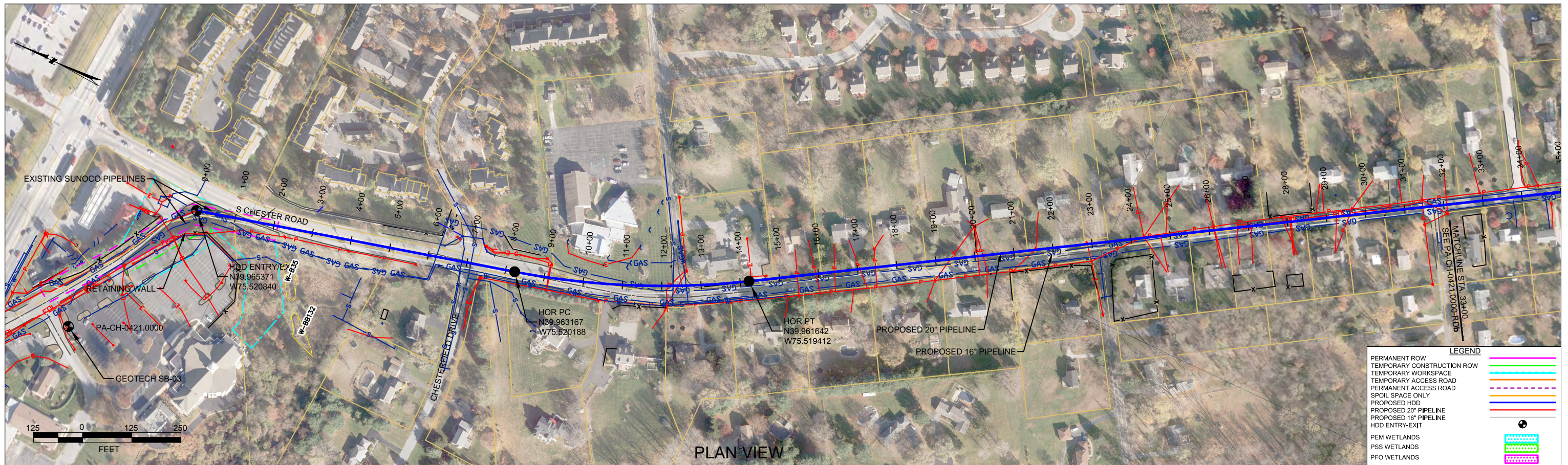


HDD PA-CH-0421.0000-RD (S Chester Road)

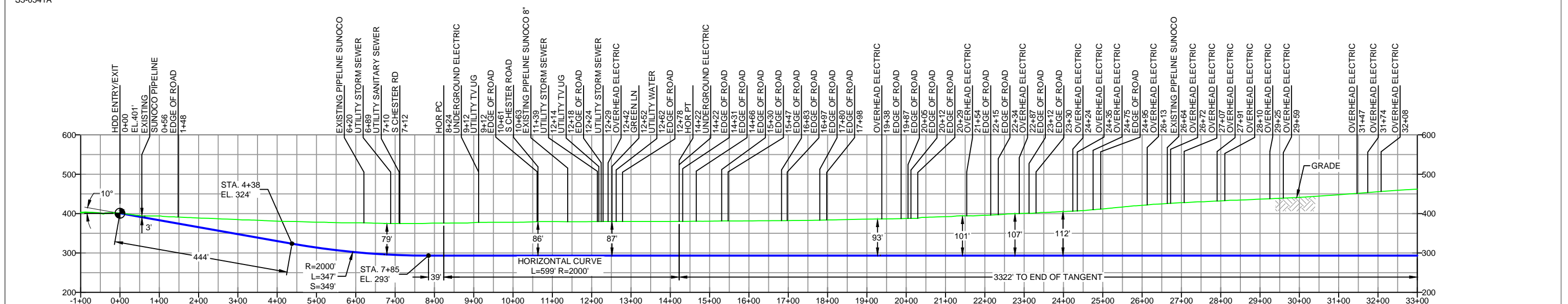
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts,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

The drill will enter/exit 148 feet northwest of S Chester Road. The drill will continue under S Chester Road for approximately 6049 feet. This point is 151 feet northwest of the southeast entry/exit point. After the entry/exit point, the drill will pass between 63 and 176 feet under this road. 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/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDMONT TOWNSHIP
S3-0541A

PROFILE VIEW



GEOTECH SB-03

- NG EL. 430'
- TOPSOIL (0' - 0.3')
- SM (0.3' - 18.5')
- WEATHERED QUARTZ (18.5' - 18.9')
- COMPLETION DEPTH EL. 410'

NOTE: REFER TO TEST BORING LOG S3-0530 FOR COMPLETE SOIL MATERIAL DESCRIPTION

- 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): 6346'
HDD PIPE LENGTH (S): 6349'
20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
 - INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50).
 - INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
 - PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
 - CARRIER PIPE NOT ENCASED.
 - PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
 - CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
 - SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
 - SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
 - SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

- ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
- STATIONING IS BASED ON HORIZONTAL DISTANCES.
- ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
- CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
- SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING	TO	DESCRIPTION
ES-6.70	ES-6.01	EROSION & SEDIMENT PLAN
SHEET 46	SHEET 1	AERIAL SITE PLAN
		EP1 REVISED PER PADEP COMMENTS
		EP ISSUED FOR CONSTRUCTION
DWG NO	DWG NO	DESCRIPTION

REVISIONS

BY	DATE	CHK	DATE	APP	DATE
JTW	05/10/16	RMB	05/10/16	AAW	05/10/16
MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
MRS	02/19/16	RMB	02/19/16	AAW	02/19/16

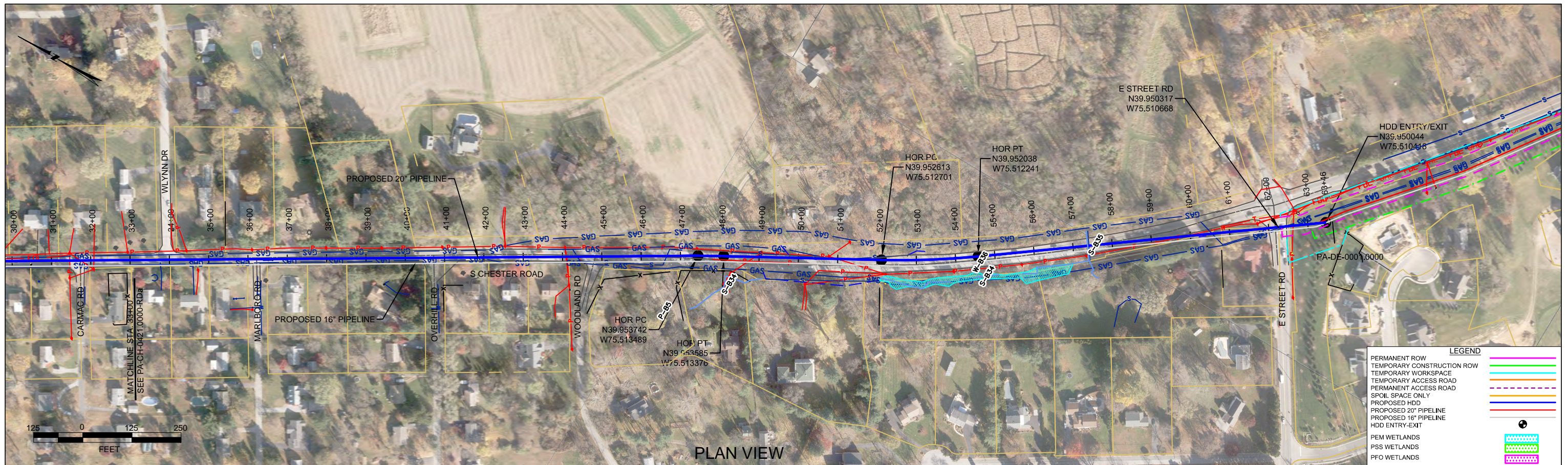
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD
PENNSYLVANIA PIPELINE PROJECT

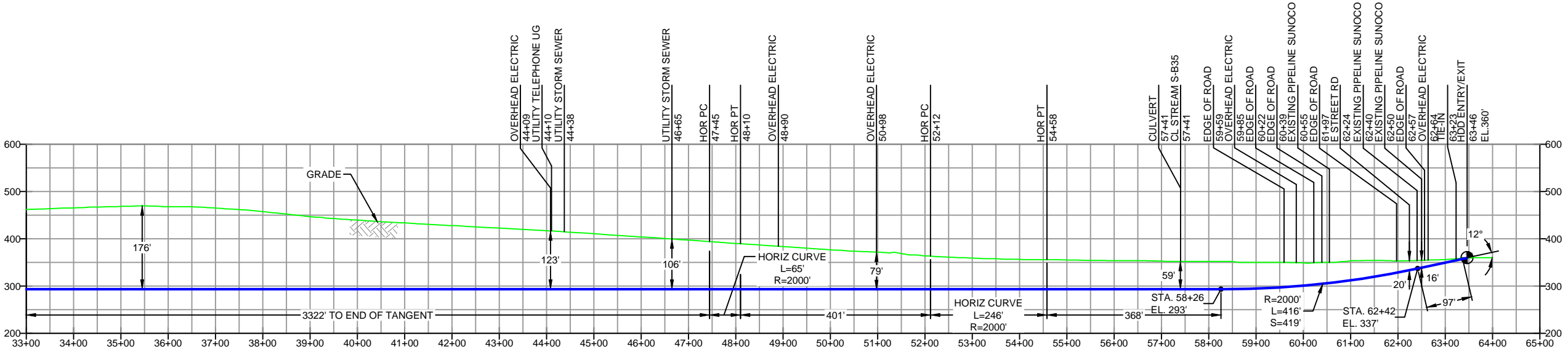
SCALE: 1"=250' DWG. NO: PA-CH-0421.0000-RDa



PLAN VIEW

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541A

PROFILE VIEW



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 - CROSSING PIPE SPECIFICATION:
HDD HORZ. LENGTH (L-): 6346'
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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).
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NOTES	
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5.	SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING		REVISIONS	
ES-6.70	TO ES-6.01	EROSION & SEDIMENT PLAN	
SHEET 46	TO SHEET 1	AERIAL SITE PLAN	
		EP1	REVISED PER PADEP COMMENTS
		EP	
		0	ISSUED FOR CONSTRUCTION
DWG NO	DWG NO	DESCRIPTION	DESCRIPTION

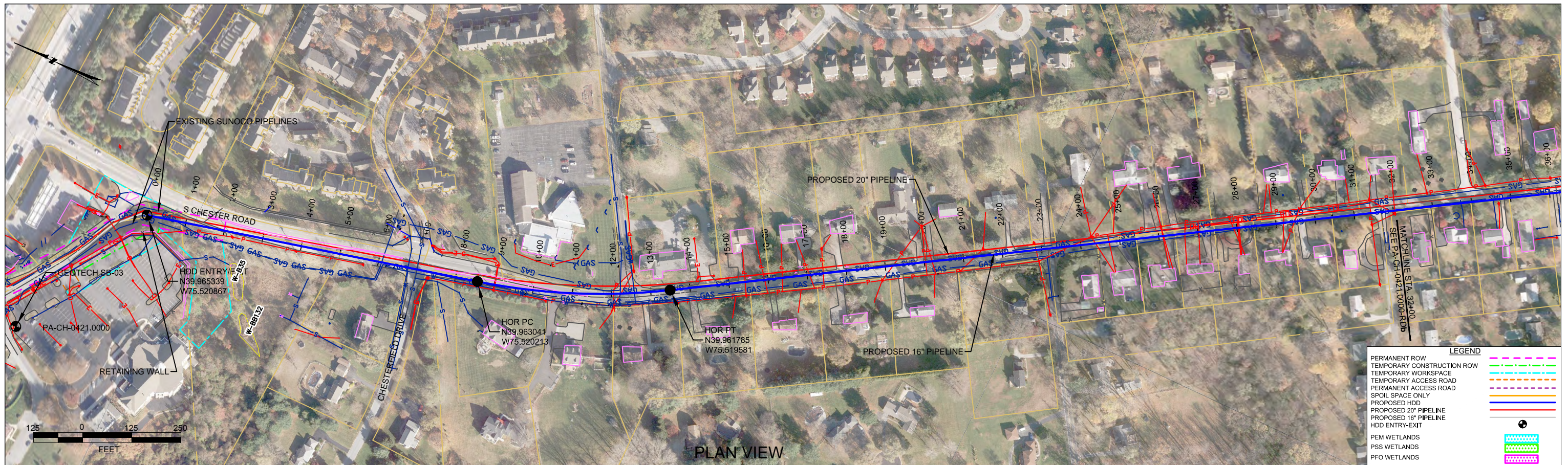
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250' DWG. NO. PA-CH-0421.0000-RDb

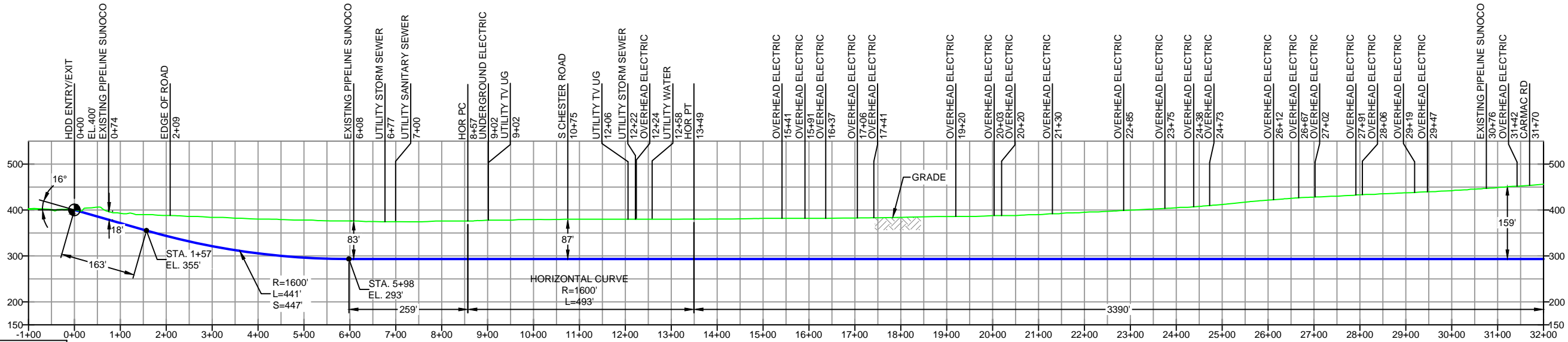


PLAN VIEW

LEGEND	
PERMANENT ROW	
TEMPORARY CONSTRUCTION ROW	
TEMPORARY WORKSPACE	
TEMPORARY ACCESS ROAD	
PERMANENT ACCESS ROAD	
SPOIL SPACE ONLY	
PROPOSED HDD	
PROPOSED 20\"/>	

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541A-16

PROFILE VIEW



GEOTECH SB-03

NG EL. 430'
-TOPSOIL (0' - 0.3')
-SM (0.3' - 18.5')
-WEATHERED QUARTZ (18.5' - 18.9')
-COMPLETION DEPTH EL. 410'

NOTE: REFER TO TEST BORING LOG S3-0530 FOR COMPLETE SOIL MATERIAL DESCRIPTION

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 - DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
 - CROSSING PIPE SPECIFICATION:
HDD HORZ. LENGTH (L): 6312'
HDD PIPE LENGTH (S): 6332'
16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
 - INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50).
 - INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
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REF. DRAWING	REVISIONS
ES-6.70 TO ES-6.01 SHEET 46 TO SHEET 1	EROSION & SEDIMENT PLAN AERIAL SITE PLAN
	EP1 REVISED PER PADEP COMMENTS
	EP ISSUED FOR CONSTRUCTION
DWG NO	DWG NO
DESCRIPTION	DESCRIPTION

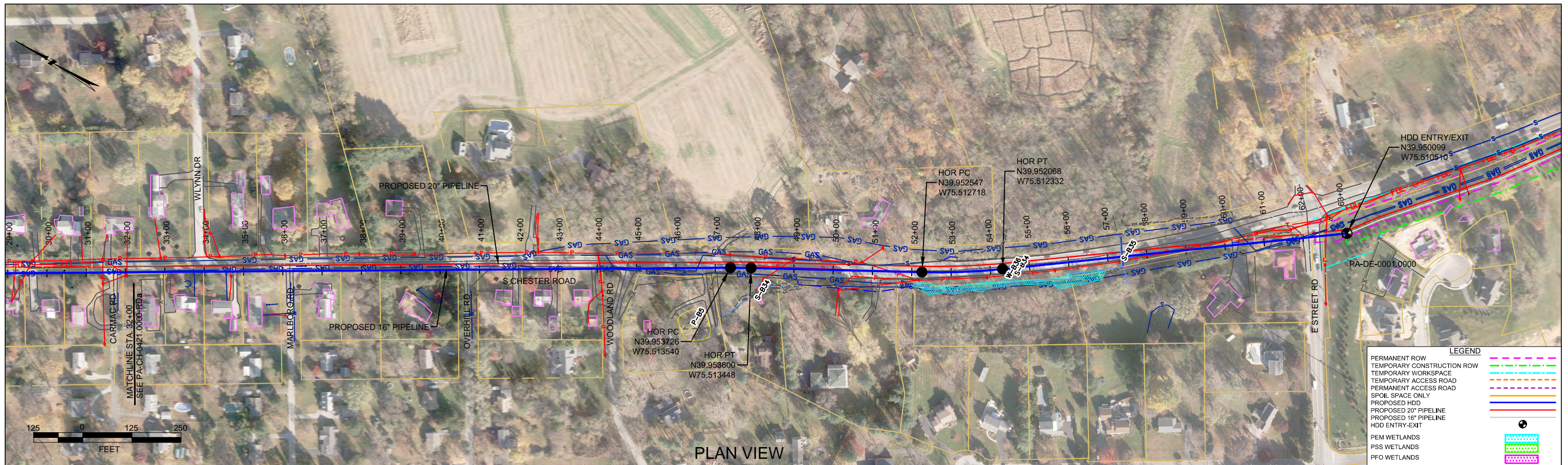
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD
PENNSYLVANIA PIPELINE PROJECT

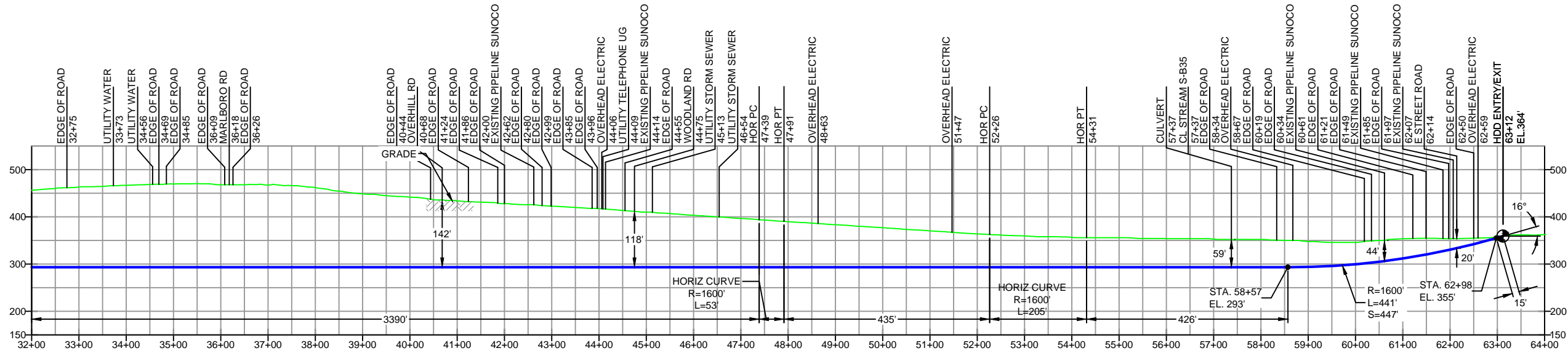
SCALE: 1"=250'
DWG. NO: PA-CH-0421.0000-RDa-16



PLAN VIEW

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541B-16

PROFILE VIEW



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		EP1	REVISED PER PADEP COMMENTS
		EP	
		0	ISSUED FOR CONSTRUCTION
DWG NO	DWG NO	DESCRIPTION	NO.

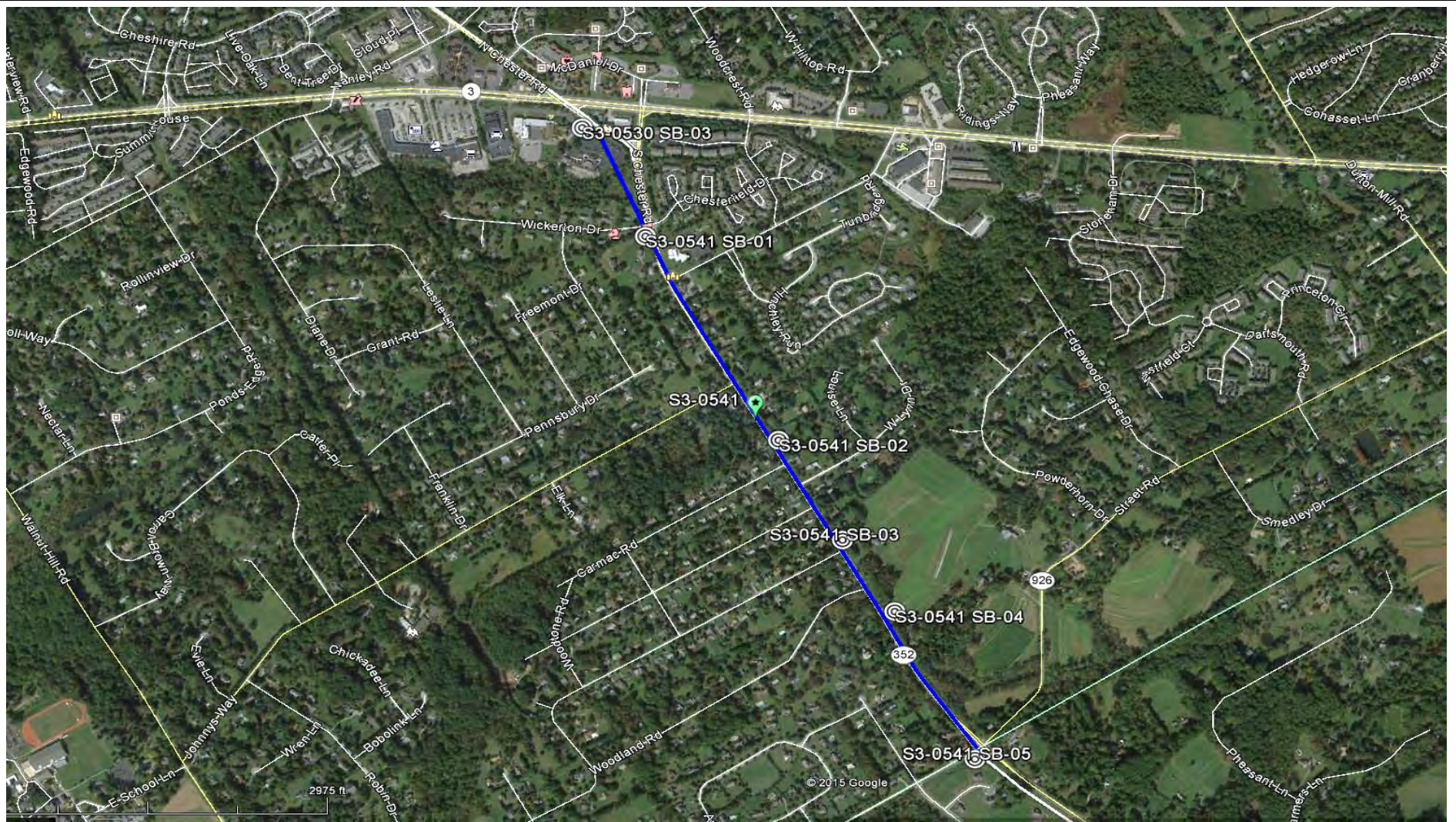
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SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250' DWG. NO. PA-CH-0421.0000-RDb-16



LEGEND:

⊙ Geotechnical Soil Boring (SB) Locations



GEOTECHNICAL BORING LOCATIONS
 HDD S3-0541
 CHESTER COUNTY, WESTTOWN TWP, AND
 DELAWARE COUNTY, THORNBURY 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:	6 CAVANAUGH COURT, ST. SIMON & JUDE CHURCH, WEST CHESTER, PA	Page 1 of 1	
HDD No.:	S3-0541	Dates(s) Drilled:	06-30-15
Boring No.:	SB-01	Inspector:	E. WATT
Drilling Contractor:	HAD DRILLING	Drilling Method:	SPT - ASTM D1586
		Driller:	S. HOFFER
		Groundwater Depth (ft):	25.0
		Total Depth (ft):	30.0
Boring Location Coordinates:	39° 57' 47.444" N		75° 31' 13.514" 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		18	SM	DR, VARIEGATED BROWN, ORANGE BROWN AND GRAY FINE TO MEDIUM SAND AND SILT, WITH A LITTLE F-C GNEISS GRAVEL.	4	5	8	10	13	
2	8.0	10.0			24		DR, VARIEGATED GRAY, LIGHT GRAY FINE TO MEDIUM MICACEOUS SAND AND SILT, TRACE UNWEATHERED FINE GNEISS GRAVEL.	3	14	12	20	26	
3	13.0	15.0			24		DR, VARIEGATED GRAY, LIGHT GRAY FINE TO MEDIUM MICACEOUS SAND AND SILT, TRACE UNWEATHERED FINE GNEISS GRAVEL.	3	16	23	17	39	
4	18.0	19.9			24		SAME. (USCS: SM).	4	15	34	50/5"	49	
5	23.0	25.0			24		SAME.	13	20	25	34	45	
6	28.0	29.9			24		DR, VARIEGATED GRAY, LIGHT GRAY FINE TO MEDIUM MICACEOUS SAND, A LITTLE SILT, TRACE UNWEATHERED FINE GNEISS GRAVEL.	6	31	35	50/5"	66	
				30.0									
								AUGERED TO 30'.					
								WET ON SPOON AT 27'.					
								WATER LEVEL THROUGH AUGERS AT 25'.					
							CAVED AT 28', WATER LEVEL ON CAVE AT 25'.						

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
 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:	913 S. CHESTER ROAD, WEST CHESTER, PA	Page 1 of 1	
HDD No.:	S3-0541	Dates(s) Drilled:	12-21-15
Boring No.:	SB-02	Inspector:	J. COSTELLO
Drilling Contractor:	HAD DRILLING	Drilling Method:	SPT - ASTM D1586
		Driller:	E. ODGEN
		Groundwater Depth (ft):	NOT ENCOUNTERED
		Total Depth (ft):	
Boring Location Coordinates:	39°57'29.08"N	75°30'59.38"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		16	SM	DR, BROWN WITH BLACK NODULES FINE SAND AND SILT, TRACE MICA.	1	4	4	3	8	
2	8.0	10.0			17		DR, BROWN WITH BLACK NODULES, FINE SAND AND SILT, TRACE FINE GNEISS ROCK FRAGS., MICACEOUS.	4	5	7	8	12	
3	13.0	14.3	11.5		11	SM	DR, BROWN WITH BLACK NODULES, FINE SAND AND SILT, A LITTLE F-C GNEISS ROCK FRAGS., MICACEOUS. (USCS: SM).	17	50	50/4"		>50	
4	18.0	18.6			2		SAME	22	50/1"			>50	
5	23.0	24.3	23.5		10	SM/GM	DR, REDDISH BROWN AND BLACK LAYERING OF F-M SAND AND PARTIALLY WEATHERED GNEISS ROCK.	1	27	50/4"		>50	
6	28.0	30.0		32.0	18		SAME.	1	27	21	11	48	
							AUGER REFUSAL AT 32'.						
							<u>ROCK CORING</u>						
RUN 1	32.0	37.0	32.0		49	GNEISS ROCK	INTENSELY TO VERY INTENSELY FRACTURED LIGHT GRAY TO GRAY FELSIC GNEISS.	TCR: 82%, SCR: 33%, RQD: 9%					
RUN 2	37.0	42.0		42.0	55		SAME	TCR: 92%, SCR: 30%, RQD: 11%					
							<u>CORE TESTING RESULTS (DEPTH 39-39.5 '):</u>						
							COMPRESSIVE STRENGTH: 13,333 PSI						
							UNIT WEIGHT: 162.8 PCF						

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

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: 1009 MIDDLETOWN RD, WEST CHESTER, PA			Page 1 of 1		
HDD No.: S3-0541		Dates(s) Drilled: 09-13-15		Inspector: E. WATT	
Boring No.: SB-03		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): SEE NOTES		Total Depth (ft): 68.5	
Boring Location Coordinates:			39° 57' 20.144" N		75° 30' 52.646" 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	0.1			TOPSOIL (2")						
1	3.0	5.0	0.1		10	ML	YELLOWISH BROWN TO BROWN SILT WITH SOME FINE SAND, TRACE FINE GRAVEL.	5	7	8	11	15	
2	8.0	10.0	9.0		17		DR, VARIEGATED BROWN, TAN, GRAY FINE TO MEDIUM SAND AND SILT, TRACE UNWEATEHRED FINE ROCK FRAGS.	3	6	7	9	13	
3	13.0	15.0			15	SM	SAME	1	4	6	7	10	
4	18.0	20.0			21		DR, VARIEGATED GRAY, ORANGE BROWN, TAN, WHITE F-M SAND AND SILT, WITH A LITTLE F-C UNWEATHERED ROCK FRAGS.	2	21	41	50	62	
5	23.0	25.0			13	SM	DR, VARIEGATED REDDISH BROWN, GRAY, BLACK MICACEOUS FINE SAND AND SILT. (USCS: SM).	1	2	4	5	6	
6	28.0	29.9			16		DR, VARIEGATED REDDISH BROWN, GRAY, BLACK MICACEOUS F-C SAND WITH SOME SILT, TRACE UNWEATHERED F-C ROCK FRAGS.	1	4	12	50/5"	16	
7	33.0	35.0			17	SM	DR, VARIEGATED GRAY, BROWN, ORANGE BROWN MICACEOUS F-M SAND WITH SOME SILT.	13	12	32	44	44	
8	38.0	39.8			14		SAME, WITH A LITTLE F-C UNWEATHERED ROCK FRAGS.	2	19	32	50/3"	51	
9	43.0	45.0			13	SM	DR, VARIEGATED GRAY, BROWN, WHITE MICACEOUS FINE TO MEDUM SAND AND SILT, TRACE UNWEATHERED ROCK FRAGS.	9	9	22	39	31	
10	48.0	50.0			12		SAME	2	8	10	18	18	
11	53.0	54.3			19	SM	SAME (USCS: SM).	2	22	50/4"		>50	
12	58.0	59.4			16		DR, VARIEGATED GRAY, BROWN, WHITE MICACEOUS FINE TO MEDUM SAND AND SILT, WITH A LITTLE UNWEATHERED ROCK FRAGS.	3	25	50/5"		>50	
13	63.0	64.0			8	SM	SAME	13	50/6"			>50	
14	68.0	68.3		68.5	4		SAME	50/3"				>50	
							AUGER REFUSAL AT 68.5'.						

Notes/Comments:
Pocket Pentrometer Testing
 S1: 2.75 TSF

DR: DECOMPOSED ROCK (FELSIC GNEISS ORGIN)
 PERCHED WATER AT 8'.
 WATER LEVEL THROUGH AUGERS AT 39'.
 CAVED AND WET AT 40'.

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: 1121 S. CHESTER ROAD, WEST CHESTER, PA			Page 1 of 1		
HDD No.: S3-0541		Dates(s) Drilled: 07-09-15		Inspector: E. WATT	
Boring No.: SB-04		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 18.0		Total Depth (ft): 48.0	
Boring Location Coordinates:			39° 57' 13.675" N		75° 30' 47.131" 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		20	ML	REDDISH TO ORANGE BROWN SILT WITH A LITTLE FINE SAND,	1	5	4	5	9	
				6.5			MICACEOUS. (USCS: ML).						
2	8.0	10.0	6.5		16	SM	DR, VARIEGATED BROWN AND GRAY FINE TO MEDIUM SAND WITH	5	7	9	7	16	
							SOME SILT, TRACE FINE ROCK FRAGS.						
3	13.0	15.0			24		DR, VARIEGATED BROWN, ORANGE BROWN AND LIGHT GRAY FINE	2	3	4	4	7	
							TO MEDIUM SAND, SOME SILT.						
4	18.0	20.0			24		DR, VARIEGATED BROWN, ORANGE BROWN AND LIGHT GRAY FINE	2	3	4	8	7	
							TO MEDIUM SAND AND SILT.						
5	23.0	25.0			24		DR, VARIEGATED BROWN AND ORANGE BROWN FINE MICACEOUS	1	6	10	15	16	
							SAND AND SILT.						
6	28.0	30.0			24	DR, VARIEGATED BROWN FINE TO MEDIUM SAND AND SILT.	3	18	25	36	43		
				31.5		(USCS: SM).							
7	33.0	33.9	31.5		11	SM	DR, VARIEGATED LIGHT BROWN AND BROWN MICACEOUS FINE TO	6	50/5"			>50	
							MEDIUM SAND AND SILT, TRACE FINE GNEISS ROCK FRAGS.						
8	38.0	38.8			7		DR, VARIEGATED LIGHT BROWN AND BROWN MICACEOUS FINE TO	32	50/3"			>50	
				40.0		MEDIUM SAND AND SILT, TRACE FINE GNEISS ROCK FRAGS.							
9	42.0	42.0	40.0	42.0	1		PARTIALLY WEATHERED GRAY GNEISS.	50/0"				>50	
							AUGER REFUSAL AT 42'.						
							<u>ROCK CORING</u>						
RUN 1	42.0	46.0	42.0		41	GNEISS ROCK	INTENSELY TO VERY INTENSELY FRACTURED LIGHT GRAY TO GRAY	TCR: 85%, SCR: 21%, RQD: 8%					
							FELSIC GNEISS.						
RUN 2	46.0	48.0		48.0	24		SAME	TCR: 100%, SCR: 21%, RQD: 0%					
							COULD NOT TEST CORE SAMPLE FOR COMPRESSIVE STRENGTH.						
							DUE TO FRACTURE PLANES (WOULD BREAK DURING CORE PREP.)						

Notes/Comments:
Pocket Pentrometer Testing
 S1: 3.5 TSF
 DR: DECOMPOSED ROCK
 AUGER GRINDING AT 40'.
 WET ON SPOON AT 18'.
 WATER LEVEL THROUGH AUGERS AT 21'.
 CAVED AT 37.5', WATER LEVEL ON CAVE AT 16'.

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: MIDDLETOWN ROAD AND RT. 926, GLEN MILLS, PA			Page 1 of 1		
HDD No.: S3-0541		Dates(s) Drilled: 11-12-15		Inspector: J. COSTELLO	
Boring No.: SB-05		Drilling Method: SPT - ASTM D1586		Driller: E. ODGEN	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): NOT ENCOUNTERED		Total Depth (ft): 30.0	
Boring Location Coordinates:			39°57'0.29"N		75°30'38.61"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	0.1			TOPSOIL (2")						
1	3.0	5.0	0.1		18	SM	DR, VARIEGATED DARK GRAYISH BROWN FINE TO MEDIUM SAND AND SILT, TRACE FINE GRAVEL.	2	4	4	5	8	
2	8.0	10.0			18		DR, VARIEGATED GRAY AND BROWN FINE SAND AND SILT, TRACE FINE GRAVEL.	2	6	7	8	13	
3	13.0	15.0			20		SAME. (USCS: SM).	3	12	16	18	28	
4	18.0	20.0			21		SAME.	1	4	10	11	14	
5	23.0	25.0			24		SAME. (USCS: SM).	1	8	17	22	25	
				26.5									
6	28.0	29.3	26.5		16	SM	DR, VARIEGATED GRAY AND BROWN FINE SAND AND SILT, A LITTLE FINE GRAVEL (UNWEATHERED ROCK FRAGS.).	4	37	50/4"		>50	
				30.0									
							AUGERED TO 30'.						
							CAVED AND DRY AT 26'.						

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.

**ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0541**

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					
S3-0541	SB-02	1	32	37	82	33	9	32	37	Moderate	Gneiss	Massive	Gray and White	Nearly rubble, fracturing ranging from 25 to 60 degrees
		2	37	42	92	30	11	37	42	Moderate	Gneiss	Massive	Gray and White	Nearly rubble, no bedding visible.
	SB-4	1	42	46	85	21	8	42	46	Slight	Paragneiss	Massive	Gray	Fractures ranging from 30° to 65°, Avg. 60°
		2	46	48	100	21	0	46	48	Moderate	Gneiss	Thin (foliation)	Gray and White	Fractures average 45°; fractures parallel to foliation, no bedding visible

**GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0541**

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, %	
S3-530	SB-03	1	3.0	5.0	27.8	36.5	-	-	-	-
		2	8.0	10.0	14.9	18.0	-	-	-	-
		3	13.0	15.0	12.0	23.1	NV	NP	NP	SM
		4	18.0	18.9	1.7	6.9	-	-	-	-
S3-0541	SB-01	2	8.0	10.0	15.8	46.3	-	-	-	-
		3	13.0	15.0	16.9	45.8	-	-	-	-
		4	18.0	19.9	12.9	45.0	32	26	6	SM
		5	23.0	25.0	13.8	39.3	-	-	-	-
		6	28.0	29.9	7.9	13.0	-	-	-	-
	SB-02	1	3.0	5.0	27.6	41.5	-	-	-	-
		2	8.0	10.0	29.3	42.4	-	-	-	-
		3	13.0	14.3	21.9	47.2	33	26	7	SM
		5	23.0	24.3	6.7	15.5	-	-	-	-
	SB-03	3	13.0	15.0	12.6	41.0	-	-	-	-
		5	23.0	25.0	35.5	41.9	39	28	11	SM
		7	33.0	35.0	21.9	27.9	-	-	-	-
		10	48.0	50.0	18.8	39.0	-	-	-	-
		11	53.0	54.3	14.7	43.6	35	25	10	SM
	SB-04	1	3.0	5.0	29.1	83.3	42	28	14	ML
		2	8.0	10.0	12.8	34.4	-	-	-	-
		4	18.0	20.0	35.0	46.0	-	-	-	-
		6	28.0	30.0	17.2	46.7	33	26	7	SM
		8	38.0	38.8	8.5	41.4	-	-	-	-
	SB-05	2	8.0	10.0	13.6	45.1	-	-	-	-
		3	13.0	15.0	10.4	47.0	35	26	9	SM
		4	18.0	20.0	11.3	44.8	-	-	-	-
		5	23.0	25.0	16.6	48.2	34	25	9	SM
			6	28.0	29.3	18.4	49.5	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-02	2	39-39.5	13,333	162.8
SB-04	Could not test core samples for compressive strength due to fracture plains, core readily broke apart.			

Notes:

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

**REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0541**

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
S3-0530		SB-03	Felsic gneiss - Light, medium grained; includes rocks of probable sedimentary origin.	Generally level	Felsic gneiss (Precambrian age)	Felsic gneiss; Secondary - paragneiss	No information found during literature review	Ranges from 9 to 70 ft bgs, Avg. 42 ft bgs (.5 mile radius)	All part of Glenarm Supergroup a name given to provincial series of pre-Cambrian metamorphosed sedimentary rocks present in northern VA, MD, southeastern PA, western NJ, and possibly southeastern NY. Rocks from this assemblage consists of a thick sequence of metasedimentary rock and include the following formations; Setters metaquartzite, Cockeysville marble, Wissahickon Schist (along with subset of the Octoraro schist), Peters Creek metaquartzite and meta siltstones and the Peach Bottom Clate (Geology of Pennsylvania SP-1, 1999) . Drilling in these formations generally difficult to very difficult except where fractures and weathered exposed zones present.
S3-0541		SB-01	Felsic gneiss - Light, medium grained; includes rocks of probable sedimentary origin.	Generally level					
		SB-02	Felsic gneiss - Light, medium grained; includes rocks of probable sedimentary origin.	Generally level, slightly sloping to the south					
		SB-03	Felsic gneiss - Light, medium grained; includes rocks of probable sedimentary origin.	Generally level, slightly dipping ot the south					
		SB-04	Felsic gneiss - Light, medium grained; includes rocks of probable sedimentary origin.	Gently sloping to the SW					
		SB-05	Felsic gneiss - Light, medium grained; includes rocks of probable sedimentary origin.	Generally level					

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	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3 Not meeting C_u or C_c requirements for GW		
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines			
		Gravel with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below A Line or I_p less than 4	Limits plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols	
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above A line with I_p greater than 7		
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Clean sands (Little or no fines)	SW	Well graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3 Not meeting C_u or C_c requirements for SW		
			SP	Poorly graded sands, gravelly sands, little or no fines			
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures	Atterberg limits below A Line or I_p less than 4	Limits Plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols	
			SC	Clayey sands, sand-clay mixtures	Atterberg limits above A line with I_p greater than 7		
		Determine Percentage of sand and gravel from grain size curve. Depending on Percentage of fines (fraction smaller than No. 200 sieve), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP More than 12 percent GM, GC, SM, SC 5 to 12 percent Borderline cases requiring dual symbols ⁽¹⁾					
		Major Divisions		Group Symbols	Typical Descriptions	For soils plotting nearly on A line use dual symbols i.e., $I_p = 29.5$, $w_L = 60$ gives CH-MH. When w_L is near 50 use CL-CH or ML-MH. Take near as ± 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.