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Γransm	nittal			
O: Delaney Pete	arson		DATE: 11/26/2019	GTX NO: 310685
Anchor QEA, LLC 720 Olive Way, Suite 1900				G1X NO. 310083
			RE: Gasco PDI	
Seattle, WA	98101			
COPIES	DATE		DESCRIPTION	
	11/26/2019	November 2019 Laboratory 1		
EMARKS:				
-				
		SIGNED:	Ruhsh	
CC:			Barbara Sanchez, Assistan	t Laboratory Manager
		APPROVED BY	Jon Tu	im
			Jonathan Campbell, Labor	atory Manager



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November 26, 2019

Delaney Peterson Anchor QEA, LLC 720 Olive Way, Suite 1900 Seattle, WA 98101

RE: Gasco PDI (GTX-310685)

Dear Delaney:

Enclosed are the test results you requested for the above referenced project. GeoTesting Express, Inc. (GTX) received eight samples from you on 11/1/2019. These samples were labeled as follows:

Sample Number
PDI-022SC-B-5.5-7.5-191016
PDI-031SC-B-8.9-10.9-191017
PDI-057SC-B-06-08-191023
PDI-059SC-B-06-08-191016
PDI-069SC-B-10-12-191016
PDI-083SC-B-08-10-191022
PDI-097SC-B-02-04-191017
PDI-099SC-B-02-04-191022

GTX performed the following tests on these samples:

- 8 ASTM D2216 Moisture Content
- 8 ASTM D4318 Atterberg Limits
- 2 ASTM D6913 Sieve Analysis
- 6 ASTM D6913/D7928 Grain Size Analysis Sieve and Hydrometer
- 8 ASTM D854 Specific Gravity

A copy of your test request is attached.

The results presented in this report apply only to the items tested. This report shall not be reproduced except in full, without written approval from GeoTesting Express. The remainder of these samples will be retained for a period of sixty (60) days and will then be discarded unless otherwise notified by you. Please call me if you have any questions or require additional information. Thank you for allowing GeoTesting Express the opportunity of providing you with testing services. We look forward to working with you again in the future.

GeoTesting Express, Inc. 125 Nagog Park Acton, MA 01720 Toll Free 800 434 1062 Fax 978 635 0266



Boston Atlanta Chicago Los Angeles New York www.geotesting.com

Respectfully yours,

Barbara Sanchez

Assistant Laboratory Manager

GeoTesting Express, Inc. 125 Nagog Park Acton, MA 01720 Toll Free 800 434 1062 Fax 978 635 0266



Boston Atlanta Chicago Los Angeles New York www.geotesting.com

Geotechnical Test Report

11/26/2019

GTX-310685 Gasco PDI

Prepared for:

Anchor QEA, LLC



Location:

Project No: GTX-310685 Boring ID: ---Sample Type: ---Tested By: ckg 11/19/19 Checked By: bfs Sample ID: ---Test Date:

Test Id: Depth: 529668

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
	PDI- 2SC-B-5.5 -7.5-1910		Moist, dark gray sand	10.7
	PDI- SC-B-8.9 -10.9-1910		Moist, dark gray sand	16.0
	PDI- 57SC-B-06 -08-19102		Wet, dark gray clay	77.2
	PDI- 59SC-B-06 -08-19101		Moist, dark grayish brown silty sand	38.4
	PDI- 69SC-B-10 -12-19101		Moist, very dark gray silt	67.2
	PDI- 83SC-B-08 -10-19102		Moist, dark gray clay	76.2
	PDI- 97SC-B-02 -04-19101		Wet, dark gray silt	86.8
	PDI- 99SC-B-02 -04-19102		Moist, very dark gray clay	79.6

Notes: Temperature of Drying: 110° Celsius



Location:

Project No: GTX-310685 Boring ID: ---Sample Type: ---Tested By: ckg 11/19/19 Checked By: bfs Sample ID: ---Test Date:

Test Id: Depth: 529676

Specific Gravity of Soils by ASTM D854

Boring ID	Sample ID	Depth	Visual Description	Specific Gravity	Comment
	PDI- 3C-B-5.5-7.5-19		Moist, dark gray sand	2.75	
	PDI- C-B-8.9-10.9-19		Moist, dark gray sand	2.75	
	PDI- SC-B-06-08-191		Wet, dark gray clay	2.71	
	PDI- SC-B-06-08-191		Moist, dark grayish brown silty sand	2.80	
	PDI- SC-B-10-12-191		Moist, very dark gray silt	2.73	
	PDI- SC-B-08-10-191		Moist, dark gray clay	2.65	
	PDI- SC-B-02-04-191		Wet, dark gray silt	2.66	
	PDI- SC-B-02-04-191		Moist, very dark gray clay	2.71	

Notes: Specific Gravity performed by using method B (oven dried specimens) of ASTM D854 Moisture Content determined by ASTM D2216.



Location: Project No: GTX-310685 Boring ID: ---Sample Type: bag Tested By: ckg

Sample ID: PDI-022SC-B-5.5-7.5-191Test Date: 11/19/19 Checked By: bfs

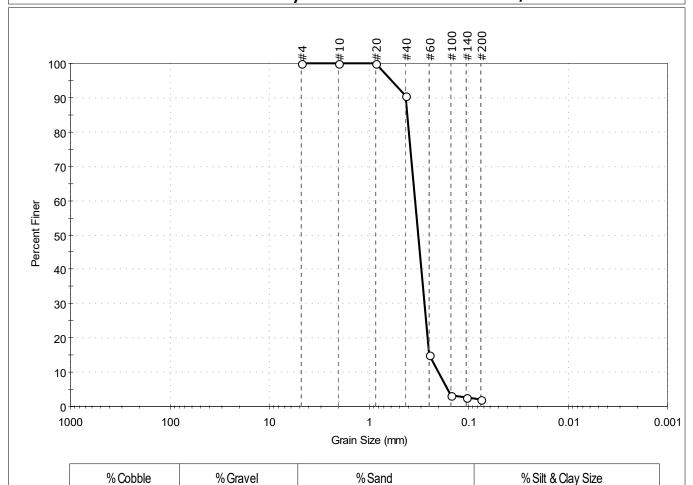
Test Id: 529663 Depth:

Test Comment:

Visual Description: Moist, dark gray sand

Sample Comment:

Particle Size Analysis - ASTM D6913/D7928



97.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	90		
#60	0.25	15		
#100	0.15	3		
#140	0.11	3		
#200	0.075	2.2		

0.0

<u>Coefficients</u>				
D ₈₅ =0.4090 mm	$D_{30} = 0.2779 \text{ mm}$			
D ₆₀ = 0.3431 mm	D ₁₅ =0.2500 mm			
D ₅₀ = 0.3198 mm	$D_{10} = 0.2015 \text{ mm}$			
C _u =1.703	$C_c = 1.117$			

2.2

Classification
Poorly graded SAND (SP) <u>ASTM</u>

AASHTO Fine Sand (A-3 (1))

<u>Sample/Test Description</u> Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness: ---



Location: Project No: GTX-310685

Boring ID: --- Sample Type: bag Tested By: ckg

Boring ID: --- Sample Type: bag Tested By: ckg Sample ID: PDI-031SC-B-8.9-10.9-19Test Date: 11/19/19 Checked By: bfs

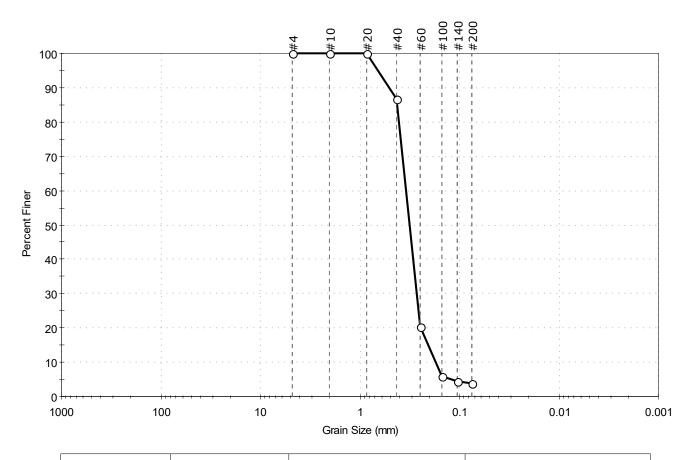
Depth: --- Test Id: 529661

Test Comment: ---

Visual Description: Moist, dark gray sand

Sample Comment: ---

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
_	0.0	96.1	3.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	87		
#60	0.25	20		
#100	0.15	6		
#140	0.11	4		
#200	0.075	3.9		

<u>Coefficients</u>				
D ₈₅ = 0.4188 mm	$D_{30} = 0.2702 \text{ mm}$			
D ₆₀ = 0.3432 mm	$D_{15} = 0.2076 \text{ mm}$			
D ₅₀ = 0.3169 mm	$D_{10} = 0.1740 \text{ mm}$			
C _u =1.972	$C_c = 1.223$			

ASTM Poorly graded SAND (SP)

AASHTO Fine Sand (A-3 (1))

Sample/Test Description
Sand/Gravel Particle Shape: --Sand/Gravel Hardness: ---



Location: Project No: GTX-310685 Boring ID: ---Sample Type: bag Tested By: ckg

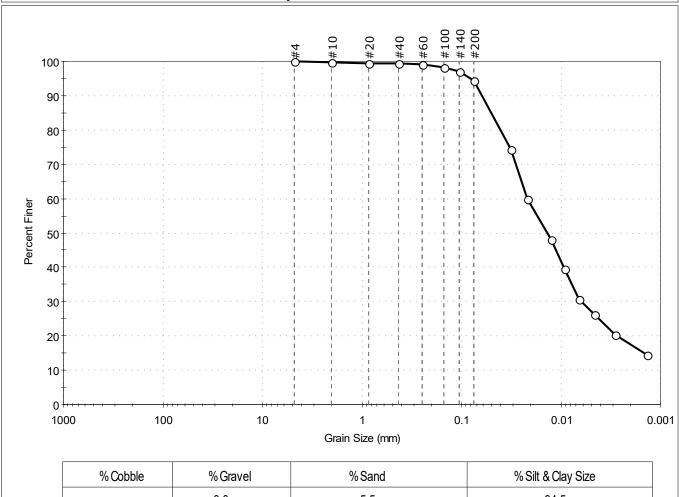
Sample ID: PDI-057SC-B-06-08-1910Test Date: 11/19/19 Checked By: bfs

Test Id: 529658 Depth:

Test Comment:

Visual Description: Wet, dark gray clay Sample Comment: Sample contains organics

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
	0.0	5.5	94.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	99		
#100	0.15	98		
#140	0.11	97		
#200	0.075	94		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0320	74		
	0.0215	60		
	0.0126	48		
	0.0091	39		
	0.0065	31		
	0.0047	26		
	0.0029	20		
	0.0014	15		

<u>Coefficients</u>				
D ₈₅ = 0.0502 mm	$D_{30} = 0.0062 \text{ mm}$			
D ₆₀ = 0.0216 mm	$D_{15} = 0.0015 \text{ mm}$			
D ₅₀ = 0.0137 mm	$D_{10} = N/A$			
C _{II} =N/A	$C_c = N/A$			

<u>Classification</u> Fat CLAY (CH) <u>ASTM</u>

AASHTO Clayey Soils (A-7-6 (49))

<u>Sample/Test Description</u> Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness: ---

Dispersion Device: Apparatus A - Mech Mixer

Dispersion Period: 1 minute Est. Specific Gravity: 2.65

Separation of Sample: #200 Sieve



Location: Project No: GTX-310685 Boring ID: ---Sample Type: bag Tested By: ckg

Sample ID: PDI-059SC-B-06-08-1910Test Date: 11/19/19 Checked By: bfs

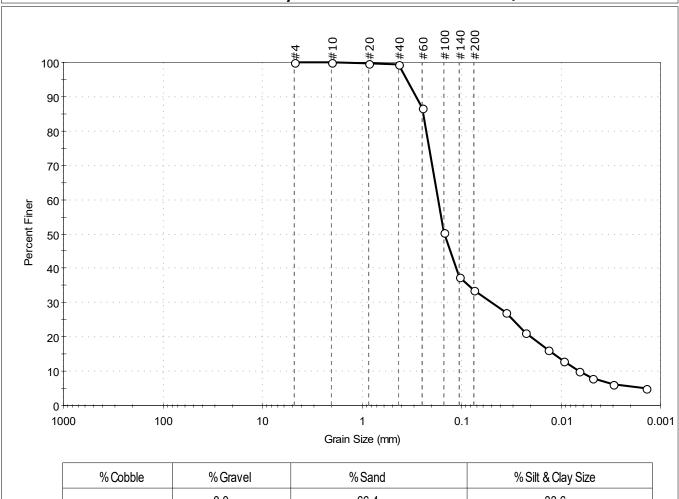
Depth: Test Id: 529664

Test Comment:

Visual Description: Moist, dark grayish brown silty sand

Sample Comment:

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
_	0.0	66.4	33.6

		•		•
Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	87		
#100	0.15	51		
#140	0.11	37		
#200	0.075	34		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0356	27		
	0.0229	21		
	0.0133	16		
	0.0095	13		
	0.0067	10		
	0.0048	8		
	0.0030	6		
	0.0014	5		

<u>Coefficients</u>					
D ₈₅ = 0.2437 mm	$D_{30} = 0.0492 \text{ mm}$				
D ₆₀ = 0.1713 mm	$D_{15} = 0.0117 \text{ mm}$				
D ₅₀ = 0.1477 mm	$D_{10} = 0.0066 \text{ mm}$				
C ₁₁ =25.955	$C_c = 2.141$				

<u>Classification</u> Silty SAND (SM) **ASTM**

AASHTO Silty Gravel and Sand (A-2-4 (0))

<u>Sample/Test Description</u> Sand/Gravel Particle Shape: ---

Sand/Gravel Hardness: ---

Dispersion Device: Apparatus A - Mech Mixer



Location: Project No: GTX-310685 Boring ID: ---Sample Type: bag Tested By: ckg

Sample ID: PDI-069SC-B-10-12-1910Test Date: 11/19/19 Checked By: bfs

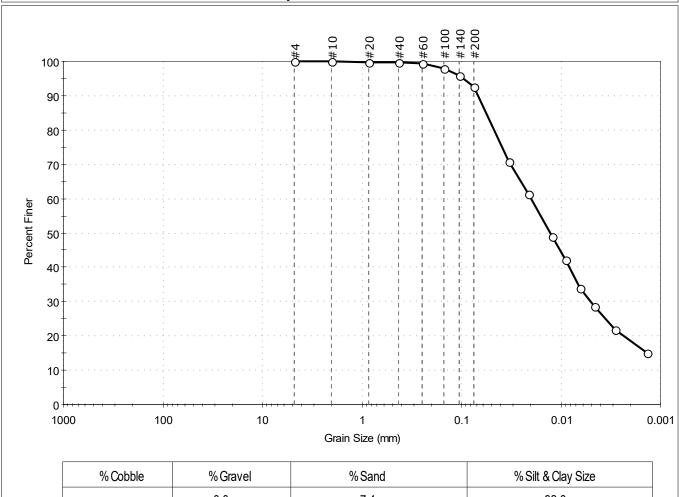
529665 Depth: Test Id:

Test Comment:

Visual Description: Moist, very dark gray silt

Sample Comment:

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
_	0.0	7.4	92.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	98		
#140	0.11	96		
#200	0.075	93		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0330	71		
	0.0210	61		
	0.0124	49		
	0.0090	42		
	0.0065	34		
	0.0046	29		
	0.0029	22		
	0.0014	15		

Cocincients				
D ₈₅ = 0.0563 mm	$D_{30} = 0.0050 \text{ mm}$			
D ₆₀ = 0.0199 mm	$D_{15} = 0.0014 \text{ mm}$			
D ₅₀ = 0.0129 mm	$D_{10} = N/A$			
C _u =N/A	$C_{c} = N/A$			

Coefficients

<u>Classification</u> Elastic SILT (MH) <u>ASTM</u> AASHTO Clayey Soils (A-7-5 (40))

<u>Sample/Test Description</u> Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness: ---

Dispersion Device : Apparatus A - Mech Mixer



Location: Project No:

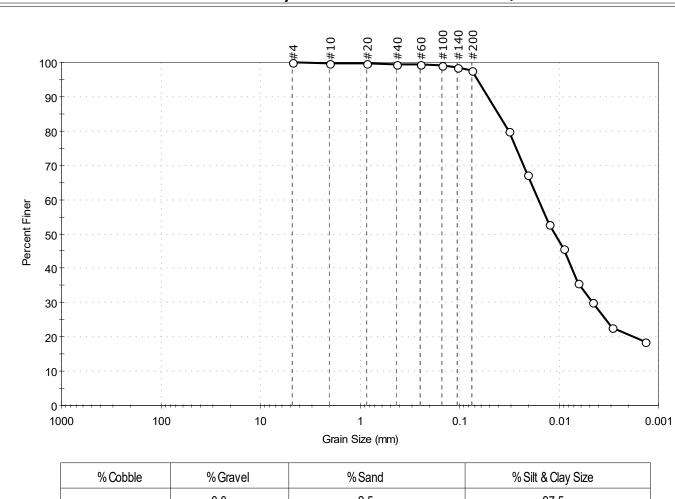
Boring ID: ---Sample Type: bag Tested By: ckg Sample ID: PDI-083SC-B-08-10-1910Test Date: 11/19/19 Checked By: bfs

Test Id: 529659 Depth:

Test Comment:

Visual Description: Moist, dark gray clay Sample Comment: Sample contains organics

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
_	0.0	2.5	97.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	99		
#100	0.15	99		
#140	0.11	99		
#200	0.075	98		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0320	80		
	0.0208	67		
	0.0125	53		
	0.0089	46		
	0.0065	36		
	0.0046	30		
	0.0029	23		
	0.0014	19		

	<u>Coefficients</u>				
D ₈₅ = 0.0408 mm		$D_{30} = 0.0046 \text{ mm}$			
	D ₆₀ = 0.0161 mm	$D_{15} = N/A$			
	D ₅₀ = 0.0109 mm	$D_{10} = N/A$			
	C _{II} =N/A	$C_C = N/A$			

GTX-310685

<u>Classification</u> Fat CLAY (CH) **ASTM** AASHTO Clayey Soils (A-7-5 (55))

<u>Sample/Test Description</u> Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness: ---

Dispersion Device: Apparatus A - Mech Mixer



Location: Project No: GTX-310685 ckg

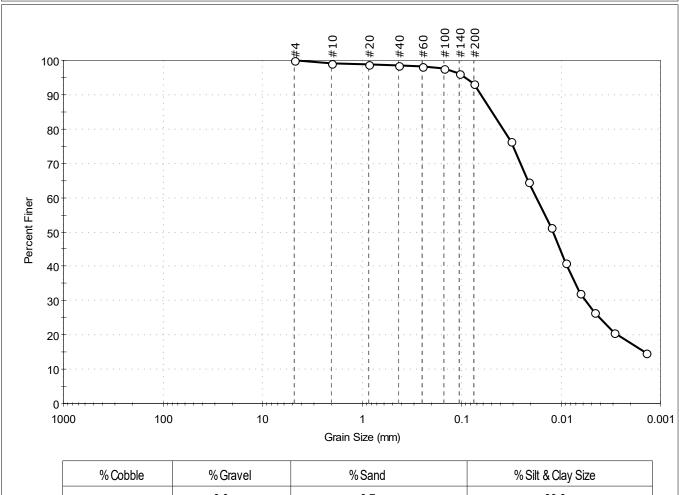
Boring ID: ---Sample Type: bag Tested By: Sample ID: PDI-097SC-B-02-04-1910Test Date: 11/19/19 Checked By: bfs

Test Id: Depth: 529662

Test Comment:

Visual Description: Wet, dark gray silt Sample Comment: Sample contains organics

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
_	0.0	6.7	93.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	99		
#40	0.42	98		
#60	0.25	98		
#100	0.15	98		
#140	0.11	96		
#200	0.075	93		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0318	76		
	0.0212	65		
	0.0125	51		
	0.0091	41		
	0.0065	32		
	0.0047	26		
	0.0030	21		
	0.0014	15		

	<u>Coefficients</u>				
D ₈₅ = 0.0493 mm		$D_{30} = 0.0057 \text{ mm}$			
	D ₆₀ = 0.0177 mm	$D_{15} = 0.0014 \text{ mm}$			
	D ₅₀ = 0.0120 mm	$D_{10} = N/A$			
	C _{II} =N/A	$C_c = N/A$			

<u>Classification</u> Elastic SILT (MH) <u>ASTM</u>

AASHTO Clayey Soils (A-7-5 (39))

<u>Sample/Test Description</u> Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness: ---

Dispersion Device: Apparatus A - Mech Mixer



Location: Project No: GTX-310685 Boring ID: ---Sample Type: bag Tested By: ckg

Sample ID: PDI-099SC-B-02-04-1910Test Date: 11/19/19 Checked By: bfs

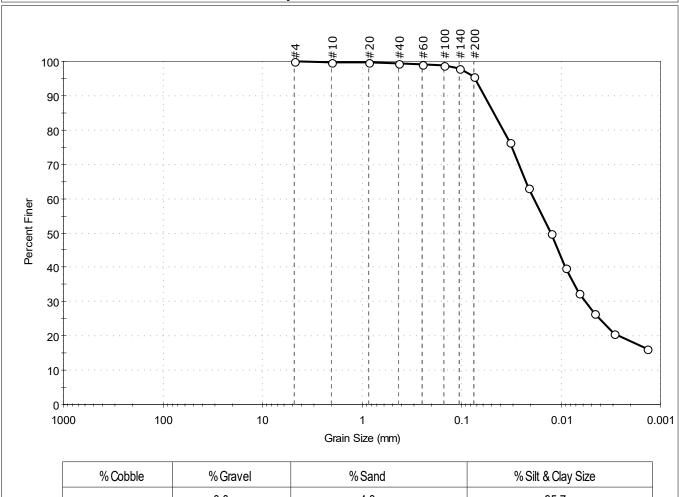
529660 Depth: Test Id:

Test Comment:

Visual Description: Moist, very dark gray clay

Sample Comment:

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
_	0.0	4.3	95.7

_	-	_		
Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	99		
#100	0.15	99		
#140	0.11	98		
#200	0.075	96		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0326	76		
	0.0214	63		
	0.0126	50		
	0.0091	40		
	0.0065	32		
	0.0047	26		
	0.0029	21		
	0.0014	16		

	CHICICHES
D ₈₅ = 0.0472 mm	$D_{30} = 0.0057 \text{ mm}$
D ₆₀ = 0.0188 mm	$D_{15} = N/A$
D ₅₀ = 0.0126 mm	$D_{10} = N/A$
$C_u = N/A$	$C_c = N/A$

Coefficients

<u>Classification</u> Fat CLAY (CH) <u>ASTM</u> AASHTO Clayey Soils (A-7-5 (54))

<u>Sample/Test Description</u> Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness: ---

Dispersion Device : Apparatus A - Mech Mixer



Location: Project No: GTX-310685

Boring ID: --- Sample Type: bag Tested By: cam Sample ID: PDI-022SC-B-5.5-7.5-191Test Date: 11/18/19 Checked By: bfs

Depth: --- Test Id: 529655

Test Comment: ---

Visual Description: Moist, dark gray sand Sample Comment: ---

Atterberg Limits - ASTM D4318

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
•	22SC-B-5.5-7.5-19			11	n/a	n/a	n/a	n/a	Poorly graded SAND (SP)

10% Retained on #40 Sieve

Dry Strength: NONE Dilatancy: RAPID Toughness: n/a

The sample was determined to be Non-Plastic



Location: Project No: GTX-310685

Boring ID: --- Sample Type: bag Tested By: cam Sample ID: PDI-031SC-B-8.9-10.9-19Test Date: 11/18/19 Checked By: bfs

Depth: --- Test Id: 529653

Test Comment: --Visual Description: Moist, dark gray sand

Sample Comment: ---

Atterberg Limits - ASTM D4318

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
•	31SC-B-8.9-10.9-1			16	n/a	n/a	n/a	n/a	Poorly graded SAND (SP)

13% Retained on #40 Sieve

Dry Strength: NONE Dilatancy: RAPID Toughness: n/a

The sample was determined to be Non-Plastic



Location: Project No: GTX-310685

Boring ID: --- Sample Type: bag Tested By: cam

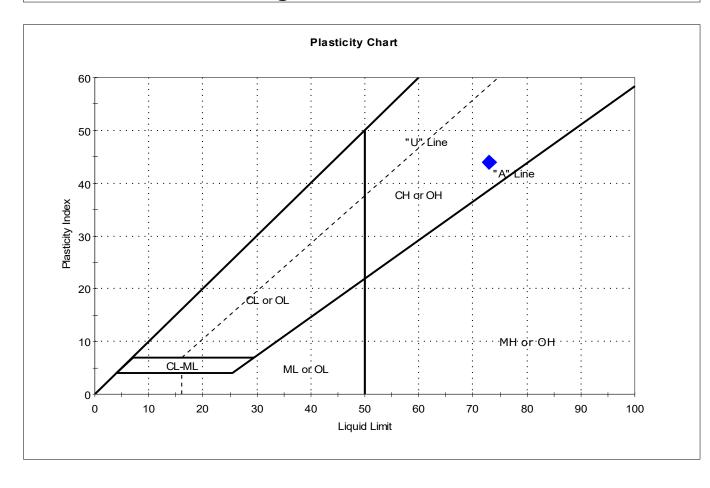
Sample ID: PDI-057SC-B-06-08-1910Test Date: 11/21/19 Checked By: bfs

Depth: --- Test Id: 529650

Test Comment: ---

Visual Description: Wet, dark gray clay
Sample Comment: Sample contains organics

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
•)57SC-B-06-08-19			77	73	29	44	1.1	Fat CLAY (CH)

Sample Prepared using the WET method

1% Retained on #40 Sieve

Dry Strength: HIGH Dilatancy: SLOW Toughness: LOW



Location: Project No: GTX-310685 Boring ID: ---Sample Type: bag Tested By: cam

Test Id:

529656

Sample ID: PDI-059SC-B-06-08-1910Test Date: 11/19/19 Checked By: bfs

Depth: Test Comment:

Visual Description: Moist, dark grayish brown silty sand

Sample Comment:

Atterberg Limits - ASTM D4318

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
•)59SC-B-06-08-19			38	n/a	n/a	n/a	n/a	Silty SAND (SM)

1% Retained on #40 Sieve Dry Strength: MEDIUM Dilatancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic



Location: Project No: GTX-310685
Boring ID: --- Sample Type: bag Tested By: cam

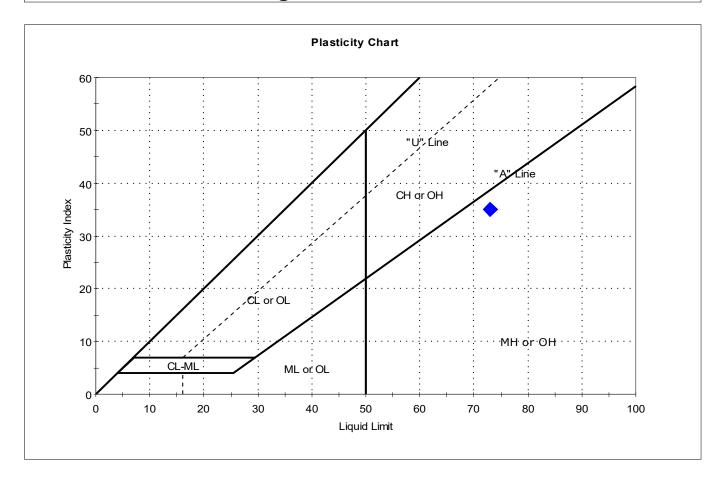
Sample ID: PDI-069SC-B-10-12-1910Test Date: 11/20/19 Checked By: bfs Depth: --- Test Id: 529657

Test Comment: ---

Visual Description: Moist, very dark gray silt

Sample Comment: ---

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
•	069SC-B-10-12-19			67	73	38	35	8.0	Elastic SILT (MH)

Sample Prepared using the WET method

0% Retained on #40 Sieve Dry Strength: VERY HIGH

Dilatancy: SLOW Toughness: LOW



Location: Project No: GTX-310685 Sample Type: bag Boring ID: ---Tested By: cam

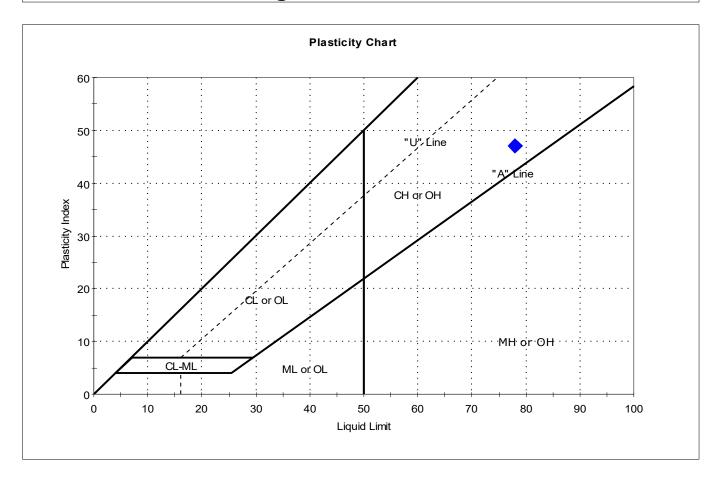
Sample ID: PDI-083SC-B-08-10-1910Test Date: 11/20/19 Checked By: bfs

Depth: Test Id: 529651

Test Comment:

Visual Description: Moist, dark gray clay Sample contains organics Sample Comment:

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
•	083SC-B-08-10-19			76	78	31	47	1	Fat CLAY (CH)

Sample Prepared using the WET method

1% Retained on #40 Sieve Dry Strength: VERY HIGH

Dilatancy: SLOW Toughness: LOW



Location: Project No: GTX-310685

Boring ID: --- Sample Type: bag Tested By: cam

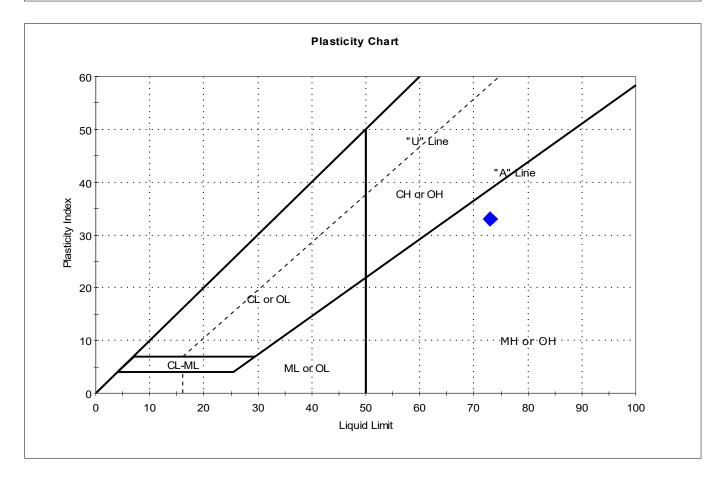
Sample ID: PDI-097SC-B-02-04-1910Test Date: 11/19/19 Checked By: bfs

Sample ID: PDI-097SC-B-02-04-1910Test Date: 11/19/19
Depth: --- Test Id: 529654

Test Comment: ---

Visual Description: Wet, dark gray silt
Sample Comment: Sample contains organics

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
•	097SC-B-02-04-19			87	73	40	33	1.4	Elastic SILT (MH)

Sample Prepared using the WET method

2% Retained on #40 Sieve

Dry Strength: HIGH Dilatancy: SLOW Toughness: LOW



Location: Project No: GTX-310685 Sample Type: bag Tested By: cam

Boring ID: ---Sample ID: PDI-099SC-B-02-04-1910Test Date: 11/20/19 Checked By: bfs

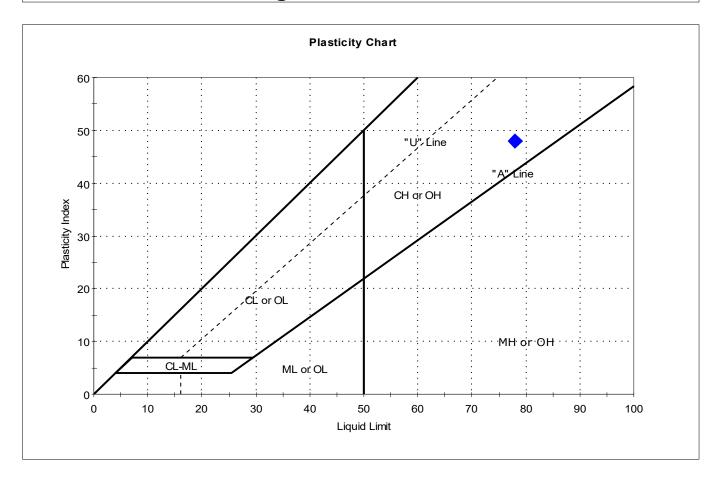
Depth: Test Id: 529652

Test Comment:

Visual Description: Moist, very dark gray clay

Sample Comment:

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
•	099SC-B-02-04-19			80	78	30	48	1	Fat CLAY (CH)

Sample Prepared using the WET method

1% Retained on #40 Sieve Dry Strength: VERY HIGH

Dilatancy: SLOW Toughness: LOW

ENVIRONMENTAL SAMPLE CHAIN OF CUSTODY

POC: * Delaney Peterson (360-715-2707)

1605 Cornwall Avenue, Bellingham, WA 98225

Project:

Client:

Gasco PDI

NW Natural

COC ID:

NWGEO-201910.

Geotesting Express CO, SN, BJ, SS

Sample Custodian:

Lab:

	_					Т
Preservative			4°C	4°C	4°C	4°C
TAT**			30	30	30	30
Method			D4318	D6913/D7928	D2216	D854
Test Request			Atterberg Limits	Grain Size	Moisture Content	Specific gravity
Lab QC*						
# Contain	ers	-				
Collected	Date Time	10/23/2019 12:46				
Matrix	21	SE				
Samp Type	le	z				
			1			

PDI-057SC-B-06-08-191023

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Field Sample ID

COC Sample Number

Comment:		/3	0 0	2	
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Company Anchor OEH		Company	Сотрапу	Сотрапу	Company
Date/Time 10/19 @ 1215	Date/Time	Date/Time	Date/Time	Date/Time	Date/Time

* Lab QC Requested for sample when box is checked ** TAT = Turn Around Time in DAYS # POC = Project Point of Contact

OR	2600, Seattle, WA 98101
* ANC	201 3rd Avenue, §

ENVIRONMENTAL SAMPLE CHAIN OF CUSTODY

Project:

Gasco PD

Client:

1605 Cornwall Avenue, Bellingham, WA 98225

POC: * Delaney Peterson (360-715-2707)

NWGFO-20191022-162549

				COC ID:		NWGEO-20191022-102349	022-102343	
Gasco PDI	PDI			Sample	Sample Custodian:	CO, SN, BJ, SS	"	
NW Natural	atural			Lab:		Geotesting Express	ress	
ō	# Contain	유 생 # Contain	Test Request	9	Method	TAT**	Preservative	
Time	ers							
10.11	,							
14:05	_				D4318	30	4°C	
			Atterberg Limits	1	20040,01000	20	4°C	
			Grain Size		D6913/D7928	200	۷,۰	
			Moisture Content		D2216	30	7	
			Mostar Controls		D854	30	4°C	
			Specific gravity		100			
0,00	,							
10:48	_				D4318	30	4°C	
			Atterberg Limits		0001010101010101010101010101010101010101	00	4°C	
			Grain Size		D6913/D7928	200	Cor	
			Mainting Content		D2216	30	4-7 ا	_
			Moistal & Collicin		DSEA	30	4°C	_
			Specific gravity		+000			_

Date

Collected

Sample Type

14:05

10/22/2019

SE

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PDI-083SC-B-08-10-191022

001

Field Sample ID

COC Sample Number

Specific gravity

10/22/2019 10:48

SE

z

PDI-099SC-B-02-04-191022

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		By.	Signature		Print Name		Company		Date/Time		* I ab OC Beniested for sample when box is checked ** TAT = Turn Around Time in DAYS # POC = Project Point of Contact	
		Relinquished By:			Print Name		Company		Date/Time		ample when box is checked ** TAT = T_c	
				12		7	Someony Company		DateCline	"	s Tof betselling OC 40 1 *	רמם על ייפליניני ייי
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Date Printed: 10/22/2019

ANCHOR OEA EEEE ODE 3010 Seattle, WA 98101

POC: * Delaney Peterson (360-715-2707)

ENVIRONMENTAL SAMPLE CHAIN OF CUSTODY

Gasco PDI Project:

NW Natural

COC Sample Number

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002

COC ID:

NWGEO-20191017-123936

Sample Custodian:

SN

Geotesting Express

Lab:

Field Sample ID Edg and Sample ID Attended Sample ID Indicated ID	1605 Cornwall Avenue, Bellingham, WA 98225	ham, WA	98225	Client:	NW Natural	atural		Lab:		Geotesting Express	bress
Date Time B Atterberg Limits Da516 30 N SE 10/17/2019 10:46 1	Glad Samula II	Typ	_		Þ	# Contain	Lab QC*	Test Request	Method	TAT**	Preservative
N SE 10/17/2019 9:06 1 Atterberg Limits Atterberg Limits D4318 30 Grain Size Moisture Content D6913/D7928 30 Specific gravity D854 30 Atterberg Limits D4318 30 Grain Size Moisture Content D6913/D7928 30 Moisture Content D5216 30 Moisture Content D6913/D7928 30 Moisture Content D854 30	בפות סמוולוס וס	e e	alo.	Date	Time	ers					
N SE 10/17/2019 10:46 1 I I I I I I I I I	DI-031SC-B-8.9-10.9-191017	z	S.	├	90:6	<u>_</u>					
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Noisture Content DD216 30 Specific gravity DB54 30 Atterberg Limits D4318 30 Grain Size Moisture Content D6913/D7928 30 Moisture Content D2216 30 Specific gravity D854 30	*							Grain Size	D6913/D7928	30	4°C
N SE 10/17/2019 10:46 1								Moisture Content	D2216	30	4°C
N SE 10/17/2019 10:46 1 Image: Content of the cont								Specific gravity	D854	30	4°C
Atterberg Limits D4318 30 Grain Size D6913/D7928 30 Moisture Content D2216 30 Specific gravity D854 30	1-097SC-R-02-04-191017	Z	\ \frac{\partial}{\partial}	-	10.46	_					
D6913/D7928 30 D2216 30 D854 30		-	3	┨				Atterbera Limits	D4318	30	4°C
D2216 30 D854 30								Grain Size	D6913/D7928	30	4°C
D854 30								Moisture Content	D2216	30	4°C
								Specific gravity	D854	30	4°C

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Comment:				
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Relinquished By: Signature Signature Signature	Signature	4	Signature	Signature
Print Name	Print Name	Print Name	Print Name	Print Name
Company Company	Company	Company	Company	Сотрапу
Date/Time	Date/Time	Date/Time	Date/Time	Date/Time
	* Lab QC Requested for sample when box is checked ** TAT = Turn Around Time in DAYS # POC = Project Point of Contact	urn Around Time in DAYS # POC = Proj	ect Point of Contact	Page 1 of 1

ANCHOR OEA : OEA :

ENVIRONMENTAL SAMPLE CHAIN OF CUSTODY

COC ID:

NWGEO-20191016-143858

CO, SN, BJ, DL

Geotesting Express

Lab:

NW Natural Gasco PDI

1605 Cornwall Avenue, Bellingham, WA 98225

POC: * Delaney Peterson (360-715-2707)

PDI-022SC-B-5.5-7.5-191016

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Field Sample ID

COC Sample Number

Project: Client:

Sample Custodian:

Г												r resul				\Box	
	Preservative		4°C	4°C	4°C	4°C		4°C	4°C	4°C	4°C		4°C	4°C	4°C	4°C	
	TAT**		30	30	30	30		30	30	30	30		30	30	30	30	
	Method		D4318	D6913/D7928	D2216	D854		D4318	D6913/D7928	D2216	D854		D4318	D6913/D7928	D2216	D854	
	Test Request		Atterbera Limits	Grain Size	Moisture Content	Specific gravity	2	Atterbera Limits	Grain Size	Moisture Content	Specific gravity		Atterberg Limits	Grain Size	Moisture Content	Specific gravity	
	Lab QC*]]				
	Containers	1 1					57 1					38 1					
	Collected	10/16/2019 13:41					10/16/2019 7:57					10/16/2019 10:38					
	Matrix	SE					R.	1				T,	20				
	Sample Type	z					z	2				z	:				
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PDI-059SC-B-06-08-191016

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003 PDI-069SC-B-10-12-191016

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20		Delinuished Rv.	Signature	Print Name	Company	Date/Time	
			Signature By:	Print Name		Kar	١
	Comment:	ř	Relinquished By: Signature	PYT	1	V	一 (ダ) こっちご

Date Printed: 10/16/2019



WARRANTY and LIABILITY

GeoTesting Express (GTX) warrants that all tests it performs are run in general accordance with the specified test procedures and accepted industry practice. GTX will correct or repeat any test that does not comply with this warranty. GTX has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material

GTX may report engineering parameters that require us to interpret the test data. Such parameters are determined using accepted engineering procedures. However, GTX does not warrant that these parameters accurately reflect the true engineering properties of the *in situ* material. Responsibility for interpretation and use of the test data and these parameters for engineering and/or construction purposes rests solely with the user and not with GTX or any of its employees.

GTX's liability will be limited to correcting or repeating a test which fails our warranty. GTX's liability for damages to the Purchaser of testing services for any cause whatsoever shall be limited to the amount GTX received for the testing services. GTX will not be liable for any damages, or for any lost benefits or other consequential damages resulting from the use of these test results, even if GTX has been advised of the possibility of such damages. GTX will not be responsible for any liability of the Purchaser to any third party.

Commonly Used Symbols

B pore pressure parameter for $\Delta \circ s$ T temperature $S \circ s$ CAI CERCHAR Abrasiveness index $S \circ s$ to time of the propersion ratio for one dimensional consolidation $S \circ s$ cyclic stress ratio $S $	A	pore pressure parameter for $\Delta \sigma_1 - \Delta \sigma_3$	$S_{\rm r}$	Post cyclic undrained shear strength
CAI Use CERCHAR Abrasiveness Index CIU is or compression ratio for one dimensional consolidation cross or compression ratio for one dimensional consolidation consequence of the compression ratio for one dimensional consolidation consequence of the compression ratio for one dimensional consolidation consequence of the compression ratio for one dimensional consolidation consequence of the co	В	pore pressure parameter for $\Delta\sigma_3$		·
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	CAI	CERCHAR Abrasiveness Index		1
CR CSR compression ratio for one dimensional consolidation UU, Q unconsolidated undrained triaxial test CSR cyclic stress ratio u. a excess pore water pressure C₂ coefficient of curvature, $(D x_0)^2 / (D r_0 x D r_0)$ u. u. w pore gas pressure C₂ coefficient of consolidation V total volume volume of solids C₂ coefficient of consolidation V₂ volume of solids c⟩ coefficient of consolidation V₂ volume of solids c⟩ coefficient of consolidation V₂ volume of solids c⟩ coefficient of consolidation V₂ volume of voids c⟩ cohesion intercept for tofal stresses V₂ volume of voids D diameter at which 10% of soil is finer V₂ volume of voids D diameter at which 10% of soil is finer V₂ volume of voids D ₁₀ diameter at which 30% of soil is finer W₂ veight of vater D ₂₀ diameter at which 30% of soil is finer W₂ veight of vater D ₃₀ diameter at which 85% of soil is finer	CIU	isotropically consolidated undrained triaxial shear test		
CSR cyclic stress ratio u_a pore gas pressure C_a coefficient of curvature, $(D \otimes)^2 / (D \log x D \otimes)$ u_a excess pore water pressure C_a coefficient of curvature, $(D \otimes)^2 / (D \log x D \otimes)$ u_b excess pore water pressure C_a coefficient of secondary compression V_a volume of gas c_b coefficient of secondary compression V_a volume of solids c_b coefficient of secondary compression V_a volume of solids c_b coefficient of consolidation V_a volume of solids c_b coefficient of consolidation V_a volume of solids c_b cobesion intercept for total stresses V_a volume of voids c_b dameter at which 10% of soil is finer V_a volume of voids c_b dameter at which 15% of soil is finer V_a volume of voids c_b diameter at which 15% of soil is finer V_a weight of solids c_b diameter at which 50% of soil is finer V_a water content c_b	CR	compression ratio for one dimensional consolidation	,	•
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	CSR	cyclic stress ratio		
Ga coefficient of uniformity, Don/D10 u, uw pore water pressure Ca compression index for one dimensional consolidation Vg volume of gas Ca coefficient of secondary compression Vg volume of gas Ca coefficient of consolidation Vg volume of solids C cohesion intercept for total stresses Vy volume of voids D diameter of specimen Vw volume of water D diameter at which 10% of soil is finer Vw volume of water Dis diameter at which 15% of soil is finer Ww weight of solids Ds0 diameter at which 30% of soil is finer Ww weight of solids Ds0 diameter at which 50% of soil is finer Ww water content Ds0 diameter at which 50% of soil is finer Ww water content Ds0 diameter at which 50% of soil is finer Ww water content Ds0 diameter at which 50% of soil is finer Ww water content Ds0 diameter at which 50% of soil is finer Ww water content	C_c	coefficient of curvature, $(D_{30})^2 / (D_{10} \times D_{60})$		
Cc compression index for one dimensional consolidation Vg total volume Cs coefficient of secondary compression Vg volume of gas c cobesion intercept for total stresses Vs shear wave velocity c cobesion intercept for effective stresses Vs volume of voids D diameter of specimen Vs volume of water D diameter at which 10% of soil is finer Vs volume of water Dis diameter at which 10% of soil is finer W total weight Ds diameter at which 30% of soil is finer W weight of solids Ds diameter at which 50% of soil is finer W water content Ds diameter at which 60% of soil is finer W water content Ds diameter at which 85% of soil is finer W water content Ds diameter at which 85% of soil is finer W water content Ds diameter at which 85% of soil is finer W water content Ds diameter at which 85% of soil is finer W water content Ds	$C_{\rm u}$	coefficient of uniformity, D ₆₀ /D ₁₀		<u> </u>
Ca coefficient of secondary compression Vg volume of solids c. coefficient of consolidation Vg volume of solids c. coefficient of consolidation Vg volume of voids d. coefficient of consolidation Vg volume of voids D. diameter of specimen Vg volume of water D. dameter at which 15% of soil is finer Vg volume of water D. diameter at which 15% of soil is finer Wg weight of solids D. diameter at which 50% of soil is finer Wg weight of water D. diameter at which 50% of soil is finer Wg water content D. diameter at which 50% of soil is finer Wg water content D. diameter at which 50% of soil is finer Wg water content D. diameter at which 50% of soil is finer Wg water content D. diameter at which 50% of soil is finer Wg water content D. diameter at which 50% of soil is finer Wg water content D.	C_c		,	
cv coefficient of consolidation V_s volume of solids c cohesion intercept for total stresses V_s volume of voids D diameter of specimen V_w volume of voids D damping ratio V_w volume of water D10 diameter at which 10% of soil is finer V_w velocity D15 diameter at which 15% of soil is finer W_w weight of solids D20 diameter at which 50% of soil is finer W_w weight of water D20 diameter at which 60% of soil is finer W_w water content D3 diameter at which 60% of soil is finer W_w water content D4 diameter at which 60% of soil is finer W_w water content D4 diameter at which 60% of soil is finer W_w water content D4 diameter at which 60% of soil is finer W_w water content D4 displacement for 50% consolidation W_w water content D4 displacement for 100% consolidation W_w final water content	C_{α}	coefficient of secondary compression		
c' cohesion intercept for effective stresses V_v volume of voids D' diameter of specimen V_w volume of voids D diameter of specimen V_w volume of voids D diameter of specimen V_w volume of voids D diameter at which 10% of soil is finer V_w velocity D15 diameter at which 30% of soil is finer W_w weight of solids D80 diameter at which 50% of soil is finer W_w weight of water D81 diameter at which 85% of soil is finer W_w water content D83 diameter at which 85% of soil is finer W_w water content D84 diameter at which 85% of soil is finer W_w water content D85 diameter at which 85% of soil is finer W_w water content D85 diameter at which 85% of soil is finer W_w water content D86 diameter at which 85% of soil is finer W_w water content D85 diameter at which 85% of soil is finer W_w water content	c_{v}	coefficient of consolidation		e e e e e e e e e e e e e e e e e e e
c' cohesion intercept for effective stresses V.v volume of voids D diameter of specimen V.w volume of water D damping ratio V.v volume of water D10 diameter at which 10% of soil is finer V velocity D10 diameter at which 50% of soil is finer W.w weight of solids D20 diameter at which 50% of soil is finer W.w weight of water D30 diameter at which 60% of soil is finer W.w water content D40 diameter at which 60% of soil is finer W.w water content D40 diameter at which 60% of soil is finer W.w water content D40 displacement for 90% consolidation W.r final water content D40 displacement for 90% consolidation W.r initial water content D4 diardia W.v shrinkage limit D4 void ratio W.v shrinkage limit D5 shear modulus α ' slope of α ' versus pr' D6 shear modulus α '<	c	cohesion intercept for total stresses		
D diameter of specimen V _v volume of water D damping ratio V _o initial volume D ₁₀ diameter at which 10% of soil is finer V volocity D ₂₀ diameter at which 30% of soil is finer W weight of solids D ₂₀ diameter at which 50% of soil is finer W _w weight of solids D ₂₀ diameter at which 50% of soil is finer W _w weight of water D ₂₀ diameter at which 60% of soil is finer W _w water content D ₂₀ diameter at which 85% of soil is finer W _w water content D ₃₀ diameter at which 85% of soil is finer W _w water content D ₃₀ diameter at which 85% of soil is finer W _w water content D ₃₀ diameter at which 85% of soil is finer W _w water content D ₃₀ diameter at which 85% of soil is finer W _w water content D ₄ d ₄ d ₄ d ₄ d ₄ D ₄ void ratio v ₁ d ₄ d ₄	c'	cohesion intercept for effective stresses		•
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	D	1		
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D8s diameter at which 85% of soil is finer w_c water content at consolidation d_{00} displacement for 50% consolidation w_f final water content d_{00} displacement for 90% consolidation d_{100} displacement for 100% consolidation d_{100} displacement for 100% consolidation d_{100} d_{100} displacement for 100% consolidation d_{100} $d_$				e
$ \begin{array}{c} d_{50} & displacement for 50\% consolidation \\ d_{90} & displacement for 90\% consolidation \\ d_{100} & displacement for 100\% consolidation \\ E & Young's modulus \\ e & void ratio \\ e_c & void ratio after consolidation \\ e_c & void ratio after consolidation \\ e_o & initial void ratio \\ e_o & specific gravity of soil particles \\ H & height of specimen \\ HR & Rebound Hardness number \\ i & gradient \\ Is & Uncorrected point load strength index \\ HA & Modified Taber Abrasion \\ HAT & Total hardness \\ HA & Modified Taber Abrasion \\ HIT & Total hardness \\ K_o & lateral stress ratio for one dimensional strain \\ K & permeability Index \\ mv & coefficient of volume change \\ n & porosity \\ Pc & preconsolidation pressure \\ p & (\sigma_1 + \sigma_3)/2, (\sigma_2 + \sigma_b)/2 \sigma_3 minor principal stress and possible for the first of the $				
$\begin{array}{c} d_{90} & \text{displacement for 90\% consolidation} \\ d_{100} & \text{displacement for 100\% consolidation} \\ d_{100} & \text{displacement for 100\% consolidation} \\ E & Young's modulus \\ e & \text{void ratio} \\ e & \text{void ratio} \\ e & \text{void ratio} \\ e & \text{void ratio difer consolidation} \\ e & \text{shear modulus} \\ G & \text{shear modulus} \\ G & \text{shear modulus} \\ G & \text{specific gravity of soil particles} \\ H & \text{height of specimen} \\ H & \text{Rebound Hardness number} \\ 1 & \text{gradient} \\ 1 & \text{gradient} \\ 1 & \text{gradient} \\ 1 & \text{Size corrected point load strength} \\ 1 & \text{Size corrected point load strength index} \\ 1 & \text{Evol} \\ 1 & \text{Modified Taber Abrasion} \\ 1 & \text{Modified Taber Abrasion} \\ 1 & \text{Poisson's ratio, also viscosity} \\ 1 & \text{Not premeability} \\ 1 & \text{Liquidity Index} \\ 1 & \text{permeability} \\ 2 & \text{gradient} \\ 3 & \text{permeability} \\ 4 & \text{permeability} \\ 5 & \text{premeability} \\ 6 & \text{premeability} \\ 1 & \text{plasticity index} \\ 6 & \text{preconsolidation pressure} \\ 6 & \text{preconsolidation pressure} \\ 1 & \text{plasticity index} \\ 6 & \text{preconsolidation pressure} \\ 6 & \text{preconsolidation pressure} \\ 7 & \text{principal stress} \\ 7 & \text{principal stress} \\ 8 & \text{principal stress} \\ 8 & \text{principal stress} \\ 9 & princi$				
$\begin{array}{c} d_{100} & \mbox{displacement for } 100\% \mbox{consolidation} & \mbox{w}_n & \mbox{natural water content} \\ E & Young's modulus & \mbox{w}_p & \mbox{plastic limit} \\ e & \mbox{void ratio} & \mbox{woid ratio} & \mbox{wo, wi} & \mbox{initial water content} \\ e_o & \mbox{initial void ratio} & \mbox{a} & \mbox{slope of } q_r \mbox{versus } p_r \\ e_o & \mbox{initial void ratio} & \mbox{a} & \mbox{slope of } q_r \mbox{versus } p_r \\ e_o & \mbox{initial void ratio} & \mbox{a} & \mbox{slope of } q_r \mbox{versus } p_r \\ e_o & \mbox{slope of } q_r v$		1		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		•		•
e void ratio w_s shrinkage limit e_c void ratio after consolidation w_o , w_i initial water content e_o initial void ratio a slope of q_f versus p_f g_s specific gravity of soil particles g_s specific gravity of soil parti		•		
$\begin{array}{c} e_c \\ \text{o} \\ \text{initial void ratio} \\ \text{G} \\ \text{Shear modulus} \\ \text{G}_s \\ \text{Specific gravity of soil particles} \\ \text{H} \\ \text{height of specimen} \\ \text{HR} \\ \text{Rebound Hardness number} \\ \text{i} \\ \text{gradient} \\ \text{Is} \\ \text{Uncorrected point load strength} \\ \text{Is} \\ \text{Uncorrected point load strength index} \\ \text{Evol} \\ \text{Volume strain} \\ \text{HA} \\ \text{Modified Taber Abrasion} \\ \text{Eb, Ev} \\ \text{horizontal strain, vertical strain} \\ \text{HT} \\ \text{Total hardness} \\ \text{Ko} \\ \text{lateral stress ratio for one dimensional strain} \\ \text{G} \\ \text{normal stress} \\ \text{It} \\ \text{Liquidity Index} \\ \text{G}_c, \sigma^*_c \\ \text{consolidation stress in isotropic stress system} \\ \text{mv} \\ \text{coefficient of volume change} \\ \text{n} \\ \text{porosity} \\ \text{q} \\ \text{porosity} \\ \text{q} \\ \text{preconsolidation pressure} \\ \text{p} \\ \text{p} \\ \text{($\sigma_1 + \sigma_3$)/2, ($\sigma_v + \sigma_h$)/2} \\ \text{p} \\ \text{p} \\ \text{($\sigma_1 + \sigma_3$)/2, ($\sigma_v + \sigma_h$)/2} \\ \text{p} \\ \text{g} \\ \text{q} \\ \text{($\sigma_1 - \sigma_3$)/2} \\ \text{($\sigma_1 - \sigma_3$)/2} \\ \text{q} \\ \text{minimal stress} \\ \text{q} \\ \text{q} \\ \text{q} \\ \text{friction angle based on total stresses} \\ \text{q} \\ \text{q} \\ \text{q} \\ \text{friction angle based on effective stresses} \\ \text{q} \\ \text{q} \\ \text{q} \\ finitial water content with unit weight of value with total unit weight of value with total unit weight of value with total unit weight of solids unit weigh$		e	•	1
$\begin{array}{c} e_{0} & \text{initial void ratio} \\ G & \text{shear modulus} \\ G_{s} & \text{specific gravity of soil particles} \\ H & \text{height of specimen} \\ H_{R} & \text{Rebound Hardness number} \\ I & \text{gradient} \\ I_{S} & \text{Uncorrected point load strength} \\ I_{S} & \text{Uncorrected point load strength} \\ I_{S} & \text{Uncorrected point load strength index} \\ H_{T} & \text{Total hardness} \\ K_{O} & \text{lateral stress ratio for one dimensional strain} \\ K & \text{permeability} \\ I_{O} & \text{coefficient of volume change} \\ I_{O} & \text{possibly} \\ I_{O} & \text{preconsolidation pressure} \\ I_{O} & \text{quantity of flow} \\ I$				•
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n porosity σ_{v} , σ_{v} vertical normal stress PI plasticity index σ_{v} , σ_{v} vertical normal stress Effective vertical consolidation stress σ_{v} Effective vertical consolidation stress σ_{v} major principal stress σ_{v} intermediate principa		1 ,	σ_c, σ'_c	consolidation stress in isotropic stress system
PI plasticity index σ'_{vc} Effective vertical consolidation stress σ'_{vc} preconsolidation pressure σ_1 major principal stress σ_2 intermediate principal stress σ'_{vc} principal stress σ'_{vc} σ'_{vc} intermediate principal stress σ'_{vc} σ'_{vc		<u> </u>	σ_h, σ'_h	horizontal normal stress
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		•	σ_v, σ'_v	vertical normal stress
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		± •	σ'_{vc}	Effective vertical consolidation stress
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	P_c	•	σ_1	major principal stress
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			σ_2	intermediate principal stress
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$\begin{array}{cccccccccccccccccccccccccccccccccccc$	p'c	•	τ	shear stress
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	Q	1 7	φ	friction angle based on total stresses
q_f q at failure ϕ'_r residual friction angle q_0, q_i initial q ϕ_{ult} ϕ for ultimate strength	q		•	friction angle based on effective stresses
q_o,q_i initial q ϕ_{ult} ϕ for ultimate strength	q_{f}	•		e e e e e e e e e e e e e e e e e e e
	q_o, q_i	•		
	q_c	q at consolidation	•	-