HORIZONTAL DIRECTIONAL DRILL ANALYSIS
WOODBINE DRIVE CROSSING
PADEP SECTION 105 PERMIT NO.: E22-617
PA-DA-0063.0000-RD-16
(SPLP HDD No. S3-0081-16)

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This reevaluation of the horizontal directional drill (HDD) installation of a 16-inch diameter pipeline that traverses Woodbine Drive and Primrose Drive in Conewago 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 reevaluation 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 installation of the 20-inch diameter pipeline using HDD was initiated before the temporary injunction issued by the PADEP Environmental Hearing Board on July 25, 2017. This first pipeline HDD had four (4) inadvertent returns (IRs), and therefore, the installation of the second pipeline (16-inch diameter) requires reevaluation. The IRs for the 20-inch pipeline were remediated and the HDD installation for the 20-inch diameter pipeline was completed.

The 16-inch pipeline HDD is referred to herein as HDD S3-0081-16.

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: 2,777 feet (ft)
- Entry/Exit angle: 8-10 degrees
- Maximum depth of cover: 127 ft
- Pipe design radius: 1,600 ft

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

The four IR events during the installation of the 20-inch diameter pipeline resulted from drilling fluid traveling along bed rock fractures and bedding planes from the HDD annulus and through soft overburden soils to the land surface. All four IRs occurred within 110 ft of the exit point. The 20-inch HDD exit profile is relatively shallow when compared with the land surface and extends entirely within both the shallow and unconsolidated materials, and weathered and unweathered bedrock.

GEOLOGIC AND HYDROGEOLOGIC ANALYSIS

HDD S3-0081-16 is located within the Gettysburg-Newark Lowland Section of the Piedmont Physiographic Province. The Gettysburg-Newark Lowland Section consists of rolling lowlands, shallow valleys, and isolated hills developed on red sedimentary rock. Soils are comprised of Jurassic to Triassic age reddish-brown to maroon silty mudstone and shale and soft, red-brown, medium- to fine-grained sandstone with minor amounts of yellowish-brown shale and sandstone and thin beds of impure limestone.

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According to Google Earth, the proposed HDD profile is exclusively underlain by the Triassic age Gettysburg Formation (Trg). The Gettysburg Formation is composed of reddish-brown to maroon, silty mudstone and shale containing thin red sandstone interbeds with several thin beds of impure limestone. The overlying soil mantle is generally thin. The ease of excavation (and drilling) is classified as moderately easy. 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 (Geyer and Wilshusen, 1982). The general structure of the Newark Group is a north-northwestward dipping homocline.

Karst geology is not present at this HDD location. SPLP possesses a full geologic profile from the drilling of the 20-inch pipeline and vertical geotechnical core data. No additional information is needed to evaluate the 16-inch HDD.

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

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 The Gettysburg Formation is the uppermost rock unit underlying the HDD S3-0081-16 bore path with the Gettysburg Conglomerate located approximately 100 feet east of the HDD exit point and diabase located approximately 630 feet southwest of the HDD entry point.

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.

Groundwater was encountered at the original geotech bores SB-01 at 20 feet, SB-02 at 24 feet and at SB-03 groundwater was not encountered. In the most recent geotech borings groundwater was discovered at B-1 at 43 feet and B-2 at 23 feet.

Well records from the 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, 2018). The search identified 97 wells within the 0.5-mile radius of the HDD. These wells consist of 89 domestic supply wells, 4 geothermal wells, 1 well identified as institutional, 1 well identified for stock, and 2 wells identified as other. Based solely on the PaGWIS database, the depth to bedrock ranges from 4 to 130 feet. Reported well yields range from 0 to 65 gallons per minute (gpm).

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

INADVERTENT RETURN (IR) DISCUSSION

Four (4) IRs occurred during installation of the 20-inch pipeline, varying between 10 and 40 gallons in volume. Three of the IRs occurred during drilling of the pilot hole, and one occurred during reaming of the bore hole. All four IRs occurred within 110 ft of the HDD exit point. As shown on Figure 1 in Attachment 2, the last 110 ft of the 20-inch as built profile was at approximately 13 ft or less below ground, and the first IR point approximates the bedrock/overburden interface. IRs at the bedrock/overburden interface are common and difficult to control. While the IR pilot tool, called a mud motor, is drilling through the last footage of rock in the profile, it is usually passing through weathered rock that has low integrity or strength to prevent the movement of drilling fluids, but the rock is still substantial enough to require cutting by the rock bit on the front of the tool. Once the pilot tool is out of rock, then the pilot hole exit can be completed by just pushing the tool the remaining way to exit point with little to no drilling fluid pressure or use. The only means to minimize the potential for IRs in this setting is to increase the depth of profile and increase the entry and exit angle which accelerates the penetration into and exit out of competent rock. These adjustments have been applied to the redesigned 16-inch HDD profile as shown on Figure 2 in Attachment 2.

ADJACENT FEATURES ANALYSIS

The crossing of Woodbine Drive is located in Conewago Township, Dauphin County, approximately 3.2 miles (mi) south of the community of Hershey, and 11.8 mi east/southeast of Harrisburg, Pennsylvania.

The pipeline route follows parallel to two existing SPLP pipelines and runs parallel to and on the south side of Laurel Drive between Woodbine Drive and Primrose Drive. At this HDD location, private residences and various underground utilities (e.g. electric lines, sewage lines, telephone line, water line, fiber optic line, and gas lines) are adjacent to the existing permanent utility easement, parallel to and crossing perpendicular to the easement.

According to the Conewago Township website, there is public water service available from the Pennsylvania American Water Company in part of the neighborhood near the S3-0081-16 HDD, including Laurel Drive, Woodbine Drive, Primrose Drive, and Azalea Drive. In addition, SPLP performed a preconstruction survey of landowners within 450 feet and greater from the HDD S3-0081-16 alignment. 51 wells are located within 450 feet of the HDD drill path. SPLP sent each of these landowners a notice letter via both certified and first-class mail that included an offer to sample the landowner's private water supply/well in accordance with the terms of the Order and the Water Supply Assessment, Preparedness, Prevention and Contingency Plan. The letter also requested that each landowner contact the Right-of-Way agent for the local area and provide SPLP with information regarding: (1) whether the landowner has a well; (2) where that well is located, and its depth and size if known; and (3) whether the landowner would like to have the well sampled. In accordance with paragraph 10 of the Order, copies of the certified mail receipts for the letters sent to landowners have been provided to Karyn Yordy, Executive Assistant, Office of Programs at the Department's Central Office. With landowner permission, all wells were tested pre, during and post construction during drilling of the 20-inch pipeline. With landowner permission, pre, during, and post construction sampling will be performed during drilling and installation of the 16-inch pipeline.

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 of any direction of the revised HDD alignment.

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 noted in the Alternatives Analysis, using the HDD method at this location avoids direct impacts to Woodbine Drive, Primrose Drive, existing underground utilities, and numerous abutting residential residences. Alteration of the current permitted route and plans for installation would require major modifications of the state Chapter 102 and Chapter 105 permits, easement authorizations, and associated National Environmental Policy Act (NEPA) Environmental Assessment and Finding of No Significant Impact (FONSI) issued by the USACE. As described below, the open cut and re-route analyses have confirmed the conclusions reached in the previously submitted Alternatives Analysis.

Open-cut Analysis

The pipeline route follows parallel to an existing SPLP pipeline easement. SPLP specifications require a minimum of 48 inches of cover over the installed pipelines below ground. To meet this cover requirement, construction would require a minimum authorized open cut work space of 75 feet in width to accommodate the 16-inch diameter pipeline, allowing for the pipeline to be installed with sufficient separation for integrity management. The workspace required for an open cut installation of the 16-inch pipeline would require landowner permission for Additional Temporary Workspace within the residential yards adjacent to both side of the exiting SPLP easement, or the use of condemnation to acquire the necessary workspace. The use of HDD mitigates the need for disturbing the residential yards during construction, or the use of imminent domain to acquire the required workspace.

Use of Conventional Auger Bore

Planning for a conventional bore must account for the extent or width of the feature (road, stream, residence, etc.) being bored past or under, as well as the length and width of the setup-entry pit for setting the boring equipment within while operating and the receiving pit through which the product pipeline is pulled back through after the boring machinery exits.

Based on the track record of installations during construction of this pipeline project in this area of the state, conventional auger bores should be limited to approximately 200 linear feet or less, varying by the underlying substrate at a proposed bore location. Conventional auger bores for the 20-inch pipeline, attempted at longer distances, have at times had alignment drift and elevation deflections occur which have complicated installation. Drift and deflection is safety concern when boring adjacent to in-service pipelines.

The use of conventional auger bore is feasible for most of the linear footage that was drilling under during installation of the 20-inch pipeline, and is feasible for sections, with limits as discussed above, for installation of the 16-inch pipeline. This plan of construction would be multiple bore sections, tied together with open cut conventional pipeline lay. As discussed in the Open Cut Analysis section above, the workspace required for a conventional bore and open cut installation of the 16-inch pipeline would require landowner permission for Additional Temporary Workspace within the residential yards adjacent to both side of the exiting SPLP easement, or the use of condemnation to acquire the necessary workspace. The use of HDD mitigates the need for disturbing the residential yards during construction, or the use of eminent domain to acquire the required workspace to implement this type of construction.

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Re-Route Analysis

The pipeline route as currently permitted follows an existing SPLP easement and this HDD bypasses or avoids direct impacts to two (2) roads and several underground utilities perpendicular to the easement as well as numerous residential structures and properties abutting the easement.

No practicable re-route option lies to the north or south of the proposed route that would not transect the same roads and/or additional roads transected by the proposed route or encroach upon residential structures. Shifting the pipeline route north or south would 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 existing resources.

In summary, due to the density of residential properties 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 existing resources and existing residences and associated infrastructure in the vicinity of HDD S3-0081-16.

This re-route analysis conducted for the Woodbine Drive HDD is consistent with the conclusions reached in the Alternatives Analysis previously submitted to PADEP.

HORIZONTAL DIRECTIONAL DRILL REDESIGN

Additional geologic investigations have been completed, and the “as built” record for the 20-inch pipeline has been utilized in the redesign of the planned 16-inch HDD. The redesign adjusts the HDD profile deeper to minimize the risk of drilling fluid loss, drilling difficulties, and IRs. A summary of the redesign factors is provided below. The original and redesigned 16-inch HDD plan and profile drawings are provided in Attachment 2.

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

Revised Horizontal Directional Drill Design Summary: 16-inch

- Horizontal length: 2,923 feet
- Entry/Exit angle: 16 degrees
- Maximum depth of cover: 151 feet
- Pipe design radius: 2,000 feet

CONCLUSION

As shown on Figure 2 in Attachment 2, the redesigned HDD profile for the 16-inch pipeline is deeper, with a maximum depth of cover increased by approximately 24 ft from the permitted design and the entry and exit angles increased to rapidly proceed into and exit out of the bedrock. These adjustments reduce the risk of IRs.

The redesign of the HDD will not prevent all IRs. IR’s are common on entry and exit of the drilling tool and other measures are required to minimize IR potential. In particular, upon the start of this HDD, SPLP will employ the following HDD best management practices:

- SPLP will provide the drilling crew and company inspectors 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, so that monitoring can be enhanced when drilling through these locations.

- SPLP will require and enforce the use of annular pressure (AP) monitoring during the drilling of the pilot holes, which assists in immediate identification of pressure changes indicative of loss of return flows or over pressurization of the annulus to manage development of pressures that can induce an IR;

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

- SPLP will 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) can be considered if indications of a potential IR are noted or an IR is observed. However, the use of LCMs is less effective below 70 ft of the ground surface. The AP below that depth can exceed the effective stabilization capability of LCMs. This HDD is below 70 ft of depth for the horizontal length of the profile. Accordingly, the corrective action needed to address the occurrence of Losses of Circulation or presence of fractures at greater depths below ground requires 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.

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FEASIBILITY DETERMINATION

Based on the information reviewed by the Geotechnical 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

2-24-2019

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

Date

Pertaining to the practice of geology

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Pertaining to the pipeline stress and HDD geometry

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February 26, 2019

Mr. Matthew Gordon
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Re: Sunoco PA Pipeline Project Mariner East II, Woodbine Drive HDD S3-0081, PA-DA-0063.0000-RD-16
Hydrogeologic Re-Evaluation Report for 16-Inch Pipeline
Conewago Township, Dauphin County, Pennsylvania
Rettew Project No. 096302011

EXECUTIVE SUMMARY

1. This hydrogeologic re-evaluation is being prepared as a result of inadvertent returns (IRs) that occurred during the 20-inch pilot and reaming phases at the Woodbine Drive horizontal directional drill (HDD) S3-0081.

2. The Woodbine Drive HDD bore path is underlain by sedimentary rocks of the Triassic age Gettysburg Formation (TRg). Jurassic age Diabase (Jd), which is a crystalline igneous intrusive rock, underlies an area approximately 0.12 mile to the southwest of the HDD entry point, at the nearest point. Also, Triassic age Gettysburg Quartz Conglomerate (Trgc) lies within approximately 100 feet east of the HDD exit point, but neither the Diabase nor the Quartz Conglomerate is mapped under the actual HDD drill profile.

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.

4. Water-bearing zones in the underlying geology 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).

5. The 20-inch HDD pipeline installation was completed on August 1, 2018. The HDD profile for the proposed 16-inch HDD has been redesigned to increase its depth below buried utilities serving a residential neighborhood.

6. Based on the hydro-structural characteristics of the underlying geology and the IRs that occurred during the installation of the 20 inch pilot drill, the proposed 16-inch Woodbine

Drive HDD is susceptible to the inadvertent return of drilling fluids during HDD operations.

1.0 INTRODUCTION

The purpose of this report is to describe the geologic and hydrogeologic setting of the Woodbine Drive (S3-0081) HDD location on the Sunoco Pipeline, L.P. (SPLP) Pennsylvania Pipeline Project-Mariner East II (PPP-ME2) Project. The Woodbine Drive HDD (the site) is located in Conewago Township, Dauphin County, Pennsylvania, approximately 3 miles south of Hershey and approximately 2 miles north of the Pennsylvania Turnpike (I-76). The original 16-inch HDD was designed to be drilled under portions of Woodbine Drive, Primrose Drive, and various underground utilities (refer to **Figure 1**). The redesigned 16-inch HDD profile will traverse under the same features. This re-evaluation report is being prepared as a result of the IRs that occurred during operations for installing the 20-inch pipeline.

Local relief at the site is low to moderate and ranges in the vicinity of the site from approximately 680 feet above mean sea level (AMSL) to 740 feet AMSL (GoogleEarth, 2017). The area surrounding the HDD profile consists of suburban residential properties. According to the drilling path profile provided by Prime Horizontal, Inc., the 20-inch HDD crosses under Woodbine Drive and adjacent buried utiliites at a depth of approximately 118.2 feet below ground surface (bgs) and under Primrose Drive and adjacent utiliites at 38.6 feet bgs. The proposed 16-inch HDD profile was redesigned on January 25, 2019, and the inclination of the eastern and western entry/exit angles has been increased to approximately 16°. These changes were made to increase the overall length of the boring, increase the amount of protective cover to install the pipe through the soils and bedrock in closer proximity to the entry and exit points, and deepen the profile to approximately 67 to 151 feet below the utilities and residential neighborhood (this is approximately 31 to 34 feet deeper than the 20-inch pipe). The redesigned west HDD entry/exit is at a surface elevation of approximately 676 feet AMSL and the redesigned east entry/exit is at an elevation of approximately 742 feet AMSL. The proposed 16-inch HDD profile, located approximately between Stations 11616+00 and 11644+45 on the pipeline, was extended to the west by 146 feet for a total bore length of 2,923 feet and a total pipe length of 2,952 feet. The existing 20-inch and proposed 16-inch S3-0081 HDD locations are shown on **Figure 1**, and the redesigned 16-inch profile is included in **Attachment 1**.

2.0 GEOLOGY AND SOILS

Thirteen available published and online references were reviewed to evaluate the hydrogeology and soils present in the vicinity of the site. Detailed descriptions of the soils and bedrock geology underlying S3-0081 are included below.

According to the United States Department of Agriculture Soil Survey of Dauphin County, Pennsylvania, soils within approximately 600 feet of the drill path for HDD S3-0081 consist of eight soils primarily composed of gravelly sandy loam and channery silt loam with lesser amounts of silt loam, gravelly silt loam, and very stony sandy loam. A site map showing the spatial distribution of the various soils along with the soil profile descriptions is included as **Attachment 1**.

The Pennsylvania Department of Conservation and Natural Resources (2000) reported that the S3-0081 HDD site is situated in the northern portion of 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 predominant rock type consists mainly of red shale, siltstone, and sandstone with some conglomerate and diabase. The predominant geologic structure within this physiographic section consists of a half-graben having low, monoclinal, northwest-dipping beds. The surface drainage pattern is both dendritic and trellis.

According to Google Earth, three geologic formations occur within a 0.5-mile radius of HDD S3-0081. These include the Triassic age Gettysburg Formation (Trg), Gettysburg Formation Conglomerate (Trgc), and the younger Jurassic age Diabase (Jd). These geologic units are identified on the geologic mapping included as **Figure 2**.

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

The Gettysburg Formation-Conglomerate is described as coarse, quartz conglomerate containing rounded pebbles and cobbles in a matrix of red sand (Geyer and Wilshusen, 1982). The general structure of the Newark Group is a north-northwestward dipping homocline. Typical dip directions are north or northwest and range from 20° to 40° (Wood, 1980) (**Figure 2**).

The diabase 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 (Pennsylvania Department of Conservation and Natural Resources [PA 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 classified as slow due to the density and hardness of the rock.

3.0 HYDROGEOLOGY

Bedrock geology ultimately influences the storage, transmission, and use of ground-water. Geologic factors such as rock type, intergranular porosity, rock strata inclination, faults, joints, bedding planes, and solution channels affect groundwater movement and availability. According to Wood (1980) and Low (2002), groundwater within the clastic rocks of the Gettysburg Formation within Dauphin County occurs under both unconfined (i.e., water table) and confined conditions. In general, groundwater generally occurs under unconfined conditions within the upper portion of the aquifer and under confined or semiconfined conditions in the deeper portions of the aquifer. The groundwater flow system was conceptualized by Wood (1980) as a series of sedimentary beds with relatively high transmissivity separated by beds exhibiting lower transmissivities. This sequence of beds exhibits different hydraulic properties that collectively act as a series of alternating aquifers and confining or semi-confining units forming a leaky multi-aquifer system (LMAS, Wood 1980). 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 McGlade and Geyer (1976), and Google Earth Pro, the Gettysburg Formation is the uppermost rock unit underlying the HDD S3-0081 bore path with the Gettysburg Conglomerate located approximately 100 feet east of the HDD exit point and diabase located approximately 630 feet southwest of the HDD entry point (**Figure 2**). Based on the initial Tetra Tech geotechnical report, groundwater was encountered at 20 feet bgs in SB-01, and 24 feet bgs in SB-02. Groundwater was not encountered in SB-03. In the recent geotechnical report prepared by Intertek Professional Service Industries Inc., at Boring B-1, located near the eastern HDD entry point overlying Gettysburg Formation sandstone bedrock, groundwater was encountered at 43 feet bgs in sandstone and the bedrock was cored from 39 feet to 100 feet bgs. At Boring B-2 drilled in the Gettysburg Formation near the western HDD exit point, groundwater was encountered in the overburden at 23 feet bgs, metamorphosed blue/gray siltstone was encountered at 38.6 feet bgs, and the bedrock was cored from 38.6 to 97 feet bgs. Both geotechnical reports are included as **Attachment 2**.

The direction of groundwater flow within the clastic rocks of the Gettysburg Formation in Dauphin County is largely controlled by the hydraulic gradient and spatial variability of hydraulic conductivity. The groundwater flow system in the clastic rocks is highly anisotropic with the predominant flow direction parallel to the strike of the rock beds. The potential for well interference related to pumping is generally greatest for wells aligned parallel to strike, rather than in wells drilled in the direction of bedding dip (i.e., perpendicular to strike). The presence of diabase often acts as a barrier to flow (Becher and Root, 1981; and Wood, 1980). No groundwater modeling was performed for the area surrounding HDD S3-0081.

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 five or fewer water-bearing zones per 50-foot interval. The overall density of water-bearing zones in the Gettysburg Formation is 0.41 per 50 feet of well depth.

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

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

Well records from the 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, 2018).

The search identified 97 wells within the 0.5-mile radius of the HDD. These wells consist of 89 domestic supply wells, 4 geothermal wells, 1 well identified as institutional, 1 well identified for stock, and 2 wells 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 (**Figure 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 400 feet bgs. Based solely on the PaGWIS database, the depth to bedrock ranges from 4 to 130 feet and well construction consists of 29 to 130 feet of steel casing with the open-rock portions of the wells extending from 29 feet to 400 feet bgs. Reported well yields range from 0 to 65 gallons per minute (gpm). Static water level measurements were recorded which range from 23 to 150 feet bgs. Based on the PaGWIS database, the majority of the wells identified above were completed in the Gettysburg Formation, with one well identified as being in the diabase.

In addition, water quality samples were collected by GES from 51 wells located within 450 feet of the HDD drill path. According to the Conewago Township website, there is public water service available from the Pennsylvania American Water Company in part of the neighborhood near the S3-0081 HDD, including Laurel Drive, Woodbine Drive, Primrose Drive, and Azalea Drive. However, connection to the public water supply is currently voluntary and not required. These wells were located within approximately 450 feet of the HDD trace as shown in **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).

One fracture trace in the vicinity of the S3-0081 HDD was identified. The approximate location of this fracture trace, copied from Plate 1, Sheet 2, in Wood (1980) and McGlade and Geyer (1976), is depicted on the Geology Map included as **Figure 2** and the Groundwater Well Location Map presented as **Figure 3**. The mapped fracture trace, which crosses the HDD bore path, trends northeast-southwest approximately 1,700 feet east of the HDD entry point (western end of HDD). The identified fracture trace is related to the primary geologic structure in the vicinity of the HDD site. The general surface drainage patterns near the HDD site are characterized by the linear stream reaches of several surface streams generally trending northeast-southwest which appear to reflect this local geologic structure.

5.0 GEOTECHNICAL EVALUATION

Two phases of geotechnical investigation have been completed at the site. Two geotechnical borings (SB-01 and SB-03) were completed on May 5, 2015, and a third boring (SB-02), was completed on October 9, 2015, during the preliminary investigation of HDD S3-0081 and prior to initiating HDD operations. Two additional borings (B-1 and B-2) were completed in July 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 point, SB-02 was located approximately 1,400 feet east of the entry point, 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**: Clayey silt from ground surface to 11.5 feet bgs; silty sands with fine gravel from 11.5 feet to 22.5 feet bgs; and gravel, sand, and silt from 22.5 feet to the total depth of the boring at 28.8 feet bgs. Groundwater was encountered at 20 feet bgs.

- **SB-02:** Clayey silt with fine sand from ground surface to 11.5 feet bgs; fine to medium sand with silt and gravel from 11.5 to 19.0 feet bgs; silty clay with fine sand from 19 feet to the total boring depth of 32 feet bgs. Groundwater was encountered at 24 feet bgs.

- **SB-03:** Silty clay and fine sand from ground surface to 16.5 feet bgs; silty clay with fine sand from 16.5 to 21.0 feet bgs; fine to medium sand with gravel and silty clay from 21.0 feet to the total depth of the boring at 30.0 feet bgs. Groundwater was not encountered.

The boring logs indicate that the soil/bedrock interface was not encountered except in SB-02 where auger refusal was encountered at 32 feet bgs which probably indicates the depth to bedrock.

Two additional borings (B-1 and B-2) were completed during July 2017 as part of the second phase of the geotechnical investigation. B-1 was drilled on July 14 through 16, 2017, and B-2 was drilled July 17 through 19, 2017. The generalized subsurface profile observed in B-1 and B-2 is described as follows.

- **B-1**: Clayey and silty sands with traces of gravel were encountered from the ground surface to 39 feet bgs; red sandstone bedrock was encountered from 39 feet to the total depth of the borehole at 100 feet bgs. Groundwater was encountered at 43 feet bgs.

- **B-2:** Silts, sands, and clay were encountered from the ground surface to 38.6 feet bgs; bedrock consisting of hard, metamorphosed, siltstone and sandstone was encountered between 38.6 feet bgs and the total borehole depth of 97 feet. Groundwater was encountered at approximately 23 feet bgs.

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

Please note that Skelly and Loy or RETTEW did not oversee or direct the geotechnical drilling programs associated with the S3-0081 HDD including but not limited to the selection of boring locations, determination of location, determination of surface elevation, target depths, observations of rock cores during drilling operations, or preparation of boring logs. The geotechnical reports, boring logs, and core photographs that resulted from these programs were generated by other Sunoco Pipeline, L.P. contractors. Skelly and Loy/RETTEW relied on these reports and incorporated their data into the general geologic and hydrogeologic framework of the analysis of the proposed 20-inch and 16-inch S3-0081 HDD's for this report.

6.0 FIELD OBSERVATIONS

Site reconnaissance activities performed by Skelly and Loy geologists from December 18 through 21, 2017, and on January 11, 2018, did not identify any bedrock exposures within the Woodbine Drive HDD drill path or in the nearby surrounding area; therefore, no structural geologic measurements were obtained for this HDD. 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 rock outcrops where bedding planes or consistent fracture sets were observed (partly due to leaf and snow cover). Other outcrop locations were not visited because their locations were likely on private property. Published structural geologic measurements of the Gettysburg Formation indicate that the bedrock strike is generally to the north-northeast (between 20° and 70°) with bedding dip ranging from 20° to 30° northwest.

According to available geologic mapping, the HDD bore path is underlain by bedrock mapped as Gettysburg Formation Sandstone. The rocks proximate to the diabase sill near the western most HDD entry/exit point comprise a baked zone that has been metamorphosed, crystallized, and hardened by the intrusive diabase. This mapping is consistent with Skelly and Loy's field observations and the results of the geotechnical investigations. In addition to the Iron Run tributaries and identified private water supplies, no additional potential environmental receptors of concern were identified within the defined 0.5-mile HDD buffer area.

On October 28, 2017, during drilling of the 20-inch pilot hole, approximately 45 gallons of drilling fluid reached the surface in an upland area along the existing SPLP easement. These fluids were contained and recovered by vacuum truck. Additional upland IRs were observed within the limit of disturbance (LOD) on November 2 and 3, 2017, and involved the release of approximately 20 gallons and 10 gallons, respectively. Drilling operations ceased until these IRs were contained and recovered. The November 2 and 3, 2017, IRs occurred within 170 feet of the HDD exit on the eastern side of Primrose Drive. On November 10, 2017, the pilot pass was completed. As of November 25, 2017, the drilling crew completed 473 feet of 24-inch reaming with no re-activation of the previously identified IRs.

On December 2, 2017, the previous drilling fluid release point adjacent to the exit location was re-activated with an estimated 40 gallons of drilling fluid released into the previously installed containment structure. On December 16, 2017, the contractor used compressed air to clear freeze blockages from the drilling stem and re-activated the previous IR location adjacent to the exit location, with an estimated 15 gallons of drilling fluid surfacing within the pre-existing containment structure. The drill was in the reaming phase but was shut down per the January 3, 2018, Administrative Order issued by the Pennsylvania Department of Environmental Protection (PA DEP). On March 16, 2018, approximately 40 gallons of drilling fluid surfaced in an upland area within the existing SPLP easement. The IR occurred during the initial start-up of the mud pump at 9:35 A.M. No drilling was occurring at the time of the IR. The pump was shut down at approximately 9:45 A.M., and the IR ceased following pump shut down. A restart report was submitted to the PA DEP on April 5, 2018, and restart approval was received from PA DEP on May 25, 2018. The HDD contractor restarted HDD operations on June 9, 2018, with the crew removing/replacing the 24-inch reamer. By the end of the day on June 10, 2018, the crew installed 21 pipe joints downhole with no IRs or LOCs reported. The existing IR containments were rebuilt along the HDD bore path using plastic sheeting to create an impermeable barrier. Pipe pullback for the 20-inch HDD was completed on August 1, 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. The closest carbonate bedrock is mapped as the Buffalo Springs Formation which is approximately 1.4 miles northeast of the HDD at its closest point. Although the PA DEP has indicated that the use of geophysical surveys should be considered in karst areas, based on the lack of karst geologic features and extensively fractured bedrock, the use of geophysical surveys during re-evaluation was considered but was ultimately not implemented at the Woodbine Drive HDD location because the results of geophysical surveys would not likely provide additional information that would reduce the risk of an IR. In addition, results of geophysical surveys in karst terrain with the resolution necessary to image features that could affect the HDD are typically limited to the upper 20 to 50 feet of the ground surface. Based on our experience working in karst geology, the lack of mapped karst geology along the HDD trace and lack of continuous thick-bedded limestone units, the diabase and Gettysburg Formations are not deemed susceptible to the solution activity present in carbonate geologic formations in

Pennsylvania. In our professional opinion, geophysical surveys would not provide additional information on the formational thickness, interbedded sandstone, shale, diabase, and thin beds of quartz conglomerate-fanglomerate at depths greater than 50 feet bgs along the HDD 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 Iron Run watershed occupied by the Woodbine Drive HDD originates as precipitation or snowmelt. Precipitation infiltrates through the overburden soils. As previously described (Section 3.0), shallow groundwater generally occurs under unconfined conditions within the upper portion of the bedrock LMAS. 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 and upper portion of the bedrock (23 to 150 feet bgs) proximate to the HDD path. Based on these limited site-specific data, it appears that the groundwater table proximate to the HDD path is relatively shallow and may exist in some areas of the overburden soils that contribute flow to local shallow groundwater discharge zones supporting an unnamed tributary to Iron Run located approximately 1,100 feet south of the HDD entry point. The thickness of the regolith and saturated regolith varies according to the underlying geohydrologic unit and topographic setting (Low, et. al, 2002).

Logs of the five geotechnical borings drilled from May 2015 through July 2017 indicated that the soil thickness near HDD S3-0081 ranges from approximately 28.8 to 39 feet and consists of various soils ranging from clay, silt, sand, and gravel. Recorded descriptions of the bedrock cores included red sandstone and hornfels. Data tabulated for supply wells found in the PaGWIS database (**Figure 3**) within a 0.5-mile radius of the HDD trace recorded measured water levels in the bedrock aquifer ranging from 23 to 150 feet bgs. Groundwater was encountered in two of the three shallow geotechnical soil borings, SB-01 and SB-02, at depths of 20 and 24 feet bgs, respectively. Depth to water measurements were obtained from Boring B-1 at 43 feet bgs in the bedrock, and from Boring B-2 at 23 feet bgs in the overburden.

The Gettysburg Formation is 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 evaluation of the bedrock has 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 to the south and southeast toward the unnamed tributary discharging to Iron Run. The geotechnical report and boring logs included as **Attachment 2** show that groundwater was present in the unconsolidated soils and the depth to water can be quite shallow proximate to the HDD path based on measured depths to water of 20 feet bgs to 43 feet bgs. As stated above, measured water levels in private supply wells located within 0.5-mile of the site range from 23 to 150 feet bgs. Based on this information, the uppermost groundwater table is presumed to occur within the uppermost soils under unconfined conditions.

9.0 CONCLUSIONS

Based on published geologic and hydrogeologic information, the S3-0081 Woodbine Drive HDD location is underlain by clastic sedimentary rocks consisting primarily of red sandstone and siltstone of the Gettysburg Formation. Located near the western HDD entry/exit point is metamorphic hornfels and dense, very fine to coarsely crystalline intrusive diabase. Located within 100 feet of the eastern HDD entry/exit point is quartz conglomerate of the Gettysburg Formation. 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, siltstone, and metamorphic hornfels. 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 relies on the shallow unconsolidated overburden as a source of groundwater supply. The uppermost unconsolidated soils and weathered bedrock, and potentially the bedrock aquifer, provide groundwater discharge to Iron Run.

The proposed 16-inch HDD profile is relatively shallow when compared with the land surface and extends entirely within both the shallow unconsolidated regolith materials and weathered to unweathered bedrock. Based on the hydro-structural characteristics of the underlying geology described in this report and the known HDD profile through shallow soils and bedrock, the Woodbine Drive HDD site is susceptible to the inadvertent return of drilling fluids during HDD operations. The redesigned 16-inch HDD profile has been lengthened so that the western entry point is approximately 146 feet west of the originally proposed entry point location to allow for deeper crossings beneath the roads and utilities (67 to 151 feet bgs vs. 36 to 117 feet bgs). Additionally, the redesigned 16-inch HDD profile is deeper than the as-built profile for the 20-inch HDD, although the original proposed 16-inch HDD profile was shallower than the as-built profile for the 20-inch HDD. The inclination of the entry and exit angles for the 16-inch pipeline has been increased as a means to install the pipe through these protective soils, residual soils, and bedrock in closer proximity to the entry and exit points than the original, shorter profile. From a geologic perspective, the laterally adjusted, longer and deeper profile, in conjunction with the proposed engineering controls and/or drilling BMPs, will be used to reduce the risk of an IR.

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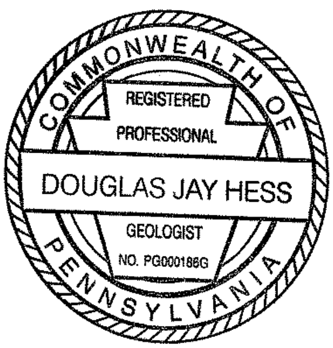
11.0 CERTIFICATION

The studies and evaluations presented in this report (other than Section 5.0) 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.



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

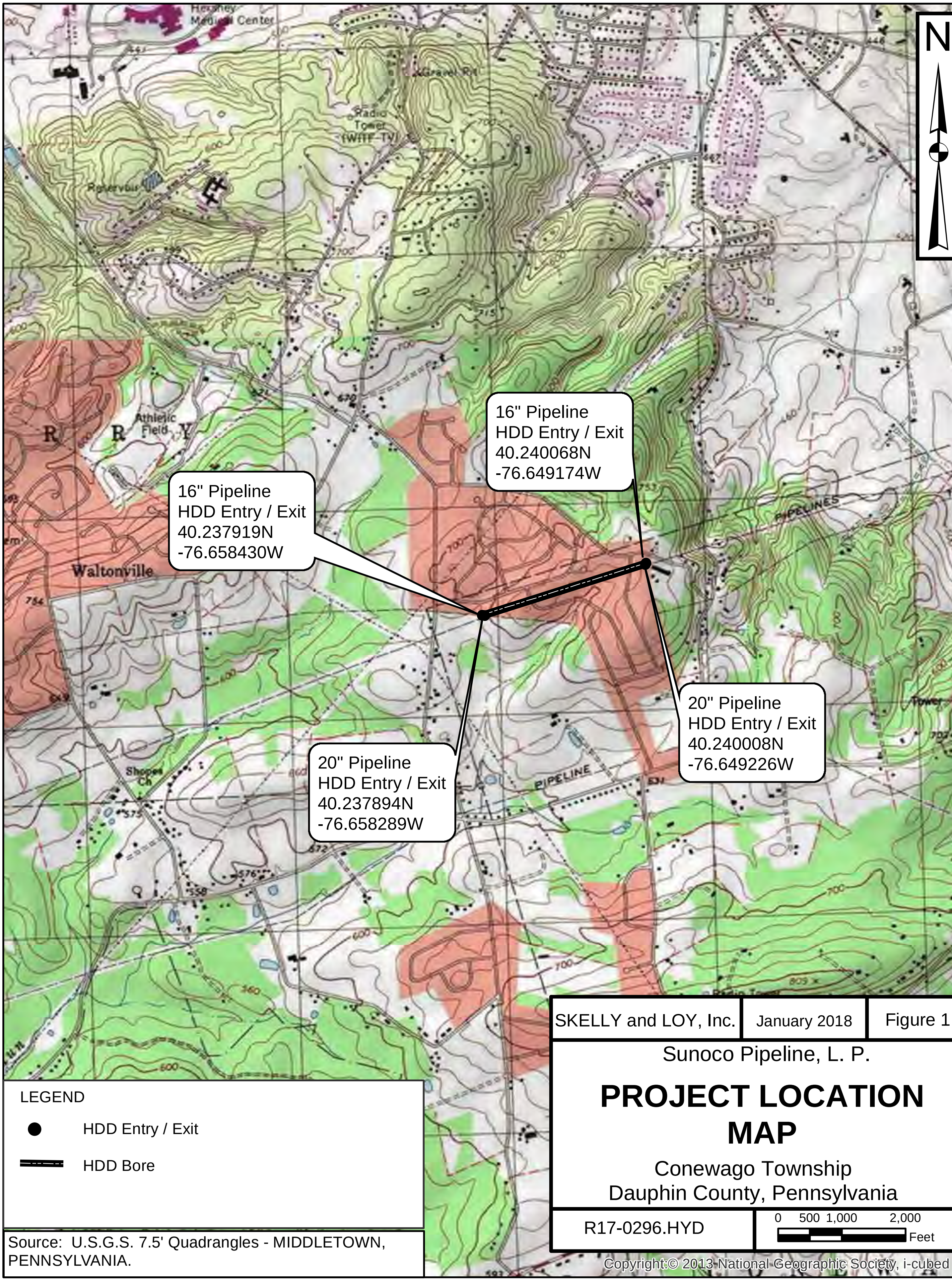
Sincerely yours,

SKELLY and LOY, Inc.

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

Enclosures
cc: R17-0296.HYD
File: Hydrogeologic Report (Woodbine Drive) - DJH 16 FINAL2.docx

FIGURES



SKELLY and LOY, Inc.	January 2018	Figure 1

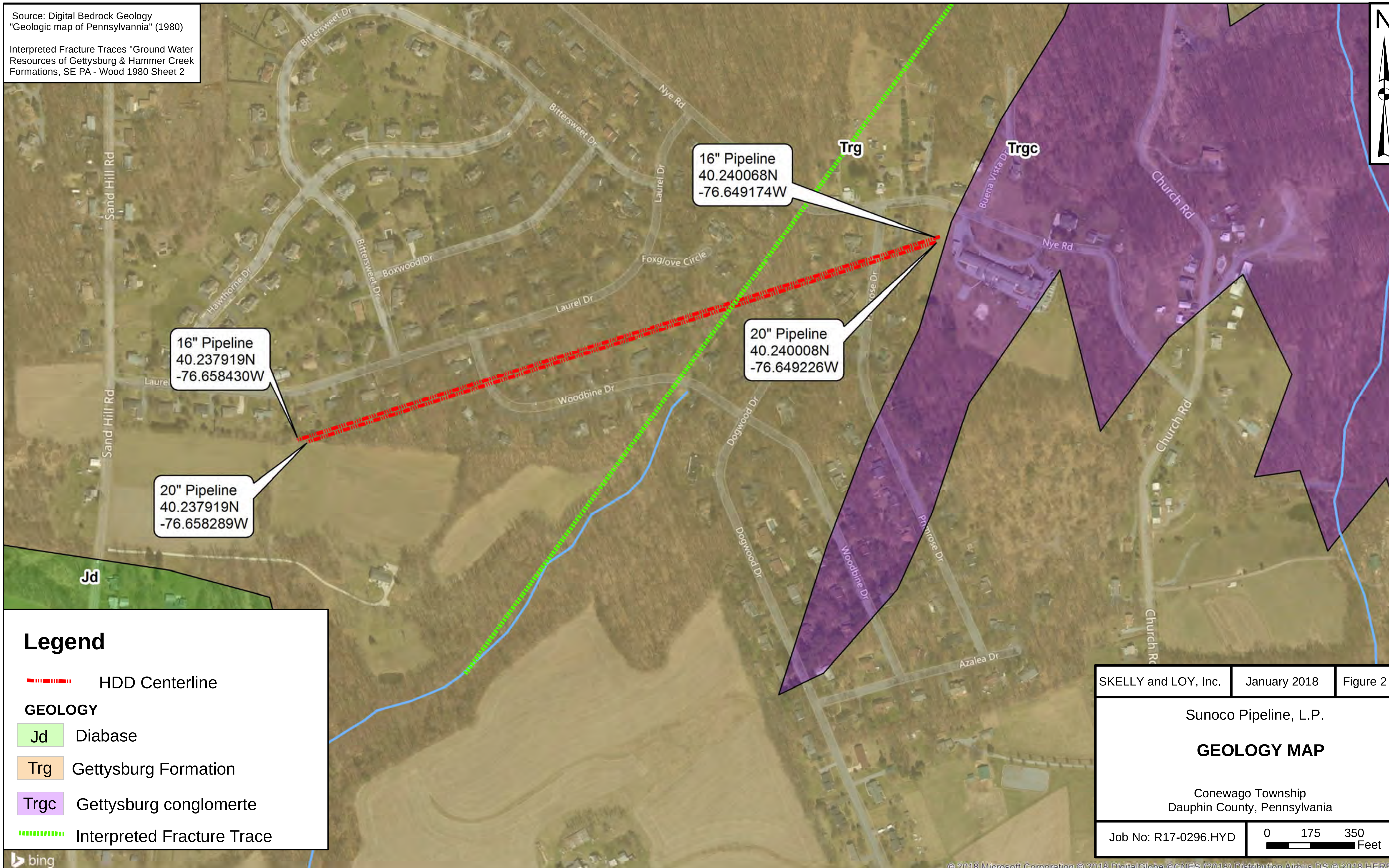
Sunoco Pipeline, L. P.

PROJECT LOCATION MAP

Conewago Township
Dauphin County, Pennsylvania

R17-0296.HYD

Source: U.S.G.S. 7.5' Quadrangles - MIDDLETOWN, PENNSYLVANIA.


Source: Digital Bedrock Geology
"Geologic map of Pennsylvannia" (1980)
Interpreted Fracture Traces "Ground Water Resources of Gettysburg & Hammer Creek Formations, SE PA - Wood 1980 Sheet 2
16" Pipeline 40.240068N -76.649174W
20" Pipeline 40.240008N -76.649226W
16" Pipeline 40.237919N -76.658430W
20" Pipeline 40.237919N -76.658289W
Trg
Trgc
Jd
Sand Hill Rd
Bittersweet Dr
Nye Rd
Laurel Dr
Boxwood Dr
Foxglove Circle
Hawthorne Dr
Woodbine Dr
Dogwood Dr
Primrose Dr
Buena Vista Dr
Church Rd
Azalea Dr
Legend
HDD Centerline
GEOLOGY
Jd Diabase
Trg Gettysburg Formation
Trgc Gettysburg conglomerte
Interpreted Fracture Trace
N
SKELLY and LOY, Inc.
January 2018
Figure 2
Sunoco Pipeline, L.P.
GEOLOGY MAP
Conewago Township
Dauphin County, Pennsylvania
Job No: R17-0296.HYD
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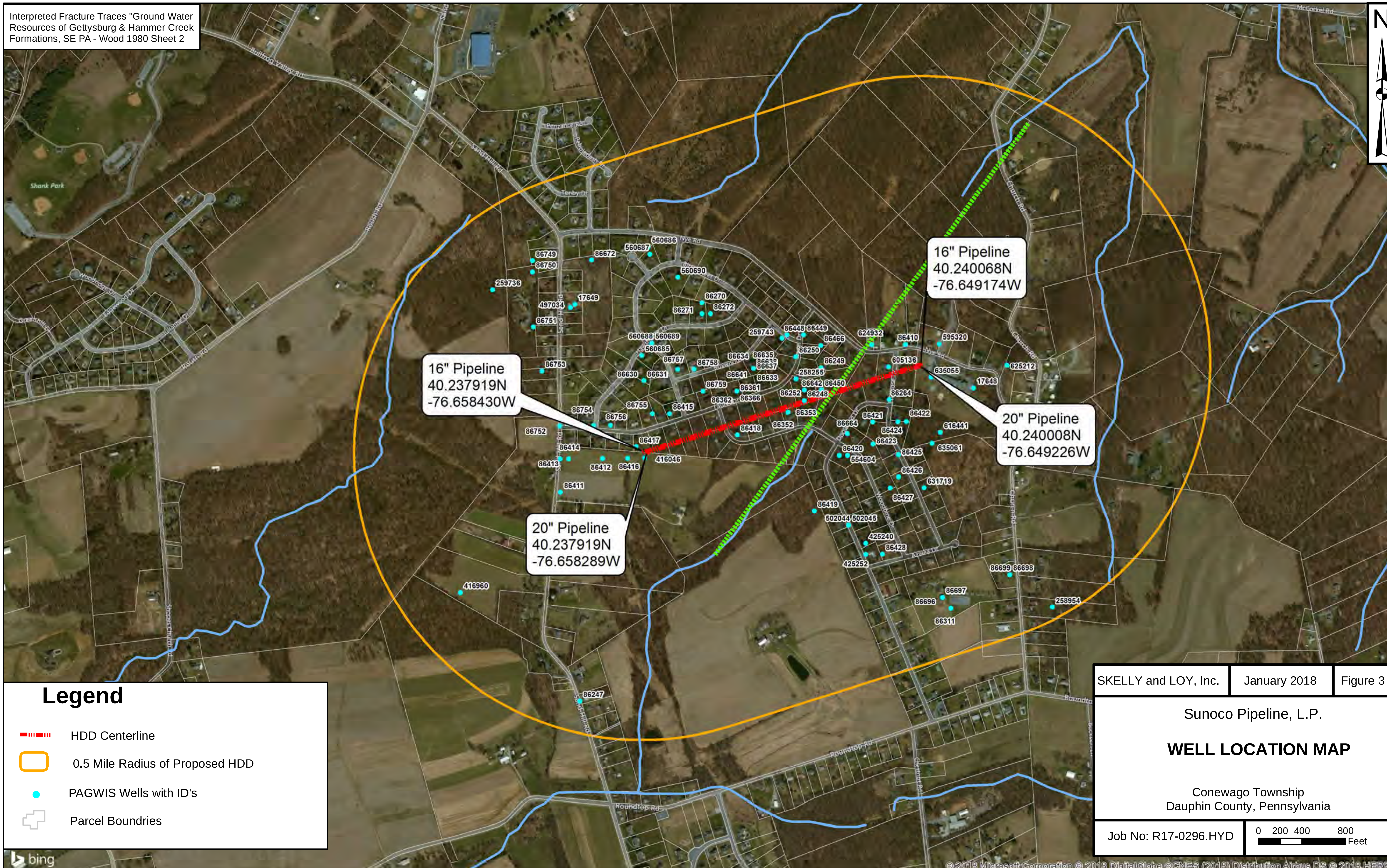


Interpreted Fracture Traces "Ground Water Resources of Gettysburg & Hammer Creek Formations, SE PA - Wood 1980 Sheet 2
N
16" Pipeline
40.240068N
-76.649174W
16" Pipeline
40.237919N
-76.658430W
20" Pipeline
40.240008N
-76.649226W
20" Pipeline
40.237919N
-76.658289W
Legend
HDD Centerline
0.5 Mile Radius of Proposed HDD
PAGWIS Wells with ID's
Parcel Boundries
SKELLY and LOY, Inc.
January 2018
Figure 3
Sunoco Pipeline, L.P.
WELL LOCATION MAP
Conewago Township
Dauphin County, Pennsylvania
Job No: R17-0296.HYD
0 200 400 800
Feet
© 2018 Microsoft Corporation © 2018 DigitalGlobe ©CNES (2018) Distribution Airbus DS © 2018 HERE

ATTACHMENT 1

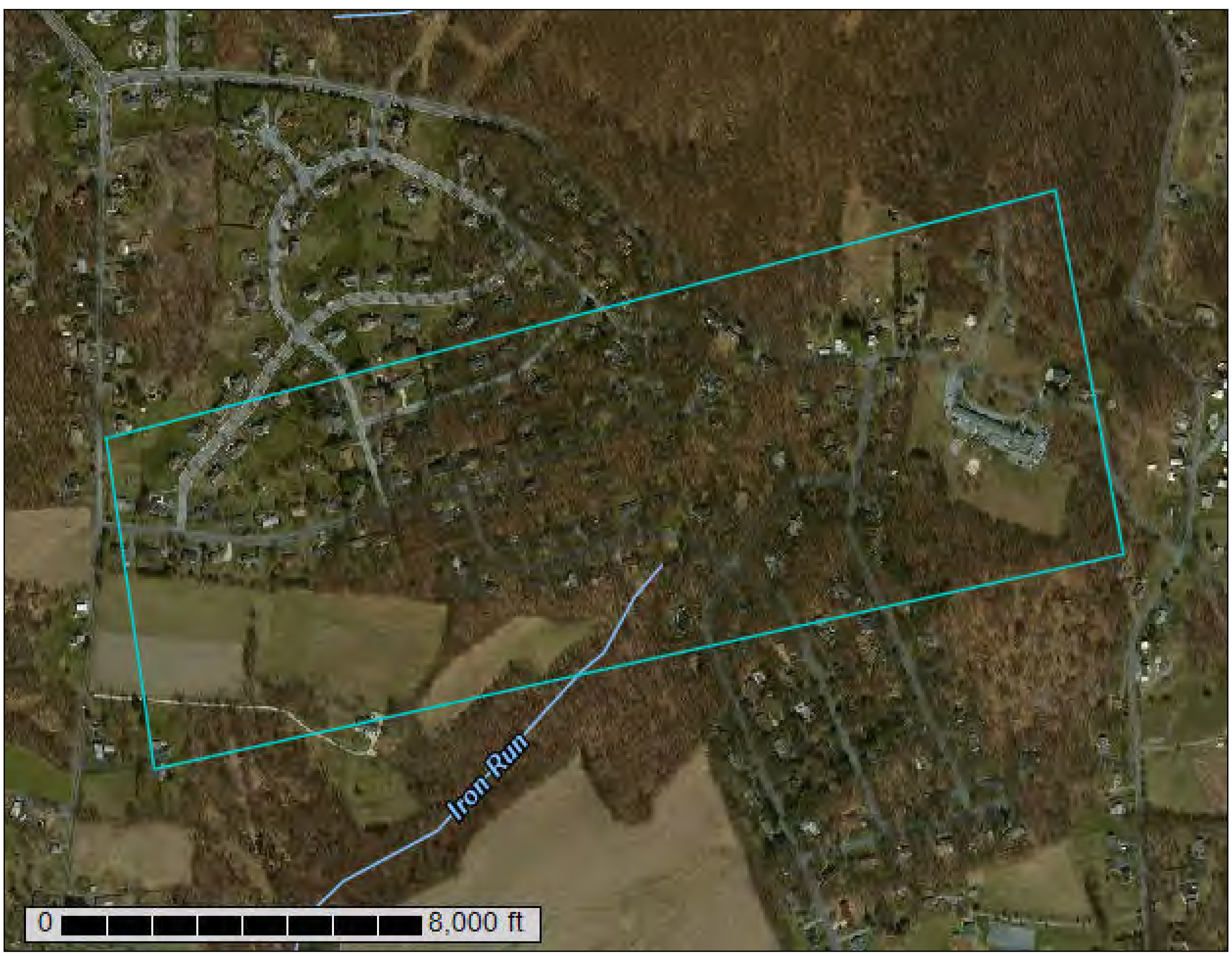
United States Department of Agriculture

Natural Resources Conservation Service

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

Custom Soil Resource Report for

Dauphin County, Pennsylvania



January 8, 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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

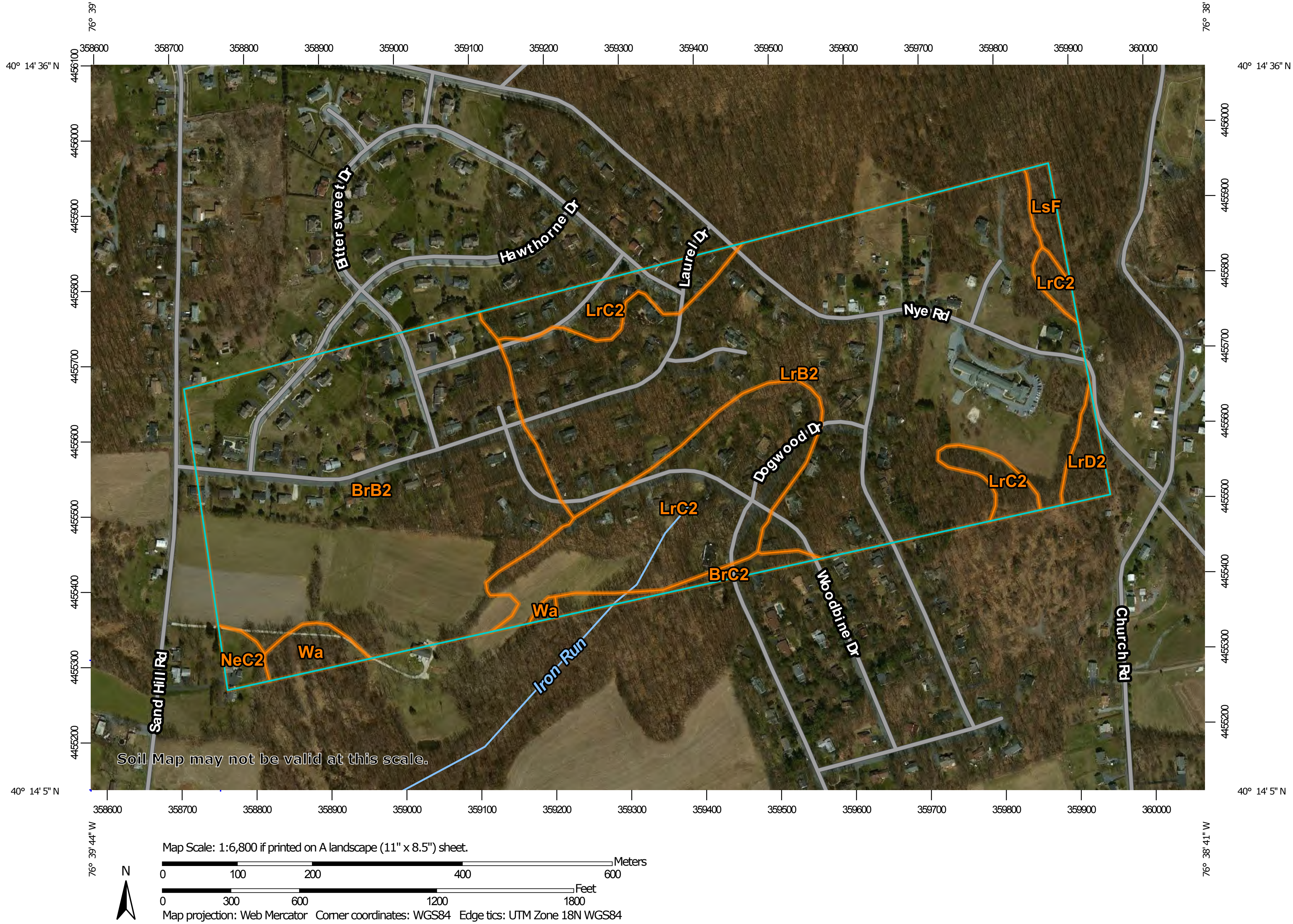
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree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

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

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

Soil Map


76° 39' 44" W
76° 38' 41" W
40° 14' 36" N
40° 14' 5" N
358600
358700
358800
358900
359000
359100
359200
359300
359400
359500
359600
359700
359800
359900
360000
4456100
4456000
4455900
4455800
4455700
4455600
4455500
4455400
4455300
4455200
Bittersweet Dr
Hawthorne Dr
Laurel Dr
Nye Rd
Dogwood Dr
Woodbine Dr
Church Rd
Sand Hill Rd
Iron Run
LsF
LrC2
LrB2
LrD2
BrB2
BrC2
Wa
NeC2
Soil Map may not be valid at this scale.
Map Scale: 1:6,800 if printed on A landscape (11" x 8.5") sheet.
Meters
0
100
200
400
600
Feet
0
300
600
1200
1800
N
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	41.7	33.0%
BrC2	Brecknock channery silt loam, 8 to 20 percent slopes, moderately eroded	1.4	1.1%
LrB2	Lewisberry gravelly sandy loam, 3 to 8 percent slopes, moderately eroded	56.6	44.7%
LrC2	Lewisberry gravelly sandy loam, 8 to 15 percent slopes, moderately eroded	21.7	17.2%
LrD2	Lewisberry gravelly sandy loam, 15 to 25 percent slopes, moderately eroded	1.3	1.0%
LsF	Lewisberry very stony sandy loam, 25 to 60 percent slopes	1.0	0.8%
NeC2	Neshaminy gravelly silt loam, 3 to 12 percent slopes, moderately eroded	1.0	0.8%
Wa	Watchung silt loam	1.8	1.4%
Totals for Area of Interest		**126.5**	**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

LrB2—Lewisberry gravelly sandy loam, 3 to 8 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: l4pg
Elevation: 300 to 1,500 feet
Mean annual precipitation: 38 to 48 inches
Mean annual air temperature: 48 to 57 degrees F
Frost-free period: 165 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Lewisberry

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope, nose slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Residuum weathered from conglomerate and/or residuum weathered from sandstone

Typical profile

H1 - 0 to 12 inches: gravelly sandy loam
H2 - 12 to 46 inches: gravelly sandy loam
H3 - 46 to 62 inches: extremely gravelly sandy loam
H4 - 62 to 72 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 48 to 84 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 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 5.3 inches)

Interpretive groups

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

Minor Components

Steinsburg

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

Arendtsville

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

Penn

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

LrC2—Lewisberry gravelly sandy loam, 8 to 15 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: l4ph
Elevation: 300 to 1,500 feet
Mean annual precipitation: 38 to 48 inches
Mean annual air temperature: 48 to 57 degrees F
Frost-free period: 165 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

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

Description of Lewisberry

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope, nose slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Residuum weathered from conglomerate and/or residuum weathered from sandstone

Typical profile

H1 - 0 to 12 inches: gravelly sandy loam
H2 - 12 to 46 inches: gravelly sandy loam
H3 - 46 to 62 inches: extremely gravelly sandy loam
H4 - 62 to 72 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 48 to 84 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 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 5.3 inches)

Interpretive groups

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

Minor Components

Steinsburg

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

Penn

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

Arendtsvillle

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

LrD2—Lewisberry gravelly sandy loam, 15 to 25 percent slopes, moderately eroded

Map Unit Setting

National map unit symbol: l4pj
Elevation: 250 to 1,500 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 160 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Lewisberry

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope, nose slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Residuum weathered from conglomerate and/or residuum weathered from sandstone

Typical profile

H1 - 0 to 9 inches: gravelly sandy loam
H2 - 9 to 40 inches: gravelly sandy loam
H3 - 40 to 60 inches: very gravelly sandy loam

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: 48 to 60 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 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 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Lewisberry, stony

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope, nose slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Readington

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

Penn

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

LsF—Lewisberry very stony sandy loam, 25 to 60 percent slopes

Map Unit Setting

National map unit symbol: l4pl
Elevation: 250 to 1,500 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 160 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Lewisberry, Very Stony

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope, nose slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Residuum weathered from conglomerate and/or residuum weathered from sandstone

Typical profile

H1 - 0 to 9 inches: channery sandy loam
H2 - 9 to 40 inches: gravelly sandy loam
H3 - 40 to 60 inches: very gravelly sandy loam

Properties and qualities

Slope: 25 to 60 percent
Percent of area covered with surface fragments: 1.6 percent
Depth to restrictive feature: 48 to 60 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 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 5.2 inches)

Interpretive groups

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

Minor Components

Penn

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

Readington

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

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

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

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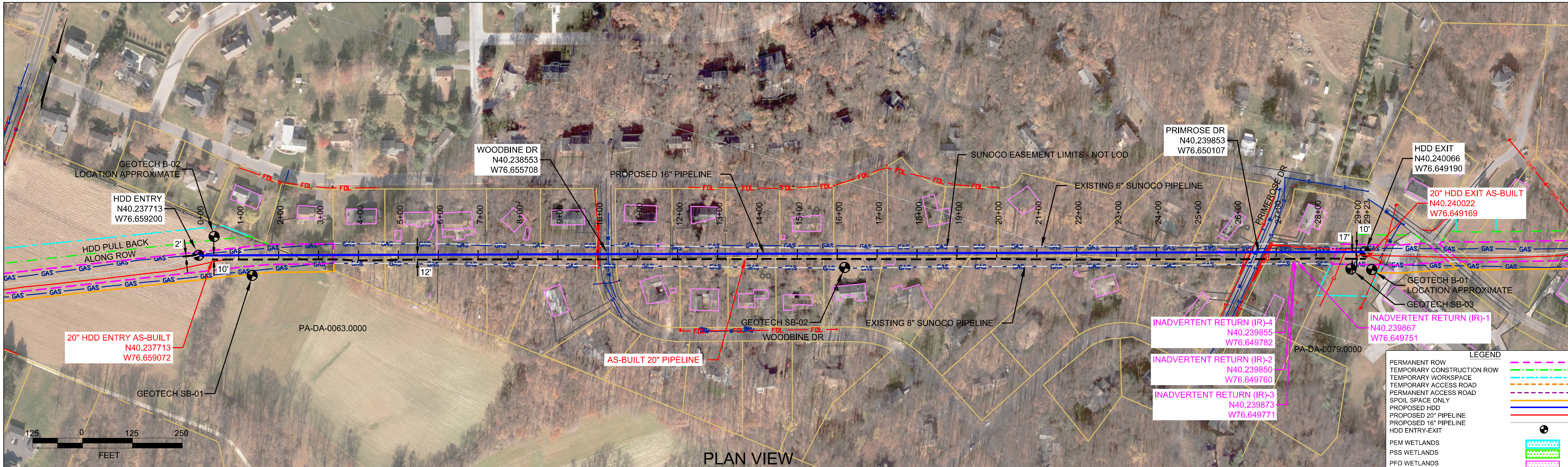
ATTACHMENT 2



PLAN VIEW

DAUPHIN COUNTY, PENNSYLVANIA - DERRY TOWNSHIP
S3-0081-16

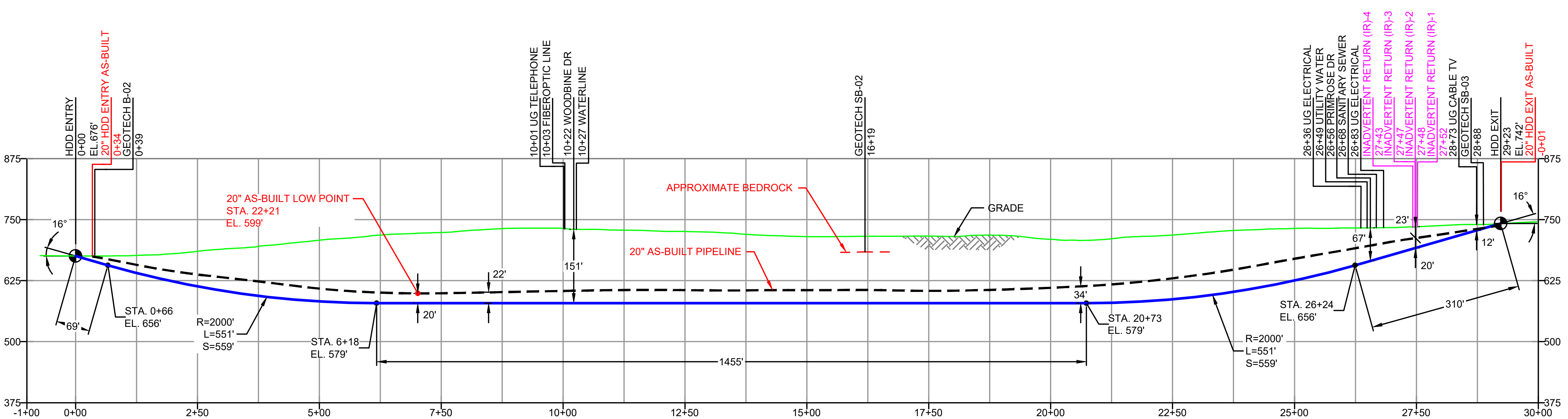
PROFILE VIEW

GEOTECH SB-01
- NG EL. 675'
- TOPSOIL (0' - 0.3')
- ML/CL (0.3' - 11.5')
- SM (11.5' - 22.5')
- GROUNDWATER (20.0')
- SM/GM (22.5' - 28.8')
- COMPLETION DEPTH EL. 646'

GEOTECH SB-02
- NG EL. 715'
- TOPSOIL (0' - 0.1')
- ML (0.1' - 11.5')
- SM (11.5' - 19.0')
- GROUNDWATER (24.0')
- CL (19.0' - 32.0')
- AUGER REFUSAL (32.0')
- COMPLETION DEPTH EL. 683'

GEOTECH SB-03
- NG EL. 739'
- TOPSOIL (0' - 0.3')
- CL/SC (0.3' - 16.5')
- CL (16.5' - 21.0')
- SC (21.0' - 30.0')
- COMPLETION DEPTH EL. 709'

NOTE: REFER TO TEST BORING LOG S2-0081 FOR COMPLETE SOIL MATERIAL DESCRIPTION



GEOTECH B-01
- NG EL. 743'
- RESIDUUM CLAYEY SAND SC (0.0' - 4.0')
- RESIDUUM SAND SP (4.0' - 8.0')
- RESIDUUM CLAYEY SAND SC-SM (8.0' - 33.0')
- SPOON REFUSAL (33.0')
- GROUNDWATER (43.0')
- BEDROCK SANDSTONE (33.0' - 100.0')
- BORING TERMINATED EL.643'

NOTE: REFER TO TEST BORING LOG B-01 INTERTEK PROJECT #04911436 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-02
- NG EL. 678'
- RESIDUUM LEAN CLAY CL (0.0' - 8.0')
- RESIDUUM CLAYEY SAND SC (8.0' - 11.5')
- RESIDUUM SILTY SAND W/ GRAVEL SM (11.5' - 16.5')
- GROUNDWATER (23.0')
- RESIDUUM SANDY SILT ML (16.5' - 21.5')
- RESIDUUM SILTY SAND SM (21.5' - 36.5')
- RESIDUUM FINE SANDY SILT ML (36.5' - 38.5')
- BEDROCK SANDSTONE (38.5' - 97.0')
- BORING TERMINATED EL.581'

NOTE: REFER TO TEST BORING LOG B-02 INTERTEK PROJECT #04911436 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:
1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXITING 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=): 2923'
   HDD PIPE LENGTH (S=): 2952'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 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

DWG NO		DWG NO	DESCRIPTION
ES-4.27	TO	ES-4.29	EROSION & SEDIMENT PLAN
SHEET 17	TO	SHEET 17	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP3	DESIGN CHANGE - LOWERED DRILL AND ADDED GEOTECH	MRS	01/25/19	RMB	01/25/19	AMC	01/25/19
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		DLM	11/13/15	RMB	11/13/15	AAW	11/13/15
B	ADDED GEOTECH INFO/DESIGN ADJUSTMENT	MRS	10/27/15	RMB	10/27/15	AAW	10/27/15
A	ISSUED FOR BID	MRS	08/31/15	RMB	08/31/15	AAW	08/31/15

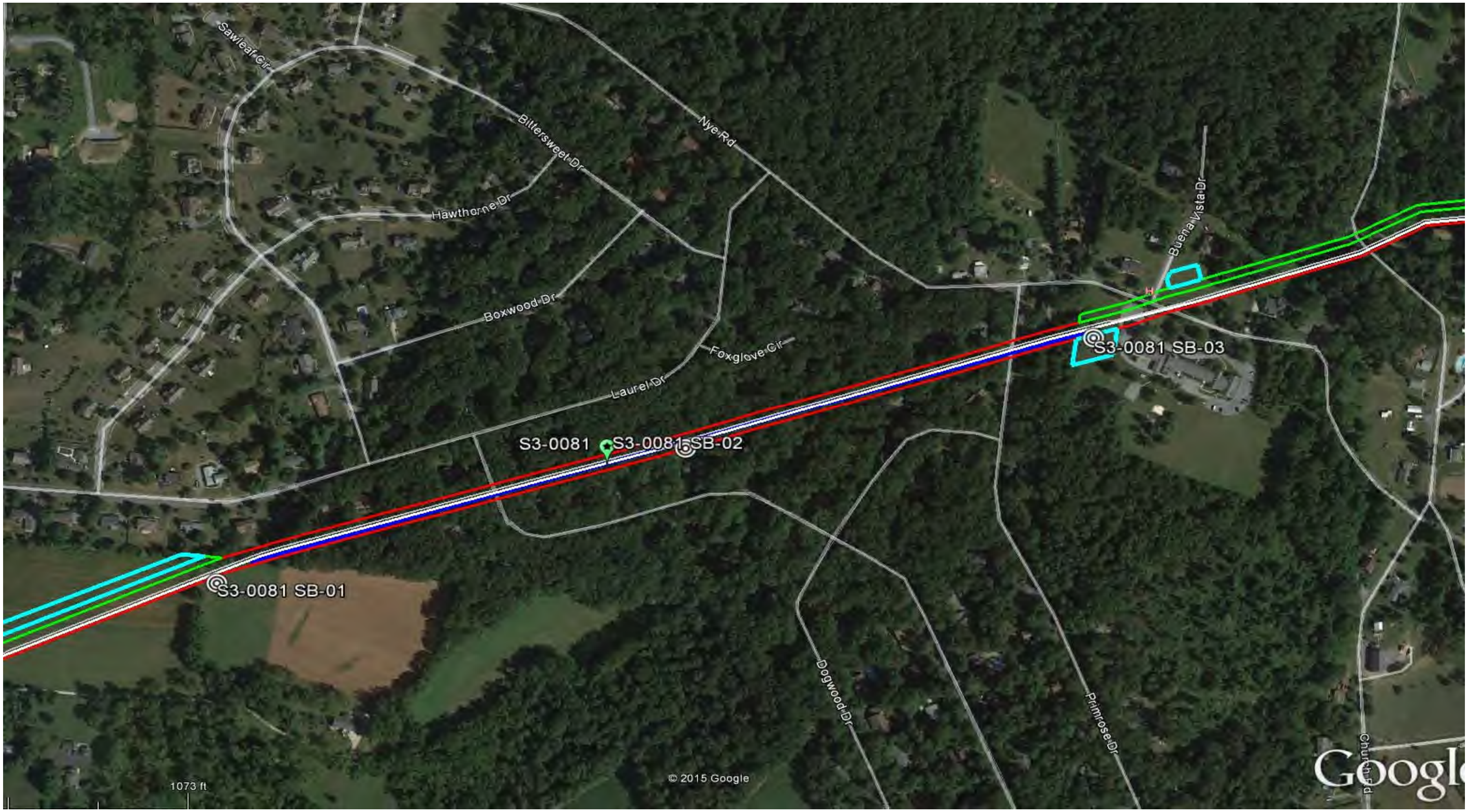
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WOODBINE DRIVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'
DWG. NO: PA-DA-0063.0000-RD-16



LEGEND:

Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0081 WOODBINE ROAD
DAUPHIN COUNTY, CONEWAGO 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:	SAND HILL ROAD, HERSHEY, PA			Page 1 of 1	
HDD No.:	S3-0081	Dates(s) Drilled: 05-05-15		Inspector:	E. WATT
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586		Driller:	S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 20.0		Total Depth (ft):	28.8
Boring Location Coordinates:		40° 14' 15.678" N		76° 39' 31.214" 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	0.3			TOPSOIL (4")					
1	3.0	5.0	0.3		9	ML/ CL	MOTTLED GRAY AND BROWN CLAYEY SILT, WITH SOME FINE SAND.	1	3	6	8	**9**
2	8.0	10.0			21		MOTTLED GRAY AND BROWN CLAYEY SILT WITH SOME FINE SAND	3	6	7	9	**13**
				11.5			(USCS: ML/CL).					
3	13.0	15.0	11.5		24	SM	GRAY FINE TO MEDIUM SAND WITH A LITTLE SILT, AND SOME FINE	14	40	18	18	**58**
							GRAVEL.					
4	18.0	19.5			12		LIGHT GRAY AND LIGHT BROWN FINE TO MEDIUM SAND WITH SOME	3	23	50		**73**
				22.5			SILT, TRACE FINE GRAVEL. (USCS: SM).					
5	23.0	24.0	22.5		7	GM/ SM	WET, GRAY AND BROWN FINE TO COARSE GRAVEL AND FINE TO	20	50/6"			**>50**
							COARSE SAND, SOME SILT.					
6	28.0	28.8			9		WET, GRAY AND BROWN FINE TO COARSE GRAVEL AND FINE TO	4	50/3"			**>50**
				28.8			COARSE SAND, SOME SILT.					
							WET ON SPOON AT 25'.					
							WATER LEVEL THROUGH AUGERS AT 20'.					
							CAVED AT 25', WATER LEVEL ON CAVE AT 20'.					
							STARTED GRINDING BETWEEN 22' AND 23'.					

Notes/Comments:

Pocket Pentrometer Testing
8': 3.0 TSF
10': 1.5 TSF

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

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

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

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406
Project Location:	WOODBINE AND LAUREL DRIVE, HERSHEY, PA			Page 1 of 1
HDD No.:	S3-0081	Dates(s) Drilled: 10-09-15	Inspector:	J. COSTELLO
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller:	E. ODGEN
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 24.0	Total Depth (ft):	32.0
Boring Location Coordinates:		40°14'20.13"N	76°39'12.97"W	

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
	From	To	From	To								
			0.0	0.1			TOPSOIL (<1")					
1	3.0	5.0	0.1		20	ML	PURPLISH BROWN CLAYEY SILT WITH SOME FINE SAND, TRACE	3	7	12	19	**19**
							FINE ROCK FRAGS.					
2	8.0	10.0			22		PURPLISH BROWN CLAYEY SILT, TRACE FINE SAND.	2	4	4	5	**8**
				11.5			(USCS: ML)					
3	13.0	15.0	11.5		24	SM	PURPLISH BROWN FINE TO MEDIUM SAND WITH SOME SILT, WITH	3	7	12	13	**19**
							A LITTLE FINE TO COARSE GRAVEL.					
4	18.0	20.0			24		PURPLISH BROWN FINE TO MEDIUM SAND WITH SOME SILT, WITH	5	31	30	21	**61**
				19.0			A TRACE FINE TO COARSE GRAVEL.					
5	23.0	25.0	19.0		24	CL	PURPLISH BROWN SILTY CLAY WITH SOME FINE SAND.	2	5	6	7	**11**
							(USCS: CL).					
6	28.0	29.3		32.0	12		PURPLISH BROWN SILTY CLAY AND FINE SAND.	5	21	50/3"		**>50**
							AUGER REFUSAL AT 32'.					
							WET ON SPOON AT 24'.					
							WATER LEVEL THROUGH AUGERS AT 24'.					
							CAVED AT 30'.					

Notes/Comments:

Pocket Pentrometer Testing
S2: 2.75 TSF
S5: 3 TSF
S6: > 4 TSF

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

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

TETRA TECH
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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:	SAND HILL ROAD, HERSHEY, PA		Page 1 of 1	
HDD No.:	S3-0081	Dates(s) Drilled: 05-05-15	Inspector:	E. WATT
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller:	S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft):	28.8
Boring Location Coordinates:		40° 14' 23.739" N	76° 38' 57.302" 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	0.3			TOPSOIL (3")					
1	3.0	5.0	0.3		23	CL/ SC	REDDISH BROWN SILTY CLAY AND FINE SAND	6	8	6	9	**14**
2	8.0	10.0			24		REDDISH BROWN SILTY CLAY AND FINE SAND	1	4	7	10	**11**
3	13.0	15.0			22		REDDISH BROWN SILTY CLAY AND FINE SAND	2	6	8	2	**14**
				16.5			(USCS: CL/SC).					
4	18.0	19.5	16.5		18	CL	REDDISH BROWN AND PURPLISH BROWN SILTY CLAY WITH SOME	11	24	50		**74**
				21.0			FINE SAND, TRACE FINE GRAVEL. (USCS: CL).					
5	23.0	24.0	21.0		9	SC	REDDISH BROWN FINE TO MEDIUM SAND, TRACE FINE GRAVEL,	9	50/6"			**>50**
							WITH SOME SILTY CLAY.					
6	28.0	28.8			8		REDDISH BROWN FINE TO MEDIUM SAND, TRACE FINE GRAVEL,	22	50/3"			**>50**
				30.0			WITH SOME SILTY CLAY.					
							AUGERED TO 30'.					
							DRY AND CAVED AT 27'.					

Notes/Comments:

Pocket Pentrometer Testing
10': 2.5 TSF

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

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

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0081

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.)		Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318)			USCS Classif. (ASTM D2487)
			From	To			Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	
S3-0081	SB-01	2	8.0	10.0	26.3	71.3	37	25	12	ML/CL
		3	13.0	15.0	11.9	18.8	-	-	-	-
		4	18.0	19.5	15.5	29.1	29	34	5	SM
		6	28.0	28.8	18.2	25.8	-	-	-	-
	SB-02	2	8.0	10.0	32.0	95.0	41	32	9	ML
		3	13.0	15.0	13.4	32.6	-	-	-	-
		4	18.0	20.0	9.1	24.2	-	-	-	-
		5	23.0	25.0	28.3	70.7	48	26	22	CL
		6	28.0	29.3	19.4	61.9	-	-	-	-
	SB-03	2	8.0	10.0	16.4	51.7	-	-	-	-
		3	13.0	15.0	17.4	51.5	30	21	9	CL/SC
		4	18.0	19.5	16.8	85.4	38	23	15	CL
		5	23.0	24.0	9.4	34.2	-	-	-	-
		6	28.0	28.8	7.9	31.9	-	-	-	-

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0081

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
S3-0081	Woodbine Drive	SB-01	**Gettysburg Fm** - reddish-brown to maroon silty mudstone and shale and soft, red-brown, medium- to fine-grained sandstone, with minor amounts of yellowish-brown shale and sandstone and thin beds of impure limestone.	Moderately sloping rolling hills	Gettysburg Fm	Silty mudstone-shale-sandstone w/ some impure limestone	16,000		
		SB-02						30-65	Well yields generally 5-30 gpm
		SB-03							

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.

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).

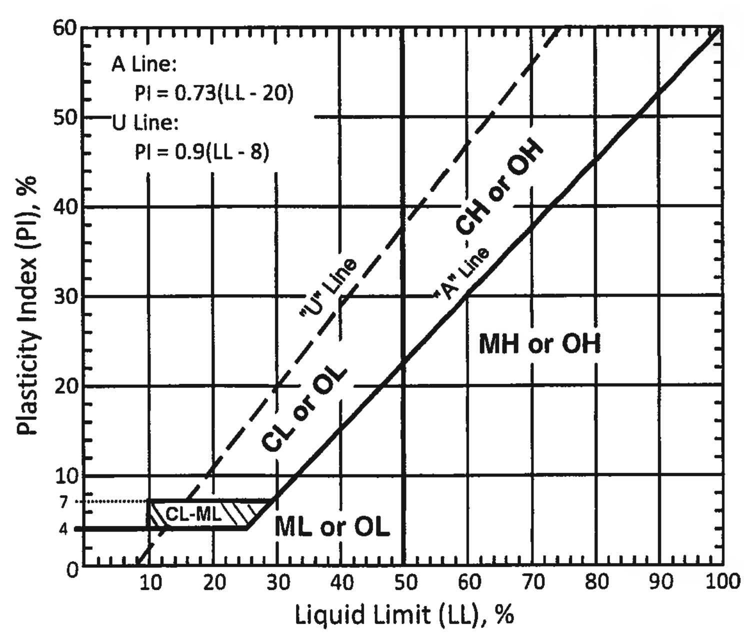
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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.

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Figure 1: Site Vicinity Map

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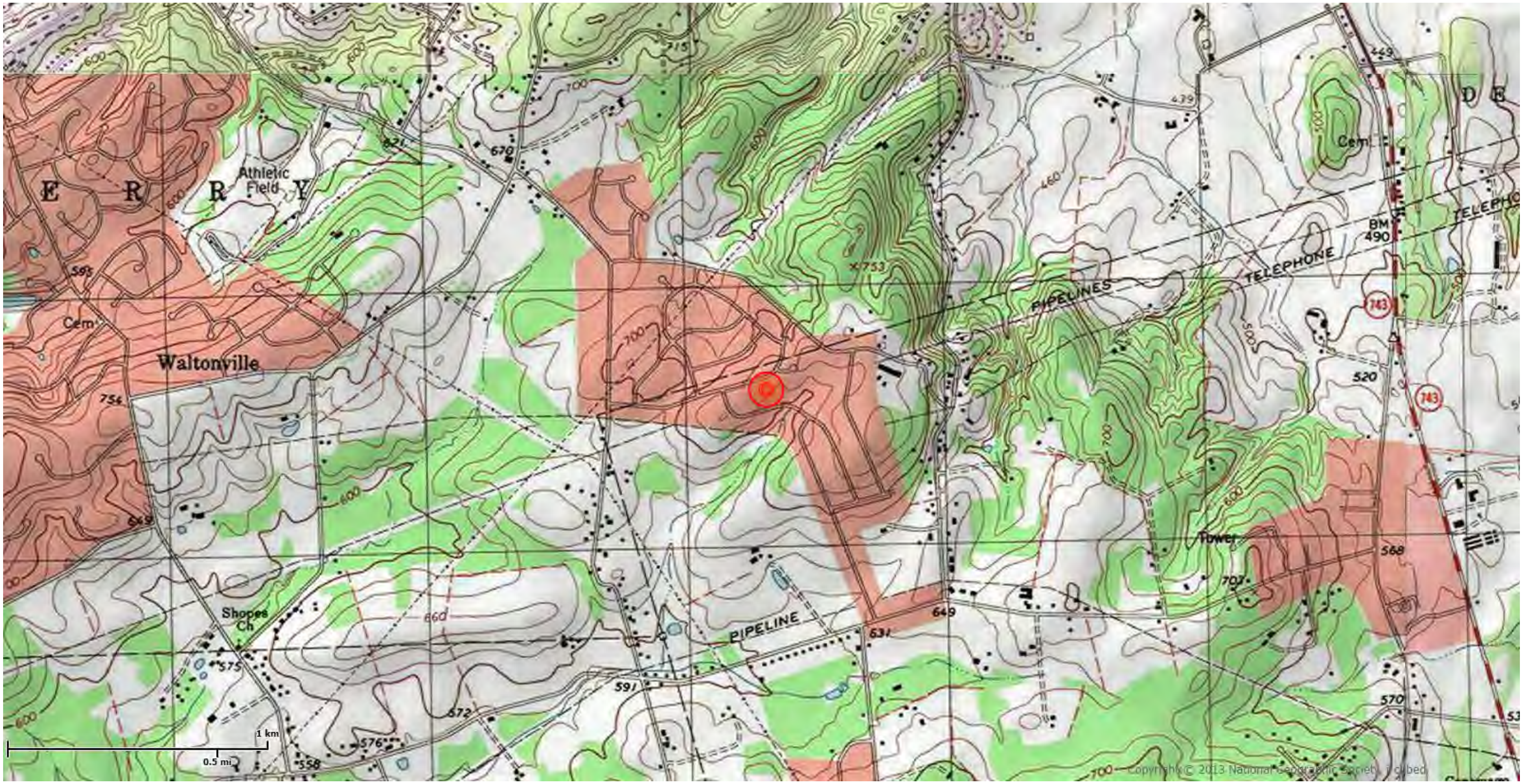

Created using PA DCNR Map Viewer

Map created on Sun Jul 30 2017

Figure 2: Boring Location Plan
Woodbine (PPP4) - Dauphin Co., PA
PSI Project No.: 04911436
(Boring locations are approximate)
Woodbine Geobore #1 (PPP4)
Woodbine geo bore #2 (PPP4)
Bittersweet Dr
Nye Rd
Hawthorne Dr
Boxwood Dr
Foxglove Cir
Laurel Dr
Buena Vista Dr
LsF
LrD2
LsD
LsF
LrC2
NeC2
BrB2
LrB2
LrC2
LrC2
BrC2
LrC2
LrD2
LrD2
LrC2
BrB2
Wa
BrB2
BrC2
NeC2
RdB
BrB2
BrB2
BrC
Cr
N
2000 ft
Google earth
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Figure 3: Site Geology Map

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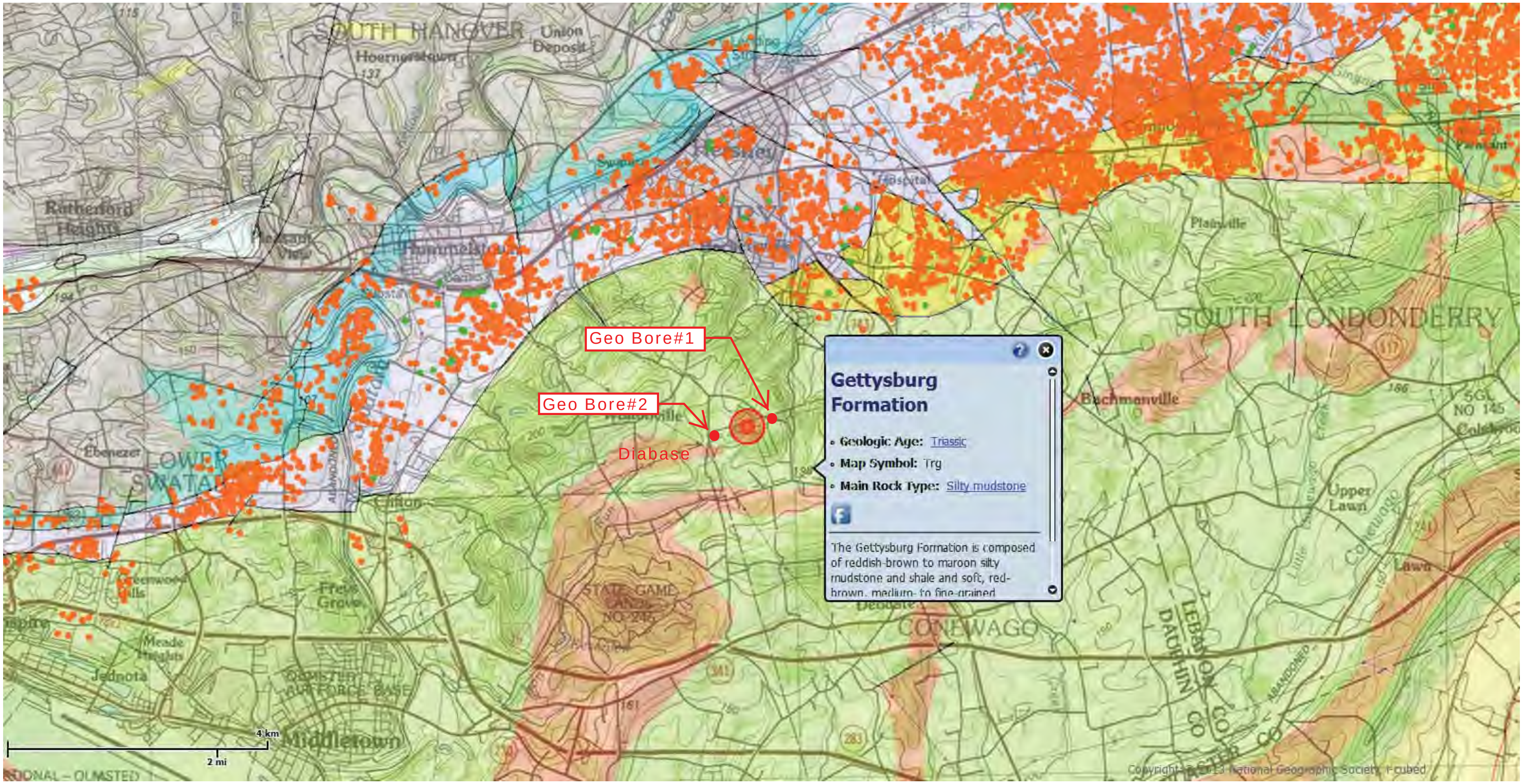


Created using PA DCNR Map Viewer

Map created on Sun Jul 30 2017

BORING B-01

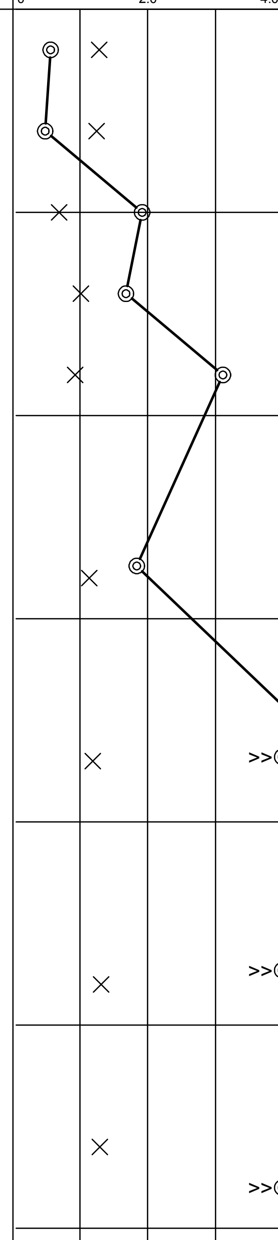
DATE STARTED:	7/14/17
DATE COMPLETED:	7/15/17
COMPLETION DEPTH	100.0 ft
BENCHMARK:	N/A
ELEVATION:	N/A
LATITUDE:	n/a°
LONGITUDE:	n/a°
STATION:	N/A
OFFSET:	N/A
REMARKS:	
DRILL COMPANY:	Allied Well Drilling
DRILLER:	
LOGGED BY:	H. Patel
DRILL RIG:	Track Rig
DRILLING METHOD:	Hollow Stem Auger
SAMPLING METHOD:	2-in SS1.874-in Core
HAMMER TYPE:	Automatic
EFFICIENCY	N/A
REVIEWED BY:	P. McMichael

Water ▽ 2PM-07/15/17 43 feet

BORING LOCATION: See Boring Location Plan

Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	Additional Remarks
0	S-1	7	**RESIDUUM** - Loose, Brown **Clayey SAND**, trace Gravel, moist	SC	3-5-2-3 N=7	16	
	S-2	8			3-3-3-3 N=6	16	Fines=36.3%
5	S-3	10	**RESIDUUM** - Medium Dense, Brown, **Silty SAND**, moist	SM	3-8-16-23 N=24	9	
	S-4	12			6-8-13-12 N=21	13	Fines=19.5%
	S-5	24	**RESIDUUM** - Medium Dense to Very Dense, Brown to Gray Red Brown **Silty, Clayey SAND**, trace Gravel, moist	SC-SM	9-10-29-28 N=39	12	
10							
	S-6	14			7-16-50/5" N=23	14	Fines=18.8%
15							
	S-7	7			26-50/3"	15	
20							
	S-8	14	**RESIDUUM** - Medium Dense to Very Dense, Red Brown to Gray Red Brown **Silty SAND**, trace Gravel, moist	SM	14-44-50/2"	16	Fines=29.7%
25							
						16	
	S-9	2			50/4"		
30							

STANDARD PENETRATION TEST DATA: N in blows/ft ◎; × Moisture; PL; LL (0–25–50). STRENGTH, tsf: ▲ Qu; ✳ Qp (0–2.0–4.0)



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

PROJECT NO.: 04911436
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Woodbine Dr. (PPP4)
Dauphin Co., PA
PA-DA-0063.0000-RD/PO#20170724-1

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

DATE STARTED:	7/14/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	7/15/17	**DRILLER:**	**LOGGED BY:** H. Patel
COMPLETION DEPTH	100.0 ft	**DRILL RIG:**	Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael
REMARKS:			

BORING B-01

Water ▽ 2PM-07/15/17 43 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					**RESIDUUM** - Medium Dense to Very Dense, Red Brown to Gray Red Brown **Silty SAND**, trace Gravel, moist	SM				
				S-10	0	Spoon Refusals @: 33 ft (S10) and 38 ft (S11) => Little to no sample recoveries		50/1"		>>◎	
	35										
				S-11	0			50/0"		>>◎	
				R-1	8	**BEDROCK** - Red, **SANDSTONE**. Fine-to-Coarse-Grained, Medium Hard		RQD=42 Rec=67%		>>◎	
	40					**BEDROCK** - Red, **SANDSTONE**, Fine-Grained, Medium Hard				>>▲ Q_u = 531.0 tsf 155.1 pcf	3 min.
											2 min.
				R-2	28	▽ **Highly Weathered Sandstone** - Presumed zone of recovery loss; recovery consisted of broken rock pieces		RQD=15 Rec=47%			2 min.
											1 min.
											1 min.
	45					**Weathered to Highly Weathered Sandstone** 45 to 47 ft: Presumed zone of recovery loss					1 min.
											1 min.
											1 min.
				R-3	26			RQD=15 Rec=43%			1 min.
											3 min.
	50					**BEDROCK** - Red **SANDSTONE**, Fine-to-Coarse-Grained (porous), Medium/Moderately Hard					2 min.
											2 min.
											2 min.
				R-4	50	54 to 55 ft: Presumed zone of recovery loss/rock broken at bottom of core run		RQD=55 Rec=83%			2 min.
											2 min.
	55					**Very Low Rock Core Recovery** - Recovery consisted of broken red sandstone.					2 min.
											2 min.
											2 min.
				R-5	5			RQD=0 Rec=8%			2 min.
											2 min.
	60										

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

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PROJECT NO.: 04911436
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Woodbine Dr. (PPP4)
Dauphin Co., PA
PA-DA-0063.0000-RD/PO#20170724-1

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

DATE STARTED: 7/14/17	**DRILL COMPANY:** Allied Well Drilling	**BORING B-01**	
DATE COMPLETED: 7/15/17	**DRILLER:** **LOGGED BY:** H. Patel	**Water** ∇ 2PM-07/15/17	43 feet
COMPLETION DEPTH 100.0 ft	**DRILL RIG:** Track Rig	▼	
BENCHMARK: N/A	**DRILLING METHOD:** Hollow Stem Auger	∇	
ELEVATION: N/A	**SAMPLING METHOD:** 2-in SS1.874-in Core		
LATITUDE: n/a°	**HAMMER TYPE:** Automatic	**BORING LOCATION:**	
LONGITUDE: n/a°	**EFFICIENCY** N/A	See Boring Location Plan	
STATION: N/A **OFFSET:** N/A	**REVIEWED BY:** P. McMichael		
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	60	**BEDROCK** - Red, **SANDSTONE**, Fine-to-Coarse-Grained, Medium Hard, Slightly Broken to Massive		RQD=77 Rec=100%		>>▲ Q_u = 883.8 tsf 157.1 pcf	2 min. 2 min. 2 min. 2 min. 2 min.
	65			R-7	60			RQD=95 Rec=100%			3 min. 2 min. 2 min. 2 min. 2 min.
	70			R-8	57			RQD=88 Rec=95%		>>▲ Q_u = 956.8 tsf 163.3 pcf	2 min. 2 min. 2 min. 3 min. 2 min.
	75			R-9	52	**BEDROCK** - Red **SANDSTONE**, Fine-to-Medium-Grained, Medium Hard, Slightly Broken		RQD=43 Rec=87%			2 min. 1 min. 1 min. 1 min. 1 min.
	80			R-10	60	**BEDROCK** - Red <<B>SANDSTONE, **Fine-Grained, Medium Hard, Broken to Slightly Broken**		RQD=82 Rec=100%			1 min. 2 min.
						BEDROCK - Red, **SANDSTONE**, Very Fine-to Medium Grained, Medium Hard, Slightly Broken to Massive					2 min. 3 min. 2 min.
	85			R-11	60	**BEDROCK** - Red **SANDSTONE**, Fine-to-Medium Grained, Medium Hard, Slightly Broken to Massive		RQD=87 Rec=100%			3 min. 2 min. 2 min. 2 min. 2 min.
	90										

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.: 04911436
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Woodbine Dr. (PPP4)
Dauphin Co., PA
PA-DA-0063.0000-RD/PO#20170724-1

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

BORING B-01

DATE STARTED:	7/14/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	7/15/17	**DRILLER:**	**LOGGED BY:** H. Patel
COMPLETION DEPTH	100.0 ft	**DRILL RIG:**	Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael
REMARKS:			

Water ∇ 2PM-07/15/17 43 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	**BEDROCK** - Red, **SANDSTONE**, Fine-Grained, Medium Hard, Massive		RQD=95 Rec=100%		>>▲	1 min. 2 min. 2 min. Q_u = 234.5 tsf 141.7 pcf 2 min. 2 min. 2 min.
	95			R-13	60			RQD=93 Rec=100%		>>▲	2 min. Q_u = 239.7 tsf 139.8 pcf 1 min. 2 min. 2 min. 2 min.
	100					Boring terminated at 100 feet					

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PROJECT NO.: 04911436
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Woodbine Dr. (PPP4)
Dauphin Co., PA
PA-DA-0063.0000-RD/PO#20170724-1

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

Boring B1 (1 of 4)

Boring B1 (2 of 4)

Boring B1 (3 of 4)

Boring B1 (4 of 4)

BORING B-02

DATE STARTED:	7/17/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	7/19/17	**DRILLER:**	**LOGGED BY:** H. Patel
COMPLETION DEPTH	97.0 ft	**DRILL RIG:**	Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael
REMARKS:			

Water: ▽ 4:25PM-07/18/17 — 23 feet

BORING LOCATION: See Boring Location Plan

STANDARD PENETRATION TEST DATA: N in blows/ft ◎; × Moisture; PL; LL (scale 0 – 25 – 50). STRENGTH, tsf: ▲ Qu; ✳ Qp (scale 0 – 2.0 – 4.0)

Depth, (feet)	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	Additional Remarks
0 – 4	SS	S-1	10	**RESIDUUM** - Medium Stiff to Stiff, brown **Lean CLAY**, trace Sand, moist	CL	4-4-3-3 N=7	19	
	SS	S-2	24			4-5-5-8 N=10	18	
4 – 8	SS	S-3	23	**RESIDUUM** - Very Stiff, brown **SILT with Sand**, moist	ML	4-7-9-12 N=16	16	
	SS	S-4	18			5-7-9-8 N=16	23	LL = 40 PL = 26
8 – 11.5	SS	S-5	17	**RESIDUUM** - Dense, Yellow Brown **Silty/Clayey SAND with Gravel**, moist	SC	13-15-15-16 N=30	14	Fines=29.7%
11.5 – 16.5	SS	S-6	18	**RESIDUUM** - Very Stiff, Dark Gray **Sandy SILT**, trace Gravel, moist	ML	5-8-10-15 N=18	22	Fines=53.2%
16.5 – 21.5	SS	S-7	17	**RESIDUUM** - Stiff, Dark Gray **SILT with Sand**, moist	ML	3-5-6-8 N=11	23	LL = 24 PL = 26
21.5 – 30	SS	S-8	20	**RESIDUUM** - Medium Dense, Brown **Silty SAND**, moist (▽ at 23 ft)	SM	5-6-7-10 N=13	25	
	SS	S-9	16			4-6-7-11 N=13	47	

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Harrisburg, PA 17104
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PROJECT NO.: 04911436
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Woodbine Dr. (PPP4)
Dauphin Co., PA
PA-DA-0063.0000-RD/PO#20170724-1

BORING B-02

DATE STARTED:	7/17/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	7/19/17	**DRILLER:**	**LOGGED BY:** H. Patel
COMPLETION DEPTH	97.0 ft	**DRILL RIG:**	Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

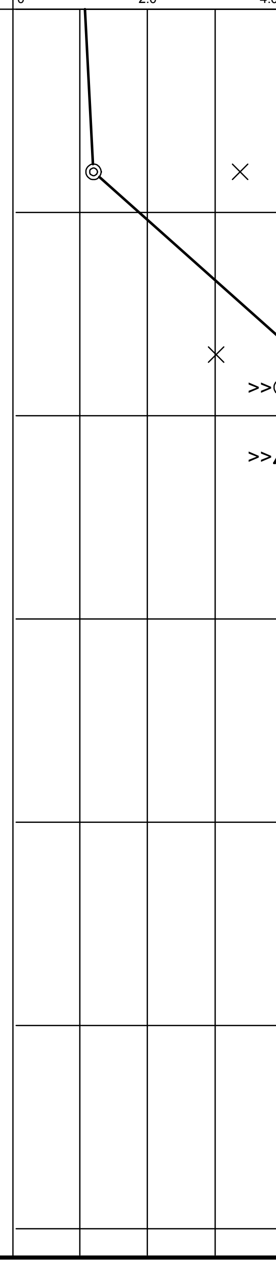
REMARKS:

Water ▽ 4:25PM-07/18/17 23 feet

BORING LOCATION: See Boring Location Plan

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	Additional Remarks
	30			**RESIDUUM** - Medium Dense, Brown **Silty SAND**, moist	SM			
		S-10	22			3-5-10-4 N=15	42	Fines=44.8%
	35							
				RESIDUUM - Very Stiff, Light Brown **Fine Sandy SILT**, moist/wet	ML			
		S-11	7			23-50/1"	38	
		R-1	16	**Weathered BEDROCK** - Blue-Gray, **Porcelanite?**, Moderately Hard, Broken		RQD=0 Rec=95%		
	40			**BEDROCK** - Blue-Gray, **Diabase?**, Hard, Slightly Broken to Massive				14 min.
								Qu = 545.4 tsf 4 min. 184.5 pcf
								4 min.
		R-2	60			RQD=65 Rec=100%		5 min.
								4 min.
	45			**BEDROCK** - Blue-Gray, **Diabase?**, Hard, Slightly Broken to Very Broken				6 min.
								6 min.
								7 min.
		R-3	60			RQD=27 Rec=100%		5 min.
								4 min.
	50			**BEDROCK** - Gray to Gray Brown, **Sandstone/Siltstone**, Hard, Massive to Broken, Very Fine-Grained				3 min.
								4 min.
		R-4	48	~51 ft: Steeply dipping fracture		RQD=37 Rec=80%		4 min.
				BEDROCK - Blue-Gray, **Siltstone**, Hard, Broken to Very Broken (irregular to steeply dipping fractures)				4 min.
								6 min.
	55							3 min.
								6 min.
								6 min.
		R-5	60			RQD=0 Rec=100%		9 min.
								4 min.
	60							

STANDARD PENETRATION TEST DATA: N in blows/ft ◎; × Moisture; PL; LL (0, 25, 50). STRENGTH, tsf: ▲ Qu; ✳ Qp (0, 2.0, 4.0)



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PROJECT NO.: 04911436
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Woodbine Dr. (PPP4)
Dauphin Co., PA
PA-DA-0063.0000-RD/PO#20170724-1

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

DATE STARTED: 7/17/17	**DRILL COMPANY:** Allied Well Drilling	**BORING B-02**	
DATE COMPLETED: 7/19/17	**DRILLER:** **LOGGED BY:** H. Patel	**Water** ∇ 4:25PM-07/18/17	23 feet
COMPLETION DEPTH 97.0 ft	**DRILL RIG:** Track Rig	▼	
BENCHMARK: N/A	**DRILLING METHOD:** Hollow Stem Auger	▼	
ELEVATION: N/A	**SAMPLING METHOD:** 2-in SS1.874-in Core		
LATITUDE: n/a°	**HAMMER TYPE:** Automatic	**BORING LOCATION:**	
LONGITUDE: n/a°	**EFFICIENCY** N/A	See Boring Location Plan	
STATION: N/A **OFFSET:** N/A	**REVIEWED BY:** P. McMichael		
REMARKS:			

Elevation (feet)	Depth, (feet)	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	60	**BEDROCK** - Blue-Gray, **Siltstone**, Hard, Massive to Very Broken (irregular to steeply dipping fractures)		RQD=40 Rec=100%			3 min. 5 min. 13 min. 15 min. 10 min.
	65	R-7		**BEDROCK** - Blue-Gray/Brown to Light Gray, **Conglomeritic Sandstone**, Moderately Hard/Hard, Fine-to-Coarse-Grained				>>▲	4 min. Q_u = 187.7 tsf 3 min. 134.0 pcf 1 min. 1 min. 3 min.
	70	R-8		**BEDROCK** - Blue-Gray **Sandstone**, Hard, Fine-Grained, Slightly Broken to Massive **Weathered BEDROCK** - Blue-Gray **Sandstone**, Hard, Fine-Grained, Very Broken **Weathered BEDROCK** - Blue-Gray **Sandstone**, Hard, Fine-Grained, Massive to Broken					4 min.
	75	R-9	60	**BEDROCK** - Blue-Gray, **Sandstone**, Hard, Very Fine-to-Fine Grained, Massive to Slighlty Broken (irregular to steeply dipping fractures)		RQD=78 Rec=100%		>>▲	3 min. 4 min. 4 min. Q_u = 976.2 tsf 5 min. 154.8 pcf
	80	R-10	60	**BEDROCK** - Blue-Gray, **Sandstone**, Hard, Fine-Grained, Slighlty Broken to Broken (irregular to steeply dipping fractures)		RQD=8 Rec=100%			5 min. 4 min. 5 min. 4 min. 6 min.
	85	R-11	60			RQD=22 Rec=100%		>>▲	8 min. 9 min. Q_u = 448.9 tsf 6 min. 153.5 pcf 6 min. 4 min.
	90								

Continued Next Page

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

PROJECT NO.: 04911436
PROJECT: Energy Transfer HDD (DPS)
LOCATION: Woodbine Dr. (PPP4)
Dauphin Co., PA
PA-DA-0063.0000-RD/PO#20170724-1

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

DATE STARTED:	7/17/17	DRILL COMPANY:	Allied Well Drilling
DATE COMPLETED:	7/19/17	DRILLER:	LOGGED BY: H. Patel
COMPLETION DEPTH	97.0 ft	DRILL RIG:	Track Rig
BENCHMARK:	N/A	DRILLING METHOD:	Hollow Stem Auger
ELEVATION:	N/A	SAMPLING METHOD:	2-in SS1.874-in Core
LATITUDE:	n/a°	HAMMER TYPE:	Automatic
LONGITUDE:	n/a°	EFFICIENCY	N/A
STATION: N/A	OFFSET: N/A	REVIEWED BY:	P. McMichael
REMARKS:			

BORING B-02

Water: ▽ 4:25PM-07/18/17 23 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	**BEDROCK** - Blue-Gray, **Sandstone**, Hard, Fine-Grained, Slighlty Broken to Broken (irregular to steeply dipping fractures)		RQD=20 Rec=100%			9 min. 13 min. 19 min. 15 min. 12 min.
	95			R-13	24			RQD=33 Rec=100%			9 min. 14 min. 14 min.
						Test Boring Terminated @ 97 (core bit wore out)					

Notes:

1) Rock coring required relatively high core times (upwards of 20 minutes per foot) and water volumes (50 to 60 gallons per foot). However, the driller reported the core bit was towards the end of its useful life and may have partly contributed to longer core times/water usage, but the rock was relatively hard and not easily scratched with a knife.

2) Per the soil survey, the map unit in the area of the boring is Brecknock channery silt loam (BrB2) which is developed from residuum of "metamorphosed red shale and sandstone"; the Rock horizon within this map units profile is indicated to be dark gray to dark bluish gray "porcelanite".

3) Per PA geological map, a diabase formation is located in close proximit to the boring to the southwest.

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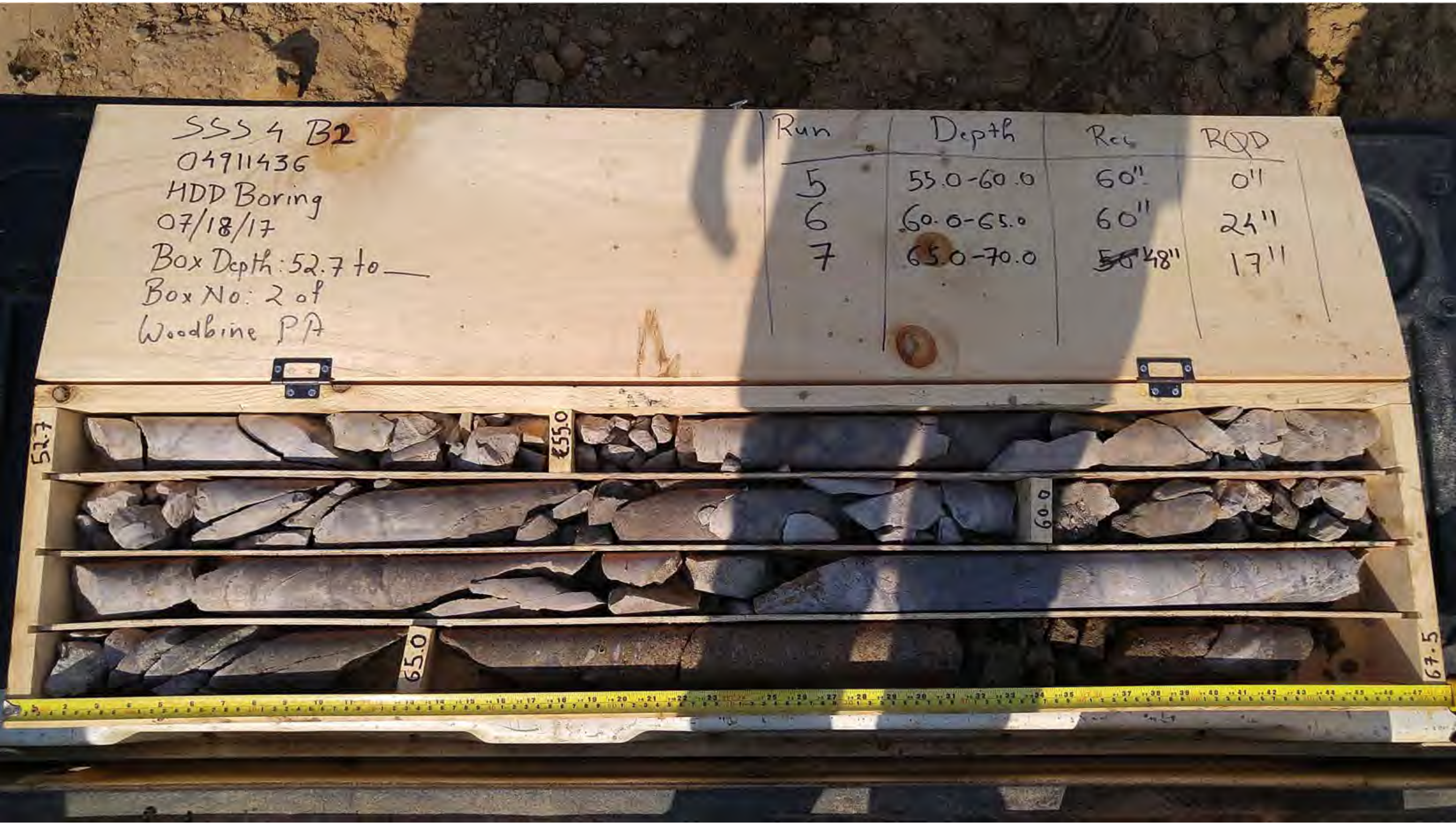
The stratification lines represent approximate boundaries. The transition may be gradual.


SSS4 B2
04911436
HDD Boring
07/17/17
Depth: 38.6 to __
Box: 1 of __
Run
Depth
Recovery
RQD
1
38.6-40.0
16"
0"
2
40.0-45.0
60"
39"
3
45.0-50.0
60"
16"
4
50.0-55.0
48"
22"
38.6
40.0
45.
50.0
52.7


SSS 4 B2
04911436
HDD Boring
07/18/17
Box Depth: 52.7 to
Box No: 2 of
Woodbine PA
Run Depth Rec RQD
5 55.0-60.0 60" 0"
6 60.0-65.0 60" 24"
7 65.0-70.0 50 48" 17"
52.7
55.0
60.0
65.0
67.5


Box: 5 of 5
Woodbine, PA
SSS4 B2
04911436
HDD Boring
07/18/17
Depth: 67.5 - 82.3
Box: 3 of 5
Area:
Woodbine, PA
Run | Depth | Rec | RQD
8 | 70-75.0 | 60" | 15"
9 | 75-80.0 | 60" | 47"
10 | 80.0-85.0 | 60" | 4.5"
67.5
70.0
75.0
75.0
80.0
82.3
SSS4 B2
04911436
HDD Coring
Run | Depth | Rec | RQD
11 | 85.0-90.0 | 60" | 13"


SSS4 B2
04911436
HDD Coring
07/19/17
Depth: 82.3 to 95
Box: 4 of 5
Woodbine, PA
Run
Depth
Rec
RQD
11
85.0-90.0
60"
13"
12
90.0-95.0
60"
12"
82.3
85.0
90.0
95.0


SSS4 B2 (HDD Boring)
04911436
07/19/17
Depth: 95-100
Box: 5 of 5
Woodbine PA
Run
Depth
Recovery
RQD
13
95.0-100.0
97.0
23"
8"
95.0

GENERAL NOTES

SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

DRILLING AND SAMPLING SYMBOLS

SFA: Solid Flight Auger - typically 4" diameter flights, except where noted.
HSA: Hollow Stem Auger - typically 3¼" or 4¼ I.D. openings, except where noted.
M.R.: Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry
R.C.: Diamond Bit Core Sampler
H.A.: Hand Auger
P.A.: Power Auger - Handheld motorized auger

SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
ST: Shelby Tube - 3" O.D., except where noted.
RC: Rock Core
TC: Texas Cone
BS: Bulk Sample
PM: Pressuremeter
CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings

SOIL PROPERTY SYMBOLS

N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
N_{60}: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
Q_u: Unconfined compressive strength, TSF
Q_p: Pocket penetrometer value, unconfined compressive strength, TSF
w%: Moisture/water content, %
LL: Liquid Limit, %
PL: Plastic Limit, %
PI: Plasticity Index = (LL-PL),%
DD: Dry unit weight, pcf
▼,▽,▼: Apparent groundwater level at time noted

RELATIVE DENSITY OF COARSE-GRAINED SOILS

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

ANGULARITY OF COARSE-GRAINED PARTICLES

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

GRAIN-SIZE TERMINOLOGY

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

PARTICLE SHAPE

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

RELATIVE PROPORTIONS OF FINES

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

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GENERAL NOTES

(Continued)

CONSISTENCY OF FINE-GRAINED SOILS

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

MOISTURE CONDITION DESCRIPTION

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

RELATIVE PROPORTIONS OF SAND AND GRAVEL

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

STRUCTURE DESCRIPTION

Description	Criteria
Stratified:	Alternating layers of varying material or color with layers at least ¼-inch (6 mm) thick
Laminated:	Alternating layers of varying material or color with layers less than ¼-inch (6 mm) thick
Fissured:	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided:	Fracture planes appear polished or glossy, sometimes striated

Description	Criteria
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 GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	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
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	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

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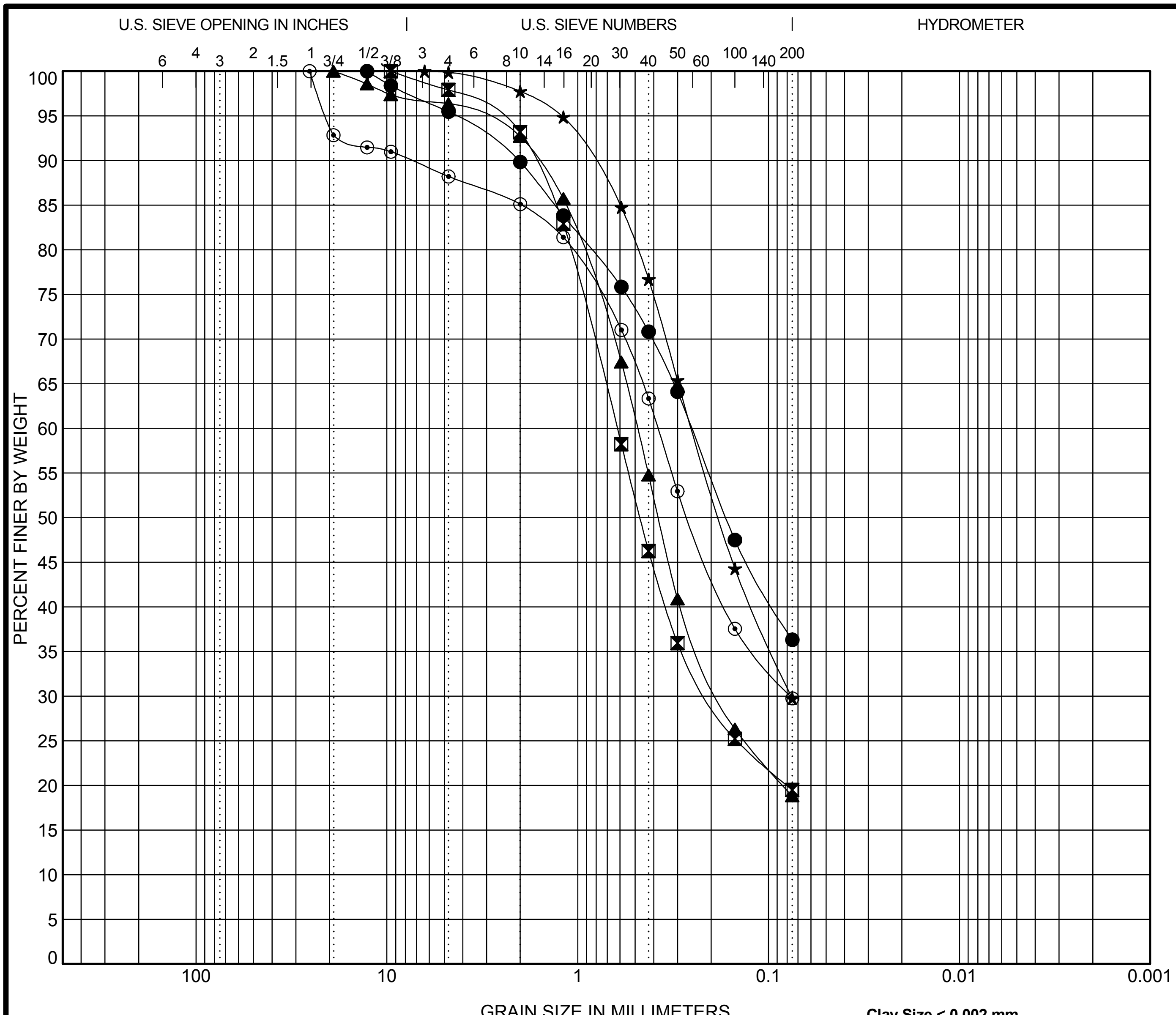

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● B-01	3.0	**Clayey SAND (SC)**					
⧗ B-01	7.0	**Silty SAND (SM)**					
▲ B-01	14.0	**Silty, Clayey SAND (SC-SM)**					
★ B-01	24.0	**Silty SAND (SM)**					
⊙ B-02	9.0	**Clayey SAND (SC)**					

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-01	3.0	12.7	0.253			4.5	59.2	36.3	
⧗ B-01	7.0	9.525	0.621	0.204		2.1	78.4	19.5	
▲ B-01	14.0	19.05	0.487	0.179		3.6	77.6	18.8	
★ B-01	24.0	6.35	0.251	0.076		0.1	70.1	29.7	
⊙ B-02	9.0	25.4	0.38	0.077		11.8	58.5	29.7	

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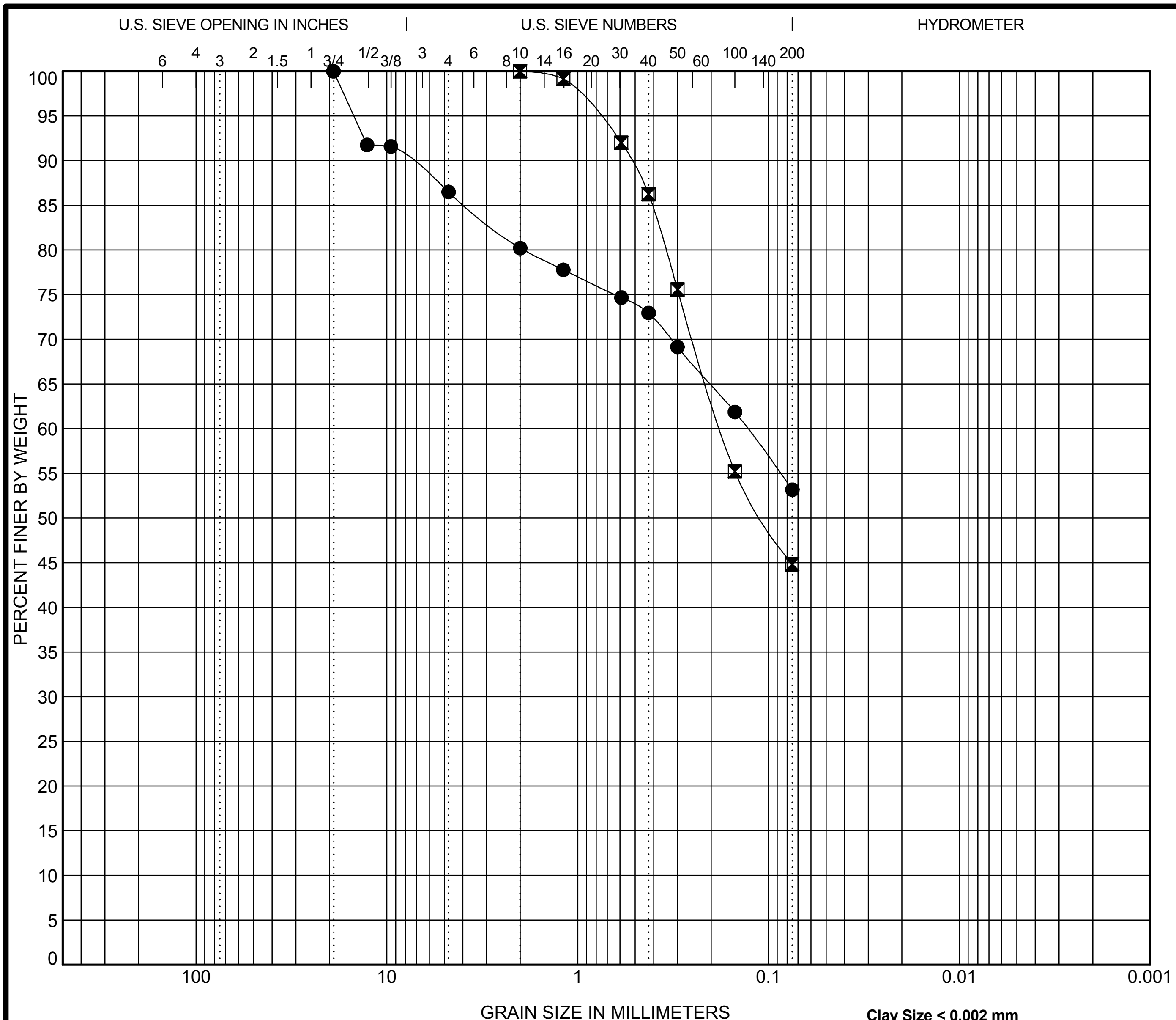
GRAIN SIZE DISTRIBUTION

Project: Energy Transfer HDD (DPS)
PSI Job No.: 04911436
Location: Woodbine Dr. (PPP4)
Dauphin Co., PA



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-02	14.0	**Sandy SILT (ML)**					
⧗	B-02	34.0	**Silty SAND (SM)**					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-02	14.0	19.05	0.129			13.5	33.3	53.2	
⧗	B-02	34.0	2	0.177			0.0	55.2	44.8	

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PSI Job No.: 04911436
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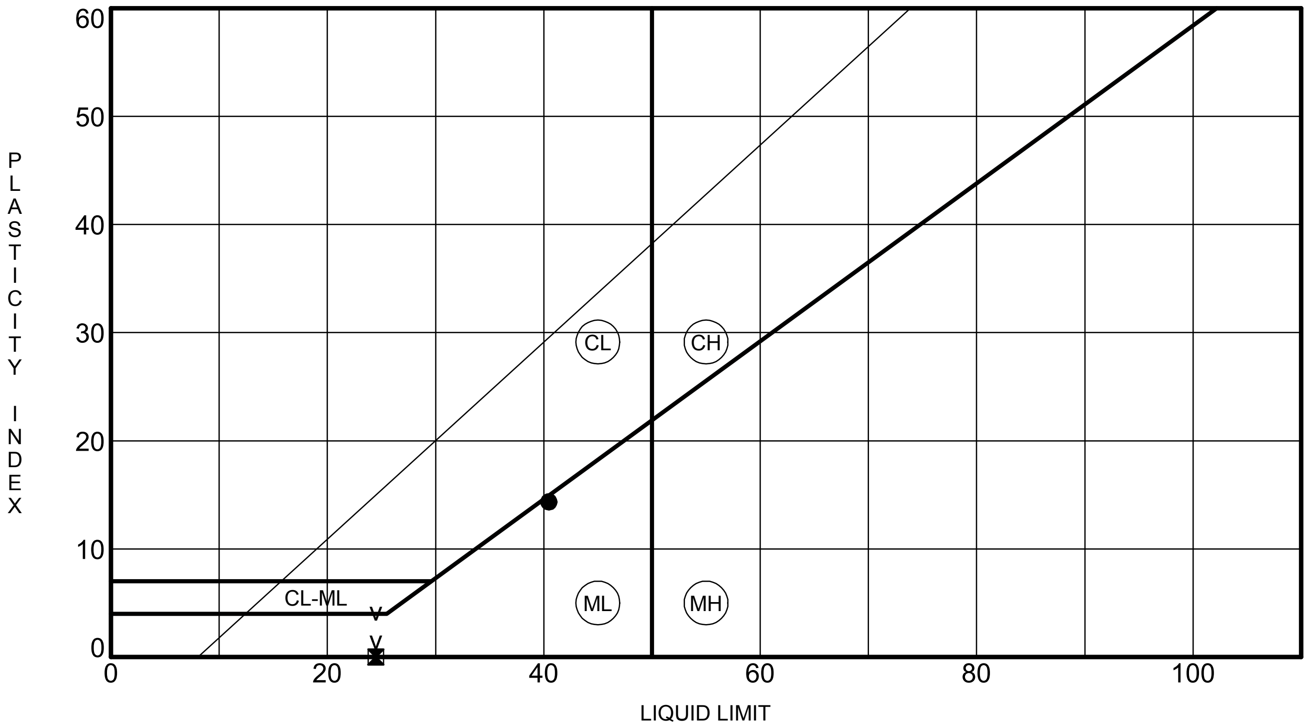

	Boring	Depth (ft)	LL	PL	PI	Fines	Classification (*Visual)
●	B-02	7.0	40	26	14		
⧗	B-02	19.0	24	26	NP		

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ATTERBERG LIMIT RESULTS

PSI Job No.: 04911436
Project: Energy Transfer HDD (DPS)
Location: Woodbine Dr. (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-01	1							16			
B-01	3					36.3%		16			
B-01	5							9			
B-01	7					19.5%		13			
B-01	9							12			
B-01	14					18.8%		14			
B-01	18.5							15			
B-01	24					29.7%		16			
B-01	28							16			
B-01	40.4				531.04						
B-01	63.9				883.84						
B-01	70.4				956.76						
B-01	92.3				234.50						
B-01	96				239.68						
B-02	1							19			
B-02	3							18			
B-02	5							16			
B-02	7	40	26	14				23			
B-02	9					29.7%		14			
B-02	14					53.2%		22			
B-02	19	24	26	-2				23			
B-02	24							25			
B-02	29							47			
B-02	34					44.8%		42			
B-02	38.5							38			
B-02	41				545.40						
B-02	66				187.74						
B-02	78.6				976.20						
B-02	86.5				448.86						

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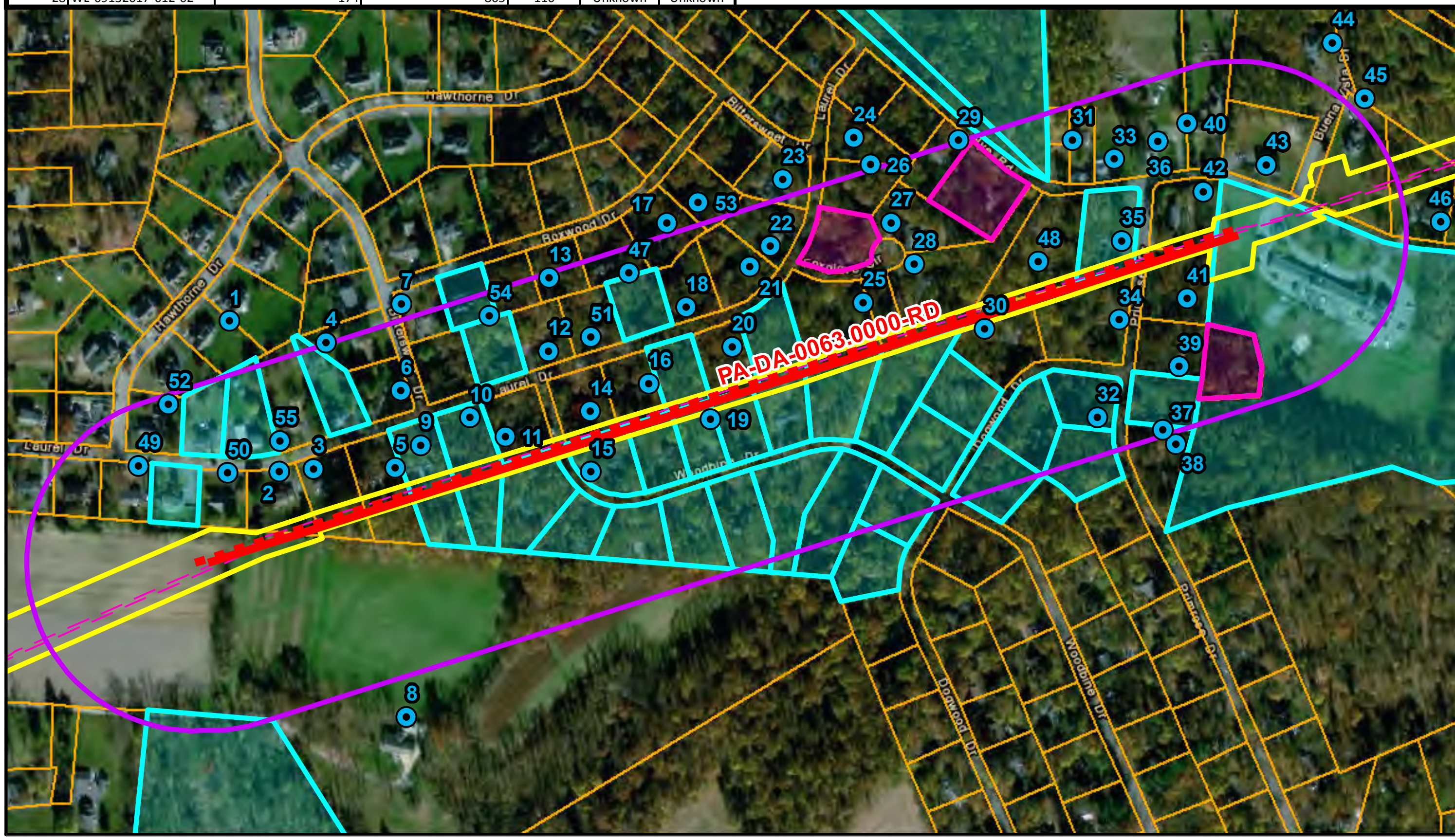
Summary of Laboratory Results

PSI Job No.: 04911436
Project: Energy Transfer HDD (DPS)
Location: Woodbine Dr. (PPP4)
Dauphin Co., PA
PA-DA-0063.0000-RD/PO#20170724-1

ATTACHMENT 3

Map Locator ID	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
1	WL-09122017-609-02	587	648	150-250	Unknown	Unknown
2	WL-09142017-606-01	163	308	250	Unknown	250
3	WL-09212017-618-01	141	376	Unknown	Unknown	Unknown
4	WL-09122017-617-01	453	667	Unknown	Unknown	Unknown
5	WL-06282017-606-01	78	559	70	Unknown	60
6	WL-09052017-610-01	270	689	100	40.5	58
7	WL-09082017-612-01	491	863	Unknown	Unknown	Unknown
8	WL-09122017-617-02	555	672	250	Unknown	230
9	WL-07112017-604-01	114	649	100	Unknown	75
10	WL-07112017-604-02	145	800	Unknown	Unknown	Unknown
11	WL-05232017-604-01	68	863	165	Unknown	160
12	WL-09122017-610-03	249	1,069	~170	Unknown	Unknown
13	WL-09082017-618-01	437	1,187	Unknown	Unknown	Unknown
14	WL-08072017-605-01	62	1,098	170-180	67-69	~160
15	WL-08040217-606-01	79	1,051	200+	Unknown	200
16	WL-06072017-475-02	85	1,271	90	Unknown	Unknown
17	WL-09122017-617-03	481	1,525	200	Unknown	Unknown
18	WL-09112017-612-01	249	1,448	Unknown	Unknown	Unknown
19	WL-06282017-606-02	42	1,396	LO Unavailable		
20	WL-06072017-475-01	111	1,383	Unknown	Unknown	Unknown
21	WL-09082017-612-03	301	1,303	Unknown	Unknown	Unknown
22	WL-09112017-618-01	336	1,246	Unknown	Unknown	Unknown
23	WL-09122017-609-01	496	1,218	LO Unavailable		
24	WL-09142017-609-02	545	1,051	LO Unavailable		
25	WL-05232017-604-02	117	1,017	Unknown	Unknown	Unknown
26	WL-09072017-609-03	462	992	Unknown	Unknown	Unknown
27	WL-09122017-611-01	297	923	Unknown	Unknown	Unknown
28	WL-09132017-612-02	174	865	110	Unknown	Unknown
29	WL-09132017-611-01	452	778	Unknown	Unknown	Unknown
30	WL-05242017-604-01	34	723	103	Unknown	80
31	WL-10062017-629-01	360	497	250	Unknown	Unknown
32	WL-09082017-618-02	351	616	Unknown	Unknown	Unknown
33	WL-09122017-610-01	278	375	150	70	Unknown
34	WL-09182017-609-01	120	390	300	Unknown	Unknown
35	WL-05242017-604-04	62	307	100	60-65	95
36	WL-09132017-612-01	287	314	180	140	Unknown
37	WL-09122017-610-02	435	558	400	Unknown	Unknown
38	WL-09132017-611-03	483	583	90	64	Unknown
39	WL-05242017-604-03	288	386	Unknown	Unknown	Unknown
40	WL-10062017-610-01	309	311	~180	~40	Unknown
41	WL-05242017-604-02	121	217	240	Unknown	130
42	WL-01092017-551-01	121	132	180-185	Unknown	185
43	WL-09132017-611-02	189	189	175	Unknown	Unknown
44	WL-09082017-612-02	561	561	350	190.4	Unknown
45	WL-09082017-613-03	492	492	350	Unknown	325
46	WL-09192017-475-01	544	544	Unknown	Unknown	Unknown
47	WL-08282017-606-04	384	1,366	Unknown	Unknown	Unknown
48	WL-09112017-616-01	78	534	LO Unavailable		
49	WL-09132017-608-02	300	300	120	Unknown	Unknown
50	WL-09252017-630-01	202	245	Unknown	Unknown	Unknown
51	WL-09112017-612-02	251	1,187	Unknown	Unknown	Unknown
52	WL-02152018-611-01	425	429	Unknown	Unknown	Unknown
53	WL-02212018-628-01	506	1,440	Unknown	Unknown	Unknown
54	WL-02232018-628-01	388	999	Unknown	Unknown	Unknown
55	WL-03122018-617-01	240	377	Unknown	Unknown	Unknown



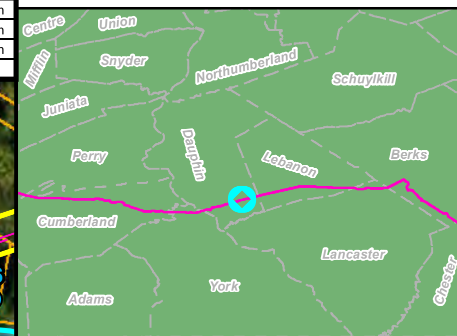
Legend

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

Testing Locations Current as of 2/5/2019

- GES Well Testing Location

Location



N

0 300 600 Feet

Well Location Map
HDD# PA-DA-0063.0000-RD
Dauphin County, PA.

Prepared By: TETRA TECH

Date: 2/5/2019

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

Coordinate System: NAD 83 Stateplane, PA South, Feet

P:\GIS\projects\112C05958-PPP\MXD\WellLocations\WellLocation_PA_DA_0063_0000.mxd JL

PAWellID	County	Municipali	QuadName	WellAddres	WellZip Code	DateDrille	TypeOfActi	LatitudeDD	LongitudeD	Driller	OriginalOw	WellUse
86247	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN			1983-08-02	NEW WELL	40.23167	-76.66056	MYERS BROS DRILLING CONTRACTORS INC	LUTRELL R	WITHDRAWAL
86311	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23389	-76.64833	EICHELBERGERS INC.	COBAUGH ROBERT	WITHDRAWAL
258954	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN	2885 Church Road		1989-02-01	NEW WELL	40.23389	-76.645		Champ	
86696	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23417	-76.64861	EICHELBERGERS INC.	EBERSOLE RALPH	WITHDRAWAL
86697	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23417	-76.64861	EICHELBERGERS INC.	MCROAKEL DON	WITHDRAWAL
416960	DAUPHIN	DERRY TWP.		2149 SANDHILL ROAD		2006-05-30	NEW WELL	40.23444	-76.66444	MYERS BROS DRILLING CONTRACTORS INC	CULLARI	
86699	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23472	-76.64639	EICHELBERGERS INC.	MCCORKEL DON	WITHDRAWAL
86698	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23472	-76.64639	EICHELBERGERS INC.	MCCORKEL DON	WITHDRAWAL
425252	DAUPHIN	CONEWAGO TWP.		183 DOGWOOD DRIVE		2008-09-16	NEW WELL	40.23528	-76.65111	MYERS BROS DRILLING CONTRACTORS INC	WENDLING	GEOTHERMAL
86428	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23528	-76.65056	MYERS BROS DRILLING CONTRACTORS INC	LYLE E	WITHDRAWAL
425240	DAUPHIN	CONEWAGO TWP.		183 DOGWOOD DRIVE		2008-09-16	NEW WELL	40.23556	-76.65111	MYERS BROS DRILLING CONTRACTORS INC	WENDLING	GEOTHERMAL
502044	DAUPHIN	CONEWAGO TWP.		171 Dogwood Drive	17033	2012-09-12	NEW WELL	40.23602	-76.65166	SENSENIG & WEAVER WELL DRILLING	Levi	GEOTHERMAL
502045	DAUPHIN	CONEWAGO TWP.		171 Dogwood Drive	17033	2012-09-12	NEW WELL	40.23602	-76.65166	SENSENIG & WEAVER WELL DRILLING	Levi	GEOTHERMAL
86419	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23639	-76.65278	MYERS BROS DRILLING CONTRACTORS INC	LUTTRELL RALPH	WITHDRAWAL
86411	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23694	-76.66111	MYERS BROS DRILLING CONTRACTORS INC	HAWK J	WITHDRAWAL
86427	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23694	-76.65028	MYERS BROS DRILLING CONTRACTORS INC	ZUDAY PETER	WITHDRAWAL
631719	DAUPHIN	CONEWAGO TWP.		150 WOODBINE DRIVE	17033	2002-02-12	NEW WELL	40.23694	-76.64917	EICHELBERGERS INC.	GARY C. PAINTER	WITHDRAWAL
86426	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23722	-76.65	MYERS BROS DRILLING CONTRACTORS INC	SHAFFER & SON	WITHDRAWAL
86414	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23778	-76.66111	MYERS BROS DRILLING CONTRACTORS INC	LUTTRELL RALPH	WITHDRAWAL
86413	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23778	-76.66083	MYERS BROS DRILLING CONTRACTORS INC	SHAFFER & SON	WITHDRAWAL
86412	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23778	-76.65972	MYERS BROS DRILLING CONTRACTORS INC	LUTTRELL RALPH	WITHDRAWAL
86416	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23778	-76.65889	MYERS BROS DRILLING CONTRACTORS INC	STOVER TOM	WITHDRAWAL
416046	DAUPHIN	CONEWAGO TWP.		3444 ROUND TOP ROAD		2006-03-13	NEW WELL	40.23778	-76.65833	MYERS BROS DRILLING CONTRACTORS INC	MUSSER	
86420	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23778	-76.65194	MYERS BROS DRILLING CONTRACTORS INC	LUTTRELL RALPH	WITHDRAWAL
554604	DAUPHIN	CONEWAGO TWP.		46 WOODBINE DRIVE	17033	2002-10-09	NEW WELL	40.23778	-76.65167	EICHELBERGERS INC.	ROBERT ATNIP	WITHDRAWAL
86425	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23778	-76.65	MYERS BROS DRILLING CONTRACTORS INC	BRIGHTON J	WITHDRAWAL
86417	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23806	-76.65861	MYERS BROS DRILLING CONTRACTORS INC	WINFRED HOMES	WITHDRAWAL
86423	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23806	-76.65083	MYERS BROS DRILLING CONTRACTORS INC	EBERSOLE RALPH	WITHDRAWAL
635061	DAUPHIN	CONEWAGO TWP.		38 DOGWOOD DRIVE	17033	2002-10-31	YIELD ENHAN	40.23806	-76.64889	EICHELBERGERS INC.	RICHARD J. SALUS	WITHDRAWAL
86418	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23833	-76.65528	MYERS BROS DRILLING CONTRACTORS INC	LEAMAN DAVID	WITHDRAWAL
86664	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23833	-76.65167	KOHL BROS. INC.	PAUL REBER BLDR	WITHDRAWAL
616441	DAUPHIN	CONEWAGO TWP.		10 DOGWOOD DRIVE	17033	2002-02-11	NEW WELL	40.23833	-76.64861	EICHELBERGERS INC.	JOHN W. GABRIEL	WITHDRAWAL
86752	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23861	-76.66111	MYERS BROS DRILLING CONTRACTORS INC	LUTRELL INC R W	WITHDRAWAL
86754	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23861	-76.66	MYERS BROS DRILLING CONTRACTORS INC	LUTRELL INC R W	WITHDRAWAL
86756	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23861	-76.65944	MYERS BROS DRILLING CONTRACTORS INC	SHAFFER FRED	WITHDRAWAL
86421	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23861	-76.65083	MYERS BROS DRILLING CONTRACTORS INC	WINFRED HOMES	WITHDRAWAL
86424	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23861	-76.65	MYERS BROS DRILLING CONTRACTORS INC	LUTTRELL RALPH	WITHDRAWAL
86422	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23861	-76.64972	MYERS BROS DRILLING CONTRACTORS INC	DAWSON L	WITHDRAWAL
86755	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23889	-76.65806	MYERS BROS DRILLING CONTRACTORS INC	SHAFFER & SON	WITHDRAWAL
86415	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23889	-76.6575	MYERS BROS DRILLING CONTRACTORS INC	LUTTRELL RALPH	WITHDRAWAL
86352	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23889	-76.65361	EICHELBERGERS INC.	LUTTREIL RALPH	WITHDRAWAL
86353	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23889	-76.65361	EICHELBERGERS INC.	LUTTRELL RALPH	WITHDRAWAL
86252	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN			1980-08-11	NEW WELL	40.23917	-76.65306	EICHELBERGERS INC.	WILLS T	WITHDRAWAL
86248	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN			1980-07-10	NEW WELL	40.23917	-76.65306	MYERS BROS DRILLING CONTRACTORS INC	DANNELS E	WITHDRAWAL
86264	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN			1981-02-01	NEW WELL	40.23917	-76.65028	EICHELBERGERS INC.	WOOD R	WITHDRAWAL
86759	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23944	-76.65639	MYERS BROS DRILLING CONTRACTORS INC	SHAFFER & SON	WITHDRAWAL
86362	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23944	-76.65528	EICHELBERGERS INC.	BULMER	WITHDRAWAL
86366	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23944	-76.65528	EICHELBERGERS INC.	DEROOY JACOB	WITHDRAWAL
86361	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.23944	-76.65528	EICHELBERGERS INC.	DENLINGER	WITHDRAWAL
86642	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23944	-76.65306	EICHELBERGERS INC.	LUTTRELL RALPH	WITHDRAWAL
86450	DAUPHIN	DERRY TWP.	MIDDLETOWN			1980-11-01	NEW WELL	40.23944	-76.6525	EICHELBERGERS INC.	PARR G	WITHDRAWAL
17648	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN			1958-10-28		40.23944	-76.6475	HARRISBURG'S KOHL BROS INC	HELEN O SNAVELY MI	WITHDRAWAL
86631	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23972	-76.65833	MYERS BROS DRILLING CONTRACTORS INC	SHAFFER & SON	WITHDRAWAL
86661	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23972	-76.65833	EICHELBERGERS INC.	LUTTRELL RALPH	WITHDRAWAL
86630	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23972	-76.65833	MYERS BROS DRILLING CONTRACTORS INC	FUGATE JOHN	WITHDRAWAL
86632	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.23972	-76.65833	MYERS BROS DRILLING CONTRACTORS INC	GOOD GEORGE	WITHDRAWAL
258255	DAUPHIN	DERRY TWP.	MIDDLETOWN	410 Laurel Drive		1991-11-01	NEW WELL	40.23972	-76.65333		Pharmer	
635055	DAUPHIN	CONEWAGO TWP.		26 PRIMROSE DRIVE	17033	2002-10-10	NEW WELL	40.23972	-76.64889	EICHELBERGERS INC.	SAMUEL P. WARD	WITHDRAWAL
86753	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.66167	ETNOYER WELL DRILLING	SHANK JERRY	WITHDRAWAL
86757	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.65722	MYERS BROS DRILLING CONTRACTORS INC	MCCORKEL D	WITHDRAWAL
86758	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.65667	EICHELBERGERS INC.	MCCOY TERRY	WITHDRAWAL
86635	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.65472	EICHELBERGERS INC.	LUTTRELL RALPH	WITHDRAWAL
86637	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.65472	EICHELBERGERS INC.	LUTTRELL RALPH	WITHDRAWAL
86638	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.65472	EICHELBERGERS INC.	FRANKHANEL RICH	WITHDRAWAL
86639	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.65472	WATER WELL DRILLERS LICENSING--TOPO G	LUTTRELL RALPH	WITHDRAWAL
86640	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.65472	EICHELBERGERS INC.	LUTTRELL RALPH	WITHDRAWAL
86641	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.65472	EICHELBERGERS INC.	LUTTRELL RALPH	WITHDRAWAL
86633	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.65472	EICHELBERGERS INC.	LUTTRELL RALPH	WITHDRAWAL
86634	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.65472	EICHELBERGERS INC.	LUTTRELL RALPH	WITHDRAWAL
86636	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24	-76.65472	EICHELBERGERS INC.	LUTTRELL RALPH	WITHDRAWAL
86249	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN			1980-05-06	NEW WELL	40.24	-76.6525	MYERS BROS DRILLING CONTRACTORS INC	LUTTRELL R	WITHDRAWAL
605136	DAUPHIN	CONEWAGO TWP.		7 PRIMROSE DRIVE	17036	2002-01-26	NEW WELL	40.24	-76.65028	EICHELBERGERS INC.	RANDY RUDY	WITHDRAWAL
625212	DAUPHIN	CONEWAGO TWP.		437 NYE ROAD	17036	2001-12-21	NEW WELL	40.24	-76.64639	EICHELBERGERS INC.	BRUCE KIRMAN	WITHDRAWAL
86250	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN			1980-01-23	NEW WELL	40.24028	-76.65333	MYERS BROS DRILLING CONTRACTORS INC	LUTTRELL R	WITHDRAWAL
560685	DAUPHIN	DERRY TWP.				1993-05-06	NEW WELL	40.24036	-76.65838	MYERS BROS DRILLING CONTRACTORS INC	collins	WITHDRAWAL
86466	DAUPHIN	DERRY TWP.	MIDDLETOWN			1983-08-01	NEW WELL	40.24056	-76.6525	EICHELBERGERS INC.	KULZER G	WITHDRAWAL
624932	DAUPHIN	DERRY TWP.		381 NYE ROAD	17036	2002-01-28	NEW WELL	40.24056	-76.65083	EICHELBERGERS INC.	JOHN L. GETTLE	WITHDRAWAL
86410	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN				NEW WELL	40.24056	-76.64972	HARRISBURG'S KOHL BROS INC	ALDINGER E	WITHDRAWAL
595320	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN	391 NYE ROAD	17036	2001-12-03	NEW WELL	40.24056	-76.64861	EICHELBERGERS INC.	BRUCE WILLMAN	WITHDRAWAL
560688	DAUPHIN	DERRY TWP.				1992-03-31	NEW WELL	40.24067	-76.65805	MYERS BROS DRILLING CONTRACTORS INC	collins	WITHDRAWAL
560689	DAUPHIN	DERRY TWP.				1992-03-31	NEW WELL	40.24067	-76.65805	MYERS BROS DRILLING CONTRACTORS INC	collins	WITHDRAWAL
259743	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN	11 Dogwood Drive		1993-06-29	NEW WELL	40.24075	-76.65377		Richard	
86448	DAUPHIN	DERRY TWP.	MIDDLETOWN			1980-07-16	NEW WELL	40.24083	-76.65361	MYERS BROS DRILLING CONTRACTORS INC	EBERSOLE R	WITHDRAWAL
86449	DAUPHIN	DERRY TWP.	MIDDLETOWN			1980-07-15	NEW WELL	40.24083	-76.65306	MYERS BROS DRILLING CONTRACTORS INC	LUTTRELL T	WITHDRAWAL
86751	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24111	-76.66194	MYERS BROS DRILLING CONTRACTORS INC	BANTA & DEIMLER	WITHDRAWAL
86271	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN			1983-09-09	NEW WELL	40.24139	-76.65639	MYERS BROS DRILLING CONTRACTORS INC	PANKAKE D	WITHDRAWAL
86272	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN			1982-03-19	NEW WELL	40.24139	-76.65611	HARRISBURG'S KOHL BROS INC	KRAFT E R	WITHDRAWAL
497034	DAUPHIN	DERRY TWP.		1871 Sandhill Road	17033	2011-08-05	NEW WELL	40.24159	-76.66071	SENSENIG & WEAVER WELL DRILLING	Shank	WITHDRAWAL
17649	DAUPHIN	DERRY TWP.	MIDDLETOWN			1970-09-29		40.24167	-76.66056	KOHL BROS. INC.	KROLL STANLEY	WITHDRAWAL
86270	DAUPHIN	CONEWAGO TWP.	MIDDLETOWN			1983-08-03	NEW WELL	40.24167	-76.65639	MYERS BROS DRILLING CONTRACTORS INC	RIDGELAND CORP	WITHDRAWAL
259736	DAUPHIN	DERRY TWP.	MIDDLETOWN	1852 Sand Hill Rd.		1997-10-02	NEW WELL	40.24206	-76.66326		Bucher & Clugh Custom	
560690	DAUPHIN	DERRY TWP.				1992-04-02	NEW WELL	40.24232	-76.65717	MYERS BROS DRILLING CONTRACTORS INC	collins	WITHDRAWAL
86750	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.2425	-76.66194	EICHELBERGERS INC.	NOORI S	WITHDRAWAL
86749	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24278	-76.66194	EICHELBERGERS INC.	NOORI S	WITHDRAWAL
86672	DAUPHIN	DERRY TWP.	MIDDLETOWN				NEW WELL	40.24278	-76.66	EICHELBERGERS INC.	LUTTRELL RALPH	WITHDRAWAL
560687	DAUPHIN	UNKNOWN				1992-04-01	NEW WELL	40.24291	-76.65808	MYERS BROS DRILLING CONTRACTORS INC	collins	WITHDRAWAL
560686	DAUPHIN	DERRY TWP.				1992-04-01	NEW WELL	40.24309	-76.65813	MYERS BROS DRILLING CONTRACTORS INC	collins	WITHDRAWAL

ATTACHMENT 3
WELLS WITHIN 0.5 MILES OF S3-0081 WOODBINE DR HDD
FROM PAGWIS DATABASE 1-10-18

PAWellID	WaterUse	Well Depth	TopOf Casin	BottomO fCa	CasingD iam	Depth ToBed	Bedrock Not	Well Yield	Static Water	Water Level	Length OfTe	YieldMeasu	FormationN	Remark
86247	DOMESTIC	125	0	73	6	41	False	12	0			VOLUMETRIC WATCH & BUCKET	HEIDLERSBURG MEM OF GETTY	
86311	STOCK	125	0	86	6	4	False	25	0			UNKNOWN	GETTYSBURG FORMATION	
258954	DOMESTIC	180	0	60	6	46	False	15	45	160	30	VOLUMETRIC WATCH & BUCKET		
86696	DOMESTIC	103	0	41	6	32	False	7	0			UNKNOWN	GETTYSBURG FORMATION	
86697	DOMESTIC	103	0	29	6	19	False	36	0			UNKNOWN	GETTYSBURG FORMATION	
416960	DOMESTIC	300	0	80	6	19	False	10	0			VOLUMETRIC WATCH & BUCKET		
86699	DOMESTIC	185	0	55	6	51	False	20	0			UNKNOWN	GETTYSBURG FORMATION	
86698	DOMESTIC	164	0	61	6	54	False	15	0			UNKNOWN	GETTYSBURG FORMATION	
425252	GEOTHERMAL	280	0	42	6	27	False	15	0			VOLUMETRIC WATCH & BUCKET		
86428	DOMESTIC	150	0	102	6	89	False	35	0			UNKNOWN	GETTYSBURG FORMATION	
425240	GEOTHERMAL	280	0	42	6	36	False	2	0			VOLUMETRIC WATCH & BUCKET		
502044	GEOTHERMAL	225	0	60	6	40	False	0	0					
502045	GEOTHERMAL	225	0	60	6	40	False	0	0					
86419	DOMESTIC	125	0	82	6	67	False	40	0				GETTYSBURG FORMATION	
86411	DOMESTIC	200	0	41	6	29	False	2	0			UNKNOWN	DIABASE DIKES AND SILLS	
86427	DOMESTIC	200	0	82	6	70	False	15	0				GETTYSBURG FORMATION	
631719	DOMESTIC	240	0	60	6	52	False	7	115	105	30	VOLUMETRIC WATCH & BUCKET		
86426	DOMESTIC	125	0	82	6	67	False	25	0				GETTYSBURG FORMATION	
86414	DOMESTIC	200	0	61	6	50	False	4	0				GETTYSBURG FORMATION	
86413	DOMESTIC	125	0	72	6	68	False	30	0				GETTYSBURG FORMATION	
86412	DOMESTIC	275	0	82	6	70	False	4	0			UNKNOWN	GETTYSBURG FORMATION	
86416	DOMESTIC	150	0	82	6	65	False	30	0				GETTYSBURG FORMATION	
416046	DOMESTIC	150	0	40	6	32	False	30	0			VOLUMETRIC WATCH & BUCKET		
86420	DOMESTIC	125	0	83	6	72	False	30	0				GETTYSBURG FORMATION	
554604	DOMESTIC	160	0	81	6	65	False	50	86	54	30	VOLUMETRIC WATCH & BUCKET		
86425	DOMESTIC	185	0	61	6	49	False	15	0			UNKNOWN	GETTYSBURG FORMATION	
86417	DOMESTIC	125	0	61	6	50	False	20	0				GETTYSBURG FORMATION	
86423	DOMESTIC	175	0	82	6	72	False	30	0				GETTYSBURG FORMATION	
635061	DOMESTIC	200	0	0	0	0	False	10	72	108	30	VOLUMETRIC WATCH & BUCKET		
86418	DOMESTIC	150	0	82	6	59	False	30	0				GETTYSBURG FORMATION	
86664	DOMESTIC	216	0	40	6	28	False	4	70		2	UNKNOWN	GETTYSBURG FORMATION	
616441	DOMESTIC	220	0	101	6	80	False	15	39	161	30	VOLUMETRIC WATCH & BUCKET		
86752	DOMESTIC	175	0	61	6	50	False	15	0				GETTYSBURG FORMATION	
86754	DOMESTIC	150	0	61	6	51	False	30	0				GETTYSBURG FORMATION	
86756	DOMESTIC	150	0	82	6	69	False	12	0				GETTYSBURG FORMATION	
86421	DOMESTIC	135	0	101	6	92	False	30	0			UNKNOWN	GETTYSBURG FORMATION	
86424	DOMESTIC	125	0	82	6	69	False	30	0				GETTYSBURG FORMATION	
86422	DOMESTIC	150	0	102	6	90	False	40	0			UNKNOWN	GETTYSBURG FORMATION	
86755	DOMESTIC	175	0	73	6	63	False	15	0				GETTYSBURG FORMATION	
86415	DOMESTIC	150	0	71	6	57	False	15	0				GETTYSBURG FORMATION	
86352	DOMESTIC	275	0	42	6	31	False	5	0			UNKNOWN	GETTYSBURG FORMATION	
86353	DOMESTIC	85	0	72	6	52	False	25	0			UNKNOWN	GETTYSBURG FORMATION	
86252	DOMESTIC	150	0	64	6	45	False	15	63			VOLUMETRIC WATCH & BUCKET	HEIDLERSBURG MEM OF GETTY	
86248	DOMESTIC	150	0	102	6	86	False	45	0			VOLUMETRIC WATCH & BUCKET	HEIDLERSBURG MEM OF GETTY	
86264	DOMESTIC	150	0	0	0	0	False	8	58	140	0.5	VOLUMETRIC WATCH & BUCKET	HEIDLERSBURG MEM OF GETTY	ROCK TYPE=SS AND CGL
86759	DOMESTIC	225	0	82	6	60	False	15	0			UNKNOWN	GETTYSBURG FORMATION	
86362	DOMESTIC	103	0	53	6	43	False	15	0			UNKNOWN	GETTYSBURG FORMATION	
86366	DOMESTIC	175	0	104	6	40	False	20	0			UNKNOWN	GETTYSBURG FORMATION	
86361	DOMESTIC	82	0	42	6	37	False	0	0				GETTYSBURG FORMATION	
86642	DOMESTIC	125	0	45	6	40	False	10	0			UNKNOWN	GETTYSBURG FORMATION	
86450	DOMESTIC	125	0	50	6	37	False	25	62			VOLUMETRIC WATCH & BUCKET	HEIDLERSBURG MEM OF GETTY	
17648	INSTITUTIONAI	300	0	64	6	0	False	30	150	238	24		GETTYSBURG FORMATION	
86631	DOMESTIC	275	0	73	6	61	False	4	0			UNKNOWN	GETTYSBURG FORMATION	
86661	DOMESTIC	123	0	55	6	50	False	12	0				GETTYSBURG FORMATION	
86630	DOMESTIC	125	0	61	6	47	False	25	0			UNKNOWN	GETTYSBURG FORMATION	
86632	DOMESTIC	75	0	51	6	45	False	15	0			UNKNOWN	GETTYSBURG FORMATION	
258255	DOMESTIC	300	0	42	6	35	False	20	70	280		VOLUMETRIC WATCH & BUCKET		
635055	DOMESTIC	260	0	61	6	18	False	20	135	105	30	VOLUMETRIC WATCH & BUCKET		
86753	DOMESTIC	55	0	44	6	0	False	28	23		1	UNKNOWN	GETTYSBURG FORMATION	
86757	DOMESTIC	125	0	82	6	45	False	40	0			UNKNOWN	GETTYSBURG FORMATION	
86758	DOMESTIC	100	0	68	6	56	False	30	0				GETTYSBURG FORMATION	
86635	DOMESTIC	200	0	60	6	54	False	10	0			UNKNOWN	GETTYSBURG FORMATION	
86637	DOMESTIC	150	0	58	6	52	False	30	0			UNKNOWN	GETTYSBURG FORMATION	
86638	DOMESTIC	225	0	64	6	60	False	9	0			UNKNOWN	GETTYSBURG FORMATION	
86639	DOMESTIC	83	0	64	6	54	False	40	0			UNKNOWN	GETTYSBURG FORMATION	
86640	DOMESTIC	200	0	53	6	50	False	8	0			UNKNOWN	GETTYSBURG FORMATION	
86641	DOMESTIC	150	0	42	6	36	False	15	0			UNKNOWN	GETTYSBURG FORMATION	
86633	DOMESTIC	210	0	92	6	87	False	50	0			UNKNOWN	GETTYSBURG FORMATION	
86634	DOMESTIC	175	0	46	6	40	False	25	0			UNKNOWN	GETTYSBURG FORMATION	
86636	DOMESTIC	150	0	124	6	120	False	30	0			UNKNOWN	GETTYSBURG FORMATION	
86249	DOMESTIC	150	0	112	6	102	False	20	0			VOLUMETRIC WATCH & BUCKET	HEIDLERSBURG MEM OF GETTY	
605136	DOMESTIC	120	0	84	6	65	False	35	62	38	30	VOLUMETRIC WATCH & BUCKET		
625212	DOMESTIC	300	0	60	6	45	False	7	108	172	30	VOLUMETRIC WATCH & BUCKET		
86250	DOMESTIC	150	0	103	6	90	False	30	0			VOLUMETRIC WATCH & BUCKET	HEIDLERSBURG MEM OF GETTY	
560685	DOMESTIC	0	0	0	0	0	False	0	0					
86466	DOMESTIC	400	0	70	6	60	False	6	30	390	0.5		HEIDLERSBURG MEM OF GETTY	
624932	DOMESTIC	165	0	63	6	25	False	6	75	70	30	VOLUMETRIC WATCH & BUCKET		
86410	DOMESTIC	220	0	75	6	69	False	15	100		1	UNKNOWN	GETTYSBURG FORMATION	
595320	DOMESTIC	150	0	56	6	32	False	15	70	60	30	VOLUMETRIC WATCH & BUCKET		
560688	DOMESTIC	0	0	0	0	0	False	0	0					Note: Coordinates are approximate. A second location based on the driller sketch was placed more than 500 feet away from this location.
560689	DOMESTIC	0	0	0	0	0	False	0	0					Note: Coordinates are approximate. A second location based on the driller sketch was placed more than 500 feet away from this location.
259743	OTHER	350	0	105	6	91	False	6	83	330		VOLUMETRIC WATCH & BUCKET		
86448	DOMESTIC	150	0	102	6	90	False	30	0			VOLUMETRIC WATCH & BUCKET	HEIDLERSBURG MEM OF GETTY	
86449	DOMESTIC	175	0	122	6	95	False	20	0			VOLUMETRIC WATCH & BUCKET	HEIDLERSBURG MEM OF GETTY	
86751	DOMESTIC	100	0	61	6	47	False	30	0				GETTYSBURG FORMATION	
86271	DOMESTIC	175	0	82	6	35	False	15	0			VOLUMETRIC WATCH & BUCKET	GETTYSBURG FORMATION	
86272	DOMESTIC	300	0	50	6	30	False	12	65	300	1	VOLUMETRIC WATCH & BUCKET	GETTYSBURG FORMATION	
497034	DOMESTIC	160	0	42	6	37	False	30	0			VOLUMETRIC WATCH & BUCKET		
17649	DOMESTIC	216	0	40	6	0	False	4	75	205	2		GETTYSBURG FORMATION	
86270	DOMESTIC	175	0	102	6	55	False	7	0			VOLUMETRIC WATCH & BUCKET	GETTYSBURG FORMATION	
259736	OTHER	225	0	120	6	105	False	18	30	205		VOLUMETRIC WATCH & BUCKET		
560690	DOMESTIC	0	0	0	0	0	False	0	0					Note: Coordinates are approximate. A second location based on the driller sketch was placed more than 500 feet away from this location.
86750	DOMESTIC	175	0	58	6	58	False	65	0			UNKNOWN	GETTYSBURG FORMATION	
86749	DOMESTIC	175	0	130	6	130	False	50	0				GETTYSBURG FORMATION	
86672	DOMESTIC	246	0	45	6	40	False	0	0				GETTYSBURG FORMATION	
560687	DOMESTIC	0	0	0	0	0	False	0	0					Note: Coordinates are approximate. A second location based on the driller sketch was placed more than 500 feet away from this location.
560686	DOMESTIC	0	0	0	0	0	False	0	0					Note: Coordinates are approximate. A second location based on the driller sketch was placed more than 500 feet away from this location.

HORIZONTAL DIRECTIONAL DRILL ANALYSIS
WOODBINE DRIVE CROSSING
PADEP SECTION 105 PERMIT NO.: E22-617
PA-DA-0063.0000-RD-16
(SPLP HDD No. S3-0081-16)

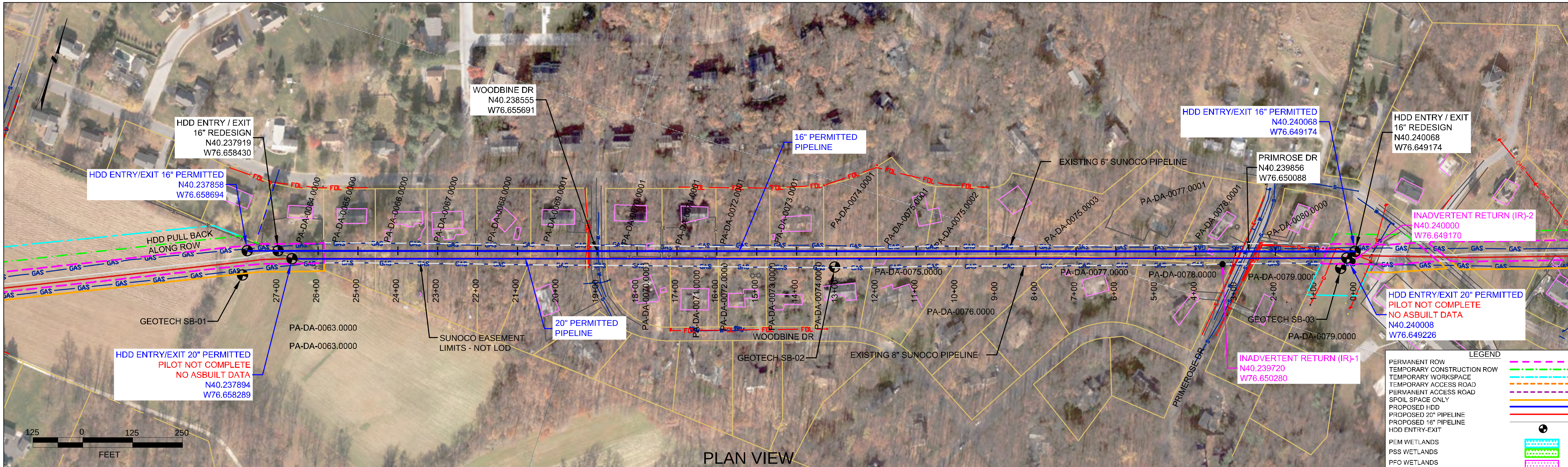
ATTACHMENT 1

GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT

HORIZONTAL DIRECTIONAL DRILL ANALYSIS
WOODBINE DRIVE CROSSING
PADEP SECTION 105 PERMIT NO.: E22-617
PA-DA-0063.0000-RD-16
(SPLP HDD No. S3-0081-16)

ATTACHMENT 2

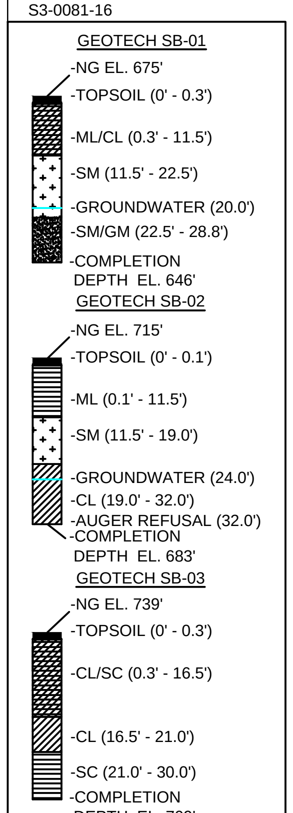
HORIZONTAL DIRECTIONAL DRILL PLAN AND PROFILES



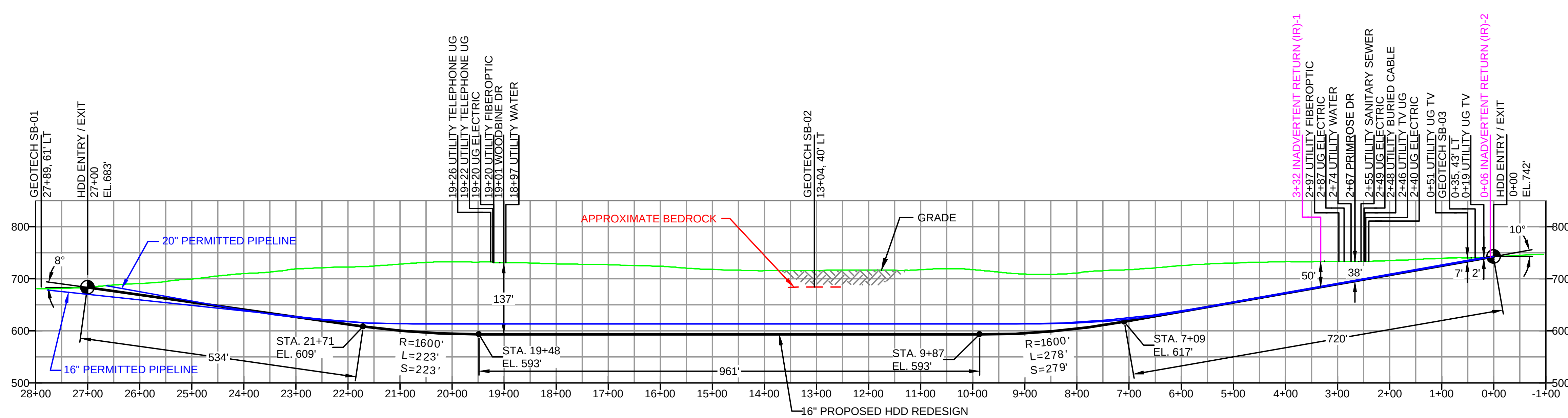
PLAN VIEW

DAUPHIN COUNTY, PENNSYLVANIA - CONEWAGO TOWNSHIP
S3-0081-16

PROFILE VIEW



NOTE: REFER TO TEST BORING LOG S2-0081 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=): 2700'
   HDD PIPE LENGTH (S=): 2717'
   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 1. 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	DESIGN CHANGE - SHORTENED DRILL	MRS	03/16/17	RMB	03/16/17	AMC	03/16/17
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

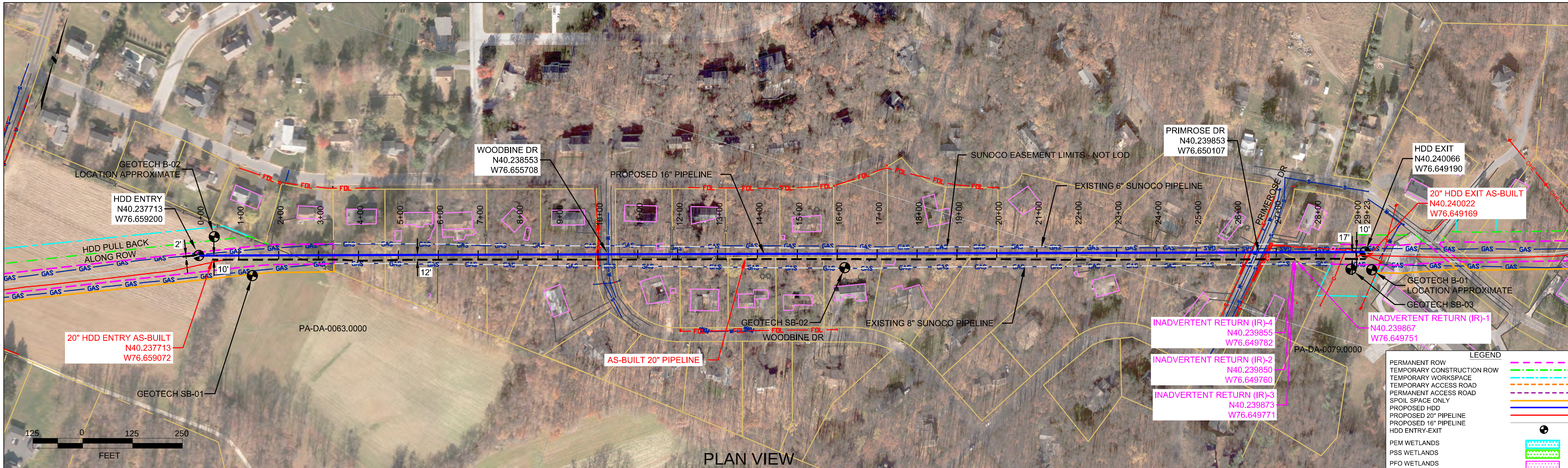
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WOODBINE DRIVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'
DWG. NO: PA-DA-0063.0000-RD-16 IR EXHIE



PLAN VIEW

DAUPHIN COUNTY, PENNSYLVANIA - DERRY TOWNSHIP
S3-0081-16

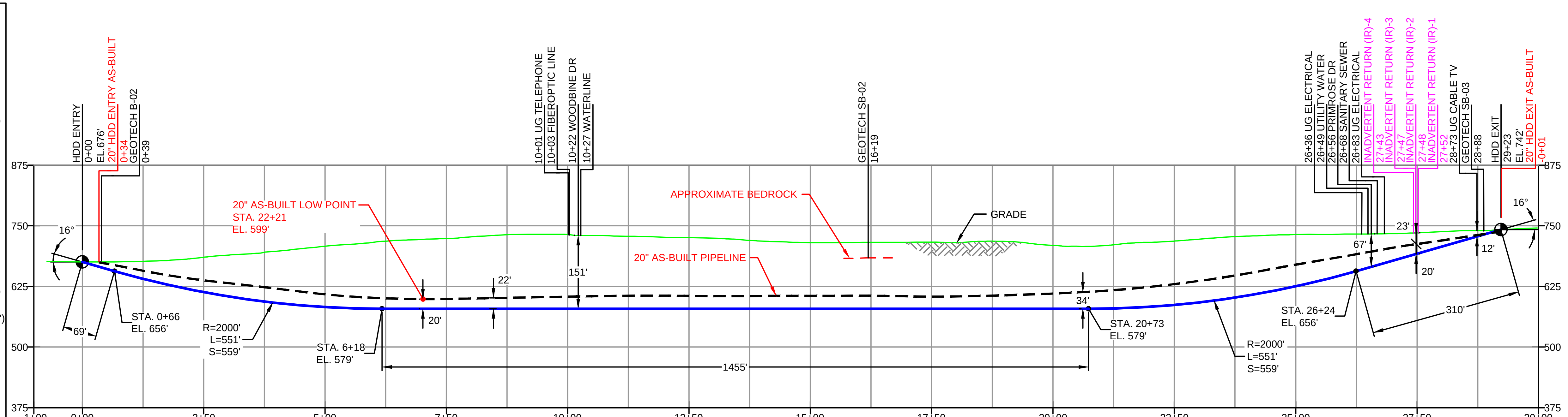
PROFILE VIEW

GEOTECH SB-01
- -NG EL. 675'
- -TOPSOIL (0' - 0.3')
- -ML/CL (0.3' - 11.5')
- -SM (11.5' - 22.5')
- -GROUNDWATER (20.0')
- -SM/GM (22.5' - 28.8')
- -COMPLETION DEPTH EL. 646'

GEOTECH SB-02
- -NG EL. 715'
- -TOPSOIL (0' - 0.1')
- -ML (0.1' - 11.5')
- -SM (11.5' - 19.0')
- -GROUNDWATER (24.0')
- -CL (19.0' - 32.0')
- -AUGER REFUSAL (32.0')
- -COMPLETION DEPTH EL. 683'

GEOTECH SB-03
- -NG EL. 739'
- -TOPSOIL (0' - 0.3')
- -CL/SC (0.3' - 16.5')
- -CL (16.5' - 21.0')
- -SC (21.0' - 30.0')
- -COMPLETION DEPTH EL. 709'

NOTE: REFER TO TEST BORING LOG S2-0081 FOR COMPLETE SOIL MATERIAL DESCRIPTION



GEOTECH B-01
- -NG EL. 743'
- -RESIDUUM CLAYEY SAND SC (0.0' - 4.0')
- -RESIDUUM SAND SP (4.0' - 8.0')
- -RESIDUUM CLAYEY SAND SC-SM (8.0' - 33.0')
- -SPOON REFUSAL (33.0')
- -GROUNDWATER (43.0')
- -BEDROCK SANDSTONE (33.0' - 100.0')
- -BORING TERMINATED EL.643'

NOTE: REFER TO TEST BORING LOG B-01 INTERTEK PROJECT #04911436 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-02
- -NG EL. 678'
- -RESIDUUM LEAN CLAY CL (0.0' - 8.0')
- -RESIDUUM CLAYEY SAND SC (8.0' - 11.5')
- -RESIDUUM SILTY SAND W/ GRAVEL SM (11.5' - 16.5')
- -GROUNDWATER (23.0')
- -RESIDUUM SANDY SILT ML (16.5' - 21.5')
- -RESIDUUM SILTY SAND SM (21.5' - 36.5')
- -RESIDUUM FINE SANDY SILT ML (36.5' - 38.5')
- -BEDROCK SANDSTONE (38.5' - 97.0')
- -BORING TERMINATED EL.581'

NOTE: REFER TO TEST BORING LOG B-02 INTERTEK PROJECT #04911436 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:
1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXITING 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=):2923'
   HDD PIPE LENGTH (S=):2952'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 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 2. Redesigned 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

DWG NO		DWG NO	DESCRIPTION
ES-4.27	TO	ES-4.29	EROSION & SEDIMENT PLAN
SHEET 17	TO	SHEET 17	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP3	DESIGN CHANGE - LOWERED DRILL AND ADDED GEOTECH	MRS	01/25/19	RMB	01/25/19	AMC	01/25/19
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		DLM	11/13/15	RMB	11/13/15	AAW	11/13/15
B	ADDED GEOTECH INFO/DESIGN ADJUSTMENT	MRS	10/27/15	RMB	10/27/15	AAW	10/27/15
A	ISSUED FOR BID	MRS	08/31/15	RMB	08/31/15	AAW	08/31/15

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WOODBINE DRIVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'
DWG. NO: PA-DA-0063.0000-RD-16