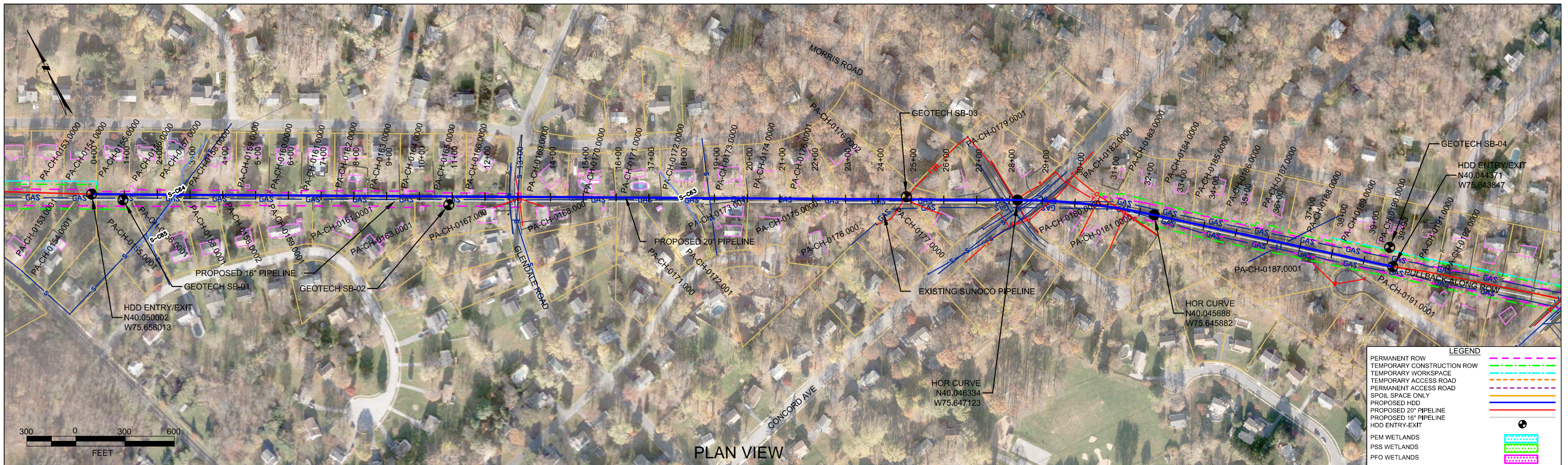


HDD PA-CH-0167.0000-RD (S-C64, and S-C63)

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.

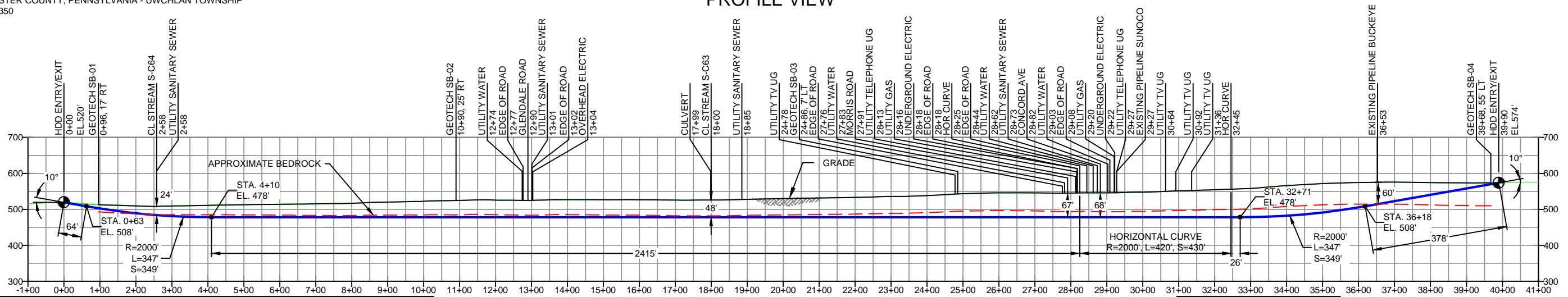
The drill will enter/exit 258 feet northwest of stream C64. The drill will pass 24 feet under this stream. Using the results of the geotechnical investigation, as well as several other data points, the entry/exit, angles, and depths have been configured to pass through the best substrates while maintaining pipe integrity (e.g., no large bends). The majority of the substrate that will be passed through is estimated to be clay, and silty clay.

The drill will enter/exit 1800 feet northwest of stream C63. The drill will pass 48 feet under this stream. 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, and gneiss.

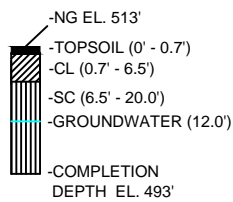


CHESTER COUNTY, PENNSYLVANIA - UWCHLAN TOWNSHIP
S3-0350

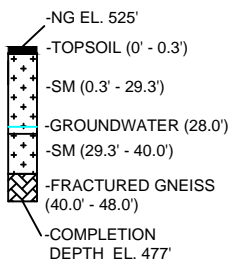
PROFILE VIEW



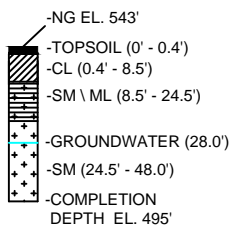
GEOTECH SB-01



GEOTECH SB-02



GEOTECH SB-03

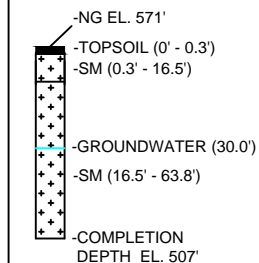


DESIGN AND CONSTRUCTION:

- 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=): 3990'
HDD PIPE LENGTH (S=): 4001'
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.

GEOTECH SB-04



NOTE: REFER TO TEST BORING LOG S3-0350 FOR COMPLETE SOIL MATERIAL DESCRIPTION

- 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	
ES-6.40	TO ES-6.42 EROSION & SEDIMENT PLAN
SHEET 23	TO SHEET 25 AERIAL SITE PLAN

REVISIONS	
EP1	REVISED PER PADEP COMMENTS
EP	
0	ISSUED FOR CONSTRUCTION

BY	DATE	CHK	DATE	APP	DATE
MRS	05/11/16	RMB	05/11/16	AAW	05/11/16
MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
MRS	02/19/16	RMB	02/19/16	AAW	02/19/16

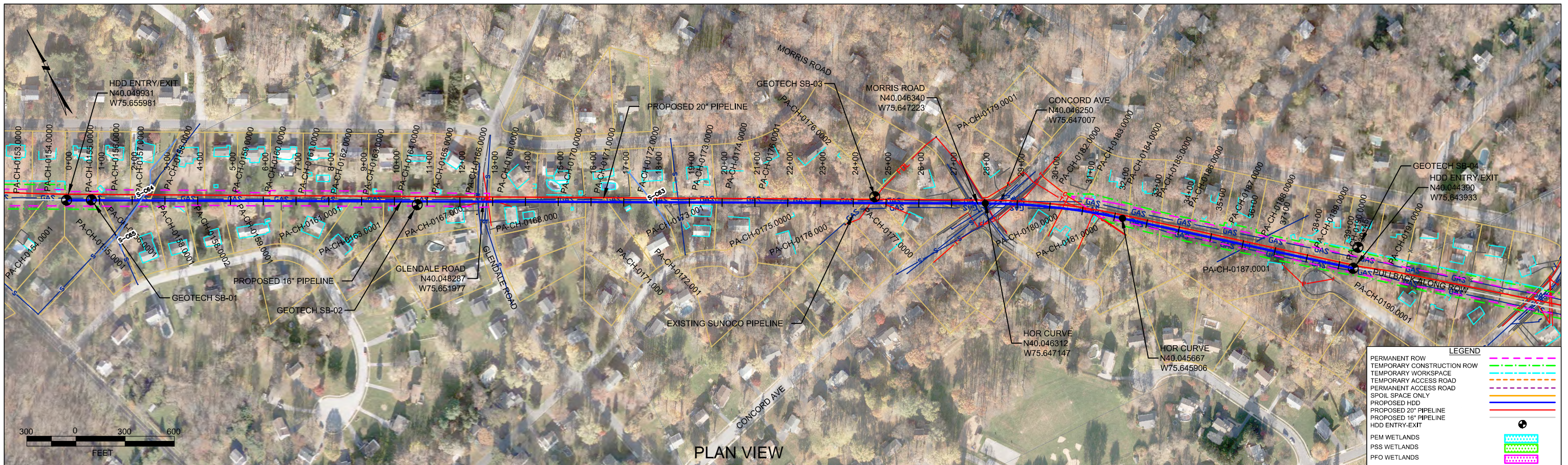
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

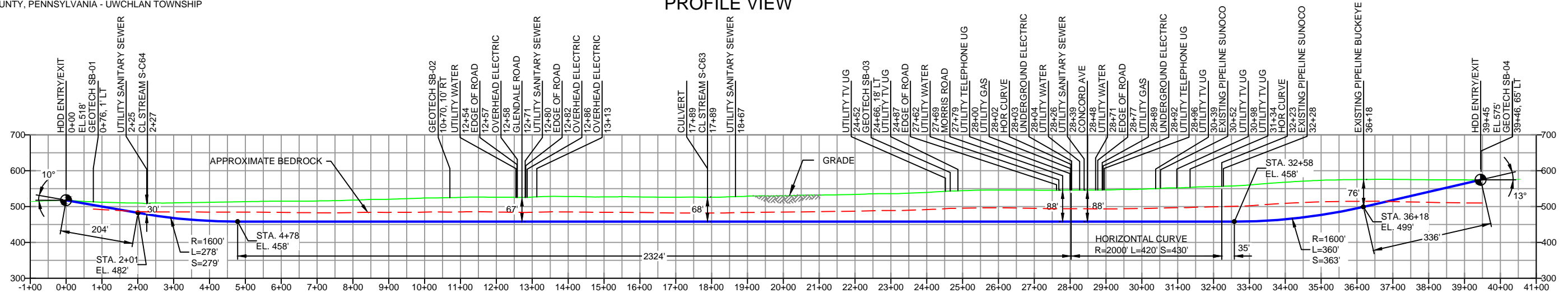
20-INCH HORIZONTAL DIRECTIONAL DRILL
CONCORD AVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=300'
DWG. NO. PA-CH-0167.0000-RD

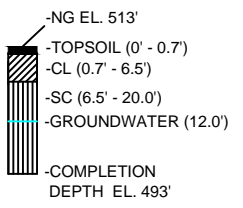


CHESTER COUNTY, PENNSYLVANIA - UWCHLAN TOWNSHIP
S3-0350-16

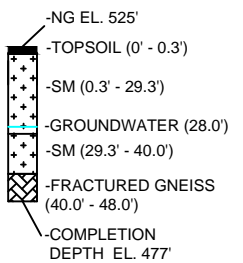
PROFILE VIEW



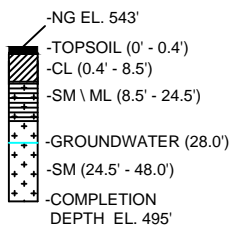
GEOTECH SB-01



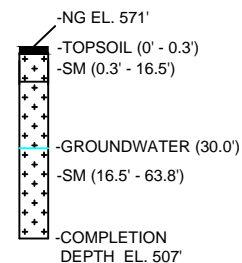
GEOTECH SB-02



GEOTECH SB-03



GEOTECH SB-04



DESIGN AND CONSTRUCTION:

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- DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
- CROSSING PIPE SPECIFICATION:
HDD HORZ. LENGTH (L_H): 3945'
HDD PIPE LENGTH (S_H): 3961'
16" x 0.438" W.T., X-70, APISL, 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

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REF. DRAWING

ES-6.40	TO	ES-6.42	EROSION & SEDIMENT PLAN
SHEET 23	TO	SHEET 25	AERIAL SITE PLAN
		EP1	REVISED PER PADEP COMMENTS
		EP	
		0	ISSUED FOR CONSTRUCTION

REVISIONS

BY	DATE	CHK	DATE	APP	DATE
MRS	05/11/16	RMB	05/11/16	AAW	05/11/16
MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
MRS	02/19/16	RMB	02/19/16	AAW	02/19/16



SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
CONCORD AVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=300'

DWG. NO. PA-CH-0167.0000-RD-16



LEGEND:

⊙ Geotechnical Soil Boring (SB) Locations



GEOTECHNICAL BORING LOCATIONS
 HDD S3-0350
 CHESTER COUNTY, UWCHLAN 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: CH-0155, EXTON, PA			Page 1 of 1		
HDD No.: S3-0350		Dates(s) Drilled: 05-29-15		Inspector: J. COSTELLO	
Boring No.: SB-01		Drilling Method: SPT - ASTM D1586		Driller: GREGG	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 12.0		Total Depth (ft): 30.0	
Boring Location Coordinates:			40° 2' 59.416" N		75° 39' 20.599" W

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 (8")					
1	3.0	5.0	0.7		22	CL	MOTTLED REDDISH BROWN SILTY CLAY WITH A LITTLE FINE SAND, TRACE FINE GRAVEL. (USCS: CL).	4	6	11	13	17
2	8.0	10.0	6.5		24	SC	DR WEATHERED TO A VARI-COLORED FINE TO MEDIUM SAND WITH SOME SILTY CLAY, WITH TRACE FINE GRAVEL.	1	2	13	28	15
3	13.0	15.0			16	SC	DR WEATHERED TO A VARI-COLORED FINE TO MEDIUM SAND WITH SOME SILTY CLAY, WITH A LITTLE FINE GRAVEL.	1	13	27	41	40
4	18.0	18.8			9	SC	DR WEATHERED TO A VARI-COLORED FINE TO MEDIUM SAND WITH SOME SILTY CLAY, WITH A LITTLE FINE GRAVEL.	15	50/3"			>50
				20.0								
							AUGER REFUSAL AT 20'.					
							WHILE AUGERING AT 20', RIG GEAR BOX BROKE DOWN.					
							WET ON SPOON AT 12' BGS.					
							WATER LEVEL THROUGH AUGERS AT 12'.					
							CAVED AT 16'.					

Notes/Comments:
Pocket Pentrometer Testing DR: DECOMPOSED ROCK
 S1: > 4 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: CH-0155, EXTON, PA			Page 1 of 1		
HDD No.: S3-0350		Dates(s) Drilled: 05-28/29-15		Inspector: E. WATT	
Boring No.: SB-02		Drilling Method: SPT - ASTM D1586		Driller: S. HUFLER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 28		Total Depth (ft): 48.0	
Boring Location Coordinates:			40° 2' 54.693" N		75° 39' 9.386" W

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")						
1	3.0	5.0	0.3		24	SM	BROWN AND LIGHT BROWN MICACEOUS FINE SAND AND SILT.	3	3	3	5	6	
2	8.0	10.0			14		BROWN AND LIGHT BROWN FINE TO MEDIUM MICACEOUS SAND AND SILT.	1	2	4	5	6	
3	13.0	15.0			24		BROWN AND LIGHT BROWN FINE TO MEDIUM MICACEOUS SAND AND SILT. (USCS: SM).	1	1	2	3	3	
4	18.0	18.8			24		BROWN AND LIGHT BROWN FINE TO MEDIUM MICACEOUS SAND AND SILT.	1	1	1	2	2	
5	23.0	25.0			24		BROWN AND LIGHT BROWN FINE TO MEDIUM SAND WITH SOME SILT.	3	4	7	9	11	
				29.3									
6	28.0	30.0	29.3		24		SM	DR WEATHRED TO A VARIEGATED BROWN, LIGHT BROWN, WHITE, FINE TO MEDIUM SAND WITH SOME SILT, TRACE F-GRAVEL.	3	8	14	20	22
7	33.0	35.0			24			DR WEATHRED TO A VARIEGATED BROWN, LIGHT BROWN, WHITE, FINE TO MEDIUM SAND WITH SOME SILT, TRACE F-GRAVEL.	4	13	33	50	46
8	38.0	38.9			9	DR WEATHRED TO A VARIEGATED BROWN, LIGHT BROWN, WHITE, FINE TO MEDIUM SAND WITH SOME SILT, A LITTLE F-C GRAVEL.		8	50/5"			>50	
				40.0									
							AUGER REFUSAL AT 40'.						
							<u>ROCK CORING</u>						
RUN 1	40.0	43.0	40.0		36	ROCK	INTENSELY TO VERY INTENSELY FRACTURED LIGHT GRAY GNEISS.	TCR: 100%, SCR: 26%, RQD: 11%					
RUN 2	43.0	48.0		48.0	53		MODERATELY TO INTENSELY FRACTURED LIGHT GRAY GNEISS.	TCR: 88%, SCR: 50%, RQD: 42%					
							<u>CORE TESTING RESULTS (RUN 2, DEPTH 46 TO 46.5')</u>						
							COMPRESSIVE STRENGTH: 5,910 PSI						
							UNIT WEIGHT: 163.1 PCF						
							WET ON SPOON AT 32'.						
							WATER LEVEL THROUGH AUGERS AT 28'.						
							CAVED AT 23'.						

Notes/Comments:
Pocket Pentrometer Testing
 S1: > 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: 216 CRUMP ROAD, EXTON, PA			Page 1 of 1		
HDD No.: S3-0350		Dates(s) Drilled: 06-13-15		Inspector: E. WATT	
Boring No.: SB-03		Drilling Method: SPT - ASTM D1586		Driller: S. HUFFER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 28.0		Total Depth (ft): 48.0	
Boring Location Coordinates:			40° 2' 48.457" N		75° 38' 53.373" W

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		12	CL	REDDISH BROWN SILTY CLAY AND FINE SAND.	2	5	7	8	12	
				8.5									
2	8.0	10.0	8.5		22	SM/ML	DR WEATHERED TO A LIGHT BROWN AND ORANGE BROWN F-M SAND AND SILT, TRACE MICA. (USCS: SM/ML).	1	4	4	5	8	
3	13.0	15.0			22		DR WEATHERED TO A LIGHT BROWN AND ORANGE BROWN F-M SAND AND SILT, TRACE MICA. (USCS: SM/ML).	2	4	6	6	10	
4	18.0	20.0			24	SM	DR WEATHERED TO A BROWN, LIGHT BROWN, AND WHITE MICACEOUS FINE SAND AND SILT.	3	7	11	13	18	
				24.5			DR WEATHERED TO A LIGHT BROWN AND WHITE FINE TO MEDIUM SAND AND SILT, TRACE FINE QUARTZ GRAVEL.						
5	23.0	25.0	24.5		24	SM	DR WEATHERED TO A LIGHT BROWN AND WHITE MICACEOUS FINE SAND AND SILT.	4	12	11	18	23	
6	28.0	30.0			24		DR WEATHERED TO A BROWN, LIGHT BROWN AND WHITE FINE TO MEDIUM SAND AND SILT. (USCS: SM).	1	7	14	40	21	
7	33.0	35.0			24	SM	DR WEATHERED TO A WHITE AND LIGHT BROWN FINE SAND AND SILT, TRACE FINE QUARTZ.	50/5"				>50	
8	38.0	38.4			5		DR WEATHERED TO A WHITE, LIGHT BROWN AND BROWN FINE TO MEDIUM SAND WITH SOME SILT, TRACE FRAGMENTS OF QUARTZ.	32	50/2"			>50	
9	43.0	43.7			7	SM	DR WEATHERED TO A WHITE, LIGHT BROWN AND BROWN FINE TO MEDIUM SAND WITH SOME SILT, TRACE FRAGMENTS OF QUARTZ.	50/6"				>50	
10	47.5	48.0			6		DR WEATHERED TO A WHITE, LIGHT BROWN AND BROWN FINE TO MEDIUM SAND WITH SOME SILT, TRACE FRAGMENTS OF QUARTZ.						
				48.0									
							AUGER REFUSAL AT 47.5'.						
							WET ON SPOON AT 28'.						
							WATER LEVEL THROUGH AUGERS AT 31'.						
							CAVED AT 37', WATER LEVEL ON CAVE AT 22'.						

Notes/Comments:
 Pocket Pentrometer Testing
 S1: 2.5 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.



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)		Strata Depth (ft)		Recov. (ft)	Strata (USCS)	Description of Materials	6" Increment Blows *				N	
	From	To	From	To									
			0.0	0.3			TOPSOIL (4")						
1	3.0	5.0	0.3		SM	14	DR, LIGHT BROWN TO ORANGE BROWN FINE SAND WITH A LITTLE SILT.	1	3	5	7	8	
2	8.0	10.0				19	DR, VARIABLE BROWN, TAN, ORANGE BROWN, REDDISH BROWN F-SAND WITH SOME SILT, TRACE F-QUARTZ GRAVEL. (USCS: SM)	1	5	9	12	14	
3	13.0	15.0				21	SAME	2	9	12	19	21	
				16.5									
4	18.0	19.8	16.5		SM	18	DR, VARIABLE BROWN, TAN, ORANGE BROWN, REDDISH BROWN FINE SAND WITH SOME SILT, W/A LITTLE F-C QUARTZ GRAVEL.	5	20	37	50/4"	57	
5	23.0	24.1				12	DR, LIGHT GRAY, ORANGE AND REDDISH BROWN FINE SAND, SOME SOME SILT, WITH A LITTLE F-C QUARTZ GRAVEL.	28	50	50/1"		>50	
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 F-C QUARTZ GRAVEL.	50/4"				>50	
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. (USCS: SM)	50/1"				>50	
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 F-C QUARTZ GRAVEL.	8	50/3"			>50	
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.

**ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0350**

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					
S3-0350	SB-2	1	40	43	100	26	11	40	48	Moderate	Gneiss	Massive	Light gray	Fractures ranging from 0° to 78°, Avg 26°; Heavily fractured
		2	43	48	88	50	42							

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0350

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, %	
S3-0350	SB-01	1	3.0	5.0	20.8	84.2	40	22	18	CL
		2	8.0	10.0	14.4	24.4	-	-	-	-
		3	13.0	15.0	12.7	23.4	-	-	-	-
		4	18.0	18.8	12.4	32.6	-	-	-	-
	SB-02	2	8.0	10.0	26.7	44.4	-	-	-	-
		3	13.0	15.0	29.3	46.6	33	26	7	SM
		5	23.0	25.0	38.2	36.2	-	-	-	-
		6	28.0	30.0	20.2	33.4	-	-	-	-
		8	38.0	38.9	6.9	24.5	-	-	-	-
	SB-03	1	3.0	5.0	20.3	68.8	-	-	-	-
		2	8.0	10.0	21.8	49.7	34	27	7	SM/ML
		4	18.0	20.0	25.6	50.0	-	-	-	-
		5	23.0	25.0	23.3	40.2	-	-	-	-
		7	33.0	35.0	16.6	39.8	32	25	7	SM
		9	43.0	43.7	7.6	28.0	-	-	-	-
	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	-	-	-	-	

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-02	2	46.0-46.5	5,910	163.1

Notes:

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

**REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0350**

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-01	Felsic and intermediate gneiss - Medium grained, light pink to greenish gray; largely quartz, feldspar, and mica; commonly gneissic, containing alteration minerals; interfingers with gabbroic gneiss.	Generally level, slight slope to the SE	Felsic and intermediate gneiss (PreCambrian)	Felsic gneiss	No information found during literature review	Ranges from 10 to 65 ft bgs, Avg. 31 ft bgs (.5 mile radius)	
		SB-02		Generally level				Ranges from 10 to 65 ft bgs, Avg. 32 ft bgs (.5 mile radius)	
		SB-03		Generally level				Ranges from 10 to 65 ft bgs, Avg. 42 ft bgs (.5 mile radius)	
		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)	

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)

<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		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			
			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.