HORIZONTAL DIRECTIONAL DRILL ANALYSIS
WALTONVLLE ROAD CROSSING
PADEP SECTION 105 PERMIT NO.: E22-617
PA-DA-0056.0000-RD
(SPLP HDD No. S3-0080-16)

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This reanalysis of the horizontal directional drill (HDD) installation of a 16-inch diameter pipeline that traverses Waltonville Road, Shopes Church Road, four wetlands (4) wetlands (W-B56 through W-B58 and W-C26), and Streams S-B60 through S-B63 in Derry Township, Dauphin County, Pennsylvania, is in accordance with Condition No. 3 of the Stipulated Order issued under Environmental Hearing Board Docket No. 2017-009-L. Condition No. 3 stipulates, for HDDs initiated after the temporary injunction issued by the Pennsylvania Department of Environmental Protection (PADEP) Environmental Hearing Board on July 25, 2017, a reanalysis must be performed on HDDs for which an inadvertent return (IR) occurs during the installation of one pipe (20-inch or 16-inch diameter) where a second pipe will thereafter be installed in the same right-of-way (ROW).

The 16-inch pipeline HDD is referred to herein as HDD S3-0080-16.

There were two IR events during the installation of the 20-inch pipe which were remediated. The HDD installation of the 20-inch pipeline at this location is complete.

PIPE INFORMATION

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: 16-INCH

- Horizontal length: 3,870 feet (ft)
- Entry/Exit angle: 10 degrees
- Maximum depth of cover: 60 ft
- Depths below streams and wetlands: 15-40 ft
- Pipe design radius: 1,600 ft

ROOT CAUSE ANALYSIS FOR THE 20-INCH PIPELINE INSTALLATION INADVERDENT RETURNS

The occurrence of the IR events in during the installation of the 20-inch diameter pipeline resulted from advancing the drilling tool through rocks within the shallow and weak substrate immediately before the exit point, which allowed drilling fluid to travel through the surrounding wet and soft soils and discharge to the land surface.

GEOLOGIC AND HYDROGEOLOGIC ANALYSIS

The Pennsylvania Department of Conservation and Natural Resources (2000) reported that the S3-0080 HDD site is situated in the Gettysburg-Newark Lowland Section of the Piedmont Physiographic Province. The dominant topography is rolling lowlands, shallow valleys, and isolated hills with low to moderate relief. The rock type generally consists 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 Gettysburg Formation located to the north and south of the site is composed of Reddish-brown shale and soft, red-brown, medium-to fine-grained sandstone; conglomeratic sandstone; minor amounts of

yellowish-brown shale and sandstone; may be metamorphosed by intrusive diabase to dark-purple to black argillite; total thickness is about 16,000 feet (Geyer and Wilshusen, 1982).

The diabase underlying the site is described as a medium- to coarse-grained, quartznormative tholeiitic basalt; composed of labradorite and various pyroxenes; occurs as dikes, sheets, and a few small flows (DCNR, 2001). 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.

Karst geology is not present in the immediate vicinity of this HDD location.

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

HYDROGEOLOGY, GROUNDWATER, AND WELL PRODUCTION ZONES

According to Wood (1980) and Low, et al. (2002), groundwater within the elastic rocks of the Gettysburg Formation occurs under both unconfined (i.e., water table) and confined conditions. Groundwater flow paths within the elastic 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. According to the geologic map diabase underlies the entire site.

Based on the geotechnical reports groundwater was encountered in the five borings at depths ranging from 6 to 17 feet bgs.

Well records from the Pennsylvania Department of Conservation and Natural Resources (PADCNR) Pennsylvania Groundwater Information System (PaGWIS) database were reviewed to identify domestic water supply and other wells located within a 0.5-mile radius of the proposed HOD right-of-way (ROW) boundary (PaGWIS, 2019). The search identified 62 wells within the 0.5-mile radius of the HOD. These wells consist of 35 domestic supply wells, 21 geothermal wells, 1 domestic irrigation well, and 1 well identified as "other". Based on this data it appears that the majority of the identified wells were completed as 6-inch-diameter open-rock wells at depths ranging from 55 to 500 feet bgs. Based solely on the PaGWIS database, the depth to bedrock ranges from 0 to 85 feet bgs, and well construction consists of 0 to 105 feet of steel casing with the open-rock portions of the wells ranging from 2 to 500 feet bgs. Reported well yields range from 0 to 80 gpm, Static water level measurements ranged from 2 to 65 feet bgs. Based on the PaGWIS database, the majority of the wells identified above were completed in the Gettysburg Formation.

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

INADVERTENT RETURN (IR) DISCUSSION

Two IRs occurred during the pilot hole phase for installation of the 20-inch pipeline. The first IR occurred subsequent to a 20 percent loss of returns (LOR) at a drilling tool trajectory length of 3,693.95 feet and depth of 17.86 feet bgs, approximate 75 feet from the eastern exit point. The second IR occurred at a drilling tool trajectory length of 3,720.95 feet, approximately 128 feet

from the eastern exit point. Both of these IRs are considered "Punch Out" IR's and resulted from the shallow depth of cover and weak substrate while the drilling tool was still advancing through rocks within the substrate before exiting.

Punch out IRs are difficult to prevent. Regardless, SPLP drilling specialists have modified the profile for the 16-inch pipeline to increase the depth of profile, and increase the angles of entry and exit to reduce the potential for IR events during the drilling phases for completion of the second pipeline installation.

ADJACENT FEATURES ANALYSIS

The crossing of Waltonville Road is located in Dauphin County, approximately 2.8 miles southeast of the borough of Hummelstown, Pennsylvania, and approximately 3.7 miles northeast of the borough of Middletown, Pennsylvania. This HDD location is set under these two (2) roads as well as Wetlands W-B56 through W-B58 and W-C26, and Stream S-B60 through S-B63. This HDD avoids surficial impacts to the streams, wetlands, and minimizes potential expanded surficial impacts by avoiding the need to cross under two (2) pipelines perpendicular to the HDD by other construction methods.

SPLP performed a preconstruction survey of all landowners within 450 ft and greater from the HDD S3-0080-16 alignment. Through this outreach effort twelve landowners provided their well location and well data if known. As a result, six water wells were identified within the 450-foot buffer of the alignment. Well locations and limited information regarding depth to water, well yield and pump setting are in the Hydrogeologic Report in Attachment 1.

To further avoid and mitigate any adverse effects from the HDD to private water wells, and in accordance with the requirements of the Stipulated Order, SPLP will transmit a copy of this HDD analysis to all landowners having a property line within 450 ft in any direction of this HDD location. SPLP previously informed these landowners that SPLP will conduct pre-, during, and post-construction sampling of their private water wells to ensure that mitigating actions are taken, if necessary.

ALTERNATIVES 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 a number of different routings, locations, and designs to determine whether there was a practicable alternative to the proposed route. 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.

Using the HDD method avoids direct impacts to Streams S-B60 through S-B63 and Wetlands W-B56 through W-B58 and W-C26 and their associated floodways, associated forested woodlands and riparian habitats; and existing underground utilities. Alteration of the current permitted route and plans for

installation would require major modifications of the state Chapter 102 and Chapter 105 permits, and Section 404, Section 408, and easement authorizations, and associated National Environmental Policy Act (NEPA) Environmental Assessment and Finding of No Significant Impact (FONSI) issued by the USACE.

Open-cut and Conventional Bore Analysis

The pipeline route is within an existing SPLP pipeline easement. SPLP specifications require a minimum of 48 inches of cover over the installed pipelines below ground and below the bottom of watercourses. To meet this cover requirement, construction through Streams S-B60 through S-B63 and Wetlands W-B56 through W-B58 and W-C26 would require a minimum authorized open cut work space 50 ft in width to accommodate the 16-inch diameter pipeline, allowing for the pipeline to be installed with sufficient separation for integrity management and in consideration of the effects of trenching in open water on construction workspace. The assessed area of impact by this open cut plan would directly affect 0.08 acres of state water bottoms, and 2.3 acres of forested wetland.

Re-Route Analysis

The pipeline route as currently permitted follows an existing SPLP easement and this HDD bypasses or avoids direct impacts to forested woodlands, multiple stream channels, and floodway.

No practicable re-route option lies immediately to the north or south of the proposed route that would not transect the same resources transected by the proposed route or encroach upon residential or commercial structures. Shifting the pipeline route north would cross Streams S-B61, S-B64 and S-BB36; Wetlands W-BB36 and W-C26; forested woodlands; Waltonville Road; Shopes Church Road; have additional direct effects on underground utilities; require a new utility corridor requiring consent of newly-affected landowners or the use of eminent domain/condemnation; and create a new land encumbrance on every private property crossed. Shifting the pipeline route south to follow an existing overhead utility corridor would add 0.4 miles of pipe length; require crossing Streams S-B60 and S-B61; Wetlands W-B57, W-C26, and W-J34; forested woodlands; Cedardel Lane; Waltonville Road; three (3) private residential driveways; have additional direct effects on underground utilities; require new utility corridor requiring consent of newly-affected landowners or the use of eminent domain/condemnation; and create a new land encumbrance on every private property crossed. Given site conditions and features north and south of the proposed pipeline alignment, no practicable re-route exists that would result in less impacts to environmental resources.

In summary, due to the woodlands and resources to the north and south of the proposed HDD, additional direct effects to infrastructure, and creation of a new “greenfield” corridor for any shift north or south, there is no identifiable alternative route that would result in less impacts to aquatic and forested woodland resources and existing residences and associated infrastructure in the vicinity of HDD S3-0080.

This re-route analysis conducted for the Waltonville Road HDD is consistent with the conclusions reached in the alternatives analysis previously submitted to PADEP.

HORIZONTAL DIRECTIONAL DRILL REDESIGN

After review of the original HDD designs; available geologic/geotechnical data; field reports related to IR events that occurred during installation of the 20-inch pipe, and the hydro-structural characteristics of the underlying geology, SPLP HDD specialists have redesigned this HDD. A summary of the redesign factors is provided below.

A summary of the redesign factors is provided below. The original and redesigned HDD plan and profile drawings are provided in Attachment 2.

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Revised Horizontal Directional Drill Design Summary: 16-inch

- Horizontal length: 4,095 ft
- Entry/Exit angle: 12-16 degrees
- Maximum depth of cover: 124 ft
- Depths below streams and wetlands: 52-87 ft
- Pipe design radius: 2,000 ft

CONCLUSION

The proposed redesign will extend the HDD approximately 125 ft, deepen the profile by 44 ft, and increases the entry/exit angles are increased to minimize the potential for IRs. The new design places the HDD deeper to allow for more cover under the aquatic resources.

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

- SPLP will provide the drilling crew and company inspectors (UI, EI, PGs) the location(s) data on potential zones of higher risk for fluid loss and IRs, including the area related to previous IRs, and potential zones of fracture concentration identified by the fracture trace analysis along the drill path, so that monitoring can be enhanced when drilling through these locations;

- SPLP will mandate annular pressure monitoring (APM) during the drilling of the pilot hole, which assists in immediate identification of pressure changes indicative of loss of circulation (LOC) or over pressurization of the annulus, managing development pressures that can induce an IR;

- SPLP's drilling contractor will utilize the drilling and monitoring log data for the 20-inch HDD as guidance on approaching the potential zone where drilling fluids were lost during the 20-inch HDD, such that corrective action by injection of Loss Control Materials (LCMs), or grouting can be implemented if the APM or return of drilling fluids indicate a loss in the same general area of the profile, or elsewhere;

- 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 implement short-tripping of the reaming tools as return flow monitoring indicates 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;

- During all drilling phases, the use of Loss Control Materials (LCMs) will be considered if indications of a potential IR are noted or an IR is observed. The use of LCMs, however, is less effective below 70 ft of the ground surface. The AP below that depth can exceed the effective stabilization capability of LCMs. Accordingly, the preferred proactive corrective action needed to address the presence of Losses of Circulation and fractures at greater depths below ground may require grouting of the HDD annulus. Two types of grouting will be utilized for corrective actions

to seal the annulus. These are: 1) grouting using “neat cement”; and 2) grouting using a sand/cement mix. Neat cement grout is a slurry of Portland cement and water. The sand/cement grout mix is a slurry of mostly sand with a small percentage of Portland cement and activators that after setup results in a material having the competency of a friable sandstone or mortar. Both grouting actions require tripping out the drilling tool, and then tripping in with an open-ended drill stem to apply or inject the grout mixes. Either of these grouting actions will be implement upon the first detection of an LOC with the selection of the treatment based upon the circumstances of the LOC, being small or large in magnitude.

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FEASIBILITY DETERMINATION

Based on the information reviewed by the Geotechncial Evaluation Leader, Professional Geologists, Professional Engineers, and HDD specialists, the HDD Reevaluation Team's opinion is that the proposed HDD design and implementation of the management measures contained within this re-revaluation report will minimize the risk of IRs and impacts to public and private water supplies during the construction phases of the HDD.

Pertaining to Horizontal Directional Drilling Practices and Procedures; Conventional Construction; Alternatives; and Environmental Effects

2-17-2018
Date

Larry J. Gremminger, CWB
Geotechnical Evaluation Leader
Mariner East 2 Pipeline Project

Pertaining to the practice of geology

2/17/18
Date

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

Pertaining to the pipeline stress and HDD geometry

2/16/19
Date

Jeffery A. Lowy, P.E.
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ATTACHMENT 1

GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT

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February 13, 2019

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

Re: Sunoco PA Pipeline Project Mariner East II, Waltonville Road HDD S3-0080, PA-DA-0056.0000-RDa-16
Hydrogeological Re-Evaluation Report for 16-inch Pipeline
Derry Township, Dauphin County, Pennsylvania
RETTEW Project No. 096302009

EXECUTIVE SUMMARY

1. During drilling of HDD S3-0080 for installation of the 20-inch diameter pipeline, two "punch out" inadvertent returns (IRs) of drilling fluids occurred during the pilot phase. Due to the occurrence of these IRs during HDD operations for the 20-inch pipeline, this hydrogeologic report was prepared to address the potential for IRs during the proposed 16-inch HDD operations.

2. The Waltonville Road HDD bore path is underlain by crystalline intrusive (igneous) rocks composed of Jurassic age diabase (Jd). Sedimentary rocks of the Triassic age Gettysburg Formation (Trg) are adjacent both north and south of the diabase (refer to **Figure 2**).

3. Geologic mapping and published reports indicate a moderate degree of bedrock fracturing in the Gettysburg Formation characterized by a blocky, moderately to well-developed pattern of open joints with low angle northwest dipping beds. Geologic mapping and published reports 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. To date, HDD operations have been completed at the S3-0080 location for the 20-inch pipeline. The 20-inch product pipe pull was completed on April 10 and 11, 2018.

6. Based on the hydro-structural characteristics of the underlying geology and the profile of the permitted 16-inch HDD profile within shallow unconsolidated soil materials and generally shallow bedrock, the proposed 16-inch HDD is susceptible to the inadvertent return of drilling fluids during HDD operations. A redesigned 16-inch HDD profile (**Attachment 2, Figure 2**) and proactive Best Management Practices (BMPs) during drilling operations 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 Waltonville Road (S3-0080) HDD location. The Waltonville Road HDD (the site) is located in Derry Township, Dauphin County, Pennsylvania. The site is located approximately 2.8 miles southeast of Hummelstown Borough and approximately 3.8 miles northeast of Middletown Borough. The HDD was designed to be drilled under wetlands, Waltonville Road and Shopes Church Road (refer to **Figure 1**). Due to the occurrence of IRs during HDD operations for the 20-inch pipeline, this hydrogeologic report was prepared to address the potential for IRs during the proposed 16-inch drilling operations.

Local relief is low to moderate and ranges in the vicinity of the site from approximately 591 feet above mean sea level (AMSL) at the western entry/exit point to 612 feet AMSL at the eastern entry/exit point (Google Earth, 2018). The site is drained by a shallow, unnamed intermittent stream and wetland situated at the eastern half of the HDD trace. The unnamed tributary flows approximately 1.7 miles to the southwest before discharging to the Middletown Reservoir. The area surrounding the HDD profile consists predominantly of a combination of agricultural, open and forested semi-rural land.

The pilot hole for the proposed 16-inch HDD entry/exit point (western end) is at a surface elevation of 591 feet AMSL and forms a slightly concave HDD profile that slopes gently upward toward the east to an elevation of 632 feet AMSL at the easternmost HDD entry/exit point. The proposed 16-inch HDD pilot hole crosses beneath Waltonville Road at a depth of approximately 80 feet below ground surface (bgs) and Shopes Church Road at 88 feet bgs. The proposed 16-inch HDD is located approximately between STATIONS 11550+63 and 11589+12 on the pipeline, for an overall approximate horizontal length of 4,095 feet and a pipe length/bore path length of 4,115 feet. The existing 20-inch and proposed 16-inch S3-0080 HDD locations are shown on **Figure 1** and the redesigned 16-inch profile is included as **Attachment 1.**

2.0 GEOLOGY AND SOILS

Ten available published and online references were reviewed to evaluate the hydrogeology and soils present in the vicinity of the proposed Waltonville Road HDD location (S3-0080). Detailed descriptions of the soils and bedrock geology underlying S3-0080 are included below.

The Pennsylvania Department of Conservation and Natural Resources (2000) reported that the S3-0080 HDD site is situated in the Gettysburg-Newark Lowland Section of the

Piedmont Physiographic Province. The dominant topography is rolling lowlands, shallow valleys, and isolated hills with low to moderate relief. The rock type generally consists 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 surface drainage pattern is both dendritic and trellis.

According to Google Earth (2018), two geologic formations occur within a 1,500 foot radius of the site. These include the Triassic age Gettysburg Formation (Trg), and the younger Jurassic age Diabase (Jd). These geologic units are identified on the geologic mapping included as **Figure 2**.

The Gettysburg Formation located to the north and south of the site is composed of Reddish-brown shale and soft, red-brown, medium-to fine-grained sandstone; conglomeratic sandstone; minor amounts of yellowish-brown shale and sandstone; may be metamorphosed by intrusive diabase to dark-purple to black argillite; total thickness is about 16,000 feet (Geyer and Wilshusen, 1982). This formation is moderately to well-bedded with individual beds ranging from thin to flaggy with moderately developed, moderately abundant, closely spaced, naturally occurring fractures known as joints. These joints are typically blocky, open and steeply dipping. The joint and bedding plane openings collectively provide a secondary porosity of moderate magnitude and moderate permeability. Surface drainage is good. The topography is characterized by undulating hills of low relief. Natural slopes are moderately steep and stable. Drilling rates are typically moderate to fast, except in areas where the rock is adjacent to diabase intrusions making the rock harder with a slower drilling rate.

The diabase underlying the site is described as a medium- to coarse-grained, quartz-normative tholeiitic basalt; composed of labradorite and various pyroxenes; occurs as dikes, sheets, and a few small flows (DCNR, 2001). 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.

According to the United States Department of Agriculture Soil Survey of Dauphin County, Pennsylvania (2018), soils within approximately 600 feet of the drill path for HDD S3-0080 consist of four soil types primarily very stony silt loam with lesser amounts of silt loam, gravelly 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**.

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, et al. (2002), groundwater within the clastic rocks of the Gettysburg Formation occurs under both unconfined (i.e., water table) and confined conditions. In general, groundwater 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 (i.e., hydraulically interconnected) 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.

According to the geologic map (**Figure 2**), diabase underlies the entire site. Based on the geotechnical reports (**Attachment 2**), groundwater was encountered in the five borings at depths ranging from 6 to 17 feet bgs.

The direction of groundwater flow within the clastic rocks of the Gettysburg Formation 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 the strike, rather than in wells drilled in the direction of bedding dip (i.e., perpendicular to the 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 the HDD.

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 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 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 (%) 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 and other wells located within a 0.5-mile radius of the proposed HDD right-of-way (ROW) boundary (PaGWIS, 2019). The search identified 62 wells within the 0.5-mile radius of the HDD. These wells consist of 35 domestic supply wells, 21 geothermal wells, 1 domestic irrigation well, and 1 well identified as "other". A map showing the well locations relative to the proposed HDD location is included as **Figure 3**. Based on the PaGWIS database (**Attachment 3**), it appears that the majority of the identified wells were completed as 6-inch-diameter open-rock wells at depths ranging from 55 to 500 feet bgs. Based solely on the PaGWIS database, the depth to bedrock ranges from 0 to 85 feet bgs, and well construction consists of 0 to 105 feet of steel casing with the open-rock portions of the wells ranging from 2 to 500 feet bgs. Reported well yields range from 0 to 80 gpm. Static water level measurements ranged from 2 to 65 feet bgs. Based on the PaGWIS database, the majority of the wells identified above were completed in the Gettysburg Formation.

In February 2019, other Sunoco subcontractors researched private water supplies within 450 feet of the Waltonville Road HDD. Six water wells were identified within the 450-foot buffer of the alignment. Well locations and limited information regarding depth to water, well yield and pump setting are shown on **Attachment 3**.

4.0 FRACTURE TRACE ANALYSIS

Fracture traces are natural linear features that are unaffected by local topographic relief and, as a result, are considered surface manifestations of concentrated high-angle bedrock fracturing. Fracture traces may be observed on aerial photographs as linear topography, straight stream segments, vegetation, or soil tonal alignments. The occurrence of fracture traces underlying, or in close proximity to, the site were mapped by Wood (1980) and McGlade and Geyer (1976). The closest fracture trace was mapped approximately 1,040 feet northwest of the HDD bore path; other fracture traces are mapped but are located at distances greater

than 2,800 feet from the HDD trace. The local fracture traces are depicted on the Geology Map included as **Figure 2** and the Groundwater Well Location Map presented as **Figure 3**. None of the identified fracture traces crosses the proposed HDD bore path.

5.0 GEOTECHNICAL EVALUATION

Two phases of geotechnical investigation were completed at the HDD drill site. Three geotechnical borings (SB-01, SB-02 and SB-03) were completed in November 2014 during the preliminary investigation of the site and prior to initiating HDD operations. Two additional borings (B-1 and B-2) were completed in November 2017. The borings were completed to investigate soil, residual soil, and bedrock conditions using hollow-stem augers with split spoons for soil sampling and a core barrel/bit for rock coring. **Attachment 2** presents a map depicting the boring locations, boring logs, and geotechnical reports for the two studies.

SB-01 was located near the western HDD entry/exit point, SB-02 was located next to Shopes Church Road near the central portion of the HDD, and SB-03 was located near the easternmost entry/exit point. The generalized subsurface profile observed in SB-01 through SB-03 is described as follows.

- **SB-01**: Topsoil was encountered from ground surface to 1 foot bgs, and sand from 1 to 30 feet bgs. Groundwater was encountered at 8 feet bgs.
- **SB-02:** Sand from ground surface to 15 feet bgs, and sandstone from 15 to 20 feet bgs. Groundwater was encountered at 6 feet bgs.
- **SB-03:** Topsoil was encountered from ground surface to 0.5 foot bgs; sands and silts from 0.5 to 11.5 feet bgs; silt from 11.5 to 26.5 feet bgs; and sand, sandstone and gravel was encountered from 26.5 to 30 feet bgs. Groundwater was apparently encountered at 16 feet bgs.

The boring logs indicate that the soil/bedrock interface ranges from approximately 15 feet (SB-02) to 30 feet (SB-01 and SB-03) bgs. The bedrock was described in SB-02 as highly fractured and heavily weathered sandstone.

Two additional borings (B-1 and B-2) were completed during November 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 HDD entry/exit point. The generalized subsurface profile observed in B-1 and B-2 is described as follows.

- **B-1**: Clays, sands, silts and gravels were encountered from the ground surface to approximately 24 feet bgs. Alternating units of diabase and conglomeratic sandstone bedrock were encountered from 24 to the total depth of the borehole at 143 feet bgs. Groundwater was encountered at approximately 12 feet bgs.

- **B-2:** Sands and silts were encountered from the ground surface to 34 feet bgs. Alternating units of diabase and conglomeratic sandstone bedrock were encountered from 34 to the total depth of the borehole at 143 feet bgs. Groundwater was encountered at approximately 17 feet bgs.

The bedrock in both borings was described as ranging from soft to hard, and very 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 or RETTEW did not oversee or direct the geotechnical drilling programs associated with the site, 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 and RETTEW relied on these reports and incorporated their data into the general geologic and hydrogeologic framework of the analysis of the proposed 16-inch S3-0080 HDD for this report.

6.0 FIELD OBSERVATIONS

Site reconnaissance activities were performed by Skelly and Loy geologists on January 11, 2018. The entire HDD trace was walked, but no obvious bedrock outcrops were noted. Local (approximately 0.9 mile from the HDD trace) exposures of the Gettysburg Formation as indicated by strike and dip symbols shown on mapping by Wood (1980) were visited. Two locations were visited near 1625 Kaylor Road, and one location was visited near 1044 Stoverdale Road. Neither location yielded bedrock outcrops where bedding planes or consistent fracture sets were observed (in part due to leaf and snow cover). Other outcrop locations were not visited because their locations were likely situated on private property. Published local structural geologic measurements (Wood, 1980) of the Gettysburg Formation indicate that the bedrock strike is generally to the northeast/southwest with bedding dip ranging from approximately 30° to 50° northwest.

Michels Directional Crossings (Michels) initiated drilling of the pilot hole for the 20-inch pipeline on June 12, 2017, from the western entry/exit point depicted on the approved HDD profile. Michels stopped the pilot hole on June 13, 2017, to install 14-inch casing into bedrock to aid in getting the pilot bit to advance through the unconsolidated material and bedrock interface along the approved bore path. Pilot hole advancement resumed on June 15 and on July 25, 2017, had reached a trajectory length of 2,903 feet when all drilling activities across the PPP-ME2 project were suspended by the Pennsylvania Department of Environmental Protection (PA DEP). Following PA DEP's re-start approval, and resumption of drilling activities on August 19, 2017, Michels advanced a "sizing" tool into the pilot hole to ensure the bore hole was still open following the suspension of drilling activities. Michels resumed pilot hole advancement on August 24 and continued until September 6, 2017, when they experienced a 20 percent loss of

returns (LOR) at a trajectory length of 3,693.95 feet and a depth of 17.86 feet bgs. In an attempt to regain circulation, Michels tripped the pilot bit completely out of the boring and, while tripping the bit back into the boring on September 7, 2017, an IR occurred approximate 75 feet from the eastern exit point and flowed back into Wetland C26 PEM. All drilling activities were immediately stopped and Michels began to construct containment structures consisting of silt fence reinforced with sand bags around the IR and recovered the released drilling fluids. HDD activities remained suspended until the PA DEP granted re-start approval. Michels resumed pilot hole advancement on December 5th, 2017, and experienced a second IR at a trajectory length of 3,720.95 feet, approximately 128 feet from the eastern exit point. The new IR was contained, recovery operations were initiated and the pilot hole was completed.

Michels started the 30-inch ream pass on December 8, 2017, and continued until December 22, 2017, when HDD activities were suspended for the holiday break. Michels prepared to resume reaming activities on January 3, 2018; however, as the equipment was being inspected and warmed up, notification of the PADEP suspension of all work on the PPP-ME2 project was received. Following the release of the PADEP suspension, Michels resumed the 30-inch ream pass on March 2, 2018. On March 9, 2018, Michels began to trip the reamer out of the borehole to inspect the cutting cones. On March 13, the 30-inch reamer was pulled out of the borehole and two cutting cones were missing. Between March 19 and 22, 2018, Michels conducted retrieval operations to recover the two cutting cones that remained in the borehole. Michels resumed 30-inch reaming operations on March 23 after successfully recovering both cutting cones. Reaming operations continued until April 7, 2018, when the pass was completed and the 30-inch swab pass was started. Michels completed the 30-inch swab pass on April 9, 2018 and the 20-inch product line was pulled through the borehole between April 10 and 11, 2018.

7.0 GEOPHYSICAL SURVEY CONSIDERATIONS

No karst geology was observed during the field reconnaissance or is mapped as being present at this HDD location. Secondly, SPLP possesses a complete geologic record of the bore path from drilling the 20-inch profile. 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 observed during the 20-inch HDD, the use of geophysical surveys during the site re-evaluation was considered but was ultimately not implemented because the results of geophysical surveys would not likely provide additional information that would reduce the risk of an IR. Based on our experience working in karst geology, the lack of mapped karst geology along the HDD trace and the lack of continuous thick-bedded limestone units, the diabase and Gettysburg Formations are 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 of the interbedded sandstone and diabase 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 Waltonville Road HDD originates as precipitation or snowmelt. The precipitation infiltrates through the overburden soils. As previously described, shallow groundwater generally occurs under unconfined conditions. Based on site-specific geotechnical data (Section 5.0) and information obtained from the PaGWIS database (Section 3.0), the groundwater table occurs within the overburden soils (approximately 6 to 17 feet bgs) proximate to the HDD path and contributes flow to local shallow groundwater discharge zones (i.e., unnamed tributary and wetlands).

The geologic formations underlying the HDD site are highly anisotropic, with the predominant groundwater flow direction parallel to bedrock strike. The transport of groundwater in the fractured bedrock is generally greatest within highly permeable fractures, and the orientation of bedding planes and fractures primarily influence the direction of groundwater flow. Some site-specific evaluations of the bedrock have been completed in the area proximate to the geotechnical core 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 slopes gently to the southwest toward the unnamed tributary discharging to the Middletown Reservoir.

9.0 CONCLUSIONS

Based on published geologic and hydrogeologic information, the site is underlain by clastic sedimentary rocks (primarily sandstone and conglomeratic sandstone) of the Gettysburg Formation 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 confirm that the local bedrock ranges from fractured and broken to massive sandstone, conglomerate, and diabase comprised of well-developed thin to massive moderately steeply dipping joint and bedding planes. All of the private water supply wells identified in the vicinity of the HDD are constructed in bedrock, indicating that none of the domestic wells rely on the shallow unconsolidated overburden as a source of groundwater supply. The uppermost unconsolidated soils, weathered bedrock, and potentially the bedrock aquifer, provide groundwater discharge to the local wetlands and unnamed tributary.

The originally proposed 16-inch and 20-inch HDD profiles were relatively shallow at the entry and exit points, and passed through both the unconsolidated overburden and fractured bedrock. Based on the hydro-structural characteristics of the underlying geology described in this report and the proposed HDD profiles, the Waltonville Road HDD site is susceptible to the inadvertent return of drilling fluids during HDD operations. As a result, the HDD profile has been

redesigned to allow for deeper crossings beneath the wetland and stream. The inclination of the entry and exit angles for the 16-inch pipeline has been increased to allow the pipe to be installed through the protective soils, residual soils, and bedrock in closer proximity to the entry and exit points than the original, shorter profile. The redesigned 16-inch HDD profile will minimize the potential for an IR. From a geologic perspective, the laterally adjusted, longer and deeper profile, in conjunction with the proposed proactive use of engineering controls and/or drilling BMPs, will reduce the risk of an IR. Drilling BMPs are described in the Horizontal Directional Drill Analysis component of the overall re-evaluation package.

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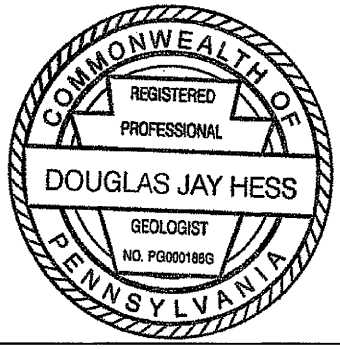
11.0 CERTIFICATION

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



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License No. PG-000186-G

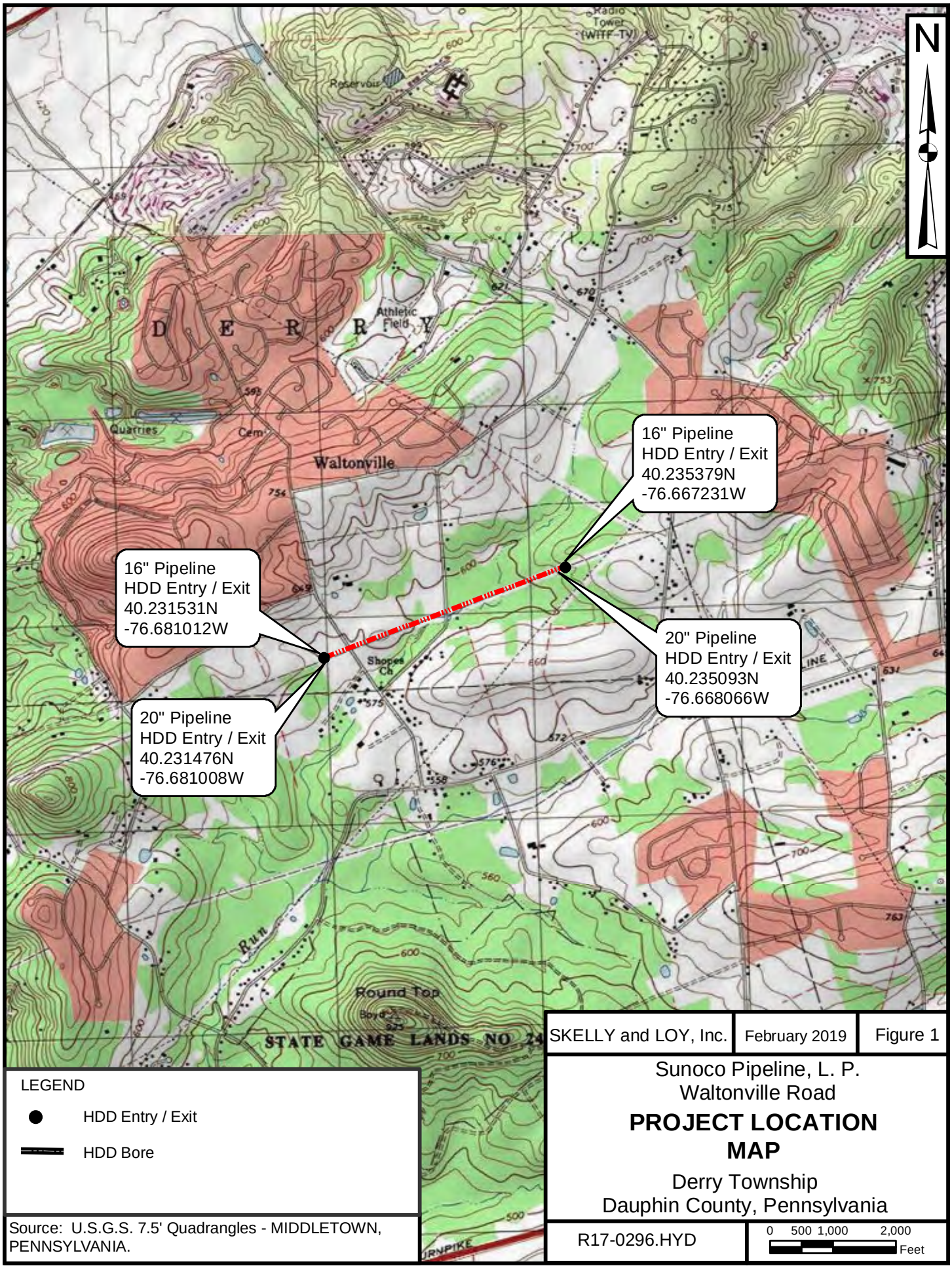
Sincerely yours,

SKELLY and LOY, Inc.

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

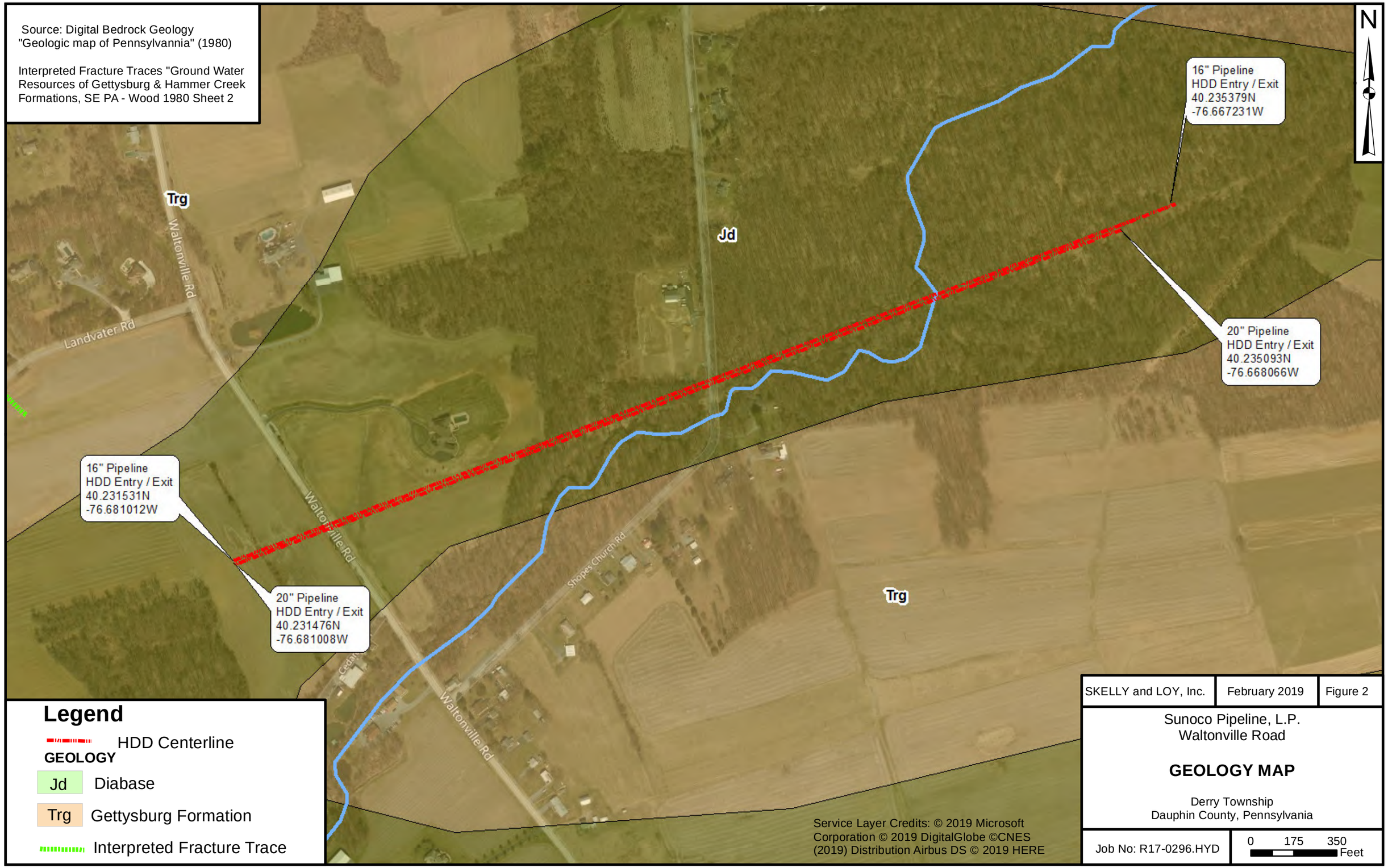
Enclosures
cc: R17-0296.HYD
File: Hydrogeologic Re-Eval Report FINAL - DJH.docx

FIGURES


N
16" Pipeline
HDD Entry / Exit
40.235379N
-76.667231W
16" Pipeline
HDD Entry / Exit
40.231531N
-76.681012W
20" Pipeline
HDD Entry / Exit
40.235093N
-76.668066W
20" Pipeline
HDD Entry / Exit
40.231476N
-76.681008W
Waltonville
Quarries
Cem
Athletic Field
Reservoir
Radio Tower (WITF-TV)
Shopes Ch
Round Top
STATE GAME LANDS NO 24
Run
D E R R Y
LEGEND
HDD Entry / Exit
HDD Bore
Source: U.S.G.S. 7.5' Quadrangles - MIDDLETOWN, PENNSYLVANIA.
SKELLY and LOY, Inc.
February 2019
Figure 1
Sunoco Pipeline, L. P.
Waltonville Road
PROJECT LOCATION MAP
Derry Township
Dauphin County, Pennsylvania
R17-0296.HYD
0 500 1,000 2,000
Feet

Source: Digital Bedrock Geology
"Geologic map of Pennsylvania" (1980)

Interpreted Fracture Traces "Ground Water Resources of Gettysburg & Hammer Creek Formations, SE PA - Wood 1980 Sheet 2



Legend

HDD Centerline

GEOLOGY

Jd Diabase

Trg Gettysburg Formation

Interpreted Fracture Trace

Service Layer Credits: © 2019 Microsoft Corporation © 2019 DigitalGlobe ©CNES (2019) Distribution Airbus DS © 2019 HERE

SKELLY and LOY, Inc.	February 2019	Figure 2

Sunoco Pipeline, L.P.
Waltonville Road

GEOLOGY MAP

Derry Township
Dauphin County, Pennsylvania

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

Interpreted Fracture Traces "Ground Water Resources of Gettysburg & Hammer Creek Formations, SE PA - Wood 1980 Sheet 2"

N

16" Pipeline
HDD Entry / Exit
40.235379N
-76.667231W

20" Pipeline
HDD Entry / Exit
40.235093N
-76.668066W

16" Pipeline
HDD Entry / Exit
40.231531N
-76.681012W

20" Pipeline
HDD Entry / Exit
40.231476N
-76.681008W

Legend

- HDD Centerline
- 0.5 Mile Radius of Proposed HDD
- PAGWIS Wells with ID's
- Parcel Boundries
- Interpreted Fracture Trace

SKELLY and LOY, Inc.	February 2019	Figure 3

Sunoco Pipeline, L.P.
Waltonville Road

WELL LOCATION MAP

Derry Township
Dauphin County, Pennsylvania

Job No: R17-0296.HYD	0 200 400 800 Feet

ATTACHMENT 1

ATTACHMENT 1

United States Department of Agriculture

NRCS

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 Dauphin County, Pennsylvania

Waltonville Road HDD, Derry Township, Dauphin Co., PA

January 5, 2018

Preface

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

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

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

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

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

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

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How Soil Surveys Are Made

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

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

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

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

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

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.

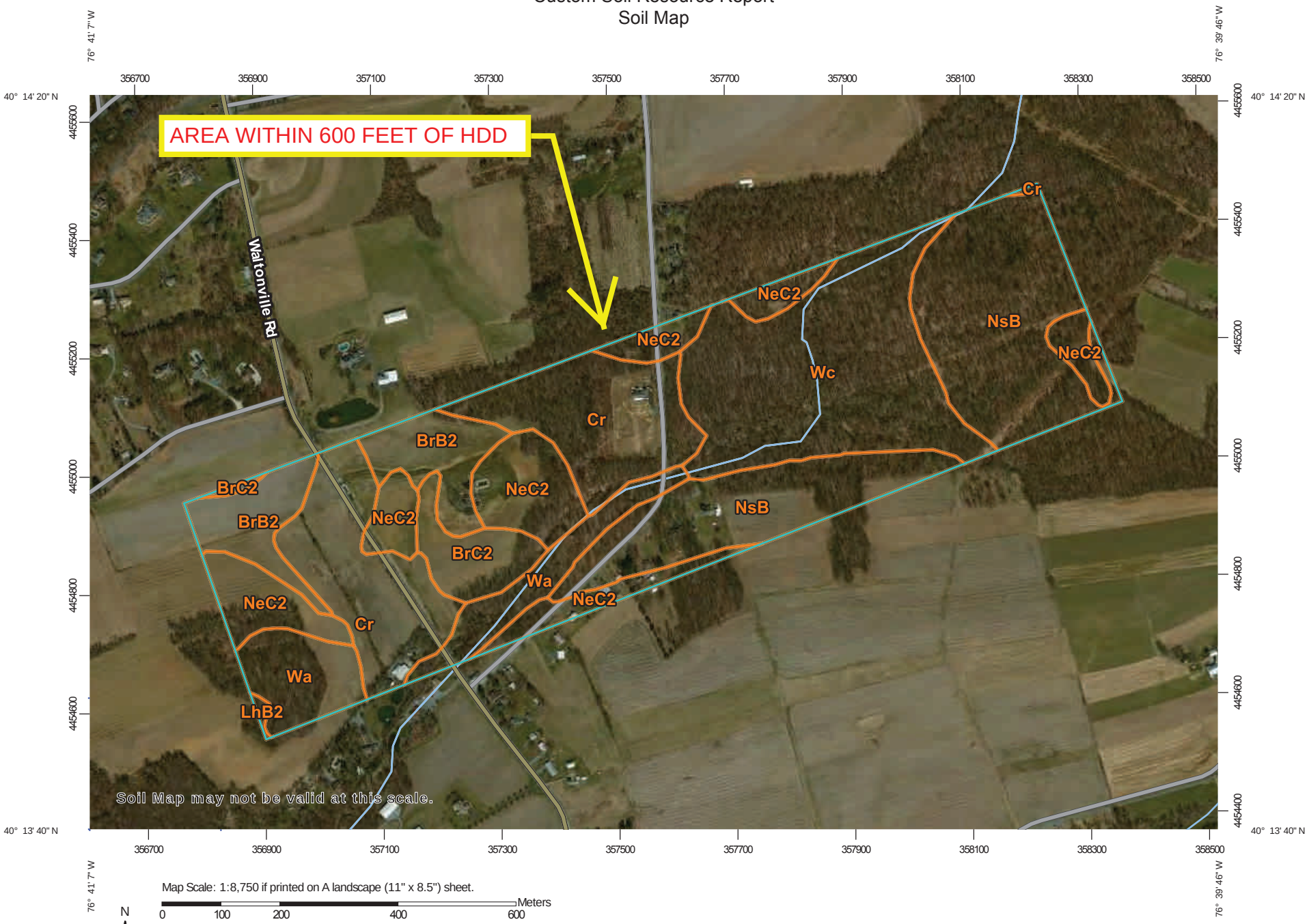
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

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: 1:8,750 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 400 800 1600 2400

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 1:15,800.

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: Dauphin County, Pennsylvania
Survey Area Data: Version 13, Nov 27, 2017

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

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BrB2	Brecknock channery silt loam, 3 to 8 percent slopes, moderately eroded	12.8	8.1%
BrC2	Brecknock channery silt loam, 8 to 20 percent slopes, moderately eroded	5.9	3.7%
Cr	Croton silt loam, occasionally ponded, 0 to 3 percent slopes	30.6	19.4%
LhB2	Lehigh silt loam, 3 to 8 percent slopes, moderately eroded	0.3	0.2%
NeC2	Neshaminy gravelly silt loam, 3 to 12 percent slopes, moderately eroded	23.1	14.7%
NsB	Neshaminy very stony silt loam, 0 to 8 percent slopes	39.6	25.1%
Wa	Watchung silt loam	13.1	8.3%
Wc	Watchung very stony silt loam	32.2	20.4%
Totals for Area of Interest		**157.6**	**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.

Dauphin County, Pennsylvania

BrB2—Brecknock channery silt loam, 3 to 8 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: l4n3
Elevation: 250 to 1,000 feet
Mean annual precipitation: 40 to 48 inches
Mean annual air temperature: 48 to 55 degrees F
Frost-free period: 150 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Brecknock and similar soils: 93 percent
Minor components: 7 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Brecknock

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Parent material: Residuum weathered from porcellanite and/or red metamorphosed residuum weathered from sandstone and shale

Typical profile

Ap - 0 to 10 inches: channery silt loam
Bt - 10 to 32 inches: channery silt loam
C - 32 to 41 inches: very channery silt loam
R - 41 to 51 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 40 to 60 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: Low (about 4.3 inches)

Interpretive groups

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

Minor Components

Lehigh

Percent of map unit: 7 percent
Landform: Hillsides
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Hydric soil rating: No

BrC2—Brecknock channery silt loam, 8 to 20 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: l4n4
Elevation: 250 to 1,000 feet
Mean annual precipitation: 40 to 48 inches
Mean annual air temperature: 48 to 55 degrees F
Frost-free period: 150 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Brecknock and similar soils: 91 percent
Minor components: 9 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Brecknock

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Parent material: Residuum weathered from porcellanite and/or red metamorphosed residuum weathered from sandstone and shale

Typical profile

Ap - 0 to 10 inches: channery silt loam
Bt - 10 to 32 inches: channery silt loam
C - 32 to 41 inches: very channery silt loam
R - 41 to 51 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 40 to 60 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: Low (about 4.3 inches)

Interpretive groups

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

Minor Components

Lehigh

Percent of map unit: 9 percent
Landform: Hillsides
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Hydric soil rating: No

Cr—Croton silt loam, occasionally ponded, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2tkpx
Elevation: 300 to 800 feet
Mean annual precipitation: 40 to 48 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 160 to 190 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Croton, Occasionally Ponded

Setting

Landform: Depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Parent material: Residuum weathered from sandstone and shale

Typical profile

Ap - 0 to 11 inches: silt loam

Btg - 11 to 19 inches: silty clay loam
Btxg - 19 to 30 inches: channery silty clay loam
Cx - 30 to 44 inches: channery silt loam
R - 44 to 64 inches: bedrock

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 18 to 20 inches to fragipan; 40 to 60 inches to lithic bedrock
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: Occasional
Available water storage in profile: Low (about 3.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: D
Hydric soil rating: Yes

Minor Components

Abbottstown, occasionally ponded

Percent of map unit: 10 percent
Landform: Depressions
Landform position (two-dimensional): Toeslope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Readington

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

LhB2—Lehigh silt loam, 3 to 8 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: l4pf
Elevation: 200 to 1,000 feet
Mean annual precipitation: 40 to 48 inches
Mean annual air temperature: 48 to 55 degrees F
Frost-free period: 150 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Lehigh

Setting

Landform: Hillsides
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Parent material: Residuum weathered from porcellanite

Typical profile

Ap - 0 to 7 inches: silt loam
Bt - 7 to 40 inches: channery silt loam
C - 40 to 58 inches: extremely channery silt loam
R - 58 to 62 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 40 to 60 inches to lithic bedrock
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 6 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.1 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

Brecknock

Percent of map unit: 12 percent
Landform: Hills, ridges
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

Croton

Percent of map unit: 8 percent
Landform: Depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, linear

Across-slope shape: Linear, concave
Hydric soil rating: Yes

NeC2—Neshaminy gravelly silt loam, 3 to 12 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: l4ps
Elevation: 250 to 1,600 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 150 to 210 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 10 inches: gravelly silt loam
H2 - 10 to 40 inches: gravelly sandy clay loam
H3 - 40 to 46 inches: bedrock

Properties and qualities

Slope: 3 to 12 percent
Depth to restrictive feature: 40 to 72 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.2 inches)

Interpretive groups

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

Minor Components

Neshaminy, stony
Percent of map unit: 5 percent
Hydric soil rating: No

Brecknock
Percent of map unit: 5 percent
Landform: Hills, ridges
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

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

NsB—Neshaminy very stony silt loam, 0 to 8 percent slopes

Map Unit Setting
National map unit symbol: l4pt
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: 0 to 8 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: Low
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

Wa—Watchung silt loam

Map Unit Setting

National map unit symbol: l4q9
Elevation: 200 to 2,000 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 140 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Watchung, silt loam, and similar soils: 86 percent
Minor components: 14 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Watchung, Silt Loam

Setting

Landform: Depressions
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Residuum weathered from diabase

Typical profile

Ap - 0 to 9 inches: silt loam
Btg1 - 9 to 18 inches: silty clay
Btg2 - 18 to 25 inches: clay
Btg3 - 25 to 30 inches: clay

Btg4 - 30 to 40 inches: clay
C - 40 to 60 inches: 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): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Towhee

Percent of map unit: 9 percent
Landform: Depressions
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Side slope, head slope
Down-slope shape: Concave, linear
Across-slope shape: Concave
Hydric soil rating: Yes

Codorus

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

Wc—Watchung very stony silt loam

Map Unit Setting

National map unit symbol: l4qb
Elevation: 300 to 2,000 feet
Mean annual precipitation: 34 to 50 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 130 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Watchung, extremely stony, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Watchung, Extremely Stony

Setting

Landform: Drainageways, depressions
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Residuum weathered from diabase

Typical profile

A - 0 to 13 inches: silt loam
Btg - 13 to 47 inches: silty clay loam
C - 47 to 65 inches: channery loam

Properties and qualities

Slope: 0 to 8 percent
Percent of area covered with surface fragments: 5.1 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): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Mount lucas, silt loam

Percent of map unit: 10 percent
Landform: Hillslopes, hillsides
Landform position (two-dimensional): Footslope, backslope, summit
Landform position (three-dimensional): Side slope
Down-slope shape: Linear, concave, convex
Across-slope shape: Concave, linear, convex
Hydric soil rating: No

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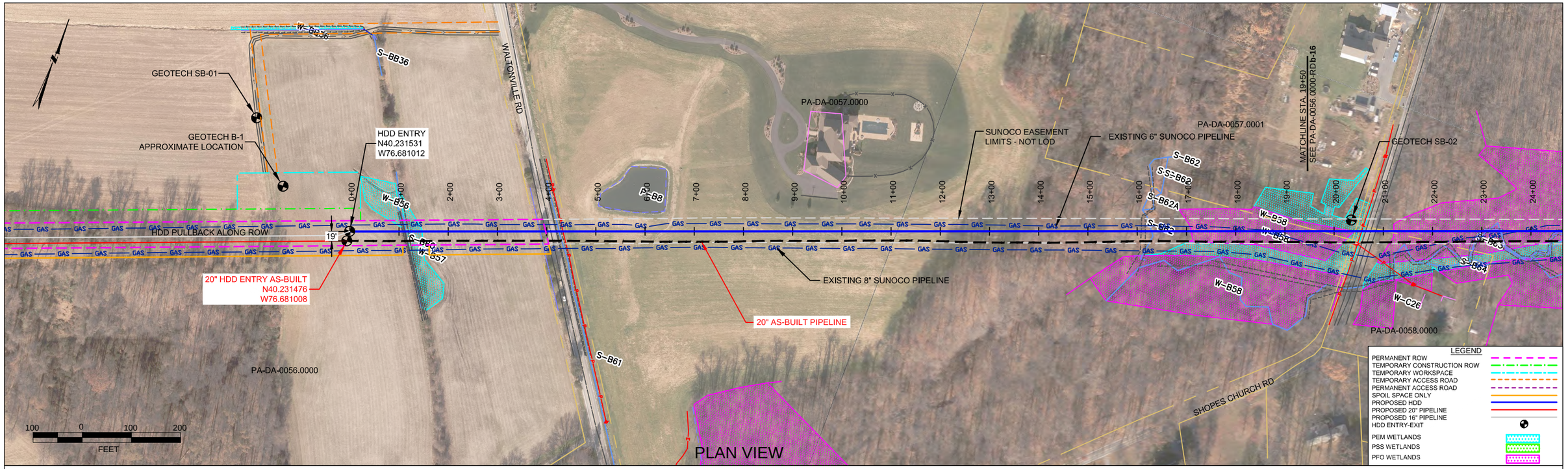
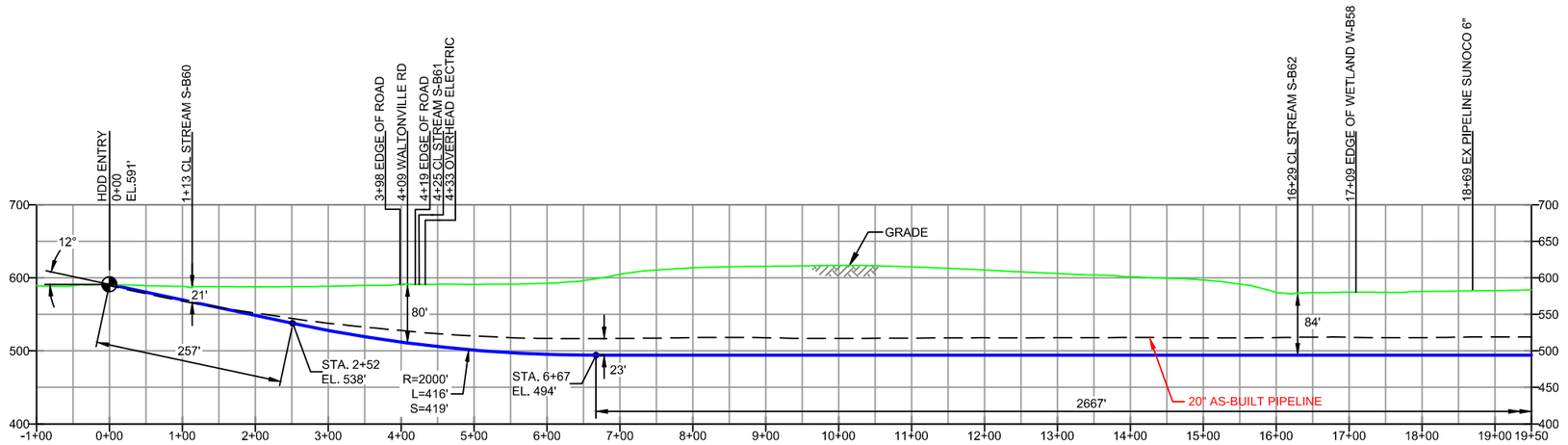
ATTACHMENT 2



PLAN VIEW

DAUPHIN COUNTY, PENNSYLVANIA - DERRY TOWNSHIP
S3-0080-16

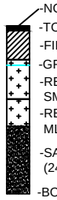
PROFILE VIEW



GEOTECH SB-01

NOTE: REFER TO TEST BORING LOG S3-0080 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-1



NOTE: REFER TO TEST BORING LOG B-1 INTERTEK PROJECT #04911517 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=): 4095'
   HDD PIPE LENGTH (S=): 4120'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
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 2625 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

ES-4.23	TO	ES-4.25	EROSION & SEDIMENT PLAN	
SHEET 14	TO	SHEET 15	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	DESIGN CHANGE - INCREASED DRILL EXIT ANGLE	MRS	02/13/19	RMB	02/13/19	AMC	02/13/19
EP3	DESIGN CHANGE - EXTENDED DRILL AND UPDATED GEOTECH INFORMATION	MRS	12/07/18	RMB	12/07/18	AMC	12/07/18
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	05/09/16	RMB	05/09/16	AAW	05/09/16
EP		JTW	03/15/16	RMB	03/15/16	AAW	03/15/16
B	ADDED GEOTECH INFO	MRS	09/22/15	RMB	09/22/15	AAW	09/22/15

Sunoco Logistics Partners L.P.

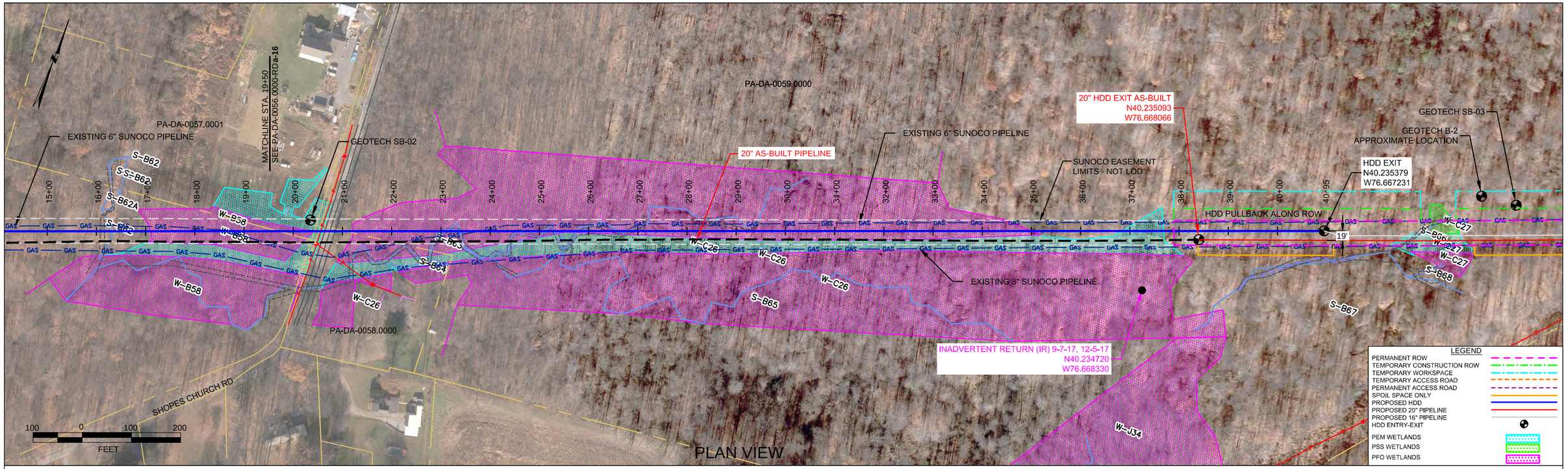
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WALTONVILLE ROAD
PENNSYLVANIA PIPELINE PROJECT

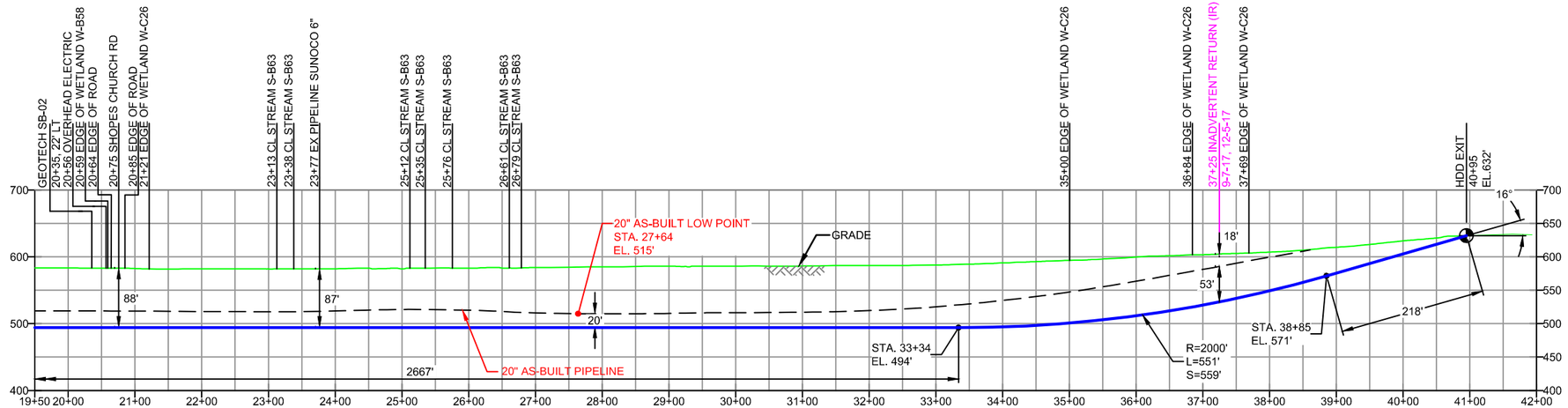
SCALE: 1"=200'

DWG. NO: PA-DA-0056.0000-RDa-16



PLAN VIEW

PROFILE VIEW



DAUPHIN COUNTY, PENNSYLVANIA - DERRY TOWNSHIP
S3-0080-16

GEOTECH SB-02

-NG EL. 584'
-TOPSOIL (<1")
-GROUNDWATER (6.0')
-SM (1.0' - 15.0')
-AUGER REFUSAL (15.0')
-SANDSTONE (15.0' - 20.0')
-COMPLETION DEPTH EL. 564'

GEOTECH SB-03

-NG EL. 661'
-TOPSOIL (0.0' - 0.6')
-ML (0.6' - 21.5')
-GROUNDWATER (16.0')
-SILT (USCS:MH) (21.5' - 26.5')
-SM / GM (26.5' - 30.0')
-COMPLETION DEPTH EL. 631'

NOTE: REFER TO TEST BORING LOG S3-0080 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-2

-NG EL. 655'
-TOPSOIL (0' - 1.0')
-FILL ML (1.0' - 8.5')
-RESIDUUM-SILTY SAND SM (8.5' - 13.5')
-GROUNDWATER (17.6')
-RESIDUUM-SANDY SILT ML (13.5' - 18.5')
-RESIDUUM-SILTY SAND SM (18.5' - 34.0')
-SANDSTONE/DIABASE (34.0' - 143.0')
-BORING TERMINATED EL.512'

NOTE: REFER TO TEST BORING LOG B-2 INTERTEK PROJECT #04911517 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=): 4095'
   HDD PIPE LENGTH (S=): 4120'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
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 2625 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.
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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

ES-4.23	TO	ES-4.25	EROSION & SEDIMENT PLAN	
SHEET 14	TO	SHEET 15	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	DESIGN CHANGE - INCREASED DRILL EXIT ANGLE	MRS	02/13/19	RMB	02/13/19	AMC	02/13/19
EP3	DESIGN CHANGE - EXTENDED DRILL AND UPDATED GEOTECH INFORMATION	MRS	12/07/18	RMB	12/07/18	AMC	12/07/18
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	03/15/16	RMB	03/15/16	AAW	03/15/16
B	ISSUED FOR BID	MRS	09/22/15	RMB	09/22/15	AAW	09/22/15

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WALTONVILLE ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

DWG. NO: PA-DA-0056.0000-RDb-16

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AND NATURAL RESOURCES

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Figure 1: Site Vicinity Map

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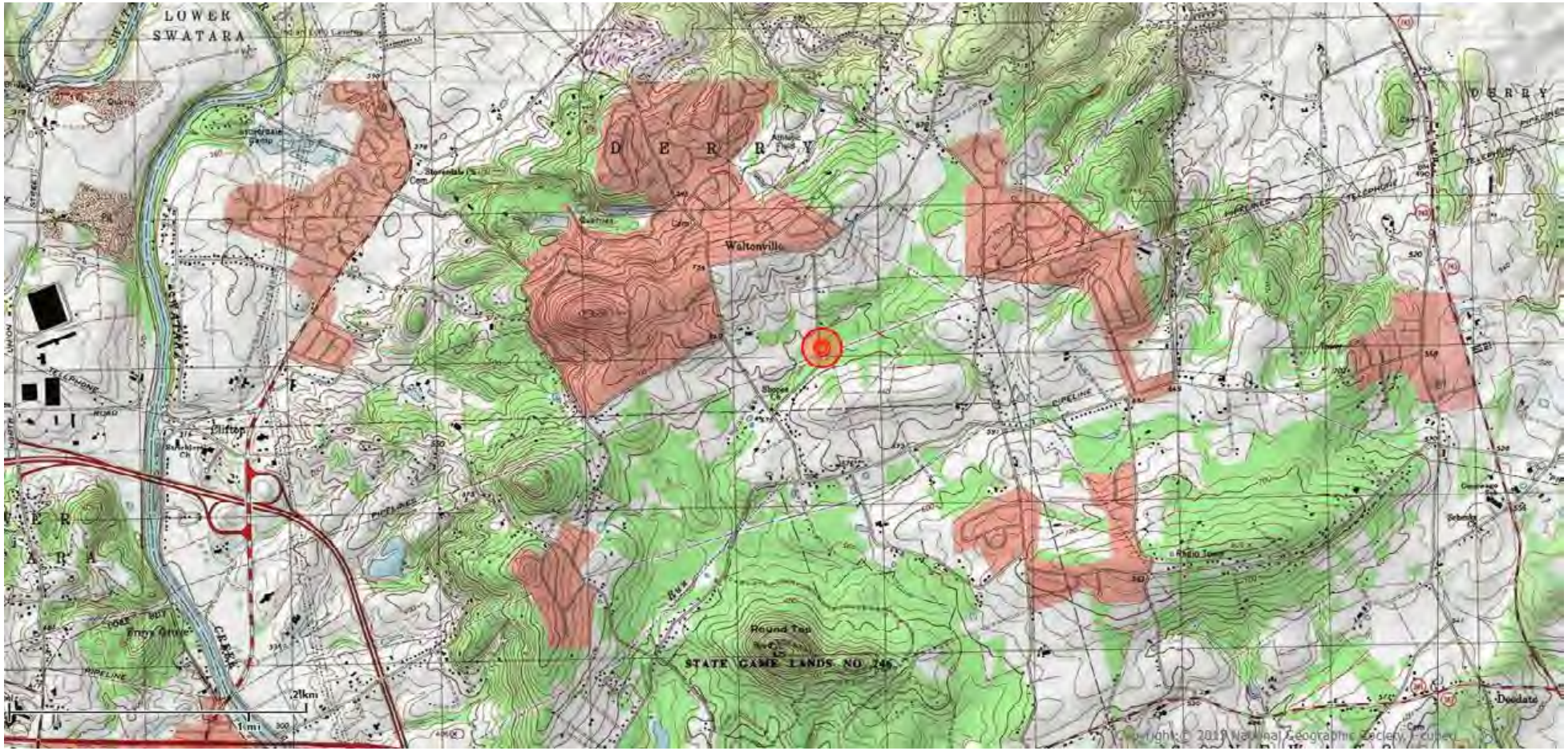
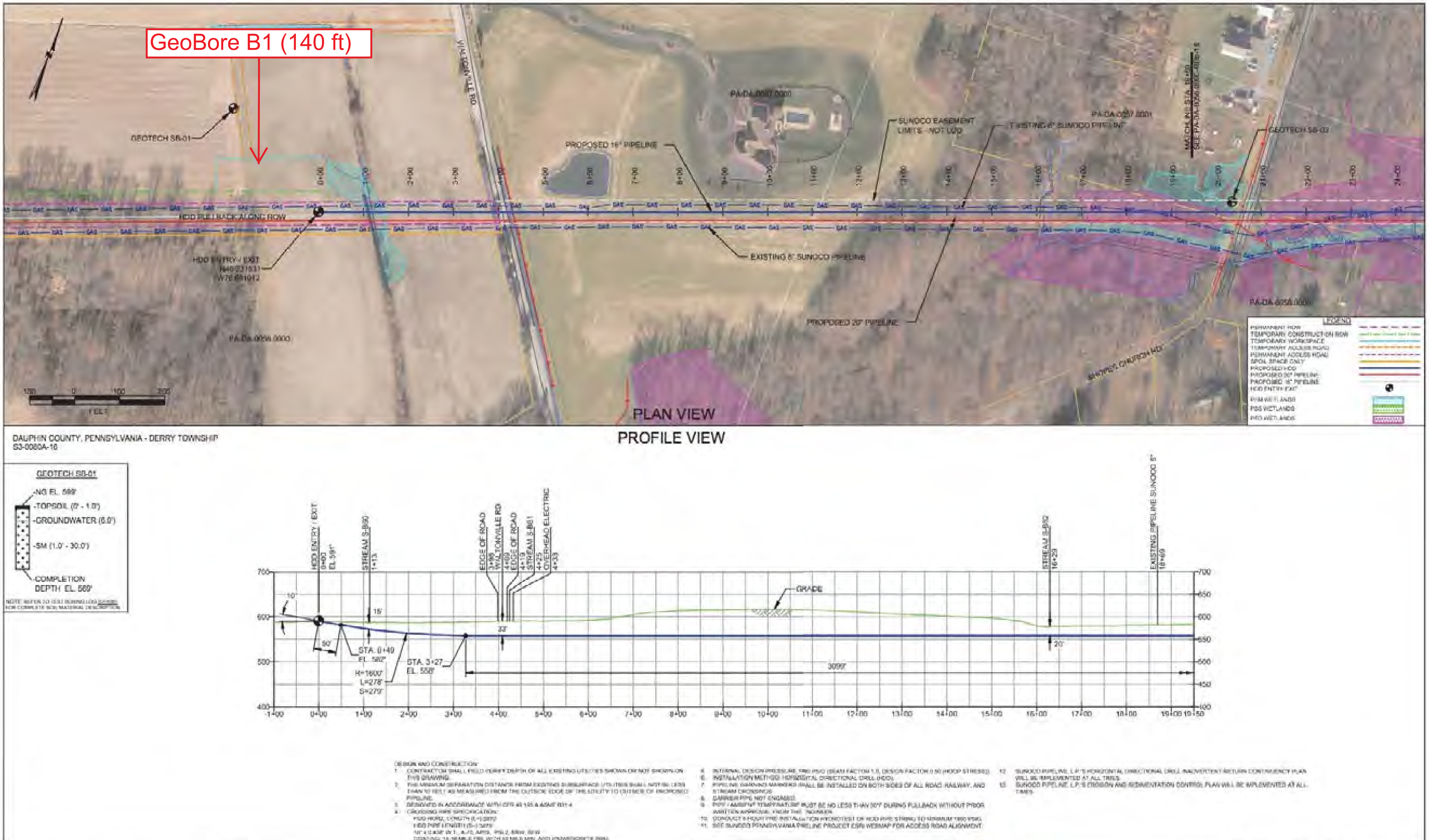


Created using PA DCNR Map Viewer

Map created on Mon Nov 6 2017

FIGURE 2A: BORING LOCATION PLAN
"Waltonville Road" (PPP4)- Dauphin Co, PA
PSI Project No.: 04911517



NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
4	DRILL ENTRY / EXIT LAT LONG UPDATE	MRG	04/03/17	RMB	04/03/17	AMG	04/03/17
3	REVISED PROFILE WITH 2017 LIDAR	MRG	02/27/17	RMB	02/27/17	AMG	02/27/17
2	REVISED PER ENGINEERING COMMENTS	MRG	08/31/16	RMB	08/31/16	AAW	08/31/16
1	REVISED PER COMMENTS FROM REVIEW	MRG	02/19/16	RMB	02/19/16	AAW	02/19/16
0	ISSUED FOR CONSTRUCTION	MRG	01/18/16	RMB	01/18/16	AAW	01/18/16

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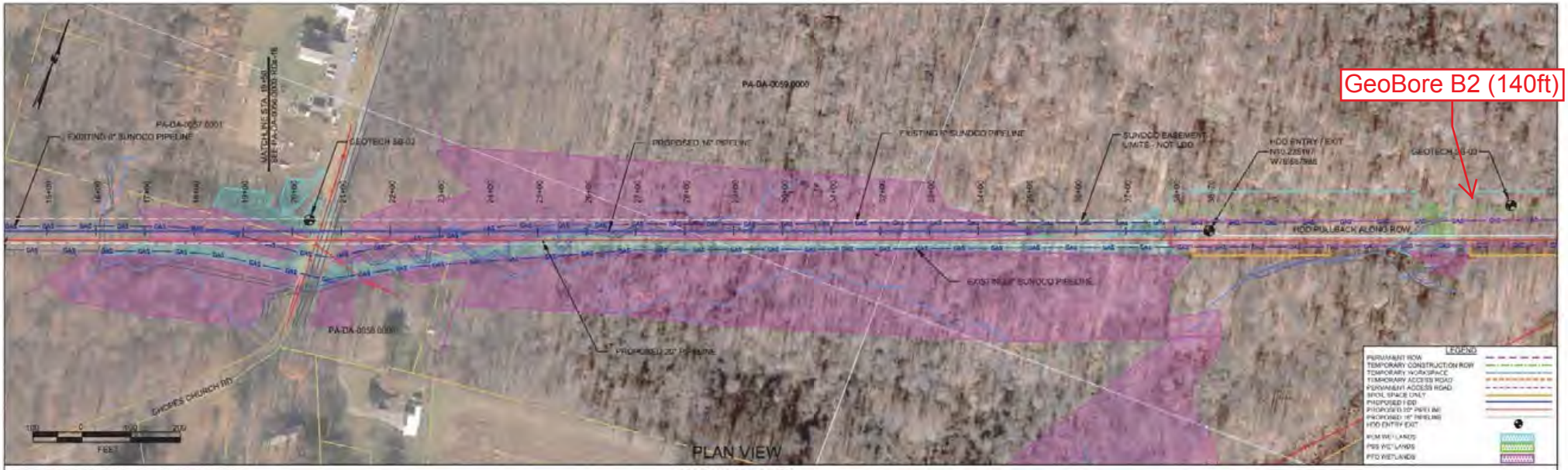
TETRA TECH ROONEY (303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WALTONVILLE ROAD
PENNSYLVANIA PIPELINE PROJECT

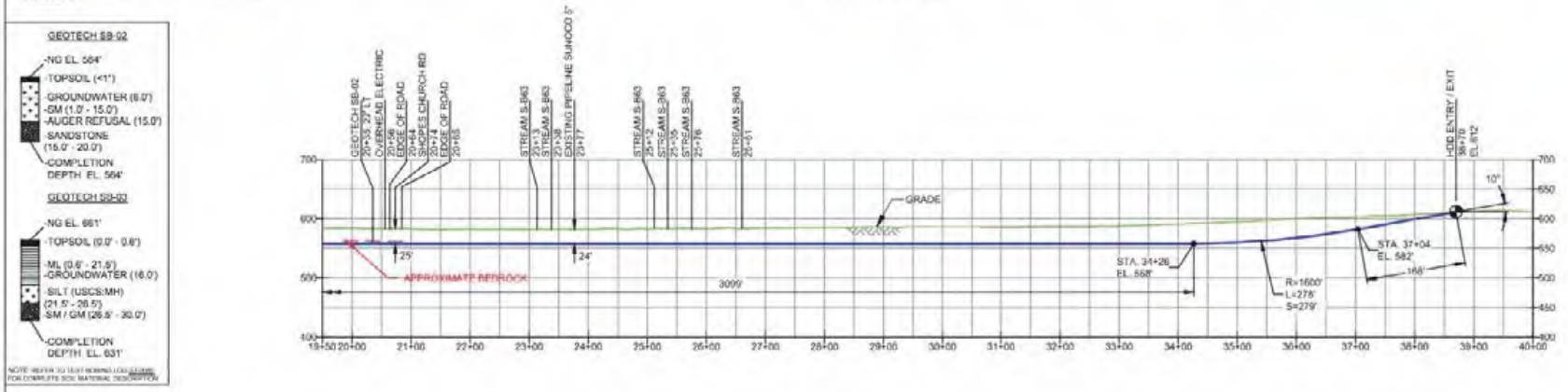
SCALE: 1"=200' DWG NO. PA-DA-0056.0000-RDa-16

FIGURE 2B: BORING LOCATION PLAN
"Waltonville Road" (PPP4)- Dauphin Co, PA
PSI Project No.: 04911517



DAUPHIN COUNTY, PENNSYLVANIA - DERRY TOWNSHIP
53-00800-16

PROFILE VIEW



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 POSSIBLE UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THIS 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.

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 HORIZ. LENGTH (L=3,867')
   HDD PIPE LENGTH (5+/-3,867')
   16" x 0.438" (X-T., X-70, API 5L, PSL2, ERW, BPE)
   COATING: 14-16 MILS FBE WITH 45 MILS MIN. ARO (POWERCRETE R60)
6. INTERNAL DESIGN PRESSURE 1480 PSIG (SCAM FACTOR 1.0, DESIGN FACTOR 0.90 (HOOP STRESS)).
7. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
8. PIPELINE MARKING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
9. CARRIER PIPE NOT ENCASED.
10. PUSH / MAINLINE TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
11. CONDUCT 24-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
12. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
13. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
14. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
4	DRILL ENTRY / EXIT LAT LONG UPDATE	MRS	04/03/17	RMB	04/03/17	AMC	04/03/17
3	REVISED PROFILE WITH 2017 LIDAR	MRS	02/27/17	RMB	02/27/17	AMC	02/27/17
2	REVISED PER ENGINEERING COMMENTS	MRS	06/01/16	RMB	06/01/16	AAW	06/01/16
1	REVISED PER COMMENTS FROM RCI REVIEW	MRS	03/09/16	RMB	03/09/16	AAW	03/09/16
0	ISSUED FOR CONSTRUCTION	MRS	01/26/16	RMB	01/26/16	AAW	01/26/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY (303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WALTONVILLE ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200' | DWG. NO. PA-DA-0056.0000-RDb-16

pennsylvania
DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES

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Figure 3: Site Geology Map

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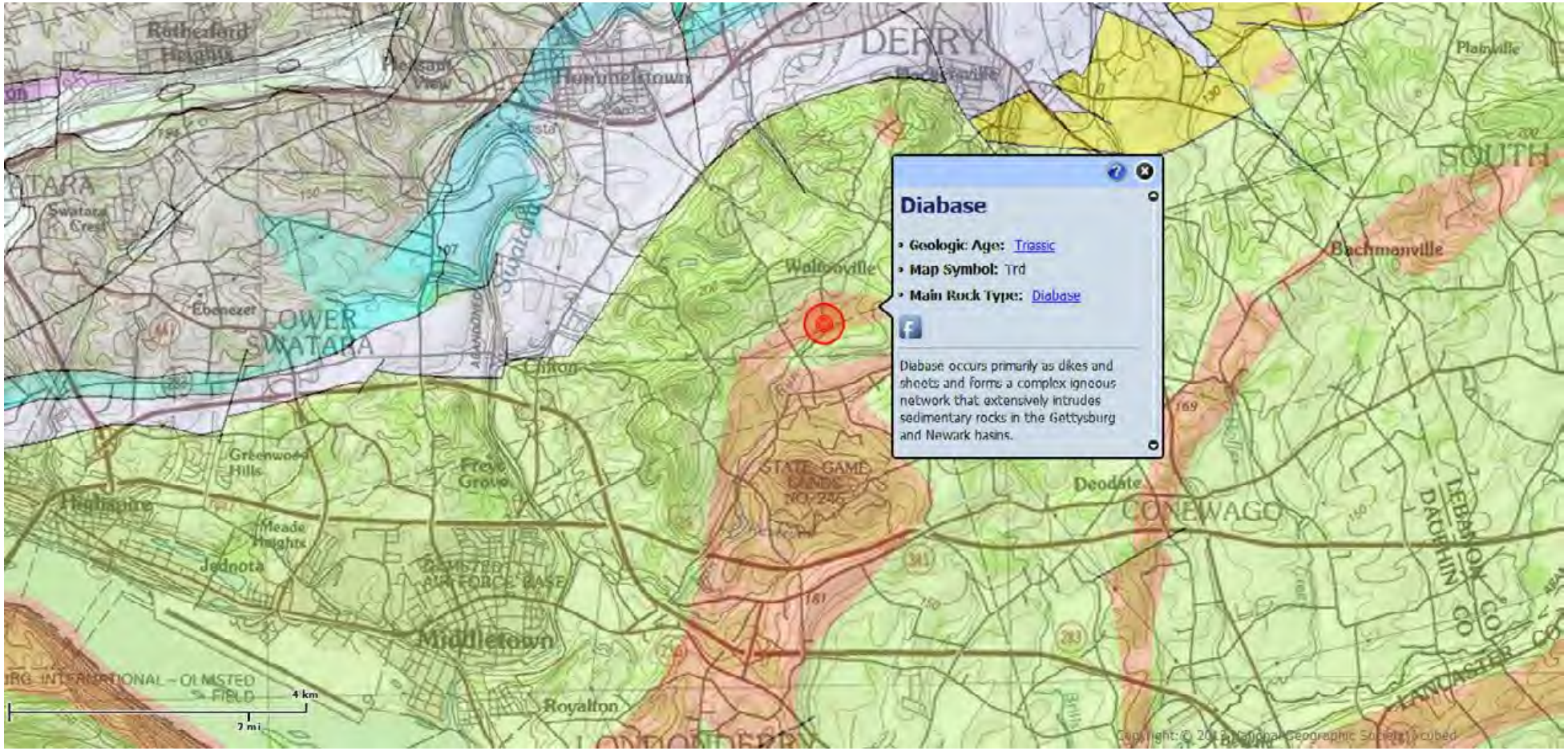

Created using PA DCNR Map Viewer

Map created on Mon Nov 6 2017

BORING B-1

DATE STARTED:	11/16/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	11/17/17	**DRILLER:** B. Deininger	**LOGGED BY:** K. Gibney
COMPLETION DEPTH	143.0 ft	**DRILL RIG:**	Versadrill GT8 Track
BENCHMARK:	N/A	**DRILLING METHOD:**	HSA/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS2.000-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

Water — Pre-Core 6.7 feet; Post-Core 11.8 feet

BORING LOCATION: See Boring Location Plan

REMARKS:

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	20	Approximately 1 foot topsoil **FILL**-Brown to red-brown, Lean CLAY, trace Sand, moist	CL	WOH-1-2-5 N=3	28	
	5			S-2	11	Grades to Sandy Lean CLAY with Gravel from 5 to 7 feet.		6-18-16-39 N=34	32	LL = 44 PL = 25 Fines=60.4%
	10			S-3	22	**RESIDUUM**-Loose, Light gray, Silty SAND, wet	SM	2-2-4-6 N=6	25	Fines=29.4%
	15			S-4	20	**RESIDUUM**-Medium Dense, Gray-brown, Silty SAND, moist/wet	SM	7-15-13-22 N=28	17	
	20			S-5	24	**RESIDUUM**-Very Stiff, Dark gray-brown, Sandy SILT, moist/wet	ML	11-14-13-15 N=27	28	Fines=63.1%
	25			R-1	35	Auger refusal encountered at approximately 24.5 feet **Conglomeric SANDSTONE**-Light gray to light gray-brown, Weathered to Highly Weathered, very broken to massive, cross bedded, thin to medium bedding, with interbeds of fine grained and large grained Sandstone, shallow to sheer, narrowly to medium spaced discontinuities, narrow to large joint openings		RQD=29 Rec=83%		Q_u = 647.0 tsf 155.9 pcf
	30									

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

Continued Next Page

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

PROJECT NO.: 04911517
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Waltonville Road (PPP4)
Dauphin Co., PA
PA-DA-0056.0000-Rda+b-16/DPS PO#20171103-2

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

BORING B-1

DATE STARTED:	11/16/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	11/17/17	**DRILLER:** B. Deininger	**LOGGED BY:** K. Gibney
COMPLETION DEPTH	143.0 ft	**DRILL RIG:**	Versadrill GT8 Track
BENCHMARK:	N/A	**DRILLING METHOD:**	HSA/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS2.000-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

Water Pre-Core 6.7 feet; Post-Core 11.8 feet

BORING LOCATION: See Boring Location Plan

REMARKS:

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
	30			R-2	56	**Conglomeratic SANDSTONE**-Light gray to light gray-brown, Weathered to Highly Weathered, very broken to massive, cross bedded, thin to medium bedding, with interbeds of fine grained and large grained Sandstone, shallow to sheer, narrowly to medium spaced discontinuities, narrow to large joint openings		RQD=46 Rec=94%			>> Q_u = 647.0 tsf 154.1 pcf 1 min.
	35			R-3	60			RQD=32 Rec=100%			1 min. 1 min. 1 min. 1 min.
	40			R-4	36	**Conglomeratic SANDSTONE**-Light gray-brown, Weathered to Slightly Weathered, slightly broken to massive, cross bedded, thin to medium bedding, with interbeds of fine grained and large grained Sandstone, shallow to sheer, narrowly to medium spaced discontinuities, narrow to large joint openings Weathered/very broken layer @ 39 feet (~ 4-1/4 inches thick)		RQD=33 Rec=67%			>> Q_u = 284.8 tsf 152.6 pcf 2 min. 2 min. 1 min. 1 min. 2 min.
	45			R-5	48	Highly Weathered/Completely Weathered from 40.5 to 42.8 feet. Weathered/Highly Weathered layer from 44 to 45.4 feet.		RQD=0 Rec=100%			2 min. 2 min. 2 min. 1 min. 1 min.
	50			R-6	60	Weathered/broken layer @ 48.1 feet (~ 2-3/4 inches thick) Weathered/Highly Weathered layer @ 50.6 feet (~ 11 inches thick)		RQD=36 Rec=100%			2 min. >> Q_u = 528.8 tsf 154.6 pcf 1 min.
	55			R-7	16	Weathered layer @ 52.5 feet (~ 6 inches thick)		RQD=0 Rec=87%			>> Q_u = 647.0 tsf 153.9 pcf 2 min.
	60			R-8	60	Highly Weathered/very broken layer @ 55.1 feet (~ 9 inches thick) **DIABASE**-Light brown to dark gray, Weathered to Highly Weathered, very broken to massive, indistinct bedding/flow boundary, very hard, shallow to sheer, narrowly to medium spaced discontinuities, tight to wide joint openings		RQD=36 Rec=100%			2 min. >> Q_u = 1235.0 tsf 167.3 pcf 2 min.

Continued Next Page

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

PROJECT NO.: 04911517
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Waltonville Road (PPP4)
Dauphin Co., PA
PA-DA-0056.0000-Rda+b-16/DPS PO#20171103-2

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

BORING B-1

DATE STARTED:	11/16/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	11/17/17	**DRILLER:** B. Deininger	**LOGGED BY:** K. Gibney
COMPLETION DEPTH	143.0 ft	**DRILL RIG:**	Versadrill GT8 Track
BENCHMARK:	N/A	**DRILLING METHOD:**	HSA/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS2.000-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

Water — Pre-Core 6.7 feet; Post-Core 11.8 feet

BORING LOCATION: See Boring Location Plan

REMARKS:

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
	60			R-9		Weathered/very broken layer from 58.7 to 61.3 feet. **DIABASE**-Light brown to dark gray, Weathered to Highly Weathered, very broken to massive, indistinct bedding/flow boundary, very hard, shallow to sheer, narrowly to medium spaced discontinuities, tight to wide joint openings					2 min.
	65			R-10	60	Broken/very broken layer from 61.4 to 64.8 feet. **DIABASE**-Light brown to dark gray, Weathered to Slightly Weathered, very broken to massive, indistinct bedding/flow boundary, very hard, shallow to sheer, narrowly to medium spaced discontinuities, tight to wide joint openings		RQD=26 Rec=100%			2 min. 2 min. 2 min. 2 min. 2 min. >> Q_u = 844.1 tsf 134.7 pcf
	70			R-11	60			RQD=46 Rec=100%			2 min. 2 min. 1 min. 1 min. 2 min. 2 min.
	75			R-12	60	Weathered/broken layer from 75.7 to 77.1 feet. **Conglomeratic SANDSTONE**-Light gray to dark brown, Weathered to Slightly Weathered, very broken to massive, very hard, cross bedded, thin to medium bedding, with interbeds of fine grained and large grained Sandstone, shallow to sheer, narrowly to medium spaced discontinuities, narrow to large joint openings		RQD=0 Rec=100%			2 min. >> Q_u = 492.2 tsf 155.5 pcf 2 min.
	80			R-13	60	Weathered layer @ 79.2 feet (~ 6-1/4 inches thick) Weathered/broken layer @ 80.8 feet (~ 19-1/4 inches thick)		RQD=30 Rec=100%			2 min. 2 min.
	85			R-14	60	**Conglomeratic SANDSTONE**-Light gray to red-gray-brown to dark gray-brown, Slightly Weathered, very broken to massive, very hard, cross bedded, thin to medium bedding, with interbeds of fine grained and large grained Sandstone, shallow to sheer, narrowly to medium spaced discontinuities, narrow to large joint openings		RQD=40 Rec=100%			2 min. 2 min. 1 min. 2 min. 2 min >> Q_u = 943.5 tsf 155.3 pcf 2 min.
	90										

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Telephone: (717) 230-8622

PROJECT NO.: 04911517
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Waltonville Road (PPP4) Dauphin Co., PA
PA-DA-0056.0000-Rda+b-16/DPS PO#20171103-2

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

BORING B-1

DATE STARTED:	11/16/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	11/17/17	**DRILLER:** B. Deininger	**LOGGED BY:** K. Gibney
COMPLETION DEPTH	143.0 ft	**DRILL RIG:**	Versadrill GT8 Track
BENCHMARK:	N/A	**DRILLING METHOD:**	HSA/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS2.000-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

Water — Pre-Core 6.7 feet; Post-Core 11.8 feet

BORING LOCATION: See Boring Location Plan

REMARKS:

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
	90			R-15	60	**Conglomeratic SANDSTONE**-Light gray to red-gray-brown to dark gray-brown, Slightly Weathered, very broken to massive, very hard, cross bedded, thin to medium bedding, with interbeds of fine grained and large grained Sandstone, shallow to sheer, narrowly to medium spaced discontinuities, narrow to large joint openings		RQD=50 Rec=100%			2 min. 2 min. 2 min. 2 min. 2 min. 2 min.
	95			R-16	60			RQD=66 Rec=100%			2 min. 2 min. 2 min. 2 min. >> ▲ Q_u = 623.3 tsf 1 min. 151.8 pcf
	100			R-17	60	**DIABASE**-Gray to dark gray, Weathered to Slightly Weathered, very broken to massive, indistinct bedding/flow boundary, very hard, shallow to sheer, narrowly to medium spaced discontinuities, tight to wide joint openings Broken layer @ 103 feet (~ 2-1/2 inches thick)		RQD=72 Rec=100%			1 min. 1 min. 2 min. >> ▲ Q_u = 683.7 tsf 165.8 pcf 2 min. 2 min.
	105			R-18	60	Broken layer @ 106.5 feet (~ 4-1/2 inches thick)		RQD=44 Rec=100%			2 min. 2 min. 1 min. 1 min. 2 min.
	110			R-19	56	Weathered/broken layer @ 112.3 feet (~ 11-3/4 inches thick) Weathered layer @ 114 feet (~ 3 inches thick)		RQD=18 Rec=94%			1 min. 2 min. >> ▲ Q_u = 181.2 tsf 1 min. 160.6 pcf 1 min. 2 min.
	115			R-20	60	Broken layer @ 117.4 feet (~ 4 inches thick)		RQD=56 Rec=100%			2 min. 2 min. 2 min. 1 min. >> ▲ Q_u = 551.3 tsf
	120										

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PROJECT NO.: 04911517
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Waltonville Road (PPP4) Dauphin Co., PA
PA-DA-0056.0000-Rda+b-16/DPS PO#20171103-2

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

BORING B-1

DATE STARTED:	11/16/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	11/17/17	**DRILLER:** B. Deininger	**LOGGED BY:** K. Gibney
COMPLETION DEPTH	143.0 ft	**DRILL RIG:**	Versadrill GT8 Track
BENCHMARK:	N/A	**DRILLING METHOD:**	HSA/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS2.000-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
- Pre-Core 6.7 feet
- Post-Core 11.8 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
	120			R-21	60	**DIABASE**-Gray to dark gray, Weathered to Slightly Weathered, very broken to massive, indistinct bedding/flow boundary, very hard, shallow to sheer, narrowly to medium spaced discontinuities, tight to wide joint openings Broken layer @ 121.9 feet (~ 8-1/4 inches thick)		RQD=30 Rec=100%			161.5 pcf 2 min. 2 min. 2 min. 2 min. 2 min. 2 min.
	125			R-22	60	**Conglomeratic SANDSTONE**-Light gray to dark brown, Weathered to Slightly Weathered, very broken to massive, very hard, cross bedded, thin to medium bedding, with interbeds of fine grained and large grained Sandstone, shallow to sheer, narrowly to medium spaced discontinuities, narrow to large joint openings		RQD=68 Rec=100%		>> ▲ Q_u = 935.3 tsf	2 min. 156.3 pcf 2 min. 2 min. 2 min. 2 min. 2 min.
	130			R-23	60	Broken layer @ 129.5 feet (~ 6-1/4 inches thick) Weathered/broken layer @ 130.6 feet (~ 8-1/2 inches thick) Weathered layer @ 132.6 feet (~ 4 inches thick)		RQD=8 Rec=100%		>> ▲ Q_u = 319.9 tsf	2 min. 2 min. 2 min. 2 min. 155.6 pcf 2 min. 1 min.
	135			R-24	59	**Conglomeratic SANDSTONE**-Light gray to dark brown, Slightly Weathered, very broken to massive, very hard, cross bedded, thin to medium bedding, with interbeds of fine grained and large grained Sandstone, shallow to sheer, narrowly to medium spaced discontinuities, narrow to large joint openings		RQD=74 Rec=98%			1 min. 2 min. 2 min. 2 min. 2 min.
	140			R-25	60	**DIABASE**-Dark gray, Slightly Weathered, slightly broken, indistinct bedding/flow boundary, very hard, shallow to sheer Test boring terminated @ 143 feet		RQD=56 Rec=100%			2 min. 1 min. 2 min.

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Telephone: (717) 230-8622

PROJECT NO.: 04911517
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Waltonville Road (PPP4)
Dauphin Co., PA

PA-DA-0056.0000-Rda+b-16/DPS PO#20171103-2

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


B-1 11/16/17 Waltonville RD PPP-4
Box 1 of 8 Depth 24.5 to 40.3
PSI 049/11517 DPS 20171103-2
PA-DA-0056-0000-RD-A-16
Run | Depth | Rec | Rqd
R-1 | 24.5 - 28.0 | 2.9 | 1.0
R-2 | 28.0 - 33.0 | 4.7 | 2.3
R-3 | 33.0 - 38.0 | 5.0 | 1.6
R-4 | 38.0 - 42.5 | 3.0 | 1.5
24.5
28.0
33.0
38.0
40.3


B-1 11/16/17 Walton Ville RD PPP-4
2 OF 8 Depth 40.3 to 57.0
PSI 04911517 DPS 20171103-2
PA-DA-0056-0000-RD-A-16
Run | Depth | Rec | RQD
R-4 | 38.0 - 42.5 | 3.0 | 1.5
R-5 | 42.5 - 46.5 | 4.0 | 0.0
R-6 | 46.5 - 51.5 | 5.0 | 1.8
R-7 | 51.5 - 53.0 | 1.3 | 0.0
Run | Depth | Rec | RQD
R-8 | 53.0 - 58.0 | 5.0 | 1.8
40.3
42.5
46.5
51.5
53.0
57.0


B-1 11/16/17 Walton Ville RD
Box 2 of 8 Depth 40.3 to 57.0
PSI 04911517 PPP-4
B-1 11/16/17 Walton Ville RD
Box 3 of 8 Depth 57.0 to 70.6
PST 04911517 PPP-4 DPS 20171103-2
PA-DA-0056-0000-RD-A-16
Run | Depth | Rec | RQD
R-8 | 53.0 - 58.0 | 5.0 | 1.8
R-9 | 58.0 - 63.0 | 5.0 | 0.4
R-10 | 63.0 - 68.0 | 5.0 | 1.3
R-11 | 68.0 - 73.0 | 5.0 | 2.3
57.0
58.0
63.0
68.0
70.6


PA-DA-0056-0000-RD-A-16 DPS 20171103-2
B-1 11/16/17 Walton Mill Rd
4 OF 8 Depth 70.6 to 84.3
PSI 04911517 PPP-4 DPS 20171103-2
PA-DA-0056-0000-RD-A-16
Run | Depths | Rec | RQD
R-11 | 68.0 - 73.0 | 5.0 | 2.3
R-12 | 73.0 - 78.0 | 5.0 | 0.0
R-13 | 78.0 - 83.0 | 5.0 | 1.5
R-14 | 83.0 - 88.0 | 5.0 | 2.0
70.6
73.0
78.0
83.0
84.3


B-1 11/16/17 Waltonville RD
5 of 8 Depth 84.3 to 99.3
PSI 04911517 PPP-4 DPS 20171103-2
PA-DA-0056-0000-RD-A-16
Run Depth Rec. RQD
R-14 83.0 - 88.0 5.0 2.0
R-15 88.0 - 93.0 5.0 2.5
R-16 93.0 - 98.0 5.0 3.3
R-17 98.0 - 103.0 5.0 3.6
84.3
88.0
88.0
93.0
98.0
99.3


B-1 11/16/17 Waltonville RD
6 OF 8 Depth 99.3 to 114.0
PSI 04911517 PPP-4 DPS 20171103-2
PA-DA-0056-0000-RD-A-16
Run Depth Rec RQD
R-17 98.0 - 103.0 5.0 3.6
R-18 103.0 - 108.0 5.0 2.2
R-19 108.0 - 113.0 4.7 0.9
R-20 113.0 - 118.0 5.0 2.8
99.3
103.0
103.0
108.0
113.0
114.0


B-1 11/16/17 Wolton Ville RD
Box 7 of 8 Depth 114.0 to 128.0
PSI 04911517 PPP-4 DPS 20171103-2
PA-DA-0056-0000-RD-A-16
Run | Depth | | ROC | RQD
R-20 | 113.0 | - 118.0 | 5.0 | 2.8
R-21 | 118.0 | - 123.0 | 5.0 | 1.5
R-22 | 123.0 | - 128.0 | 5.0 | 3.4
114.0
118.0
123.0
128.0


A-DA-0056-0000-RD-A-16
B-1 11/16/17 Waltonville RD
8 of 8 Depth 128.0 to 143.0
PSI 0491151 7 PPP-4 DPS 2017 1103-2
PA-DA-0056-0000-RD-A-16
Run | Depth | Rec | RQD
R-23 | 128.0 - 133.0 | 5.0 | 0.4
R-24 | 133.0 - 138.0 | 4.9 | 3.7
R-25 | 138.0 - 143.0 | 5.0 | 2.8
EOB
128.0
133.0
138.0
143.0

BORING B-2

DATE STARTED:	11/14/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	11/15/17	**DRILLER:** B. Deininger	**LOGGED BY:** K. Gibney
COMPLETION DEPTH	143.0 ft	**DRILL RIG:**	Versadrill GT8 Track
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS2.000-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

Water — Pre-Core 16.9 feet; Post-Core 17.6 feet

BORING LOCATION: See Boring Location Plan

REMARKS:

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	24	Approximately 1 foot topsoil **FILL**-Brown to red-brown, SILT with Sand, moist	ML	7-5-7-6 N=12	21	
	5			S-2	24	Trace organics from 5 to 7 feet.		8-8-8-8 N=16	35	LL = 49 PL = 33
	10			S-3	14	**RESIDUUM**-Loose, Brown, Silty SAND with Gravel, wet	SM	2-3-5-7 N=8	34	Fines=12.0%
	15			S-4	24	**RESIDUUM**-Stiff, Yellow-brown, Sandy SILT, moist	ML	4-7-6-7 N=13	56	>>Non-Plastic Fines=54.7%
	20			S-5	18	**RESIDUUM**-Loose, Brown to yellow-gray-brown, Silty SAND, moist	SM	2-4-3-7 N=7	30	
	25			S-6	22			3-5-56 N=10	48	Fines=30.5%
	30					**RESIDUUM**-Medium Dense, Gray-brown, Silty SAND, moist	SM			

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

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PROJECT NO.: 04911517
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Waltonville Road (PPP4)
Dauphin Co., PA
PA-DA-0056.0000-Rda+b-16/DPS PO#20171103-2

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

BORING B-2

DATE STARTED:	11/14/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	11/15/17	**DRILLER:** B. Deininger	**LOGGED BY:** K. Gibney
COMPLETION DEPTH	143.0 ft	**DRILL RIG:**	Versadrill GT8 Track
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS2.000-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
- Pre-Core 16.9 feet
- Post-Core 17.6 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
	30			S-7	23	**RESIDUUM**-Medium Dense, Gray-brown, Silty SAND, moist	SM	5-5-7-30 N=12	31		
						Casing refusal @ 34.0 feet					
	35			R-1	12	**DIABASE**-Light gray-brown to light gray, Highly Weathered, very broken to slightly broken		RQD=0 Rec=25%			
	40			R-2	26			RQD=0 Rec=44%			
	45			R-3	42			RQD=0 Rec=70%			
	50			R-4	24			RQD=0 Rec=40%			
						DIABASE-Light gray-brown to dark gray, Weathered to Slightly Weathered, very broken to massive, very hard, laminated to flow bending, pregmatic in areas, flow bending, mineral veining, shallow to steep, laminated to medium spaced discontinuities, shallow to shear dip, random fractures, tight to wide joint openings					
	55			R-5	60			RQD=26 Rec=100%			>> ▲Q_u = 766.0 tsf 169.1 pcf
	60										2 min.

Continued Next Page

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PROJECT NO.: 04911517
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Waltonville Road (PPP4)
Dauphin Co., PA
PA-DA-0056.0000-Rda+b-16/DPS PO#20171103-2

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

BORING B-2

DATE STARTED:	11/14/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	11/15/17	**DRILLER:** B. Deininger	**LOGGED BY:** K. Gibney
COMPLETION DEPTH	143.0 ft	**DRILL RIG:**	Versadrill GT8 Track
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS2.000-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

Water — Pre-Core 16.9 feet; Post-Core 17.6 feet

BORING LOCATION: See Boring Location Plan

REMARKS:

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
	60			R-6	59			RQD=28 Rec=98%			2 min. 2 min. 2 min. 2 min.
						Conglomeratic SANDSTONE-Light red-gray-brown to brown, Slightly Weathered, broken to massive, very hard, shallow to steep, laminated to medium spaced discontinuities, shallow to shear dip, tight to wide joint openings				>> Q_u = 1118.7 tsf	2 min. 158.2 pcf
	65			R-7	60			RQD=46 Rec=100%			2 min. 2 min. 2 min.
										>> Q_u = 890.9 tsf	2 min. 158.5 pcf
	70			R-8	60			RQD=66 Rec=100%			2 min. 2 min. 2 min. 2 min. 2 min.
	75			R-9	60			RQD=48 Rec=100%		>> Q_u = 329.2 tsf	156.8 pcf 2 min. 2 min. 2 min. 2 min.
						Diabase layer from 77.8 to 78.8 feet. Highly Weathered layer from 78.8 to 80 feet.					
	80			R-10	60			RQD=28 Rec=100%		>> Q_u = 459.5 tsf	1 min. 157.0 pcf 2 min. 2 min. 2 min. 2 min.
						DIABASE-Light gray to gray-brown, Weathered to Slightly Weathered, very broken to massive, very hard, laminated to flow bending, pregmatic in areas, flow bending, mineral veining, shallow to steep, laminated to medium spaced discontinuities, shallow to shear dip, random fractures, tight to wide joint openings Broken layer @ 84.6 feet (~ 10 inches thick)					
	85			R-11	60			RQD=16 Rec=100%			2 min. 2 min. 2 min. 2 min.
	90										

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PROJECT NO.: 04911517
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Waltonville Road (PPP4) Dauphin Co., PA
PA-DA-0056.0000-Rda+b-16/DPS PO#20171103-2

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

DATE STARTED:	11/14/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	11/15/17	**DRILLER:** B. Deininger	**LOGGED BY:** K. Gibney
COMPLETION DEPTH	143.0 ft	**DRILL RIG:**	Versadrill GT8 Track
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS2.000-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
Pre-Core 16.9 feet
Post-Core 17.6 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
	90			R-12	60	Broken layer @ 89.6 feet (~ 5 inches thick) **Conglomeratic SANDSTONE**-Gray-brown to brown, Slightly Weathered, very broken to massive, very hard, occasional Diabase intrusions, shallow to steep, laminated to medium spaced discontinuities, shallow to shear dip, tight to wide joint openings Weathered/broken layer @ 92.3 feet (~ 4-1/2 inches thick)		RQD=30 Rec=100%			2 min. 2 min. 2 min. 2 min. >> Q_u = 804.4 tsf 159.2 pcf 2 min.
	95			R-13	60	Diabase intrusion from 95.2 to 97.7 feet. Broken layer @ 97.6 feet (~ 5 inches thick)		RQD=36 Rec=100%			2 min. 2 min. 2 min. 2 min. 2 min. 2 min.
	100			R-14	60	Highly Weathered/very broken layer @ 102 feet (~ 11-3/4 inches thick)		RQD=58 Rec=100%			>> Q_u = 1417.7 tsf 160.1 pcf 2 min. 2 min. 2 min. 2 min.
	105			R-15	54	Highly Weathered layer @ 104.8 feet (~ 9 inches thick) Highly Weathered layer @ 106.5 feet (~ 2-1/4 inches thick)		RQD=42 Rec=90%			2 min. 2 min. 2 min. 2 min. 2 min. >> Q_u = 185.2 tsf 156.4 pcf 2 min.
	110			R-16	60			RQD=20 Rec=100%			2 min. 2 min. 2 min. 2 min. 2 min.
	115			R-17	60			RQD=82 Rec=100%			>> Q_u = 572.1 tsf 162.4 pcf 2 min. 2 min. 2 min. 1 min.
	120										

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PROJECT NO.: 04911517
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Waltonville Road (PPP4)
Dauphin Co., PA
PA-DA-0056.0000-Rda+b-16/DPS PO#20171103-2

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

BORING B-2

DATE STARTED:	11/14/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	11/15/17	**DRILLER:** B. Deininger	**LOGGED BY:** K. Gibney
COMPLETION DEPTH	143.0 ft	**DRILL RIG:**	Versadrill GT8 Track
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS2.000-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
- Pre-Core 16.9 feet
- Post-Core 17.6 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
	120			R-18	60	**Conglomeratic SANDSTONE**-Gray-brown to brown, Slightly Weathered, very broken to massive, very hard, occasional Diabase intrusions, shallow to steep, laminated to medium spaced discontinuities, shallow to shear dip, tight to wide joint openings		RQD=62 Rec=100%			2 min. 2 min. >> Q_u = 315.2 tsf 156.0 pcf 2 min. 2 min. 2 min.
	125			R-19	60			RQD=92 Rec=100%			2 min. 2 min. 2 min. 2 min. 2 min.
	130			R-20	60			RQD=88 Rec=100%			>> Q_u = 799.1 tsf 157.2 pcf 2 min. 1 min. 2 min. 2 min.
	135			R-21	59			RQD=72 Rec=98%			2 min. 2 min. 2 min. 2 min. 2 min.
	140			R-22	60	Diabase intrusion from 138.9 to 140 feet.		RQD=68 Rec=100%			>> Q_u = 916.5 tsf 159.6 pcf 2 min. 2 min. 2 min.
						Test boring terminated @ 143 feet					

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

PROJECT NO.: 04911517
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Waltonville Road (PPP4)
Dauphin Co., PA

PA-DA-0056.0000-Rda+b-16/DPS PO#20171103-2

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


B-2 11/13/17 PST 04911517 PPP-4 Waltham Hill Rd
Box 1 of 7 Depth 34.0 to 58.9
DFS 20171103-2 PA-DA-0056-0000-RD-B-16
Run Depth Rec RQD
R-1 34.0 -38.0 1.0 0.0
R-2 38.0 -43.0 2.2 0.0
R-3 43.0 -48.0 3.5 0.0
R-4 48.0 -53.0 1.0 0.0
R-5 53.0 -58.0 5.0 1.3
Run Depth Rec RQD
R-6 58.0 -63.0 4.9 1.4
34.0
38.0
43.0
48.0
53.0
58.0
58.9


B-2 11/13/17 PSI 04911517 PPP-4
Box 2 of 7 Depth 58.9 to 73.0
Wilmington Rd DPS 20171103-2
PA-DA-0056-0000-RD-B-16
Run | Depth | Rec | RQD
R-6 | 58.0 - 63.0 | 4.9 | 1.4
R-7 | 63.0 - 68.0 | 5.0 | 2.3
R-8 | 68.0 - 73.0 | 5.0 | 3.3
R-9 | 73.0 - 78.0 | 5.0 | 2.4
58.9
63.0
68.0
73.0


B-2 11/14/17 PSI 04911517 PPP-4
3 of 7 Depth 73.0 to 86.7 Washington RD
DPS 20171103-2 PA-DA-0056-0000 RD B-16
Run | Depth | Rec | RQD
R-9 | 73.0 - 78.0 | 5.0 | 2.4
R-10 | 78.0 - 83.0 | 5.0 | 1.4
R-11 | 83.0 - 88.0 | 5.0 | 0.8
73.0
78.0
83.0
86.9


B-2 11/ /17 PSI 049 11517 PPP-4
4 of 7 Depth 86.9 to 101.5
Walton Ville RD DPW 2017 1103-2
PA-DA-0056-0000-RD-B-16
Run | Depth | Rec | RQD
R-11 | 83.0 - 88.0 | 5.0 | 0.8
R-12 | 88.0 - 93.0 | 5.0 | 1.5
R-13 | 93.0 - 98.0 | 5.0 | 1.8
R-14 | 98.0 - 103.0 | 5.0 | 2.9
86.9
88.0
93.0
98.0
101.5


B-2 11/14/17 PSI-04711517 PPP4
5 OF 7 Depth 101.5 TO 115.8
Walton Vine RD DPS 20171103-2
PA-DA-0056-0000-RD-B-16
Run | Depth | | Rec | RQD
R-14 | 98.0 | -103.0 | 5.0 | 2.9
R-15 | 103.0 | -108.0 | 4.5 | 2.1
R-16 | 108.0 | -113.0 | 5.0 | 1.0
R-17 | 113.0 | -118.0 | 5.0 | 4.1
101.5
103.0
108.0
113.0
115.8


B-2 11/14/17 PSF-0422517 PPP-4
6 of 7 Depth 115.8 to 130.5
Waltonville RD DPS 20171103-2
PA-DA-0056-0000-RD-B-16
Run | Depth | Rec | RQD
R-17 | 113.0 - 118.0 | 5.0 | 4.1
R-18 | 118.0 - 123.0 | 5.0 | 3.1
R-19 | 123.0 - 128.0 | 5.0 | 4.6
R-20 | 128.0 - 133.0 | 5.0 | 4.4
115.8
118.0
123.0
128.0
133.0
130.5


B-2 11/14/17 PSI 0491517 PPA-4
7 OF 7 Depth 130.5 to 143.0
Walton Vine Rd DPS 20171103-2
PA-DA-0056-0000-RD-B-16
Run | Depth | Rec | RQD
R-20 | 128.0 - 133.0 | 5.0 | 4.7
R-21 | 133.0 - 138.0 | 4.9 | 3.6
R-22 | 138.0 - 143.0 | 5.0 | 3.4
EOR
130.5
133.0
138.0
143.0

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%

intertek psi
Total Quality. Assured.

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

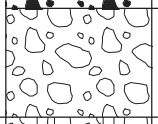
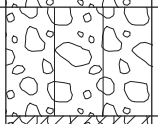
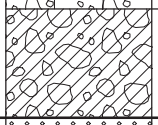
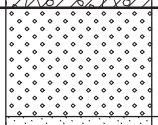
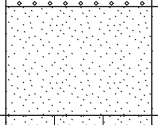
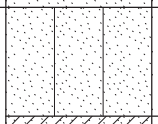
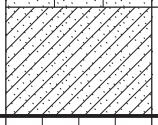
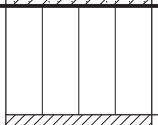
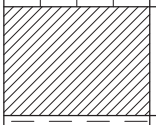
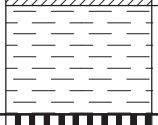
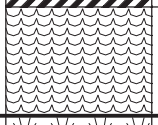
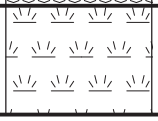
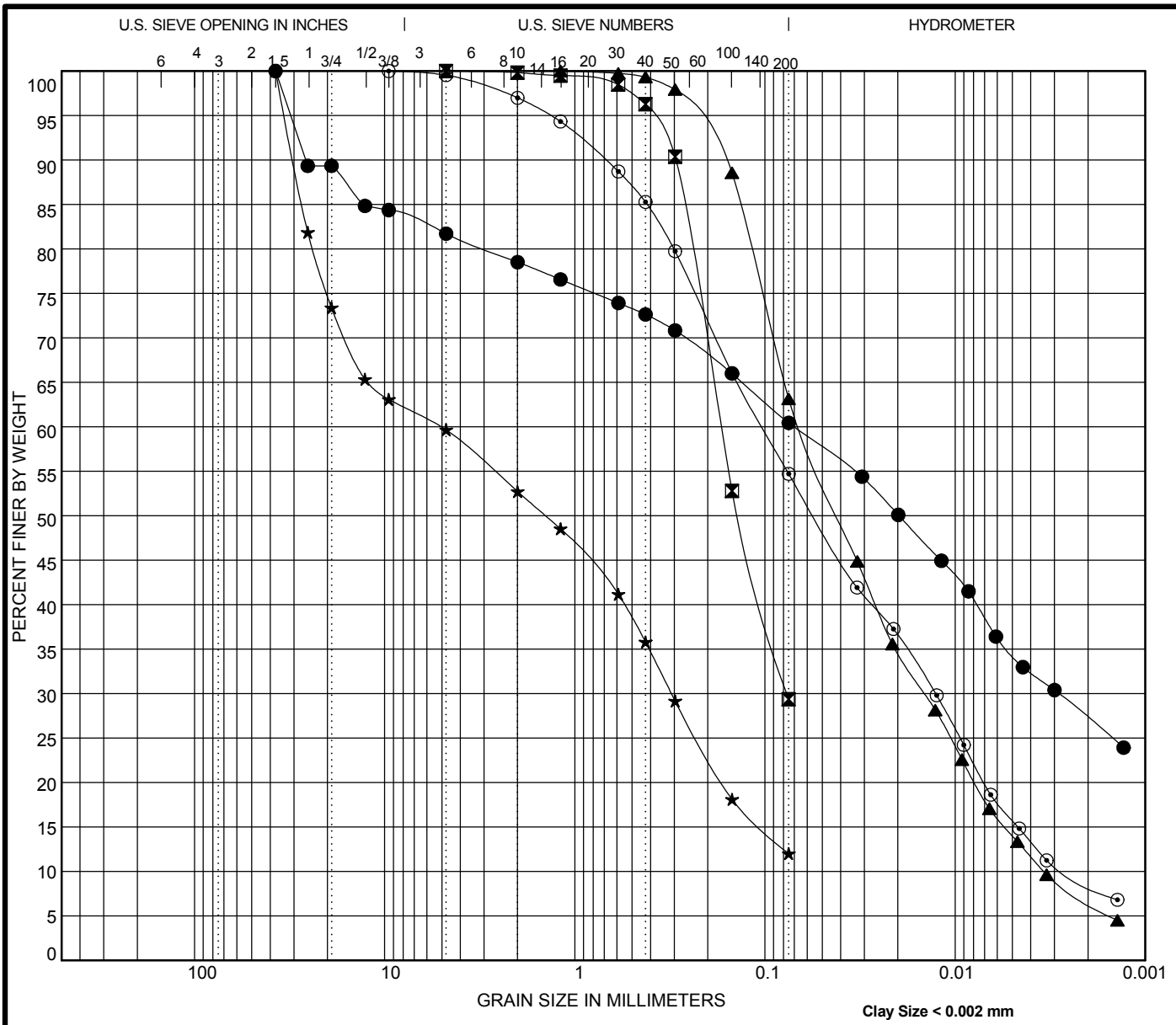
MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	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
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	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	6.0	Sandy Lean CLAY with Gravel (CL)	44	25	19		
⊠	B-1	11.0	Silty SAND (SM)					
▲	B-1	21.0	Sandy SILT (ML)				0.94	19.03
★	B-2	11.0	Silty SAND with Gravel (SM)				0.32	85.14
⊙	B-2	16.0	Sandy SILT (ML)	NP	NP	NP	0.60	39.83

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	6.0	37.5	0.07	0.003		18.3	21.3	33.2	27.3
⊠	B-1	11.0	4.75	0.17	0.076		0.0	70.6	29.4	
▲	B-1	21.0	1.19	0.065	0.014	0.003	0.0	36.9	56.5	6.6
★	B-2	11.0	37.5	5.096	0.311		40.3	47.6	12.0	
⊙	B-2	16.0	9.525	0.103	0.013	0.003	0.5	44.8	46.1	8.7

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GRAIN SIZE DISTRIBUTION

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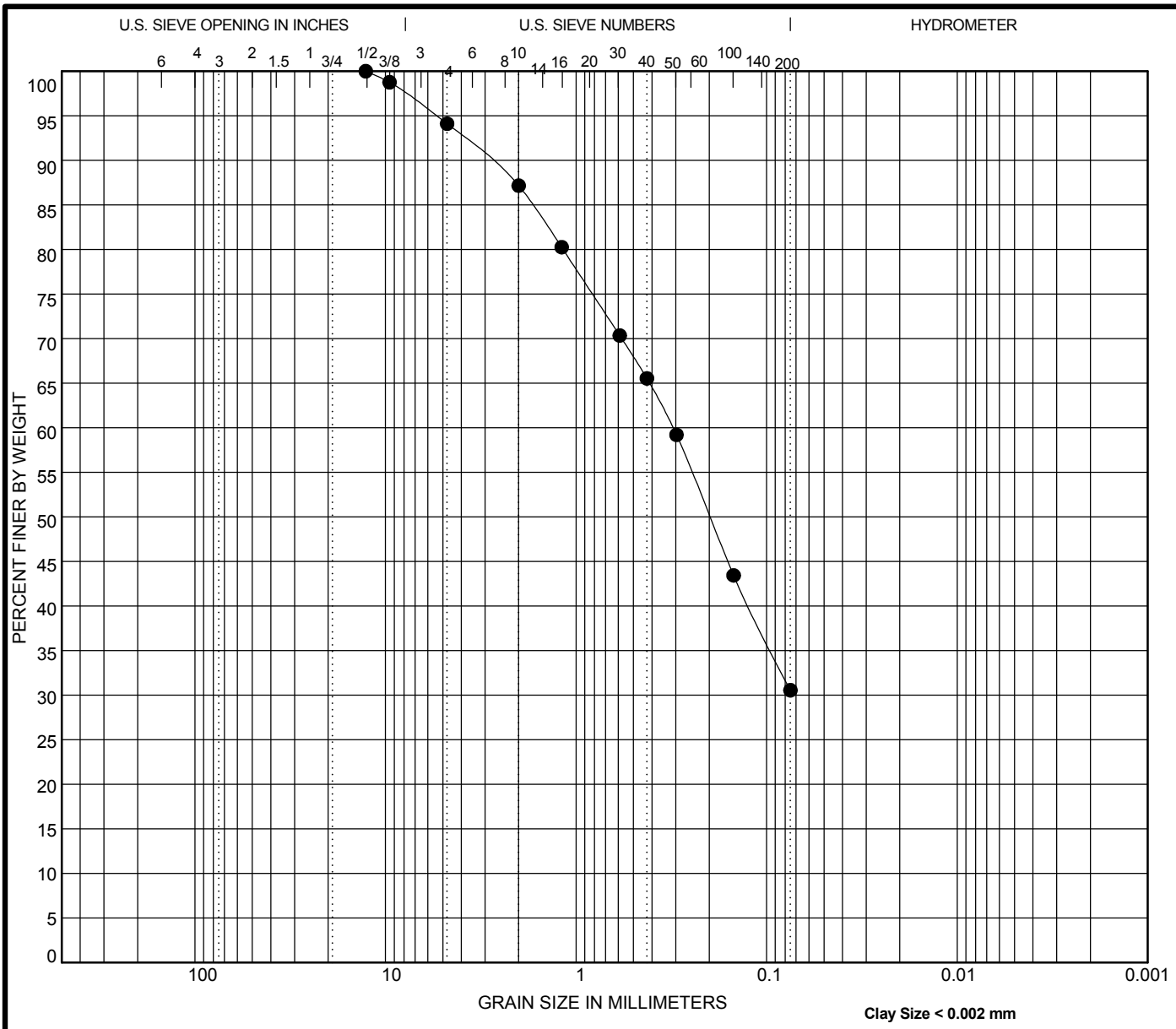
PSI Job No.: 04911517
Location: Waltonville Road (PPP4)
Dauphin Co., PA



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● B-2	26.0	Silty SAND (SM)					

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-2	26.0	12.7	0.311			5.9	63.6	30.5	

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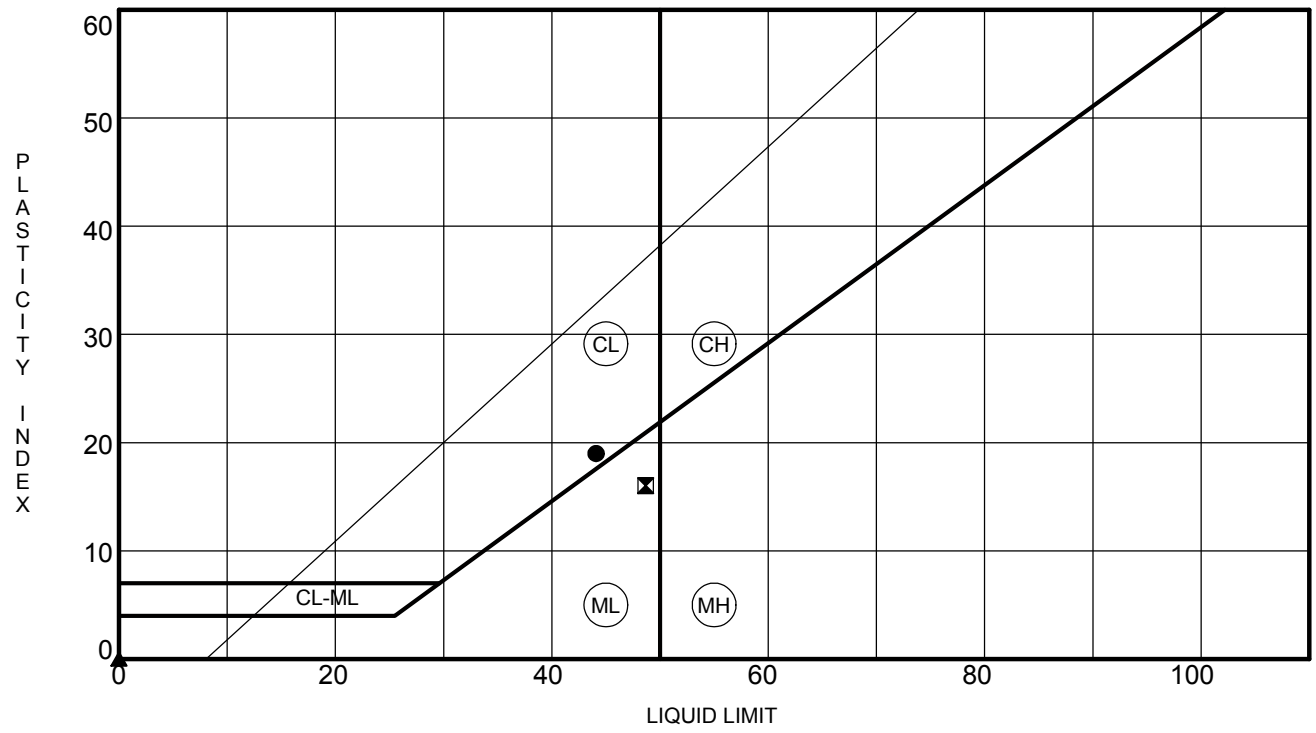
Project: Energy Transfer HDD (DPS)
PSI Job No.: 04911517
Location: Waltonville Road (PPP4)
Dauphin Co., PA



	Boring	Depth (ft)	LL	PL	PI	Fines	Classification (*Visual)
●	**B-1**	**6.0**	**44**	**25**	**19**	**60.4**	**Sandy Lean CLAY with Gravel (CL)**
⊠	**B-2**	**6.0**	**49**	**33**	**16**		**SILT with Sand (ML)**
▲	**B-2**	**16.0**	**NP**	**NP**	**NP**	**54.7**	**Sandy SILT (ML)**

Professional Service Industries, Inc.
1707 S. Cameron Street, Suite B
Harrisburg, PA 17104
Telephone: (717) 230-8622
Fax: (717) 230-8626

ATTERBERG LIMIT RESULTS

PSI Job No.: 04911517
Project: Energy Transfer HDD (DPS)
Location: Waltonville Road (PPP4)
Dauphin Co., 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							28			
B-1	6	44	25	19		60.4%		32			
B-1	11					29.4%		25			
B-1	16							17			
B-1	21					63.1%		28			
B-1	28				646.98						
B-1	32				647.03						
B-1	38				284.81						
B-1	49.9				528.80						
B-1	53.6				647.03						
B-1	57.1				1235.03						
B-1	68.7				844.06						
B-1	78.5				492.15						
B-1	88.4				943.47						
B-1	98.8				623.26						
B-1	102.3				683.70						
B-1	111.8				181.21						
B-1	119.4				551.27						
B-1	126.3				935.26						
B-1	133.5				319.85						
B-2	1							21			
B-2	6	49	33	16				35			
B-2	11					12.0%		34			
B-2	16	0	0	0		54.7%		56			
B-2	21							30			
B-2	26					30.5%		48			
B-2	31							31			
B-2	55.6				766.01						
B-2	64.1				1118.69						
B-2	68.1				890.90						
B-2	75.1				329.21						
B-2	80.4				459.50						
B-2	93.2				804.37						
B-2	100.9				1417.73						
B-2	109.3				185.15						
B-2	115				572.07						
B-2	121.8				315.22						
B-2	129.8				799.05						
B-2	140.4				916.49						

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Summary of Laboratory Results

PSI Job No.: 04911517
Project: Energy Transfer HDD (DPS)
Location: Waltonville Road (PPP4)
Dauphin Co., PA
PA-DA-0056.0000-Rda+b-16/DPS PO#20171103-2

LEGEND:

◎ Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0080
DAUPHIN COUNTY, DERRY 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:	WALTONVILLE ROAD, HUMMELSTOWN, PA		Page 1 of 1
HDD No.:	S3-0080	Dates(s) Drilled: 11-11-14	Inspector: E. WATT
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 6.0	Total Depth (ft): 30.0
Boring Location Coordinates:		40° 13' 55.015" N	76° 40' 54.952" W

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	1.0			TOPSOIL (12")					
1	3.0	5.0	1.0		16	SM	BROWN TO ORANGE BROWN MEDIUM TO COARSE SAND WITH	2	8	10	11	**18**
							SOME SILT AND A LITTLE FINE TO COARSE GRAVEL.					
2	8.0	10.0			20		GRAY FINE TO MEIDUM SAND WITH SOME SILT.	2	6	6	6	**12**
3	13.0	15.0			24		GRAY FINE SAND WITH SOME SILT, TRACE FINE GRAVEL.	1	3	6	12	**9**
4	18.0	20.0			8		GRAY FINE TO MEDIUM SAND WITH SOME SILT, AND WITH SOME	3	14	15	15	**29**
							FINE TO COARSE GRAVEL.					
5	23.0	25.0			22		GRAY AND BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, AND	6	22	19	50	**41**
							A LITTLE FINE GRAVEL.					
6	28.0	29.2			10		BROWN TO ORANGE BROWN MEDIUM TO COARSE SAND WITH A	2	15	50/2"		**>65**
				30.0			LITTLE SILT.					
							WET ON SPOON AT 6'.					
							WATER LEVEL THROUGH AUGERS AT 8'.					
							CAVED AT 21', WATER LEVEL ON CAVE AT 5'.					

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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Newark, Delaware 19713
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fax: 302.454.5988

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	SHOPS CHURCH ROAD, HUMMELSTOWN, PA		Page 1 of 1
HDD No.:	S3-0080	Dates(s) Drilled: 11-11-14	Inspector: E. WATT
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 6.0	Total Depth (ft): 20.0
Boring Location Coordinates:		40° 14' 0.606" N	76° 40' 27.087" W

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	0.0			TOPSOIL (<1")					
1	3.0	5.0	0.0		18		BROWN, YELLOWISH BROWN TO ORANGE BROWN FINE TO COARSE	1	6	11	11	**17**
							SAND WITH A LITTLE SILT, AND LITTLE F-C GRAVEL.					
2	8.0	9.9			24		SAME, WITH PIECES OF UNWEATHERED SANDSTONE.	2	9	26	50/5"	**35**
							AUGER REFUSAL AT 12', OFF-SET 10' SOUTH, AND CONTINUOULSY					
						SM	AUGERED TO 10'.					
3	10.0	12.0					DR WEATHERED TO A YELLOWISH BROWN TO GRAY FINE TO	8	29	17	50/6"	**46**
							COARSE SAND AND SILT, WITH SOME F-C UNWEATHERED SANDSTONE					
				15.0			GRAVEL.					
							AUGERS STICKING UP TOO HIGH TO ROCK CORE. OFF-SET BORING					
							AND CONTINUOUSLY AUGERED TO REFUSAL AT 15"					
							<u>ROCK CORING</u>					
RUN 1	15.0	20.0	15.0	20.0	24		HIGHLY FRACTURED AND HEAVILY WEATHERED GRAY SAND STONE.	TCR: 40%, SCR: 0%, RQD: 0%				
							COULD NOT PERFORM AN ADDITIONAL ROCK CORE RUN. BORING					
							CAVED DUE TO HEAVILY FRACTURED/WEATHERED ROCK.					
							WET ON SPOON AT 10'					
							WATER LEVEL THROUGH AUGERS AT 6'.					
							CAVED AT 4', WATER AT SURFACE.					

Notes/Comments:
<u>Pocket Pentrometer Testing</u>

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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fax: 302.454.5988

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	SAND HILL ROAD, NUMMELSTOWN, PA		Page 1 of 1
HDD No.:	S3-0080	Dates(s) Drilled: 11-12-14	Inspector: E. WATT
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 16.0	Total Depth (ft): 30.0
Boring Location Coordinates:		40° 14' 9.164" N	76° 39' 57.534" W

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	0.6			TOPSOIL (7")					
1	3.0	5.0	0.6		17		BROWN SILT AND FINE SAND WITH A TRACE FINE	2	7	8	9	**15**
				6.5			GRAEL.					
2	8.0	10.0	6.5		24		ORANGE BROWN CLAYEY SILT AND FINE SAND, TRACE FINE	4	9	7	12	**16**
				11.5		ML	GRAVEL (USCS: ML).					
3	13.0	15.0	11.5		24		ORANGE BROWN TO REDDISH BROWN CLAYEY SILT WITH A LITTLE	1	2	4	5	**6**
							FINE SAND, TRACE FINE GRAVEL.					
4	18.0	20.0			24		ORANGE BROWN TO REDDISH BROWN CLAYEY SILT AND FINE	1	1	7	22	**8**
				21.5			SAND, TRACE FINE GRAVEL.					
5	23.0	25.0	21.5		15	MH	MOTTLED (GRAY, YELLOWISH BRWN,BLACK) CLAYEY SILT WITH	8	12	3	11	**15**
				26.5			SOME FINE SAND, TRACE FINE GRAVEL. (USCS: MH)					
6	28.0	30.0	26.5		13	SM/ GM	VARI-COLORED FINE TO COARSE SAND AND FINE TO COARSE	3	21	34	43	**55**
				30.0			SANDSTONE GRAVEL.					
							SOME GRINDING AT 9'.					
							WET ON SPOON AT 16'.					
							WATER LEVEL NOT DETECTED THORUGH AUGERS.					
							CAVED AT 26', WATER LEVEL ON CAVE AT 20'.					

Notes/Comments:

Pocket Pentrometer Testing
S1: > 4 TSF S4: 1.25 TSF
S2: 3 TSF
S3: 1.5 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.

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0080

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)
S3-0080	SB-01	2	8.0	10.0	19.1	30.4	-	-	-	-
		3	13.0	15.0	17.5	27.2	-	-	-	-
		5	23.0	25.0	16.3	21.0	-	-	-	-
		6	28.0	29.2	16.7	16.2	-	-	-	-
	SB-02	1	3.0	5.0	13.8	18.9	-	-	-	-
		2	8.0	9.9	9.6	14.5	-	-	-	-
		3	10.0	12.0	29.8	46.2	-	-	-	-
	SB-03	1	3.0	5.0	15.1	55.7	-	-	-	-
		2	8.0	10.0	39.4	54.0	49	34	15	ML
		3	13.0	15.0	50.0	81.0	-	-	-	-
		4	18.0	20.0	49.5	66.3	-	-	-	-
		5	23.0	25.0	45.5	73.7	53	38	15	MH

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0080

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
S3-0080	Wetland C26 - Shopes Church Rd.	SB-01 SB-02 SB-03	**Diabase** - occurs primarily as dikes and sheets and forms a complex igneous network that extensively intrudes sedimentary rocks in the Gettysburg and Newark basins.	Moderately sloping rolling hills	Diabase	Ophitic texture , an important variety of basalt texture where pyroxene (or occasionally olivine) forms larger crystals and typically contains numerous crystals of plagioclase (right).	N/A	10-62	Diabase - Medium- to coarse-grained, quartz-normative tholeiite; composed of labradorite and various pyroxenes; occurs as dikes, sheets, and a few small flows. Includes the dark-gray York Haven Diabase (high titanium oxide) and the slightly younger Rossville Diabase (low titanium oxide). In chilled margins, the Rossville is distinguished from the York Haven by its lighter gray color and distinctive, sparse, centimeter-sized calcic-plagioclase phenocrysts.

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 S3-0080

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					
S3-0080	SB-2	1	15	20	40	0	0	15	20	Heavily	Sandstone	Massive	Gray	Heavily fractured, ranging from 0° to 90°

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).

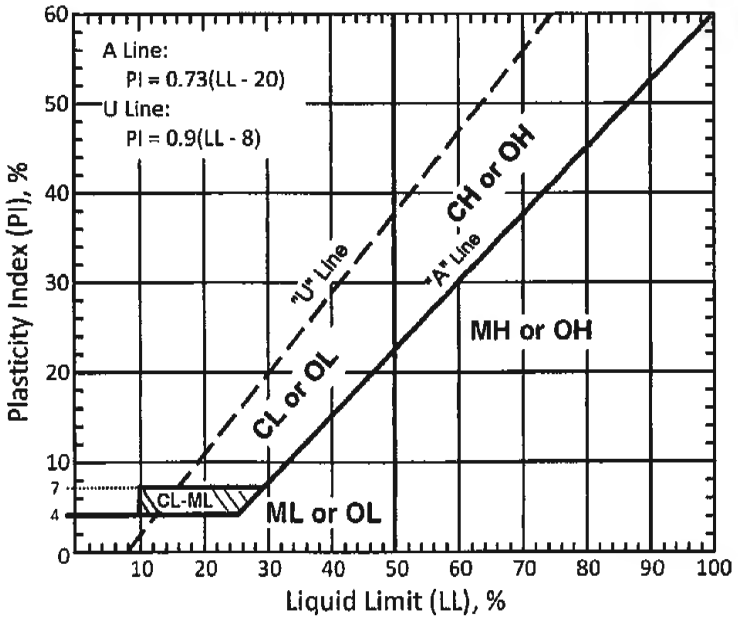
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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 size)	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.

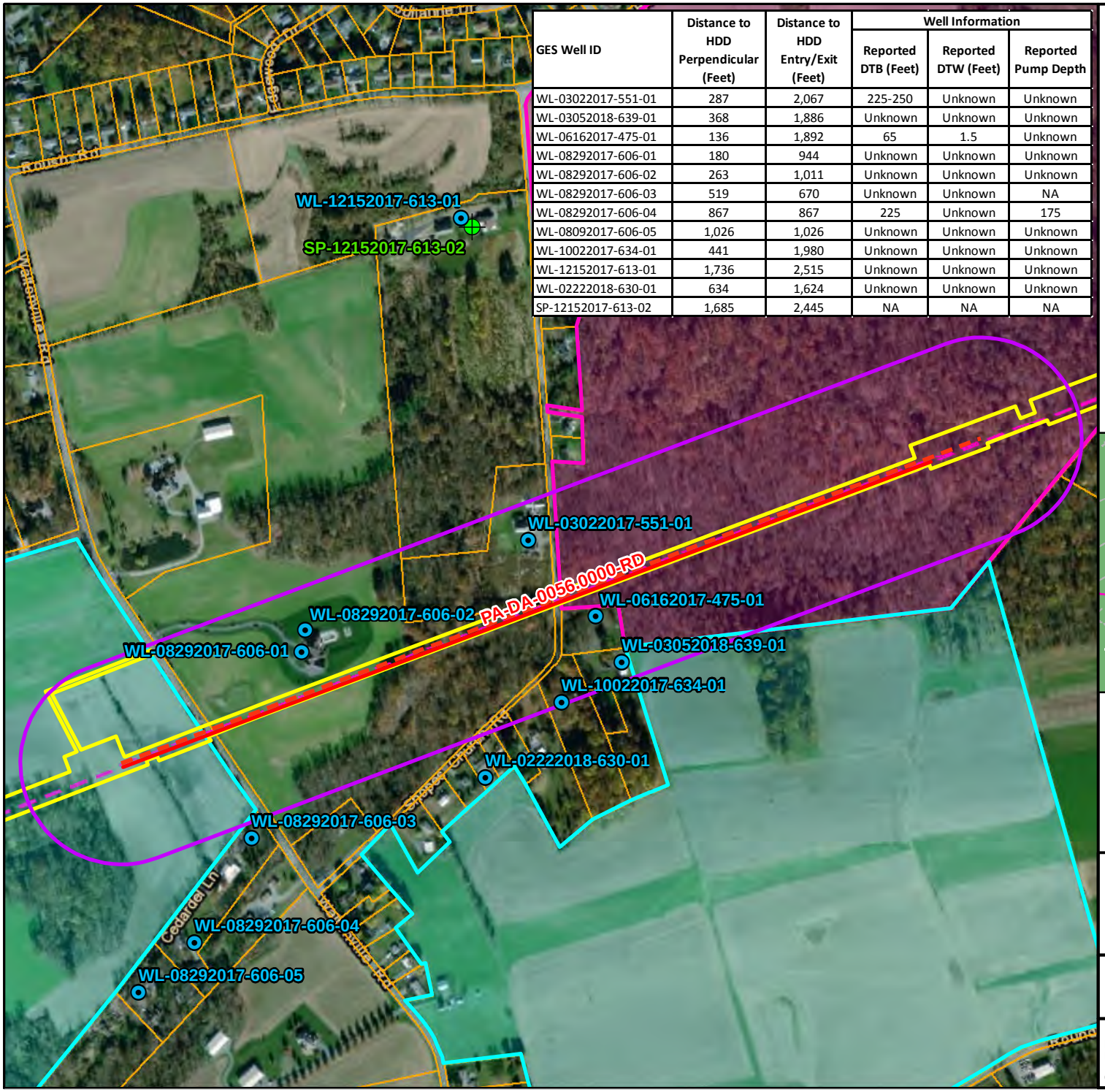
ATTACHMENT 3

ATTACHMENT 3
WELLS WITHIN 0.5 MILES OF PROPOSED 16" HDD TRACE - SUNOCO WALTONVILLE ROAD
FROM PAGWIS DATABASE 2-12-19

FID	PAWellID	County	Municipali	QuadName	WellAddres	WellZip Cod	DateDrille	TypeOfActi	LatitudeDD	LongitudeD	Driller	OriginalOw
0	86721	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23111	-76.69028	ETNOYER WELL DRILLING	SHULER GARY
1	478751	DAUPHIN	DERRY TWP.		1629 Nottingham Drive	17036	2009-06-17	OTHER	40.23383	-76.68906	MYERS BROS DRILLING CONTRACTORS INC	Lutz
2	489473	DAUPHIN	DERRY TWP.		1629 Nottingham Drive	17036	2009-06-17	OTHER	40.23383	-76.68906	MYERS BROS DRILLING CONTRACTORS INC	Lutz
3	480988	DAUPHIN	DERRY TWP.		1630 Nottingham Drive		2010-08-02	NEW WELL	40.23354	-76.68886	MYERS BROS DRILLING CONTRACTORS INC	Button
4	480989	DAUPHIN	DERRY TWP.		1630 Nottingham Drive		2010-08-02	NEW WELL	40.23354	-76.68886	MYERS BROS DRILLING CONTRACTORS INC	Button
5	481757	DAUPHIN	DERRY TWP.		1630 Nottingham Drive		2010-08-02	NEW WELL	40.23354	-76.68886	MYERS BROS DRILLING CONTRACTORS INC	Button
6	86731	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23222	-76.68778	MYERS BROS DRILLING CONTRACTORS INC	WHITTLE STEVE
7	649824	DAUPHIN	DERRY TWP.		Deerfield Dr Hummlestown	17036	2017-05-10	NEW WELL	40.23573	-76.68715	MYERS BROS DRILLING CONTRACTORS INC	Bellezza
8	86732	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.2325	-76.68694	MYERS BROS DRILLING CONTRACTORS INC	DEMMEL BILL
9	86734	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23194	-76.68667	MYERS BROS DRILLING CONTRACTORS INC	NYE HAROLD E
10	657129	DAUPHIN	DERRY TWP.	MIDDLETOWN	1625 Landvater Rd. Hummelstown	17036	1994-12-02	NEW WELL	40.23305	-76.68589	MYERS BROS DRILLING CONTRACTORS INC	Kiessling
11	86733	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23222	-76.68583	MYERS BROS DRILLING CONTRACTORS INC	VICKROY RICHARD
12	17640	DAUPHIN	DERRY TWP.	MIDDLETOWN			1972-10-06		40.23444	-76.68556	HARRISBURG'S KOHL BROS INC	LINEBAUGH L L
13	17644	DAUPHIN	DERRY TWP.	MIDDLETOWN			1973-03-27		40.23778	-76.68528	ETNOYER WELL DRILLING	LIM HANG
14	501319	DAUPHIN	DERRY TWP.		1108 Waltonville Road	17036	2012-08-16	NEW WELL	40.23788	-76.68505	SENSENIG & WEAVER WELL DRILLING	Sheppard and Son Builders
15	501320	DAUPHIN	DERRY TWP.		1108 Waltonville Road	17036	2012-08-16	NEW WELL	40.23788	-76.68505	SENSENIG & WEAVER WELL DRILLING	Sheppard and Son Builders
16	501321	DAUPHIN	DERRY TWP.		1108 Waltonville Road	17036	2012-08-16	NEW WELL	40.23788	-76.68505	SENSENIG & WEAVER WELL DRILLING	Sheppard and Son Builders
17	501322	DAUPHIN	DERRY TWP.		1108 Waltonville Road	17036	2012-08-16	NEW WELL	40.23788	-76.68505	SENSENIG & WEAVER WELL DRILLING	Sheppard and Son Builders
18	423853	DAUPHIN	DERRY TWP.		1441 DEERFIELD DRIVE		2008-05-21	NEW WELL	40.23667	-76.68389	MYERS BROS DRILLING CONTRACTORS INC	MCCURDY
19	86668	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23861	-76.68278	HARRISBURG'S KOHL BROS INC	PROJECT BLDRS
20	86669	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23861	-76.68278	HARRISBURG'S KOHL BROS INC	PROJECT BLDRS
21	490370	DAUPHIN	DERRY TWP.		1301 Waltonville Road Hummelstown PA		2010-02-19	OTHER	40.23457	-76.68163	MYERS BROS DRILLING CONTRACTORS INC	Custer Homes
22	490371	DAUPHIN	DERRY TWP.		1301 Waltonville Road Hummelstown PA		2010-02-19	OTHER	40.23457	-76.68163	MYERS BROS DRILLING CONTRACTORS INC	Custer Homes
23	490275	DAUPHIN	DERRY TWP.		1301 Waltonville Road Hummelstown PA		2010-02-19	OTHER	40.23457	-76.68163	MYERS BROS DRILLING CONTRACTORS INC	Custer Homes
24	490276	DAUPHIN	DERRY TWP.		1301 Waltonville Road Hummelstown PA		2010-02-18	OTHER	40.23457	-76.68163	MYERS BROS DRILLING CONTRACTORS INC	Custer Homes
25	490274	DAUPHIN	DERRY TWP.		1301 Waltonville Road Hummelstown PA		2010-02-18	OTHER	40.23457	-76.68163	MYERS BROS DRILLING CONTRACTORS INC	Custer Homes
26	490272	DAUPHIN	DERRY TWP.		1301 Waltonville Road Hummelstown PA		2010-02-17	OTHER	40.23457	-76.68163	MYERS BROS DRILLING CONTRACTORS INC	Custer Homes
27	490273	DAUPHIN	DERRY TWP.		1301 Waltonville Road Hummelstown PA		2010-02-17	OTHER	40.23457	-76.68163	MYERS BROS DRILLING CONTRACTORS INC	Custer Homes
28	492932	DAUPHIN	DERRY TWP.		1301 Waltonville Road		2010-02-05	NEW WELL	40.23457	-76.68163	MYERS BROS DRILLING CONTRACTORS INC	Custer Homes
29	480934	DAUPHIN	DERRY TWP.		1301 Waltonville Road		2010-07-21	NEW WELL	40.23489	-76.68125	MYERS BROS DRILLING CONTRACTORS INC	Custer Homes
30	86592	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23944	-76.67972	JOHN THRAN	BERTOLDI A
31	86744	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23944	-76.67861	MYERS BROS DRILLING CONTRACTORS INC	SMITH GERRY
32	86741	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23944	-76.67806	MYERS BROS DRILLING CONTRACTORS INC	PEFFLEY S
33	86494	DAUPHIN	DERRY TWP.	MIDDLETOWN			1980-12-12	NEW WELL	40.24	-76.67778	MYERS BROS DRILLING CONTRACTORS INC	RIDGELAND CORP
34	86499	DAUPHIN	DERRY TWP.	MIDDLETOWN			1983-09-29	NEW WELL	40.23972	-76.67778	MYERS BROS DRILLING CONTRACTORS INC	RIDGELAND CORP
35	86497	DAUPHIN	DERRY TWP.	MIDDLETOWN			1979-08-16	NEW WELL	40.24	-76.67722	MYERS BROS DRILLING CONTRACTORS INC	GROVE D
36	86460	DAUPHIN	DERRY TWP.	MIDDLETOWN			1981-11-01	NEW WELL	40.24	-76.67611	EICHELBERGERS INC.	LORD P
37	86690	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.67611	EICHELBERGERS INC.	EBERSOLE RALPH
38	642207	DAUPHIN	DERRY TWP.	MIDDLETOWN	1425 Shopes Church Road	17036	2016-05-31	NEW WELL	40.23115	-76.67577	EICHELBERGERS INC.	Homesale Settlement Services
39	258988	DAUPHIN	DERRY TWP.	MIDDLETOWN	Rousch Road		1995-03-27	NEW WELL	40.23972	-76.67566		Hogg
40	86695	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23556	-76.67472	HARRISBURG'S KOHL BROS INC	BONAWITZ GLADYS
41	86748	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23972	-76.67472	MYERS BROS DRILLING CONTRACTORS INC	WINFRED HOMES
42	501396	DAUPHIN	DERRY TWP.		1250 Shopes Church Road	17036	2012-08-23	NEW WELL	40.23806	-76.67445	SENSENIG & WEAVER WELL DRILLING	Zimmerman
43	501429	DAUPHIN	DERRY TWP.		1250 Shopes Church Road	17036	2012-08-22	NEW WELL	40.23806	-76.67445	SENSENIG & WEAVER WELL DRILLING	Zimmerman
44	501430	DAUPHIN	DERRY TWP.		1250 Shopes Church Road	17036	2012-08-22	NEW WELL	40.23806	-76.67445	SENSENIG & WEAVER WELL DRILLING	Zimmerman
45	501486	DAUPHIN	DERRY TWP.		1250 Shopes Church Road	17036	2012-08-22	NEW WELL	40.23806	-76.67445	SENSENIG & WEAVER WELL DRILLING	Zimmerman
46	501487	DAUPHIN	DERRY TWP.		1250 Shopes Church Road	17036	2012-08-22	NEW WELL	40.23806	-76.67445	SENSENIG & WEAVER WELL DRILLING	Zimmerman
47	501488	DAUPHIN	DERRY TWP.		1250 Shopes Church Road	17036	2012-08-22	NEW WELL	40.23806	-76.67445	SENSENIG & WEAVER WELL DRILLING	Zimmerman
48	86742	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24028	-76.67417	MYERS BROS DRILLING CONTRACTORS INC	MATTHEWS JIM
49	86452	DAUPHIN	DERRY TWP.	MIDDLETOWN			1980-10-01	NEW WELL	40.23194	-76.67389	EICHELBERGERS INC.	SHISSLER J
50	666174	DAUPHIN	DERRY TWP.		1335 SHOPE'S CHURCH ROAD		2005-06-02	NEW WELL	40.2355	-76.67383	MYERS BROS DRILLING CONTRACTORS INC	MCLAIN & SON CONTR
51	86743	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24056	-76.67333	MYERS BROS DRILLING CONTRACTORS INC	DICKERSON LEE
52	86740	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24083	-76.67278	JOHN THRAN	MOWRER D
53	86739	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24139	-76.67222	MYERS BROS DRILLING CONTRACTORS INC	TOMKO P
54	416933	DAUPHIN	DERRY TWP.		2149 SANDHILL ROAD		2006-06-01	NEW WELL	40.23444	-76.66917	MYERS BROS DRILLING CONTRACTORS INC	CULLARI
55	416959	DAUPHIN	DERRY TWP.		2149 SANDHILL ROAD		2006-05-31	NEW WELL	40.23444	-76.66917	MYERS BROS DRILLING CONTRACTORS INC	CULLARI
56	416938	DAUPHIN	DERRY TWP.		2149 SANDHILL ROAD		2006-05-31	NEW WELL	40.23444	-76.66806	MYERS BROS DRILLING CONTRACTORS INC	CULLARI
57	416949	DAUPHIN	DERRY TWP.		2149 SANDHILL ROAD		2006-05-26	NEW WELL	40.23444	-76.66806	MYERS BROS DRILLING CONTRACTORS INC	CULLARI
58	416960	DAUPHIN	DERRY TWP.		2149 SANDHILL ROAD		2006-05-30	NEW WELL	40.23444	-76.66444	MYERS BROS DRILLING CONTRACTORS INC	CULLARI
59	86753	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.66167	ETNOYER WELL DRILLING	SHANK JERRY
60	86752	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23861	-76.66111	MYERS BROS DRILLING CONTRACTORS INC	LUTRELL INC R W
61	86754	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23861	-76.66	MYERS BROS DRILLING CONTRACTORS INC	LUTRELL INC R W

ATTACHMENT 3
WELLS WITHIN 0.5 MILES OF PROPOSED 16" HDD TRACE - SUNOCO WALTONVILLE ROAD
FROM PAGWIS DATABASE 2-12-19

FID	PAWellID	WellUse	WaterUse	Well Depth	TopOf Casin	Bottom OfCa	Casing Diam	Depth ToBed	Bedrock Not	Well Yield	Static Wate	Water Level	Length OfTe	YieldMeasu	FormationN	Remark
0	86721	WITHDRAWAL	DOMESTIC	107	0	43	6	34	False	15	55			UNKNOWN	GETTYSBURG FORMATION	
1	478751	GEOTHERMAL	UNUSED	450	0	40	6	15	False	30				VOLUMETRIC WATCH & BUCKET		
2	489473	GEOTHERMAL	UNUSED	450	0	40	6	15	False	30				VOLUMETRIC WATCH & BUCKET		
3	480988	GEOTHERMAL	UNUSED	300	0	0	0	18	False	5				VOLUMETRIC WATCH & BUCKET		
4	480989	GEOTHERMAL	UNUSED	300	0	0	0	18	False	15				VOLUMETRIC WATCH & BUCKET		
5	481757	GEOTHERMAL	UNUSED	300	0	0	0	20	False	3				VOLUMETRIC WATCH & BUCKET		
6	86731	WITHDRAWAL	DOMESTIC	200	0	76	6	68	False	12					GETTYSBURG FORMATION	
7	649824	WITHDRAWAL	DOMESTIC	400	0	105	6	10	False	4				VOLUMETRIC WATCH & BUCKET		
8	86732	WITHDRAWAL	DOMESTIC	275	0	72	6	62	False	5					GETTYSBURG FORMATION	
9	86734	WITHDRAWAL	DOMESTIC	100	0	61	6	46	False	30					GETTYSBURG FORMATION	
10	657129	WITHDRAWAL	DOMESTIC	500	0	0	0	57	False	1			90			
11	86733	WITHDRAWAL	DOMESTIC	250	0	77	6	65	False	20					GETTYSBURG FORMATION	
12	17640	WITHDRAWAL	DOMESTIC	160	0	50	6	0	False	20	50	160	1		GETTYSBURG FORMATION	
13	17644	WITHDRAWAL	DOMESTIC	74	0	36	6	0	False	14	35	74	1		GETTYSBURG FORMATION	
14	501319	CLOSED-LOOP GEOTHERMAL	GEOTHERMAL	300	0	40	6	39	False	0						
15	501320	CLOSED-LOOP GEOTHERMAL	GEOTHERMAL	300	0	40	6	39	False	0						
16	501321	CLOSED-LOOP GEOTHERMAL	GEOTHERMAL	300	0	40	6	39	False	0						
17	501322	CLOSED-LOOP GEOTHERMAL	GEOTHERMAL	300	0	40	6	39	False	0						
18	423853	WITHDRAWAL	DOMESTIC	500	0	84	9	30	False	10				VOLUMETRIC WATCH & BUCKET		
19	86668	WITHDRAWAL	DOMESTIC	120	0	47	6	40	False	15	50		1	UNKNOWN	GETTYSBURG FORMATION	
20	86669	WITHDRAWAL	DOMESTIC	100	0	62	6	55	False	15	45		1	UNKNOWN	GETTYSBURG FORMATION	
21	490370	GEOTHERMAL	UNUSED	225	0	20	6	18	False	40				VOLUMETRIC WATCH & BUCKET		
22	490371	GEOTHERMAL	UNUSED	225	0	20	6	18	False	40				VOLUMETRIC WATCH & BUCKET		
23	490275	GEOTHERMAL	UNUSED	225	0	20	6	18	False	40				VOLUMETRIC WATCH & BUCKET		
24	490276	GEOTHERMAL	UNUSED	225	0	20	6	18	False	40				VOLUMETRIC WATCH & BUCKET		
25	490274	GEOTHERMAL	UNUSED	225	0	20	6	18	False	10				VOLUMETRIC WATCH & BUCKET		
26	490272	GEOTHERMAL	UNUSED	225	0	20	6	18	False	10				VOLUMETRIC WATCH & BUCKET		
27	490273	GEOTHERMAL	UNUSED	225	0	20	6	18	False	40				VOLUMETRIC WATCH & BUCKET		
28	492932	WITHDRAWAL	DOMESTIC	300	0	84	6	10	False	15				VOLUMETRIC WATCH & BUCKET		
29	480934	WITHDRAWAL	IRRIGATION	250	0	60	6	45	False	80				VOLUMETRIC WATCH & BUCKET		
30	86592	WITHDRAWAL	DOMESTIC	200	0	45	6	50	False	5				UNKNOWN	GETTYSBURG FORMATION	
31	86744	WITHDRAWAL	DOMESTIC	125	0	61	6	43	False	20					GETTYSBURG FORMATION	
32	86741	WITHDRAWAL	DOMESTIC	175	0	68	6	58	False	12				UNKNOWN	GETTYSBURG FORMATION	
33	86494	WITHDRAWAL	DOMESTIC	100	0	74	6	7	False	60				VOLUMETRIC WATCH & BUCKET	GETTYSBURG FORMATION	
34	86499	WITHDRAWAL	DOMESTIC	150	0	94	6	79	False	45				VOLUMETRIC WATCH & BUCKET	GETTYSBURG FORMATION	
35	86497	WITHDRAWAL	DOMESTIC	150	0	82	6	64	False	60				VOLUMETRIC WATCH & BUCKET	GETTYSBURG FORMATION	
36	86460	WITHDRAWAL	DOMESTIC	175	0	2	6	0	False	8	65	165	0.5	VOLUMETRIC WATCH & BUCKET	HEIDLERSBURG MEM OF GETTY	REDRILL
37	86690	WITHDRAWAL	DOMESTIC	143	0	90	6	85	False	10				UNKNOWN	GETTYSBURG FORMATION	
38	642207	WITHDRAWAL	DOMESTIC	150	0	78	6	62	False	50	20		30	VOLUMETRIC WATCH & BUCKET		
39	258988		OTHER	120	0	62	6	34	False	12	25	100		VOLUMETRIC WATCH & BUCKET		
40	86695	WITHDRAWAL	DOMESTIC	58	0	25	6	25	False	40	2		1	UNKNOWN	GETTYSBURG FORMATION	
41	86748	WITHDRAWAL	DOMESTIC	225	0	61	6	47	False	7					GETTYSBURG FORMATION	
42	501396	WITHDRAWAL	DOMESTIC	180	0	42	6	36	False	60				VOLUMETRIC WATCH & BUCKET		
43	501429	CLOSED-LOOP GEOTHERMAL	GEOTHERMAL	300	0	16	6	14	False	0						
44	501430	CLOSED-LOOP GEOTHERMAL	GEOTHERMAL	300	0	16	6	14	False	0						
45	501486	CLOSED-LOOP GEOTHERMAL	GEOTHERMAL	300	0	21	6	14	False	0						
46	501487	CLOSED-LOOP GEOTHERMAL	GEOTHERMAL	225	0	16	6	14	False	0						
47	501488	CLOSED-LOOP GEOTHERMAL	GEOTHERMAL	225	0	16	6	14	False	0						
48	86742	WITHDRAWAL	DOMESTIC	150	0	82	6	71	False	25					GETTYSBURG FORMATION	
49	86452	WITHDRAWAL	DOMESTIC	450	0	26	6	21	False	1				VOLUMETRIC WATCH & BUCKET	DIABASE DIKES AND SILLS	ROCK TYPE= HORNFELS
50	666174	WITHDRAWAL	DOMESTIC	100	0	20	6	14	False	80				VOLUMETRIC WATCH & BUCKET		
51	86743	WITHDRAWAL	DOMESTIC	125	0	61	6	47	False	30					GETTYSBURG FORMATION	
52	86740	WITHDRAWAL	DOMESTIC	175	0	60	6	0	False	10				UNKNOWN	GETTYSBURG FORMATION	
53	86739	WITHDRAWAL	DOMESTIC	250	0	82	6	70	False	10				UNKNOWN	GETTYSBURG FORMATION	
54	416933		GEOTHERMAL	275	0	41	6	24	False	10				VOLUMETRIC WATCH & BUCKET		
55	416959		GEOTHERMAL	275	0	41	6	19	False	40				VOLUMETRIC WATCH & BUCKET		
56	416938		GEOTHERMAL	275	0	41	6	25	False	10				VOLUMETRIC WATCH & BUCKET		
57	416949		GEOTHERMAL	275	0	41	6	55	False	40				VOLUMETRIC WATCH & BUCKET		
58	416960		DOMESTIC	300	0	80	6	19	False	10				VOLUMETRIC WATCH & BUCKET		
59	86753	WITHDRAWAL	DOMESTIC	55	0	44	6	0	False	28	23		1	UNKNOWN	GETTYSBURG FORMATION	
60	86752	WITHDRAWAL	DOMESTIC	175	0	61	6	50	False	15					GETTYSBURG FORMATION	
61	86754	WITHDRAWAL	DOMESTIC	150	0	61	6	51	False	30					GETTYSBURG FORMATION	



GES Well ID	Distance to HDD Perpendicular (Feet)	Distance to HDD Entry/Exit (Feet)	Well Information		
			Reported DTB (Feet)	Reported DTW (Feet)	Reported Pump Depth
WL-03022017-551-01	287	2,067	225-250	Unknown	Unknown
WL-03052018-639-01	368	1,886	Unknown	Unknown	Unknown
WL-06162017-475-01	136	1,892	65	1.5	Unknown
WL-08292017-606-01	180	944	Unknown	Unknown	Unknown
WL-08292017-606-02	263	1,011	Unknown	Unknown	Unknown
WL-08292017-606-03	519	670	Unknown	Unknown	NA
WL-08292017-606-04	867	867	225	Unknown	175
WL-08092017-606-05	1,026	1,026	Unknown	Unknown	Unknown
WL-10022017-634-01	441	1,980	Unknown	Unknown	Unknown
WL-12152017-613-01	1,736	2,515	Unknown	Unknown	Unknown
WL-02222018-630-01	634	1,624	Unknown	Unknown	Unknown
SP-12152017-613-02	1,685	2,445	NA	NA	NA

Legend

- LOD
- Parcel
- PPP Centerline
- PPP 1 HDD
- Proposed PPP 2 HDD Redesign
- Public Water Supply/Landowner Confirmed No Well
- Testing Refused

****Testing locations current as of 02/07/2019**

- GES Testing Location
- GES Spring Testing Location

Location

N

0 300 600

Feet

Well Location Map
HDD# PA-DA-0056.0000-RD
York County, PA.

Prepared By:

Date: 2/7/2019

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

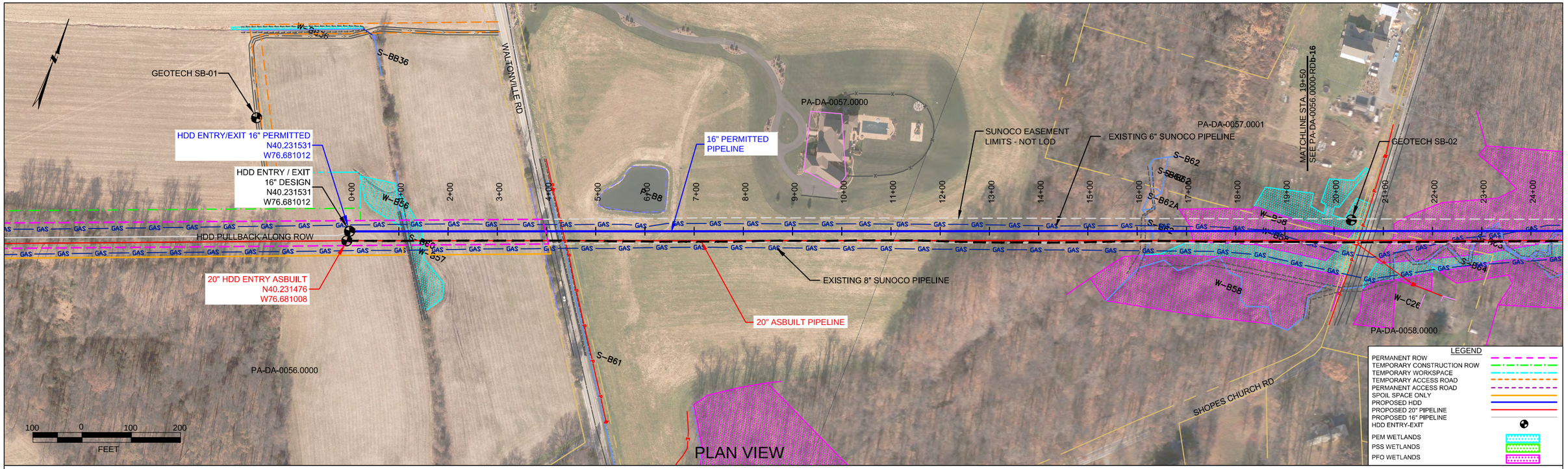
Coordinate System: NAD 83 Stateplane, PA South, Feet

P:\GIS\projects\112\03938-PPP\MXD\WellLocations\WellLocation_PA_DA_0056_0000.mxd JL

HORIZONTAL DIRECTIONAL DRILL ANALYSIS
WALTONVLLE ROAD CROSSING
PADEP SECTION 105 PERMIT NO.: E22-617
PA-DA-0056.0000-RD
(SPLP HDD No. S3-0080-16)

ATTACHMENT 2

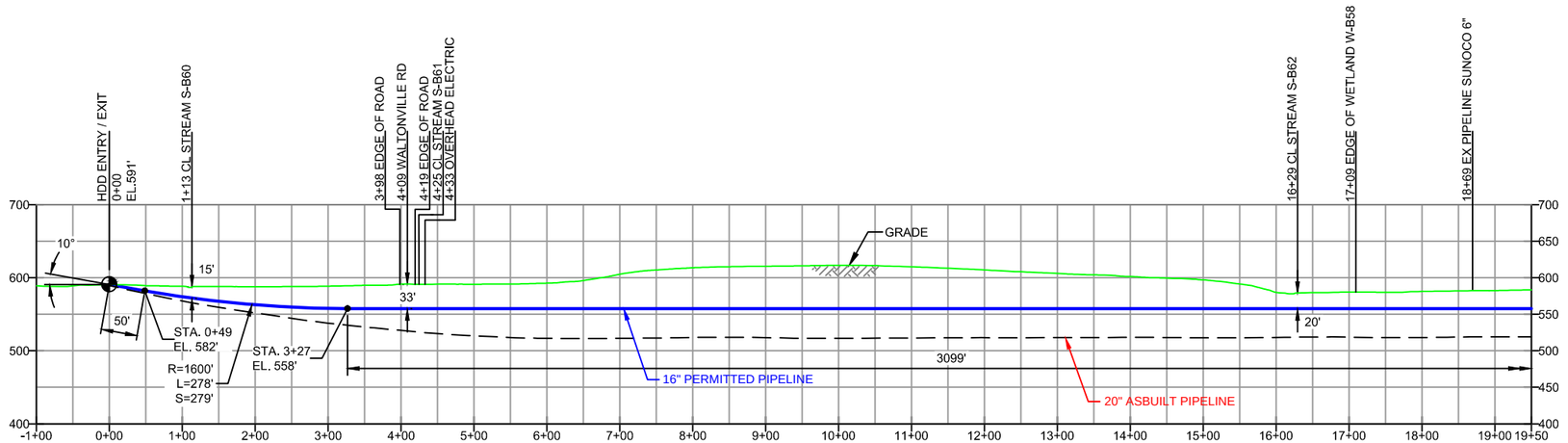
HORIZONTAL DIRECTIONAL DRILL PLAN AND PROFILES



PLAN VIEW

DAUPHIN COUNTY, PENNSYLVANIA - DERRY TOWNSHIP
S3-0080A-16

PROFILE VIEW



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=): 3870'
   HDD PIPE LENGTH (S=): 3875'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
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 APPPROVAL 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.

Figure 1A. Permitted 16-Inch HDD Plan and Profile with 20-Inch IR Data

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	MRS	04/03/17	RMB	04/03/17	AMC	04/03/17
3	REVISED PROFILE WITH 2017 LIDAR	MRS	02/27/17	RMB	02/27/17	AMC	02/27/17
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.

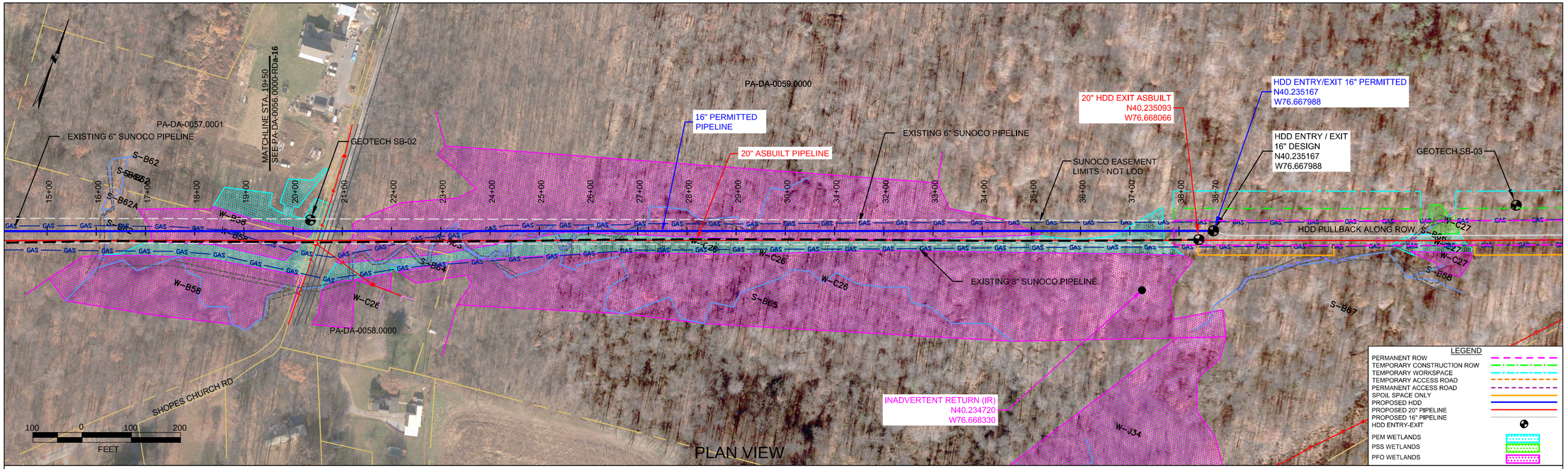
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WALTONVILLE ROAD
PENNSYLVANIA PIPELINE PROJECT

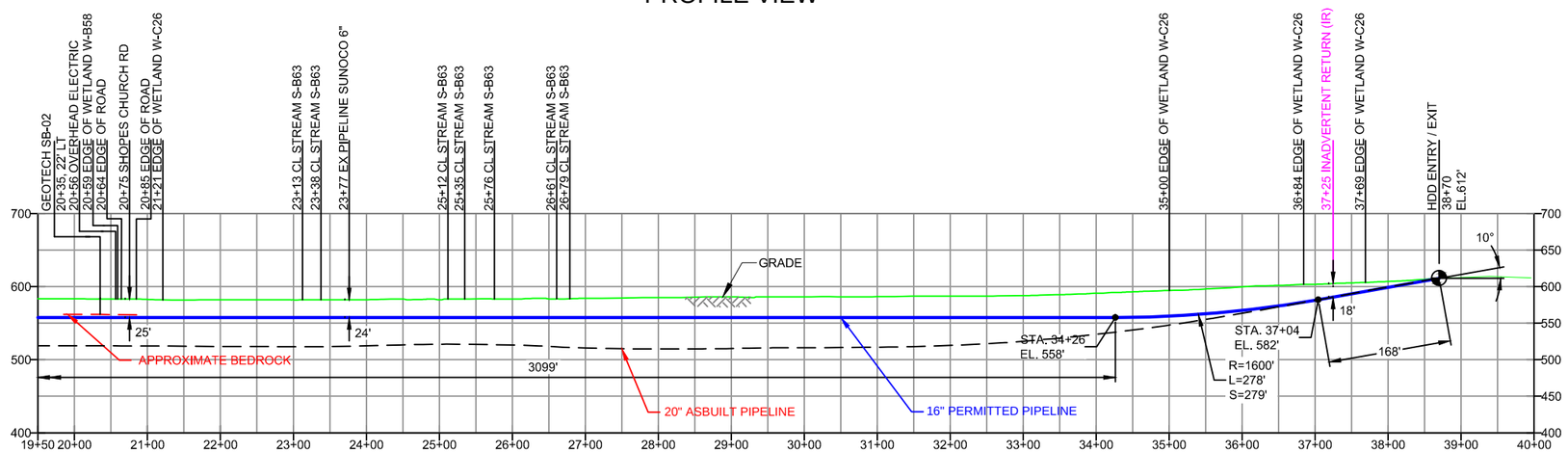
SCALE: 1"=200'

DWG. NO: PA-DA-0056.0000-RDa-16

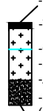


DAUPHIN COUNTY, PENNSYLVANIA - DERRY TOWNSHIP
S3-0080B-16

PROFILE VIEW



GEOTECH SB-02



-NG EL. 584'
-TOPSOIL (<1")
-GROUNDWATER (6.0')
-SM (1.0' - 15.0')
-AUGER REFUSAL (15.0')
-SANDSTONE (15.0' - 20.0')
-COMPLETION DEPTH EL. 564'

GEOTECH SB-03

-NG EL. 661'
-TOPSOIL (0.0' - 0.6')
-ML (0.6' - 21.5')
-GROUNDWATER (16.0')
-SILT (USCS:MH) (21.5' - 26.5')
-SM / GM (26.5' - 30.0')
-COMPLETION DEPTH EL. 631'

NOTE: REFER TO TEST BORING LOG S3-0080 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=): 3870'
   HDD PIPE LENGTH (S=): 3875'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
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 APPPROVAL 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.

Figure 1B. Permitted 16-Inch HDD Plan and Profile with 20-Inch IR Data

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	MRS	04/03/17	RMB	04/03/17	AMC	04/03/17
3	REVISED PROFILE WITH 2017 LIDAR	MRS	02/27/17	RMB	02/27/17	AMC	02/27/17
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.

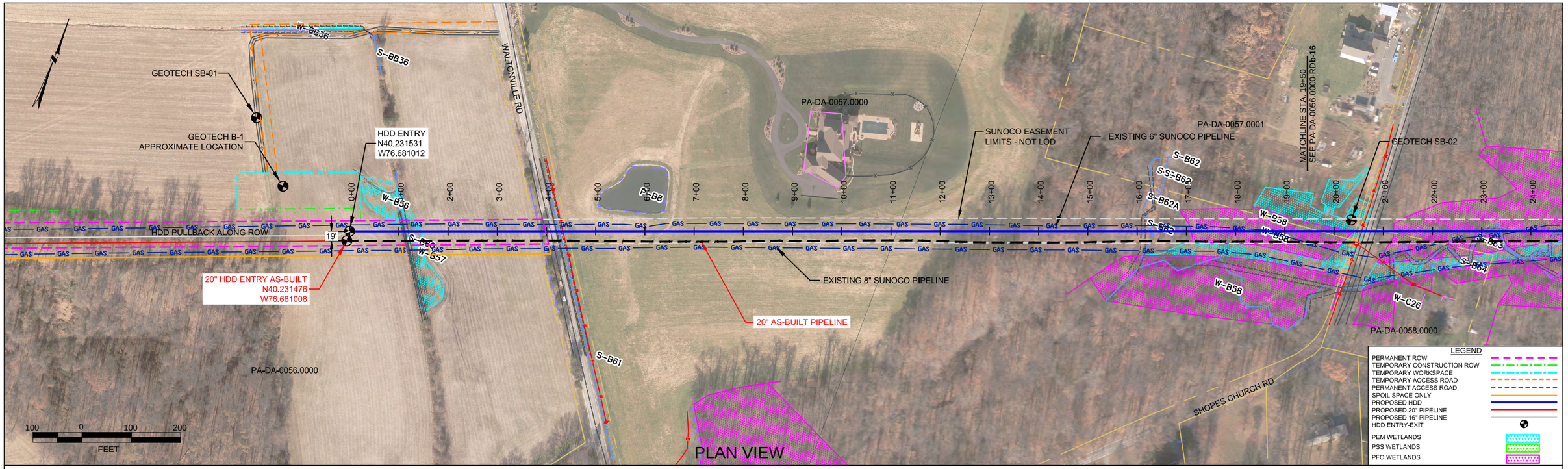
HORIZONTAL DIRECTIONAL DRILL
WALTONVILLE ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

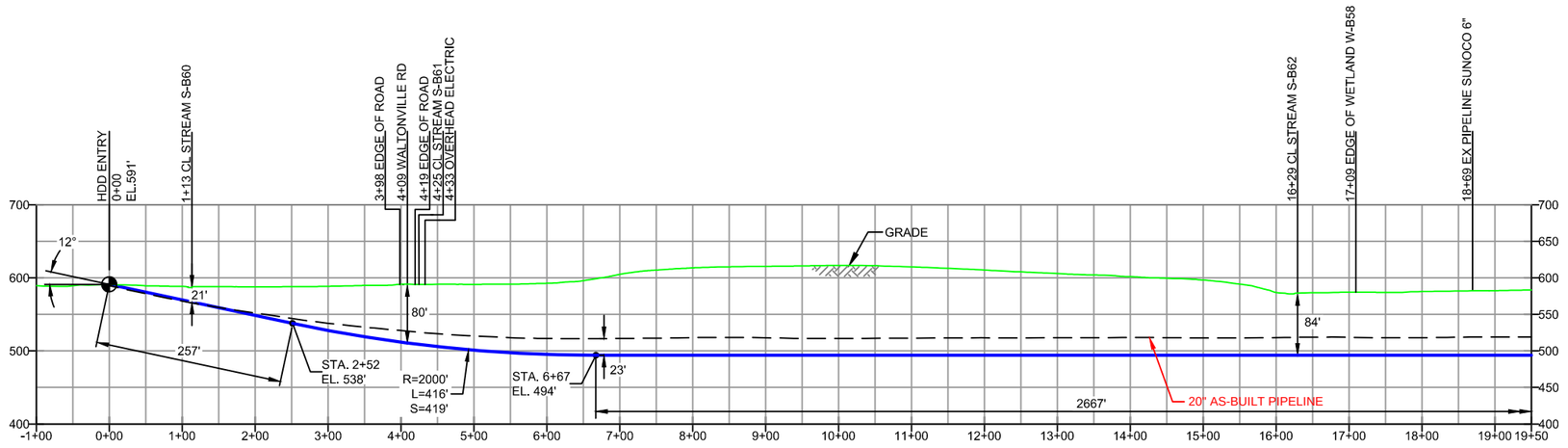
DWG. NO: PA-DA-0056.0000-RDb-16

DAUPHIN COUNTY, PENNSYLVANIA - DERRY TOWNSHIP
S3-0080-16

PLAN VIEW



PROFILE VIEW



GEOTECH SB-01

-NG EL. 599'
-TOPSOIL (0' - 1.0')
-GROUNDWATER (6.0')
-SM (1.0' - 30.0')
-COMPLETION DEPTH EL. 569'

NOTE: REFER TO TEST BORING LOG S3-0080 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-1

-NG EL. 599'
-TOPSOIL (0' - 1.0')
-FILL CL (1.0' - 8.5')
-GROUNDWATER (11.8')
-RESIDUUM-SILTY SAND SM (8.5' - 18.5')
-RESIDUUM-SILTY SAND ML (18.5' - 24.5')
-SANDSTONE/DIABASE (24.5' - 143.0')
-BORING TERMINATED EL.456'

NOTE: REFER TO TEST BORING LOG B-1 INTERTEK PROJECT #04911517 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=): 4095'
   HDD PIPE LENGTH (S=): 4120'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
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 2625 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.

Figure 2A. Revised 16-Inch HDD Plan and Profile

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

ES-4.23	TO	ES-4.25	EROSION & SEDIMENT PLAN	
SHEET 14	TO	SHEET 15	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	DESIGN CHANGE - INCREASED DRILL EXIT ANGLE	MRS	02/13/19	RMB	02/13/19	AMC	02/13/19
EP3	DESIGN CHANGE - EXTENDED DRILL AND UPDATED GEOTECH INFORMATION	MRS	12/07/18	RMB	12/07/18	AMC	12/07/18
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	05/09/16	RMB	05/09/16	AAW	05/09/16
EP		JTW	03/15/16	RMB	03/15/16	AAW	03/15/16
B	ADDED GEOTECH INFO	MRS	09/22/15	RMB	09/22/15	AAW	09/22/15

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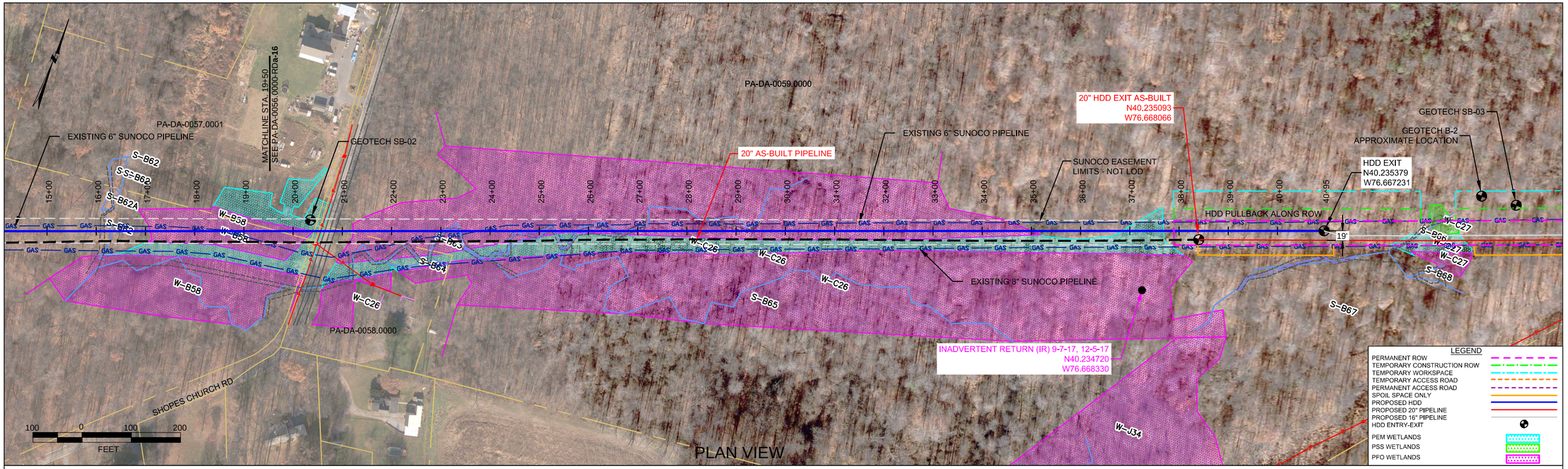
SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WALTONVILLE ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

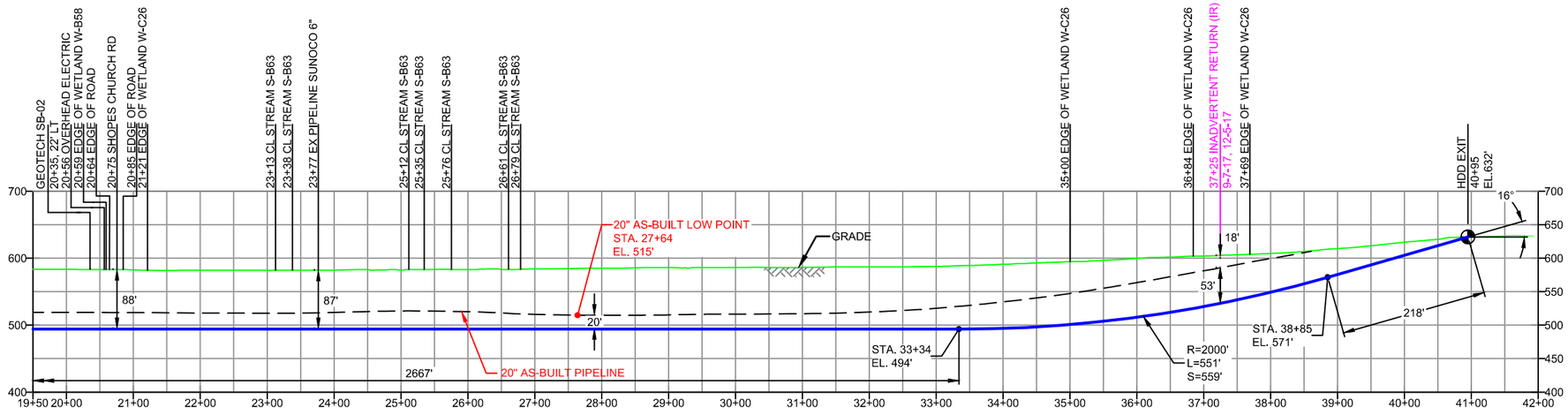
DWG. NO: PA-DA-0056.0000-RDa-16



PLAN VIEW

DAUPHIN COUNTY, PENNSYLVANIA - DERRY TOWNSHIP
S3-0080-16

PROFILE VIEW



GEOTECH SB-02

- -NG EL. 584'
- -TOPSOIL (<1")
- -GROUNDWATER (6.0')
- -SM (1.0' - 15.0')
- -AUGER REFUSAL (15.0')
- -SANDSTONE (15.0' - 20.0')
- -COMPLETION DEPTH EL. 564'

GEOTECH SB-03

- -NG EL. 661'
- -TOPSOIL (0.0' - 0.6')
- -ML (0.6' - 21.5')
- -GROUNDWATER (16.0')
- -SILT (USCS:MH) (21.5' - 26.5')
- -SM / GM (26.5' - 30.0')
- -COMPLETION DEPTH EL. 631'

NOTE: REFER TO TEST BORING LOG S3-0080 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-2

- -NG EL. 655'
- -TOPSOIL (0' - 1.0')
- -FILL ML (1.0' - 8.5')
- -RESIDUUM-SILTY SAND SM (8.5' - 13.5')
- -GROUNDWATER (17.6')
- -RESIDUUM-SANDY SILT ML (13.5' - 18.5')
- -RESIDUUM-SILTY SAND SM (18.5' - 34.0')
- -SANDSTONE/DIABASE (34.0' - 143.0')
- -BORING TERMINATED EL.512'

NOTE: REFER TO TEST BORING LOG B-2 INTERTEK PROJECT #04911517 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

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4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 4095'
   HDD PIPE LENGTH (S=): 4120'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
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 2625 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.
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Figure 2B. Revised 16-Inch HDD Plan and Profile

NOTES

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5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES-4.23	TO	ES-4.25	EROSION & SEDIMENT PLAN
SHEET 14	TO	SHEET 15	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	DESIGN CHANGE - INCREASED DRILL EXIT ANGLE	MRS	02/13/19	RMB	02/13/19	AMC	02/13/19
EP3	DESIGN CHANGE - EXTENDED DRILL AND UPDATED GEOTECH INFORMATION	MRS	12/07/18	RMB	12/07/18	AMC	12/07/18
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	03/15/16	RMB	03/15/16	AAW	03/15/16
B	ISSUED FOR BID	MRS	09/22/15	RMB	09/22/15	AAW	09/22/15

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PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

DWG. NO: PA-DA-0056.0000-RDb-16