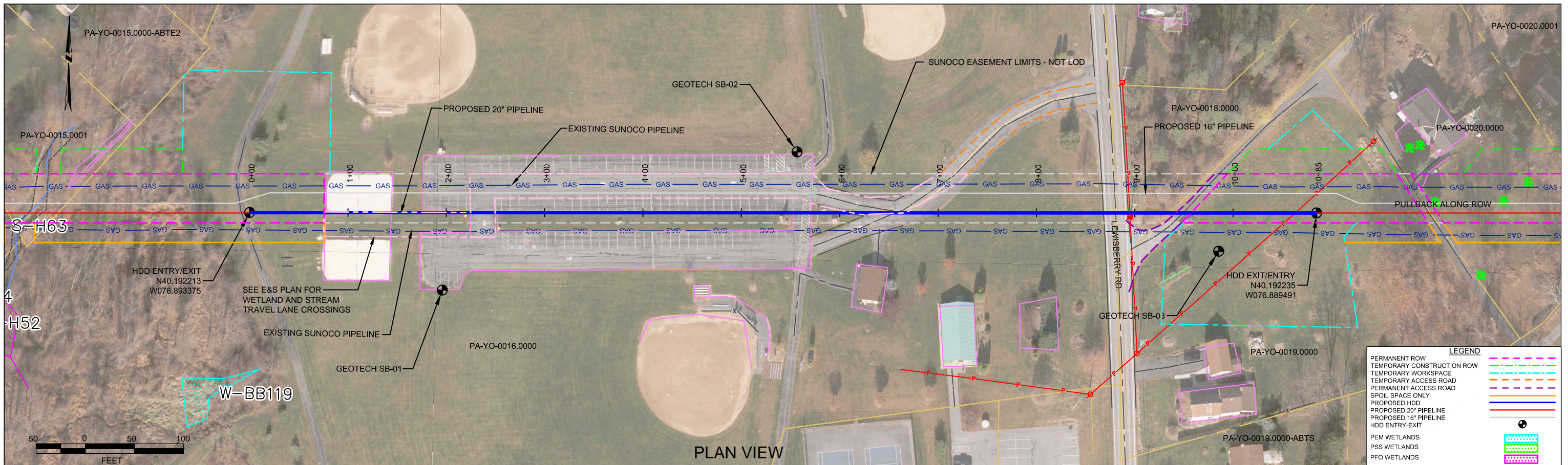


***HDD PA-YO-0016.0000-RD***

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.

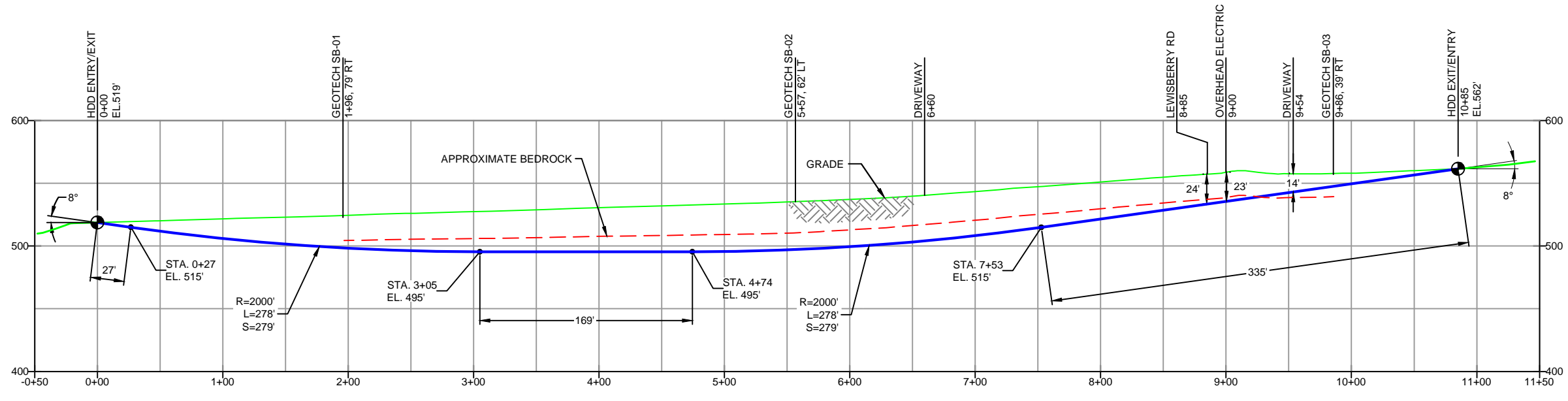
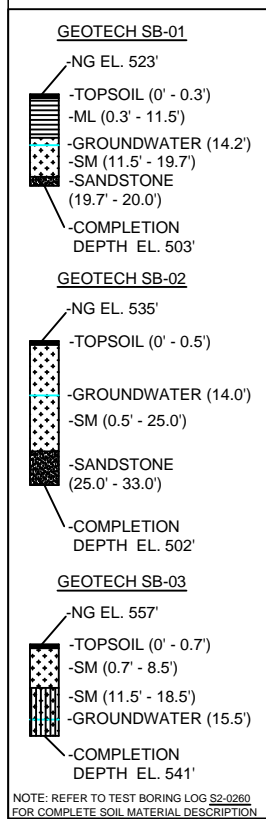
The drill will enter/exit 870 feet from the western edge of Lewisberry Road and enter/exit 210 feet from the eastern edge. The drill will pass below the road about 24 feet. The geotechnical results, as well as other data points, were used to determine the entry/exit angles, and depths to pass through 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 below layers of silts and fine sands. Based on the geotechnical report and the drill profile minimal inadvertent returns are expected.



PLAN VIEW

YORK COUNTY, PENNSYLVANIA - FAIRVIEW TOWNSHIP  
S2-0260

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)=1085'  
HDD PIPE LENGTH (S)=1089'  
20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW  
COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
- 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 811-900-786-7440.

REF. DRAWING		REVISIONS		
ES-4.04	TO ES-4.04	EROSION & SEDIMENT PLAN	EP2 REVISED PER PADEP COMMENTS RECEIVED 09-06-16	
SHEET 3	TO SHEET 3	AERIAL SITE PLAN	EP1 REVISED PER PADEP COMMENTS	
			EP	
			C ADDED GEOTECH INFO	
			B ISSUED FOR BID	
			A ISSUED FOR REVIEW	
DWG NO	DWG NO	DESCRIPTION	NO.	DESCRIPTION

BY	DATE	CHK	DATE	APP	DATE
MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
MRS	05/09/16	RMB	05/09/16	AAW	05/09/16
JTW	03/15/16	RMB	03/15/16	AAW	03/15/16
MRS	09/17/15	RMB	09/17/15	AAW	09/17/15
MRS	07/31/15	RMB	07/31/15	AAW	07/31/15
JAM	03/25/15	RMB	03/25/15	AAW	03/25/15



**Sunoco Logistics  
Partners L.P.**

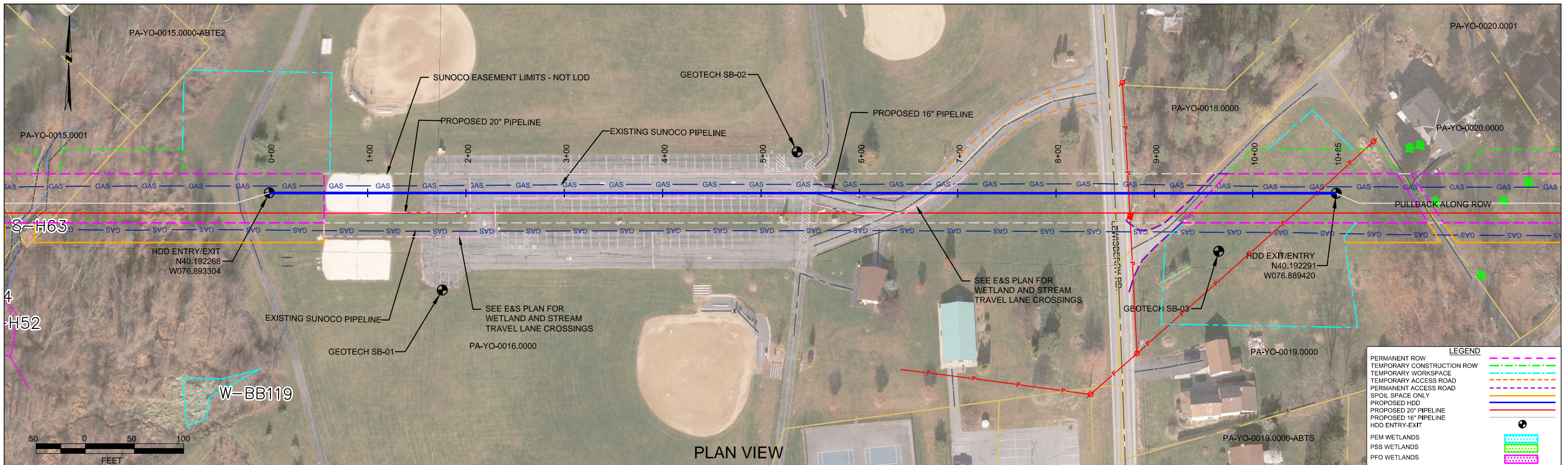


**TETRA TECH ROONEY**  
(303) 792-5911

**SUNOCO PIPELINE, L.P.**

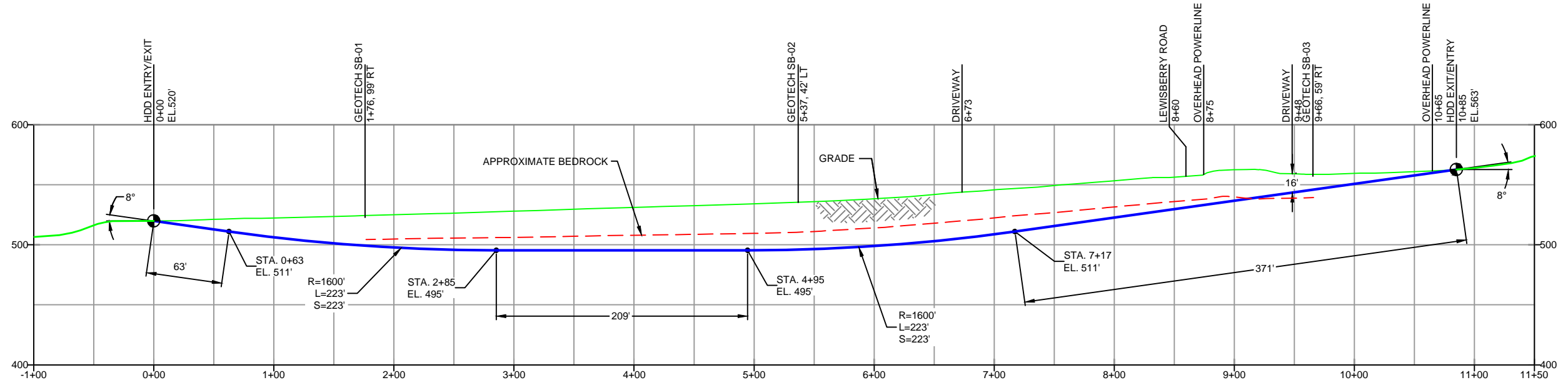
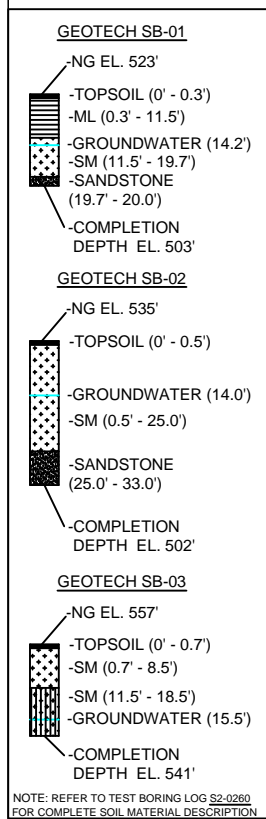
20-INCH HORIZONTAL DIRECTIONAL DRILL  
LEWISBERRY ROAD  
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=100'    DWG. NO: PA-YO-0016.0000-RD



YORK COUNTY, PENNSYLVANIA - FAIRVIEW TOWNSHIP  
S2-0260-16

PROFILE VIEW



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- DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
- CROSSING PIPE SPECIFICATION:  
HDD HORZ. LENGTH (L-): 1085'  
HDD PIPE LENGTH (S-): 1089'  
16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW  
COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
- INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50).
- INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
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- SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING		REVISIONS	
ES-4.04	TO	ES-4.04	DESCRIPTION
SHEET 3	TO	SHEET 3	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.

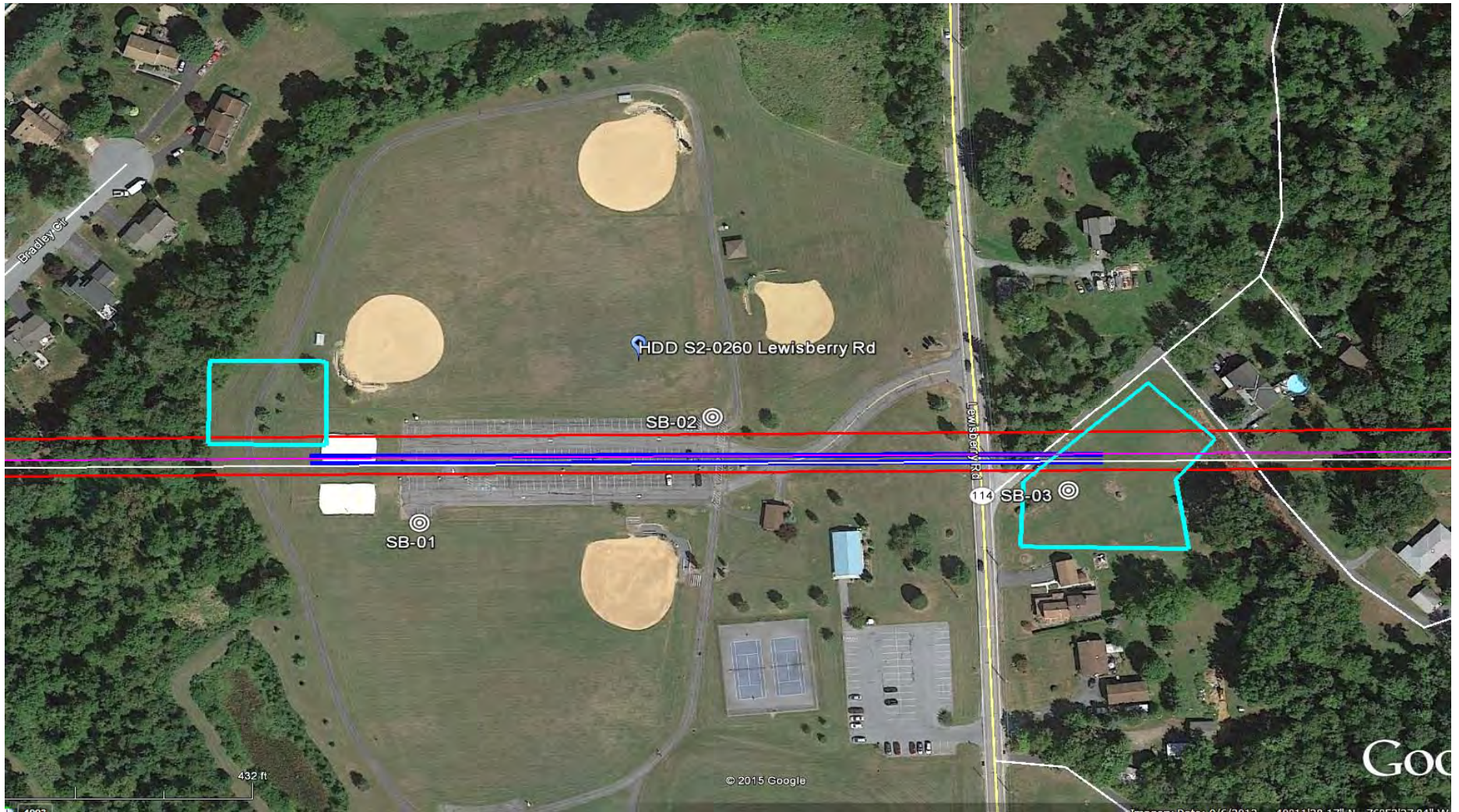
**Sunoco Logistics  
Partners L.P.**

**TETRA TECH ROONEY**  
(303) 792-5911

**SUNOCO PIPELINE, L.P.**

16-INCH HORIZONTAL DIRECTIONAL DRILL  
LEWISBERRY ROAD  
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=100'	DWG. NO: PA-YO-0016.0000-RD-16
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**LEGEND:**

⊙ Geotechnical Soil Boring (SB) Locations



**GEOTECHNICAL BORING LOCATIONS**  
 HDD S2-0260  
 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: ROOF PARK, LEWISBERRY ROAD, NEW CUMBERLAND, PA				Page 1 of 1			
HDD No.: S2-0260		Dates(s) Drilled: 10-27-14		Inspector: E. WATT			
Boring No.: SB-01		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER			
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 14.2		Total Depth (ft): 28.0			

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	0.3			TOPSOIL (4")					
			0.3	3.5			GRAY SILT WITH A LITTLE FINE SAND.					
1	3.0	5.0	3.5			ML	MOTTLED BROWN AND ORANGE BROWN SILT AND FINE SAND (USCS: ML)	2	4	6	7	10
2	8.0	10.0		11.5			MOTTLED BROWN TO GREENISH BROWN SILT AND FINE SAND.	3	10	11	10	21
3	13.0	15.0	11.5			SM	DR WEATHERED TO A VARI-COLORED FINE SAND WITH SOME SILT AND TRACE OF UNWEATHERED FINE SANDSTONE GRAVEL.	3	6	8	16	14
4	18.0	18.6					DR WEATHERED TO A VARI-COLORED F-M SAND WITH SOME SILT AND TRACE OF UNWEATHERED FINE SANDSTONE GRAVEL.	18	50/1"			>50
5	19.7	20.0	19.7	20.0			PARTIALLY WEATHERED SANDSTONE.	50/4"				>50
							AUGER REFUSAL AT 19.7'.					
							<u>ROCK CORING</u>					
RUN 1	20.0	22.0	20.0		24	ROCK	GRAY HIGHLY FRACTURED AND WEATHERED SANDSTONE.	TCR: 100%, SCR: 0%, RQD: 0%				
RUN 2	22.0	25.0			36		GRAY HIGHLY FRACTURED AND WEATHERED SANDSTONE.	TCR: 100%, SCR: 0%, RQD: 0%				
RUN 2	25.0	28.0		28.0	33		GRAY HIGHLY FRACTURED AND WEATHERED SANDSTONE.	TCR: 92%, SCR: 7%, RQD: 0%				
							WATER LEVEL THROUGH AUGERS AT 14.2'.					
							CAVED AT 19.5'.					

Notes/Comments: Pocket Pentrometer Testing DR: DECOMPOSED ROCK  
 S1: 2 TSF  
 S2: 2.5 TSF

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



**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: ROOF PARK, LEWISBERRY ROAD, NEW CUMBERLAND, PA			Page 1 of 1		
HDD No.: S2-0260		Dates(s) Drilled: 10-27 and 11-04-14		Inspector: E. WATT	
Boring No.: SB-02		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING			Groundwater Depth (ft): 14.0		Total Depth (ft): 33.0

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		19	SM	GREENISH BROWN TO GRAYISH BROWN FINE SAND WITH SOME SILT.	3	8	9	12	17
2	8.0	10.0			16		YELLOWISH BROWN TO LIGHT BROWN FINE TO MEDIUM SAND WITH SOME SILT, TRACE FINE GRAVEL.	4	20	39	50	59
3	13.0	13.9			9		YELLOWISH BROWN TO LIGHT BROWN FINE TO MEDIUM SAND WITH SOME SILT, TRACE FINE GRAVEL.	7	50/5"			>50
4	18.0	18.9			10		BROWN TO YELLOWISH BROWN MEDIUM TO COARSE SAND WITH SOME SILT, AND A LITTLE FINE GRAVEL.	3	50/5"			>50
5	20.0	20.8			5		LIGHT BROWN TO YELLOWISH BROWN F-M SAND WITH A LITTLE SILT.	2	50/4"			>50
6	23.0	23.3			3		PARTIALLY WEATHERED SANDSTONE.	50/4"				>50
							AUGER REFUSAL AT 25'.					
							<u>ROCK CORING</u>					
RUN 1	25.0	28.0	25.0		12		GRAY HIGHLY FRACTURED AND DEGRADED SANDSTONE, WITH OXIDATION.	TCR: 33%, SCR: 0%, RQD: 0%				
RUN 2	29.0	33.0		33.0	26		GRAY HIGHLY FRACTURED AND DEGRADED SANDSTONE, WITH OXIDATION.	TCR: 54%, SCR: 0%, RQD: 0%				
							BORING COLLAPSED AFTER REMOVING COE BAREL AFTER RUN 1.					
							AUGERED BACK DOWN TO 29'. EACH CORE RUN TOOK SEVERAL ATTEMPTS BECAUSE SANDSTONE FRAGMENTS KEPT COLLAPSING INTO BOREHOLE.					
							REFUSAL MATERIAL MAY BE A RESULT OF BOULDERY CONDITIONS.					

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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 Newark, Delaware 19713  
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**TEST BORING LOG**

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: ROOF PARK, LEWISBERRY ROAD, NEW CUMBERLAND, PA			Page 1 of 1		
HDD No.: S2-0260		Dates(s) Drilled: 10-26-14		Inspector: E. WATT	
Boring No.: SB-03		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING			Groundwater Depth (ft): 15.5		Total Depth (ft): 18.5

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	0.7			TOPSOIL (7")						
1	3.0	5.0	0.7		21	SM	MOTTLED ORANGE BROWN AND LIGHT BROWN FINE TO MEDIUM SAND AND SILT (USCS: SM).	1	6	5	10	11	
				8.5									
2	8.0	10.0	8.5		24	DR	DR WEATHERED TO A GREENISH BROWN TO GRAYISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILTY CLAY, TRACE F-GRAVEL.	2	12	15	20	27	
3	13.0	13.8			9	SC/SM	DR WEATHERED TO A GREENISH BROWN TO GRAYISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILTY CLAY, TRACE F-GRAVEL.	20	50/3"			>50	
4	18.0	18.2			3	DR	DR WEATHERED TO A LIGHT BROWN TO YELLOWISH BROWN MEDIUM TO COARSE SAND WITH A LITTLE SILTY CLAY.	50/3"				>50	
5	18.5	18.5		18.5	0		NO RETURN.	50/0"					
							AUGER REFUSAL AT 18.5'.						
							REFUSAL MATERIAL MAY BE A RESULT OF EITHER BOULDERY OR CONGLOMERATE SUBSURFACE CONDITIONS.						

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 S2-0260**

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, %	
S2-0260	SB-01	1	3.0	5.0	17.4	53.1	39	37	2	ML
		2	8.0	10.0	32.2	53.8	-	-	-	-
		3	13.0	15.0	22.5	26.2	-	-	-	-
		4	18.0	18.6	6.6	21.4	-	-	-	-
		5	19.7	20.0	9.1	22.8	-	-	-	-
	SB-02	1	3.0	5.0	9.1	27.5	-	-	-	-
		2	8.0	10.0	7.0	24.0	-	-	-	-
		3	13.0	13.9	8.5	26.1	-	-	-	-
		4	18.0	18.9	12.9	22.8	-	-	-	-
		6	23.0	23.3	6.1	14.0				
	SB-03	1	3.0	5.0	15.2	36.8	29	22	7	SM
		2	8.0	10.0	12.2	19.3	-	-	-	-
		3	13.0	13.8	5.3	12.6	-	-	-	-
		4	18.0	18.2	4.4	14.1	-	-	-	-

Notes:

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



**REGIONAL GEOLOGY SUMMARY  
SUNOCO PENNSYLVANIA PIPELINE PROJECT  
HDD S2-0260**

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
S2-0260	Lewisberry Road	SB-01	<b>Quartz Fanglomerate</b> - consists of coarse conglomerate containing rounded cobbles and boulders of quartzite, sandstone, quartz, and some metarhyolite in a matrix of red sand.	Gently sloping to level upland (suburban)	Quartz fanglomerate	Conglomerate-sandstone		31-64	
		SB-02							
		SB-03	<b>Gettysburg conglomerate</b> is a coarse quartz conglomerate containing rounded pebbles and cobbles in a matrix of red sand. <b>Diabase</b> - occurs primarily as dikes and sheets and forms a complex igneous network that extensively intrudes sedimentary rocks in the Gettysburg basin.		Gettysburg Conglomerate with diabase sheets to the east	Quartz conglomerate with sand to occasional diabase dikes and sheets	7,300	15-31	

*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 S2-0260**

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					
S2-260	SB-1	1	20	22	100	0	0							Extremely heavily fractured, ranging from 0° to 90°; no pieces large or intact enough for compression testing
S2-260	SB-1	2	22	25	100	0	0	20	28	Moderately to heavily	Coarse sandstone	Massive	Light gray	
S2-260	SB-1	3	25	28	92	7	0							
S2-260	SB-2	1	25	28	33	0	0	25	28	Moderate	Sandstone	Massive	Red	Poor recovery, fractures ranging from 0° to 45°
S2-260	SB-2	2	29	33	54	0	0	29	33	Heavily	Sandstone	Massive	Gray	Heavily fractured, ranging from 0° to 90°

# 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	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3  Not meeting $C_u$ or $C_c$ requirements for GW		
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines			
		Gravel with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below A Line or $I_p$ less than 4	Limits plotting in hatched zone with $I_p$ between 4 and 7 are borderline cases requiring use of dual symbols	
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above A line with $I_p$ greater than 7		
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Clean sands (Little or no fines)	SW	Well graded sands, 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  Not meeting $C_u$ or $C_c$ requirements for SW		
			SP	Poorly graded sands, gravelly sands, little or no fines			
		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		
		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 <sup>(1)</sup>					
		Major Divisions		Group Symbols	Typical Descriptions	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 $\pm 2$ 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.