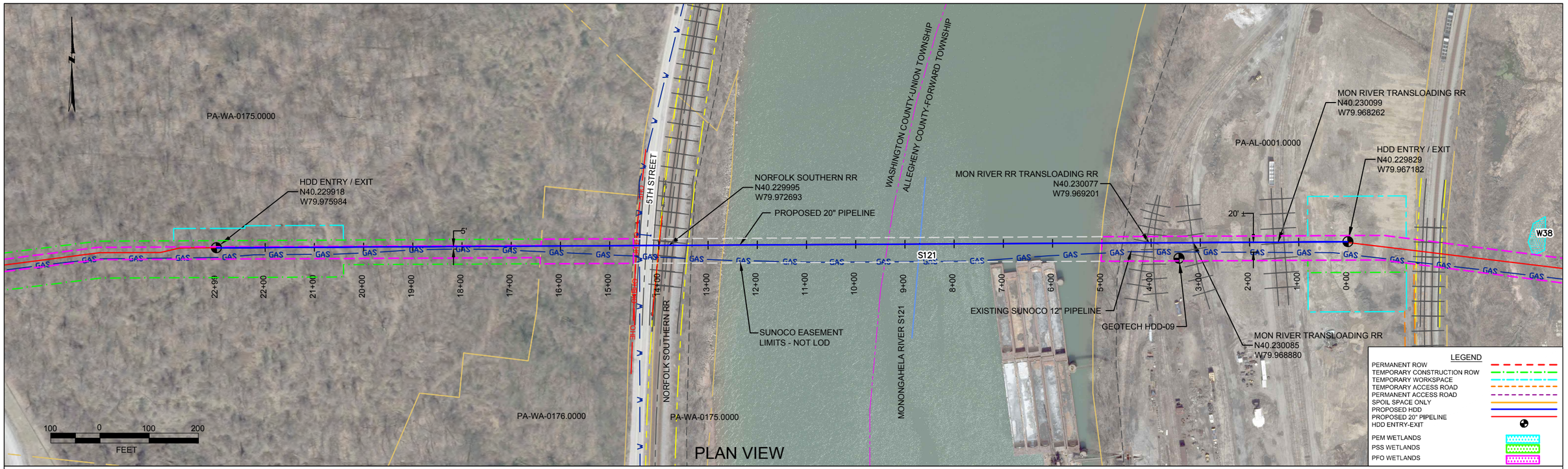
HDD PA-WA-0176.0000-RD (S121)

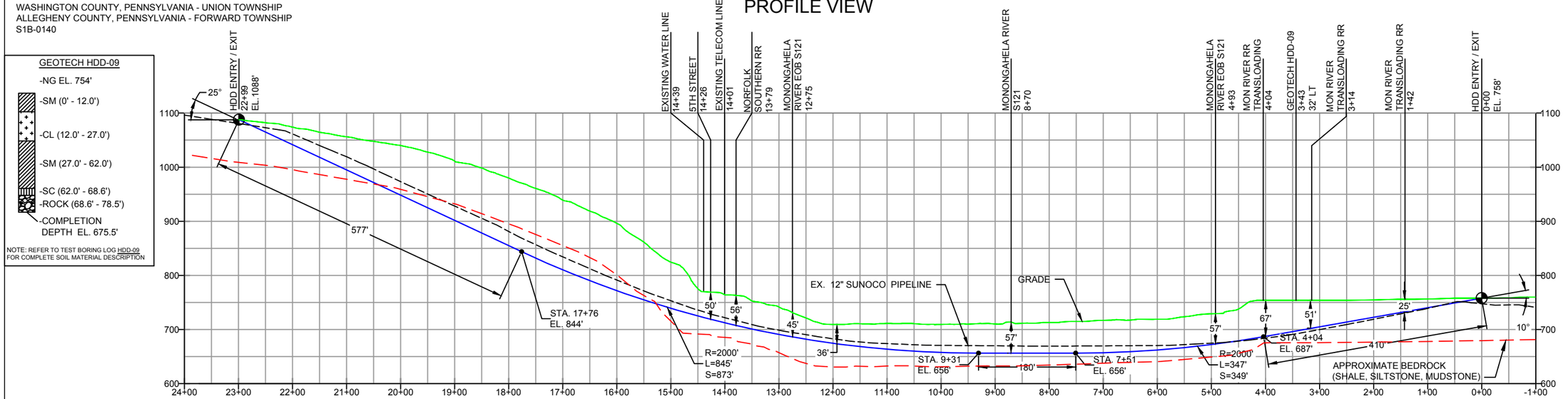
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts,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

The drill will enter/exit 1,000 feet from the western edge of the Monongahela River (S121) and enter/exit 530 feet from the eastern edge and cross at depths greater than 40 feet. The 20" drill will parallel the existing ME1 12" pipeline drill. The geotechnical results from the previous drill, as well as other data points, were used to determine the entry/exit angles, and depths to pass through the best substrates while maintaining the pipe integrity (e.g., no large bends). According to the geotechnical report the primary substrate at the crossing (S121) is estimated to be silt and clay. Based on the geotechnical report, the drill profile, and the previous drill data minimal inadvertent returns are expected.



WASHINGTON COUNTY, PENNSYLVANIA - UNION TOWNSHIP
ALLEGHENY COUNTY, PENNSYLVANIA - FORWARD TOWNSHIP
S1B-0140

PROFILE VIEW



DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXITING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. 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.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 2299'
   HDD PIPE LENGTH (S=): 2389'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. 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.
12. BLASTING NOT PERMITTED.
13. 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-1.59	TO	ES-1.01	EROSION & SEDIMENT PLAN	
SHEET 35	TO	SHEET 36	AERIAL SITE PLAN	

DWG NO		DWG NO	DESCRIPTION

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/20/16	RMB	05/20/16	AAW	05/20/16
EP		DLM	03/15/16	RMB	03/15/16	AAW	03/15/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
NORFOLK SOUTHERN RR, MONONGAHELA RIVER
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200' | DWG. NO: PA-WA-0176.0000-RR

Source: Topo data from USGS DLG Roads from DelDOT

S:\03-Projects*\arcmap\mxd*\ Rooney (RE)\GIS\Boring Map HDD-09.mxd

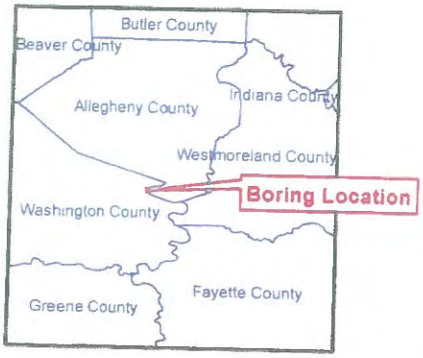


Figure
Boring Location HDD-09
Sunoco Mariner East Project
Allegheny County, PA

0 250 500 1,000 Feet

1 inch = 500 feet

Tetra Tech, Inc.
Phone: (302) 738-7551
Toll Free: (800) 462-0910
www.tetratech.com

TETRA TECH
240 Continental Drive, Suite 200
Newark, Delaware 19713
302.738.7551
fax 302.454.5988

TEST BORING LOG

Project Name: SUNOCO MARINER EAST | Project No.: 103IP2762

Project Location: ALLEGHANY COUNTY, PA | Page 1 of 1

Test Boring No.: HDD-09 | Dates(s) Drilled: 09/09/13 | Inspector: E. WATT

Drilling Contractor: CONNELLY | Drilling Method: SPT - ASTM D1586 | Driller: K. KERCH

Surface Elevation (ft): | Groundwater Depth (ft): 24.5 | Total Depth (ft): 78.5

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *			N
1	3.5	5.0	0.0		6	SM	LIGHT BROWN FINE TO MEDIUM SAND WITH A TRACE OF	3	4	5	9
							SANDSTONE GRAVEL., AND A LITTLE SILT (HISTORIC FILL).				
2	8.5	10.0			2		LIGHT BROWN FINE TO MEDIUM SAND WITH A TRACE OF	3	3	5	8
				12.0			SANDSTONE GRAVEL, AND A LITTLE SILT (HISTORIC FILL).				
3	13.5	15.0	12.0		10	CL	MOTTLED BROWN AND GRAY SILTY CLAY, TRACE MICA, TRACE	2	3	3	6
							TO LITTLE SILT. USCS: CL				
4	18.5	20.0			18		BROWN SILTY CLAY WITH SOME FINE SAND, TRACE MICA.	3	3	3	6
5	23.5	25.0		27.0	18		BROWN SANDY CLAY, TRACE MICA.	1	1	2	3
6	28.5	30.0	27.0		1	SM	BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT.	2	3	3	6
7	33.5	35.0			18		BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT.	3	3	6	9
8	38.5	40.0			18		BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT. 2" BLACK	1	3	4	7
							SEAM PRESENT (LIGNITE?)				
9	43.5	45.0			18		BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT.	3	4	7	11
10	48.5	50.0			18		BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT. 2" BLACK	3	6	7	13
							SEAM PRESENT (LIGNITE?).				
11	53.5	55.0			18		BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, WITH A	3	17	30	47
							LITTLE FINE GRAVEL, INTERLAYERED WITH "LIGNITE?".				
12	58.5	60.0			17		BROWN FINE TO COARSE SAND WITH A LITTLE SILT, WITH A	8	16	17	33
				62.0			LITTLE FINE GRAVEL.				
13	63.5	65.0	62.0		18	SC	DECOMPOSED ROCK WEATHERED TO A MULT-COLORED FINE	19	32	50	82
							TO MEDIUM SAND, WITH SOME CLAY.				
14	68.5	68.6		68.6	<1		LIGHT GRAY PARTIALLY WEATHERED SILTSTONE.	50/1"			
							AUGER REFUSAL AT 68.5'.				
							ROCK CORING				
RUN 1	68.5	73.5	68.5			ROCK*	ROCK CORING: 89% RECOVERY, 37% RQD				
RUN 2	73.5	78.5		78.5			ROCK CORING: 95% RECOVERY, 58% RQD				
							*PREDOMINATELY GRAY AND GREENSIH GRAY SILTSTONE, WITH A				
							THIN SEAM OF CALCEROUS CLAYSTONE, AND A THIN SEAM OF				
							GRAY LIMESTONE.				

Notes/Comments:

Pocket Pentrometer Testing
S3: 0.75 TSF
S4: 0.75 TSF
S13: > 4 TSF

WET ON SPOON AT 28.0'.
WATER LEVEL THROUGH AUGERS AT 24.5'.

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.

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

Density	***N (blows)****
Very Loose	5 or less
Loose	6 to 10
Medium Dense	11 to 30
Dense	31to 50
Very Dense	51 or more

Relative Proportions

Description Term	*Percent*
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

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)	

COHESIVE SOILS

(Silt, Clay & Combinations)

Consistency	***N (blows)****
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

Degree of Plasticity	*Plasticity Index*
None to Slight	0 - 4
Slight	5 - 7
Medium	8- 22
High to Very High	> 22

ROCK

(Rock Cores)

Rock Quality Designation (RQD), %	***Rock Quality Description***
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).

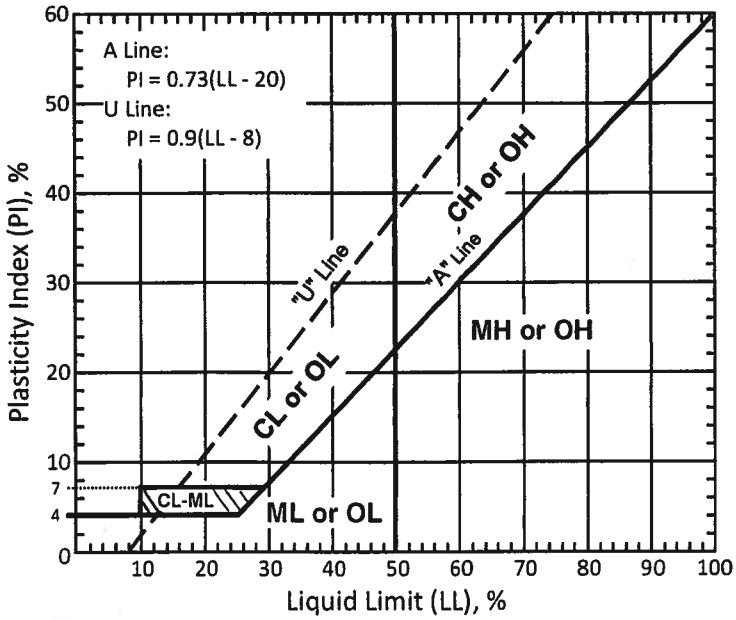
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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	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, gravely 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	

Major Divisions		Group Symbols	Typical Descriptions
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts 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
	Silts 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

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.



(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.