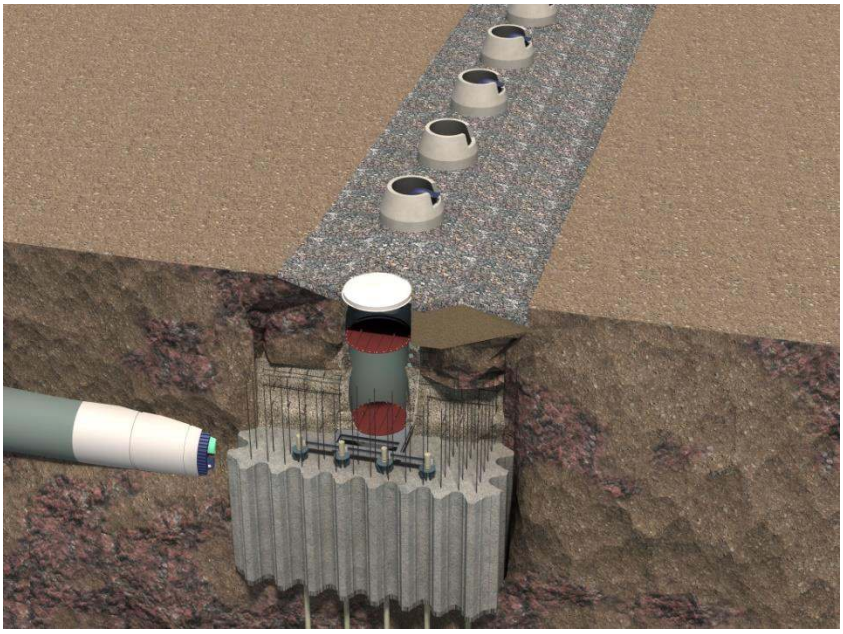
APPENDIX B
GEOTECHNICAL REPORTS

B.1: Geotechnical Data Report

Part J: Appendix G, Secondary Testing

Annacis Island WWTP New Outfall System

Vancouver Fraser Port Authority
Project and Environmental Review Application



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CDM Smith

Golder Associates

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APPENDIX G

Laboratory Testing Reports

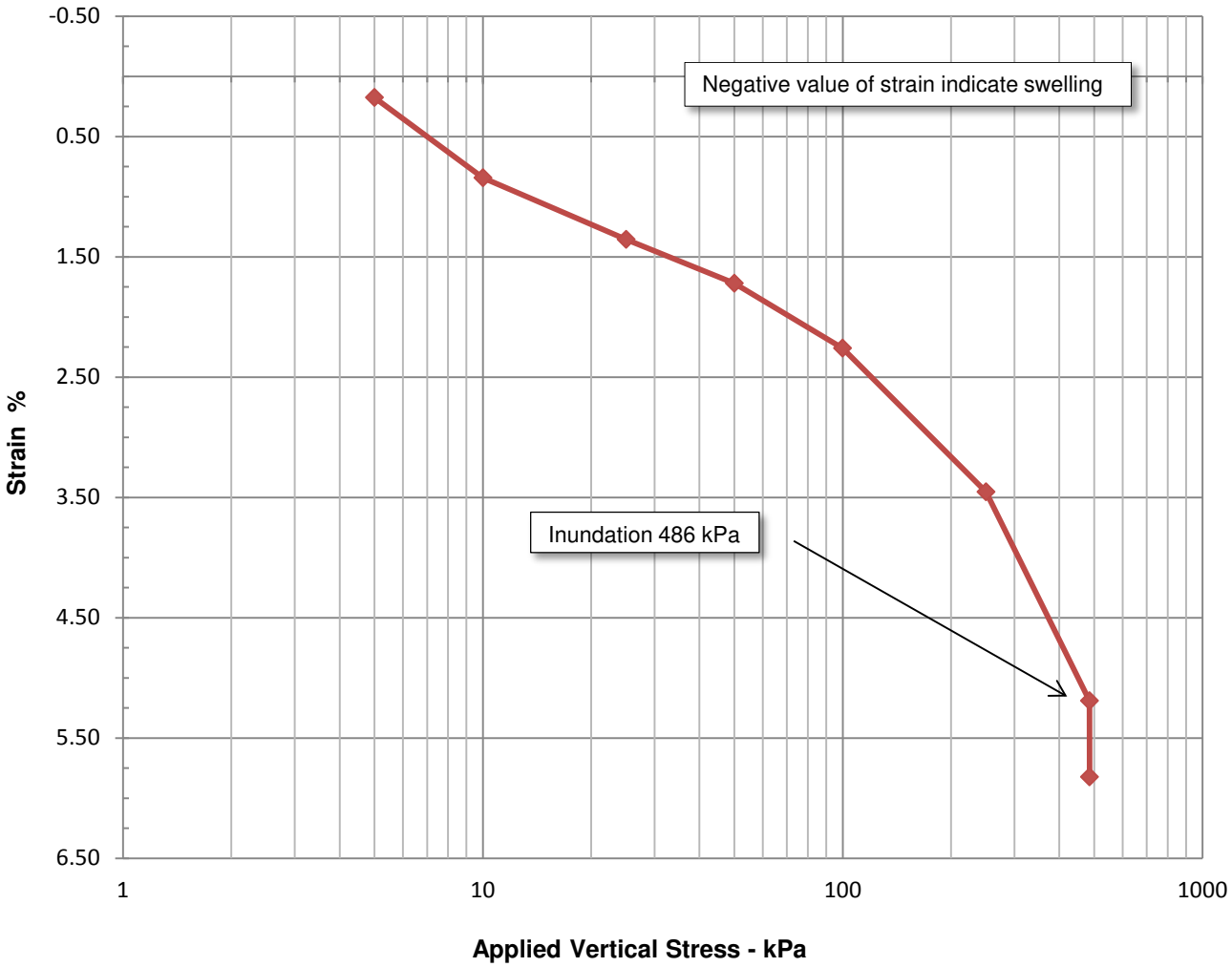
Swelling Tests

Golder Associates Ltd. - Burnaby Laboratory
Unit 300 - 3811 North Fraser Way
Burnaby, B.C. Canada V5J 5J2

Standard Test Methods for One-Dimensional Swell or Collapse of Soil

Reference(s)
ASTM D 4546

Client:	CDM Smith Canada ULC	**Sample ID:**	BH16-06
Project:	Annacis Outfall and Transient Mitigation	**Sample:**	33
Location:	Annacis Island	**Test ID:**	49.99 - 50.60
Project No.:	1525010/3000	**Lab Sch No:**	28
ASTM Method:	Method B	**Preparation Method:**	Intact
Sample Description:	SILTY CLAY, grey, w>PL, firm	**Other Remarks:**	**Type of water:** Tap water
			Specimen Preparation: N/A



Remark: Final height taken from the final LVDT reading.

MM	March 22, 2017	DL	March 28, 2017
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd. - Burnaby Laboratory
Unit 300 - 3811 North Fraser Way
Burnaby, B.C. Canada V5J 5J2

Standard Test Methods for One-Dimensional Swell or Collapse of Soil

Reference(s): **ASTM D 4546**

Client:	CDM Smith Canada ULC	**Sample ID:**	BH16-06
Project:	Annacis Outfall and Transient Mitigation	**Sample:**	33
Location:	Annacis Island	**Test ID:**	49.99 - 50.60
Project No.:	1525010/3000	**Lab Sch No:**	28
ASTM Method:	Method B	**Preparation Method:**	Intact
Sample Description:	SILTY CLAY, grey, w>PL, firm	**Other Remarks:**	**Type of water:** Tap water
			Specimen Preparation: N/A

Equipment

Machine:	Sigma-1
Mach No.	6
Ring No.	X
Load Cell	2000 lbs
Drainage:	Double-sided

Specimen Geometry

	Initial	Final
Height (mm) =	21.77	20.50
Diameter (mm) =	63.53	63.53
Area (cm^2) =	31.69	31.69
Volume (cm^3) =	68.99	64.97

Phase Relationships

	Initial	Final
Wet Wt (g) =	133.67	131.24
Dry Wt (g) =	105.15	105.15
w (%) =	27.12	28.27
e =	0.77	0.67
ρ_{wet} (kg/m^3) =	1938	2020
ρ_{dry} (kg/m^3) =	1524	1618
S (%) =	95	100

Sample Properties

G_s =	2.70	Calculated
H_s (mm) =	12.27	

Atterberg Limits

Liquild Limit:	33
Plastic Limit:	18
Plasticity Index:	15

Soil Classification: CI

Stress kPa	ΔH (mm)	$D_{f\_corrected}$ (mm)	ε (%)	H-Hs (mm)	e
5	0.04	21.73	0.18	9.460	0.771
10	0.18	21.58	0.84	9.315	0.759
25	0.16	21.47	1.35	9.203	0.750
50	0.12	21.39	1.72	9.124	0.744
100	0.17	21.28	2.26	9.006	0.734
250	0.34	21.02	3.45	8.746	0.713
485	0.42	20.64	5.19	8.368	0.682
485	0.14	20.50	5.82	8.231	0.671

MM	March 22, 2017	DL	March 28, 2017
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd. - Burnaby Laboratory
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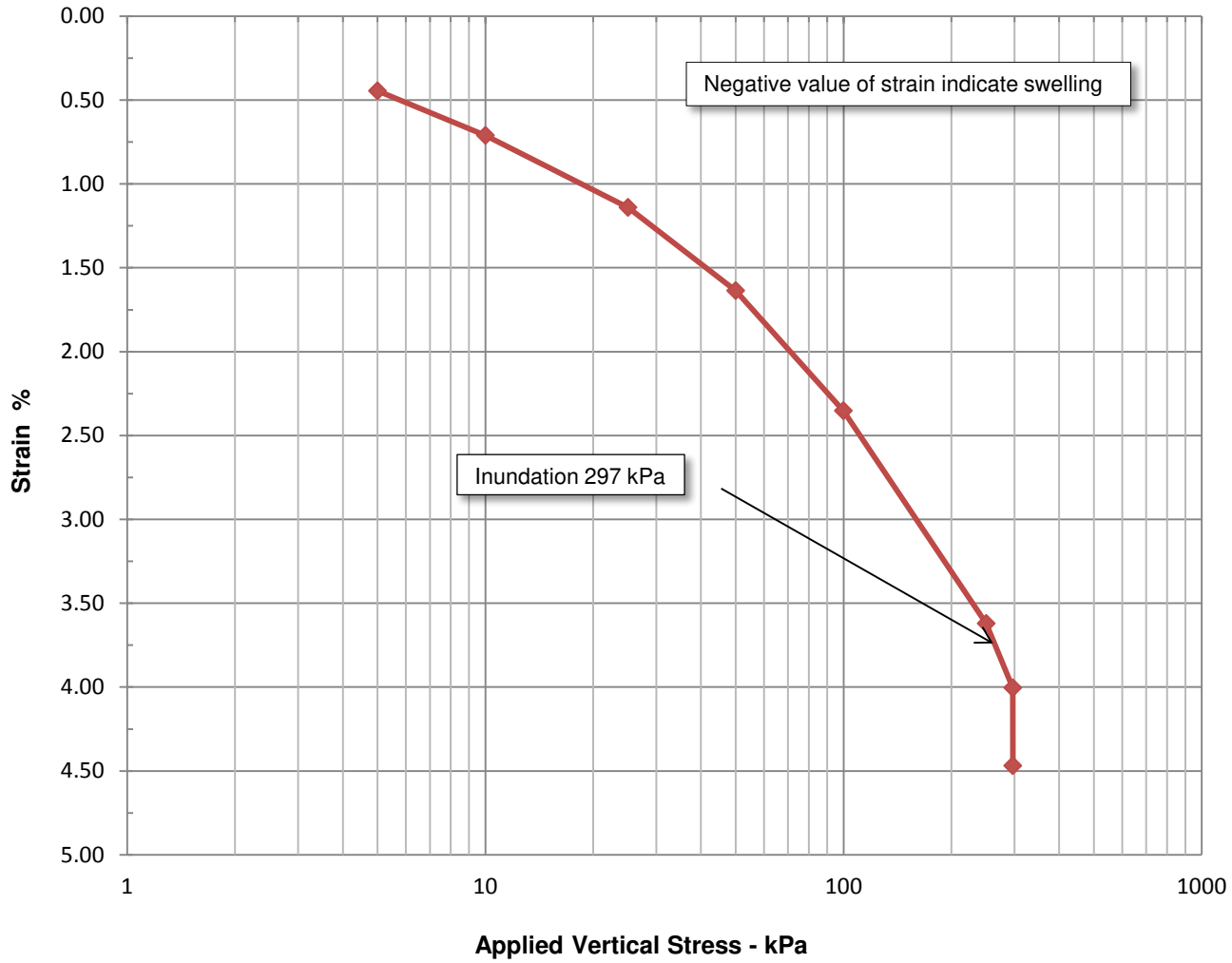
Burnaby, B.C. Canada V5J 5J2

Standard Test Methods for One-Dimensional Swell or Collapse of Soil

Reference(s)
ASTM D 4546

Client:	CDM Smith Canada ULC	**Sample ID:**	BH16-08
Project:	Annacis Outfall and Transient Mitigation	**Sample:**	21
Location:	Annacis Island	**Test ID:**	32.0 - 32.6
Project No.:	1525010/3000	**Lab Sch No:**	28
ASTM Method:	Method B	**Preparation Method:**	Intact
Sample Description:	CLAYEY SILT, grey, w>PL, soft to firm.	**Other Remarks:**	**Type of water:** Tap water **Specimen Preparation:** N/A



Remark: Final height taken from the final LVDT reading.

MM	March 22, 2017	DL	March 29, 2017
TESTED BY	DATE	CHECKED BY	DATE

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Standard Test Methods for One-Dimensional Swell or Collapse of Soil

Reference(s): **ASTM D 4546**

Client:	CDM Smith Canada ULC	**Sample ID:**	BH16-08
Project:	Annacis Outfall and Transient Mitigation	**Sample:**	21
Location:	Annacis Island	**Test ID:**	32.0 - 32.6
Project No.:	1525010/3000	**Lab Sch No:**	28
ASTM Method:	Method B	**Preparation Method:**	Intact
Sample Description:	CLAYEY SILT, grey, w>PL, soft to firm.	**Other Remarks:**	**Type of water:** Tap water **Specimen Preparation:** N/A

Equipment

Machine:	Sigma-1
Mach No.	7
Ring No.	AC2
Load Cell	2000 lbs
Drainage:	Double-sided

Specimen Geometry

	Initial	Final
Height (mm) =	21.74	20.77
Diameter (mm) =	63.54	63.54
Area (cm^2) =	31.70	31.70
Volume (cm^3) =	68.93	65.85

Phase Relationships

	Initial	Final
Wet Wt (g) =	134.95	133.50
Dry Wt (g) =	106.41	106.41
w (%) =	26.82	25.84
e =	0.78	0.70
ρ_{wet} (kg/m^3) =	1958	2027
ρ_{dry} (kg/m^3) =	1544	1616
S (%) =	94	100

Sample Properties

G_s =	2.75	Assumed
H_s (mm) =	12.20	

Atterberg Limits

Liquid Limit:	23
Plastic Limit:	17
Plasticity Index:	6

Soil Classification: CL-ML

Stress kPa	ΔH (mm)	$D_{f\_corrected}$ (mm)	ε (%)	H-Hs (mm)	e
5	0.11	21.65	0.44	9.441	0.774
10	0.11	21.59	0.71	9.383	0.769
25	0.17	21.49	1.14	9.290	0.761
50	0.16	21.39	1.64	9.182	0.752
100	0.22	21.23	2.35	9.026	0.740
250	0.39	20.96	3.62	8.750	0.717
297	0.11	20.87	4.01	8.667	0.710
297	0.10	20.77	4.47	8.566	0.702

MM	March 22, 2017	DL	March 29, 2017
TESTED BY	DATE	CHECKED BY	DATE

One-Dimensional Consolidation Tests

Golder Associates Ltd. - Burnaby Laboratory
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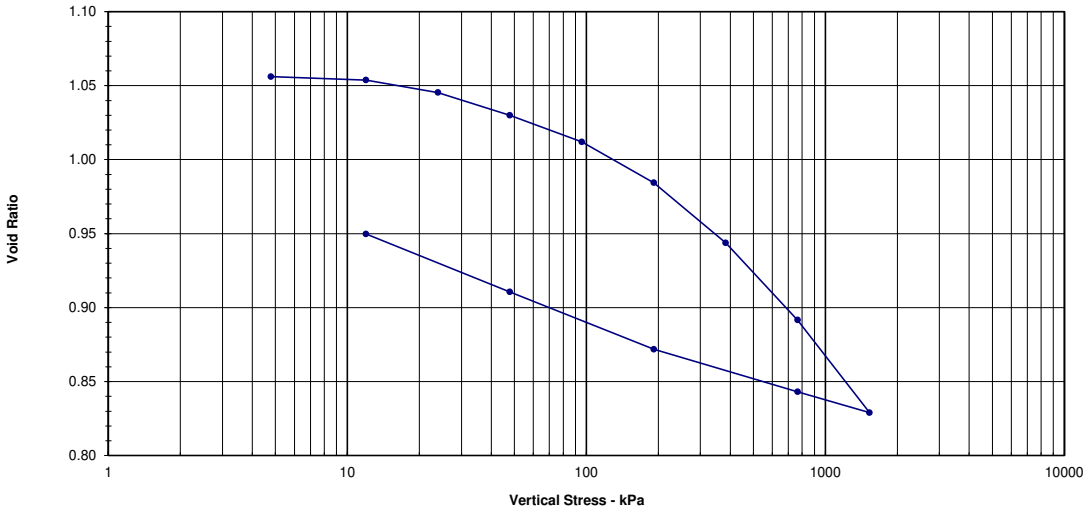
Burnaby, B.C. Canada V5J 5J2

One-Dimensional Consolidation Properties of Soils

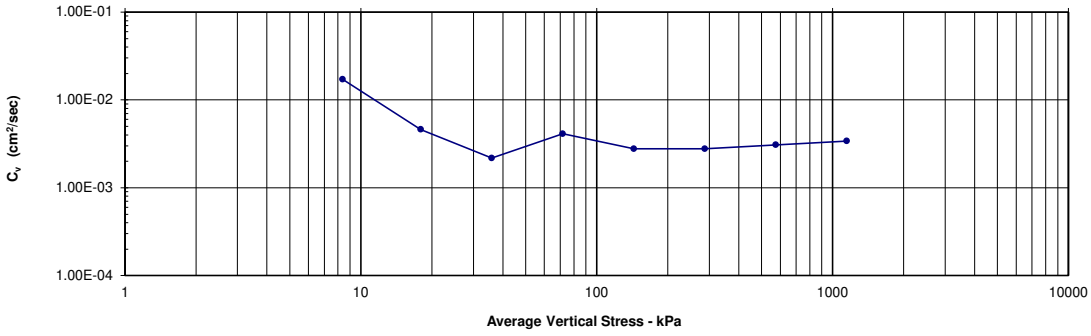
Reference(s)
ASTM D 2435/D 2435M-11

Project No. :	1532895 Phase: 1000	**Client :**	Black & Veatch	**Borehole:**	BH15-04
Sch No.	306	**Project :**	Annacis Outfall	**Sample:**	31
Lab Work:	CS/MM	**Location:**	Annacis Island, Delta, BC	**Depth (m) :**	43.59 - 44.20

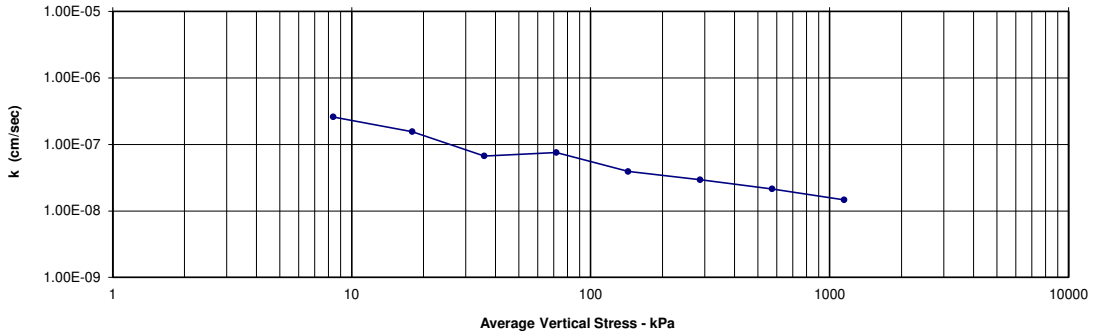
Void Ratio vs Stress



Coefficient of Consolidation vs Stress



Coefficient of Permeability vs Stress



CS/MM	August 25, 2015	L.Lee	September 14, 2015
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd. - Burnaby Laboratory
Unit 300 - 3811 North Fraser Way
Burnaby, B.C. Canada V5J 5J2

One-Dimensional Consolidation Properties of Soils

Reference(s)
ASTM D 2435/D 2435M-11

Project No. :	1532895 Phase: 1000	**Client :**	Black & Veatch	**Borehole:**	BH15-04
Sch No.	306	**Project :**	Annacis Outfall	**Sample:**	31
Lab Work:	CS/MM	**Location:**	Annacis Island, Delta, BC	**Depth (m) :**	43.59 - 44.20

Equipment

Machine:	Sigma-1
Mach No.	2
Ring No.	B1
Drainage:	Double-sided

Specimen Geometry

	Initial	Final
Height (mm) =	22.09	19.61
Diameter (mm) =	63.32	63.32
Area (cm^2) =	31.48	31.48
Volume (cm^3) =	69.54	61.73

Phase Relationships

	Initial	Final
Wet Wt (g) =	128.71	121.65
Dry Wt (g) =	93.70	93.70
w (%) =	37.36	29.83
e =	1.056	0.825
ρ_{wet} (kg/m^3) =	1851	1971
ρ_{drv} (kg/m^3) =	1347	1518
S (%) =	98	100

Remarks

ASTM Method:	B - Constant Time Increment @ EOP
Method for Cv :	Taylor
H_{avg} **:**	Half the specimen height
Time Increment:	600 min

Sample Properties

G_s =	2.77	Assumed
H_s (mm) =	10.74	

Atterberg Limits

Liquid Limit:	N/A
Plastic Limit:	N/A
Plasticity Index:	N/A
Soil Classification:	N/A

Estimated Preconsolidation Stress: N/A

Load #	Stress (kPa)	ΔH (mm)	Corrected d_f (mm)	ε $\Sigma \Delta H / Ho$ (%)	H-H_s (mm)	e $(H-H_s)/H_s$	Stress $_{avg}$ (kPa)	e_{avg}	H_{avg} (mm)	t 90 (min)	Cv (cm^2/sec)	k (cm/sec)
1	5	0.01	22.09	0.03	11.35	1.056						
2	12	0.04	22.07	0.14	11.32	1.054	8	1.05	11.04	1.01	1.7E-02	2.6E-07
3	24	0.12	21.97	0.55	11.23	1.045	18	1.05	11.01	3.72	4.6E-03	1.6E-07
4	48	0.20	21.81	1.30	11.07	1.030	36	1.04	10.95	7.80	2.2E-03	6.7E-08
5	96	0.22	21.62	2.18	10.87	1.012	72	1.02	10.86	4.04	4.1E-03	7.5E-08
6	192	0.34	21.32	3.52	10.58	0.984	144	1.00	10.73	5.86	2.8E-03	3.9E-08
7	383	0.49	20.88	5.50	10.14	0.944	287	0.96	10.55	5.66	2.8E-03	2.9E-08
8	766	0.65	20.32	8.03	9.58	0.892	575	0.92	10.30	4.87	3.1E-03	2.1E-08
9	1532	0.79	19.65	11.08	8.91	0.829	1149	0.86	9.99	4.15	3.4E-03	1.5E-08
10	766	-0.23	19.80	10.39	9.06	0.843						
11	192	-0.42	20.11	9.00	9.37	0.872						
12	48	-0.46	20.53	7.11	9.78	0.911						
13	12	-0.45	20.95	5.20	10.20	0.950						

Comments: Void Ratio Vs. Stress computed for end of primary consolidation.
Final height measured after unloading.

Description: CLAY; some silt, grey, moist, stiff.

CS/MM	August 25, 2015	L.Lee	September 14, 2015
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd. - Burnaby Laboratory
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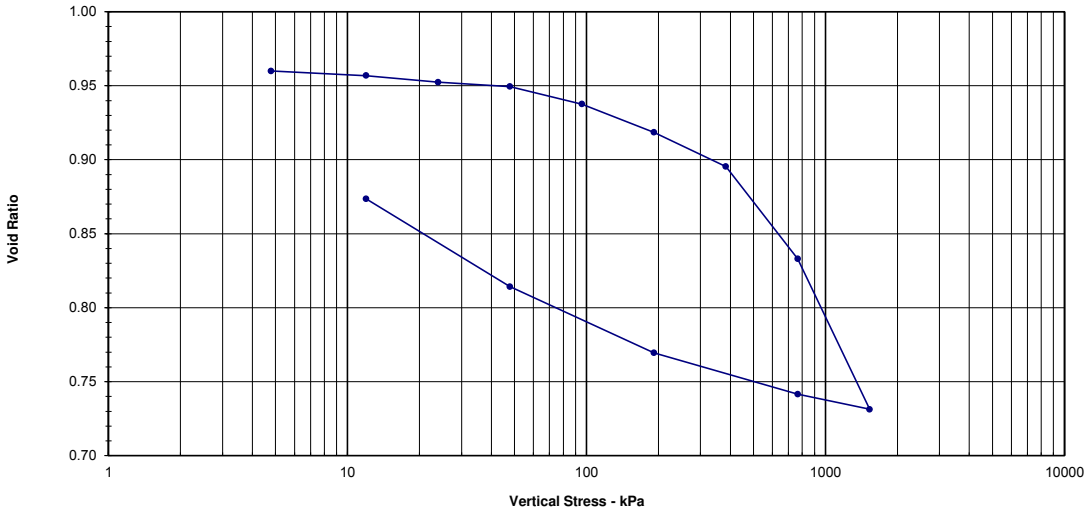
One-Dimensional Consolidation Properties of Soils

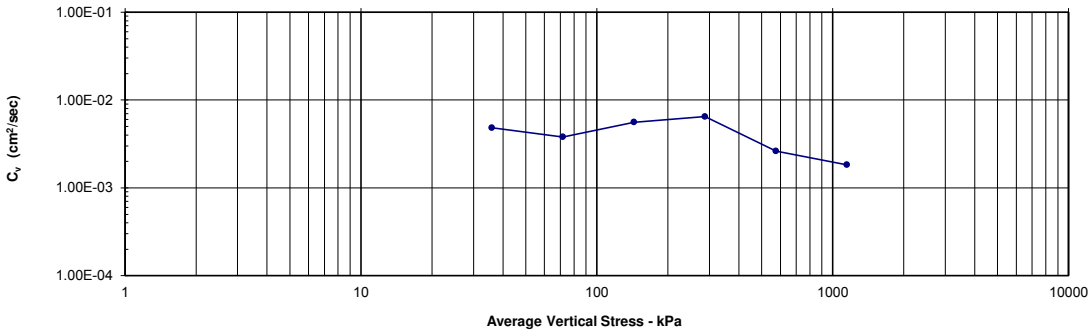
Reference(s)
ASTM D 2435/D 2435M-11

Project No. :	1532895 Phase: 1000	**Client :**	Black & Veatch	**Borehole:**	BH15-05
Sch No.	306	**Project :**	Annacis Outfall	**Sample:**	34
Lab Work:	CS/MM	**Location:**	Annacis Island, Delta, BC	**Depth (m) :**	50.90 - 51.51

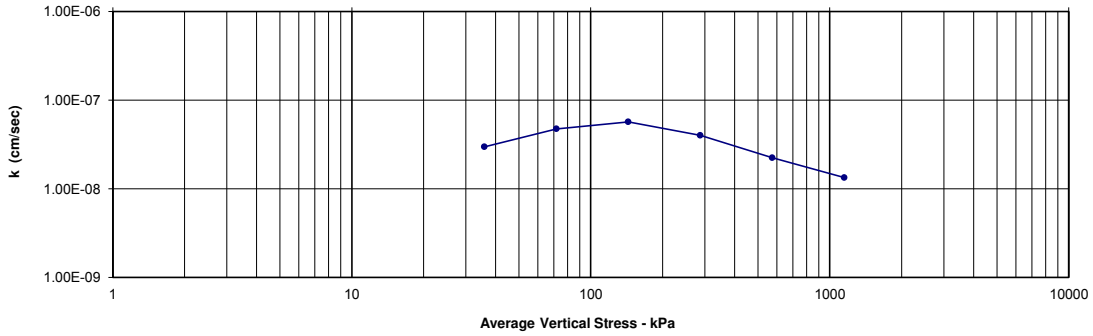
Void Ratio vs Stress



Coefficient of Consolidation vs Stress



Coefficient of Permeability vs Stress



CS/MM	August 25, 2015	L.Lee	September 17, 2015
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd. - Burnaby Laboratory
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One-Dimensional Consolidation Properties of Soils

Reference(s)
ASTM D 2435/D 2435M-11

Project No. :	1532895 Phase: 1000	**Client :**	Black & Veatch	**Borehole:**	BH15-05
Sch No.	306	**Project :**	Annacis Outfall	**Sample:**	34
Lab Work:	CS/MM	**Location:**	Annacis Island, Delta, BC	**Depth (m) :**	50.90 - 51.51

Equipment

Machine:	Sigma-1
Mach No.	4
Ring No.	4
Drainage:	Double-sided

Specimen Geometry

	Initial	Final
Height (mm) =	22.10	20.06
Diameter (mm) =	63.29	63.29
Area (cm^2) =	31.46	31.46
Volume (cm^3) =	69.52	63.10

Phase Relationships

	Initial	Final
Wet Wt (g) =	125.02	122.10
Dry Wt (g) =	94.64	94.64
w (%) =	32.10	29.02
e =	0.950	0.770
ρ_{wet} (kg/m^3) =	1798	1935
ρ_{drv} (kg/m^3) =	1361	1500
S (%) =	90	100

Remarks

ASTM Method:	B - Constant Time Increment @ EOP
Method for Cv :	Taylor
H_{avg} **:**	Half the specimen height
Time Increment:	360 min

Sample Properties

G_s =	2.65	Calculated
H_s (mm) =	11.33	

Atterberg Limits

Liquid Limit:	N/A
Plastic Limit:	N/A
Plasticity Index:	N/A
Soil Classification:	N/A

Estimated Preconsolidation Stress: 538 kPa

Load #	Stress (kPa)	ΔH (mm)	Corrected d_f (mm)	ε $\Sigma \Delta H / Ho$ (%)	H-H_s (mm)	e $(H-H_s)/H_s$	Stress $_{avg}$ (kPa)	e_{avg}	H_{avg} (mm)	t 90 (min)	Cv (cm^2/sec)	k (cm/sec)
1	5	-0.10	22.21	-0.49	10.88	0.960						
2	12	0.07	22.17	-0.33	10.84	0.957						
3	24	0.07	22.12	-0.11	10.79	0.952						
4	48	0.07	22.09	0.05	10.76	0.949	36	0.95	11.05	3.58	4.8E-03	3.0E-08
5	96	0.17	21.95	0.65	10.62	0.938	72	0.94	11.01	4.51	3.8E-03	4.7E-08
6	192	0.25	21.74	1.63	10.41	0.918	144	0.93	10.92	3.01	5.6E-03	5.7E-08
7	383	0.33	21.47	2.82	10.14	0.895	287	0.91	10.80	2.55	6.5E-03	4.0E-08
8	766	0.78	20.77	6.02	9.44	0.833	575	0.86	10.56	6.00	2.6E-03	2.3E-08
9	1532	1.25	19.62	11.23	8.29	0.731	1149	0.78	10.10	7.85	1.8E-03	1.3E-08
10	766	-0.21	19.73	10.71	8.40	0.742						
11	192	-0.52	20.05	9.27	8.72	0.770						
12	48	-0.56	20.55	6.98	9.22	0.814						
13	12	-0.70	21.23	3.94	9.90	0.874						

Comments: Void Ratio Vs. Stress computed for end of primary consolidation. Advanced to 24 kPa due to swelling.
Final height measured by LVDT reading.

Description: SILTY CLAY; some shell fragments, grey, moist, firm.

CS/MM	August 25, 2015	L.Lee	September 17, 2015
TESTED BY	DATE	CHECKED BY	DATE

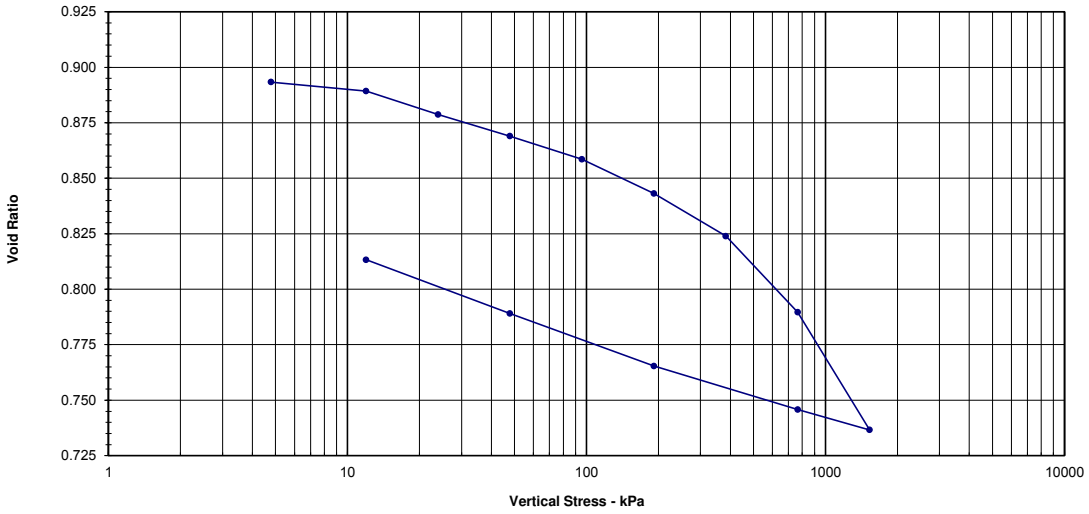
Golder Associates Ltd. - Burnaby Laboratory
Unit 300 - 3811 North Fraser Way
Burnaby, B.C. Canada V5J 5J2

One-Dimensional Consolidation Properties of Soils

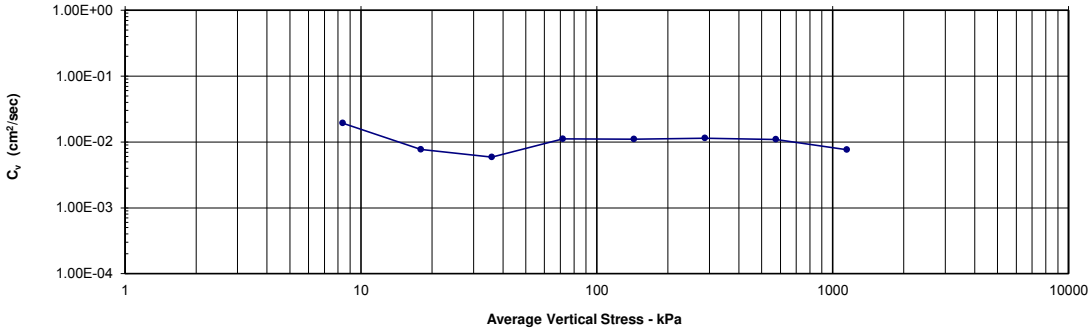
Reference(s)
ASTM D 2435/D 2435M-11

Project No. :	1532895 Phase: 1000	**Client :**	Black & Veatch	**Borehole:**	BH15-13
Sch No.	306	**Project :**	Annacis Outfall	**Sample:**	32
Lab Work:	TM	**Location:**	Annacis Island, Delta, BC	**Depth (m) :**	48.46 - 49.07

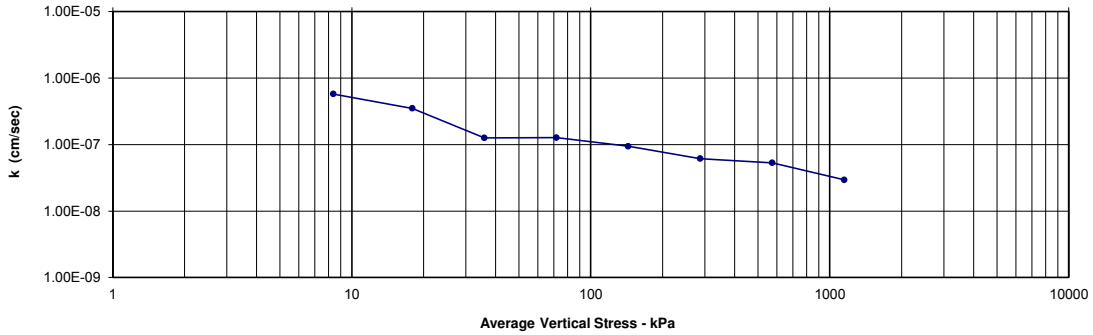
Void Ratio vs Stress



Coefficient of Consolidation vs Stress



Coefficient of Permeability vs Stress



TM	August 31, 2015	L.Lee	September 14, 2015
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd. - Burnaby Laboratory
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One-Dimensional Consolidation Properties of Soils

Reference(s)
ASTM D 2435/D 2435M-11

Project No. :	1532895 Phase: 1000	**Client :**	Black & Veatch	**Borehole:**	BH15-13
Sch No.	306	**Project :**	Annacis Outfall	**Sample:**	32
Lab Work:	TM	**Location:**	Annacis Island, Delta, BC	**Depth (m) :**	48.46 - 49.07

Equipment

Machine:	Sigma-1
Mach No.	4
Ring No.	Stn 1
Drainage:	Double-sided

Specimen Geometry

	Initial	Final
Height (mm) =	22.37	20.46
Diameter (mm) =	63.49	63.49
Area (cm^2) =	31.66	31.66
Volume (cm^3) =	70.80	64.78

Phase Relationships

	Initial	Final
Wet Wt (g) =	135.00	130.59
Dry Wt (g) =	103.30	103.30
w (%) =	30.69	26.42
e =	0.892	0.731
ρ_{wet} (kg/m^3) =	1907	2016
ρ_{drv} (kg/m^3) =	1459	1595
S (%) =	95	100

Remarks

ASTM Method:	B - Constant Time Increment @ EOP
Method for Cv :	Taylor
H_{avg} **:**	Half the specimen height
Time Increment:	360 min

Sample Properties

G_s =	2.76	Assumed
H_s (mm) =	11.82	

Atterberg Limits

Liquid Limit:	N/A
Plastic Limit:	N/A
Plasticity Index:	N/A
Soil Classification:	N/A

Estimated Preconsolidation Stress: N/A

Load #	Stress (kPa)	ΔH (mm)	Corrected d_f (mm)	ε $\Sigma \Delta H / Ho$ (%)	H-H_s (mm)	e $(H-H_s)/H_s$	Stress $_{avg}$ (kPa)	e_{avg}	H_{avg} (mm)	t 90 (min)	Cv (cm^2/sec)	k (cm/sec)
1	5	0.00	22.38	-0.03	10.56	0.893						
2	12	0.09	22.34	0.18	10.51	0.889	8	0.89	11.18	0.91	1.9E-02	5.8E-07
3	24	0.14	22.21	0.74	10.39	0.879	18	0.88	11.14	2.28	7.7E-03	3.5E-07
4	48	0.15	22.10	1.26	10.27	0.869	36	0.87	11.08	2.94	5.9E-03	1.3E-07
5	96	0.16	21.97	1.81	10.15	0.859	72	0.86	11.02	1.55	1.1E-02	1.3E-07
6	192	0.22	21.79	2.62	9.97	0.843	144	0.85	10.94	1.53	1.1E-02	9.4E-08
7	383	0.29	21.56	3.64	9.74	0.824	287	0.83	10.84	1.45	1.1E-02	6.1E-08
8	766	0.48	21.16	5.45	9.34	0.790	575	0.81	10.68	1.47	1.1E-02	5.3E-08
9	1532	0.72	20.53	8.25	8.71	0.737	1149	0.76	10.42	2.01	7.6E-03	2.9E-08
10	766	-0.19	20.64	7.77	8.82	0.746						
11	192	-0.32	20.87	6.73	9.05	0.765						
12	48	-0.33	21.15	5.48	9.33	0.789						
13	12	-0.31	21.44	4.20	9.61	0.813						

Comments: Void Ratio Vs. Stress computed for end of primary consolidation.
Final height measured by LVDT reading.

Description: CLAY; some silt; trace sand, grey, moist, firm to stiff.

TM	August 31, 2015	L.Lee	September 14, 2015
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd. - Burnaby Laboratory
Unit 300 - 3811 North Fraser Way
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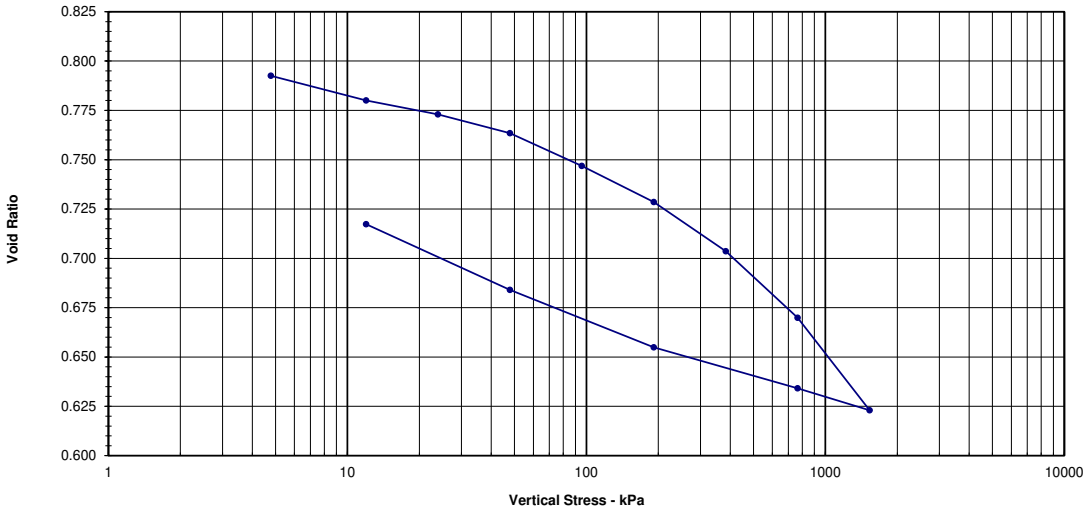
One-Dimensional Consolidation Properties of Soils

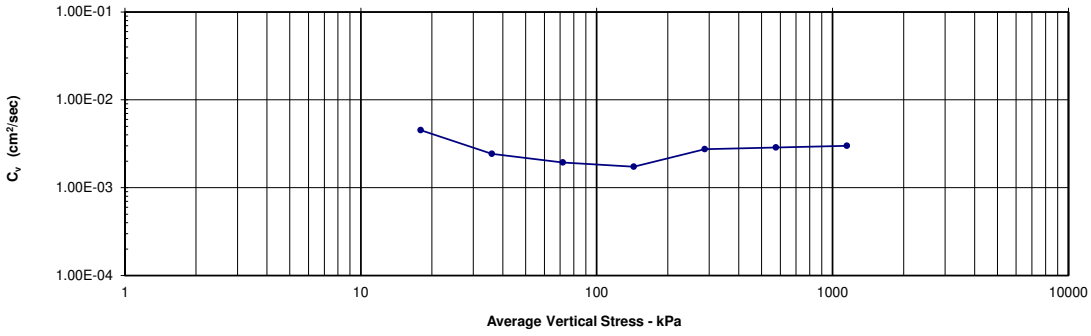
Reference(s)
ASTM D 2435/D 2435M-11

Project No. :	1525010/3000	**Client :**	CDM Smith Canada ULC	**Borehole:**	BH16-06
Sch No.	28	**Project :**	Annacis Outfall and Transient Mitigation	**Sample:**	33
Lab Work:	CP/MM	**Location:**	Annacis Island	**Depth (m) :**	49.99 - 50.60

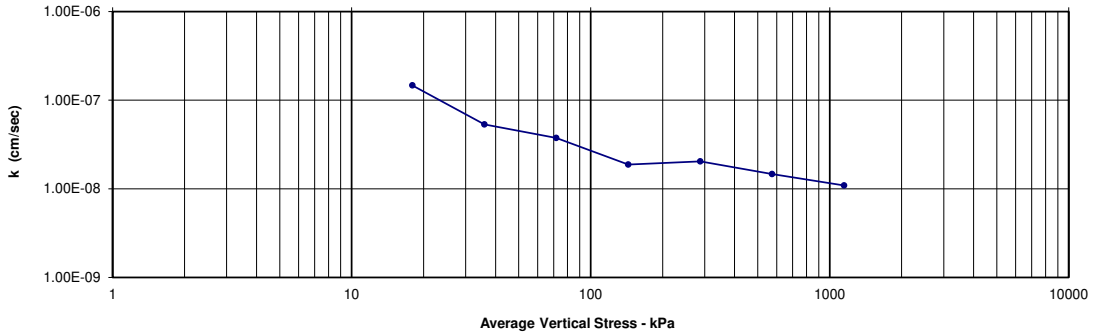
Void Ratio vs Stress



Coefficient of Consolidation vs Stress



Coefficient of Permeability vs Stress



MM/CP	February 23, 2017	DL	March 3, 2017
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd. - Burnaby Laboratory
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One-Dimensional Consolidation Properties of Soils

Reference(s)
ASTM D 2435/D 2435M-11

Project No. :	1525010/3000	**Client :**	CDM Smith Canada ULC	**Borehole:**	BH16-06
Sch No.	28	**Project :**	Annacis Outfall and Transient Mitigation	**Sample:**	33
Lab Work:	CP/MM	**Location:**	Annacis Island	**Depth (m) :**	49.99 - 50.60

Equipment

Machine:	Sigma-1
Mach No.	2
Ring No.	G
Drainage:	Double-sided

Specimen Geometry

	Initial	Final
Height (mm) =	21.95	20.44
Diameter (mm) =	63.53	63.53
Area (cm^2) =	31.70	31.70
Volume (cm^3) =	69.56	64.79

Phase Relationships

	Initial	Final
Wet Wt (g) =	135.35	130.85
Dry Wt (g) =	105.13	105.13
w (%) =	28.75	24.47
e =	0.786	0.664
ρ_{wet} (kg/m^3) =	1946	2020
ρ_{drv} (kg/m^3) =	1511	1623
S (%) =	99	100

Remarks

ASTM Method:	B - Constant Time Increment @ EOP
Method for Cv :	Taylor
H_{avg} **:**	Half the specimen height
Time Increment:	720 min

Sample Properties

G_s =	2.70	Calculated
H_s (mm) =	12.28	

Atterberg Limits

Liquid Limit:	33
Plastic Limit:	18
Plasticity Index:	15
Soil Classification:	CI

Estimated Preconsolidation Stress: N/A

Load #	Stress (kPa)	ΔH (mm)	Corrected d_f (mm)	ε Σ ΔH / Ho (%)	H-H_s (mm)	e (H-H_s)/H_s	Stress $_{avg}$ (kPa)	e_{avg}	H_{avg} (mm)	t 90 (min)	Cv (cm^2/sec)	k (cm/sec)
1	5	-0.07	22.02	-0.33	9.74	0.793						
2	12	0.17	21.87	0.37	9.58	0.780						
3	24	0.11	21.78	0.76	9.49	0.773	18	0.78	10.91	3.73	4.5E-03	1.5E-07
4	48	0.15	21.66	1.29	9.38	0.763	36	0.77	10.86	6.88	2.4E-03	5.3E-08
5	96	0.23	21.46	2.22	9.17	0.747	72	0.76	10.78	8.49	1.9E-03	3.7E-08
6	192	0.27	21.23	3.25	8.95	0.729	144	0.74	10.67	9.29	1.7E-03	1.9E-08
7	383	0.36	20.93	4.64	8.64	0.704	287	0.72	10.54	5.73	2.7E-03	2.0E-08
8	766	0.51	20.51	6.53	8.23	0.670	575	0.69	10.36	5.28	2.9E-03	1.5E-08
9	1532	0.70	19.94	9.16	7.65	0.623	1149	0.65	10.11	4.83	3.0E-03	1.1E-08
10	766	-0.21	20.07	8.53	7.79	0.634						
11	192	-0.36	20.33	7.37	8.04	0.655						
12	48	-0.41	20.69	5.74	8.40	0.684						
13	12	-0.44	21.10	3.87	8.81	0.717						

Comments: Void Ratio Vs. Stress computed for end of primary consolidation. Final height measured by final LVDT reading.
Sample advanced to 12 kPa due to swelling.

Description: SILTY CLAY, grey, w>PL, firm.

MM/CP	February 23, 2017	DL	March 3, 2017
TESTED BY	DATE	CHECKED BY	DATE

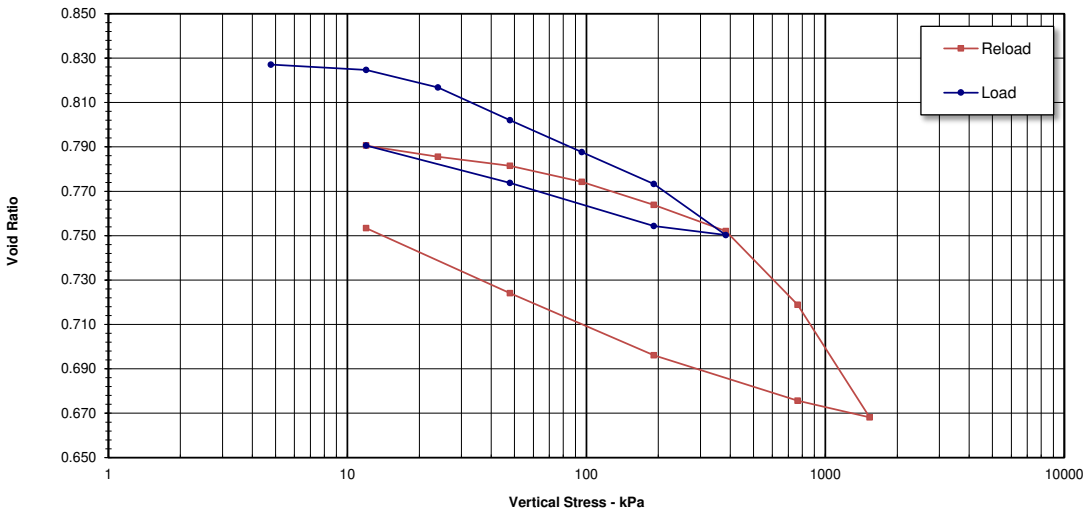
Golder Associates Ltd. - Burnaby Laboratory
Unit 300 - 3811 North Fraser Way
Burnaby, B.C. Canada V5J 5J2

One-Dimensional Consolidation Properties of Soils

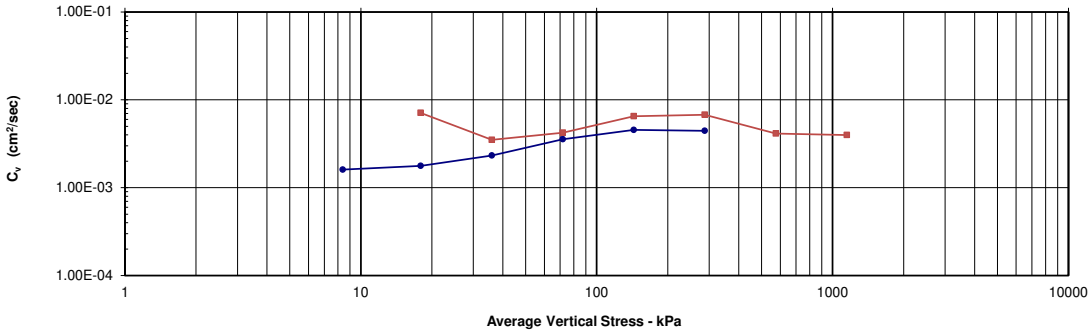
Reference(s)
ASTM D 2435/D 2435M-11

Project No. :	1525010/3000	**Client :**	CDM Smith Canada ULC	**Borehole:**	BH16-08
Sch No.	28	**Project :**	Annacis Outfall and Transient Mitigation	**Sample:**	19
Lab Work:	CP/MM	**Location:**	Annacis Island	**Depth (m) :**	28.96 - 29.57

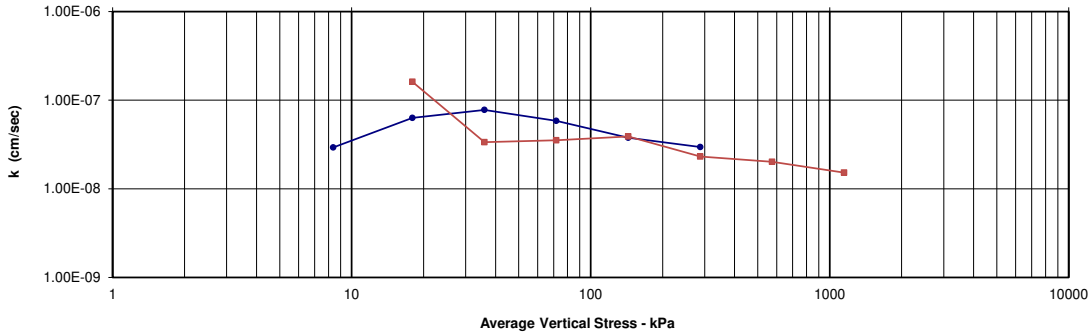
Void Ratio vs Stress



Coefficient of Consolidation vs Stress



Coefficient of Permeability vs Stress



CP/MM	December 28, 2015	DL	February 27, 2017
TESTED BY	DATE	CHECKED BY	DATE

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One-Dimensional Consolidation Properties of Soils

Reference(s)
ASTM D 2435/D 2435M-11

Project No. :	1525010/3000	**Client :**	CDM Smith Canada ULC	**Borehole:**	BH16-08
Sch No.	28	**Project :**	Annacis Outfall and Transient Mitigation	**Sample:**	19
Lab Work:	CP/MM	**Location:**	Annacis Island	**Depth (m) :**	28.96 - 29.57

Equipment

Machine:	Sigma-1
Mach No.	5
Ring No.	AC2
Drainage:	Double-sided

Specimen Geometry

	Initial	Final
Height (mm) =	21.74	19.87
Diameter (mm) =	63.51	63.51
Area (cm^2) =	31.68	31.68
Volume (cm^3) =	68.86	62.94

Phase Relationships

	Initial	Final
Wet Wt (g) =	132.01	126.95
Dry Wt (g) =	102.32	102.32
w (%) =	29.02	24.07
e =	0.830	0.673
ρ_{wet} (kg/m^3) =	1917	2017
ρ_{drv} (kg/m^3) =	1486	1626
S (%) =	95	97

Remarks

ASTM Method:	B - Constant Time Increment @ EOP
Method for Cv :	Taylor
H_{avg} **:**	Half the specimen height
Time Increment:	360 min

Sample Properties

G_s =	2.72	Calculated
H_s (mm) =	11.88	

Atterberg Limits

Liquid Limit:	24
Plastic Limit:	17
Plasticity Index:	7
Soil Classification:	CL-ML

Estimated Preconsolidation Stress: N/A

Load #	Stress (kPa)	ΔH (mm)	Corrected d_f (mm)	ε Σ ΔH / Ho (%)	H-H_s (mm)	e (H-H_s)/H_s	Stress $_{avg}$ (kPa)	e_{avg}	H_{avg} (mm)	t 90 (min)	Cv (cm^2/sec)	k (cm/sec)
1	5	0.05	21.70	0.21	9.82	0.827						
2	12	0.11	21.67	0.34	9.79	0.825	8	0.83	10.84	10.33	1.6E-03	2.9E-08
3	24	0.19	21.57	0.77	9.70	0.817	18	0.82	10.81	9.31	1.8E-03	6.3E-08
4	48	0.39	21.40	1.58	9.52	0.802	36	0.81	10.74	7.01	2.3E-03	7.8E-08
5	96	0.22	21.23	2.36	9.35	0.788	72	0.79	10.66	4.51	3.6E-03	5.8E-08
6	192	0.26	21.06	3.15	9.18	0.773	144	0.78	10.57	3.47	4.6E-03	3.8E-08
7	383	0.38	20.79	4.40	8.91	0.750	287	0.76	10.46	3.48	4.4E-03	3.0E-08
8	192	-0.12	20.83	4.18	8.96	0.754						
9	48	-0.28	21.06	3.12	9.19	0.774						
10	12	-0.24	21.26	2.20	9.39	0.791						
11	24	0.07	21.20	2.47	9.33	0.786	18	0.79	10.62	2.24	7.1E-03	1.6E-07
12	48	0.06	21.15	2.70	9.28	0.781	36	0.78	10.59	4.52	3.5E-03	3.4E-08
13	96	0.11	21.07	3.10	9.19	0.774	72	0.78	10.56	3.72	4.2E-03	3.5E-08
14	192	0.16	20.95	3.66	9.07	0.764	144	0.77	10.50	2.40	6.5E-03	3.9E-08
15	383	0.22	20.81	4.30	8.93	0.752	287	0.76	10.44	2.27	6.8E-03	2.3E-08
16	766	0.52	20.41	6.12	8.54	0.719	575	0.74	10.30	3.64	4.1E-03	2.0E-08
17	1532	0.81	19.81	8.89	7.93	0.668	1149	0.69	10.06	3.60	4.0E-03	1.5E-08
18	766	-0.26	19.90	8.48	8.02	0.676						
19	192	-0.41	20.14	7.36	8.27	0.696						
20	48	-0.41	20.47	5.84	8.60	0.724						
21	12	-0.38	20.82	4.23	8.95	0.753						

Comments: Void Ratio Vs. Stress computed for end of primary consolidation. Final height measured by final LVDT reading.

Description: SILTY CLAY, grey, w>PL, firm.

TESTED BY	DATE	CHECKED BY	DATE
CP/MM	December 28, 2015	DL	February 27, 2017

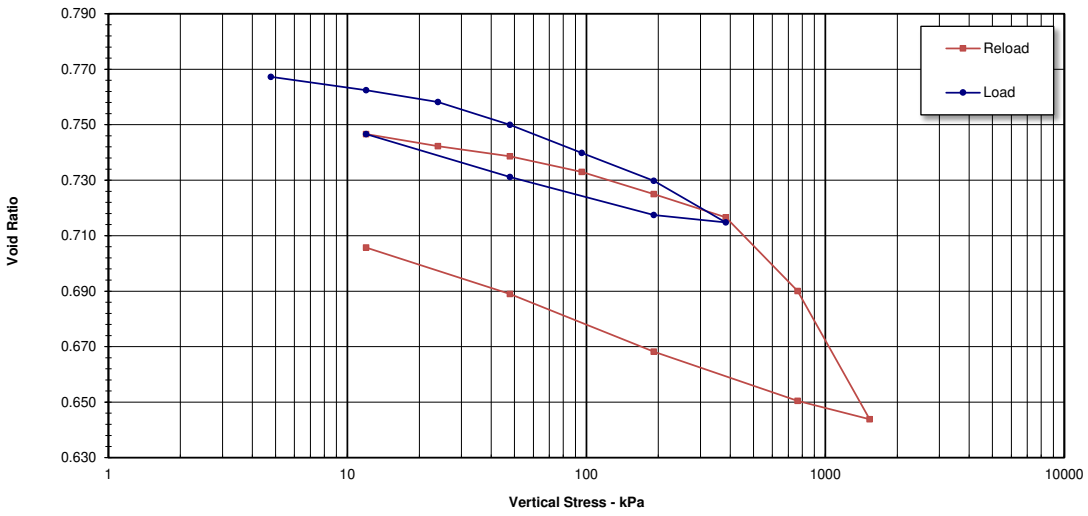
Golder Associates Ltd. - Burnaby Laboratory
Unit 300 - 3811 North Fraser Way
Burnaby, B.C. Canada V5J 5J2

One-Dimensional Consolidation Properties of Soils

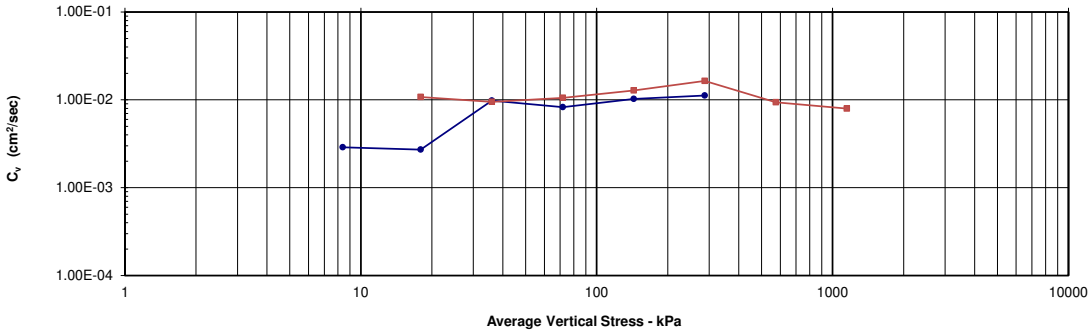
Reference(s)
ASTM D 2435/D 2435M-11

Project No. :	1525010/3000	**Client :**	CDM Smith Canada ULC	**Borehole:**	BH16-08
Sch No.	28	**Project :**	Annacis Outfall and Transient Mitigation	**Sample:**	24
Lab Work:	MM	**Location:**	Annacis Island	**Depth (m) :**	36.58 - 37.19

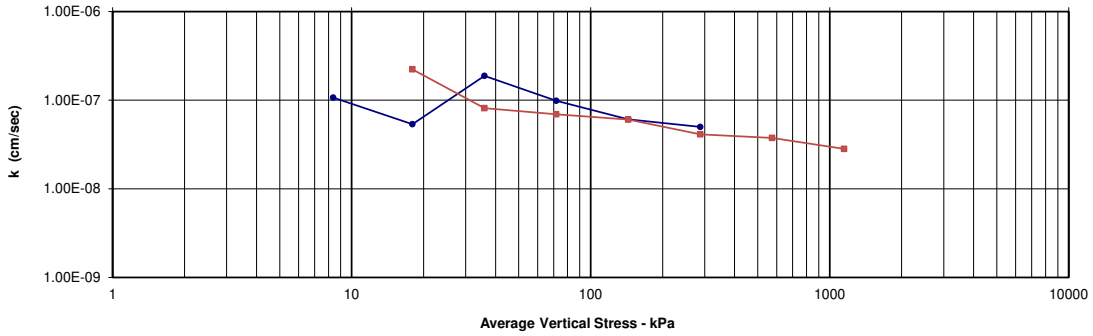
Void Ratio vs Stress



Coefficient of Consolidation vs Stress



Coefficient of Permeability vs Stress



MM	March 21, 2017	DL	March 31, 2017
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd. - Burnaby Laboratory
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Burnaby, B.C. Canada V5J 5J2

One-Dimensional Consolidation Properties of Soils

Reference(s)
ASTM D 2435/D 2435M-11

Project No. :	1525010/3000	**Client :**	CDM Smith Canada ULC	**Borehole:**	BH16-08
Sch No.	28	**Project :**	Annacis Outfall and Transient Mitigation	**Sample:**	24
Lab Work:	MM	**Location:**	Annacis Island	**Depth (m) :**	36.58 - 37.19

Equipment

Machine:	Sigma-1
Mach No.	5
Ring No.	z
Drainage:	Double-sided

Specimen Geometry

	Initial	Final
Height (mm) =	21.94	20.12
Diameter (mm) =	63.50	63.50
Area (cm^2) =	31.66	31.66
Volume (cm^3) =	69.46	63.71

Phase Relationships

	Initial	Final
Wet Wt (g) =	134.41	130.28
Dry Wt (g) =	106.20	106.20
w (%) =	26.56	22.67
e =	0.773	0.626
ρ_{wet} (kg/m^3) =	1935	2045
ρ_{drv} (kg/m^3) =	1529	1667
S (%) =	93	98

Remarks

ASTM Method:	B - Constant Time Increment @ EOP
Method for Cv :	Taylor
H_{avg} **:**	Half the specimen height
Time Increment:	600 min

Sample Properties

G_s =	2.71	Calculated
H_s (mm) =	12.38	

Atterberg Limits

Liquid Limit:	26
Plastic Limit:	18
Plasticity Index:	8
Soil Classification:	CL

Estimated Preconsolidation Stress: N/A

Load #	Stress (kPa)	ΔH (mm)	Corrected d_f (mm)	ε Σ ΔH / Ho (%)	H-H_s (mm)	e (H-H_s)/H_s	Stress $_{avg}$ (kPa)	e_{avg}	H_{avg} (mm)	t 90 (min)	Cv (cm^2/sec)	k (cm/sec)
1	5	0.08	21.87	0.33	9.50	0.767						
2	12	0.14	21.81	0.60	9.44	0.762	8	0.76	10.92	5.85	2.9E-03	1.1E-07
3	24	0.25	21.76	0.84	9.38	0.758	18	0.76	10.89	6.18	2.7E-03	5.4E-08
4	48	0.21	21.66	1.31	9.28	0.750	36	0.75	10.85	1.70	9.8E-03	1.9E-07
5	96	0.17	21.53	1.88	9.16	0.740	72	0.74	10.80	1.99	8.3E-03	9.8E-08
6	192	0.21	21.41	2.45	9.03	0.730	144	0.73	10.74	1.58	1.0E-02	6.1E-08
7	383	0.30	21.22	3.29	8.85	0.715	287	0.72	10.66	1.43	1.1E-02	5.0E-08
8	192	-0.11	21.26	3.14	8.88	0.717						
9	48	-0.22	21.43	2.37	9.05	0.731						
10	12	-0.23	21.62	1.50	9.24	0.747						
11	24	0.06	21.56	1.74	9.19	0.742	18	0.74	10.79	1.53	1.1E-02	2.2E-07
12	48	0.06	21.52	1.95	9.14	0.739	36	0.74	10.77	1.73	9.5E-03	8.1E-08
13	96	0.09	21.45	2.27	9.07	0.733	72	0.74	10.74	1.55	1.1E-02	6.9E-08
14	192	0.13	21.35	2.72	8.97	0.725	144	0.73	10.70	1.26	1.3E-02	6.1E-08
15	383	0.19	21.25	3.19	8.87	0.717	287	0.72	10.65	0.98	1.6E-02	4.1E-08
16	766	0.45	20.92	4.69	8.54	0.690	575	0.70	10.54	1.67	9.4E-03	3.7E-08
17	1532	0.78	20.34	7.29	7.97	0.644	1149	0.67	10.32	1.89	8.0E-03	2.8E-08
18	766	-0.25	20.43	6.92	8.05	0.650						
19	192	-0.38	20.65	5.92	8.27	0.668						
20	48	-0.34	20.90	4.75	8.53	0.689						
21	12	-0.24	21.11	3.81	8.73	0.706						

Comments: Void Ratio Vs. Stress computed for end of primary consolidation. Final height measured by final LVDT reading.

Description: SILTY CLAY, grey, w>PL, firm.

MM	March 21, 2017	DL	March 31, 2017
TESTED BY	DATE	CHECKED BY	DATE

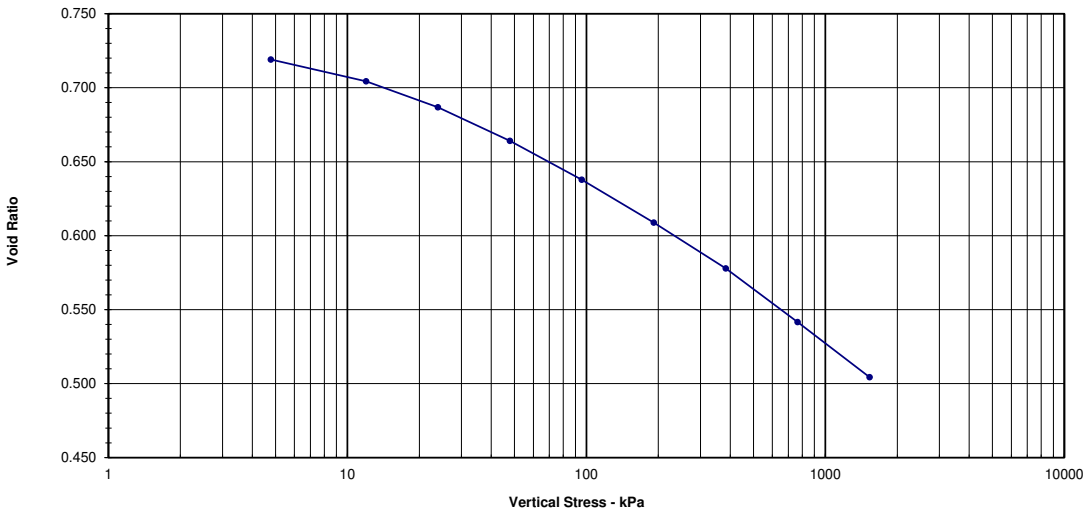
Golder Associates Ltd. - Burnaby Laboratory
Unit 300 - 3811 North Fraser Way
Burnaby, B.C. Canada V5J 5J2

One-Dimensional Consolidation Properties of Soils

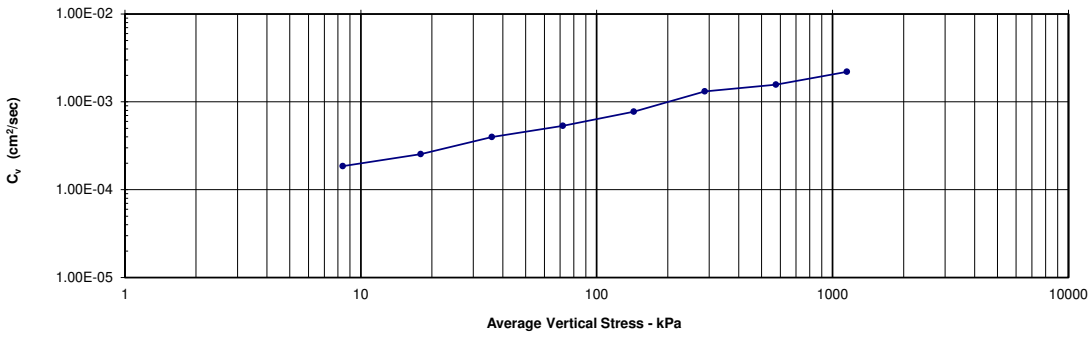
Reference(s)
ASTM D 2435/D 2435M-11

Project No. :	1525010/3000	**Client :**	CDM Smith Canada ULC	**Borehole:**	BH16-08
Sch No.	28	**Project :**	Annacis Outfall and Transient Mitigation	**Sample:**	25 (redo)
Lab Work:	MM	**Location:**	Annacis Island	**Depth (m) :**	38.1 - 38.7

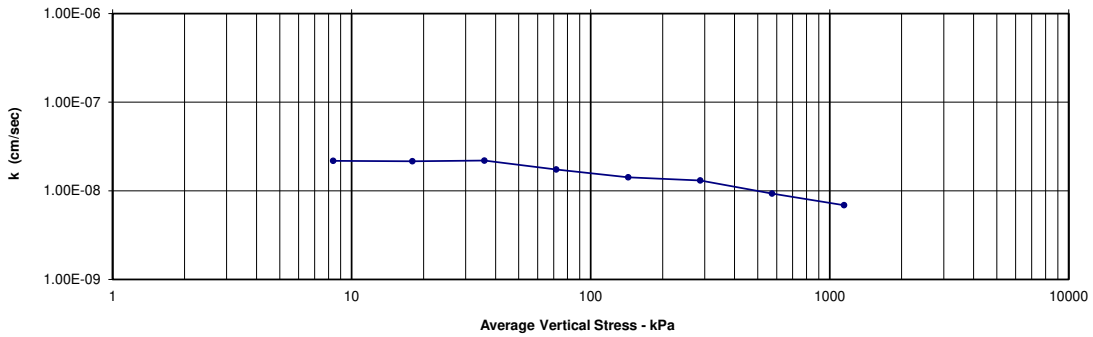
Void Ratio vs Stress



Coefficient of Consolidation vs Stress



Coefficient of Permeability vs Stress



TM	March 3, 2017	DL	March 16, 2017
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd. - Burnaby Laboratory
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One-Dimensional Consolidation Properties of Soils

Reference(s): **ASTM D 2435/D 2435M-11**

Project No. :	1525010/3000	**Client :**	CDM Smith Canada ULC	**Borehole:**	BH16-08
Sch No.	28	**Project :**	Annacis Outfall and Transient Mitigation	**Sample:**	25 (redo)
Lab Work:	MM	**Location:**	Annacis Island	**Depth (m) :**	38.1 - 38.7

Equipment

Machine:	Sigma-1
Mach No.	5
Ring No.	Y
Drainage:	Double-sided

Specimen Geometry

	Initial	Final
Height (mm) =	21.98	17.86
Diameter (mm) =	63.51	63.51
Area (cm^2) =	31.67	31.67
Volume (cm^3) =	69.60	56.56

Phase Relationships

	Initial	Final
Wet Wt (g) =	134.66	122.25
Dry Wt (g) =	104.11	104.11
w (%) =	29.34	17.42
e =	0.812	0.472
ρ_{wet} (kg/m^3) =	1935	2162
ρ_{drv} (kg/m^3) =	1496	1841
S (%) =	98	100

Remarks

ASTM Method:	B - Constant Time Increment @ EOP
Method for Cv :	Taylor
H_{avg} **:**	Half the specimen height
Time Increment:	360 min

Sample Properties

G_s = 2.71 Assumed

H_s (mm) = 12.13

Atterberg Limits

Liquid Limit:	N/A
Plastic Limit:	N/A
Plasticity Index:	N/A
Soil Classification:	N/A

Estimated Preconsolidation Stress: N/A

Load #	Stress (kPa)	ΔH (mm)	Corrected d_f (mm)	ε Σ ΔH / Ho (%)	H-H_s (mm)	e (H-H_s)/H_s	Stress $_{avg}$ (kPa)	e_{avg}	H_{avg} (mm)	t 90 (min)	Cv (cm^2/sec)	k (cm/sec)
1	5	1.12	20.85	5.10	8.72	0.719						
2	12	0.21	20.67	5.91	8.54	0.704	8	0.71	10.38	82.14	1.9E-04	2.2E-08
3	24	0.25	20.46	6.89	8.33	0.687	18	0.70	10.28	58.99	2.5E-04	2.2E-08
4	48	0.32	20.18	8.14	8.05	0.664	36	0.68	10.16	36.76	4.0E-04	2.2E-08
5	96	0.36	19.87	9.58	7.74	0.638	72	0.65	10.01	26.55	5.3E-04	1.7E-08
6	192	0.41	19.51	11.19	7.38	0.609	144	0.62	9.84	17.68	7.7E-04	1.4E-08
7	383	0.46	19.14	12.90	7.01	0.578	287	0.59	9.66	10.04	1.3E-03	1.3E-08
8	766	0.54	18.70	14.90	6.57	0.542	575	0.56	9.46	8.06	1.6E-03	9.3E-09
9	1532	0.65	18.25	16.95	6.12	0.504	1149	0.52	9.24	5.49	2.2E-03	6.9E-09

Comments: Void Ratio Vs. Stress computed for end of primary consolidation. Final height taken from the final load LVDT reading.

Description: SILT, some clay, some sand, w>PL, grey, firm.

TM	March 3, 2017	DL	March 16, 2017
TESTED BY	DATE	CHECKED BY	DATE

Monotonic and Cyclic Direct Simple Shear Tests

24 January 2018
Report No. 1525010-108-R-Rev0

Golder Associates


Cyclic Direct Simple Shear Test BH15-03 SA30 CSR = 0.16
Static Direct Simple Shear Test BH15-03 Sa30
Cyclic Direct Simple Shear Test BH15-03 Sa30 CSR = 0.13, 0.15
20
25
30
35
40
50
GOLDER ASSOC
29 OCT 2015
1525010
BH15-03 SA30
GOLDER ASSOC
29 OCT 2015
1525010
BH15-03 SA30

Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010	**Sample Number:**	BH15-03 Sa 30
Project:	Annacis Outfall	**Test ID:**	420kPa, Static
Location:	New Westminster	**Depth (m):**	42.53-42.57
Client:	CDM Smith	**Lab ID No:**	460

General Remarks

Equipment Description: GDS - Station 1

Vertical LVDT	Serial No.:	113179
Vertical Load Cell	Serial No.:	89612
Shear Load Cell	Serial No.:	30465

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.46
Diameter (mm)	70.35
Area (cm^2)	38.87
Volume (cm^3)	91.19
Specific Gravity (Assumed)	2.80

Visual Description	SILTY CLAY; some sand; grey, cohesive, firm		
Sand Fraction (%)	N/A	Liquid Limit	30
Fines Fraction (%)	N/A	Plastic Limit	21
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	176.5	Initial Water Content (%)	34.04
Dry Mass (g)	131.68	Initial Saturation (%)	101.49
Initial γ_{wet} (kN/m^3)	18.99	Final Water Content (%)	31.45
Initial γ_{dry} (kN/m^3)	14.17	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	N/A	Max. Axial Strain %	8.01
Max Applied Vertical Stress (kPa)	420.19	Axial Strain at end of Consol. %	8.01
Vertical Stress at end of Consol (kPa)	419.91	Change in Height ΔH_c (mm)	1.88
Laboratory OCR	N/A		

Direct Simple Shear Test Results

Initial Vertical Stress (kPa)	419.91	Peak Shear Strength (kPa)	91.64
Initial Shear Stress (kPa)	-0.05	Excess Pore Pressure at Peak (kPa)	265.81
Applied Shear Bias (kPa)	0.00	Ratio of Peak / $\sigma'v$	0.22
Rate of Shearing (%/hr)	5.00	Maximum Shear Strain γ_{MAX} (%)	19.98
Test Condition	Undrained	Shear Strength at γ_{MAX} (kPa)	77.80

Comments / Special Instructions

The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

G. Patton	November 5, 2015	M. Sanin	November 27, 2015
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd.
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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

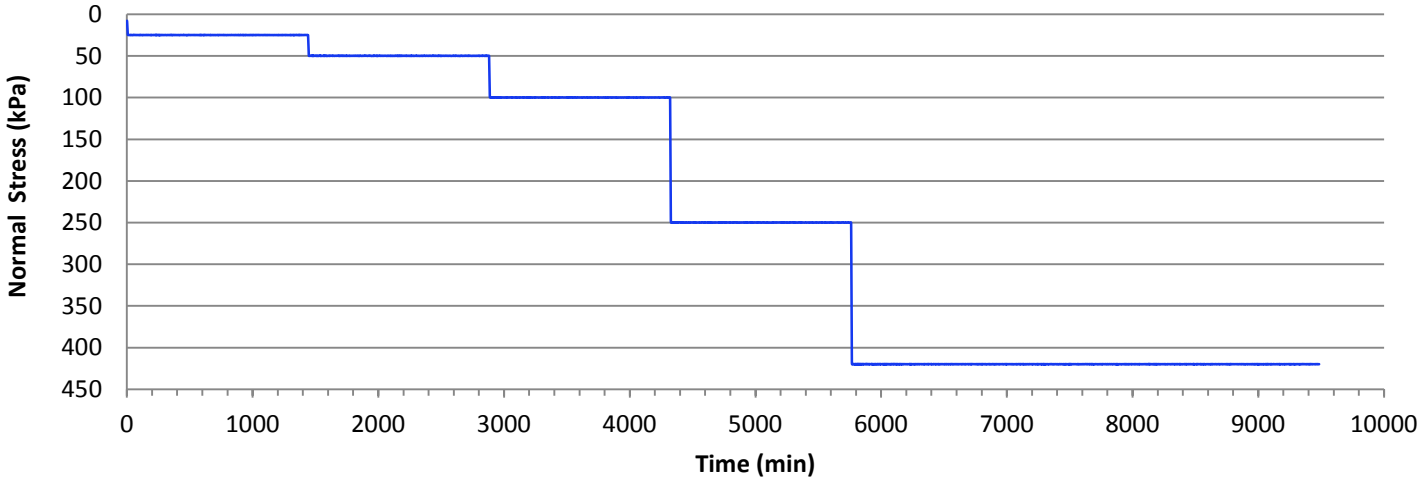
Project No.:	1525010	**Sample Number:**	BH15-03 Sa 30
Project:	Annacis Outfall	**Test ID:**	420kPa, Static
Location:	New Westminster	**Depth (m):**	42.53-42.57
Client:	CDM Smith	**Lab ID No:**	460

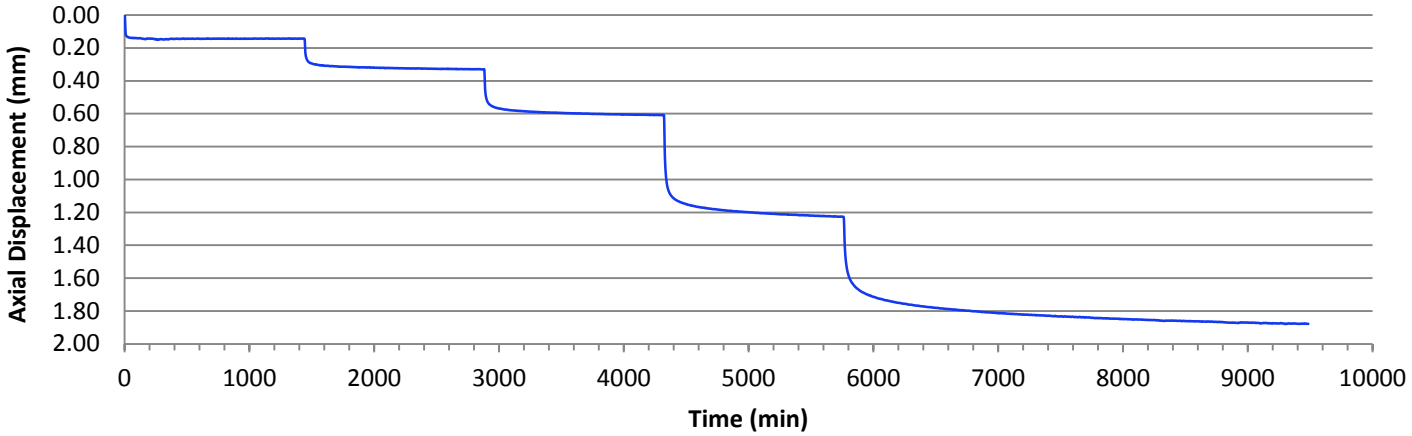
Consolidation Summary

Stress at end of Consolidation (kPa)	419.91
Axial Strain at end of Consolidation (%)	8.01
OCR	N/A
Change in Height ΔH_c (mm)	1.88

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	420		
Load (kN)	0.0986	0.1943	0.3889	0.9721	1.6333		
Duration (min)	240	240	240	240	621		
Axial Strain (%)	0.64	1.41	2.59	5.23	8.01		





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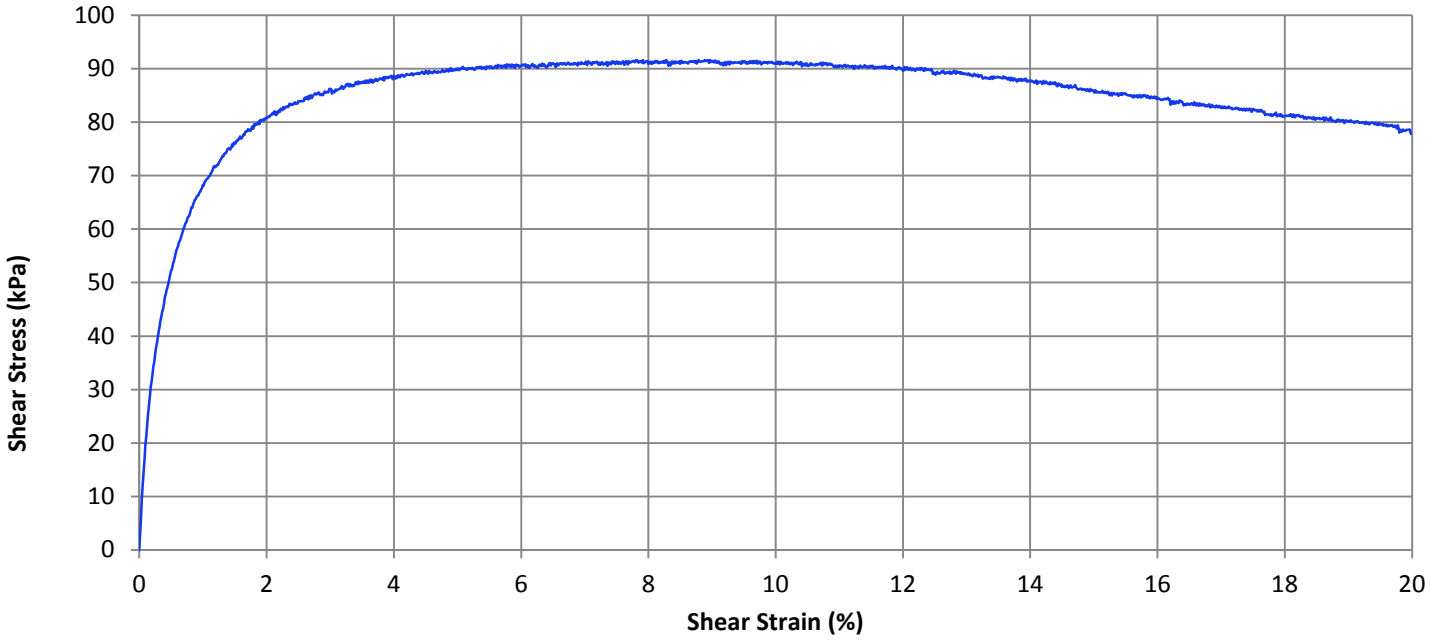
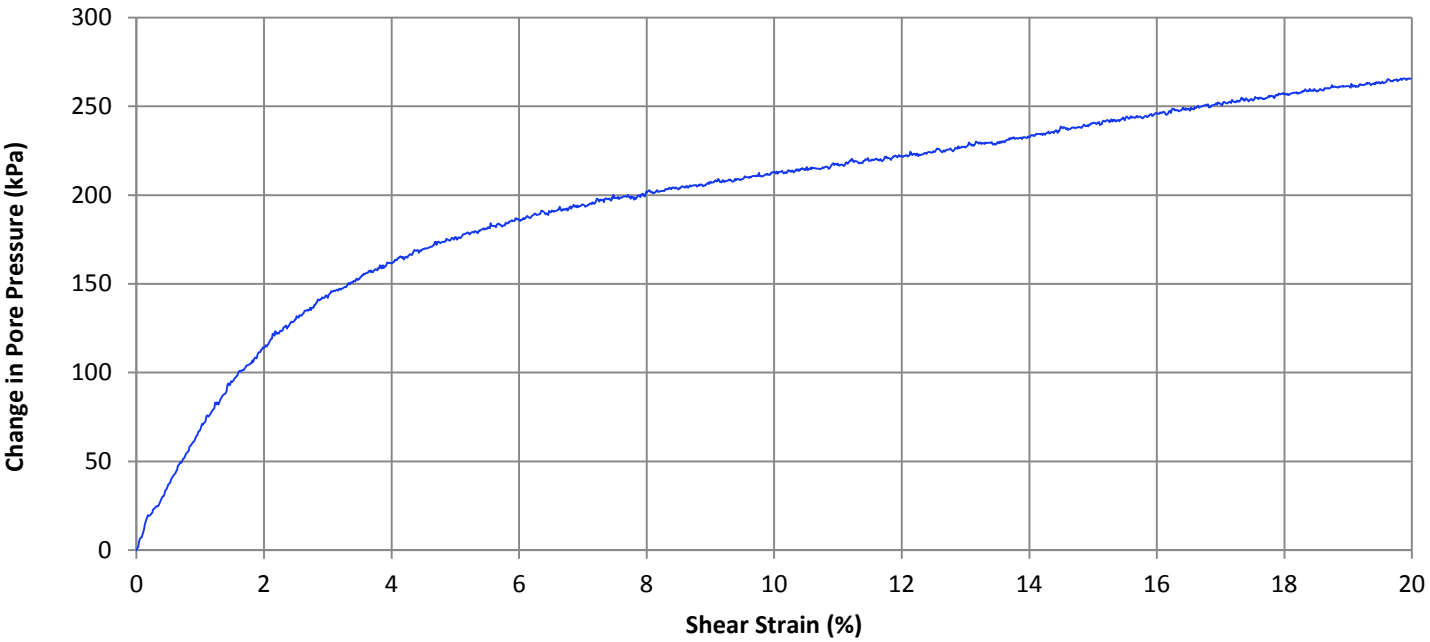
Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010	**Sample Number:**	BH15-03 Sa 30
Project:	Annacis Outfall	**Test ID:**	420kPa, Static
Location:	New Westminster	**Depth (m):**	42.53-42.57
Client:	CDM Smith	**Lab ID No:**	460





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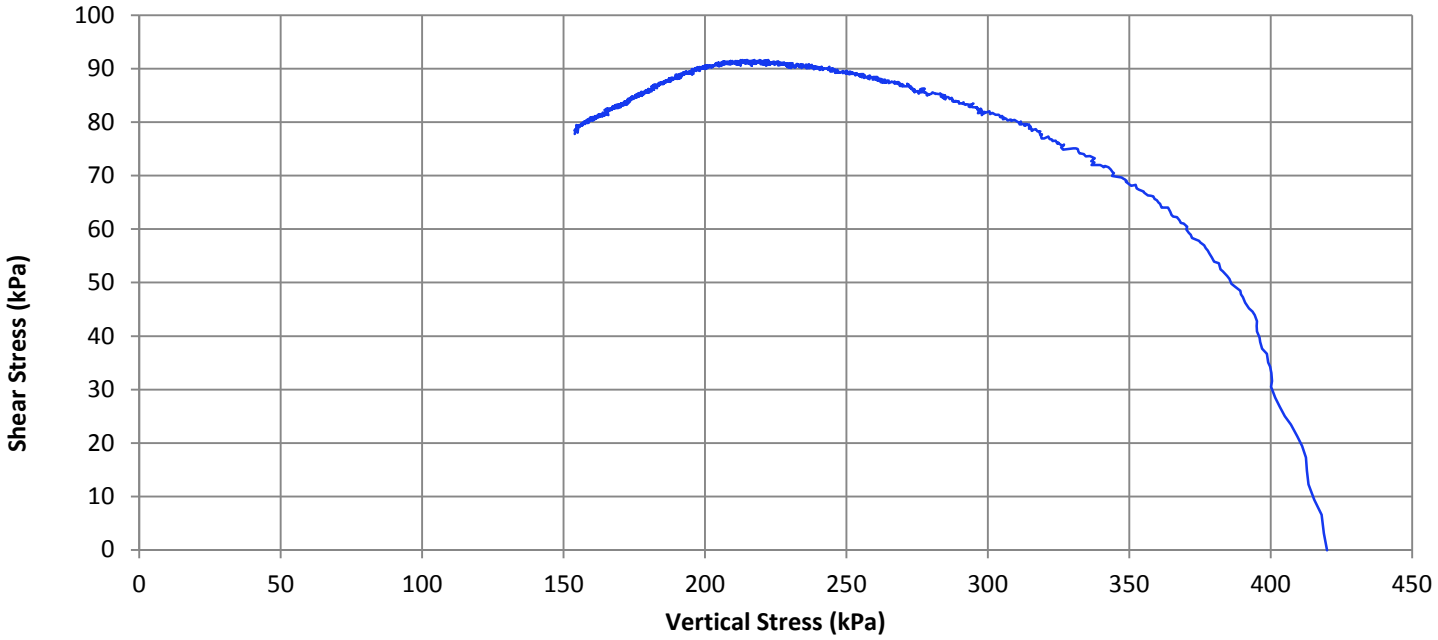
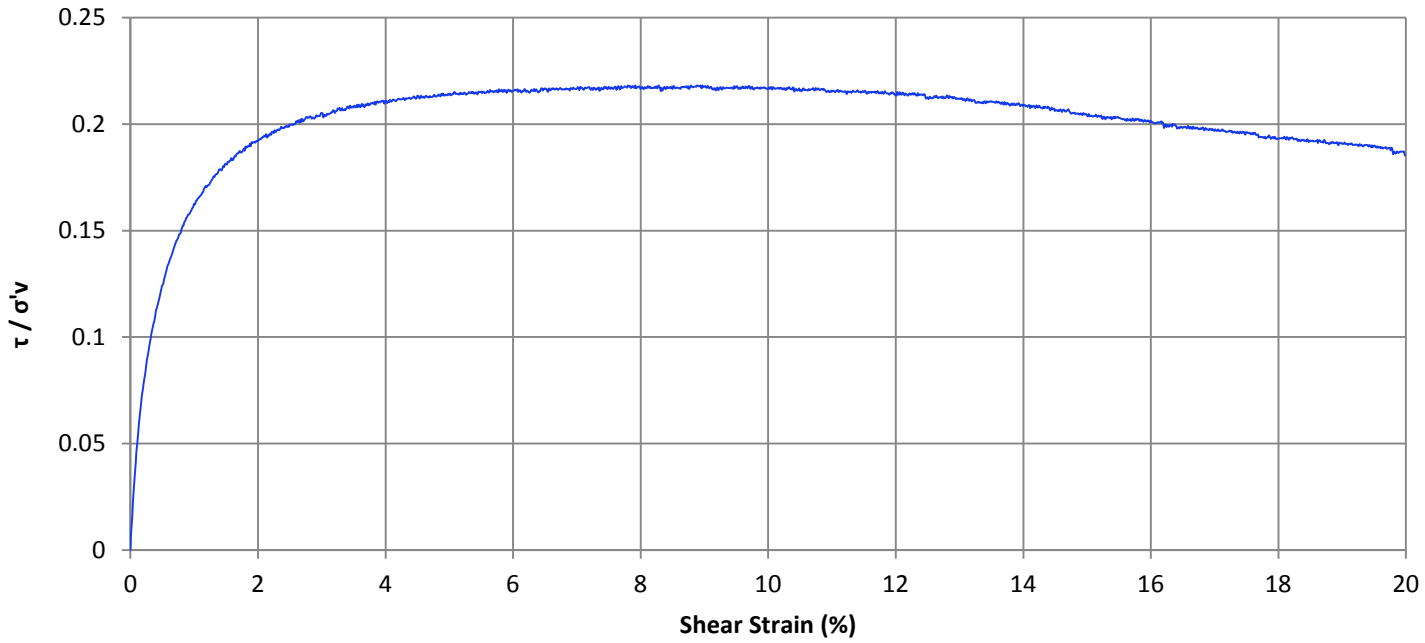
Project:	Annacis Outfall	**Test ID:**	420kPa, Static
Location:	New Westminster	**Depth (m):**	42.53-42.57
Client:	CDM Smith	**Lab ID No:**	460





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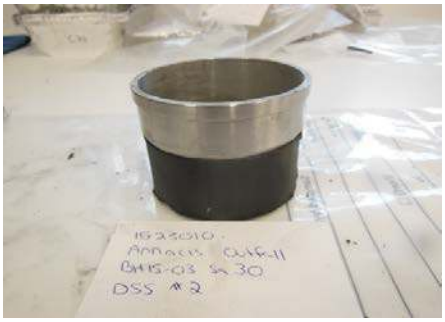
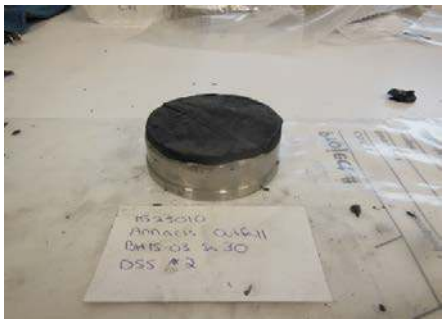
Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010	**Sample Number:**	BH15-03 Sa 30
Project:	Annacis Outfall	**Test ID:**	420kPa, Static
Location:	New Westminster	**Depth (m):**	42.53-42.57
Client:	CDM Smith	**Lab ID No:**	460





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G. Patton	November 5, 2015	M. Sanin	November 27, 2015
TESTED BY	DATE	CHECKED BY	DATE

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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010	**Sample Number:**	BH15-03 Sa 30
Project:	Annacis Outfall	**Test ID:**	420kPa, Multi-CSR
Location:	New Westminster	**Depth (m):**	42.47-42.50
Client:	CDM Smith	**Lab ID No:**	460

General Remarks

Equipment Description: GDS - Station 1

Vertical LVDT	Serial No.:	113179
Vertical Load Cell	Serial No.:	89612
Shear Load Cell	Serial No.:	30465

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.27
Diameter (mm)	70.40
Area (cm^2)	38.93
Volume (cm^3)	90.58
Specific Gravity (Assumed)	2.80

Visual Description	SILTY CLAY; some sand; grey, cohesive, firm		
Sand Fraction (%)	N/A	Liquid Limit	30
Fines Fraction (%)	N/A	Plastic Limit	21
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	178.86	Initial Water Content (%)	30.56
Dry Mass (g)	136.99	Initial Saturation (%)	100.52
Initial Wet Unit Weight (kN/m^3)	19.37	Final Water Content (%)	27.71
Initial Dry Unit Weight (kN/m^3)	14.84	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	N/A	Max. Axial Strain %	6.88
Max Applied Vertical Stress (kPa)	420.26	Axial Strain at end of Consol. %	6.88
Vertical Stress at end of Consol (kPa)	419.90	Change in Height ΔH_c (mm)	1.60
Laboratory OCR	N/A		

Cyclic Test Results

Frequency (Hz)	0.10
CSR	0.13 & 0.15
Number of Cycles to Failure (3%)	64
Initial Vertical Stress (kPa)	419.85
Max Cyclic Shear Stress (kPa)	59.96
Max. Shear Strain at Failure (zero load)	0.27
Min. Shear Strain at Failure (zero load)	-1.85
Max. ΔU at Failure (zero load)	308.60
Min. ΔU at Failure (zero load)	305.80

Post Cyclic Reconsolidation Test Results

Initial Vertical Stress (kPa)	58.03
Initial Shear Stress (kPa)	22.68
Reconsolidation data calculated from the sample height at end of initial consolidation	
Max Load (kN)	1.64
Duration (min)	131.67
Max Axial Strain (%)	2.73
Stress end of reconsol. (kPa)	419.78
Change in height ΔHc (mm)	0.59

Comments / Special Instructions

Tested @ CSR = 0.13 for 30 cylcles, followed by CSR = 0.15 for 36 cycles.

Sample brought back to zero shear strain over 30min prior to reconsolidation.

The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

G. Patton	November 3, 2015	M. Sanin	November 27, 2015
TESTED BY	DATE	CHECKED BY	DATE

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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

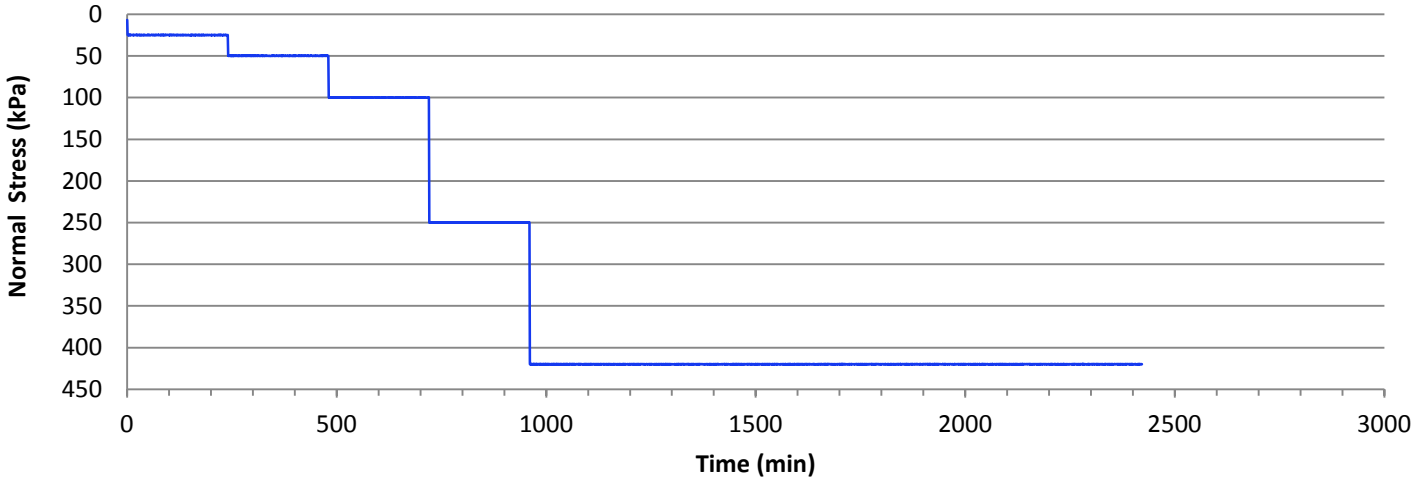
Project No.:	1525010	**Sample Number:**	BH15-03 Sa 30
Project:	Annacis Outfall	**Test ID:**	420kPa, Multi-CSR
Location:	New Westminster	**Depth (m):**	42.47-42.50
Client:	CDM Smith	**Lab ID No:**	460

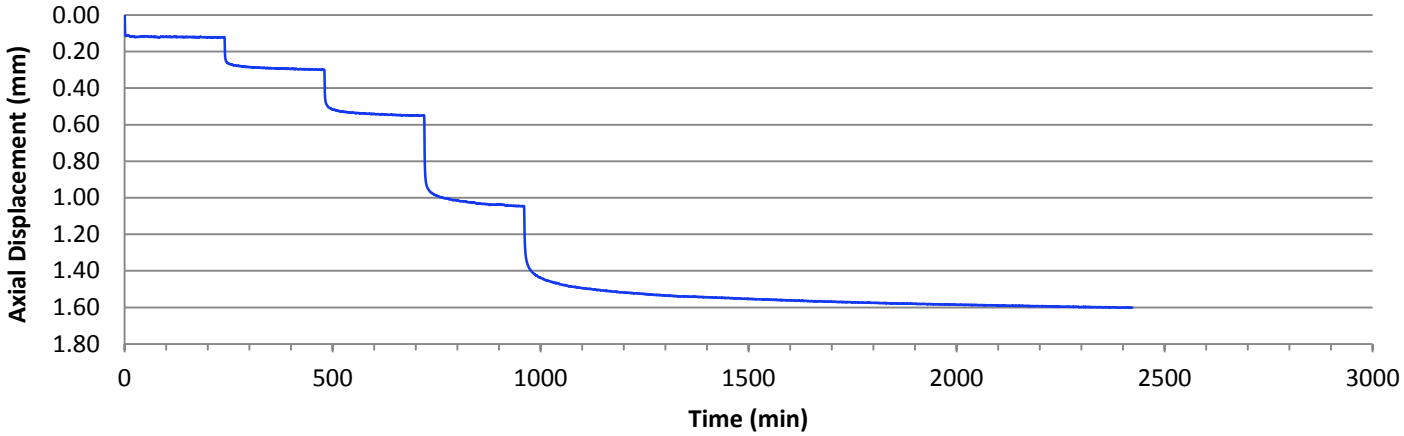
Consolidation Summary

Stress at end of Consolidation (kPa)	419.90
Axial Strain at end of Consolidation (%)	6.88
OCR	N/A
Change in Height ΔH_c (mm)	1.60

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	420		
Load (kN)	0.0973	0.1946	0.3896	0.9739	1.6359		
Duration (min)	240	240	240	240	1462		
Axial Strain (%)	0.53	1.29	2.37	4.50	6.88		





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TESTED BY	DATE	CHECKED BY	DATE

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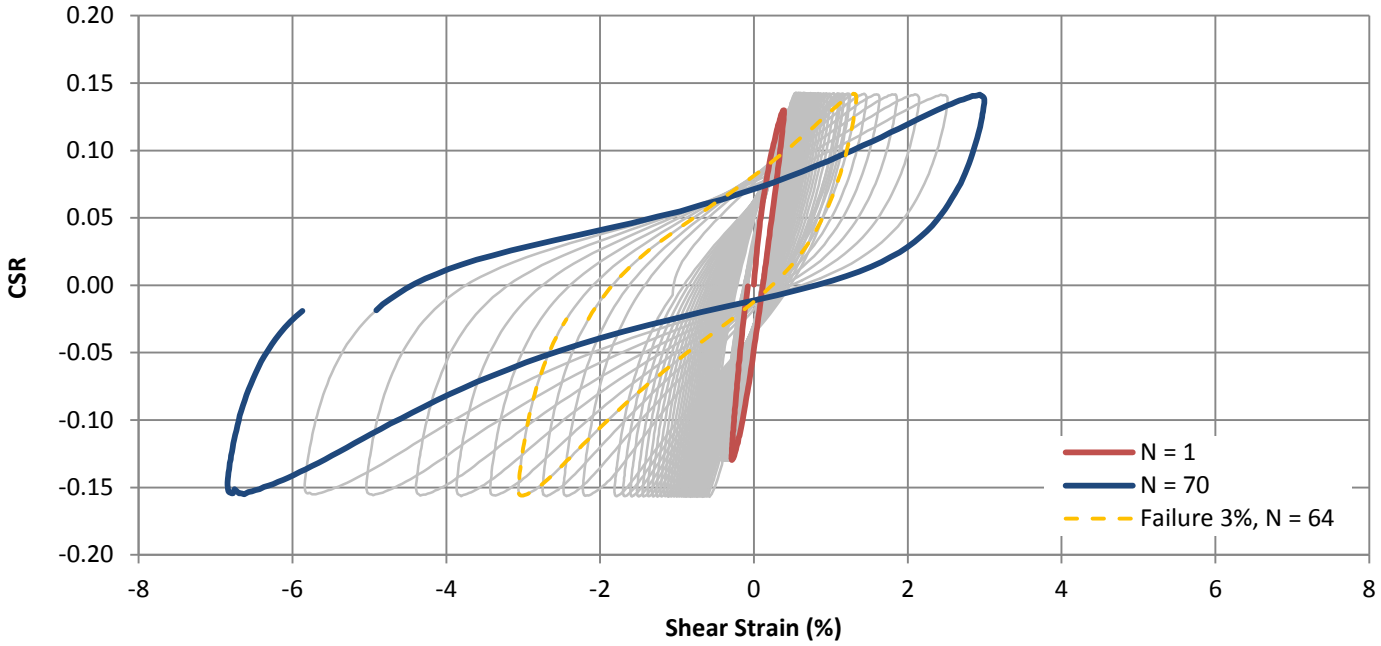
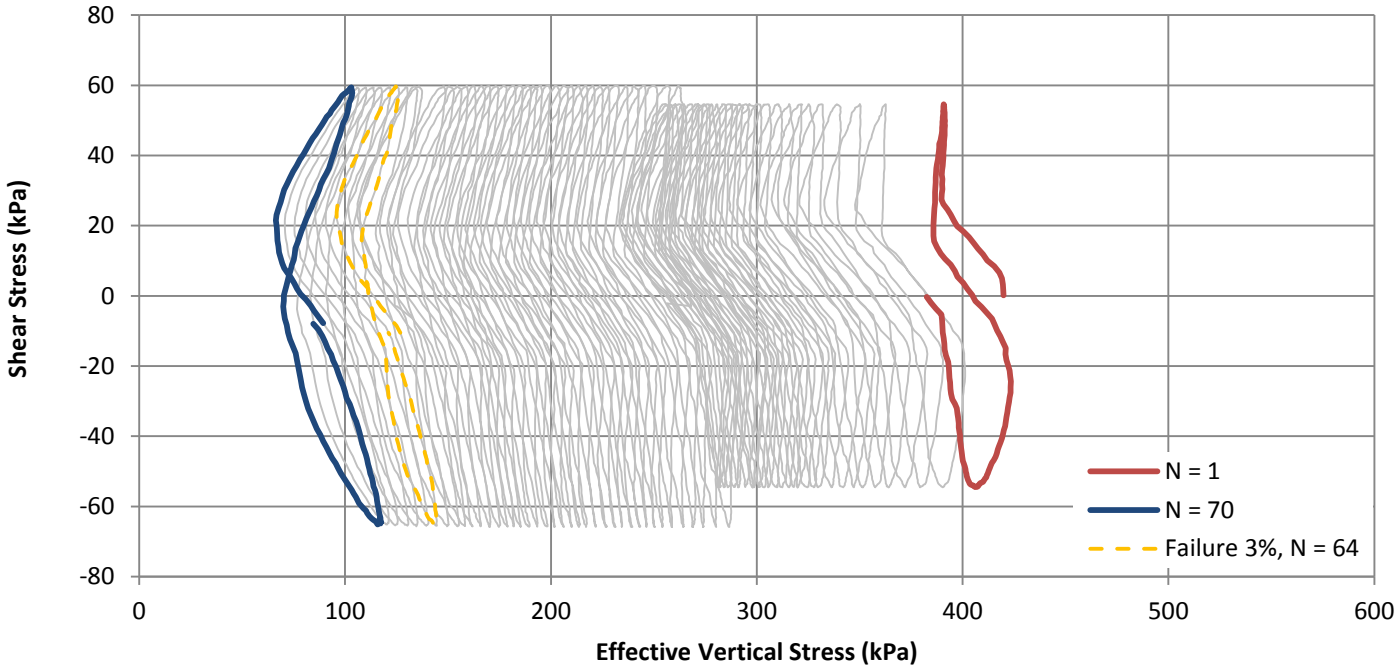
Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010	**Sample Number:**	BH15-03 Sa 30
Project:	Annacis Outfall	**Test ID:**	420kPa, Multi-CSR
Location:	New Westminster	**Depth (m):**	42.47-42.50
Client:	CDM Smith	**Lab ID No:**	460





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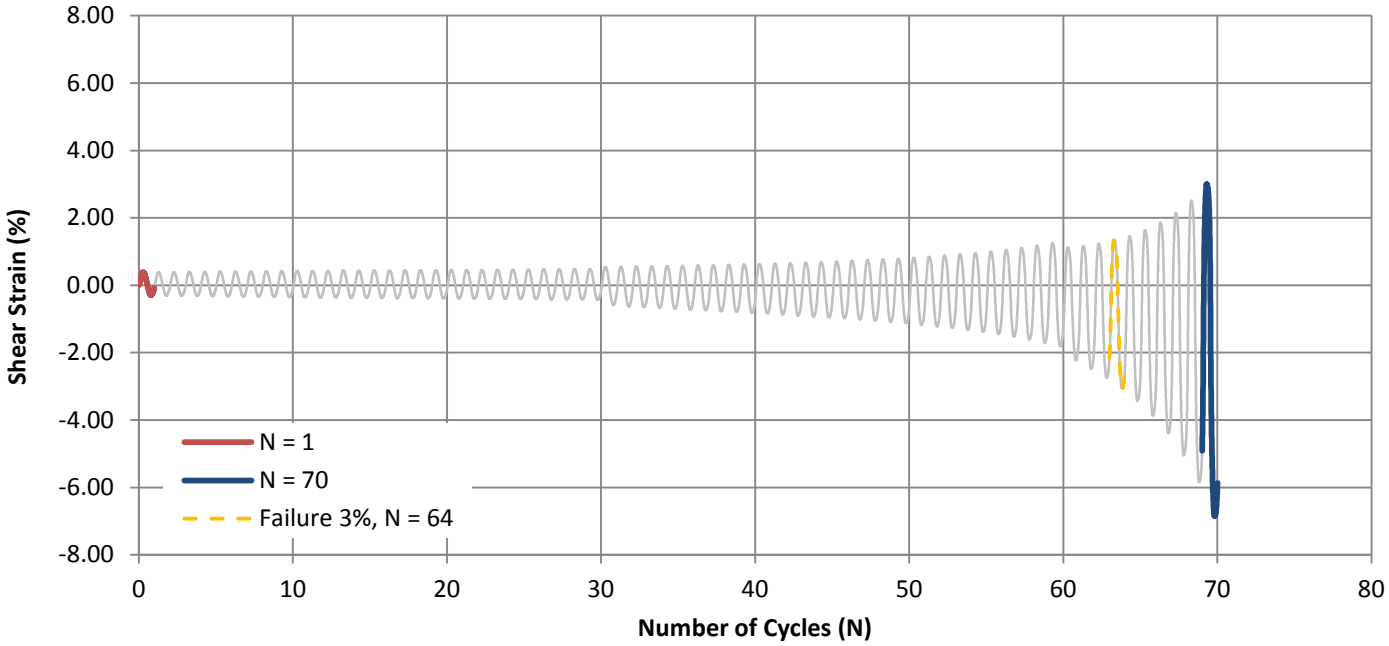
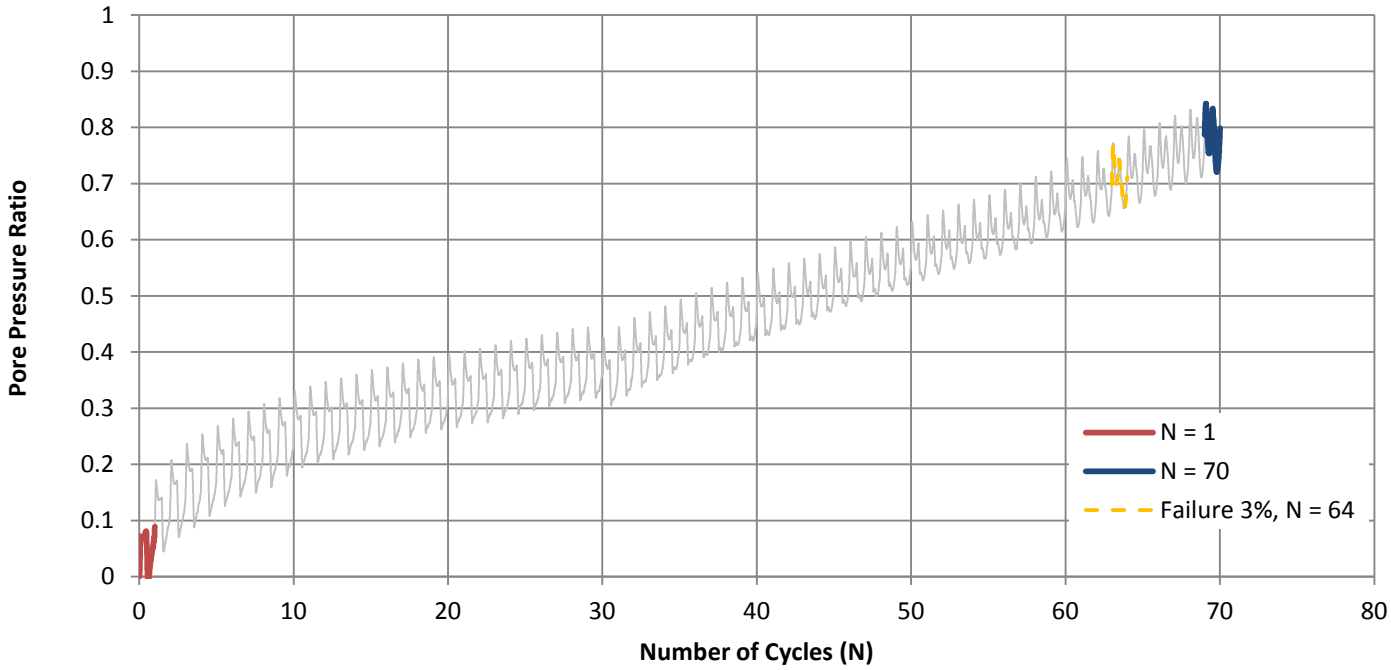
Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010	**Sample Number:**	BH15-03 Sa 30
Project:	Annacis Outfall	**Test ID:**	420kPa, Multi-CSR
Location:	New Westminster	**Depth (m):**	42.47-42.50
Client:	CDM Smith	**Lab ID No:**	460





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TESTED BY	DATE	CHECKED BY	DATE

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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

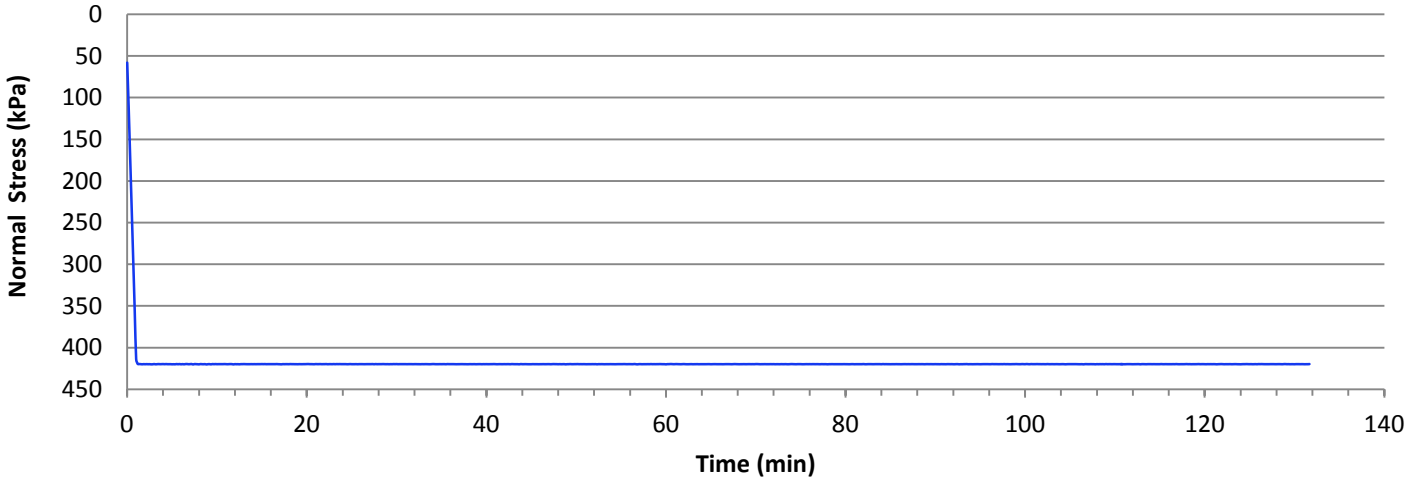
NORSOK G-001

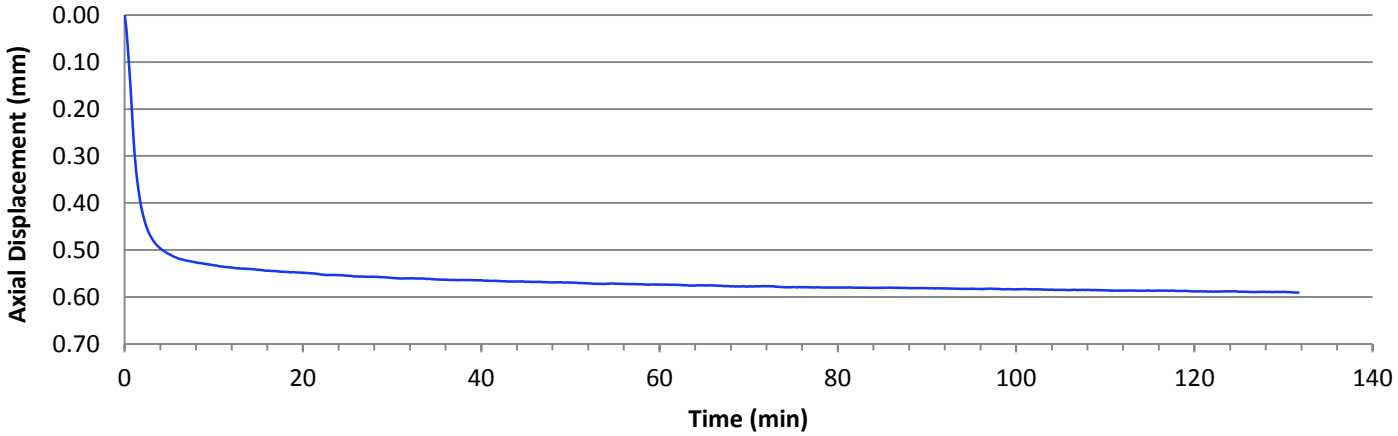
Project No.:	1525010	**Sample Number:**	BH15-03 Sa 30
Project:	Annacis Outfall	**Test ID:**	420kPa, Multi-CSR
Location:	New Westminster	**Depth (m):**	42.47-42.50
Client:	CDM Smith	**Lab ID No:**	460

Stress at Start of Reconsolidation (kPa)	58.03
Stress at end of Reconsolidation (kPa)	419.78
Axial Strain at end of Reconsolidation (%)	2.73
Change in Height ΔH_c (mm)	0.59

Comments
Reconsolidation data calculated from the sample height at end of initial consolidation

Increment (kPa)	420						
Load (kN)	1.6356						
Duration (min)	132						
Axial Strain (%)	2.73						





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TESTED BY	DATE	CHECKED BY	DATE

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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010	**Sample Number:**	BH15-03 Sa 30
Project:	Annacis Outfall	**Test ID:**	420kPa, Multi-CSR
Location:	New Westminster	**Depth (m):**	42.47-42.50
Client:	CDM Smith	**Lab ID No:**	460

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G. Patton	November 3, 2015	M. Sanin	November 27, 2015
TESTED BY	DATE	CHECKED BY	DATE

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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010	**Sample Number:**	BH15-03 Sa 30
Project:	Annacis Outfall	**Test ID:**	420kPa, 0.16 CSR
Location:	New Westminster	**Depth (m):**	42.60-42.63
Client:	CDM Smith	**Lab ID No:**	460

General Remarks

Equipment Description: GDS - Station 1

Vertical LVDT	Serial No.:	113179
Vertical Load Cell	Serial No.:	89612
Shear Load Cell	Serial No.:	30465

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.28
Diameter (mm)	70.57
Area (cm^2)	39.11
Volume (cm^3)	91.06
Specific Gravity (Assumed)	2.80

Visual Description	SILTY CLAY; some sand; grey, cohesive, firm		
Sand Fraction (%)	N/A	Liquid Limit	30
Fines Fraction (%)	N/A	Plastic Limit	21
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	178.6	Initial Water Content (%)	32.66
Dry Mass (g)	134.63	Initial Saturation (%)	102.32
Initial Wet Unit Weight (kN/m^3)	19.24	Final Water Content (%)	28.11
Initial Dry Unit Weight (kN/m^3)	14.50	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	N/A	Max. Axial Strain %	7.75
Max Applied Vertical Stress (kPa)	420.29	Axial Strain at end of Consol. %	7.75
Vertical Stress at end of Consol (kPa)	419.80	Change in Height ΔH_c (mm)	1.80
Laboratory OCR	N/A		

Cyclic Test Results

Frequency (Hz)	0.10
CSR	0.16
Number of Cycles to Failure (3%)	23
Initial Vertical Stress (kPa)	419.88
Max Cyclic Shear Stress (kPa)	71.43
Max. Shear Strain at Failure (zero load)	1.77
Min. Shear Strain at Failure (zero load)	-1.30
Max. ΔU at Failure (zero load)	317.68
Min. ΔU at Failure (zero load)	312.66

Post Cyclic Reconsolidation Test Results

Initial Vertical Stress (kPa)	49.98
Initial Shear Stress (kPa)	15.52
Reconsolidation data calculated from the sample height at end of initial consolidation	
Max Load (kN)	1.64
Duration (min)	239.83
Max Axial Strain (%)	2.86
Stress end of reconsol. (kPa)	419.80
Change in height ΔHc (mm)	0.61

Comments / Special Instructions

Comments / Special Instructions

Sample brought back to zero shear strain over 30min prior to reconsolidation.

The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

G. Patton	November 9, 2015	M. Sanin	November 27, 2015
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd.
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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

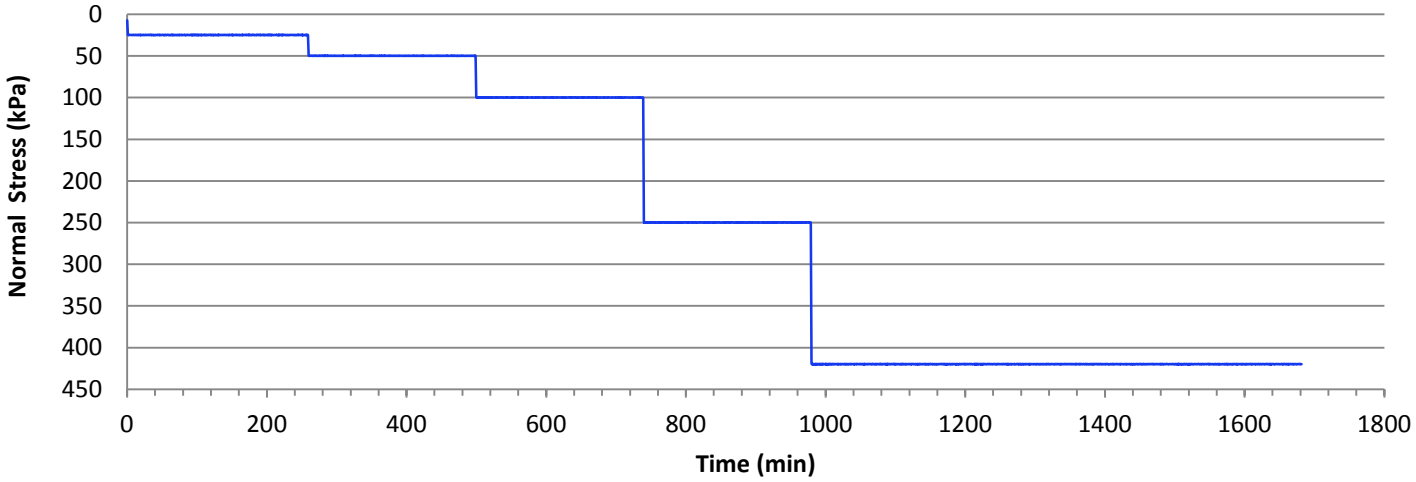
Project No.:	1525010	**Sample Number:**	BH15-03 Sa 30
Project:	Annacis Outfall	**Test ID:**	420kPa, 0.16 CSR
Location:	New Westminster	**Depth (m):**	42.60-42.63
Client:	CDM Smith	**Lab ID No:**	460

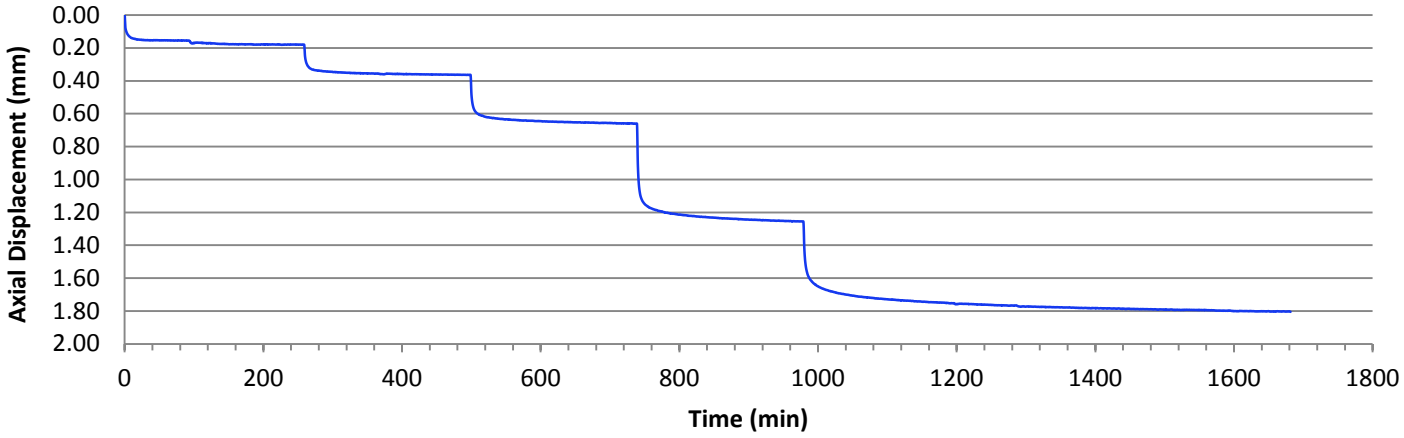
Consolidation Summary

Stress at end of Consolidation (kPa)	419.80
Axial Strain at end of Consolidation (%)	7.75
OCR	N/A
Change in Height ΔH_c (mm)	1.80

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	420		
Load (kN)	0.098	0.1957	0.3919	0.9783	1.6439		
Duration (min)	259	240	240	240	703		
Axial Strain (%)	0.78	1.56	2.84	5.39	7.75		





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TESTED BY	DATE	CHECKED BY	DATE

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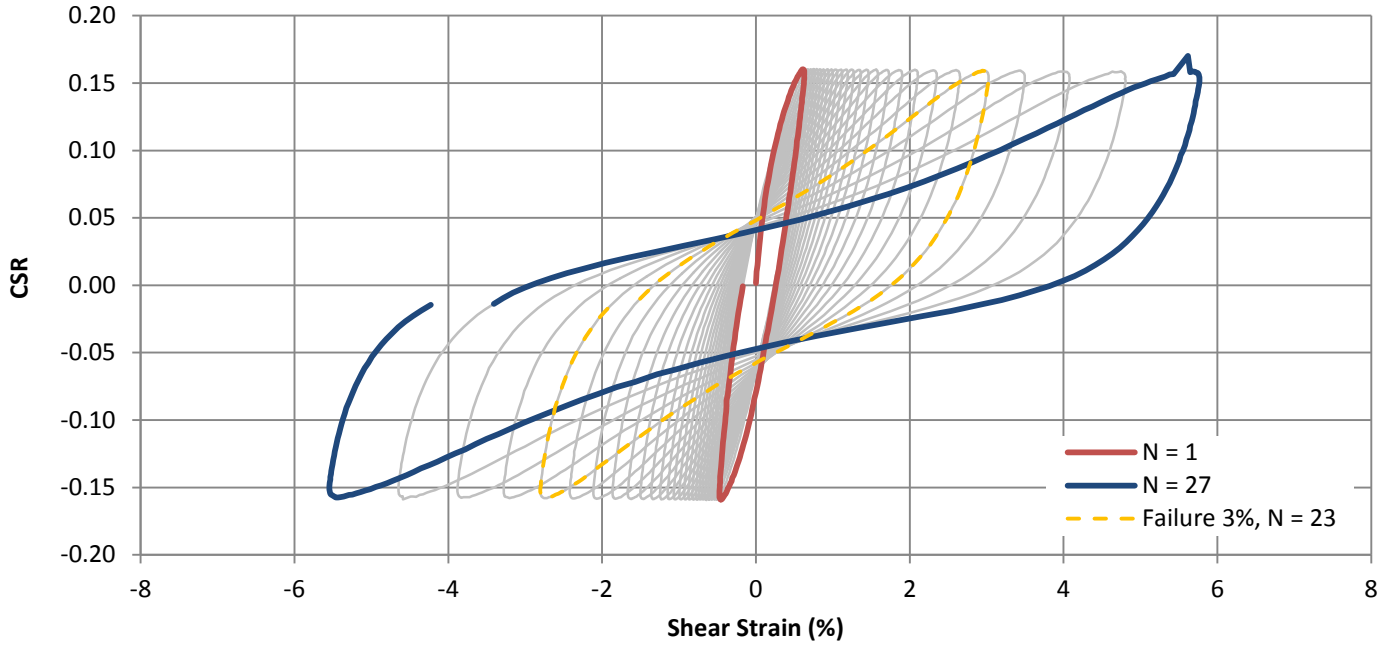
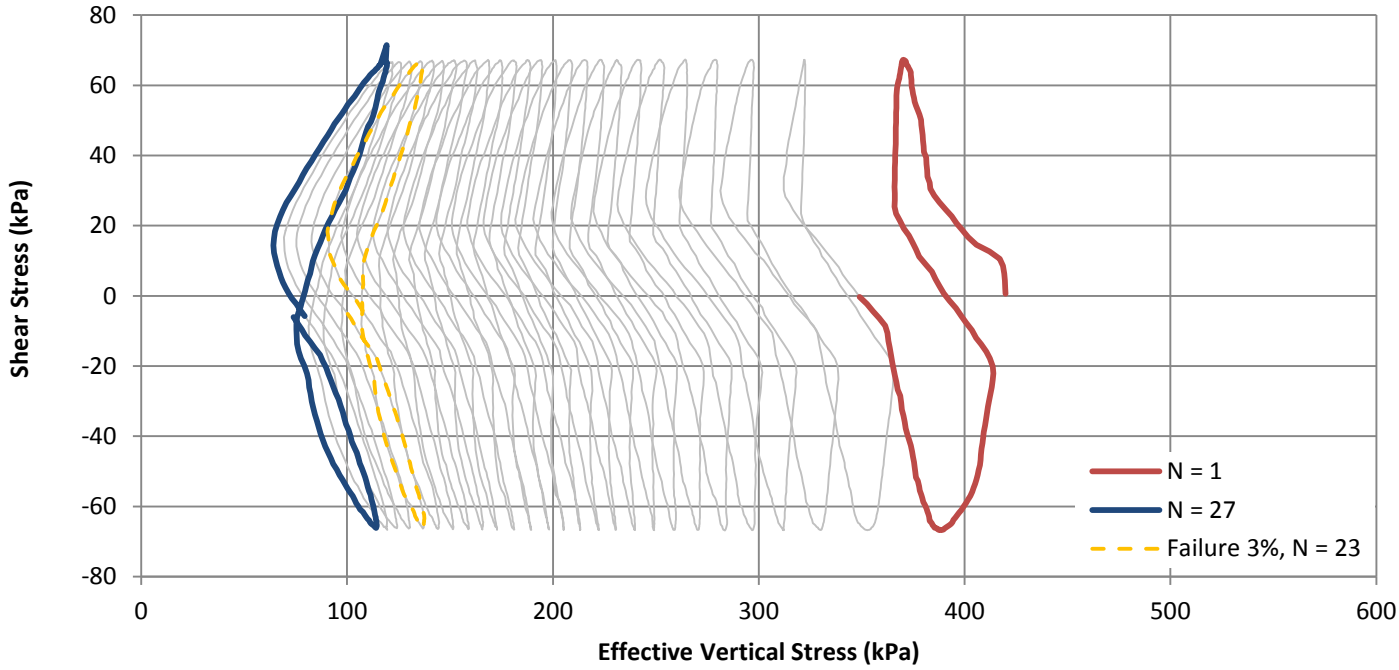
Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010	**Sample Number:**	BH15-03 Sa 30
Project:	Annacis Outfall	**Test ID:**	420kPa, 0.16 CSR
Location:	New Westminster	**Depth (m):**	42.60-42.63
Client:	CDM Smith	**Lab ID No:**	460





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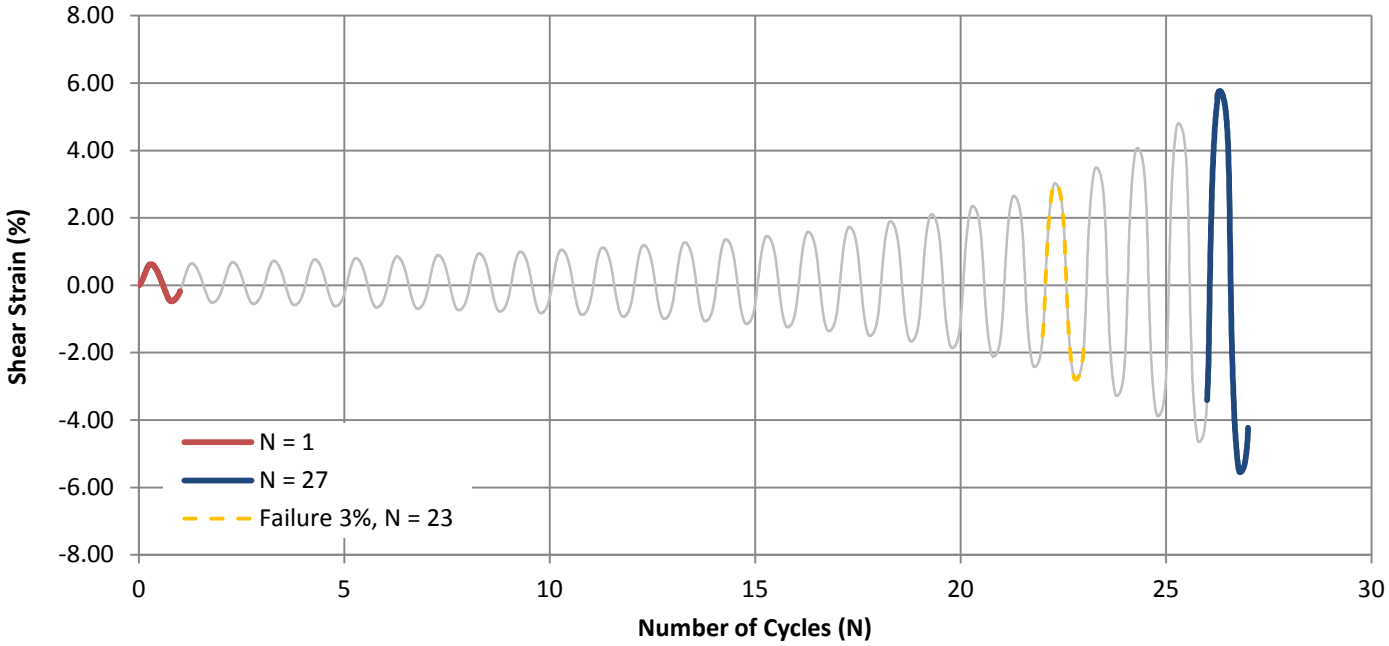

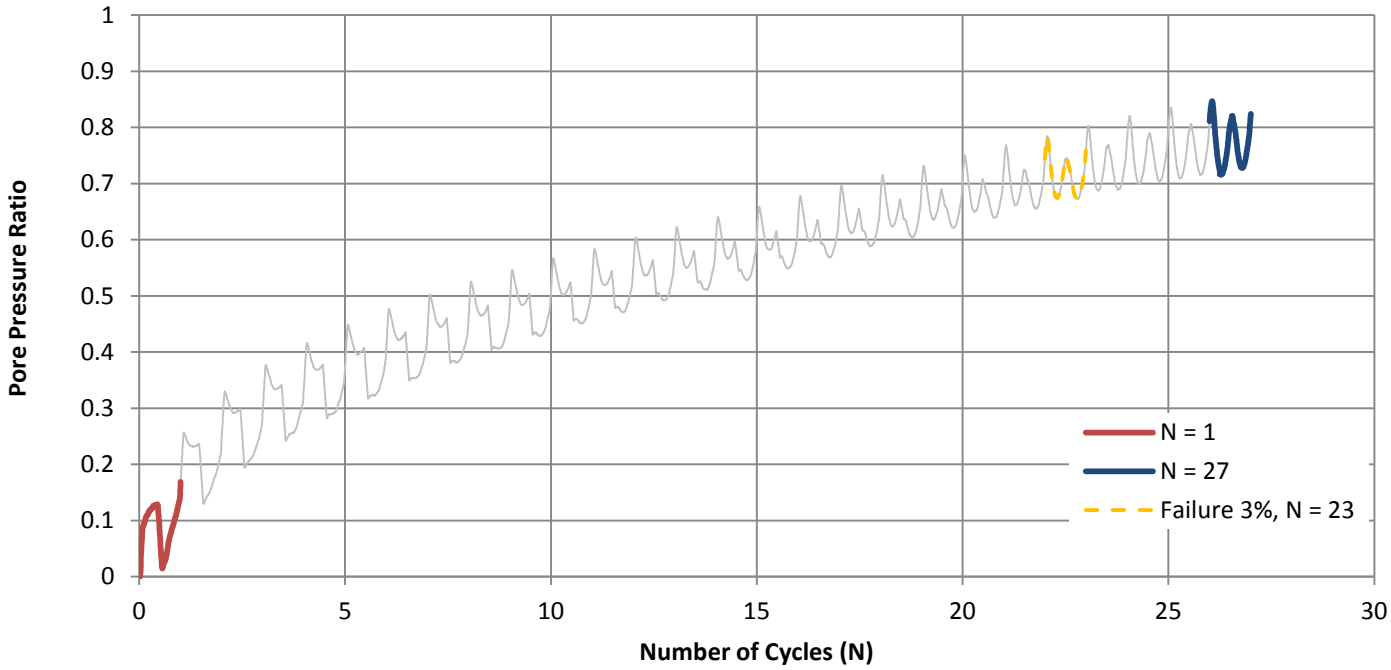

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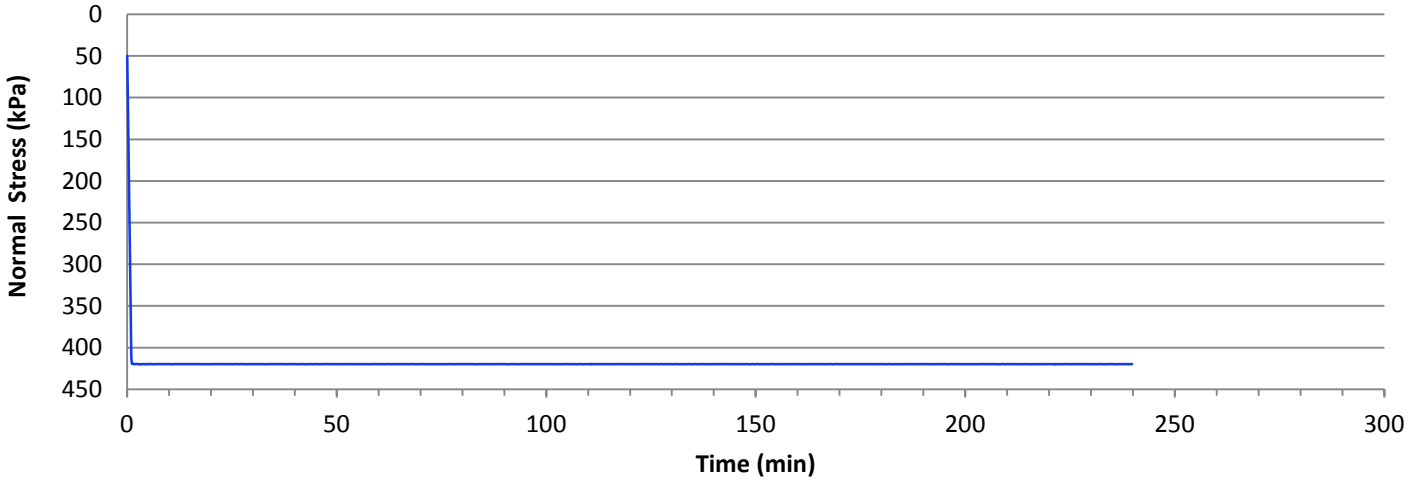
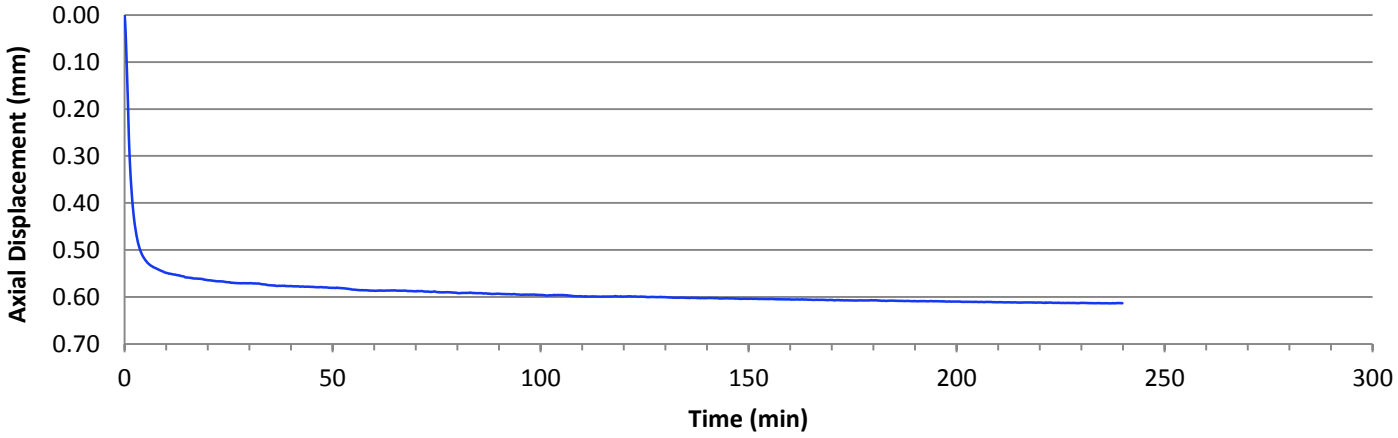
Project:	Annacis Outfall	**Test ID:**	420kPa, 0.16 CSR
Location:	New Westminster	**Depth (m):**	42.60-42.63
Client:	CDM Smith	**Lab ID No:**	460

Stress at Start of Reconsolidation (kPa)	49.98
Stress at end of Reconsolidation (kPa)	419.80
Axial Strain at end of Reconsolidation (%)	2.86
Change in Height ΔH_c (mm)	0.61

Comments
Reconsolidation data calculated from the sample height at end of initial consolidation

Increment (kPa)	420						
Load (kN)	1.6443						
Duration (min)	240						
Axial Strain (%)	2.86						





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Location:	New Westminster	**Depth (m):**	42.60-42.63
Client:	CDM Smith	**Lab ID No:**	460











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Static Direct Simple Shear Test
BH15 - 09
Sa27

Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

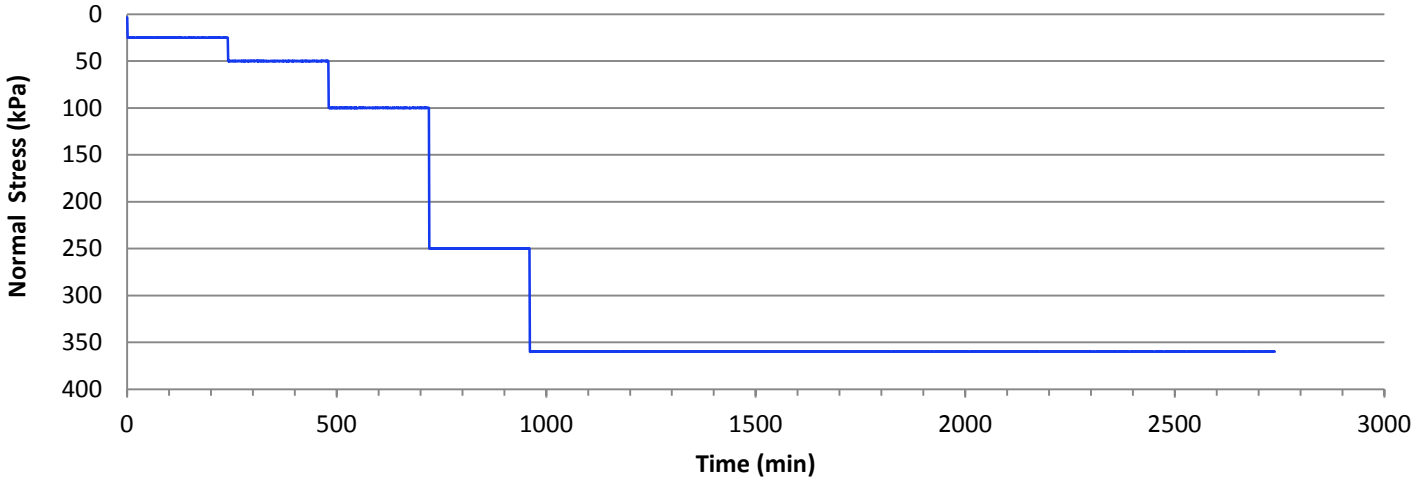
Project No.:	1525010	**Sample Number:**	BH15-09 Sa 27
Project:	Annacis Outfall	**Test ID:**	360kPa, Static
Location:	New Westminster	**Depth (m):**	40.66-40.69
Client:	CDM Smith	**Lab ID No:**	460

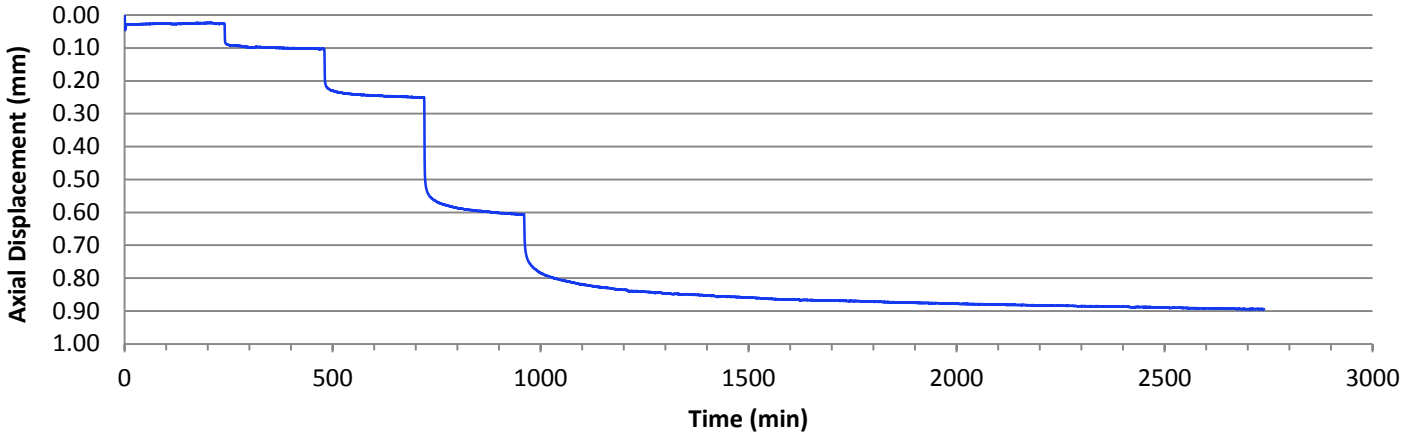
Consolidation Summary

Stress at end of Consolidation (kPa)	359.92
Axial Strain at end of Consolidation (%)	3.83
OCR	N/A
Change in Height ΔH_c (mm)	0.89

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	360		
Load (kN)	0.098	0.1955	0.3907	0.9762	1.4065		
Duration (min)	240	240	240	240	1779		
Axial Strain (%)	0.20	0.44	1.07	2.60	3.83		





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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

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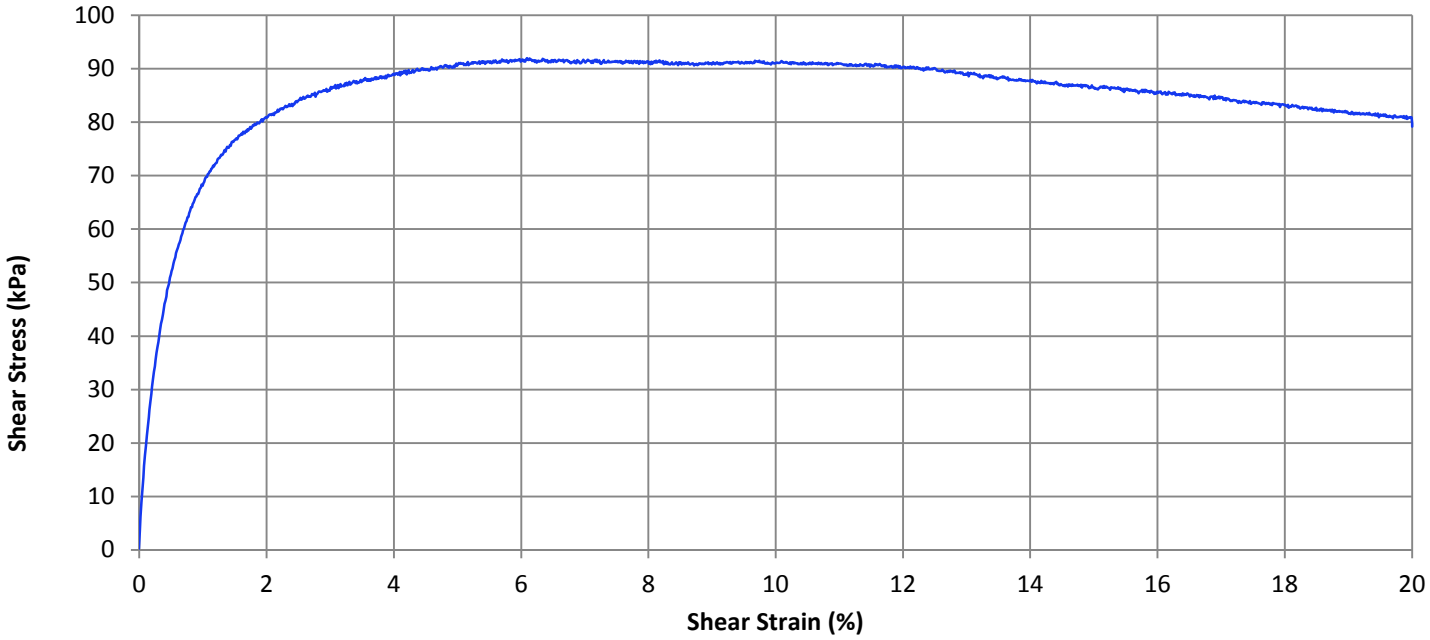
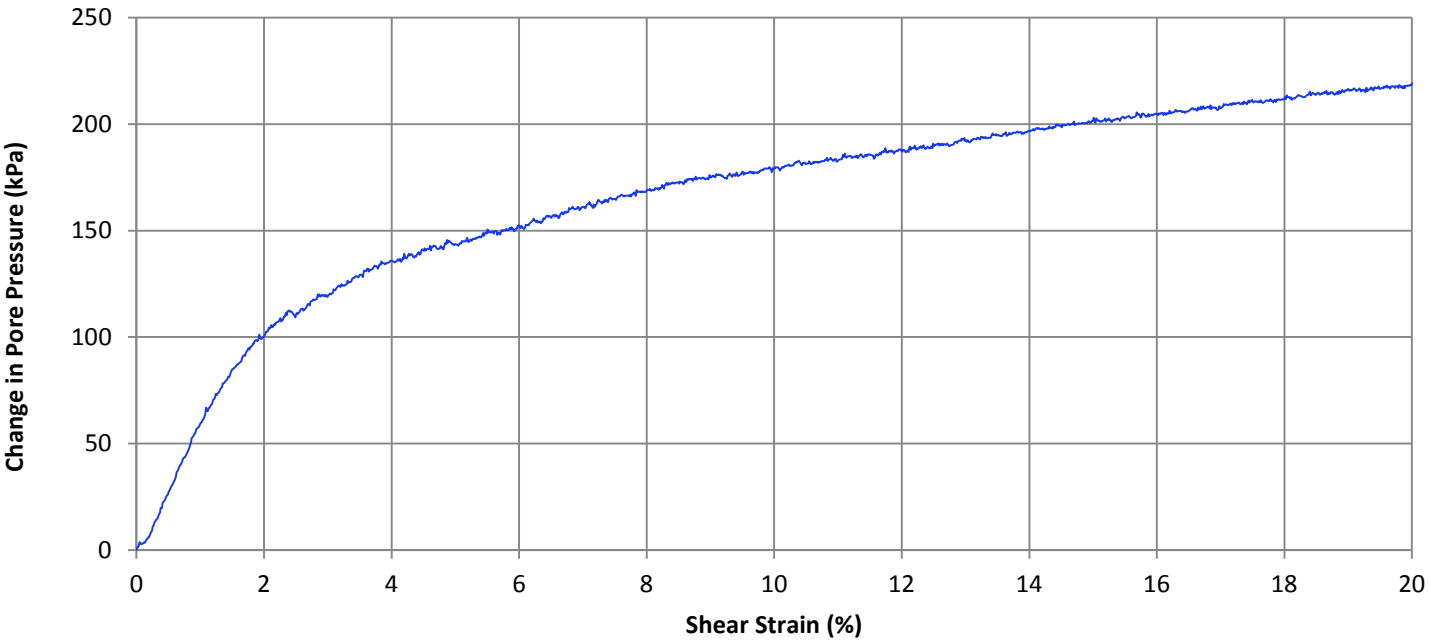
Project:	Annacis Outfall	**Test ID:**	360kPa, Static
Location:	New Westminster	**Depth (m):**	40.66-40.69
Client:	CDM Smith	**Lab ID No:**	460





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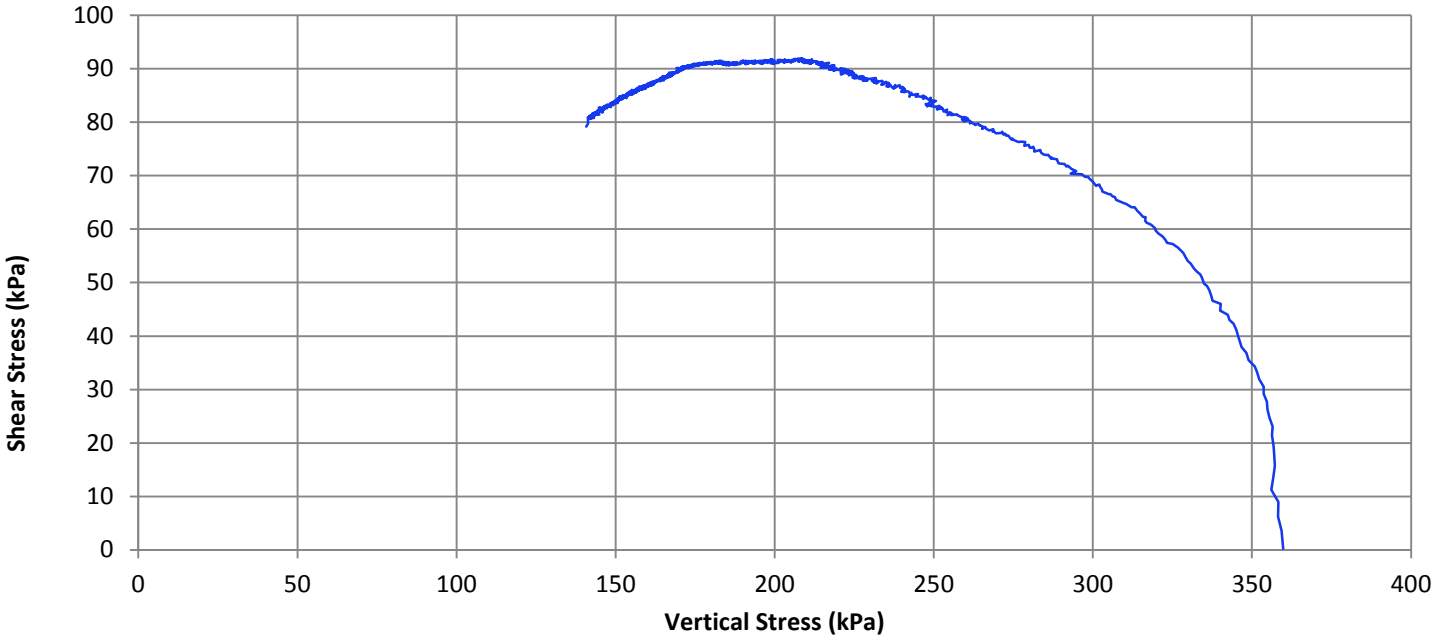

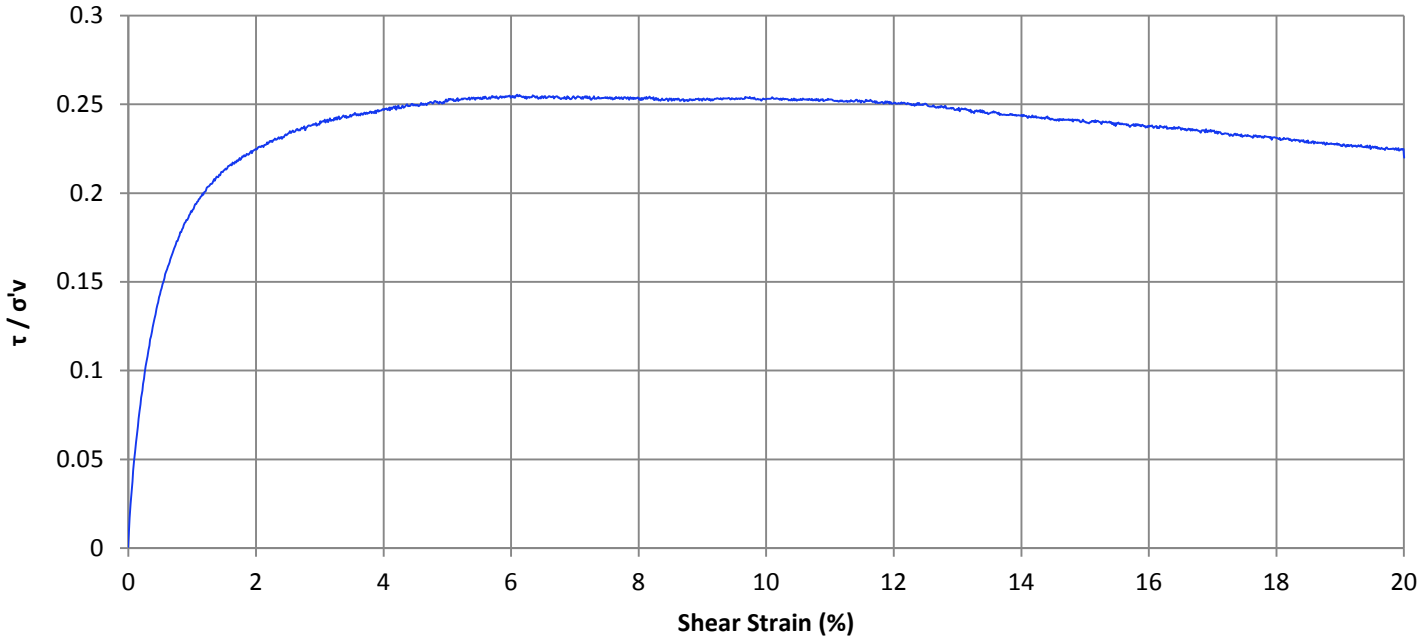

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Project:	Annacis Outfall	**Test ID:**	360kPa, Static
Location:	New Westminster	**Depth (m):**	40.66-40.69
Client:	CDM Smith	**Lab ID No:**	460

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GOLDER ASSOC
08 MAY 2016
1525010
BH16-01 S35
Cyclic Direct
Simple Shear
Test BH16-01
SA35
CSR = 0.15
35
40
50
60
70

Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-01 Sa 35
Project:	Annacis Island WWTP	**Test ID:**	512kPa, 0.15 CSR
Location:	Annacis Island, Delta	**Depth (m):**	53.47-53.56
Client:	CDM Smith	**Lab ID No:**	134

General Remarks

Equipment Description: GDS - Station 2

Vertical LVDT	Serial No.:	11897
Vertical Load Cell	Serial No.:	38408
Shear Load Cell	Serial No.:	158877

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.40
Diameter (mm)	70.43
Area (cm^2)	38.96
Volume (cm^3)	91.16
Specific Gravity (Assumed)	2.71

Visual Description	CLAY; trace silt; dark grey, cohesive, w > PL, firm		
Sand Fraction (%)	N/A	Liquid Limit	34
Fines Fraction (%)	N/A	Plastic Limit	19
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	181.6
Dry Mass (g)	139.82
Initial Wet Unit Weight (kN/m^3)	19.54
Initial Dry Unit Weight (kN/m^3)	15.05

Initial Water Content (%)	29.88
Initial Saturation (%)	>100
Final Water Content (%)	27.03
Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	512.00
Max Applied Vertical Stress (kPa)	512.90
Vertical Stress at end of Consol (kPa)	512.39
Laboratory OCR	N/A

Max. Axial Strain %	7.05
Axial Strain at end of Consol. %	7.03
Change in Height ΔH_c (mm)	1.65

Cyclic Test Results

Frequency (Hz)	0.10
CSR	0.15
Cycles to 3.00% Shear Strain	Failure not reached
Initial Vertical Stress (kPa)	512.49
Max Cyclic Shear Stress (kPa)	76.62
Max. Shear Strain at N= n/a (zero load)	Failure not reached
Min. Shear Strain at N= n/a (zero load)	Failure not reached
Max. DU at N= n/a (zero load)	Failure not reached
Min. DU at N= n/a (zero load)	Failure not reached

Post Cyclic Reconsolidation Results

Stress at Start of Reconsolidation (kPa)	139.89
Stress at End of Reconsolidation (kPa)	512.31
Max. Axial Strain %	1.50
Change in Height ΔH_c (mm)	0.32

**Reconsolidation data calculated from the sample height at end of initial consolidation*

Comments / Special Instructions

A maximum of 35 cycles requested by client. Sample did not reach target shear strain of 3% or 90% excess PWP.

Comments / Special Instructions

After cycling sample brought back to zero shear strain over a period of 1hr prior to reconsolidating to 512kPa

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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

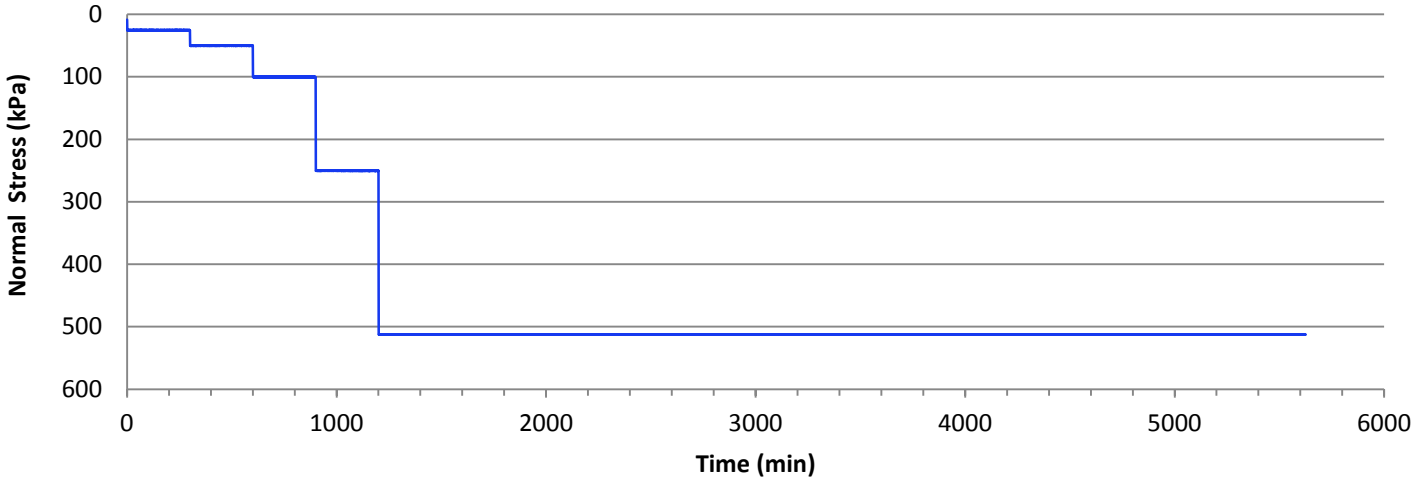
Project No.:	1525010/605	**Sample Number:**	BH16-01 Sa 35
Project:	Annacis Island WWTP	**Test ID:**	512kPa, 0.15 CSR
Location:	Annacis Island, Delta	**Depth (m):**	53.47-53.56
Client:	CDM Smith	**Lab ID No:**	134

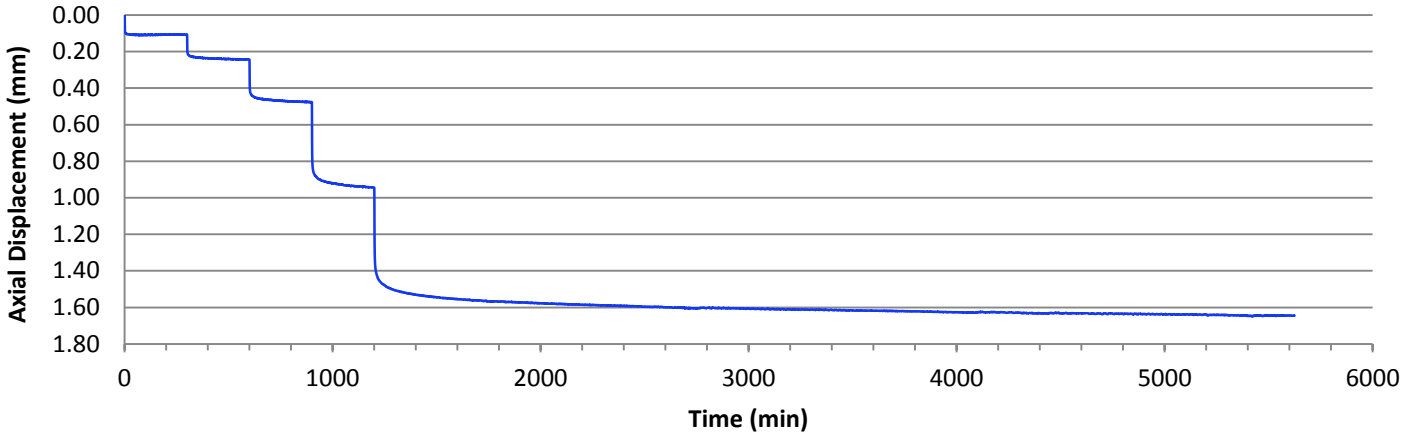
Consolidation Summary

Stress at end of Consolidation (kPa)	512.39
Axial Strain at end of Consolidation (%)	7.03
OCR	N/A
Change in Height ΔH_c (mm)	1.65

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	512		
Load (kN)	0.0999	0.1974	0.3923	0.9769	1.9982		
Duration (min)	300	300	300	300	4424		
Axial Strain (%)	0.47	1.04	2.04	4.04	7.05		





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Location:	Annacis Island, Delta	**Depth (m):**	53.47-53.56
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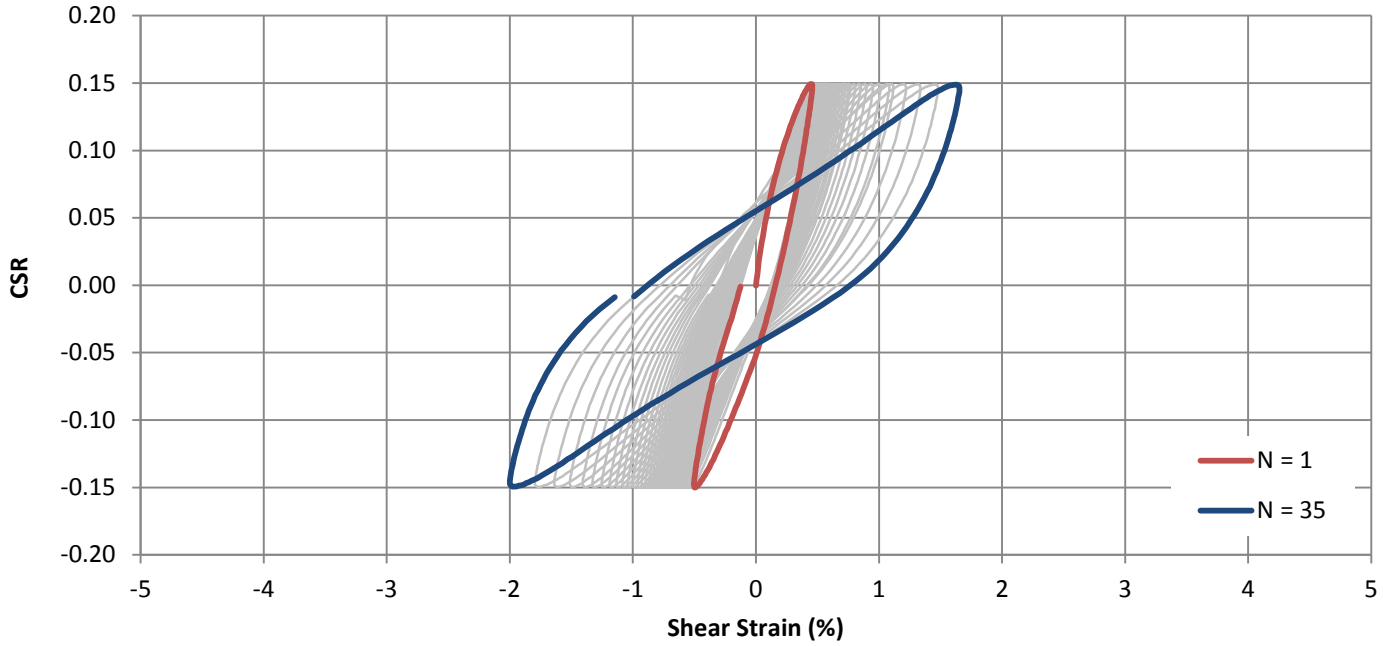

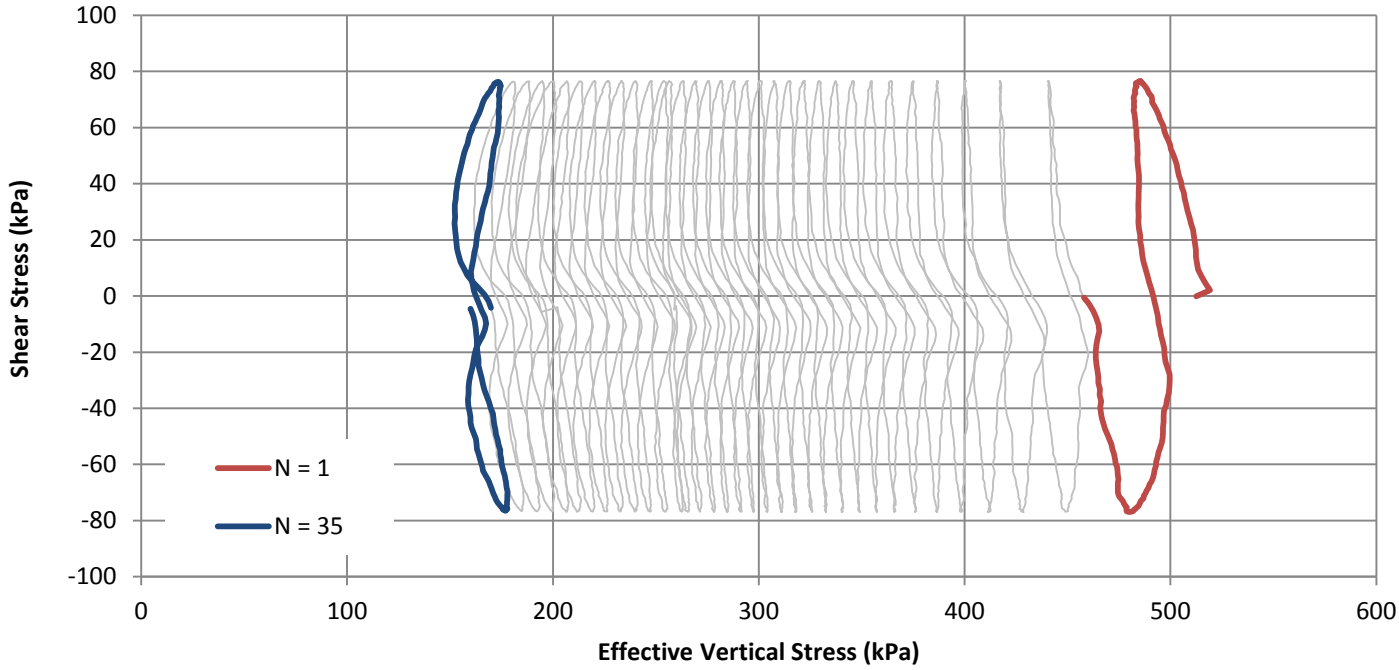

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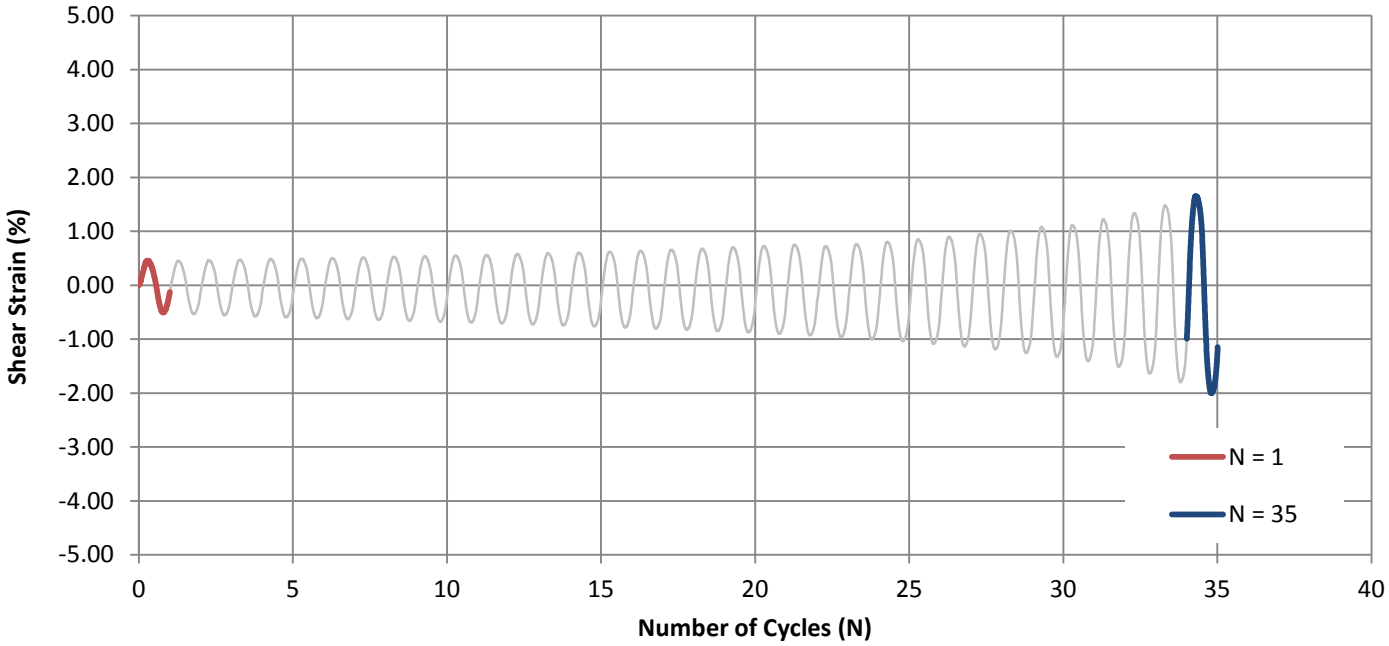

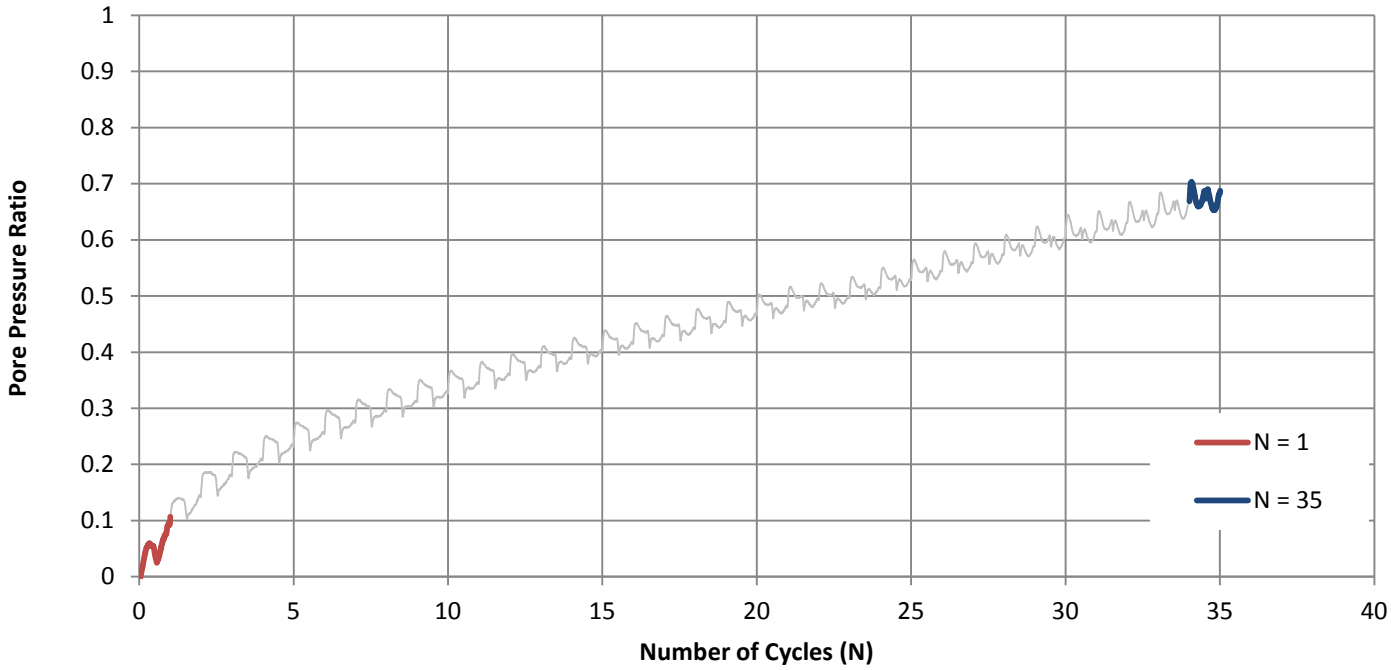

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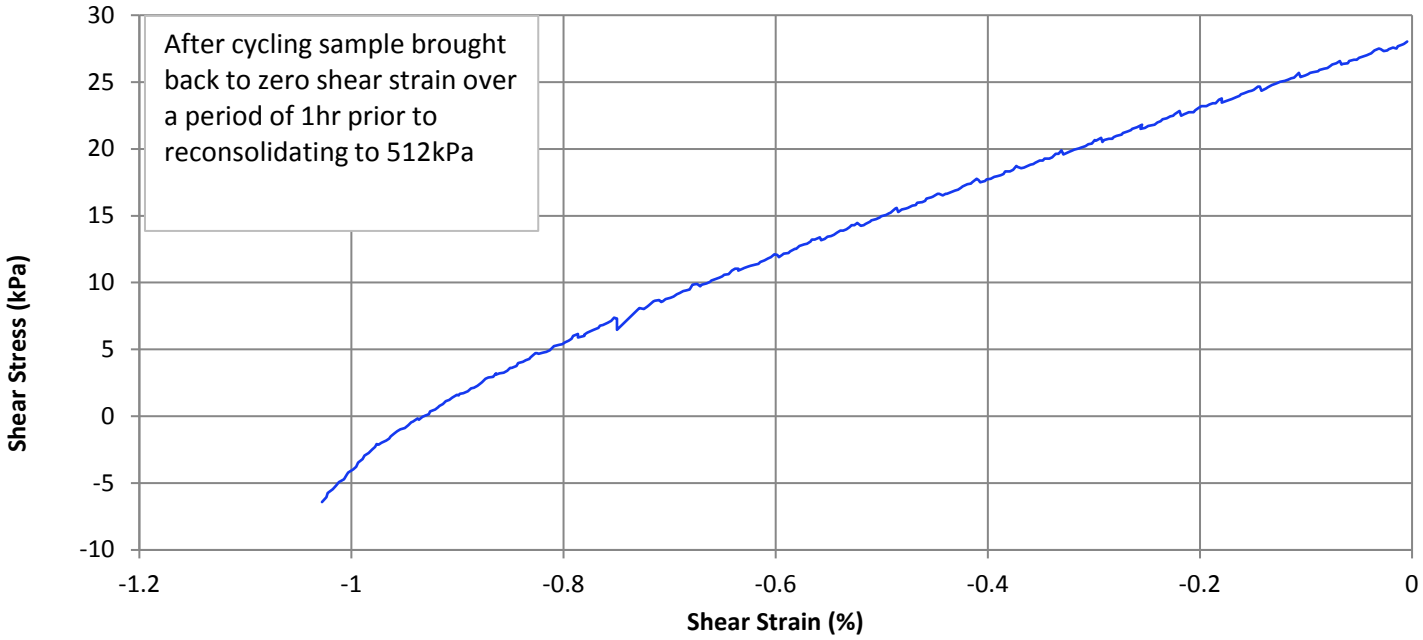

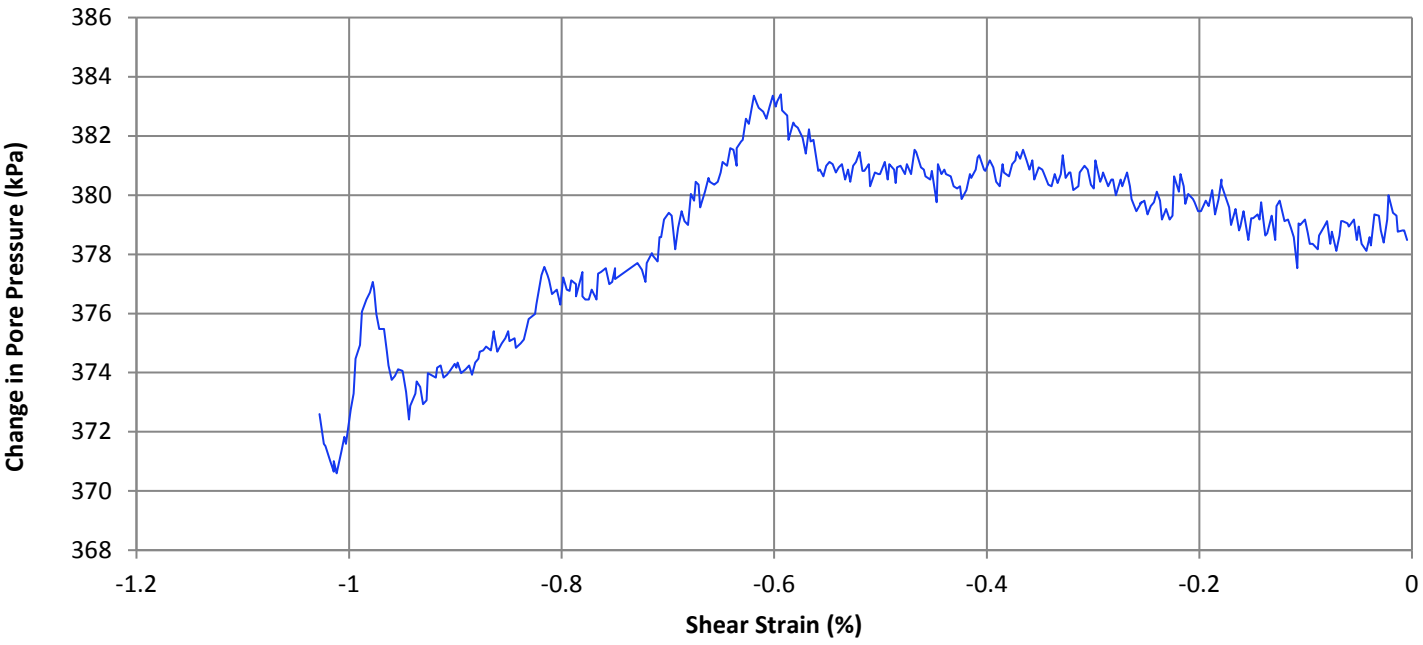

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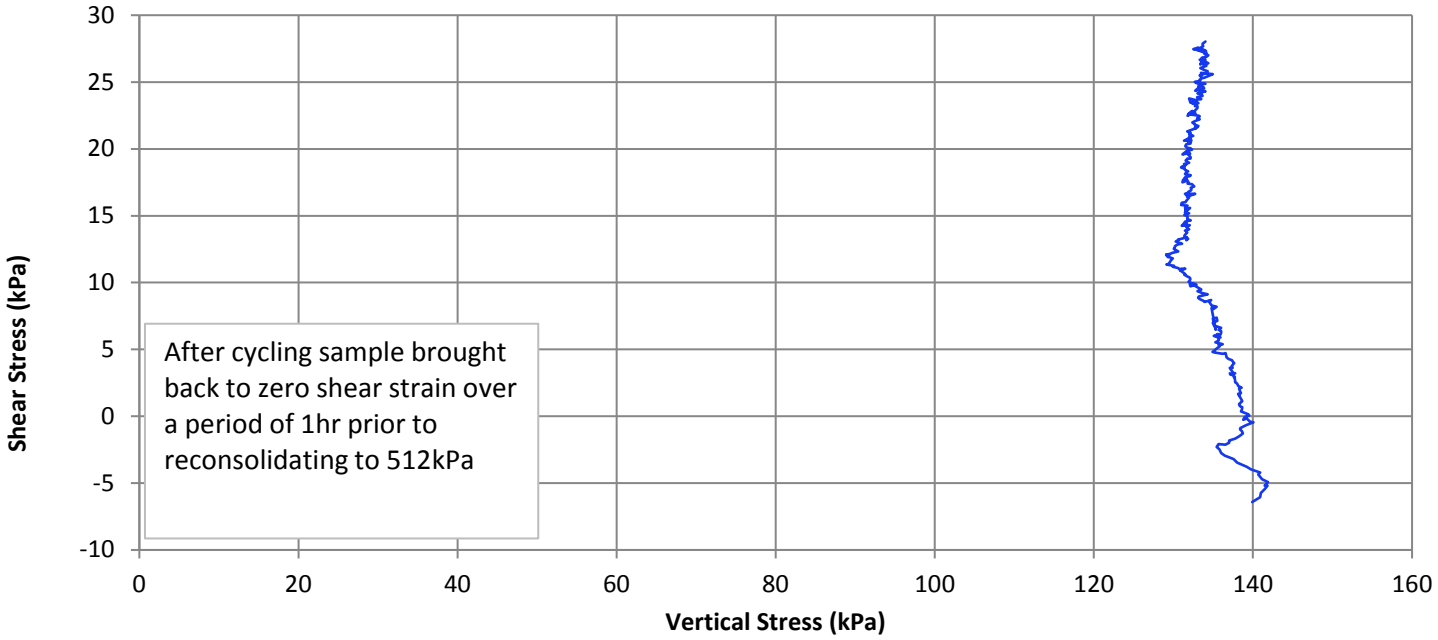

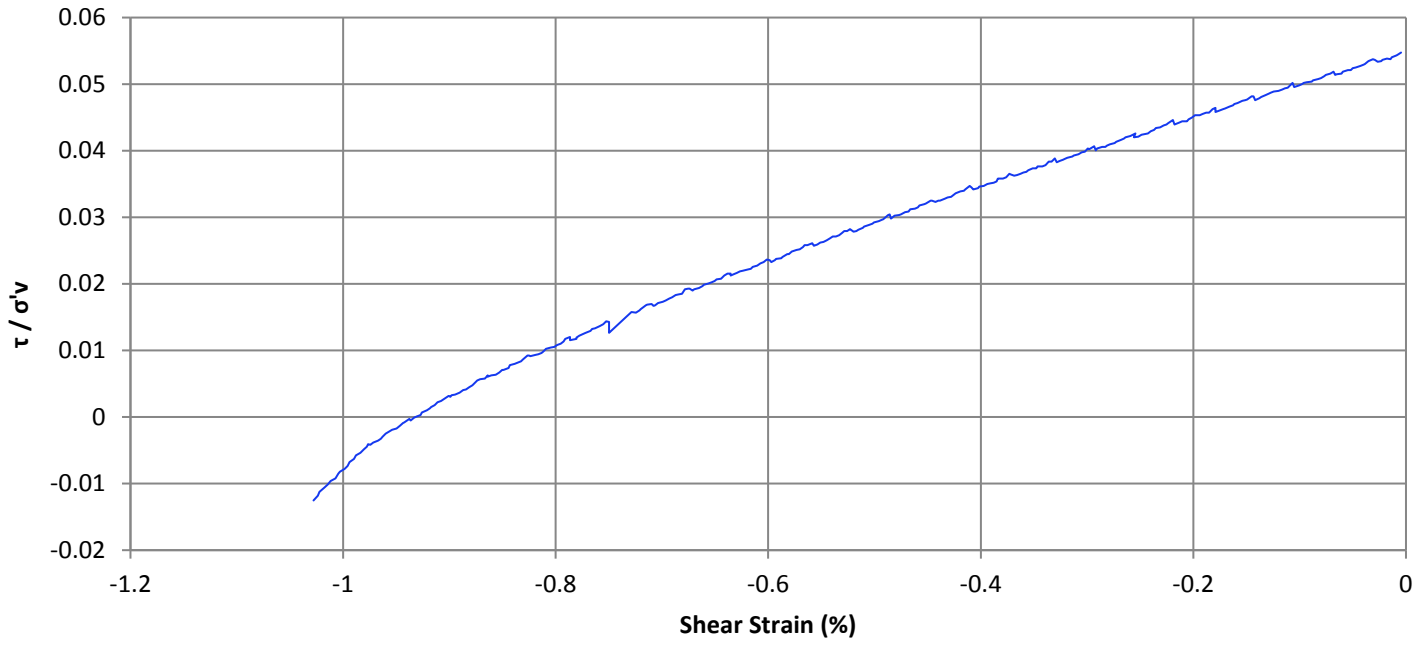

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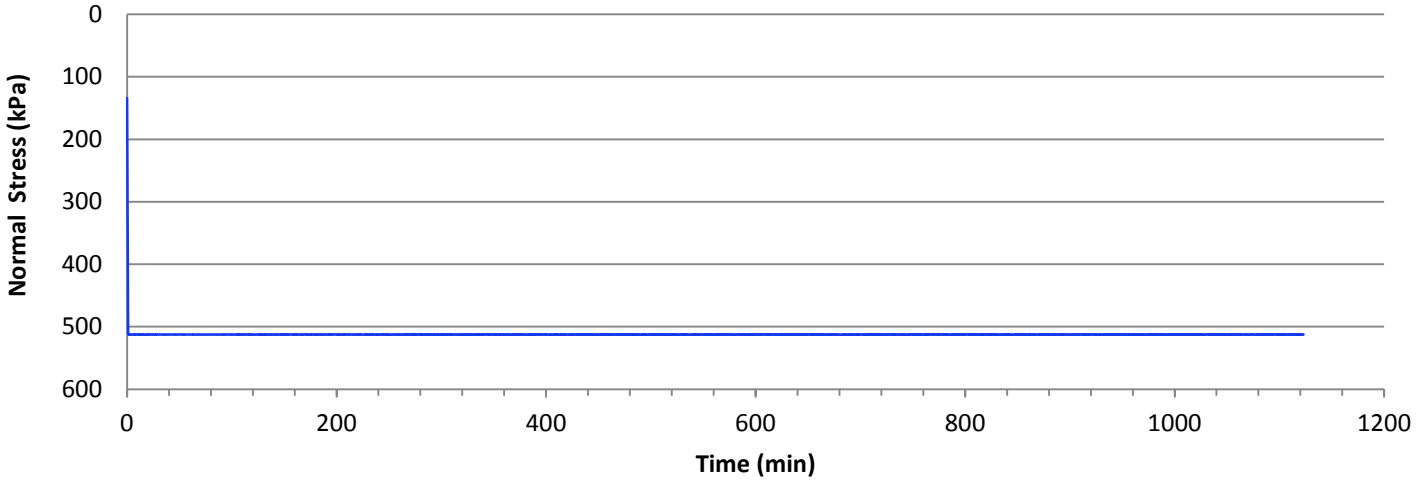
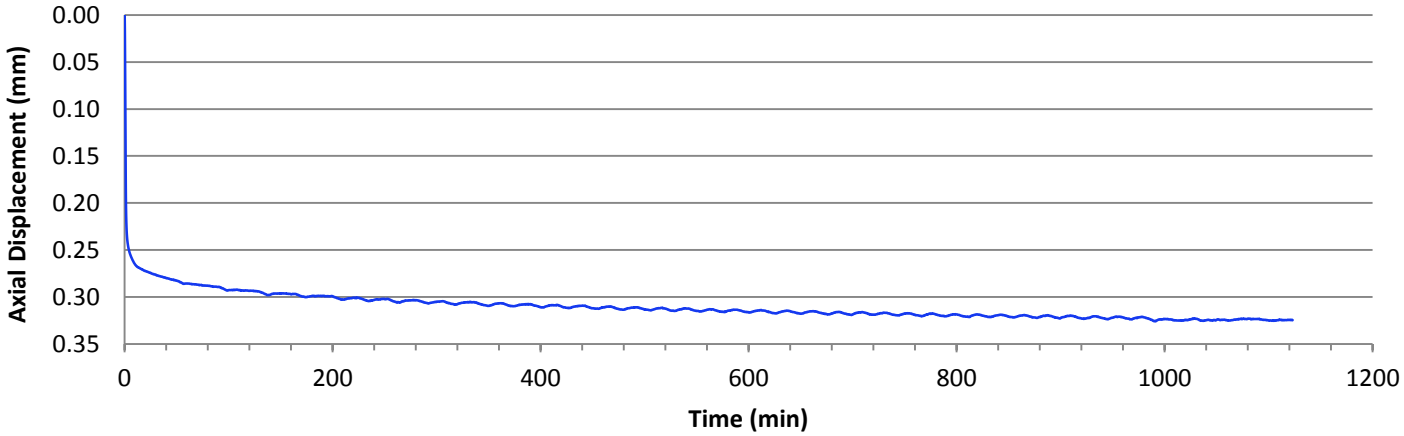
Client:	CDM Smith	**Lab ID No:**	134

Stress at Start of Reconsolidation (kPa)	139.89
Stress at end of Reconsolidation (kPa)	512.31
Axial Strain at end of Reconsolidation (%)	1.50
Change in Height ΔH_c (mm)	0.32

Comments
Reconsolidation data calculated from the sample height at end of initial consolidation

Increment (kPa)	512						
Load (kN)	1.9982						
Duration (min)	1123						
Axial Strain (%)	1.50						





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G. Patton	May 27, 2016	M. Sanin	June 7, 2016
TESTED BY	DATE	CHECKED BY	DATE

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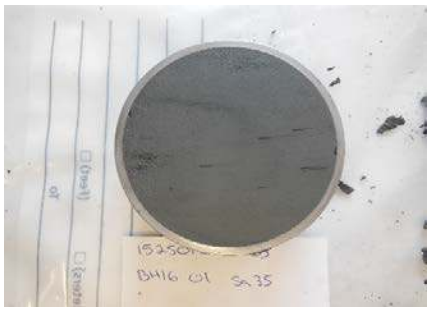
Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-01 Sa 35
Project:	Annacis Island WWTP	**Test ID:**	512kPa, 0.15 CSR
Location:	Annacis Island, Delta	**Depth (m):**	53.47-53.56
Client:	CDM Smith	**Lab ID No:**	134



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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-02 Sa 36
Project:	Annacis Island WWTP	**Test ID:**	570kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	59.44-59.49
Client:	CDM Smith	**Lab ID No:**	134

General Remarks

Equipment Description: GDS - Station 2

Vertical LVDT	Serial No.:	11897
Vertical Load Cell	Serial No.:	38408
Shear Load Cell	Serial No.:	158877

Sample Properties

Preparation Method	Moist Tamping
Height (mm)	23.34
Diameter (mm)	70.56
Area (cm^2)	39.10
Volume (cm^3)	91.27
Specific Gravity (Assumed)	2.71

Visual Description	Silty CLAY; trace silt; dark grey, cohesive, w > PL, firm		
Sand Fraction (%)	N/A	Liquid Limit	28
Fines Fraction (%)	N/A	Plastic Limit	19
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	178.96	Initial Water Content (%)	31.83
Dry Mass (g)	135.75	Initial Saturation (%)	>100
Initial γ_{wet} (kN/m^3)	19.24	Final Water Content (%)	28.74
Initial γ_{dry} (kN/m^3)	14.59	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	485.00	Max. Axial Strain %	8.35
Max Applied Vertical Stress (kPa)	570.88	Axial Strain at end of Consol. %	8.35
Vertical Stress at end of Consol (kPa)	570.34	Change in Height ΔH_c (mm)	1.95
Laboratory OCR	N/A		

Direct Simple Shear Test Results

Initial Vertical Stress (kPa)	570.40	Peak Shear Strength (kPa)	142.52
Initial Shear Stress (kPa)	-0.10	Excess Pore Pressure at Peak (kPa)	310.08
Applied Shear Bias (kPa)	0.00	Ratio of Peak / $\sigma'v$	0.25
Rate of Shearing (%/hr)	5.00	Maximum Shear Strain γ_{MAX} (%)	20.00
Test Condition	Undrained	Shear Strength at γ_{MAX} (kPa)	125.75

Comments / Special Instructions

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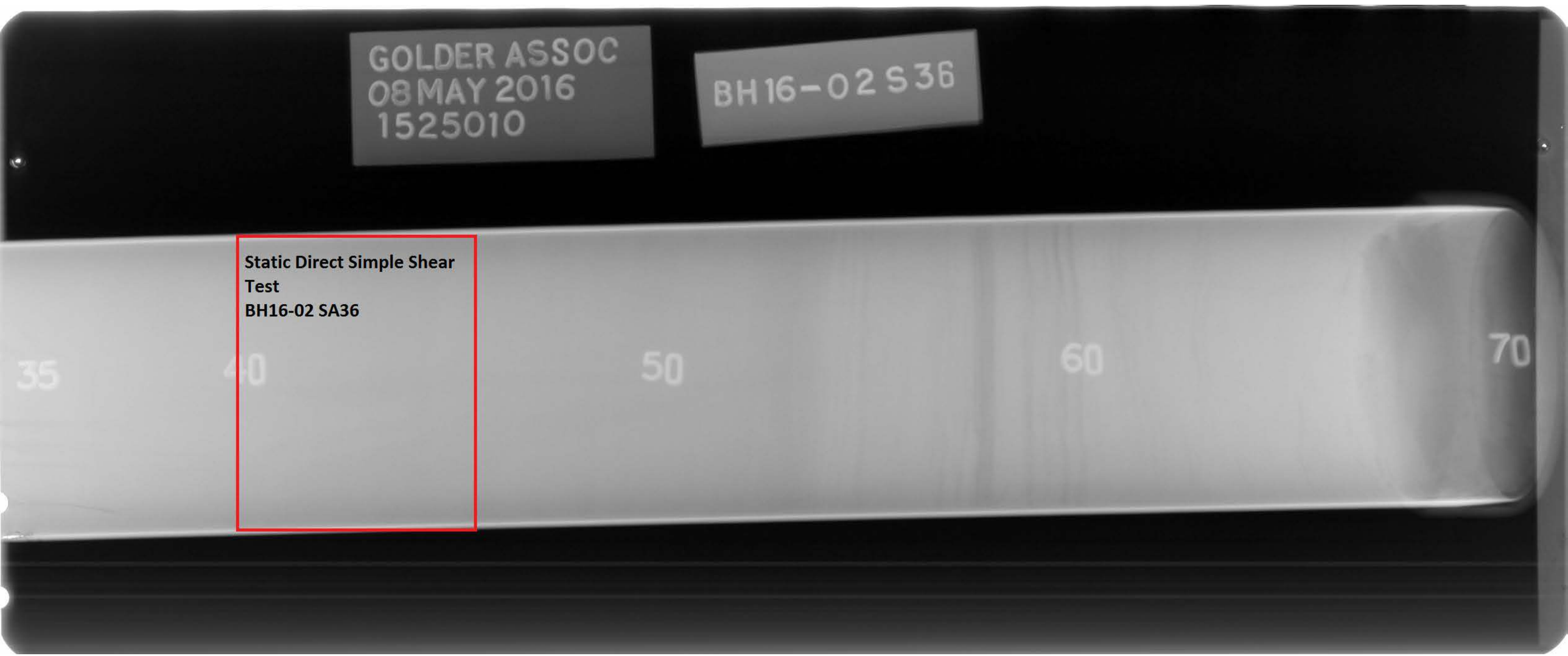
GOLDER ASSOC
08 MAY 2016
1525010
BH16-02 S36
Static Direct Simple Shear
Test
BH16-02 SA36
35
40
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60
70

Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

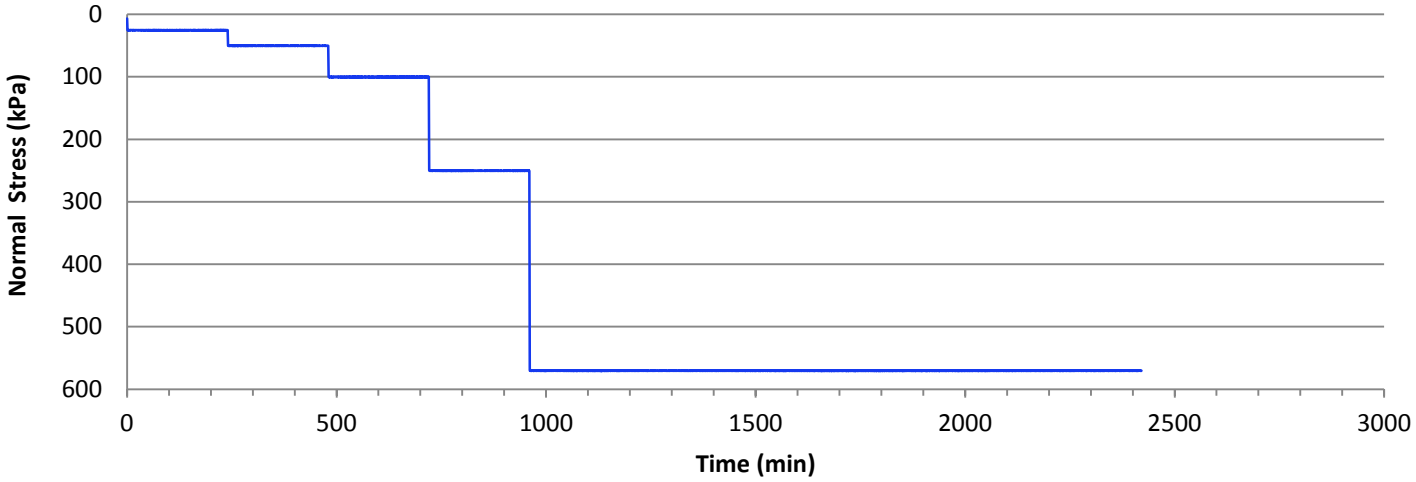
Project No.:	1525010/605	**Sample Number:**	BH16-02 Sa 36
Project:	Annacis Island WWTP	**Test ID:**	570kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	59.44-59.49
Client:	CDM Smith	**Lab ID No:**	134

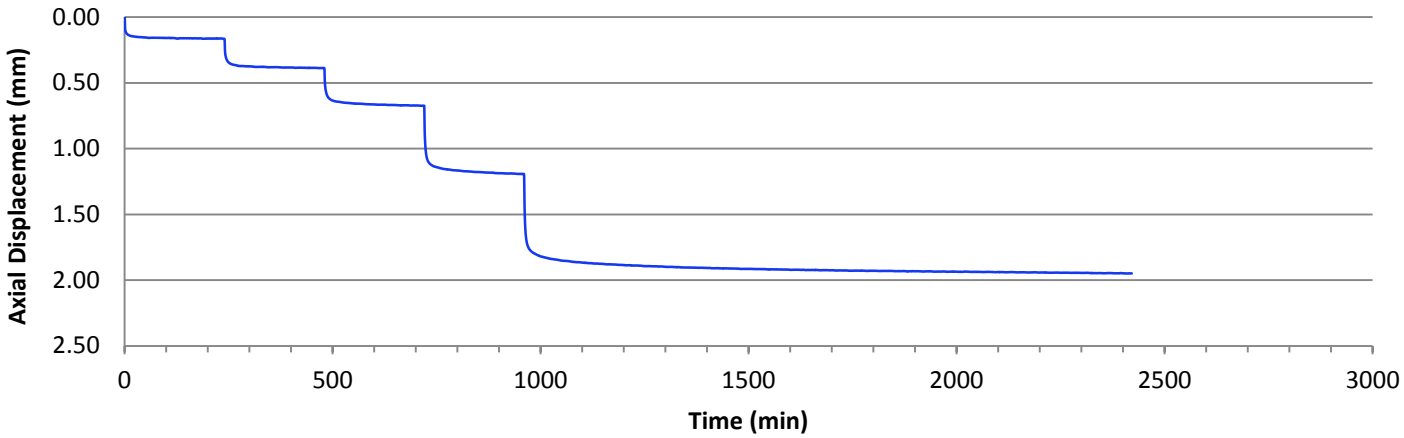
Consolidation Summary

Stress at end of Consolidation (kPa)	570.34
Axial Strain at end of Consolidation (%)	8.35
OCR	N/A
Change in Height ΔH_c (mm)	1.95

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	570		
Load (kN)	0.1003	0.1981	0.3939	0.9804	2.2323		
Duration (min)	240	240	240	240	1461		
Axial Strain (%)	0.71	1.66	2.89	5.11	8.35		





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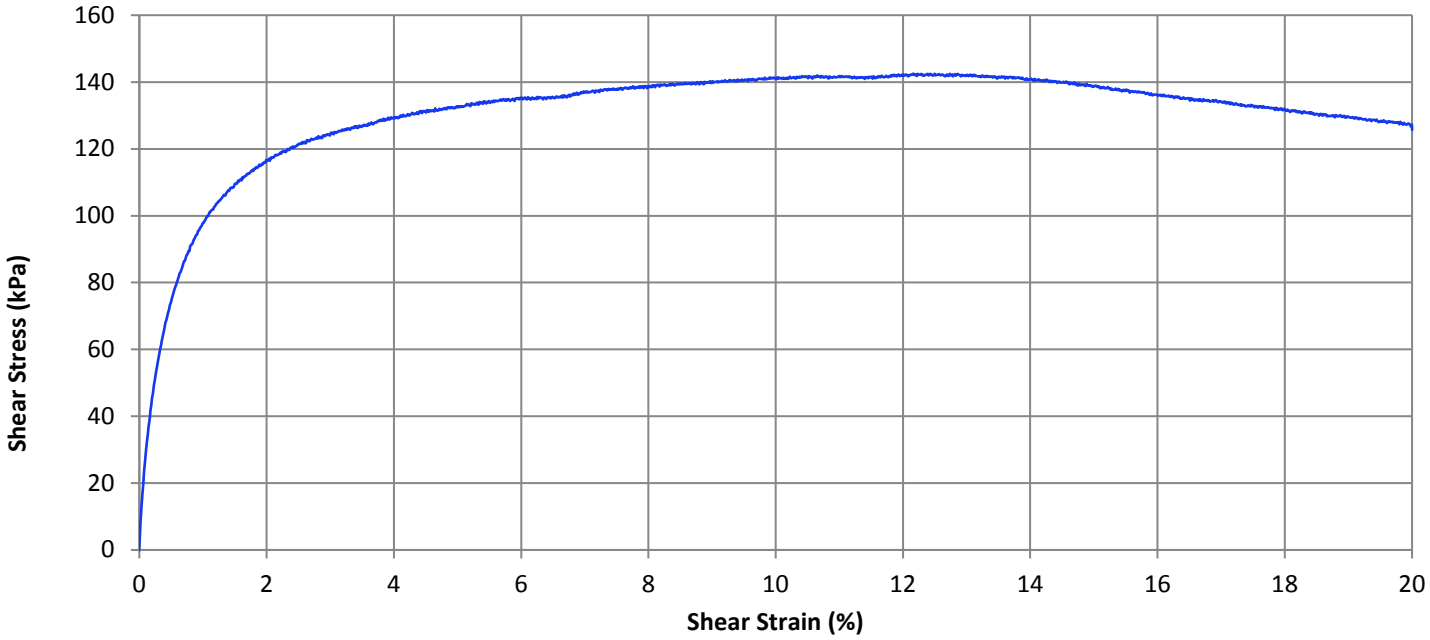
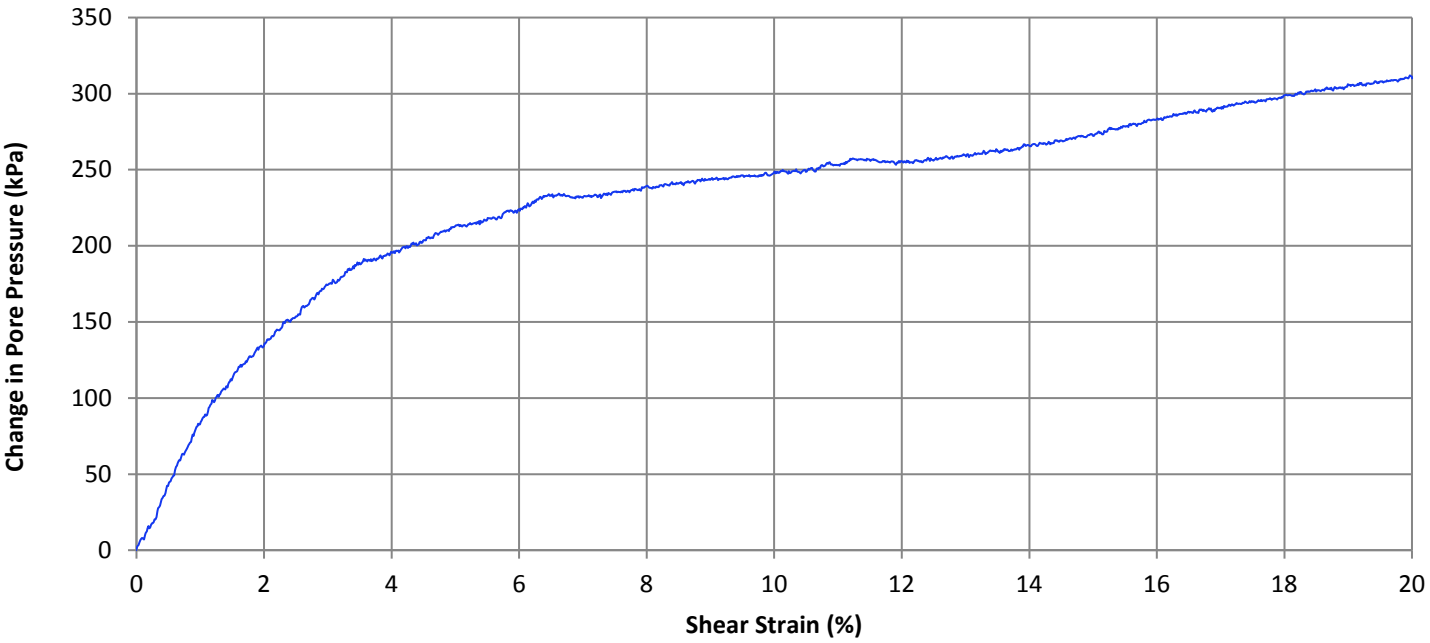
Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-02 Sa 36
Project:	Annacis Island WWTP	**Test ID:**	570kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	59.44-59.49
Client:	CDM Smith	**Lab ID No:**	134





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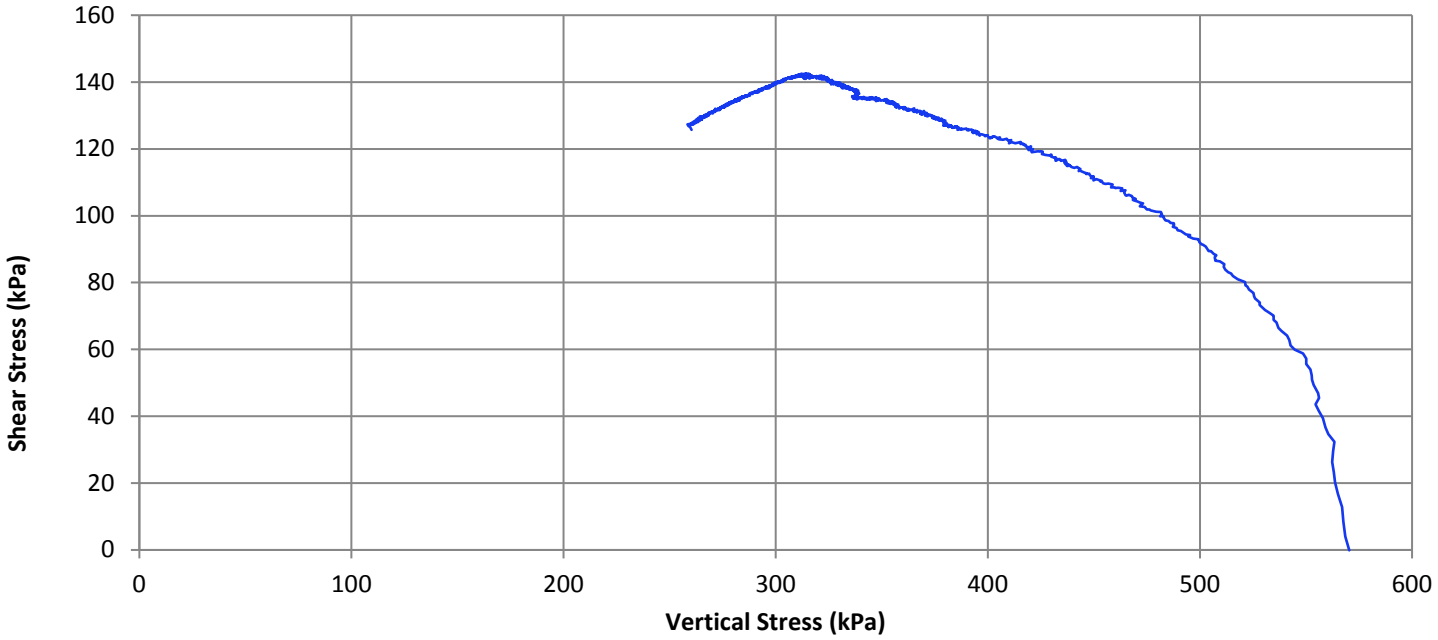
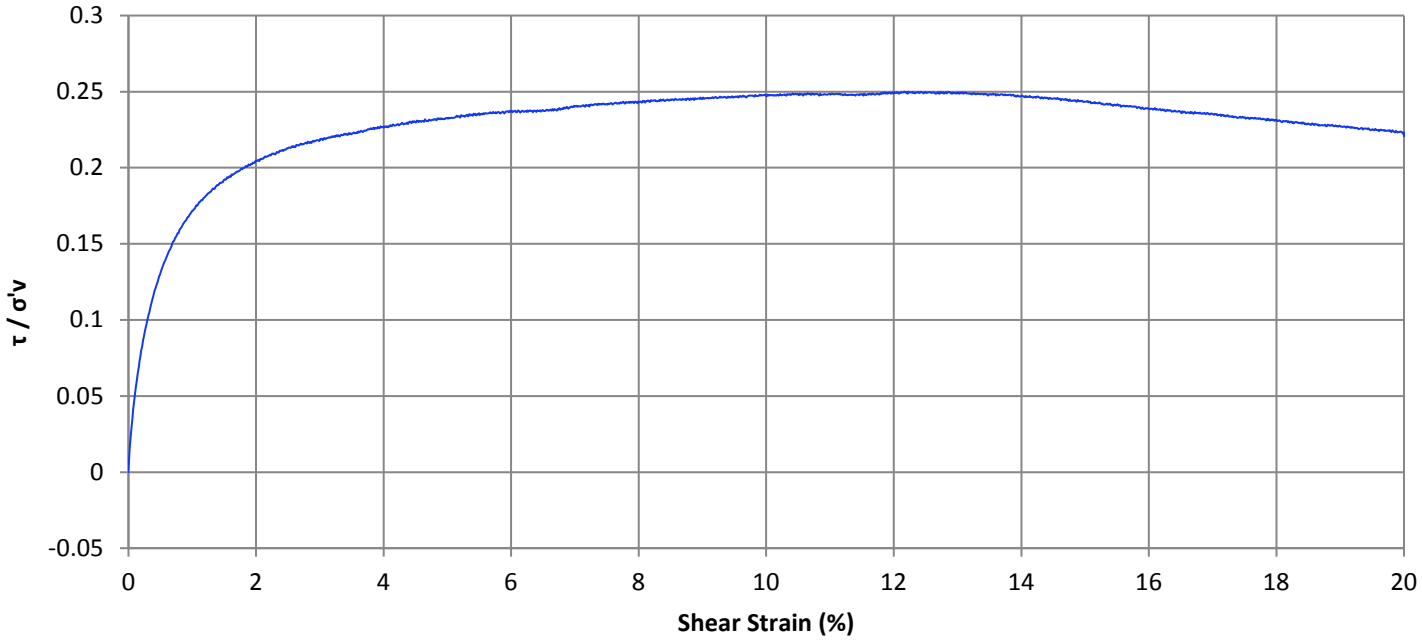
Project No.:	1525010/605	**Sample Number:**	BH16-02 Sa 36
Project:	Annacis Island WWTP	**Test ID:**	570kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	59.44-59.49
Client:	CDM Smith	**Lab ID No:**	134





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Project No.:	1525010/605	**Sample Number:**	BH16-02 Sa 36
Project:	Annacis Island WWTP	**Test ID:**	570kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	59.44-59.49
Client:	CDM Smith	**Lab ID No:**	134









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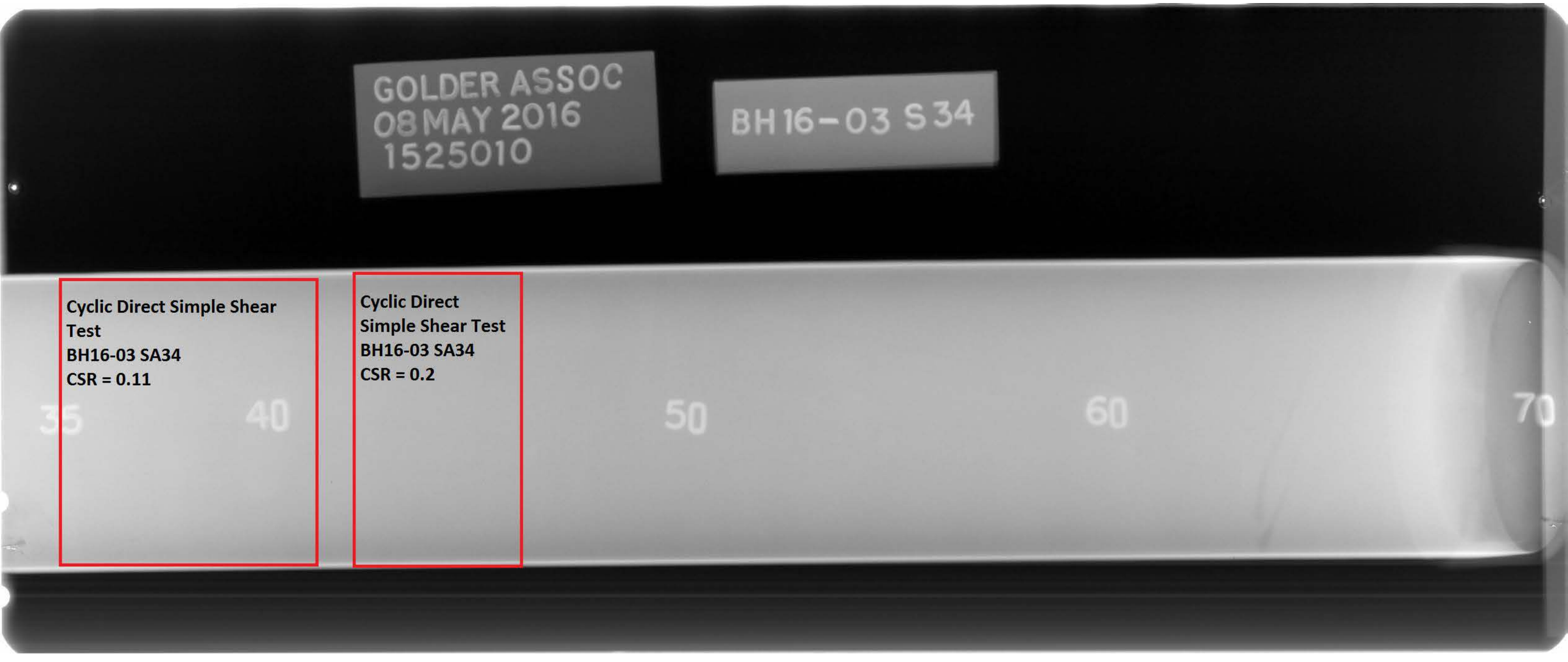
GOLDER ASSOC
08 MAY 2016
1525010
BH16-03 S34
Cyclic Direct Simple Shear Test
BH16-03 SA34
CSR = 0.11
Cyclic Direct Simple Shear Test
BH16-03 SA34
CSR = 0.2
35
40
50
60
70

Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 34
Project:	Annacis Island WWTP	**Test ID:**	490kPa, 0.20 CSR
Location:	Annacis Island, Delta	**Depth (m):**	51.38-51.44
Client:	CDM Smith	**Lab ID No:**	134

General Remarks

Equipment Description: GDS - Station 2

Vertical LVDT	Serial No.:	11897
Vertical Load Cell	Serial No.:	38408
Shear Load Cell	Serial No.:	158877

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.57
Diameter (mm)	70.47
Area (cm^2)	39.00
Volume (cm^3)	91.93
Specific Gravity (Assumed)	2.71

Visual Description	CLAY; trace silt; dark grey, cohesive, w > PL, firm		
Sand Fraction (%)	N/A	Liquid Limit	33
Fines Fraction (%)	N/A	Plastic Limit	19
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	181.24	Initial Water Content (%)	29.95
Dry Mass (g)	139.47	Initial Saturation (%)	>100
Initial Wet Unit Weight (kN/m^3)	19.34	Final Water Content (%)	25.24
Initial Dry Unit Weight (kN/m^3)	14.88	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	490.00	Max. Axial Strain %	5.77
Max Applied Vertical Stress (kPa)	490.83	Axial Strain at end of Consol. %	5.76
Vertical Stress at end of Consol (kPa)	490.42	Change in Height ΔH_c (mm)	1.36
Laboratory OCR	N/A		

Cyclic Test Results

Frequency (Hz)	0.10
CSR	0.20
Cycles to 3.00% Shear Strain	7
Initial Vertical Stress (kPa)	490.65
Max Cyclic Shear Stress (kPa)	100.43
Max. Shear Strain at N=7 (zero load)	1.93
Min. Shear Strain at N=7 (zero load)	-1.72
Max. DU at N=7 (zero load)	310.99
Min. DU at N=7 (zero load)	297.22

Post Cyclic Reconsolidation Test Results

Stress at Start of Reconsolidation (kPa)	46.15
Stress at End of Reconsolidation (kPa)	490.37
Max. Axial Strain %	5.93
Change in Height ΔH_c (mm)	1.32

**Reconsolidation data calculated from the sample height at end of initial consolidation*

Comments / Special Instructions

Sample cycled in stages as per client request. Targeting 90% excess pore water pressure.

Comments / Special Instructions

After cycling sample brought back to zero shear strain over a period of 5hrs prior to reconsolidating to 490kPa

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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

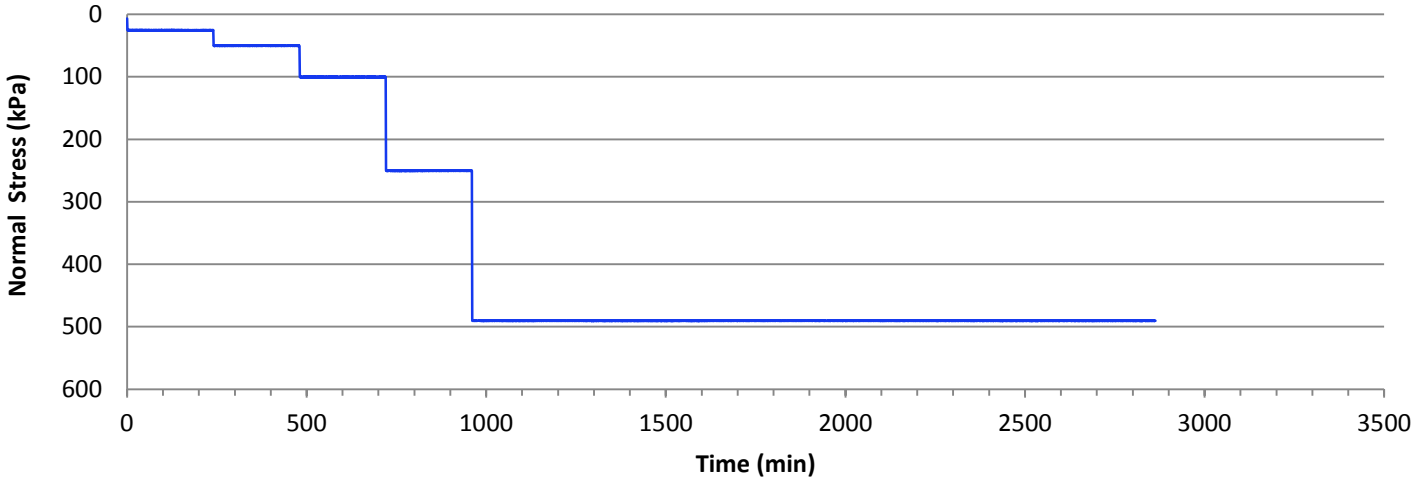
Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 34
Project:	Annacis Island WWTP	**Test ID:**	490kPa, 0.20 CSR
Location:	Annacis Island, Delta	**Depth (m):**	51.38-51.44
Client:	CDM Smith	**Lab ID No:**	134

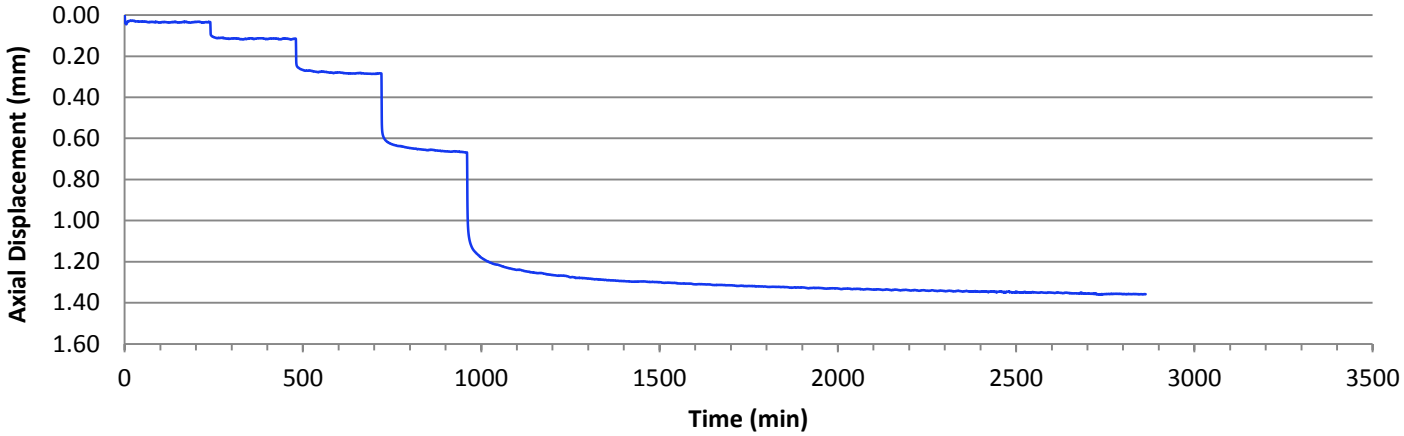
Consolidation Summary

Stress at end of Consolidation (kPa)	490.42
Axial Strain at end of Consolidation (%)	5.76
OCR	N/A
Change in Height ΔH_c (mm)	1.36

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	490		
Load (kN)	0.1008	0.1979	0.3932	0.9781	1.9144		
Duration (min)	240	240	240	240	1903		
Axial Strain (%)	0.19	0.50	1.22	2.84	5.77		





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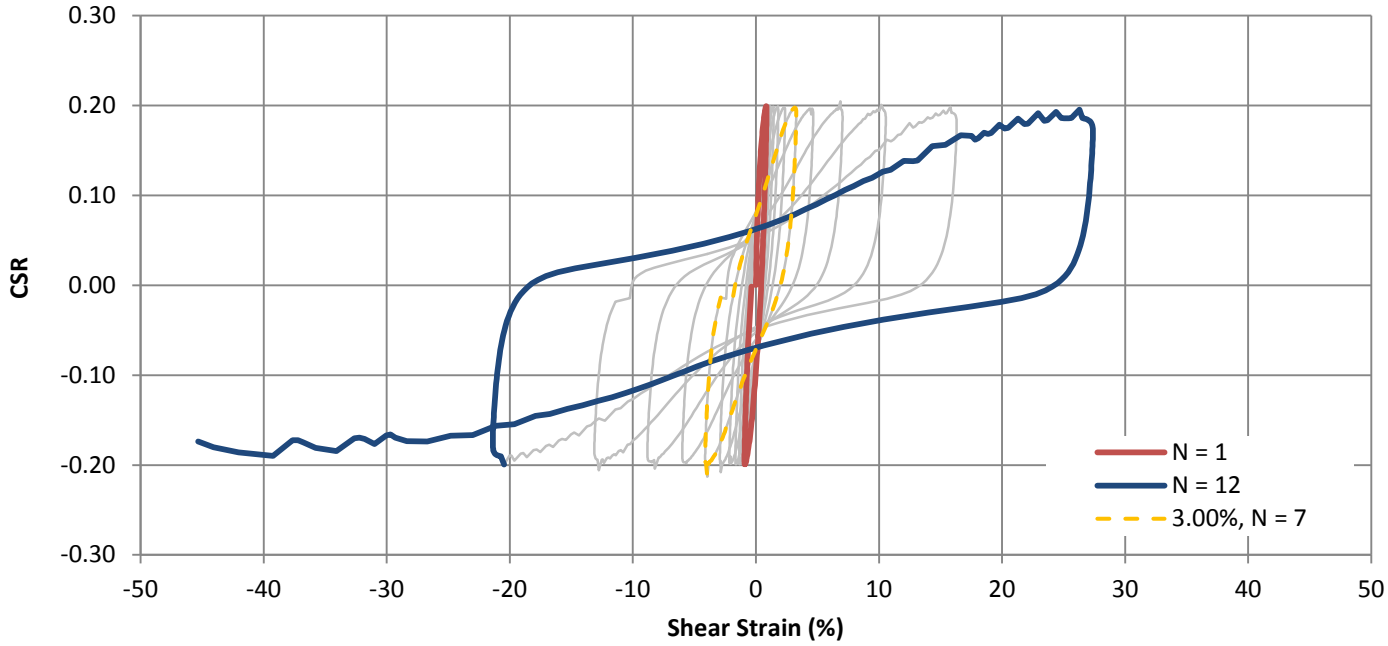
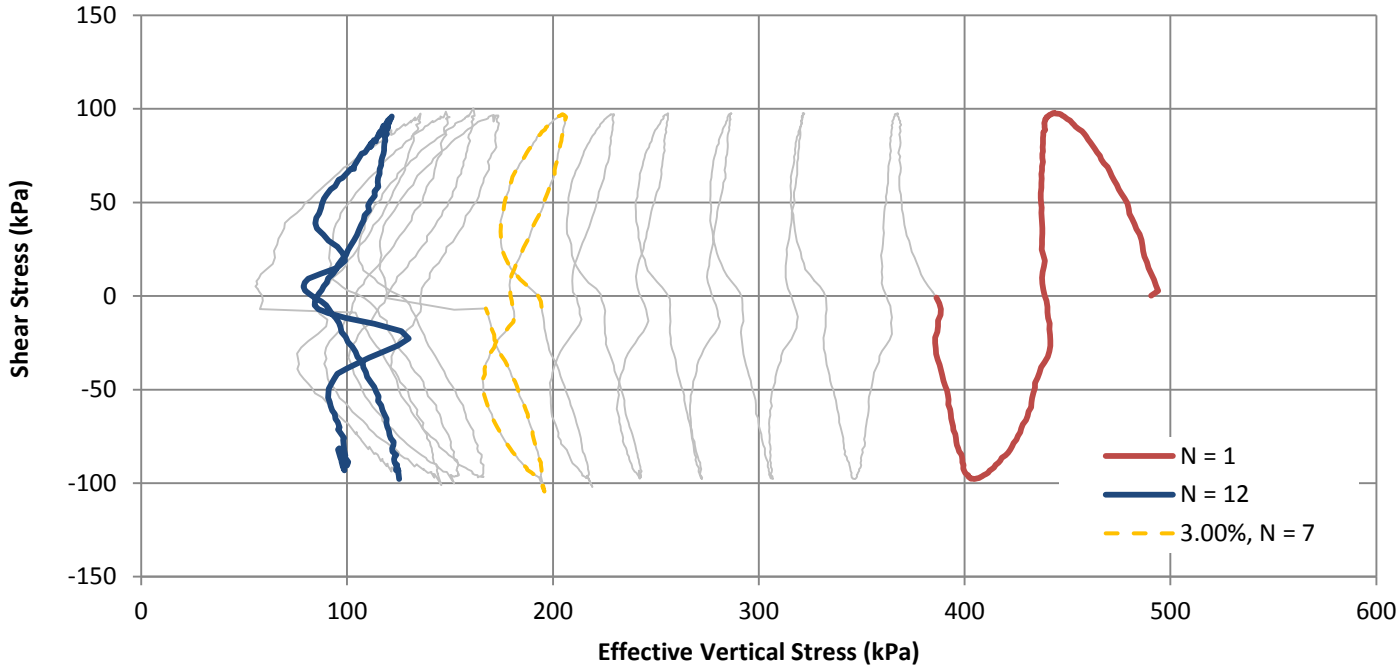
Project:	Annacis Island WWTP	**Test ID:**	490kPa, 0.20 CSR
Location:	Annacis Island, Delta	**Depth (m):**	51.38-51.44
Client:	CDM Smith	**Lab ID No:**	134





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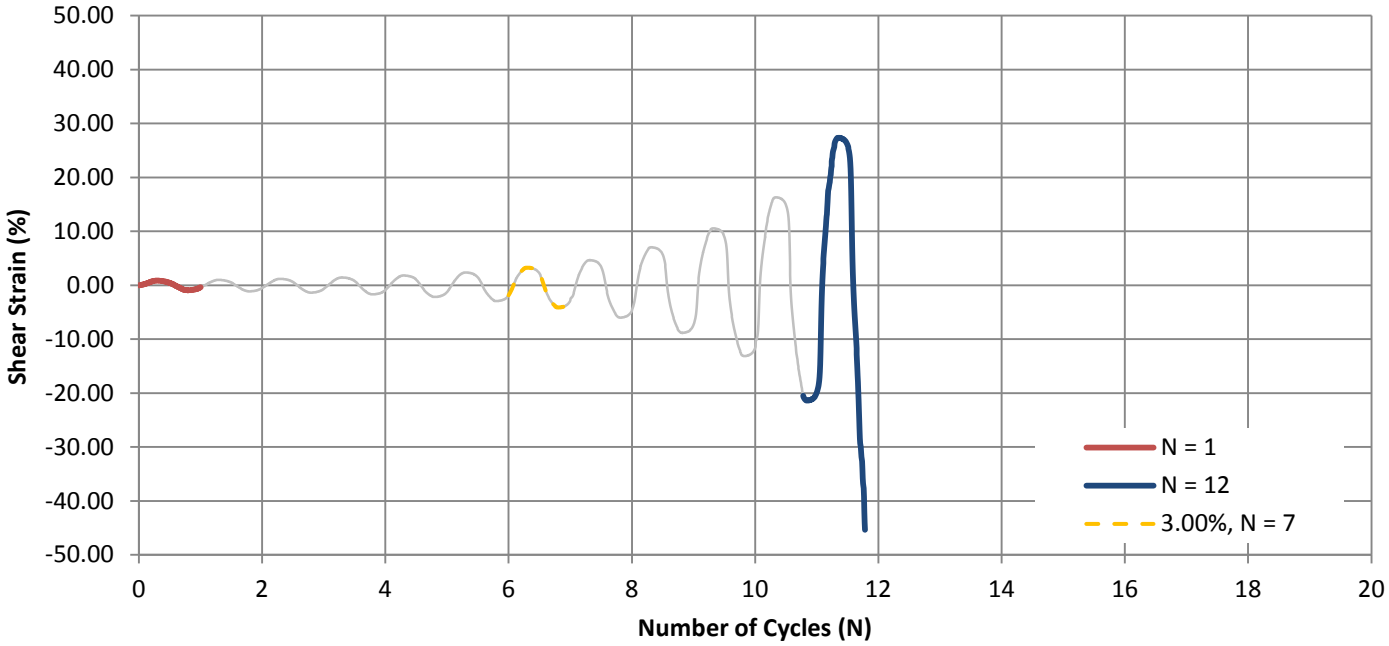
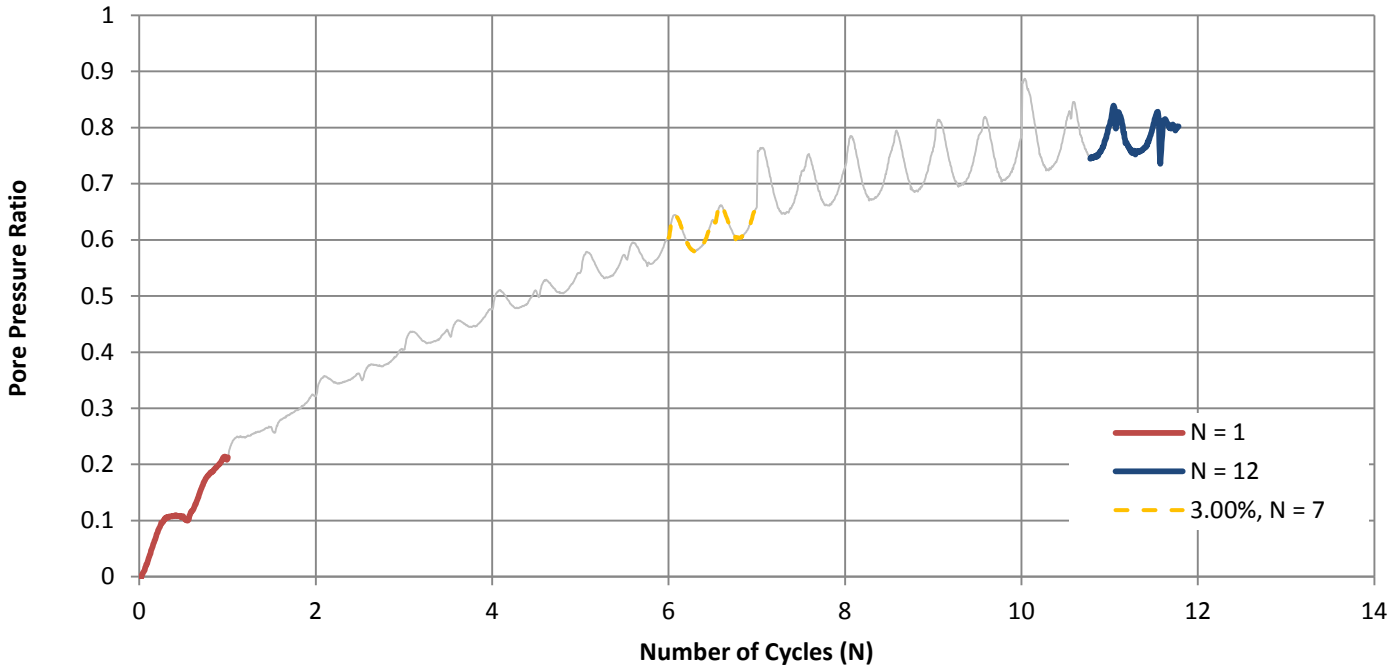
Project:	Annacis Island WWTP	**Test ID:**	490kPa, 0.20 CSR
Location:	Annacis Island, Delta	**Depth (m):**	51.38-51.44
Client:	CDM Smith	**Lab ID No:**	134





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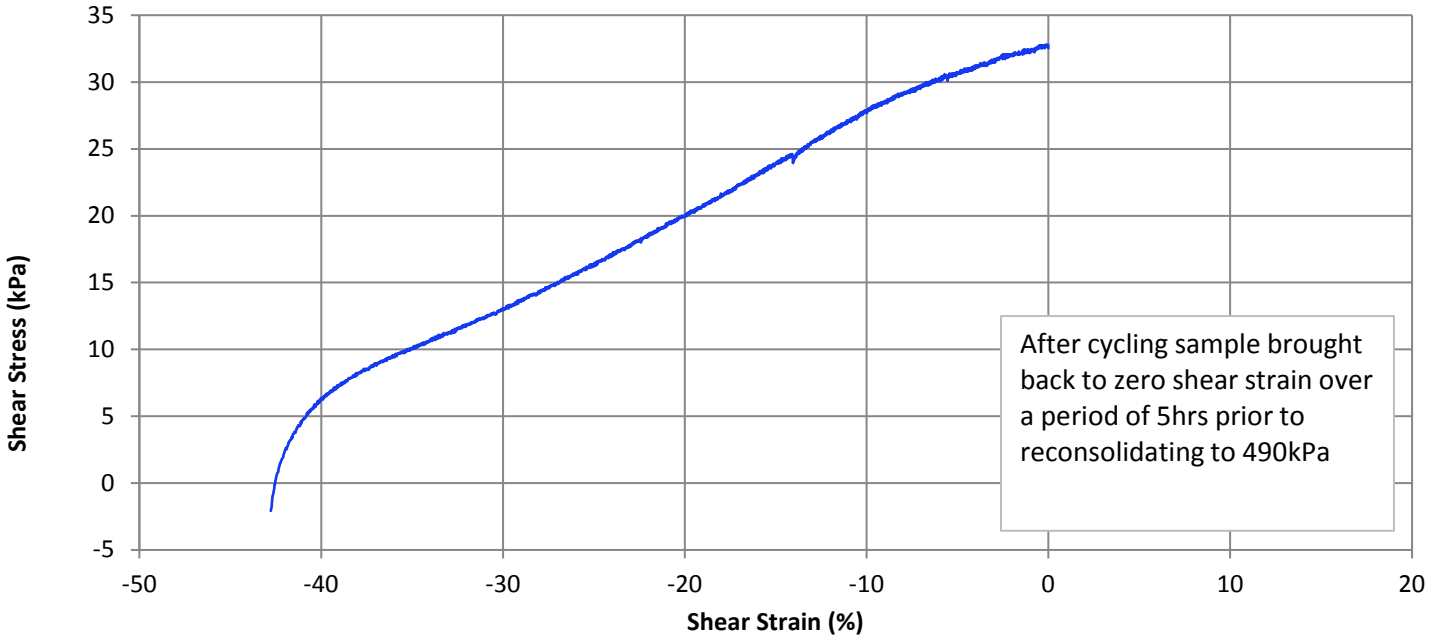
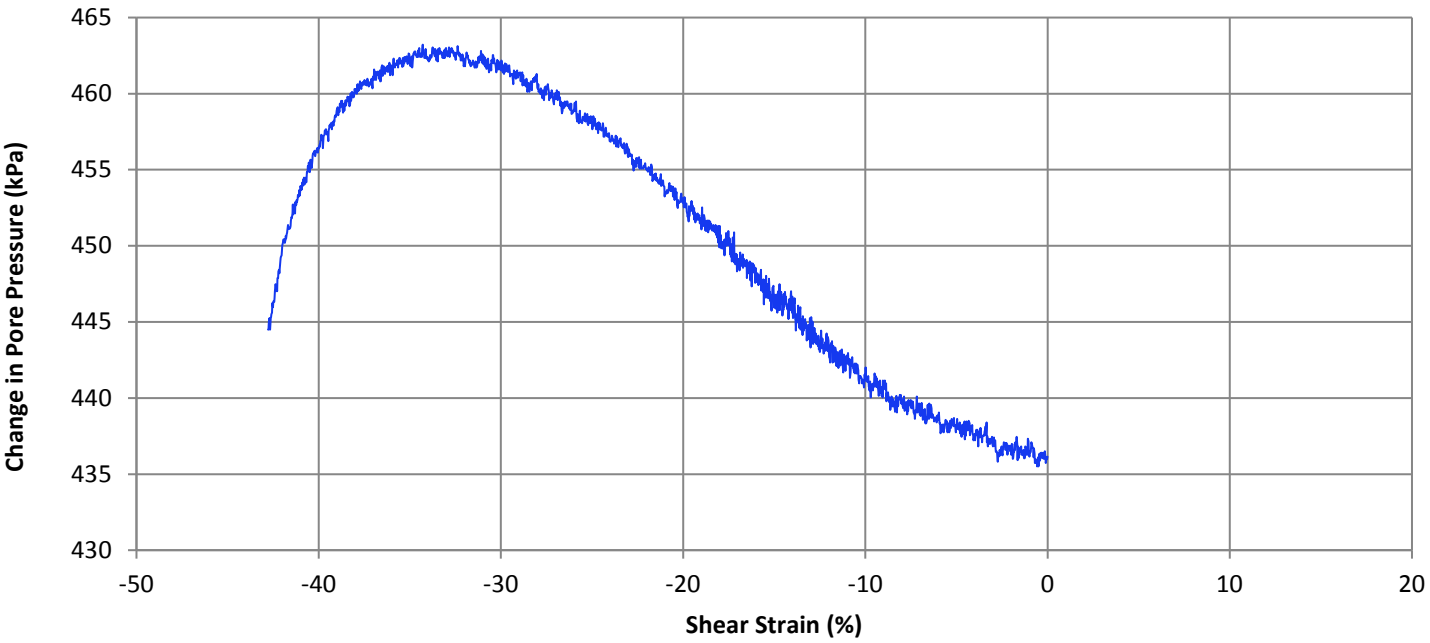
Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 34
Project:	Annacis Island WWTP	**Test ID:**	490kPa, 0.20 CSR
Location:	Annacis Island, Delta	**Depth (m):**	51.38-51.44
Client:	CDM Smith	**Lab ID No:**	134





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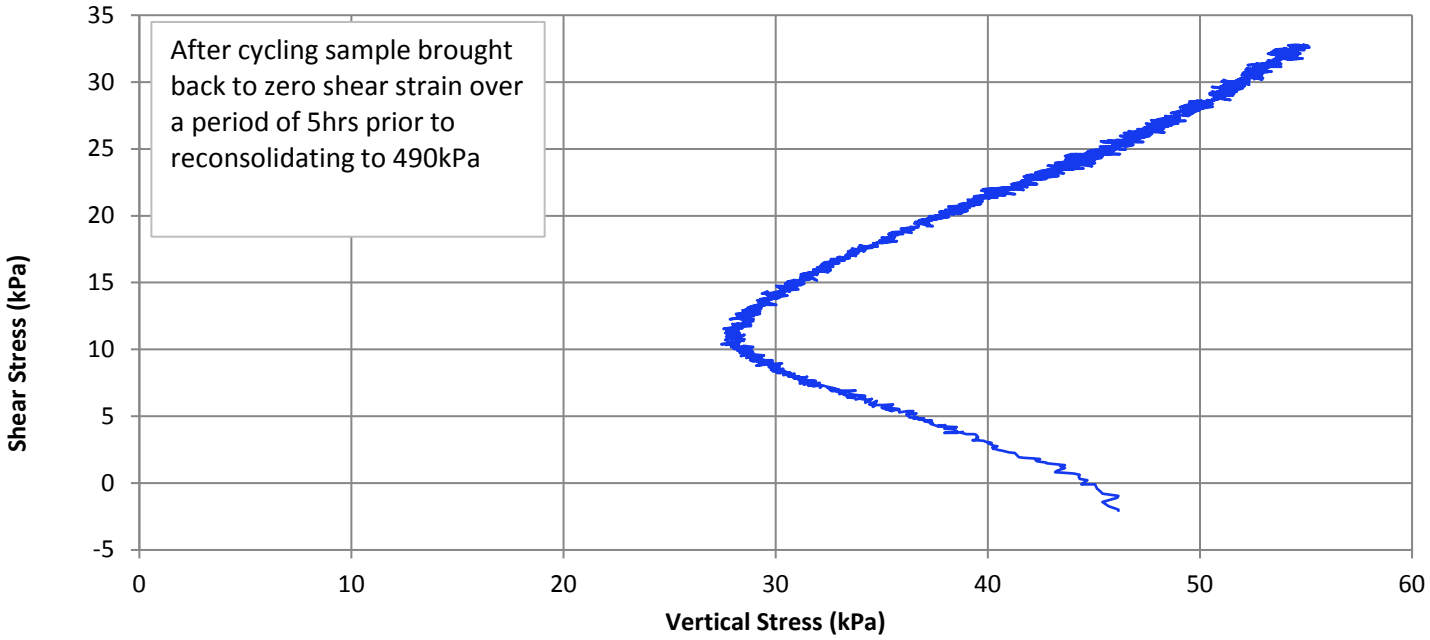
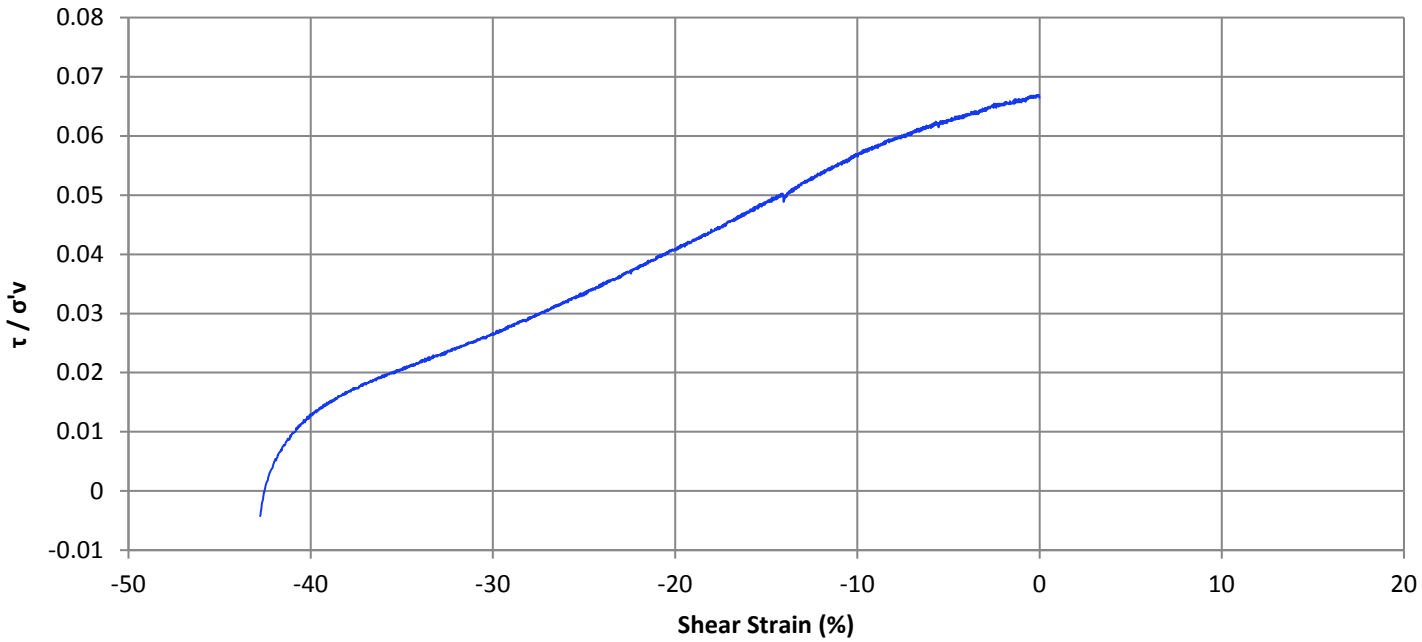
Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 34
Project:	Annacis Island WWTP	**Test ID:**	490kPa, 0.20 CSR
Location:	Annacis Island, Delta	**Depth (m):**	51.38-51.44
Client:	CDM Smith	**Lab ID No:**	134





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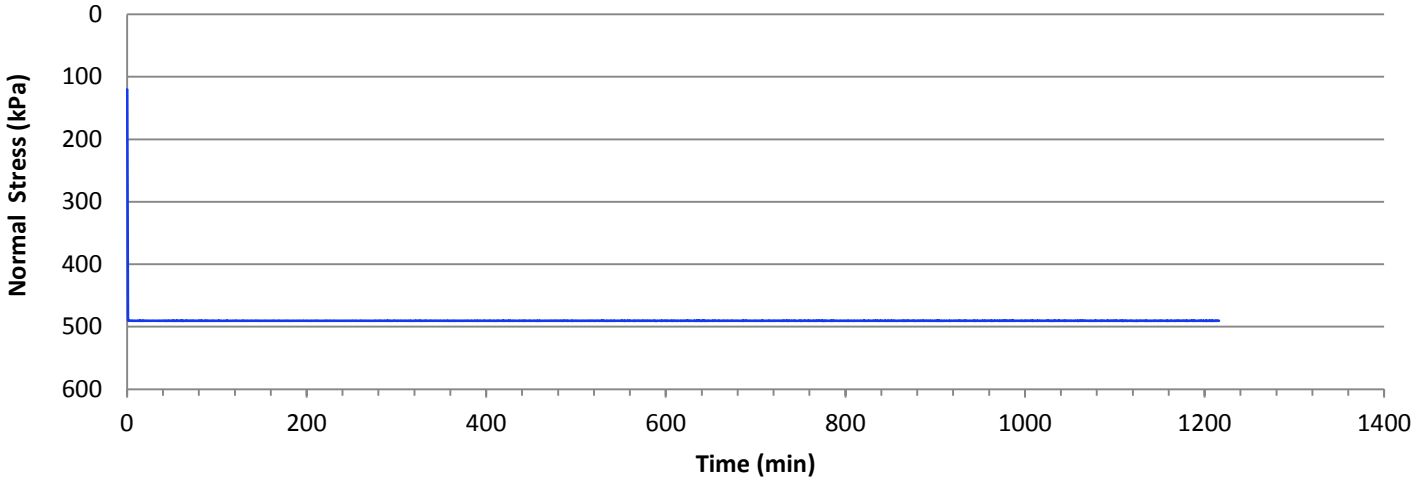
NORSOK G-001

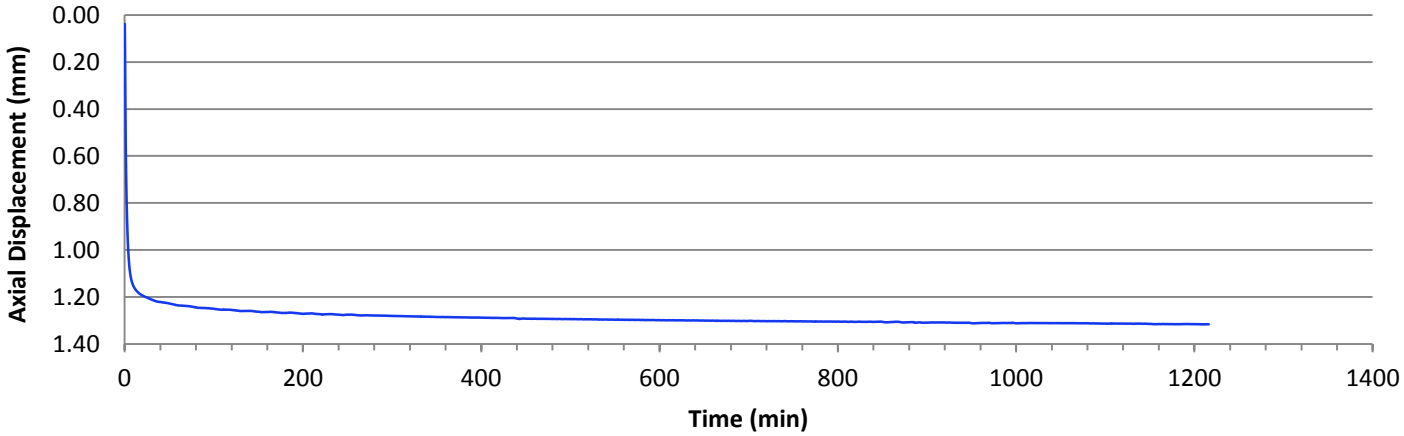
Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 34
Project:	Annacis Island WWTP	**Test ID:**	490kPa, 0.20 CSR
Location:	Annacis Island, Delta	**Depth (m):**	51.38-51.44
Client:	CDM Smith	**Lab ID No:**	134

Stress at Start of Reconsolidation (kPa)	46.15
Stress at end of Reconsolidation (kPa)	490.37
Axial Strain at end of Reconsolidation (%)	5.93
Change in Height ΔH_c (mm)	1.32

Comments
Reconsolidation data calculated from the sample height at end of initial consolidation

Increment (kPa)	490						
Load (kN)	1.9142						
Duration (min)	1216						
Axial Strain (%)	5.93						





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NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 34
Project:	Annacis Island WWTP	**Test ID:**	490kPa, 0.20 CSR
Location:	Annacis Island, Delta	**Depth (m):**	51.38-51.44
Client:	CDM Smith	**Lab ID No:**	134






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G. Patton	May 24, 2016	M. Sanin	June 7, 2016
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd.
300, 3811 North Fraser Way, Burnaby, British Columbia, Canada V5J 5J2
Tel: 604-412-6899 Fax: 604-412-6816 www.golder.com

Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 34
Project:	Annacis Island WWTP	**Test ID:**	491kPa, 0.11CSR
Location:	Annacis Island, Delta	**Depth (m):**	51.31-51.38
Client:	CDM Smith	**Lab ID No:**	134

General Remarks

Equipment Description: GDS - Station 2

Vertical LVDT	Serial No.:	11897
Vertical Load Cell	Serial No.:	38408
Shear Load Cell	Serial No.:	158877

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.47
Diameter (mm)	70.56
Area (cm^2)	39.10
Volume (cm^3)	91.77
Specific Gravity (Assumed)	2.71

Visual Description	silty CLAY; trace shell fragments; dark grey, cohesive, w > PL, soft-firm		
Sand Fraction (%)	N/A	Liquid Limit	36
Fines Fraction (%)	N/A	Plastic Limit	23
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	179.39	Initial Water Content (%)	31.17
Dry Mass (g)	136.76	Initial Saturation (%)	>100
Initial Wet Unit Weight (kN/m^3)	19.18	Final Water Content (%)	31.44
Initial Dry Unit Weight (kN/m^3)	14.62	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	491.00	Max. Axial Strain %	5.82
Max Applied Vertical Stress (kPa)	491.94	Axial Strain at end of Consol. %	5.81
Vertical Stress at end of Consol (kPa)	491.45	Change in Height ΔH_c (mm)	1.36
Laboratory OCR	N/A		

Cyclic Test Results

Frequency (Hz)	0.10
CSR	0.11
Cycles to 3.00% Shear Strain	Failure not reached
Initial Vertical Stress (kPa)	493.57
Max Cyclic Shear Stress (kPa)	53.99
Max. Shear Strain at N= n/a (zero load)	Failure not reached
Min. Shear Strain at N= n/a (zero load)	Failure not reached
Max. DU at N= n/a (zero load)	Failure not reached
Min. DU at N= n/a (zero load)	Failure not reached

Post Cyclic Reconsolidation Results

Stress at Start of Reconsolidation (kPa)	380.31
Stress at End of Reconsolidation (kPa)	491.40
Max. Axial Strain %	0.38
Change in Height ΔH_c (mm)	0.08

**Reconsolidation data calculated from the sample height at end of initial consolidation*

Comments / Special Instructions

A maximum of 60 cycles applied to sample. Sample did not reach target shear strain of 3% or 90% excess PWP.

Comments / Special Instructions

After cycling sample brought back to zero shear strain over a period of 1hr prior to reconsolidating to 491kPa

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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

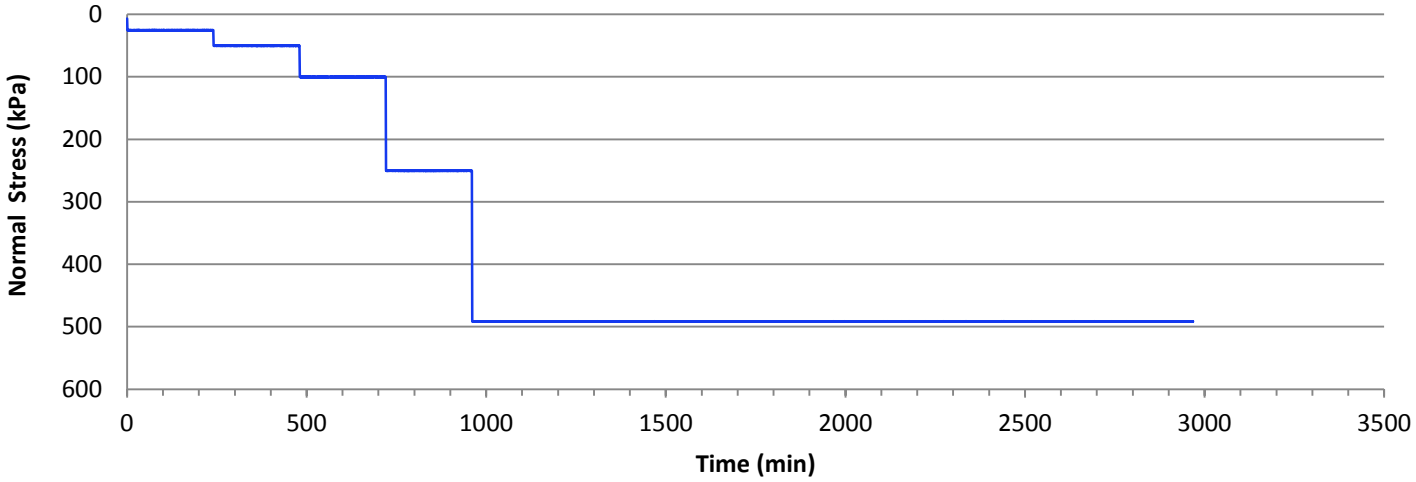
Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 34
Project:	Annacis Island WWTP	**Test ID:**	491kPa, 0.11CSR
Location:	Annacis Island, Delta	**Depth (m):**	51.31-51.38
Client:	CDM Smith	**Lab ID No:**	134

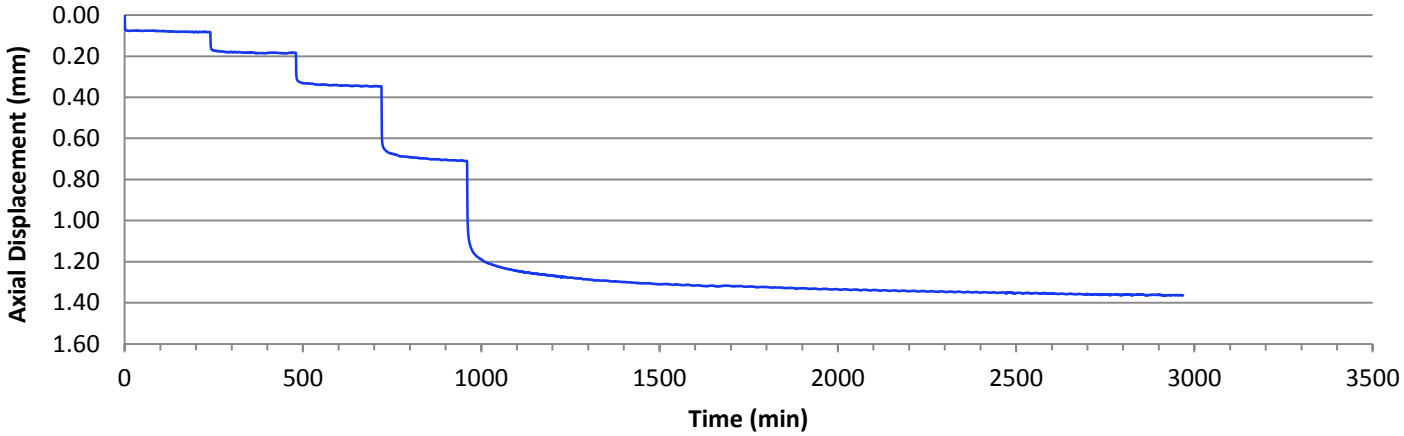
Consolidation Summary

Stress at end of Consolidation (kPa)	491.45
Axial Strain at end of Consolidation (%)	5.81
OCR	N/A
Change in Height ΔH_c (mm)	1.36

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	491		
Load (kN)	0.1006	0.1986	0.3944	0.9808	1.9236		
Duration (min)	240	240	240	240	2008		
Axial Strain (%)	0.36	0.80	1.48	3.03	5.82		





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NORSOK G-001

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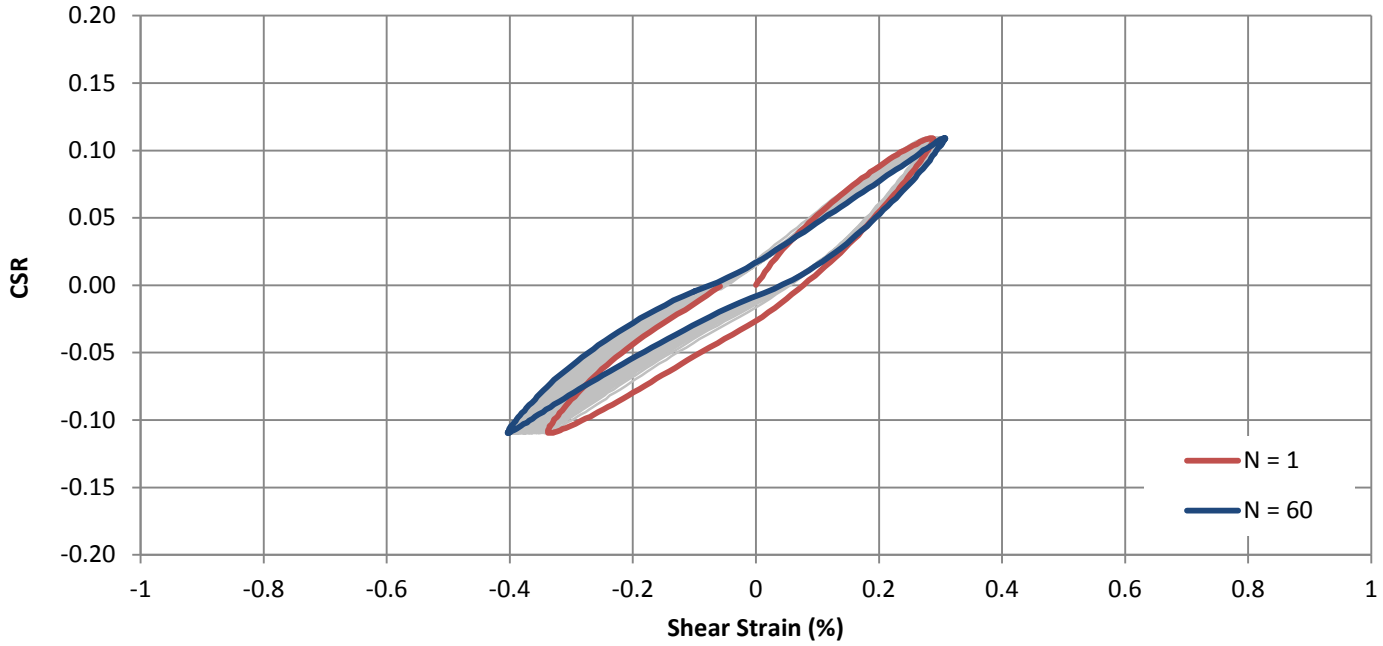
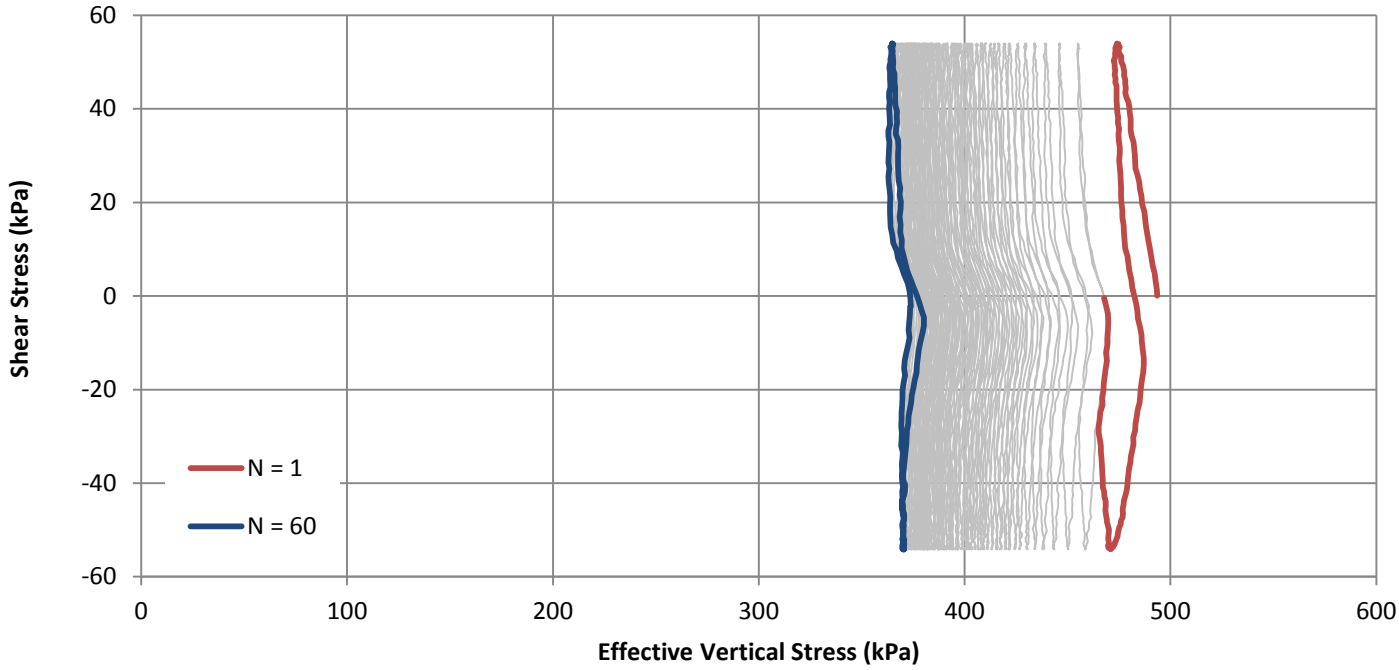
Project:	Annacis Island WWTP	**Test ID:**	491kPa, 0.11CSR
Location:	Annacis Island, Delta	**Depth (m):**	51.31-51.38
Client:	CDM Smith	**Lab ID No:**	134





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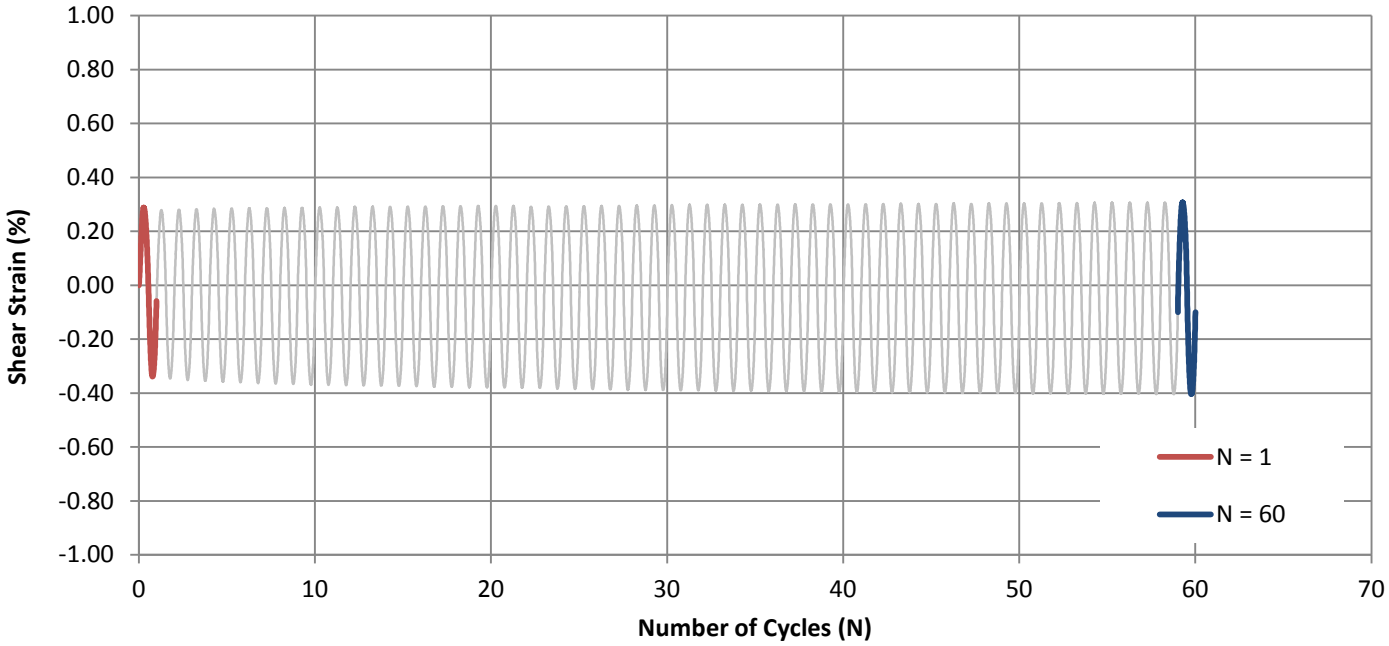
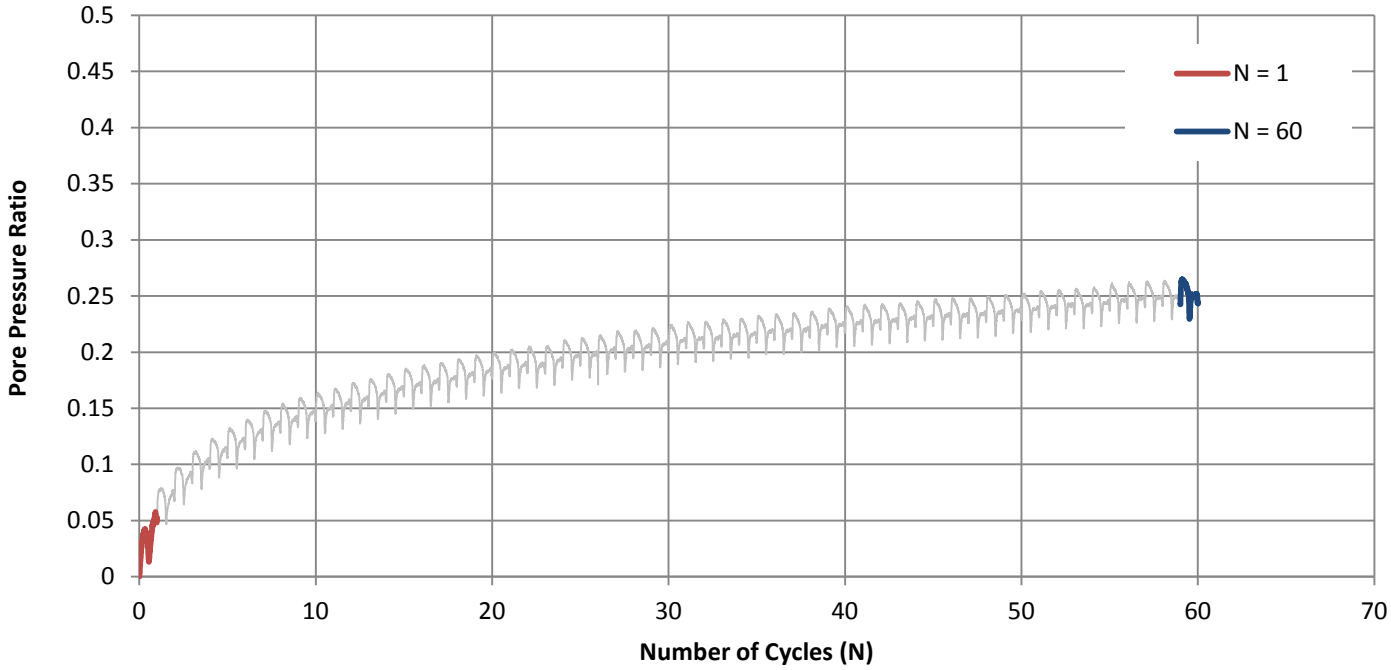
Location:	Annacis Island, Delta	**Depth (m):**	51.31-51.38
Client:	CDM Smith	**Lab ID No:**	134





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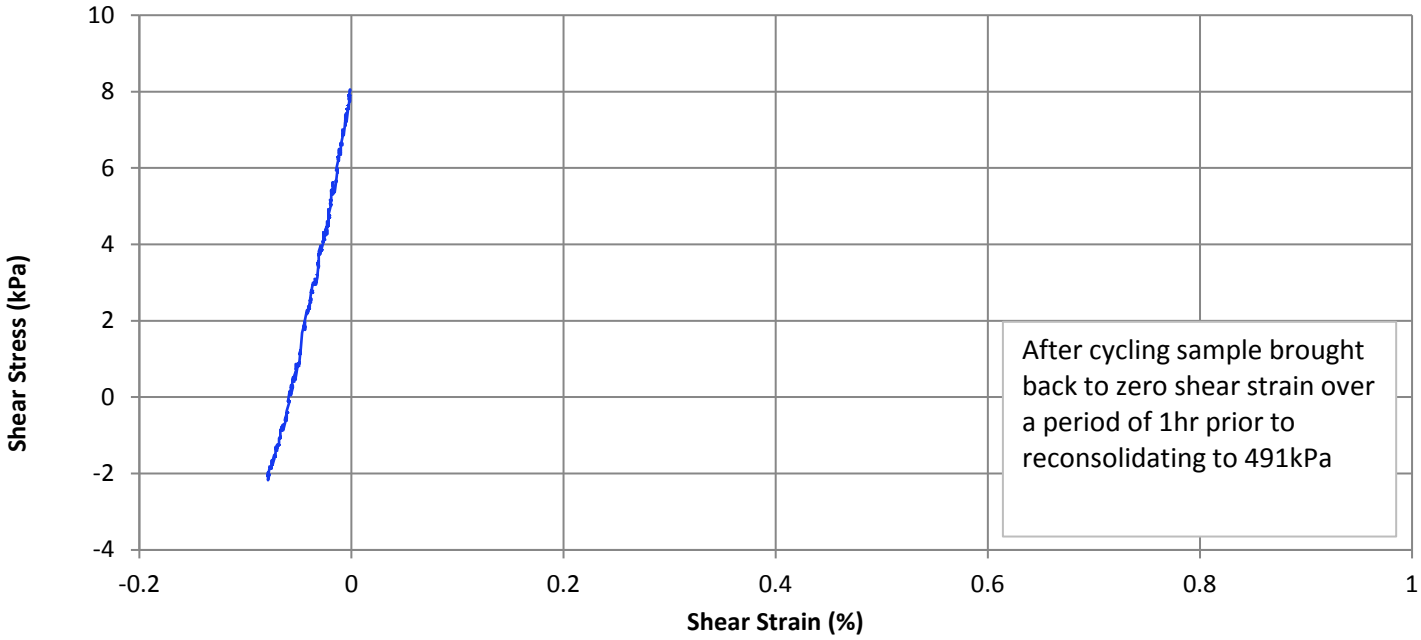
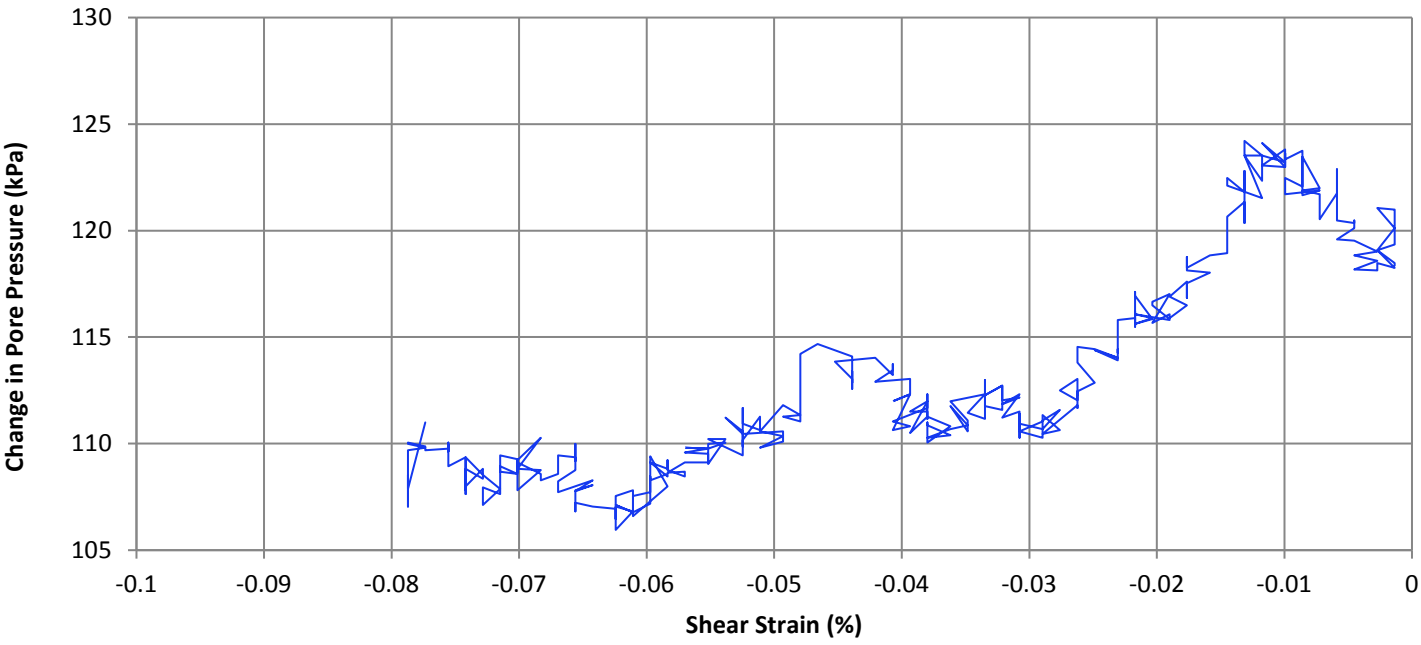
Location:	Annacis Island, Delta	**Depth (m):**	51.31-51.38
Client:	CDM Smith	**Lab ID No:**	134





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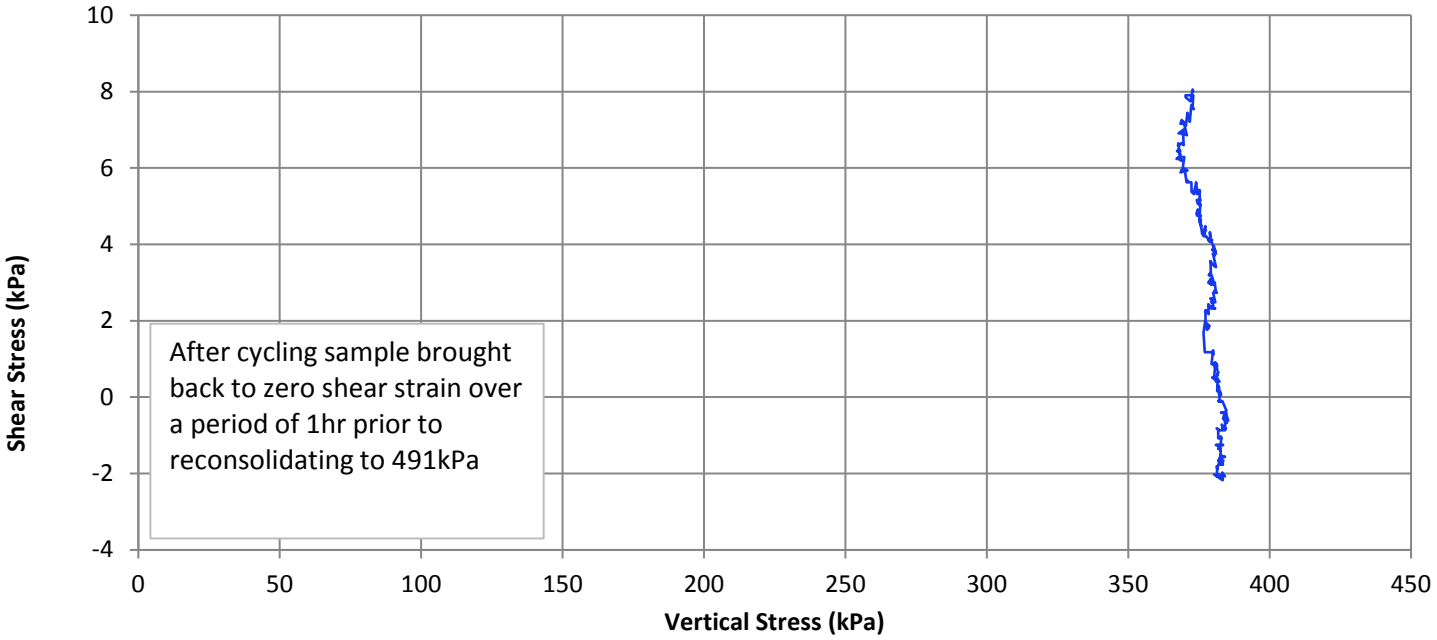
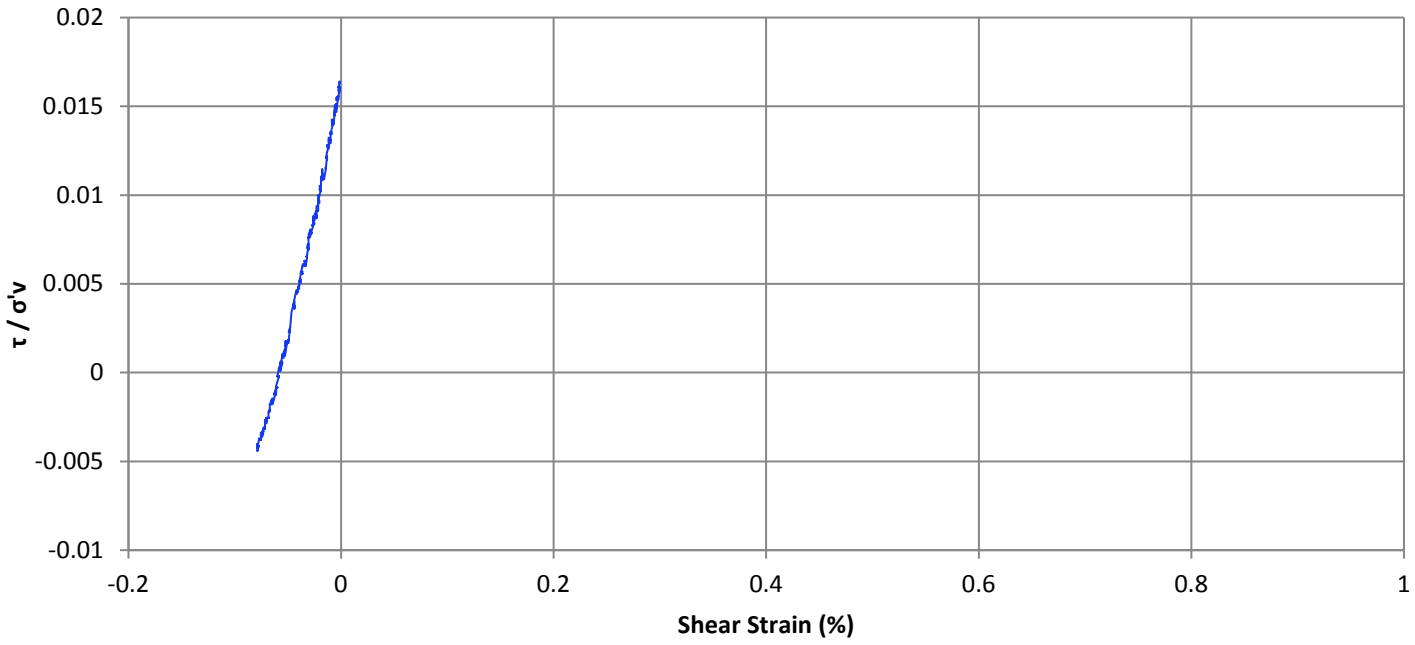
Location:	Annacis Island, Delta	**Depth (m):**	51.31-51.38
Client:	CDM Smith	**Lab ID No:**	134





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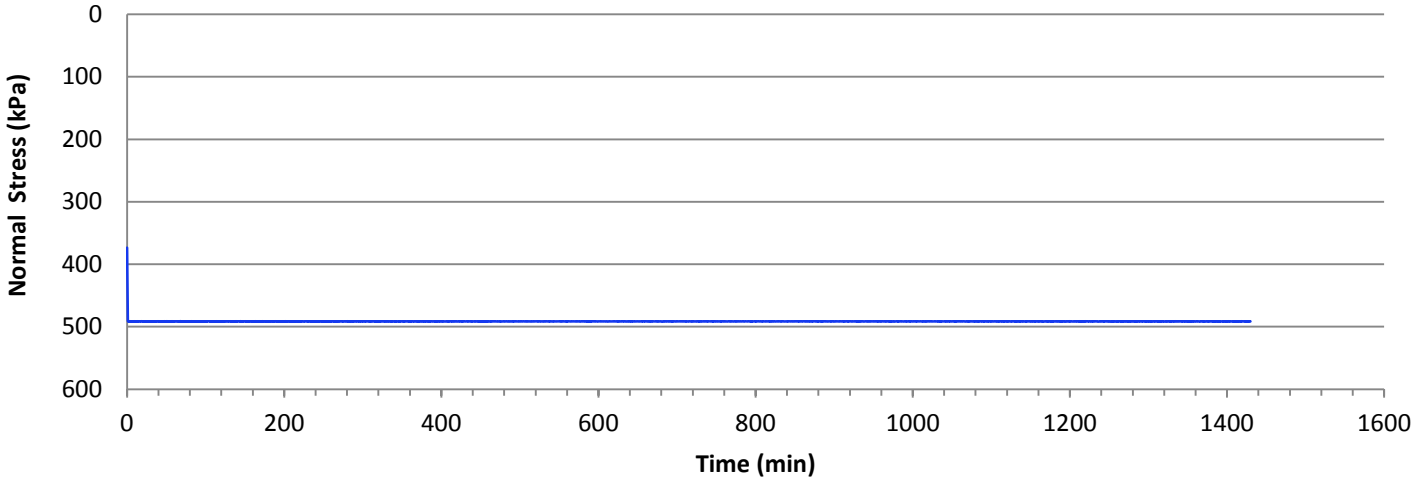
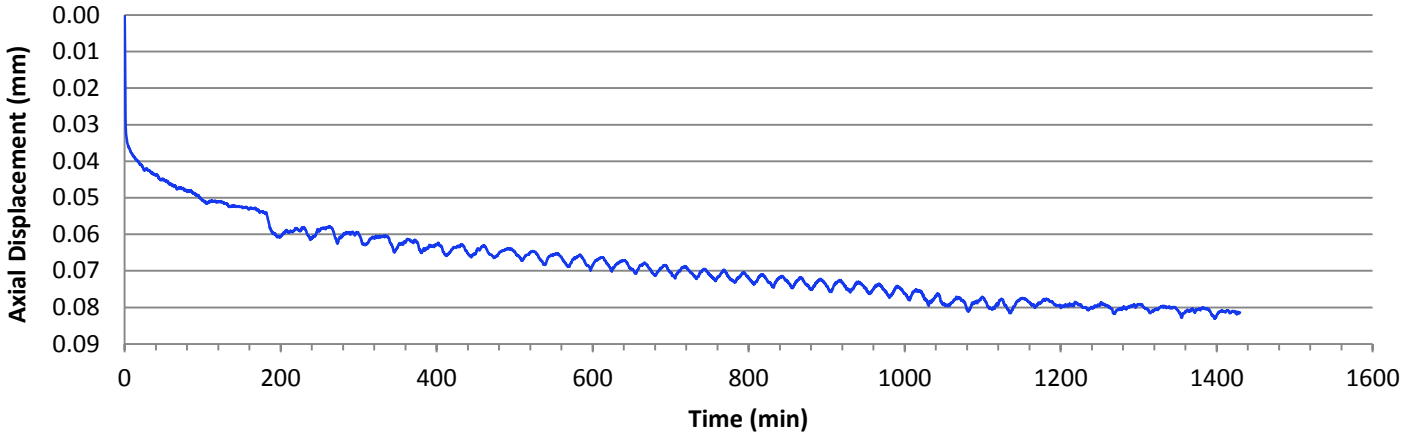
Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 34
Project:	Annacis Island WWTP	**Test ID:**	491kPa, 0.11CSR
Location:	Annacis Island, Delta	**Depth (m):**	51.31-51.38
Client:	CDM Smith	**Lab ID No:**	134

Stress at Start of Reconsolidation (kPa)	380.31
Stress at end of Reconsolidation (kPa)	491.40
Axial Strain at end of Reconsolidation (%)	0.38
Change in Height ΔH_c (mm)	0.08

Comments
Reconsolidation data calculated from the sample height at end of initial consolidation

Increment (kPa)	491						
Load (kN)	1.9231						
Duration (min)	1430						
Axial Strain (%)	0.38						





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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 34
Project:	Annacis Island WWTP	**Test ID:**	491kPa, 0.11CSR
Location:	Annacis Island, Delta	**Depth (m):**	51.31-51.38
Client:	CDM Smith	**Lab ID No:**	134








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GOLDER ASSOC
08 MAY 2016
1525010
BH 16-03 S 35
10
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30
35
Static Direct
Simple
Shear Test
BH16-03
SA35


GOLDER ASSOC
08 MAY 2016
1525010
BH16-03 S35
Cyclic Direct Simple
Shear Test
BH16-03 SA35
CSR = 0.12
35
40
50
60
70

Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 35
Project:	Annacis Island WWTP	**Test ID:**	505kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	53.24-53.29
Client:	CDM Smith	**Lab ID No:**	134

General Remarks

Equipment Description: GDS - Station 1

Vertical LVDT	Serial No.:	113179
Vertical Load Cell	Serial No.:	89612
Shear Load Cell	Serial No.:	30465

Sample Properties

Preparation Method	Moist Tamping
Height (mm)	23.52
Diameter (mm)	70.50
Area (cm^2)	39.04
Volume (cm^3)	91.81
Specific Gravity (Assumed)	2.71

Visual Description	CLAY; trace silt; dark grey, cohesive, w > PL, firm		
Sand Fraction (%)	N/A	Liquid Limit	42
Fines Fraction (%)	N/A	Plastic Limit	21
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	174.91	Initial Water Content (%)	35.38
Dry Mass (g)	129.2	Initial Saturation (%)	>100
Initial γ_{wet} (kN/m^3)	18.69	Final Water Content (%)	33.42
Initial γ_{dry} (kN/m^3)	13.80	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	505.00	Max. Axial Strain %	7.78
Max Applied Vertical Stress (kPa)	505.33	Axial Strain at end of Consol. %	7.77
Vertical Stress at end of Consol (kPa)	504.92	Change in Height ΔH_c (mm)	1.83
Laboratory OCR	N/A		

Direct Simple Shear Test Results

Initial Vertical Stress (kPa)	504.86	Peak Shear Strength (kPa)	101.73
Initial Shear Stress (kPa)	0.18	Excess Pore Pressure at Peak (kPa)	306.13
Applied Shear Bias (kPa)	0.00	Ratio of Peak / $\sigma'v$	0.20
Rate of Shearing (%/hr)	5.00	Maximum Shear Strain γ_{MAX} (%)	20.00
Test Condition	Undrained	Shear Strength at γ_{MAX} (kPa)	90.66

Comments / Special Instructions

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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

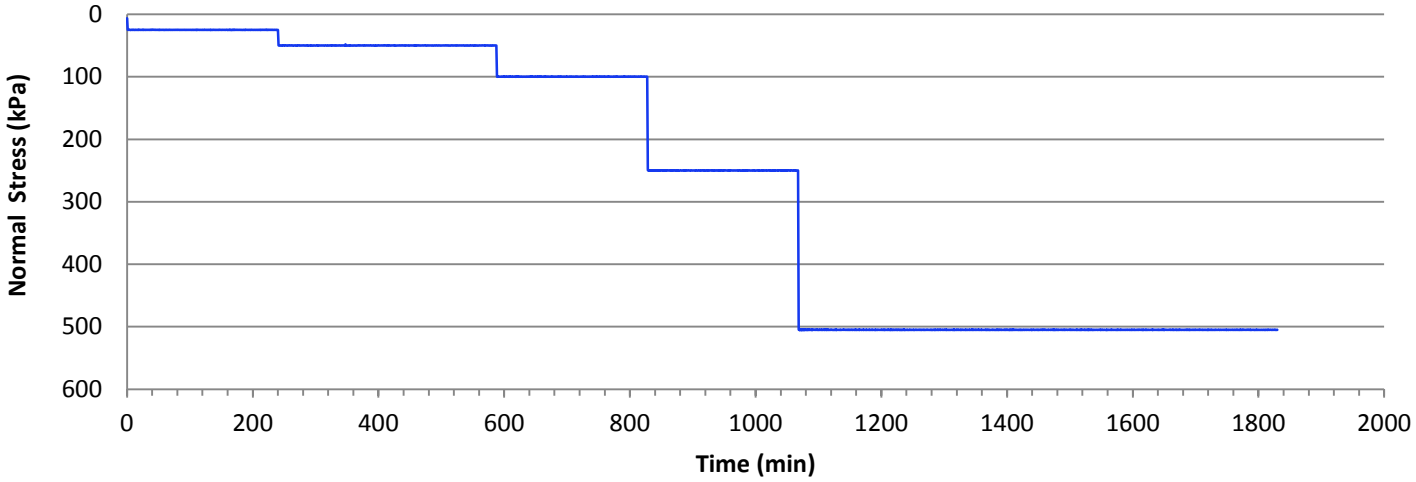
Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 35
Project:	Annacis Island WWTP	**Test ID:**	505kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	53.24-53.29
Client:	CDM Smith	**Lab ID No:**	134

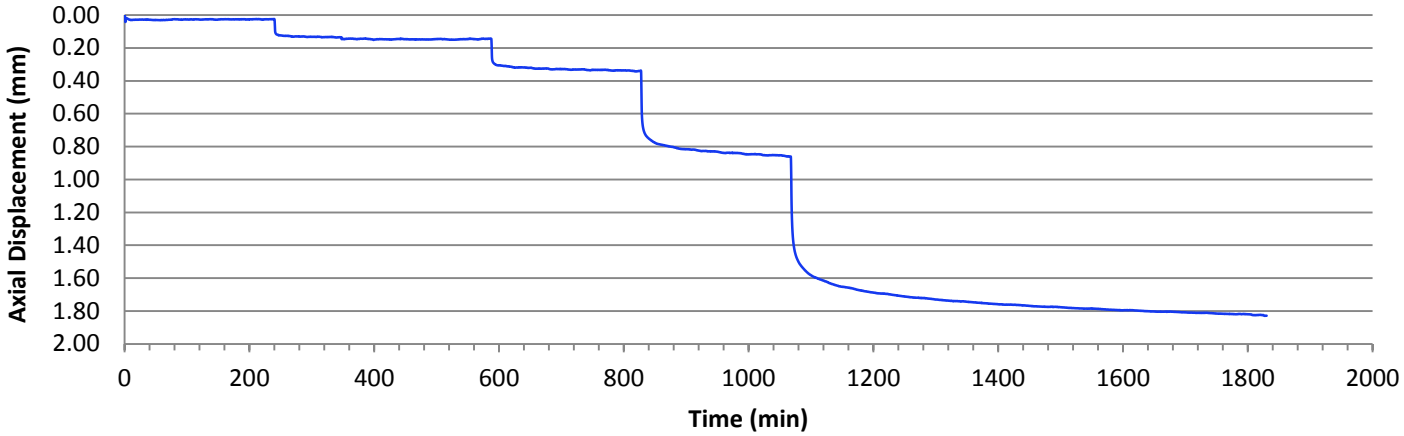
Consolidation Summary

Stress at end of Consolidation (kPa)	504.92
Axial Strain at end of Consolidation (%)	7.77
OCR	N/A
Change in Height ΔH_c (mm)	1.83

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	505		
Load (kN)	0.0978	0.1955	0.3908	0.9767	1.9726		
Duration (min)	240	347	240	240	763		
Axial Strain (%)	0.18	0.64	1.46	3.66	7.78		





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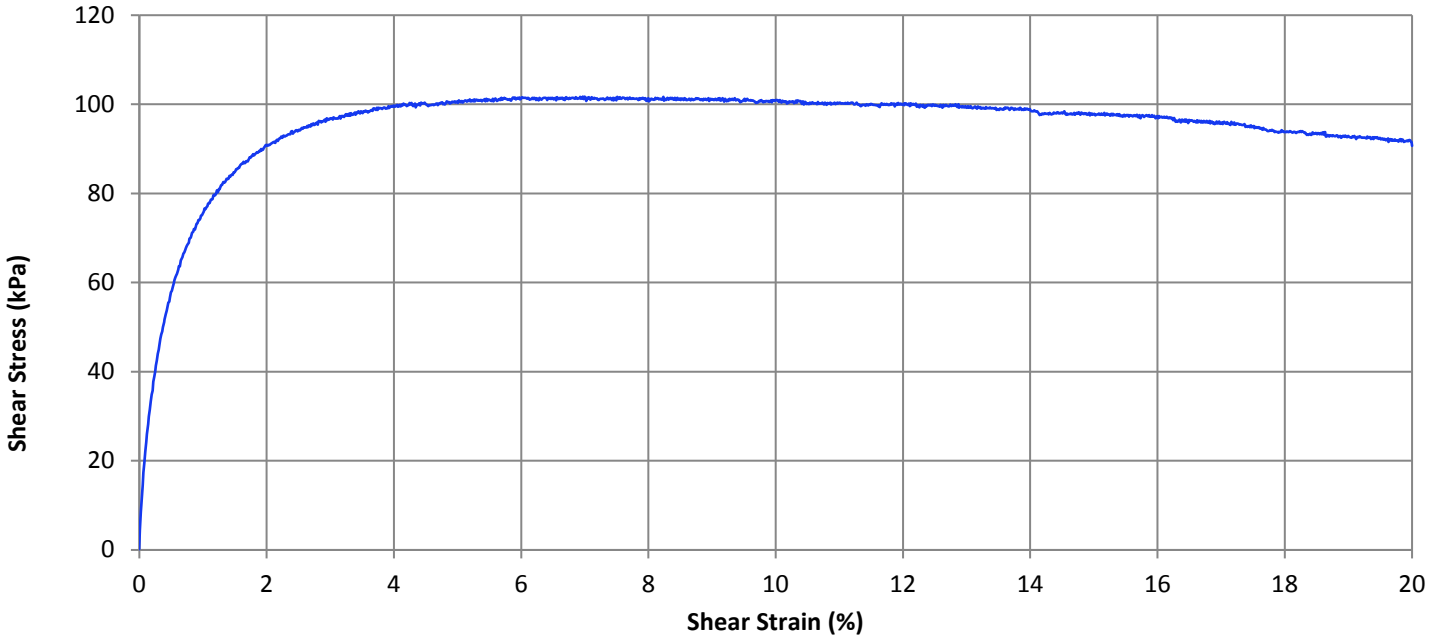
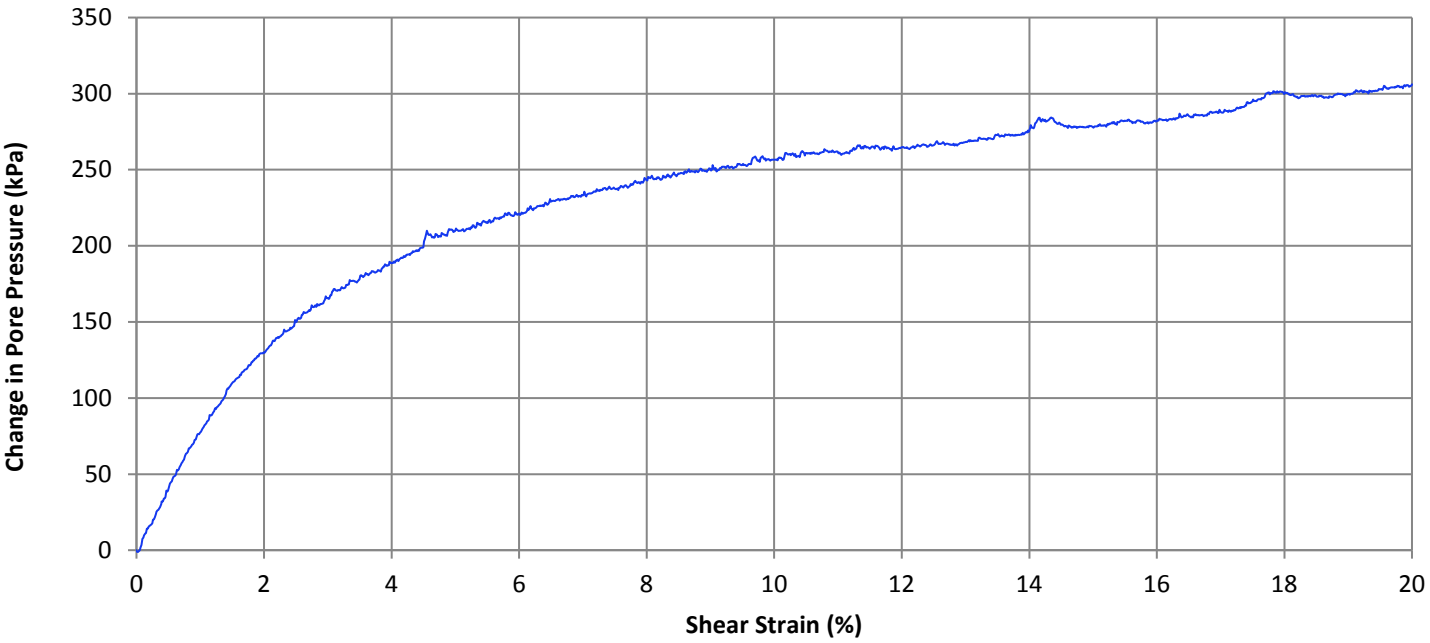
Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 35
Project:	Annacis Island WWTP	**Test ID:**	505kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	53.24-53.29
Client:	CDM Smith	**Lab ID No:**	134





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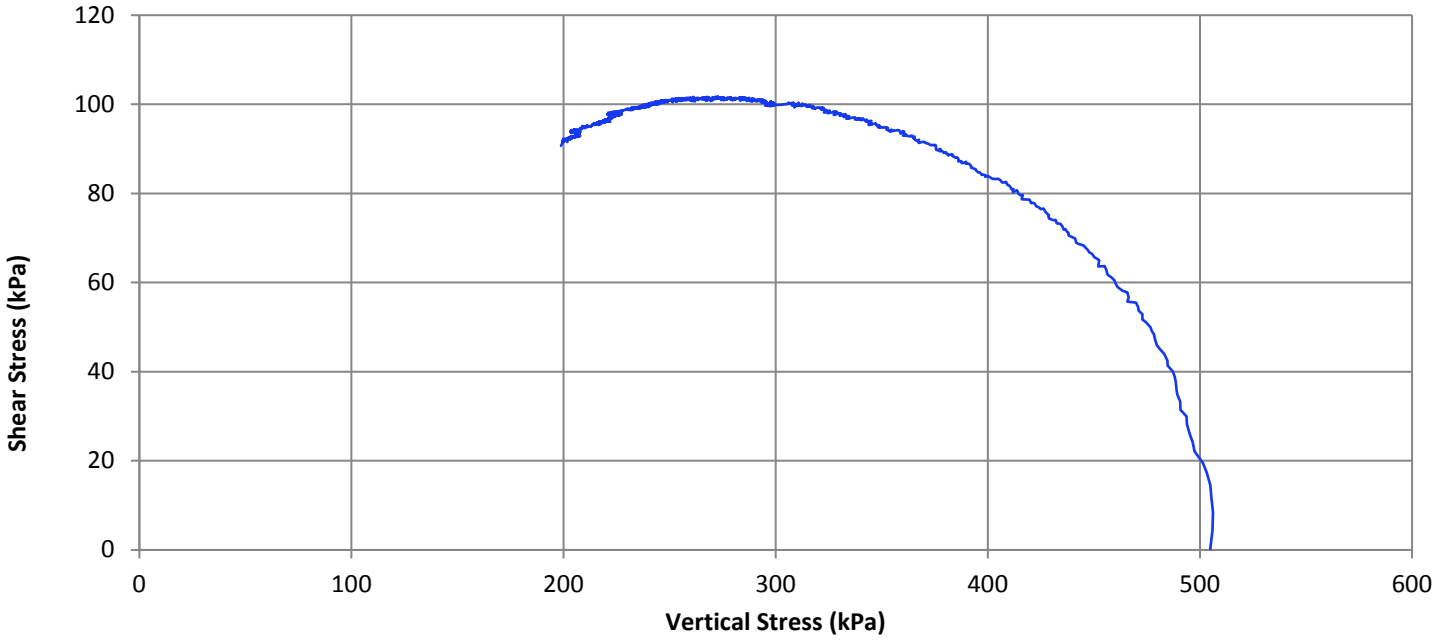
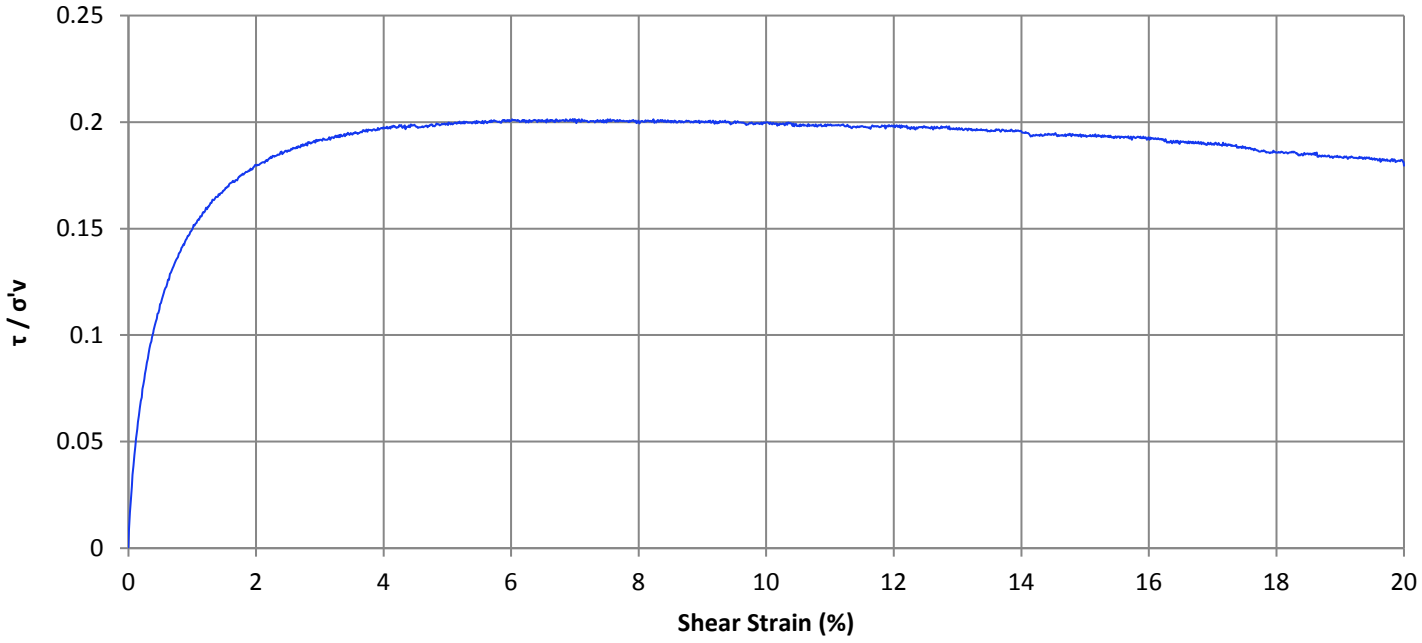
Client:	CDM Smith	**Lab ID No:**	134





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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 35
Project:	Annacis Island WWTP	**Test ID:**	505kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	53.24-53.29
Client:	CDM Smith	**Lab ID No:**	134









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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 35
Project:	Annacis Island WWTP	**Test ID:**	505kPa, 0.12 CSR
Location:	Annacis Island, Delta	**Depth (m):**	53.29-53.34
Client:	CDM Smith	**Lab ID No:**	134

General Remarks

Equipment Description: GDS - Station 3

Vertical LVDT	Serial No.:	11894
Vertical Load Cell	Serial No.:	38407
Shear Load Cell	Serial No.:	158879

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.56
Diameter (mm)	70.52
Area (cm^2)	39.06
Volume (cm^3)	92.02
Specific Gravity (Measured)	2.71

Visual Description	CLAY; trace silt; dark grey, cohesive, w > PL, firm		
Sand Fraction (%)	N/A	Liquid Limit	42
Fines Fraction (%)	N/A	Plastic Limit	21
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	170.3	Initial Water Content (%)	38.37
Dry Mass (g)	123.08	Initial Saturation (%)	>100
Initial Wet Unit Weight (kN/m^3)	18.15	Final Water Content (%)	36.07
Initial Dry Unit Weight (kN/m^3)	13.12	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	505.00	Max. Axial Strain %	7.69
Max Applied Vertical Stress (kPa)	505.45	Axial Strain at end of Consol. %	7.67
Vertical Stress at end of Consol (kPa)	504.96	Change in Height ΔH_c (mm)	1.81
Laboratory OCR	N/A		

Cyclic Test Results

Frequency (Hz)	0.10
CSR	0.12
Cycles to 3.00% Shear Strain	Failure not reached
Initial Vertical Stress (kPa)	505.09
Max Cyclic Shear Stress (kPa)	60.65
Max. Shear Strain at N= n/a (zero load)	Failure not reached
Min. Shear Strain at N= n/a (zero load)	Failure not reached
Max. DU at N= n/a (zero load)	Failure not reached
Min. DU at N= n/a (zero load)	Failure not reached

Post Cyclic Reconsolidation Test Results

Stress at Start of Reconsolidation (kPa)	285.62
Stress at End of Reconsolidation (kPa)	505.04
Max. Axial Strain %	0.94
Change in Height ΔH_c (mm)	0.20

**Reconsolidation data calculated from the sample height at end of initial consolidation*

Comments / Special Instructions

Sample did not reach target shear strain of 3% or 90% excess PWP.

Comments / Special Instructions

After cycling sample brought back to zero shear strain over a period of 1hr prior to reconsolidating to 505kPa

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G. Patton	May 27, 2016	M. Sanin	June 7, 2016
TESTED BY	DATE	CHECKED BY	DATE

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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

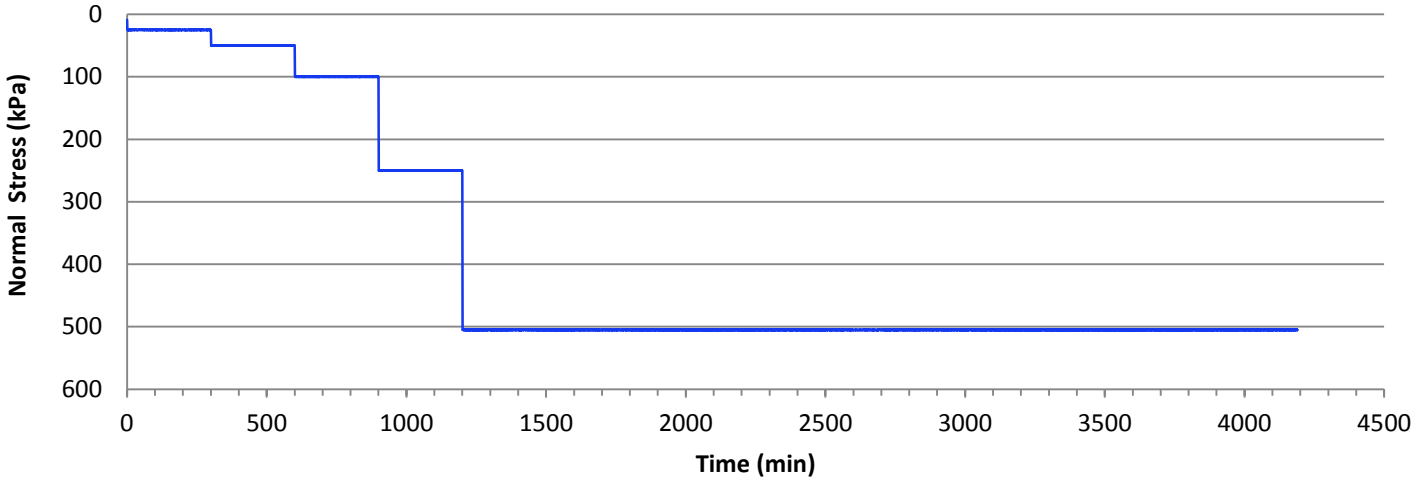
Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 35
Project:	Annacis Island WWTP	**Test ID:**	505kPa, 0.12 CSR
Location:	Annacis Island, Delta	**Depth (m):**	53.29-53.34
Client:	CDM Smith	**Lab ID No:**	134

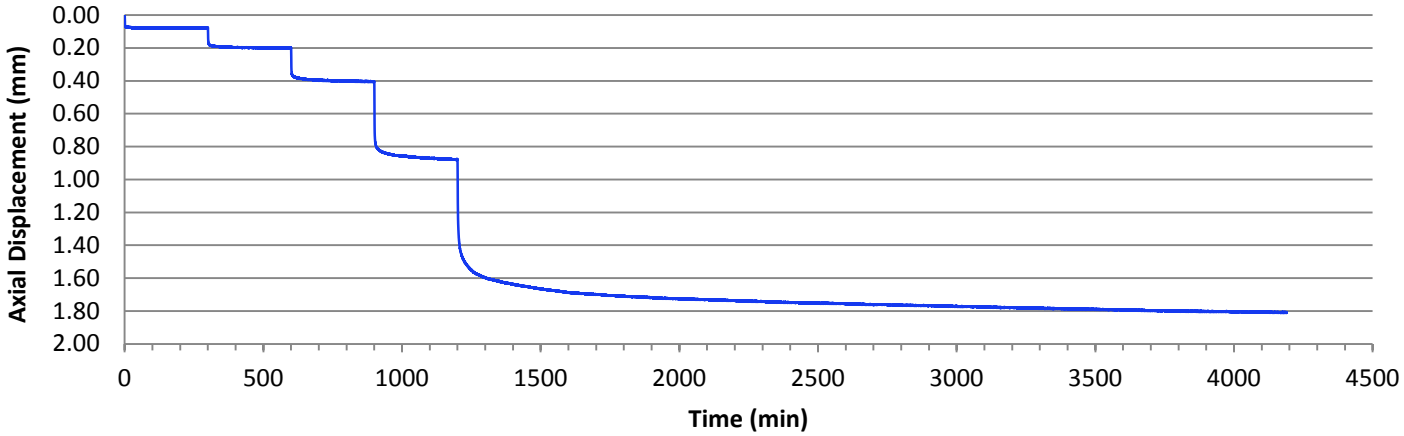
Consolidation Summary

Stress at end of Consolidation (kPa)	504.96
Axial Strain at end of Consolidation (%)	7.67
OCR	N/A
Change in Height ΔH_c (mm)	1.81

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	505		
Load (kN)	0.0985	0.1965	0.3918	0.9779	1.9742		
Duration (min)	300	300	300	300	2990		
Axial Strain (%)	0.35	0.87	1.72	3.75	7.69		





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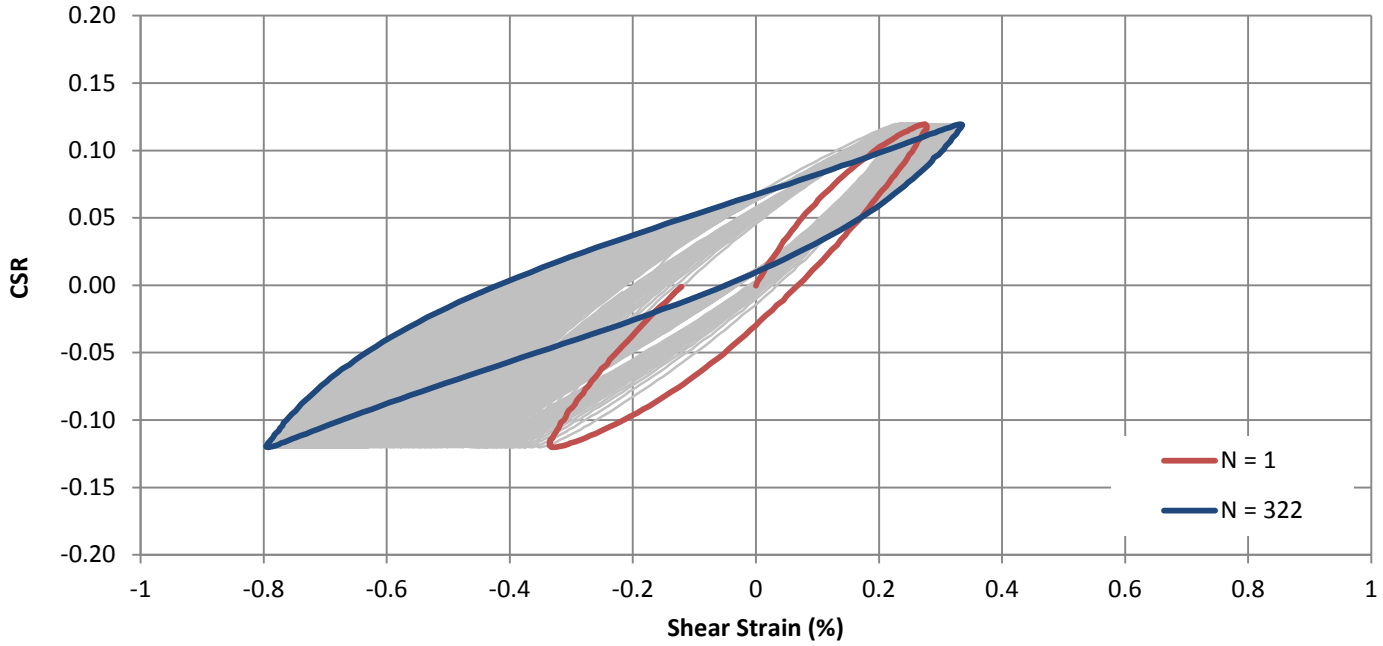
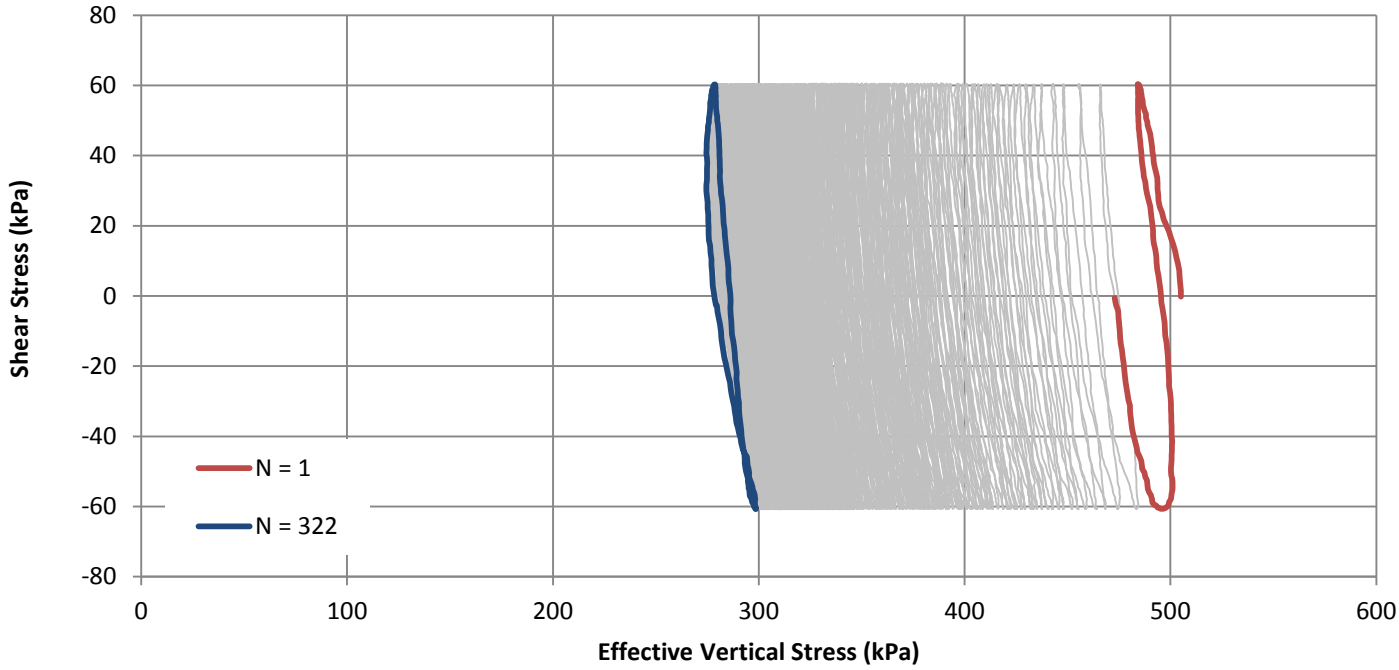
Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 35
Project:	Annacis Island WWTP	**Test ID:**	505kPa, 0.12 CSR
Location:	Annacis Island, Delta	**Depth (m):**	53.29-53.34
Client:	CDM Smith	**Lab ID No:**	134





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GOLDER ASSOC
08 MAY 2016
1525010

BH 16-03 S 41

10

20

Cyclic Direct Simple
Shear Test
BH16-03 SA41
CSR = 0.10

Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 41
Project:	Annacis Island WWTP	**Test ID:**	577kPa, 0.10CSR
Location:	Annacis Island, Delta	**Depth (m):**	61.17-61.22
Client:	CDM Smith	**Lab ID No:**	134

General Remarks

Equipment Description: GDS - Station 3

Vertical LVDT	Serial No.:	11894
Vertical Load Cell	Serial No.:	38407
Shear Load Cell	Serial No.:	158879

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.33
Diameter (mm)	70.51
Area (cm^2)	39.05
Volume (cm^3)	91.10
Specific Gravity (Assumed)	2.71

Visual Description	CLAY; trace silt; dark grey, cohesive, w > PL, firm		
Sand Fraction (%)	N/A	Liquid Limit	50
Fines Fraction (%)	N/A	Plastic Limit	25
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	172.73	Initial Water Content (%)	35.94
Dry Mass (g)	127.06	Initial Saturation (%)	>100
Initial Wet Unit Weight (kN/m^3)	18.60	Final Water Content (%)	36.03
Initial Dry Unit Weight (kN/m^3)	13.68	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	577.00	Max. Axial Strain %	7.21
Max Applied Vertical Stress (kPa)	577.40	Axial Strain at end of Consol. %	7.20
Vertical Stress at end of Consol (kPa)	577.22	Change in Height ΔH_c (mm)	1.68
Laboratory OCR	N/A		

Cyclic Test Results

Frequency (Hz)	0.10
CSR	0.10
Cycles to 3.00% Shear Strain	Failure not reached
Initial Vertical Stress (kPa)	577.12
Max Cyclic Shear Stress (kPa)	57.55
Max. Shear Strain at N= n/a (zero load)	Failure not reached
Min. Shear Strain at N= n/a (zero load)	Failure not reached
Max. DU at N= n/a (zero load)	Failure not reached
Min. DU at N= n/a (zero load)	Failure not reached

Post Cyclic Reconsolidation Results

Stress at Start of Reconsolidation (kPa)	508.59
Stress at End of Reconsolidation (kPa)	577.22
Max. Axial Strain %	0.21
Change in Height ΔH_c (mm)	0.04

**Reconsolidation data calculated from the sample height at end of initial consolidation*

Comments / Special Instructions

A maximum of 60 cycles applied to sample. Sample did not reach target shear strain of 3% or 90% excess PWP.

Comments / Special Instructions

After cycling sample brought back to zero shear strain over a period of 1hr prior to reconsolidating to 577kPa

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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

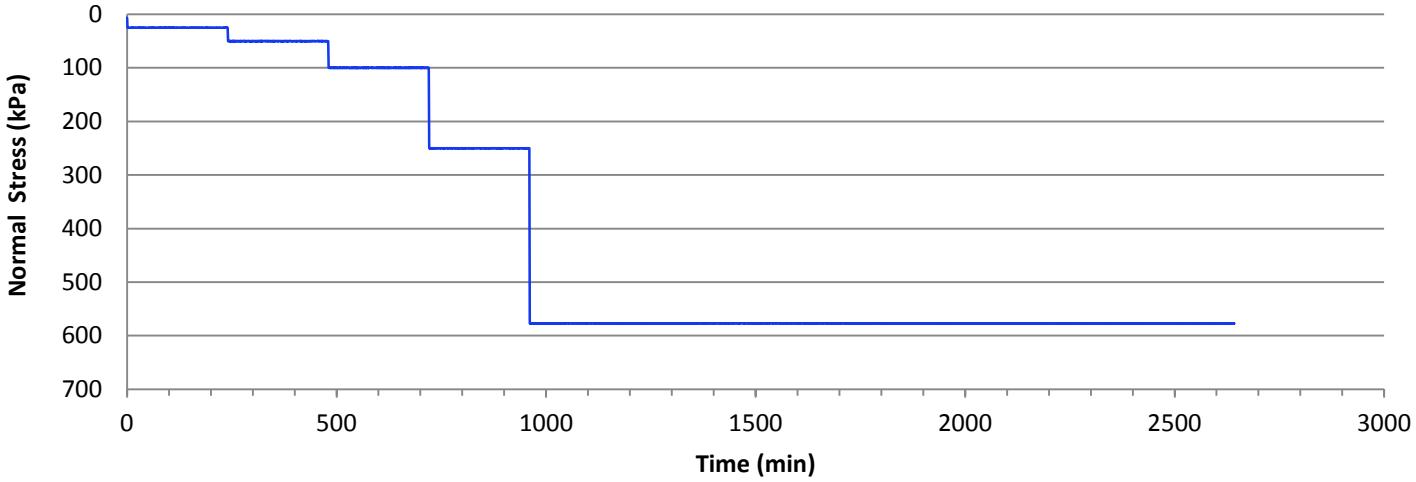
Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 41
Project:	Annacis Island WWTP	**Test ID:**	577kPa, 0.10CSR
Location:	Annacis Island, Delta	**Depth (m):**	61.17-61.22
Client:	CDM Smith	**Lab ID No:**	134

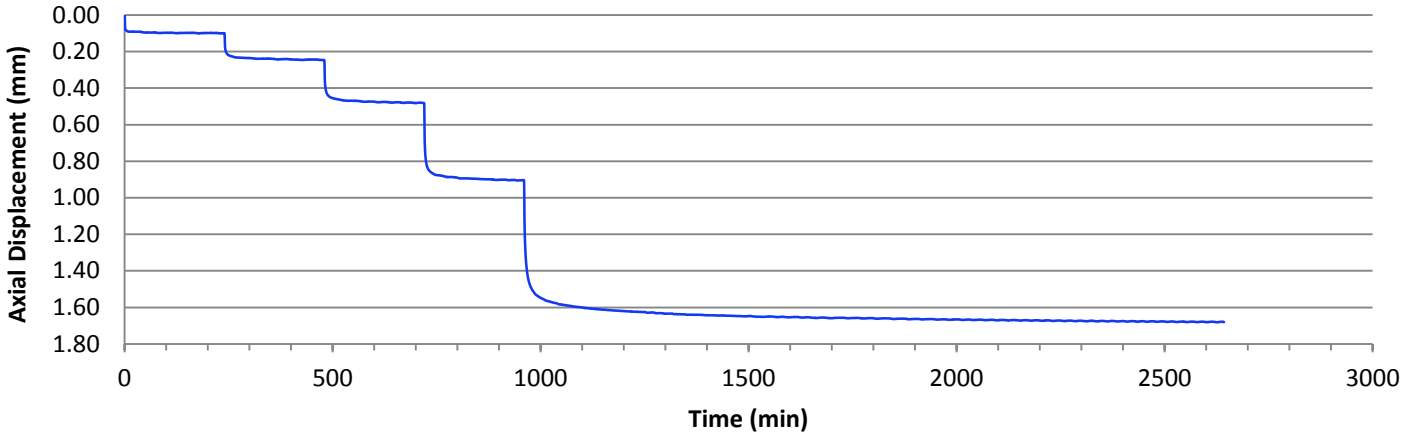
Consolidation Summary

Stress at end of Consolidation (kPa)	577.22
Axial Strain at end of Consolidation (%)	7.20
OCR	N/A
Change in Height ΔH_c (mm)	1.68

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	577		
Load (kN)	0.0983	0.1963	0.3913	0.9772	2.2546		
Duration (min)	240	240	240	240	1683		
Axial Strain (%)	0.43	1.06	2.07	3.88	7.21		





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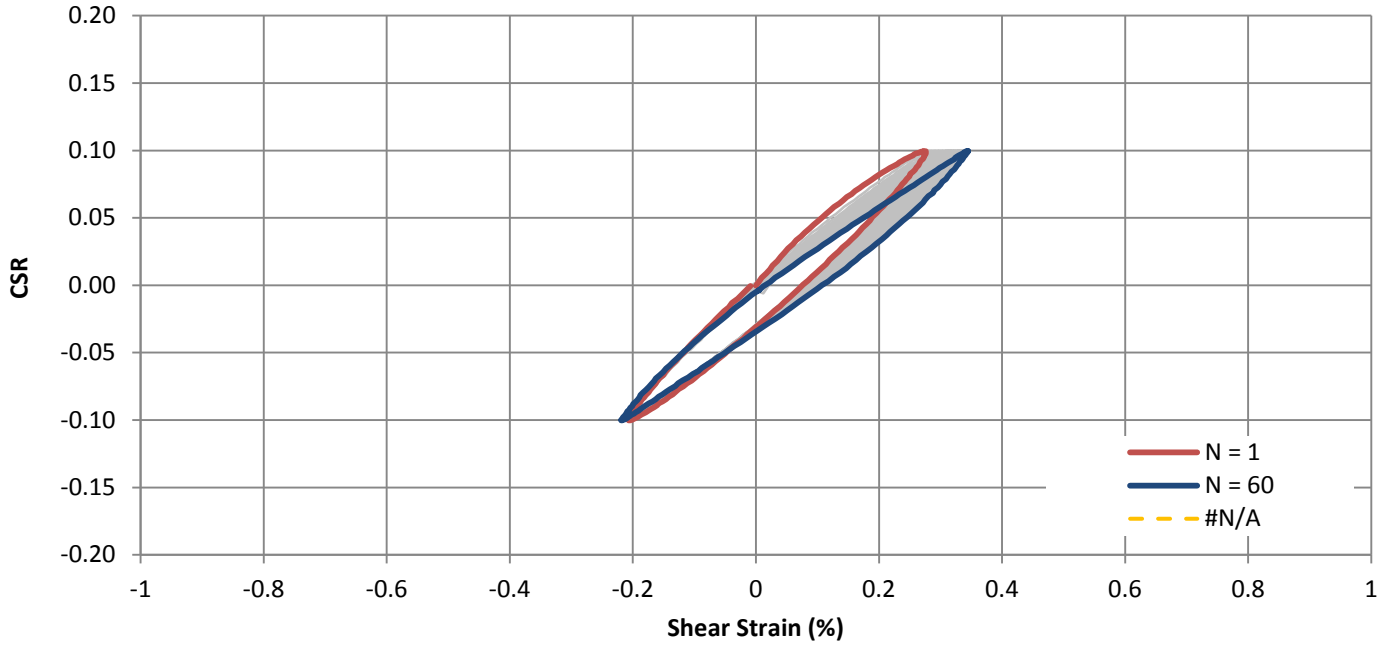
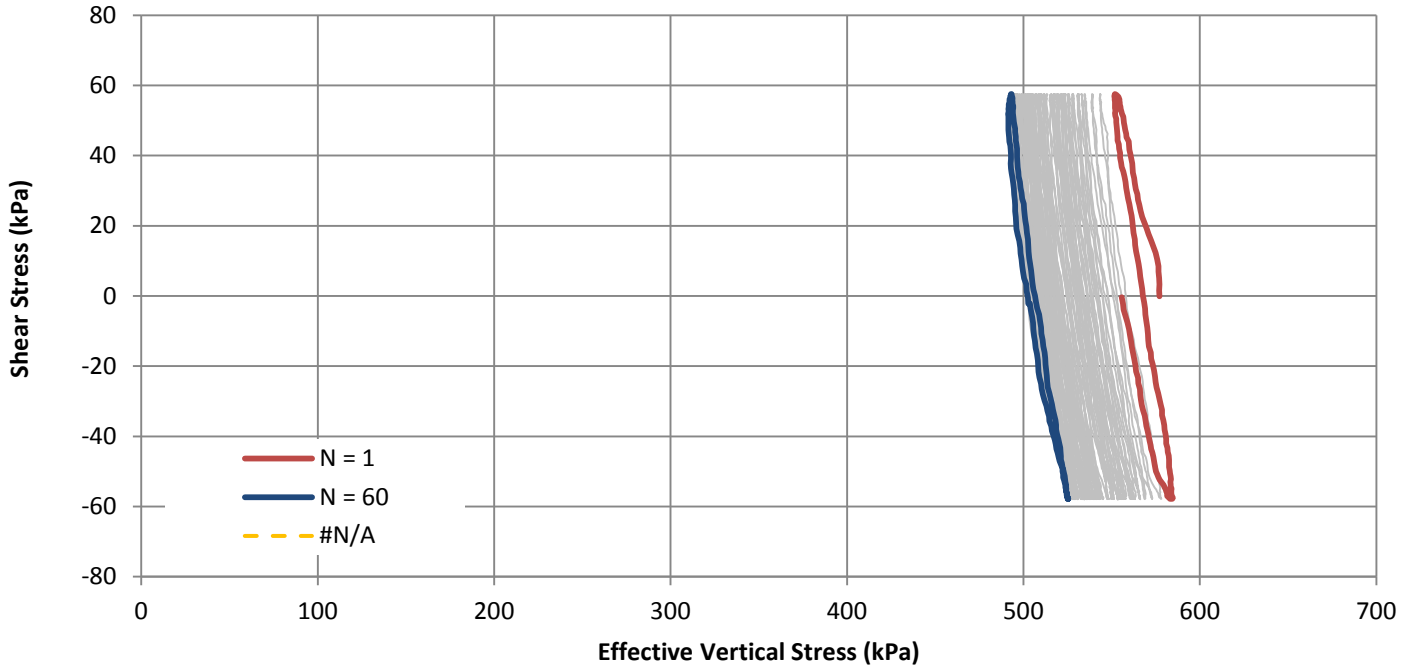
Project:	Annacis Island WWTP	**Test ID:**	577kPa, 0.10CSR
Location:	Annacis Island, Delta	**Depth (m):**	61.17-61.22
Client:	CDM Smith	**Lab ID No:**	134





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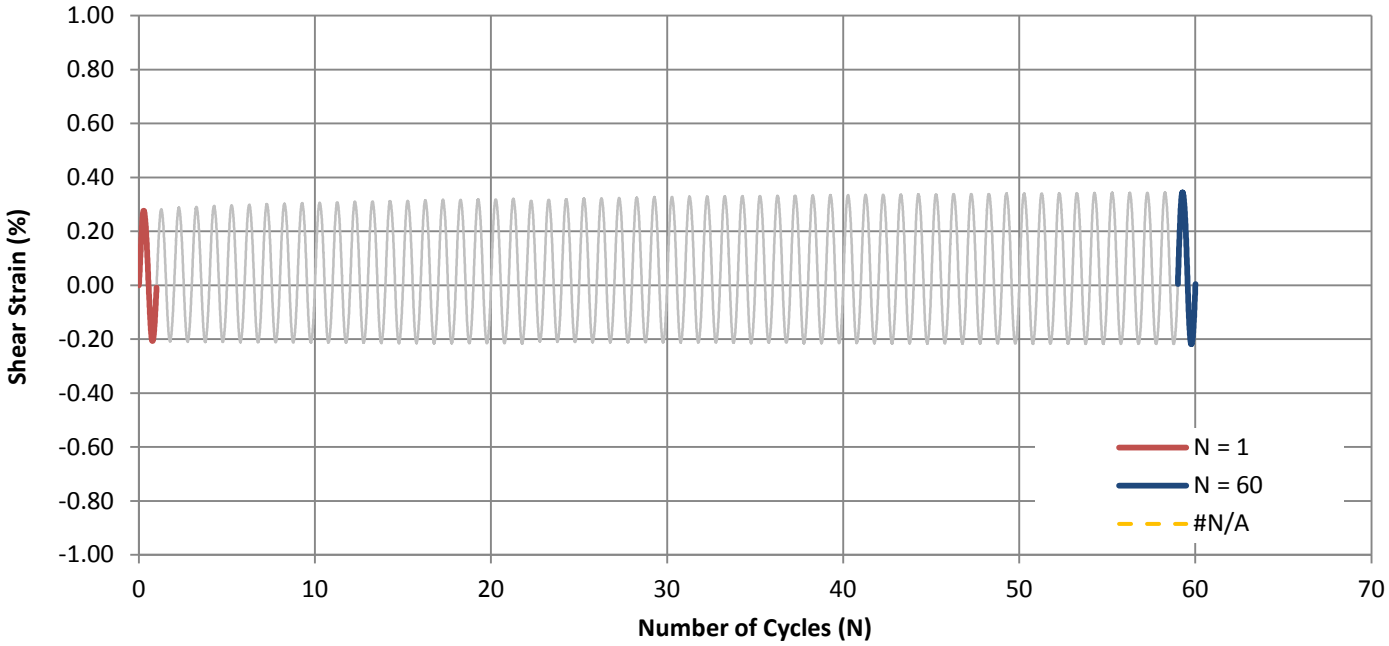
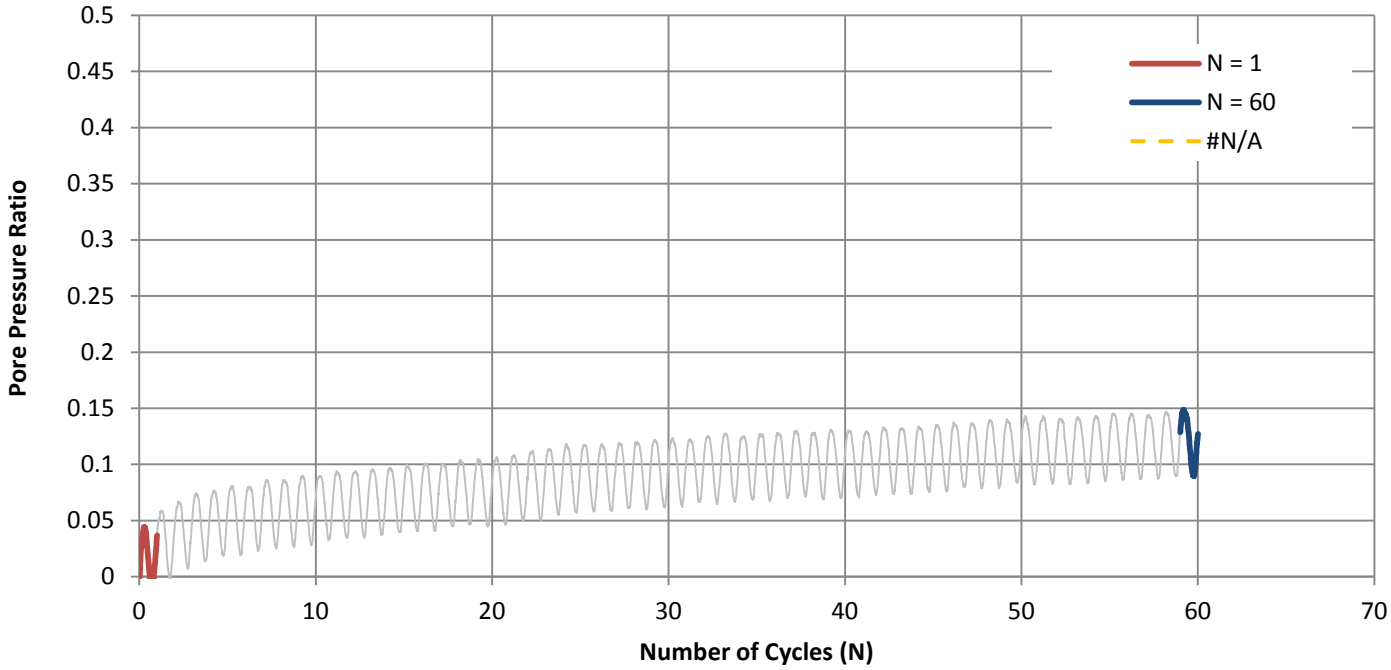
Client:	CDM Smith	**Lab ID No:**	134





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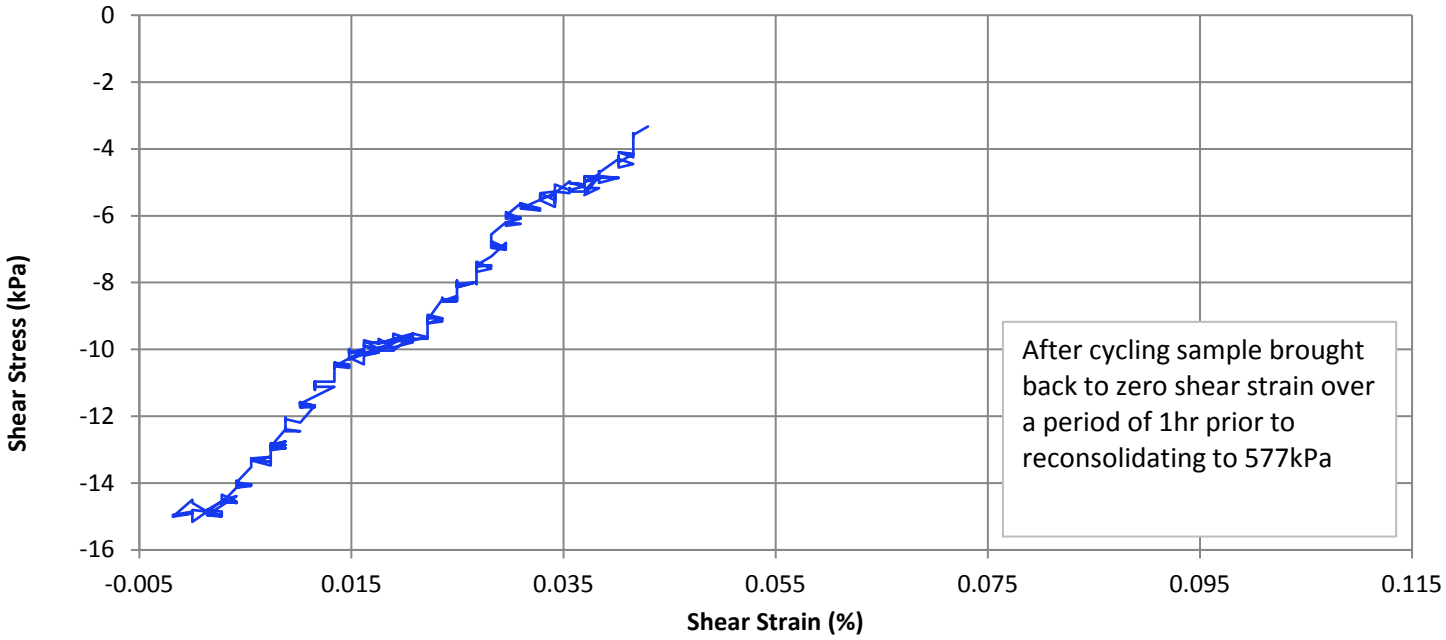
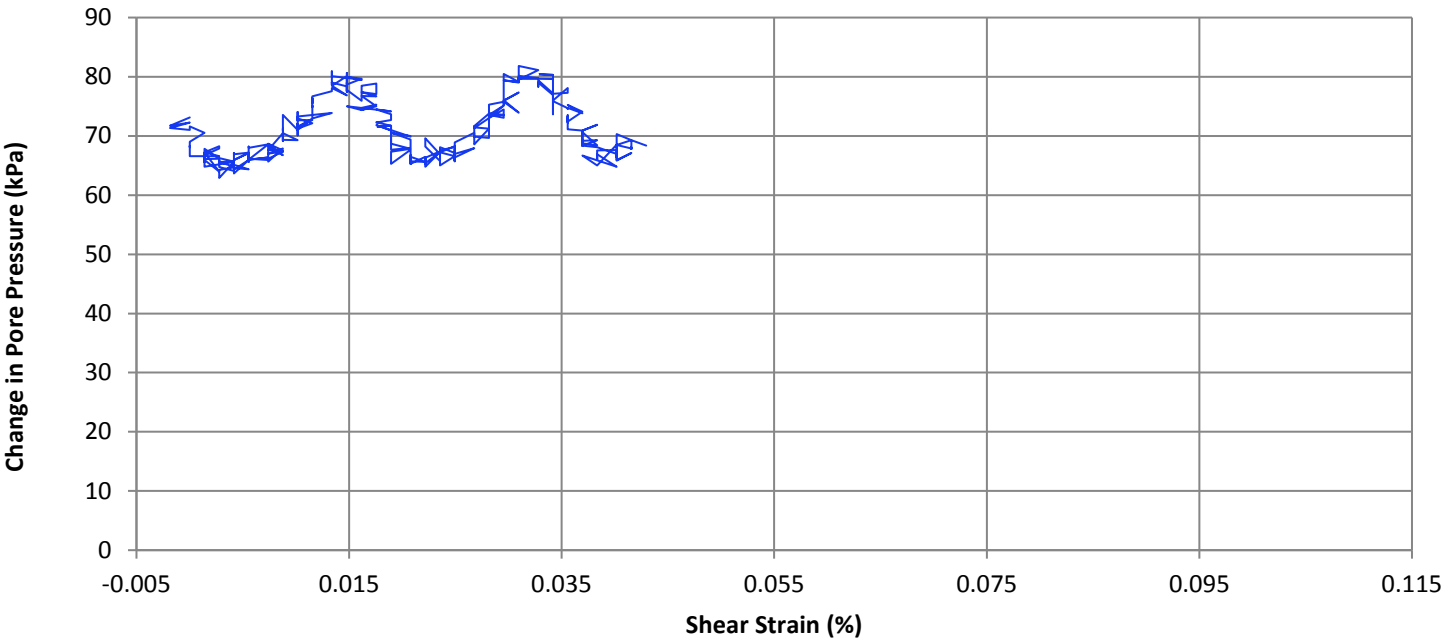
Location:	Annacis Island, Delta	**Depth (m):**	61.17-61.22
Client:	CDM Smith	**Lab ID No:**	134





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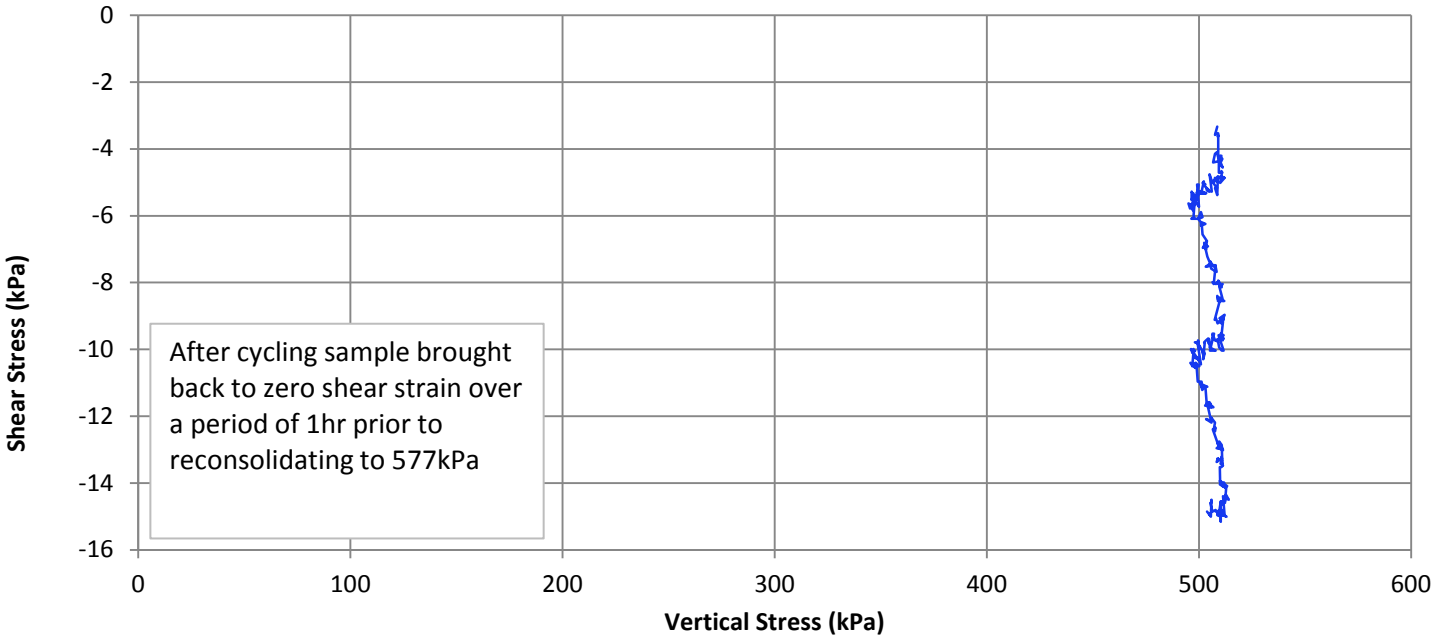
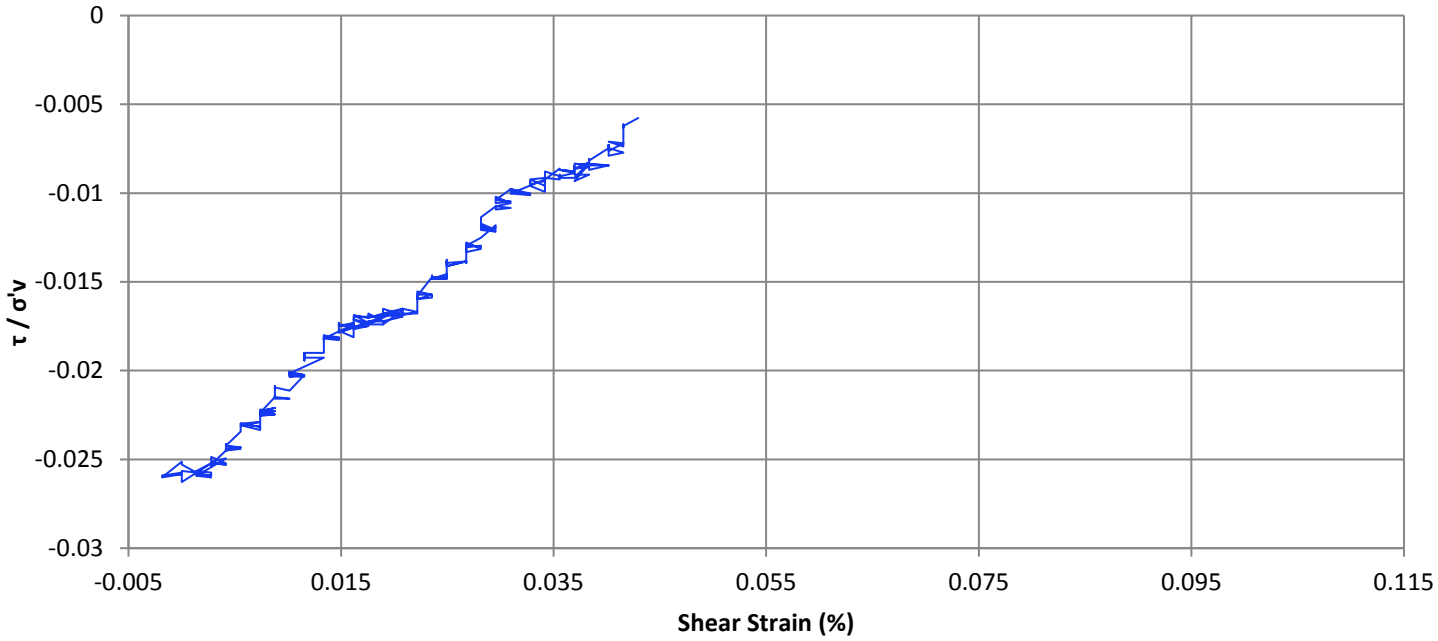
Project:	Annacis Island WWTP	**Test ID:**	577kPa, 0.10CSR
Location:	Annacis Island, Delta	**Depth (m):**	61.17-61.22
Client:	CDM Smith	**Lab ID No:**	134





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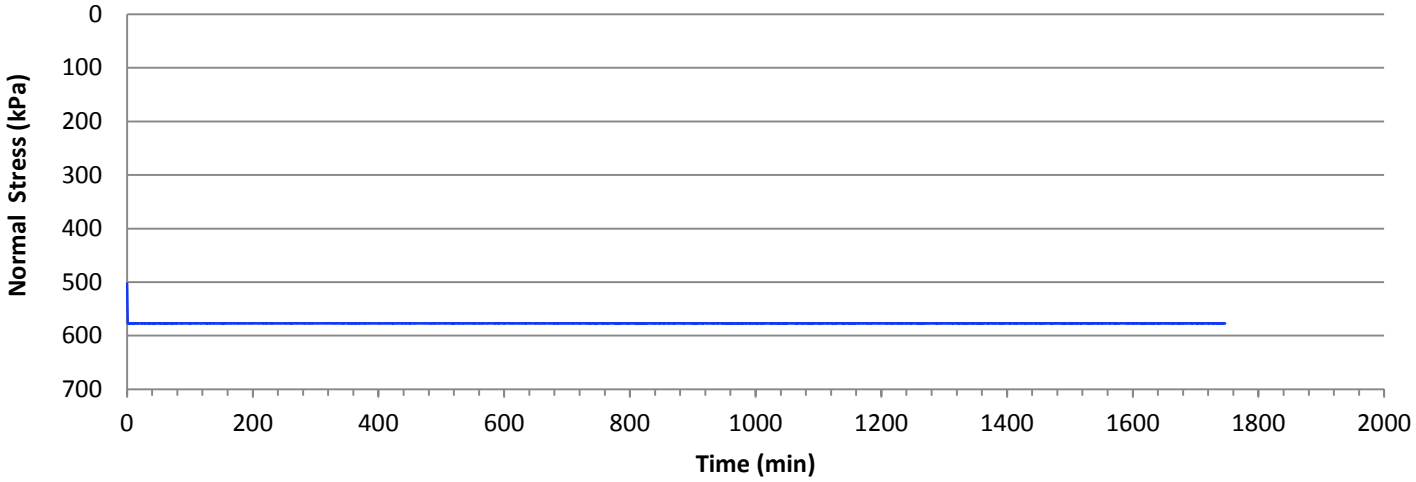
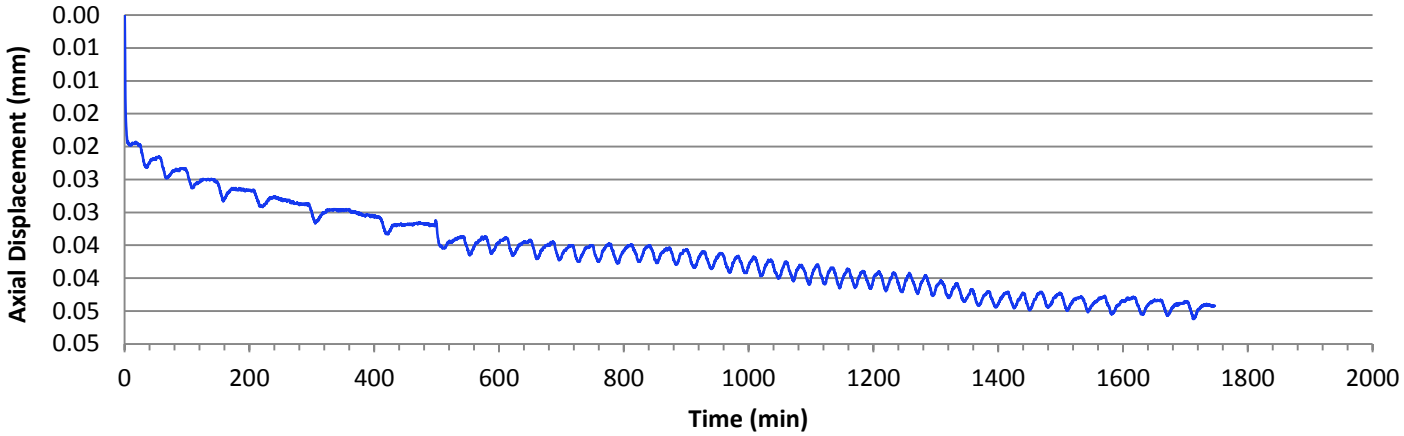
Project:	Annacis Island WWTP	**Test ID:**	577kPa, 0.10CSR
Location:	Annacis Island, Delta	**Depth (m):**	61.17-61.22
Client:	CDM Smith	**Lab ID No:**	134

Stress at Start of Reconsolidation (kPa)	508.59
Stress at end of Reconsolidation (kPa)	577.22
Axial Strain at end of Reconsolidation (%)	0.21
Change in Height ΔH_c (mm)	0.04

Comments
Reconsolidation data calculated from the sample height at end of initial consolidation

Increment (kPa)	577						
Load (kN)	2.2546						
Duration (min)	1747						
Axial Strain (%)	0.21						





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Project No.:	1525010/605	**Sample Number:**	BH16-03 Sa 41
Project:	Annacis Island WWTP	**Test ID:**	577kPa, 0.10CSR
Location:	Annacis Island, Delta	**Depth (m):**	61.17-61.22
Client:	CDM Smith	**Lab ID No:**	134

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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-04 Sa 31
Project:	Annacis Island WWTP	**Test ID:**	485kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	50.41-50.48
Client:	CDM Smith	**Lab ID No:**	134

General Remarks

Equipment Description: GDS - Station 1

Vertical LVDT	Serial No.:	113179
Vertical Load Cell	Serial No.:	89612
Shear Load Cell	Serial No.:	30465

Sample Properties

Preparation Method	Moist Tamping
Height (mm)	23.64
Diameter (mm)	70.56
Area (cm^2)	39.10
Volume (cm^3)	92.44
Specific Gravity (Assumed)	2.71

Visual Description	Silty CLAY; trace silt; dark grey, cohesive, w > PL, soft		
Sand Fraction (%)	N/A	Liquid Limit	25
Fines Fraction (%)	N/A	Plastic Limit	19
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	187.81	Initial Water Content (%)	27.28
Dry Mass (g)	147.56	Initial Saturation (%)	>100
Initial γ_{wet} (kN/m^3)	19.93	Final Water Content (%)	24.42
Initial γ_{dry} (kN/m^3)	15.66	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	485.00	Max. Axial Strain %	7.65
Max Applied Vertical Stress (kPa)	485.21	Axial Strain at end of Consol. %	7.64
Vertical Stress at end of Consol (kPa)	484.93	Change in Height ΔH_c (mm)	1.80
Laboratory OCR	N/A		

Direct Simple Shear Test Results

Initial Vertical Stress (kPa)	484.93	Peak Shear Strength (kPa)	127.89
Initial Shear Stress (kPa)	0.23	Excess Pore Pressure at Peak (kPa)	264.74
Applied Shear Bias (kPa)	0.00	Ratio of Peak / $\sigma'v$	0.26
Rate of Shearing (%/hr)	5.00	Maximum Shear Strain γ_{MAX} (%)	20.00
Test Condition	Undrained	Shear Strength at γ_{MAX} (kPa)	118.84

Comments / Special Instructions

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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

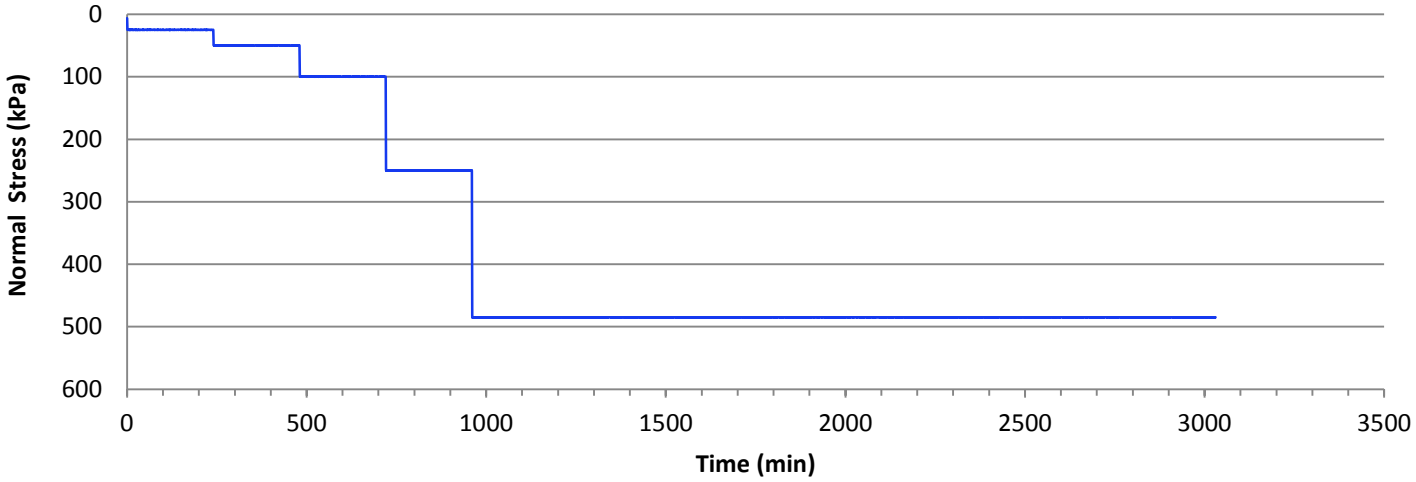
Project No.:	1525010/605	**Sample Number:**	BH16-04 Sa 31
Project:	Annacis Island WWTP	**Test ID:**	485kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	50.41-50.48
Client:	CDM Smith	**Lab ID No:**	134

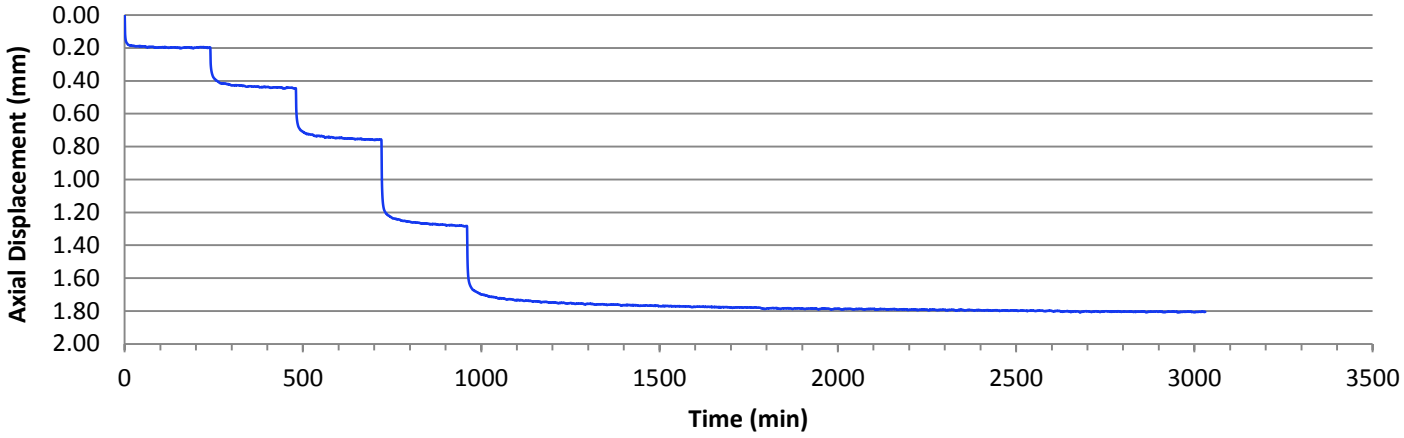
Consolidation Summary

Stress at end of Consolidation (kPa)	484.93
Axial Strain at end of Consolidation (%)	7.64
OCR	N/A
Change in Height ΔH_c (mm)	1.80

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	485		
Load (kN)	0.098	0.1957	0.3912	0.9785	1.8973		
Duration (min)	240	240	240	240	2071		
Axial Strain (%)	0.85	1.89	3.22	5.44	7.65		





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NORSOK G-001

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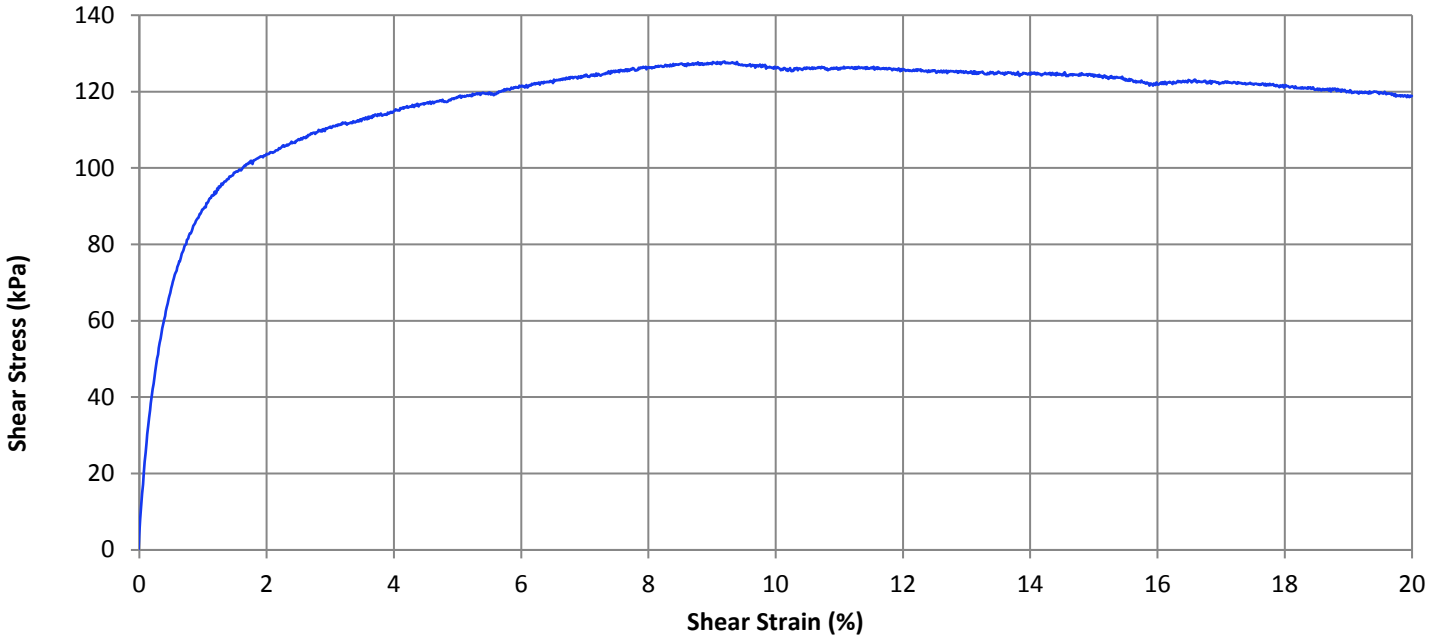
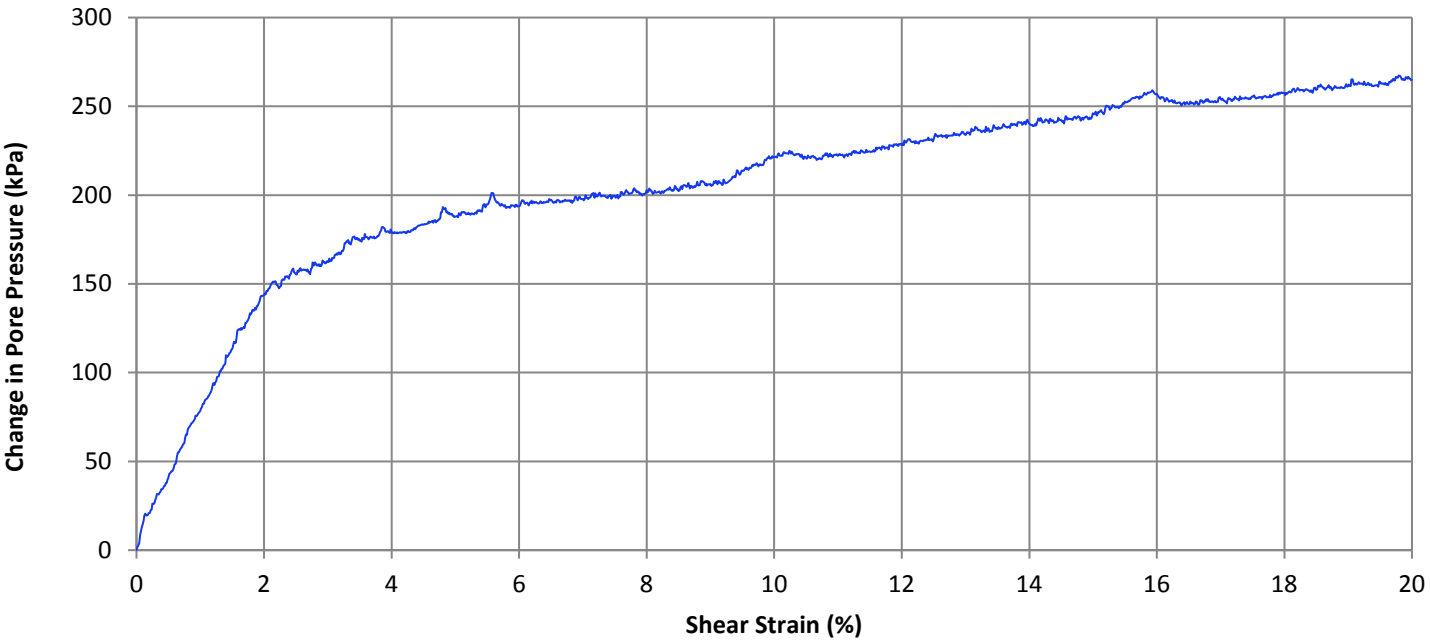
Project:	Annacis Island WWTP	**Test ID:**	485kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	50.41-50.48
Client:	CDM Smith	**Lab ID No:**	134





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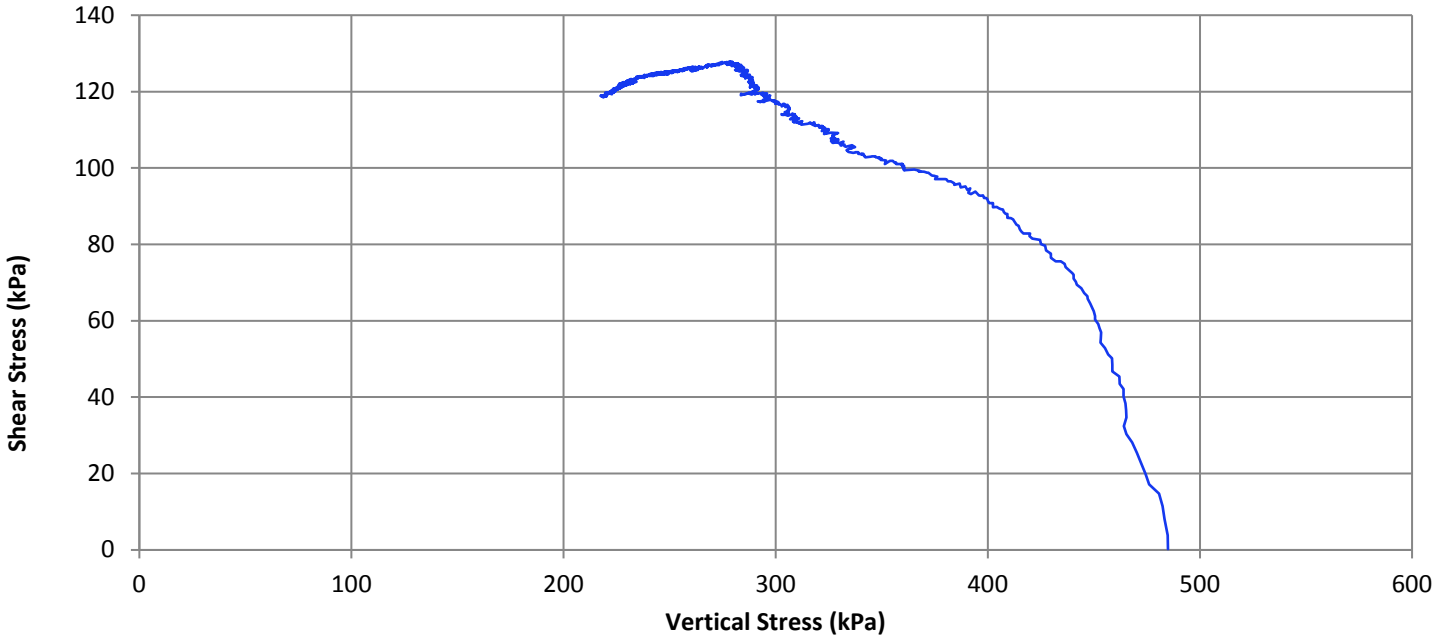
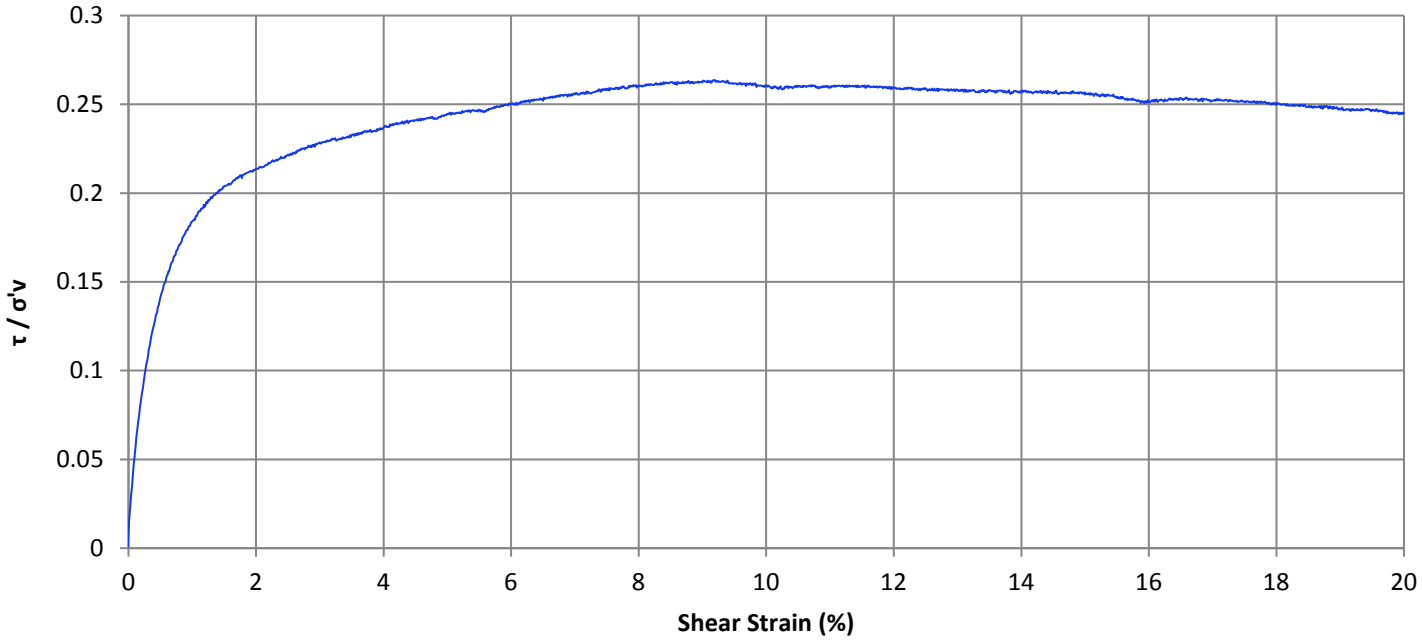
Project No.:	1525010/605	**Sample Number:**	BH16-04 Sa 31
Project:	Annacis Island WWTP	**Test ID:**	485kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	50.41-50.48
Client:	CDM Smith	**Lab ID No:**	134





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G. Patton	June 2, 2016	M. Sanin	June 7, 2016
TESTED BY	DATE	CHECKED BY	DATE

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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010/605	**Sample Number:**	BH16-04 Sa 31
Project:	Annacis Island WWTP	**Test ID:**	485kPa, Static
Location:	Annacis Island, Delta	**Depth (m):**	50.41-50.48
Client:	CDM Smith	**Lab ID No:**	134








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G. Patton	June 2, 2016	M. Sanin	June 7, 2016
TESTED BY	DATE	CHECKED BY	DATE

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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-06 Sa 33
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	485.5kPa, Static
Location:	Annacis Island	**Depth (m):**	50.20-50.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

General Remarks

Equipment Description: GDS - Station 2

Vertical LVDT	Serial No.:	11897
Vertical Load Cell	Serial No.:	38408
Shear Load Cell	Serial No.:	158877

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.55
Diameter (mm)	70.32
Area (cm^2)	38.84
Volume (cm^3)	91.46
Specific Gravity (Measured)	2.70

Visual Description	SILTY CLAY and CLAYEY SILT; grey; w>PL, firm.		
Sand Fraction (%)	N/A	Liquid Limit	33
Fines Fraction (%)	N/A	Plastic Limit	18
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	176.04	Initial Water Content (%)	33.13
Dry Mass (g)	132.23	Initial Saturation (%)	>100
Initial γ_{wet} (kN/m^3)	18.88	Final Water Content (%)	30.57
Initial γ_{dry} (kN/m^3)	14.18	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	N/A	Max. Axial Strain %	8.51
Max Applied Vertical Stress (kPa)	486.34	Axial Strain at end of Consol. %	8.51
Vertical Stress at end of Consol (kPa)	485.90	Change in Height ΔH_c (mm)	2.00
Laboratory OCR	N/A		

Direct Simple Shear Test Results

Initial Vertical Stress (kPa)	486.03	Peak Shear Strength (kPa)	105.03
Initial Shear Stress (kPa)	-0.10	Excess Pore Pressure at Peak (kPa)	224.27
Applied Shear Bias (kPa)	0.00	Ratio of Peak / $\sigma'v$	0.22
Rate of Shearing (%/hr)	5.00	Maximum Shear Strain γ_{MAX} (%)	19.98
Test Condition	Undrained	Shear Strength at γ_{MAX} (kPa)	90.04

Comments / Special Instructions

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G. Patton	February 14, 2017	C. Jeong	February 21, 2017
TESTED BY	DATE	CHECKED BY	DATE

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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

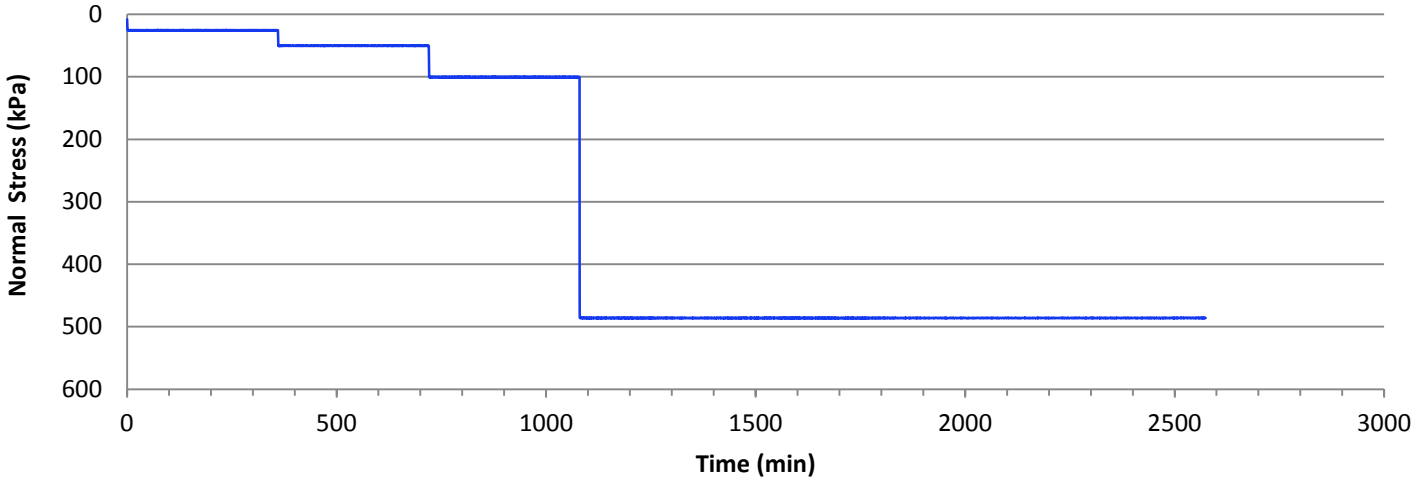
Project No.:	1525010 / 3000	**Sample Number:**	BH16-06 Sa 33
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	485.5kPa, Static
Location:	Annacis Island	**Depth (m):**	50.20-50.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

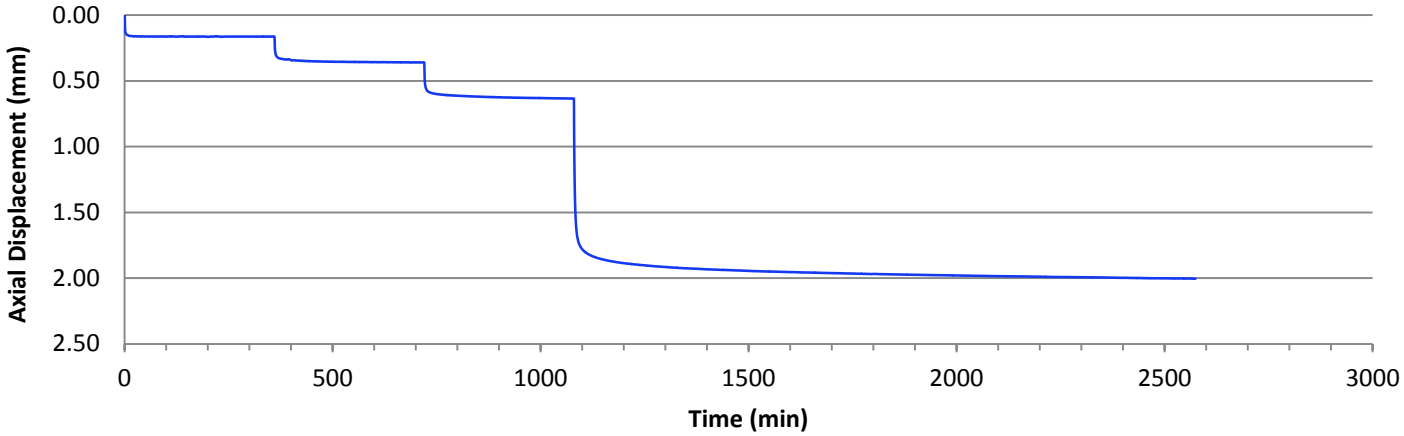
Consolidation Summary

Stress at end of Consolidation (kPa)	485.90
Axial Strain at end of Consolidation (%)	8.51
OCR	N/A
Change in Height ΔH_c (mm)	2.00

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	485.5			
Load (kN)	0.1003	0.197	0.3916	1.8888			
Duration (min)	360	360	360	1495			
Axial Strain (%)	0.70	1.53	2.70	8.51			





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TESTED BY	DATE	CHECKED BY	DATE

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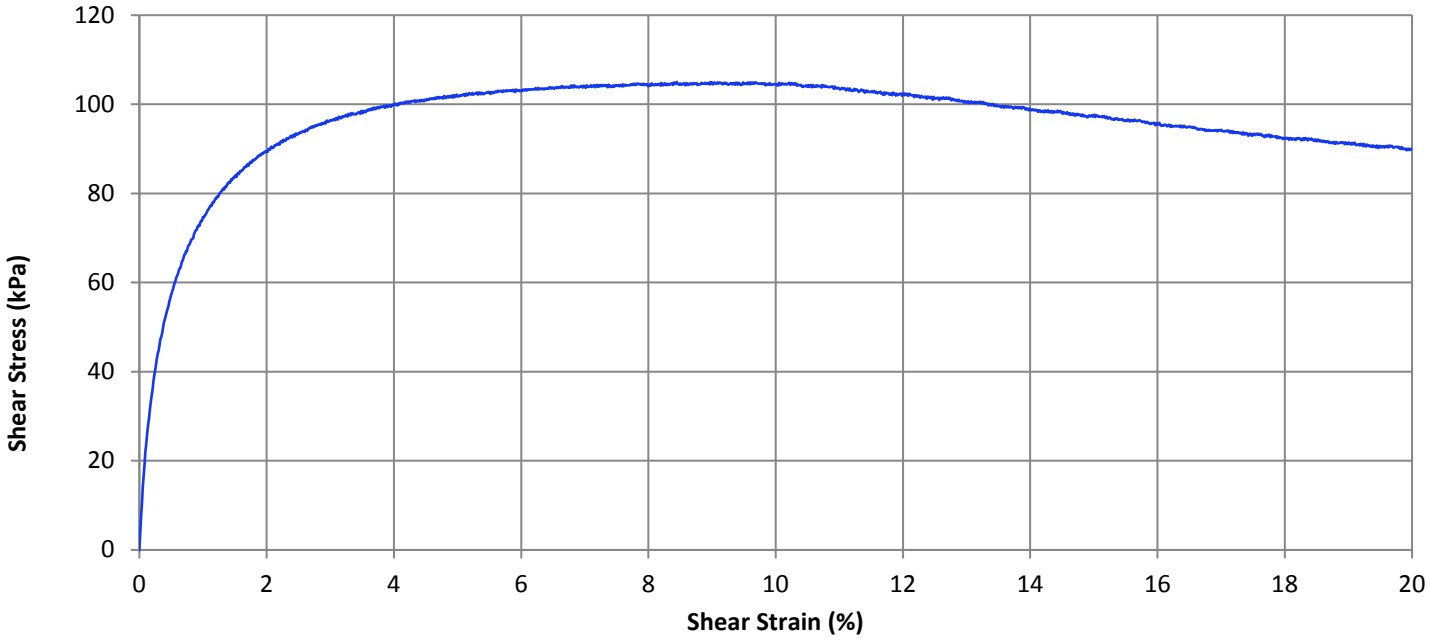
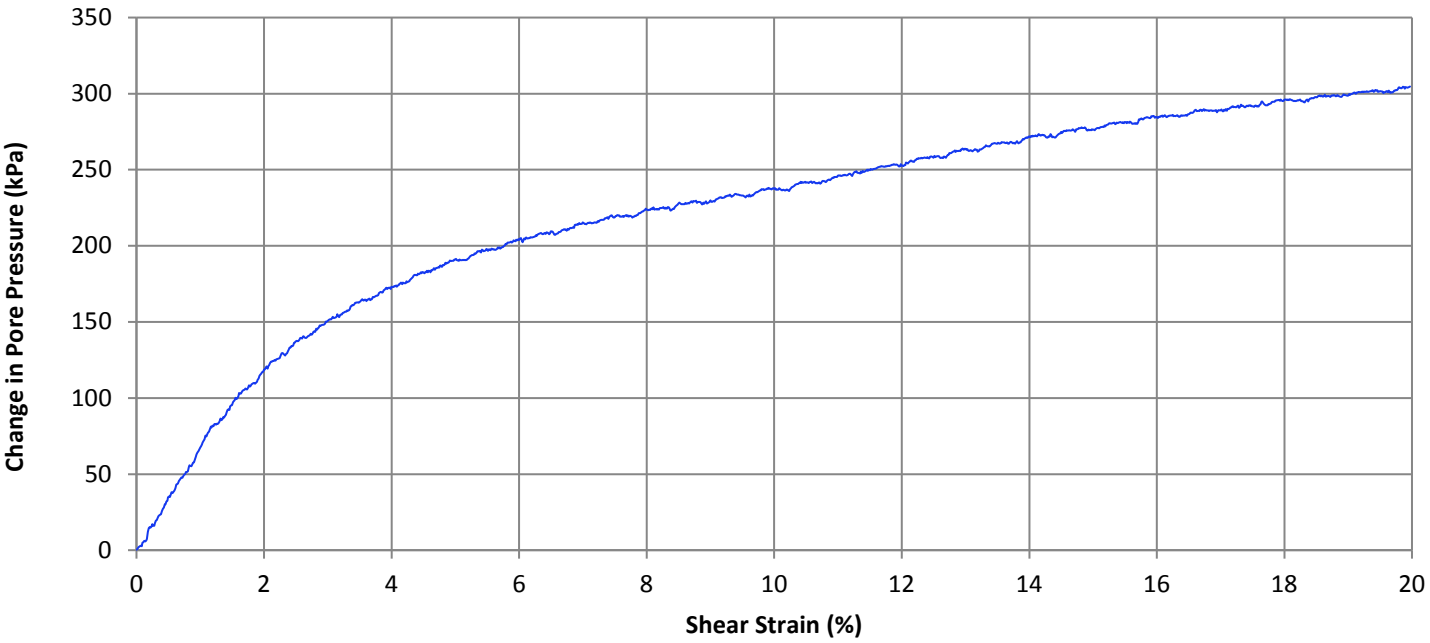
Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-06 Sa 33
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	485.5kPa, Static
Location:	Annacis Island	**Depth (m):**	50.20-50.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28





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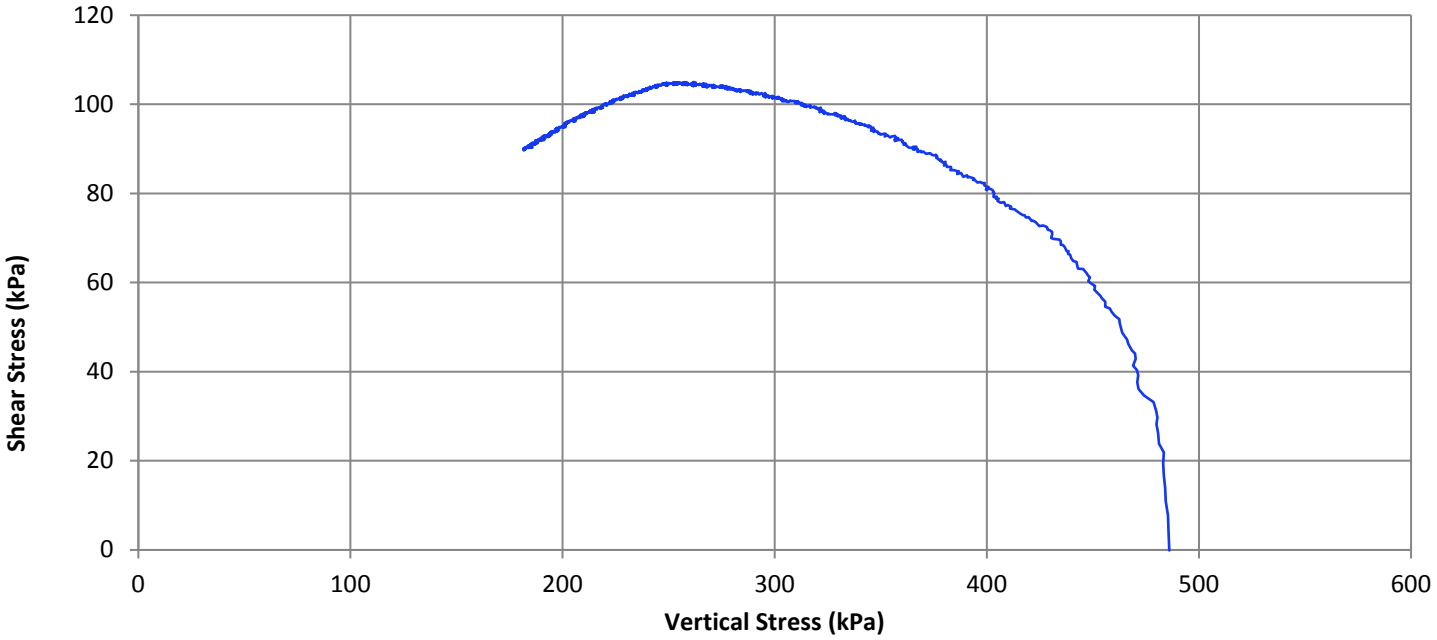
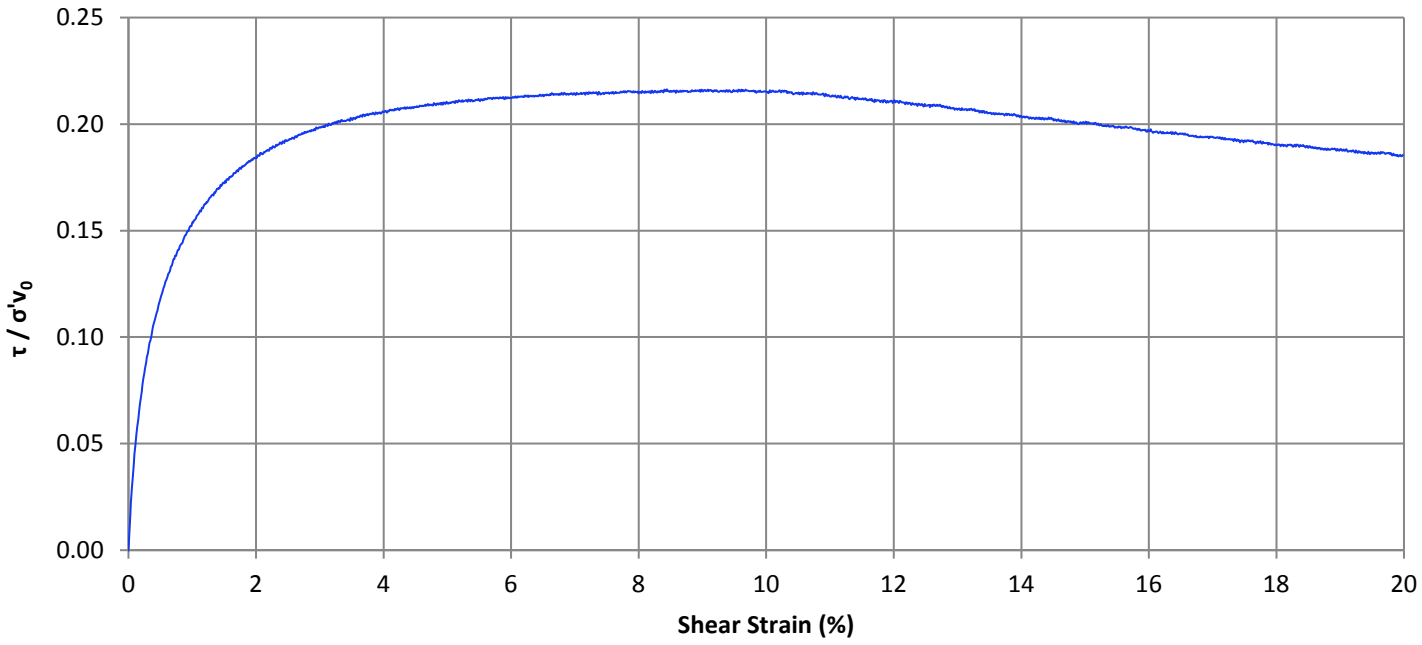
Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-06 Sa 33
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	485.5kPa, Static
Location:	Annacis Island	**Depth (m):**	50.20-50.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28





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TESTED BY	DATE	CHECKED BY	DATE

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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-06 Sa 33
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	485.5kPa, Static
Location:	Annacis Island	**Depth (m):**	50.20-50.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

G. Patton	February 14, 2017	C. Jeong	February 21, 2017
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates Ltd.
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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-06 Sa 33
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	485.5kPa, 0.12 CSR
Location:	Annacis Island	**Depth (m):**	50.20-50.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

General Remarks

Equipment Description: GDS - Station 2

Vertical LVDT	Serial No.:	11897
Vertical Load Cell	Serial No.:	38408
Shear Load Cell	Serial No.:	158877

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.57
Diameter (mm)	70.40
Area (cm^2)	38.93
Volume (cm^3)	91.75
Specific Gravity (Measured)	2.70

Visual Description	SILTY CLAY and CLAYEY SILT; grey; w>PL, firm.		
Sand Fraction (%)	0.24	Liquid Limit	33
Fines Fraction (%)	99.76	Plastic Limit	20
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	180.66	Initial Water Content (%)	30.75
Dry Mass (g)	138.17	Initial Saturation (%)	>100
Initial Wet Unit Weight (kN/m^3)	19.32	Final Water Content (%)	28.98
Initial Dry Unit Weight (kN/m^3)	14.77	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	N/A	Max. Axial Strain %	7.06
Max Applied Vertical Stress (kPa)	486.39	Axial Strain at end of Consol. %	7.06
Vertical Stress at end of Consol (kPa)	486.06	Change in Height ΔH_c (mm)	1.66
Laboratory OCR	N/A		

Cyclic Test Results

Frequency (Hz)	0.10
CSR	0.12
Cycles to 3.75% Shear Strain	3.75% not reached
Initial Vertical Stress (kPa)	488.03
Max Abs. Cyclic Shear Stress (kPa)	58.50
Max. Shear Strain at N= n/a (zero load)	3.75% not reached
Min. Shear Strain at N= n/a (zero load)	3.75% not reached
Max. DU at N= n/a (zero load)	3.75% not reached
Min. DU at N= n/a (zero load)	3.75% not reached

Post Cyclic Reconsolidation Test Results

Initial Vertical Stress (kPa)	354.32
Initial Shear Stress (kPa)	-1.85
Max Applied Vertical Stress (kPa)	485.93
Axial Strain at end of Reconsol. %	0.45
Change in Height ΔH_c (mm)	0.10

Comments / Special Instructions

Only 22 cycles requested.

Comments / Special Instructions

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G. Patton	February 18, 2017	CJ	Feburary 28, 2017
TESTED BY	DATE	CHECKED BY	DATE

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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

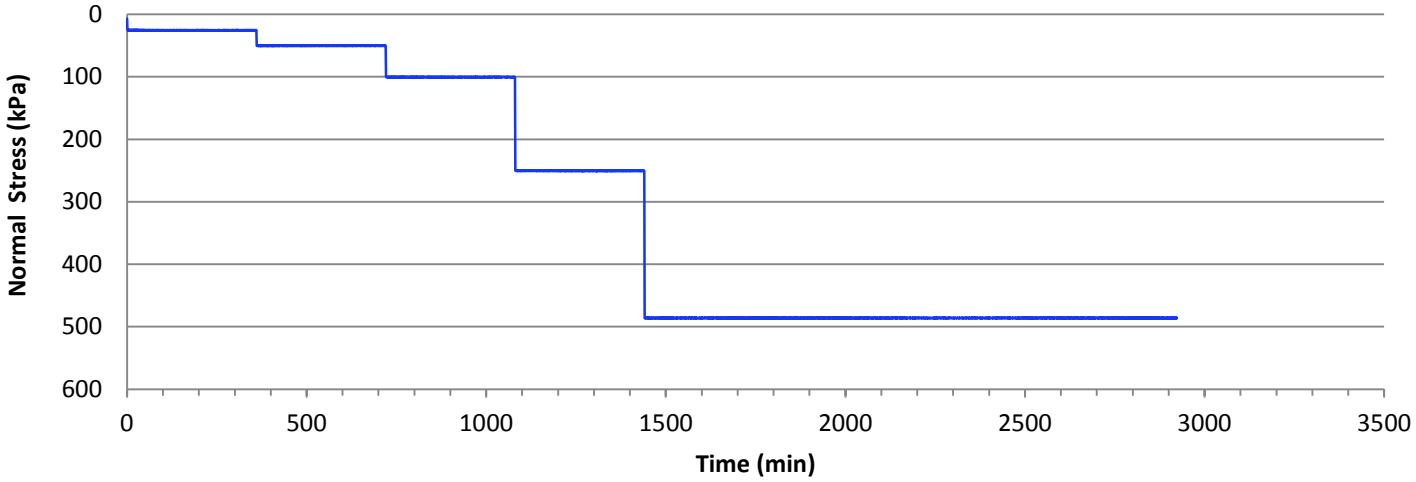
Project No.:	1525010 / 3000	**Sample Number:**	BH16-06 Sa 33
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	485.5kPa, 0.12 CSR
Location:	Annacis Island	**Depth (m):**	50.20-50.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

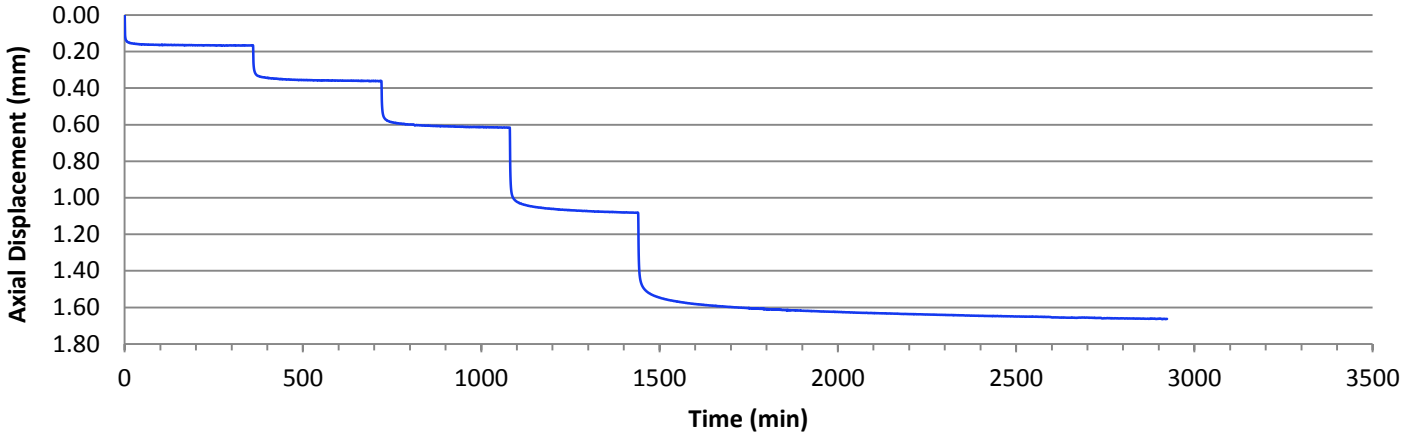
Consolidation Summary

Stress at end of Consolidation (kPa)	486.06
Axial Strain at end of Consolidation (%)	7.06
OCR	N/A
Change in Height ΔH_c (mm)	1.66

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	485.5		
Load (kN)	0.1006	0.1976	0.3923	0.9764	1.8933		
Duration (min)	360	360	360	360	1483		
Axial Strain (%)	0.71	1.53	2.61	4.59	7.06		





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G. Patton	February 18, 2017	CJ	February 28, 2017
TESTED BY	DATE	CHECKED BY	DATE

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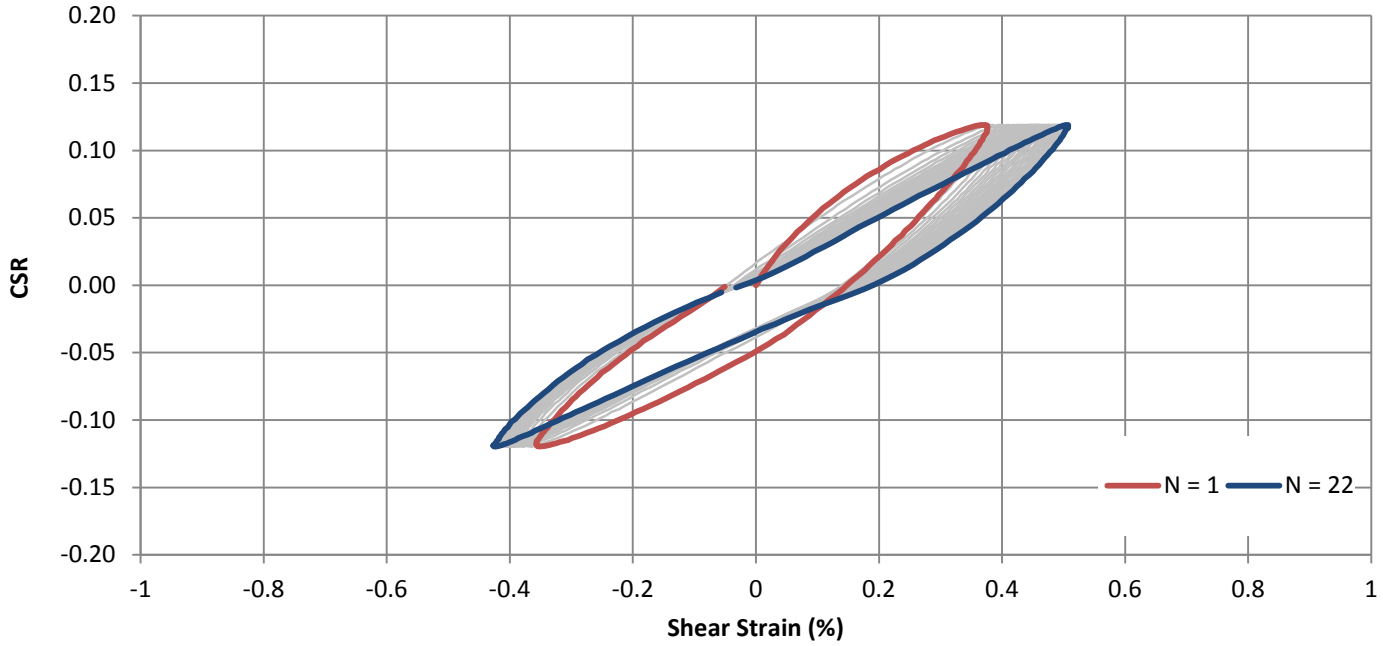
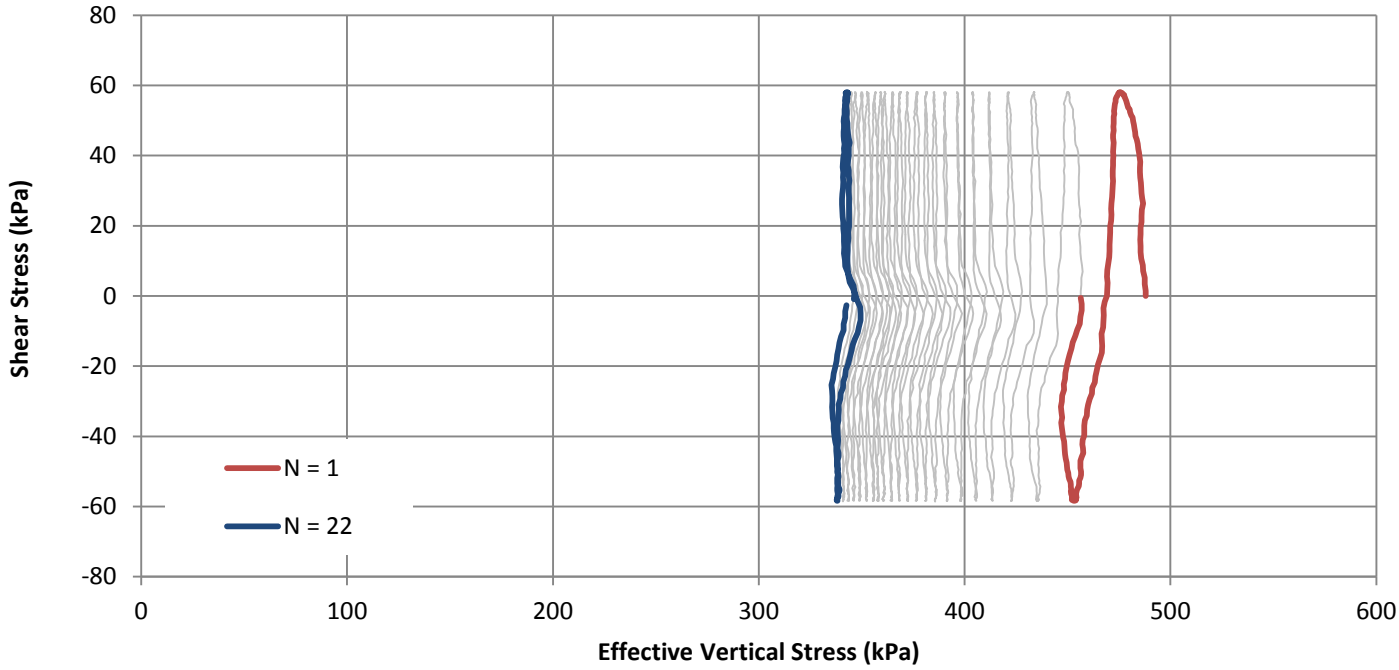
Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-06 Sa 33
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	485.5kPa, 0.12 CSR
Location:	Annacis Island	**Depth (m):**	50.20-50.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28





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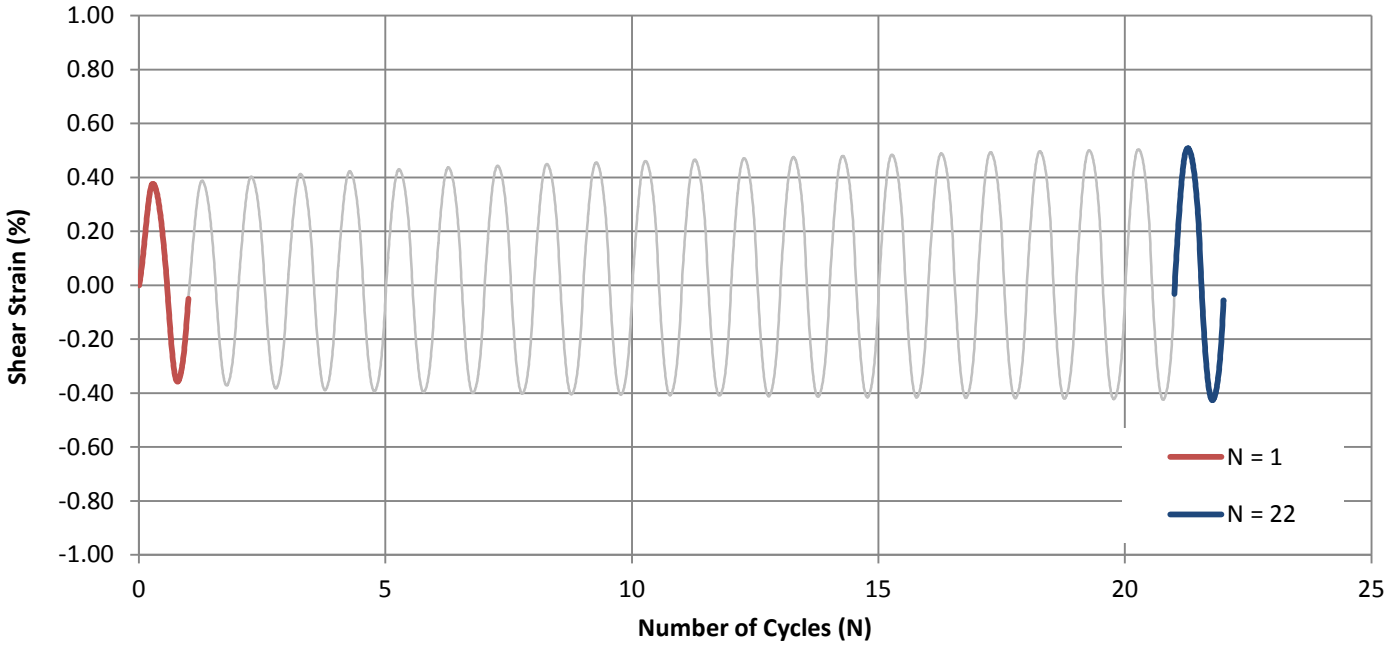
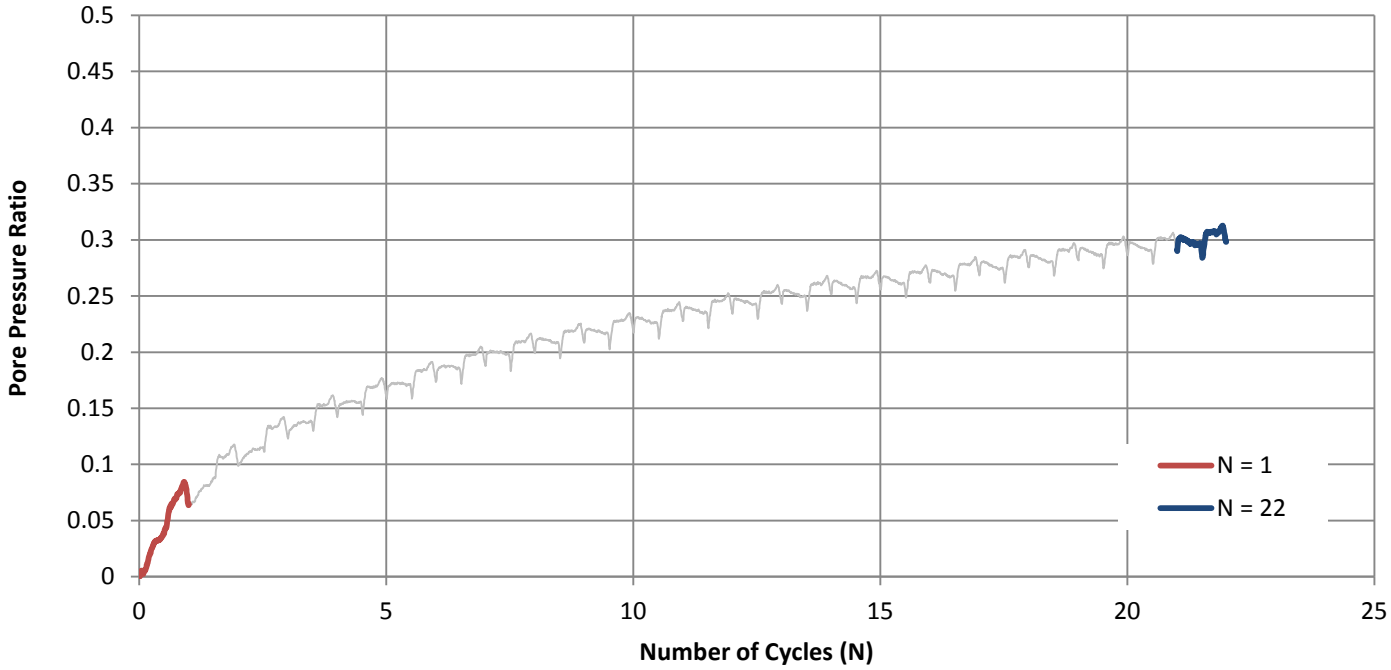
Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-06 Sa 33
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	485.5kPa, 0.12 CSR
Location:	Annacis Island	**Depth (m):**	50.20-50.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28





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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

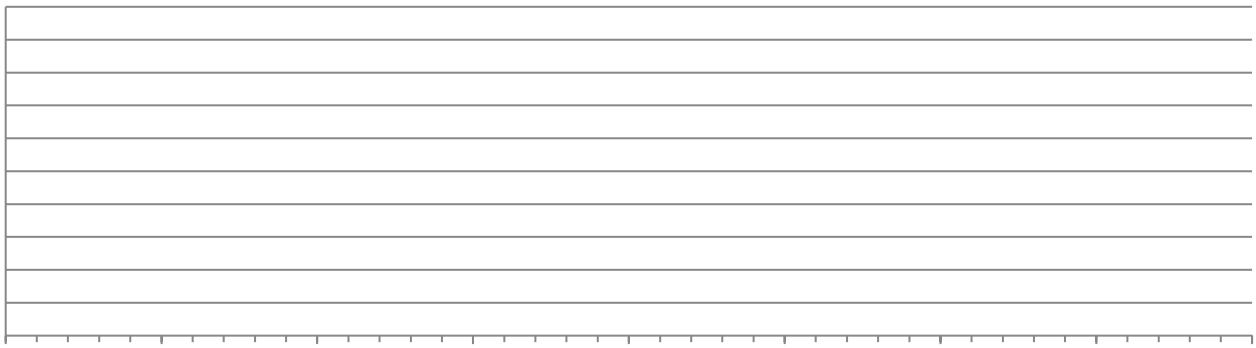
NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-06 Sa 33
Project:	Annacis Outfall and Transient Mi	**Test ID:**	485.5kPa, 0.12 CSR
Location:	Annacis Island	**Depth (m):**	50.20-50.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

Stress at Start of Reconsolidation (kPa)	354.32
Stress at end of Reconsolidation (kPa)	485.93
Axial Strain at end of Reconsolidation (%)	0.45
Change in Height ΔH_c (mm)	0.10

Comments
Reconsolidation data calculated from the sample height at end of initial consolidation

Increment (kPa)	485.5						
Load (kN)	1.8936						
Duration (min)	1442						
Axial Strain (%)	0.45						



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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-06 Sa 33
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	485.5kPa, 0.12 CSR
Location:	Annacis Island	**Depth (m):**	50.20-50.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

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GOLDER ASSOC
24 JAN 2017
1525010/3200

BH16-07 SA37

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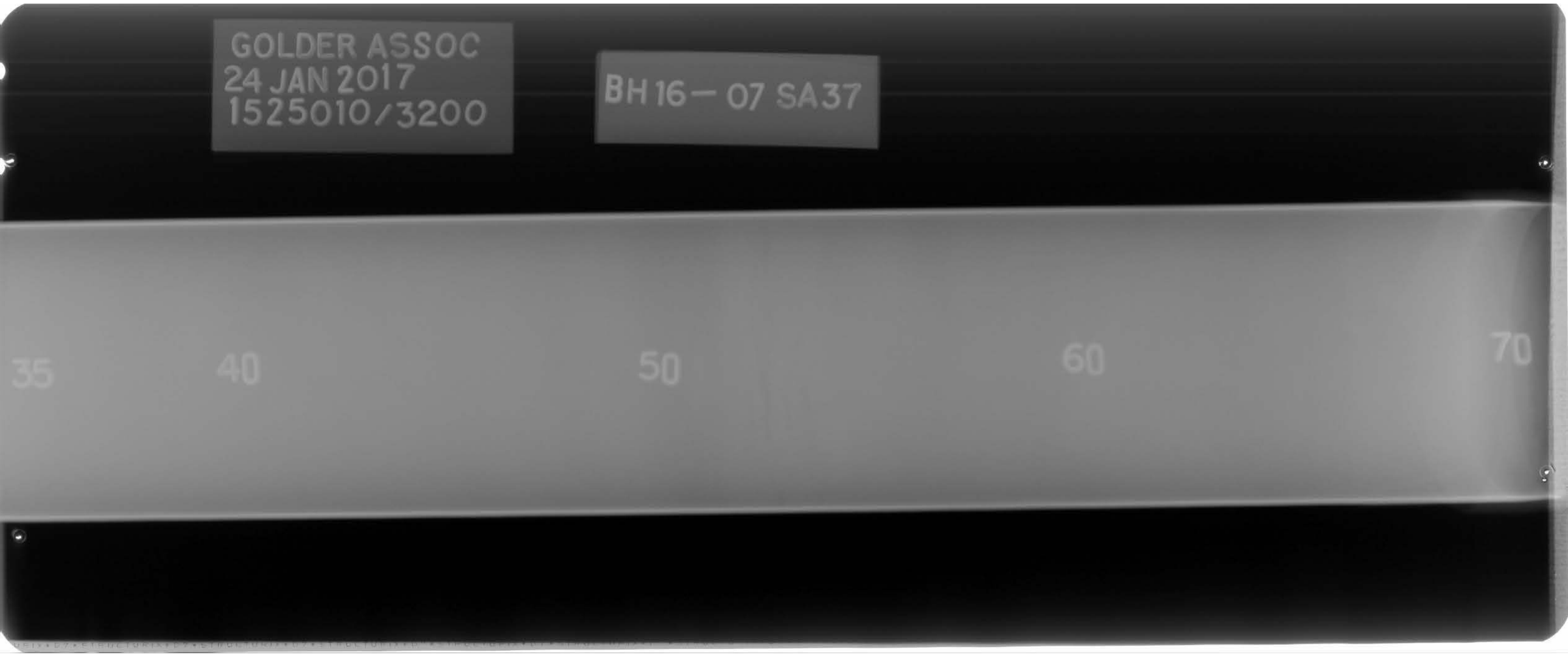
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BH16-07 SA37
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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-07 Sa 37
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	609.4kPa, Static
Location:	Annacis Island	**Depth (m):**	63.60-63.65
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

General Remarks

Equipment Description: GDS - Station 3

Vertical LVDT	Serial No.:	11894
Vertical Load Cell	Serial No.:	38407
Shear Load Cell	Serial No.:	158879

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.58
Diameter (mm)	70.44
Area (cm^2)	38.97
Volume (cm^3)	91.89
Specific Gravity (Measured)	2.71

Visual Description	SILTY CLAY; grey; w>PL, stiff.		
Sand Fraction (%)	N/A	Liquid Limit	30
Fines Fraction (%)	N/A	Plastic Limit	19
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	181.6	Initial Water Content (%)	29.29
Dry Mass (g)	140.46	Initial Saturation (%)	>100
Initial γ_{wet} (kN/m^3)	19.39	Final Water Content (%)	27.65
Initial γ_{dry} (kN/m^3)	15.00	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	N/A	Max. Axial Strain %	6.82
Max Applied Vertical Stress (kPa)	609.83	Axial Strain at end of Consol. %	6.81
Vertical Stress at end of Consol (kPa)	609.57	Change in Height ΔH_c (mm)	1.61
Laboratory OCR	N/A		

Direct Simple Shear Test Results

Initial Vertical Stress (kPa)	609.34	Peak Shear Strength (kPa)	135.36
Initial Shear Stress (kPa)	-0.36	Excess Pore Pressure at Peak (kPa)	281.63
Applied Shear Bias (kPa)	0.00	Ratio of Peak / $\sigma'v$	0.22
Rate of Shearing (%/hr)	5.00	Maximum Shear Strain γ_{MAX} (%)	19.99
Test Condition	Undrained	Shear Strength at γ_{MAX} (kPa)	117.27

Comments / Special Instructions

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G. Patton	February 14, 2014	C. Jeong	February 21, 2017
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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

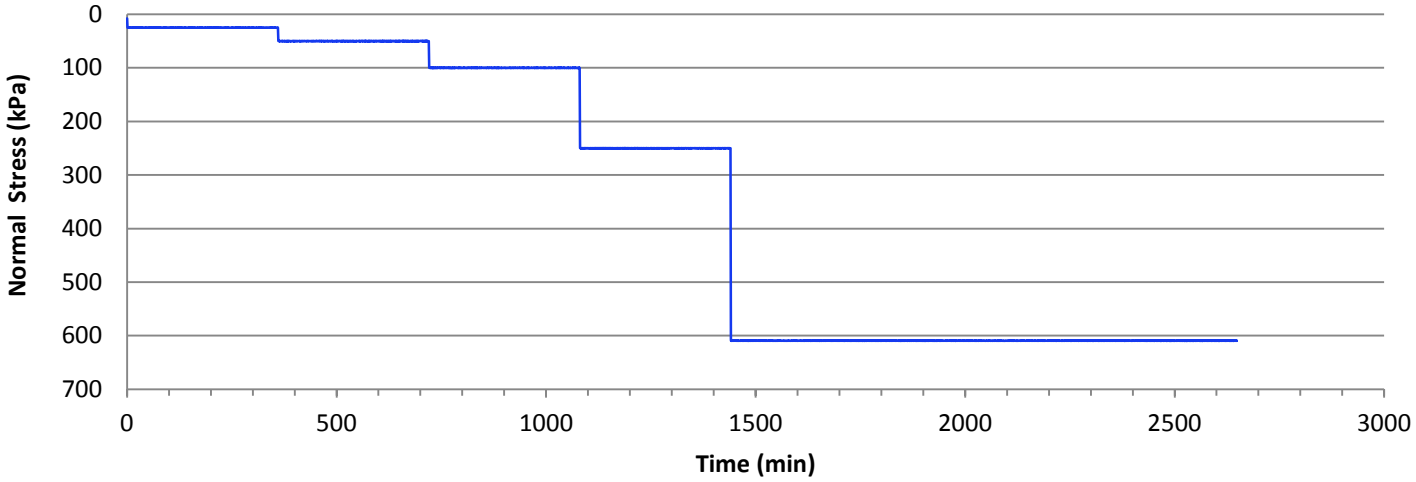
Project No.:	1525010 / 3000	**Sample Number:**	BH16-07 Sa 37
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	609.4kPa, Static
Location:	Annacis Island	**Depth (m):**	63.60-63.65
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

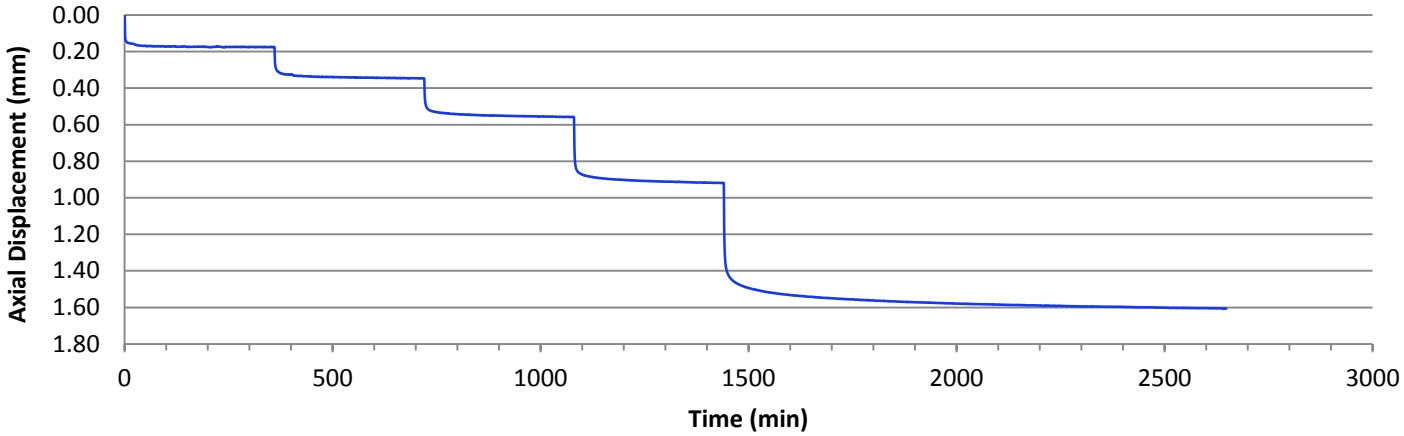
Consolidation Summary

Stress at end of Consolidation (kPa)	609.57
Axial Strain at end of Consolidation (%)	6.81
OCR	N/A
Change in Height ΔH_c (mm)	1.61

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	250	609.4		
Load (kN)	0.0982	0.1958	0.3906	0.9751	2.3765		
Duration (min)	360	360	360	360	1208		
Axial Strain (%)	0.75	1.47	2.37	3.90	6.82		





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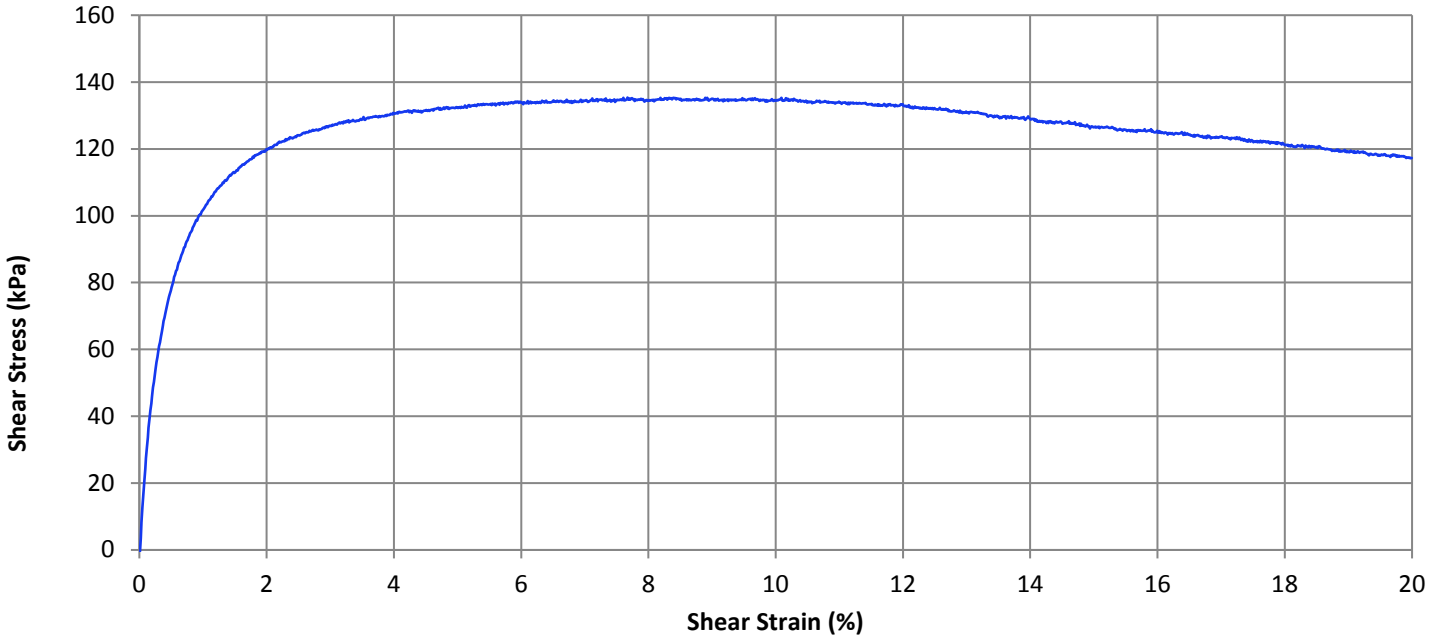
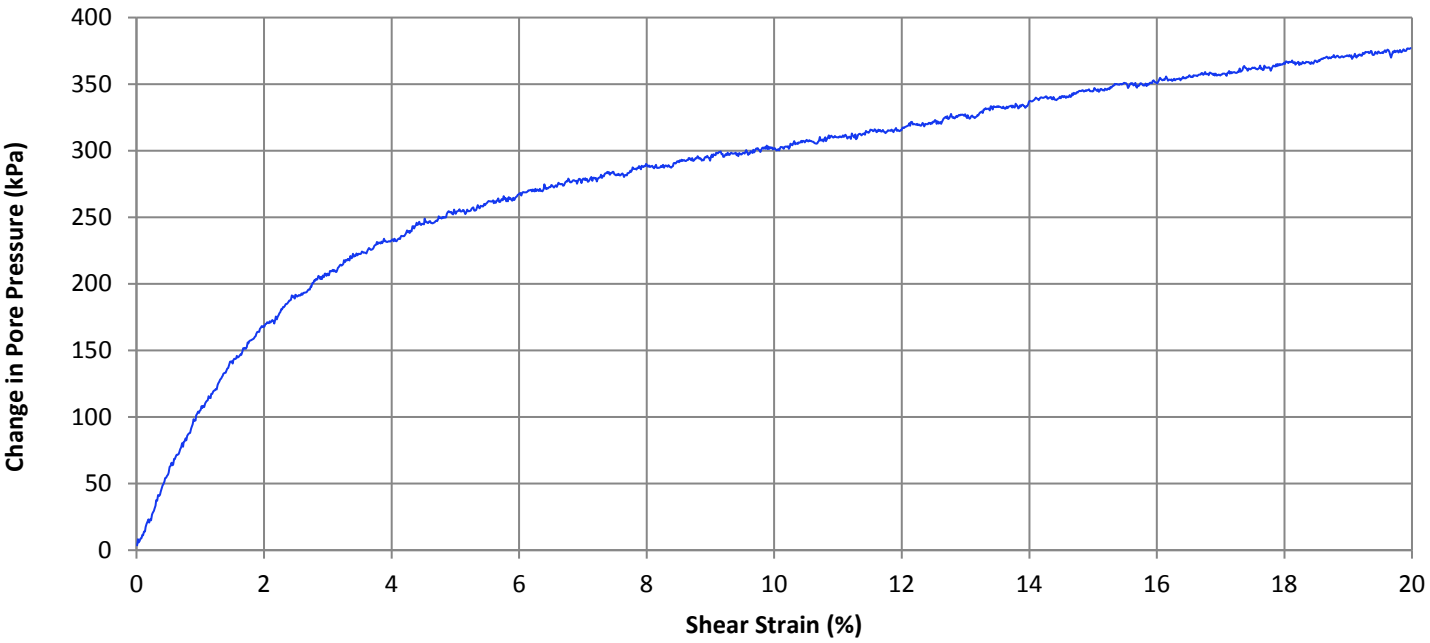
Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-07 Sa 37
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	609.4kPa, Static
Location:	Annacis Island	**Depth (m):**	63.60-63.65
Client:	CDM Smith Canada ULC	**Lab ID No:**	28





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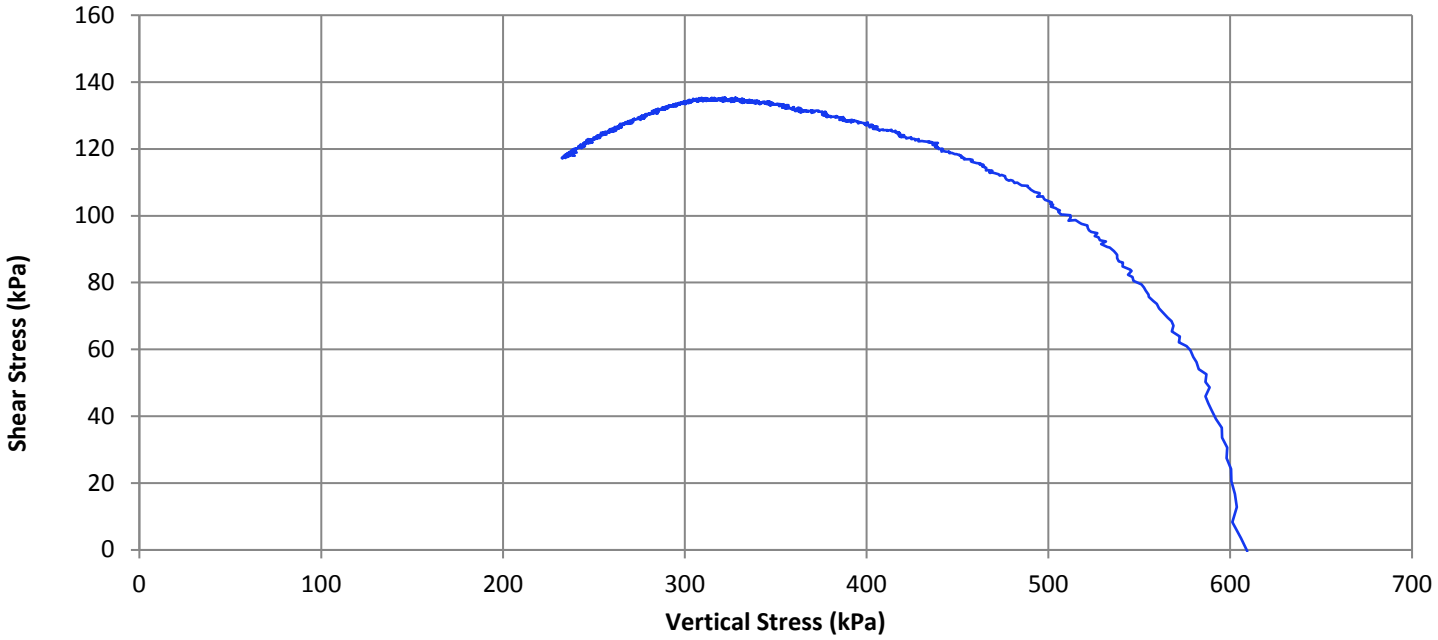
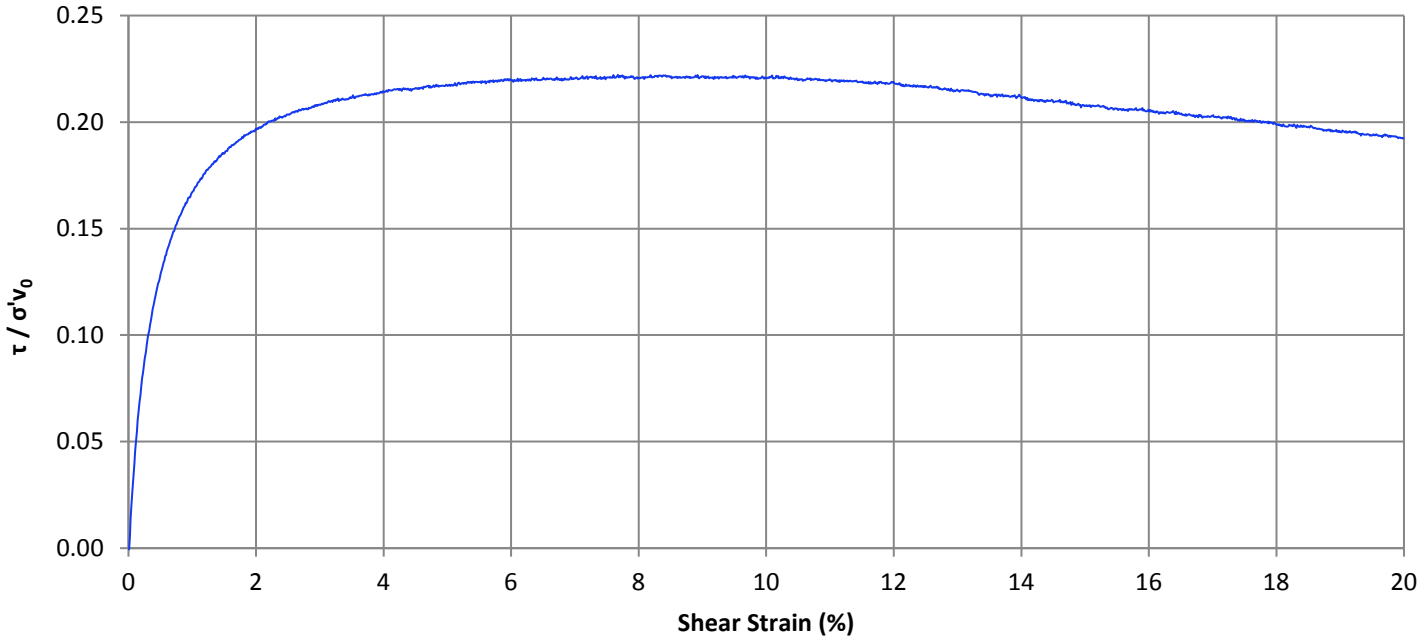
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	609.4kPa, Static
Location:	Annacis Island	**Depth (m):**	63.60-63.65
Client:	CDM Smith Canada ULC	**Lab ID No:**	28





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Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	609.4kPa, Static
Location:	Annacis Island	**Depth (m):**	63.60-63.65
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

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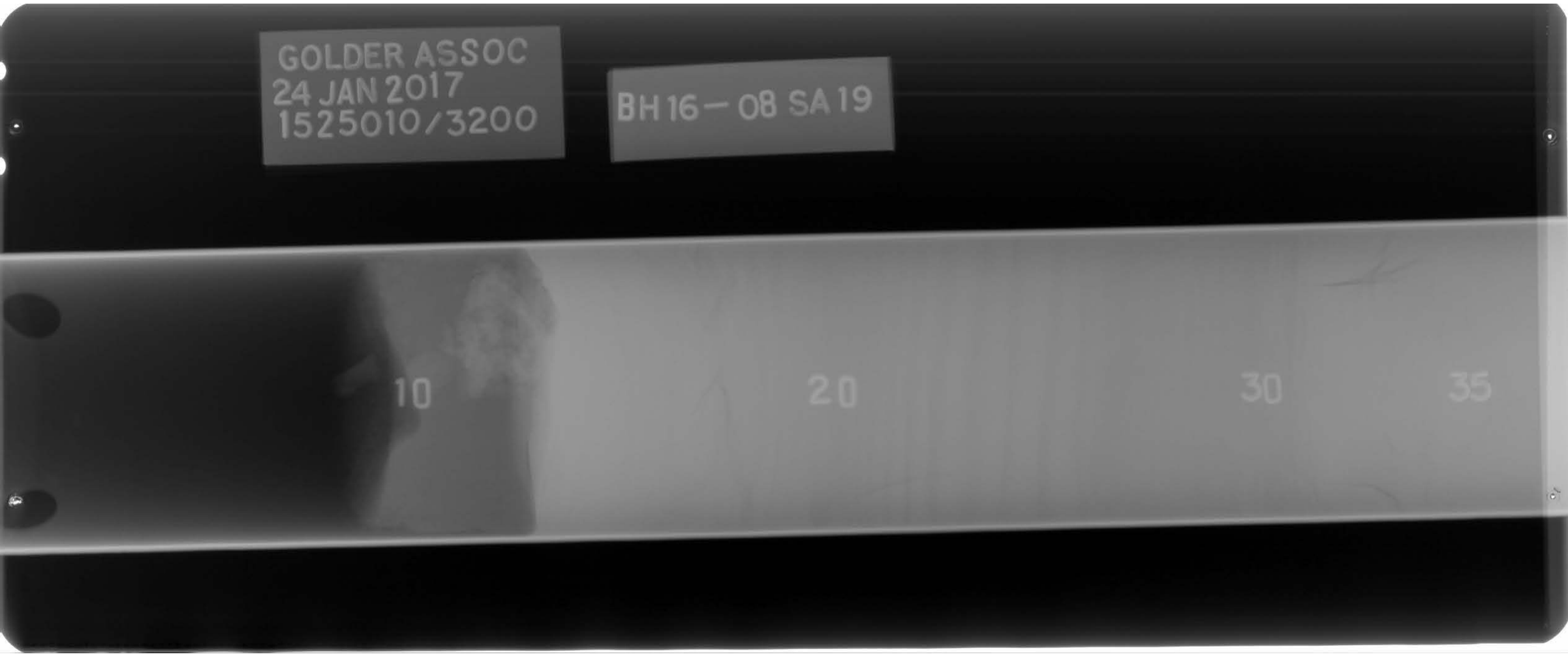
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24 JAN 2017
1525010/3200
BH16-08 SA19
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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-08 Sa 19
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	269.6kPa, Static
Location:	Annacis Island	**Depth (m):**	29.20-29.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

General Remarks

Equipment Description: GDS - Station 1

Vertical LVDT	Serial No.:	113179
Vertical Load Cell	Serial No.:	89612
Shear Load Cell	Serial No.:	30465

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.36
Diameter (mm)	70.28
Area (cm^2)	38.79
Volume (cm^3)	90.62
Specific Gravity (Measured)	2.72

Visual Description	SILTY CLAY - CLAYEY SILT, trace fine sand; grey; cohesive, w>PL, firm.		
Sand Fraction (%)	N/A	Liquid Limit	24
Fines Fraction (%)	N/A	Plastic Limit	17
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	182.81	Initial Water Content (%)	28.20
Dry Mass (g)	142.6	Initial Saturation (%)	>100
Initial γ_{wet} (kN/m^3)	19.79	Final Water Content (%)	26.61
Initial γ_{dry} (kN/m^3)	15.44	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	N/A	Max. Axial Strain %	5.65
Max Applied Vertical Stress (kPa)	269.71	Axial Strain at end of Consol. %	5.65
Vertical Stress at end of Consol (kPa)	269.53	Change in Height ΔH_c (mm)	1.32
Laboratory OCR	N/A		

Direct Simple Shear Test Results

Initial Vertical Stress (kPa)	269.95	Peak Shear Strength (kPa)	63.77
Initial Shear Stress (kPa)	0.88	Excess Pore Pressure at Peak (kPa)	123.37
Applied Shear Bias (kPa)	0.00	Ratio of Peak / $\sigma'v$	0.24
Rate of Shearing (%/hr)	5.00	Maximum Shear Strain γ_{MAX} (%)	19.98
Test Condition	Undrained	Shear Strength at γ_{MAX} (kPa)	53.41

Comments / Special Instructions

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Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

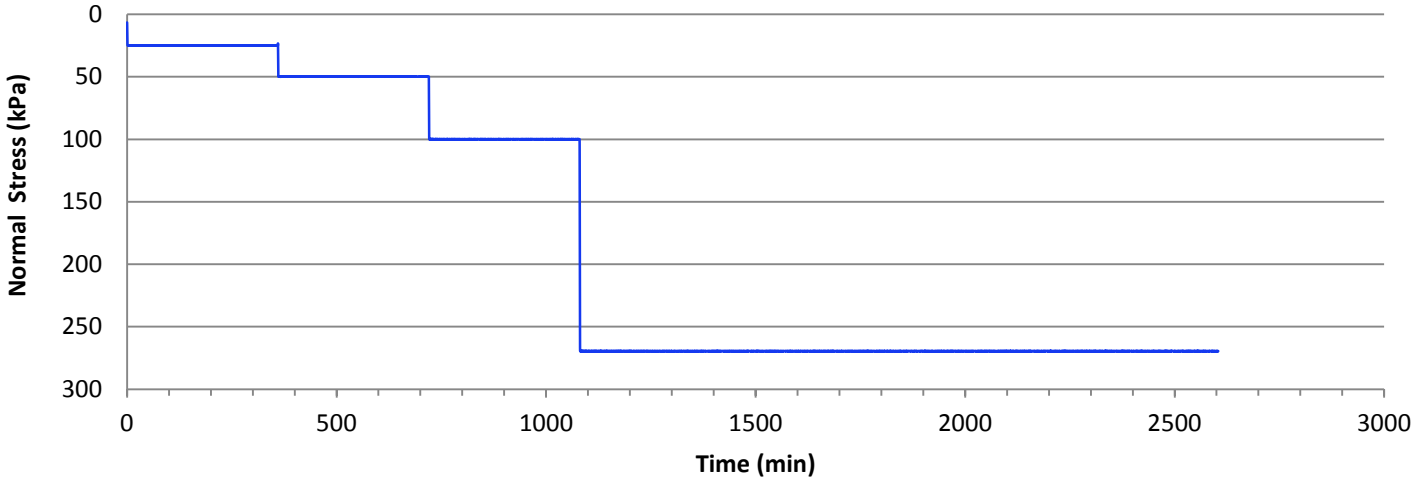
Project No.:	1525010 / 3000	**Sample Number:**	BH16-08 Sa 19
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	269.6kPa, Static
Location:	Annacis Island	**Depth (m):**	29.20-29.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

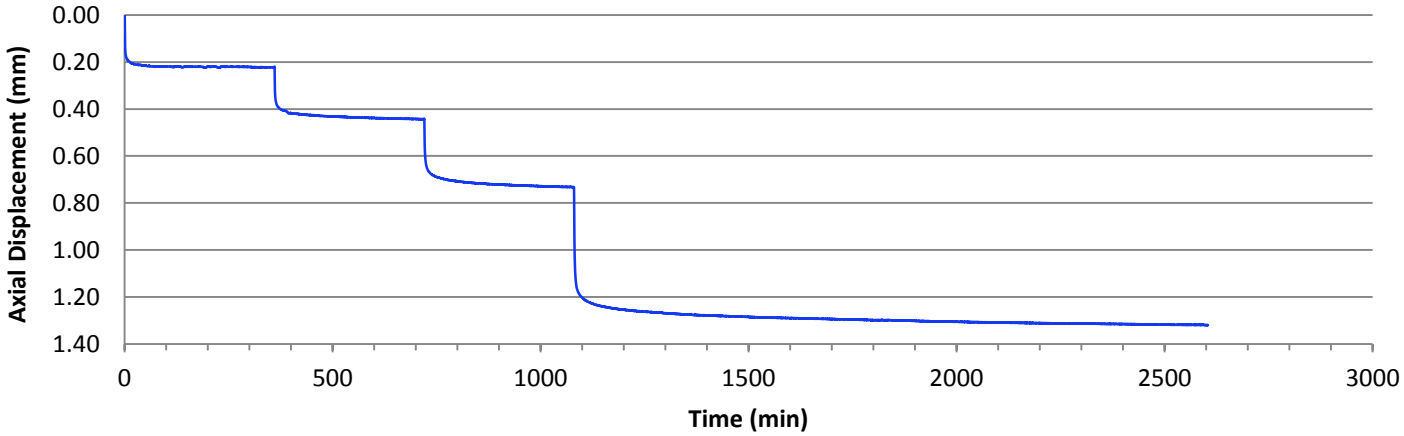
Consolidation Summary

Stress at end of Consolidation (kPa)	269.53
Axial Strain at end of Consolidation (%)	5.65
OCR	N/A
Change in Height ΔH_c (mm)	1.32

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	269.6			
Load (kN)	0.0973	0.1943	0.3884	1.0463			
Duration (min)	360	360	360	1524			
Axial Strain (%)	0.95	1.90	3.13	5.65			





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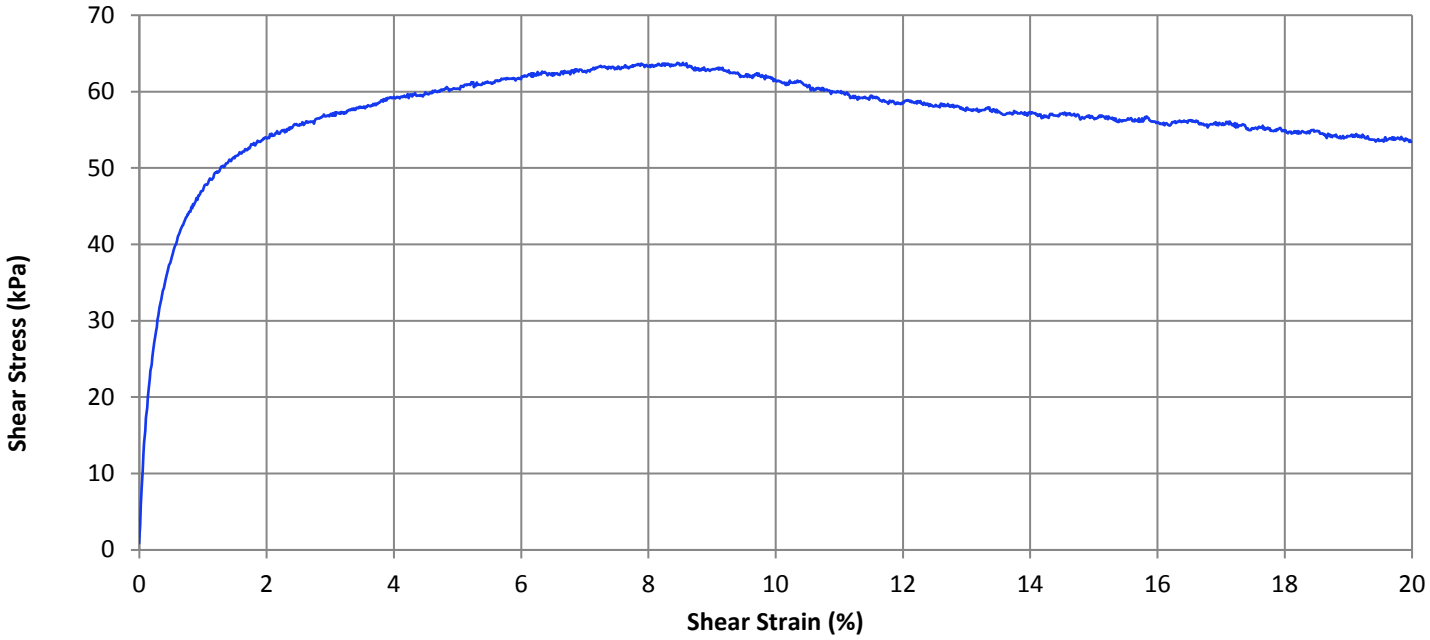
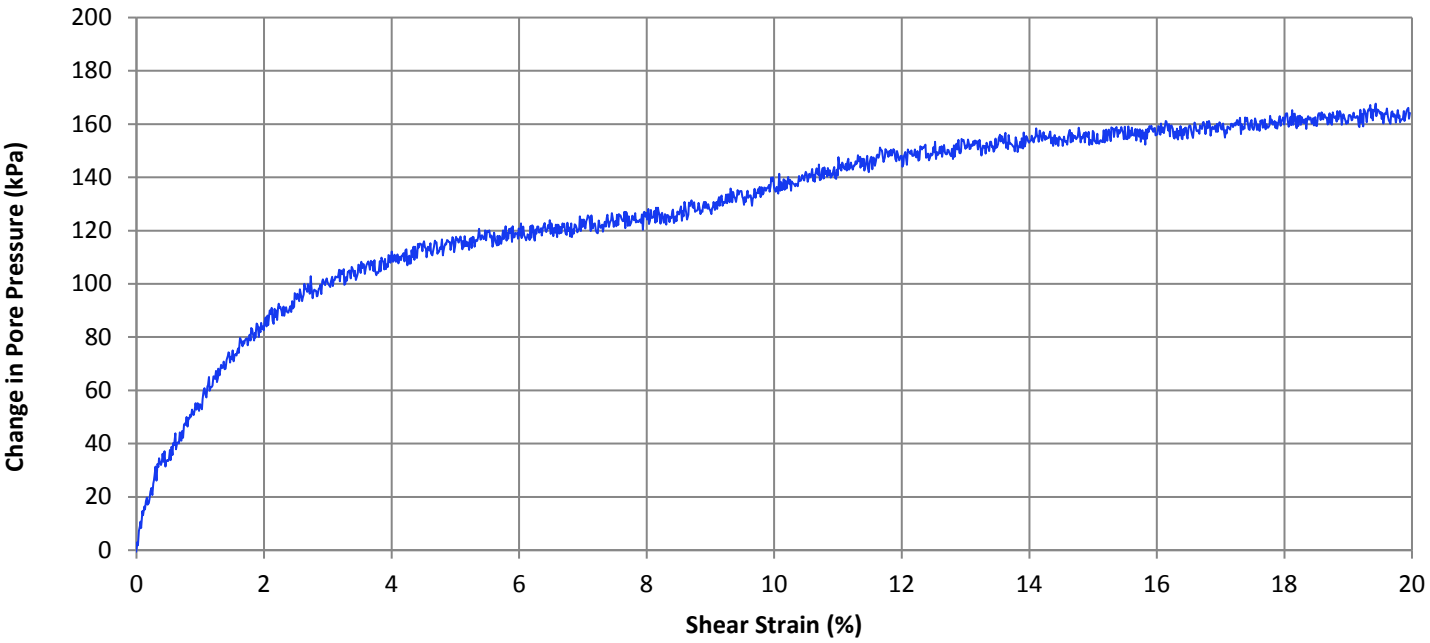
NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-08 Sa 19
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	269.6kPa, Static
Location:	Annacis Island	**Depth (m):**	29.20-29.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28





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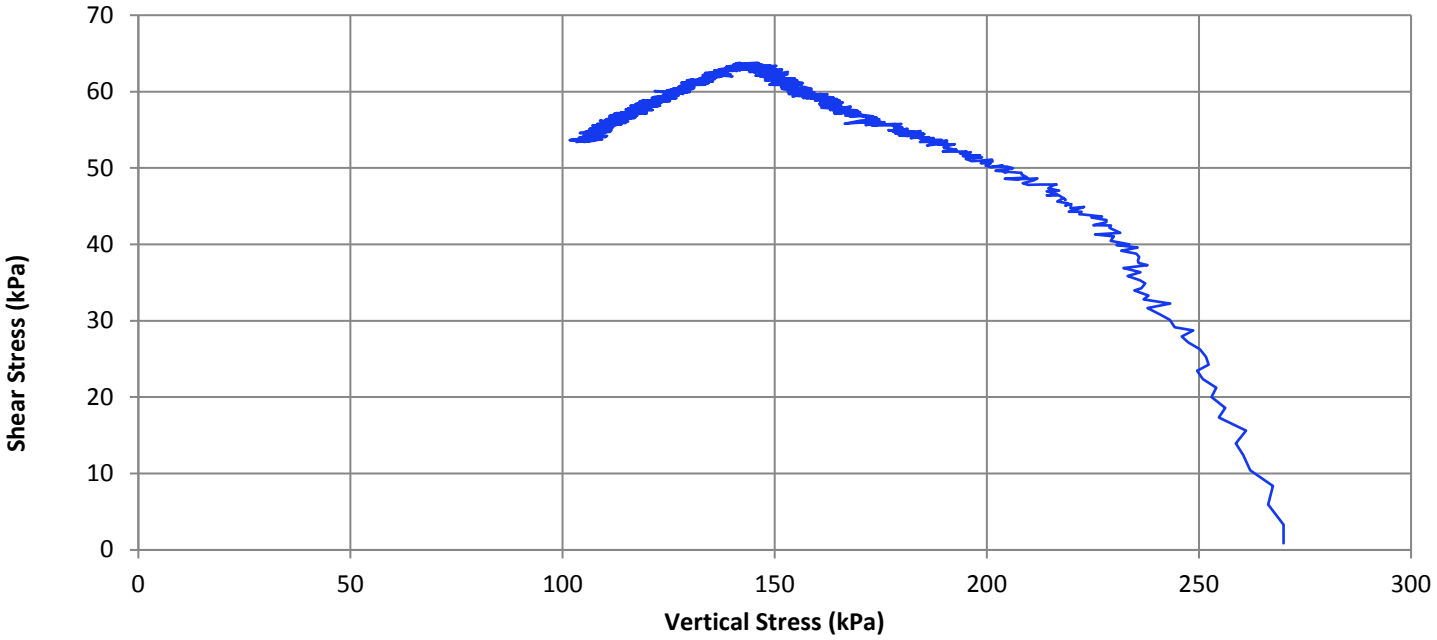
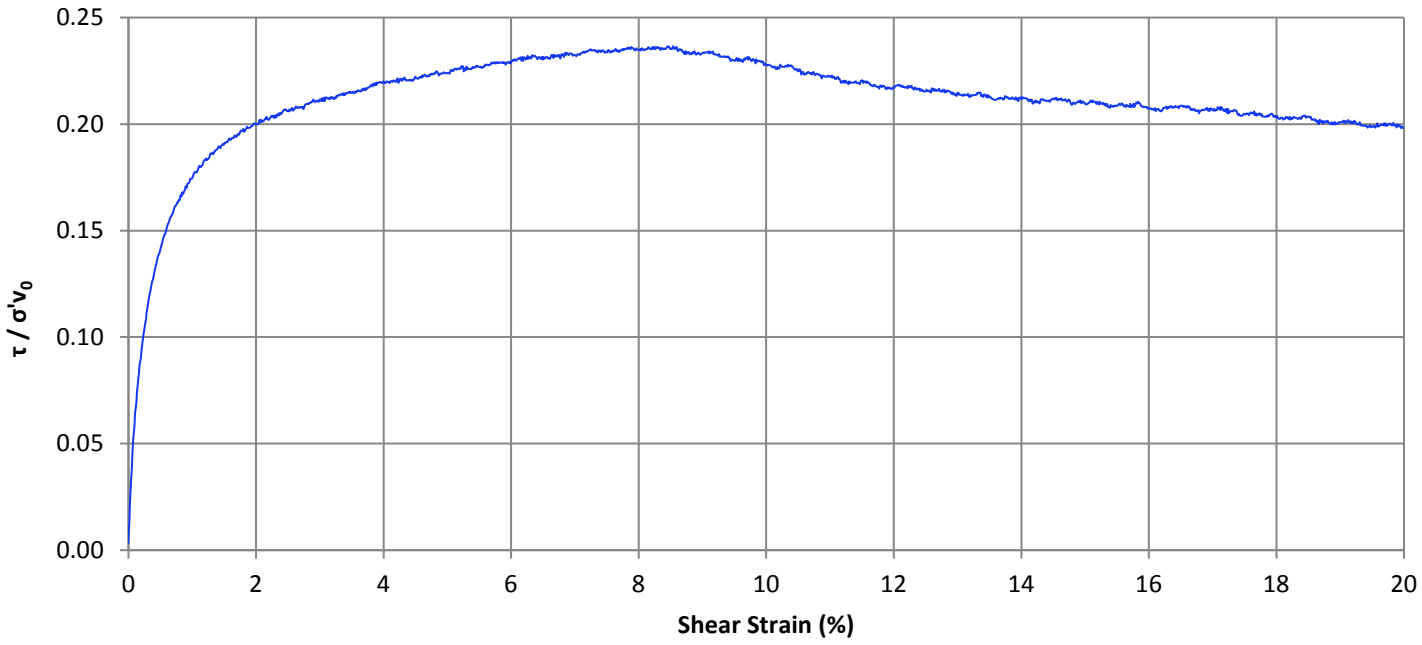
Location:	Annacis Island	**Depth (m):**	29.20-29.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28





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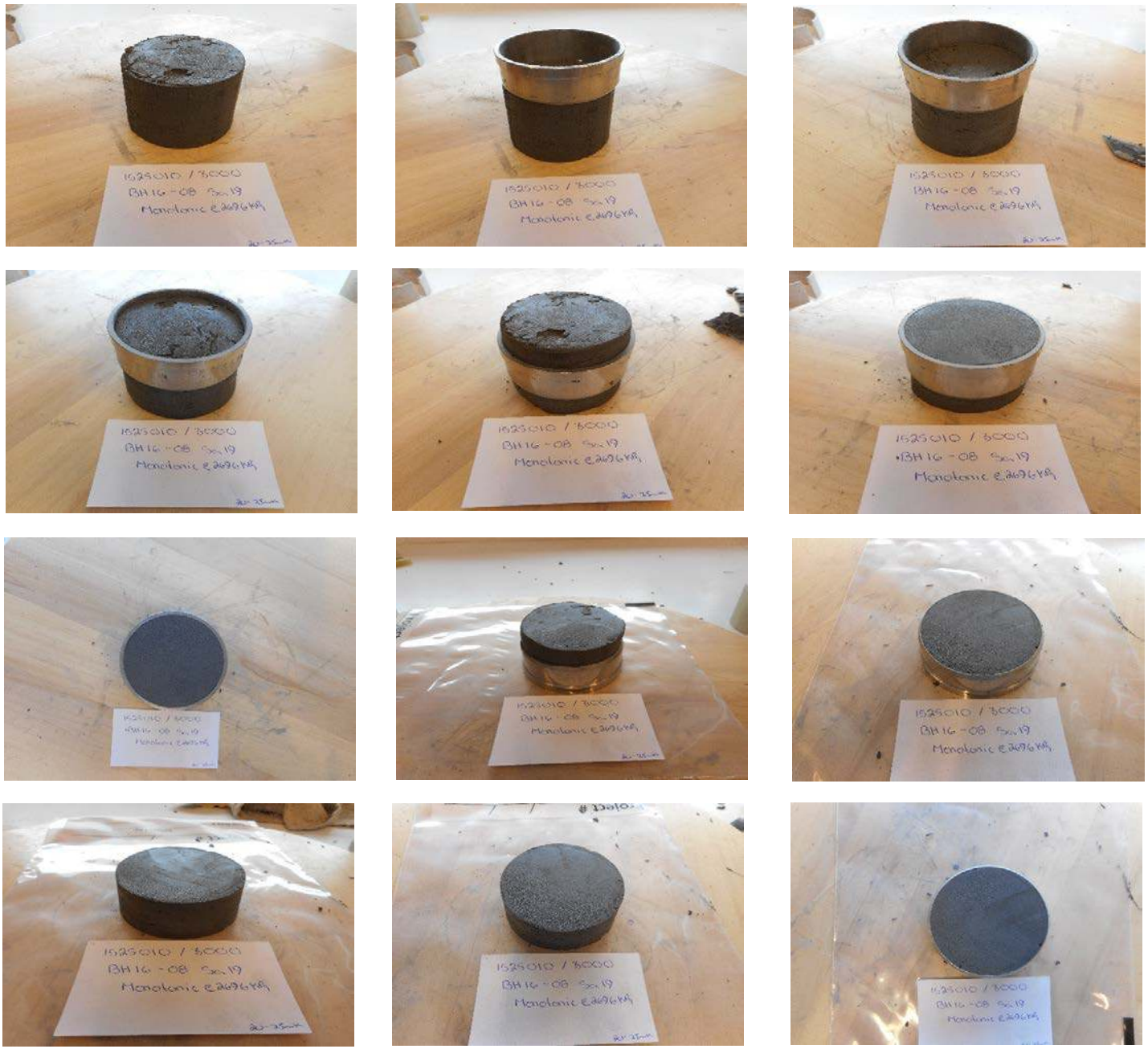
Project No.:	1525010 / 3000	**Sample Number:**	BH16-08 Sa 19
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	269.6kPa, Static
Location:	Annacis Island	**Depth (m):**	29.20-29.25
Client:	CDM Smith Canada ULC	**Lab ID No:**	28



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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-08 Sa 19
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	269.6kPa, 0.17 CSR
Location:	Annacis Island	**Depth (m):**	29.00-29.60
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

General Remarks

Equipment Description: GDS - Station 2

Vertical LVDT	Serial No.:	11897
Vertical Load Cell	Serial No.:	38408
Shear Load Cell	Serial No.:	158877

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.04
Diameter (mm)	70.46
Area (cm^2)	38.99
Volume (cm^3)	89.84
Specific Gravity (Measured)	2.72

Visual Description	SILTY CLAY - CLAYEY SILT, trace fine sand; grey; cohesive, w>PL, firm.		
Sand Fraction (%)	N/A	Liquid Limit	Non Plastic
Fines Fraction (%)	N/A	Plastic Limit	Non Plastic
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	182.64	Initial Water Content (%)	27.63
Dry Mass (g)	143.1	Initial Saturation (%)	>100
Initial Wet Unit Weight (kN/m^3)	19.94	Final Water Content (%)	23.72
Initial Dry Unit Weight (kN/m^3)	15.63	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	N/A	Max. Axial Strain %	4.74
Max Applied Vertical Stress (kPa)	270.39	Axial Strain at end of Consol. %	4.73
Vertical Stress at end of Consol (kPa)	269.98	Change in Height ΔH_c (mm)	1.09
Laboratory OCR	1.00		

Cyclic Test Results

Frequency (Hz)	0.10
CSR	0.17
Cycles to 3.75% Shear Strain	16
Initial Vertical Stress (kPa)	271.93
Max Abs. Cyclic Shear Stress (kPa)	45.91
Max. Shear Strain at N=16 (zero load)	2.17
Min. Shear Strain at N=16 (zero load)	-2.40
Max. DU at N=16 (zero load)	220.70
Min. DU at N=16 (zero load)	213.80

Post Cyclic Reconsolidation Test Results

Initial Vertical Stress (kPa)	22.80
Initial Shear Stress (kPa)	9.87
Max Applied Vertical Stress (kPa)	270.21
Axial Strain at end of Reconsol. %	2.39
Change in Height ΔH_c (mm)	0.52

Comments / Special Instructions

Comments / Special Instructions

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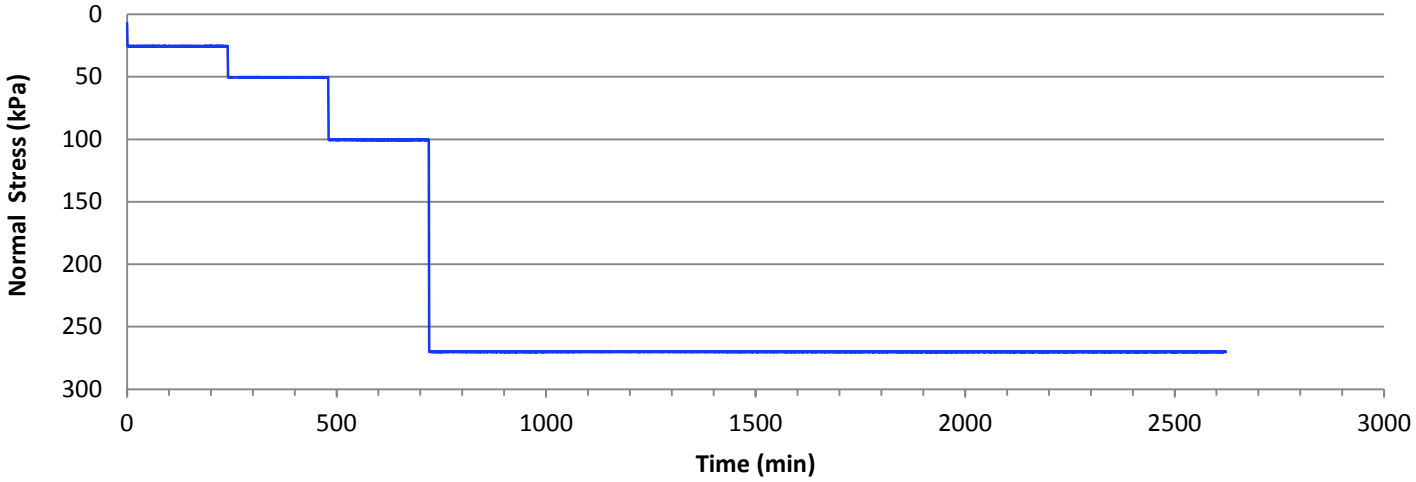
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	269.6kPa, 0.17 CSR
Location:	Annacis Island	**Depth (m):**	29.00-29.60
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

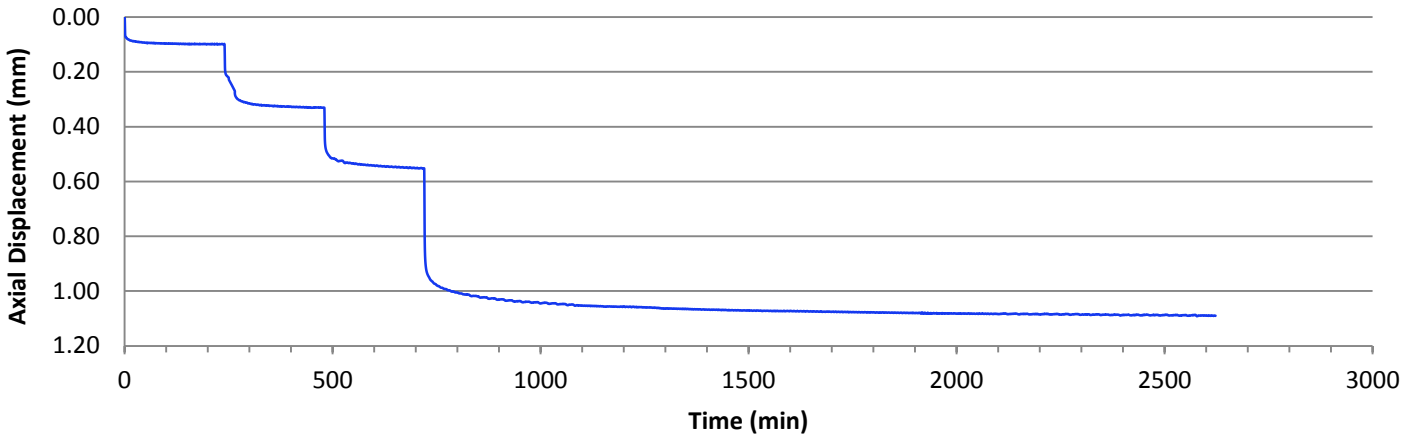
Consolidation Summary

Stress at end of Consolidation (kPa)	269.98
Axial Strain at end of Consolidation (%)	4.73
OCR	1.00
Change in Height ΔH_c (mm)	1.09

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	269.9			
Load (kN)	0.1006	0.1979	0.393	1.0543			
Duration (min)	240	240	240	1902			
Axial Strain (%)	0.43	1.44	2.40	4.74			





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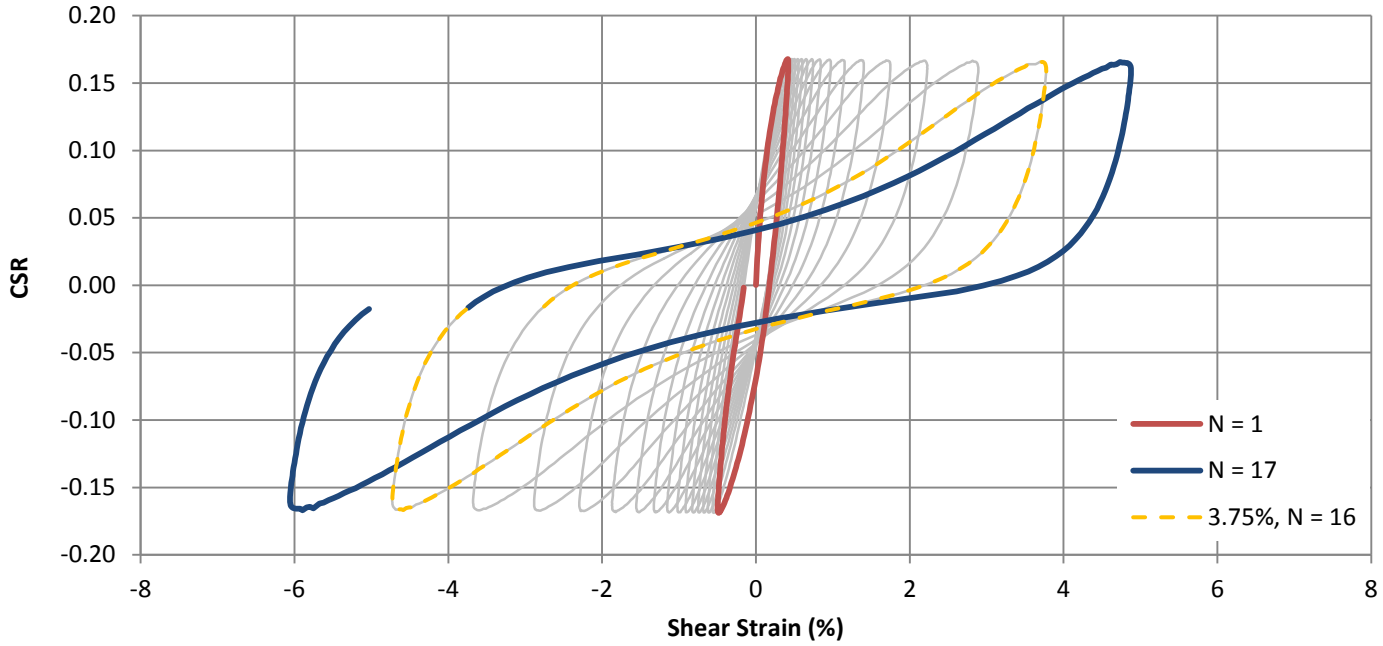
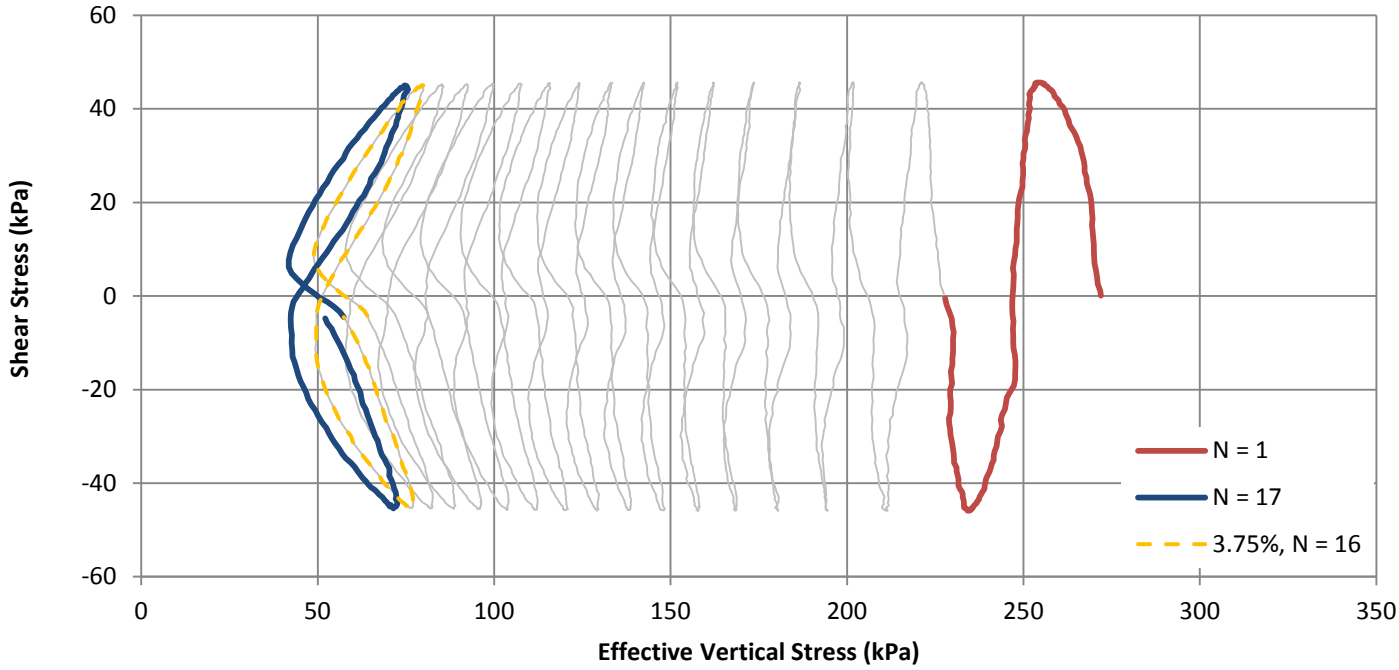
Location:	Annacis Island	**Depth (m):**	29.00-29.60
Client:	CDM Smith Canada ULC	**Lab ID No:**	28





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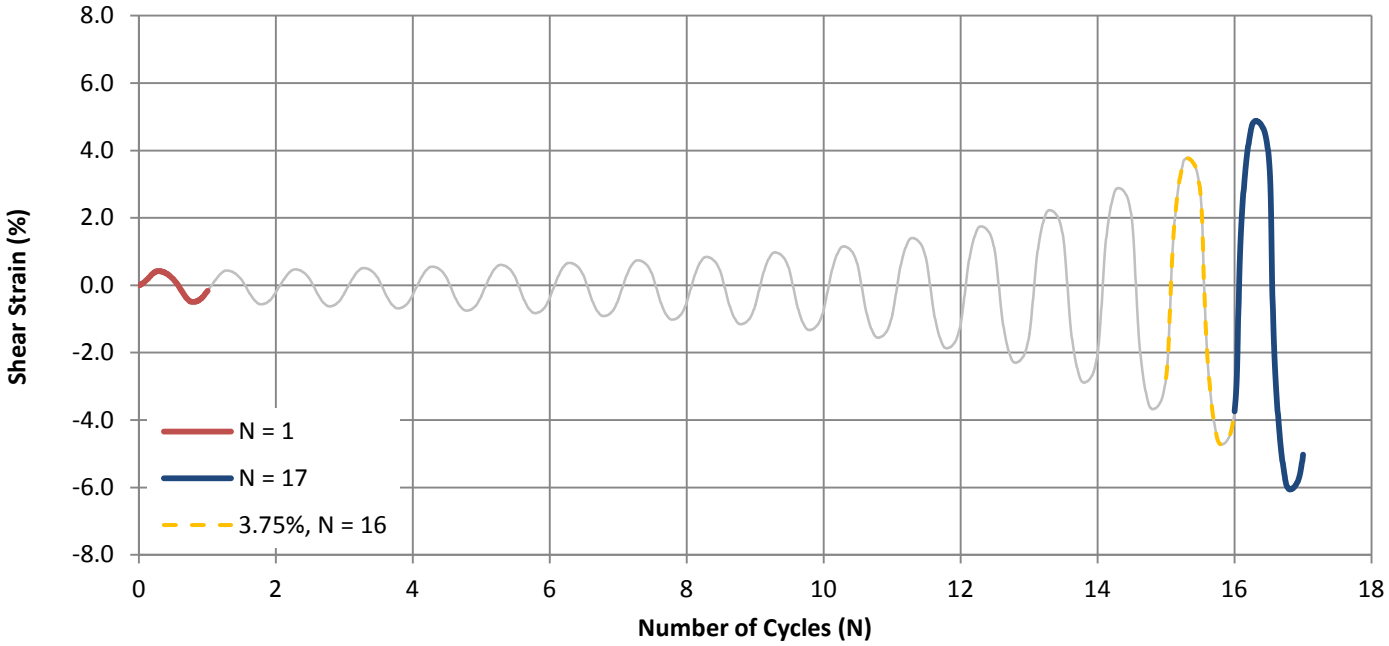

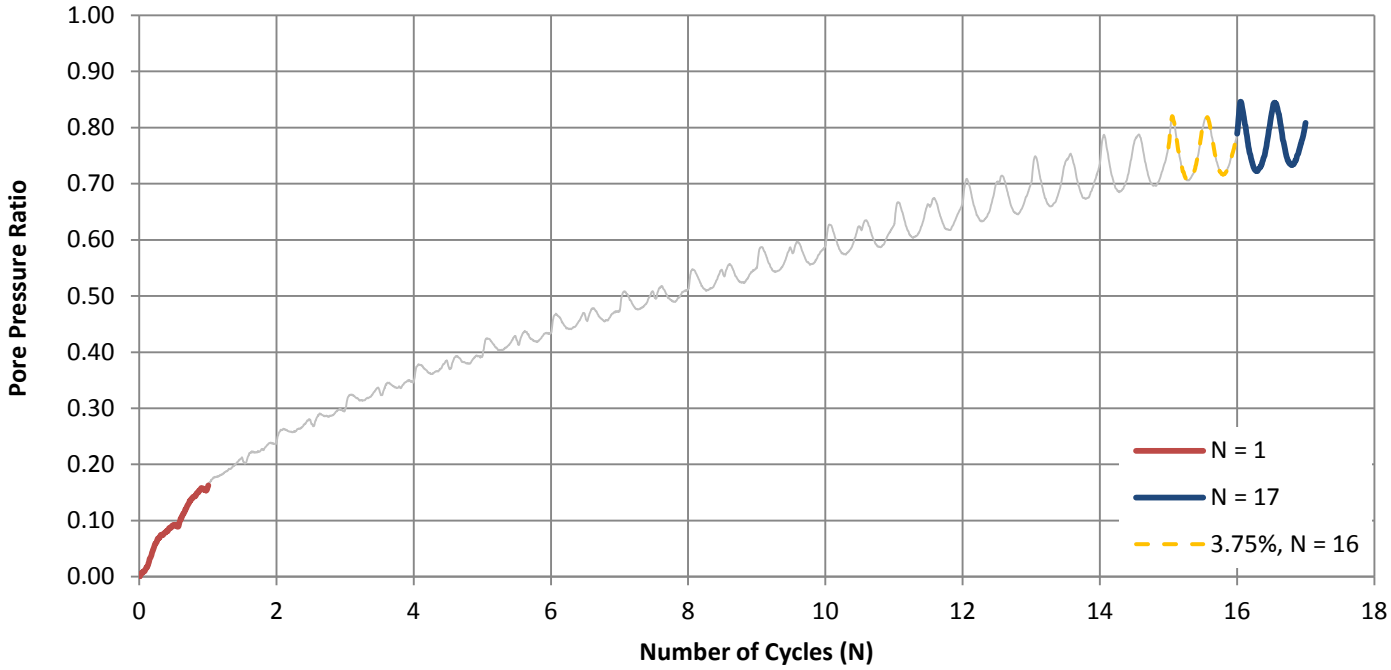

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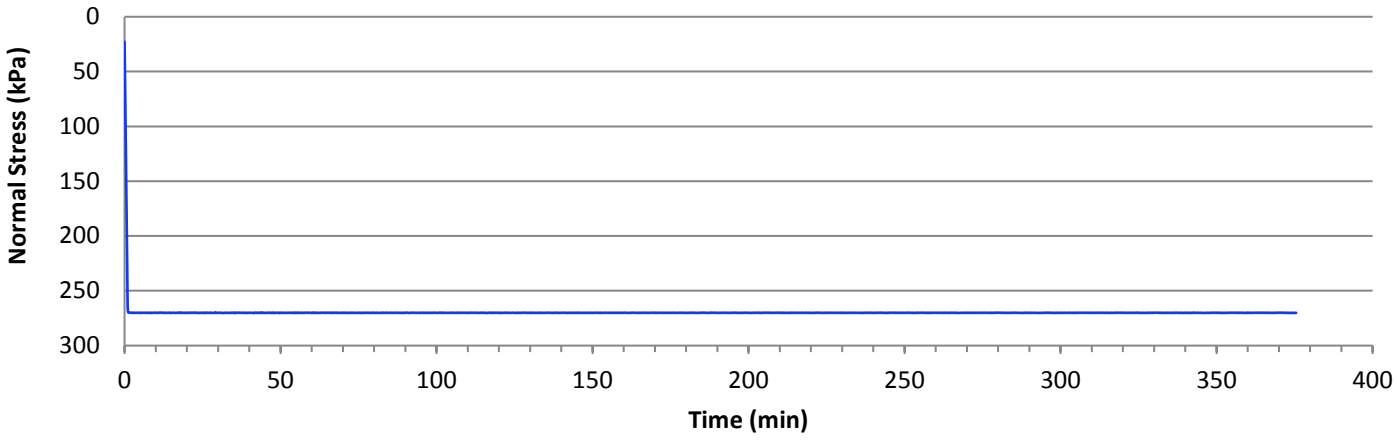
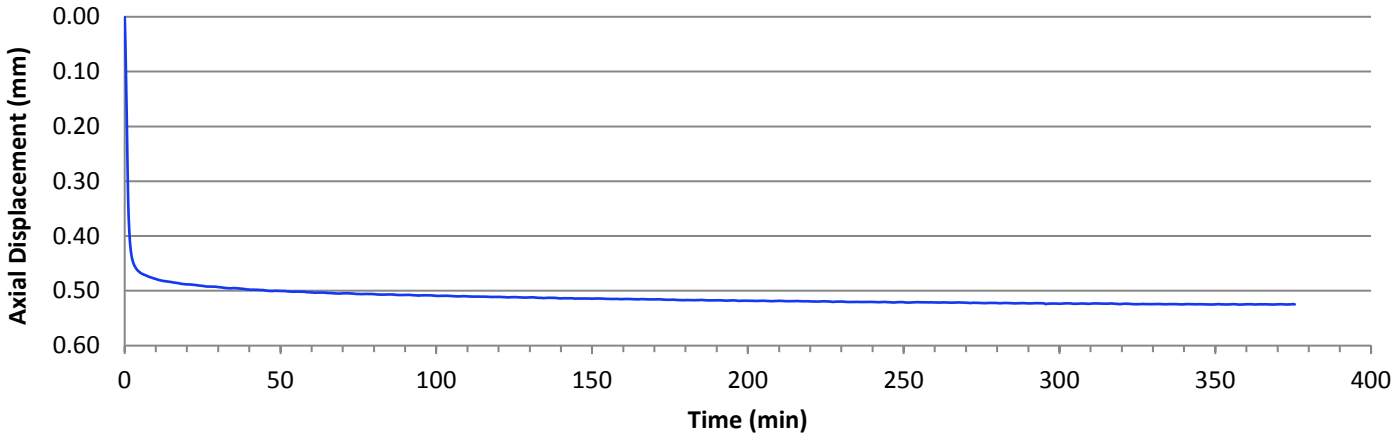
Project No.:	1525010 / 3000	**Sample Number:**	BH16-08 Sa 19
Project:	Annacis Outfall and Transient Mi	**Test ID:**	269.6kPa, 0.17 CSR
Location:	Annacis Island	**Depth (m):**	29.00-29.60
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

Stress at Start of Reconsolidation (kPa)	22.80
Stress at end of Reconsolidation (kPa)	270.21
Axial Strain at end of Reconsolidation (%)	2.39
Change in Height ΔH_c (mm)	0.52

Comments
Reconsolidation data calculated from the sample height at end of initial consolidation

Increment (kPa)	269.6						
Load (kN)	1.0543						
Duration (min)	376						
Axial Strain (%)	2.39						





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Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	269.6kPa, 0.17 CSR
Location:	Annacis Island	**Depth (m):**	29.00-29.60
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

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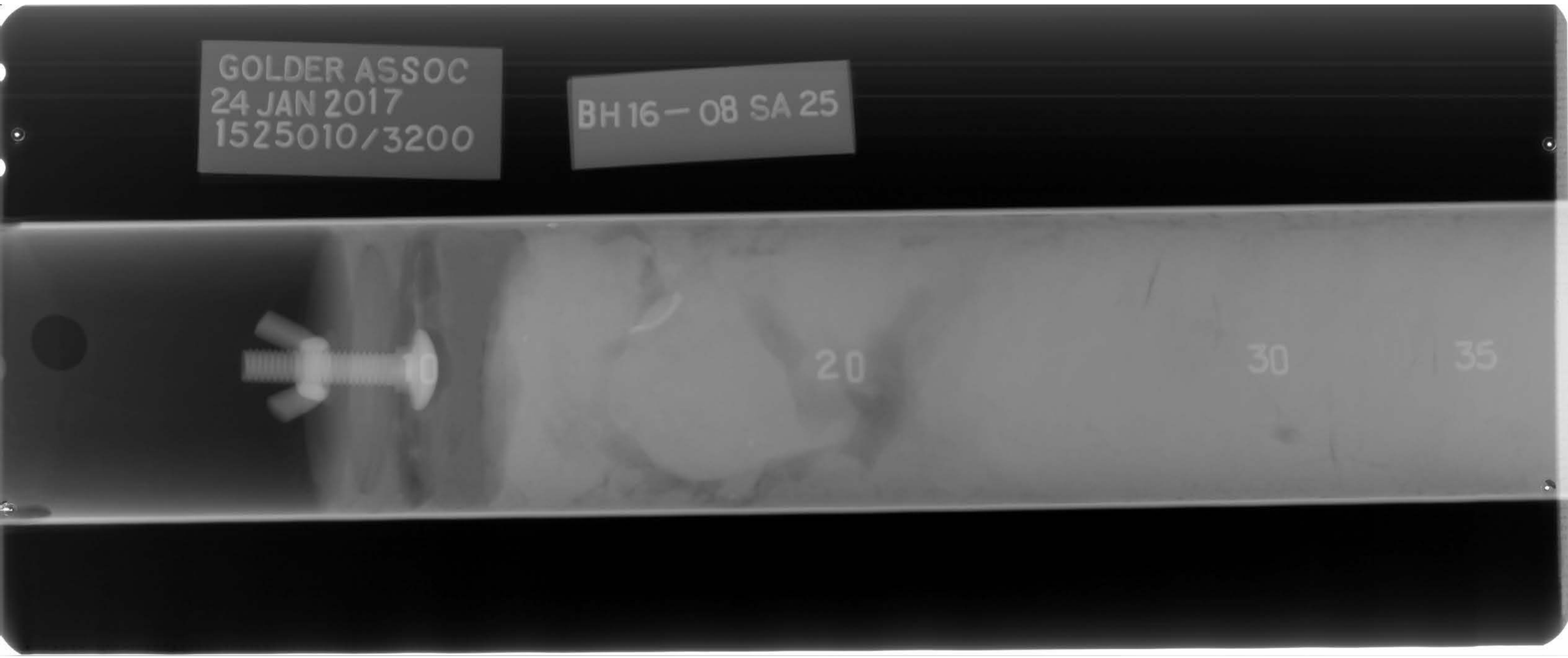
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GOLDER ASSOC
24 JAN 2017
1525010/3200

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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

Project No.:	1525010 / 3000	**Sample Number:**	BH16-08 Sa 24
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	339.1kPa, 0.15 CSR
Location:	Annacis Island	**Depth (m):**	36.6-37.2
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

General Remarks

Equipment Description: GDS - Station 2

Vertical LVDT	Serial No.:	11897
Vertical Load Cell	Serial No.:	38408
Shear Load Cell	Serial No.:	158877

Sample Properties

Preparation Method	Trim from Undisturbed
Height (mm)	23.53
Diameter (mm)	70.50
Area (cm^2)	39.04
Volume (cm^3)	91.85
Specific Gravity (Measured)	2.71

Visual Description	SILTY CLAY and CLAYEY SILT; grey; w>PL, firm.		
Sand Fraction (%)	N/A	Liquid Limit	26
Fines Fraction (%)	N/A	Plastic Limit	18
Shear Strength est. (kPa)		N/A	
Sensitivity		N/A	

Weight Volume Relationships

Initial Wet Mass (g)	181.45	Initial Water Content (%)	29.42
Dry Mass (g)	140.2	Initial Saturation (%)	>100
Initial Wet Unit Weight (kN/m^3)	19.38	Final Water Content (%)	28.94
Initial Dry Unit Weight (kN/m^3)	14.97	Final Saturation (%)	>100

Consolidation

Effective Overburden Pressure (kPa)	N/A	Max. Axial Strain %	4.99
Max Applied Vertical Stress (kPa)	339.94	Axial Strain at end of Consol. %	4.99
Vertical Stress at end of Consol (kPa)	339.61	Change in Height ΔH_c (mm)	1.17
Laboratory OCR	N/A		

Cyclic Test Results

Frequency (Hz)	0.10
CSR	0.15
Cycles to 3.75% Shear Strain	3.75% not reached
Initial Vertical Stress (kPa)	339.02
Max Abs. Cyclic Shear Stress (kPa)	51.08
Max. Shear Strain at N= n/a (zero load)	3.75% not reached
Min. Shear Strain at N= n/a (zero load)	3.75% not reached
Max. DU at N= n/a (zero load)	3.75% not reached
Min. DU at N= n/a (zero load)	3.75% not reached

Post Cyclic Reconsolidation Test Results

Initial Vertical Stress (kPa)	178.22
Initial Shear Stress (kPa)	-3.77
Max Applied Vertical Stress (kPa)	339.66
Axial Strain at end of Reconsol. %	0.54
Change in Height ΔH_c (mm)	0.12

Comments / Special Instructions

Only 22 cycles requested.

Comments / Special Instructions

The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

G. Patton	March 21, 2017	M. Sanin & S.Thiru	May 29, 2017
TESTED BY	DATE	CHECKED BY	DATE

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Cyclic Direct Simple Shear Testing of Soils Under Consolidated Constant-Volume Conditions

NORSOK G-001

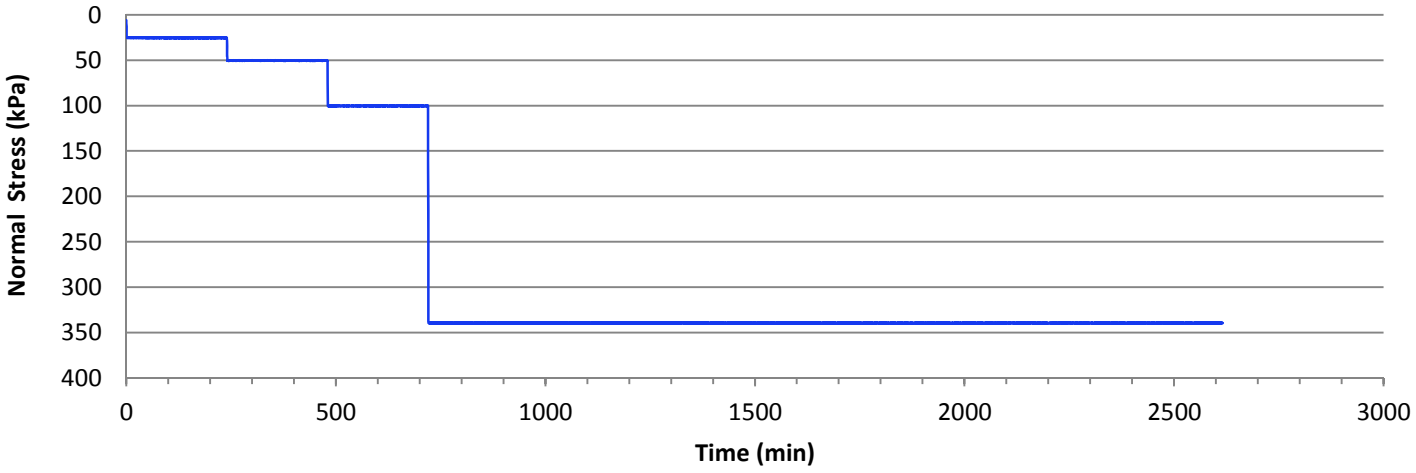
Project No.:	1525010 / 3000	**Sample Number:**	BH16-08 Sa 24
Project:	Annacis Outfall and Transient Mitigation	**Test ID:**	339.1kPa, 0.15 CSR
Location:	Annacis Island	**Depth (m):**	36.6-37.2
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

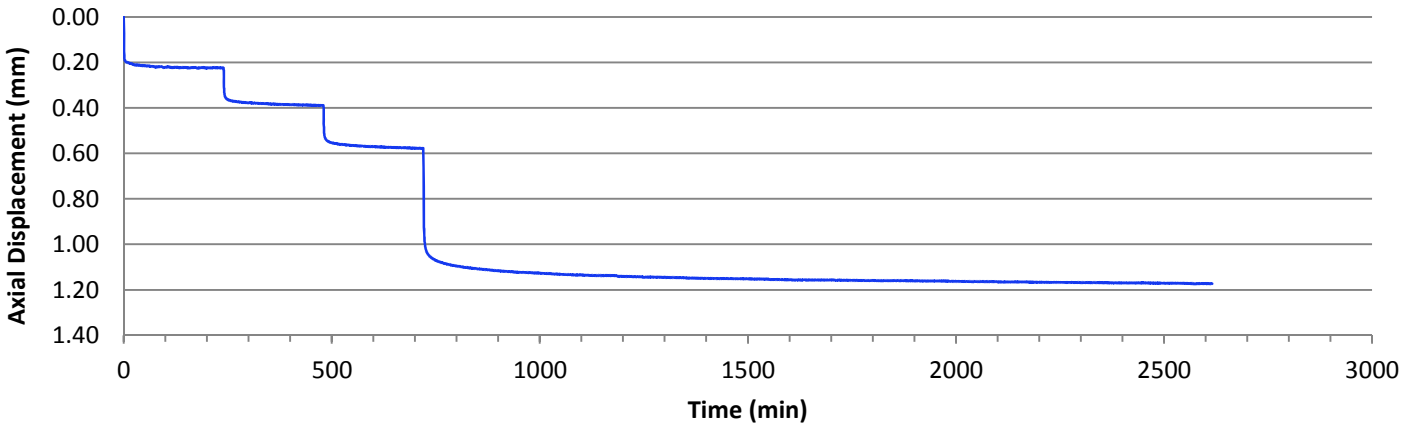
Consolidation Summary

Stress at end of Consolidation (kPa)	339.61
Axial Strain at end of Consolidation (%)	4.99
OCR	N/A
Change in Height ΔH_c (mm)	1.17

Comments
Volumetric strains during consolidation may not be comparable to those measured in an oedometer test due to seating of the platens and possible lateral sample deformation during loading.

Increment (kPa)	25	50	100	339.1			
Load (kN)	0.1008	0.1981	0.3937	1.327			
Duration (min)	240	240	240	1896			
Axial Strain (%)	0.96	1.66	2.46	4.99			





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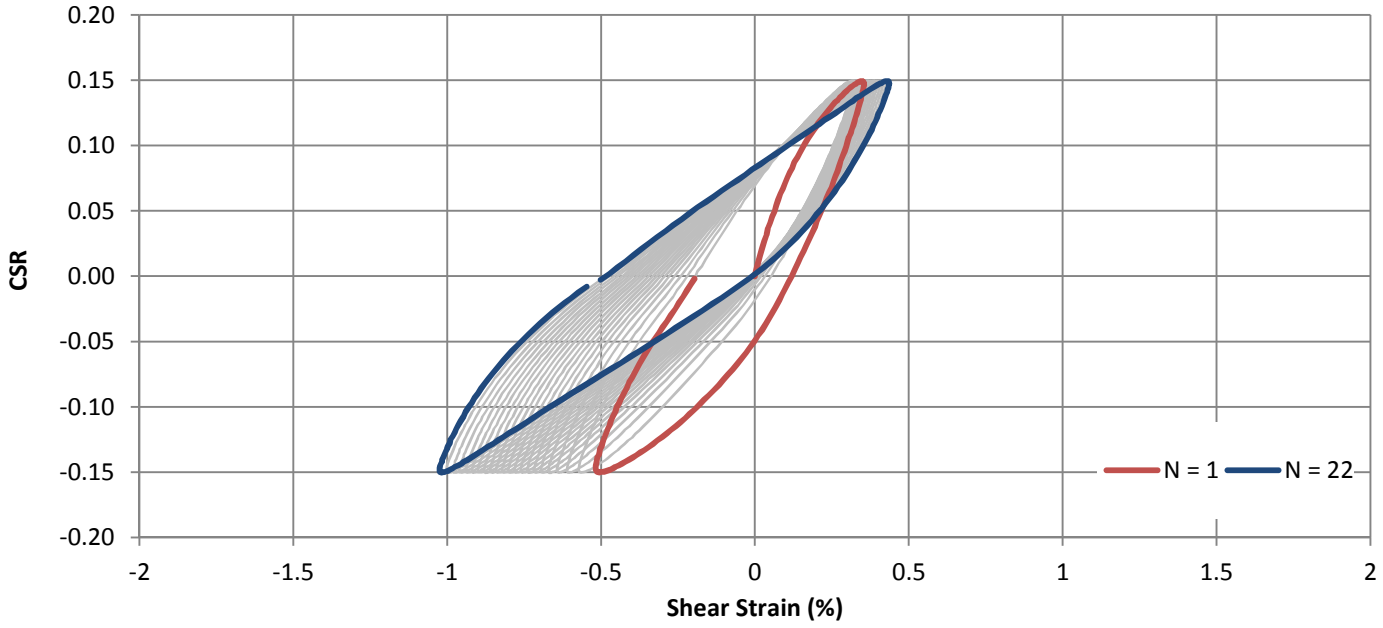

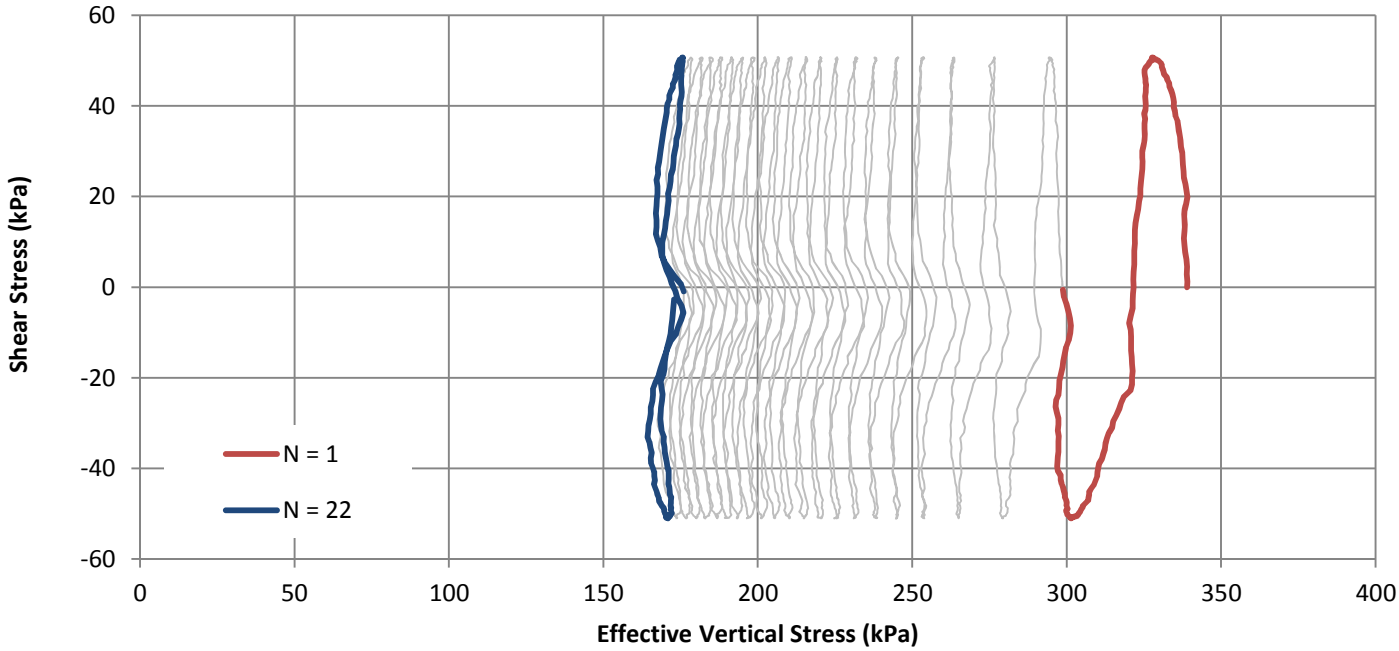

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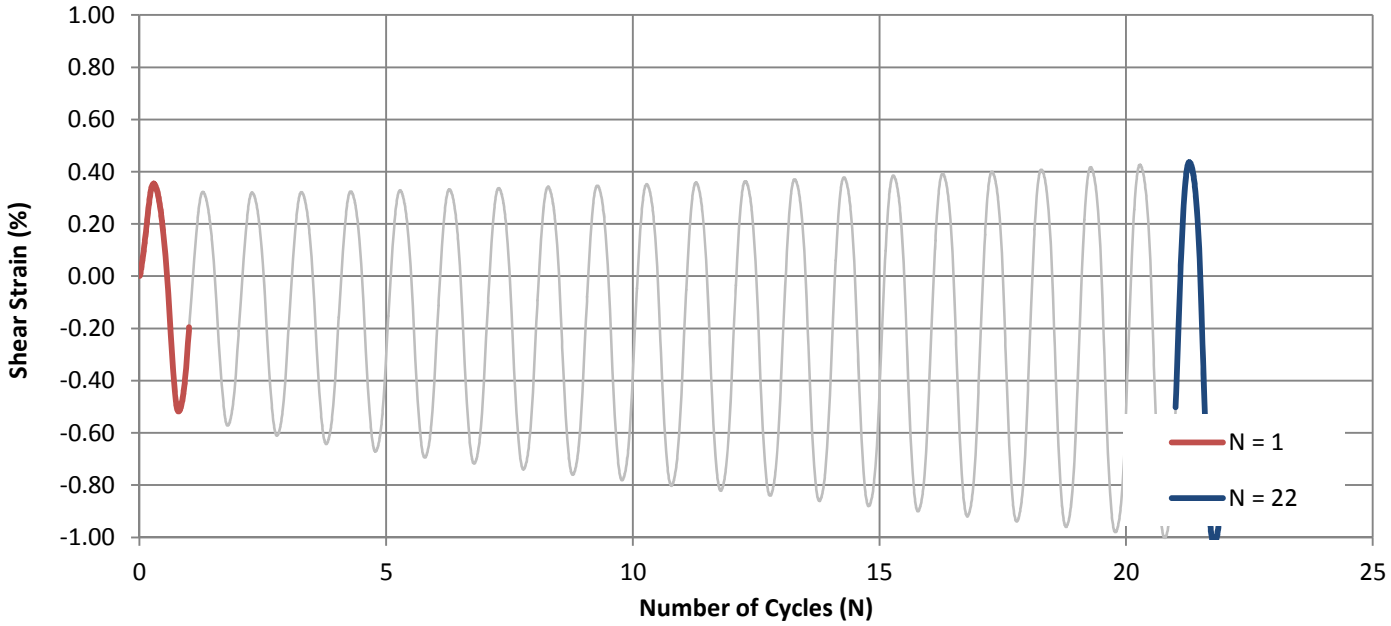

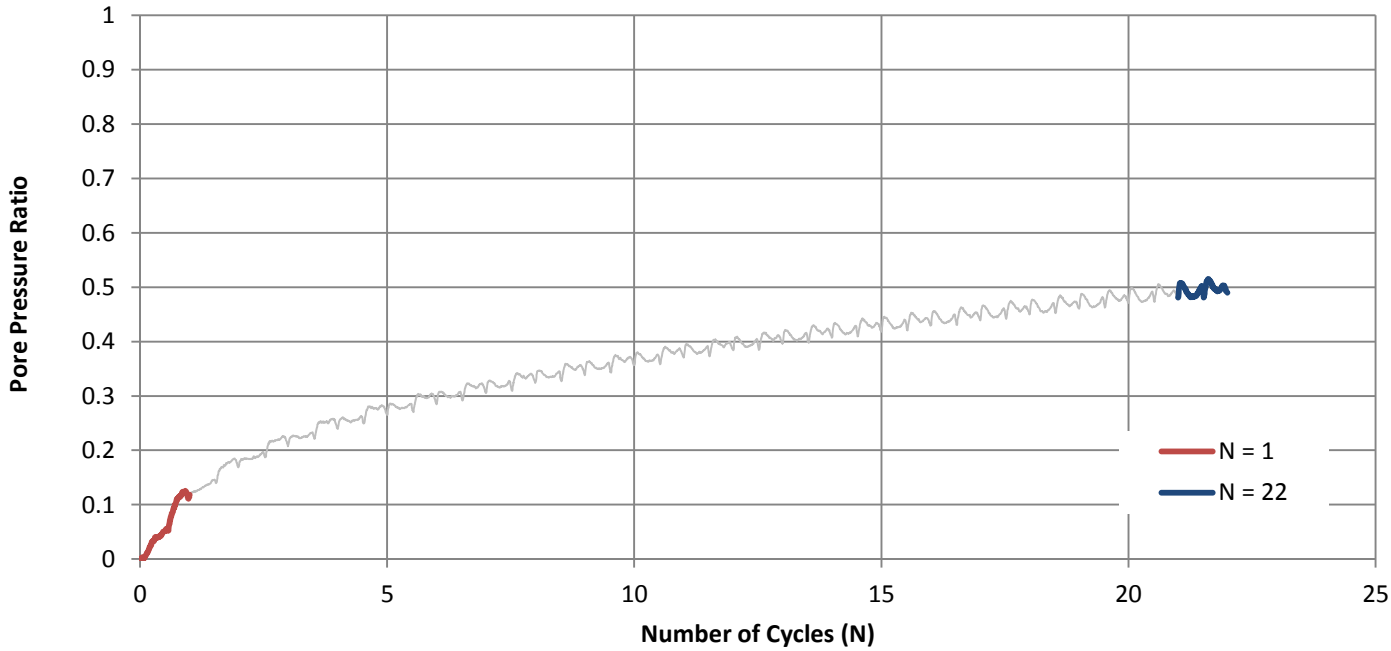

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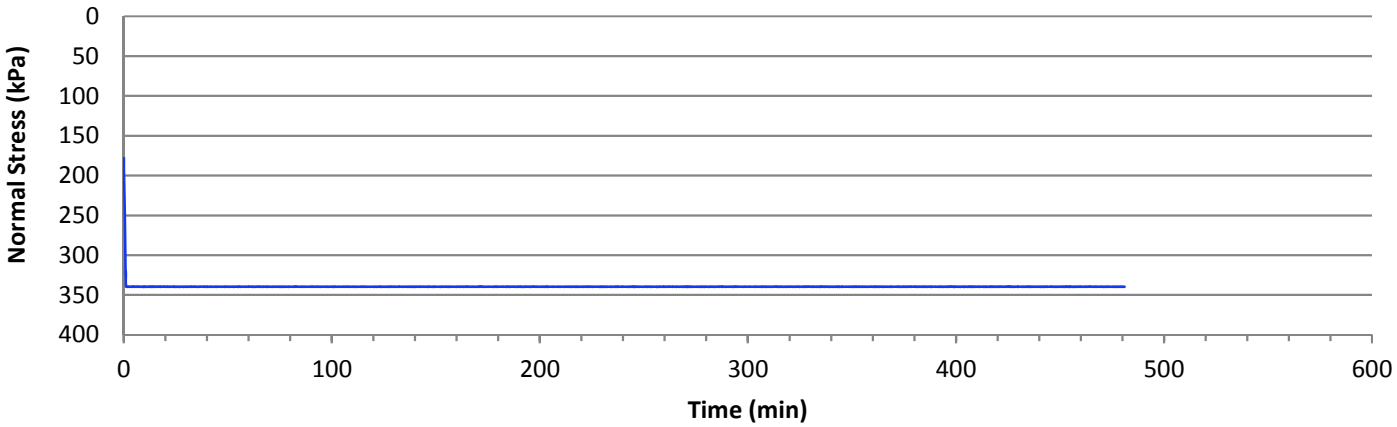
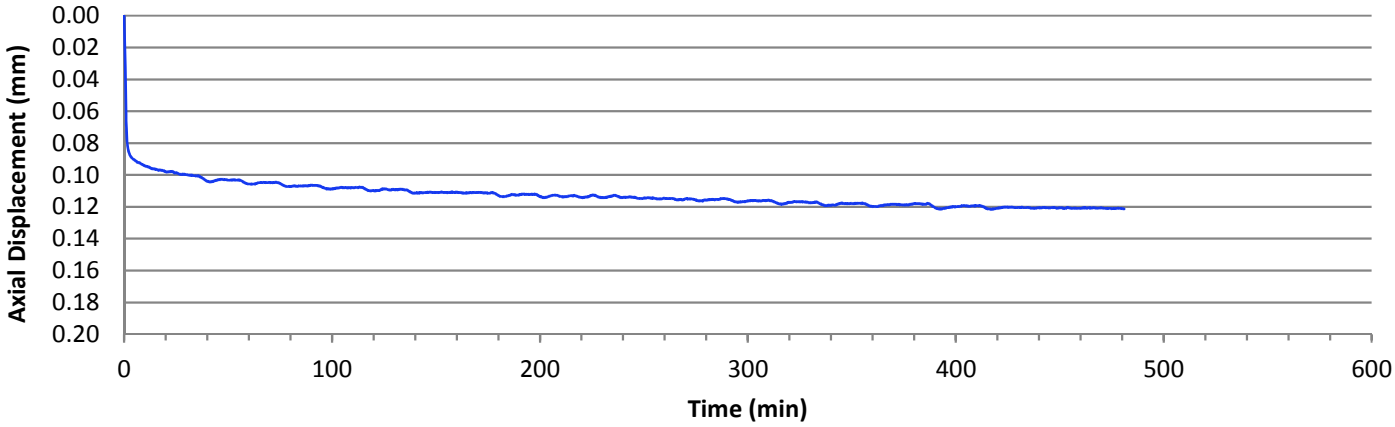
Project:	Annacis Outfall and Transient Mi	**Test ID:**	339.1kPa, 0.15 CSR
Location:	Annacis Island	**Depth (m):**	36.6-37.2
Client:	CDM Smith Canada ULC	**Lab ID No:**	28

Stress at Start of Reconsolidation (kPa)	178.22
Stress at end of Reconsolidation (kPa)	339.66
Axial Strain at end of Reconsolidation (%)	0.54
Change in Height ΔH_c (mm)	0.12

Comments
Reconsolidation data calculated from the sample height at end of initial consolidation

Increment (kPa)	339.1						
Load (kN)	1.3263						
Duration (min)	481						
Axial Strain (%)	0.54						





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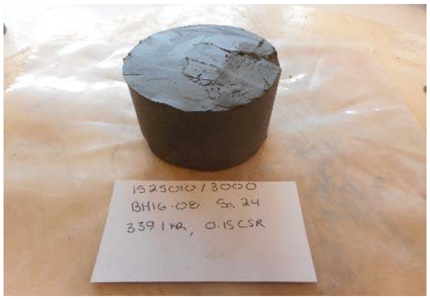
Client:	CDM Smith Canada ULC	**Lab ID No:**	28



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Unconfined Compression Strength Tests

Standard Test Methods for Unconfined Compression Strength of Cohesive Soil

ASTM D2166

Project No.:	1532895/1000	**Borehole:**	BH15-13
Project:	Annacis Outfall	**Sample:**	32
Location:	Annacis Island, Delta, BC	**Depth (m):**	48.46-49.07
Client:	B&V	**Lab ID No:**	306

Sample Type:	Intact	**Classification:**	CI
Sample Description:	CLAY, some silt, gray, moist, firm to stiff		
Remarks:	Thin sand layer on the top of the specimen.		

Sample Properties

	Initial	Final
Height (cm)	14.34	12.20
Diameter (cm)	7.24	7.85
Area (cm^2)	41.22	48.44
Volume (cm^3)	591	591
Wet weight (g)	1170.3	1169.5
Dry weight (g)	918.6	918.6
Water content (%)	27.4	27.3
Wet density, ρ_{wet} (kg/m^3)	1981	1979
Dry density, ρ_{dry} (kg/m^3)	1555	1555
Saturation (%)	98	98
Void ratio, e (-)	0.77	0.77
Specific Gravity (assumed)	2.75	
Sensitivity	N/A	

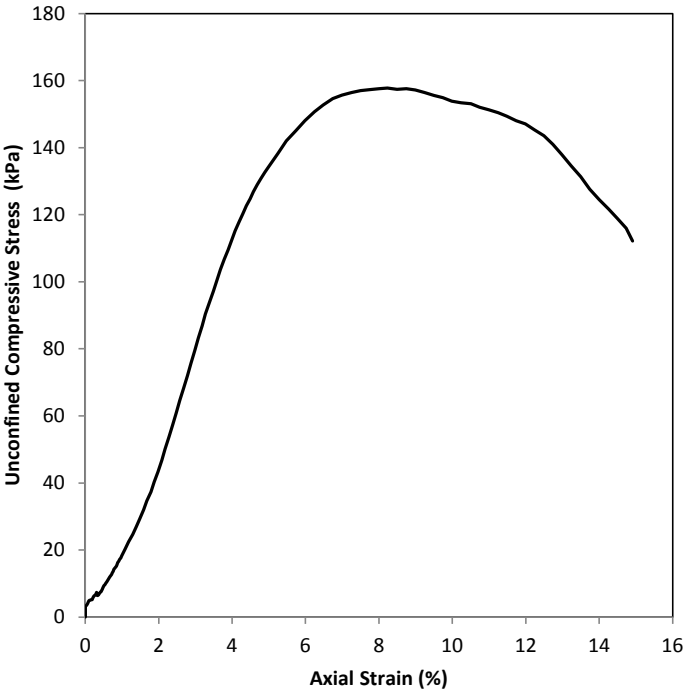
Equipment

Machine	Load Frame - Station 5
Load Cell	717074
Axial DCDT	LP-828
Feed Rate (%/min)	1.00

Test Results

Unconfined Compressive Stress (kPa)	**158**
Strain at Failure, ε_f (%)	**8.24**
Shear Strength (kPa)	79
Initial Height/Diameter Ratio	1.98

Test Comments: -



CS	August 31, 2015	L.Lee	September 10, 2015
TESTED BY	DATE	CHECKED BY	DATE

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Standard Test Methods for Unconfined Compression Strength of Cohesive Soil

ASTM D2166

Project No.:	1532895/1000	**Borehole:**	BH15-05
Project:	Annacis Outfall	**Sample:**	34
Location:	Annacis Island, Delta, BC	**Depth (m):**	50.90-51.51
Client:	B&V	**Lab ID No:**	306

Sample Type:	Intact	**Classification:**	CI
Sample Description:	SILTY CLAY, gray, moist, firm.		
Remarks:	-		

Sample Properties

	Initial	Final
Height (cm)	16.22	14.43
Diameter (cm)	7.26	7.69
Area (cm^2)	41.36	46.48
Volume (cm^3)	671	671
Wet weight (g)	1281.4	1280.4
Dry weight (g)	954.3	954.3
Water content (%)	34.3	34.2
Wet density, ρ_{wet} (kg/m^3)	1910	1909
Dry density, ρ_{dry} (kg/m^3)	1423	1423
Saturation (%)	100	100
Void ratio, e (-)	0.95	0.95
Specific Gravity (assumed)	2.78	
Sensitivity	N/A	

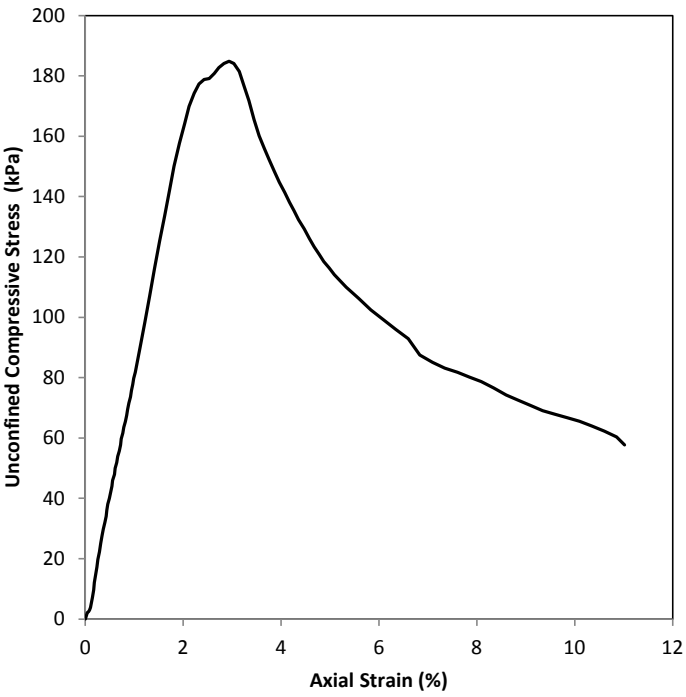
Equipment

Machine	Load Frame - Station 1
Load Cell	400469
Axial DCDT	LP-1215
Feed Rate (%/min)	1.00

Test Results

Unconfined Compressive Stress (kPa)	**185**
Strain at Failure, ε_f (%)	**2.94**
Shear Strength (kPa)	92
Initial Height/Diameter Ratio	2.23

Test Comments: -



MM/CS	August 24, 2015	L.Lee	September 10, 2015
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