HORIZONTAL DIRECTIONAL DRILL ANALYSIS
ROUTE 897, WETLAND B72PEM, & STREAM S-B82 CROSSINGS
PADEP SECTION 105 PERMIT NO.S:
PA-LA-0024.000-RD & PA-LA-0024.000-RD-16
(SPLP HDD# S3-0170)

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INTRODUCTION

The crossing of Route 897, Wetland B72PEM, and Stream S-B82 was originally designed and permitted as a conventional bore of the road, wetland, and stream with the pipeline installations parallel to the existing Sunoco Pipeline, L.P. (SPLP) pipelines.

The Pennsylvania Department of Transportation (PADOT) denied a permit for the original plan of construction due to concerns of potential damage to the bridge foundation at the crossing location. To address PADOT concerns, a horizontal directional drill (HDD) was designed, submitted, and approved by PADOT. However, due to concerns on the short length and shallow profile of the HDD an analysis of the HDD was performed by SPLP before submittal to the Pennsylvania Department of Environmental Protection. The discussion below presents the results, conclusion, and revised construction plans derived from the HDD analysis.

HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 20-INCH & 16-INCH

- Horizontal length: 968 feet
- Entry angle: 11 degrees
- Maximum depth of cover: 40 feet
- Pipe stress radius: 2,000 feet

GEOLOGIC ANALYSIS

According to the analysis provided in Attachment 1 the crossings of Route 897, Wetland B72PEM and Stream S-B82 is situated in the northern portion of the Gettysburg-Newark Lowland Section of the Piedmont Physiographic Province. In eastern Pennsylvania, this portion of the Gettysburg-Newark Lowland Physiographic Province is underlain by sedimentary rocks of the Newark Group. These sedimentary rocks were deposited in a fault-bounded rift basin, commonly referred to as the Newark Basin during late Triassic through early Jurassic time (Root and MacLachlan, 1999). The rocks comprising the Newark Basin often exhibit a reddish color and consist principally of conglomerate, arkose, sandstone, siltstone, argillite, and shale. Locally, the sedimentary sequence is interbedded with basaltic lava flows and is intruded by diabase dikes and sills.

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

HYDROGEOLOGY, GROUND WATER, AND WELL PRODUCTION ZONES

Groundwater movement within the rocks underlying the Lancaster County area 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. Primary porosity and permeability within the clastic rocks underlying the Lancaster County area is virtually nonexistent. The secondary porosity of the rock is determined by the number and size of the openings, whereas the secondary permeability is a reflection of the degree of interconnection of the openings.

Sufficient water for domestic purposes can be obtained from wells drilled 40 to 500 feet below the ground surface. Poth (1977) reports that groundwater yields from domestic water supply wells completed in the Hammer Creek Formation in Lancaster County range from 5 to 94 gallons per minute (gpm), with a median yield of 16 gpm.

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Attachment 1 provides a discussion on the hydrogeology and groundwater characteristics at this location.

ADJACENT FEATURES ANALYSIS

The crossings of Route 897, adjacent stream, and wetland is located in rural Lancaster County, approximately 0.6 miles west of the community of Blainsport and 18 miles north-northeast of Lancaster, PA.

The pipeline route in this area of Lancaster County follows parallel to two (2) previously existing SPLP pipelines. At this location, on the east side of the Route 897, a residential home site and secondary structures are immediate to the existing permanent utility easement. To minimize the disturbance to natural resources and the residential home site while crossing the state highway a horizontal directional drill was planned as described in the specifications above and as shown Figure 1 in Attachment 2. The HDD as designed would result in no direct affect to the wetland, stream, or residential area.

In addition to the resources listed above, four (4) domestic (private) supply wells are within 450 feet of the proposed HDD.

INADVERTENT RETURNS DISCUSSION

As discussed in the Geologic and Hydrogeology Report in Attachment 1, the shallow depth to bedrock in the geotechnical borings, and a reported static water level of 11.9 feet below grade in a domestic well near the HDD entry suggests groundwater flow in the unconsolidated materials overlying bedrock. Based on this information, the HDD location is susceptible to the release of drilling fluids (Inadvertent Return, or IR) into the unconsolidated materials.

The subsurface characteristics in combination with the HDD design resulted in a conclusion that potentially uncontrollable IR’s to the stream and wetland were likely, and an alternate plan of construction should be developed.

ALTERNATIVES ANALYSIS

Because of geographic orientation of the overall route of the pipeline project, there is no alternative route than can avoid crossing Route 897 and Stream S-B82.

The original plan of construction was a conventional bore of the roadway and stream, and open trench construction following parallel to the existing pipelines through Wetland B72PEM and the residence yard,.

The HDD was the first alternative plan of installation to avoid impacts to the stream, wetland, and residence area as illustrated on Figure 1 in Attachment 2.

The third and final plan of installation is illustrated on Figure 2 in Attachment 2. This alternative route and construction plan creates a new permanent utility easement outside and separate from the existing utility easement, creating an additional encumbrance to the property of the affected private landowner; however by use of conventional bores, avoids direct impacts to the roadway, stream and wetland.

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Open-cut Analysis

PADOT will not allow an open cut crossing of Route 897.

Secondary to the open cut of the highway, an open cut of Wetland B72PEM and Stream S-B82 has been considered and rejected since these actions would require a major modification of the Chapter 105 permits issued by the Pennsylvania Department of Environmental Protection (PADEP) and alternative procedures exist to maintain these permits while accomplishing the pipeline installations.

Re-Route Analysis

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

The proposed route, as discussed in the conclusions section below is a deviation away from the existing permanent easement, and creates a new utility permanent encumbrance to the private property owners.

There are no other route adjustments that can eliminate or minimize the encumbrance of the proposed route and potential affects to natural resources.

CONCLUSION

The analysis of the HDD plans resulted in a conclusion of unacceptable IR risk if this HDD was attempted; therefore the HDD plan has been abandoned. To avoid potential unauthorized discharges to waters and wetlands of the state an altered conventional bore construction plan has been designed to address the concerns proffered by PADOT while maintaining the PADEP permit validity.

As illustrated on Figure 2 in Attachment 2, the revised plan of construction is to install the 16-inch and 20-inch pipelines by a combination of two (2) conventional horizontal bores (not HDD) and open cut (trench) construction.

The existing limits of disturbance (LOD) are sufficient to accommodate this revised plan of construction and does not require a modification of any state or federal permits.

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ATTACHMENT 1

GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT

RETTEW

We answer to you.

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Engineers

Environmental Consultants

Surveyors

Landscape Architects

Safety Consultants

September 8, 2017

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

RE: Sunoco Pipeline, L.P. Pipeline Project - Mariner East II
State Route 897 Horizontal Directional Drill Location (S3-0170)
Hydrogeological Re-Evaluation Report
West Cocalico Township, Lancaster County, Pennsylvania
RETTEW Project No. 096302011

Dear Mr. Gordon:

RETTEW Associates, Inc. is pleased to provide the enclosed Hydrogeological Re-Evaluation Report for the State Route 897 Horizontal Directional Drill (HDD) Location (S3-0170). This HDD Re-Evaluation Report was performed as required by the Stipulated Order dated August 8, 2017. Please note that the HDD Re-Evaluation Report for S3-0170 was prepared by Skelly and Loy, Inc. (Skelly & Loy) under subcontract to RETTEW. Mr. Douglas Hess, Director of Groundwater and Site Characterization Services, was the Professional Geologist (P.G.) at Skelly and Loy that supervised the work for this report.

If you have any questions regarding the Hydrogeological Re-Evaluation Report for HDD S3-0170, please do not hesitate to call Mr. Hess at 717-232-1799.

Sincerely,

Matthew T. Bruckner, P.G.

Enclosure

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September 7, 2017

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

Re: Sunoco PA Pipeline Project Mariner East II State Route 0897 Horizontal Directional Drill (HDD) Location (S3-0170)
Hydrogeological Reevaluation Report
West Cocalico Township, Lancaster County, Pennsylvania
Rettew Project No. 096302011

EXECUTIVE SUMMARY

1. The State Route 0897 Horizontal Directional Drill (HDD) location is included in the Stipulated Order August 8, 2017, requiring reevaluation, including a geologic report.

2. HDD 897 is underlain by sedimentary rocks of the Hammer Creek Formation.

3. Geologic mapping, reports, and field observations indicate typically open and steeply dipping beds with regularly spaced jointing and fracturing.

4. Water-bearing zones generally occur in secondary openings along bedding planes, joints, faults and fractures. Water-bearing zones in the Hammer Creek Formation are reported to be distributed within the first 200 feet of the subsurface, with the greatest density of water-bearing zones occurring within the upper 100 feet of the subsurface.

5. The proposed HDD bore path is relatively shallow compared with the land surface, wetland (B72PEM), and the streambed of Harnish Run (Stream S-B82).

6. To date, no HDD operations have been initiated at the HDD 897 site. As a result, no drilling observations were available for review or inclusion with this HDD reevaluation report.

7. Based on the hydro-structural characteristics of the underlying geology and proposed bore path through shallow unconsolidated soil materials and above shallow bedrock, the Route 0897 HDD is susceptible to the inadvertent return of drilling fluids during HDD operations.

1. INTRODUCTION

The purpose of this report is to describe the hydrogeologic setting of the Route 0897 (S3-0170) HDD location on the Sunoco Pipeline, L.P. (SPLP) Pennsylvania Pipeline Project-Mariner East (PPP-ME2) Project. HDD 897 is located in West Cocalico Township, Lancaster County, Pennsylvania. The site is located east of South Peartown Road and was designed to be drilled under the stream channel of Harnish Run, a wetland area, and State Route 0897 (refer to **Figure 1**). This hydrogeologic report is part of the response to the Stipulated Order dated August 8, 2017, related to the potential for the inadvertent return of drilling fluids during proposed drilling operations.

Proposed HDD 897 is located within the Gettysburg-Newark Lowland Section of the Piedmont Physiographic Province (Pennsylvania Department of Conservation and Natural Resources [DCNR], 2000). The dominant topography is typified by rolling lowlands, shallow valleys, and isolated hills. Local relief is low to moderate and ranges within the site from approximately 474 feet above mean sea level (AMSL) to 483 feet AMSL (Google Earth, 2017). The site is drained by Harnish Run which flows from north to south through the center of the proposed east-west HDD path. Harnish Run flows approximately 0.7 mile southward from the site and empties into Blue Lake/Cocalico Creek. In addition, a farm pond is located within approximately 600 feet of the eastern end of the HDD. The area surrounding the HDD is comprised of rural properties and land uses (e.g., farming, agriculture).

The proposed HDD entry point is at a surface elevation of 473 feet AMSL forming a slightly concave HDD profile that slopes gently upward toward the east to an elevation of 487 feet AMSL at the HDD exit point. The proposed HDD will cross Harnish Run at a depth of approximately 40 feet below ground surface (bgs). The HDD is located between Stations 13083+00 and 13092+25 on the pipeline, for an overall horizontal length of 968 feet. The location of HDD 897 is shown on **Figure 1**.

2. GEOLOGY AND SOILS

A number of available published and online references were reviewed to evaluate the geology and soils present in the vicinity of HDD 897. Detailed descriptions of the soils and bedrock geology underlying HDD 897 are included in the following sections.

According to the United States Department of Agriculture Soil Survey of Lancaster County, Pennsylvania, soils at the site within 450 feet of the drill path of the S3-0170 HDD consist of Bowmansville silt loam (Bo), Holly silt loam (Hg), Rowland silt loam (Rd), Ungers loam (UaB), and Readington silt loam (RaB). A site map showing the spatial distribution of the various soils along with the soil profile descriptions is included as **Attachment 1**.

Geyer and Bolles (1979) reported that the HDD 897 area is situated in the northern portion of the Gettysburg-Newark Lowland Section of the Piedmont Physiographic Province. In eastern Pennsylvania, this portion of the Gettysburg-Newark Lowland Physiographic Province is underlain by sedimentary rocks of the Newark Group. These sedimentary rocks were deposited in a fault-bounded rift basin, commonly referred to as the Newark Basin during late Triassic through early Jurassic time (Root and MacLachlan, 1999). The rocks comprising the Newark Basin often exhibit a reddish color and consist principally of conglomerate, arkose, sandstone, siltstone, argillite, and shale. Locally, the sedimentary sequence is interbedded with basaltic lava flows and is intruded by diabase dikes and sills.

According to Poth (1977) and Berg and Dodge (1981), the area in the vicinity of HDD 897 is underlain by clastic rocks (i.e., siltstone/sandstone and shale) that are mapped as the Hammer Creek formation of Triassic age. The Hammer Creek formation in Lancaster County is comprised primarily of red and brown shale, siltstone, sandstone, and conglomerates. The shales and siltstones are typically thin to medium-bedded, whereas the sandstones are very fine- to coarse-grained and thin to thick-bedded. The conglomerates are thick bedded with clasts/interbeds of quartz, quartzite, sandstone, siltstone, limestone, and shale. The rocks of the Newark Basin generally dip an average of 200 to the north-northwest. The geologic structure of the Gettysburg-Newark Lowland Physiographic Province consists principally of a north-northwestward dipping homocline (Newport, 1971).

According to Geyer and Wilshusen (1982), the Hammer Creek Formation underlying the HDD 897 area has moderately developed, moderately abundant, regularly spaced, naturally occurring fractures known as joints. These joints are typically open and steeply dipping. The joint and bedding plane openings collectively provide a secondary porosity of moderate magnitude and a permeability of low to moderate magnitude. The formation is moderately resistant to weathering and is characterized by rough terrain of high relief. Natural slopes are generally steep and stable. The overlying soil mantle is moderately thick. The shales comprising the formation are highly weathered to a moderate depth, whereas the areas underlain by sandstones and conglomerates exhibit much less weathering. The unweathered portions of the Hammer Creek formation are usually difficult to excavate. The rock reportedly provides good foundation stability. Drilling rates are typically slow due to the presence of quartz pebble conglomerate and in areas where rock is adjacent to diabase intrusions.

3. HYDROGEOLOGY

The pore spaces within the bedrock matrix are relatively small (Poth, 1977, and Wood, 1980). As a result, primary porosity and permeability within the clastic rocks underlying the Lancaster County area are virtually nonexistent. The secondary porosity of the rock is determined by the number and size of the openings, whereas the secondary permeability is a reflection of the degree of interconnection of the openings. Groundwater movement within these rocks underlying the Lancaster County area 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. Some fractures may parallel the bedding planes. These fractures, however, are generally narrow and are not considered to be an important mechanism in the movement of groundwater within the aquifer. The most important openings for the movement of groundwater in the subsurface are the nearly vertical joint planes that intersect each other at various angles. These vertical joints provide an interconnected series of channels through which groundwater can flow. Two small faults are mapped to the north, one approximately 1,000 feet and the second approximately 2,000 feet from the HDD entry point. These structural features are identified on the geologic mapping included as **Figure 2**.

Bedrock geology ultimately influences the storage, transmission, and use of groundwater. Geologic factors such as rock type, intergranular porosity, rock strata inclination, faults, joints, bedding planes, and solution channels affect groundwater movement and availability. According to Wood (1980) groundwater within the clastic rocks of Lancaster County occurs under both unconfined (i.e., water table) and confined (i.e., artesian) 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 is conceptualized by Wood (1980) as a series of sedimentary beds with relatively high transmissivity separated by beds exhibiting lower transmissivities. This sequence of beds exhibit different hydraulic properties that collectively act as a series of alternating aquifers and confining or semi-confining units forming a leaky multi-aquifer system. Groundwater flow paths within the clastic rocks have both local and regional components. Locally, shallow groundwater discharges to the gaining portions of nearby streams. Deeper regional groundwater flow is toward points of regional groundwater discharge such as the Schuylkill River. Groundwater divides may be different for each zone of groundwater flow, and therefore may not coincide with surface water divides. Based on our review of available reference sources, no regional water table mapping is available for the HDD 897 site or surrounding area. As a result, no water table mapping was available for review or inclusion with this HDD reevaluation report.

The direction of groundwater flow within the clastic rocks of Lancaster County is largely controlled by the hydraulic gradient and spatial variability of the 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 (Poth, 1977). The movement of groundwater in the fractured bedrock is generally greatest in highly permeable fractures and the orientation of the bedding planes and fractures strongly control the direction of groundwater flow within the aquifer (Sloto and Schreffler, 1994). Wells drilled to the same depth along strike generally penetrate the same water-bearing zones, whereas wells drilled to the same depth several hundred feet down dip of each other rarely intersect the same water bearing beds. The potential for well interference caused by pumping is generally greatest for wells aligned parallel to strike, rather than in wells drilled in the direction of dip (i.e., perpendicular to strike). Wells spaced less than 2,000 feet apart along strike often experience interference effects (Newport, 1971). The cones of depression induced by pumping wells are usually elliptical in nature rather than circular, with the long axis orientated parallel to the strike of the rock bedding (Sloto and Schreffler, 1994). No groundwater modeling was performed for the area surrounding HDD 897.

The success of a well drilled into a bedrock formation is dependent on the number and size of the natural openings encountered by the well bore as well as the degree to which these fissures are interconnected. Poth (1977) reports that the Hammer Creek formation in Lancaster

County is generally a reliable source of small to moderate supplies of groundwater. Hall (1934) reports that water-bearing fractures contained in the Hammer Creek formation generally decrease in size and number with depth. A study of the Brunswick formation (Hammer Creek equivalent) in Berks and Montgomery Counties by Longwill and Wood (1965) suggests that, if groundwater yields of 100 gallons per minute (gpm) or more are desired, wells should be drilled to depths of at least 200 feet. This same study suggests that wells drilled to depths between 200 and 550 feet are the most likely to obtain maximum yields of groundwater. Sufficient water for domestic purposes can be obtained from wells drilled 40 to 500 feet below the ground surface. Poth (1977) reports that groundwater yields from domestic water supply wells completed in the Hammer Creek Formation in Lancaster County range from 5 to 94 gpm, with a median yield of 16 gpm.

According to Low, et al (2002), the depths of water-bearing zones range from 5 to 445 feet below land surface. In addition, 50% of the 544 water-bearing zones were penetrated at a depth of less than 90 feet with 90% of the water-bearing zones occurring at a depth of less than 197 feet. The greatest density of water-bearing zones is from 51 to 100 feet below land surface. The density of water-bearing zones encountered at depths greater than 301 feet are based on the presence of 6 or fewer water-bearing zones per 50-foot interval. The overall density of water-bearing zones in the Hammer Creek Formation is 0.67 per 50 feet of well depth.

Well records from the PA DCNR's Pennsylvania Groundwater Information System (PaGWIS) database were reviewed to identify domestic water supply wells located within 450 feet of the proposed HDD right-of-way (ROW) boundary (PaGWIS, 2017). The search resulted in the identification of four domestic (private) supply wells, one monitoring well installed in 2004 for Sunoco Logistics, and miscellaneous well construction and ownership information for each well as shown in **Figure 3**. A map showing the well locations relative to the proposed HDD is also included in **Figure 3**. Based solely on the PaGWIS database (**Figure 3**), it appears that the identified wells are completed in the Hammer Creek Formation at depths ranging from 140 to 155 feet below grade, are constructed with between 42 and 80 feet of steel casing, and yield from 40 to 75 gpm. The reported depth to bedrock ranges from 12 to 65 feet below grade. One static water level measurement of 11.9 feet was recorded in one of the domestic wells. One of the wells listed was also identified as being completed in the Gettysburg Formation; however, it is unknown how this was determined. Based on mapping available for the area and geologic similarities between the Gettysburg Formation (located west of the Dauphin County line) and the Hammer Creek Formation, it would appear that all of the wells identified above were completed in the Hammer Creek Formation.

4. FRACTURE TRACE ANALYSIS

Fracture traces are defined as concentrated areas of high angle bedrock fracturing forming linear features that can be identified using topographic mapping and aerial photography. Five fracture traces are reported to lie to the northeast, east, and southeast of HDD 897 and within 2,000 feet of the currently proposed HDD entry point. Another fracture trace is mapped less than 1,000 feet to the northwest of the entry point. These features are likely related to the primary geologic structure of the project area discussed above. The approximate locations of these fracture traces were copied from Plate 1, Part 2, in Wood (1980) and plotted on the Geology Map included as **Figure 2**.

A review of aerial photography dated November 11, 1957, was also performed to supplement the fracture analysis reported in Wood (1980). The fracture traces identified in Wood (1980) in close proximity to HDD 897 were identified on the photography; however, none of the features mapped beyond 1,000 feet east of the HDD exit point were discernible and as a result could not be verified. These fracture trace locations or their associated degree of topographic expression were not verified in the field; however, general surface drainage patterns near the HDD are characterized by linear stream reaches in a NE-SW or W-E trend. Harnish Run flows generally NE-SW which appears to reflect this local geologic structure.

5. GEOTECHNICAL EVALUATION

Two geotechnical borings (Geotech SP-5-1B and Geotech SP-5-1A) were completed from July 5 through July 7, 2017, during the preliminary investigation of the HDD 897 site and prior to initiating HDD operations. Both borings were completed to investigate soil, residual soil, and shallow weathered bedrock conditions using hollow-stem auger drilling methods. An NQ core barrel/bit was used for rock coring. Both borings are located on the north side of the HDD limit of disturbance (LOD) with SP-5-1B located on the west side of Harnish Run approximately 1,000 feet east of the HDD entry point and SP-5-1A located approximately 125 feet east of the mid-point of the bore path on the east side of Harnish Run.

The generalized subsurface profile observed in the borings completed at HDD 897 can be described as follows.

- **SP-5-1B**: ALLUVIUM comprised of Silty/Clayey GRAVEL, Silty to poorly graded SAND and CLAY with subordinate amounts of Gravel (SM, SC/SM, GC/GM, CL), overlying RESIDUUM consisting of Silty/Clayey SAND, CLAY/SILT, and Silty SAND (ML/CL, SM). The underlying bedrock was described as weathered to highly weathered SANDSTONE and CONGLOMERATIC SANDSTONE.

- **SP-5-1A**: ALLUVIUM comprised of Sandy SILT and Silty to poorly graded SAND with subordinate amounts of Gravel (ML, SM, SP) overlying RESIDUUM consisting of CLAY, Silty SAND, Clayey SAND, and Sandy CLAY (SM, CL, SC). The underlying bedrock was described as weathered to highly weathered SANDSTONE, SANDSTONE/ SILTSTONE, and CONGLOMERATIC SANDSTONE.

The boring logs indicate that the soil/weathered bedrock interface ranges from 28 feet (1A) to 23 feet (1B) below the ground surface. According to the Unified Soil Classification System (USCS), the soils consist of sandy silt (ML) to silty sand (SM) with some well-graded gravel

(GW) beds collectively characterized as alluvial soils above a depth of 8 feet with silty sand with gravel (SM) to lean clay with sand (CL) residual soils residing between the alluvial soils and the top of bedrock. No new geotechnical borings were performed at this HDD location. No geophysical studies were performed at this location. The geotechnical report for HDD 897 is provided as **Attachment 2**.

Below the auger refusal depth to the total depth of the NQ cores, bedrock was encountered and was described as follows:

- **SP-5-1B**: From 63 to 80 feet, slightly to highly weathered, reddish brown, medium hard to hard sandstone and siltstone bedrock. Rock recovery was very poor to excellent (0% to 100%) and rock quality designations (RQD) were poor to excellent (16% to 90%). The lowest RQDs were observed from 64 to 69 feet where closely spaced 35° to 55° fractures were identified in weathered siltstone.

- **SP-5-1A**: From 45 to 80 feet, slightly to highly weathered, reddish brown, medium hard to hard sandstone and sandy siltstone bedrock. Rock recovery was poor to excellent (28% to 100%) and rock quality designations (RQD) were very poor to good (8% to 76%). The lowest RQDs were observed from 59 to 64 feet where very close to medium spaced 20° to 45° degree fractures were identified in weathered conglomeratic sandstone.

Please note that Skelly and Loy did not oversee or direct the geotechnical drilling programs associated with HDD 897, including but not limited to, the selection of boring locations and target depths, observations of rock cores during drilling operations, or preparation of boring logs. The geotechnical reports, boring logs, and core photographs that resulted from these programs were generated by other Sunoco contractors. Skelly and Loy relied on these reports and incorporated their data into the general geologic and hydrogeologic framework of the analysis of the 897 HDD in this report.

6. FIELD OBSERVATIONS

A site reconnaissance was performed during the afternoon of August 28, 2017, for the purpose of locating local domestic wells, obtaining structural geologic measurements from bedrock exposures for fracture fabric analysis, evaluating and ground-truthing the topographic expression of prominent fracture trace features identified during the desktop exercise, and evaluating other potentially sensitive environmental receptors. The domestic well survey consisted of viewing properties from within the HDD ROW and through available access along public roads to identify wells located within 450 feet of the HDD ROW. No bedrock exposures were observed within the stream bed of Harnish Run within 450 feet of the HDD ROW, and no bedrock structural measurements were collected. Based on local topography and bedrock dip reported in the published literature, bedrock strike is generally to the north-northeast (20° to

70°). With the exception of Harnish Run and previously mapped wetland areas, no additional environmental receptors of concern were noted within the defined 450-foot HDD buffer area.

A survey of local wells was performed by viewing the properties from within the HDD ROW and through available access along public roads. The results of this visual reconnaissance effort identified four domestic supply wells to be located within the 450-foot buffer area. However, given the rural setting of the area, it is assumed that each residence is served by at least one private supply well. Because 10 private properties/residences were identified within 450 feet of the HDD ROW, we expect that a total of approximately 10 domestic water supply wells exist within the 450-foot ROW buffer of HDD 897.

7. CONCEPTUAL HYDROGEOLOGIC MODEL

Groundwater occurring in the watershed occupied by HDD 897 originates as precipitation or snowmelt. The precipitation infiltrates through the overburden soils. As previously described, the groundwater generally occurs under unconfined conditions within the upper portion of the aquifer. Due to the lack of site-specific data, it has not been determined if the groundwater table occurs within the soils or bedrock; however, because Harnish Run flows above (across) the HDD trace, it is assumed that the groundwater table proximate to the HDD path is relatively shallow occurring within the overburden soils that contribute flow to this local shallow groundwater discharge zone. Review of the logs of two geotechnical borings drilled in July 2017 indicated that the soil thickness near HDD 897 ranges from approximately 23 to 28 feet consisting predominantly of silts, sands, and some gravel. Data tabulated for a domestic groundwater well found in the PaGWIS database (**Figure 3**) and located approximately 300 feet north of the HDD entry had a measured water level of approximately 11.9 feet below grade.

This formation is highly anisotropic with the predominant flow direction parallel to bedrock strike. No local interbeds of basaltic lava flows or intrusions of diabase dikes or sills were identified proximate to this HDD. The transport of groundwater in the fractured bedrock is generally greatest within highly permeable fractures. The orientation of the bedding planes and fractures primarily control the direction of groundwater flow within the aquifer (Sloto and Schreffler, 1994). Wells drilled to the same depths along bedrock strike generally penetrate the same water-bearing zones, whereas wells drilled to the same depth several hundred feet down dip of each other rarely intersect the same water-bearing zones. No site-specific evaluation of the bedrock has been completed in the area proximate to this HDD, and no detailed characterization or groundwater flow modeling of the bedrock aquifer was performed as part of this hydrogeologic reevaluation.

The groundwater flow direction in the overburden soils is presumed to mimic surface topography which slopes gently to the south toward Harnish Run located near the center of the proposed HDD 897 trace. Harnish Run flows southward near the center of the HDD trace and eventually discharges into Blue Lake/Cocalico Creek located approximately 0.7 mile south of the study area. The groundwater table is presumed to occur within these overburden materials under unconfined conditions.

8. CONCLUSIONS

Based on published geologic and hydrogeologic information, the State Route 0897 HDD location is underlain by clastic sedimentary rocks (siltstone/sandstone and shale) of the Hammer Creek 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. Geotechnical rock core observations have confirmed that the local bedrock is fractured and comprised of steeply dipping bedding planes. All of the domestic wells identified within 450 feet of the HDD are constructed in the bedrock aquifer indicating that none of the domestic wells relies on the shallow (uppermost) water table aquifer providing discharge to the wetland and Harnish Run. The proposed HDD profile extends entirely within the shallow unconsolidated materials and weathered to highly weathered bedrock. Based on the hydro-structural characteristics of the underlying geology described in this report and the proposed HDD profile, HDD 897 is susceptible to the inadvertent return of drilling fluids during HDD operations.

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10.0 CERTIFICATION

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

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

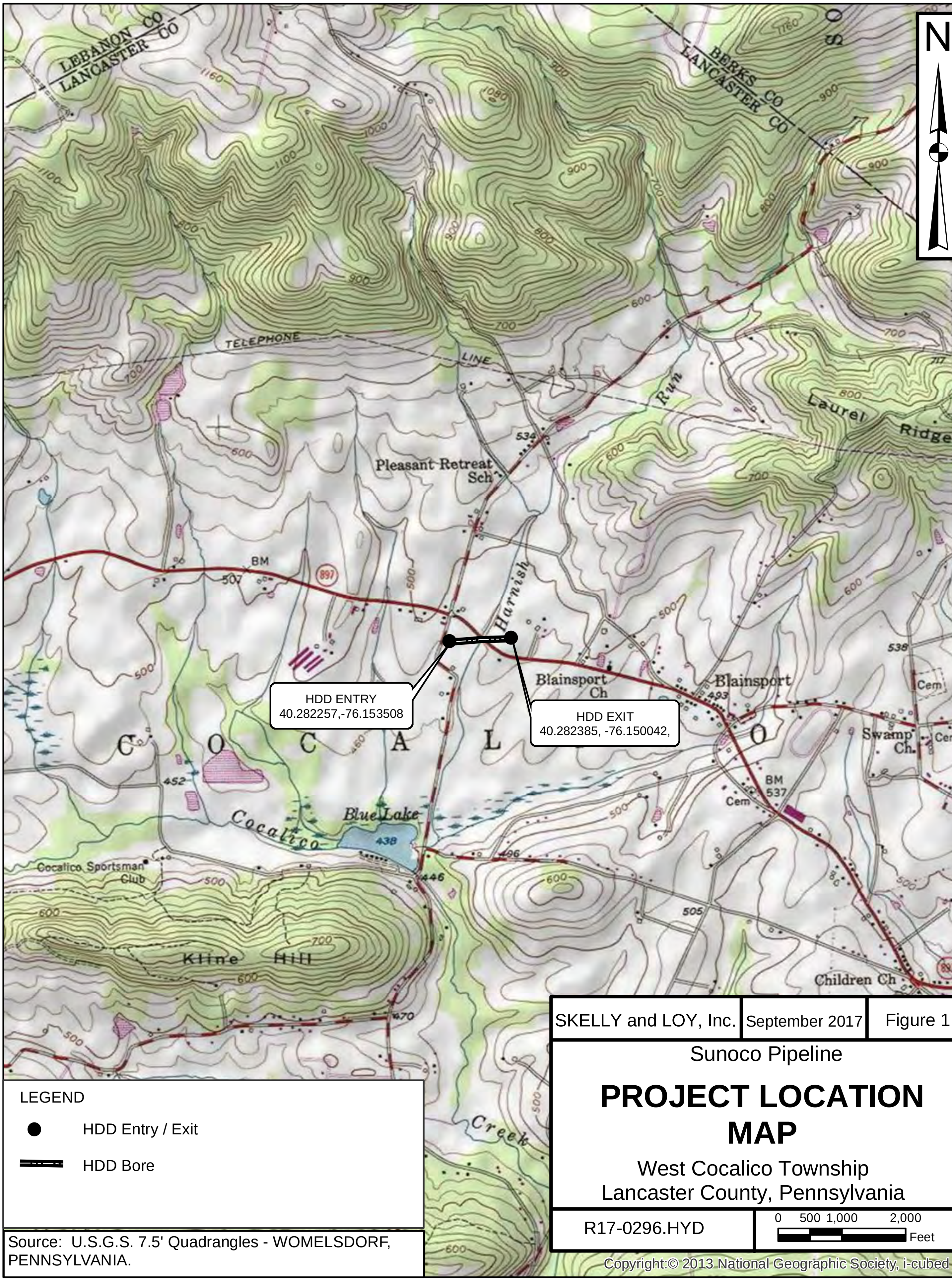
Sincerely yours,

SKELLY and LOY, Inc.

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

Enclosure
cc: R17-0296.HYD
File: HYDROGEOLOGIC_REPORT-897 - FINAL.docx

FIGURES



SKELLY and LOY, Inc.	September 2017	Figure 1

Sunoco Pipeline

PROJECT LOCATION MAP

West Cocalico Township
Lancaster County, Pennsylvania

R17-0296.HYD

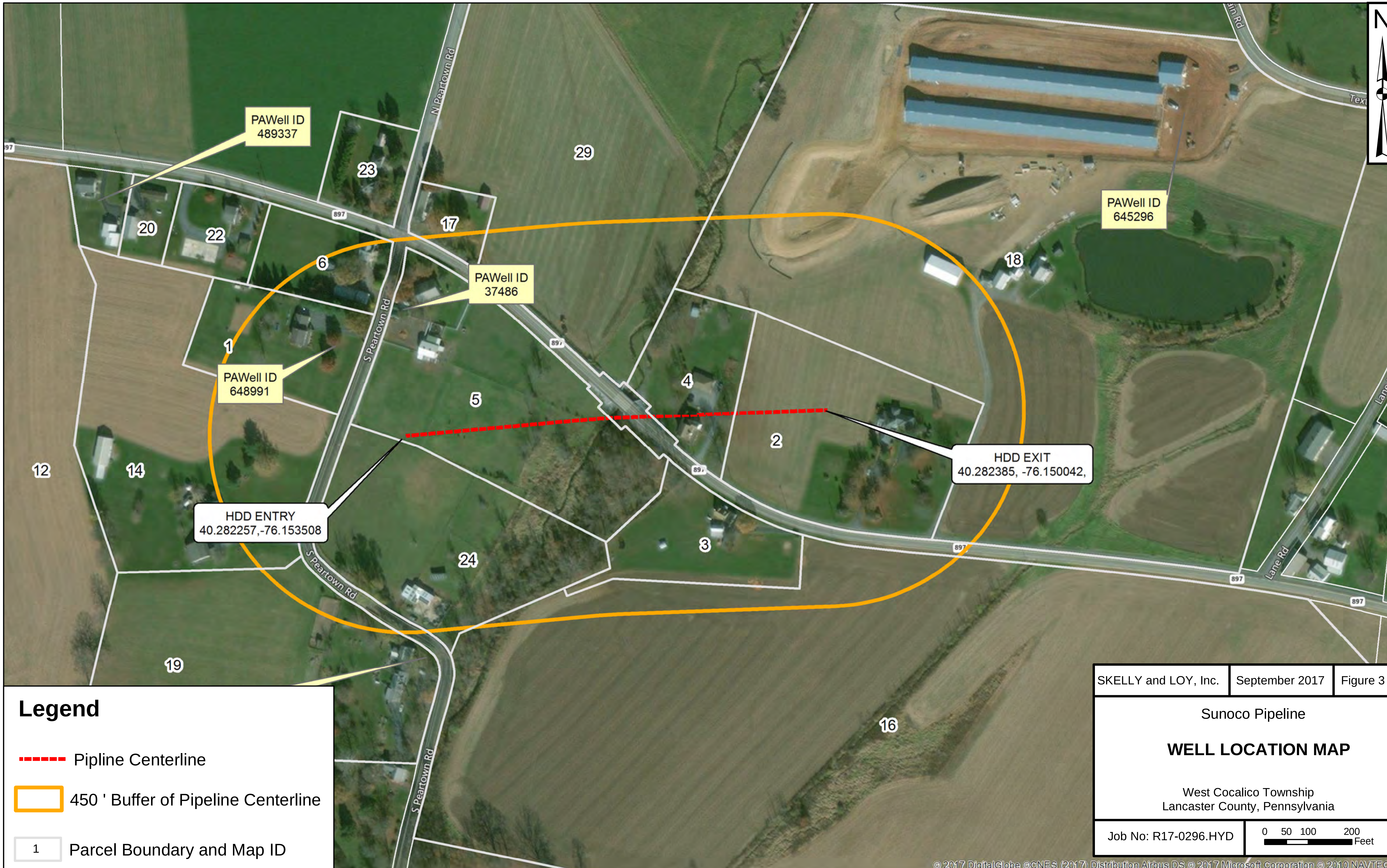
0 500 1,000 2,000 Feet

LEGEND

- HDD Entry / Exit
- HDD Bore

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

N
Trhc
Trh
Trhc
Trhc
Trh
Trhc
Trh
Trhc
Trhc
Trh
Trh
HDD EXIT
40.282385, -76.150042,
HDD ENTRY
40.282257,-76.153508
Marsh Rd
N Peartown Rd
S Peartown Rd
Tannery Rd
Legend
HDD 897 Centerline
GEOLOGY
Approximate location of fracture traces.
Copied from Wood (1980), Plate1, Part 2.
Fault
Trh Hammer Creek Sandstone/Shale
Trhc Hammer Creek Conglomerate
SKELLY and LOY, Inc.
August 2017
Figure 2
Sunoco Pipeline
GEOLOGY MAP
West Cocalico Township
Lancaster County, Pennsylvania
Job No: R17-0296.HYD
0 125 250 500
Feet
© 2010 DigitalGlobe ©CNES (2017) Distribution Airbus DS © 2017 Microsoft Corporation © 2010 NAVTEQ



PAWell ID
489337
PAWell ID
645296
PAWell ID
37486
PAWell ID
648991
HDD EXIT
40.282385, -76.150042,
HDD ENTRY
40.282257,-76.153508
N Peartown Rd
S Peartown Rd
Lane Rd
897
29
23
17
20
22
6
18
1
4
5
2
12
14
3
24
19
16
N
Legend
Pipline Centerline
450 ' Buffer of Pipeline Centerline
1
Parcel Boundary and Map ID
SKELLY and LOY, Inc.
September 2017
Figure 3
Sunoco Pipeline
WELL LOCATION MAP
West Cocalico Township
Lancaster County, Pennsylvania
Job No: R17-0296.HYD
0 50 100 200
Feet
© 2017 DigitalGlobe ©CNES (2017) Distribution Airbus DS © 2017 Microsoft Corporation © 2010 NAVTEQ

ATTACHMENT 1 -
SOIL MAP AND DESCRIPTIONS

Attachment 1

Soil Map—Lancaster County, Pennsylvania
(soil map)

Map Scale: 1:2,540 if printed on B landscape (17" x 11") sheet.

N

0 35 70 140 210 Meters

0 100 200 400 600 Feet

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

Attachment 1

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: Lancaster County, Pennsylvania
Survey Area Data: Version 13, Sep 19, 2016

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

Date(s) aerial images were photographed: Jun 29, 2011—Mar 16, 2017

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

Map Unit Legend

Lancaster County, Pennsylvania (PA071)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Bo	Bowmansville silt loam	1.7	3.2%
BuA	Bucks silt loam, 0 to 3 percent slopes	0.8	1.4%
Hg	Holly silt loam	12.4	22.4%
RaB	Readington silt loam, 3 to 8 percent slopes	12.7	23.0%
Rd	Rowland silt loam	8.1	14.6%
UaB	Ungers loam, 3 to 8 percent slopes	19.1	34.5%
W	Water	0.5	0.9%
Totals for Area of Interest		**55.2**	**100.0%**

Component Text Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the selected area. The component descriptions in this report, 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 associated 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 (components) for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

The "Map Unit Component Nontechnical Descriptions" report gives a brief, general description of the soil components that occur in a map unit. Descriptions of nonsoil (miscellaneous areas) and minor map unit components may or may not be included. This description is written by the local soil scientists responsible for the respective soil survey area data. A more detailed description can be generated by the "Map Unit Description" report.

Additional information about the map units described in this report is available in other Soil Data Mart reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the Soil Data Mart reports define some of the properties included in the map unit descriptions.

Report—Component Text Descriptions

Lancaster County, Pennsylvania

Map Unit: Bo—Bowmansville silt loam

Description Category: GENSOIL

Bowmansville: 90 percent

The Bowmansville component makes up 90 percent of the map unit. Slopes are 0 to 3 percent. This component is on nearly level flood plains, uplands. The parent material consists of recent alluvial deposits weathered from sandstone and siltstone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is somewhat poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is high. Shrink-swell potential is low. This soil is frequently flooded. It is not ponded. A seasonal zone of water saturation is at 9 inches during January, February, March, April, May, September, October, November, December. Organic matter content in the surface horizon is about 4 percent. Nonirrigated land capability classification is 3w. This soil meets hydric criteria.

Description Category: GENSOIL

Rowland: 10 percent

Generated brief soil descriptions are created for major soil components. The Rowland soil is a minor component.

Map Unit: BuA—Bucks silt loam, 0 to 3 percent slopes

Description Category: GENSOIL

Bucks: 90 percent

The Bucks component makes up 90 percent of the map unit. Slopes are 0 to 3 percent. This component is on rolling hillslopes, uplands. The parent material consists of silt mantle over residuum weathered from sandstone and siltstone. Depth to a root restrictive layer, bedrock, lithic, is 40 to 72 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 1. This soil does not meet hydric criteria.

Description Category: GENSOIL

Readington: 5 percent

Generated brief soil descriptions are created for major soil components. The Readington soil is a minor component.

Description Category: GENSOIL

Lehigh: 2 percent

Generated brief soil descriptions are created for major soil components. The Lehigh soil is a minor component.

Description Category: GENSOIL

Ungers: 2 percent

Generated brief soil descriptions are created for major soil components. The Ungers soil is a minor component.

Description Category: GENSOIL

Lansdale: 1 percent

Generated brief soil descriptions are created for major soil components. The Lansdale soil is a minor component.

Map Unit: Hg—Holly silt loam

Description Category: GENSOIL

Holly: 94 percent

The Holly component makes up 94 percent of the map unit. Slopes are 0 to 3 percent. This component is on sandstone & shale hills, flood plains. The parent material consists of alluvium derived from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is high. Shrink-swell potential is low. This soil is frequently flooded. It is occasionally ponded. A seasonal zone of water saturation is at 6 inches during January, February, March, April, May, December. Organic matter content in the surface horizon is about 4 percent. Nonirrigated land capability classification is 3w. This soil meets hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 3 percent.

Description Category: GENSOIL

Brinkerton: 2 percent

Generated brief soil descriptions are created for major soil components. The Brinkerton soil is a minor component.

Description Category: GENSOIL

Gibraltar: 2 percent

Generated brief soil descriptions are created for major soil components. The Gibraltar soil is a minor component.

Description Category: GENSOIL

Linden: 2 percent

Generated brief soil descriptions are created for major soil components. The Linden soil is a minor component.

Map Unit: RaB—Readington silt loam, 3 to 8 percent slopes

Description Category: GENSOIL

Readington: 85 percent

The Readington component makes up 85 percent of the map unit. Slopes are 3 to 8 percent. This component is on red shale, siltstone, & sandstone hills, piedmonts. The parent material consists of Triassic colluvium derived from shale and siltstone and/or Triassic residuum weathered from shale and siltstone. Depth to a root restrictive layer, fragipan, is 20 to 36 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches (or restricted depth) is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 24 inches during January, February, March, April, May, June, July, August, September, October, November, December. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2e. This soil does not meet hydric criteria.

Description Category: GENSOIL

Reaville: 5 percent

Generated brief soil descriptions are created for major soil components. The Reaville soil is a minor component.

Description Category: GENSOIL

Penn: 5 percent

Generated brief soil descriptions are created for major soil components. The Penn soil is a minor component.

Description Category: GENSOIL

Abbottstown: 5 percent

Generated brief soil descriptions are created for major soil components. The Abbottstown soil is a minor component.

Map Unit: Rd—Rowland silt loam

Description Category: GENSOIL

Rowland: 90 percent

The Rowland component makes up 90 percent of the map unit. Slopes are 0 to 3 percent. This component is on relatively narrow nearly level flood plains, uplands. The parent material consists of alluvium derived from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is occasionally flooded. It is not ponded. A seasonal zone of water saturation is at 24 inches during January, February, March, April, May, November, December. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 2w. This soil does not meet hydric criteria.

Description Category: GENSOIL

Bowmansville: 8 percent

Generated brief soil descriptions are created for major soil components. The Bowmansville soil is a minor component.

Description Category: GENSOIL

Abbottstown: 1 percent

Generated brief soil descriptions are created for major soil components. The Abbottstown soil is a minor component.

Description Category: GENSOIL

Readington: 1 percent

Generated brief soil descriptions are created for major soil components. The Readington soil is a minor component.

Map Unit: UaB—Ungers loam, 3 to 8 percent slopes

Description Category: GENSOIL

Ungers: 85 percent

The Ungers component makes up 85 percent of the map unit. Slopes are 3 to 8 percent. This component is on mountain slopes. The parent material consists of residuum weathered from sandstone and siltstone. Depth to a root restrictive layer, bedrock, lithic, is 40 to 80 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2e. This soil does not meet hydric criteria.

Description Category: GENSOIL

Penn: 7 percent

Generated brief soil descriptions are created for major soil components. The Penn soil is a minor component.

Description Category: GENSOIL

Readington: 5 percent

Generated brief soil descriptions are created for major soil components. The Readington soil is a minor component.

Description Category: GENSOIL

Bucks: 3 percent

Generated brief soil descriptions are created for major soil components. The Bucks soil is a minor component.

Map Unit: W—Water

Description Category: GENSOIL

Water: 100 percent

Generated brief soil descriptions are created for major soil components. The Water is a miscellaneous area.

Data Source Information

Soil Survey Area: Lancaster County, Pennsylvania
Survey Area Data: Version 13, Sep 19, 2016

ATTACHMENT 2 - GEOTECHNICAL REPORT

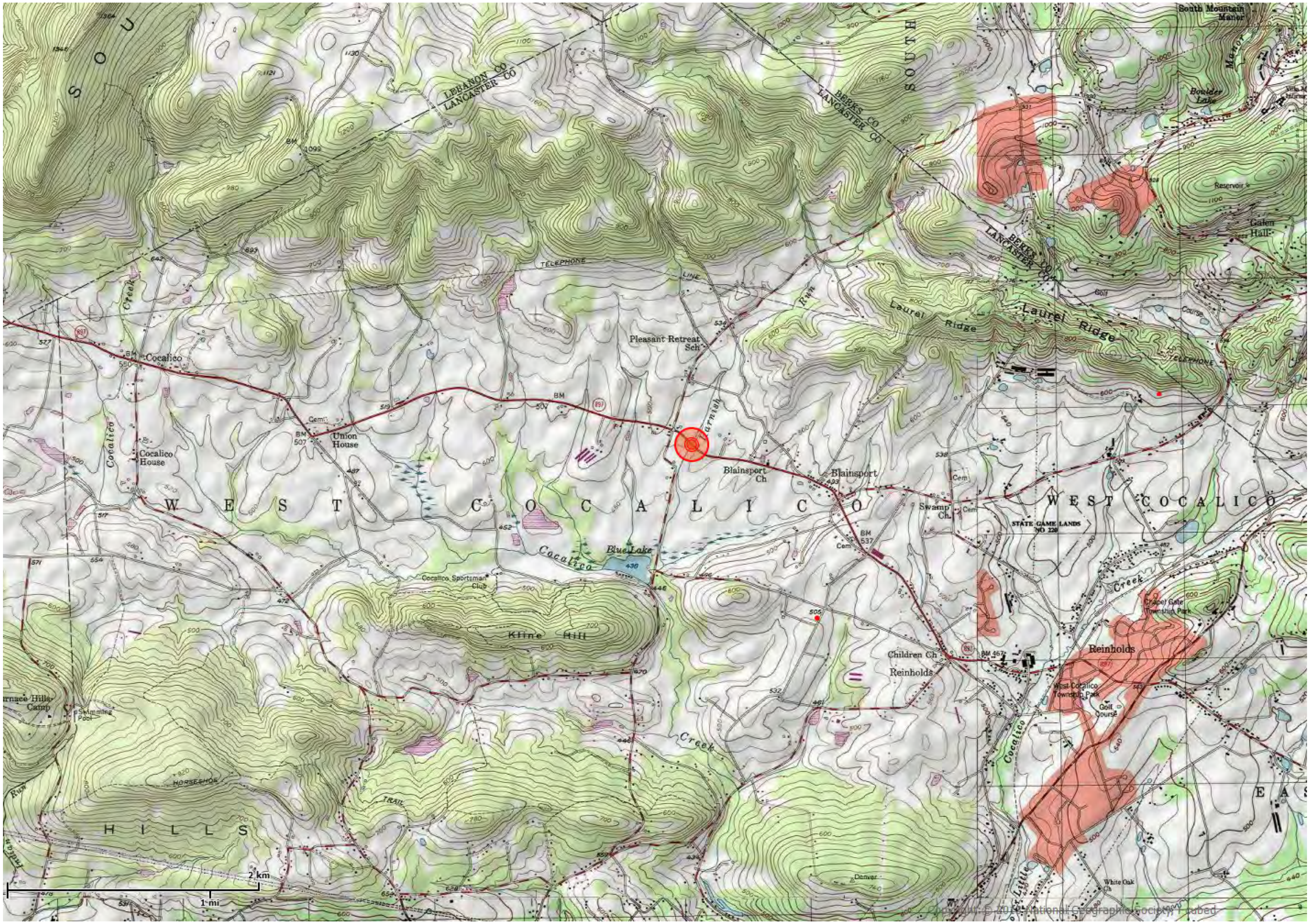
Visit us at http://www.dcnr.state.pa.us

Figure 1: Site Vicinity Map-SR 897

Make online reservations at

www.visitPAparks.com

or call toll-free 888-PA-PARKS

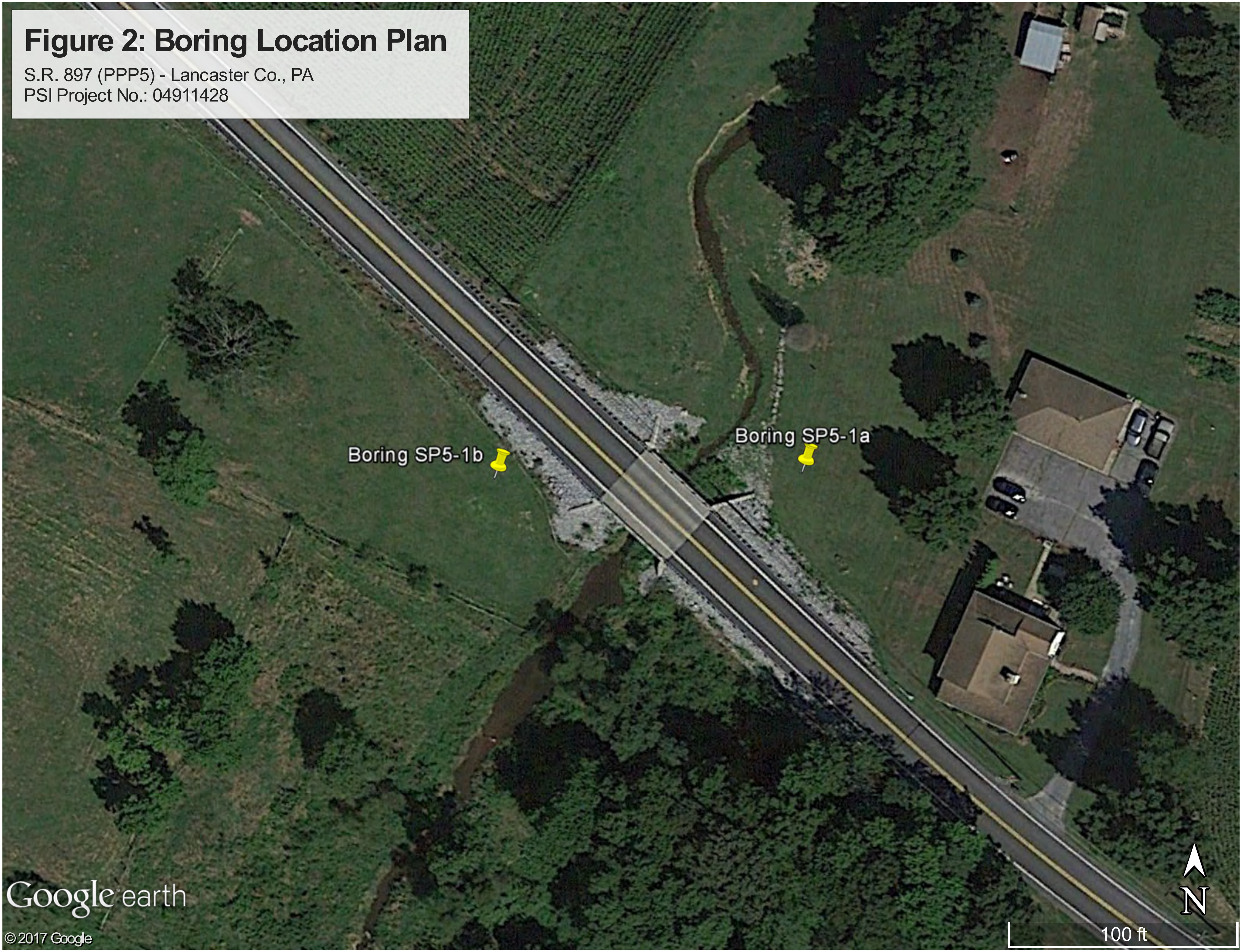


Created using PA DCNR Map Viewer

Map created on Thu Jul 20 2017

Figure 2: Boring Location Plan

S.R. 897 (PPP5) - Lancaster Co., PA
PSI Project No.: 04911428



pennsylvania
DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES

Figure 3: Site Geology Map-SR 897

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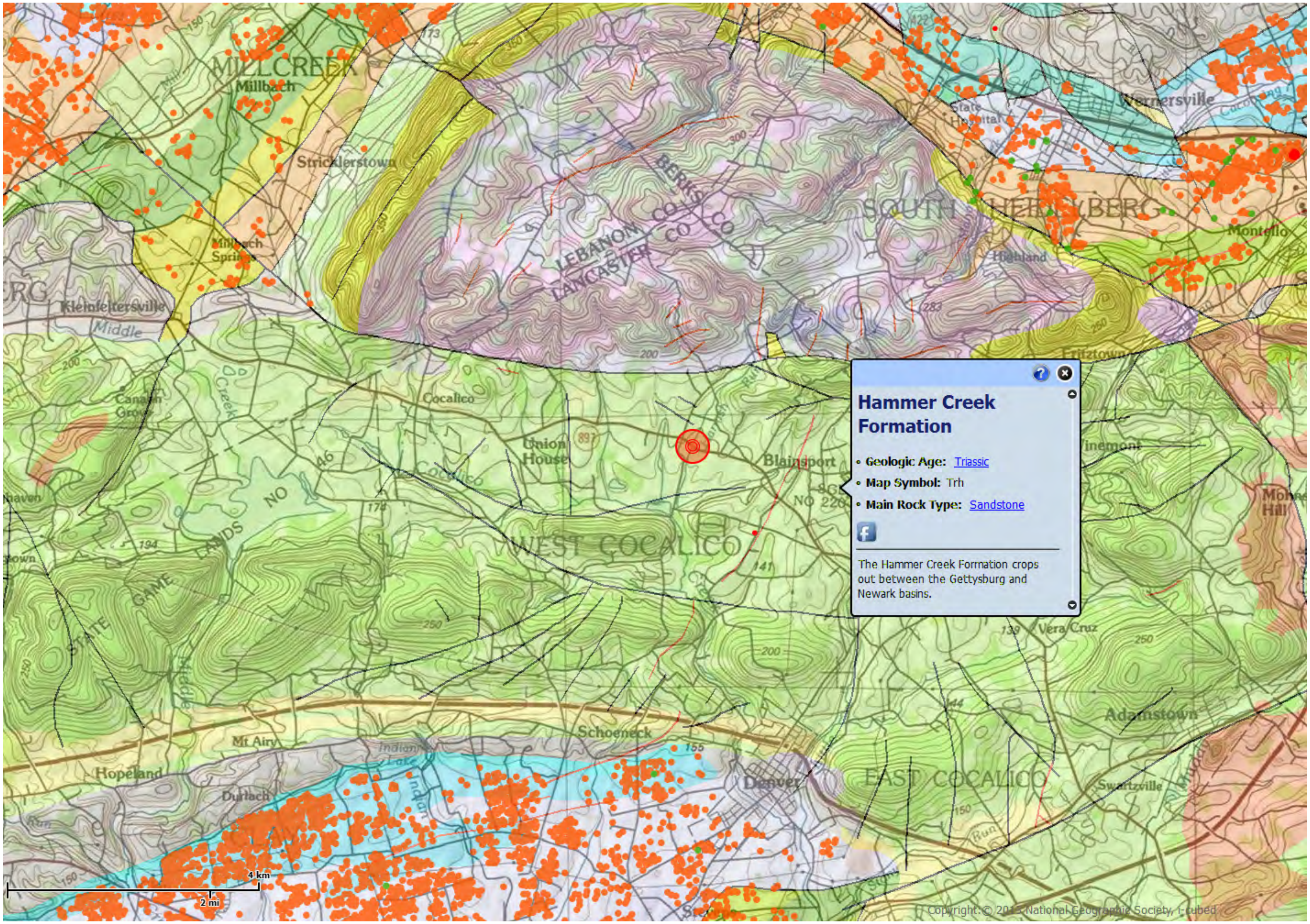


Created using PA DCNR Map Viewer *Map created on Thu Jul 20 2017*

DATE STARTED: 7/6/17	**DRILL COMPANY:** Allied Well Drilling, Inc.		
DATE COMPLETED: 7/8/17	**DRILLER:**	**LOGGED BY:** H. Patel	
COMPLETION DEPTH 80.0 ft	**DRILL RIG:** Diedrich D-50		
BENCHMARK: N/A	**DRILLING METHOD:** Casing & Roller bit		
ELEVATION: 474.5 ft	**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		

BORING SP5-1A

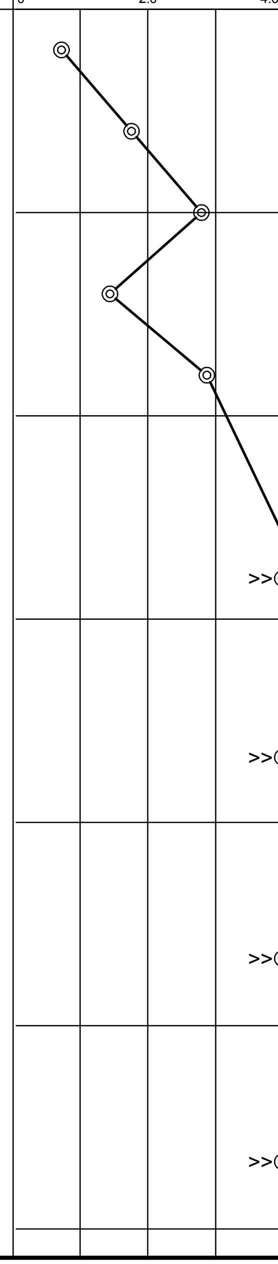
Water

BORING LOCATION:
N: 349797.289
E: 2414450.736

REMARKS: Boring ground elevation & northing-easting obtained from survey stake

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	Additional Remarks
	0			Topsoil				
		S-1	20	**ALLUVIUM**- Medium Stiff, Dark Brown Sandy SILT, moist	ML	3-4-5-7 N=9		
		S-2	10	**ALLUVIUM**- Medium Dense, Brown Silty SAND, trace Gravel, wet	SM	7-11-11-10 N=22		
470	5	S-3	15	**ALLUVIUM**- Dense, Brown Silty SAND with Gravel, wet	SM	9-20-15-13 N=35		
		S-4	6	**ALLUVIUM**- Medium Dense, Brown Poorly Graded SAND with Gravel, wet	SP	3-8-10-9 N=18		
465	10	S-5	20	**ALLUVIUM**- Dense, Brown Silty SAND with Gravel, wet	SM	15-17-19-24 N=36		
460	15	S-6	18	**RESIDUUM**- Hard, Red Brown Lean CLAY, moist	CL	11-23-31-38 N=54		
455	20	S-7	9	**RESIDUUM**- Hard, Red Brown Sandy Lean CLAY, moist	CL	22-50/4"		
450	25	S-8	5	**RESIDUUM**- Very Dense, Red Brown Silty SAND, moist	SM	49-50/2"		
445	30	S-9	8	**RESIDUUM**- Hard, Red Brown Sandy Lean CLAY, moist	CL	44-50/2"		

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



Continued Next Page

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

PROJECT NO.: 04911428
PROJECT: Energy Transfer HDD (DPS)
LOCATION: State Route 897
Lancaster Co., PA

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

DATE STARTED: 7/6/17	**DRILL COMPANY:** Allied Well Drilling, Inc.	**BORING SP5-1A**	
DATE COMPLETED: 7/8/17	**DRILLER:** **LOGGED BY:** H. Patel	**Water**	
COMPLETION DEPTH 80.0 ft	**DRILL RIG:** Diedrich D-50		
BENCHMARK: N/A	**DRILLING METHOD:** Casing & Roller bit		
ELEVATION: 474.5 ft	**SAMPLING METHOD:** 2-in SS1.874-in Core		
LATITUDE: n/a°	**HAMMER TYPE:** Automatic	**BORING LOCATION:**	
LONGITUDE: n/a°	**EFFICIENCY** N/A	N: 349797.289	
STATION: N/A **OFFSET:** N/A	**REVIEWED BY:** P. McMichael	E: 2414450.736	

REMARKS: Boring ground elevation & northing-easting obtained from survey stake

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	STANDARD PENETRATION TEST DATA N in blows/ft	Additional Remarks
	30			**RESIDUUM**- Hard, Red Brown Sandy Lean CLAY, moist	CL			
				RESIDUUM- Very Dense, Red Brown Clayey SAND, moist	SC			
		S-10	1			50/1"	>>	
				Spoon Refusal @ 43 ft				
440	35							
		S-11	2			50/2"	>>	
435	40							
		S-12	0			50/0"	>>	
		R-1	6	**SANDSTONE**- Red Brown, Fine-Grained, Weathered to Highly Weathered		RQD=0 Rec=50%		2 min.
430	45							2 min.
		R-2	36			RQD=30 Rec=60%		2 min.
								2 min.
								2 min.
425				**SANDSTONE/SILTSTONE**- Red Brown, Very Fine-Grained, Weathered				2 min.
	50							3 min.
								4 min.
		R-3	60			RQD=58 Rec=100%		3 min.
								3 min.
420								3 min.
	55			**CONGLOMERATIC SANDSTONE**- Red Brown, Fine- to Medium-Grained, Weathered				2 min.
		R-4	60			RQD=77 Rec=100%		2 min.
								2 min.
								2 min.
415	60							2 min.

Legend: Moisture; PL; LL; N in blows/ft (0, 25, 50); STRENGTH, tsf: Qu, Qp (0, 2.0, 4.0)

Continued Next Page

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

PROJECT NO.: 04911428
PROJECT: Energy Transfer HDD (DPS)
LOCATION: State Route 897
Lancaster Co., PA

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

DATE STARTED: 7/6/17	**DRILL COMPANY:** Allied Well Drilling, Inc.	**BORING SP5-1A**	
DATE COMPLETED: 7/8/17	**DRILLER:** **LOGGED BY:** H. Patel	**Water**	
COMPLETION DEPTH 80.0 ft	**DRILL RIG:** Diedrich D-50		
BENCHMARK: N/A	**DRILLING METHOD:** Casing & Roller bit		
ELEVATION: 474.5 ft	**SAMPLING METHOD:** 2-in SS1.874-in Core		
LATITUDE: n/a°	**HAMMER TYPE:** Automatic	**BORING LOCATION:**	
LONGITUDE: n/a°	**EFFICIENCY** N/A	N: 349797.289	
STATION: N/A **OFFSET:** N/A	**REVIEWED BY:** P. McMichael	E: 2414450.736	

REMARKS: Boring ground elevation & northing-easting obtained from survey stake

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-5	16	**CONGLOMERATIC SANDSTONE**- Red Brown, Fine- to Medium-Grained, Highly Weathered		RQD=7 Rec=27%			2 min. 1 min. 2 min. 4 min.
410	65	R-6	27	**SANDSTONE/SILTSTONE**- Red Brown, Very Fine-Grained, Weathered to Highly Weathered		RQD=10 Rec=45%			2 min. 3 min. 6 min. 7 min. 8 min.
405	70			**SANDSTONE/SILTSTONE**- Red Brown, Very Fine-Grained, Weathered					3 min. 5 min.
		R-7	60	**SANDSTONE**- Red Brown, Fine-Grained, Weathered		RQD=32 Rec=100%			2 min. 2 min. 3 min. 3 min.
400	75	R-8	60			RQD=67 Rec=100%			2 min. 2 min. 1 min. 1 min. 2 min.
395	80	R-9	12			RQD=33 Rec=100%			1 min.
				Test Boring Terminated @ 80 ft					

Intertek psi

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

PROJECT NO.: 04911428
PROJECT: Energy Transfer HDD (DPS)
LOCATION: State Route 897
Lancaster Co., PA

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


BOX 1 OF 2
DATE: 7-7-17
BORING NO. 1A
DEPTH 43 FT TO 59 FT
DATE: 7-7-17
ELEVATION 474.5
SR 897 SEC STA. OFF. FROM CL
COUNTY LANC
SEGMENT OFF.
PPP Spread 5 1A
RUN NO. DEPTH RECOVERY RQD
1 43.0-44.0 6" 0
2 44.0-49.0 36" 18"
3 49.0-54.0 60" 35"
4 54.0-59.0 60" 46"
TOP SP5-1A 43.0
44.0
49
49
54
59


BOX 2 OF 2
DATE: 7-7-17
BORING NO. 1A DEPTH 59 FT TO 80 FT
DATE 7-7-17 ELEVATION 474.5
SR 897 SEC ___ STA ___ OFF. FROM CL ___
COUNTY LANC SEGMENT ___ OFF. ___
RUN NO.
DEPTH
RECOVERY
RQD
5 1 59-64 16" 4"
6 2 64-69 27" 6"
7 3 69-74 60" 19"
8 4 74-79 60" 40"
9 79-80 12" 4"
59
64
64
69
74
79

BORING SP5-1B

DATE STARTED:	7/5/17	**DRILL COMPANY:**	Allied Well Drilling, Inc.
DATE COMPLETED:	7/6/17	**DRILLER:** **LOGGED BY:**	P. McMichael
COMPLETION DEPTH	80.0 ft	**DRILL RIG:**	Diedrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	HSA/Casing & Roller bit
ELEVATION:	474.3 ft	**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

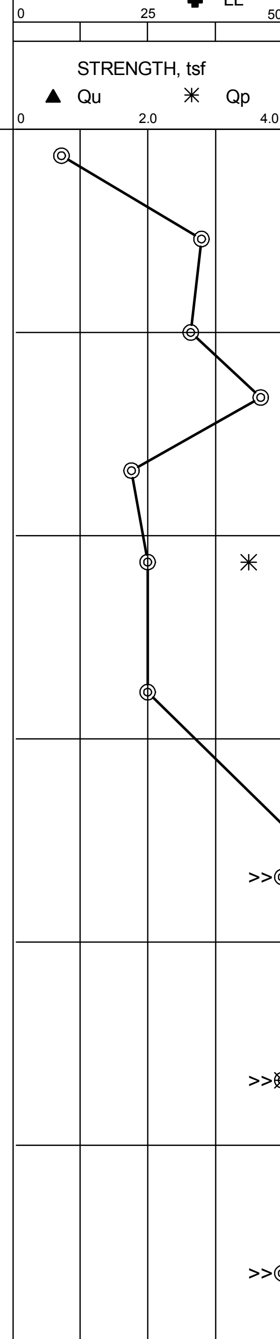
REMARKS: Boring ground elevation & northing-easting obtained from survey stake

Water		
While Drilling		4 feet
Post Coring		0.3 ft
15-HR		0.5 ft

BORING LOCATION:
N:349793.744
E:2414312.102

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	Additional Remarks
	0			Topsoil				
		S-1	15	**ALLUVIUM**- Loose, Brown Silty SAND, trace Gravel, moist	SM	3-3-6-12 N=9		
		S-2	17	**ALLUVIUM**- Dense, Brown Silty SAND with Gravel, moist/wet	SM	18-14-21-22 N=35		
470	5	S-3	24	**ALLUVIUM**- Dense, Brown Silty/Clayey SAND with Gravel, wet	SC/SM	4-12-21-26 N=33		
		S-4	14	**ALLUVIUM**- Dense, Brown Silty/Clayey GRAVEL with Sand, wet	GC/GM	23-25-21-17 N=46		
465	10	S-5	8	**ALLUVIUM**- Medium Dense, Gray Brown Silty SAND with Gravel, wet	SM	8-12-10-9 N=22		
		S-6	15	**RESIDUUM**- Very Stiff, Red Brown Lean CLAY with Sand, trace Gravel, moist	CL	10-11-14-17 N=25		
460	15	S-7	20			6-10-15-29 N=25		
455		S-8	9	**RESIDUUM**- Very Dense, Red Brown Silty/Clayey SAND, moist	SC/SM	25-50/3"		
450	20	S-9	8	Drilling method switched from HSA to Casing/Mud-Rotary at 28 ft.		14-50/2"		
445	25	S-10	4			50/4"		
	30							

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture, PL, LL
STRENGTH, tsf
▲ Qu ✳ Qp



Continued Next Page

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

PROJECT NO.: 04911428
PROJECT: Energy Transfer HDD (DPS)
LOCATION: State Route 897
Lancaster Co., PA

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

DATE STARTED: 7/5/17	**DRILL COMPANY:** Allied Well Drilling, Inc.	**BORING SP5-1B**	
DATE COMPLETED: 7/6/17	**DRILLER:** **LOGGED BY:** P. McMichael		
COMPLETION DEPTH 80.0 ft	**DRILL RIG:** Diedrich D-50	**Water** While Drilling	4 feet
BENCHMARK: N/A	**DRILLING METHOD:** HSA/Casing & Roller bit	Post Coring	0.3 ft
ELEVATION: 474.3 ft	**SAMPLING METHOD:** 2-in SS1.874-in Core	15-HR	0.5 ft
LATITUDE: n/a°	**HAMMER TYPE:** Automatic	**BORING LOCATION:**	
LONGITUDE: n/a°	**EFFICIENCY** N/A	N:349793.744	
STATION: N/A **OFFSET:** N/A	**REVIEWED BY:** P. McMichael	E:2414312.102	

REMARKS: Boring ground elevation & northing-easting obtained from survey stake

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	Additional Remarks
	30			**RESIDUUM**- Hard, Red Brown Sandy CLAY/SILT, moist	ML/CL				
		S-11	3			50/3"		>>	
440	35								
435		S-12	17			28-43-46-35 N=89		>>	
	40								
				RESIDUUM- Very Dense, Red Brown Silty SAND, moist/wet	SM				
		S-13	2			50/2"		>>	
430	45								
		S-14	1			50/1"		>>	
425	50								
		S-15	2			50/2"		>>	
420	55								
		S-16	0			50/2"		>>	
415	60								

Legend: Moisture; PL; LL; STRENGTH, tsf: Qu, Qp. Scales: 0, 25, 50; 0, 2.0, 4.0

Continued Next Page

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

PROJECT NO.: 04911428
PROJECT: Energy Transfer HDD (DPS)
LOCATION: State Route 897, Lancaster Co., PA

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

BORING SP5-1B

DATE STARTED:	7/5/17	**DRILL COMPANY:**	Allied Well Drilling, Inc.
DATE COMPLETED:	7/6/17	**DRILLER:**	**LOGGED BY:** P. McMichael
COMPLETION DEPTH	80.0 ft	**DRILL RIG:**	Diedrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	HSA/Casing & Roller bit
ELEVATION:	474.3 ft	**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 ground elevation & northing-easting obtained from survey stake

Water
- While Drilling: 4 feet
- Post Coring: 0.3 ft
- 15-HR: 0.5 ft

BORING LOCATION:
N:349793.744
E:2414312.102

Elevation (feet)	Depth, (feet)	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	Additional Remarks
	60				**RESIDUUM**- Very Dense, Red Brown Silty SAND, moist/wet Spoon Refusal @ 63 ft	SM				
	63		S-17	0			50/0"		>>	
410			R-1	12	**SANDSTONE**- Red Brown, Fine-Grained, Weathered		RQD=92 Rec=100%			2 min.; 2 min.
	65		R-2	58	**SILTSTONE**- Red Brown, Very Fine-Grained, Weathered		RQD=17 Rec=97%			3 min.; 4 min.; 4 min.; 2 min.; 3 min.
405	70		R-3	55			RQD=33 Rec=92%			4 min.; 1 min.
					SANDSTONE- Red Brown, Fine-Grained, Weathered					2 min.; 3 min.; 2 min.
400	75		R-4	31	**CONGLOMERATIC SANDSTONE**- Red Brown, Fine- to Medium-Grained, Highly Weathered		RQD=19 Rec=43%		>>	2 min.; 2 min.; 2 min.; 4 min.; 2 min.
395	80				Test Boring Terminated @ 80 ft					

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

PROJECT NO.: 04911428
PROJECT: Energy Transfer HDD (DPS)
LOCATION: State Route 897
Lancaster Co., PA

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

BOX 1 OF 1 DATE: 7-6-17
BORING NO. 1B DEPTH 63.0 FT. TO 74 FT.
DATE 7-6-17 ELEVATION 474.3
SR 897 SEC STA. OFF. FROM CL.
COUNTY Lancaster SEGMENT OFF.
PPP Spread 5 1B
RUN NO. DEPTH RECOVERY RQD
1 63.0-64' 12" 11"
2 64-69' 58" 10"
3 69.0-74.0' 55" 20"
4 74-80' 31" 14"
TOP SP5-1B
63.0
64'
69'
74'
80'


SR
COUNTY Lancaster SEGMENT OFF.
OFF. FROM CL
4
TOP SP5-1B
63.0
64'
74.0


69'
74'
~76.5'
Core
wash
out
80'
108

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%

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 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

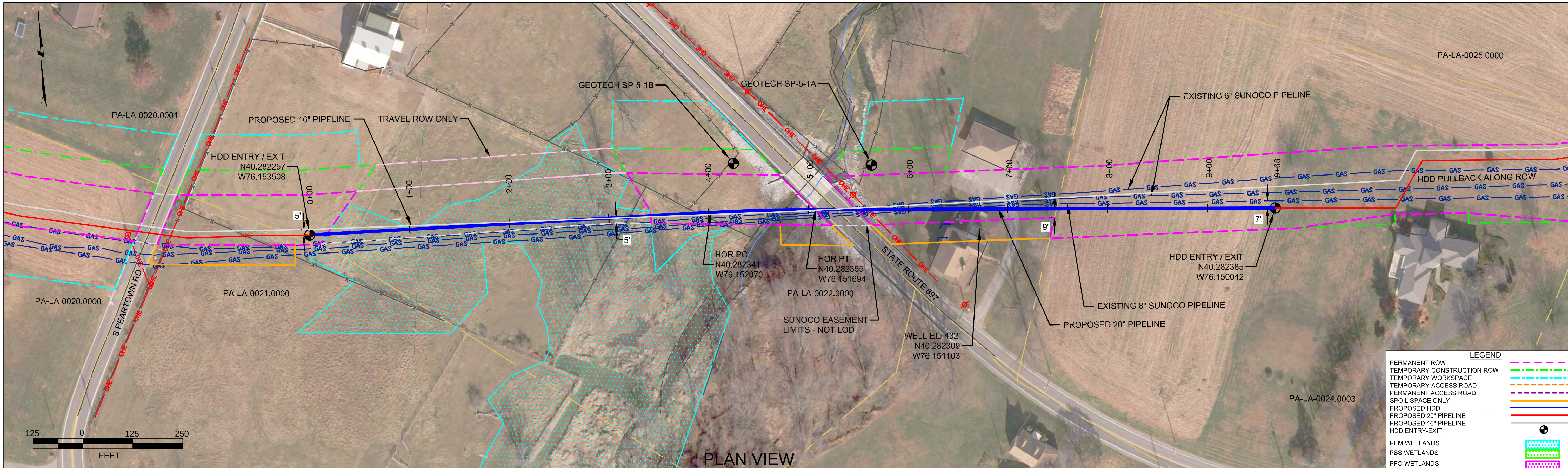
MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 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

psi

ROUTE 897, WETLAND B72PEM, & STREAM S-B82 CROSSINGS
PADEP SECTION 105 PERMIT NO.S:
PA-LA-0024.000-RD & PA-LA-0024.000-RD-16
(SPLP HDD# S3-0170)

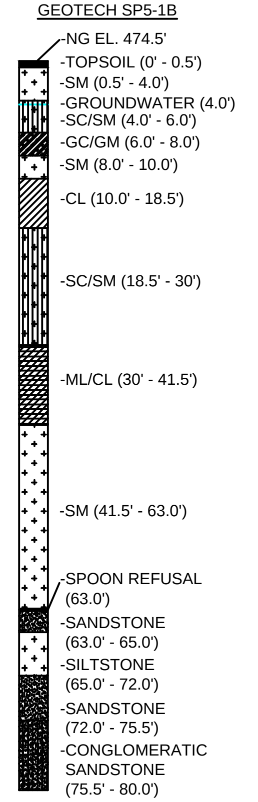
ATTACHMENT 2

ORIGINAL AND REVISED CONSTRUCTION PLANS

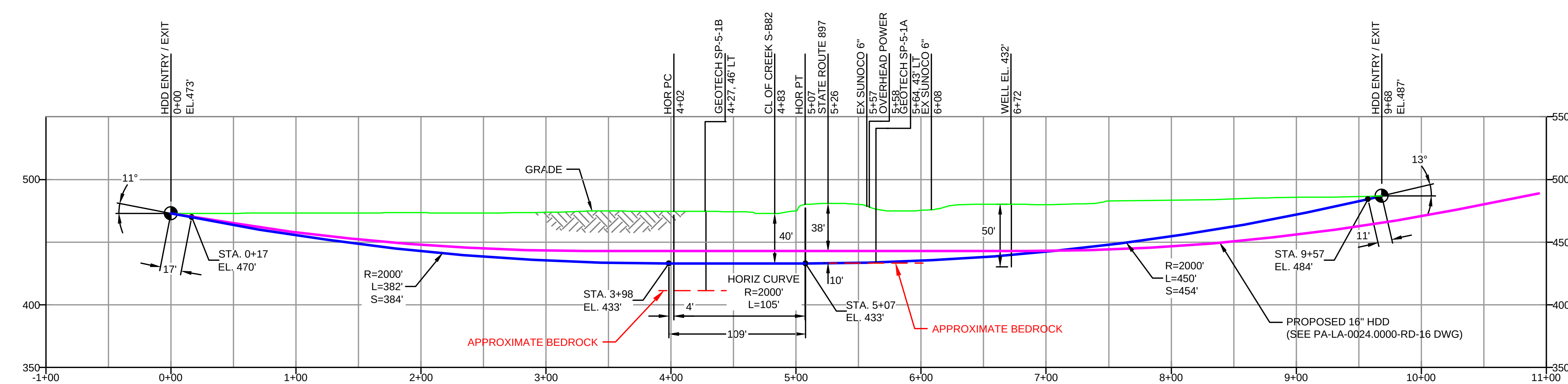


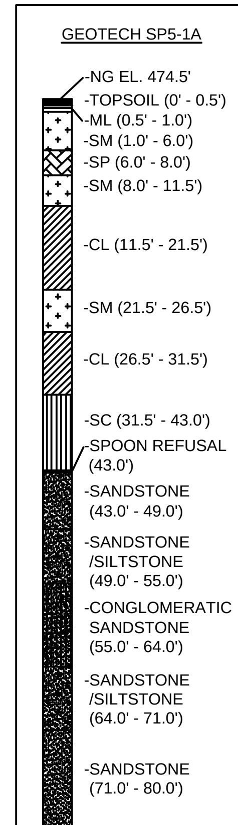
LANCASTER COUNTY, PENNSYLVANIA - WEST COCALICO TOWNSHIP
S3-0170

PROFILE VIEW



NOTE: REFER TO TEST BORING LOG SP5-1B FOR COMPLETE SOIL MATERIAL DESCRIPTION





NOTE: REFER TO TEST BORING LOG SP5-1A 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=): 968'
   HDD PIPE LENGTH (S=): 975'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

Figure 1: HDD Construction Plan

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
0	REVISED HDD PER THE DIRECTION OF ELLEN B. CM SPREAD 5	MRS	07/17/17	RMB	07/17/17	AMC	07/17/17

Sunoco Logistics Partners L.P.

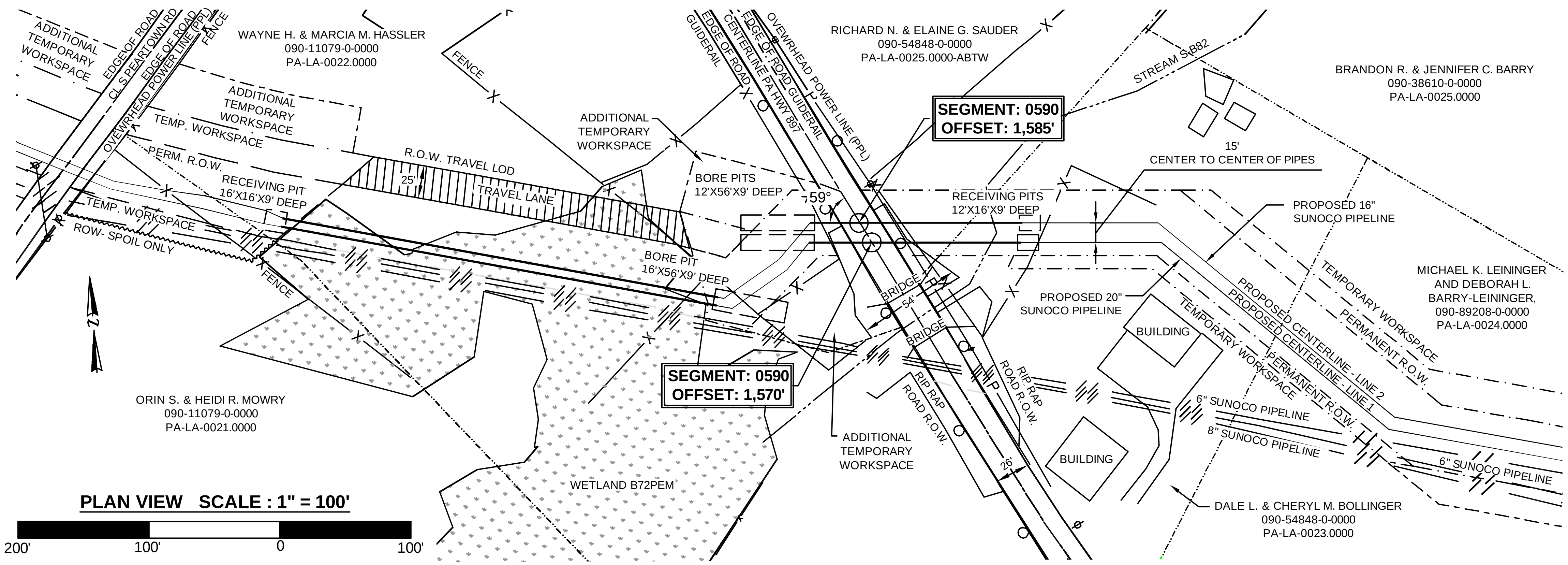
TETRA TECH ROONEY
(303) 792-5911

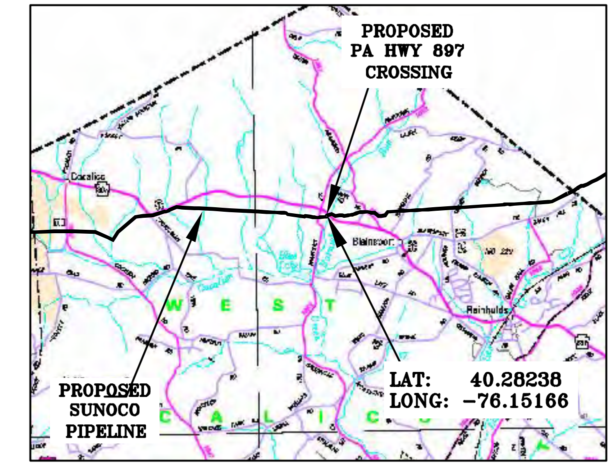
SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
STATE ROUTE 897
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'
DWG. NUMBER: PA-LA-0024.0000-RD

WEST COCALICO TOWNSHIP, LANCASTER COUNTY, PENNSYLVANIA



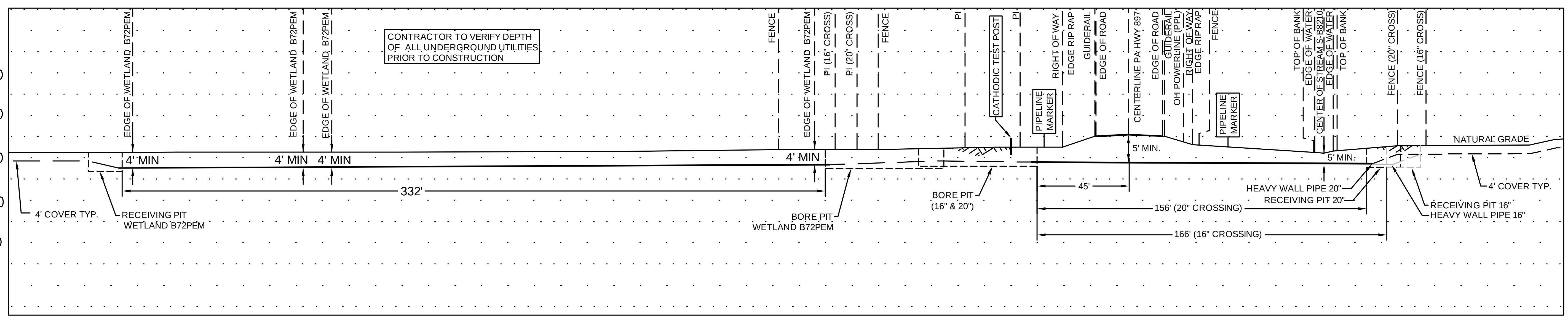


AERIAL VIEW
SCALE: 1" = 2MI

DRAWING LEGEND

- PERMANENT R.O.W.
- TEMPORARY WORKSPACE
- ROAD R.O.W.
- PIPELINE
- OVERHEAD POWER LINE
- GUIDERAIL
- FENCE
- PROPERTY LINE
- EDGE OF WATER
- ADDITIONAL TEMPORARY WORKSPACE
- ROW- SPOIL ONLY
- POWER POLE

PA HWY 897



HORIZ. SCALE : 1" = 50'
VERT. SCALE : 1" = 50'

100' 50' 0' 50'

ROAD NOTES
(APPLIES TO BOTH 16" & 20" PIPELINES)

1. 20" WELDED STEEL PIPE 20" OD x .456 WT., X-65, API 5L, PSL2, ERW, DRL
2. 16" WELDED STEEL PIPE 16" OD x .438 WT., X-70, API 5L, PSL2, ERW, BFW
3. COATING: 14-16 MILS OF 3M SCOTCHKOTE TM 6233 FBE WITH 40 MILS MIN. DFT POWERCRETE R95
4. DESIGN FACTOR: 0.50 (HOOP STRESS)
5. DESIGN PSI: 1480 PSIG TEST PSI: 1850
6. WELDING PROCESS(ES): ALL WELDING IS DONE IN ACCORDANCE TO PENNDOT AND APPROVED SUNOCO PROCEDURES.
7. THE COATING ON THE CARRIER PIPE SHALL BE INSPECTED IMMEDIATELY PRIOR TO ITS INSTALLATION AND ALL DAMAGED COATING SHALL BE REPAIRED IN ACCORDANCE WITH SUNOCO PIPELINE SPECIFICATIONS
8. PIPELINE CROSSING SHALL BE AS NEAR TO PERPENDICULAR TO THE ROADWAY CENTERLINE AS PRACTICAL
9. INSTALL CATHODIC PROTECTION TEST LEADS AS SPECIFIED ON THE ALIGNMENT SHEETS OR SUNOCO CORROSION TECHNICIAN
10. WELDED JOINTS INSIDE R.O.W. SHALL BE 100% X-RAYED
11. ROAD R.O.W. WIDTHS SHOWN ARE BASED ON VISUAL EVIDENCE.

CONSTRUCTION NOTES

1. CONTRACTOR WILL MAINTAIN 4' OF COVER TO THE TOP OF PIPE OUTSIDE OF ROAD R.O.W. USING FIELD BENDS
2. CONTRACTOR SHALL USE THE "ONE CALL" SYSTEM PRIOR TO BEGINNING WORK. CONTRACTOR SHALL BE RESPONSIBLE TO LOCATE AND VERIFY ALL PARALLEL AND CROSSED UTILITIES PRIOR TO EXCAVATION OR CONSTRUCTION (AND MONITOR DURING EXCAVATION OR CONSTRUCTION). THIS DRAWING SHALL NOT CONSTITUTE VERIFICATION OF LOCATION, QUANTITY, SIZE, DEPTH, OR TYPES OF EXISTING UTILITIES.
3. EMERGENCY CONTACT INFORMATION: SEE INCLUDED COMPANY INFORMATION
4. UPON COMPLETION, UTILITY WILL BE REGISTERED WITH PENNSYLVANIA ONE-CALL SYSTEM
5. ALL WORK AND MATERIALS SHALL CONFORM WITH PENNDOT AND ALL FEDERAL REGULATIONS AND STANDARDS
6. PUBLICATION 213 PATA 5 & PATA 10A APPLIES
7. SUNOCO PIPELINE, L.P. WILL BE AVAILABLE 24/7 FOR EMERGENCY AT 800-786-7440 IF SUCH A PROBLEM SHOULD ARISE.
8. THIS PLAN IS FOR PERMITTING PURPOSES ONLY

PER PUBLICATION 16M; DESIGN MANUAL PART 5, CHAPTER 1.3.D FOR UNCASED PIPELINE:

1. CATHODIC PROTECTION TEST LEADS ARE INSTALLED AS SPECIFIED ON THE ALIGNMENT SHEETS PER SUNOCO'S CORROSION PROGRAM.
2. PLASTIC PIPE WILL NOT BE USED; ONLY WELDED STEEL.
3. DUCTILE IRON OR REINFORCED CONCRETE WILL NOT BE USED; ONLY WELDED STEEL.
4. THE WALL THICKNESS SHOWN ON THE DRAWINGS MEET OR EXCEED ALL APPLICABLE FEDERAL AND INDUSTRY STANDARDS.
5. THE OPERATING STRESS LEVELS INDICATED ON THE DRAWINGS ARE IN ACCORDANCE WITH THE FEDERAL PIPELINE SAFETY REGULATIONS.
6. IT IS ACKNOWLEDGED THAT IF IN THE FUTURE THE CROSSING NEEDS REPLACEMENT, THE REPLACEMENT LINE WILL BE BORED AT A NEW LOCATION.

COORDINATE SYSTEM

PENNSYLVANIA STATE PLANE SOUTH
NAD 83 US FEET

R.O.W. INGRESS
X = 2414354.81
Y = 349755.51

R.O.W. EGRESS
X = 2414449.44
Y = 349765.04

24/7 CONTACT INFO & PIPE MARKER INFO:

SUNOCO PIPELINE L.P.
525 FRITZTOWN ROAD
SINKING SPRING, PA 19608
PHONE NUMBER: 800-786-7440
NATURAL GAS PIPELINE

CENTERLINE REV DATE: 08-04-2017

Figure 2: Revised Conventional Bore Plan

SUNOCO
PA HWY 897

WEST COCALICO TOWNSHIP, LANCASTER CO., PA

04/02/15
REVISED 08/21/17

SCALE
AS NOTED

DWG #: PA-LA-0022.0000-RD

Prepared by TRICO SURVEYING AND MAPPING
BLOOMINGTON, INDIANA
WWW.TRICOSURVEYING.COM

8