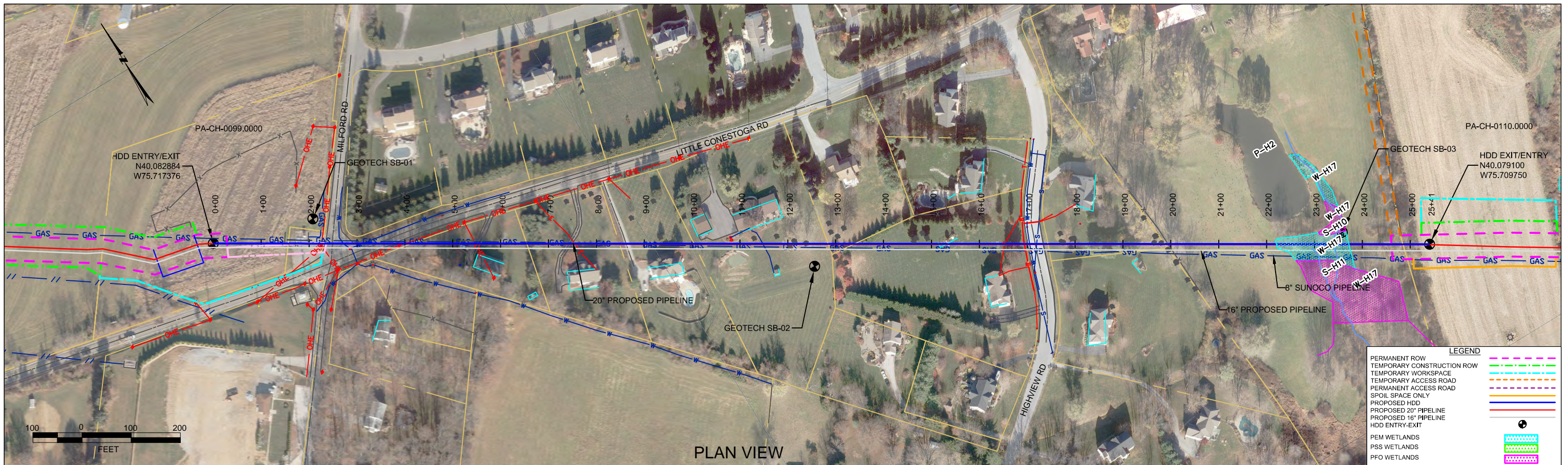


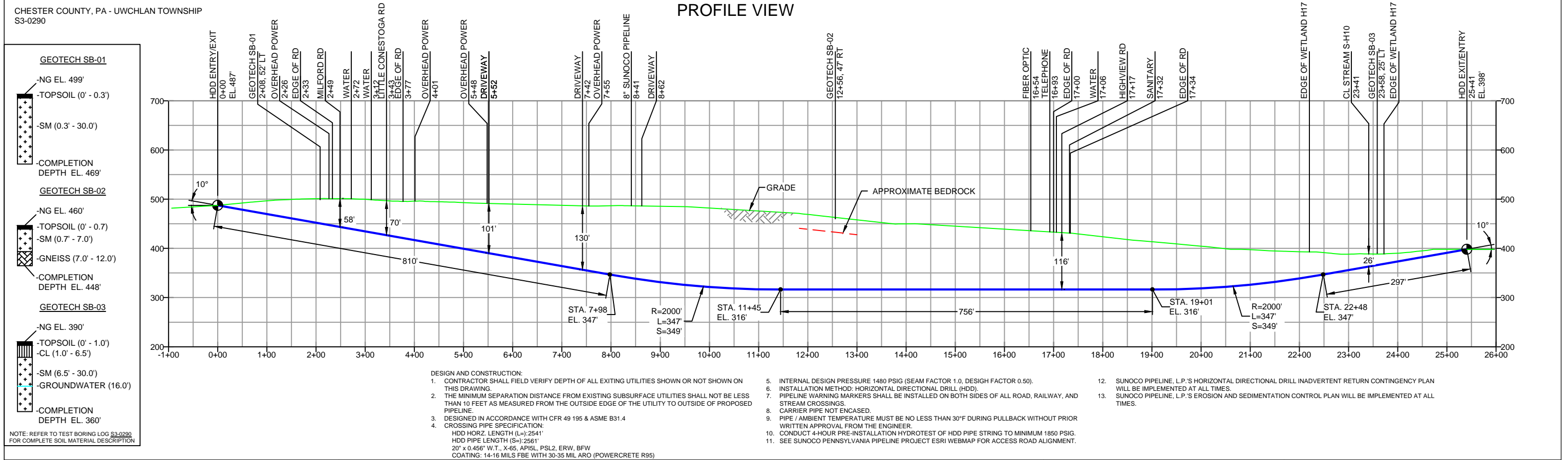
HDD PA-CH-0100.0000-RD (W-H17, S-H10)

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 2220 feet northwest of the northwestern most boundary of wetland H17. The other entry/exit point is 171 feet southeast of the southeastern most boundary of wetland H17. The drill will pass 50 feet under the northwestern most boundary of the wetland and 20 feet under the southeastern most boundary of the wetland. Stream H10 runs through this wetland, 200 feet northwest of the southeastern entry/exit point. The drill will pass 26 feet under the 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.



PLAN VIEW



PROFILE VIEW

CHESTER COUNTY, PA - UWCHLAN TOWNSHIP
S3-0290

GEOTECH SB-01
-NG EL. 499'
-TOPSOIL (0' - 0.3')
-SM (0.3' - 30.0')
-COMPLETION DEPTH EL. 469'
GEOTECH SB-02
-NG EL. 460'
-TOPSOIL (0' - 0.7')
-SM (0.7' - 7.0')
-GNEISS (7.0' - 12.0')
-COMPLETION DEPTH EL. 448'
GEOTECH SB-03
-NG EL. 390'
-TOPSOIL (0' - 1.0')
-CL (1.0' - 6.5')
-SM (6.5' - 30.0')
-GROUNDWATER (16.0')
-COMPLETION DEPTH EL. 360'

NOTE: REFER TO TEST BORING LOG S3-0290 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)=2541'
HDD PIPE LENGTH (S)=2561'
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 811-900-786-7440.

REF. DRAWING		REVISIONS	
ES-6.27	TO	ES-6.29	DESCRIPTION
SHEET 16	TO	SHEET 17	AERIAL SITE PLAN
		EP1	EROSION & SEDIMENT PLAN
		EP	REVISED PER PADEP COMMENTS
		D	ADDED GEOTECH INFO
		C	ISSUED FOR BID
		B	ISSUED FOR BID
		A	ISSUED FOR REVIEW
DWG NO	DWG NO	DESCRIPTION	NO.

BY	DATE	CHK	DATE	APP	DATE
JTW	05/09/16	RMB	05/09/16	AAW	05/09/16
MRS	12/07/15	RMB	12/07/15	AAW	12/07/15
MRS	09/25/15	RMB	09/25/15	AAW	09/25/15
DLM	08/21/15	RMB	08/21/15	AAW	08/21/15
DLM	07/31/15	RMB	07/31/15	AAW	07/31/15
KB	03/28/15	RMB	03/28/15	AAW	03/28/15

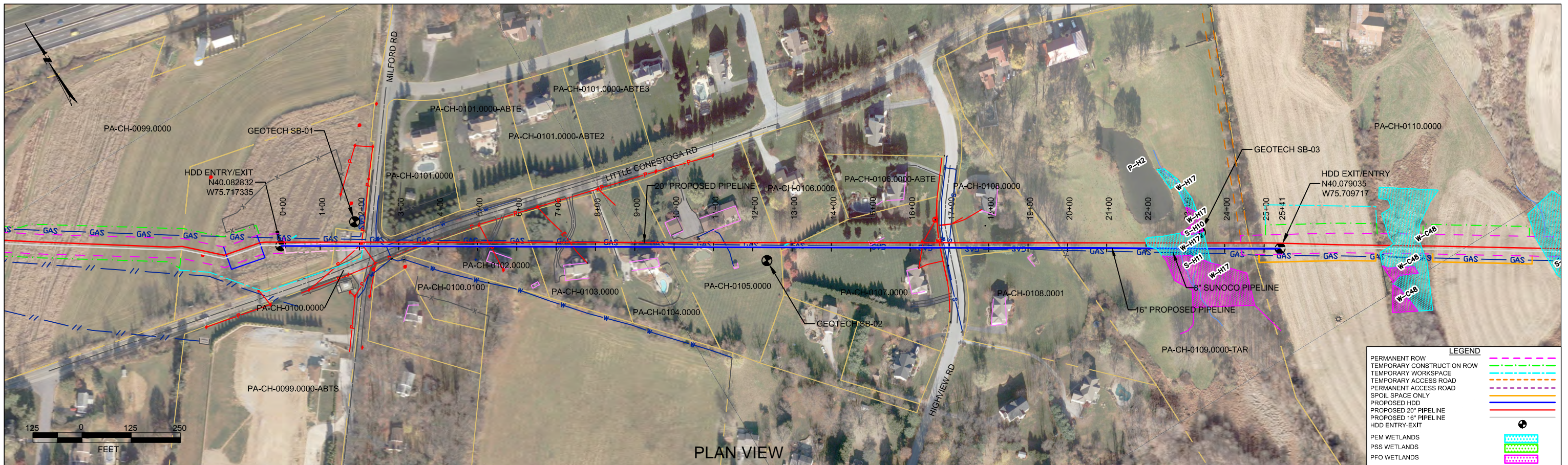
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

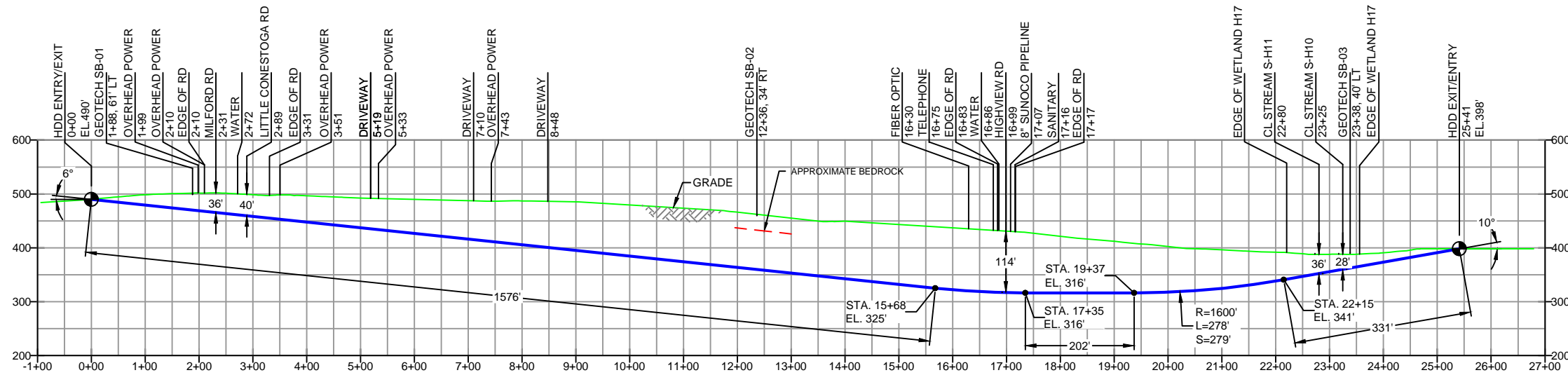
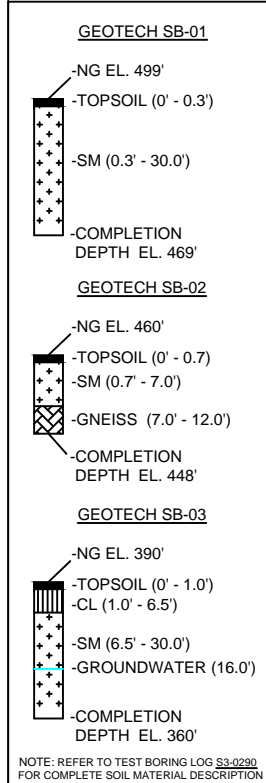
20-INCH HORIZONTAL DIRECTIONAL DRILL
LITTLE CONESTOGA ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'
DWG. NO: PA-CH-0100.0000-RD



PLAN VIEW
PROFILE VIEW

CHESTER COUNTY, PA - UWCHLAN TOWNSHIP
S3-0290-16



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_H): 2541'
HDD PIPE LENGTH (S): 2557'
16" x 0.438" W.T., X-70, API5L, PSL2, ERW, 8FW
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.
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- SUNOCO EMERGENCY HOTLINE NUMBER IS 811-800-786-7440.

REF. DRAWING		REVISIONS	
ES-6.27	TO ES-6.29	EROSION & SEDIMENT PLAN	
SHEET 16	TO SHEET 17	AERIAL SITE PLAN	
		EP1	REVISED PER PADEP COMMENTS
		EP	
		B	ADDED GEOTECH INFO
		A	ISSUED FOR BID
DWG NO	DWG NO	DESCRIPTION	NO.

BY	DATE	CHK	DATE	APP	DATE
JTW	05/10/16	RMB	05/10/16	AAW	05/10/16
MRS	03/15/16	RMB	03/15/16	AAW	03/15/16
MRS	09/25/15	RMB	09/25/15	AAW	09/25/15
MRS	08/31/15	RMB	08/31/15	AWW	08/31/15



SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
LITTLE CONESTOGA ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'
DWG. NO: PA-CH-0100.0000-RD-16



LEGEND:

⊙ Geotechnical Soil Boring (SB) Locations



GEOTECHNICAL BORING LOCATIONS
 HDD S3-0290
 CHESTER COUNTY, UPPER 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: MILFORD AND LITTLE CONESTOGA ROADS, DOWNINGTOWN, PA			Page 1 of 1		
HDD No.: S3-0290		Dates(s) Drilled: 05-20-15		Inspector: E. WATT	
Boring No.: SB-01		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): NOT ENCOUNTERED		Total Depth (ft): 30.0	
Boring Location Coordinates:			40° 4' 57.699" N		75° 42' 59.880" 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		19	SM	LIGHT BROWN AND WHITE FINE TO MEDIUM SAND WITH SOME SILT.	16	30	21	18	51	
2	8.0	9.5			13		VARI-COLORED FINE TO MEDIUM SAND WITH SOME SILT, TRACE FINE GRAVEL.	3	20	50		70	
3	13.0	14.9			22		VARI-COLORED FINE TO MEDIUM SAND WITH SOME SILT, TRACE FINE GRAVEL.	3	9	22	50/5"	31	
4	18.0	18.9			7		LIGHT BROWN AND WHITE FINE TO MEDIUM SAND WITH SOME SILT, AND A LITTLE FINE QUARTZ GRAVEL.	6	50/5"			>50	
5	23.0	23.8			8		LIGHT BROWN AND WHITE FINE TO MEDIUM SAND WITH SOME SILT, AND A LITTLE FINE QUARTZ GRAVEL. (USCS: SM).	28	50/3"			>50	
6	28.0	28.7			5		LIGHT BROWN AND WHITE FINE TO MEDIUM SAND WITH SOME SILT, AND A LITTLE FINE QUARTZ GRAVEL.	5	50/2"			>50	
				30.0									
								AUGERED TO 30'.					
								CAVED AND DRY AT 28.5'.					
								SAMPLES 2 THRU 6 ARE HIGHLY DECOMPOSED ROCK SOILS. (SOILS THAT HAVE BEEN WEATHERED IN-PLACE FROM ROCK)					

Notes/Comments:
Pocket Pentrometer Testing

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: 465 LITTLE CONESTOGA ROAD, DOWNINGTOWN, PA			Page 1 of 1		
HDD No.: S3-0290		Dates(s) Drilled: 05-27-15		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): 12.0	
Boring Location Coordinates:			40° 4' 51.263" N		75° 42' 49.239" 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	0.7			TOPSOIL (8")						
1	3.0	5.0	0.7		16	SM	BROWN AND GRAY FINE TO MEDIUM SAND AND SILT, WITH A LITTLE	13	22	28	23	50	
				7.0			FINE TO COARSE UNWEATHERED ROCK GRAVEL (GNEISS). (USCS: SM).						
							AUGER REFUSAL AT 7'.						
							<u>ROCK CORING</u>						
RUN 1	7.0	12.0	7.0	11.0	60	ROCK	VERY INTENSELY FRACTURED GRAY GNEISS, SOME OXIDATION.	TCR: 100%, SCR: 35%, RQD: 20%					
			11.0	11.9			MODERATELY FRACTURED GRAY GNEISS.						
			11.9	12.0			VERY INTENSELY FRACTURED GRAY GNEISS.						
							<u>CORE TESTING RESULTS (RUN 1, DEPTH 7.7):</u>						
							COMPRESSIVE STRENGTH: 5,690 PSI						
							UNIT WEIGHT: 172.8 PCF						
							<u>CORE TESTING RESULTS (RUN 1, DEPTH 11.5):</u>						
							COMPRESSIVE STRENGTH: 3,360 PSI						
							UNIT WEIGHT: 160.8 PCF						
							OBSTRUCTION AT 9' PREVENTED ROCK CORE BARRELL FROM						
							BEING ADVANCED TO START RUN 2.						

Notes/Comments:
Pocket Pentrometer Testing

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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 fax: 302.454.5988

TEST BORING LOG

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: CH-0109, DOWNINGTOWN, PA			Page 1 of 1		
HDD No.: S3-0290		Dates(s) Drilled: 05-27-15		Inspector: J. COSTELLO	
Boring No.: SB-03		Drilling Method: SPT - ASTM D1586		Driller: GREG	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 16.0		Total Depth (ft): 30.0	
Boring Location Coordinates:			40° 4' 45.950" N		75° 42' 36.827" 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		24	CL	MOTTLED BROWN AND GRAY SILTY CLAY WITH A LITTLE FINE SAND, TRACE FINE ROOTS. (USCS: CL).	5	7	9	11	16	
				6.5									
2	8.0	10.0	6.5		20	SM	DR WEATHERED TO A VARI-COLORED FINE SAND AND SILT, TRACE FINE UNWEATHERED GRAVEL. (USCS: SM).	3	4	6	7	10	
3	13.0	15.0			23		DR WEATHERED TO A WHITE, GRAY, TAN FINE TO MEDIUM SAND AND SILT, TRACE UNWEATHERED FINE GRAVEL.	1	4	6	8	10	
4	18.0	20.0			24		DR WEATHERED TO A WHITE, GRAY, TAN FINE SAND AND SILT, TRACE UNWEATHERED FINE GRAVEL.	2	3	7	12	10	
5	23.0	25.0			24		DR WEATHERED TO A WHITE, GRAY, TAN FINE SAND AND SILT, TRACE UNWEATHERED FINE GRAVEL.	1	4	6	10	10	
6	28.0	30.0			24		DR WEATHERED TO A WHITE, GRAY, TAN FINE SAND AND SILT, TRACE UNWEATHERED FINE GRAVEL. (USCS: SM).	1	1	6	4	7	
				30.0									

Notes/Comments:
Pocket Penetrometer Testing DR: DECOMPOSED ROCK
 S1: > 4TSF

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 S3-0290**

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, %	
S3-0290	SB-01	1	3.0	5.0	11.7	27.8	-	-	-	-
		2	8.0	9.5	6.3	22.0	-	-	-	-
		4	18.0	18.9	7.4	31.5	-	-	-	-
		5	23.0	23.8	6.6	30.5	29	24	5	SM
		6	28.0	28.7	7.4	37.7	-	-	-	-
	SB-02	1	3.0	5.0	13.0	38.8	30	24	6	SM
	SB-03	1	3.0	5.0	20.3	83.0	41	23	18	CL
		2	8.0	10.0	21.5	48.0	36	26	10	SM
		3	13.0	15.0	23.9	42.1	-	-	-	-
		5	23.0	25.0	22.9	47.6	-	-	-	-
		6	28.0	30.0	22.9	47.6	55	37	18	SM

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-02	1	7.7	5,690	172.8
SB-02	1	11.5	3,360	160.8

Notes:

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

**ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0290**

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					
S3-0290	SB-2	1	7	12	100	35	20	7	8	Moderate	Gneiss	Massive	Light gray	Fractures ranging from 0° to 45°, Avg. 29°
								8	10	Moderate	Metavolcanic inclusion	2	Gray, brown, black	Fractures ranging from 4° to 75°, Avg. 49°
								10	12	Moderate	Gneiss	Massive	Light gray	Fractures ranging from 30° to 75°, Avg. 51°

**REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0290**

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
S3-0290	Little Conestoga Road, Downingtown	SB-01	Graphitic felsic gneiss - Includes Pickering Gneiss and small areas of marble; dominantly quartz and feldspar with varying amounts of graphite and various metamorphic minerals; medium grained, light to dark gray and greenish gray; sedimentary origin.	Gently sloping to the north	Graphitic felsic gneiss (PreCambrian)	Graphitic gneiss	Unknown	Ranges from 4 to 50 ft bgs, Avg. 27 ft bgs (.25 mile radius)	
		SB-02		Generally level, slightly sloping to the south				Ranges from 10 to 50 ft bgs, Avg. 29 ft bgs (.25 mile radius)	
		SB-03		Generally level				Ranges from 10 to 50 ft bgs, Avg. 31 ft bgs (.25 mile radius)	

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

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

<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	MH or OH			
		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.