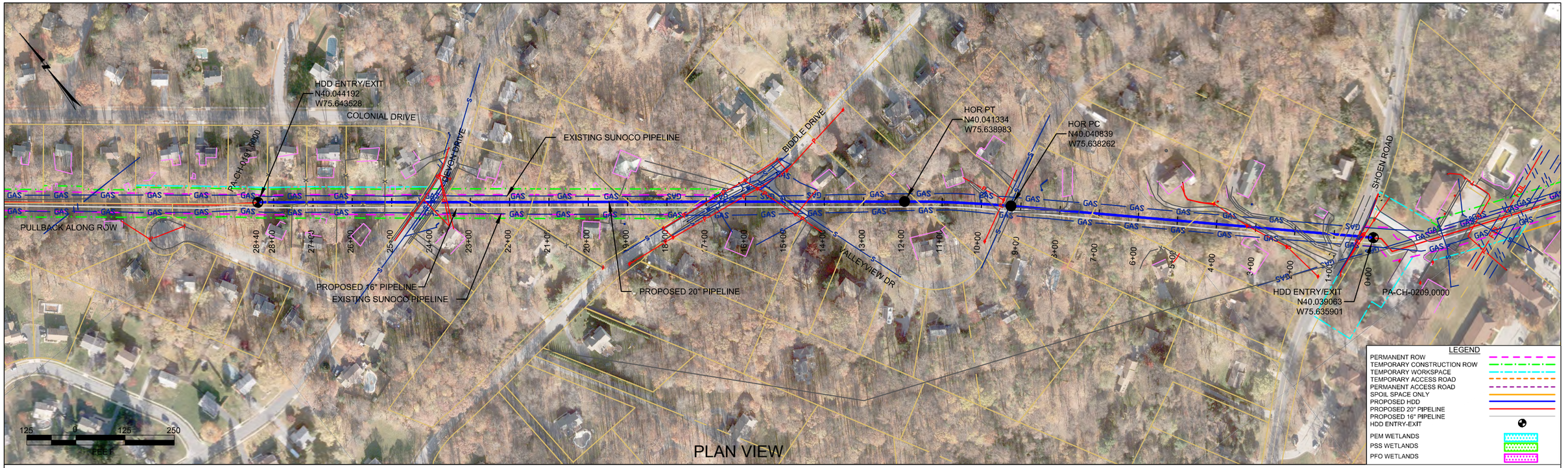
HDD PA-CH-0199.0000-RD (Devon Drive, Biddle Drive, and Shoen Road)

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 437 feet northwest of Devon Drive. The drill will pass 76 feet under this street. Using the results of the geotechnical investigation, as well as several other data points, the entry/exit, angles, and depths have been configured to pass through the best substrates while maintaining pipe integrity (e.g., no large bends). The majority of the substrate that will be passed through is estimated to be silty sand.

The drill will enter/exit 1166 feet northwest of Biddle Drive. The drill will pass 150 feet under this street. Using the results of the geotechnical investigation, as well as several other data points, the entry/exit, angles, and depths have been configured to pass through the best substrates while maintaining pipe integrity (e.g., no large bends). The majority of the substrate that will be passed through is estimated to be fine silt and sand.

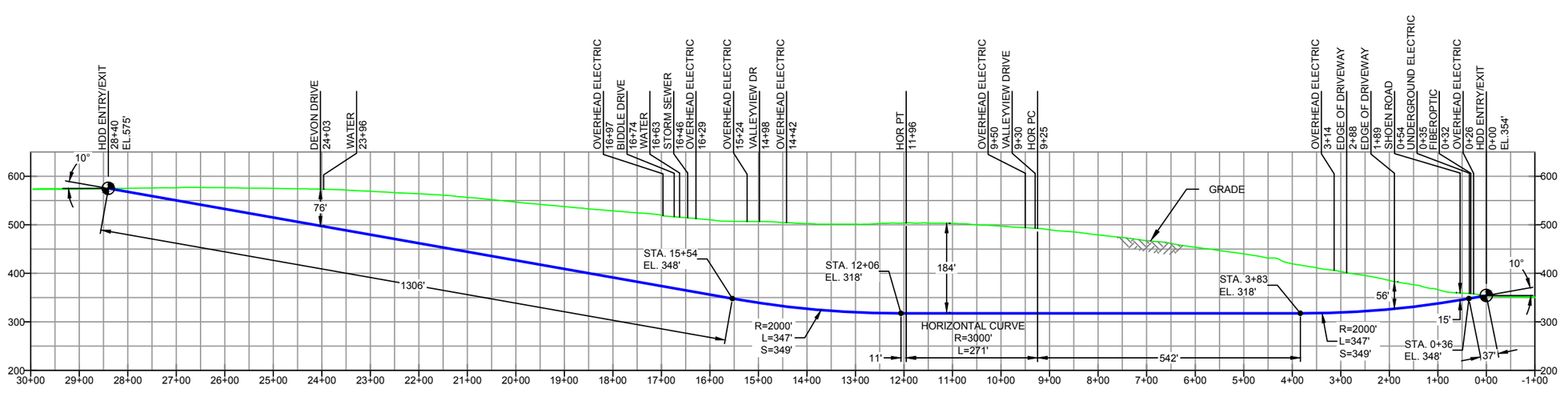
The drill will enter/exit 54 feet southeast of Shoen Road. The drill will pass 15 feet under this street. Using the results of the geotechnical investigation, as well as several other data points, the entry/exit, angles, and depths have been configured to pass through the best substrates while maintaining pipe integrity (e.g., no large bends). The majority of the substrate that will be passed through is estimated to be fine silt, sand and silty sand.



PLAN VIEW

PROFILE VIEW

CHESTER COUNTY, PENNSYLVANIA- UWCHLAN TOWNSHIP
S3-0360



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=):2840'
   HDD PIPE LENGTH (S=):2857'
   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

ES-6.42	TO	ES-6.44	EROSION & SEDIMENT PLAN	
SHEET 25	TO	SHEET 26	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	NO.

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP1	REVISED PER PADEP COMMENTS	MRS	05/11/16	RMB	05/11/16	AAW	05/11/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
C	ISSUED FOR BID	DLM	08/21/15	RMB	08/21/15	AAW	08/21/15
B	ISSUED FOR BID	DLM	07/31/15	RMB	07/31/15	AAW	07/31/15
A	ISSUED FOR REVIEW	JAM	03/26/15	RMB	03/26/15	AAW	03/26/15

Sunoco Logistics Partners L.P.

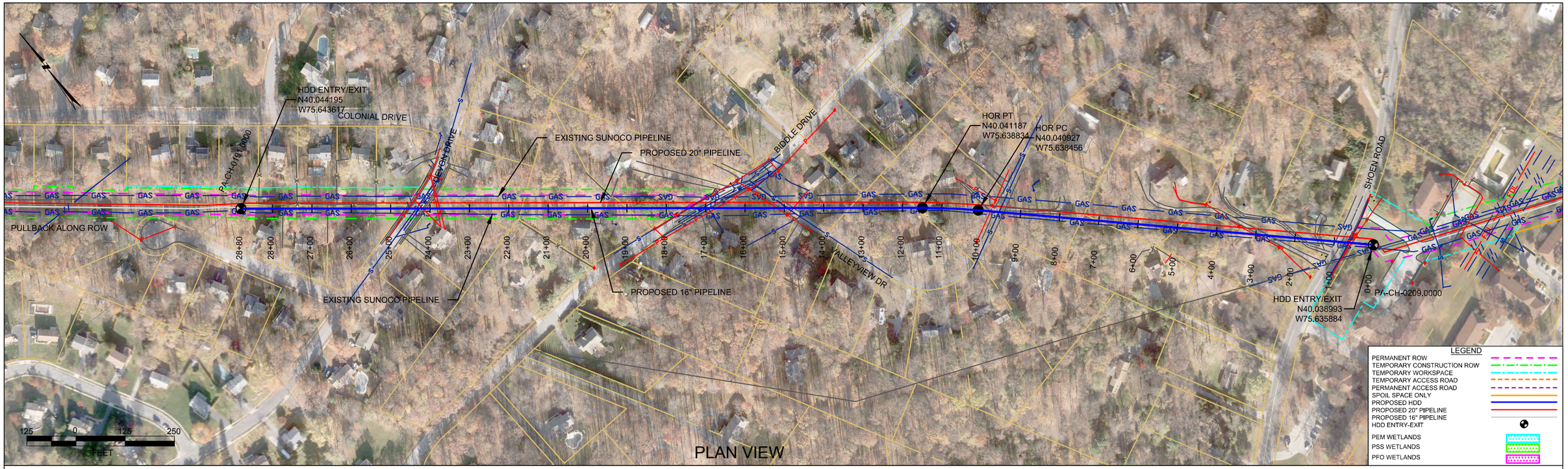
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
BIDDLE DRIVE
PENNSYLVANIA PIPELINE PROJECT

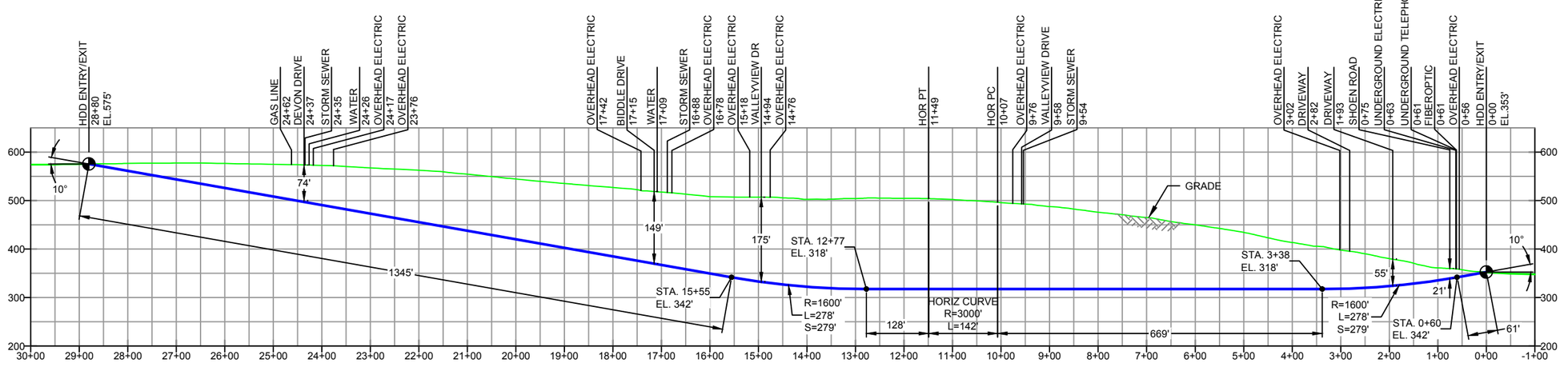
SCALE: 1"=250'

DWG. NO: PA-CH-0199.0000-RD



PLAN VIEW

PROFILE VIEW



CHESTER COUNTY, PENNSYLVANIA- UWCHLAN TOWNSHIP
S3-0360-16

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=):2880'
   HDD PIPE LENGTH (S=):2903'
   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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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.
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5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

ES-6.42	TO	ES-6.44	EROSION & SEDIMENT PLAN	
SHEET 25	TO	SHEET 26	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	NO.

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP1	REVISED PER PADEP COMMENTS	MRS	05/11/16	RMB	05/11/16	AAW	05/11/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
A	ISSUED FOR BID	MRS	08/31/15	RMB	08/31/15	AAW	08/31/15

Sunoco Logistics Partners L.P.

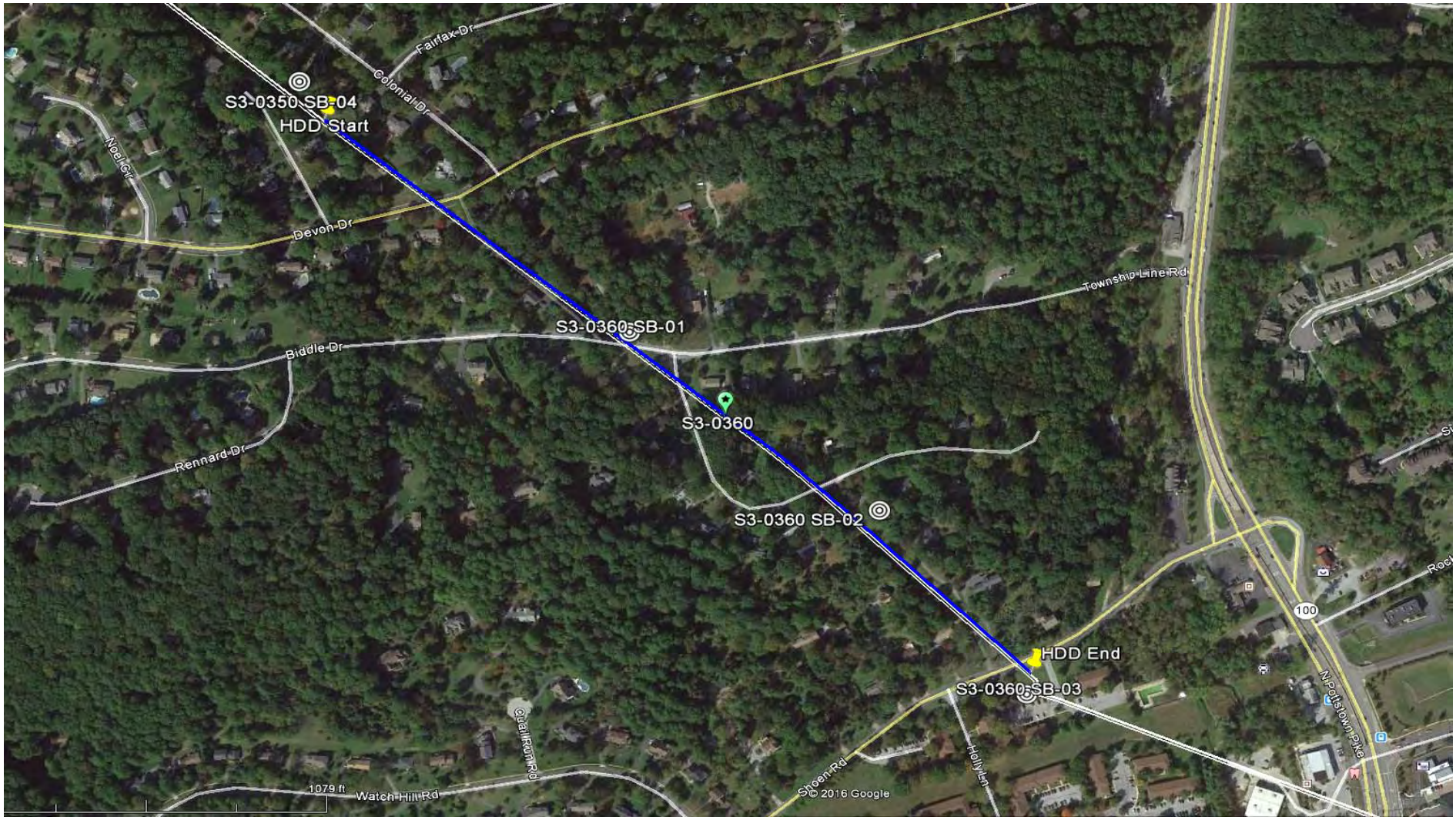
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
BIDDLE DRIVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'

DWG. NO: PA-CH-0199.0000-RD-16



LEGEND:

◎ Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0360
CHESTER COUNTY, UWCHLAN/WEST WHITELAND TWP, 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:	317 COLONIAL DRIVE, EXTON, PA		Page 1 of 1
HDD No.:	S3-0350	Dates(s) Drilled: 01-22-16	Inspector: E. WATT
Boring No.:	SB-04	Drilling Method: SPT - ASTM D1586	Driller: E. OGDEN
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 30.0	Total Depth (ft): 63.8
Boring Location Coordinates:		40° 2' 40.30" N	75° 38' 37.54" W

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.3			TOPSOIL (4")					
1	3.0	5.0	0.3			14	DR, LIGHT BROWN TO ORANGE BROWN FINE SAND WITH A LITTLE	1	3	5	7	**8**
							SILT.					
2	8.0	10.0				19	DR, VARIABLE BROWN, TAN, ORANGE BROWN, REDDISH BROWN	1	5	9	12	**14**
					SM		F-SAND WITH SOME SILT, TRACE F-QUARTZ GRAVEL. (USCS: SM)					
3	13.0	15.0				21	SAME	2	9	12	19	**21**
				16.5								
4	18.0	19.8	16.5			18	DR, VARIABLE BROWN, TAN, ORANGE BROWN, REDDISH BROWN	5	20	37	50/4"	**57**
							FINE SAND WITH SOME SILT, W/A LITTLE F-C QUARTZ GRAVEL.					
5	23.0	24.1				12	DR, LIGHT GRAY, ORANGE AND REDDISH BROWN FINE SAND, SOME	28	50	50/1"		**>50**
							SOME SILT, WITH A LITTLE F-C QUARTZ GRAVEL.					
6	28.0	30.0				20	SAME (USCS: SM)	5	25	36	46	**61**
7	33.0	33.8				7	SAME	18	50/3"			**>50**
8	38.0	38.3				4	DR, GRAY FINE TO MEDIUM SAND, SOME SILT, WITH A LITTLE	50/4"				**>50**
					SM		F-C QUARTZ GRAVEL.					
9	43.0	43.7				5	SAME	20	50/2"			**>50**
10	48.0	48.1				1	DR, GRAY FINE SAND AND SILT, WITH A LITTLE F-C QUARTZ GRAVEL.	50/1"				**>50**
							(USCS: SM)					
11	53.0	53.9				4	DR, GRAY FINE SAND AND SILT, WITH A LITTLE F-C QUARTZ GRAVEL.	16	50/5"			**>50**
12	58.0	58.8				7	DR, TAN AND ORANGE BROWN FINE SAND AND SILT, WITH A LITTLE	8	50/3"			**>50**
							F-C QUARTZ GRAVEL.					
13	63.0	63.8		63.8		6	SAME	10	50/3"			**>50**
							SLOW HARD AUGERING AFTER 45'.					
							WATER LEVEL THROUGH AUGERS AT 30'					
							CAVED AT 63', WATER LEVEL ON CAVE AT 30'.					

Notes/Comments:

Pocket Pentrometer Testing

DR: DECOMPOSED ROCK

HAD TO STOP DRILLING AT 63' INTERVAL BECAUSE GOT TOO DARK TO WORK SAFELY, AND NEEDED TO DEMOB. DUE TO COMING SNOW BLIZZARD.

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:	331 BIDDLE DRIVE, EXTON, PA		Page 1 of 1
HDD No.:	S3-0360	Dates(s) Drilled: 06-17-15	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): 30.0
Boring Location Coordinates:		40° 2' 32.202" N	75° 38' 25.037" W

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		12		ORANGE BROWN SILT AND FINE SAND, TRACE FINE GRAVEL.	5	8	11	11	**19**
2	8.0	10.0			16		ORANGE BROWN SILT AND FINE SAND, TRACE FINE GRAVEL.	1	5	5	6	**10**
						ML						
3	13.0	15.0			22		ORANGE BROWN SILT AND FINE SAND, TRACE FINE QUARTZ	4	6	5	4	**11**
							GRAVEL (USCS: ML).					
4	18.0	20.0			18		LIGHT BROWN AND ORANGE BROWN MICACEOUS SILT AND FINE	3	4	5	5	**9**
				23.0			SAND, TRACE FINE QUARTZ GRAVEL.					
5	23.0	25.0	23.0		24		LIGHT BROWN AND BROWN MICACEOUS SILT AND FINE SAND.	3	6	12	14	**18**
						ML	(HIGHLY WEATHERED QUARTZITE?)					
6	28.0	30.0			21		LIGHT BROWN AND BROWN MICACEOUS SILT WITH SOME FINE	3	26	40	40	**66**
				30.0			SAND. (USCS: ML). (HIGHLY WEATHERED QUARTZITE?)					
							AUGER GRINDING AT 23'.					
							CAVED AND DRY AT 28'.					

Notes/Comments:

Pocket Pentrometer Testing
S1: > 4 TSF
S2: > 4 TSF

DR: DECOMPOSED ROCK

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

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

TETRA TECH
240 Continental Drive, Suite 200
Newark, Delaware 19713
302.738.7551
fax: 302.454.5988

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	156 VALLEYVIEW, EXTON, PA		Page 1 of 1
HDD No.:	S3-0360	Dates(s) Drilled: 06-13-15	Inspector: J. COSTELLO
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: GREGG
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 41.0
Boring Location Coordinates:		40° 2' 26.296" N	75° 38' 15.356" W

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		10	SM	BROWN TO PURPLISH BROWN FINE TO MEDIUM SAND AND SILT	1	1	3	4	**4**
				6.5			TRACE FINE GRAVEL (QUARTZ).					
2	8.0	10.0	6.5		18	SM	DR SHIST WEATHERED TO A TAN AND WHITE FINE TO MEDIUM SAND	3	25	29	30	**54**
				11.5			WITH SOME SILT, A LITTLE FINE GRAVEL.					
3	13.0	14.0	11.5		11	ML	DR WEATHERED TO A BROWN SILT WITH SOME FINE SAND,	10	50/6"			**>50**
							POTENTIAL WEATHERED SCHIST. (USCS: ML).					
4	18.0	20.0					RIG HAMMER BROKE - CUTTINGS: DR SCHIST WEATHERED TO A	-	-	-	-	**-**
							BROWN SILT AND FINE SAND.					
5	21.0	21.8			9		YELLOWISH BROWN SILT AND FINE TO MEDIUM SAND (DR), TRACE	14	50/4"			**>50**
				22.0			FINE GRAVEL.					
6	26.0	26.7	22.0		8	SM	DR SHIST WEATHERED TO A YELLOWISH BROWN FINE TO MEDIUM	4	50/3"			**>50**
				30.0			SAND AND SILT, WITH A LITTLE F-C ROCK FRAGMENTS. (USCS: SM).					
7	31.0	31.6	30.0	34.0	6		PARTIALLY WEATHERED QUARTZITE.	20	50/1"			**>50**
							AUGER REFUSAL AT 34'.					
							ROCK CORING					
RUN 1	34.0	37.0	34.0		24.5	ROCK	WHITE TO LIGHT BROWN QUARTZITE, WITH IRON STAINING.	TCR: 68%, SCR: 54%, RQD: 47%				
							MODERATELY TO INTENSELY FRACTURED.					
RUN2	37.0	41.0			40		WHITE TO LIGHT BROWN QUARTZITE, WITH IRON STAINING.	TCR: 83%, SCR: 68%, RQD: 56%				
				41.0			MODERATELY TO INTENSELY FRACTURED.					
							CORE TESTING RESULTS (RUN 1, DEPTH 35 TO 36'):					
							COMPRESSIVE STRENGTH: 3,130 PSI					
							UNIT WEIGHT: 149.0 PCF					
							CAVED AND DRY AT 31'.					

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
302.738.7551
fax: 302.454.5988

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	SHOEN ROAD, EXTON, PA		Page 1 of 1
HDD No.:	S3-0360	Dates(s) Drilled: 06-14-15	Inspector: J. COSTELLO
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: GREGG
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 28.0	Total Depth (ft): 30.0
Boring Location Coordinates:		40° 2' 19.944" N	75° 38' 9.409" W

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.3			TOPSOIL (4")					
1	3.0	5.0	0.3		22	ML	YELLOWISH BROWN SILT WITH A LITTLE FINE SAND, TRACE FINE	1	6	7	9	**13**
				6.5			GRAVEL (USCS: ML).					
2	8.0	10.0	6.5		14	SM	DR WEATHERED TO A GRAY FINE TO COARSE SAND WITH SOME SILT,	1	8	10	15	**18**
							WITH A LITTLE FINE TO COARSE GRAVEL.					
3	13.0	15.0			16		DR WEATHERED TO A BROWNISH GRAY TO BROWN, FINE TO MEDIUM	2	4	4	8	**8**
							SAND WITH SOME SILT, TRACE UNWEATHERED FINE GRAVEL.					
4	18.0	20.0			14		YELLOWISH BROWN FINE TO COARSE SAND WITH SOME SILT, WITH	3	4	13	13	**17**
							A LITTLE UNWEATHERED FINE GRAVEL. (DR)					
5	23.0	25.0			25		DR WEATHERED TO A YELLOWISH BROWN TO REDDISH BROWN, FINE	1	4	8	9	**12**
							TO MEDIUM SAND, SOME SILT, WITH A LITTLE F-C GRAVEL.					
6	28.0	30.0			14		DR WEATHERED TO A YELLOWISH BROWN TO REDDISH BROWN, FINE	2	11	22	20	**33**
				30.0			TO MEDIUM SAND, SOME SILT, WITH A LITTLE F-C GRAVEL.					

Notes/Comments:

Pocket Pentrometer Testing
S1: 3.25 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.

ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0360

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					
S3-360	SB-2	1	34	37	68	54	47	34	41	Slight	Quartzite	Massive	White to very light brown	Microfoliations, but no bedding; Fractures ranging from 30° to 70°, Avg 54°
		2	37	41	83	68	56							

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0360

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)
S3-0350	SB-04	2	8.0	10.0	4.9	38.0	NV	NP	NP	SM
		4	18.0	19.8	5.5	33.6	-	-	-	-
		6	28.0	30.0	11.5	38.9	NV	NP	NP	SM
		9	43.0	43.7	11.2	39.3	-	-	-	-
		10	48.0	48.1	16.2	47.9	30	20	6	SM
		12	58.0	58.8	18.1	40.1	-	-	-	-
		13	63.0	63.8	16.3	47.3	-	-	-	-
S3-0360	SB-01	2	8.0	10.0	17.1	62.9	-	-	-	-
		3	13.0	15.0	16.2	53.0	NV	NP	NP	ML
		4	18.0	20.0	13.7	54.5	-	-	-	-
		5	23.0	25.0	10.1	69.4	-	-	-	-
		6	28.0	30.0	10.4	79.9	31	25	6	ML
	SB-02	2	8.0	10.0	5.3	42.9	-	-	-	-
		3	13.0	14.0	9.3	70.9	35	27	8	ML
		5	21.0	21.8	10.1	61.1	-	-	-	-
		6	26.0	26.7	6.4	30.6	NL	NP	NP	SM
		7	31.0	31.6	3.9	19.5	-	-	-	-
	SB-03	1	3.0	5.0	22.6	81.1	36	27	9	ML
		2	8.0	10.0	12.2	33.3	-	-	-	-
		3	13.0	15.0	16.5	35.8	-	-	-	-
		4	18.0	20.0	11.3	26.1	-	-	-	-
		5	23.0	25.0	16.3	29.3	-	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-02	1	35.0-36.0	3,130	149.0

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0360

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
S3-350		SB-04	Chickies Formation - Light-gray, hard, massive, Scolithus-bearing quartzite and quartz schist; thin, interbedded dark slate at top; conglomerate (Hellam Member) at base.	Generally level, slight slope to the NE	Chickies Formation (Cambrian)	Quartzite, schist, slate, conglomerate	600	Ranges from 35 to 70 ft bgs, Avg. 55 ft bgs (.5 mile radius)	
S3-360		SB-01		Gentle slope to the SW				Ranges from 20 to 78 ft bgs, Avg. 51 ft bgs (.5 mile radius)	
		SB-02		Gentle to moderate slope to the SW				Ranges from 35 to 70 ft bgs, only two wells found within .25 miles	
		SB-03		Generally level, slight slope to the south				Ranges from 20 to 78 ft bgs, Avg. 51 ft bgs (.25 mile radius)	

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).

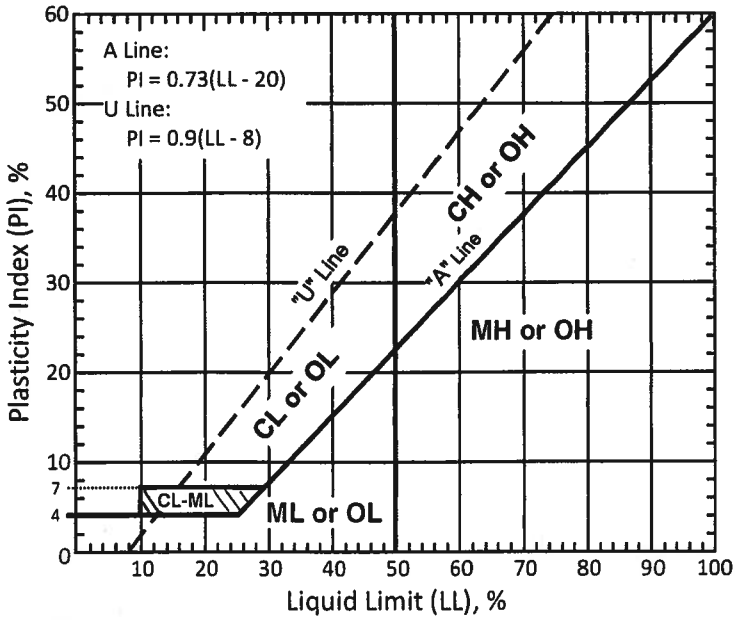
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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.