

HDD PA-DE-0104.0023-RR (W-I16, S-I18, W-BA5 and W-BA6)

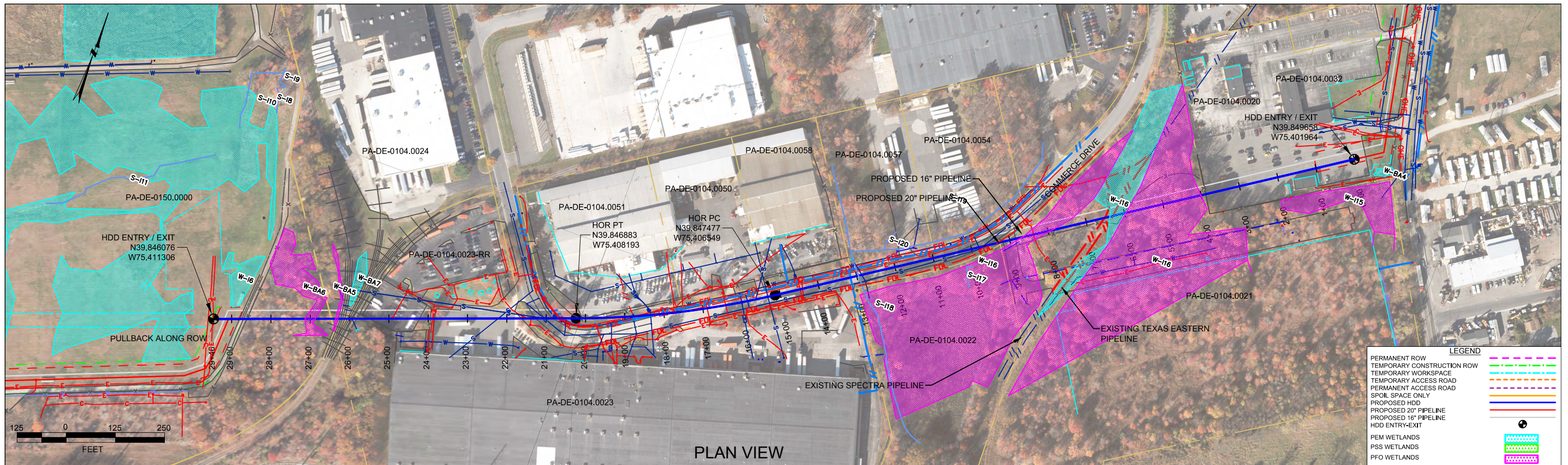
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts,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

The drill will enter/exit 400 feet northeast of the northeastern most boundary of wetland I16. The drill will pass 54 feet under this wetland. 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, gneiss and schist.

The drill will enter/exit 1295 feet northeast of stream I18. The drill will pass 51 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, gneiss and schist.

The drill will enter/exit 2630 feet northeast of the northeastern most boundary of wetland BA5. The other entry/exit point is 316 feet southwest of the southwestern most boundary of this wetland. The drill will pass 50 feet under this wetland. 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.

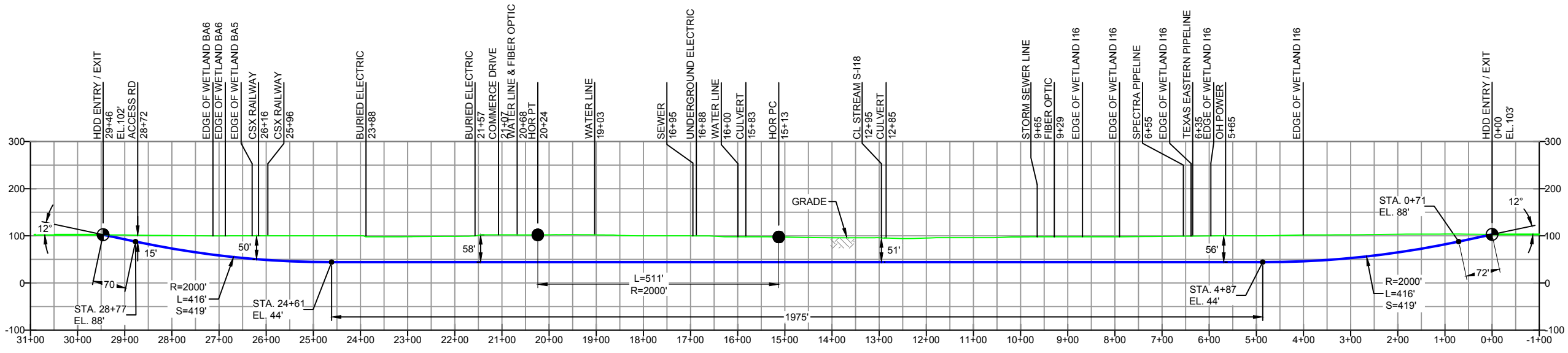
The drill will enter/exit 2690 feet northeast of the northeastern most boundary of wetland BA6. The other entry/exit point is 236 feet southwest of the southwestern most boundary of this wetland. The drill will pass 40 feet under this wetland. Using the results of the geotechnical investigation, as well 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.



PLAN VIEW

DELAWARE COUNTY PENNSYLVANIA, UPPER CHICHESTER TOWNSHIP
S3-0670

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-): 2946'
HDD PIPE LENGTH (S-): 2955'
20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
 - INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
 - 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.
 - PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
 - BLASTING NOT PERMITTED.
 - SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

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-6.32	TO ES-6.34 EROSION & SEDIMENT PLAN
SHEET 21	TO SHEET 22 AERIAL SITE PLAN
DWG NO	DWG NO DESCRIPTION

REVISIONS	
EP1	REVISED PER PADEP COMMENTS
EP	
C	ISSUED FOR BID
B	ISSUED FOR BID
A	ISSUED FOR REVIEW
NO.	DESCRIPTION

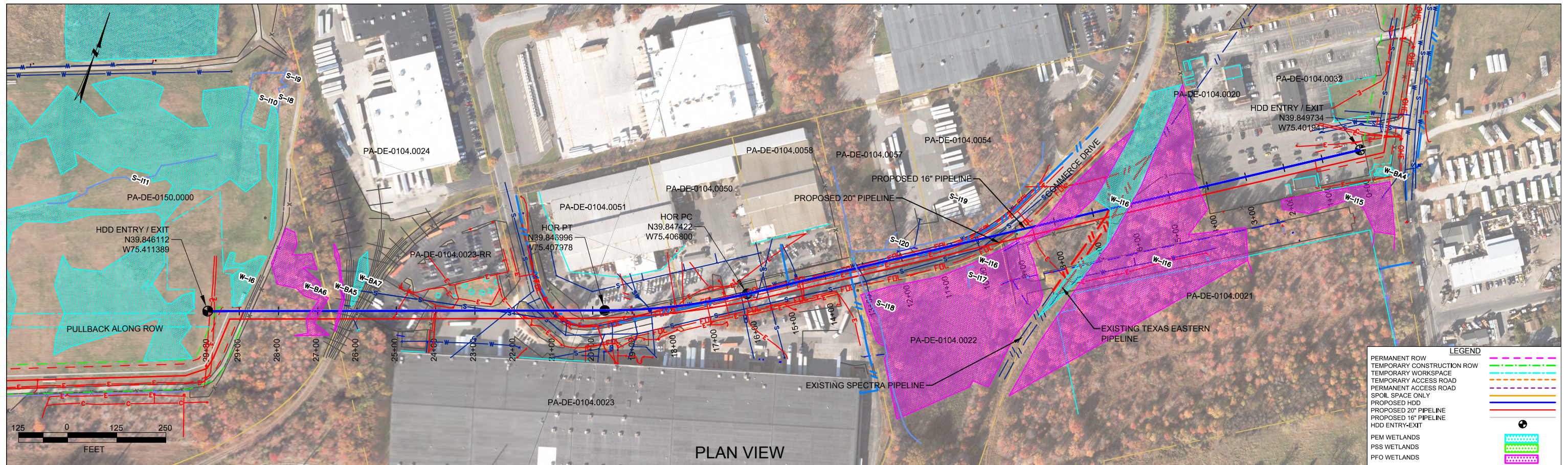
BY	DATE	CHK	DATE	APP	DATE
MRS	05/05/16	RMB	05/05/16	AAW	05/05/16
MRS	12/08/15	RMB	12/08/15	AAW	12/08/15
DLM	08/21/15	RMB	08/21/15	AAW	08/21/15
DLM	07/31/15	RMB	07/31/15	AAW	07/31/15
JAM	03/23/15	RMB	03/23/15	AAW	03/23/15

(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
COMMERCE DRIVE / CSX RAILROAD
PENNSYLVANIA PIPELINE PROJECT

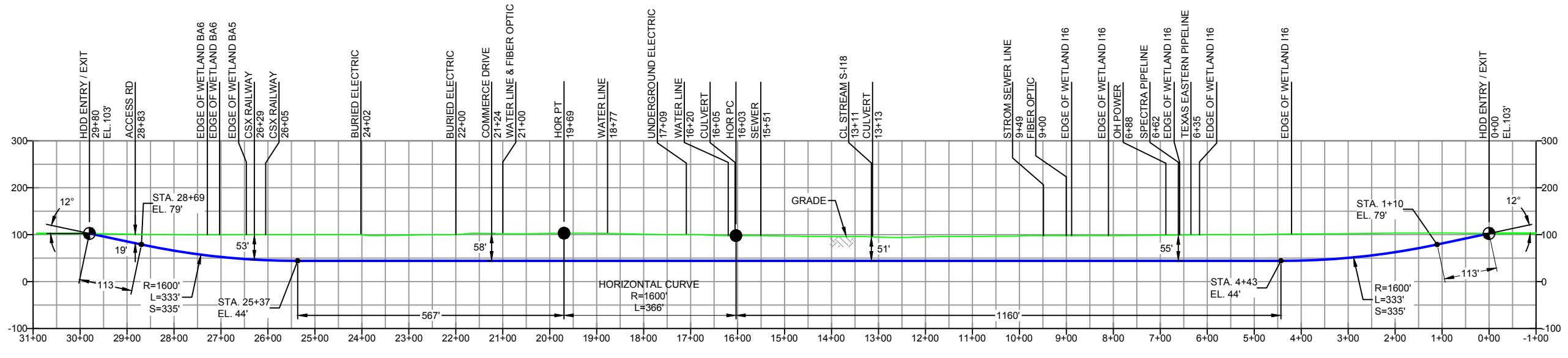
SCALE: 1"=250' DWG. NO: PA-DE-0104.0023-RR



PLAN VIEW

DELAWARE COUNTY PENNSYLVANIA, UPPER CHICHESTER TOWNSHIP
S3-0670-16

PROFILE VIEW



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 - DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
 - CROSSING PIPE SPECIFICATION:
HDD HORIZ. LENGTH (L): 2980'
HDD PIPE LENGTH (S): 2989'
16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
 - INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
 - 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.
 - PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
 - BLASTING NOT PERMITTED.
 - SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

NOTES	
1.	ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2.	STATIONING IS BASED ON HORIZONTAL DISTANCES
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5.	SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING		REVISIONS	
ES-6.32	TO ES-6.34	EROSION & SEDIMENT PLAN	
SHEET 21	TO SHEET 22	AERIAL SITE PLAN	
		EP1	REVISED PER PADEP COMMENTS
		EP	
		B	ISSUED FOR BID
		A	ISSUED FOR REVIEW
DWG NO	DWG NO	DESCRIPTION	DESCRIPTION

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
COMMERCE DRIVE / CSX RAILROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250' DWG. NO: PA-DE-0104.0023-RR-16



LEGEND:

⊙ Geotechnical Soil Boring (SB) Locations



GEOTECHNICAL BORING LOCATIONS
 HDD S3-0670
 DELAWARE COUNTY, CHESTER 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:	150 COMMERCE DRIVE, ASTON, PA	Page 1 of 1	
HDD No.:	S3-0670	Dates(s) Drilled:	09-01/02-15
Boring No.:	SB-02	Inspector:	E. WATT
Drilling Contractor:	HAD DRILLING	Drilling Method:	SPT - ASTM D1586
		Driller:	E. OGDEN
		Groundwater Depth (ft):	10
		Total Depth (ft):	56.0
Boring Location Coordinates:	39° 50' 52.071" N	75° 24' 22.178" W	

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (in)	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		19	CL	MOTTLED (GRAY, LIGHT BROWN, ORANGE BROWN) SILTY CLAY, TRACE FINE SAND.	1	4	9	10	13	
2	8.0	10.0	9.6		15	SC	ORANGE BROWN FINE TO MEDIUM SAND WITH SOME SILT, TRACE TO A LITTLE FINE GRAVEL.	2	4	9	4	13	
3	13.0	15.0		18.4	24	SC	DR, WEATHERED TO A VARIEGATED (ORANGE BROWN, BROWN, GRAY) MICACEOUS F-M SAND AND SILTY CLAY. USCS: SC).	1	2	4	6	6	
4	18.0	20.0	18.4		24	SM	DR, WEATHERED TO A WHITE, GRAY, LIGHT BROWN F-C MICACEOUS SAND AND SILT, TRACE UNWEATHERED SCHIST FINE GRAVEL.	1	9	12	19	21	
5	23.0	25.0			24	SM	SAME. (USCS: SM).	1	2	6	6	8	
6	28.0	30.0			24	SM	DR, WEATHERED TO A WHITE, GRAY, LIGHT BROWN MICACEOUS F-C SAND, SOME SILT, TRACE UNWEATHERED SCHIST GRAVEL.	2	11	13	18	24	
7	33.0	34.3			15	SM	DR, WEATHERED TO A WHITE, GRAY, LIGHT BROWN MICACEOUS F-C SAND, SOME SILT, A LITTLE UNWEATHERED SCHIST GRAVEL.	4	23	50/3"		>50	
8	38.0	40.0			18	SM	SAME.	5	29	38	45	67	
9	43.0	44.3		46.0	13	SM	SAME.	3	13	50/4"		>50	
							AUGER REFUSAL AT 46.0'.						
							ROCK CORING						
RUN 1	46.0	50.0	46.0	50.0	40		WHITE AND GRAY GNEISS	TCR: 83%, SCR: 75%, RQD: 54%					
RUN 2	50.0	51.0	50.0		6		DARK GRAY HIGHLY WEATHERED SCHIST	TCR: 50%, SCR: 0%, RQD: 0%					
RUN 3	51.0	56.0		56.0	24		DARK GRAY HIGHLY WEATHERED SCHIST	TCR: 40%, SCR: 0%, RQD: 0%					
							CORE TESTING RESULTS (DEPTH 47-47.5'):						
							COMPRESSIVE STRENGTH: 5,690 PSI						
							UNIT WEIGHT: 159.5 PCF						

Notes/Comments:

Pocket Pentrometer Testing
 4': 3.0 TSD
 13': 0.5 TSF
 19': 1.75 TSF

DR: DECOMPOSED ROCK
 CAVED AT 24.7'.
 WATER LEVEL ON CAVE AT 10'.

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 S3-0670**

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					
S3-0670	SB-2	1	46	50	83	75	54	46	50	Moderate	Gneiss	4	White/Gray	Fractures ranging from 10° to 42°, Avg. 30°
		2	50	51	50	0	0	50	56	Heavily	Schist	Massive	Dark gray	Rubble
		3	51	56	40	0	0							

**GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0670**

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, %	
S3-0670	SB-01	BORING HAS NOT YET BEEN ADVANCED								
	SB-02	2	8.0	10.0	16.1	31.8	-	-	-	-
		3	13.0	15.0	31.7	41.8	45	25	20	SC
		5	23.0	25.0	26.3	39.2	29	23	6	SM
		6	28.0	30.0	17.5	29.4	-	-	-	-
		7	33.0	34.3	5.5	22.6	-	-	-	-
		9	43.0	44.3	14.9	29.2	-	-	-	-
	SB-03	2	8.0	10.0	22.3	18.8	-	-	-	-
		3	13.0	15.0	27.8	38.7	33	25	8	SM
		4	18.0	20.0	17.3	32.3	-	-	-	-
		5	23.0	25.0	22.4	28.9	-	-	-	-
		6	28.0	30.0	16.5	33.3	-	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-02	1	47-47.5	5,690	159.5

Notes:

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

**REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0670**

HDD No.	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
S3-0670	SB-01	Pensauken and Bridgeton Formations , undifferentiated - Dark-reddish-brown, cross-stratified, feldspathic quartz sand and some thin beds of fine gravel and rare layers of clay or silt.	Generally level	Pensauken and Bridgeton Formations, undifferentiated	Sand; Secondary gravel; Other - clay or mud, silt	At least 30 feet	Ranges from 11 to 25 ft bgs, Avg. 18 ft bgs (.75 mile radius)	Depth to rock likely to increase further east; all borings near mapped contacts with underlying formation (Mafic Gneiss), indicating rock may be shallower than 30 ft. Reviewed wells may be outside of formation; bottom of well may also have been recorded as depth to bedrock, which could bias depth.
	SB-02							
	SB-03							

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

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

RQD: Rock Quality Designation

TCR: Total Core Recovery

SCR: Solid Core Recovery

***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.