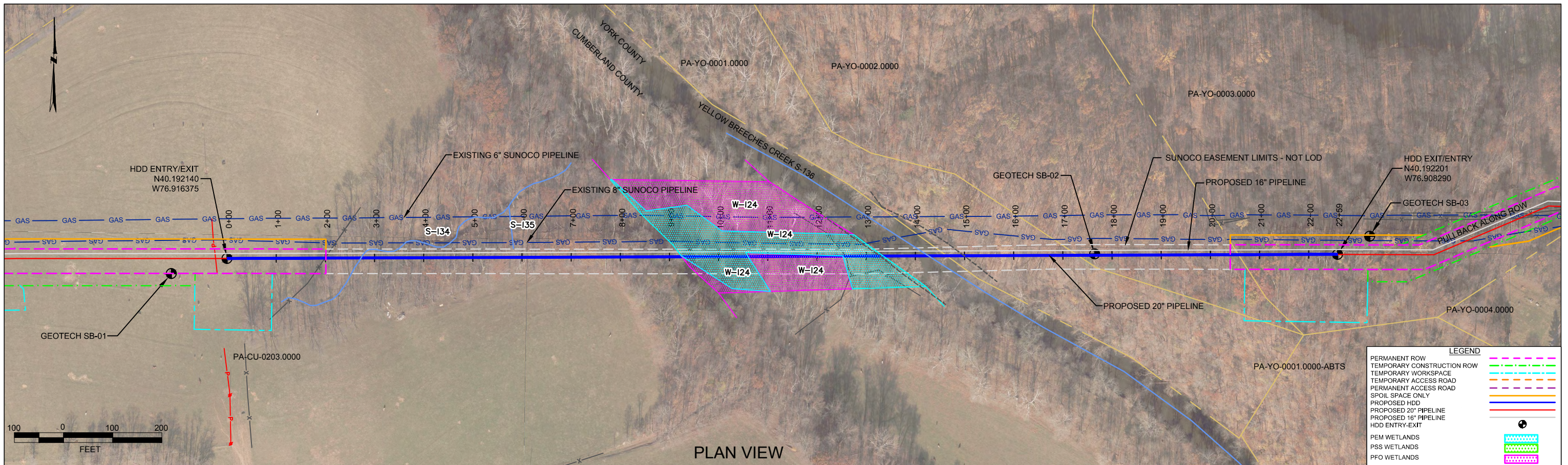


HDD PA-CU-0203.0000-WX (S-I34, W-I24, S-I36)

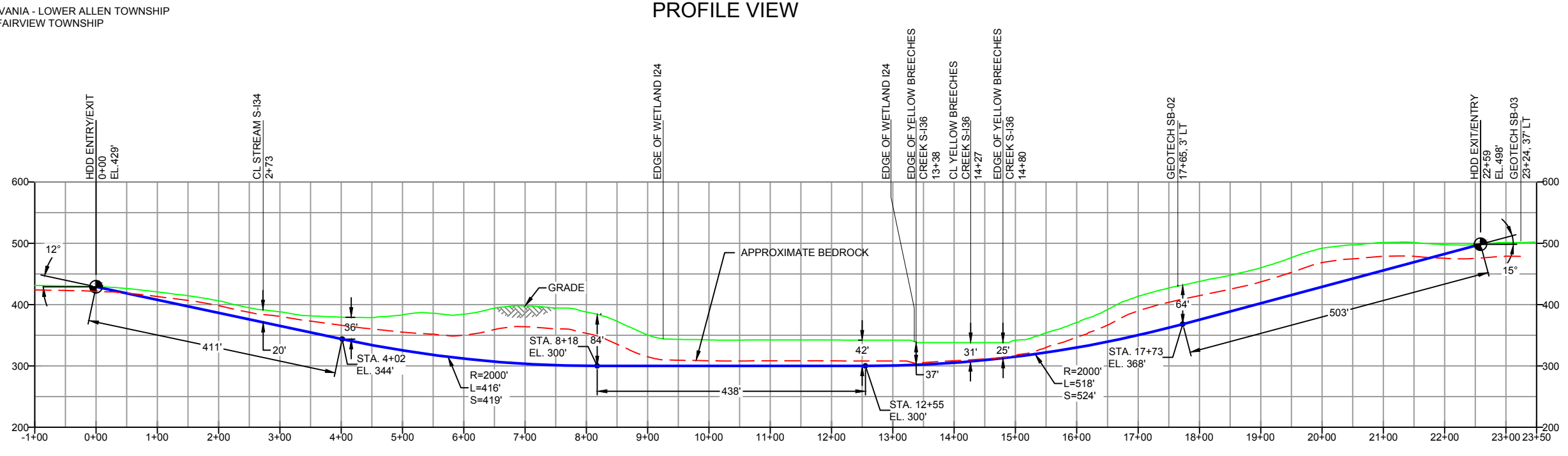
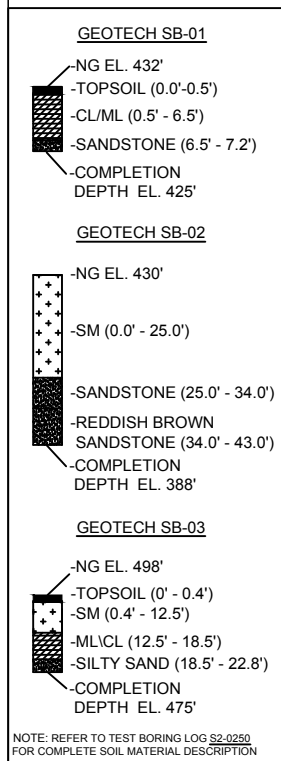
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts, if they were to occur, are also minimized to the maximum extent.

The drill will enter/exit 290 feet from the western edge of Stream I34 (S-I34) and enter/exit 2,000 feet from the eastern edge. The drill will enter/exit 950 feet from the western edge of the Wetland (grassy and forested) I24 (W-I24) and enter/exit 950 feet from the eastern edge. The horizontal directional drill will enter/exit 1,355 feet from the western edge of Yellow Breeches Creek (S-I36) and enter/exit 790 feet from the eastern edge. The drill will pass 20 feet below S-I34, 40 feet below W-I24, and 30 feet beneath the creek. The geotechnical results, as well as other data points, were used to determine the entry/exit angles, and depths to pass through the best substrates while maintaining the pipe integrity (e.g., no large bends). According to the geotechnical report primary substrates being drilled through are sandstone and fine sands with clays. Based on the geotechnical report and the drill profile minimal inadvertent returns are expected.



PLAN VIEW

CUMBERLAND COUNTY, PENNSYLVANIA - LOWER ALLEN TOWNSHIP
 YORK COUNTY, PENNSYLVANIA - FAIRVIEW TOWNSHIP
 S2-0250



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)=2259'
 HDD PIPE LENGTH (S)=2295'
 20" x 0.456" W.T., X-65, API5L, PSL2, ERW, 8FW
 COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)

5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50).
 6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
 7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
 8. CARRIER PIPE NOT ENCASED.
 9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
 10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
 11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
 13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

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		REVISIONS	
ES-4.100	TO ES-4.01	EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16
SHEET 62	TO SHEET 1	EP1	REVISED PER PADEP COMMENTS
		EP	
		C	ADDED GEOTECH INFO
		B	ISSUED FOR BID
		A	ISSUED FOR REVIEW
DWG NO	DWG NO	NO.	DESCRIPTION

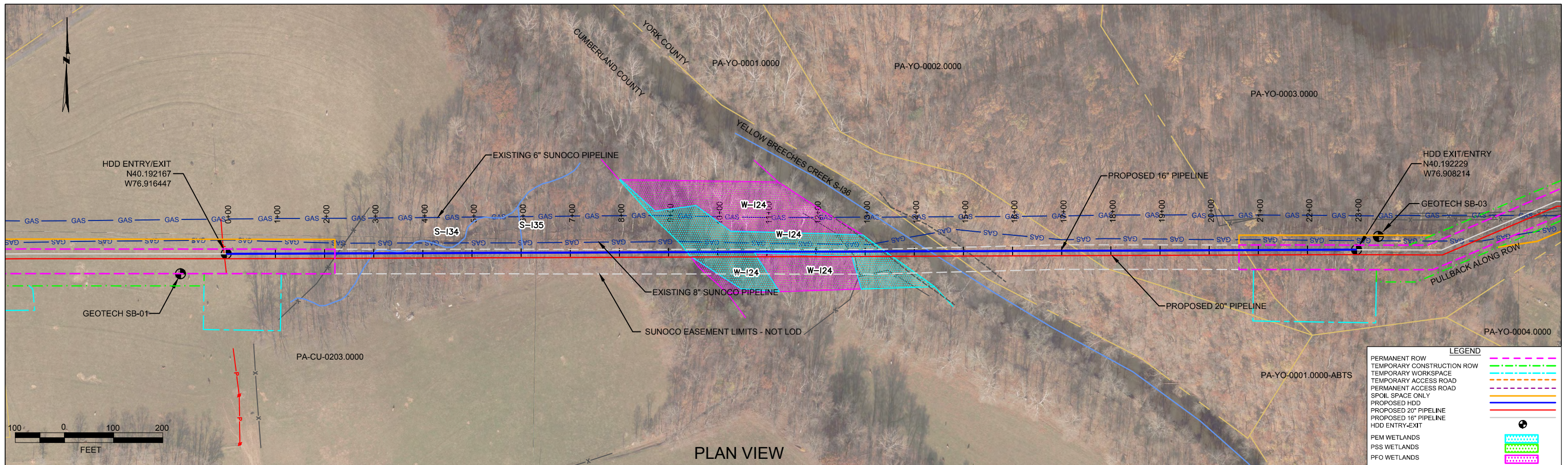
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
 (303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
 YELLOW BREECHES CREEK
 PENNSYLVANIA PIPELINE PROJECT

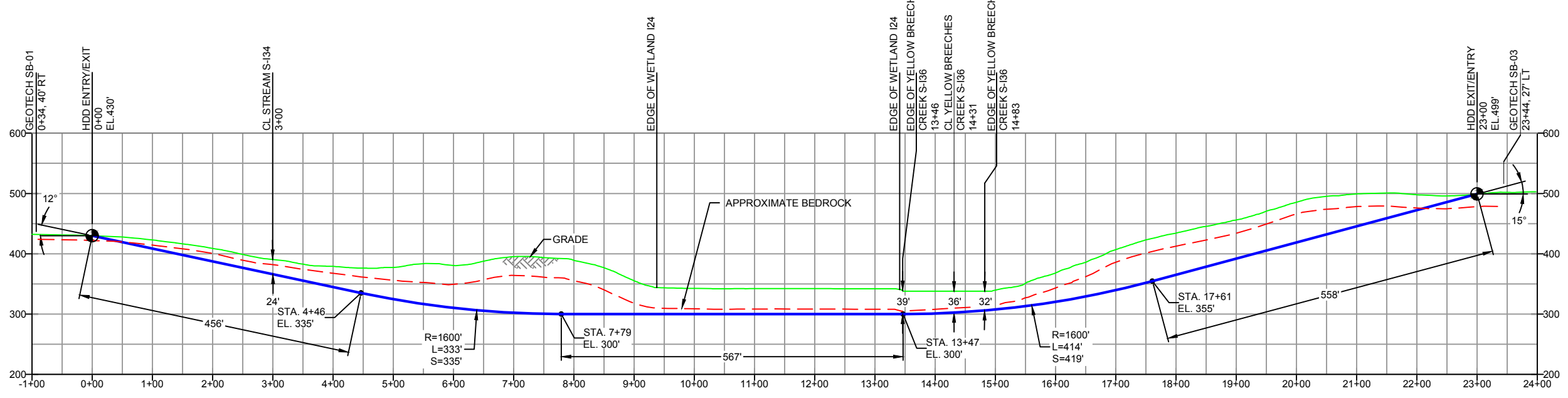
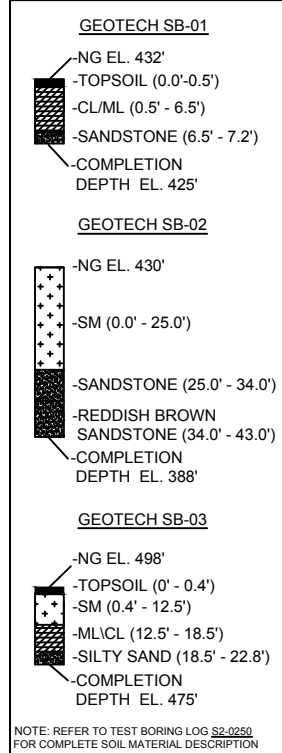
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PLAN VIEW

CUMBERLAND COUNTY, PENNSYLVANIA - LOWER ALLEN TOWNSHIP
 YORK COUNTY, PENNSYLVANIA - FAIRVIEW TOWNSHIP
 S2-0250-16

PROFILE VIEW



- DESIGN AND CONSTRUCTION:
- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
 - 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.
 - DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
 - CROSSING PIPE SPECIFICATION:
 HDD HORZ. LENGTH (L)=2300'
 HDD PIPE LENGTH (S)=2335'
 16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
 COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
 - INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50).
 - INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
 - PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
 - CARRIER PIPE NOT ENCASED.
 - PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
 - CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
 - SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
 - SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
 - SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

- ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
- STATIONING IS BASED ON HORIZONTAL DISTANCES
- 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.
- CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
- SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING		REVISIONS	
ES 4.100	TO ES 4.01	DESCRIPTION	
SHT 62	TO SHT 1	AERIAL SITE PLAN	EP2 REVISED PER PADEP COMMENTS RECEIVED 09-06-16
			EP1 REVISED PER PADEP COMMENTS
			EP
			B ADDED GEOTECH INFO
			A ISSUED FOR BID
DWG NO	DWG NO	DESCRIPTION	NO.

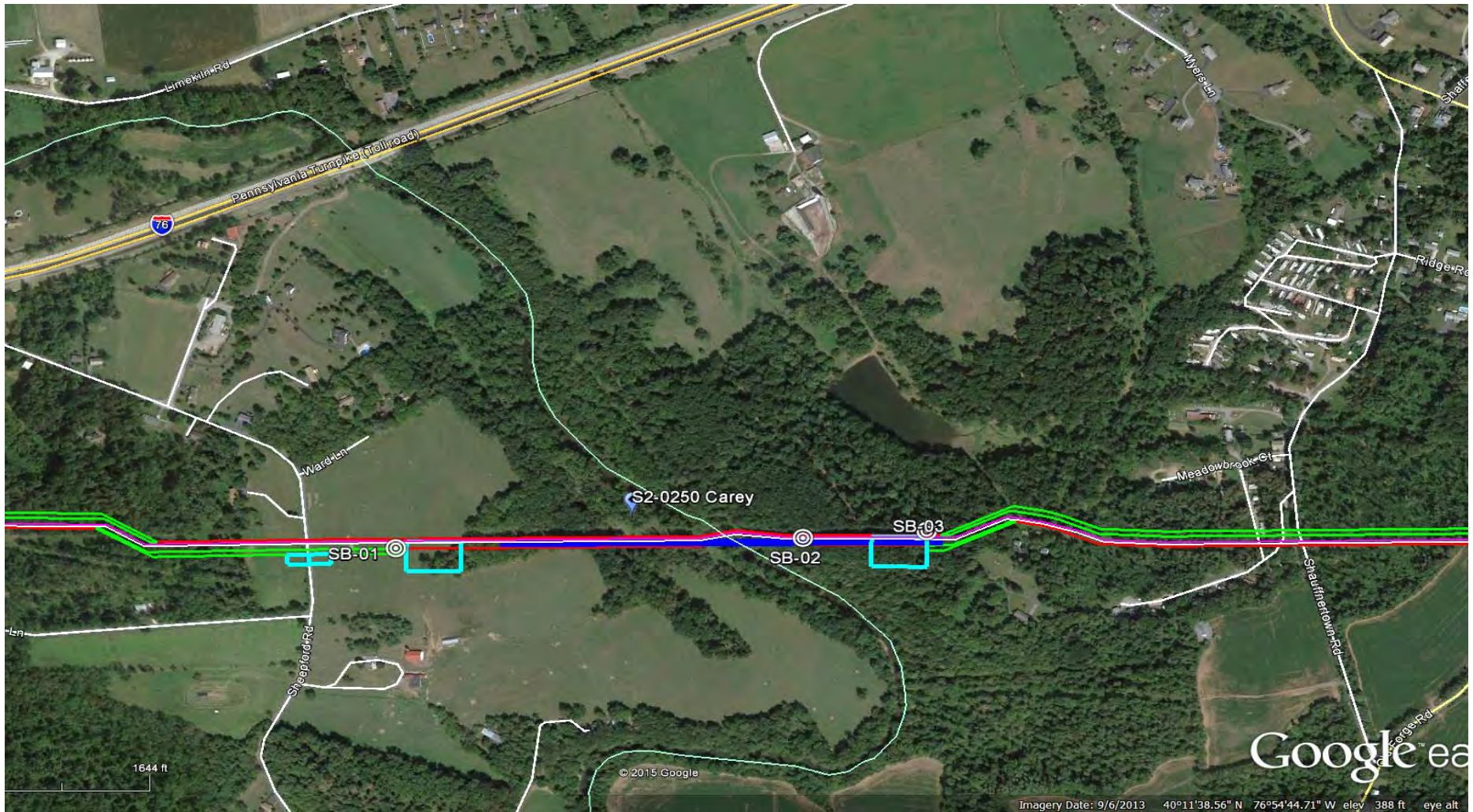
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
 (303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
 YELLOW BREECHES CREEK
 PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200' DWG. NO: PA-CU-0203.0000-WX-16



LEGEND:

⊙ Geotechnical Soil Boring (SB) Locations



GEOTECHNICAL BORING LOCATIONS
 HDD S2-0250
 CUMBERLAND COUNTY, LOWER ALLEN TOWNSHIP AND
 YORK COUNTY, FAIRVIEW 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:	SHEEPFORD ROAD, MECHANICSBURG, PA	Page 1 of 1	
HDD No.:	S2-0250	Dates(s) Drilled:	10-25-14
Boring No.:	SB-01	Inspector:	E. WATT
Drilling Contractor:	HAD DRILLING	Drilling Method:	SPT - ASTM D1586
		Driller:	S. HOFFER
		Groundwater Depth (ft):	NOT ENCOUNTERED
		Total Depth (ft):	7.2

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (ft)	Strata (USCS)	Description of Materials	6" Increment Blows *				N	
	From	To	From	To									
			0.0	0.5			TOPSOIL (6")						
1	3.0	5.0	0.5		11	CL/ML	ORANGE BROWN CLAY/SILT WITH SOME F-C SAND, TRACE	2	4	9	8	13	
				6.5			FINE SANDSTONE GRAVEL. (USCS: CL/ML)						
2	7.0	7.2	6.5	7.2	1		PARTIALLY WEATHERED GRAY SANDSTONE.	50/2"				>50	

Notes/Comments: Pocket Pentrometer Testing DR: DECOMPOSED ROCK
 S1: 2 TSF

Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.
 * Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
 N: Number of blows to drive spoon from 6" to 18" interval.



TETRA TECH

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 fax: 302.454.5988

TEST BORING LOG

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: 277 SHAUFFNERTOWN ROAD, MECHANICSBURG, PA			Page 1 of 1		
HDD No.: S2-0250		Dates(s) Drilled: 10-25/26-14		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): 43.0

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (ft)	Strata (USCS)	Description of Materials	6" Increment Blows *				N	
	From	To	From	To									
							NO DISCERNABLE TOPSOIL						
1	3.0	5.0	0.0		20	SM	REDDISH BROWN FINE SAND WITH SOME SILT, TRACE FINE	1	8	8	10	16	
							SANDSTONE GRAVEL.						
2	8.0	10.0			14		REDDISH BROWN FINE SAND WITH SOME SILT, TRACE FINE	3	5	9	11	14	
							SANDSTONE GRAVEL.						
3	13.0	15.0			17		REDDISH BROWN FINE SAND WITH SOME SILT, WITH A LITTLE FINE	2	10	12	10	22	
							SANDSTONE GRAVEL.						
4	18.0	20.0			15		REDDISH BROWN FINE SAND WITH SOME SILT, TRACE FINE	1	1	3	10	4	
							SANDSTONE GRAVEL.						
5	23.0	25.0			16		REDDISH BROWN FINE SAND WITH SOME SILT, TRACE FINE	2	9	17	24	26	
				25.0			SANDSTONE GRAVEL.						
6	28.0	28.1	25.0		1	PARTIALLY WEATHERED REDDISH BROWN SANDSTONE.	50/1"					>50	
7	33.0	33.2		34.0	2	PARTIALLY WEATHERED REDDISH BROWN SANDSTONE.	50/2"					>50	
							AUGER REFUSAL AT 34'.						
							ROCK CORING						
RUN 1	34.0	38.0	34.0		45	ROCK	REDDISH BROWN SANDSTONE. FRACTURE ZONE 34.1 TO 34.2,	TCR: 94%, SCR: 54%, RQD: 17%					
							FRACTURES AT 34.5 AND 34.6, 34.7 TO 35, 35.3, 35.6, 35.9, 36.3,						
							37.3, 37.7 AND 37.9. CONGLOMERATE LENS FROM 36.9 TO 37.45'.						
RUN 2	38.0	43.0			51		CONTINUE REDDISH BROWN SANDSTONE, FRACTURE AT 38.9,	TCR: 85%, SCR: 61%, RQD: 53%					
							40.5. CONGLOMERATE LENSE FROM 40.6 TO 41.0. SANDSTONE						
				43.0		FRACTURES ALSO AT 42.2 AND 42.5 TO 43.							
							CORE TESTING RESULTS (DEPTH 36.5):						
							COMPRESSIVE STRENGTH: 550 PSI						
							UNIT WEIGHT: 160.5 PCF						
							CAVED AT 32'.						

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.



TETRA TECH

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 Newark, Delaware 19713
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 fax: 302.454.5988

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT	Project No.:	103IP3406
Project Location:	SHAUFFNERTOWN ROAD, NEW CUMBERLAND, PA	Page 1 of 1	
HDD No.:	S2-0250	Dates(s) Drilled:	10-25-14
Boring No.:	SB-03	Inspector:	E. WATT
Drilling Contractor:	HAD DRILLING	Drilling Method:	SPT - ASTM D1586
		Driller:	S. HOFFER
		Groundwater Depth (ft):	NOT ENCOUNTERED
		Total Depth (ft):	22.8

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (ft)	Strata (USCS)	Description of Materials	6" Increment Blows *				N	
	From	To	From	To									
			0.0	0.4			TOPSOIL (5")						
1	3.0	5.0	0.4		19	SM	REDDISH BROWN FINE SAND AND SILT (CONGLOMERATE IN SPOON SHOE).	2	16	22	14	38	
2	8.0	10.0			13		REDDISH BROWN FINE SAND AND SILT, WITH INTERMITTENT QUARTZ CONGLOMERATE LENSES.	5	8	7	6	15	
3	13.0	15.0	12.5		17	ML/CL	REDDISH BROWN SILT AND CLAY WITH A LITTLE FINE SAND, TRACE MICA (USCS: ML/CL)	2	9	9	7	18	
4	18.0	18.8	18.5		8		REDDISH BROWN SILT/CLAY AND F-SAND, WITH A LITTLE F-GRAVEL.	10	50/3"			>50	
5	22.5	22.8		22.8	2	REDDISH BROWN SILTY SAND, INDICATION OF QUARTZ CONGLOM.	50/3"				>50		
							AUGER REFUSAL AT 22.5'. MAY BE DUE TO CONGLOMERATE. (MAY NOT BE BEDROCK).						
							CAVED AND DRY AT 19'.						

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 S2-0250

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.)		Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318)			USCS Classif. (ASTM D2487)
			From	To			Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	
S2-0250	SB-01	1	3.0	5.0	35.9	77.3	35	24	11	CL/ML
	SB-02	1	3.0	5.0	7.6	37.3	-	-	-	-
		3	13.0	15.0	5.8	24.0	-	-	-	-
		4	18.0	20.0	14.8	36.6	-	-	-	-
		5	23.0	25.0	6.4	28.3	-	-	-	-
		6	28.0	28.1	4.8	9.1	-	-	-	-
	SB-03	1	3.0	5.0	5.7	30.9	-	-	-	-
		2	8.0	10.0	12.4	42.6	-	-	-	-
		3	13.0	15.0	14.9	88.3	27	22	5	ML/CL
		4	18.0	18.8	9.1	53.6	-	-	-	-
		5	22.5	22.8	8.4	71.5	-	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-02	1	36.5	550	160.5

Notes:

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

**REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0250**

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
S2-0250	Carey	SB-01	Gettysburg Fm - reddish-brown to maroon silty mudstone and shale and soft, red-brown, medium- to fine-grained sandstone, with minor amounts of yellowish-brown shale and sandstone and thin beds of impure limestone.	Steep sloping valley	Gettysburg Fm	Silty mudstone-shale-sandstone w/ some impure limestone		9-43	Very steep slope from SB02 to SB03. Limestone and voids noted on drilling logs. PWS well within 0.25-mi.
		SB-02							
		SB-03							

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

**ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0250**

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					
S2-0250	SB-2	1	34	38	94	54	17	34	37	Slight	Siltstone to sandstone	Massive	Red	Slight fracturing, Avg. Dip 27° (2° - 75°)
								37	38	Slight	Sandstone grading to conglomerate	Massive	Red	Only one fracture in run, probably mechanical
S2-0250	SB-2	2	38	43	85	61	53	38	40	Slight	Siltstone to sandstone	Massive	Red	No fractures
								40	42	Slight	Coarse sandstone with gravel	Massive	Red	No fractures
								42	43	Slight	Siltstone	Massive	Red	Heavily fractured, appears to have been broken up by drilling

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

<u>Density</u>	<u>N (blows)*</u>
Very Loose	5 or less
Loose	6 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	51 or more

Particle Size Identification

Boulders	8 in. diameter or more
Cobbles	3 to 8 in. diameter
Gravel	Coarse (C) 3 in. to ¾ in. sieve
	Fine (F) ¾ in. to No. 4 sieve
Sand	Coarse (C) No. 4 to No. 10 sieve (4.75mm-2.00mm)
	Medium (M) No. 10 to No. 40 sieve (2.00mm – 0.425mm)
	Fine (F) No. 40 to No. 200 sieve (0.425 – 0.074mm)
Silt/Clay	Less Than a No. 200 sieve (<0.074mm)

Relative Proportions

<u>Description Term</u>	<u>Percent</u>
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

COHESIVE SOILS

(Silt, Clay & Combinations)

<u>Consistency</u>	<u>N (blows)*</u>
Very Soft	3 or less
Soft	4 to 5
Medium Stiff	6 to 10
Stiff	11 to 15
Very Stiff	16 to 30
Hard	31 or more

Plasticity

<u>Degree of Plasticity</u>	<u>Plasticity Index</u>
None to Slight	0 - 4
Slight	5 - 7
Medium	8 - 22
High to Very High	> 22

ROCK

(Rock Cores)

<u>Rock Quality Designation (RQD), %</u>	<u>Rock Quality Description</u>
0-25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
90-100	Excellent

***N - Standard Penetration Resistance.** Driving a 2.0" O.D., 1-3/8" I.D. sampler a distance of 18 inches into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. The number of hammer blows to drive the sampler through each 6 inch interval is recorded; the number of blows required to drive the sampler through the final 12 inch interval is termed the Standard Penetration Resistance (SPR) N-value. For example, blow counts of 6/8/9 (through three 6-inch intervals) results in an SPR N-value of 17 (8+9).

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

UNIFIED SOIL CLASSIFICATION SYSTEM [Casagrande (1948)]

Major Divisions		Group Symbols	Typical Descriptions	Laboratory Classifications				
Coarse Grained Soils (More than half of material is larger than No. 200 sieve)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravel (Little or no fines)	GW Well-graded gravels, gravel-sand mixtures, little or no fines	Determine Percentage of sand and gravel from grain size curve. Depending on Percentage of fines (fraction smaller than No. 200 sieve), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP More than 12 percent GM, GC, SM, SC 5 to 12 percent Borderline cases requiring dual symbols ⁽¹⁾	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3			
		GP Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting C_u or C_c requirements for GW					
		Gravel with fines (Appreciable amount of fines)	GM Silty gravels, gravel-sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols		
			GC Clayey gravels, gravel-sand-clay mixtures					
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Clean sands (Little or no fines)	SW Well graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3			
			SP Poorly graded sands, gravelly sands, little or no fines		Not meeting C_u or C_c requirements for SW			
		Sands with fines (Appreciable amount of fines)	SM Silty sands, sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits Plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols		
			SC Clayey sands, sand-clay mixtures		Atterberg limits above A line with I_p greater than 7			
						For soils plotting nearly on A line use dual symbols i.e., $I_p = 29.5$, $w_L = 60$ gives CH-MH. When w_L is near 50 use CL-CH or ML-MH. Take near as ± 2 percent.		
		Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silt 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								
Silt and Clays (Liquid limit greater than 50)	MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts							
	CH Inorganic clays of high plasticity, fat clays							
	OH Organic clays of medium to high plasticity, organic silts							
Highly organic soils	Pt Peat and other highly organic soils							

(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.