HORIZONTAL DIRECTIONAL DRILL ANALYSIS
WILLIAM PENN AVENUE CROSSING
PADEP SECTION 105 PERMIT NO.: E11-352
PA-CA-0023.0000-RD and PA-CA-0023.0000-RD-16
(SPLP HDD No. S2-0070)

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This reanalysis of the horizontal directional drill (HDD) of the Sunoco Pipeline, LP (SPLP) 20-inch and 16-inch diameter pipeline crossing of streams S-N36, S-N39, S-O43, and S-O44, wetlands N20, N24, and O35, and William Penn Avenue in Jackson Township, Cambria County, is in accordance with Stipulated Order issued under Environmental Hearing Board Docket No. 2017-009-L for HDDs listed on Exhibit 2 of the Stipulated Order. This HDD is number 6 on the list of HDDs included on Exhibit 2. These HDDs were not initiated before the issuance of the Order.

PIPE INFORMATION

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

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

ORIGINAL HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 20-INCH

- Horizontal length: 2,265 foot (ft)
- Entry/Exit angle: 12-14 degrees
- Maximum Depth of cover: 40 ft
- Depth under William Penn Ave: 32 ft
- Depth under streams: 13-36 ft
- Depth under wetlands: 12-38 ft
- Pipe design radius: 2,000 ft

ORIGINAL HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 16-INCH

- Horizontal length: 2,263 foot (ft)
- Entry/Exit angle: 12-16 degrees
- Maximum Depth of cover: 41 ft
- Depth under William Penn Ave: 36 ft
- Depth under streams: 14-39 ft
- Depth under wetlands: 20-39 ft
- Pipe design radius: 1,600 ft

GEOLOGIC AND HYDROGEOLOGIC ANALYSIS

Bedrock underlying the area of HDD S2-0070 belongs to the Pennsylvanian age Glenshaw Formation, part of the Conemaugh Group. The Glenshaw Formation consists of repeated sequences of sandstone, siltstone, shale, claystone (including red beds), limestone, and coal. Shale is the primary rock type. It contains four major marine zones that are, from highest to lowest in stratigraphic position: the Ames, Woods Run, Pine Creek, and Brush Creek. The formation decreases in thickness from about 410 ft in the northeast to approximately 280 ft in the southwest. The coal beds in the Glenshaw Formation are sporadically mined. The overburden can range from three to greater than six ft thick and is primarily composed of channery silt loam and silt loam from weathered limestone, sandstone and shale (Geyer and Wilshusen, 1982; McElroy, 2001).

Although coal mining has been extensive in this region, a review of published mining data indicate that no documented mining has occurred within the LOD of HDD S2-0070. Glover (1990) shows the limit of deep Lower Kittanning coal mining is approximately 200 ft from HDD S2-0070 to the north at its closest point.

Based on published geologic data, no karst features are anticipated within the limits of HDD S2-0070. Although limestone was observed in geotechnical boring B2-3E east of the eastern entry/exit point along the revised profile, karst conditions are not anticipated because the limestone within the Glenshaw Formation is thinly interbedded and karst terrain is not characteristic for these limestones; therefore, the use of geophysics assessments was considered but not performed because this type of assessment would not provide additional data for use in the analysis of this HDD.

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

HYDROGEOLOGY, GROUND WATER, AND WELL PRODUCTION ZONES

Groundwater flow proximal to HDD S2-0070 moves along gradients established by a water table surface that is a subdued reflection of the local topography. The alignment of S2-0070 HDD passes west to east through a headwater valley holding Hinckston Run (S-N39), a few tributaries, and some delineated wetlands. The density of stream channels and wetlands indicates the drill passes through a local groundwater discharge zone and is the reason why HDD installation was selected for pipe construction across the area. The surrounding terrain is higher in elevation in all directions away from the HDD alignment and groundwater is flowing from these uplands towards the streams and wetlands.

Most groundwater in area of the drill occurs and moves within a fractured bedrock aquifer. Groundwater occurs within the secondary porosity created by fractures, bedding plan partings, and faults. Given this HDD location is a groundwater discharge zone, the water table is shallow at some locations and occupies unconsolidated alluvium associated with the Hinckston Run flood plain. Based on data contained in the geotechnical borings, groundwater was detected in the SB-01 boring at a depth of 5 ft below ground surface (bgs) in unconsolidated sediments and in SB-03 at a depth of 12 ft in unconsolidated sediments. A groundwater level was measured at 25.5 ft bgs in boring B2-3E where the surface elevation is tens of ft higher.

The Pennsylvania Groundwater Information System (PaGWIS) reported six wells within 1,000 ft of HDD S2-0070. Four of these (PA Well IDs 81845, 81846, 81847, and 81848) are given the same latitude and longitude for a position approximately 350 ft north of the LOD along the western part of the alignment. All four wells were completed between 106 and 250 ft bgs and reported within the Conemaugh Group. Static water was reported in three wells from 91 to 216 ft bgs, the latter being from the deepest well. Based on the results of a PaGWIS database search, yields from wells drilled into the Glenshaw Formation and within a mile of HDD S2-0070 range from 4 to 25 gpm. The production zone for waters wells in a bedrock formation is from the well bottom to highest point of water inflow from the water bearing seams, joints, and fractures in the rock formation.

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

INADVERTENT RETURNS DISCUSSION

An HDD has not been initiated at this location.

No IRs were reported along the alignment of the HDD S2-0070 drill on the list of IRs for ME I documented in the IR PPC Plan for Cambria County.

Sunoco Pipeline, L.P. (SPLP) HDD consultants reviewed the HDD design and geotechnical data for this area and determined that the risk of IRs to the waters and wetlands overlying the HDD could be reduced by increasing the depth of the HDD.

The results of the new geotechnical core borings show the revised HDD profile will encounter and transition through shale, sandstone, and claystone while proceeding to maximum profile depth. Overall rock quality parameters improve as depth below ground increases. The core data shows shale at top of bedrock with a recovery value of 63, and RQD value of 37, changing to sandstone with recovery values varying from 85-100 and RQD values ranging from 60-100. At maximum profile depth the profile is set within claystone with a recovery value of 100 and RQD value of 67, indicative of moderate overall rock quality, which assists in suppression of IRs. The sandstone layer overlying the claystone will act as a barrier to IRs above the horizontal run of the HDD.

Based on the original profiles for HDD S2-0070, the revised profiles for HDD S2-0070 are longer, go deeper into bedrock, and are deeper beneath water resources than the original profile. As such, the revised profiles represent a reduced risk of creating an IR.

ADJACENT FEATURES ANALYSIS

This HDD location is approximately 0.8 mile north/northwest of Vinco, Pennsylvania, set primarily within a rural residential area. Based on review of 2015 aerial photography, the nearest residence is 25 feet south of the HDD. The HDD would cross under four streams and three wetlands. The HDD is located approximately at, and up to, 1,600 feet and 200 feet east of William Penn Avenue, and approximately 260 feet south of the intersection of William Penn Avenue with Benshoff Hill Road. Streams S-N35 and S-N40 and wetland N21 are located just north of this HDD. Streams S-N37 and S-N38 and wetlands N19, N22, and N23 are located south of this HDD.

SPLP has identified all landowners with property located within 450 ft of the HDD alignment. There are thirty-two (32) individual landowners with properties located within 450 ft of the HDD alignment. SPLP sent each of these landowners a notice letter via both certified and first class mail on October 30, 2017, that included an offer to sample the landowner's private water supply/well in accordance with the terms of the Order and the Water Supply Assessment, Preparedness, Prevention and Contingency Plan. The letter also requested that each landowner contact the Right-of-Way agent for the local area and provide SPLP with information regarding: (1) whether the landowner has a well; (2) where that well is located, and its depth and size if known; and (3) whether the landowner would like to have the well sampled. In accordance with paragraph 10 of the Order, copies of the certified mail receipts for the letters sent to landowners have been provided to Karyn Yordy, Executive Assistant, Office of Programs at the Department's Central Office.

To date, ten (10) landowners have verified the presence of a private water well for which the data has been acquired for analysis relative to the HDD profile. Of these, six of the water supplies (5 wells and 1 spring) are within 450 ft of the HDD profile, and three are within 100 ft of the HDD profile. An illustration of the water supplies adjacent to the HDD profile is provided in Attachment 2

Based upon the understanding of the groundwater levels and movement through the overburden and subsurface bedrock fractures and fissures as described in the hydrogeology report, SPLP believes that HDD activities could affect individual well use during active drilling for wells located within 150 linear ft either side of the profile. Use of the wells within this area draws upon the ground water reserves through underground porosity, fissures, and fractures. The HDD is an active "pressure event" in the aquifer that pushes upon the static ground water and at minimum could agitate settled sediments within the water bearing zones, or could result in transport of diluted drilling fluids towards the withdrawn zone for individual wells. As a result, active well use during HDD activities potentially could result in the uptake of

turbid water. While this does not present a health hazard, it can be unsightly to users and could affect taste.

SPLP will engage in a final outreach to encourage landowners to make advance arrangements for the supply of alternative water sources as necessary during the HDDs. Agents for SPLP will initiate direct contact by phone or in person, and SPLP will prepare a second communication specifically directed to all landowners with known wells, or unidentified water supplies within 100 ft of the HDD profiles. The letter will communicate our analysis regarding their water supply. It will clearly state the preference to establishing communications in advance of the work; request permission to perform monitoring during the HDDs, and landowner's preference to installing alternative water in advance of the HDDs.

During the active HDD process, any landowner contacting SPLP with concerns about their water supply will be responded to. If an impact from the HDD is verified, then SPLP will encourage the affected landowner to allow the installation of alternative water supply.

ALTERNATIVES ANALYSIS

As required by the Order, the reanalysis of S2-0070 included an evaluation of open cut alternatives and a re-route analysis. As part of the PADEP Chapter 105 permit process for the Mariner II East Project, SPLP developed and submitted for review a project-wide Alternatives Analysis. During the development and siting of the Project, SPLP considered a number of different routings, locations, and designs to determine whether there was a practicable alternative to the proposed impact. SPLP performed this determination through a sequential review of routes and design techniques, which concluded with an alternative that has the least environmental impacts, taking into consideration cost, existing technology, and logistics. The baseline route provided for the pipeline construction was to cross every wetland and stream on the project by open cut construction procedures. The Alternatives Analysis submitted to PADEP conceptually analyzed the potential feasibility of any alternative to baseline route trenched resource crossings (e.g., reroute, conventional bore, HDD). The decision making processes for selection of the HDD instead of an open cut crossing methodology is discussed thoroughly in the submitted alternatives analysis and was an important part of the overall PADEP approval of HDD plans as currently permitted. As described below, the open cut and re-route analyses have confirmed the conclusions reached in the previously submitted Alternatives Analysis.

Open-cut Analysis

Conversion to open cut would result in direct but temporary impacts to PADEP designated coldwater fisheries (Streams S-N39 and S-O44) and PAFBC designated stocked trout fisheries (Stream S-N39). SPLP specifications require a minimum of 48-inches of cover over the installed pipeline beneath the bottom of the watercourse. To meet this cover requirement, during construction through the four streams, an open cut workspace with a width of 75 feet would be required to accommodate pipeline and provide sufficient space for trench excavation, spoil storage, and allowing the pipeline to be installed with sufficient separation from the existing 8" pipeline for integrity management. The assessed area of impact by this open cut plan would directly affect approximately 1.261 acres of wetlands, including 0.566 acres of Palustrine forested (PFO) disturbance, which would require both on-site replanting and off-site mitigation. The change would also effect 0.081 acres of stream bed between the four streams, and an additional 0.917 acres of PADEP Chapter 105 regulated floodway. Conventional crossings of these streams would require the damming the stream using a upstream and downstream geotube, while simultaneously pumping around all stream flows, and pumping out of all produced groundwater discharge from the excavated shallow soil horizons and water seepage below the geotube dams installed in the channel for the entire duration of the open cut crossing event. Although the temporary impacts would be controlled and managed using these appropriate mitigation measures, the preferred method is to drill below these resources.

A conventional auger bore cannot replace this HDD due the length limitations of these methods. When considering the use of bores to replace portions of this HDD, a bore of William Penn Road is possible but direct effects to stream S-N35 could not be avoided either by the entry or exits pits. The remaining length of the HDD area, west of William Penn Road, has the broadest extent of the wetland and stream resources associated with this portion of the right-of-way. As shown in the HDD plan views in Attachment 2, the wetlands and streams are intertwined and adjacent to each other, resulting in a bore length that is beyond technical length limitations. In summary, no direct effects to these resources can be avoided by conventional bore technologies.

Re-Route Analysis

In accordance with state and federal guidance, SPLP has routed the Project to be co-located with existing pipeline and other utility corridors to avoid new "greenfield" routing alignments, to the maximum extent practicable. This avoids and minimizes new and permanent impacts on previously undisturbed land, land use encumbrance, and site-specific and cumulative impacts on land, environmental, and community resources. This HDD is co-located within the existing SPLP 8" pipeline installed by conventional methods and rerouting would result in new greenfield impacts. In addition, given the length and general perpendicular direction of the streams this HDD crosses, and the location of additional streams and wetlands both north and south of this HDD, no practicable re-route option lies to the north or south of the proposed route that would not ultimately cross streams or wetlands.

An existing electrical transmission corridor occurs 0.3 miles south of the SPLP easement. This easement does not intersect, originate, or proceed in the general direction of the existing SPLP easement and therefore is not a viable alternate to this HDD.

Two (2) existing utility corridors occur north of this HDD at 1.1 miles and 1.4 miles north respectively. The most northern corridor does not intersect, originate, or proceed in the general direction of the SPLP easement and is therefore not a viable alternative to this HDD. The second corridor at 1.1 miles north intersects the existing SPLP route 4.2 miles to the west, and re-intersects the SPLP route 3.8 miles to the east and as such presents a viable 7.4 mile long alternative route for consideration to the current HDD location. Review of topographic maps and aerial photography reveals that this route would not result in a decrease in total number of streams crossed for equivalent miles of route. At minimum, 1,800 foot of wetland occurs on this route, and this route crosses through the middle of a high density residential area on the east side of William Penn Road, approximately 1.4 miles north of SPLP's crossing point. Due to the presence of the natural resources and residential occurrences, this potential alternative does not present any advantage over the current route and HDD location.

Finally, the current route utilizes existing easements that were acquired for pipelines prior to development surrounding the existing pipeline commenced. Accordingly, the developments surrounding the existing easement took place with the knowledge of existing pipelines and a permanent encumbrance on the land. By contrast, using a "greenfield" corridor outside of the existing developments in any direction away from the existing easement would require additional landowners to accept the establishment of a new encumbrance for pipeline use that did not exist at the time of acquisition.

RECONSIDERATION OF THE HORIZONTAL DIRECTIONAL DRILL

SPLP HDD consultants reviewed the HDD designs and geotechnical data for this location. Based upon this review, it was determined that the risk of IRs to regulated resources overlying the HDD could be reduced by increasing the depth of the original permitted HDD profile. Additional geologic investigations have been completed and utilized in the redesign of the planned HDD. The redesign adjusts the HDD

profile deeper to place the HDD pathway through bedrock having better structural integrity than a shallower profile and increase the overall length of the HDD due to pipe design requirements. A summary of the redesign factors is provided below.

Revised Horizontal Directional Drill Design Summary: 20-inch

- Horizontal length: 2,493 foot (ft)
- Entry/Exit angle: 14-16 degrees
- Maximum Depth of cover: 76 ft
- Depth under William Penn Ave: 63 ft
- Depth under streams: 41-56 ft
- Depth under wetlands: 26-76 ft
- Pipe design radius: 2,400 ft

Revised Horizontal Directional Drill Design Summary: 16-inch

- Horizontal length: 2,434 ft
- Entry/Exit angle: 16 degrees
- Maximum Depth of cover: 97 ft
- Depth under William Penn Ave: 78 ft
- Depth under streams: 52-72 ft
- Depth under wetlands: 40-96 ft
- Pipe design radius: 1,800-2,000 ft

The redesigned HDD profile for the 20-inch pipeline is 228 ft longer, with a depth of cover below the streams and wetlands increased by 14-38 ft from the permitted design. In addition, the entry/exit angles have been increased allowing for a sharper and quicker descent into more competent rock. The redesigned HDD profile for the 16-inch pipeline is 171 ft longer, with a depth of cover below the streams and wetlands increased by 20-47 ft and designed for a sharp and quick entry and exit from the horizontal depth.

Upon the start of this HDD, Sunoco will employ the following HDD best management practices as follows:

- SPLP will mandate rotational drilling of the pilot hole until competent bedrock is reached, such that the initial drilling at entry is performed at fluid pressures less than those required to operate the mud motor drive;

- SPLP will mandate annular pressure monitoring during the drilling of the pilot hole, which assists in immediate identification of pressure changes indicative of loss of return flows or over pressurization of the annulus, managing the 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 mandate short-tripping of the reaming tools to ensure an open annulus is maintained to manage the potential inducement of IRs;

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

- During the reaming phase, the use of Loss Control Materials can be implemented if indications of a potential IR are noted or an IR is observed;

- If LCMs prove ineffective to mitigate loss of returns or IRs, then grouting of the pilot hole may be implemented; and

- If necessary, the pilot hole and reaming phases at the point of entry for the HDD may utilize casing, hammered into the substrate down to structurally better rock, to prevent vertical or lateral movement of drilling fluids at shallow depths.

CONCLUSION

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

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(SPLP HDD No. S2-0070)

ATTACHMENT 1

GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT

HDD HYDROGEOLOGIC REEVALUATION REPORT

Mariner East II
Spread 2
S2-0070
William Penn Avenue
Jackson Township, Cambria County, Pennsylvania

Prepared for:

Sunoco Pipeline, L.P.

Prepared by:

Groundwater & Environmental Services, Inc.
440 Creamery Way, Suite 500
Exton, Pennsylvania 19341

December 2017

HDD HYDROGEOLOGIC REEVALUTION REPORT

Mariner East II
Spread 2
S2-0070
William Penn Avenue
Jackson Township, Cambria County, Pennsylvania

December 2017

Prepared for:

Sunoco Pipeline, L.P.
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Sinking Spring, Pennsylvania 19608

Prepared by:

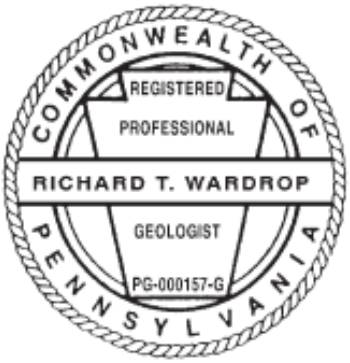
Richard T. Wardrop, P.G.
Lead Hydrogeologist

Reviewed by:

Jack L. Vasalani, P. G.
Principal Hydrogeologist

Groundwater & Environmental Services, Inc.
440 Creamery Way, Suite 500
Exton, Pennsylvania 19341
(610) 458-1077

By affixing my seal to this document, I am certifying that the information is true and correct. I further certify 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.



December 29, 2017

Richard T. Wardrop, P. G.
Lic. No. PG000157G

Date

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ATTACHMENTS

1.0 INTRODUCTION

Sunoco Pipeline, L.P., (SPLP) retained Groundwater & Environmental Services, Inc. (GES) to prepare HDD Hydrogeologic Reevaluation Reports (HRRs) for horizontal directional drills (HDDs) listed on Exhibit 2 of Stipulated Order EHB Docket No. 2017-009-L signed August 10, 2017. This report discusses the hydrogeologic reevaluation for HDD S2-0070-20 and HDD S2-0070-16 (the 20-inch and 16-inch HDDs for this location, respectively), hereinafter collectively referred to as HDD S2-0070 unless otherwise noted. The planned alignment for HDD S2-0070 is located between Benson Hill Road and William Penn Avenue (Route 271) in Jackson Township, Cambria County, Pennsylvania. The discussion presented in this report is based on an alignment and profile developed by Tetra Tech/Rooney, revised on March 17, 2017 (original profile). GES has also been provided a proposed alternative profile for HDD S2-0070, revised November 28, 2017 (revised profile) (see **Attachment A**). The revised profile was developed to increase the depth of the borehole by extending the east and west entry/exit points and making the profile longer. The purpose is to minimize the risk of inadvertent returns (IRs) by advancing the pipes deeper into competent bedrock. For the purpose of this assessment, GES utilized both HDD original and revised profiles to evaluate the hydrogeologic conditions at HDD S2-0070.

As described in the Stipulated Order (pages 3 and 4), the HRRs will provide information to eliminate, reduce, or control the release or IR of HDD drilling fluids to the surface of the ground or impact to water supplies at the location during HDD operations. The HRRs are not intended to evaluate potential adverse effects of nearby man-made structures from HDD operations.

A map depicting the location of the HDD with topographic information for the surrounding area is presented as **Figure 1**.

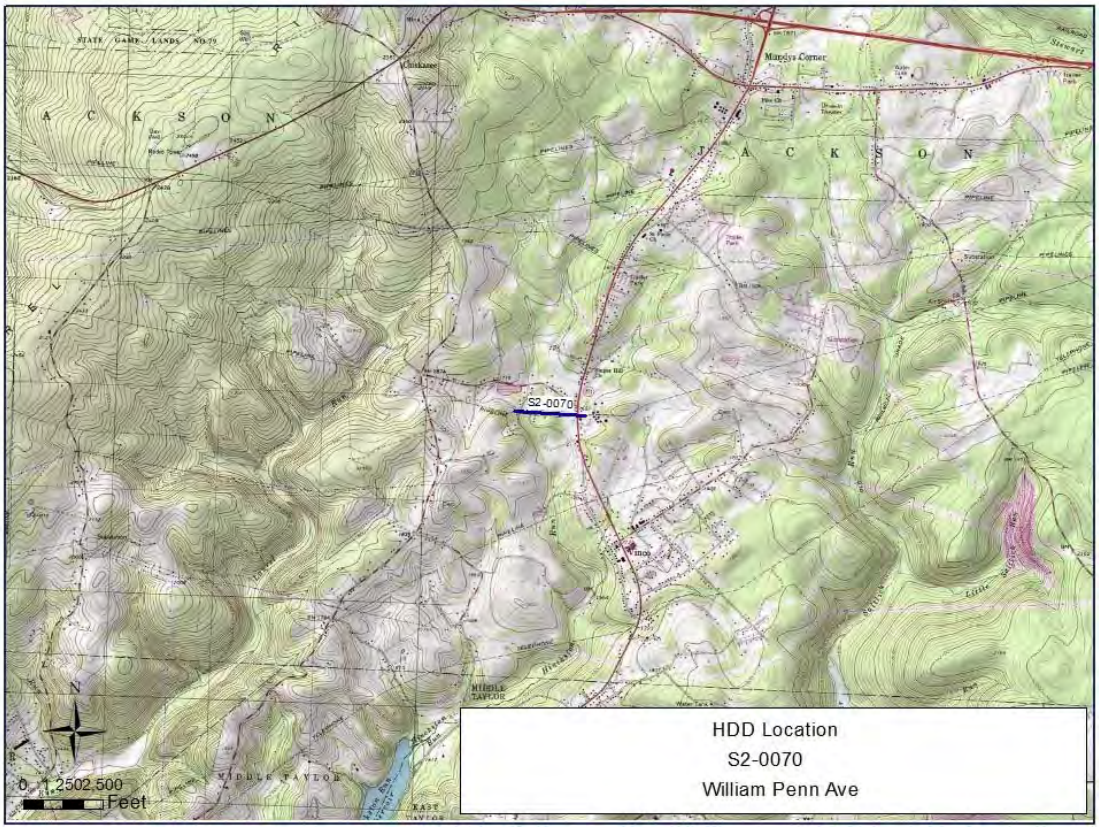

Figure 1. Site Location Map (modified from USGS Nanty Glo 1:24,000 Topo. Quad., rev. 1982)

This report presents the following information:

- Geologic and hydrogeologic characteristics in the area of HDD S2-0070;
- Summaries of studies performed pertinent to reevaluation, including fracture trace analysis and geotechnical borings;
- A site conceptual model; and
- A reevaluation summary with conclusions.

The contents of this report were developed from interpretation of published information, field observations, and related field studies. Site geotechnical boring programs were conducted by Tetra Tech in September 2014 and, more recently by Terracon Consultants, Inc. (Terracon) in September 2017, in support of the HDD S2-0070 reevaluation. Please note that GES did not oversee or direct either geotechnical drilling program, including, but not limited to, the selection of number and location of borings, determination of surface elevations, target depths, observations of rock cores during drilling operations, or preparation of boring logs. The geotechnical reports, boring logs, and any core photographs that resulted from these programs were generated by the two SPLP contractors. GES relied on these reports and incorporated their data into the general geologic and hydrogeologic framework for this hydrogeologic reevaluation report.

2.0 HDD GEOLOGY / HYDROGEOLOGY

2.1 Physiography

HDD S2-0070 is located within the Allegheny Mountain Section of the Appalachian Plateaus Physiographic Province, which consists of wide ridges separated by broad valleys and ridge elevations decreasing to the northwest. Local relief between valley floors and the ridges typically range from 200 to 300 feet. The Conemaugh River is the only major stream draining Cambria County; the southern half of Cambria County is drained by tributaries of the Conemaugh River such as Hinckston Run (S-N39), the primary tributary that crosses the HDD S2-0070 drill path at station 6+11 on the revised profile for the 20-inch HDD.

2.1.1 Topography

The topography along HDD S2-0070 consists of rolling hills with moderate relief and flat areas adjacent to local water features. The surrounding area is comprised of rural, residential and agricultural properties. The site location is depicted on **Figure 1**.

The original profile for the 20-inch line, developed/revised by Tetra Tech/Rooney on March 17, 2017, is a concave bore on the eastern and western ends with a straight run at the base of the bore. The surface elevation of the western entry/exit of HDD S2-0070-20 is 1,714 feet above mean sea level (ft amsl) with a very gradual decline in the eastern direction to about 1,646 ft amsl at Hinckston Run. The profile passes under a flat lying area until it passes under William Penn Avenue and the eastern entry/exit of HDD S2-0070-20 is reached at a surface elevation of 1,658 ft amsl. The overall length of HDD S2-0070-20 for the original profile is 2,265 feet. The revised profile prepared by Tetra Tech/Rooney (rev. 11/28/17), is longer and runs deeper than the original profile with the purpose of reducing the risk of IRs. The entry/exit locations are altered approximately 171 feet to the east and 57 feet to the west, thus extending the overall length to 2,493 feet. The surface elevation of the eastern entry/exit in the revised profile is 1,673 ft amsl and the elevation of the western entry/exit on the revised profile is approximately is 1,729 ft amsl.

The original profile for the 16-inch line, developed/revised by Tetra Tech/Rooney on March 17, 2017, is similar in shape to the 20-inch profile. The surface elevation of the western entry/exit of HDD S2-0070-16 is 1,710 feet above mean sea level (ft amsl) and the eastern entry/exit of the original HDD S2-0070-16 is 1,658 ft amsl. The overall length of HDD S2-0070-16 for the original profile is 2,263 feet. The revised

profile prepared by Tetra Tech/Rooney is longer and runs deeper than the original 16-inch profile. The entry/exit locations are altered approximately 133 feet to the east and 38 feet to the west, thus extending the overall length to 2,434 feet. The surface elevation of the eastern entry/exit in the revised profile is 1,670 ft amsl and the elevation of the western entry/exit on the revised profile is approximately is 1,717 ft amsl.

2.1.2 Hydrology

The nearest surface water bodies to the HDD S2-0070 location include streams S-O43, S-O44, S-N36, and S-N39 that cross the drill path on the original 20-inch profile at Stations 21+90, 19+76, 14+32, and 5+56, respectively. These streams are tributaries to Hinckston Run that runs south to the Hinckston Run Reservoir, approximately 2 miles south of HDD S2-0070. Wetlands that cross the drill path include wetlands W-N24 (original profile Stations 2+70 to 5+40) and W-N20 (original profile Stations 11+75 to 16+65). The original profile had the western entry/exit at 270 feet west of wetland W-N24 and crossing 12 feet below it. The revised profile shows the boring will be approximately 13 feet deeper at this location. The original profile had the eastern entry/exit at 75 feet west of stream S-O43 and crossing approximately 10 feet below the stream. The revised profile for the 20-inch line shows the boring will be approximately 31 feet deeper at this location.

2.2 Geology

2.2.1 Soils

Based on information obtained from the National Resource Conservation Service Web Soil Survey database ((USDA NRCS Web Soil Survey for Cambria County (http:\\websoilsurvey.nrcs.usda.gov)), soils along the path of HDD S2-0070 can range from 2.5 to 6 feet thick. Overburden is primarily composed of poorly to well drained fine-loamy colluvium and residuum from weathered siltstone, sandstone, and shale. These soils are moderately to well drained and groundwater levels are at 1.5 to greater than 7 feet below ground surface (ft bgs).

2.2.2 Bedrock Lithology

Figure 2 is a map depicting site bedrock geology for the area surrounding HDD S2-0070 (McElroy, 1998). Bedrock underlying the area of HDD S2-0070 belongs to the Pennsylvanian age Glenshaw Formation, part of the Conemaugh Group. The Glenshaw Formation consists of repeated sequences of sandstone, siltstone, shale, claystone (including red beds), limestone, and coal. Shale is the primary rock type. It contains four major marine zones that are, from highest to lowest in stratigraphic position: the Ames, Woods Run, Pine Creek, and Brush Creek. The formation decreases in thickness from about 410 feet in the northeast to approximately 280 feet in the southwest. The coal beds in the Glenshaw Formation are sporadically mined. The overburden can range from three to greater than six feet thick and is primarily composed of channery silt loam and silt loam from weathered limestone, sandstone and shale (Geyer and Wilshusen, 1982; McElroy, 2001).

2.2.3 Structure

McElroy (1998) provides structure contour maps for persistent coal beds in Cambria County. **Figure 2** shows the structure contours on the base of the Lower Kittanning coal. Structurally, the HDD S2-0070 drill paths are located on the western flank of the Johnstown syncline. The axial plane trace of the Johnstown syncline is located east of the eastern end of HDD S2-0070 and plunges to the south-southwest at a gradient of 0.015 feet/foot in the vicinity of the drill path. The amplitude of folds in the Allegheny Mountain section are typically 2,000 feet with bedrock dipping at approximately 7.5 degrees (McElroy, 1998).

Discontinuities in the form of joints and faults are imprinted in the broadly folded bedrock in the region. These fractures can act as conduits for groundwater movement and/or represent areas of weakness in the rock. Fold axes can be areas of increased density of fracturing (McElroy, 1998). Nickelsen and Hough (1967) conducted regional mapping of joints in shale, coal and sandstone in the Appalachian Plateau. Two

systematic joint sets were mapped in the vicinity of HDD S2-0070 with approximate trends of west-northwest and northwest. Less frequent non-systematic joints were mapped approximately orthogonal to the systematic joints.

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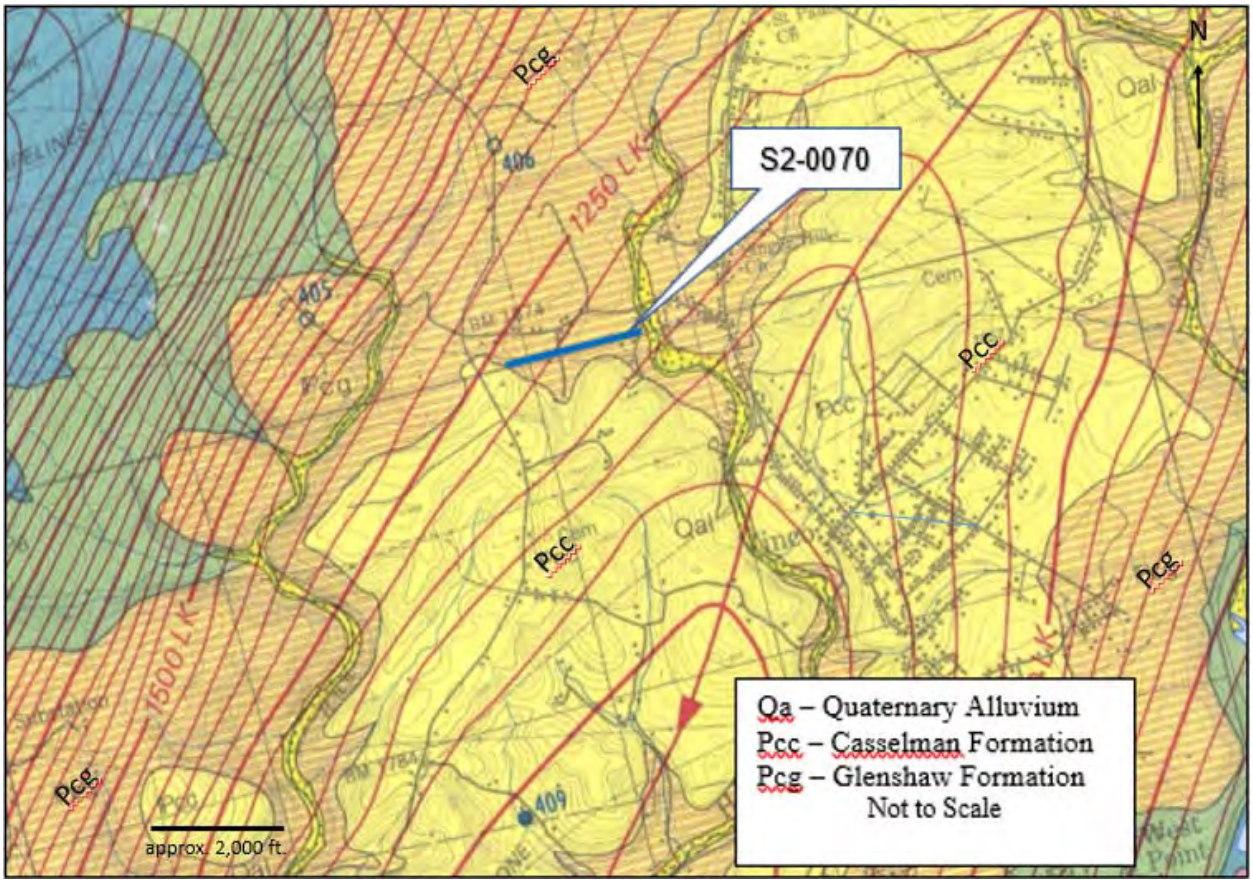

Figure 2. Site Geology Map and Structure Contour Map of the Lower Kittanning Coal (modified from McElroy, 1998)

2.2.4 Fracture Trace Analysis

Fracture trace analysis using high altitude aerial photography was performed for the area of interest to identify potential zones of bedrock weakness along drill paths. Fracture traces (one mile in length or less) and lineaments (greater than one mile in length) are the surficial expression on natural landscapes of vertical zones of bedrock fracture concentration. Fracture trace analysis is partly subjective; therefore, every mapped fracture trace does not necessarily represent a zone of bedrock fracture concentration.

Figure 3 shows a fracture trace map prepared for this reevaluation. This mapping was performed using aerial stereographic pairs flown in the spring of 1939. As such, much of the land surface appears undeveloped therefore; fracture traces are more easily seen. Four general orientations are present in the set of fracture traces. Two of the trace orientations generally match the joint alignments mapped by Nickelsen and Hough (1967): a northwestern trending set (systematic joints) and the majority of the traces trending northeast (non-systematic joints) perpendicular to the northwest aligned traces. A third fracture trace pattern is generally oriented north to south.

The proposed path of the revised profile is shown in red on **Figure 3** and transects five of the mapped fracture traces. Two of these traces intersect at the approximate location of the drill path at either end and three fracture traces are more central to the profile.

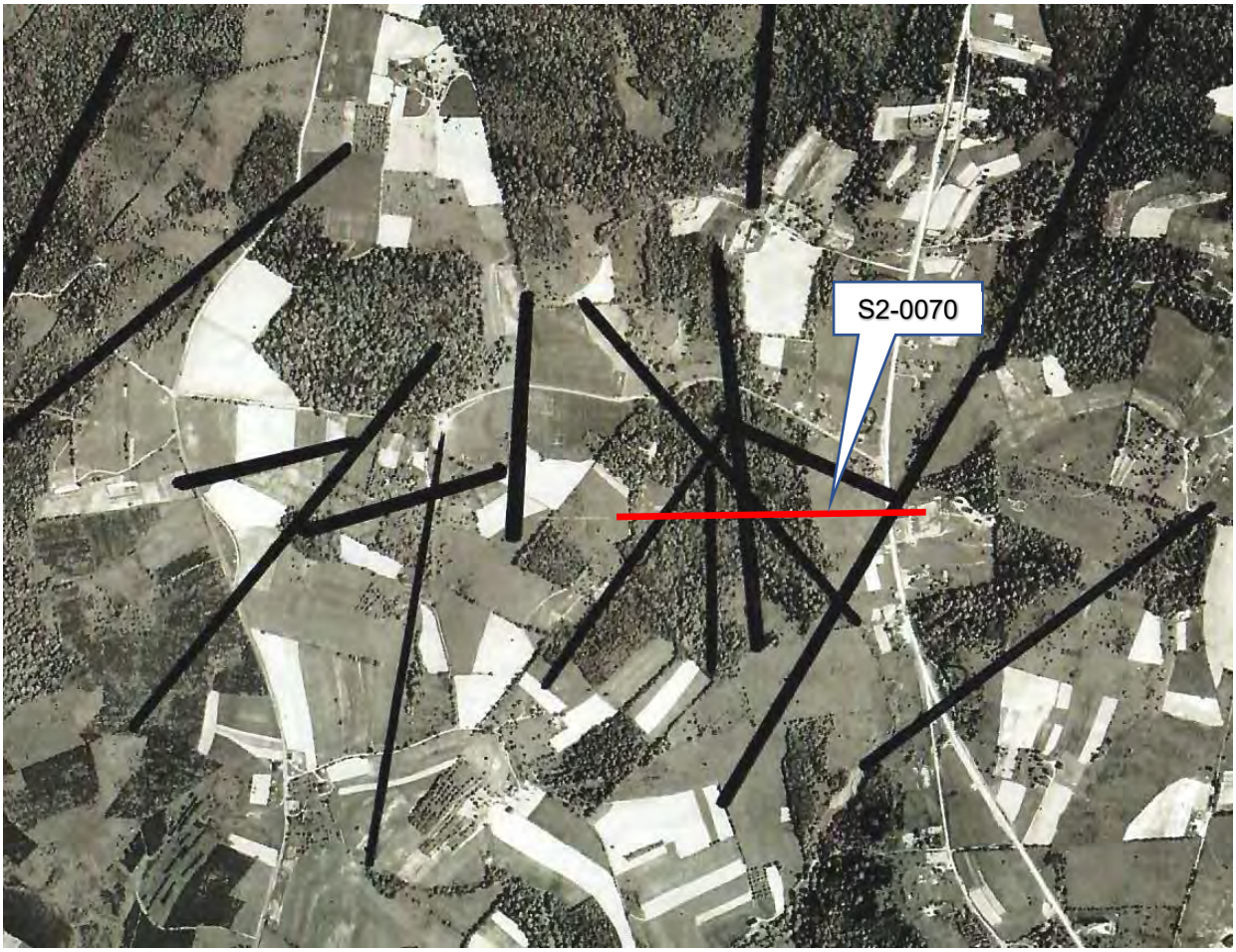

Figure 3. Fracture Trace Map

2.2.5 Karst

Based on published geologic data, no karst features are anticipated within the limit of disturbance (LOD) of HDD S2-0070. Although limestone was observed in geotechnical boring B2-3E east of the eastern entry/exit point along the revised profile, karst conditions are not anticipated due to the thinly interbedded nature of these limestone beds in the regional Glenshaw Formation.

2.2.6 Mining

Although coal mining has been extensive in this region, a review of published mining data indicate that no documented mining has occurred within the LOD of HDD S2-0070. Glover (1990) shows the limit of deep Lower Kittanning coal mining approximately 200 feet from HDD S2-0070 to the north, at its closest point near the eastern entry/exit (see **Figure 4**). The absence of deep mining beneath the planned HDD was confirmed by searches using the Pennsylvania Mine Map Atlas http://www.minemaps.psu.edu/ and PADEP eMap PA http://www.depgis.state.pa.us/emappa/ web sites and by visiting DEP's District Mining Office in California, PA.

Figure 4 shows a portion of the mine map for the Mine 31-B seam and approximate position of the revised 20-inch line profile for HDD S2-0070. An assessment of subsidence potential was performed by projecting a 35 degree angle of draw from the southern limit of mining and the estimated elevation of the top of the mine void at that location. Projecting upward and south, an estimate of the limit of subsidence potential in map view was derived (see **Figure 4**).

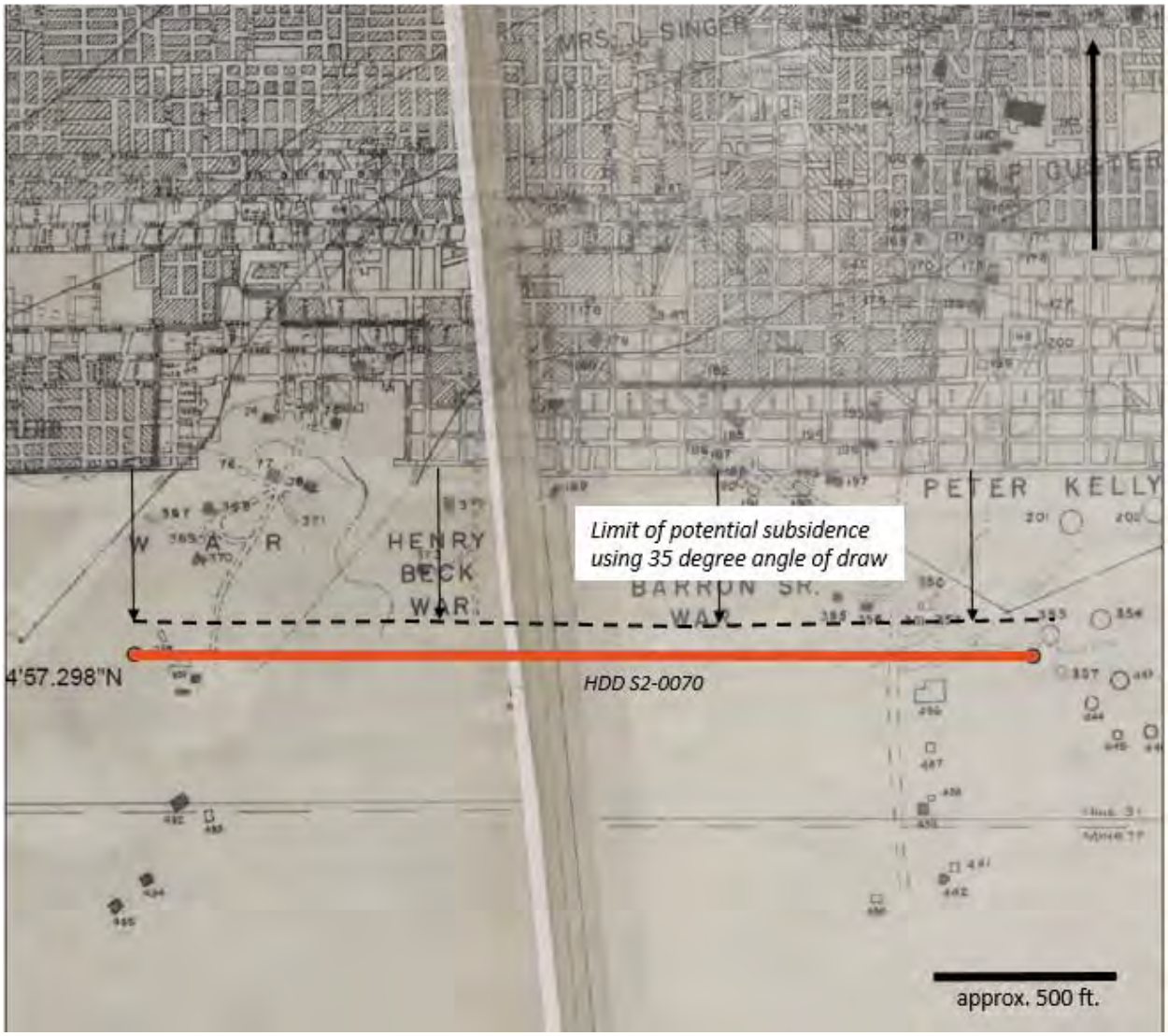

Figure 4. Limits of Lower Kittanning Coal (B) Seam Deep Mining Near HDD 02-0070
(modified from base map provided by PADEP)

The estimated area for potential subsidence was performed by assuming a distance from top of mine to land surface using the highest HDD entry/exit elevation as the land surface. As all other land above the profile and between the profile and the edge of the mine is lower in elevation, the estimated depth of cover and resultant width of the zone of potential subsidence using a 35 degree angle of draw is conservatively large.

2.2.7 Rock Engineering Properties

The Glenshaw Formation rock properties are as follows (Geyer and Wilshusen 1982):

- Well bedded; thick to massive sandstone, well bedded to nodular limestone, thin and fissile shale, and very poor bedded claystone.
- Joints are poorly to moderately well formed; open and vertical; closely to moderately spaced; and moderate distribution.
- Sandstone, siltstone, and limestone are moderately resistant weathering, whereas, claystone, shale, and coal weather extensively and deeply.
- Fast to moderate drilling rate.

2.2.8 Results of Geotechnical Borings

Original Borings

Three geotechnical borings, SB-01, SB-02, and SB-03, were installed by Tetra Tech in September 2014 in support of the original HDD design (**Attachment B**). The borings were advanced to depths of 20.9 ft bgs, 5.8 ft bgs, and 28.6 ft bgs, respectively. Boring SB-01 is located at Station 16+39 of the original plan and profile with a surface elevation of approximately 1,648 ft amsl. Boring SB-02 is located at Station 19+21 with a surface elevation of approximately 1,651 ft amsl. Boring SB-03 is located at Station 23+35 (70 feet east of the eastern entry/exit) with a surface elevation of approximately 1,661 ft amsl.

Unconsolidated materials in SB-01 are comprised of 13.5-feet of silty clay and sand above 7 feet of silty sand and gravel. A 3.8-foot layer of topsoil (5 inches) and silty sand is the overburden in SB-02. Overburden in SB-03 consists of 6.5-feet of fill material comprised of various colored sand, shale fragments and trace of masonry material. This fill overlies approximately 12.5-feet of silty sand with shale and sandstone gravel that overlies bedrock.

Sandstone bedrock was encountered in all three Tetra Tech borings SB-01, SB-02, and SB-03, at depths of 18.8 ft bgs, 5.8 ft bgs, and 20.9 ft bgs; respectively. Groundwater was encountered at 5.0 ft bgs at SB-01 and at 12.0 ft bgs at SB-03. Groundwater was not detected in SB-02.

For SB-03, bedrock cores were obtained from at the depth of auger refusal in weathered bedrock at 19.6 ft bgs to 28.6 ft bgs. The cores were described as gray sandstone with weathered, oxidized, fracturing. Over the two core runs, core recovery was 100 percent and RQDs ranged from 75 to 85 percent.

Recent Borings

B2-3E

Boring B2-3E was advanced on September 7, 2017, approximately 205 feet east of the revised eastern entry/exit point (**Attachment B**). The surface elevation is listed on the log as approximately 1,684 ft amsl and the boring was installed to a depth of 131.8 feet or approximate elevation 1,552 ft. amsl. The lowest elevation for the revised profile is 1,570 ft amsl for the 20-inch pipe and 1550 ft amsl for the 16-inch pipe. Unconsolidated overburden observed at B2-3E was comprised of gravelly clay to 8.5 ft bgs, followed by dark gray weathered mudstone to 18.6 ft bgs before split spoon refusal and the start of coring.

Bedrock cores contained shale, claystone, and sandstone characteristic of the Glenshaw Formation part of the Conemaugh Group. Zones of high angle fracturing were noted from 18.6 to approximately 30 ft bgs and in the five-foot core runs ending at 116.8 and 121.8 ft bgs. Recoveries throughout the core were high ranging from 81.5 to 100 percent with many at 100 percent. Regarding RQD values, cores from 21.8 to 46.8 were generally low ranging from 13 to 78 percent. A zone of high strength rock (sandstone) occurred from 46.8 to 96.8 for which RQDs were logged 90 percent or greater, except for a shale zone in the five-foot run ending at 86.8 ft bgs with an RQD of 37 percent. The RQDs for cores from 96.8 ft bgs to total depth at 131.8 ft bgs were representative bedrock with varying strength. Over this interval, RQD values ranged from 20 to 80 percent. A static groundwater level was measured in B2-3E at 25.5 ft bgs.

2.3 Hydrogeology

In general, groundwater flow proximal to HDD S2-0070 moves along gradients established by a water table surface that is a subdued reflection of the local topography. The alignments for the S2-0070 HDDs pass west to east through a headwater valley holding Hinckston Run (S-N39), a few tributaries, and some delineated wetlands. The density of stream channels and wetlands indicates the drill passes through a local groundwater discharge zone and is the reason why HDD installation was selected for pipe construction

across the area. The surrounding terrain is higher in elevation, in all directions away from the HDD alignment and groundwater is flowing from these uplands towards the streams and wetlands.

2.3.1 Occurrence of Groundwater

Most groundwater in area of the drill occurs and moves within a fractured bedrock aquifer. Groundwater occurs within the secondary porosity created by fractures, bedding plane partings, and faults. Given this is a groundwater discharge zone, the water table is shallow at some locations and occupies unconsolidated alluvium associated with the Hinckston Run flood plain. Water level data is discussed in **Section 2.3.3**.

2.3.2 Ground Elevation between HDD entry/exits

The surface elevation of the eastern entry/exit in the original profile for the 20-inch line is 1,658 ft amsl and the elevation of the western exit/entry is 1,714 ft amsl. The original profile has a bottom elevation of 1,606 ft amsl. The surface elevation of the eastern entry/exit in the original profile for the 16-inch line is also 1,658 ft amsl and the elevation of the western exit/entry is 1,710 ft amsl. The original profile has a bottom elevation of 1,606 ft amsl, as well.

The horizontal length of the 20-inch drill was increased 228 feet by moving the western entry/exit point 57 west and moving the eastern entry/exit point 171 feet east. The surface elevation of the eastern entry/exit in the revised profile is 1,673 ft amsl and the elevation of the western exit/entry is 1,729 ft amsl. The revised profile has an approximate bottom elevation of 1,570 ft amsl, 36 feet lower than the original profile.

The horizontal length of the 16-inch drill was increased 171 feet by moving the western entry/exit point 38 feet west and moving the eastern entry/exit point 133 feet east. The surface elevation of the eastern entry/exit in the revised profile is 1,670 ft amsl and the elevation of the western exit/entry is 1,717 ft amsl. The revised profile has an approximate bottom elevation of 1,550 ft amsl, 56 feet lower than the original profile.

2.3.3 Water Level

Groundwater was encountered at 12.0 ft bgs in boring SB-03, installed at Station 23+35 on the revised profile (20-inch), and at 5.0 ft bgs in boring SB-01, installed at Station 17+19. Groundwater was encountered at 36.5 ft bgs and static water level was measured at 25.5 ft bgs in boring B2-3E, installed at Station 27+01, which is 205 feet east of the eastern entry/exit on the revised profile.

The Pennsylvania Groundwater Information System (PaGWIS) reported six wells within 1,000 feet of HDD S2-0070. Four of these are given the same latitude and longitude for a position approximately 350 feet north of the LOD along the western part of the alignment (well IDs 81845, 81846, 81847, and 81848). All four wells were completed between 106 and 250 ft bgs and reported within the Conemaugh Group. Static water was reported in three wells from 91 to 216 ft bgs, the latter being from the deepest well. The well yield ranged from 4 to 11 gallons per minute (gpm). Pennsylvania Well ID 81843 is a domestic well located approximately 540 feet north of the alignment and is completed at 78 ft bgs. Database records indicate static water was at 35 ft bgs with a reported yield of 8 gpm.

2.3.4 Well Yields

Published median well yields (Geyer and Wilshusen 1982) are highly variable in the Conemaugh Group and have ranged from 1 to 357 gpm. McElroy (1998) notes that median yield of wells drilled into the Glenshaw Formation is 12 gpm with a range from 0 to 30 gpm. Based on the results of a PaGWIS database search, yields from wells drilled into the Glenshaw Formation and within a mile of HDD S2-0070 range from 4 to 25 gpm.

2.3.5 Local Water Supply Wells

SPLP performed a preconstruction survey of landowners within 450 feet of the HDD S2-0070 alignments. Six landowners have been identified as owning domestic supply wells and one land owner owns a spring within the 450-foot boundary. Two additional landowners own domestic supply wells just outside the northern part of the 450-foot survey area. **Figure 5** shows the locations of these water supplies. Well depth, depth to water and pump depths for some of the wells are listed on **Table 1**.

Table 1. Local Water Supply Information

GES Well ID	Distance to HDD Perpindicular (Feet)	Distance to HDD Entry/Exit (Feet)	Well Information		
			Reported DTB (Feet)	Reported DTW (Feet)	Reported Pump Depth
WL-11022016-499-02	21	126	25-40	20	25
WL-12202016-551-04	227	680	80	1	60
WL-12202016-551-01	94	716	80	0.5	60
WL-12202016-551-02	77	1,052	80	1	75
SP-06062017-604-01	177	281	NA	NA	NA
WL-11062017-614-02	475	749	79	69	Unknown
WL-11142017-614-01	347	865	Unknown	Unknown	Unknown
WL-11212017-612-01	156	167	40	20	Unknown
SP-11142017-614-02	1,273	1,273	NA	NA	NA
WL-11292017-614-01	467	498	Unknown	Unknown	Unknown

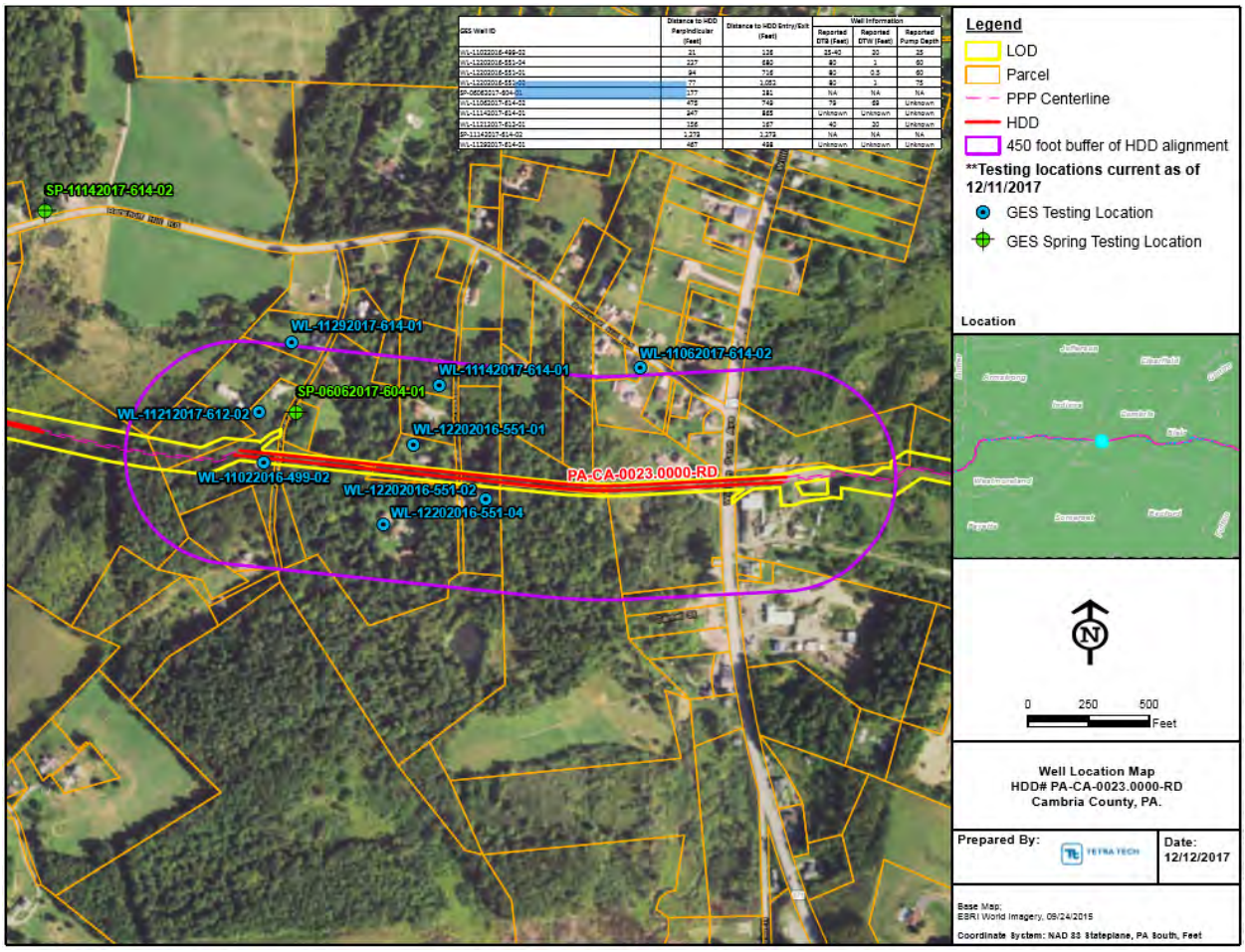

Figure 5. Preconstruction Groundwater Supply Sampling Locations

Sample WL-12202016-551-04 was collected at parcel from an 80-foot deep well located 675 feet east-southeast of the western entry/exit of HDD S2-0070. The depth to water is reported at 1 ft bgs and the pump is set at 60 ft bgs.

In June 2017, a water sample (SP-06062017-604-01) was collected from a spring located on parcel PA-CA-0018.0000-ABTE, approximately 290 feet northeast of the western entry/exit.

2.3.6 Mine Pools

Water filled sections of local abandoned coal mines, or mine pools, act as groundwater sinks in the region. According to PADEP, mine pools are known to exist within Mine 31, north of the proposed HDD (see Figure 4) and south and east of the HDD in Mine 72 and Mine 77, respectively. HDD installation procedures need to account for any adverse effects a large volume loss of drilling fluid return (LOR) would have from raising the water level in local and regional mine pools. Raising a mine pool level could cause higher than normal flow at known mine pool discharges or the appearance of a new mine discharge point.

2.4 Summary of Geophysical Studies

No geophysical studies were conducted for this reevaluation as there is no indication of karst development in the area and deep mining has not been identified beneath the HDD alignment.

3.0 OBSERVATIONS TO DATE

3.1 On This HDD Alignment

3.1.1 ME I

No IRs were reported along the alignment of the HDD S2-0070 drill on the list of IRs for ME I documented in the IR PPC Plan for Cambria County.

3.1.2 ME II

No drilling activities have been initiated at HDD S2-0070 as part of the ME II pipeline installation.

3.2 On Other HDD Alignments in Similar Hydrogeologic Settings

3.2.1 ME I

No IRs were reported on the list of IRs for ME I documented in the IR PPC Plan for sites underlain by Glenshaw formation bedrock.

3.2.2 ME II

To date, MEII pipeline installations within the Glenshaw Formation have been completed at the following HDD locations:

- S2-0016 Livermore Road – 20”
- S2-0050 Buffalo-Pittsburgh Highway (Rt. 119) – 20”
- S2-0060 Rt. 22 William Penn Highway – 20”
- S2-0062 Wetland (Clair Road) – 20”

All of the IRs to date in Spreads 1 and 2 for the ME II pipeline to date have occurred while drilling through the cyclic sequences of sandstone, shale, limestone, clays seams and coal present within western Pennsylvania bedrock formations, including the Allegheny Group, Casselman Formation, Glenshaw Formation, Monongahela Group, and Waynesburg Formation. Entries and exits pass through alluvium,

colluvium and soils developed on top weathered bedrock and mine spoils. In general, the IRs have been related to shallow overburden (especially under water bodies), large elevation changes between entries and exits, coarse grained unconsolidated materials near the surface (such as alluvium and mine spoil), and the interconnectivity of open bedrock structural features that is difficult to predict.

An IR occurred during the HDDS2-0016 20-inch line at Livermore Road. The root causes for this IR were limited overburden over the drill (38 feet) while passing under the Spruce Run flood plain along the central part of the drill and a large elevation differences between the two exit/entry points and the flood plain (approximately 77 ft and 213 ft). IRs did not occur during the other three 20-inch installations.

An IR did occur during the16-inch installation at S2-0050 Buffalo-Pittsburgh Highway (Rt. 119). The IR was related to large elevation changes between entries and exits and previously unidentified interconnected bedrock structural features. A relatively slow persistent loss of drilling fluid eventually filled the available secondary pore space along a path from the boring to the IR. This slow, persistent loss was caused by plugging at the reamer and the buildup of fluid pressure behind the reamer, within an upward sloping borehole.

4.0 SUMMARY AND CONCLUSIONS

4.1 HDD Site Conceptual Model

The profile for HDD S2-0070 is relatively symmetric with entry/exits points located on elevated ground west and east of the flood plain of Hinckston Run, its tributaries, and associated wetlands, central to the alignment (see **Attachment A**). The central lowland area that is above most of the HDD profile is a groundwater discharge zone therefore the water table will be relatively close to land surface and it is anticipated that a large percentage of the drill will be below the water table. On the revised plan, the western entry/exit for the 20-inch line is approximately 81 feet above the flood plain and the eastern/entry point is approximately 25 feet above the flood plain. Based on the information provided in this reevaluation report, the revised drilling path for HDD S2-0070 will encounter competent Glenshaw Formation bedrock throughout the majority of profile with approximately 6 to 21 feet of overburden soils proximal to the entry/exit point.

The planned boreholes crosses beneath four streams and two wetland complexes. On the revised profiles, the minimum depth from a water resource to the boring is approximately 25 feet along the western edge of wetland W-N24 whereas on the original profile this separation was only 12 feet. Similarly, in the eastern part of the alignment, the depth from stream S-043 to the HDD profile is approximately 10 feet on the original profile, but is shown at approximately 41and 52 feet on the revised profiles for the 20-inch and 16-inch, respectively. The difference in depth of profile between the original and revised profiles in the central part of the HDD is an increase of approximately 36 feet and 56 feet for the 20-inch and 16-inch pipes, respectively.

The possibility of the pilot hole for HDD S2-0070 creating a drain causing excessive groundwater discharge at either exit/entry point, or an associated lowering of the local water table, is low because the entry/exit points are both at higher elevations than the water table along the entire path. Given that the HDD is located in a groundwater discharge zone, an upward vertical groundwater flow gradient may be present along the bore path. An upward flow gradient was indicated during the advance of B2-3E where groundwater was encountered at 36.5 ft bgs and the water level rose to 25.5 ft bgs after 12 hours. The upward flow gradient may impart a pressure on the borehole greater than anticipated and the drilling contractor should be prepared to limit groundwater flux into the borehole, for example, by increasing the weight of the drilling fluid.

The log for geotechnical boring B2-3E (located approximately 205 feet east of the revised eastern entry/exit point), drilled in September 2017, shows 8.5 feet of gravelly lean clay from the ground surface to the top of weathered bedrock at 8.5 ft bgs. However, the log for SB-03 (located approximately 161 feet west of the revised eastern entry/exit and south of the ROW) shows approximately 19 feet of coarse grained materials comprised of sand, gravel, silt, shale fragments and masonry fragments. The more clayey soil represents a reduced IR risk upon entry/exit whereas the more coarse soils do not. Further, it is unknown what soil texture conditions exist at the western entry/exit as no geotechnical borings were advanced near that location. The overburden logged on higher ground at B2-2E, located approximately 750 feet west of western entry/exit, is described as weathered rock with fat clay from surface to 28.5 ft bgs, indicating relatively cohesive material at the surface, at that location.

Bedrock cores were obtained at geotechnical borings, SB-03 and B2-3E, proximal to the eastern portion of the profile. At these two locations, RQD values were variable ranging from 13 to 100 percent. At B2-3E the core from 21.8 to 46.8 ft bgs showed low RQDs ranging from 13 to 78 percent. A zone of high strength rock (sandstone), occurred from 46.8 to 96.8 ft bgs for which RQDs were all 90 percent or greater, except for one five-foot run with an RQD of 37 percent. The RQDs for cores from 96.8 ft bgs to total depth at 131.8 ft bgs were variable and ranged from 20 to 80 percent. The path of the profile crosses five mapped fracture traces reinforcing the indication that rock strength is variable and zones of weaker bedrock may be encountered multiple times along the drill.

Eight domestic supply wells and one spring have been identified within, or close to, a 450-foot perimeter drawn around the HDD alignments. The range of well depths for those wells is 20 to 80 feet. On the revised profiles, the HDDs are planned to run approximately 74 and 94 ft bgs, for the 20-inch and 16-inch, respectively, within this range of well depths.

An abandoned Lower Kittanning coal deep mine (Bethlehem Coal Corp., Mine 31) exists due north of the HDD alignments. The alignments fall outside a potential mine subsidence zone defined using a 35 degree angle of draw. Mine pools are known to exist within Mine 31, north of the proposed HDD and south and east of the HDD in Mine 72 and Mine 77, respectively. HDD installation procedures need to prevent any adverse effects on mine pool levels caused by a large loss of drilling fluid return (LOR). Such adverse effects would include raising the mine pool level causing higher than normal flow at known mine pool discharges or the appearance of a new mine discharge point.

4.2 Conclusions and Recommendations

Based on the original and revised profiles for HDD S2-0070 the revised profile for HDD S2-0070 is longer, goes deeper into bedrock, and is deeper beneath water resources than the original profile see (**Attachment A**). As such, the revised profile represents a reduced risk of creating an IR. Based on this hydrogeologic reevaluation, installation procedures should plan for conditions associated with:

1. Thin, coarse grained overburden, at the entry/exit points and at the west edge of wetland W-N24.
2. Variability in rock strength (based on RQD values and fracture trace analysis).

The production intervals of local water supply wells overlap the position of the HDD boring profile therefore precautions should be taken to limit migration of any drilling fluid to these wells.

Although deep mine pools exist in the area of the HDD alignments, an adverse effect on a mine pool level from HDD installation is unlikely due to the very large volume of fluid needed to raise the pool. Current procedures mandate an immediate stop to HDD drilling when an LOR occurs. It is recommended that drillers implement mitigation measures that will effectively stop LORs if they occur. Limiting the volume of LORs will assure no adverse effects on mine pool levels.

5.0 REFERENCES

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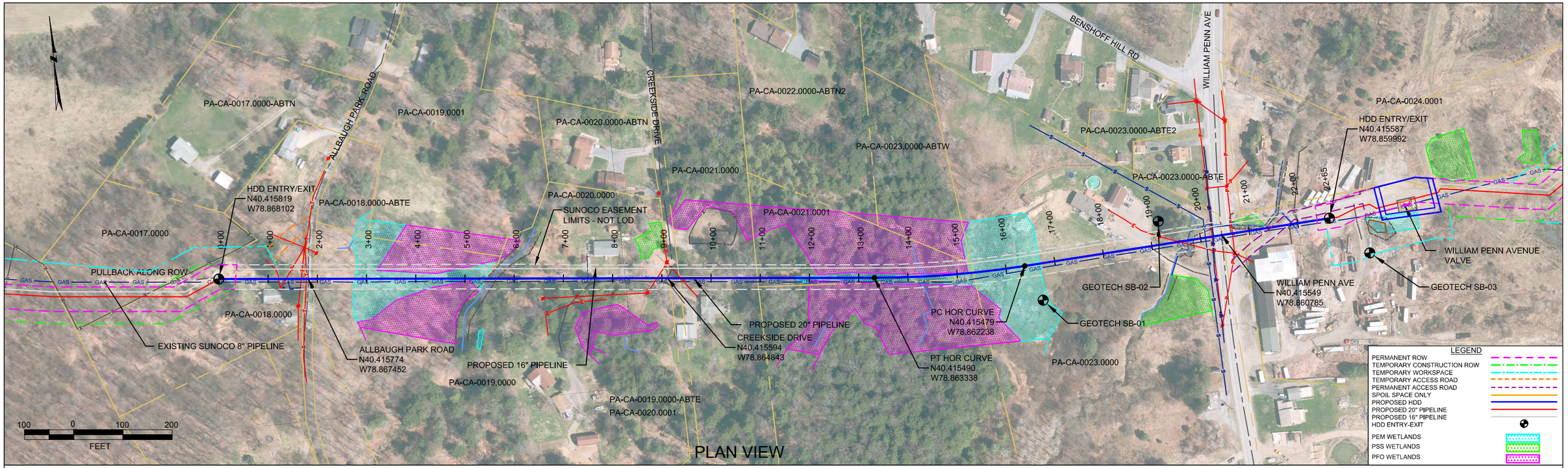
Pennsylvania Mine Map Atlas (http://www.minemaps.psu.edu).

USDA NRCS WSS, United States Department of Agriculture, Natural Resources Conservation Service – Web Soil Survey for Cambria County, (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx).

USGS (United States Geological Survey), Nanty Glo, Pennsylvania, 1:24,000 topographic quadrangle map, rev. 1982.

Attachment A

Original and Revised Plan and Profile



PROFILE VIEW

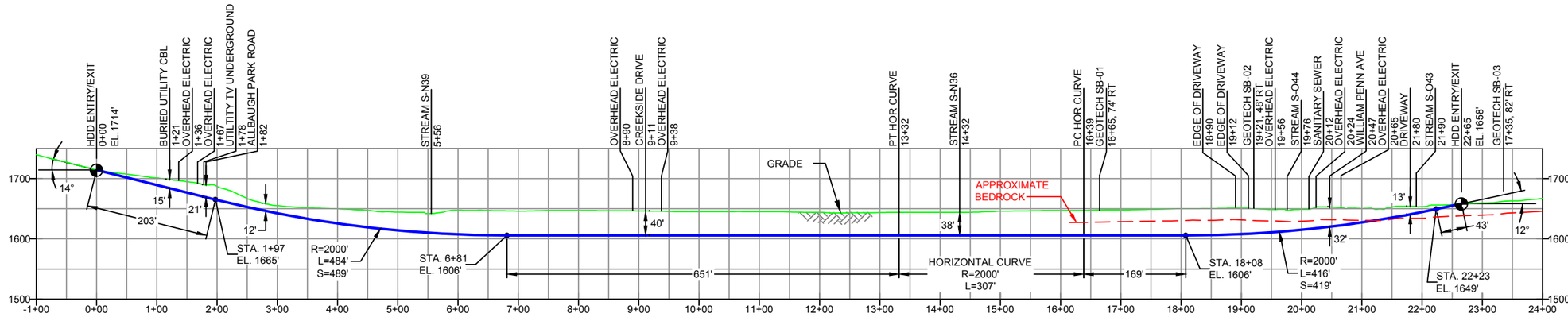
CAMBRIA COUNTY, PENNSYLVANIA - JACKSON TOWNSHIP
S2-0070

GEOTECH SB-01
-NG EL. 1648'
-TOPSOIL (0' - 0.3')
-GROUNDWATER (5.0')
-CL (0.3' - 13.5')
-SM (13.5' - 19.5')
-SM / GM (19.5' - 20.9')
-SANDSTONE (20.9')
-COMPLETION DEPTH EL. 1627'

GEOTECH SB-02
-NG EL. 1651'
-TOPSOIL (0' - 0.4')
-SM (0.4' - 3.8')
-SANDSTONE (3.8' - 5.8')
-COMPLETION DEPTH EL. 1645'

GEOTECH SB-03
-NG EL. 1661'
-FILL (0.0' - 6.5')
-SM (6.5' - 13.5')
-GROUNDWATER (12.0')
-SM / GM (13.5' - 18.8')
-SANDSTONE (18.8' - 19.6')
-SANDSTONE (19.6' - 28.6')
-COMPLETION DEPTH EL. 1632.5'

NOTE: REFER TO TEST BORING LOG S2-0070 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=): 2265'
   HDD PIPE LENGTH (S=): 2280'
   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.

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	REVISED PROFILE WITH 2017 LIDAR	MRS	03/17/17	RMB	03/17/17	CAG	03/17/17
3	DESIGN CHANGE - ADJUSTED HORIZONTAL CURVE DISTANCE - NO CENTERLINE CHANGE	MRS	10/27/16	RMB	10/27/16	AAW	10/27/16
2	REVISED PER ENGINEERING COMMENTS	MRS	08/26/16	RMB	08/26/16	AAW	08/26/16
1	MLV NAME UPDATED	DLM	04/07/16	RMB	04/07/16	AAW	04/07/16
0	ISSUED FOR CONSTRUCTION	MRS	12/21/15	RMB	12/21/15	AAW	12/21/15

Sunoco Logistics Partners L.P.

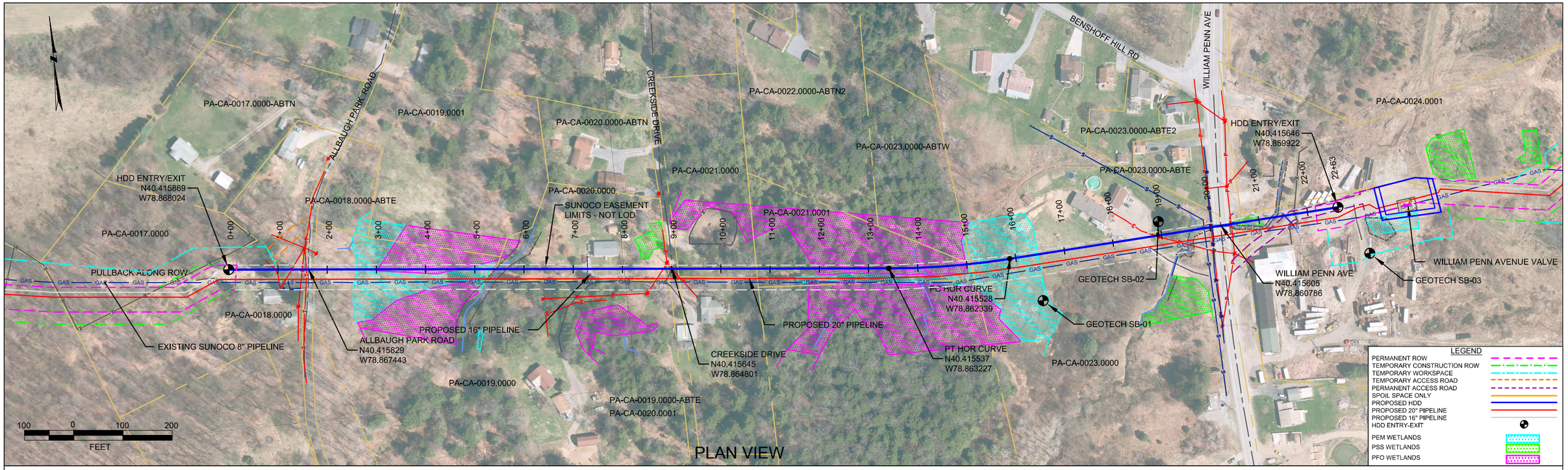
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WILLIAM PENN AVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

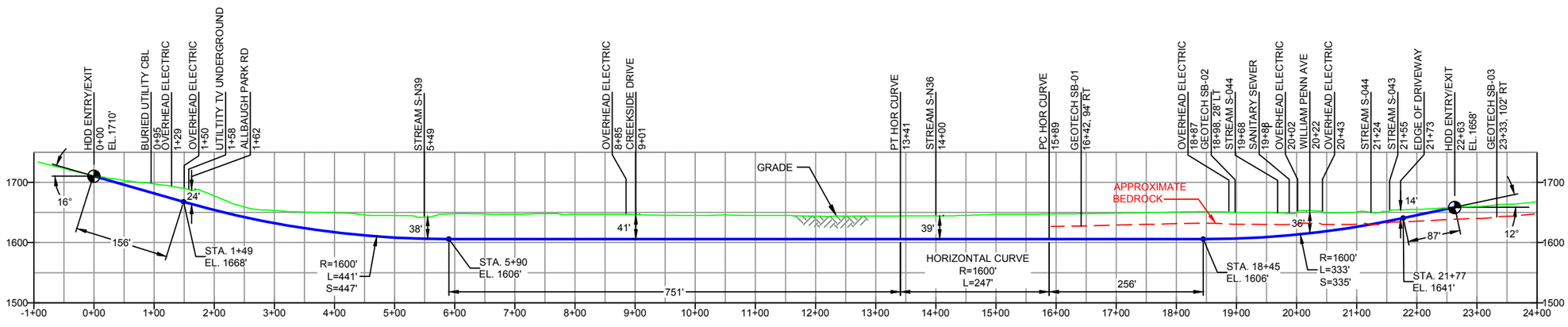
DWG. NUMBER: PA-CA-0023.0000-RD



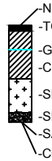
PLAN VIEW

PROFILE VIEW

CAMBRIA COUNTY, PENNSYLVANIA - JACKSON TOWNSHIP
S2-0070-16



GEOTECH SB-01

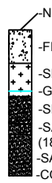


-NG EL. 1648'
-TOPSOIL (0' - 0.3')
-GROUNDWATER (5.0')
-CL (0.3' - 13.5')
-SM (13.5' - 19.5')
-SM / GM (19.5' - 20.9')
-SANDSTONE (20.9')
-COMPLETION DEPTH EL. 1627'

GEOTECH SB-02

-NG EL. 1651'
-TOPSOIL (0' - 0.4')
-SM (0.4' - 3.8')
-SANDSTONE (3.8' - 5.8')
-COMPLETION DEPTH EL. 1645'

GEOTECH SB-03



-NG EL. 1661'
-FILL (0.0' - 6.5')
-SM (6.5' - 13.5')
-GROUNDWATER (12.0')
-SM / GM (13.5' - 18.8')
-SANDSTONE (18.8' - 19.6')
-SANDSTONE (19.6' - 28.6')
-COMPLETION DEPTH EL. 1632.5'

NOTE: REFER TO TEST BORING LOG S2-0070 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=): 2263'
   HDD PIPE LENGTH (S=): 2279'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN 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.

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	REVISED PROFILE WITH 2017 LIDAR	MRS	03/17/17	RMB	03/17/17	CAG	03/17/17
3	REVISED PER ENGINEERING COMMENTS	MRS	08/26/16	RMB	08/26/16	AAW	08/26/16
2	MLV NAME UPDATED	DLM	04/07/16	RMB	04/07/16	AAW	04/07/16
1	DESIGN ANNOTATION CORRECTION	DLM	02/12/16	RMB	02/12/16	AAW	02/12/16
0	ISSUED FOR CONSTRUCTION	MRS	12/21/15	RMB	12/21/15	AAW	12/21/15

Sunoco Logistics Partners L.P.

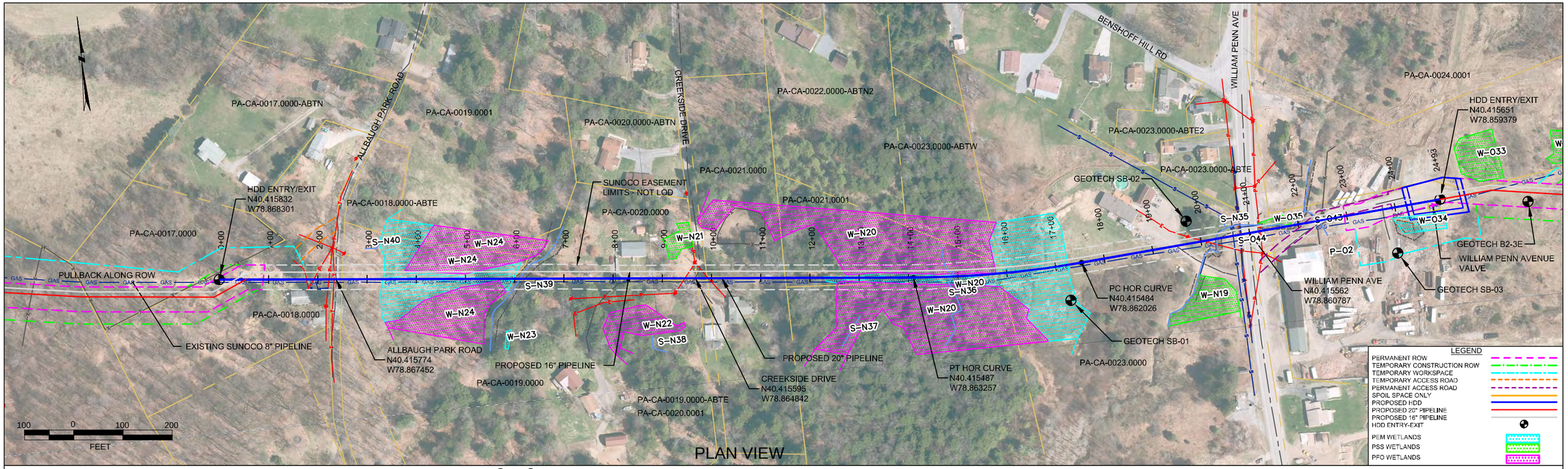
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WILLIAM PENN AVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

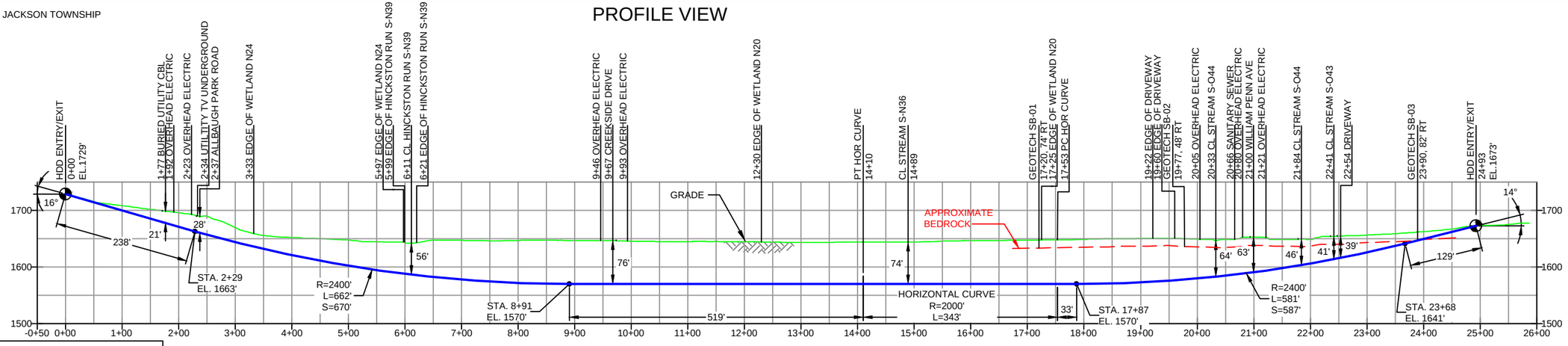
DWG. NO: PA-CA-0023.0000-RD-16



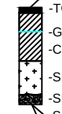
PLAN VIEW

CAMBRIA COUNTY, PENNSYLVANIA - JACKSON TOWNSHIP
S2-0070

PROFILE VIEW



GEOTECH SB-01



GEOTECH SB-02

GEOTECH SB-03

NOTE: REFER TO TEST BORING LOG S2-0070 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B2-3E

NOTE: REFER TO TEST BORING LOG B2-3E TERRACON PROJECT #J217P078 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=): 2493'
   HDD PIPE LENGTH (S=): 2519'
   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.

NOTES

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4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

ES-2.15	TO	ES-2.17	EROSION & SEDIMENT PLAN	
SHEET 10	TO	SHEET 11	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/28/17	RMB	11/28/17	CAG	11/28/17
EP3	RELOCATED DRILL ENTRY / EXIT - DESIGN CHANGE PER LONE STAR	MRS	09/21/17	RMB	09/21/17	CAG	09/21/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		JTW	03/15/16	RMB	03/15/16	AAW	03/15/16

Sunoco Logistics Partners L.P.

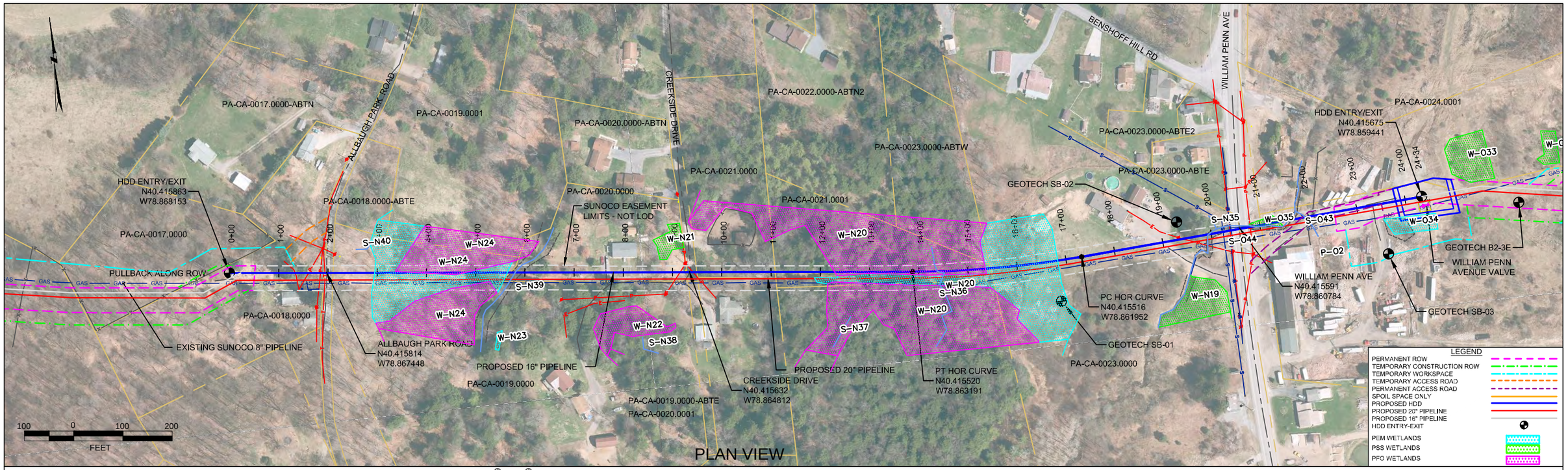
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WILLIAM PENN AVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

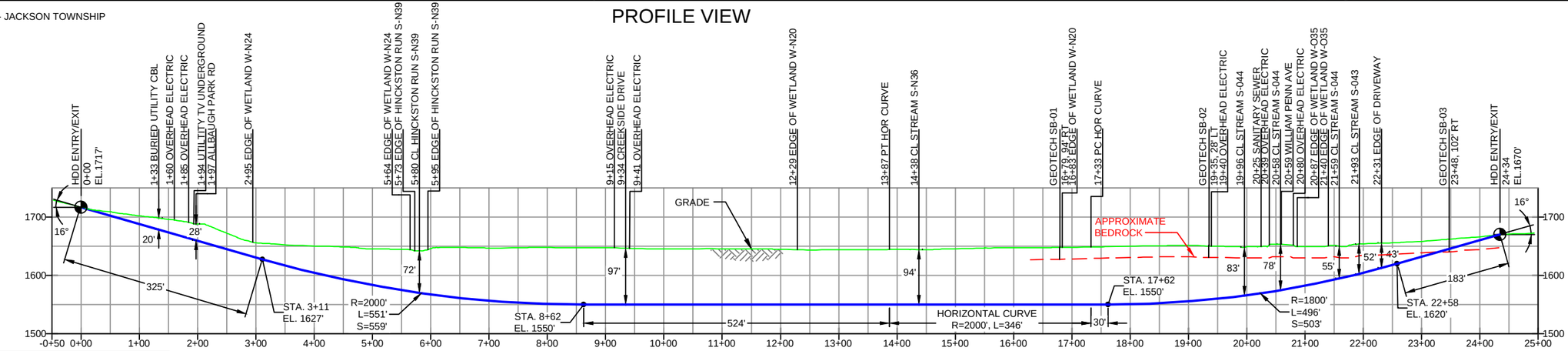
DWG. NUMBER: PA-CA-0023.0000-RD



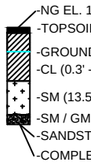
PLAN VIEW

CAMBRIA COUNTY, PENNSYLVANIA - JACKSON TOWNSHIP
S2-0070-16

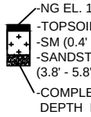
PROFILE VIEW



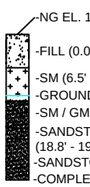
GEOTECH SB-01



GEOTECH SB-02



GEOTECH SB-03



NOTE: REFER TO TEST BORING LOG S2-0070 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B2-3E

NOTE: REFER TO TEST BORING LOG B2-3E TERRACON PROJECT #J217P078 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=): 2434'
   HDD PIPE LENGTH (S=): 2471'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN 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.

NOTES

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

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES-2.15	TO	ES-2.17	EROSION & SEDIMENT PLAN
SHEET 10	TO	SHEET 11	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/28/17	RMB	11/28/17	CAG	11/28/17
EP3	RELOCATED DRILL ENTRY / EXIT - DESIGN CHANGE PER LONE STAR	MRS	10/25/17	RMB	10/25/17	CAG	10/25/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	DLM	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		JTW	03/15/16	RMB	03/15/16	AAW	03/15/16
B	ADDED GEOTECH INFO	MRS	09/05/15	RMB	09/05/15	AAW	09/05/15

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

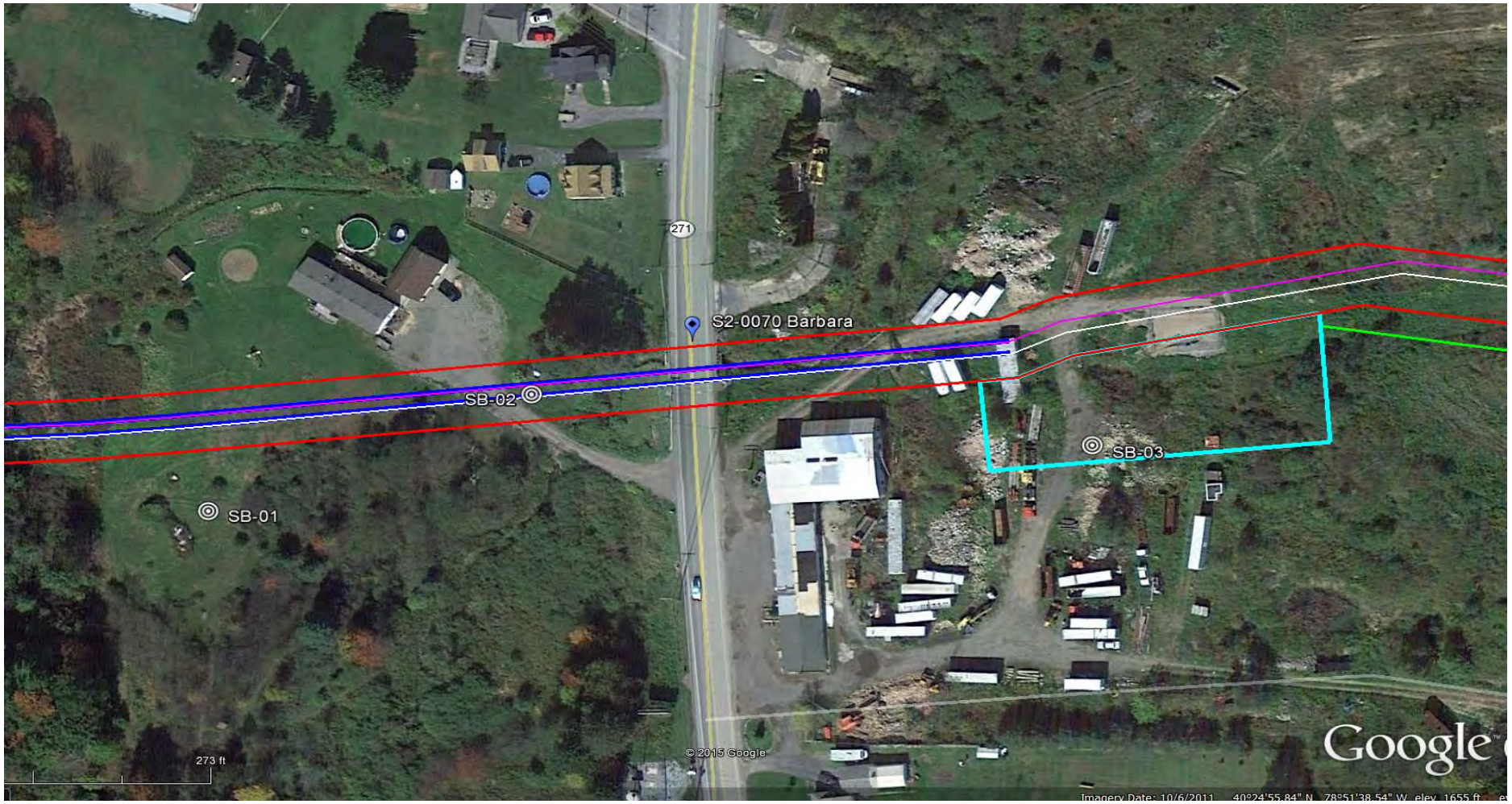
HORIZONTAL DIRECTIONAL DRILL
WILLIAM PENN AVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

DWG. NO: PA-CA-0023.0000-RD-16

Attachment B

Geotechnical Reports



LEGEND:

◎ Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S2-0070
CAMBRIA COUNTY, JACKSON 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:	WILLIAM PENN AVENUE, VINCO, PA		Page 1 of 1
HDD No.:	S2-0070	Dates(s) Drilled: 09-21-14	Inspector: E. WATT
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 5.0	Total Depth (ft): 20.9

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		13		DR WEATHERED TO A VARI-COLORED (BROWN, ORANGE-BROWN,	2	5	9	13	**14**
							GRAY) SILTY CLAY AND FINE SAND.					
2	8.0	10.0			14	CL	DR WEATHERED TO A VARI-COLORED (BROWN, ORANGE-BROWN,	3	6	8	10	**14**
							GRAY) SILTY CLAY AND FINE SAND.					
3	13.0	13.8		13.5	8		BROWN CLAY, TRACE FINE SAND.	14	50/3"			**>50**
4	18.0	18.9	13.5		8	SM	DR WEATHERED TO A GRAY SILTY FINE SAND WITH A TRACE	5	50/5"			**>50**
				19.5			UNWEATHERED SANDSTONE GRAVEL.					
5	20.0	20.9	19.5		6	SM/ GM	DR WEATHERED TO A GRAY SILTY FINE SAND AND	2	50/4"			**>50**
				20.9			UNWEATHERED SANDSTONE GRAVEL.					
							AUGER REFUSAL AT 20.0'. OFF-SET BORING AUGERED TO					
							REFUSAL AT 19.7'.					
							WET ON SPOON AT 5.5'.					
							WATER LEVEL THRU AUGERS AT 5'.					
							CAVED AT 19'. WATER LEVEL ON TOP OF CAVE AT 4'.					

Notes/Comments:

Pocket Pentrometer Testing
S1: >4 TSF

DR: DECOMPOSED ROCK

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

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

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:	WILLIAM PENN AVENUE, VINCO, PA		Page 1 of 1
HDD No.:	S2-0070	Dates(s) Drilled: 09-22-14	Inspector: E. WATT
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 5.8

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.4			TOPSOIL (5").					
1	3.0	3.9	0.4		5	SM	VARI-COLORED (BROWN, ORANGE-BROWN, GRAY) SILTY FINE	2	50/5"			**>50**
				3.8			SAND (SOFT).					
2	5.0	5.2	3.8	5.8	<2		PARTIALLY WEATHERED BROWN SANDSTONE.	50/2"				**>50**
							AUGER REFUSAL AT 5.5'. OFF-SET BORING AND AUGERED TO					
							REFUSAL AT 5.8'. RESUSAL MATERIAL IS PARTIALLY WEATHERED					
							SANDSTONE.					
							CAVED AND DRY AT 4'.					

Notes/Comments:
Pocket Pentrometer Testing

DR: DECOMPOSED ROCK

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

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

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TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	WILLIAM PENN AVENUE, VINCO, PA		Page 1 of 1
HDD No.:	S2-0070	Dates(s) Drilled: 09-21-14	Inspector: E. WATT
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 12.0	Total Depth (ft): 28.6

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
							NO TOPSOIL					
1	3.0	5.0	0.0		7	FILL	HISTORIC FILL: MATRIX OF MULTI-COLORED FINE TO MEDIUM SAND	1	1	5	3	**6**
				6.5			WITH A LITTLE SILT, SHALE FRAGMENTS, TRACE MASONRY FRAGS.					
2	8.0	10.0	6.5		17	SM	VARI-COLORED (BROWN, ORANGE-BROWN, GRAY) SILTY FINE	2	2	4	5	**6**
							SAND WITH A LITTLE F-GRAVEL/WEATHERED SILTSTONE.					
3	13.0	13.9			11		DR WEATHERED TO A VARI-COLORED SILTY FINE SAND, WITH A LITTLE	2	50/5"			**>50**
				13.5			UNWEATHERED FINE GRAVEL (SHALE).					
4	18.0	18.8	13.5		7	SM/ GM	DR WEATHERED TO A GRAY FINE SAND AND UNWEATHERED FINE TO	30	50/3"			**>50**
				18.8			COARSE SANDSTONE GRAVEL.					
5	19.0	19.6	18.8	19.6	5		PARTIALLY WEATHERED GRAY SANDSTONE.	2	50/1"			**>50**
							AUGUR REFUSAL AT 19.0".					
							ROCK CORING					
RUN 1	19.6	23.6	19.6		48	ROCK	GRAY SANDSTONE, FRACTURES AT 20.1', 20.2', 20.5',	TCR: 100%, SCR: 92%, RQD: 85%				
							AND 21'. FRACTURE ZONES AT 21.3 TO 21.37 WITH WEATHERING &					
							OXIDATION, FRACTURE AT 22.7 AND 22.2 WITH WEATHERING AND					
							OXIDATION.					
RUN 2	23.6	28.6			60		GRAY SANDSTONE, BEDDING APPEARS UNIFORM. FRACTURE W/	TCR: 100%, SCR: 80%, RQD: 75%				
							WEATHERING/OXIDATION AT 23.7', 23.8', 23.9', 25', 25.1', 26.2',					
				28.6			AND 26.7 TO 27.1'.					
							CORE TESTING RESULTS (DEPTH 22.6'):					
							COMPRESSIVE STRENGTH: 5,980 PSI					
							UNIT WEIGHT: 158.3 PCF					
							WET ON SPOON AT 12'.					
							WATER LEVEL THROUGH AUGERS AT 15'.					

Notes/Comments:
Pocket Pentrometer Testing

DR: DECOMPOSED ROCK

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

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

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0070

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.) From	Depth of Sample (ft.) To	Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318) Liquid Limit, %	Atterburg Limits (ASTM D4318) Plastic Limit, %	Atterburg Limits (ASTM D4318) Plasticity Index, %	USCS Classif. (ASTM D2487)
S2-0070	SB-01	1	3.0	5.0	14.6	62.4	-	-	-	-
		2	8.0	10.0	13.9	53.1	-	-	-	-
		3	13.0	13.8	26.0	93.1	36	21	15	CL
		4	18.0	18.9	11.8	39.5	-	-	-	-
		5	20.0	20.9	11.5	41.3	-	-	-	-
	SB-02	1	3.0	3.9	11.8	39.6	-	-	-	-
	SB-03	1	3.0	5.0	9.6	13.9	-	-	-	-
		2	8.0	10.0	17.3	38.7	-	-	-	-
		3	13.0	13.9	15.4	38.8	-	-	-	-
		4	18.0	18.8	1.6	14.9	-	-	-	-
		5	19.0	19.6	0.6	0.6	-	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-03	Run 1	22.6	5,980	158.3

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0070

HDD No.	NAME	BORING NO.	REGIONAL GEOLOGY DESCRIPTION	GENERAL TOPOGRAPHIC SETTING	BEDROCK FORMATION	GENERAL ROCK TYPE	APPROX MAX FM THICKNESS (FT)	DEPTH TO ROCK (Ft bgs) based on nearby well drilling logs	NOTES / COMMENTS
S2-0070	Barbara	SB-01 SB-02 SB-03	**Glenshaw Formation** - Cyclic sequences of shale, sandstone, red beds, and thin limestone and coal; includes four marine limestone or shale horizons; red beds are involved in landslides; base is at top of Upper Freeport coal.	Plateau	Glenshaw	Shale-sandstone with limestone-clastic-coal	280-375	12-27	

Note : Source of well log data - http://www.dcnr.state.pa.us/topogeo/groundwater/pagwis/records/index.htm. All other sources as referenced in comments section.

ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0070

Location	Boring No.	Core Run	Core Depth (ft)		TCR (%)	SCR (%)	RQD (%)	Depth (ft)		Weathering	Classification	Bedding Thickness (ft)	Color	Discontinuity Data
			From	To				From	To					
S2-0070	SB-3	1	19	23	100	92	85	19	28	Slight	Sandy Limestone	9	Gray	Slightly laminated; Moderately fracture - Avg. Dip 7° (2°- 23°)
S2-0070	SB-3	2	23	28	100	80	75							

October 13, 2017

Directional Project Support, Inc.
33311 Lois Lane, Suite A
Magnolia, TX 77354

Attn: Mr. Robert Sessions
P: (318) 542 6657
E: fielduspl@Hotmail.com

Re: Geotechnical Site Characterization
Mariner East 2 Pipeline Project
Spread 2 – William Penn Entry
Commonwealth of Pennsylvania
Drawing # PA-CA-0023.0000-RD
PO #20170804-12
Terracon Project No. J217P078

Dear Mr. Sessions:

This letter provides a summary of the bedrock characterization for the Mariner East 2 Pipeline Project crossing to be located at William Penn Entry (Drawing # PA-CA-0023.0000-RD) in the Commonwealth of Pennsylvania. Our services were performed in general accordance with our proposal number PJ2175108 dated July 28, 2017. Our scope of services included advancing one boring, designated as B2-3E, visual classification and photography of the rock core samples, and laboratory testing of representative rock samples.

Test boring, B2-3E was drilled between September 5 and 7, 2017 to a depth of 131.8 feet, as shown on the attached **Test Boring Location Plan**. Bedrock typically consisted of interlayered sedimentary rock comprised of shale, sandstone, and claystone. The final test boring log documenting overburden soil and bedrock conditions as well as photographs of the rock core samples are attached.

Rock compressive strength testing was performed on samples from approximately 20-foot intervals within the bedrock strata at the boring location. Unconfined compressive strength test results are shown on the attached reports.

When laboratory soil testing results are available, we will submit a complete data report for the subject crossing. In the meantime, if you have questions, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Marc A. Gullison, E.I.T.
Staff Geotechnical Engineer

Lawrence J. Dwyer, P.E. (CT 15120)
Principal

Attch:

TEST BORING LOCATION PLAN
EXPLORATION RESULTS (Boring Log, Laboratory Data, Rock Core Photographs)
SUPPORTING INFORMATION (Unified Soil Classification System, Description of Rock Properties)

TEST BORING LOCATION PLAN

N

APPROXIMATE BORING LOCATION

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: JGS	Project No. J217P078
Drawn by: SBL	Scale: N.T.S.
Checked by: LJD	File Name: J217P078 BLP
Approved by: LJD	Date: September. 2017

Terracon
Consulting Engineers & Scientists
201 Hammer Mill Road Rocky Hill, Ct 06067
PH. (860) 721-1900 FAX. (860) 721-1939

TEST BORING LOCATION PLAN

William Penn Entry HDD Core B2-3E
PA-CA-0023.0000-RD
Cambria County, Pennsylvania

Exhibit

A-2

EXPLORATION RESULTS

BORING LOG NO. B2-3E William Penn Entry East

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 2

LOCATION PA-CA-0023.0000-RD
20170804-12
Latitude: 40.415593° Longitude: -78.85874°

Approximate Surface Elev: 1684 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)
		Drilled through opening in matting, no surface thickness available						
8.5	1675.5+/-	**GRAVELLY LEAN CLAY (CL)**, trace sand, shale fragments, brown, stiff			13	3-5-6 N=11		
			5					
		Weathered rock, soft, dark gray, carbonaceous, friable			8	20-50/3'		
			10					
					4	50/4"		
18.6	1665.5+/-		15					
		Run 1, Moderately hard, slightly weathered, gray SHALE, interbedded with limestone, very thin bedding, primary joint set, moderately dipping, close, slickensided, planar, fresh, tight to slightly open; secondary joint set, high angle, moderately close, rough, stepped, moderately open, iron-stained			1	50/1"		
21.8	1662+/-		20		38		37	.5 1 1.25 1 .75
		Run 2, Moderately hard, slightly weathered, gray SHALE, interbedded with limestone, very thin bedding, primary joint set, low angle, close, rough, planar, open, iron-stained; secondary joint set, moderately dipping, moderately close, rough, planar, moderately open, iron-stained	25		60		78	.75 1.25 1.5 1 1
26.8	1657+/-							
		Run 3, Similar to 29.6 feet At 29.6 feet:Moderately hard, slightly weathered, gray SHALE, occasional calcareous nodules, very thin bedding, primary joint set, low angle, close to very close, planar, smooth, fresh, slightly open to tight	30		60		33	.75 1.25 1

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

25.5' after 12 hrs.

36.5' AB

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 09-05-2017 | Boring Completed: 09-07-2017

Drill Rig: Diedrich D-50 | Driller: Terracon/Mike P.

Project No.: J217P078 | Exhibit: A-1

BORING LOG NO. B2-3E William Penn Entry East

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 2

LOCATION PA-CA-0023.0000-RD
20170804-12
Latitude: 40.415593° Longitude: -78.85874°
Approximate Surface Elev: 1684 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
31.8	1652+/-				60			1 1.5	
Run 4, Similar									
36.8	1647+/-	35	▽		60		47	1.25 1.25 1.25 1 1	
Run 5, Similar									
41.8	1642+/-	40			50		13	1.25 1.5 1.5 2 2.25	
Run 6, Similar to 43.7 feet At 43.7 feet: Moderately hard to hard, slightly weathered, gray, fine to medium-grained, micaceous SANDSTONE, thin bedding, primary joint set, low angle, close to moderately close, rough, planar, fresh, slightly open									
46.8	1637+/-	45			49		55	.5 0 .75 .5 .5	
Run 7, Similar									
51.8	1632+/-	50			60		95	.75 .75 .75 1.25 1	
Run 8, Similar									
56.8	1627+/-	55			60		98	1.25 .75 .5 .75 1.25	
Run 9, Similar									
		60			60		100	.5 .25 .5	

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

▽ *25.5' after 12 hrs.*

▽ *36.5' AB*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 09-05-2017 | Boring Completed: 09-07-2017

Drill Rig: Diedrich D-50 | Driller: Terracon/Mike P.

Project No.: J217P078 | Exhibit: A-1

BORING LOG NO. B2-3E William Penn Entry East

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 2

LOCATION PA-CA-0023.0000-RD
20170804-12
Latitude: 40.415593° Longitude: -78.85874°
Approximate Surface Elev: 1684 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	RECOVERY (In.)	RQD (%)	Core rate (min/ft)
	Run 9, Similar *(continued)*				.5 .75
61.8	1622+/-		60		
	Run 10, Similar				.5 .5 .25 .25 .5
66.8	1617+/-	65	60	100	
	Run 11, Similar				.5 .5 .25 .75 .25
71.8	1612+/-	70	60	98	
	Run 12, Similar				.5 .5 .5 .25 .25
76.8	1607+/-	75	60	100	
	Run 13, Similar				.5 .5 .5 .25 .5
81.8	1602+/-	80	60	95	
	Run 14, Similar to 82.6 feet At 82.6 feet: Moderately hard, slightly weathered, dark gray SHALE, very thin bedding, primary joint set, low angle, very close to close, smooth, planar, fresh, slightly open At 86.2 feet: Moderately hard to hard, slightly weathered, gray, fine to medium-grained, argillaceous, micaceous SANDSTONE, thin bedding, primary joint set, low angle, close, rough, planar, fresh, slightly open to open				1.25 2.75 2.25 2.25 1.25
86.8	1597+/-	85	60	37	
	Run 15, Similar				.5 .75 .75
		90	60	90	

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

25.5' after 12 hrs.

36.5' AB

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 09-05-2017 | Boring Completed: 09-07-2017

Drill Rig: Diedrich D-50 | Driller: Terracon/Mike P.

Project No.: J217P078 | Exhibit: A-1

BORING LOG NO. B2-3E William Penn Entry East

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 2

LOCATION PA-CA-0023.0000-RD
20170804-12
Latitude: 40.415593° Longitude: -78.85874°
Approximate Surface Elev: 1684 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	RECOVERY (In.)	RQD (%)	Core rate (min/ft)
	Run 15, Similar *(continued)*				.5 .25
91.8	1592+/-		60		
	Run 16, Similar				.75 .5 .5 .25 .25
96.8	1587+/-	95	60	100	
	Run 17, Similar to 99.6 feet At 99.6 feet: Soft to moderately hard, moderately weathered, gray CLAYSTONE, interbedded with occasional calcareous nodules and shale, very thin bedding, primary joint set, moderately dipping, very close to close, slickensided, planar, fresh, tight to slightly open; secondary joint set, low angle, close to very close, rough, planar, fresh, tight to slightly open				1 1.25 1.25 1.25 1
101.8	1582+/-	100	51	60	
	Run 18, Similar				1.25 1.25 1.25 1 1
106.8	1577+/-	105	60	37	
	Run 19, Similar				2.5 1.25 1.25 1.25 2.25
111.8	1572+/-	110	49	20	
	Run 20, Soft to moderately hard, slightly weathered, gray CLAYSTONE, interbedded with occasional calcareous nodules and shale, very thin bedding, primary joint set, high angle, close, slickensided, planar, fresh, tight to moderately open; secondary joint set, low angle, moderately close, rough, planar, fresh, slightly open				2.25 1 1.25 1.5 1.25
116.8	1567+/-	115	60	67	
	Run 21, Similar				1.25 1 1
		120	56	47	

Penetrometer Test (tsf)

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

25.5' after 12 hrs.

36.5' AB

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 09-05-2017 | Boring Completed: 09-07-2017

Drill Rig: Diedrich D-50 | Driller: Terracon/Mike P.

Project No.: J217P078 | Exhibit: A-1

BORING LOG NO. B2-3E William Penn Entry East

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 2

LOCATION PA-CA-0023.0000-RD
20170804-12
Latitude: 40.415593° Longitude: -78.85874°
Approximate Surface Elev: 1684 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
Run 21, Similar *(continued)*									
121.8	1562+/-				56			1.25 1.5	
Run 22, Moderately hard, slightly weathered, gray SHALE, interbedded with occasional calcareous nodules and siltstone, very thin bedding, primary joint set, low angle, close to moderately close, smooth, planar, fresh, slightly open; secondary joint set, high angle, moderately close, slickensided, planar, fresh, tight		125			57		83	1.25 1 1.25 1 1	
126.8	1557+/-								
Run 23, Similar		130			60		53	.75 1 1.25 1.25 1.25	
131.8	1552+/-								
Boring Terminated at 131.8 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

25.5' after 12 hrs.

36.5' AB

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 09-05-2017 | Boring Completed: 09-07-2017

Drill Rig: Diedrich D-50 | Driller: Terracon/Mike P.

Project No.: J217P078 | Exhibit: A-1

ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

Boring No.:	B2-3E	Lithology :	Sandstone
Sample No.:	1	Moisture Content :	As received
Sample Depth:	44 feet	Lab Temperature :	70° F
Sampling Date:	9/5/17	Loading Rate:	55 psi/s
		Time to Failure:	8 min

Diameter:	1.98 in	Maximum Axial Load at Failure:	25,210 lb
Length:	4.34 in	Compressive Strength:	8,188 psi
L/D:	2.19	Compressive Strength:	56.45 Mpa
End Area:	3.08 in^2	Unit Weight	168 pcf

Before the Test

After the Test

Drawing # : PA-CA-0023.0000-RD
PO # : 20170804-12
Crossing : William Penn Entry
Spread : Spread 2

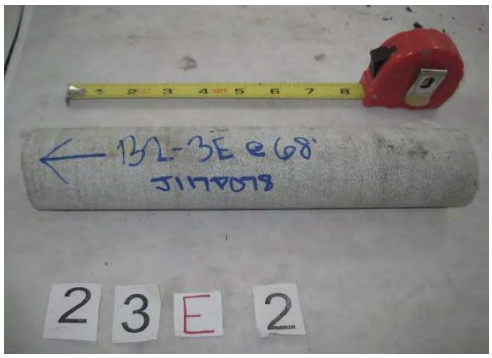
Project:	Mariner East Pipeline	Terracon	Performed by:	H. Whitford
Project No.	J217P078		Test Date:	10/9/2017
Location:	Spread 2		Reviewed By :	L.Dwyer
Client :	Directional Project Support Inc.	77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Review Date :	10/12/2017

ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

Boring No.:	B2-3E	Lithology :	Sandstone
Sample No.:	2	Moisture Content :	As received
Sample Depth:	68 feet	Lab Temperature :	70° F
Sampling Date:	9/5/17	Loading Rate:	55 psi/s
		Time to Failure:	11 min

Diameter:	1.98 in	Maximum Axial Load at Failure:	36,730 lb
Length:	4.42 in	Compressive Strength:	11,929 psi
L/D:	2.23	Compressive Strength:	82.25 Mpa
End Area:	3.08 in^2	Unit Weight	159 pcf

Before the Test



After the Test

Drawing # : PA-CA-0023.0000-RD
PO # : 20170804-12
Crossing : William Penn Entry
Spread : Spread 2

Project:	Mariner East Pipeline	Terracon	Performed by:	H. Whitford
Project No.	J217P078	77 Sundial Ave., Suite 401 W	Test Date:	10/9/2017
Location:	Spread 2	Manchester, New Hampshire	Reviewed By :	L.Dwyer
Client :	Directional Project Support Inc.		Review Date :	10/12/2017

ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

Boring No.:	B2-3E	Lithology :	Sandstone
Sample No.:	3	Moisture Content :	As received
Sample Depth:	78 feet	Lab Temperature :	70° F
Sampling Date:	9/5/17	Loading Rate:	55 psi/s
		Time to Failure:	14 min

Diameter:	1.97 in	Maximum Axial Load at Failure:	47,670 lb
Length:	4.31 in	Compressive Strength:	15,639 psi
L/D:	2.19	Compressive Strength:	107.83 Mpa
End Area:	3.05 in^2	Unit Weight	161 pcf

Before the Test

After the Test

Drawing # :	PA-CA-0023.0000-RD
PO # :	20170804-12
Crossing :	William Penn Entry
Spread :	Spread 2

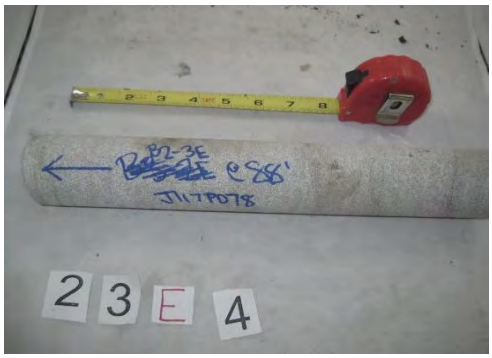
Project:	Mariner East Pipeline	Terracon	Performed by:	H. Whitford
Project No.	J217P078		Test Date:	10/9/2017
Location:	Spread 2		Reviewed By :	L.Dwyer
Client :	Directional Project Support Inc.	77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Review Date :	10/12/2017

ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

Boring No.:	B2-3E	Lithology :	Sandstone
Sample No.:	4	Moisture Content :	As received
Sample Depth:	88 feet	Lab Temperature :	70° F
Sampling Date:	9/5/17	Loading Rate:	55 psi/s
		Time to Failure:	14 min

Diameter:	1.95 in	Maximum Axial Load at Failure:	45,020 lb
Length:	4.53 in	Compressive Strength:	15,075 psi
L/D:	2.32	Compressive Strength:	103.94 Mpa
End Area:	2.99 in^2	Unit Weight	156 pcf

Before the Test



After the Test

Drawing # : PA-CA-0023.0000-RD
PO # : 20170804-12
Crossing : William Penn Entry
Spread : Spread 2

Project:	Mariner East Pipeline	Terracon	Performed by:	H. Whitford
Project No.	J217P078		Test Date:	10/9/2017
Location:	Spread 2		Reviewed By :	L.Dwyer
Client :	Directional Project Support Inc.	77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Review Date :	10/12/2017

Photograph 1: B2-3E, Samples C-1 to C-4 (18.6 to 36.8 feet)

Photograph 2: B2-3E, Samples C-5 to C-8 (36.8 to 56.8 feet)

Photograph 3: B2-3E, Samples C-9 to C-12 (56.8 to 76.8 feet)

Photograph 4: B2-3E, Samples C-13 to C-16 (76.8 to 96.8 feet)

Photograph 5: B2-3E, Samples C-17 to C-20 (96.8 to 116.8 feet)

Photograph 6: B2-3E, Samples C-21 to C-23 (116.8 to 131.8 feet)

SUPPORTING INFORMATION

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu ³ 4 and 1 £ Cc £ 3 [E]		GW	Well-graded gravel [F]
			Cu < 4 and/or 1 > Cc > 3 [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ³ 6 and 1 £ Cc £ 3 [E]		SW	Well-graded sand [I]
			Cu < 6 and/or 1 > Cc > 3 [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A"		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OL	Organic clay [K,L,M,N] / Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OH	Organic clay [K,L,M,P] / Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ³ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ³ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ³ 30% plus No. 200 predominantly sand, add "sandy" to group name.

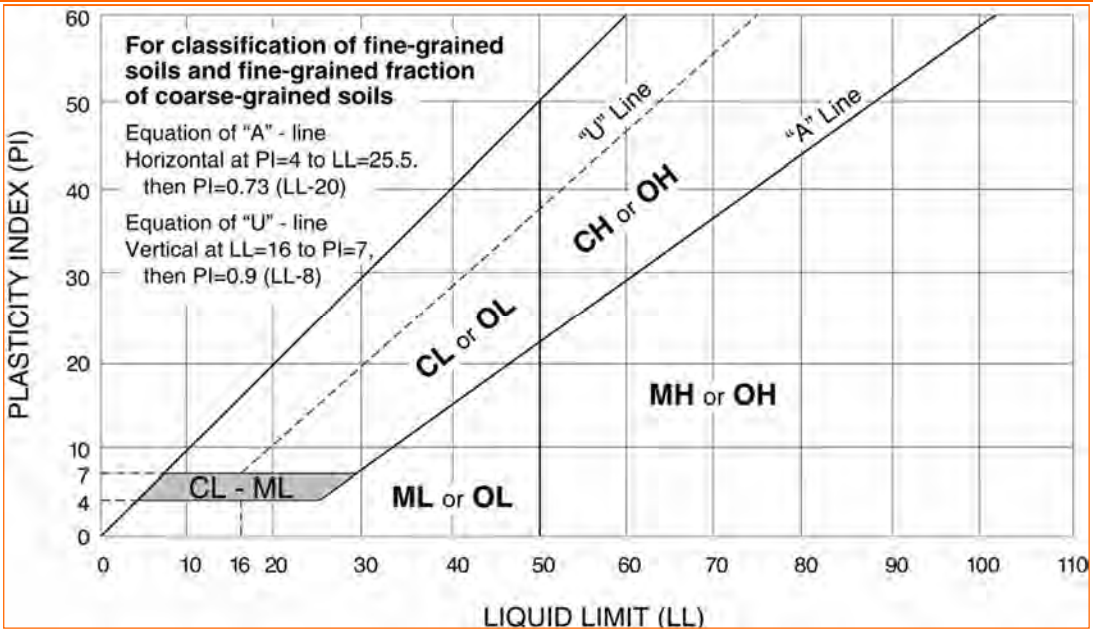
[M] If soil contains ³ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ³ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



DESCRIPTION OF ROCK PROPERTIES

WEATHERING	
Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very Slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately Severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very Severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" no discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.
HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)	
Very Hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately Hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very Soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock [1]

Spacing	Joints	Bedding/Foliation
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

1. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

Rock Quality Designator (RQD) [1]

RQD, as a percentage	Diagnostic description
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

1. RQD (given as a percentage) = length of core in pieces 4 inches and longer / length of run

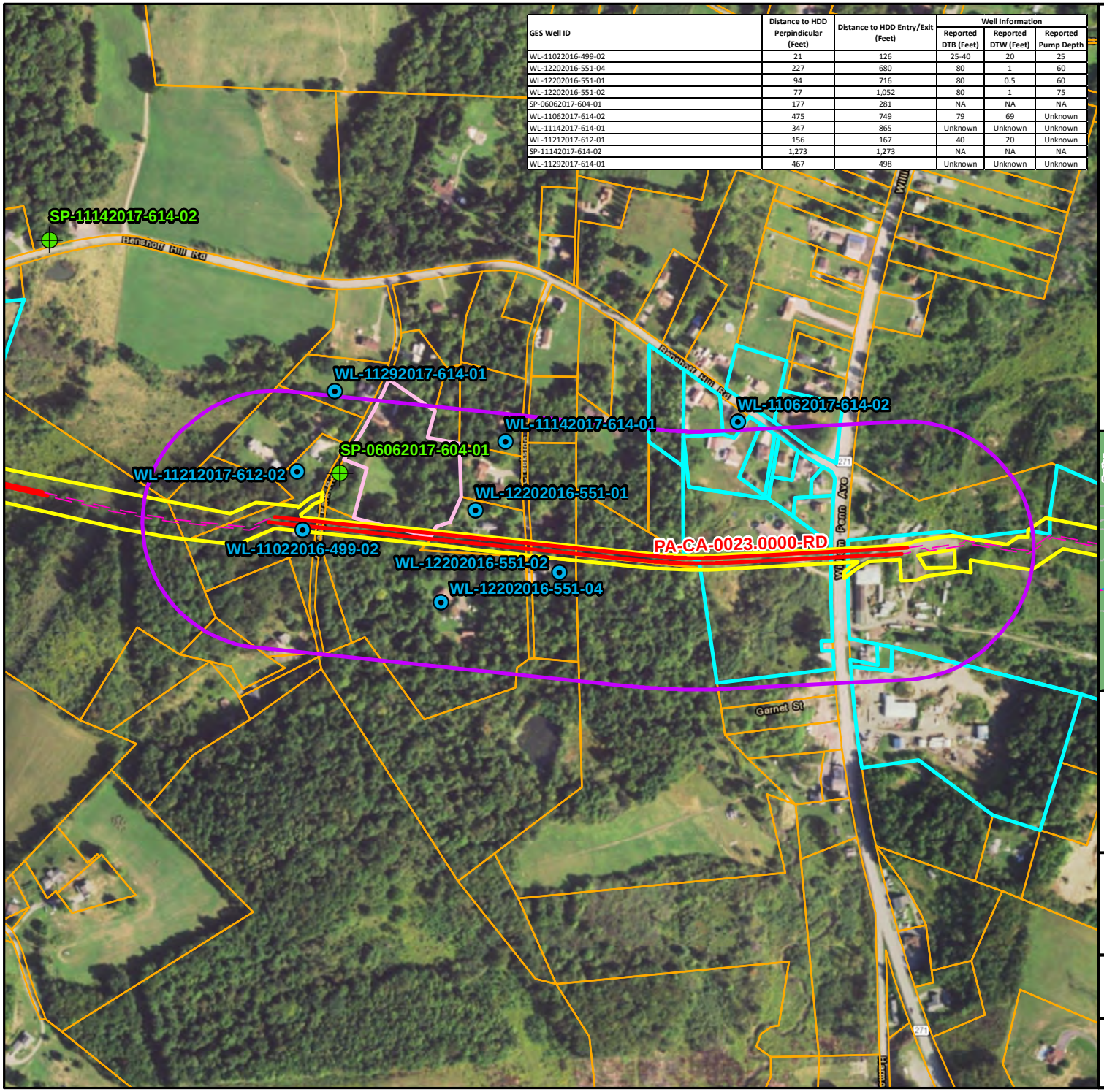
Joint Openness Descriptors

Openness	Descriptor
No Visible Separation	Tight
Less than 1/32 in.	Slightly Open
1/32 to 1/8 in.	Moderately Open
1/8 to 3/8 in.	Open
3/8 in. to 0.1 ft.	Moderately Wide
Greater than 0.1 ft.	Wide

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976. U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.

ATTACHMENT 2

WATER SUPPLY ILLUSTRATION



GES Well ID	Distance to HDD Perpindicular (Feet)	Distance to HDD Entry/Exit (Feet)	Well Information		
			Reported DTB (Feet)	Reported DTW (Feet)	Reported Pump Depth
WL-11022016-499-02	21	126	25-40	20	25
WL-12202016-551-04	227	680	80	1	60
WL-12202016-551-01	94	716	80	0.5	60
WL-12202016-551-02	77	1,052	80	1	75
SP-06062017-604-01	177	281	NA	NA	NA
WL-11062017-614-02	475	749	79	69	Unknown
WL-11142017-614-01	347	865	Unknown	Unknown	Unknown
WL-11212017-612-01	156	167	40	20	Unknown
SP-11142017-614-02	1,273	1,273	NA	NA	NA
WL-11292017-614-01	467	498	Unknown	Unknown	Unknown

Legend

- LOD
- Parcel
- PPP Centerline
- HDD
- 450 foot buffer of HDD alignment
- Public Water Supply/Landowner Confirmed No Well
- Well Present; Testing Denied

****Testing locations current as of 12/11/2017**

- GES Testing Location
- GES Spring Testing Location

Location

N

0 250 500

Feet

Well Location Map
HDD# PA-CA-0023.0000-RD
Cambria County, PA.

Prepared By: TETRA TECH

Date: 12/28/2017

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

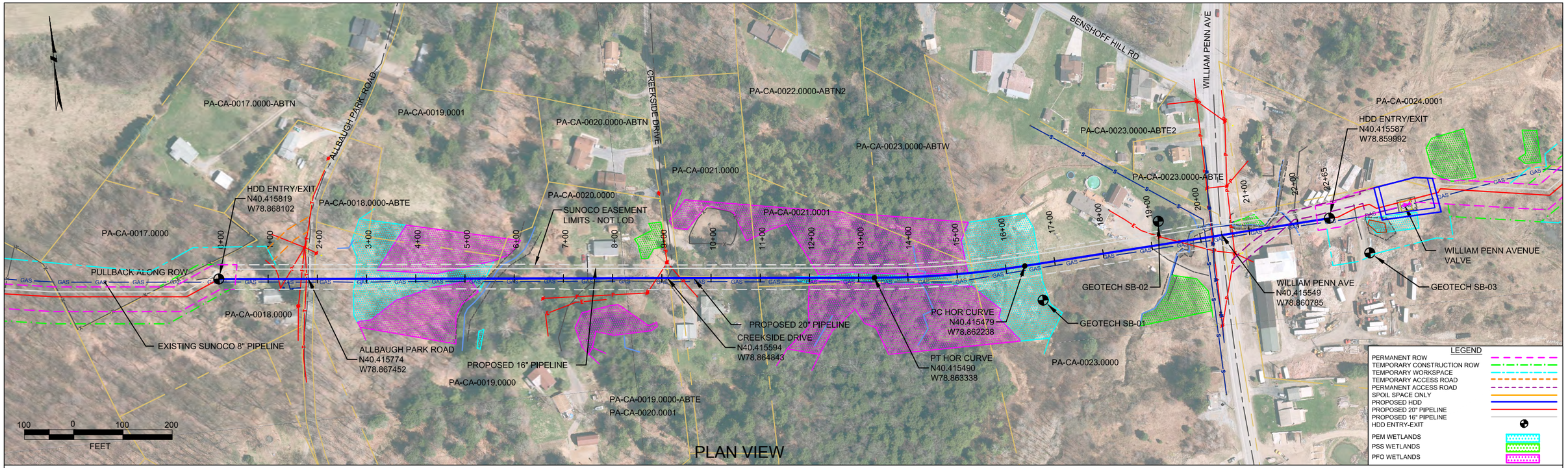
Coordinate System: NAD 83 Stateplane, PA South, Feet

P:\GIS\projects\112\05958-PPP\MXD\WellLocations\WellLocation_PA_CA_0023_0000.mxd JL

WILLIAM PENN AVENUE CROSSING
PADEP SECTION 105 PERMIT NO.: E11-352
PA-CA-0023.0000-RD and PA-CA-0023.0000-RD-16
(SPLP HDD No. S2-0070)

ATTACHMENT 3

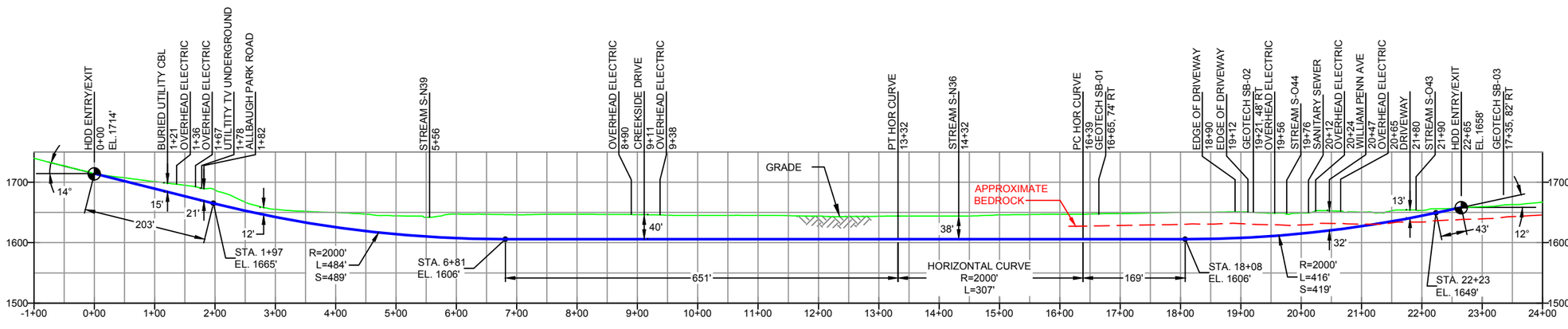
ORIGINAL AND REVISED HORIZONTAL DIRECTIONAL DRILL PLAN AND PROFILES



PLAN VIEW

PROFILE VIEW

CAMBRIA COUNTY, PENNSYLVANIA - JACKSON TOWNSHIP
S2-0070



GEOTECH SB-01

- NG EL. 1648'
- TOPSOIL (0' - 0.3')
- GROUNDWATER (5.0')
- CL (0.3' - 13.5')
- SM (13.5' - 19.5')
- SM / GM (19.5' - 20.9')
- SANDSTONE (20.9')
- COMPLETION DEPTH EL. 1627'

GEOTECH SB-02

- NG EL. 1651'
- TOPSOIL (0' - 0.4')
- SM (0.4' - 3.8')
- SANDSTONE (3.8' - 5.8')
- COMPLETION DEPTH EL. 1645'

GEOTECH SB-03

- NG EL. 1661'
- FILL (0.0' - 6.5')
- SM (6.5' - 13.5')
- GROUNDWATER (12.0')
- SM / GM (13.5' - 18.8')
- SANDSTONE (18.8' - 19.6')
- SANDSTONE (19.6' - 28.6')
- COMPLETION DEPTH EL. 1632.5'

NOTE: REFER TO TEST BORING LOG S2-0070 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=): 2265'
   HDD PIPE LENGTH (S=): 2280'
   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.

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	REVISED PROFILE WITH 2017 LIDAR	MRS	03/17/17	RMB	03/17/17	CAG	03/17/17
3	DESIGN CHANGE - ADJUSTED HORIZONTAL CURVE DISTANCE - NO CENTERLINE CHANGE	MRS	10/27/16	RMB	10/27/16	AAW	10/27/16
2	REVISED PER ENGINEERING COMMENTS	MRS	08/26/16	RMB	08/26/16	AAW	08/26/16
1	MLV NAME UPDATED	DLM	04/07/16	RMB	04/07/16	AAW	04/07/16
0	ISSUED FOR CONSTRUCTION	MRS	12/21/15	RMB	12/21/15	AAW	12/21/15

Sunoco Logistics Partners L.P.

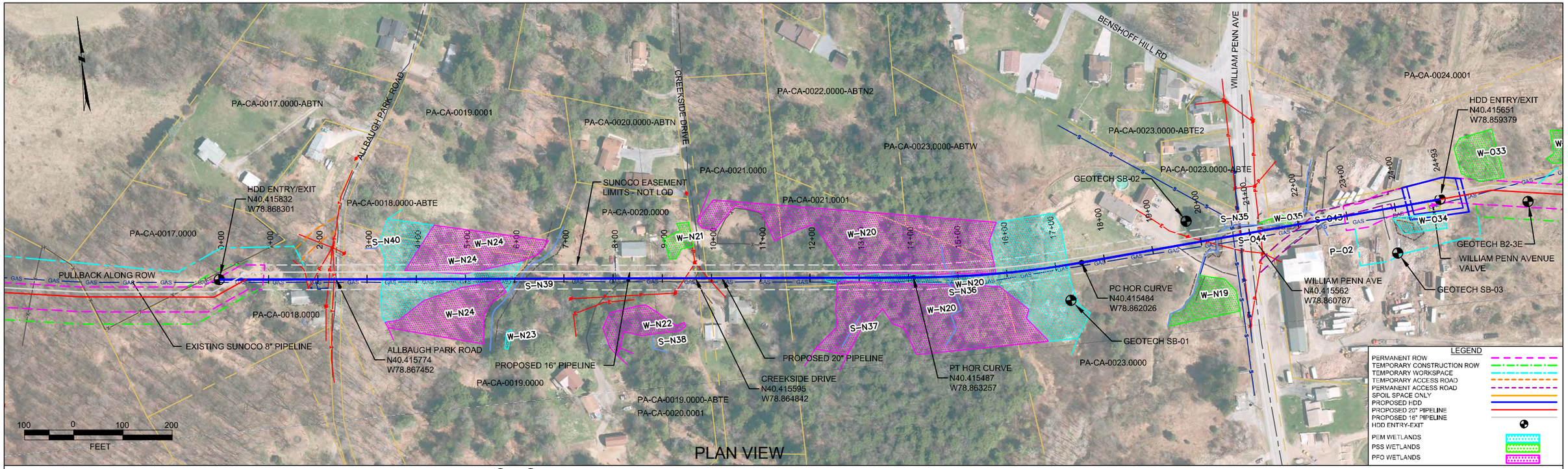
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WILLIAM PENN AVE
PENNSYLVANIA PIPELINE PROJECT

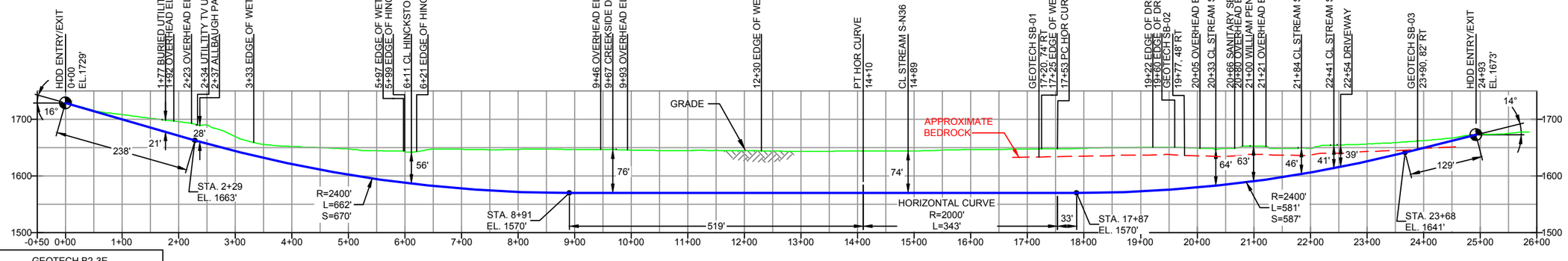
SCALE: 1"=200'

DWG. NUMBER: PA-CA-0023.0000-RD



PLAN VIEW

PROFILE VIEW



CAMBRIA COUNTY, PENNSYLVANIA - JACKSON TOWNSHIP
S2-0070

GEOTECH SB-01

-NG EL. 1648'
-TOPSOIL (0' - 0.3')
-GROUNDWATER (5.0')
-CL (0.3' - 13.5')
-SM (13.5' - 19.5')
-SM / GM (19.5' - 20.9')
-SANDSTONE (20.9')
-COMPLETION DEPTH EL. 1627'

GEOTECH SB-02

-NG EL. 1651'
-TOPSOIL (0' - 0.4')
-SM (0.4' - 3.8')
-SANDSTONE (3.8' - 5.8')
-COMPLETION DEPTH EL. 1645'

GEOTECH SB-03

-NG EL. 1661'
-FILL (0.0' - 6.5')
-SM (6.5' - 13.5')
-GROUNDWATER (12.0')
-SM / GM (13.5' - 18.8')
-SANDSTONE (18.8' - 19.6')
-SANDSTONE (19.6' - 28.6')
-COMPLETION DEPTH EL. 1632.5'

NOTE: REFER TO TEST BORING LOG S2-0070 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B2-3E

-NG EL. 1690'
-GRAVELY LEAN CLAY CL (0.0' - 8.5')
-WEATHERED ROCK SANDSTONE/SHALE (8.5' - 131.8')
-GROUNDWATER (36.5')
-BORING TERMINATED EL.1558'

NOTE: REFER TO TEST BORING LOG B2-3E TERRACON PROJECT #J217P078 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.
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3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 2493'
   HDD PIPE LENGTH (S=): 2519'
   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.

NOTES

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

REF. DRAWING

ES-2.15	TO	ES-2.17	EROSION & SEDIMENT PLAN	
SHEET 10	TO	SHEET 11	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/28/17	RMB	11/28/17	CAG	11/28/17
EP3	RELOCATED DRILL ENTRY / EXIT - DESIGN CHANGE PER LONE STAR	MRS	09/21/17	RMB	09/21/17	CAG	09/21/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		JTW	03/15/16	RMB	03/15/16	AAW	03/15/16

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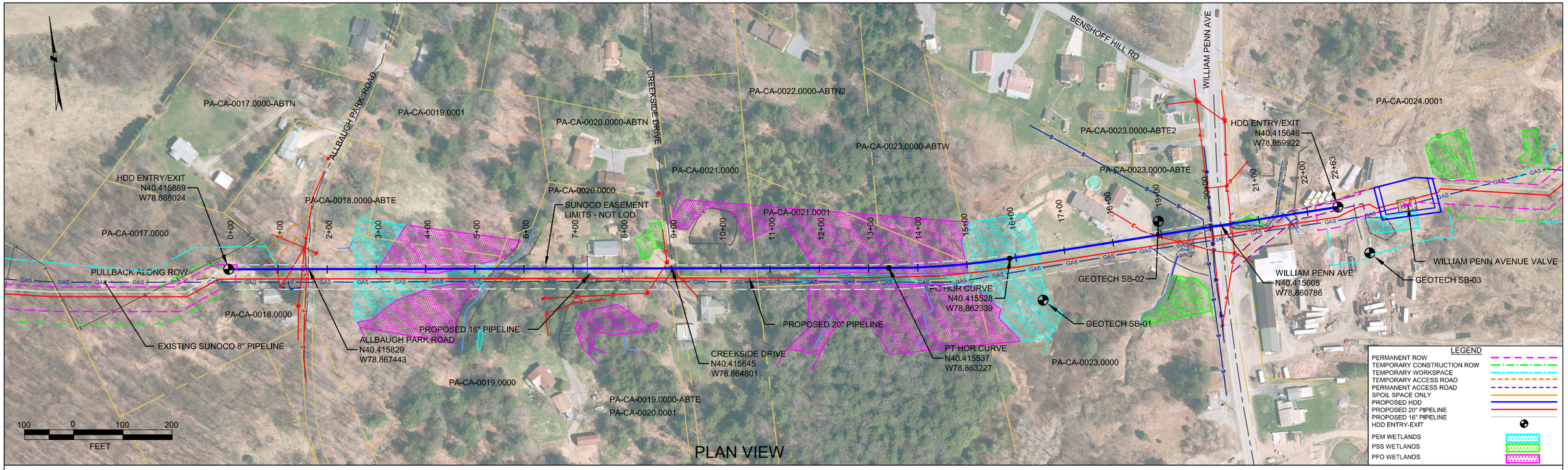
SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WILLIAM PENN AVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

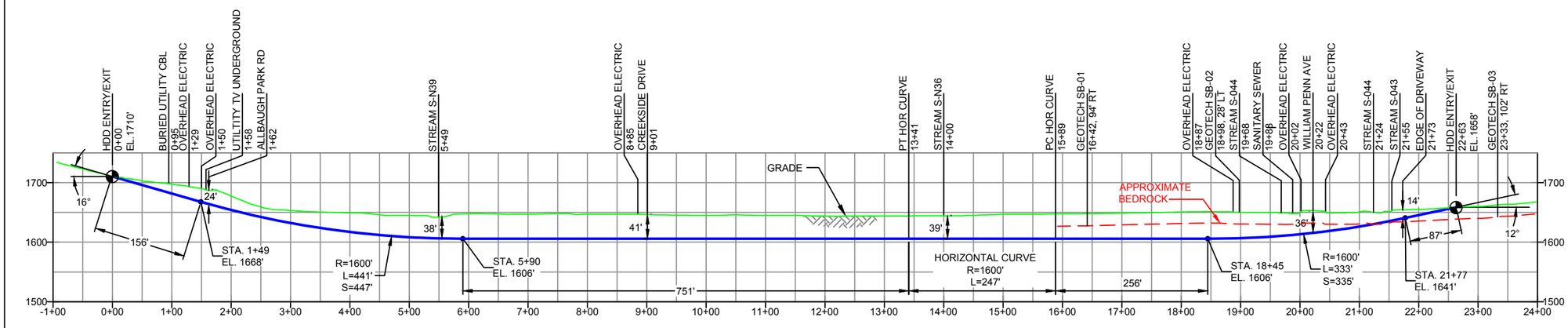
DWG. NUMBER: PA-CA-0023.0000-RD



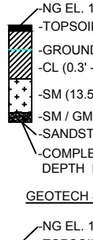
PLAN VIEW

CAMBRIA COUNTY, PENNSYLVANIA - JACKSON TOWNSHIP
S2-0070-16

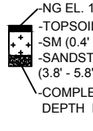
PROFILE VIEW



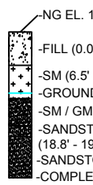
GEOTECH SB-01



GEOTECH SB-02



GEOTECH SB-03



NOTE: REFER TO TEST BORING LOG S2-0070 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

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3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 2263'
   HDD PIPE LENGTH (S=): 2279'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN 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.

NOTES

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

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
4	REVISED PROFILE WITH 2017 LIDAR	MRS	03/17/17	RMB	03/17/17	CAG	03/17/17
3	REVISED PER ENGINEERING COMMENTS	MRS	08/26/16	RMB	08/26/16	AAW	08/26/16
2	MLV NAME UPDATED	DLM	04/07/16	RMB	04/07/16	AAW	04/07/16
1	DESIGN ANNOTATION CORRECTION	DLM	02/12/16	RMB	02/12/16	AAW	02/12/16
0	ISSUED FOR CONSTRUCTION	MRS	12/21/15	RMB	12/21/15	AAW	12/21/15

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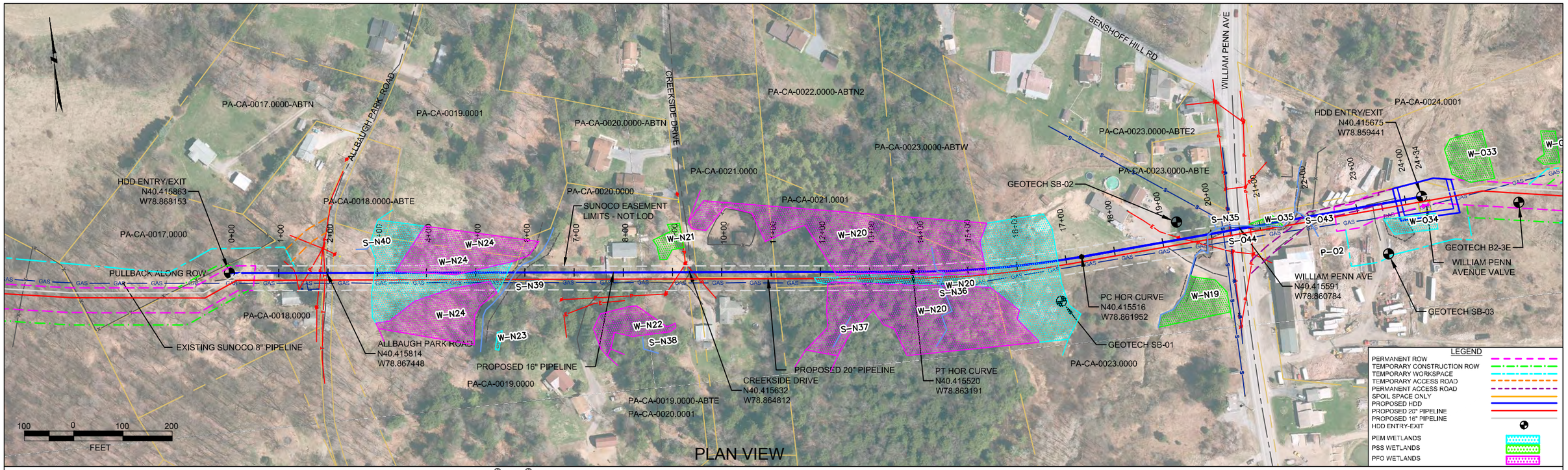
HORIZONTAL DIRECTIONAL DRILL
WILLIAM PENN AVE
PENNSYLVANIA PIPELINE PROJECT

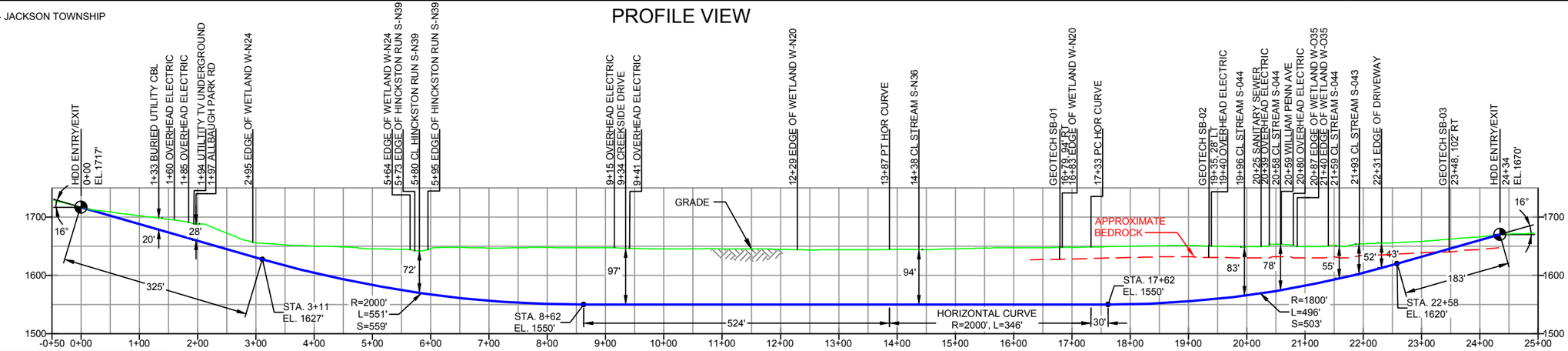
SCALE: 1"=200'

DWG. NO: PA-CA-0023.0000-RD-16



PLAN VIEW

PROFILE VIEW

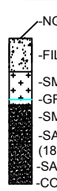


CAMBRIA COUNTY, PENNSYLVANIA - JACKSON TOWNSHIP
S2-0070-16

GEOTECH SB-01

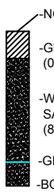
GEOTECH SB-02

GEOTECH SB-03



NOTE: REFER TO TEST BORING LOG S2-0070 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B2-3E



NOTE: REFER TO TEST BORING LOG B2-3E TERRACON PROJECT #J217P078 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=): 2434'
   HDD PIPE LENGTH (S=): 2471'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN 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.

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-2.15	TO	ES-2.17	EROSION & SEDIMENT PLAN
SHEET 10	TO	SHEET 11	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/28/17	RMB	11/28/17	CAG	11/28/17
EP3	RELOCATED DRILL ENTRY / EXIT - DESIGN CHANGE PER LONE STAR	MRS	10/25/17	RMB	10/25/17	CAG	10/25/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	DLM	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		JTW	03/15/16	RMB	03/15/16	AAW	03/15/16
B	ADDED GEOTECH INFO	MRS	09/05/15	RMB	09/05/15	AAW	09/05/15

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
WILLIAM PENN AVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

DWG. NO: PA-CA-0023.0000-RD-16