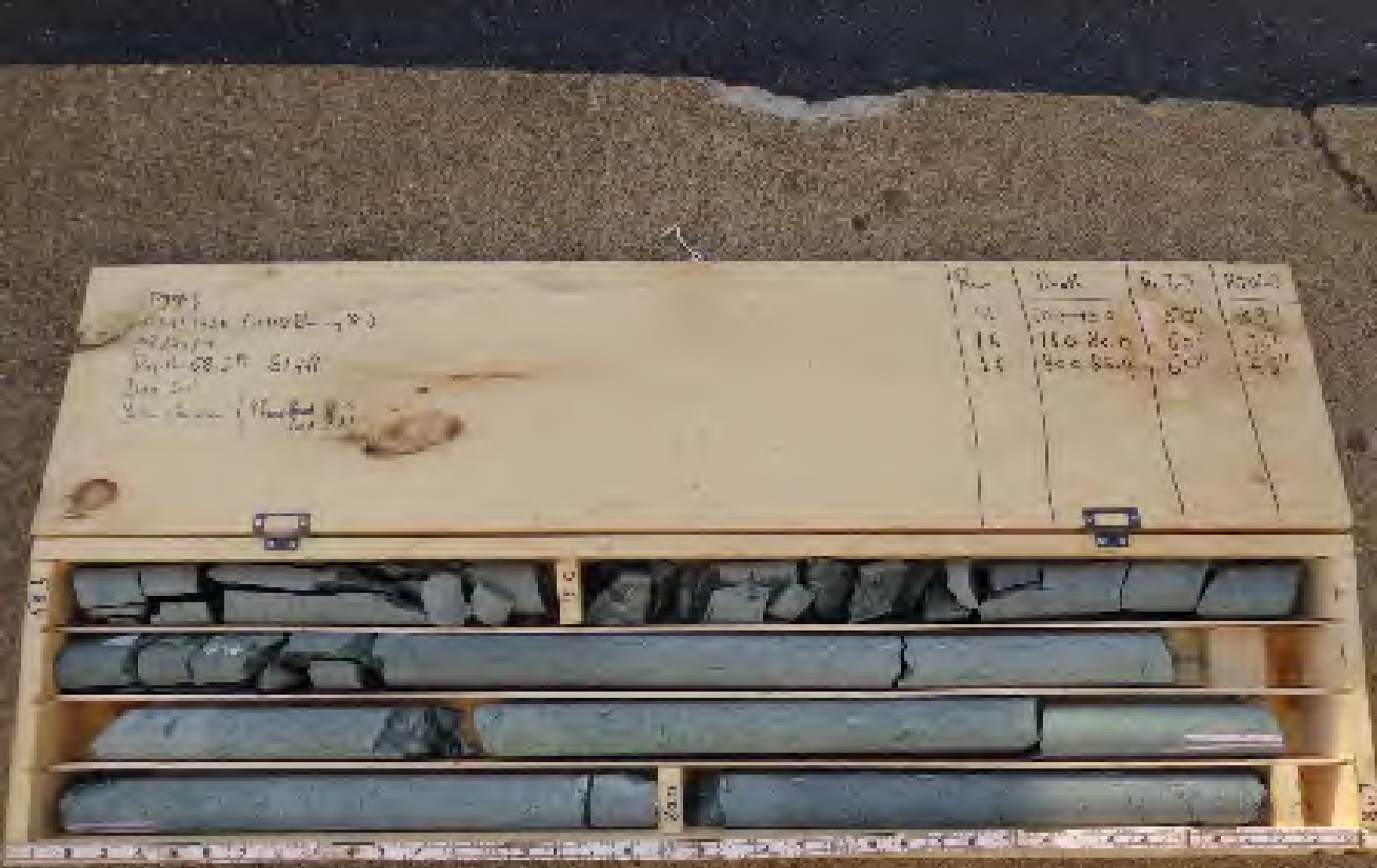
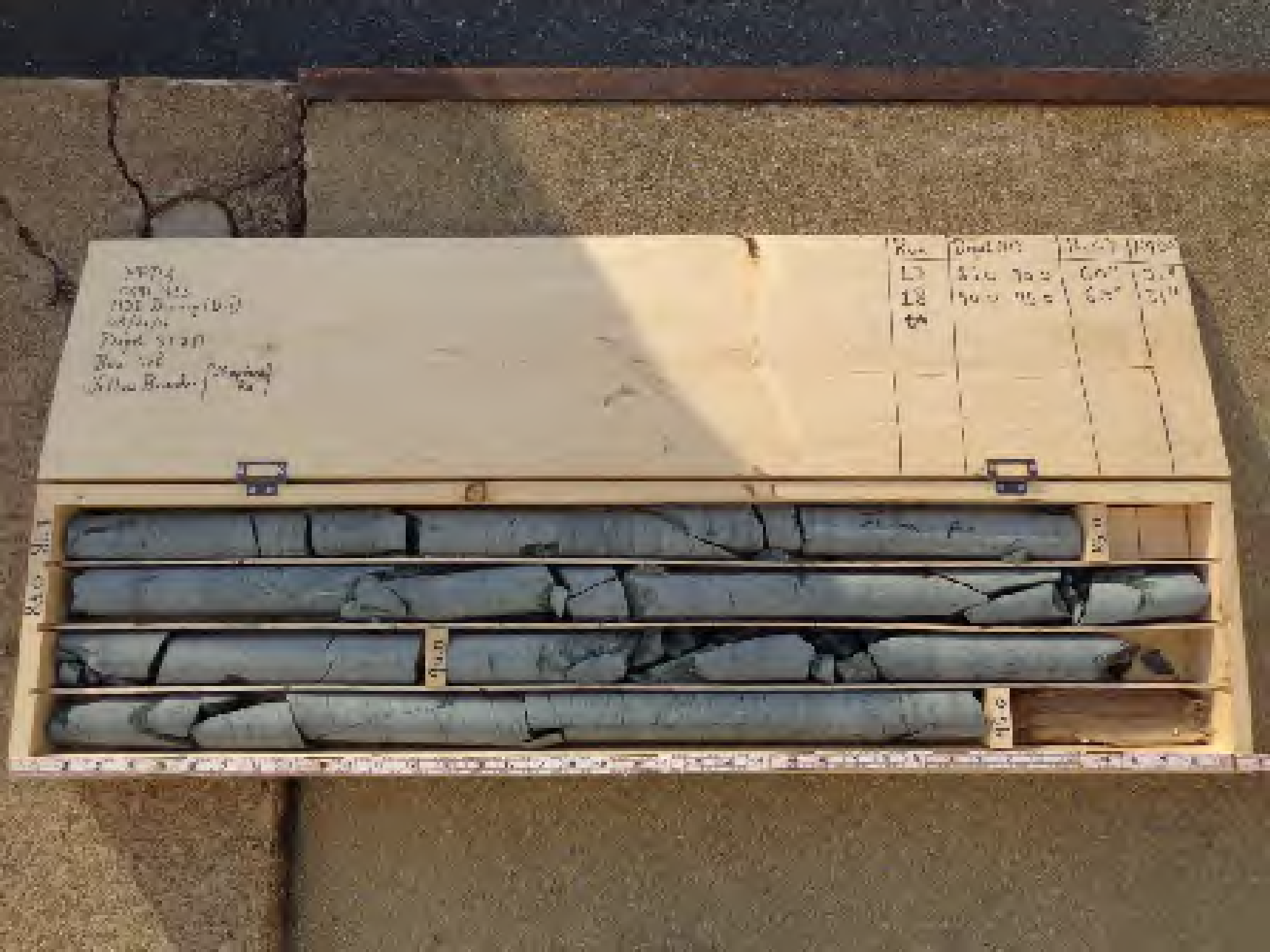
PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

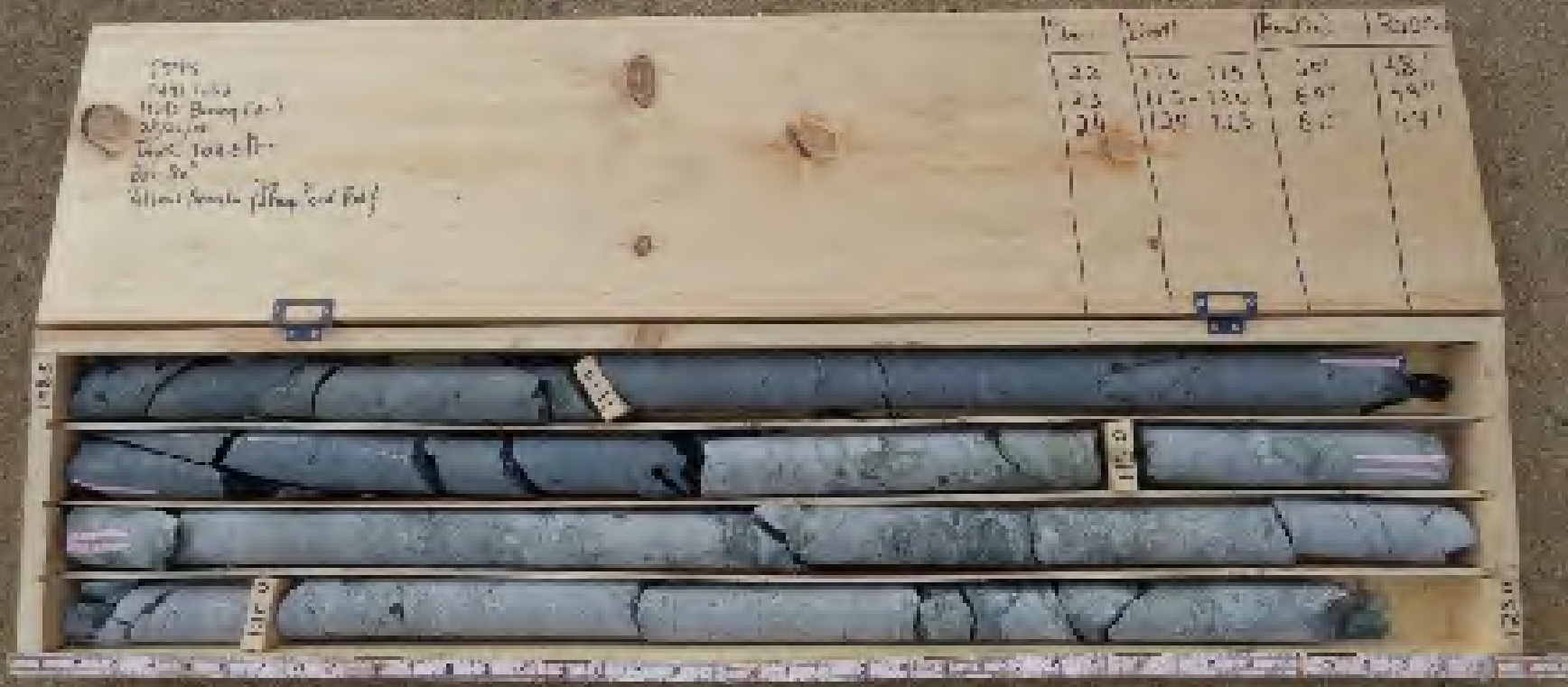
The stratification lines represent approximate boundaries. The transition may be gradual.

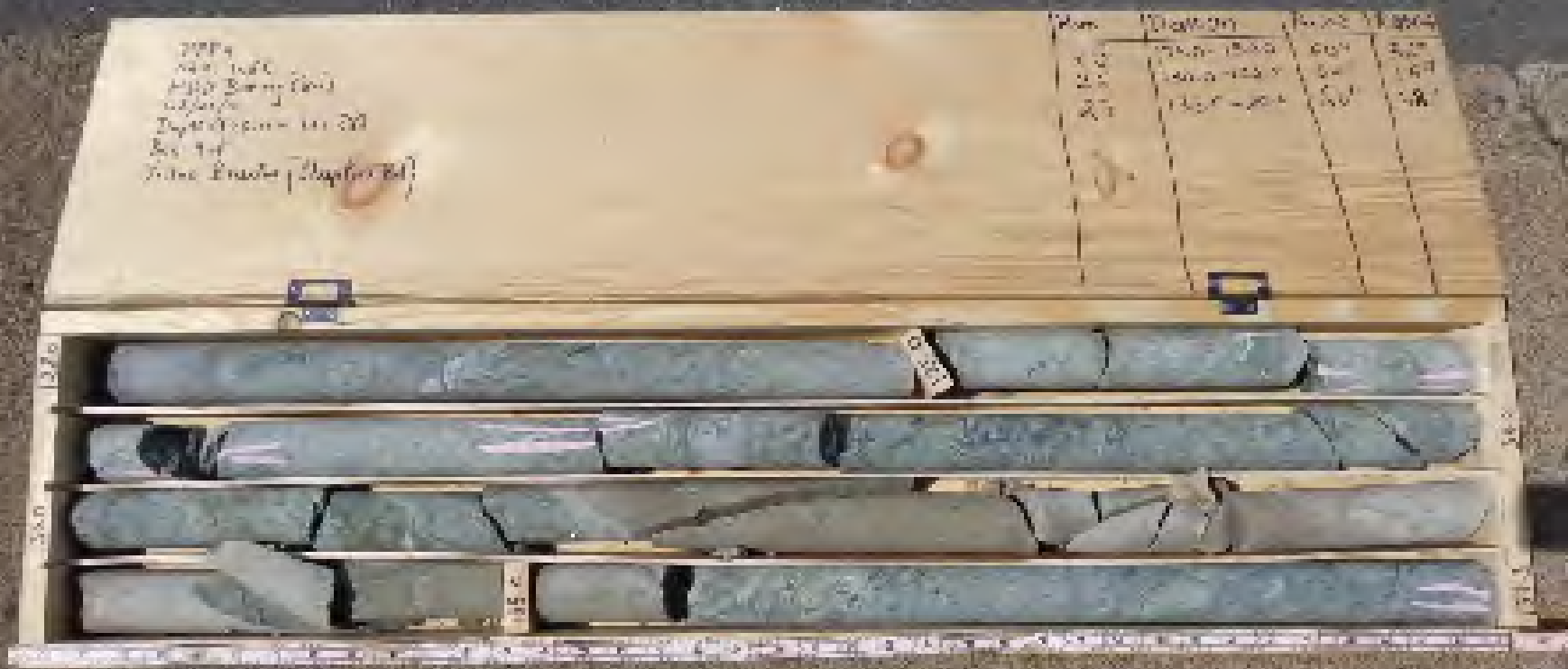
Yellow Breccia


PPP4
Run
6
7
8
30.0-35.0
35.0-40.0
40.0-45.0
60°
60°
60°









BORING B-2

DATE STARTED:	8/28/17
DATE COMPLETED:	8/31/17
COMPLETION DEPTH	250.0 ft
BENCHMARK:	N/A
ELEVATION:	N/A
LATITUDE:	n/a°
LONGITUDE:	n/a°
STATION:	N/A **OFFSET:** N/A
REMARKS:	

DRILL COMPANY:	Allied Well Drilling
DRILLER:	R. Miller **LOGGED BY:** H. Patel
DRILL RIG:	Diedrich D-50 Turbo
DRILLING METHOD:	Casing/Rock Coring
SAMPLING METHOD:	2-in SS1.874-in Core
HAMMER TYPE:	Automatic
EFFICIENCY	N/A
REVIEWED BY:	F. Hoffman

Water		
While Drilling	18	feet
8/28/2017 @ 4:35 p.m.	13	feet
8/31/2017 @ 4:45 p.m.	25	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) RQD & Recovery % (NX)	Moisture, %	Additional Remarks
	0			S-1	22	**RESIDUUM**-Loose, Dark brown, Clayey SAND, trace Gravel, moist	SC	5-4-6-9 N=10	13	Fines=38.6%
				S-2	18	**RESIDUUM**-Medium Dense, Dark brown, Silty SAND, moist With Gravel from 2 to 4 feet.	SM	6-9-11-10 N=20	12	
	5			S-3	22			8-7-6-6 N=13	13	Fines=22.7%
				S-4	20	**RESIDUUM**-Medium Dense, Dark brown, Clayey SAND with Gravel, moist	SC	5-6-7-6 N=13	15	
				S-5	21	**RESIDUUM**-Medium Dense, Brown to dark brown, Silty SAND, moist With Gravel from 8 to 10 feet.		7-7-7-8 N=14	20	
	10						SM			
				S-6	14			6-5-7-12 N=12	9	Fines=23.9%
	15					**RESIDUUM**-Medium Dense to Dense, Dark brown, Poorly Graded SAND with Silt, dry/moist				
				S-7	18	Moist/wet from 18 to 20 feet.		12-15-13-14 N=28	13	
	20						SP-SM			
	25									

Continued Next Page

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0

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Telephone: (717) 230-8622

PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	8/28/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	8/31/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	250.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
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:**	F. Hoffman

REMARKS:

BORING B-2

Water		
While Drilling	18	feet
8/28/2017 @ 4:35 p.m.	13	feet
8/31/2017 @ 4:45 p.m.	25	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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ / Moisture ✕ / PL ◪ / LL ✚ (0, 25, 50) / STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
				S-8	14	With Gravel, moist/wet from 25 to 26.9 feet.	SP-SM	45-26-17-50/5"11 N=43			
						SANDSTONE-Brown to gray-brown, Fine grained, Highly Weathered, very broken, moderately hard					
				R-1	18	**SANDSTONE**-Dark brown, Fine grained, Weathered to Slightly Weathered, slightly broken, moderately hard		RQD=0 Rec=50%			>> Q_u = 337.3 tsf 163.3 pcf
	30					**CONGLOMERATE**-Light gray to dark brown, Fine to very coarse grained, Slightly Weathered, broken to massive, moderately hard to hard					3 min.
				R-2	60	Weathered seam @ 29.8 feet (~ 2 inches thick)		RQD=100 Rec=100%			2 min. 3 min. 2 min.
	35										2 min. 2 min. 2 min.
				R-3	60			RQD=93 Rec=100%			2 min. >> Q_u = 302.8 tsf 165.3 pcf 2 min.
	40										2 min. 2 min. 2 min.
				R-4	60			RQD=100 Rec=100%			3 min. 3 min.
	45										2 min. 3 min. 2 min.
				R-5	60			RQD=95 Rec=100%			2 min. 3 min. >> Q_u = 430.8 tsf 162.4 pcf
	50										2 min. 3 min.

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PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	8/28/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	8/31/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	250.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
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:**	F. Hoffman

REMARKS:

BORING B-2

Water		
While Drilling	18	feet
8/28/2017 @ 4:35 p.m.	13	feet
8/31/2017 @ 4:45 p.m.	25	feet

BORING LOCATION:
See Boring Location Plan

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	Additional Remarks
	55	R-6	60	Weathered/Highly Weathered seam @ 52.1 feet (~ 3 inches thick) **SILTSTONE**-Red-brown, Very fine grained, Slightly Weathered, very broken to massive, moderately hard Sandstone seam @ 53.3 feet (~ 2-1/2 inches thick) Sandstone layer @ 54.5 feet (~ 3-1/4 inches thick)		RQD=70 Rec=100%		3 min. 3 min. >> Q_u = 309.3 tsf 169.1 pcf 2 min.
		R-7	60	**Conglomeratic SANDSTONE**-Brown to gray-brown, Fine to very coarse grained, Slightly Weathered, broken to massive, hard		RQD=85 Rec=100%		2 min. 2 min. 2 min. 2 min. 2 min.
	60	R-8	60	**CONGLOMERATE**-Light gray to dark brown, Fine to very coarse grained, Slightly Weathered, broken to massive, hard		RQD=87 Rec=100%		3 min. 3 min. 3 min. 3 min. 3 min.
	65	R-9	60	**Conglomeratic SANDSTONE**-Light gray-brown to dark brown, Fine to very coarse grained, Slightly Weathered, broken to massive, moderately hard to very hard Conglomerate layer @ 65.8 feet (~ 9-1/4 inches thick)		RQD=97 Rec=100%		3 min. 2 min. 2 min. 2 min. 2 min.
	70	R-10	58	**CONGLOMERATE**-Buff to dark gray-brown, Fine to very coarse grained, Slightly Weathered, massive, hard to very hard		RQD=88 Rec=97%		2 min. 3 min. 3 min. 2 min. 3 min. >> Q_u = 307.1 tsf 163.6 pcf 2 min.
	75	R-11	60	**Conglomeratic SANDSTONE**-Light gray-brown to dark brown, Fine to very coarse grained, Slightly Weathered, slightly broken to massive, hard to very hard		RQD=95		3 min. 2 min. 2 min.

Continued Next Page

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PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	8/28/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	8/31/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	250.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
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:**	F. Hoffman

REMARKS:

BORING B-2

Water		
While Drilling	18	feet
8/28/2017 @ 4:35 p.m.	13	feet
8/31/2017 @ 4:45 p.m.	25	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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ Moisture × PL ◪ LL ✚ (0 / 25 / 50) STRENGTH, tsf Qu ▲ Qp ✳ (0 / 2.0 / 4.0)	Additional Remarks
	80			R-12	60	**CONGLOMERATE**-Buff to light gray to dark brown, Fine to very coarse grained, Slightly Weathered, broken to massive, hard to very hard		Rec=100% RQD=97 Rec=100%			3 min. 3 min. 3 min. 4 min. 3 min. >> Q_u = 554.4 tsf 179.4 pcf 3 min.
	85			R-13	60			RQD=92 Rec=100%			3 min. 3 min. 4 min. 3 min. 3 min. 3 min.
	90			R-14	60	**Conglomeratic SANDSTONE**-Gray-brown, Fine to coarse grained, Slightly Weathered, massive, very hard **CONGLOMERATE**-Light gray to dark brown, Fine to very coarse grained, Slightly Weathered, slightly broken to massive, very hard, trace pits and vugs **Conglomeratic SANDSTONE**-Gray-brown to dark gray-brown, Fine to very coarse grained, broken to massive, hard to very hard		RQD=88 Rec=100%			2 min. 3 min. 3 min. 2 min. 2 min. >> Q_u = 430.9 tsf 166.2 pcf 3 min.
	95			R-15	60	**CONGLOMERATE**-Gray to dark brown, Fine to very coarse grained, Slightly Weathered, broken to massive, very hard **Conglomeratic SANDSTONE**-Light gray-brown to dark brown, Fine to very coarse grained, Slightly Weathered, slightly broken to massive, hard to very hard		RQD=90 Rec=100%			3 min. 3 min. 2 min. 2 min. 2 min.
	100			R-16	60	**CONGLOMERATE**-Light gray to dark brown, Fine to very coarse grained, Slightly Weathered, massive, very hard to extremely hard		RQD=93 Rec=100%			>> Q_u = 395.4 tsf 163.8 pcf 2 min. 2 min.

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PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	8/28/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	8/31/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	250.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
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:**	F. Hoffman

REMARKS:

BORING B-2

Water		
While Drilling	18	feet
8/28/2017 @ 4:35 p.m.	13	feet
8/31/2017 @ 4:45 p.m.	25	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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0 25 50) STRENGTH, tsf ▲ Qu ✳ Qp (0 2.0 4.0)	Additional Remarks
	105					**Conglomeratic SANDSTONE**-Light gray-brown, Fine to coarse grained, Slightly Weathered, massive, extremely hard					2 min.
				R-17	60	**SANDSTONE**-Red-brown to red-gray-brown, Fine grained, Weathered to Slightly Weathered, very broken to massive, moderately hard to hard		RQD=82 Rec=100%			3 min. >> Q_u = 627.9 tsf 162.5 pcf
						Weathered/Highly Weathered seam @ 108 feet (~ 2-1/4 inches thick)					2 min.
	110										3 min.
											2 min.
				R-18	60	Weathered/Highly Weathered seam @ 112.3 feet (~ 1-3/4 inches thick)		RQD=62 Rec=100%			3 min.
						SANDSTONE-Dark gray-brown to dark brown, Fine to medium grained, Slightly Weathered, slightly broken to massive, moderately hard to hard					3 min.
	115										3 min.
											3 min. >> Q_u = 348.4 tsf 159.9 pcf
						Highly Weathered seam @ 116.7 feet (~ 2-1/2 inches thick)					2 min.
				R-19	60	**Conglomeratic SANDSTONE**-Gray-brown to dark brown, Fine to very coarse grained, Slightly Weathered, massive, hard to very hard		RQD=92 Rec=100%			2 min.
	120										3 min.
											2 min.
											5 min.
				R-20	60			RQD=93 Rec=100%			3 min.
						CONGLOMERATE-Light gray to dark gray-brown, Fine to very coarse grained, Slightly Weathered, broken to massive, hard to very hard					3 min.
	125										4 min.
						Conglomeratic SANDSTONE-Light gray-brown to dark brown, Fine to very coarse grained, Slightly Weathered, massive, very hard					3 min. >> Q_u = 191.8 tsf 164.3 pcf
				R-21	60			RQD=93 Rec=100%			3 min.
											2 min.
											3 min.
	130										

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PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	8/28/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	8/31/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	250.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
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:**	F. Hoffman

REMARKS:

BORING B-2

Water		
While Drilling	18	feet
8/28/2017 @ 4:35 p.m.	13	feet
8/31/2017 @ 4:45 p.m.	25	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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	130					**Conglomeratic SANDSTONE**-Light gray-brown to dark brown, Fine to very coarse grained, Slightly Weathered, massive, very hard					3 min.
				R-22	60			RQD=92 Rec=100%			2 min.
											2 min.
											2 min.
						Conglomerate layer @ 134.3 feet (~ 5 inches thick)					2 min.
	135					**CONGLOMERATE**-Light gray to gray-brown, Fine to very coarse grained, Slightly Weathered, massive, hard					3 min.
											3 min.
				R-23	60	**Conglomeratic SANDSTONE**-Light gray-brown to dark brown, Fine to very coarse grained, Slightly Weathered, massive, moderately hard to very hard		RQD=93 Rec=100%			3 min.
											3 min.
						CONGLOMERATE-Light gray-brown to dark brown, Fine to very coarse grained, Slightly Weathered, slightly broken to massive, very hard					3 min.
	140										2 min.
						Conglomeratic SANDSTONE-Light gray-brown to dark brown, Fine to very coarse grained, very broken to massive, hard to very hard					3 min.
				R-24	60			RQD=93 Rec=100%			3 min.
											3 min.
											3 min.
	145										2 min.
											2 min.
											2 min.
				R-25	60	**CONGLOMERATE**-Light gray to dark brown, Fine to very coarse grained, Slightly Weathered, massive, hard to very hard		RQD=83 Rec=100%			2 min.
										>> Q_u = 576.4 tsf	3 min.
										167.4 pcf	
	150					**Conglomeratic SANDSTONE**-Light gray-brown to gray-brown, Fine to very coarse grained, Slightly Weathered, slightly broken to massive, hard					3 min.
											2 min.
						CONGLOMERATE-Light gray to dark brown, Fine to very coarse grained, Slightly Weathered, massive, hard to very hard					2 min.
				R-26	60			RQD=93 Rec=100%			3 min.
											3 min.
											3 min.
	155										3 min.

Continued Next Page

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Harrisburg, PA 17104
Telephone: (717) 230-8622

PROJECT NO.:	04911455
PROJECT:	Energy Transfer HDD (DPS)
LOCATION:	Yellow Breeches (PPP4)
	Cumberland/York COs, PA
	PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-2

DATE STARTED:	8/28/17
DATE COMPLETED:	8/31/17
COMPLETION DEPTH	250.0 ft
BENCHMARK:	N/A
ELEVATION:	N/A
LATITUDE:	n/a°
LONGITUDE:	n/a°
STATION:	N/A **OFFSET:** N/A
REMARKS:	

DRILL COMPANY:	Allied Well Drilling
DRILLER:	R. Miller **LOGGED BY:** H. Patel
DRILL RIG:	Diedrich D-50 Turbo
DRILLING METHOD:	Casing/Rock Coring
SAMPLING METHOD:	2-in SS1.874-in Core
HAMMER TYPE:	Automatic
EFFICIENCY	N/A
REVIEWED BY:	F. Hoffman

Water

While Drilling	18	feet
8/28/2017 @ 4:35 p.m.	13	feet
8/31/2017 @ 4:45 p.m.	25	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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ / Moisture × / PL ◪ / LL ✚ (0, 25, 50) / STRENGTH, tsf Qu ▲ Qp ✳ (0, 2.0, 4.0)	Additional Remarks
				R-27	60	**SANDSTONE**-Light gray-brown to red-brown-gray to dark red-brown, Fine to medium grained, Slightly Weathered, very broken to massive, moderately hard to very hard		RQD=68 Rec=100%			3 min. 3 min. 2 min. 2 min.
	160										3 min. >> Q_u = 416.7 tsf 163.4 pcf
				R-28	60			RQD=67 Rec=100%			3 min. 2 min. 2 min. 3 min.
	165					Very broken seam @ 164.3 feet (~ 1-3/4 inches thick)					3 min.
						Weathered/Highly Weathered seam @ 165.9 feet (~ 1-1/2 inches thick)					2 min.
				R-29	60	**Conglomeratic SANDSTONE**-Light gray-brown to gray-brown, Fine to very coarse grained, Slightly Weathered, massive, very hard		RQD=93 Rec=100%			2 min. 2 min. 2 min. >> Q_u = 417.2 tsf 164.3 pcf
	170										3 min. 2 min. 2 min.
				R-30	60	**CONGLOMERATE**-Light gray to dark gray-brown, Fine to very coarse grained, Slightly Weathered, massive, very hard		RQD=100 Rec=100%			3 min. 3 min.
						Conglomeratic SANDSTONE-Gray-brown to dark gray-brown, Fine to very coarse grained, Slightly Weathered, massive, hard to very hard					
	175										3 min. 3 min.
				R-31	60			RQD=92 Rec=100%			3 min. 3 min. 3 min.
						SANDSTONE-Brown to dark brown, Fine grained, Slightly Weathered, massive, moderately hard					
	180										3 min. >> Q_u = 478.4 tsf 155.5 pcf

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PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-2

DATE STARTED:	8/28/17	**DRILL COMPANY:** Allied Well Drilling
DATE COMPLETED:	8/31/17	**DRILLER:** R. Miller **LOGGED BY:** H. Patel
COMPLETION DEPTH	250.0 ft	**DRILL RIG:** Diedrich D-50 Turbo
BENCHMARK:	N/A	**DRILLING METHOD:** Casing/Rock Coring
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:** F. Hoffman
REMARKS:		

Water

While Drilling	18	feet
8/28/2017 @ 4:35 p.m.	13	feet
8/31/2017 @ 4:45 p.m.	25	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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0 25 50) STRENGTH, tsf ▲ Qu ✳ Qp (0 2.0 4.0)	Additional Remarks
				R-32	60	**CONGLOMERATE**-Light gray to dark gray-brown, Fine to very coarse grained, Slightly Weathered, massive, very hard		RQD=97 Rec=100%			3 min. 3 min. 3 min.
	185					**SANDSTONE**-Brown to dark brown, Fine grained, Slightly Weathered, broken to massive, hard					3 min. 2 min. 2 min.
				R-33	60	**Conglomeratic SANDSTONE**-Gray-brown to dark brown, Fine to very coarse grained, Slightly Weathered, massive, hard to very hard		RQD=77 Rec=100%			2 min. 2 min. 2 min.
	190					**CONGLOMERATE**-Light gray to gray-brown, Fine to very coarse grained, Slightly Weathered, massive, hard to very hard				>> Q_u = 468.4 tsf 166.4 pcf	2 min.
				R-34	60	**Conglomeratic SANDSTONE**-Gray-brown, Fine to very coarse grained, Slightly Weathered, massive, hard to very hard		RQD=88 Rec=100%			3 min. 2 min.
						SANDSTONE-Brown to red-brown, Fine grained, Slightly Weathered, broken to slightly broken, moderately hard to hard					3 min.
	195					**CONGLOMERATE**-Light gray to dark brown, Fine to very coarse grained, Slightly Weathered, slightly broken to massive, hard, trace pits					3 min. 4 min.
				R-35	60			RQD=88 Rec=100%			3 min. 3 min.
	200					**SANDSTONE**-Brown to gray-brown, Fine grained, Slightly Weathered, broken to massive, moderately hard				>> Q_u = 370.9 tsf 162.7 pcf	4 min. 4 min.
				R-36	60	Weathered/Highly Weathered layer @ 202.8 feet (~ 7-1/2 inches thick)		RQD=70 Rec=100%			4 min. 4 min.
	205										5 min. 4 min.
				R-37	60			RQD=85			4 min.

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PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED:	8/28/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	8/31/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	250.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
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:**	F. Hoffman

REMARKS:

BORING B-2

Water		
While Drilling	18	feet
8/28/2017 @ 4:35 p.m.	13	feet
8/31/2017 @ 4:45 p.m.	25	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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ Moisture × PL ◪ LL ✚ (0 / 25 / 50) STRENGTH, tsf Qu ▲ Qp ✳ (0 / 2.0 / 4.0)	Additional Remarks
								Rec=100%			4 min. >> Q_u = 269.6 tsf 165.3 pcf
	210					**SANDSTONE**-Brown to red-brown, Fine grained, Weathered to Highly Weathered, very broken to slightly broken, moderately hard					4 min.
											3 min.
											4 min.
				R-38	60	**SANDSTONE**-Red-brown, Fine grained, Slightly Weathered, massive, moderately hard		RQD=60 Rec=100%			4 min.
						Conglomeratic SANDSTONE-Dark brown to red-gray-brown, Fine to very coarse grained, Slightly Weathered, massive, moderately hard					4 min.
	215										4 min.
											3 min.
				R-39	60	**SHALE**-Dark brown to brown, Very fine grained, Slightly Weathered, broken to massive, moderately hard		RQD=98 Rec=100%			3 min.
											4 min.
											4 min.
	220										4 min.
											4 min.
						Weathered/Highly Weathered seam @ 221.4 feet (~ 2-1/2 inches thick)					3 min.
				R-40	60	**CONGLOMERATE**-Light gray to dark brown, Fine to very coarse grained, Slightly Weathered, slightly broken to massive, hard to very hard		RQD=72 Rec=100%			3 min.
											3 min.
	225										3 min.
											3 min.
											3 min.
				R-41	60			RQD=100 Rec=100%			3 min.
											3 min.
											3 min.
	230										3 min.
											3 min.
											2 min.
				R-42	60			RQD=98 Rec=100%			3 min. >> Q_u = 395.4 tsf

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PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-2

DATE STARTED:	8/28/17	**DRILL COMPANY:** Allied Well Drilling
DATE COMPLETED:	8/31/17	**DRILLER:** R. Miller **LOGGED BY:** H. Patel
COMPLETION DEPTH	250.0 ft	**DRILL RIG:** Diedrich D-50 Turbo
BENCHMARK:	N/A	**DRILLING METHOD:** Casing/Rock Coring
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:** F. Hoffman

REMARKS:

Water

While Drilling	18	feet
8/28/2017 @ 4:35 p.m.	13	feet
8/31/2017 @ 4:45 p.m.	25	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) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	235			R-43	60	**CONGLOMERATE**-Light gray to dark brown, Fine to very coarse grained, Slightly Weathered, slightly broken to massive, hard to very hard		RQD=98 Rec=100%		2 min. 3 min. 2 min. 2 min. 2 min. 3 min.	161.7 pcf
	240			R-44	60	**SHALE**-Dark brown to brown, Very fine grained, Slightly Weathered, very broken to massive, moderately hard		RQD=75 Rec=100%		4 min. 2 min. 3 min. 4 min. 4 min.	
	245			R-45	60	**CONGLOMERATE**-Gray-brown, Fine to very coarse grained, Slightly Weathered, massive, very hard		RQD=98 Rec=100%		3 min. 3 min. 3 min. 3 min. 3 min.	
	250					Test boring terminated @ 250 feet				4 min.	

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PROJECT NO.: 04911455
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

The stratification lines represent approximate boundaries. The transition may be gradual.

PPP4
0491 1455
HDD Boring (B-2)
08/29/17
Depth: 27.0ft - 42.2'
Box: 1of
Shawthorn Rd, New Cumberland PA

Run	Depth (ft)	Rec (in)	RQD (in)
1	27.0 - 30.0	32.0	8.0"
2	30.0 - 35.0	60.0	60.0"
3	35.0 - 40.0	60.0	56.0"
4	40.0 - 45.0	60.0	60"

Schauffhurtown Rd,

PPP4
0491 1455
HDD Boring (B-1)
08/29/17
Depth: 42.5ft - 56.5ft
Box: 2of
Schauffhurtown Rd, New Cumberland, PA

Run	Depth (ft)	Rec (in)	RQD (in)
5	45.0 - 50.0	60.0	57"
6	50.0 - 55.0	60.0	42.0"
7	55.0 - 60.0	60.0	51.0"
8	~~50.0 - 55.0~~		


PPP4
0491 1455
HDD Boring (B-2)
08/29/17
Depth: 56.5ft -
Box: 3 of
Schauffnertown Rd, New Cumberland PA
Run | Depth | Rec(in) | RQD(in)
8 | 60-65 | 60" | 52"
9 | 65-70 | 60" | 58"
10 | 70-75 | 58" | 53"
56.5
60.0
60.0
65.0
70.0
71.0


PPP 4
0491 1455
HDD Boring (B-2)
08/29/17
Depth: 71.0 ft - 85.0 ft.
Box 4 of
Schauffnerstown Rd, New Cumberland PA
Run | Depth (ft) | Rec (in) | RQD (in)
11 | 75.0-80.0 | 60" | 57"
12 | 80.0-85.0 | 60" | 58"
71.0
75.0
80.0
85.0


PPP4
0491 1455
HDD Boring (B-2)
08/29/17
Depth: 85.0ft – 100.0ft
Box: 5 of
Schaufftnertown Rd, New Cumberland, PA
Run | Depth (ft) | Rec (in) | RQD (in)
13 | 85.0-90.0 | 60" | 55"
14 | 90.0-95.0 | 60" | 53"
15 | 95.0-100.0 | 60" | 54"
85.0
90.0
95.0
100.0


PPP 4
0491 1455
HDD Boring (B-2)
08/29/17
Depth 100.0ft - 114.5 ft.
Shaufferstown Rd, New Cumberland, PA
Run
Depth
Rec
RQD
16
100-105
60"
56"
17
105-110
60"
18
110-115
60"
100.0
105.0
110.0


0491 1455
HDD Boring
08/29/17
Depth: 114.5ft – 128.0ft
Box: 7 of
Schaffnertown Rd, New Cumberland, PA
Run Depth Rec Rec
19 115-120 60" 55"
20 120-125 60" 56"
21 125-130 60" 56"
115.0
120.0
125.0


PPP4
0491 1455
HDD Boring (B-12)
08/30/17
Depth: 128.0ft - 142.5ft
Box: 8 of
Schaufftown Rd, New Cumberland, PA
Run | Depth(ft) | Rec(in) | RQD(in)
22 | 130 - 135 | 60" | 55"
23 | 135 - 140 | 60" | 56"
24 | 140 - 145 | 60" | 56"
128.0
130.0
135.0
135.0
140.0
142.5


0491 145.5
HDD Boring (B[redacted]-2)
08/30/17
Depth: (142.5 - 157.5) ft
Box: 9[redacted]
Run | Depth (ft) | Rec | RQD
25 | 145.0-150.0 | 60" | 50"
26 | 150.0-155.0 | 60" | 56"
27 | 155.0-160.0 | 60" | 41"
142.5
145.0
150.0
150.0
155.0
157.5


PPP4
0491 1455
HDD Boring (B-1)
08/30/17
Depth: 157.5ft of
Box: 10 of
Schauffnerfown Rd.
Run | Depth | Rec | RQD
28 | 160.0-165.0 | 60" | 40"
29 | 165.0-170.0 | 60" | 56"
30 | 170.0-175.0 | 60" | 60"
157.5
165.0
160.0
170.0


PPP4
0491 1455
HDD Boring (B[redacted]-2)
08/30/17
Depth: 171.5ft – 186.0ft
Box: 11of
Run
Depth (ft)
Rec
RQD
31 175-180 60" 55"
32 180-185 60" 58"
33 185-190 60" 46"
171.5
175.0
180
185.0
186.0


PPP 4
0491 1455
08/30/17
Depth: 186.0-200ft (B-2)
Box: 12 of
Schauffnertown Rd, PA
Run Depth Rec RQD
34 190-195 60" 53"
35 195-200 60" 53"
186.0
190.0
195.0
200.0


PPP4
0491 1455
MDD Boring (B[redacted]-2)
08/30/17
Depth: 200ft - 213.5 ft
Box: 13 of
Schaefferstown Rd.
Run | Depth | Rec(in) | RQD(in)
36 | 200 - 205 | 60" | 42"
37 | 205 - 210 | 60" | 51"
38 | 210 - 215 | 60" | 36"
200
205.0
210.0
210.0
213.5

Run | Depth | Rec | RQD
39 | 215.0 - 220.0 | 60" | 59"
40 | 220.0 - 225.0 | 60" | 43"
41 | 225.0 - 230.0 | 60" | 60"
PPP4
0491 1455
HDD Boring ([redacted] B-2)
Depth (213.5 - 228.0) ft
Box: 14 of
Schauffnertown Rd, PA
213.5
215.0
220.0
225.0
228.0


PPP 4
0491 1455
08/31/17
Depth: (228.0-242.0)ft (B-2)
Box: 15of
Schauffnertown Rd.
Run | Depth | Rec | RQD
42 | 230-235 | 60" | 59"
43 | 235-240 | 60" | 59"
44 | 240-245 | 60" | 45"
228.0
230.0
235.0
240.0
242.5

PPP4
0491 1455
HDD Boring (B-2)
08/31/17
Depth 242.5 ft - 250 ft
Box: 16 of 16
Run
Depth
Rec
RQD
45
245-250
60"
59"
242.5
245.0
250.0

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.
HSA: Hollow Stem Auger - typically 3¼" or 4¼ I.D. openings, except where noted.
M.R.: Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry
R.C.: Diamond Bit Core Sampler
H.A.: Hand Auger
P.A.: Power Auger - Handheld motorized auger

SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
ST: Shelby Tube - 3" O.D., except where noted.
RC: Rock Core
TC: Texas Cone
BS: Bulk Sample
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.
N_{60}: 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

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

ANGULARITY OF COARSE-GRAINED PARTICLES

Description	Criteria
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

Component	Size Range
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

Description	Criteria
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

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

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GENERAL NOTES

(Continued)

CONSISTENCY OF FINE-GRAINED SOILS

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

MOISTURE CONDITION DESCRIPTION

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

RELATIVE PROPORTIONS OF SAND AND GRAVEL

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

STRUCTURE DESCRIPTION

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

Q_U - TSF	Consistency
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

Description	Criteria
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	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

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

GRAIN-SIZED TERMINOLOGY

(Typically Sedimentary Rock)

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

ROCK QUALITY DESCRIPTION

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

Degree of Brokeness

Characteristic	Description
Less than 1 inch	Very Broken
1 inch to 3 inches	Broken
3 inches to 6 inches	Slightly Broken
Greater than 6 inches	Massive

DEGREE OF WEATHERING

Slightly Weathered: Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.

Weathered: Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.

Highly Weathered: Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

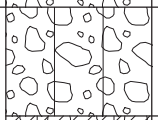
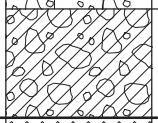
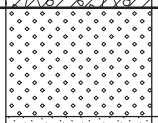
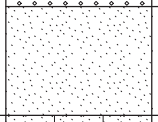
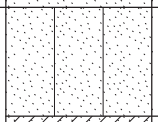
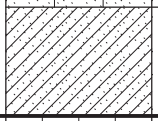
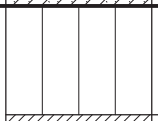
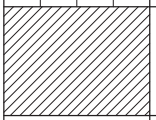
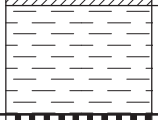
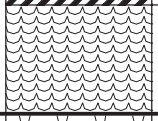
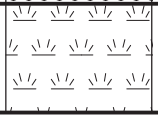
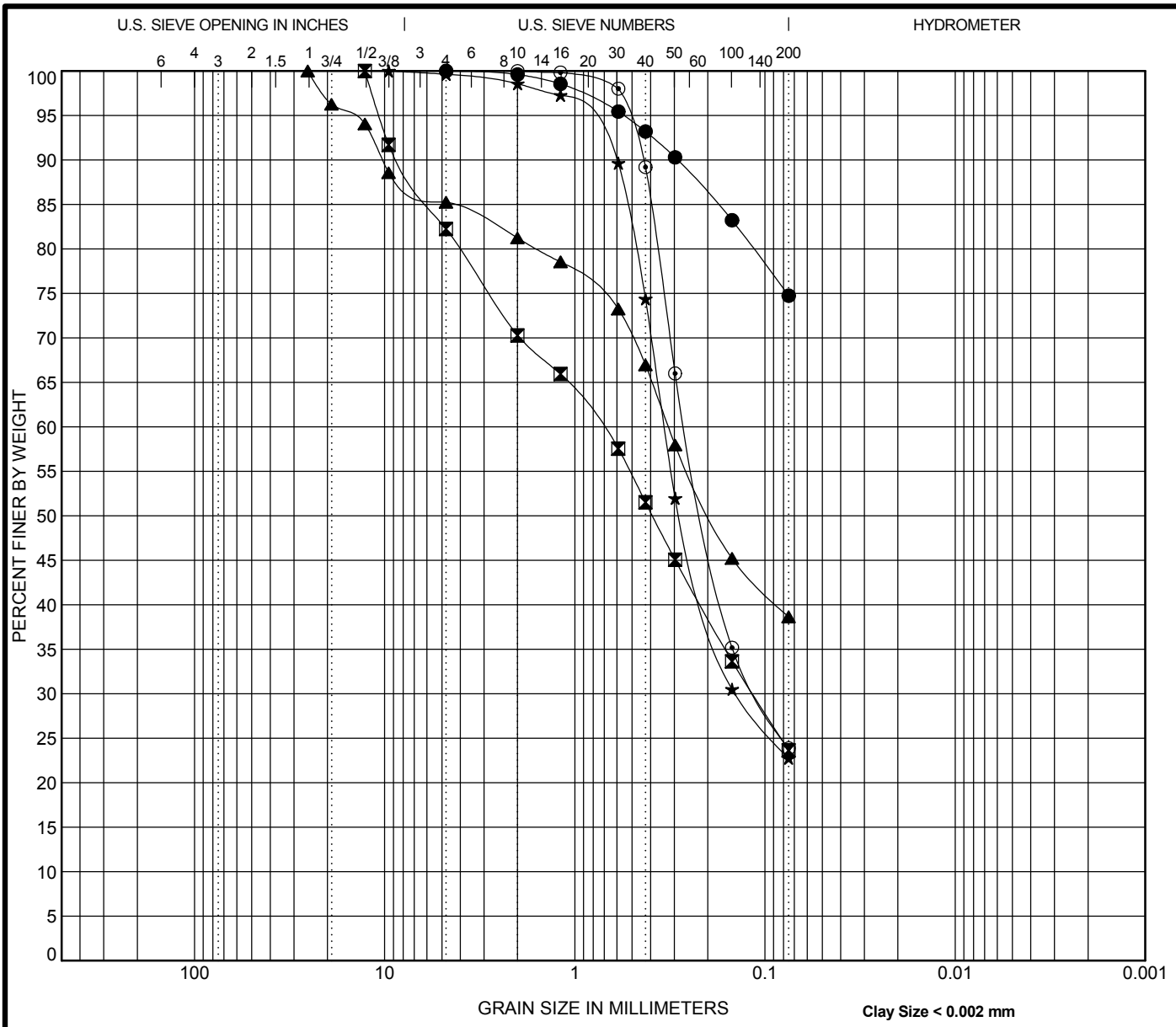
MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS 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
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				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.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-1	1.0	Lean CLAY with Sand (CL)					
⊠	B-1	5.0	Silty SAND with Gravel (SM)					
▲	B-2	1.0	Clayey SAND (SC)					
★	B-2	5.0	Silty SAND (SM)					
⊙	B-2	14.0	Silty SAND (SM)					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	1.0	4.75				0.0	25.3	74.7	
⊠	B-1	5.0	12.7	0.724	0.116		17.8	58.6	23.6	
▲	B-2	1.0	25.4	0.322			14.8	46.6	38.6	
★	B-2	5.0	9.525	0.338	0.143		0.4	76.9	22.7	
⊙	B-2	14.0	4.75	0.26	0.109		0.0	76.1	23.9	

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Harrisburg, PA 17104
Telephone: (717) 230-8622
Fax: (717) 230-8626

GRAIN SIZE DISTRIBUTION

Project: Energy Transfer HDD (DPS)
PSI Job No.: 04911455
Location: Yellow Breeches (PPP4)
Cumberland/York COs, PA

Laboratory Summary Sheet

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-1	1					74.7%		37			
B-1	3							11			
B-1	5					23.6%		23			
B-1	7							14			
B-1	9							24			
B-1	23.4				681.48						
B-1	41				208.34						
B-1	51.2				261.49						
B-1	61.2				670.62						
B-1	77.9				271.41						
B-1	89.2				182.39						
B-1	101.5				134.69						
B-1	110.2				136.30						
B-1	114				123.70						
B-1	118.5				289.72						
B-1	123.6				282.94						
B-1	129				202.74						
B-1	139				241.41						
B-1	143				596.56						
B-1	152.5				352.39						
B-1	161.5				647.49						
B-1	174.3				199.14						
B-2	1					38.6%		13			
B-2	3							12			
B-2	5					22.7%		13			
B-2	7							15			
B-2	9							20			
B-2	14					23.9%		9			
B-2	19							13			
B-2	26							11			
B-2	28.8				337.30						
B-2	38.2				302.79						
B-2	49.5				430.81						
B-2	53.7				309.31						
B-2	73.5				307.08						
B-2	82.4				554.43						
B-2	94.4				430.86						
B-2	100.7				395.42						
B-2	107.2				627.86						
B-2	115.7				348.42						
B-2	126.2				191.81						
B-2	148.6				576.41						

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Summary of Laboratory Results

PSI Job No.: 04911455
Project: Energy Transfer HDD (DPS)
Location: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

Laboratory Summary Sheet

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-2	160.3				416.69						
B-2	169.1				417.16						
B-2	180.6				478.43						
B-2	190.3				468.42						
B-2	201				370.85						
B-2	208.6				269.61						
B-2	233.4				395.43						

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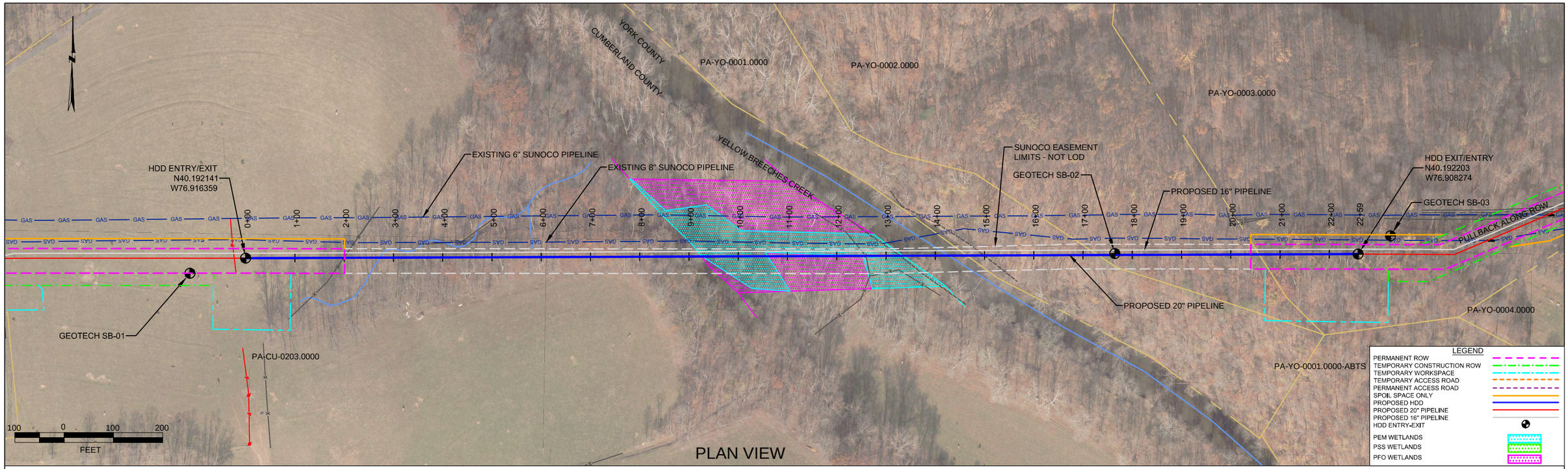
Summary of Laboratory Results

PSI Job No.: 04911455
Project: Energy Transfer HDD (DPS)
Location: Yellow Breeches (PPP4)
Cumberland/York COs, PA
PA-CU-0203.0000-WX/PO#20170816-1

YELLOW BREECHES CREEK CROSSING
PADEP SECTION 105 PERMIT NO.S: E21-449
PA-CU-0203.0000-WX & PA-CU-0203.0000-WX-16
(SPLP HDD No. S2-0250)

ATTACHMENT 2

ORIGINAL AND REVISED HORIZONTAL DIRECTIONAL DRILL PLAN AND PROFILES



PLAN VIEW

PROFILE VIEW

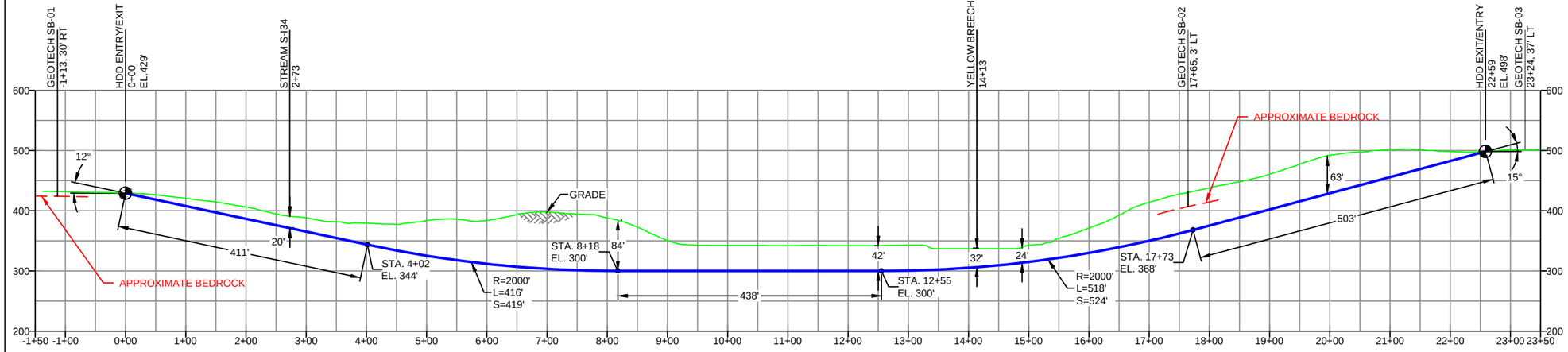
CUMBERLAND COUNTY, PENNSYLVANIA - LOWER ALLEN TOWNSHIP
YORK COUNTY, PENNSYLVANIA - FAIRVIEW TOWNSHIP
S2-0250

GEOTECH SB-01
-NG EL. 432'
-TOPSOIL (0.0'-0.5')
-CL/ML (0.5' - 6.5')
-SANDSTONE (6.5' - 7.2')
-AUGER REFUSAL (7.0')
-COMPLETION DEPTH EL. 425'

GEOTECH SB-02
-NG EL. 430'
-SM (0.0' - 25.0')
-SANDSTONE (25.0' - 34.0')
-AUGER REFUSAL (34.0')
-REDDISH BROWN SANDSTONE (34.0' - 43.0')
-COMPLETION DEPTH EL. 388'

GEOTECH SB-03
-NG EL. 498'
-TOPSOIL (0' - 0.4')
-SM (0.4' - 12.5')
-ML\CL (12.5' - 18.5')
-SILTY SAND (18.5' - 22.8')
-COMPLETION DEPTH EL. 475'

NOTE: REFER TO TEST BORING LOG S2-0250 FOR COMPLETE SOIL MATERIAL DESCRIPTION



DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):2259'
   HDD PIPE LENGTH (S=):2295'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. 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.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
4	DRILL ENTRY/EXIT LAT LONG UPDATE	DLM	04/03/17	RMB	04/03/17	CAG	04/03/17
3	REVISED PROFILE WITH 2017 LIDAR	MRS	02/24/17	RMB	02/24/17	CAG	02/24/17
2	REVISED PER ENGINEERING COMMENTS	MRS	08/31/16	RMB	08/31/16	AAW	08/31/16
1	REVISED PER COMMENTS FROM REI REVIEW	MRS	02/19/16	RMB	02/19/16	AAW	02/19/16
0	ISSUED FOR CONSTRUCTION	MRS	01/19/16	RMB	01/19/16	AAW	01/19/16

Sunoco Logistics Partners L.P.

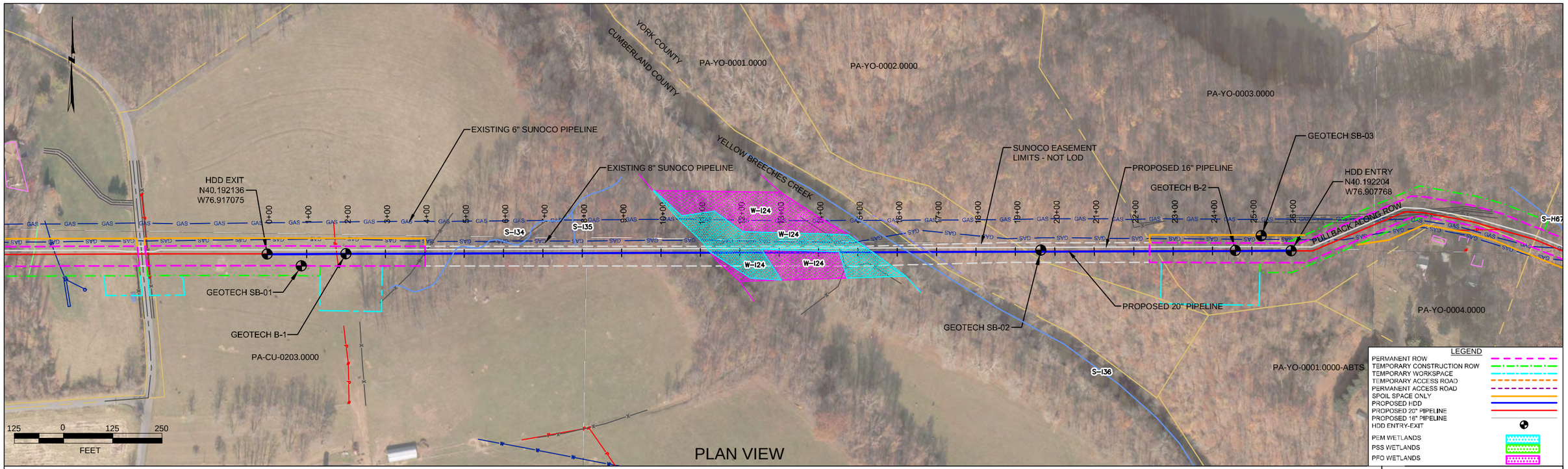
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
YELLOW BREECHES CREEK
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

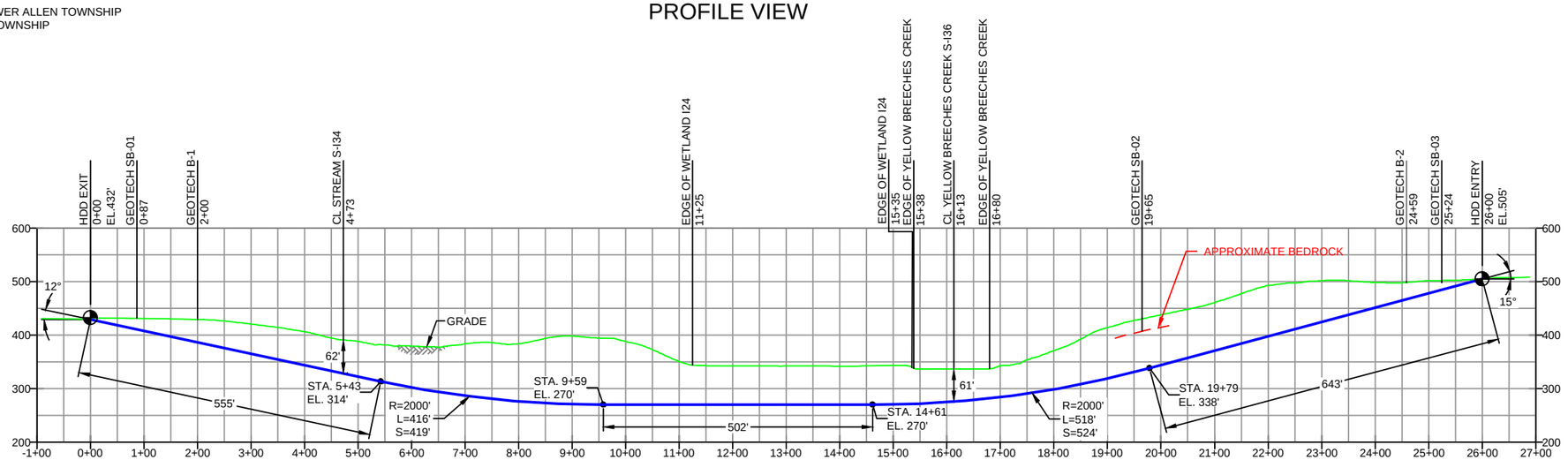
DWG. NUMBER: PA-CU-0203.0000-WX



PLAN VIEW

PROFILE VIEW

CUMBERLAND COUNTY, PENNSYLVANIA - LOWER ALLEN TOWNSHIP
YORK COUNTY, PENNSYLVANIA - FAIRVIEW TOWNSHIP
S2-0250



GEOTECH SB-01

-NG EL. 432'
-TOPSOIL (0.0'-0.5')
-CL/ML (0.5' - 6.5')
-SANDSTONE (6.5' - 7.2')
-AUGER REFUSAL (7.0')
-COMPLETION DEPTH EL. 425'

GEOTECH SB-02

-NG EL. 430'
-SM (0.0' - 25.0')
-SANDSTONE (25.0' - 34.0')
-AUGER REFUSAL (34.0')
-REDDISH BROWN SANDSTONE (34.0' - 43.0')
-COMPLETION DEPTH EL. 388'

GEOTECH SB-03

-NG EL. 498'
-TOPSOIL (0' - 0.4')
-SM (0.4' - 12.5')
-ML\CL (12.5' - 18.5')
-SILTY SAND (18.5' - 22.8')
-COMPLETION DEPTH EL. 475'

NOTE: REFER TO TEST BORING LOG S2-0250 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-1

-NG EL. 429'
-LEAN CLAY CL (0.0' - 2.0')
-CLAYEY GRAVEL GC GC (2.0' - 4.0')
-SILTY SAND SM (4.0' - 8.0')
-GROUNDWATER (7.0')
-SILTY SAND SM (8.0' - 12.0')
-DIABASE/SANDSTONE (12.0' - 180.0')
-COMPLETION DEPTH EL.249'

NOTE: REFER TO TEST BORING LOG B-1 INTERTEK PROJECT # 04911455 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-2

-NG EL. 498'
-CLAYEY SAND SC GC (0.0' - 2.0')
-SILTY SAND SM (2.0' - 6.0')
-GROUNDWATER (13.0')
-CLAYEY SAND SC GC (6.0' - 8.0')
-SILTY SAND SM (8.0' - 16.5')
-SILTY SAND SP-SM (16.5' - 27.0')
-CONGLOMERATE/SANDSTONE (27.0' - 250.0')
-COMPLETION DEPTH EL.248'

NOTE: REFER TO TEST BORING LOG B-2 INTERTEK PROJECT # 04911455 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):2600'
   HDD PIPE LENGTH (S=): 2643'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. 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.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES-4.100	TO	ES-4.01	EROSION & SEDIMENT PLAN
SHEET 62	TO	SHEET 1	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP3	RELOCATED ENTRY/EXIT POINTS - DESIGN CHANGE BY DPS	MRS	10/30/17	RMB	10/30/17	CAG	10/30/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/17/16	RMB	05/17/16	AAW	05/17/16
EP		JTW	11/23/15	RMB	11/23/15	AAW	11/23/15
C	ADDED GEOTECH INFO	MRS	09/16/15	RMB	09/16/15	AAW	09/16/15
B	ISSUED FOR BID	DLM	7/31/15	RMB	7/31/15	AAW	7/31/15

Sunoco Logistics Partners L.P.

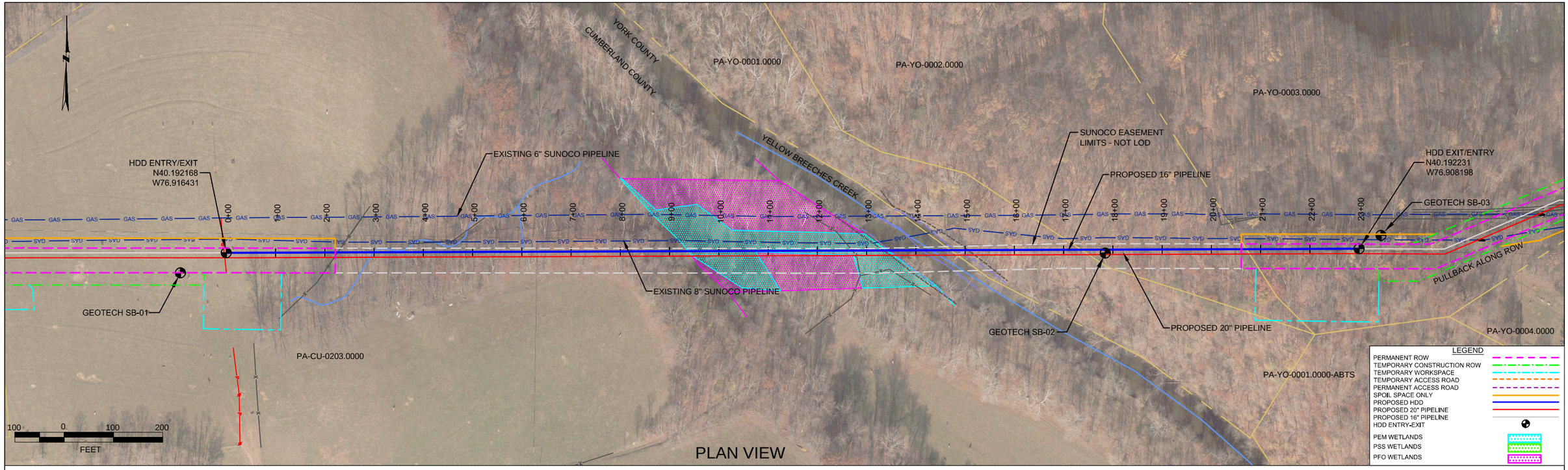
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
YELLOW BREECHES CREEK
PENNSYLVANIA PIPELINE PROJECT

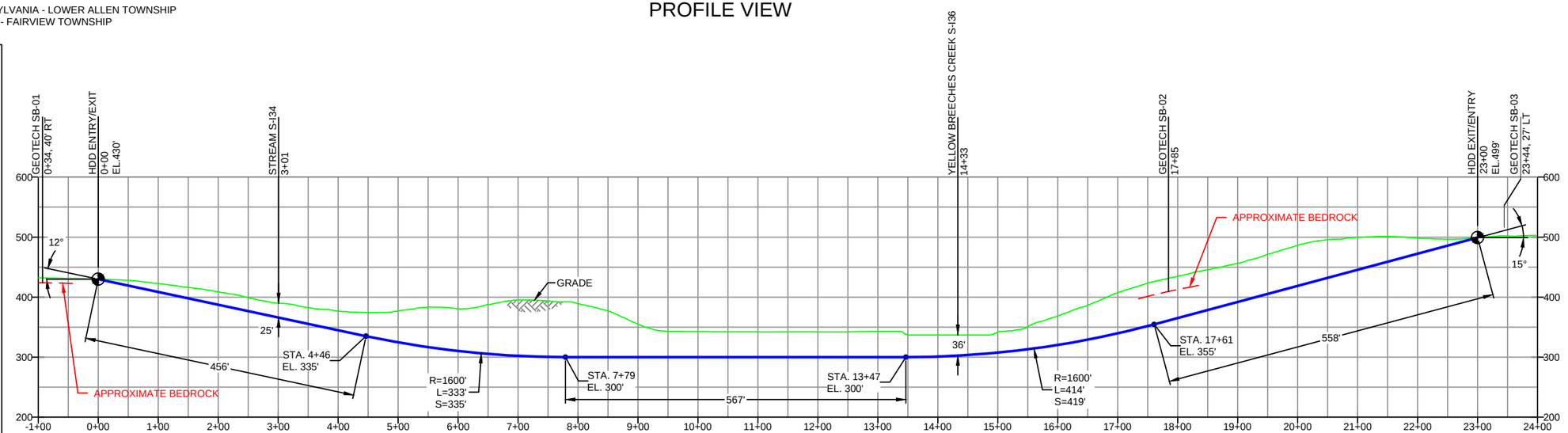
SCALE: 1"=250'

DWG. NUMBER: PA-CU-0203.0000-WX



PLAN VIEW

PROFILE VIEW



CUMBERLAND COUNTY, PENNSYLVANIA - LOWER ALLEN TOWNSHIP
YORK COUNTY, PENNSYLVANIA - FAIRVIEW TOWNSHIP
S2-0250-16

GEOTECH SB-01
-NG EL. 432'
-TOPSOIL (0.0'-0.5')
-CL/ML (0.5' - 6.5')
-SANDSTONE (6.5' - 7.2')
-AUGER REFUSAL (7.0')
-COMPLETION DEPTH EL. 425'

GEOTECH SB-02
-NG EL. 430'
-SM (0.0' - 25.0')
-SANDSTONE (25.0' - 34.0')
-AUGER REFUSAL (34.0')
-REDDISH BROWN SANDSTONE (34.0' - 43.0')
-COMPLETION DEPTH EL. 388'

GEOTECH SB-03
-NG EL. 498'
-TOPSOIL (0' - 0.4')
-SM (0.4' - 12.5')
-ML\CL (12.5' - 18.5')
-SILTY SAND (18.5' - 22.8')
-COMPLETION DEPTH EL. 475'

NOTE: REFER TO TEST BORING LOG S2-0250 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:
1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. 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.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):2300'
   HDD PIPE LENGTH (S=):2335'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. 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.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
4	DRILL ENTRY/EXIT LAT LONG UPDATE	DLM	04/03/17	RMB	04/03/17	CAG	04/03/17
3	REVISED PROFILE WITH 2017 LIDAR	MRS	02/24/17	RMB	02/24/17	CAG	02/24/17
2	REVISED PER ENGINEERING COMMENTS	MRS	08/31/16	RMB	08/31/16	AAW	08/31/16
1	REVISED PER COMMENTS FROM REI REVIEW	MRS	02/19/16	RMB	02/19/16	AAW	02/19/16
0	ISSUED FOR CONSTRUCTION	MRS	01/19/16	RMB	01/19/16	AAW	01/19/16

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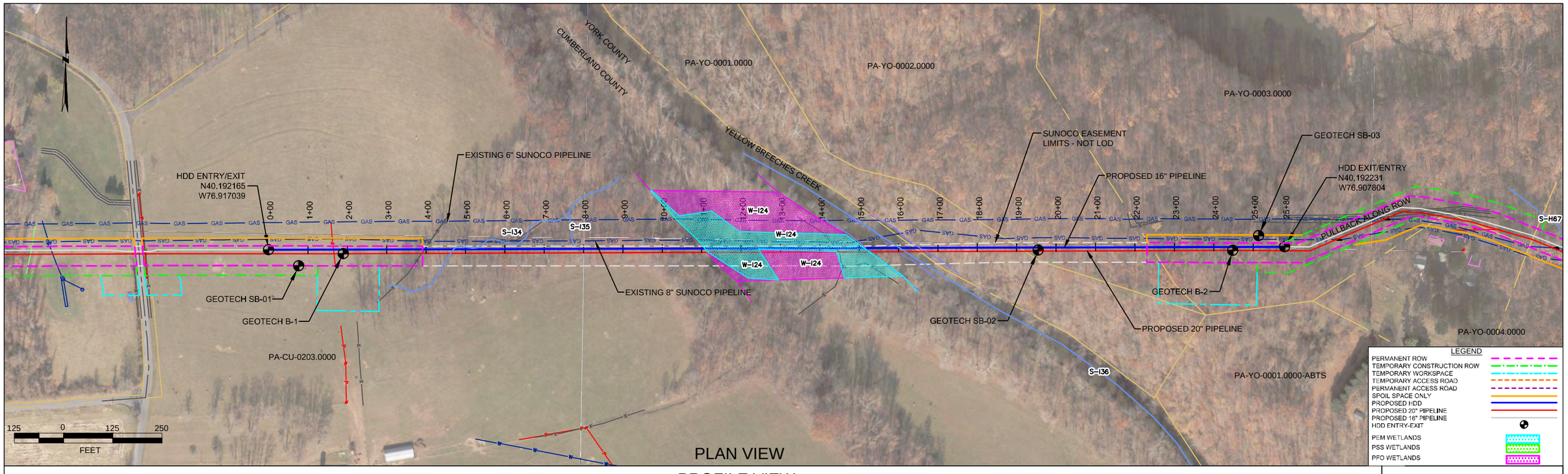
SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
YELLOW BREECHES CREEK
PENNSYLVANIA PIPELINE PROJECT

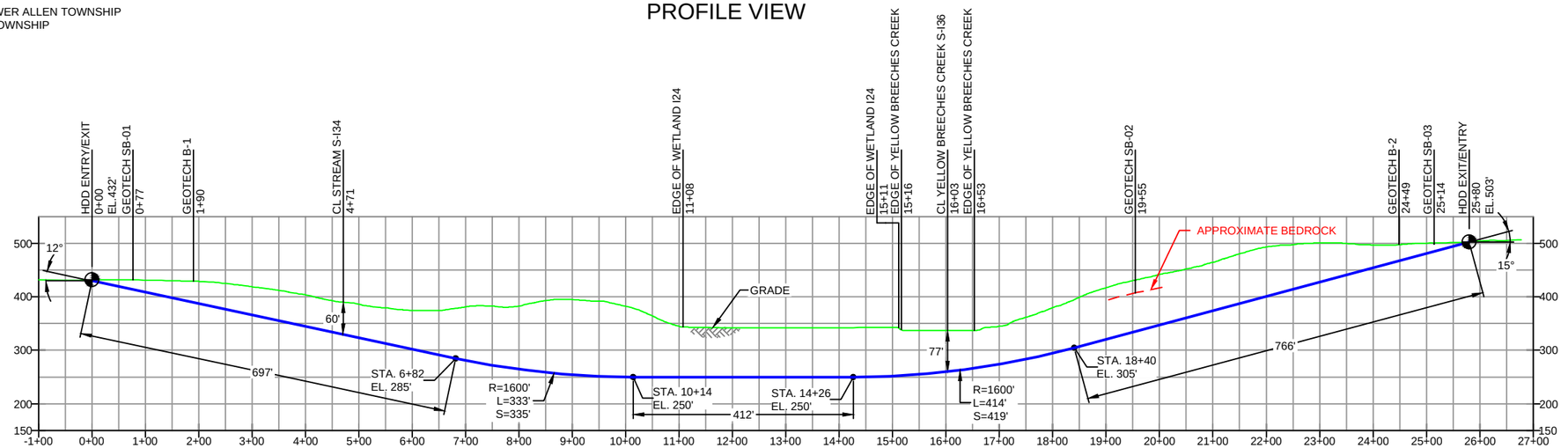
SCALE: 1"=200'

DWG. NO: PA-CU-0203.0000-WX-16



PLAN VIEW

PROFILE VIEW



CUMBERLAND COUNTY, PENNSYLVANIA - LOWER ALLEN TOWNSHIP
YORK COUNTY, PENNSYLVANIA - FAIRVIEW TOWNSHIP
S2-0250-16

GEOTECH SB-01

-NG EL. 432'
-TOPSOIL (0.0'-0.5')
-CL/ML (0.5' - 6.5')
-SANDSTONE (6.5' - 7.2')
-AUGER REFUSAL (7.0')
-COMPLETION DEPTH EL. 425'

GEOTECH SB-02

-NG EL. 430'
-SM (0.0' - 25.0')
-SANDSTONE (25.0' - 34.0')
-AUGER REFUSAL (34.0')
-REDDISH BROWN SANDSTONE (34.0' - 43.0')
-COMPLETION DEPTH EL. 388'

GEOTECH SB-03

-NG EL. 498'
-TOPSOIL (0' - 0.4')
-SM (0.4' - 12.5')
-ML\CL (12.5' - 18.5')
-SILTY SAND (18.5' - 22.8')
-COMPLETION DEPTH EL. 475'

NOTE: REFER TO TEST BORING LOG S2-0250 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-1

-NG EL. 429'
-LEAN CLAY CL (0.0' - 2.0')
-CLAYEY GRAVEL GC GC (2.0' - 4.0')
-SILTY SAND SM (4.0' - 8.0')
-GROUNDWATER (7.0')
-SILTY SAND SM (8.0' - 12.0')
-DIABASE/SANDSTONE (12.0' - 180.0')
-COMPLETION DEPTH EL.249'

NOTE: REFER TO TEST BORING LOG B-1 INTERTEK PROJECT # 04911455 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-2

-NG EL. 498'
-CLAYEY SAND SC GC (0.0' - 2.0')
-SILTY SAND SM (2.0' - 6.0')
-GROUNDWATER (13.0')
-CLAYEY SAND SC GC (6.0' - 8.0')
-SILTY SAND SM (8.0' - 16.5')
-SILTY SAND SP-SM (16.5' - 27.0')
-CONGLOMERATE/SANDSTONE (27.0' - 250.0')
-COMPLETION DEPTH EL.248'

NOTE: REFER TO TEST BORING LOG B-2 INTERTEK PROJECT # 04911455 FOR COMPLETE SOIL MATERIAL DESCRIPTION

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3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 2580'
   HDD PIPE LENGTH (S=): 2629'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
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6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
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10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
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REF. DRAWING

ES 4.100	TO	ES 4.01	EROSION & SEDIMENT PLAN	
SHT 62	TO	SHT 1	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP3	RELOCATED ENTRY/EXIT POINTS- DESIGN CHANGE BY DPS	MRS	10/30/17	RMB	10/30/17	CAG	10/30/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	DLM	05/17/16	RMB	05/17/16	AAW	05/17/16
EP		JTW	11/23/15	RMB	11/23/15	AAW	11/23/15
B	ADDED GEOTECH INFO	MRS	09/17/15	RMB	09/17/15	AAW	09/17/15
A	ISSUED FOR BID	MRS	08/31/15	RMB	08/31/15	AAW	08/31/15

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SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
YELLOW BREECHES CREEK
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'

DWG. NO: PA-CU-0203.0000-WX-16