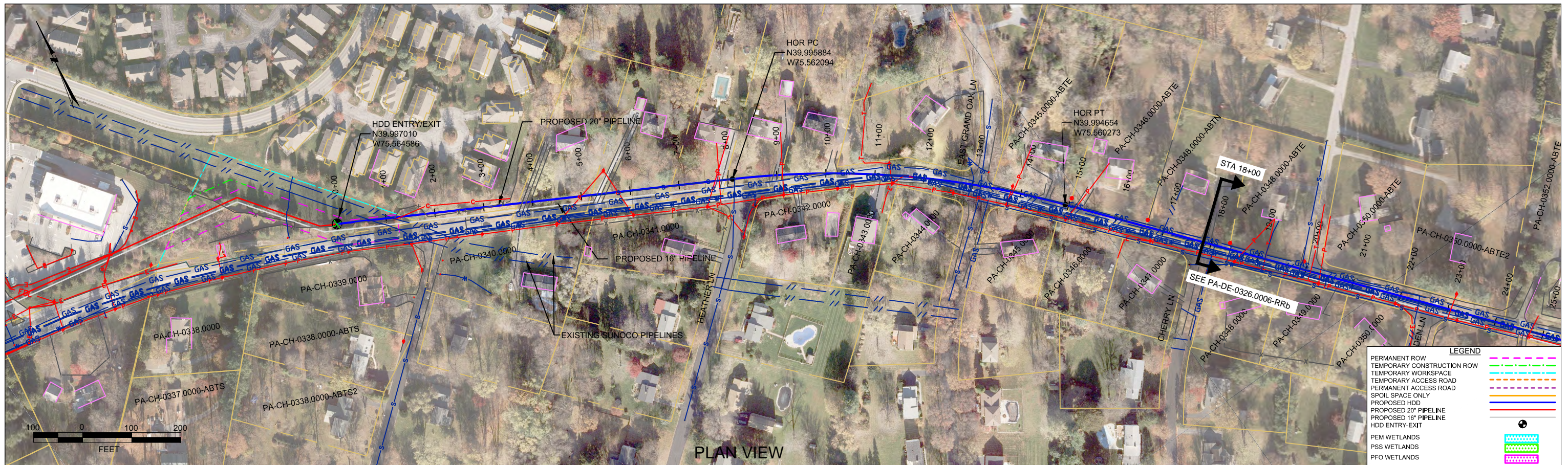


***HDD PA-CH-0326.0006-RD (E Boot Road)***

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.

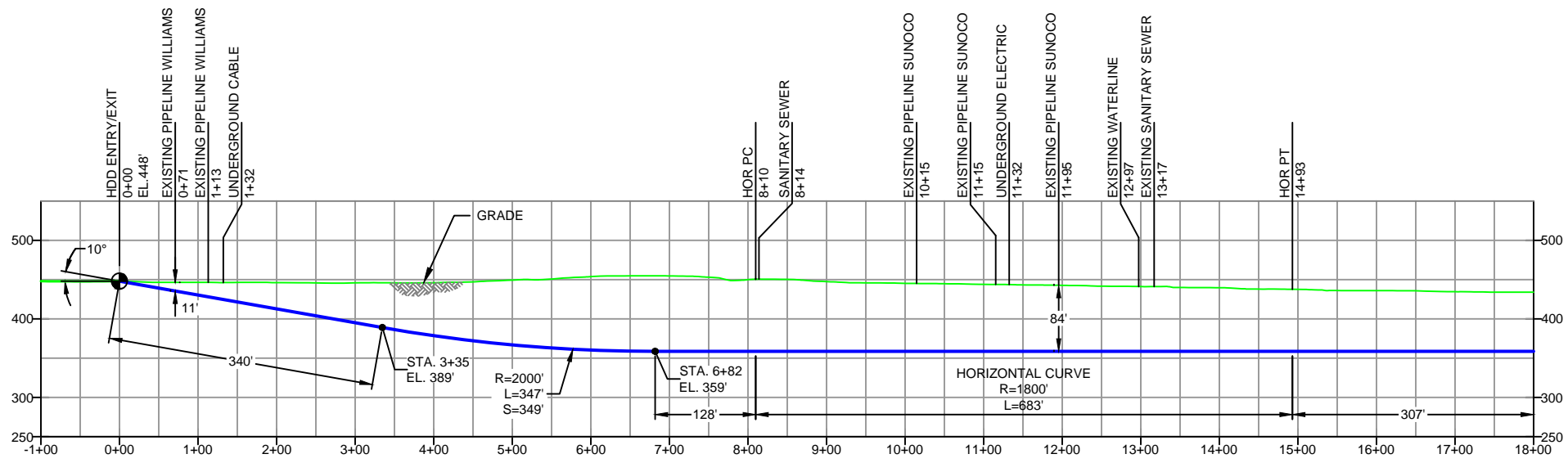
The drill will enter/exit 1000 feet northwest of E Boot Road. The drill will continue under E Boot Road for approximately 2450 feet. This point is 50 feet northwest of the southeast entry/exit point. The drill will pass between 82 and 92 feet under this road. Using the results of the geotechnical investigation, 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.



PLAN VIEW

CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP  
S3-0471A

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): 3510'  
HDD PIPE LENGTH (S): 3523'  
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	
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		REVISIONS	
ES-6.60	TO ES-6.62	EROSION & SEDIMENT PLAN	
SHEET 40	TO SHEET 41	AERIAL SITE PLAN	
		EP1	REVISED PER PADEP COMMENTS
		EP	
		B	ISSUED FOR BID
		A	ISSUED FOR REVIEW
DWG NO	DWG NO	DESCRIPTION	NO.

BY	DATE	CHK	DATE	APP	DATE
DLM	05/11/16	RMB	05/11/16	AAW	05/11/16
MRS	12/07/15	RMB	12/07/15	AAW	12/07/15
MRS	08/21/15	DLM	08/21/15	AAW	08/21/15
JAM	03/26/15	RMB	03/26/15	AAW	03/26/15

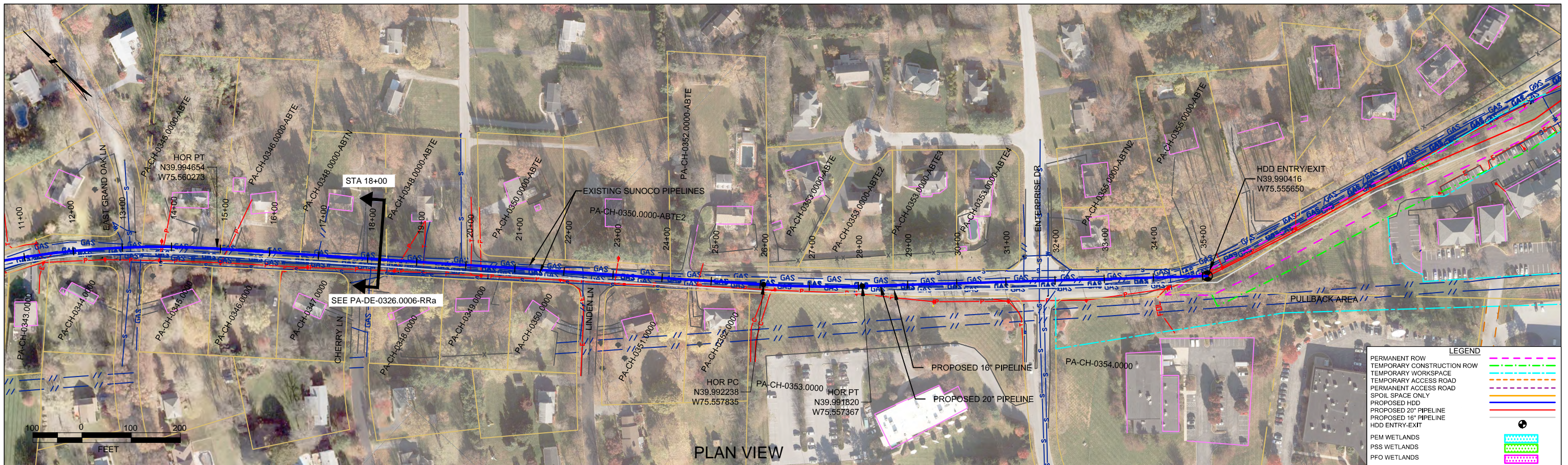
**Sunoco Logistics Partners L.P.**

**TETRA TECH ROONEY**  
(303) 792-5911

**SUNOCO PIPELINE, L.P.**

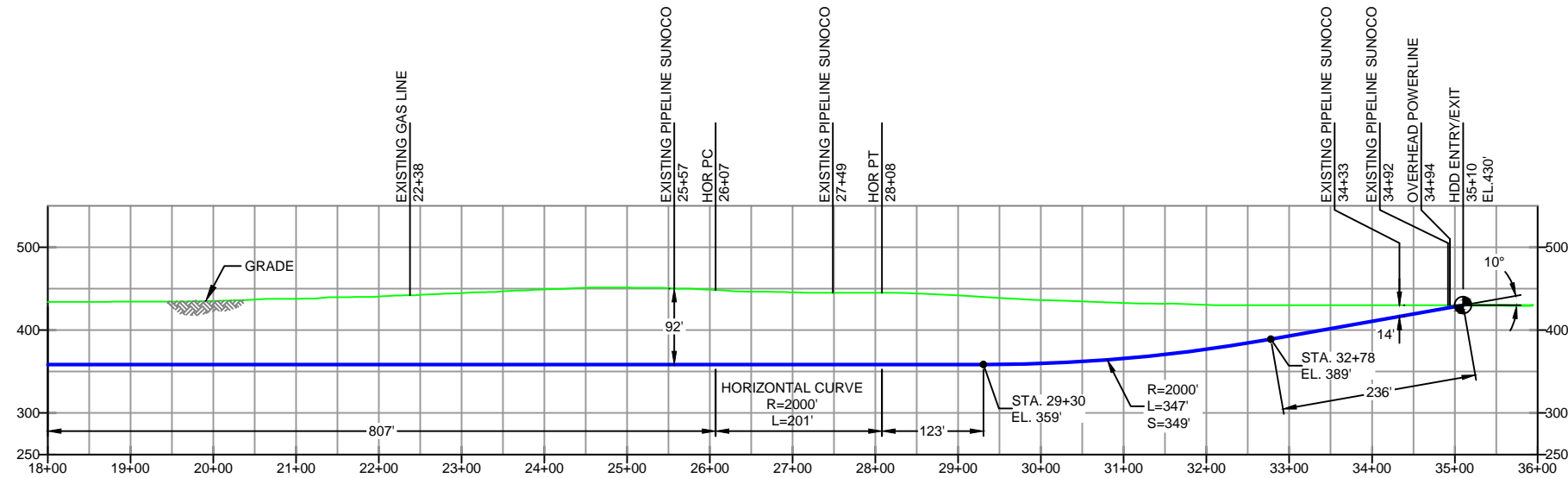
20-INCH HORIZONTAL DIRECTIONAL DRILL  
VILLAGE SQUARE DRIVE  
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'    DWG. NO: PA-CH-00326.0006-RDa



CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP  
S3-0471B

PLAN VIEW  
PROFILE VIEW



DESIGN AND CONSTRUCTION:

- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
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HDD HORZ. LENGTH (L=): 3510'  
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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).
- INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
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- CARRIER PIPE NOT ENCASED.
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- SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
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NOTES

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- STATIONING IS BASED ON HORIZONTAL DISTANCES.
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REF. DRAWING

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SHEET 40	TO	SHEET 41	AERIAL SITE PLAN
			EP1 REVISED PER PADEP COMMITMENTS
			EP
			B ISSUED FOR BID
			A ISSUED FOR REVIEW
DWG NO	DWG NO	DESCRIPTION	NO.

REVISIONS

BY	DATE	CHK	DATE	APP	DATE
DLM	05/11/16	RMB	05/11/16	AAW	05/11/16
MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
MRS	08/21/15	DLM	08/21/15	AAW	08/21/15
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**Sunoco Logistics Partners L.P.**

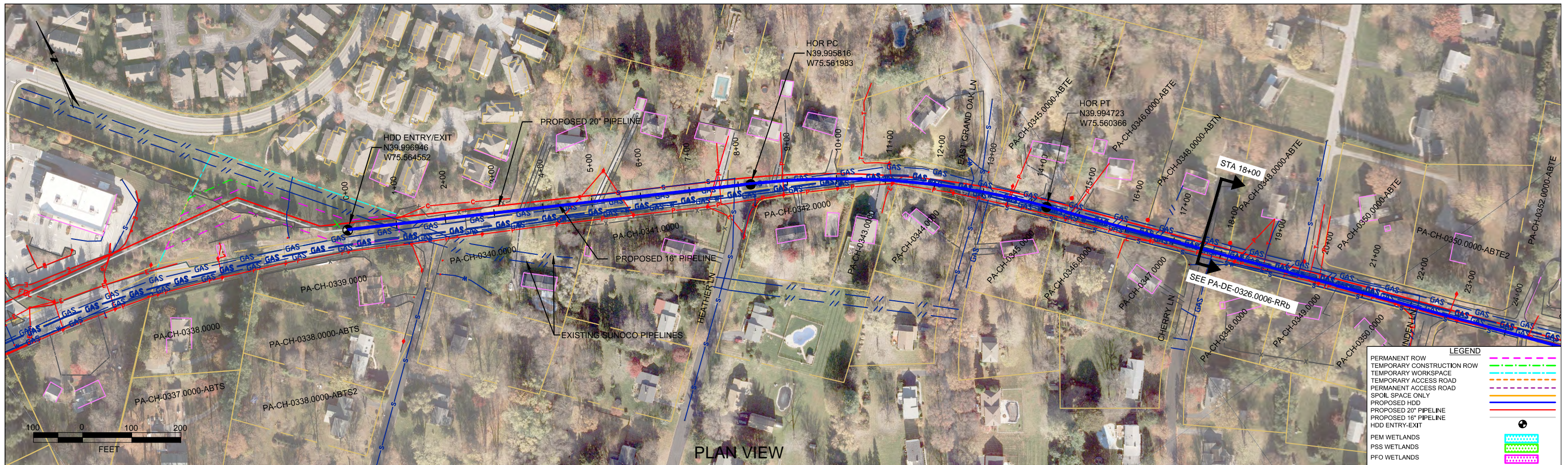
**TETRA TECH ROONEY**  
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL  
VILLAGE SQUARE DRIVE  
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

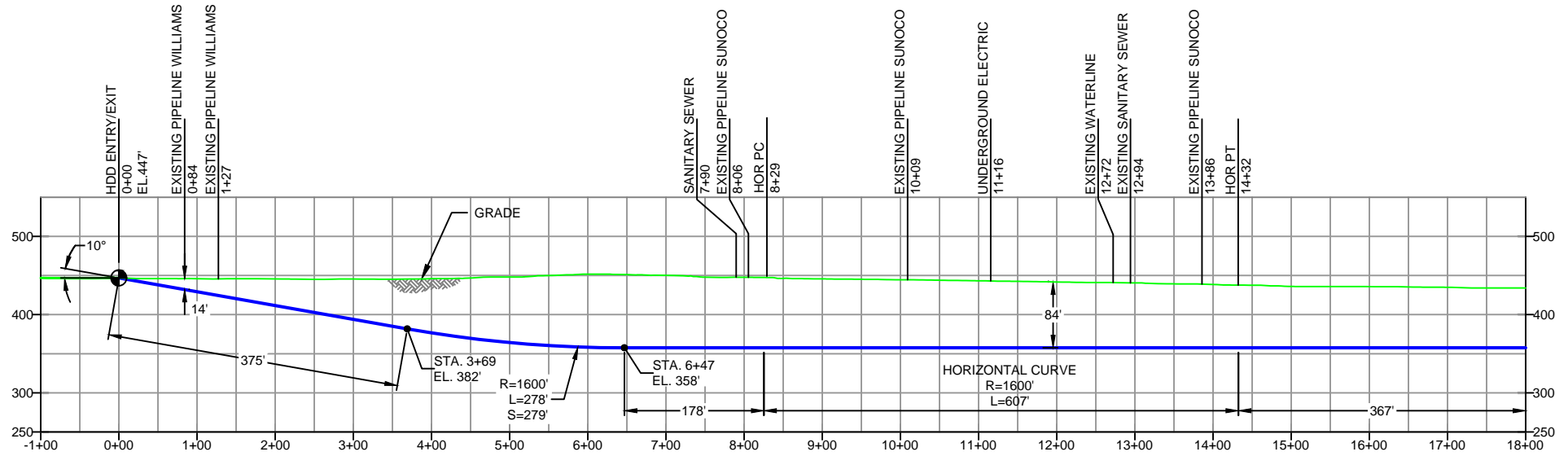
DWG. NO: PA-CH-00326.0006-RDb



PLAN VIEW

CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP  
S3-0471A-16

PROFILE VIEW



- DESIGN AND CONSTRUCTION:**
- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
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  - CROSSING PIPE SPECIFICATION:  
HDD HORZ. LENGTH (L): 3507'  
HDD PIPE LENGTH (S): 3519'  
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).
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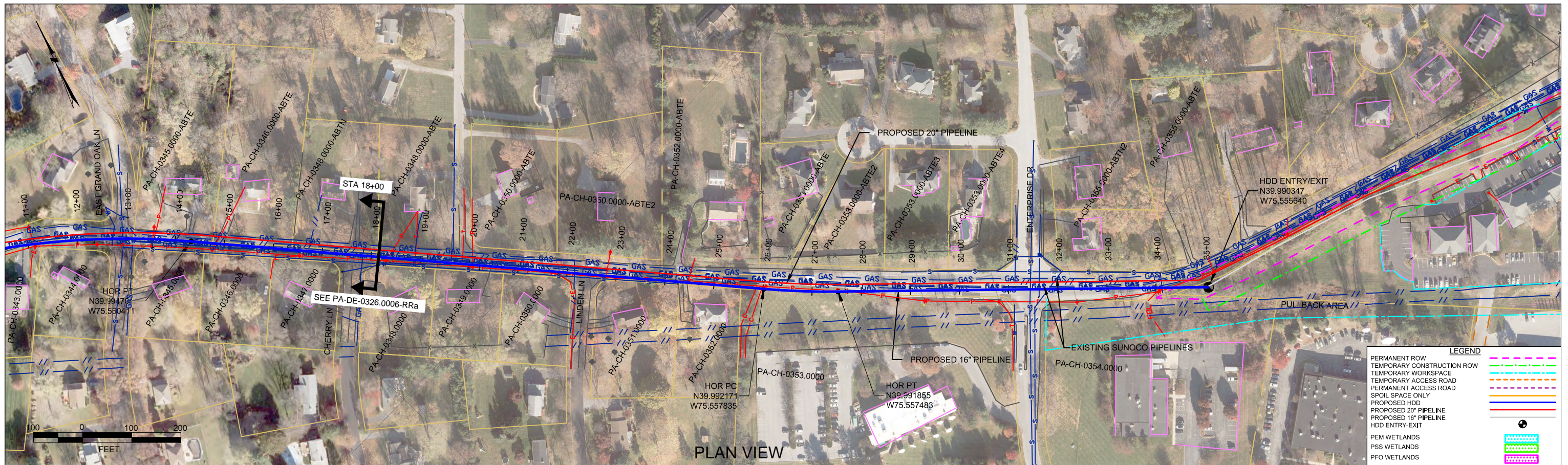
**Sunoco Logistics Partners L.P.**

**TETRA TECH ROONEY**  
(303) 792-5911

**SUNOCO PIPELINE, L.P.**

16-INCH HORIZONTAL DIRECTIONAL DRILL  
VILLAGE SQUARE DRIVE  
PENNSYLVANIA PIPELINE PROJECT

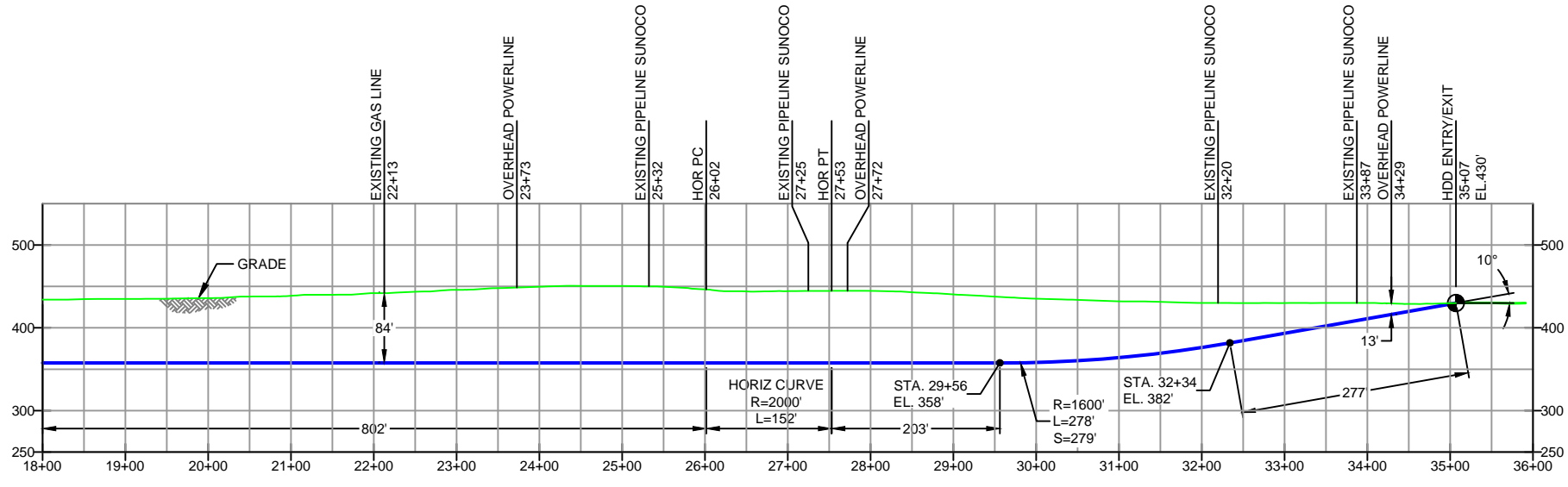
SCALE: 1"=200'    DWG. NO: PA-CH-00326.0006-RDa-16



PLAN VIEW

CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP  
S3-0471B-16

PROFILE VIEW



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		A	ISSUED FOR REVIEW
DWG NO	DWG NO	DESCRIPTION	NO.

**Sunoco Logistics Partners L.P.**

**TETRA TECH ROONEY**  
(303) 792-5911

**SUNOCO PIPELINE, L.P.**

16-INCH HORIZONTAL DIRECTIONAL DRILL  
VILLAGE SQUARE DRIVE  
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'    DWG. NO: PA-CH-00326.0006-RDb-16



**LEGEND:**

☉ Geotechnical Soil Boring (SB) Locations



GEOTECHNICAL BORING LOCATIONS

HDD S3-0470

CHESTER COUNTY, EAST GOSHEN 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: VILLAGE SQUARE SHOPS, WEST CHESTER, PA			Page 1 of 1		
HDD No.: S3-0461		Dates(s) Drilled: 06-25-15		Inspector: E. WATT	
Boring No.: SB-02		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:			39° 59' 52.399" N		75° 34' 3.387" 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 (3")						
1	3.0	5.0	0.3				HAND CLEARED TO 4', DUE TO POTENTIAL UTILITIES. CUTTINGS: ORANGE BROWN FINE SAND AND SILT.						
2	8.0	10.0			15	SM	ORANGE BROWN FINE SAND AND SILT.	2	3	4	3	7	
3	13.0	15.0			24		ORANGE BROWN FINE SAND AND SILT.	1	3	4	6	7	
				16.5									
4	18.0	20.0	16.5		18		DR, VARIEGATED LIGHT BROWN AND ORANGE BROWN MICACEOUS F-M SAND WITH SOME SILT.	2	6	8	12	14	
5	23.0	25.0			20	SM	DR, VARIEGATED LIGHT BROWN AND ORANGE BROWN MICACEOUS F-M SAND WITH SOME SILT.	2	5	13	21	18	
6	28.0	30.0			20		DR, VARIEGATED LIGHT BROWN, ORANGE BROWN, GRAY MICACEOUS F-M SAND AND SILT. (USCS: SM)	2	7	7	10	14	
				30.0									
							AUGERED TO 30'.						
							CAVED AND DRY AT 29'.						

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: HERSHEY MILLS, WEST CHESTER, PA			Page 1 of 1		
HDD No.: S3-0470		Dates(s) Drilled: 09-15-15		Inspector: E. WATT	
Boring No.: SB-01		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 28.0		Total Depth (ft): 75.0	
Boring Location Coordinates:			39° 59' 49.362" N		75° 33' 52.513" 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	1.0			TOPSOIL (12")						
1	3.0	5.0	1.0		10	ML	BROWN SILT WITH SOME FINE SAND, TRACE FINE GRAVEL.	10	10	12	13	22	
2	8.0	10.0			18		DR, REDDISH BROWN, ORANGE BROWN, GRAY SILT AND FINE SAND, TRACE MICA.	3	4	4	5	8	
3	13.0	15.0			24		DR, ORANGE BROWN WITH BLACK AND YELLOW NODULES SILT WITH A LITTLE FINE SAND, TRACE MICA. (USCS: ML)	1	2	4	6	6	
4	18.0	20.0			24		DR, ORANGE BROWN WITH BLACK AND YELLOW NODULES SILT WITH A LITTLE FINE SAND, TRACE MICA.	1	4	5	8	9	
				24.0									
5	23.0	25.0	24.0		24	SM	DR, VARIEGATED GRAY, WHITE, BROWN FINE TO MEDIUM SAND AND SILT.	1	4	5	9	9	
6	28.0	30.0			24		DR, VARIEGATED GRAY, WHITE, BROWN FINE TO MEDIUM SAND AND SILT.	1	4	9	20	13	
7	33.0	35.0			24		DR, VARIEGATED GRAY, WHITE, BROWN FINE TO MEDIUM SAND AND SILT, TRACE FINE UNWEATHERED GRAVEL, TRACE MICA.	2	9	20	21	29	
8	38.0	40.0			18		DR, VARIEGATED GRAY, WHITE, BROWN FINE TO MEDIUM SAND AND SILT, TRACE FINE UNWEATHERED GRAVEL, TRACE MICA.	6	13	19	31	32	
9	43.0	45.0			24		DR, VARIEGATED DARK BROWN, ORANGE BROWN, GRAY FINE TO MEDIUM SAND AND SILT, TRACE FINE UNWEATHERED GRAVEL.	6	22	41	50	63	
10	48.0	49.3			22		DR, VARIEGATED DARK BROWN, ORANGE BROWN, GRAY FINE TO MEDIUM SAND AND SILT, TRACE FINE UNWEATHERED GRAVEL.	4	21	41	50/4"	62	
11	53.0	54.5			12		DR, VARIEGATED DARK BROWN, ORANGE BROWN, GRAY F-M SAND AND SILT, TRACE FINE UNWEATHERED GRAVEL. (USCS: SM).	6	29	50		79	
12	58.0	59.9			13		DR, VARIEGATED YELLOW, BROWN, WHITE, GRAY FINE TO MEDIUM SAND AND SILT, TRACE MICA, TRACE UNWEATHERED F-GRAVEL.	6	13	27	50/5"	40	
13	63.0	63.3			8		DR, VARIEGATED YELLOW, BROWN, WHITE, GRAY FINE TO MEDIUM SAND AND SILT, TRACE MICA, TRACE UNWEATHERED F-GRAVEL.	13	50/3"			>50	
14	68.0	69.5			12		DR, VARIEGATED GRAY, BROWN, YELLOW FINE TO MEDIUM SAND, TRACE MICA, TRACE UNWEATHERED FINE GRAVEL.	6	19	50		69	
15	73.0	73.7			7	DR, VARIEGATED GRAY, BROWN, YELLOW FINE TO MEDIUM SAND, TRACE MICA, TRACE UNWEATHERED FINE GRAVEL.	18	50/2"			>50		
				75.0			TRACE MICA, TRACE UNWEATHERED FINE GRAVEL.						
							AUGERED TO 75'.						

Notes/Comments:

Pocket Pentrometer Testing  
S1: > 4 TSF  
S3: 1.75 TSF

DR: DECOMPOSED ROCK (FELSIC GNEISS SCHIST ORIGIN).  
WATER LEVEL THROUGH AUGERS AT 28'.  
CAVED AT 65'.

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

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



**GEOTECHNICAL LABORATORY TESTING SUMMARY**  
**SUNOCO PENNSYLVANIA PIPELINE PROJECT**  
**HDD S3-0470**

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, %	
S3-0461	SB-02	2	8.0	10.0	21.8	46.1	-	-	-	-
		3	13.0	15.0	22.4	47.7	-	-	-	-
		4	18.0	20.0	18.0	23.5	-	-	-	-
		5	23.0	25.0	16.5	38.8	-	-	-	-
		6	28.0	30.0	17.2	45.5	31	25	6	SM
S3-0470	SB-01	3	13.0	15.0	28.1	86.2	48	30	18	ML
		5	23.0	25.0	26.2	45.1	-	-	-	-
		7	33.0	35.0	17.9	37.7	-	-	-	-
		9	43.0	45.0	15.1	44.3	-	-	-	-
		11	53.0	54.5	13.4	45.4	35	26	9	SM
		13	63.0	63.3	12.3	38.7	-	-	-	-
S3-0480	SB-01	1	3.0	5.0	22.9	79.5	33	24	9	ML
		2	8.0	10.0	12.2	20.8	-	-	-	-
		3	13.0	15.0	14.6	24.9	-	-	-	-
		4	18.0	20.0	17.8	33.0	32	25	7	SM
		5	23.0	25.0	15.5	30.6	-	-	-	-
		6	28.0	30.0	19.7	31.0	-	-	-	-

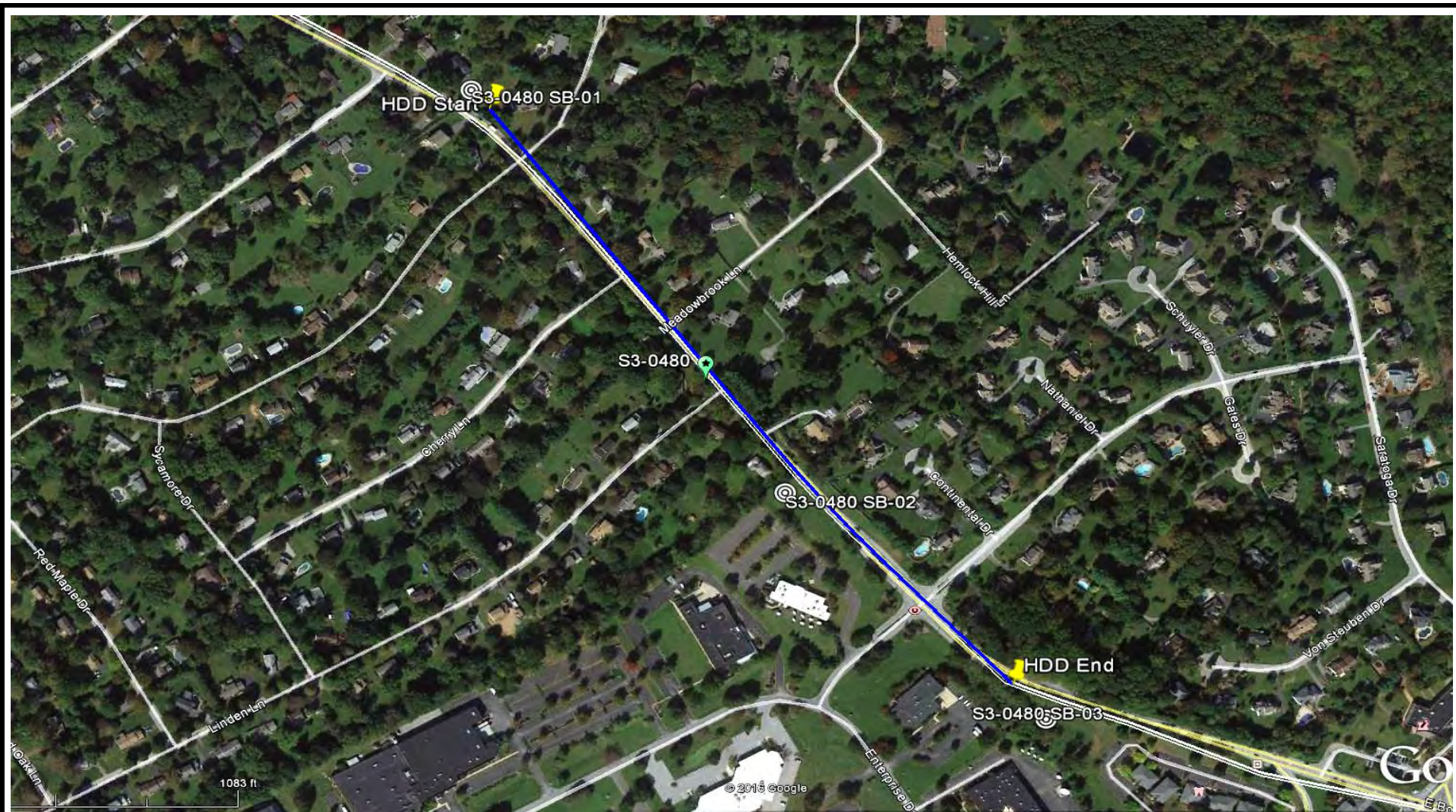
**Notes:**

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

**REGIONAL GEOLOGY SUMMARY  
SUNOCO PENNSYLVANIA PIPELINE PROJECT  
HDD S3-0470**

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
S3-0461	SB-02	Felsic gneiss - Light, medium grained; includes rocks of probable sedimentary origin.	Generally level, slight berm to the north	Felsic gneiss (Precambrian age)	Felsic gneiss; Secondary - paragneiss	No information found during literature review	Ranges from 7 to 21 ft bgs, Avg. 12 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.
S3-0470	SB-01		Generally level					
S3-0480	SB-01		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.



**LEGEND:**

⊙ Geotechnical Soil Boring (SB) Locations



GEOTECHNICAL BORING LOCATIONS  
 HDD S3-0480  
 CHESTER COUNTY, EAST GOSHEN 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: 1385 ENTERPRISE DRIVE, WEST CHESTER, PA			Page 1 of 1		
HDD No.: S3-0480		Dates(s) Drilled: 11-11-15		Inspector: J. COSTELLO	
Boring No.: SB-02		Drilling Method: SPT - ASTM D1586		Driller: E. ODGEN	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 30.0		Total Depth (ft): 40.0	
Boring Location Coordinates:			39°59'31.47"N		75°33'28.57"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	0.2			TOPSOIL (2")							
1	3.0	5.0	0.2		19	ML	BROWN SILT AND FINE SAND, TRACE F-GRAVEL. (USCS: ML).	4	6	12	12		18	
2	8.0	10.0	7.0		19	SM	BROWN FINE SAND WITH A LITTLE SILT.	2	4	4	6		8	
				13.5										
3	13.0	15.0	13.5		24	SM	DR, VARIEGATED WHITE, BROWN, GRAY FINE TO MEDIUM SAND, SOME SILT, TRACE FINE GRAVEL.	5	14	14	19		28	
4	18.0	19.3			14		DR, VARIEGATED WHITE, BROWN, GRAY FINE TO MEDIUM SAND, SOME SILT, TRACE FINE GRAVEL, MICACEOUS. (USCS: SM).	8	22	50/4"				>50
5	23.0	23.9			10		SAME	3	50/5"					>50
6	28.0	28.4			4		SAME	50/5"						>50
				31.0										
								AUGER REFUSAL AT 31'.						
							<u>ROCK CORING</u>							
RUN 1	31.0	35.0	31.0		0		NO RECOVERY IN CORE BARREL (ALL HIGHLY WEATHERED).	TCR: 0%, SCR: 0%, RQD: 0%						
RUN 2	35.0	40.0		40.0	22		WHITE AND GRAY FELSIC GNEISS, HIGHLY WEATHERED AND FRACTURED.	TCR: 37%, SCR: 21%, RQD: 0%						
							<u>CORE TESTING RESULTS (DEPTH 37.0-37.5):</u>							
							COMPRESSIVE STRENGTH: 4,693 PSI							
							UNIT WEIGHT: 164.1 PCF							
							WET ON SPOON AT 30'.							
							CAVED AND DAMP AT 30'.							

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.



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**TEST BORING LOG**

Project Name:		SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406	
Project Location:		GOSHEN EXECUTIVE CENTER, 1450 BOOT ROAD, WEST CHESTER, PA		Page 1 of 1	
HDD No.:	S3-0480	Dates(s) Drilled:	06-25-15	Inspector:	E. WATT
Boring No.:	SB-03	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:		39° 59' 24.267" N		75° 33' 18.804" 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	0.2			TOPSOIL (2")						
1	3.0	5.0	0.2		21	SM	DR, VARIEGATED BROWN, LIGHT BROWN, AND ORANGE BROWN MICACEOUS FINE TO MEDIUM SAND AND SILT.	1	2	2	3	4	
2	8.0	10.0			18		SAME	1	4	6	8	10	
3	13.0	15.0			20		SAME	1	7	9	14	16	
4	18.0	20.0			24		DR, VARIEGATED BROWN AND ORANGE BROWN, MICACEOUS FINE TO MEDIUM SAND AND SILT.	1	9	9	15	18	
				21.5									
5	23.0	24.5	21.5		17	SM	DR, VARIEGATED BROWN, LIGHT BROWN, ORANGE BROWN, WHITE MICACEOUS FINE SAND AND SILT, TRACE FINE ROCK FRAGS. (USCS: SM)	3	30	50		80	
6	28.0	29.0			7		DR, VARIEGATED BROWN AND GRAY, MICACEOUS FINE TO MEDIUM SAND AND SILT, TRACE FINE ROCK FRAGS.	5	50/6"			>50	
				30.0									
							AUGERED TO 30'.						
							CAVED AND DRY AT 28'.						

Notes/Comments:  
Pocket Penetrometer 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 S3-0480**

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					
S3-0480	SB-02A	1	31	35	0	0	0	31	35	n/a	n/a	n/a	n/a	No Recovery
		2	35	40	37	21	0	35	40	Moderate	Felsic gneiss	Massive	White/ brown	Fractures ranging from 5° to 44°, Avg. 24°

**GEOTECHNICAL LABORATORY TESTING SUMMARY  
SUNOCO PENNSYLVANIA PIPELINE PROJECT  
HDD S3-0480**

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, %	
S3-0480	SB-01	1	3.0	5.0	22.9	79.5	33	24	9	ML
		2	8.0	10.0	12.2	20.8	-	-	-	-
		3	13.0	15.0	14.6	24.9	-	-	-	-
		4	18.0	20.0	17.8	33.0	32	25	7	SM
		5	23.0	25.0	15.5	30.6	-	-	-	-
		6	28.0	30.0	19.7	31.0	-	-	-	-
	SB-02	1	3.0	5.0	26.8	60.0	32	25	7	ML
		2	8.0	10.0	6.6	17.7	-	-	-	-
		3	13.0	15.0	8.8	25.1	-	-	-	-
		4	18.0	19.3	6.6	25.3	NV	NP	NP	SM
		5	23.0	23.9	13.2	27.6	-	-	-	-
	SB-03	2	8.0	10.0	12.0	44.1	-	-	-	-
		3	13.0	15.0	13.5	44.9	-	-	-	-
		4	18.0	20.0	17.2	44.7	-	-	-	-
		5	23.0	24.5	10.6	44.8	33	25	8	SM
		6	28.0	29.0	7.6	36.5	-	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-02	2	37.0-37.5	4693	164.1

**Notes:**

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

**REGIONAL GEOLOGY SUMMARY  
SUNOCO PENNSYLVANIA PIPELINE PROJECT  
HDD S3-0480**

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
S3-0480	SB-01	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 10 to 78 ft bgs, Avg. 29 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.
	SB-02		Generally level, slightly sloping to the SW					
	SB-03		Generally level, slightly sloping to the west					

*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 <sup>(1)</sup>					
		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 $\pm 2$ 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.