SUNOCO PIPELINE
An ENERGY TRANSFER Company

535 Fritztown Road
Sinking Spring, PA 19608

February 27, 2020

Via Electronic Mail
Mr. Scott R. Williamson
Program Manager, Waterways & Wetlands Program
Pennsylvania Department of Environmental Protection
Southcentral Regional Office
909 Elmerton Avenue
Harrisburg, PA 17110-8200

Re: Hydrogeologic HDD Re-Evaluation Report
Snitz Creek/North Zinns Mill Road Crossing
16" Horizontal Directional Drill Location (S3-0101-16)
Permit No. E38-194
West Cornwall Township, Lebanon County

Dear Mr. Williamson:

In compliance with the Corrected Stipulated Order dated August 10, 2017, a Re-Evaluation Report for the above-referenced horizontal directional drill (HDD) was submitted to the Pennsylvania Department of Environmental Protection (Department) on February 7, 2019. In a letter dated March 19, 2019, the Department requested further information. August 29, 2019, Sunoco Pipeline, LP (SPLP) submitted a letter responding to each item in the Department's letter. In response to the Department's second request for further information received on December 12, 2019, SPLP submits the following responses to the Department's letter. The requests are bolded below followed by SPLP's responses.

1. **As required by Paragraph 4. and 5. of the Environmental Hearing Board's August 10, 2017 Corrected Stipulated Order ("Order"), SPLP failed to fully utilize the information gathered, or respond to DEP's March 19, 2019 request for more information, during the HDD of the 20-inch bore as part of the HDD Re-evaluation for the 16-inch pipeline. What "monitoring data collected during active drilling" was used? Please present all of the data, including the "monitoring data collected during active drilling" of the 20-inch HDD, and explain how the location of the revised 16-inch HDD profile was determined.**

   Additionally, SPLP did not collect any new geological data, including geo-physical data, for the area where most of the inadvertent returns occurred during the construction of the 20-inch pipeline. Boring B-2 is approximately 125 feet from Snitz Creek and even farther away from the nearest IR. Bedrock strike and dip is not defined, discussed, or field verified within the analysis based on any data collected from the site. SPLP reports that there is bedrock outcrop in Snitz Creek. Could local strike/dip measurements not be taken at that location?

Further, Section 8.0 Conceptual Hydrogeologic Model in the first 16-inch HDD re-evaluation's geologic report stated that "some site-specific evaluation of the bedrock has been completed in the area proximate to the geotechnical borings completed along this HDD profile and at bedrock outcrops identified along the stream bank proximate to the IR locations identified on the redesigned 16-inch HDD . . . ". What are the results of the site-specific evaluation of the bedrock outcrops? Please provide and incorporate into the HDD re-evaluation.

DEP requests that SPLP conduct additional geo-technical investigation of the portion of the HDD profile and area where most of IRs occurred on the 20-inch bore. SPLP should incorporate the results of such additional geo-technical investigation into the HDD re-evaluation. Alternatively, if additional geo-technical investigation is not feasible, SPLP should provide an adequate justification of why collecting such additional data is not feasible. In accordance with Paragraph 5. of the Order, SPLP should collectively use and present all of the available data compiled from the construction of the 20-inch line and any new geo-technical data to explain in detail how the 16-inch profile was chosen in order to minimize IRs during construction of the 16-inch pipeline.

As referenced in the August 29, 2019 response letter, SPLP utilized all the information obtained during completion of the 20-inch HDD, as well as the 2017 geotechnical investigation and the 2018 and 2019 geophysical surveys, in our internal assessment and evaluation of the 16-inch HDD profile. This information, which included annular pressure measurements, rates of advancement, cuttings (lithologic) observations, and the force (weight on bit) applied during drilling operations, as well as geologic information ascertained from the 2017 geotechnical investigation and the 2018 and 2019 geophysical surveys, was utilized to determine that the originally permitted 16-inch profile was susceptible to IRs. The information was also taken into account when redesigning the 16-inch profile to achieve a greater depth and quicker entry/exit into competent bedrock.

Based on a review of the drilling data and daily inspection reports, no appreciable/significant changes in drilling fluid returns or annular pressures were observed prior to the repeated IR events. Therefore, it was concluded that the IRs resulted from the 20-inch boring passing through areas containing preferential pathways (i.e., fractured and broken bedrock [i.e., incompetent bedrock] or unconsolidated material) which enabled the movement of drilling fluids to the land surface. Based on cutting returns, depth of pilot/reamer bit and recorded annular pressures, SPLP believes that the preferential pathways were located within the unconsolidated material and the fractured/broken weathered bedrock. Since all the IRs occurred within a relatively short linear distance of each other, they can all be considered to originate from the same “source area” of interconnected fractures within incompetent/weathered bedrock and the bedrock/overburden interface.

A review of geologic publications for this area identified the presence of bedrock in which bedrock dip angles in and around the HDD location ranged from 10° to overturned beds (15 to 29°). No in place bedrock outcrops were identified at the HDD location; however, one possible “outcrop” was observed within Snitz Creek. Based on visual observation from the temporary bridge constructed over Snitz Creek

it appeared that the beds were dipping at a nearly vertical angle. The on-site PG was unable to acquire accurate measurements of the bedding dip because of the water level within the creek and was also not able to determine if the "outcrop" was in-place. Several attempts have been made to return to measure the dip angle of this outcrop, but each time the water level within the creek has been too high to allow for direct or estimated measurements.

Based on this uncertainty relative to the dip of the beds within the proposed 16-inch profile, SPLP elected to install an additional geotechnical boring to the east of Snitz Creek, as illustrated in the enclosed geotechnical investigation report. The location for the boring was selected to provide geotechnical data along the profile in the area where the IR source area is suspected to be located. The boring was completed in January 2020 and was completed to a total depth 20 feet below the bottom of the proposed HDD profile. A review of the boring log shows that the subsurface immediately at the HDD profile's passage under Snitz Creek is comprised of weathered dolomite with fractures and highly broken zones from 6 to 90 feet of below ground surface (bgs), with resulting variations throughout in Rock Quality Designation (RQD) and recovery values. From 90 feet bgs to115 bgs, RQD values ranged from 68 to 99, and recoveries were 100. The RQD values for the 5-foot sample interval above and below the proposed profile depth were 68 and 61, respectively. These RQD values are indicative of competent bedrock overlying the HDD profile for the horizontal run for 412 feet before and 341 feet after the geographic location of the IR events during the 20-inch HDD. Additionally, the eastern radius and entry/exit run maintains a depth of profile below 100 ft below ground surface until 500 ft before the east entry/exit point. On the 20-inch HDD no issues occurred as the HDD progressed west of Snitz Creek. The results of this boring illustrate that the revised profile has been designed to advance through more competent bedrock than the original 20-inch profile. Based on the revised profile, the potential for IRs has been reduced.

2. Relating to the Analysis of geologic strength at profile depth:

a. The SPLP August 29, 2019 response does not adequately address the previous DEP comments. The comments identified in Comment No. 1 above apply here as well. A correlation of the high RQD zones discussed in the SPLP re-evaluation across the HDD profile cannot be made without knowing bedrock dip. Without some field verified data, "high-strength bedrock above profile depth" as a barrier to IRs in a zone where not field data was collected cannot be relied upon as a basis for the 16-inch design and minimization of IRs. Without additional geo-technical investigation, it cannot be known whether that "high-strength bedrock above profile depth" is intact in the profile area beneath Snitz Creek, or whether the bedrock is highly-fractured.

As stated in the response to Comment #1, SPLP agreed to install an additional geotechnical boring. Data from the additional geotechnical boring supports the correlation of high RQD bedrock at the proposed depth of the 16-inch HDD in the suspected source area.

3. Relating to the overall Geologic Report produced by Skelly and Loy:

a. The Corrected Stipulated Order states in Section 5(i) "the report shall document, in detail, the information considered for the re-evaluation of the design of the HDD at that site." DEP requests that SPLP provide a detailed account of and the inclusion of the "monitoring data collected during active drilling" in the re-evaluation. SPLP should include the actual content of daily drilling reports and daily HDD inspection reports, along with how that data was used to determine the location of the revised 16-inch profile.

Copies of the daily drilling reports were hand delivered to the Department at a meeting on January 15, 2020. The Professional Geologists HDD Inspection Reports completed during the 20-inch HDD have been included as an attachment. These data (i.e., lithological descriptions, annular and mud pressure readings, material usage reports, etc.), along with the Hydrogeologic Re-Evaluation Report were used to determine that the 16-inch HDD as permitted would likely result in additional IRs. Based on this conclusion, SPLP re-designed the 16-inch profile to the maximum depth permitted by the bending radius of the pipe in an effort to advance the boring through more competent bedrock, thus reducing the risk of IRs.

b. DEP requests that SPLP further explain how they determined the "lack of interconnected fractures" discussed in the re-evaluation report and how does SPLP know that there is a lack of interconnected fractures, given the lack of geophysical data to support this statement. It does not seem appropriate that the existing core borings be used to extrapolate across the profile length without bedrock dip measurements.

Based on analysis of the annular and mud pressures recorded during completion of the 20-inch HDD, it was concluded that the fractures encountered during completion of the 20-inch HDD were not interconnected. Repeated occurrences of pressure changes indicative of interconnected fractures were not reported and observations (cuttings inspection, multiple zones of LOCs/LORs, etc.) were also not made in the field by the Professional Geologist. If the profile had been advanced through multiple zones of interconnected fractures, a repeated sequence of corresponding pressure changes would have been observed and reported. Further, if the 20-inch HDD had encountered interconnected fractures, it would be logical to suspect repeated occurrences of drilling fluid losses coincident with the interception of each fracture interval; however, none were observed. The lack of correlative pressure variations with repeated LOCs/LORs, indicates that interconnected fractures were not encountered. Therefore, given the greater depth of the revised profile through more competent bedrock, additional IRs will likely not be encountered during completion of the 16-inch HDD.

c. Please include site specific information on bedrock strike and dip and use in the re-evaluation accordingly. (see comment No. 1, above)

As stated in the response to Comment #1, no in-place bedrock outcrops were identified in and around the Zinns Mill Road HDD location. One potential outcrop was identified within Snitz Creek; however, because of water levels within the creek, accurate dip measurements could not be measured despite

several attempts to do so. A review of published data indicates that bedrock dips measured in the area of the HDD location range from 10° to overturned beds (15 to 29°). As such, SPLP elected to install one additional geotechnical boring to the west of Snitz Creek along the proposed HDD profile to ascertain the quality and strength of bedrock. The boring was located in the suspected source area for the 20-inch HDD IRs. Results of the geotechnical evaluation are attached.

4. Relating to the Geophysics discussion:

a. Why was the geophysical survey not run across the HDD length and to the proposed HDD profile depth where most IRs occurred in the past? (See comment No. 1, above)

RETTEW was unable to complete the survey across the entire HDD length because portions of the drill path were too saturated or overgrown to allow for accurate geophysical measurements. As an alternative to extending the geophysical survey, SPLP decided to install one additional geotechnical boring in the area of the profile suspected as being the source of the IRs identified during completion of the 20inch HDD.

b. Why was the geophysical survey not run across the entire HDD length and to the proposed HDD profile depth? Can any of the geophysical techniques be employed in the area between N. Cornwall Road and Quentin Road or between Quentin Road and the revised entry to the east?

Based on the saturated and overgrown conditions encountered in and around Snitz Creek, it was not and is not possible to complete a geophysical survey that will produce accurate, meaningful, and defensible data. It was because of this inability to obtain defensible data with regard to true bedrock conditions that SPLP elected to install an additional geotechnical boring in the suspected source area for the 20-inch HDD IRs.

c. If additional geophysical data can be obtained, please submit additional plan/profile maps with superimposed geophysical data.

No additional geophysical data can be obtained from the areas that were previously not surveyed. Since additional geophysical surveys cannot be completed, SPLP elected to install an additional geotechnical soil boring to evaluate bedrock conditions in the suspected source area for the 20-inch HDD IRs. The results of the geotechnical investigation are attached.

5. Relating to the Analysis of well production zones and use of information obtained during construction of the 20-inch pipeline;

The re-evaluation only includes two of three water supply complaints that were submitted to SPLP and is missing any of the information and data gained during investigation of the third

complaint. In addition, given the substantial change to the proposed drilling profile at this site and the number of private water supplies within 450 feet of the HDD, SPLP should evaluate and discuss how the proposed 16-inch bore path and profile will minimize impacts to these private water supplies.

Any private or public water supply data obtained within 450 feet or otherwise obtained in the vicinity of the 20-inch or proposed 16-inch HDD should be used and discussed as part of this HDD re-evaluation. This data should include but not be limited to any applicable water supply sampling data and any water supply complaints that SPLP may have obtained and received for water supplies within 450 of the HDD, or within the general vicinity, during construction of the 20-inch pipeline. The results of the SPLP's water supply sampling program, investigation, disposition of the complaint, and any correlation or non-correlation to SPLP's construction activities should be evaluated and discussed in the HDD re-evaluation report and used to demonstrate that the proposed 16-inch HDD activity will minimize the potential for IR's and impacts to water supplies. Please revise the re-evaluation report to include this analysis and information.

The absence of the third water well complaint was an unintentional oversight as discussed in detail below. The third water well complaint was received by SPLP on June 21, 2018 from Mr. Steckbeck and was based on an observation of cloudy water while he was filling his swimming pool using his northern water supply well. There are two water supply wells on the Steckbeck property, a northern and southern water well, which are connected by a manifold prior to entering his residence and any water treatment. On June 22, 2018, representatives of RETTEW, GES and Percheron arrived at the Steckbeck residence to collect a water quality sample from each well and to interview Mr. Steckbeck. Mr. Steckbeck indicated that water from the northern well was being used to fill his swimming pool at a pumping rate of 27 gallons per minute (gpm) when he observed the water becoming cloudy and muddy after approximately three to four minutes of pumping. Mr. Steckbeck indicated this had been the first time he had observed his water becoming cloudy. The northern and southern water supply wells were purged for 30 minutes at a rate of 27 and 8 gpm, respectively. Following the well purging, a water quality sample was collected from each water well and submitted to a ESC Lab Services, a Department accredited laboratory. Laboratory results indicated the only exceedances of Department drinking water quality standards were for suspended solids, turbidity, total iron and total manganese. The elevated concentrations of suspended solids and turbidity, evidence of sediments in the water, can explain the occurrence of the elevated concentrations of iron and manganese. Further, it was observed that shortly after purging of the northern well was started, the water began to become turbid. Based on the occurrence of the turbidity while pumping at a higher rate than normal household usage, the licensed Pennsylvania Professional Geologist who performed the investigation concluded that the turbidity observed on June 21 and 22, 2018 was the result of over pumping and the entrainment of sediment from the formation that had accumulated at the bottom of the water well. The Steckbeck Water Well Complaint Report was submitted to the Department on July 13, 2018 and summarized the findings of the investigation. The Department stated that insufficient information was available to concur with the report, but because the owner expressed satisfaction with SPLP’s response to the request, no further action is required.

Regarding how SPLP will minimize impacts to private water supply wells in the vicinity of the proposed eastern extension of the 16-inch HDD, SPLP feels the issue has previously been addressed by the Water Supply Assessment, Preparedness, Prevention and Contingency Plan (dated December 2, 2016, revised February 6, 2017). SPLP will collect pre-construction water quality samples from all residences located within 450 feet of the HDD profile to establish baseline conditions. During and post-construction samples will also be collected to determine if any changes in water quality have occurred, as well as investigating any water well complaint that is received and to provide potable water while the investigation is being completed. Based on the investigation results for the three water well complaints received during the completion of the 20-inch HDD, no direct impact to water well quality can be associated with pipeline construction activities. SPLP believes that with the best management practices developed during the completion of this project, the increased depth of the redesigned 16-inch profile, and the increase in entry/exit angles the length that the boring is being advanced through incompetent bedrock and unconsolidated material will be minimized. Taken on the whole, these design and engineering modifications will make construction-related impacts to a water well unlikely.

SPLP submits that we have been, and are, in complete compliance with the agreed terms and analysis requirements of the Order, as agreed to by the Department, and that no further analysis is required for the Department to consent to this HDD. SPLP therefore requests that the Department approve the Re-Evaluation Report for the Snitz Creek/North Zinns Mill Road Crossing HDD (S3-0101) as soon as possible.

Sincerely,

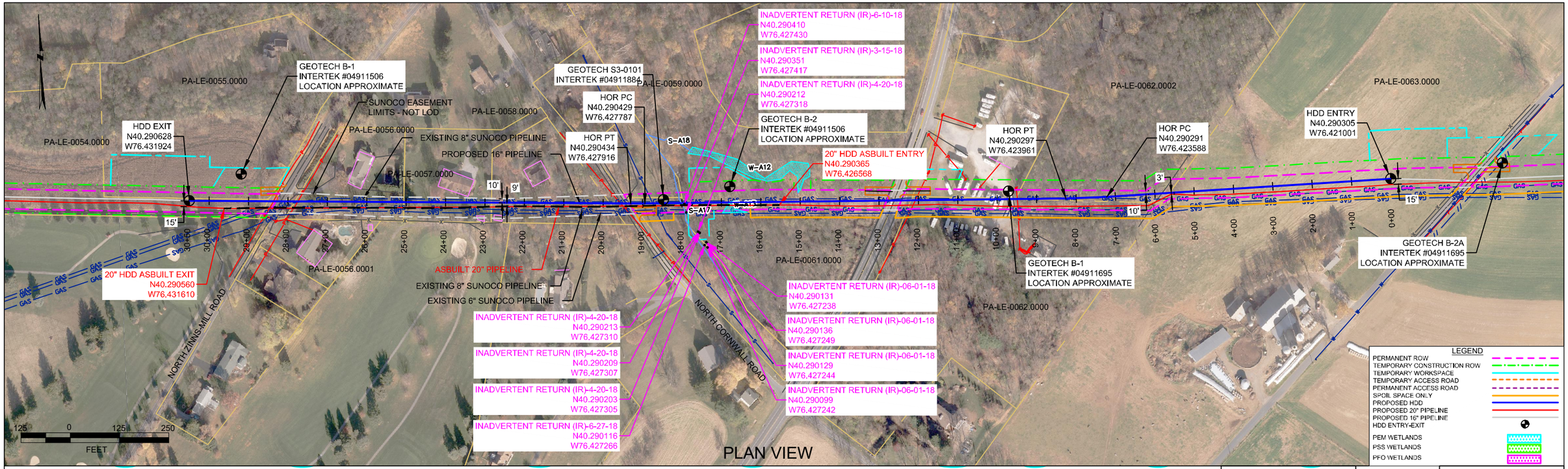
Nicholas J. Bryan, P.L.S.
Sr. Director-E&C Environmental
Energy Transfer Partners

Pertaining to the practice of geology and information conveyed.

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

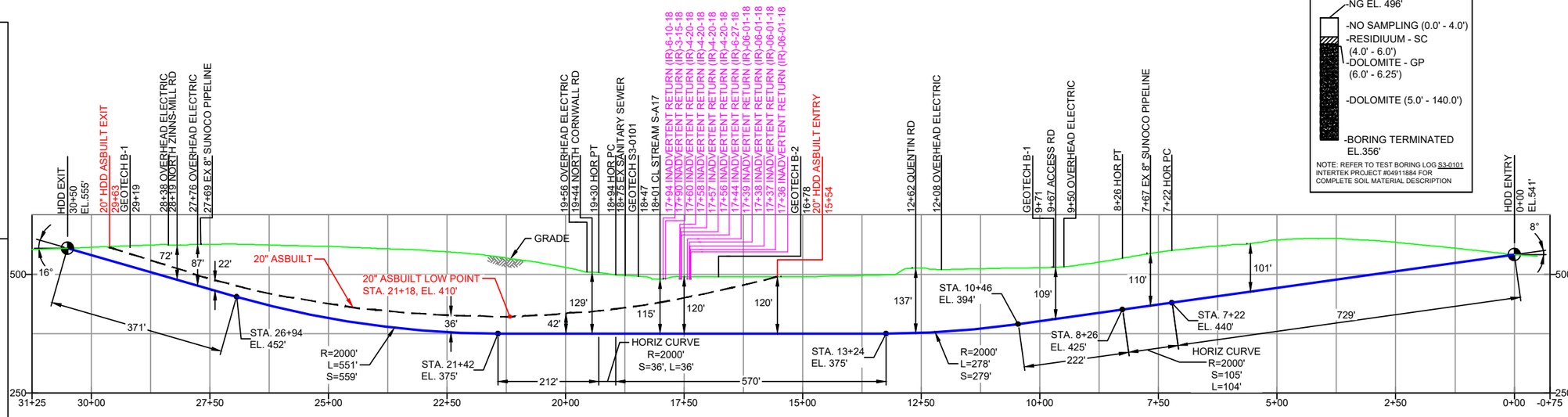
2/27/2020
Date

Attachments as stated.



PLAN VIEW

PROFILE VIEW



GEOTECH S3-0101
- NG EL. 496'
- -NO SAMPLING (0.0' - 4.0')
- -RESIDUUM - SC (4.0' - 6.0')
- -DOLOMITE - GP (6.0' - 6.25')
- -DOLOMITE (5.0' - 140.0')
- -BORING TERMINATED EL.356'

NOTE: REFER TO TEST BORING LOG S3-0101 INTERTEK PROJECT #04911884 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-1
- NG EL. 515'
- -NO SAMPLING (0.0' - 5.0')
- -FILL GP-GM (5.0' - 15.0')
- -GROUNDWATER (24.0')
- -LIMESTONE/DOLOMITE (15.0' - 152.0')
- -BORING TERMINATED EL.363'

NOTE: REFER TO TEST BORING LOG B-1 INTERTEK PROJECT #04911695 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-1
- NG EL. 556'
- -RESIDIUUM-CLAY CL (0.0' - 5.0')
- -GROUNDWATER (43.0')
- -DOLOMITE/LIMESTONE /SHALE (5.0' - 170.0')
- -BORING TERMINATED EL.386'

NOTE: REFER TO TEST BORING LOG B-1 INTERTEK PROJECT #04911506 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-2
- NG EL. 495'
- -FILL ML (0.0' - 3.5')
- -GROUNDWATER (2.9')
- -FILL MH (3.5' - 8.5')
- -DOLOMITE/LIMESTONE (8.5' - 105.0')
- -BORING TERMINATED EL.390'

NOTE: REFER TO TEST BORING LOG B-2 INTERTEK PROJECT #04911506 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-2A
- NG EL. 543'
- -NO SAMPLING (0.0' - 9.5')
- -GROUNDWATER (27.0')
- -LIMESTONE/DOLOMITE (9.5' - 153.0')
- -BORING TERMINATED EL.390'

NOTE: REFER TO TEST BORING LOG B-1 INTERTEK PROJECT #04911695 FOR COMPLETE SOIL MATERIAL DESCRIPTION

LEBANON COUNTY, PENNSYLVANIA - WEST CORNWALL TOWNSHIP
S3-0101-16

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=): 3050'
   HDD PIPE LENGTH (S=): 3083'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 2625 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES-5.32	TO	ES-5.32	EROSION & SEDIMENT PLAN
SHEET 18	TO	SHEET 18	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP7	ADDED GEOTECH INFORMATION	MRS	02/25/20	RMB	02/25/20	AMC	02/25/20
EP6	REDESIGNED PER CLIENT REQUEST AND ADDED GEOTECH INFORMATION	MRS	12/07/18	RMB	12/07/18	AMC	12/07/18
EP5	UPDATED NOTE 5 AND 10 PER INCREASED 16" MOP	MRS	04/10/18	RMB	04/10/18	CAG	04/10/18
EP4	REVISED DEPTH UNDER STREAM S-A17	MRS	12/20/17	RMB	12/20/17	AMC	12/20/17
EP3	LENGTHENED DRILL AND LOWERED UNDER STREAM S-A17	MRS	12/07/17	RMB	12/07/17	AMC	12/07/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	10/07/16	RMB	10/07/16	AAW	10/07/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
N ZINNS MILL ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'

DWG. NO: PA-LE-0055.0000-RD-16

Professional Service Industries, Inc.
1707 S. Cameron St., Suite B
Harrisburg, PA 17104
phone: 717.230.8622
intertek.com/building
psiusa.com

Revised Issue Date: February 19, 2020
Original Issue Date: February 11, 2020

Mr. Elton Sloan
Directional Project Support (DPS)
33311 Lois Lane, Suite A
Magnolia, Texas 77354

Reference: **Geotechnical Exploratory Borings**
North Zinns Mill Road (HDD S3-0101)
Lebanon County, Pennsylvania
PSI Project No.: 04911884 (Revision #1)

Mr. Sloan:

As requested, Professional Service Industries, Inc. (PSI), an Intertek company, performed an exploratory test boring at the above referenced site. Our services were performed under PSI Proposal No. 0491-214504, dated June 19, 2017 signed by Mr. William M. Gardner, President of Directional Project Support, on June 20, 2017. This revised letter report presents the results of the one (1) test boring performed at the location and depth determined by DPS. The previously issued report dated February 11, 2020 indicated an incorrect year (2019 vs 2020) on the boring log's started/completed dates which has been corrected for this revised report.

Work Task

PSI's services included hiring a geotechnical drilling subcontractor (Allied Well Drilling, Inc.) to drill the exploratory test boring designated as S3-0101 on the east side of North Cornwall Road between the road and Snitz Creek. PSI's services also included providing a field logger to visually classify the soil and rock samples. The soil and rock samples were returned to PSI's office/laboratory in Harrisburg, Pennsylvania.

Area Geology

Based on online geologic information by the Pennsylvania Department of Conservation and Natural Resources (http://www.gis.dcnr.state.pa.us/maps/index.html?geology=true), the general area of the drill site is underlain by the Snitz Creek Formation (Csc). The geologic age of the rock formation is indicated to be Cambrian. The main rock type is indicated to be gray dolomite that is thick to massively bedded, medium to coarsely crystalline with limestone and sandstone interbeds. While Karst mapping on the same website does not indicate any sinkholes or surface depressions, the regional area is known for Karst features including variable depth to bedrock and solutioning of the underlying bedrock that can result in sinkholes or ground subsidence's.

Subsurface Exploration

The exploratory test boring (S3-0101) was drilled between the dates of January 24 and January 29, 2020 with a Diedrich D-50 Turbo track-mounted drill rig. The upper 4 feet was hand-cleared by Allied Well Drilling personnel prior to drilling activities.

The borings were advanced with casing and/or rollerbit and Standard Penetration Tests (SPT) were typically performed continuously with a 24-inch length split-spoon (2-in O.D.). After refusal or increased resistances to casing/rollerbit advancement, the boring was advanced with rock coring techniques using an NQ2 sized barrel.

For obtained rock core specimens, the total length of recovered rock core, divided by the length of the run, is referred to as rock core recovery, and is expressed as a percentage. The Rock Quality Designation (RQD) is a measure of the rock mass quality, and is defined as the total length of sound, intact rock core pieces 4 inches or more in length, divided by the length of the rock core run, also expressed as a percentage.

PSI's field loggers visually classified the soil and rock recovered from the test borings. The results of the visual classifications, the SPT blow counts, soil and rock core recoveries, rock core RQDs and rock core times per foot are presented in the boring logs attached to this report. The strata shown on the logs represent the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The strata represent the approximate boundaries between subsurface materials, where the actual transition may be gradual.

Should there be any questions regarding this exploratory boring data report, please contact our office at (717) 230-8622.

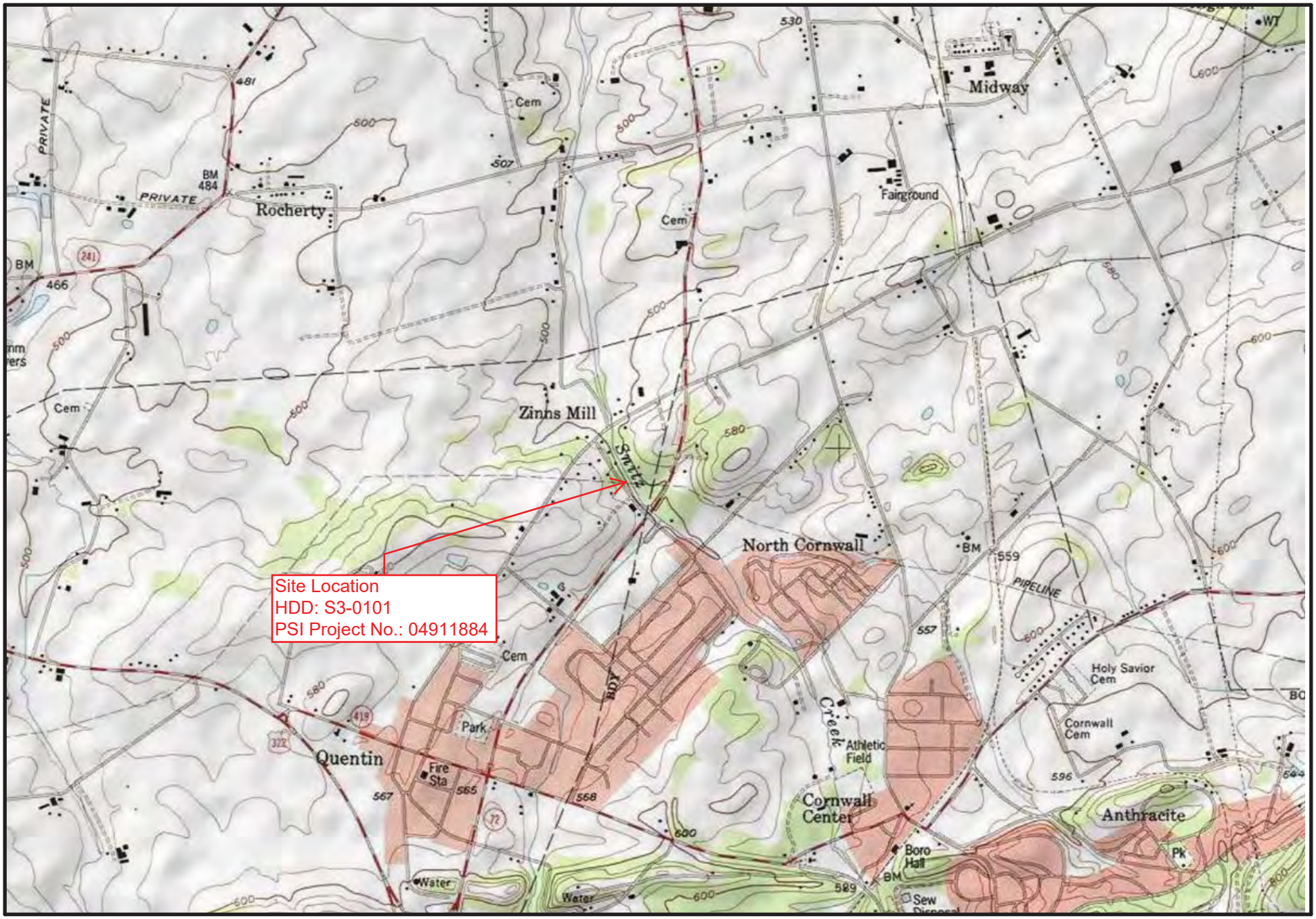
Respectfully submitted,
PROFESSIONAL SERVICE INDUSTRIES, INC.

Forrest C. Hoffman
Project Manager

Paul H. McMichael, P.E.
Principal Consultant/Project Manager

Attachment: Figure 1 – Site Vicinity Map
Figure 2 – Boring Location Plan
Figure 3 – Site Geology Map
Figure 4 – Karst Map
Boring Logs/Rock Core Photos/General Notes

FIGURE 1: SITE VICINITY MAP



Created on: 01/31/20

PASDA

FIGURE 2: BORING LOCATION PLAN

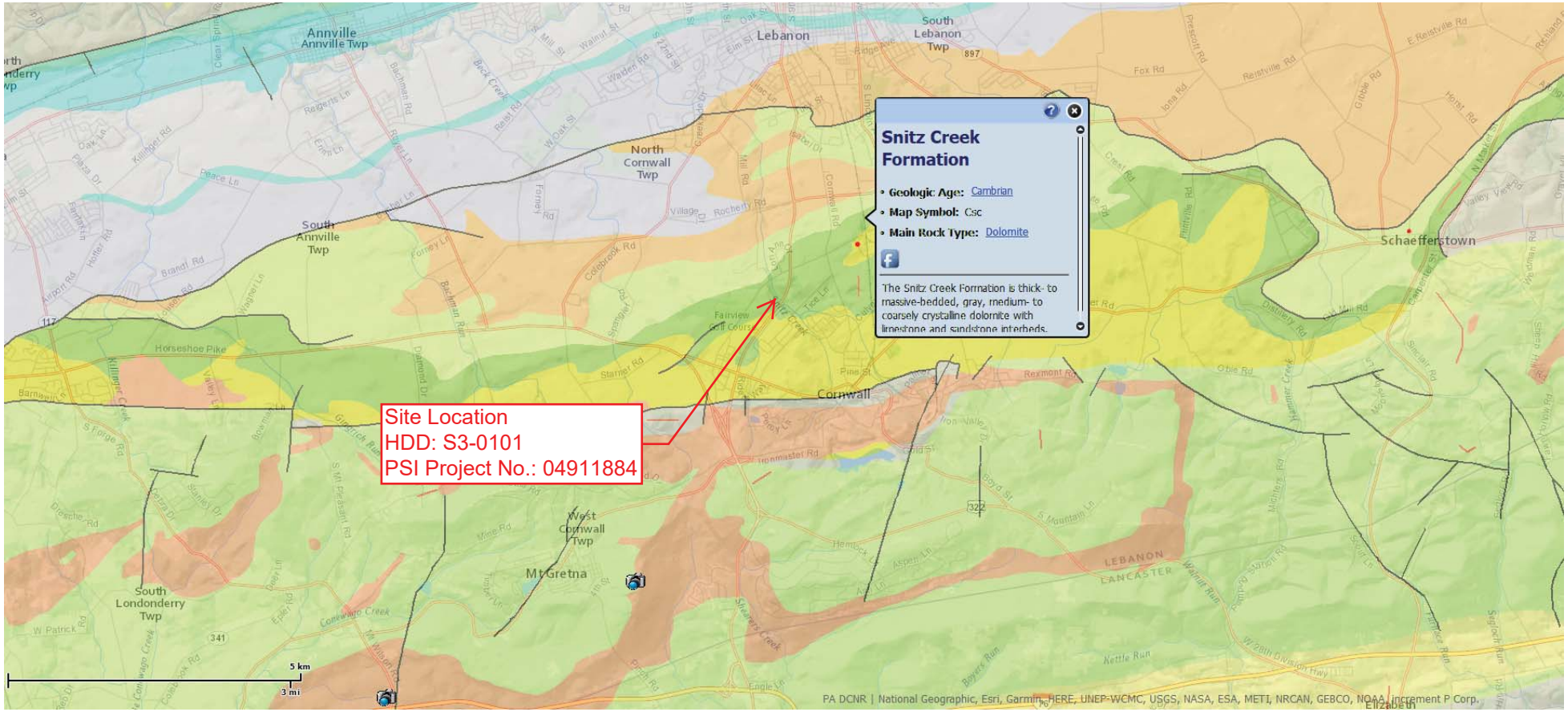
HDD: S3-0101
Lebanon Co., Pennsynania
PSI Project No.: 04911884

pennsylvania
DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES

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

FIGURE 3: SITE GEOLOGY MAP

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



Created using PA DCNR Map Viewer

Map created on Fri Jan 31 2020

SINKHOLES AND KARST-RELATED FEATURES OF LEBANON COUNTY, PENNSYLVANIA

by W.E.Kochanov

1988

OPEN-FILE REPORT: 8802

0645

FIGURE 4: KARST MAP

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
TOPOGRAPHIC AND GEOLOGIC SURVEY

LEBANON QUADRANGLE
PENNSYLVANIA—LEBANON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

BORING B-S3-0101
HDD: S3-0101 PSI
Project No.: 04911884

SYMBOLS

- individual sinkhole
- or sinkhole group
- closed depressions interpreted from aerial photographs
- surface mine, iron
- surface mine limestone/dolomite
- surface mine type unknown
- cave entrance
- bedding orientation strike and dip
- approximate strike and dip
- overturned, bed strike and dip
- joint orientation strike and dip
- joint orientation strike and 90° dip
- fault contact
- formation contact

Mapped, edited, and published by the Geological Survey

Control by USGS, USC&GS, and USSCS

Topography from aerial photographs by multiplex methods
Aerial photographs taken 1951. Field check 1955

Polyconic projection. 1927 North American datum
10,000-foot grid based on Pennsylvania coordinate system, south zone

Red tint indicates area in which only landmark buildings are shown

1000-meter Universal Transverse Mercator grid ticks, zone 18, shown in blue

Revisions shown in purple compiled in cooperation with State of Pennsylvania agencies from aerial photographs taken 1969 and 1976. This information not field checked

UTM GRID AND 1976 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

ROAD CLASSIFICATION

Heavy-duty — Light-duty
Medium-duty — Unimproved dirt
U. S. Route — State Route

0645
LEBANON, PA.

N4015—W7622.5/7.5

1955
PHOTOREVISED 1969 AND 1976
AMS 5764 IV SW—SERIES V831

Compiled by W.E.Kochanov
6/87 - 12/87

The work presented here has not been reviewed for formal publication.

**Bureau of Topographic and Geologic Survey
P.O. Box 8453, Harrisburg, PA 17105-8453**

BORING S3-0101

DATE STARTED:	1/24/20	**DRILL COMPANY:**	Allied Well Drilling, Inc.
DATE COMPLETED:	1/29/20	**DRILLER:** R. Miller	**LOGGED BY:** Kitenour/Hoffman
COMPLETION DEPTH	140.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo Track
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rollerbit/Rock Coring
ELEVATION:	496 ft	**SAMPLING METHOD:**	2-in SS2.0-in Core
LATITUDE:	40.290448°	**HAMMER TYPE:**	Automatic
LONGITUDE:	-76.427617°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water Pre-Core Not Enc.

BORING LOCATION: See Boring Location Plan

REMARKS: Boring coordinates based on "drop pin" (not surveyed) and should be considered approximate; boring ground elevation based on elevation info in Google Earth.

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
495	0					Hand-cleared to appx. 4 feet bgs.					
	5			S-1	17	**RESIDUUM**- Medium Dense, Brown, Clayey SAND, moist	SC	2-7-7-18 N=14			
490				S-2	1	**Highly Weathered DOLOMITE Sampled As:**-Very Dense, Gray to dark gray, Poorly Graded GRAVEL, trace Sand, dry	GP	50/3"		>>	2 min.
				R-1	39	**Weathered to Highly Weathered DOLOMITE**- Light gray to gray-brown, very broken to slightly broken, hard to very hard, nearly horizontal to vertical fractures, with soil		RQD=0 Rec=86%			2 min. 4 min.
	10					**Slightly Weathered DOLOMITE**- Gray to light gray, broken to massive, very hard, nearly horizontal to diagonal fractures, calcite seams and stringers					3 min.
485											3 min. 4 min.
				R-2	60			RQD=81 Rec=100%			2 min. 3 min.
	15										2 min.
480											3 min. 3 min.
				R-3	60			RQD=83 Rec=100%			3 min.
	20					18.9 feet: Weathered, nearly vertical fracture, with soil					3 min. 2 min.
475											3 min. 4 min.
				R-4	60	21.3-21.5 feet: Weathered, diagonal fracture 21.8-22.2 feet: Healed fractures 22.2-22.5 feet: Weathered, diagonal fracture		RQD=83 Rec=100%			3 min. 2 min.
	25					*Continued Next Page*					

intertek psi

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

PROJECT NO.: 04911884
PROJECT: Energy Transfer HDD (DPS)
LOCATION: N. Zinns Mill Rd.
Lebanon Co., PA

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

BORING S3-0101

DATE STARTED:	1/24/20	**DRILL COMPANY:**	Allied Well Drilling, Inc.
DATE COMPLETED:	1/29/20	**DRILLER:** R. Miller	**LOGGED BY:** Rittenour/Hoffman
COMPLETION DEPTH	140.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo Track
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rollerbit/Rock Coring
ELEVATION:	496 ft	**SAMPLING METHOD:**	2-in SS2.0-in Core
LATITUDE:	40.290448°	**HAMMER TYPE:**	Automatic
LONGITUDE:	-76.427617°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water Pre-Core Not Enc.

BORING LOCATION: See Boring Location Plan

REMARKS: Boring coordinates based on "drop pin" (not surveyed) and should be considered approximate; boring ground elevation based on elevation info in Google Earth.

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	25					**Slightly Weathered DOLOMITE**- Gray to light gray, very broken to massive, hard to very hard, horizontal to diagonal fractures, trace calcite stringers					3 min.
470											3 min.
											4 min.
				R-5	60	Core Run R-5: Trace calcite seams and stringers 26.3-26.4 feet: Weathered, diagonal fracture		RQD=88 Rec=100%			3 min.
						28.7-29.2 feet: Very broken layer					3 min.
	30					29.9-30.1 feet: Healed fracture 30.2-30.4 feet: Weathered, diagonal fracture, with soil					3 min.
465						30.5-31.1 feet: Weathered, nearly vertical fracture					2 min.
											3 min.
				R-6	60			RQD=71 Rec=100%			3 min.
											3 min.
	35										2 min.
460											2 min.
											3 min.
				R-7	60			RQD=100 Rec=100%			2 min.
											3 min.
	40					40-43.6 feet: Very broken to broken					3 min.
455											2 min.
											3 min.
				R-8	60			RQD=28 Rec=100%			2 min.
											2 min.
	45					**Slightly Weathered DOLOMITE**- Gray to light gray, very broken to massive, hard to very hard, nearly horizontal to diagonal fractures, calcite seams and stringers					2 min.
450											3 min.
											3 min.
				R-9	60	Very broken/broken layer @ 45.5 feet (~1-3/4" thick)		RQD=65 Rec=100%			2 min.
						Very broken/broken layer @ 48.8 feet (~3" thick)					3 min.
	50					*Continued Next Page*					

intertek psi

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

PROJECT NO.: 04911884
PROJECT: Energy Transfer HDD (DPS)
LOCATION: N. Zinns Mill Rd.
Lebanon Co., PA

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

DATE STARTED: 1/24/20 **DRILL COMPANY:** Allied Well Drilling, Inc.
DATE COMPLETED: 1/29/20 **DRILLER:** R. Miller **LOGGED BY:** Rittenour/Hoffman
COMPLETION DEPTH 140.0 ft **DRILL RIG:** Diedrich D-50 Turbo Track
BENCHMARK: N/A **DRILLING METHOD:** Casing/Rollerbit/Rock Coring
ELEVATION: 496 ft **SAMPLING METHOD:** 2-in SS2.0-in Core
LATITUDE: 40.290448° **HAMMER TYPE:** Automatic
LONGITUDE: -76.427617° **EFFICIENCY** N/A
STATION: N/A **OFFSET:** N/A **REVIEWED BY:** P. McMichael
REMARKS: Boring coordinates based on "drop pin" (not surveyed) and should be considered approximate; boring ground elevation based on elevation info in Google Earth.

BORING S3-0101

Water: Pre-Core Not Enc.

BORING LOCATION:
See Boring Location Plan

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	50					**Slightly Weathered DOLOMITE**- Gray to light gray, very broken to massive, hard to very hard, horizontal to nearly vertical fractures, trace calcite stringers					2 min.
445											2 min.
				R-10	60	Core Run R-10: Trace calcite seams and stringers		RQD=73 Rec=100%			3 min.
											2 min.
											2 min.
	55					54.3-54.6 feet: Weathered, diagonal fracture; crystals in fracture					2 min.
440						Partial loss of return from ~54.5 to 60 feet; advanced casing to 60 feet before resuming rock coring.					3 min.
						55.1-55.5 feet: Healed fracture					4 min.
				R-11	60	55.6-55.8 feet: Healed fracture		RQD=68 Rec=100%			2 min.
											3 min.
	60					**Slightly Weathered DOLOMITE**- Gray to light gray, very broken to massive, very hard, horizontal to diagonal fractures, calcite seams and stringers					3 min.
435											3 min.
						60-61.3 feet: Broken to slightly broken layer					4 min.
				R-12	60	After casing to 60 feet, loss of return became minor until ~90 feet.		RQD=53 Rec=100%			3 min.
						Very broken/broken layer @ 63.1 feet (~1-1/2" thick)					3 min.
	65					**Slightly Weathered DOLOMITE**- Gray to light gray, very broken to massive, hard to very hard, horizontal to nearly vertical fractures, calcite seams and stringers					3 min.
430											3 min.
											4 min.
				R-13	60			RQD=53 Rec=100%			3 min.
						68.6-70 feet: Very broken/broken layer					3 min.
	70										3 min.
425											4 min.
											5 min.
				R-14	60			RQD=18 Rec=100%			3 min.
											3 min.
	75					74.5-74.8 feet: Very broken layer					

Continued Next Page

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

PROJECT NO.: 04911884
PROJECT: Energy Transfer HDD (DPS)
LOCATION: N. Zinns Mill Rd.
Lebanon Co., PA

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

DATE STARTED:	1/24/20	**DRILL COMPANY:**	Allied Well Drilling, Inc.
DATE COMPLETED:	1/29/20	**DRILLER:** R. Miller	**LOGGED BY:** Rittenour/Hoffman
COMPLETION DEPTH	140.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo Track
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rollerbit/Rock Coring
ELEVATION:	496 ft	**SAMPLING METHOD:**	2-in SS2.0-in Core
LATITUDE:	40.290448°	**HAMMER TYPE:**	Automatic
LONGITUDE:	-76.427617°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

BORING S3-0101

Water Pre-Core Not Enc.

BORING LOCATION:
See Boring Location Plan

REMARKS: Boring coordinates based on "drop pin" (not surveyed) and should be considered approximate; boring ground elevation based on elevation info in Google Earth.

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0 25 50) STRENGTH, tsf ▲ Qu ✳ Qp (0 2.0 4.0)	Additional Remarks
	75										3 min.
420											2 min.
											4 min.
				R-15	60	**Slightly Weathered DOLOMITE**- Gray to light gray, very broken to massive, hard to very hard, horizontal to nearly vertical fractures, calcite seams and stringers 75.3-75.5 feet: Weathered, diagonal fracture 75.8-76.1 feet: Vertical, soil-filled fracture		RQD=58 Rec=100%			3 min.
											3 min.
	80										3 min.
415						**Slightly Weathered DOLOMITE**- Gray to light gray, very broken to massive, very hard, nearly horizontal to diagonal fractures, calcite seams and stringers 80.9-81.1 feet: Weathered, diagonal fracture 81.7-82.4 feet: Several healed fractures 82.4-82.7 feet: Very broken/broken layer with vertical fracture 82.7-85 feet: Several healed fractures					3 min.
				R-16	60			RQD=56 Rec=100%			4 min.
											3 min.
											3 min.
	85										3 min.
410						**Slightly Weathered DOLOMITE**- Gray to light gray, very broken to massive, very hard, nearly horizontal to nearly vertical fractures, trace calcite stringers, several healed fractures 85.7-85.8 feet: Weathered, diagonal fracture 85.8-86.3 feet: Weathered, nearly vertical fracture 88.9-89.2 feet: Very broken/broken layer					2 min.
				R-17	60			RQD=47 Rec=100%			3 min.
											3 min.
											3 min.
	90										3 min.
405						**Slightly Weathered DOLOMITE**- Gray to light gray, broken to massive, hard to very hard, horizontal to diagonal fractures, trace calcite stringers Minimal loss of return from ~90 to 110 feet.					3 min.
				R-18	60			RQD=88 Rec=100%			4 min.
											3 min.
											3 min.
	95										3 min.
400											3 min.
											4 min.
				R-19	60			RQD=99 Rec=99%			3 min.
											3 min.
	100										

Continued Next Page

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

PROJECT NO.: 04911884
PROJECT: Energy Transfer HDD (DPS)
LOCATION: N. Zinns Mill Rd.
Lebanon Co., PA

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

DATE STARTED:	1/24/20	**DRILL COMPANY:**	Allied Well Drilling, Inc.
DATE COMPLETED:	1/29/20	**DRILLER:** R. Miller	**LOGGED BY:** Rittenour/Hoffman
COMPLETION DEPTH	140.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo Track
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rollerbit/Rock Coring
ELEVATION:	496 ft	**SAMPLING METHOD:**	2-in SS2.0-in Core
LATITUDE:	40.290448°	**HAMMER TYPE:**	Automatic
LONGITUDE:	-76.427617°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

BORING S3-0101

Water Pre-Core Not Enc.

BORING LOCATION:
See Boring Location Plan

REMARKS: Boring coordinates based on "drop pin" (not surveyed) and should be considered approximate; boring ground elevation based on elevation info in Google Earth.

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	Additional Remarks
	100			**Slightly Weathered DOLOMITE**- Gray to light gray, slightly broken to massive, very hard, nearly horizontal to diagonal fractures, calcite seams and stringers				3 min.
395								3 min.
		R-20	60			RQD=98 Rec=100%		4 min.
								3 min.
								3 min.
	105							2 min.
390								2 min.
								3 min.
		R-21	60	107.5-108.3 feet: Several healed fractures		RQD=91 Rec=100%		2 min.
				108.8-109 feet: Diagonal, weathered fracture				3 min.
	110							2 min.
385				**Slightly Weathered DOLOMITE**- Gray to light gray, very broken to massive, hard to very hard, horizontal to diagonal fracture, calcite seams and stringers				2 min.
				110.2-110.3 feet: Developing fracture				3 min.
		R-22	60	Minor loss of return from ~110 to 140 feet.		RQD=88 Rec=100%		2 min.
								2 min.
				114.2-114.3 feet: Weathered, diagonal fracture				2 min.
	115			114.7-115 feet: Weathered, diagonal fracture				3 min.
380								3 min.
								4 min.
		R-23	60			RQD=68 Rec=99%		3 min.
				118-118.3 feet: Weathered, diagonal fracture; crystals in fracture				3 min.
	120							3 min.
375				**Slightly Weathered DOLOMITE**- Gray to light gray, very broken to massive, very hard, horizontal to diagonal fractures, trace calcite seams and stringers, several healed fractures				3 min.
				Very broken layer @ 120.9 feet (~1" thick)				4 min.
		R-24	60			RQD=61 Rec=100%		2 min.
								3 min.
	125			*Continued Next Page*				

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

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

PROJECT NO.:	04911884
PROJECT:	Energy Transfer HDD (DPS)
LOCATION:	N. Zinns Mill Rd.
	Lebanon Co., PA

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

BORING S3-0101

DATE STARTED:	1/24/20	**DRILL COMPANY:**	Allied Well Drilling, Inc.
DATE COMPLETED:	1/29/20	**DRILLER:** R. Miller	**LOGGED BY:** Kitenour/Hoffman
COMPLETION DEPTH	140.0 ft	**DRILL RIG:**	Diedrich D-50 Turbo Track
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rollerbit/Rock Coring
ELEVATION:	496 ft	**SAMPLING METHOD:**	2-in SS2.0-in Core
LATITUDE:	40.290448°	**HAMMER TYPE:**	Automatic
LONGITUDE:	-76.427617°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water Pre-Core Not Enc.

BORING LOCATION:
See Boring Location Plan

REMARKS: Boring coordinates based on "drop pin" (not surveyed) and should be considered approximate; boring ground elevation based on elevation info in Google Earth.

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	125					**Slightly Weathered DOLOMITE**- Gray to light gray, very broken to massive, very hard, horizontal to diagonal fractures, calcite seams and stringers					3 min.
370						126.1-126.2 feet: Very broken layer					2 min.
				R-25	60	126.5-126.6 feet: Very broken/broken layer		RQD=62			3 min.
						127.8-128.2 feet: Developing nearly vertical fracture		Rec=100%			2 min.
						128.4-128.7 feet: Very broken/broken layer					3 min.
	130										3 min.
365						130.5-130.6 feet: Developing diagonal fracture					3 min.
						Very broken layer @ 131.2 feet (~3/4" thick)					3 min.
				R-26	60			RQD=73			3 min.
								Rec=100%			3 min.
											3 min.
	135										3 min.
360						**Slightly Weathered DOLOMITE**- Gray to light gray, very broken to massive, very hard, horizontal to nearly vertical fractures, trace calcite stringers					2 min.
						Very broken layer @ 135 feet (~1/2" thick)					4 min.
				R-27	60	135.9-136.2 feet: Very broken/broken layer		RQD=32			3 min.
								Rec=100%			3 min.
											3 min.
	140					Test boring terminated @ 140 feet					3 min.

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

PROJECT NO.: 04911884
PROJECT: Energy Transfer HDD (DPS)
LOCATION: N. Zinns Mill Rd.
Lebanon Co., PA

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

04911884
N. ZINNS MILL RD
1/24/2020 - 1/27/2020
53-0101 (6.3-20.6')
Box 1

RUN	DEPTHS	LENGTH	REC.	RQD
1	6.3' - 10.0'	3.7'	39"	Ø"
2	10 - 15'	5.0'	60"	48.5"
3	15-20'	5.0'	60"	49.5"
4	20-25'	5.0'	60"	49.5"

Run #	Depths	Length	Rec	RQD
5	25-30'	5.0'	60"	53"
6	30-35'	5.0'	60"	42.5"

D4911884
N. Zone Area Pb.
1/27/20
53-0101 (20.6-34.3')
Box 2

20.6'
25'
30'
34.3'

Run #	Depth	Length	Rec	RQD
7	35-40'	5.0'	60"	60"
8	40-45'	5.0'	60"	16.5"
9	45-50'	5.0'	60"	39"

0491884
N. Z— Mill 22
1/27/2-
33-0101 (34.3-47.1')
Box 3

34.3'
35'
40'
45'

Run #	Depths	Length	Rec	RQD
10	50-55'	5.0'	60"	43.5"
11	55-60'	5.0'	60"	41"

0491 1884
N. Zims Mill Rd.
1/27/20
53-0101(47.1-60')
Box 4

47.1'

50'

55'

60'


60'
65'
70'
70'
75'

Run #	Depths	Length	Rec	RQD
15	75-80'	5.0'	60"	35"
16	80-85'	5.0'	60"	33.5"
17	85-90'	5.0'	60"	28"

04911884
N. Zions Mill Rd.
1/28/20
53-0101 (73.6-87.0')
Box #6

73.6'

75'

80'

85'

87.0'

Box #	Depths	Length	Rec	RQD
18	90-95'	5.0'	60"	53"
19	95-100'	5.0'	59.5"	59.5"
20	100-105'	5.0'	60"	58.5"

04911884
N. Zions Mill Rd.
1/28/20
53-0101(87.0-101.1')
Box 7

87.0'

95'

100'

90'

Run #	Depths	Length	Rec	RQD
21	105-110'	5.0'	60"	54.5"
22	110-115'	5.0'	60"	53"

049-1884
N. Zinc Mill Rd.
1/28/20
53-0101(101.1-115')
Box 8

101.1'
105'
110'
115'

Run #	Depths	Length	Rec	RQD
23	115-120'	5.0'	59.5"	41"
24	120-125'	5.0'	60"	36.5"
25	125-130'	5.0'	60"	37"

04911884
N. Zone Mill B.
1/29/20
53-0101 (115-129.0')
Box 9

115'

120'

125'

129'

Run #	Depths	Length	Rec	RQD
26	130-135'	5.0'	60"	43.5"
27	135-140'	5.0'	60"	19"

D4911884
N. Zinn Mill Rd.
1/29/20
53-0101 (129.0-1
Box 10

130'

135'

140'
END

GENERAL NOTES

SAMPLE IDENTIFICATION

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

DRILLING AND SAMPLING SYMBOLS

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

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

SOIL PROPERTY SYMBOLS

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

RELATIVE DENSITY OF COARSE-GRAINED SOILS

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

ANGULARITY OF COARSE-GRAINED PARTICLES

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

GRAIN-SIZE TERMINOLOGY

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

PARTICLE SHAPE

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

RELATIVE PROPORTIONS OF FINES

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

GENERAL NOTES

(Continued)

CONSISTENCY OF FINE-GRAINED SOILS

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

MOISTURE CONDITION DESCRIPTION

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

RELATIVE PROPORTIONS OF SAND AND GRAVEL

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

STRUCTURE DESCRIPTION

Description	Criteria
Stratified:	Alternating layers of varying material or color with layers at least ¼-inch (6 mm) thick
Laminated:	Alternating layers of varying material or color with layers less than ¼-inch (6 mm) thick
Fissured:	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided:	Fracture planes appear polished or glossy, sometimes striated
Blocky:	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed:	Inclusion of small pockets of different soils
Layer:	Inclusion greater than 3 inches thick (75 mm)
Seam:	Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick extending through the sample
Parting:	Inclusion less than 1/8-inch (3 mm) thick

SCALE OF RELATIVE ROCK HARDNESS

Q_U - TSF	Consistency
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
1,050 - 2,600	Hard
>2,600	Very Hard

ROCK BEDDING THICKNESSES

Description	Criteria
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	½-inch to 1¼-inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to ½-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

ROCK VOIDS

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

GRAIN-SIZED TERMINOLOGY

(Typically Sedimentary Rock)

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

ROCK QUALITY DESCRIPTION

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

Degree of Brokeness

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

Brokeness: A general rock description referring to any breaks or separations in the rock. Includes bedding planes and fractures.

DEGREE OF WEATHERING

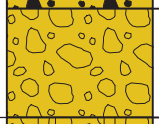
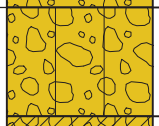
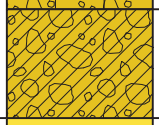
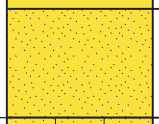
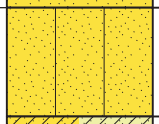
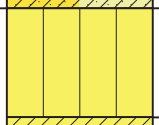
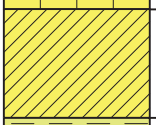
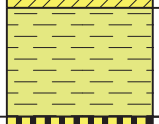
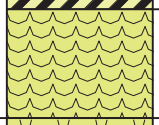
Slightly Weathered: Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.

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

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

SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

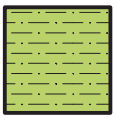
MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL -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

intertek psi

Graphic Symbols for Materials and Rock Deposits

CONCRETE
Portland Cement Concrete

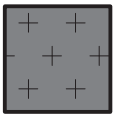
BITUMINOUS CONCRETE



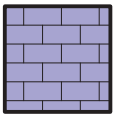
CLAYSTONE

COAL
Coal, Anthracite Coal

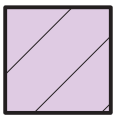
CONGLOMERATE/BRECCIA
Conglomerate, Breccia



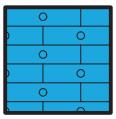
IGNEOUS ROCK
Anorthsite, Basalt, Metabasalt, Diabase (Gabbro), Gabbro, Granite/Granodionite, Homfels, Pegmatite, Rhyolite/Metarhyolite



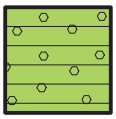
LIMESTONE
Limestone, Dolomite



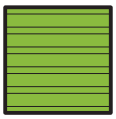
METAMORPHIC ROCK
Amphibolite, Gneiss, Marble, Phyllite, Quartzite, Schist, Serpentinite, Slate



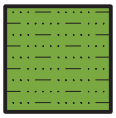
CHERT



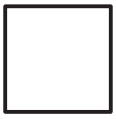
SANDSTONE
Sandstone, Orthoquarzite (Sandstone)



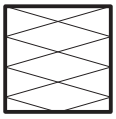
SHALE



SILTSTONE



NO RECOVERY



VOID

intertek
psi