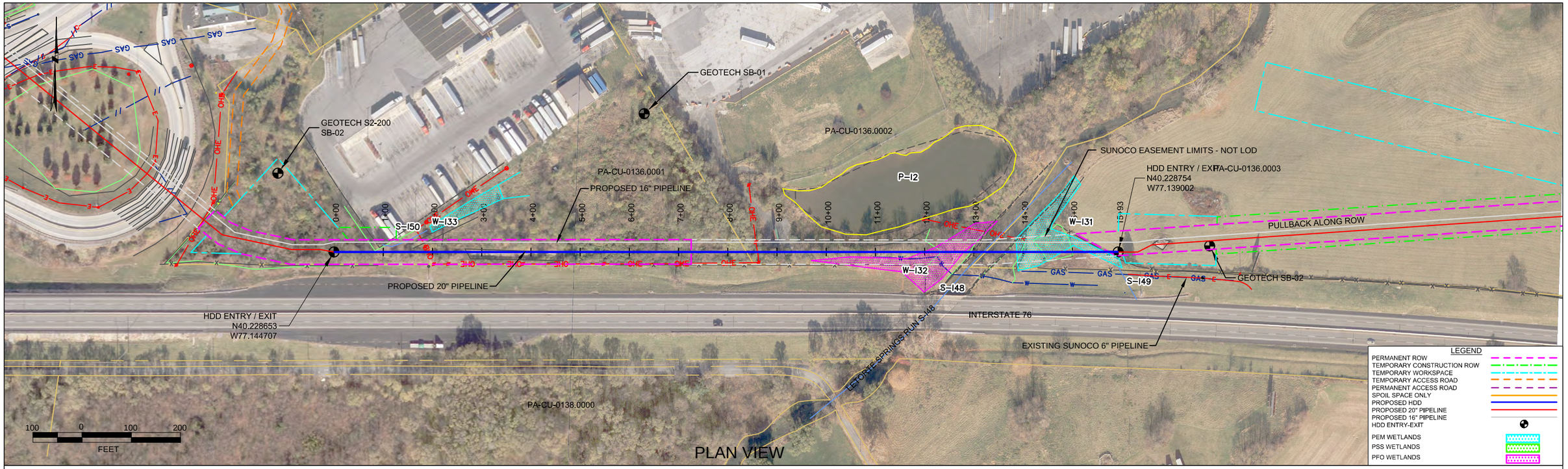
HDD PA-CU-0136.0002-WX (PFO-I32, S-I48, PEM-I31)

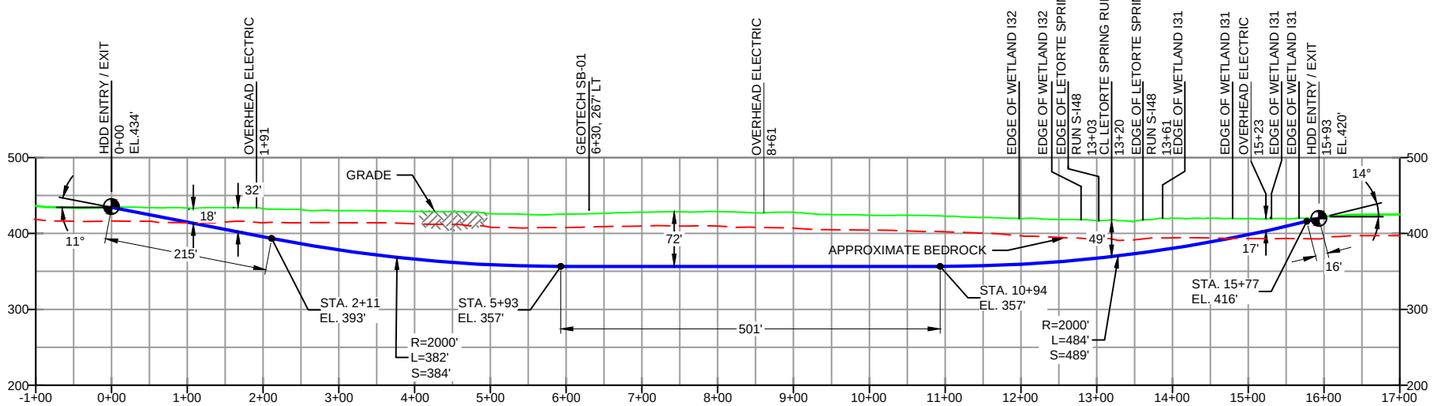
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts,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

The drill will enter/exit 1,200 feet from the western edge of Forested Wetland I32 (PFO-I32) and enter/exit 310 feet from the eastern edge. The drill will enter/exit 1,300 feet from the western bank of Letorte Spring Run (S-I48) and enter/exit 240 feet from the eastern bank. The drill will enter/exit 1,390 feet from the western edge of Grassy Wetland I31 (PEM-I31) and enter/exit 25 feet from the eastern edge. The depth of the drill below PFO-I32 is 60 feet and beneath Letorte Spring Run is about 45 feet. The drill depth changes from 25 feet on the western edge of PEM-I31 to about 5 feet on the eastern edge. 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 rock layers below layers of silts and fine sands. Based on the geotechnical report and the drill profile minimal inadvertent returns are expected.



PLAN VIEW

PROFILE VIEW



GEOTECH SB-01

-NG EL. 431'
-TOPSOIL (<1")
-ML (0.0' - 7.5')
-LIMESTONE (7.5' - 8.8')
-SILT (USCS:MH) (8.8' - 15.0')
-COMPLETION DEPTH EL. 416'

GEOTECH SB-02

-NG EL. 427'
-TOPSOIL (0' - 0.1')
-GROUNDWATER (11.0')
-SILT (USCS:MH) (0.1' - 26.5')
-LIMESTONE (26.5' - 28.4')
-COMPLETION DEPTH EL. 399'

NOTE: REFER TO TEST BORING LOG S2-0200 FOR COMPLETE SOIL MATERIAL DESCRIPTION

CUMBERLAND COUNTY, PENNSYLVANIA - MIDDLESEX TOWNSHIP
S2-0210

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXITING 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=):1593'
   HDD PIPE LENGTH (S=):1605'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH 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

DWG NO		DWG NO	DESCRIPTION
ES-4.57	TO	ES-4.58	EROSION & SEDIMENT PLAN
SHEET 36	TO	SHEET 37	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/10/16	RMB	05/10/16	AAW	05/10/16
EP		JTW	03/23/16	RMB	03/23/16	AAW	03/23/16
C	ADDED GEOTECH INFO	MRS	09/15/15	RMB	09/15/15	AAW	09/15/15
B	ISSUED FOR BID	SAF	07/23/15	RMB	07/23/15	AAW	07/23/15
A	ISSUED FOR REVIEW	JAM	03/25/15	RMB	03/25/15	AAW	03/25/15

Sunoco Logistics Partners L.P.

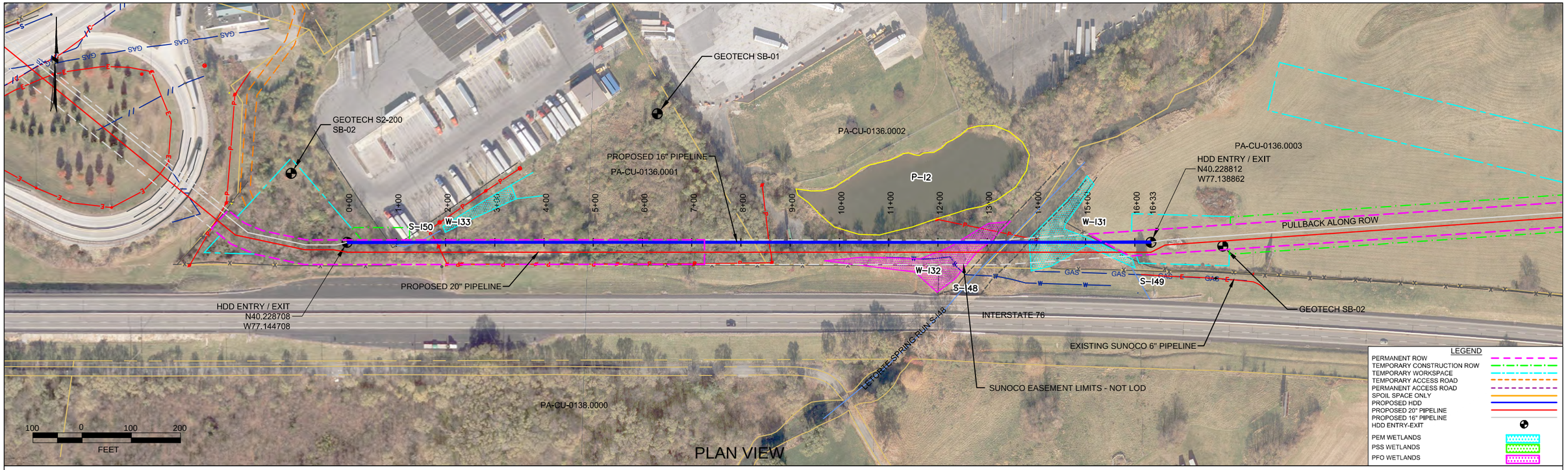
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
LETORTE SPRINGS RUN
PENNSYLVANIA PIPELINE PROJECT

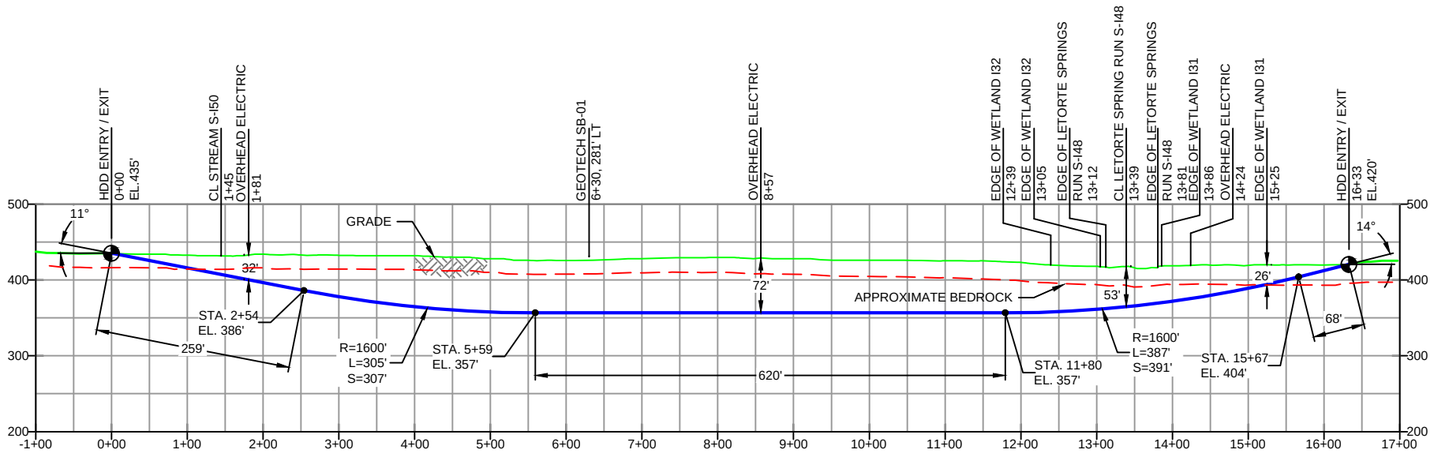
SCALE: 1"=200'

DWG. NO: PA-CU-0136.0002-WX



PLAN VIEW

PROFILE VIEW



CUMBERLAND COUNTY, PENNSYLVANIA - MIDDLESEX TOWNSHIP
S2-0210-16

GEOTECH SB-01

- NG EL. 431'
- -TOPSOIL (<1")
- -ML (0.0' - 7.5')
- -LIMESTONE (7.5' - 8.8')
- -SILT (USCS:MH) (8.8' - 15.0')
- -COMPLETION DEPTH EL. 416'

GEOTECH SB-02

- NG EL. 427'
- -TOPSOIL (0' - 0.1')
- -GROUNDWATER (11.0')
- -SILT (USCS:MH) (0.1' - 26.5')
- -LIMESTONE (26.5' - 28.4')
- -COMPLETION DEPTH EL. 399'

NOTE: REFER TO TEST BORING LOG S2-0200 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXITING 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=):1633'
   HDD PIPE LENGTH (S=):1645'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH 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

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

REF. DRAWING

ES-4.57	TO	ES-4.58	EROSION & SEDIMENT PLAN	
SHEET 36	TO	SHEET 37	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/10/16	RMB	05/10/16	AAW	05/10/16
EP		JTW	03/23/16	RMB	03/23/16	AAW	03/23/16
B	ADDED GEOTECH INFO	MRS	09/15/15	RMB	09/15/15	AAW	09/15/15
A	ISSUED FOR BID	MRS	08/31/15	RMB	08/31/15	AAW	08/31/15

Sunoco Logistics Partners L.P.

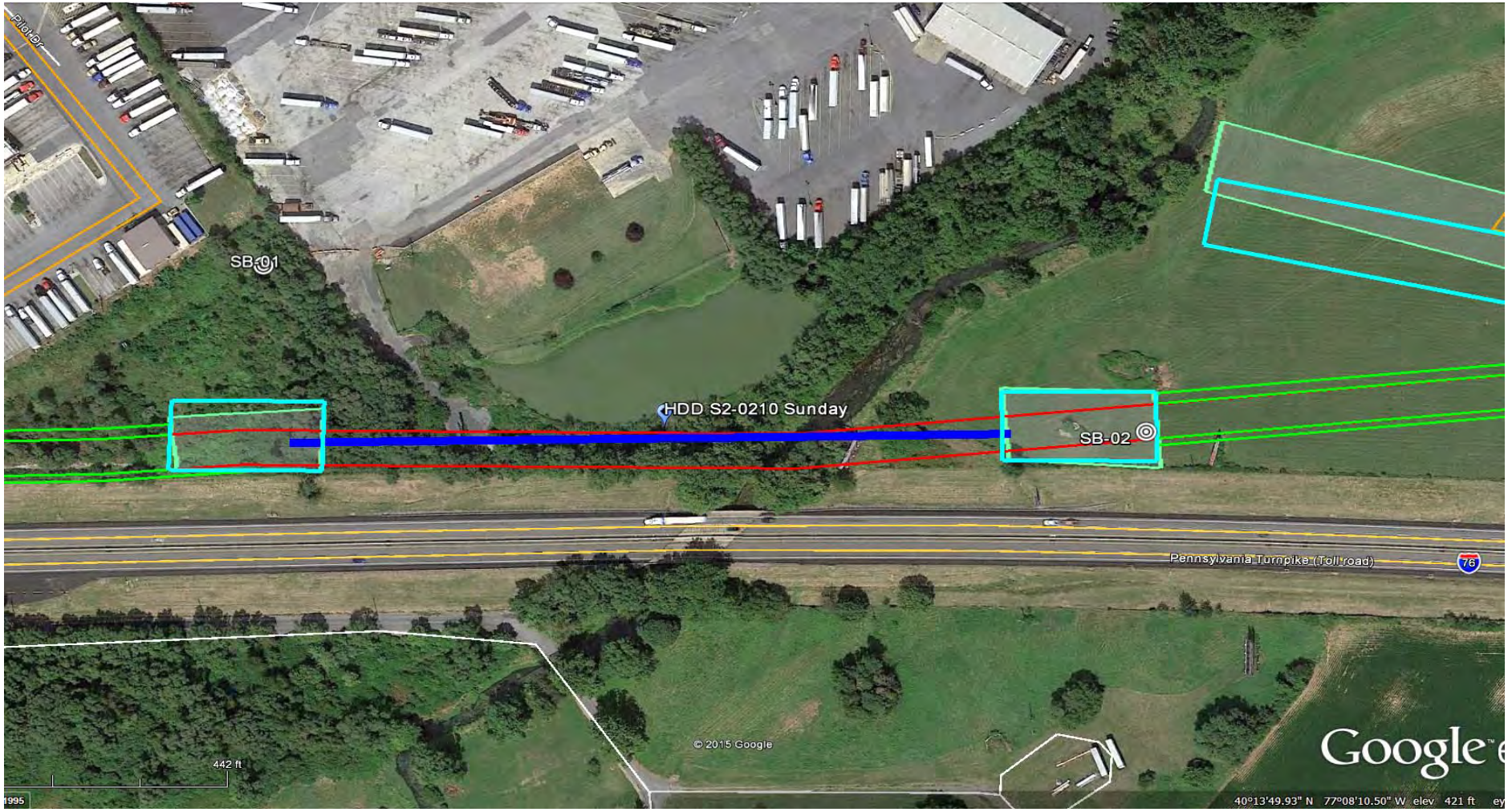
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
LETORTE SPRINGS RUN
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

DWG. NO: PA-CU-0136.0002-WX-16



LEGEND:

◎ Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S2-0210
CUMBERLAND COUNTY, MIDDLESEX 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:	PILOT DRIVE, CARLISLE, PA		Page 1 of 1
HDD No.:	S2-0210	Dates(s) Drilled: 01-25-15	Inspector: E. WATT
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 15.0

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.0			TOPSOIL (<1 ")					
1	3.0	5.0	0.0		15	ML	BROWN TO ORANGE BROWN SILT, TRACE FINE SAND	1	5	4	5	**9**
				7.5			(USCS: ML).					
2	8.0	8.8	7.5	8.8	5		GRAY WEATHERED LIMESTONE?	24	50/3"			**>50**
							AUGER REFUSAL AT 8.5'. OFF-SET BORING 18' NW, AND					
							AUGERED TO BELOW TEST DEPTH.					
3	13.0	15.0			6	MH	GRAY TO LIGHT BROWN SOFT ELASTIC SILT (USCS: MH).	1	1	1	2	**2**
4	15.0	15.0		TRACE			GRAY WEATHERED LIMESTONE?	50/0"				
							AUGER REFUSAL AT 15'. OFF-SET BORING AGAIN AND					
							CONTINUOUSLY AUGERED TO REFUSAL AT 13.8'.					
							REFUSAL MATERIAL MIGHT BE A RESULT OF BOULDERY					
							SUBSURFACE CONDITIONS.					

Notes/Comments:

Pocket Pentrometer Testing
S1: 1.0 TSF
S2: 2.75 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:	S. MIDDLESEX ROAD, NEAR SHOULDER OF I-76 W, CARLISLE, PA		Page 1 of 1
HDD No.:	S2-0210	Dates(s) Drilled: 01-25-15	Inspector: E. WATT
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 11.0	Total Depth (ft): 30.0

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.1			TOPSOIL (1 ")					
1	3.0	5.0	0.1		12		ORANGE BROWN SILT, TRACE TO A LITTLE FINE SAND, WITH A TRACE	2	5	9	8	**14**
							FINE ROCK FRAGMENTS.					
2	8.0	8.8			24		ORANGE BROWN SILT, TRACE FINE SAND, WITH A TRACE	4	3	5	5	**8**
							FINE ROCK FRAGMENTS. (USCS: MH).					
3	13.0	15.0			24	MH	ORANGE BROWN TO YELLOW BROWN ELASTIC SILT, TRACE FINE	1	2	3	10	**5**
							SAND, TRACE FINE ROCK FRAGMENTS (USCS: MH).					
4**	18.0	20.0			2		ORANGE BROWN SILT WITH SOME FINE SAND.	-	-	-	WH	**WH**
5	23.0	25.0			24		VERY SOFT BROWN SILT AND FINE SAND, TRACE LIMESTONE ROCK	1	1	WH	4	**1**
				26.5			FRAGMENTS.					
6	28.0	28.4	26.5	28.4	5		GRAY WEATHERED LIMESTONE MIXED WITH ORANGE BROWN SILT.	50/5"				
							AUGURED TO 30 FEET.					
							**WHEN COLLECTING 18' SAMPLE, RODS SETTLED 18", TO 19.5' BY					
							ROD WEIGHT ALONE. POTENTIAL VOID?					
							GRINDING BETWEEN 15' AND 16'.					
							WATER LEVEL THROUGH AUGERS AT 11'.					
							CAVED AT 10', WATER LEVEL ON CAVE AT 10'.					

Notes/Comments:

Pocket Pentrometer Testing
S1: 2 TSF
S2: 1.75 TSF
S3: 0.75 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.

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0210

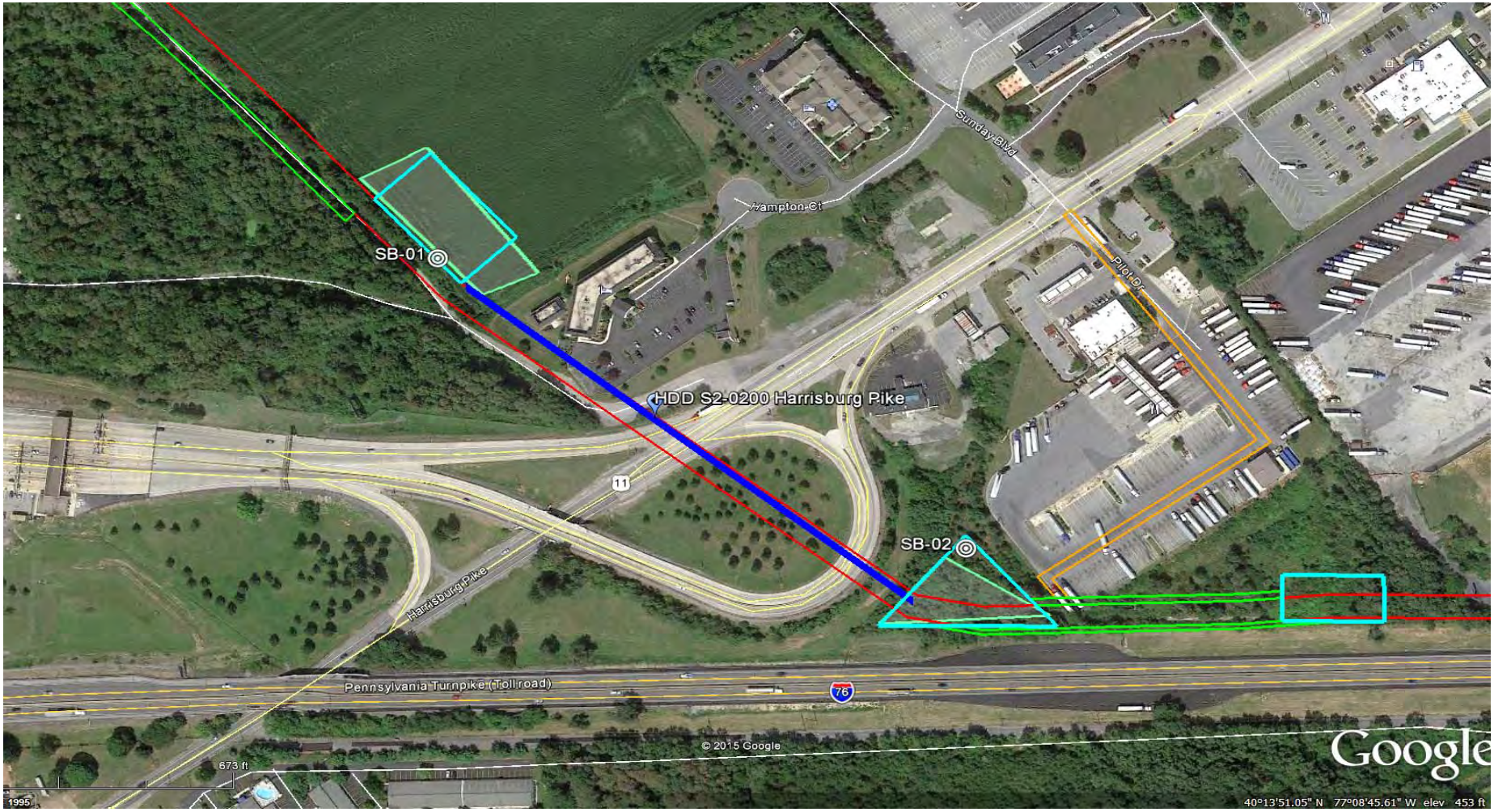
HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.) From	Depth of Sample (ft.) To	Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318) Liquid Limit, %	Atterburg Limits (ASTM D4318) Plastic Limit, %	Atterburg Limits (ASTM D4318) Plasticity Index, %	USCS Classif. (ASTM D2487)
S2-0210	SB-01	1	3.0	5.0	23.5	92.4	35	27	8	ML
		3	13.0	15.0	53.5	87.9	55	34	21	MH
	SB-02	1	3.0	5.0	31.6	89.9	-	-	-	-
		2	8.0	8.8	36.2	97.0	54	36	18	MH
		3	13.0	15.0	31.8	92.9	53	31	22	MH
		4	18.0	20.0	38.9	75.9	-	-	-	-
		5	23.0	25.0	26.3	53.1	-	-	-	-
		6	28.0	28.4	11.2	36.1	-	-	-	-

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0210

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
S2-0210	Sunday	SB-01 SB-02	**St. Paul Group** - consists of buff-colored magnesium limestone and very finely crystalline birdseye limestone at its top and base.	Level terrain	St. Paul Group	Crystalline limestone, chert, and dolomite (St. Paul)	1,500	Highly variable! 2-118, average DTB ~30 ft bgs	Yields: 8-60 gpm Very finely crystalline, "birdseye" limestone at top and base, granular fossiliferous limestone, black chert, and dolomite in middle

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.



LEGEND:

◎ Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S2-0200
CUMBERLAND COUNTY, MIDDLESEX 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:	SUNDAY BOULEVARD, CARLISLE, PA		Page 1 of 1
HDD No.:	S2-0200	Dates(s) Drilled: 01-24-15	Inspector: E. WATT
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 21.5

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.2			TOPSOIL (2 ")					
1	3.0	5.0	0.2			MH	ORANGE BROWN ELASTIC SILT, TRACE FINE SAND.	1	3	7	10	**10**
2	8.0	10.0					ORANGE BROWN ELASTIC SILT, TRACE FINE SAND.	9	4	6	9	**10**
							(USCS: MH).					
3	13.0	15.0					BROWN TO ORANGE BROWN ELASTIC SILT, TRACE FINE SAND.	1	1	2	4	**3**
							(USCS: MH).					
4	18.0	20.0					BROWN TO ORANGE BROWN SILT WITH SOME FINE SAND, PIECES	1	1	1	1	**2**
				21.5			OF GRAVEL IN SPOON SHOE.					
5	21.5	21.5	21.5	21.5			DARK GRAY LIMESTONE	50/.2"				**0**
							AUGER REFUSAL AT 21.5'. OFF-SET BORING AND CONTINUOULSY					
							AUGERED TO REFUSAL AT 19.0'.					
							REFUSAL MATERIAL MIGHT BE A RESULT OF BOULDERY					
							SUBSURFACE CONDITIONS.					

Notes/Comments:

Pocket Pentrometer Testing

S1: > 4 TSF
S2: > 4 TSF
S3: 0.75 TSF

DR: DECOMPOSED ROCK

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

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

TETRA TECH
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Newark, Delaware 19713
302.738.7551
fax: 302.454.5988

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	PILOT DRIVE, CARLISLE, PA		Page 1 of 1
HDD No.:	S2-0200	Dates(s) Drilled: 01-24-15	Inspector: E. WATT
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): SEE BELOW	Total Depth (ft): 18.0

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.2			TOPSOIL (2 ")					
1	3.0	5.0	0.2			FILL	FILL MATERIAL - MIXTURE OF LINESTONE GRAVEL WITH BROWN AND	28	20	8	9	**28**
				4.6			GRAY SILT, CLAY, SAND.					
2	8.0	10.0	4.6	10.0		MH	ORANGE BROWN ELASTIC SILT, TRACE FINE SAND. (USCS: MH).	20	8	5	3	**13**
							AUGER REFUSAL AT 10'. OFF-SET BORING 18' SOUTH, AND AUGERED					
							TO BELOW SAMPLE DEPTH.					
3	13.0	15.0	13.0			MH	ORANGE BROWN SILT, TRACE FINE SAND.	5	5	13	13	**18**
				16.0								
4	17.5	18.0	16.0	18.0			LIGHT GRAY LIMESTONE GRAVEL AND FINE TO COARSE SAND.	50/6"				**0**
							AUGER REFUSAL AT 17.5'. OFF-SET BORING AGAIN AND					
							CONTINUOUSLY AUGERED TO REFUSAL AT 15.8'.					
							REFUSAL MATERIAL MIGHT BE A RESULT OF BOULDERY					
							SUBSURFACE CONDITIONS.					
							WET ON SPOON AT 13', NO WATER LEVEL WAS OBSERVED					
							WITHIN AUGERS (MAY HAVE BEEN PERCHED WATER CAUSING					
							WET ON SPOON).					

Notes/Comments:

Pocket Pentrometer Testing
S2: 0.75 TSF
S3: 1.5 TSF

DR: DECOMPOSED ROCK

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

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

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0200

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.) From	Depth of Sample (ft.) To	Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318) Liquid Limit, %	Atterburg Limits (ASTM D4318) Plastic Limit, %	Atterburg Limits (ASTM D4318) Plasticity Index, %	USCS Classif. (ASTM D2487)
S2-0200	SB-01	1	3.0	5.0	27.1	99.1	-	-	-	-
		2	8.0	10.0	28.4	98.6	56	33	23	MH
		3	13.0	15.0	33.8	91.8	51	31	20	MH
		4	18.0	20.0	27.9	74.7	-	-	-	-
	SB-02	2	8.0	10.0	38.9	96.2	58	38	20	MH
		3	13.0	15.0	37.4	96.5	-	-	-	-
		4	17.5	18.0	13.0	45.5	-	-	-	-

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0200

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
S2-0200	Harrisburg Pike	SB-01	**Martinsburg/Chambersburg Fms** - Martinsburg is a buff-weathering, dark-gray to purple shale and slate with thin interbeds of siltstone, metabentonite, and fine-grained sandstone. The Chambersburg Formation consists of dark-gray limestone at the top, gray argillaceous limestone in the middle.	Level terrain	Martinsburg - Chambersburg Fms	Shale and slate with interbedded siltstone (Martinsburg) to argillaceous limestone		9-36	Drilling locations at/near the contact between these two formations. One outlier boring identified DTB at 80 ft bgs
		SB-02	**St. Paul Group** - consists of buff-colored magnesium limestone and very finely crystalline birdseye limestone at its top and base.		St. Paul Group	Crystalline limestone, chert, and dolomite (St. Paul)	1,500		Very finely crystalline, "birdseye" limestone at top and base, granular fossiliferous limestone, black chert, and dolomite in middle

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.

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

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

Relative Proportions

Description Term	*Percent*
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

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)	

COHESIVE SOILS

(Silt, Clay & Combinations)

Consistency	***N (blows)****
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

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

ROCK

(Rock Cores)

Rock Quality Designation (RQD), %	***Rock Quality Description***
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).

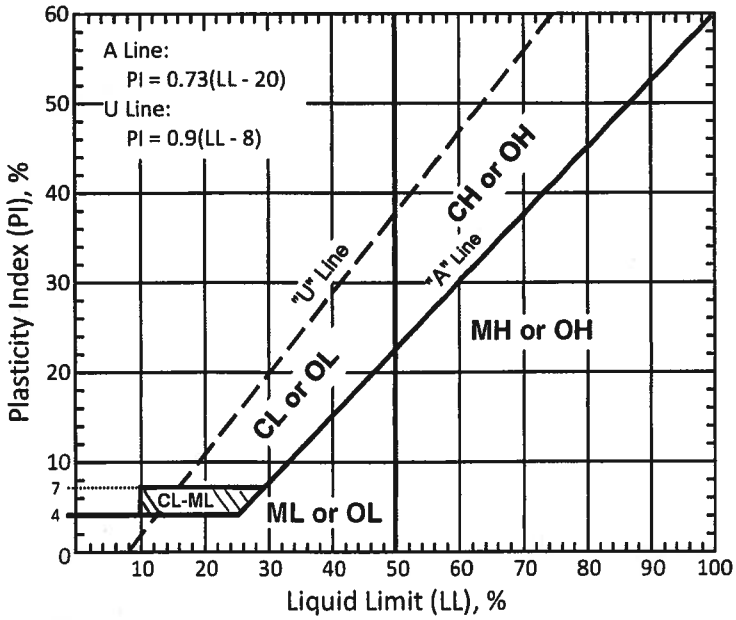
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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	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		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, gravely 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	

Major Divisions		Group Symbols	Typical Descriptions
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	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 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

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.



(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.