

APPENDIX D.1

# Summary of Laboratory Test Results

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**TABLE D1-1 SUMMARY OF LABORATORY TEST RESULTS**

**SR 710 NORTH STUDY**



BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE		
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX (I <sub>s(50)</sub> )	AXIAL CORRECTED INDEX (I <sub>s(50)</sub> )	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)
A-13-001	S-02	5.0	CL	18.3	107																	1431	7.7	9	5
A-13-001	S-04	15.0	CL	25.6	97.8	45	18	27									2.12								
A-13-001	S-06	25.0	CL	16.5	115.4	37	13	24									4.14								
A-13-001	S-08	35.0	SM	17.7	106.3				7	80	13		34	400	32	100									
A-13-001	S-09	40.0	CL	16.6		44	13	31	0	8	92														
A-13-001	S-10	45.0	ML	13.7	121.3				1	38	61														
A-13-001	S-12	55.0	SP	4	100								30	200	29	100									
A-13-001	S-13	60.0	SP-SM						25	68	7														
A-13-001	S-14	65.0	SP-SM	5.6	130.2																				
A-13-001	S-15	70.0	SW-SM	3.4					3	86	11														
A-13-001	S-16	75.0	SM	10.2	105.9				1	55	44														
A-13-001	S-18	85.0	CL	16.2	117.1				0	7	93		30	2350	28	900									
A-13-001	S-20	95.0	CL	10	128.5	26	14	12																	
RC-13-002	B-01	1 to 5	CL																			1142	7.7	380	180
RC-13-002	S-02	5.0	CH			52	20	32																	
RC-13-002	S-03	10.0	CL	18	112				10	46	44						1.2								
RC-13-002	S-04	15.0	SC			47	14	33																	
RC-13-002	S-05	20.0	CL	20	109	40	13	27	3	29	68														
RC-13-002	S-06	25.0	CL			43	12	31																	
RC-13-002	S-07	30.0	CL	21	106	44	13	31									2.18								
RC-13-002	S-09	40.0	CLAYSTONE	26	98	54	20	34									6.69								
RC-13-002	C-12	52.1	CLAYSTONE	15	114	46	19	27	0	5	95	465													
RC-13-002	C-15	67.0	CLAYSTONE	18	114												1.98								
RC-13-002	C-17	77.3	CLAYSTONE	13	115	45	18	27				482													
RC-13-003	S-02	5.0	SILTSTONE	25	93	36	17	19					35	400	35	100									
RC-13-003	S-03	10.0	SILTSTONE	26																		1154	7.9	60	61
RC-13-003	S-04	15.0	SANDSTONE	22	105				0	69	31						4.3								
RC-13-003	S-06	25.0	SANDSTONE	22	105				0	81	19		22	200	29	50									
RC-13-003	S-11	45.0	SANDSTONE						8	77	15														
RC-13-003	S-14	55.0	SANDSTONE						2	77	21														
RC-13-003	S-17	65.0	SANDSTONE	21					0	77	23														

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**SR 710 NORTH STUDY**



BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE				
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX (I <sub>s(50)</sub> )	AXIAL CORRECTED INDEX (I <sub>s(50)</sub> )	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)	
RC-13-003	S-21	80.0	SANDSTONE	23																							
RC-13-003	S-25	95.0	SANDSTONE	23	104				0	81	19		32	450	29	250											
RC-13-004	B-1	0 to 5	SC	17.1																		2541	7.6	101	60		
RC-13-004	S-2	5.0	SC			23	13	10	7	54	39																
RC-13-004	S-3	10.0	SC-SM	11.7	124.7	23	16	7	6	58	36		39	550	36	150											
RC-13-004	S-5	20.0	SC-SM	20.4	105.8				0	49	51		22	600	24	250											
RC-13-004	S-6	25.0	SC-SM																			1853	7.7	137	48		
RC-13-004	S-7	30.0	SC	19.5	110.8				0	61	39		31	400	31	100											
RC-13-004	S-9	40.0	SILTSTONE	24.4	94.2				2	43	55		30	800	29	450											
RC-13-004	C-11	51.0	SANDSTONE	14.3					0	82	18																
RC-13-004	C-13	59.8	SANDSTONE	18.5	110.8				11	77	12	102															
RC-13-004	C-15	69.7	SANDSTONE	7.3					2	88	10																
RC-13-004	C-17	81.1	SANDSTONE	4.5	153.8							2158									1.99E+05	136	471				
RC-13-004	C-21	101.1	SILTSTONE															84.6									
RC-13-005	S-02	5.0	CH			49	16	33	5	19	76																
RC-13-005	S-03	10.0	CH	28	89.4	50	21	29																			
RC-13-005	S-04	15.0	CH	26.1					0	9	91																
RC-13-005	S-05	20.0	CL	13	111.6																						
RC-13-005	S-06	25.0	SC						2	57	41																
RC-13-005	S-07	30.0	SP-SM	6.2	118.2				38	51	11		43	50	41	0											
RC-13-005	S-08	35.0	SM						3	67	30																
RC-13-005	S-09	40.0	SM	12.7	95				0	64	36																
RC-13-005	S-10	45.0	CH	20.5		50	13	37															1137	7.1	23	8	
RC-13-005	S-11	50.0	CH	19.4	107.2				1	44	55		29	300	28	200											
RC-13-005	S-13	60.0	CL	19.7	110.2	41	13	28									4.61										
RC-13-005	S-15	70.0	CL	19.5	110.2	44	13	31	0	24	76		29	800	27	700											
RC-13-005	S-16	75.0	CL			41	12	29	0	20	80																
RC-13-005	S-17	80.0	CH	25.5	99.2	52	13	39									4.01										
RC-13-005	C-21	93.7	SILTSTONE	2.2	157.6																469	511					
RC-13-005	C-22	99.5	SILTSTONE																			2057	7.9	63	21		
RC-13-005	C-28	131.5	SILTSTONE	30								136.9							58.3	3.19E+04	8						

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**SR 710 NORTH STUDY**



BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE		
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX (I <sub>s(50)</sub> )	AXIAL CORRECTED INDEX (I <sub>s(50)</sub> )	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)
RC-13-005	C-30	138.2	SILTSTONE	29														48.3		23	25				
RC-13-005	C-30	141.5	SILTSTONE	27.2	102													96.2		32	33				
RC-13-005	C-40	178.0	SILTSTONE	11	113.9						316.2							47.9	2.49E+04						
RC-13-005	C-41	183.4	SANDSTONE	6.5	116.2				0	55	45							2.5		7	8				
RC-13-005	C-42	188.6	SILTSTONE																						
RC-13-005	C-46	206.0	SANDSTONE	10.8	118.4				0	83	17														
RC-13-005	C-48	216.3	SANDSTONE	14	113.4																				
R-13-006	S02	5.0	SP-SC	12	124.9				1	48	51														
R-13-006	S04	15.0	CL-ML	14.6	119.7	21	14	7	2	45	53		32	500	33	100									
R-13-006	S07	30.0	CL-ML	9.3		21	16	5	0	37	63														
R-13-006	S08	35.0	CL-ML						0	42	58														
R-13-006	S09	40.0	CL			35	22	13	0	6	94														
R-13-006	S10	45.0	ML	11.4	117.5				0	36	64		33	650	31	100									
R-13-006	S11	50.0	SC			27	11	16	13	62	25														
R-13-006	S12	55.0	SW-SM	3.1	122.6				4	85	11														
R-13-006	S14	65.0	CLAYSTONE/SILTSTONE	26.8	97.1	56	18	38	0	6	94	41.5													
R-13-006	S15	70.0	CLAYSTONE/SILTSTONE																			1614	7.4	18	31
R-13-006	S16	75.0	CLAYSTONE/SILTSTONE	21.9	103.7	54	21	33	0	6	94					5.26	0.7								
R-13-006	S19	90.0	CLAYSTONE/SILTSTONE	29	94.9	57	20	37	0	3	97	35.6										2645	8	29	10
R-13-006	S20	95.0	CLAYSTONE/SILTSTONE	25.7	98.3							73.5							4.31E+03						
R-13-006	S21	100.0	CLAYSTONE/SILTSTONE	29.1	93.8												0.1								
R-13-006	S22	105.0	CLAYSTONE/SILTSTONE	27.7	96.9	60	22	38	0	6	94					3.66									
R-13-006	S24	115.0	CLAYSTONE/SILTSTONE	23.5	103	50	22	28	0	7	93														
RC-13-007	S-03	10.0	SM						6	60	34														
RC-13-007	S-04	15.0	SM						3	63	34														
RC-13-007	S-05	20.0	SM	4.6	103.3				0	73	27														
RC-13-007	S-07	30.0	CL-ML			21	16	5	4	42	54														
RC-13-007	S-08	35.0	SM						15	57	28														
RC-13-007	S-09	40.0	SM	16	112.9																				
RC-13-007	S-10	45.0	SW-SM						11	80	9														
RC-13-007	S-11	50.0	SP	16	112.2																				

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BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE			
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX (Is(50))	AXIAL CORRECTED INDEX (Is(50))	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)
RC-13-007	S-14	65.0	SM	21.2					3	76	21															
RC-13-007	S-16	75.0	CLAYSTONE			52	13	39	0	3	97															
RC-13-007	S-17	80.0	CLAYSTONE	25.9	99.3	56	18	38	0	2	98						6.67									
RC-13-007	C-19	90.7	CLAYSTONE	19.4		63	21	42																		
RC-13-007	C-21	100.9	CLAYSTONE	29.4	93.4							133.8									1.02E+04					
RC-13-007	C-24	115.7	CLAYSTONE	25.4	98.7	56	19	40	0	2	98						8.68									
RC-13-007	C-26	124.4	CLAYSTONE	21		58	19	39	0	4	96								13.9							
RC-13-007	C-28	136.0	CLAYSTONE	19.5	107.6							420.1									2.61E+04					
RC-13-007	C-29	137.8	CLAYSTONE	13	108				0	5	95								50.9							
RC-13-007	C-30	145.0	CLAYSTONE	20.8	107							273.9									1.17E+04	29				
RC-13-007	C-32	152.9	CLAYSTONE	22.2	104.9	48	21	27	0	1	99								48.5			11	30			
RC-13-007	C-33	157.0	CLAYSTONE																				690	7.1	1214	23
RC-13-007	C-34	159.5	CLAYSTONE	22.9	104.2							148.1									9.32E+03					
RC-13-007	C-34	162.0	CLAYSTONE			49	21	28	0	1	99															
RC-13-007	C-35	165.5	CLAYSTONE																							
RC-13-007	C-36	167.0	CLAYSTONE	23.8	99.6							382.8									1.84E+04					
RC-13-007	C-37	172.9	CLAYSTONE	15	104.8	49	21	28	0	2	98								71.7							
RC-13-007	C-38	177.4	CLAYSTONE	23	102.9							74.4									1.33E+03	26				
RC-13-007	C-40	183.2	CLAYSTONE	23.3	104.5							253.7							5.4		1.23E+04	34				
RC-13-007	C-40	185.0	CLAYSTONE						0	2	98															
RC-13-007	C-42	192.2	CLAYSTONE	22.3	100.2	46	21	25	0	4	96	397										466	7.4	2111	24	
RC-13-007	C-43	198.0	CLAYSTONE	20								427.5							14.1		2.96E+04					
RC-13-007	C-45	205.0	CLAYSTONE	22		57	21	36	0	1	99								65.5							
RC-13-007	C-46	207.0	CLAYSTONE	23.1	103.4							439.1									3.88E+04					
RC-13-007	C-46	207.7	CLAYSTONE																							
RC-13-007	C-47	215.0	CLAYSTONE			44	22	22	0	12	88															
RC-13-007	C-50	225.0	SILTSTONE	18.6	109.1														32.6							
RC-13-007	C-53	241.0	SILTSTONE						0	45	55															
RC-13-007	C-54	248.6	SILTSTONE	17.1	116.7							284.8									7.14E+03					
RC-13-007	C-56	257.4	SILTSTONE	18.1	112.2				1	43	56	363														
RC-13-007	C-58	265.8	SILTSTONE	20.4	106.6				0	6	94	533							82.7							

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BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE		
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRICAL CORRECTED INDEX (I <sub>s(50)</sub> )	AXIAL CORRECTED INDEX (I <sub>s(50)</sub> )	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)
A-13-008	S-02	5.0	SM	9.8	113.9	NP																			
A-13-008	S-03	10.0	SC						11	71	18														
A-13-008	S-04	15.0	SM	3.8	114.7				0	85	15		31	150	30	100									
A-13-008	S-06	25.0	SM	9.8	118.8				6	67	27														
A-13-008	S-07	30.0	SW-SM						20	65	15														
A-13-008	S-10	45.0	SM	12.5	111				0	56	44		34	250	31	50									
A-13-008	S-11	50.0	SP-SM						17	79	7														
A-13-008	S-12	55.0	SW-SM	3.3	114.2				17	74	9														
A-13-008	S-13	60.0	SW-SM						6	85	9														
A-13-008	S-14	65.0	SW-SM	1.9	108.2				18	76	6		36	550	36	250									
A-13-008	S-15	70.0	SM	2																		41125	7.5	30	17
A-13-008	S-16	75.0	SW-SM	1.9	105.3				26	69	5		33	550	33	450									
A-13-008	S-20	95.0	SM	8.7	117.8				0	61	39														
RC-13-009	S-02	5.0	SM	10.2					9	48	43														
RC-13-009	S-03	10.0	SP	10.6	101.9																				
RC-13-009	S-05	20.0	SW-SM	3.6	119.1				13	80	7														
RC-13-009	S-07	30.0	SW-SM		3.2	105			4	87	9		35	150	35	0									
RC-13-009	S-08	35.0	SM			NP																			
RC-13-009	S-09	40.0	ML	8.9	97.7				0	42	58														
RC-13-009	S-11	50.0	SM	3.3	101.4	NP	NP	NP	0	77	23		29	200	29	50									
RC-13-009	S-15	70.0	SM	3.9	113				0	85	15														
RC-13-009	S-17	80.0	ML	12.1	110.3				0	43	57		29	800	29	300									
RC-13-009	S-18	85.0	ML			NP																			
RC-13-009	S-21	100.0	CL-ML	15.2	117.7				2	75	23														
RC-13-009	S-23	110.0	SM	12	126.3				8	39	53														
RC-13-009	S-24	115.0	CL-ML	14.2		24	17	7	6	34	60														
RC-13-009	S-28	132.0	SM	20.7					2	71	27														
RC-13-009	S-29	137.0	SM	20.6	109.6				0	58	42														
RC-13-009	S-30	142.0	DIORITE	12.4																		6917	7.5	225	181
RC-13-009	C-35	165.4	DIORITE	5.5	141.2																17	13			
RC-13-009	C-36	167.2	DIORITE	5.6	138.6							436									3.16E+04				

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BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE			
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX (I <sub>s(50)</sub> )	AXIAL CORRECTED INDEX (I <sub>s(50)</sub> )	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)
RC-13-009	C-37	176.5	DIORITE	2.4	139.2																11					
RC-13-009	C-39	186.5	DIORITE	1.6																			11021	7.9	130	82
RC-13-009	C-40	188.2	DIORITE																							
RC-13-009	C-40	191.0	DIORITE	4.1	147.4							280.5									2.14E+04					
RC-13-009	C44	207.0	DIORITE	1.5	148.1							891.6									2.07E+06		61			
RC-13-009	C44	210.0	DIORITE	1	151													1.9				17				
RC-13-009	C44	210.8	DIORITE																			13				
RC-13-009	C47	222.8	DIORITE	3.2	148.5																	45	92			
RC-13-009	C48	227.0	DIORITE																							
RC-13-009	C48	229.6	DIORITE	1.9	149.1																		19			
RC-13-009	C49	232.8	DIORITE	3	146.6							293.5									1.57E+04					
RC-13-009	C51	244.4	DIORITE																			35				
RC-13-009	C51	245.9	DIORITE	1.6																		45	61			
RC-13-009	C52	248.0	DIORITE	1.5	152.6							1592.8									6.11E+04					
RC-13-009	C53	255.8	DIORITE	2.1	148.7							505.7									2.51E+04	11				
RC-13-009	C55	266.0	DIORITE																							
O-13-010	O05	20.0	SM	2.3					17	65	18															
O-13-010	O09	40.0	SM	6.6					0	70	30															
O-13-010	O14	65.0	SP-SM	1.8					21	74	5															
O-13-010	O21	85.0	SW-SM	2.4					28	61	11															
O-13-010	O27	101.0	SM	6.9					4	62	34															
O-13-010	O30	117.0	SM	7.9		NP	NP	NP	7	58	35															
O-13-010	O33	130.0	CL-ML			24	18	6	2	38	60															
O-13-010	O33	132.0	SM						22	69	9															
O-13-010	O34	141.0	SM	8.4					6	67	27															
O-13-010	O34	143.0	CL	19.4		29	21	8	4	28	68											5501	8	88	65	
O-13-010	O35	150.0	SM						13	53	34															
O-13-010	O37	160.0	SM	9.5					11	65	24															
O-13-010	O37	165.5	CL			28	21	7	1	26	73															
O-13-010	O38	173.0	SM						1	54	45															
O-13-010	O39	180.0	ML	20.2					1	30	69															

**TABLE D1-1 SUMMARY OF LABORATORY TEST RESULTS**

**SR 710 NORTH STUDY**



BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE				
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX (I <sub>s(50)</sub> )	AXIAL CORRECTED INDEX (I <sub>s(50)</sub> )	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)	
O-13-010	O40	191.0	CL			29	13	16	0	49	51																
O-13-010	O41	198.0	SM	6.8		17	14	3	4	54	42												11048	7.8	74	144	
O-13-010	O42	210.0	CL			30	12	18	1	43	56																
O-13-010	O43	218.0	SM	9.7					2	49	49																
O-13-010	O44	221.0	SC			27	15	12	0	51	49																
O-13-010	O44	227.0	SM						5	74	21																
O-13-010	O45	234.0	SM						23	60	17																
O-13-010	O47	243.0	CL	12.6		31	12	19	0	50	50																
A-13-015	001	5.0	CL			25	15	10	3	46	51																
A-13-015	003	15.0	SM						11	67	22																
A-13-015	007	35.0	SW-SM						25	68	7																
A-13-015	011	55.0	SP-SM						14	80	6																
A-13-015	016	75.0	SM			NP	NP	NP	26	58	16																
A-13-015	020	95.0	SANDSTONE						10	69	21																
A-13-016	001	5.0	CL			26	15	11																			
A-13-016	003	15.0	SM						11	72	17																
A-13-016	009	35.0	SP						21	76	3																
A-13-016	016	55.0	SANDSTONE						13	44	43																
A-13-017	003	15.0	SP-SM						26	68	6																
A-13-017	007	35.0	SP						16	82	2																
A-13-017	011	55.0	SP-SM						2	91	7																
A-13-017	015	75.0	SM						6	78	16																
A-13-017	019	95.0	SANDSTONE						40	57	3																
A-13-020	S-2	5.0	SM						5	62	33																
A-13-020	S-3	10.0	SM	14.5	99.4							31	300	30	200												
A-13-020	S-4	15.0	ML	19.2					1	36	63											5828	7.4	101	52		
A-13-020	S-5	20.0	SM	7	100.3				0	63	37	32	300	32	150												
A-13-020	S-7	30.0	SP-SM	5.4	111.3				18	70	12																
A-13-020	S-9	40.0	SM	14.3	104.3				0	52	48	29	350	27	100												
A-13-020	S-10	45.0	SM	12																		8435	8	22	18		
A-13-020	S-11	50.0	SP	5.9	100.5																						



**TABLE D1-1 SUMMARY OF LABORATORY TEST RESULTS**

**SR 710 NORTH STUDY**



BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE						
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX (I <sub>s(50)</sub> )	AXIAL CORRECTED INDEX (I <sub>s(50)</sub> )	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)			
A-13-020	S-12	55.0	ML	16.5		NP	NP	NP	0	33	67																		
A-13-020	S-14	65.0	SP-SM						15	73	12																		
A-13-020	S-15	70.0	SP-SM	8.3	108								33	400	33	100													
A-13-020	S-19	90.0	SW-SM						20	71	9																		
A-13-020	S-20	95.0	SW-SM	9.7	103.6																								
A-13-020	S-21	100.0	SM						4	54	42																		
A-13-020	S-25	120.0	SP	5																									
A-13-020	S-26	125.0	SM	9.9					18	67	15																		
A-13-020	S-30	136.5	CL	22.8	103.5	42	15	27	0	19	81																		
A-13-020	S-31	140.0	CL	21.3		32	23	9	0	46	54																		
A-13-021	S-05	20.0	SILTSTONE	21.1	99.2	50	21	29	0	27	73	53.7																	
A-13-021	S-07	30.0	SILTSTONE	27.3	90.9																								
A-13-021	S-09	40.0	SILTSTONE	28	84.2	56	30	26	17	46	37																		
A-13-021	S-13	60.0	SILTSTONE	22.1	91.8				0	50	50	13.2																	
A-13-021	S-14	65.0	SILTSTONE	22.1																						1287	7.7	58	120
A-13-021	S-15	70.0	SILTSTONE	29.6	86	58	27	31																					
A-13-021	S-16	75.0	SILTSTONE	21.9					3	33	64																		
A-13-021	S-17	80.0	SILTSTONE	20.4	91.6							38.6																	
A-13-021	S-18	85.0	SILTSTONE	22.1																									
A-13-021	S-19	90.0	SILTSTONE	24	90.6	52	31	21	0	42	58	19.9																	
A-13-021	S-21	100.0	SILTSTONE	22.5	97.2				6	56	37																		
A-13-021	S-23	110.0	SILTSTONE	29.6	90.6																								
A-13-022	001	5.0	ML						0	44	56																		
A-13-022	005	25.0	SP-SM						40	53	7																		
A-13-022	009	45.0	SP-SM						29	66	5																		
A-13-022	015	75.0	SM						0	65	35																		
A-13-022	019	95.0	SP-SM						19	74	7																		
O-13-023	O05	20.0	SW-SM	2.4					16	72	12																		
O-13-023	O11	42.0	SM	3.6					16	68	16																		
O-13-023	O16	62.0	SP	3.9					18	82	0																		
O-13-023	O22	85.0	SM	5.4					17	59	24																		

**TABLE D1-1 SUMMARY OF LABORATORY TEST RESULTS**

**SR 710 NORTH STUDY**



BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE				
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX (I <sub>s(50)</sub> )	AXIAL CORRECTED INDEX (I <sub>s(50)</sub> )	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)	
O-13-023	O25	99.0	CL-ML	16		24	20	4	5	42	53																
O-13-023	O32	142.0	ML	21.3		NP	NP	NP	2	28	70												9131	7.6	41	15	
O-13-023	O35	160.0	SW-SM	8.7					20	69	11																
O-13-023	O37	180.0	SM	10.3					9	77	14																
O-13-023	O39	200.0	CL	14.7		32	17	15	0	26	74												3821	7.8	43	60	
O-13-023	O40	218.0	CL	10.8		31	12	19	0	64	36																
O-13-023	O43	240.0	CL	12.7		34	13	21	1	53	46																
A-13-024	003	15.0	SM						4	54	42																
A-13-024	008	35.0	SP-SM						24	64	12																
A-13-024	015	55.0	ML						0	43	57																
A-13-024	020	75.0	SP						21	78	1																
A-13-024	023	85.0	SW-SM						28	67	5																
A-13-024	029	105.0	SM						1	60	39																
A-13-025	001	5.0	SM						9	56	35																
A-13-025	005	25.0	CL-ML			21	16	5	1	42	57																
A-13-025	007	35.0	SM			NP	NP	NP	0	54	46																
A-13-025	009	45.0	SW						15	81	4																
A-13-025	013	65.0	SM						0	86	14																
A-13-025	017	85.0	SP-SM						28	66	6																
A-13-025	021	105.0	SM						1	56	43																
A-13-026	003	15.0	SP-SM						33	62	5																
A-13-026	007	35.0	SM						0	75	25																
A-13-026	011	55.0	SP-SM						0	95	5																
A-13-026	015	75.0	SP-SM						4	91	5																
A-13-026	021	95.0	CL			32	15	17	0	30	70																
A-13-027	001	5.0	SW-SM						26	62	12																
A-13-027	005	25.0	SP-SM						42	48	10																
A-13-027	009	45.0	SM						25	61	14																
A-13-027	013	65.0	SM						0	85	15																
A-13-027	015	75.0	CL			37	12	25	0	29	71																
A-13-027	019	95.0	SC			37	17	20	2	50	48																

# TABLE D1-1 SUMMARY OF LABORATORY TEST RESULTS

## SR 710 NORTH STUDY



BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE						
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX ( $I_{s(50)}$ )	AXIAL CORRECTED INDEX ( $I_{s(50)}$ )	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)			
A-13-034	001	5.0	CL			24	16	8	10	40	50																		
A-13-034	008	25.0	SW-SM						32	59	9																		
A-13-034	014	45.0	SM						22	65	13																		
A-13-034	019	65.0	SC			36	13	23	7	60	33																		
A-13-034	021	75.0	Conglomerate						16	75	9																		
A-13-035	001	5.0	CL-ML			21	15	6																					
A-13-035	003	15.0	SM						19	65	16																		
A-13-035	008	35.0	SP						36	60	4																		
A-13-035	019	65.0	SANDSTONE						34	53	13																		
R-09-Z1-B8	S-4	15.0	SANDY SILT	23.0					8	22	70																		
R-09-Z1-B8	S-6	25.0	lean CLAY	31.9		31	20	11																					
R-09-Z1-B8	S-9	42.5	SILTY CLAYEY SAND	21.0	110.2				3	52	45				290	29													
R-09-Z1-B8	S-11	52.5	lean CLAY	21.9	109.3																								
R-09-Z1-B8	C-17	80.4	CLAYSTONE	25.7	97.2	47	28	19	0	2	98						10.9												
R-09-Z1-B8	C-23	109.4	CLAYSTONE	23.1	102.5	47	27	20	0	3	97						14.9												
R-09-Z1-B8	C-26	119.8	SILTSTONE	21.4	104.4												23.3												
R-09-Z1-B8	C-26	120.2	CLAYSTONE	15.7		48	26	22	0	4	96												343	6.18	1156	59			
R-09-Z1-B8	C-28	133.6	MUDSTONE	23.0	100.2							299.0								2.0	7.94E+03								
R-09-Z1-B8	C-31	148.2	MUDSTONE	21.8	104.9							324.0							12.9	1.00E+04									
R-09-Z1-B8	C-33	159.6	CLAYSTONE	21.5	105.7	47	26	21															410	6.26	720	76			
R-09-Z1-B8	C-37	175.4	MUDSTONE	21.7	102.2							289.0								0.0	8.79E+03								
R-09-Z1-B8	C-39	189.6	SILTSTONE	24.2	99.7												17.6												
R-09-Z1-B8	C-41	195.6	MUDSTONE	21.7	101.6							361.0							56.8	1.21E+04									
R-09-Z2-B5	S-2	10.0	Sandy SILT	19.4																									
R-09-Z2-B5	S-3	15.0	Sandy SILT	16.8																									
R-09-Z2-B5	S-6	30.0	Sandy SILT	27.2					0	44	56																		
R-09-Z2-B5	S-10	50.0	Silty SAND	21.4					3	63	34																		
R-09-Z2-B5	S-15	75.0	Fat CLAY	21.2		52	22	30																					
R-09-Z2-B5	S-17	85.0	ClayeySILT	21.4																									
R-09-Z2-B5	S-21	105.0	Lean CLAY	27.1	101.2	47	17	30	0	5	95						2.1												
R-09-Z2-B5	S-25	125.0	Fat CLAY	28.4	94.5	58	29	29									3.5												

**TABLE D1-1 SUMMARY OF LABORATORY TEST RESULTS**

**SR 710 NORTH STUDY**



BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE					
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX (I <sub>s(50)</sub> )	AXIAL CORRECTED INDEX (I <sub>s(50)</sub> )	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)		
R-09-Z2-B5	C-28	148.0	Fat CLAY	39.6	79.8				0	4	96					3.7												
R-09-Z2-B5	C-36	176.6	SILTSTONE	23.3	100.8				0	3	97	114.5																
R-09-Z2-B5	C-39	188.0	SILTSTONE	20.6	106.5							311.0						69.0	1.16E+04									
R-09-Z2-B5	C-43	203.8	MUDSTONE	22.0	104.6							47.0						29.0	1.29E+03									
R-09-Z2-B5	C-47	217.5	SILTSTONE	23.4	101.5											9.9												
R-09-Z2-B5	C-53	240.5	MUDSTONE	21.1	108.8							194.0						43.0	6.41E+03									
R-09-Z2-B5	C-59	265.0	SILTSTONE	23.6	99.7											10.0												
R-09-Z2-B5	C-65	292.1	MUDSTONE	30.9	87.8							168.0						46.0	6.19E+03									
R-09-Z3-B2	S-4	11.8	P.G. SAND with SILT and GRAVEL	9.8	129.3	NP	NP	NP																				
R-09-Z3-B2	S-5	15.0	W.G. SAND with SILT and GRAVEL	9.2					24	68	8																	
R-09-Z3-B2	S-9	31.3	W.G. SAND with SILT and GRAVEL	9.2	132.3				40	54	6																	
R-09-Z3-B2	S-11	40.0	SILTY SAND	15.3																								
R-09-Z3-B2	S-17	55.0	W.G. SAND with SILT and GRAVEL	10.9					19	74	7																	
R-09-Z3-B2	S-20	64.2	SILTY SAND	17.9					1	73	26																	
R-09-Z3-B2	C-23	71.5	SILTY SAND	14.7																								
R-09-Z3-B2	C-27	81.5	P.G. SAND with GRAVEL	15.1					23	74	3																	
R-09-Z3-B2	S-30	90.0	SILTY SAND	15.3					5	75	20																	
R-09-Z3-B2	S-34	100.0	SILTY SAND	16.8					1	77	22																	
R-09-Z3-B2	C-37	106.5	SILTY SAND	18.4																								
R-09-Z3-B2	C-39	111.5	SILTY SAND	11.5					11	58	31																	
R-09-Z3-B2	C-41	116.5	CLAYEY SAND	13.6		31	17	14																				
R-09-Z3-B2	C-49	146.9	QUARTZITE	0.3	159.8																	2928	122					
R-09-Z3-B2	C-54	171.6	QUARTZITE	0.4	155.0																	1296	54					
R-09-Z3-B2	C-68	227.6	QUARTZITE	2.5	156.1																	576	24					
R-09-Z3-B3	C52	246.4	DIORITE	13.2	141.8	25	14	11	2	64	34													1090	7.10	200	226	
R-09-Z3-B3	C53	254.0	DIORITE	3.9	147.3							229.0																
R-09-Z3-B3	C53	255.0	DIORITE		147.3							229.0								2.00E+05								
R-09-Z3-B3	C54	258.5	DIORITE		151.2							35.0																
R-09-Z3-B3	C55	270.5	FAULT GOUGE		146.5							92.0																
R-09-Z3-B3	C56	271.5	DIORITE		146.5							92.0								4.50E+04								

**TABLE D1-1 SUMMARY OF LABORATORY TEST RESULTS**

**SR 710 NORTH STUDY**



BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE		
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX (Is(50))	AXIAL CORRECTED INDEX (Is(50))	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)
R-09-Z3-B4	S-3	15.0	SILTY SAND	17.4	107.1	NP	NP	NP	2	60	38														
R-09-Z3-B4	S-8	40.0	SILT with SAND	23.6	103.8	27	24	3	0	22	78														
R-09-Z3-B4	S-10	50.0	SILTY CLAYEY SAND	15.8	118.1	NP	NP	NP	8	50	42														
R-09-Z3-B4	S-13	65.0	SILTY SAND	23.5					1	51	48														
R-09-Z3-B4	S-15	75.0	SILTY SAND	20.7																					
R-09-Z3-B4	C-20	97.0	SILTY SAND	12.0					2	65	33														
R-09-Z3-B4	C-22	107.5	SILTY SAND	13.4					1	55	44														
R-09-Z3-B4	C-32	157.5	P.G. SAND with SILT	14.1					9	84	7														
R-09-Z3-B4	C-44	218.2	ANDESITE	1.2	162.2							406.0								2.90E+04					
R-09-Z3-B4	C-45	221.2	ANDESITE	2.6	254.1							254.0								4.58E+03	144	6			
R-09-Z3-B4	C-48	236.8	DIORITE																		4488	187			
R-09-Z3-B4	C-52	248.9	DIORITE																		1176	49			
R-09-Z3-B4	C-56	270.3	DIORITE																		2544	106			
R-09-Z3-B4	C-57	272.6	DIORITE	1.2	90.4							2998.0								3.58E+05	3072	128			
R-09-Z3-B6	S-1	5.0	SILTY SAND	6.4					4	61	35														
R-09-Z3-B6	S-2	10.0	SILTY SAND with GRAV.	8.4	127.8				28	56	16														
R-09-Z3-B6	C-27	173.0	CONGLOMERATE	11.2					16	65	19														
R-09-Z3-B6	C-28	175.2	CONGLOMERATE																		696	29			
R-09-Z3-B6	C-32	198.3	CONGLOMERATE																		360	15			
R-09-Z3-B6	C-34	209.3	CONGLOMERATE	4.2	145.8							1243.0								1.06E+05	1368	57			
R-09-Z3-B6	C-35	216.4	CONGLOMERATE																		312	13			
R-09-Z3-B6	C-35	218.3	CONGLOMERATE	1.9	148.8							899.0								6.05E+04					
R-09-Z3-B6	C-35	221.5	CONGLOMERATE	3.1	141.8							393.0								3.16E+04	480	20			
R-09-Z3-B6	C-36	222.5	CONGLOMERATE																		504	21			
R-09-Z3-B6	C-37	227.5	CONGLOMERATE	2.4	152.0							523.0								5.17E+04	744	31			
R-09-Z3-B6	C-43	254.2	CONGLOMERATE																		3144	131			
R-09-Z3-B6	C-44	257.4	CONGLOMERATE	3.1																					
R-09-Z3-B6	C-44	257.7	CONGLOMERATE	2.0	153.7							770.0								5.45E+04	4176	174			
R-09-Z3-B6	C-49	284.0	CONGLOMERATE																		480	20			
R-09-Z3-B6	C-52	298.3	CONGLOMERATE																		96	4			
R-09-Z3-B6	C-52	299.0	SANDSTONE	6.1					22	56	22														

**TABLE D1-1 SUMMARY OF LABORATORY TEST RESULTS**

**SR 710 NORTH STUDY**



BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE					
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX (I <sub>s(50)</sub> )	AXIAL CORRECTED INDEX (I <sub>s(50)</sub> )	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)		
R-09-Z3-B6	C-53	304.5	SANDSTONE	11.7					9	58	33																	
R-09-Z3-B8	C-3	10.0	SANDY SILTY CLAY	24.7																								
R-09-Z3-B8	C-5	20.0	Sandy SILT	22.8	104.0	53	27	26																				
R-09-Z3-B8	C-7	29.2	SILTSTONE	24.8	96.3	59	24	35																				
R-09-Z3-B8	C-12	52.6	SANDSTONE	21.6	101.5	47	28	19																				
R-09-Z3-B8	C-20	88.0	SILTSTONE	12.8	117.0																							
R-09-Z3-B8	C-27	116.2	SILTSTONE	10.2	129.4																							
R-09-Z3-B8	C-33	140.8	SILTSTONE	9.2															92.2									
R-09-Z3-B8	C-37	156.4	SANDSTONE	7.9																		3936	164					
R-09-Z3-B8	C-40	166.6	SANDSTONE																			4176	174					
R-09-Z3-B8	C-42	174.4	SILTSTONE	6.8	137.4							663.0									4.05E+04							
R-09-Z3-B8	C-46	192.4	CLAYSTONE	10.5															94.7									
R-09-Z3-B8	C-48	197.0	SILTSTONE	8.1	131.0							2193.0									7.80E+04							
R-09-Z3-B8	C-51	205.4	SILTSTONE	8.1	132.7							774.0							95.1		2.59E+04							
R-09-Z3-B8	C-54	218.0	CLAYSTONE																					1600	7.50	5188	64	
R-09-Z3-B8	C-56	227.8	SILTSTONE	8.5															98.0									
R-09-Z3-B8	C-58	235.7	SILTSTONE	5.9	135.1							4898.0									2.68E+05							
R-09-Z3-B8	C-63	256.4	SILTSTONE	6.7	131.6							2641.0									1.31E+05							
R-09-Z3-B8	C-65	265.7	SILTSTONE																			6960	290					
R-09-Z3-B11	P-3	11	SM	13	113				3	66	31																	
R-09-Z3-B11	P-5	23.5	SP-SM	11	107	NP	NP	NP																				
R-09-Z3-B11	P-7	33.5	SM	14	102																							
R-09-Z3-B11	P-9	43.5	SP-SM	22	98				0	90	10																	
R-09-Z3-B11	P-12	63.5	SW-SM	10	138				29	64	7																	
R-09-Z3-B11	P-14	73.5	SM	21	101				0	61	39																	
R-09-Z3-B11	P-16	81	SP-SM	18	112																							
R-09-Z3-B11	S-17	86	SM	17		31	23	8																				
R-09-Z3-B11	P-18	91	ML	20	101	0	44	56																				
R-09-Z3-B11	P-20	101	SC	10	101	27	17	10																				
R-09-Z3-B11	C-24	116.4	SM	12		27	25	2	16	66	18																	
R-09-Z3-B11	C-25	125	SM	11					4	81	15																	

**TABLE D1-1 SUMMARY OF LABORATORY TEST RESULTS**

**SR 710 NORTH STUDY**



BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE		
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX (I <sub>s(50)</sub> )	AXIAL CORRECTED INDEX (I <sub>s(50)</sub> )	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)
R-09-Z3-B11	C-27	131.5	SANDY lean CLAY	26		39	18	21	1	35	64														
R-09-Z3-B11	C-30	150.5	SP-SM	14					6	86	8														
R-09-Z3-B11	C-35	171.5	CLAYSTONE	25	101	60	25	35	0	18	82						29.945					1240	6.86	91	30
R-09-Z3-B11	C-37	184.7	CLAYSTONE	22	103							58.11													
R-09-Z3-B11	C-42	209.4	SILTSTONE	21	112							47						0	2.30E+03						
R-09-Z3-B11	C-44	217.5	CLAYSTONE	22	101	61	29	32									40.86								
R-09-Z3-B11	C-46	226.4	MUDSTONE	15	119							38								2.20E+03					
R-09-Z3-B11	C-49	245.6	MUDSTONE	13	124	48	14	34				131						0.1	3.30E+03						
R-09-Z3-B11	C-53	263.4	MUDSTONE	14	119	40	21	19				12					42.45	22.4							
R-09-Z3-B12	S-5	25.0	SILTY SAND	24.0	103.7																				
R-09-Z3-B12	S-7	35.0	Silty SAND	29.4	97.3	NP	NP	NP	0	25	75														
R-09-Z3-B12	S-9	45.0	SILTY SAND	24.3	101.8				0	78	22														
R-09-Z3-B12	S-11	55.0	P.G. SAND with SILT	25.9	101.1																				
R-09-Z3-B12	S-15	75.0	MUDSTONE	20.9	106.4	44	17	27	1	16	83														
R-09-Z3-B12	C-21	101.3	MUDSTONE	17.1	102.8	48	22	26	1	19	80														
R-09-Z3-B12	C-23	109.4	MUDSTONE	22.9	94.6	51	24	27									5.5								
R-09-Z3-B12	C-27	124.8	MUDSTONE	26.6	93.4	61	29	32	0	4	96						9.6								
R-09-Z3-B12	C-30	140.0	MUDSTONE	29.1	88.0				1	4	95						10.6								
R-09-Z3-B12	C-34	164.9	SHALE																			1320	7.76	85	41
R-09-Z3-B12	C-38	178.6	CLAYSTONE	22.8	86.6																				
R-09-Z3-B12	C-40	188.3	SHALE	20.4	93.0							100.2													
R-09-Z3-B12	C-41	190.8	SHALE	22.0	93.6													87.4							
R-09-Z3-B12	C-44	201.5	SANDSTONE	16.3	92.0							48.1													
R-09-Z3-B12	C-47	214.3	SHALE	19.3	105.5							503.0						84.8	4.73E+04						
R-09-Z3-B12	C-51	229.2	SHALE																			600	7.41	798	59
R-09-Z3-B12	C-56	249.4	SHALE	19.7	102.5							232.0							2.72E+04						
R-09-Z3-B12	C-61	267.5	SHALE	11.5	101.2							518.7													
R-09-Z4-B4	S-3	15.0	SANDY SILTY CLAY	18.4	113.0	22	18	4	0	31	69														
R-09-Z4-B4	S-5	25.0	SILTY SAND	21.4	102.5																				
R-09-Z4-B4	S-7	35.0	SANDY SILTY CLAY	19.5	109.6	24	19	5	0	43	57														
R-09-Z4-B4	S-10	50.0	SILTY SAND with GRAV.	12.3					15	69	16														

**TABLE D1-1 SUMMARY OF LABORATORY TEST RESULTS**

**SR 710 NORTH STUDY**



BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (feet)	SOIL AND ROCK CLASSIFICATION	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS			SIEVE ANALYSIS			UNCONFINED COMP. (psi)	DIRECT SHEAR (Peak)		DIRECT SHEAR (Ultimate)		Undrained Shear Strength (Su) from UU Triaxial (ksf)	CERCHAR ABRASIVITY INDEX	SLAKE DURABILITY (%)	ELASTIC MODULI w/ COMP. STRENGTH (psi)	POINT LOAD (psi)		CORROSION SUITE																
						LL	PL	PI	GRAVEL (%)	SAND (%)	FINE (%)		FRICITION ANGLE (degree)	COHESION (psf)	FRICITION ANGLE (degree)	COHESION (psf)					DIAMETRAL CORRECTED INDEX (I <sub>s(50)</sub> )	AXIAL CORRECTED INDEX (I <sub>s(50)</sub> )	MIN. RESISTIVITY (ohm-cm)	pH	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)													
R-09-Z4-B4	S-13	65.0	SILTY SAND	14.3	119.2				1	61	38																												
R-09-Z4-B4	S-17	85.0	fat CLAY	27.9		56	23	33																															
R-09-Z4-B4	C-19	97.5	CLAYSTONE	26.6	95.0	57	29	28	0	1	99																												
R-09-Z4-B4	C-24	126.9	SILTSTONE	20.0	101.7	47	33	14				288.6																											
R-09-Z4-B4	C-26	139.7	SILTSTONE	17.6	101.9																																		
R-09-Z4-B4	C-28	156.7	SILTSTONE	17.4								451.0								61.0	1.94E+04																		
R-09-Z4-B4	C-33	185.2	SILTSTONE			52	34	18																															
R-09-Z4-B4	C-35	199.0	SILTSTONE	18.3								351.0								0.6	1.56E+04																		
R-09-Z4-B4	C-38	221.0	SILTSTONE	20.0	101.4																																		
R-09-Z4-B4	C-40	234.5	SILTSTONE	13.7								444.0																											
R-09-Z4-B4	C-44	263.0	SILTSTONE	20.8	102.3																																		

**Note:**

Type of Sampling:

- S = Split Spoon (includes SPT and Mod Cal Samplers)
- C = Core (both rock and soil)
- O = Others (continuous sample)

Atterberg's Limits:

- LL = Liquid Limit (in %)
- PL = Plastic Limit (in %)
- PI = Plasticity Index (LL - PL, in %)
- NP = Non-Plastic Soil

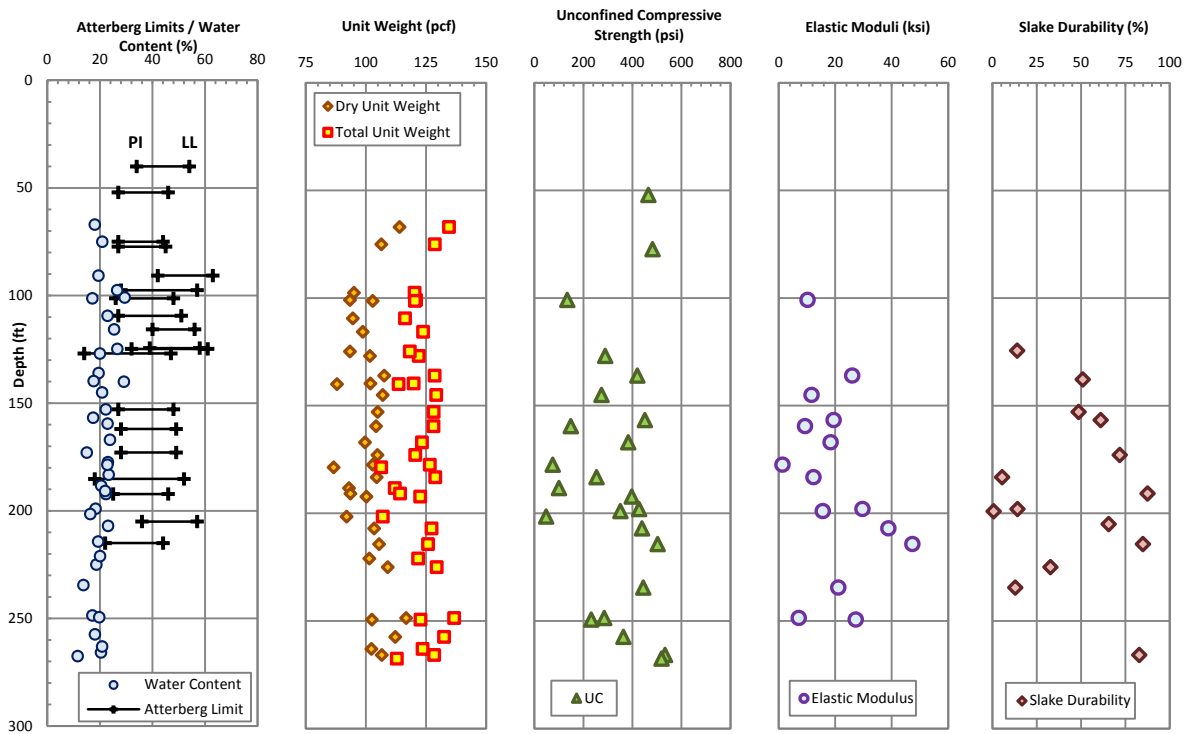
Triaxial Shear:

- UU = Unconsolidated Undrained

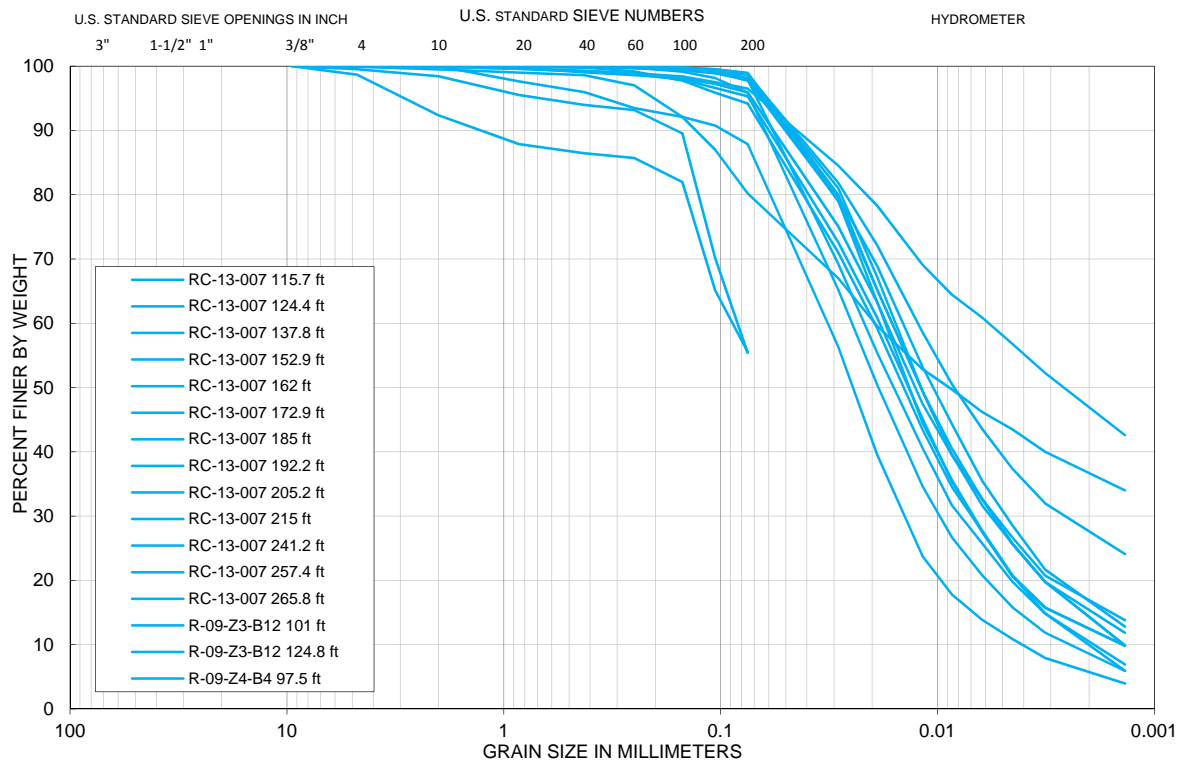
Units:

- pcf = pounds per cubic feet
- psi = pounds per square inch
- psf = pounds per square feet
- ohm-cm = Ohm-Centimeter
- ppm = parts per million

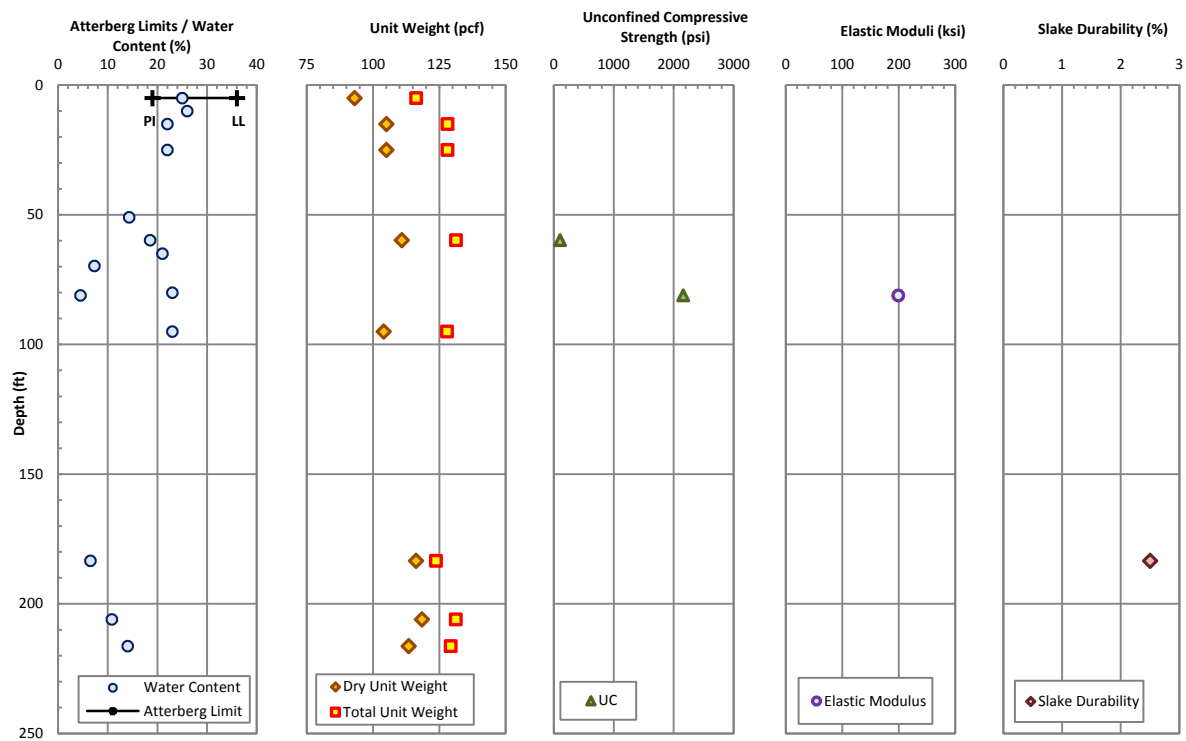




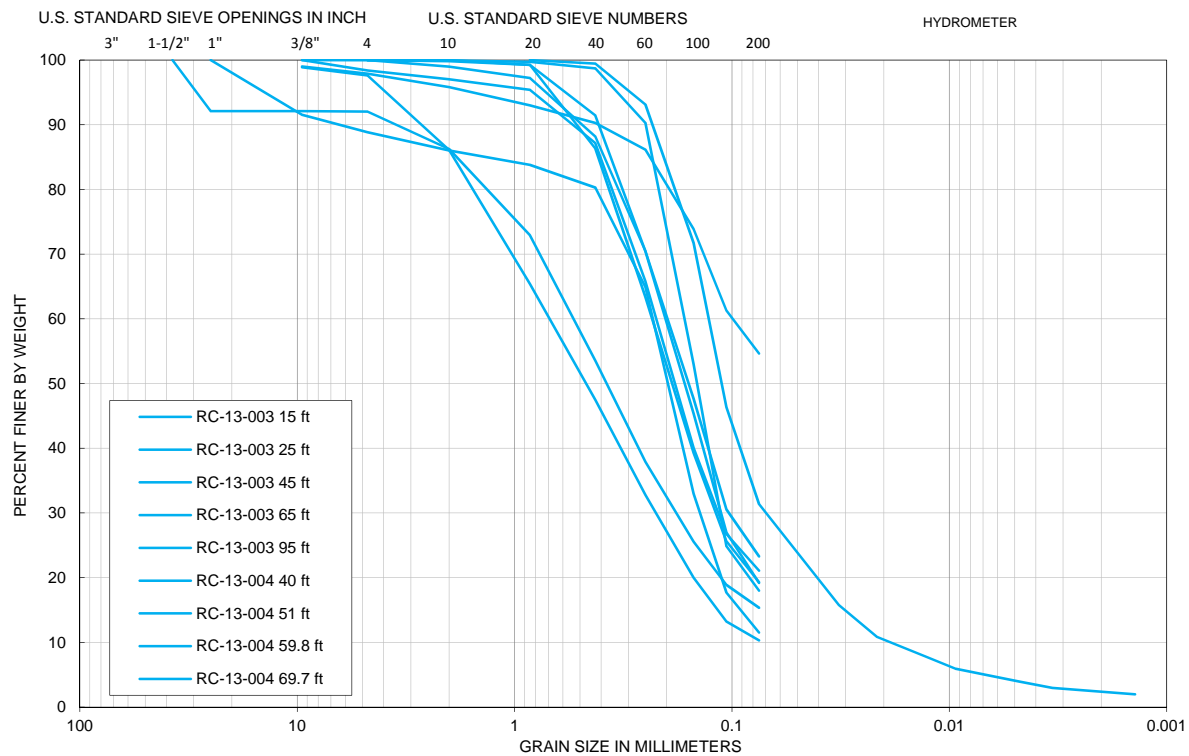
**Figure D1-1 Engineering Properties for Fernando Formation Siltstone Member (Tfsl)**



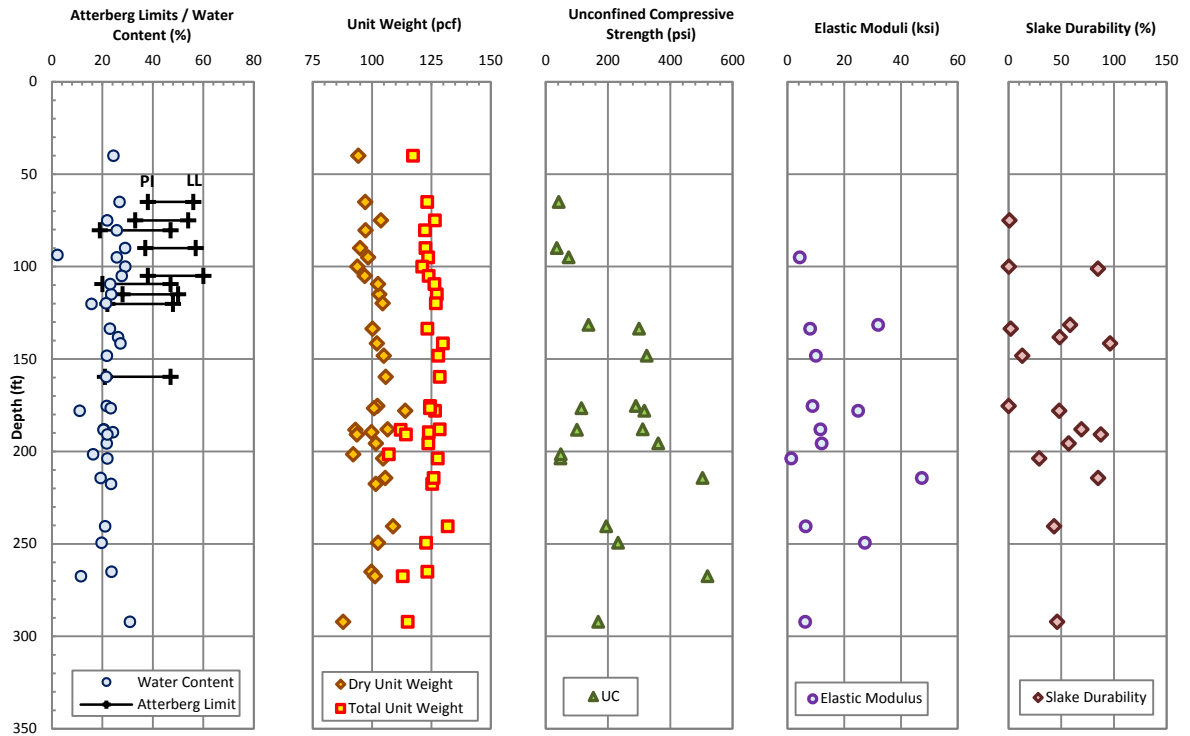
**Figure D1-2 Composite Plot of Particle Size Distribution for Fernando Formation Siltstone Member (Tfsl)**



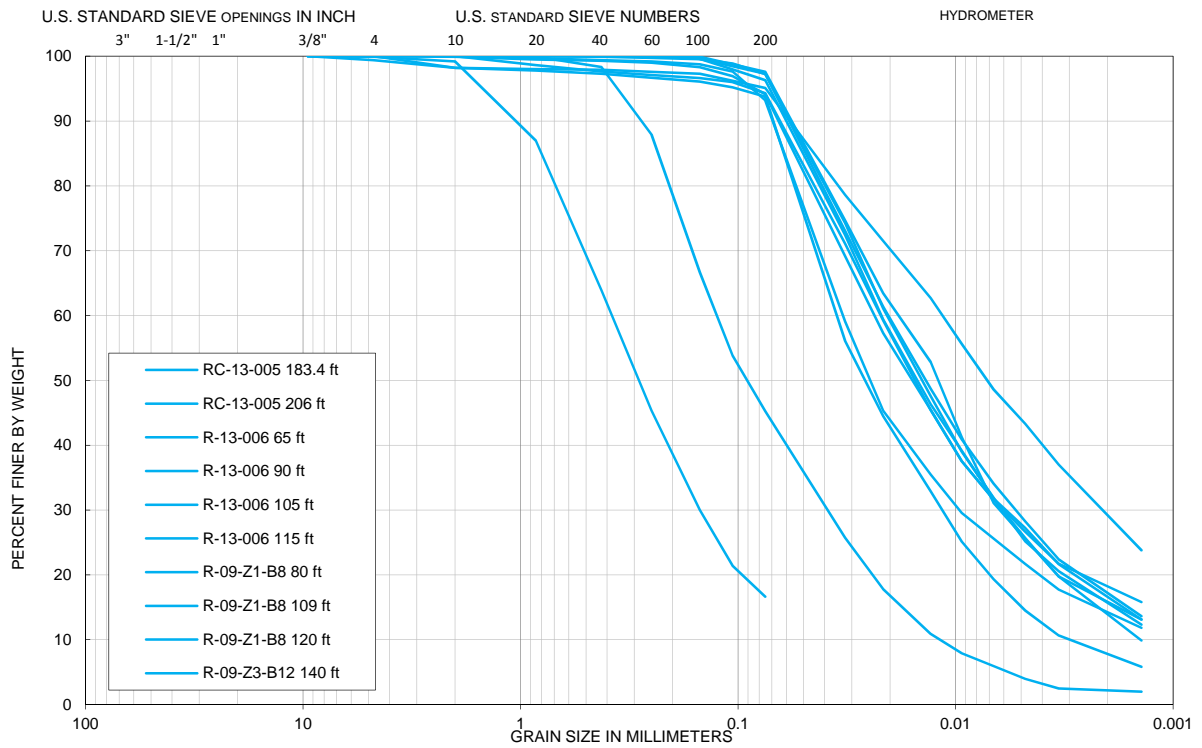
**Figure D1-3 Engineering Properties for Puente Formation Sandstone Member (Tps)**



**Figure D1-4 Composite Plot of Particle Size Distribution for Puente Formation Sandstone Member (Tps)**



**Figure D1-5 Engineering Properties for Puente Formation Siltstone Member (Tpsl)**



**Figure D1-6 Composite Plot of Particle Size Distribution for Puente Formation Siltstone Member (Tpsl)**

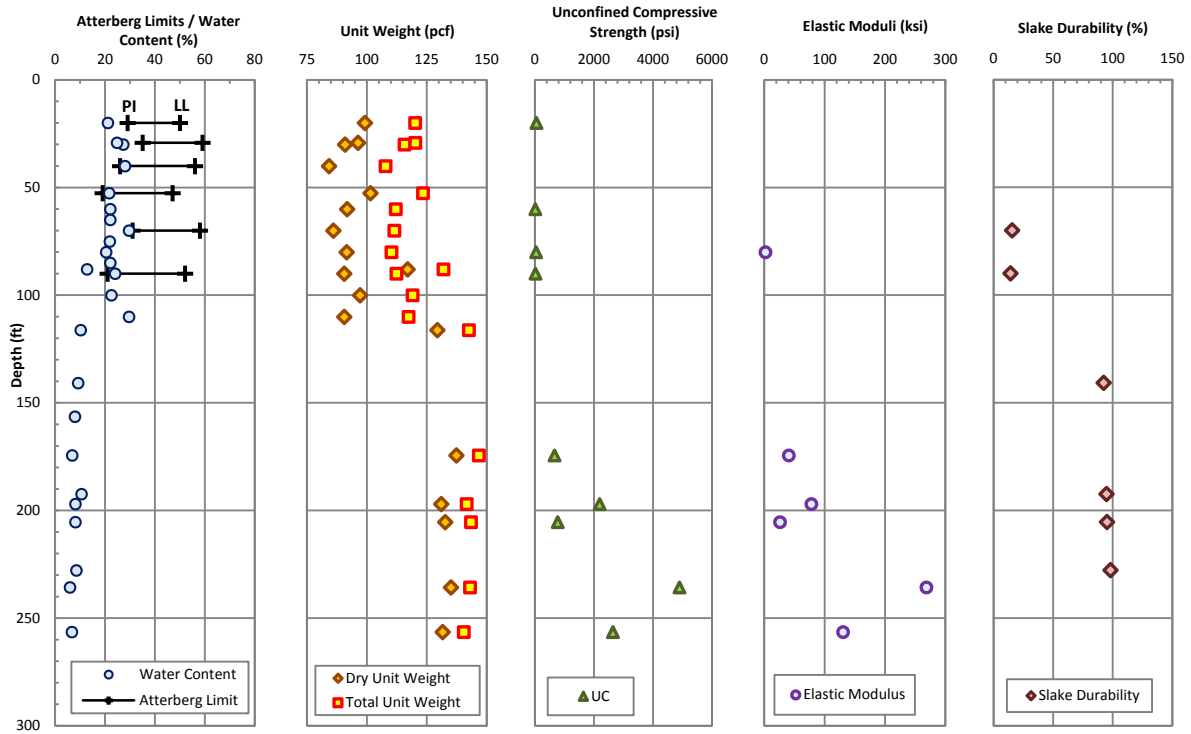


Figure D1-7 Engineering Properties for Topanga Formation Siltstone Member (Ttsl)

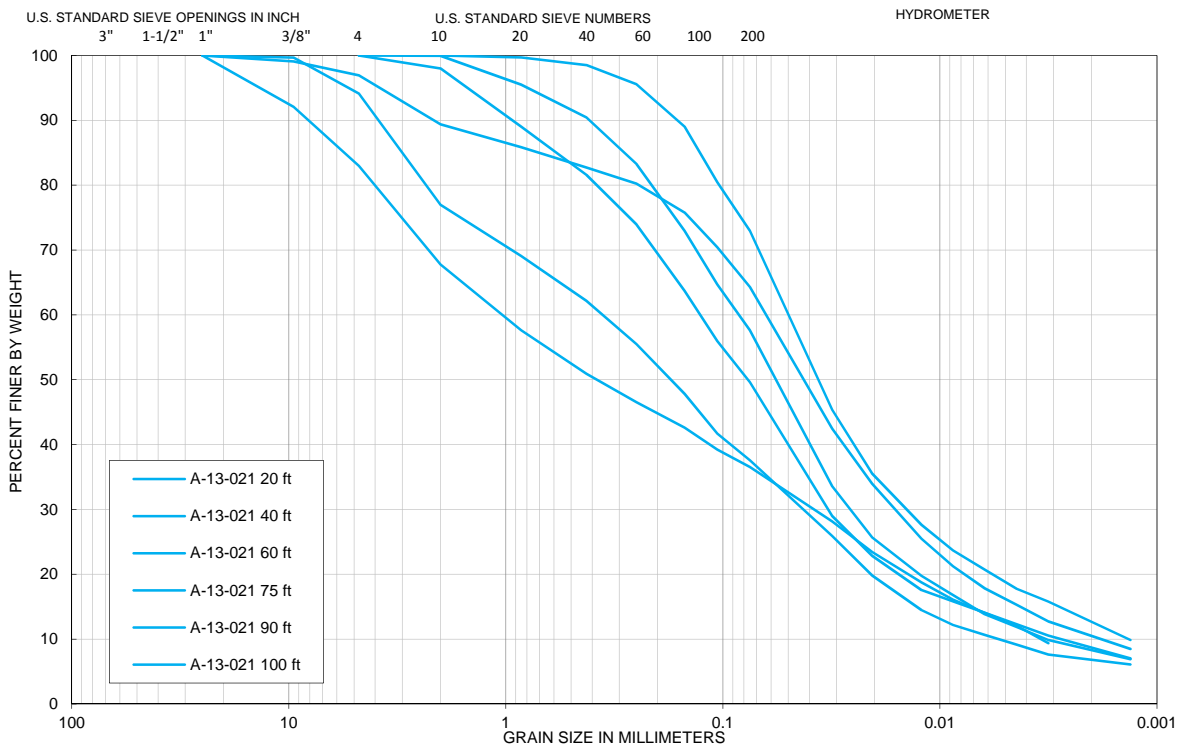
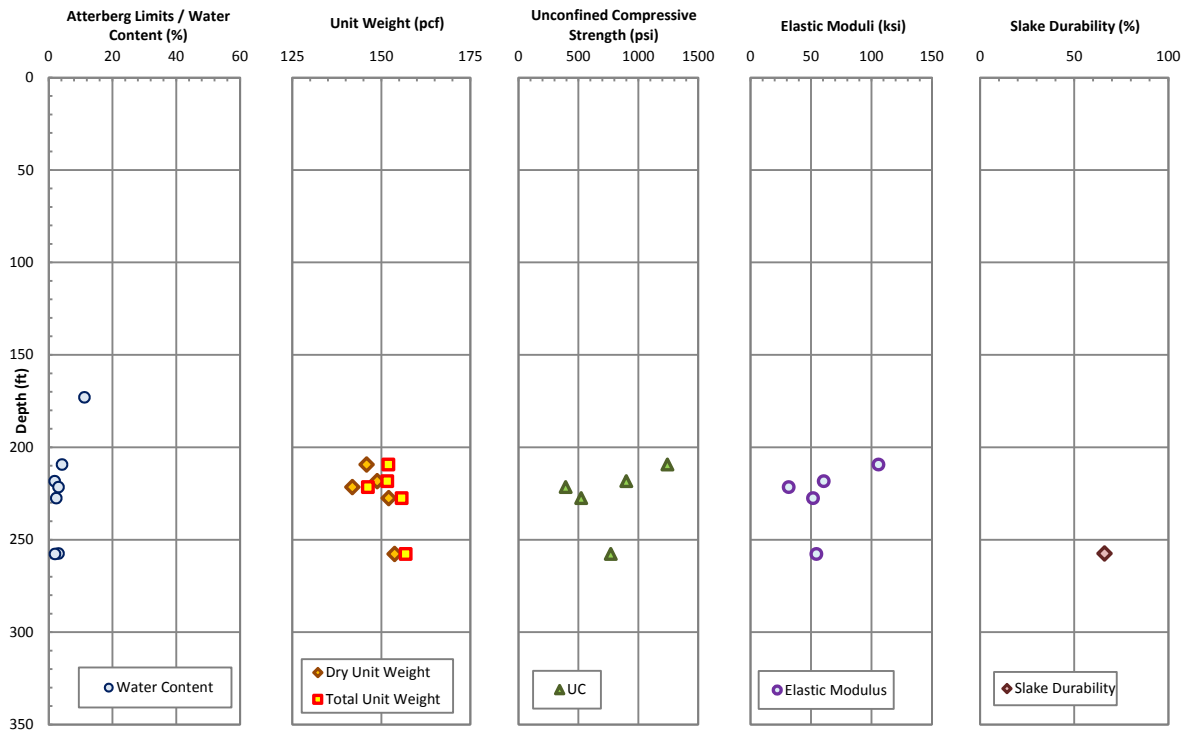
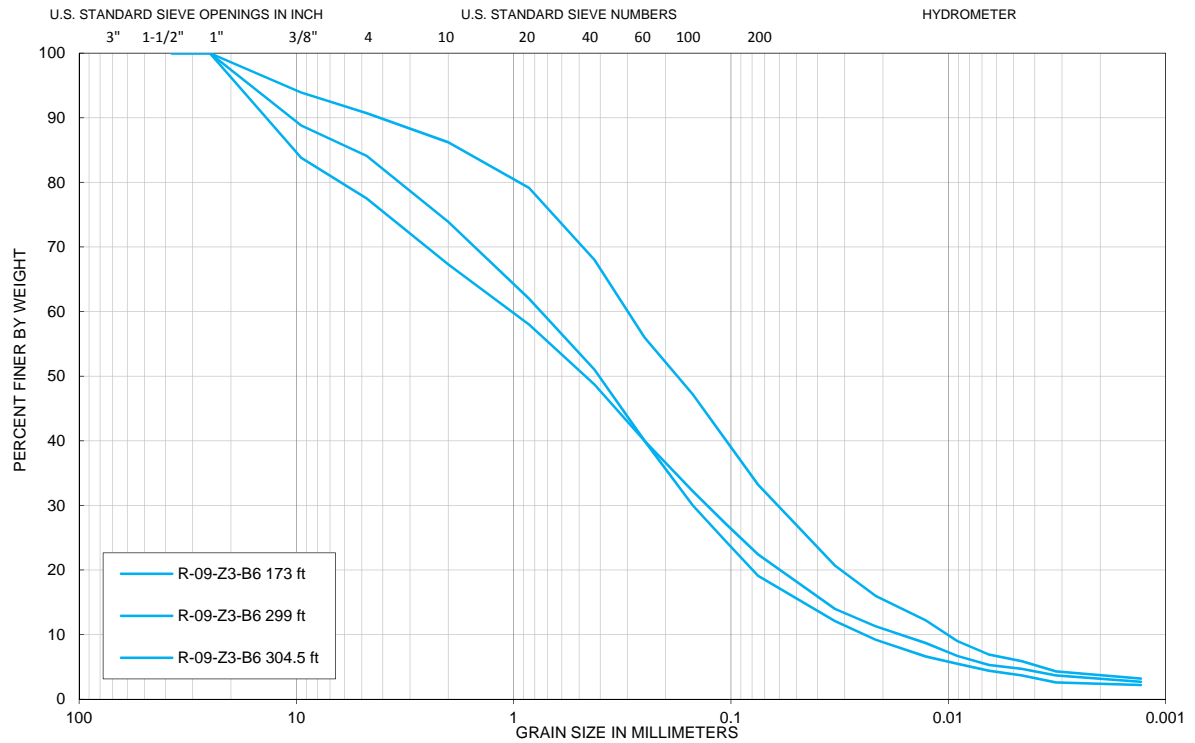


Figure D1-8 Composite Plot of Particle Size Distribution for Topanga Formation Siltstone Member (Ttsl)



**Figure D1-9 Engineering Properties for Topanga Formation Conglomerate Member (Ttcg)**



**Figure D1-10 Composite Plot of Particle Size Distribution for Topanga Formation Conglomerate Member (Ttcg)**

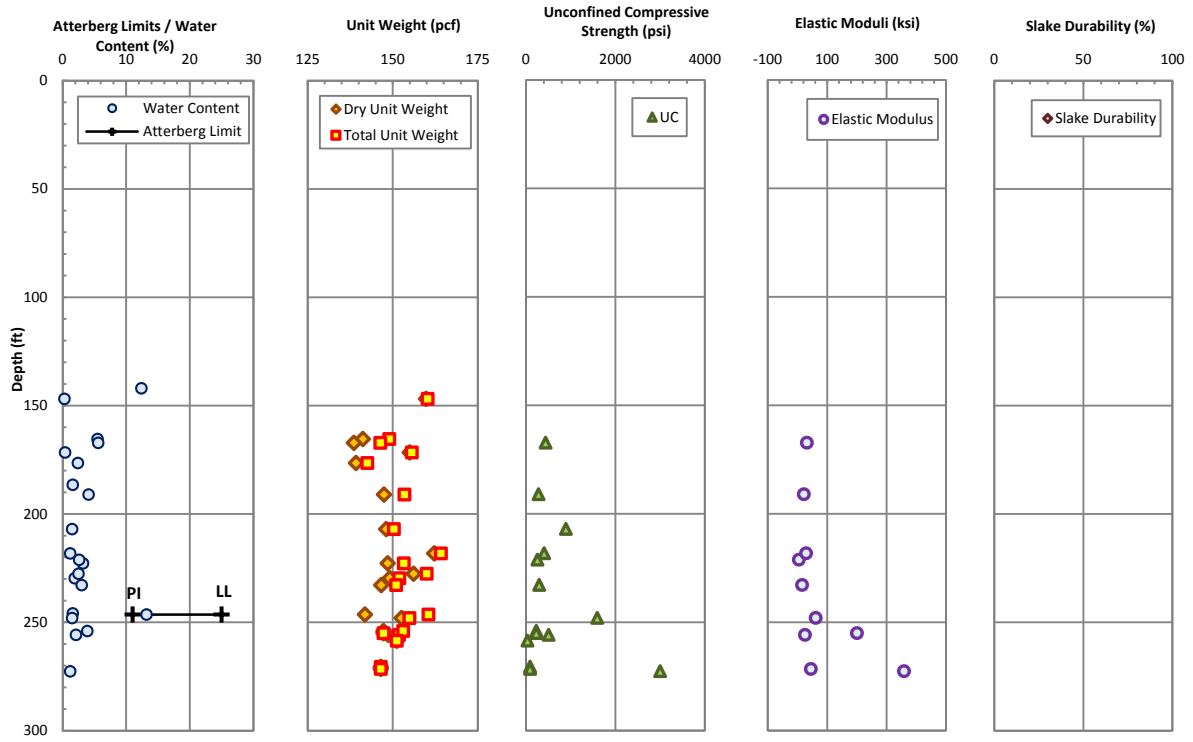


Figure D1-11 Engineering Properties for Wilson Quartz Diorite (Wqd)

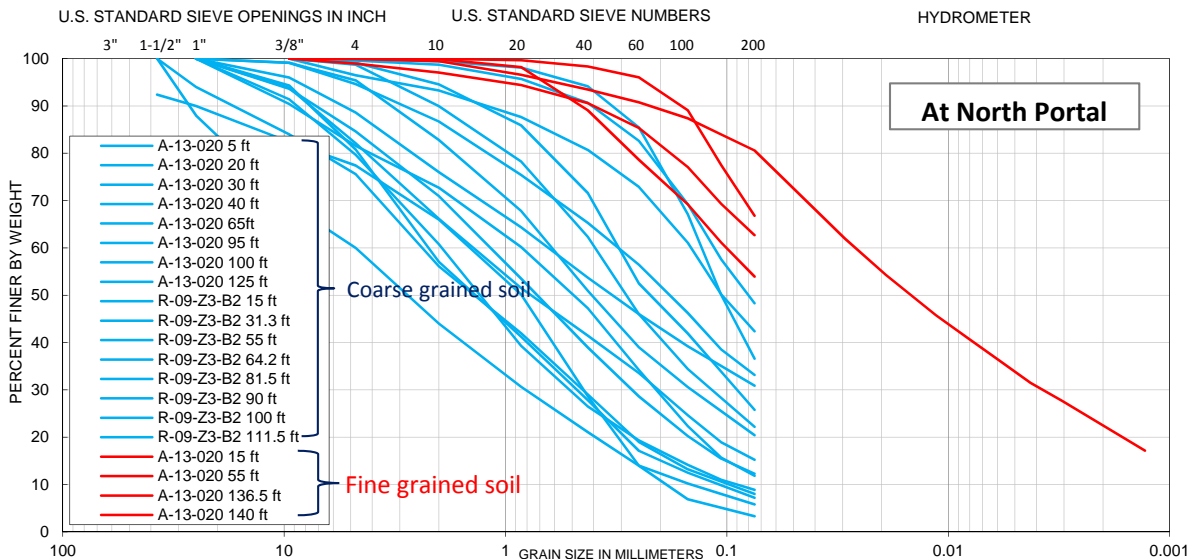
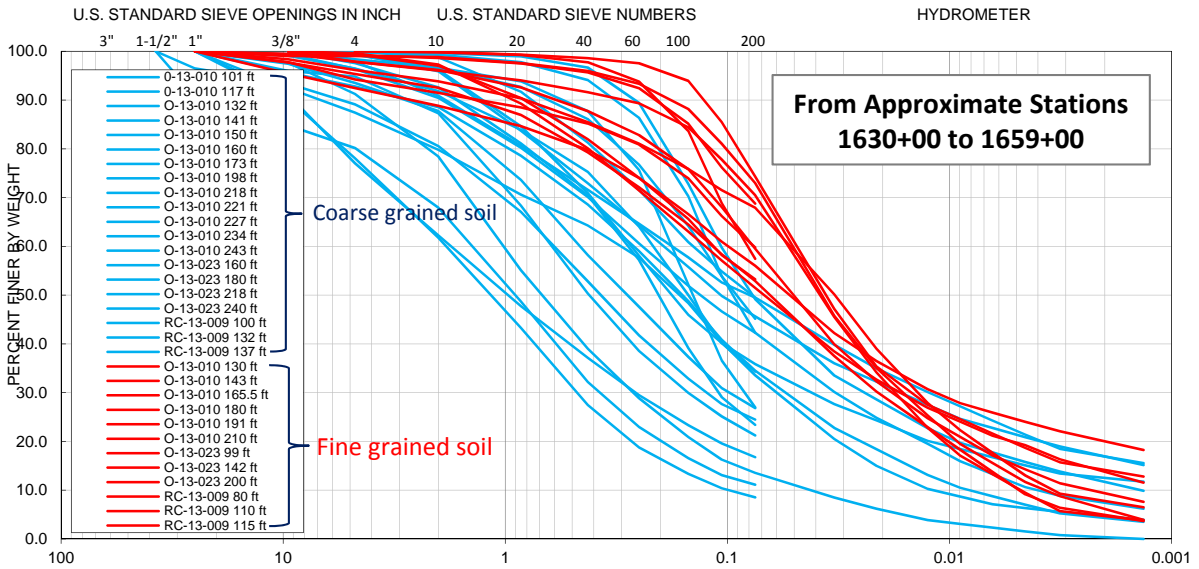
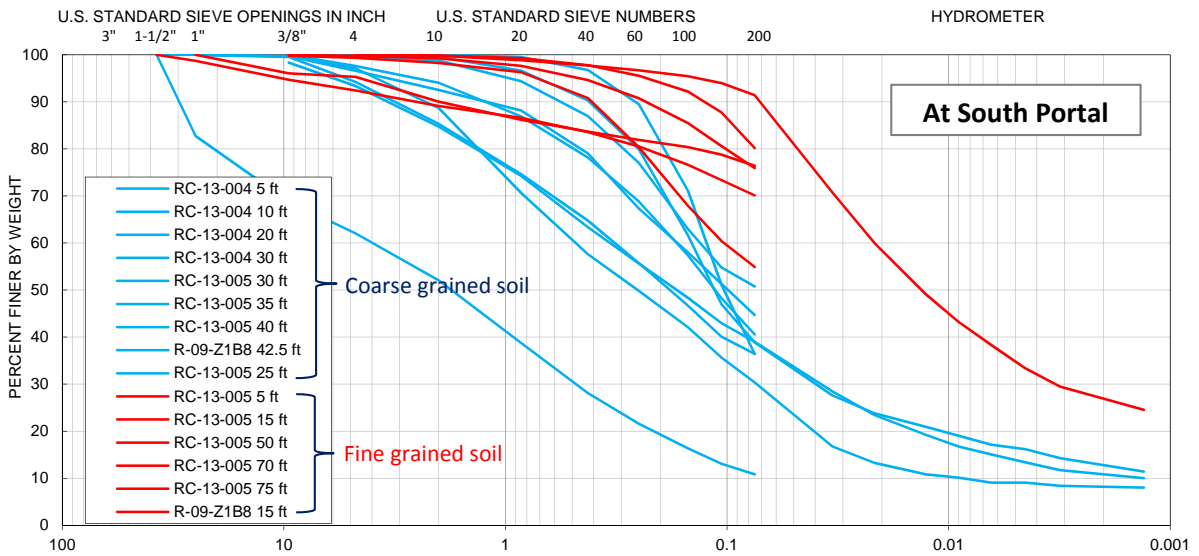
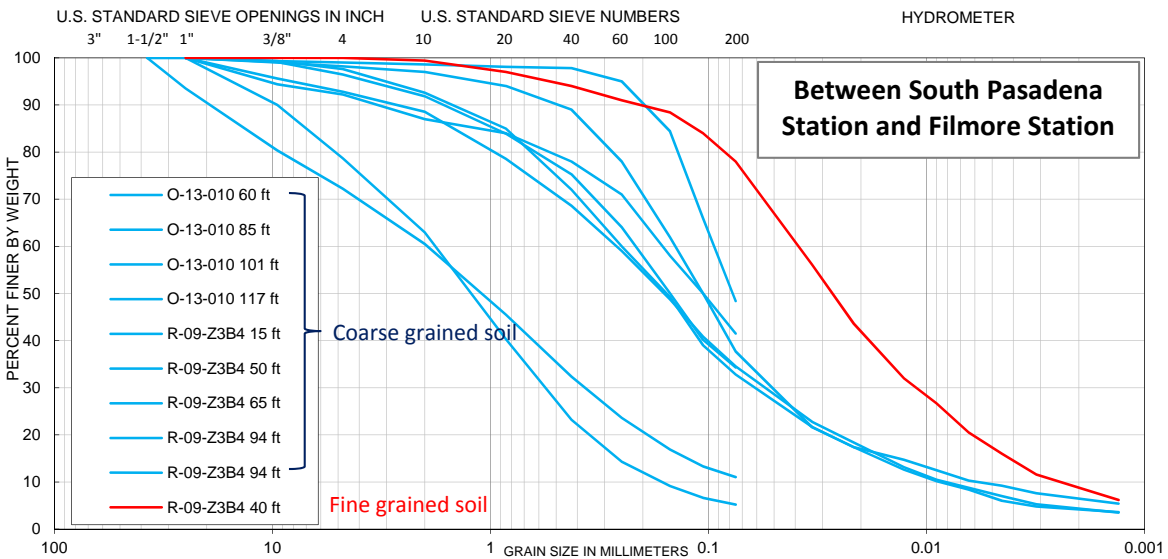
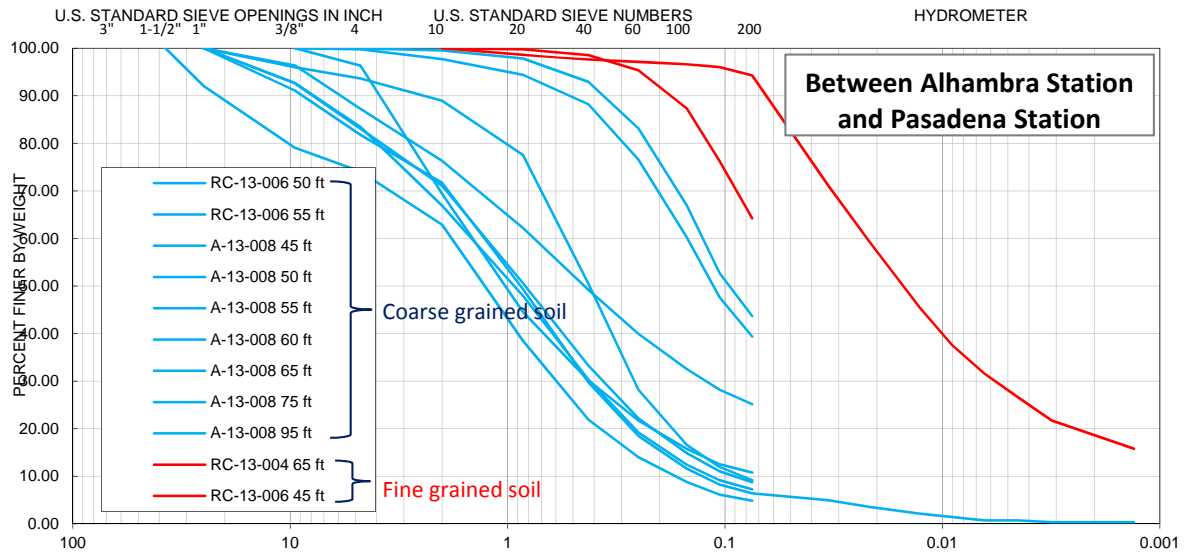
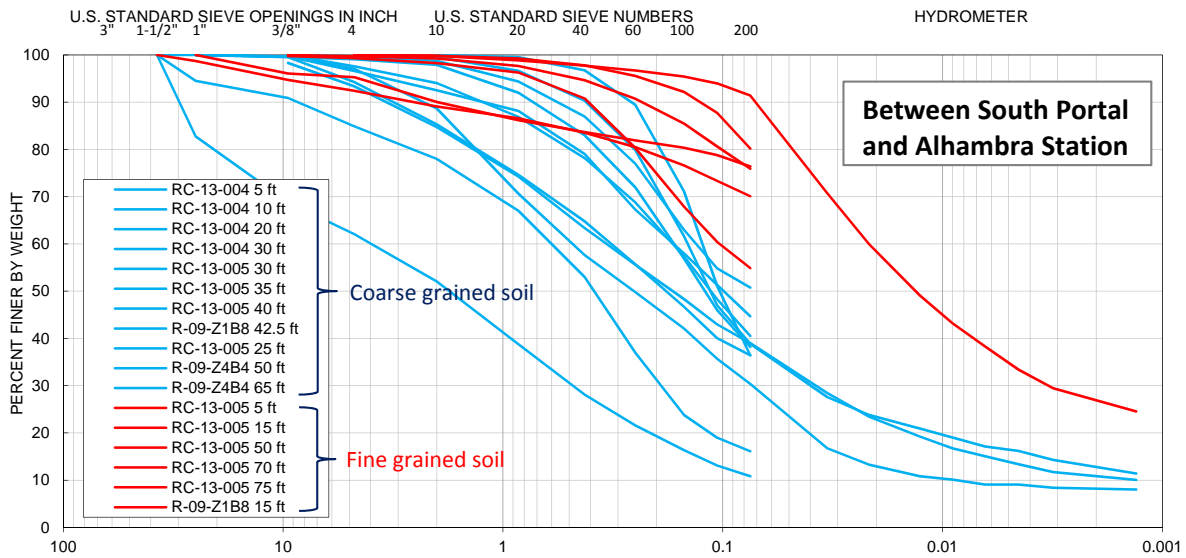


Figure D1-12 Composite Plot of Particle Size Distribution for Alluvial Soils along Freeway Tunnel Alternative



**Figure D1-13 Composite Plot of Particle Size Distribution for Alluvial Soils along LRT Alternative**



APPENDIX D.2

# Current Laboratory Test Results

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# MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

<b>Sample</b>		<b>Wet Unit</b>	<b>Dry Unit</b>	<b>Moisture</b>
<u>Identification</u>	<u>Depth, ft.</u>	<u>Weight, lb/ft.<sup>3</sup></u>	<u>Weight, lb/ft.<sup>3</sup></u>	<u>Content, %</u>
RC-13-007-C38	177.4-178.2	126.6	102.9	23.0

Test Method: ASTM D2216, ASTM D2937

**PROJECT NUMBER:** 13-031 April 29, 2013

**SR 710 North Study**



5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762  
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# MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

<u>Sample Identification</u>	<u>Depth, ft.</u>	<u>Wet Unit Weight, lb/ft.<sup>3</sup></u>	<u>Dry Unit Weight, lb/ft.<sup>3</sup></u>	<u>Moisture Content, %</u>
RC-13-007-C38	177.4-178.2	126.6	102.9	23.0
RC-13-009-C36	167.2-137.8	146.8	138.6	5.9
RC-13-009-C37	176.5-176.9	142.6	139.2	2.4
RC-13-009-C41	191.0-191.6	153.4	147.4	4.1
RC-13-009-C44	207.0-207.8	150.4	148.1	1.5
RC-13-009-C44	210.8-211.2	153.2	151.1	1.4
RC-13-009-C48	229.6-229.9	152.0	149.1	1.9
RC-13-009-C49	232.8-232.3	151.0	146.6	3.0
RC-13-009-C52	248.5-249.0	154.9	152.6	1.5
RC-13-009-C53	255.8-256.5	151.9	148.7	2.1

Test Method: ASTM D2216, ASTM D2937

**PROJECT NUMBER:** 13-031 April 29, 2013

**SR 710 North Study**



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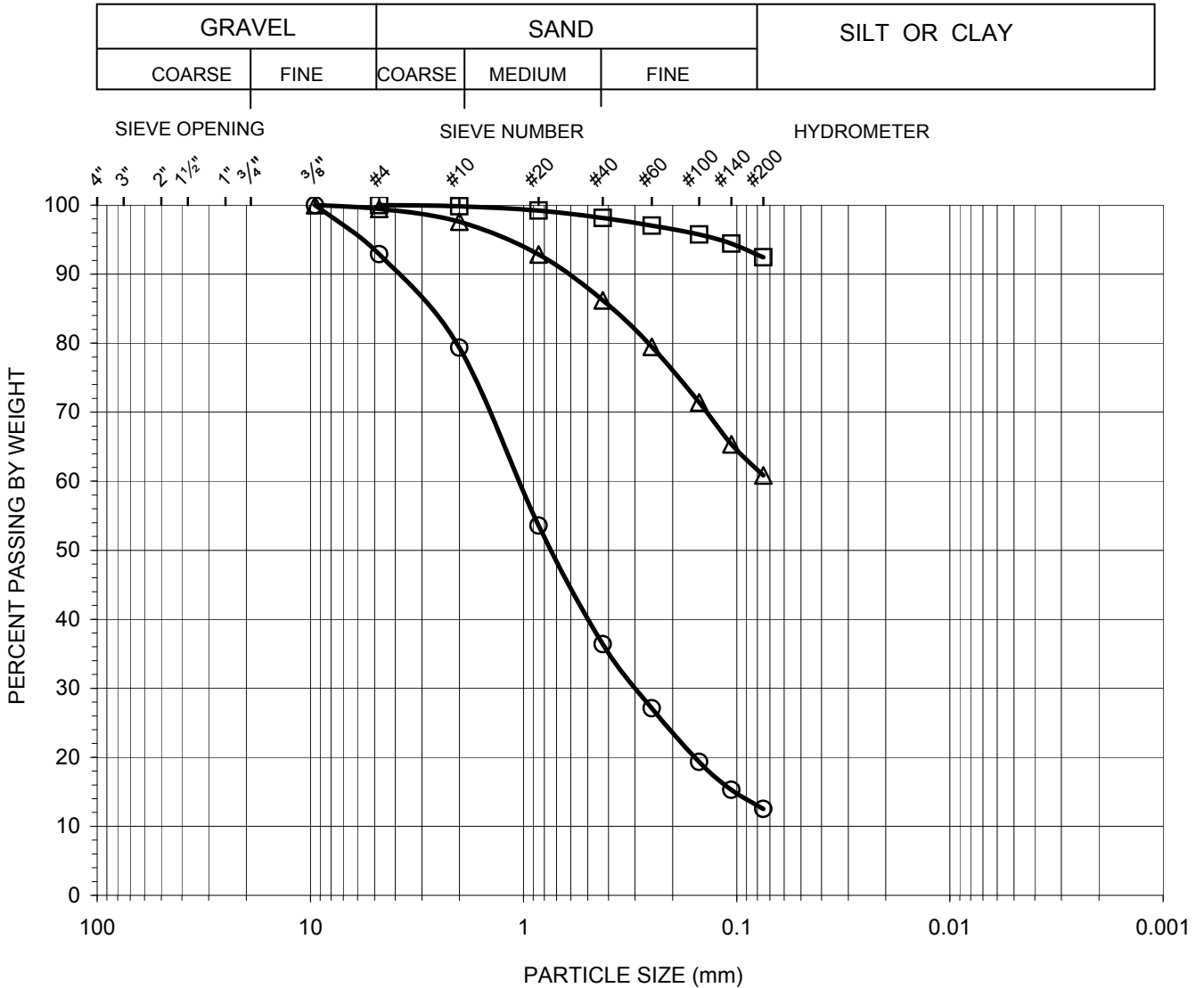






### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	DK	Date:	04/02/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	04/15/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/20/13



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-001	S08	35	7	80	13	N/A	SM
□	A-13-001	S09	40	0	8	92	44:13:31	CL
△	A-13-001	S10	45	1	38	61	N/A	ML



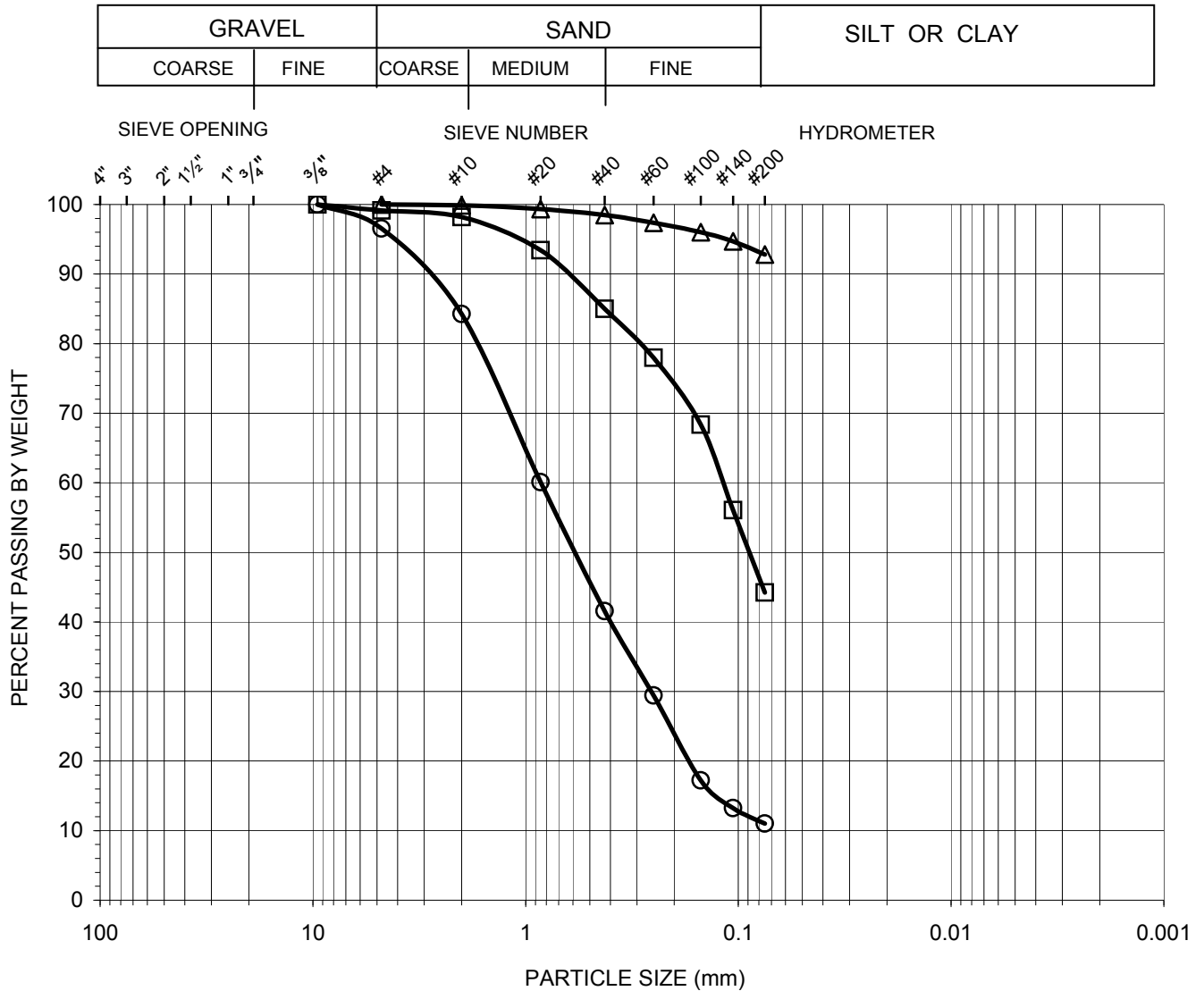




AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: DK Date: 04/02/13  
 Project Name: SR-710 North Study Computed by: KM Date: 04/15/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/20/13



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-001	S15	70	3	86	11	N/A	SW-SM
□	A-13-001	S16	75	1	55	44	N/A	SM
△	A-13-001	S18	85	0	7	93	N/A	CL





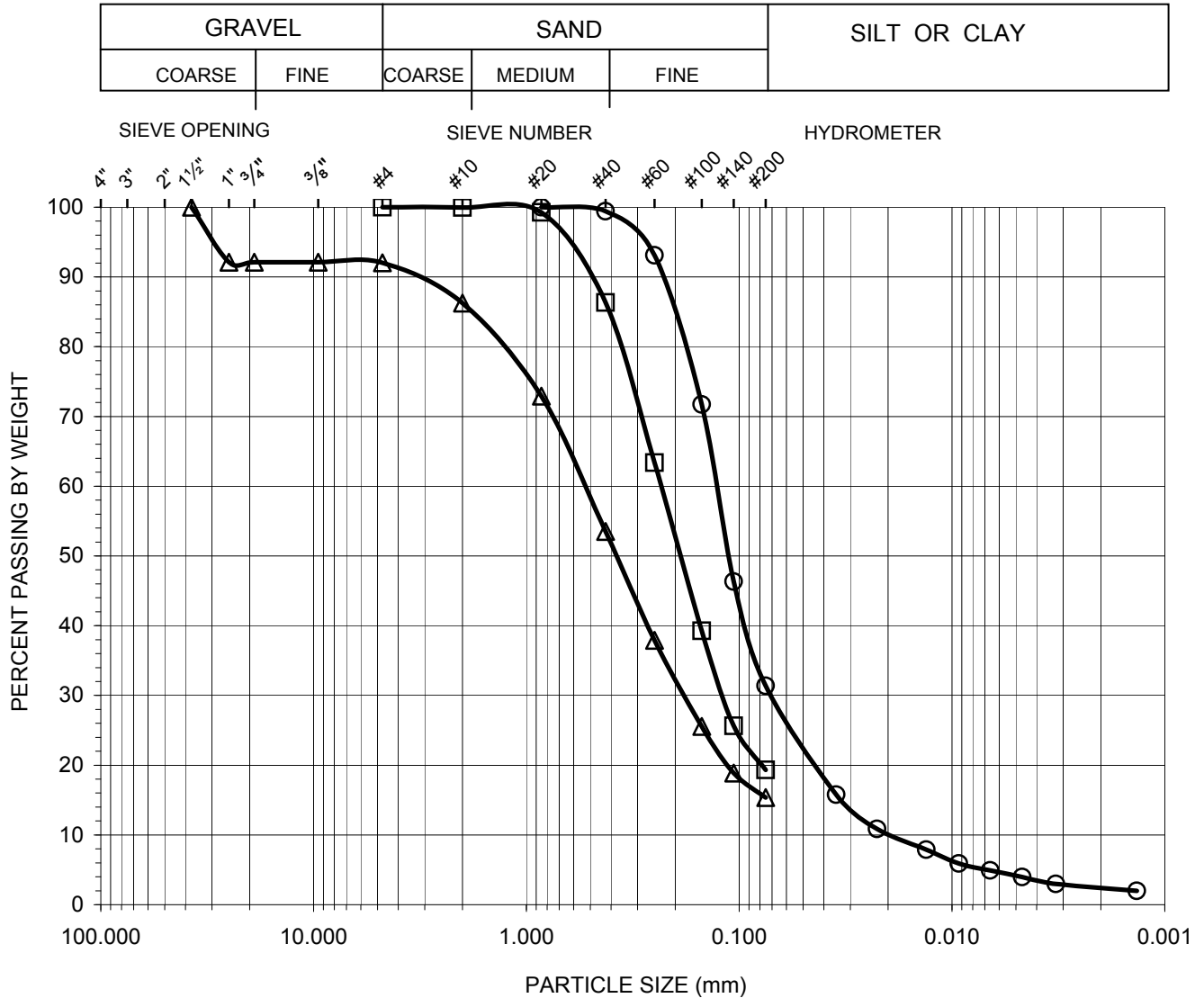




AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	04/25/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/07/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/09/13



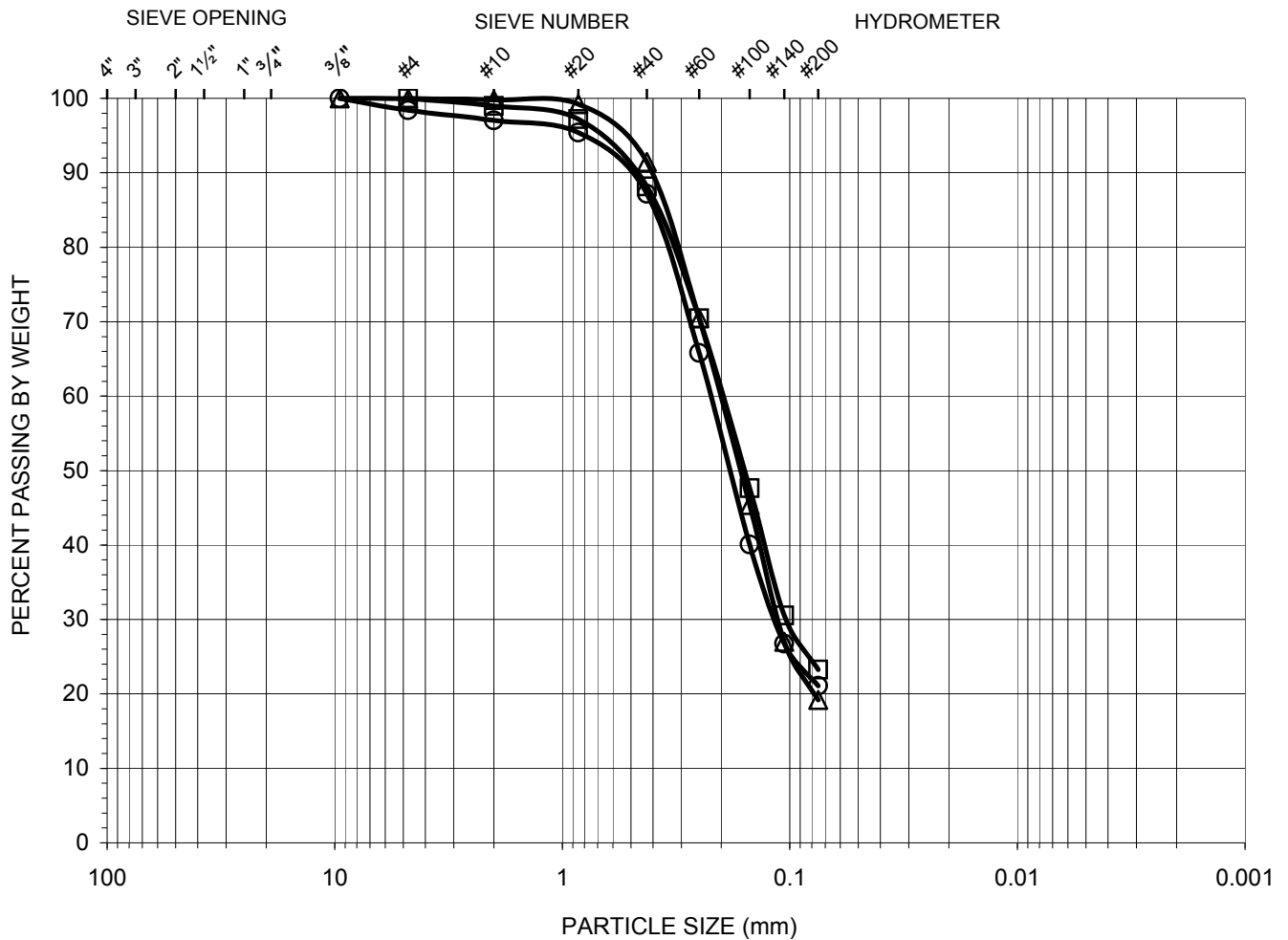
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-003	S04	15	0	69	31	N/A	SM
□	RC-13-003	S06	25	0	81	19	N/A	SM
△	RC-13-003	S11	45	8	77	15	N/A	SM



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/25/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/07/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/09/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-003	S14	55	2	77	21	N/A	SM
□	RC-13-003	S17	65	0	77	23	N/A	SM
△	RC-13-003	S25	95	0	81	19	N/A	SM

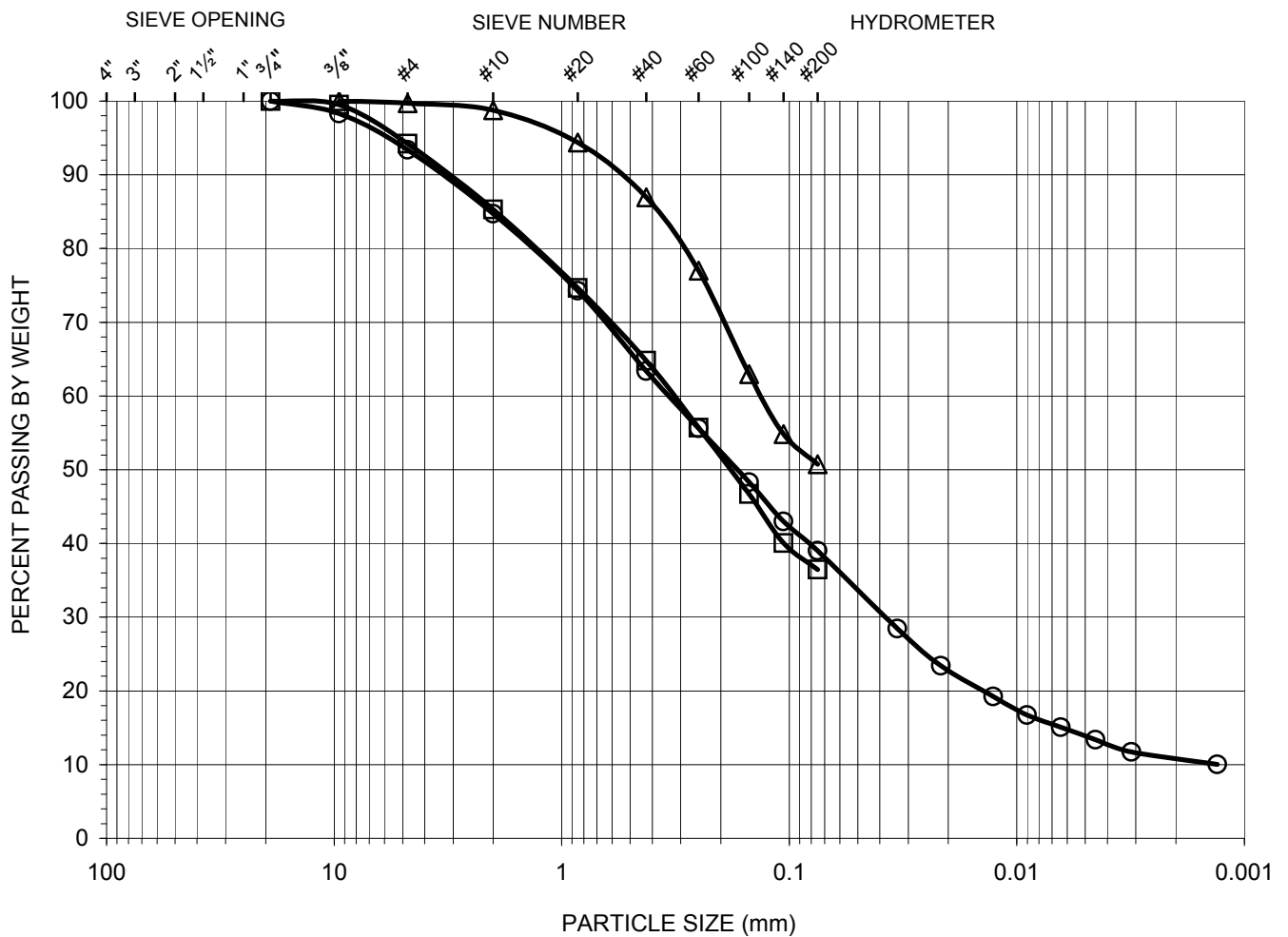


AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/17/13  
 Project Name: SR-710 North Study Computed by: KM Date: 04/29/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/02/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



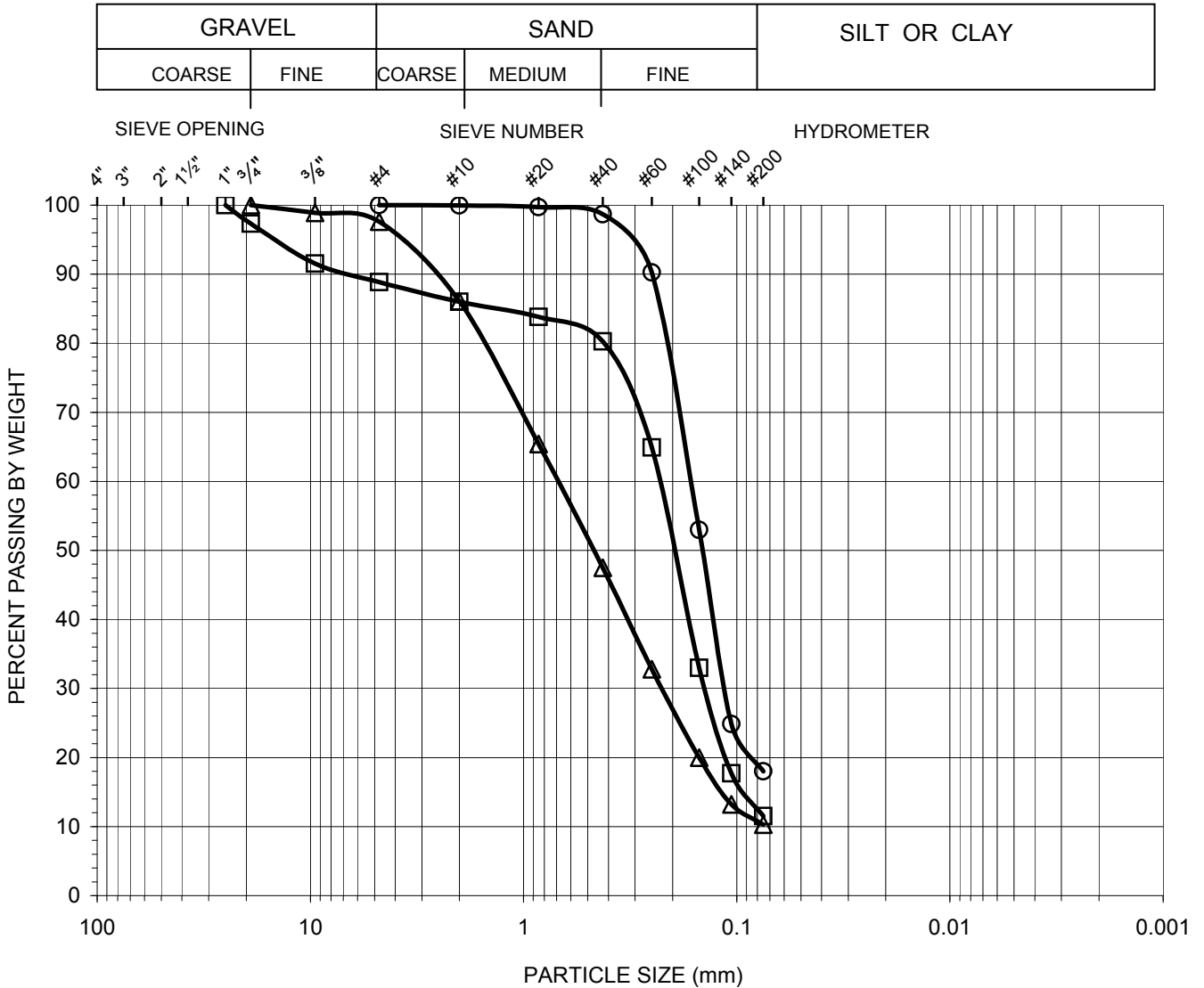
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-004	S02	5	7	54	39	23:13:10	SC
□	RC-13-004	S03	10	6	58	36	23:16:7	SC-SM
△	RC-13-004	S05	20	0	49	51	N/A	CL





### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	DK	Date:	04/23/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/01/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/02/13



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-004	C11	51-51.7	0	82	18	N/A	SM
□	RC-13-004	C13	59.8-60.3	11	77	12	N/A	SP-SM
△	RC-13-004	C15	69.7-70.1	2	88	10	N/A	SP-SM

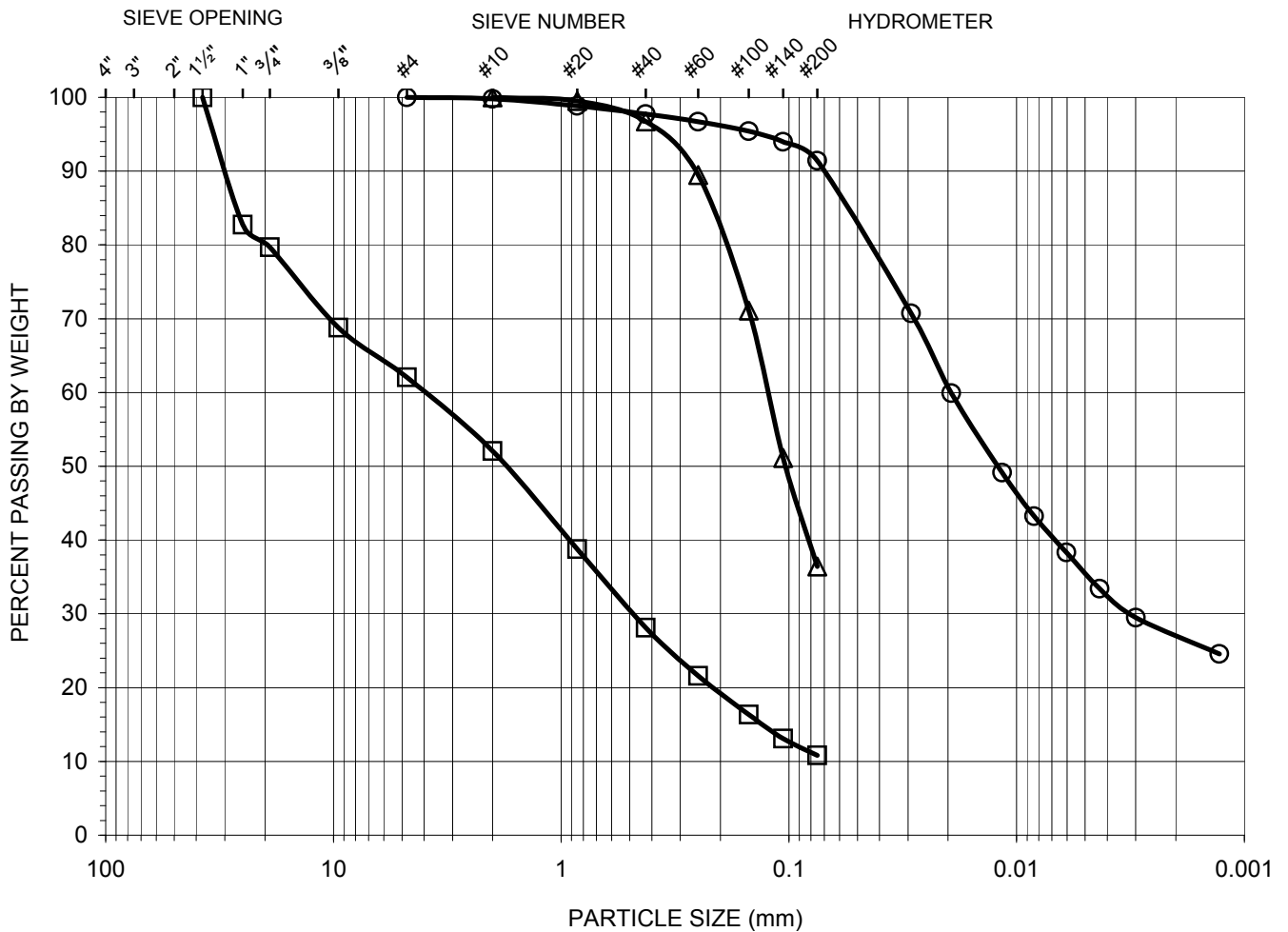




### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/02/13  
 Project Name: SR-710 North Study Computed by: KM Date: 04/15/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 04/23/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-005	S4	15-16.5	0	9	91	N/A	<del>ML</del> -CH
□	RC-13-005	S7	30-31.5	38	51	11	N/A	SP-SM
△	RC-13-005	S9	40-41.5	0	64	36	N/A	SM





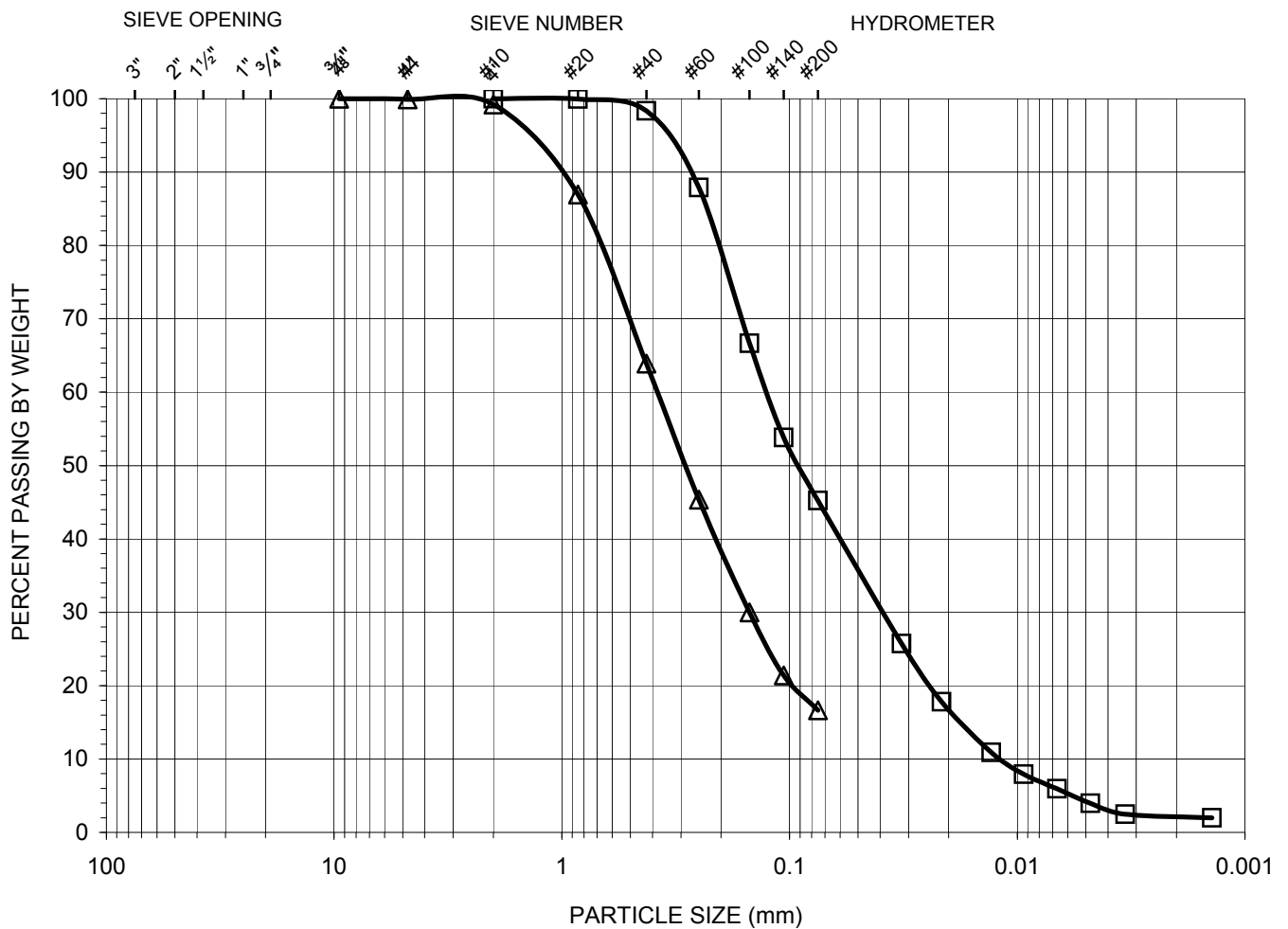




### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/12/13  
 Project Name: SR-710 North Study Computed by: KM Date: 04/15/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 04/24/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



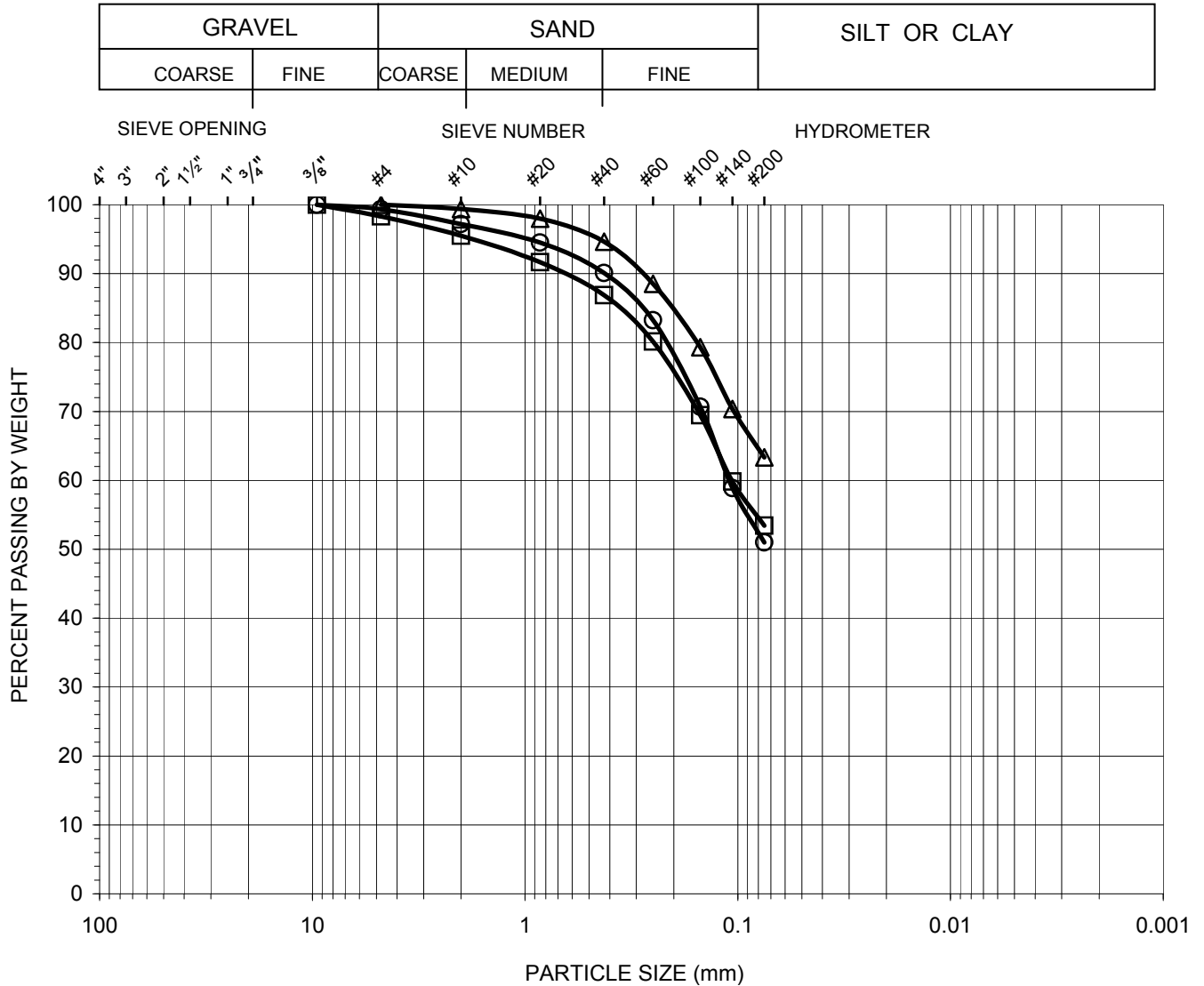
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-005	C21	93.7-94.1	Sample is hard rock and not applicable for this test.				
□	RC-13-005	C41	183.4-184.2	0	55	45	N/A	SM
△	RC-13-005	C46	206-206.5	0	83	17	N/A	SM



AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	04/26/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/03/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/07/13



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	R-13-006	S02	5	1	48	51	N/A	ML
□	R-13-006	S04	15	2	45	53	21:14:7	CL-ML
△	R-13-006	S07	30	0	37	63	21:16:5	CL-ML

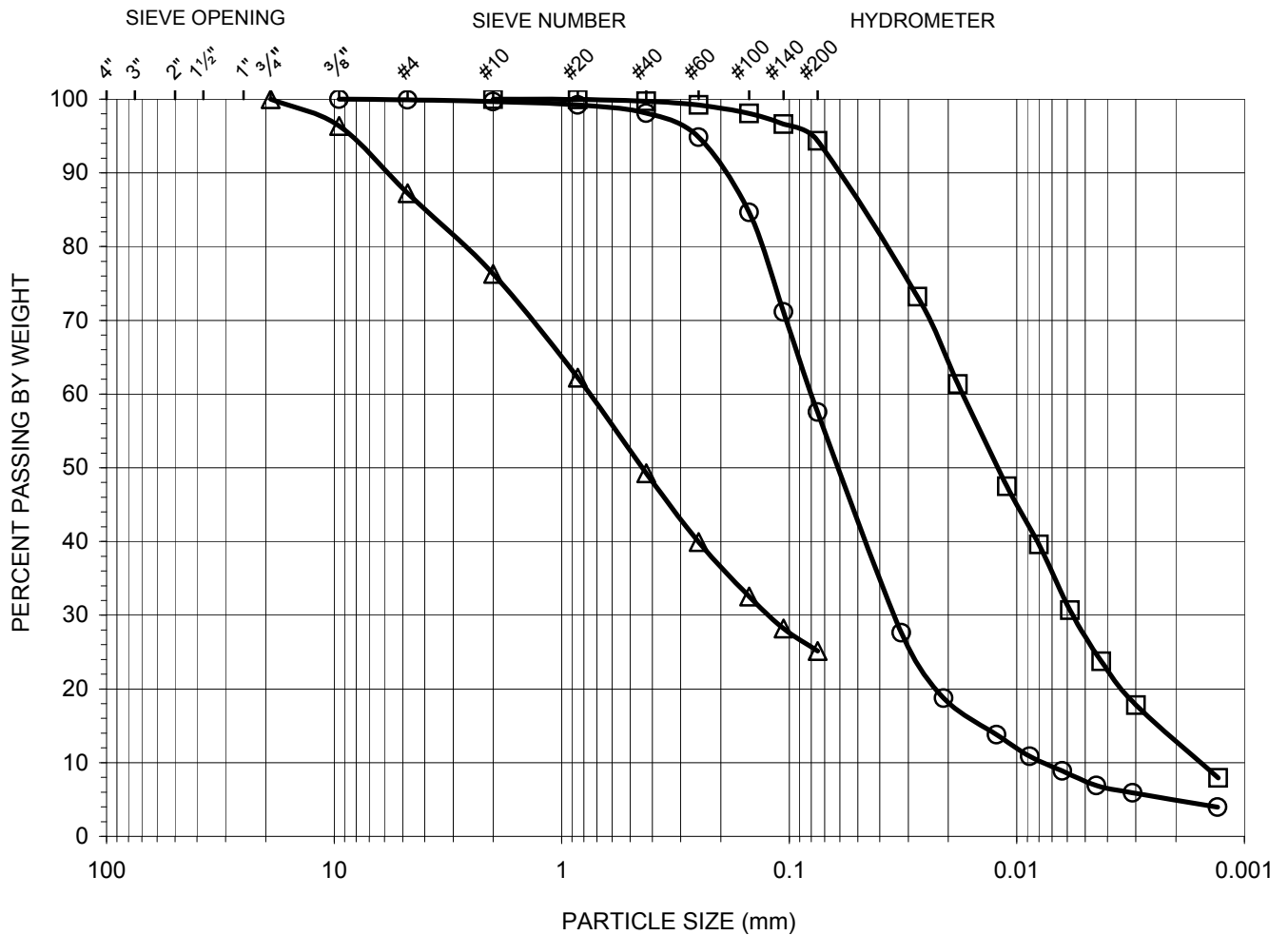


AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 06/26/13  
 Project Name: SR-710 North Study Computed by: KM Date: 07/01/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 07/03/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



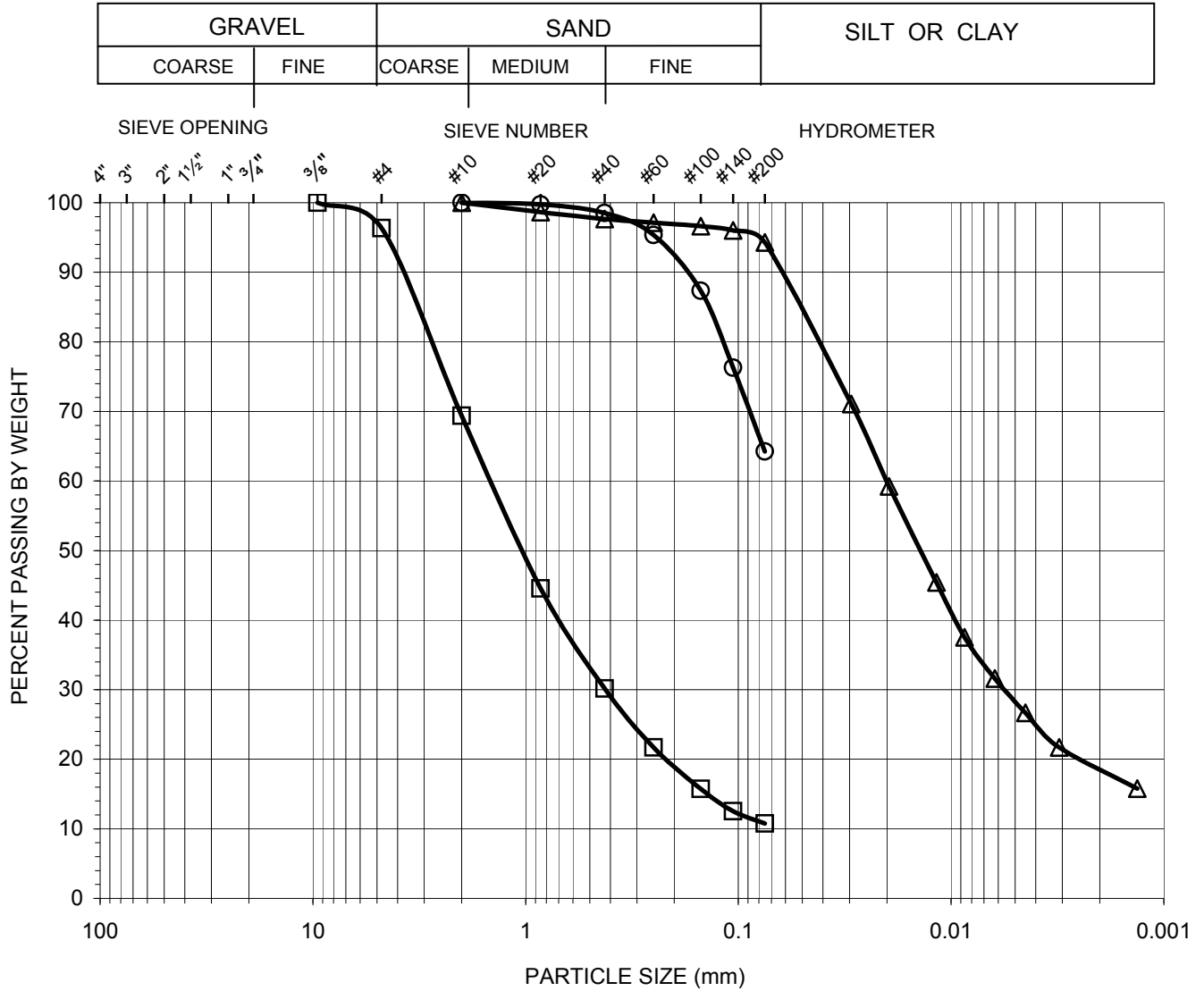
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	R-13-006	S08	35	0	42	58	N/A	ML
□	R-13-006	S09	40	0	6	94	35:22:13	CL
△	R-13-006	S11	50	13	62	25	27:11:16	SC



AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/26/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/03/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/07/13



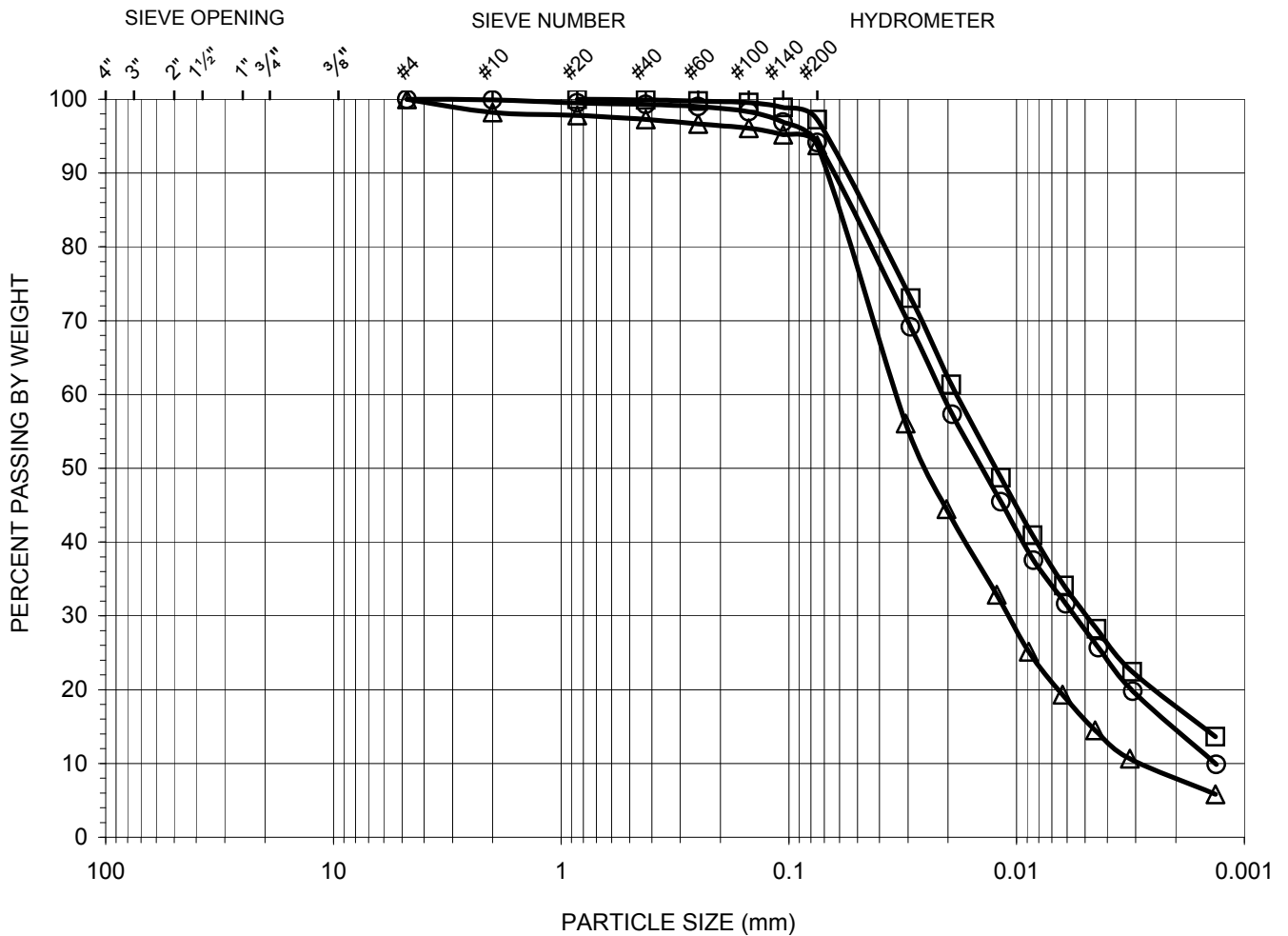
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	R-13-006	S10	45	0	36	64	N/A	ML
□	R-13-006	S12	55	4	85	11	N/A	SW-SM
△	R-13-006	S14	65	0	6	94	56:18:38	CH



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/26/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/03/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/09/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



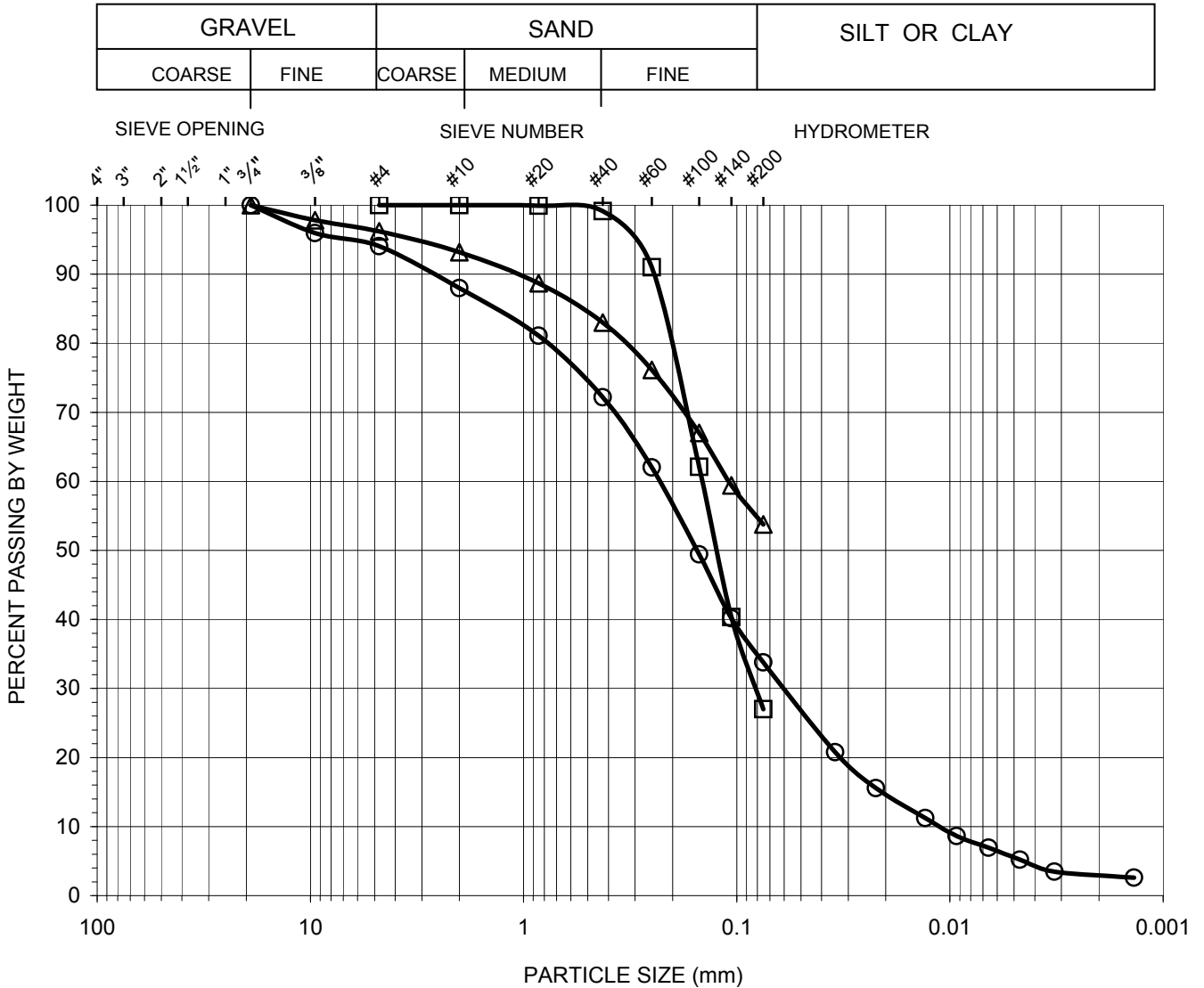
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	R-13-006	S16A	75	0	6	94	54:21:33	CH
□	R-13-006	S19A	90	0	3	97	57:20:37	CH
△	R-13-006	S22A	105	0	6	94	60:22:38	CH





### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/09/13  
 Project Name: SR-710 North Study Computed by: KM Date: 04/22/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 04/26/13



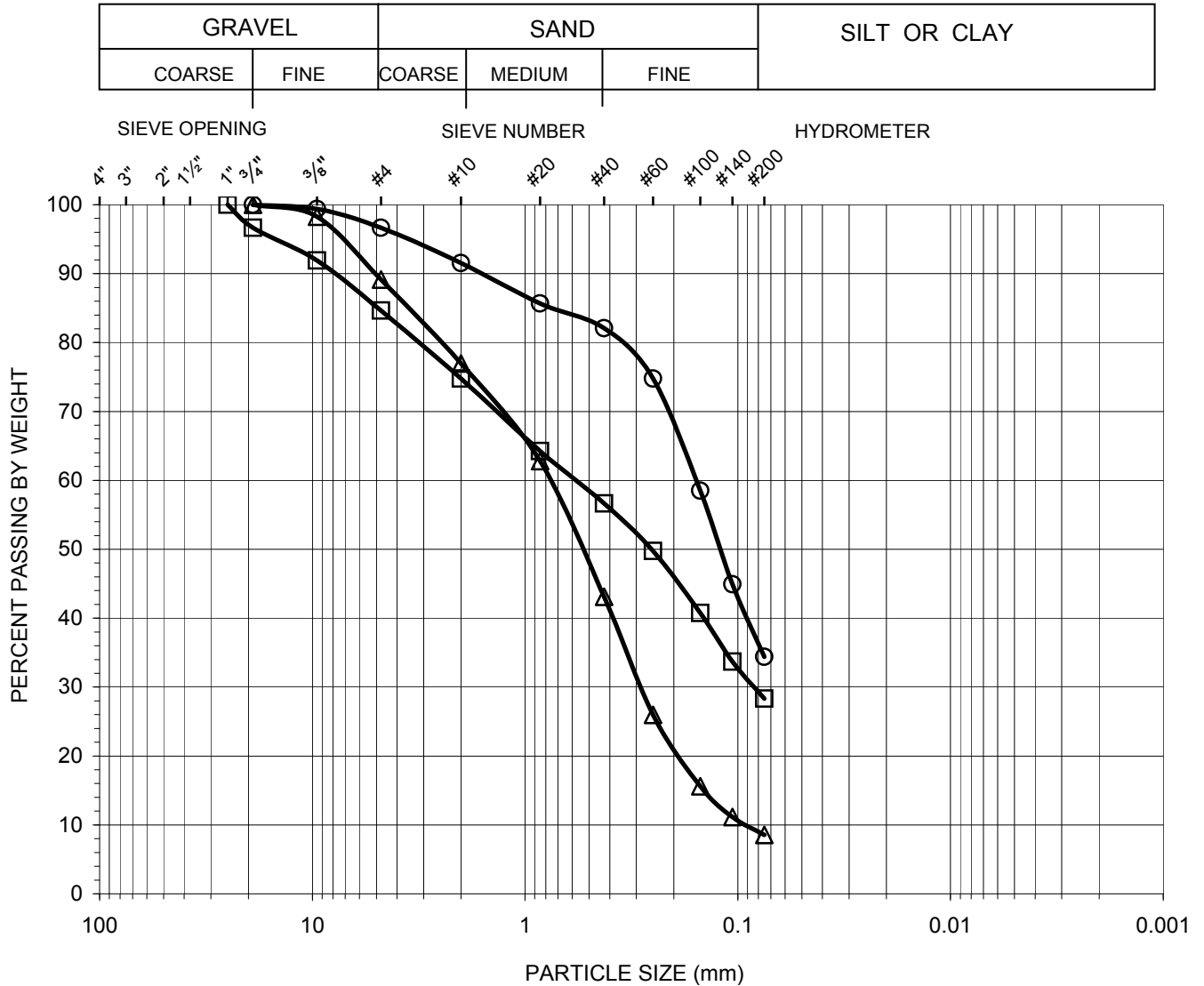
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-007	S03	10	6	60	34	N/A	SM
□	RC-13-007	S05	20	0	73	27	N/A	SM
△	RC-13-007	S07	30	4	42	54	21:16:5	CL-ML





### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	06/26/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	07/01/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	07/03/13



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-007	S04	15	3	63	34	N/A	SM
□	RC-13-007	S08	35	15	57	28	N/A	SM
△	RC-13-007	S10	45	11	80	9	N/A	SW-SM

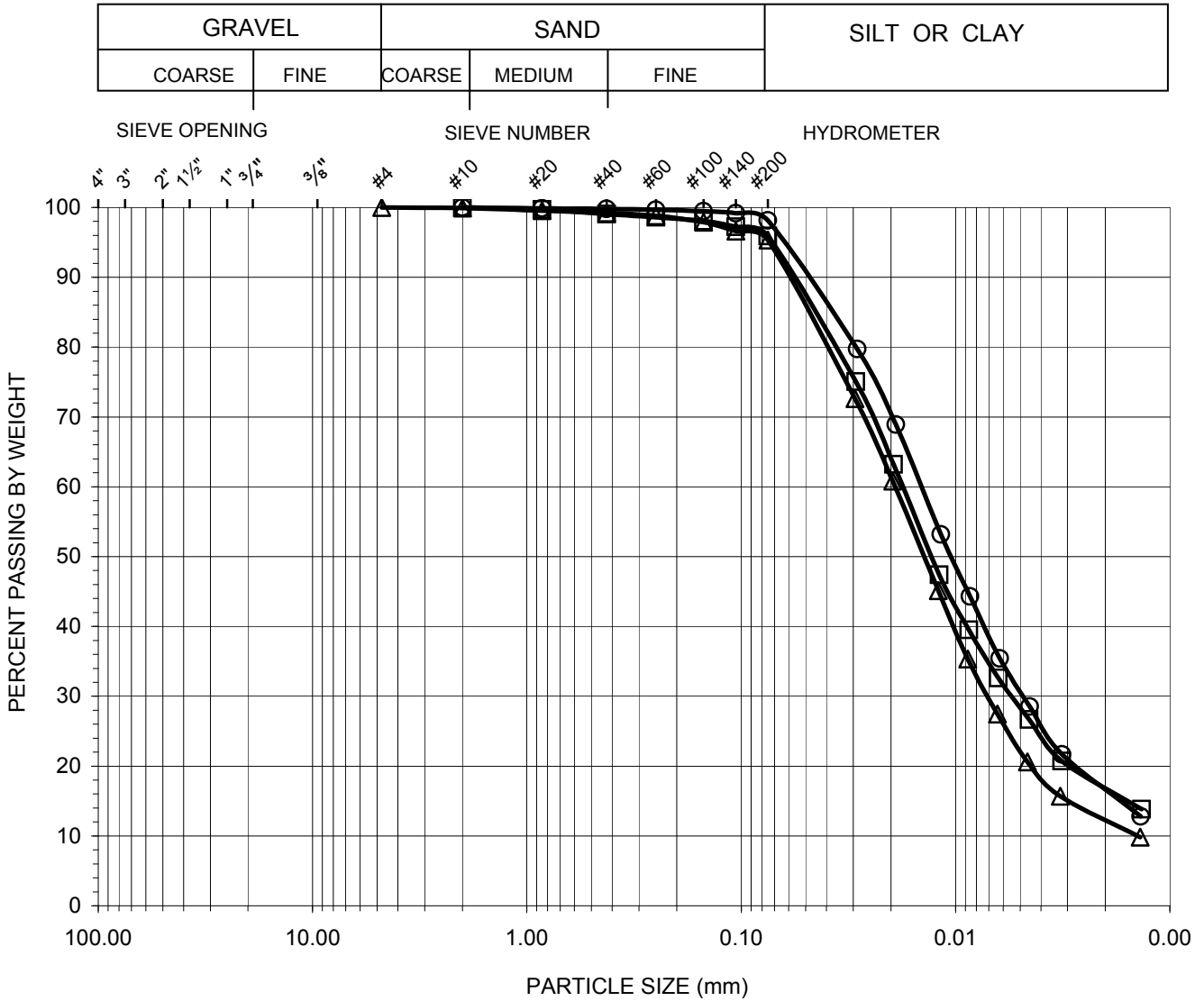






### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	04/09/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	04/22/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	04/26/13

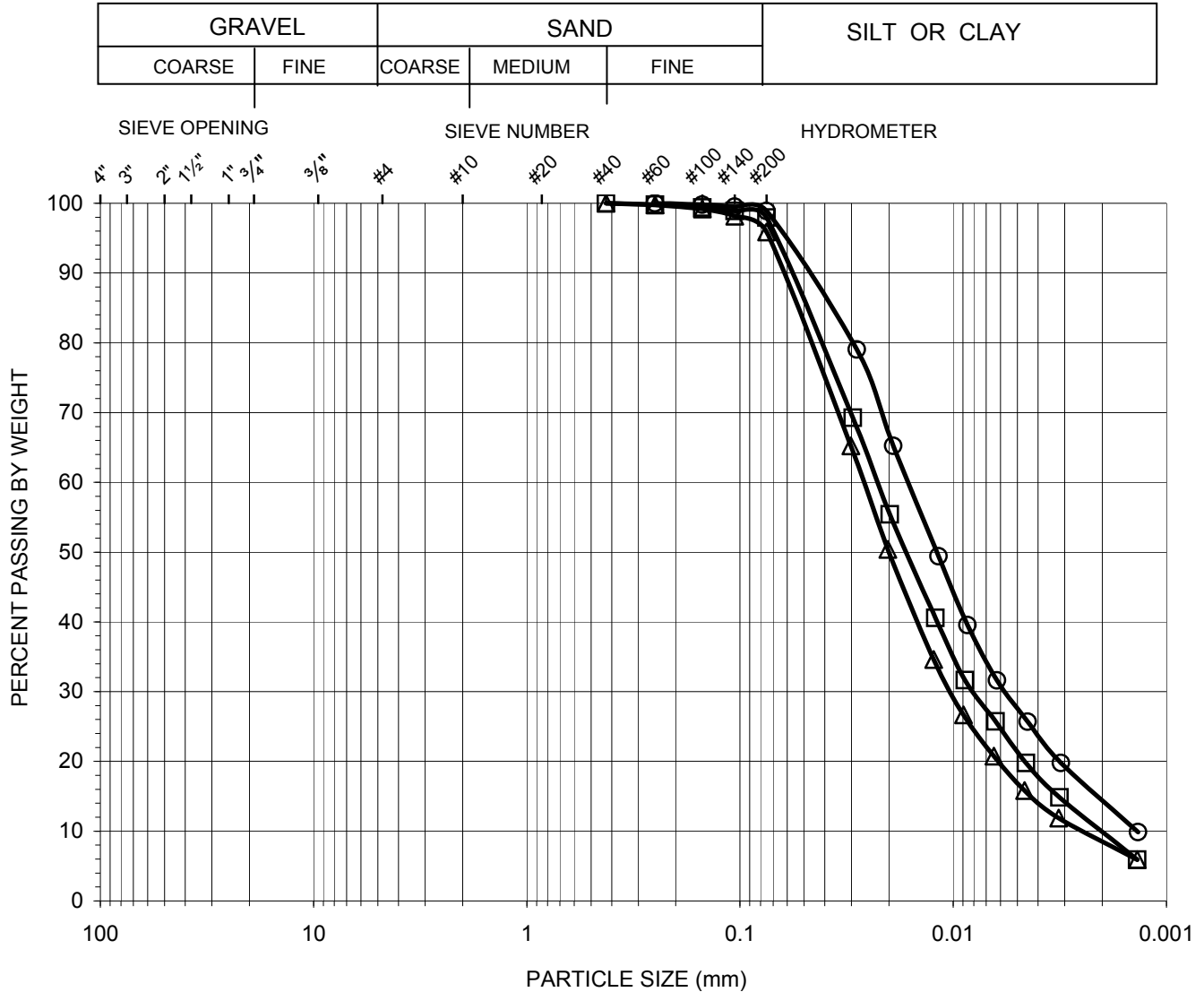


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-007	C24	115.7-116.7	0	2	98	59:19:40	CH
□	RC-13-007	C26	124.4-125.2	0	4	96	58:19:39	CH
△	RC-13-007	C29	137.8-138.6	0	5	95	N/A	ML



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/09/13  
 Project Name: SR-710 North Study Computed by: KM Date: 04/22/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 04/26/13

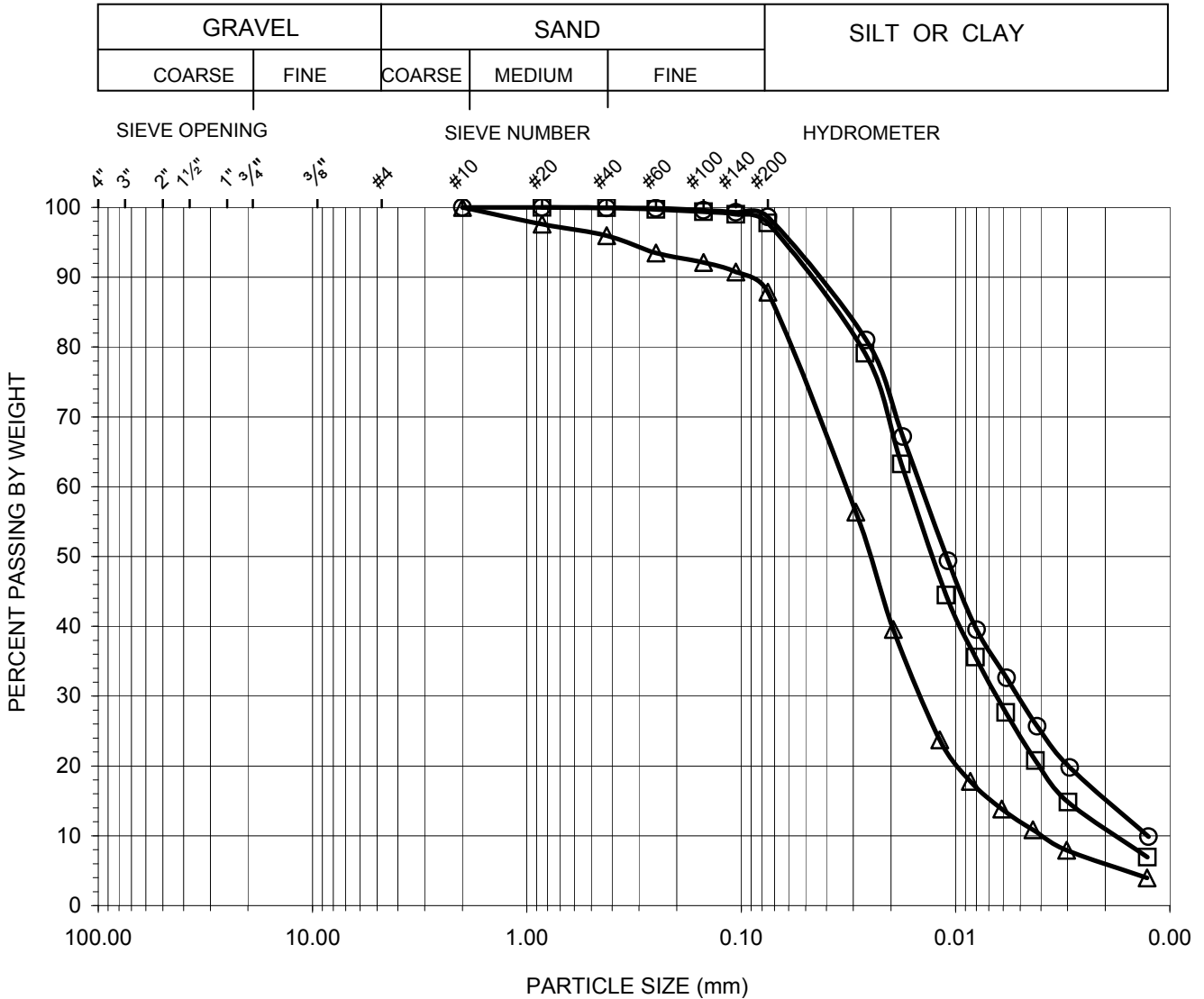


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-007	C32	152.9-153.7	0	1	99	48:21:27	CL
□	RC-13-007	C37	172.9-173.6	0	2	98	49:21:28	CL
△	RC-13-007	C42	192.2-193.1	0	4	96	46:21:25	CL



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	DK	Date:	09/06/13
Project Name:	SR710 North Study	Computed by:	JP	Date:	09/19/13
Project No.:	133978	Checked by:	AP	Date:	09/20/13



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-007	C34	162-162.8	0	1	99	49:21:28	CL
□	RC-13-007	C40	185-185.5	0	2	98	N/A	CL*
△	RC-13-007	C47	215-215.8	0	12	88	44:22:22	CL

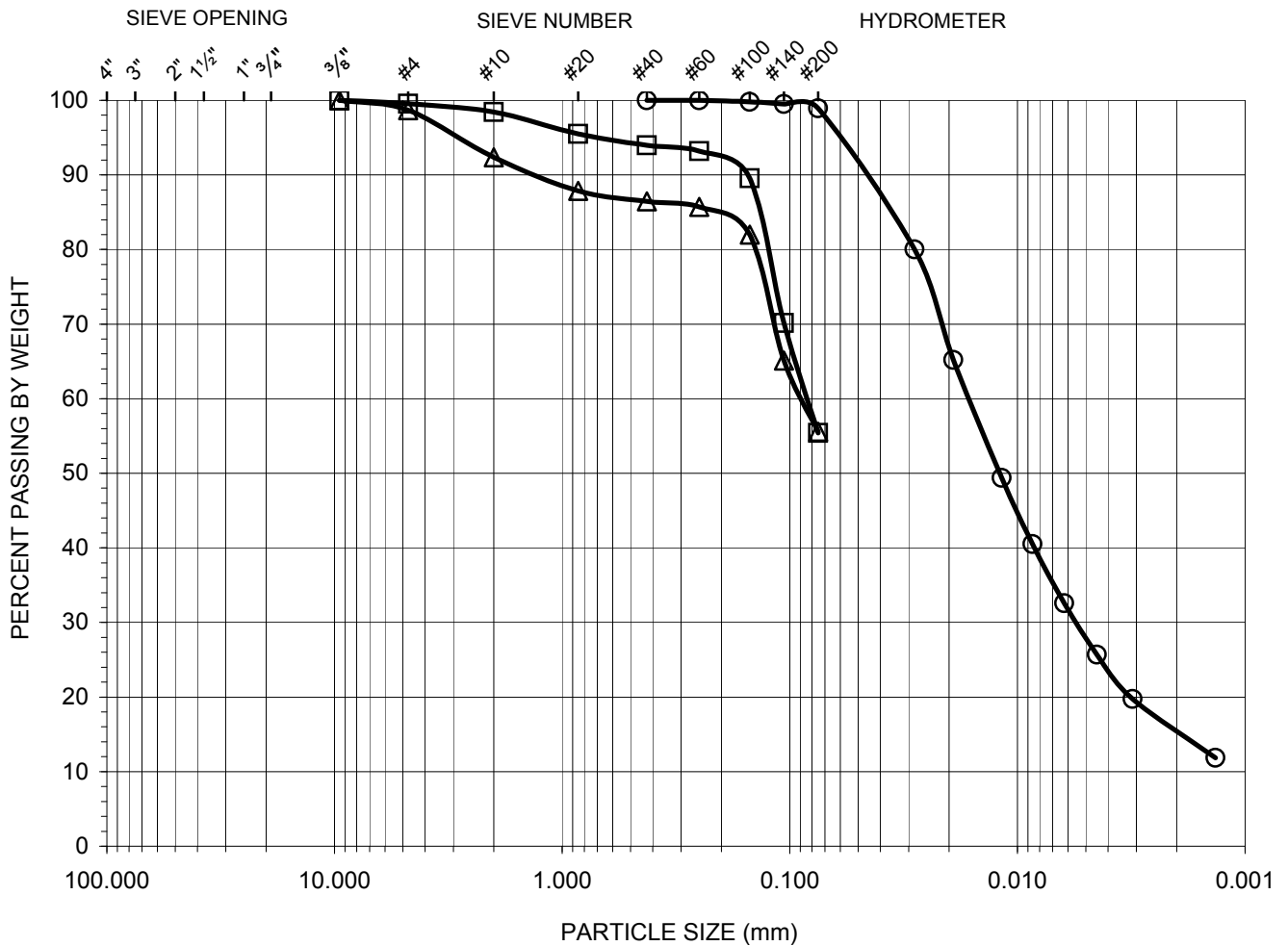
\*Note: Based on visual classification



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/09/13  
 Project Name: SR-710 North Study Computed by: KM Date: 04/22/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 04/26/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-007	C46	205.2-206	0	1	99	57:21:36	CH
□	RC-13-007	C52	241.2-242	0	45	55	N/A	ML
△	RC-13-007	C55	257.4-258.3	1	43	56	N/A	ML

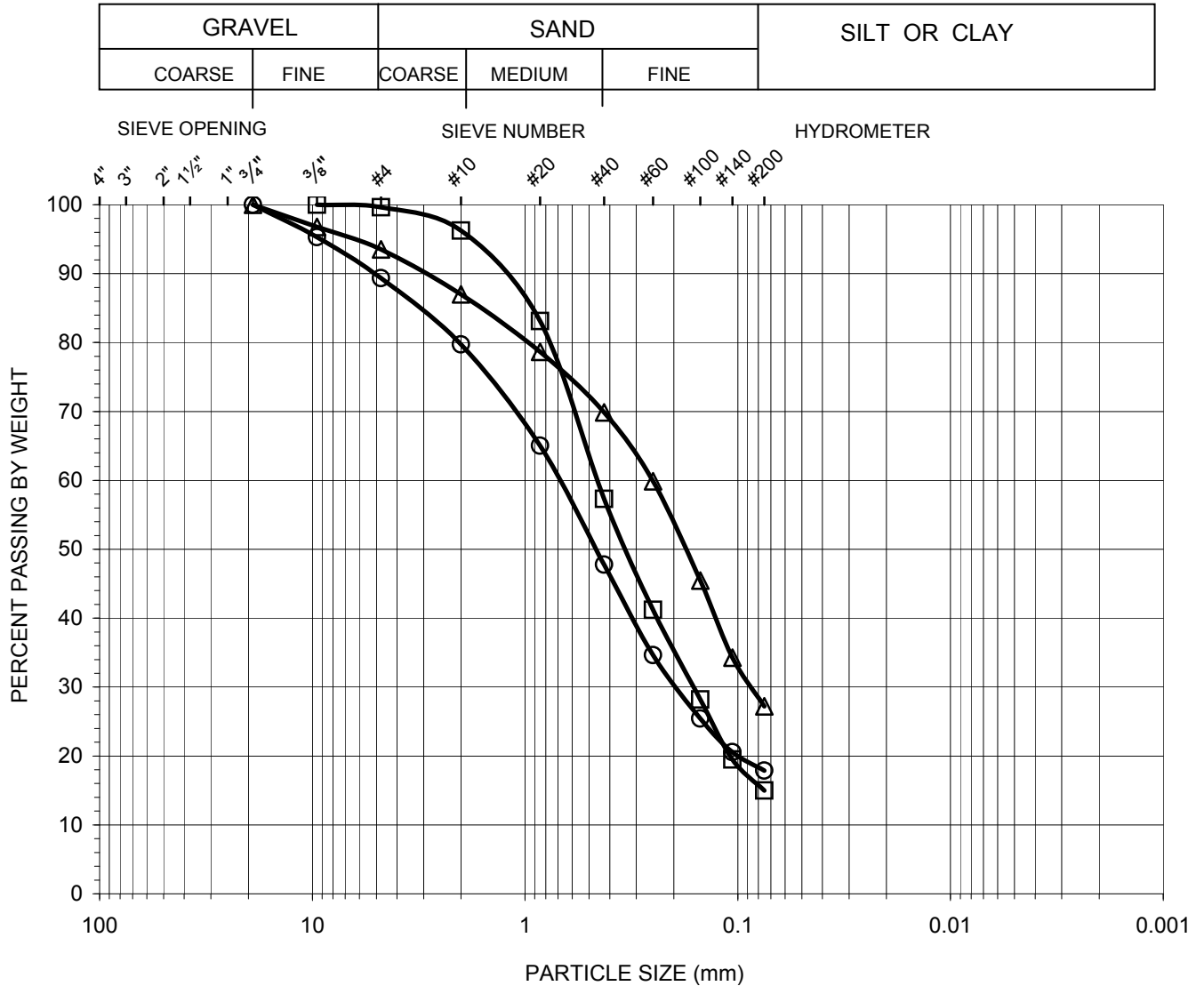






### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	05/03/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/08/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/10/13

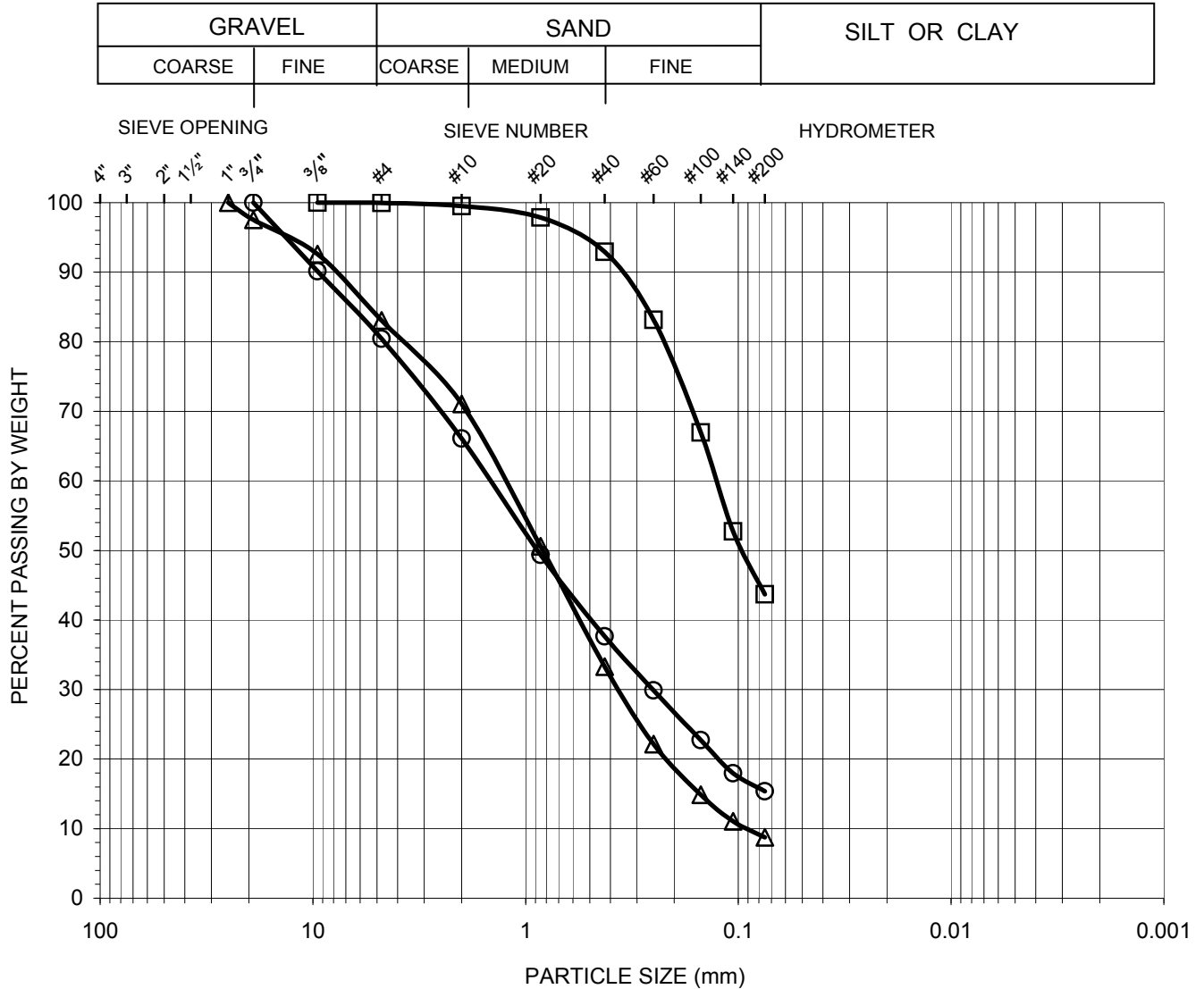


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-008	S03	10-11.5	11	71	18	N/A	SM
□	A-13-008	S04	15-16.5	0	85	15	N/A	SM
△	A-13-008	S06	25-26.5	6	67	27	N/A	SM



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 05/03/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/08/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/10/13



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-008	S07	30-31.5	20	65	15	N/A	SM
□	A-13-008	S10	45-46.5	0	56	44	N/A	SM
△	A-13-008	S12	55-56.5	17	74	9	N/A	SW-SM

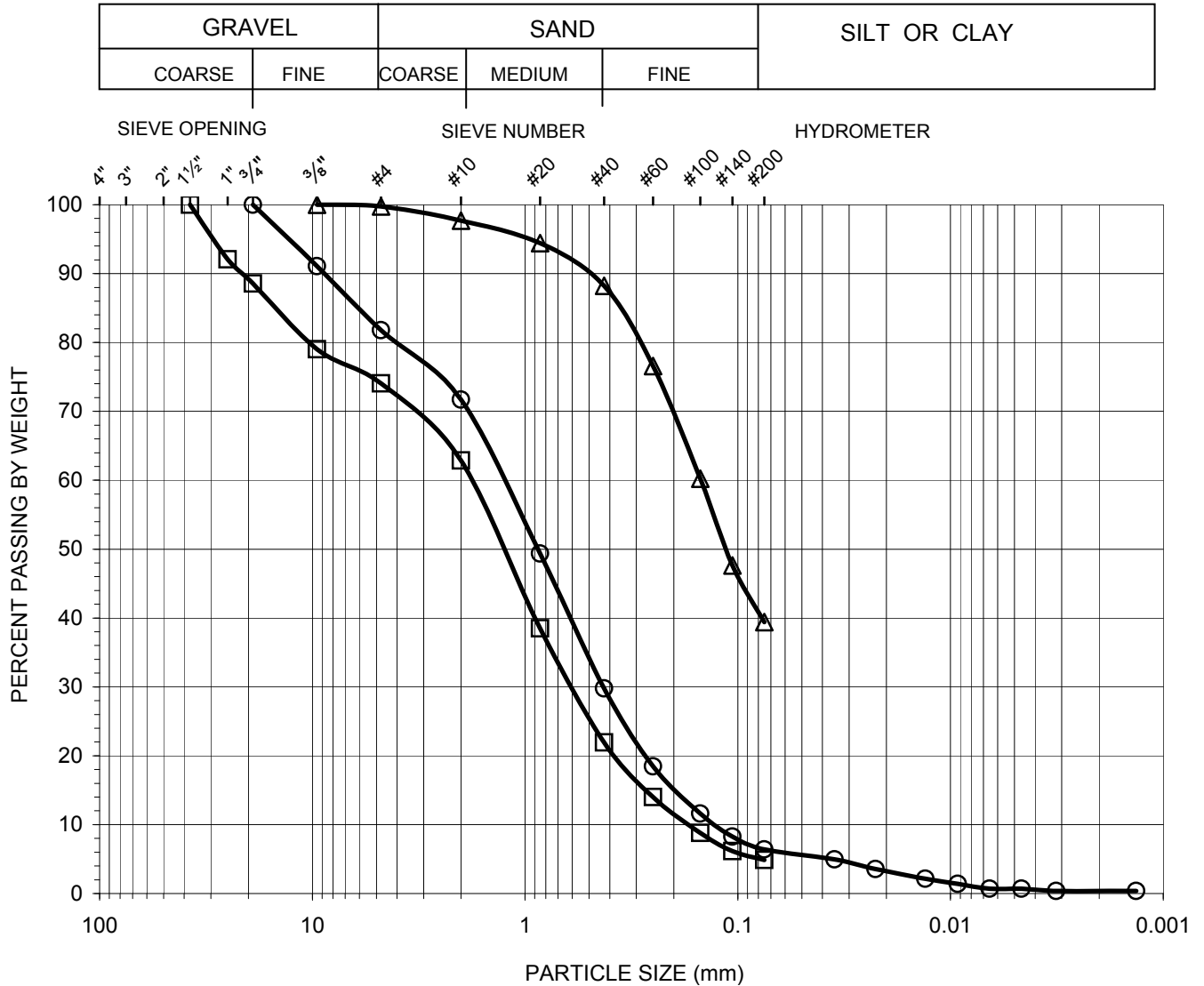




AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	05/03/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/08/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/11/13

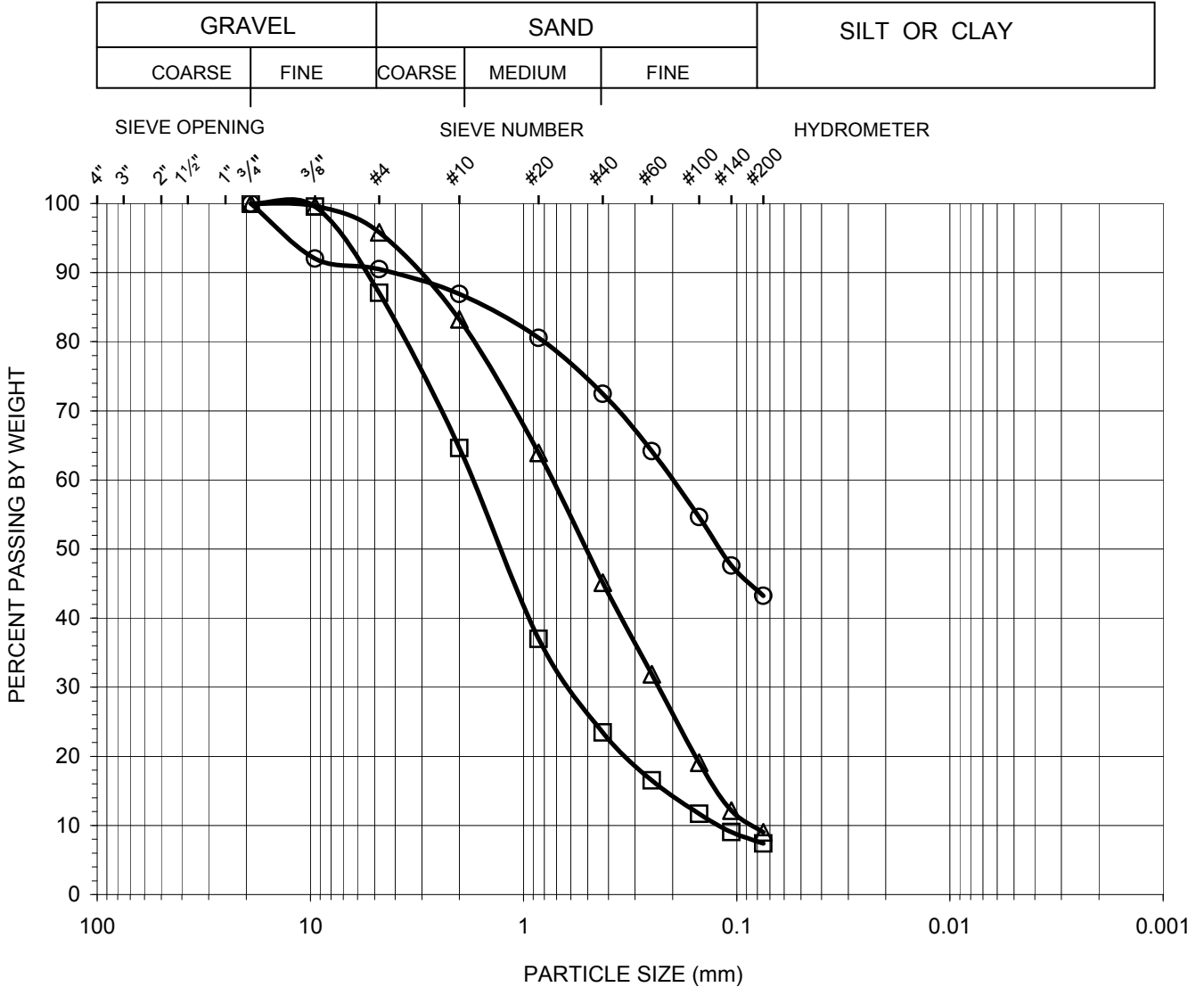


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-008	S14	65-66.5	18	76	6	N/A	SW-SM
□	A-13-008	S16	75-76.5	26	69	5	N/A	SW-SM
△	A-13-008	S20	95-96.5	0	61	39	N/A	SM



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	04/26/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/07/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/07/13



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-009	S02	5	9	48	43	N/A	SM
□	RC-13-009	S05	20	13	80	7	N/A	SW-SM
△	RC-13-009	S07	30	4	87	9	N/A	SW-SM

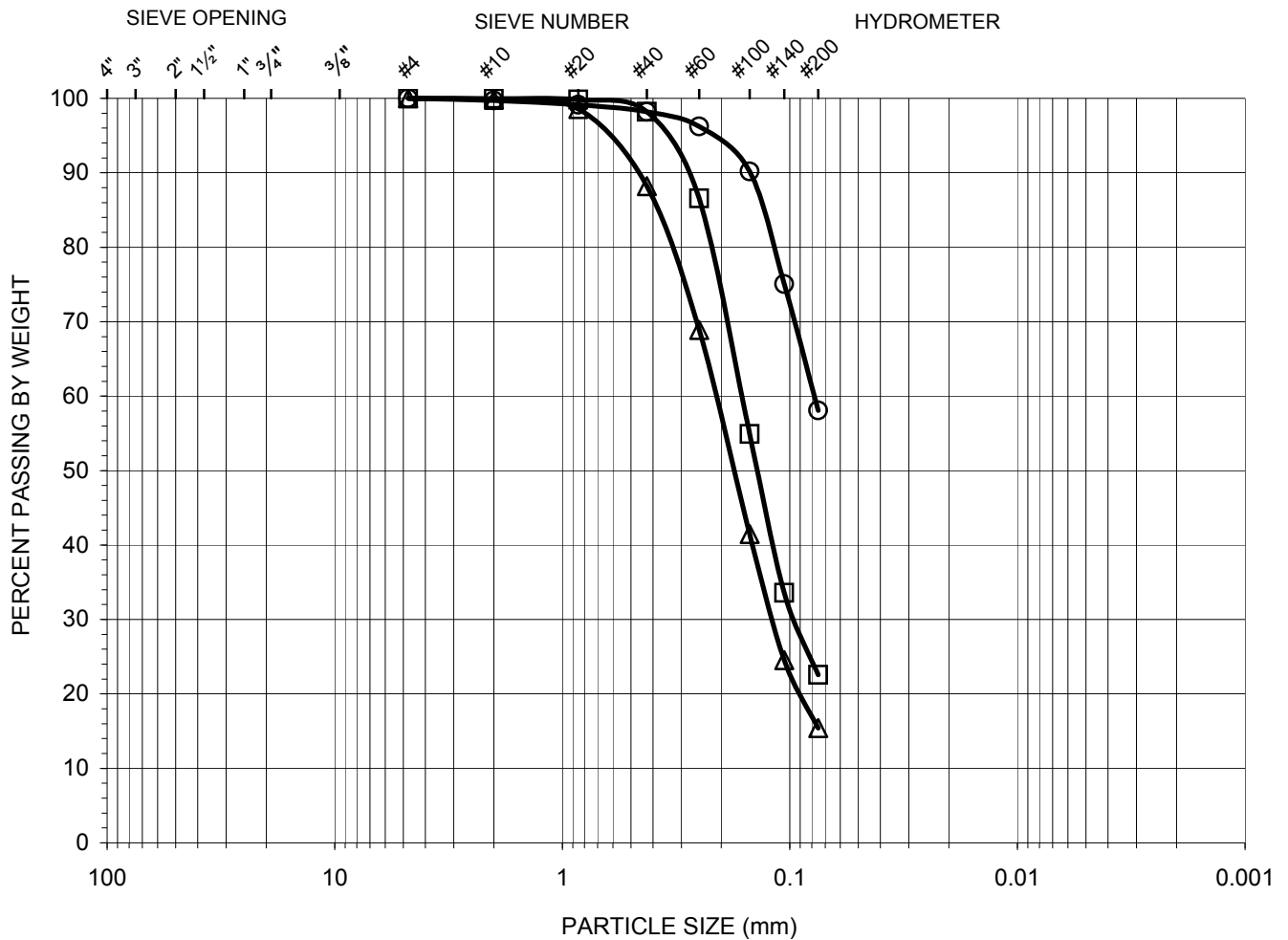


AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/26/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/07/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/07/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



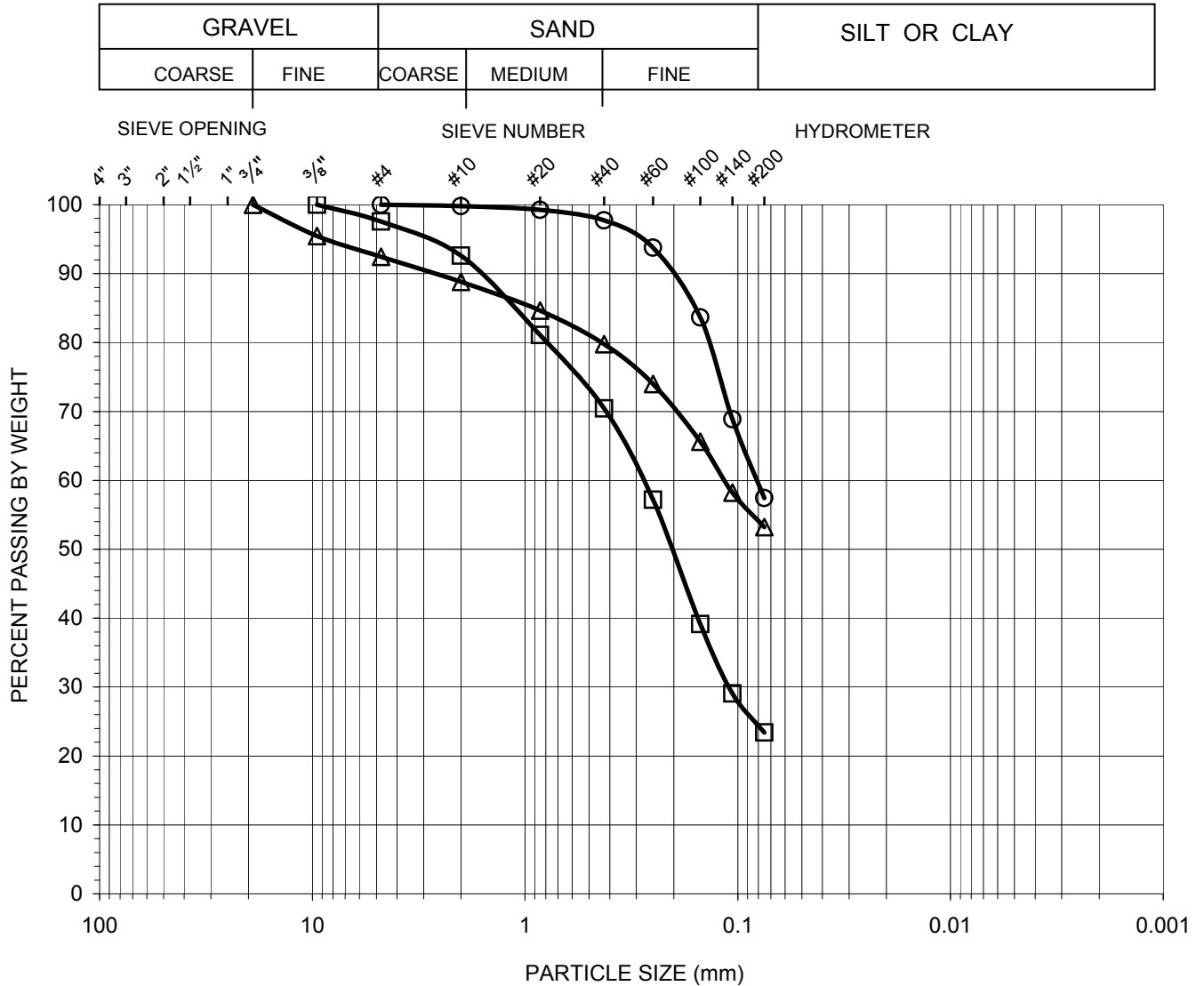
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-009	S09	40	0	42	58	N/A	ML
□	RC-13-009	S11	50	0	77	23	N/P	SM
△	RC-13-009	S15	70	0	85	15	N/A	SM



AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	04/26/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/07/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/07/13



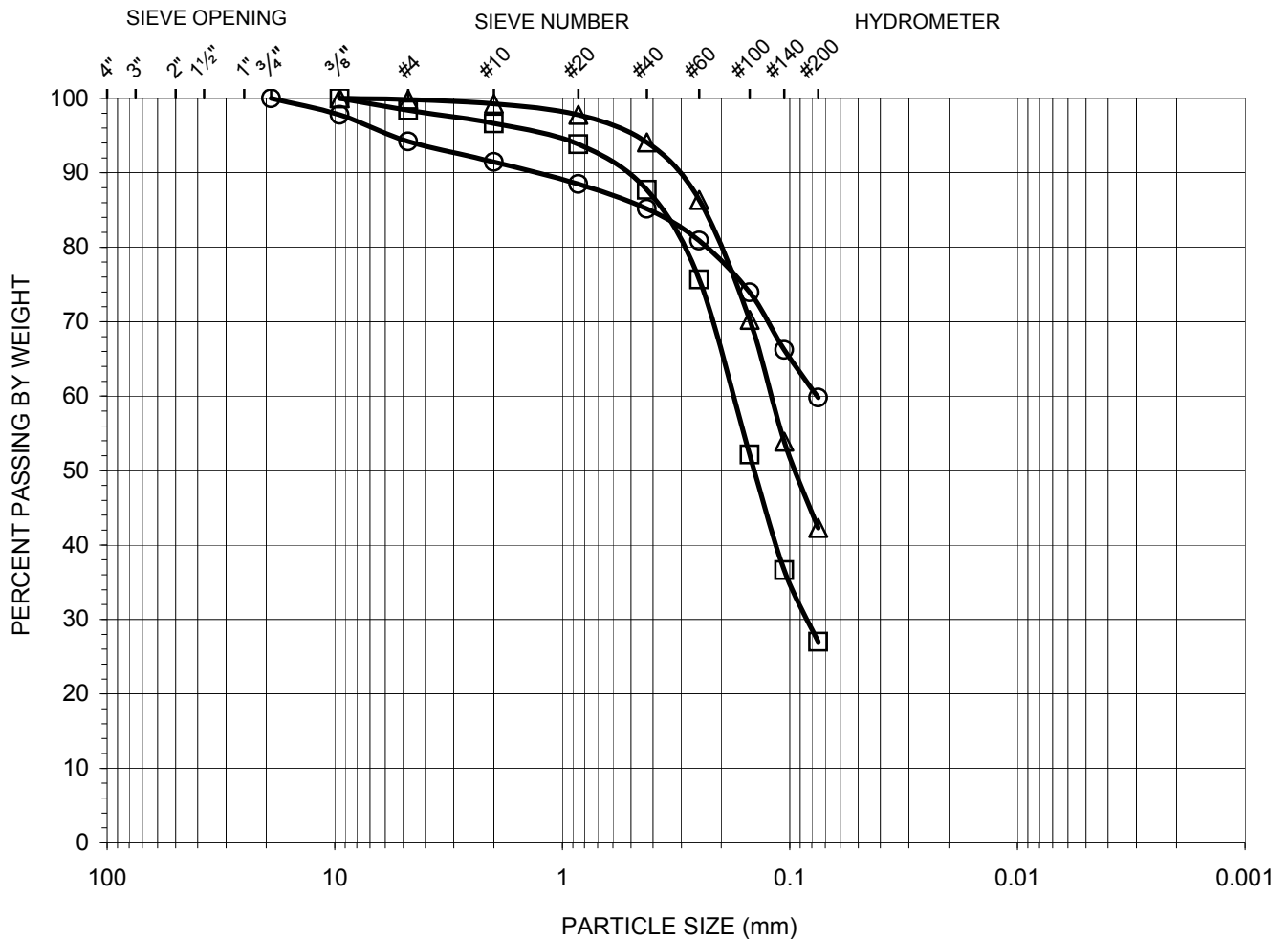
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-009	S17	80	0	43	57	N/A	ML
□	RC-13-009	S21	100	2	75	23	N/A	SM
△	RC-13-009	S23	110	8	39	53	N/A	ML



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/26/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/07/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/07/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	RC-13-009	S24	115	6	34	60	N/A	ML
□	RC-13-009	S28	132	2	71	27	N/A	SM
△	RC-13-009	S29	137	0	58	42	N/A	SM

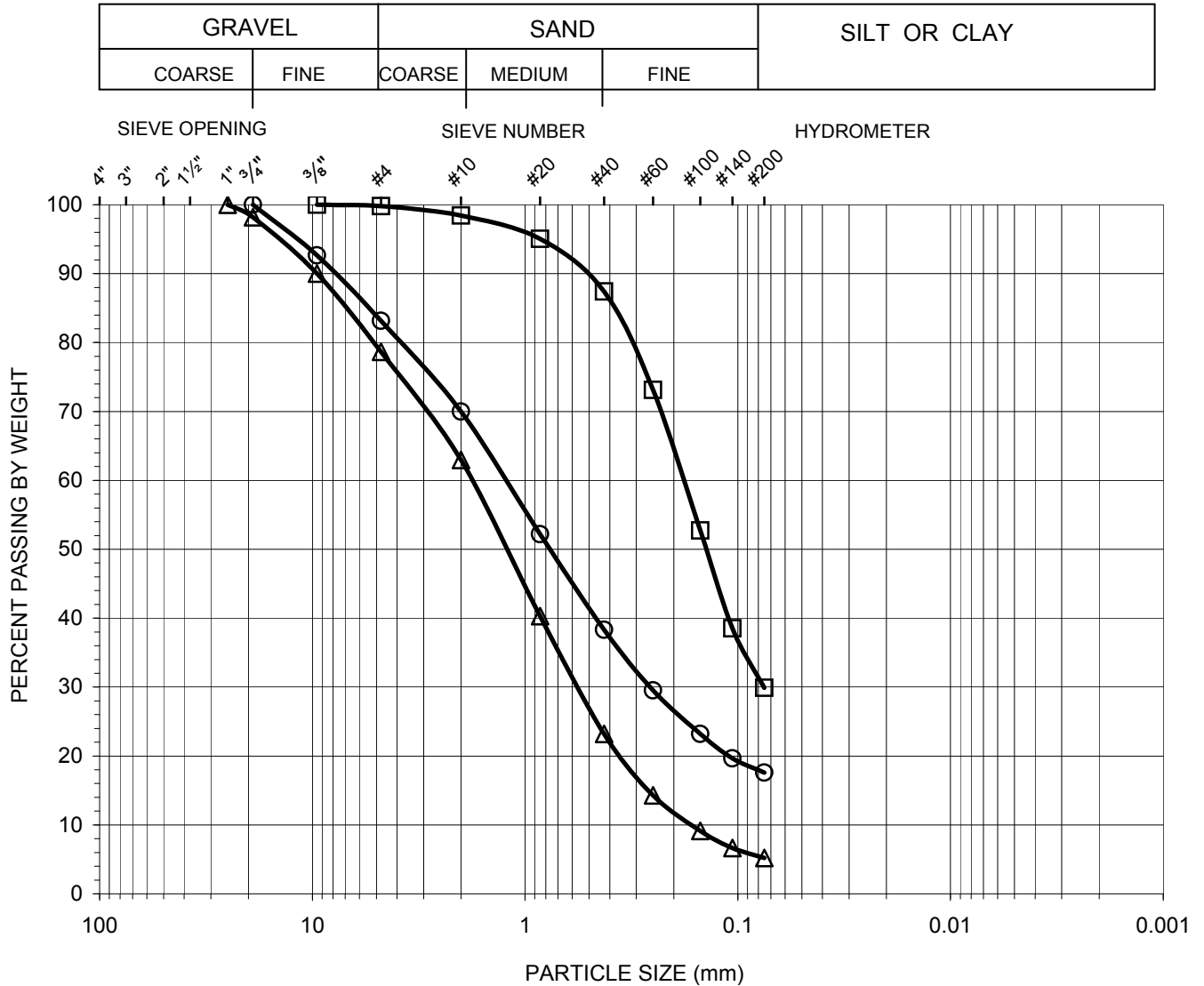




AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 05/08/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/13/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/14/13



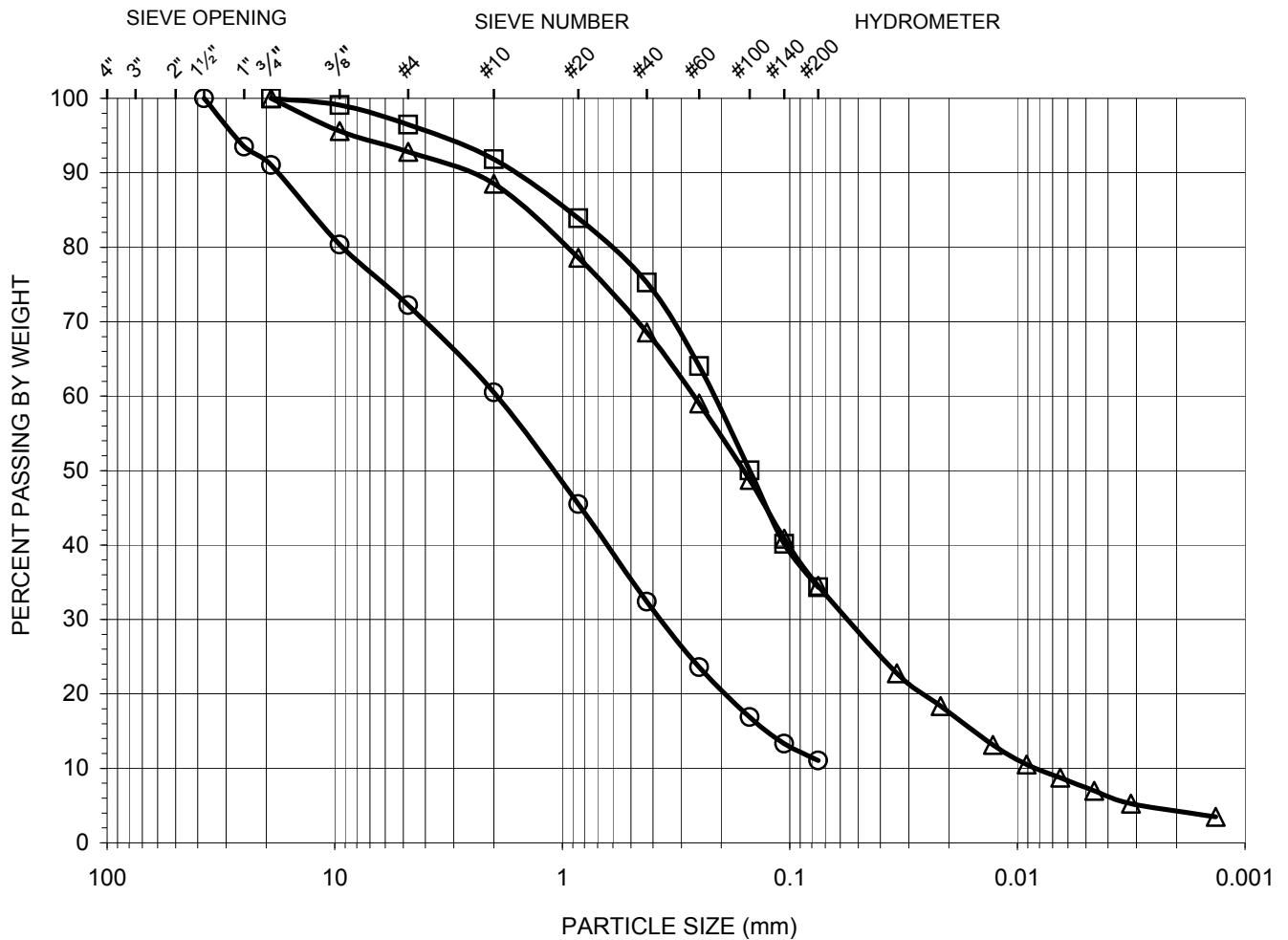
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	O-13-010	O05	20-21	17	65	18	N/A	SM
□	O-13-010	O09	40-41	0	70	30	N/A	SM
△	O-13-010	O14	60-61	21	74	5	N/A	SP-SM



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 05/08/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/13/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/14/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

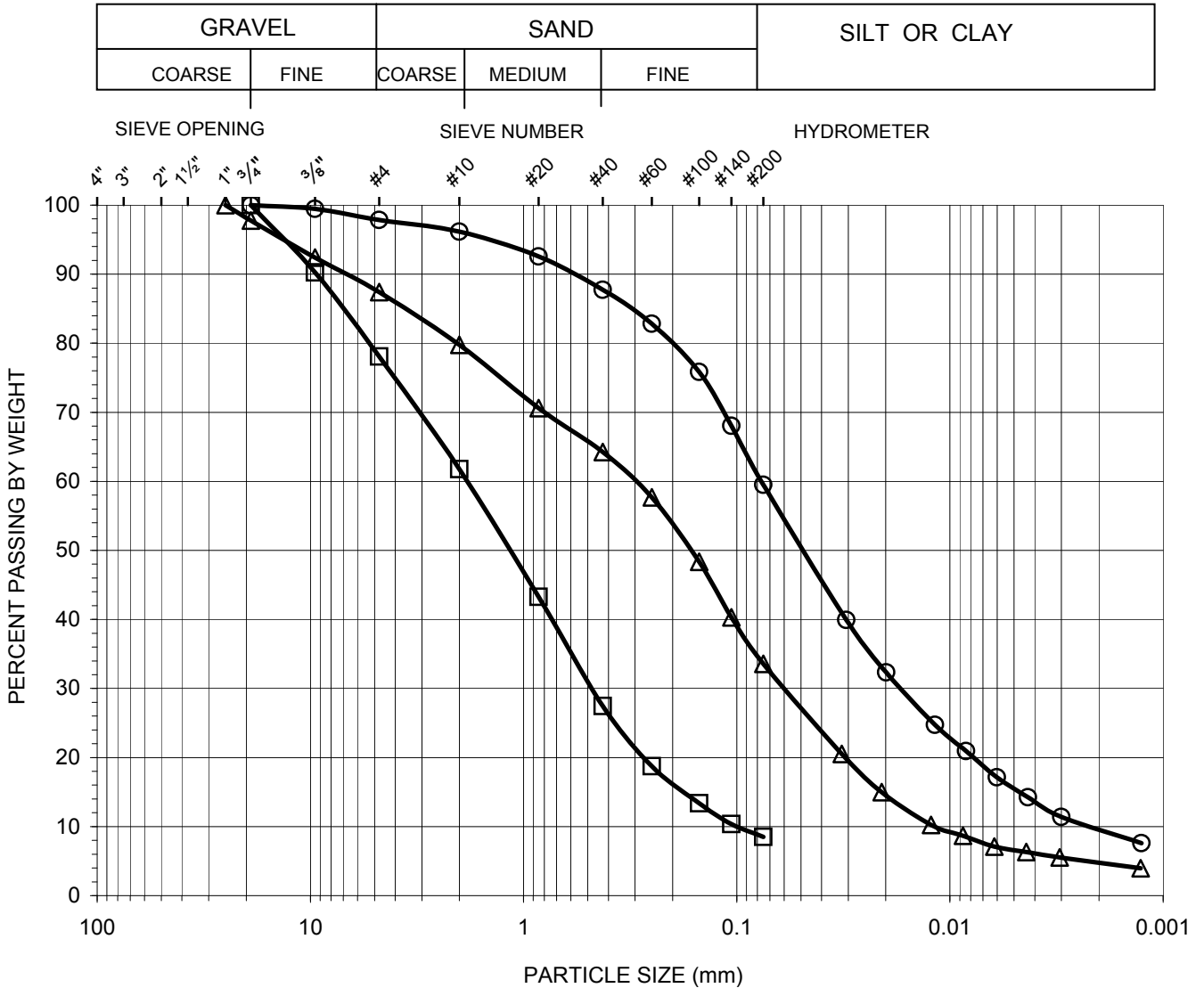


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	O-13-010	O21	85-86	28	61	11	N/A	SW-SM
□	O-13-010	O27	101-103	4	62	34	N/A	SM
△	O-13-010	O30	117-120	7	58	35	N/P	SM



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	DK	Date:	09/06/13
Project Name:	SR710 North Study	Computed by:	JP	Date:	09/19/13
Project No.:	133978	Checked by:	AP	Date:	09/20/13

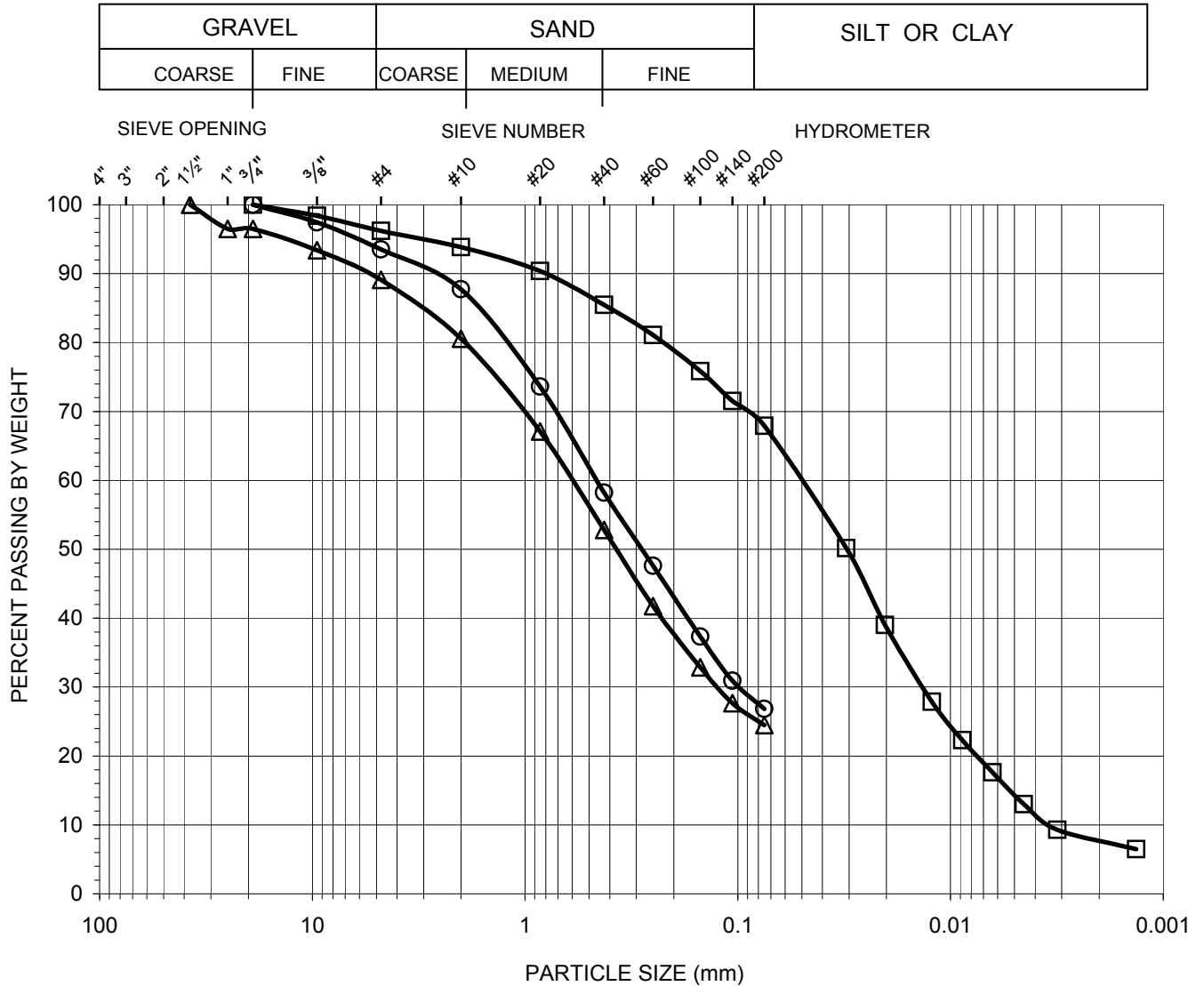


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	O-13-010	O33	130	2	38	60	24:18:6	CL-ML
□	O-13-010	O33	132	22	69	9	N/A	SM
△	O-13-010	O35	150	13	53	34	N/P	SM



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	05/08/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/13/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/14/13

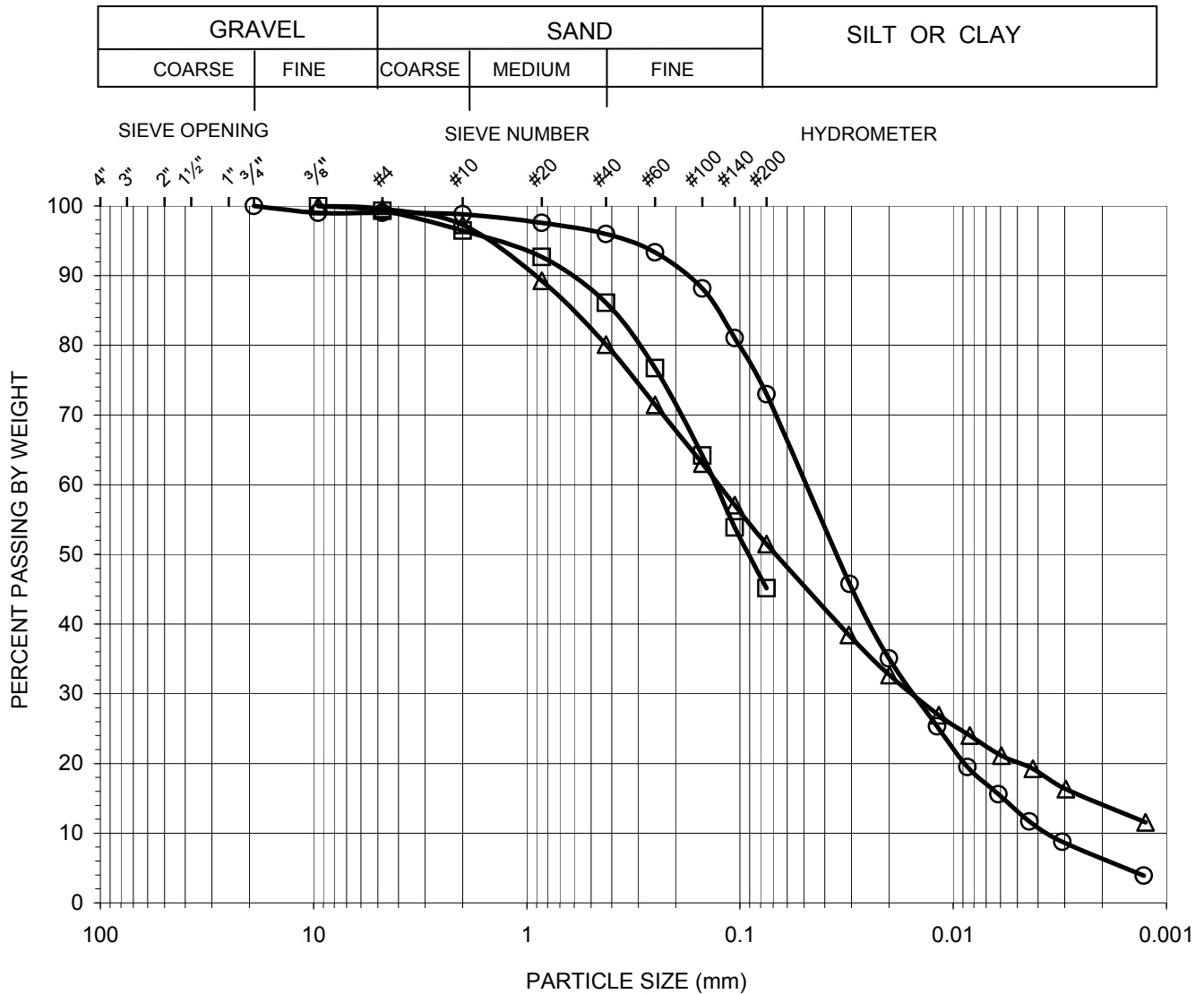


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	O-13-010	O34	141-142	6	67	27	N/A	SM
□	O-13-010	O34	143-144	4	28	68	29:21:8	CL
△	O-13-010	O37	160-161	11	65	24	N/A	SM



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	DK	Date:	09/06/13
Project Name:	SR710 North Study	Computed by:	JP	Date:	09/19/13
Project No.:	133978	Checked by:	AP	Date:	09/20/13

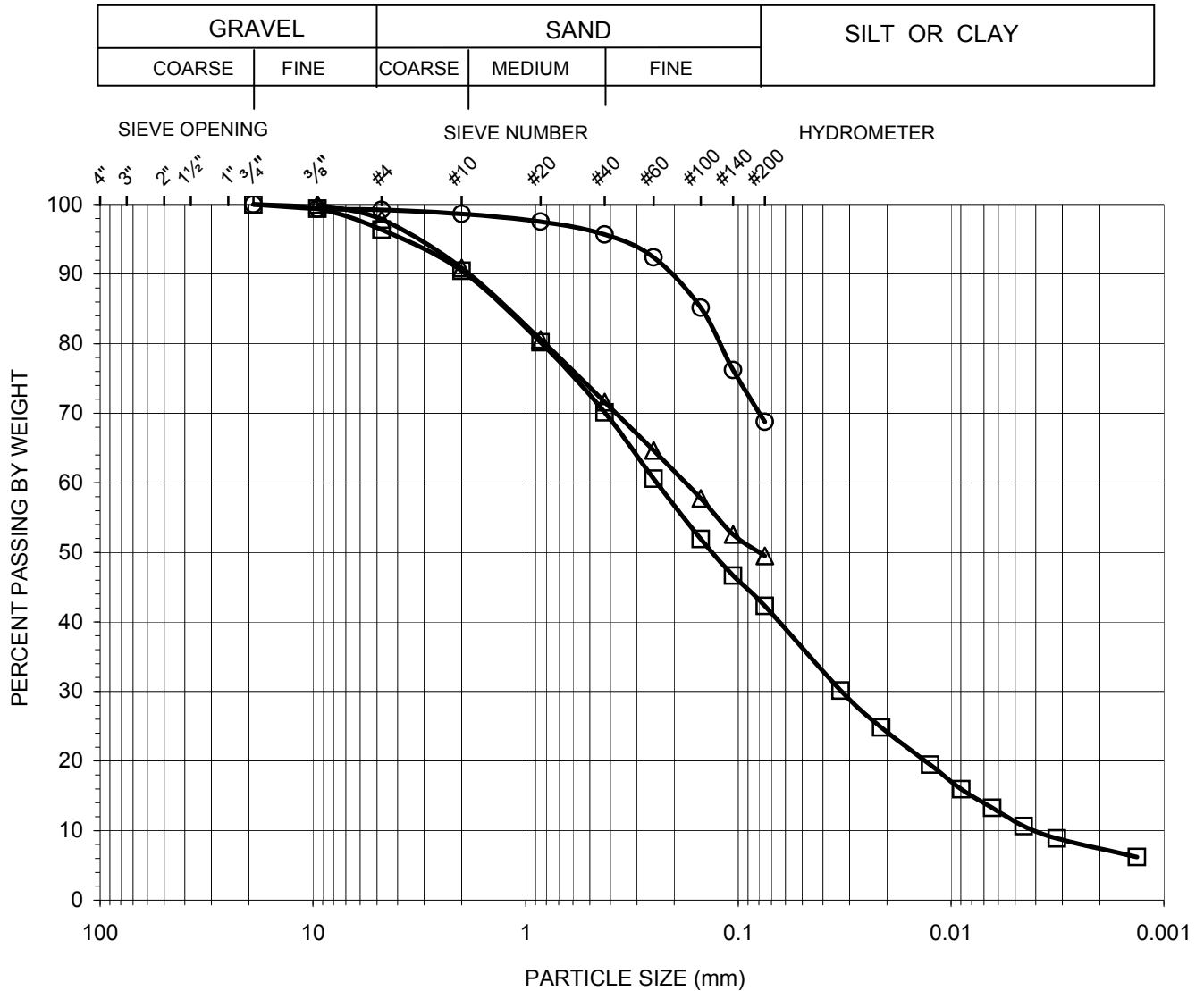


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	O-13-010	O37	165.5	1	26	73	28:21:7	CL
□	O-13-010	O38	173	1	54	45	N/A	SM
△	O-13-010	O40	191	0	49	51	29:13:16	CL



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 05/08/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/13/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/14/13



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	O-13-010	O39	180-181	1	30	69	N/A	ML
□	O-13-010	O41	198-199	4	54	42	17:14:3	SM
△	O-13-010	O43	218-219	2	49	49	N/A	SM







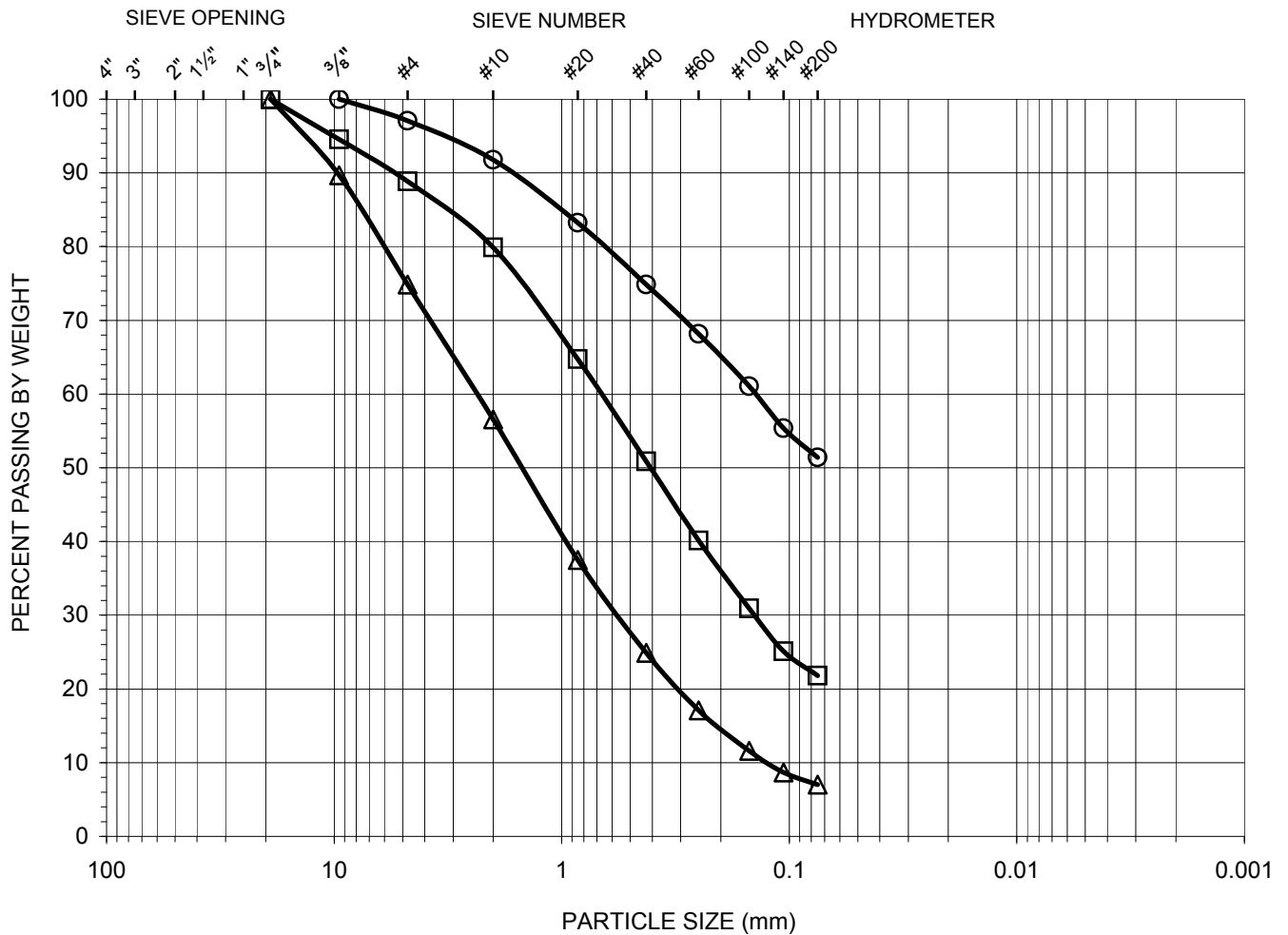




### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 05/09/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/15/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/17/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



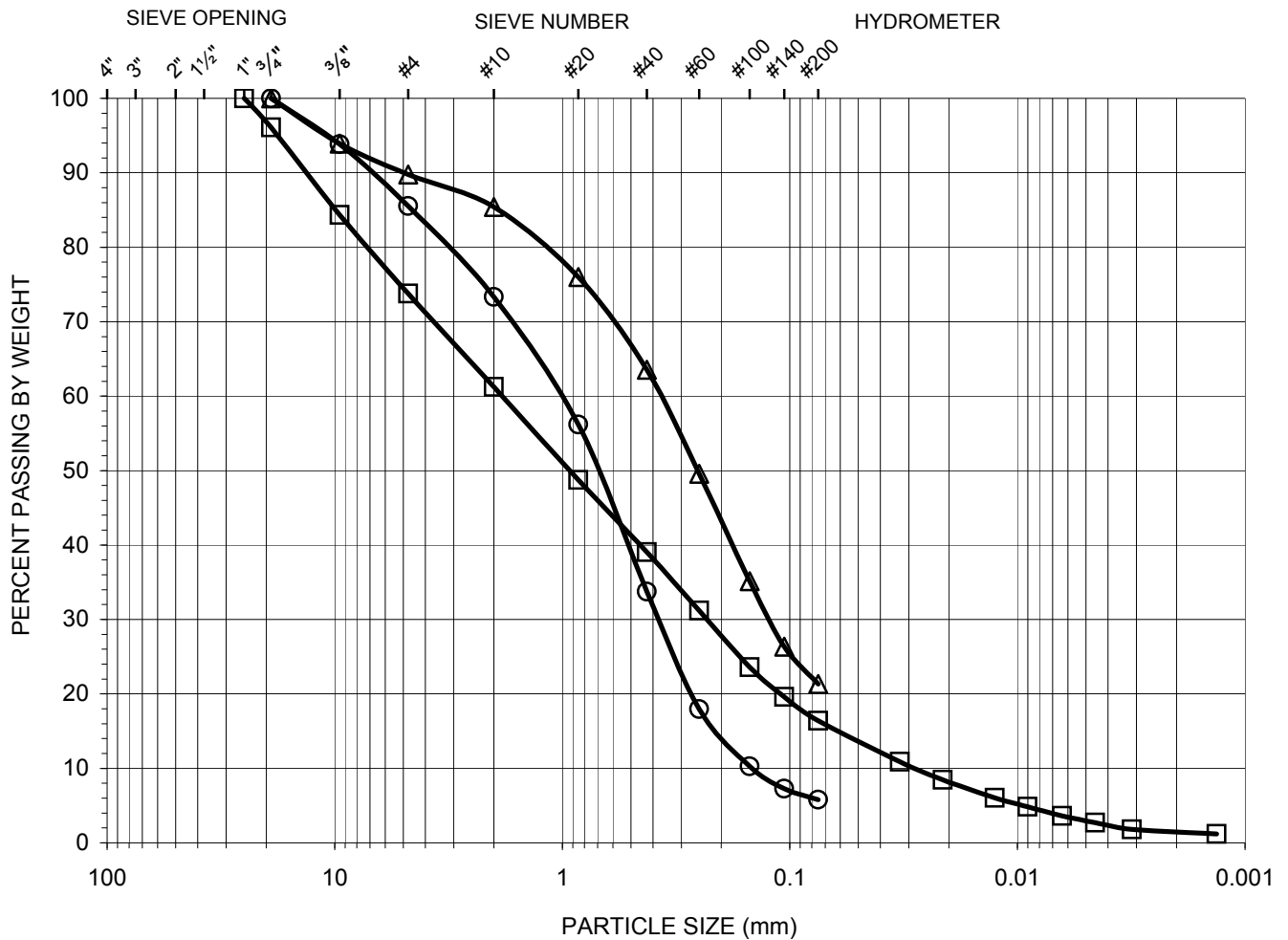
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				Gravel	Sand	Fines		
○	A-13-015	O01	5-6	3	46	51	25:15:10	CL
□	A-13-015	O03	15-16	11	67	22	N/A	SM
△	A-13-015	O07	35-36	25	68	7	N/A	SW-SM



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 05/09/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/15/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/17/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

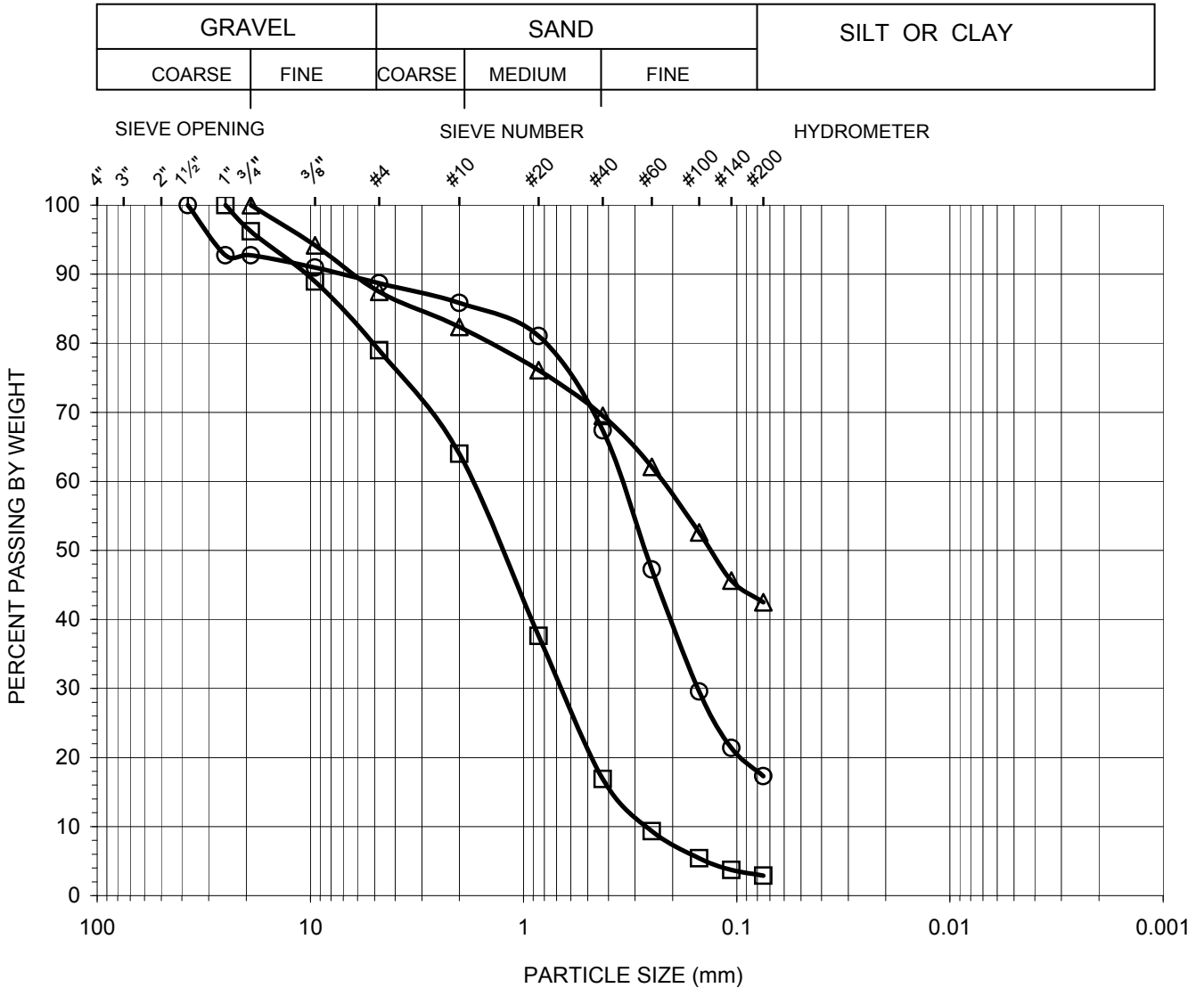


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-015	O11	55-56	14	80	6	N/A	SP-SM
□	A-13-015	O16	75-76	26	58	16	N/P	SM
△	A-13-015	O20	95-96	10	69	21	N/A	SM



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	05/09/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/15/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/17/13



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-016	O03	15-16	11	72	17	N/A	SM
□	A-13-016	O09	35-36	21	76	3	N/A	SP
△	A-13-016	O16	55-56	13	44	43	N/A	SM

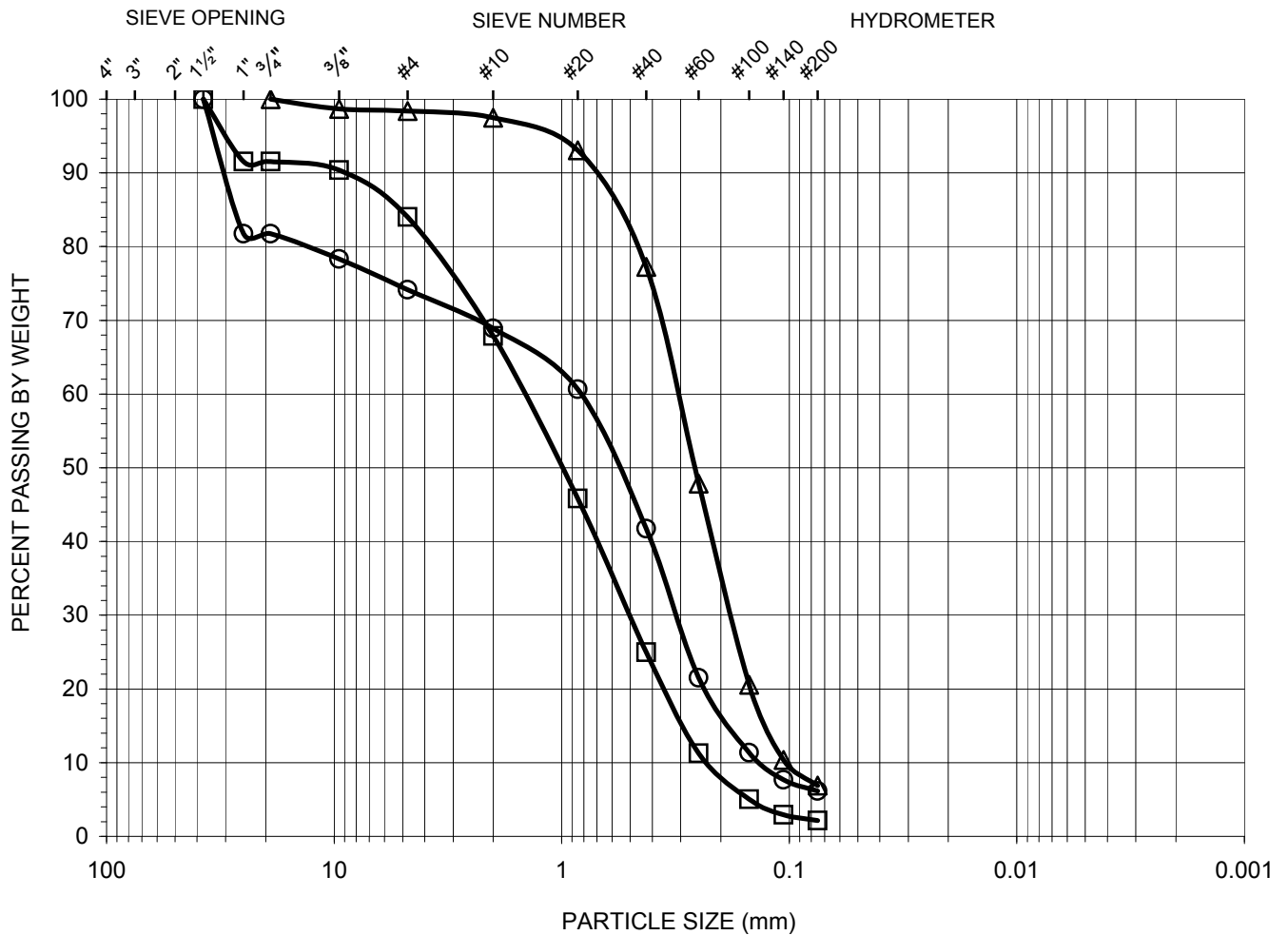


AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 05/09/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/15/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/17/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-017	O03	15-16	26	68	6	N/A	SP-SM
□	A-13-017	O07	35-36	16	82	2	N/A	SP
△	A-13-017	O11	55-56	2	91	7	N/A	SP-SM

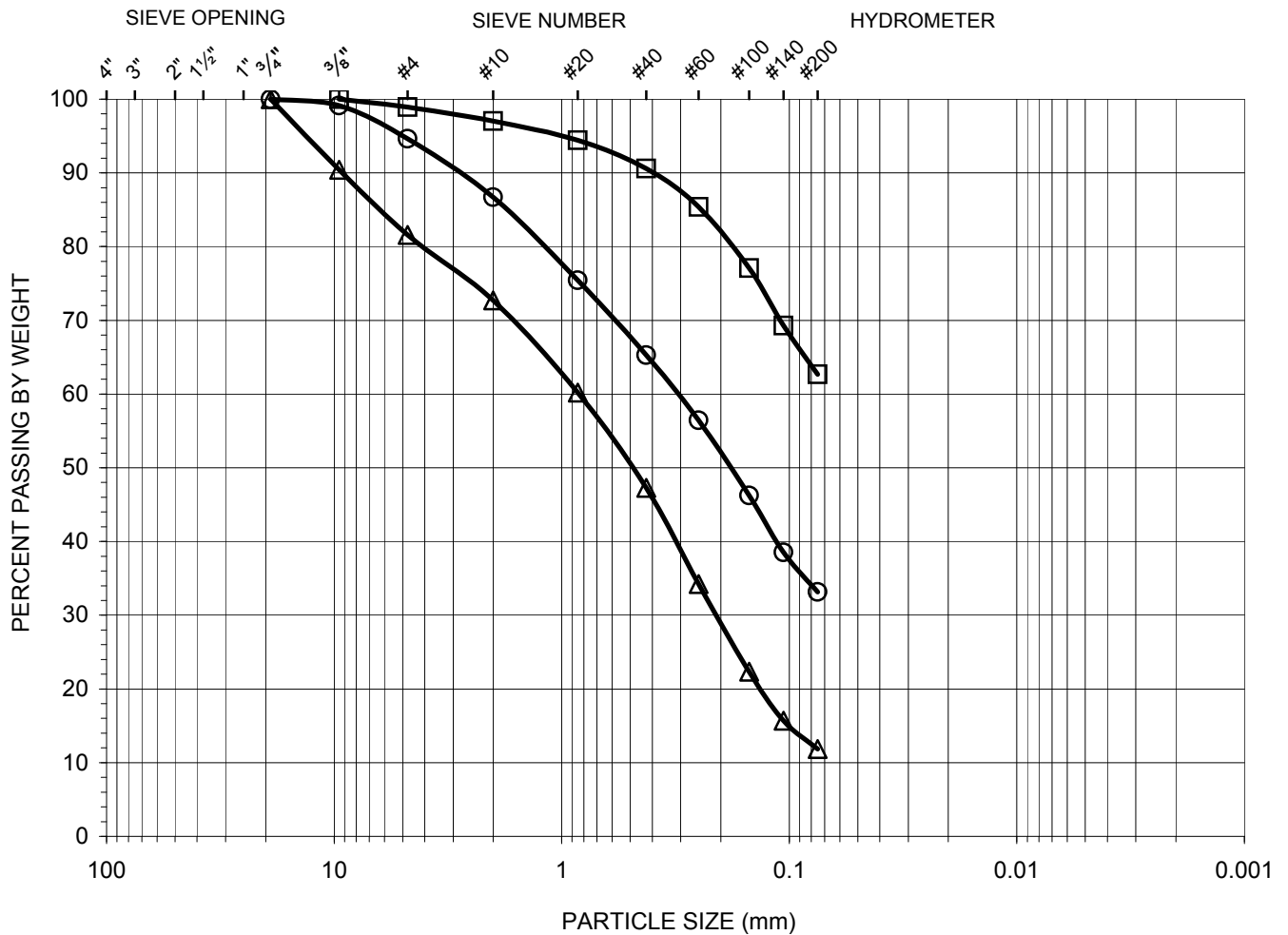




### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/17/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/03/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/04/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-020	S02	5	5	62	33	N/A	SM
□	A-13-020	S04	15	1	36	63	N/A	ML
△	A-13-020	S07	30	18	70	12	N/A	SP-SM

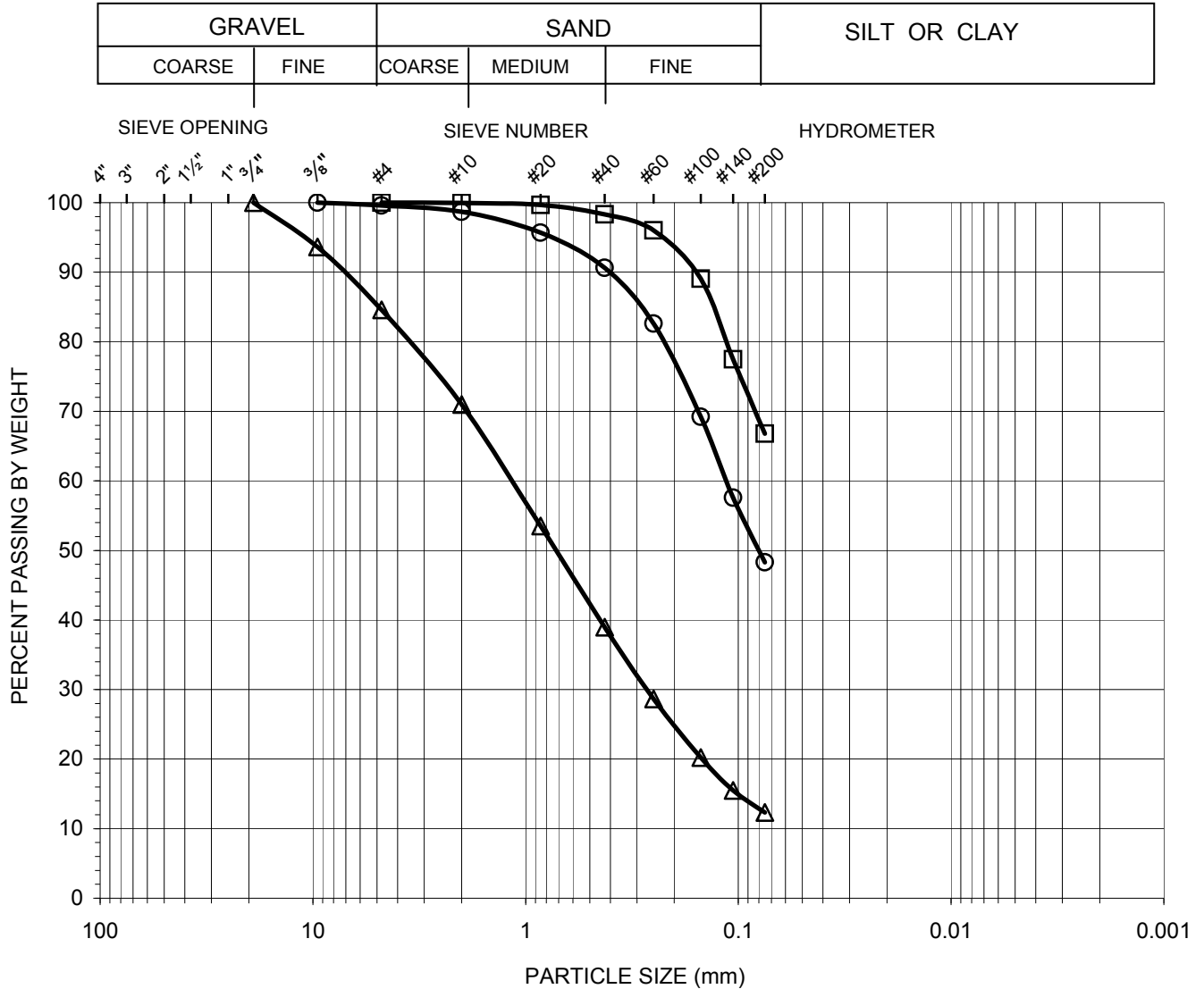






### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/17/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/03/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/04/13



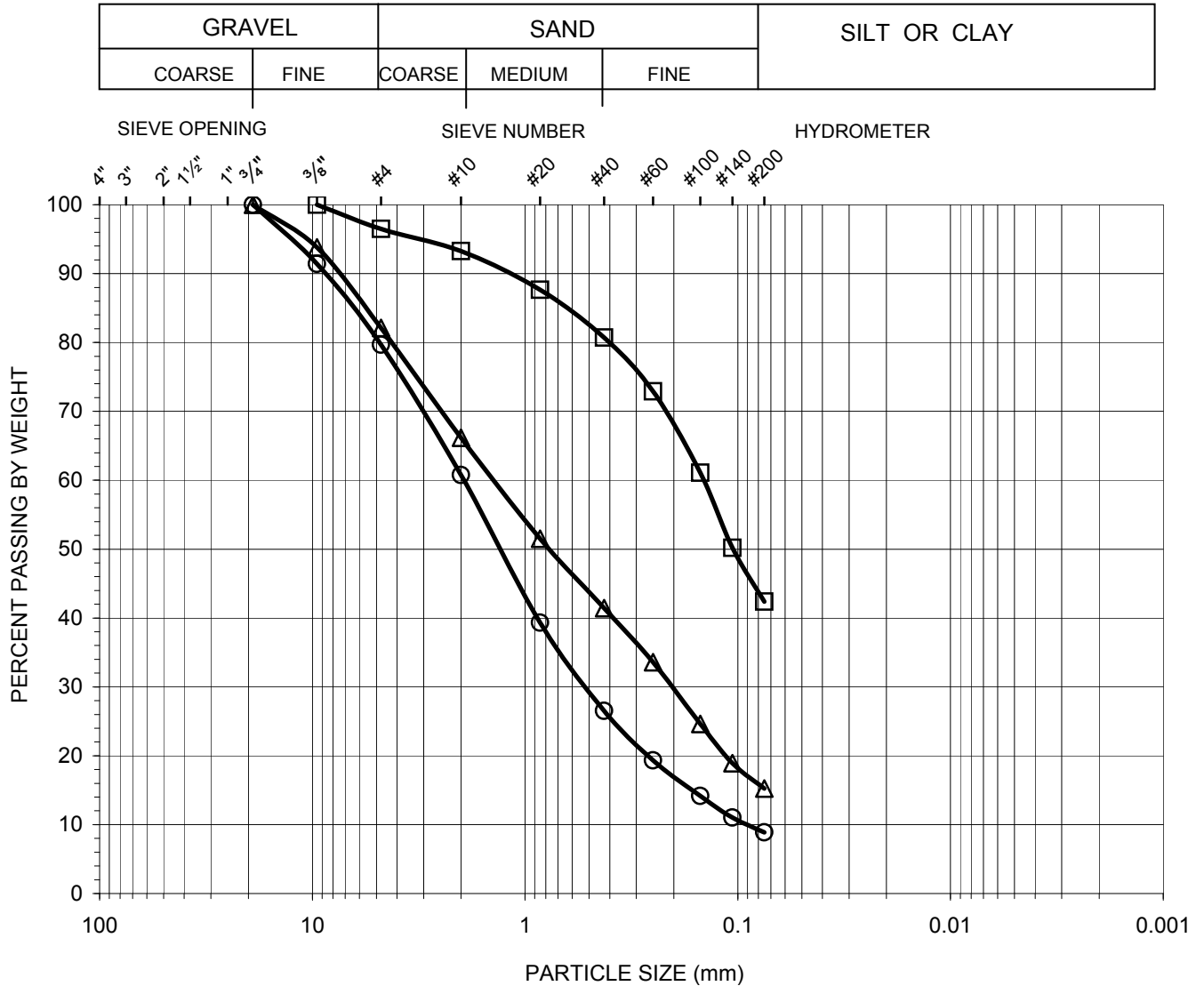
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-020	S09	40	0	52	48	N/A	SM
□	A-13-020	S12	55	0	33	67	N/A	ML
△	A-13-020	S14	65	15	73	12	N/A	SP-SM



AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	04/17/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/03/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/04/13



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-020	S19	90	20	71	9	N/A	SW-SM
□	A-13-020	S21	100	4	54	42	N/A	SM
△	A-13-020	S26	125	18	67	15	N/A	SM

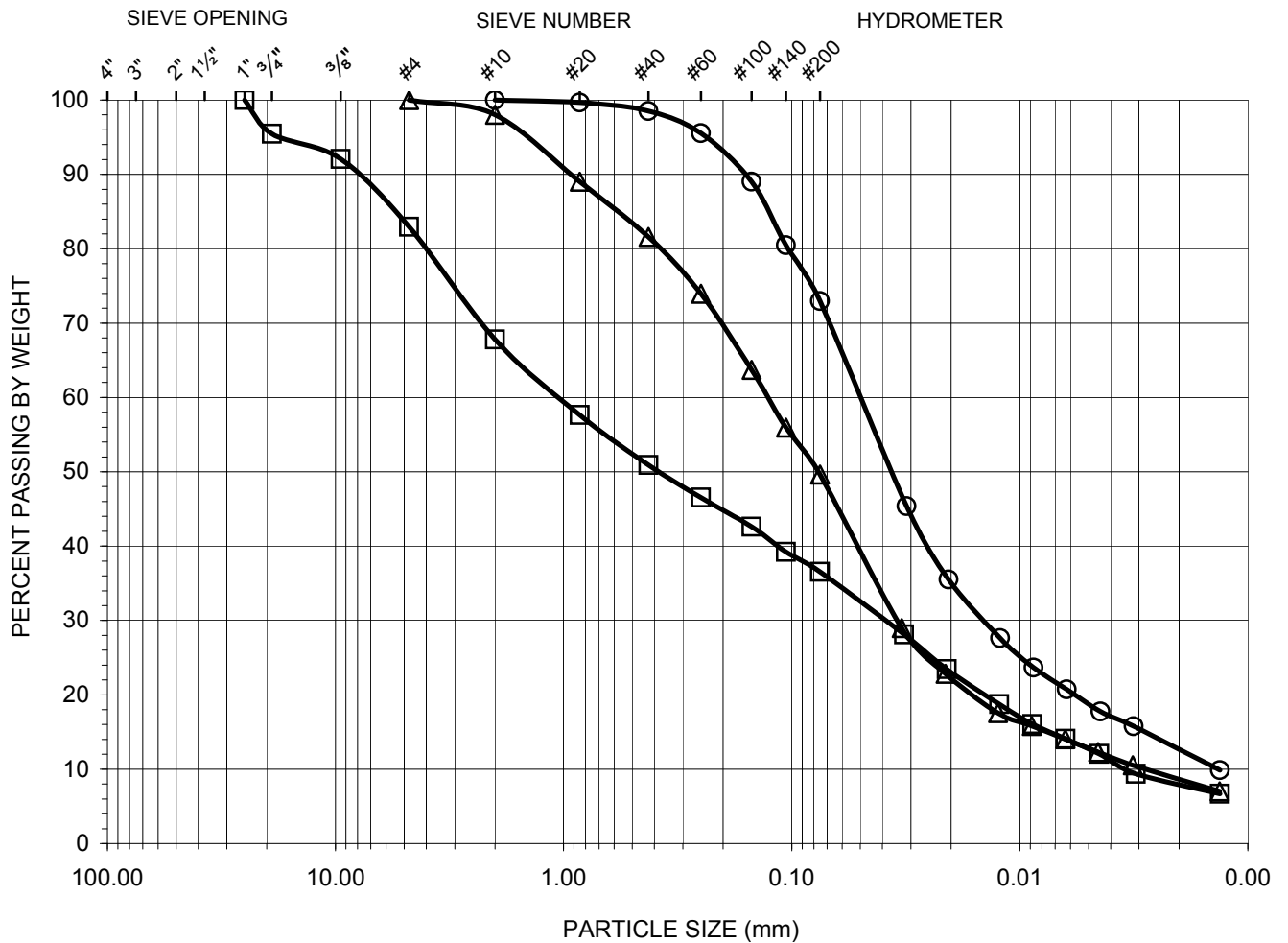




### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/25/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/08/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/11/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



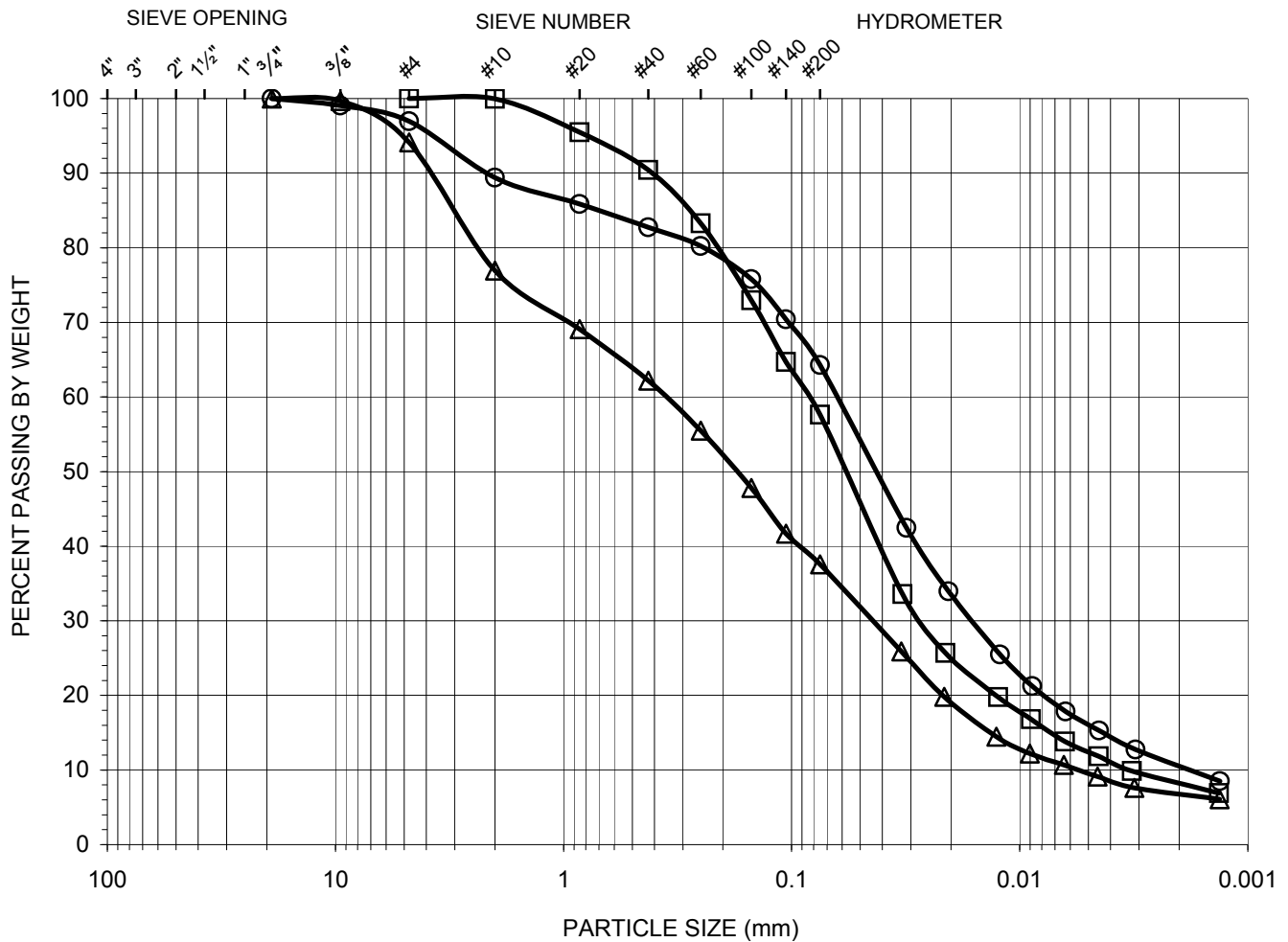
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-021	S05	20	0	27	73	50:21:29	CH
□	A-13-021	S09	40	17	46	37	56:30:26	SC
△	A-13-021	S13	60	0	50	50	N/A	ML



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 04/25/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/08/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/11/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

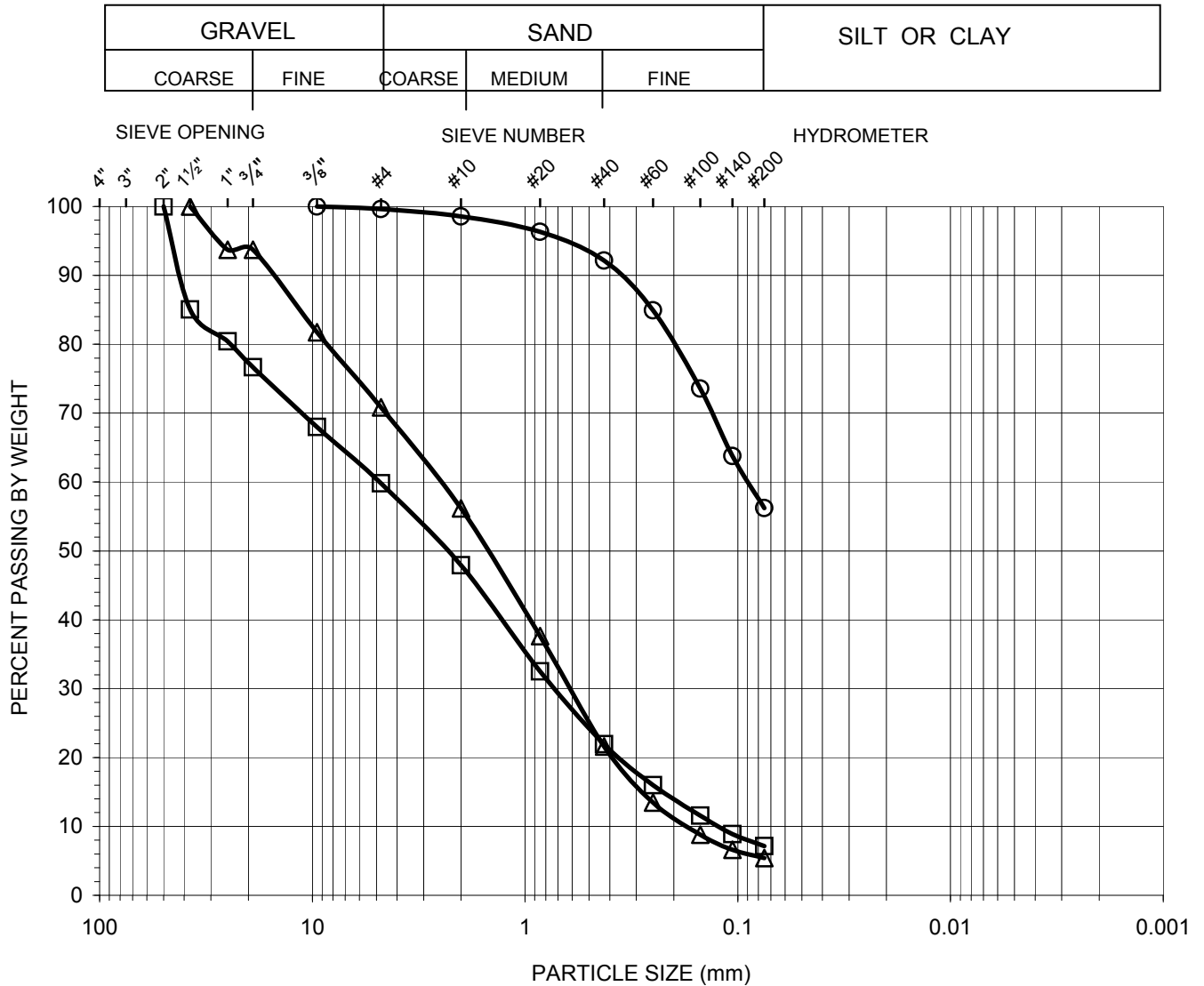


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-021	S16	75	3	33	64	N/A	ML
□	A-13-021	S19	90	0	42	58	52:31:21	MH
△	A-13-021	S21	100	6	56	38	N/A	SM



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	05/15/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/22/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/22/13



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-022	O01	5-6	0	44	56	N/A	ML
□	A-13-022	O05	25-26	40	53	7	N/A	SP-SM
△	A-13-022	O09	45-46	29	66	5	N/A	SP-SM

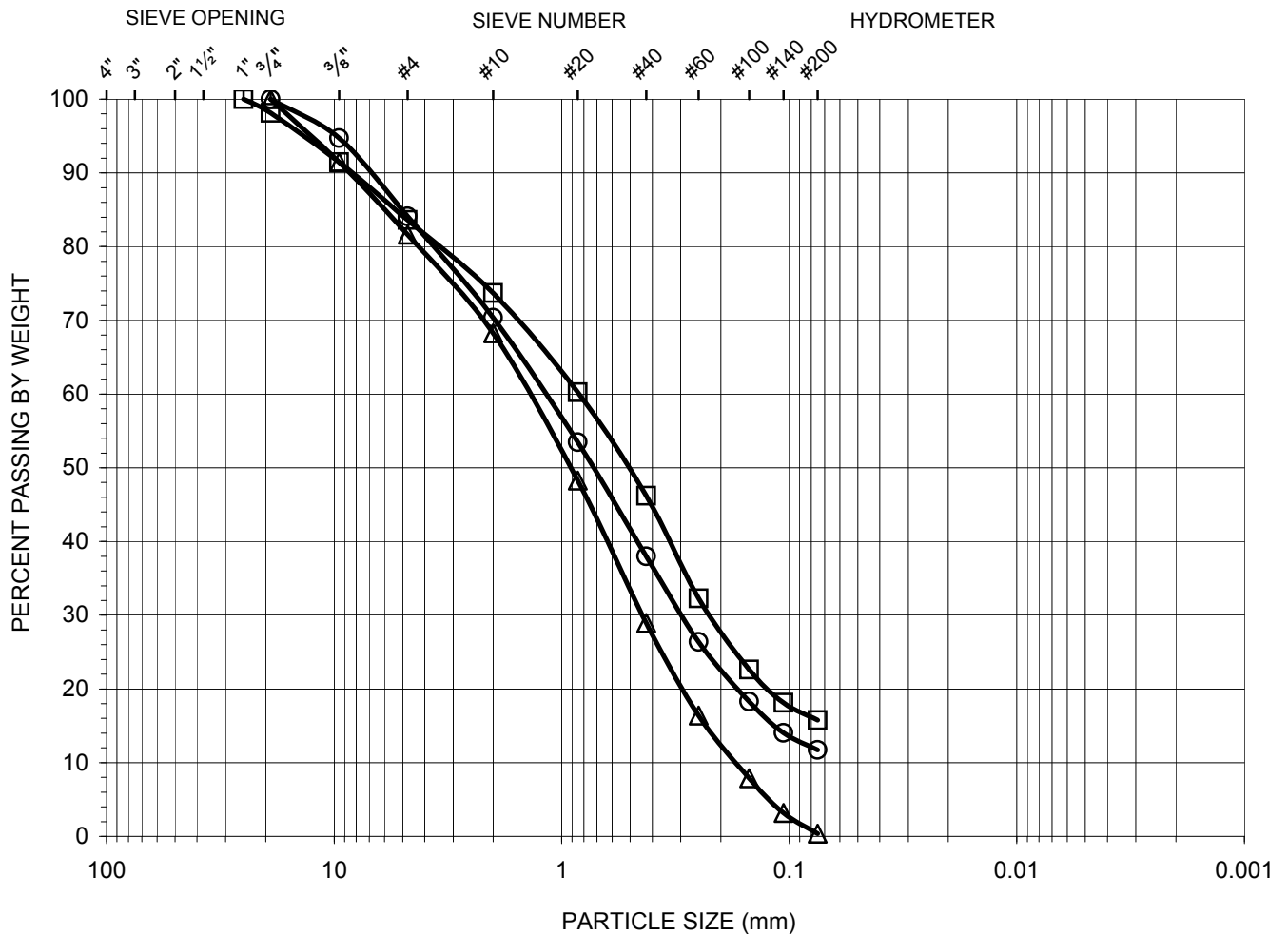




### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 05/08/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/13/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/14/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	O-13-023	O05	20-21	16	72	12	N/A	SW-SM
□	O-13-023	O11	42-43	16	68	16	N/A	SM
△	O-13-023	O16	62-63	18	82	0	N/A	SP

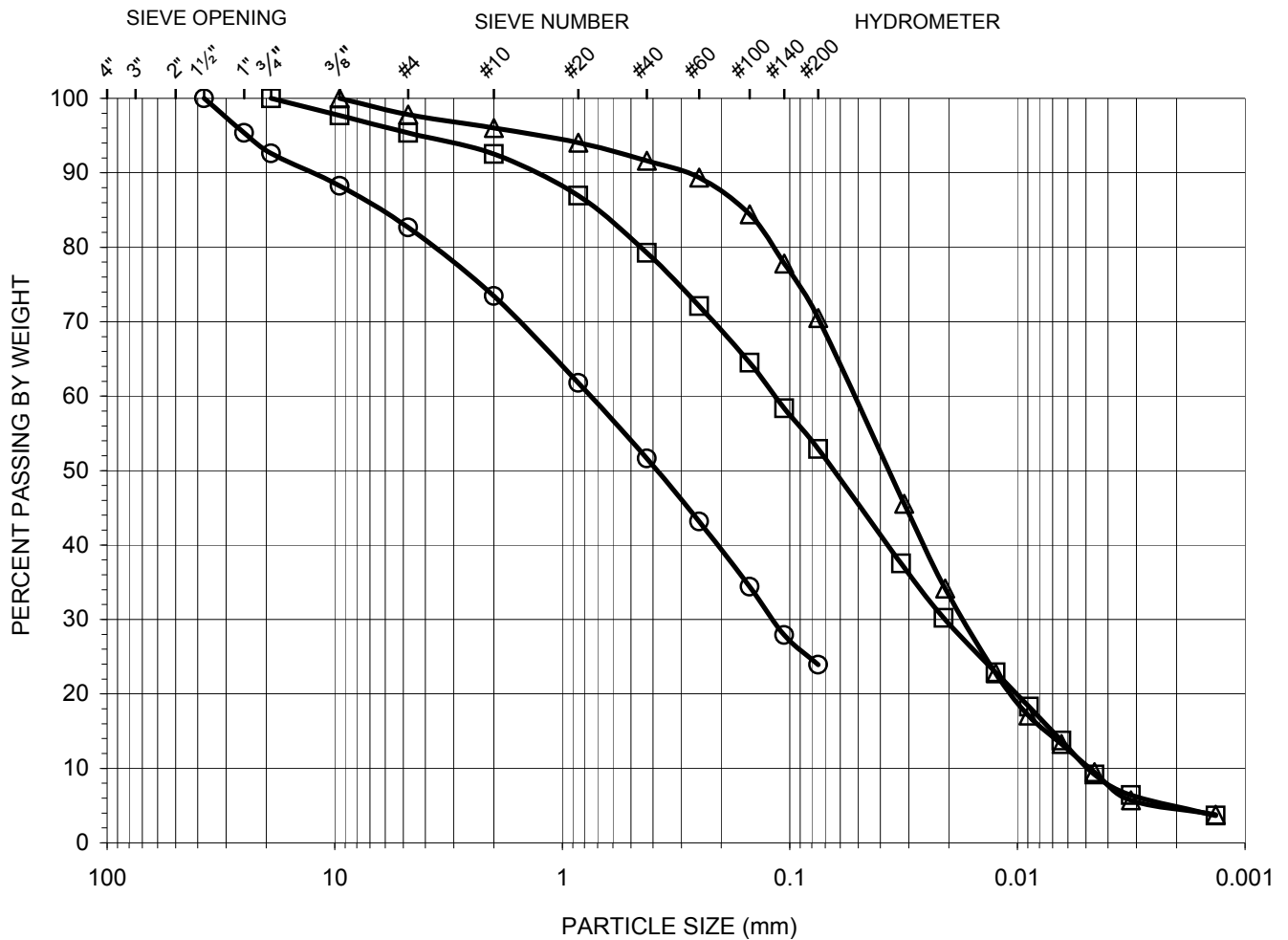




### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 05/08/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/13/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/14/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



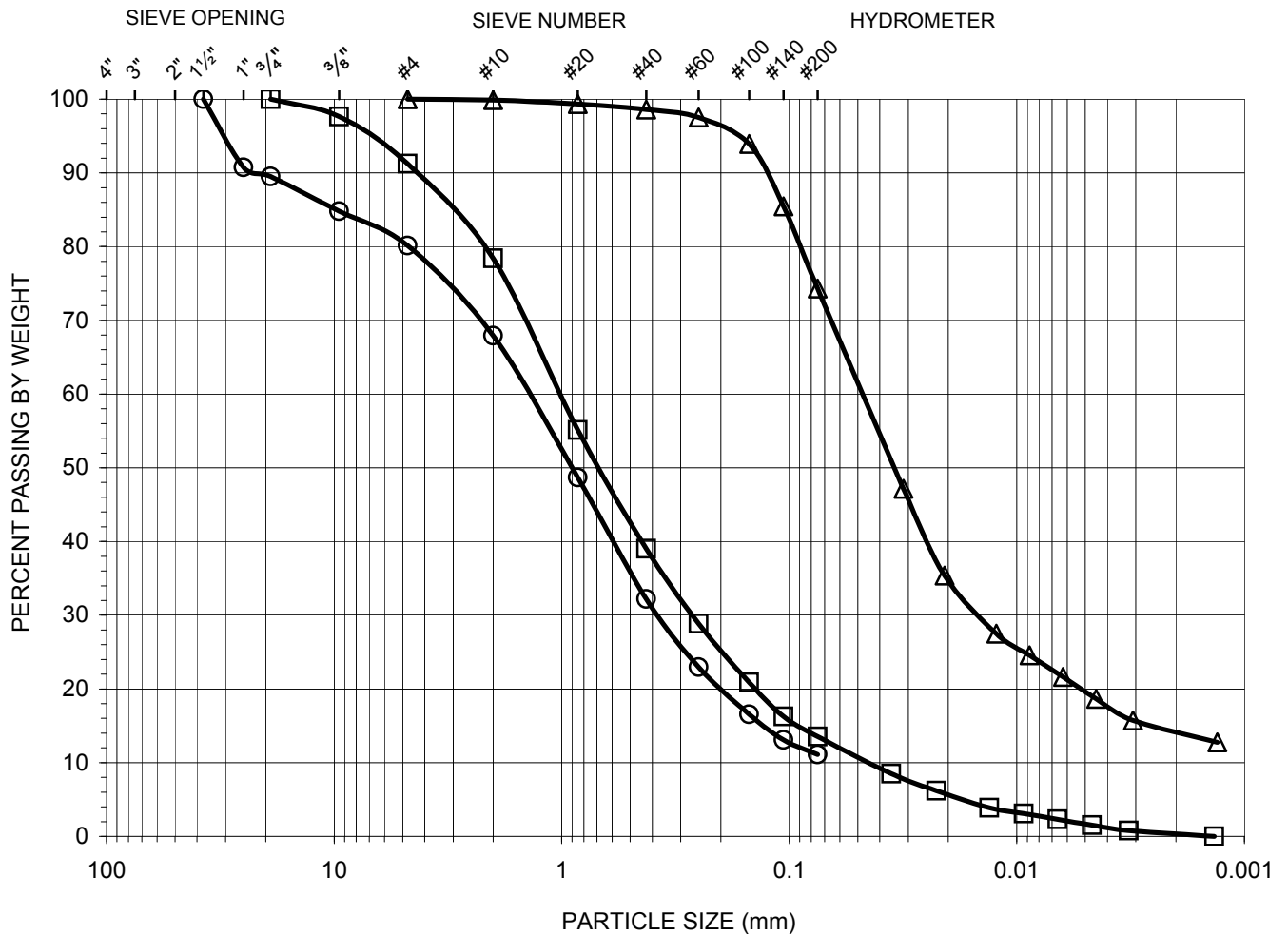
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	O-13-023	O22	85-86	17	59	24	N/A	SM
□	O-13-023	O25	99-100	5	42	53	24:20:4	CL-ML
△	O-13-023	O32	142-143	2	28	70	N/P	ML



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 05/08/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/13/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/14/13

GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	O-13-023	O35	160-161	20	69	11	N/A	SW-SM
□	O-13-023	O37	180-181	9	77	14	N/A	SM
△	O-13-023	O39	200-201	0	26	74	32:17:15	CL

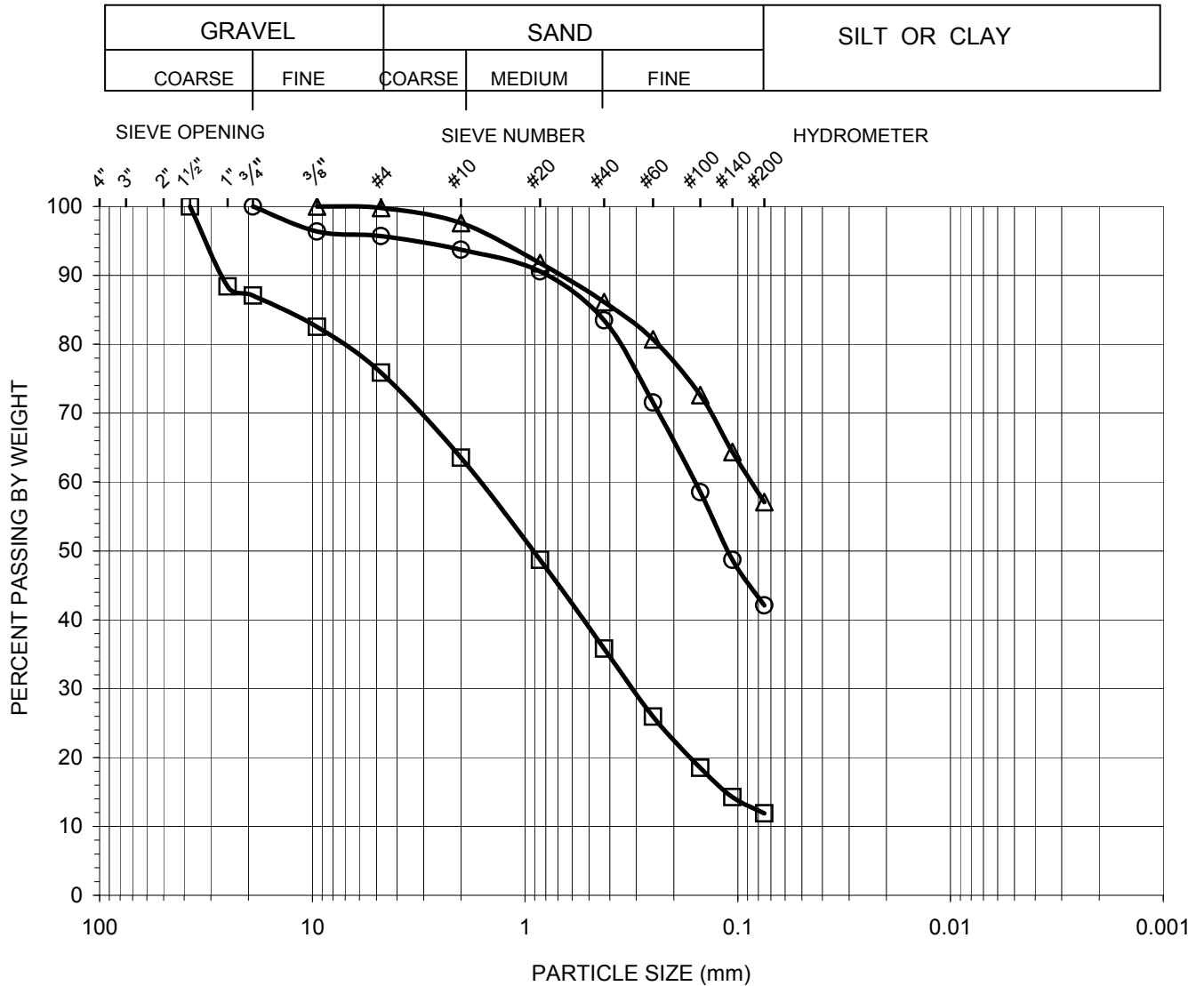




AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	05/15/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/22/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/22/13

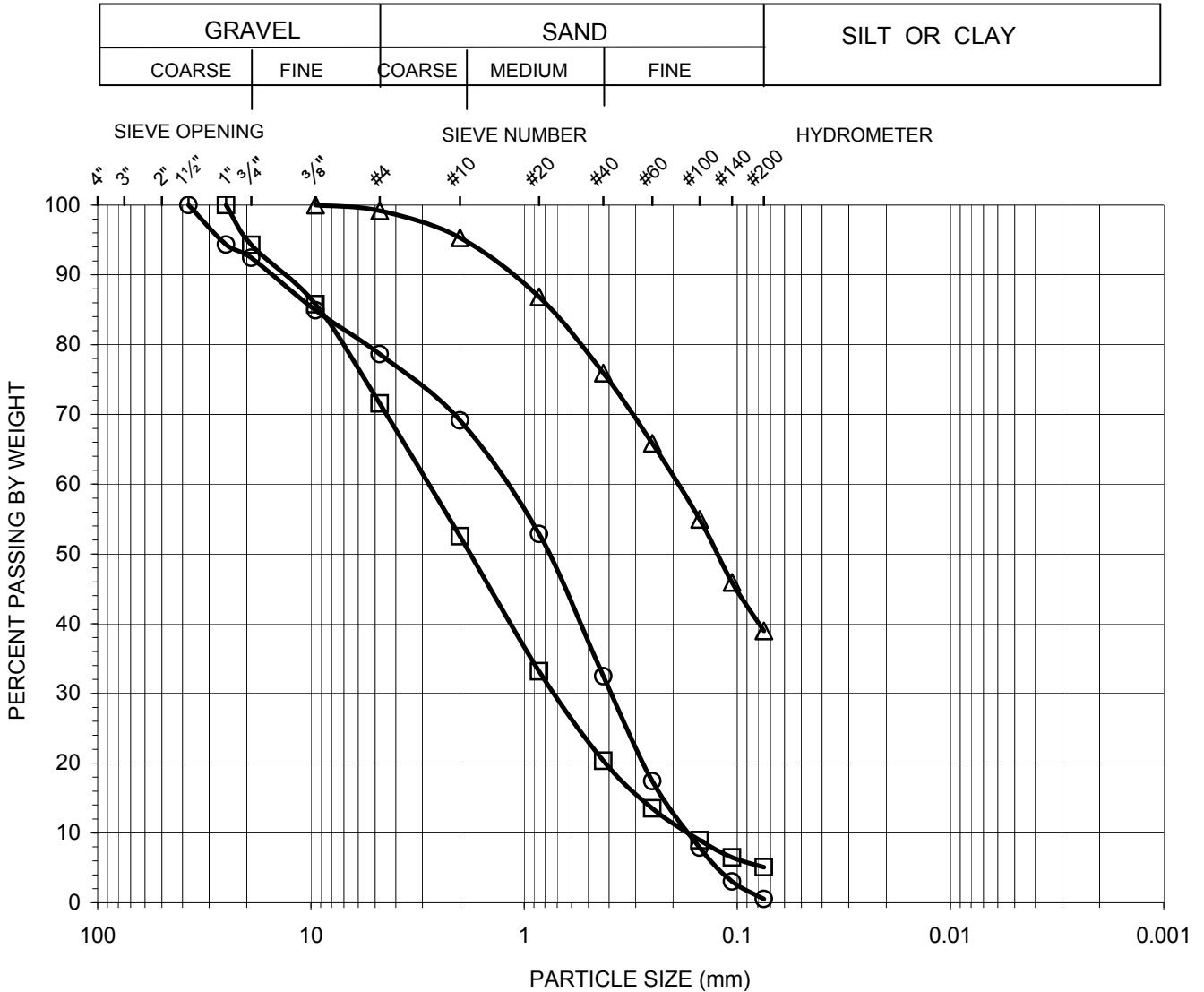


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-024	O03	15-16	4	54	42	N/A	SM
□	A-13-024	O08	35-36	24	64	12	N/A	SP-SM
△	A-13-024	O15	55-56	0	43	57	N/A	ML



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 05/15/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/22/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/22/13

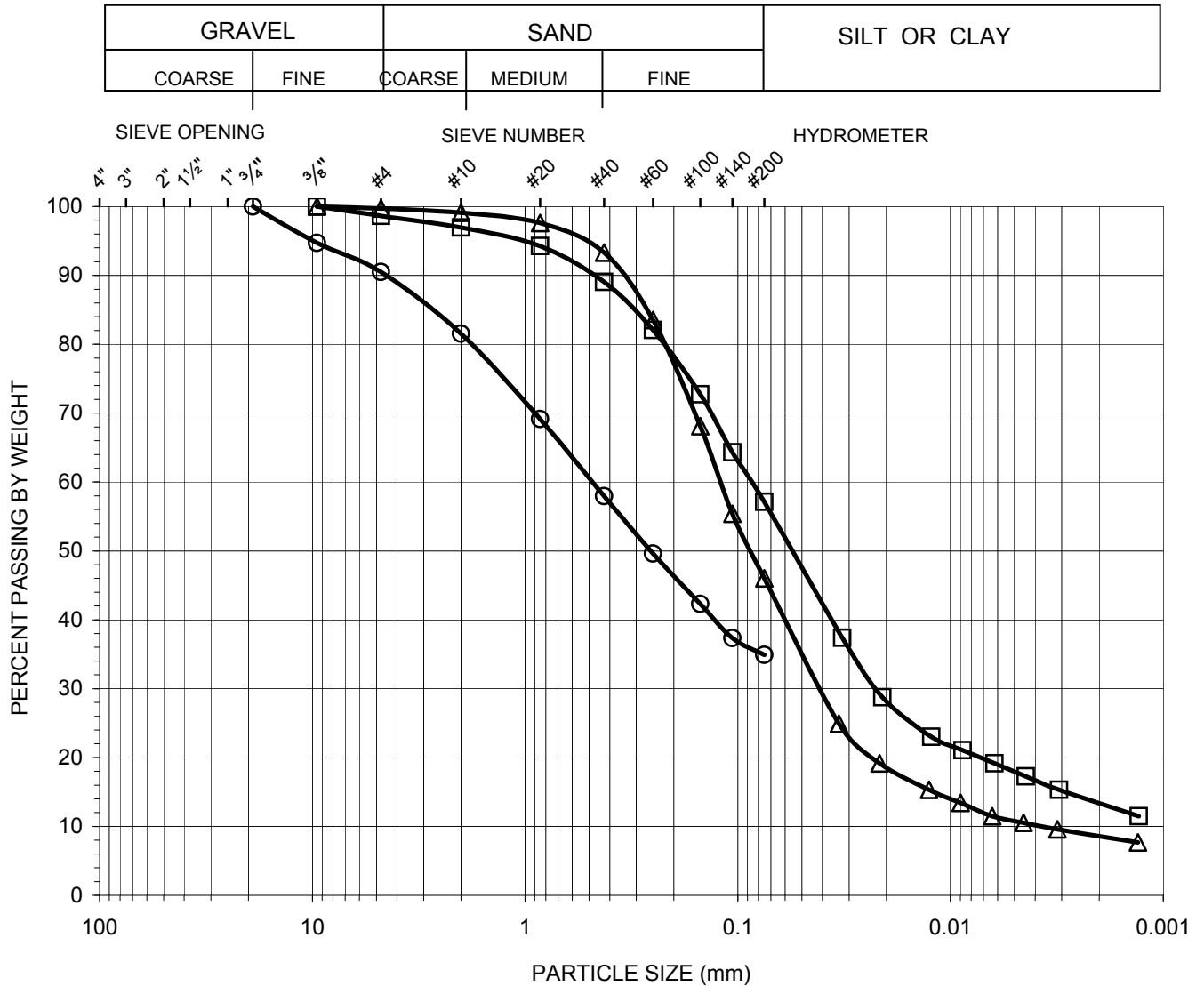


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-024	O20	75-76	21	78	1	N/A	SP
□	A-13-024	O23	85-86	28	67	5	N/A	SW-SM
△	A-13-024	O29	105-106	1	60	39	N/A	SM



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Client Name:	CH2M Hill	Tested by:	ST	Date:	05/15/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/21/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/23/13



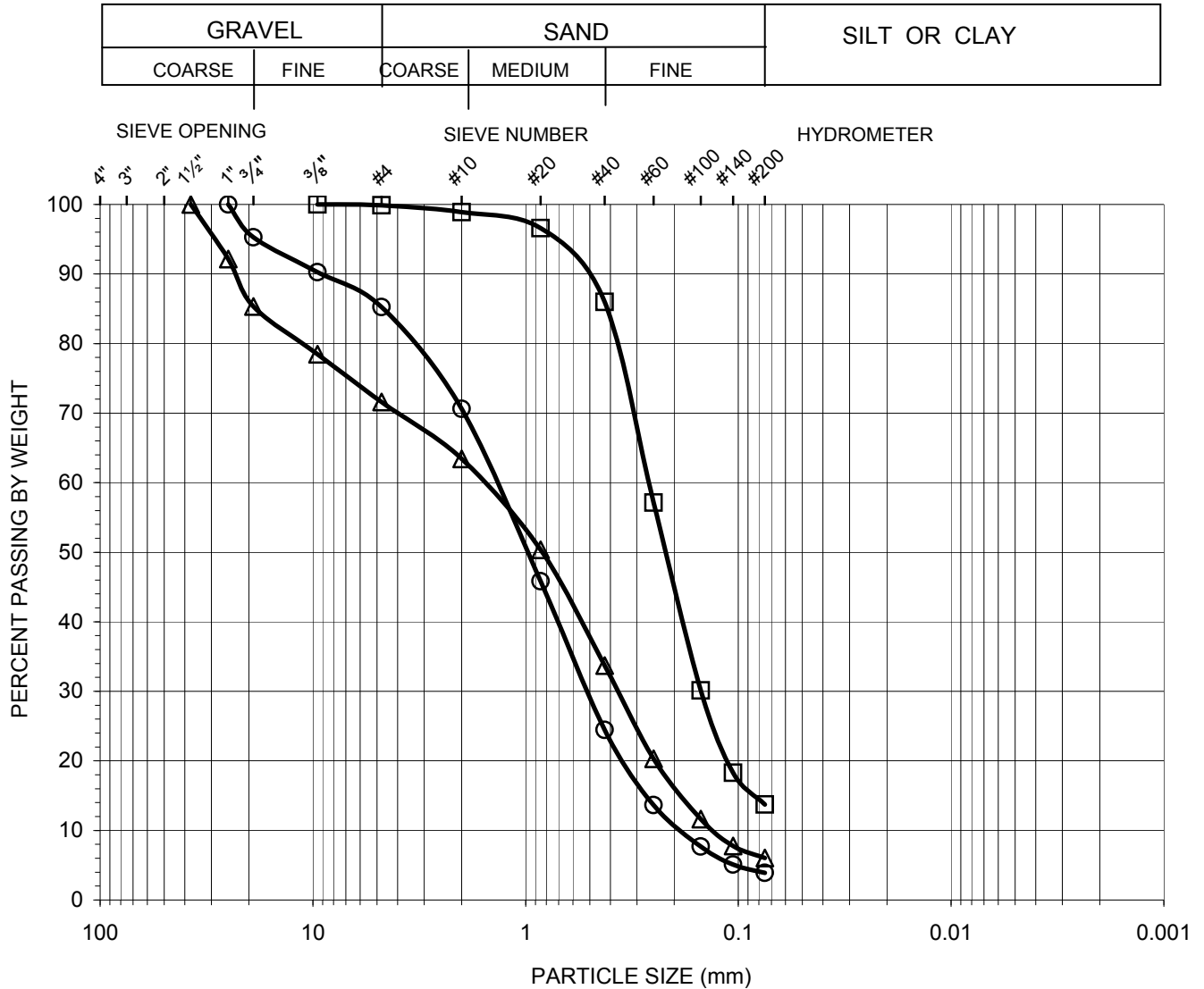
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-025	O01	5-6	9	56	35	N/A	SM
□	A-13-025	O05	25-26	1	42	57	21:16:5	CL-ML
△	A-13-025	O07	35-36	0	54	46	N/P	SM



AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 05/15/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/21/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/23/13



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-025	O09	45-46	15	81	4	N/A	SW
□	A-13-025	O13	65-66	0	86	14	N/A	SM
△	A-13-025	O17	85-86	28	66	6	N/A	SP-SM



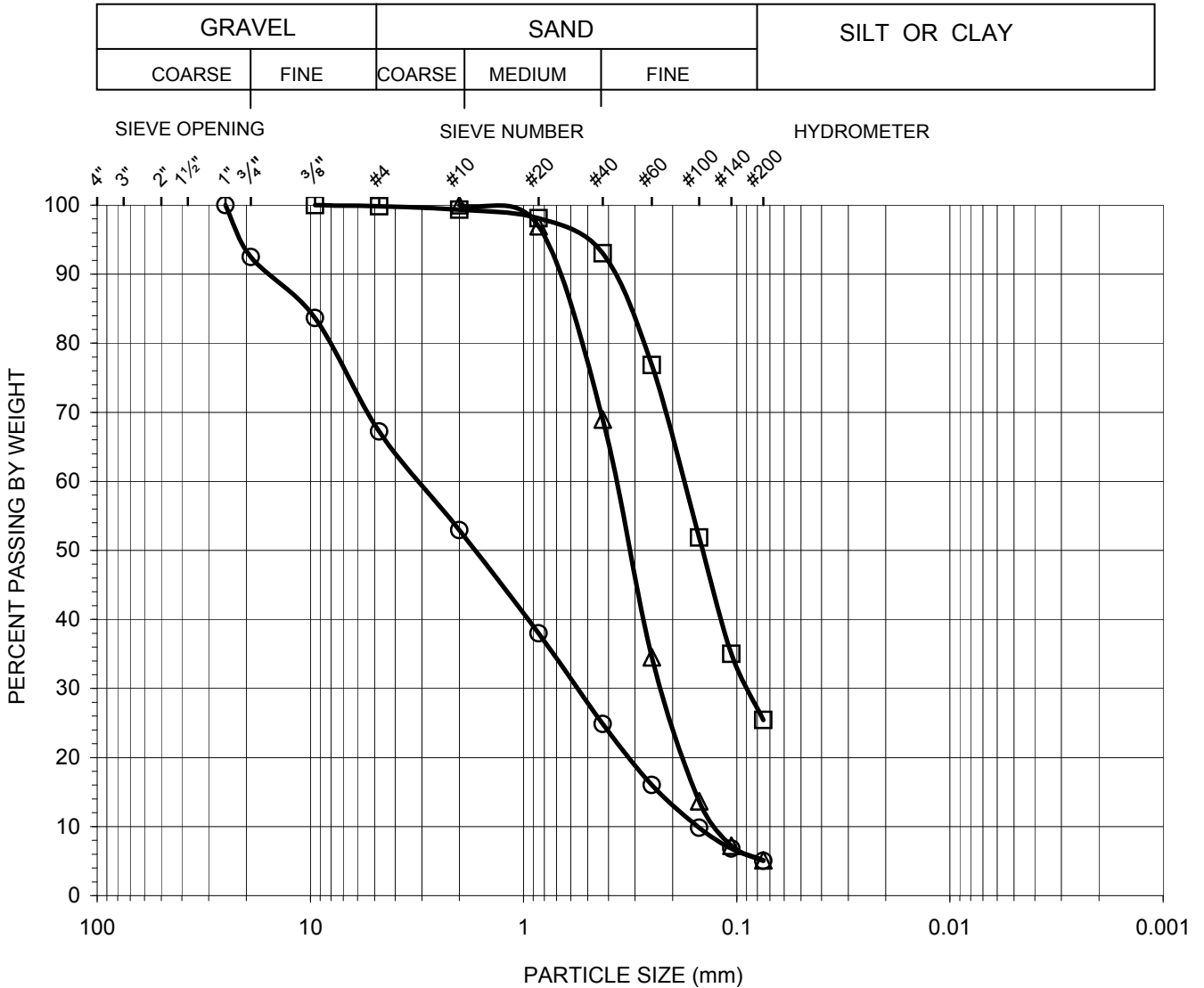




AP Engineering & Testing, Inc.

### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	05/15/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/22/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/23/13



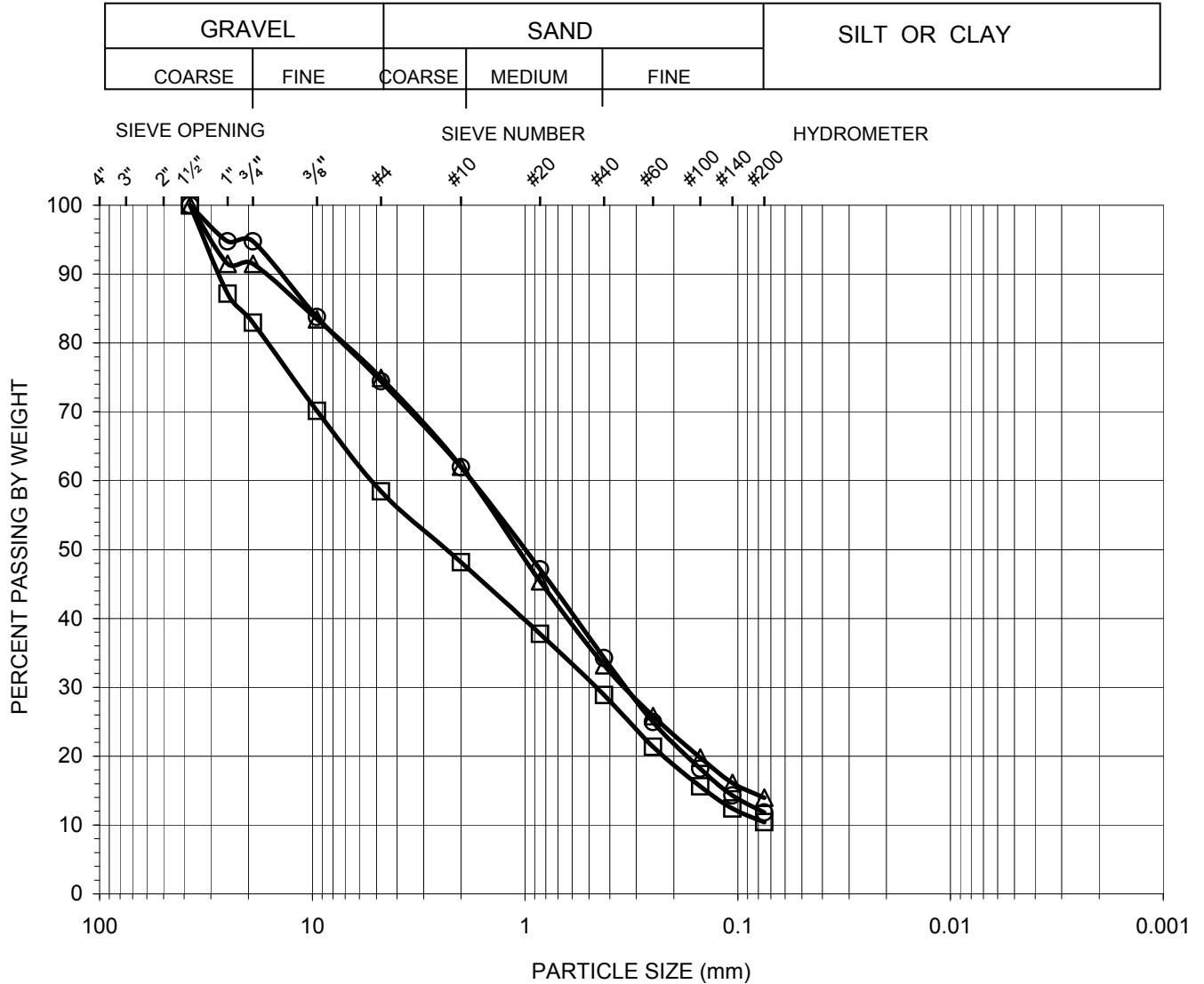
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-026	O03	15-16	33	62	5	N/A	SP-SM
□	A-13-026	O07	35-36	0	75	25	N/A	SM
△	A-13-026	O11	55-56	0	95	5	N/A	SP-SM





### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	05/15/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/21/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/23/13

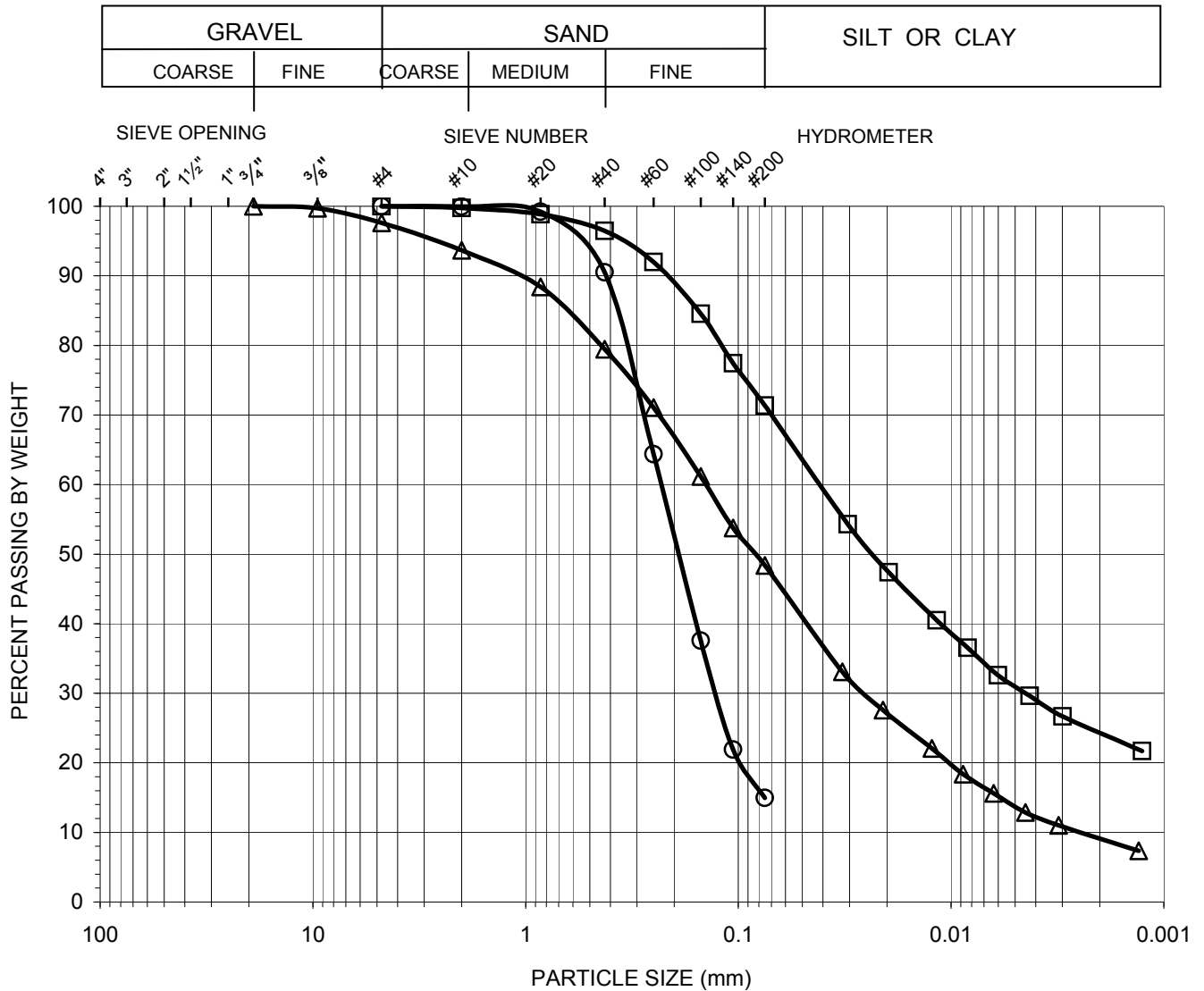


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-027	O01	5-6	26	62	12	N/A	SW-SM
□	A-13-027	O05	25-26	42	48	10	N/A	SP-SM
△	A-13-027	O09	45-46	25	61	14	N/A	SM



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name: CH2M Hill Tested by: ST Date: 05/15/13  
 Project Name: SR-710 North Study Computed by: KM Date: 05/21/13  
 Project No.: 428908.02.14.00.03.02 Checked by: AP Date: 05/23/13

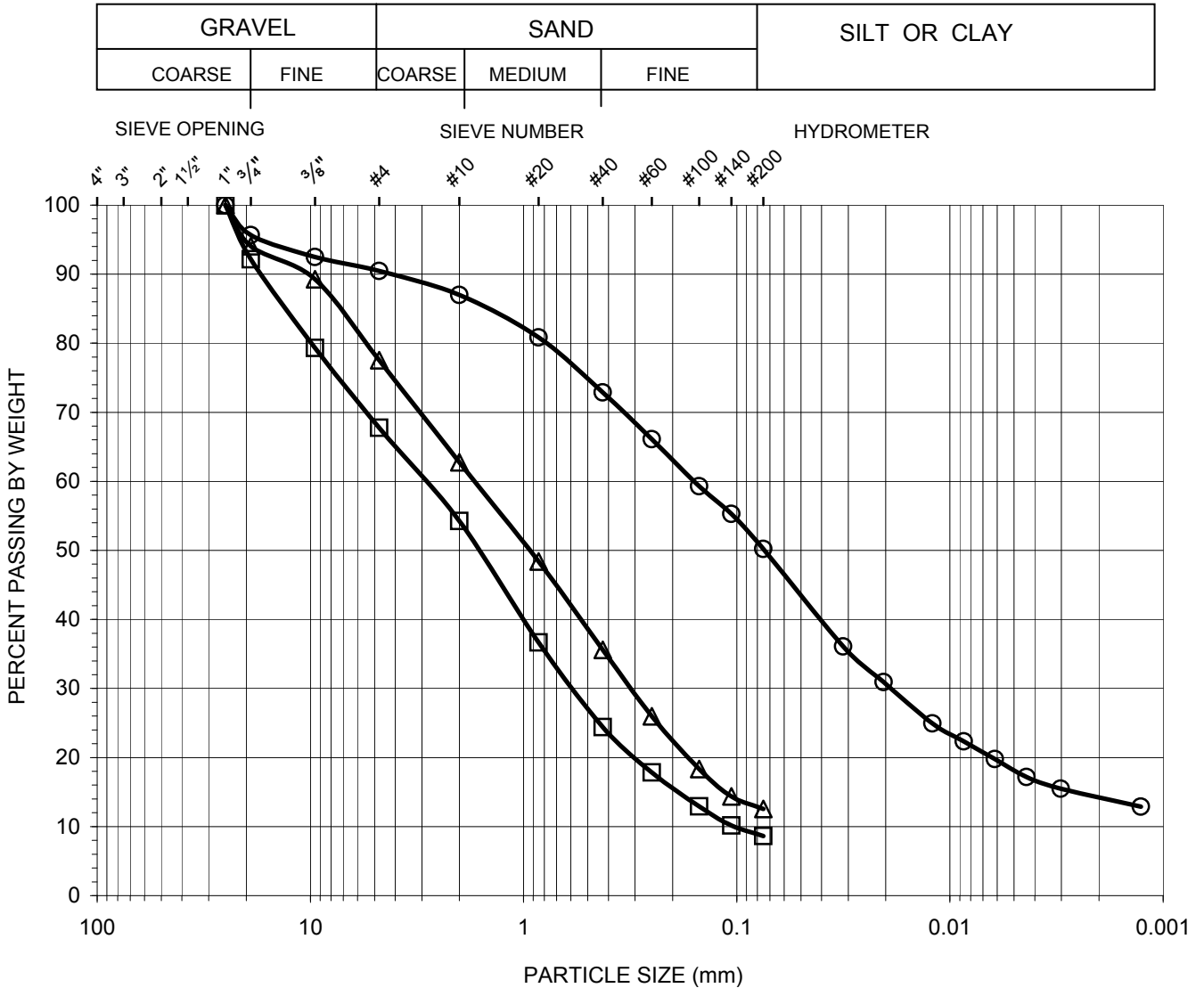


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-027	O13	65-66	0	85	15	N/A	SM
□	A-13-027	O15	75-76	0	29	71	37:12:25	CL
△	A-13-027	O19	95-96	2	50	48	37:17:20	SC



### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	05/09/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/15/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/17/13



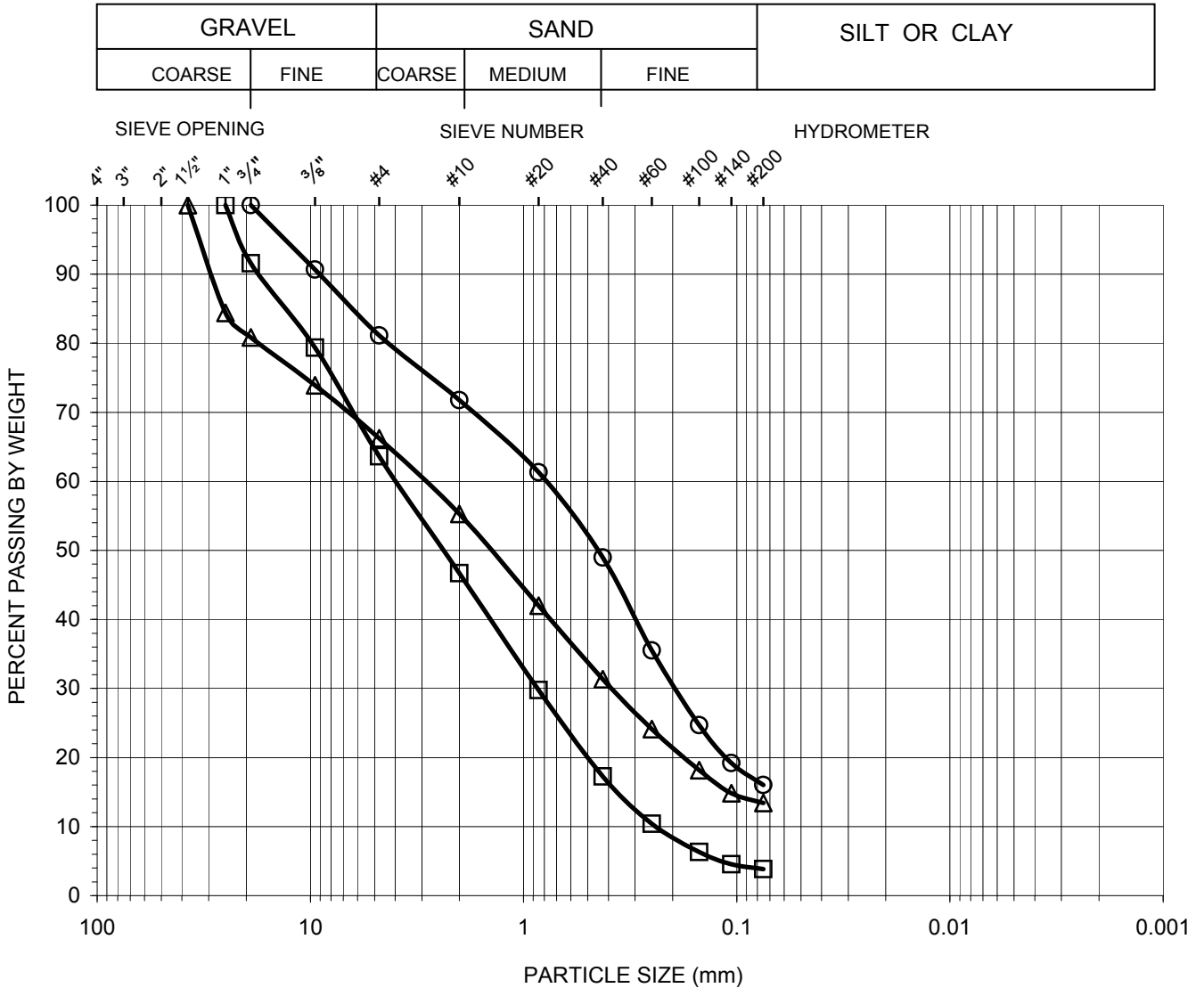
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				Gravel	Sand	Fines		
○	A-13-034	O01	5-6	10	40	50	24:16:8	CL
□	A-13-034	O08	25-26	32	59	9	N/A	SW-SM
△	A-13-034	O14	45-46	22	65	13	N/A	SM





### GRAIN SIZE DISTRIBUTION CURVE ASTM D 422

Client Name:	CH2M Hill	Tested by:	ST	Date:	05/10/13
Project Name:	SR-710 North Study	Computed by:	KM	Date:	05/15/13
Project No.:	428908.02.14.00.03.02	Checked by:	AP	Date:	05/17/13

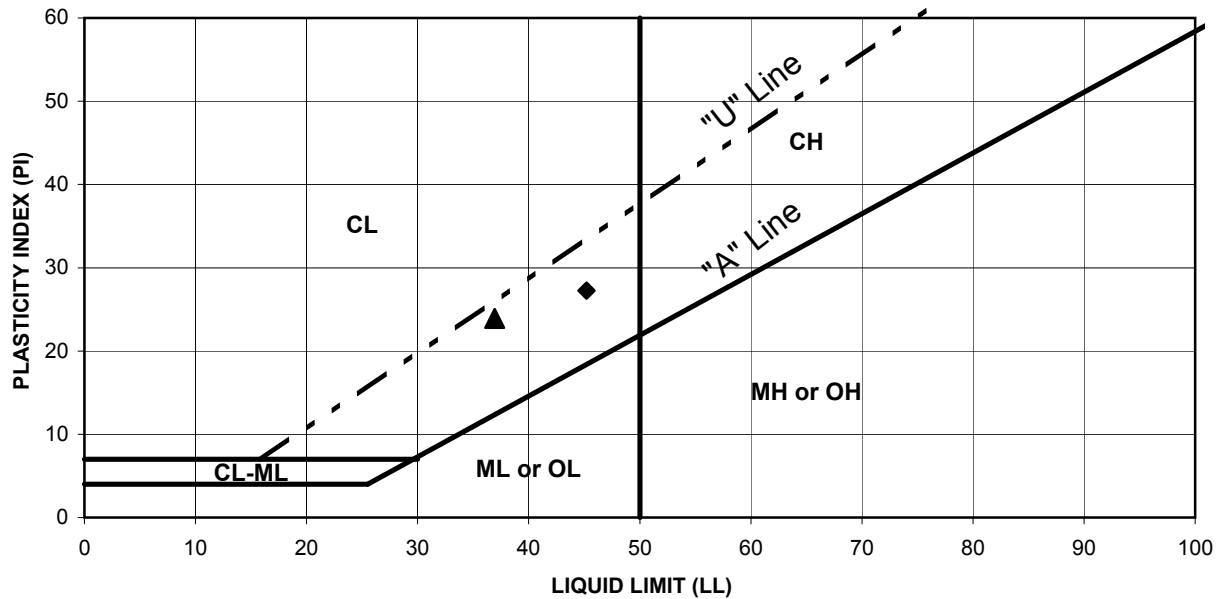


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Symbol ASTM D 2487
				Gravel	Sand	Fines		
○	A-13-035	O03	15-16	19	65	16	N/A	SM
□	A-13-035	O08	35-36	36	60	4	N/A	SP
△	A-13-035	O19	65-66	34	53	13	N/A	SM



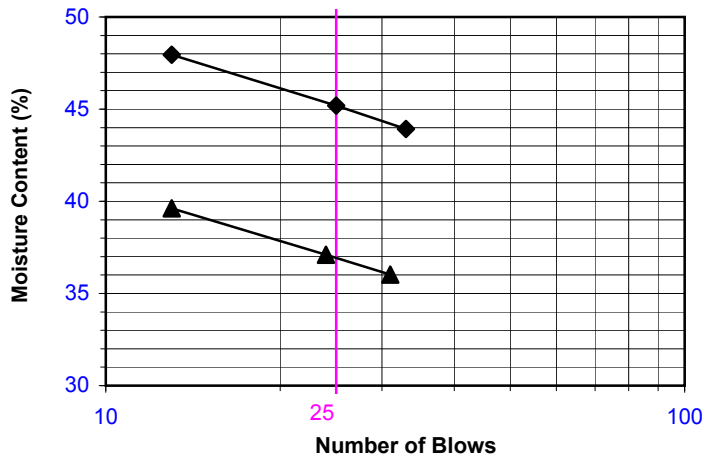
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/03/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/20/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



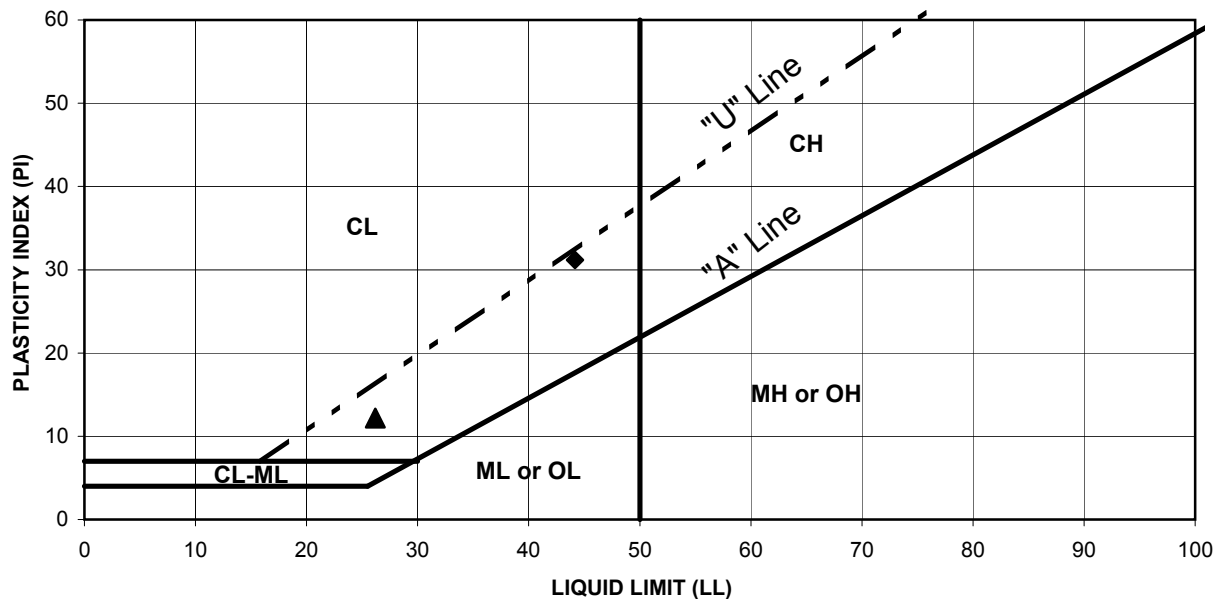
Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	A-13-001	S04	15	45	18	27	CL
▲	A-13-001	S06	25	37	13	24	CL





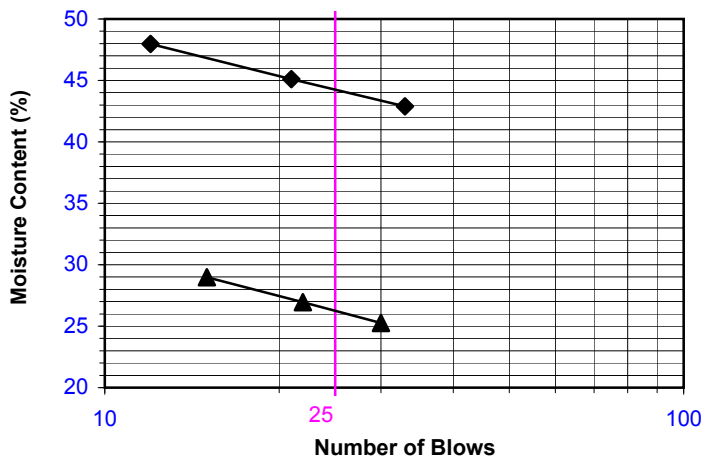
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/03/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/20/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test

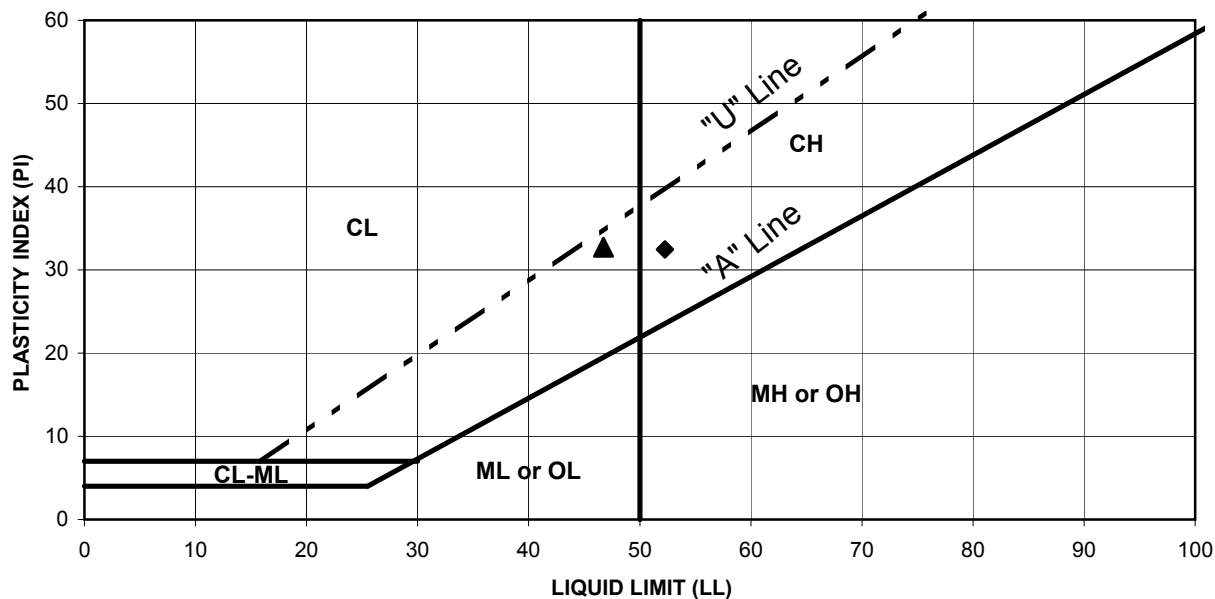


Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	A-13-001	S09	40	44	13	31	CL
▲	A-13-001	S20	95	26	14	12	CL



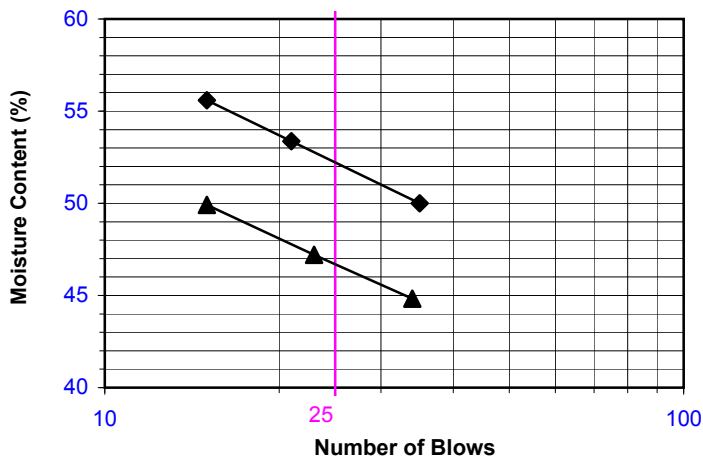
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/02/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/01/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test

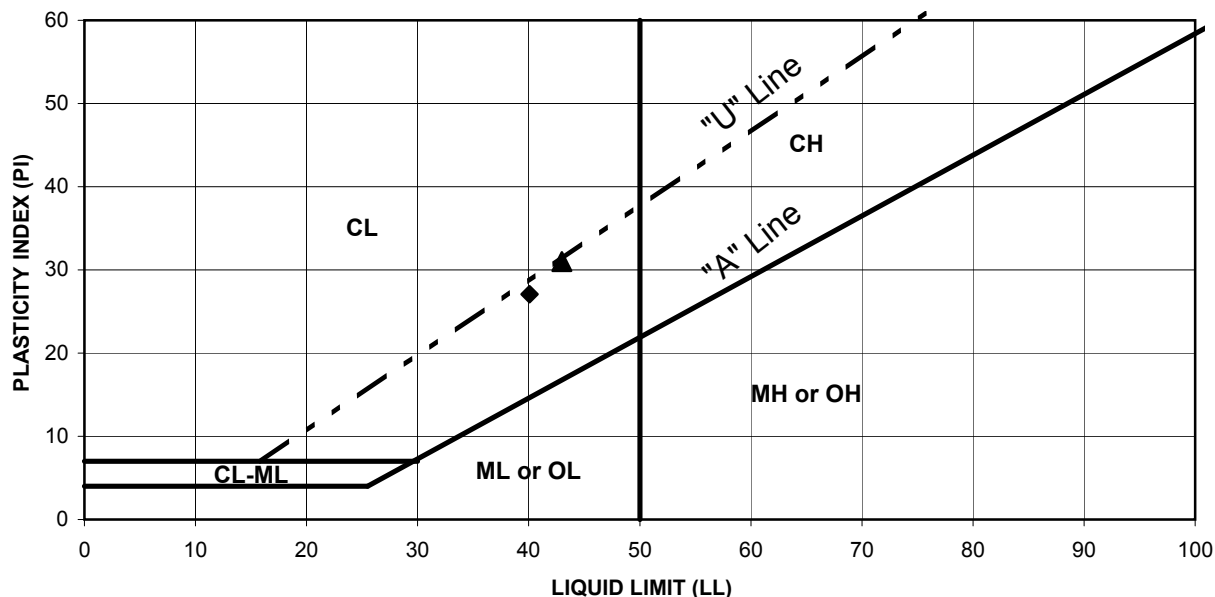


Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	RC-13-002	S02	5	52	20	32	CH
▲	RC-13-002	S04	15	47	14	33	CL



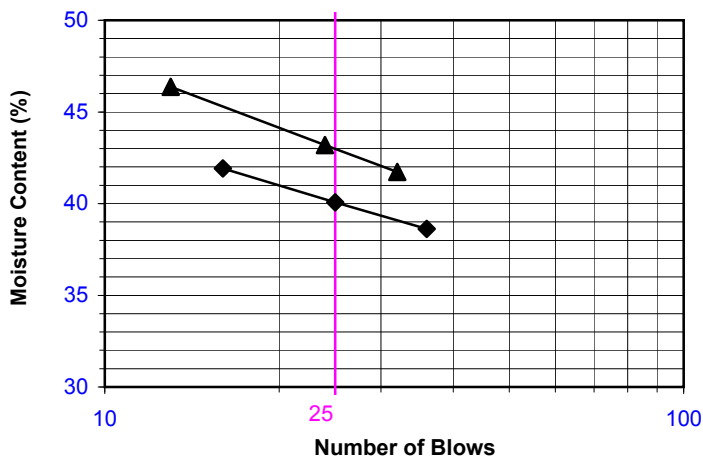
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/02/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/01/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



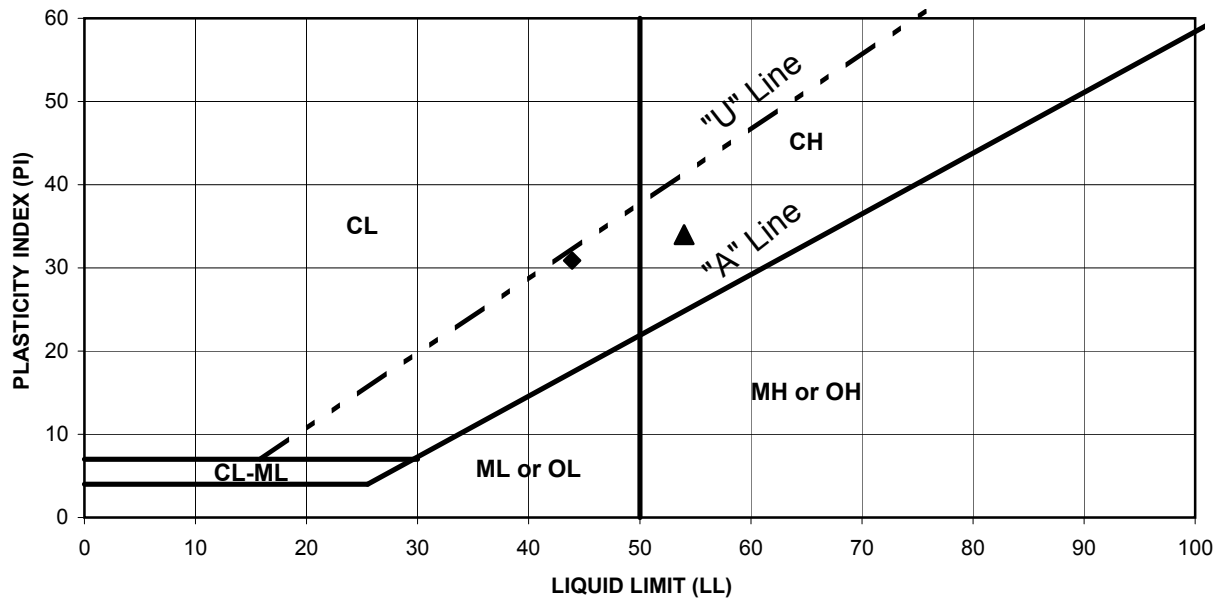
Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	RC-13-002	S05	20	40	13	27	CL
▲	RC-13-002	S06	25	43	12	31	CL



AP Engineering & Testing, Inc.

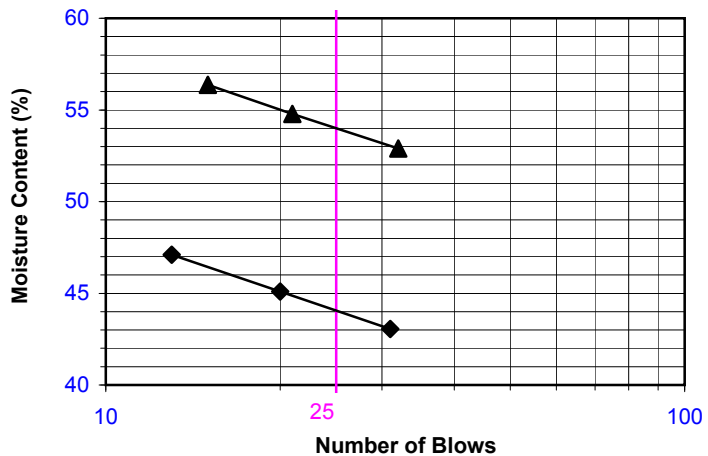
### ATTERBERG LIMITS ASTM D 4318

Project Name: SR-710 North Study Tested By: DK Date: 04/02/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/01/13



**PROCEDURE USED**

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



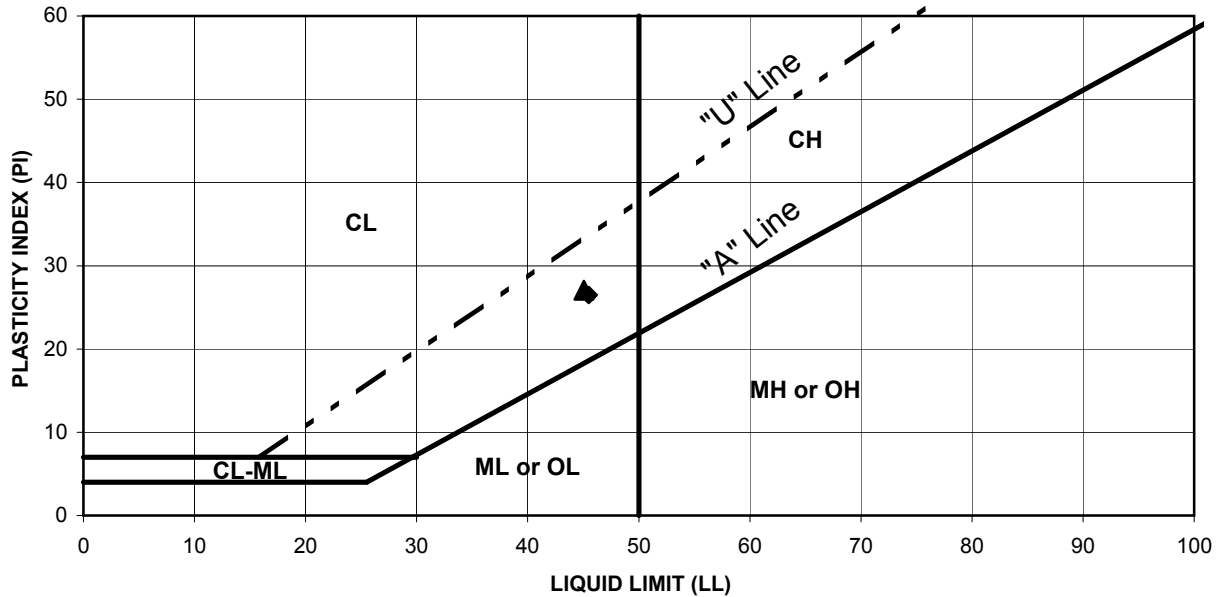
Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	RC-13-002	S07	30	44	13	31	CL
▲	RC-13-002	S09	40	54	20	34	CH



AP Engineering & Testing, Inc.

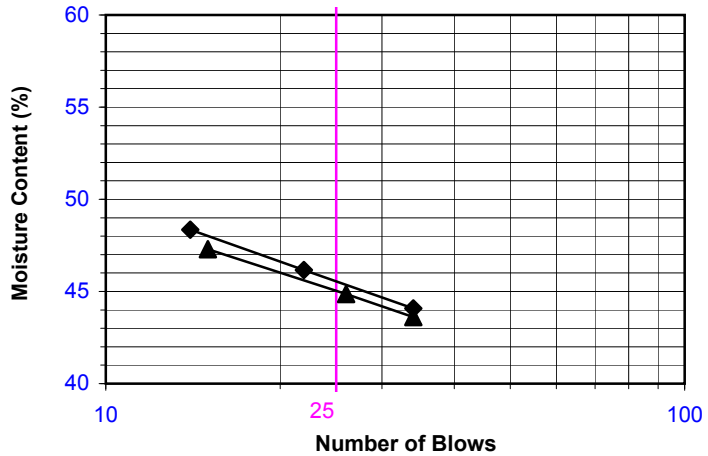
### ATTERBERG LIMITS ASTM D 4318

Project Name: SR-710 North Study Tested By: DK Date: 04/02/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/01/13



**PROCEDURE USED**

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



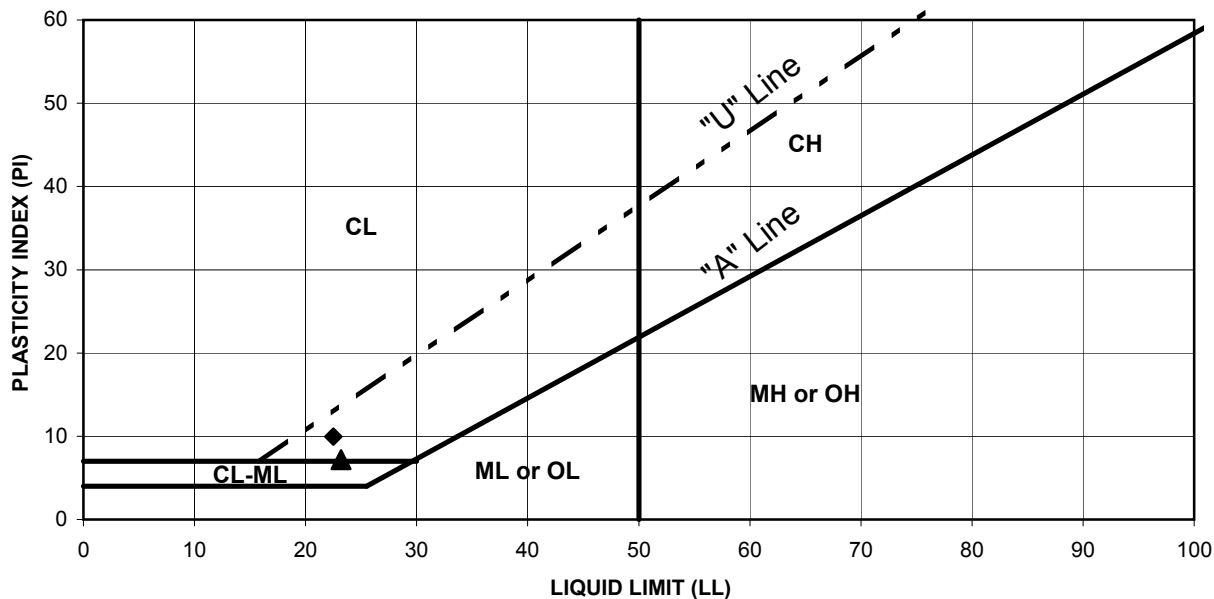
Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	RC-13-002	C12	52.1-53.4	46	19	27	CL
▲	RC-13-002	C17	77.3-78.6	45	18	27	CL





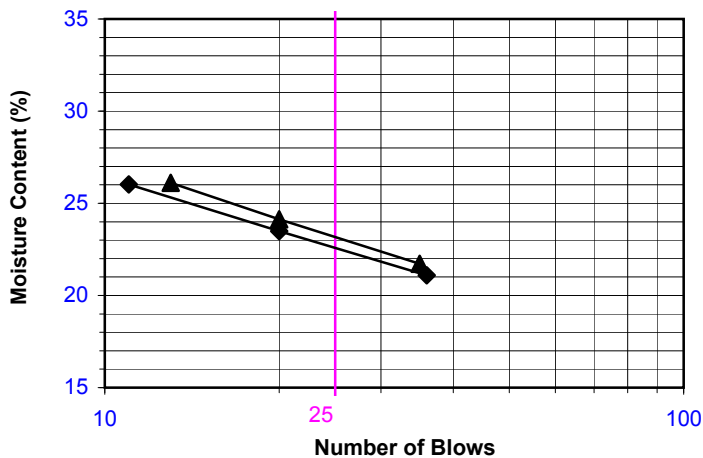
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/26/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/01/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test

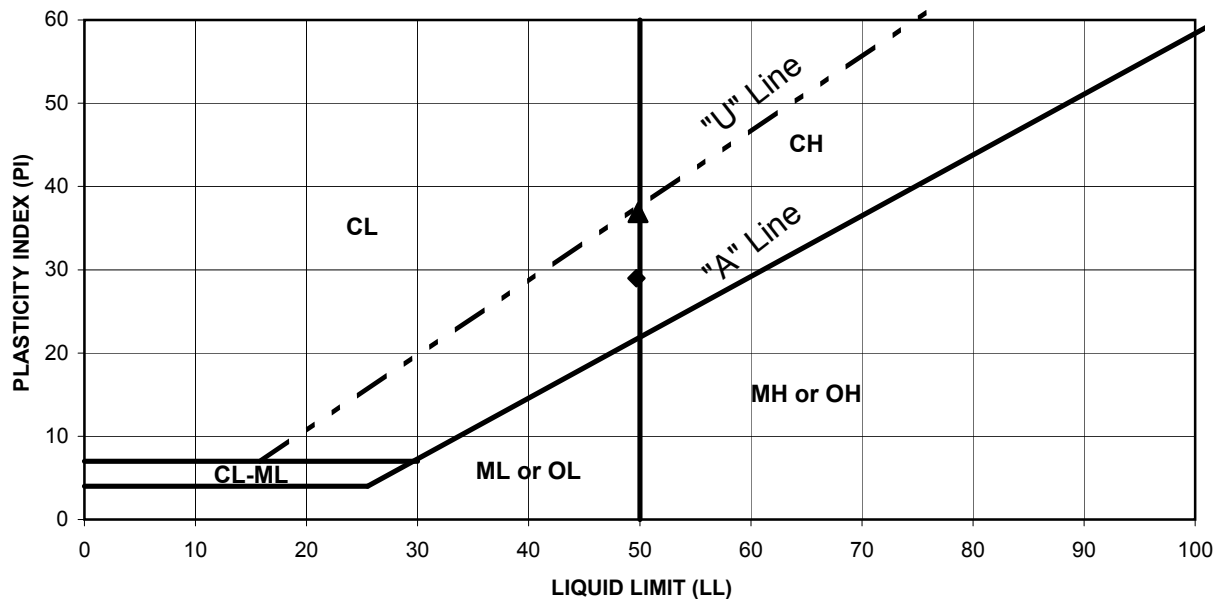


Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	RC-13-004	S02	5	23	13	10	CL
▲	RC-13-004	S03	10	23	16	7	CL-ML



**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/02/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 04/23/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



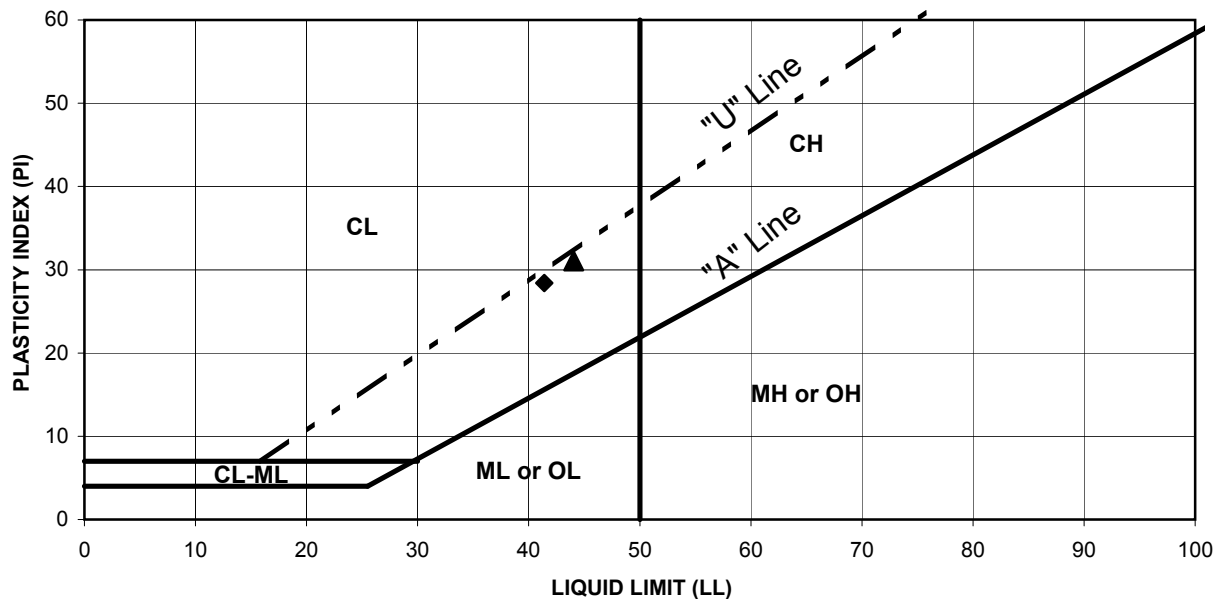
Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	RC-13-005	S3	10-11.5	50	21	29	CH
▲	RC-13-005	S10	45-46.5	50	13	37	CH





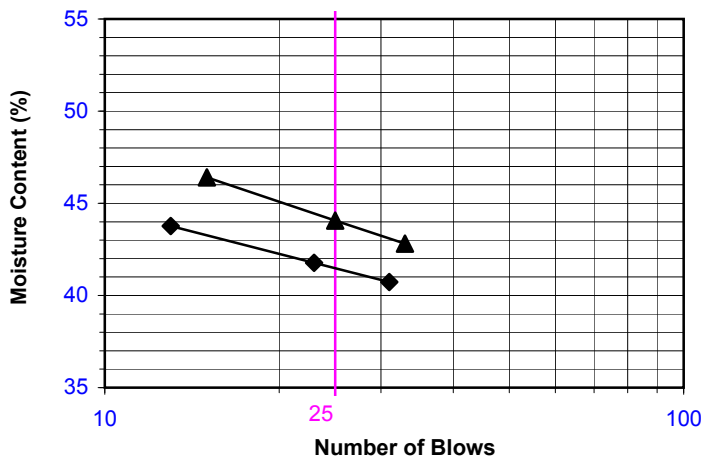
### ATTERBERG LIMITS ASTM D 4318

Project Name: SR-710 North Study Tested By: DK Date: 04/02/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 04/23/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



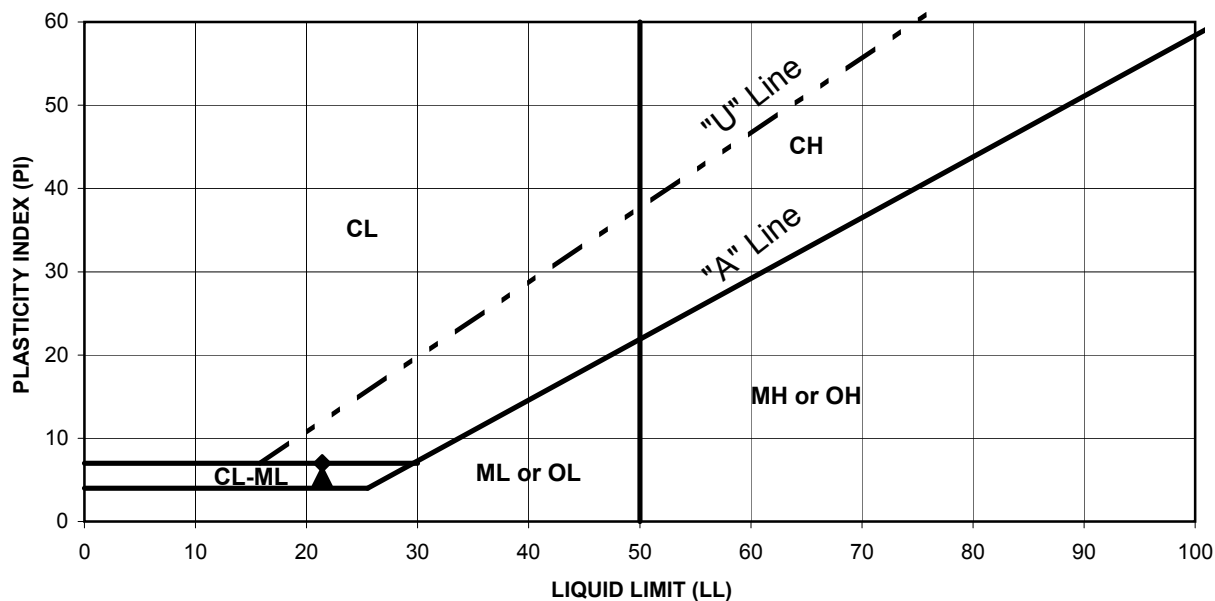
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◆	RC-13-005	S13	60-61.5	41	13	28	CL
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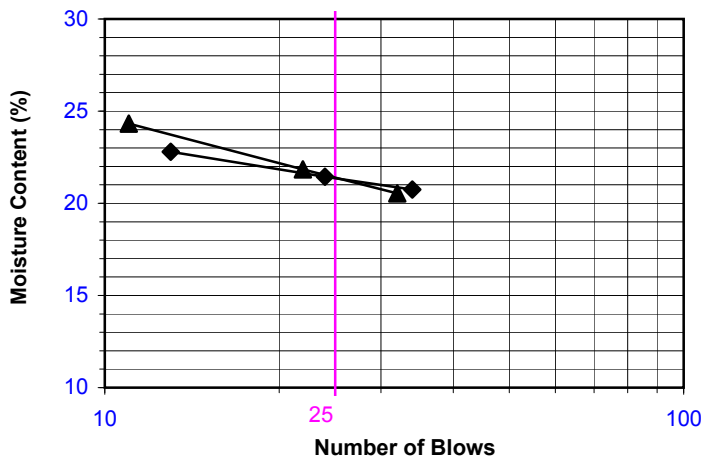
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/26/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/07/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test

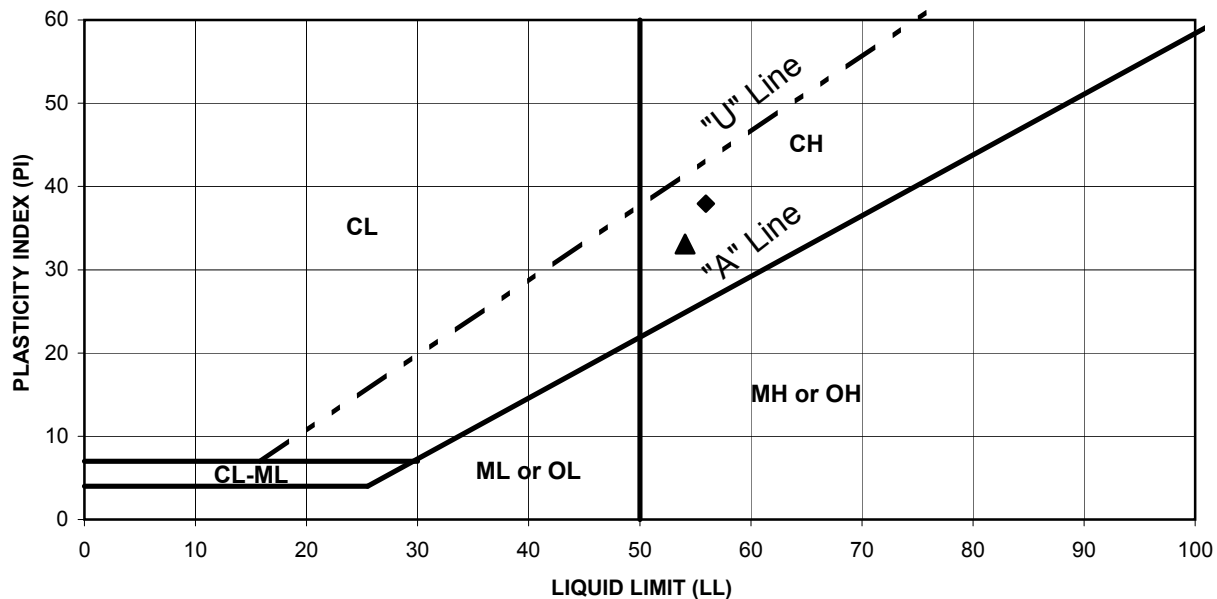


Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	R-13-006	S04	15	21	14	7	CL-ML
▲	R-13-006	S07	30	21	16	5	CL-ML



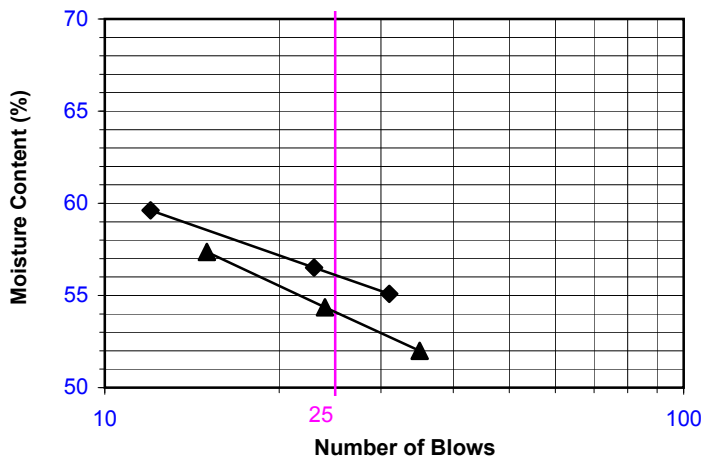
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/26/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/07/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test

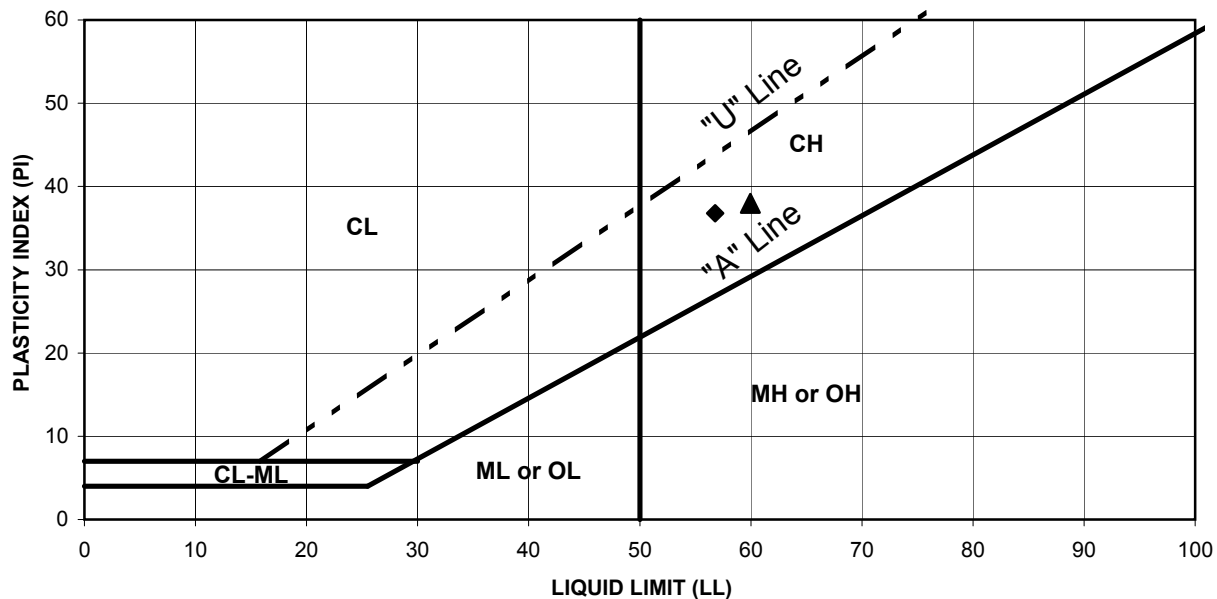


Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	R-13-006	S14	65	56	18	38	CH
▲	R-13-006	S16A	75	54	21	33	CH



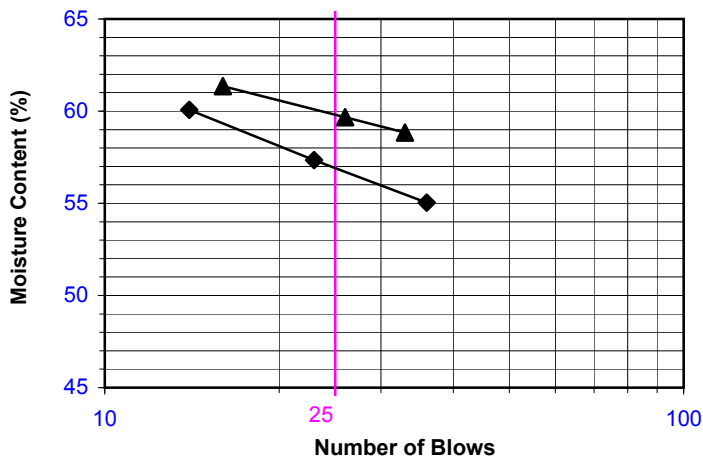
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/26/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/07/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



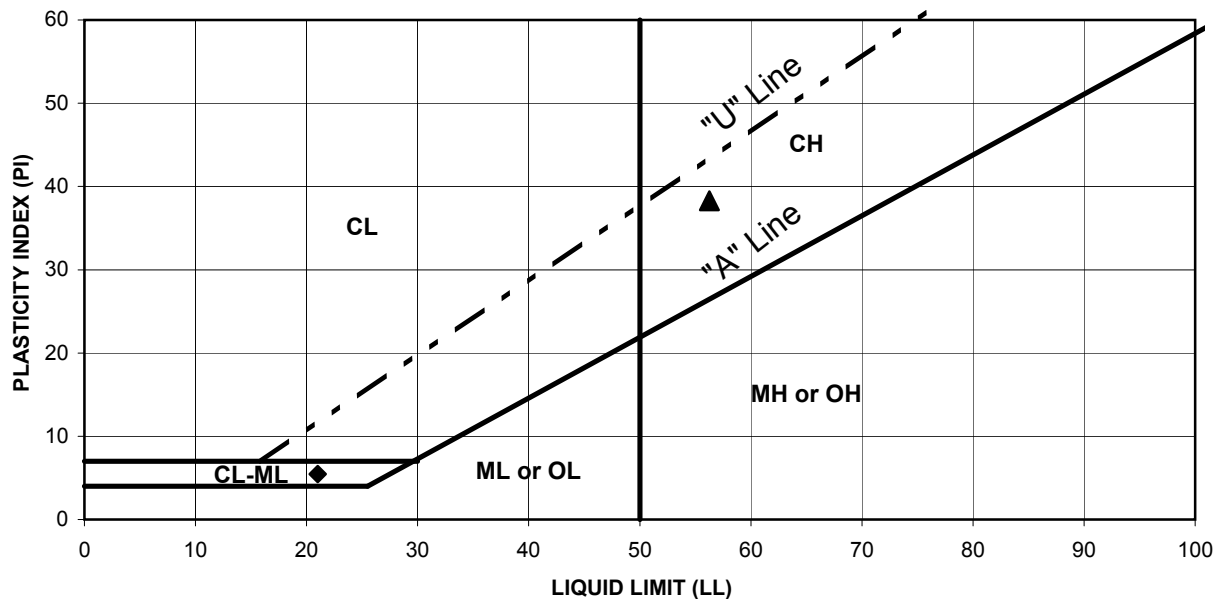
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◆	R-13-006	S19A	90	57	20	37	CH
▲	R-13-006	S22A	105	60	22	38	CH





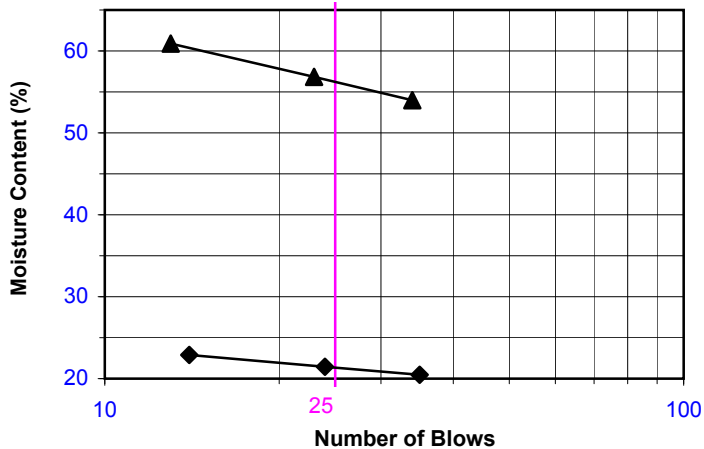
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/02/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 04/26/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	RC-13-007	S07	30	21	16	5	CL-ML
▲	RC-13-007	S17	80	56	18	38	CH

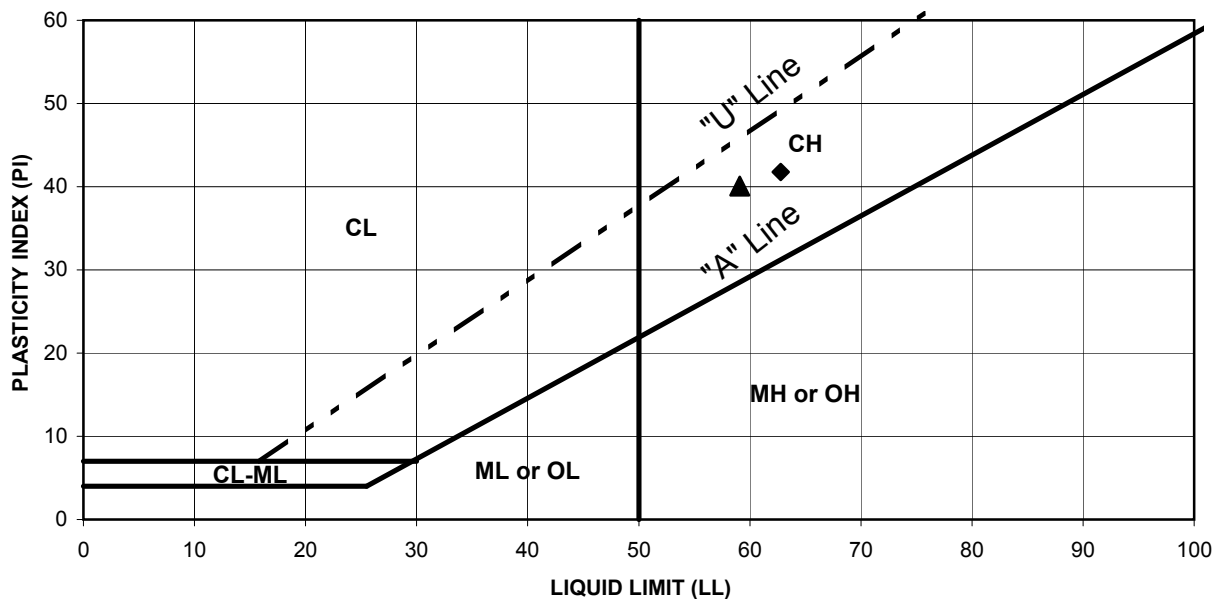






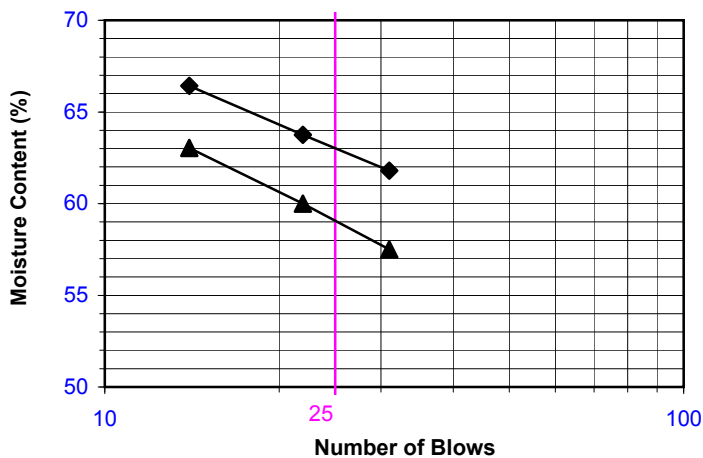
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/02/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 04/26/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test

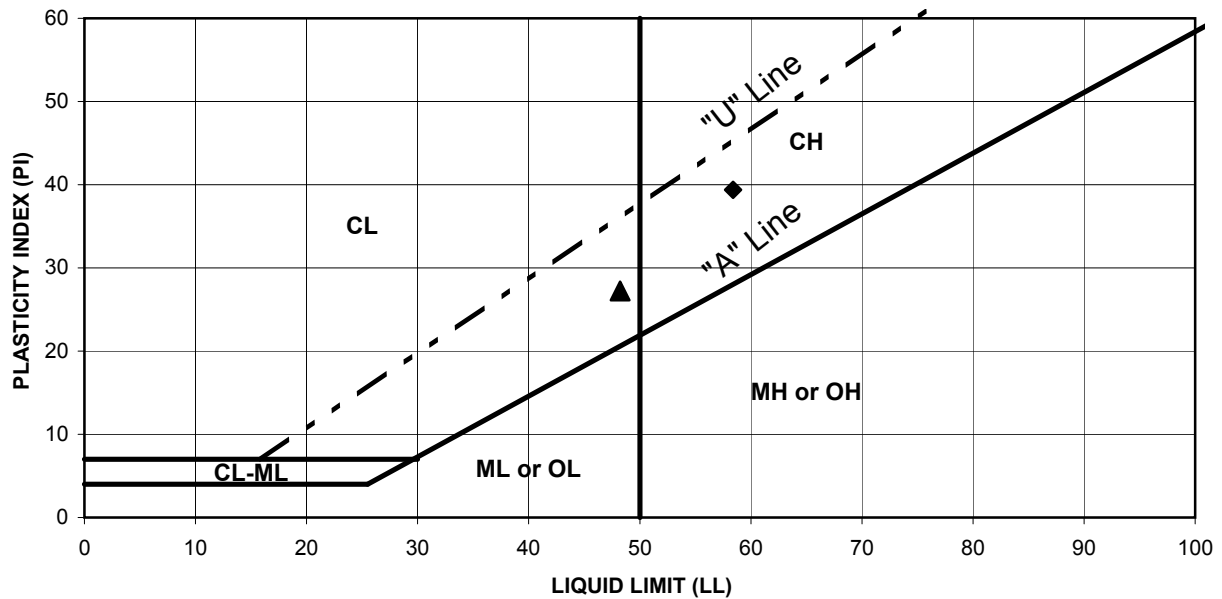


Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	RC-13-007	C19	90.7-91.2	63	21	42	CH
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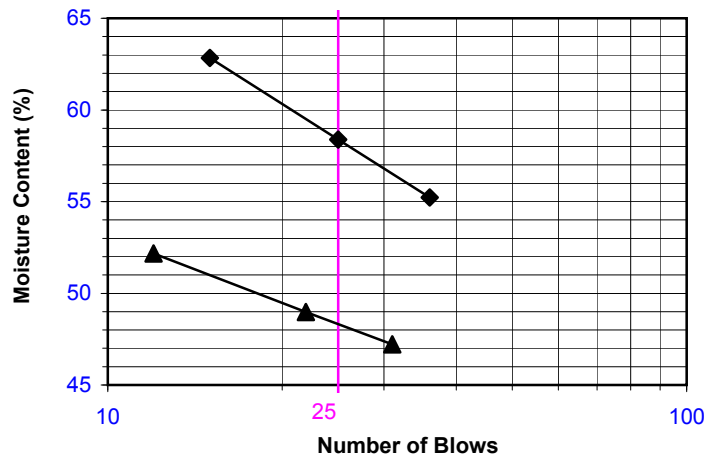
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/02/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 04/26/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	RC-13-007	C26	124.4-125.2	58	19	39	CH
▲	RC-13-007	C32	152.9-153.7	48	21	27	CL



**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR710 North Study

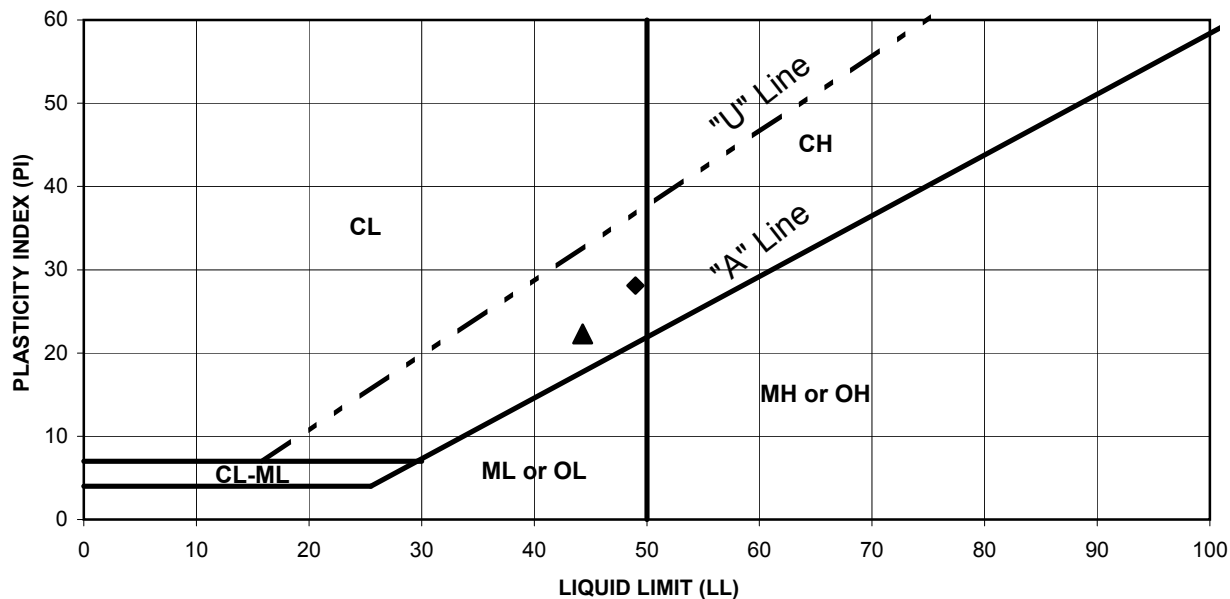
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Date: 09/09/13

Project No.: 133978

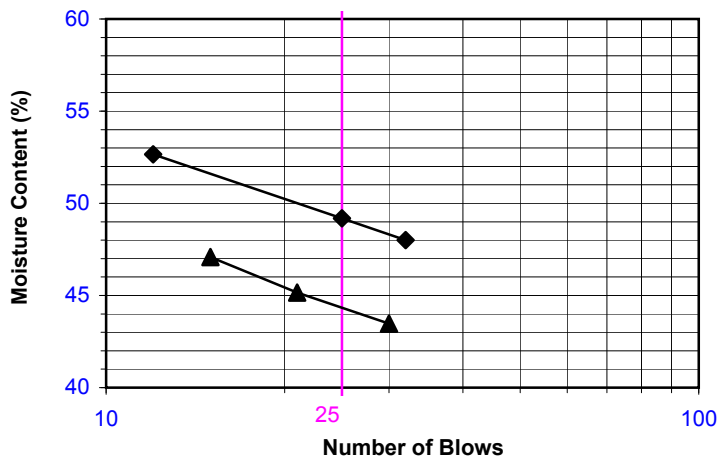
Checked By: AP

Date: 09/20/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test

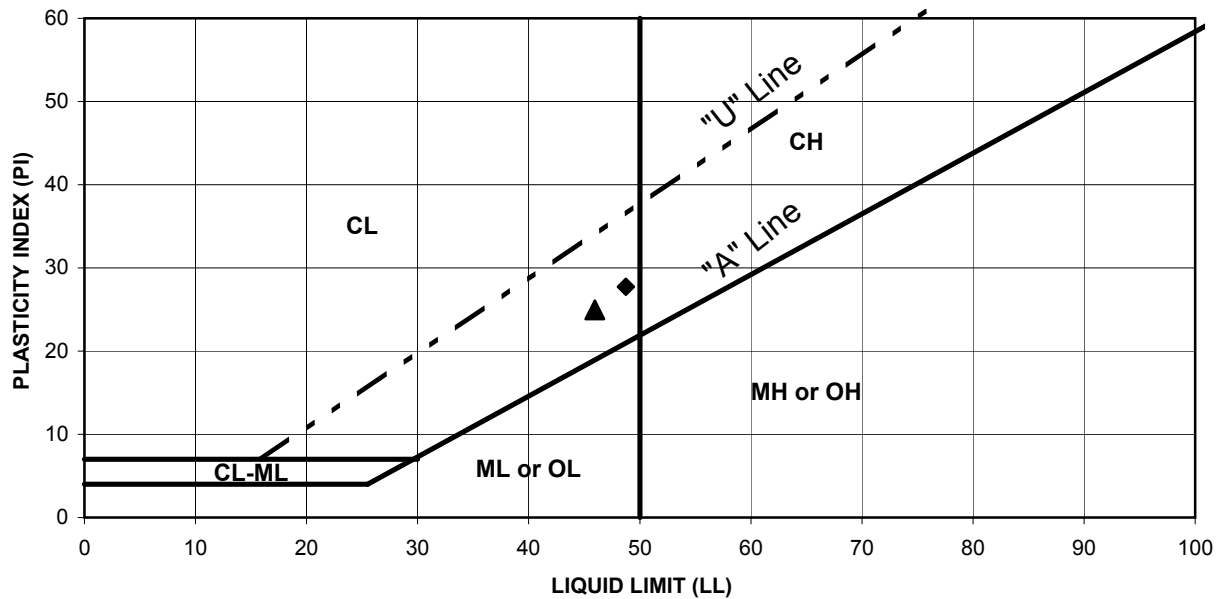


Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	Plasticity Chart Symbol
◆	RC-13-007	C34	162-162.8	49	21	28	CL
▲	RC-13-007	C47	215-215.8	44	22	22	CL



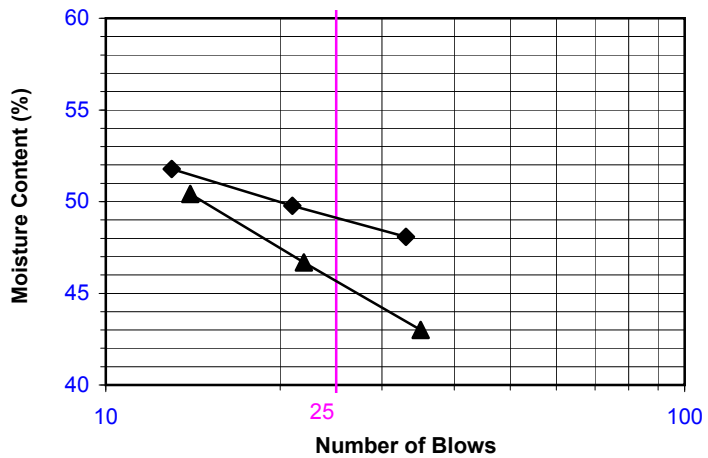
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/02/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 04/26/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



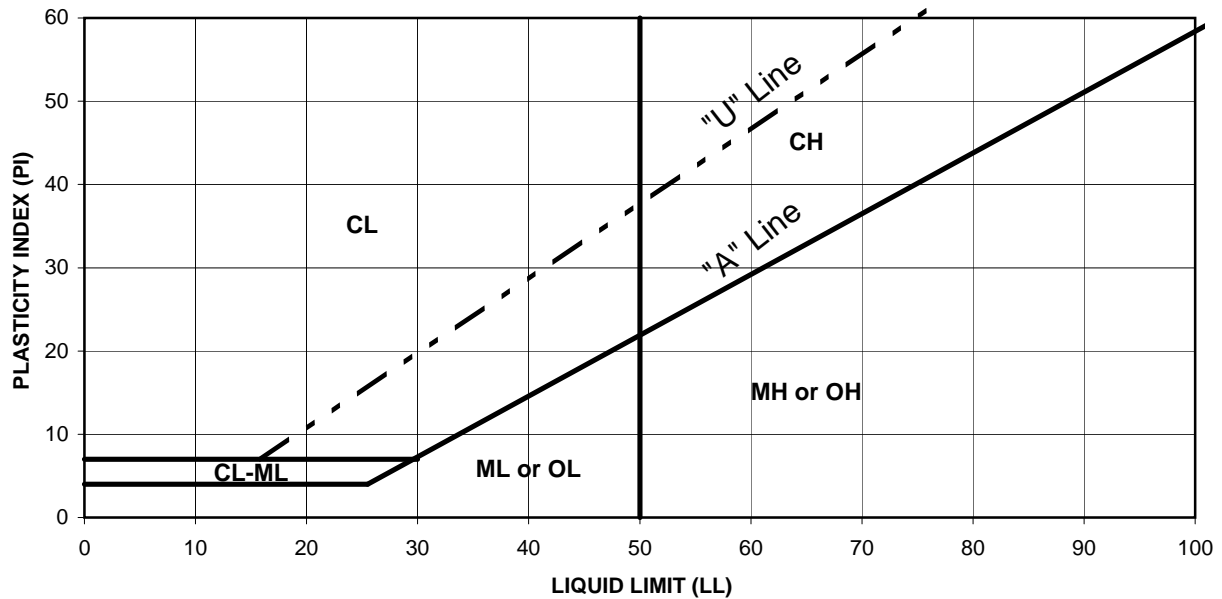
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◆	RC-13-007	C37	172.9-173.6	49	21	28	CL
▲	RC-13-007	C42	192.2-193.1	46	21	25	CL





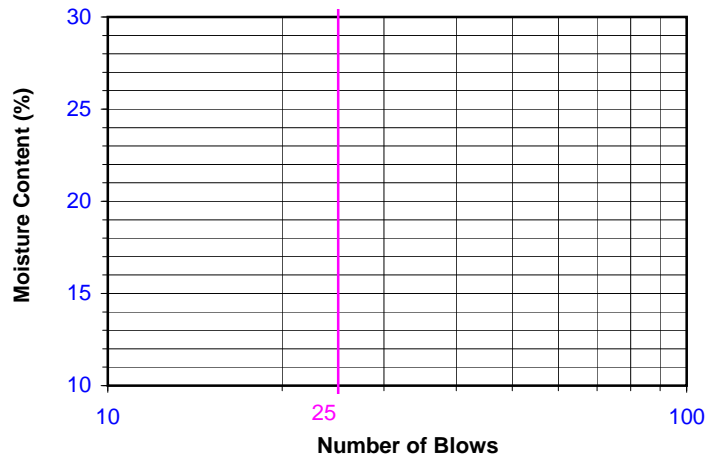
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 05/07/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/10/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



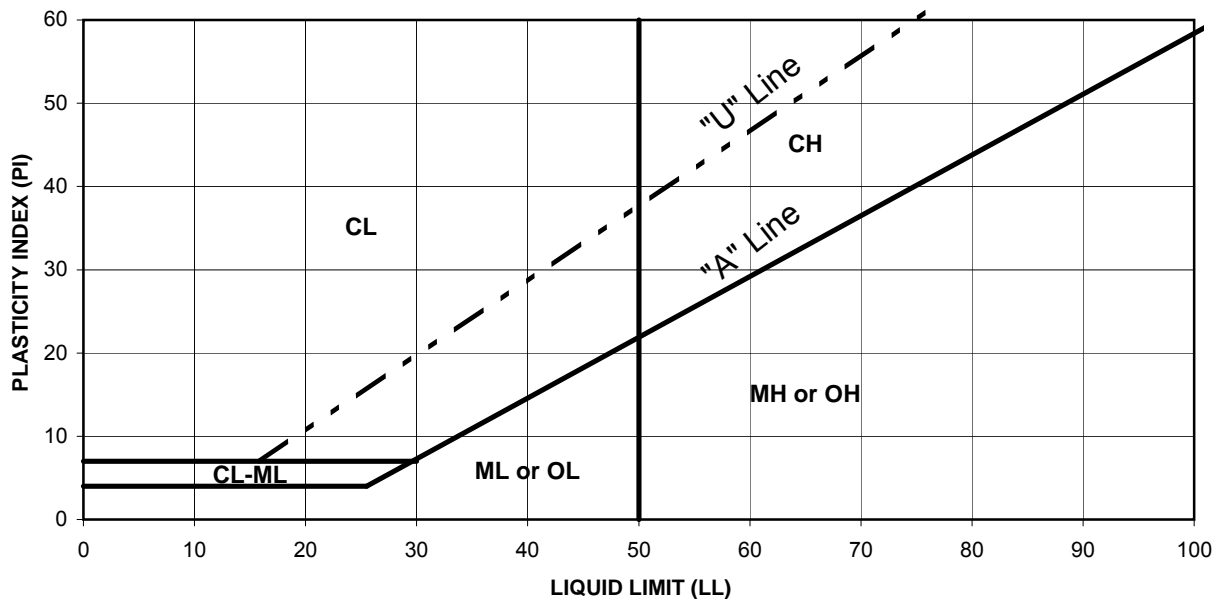
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	A-13-008	S02	5-6.5	NP	NP	NP	

\* NP denotes "non-plastic"



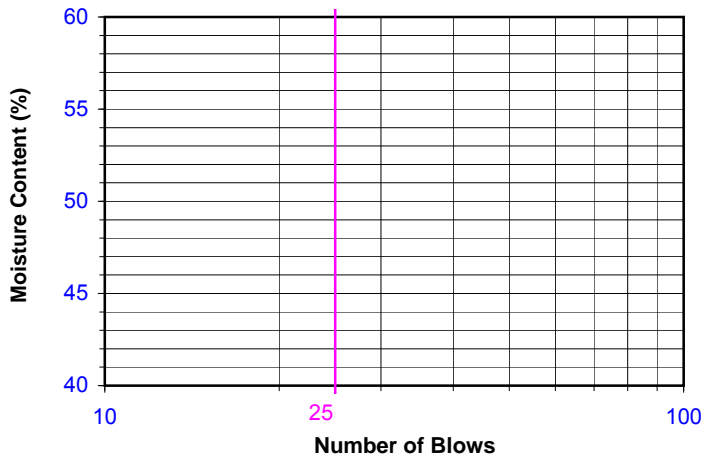
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 06/28/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 07/03/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



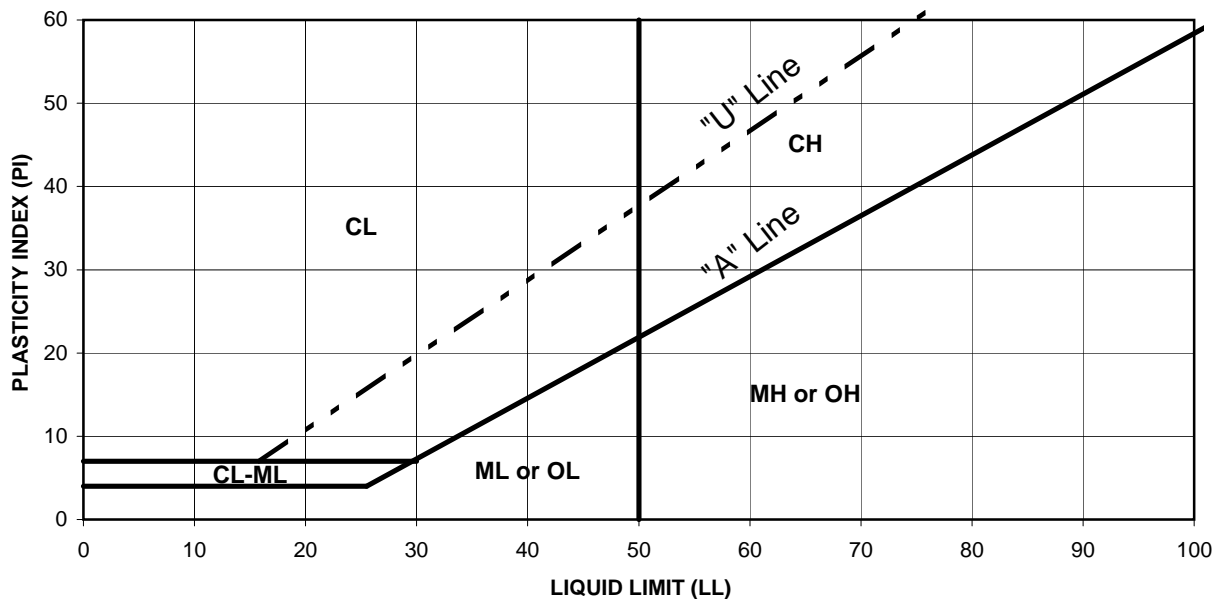
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	RC-13-009	S08	35	NP	NP	NP	
	RC-13-009	S18	85	NP	NP	NP	

\* NP denotes "non-plastic"



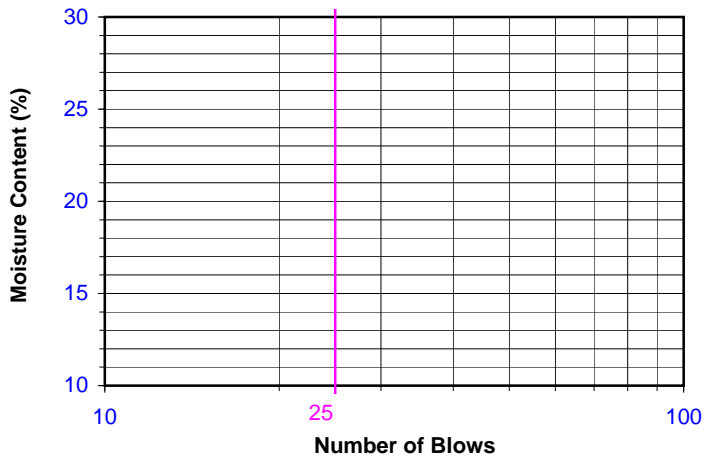
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/29/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/07/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
	RC-13-009	S11	50	NP	NP	NP	

\* NP denotes "non-plastic"

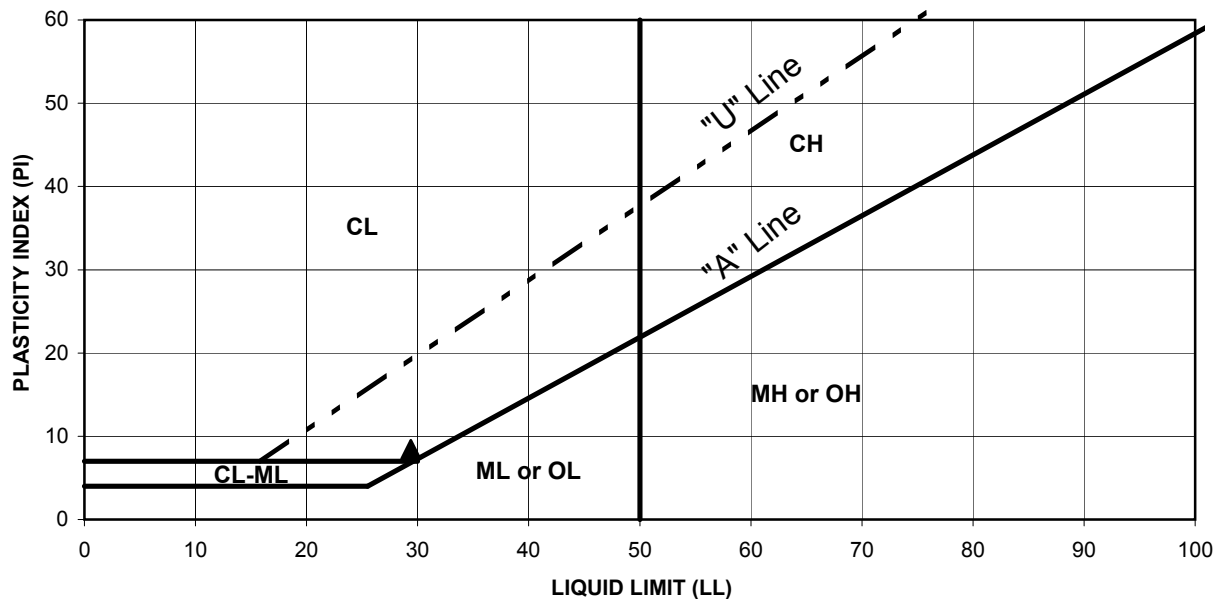






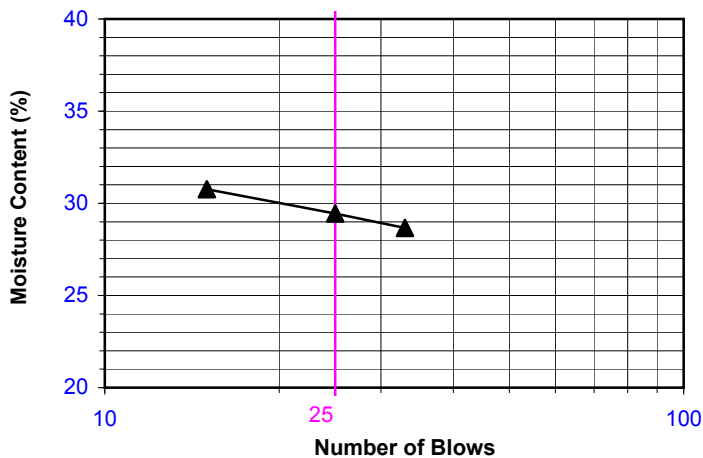
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 05/09/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/14/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
	O-13-010	O30	117-120	NP	NP	NP	
▲	O-13-010	O34	143-144	29	21	8	CL

\* NP denotes "non-plastic"



**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR710 North Study

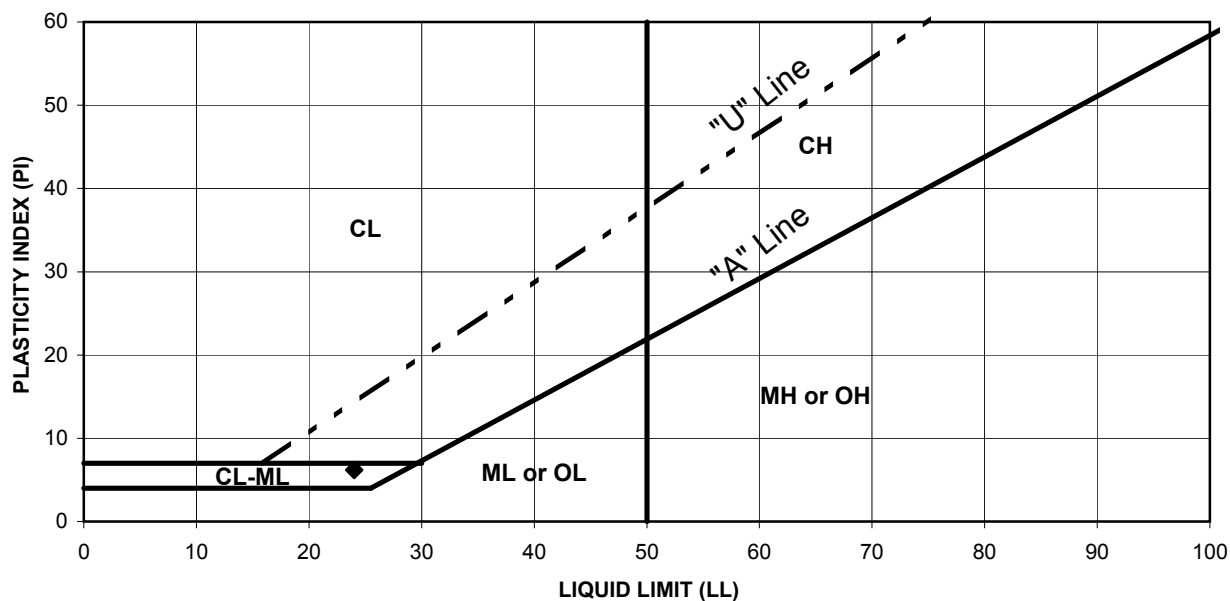
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Date: 09/09/13

Project No.: 133978

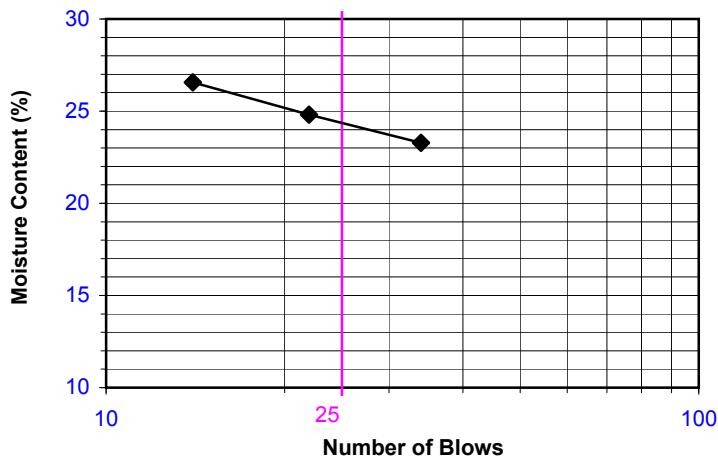
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Date: 09/20/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	Plasticity Chart Symbol
◆	O-13-010	O33	130	24	18	6	CL-ML
	O-13-010	O35	150	NP	NP	NP	

\* NP denotes "non-plastic"



**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR710 North Study

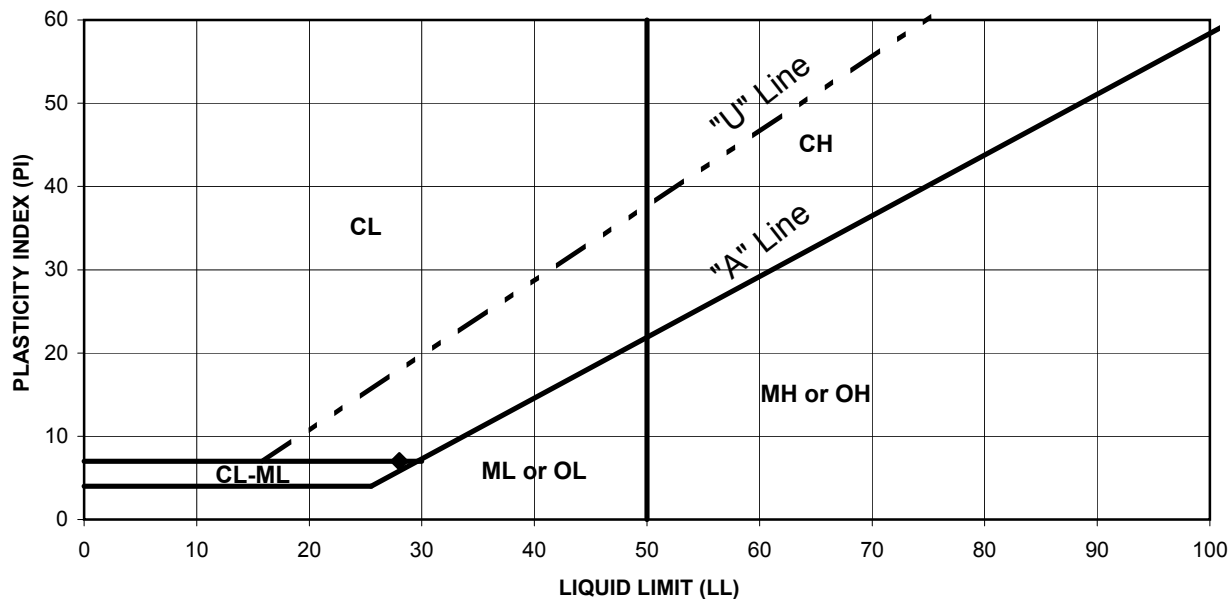
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Date: 09/09/13

Project No.: 133978

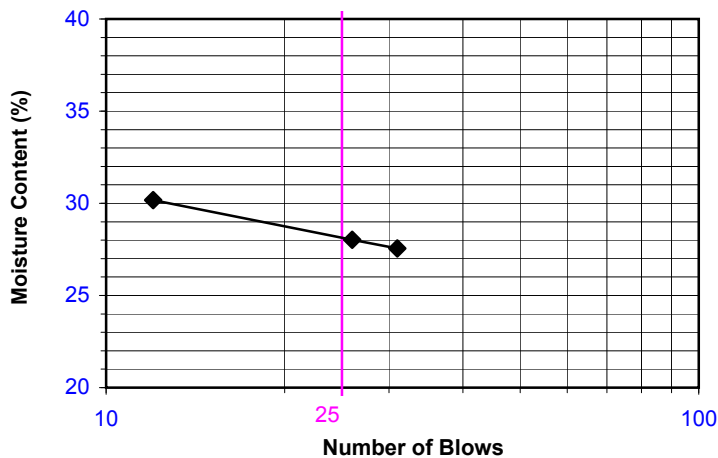
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Date: 09/20/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	Plasticity Chart Symbol
◆	O-13-010	O37	165.5	28	21	7	CL
	O-13-010	O39	180	NP	NP	NP	

\* NP denotes "non-plastic"



**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR710 North Study

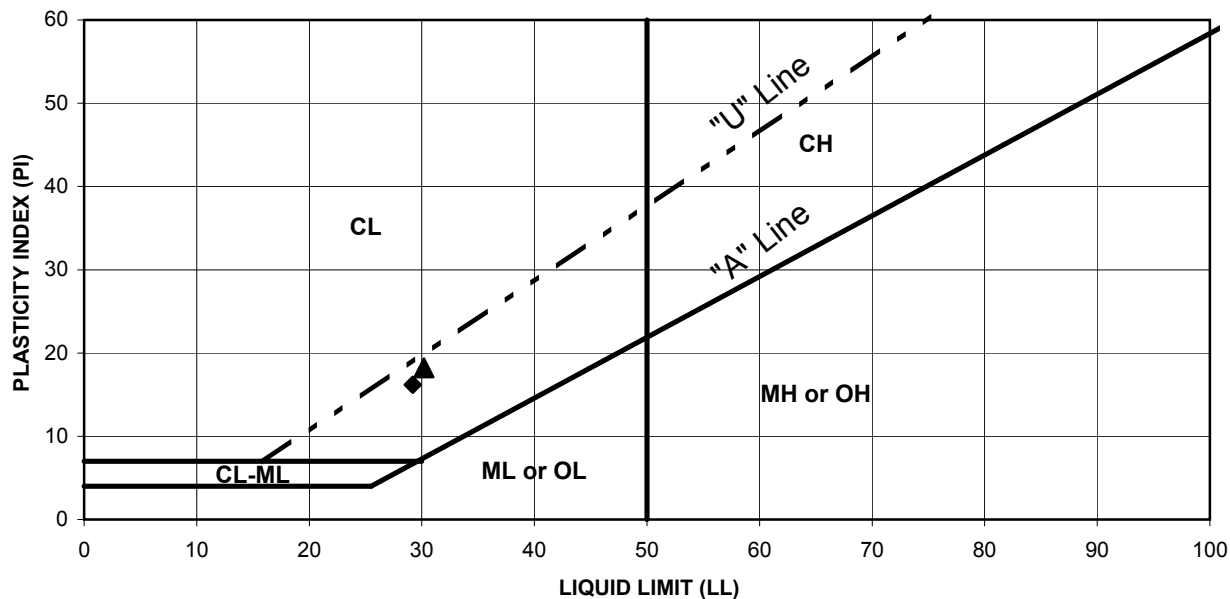
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Date: 09/09/13

Project No.: 133978

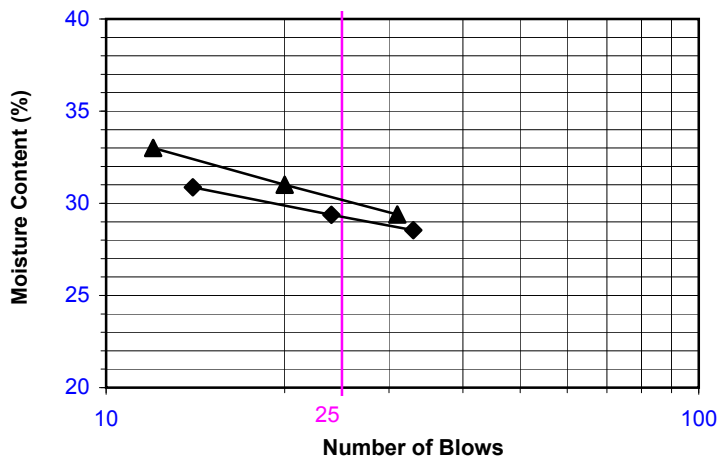
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Date: 09/20/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test

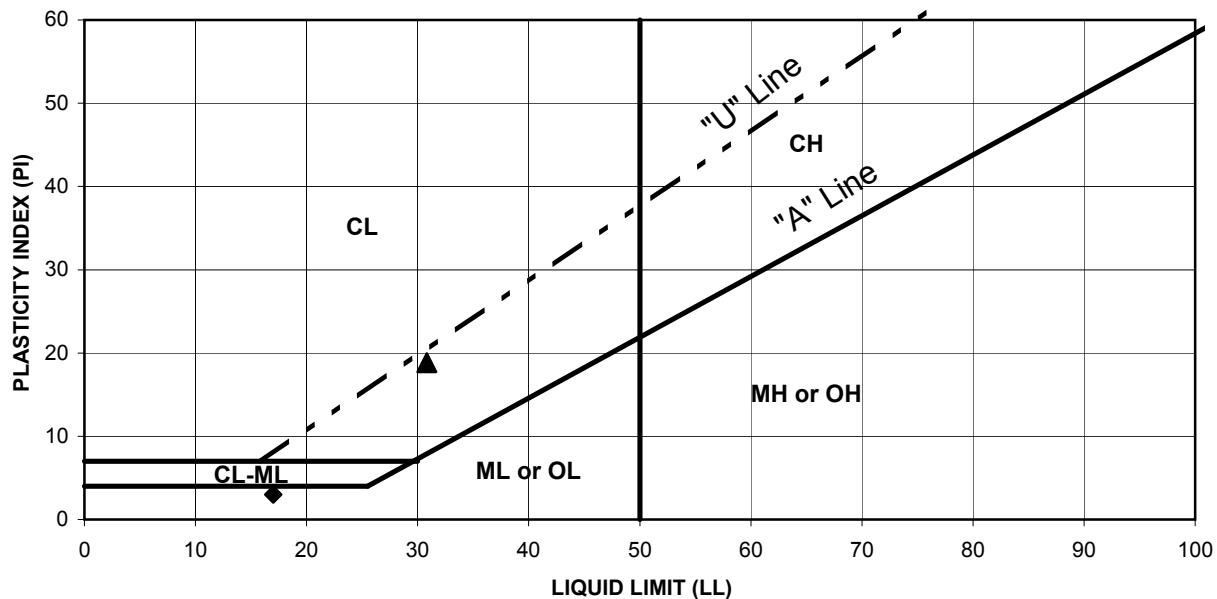


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◆	O-13-010	O40	191	29	13	16	CL
▲	O-13-010	O42	210	30	12	18	CL



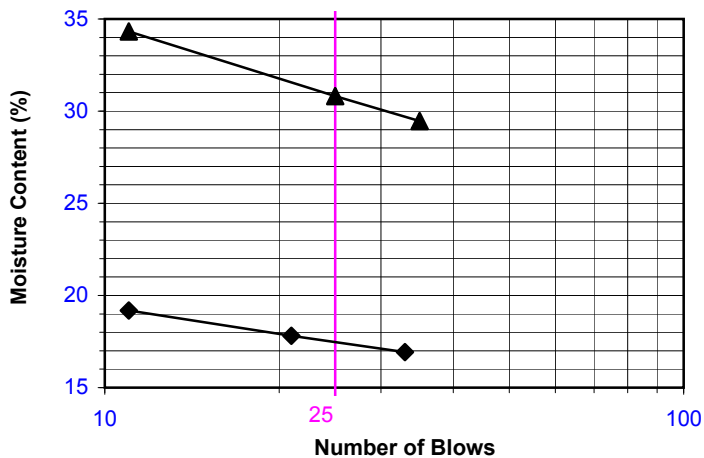
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 05/09/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/14/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



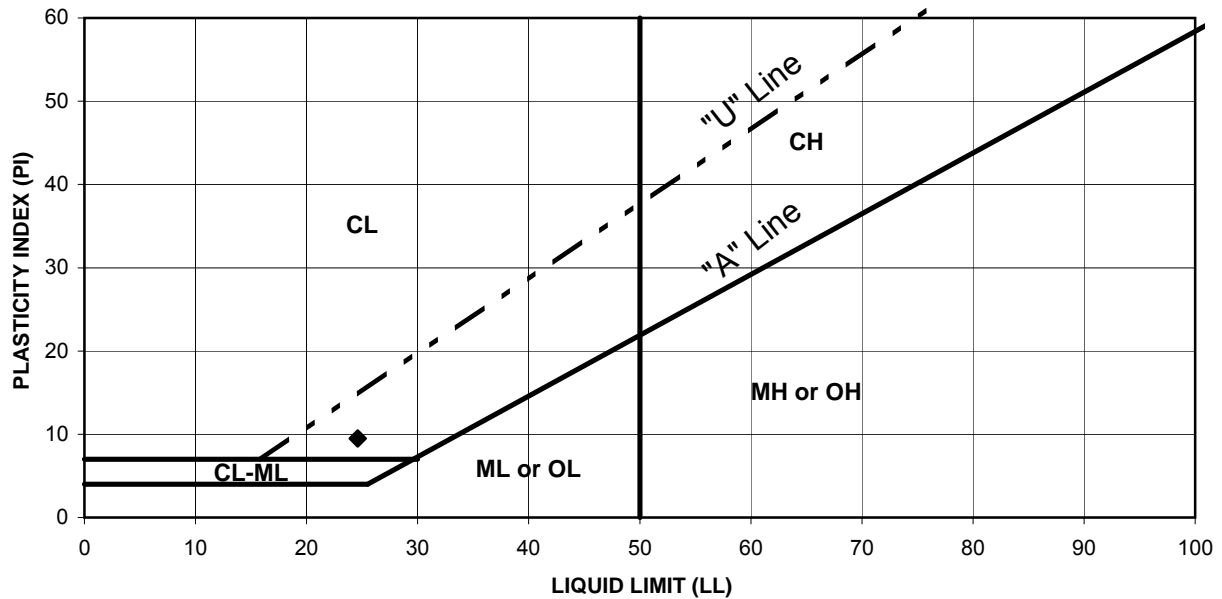
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◆	O-13-010	O41	198-199	17	14	3	ML
▲	O-13-010	O47	243-244	31	12	19	CL





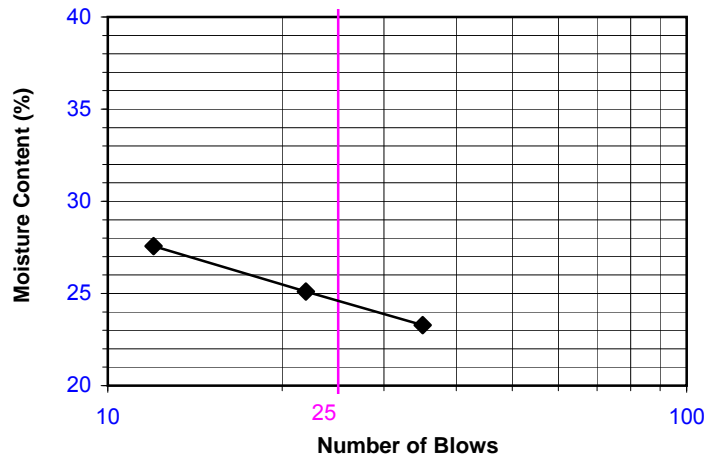
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 05/10/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/17/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	A-13-015	O01	5-6	25	15	10	CL
	A-13-015	O16	75-76	NP	NP	NP	

\* NP denotes "non-plastic"

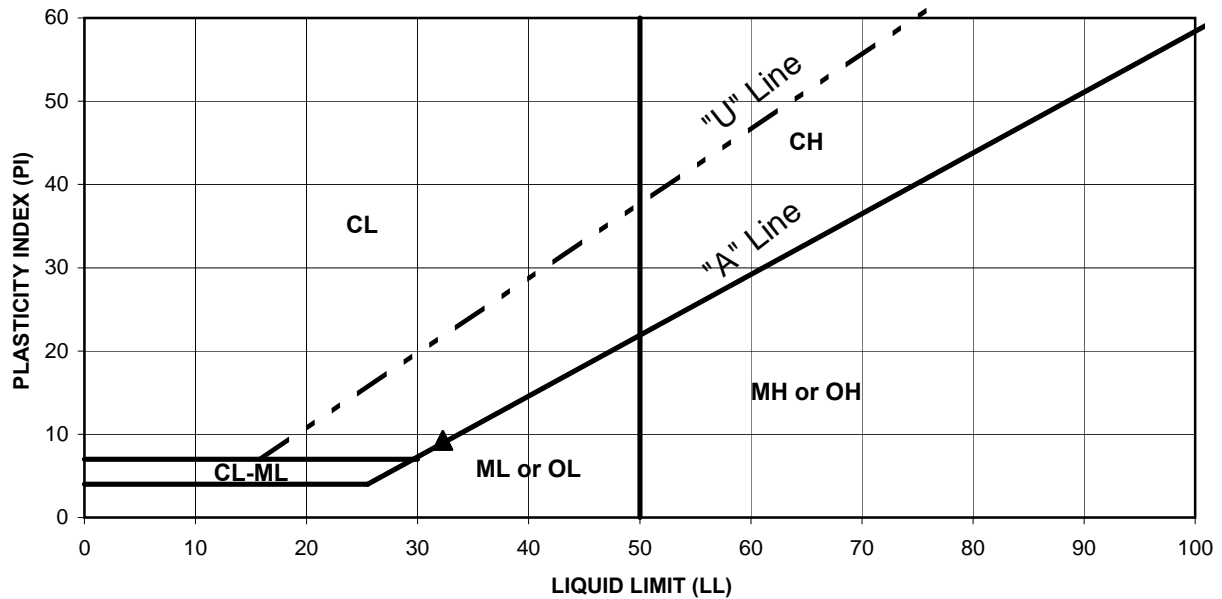






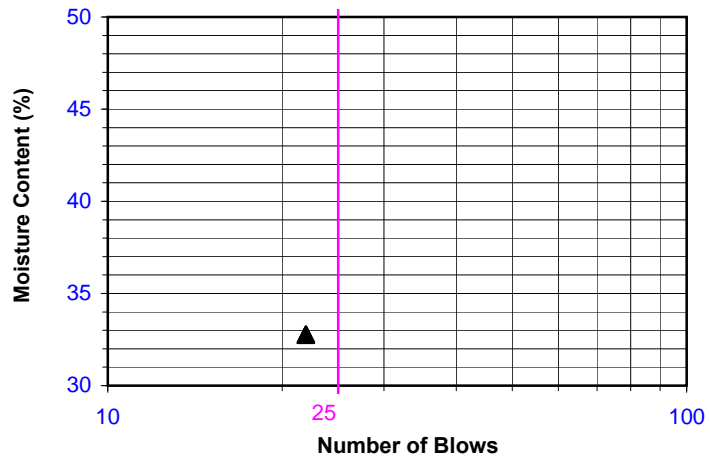
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 06/28/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 07/03/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
	A-13-020	S12	55	NP	NP	NP	
▲	A-13-020	S31	140	32	23	9	CL

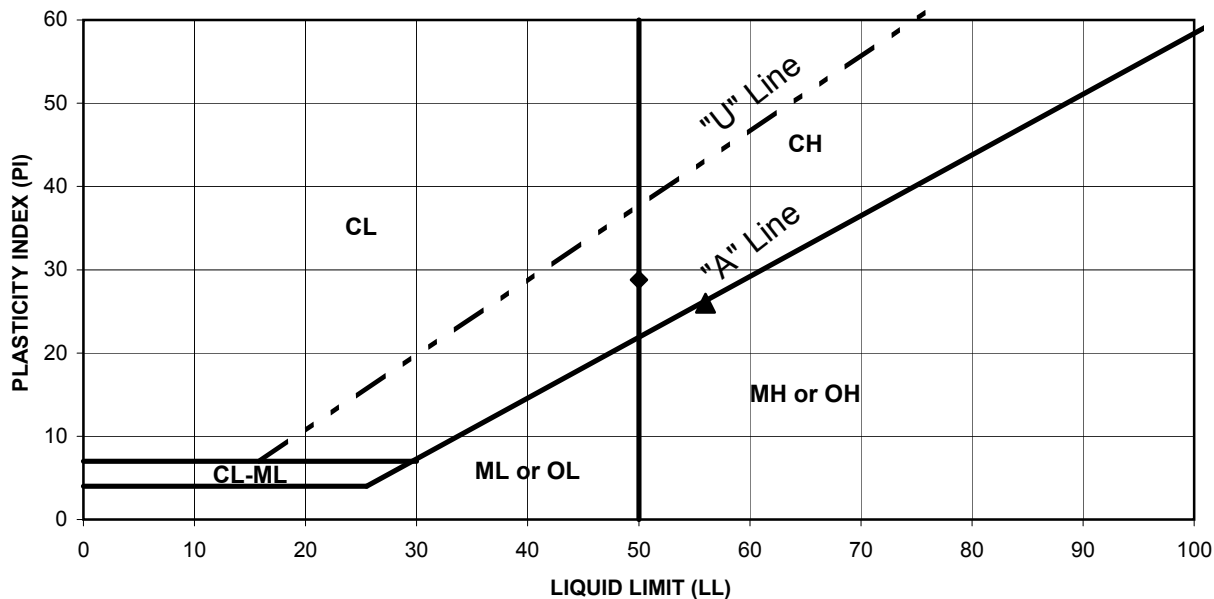
\* NP denotes "non-plastic"





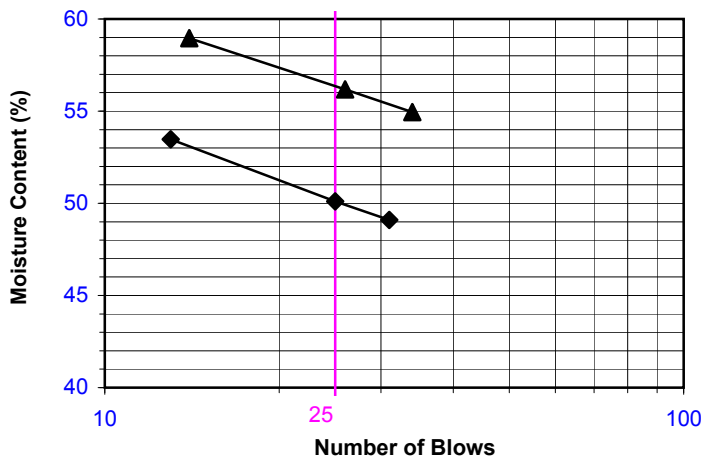
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ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 04/22/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/11/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



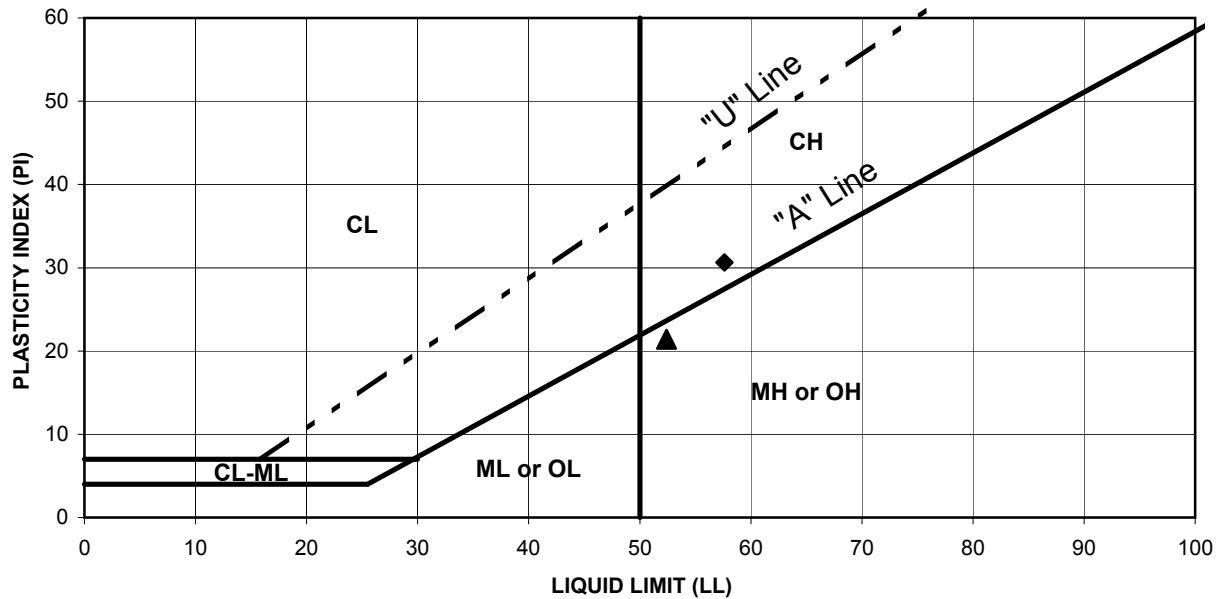
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▲	A-13-021	S09	40	56	30	26	CH



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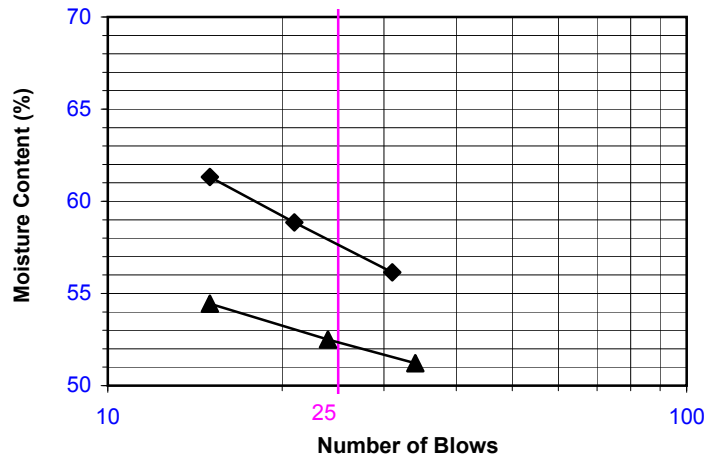
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Project Name: SR-710 North Study Tested By: DK Date: 04/22/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/11/13



**PROCEDURE USED**

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test

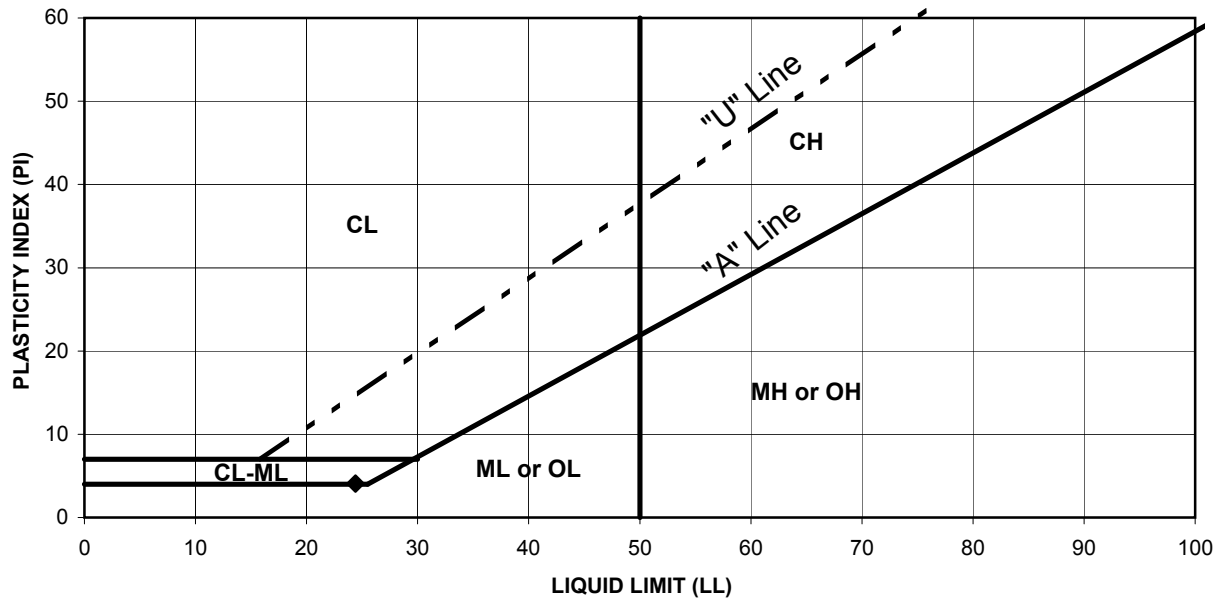


Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	A-13-021	S15	70	58	27	31	CH
▲	A-13-021	S19	90	52	31	21	MH



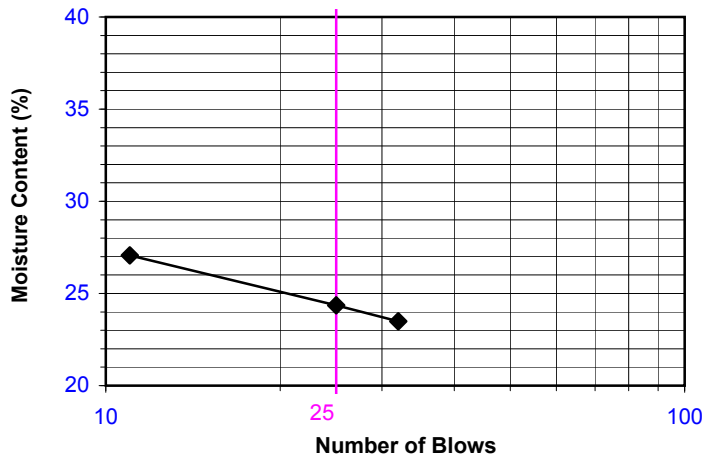
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 05/09/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/14/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	O-13-023	O25	99-100	24	20	4	CL-ML
	O-13-023	O32	142-143	NP	NP	NP	

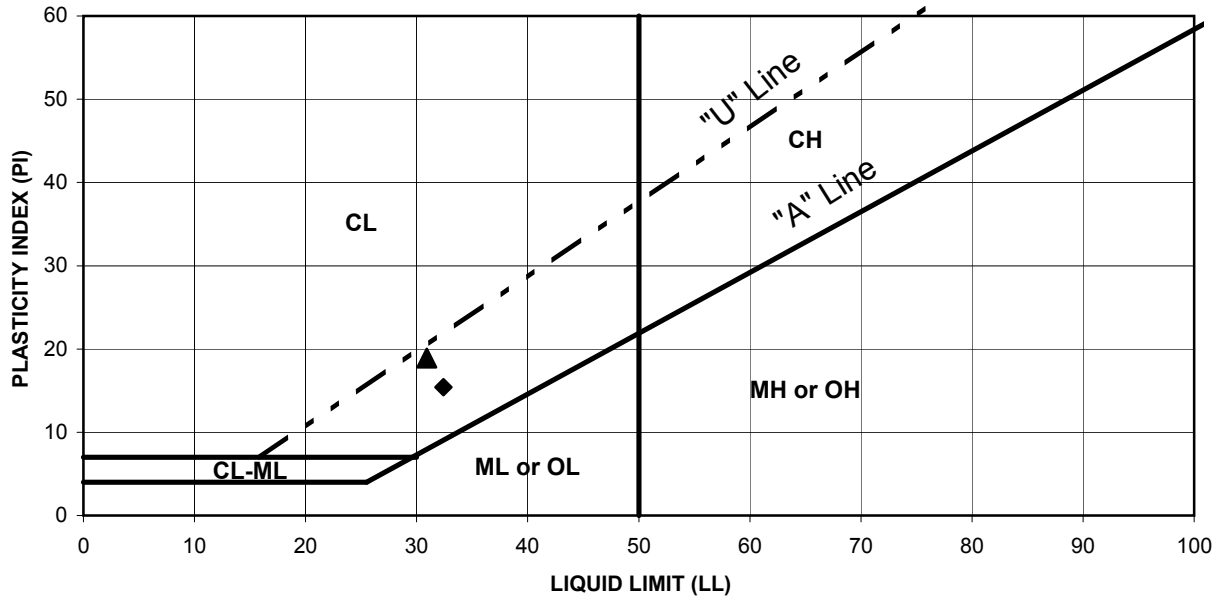
\* NP denotes "non-plastic"



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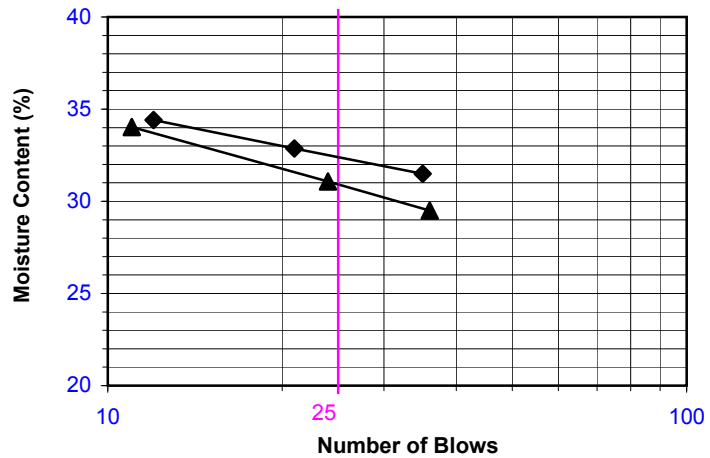
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 05/09/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/14/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	O-13-023	O39	200-201	32	17	15	CL
▲	O-13-023	O40	218-219	31	12	19	CL

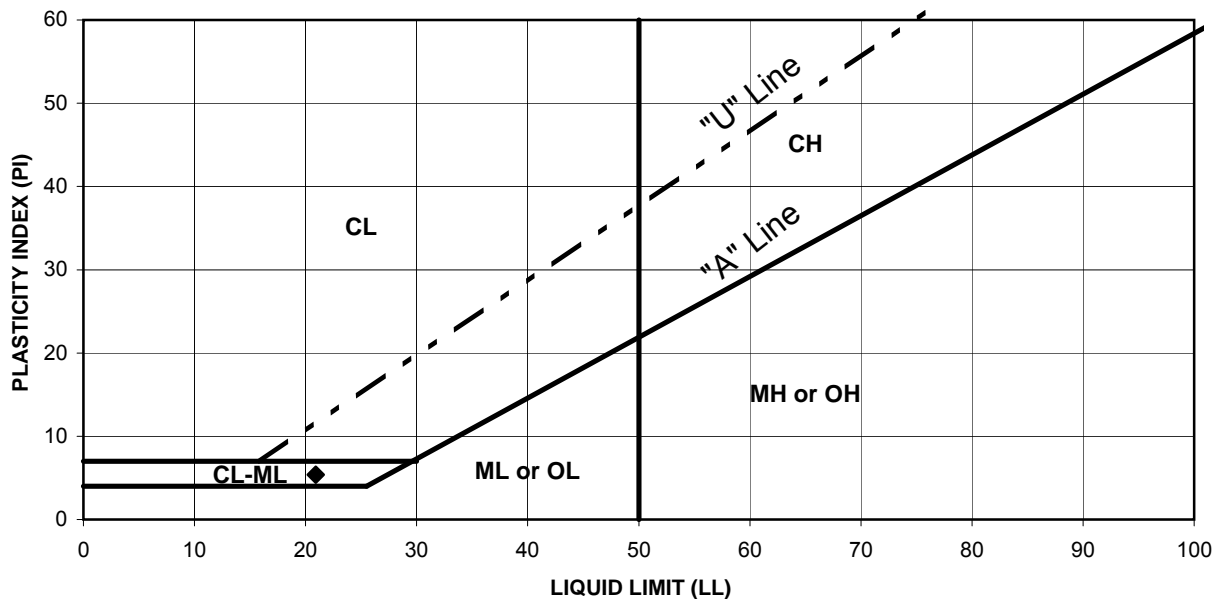






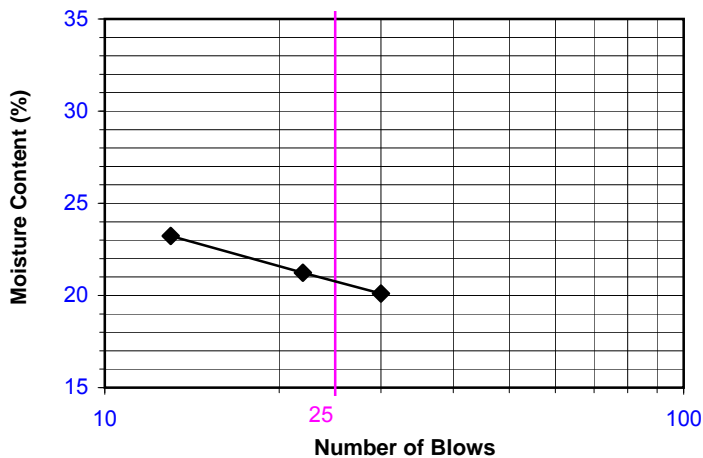
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 05/17/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/23/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	A-13-025	O05	25-26	21	16	5	CL-ML
	A-13-025	O07	35-36	NP	NP	NP	

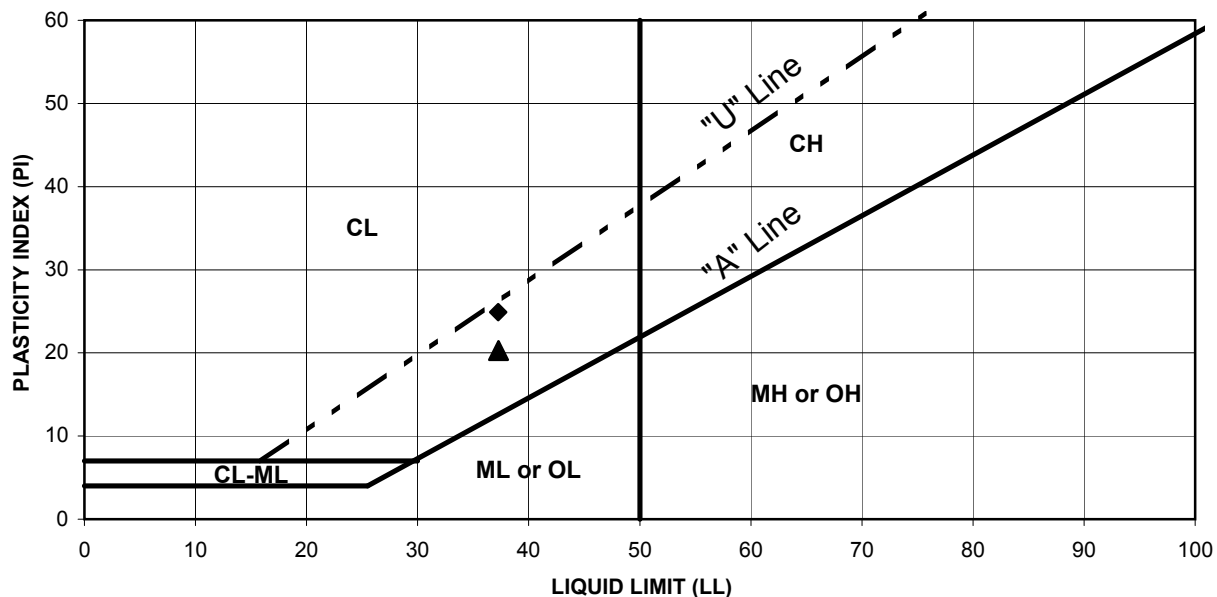
\* NP denotes "non-plastic"





**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 05/17/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/23/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test

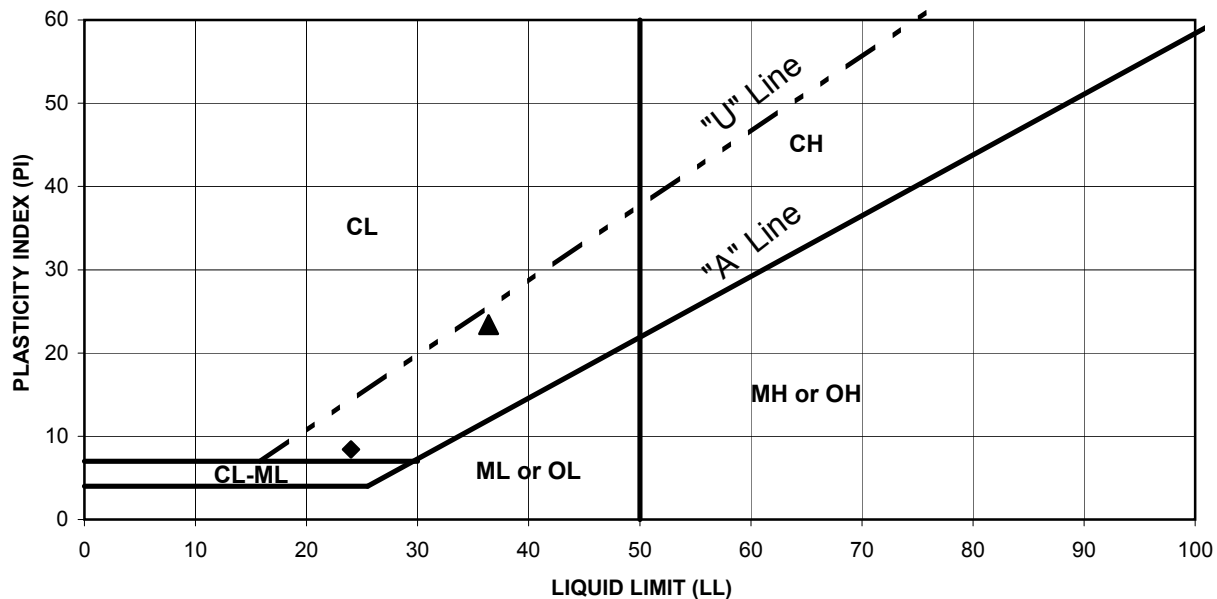


Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	A-13-027	O15	75-76	37	12	25	CL
▲	A-13-027	O19	95-96	37	17	20	CL



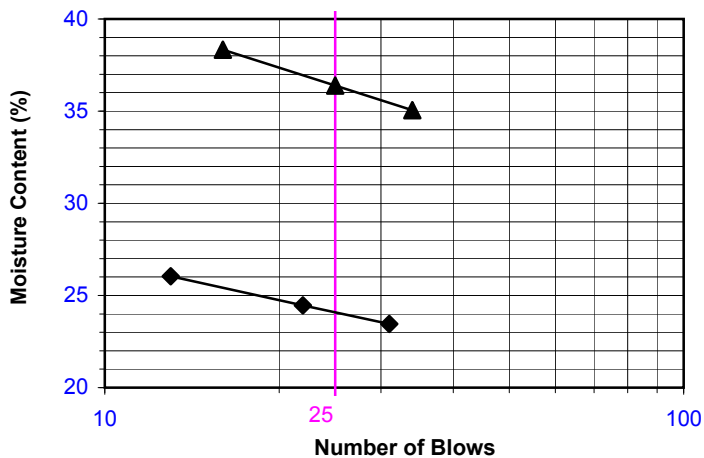
**ATTERBERG LIMITS  
ASTM D 4318**

Project Name: SR-710 North Study Tested By: DK Date: 05/13/13  
 Project No.: 428908.02.14.00.03.02 Checked By: AP Date: 05/17/13



PROCEDURE USED

- Wet Preparation
- Dry Preparation
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	U.S.C.S Symbol
◆	A-13-034	O01	5-6	24	16	8	CL
▲	A-13-034	O19	65-66	36	13	23	CL





### CORROSION TEST RESULTS

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02

AP Job No.: 13-0370  
 Date: 04/02/13

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
A-13-001	S02	5	CL	1431	7.7	9	5

NOTES: Resistivity Test and pH: California Test Method 643  
 Sulfate Content : California Test Method 417  
 Chloride Content : California Test Method 422  
 ND = Not Detectable  
 NA = Not Sufficient Sample  
 NR = Not Requested



### CORROSION TEST RESULTS

Client Name: CH2M Hill  
Project Name: SR-710 North Study  
Project No.: 428908.02.14.00.03.02

AP Job No.: 13-0430  
Date: 04/18/13

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
RC-13-002	B01	1-5	CL	1142	7.7	380	180

NOTES: Resistivity Test and pH: California Test Method 643  
Sulfate Content : California Test Method 417  
Chloride Content : California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested



AP Engineering & Testing, Inc.

## CORROSION TEST RESULTS

Client Name: CH2M Hill  
Project Name: SR-710 North Study  
Project No.: 428908.02.14.00.03.02

AP Job No.: 13-0430  
Date: 05/01/13

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
RC-13-003	S03	10	CL	1154	7.9	60	61

NOTES: Resistivity Test and pH: California Test Method 643  
Sulfate Content : California Test Method 417  
Chloride Content : California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested





### CORROSION TEST RESULTS

Client Name: CH2M Hill  
Project Name: SR-710 North Study  
Project No.: 428908.02.14.00.03.02

AP Job No.: 13-0430  
Date: 04/19/13

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
RC-13-004	B01	0-5	SC	2541	7.6	101	60
RC-13-004	S06	25	SC	1853	7.7	137	48

NOTES: Resistivity Test and pH: California Test Method 643  
Sulfate Content : California Test Method 417  
Chloride Content : California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested



### CORROSION TEST RESULTS

Client Name: CH2M Hill  
Project Name: SR-710 North Study  
Project No.: 428908.02.14.00.03.02

AP Job No.: 13-0370  
Date: 04/11/13

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
RC-13-005	S10	45-46.5	CH	1137	7.1	23	8
RC-13-005	C22	99.5-99.9	ML	2057	7.9	63	21

NOTES: Resistivity Test and pH: California Test Method 643  
Sulfate Content : California Test Method 417  
Chloride Content : California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested



### CORROSION TEST RESULTS

Client Name: CH2M Hill  
Project Name: SR-710 North Study  
Project No.: 428908.02.14.00.03.02

AP Job No.: 13-0430  
Date: 04/25/13

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
R-13-006	S15	70	CL	1614	7.4	18	31
R-13-006	S19A	90	CH	2645	8.0	29	10

NOTES: Resistivity Test and pH: California Test Method 643  
Sulfate Content : California Test Method 417  
Chloride Content : California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested



### CORROSION TEST RESULTS

Client Name: CH2M Hill  
Project Name: SR-710 North Study  
Project No.: 428908.02.14.00.03.02

AP Job No.: 13-0430  
Date: 05/07/13

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
RC-13-007	C32	152.9-153.7	CL	690	7.1	1214	23
RC-13-007	C42	192.2-193.1	CL	466	7.4	2111	24

NOTES: Resistivity Test and pH: California Test Method 643  
Sulfate Content : California Test Method 417  
Chloride Content : California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested



### CORROSION TEST RESULTS

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02

AP Job No.: 13-0430  
 Date: 05/06/13

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
A-13-008	S15	70-71.5	SP-SM	41125	7.5	30	17

NOTES: Resistivity Test and pH: California Test Method 643  
 Sulfate Content : California Test Method 417  
 Chloride Content : California Test Method 422  
 ND = Not Detectable  
 NA = Not Sufficient Sample  
 NR = Not Requested



AP Engineering & Testing, Inc.

## CORROSION TEST RESULTS

Client Name: CH2M Hill  
Project Name: SR-710 North Study  
Project No.: 428908.02.14.00.03.02

AP Job No.: 13-0474  
Date: 05/01/13

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
RC-13-009	S30	142	Granite	6917	7.5	225	181
RC-13-009	C39	186.5-187.0	Ignous Rock	11021	7.9	130	82

NOTES: Resistivity Test and pH: California Test Method 643  
Sulfate Content : California Test Method 417  
Chloride Content : California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested



### CORROSION TEST RESULTS

Client Name: CH2M Hill  
Project Name: SR-710 North Study  
Project No.: 428908.02.14.00.03.02

AP Job No.: 13-0497  
Date: 05/07/13

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
O-13-010	O34	143-144	CL	5501	8.0	88	65
O-13-010	O41	198-199	SM	11048	7.8	74	144

NOTES: Resistivity Test and pH: California Test Method 643  
Sulfate Content : California Test Method 417  
Chloride Content : California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested



### CORROSION TEST RESULTS

Client Name: CH2M Hill  
Project Name: SR-710 North Study  
Project No.: 428908.02.14.00.03.02

AP Job No.: 13-0430  
Date: 04/16/13

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
A-13-020	S04	15	ML	5828	7.4	101	52
A-13-020	S10	45	SM	8435	8.0	22	18

NOTES: Resistivity Test and pH: California Test Method 643  
Sulfate Content : California Test Method 417  
Chloride Content : California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested





### CORROSION TEST RESULTS

Client Name: CH2M Hill  
Project Name: SR-710 North Study  
Project No.: 428908.02.14.00.03.02

AP Job No.: 13-0430  
Date: 05/07/13

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
A-13-021	S14	65	ML	1287	7.7	58	120
A-13-021	S18	85	ML	1290	8.0	42	35

NOTES: Resistivity Test and pH: California Test Method 643  
Sulfate Content : California Test Method 417  
Chloride Content : California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested



AP Engineering & Testing, Inc.

## CORROSION TEST RESULTS

Client Name: CH2M Hill  
Project Name: SR-710 North Study  
Project No.: 428908.02.14.00.03.02

AP Job No.: 13-0497  
Date: 05/07/13

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
O-13-023	O32	142-143	ML	9131	7.6	41	15
O-13-023	O39	200-201	CL	3821	7.8	43	60

NOTES: Resistivity Test and pH: California Test Method 643  
Sulfate Content : California Test Method 417  
Chloride Content : California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/01/13  
 Boring No.: A-13-001 Checked By AP Date: 04/15/13  
 Sample No.: S08 Depth (ft): 35  
 Description: Silty Sand  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	587.12
Total Ring Weight (g)	135.44
Wet Density (pcf)	125.21
Dry Density (pcf)	106.33

Moisture Determination	Before Test	After Test
Cont. Weight (g)	147.86	149.10
Wet Soil+Cont. (g)	289.89	615.82
Dry Soil+Cont. (g)	268.48	535.21
Moisture Content (%)	17.7	20.9
Degree Saturation	81.9	99.5

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

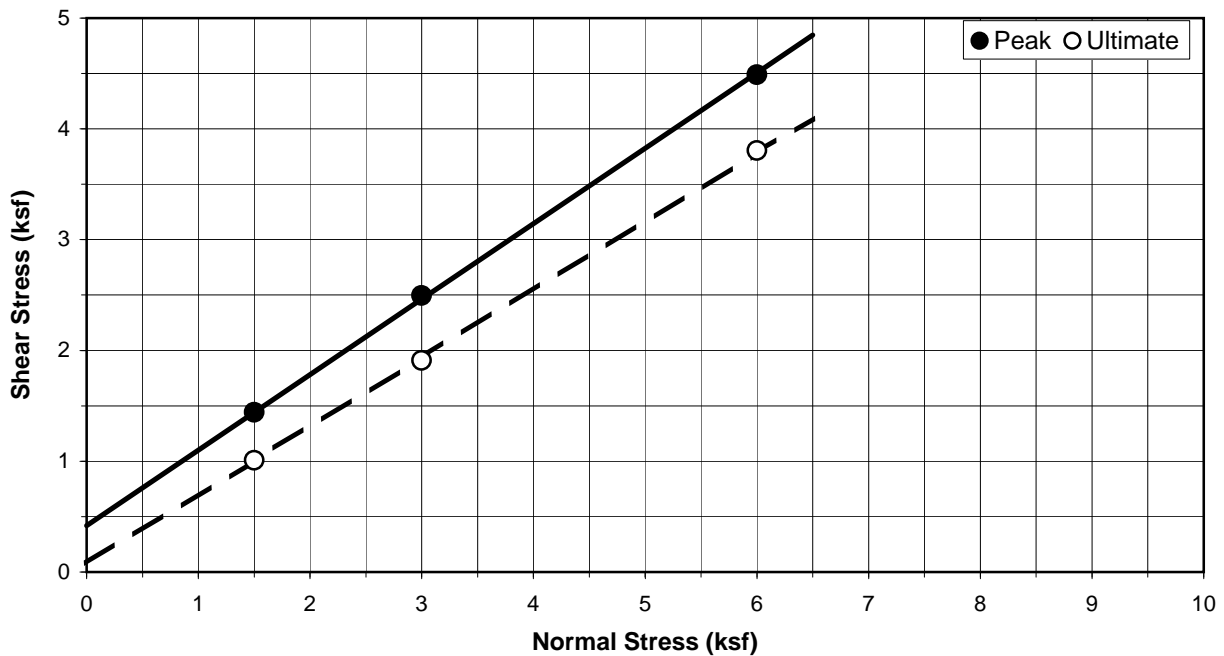
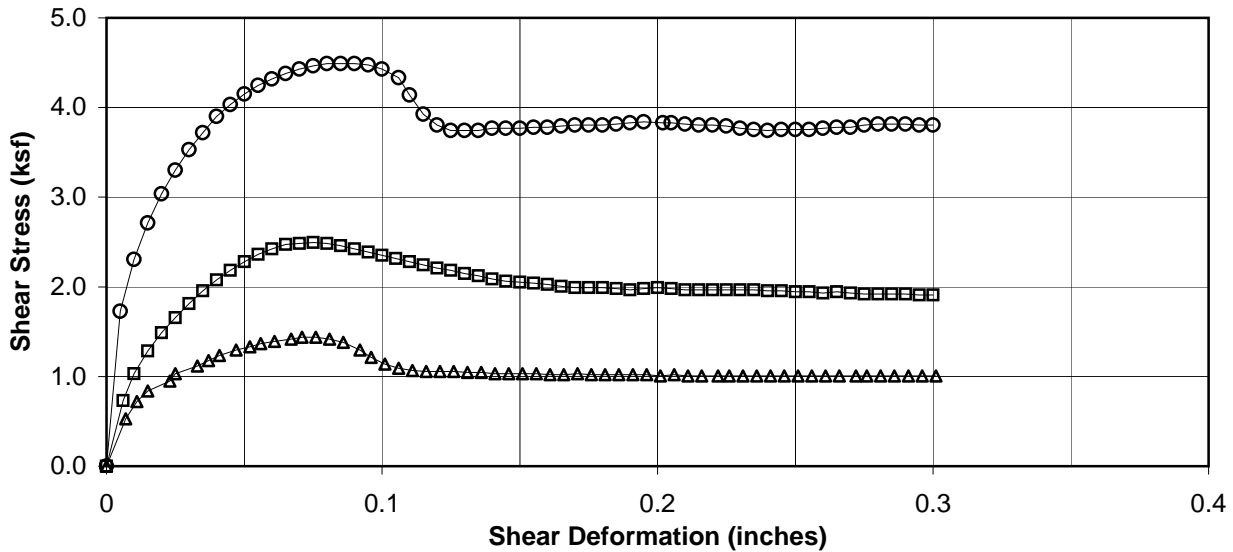
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	194.17	45.60	1.5	1440	1008	
2	194.98	44.39	3.0	2496	1908	
3	197.97	45.45	6.0	4488	3804	



**DIRECT SHEAR TEST RESULTS**  
**ASTM D 3080**

Project Name: SR-710 North Study  
 Boring No.: A-13-001  
 Sample No.: S08  
 Depth (ft): 35  
 Sample Type: Mod. Cal.  
 Soil Description: Silty Sand  
 Test Condition: Inundated

Initial Dry Density: 106.3 pcf  
 Moisture Content (before): 17.7 %  
 Moisture Content (after): 20.9 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	400	100
Friction Angle:	34 °	32 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/02/13  
 Boring No.: A-13-001 Checked By AP Date: 04/15/13  
 Sample No.: S12 Depth (ft): 55  
 Description: Silty Sand, fine grained  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	509.66
Total Ring Weight (g)	134.51
Wet Density (pcf)	103.99
Dry Density (pcf)	99.98

Moisture Determination	Before Test	After Test
Cont. Weight (g)	49.55	149.46
Wet Soil+Cont. (g)	155.22	538.37
Dry Soil+Cont. (g)	151.14	467.56
Moisture Content (%)	4.0	22.3
Degree Saturation	15.8	90.1

**METHOD OF SHEARING**

Regular Shearing Shear Rate (in/min): 0.02  
 Residual Shearing 5 Passes Shear Distance (in): 0.3

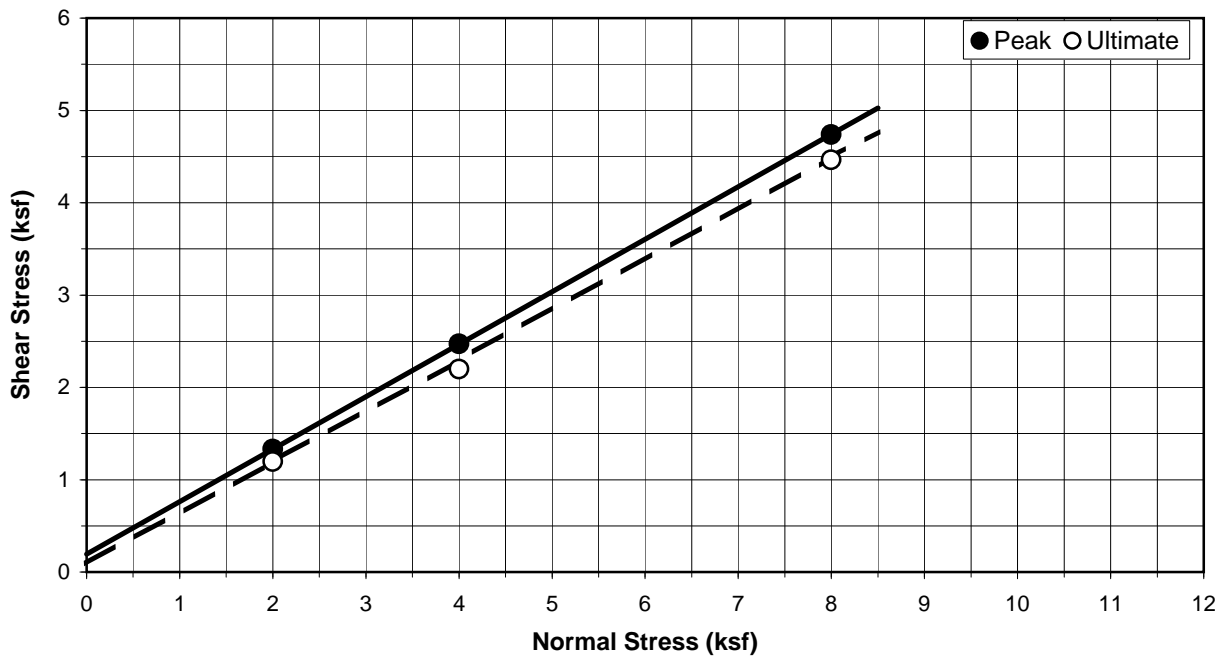
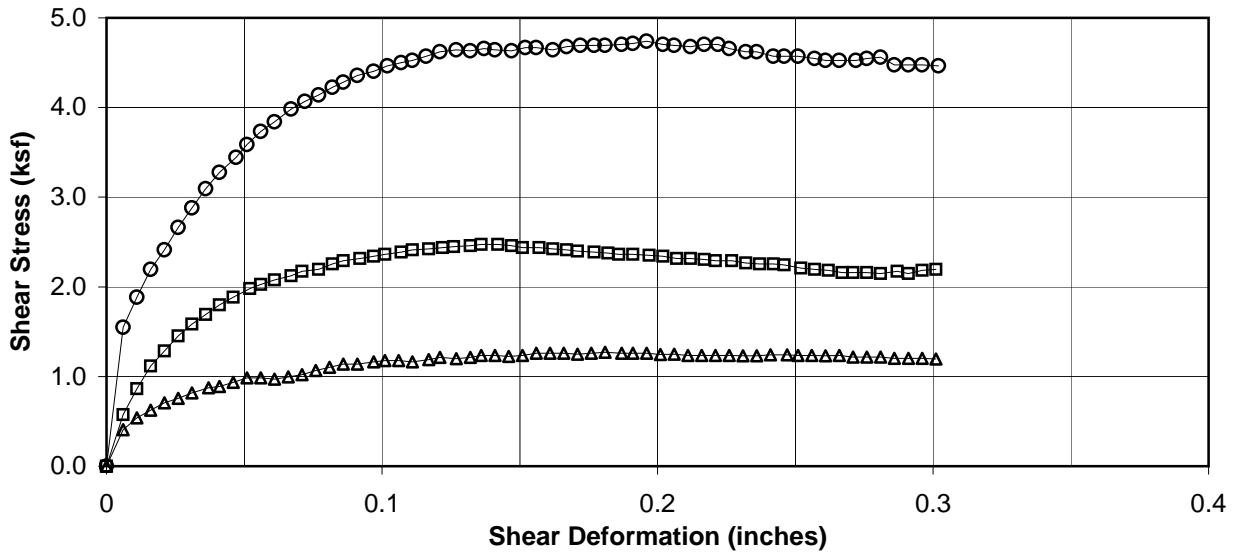
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	167.41	43.87	2.0	1332	1195	
2	169.83	45.31	4.0	2472	2196	
3	172.42	45.33	8.0	4740	4464	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: A-13-001  
 Sample No.: S12  
 Depth (ft): 55  
 Sample Type: Mod. Cal.  
 Soil Description: Silty Sand, fine grained  
 Test Condition: Inundated

Initial Dry Density: 100.0 pcf  
 Moisture Content (before): 4.0 %  
 Moisture Content (after): 22.3 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	200	100
Friction Angle:	30 °	29 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/02/13  
 Boring No.: A-13-001 Checked By AP Date: 04/15/13  
 Sample No.: S18 Depth (ft): 85  
 Description: Lean Clay  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	626.72
Total Ring Weight (g)	135.90
Wet Density (pcf)	136.06
Dry Density (pcf)	117.08

Moisture Determination	Before Test	After Test
Cont. Weight (g)	141.82	149.25
Wet Soil+Cont. (g)	359.38	657.05
Dry Soil+Cont. (g)	329.04	588.55
Moisture Content (%)	16.2	15.6
Degree Saturation	99.5	100.1

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.005

Shear Distance (in): 0.3

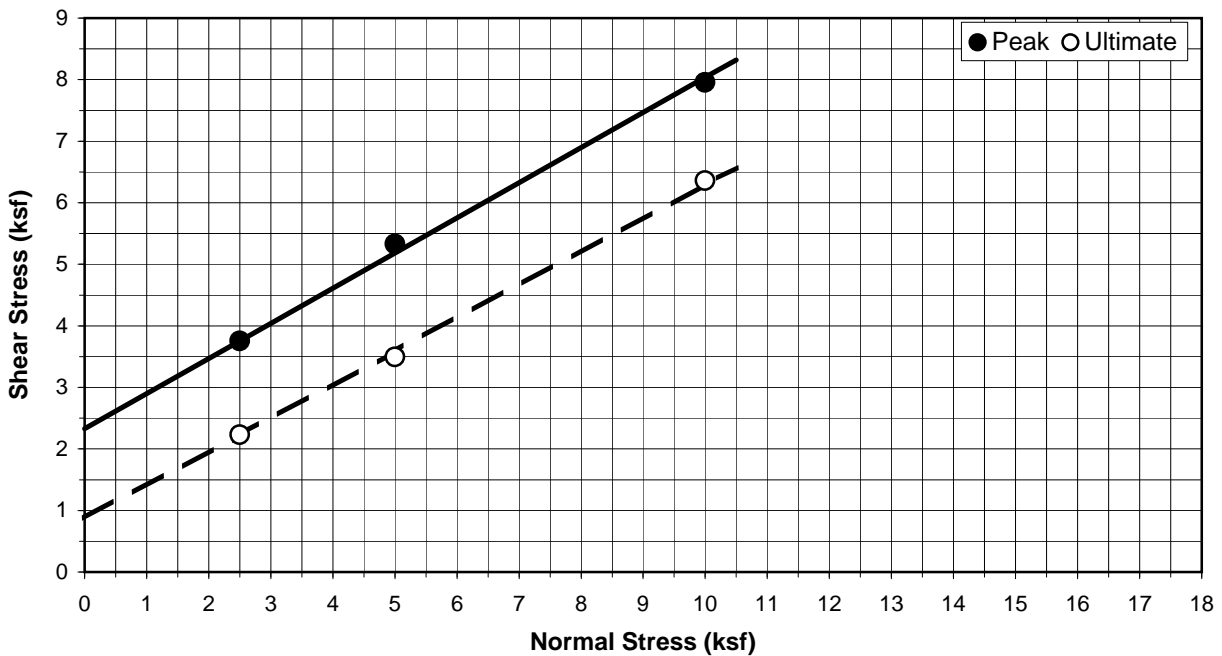
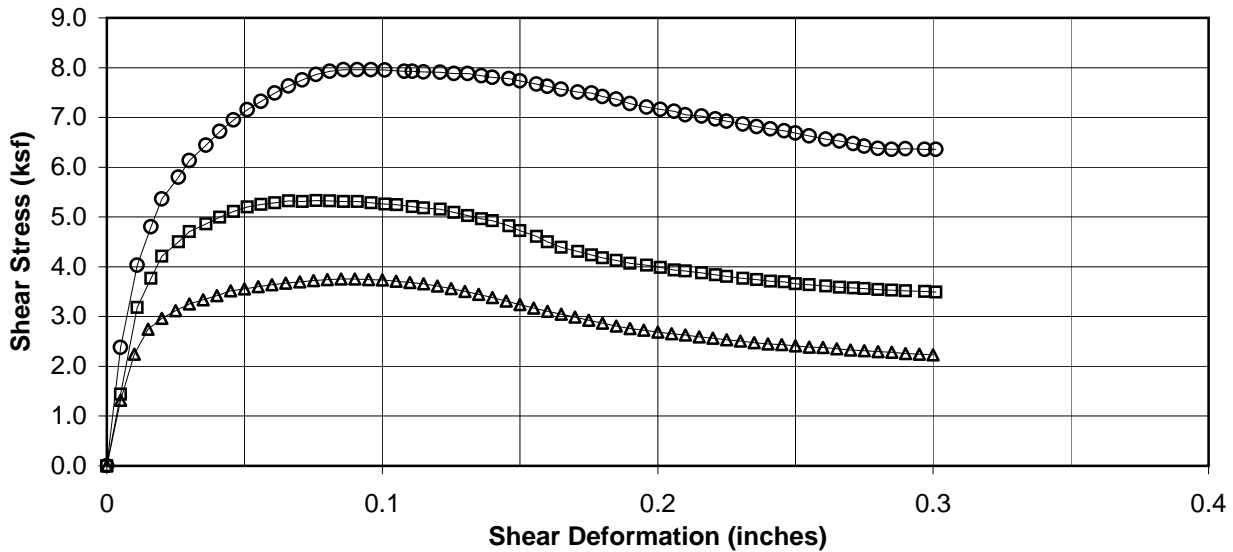
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	209.32	45.24	2.5	3756	2232	
2	209.74	45.38	5.0	5328	3492	
3	207.66	45.28	10.0	7956	6360	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: A-13-001  
 Sample No.: S18  
 Depth (ft): 85  
 Sample Type: Mod. Cal.  
 Soil Description: Lean Clay  
 Test Condition: Inundated

Initial Dry Density: 117.1 pcf  
 Moisture Content (before): 16.2 %  
 Moisture Content (after): 15.6 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	2350	900
Friction Angle:	30 °	28 °





**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/23/13  
 Boring No.: RC-13-003 Checked By AP Date: 05/07/13  
 Sample No.: S02 Depth (ft): 5  
 Description: Claystone /Siltstone  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	554.86
Total Ring Weight (g)	135.34
Wet Density (pcf)	116.29
Dry Density (pcf)	93.28

Moisture Determination	Before Test	After Test
Cont. Weight (g)	49.82	149.28
Wet Soil+Cont. (g)	184.99	590.58
Dry Soil+Cont. (g)	158.24	491.67
Moisture Content (%)	24.7	28.9
Degree Saturation	82.5	99.0

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.002

Shear Distance (in): 0.3

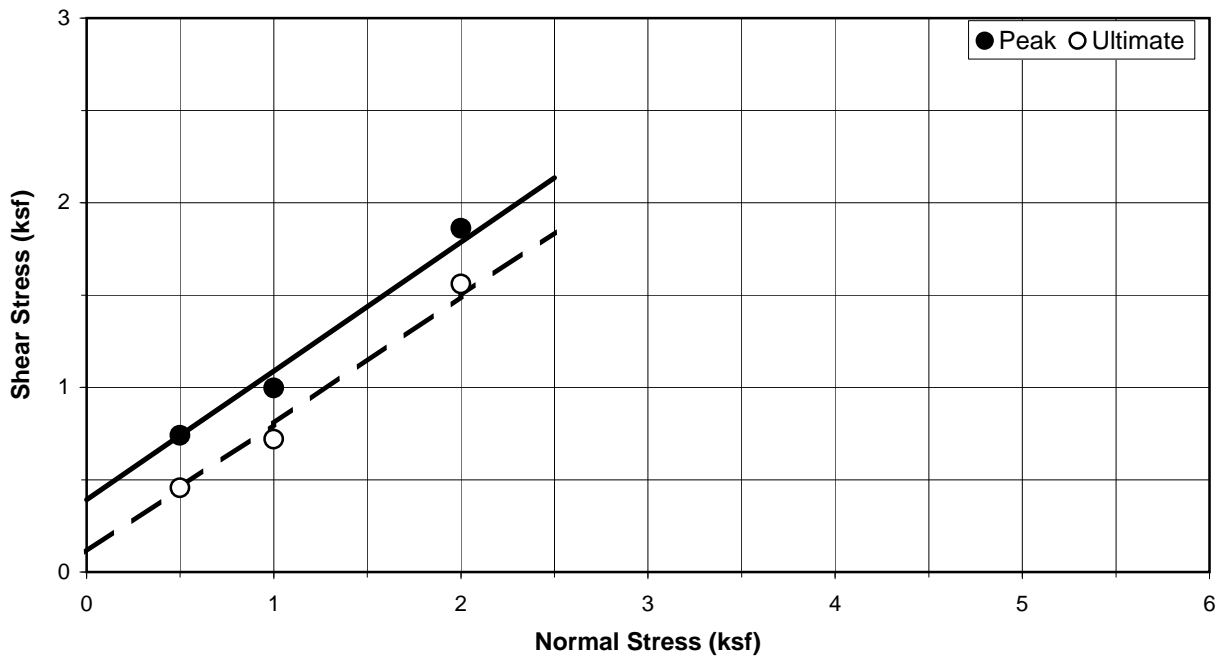
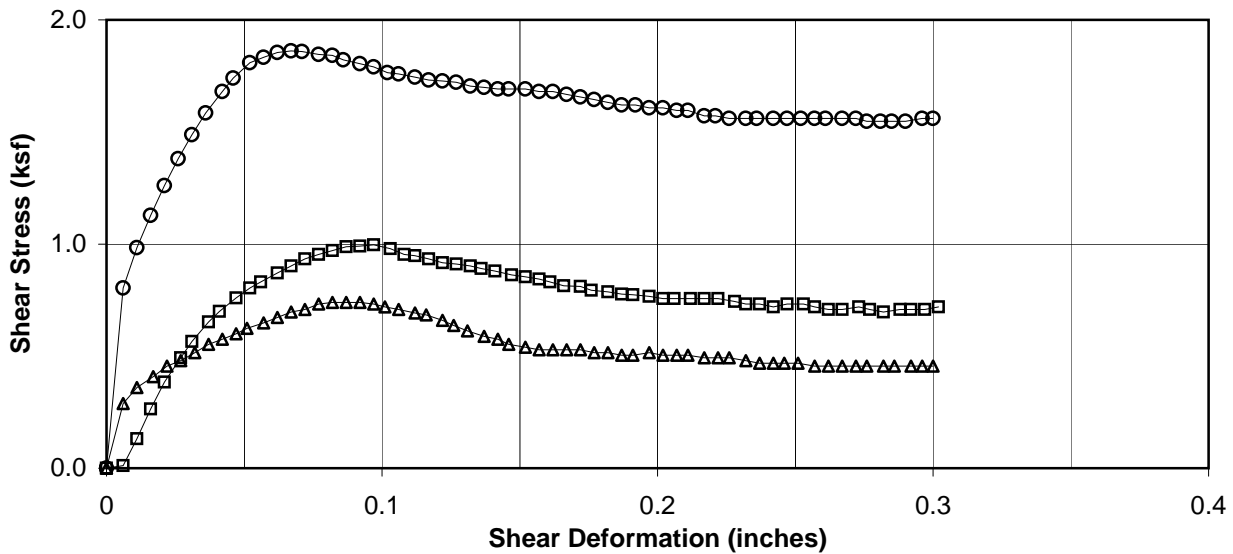
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	187.84	46.00	0.5	740	456	
2	183.50	45.09	1.0	996	720	
3	183.52	44.25	2.0	1861	1560	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: RC-13-003  
 Sample No.: S02  
 Depth (ft): 5  
 Sample Type: Mod. Cal.  
 Soil Description: Claystone  
 Test Condition: Inundated

Initial Dry Density: 93.3 pcf  
 Moisture Content (before): 24.7 %  
 Moisture Content (after): 28.9 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	400	100
Friction Angle:	35 °	35 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/23/13  
 Boring No.: RC-13-003 Checked By AP Date: 05/07/13  
 Sample No.: S06 Depth (ft): 25  
 Description: Silty Sandstone  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	595.49
Total Ring Weight (g)	133.89
Wet Density (pcf)	127.96
Dry Density (pcf)	105.16

Moisture Determination	Before Test	After Test
Cont. Weight (g)	50.10	148.81
Wet Soil+Cont. (g)	192.98	609.85
Dry Soil+Cont. (g)	167.52	527.66
Moisture Content (%)	21.7	21.7
Degree Saturation	97.1	100.3

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

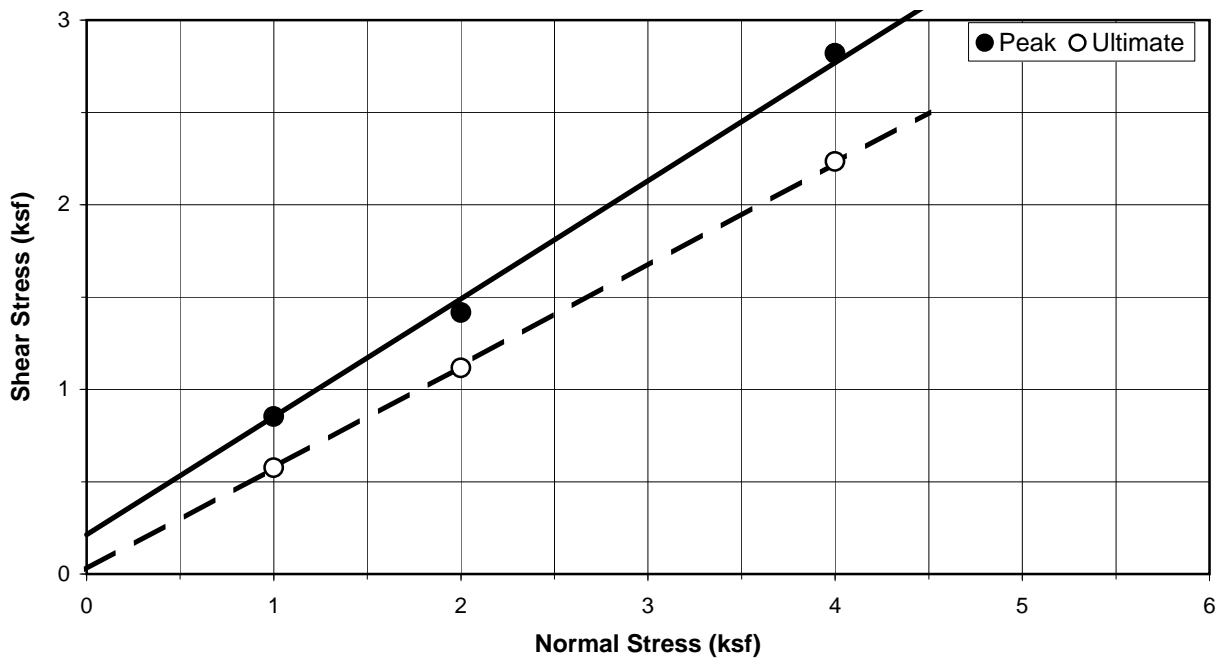
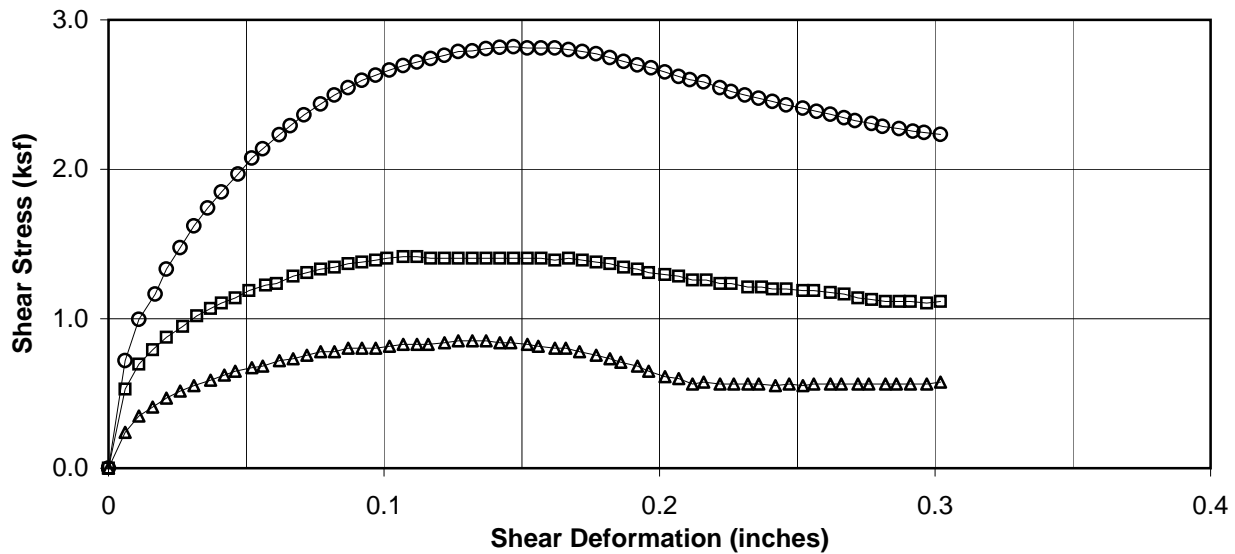
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	199.12	44.13	1.0	852	576	
2	199.20	45.72	2.0	1416	1116	
3	197.17	44.04	4.0	2820	2234	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: RC-13-003  
 Sample No.: S06  
 Depth (ft): 25  
 Sample Type: Mod. Cal.  
 Soil Description: Silty Sandstone  
 Test Condition: Inundated

Initial Dry Density: 105.2 pcf  
 Moisture Content (before): 21.7 %  
 Moisture Content (after): 21.7 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	200	50
Friction Angle:	33 °	29 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/26/13  
 Boring No.: RC-13-003 Checked By AP Date: 05/07/13  
 Sample No.: S25 Depth (ft): 95  
 Description: Silty Sandstone  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	596.83
Total Ring Weight (g)	137.59
Wet Density (pcf)	127.30
Dry Density (pcf)	103.76

Moisture Determination	Before Test	After Test
Cont. Weight (g)	50.07	149.77
Wet Soil+Cont. (g)	124.32	607.73
Dry Soil+Cont. (g)	110.59	523.90
Moisture Content (%)	22.7	22.4
Degree Saturation	98.1	99.9

**METHOD OF SHEARING**

Regular Shearing Shear Rate (in/min): 0.02  
 Residual Shearing 5 Passes Shear Distance (in): 0.3

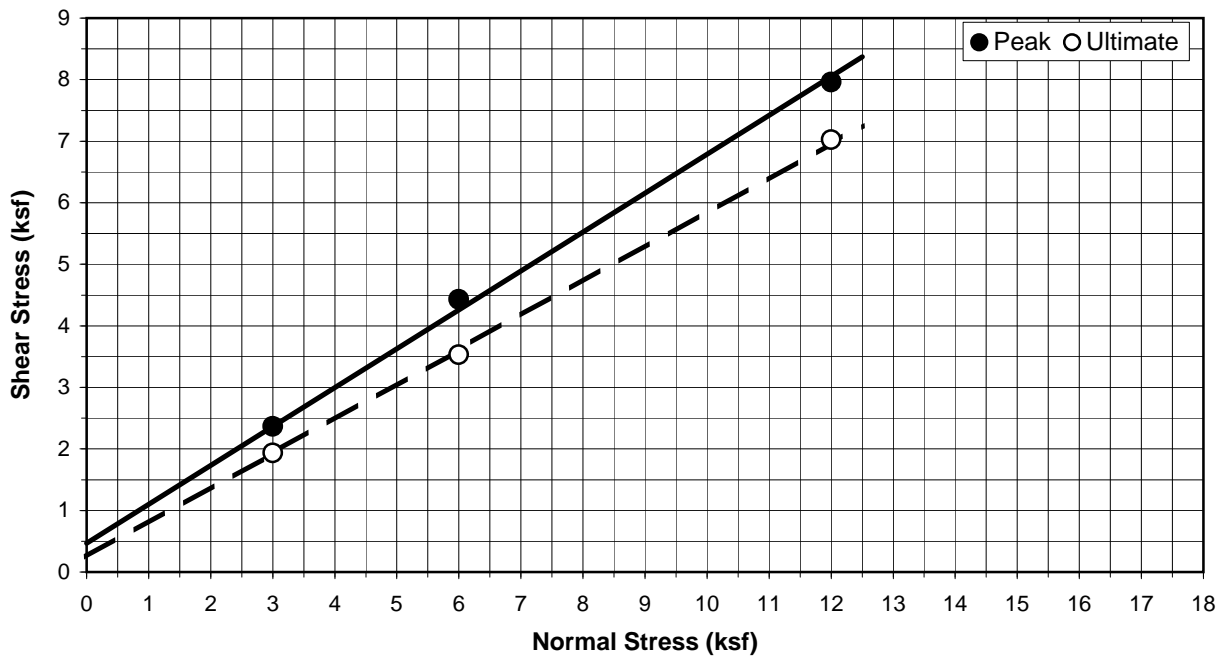
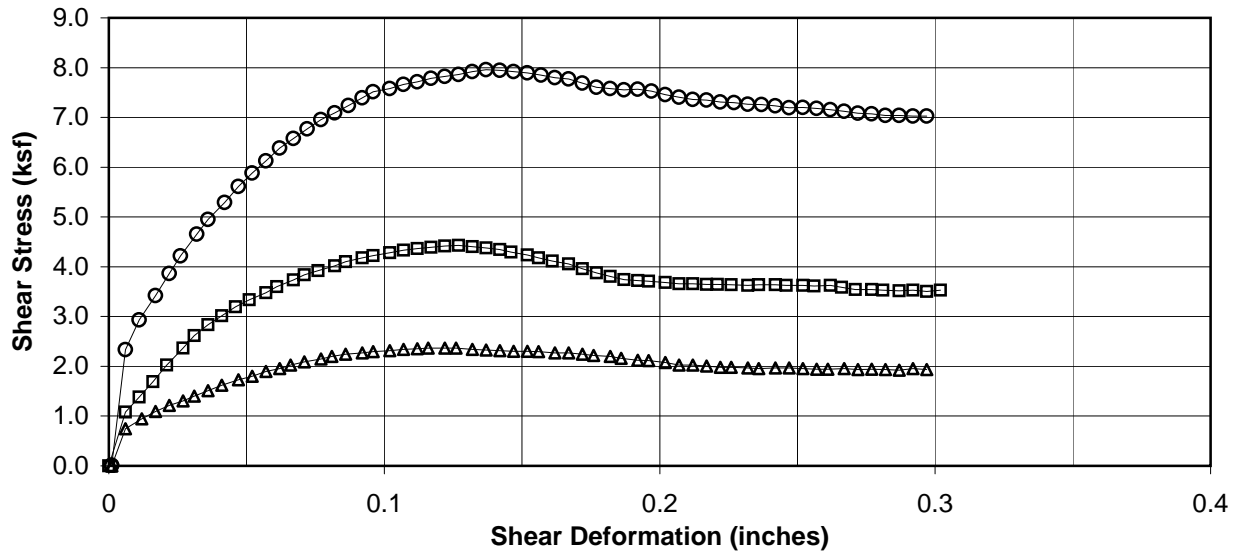
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	200.13	45.44	3.0	2364	1932	
2	197.94	45.88	6.0	4428	3528	
3	198.76	46.27	12.0	7960	7024	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: RC-13-003  
 Sample No.: S25  
 Depth (ft): 95  
 Sample Type: Mod. Cal.  
 Soil Description: Silty Sandstone  
 Test Condition: Inundated

Initial Dry Density: 103.8 pcf  
 Moisture Content (before): 22.7 %  
 Moisture Content (after): 22.4 %



Strength Parameters	Peak	Ultimate
Cohesion (psf):	450	250
Friction Angle:	32 °	29 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/22/13  
 Boring No.: RC-13-004 Checked By AP Date: 05/01/13  
 Sample No.: S03 Depth (ft): 10  
 Description: Clayey to Silty Sand  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	637.19
Total Ring Weight (g)	134.63
Wet Density (pcf)	139.31
Dry Density (pcf)	124.71

Moisture Determination	Before Test	After Test
Cont. Weight (g)	49.97	139.07
Wet Soil+Cont. (g)	193.06	650.14
Dry Soil+Cont. (g)	178.06	593.80
Moisture Content (%)	11.7	12.4
Degree Saturation	89.9	100.5

**METHOD OF SHEARING**

Regular Shearing Shear Rate (in/min): 0.02  
 Residual Shearing 5 Passes Shear Distance (in): 0.3

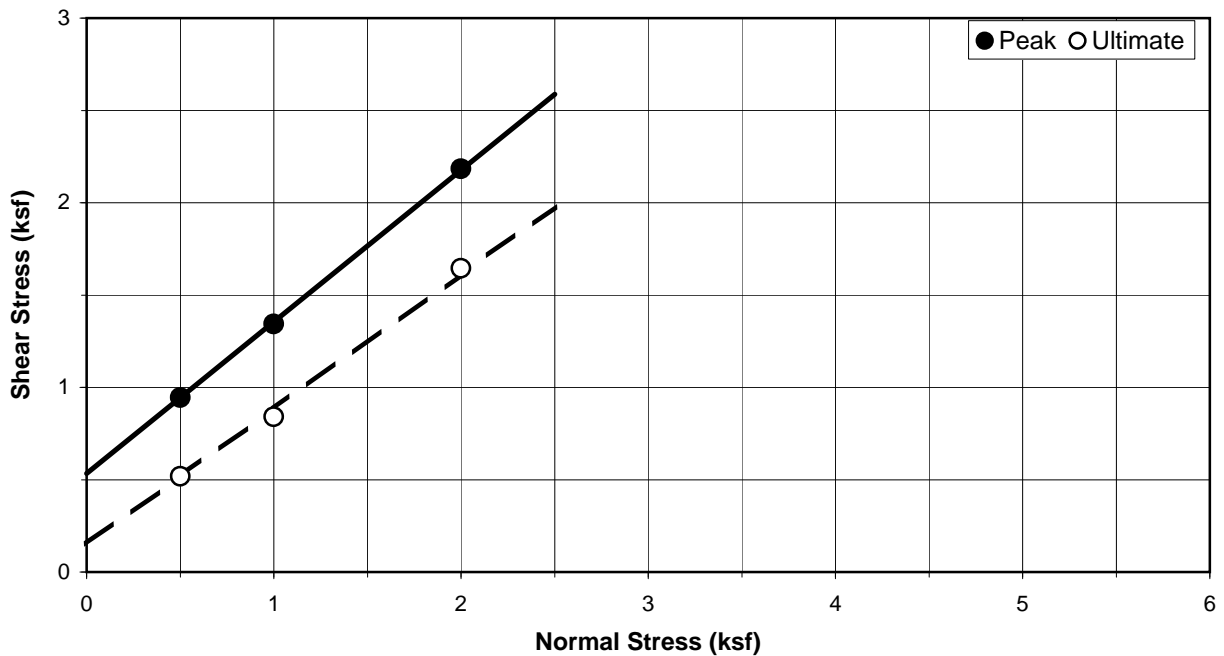
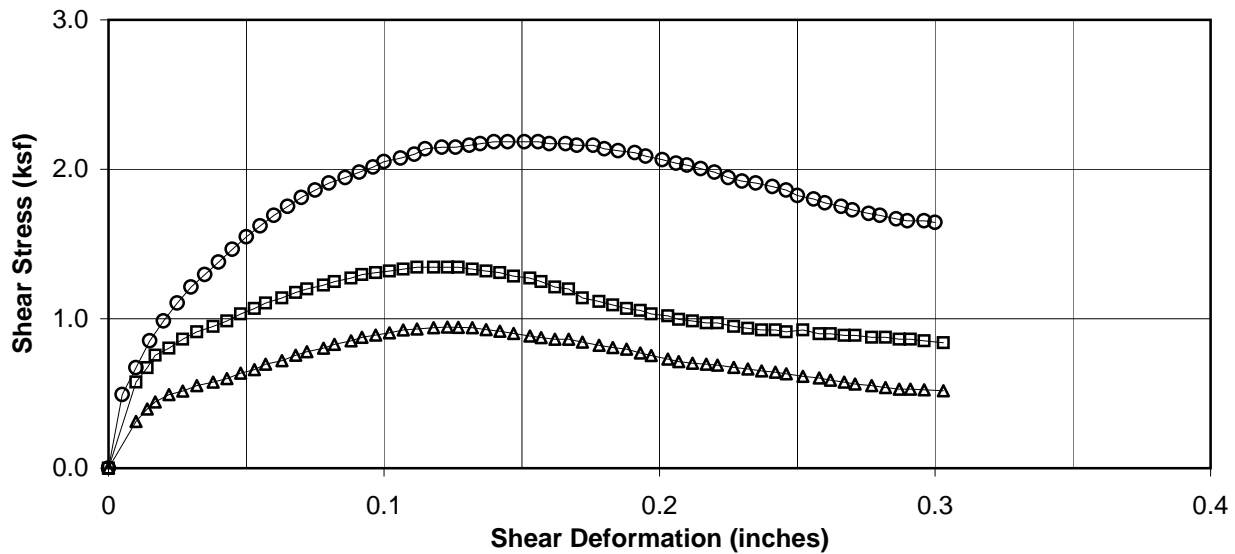
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	213.60	44.97	0.5	945	518	
2	213.14	44.78	1.0	1344	840	
3	210.45	44.88	2.0	2184	1644	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: RC-13-004  
 Sample No.: S03  
 Depth (ft): 10  
 Sample Type: Mod. Cal.  
 Soil Description: Clayey to Silty Sand  
 Test Condition: Inundated

Initial Dry Density: 124.7 pcf  
 Moisture Content (before): 11.7 %  
 Moisture Content (after): 12.4 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	550	150
Friction Angle:	39 °	36 °





**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/22/13  
 Boring No.: RC-13-004 Checked By AP Date: 05/01/13  
 Sample No.: S05 Depth (ft): 20  
 Description: Sandy Clay to Clayey Sand  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	594.36
Total Ring Weight (g)	134.83
Wet Density (pcf)	127.39
Dry Density (pcf)	105.79

Moisture Determination	Before Test	After Test
Cont. Weight (g)	149.58	149.82
Wet Soil+Cont. (g)	296.51	611.40
Dry Soil+Cont. (g)	271.60	530.16
Moisture Content (%)	20.4	21.4
Degree Saturation	92.9	100.4

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.005

Shear Distance (in): 0.3

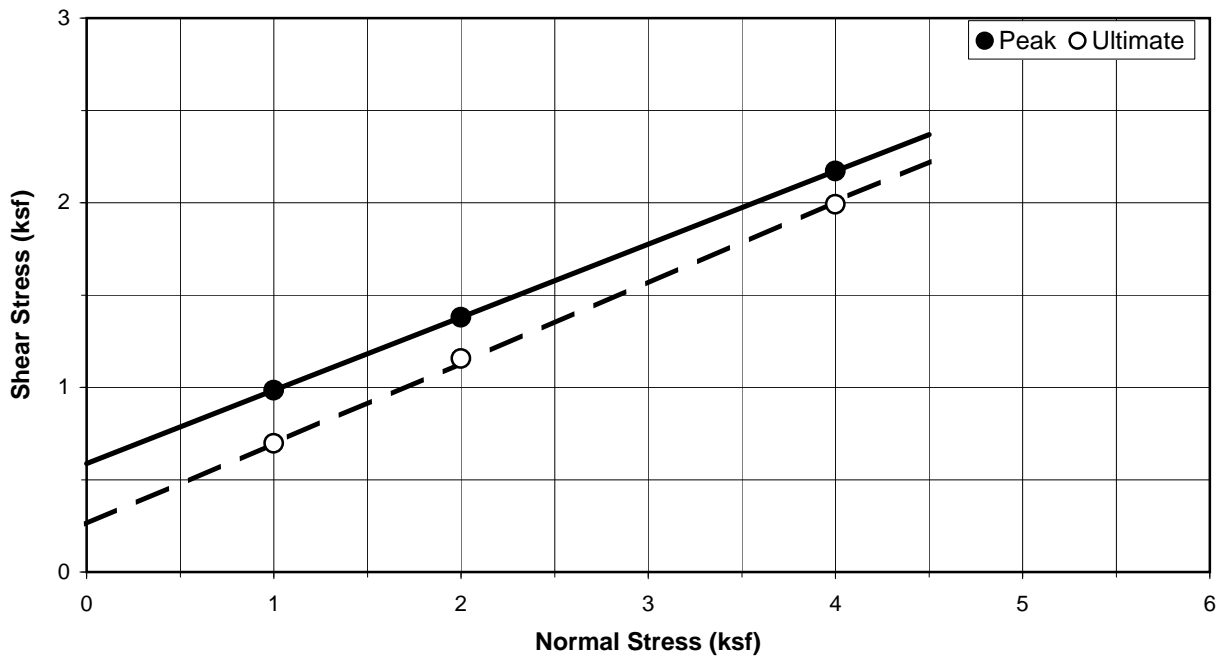
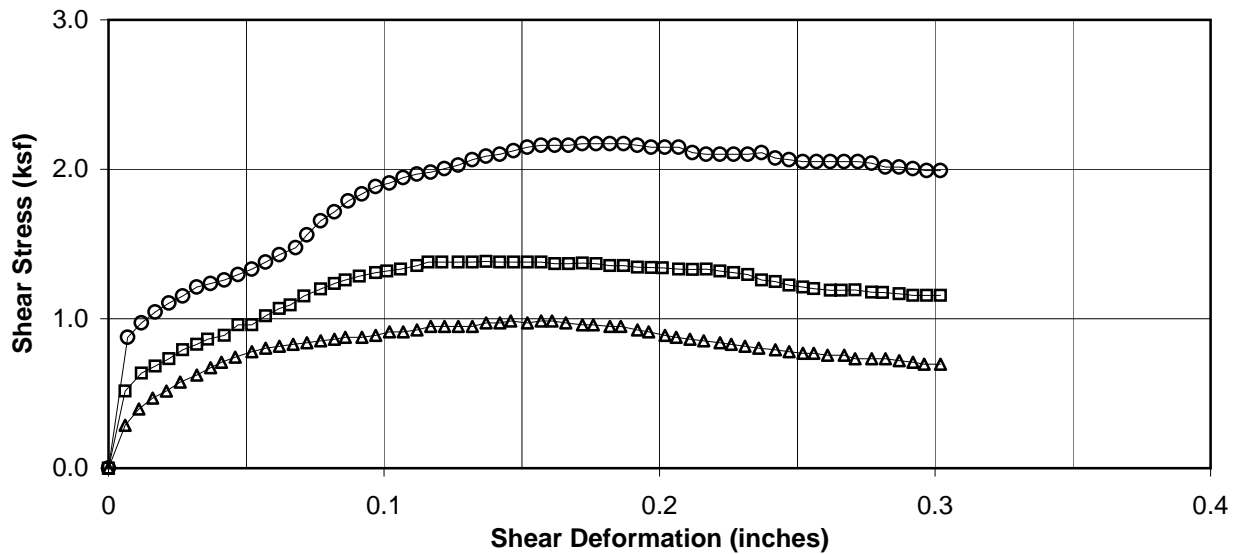
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	198.87	44.97	1.0	984	696	
2	198.62	45.12	2.0	1380	1156	
3	196.87	44.74	4.0	2172	1992	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: RC-13-004  
 Sample No.: S05  
 Depth (ft): 20  
 Sample Type: Mod. Cal.  
 Soil Description: Sandy Clay to Clayey Sand  
 Test Condition: Inundated

Initial Dry Density: 105.8 pcf  
 Moisture Content (before): 20.4 %  
 Moisture Content (after): 21.4 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	600	250
Friction Angle:	22 °	24 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/22/13  
 Boring No.: RC-13-004 Checked By AP Date: 05/01/13  
 Sample No.: S07 Depth (ft): 30  
 Description: Clayey Sand  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	612.57
Total Ring Weight (g)	135.33
Wet Density (pcf)	132.29
Dry Density (pcf)	110.75

Moisture Determination	Before Test	After Test
Cont. Weight (g)	149.66	142.83
Wet Soil+Cont. (g)	283.65	621.81
Dry Soil+Cont. (g)	261.83	546.02
Moisture Content (%)	19.5	18.8
Degree Saturation	100.6	100.9

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

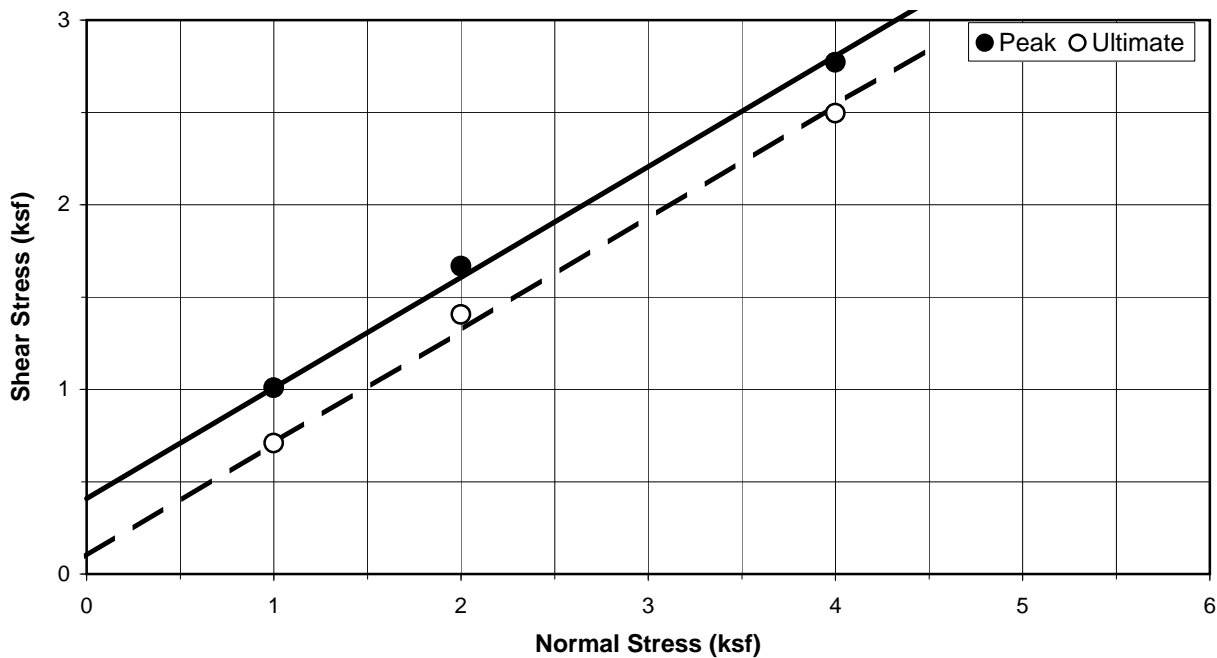
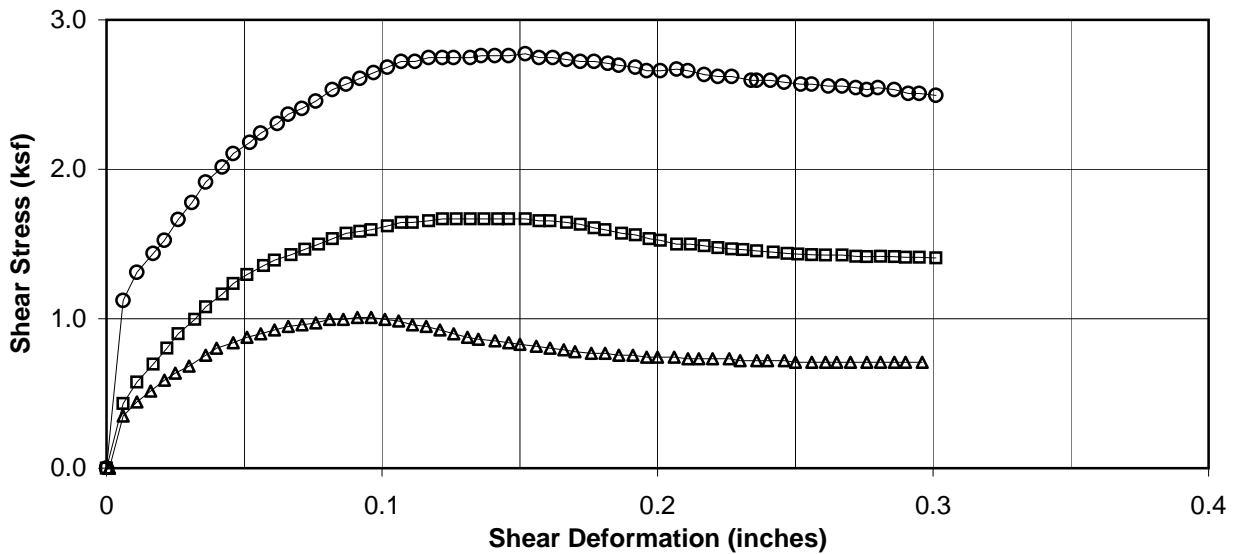
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	204.94	45.26	1.0	1008	708	
2	204.12	45.06	2.0	1668	1406	
3	203.51	45.01	4.0	2772	2495	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: RC-13-004  
 Sample No.: S07  
 Depth (ft): 30  
 Sample Type: Mod. Cal.  
 Soil Description: Clayey Sand  
 Test Condition: Inundated

Initial Dry Density: 110.8 pcf  
 Moisture Content (before): 19.5 %  
 Moisture Content (after): 18.8 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	400	100
Friction Angle:	31 °	31 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/23/13  
 Boring No.: RC-13-004 Checked By AP Date: 05/01/13  
 Sample No.: S09 Depth (ft): 40  
 Description: Sandy Siltstone  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	558.44
Total Ring Weight (g)	135.87
Wet Density (pcf)	117.14
Dry Density (pcf)	94.18

Moisture Determination	Before Test	After Test
Cont. Weight (g)	49.89	149.71
Wet Soil+Cont. (g)	192.97	570.09
Dry Soil+Cont. (g)	164.92	477.14
Moisture Content (%)	24.4	28.4
Degree Saturation	83.4	99.4

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

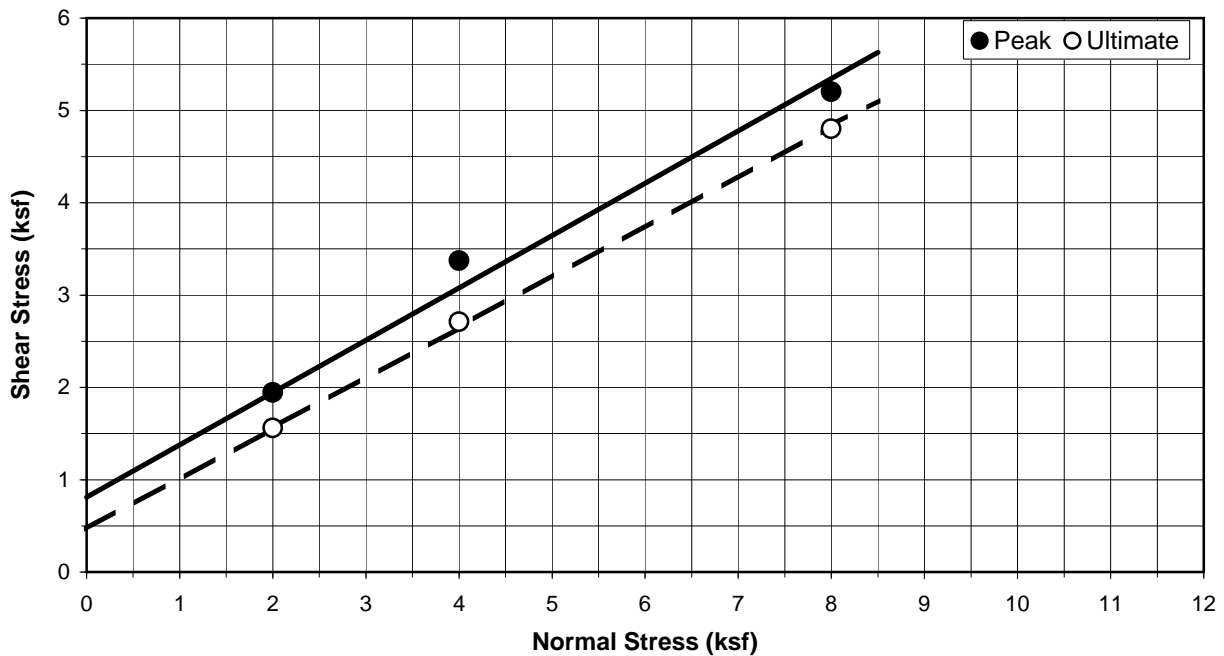
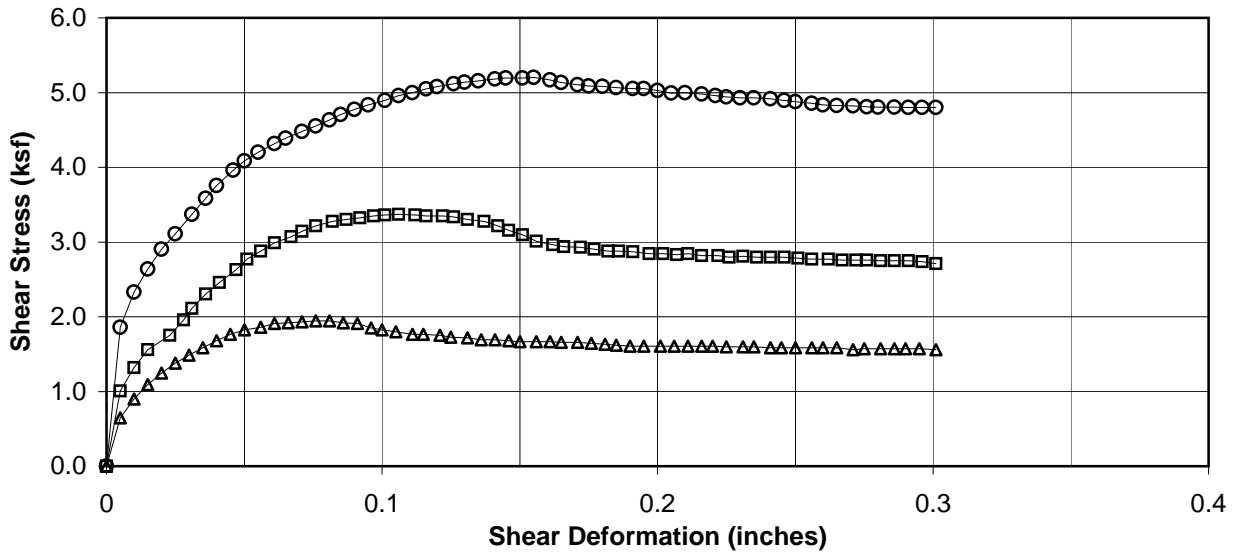
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
<b>1</b>	<b>193.14</b>	<b>45.43</b>	<b>2.0</b>	<b>1944</b>	<b>1560</b>	
<b>2</b>	<b>186.51</b>	<b>45.18</b>	<b>4.0</b>	<b>3372</b>	<b>2712</b>	
<b>3</b>	<b>178.79</b>	<b>45.26</b>	<b>8.0</b>	<b>5203</b>	<b>4799</b>	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: RC-13-004  
 Sample No.: S09  
 Depth (ft): 40  
 Sample Type: Mod. Cal.  
 Soil Description: Sandy Siltstone  
 Test Condition: Inundated

Initial Dry Density: 94.2 pcf  
 Moisture Content (before): 24.4 %  
 Moisture Content (after): 28.4 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	800	450
Friction Angle:	30 °	29 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/03/13  
 Boring No.: RC-13-005 Checked By AP Date: 04/15/13  
 Sample No.: S11 Depth (ft): 50-51.5  
 Description: Sandy Silt  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	597.44
Total Ring Weight (g)	136.02
Wet Density (pcf)	127.91
Dry Density (pcf)	107.15

Moisture Determination	Before Test	After Test
Cont. Weight (g)	148.99	135.85
Wet Soil+Cont. (g)	458.95	603.28
Dry Soil+Cont. (g)	408.65	523.60
Moisture Content (%)	19.4	20.5
Degree Saturation	91.3	100.1

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.005

Shear Distance (in): 0.3

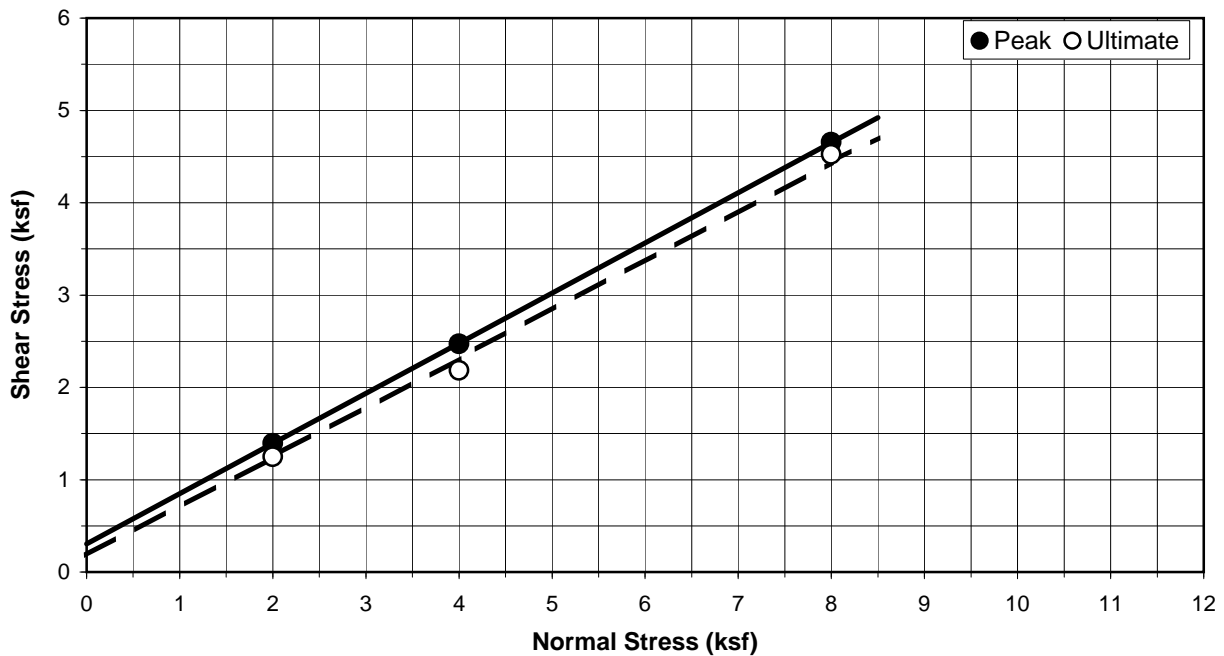
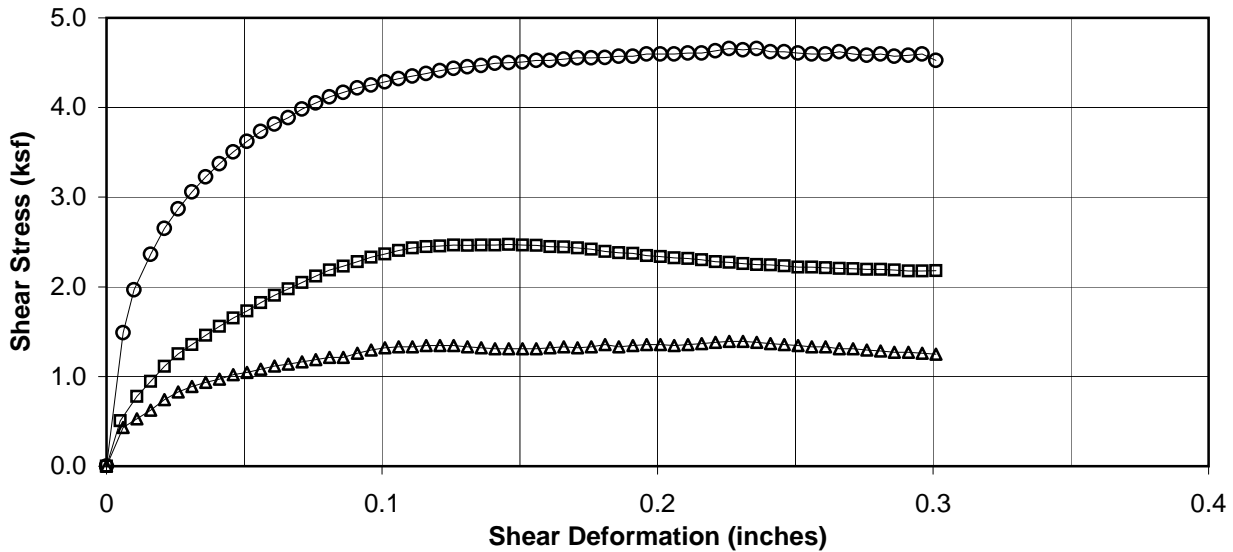
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	201.23	45.55	2.0	1392	1248	
2	198.06	44.98	4.0	2472	2182	
3	198.15	45.49	8.0	4656	4524	



**DIRECT SHEAR TEST RESULTS**  
**ASTM D 3080**

Project Name: SR-710 North Study  
 Boring No.: RC-13-005  
 Sample No.: S11  
 Depth (ft): 50-51.5  
 Sample Type: Mod. Cal.  
 Soil Description: ~~Sandy Silt~~ **Sandy Fat Clay**  
 Test Condition: Inundated

Initial Dry Density: 107.2 pcf  
 Moisture Content (before): 19.4 %  
 Moisture Content (after): 20.5 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	300	200
Friction Angle:	29 °	28 °





**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/03/13  
 Boring No.: RC-13-005 Checked By AP Date: 04/15/13  
 Sample No.: S15 Depth (ft): 70-71.5  
 Description: Lean Clay w/sand  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	610.50
Total Ring Weight (g)	135.37
Wet Density (pcf)	131.71
Dry Density (pcf)	110.21

Moisture Determination	Before Test	After Test
Cont. Weight (g)	148.39	142.41
Wet Soil+Cont. (g)	309.35	629.52
Dry Soil+Cont. (g)	283.08	551.46
Moisture Content (%)	19.5	19.1
Degree Saturation	99.5	100.9

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.005

Shear Distance (in): 0.3

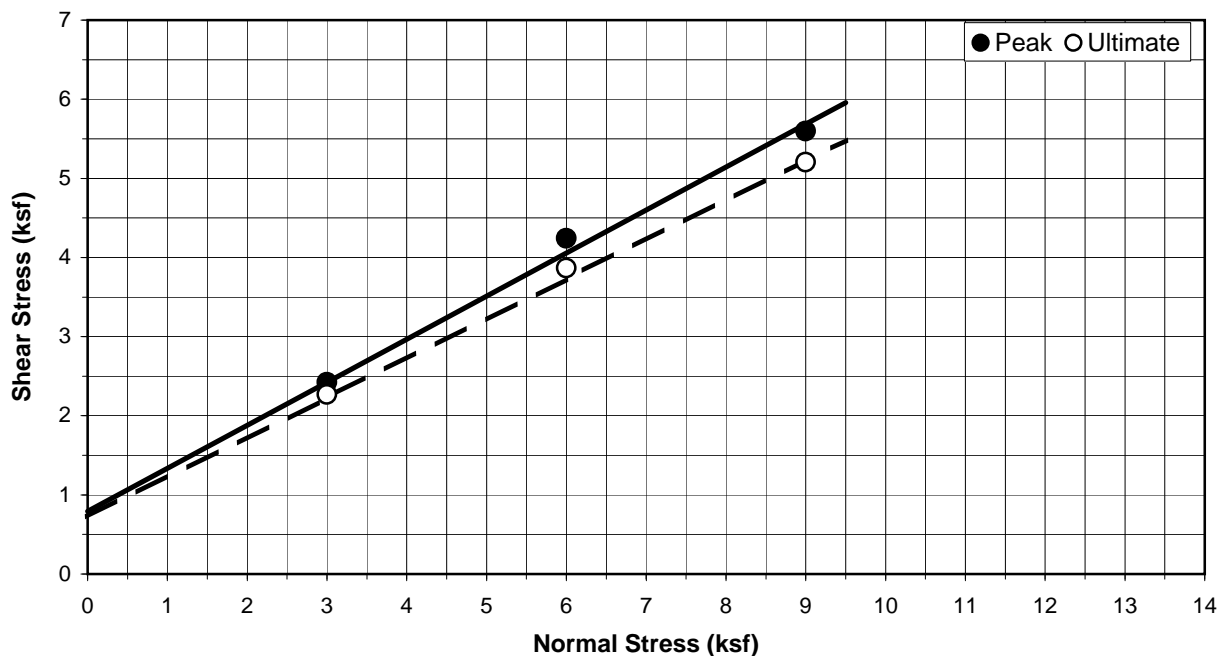
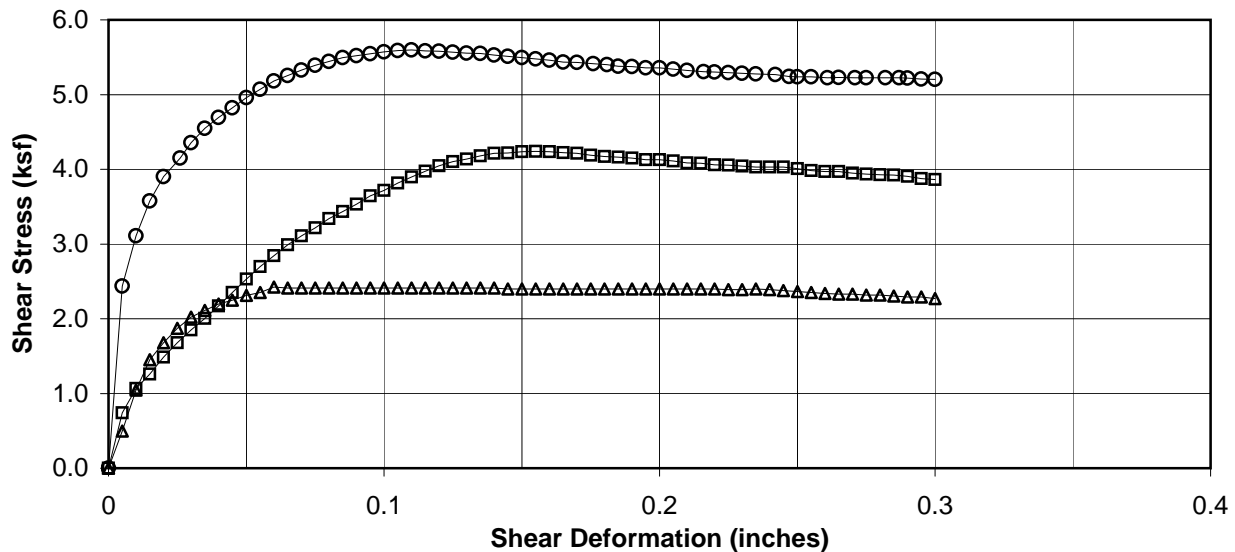
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	203.26	44.93	3.0	2424	2268	
2	203.56	45.17	6.0	4241	3864	
3	203.68	45.27	9.0	5596	5203	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: RC-13-005  
 Sample No.: S15  
 Depth (ft): 70-71.5  
 Sample Type: Mod. Cal.  
 Soil Description: Lean Clay w/sand  
 Test Condition: Inundated

Initial Dry Density: 110.2 pcf  
 Moisture Content (before): 19.5 %  
 Moisture Content (after): 19.1 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	800	700
Friction Angle:	29°	27°



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/02/13  
 Boring No.: RC-13-005 Checked By AP Date: 04/15/13  
 Sample No.: S7 Depth (ft): 30-31.5  
 Description: Poorly-Graded Sand w/silt & gravel  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	588.20
Total Ring Weight (g)	135.52
Wet Density (pcf)	125.49
Dry Density (pcf)	118.16

Moisture Determination	Before Test	After Test
Cont. Weight (g)	142.86	150.05
Wet Soil+Cont. (g)	612.20	625.70
Dry Soil+Cont. (g)	584.81	563.73
Moisture Content (%)	6.2	15.0
Degree Saturation	39.2	99.2

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

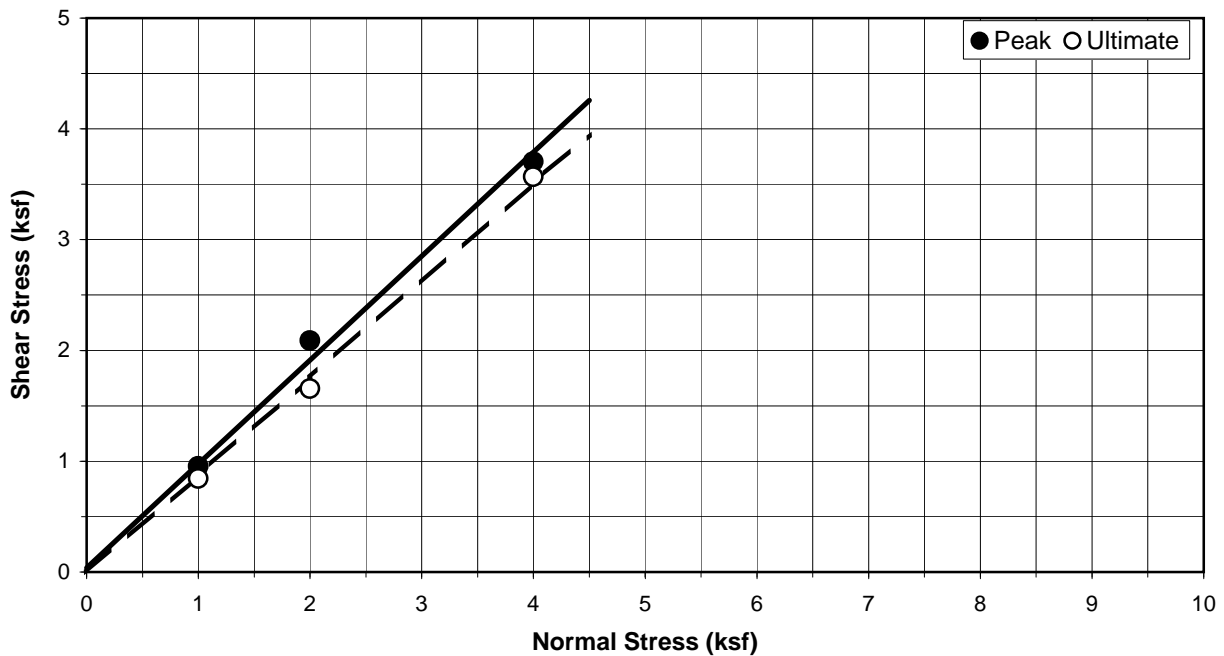
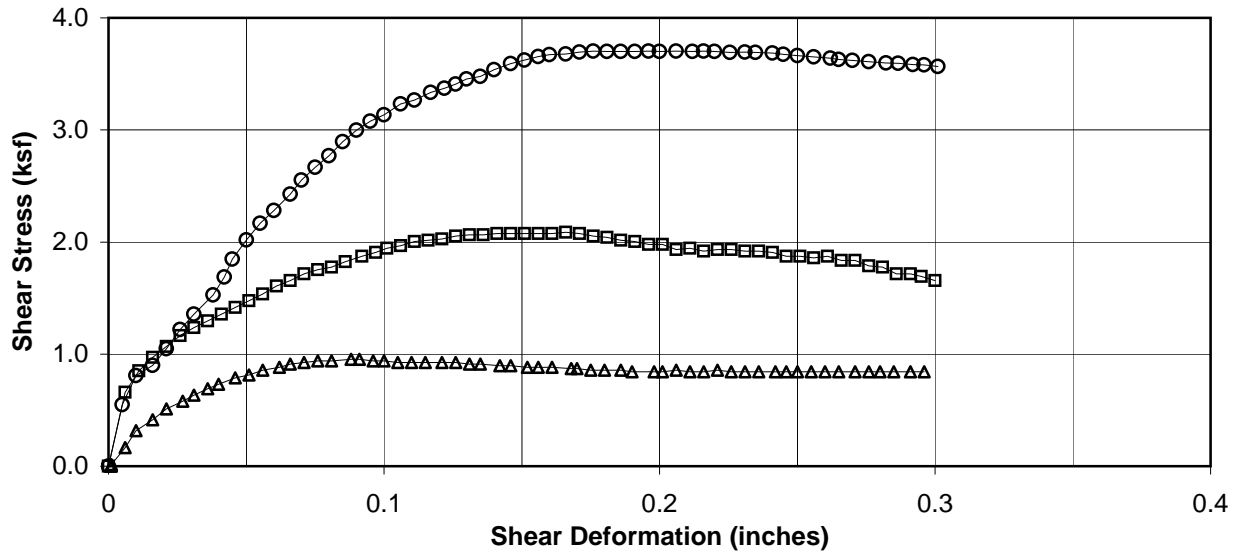
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	197.47	45.14	1.0	952	842	
2	193.62	45.01	2.0	2088	1656	
3	197.11	45.37	4.0	3704	3567	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: RC-13-005  
 Sample No.: S7  
 Depth (ft): 30-31.5  
 Sample Type: Mod. Cal.  
 Soil Description: Poorly-Graded Sand w/silt & gravel  
 Test Condition: Inundated

Initial Dry Density: 118.2 pcf  
 Moisture Content (before): 6.2 %  
 Moisture Content (after): 15.0 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	50	0
Friction Angle:	43 °	41 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/26/13  
 Boring No.: R-13-006 Checked By AP Date: 05/06/13  
 Sample No.: S04 Depth (ft): 15  
 Description: Sandy Clay  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	630.76
Total Ring Weight (g)	136.04
Wet Density (pcf)	137.14
Dry Density (pcf)	119.71

Moisture Determination	Before Test	After Test
Cont. Weight (g)	50.92	146.28
Wet Soil+Cont. (g)	187.27	646.76
Dry Soil+Cont. (g)	169.94	583.72
Moisture Content (%)	14.6	14.4
Degree Saturation	96.3	100.0

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.005

Shear Distance (in): 0.3

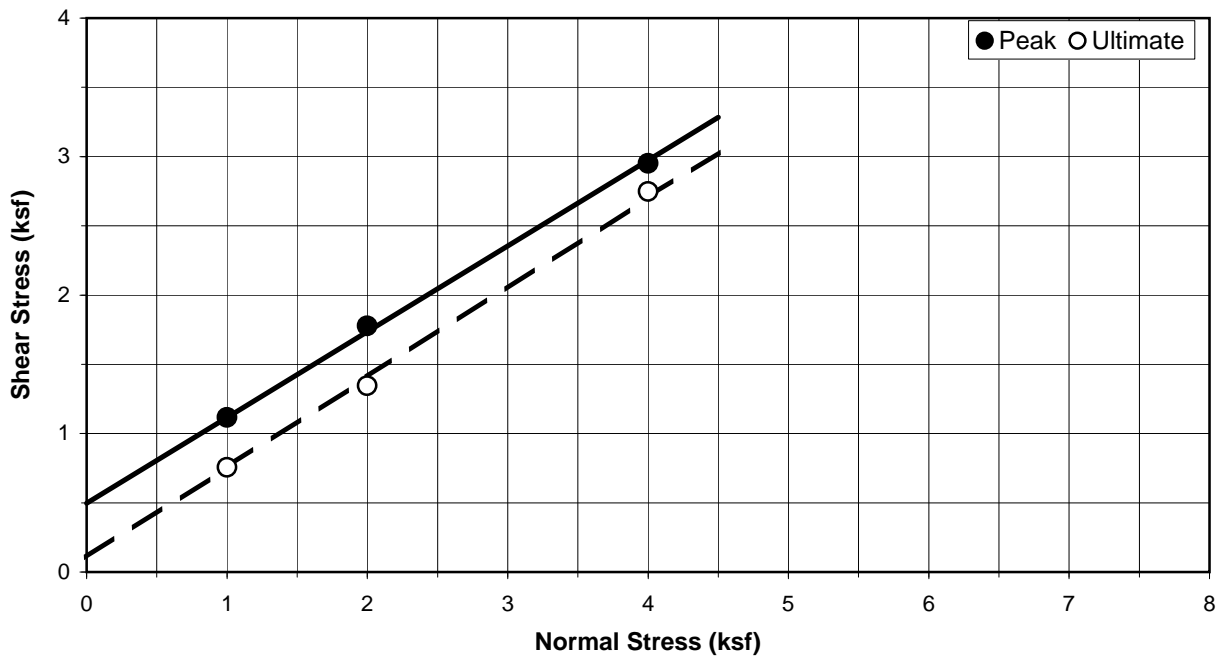
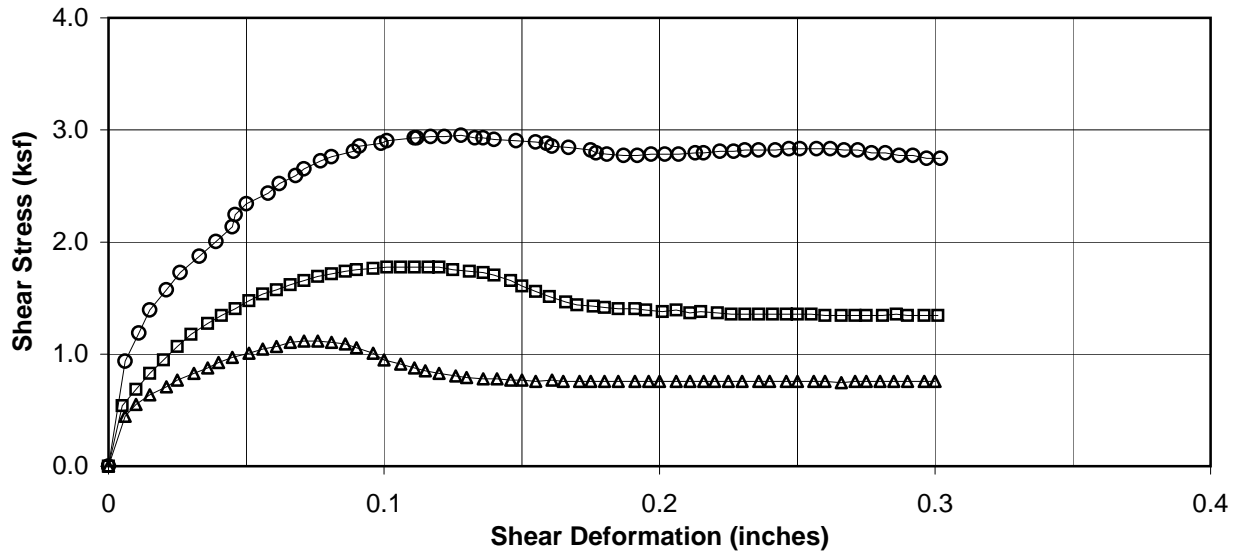
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	210.95	45.28	1.0	1116	756	
2	210.55	45.10	2.0	1776	1344	
3	209.26	45.66	4.0	2952	2748	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: R-13-006  
 Sample No.: S04  
 Depth (ft): 15  
 Sample Type: Mod. Cal.  
 Soil Description: Sandy Clay  
 Test Condition: Inundated

Initial Dry Density: 119.7 pcf  
 Moisture Content (before): 14.6 %  
 Moisture Content (after): 14.4 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	500	100
Friction Angle:	32 °	33 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/26/13  
 Boring No.: R-13-006 Checked By AP Date: 05/06/13  
 Sample No.: S10 Depth (ft): 45  
 Description: Sandy Silt  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	611.74
Total Ring Weight (g)	139.32
Wet Density (pcf)	130.96
Dry Density (pcf)	117.54

Moisture Determination	Before Test	After Test
Cont. Weight (g)	50.88	150.00
Wet Soil+Cont. (g)	176.99	646.74
Dry Soil+Cont. (g)	164.07	580.86
Moisture Content (%)	11.4	15.3
Degree Saturation	71.0	99.4

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

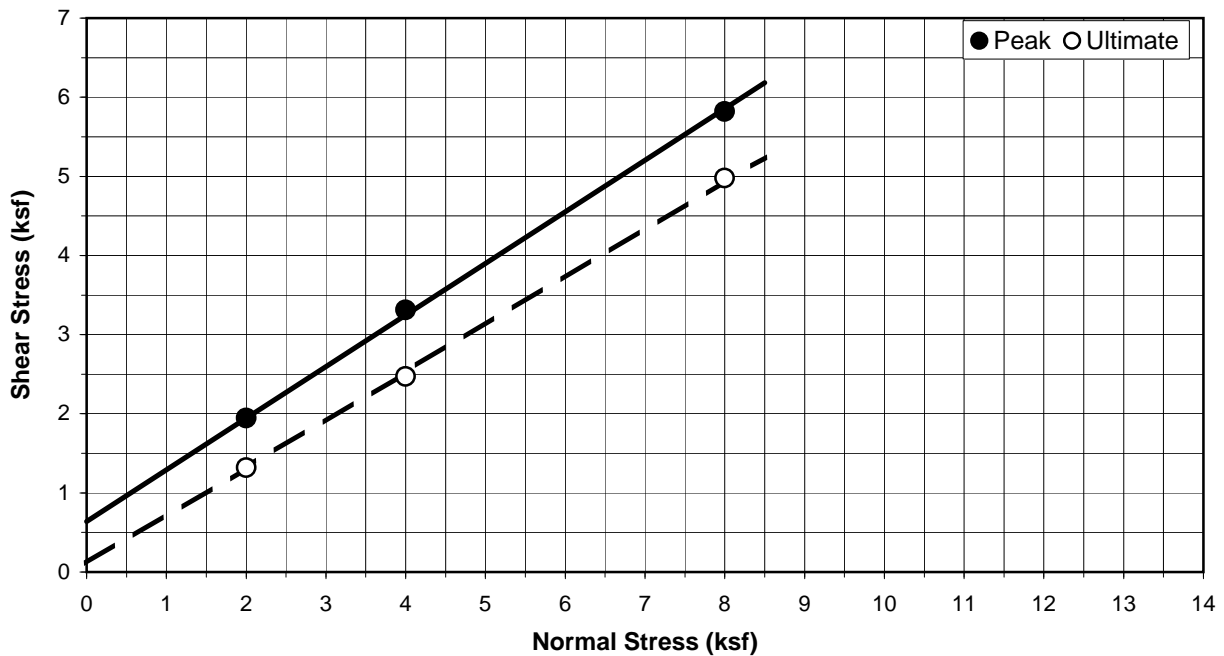
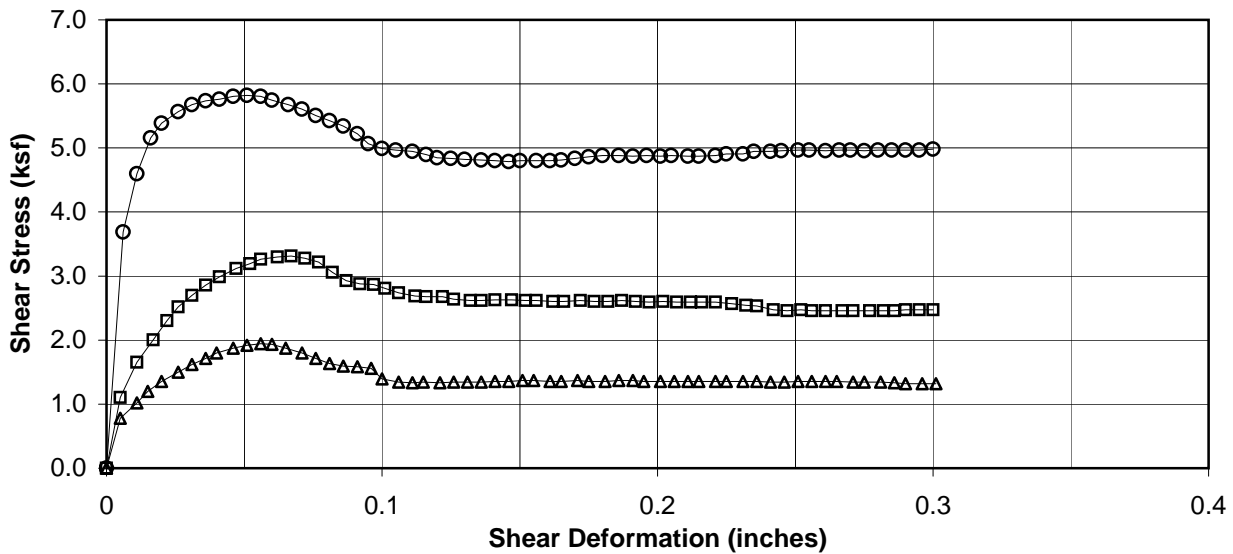
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	205.53	46.65	2.0	1944	1320	
2	203.76	46.64	4.0	3312	2472	
3	202.45	46.03	8.0	5820	4980	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: R-13-006  
 Sample No.: S10  
 Depth (ft): 45  
 Sample Type: Mod. Cal.  
 Soil Description: Sandy Silt  
 Test Condition: Inundated

Initial Dry Density: 117.5 pcf  
 Moisture Content (before): 11.4 %  
 Moisture Content (after): 15.3 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	650	100
Friction Angle:	33 °	31 °





**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study      Tested By DRE      Date: 05/06/13  
 Boring No.: A-13-008      Checked By AP      Date: 05/08/13  
 Sample No.: S04      Depth (ft): 15-16.5  
 Description: Silty Sand  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	561.91
Total Ring Weight (g)	132.43
Wet Density (pcf)	119.06
Dry Density (pcf)	114.70

Moisture Determination	Before Test	After Test
Cont. Weight (g)	50.20	170.83
Wet Soil+Cont. (g)	193.97	603.31
Dry Soil+Cont. (g)	188.71	541.54
Moisture Content (%)	3.8	16.7
Degree Saturation	21.8	99.8

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

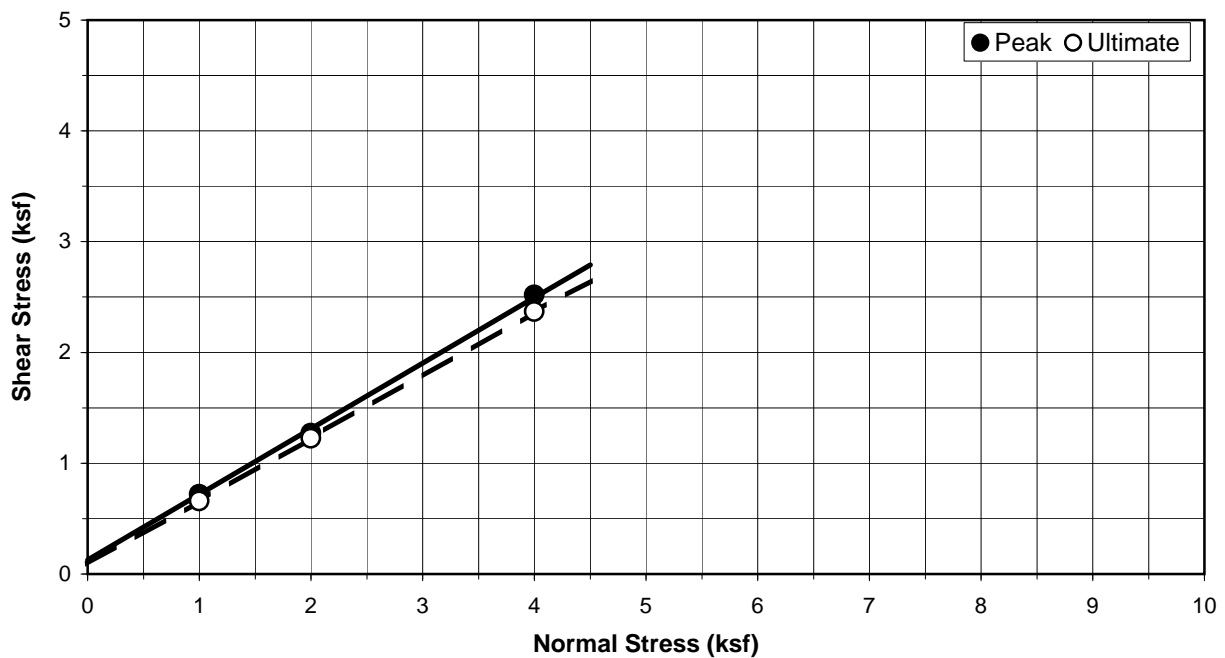
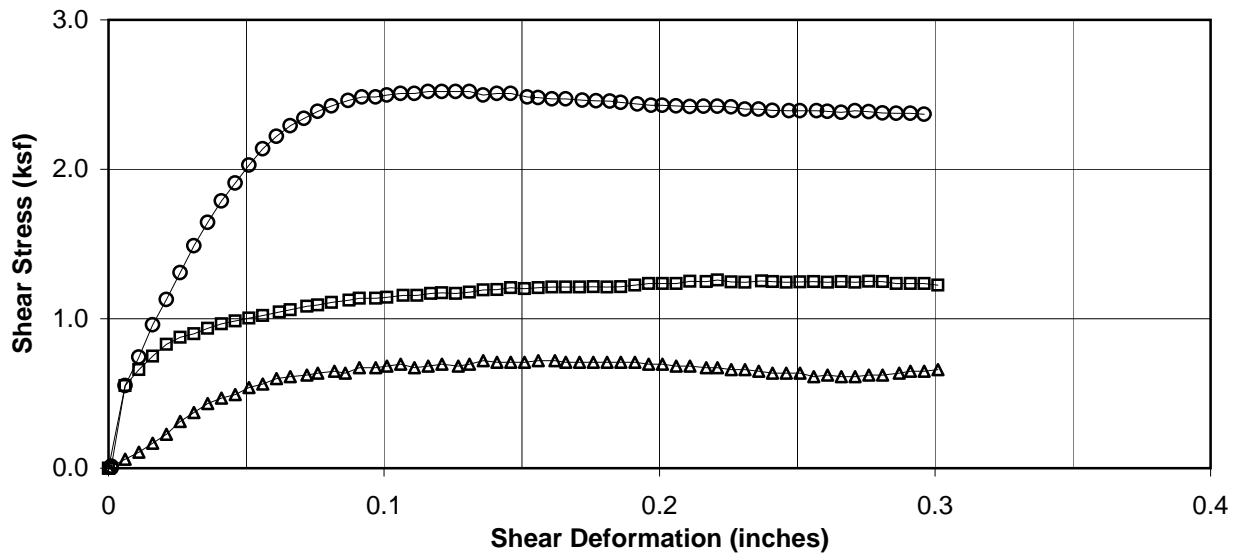
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	188.84	43.98	1.0	720	660	
2	187.78	44.25	2.0	1272	1224	
3	185.29	44.20	4.0	2520	2368	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: A-13-008  
 Sample No.: S04  
 Depth (ft): 15-16.5  
 Sample Type: Mod. Cal.  
 Soil Description: Silty Sand  
 Test Condition: Inundated

Initial Dry Density: 114.7 pcf  
 Moisture Content (before): 3.8 %  
 Moisture Content (after): 16.7 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	150	100
Friction Angle:	31 °	30 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 05/06/13  
 Boring No.: A-13-008 Checked By AP Date: 05/08/13  
 Sample No.: S10 Depth (ft): 45-46.5  
 Description: Silty Sand  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	585.52
Total Ring Weight (g)	134.96
Wet Density (pcf)	124.90
Dry Density (pcf)	111.03

Moisture Determination	Before Test	After Test
Cont. Weight (g)	50.51	142.90
Wet Soil+Cont. (g)	200.55	612.81
Dry Soil+Cont. (g)	183.89	539.32
Moisture Content (%)	12.5	18.5
Degree Saturation	65.1	100.3

**METHOD OF SHEARING**

Regular Shearing Shear Rate (in/min): 0.02  
 Residual Shearing 5 Passes Shear Distance (in): 0.3

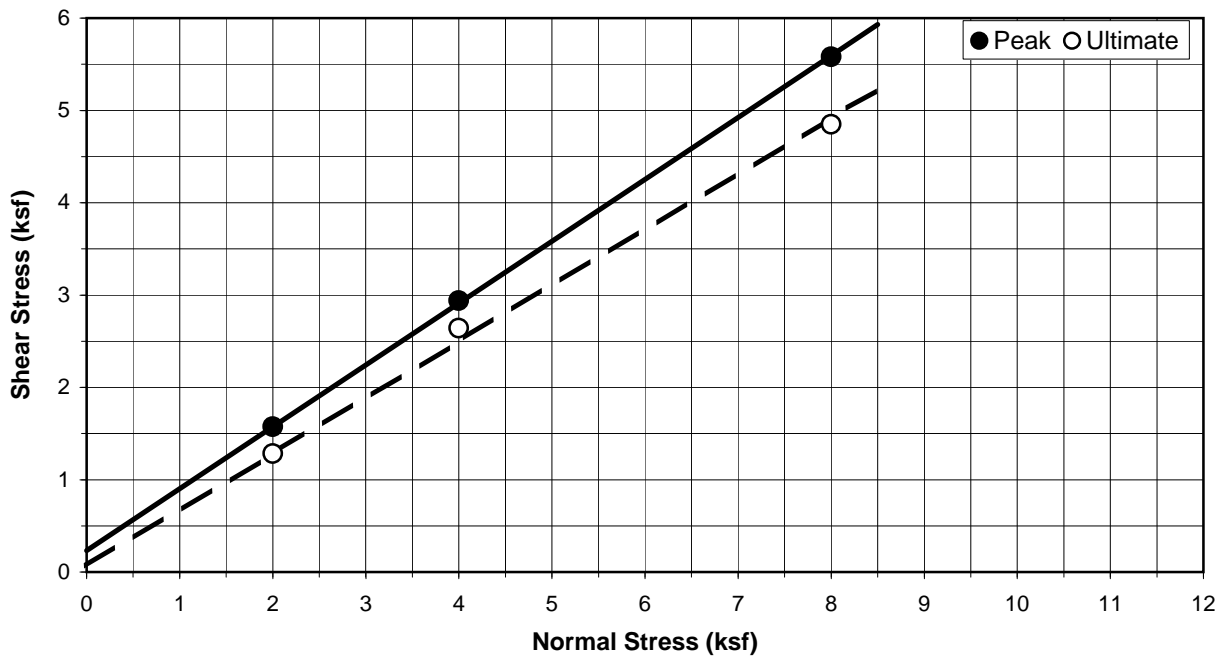
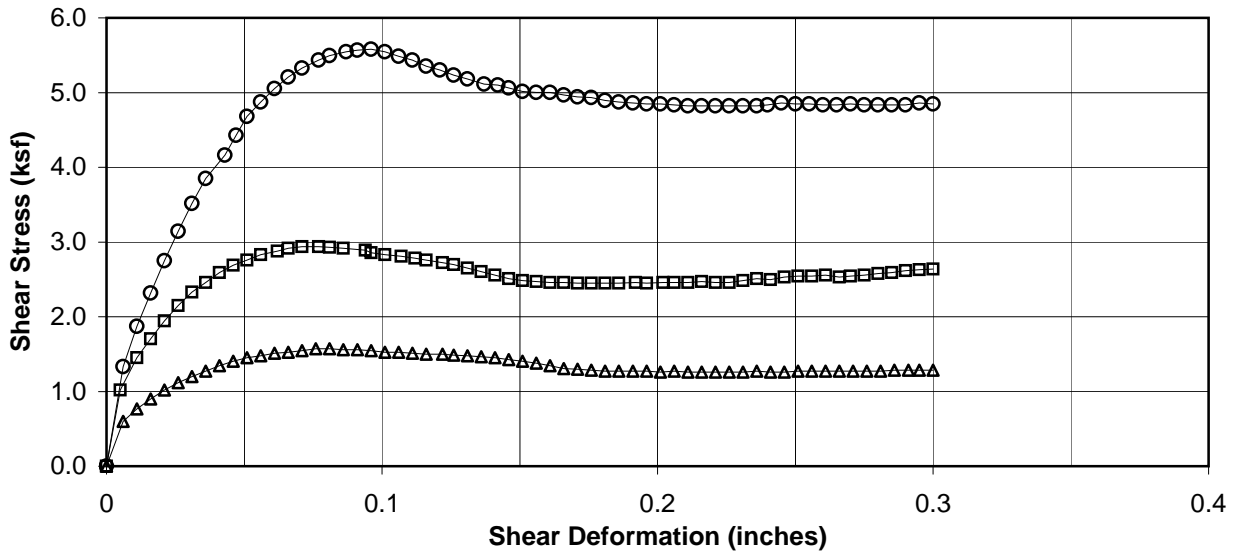
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	196.88	45.71	2.0	1572	1284	
2	195.81	44.68	4.0	2940	2640	
3	192.83	44.57	8.0	5580	4848	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: A-13-008  
 Sample No.: S10  
 Depth (ft): 45-46.5  
 Sample Type: Mod. Cal.  
 Soil Description: Silty Sand  
 Test Condition: Inundated

Initial Dry Density: 111.0 pcf  
 Moisture Content (before): 12.5 %  
 Moisture Content (after): 18.5 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	250	50
Friction Angle:	34 °	31 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 05/08/13  
 Boring No.: A-13-008 Checked By AP Date: 05/10/13  
 Sample No.: S14 Depth (ft): 65-66.5  
 Description: Sand w/silt  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	532.32
Total Ring Weight (g)	134.59
Wet Density (pcf)	110.25
Dry Density (pcf)	108.15

Moisture Determination	Before Test	After Test
Cont. Weight (g)	49.52	150.88
Wet Soil+Cont. (g)	286.73	540.70
Dry Soil+Cont. (g)	282.21	480.92
Moisture Content (%)	1.9	18.1
Degree Saturation	9.4	90.6

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

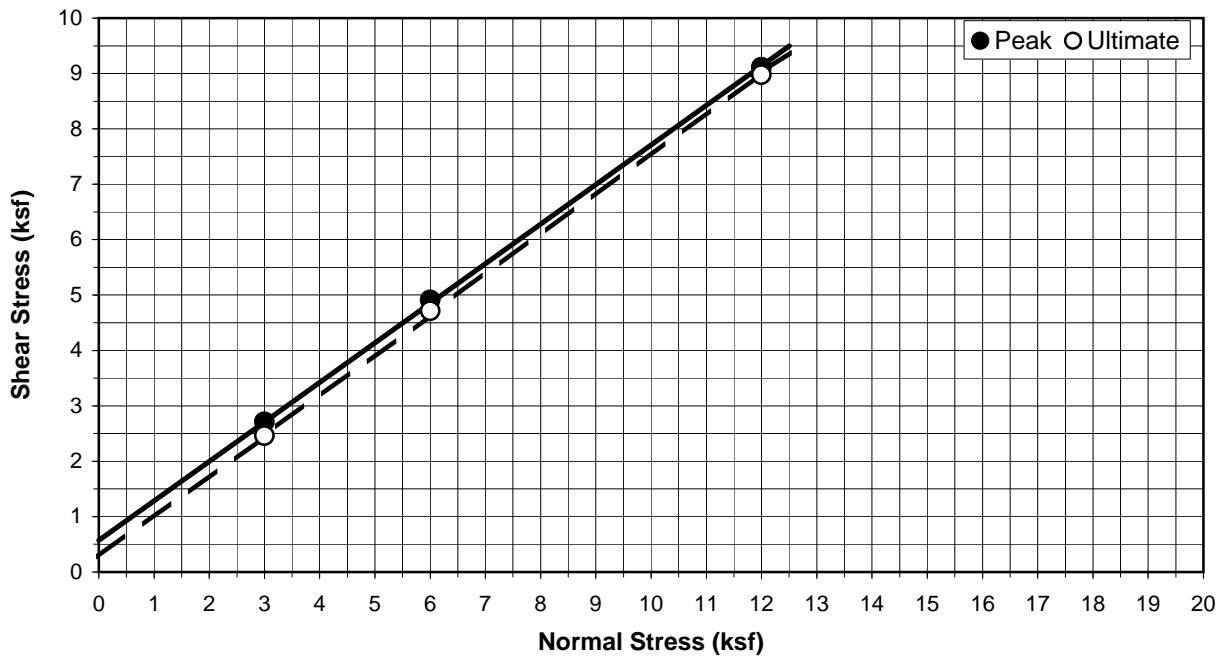
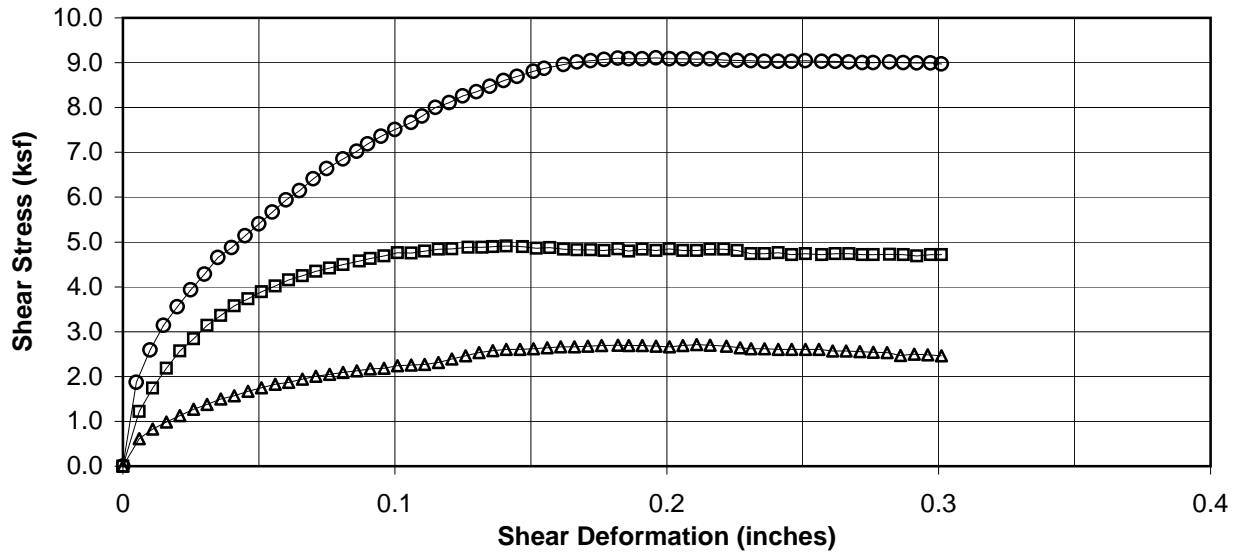
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	179.66	45.49	3.0	2712	2460	
2	177.92	43.92	6.0	4908	4716	
3	174.74	45.18	12.0	9108	8975	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: A-13-008  
 Sample No.: S14  
 Depth (ft): 65-66.5  
 Sample Type: Mod. Cal.  
 Soil Description: Sand w/silt  
 Test Condition: Inundated

Initial Dry Density: 108.2 pcf  
 Moisture Content (before): 1.9 %  
 Moisture Content (after): 18.1 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	550	250
Friction Angle:	36 °	36 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 05/08/13  
 Boring No.: A-13-008 Checked By AP Date: 05/10/13  
 Sample No.: S16 Depth (ft): 75-76.5  
 Description: Well-Graded Sand w/silt & gravel  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	521.94
Total Ring Weight (g)	134.84
Wet Density (pcf)	107.31
Dry Density (pcf)	105.28

Moisture Determination	Before Test	After Test
Cont. Weight (g)	50.42	152.03
Wet Soil+Cont. (g)	218.95	534.55
Dry Soil+Cont. (g)	215.77	472.04
Moisture Content (%)	1.9	19.5
Degree Saturation	8.6	90.6

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

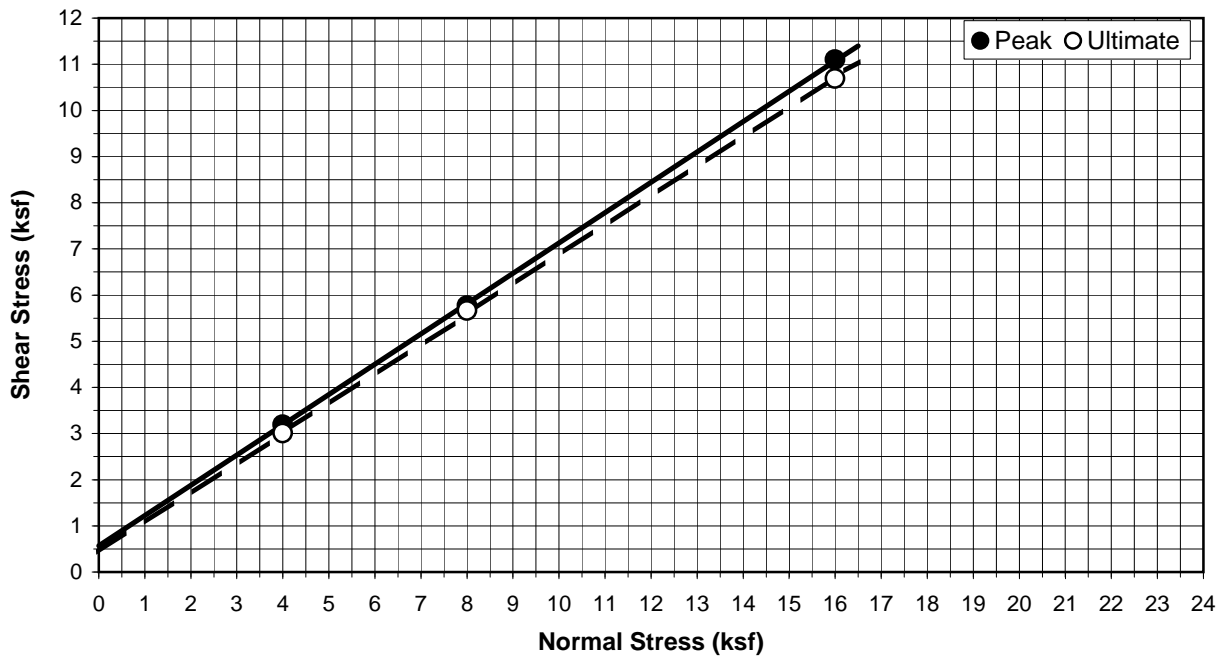
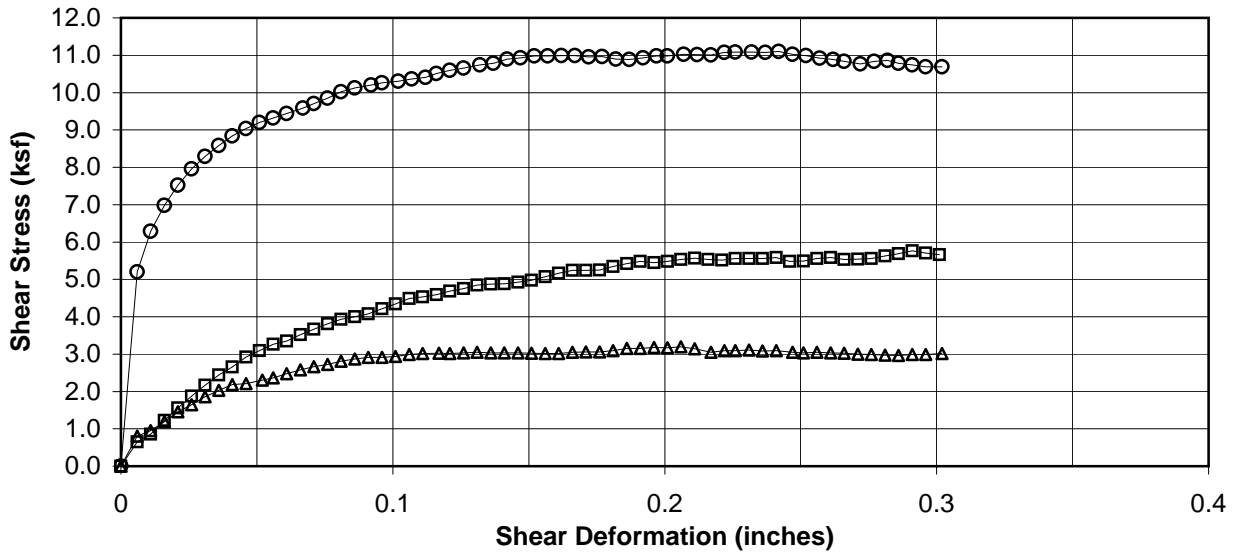
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	176.31	45.60	4.0	3192	3012	
2	174.83	44.17	8.0	5768	5663	
3	170.80	45.07	16.0	11099	10691	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: A-13-008  
 Sample No.: S16  
 Depth (ft): 75-76.5  
 Sample Type: Mod. Cal.  
 Soil Description: Well-Graded Sand w/silt & gravel  
 Test Condition: Inundated

Initial Dry Density: 105.3 pcf  
 Moisture Content (before): 1.9 %  
 Moisture Content (after): 19.5 %



Strength Parameters	Peak	Ultimate
Cohesion (psf):	550	450
Friction Angle:	33 °	33 °





**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/24/13  
 Boring No.: RC-13-009 Checked By AP Date: 05/07/13  
 Sample No.: S07 Depth (ft): 30  
 Description: Well-Graded Sand w/silt, fine-med grained  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	526.79
Total Ring Weight (g)	135.94
Wet Density (pcf)	108.35
Dry Density (pcf)	105.00

Moisture Determination	Before Test	After Test
Cont. Weight (g)	50.35	180.04
Wet Soil+Cont. (g)	134.75	585.03
Dry Soil+Cont. (g)	132.14	514.63
Moisture Content (%)	3.2	21.0
Degree Saturation	14.2	96.9

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

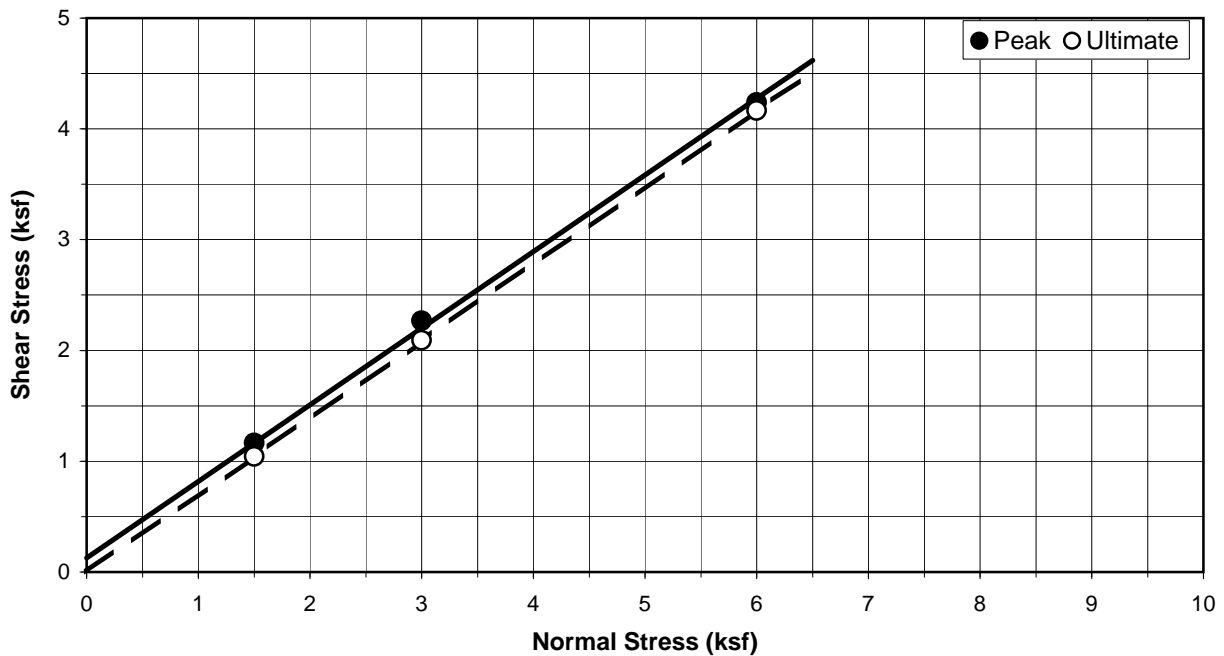
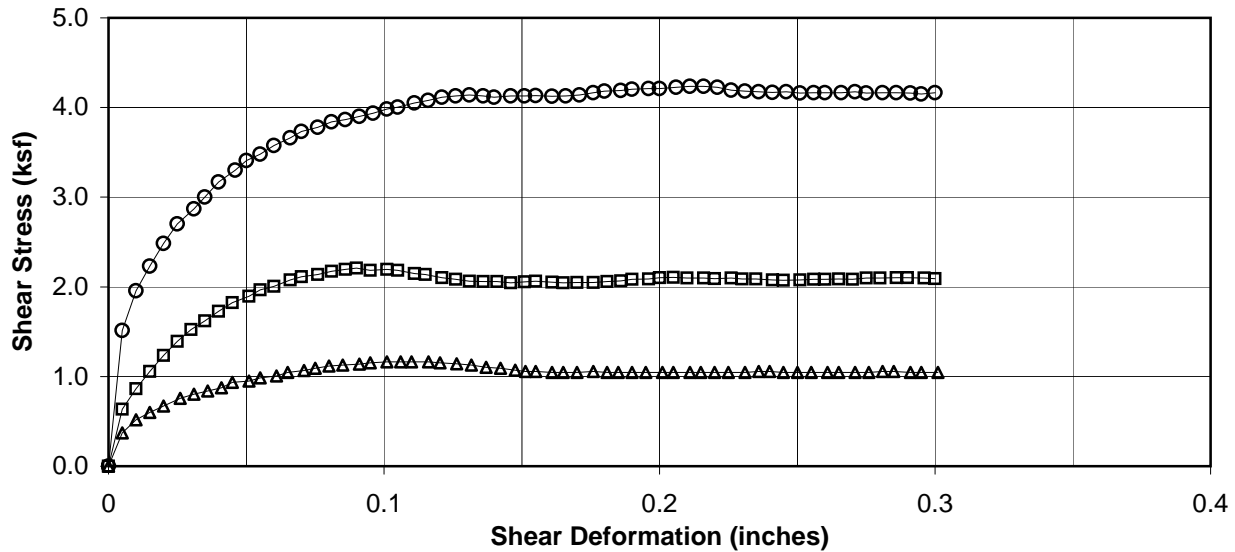
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	178.33	45.82	1.5	1164	1044	
2	176.54	44.71	3.0	2268	2092	
3	171.92	45.41	6.0	4236	4164	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: RC-13-009  
 Sample No.: S07  
 Depth (ft): 30  
 Sample Type: Mod. Cal.  
 Soil Description: Well-Graded Sand w/silt, fine-med grained  
 Test Condition: Inundated

Initial Dry Density: 105.0 pcf  
 Moisture Content (before): 3.2 %  
 Moisture Content (after): 21.0 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	150	0
Friction Angle:	35 °	35 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/24/13  
 Boring No.: RC-13-009 Checked By AP Date: 05/07/13  
 Sample No.: S11 Depth (ft): 50  
 Description: Silty Sand, fine-grained  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	513.57
Total Ring Weight (g)	135.61
Wet Density (pcf)	104.77
Dry Density (pcf)	101.43

Moisture Determination	Before Test	After Test
Cont. Weight (g)	50.17	149.46
Wet Soil+Cont. (g)	78.10	544.78
Dry Soil+Cont. (g)	77.21	468.49
Moisture Content (%)	3.3	23.9
Degree Saturation	13.4	100.4

**METHOD OF SHEARING**

Regular Shearing Shear Rate (in/min): 0.02  
 Residual Shearing 5 Passes Shear Distance (in): 0.3

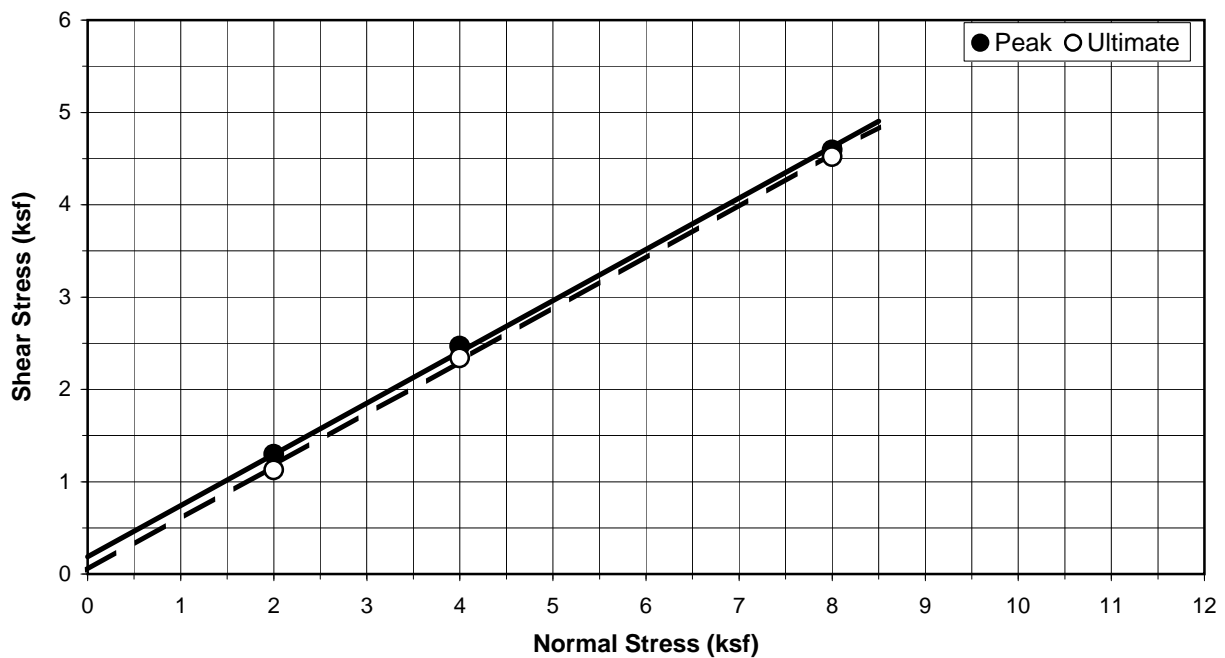
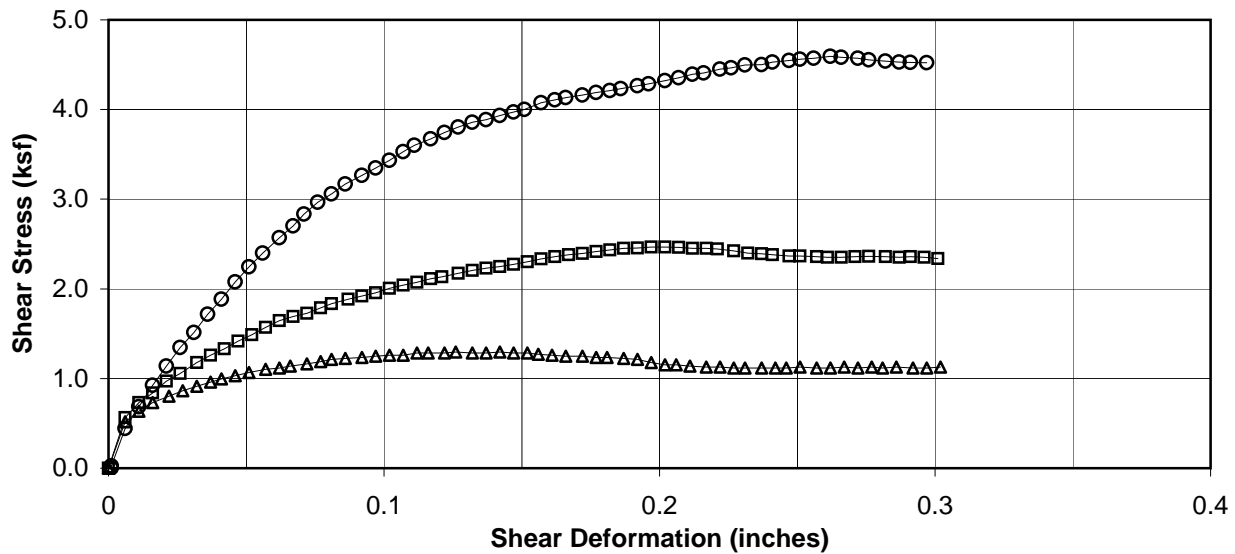
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	175.36	45.49	2.0	1296	1128	
2	169.93	44.91	4.0	2467	2339	
3	168.28	45.21	8.0	4592	4521	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
Boring No.: RC-13-009  
Sample No.: S11  
Depth (ft): 50  
Sample Type: Mod. Cal.  
Soil Description: Silty Sand, fine-grained  
Test Condition: Inundated

Initial Dry Density: 101.4 pcf  
Moisture Content (before): 3.3 %  
Moisture Content (after): 23.9 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	200	50
Friction Angle:	29 °	29 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/24/13  
 Boring No.: RC-13-009 Checked By AP Date: 05/07/13  
 Sample No.: S17 Depth (ft): 80  
 Description: Sandy Silt  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	584.41
Total Ring Weight (g)	138.49
Wet Density (pcf)	123.61
Dry Density (pcf)	110.26

Moisture Determination	Before Test	After Test
Cont. Weight (g)	50.05	150.71
Wet Soil+Cont. (g)	163.68	625.53
Dry Soil+Cont. (g)	151.41	550.12
Moisture Content (%)	12.1	18.9
Degree Saturation	61.8	100.0

**METHOD OF SHEARING**

Regular Shearing Shear Rate (in/min): 0.02  
 Residual Shearing 5 Passes Shear Distance (in): 0.3

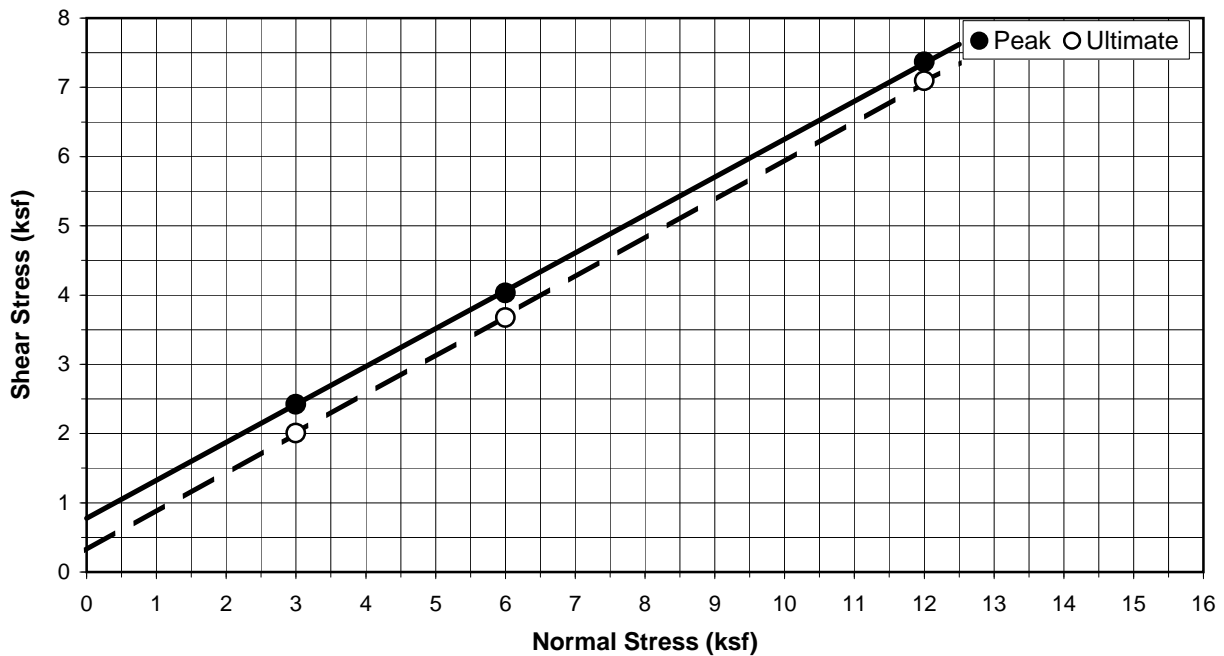
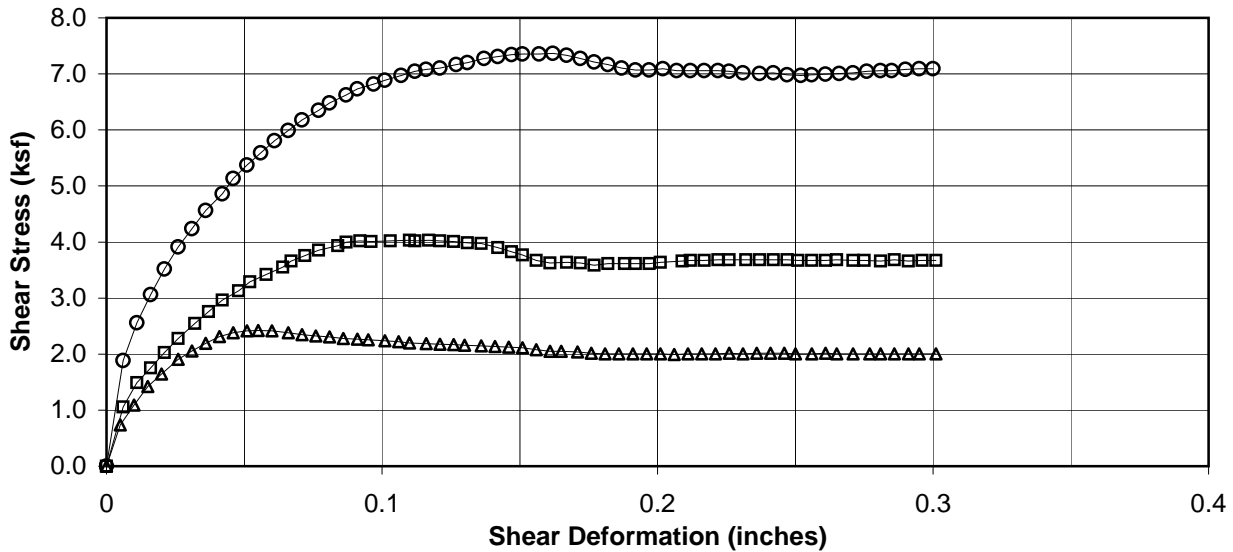
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	199.76	45.58	3.0	2421	2004	
2	195.69	46.51	6.0	4032	3672	
3	188.96	46.40	12.0	7368	7092	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: RC-13-009  
 Sample No.: S17  
 Depth (ft): 80  
 Sample Type: Mod. Cal.  
 Soil Description: Sandy Silt  
 Test Condition: Inundated

Initial Dry Density: 110.3 pcf  
 Moisture Content (before): 12.1 %  
 Moisture Content (after): 18.9 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	800	300
Friction Angle:	29 °	29 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/17/13  
 Boring No.: A-13-020 Checked By AP Date: 05/03/13  
 Sample No.: S03 Depth (ft): 10  
 Description: Silty Sand, fine-grained  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	545.76
Total Ring Weight (g)	135.28
Wet Density (pcf)	113.79
Dry Density (pcf)	99.37

Moisture Determination	Before Test	After Test
Cont. Weight (g)	49.80	142.64
Wet Soil+Cont. (g)	185.01	582.74
Dry Soil+Cont. (g)	167.88	494.55
Moisture Content (%)	14.5	25.1
Degree Saturation	56.3	99.9

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

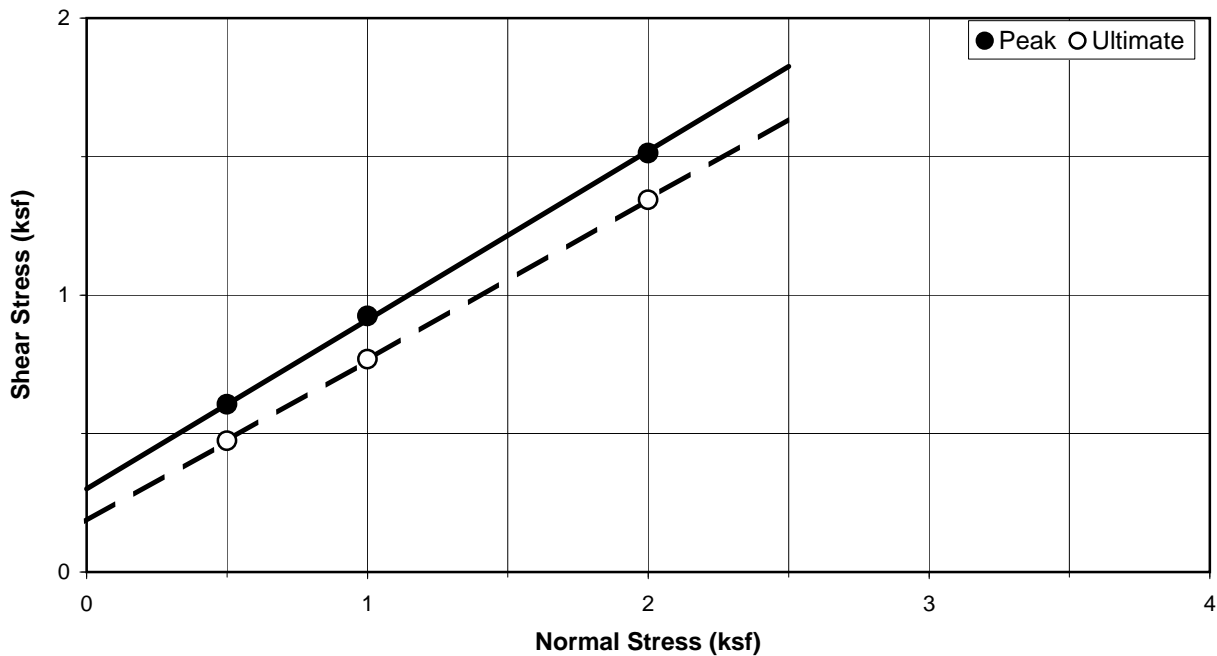
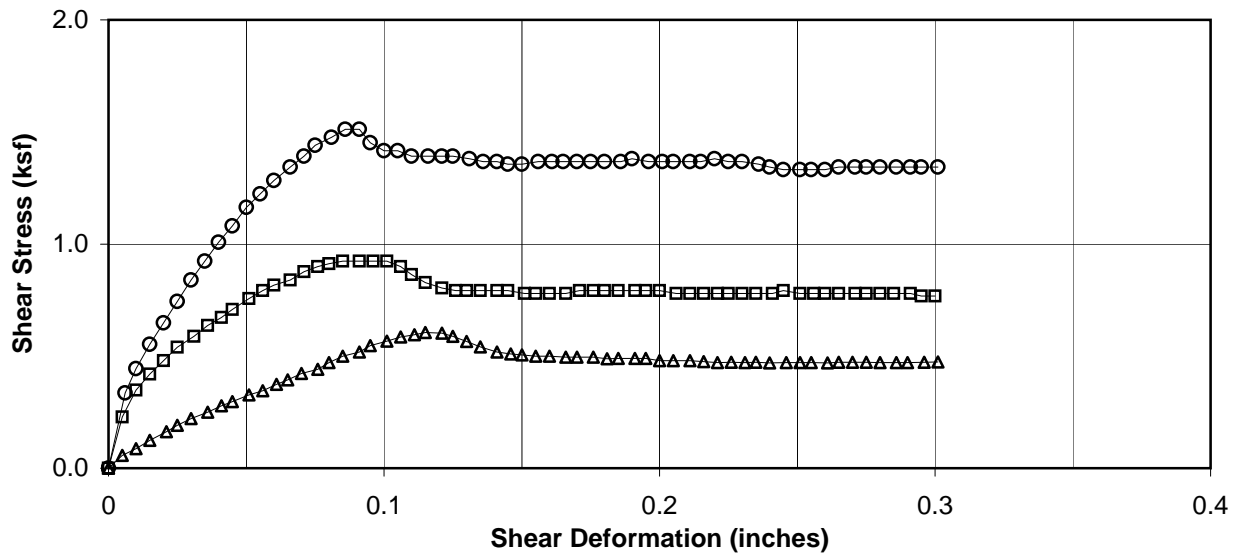
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	182.66	45.09	0.5	605	474	
2	181.95	44.98	1.0	924	768	
3	181.15	45.21	2.0	1512	1344	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: A-13-020  
 Sample No.: S03  
 Depth (ft): 10  
 Sample Type: Mod. Cal.  
 Soil Description: Silty Sand, fine-grained  
 Test Condition: Inundated

Initial Dry Density: 99.4 pcf  
 Moisture Content (before): 14.5 %  
 Moisture Content (after): 25.1 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	300	200
Friction Angle:	31 °	30 °





**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/18/13  
 Boring No.: A-13-020 Checked By AP Date: 05/03/13  
 Sample No.: S05 Depth (ft): 20  
 Description: Silty Sand, fine-grained  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	523.17
Total Ring Weight (g)	135.99
Wet Density (pcf)	107.33
Dry Density (pcf)	100.32

Moisture Determination	Before Test	After Test
Cont. Weight (g)	50.12	149.86
Wet Soil+Cont. (g)	190.34	594.22
Dry Soil+Cont. (g)	181.18	506.64
Moisture Content (%)	7.0	24.5
Degree Saturation	27.7	100.2

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

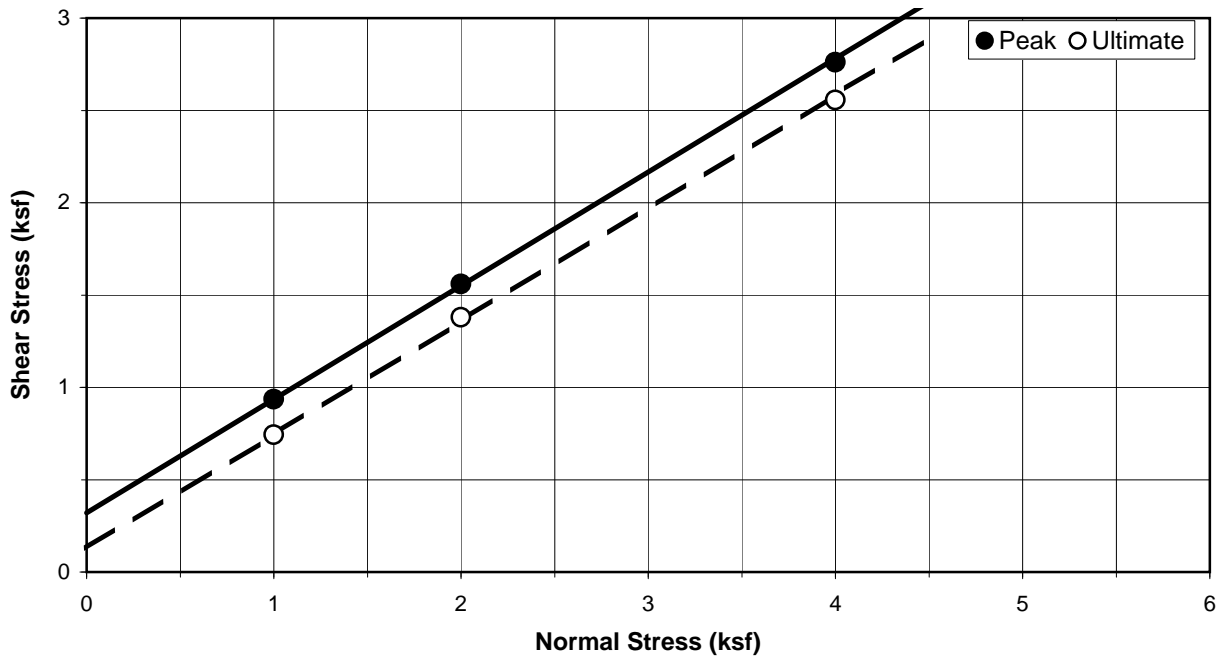
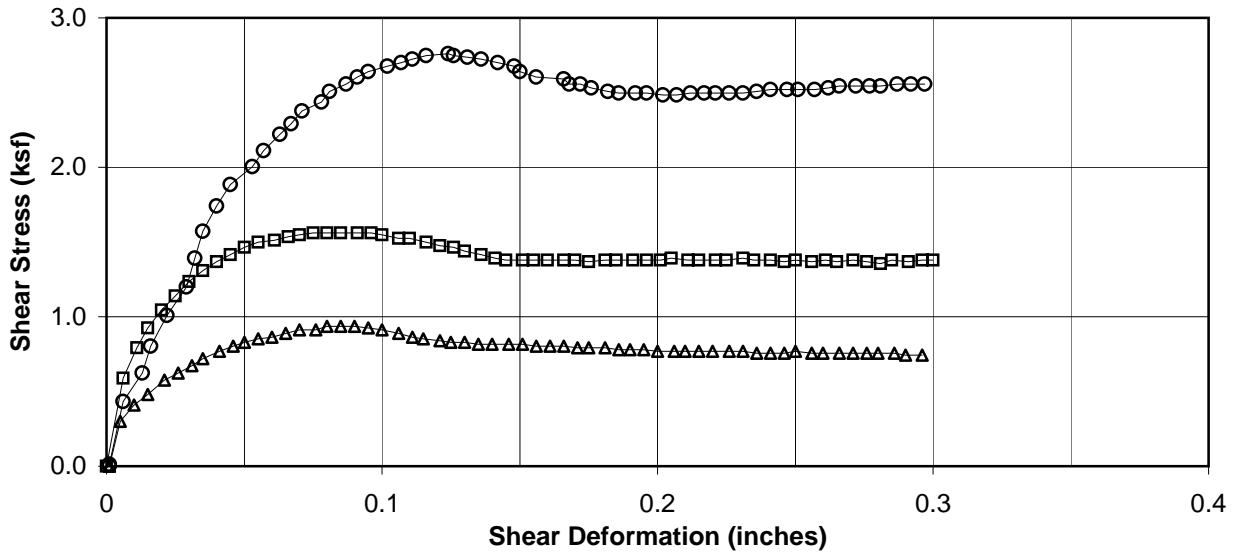
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	174.42	45.39	1.0	936	744	
2	175.59	45.55	2.0	1560	1380	
3	173.16	45.05	4.0	2760	2556	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: A-13-020  
 Sample No.: S05  
 Depth (ft): 20  
 Sample Type: Mod. Cal.  
 Soil Description: Silty Sand, fine-grained  
 Test Condition: Inundated

Initial Dry Density: 100.3 pcf  
 Moisture Content (before): 7.0 %  
 Moisture Content (after): 24.5 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	300	150
Friction Angle:	32 °	32 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/18/13  
 Boring No.: A-13-020 Checked By AP Date: 05/03/13  
 Sample No.: S09 Depth (ft): 40  
 Description: Silty Sand, fine-grained  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	566.28
Total Ring Weight (g)	136.28
Wet Density (pcf)	119.20
Dry Density (pcf)	104.28

Moisture Determination	Before Test	After Test
Cont. Weight (g)	150.33	150.52
Wet Soil+Cont. (g)	312.08	614.09
Dry Soil+Cont. (g)	291.83	530.63
Moisture Content (%)	14.3	22.0
Degree Saturation	62.7	99.2

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

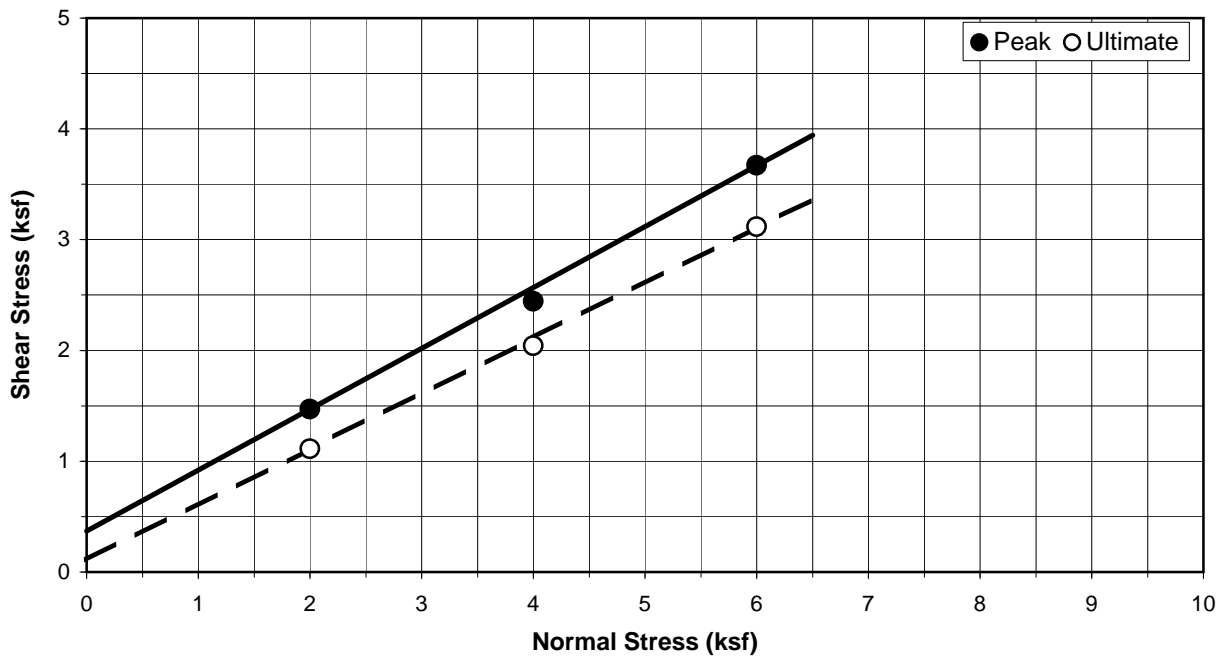
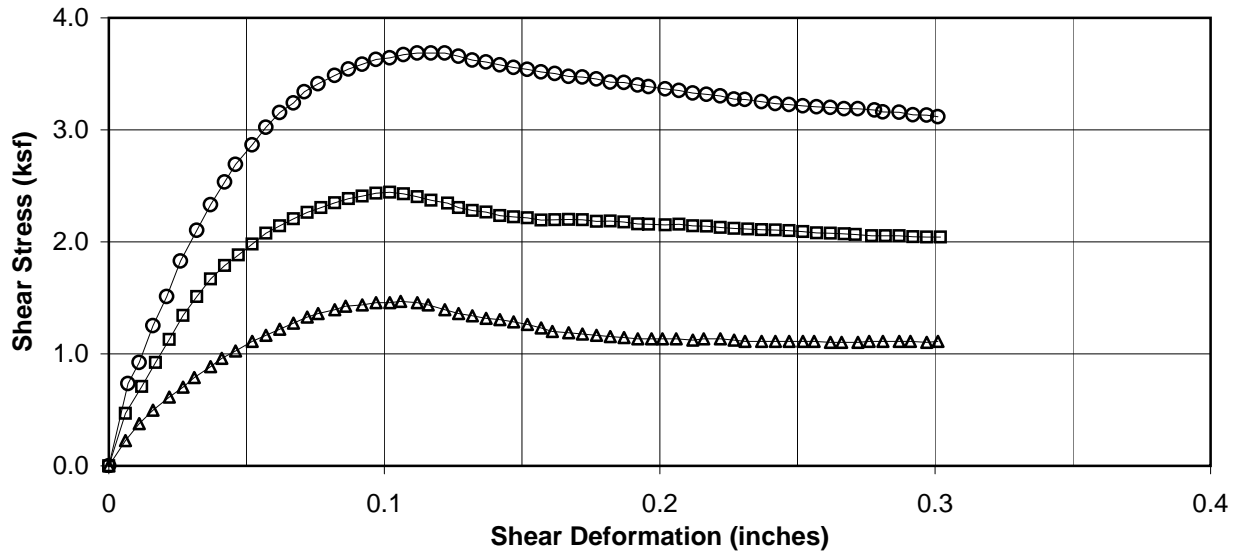
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
<b>1</b>	<b>188.68</b>	<b>45.52</b>	<b>2.0</b>	<b>1469</b>	<b>1112</b>	
<b>2</b>	<b>188.30</b>	<b>45.49</b>	<b>4.0</b>	<b>2444</b>	<b>2042</b>	
<b>3</b>	<b>189.30</b>	<b>45.27</b>	<b>6.0</b>	<b>3672</b>	<b>3116</b>	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: A-13-020  
 Sample No.: S09  
 Depth (ft): 40  
 Sample Type: Mod. Cal.  
 Soil Description: Silty Sand, fine-grained  
 Test Condition: Inundated

Initial Dry Density: 104.3 pcf  
 Moisture Content (before): 14.3 %  
 Moisture Content (after): 22.0 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	350	100
Friction Angle:	29 °	27 °



**DIRECT SHEAR TEST DATA  
ASTM D 3080**

Project Name: SR-710 North Study Tested By DRE Date: 04/18/13  
 Boring No.: A-13-020 Checked By AP Date: 05/03/13  
 Sample No.: S15 Depth (ft): 70  
 Description: Sand w/silt, fine-grained  
 Sample Type: Mod. Cal.  
 Test Condition: Inundated

Sample Diameter (in)	2.415
Sample Height (in)	1.00
Total Soil+Ring Weight(g)	557.03
Total Ring Weight (g)	134.88
Wet Density (pcf)	117.02
Dry Density (pcf)	108.04

Moisture Determination	Before Test	After Test
Cont. Weight (g)	49.86	149.63
Wet Soil+Cont. (g)	208.26	602.69
Dry Soil+Cont. (g)	196.10	527.38
Moisture Content (%)	8.3	19.9
Degree Saturation	40.1	99.4

**METHOD OF SHEARING**

- Regular Shearing  
 Residual Shearing 5 Passes

Shear Rate (in/min): 0.02

Shear Distance (in): 0.3

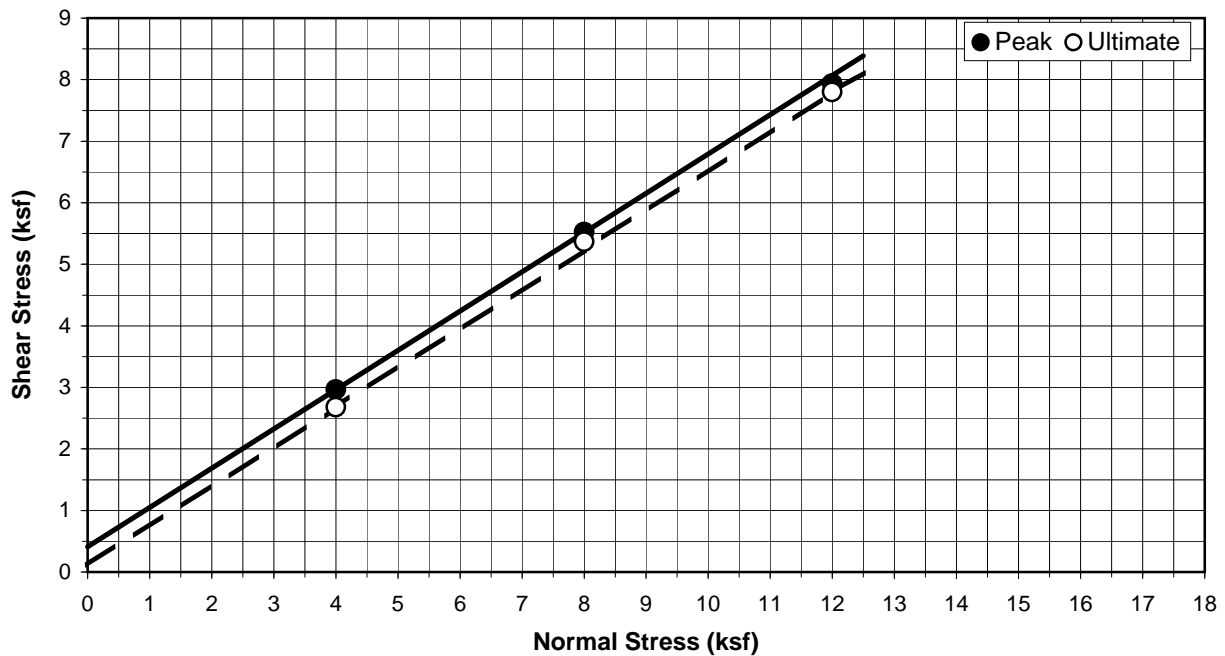
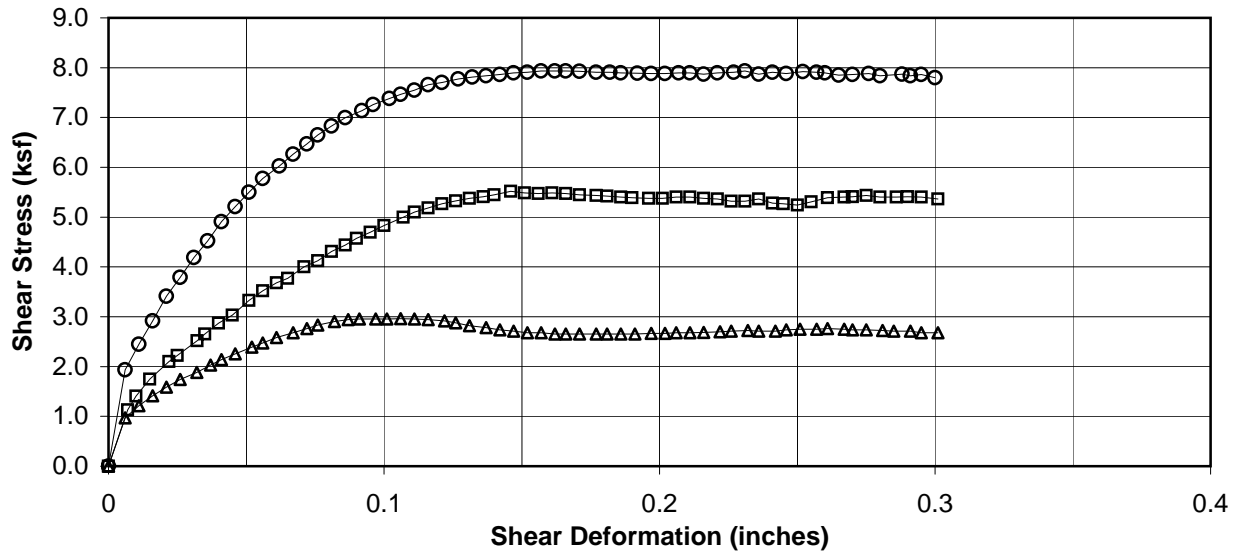
Sample Number	Sample + Ring Wt.	Ring Wt.	Normal Load (ksf)	Max. Shear Reading (psf)	Ultimate Shear Reading (psf)	Remarks
1	190.66	45.30	4.0	2964	2676	
2	186.24	45.02	8.0	5520	5364	
3	180.13	44.56	12.0	7933	7800	



### DIRECT SHEAR TEST RESULTS ASTM D 3080

Project Name: SR-710 North Study  
 Boring No.: A-13-020  
 Sample No.: S15  
 Depth (ft): 70  
 Sample Type: Mod. Cal.  
 Soil Description: Sand w/silt, fine-grained  
 Test Condition: Inundated

Initial Dry Density: 108.0 pcf  
 Moisture Content (before): 8.3 %  
 Moisture Content (after): 19.9 %



<u>Strength Parameters</u>	<u>Peak</u>	<u>Ultimate</u>
Cohesion (psf):	400	100
Friction Angle:	33 °	33 °







# POINT LOAD TEST OF ROCK

<u>Boring Number</u>	<u>Sample Number</u>	<u>Depth ft.</u>	<u>Sample Desc.</u>	<u>Type of Test</u>	<u>Point Load lb.</u>	<u>Index Strength PSI</u>	<u>Size Correction Factor</u>	<u>Corrected Point Load Index</u>
RC-13-005	C28	131.5-132.8	Siltstone	Diametral	41	7	1.10	8
RC-13-007	C30	145.0-145.9	Siltstone	Diametral	151	26	1.10	29
RC-13-007	C40	183.2-184.2	Siltstone	Diametral	172	31	1.09	34

Test Method: ASTM D2216 D5731

**PROJECT NUMBER:**

**13-031**

April 30, 2013

**SR 710 North Study**



5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762  
 Phone: (916) 939-3460 FAX: (916) 939-3507



# POINT LOAD STRENGTH INDEX OF ROCK

<u>Sample Identification</u>	<u>Lab Sample Number</u>	<u>Depth, ft.</u>	<u>Type of Test</u>	<u>Point Load, lb.</u>	<u>Index Strength psi</u>	<u>Size Correction Factor</u>	<u>Corrected Point Load, psi</u>
RC-13-007-C38	S41517	177.4-178.2	Diametral	131	24	1.09	26
RC-13-009-C36	S41519	176.5-179.6	Diametral	56	10	1.10	11
RC-13-009-C44	S41521	207-207.8	Block	74	41	0.82	61
RC-13-009-C44	S41522	210.8-211.2	Diametral	67	12	1.10	13
RC-13-009-C48	S41523	229.6-229.9	Block	81	18	1.04	19
RC-13-009-C53	S41526	255.8-256.5	Diametral	59	10	1.11	11

Test Method: ASTM D5731

Sample Type: Rock Core

**PROJECT NUMBER: 13-031**

**SR 710 North Study**



5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762  
 Phone: (916) 939-3460 FAX: (916) 939-3507



**Earth Mechanics Institute**

Client: CH2MHill

Project Name: SR 710 North Study

Project Number: 428908.02.114.00.03.02

**Colorado School of Mines**

Mining Engineering Department

Date: 06/10/2013	Rock Type	Loading Direction	Length	Average Diameter	Failure Load	Point Load Index Strength				Notes
						Is		Is(50)		
						(psi)	(MPa)	(psi)	(MPa)	
Sample ID			(in)	(in)	(N)					(Failure type)
RC-13-009@210.0-210.8	Granodiorite	Diametric	3.51	2.390	385	15	0.10	17	0.11	Valid
RC-13-009@244.4-244.9	Granodiorite	Diametric	2.75	2.400	825	32	0.22	35	0.24	Valid

**Earth Mechanics Institute**

**Client: CH2MHill**

**Project Name: SR 710 North Study**

**Project Number: 428908.02.114.00.03.02**



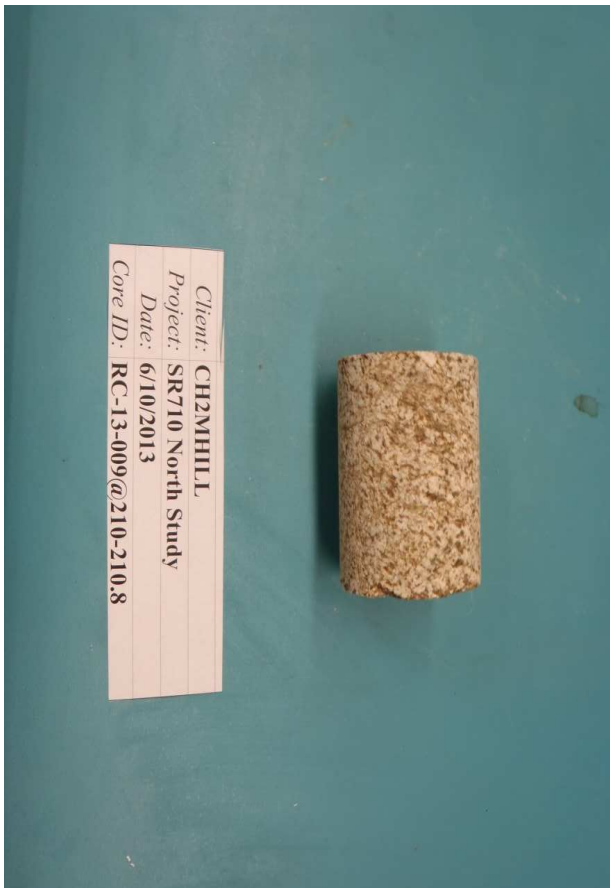
**Colorado School of Mines**

**Mining Engineering Department**

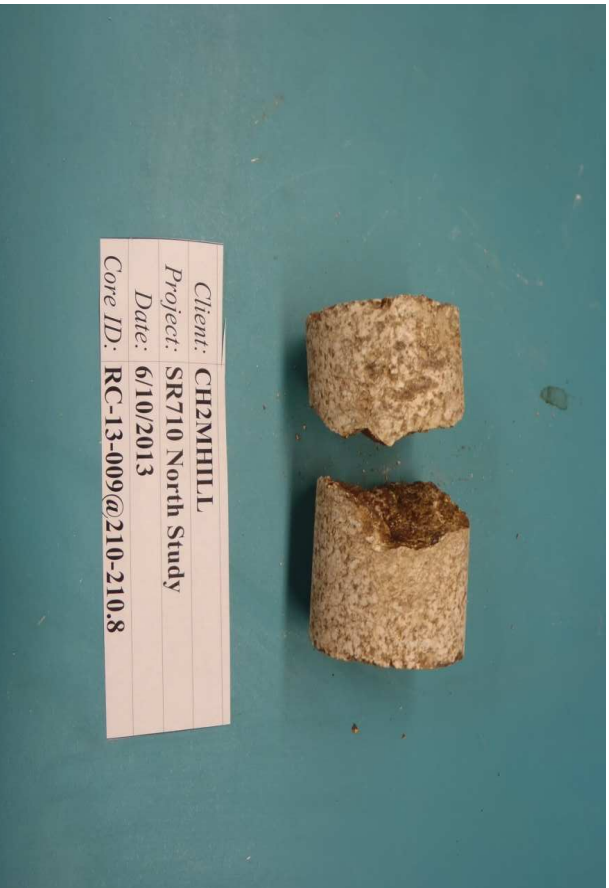
Date: 06/10/2013		
Sample ID	Rock Type	Cerchar Abrasivity Index
RC-13-009@210.0-210.8	Granodiorite	1.9

**Pictures of Sample Before and After  
Point Load Index Strength**

*Client Name:* CH2MHill  
*Project Name:* SR710 North Study  
*Date:* 6/10/2013  
*Sample ID:* RC-13-009@210.0-210.8



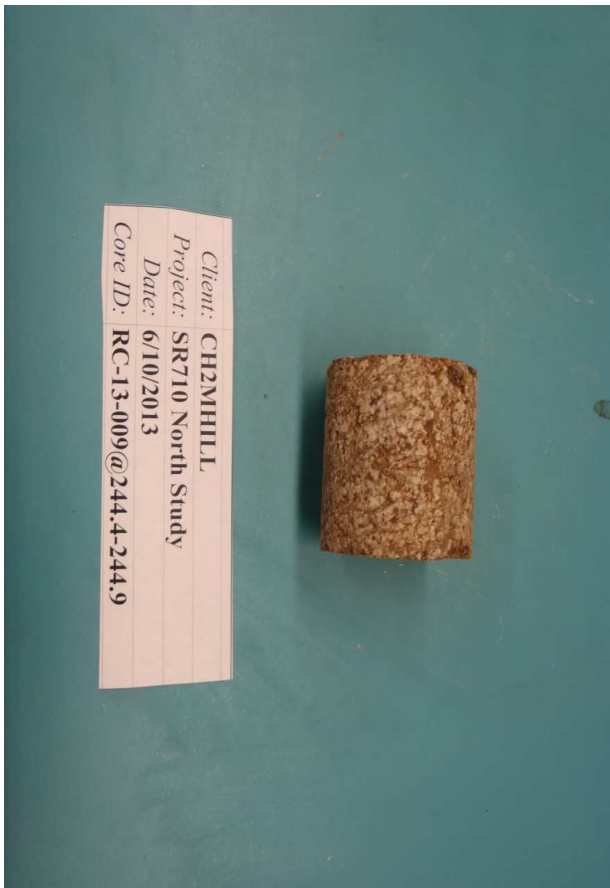
**Before**



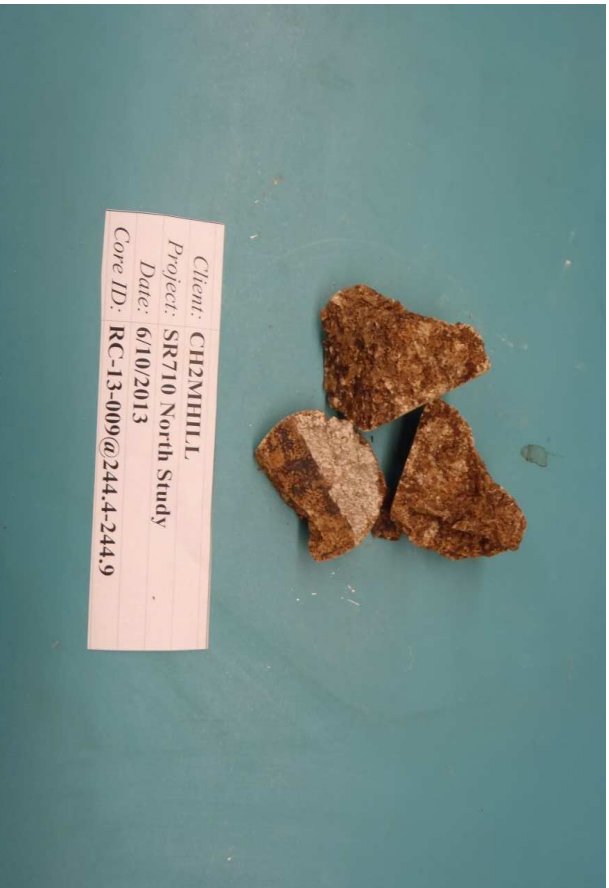
**After**

**Pictures of Sample Before and After**  
**Point Load Index Strength**

*Client Name:* CH2MHILL  
*Project Name:* SR710 North Study  
*Date:* 6/10/2013  
*Sample ID:* RC-13-009@244.4-244.9



**Before**

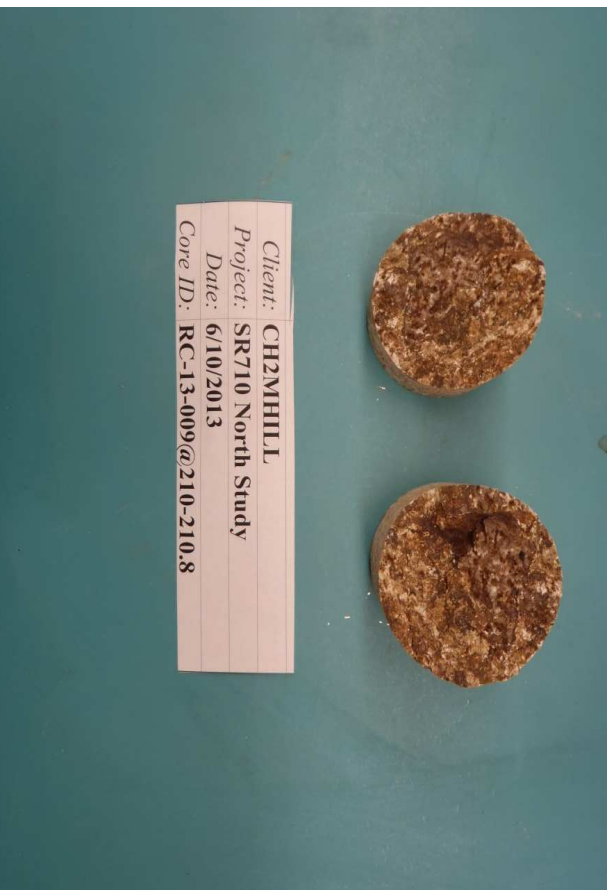


**After**



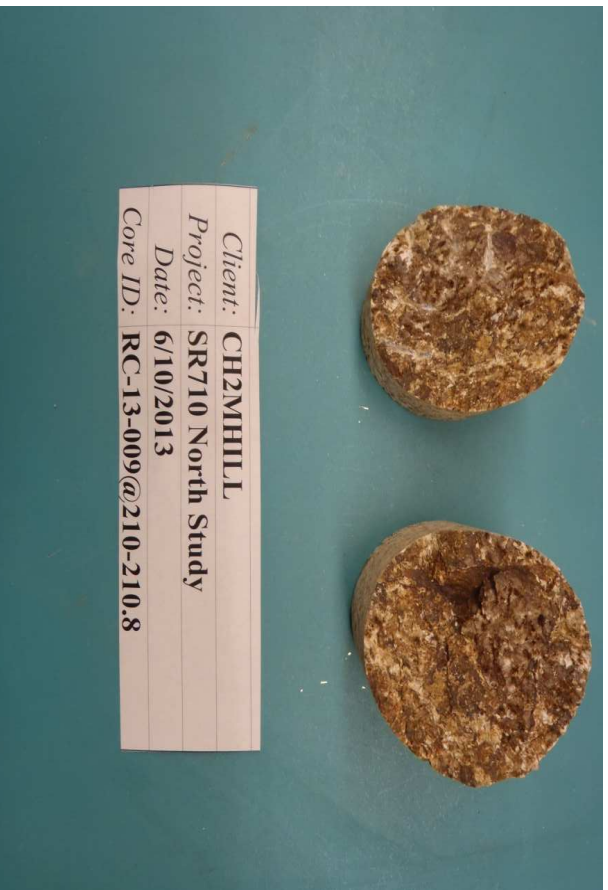
Pictures of Sample Before and After  
Cerchar Abrasivity Index

*Client Name:* CH2MHILL  
*Project Name:* SR710 North Study  
*Date:* 6/10/2013  
*Sample ID:* RC-13-009@210.0-210.8



Before

<i>Client:</i>	CH2MHILL
<i>Project:</i>	SR710 North Study
<i>Date:</i>	6/10/2013
<i>Core ID:</i>	RC-13-009@210-210.8



After

<i>Client:</i>	CH2MHILL
<i>Project:</i>	SR710 North Study
<i>Date:</i>	6/10/2013
<i>Core ID:</i>	RC-13-009@210-210.8



# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: RC-13-004  
 Sample Number: C21 Depth (ft.): 101.1-102.2  
 Description: Siltstone Sample Type: Core

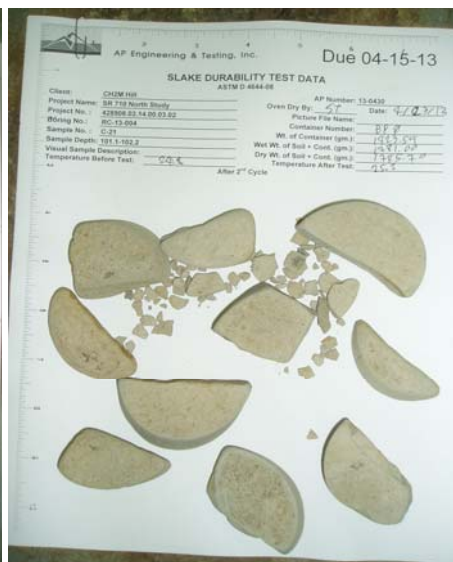
Laboratory No.: 13-0430  
 Date: 04/22/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	P4220003	Picture ID:	P4230007	Picture ID:	P4240009
		Water Temp (1)	23.5	Water Temp (1)	24.8
		Water Temp (2)	23.4	Water Temp (2)	25.2
		Average Temp	23.45	Average Temp	25
Wt. Container	177.36	Wt. Container	1423.59	Wt. Container	1423.59
Wt. Wet+Con.	615.39	Wt. Wet+Con.	1809.34	Wt. Wet+Con.	1781
Wt. Dry+Con.	558.3	Wt. Dry+Con.	1770.09	Wt. Dry+Con.	1745.7
Moisture Content	15.0%			Slake Durability Index, $I_d$ (2)	84.6%

Initial Sample

After First Cycle  
Type II—Large and small fragments.

After Second Cycle  
Type II—Large and small fragments.



# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR 710 North Study  
Project No.: 13-031  
Report Date: April 29, 2013

Client: AP Engineering & Testing Inc

Material Type: Siltstone

Lab Sample No.: S41489

Date Received: 4/15/13

Test Method: ASTM D 4644

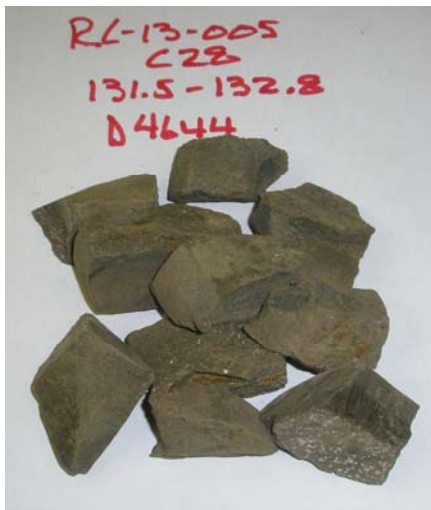
## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
RC-13-005, C28	131.5-132.8	20.0	29.6	<b>58.3</b>	<b>Type II</b>

**Type I** : Retained specimen remains virtually unchanged.

**Type II** : Retained specimen consists of large and small fragments.

**Type III** : Retained specimen is exclusively small fragments.





# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: RC-13-005 Depth (ft.): 138.2-139.3  
 Sample Number: C29 Sample Type: Core  
 Description: Siltstone

Laboratory No.: 13-0370  
 Date: 04/11/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	P411012	Picture ID:	P4130019	Picture ID:	P4150021
		Water Temp (1)	24.3	Water Temp (1)	21.1
		Water Temp (2)	24.1	Water Temp (2)	21.6
		Average Temp	24.2	Average Temp	21.35
Wt. Container	229.8	Wt. Container	1467.13	Wt. Container	1467.13
Wt. Wet+Con.	756.64	Wt. Wet+Con.	1817.73	Wt. Wet+Con.	1740.21
Wt. Dry+Con.	638.82	Wt. Dry+Con.	1741.91	Wt. Dry+Con.	1664.71
Moisture Content	28.8%			Slake Durability Index, $I_d$ (2)	48.3%

Initial Sample

After First Cycle  
Type II Large and Small Fragments

After Second Cycle  
Type II Large and Small Fragments





# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: RC-13-005  
 Sample Number: C30 Depth (ft.): 141.5-142.2  
 Description: Siltstone Sample Type: Core

Laboratory No.: 13-0370  
 Date: 04/15/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	P415013	Picture ID:	P4160010	Picture ID:	P4170011
		Water Temp (1)	19.5	Water Temp (1)	20.8
		Water Temp (2)	19.6	Water Temp (2)	21.8
		Average Temp	19.55	Average Temp	21.3
Wt. Container	147.34	Wt. Container	1465.04	Wt. Container	1465.04
Wt. Wet+Con.	560.04	Wt. Wet+Con.	1948.08	Wt. Wet+Con.	1870.42
Wt. Dry+Con.	471.67	Wt. Dry+Con.	1863.36	Wt. Dry+Con.	1776.99
Moisture Content	27.2%			Slake Durability Index, $I_d$ (2)	96.2%

Initial Sample

After First Cycle  
Type II Large and Small Fragments

After Second Cycle  
Type II Large and Small Fragments



# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR 710 North Study

Client: AP Engineering & Testing Inc

Project No.: 13-031

Report Date: April 29, 2013

Material Type: Siltstone

Lab Sample No.: S41490

Date Received: 4/15/13

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
RC-13-005, C40	178.8-180	20.0	11.0	<b>47.9</b>	<b>Type II</b>

**Type I** : Retained specimen remains virtually unchanged.

**Type II** : Retained specimen consists of large and small fragments.

**Type III** : Retained specimen is exclusively small fragments.





# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: RC-13-005  
 Sample Number: C41 Depth (ft.): 183.4-184.2  
 Description: Siltstone Sample Type: Core

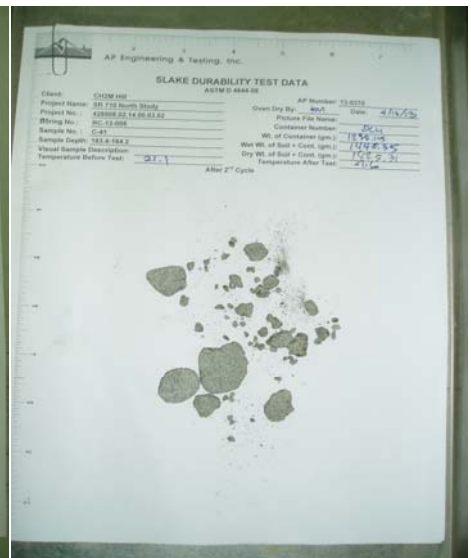
Laboratory No.: 13-0370  
 Date: 04/11/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	P411014	Picture ID:	P4130020	Picture ID:	P4150001
		Water Temp (1)	24.3	Water Temp (1)	21.1
		Water Temp (2)	24.1	Water Temp (2)	21.6
		Average Temp	24.2	Average Temp	21.35
Wt. Container	177.38	Wt. Container	1414.71	Wt. Container	1414.71
Wt. Wet+Con.	626.51	Wt. Wet+Con.	1565.59	Wt. Wet+Con.	1440.35
Wt. Dry+Con.	603.26	Wt. Dry+Con.	1536.6	Wt. Dry+Con.	1425.31
Moisture Content	5.5%			Slake Durability Index, $I_d$ (2)	2.5%

Initial Sample

After First Cycle  
Type II Large and Small Fragments

After Second Cycle  
Type II Large and Small Fragments





# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: R-13-006  
 Sample Number: S16-B Depth (ft.): 75  
 Description: Claystone Sample Type: Mod Cal

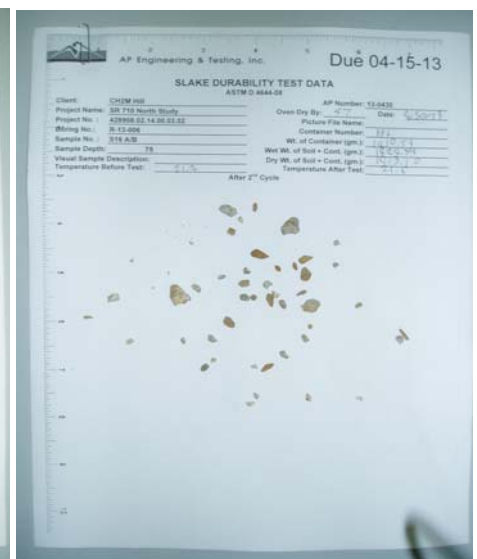
Laboratory No.: 13-0430  
 Date: 04/26/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	P4260014	Picture ID:	P4300001	Picture ID:	P5010002
		Water Temp (1)	24.6	Water Temp (1)	21.7
		Water Temp (2)	25.2	Water Temp (2)	21.6
		Average Temp	24.9	Average Temp	21.65
Wt. Container	186.93	Wt. Container	1410.53	Wt. Container	1410.53
Wt. Wet+Con.	657	Wt. Wet+Con.	1447.63	Wt. Wet+Con.	1424.39
Wt. Dry+Con.	570.13	Wt. Dry+Con.	1433.33	Wt. Dry+Con.	1413.1
Moisture Content	22.7%			Slake Durability Index, $I_d$ (2)	0.7%

Initial Sample

After First Cycle  
Type III Exclusively small fragments

After Second Cycle  
Type III Exclusively small fragments







# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: R-13-006  
 Sample Number: S21-A Depth (ft.): 100  
 Description: Claystone Sample Type: Mod Cal

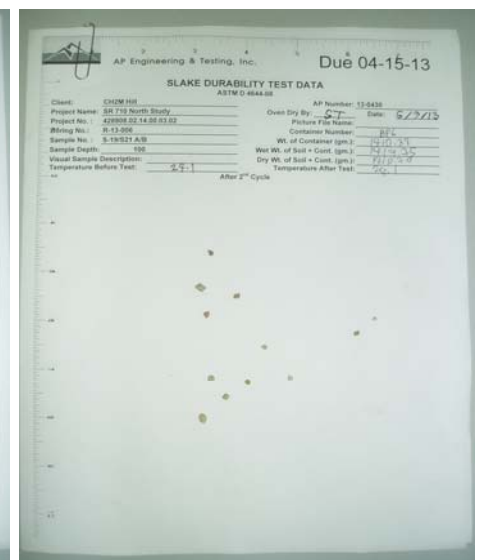
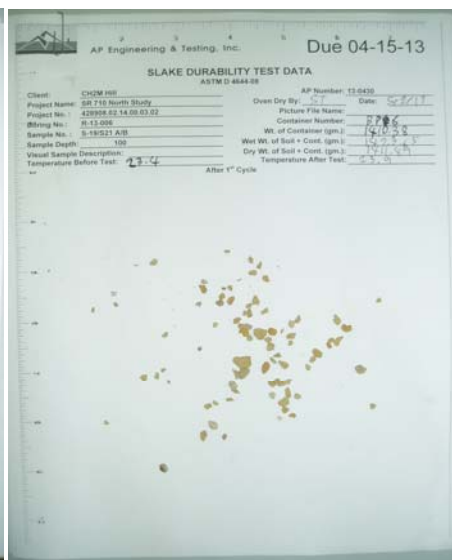
Laboratory No.: 13-0430  
 Date: 05/01/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	P5010007	Picture ID:	P5030010	Picture ID:	P5060001
		Water Temp (1)	23.4	Water Temp (1)	24.1
		Water Temp (2)	23.9	Water Temp (2)	24.1
		Average Temp	23.65	Average Temp	24.1
Wt. Container	181.28	Wt. Container	1410.38	Wt. Container	1410.38
Wt. Wet+Con.	699.66	Wt. Wet+Con.	1423.65	Wt. Wet+Con.	1419.75
Wt. Dry+Con.	580.34	Wt. Dry+Con.	1411.49	Wt. Dry+Con.	1410.7
Moisture Content	29.9%			Slake Durability Index, $I_d$ (2)	0.1%

Initial Sample

After First Cycle  
Type III Exclusively small fragments

After Second Cycle  
Type III Exclusively small fragments





# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: RC-13-007  
 Sample Number: C26 Depth (ft.): 124.4-125.2  
 Description: Claystone Sample Type: Core

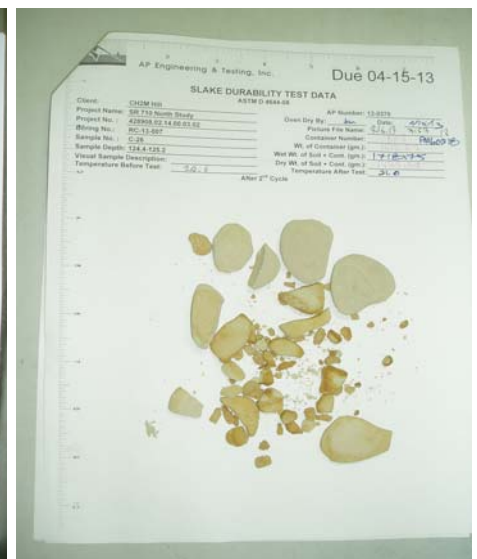
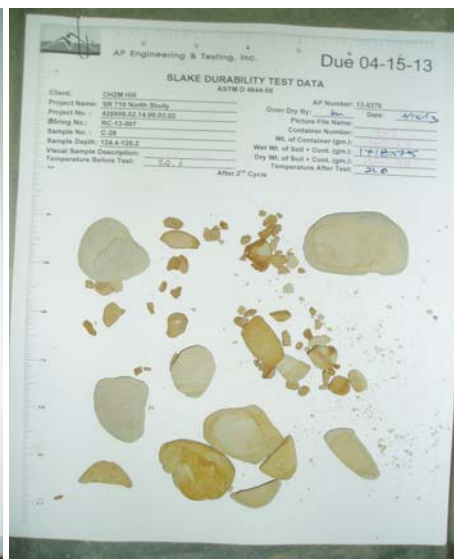
Laboratory No.: 13-0370  
 Date: 04/12/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	P4120017	Picture ID:	P4150018	Picture ID:	P4160018
		Water Temp (1)	20.3	Water Temp (1)	20.6
		Water Temp (2)	20.8	Water Temp (2)	21
		Average Temp	20.55	Average Temp	20.8
Wt. Container	175.16	Wt. Container	1412.52	Wt. Container	1412.52
Wt. Wet+Con.	700.79	Wt. Wet+Con.	1621.33	Wt. Wet+Con.	1718.75
Wt. Dry+Con.	609.75	Wt. Dry+Con.	1567.97	Wt. Dry+Con.	1472.79
Moisture Content	20.9%			Slake Durability	13.9%
				Index, I <sub>d</sub> (2)	

Initial Sample

After First Cycle  
Type II Large and small fragments

After Second Cycle  
Type II Large and small fragments





# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: RC-13-007  
 Sample Number: C29 Depth (ft.): 137.8-138.6  
 Description: Siltstone Sample Type: Core

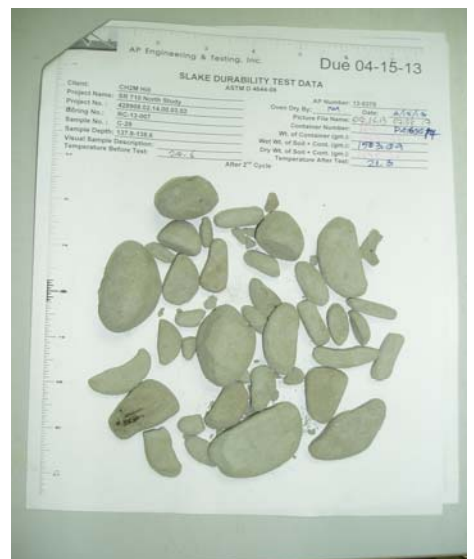
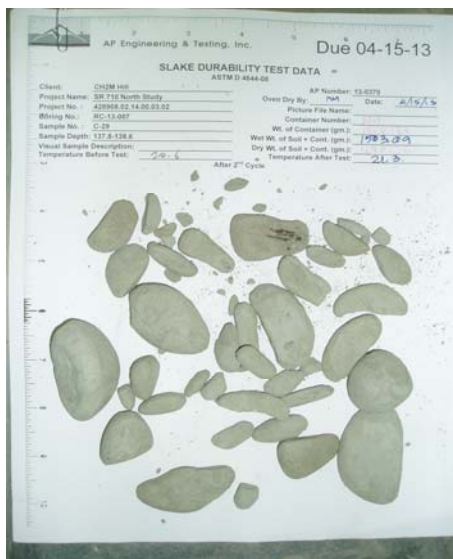
Laboratory No.: 13-0370  
 Date: 04/12/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	P4120018	Picture ID:	P4150017	Picture ID:	P4160018
		Water Temp (1)	20.3	Water Temp (1)	20.6
		Water Temp (2)	20.5	Water Temp (2)	21.3
		Average Temp	20.4	Average Temp	20.95
Wt. Container	175.2	Wt. Container	1464.87	Wt. Container	1464.87
Wt. Wet+Con.	632.5	Wt. Wet+Con.	1853.42	Wt. Wet+Con.	1503.09
Wt. Dry+Con.	578.76	Wt. Dry+Con.	1798.62	Wt. Dry+Con.	1670.26
Moisture Content	13.3%			Slake Durability	50.9%
				Index, I <sub>d</sub> (2)	

Initial Sample

After First Cycle  
Type II Large and small fragments

After Second Cycle  
Type II Large and small fragments





# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: RC-13-007  
 Sample Number: C32 Depth (ft.): 152.9-153.7  
 Description: Claystone Sample Type: Core

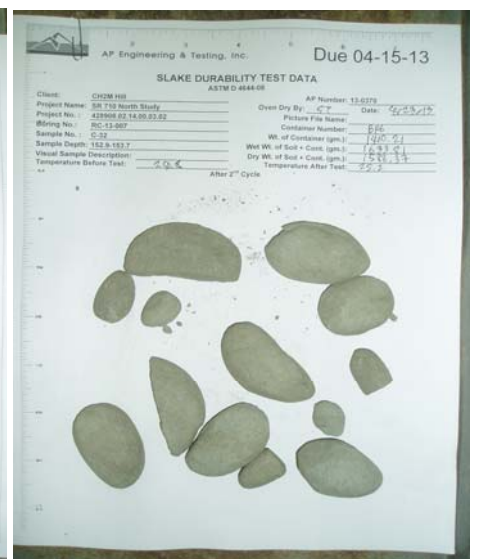
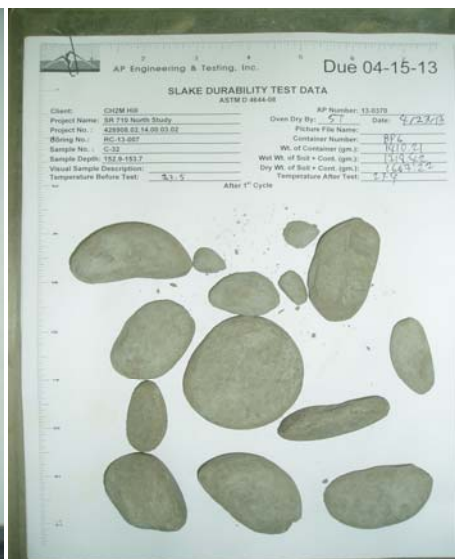
Laboratory No.: 13-0370  
 Date: 04/22/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	P4130001	Picture ID:	P230006	Picture ID:	P4240008
		Water Temp (1)	23.5	Water Temp (1)	24.8
		Water Temp (2)	23.4	Water Temp (2)	25.2
		Average Temp	23.45	Average Temp	25
Wt. Container	175.21	Wt. Container	1410.21	Wt. Container	1410.21
Wt. Wet+Con.	620.7	Wt. Wet+Con.	1718.42	Wt. Wet+Con.	1633.81
Wt. Dry+Con.	542.5	Wt. Dry+Con.	1667.22	Wt. Dry+Con.	1588.37
Moisture Content	21.3%			Slake Durability	48.5%
				Index, I <sub>d</sub> (2)	

Initial Sample

After First Cycle  
Type II Large and small fragments

After Second Cycle  
Type II Large and small fragments





# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: RC-13-007  
 Sample Number: C37 Depth (ft.): 172.9-173.6  
 Description: Claystone Sample Type: Core

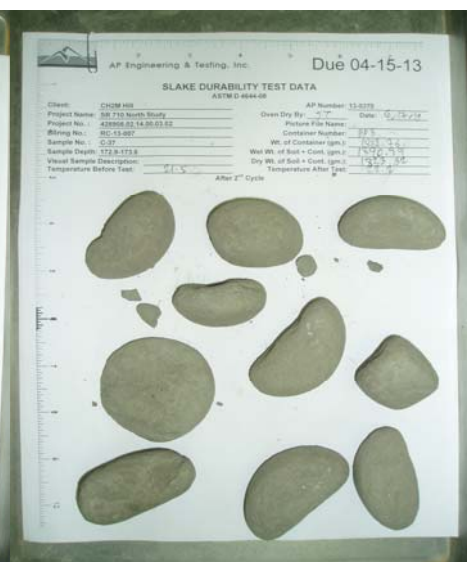
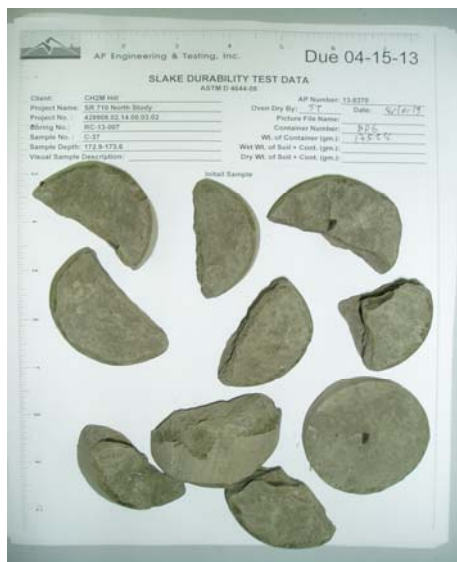
Laboratory No.: 13-0370  
 Date: 04/16/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	P4160021	Picture ID:	P4170005	Picture ID:	P4180007
		Water Temp (1)	19.5	Water Temp (1)	21.5
		Water Temp (2)	19.6	Water Temp (2)	22.2
		Average Temp	19.55	Average Temp	21.85
Wt. Container	175.24	Wt. Container	1412.76	Wt. Container	1412.76
Wt. Wet+Con.	837.93	Wt. Wet+Con.	1992.82	Wt. Wet+Con.	1890.99
Wt. Dry+Con.	747.79	Wt. Dry+Con.	1927.52	Wt. Dry+Con.	1823.32
Moisture Content	15.7%	Slake Durability <sub>1</sub>	89.9%	Slake Durability Index, I <sub>d</sub> (2)	71.7%

Initial Sample

After First Cycle  
Type I: Pieces virtually unchanged.

After Second Cycle  
Type I: Pieces virtually unchanged.



# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR 710 North Study  
Project No.: 13-031  
Report Date: April 29, 2013

Client: AP Engineering & Testing Inc

Material Type: Siltstone

Lab Sample No.: S41497

Date Received: 4/15/13

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
RC-13-007, C40	183.2-184.2	20.0	23.5	5.4	Type III

**Type I :** Retained specimen remains virtually unchanged.

**Type II :** Retained specimen consists of large and small fragments.

**Type III :** Retained specimen is exclusively small fragments.



# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR 710 North Study  
Project No.: 13-031  
Report Date: April 29, 2013

Client: AP Engineering & Testing Inc

Material Type: Siltstone

Lab Sample No.: S41498

Date Received: 4/15/13

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
RC-13-007, C43	198.1-199	20.0	20.4	14.1	Type III

**Type I :** Retained specimen remains virtually unchanged.

**Type II :** Retained specimen consists of large and small fragments.

**Type III :** Retained specimen is exclusively small fragments.





# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: RC-13-007  
 Sample Number: C46 Depth (ft.): 205.2-206  
 Description: Claystone Sample Type: Core

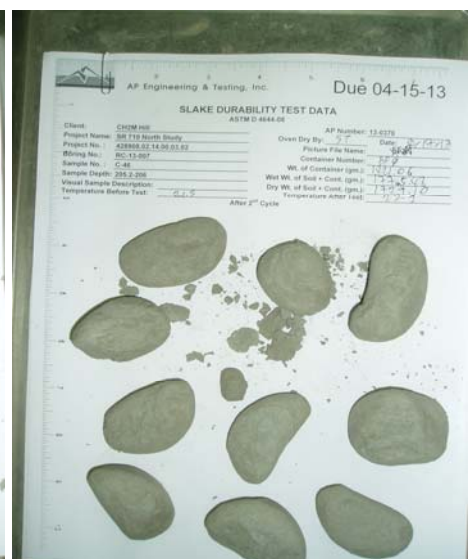
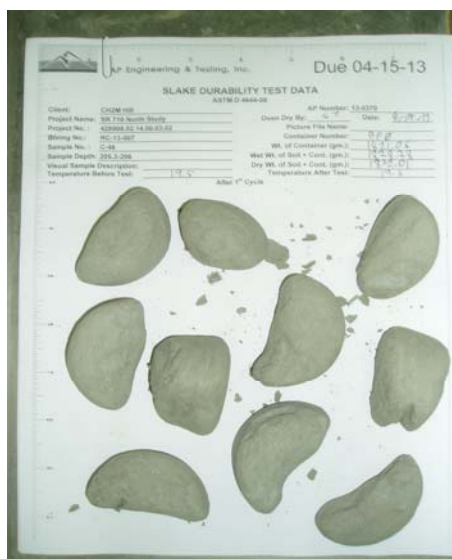
Laboratory No.: 13-0370  
 Date: 04/16/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	IMG_3604	Picture ID:	P4170006	Picture ID:	P4180008
		Water Temp (1)	19.5	Water Temp (1)	21.5
		Water Temp (2)	19.6	Water Temp (2)	22.2
		Average Temp	19.55	Average Temp	21.85
Wt. Container	177.34	Wt. Container	1421.06	Wt. Container	1421.06
Wt. Wet+Con.	753.07	Wt. Wet+Con.	1878.78	Wt. Wet+Con.	1775.48
Wt. Dry+Con.	647.67	Wt. Dry+Con.	1832.01	Wt. Dry+Con.	1729.1
Moisture Content	22.4%			Slake Durability Index, $I_d$ (2)	65.5%

Initial Sample

After First Cycle  
Type II: Large and small fragments

After Second Cycle  
Type II: Large and small fragments.





# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR 710 North Study  
Project No.: 13-031  
Report Date: April 29, 2013

Client: AP Engineering & Testing Inc

Material Type: Siltstone

Lab Sample No.: S41502

Date Received: 4/15/13

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
RC-13-007, C50	225.8-227	20.0	20.6	32.6	Type II

**Type I :** Retained specimen remains virtually unchanged.

**Type II :** Retained specimen consists of large and small fragments.

**Type III :** Retained specimen is exclusively small fragments.





# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: RC-13-007  
 Sample Number: C59 Depth (ft.): 265.8-266.6  
 Description: Siltstone Sample Type: Core

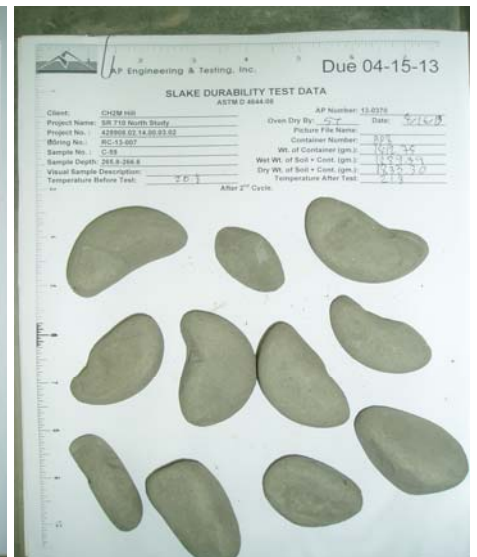
Laboratory No.: 13-0370  
 Date: 04/15/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	P4150014	Picture ID:	P4160009	Picture ID:	P4170012
		Water Temp (1)	19.5	Water Temp (1)	20.8
		Water Temp (2)	19.6	Water Temp (2)	21.8
		Average Temp	19.55	Average Temp	21.3
Wt. Container	177.42	Wt. Container	1412.75	Wt. Container	1412.75
Wt. Wet+Con.	792.67	Wt. Wet+Con.	1932.08	Wt. Wet+Con.	1889.39
Wt. Dry+Con.	685.71	Wt. Dry+Con.	1877.88	Wt. Dry+Con.	1833.3
Moisture Content	21.0%			Slake Durability Index, $I_d$ (2)	82.7%

Initial Sample

After First Cycle  
Type I: Pieces virtually unchanged.

After Second Cycle  
Type I: Pieces virtually unchanged.





# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: A-13-021  
 Sample Number: S15 Depth (ft.): 70  
 Description: Siltstone Sample Type: Mod Cal

Laboratory No.: 13-0430  
 Date: 05/07/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	P4070005	Picture ID:	P5090001	Picture ID:	P5100003
		Water Temp (1)	21.5	Water Temp (1)	22.3
		Water Temp (2)	21.8	Water Temp (2)	22.3
		Average Temp	21.65	Average Temp	22.3
Wt. Container	185.74	Wt. Container	1410.47	Wt. Container	1410.47
Wt. Wet+Con.	721.34	Wt. Wet+Con.	1513.4	Wt. Wet+Con.	1503.08
Wt. Dry+Con.	591.02	Wt. Dry+Con.	1481.15	Wt. Dry+Con.	1472.83
Moisture Content	32.2%			Slake Durability Index, $I_d$ (2)	15.4%

Initial Sample

After First Cycle  
Type III Exclusively small fragments

After Second Cycle  
Type III Exclusively small fragments





# SLAKE DURABILITY ASTM D 4644-08

Client: CH2M Hill  
 Project Name: SR 710 North Study  
 Project Number: 428908.02.14.00.03.02  
 Boring Number: A-13-021  
 Sample Number: S19 Depth (ft.): 90  
 Description: Siltstone Sample Type: Mod Cal

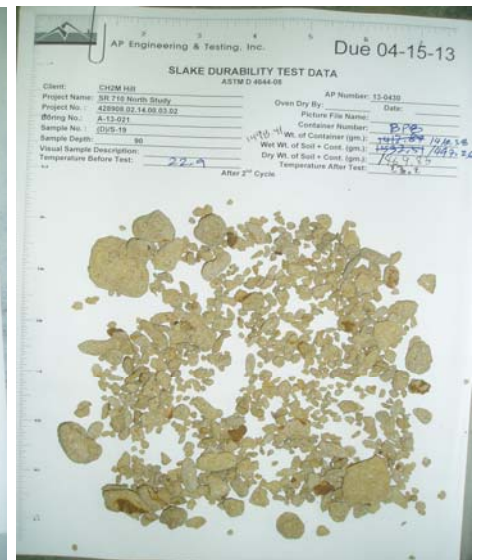
Laboratory No.: 13-0430  
 Date: 05/17/13

Initial Sample		After First Cycle		After Second Cycle	
Picture ID:	P4170019	Picture ID:	P4180017	Picture ID:	P4190018
		Water Temp (1)	19.8	Water Temp (1)	22.9
		Water Temp (2)	20.1	Water Temp (2)	23.2
		Average Temp	19.95	Average Temp	23.05
Wt. Container	177.36	Wt. Container	1412.87	Wt. Container	1410.38
Wt. Wet+Con.	688.07	Wt. Wet+Con.	1532.51	Wt. Wet+Con.	1497.26
Wt. Dry+Con.	598.93	Wt. Dry+Con.	1498.34	Wt. Dry+Con.	1469.83
Moisture Content	21.1%			Slake Durability Index, I <sub>d</sub> (2)	14.1%

Initial Sample

After First Cycle  
Type II Large and small fragments

After Second Cycle  
Type II Large and small fragments





**AP Engineering & Testing, Inc.**

**UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850**

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: A-13-001  
 Sample No.: S04 Depth (feet): 15  
 Soil Description: Sandy Lean Clay

Tested By: ST Date: 04/01/13  
 Checked by: AP Date: 05/20/13

Sample Type: Mod Cal

Sample Diameter (inch): 2.413  
 Sample Height (inch): 5.880  
 Sample Weight (gms): 867.98  
 Wt. Wet Soil+Container(gms): 656.64  
 Wt. Dry Soil+Container(gms): 552.79  
 Wt. Container (gms): 147.56



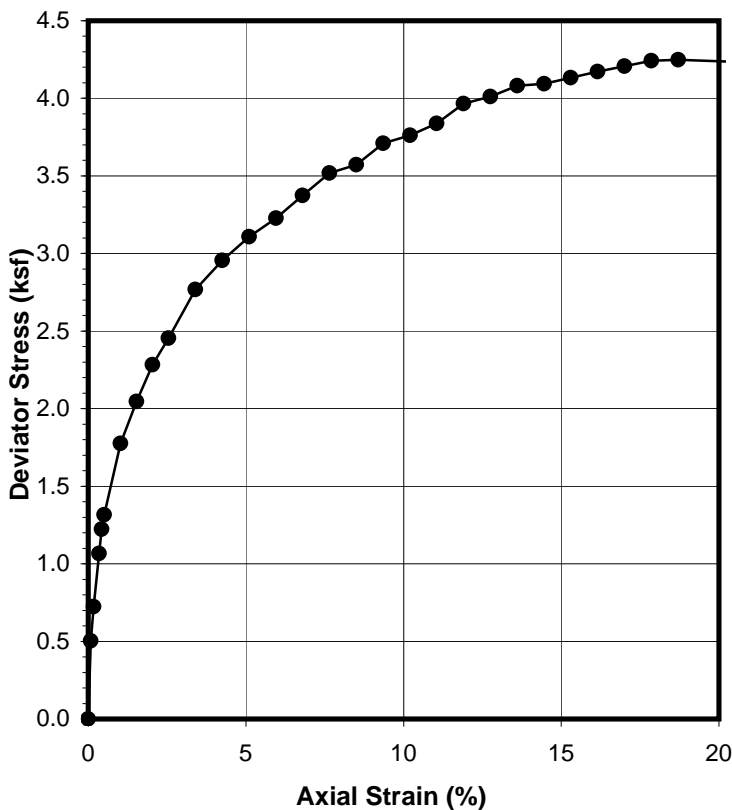
Wet Unit Weight (pcf): 122.9  
 Dry Unit Weight (pcf): 97.8  
 Moisture Content (%): 25.6  
 Void Ratio for Gs=2.7: 0.72  
 % Saturation: 95.8

**TEST DATA**

Cell Pressure (ksf): 1.50  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 1.50  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 4.25  
 Ultimate Deviator Stress (ksf): 4.24  
 Ultimate Undrained Shear Strength (ksf): 2.12  
 Axial Strain @ Maximum Stress (%): 18.71



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.57	0.00	0.00
16	0.005	4.58	0.50	0.09
23	0.010	4.58	0.72	0.17
34	0.020	4.59	1.07	0.34
39	0.025	4.59	1.22	0.43
42	0.030	4.60	1.32	0.51
57	0.060	4.62	1.78	1.02
66	0.090	4.64	2.05	1.53
74	0.120	4.67	2.28	2.04
80	0.150	4.69	2.45	2.55
91	0.200	4.73	2.77	3.40
98	0.250	4.78	2.95	4.25
104	0.300	4.82	3.11	5.10
109	0.350	4.86	3.23	5.95
115	0.400	4.91	3.37	6.80
121	0.450	4.95	3.52	7.65
124	0.500	5.00	3.57	8.50
130	0.550	5.04	3.71	9.35
133	0.600	5.09	3.76	10.20
137	0.650	5.14	3.84	11.05
143	0.700	5.19	3.97	11.90
146	0.750	5.24	4.01	12.76
150	0.800	5.29	4.08	13.61
152	0.850	5.35	4.09	14.46
155	0.900	5.40	4.13	15.31
158	0.950	5.45	4.17	16.16
161	1.000	5.51	4.21	17.01
164	1.050	5.57	4.24	17.86
166	1.100	5.63	4.25	18.71
169	1.200	5.75	4.24	20.41





**AP Engineering & Testing, Inc.**

**UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850**

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: A-13-001  
 Sample No.: S06 Depth (feet): 25  
 Soil Description: Sandy Lean Clay

Tested By: ST Date: 04/01/13  
 Checked by: AP Date: 05/21/13

Sample Type: Mod Cal

Sample Diameter (inch): 2.409  
 Sample Height (inch): 5.723  
 Sample Weight (gms): 921.06  
 Wt. Wet Soil+Container(gms): 690.57  
 Wt. Dry Soil+Container(gms): 613.15  
 Wt. Container (gms): 143.19



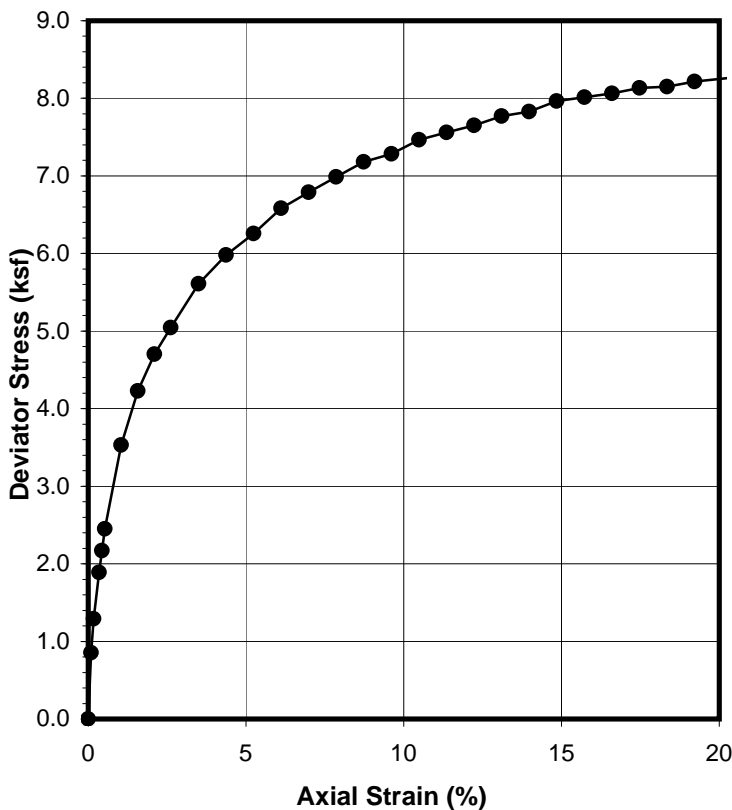
Wet Unit Weight (pcf): 134.4  
 Dry Unit Weight (pcf): 115.4  
 Moisture Content (%): 16.5  
 Void Ratio for G<sub>s</sub>=2.7: 0.46  
 % Saturation: 96.8

**TEST DATA**

Cell Pressure (ksf): 3.00  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 3.00  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 8.29  
 Ultimate Deviator Stress (ksf): 8.29  
 Ultimate Undrained Shear Strength (ksf): 4.14  
 Axial Strain @ Maximum Stress (%): 20.97



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.56	0.00	0.00
27	0.005	4.56	0.85	0.09
41	0.010	4.57	1.29	0.17
60	0.020	4.57	1.89	0.35
69	0.025	4.58	2.17	0.44
78	0.030	4.58	2.45	0.52
113	0.060	4.61	3.53	1.05
136	0.090	4.63	4.23	1.57
152	0.120	4.66	4.70	2.10
164	0.150	4.68	5.05	2.62
184	0.200	4.72	5.61	3.49
198	0.250	4.77	5.98	4.37
209	0.300	4.81	6.26	5.24
222	0.350	4.85	6.58	6.12
231	0.400	4.90	6.79	6.99
240	0.450	4.95	6.99	7.86
249	0.500	4.99	7.18	8.74
255	0.550	5.04	7.28	9.61
264	0.600	5.09	7.47	10.48
270	0.650	5.14	7.56	11.36
276	0.700	5.19	7.65	12.23
283	0.750	5.25	7.77	13.11
288	0.800	5.30	7.83	13.98
296	0.850	5.35	7.96	14.85
301	0.900	5.41	8.01	15.73
306	0.950	5.47	8.06	16.60
312	1.000	5.52	8.13	17.47
316	1.050	5.58	8.15	18.35
322	1.100	5.64	8.22	19.22
332	1.200	5.77	8.29	20.97





**AP Engineering & Testing, Inc.**

**UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850**

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: RC-13-002  
 Sample No.: S03 Depth (feet): 10  
 Soil Description: Clayey Sand

Tested By: ST Date: 04/17/13  
 Checked by: AP Date: 04/30/13

Sample Type: Mod Cal

Sample Diameter (inch): 2.402  
 Sample Height (inch): 5.947  
 Sample Weight (gms): 926.86  
 Wt. Wet Soil+Container(gms): 587.46  
 Wt. Dry Soil+Container(gms): 522.21  
 Wt. Container (gms): 148.55



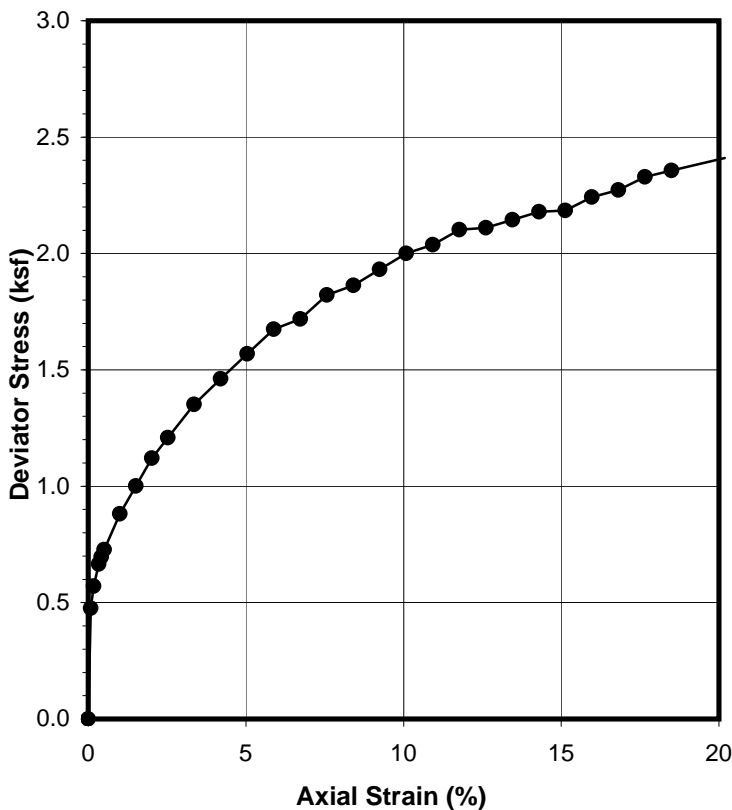
Wet Unit Weight (pcf): 130.9  
 Dry Unit Weight (pcf): 111.5  
 Moisture Content (%): 17.5  
 Void Ratio for Gs=2.7: 0.51  
 % Saturation: 92.2

**TEST DATA**

Cell Pressure (ksf): 1.20  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 1.20  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 2.41  
 Ultimate Deviator Stress (ksf): 2.41  
 Ultimate Undrained Shear Strength (ksf): 1.20  
 Axial Strain @ Maximum Stress (%): 20.18



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.53	0.00	0.00
15	0.005	4.54	0.48	0.08
18	0.010	4.54	0.57	0.17
21	0.020	4.55	0.67	0.34
22	0.025	4.55	0.70	0.42
23	0.030	4.55	0.73	0.50
28	0.060	4.58	0.88	1.01
32	0.090	4.60	1.00	1.51
36	0.120	4.62	1.12	2.02
39	0.150	4.65	1.21	2.52
44	0.200	4.69	1.35	3.36
48	0.250	4.73	1.46	4.20
52	0.300	4.77	1.57	5.04
56	0.350	4.81	1.67	5.89
58	0.400	4.86	1.72	6.73
62	0.450	4.90	1.82	7.57
64	0.500	4.95	1.86	8.41
67	0.550	4.99	1.93	9.25
70	0.600	5.04	2.00	10.09
72	0.650	5.09	2.04	10.93
75	0.700	5.14	2.10	11.77
76	0.750	5.19	2.11	12.61
78	0.800	5.24	2.15	13.45
80	0.850	5.29	2.18	14.29
81	0.900	5.34	2.18	15.13
84	0.950	5.39	2.24	15.97
86	1.000	5.45	2.27	16.82
89	1.050	5.50	2.33	17.66
91	1.100	5.56	2.36	18.50
95	1.200	5.68	2.41	20.18





**AP Engineering & Testing, Inc.**

**UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850**

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: RC-13-002  
 Sample No.: S07 Depth (feet): 30  
 Soil Description: Lean Clay

Tested By: ST Date: 04/17/13  
 Checked by: AP Date: 04/30/13

Sample Type: Mod Cal

Sample Diameter (inch): 2.413  
 Sample Height (inch): 5.764  
 Sample Weight (gms): 886.08  
 Wt. Wet Soil+Container(gms): 586.96  
 Wt. Dry Soil+Container(gms): 510.97  
 Wt. Container (gms): 148.69



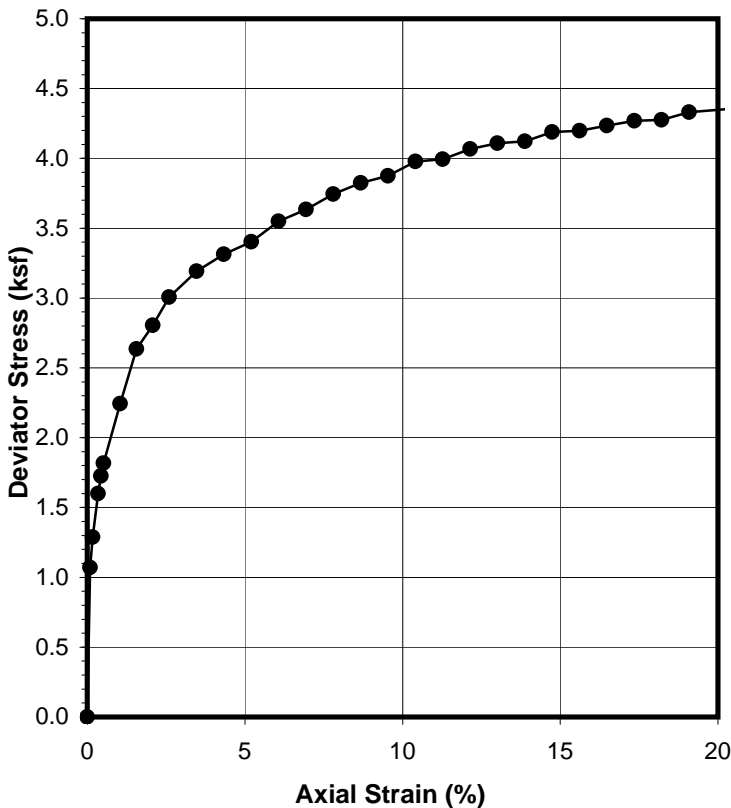
Wet Unit Weight (pcf): 128.0  
 Dry Unit Weight (pcf): 105.8  
 Moisture Content (%): 21.0  
 Void Ratio for G<sub>s</sub>=2.7: 0.59  
 % Saturation: 95.6

**TEST DATA**

Cell Pressure (ksf): 3.50  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 3.50  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 4.36  
 Ultimate Deviator Stress (ksf): 4.36  
 Ultimate Undrained Shear Strength (ksf): 2.18  
 Axial Strain @ Maximum Stress (%): 20.82



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.57	0.00	0.00
34	0.005	4.58	1.07	0.09
41	0.010	4.58	1.29	0.17
51	0.020	4.59	1.60	0.35
55	0.025	4.59	1.72	0.43
58	0.030	4.60	1.82	0.52
72	0.060	4.62	2.24	1.04
85	0.090	4.65	2.63	1.56
91	0.120	4.67	2.81	2.08
98	0.150	4.70	3.01	2.60
105	0.200	4.74	3.19	3.47
110	0.250	4.78	3.31	4.34
114	0.300	4.82	3.40	5.20
120	0.350	4.87	3.55	6.07
124	0.400	4.91	3.63	6.94
129	0.450	4.96	3.74	7.81
133	0.500	5.01	3.82	8.67
136	0.550	5.06	3.87	9.54
141	0.600	5.10	3.98	10.41
143	0.650	5.15	4.00	11.28
147	0.700	5.21	4.07	12.14
150	0.750	5.26	4.11	13.01
152	0.800	5.31	4.12	13.88
156	0.850	5.36	4.19	14.75
158	0.900	5.42	4.20	15.61
161	0.950	5.48	4.23	16.48
164	1.000	5.53	4.27	17.35
166	1.050	5.59	4.27	18.22
170	1.100	5.65	4.33	19.08
175	1.200	5.78	4.36	20.82







**AP Engineering & Testing, Inc.**

**UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850**

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: RC-13-002  
 Sample No.: S09 Depth (feet): 40  
 Soil Description: Claystone

Tested By: ST Date: 04/18/13  
 Checked by: AP Date: 04/30/13

Sample Diameter (inch): 2.414  
 Sample Height (inch): 6.055  
 Sample Weight (gms): 896.22  
 Wt. Wet Soil+Container(gms): 634.66  
 Wt. Dry Soil+Container(gms): 534.47  
 Wt. Container (gms): 141.45



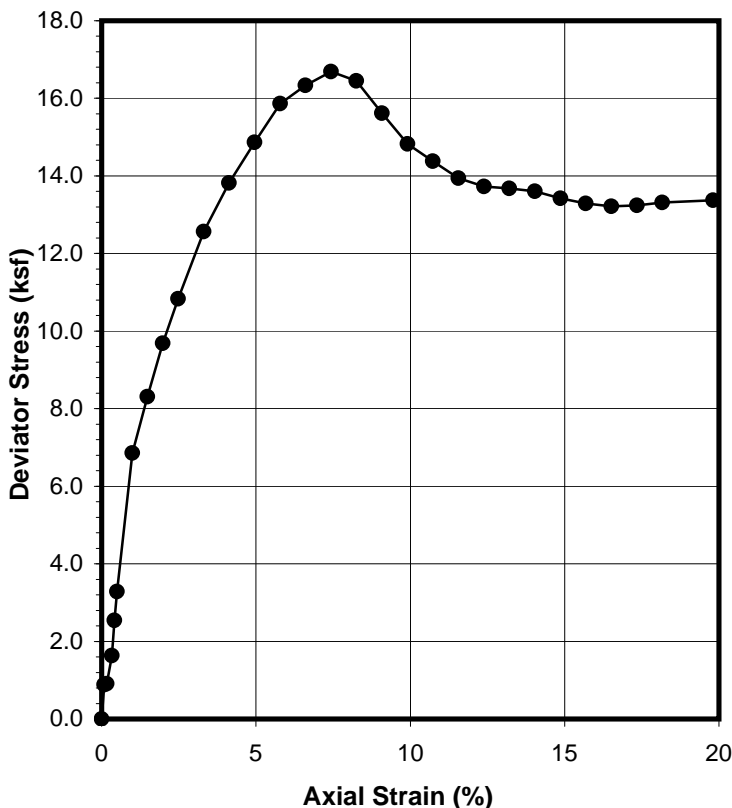
Sample Type: Mod Cal  
 Wet Unit Weight (pcf): 123.1  
 Dry Unit Weight (pcf): 98.1  
 Moisture Content (%): 25.5  
 Void Ratio for Gs=2.7: 0.72  
 % Saturation: 96.0

**TEST DATA**

Cell Pressure (ksf): 5.00  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 5.00  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 16.69  
 Ultimate Deviator Stress (ksf): 13.37  
 Ultimate Undrained Shear Strength (ksf): 6.69  
 Axial Strain @ Maximum Stress (%): 7.43



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.58	0.00	0.00
28	0.005	4.58	0.88	0.08
29	0.010	4.58	0.91	0.17
52	0.020	4.59	1.63	0.33
81	0.025	4.60	2.54	0.41
105	0.030	4.60	3.29	0.50
220	0.060	4.62	6.85	0.99
268	0.090	4.65	8.31	1.49
314	0.120	4.67	9.68	1.98
353	0.150	4.69	10.83	2.48
413	0.200	4.73	12.56	3.30
458	0.250	4.77	13.81	4.13
497	0.300	4.82	14.86	4.95
535	0.350	4.86	15.86	5.78
556	0.400	4.90	16.34	6.61
573	0.450	4.94	16.69	7.43
570	0.500	4.99	16.45	8.26
546	0.550	5.03	15.62	9.08
523	0.600	5.08	14.82	9.91
512	0.650	5.13	14.38	10.73
501	0.700	5.18	13.94	11.56
498	0.750	5.22	13.73	12.39
501	0.800	5.27	13.68	13.21
503	0.850	5.32	13.60	14.04
501	0.900	5.38	13.42	14.86
501	0.950	5.43	13.29	15.69
503	1.000	5.48	13.21	16.52
509	1.050	5.54	13.24	17.34
517	1.100	5.59	13.31	18.17
530	1.200	5.71	13.37	19.82





AP Engineering & Testing, Inc.

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: RC-13-002  
 Sample No.: C15 Depth (feet): 67-67.5  
 Soil Description: ~~Siltstone~~ Claystone

Tested By: ST Date: 04/18/13  
 Checked by: AP Date: 04/30/13

Sample Type: Core

Sample Diameter (inch): 1.983  
 Sample Height (inch): 5.731  
 Sample Weight (gms): 622.75  
 Wt. Wet Soil+Container(gms): 767.29  
 Wt. Dry Soil+Container(gms): 673.93  
 Wt. Container (gms): 149.66



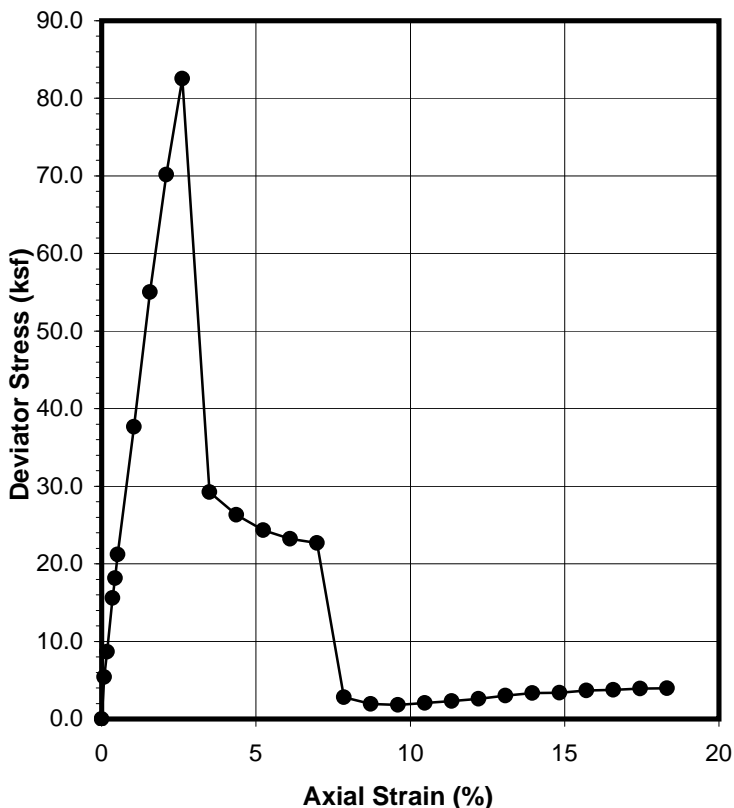
Wet Unit Weight (pcf): 134.0  
 Dry Unit Weight (pcf): 113.7  
 Moisture Content (%): 17.8  
 Void Ratio for G<sub>s</sub>=2.7: 0.48  
 % Saturation: 99.8

TEST DATA

Cell Pressure (ksf): 7.50  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 7.50  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 82.55  
 Ultimate Deviator Stress (ksf): 3.96  
 Ultimate Undrained Shear Strength (ksf): 1.98  
 Axial Strain @ Maximum Stress (%): 2.62



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	3.09	0.00	0.00
116	0.005	3.09	5.40	0.09
186	0.010	3.09	8.66	0.17
336	0.020	3.10	15.61	0.35
391	0.025	3.10	18.15	0.44
457	0.030	3.10	21.20	0.52
816	0.060	3.12	37.65	1.05
1199	0.090	3.14	55.03	1.57
1537	0.120	3.15	70.16	2.09
1818	0.150	3.17	82.55	2.62
650	0.200	3.20	29.25	3.49
590	0.250	3.23	26.31	4.36
551	0.300	3.26	24.35	5.23
530	0.350	3.29	23.20	6.11
523	0.400	3.32	22.68	6.98
65	0.450	3.35	2.79	7.85
46	0.500	3.38	1.96	8.72
43	0.550	3.42	1.81	9.60
49	0.600	3.45	2.05	10.47
56	0.650	3.48	2.31	11.34
63	0.700	3.52	2.58	12.21
74	0.750	3.55	3.00	13.09
83	0.800	3.59	3.33	13.96
85	0.850	3.63	3.38	14.83
93	0.900	3.66	3.66	15.70
97	0.950	3.70	3.77	16.58
102	1.000	3.74	3.93	17.45
104	1.050	3.78	3.96	18.32





**AP Engineering & Testing, Inc.**

**UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850**

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: RC-13-003  
 Sample No.: S04 Depth (feet): 15  
 Soil Description: Silty Sandstone

Tested By: ST Date: 04/24/13  
 Checked by: AP Date: 05/07/13

Sample Type: Mod Cal

Sample Diameter (inch): 2.405  
 Sample Height (inch): 6.007  
 Sample Weight (gms): 917.56  
 Wt. Wet Soil+Container(gms): 665.95  
 Wt. Dry Soil+Container(gms): 571.71  
 Wt. Container (gms): 149.80



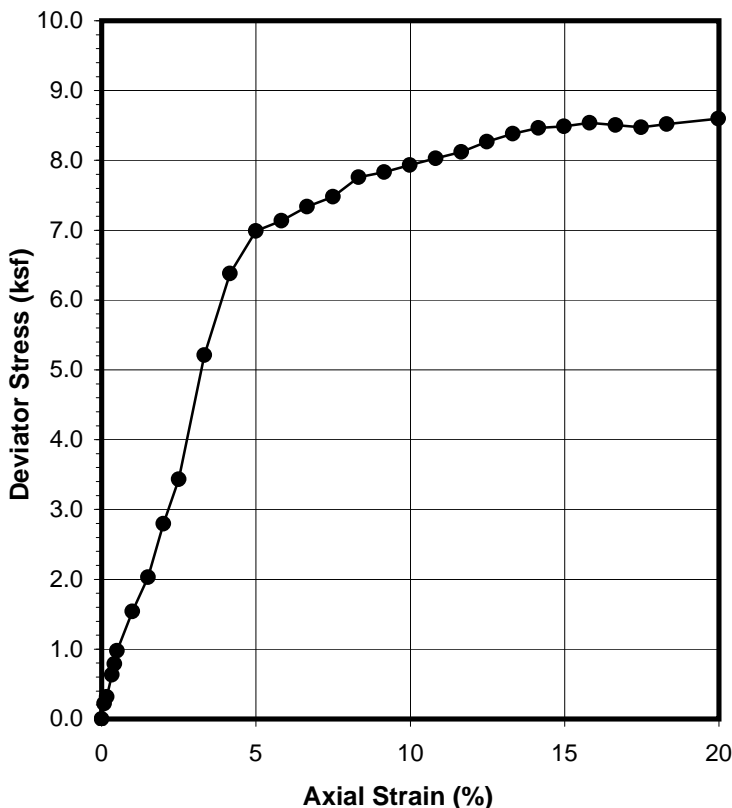
Wet Unit Weight (pcf): 128.0  
 Dry Unit Weight (pcf): 104.6  
 Moisture Content (%): 22.3  
 Void Ratio for Gs=2.7: 0.61  
 % Saturation: 98.9

**TEST DATA**

Cell Pressure (ksf): 2.00  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 2.00  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 8.60  
 Ultimate Deviator Stress (ksf): 8.60  
 Ultimate Undrained Shear Strength (ksf): 4.30  
 Axial Strain @ Maximum Stress (%): 19.98



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.54	0.00	0.00
7	0.005	4.55	0.22	0.08
10	0.010	4.55	0.32	0.17
20	0.020	4.56	0.63	0.33
25	0.025	4.56	0.79	0.42
31	0.030	4.57	0.98	0.50
49	0.060	4.59	1.54	1.00
65	0.090	4.61	2.03	1.50
90	0.120	4.64	2.80	2.00
111	0.150	4.66	3.43	2.50
170	0.200	4.70	5.21	3.33
210	0.250	4.74	6.38	4.16
232	0.300	4.78	6.99	4.99
239	0.350	4.82	7.13	5.83
248	0.400	4.87	7.34	6.66
255	0.450	4.91	7.48	7.49
267	0.500	4.96	7.76	8.32
272	0.550	5.00	7.83	9.16
278	0.600	5.05	7.93	9.99
284	0.650	5.09	8.03	10.82
290	0.700	5.14	8.12	11.65
298	0.750	5.19	8.27	12.49
305	0.800	5.24	8.38	13.32
311	0.850	5.29	8.46	14.15
315	0.900	5.34	8.49	14.98
320	0.950	5.40	8.54	15.81
322	1.000	5.45	8.51	16.65
324	1.050	5.51	8.48	17.48
329	1.100	5.56	8.52	18.31
339	1.200	5.68	8.60	19.98





**AP Engineering & Testing, Inc.**

**UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850**

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: RC-13-005  
 Sample No.: S13 Depth (feet): 60-61.5  
 Soil Description: Lean Clay

Tested By: ST Date: 04/08/13  
 Checked by: AP Date: 04/24/13

Sample Type: Mod Cal

Sample Diameter (inch): 2.403  
 Sample Height (inch): 5.800  
 Sample Weight (gms): 911.13  
 Wt. Wet Soil+Container(gms): 740.30  
 Wt. Dry Soil+Container(gms): 643.13  
 Wt. Container (gms): 149.33



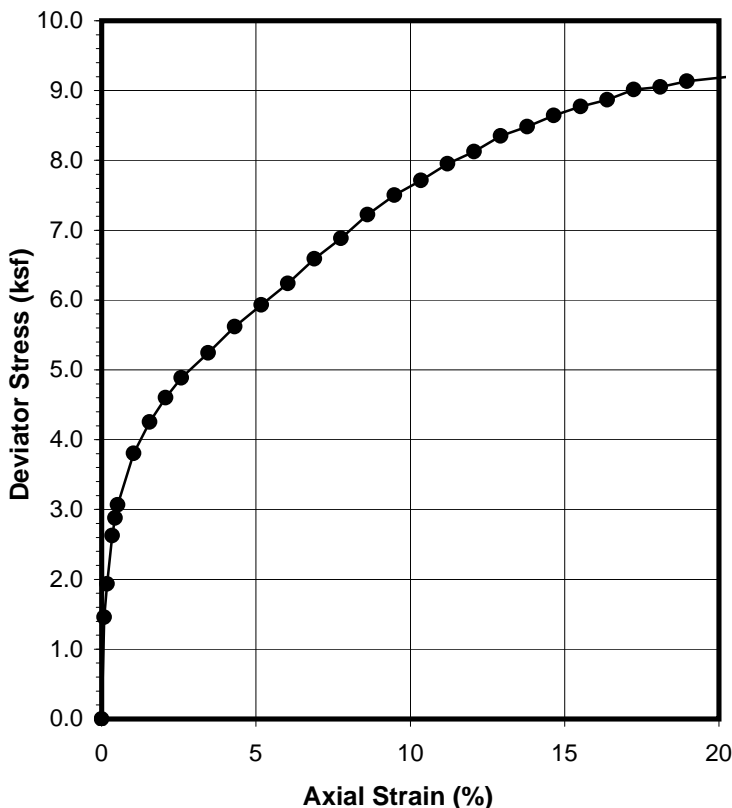
Wet Unit Weight (pcf): 131.9  
 Dry Unit Weight (pcf): 110.2  
 Moisture Content (%): 19.7  
 Void Ratio for Gs=2.7: 0.53  
 % Saturation: 100.4

**TEST DATA**

Cell Pressure (ksf): 7.00  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 7.00  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 9.22  
 Ultimate Deviator Stress (ksf): 9.22  
 Ultimate Undrained Shear Strength (ksf): 4.61  
 Axial Strain @ Maximum Stress (%): 20.69



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.54	0.00	0.00
46	0.005	4.54	1.46	0.09
61	0.010	4.54	1.93	0.17
83	0.020	4.55	2.63	0.34
91	0.025	4.55	2.88	0.43
97	0.030	4.56	3.06	0.52
121	0.060	4.58	3.80	1.03
136	0.090	4.61	4.25	1.55
148	0.120	4.63	4.60	2.07
158	0.150	4.66	4.89	2.59
171	0.200	4.70	5.24	3.45
185	0.250	4.74	5.62	4.31
197	0.300	4.78	5.93	5.17
209	0.350	4.83	6.24	6.03
223	0.400	4.87	6.59	6.90
235	0.450	4.92	6.88	7.76
249	0.500	4.96	7.22	8.62
261	0.550	5.01	7.50	9.48
271	0.600	5.06	7.71	10.34
282	0.650	5.11	7.95	11.21
291	0.700	5.16	8.12	12.07
302	0.750	5.21	8.35	12.93
310	0.800	5.26	8.49	13.79
319	0.850	5.31	8.64	14.66
327	0.900	5.37	8.77	15.52
334	0.950	5.42	8.87	16.38
343	1.000	5.48	9.01	17.24
348	1.050	5.54	9.05	18.10
355	1.100	5.60	9.13	18.97
366	1.200	5.72	9.22	20.69





**AP Engineering & Testing, Inc.**

**UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850**

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: RC-13-005  
 Sample No.: S17 Depth (feet): 80-81.5  
 Soil Description: Fat Clay

Tested By: ST Date: 04/08/13  
 Checked by: AP Date: 04/24/13

Sample Type: Mod Cal

Sample Diameter (inch): 2.412  
 Sample Height (inch): 4.871  
 Sample Weight (gms): 727.46  
 Wt. Wet Soil+Container(gms) 550.54  
 Wt. Dry Soil+Container(gms) 468.92  
 Wt. Container (gms) 148.39



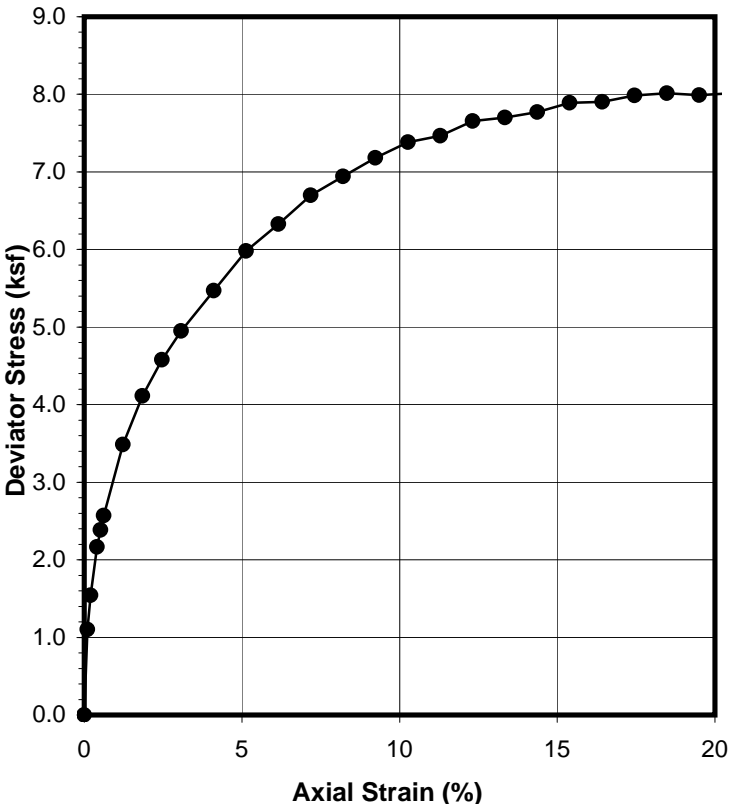
Wet Unit Weight (pcf): 124.4  
 Dry Unit Weight (pcf): 99.2  
 Moisture Content (%): 25.5  
 Void Ratio for Gs=2.7: 0.70  
 % Saturation: 98.4

**TEST DATA**

Cell Pressure (ksf): 9.60  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 9.60  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 8.02  
 Ultimate Deviator Stress (ksf): 8.01  
 Ultimate Undrained Shear Strength (ksf): 4.01  
 Axial Strain @ Maximum Stress (%): 18.48



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.57	0.00	0.00
35	0.005	4.57	1.10	0.10
49	0.010	4.58	1.54	0.21
69	0.020	4.59	2.17	0.41
76	0.025	4.59	2.38	0.51
82	0.030	4.60	2.57	0.62
112	0.060	4.63	3.49	1.23
133	0.090	4.66	4.11	1.85
149	0.120	4.68	4.58	2.46
162	0.150	4.71	4.95	3.08
181	0.200	4.76	5.47	4.11
200	0.250	4.82	5.98	5.13
214	0.300	4.87	6.33	6.16
229	0.350	4.92	6.70	7.19
240	0.400	4.98	6.94	8.21
251	0.450	5.03	7.18	9.24
261	0.500	5.09	7.38	10.26
267	0.550	5.15	7.46	11.29
277	0.600	5.21	7.65	12.32
282	0.650	5.27	7.70	13.34
288	0.700	5.34	7.77	14.37
296	0.750	5.40	7.89	15.40
300	0.800	5.47	7.90	16.42
307	0.850	5.54	7.99	17.45
312	0.900	5.60	8.02	18.48
315	0.950	5.68	7.99	19.50
320	1.000	5.75	8.01	20.53





**AP Engineering & Testing, Inc.**

**UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850**

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: R-13-006  
 Sample No.: S16-A Depth (feet): 75  
 Soil Description: Claystone

Tested By: ST Date: 04/26/13  
 Checked by: AP Date: 05/07/13

Sample Type: Mod Cal

Sample Diameter (inch): 2.412  
 Sample Height (inch): 6.031  
 Sample Weight (gms): 915.07  
 Wt. Wet Soil+Container(gms): 468.50  
 Wt. Dry Soil+Container(gms): 411.47  
 Wt. Container (gms): 151.61



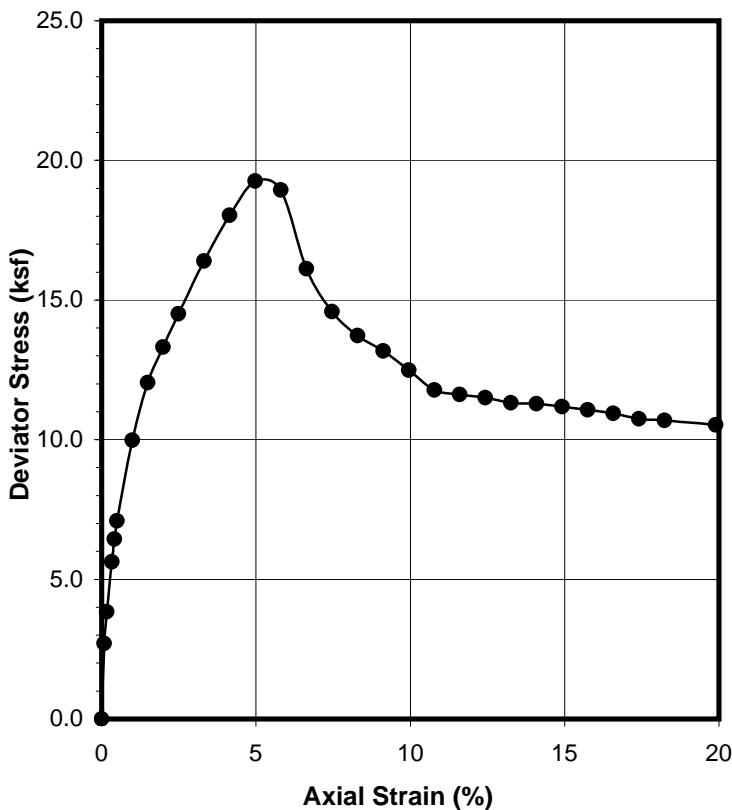
Wet Unit Weight (pcf): 126.4  
 Dry Unit Weight (pcf): 103.7  
 Moisture Content (%): 21.9  
 Void Ratio for Gs=2.7: 0.63  
 % Saturation: 94.8

**TEST DATA**

Cell Pressure (ksf): 9.00  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 9.00  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 19.26  
 Ultimate Deviator Stress (ksf): 10.53  
 Ultimate Undrained Shear Strength (ksf): 5.26  
 Axial Strain @ Maximum Stress (%): 4.97



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.57	0.00	0.00
86	0.005	4.57	2.71	0.08
122	0.010	4.58	3.84	0.17
179	0.020	4.58	5.62	0.33
205	0.025	4.59	6.43	0.41
226	0.030	4.59	7.09	0.50
320	0.060	4.62	9.98	0.99
388	0.090	4.64	12.05	1.49
431	0.120	4.66	13.31	1.99
472	0.150	4.69	14.51	2.49
538	0.200	4.73	16.39	3.32
597	0.250	4.77	18.03	4.15
643	0.300	4.81	19.26	4.97
638	0.350	4.85	18.94	5.80
548	0.400	4.89	16.12	6.63
500	0.450	4.94	14.58	7.46
475	0.500	4.98	13.73	8.29
460	0.550	5.03	13.17	9.12
440	0.600	5.07	12.49	9.95
419	0.650	5.12	11.78	10.78
417	0.700	5.17	11.62	11.61
417	0.750	5.22	11.51	12.44
414	0.800	5.27	11.32	13.26
417	0.850	5.32	11.29	14.09
417	0.900	5.37	11.18	14.92
417	0.950	5.42	11.07	15.75
416	1.000	5.48	10.94	16.58
413	1.050	5.53	10.75	17.41
415	1.100	5.59	10.69	18.24
417	1.200	5.70	10.53	19.90





# AP Engineering & Testing, Inc.

## UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q) ASTM D 2850

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: R-13-006  
 Sample No.: S22-A Depth (feet): 105  
 Soil Description: Claystone

Tested By: ST Date: 05/01/13  
 Checked by: AP Date: 05/07/13

Sample Type: Mod Cal

Sample Diameter (inch): 2.404  
 Sample Height (inch): 6.010  
 Sample Weight (gms): 886.30  
 Wt. Wet Soil+Container(gms): 584.15  
 Wt. Dry Soil+Container(gms): 489.78  
 Wt. Container (gms): 148.76



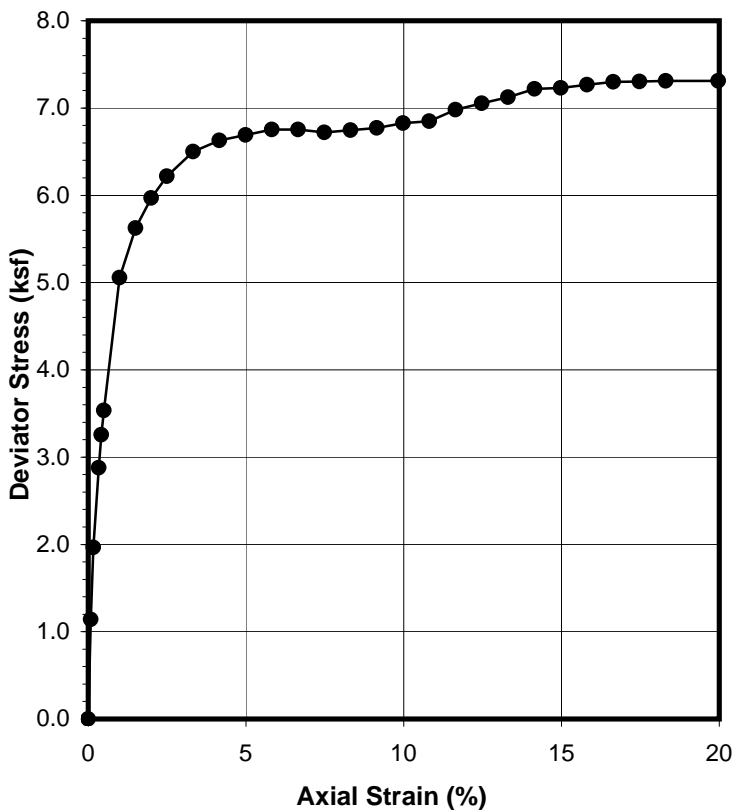
Wet Unit Weight (pcf): 123.7  
 Dry Unit Weight (pcf): 96.9  
 Moisture Content (%): 27.7  
 Void Ratio for G<sub>s</sub>=2.7: 0.74  
 % Saturation: 100.4

### TEST DATA

Cell Pressure (ksf): 12.60  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 12.60  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 7.31  
 Ultimate Deviator Stress (ksf): 7.31  
 Ultimate Undrained Shear Strength (ksf): 3.66  
 Axial Strain @ Maximum Stress (%): 19.97



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.54	0.00	0.00
36	0.005	4.54	1.14	0.08
62	0.010	4.55	1.96	0.17
91	0.020	4.55	2.88	0.33
103	0.025	4.56	3.25	0.42
112	0.030	4.56	3.54	0.50
161	0.060	4.58	5.06	1.00
180	0.090	4.61	5.62	1.50
192	0.120	4.63	5.97	2.00
201	0.150	4.66	6.22	2.50
212	0.200	4.70	6.50	3.33
218	0.250	4.74	6.63	4.16
222	0.300	4.78	6.69	4.99
226	0.350	4.82	6.75	5.82
228	0.400	4.86	6.75	6.66
229	0.450	4.91	6.72	7.49
232	0.500	4.95	6.75	8.32
235	0.550	5.00	6.77	9.15
239	0.600	5.04	6.83	9.98
242	0.650	5.09	6.85	10.82
249	0.700	5.14	6.98	11.65
254	0.750	5.19	7.05	12.48
259	0.800	5.24	7.12	13.31
265	0.850	5.29	7.22	14.14
268	0.900	5.34	7.23	14.98
272	0.950	5.39	7.27	15.81
276	1.000	5.44	7.30	16.64
279	1.050	5.50	7.30	17.47
282	1.100	5.56	7.31	18.30
288	1.200	5.67	7.31	19.97





**AP Engineering & Testing, Inc.**

**UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850**

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: RC-13-007  
 Sample No.: S17 Depth (feet): 80  
 Soil Description: Fat Clay

Tested By: ST Date: 04/08/13  
 Checked by: AP Date: 04/27/13

Sample Type: Mod Cal

Sample Diameter (inch): 2.415  
 Sample Height (inch): 5.765  
 Sample Weight (gms): 866.74  
 Wt. Wet Soil+Container(gms): 704.12  
 Wt. Dry Soil+Container(gms): 588.35  
 Wt. Container (gms): 140.90



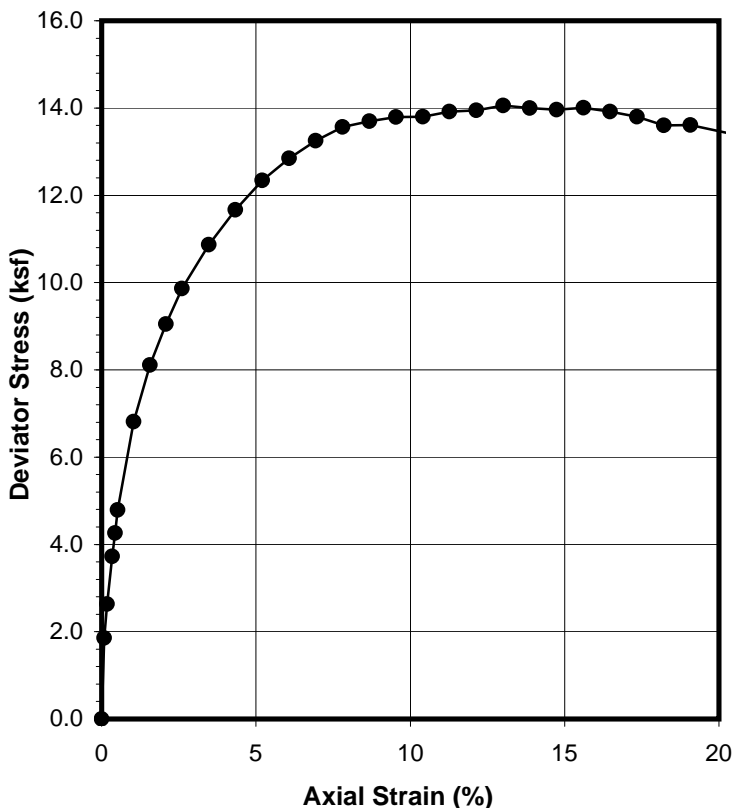
Wet Unit Weight (pcf): 125.0  
 Dry Unit Weight (pcf): 99.3  
 Moisture Content (%): 25.9  
 Void Ratio for Gs=2.7: 0.70  
 % Saturation: 100.2

**TEST DATA**

Cell Pressure (ksf): 9.50  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 9.50  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 14.06  
 Ultimate Deviator Stress (ksf): 13.34  
 Ultimate Undrained Shear Strength (ksf): 6.67  
 Axial Strain @ Maximum Stress (%): 13.01



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.58	0.00	0.00
59	0.005	4.58	1.85	0.09
84	0.010	4.59	2.64	0.17
119	0.020	4.60	3.73	0.35
136	0.025	4.60	4.26	0.43
153	0.030	4.60	4.78	0.52
219	0.060	4.63	6.81	1.04
262	0.090	4.65	8.11	1.56
294	0.120	4.68	9.05	2.08
322	0.150	4.70	9.86	2.60
358	0.200	4.75	10.86	3.47
388	0.250	4.79	11.67	4.34
414	0.300	4.83	12.34	5.20
435	0.350	4.88	12.84	6.07
453	0.400	4.92	13.25	6.94
468	0.450	4.97	13.56	7.81
477	0.500	5.02	13.69	8.67
485	0.550	5.06	13.79	9.54
490	0.600	5.11	13.80	10.41
499	0.650	5.16	13.92	11.27
505	0.700	5.21	13.95	12.14
514	0.750	5.27	14.06	13.01
517	0.800	5.32	14.00	13.88
521	0.850	5.37	13.96	14.74
528	0.900	5.43	14.01	15.61
530	0.950	5.48	13.92	16.48
531	1.000	5.54	13.80	17.35
529	1.050	5.60	13.60	18.21
535	1.100	5.66	13.61	19.08
536	1.200	5.78	13.34	20.82







**AP Engineering & Testing, Inc.**

**UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850**

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: RC-13-007  
 Sample No.: C24 Depth (feet): 115.7-116.7  
 Soil Description: Claystone

Tested By: ST Date: 04/11/13  
 Checked by: AP Date: 04/27/13

Sample Type: Core

Sample Diameter (inch): 2.319  
 Sample Height (inch): 6.052  
 Sample Weight (gms): 831.36  
 Wt. Wet Soil+Container(gms): 978.13  
 Wt. Dry Soil+Container(gms): 810.14  
 Wt. Container (gms): 149.17



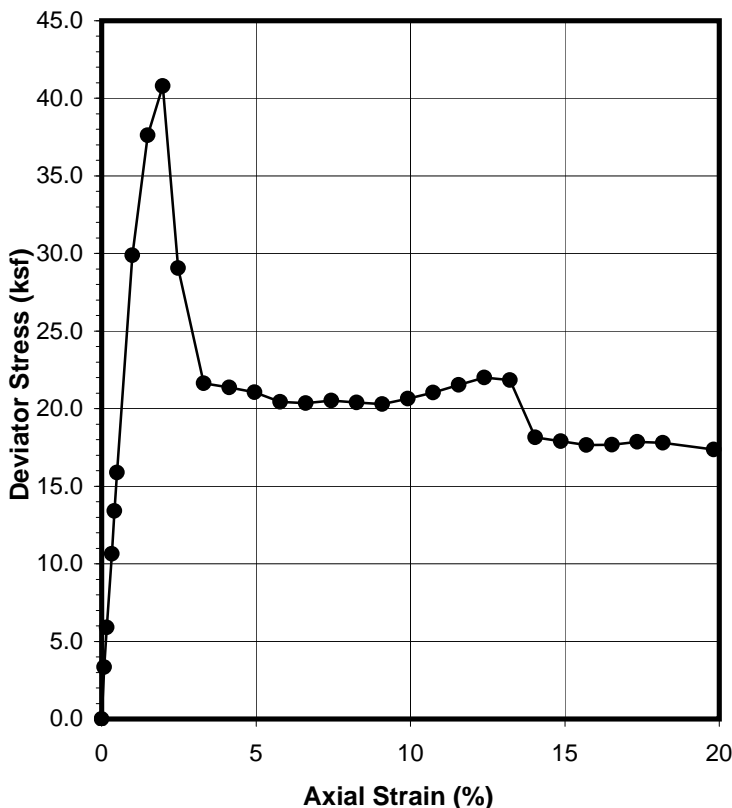
Wet Unit Weight (pcf): 123.8  
 Dry Unit Weight (pcf): 98.7  
 Moisture Content (%): 25.4  
 Void Ratio for G<sub>s</sub>=2.7: 0.71  
 % Saturation: 97.1

**TEST DATA**

Cell Pressure (ksf): 13.50  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 13.50  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 40.80  
 Ultimate Deviator Stress (ksf): 17.36  
 Ultimate Undrained Shear Strength (ksf): 8.68  
 Axial Strain @ Maximum Stress (%): 1.98



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.22	0.00	0.00
98	0.005	4.23	3.34	0.08
173	0.010	4.23	5.89	0.17
313	0.020	4.24	10.64	0.33
395	0.025	4.24	13.41	0.41
468	0.030	4.24	15.88	0.50
885	0.060	4.27	29.87	0.99
1120	0.090	4.29	37.62	1.49
1221	0.120	4.31	40.80	1.98
874	0.150	4.33	29.06	2.48
656	0.200	4.37	21.63	3.30
654	0.250	4.41	21.38	4.13
650	0.300	4.44	21.06	4.96
636	0.350	4.48	20.43	5.78
639	0.400	4.52	20.35	6.61
650	0.450	4.56	20.51	7.44
652	0.500	4.60	20.39	8.26
655	0.550	4.65	20.30	9.09
672	0.600	4.69	20.64	9.91
691	0.650	4.73	21.03	10.74
714	0.700	4.78	21.53	11.57
737	0.750	4.82	22.01	12.39
738	0.800	4.87	21.83	13.22
619	0.850	4.91	18.14	14.04
617	0.900	4.96	17.91	14.87
614	0.950	5.01	17.65	15.70
621	1.000	5.06	17.67	16.52
634	1.050	5.11	17.87	17.35
638	1.100	5.16	17.80	18.18
635	1.200	5.27	17.36	19.83





**AP Engineering & Testing, Inc.**

**UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850**

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: A-13-020  
 Sample No.: S30 Depth (feet): 136.5  
 Soil Description: Lean Clay w/sand

Tested By: ST Date: 04/17/13  
 Checked by: AP Date: 05/04/13

Sample Type: Mod Cal

Sample Diameter (inch): 2.421  
 Sample Height (inch): 5.929  
 Sample Weight (gms): 910.91  
 Wt. Wet Soil+Container(gms): 1057.86  
 Wt. Dry Soil+Container(gms): 889.26  
 Wt. Container (gms): 148.35



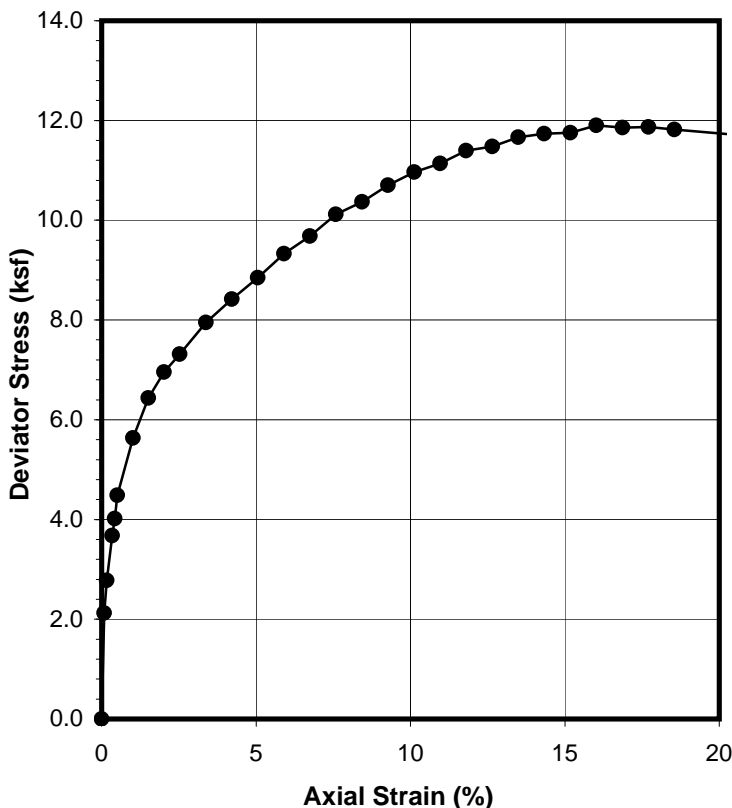
Wet Unit Weight (pcf): 127.1  
 Dry Unit Weight (pcf): 103.5  
 Moisture Content (%): 22.8  
 Void Ratio for G<sub>s</sub>=2.7: 0.63  
 % Saturation: 97.9

**TEST DATA**

Cell Pressure (ksf): 15.00  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 15.00  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 11.90  
 Ultimate Deviator Stress (ksf): 11.73  
 Ultimate Undrained Shear Strength (ksf): 5.86  
 Axial Strain @ Maximum Stress (%): 16.02



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.60	0.00	0.00
68	0.005	4.61	2.13	0.08
89	0.010	4.61	2.78	0.17
118	0.020	4.62	3.68	0.34
129	0.025	4.62	4.02	0.42
144	0.030	4.63	4.48	0.51
182	0.060	4.65	5.64	1.01
209	0.090	4.67	6.44	1.52
227	0.120	4.70	6.96	2.02
240	0.150	4.72	7.32	2.53
263	0.200	4.76	7.95	3.37
281	0.250	4.81	8.42	4.22
298	0.300	4.85	8.85	5.06
317	0.350	4.89	9.33	5.90
332	0.400	4.94	9.68	6.75
350	0.450	4.98	10.12	7.59
362	0.500	5.03	10.37	8.43
377	0.550	5.07	10.70	9.28
390	0.600	5.12	10.97	10.12
400	0.650	5.17	11.14	10.96
413	0.700	5.22	11.39	11.81
420	0.750	5.27	11.48	12.65
431	0.800	5.32	11.66	13.49
438	0.850	5.37	11.74	14.34
443	0.900	5.43	11.75	15.18
453	0.950	5.48	11.90	16.02
456	1.000	5.54	11.86	16.87
461	1.050	5.59	11.87	17.71
464	1.100	5.65	11.82	18.55
470	1.200	5.77	11.73	20.24





**AP Engineering & Testing, Inc.**

**UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (UU,Q)  
ASTM D 2850**

Client Name: CH2M Hill  
 Project Name: SR-710 North Study  
 Project No.: 428908.02.14.00.03.02  
 Boring No.: A-13-021  
 Sample No.: S09 Depth (feet): 40  
 Soil Description: Clayey Sandstone

Tested By: ST Date: 05/07/13  
 Checked by: AP Date: 05/11/13

Sample Type: Mod Cal

Sample Diameter (inch): 2.405  
 Sample Height (inch): 5.631  
 Sample Weight (gms): 724.42  
 Wt. Wet Soil+Container(gms): 597.73  
 Wt. Dry Soil+Container(gms): 499.66  
 Wt. Container (gms): 149.91



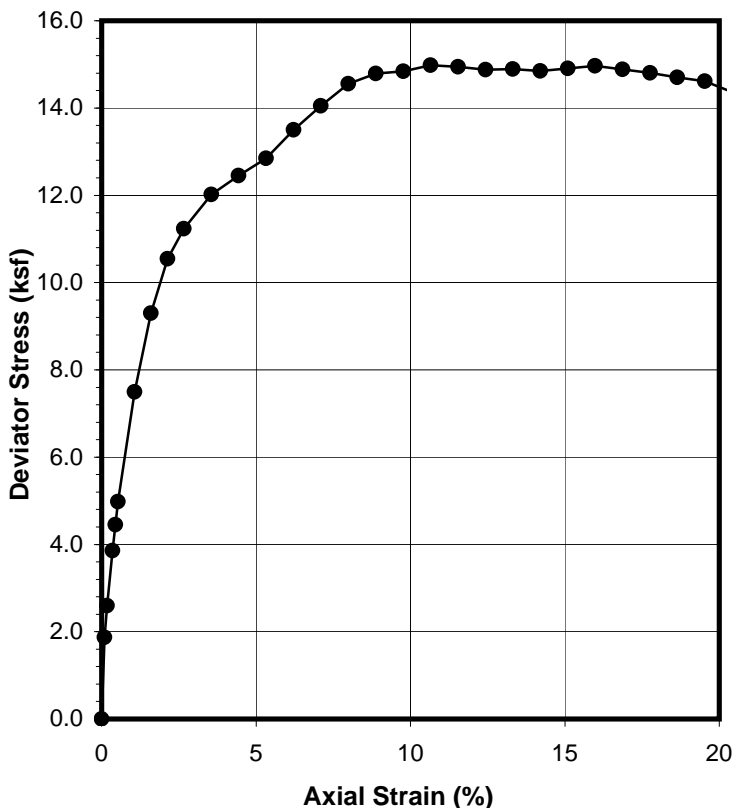
Wet Unit Weight (pcf): 107.8  
 Dry Unit Weight (pcf): 84.2  
 Moisture Content (%): 28.0  
 Void Ratio for Gs=2.7: 1.00  
 % Saturation: 75.6

**TEST DATA**

Cell Pressure (ksf): 5.00  
 Back Pressure (ksf): 0.0  
 Eff. Confining Pressure (ksf): 5.00  
 Shear Rate (%/min): 0.3  
 Maximum Deviator Stress (ksf): 14.98  
 Ultimate Deviator Stress (ksf): 14.12  
 Ultimate Undrained Shear Strength (ksf): 7.06  
 Axial Strain @ Maximum Stress (%): 10.66



Load (lbs)	Def. (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.54	0.00	0.00
59	0.005	4.55	1.87	0.09
82	0.010	4.55	2.59	0.18
122	0.020	4.56	3.85	0.36
141	0.025	4.56	4.45	0.44
158	0.030	4.57	4.98	0.53
239	0.060	4.59	7.50	1.07
298	0.090	4.62	9.30	1.60
340	0.120	4.64	10.55	2.13
364	0.150	4.67	11.23	2.66
393	0.200	4.71	12.02	3.55
411	0.250	4.75	12.45	4.44
428	0.300	4.80	12.84	5.33
454	0.350	4.84	13.50	6.22
477	0.400	4.89	14.05	7.10
499	0.450	4.94	14.55	7.99
512	0.500	4.99	14.79	8.88
519	0.550	5.03	14.84	9.77
529	0.600	5.08	14.98	10.66
533	0.650	5.14	14.95	11.54
536	0.700	5.19	14.88	12.43
542	0.750	5.24	14.89	13.32
546	0.800	5.30	14.85	14.21
554	0.850	5.35	14.91	15.10
562	0.900	5.41	14.97	15.98
565	0.950	5.46	14.89	16.87
568	1.000	5.52	14.81	17.76
570	1.050	5.58	14.70	18.65
573	1.100	5.65	14.62	19.53
566	1.200	5.77	14.12	21.31





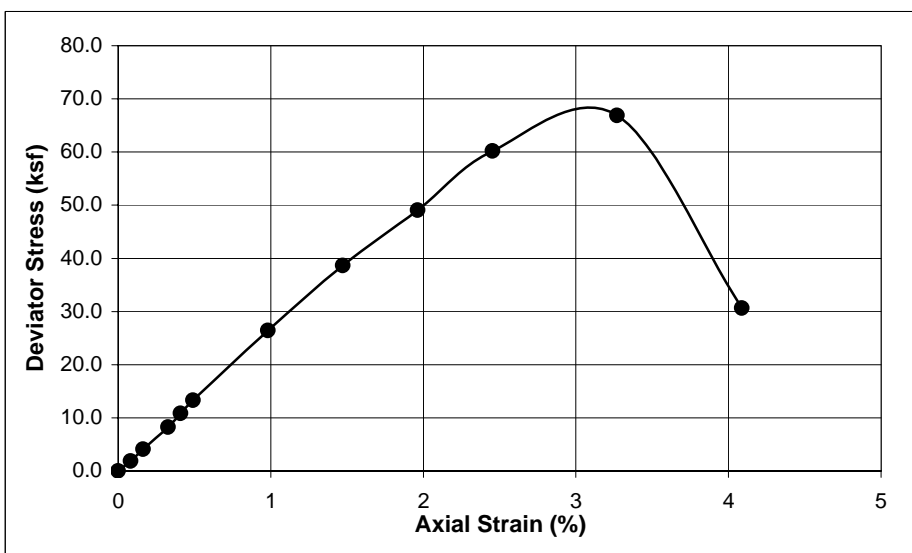
### UNCONFINED COMPRESSION TEST RESULTS ASTM D 2166

Project Name: **SR-710 North Study**  
Project No.: **428908.02.14.00.03.02**  
Boring No.: **RC-13-002**  
Sample No.: **C12**  
Depth (feet): **52.1-53.4**

Sample Type: **Core**  
Soil Description: **Claystone**  
Dry Density (pcf): **113.5**  
Moisture Content (%): **15.3**  
Test Date: **4/15/2013**

Sample Diameter (inch): **2.74**  
Sample Height (inch): **6.12**  
Sample Weight (gms): **1239.44**

Wt. Wet Soil+Container(gms): **785.51**  
Wt. Dry Soil+Container(gms): **701.07**  
Wt. Container (gms): **149.69**



Load (lbs)	Deformation (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	5.90	0.00	0.00
76	0.005	5.90	1.85	0.08
169	0.010	5.91	4.12	0.16
338	0.020	5.92	8.23	0.33
446	0.025	5.92	10.85	0.41
547	0.030	5.93	13.29	0.49
1092	0.060	5.95	26.41	0.98
1605	0.090	5.98	38.62	1.47
2048	0.120	6.01	49.03	1.96
2526	0.150	6.04	60.18	2.45
2832	0.200	6.10	66.90	3.27
1309	0.250	6.15	30.66	4.09



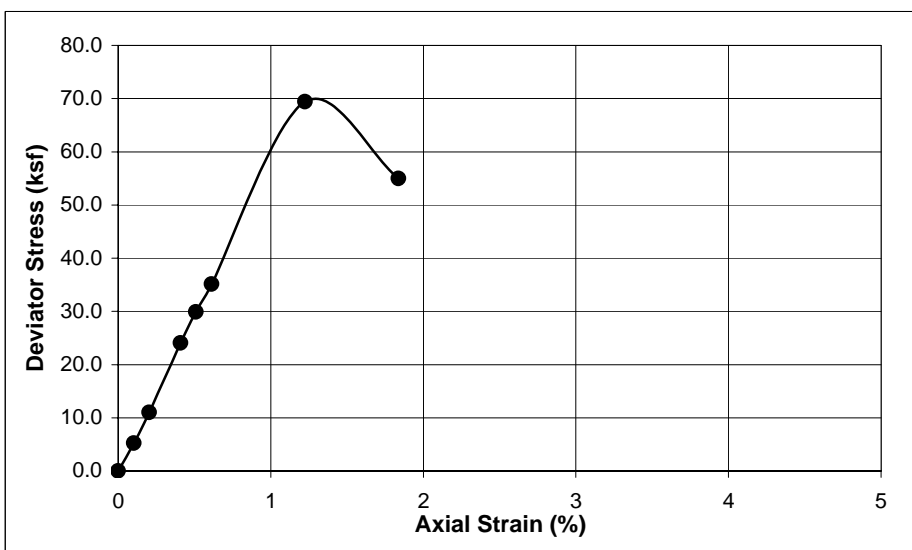
### UNCONFINED COMPRESSION TEST RESULTS ASTM D 2166

Project Name: **SR-710 North Study**  
Project No.: **428908.02.14.00.03.02**  
Boring No.: **RC-13-002**  
Sample No.: **C17**  
Depth (feet): **77.3-78.6**

Sample Type: **Core**  
Soil Description: **Claystone**  
Dry Density (pcf): **115.2**  
Moisture Content (%): **12.7**  
Test Date: **4/15/2013**

Sample Diameter (inch): **1.85**  
Sample Height (inch): **4.90**  
Sample Weight (gms): **446.82**

Wt. Wet Soil+Container(gms): **426.84**  
Wt. Dry Soil+Container(gms): **394.25**  
Wt. Container (gms): **137**



Load (lbs)	Deformation (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	2.68	0.00	0.00
97	0.005	2.68	5.21	0.10
205	0.010	2.68	11.01	0.20
449	0.020	2.69	24.06	0.41
559	0.025	2.69	29.92	0.51
657	0.030	2.69	35.13	0.61
1306	0.060	2.71	69.41	1.22
1041	0.090	2.73	54.98	1.84



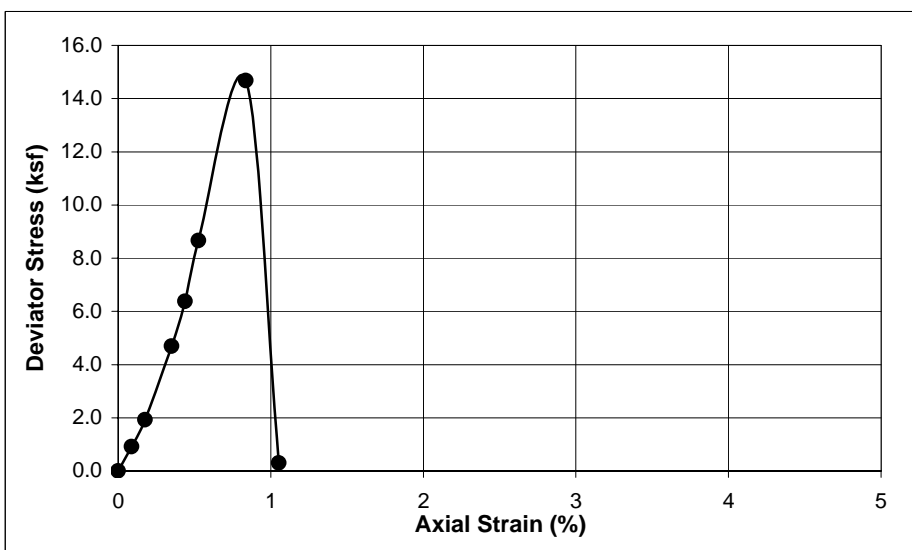
### UNCONFINED COMPRESSION TEST RESULTS ASTM D 2166

Project Name: **SR-710 North Study**  
 Project No.: **428908.02.14.00.03.02**  
 Boring No.: **RC-13-004**  
 Sample No.: **C13**  
 Depth (feet): **59.8-60.3**

Sample Type: **Core**  
 Soil Description: **Sandstone**  
 Dry Density (pcf): **110.8**  
 Moisture Content (%): **18.5**  
 Test Date: **4/15/2013**

Sample Diameter (inch): **2.33**  
 Sample Height (inch): **5.70**  
 Sample Weight (gms): **835.48**

Wt. Wet Soil+Container(gms): **519.94**  
 Wt. Dry Soil+Container(gms): **462.28**  
 Wt. Container (gms): **149.82**



Load (lbs)	Deformation (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.25	0.00	0.00
27	0.005	4.26	0.91	0.09
57	0.010	4.26	1.93	0.18
139	0.020	4.27	4.69	0.35
189	0.025	4.27	6.37	0.44
257	0.030	4.28	8.66	0.53
437	0.048	4.29	14.67	0.84
9	0.060	4.30	0.30	1.05

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR 710 North Study  
 Project No.: 13-031  
 Report Date: April 29, 2013

Client: AP Engineering & Testing, Inc

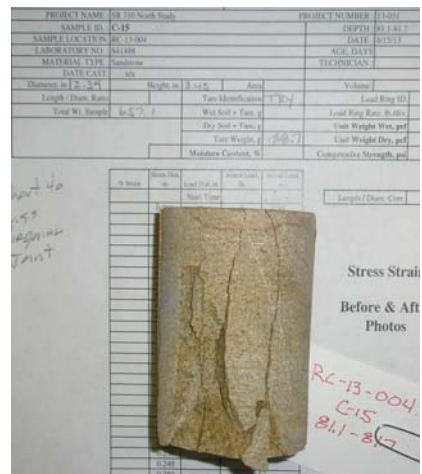
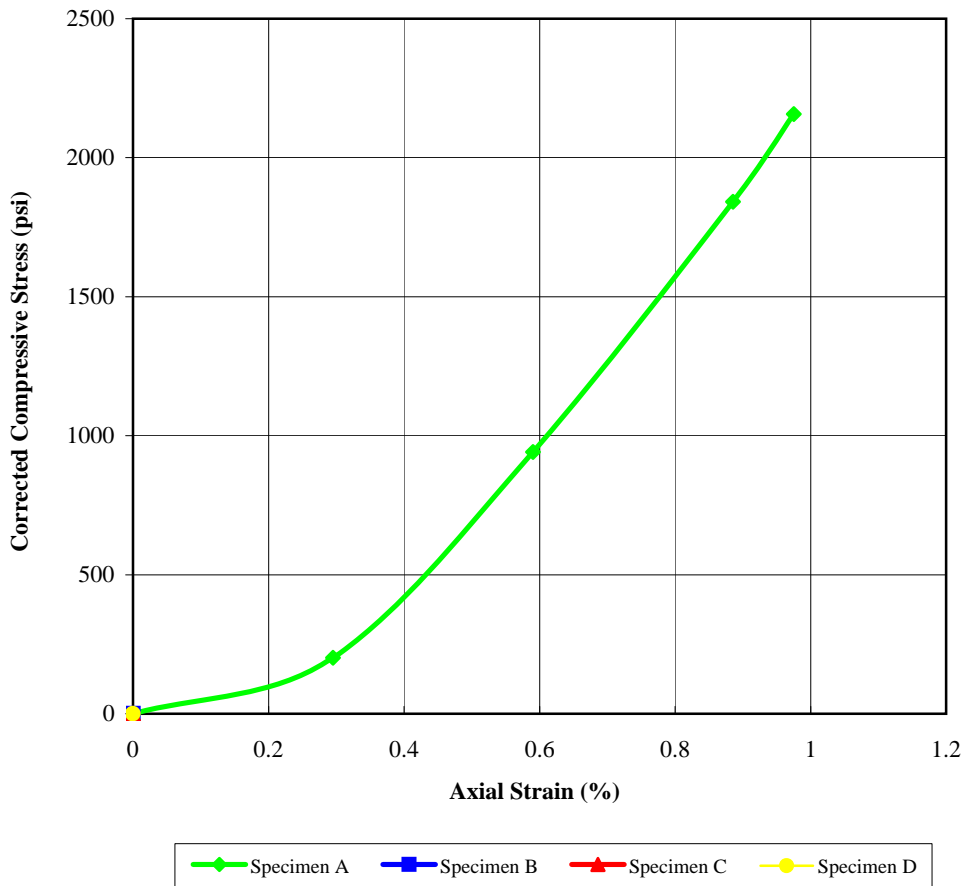
Material Type: Sandstone  
 Date Cast: n/a  
 Date Tested: 4/15/13  
 Age, Days: 0

Depth: 81.1-81.7  
 STL # S41488  
 Test Method: ASTM D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-004	C17	2.39	4.72	160.8	153.8	4.5	2157.5

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 1.99E+05**

\*using Young's Modulus Formula

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR 710 North Study  
 Project No.: 13-031  
 Report Date: April 29, 2013

Client: AP Engineering & Testing, Inc

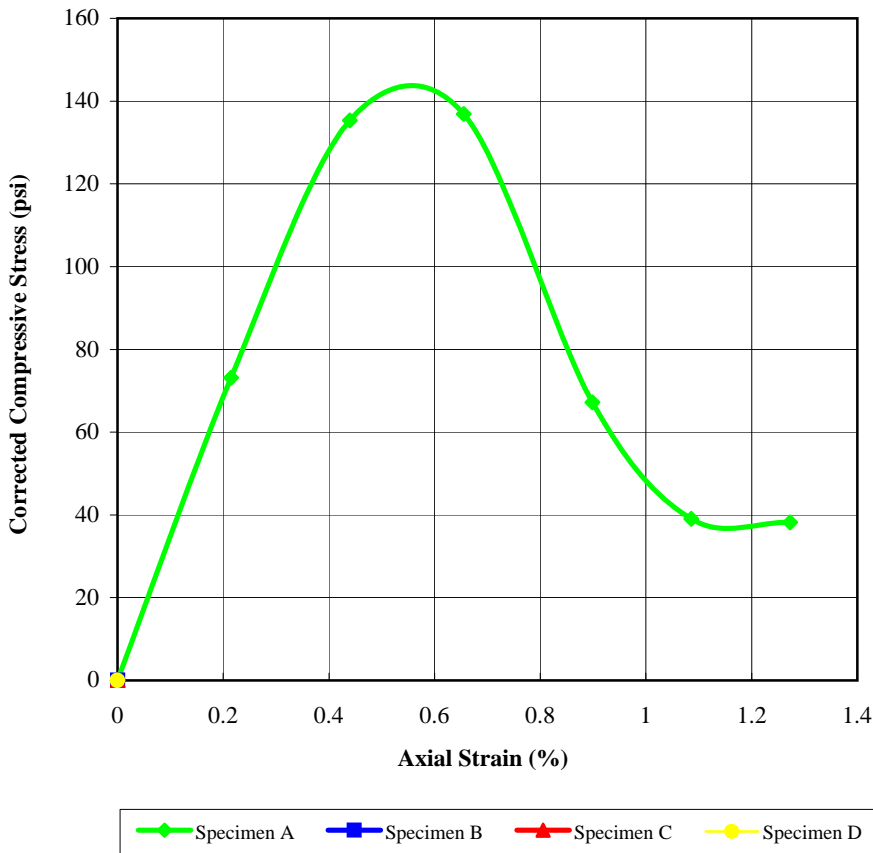
Material Type: Siltstone  
 Date Cast: n/a  
 Date Tested: 4/15/13  
 Age, Days: 0

Depth: 131.5-132.8  
 STL# S41489  
 Test Method: ASTM D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-005	C28	2.38	4.73				136.9

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 3.191E+04**

\*using Young's Modulus Formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR 710 North Study  
 Project No.: 13-031  
 Report Date: April 29, 2013

Client: AP Engineering & Testing, Inc

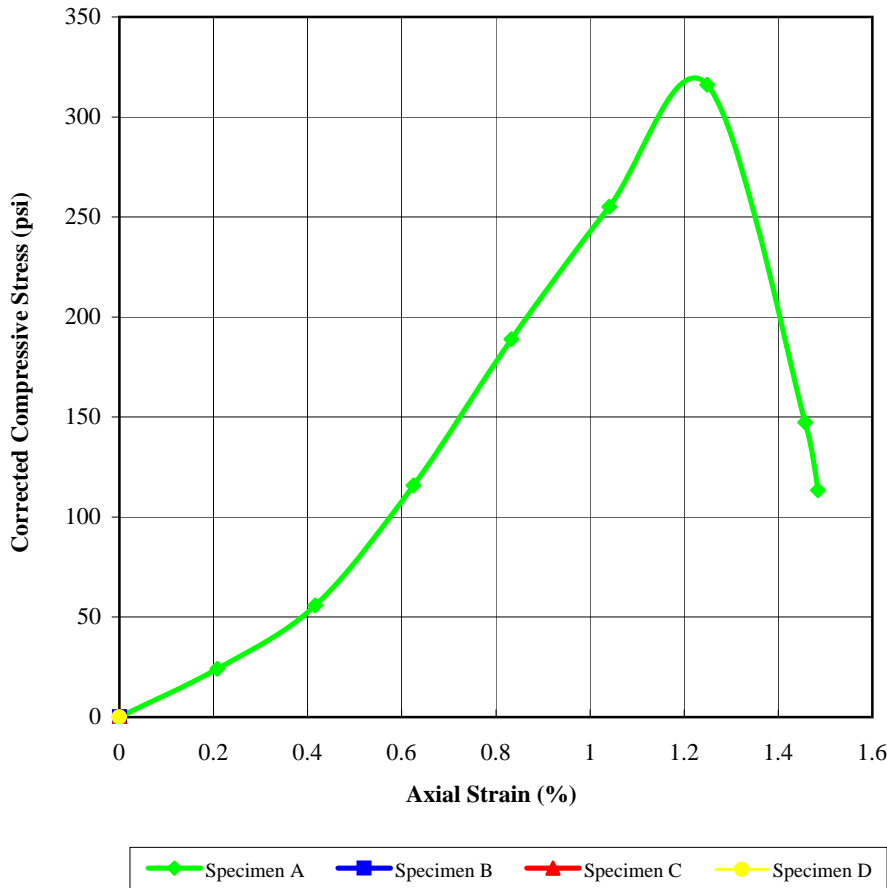
Material Type: Siltstone  
 Date Cast: n/a  
 Date Tested: 4/15/13  
 Age, Days: 0

Depth: 178.8-180  
 STL # S41490  
 Test Method: ASTM D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-005	C40	2.40	4.89	126.5	113.9	11.0	316.2

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 2.490E+04**

\*using Young's Modulus Formula



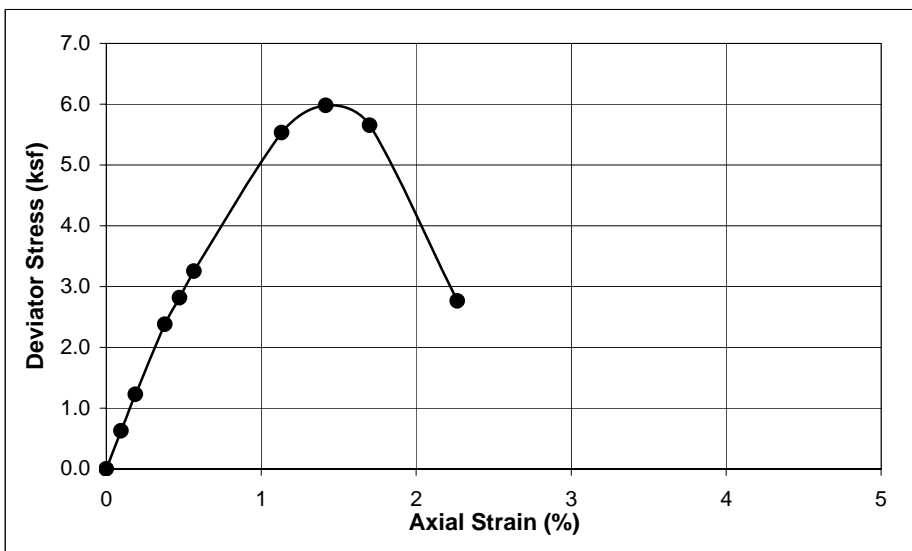
### UNCONFINED COMPRESSION TEST RESULTS ASTM D 2166

Project Name: **SR-710 North Study**  
 Project No.: **428908.02.14.00.03.02**  
 Boring No.: **R-13-006**  
 Sample No.: **S14**  
 Depth (feet): **65**

Sample Type: **Mod Cal**  
 Soil Description: **Claystone**  
 Dry Density (pcf): **97.1**  
 Moisture Content (%): **26.8**  
 Test Date: **4/16/2013**

Sample Diameter (inch): **2.42**  
 Sample Height (inch): **5.30**  
 Sample Weight (gms): **784.77**

Wt. Wet Soil+Container(gms): **593.11**  
 Wt. Dry Soil+Container(gms): **499.7**  
 Wt. Container (gms): **151.63**



Before Test



After Test



Load (lbs)	Deformation (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.58	0.00	0.00
20	0.005	4.58	0.63	0.09
39	0.010	4.59	1.22	0.19
76	0.020	4.60	2.38	0.38
90	0.025	4.60	2.82	0.47
104	0.030	4.61	3.25	0.57
178	0.060	4.63	5.53	1.13
193	0.075	4.65	5.98	1.42
183	0.090	4.66	5.66	1.70
90	0.120	4.69	2.77	2.27



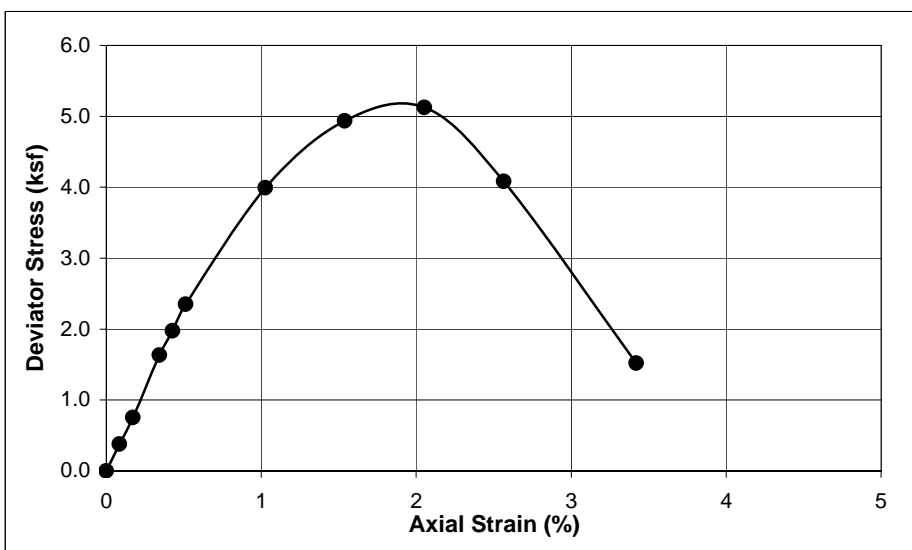
### UNCONFINED COMPRESSION TEST RESULTS ASTM D 2166

Project Name: **SR-710 North Study**  
 Project No.: **428908.02.14.00.03.02**  
 Boring No.: **R-13-006**  
 Sample No.: **S19**  
 Depth (feet): **90**

Sample Type: **Mod Cal**  
 Soil Description: **Claystone**  
 Dry Density (pcf): **94.9**  
 Moisture Content (%): **29.0**  
 Test Date: **4/16/2013**

Sample Diameter (inch): **2.41**  
 Sample Height (inch): **5.85**  
 Sample Weight (gms): **858.52**

Wt. Wet Soil+Container(gms): **471.62**  
 Wt. Dry Soil+Container(gms): **399.45**  
 Wt. Container (gms): **150.23**



Before Test



After Test



Load (lbs)	Deformation (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.57	0.00	0.00
12	0.005	4.57	0.38	0.09
24	0.010	4.58	0.76	0.17
52	0.020	4.58	1.63	0.34
63	0.025	4.59	1.98	0.43
75	0.030	4.59	2.35	0.51
128	0.060	4.62	3.99	1.03
159	0.090	4.64	4.93	1.54
166	0.120	4.66	5.12	2.05
133	0.150	4.69	4.08	2.56
50	0.200	4.73	1.52	3.42



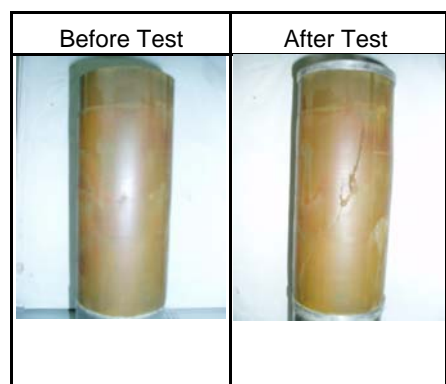
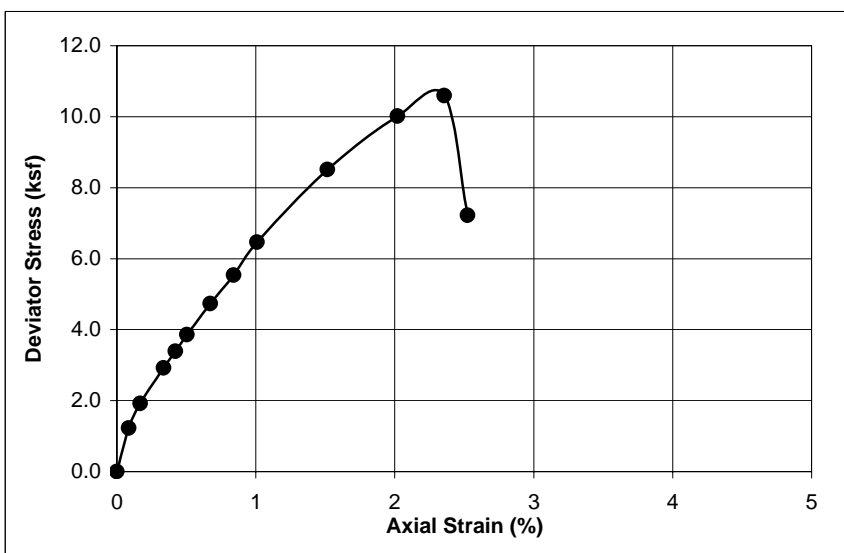
**UNCONFINED COMPRESSIVE STRENGTH WITH ELASTIC MODULI**  
ASTM D 7012

Project Name: **SR-710 North Study**  
 Project No.: **428908.02.14.00.03.02**  
 Boring No.: **R-13-006**  
 Sample No.: **S20**  
 Depth (feet): **95**

Sample Type: **Mod Cal**  
 Soil Description: **Claystone**  
 Dry Density (pcf): **98.5**  
 Moisture Content (%): **25.7**  
 Test Date: **5/1/2013**

Sample Diameter (inch): **2.41**  
 Sample Height (inch): **5.94**  
 Sample Weight (gms): **881.14**

Wt. Wet Soil+Container(gms) **335.65**  
 Wt. Dry Soil+Container(gms) **277.38**  
 Wt. Container (gms) **50.25**



Load (lbs)	Deformation (inch)	Area (sq.in)	Compressive Stress (ksf)	Axial Strain (%)
0	0.000	4.57	0.00	0.00
39	0.005	4.57	1.23	0.08
61	0.010	4.57	1.92	0.17
93	0.020	4.58	2.92	0.34
108	0.025	4.58	3.39	0.42
123	0.030	4.59	3.86	0.50
151	0.040	4.60	4.73	0.67
177	0.050	4.60	5.54	0.84
207	0.060	4.61	6.46	1.01
274	0.090	4.64	8.51	1.51
324	0.120	4.66	10.01	2.02
344	0.140	4.68	10.59	2.36
235	0.150	4.68	7.23	2.52

75% of Compressive Strength (ksf): **7.95**  
 Axial Strain @ 75% Compressive Strength (%): **1.28**

**Elastic Modulus (psi): 4.31E+03**

(\* Using Young's Modulus Formula)

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR 710 North Study  
 Project No.: 13-031  
 Report Date: April 29, 2013

Client: AP Engineering & Testing, Inc

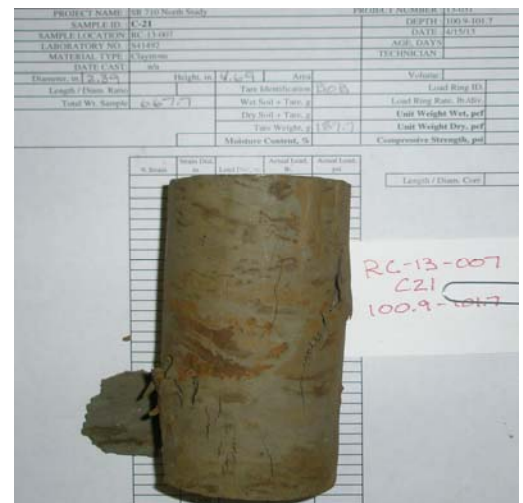
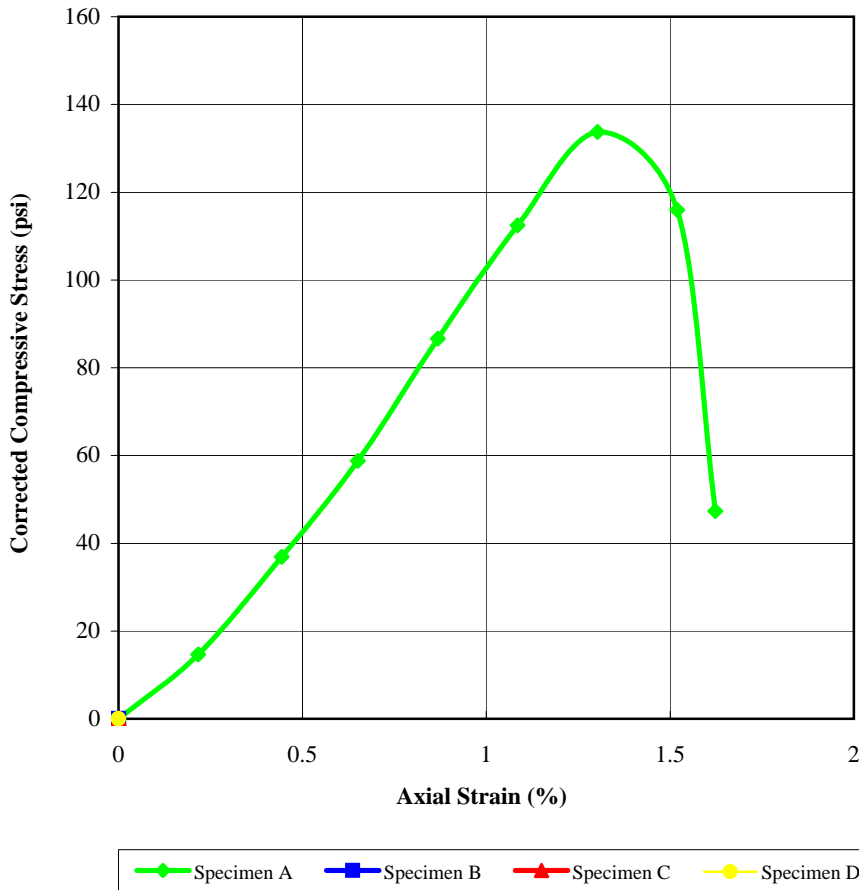
Material Type: Claystone  
 Date Cast: n/a  
 Date Tested: 4/15/13  
 Age, Days: 0

Depth: 100.9-101.7  
 STL # S41492  
 Test Method: ASTM D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-007	C21	2.39	4.69	120.9	93.4	29.4	133.8

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 1.021E+04**

\*using Young's Modulus Formula

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR 710 North Study  
 Project No.: 13-031  
 Report Date: April 29, 2013

Client: AP Engineering & Testing, Inc

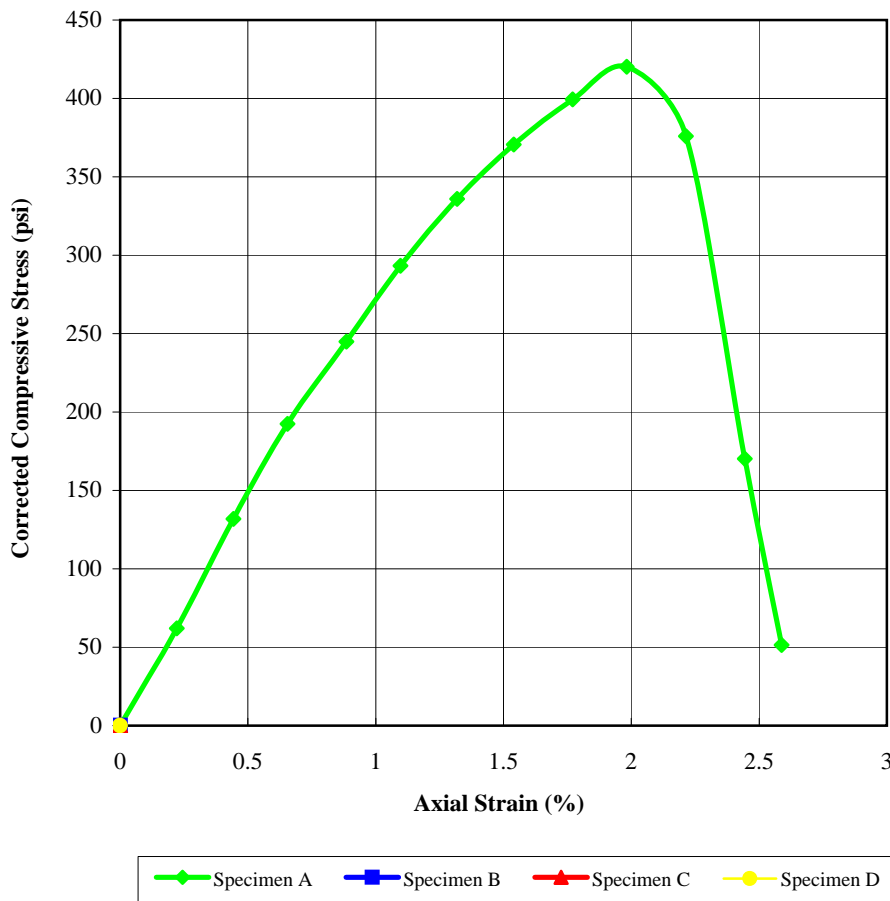
Material Type: Siltstone  
 Date Cast: n/a  
 Date Tested: 4/15/13  
 Age, Days: 0

Depth: 136-136.9  
 STL # S41493  
 Test Method: ASTM D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-007	C28	2.39	4.60	128.6	107.6	19.5	420.1

Compressive Stress Axial Strain Curve



Elastic Modulus (psi)\*: 2.605E+04

\*using Young's Modulus Formula

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR 710 North Study  
 Project No.: 13-031  
 Report Date: April 29, 2013

Client: AP Engineering & Testing, Inc

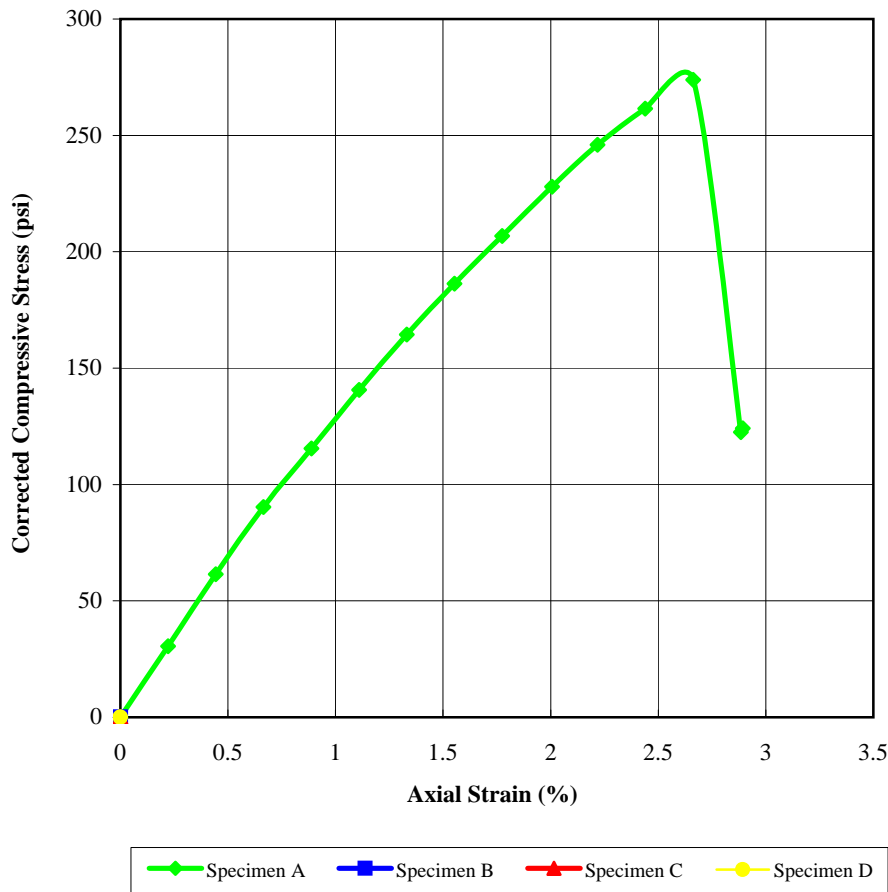
Material Type: Siltstone  
 Date Cast: n/a  
 Date Tested: 4/15/13  
 Age, Days: 0

Depth: 145-145.9  
 STL # S41494  
 Test Method: ASTM D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-007	C30	2.40	4.59	129.2	107.0	20.8	273.9

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 1.167E+04**

\*using Young's Modulus Formula

# UNCONFINED COMPRESSIVE STRENGTH

Project Name: SR 710 North Study  
Project No.: 13-031  
Report Date: April 29, 2013

Client: AP Engineering & Testing, Inc

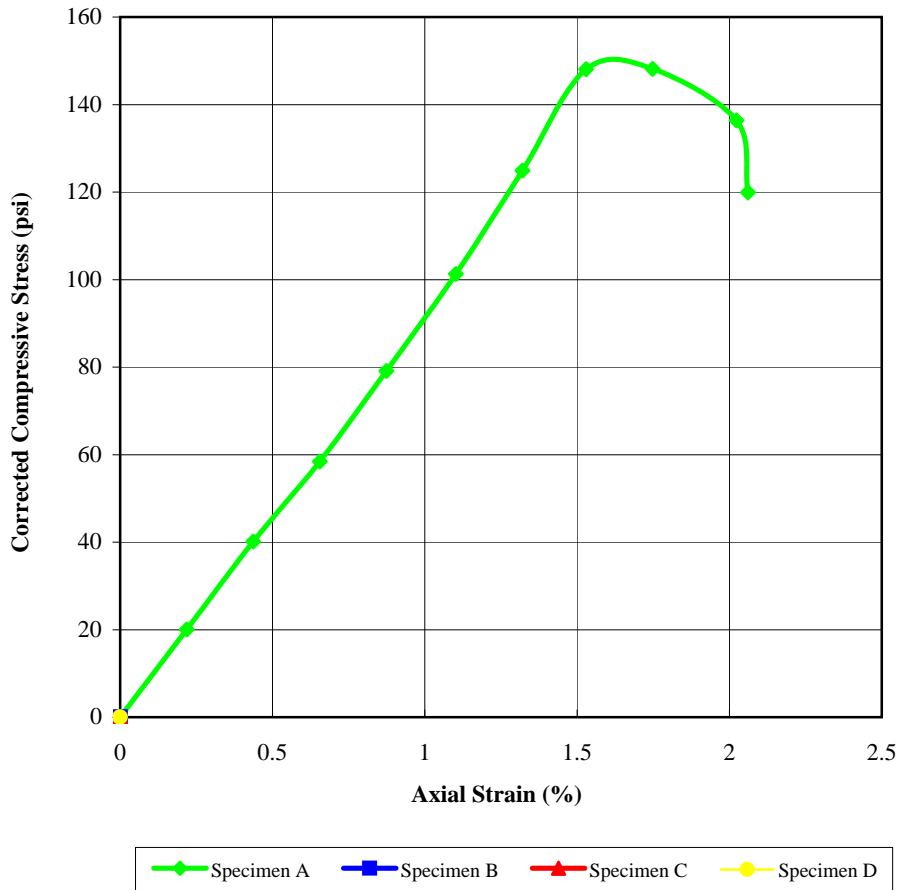
Material Type: Siltstone  
Date Cast: n/a  
Date Tested: 4/15/13  
Age, Days: 0

Depth: 159.5-160.4  
STL # S41495  
Test Method: ASTM D7012  
Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-007	C34	2.32	4.66	128.0	104.2	22.9	148.1

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 9.317E+03**

\*using Young's Modulus Formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR 710 North Study  
 Project No.: 13-031  
 Report Date: April 29, 2013

Client: AP Engineering & Testing, Inc

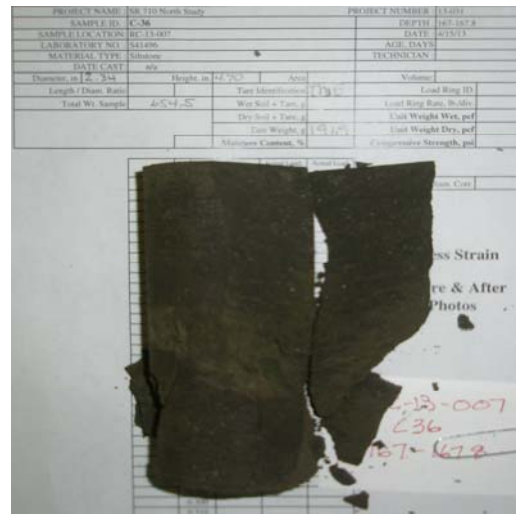
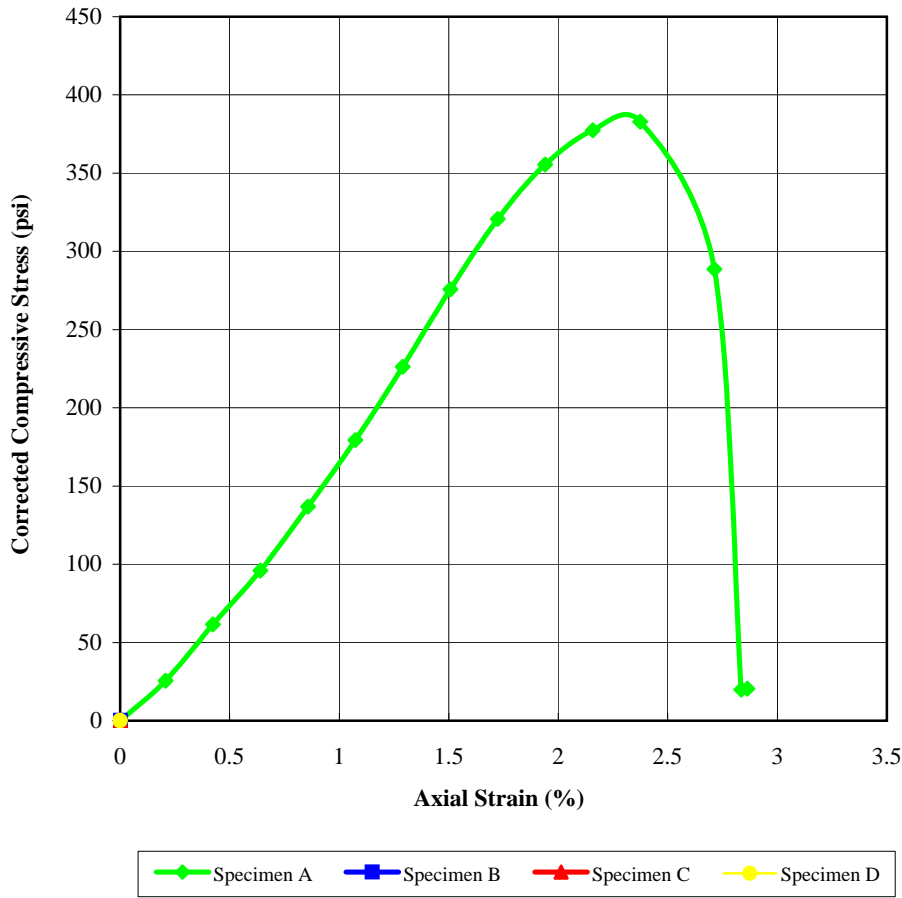
Material Type: Siltstone  
 Date Cast: n/a  
 Date Tested: 4/15/13  
 Age, Days: 0

Depth: 167-167.8  
 STL # S41496  
 Test Method: ASTM D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-007	C36	2.34	4.70	123.4	99.6	23.8	382.8

Compressive Stress Axial Strain Curve



Elastic Modulus (psi)\*: 1.838E+04

\*using Young's Modulus Formula

# UNCONFINED COMPRESSIVE STRENGTH

Project Name: SR 710 North Study  
Project No.: 13-031  
Report Date: May 7, 2013

Client: AP Engineering & Testing, Inc

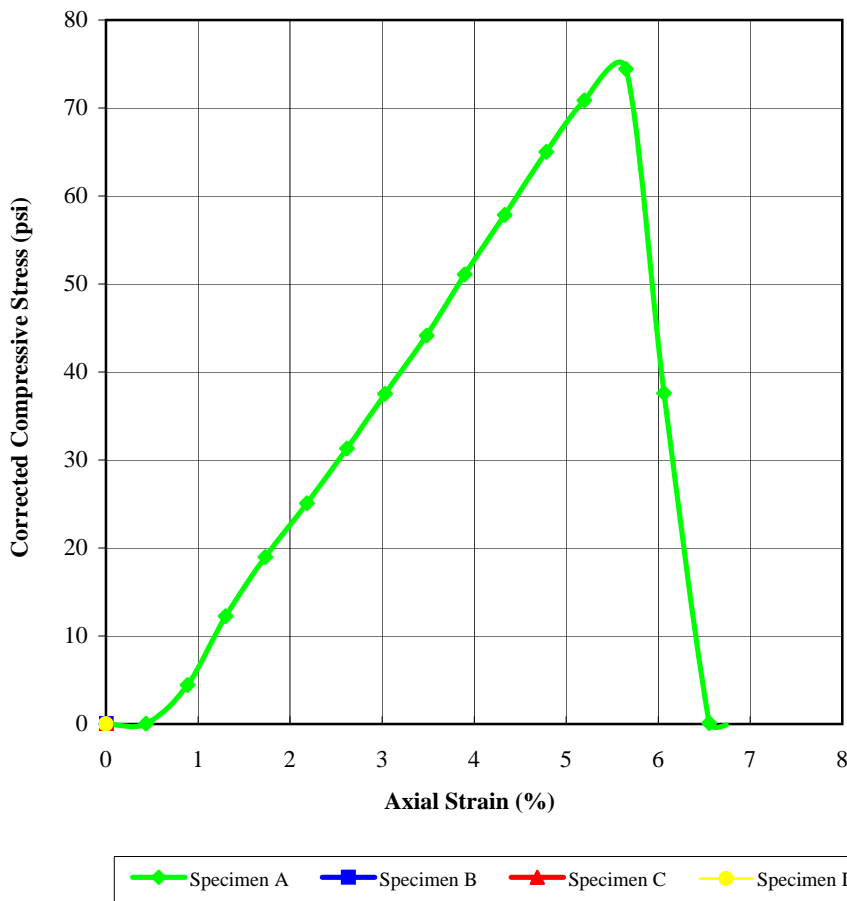
Material Type: Siltstone  
Date Cast: n/a  
Date Tested: 4/29/13  
Age, Days: 0

Depth: 177.4-178.2  
STL # S41517  
Test Method: ASTM D7012  
Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-007	C38	4.91	2.35	126.6	102.9	23.0	74.4

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 1.329E+03**

\*using Young's Modulus Formula

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR 710 North Study  
 Project No.: 13-031  
 Report Date: April 29, 2013

Client: AP Engineering & Testing, Inc

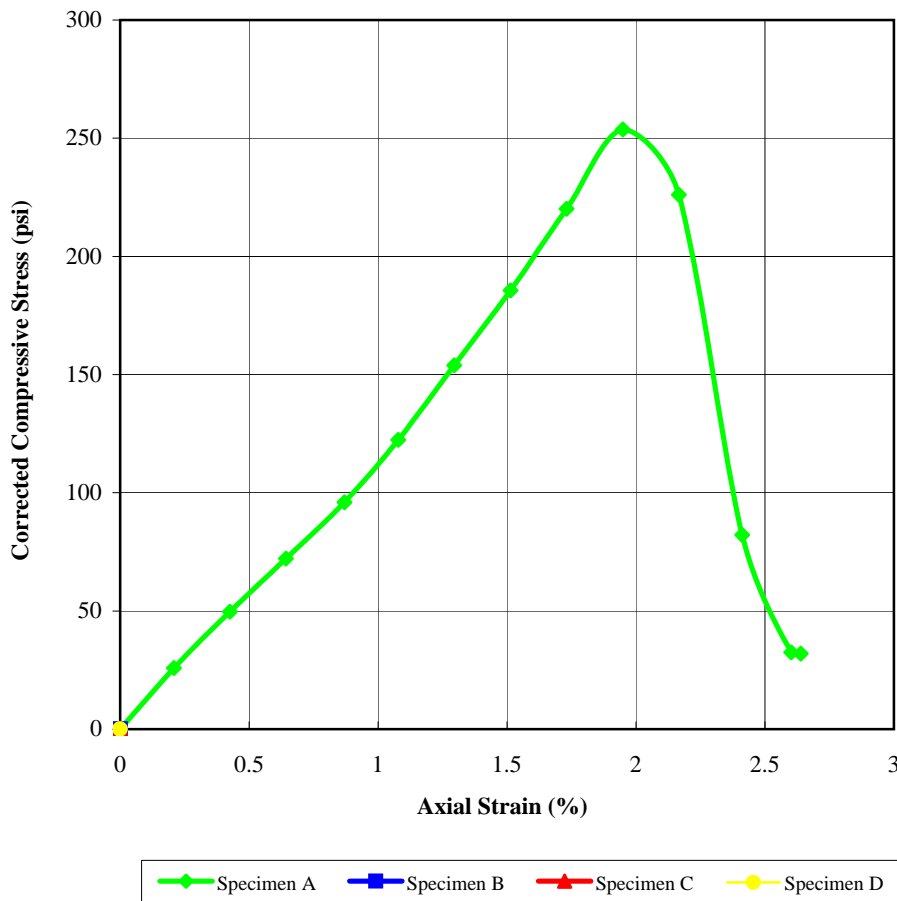
Material Type: Siltstone  
 Date Cast: n/a  
 Date Tested: 4/15/13  
 Age, Days: 0

Depth: 183.2-184.2  
 STL # S41497  
 Test Method: ASTM D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-007	C40	2.33	4.68	128.8	104.5	23.3	253.7

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 1.233E+04**

\*using Young's Modulus Formula



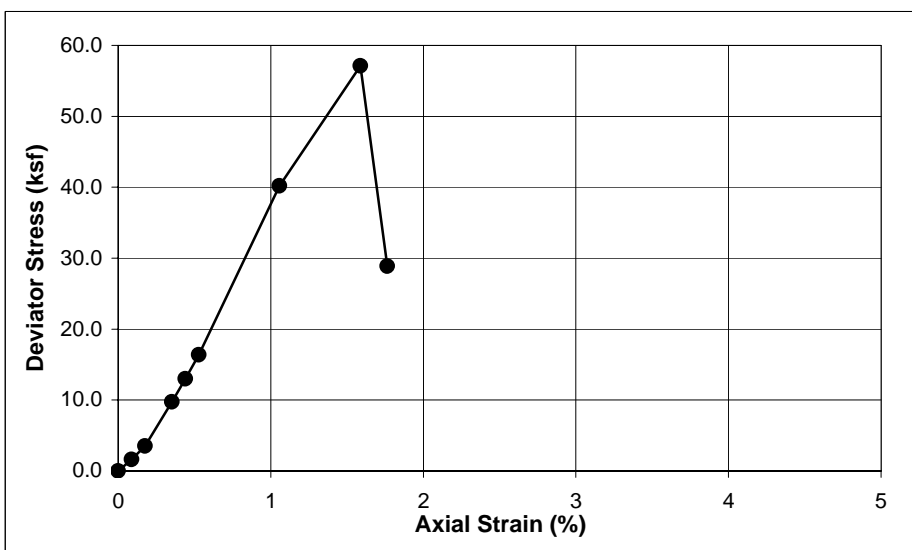
### UNCONFINED COMPRESSION TEST RESULTS ASTM D 2166

Project Name: **SR-710 North Study**  
 Project No.: **428908.02.14.00.03.02**  
 Boring No.: **RC-13-007**  
 Sample No.: **C42**  
 Depth (feet): **192.2-193.1**

Sample Type: **Core**  
 Soil Description: **Claystone**  
 Dry Density (pcf): **100.2**  
 Moisture Content (%): **22.3**  
 Test Date: **4/15/2013**

Sample Diameter (inch): **2.36**  
 Sample Height (inch): **5.67**  
 Sample Weight (gms): **800.10**

Wt. Wet Soil+Container(gms): **570.7**  
 Wt. Dry Soil+Container(gms): **493.63**  
 Wt. Container (gms): **148.05**



Load (lbs)	Deformation (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.39	0.00	0.00
50	0.005	4.39	1.64	0.09
108	0.010	4.39	3.54	0.18
298	0.020	4.40	9.75	0.35
397	0.025	4.40	12.98	0.44
502	0.030	4.41	16.40	0.53
1237	0.060	4.43	40.19	1.06
1768	0.090	4.46	57.13	1.59
895	0.100	4.46	28.87	1.76

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR 710 North Study  
 Project No.: 13-031  
 Report Date: April 29, 2013

Client: AP Engineering & Testing, Inc

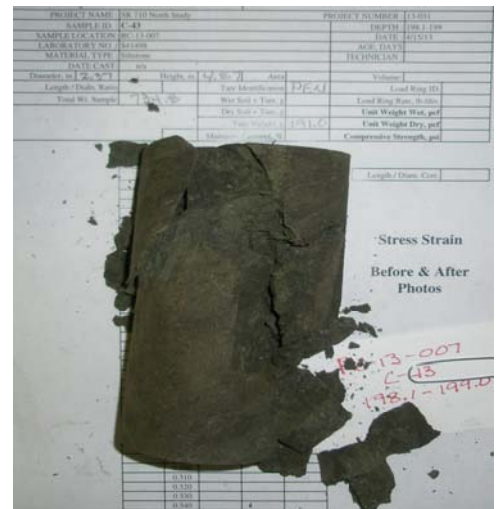
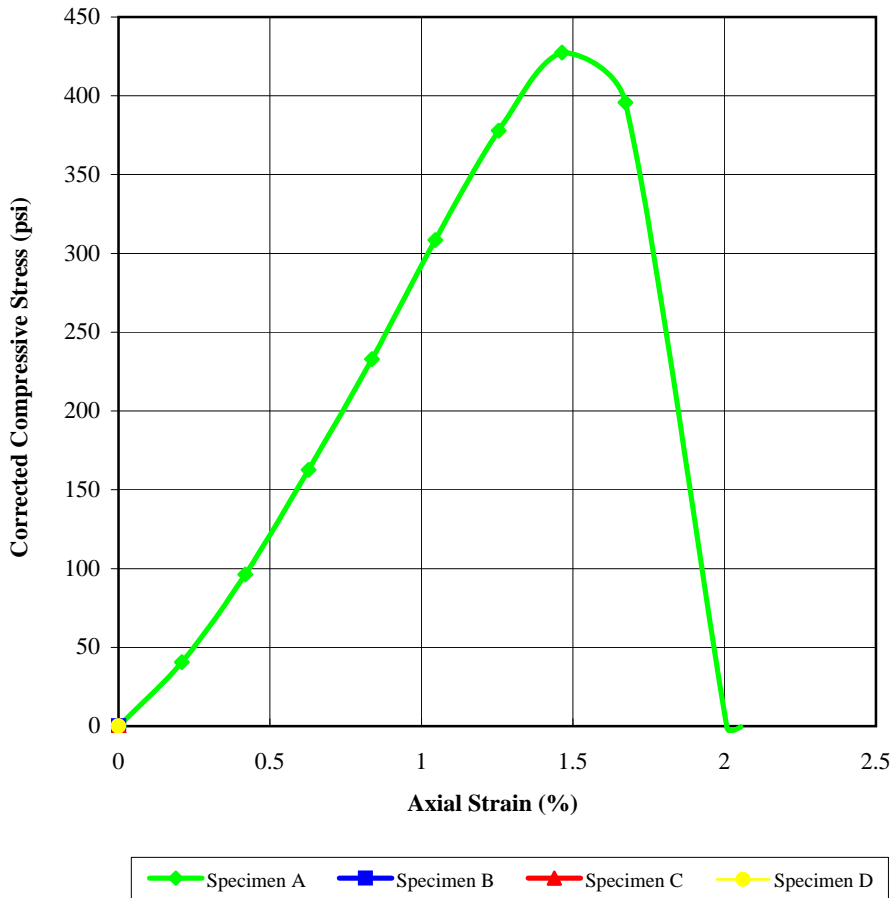
Material Type: Siltstone  
 Date Cast: n/a  
 Date Tested: 4/15/13  
 Age, Days: 0

Depth: 198.1-199  
 STL # S41498  
 Test Method: ASTM D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-007	C43	2.37	4.87				427.5

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 2.964E+04**

\*using Young's Modulus Formula

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR 710 North Study  
 Project No.: 13-031  
 Report Date: April 29, 2013

Client: AP Engineering & Testing, Inc

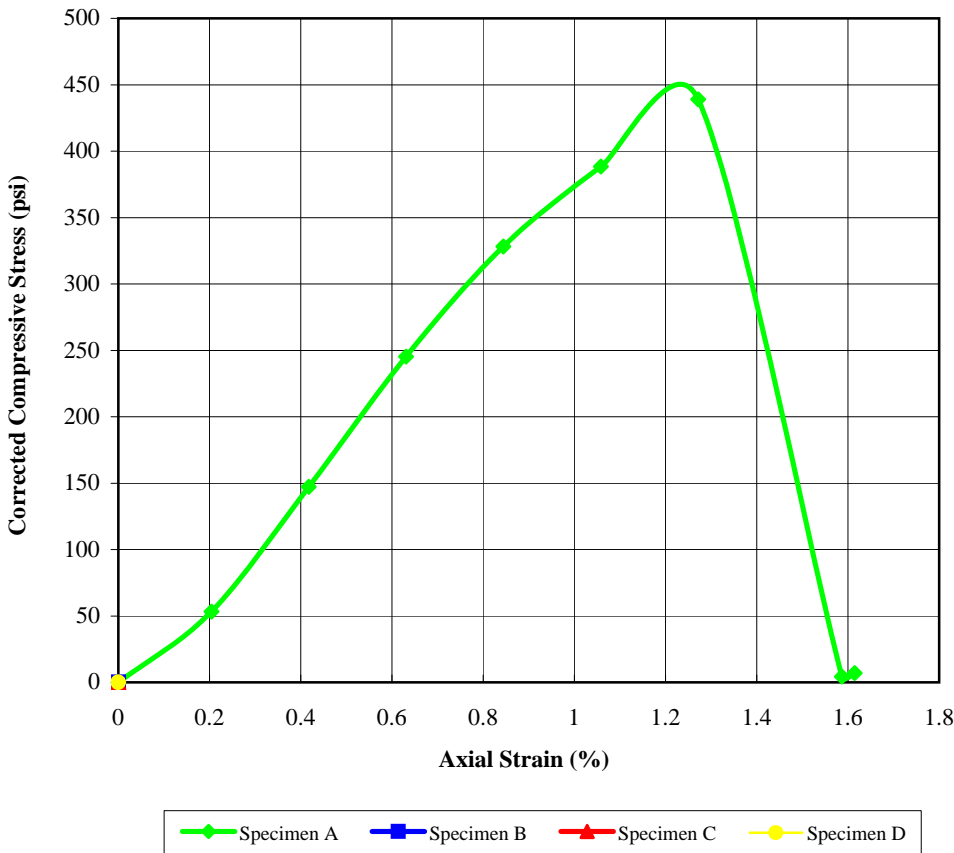
Material Type: Siltstone  
 Date Cast: n/a  
 Date Tested: 4/15/13  
 Age, Days: 0

Depth: 207.0-207.7  
 STL # S41501  
 Test Method: ASTM D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-007	C-46	2.33	4.77	127.3	103.4	23.1	439.1

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 3.879E+04**

\*using Young's Modulus Formula

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR 710 North Study  
 Project No.: 13-031  
 Report Date: April 29, 2013

Client: AP Engineering & Testing, Inc

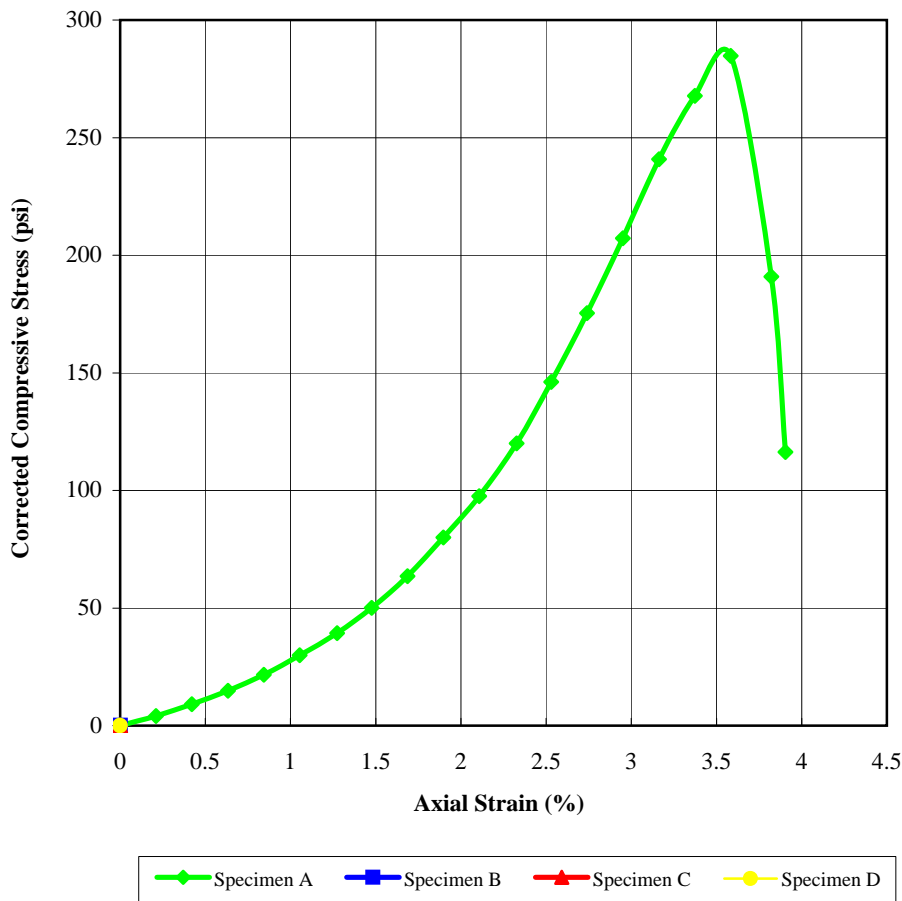
Material Type: Sandstone  
 Date Cast: n/a  
 Date Tested: 4/15/13  
 Age, Days: 0

Depth: 248.6-249.2  
 STL # S41503  
 Test Method: ASTM D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-007	C54	2.42	4.83	136.6	116.7	17.1	284.8

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 7.141E+03**

\*using Young's Modulus Formula



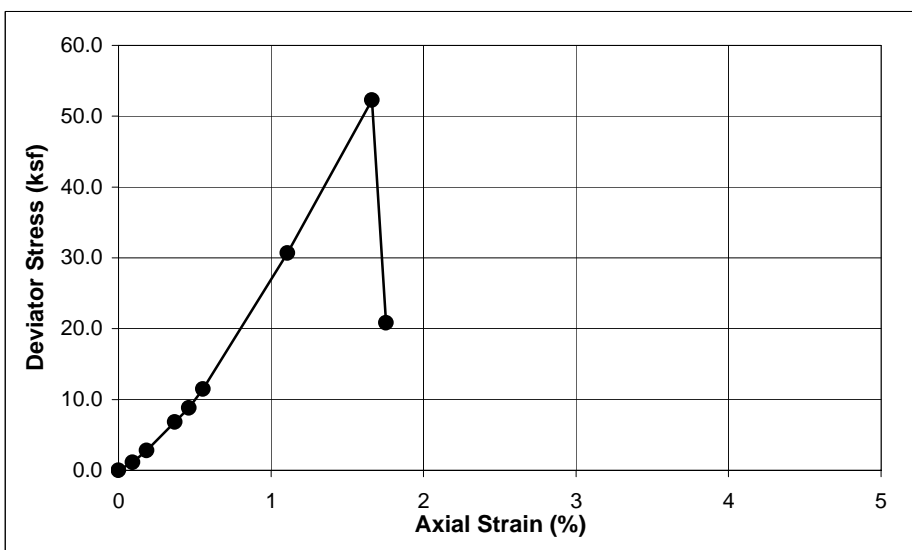
### UNCONFINED COMPRESSION TEST RESULTS ASTM D 2166

Project Name: **SR-710 North Study**  
 Project No.: **428908.02.14.00.03.02**  
 Boring No.: **RC-13-007**  
 Sample No.: **C55**  
 Depth (feet): **257.4-258.3**

Sample Type: **Core**  
 Soil Description: **Sandy Siltstone**  
 Dry Density (pcf): **112.2**  
 Moisture Content (%): **18.1**  
 Test Date: **4/15/2013**

Sample Diameter (inch): **2.41**  
 Sample Height (inch): **5.42**  
 Sample Weight (gms): **856.69**

Wt. Wet Soil+Container(gms): **551.25**  
 Wt. Dry Soil+Container(gms): **490.1**  
 Wt. Container (gms): **152.19**



Load (lbs)	Deformation (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.55	0.00	0.00
36	0.005	4.55	1.14	0.09
89	0.010	4.55	2.81	0.18
216	0.020	4.56	6.82	0.37
279	0.025	4.57	8.80	0.46
364	0.030	4.57	11.46	0.55
979	0.060	4.60	30.66	1.11
1679	0.090	4.62	52.29	1.66
669	0.095	4.63	20.82	1.75





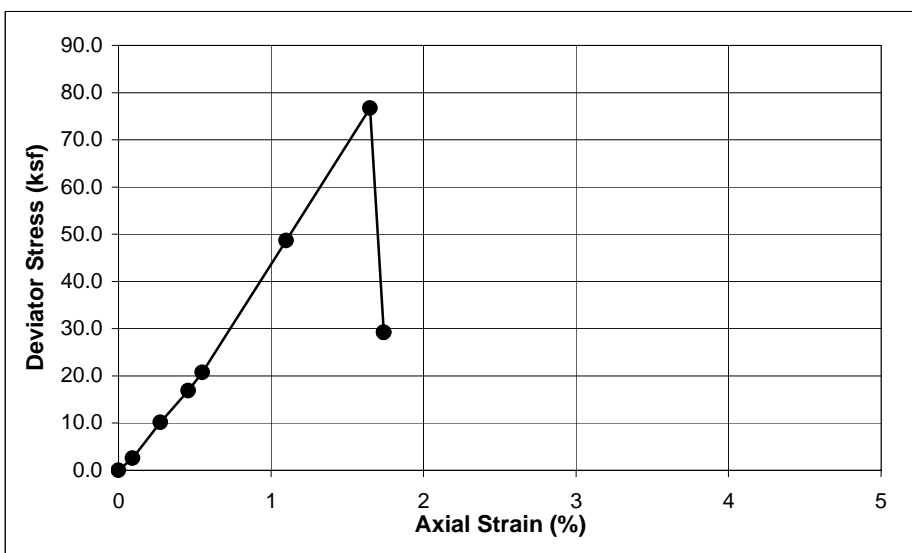
### UNCONFINED COMPRESSION TEST RESULTS ASTM D 2166

Project Name: **SR-710 North Study**  
 Project No.: **428908.02.14.00.03.02**  
 Boring No.: **RC-13-007**  
 Sample No.: ~~C59~~ **C58**  
 Depth (feet): **265.8-266.6**

Sample Type: **Core**  
 Soil Description: **Siltstone**  
 Dry Density (pcf): **106.6**  
 Moisture Content (%): **20.4**  
 Test Date: **4/15/2013**

Sample Diameter (inch): **2.35**  
 Sample Height (inch): **5.46**  
 Sample Weight (gms): **799.70**

Wt. Wet Soil+Container(gms): **563.27**  
 Wt. Dry Soil+Container(gms): **493.26**  
 Wt. Container (gms): **149.6**



Load (lbs)	Deformation (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.35	0.00	0.00
78	0.005	4.35	2.58	0.09
308	0.015	4.36	10.17	0.27
512	0.025	4.37	16.88	0.46
629	0.030	4.37	20.72	0.55
1485	0.060	4.40	48.64	1.10
2356	0.090	4.42	76.73	1.65
897	0.095	4.43	29.19	1.74
897	0.095	4.43	29.19	1.74

# UNCONFINED COMPRESSIVE STRENGTH

Project Name: SR 710 North Study  
Project No.: 13-031  
Report Date: May 7, 2013

Client: AP Engineering & Testing, Inc

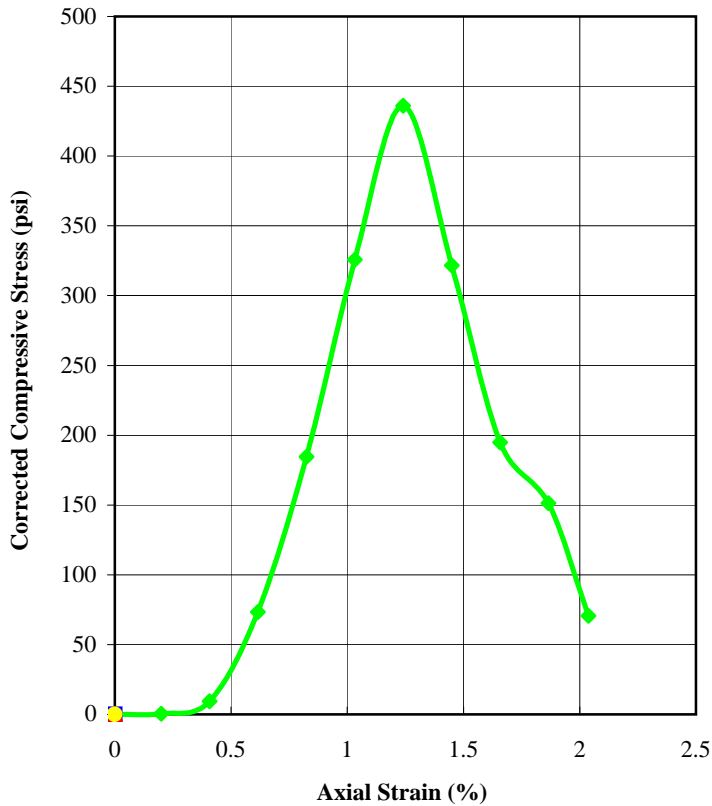
Material Type: Igneous Rock  
Date Cast: n/a  
Date Tested: 4/29/13  
Age, Days: 0

Depth: 167.2-167.8  
STL # S41518  
Test Method: ASTM D7012  
Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-009	C36	2.39	4.89	146.8	138.6	5.9	436.0

Compressive Stress Axial Strain Curve



◆ Specimen A   
 ■ Specimen B   
 ▲ Specimen C   
 ● Specimen D



**Elastic Modulus (psi)\*: 3.158E+04**

\*using Young's Modulus Formula

# UNCONFINED COMPRESSIVE STRENGTH

Project Name: SR 710 North Study  
Project No.: 13-031  
Report Date: May 7, 2013

Client: AP Engineering & Testing, Inc

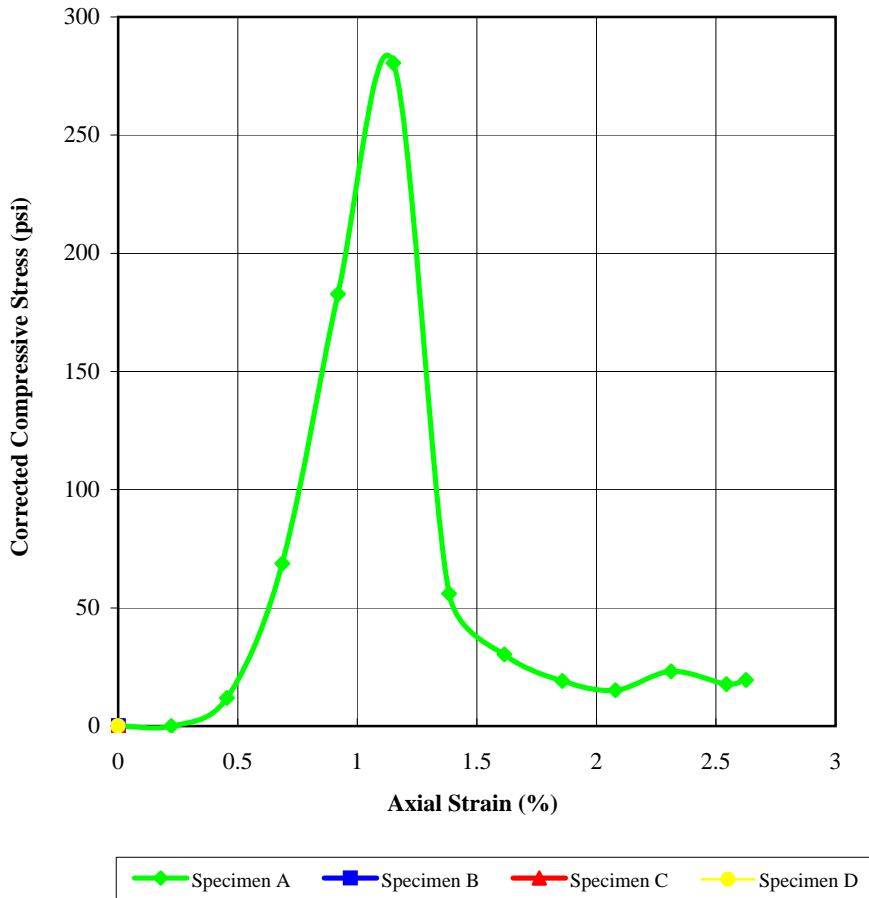
Material Type: Igneous Rock  
Date Cast: n/a  
Date Tested: 4/29/13  
Age, Days: 0

Depth: 191.0-191.6  
STL # S41520  
Test Method: ASTM D7012  
Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-009	C41	2.40	4.39	153.4	147.4	4.1	280.5

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 2.137E+04**

\*using Young's Modulus Formula

# UNCONFINED COMPRESSIVE STRENGTH

Project Name: SR 710 North Study  
Project No.: 13-031  
Report Date: May 7, 2013

Client: AP Engineering & Testing, Inc

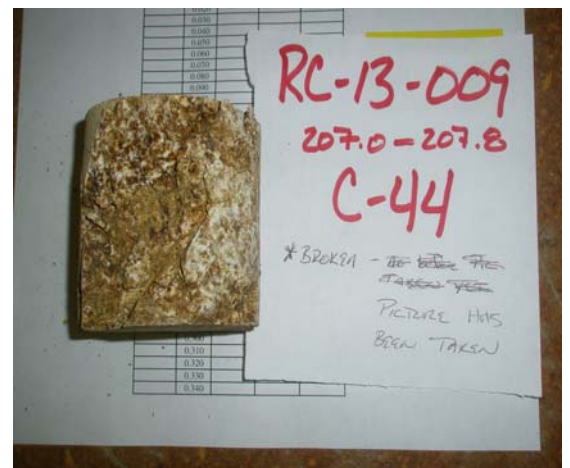
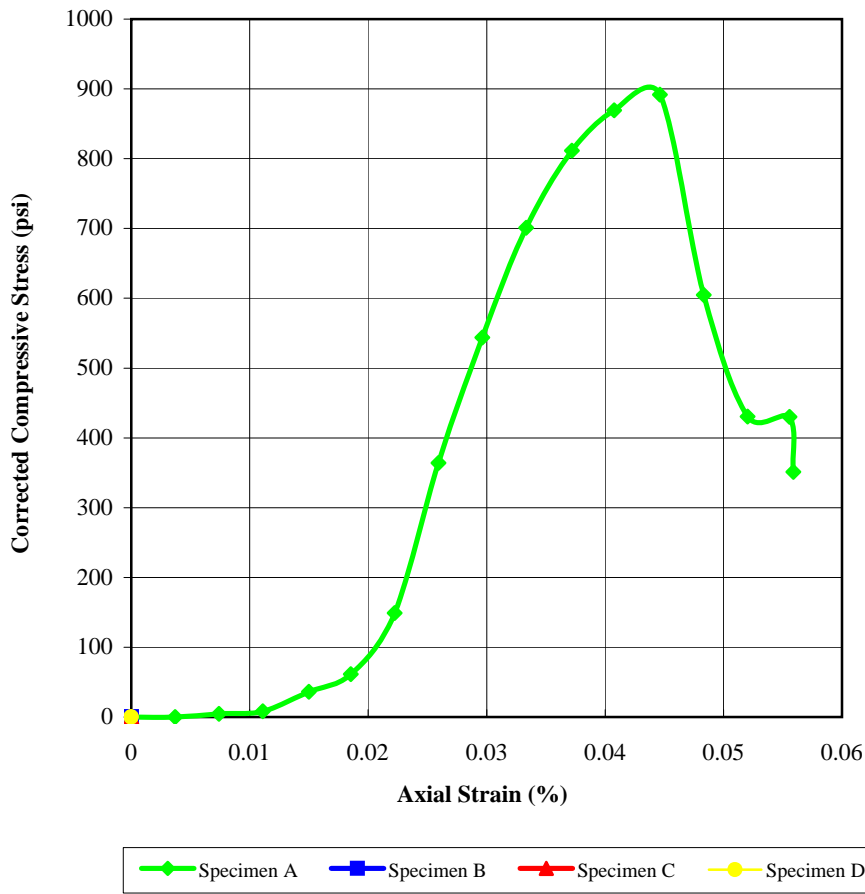
Material Type: Igneous Rock  
Date Cast: n/a  
Date Tested: 4/29/13  
Age, Days: 0

Depth: 207.0-207.8  
STL # S41521  
Test Method: ASTM D7012  
Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-009	C44	2.40	2.75	150.4	148.1	1.5	891.6

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 2.065E+06**

\*using Young's Modulus Formula

# UNCONFINED COMPRESSIVE STRENGTH

Project Name: SR 710 North Study  
Project No.: 13-031  
Report Date: May 7, 2013

Client: AP Engineering & Testing, Inc

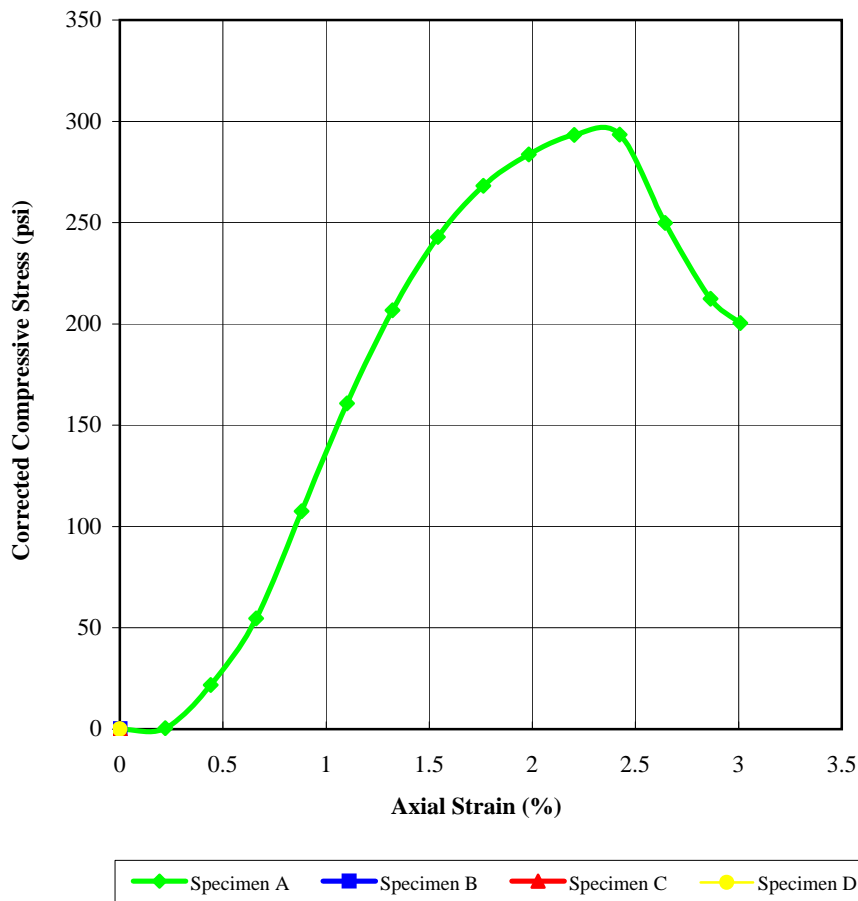
Material Type: Igneous Rock  
Date Cast: n/a  
Date Tested: 4/29/13  
Age, Days: 0

Depth: 232.8-233.3  
STL # S41524  
Test Method: ASTM D7012  
Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-009	C49	2.40	4.62	151.0	146.6	3.0	293.5

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 1.569E+04**

\*using Young's Modulus Formula

# UNCONFINED COMPRESSIVE STRENGTH

Project Name: SR 710 North Study  
Project No.: 13-031  
Report Date: May 7, 2013

Client: AP Engineering & Testing, Inc

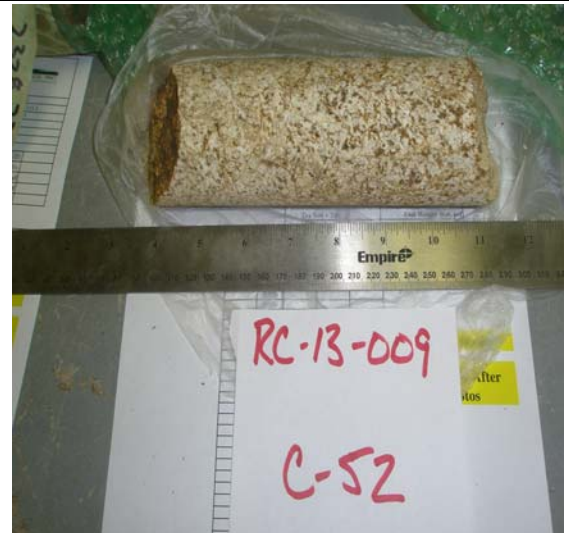
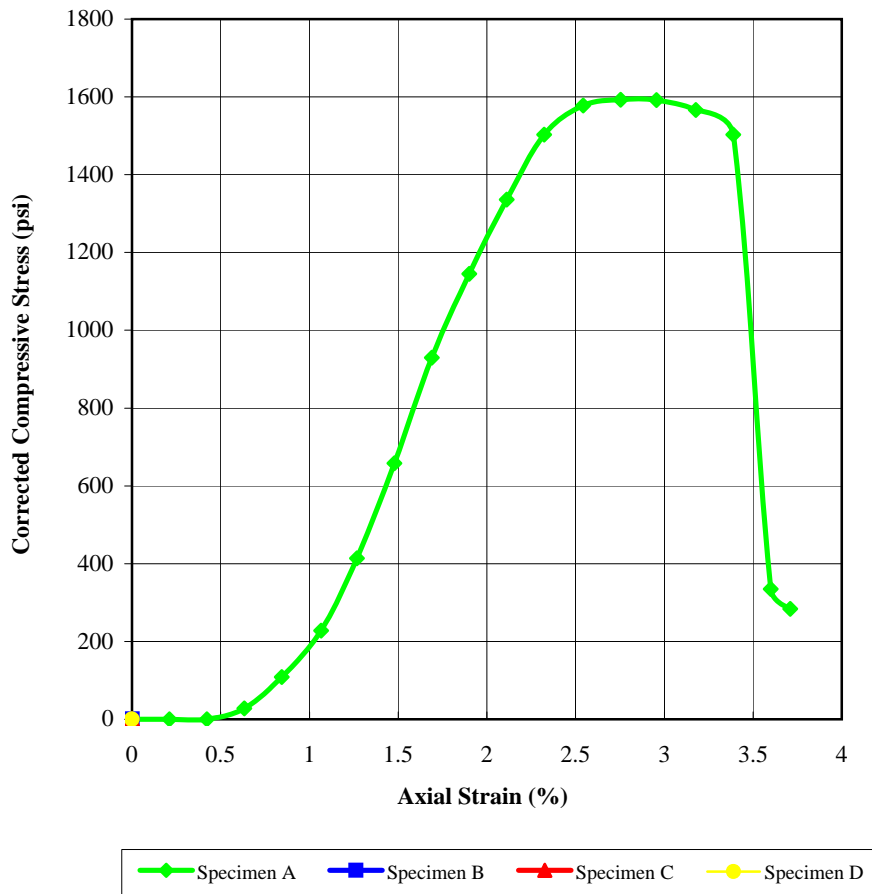
Material Type: Igneous Rock  
Date Cast: n/a  
Date Tested: 4/29/13  
Age, Days: 0

Depth: 248.5-249.0  
STL# S41525  
Test Method: ASTM D7012  
Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-009	C52	2.39	4.82	154.9	152.6	1.5	1592.8

Compressive Stress Axial Strain Curve



**Elastic Modulus (psi)\*: 6.109E+04**

\*using Young's Modulus Formula

# UNCONFINED COMPRESSIVE STRENGTH

Project Name: SR 710 North Study  
Project No.: 13-031  
Report Date: May 7, 2013

Client: AP Engineering & Testing, Inc

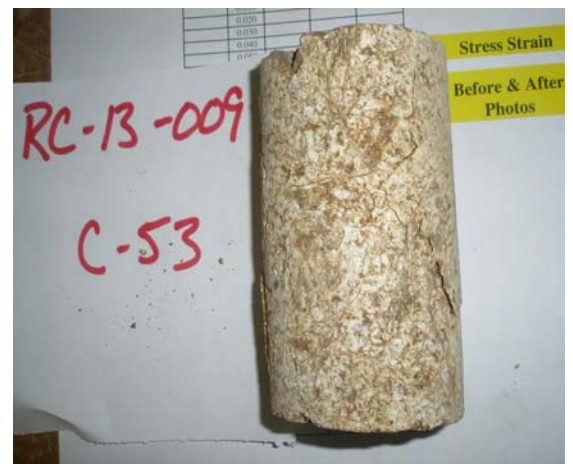
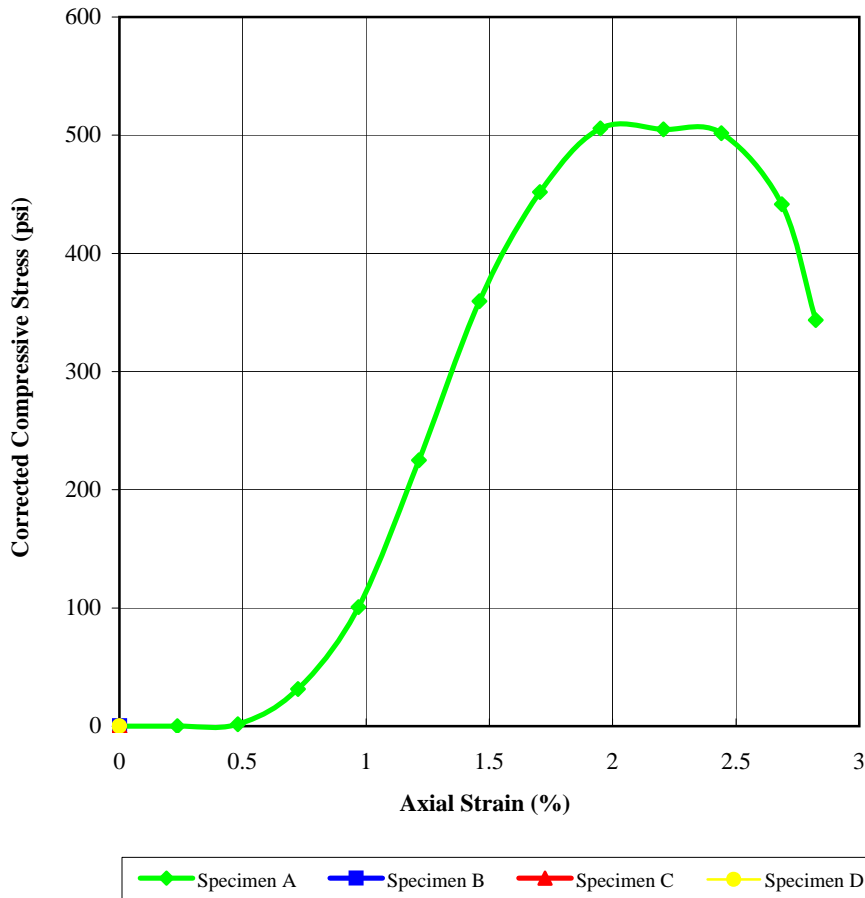
Material Type: Igneous Rock  
Date Cast: n/a  
Date Tested: 4/29/13  
Age, Days: 0

Depth: 255.8-256.5  
STL # S41526  
Test Method: ASTM D7012  
Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
RC-13-009	C53	2.40	4.15	151.9	148.7	2.1	505.7

Compressive Stress Axial Strain Curve



Elastic Modulus (psi)\*: 2.508E+04

\*using Young's Modulus Formula



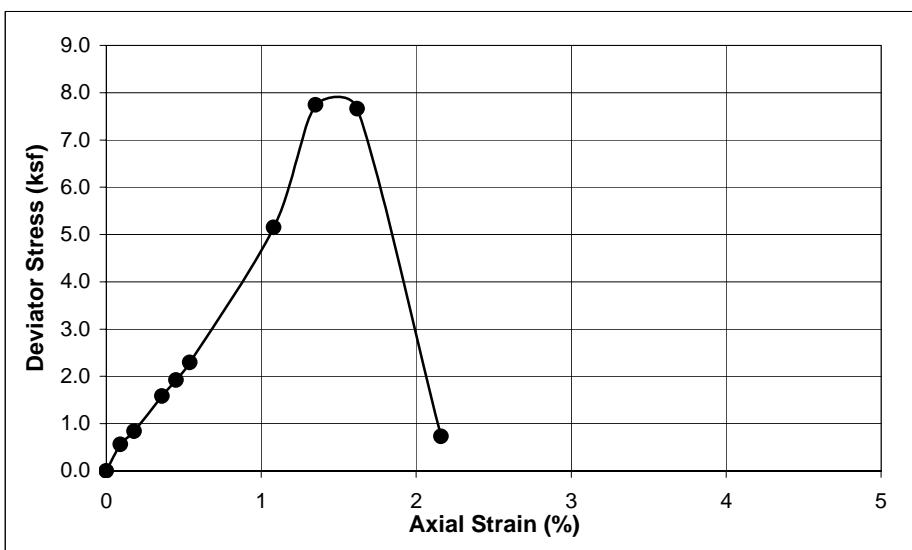
### UNCONFINED COMPRESSION TEST RESULTS ASTM D 2166

Project Name: **SR-710 North Study**  
 Project No.: **428908.02.14.00.03.02**  
 Boring No.: **A-13-021**  
 Sample No.: **S05**  
 Depth (feet): **20**

Sample Type: **Mod Cal**  
 Soil Description: **Claystone**  
 Dry Density (pcf): **99.2**  
 Moisture Content (%): **21.1**  
 Test Date: **4/17/2013**

Sample Diameter (inch): **2.43**  
 Sample Height (inch): **5.56**  
 Sample Weight (gms): **810.35**

Wt. Wet Soil+Container(gms): **570.17**  
 Wt. Dry Soil+Container(gms): **495.47**  
 Wt. Container (gms): **141.03**



Before Test



After Test



Load (lbs)	Deformation (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.62	0.00	0.00
18	0.005	4.63	0.56	0.09
27	0.010	4.63	0.84	0.18
51	0.020	4.64	1.58	0.36
62	0.025	4.64	1.92	0.45
74	0.030	4.65	2.29	0.54
167	0.060	4.67	5.15	1.08
252	0.075	4.69	7.74	1.35
250	0.090	4.70	7.66	1.62
24	0.120	4.72	0.73	2.16





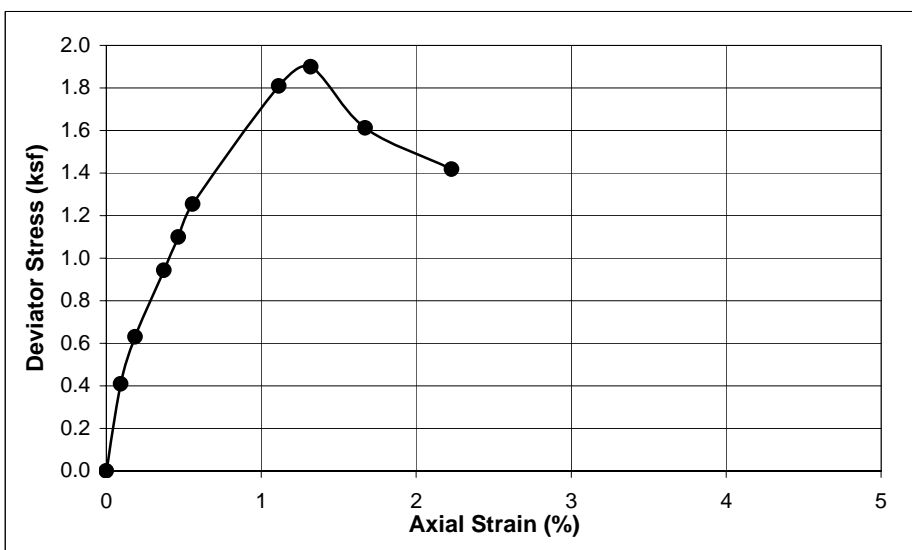
### UNCONFINED COMPRESSION TEST RESULTS ASTM D 2166

Project Name: **SR-710 North Study**  
 Project No.: **428908.02.14.00.03.02**  
 Boring No.: **A-13-021**  
 Sample No.: **S13**  
 Depth (feet): **60**

Sample Type: **Mod Cal**  
 Soil Description: **Siltstone**  
 Dry Density (pcf): **91.8**  
 Moisture Content (%): **22.1**  
 Test Date: **4/17/2013**

Sample Diameter (inch): **2.41**  
 Sample Height (inch): **5.39**  
 Sample Weight (gms): **723.87**

Wt. Wet Soil+Container(gms): **518.42**  
 Wt. Dry Soil+Container(gms): **450.37**  
 Wt. Container (gms): **143.00**



Load (lbs)	Deformation (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.57	0.00	0.00
13	0.005	4.57	0.41	0.09
20	0.010	4.57	0.63	0.19
30	0.020	4.58	0.94	0.37
35	0.025	4.59	1.10	0.46
40	0.030	4.59	1.25	0.56
58	0.060	4.62	1.81	1.11
61	0.071	4.63	1.90	1.32
52	0.090	4.64	1.61	1.67
46	0.120	4.67	1.42	2.23

# UNCONFINED COMPRESSIVE STRENGTH

Project Name: SR 710 North Study  
Project No.: 13-031  
Report Date: April 29, 2013

Client: AP Engineering & Testing, Inc

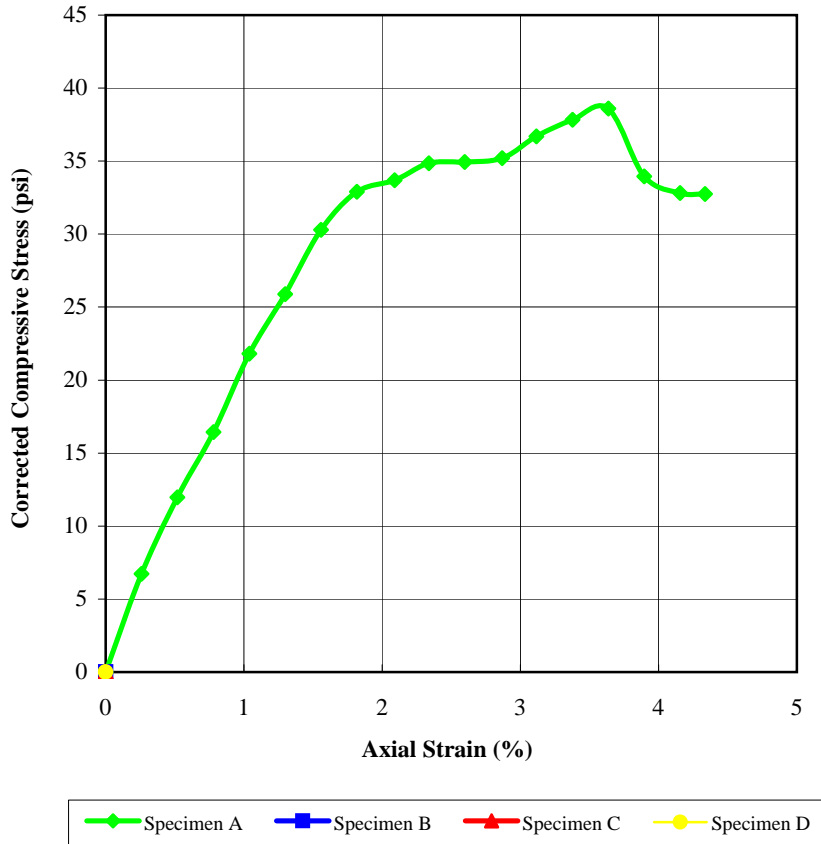
Material Type: Siltstone  
Date Cast: n/a  
Date Tested: 4/15/13  
Age, Days: 0

Depth: 80  
STL# S41504  
Test Method: ASTM D7012  
Moisture Condition At Testing: Ambient

## Test Results

Boring No.	Sample No.	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
A-13-021	(D)/S17	2.40	3.92	110.2	91.6	20.4	38.6

Compressive Stress Axial Strain Curve



(NO PRE-TEST PICTURE)



**Elastic Modulus (psi)\*: 1.957 E+03**

\*using Young's modulus formula



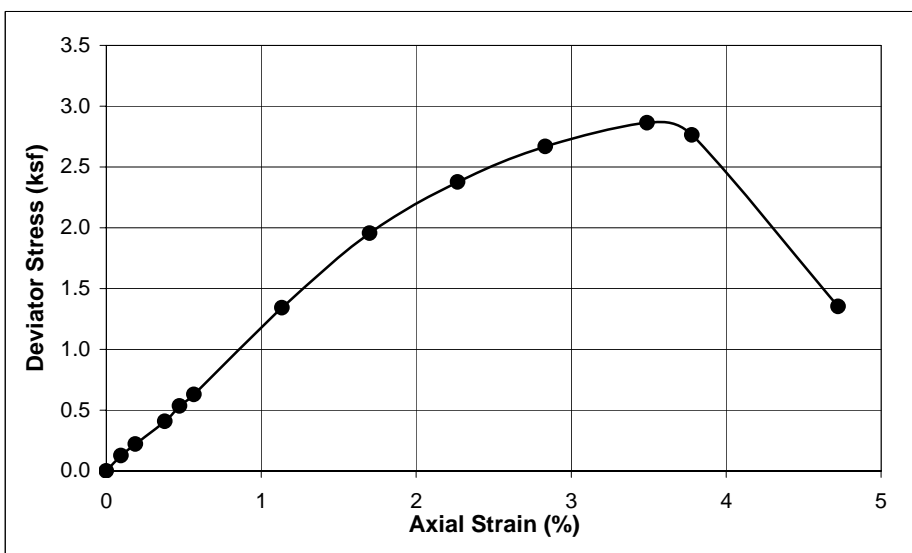
### UNCONFINED COMPRESSION TEST RESULTS ASTM D 2166

Project Name: **SR-710 North Study**  
Project No.: **428908.02.14.00.03.02**  
Boring No.: **A-13-021**  
Sample No.: **S19**  
Depth (feet): **90**

Sample Type: **Mod Cal**  
Soil Description: **Siltstone**  
Dry Density (pcf): **90.6**  
Moisture Content (%): **24.0**  
Test Date: **4/17/2013**

Sample Diameter (inch): **2.41**  
Sample Height (inch): **5.29**  
Sample Weight (gms): **712.41**

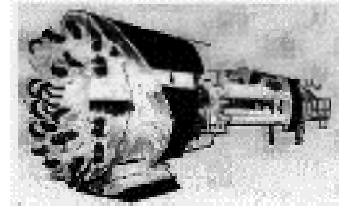
Wt. Wet Soil+Container(gms): **443.98**  
Wt. Dry Soil+Container(gms): **385.58**  
Wt. Container (gms): **142.09**



Load (lbs)	Deformation (inch)	Area (sq.in)	Deviator Stress (ksf)	Axial Strain (%)
0	0.000	4.56	0.00	0.00
4	0.005	4.57	0.13	0.09
7	0.010	4.57	0.22	0.19
13	0.020	4.58	0.41	0.38
17	0.025	4.58	0.53	0.47
20	0.030	4.59	0.63	0.57
43	0.060	4.61	1.34	1.13
63	0.090	4.64	1.95	1.70
77	0.120	4.67	2.38	2.27
87	0.150	4.69	2.67	2.83
94	0.185	4.73	2.86	3.49
91	0.200	4.74	2.76	3.78
45	0.250	4.79	1.35	4.72



EARTH MECHANICS INSTITUTE  
Department of Mining Engineering  
Colorado School of Mines  
Thin Section Petrographic Analysis



Project: SR-710 North Study, #428908.02.14.00.03.02 Studied by: Sandin E. Phillipson

Client: CH2M Hill Date: June 17, 2013

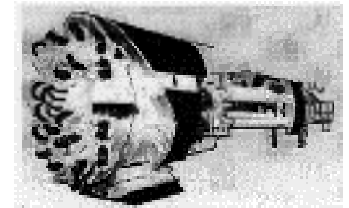
The seven samples submitted in this suite include four examples of fine-grained sedimentary rock and three examples of igneous rock. Both RC-13-005 samples can be categorized as feldspathic wacke according to Dott's 1964 classification, reflecting a significant amount of "argillaceous" matrix, or fine-grained mica. Domination by mica results in average Mohs Hardness values of 4.12-4.17. Both samples are also poorly indurated as though only semi-lithified, and can be easily gouged with a fingernail.

Both RC-13-007 samples can be categorized as bedded siltstone according to Potter's 1980 classification for shale. Despite a much higher mica content and lower quartz and plagioclase contents that results in average Mohs Hardness values of 3.50-3.62, these samples exhibit a greater degree of induration than the feldspathic wackes.

All three RC-13-009 samples represent granitoids (quartz diorite and tonalite) that have been subjected to intense brittle deformation, resulting in extensive cataclasis of the original plutonic matrix and development of micaceous shear zones. Pockets of the original igneous textures are preserved intact, bounded by granulated zones of shearing. Domination by quartz and plagioclase, with very minor orthoclase, results in average Mohs Hardness values of 5.69-5.85. Despite the interlocking igneous textures of minerals, the numerous micaceous shear zones that truncate the rock fabric may represent planes of preferential weakness. All three samples exhibit moderate to heavy sericite alteration of plagioclase, and staining by iron and manganese oxides.



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Colorado School of Mines  
Thin Section Petrographic Analysis



<b>Project:</b> SR-710 North Study	
<b>Location:</b> Los Angeles, California	<b>Client:</b> CH2M Hill
<b>Formation:</b> unknown	<b>Core ID:</b> RC-13-005 141.5-142.2
<b>Date Studied:</b> June 16, 2013	<b>Studied by:</b> Sandin E. Phillipson

*Classification*

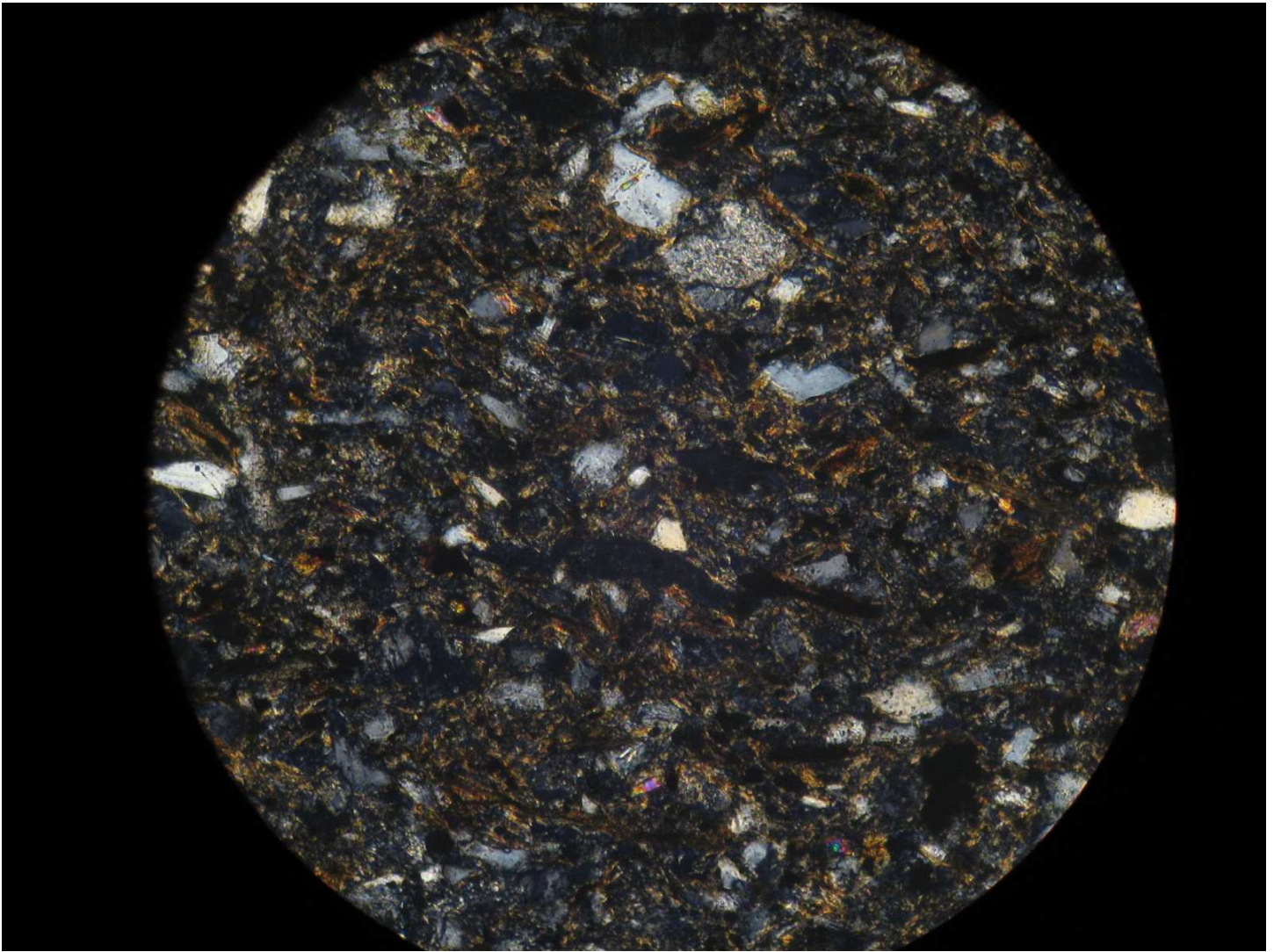
<b>Rock type:</b> sedimentary	<b>Alteration:</b> chlorite and iron oxide
<b>Texture:</b> matrix supported	<b>Rock Name:</b> feldspathic wacke

*Description of Individual Minerals*

Minerals	Mineral Content (%)	Mohs Hardness	Grain Size (mm)	Description and Comments
Biotite	50	2.5-3	.01-0.2	Ragged, irregularly-shaped flakes are abundantly distributed, and along with muscovite comprise a matrix that generally surrounds angular and subangular grains of quartz and plagioclase; some larger, individual flakes are altered to chlorite.
Quartz	20	7	.02-0.2	Angular and subangular grains are abundantly distributed, with individual grains generally isolated from contact with each other or plagioclase by a matrix composed of fine-grained mica flakes; less commonly, individual grains of quartz and plagioclase touch along tangential contacts.
Muscovite	15	2-2.5	.01-0.1	Larger, ragged flakes are sporadically distributed throughout the rock, although the matrix is composed dominantly of fine-grained muscovite and biotite flakes.
Plagioclase	15	6	.04-0.2	Angular grains are abundantly distributed, with individual grains generally isolated by the surrounding matrix of fine-grained mica; less commonly, grains touch along tangential contacts.

Weighted Average: 4.17

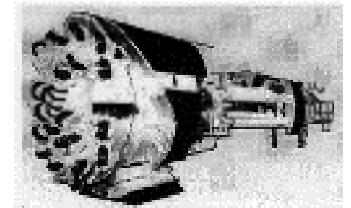
**Remarks:** The texture of this sample is characterized by angular and subangular grains of quartz and plagioclase that are abundantly distributed, but generally separated from contact with each other by a matrix composed of fine-grained flakes of muscovite and biotite. The sample exhibits layering based on grain size and mineral composition, with some layers characterized by an absence of quartz and plagioclase grains, dominated instead by fine-grained mica.



RC-13-005 141.5-142.2. Angular grains of quartz (yellow, light gray) and plagioclase (dark gray) are abundantly scattered throughout the rock but isolated from contact with each other by a matrix composed of biotite (dark brown, speckled flakes) and muscovite (speckled pink and yellow flakes). Field of view 1 mm at 100X, taken under crossed polars.



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Thin Section Petrographic Analysis



<b>Project:</b> SR-710 North Study	
<b>Location:</b> Los Angeles, California	<b>Client:</b> CH2M Hill
<b>Formation:</b> unknown	<b>Core ID:</b> RC-13-005 188.6-189.2
<b>Date Studied:</b> June 16, 2013	<b>Studied by:</b> Sandin E. Phillipson

*Classification*

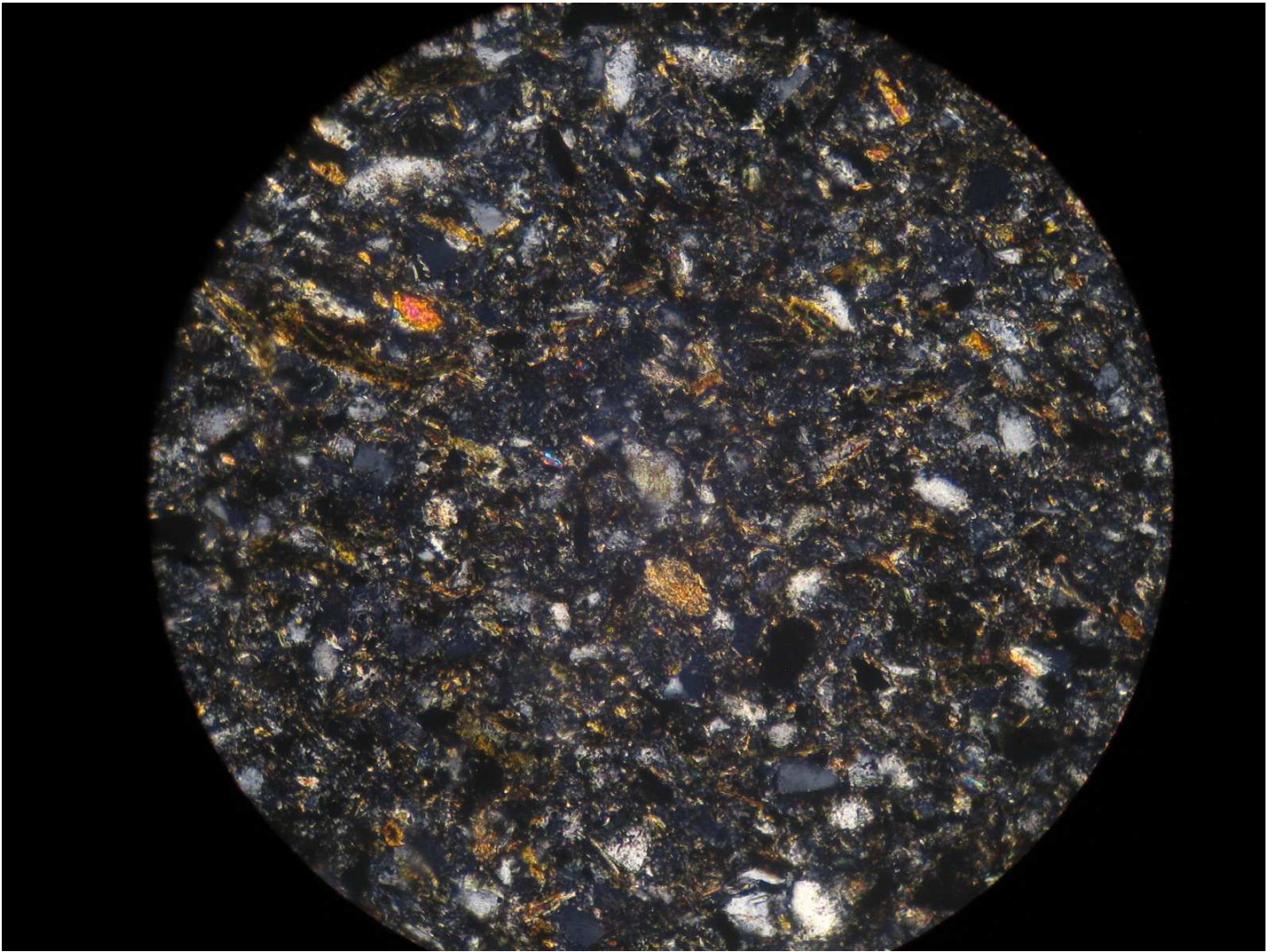
<b>Rock type:</b> sedimentary	<b>Alteration:</b> chlorite and iron oxide
<b>Texture:</b> matrix supported	<b>Rock Name:</b> feldspathic wacke

*Description of Individual Minerals*

Minerals	Mineral Content (%)	Mohs Hardness	Grain Size (mm)	Description and Comments
Biotite	50	2.5-3	.01-0.3	Small, thin flakes are abundantly distributed and, together with fine-grained muscovite, comprise a fine-grained matrix that isolates angular grains of quartz and plagioclase from contact with each other; some flakes exhibit heavy chlorite alteration.
Plagioclase	20	6	.05-0.2	Angular grains are abundantly distributed, but generally separated from contact with each other by a matrix of fine-grained, iron-stained mica; less commonly, grains touch along tangential contacts; grains commonly exhibit light sericite alteration.
Quartz	15	7	.02-0.2	Angular grains are abundantly distributed, but generally separated from contact with each other by a matrix of fine-grained, iron-stained mica; less commonly, grains touch along tangential contacts.
Muscovite	15	2-2.5	.01-0.2	Ragged lathes are abundantly distributed, intermixed with biotite flakes to define a fine-grained matrix that isolates angular grains of quartz and plagioclase from contact with each other.

Weighted Average: 4.12

**Remarks:** The texture of this sample is characterized by a matrix comprised of fine-grained flakes of biotite and muscovite, which hosts abundant, angular grains of quartz and plagioclase that uncommonly touch along tangential boundaries. Angular grains of orthoclase are also sparsely distributed throughout the rock.

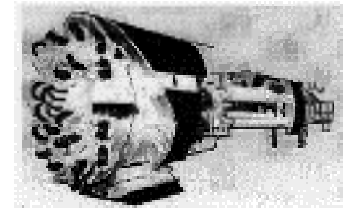


RC-13-005 188.6-189.2. Angular grains of quartz (light gray) and plagioclase (dark gray) are abundantly distributed throughout the rock, but generally separated from contact with each other by a matrix composed of biotite flakes (dark brown, speckled) and muscovite (orange and yellow, speckled). Field of view 1 mm at 100X, taken under crossed polars.





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Department of Mining Engineering  
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Thin Section Petrographic Analysis



<b>Project:</b> SR-710 North Study	
<b>Location:</b> Los Angeles, California	<b>Client:</b> CH2M Hill
<b>Formation:</b> unknown	<b>Core ID:</b> RC-13-007 165.5-165.9
<b>Date Studied:</b> June 16, 2013	<b>Studied by:</b> Sandin E. Phillipson

*Classification*

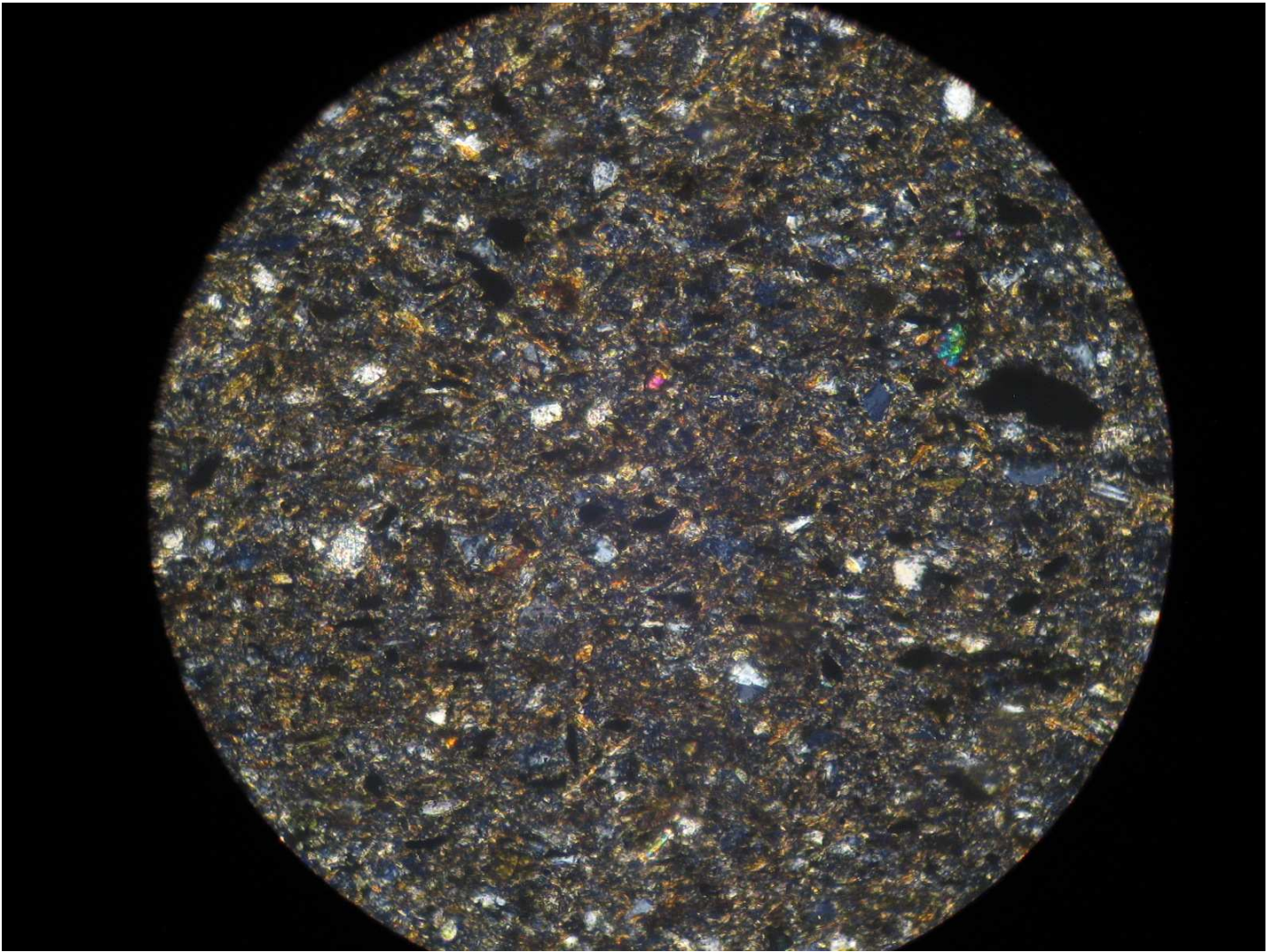
<b>Rock type:</b> sedimentary	<b>Alteration:</b> chlorite and iron oxide
<b>Texture:</b> matrix supported	<b>Rock Name:</b> bedded siltstone

*Description of Individual Minerals*

Minerals	Mineral Content (%)	Mohs Hardness	Grain Size (mm)	Description and Comments
Biotite	68	2.5-3	.01-0.2	Small flakes and larger, ragged lathes, many of which exhibit chlorite alteration, define a matrix that hosts sporadically-distributed grains of quartz and plagioclase; the long axes of lathes are aligned parallel to define bedding compaction laminations.
Muscovite	15	2-2.5	.01-.08	Thin, ragged lathes and small flakes that may represent illite are intermixed with abundant biotite to define a fine-grained matrix that hosts isolated grains of quartz and plagioclase.
Plagioclase	10	6	.01-.07	Angular and subangular grains are sporadically distributed, with individual grains isolated by the surrounding, fine-grained matrix.
Quartz	7	7	.02-0.2	Angular and subangular grains are sporadically distributed, with individual grains isolated by the surrounding, fine-grained matrix.

Weighted Average: 3.50

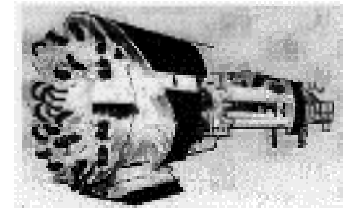
**Remarks:** The texture of this sample is characterized by a matrix composed of fine-grained biotite and muscovite, which hosts sporadically distributed grains of quartz and plagioclase that are isolated from contact with each other.



RC-13-007 165.5-165.9. Angular grains of quartz and plagioclase (gray, undifferentiated) are sporadically distributed throughout the rock, with individual grains isolated from contact with each other by a matrix composed of biotite (dark brown, speckled) and muscovite (green, pink speckled). Field of view 1 mm at 100X, taken under crossed polars.



**EARTH MECHANICS INSTITUTE**  
 Department of Mining Engineering  
 Colorado School of Mines  
**Thin Section Petrographic Analysis**



<b>Project:</b> SR-710 North Study	
<b>Location:</b> Los Angeles, California	<b>Client:</b> CH2M Hill
<b>Formation:</b> unknown	<b>Core ID:</b> RC-13-007 207.7-208.1
<b>Date Studied:</b> June 16, 2013	<b>Studied by:</b> Sandin E. Phillipson

*Classification*

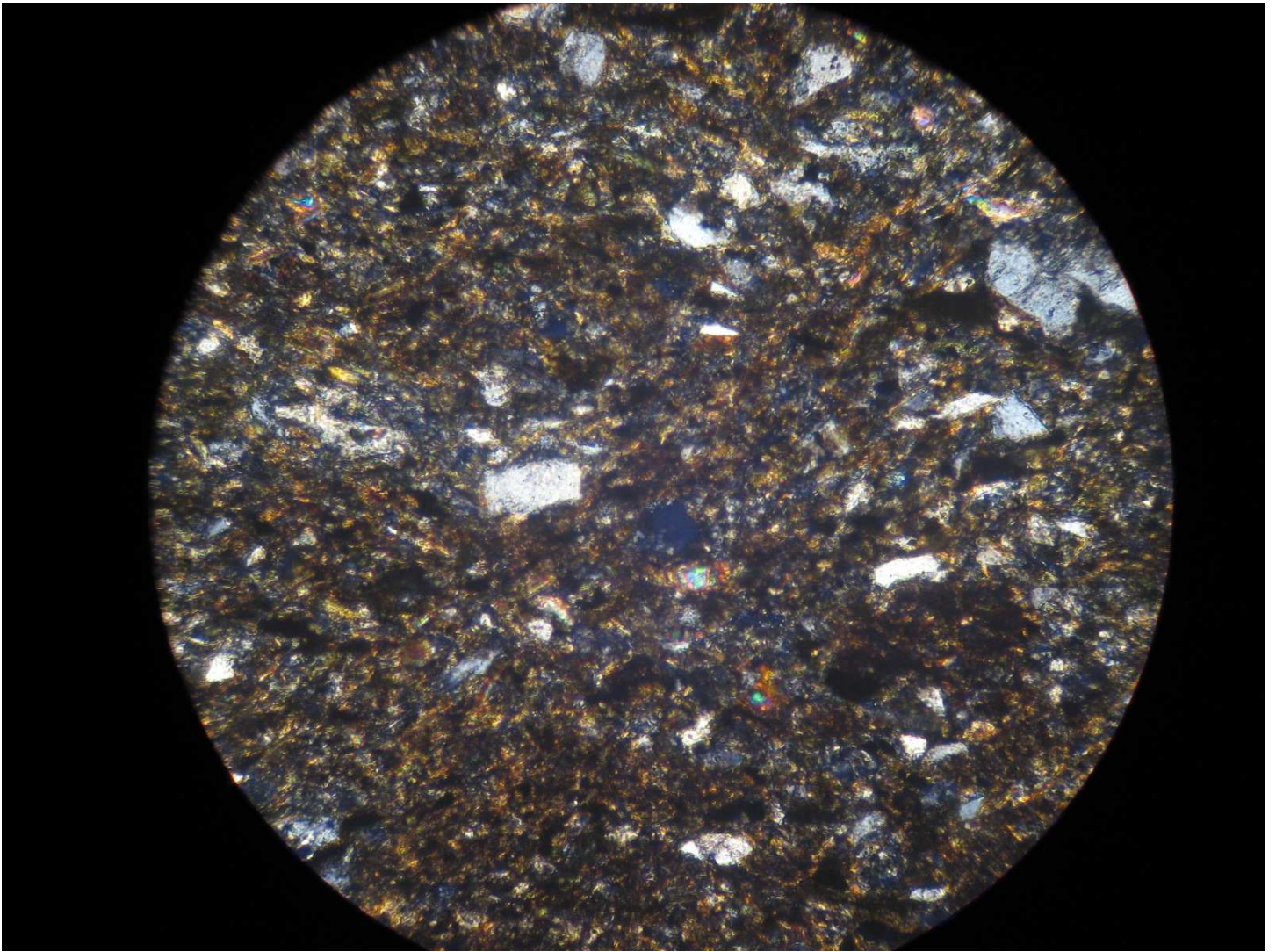
<b>Rock type:</b> sedimentary	<b>Alteration:</b> chlorite and iron oxide
<b>Texture:</b> matrix supported	<b>Rock Name:</b> bedded siltstone

*Description of Individual Minerals*

Minerals	Mineral Content (%)	Mohs Hardness	Grain Size (mm)	Description and Comments
Biotite	65	2.5-3	.01-0.3	Larger, ragged lathes are commonly altered to chlorite, with long axes aligned to represent bedding compaction; the matrix is dominated by fine-grained flakes of biotite and isolates angular grains of quartz and plagioclase from contact with each other.
Muscovite	15	2-2.5	.03-0.2	Thin lathes are sporadically distributed throughout the fine-grained matrix, which isolates angular grains of plagioclase and quartz from contact with each other; individual lathes are generally surrounded by fine-grained biotite and aligned parallel to define bedding compaction laminations.
Plagioclase	10	6	.02-.08	Angular grains are sporadically distributed, with individual grains isolated by the surrounding matrix, which is composed of fine-grained mica flakes.
Quartz	10	7	.01-0.2	Angular grains are sporadically distributed, with individual grains isolated by the surrounding matrix, which is composed of fine-grained mica flakes.

Weighted Average: 3.62

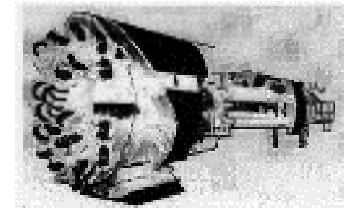
**Remarks:** The texture of this sample is characterized by a matrix of fine-grained muscovite and biotite, which hosts sporadically distributed, isolated, angular grains of quartz and plagioclase.



RC-13-007 207.7-208.1. Angular grains of quartz (white) and plagioclase (gray) are sporadically distributed throughout the rock, with individual grains isolated from contact with each other by a matrix comprised of biotite (dark brown, speckled) and muscovite (yellow-green, blue speckled). Field of view 1 mm at 100X, taken under crossed polars.



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**Thin Section Petrographic Analysis**



<b>Project:</b> SR-710 North Study	
<b>Location:</b> Los Angeles, California	<b>Client:</b> CH2M Hill
<b>Formation:</b> unknown	<b>Core ID:</b> RC-13-009 188.2-188.7
<b>Date Studied:</b> June 16, 2013	<b>Studied by:</b> Sandin E. Phillipson

*Classification*

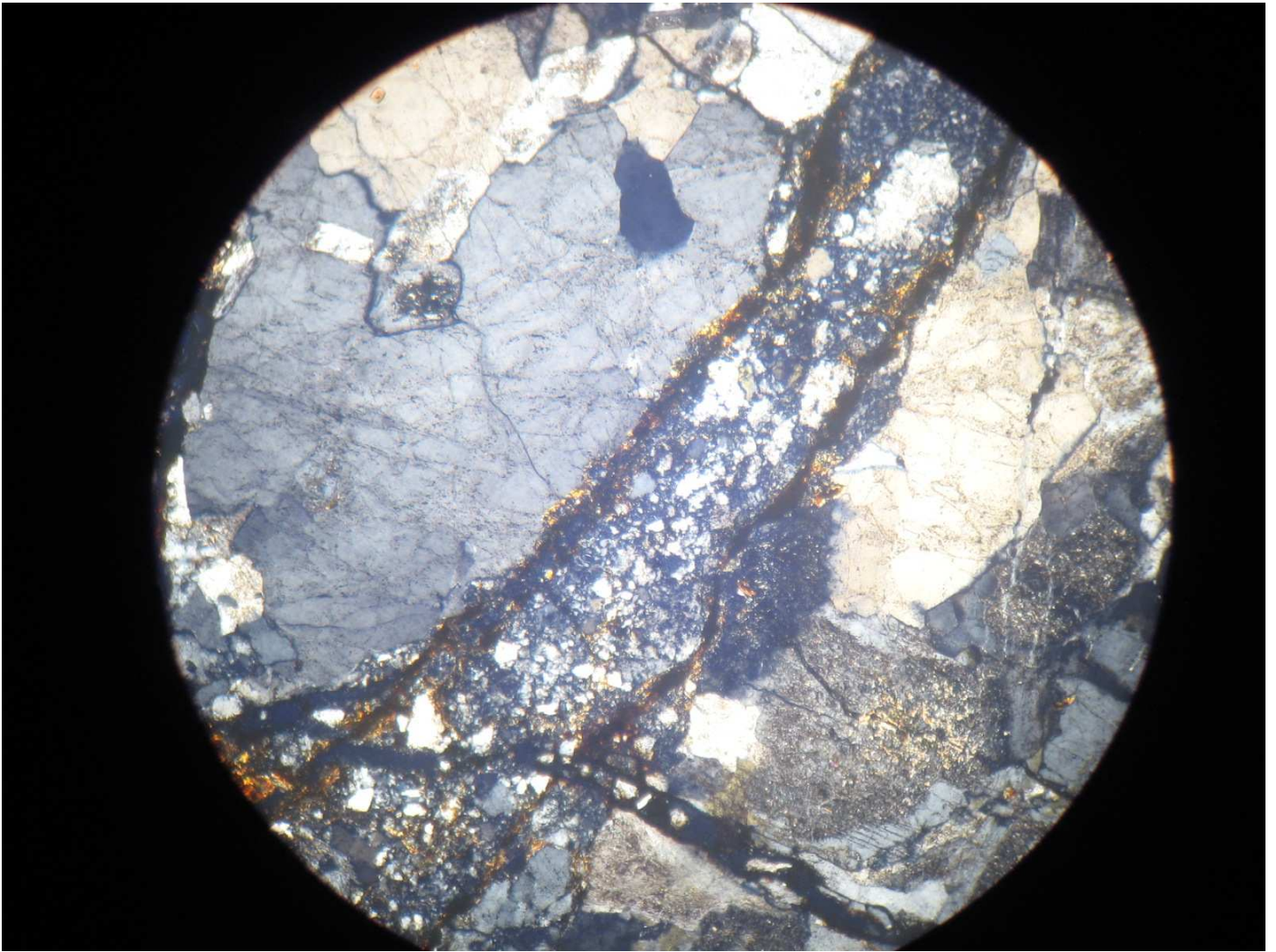
<b>Rock type:</b> igneous	<b>Alteration:</b> moderate, widespread sericite
<b>Texture:</b> extensive micro shear networks	<b>Rock Name:</b> quartz diorite

*Description of Individual Minerals*

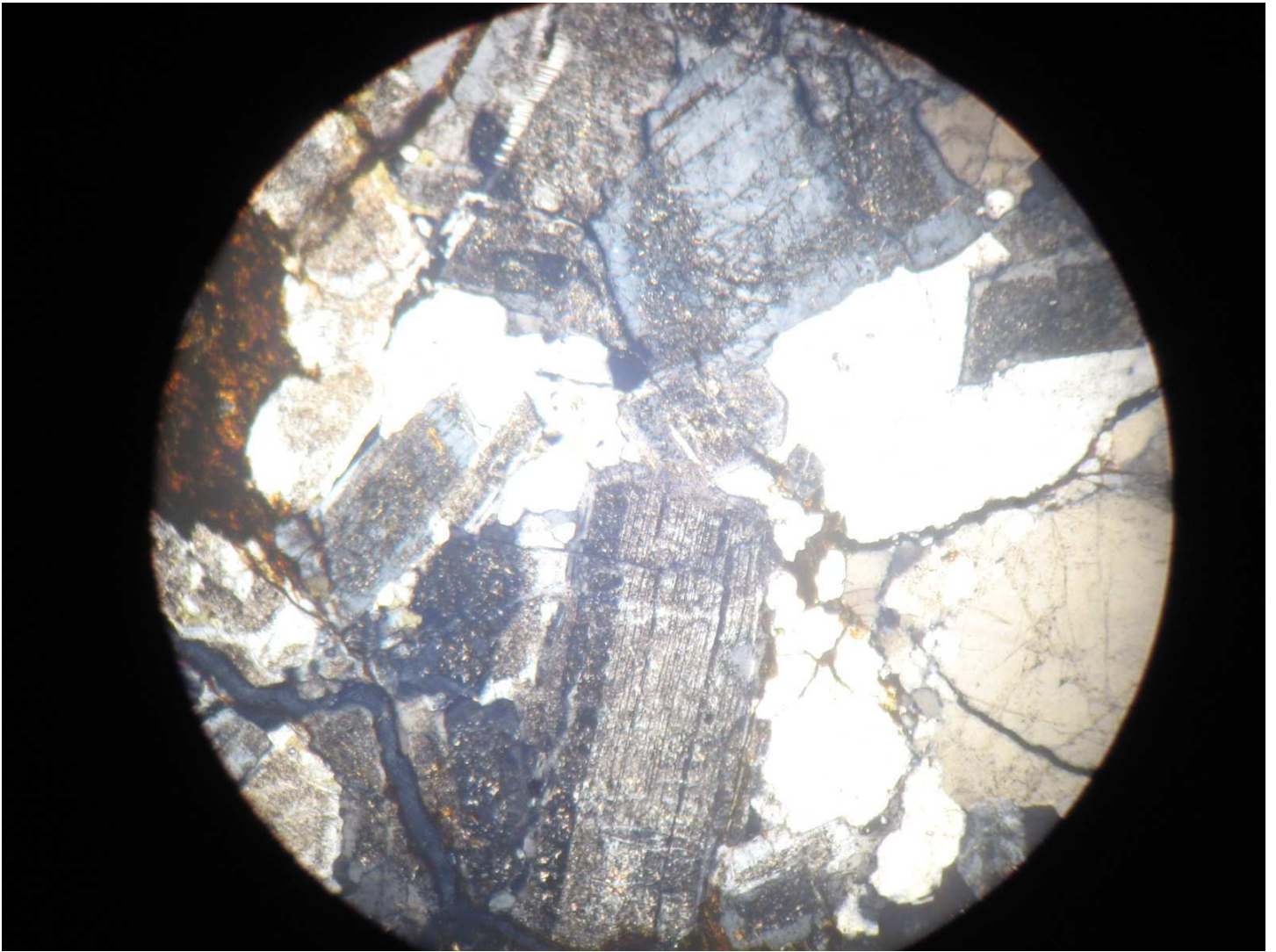
Minerals	Mineral Content (%)	Mohs Hardness	Grain Size (mm)	Description and Comments
Plagioclase	71	6	.07-1.6	The original, igneous texture of the rock is represented by large, blocky and rectangular phenocrysts that are intergrown along angular boundaries, with large interstices between phenocrysts filled with smaller, intergrown plagioclase crystals or irregularly-shaped quartz aggregates; the original igneous texture has been overprinted by a network of shear zones characterized by granulated plagioclase grains that were recrystallized during shearing; virtually all plagioclase crystals exhibit moderate sericite alteration.
Biotite	15	2.5-3	.01-1.5	Large "books" of biotite are sporadically distributed throughout the rock, but are generally isolated between surrounding plagioclase phenocrysts; biotite is heavily concentrated in shear zones and may have facilitated shearing.
Quartz	14	7	.07-2.4	Irregularly shaped crystals occupy angular interstices between larger plagioclase phenocrysts in the original igneous texture; within shear zones, mixtures of granulated quartz and plagioclase represent recrystallization during shearing.

Weighted Average: 5.69

**Remarks:** The texture of this sample is characterized by an original igneous, plutonic texture that has been overprinted by a fabric of intersecting shear zones. The original preserved texture is represented by large phenocrysts of plagioclase that are intergrown along angular, impinging boundaries and host irregularly shaped pockets of quartz in interstices. Quartz and plagioclase have been granulated along biotite-dominated shear zones.



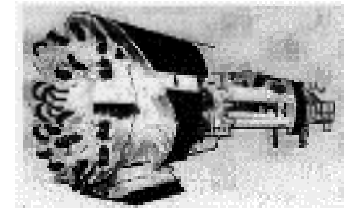
RC-13-009 188.2-188.7. A granulated zone of quartz and plagioclase (white and gray) that cuts across the igneous texture is bounded by zones of shearing along which fine-grained biotite (dark brown) has been concentrated. Field of view 2.4 mm at 40X, taken under crossed polars.



RC-13-009 188.2-188.7. The original texture is characterized by large, rectangular crystals of plagioclase (striped gray, with dusty sericite alteration) and quartz (yellow) that interlock along intergrown boundaries. Pockets of biotite (dark brown) occupy interstices between quartz and plagioclase. Field of view 2.4 mm at 40X, taken under crossed polars.



**EARTH MECHANICS INSTITUTE**  
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 Colorado School of Mines  
**Thin Section Petrographic Analysis**



<b>Project:</b> <u>SR-710 North Study</u>	
<b>Location:</b> <u>Los Angeles, California</u>	<b>Client:</b> <u>CH2M Hill</u>
<b>Formation:</b> <u>unknown</u>	<b>Core ID:</b> <u>RC-13-009 227.0-227.4</u>
<b>Date Studied:</b> <u>June 17, 2013</u>	<b>Studied by:</b> <u>Sandin E. Phillipson</u>

*Classification*

<b>Rock type:</b> <u>igneous</u>	<b>Alteration:</b> <u>heavy, widespread sericite</u>
<b>Texture:</b> <u>extensive micro shears; granulation</u>	<b>Rock Name:</b> <u>quartz diorite</u>

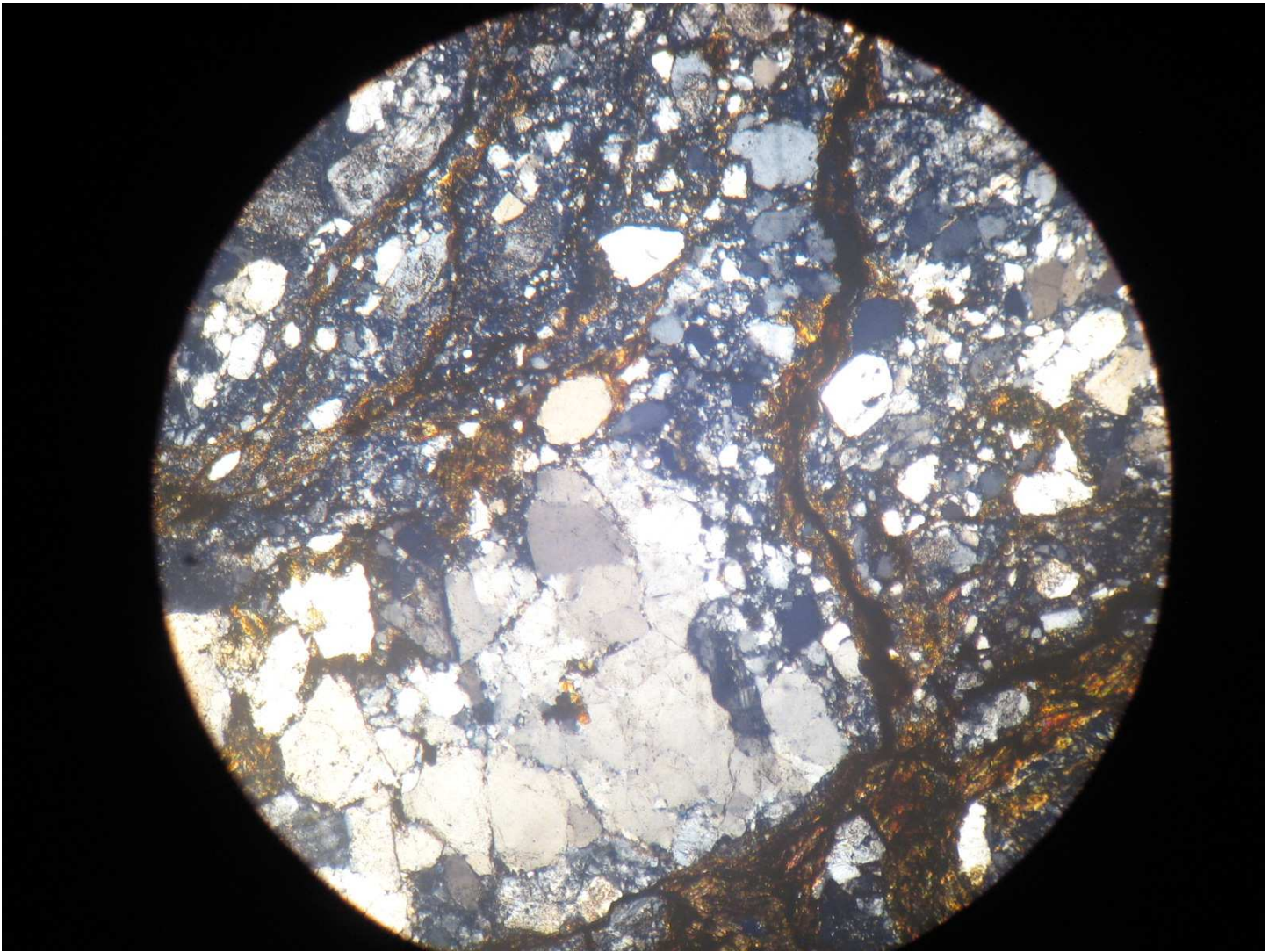
*Description of Individual Minerals*

Minerals	Mineral Content (%)	Mohs Hardness	Grain Size (mm)	Description and Comments
Plagioclase	75	6	.01-2.4	In the original igneous segments, blocky and rectangular phenocrysts impinge upon each other at intergrown corners, with interstices and coronas of late-stage quartz; fine-grained, granulated aggregates are intermixed with quartz within extensively sheared zones; plagioclase crystals exhibit heavy sericite alteration.
Quartz	13	7	.04-1.7	In the original igneous segments, angular crystals are intergrown in pockets defined by the angular interstices between larger, plagioclase phenocrysts; quartz rims also occur around individual plagioclase phenocrysts as part of the original igneous texture; fine-grained, equigranular quartz crystals are intermixed with similarly-sized plagioclase grains that have been milled and granulated within and adjacent to the abundant shear zones.
Biotite	12	2.5-3	.01-1.1	Large "books" of biotite are isolated in interstices between plagioclase phenocrysts in the original igneous texture, but are sheared out and concentrated within individual micro faults; biotite flakes are strongly concentrated and aligned parallel within wider shear zones that accompany extreme granulation of surrounding plagioclase and quartz.

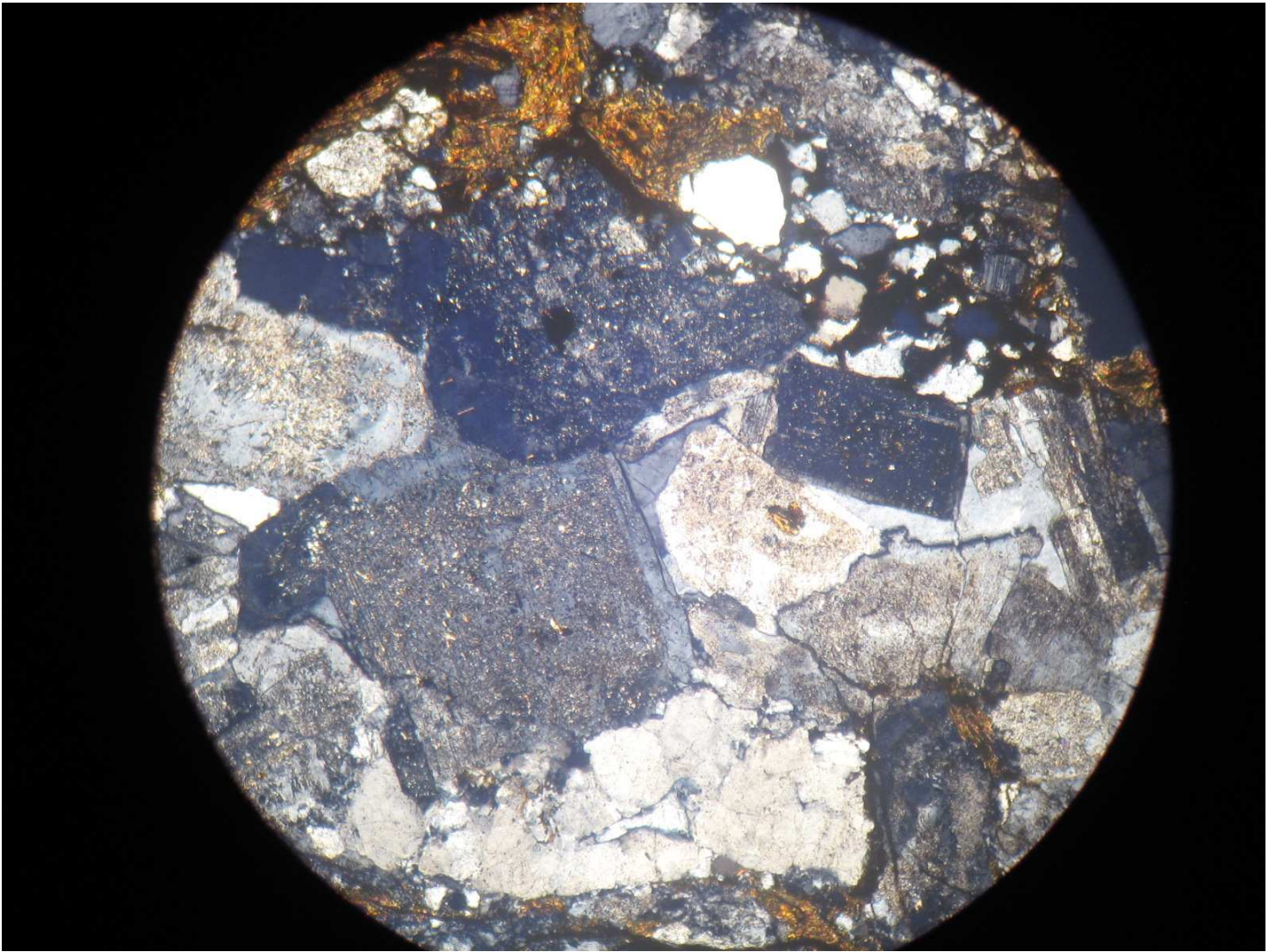
Weighted Average: 5.77

**Remarks:** The texture of this sample is characterized by isolated pockets of the original igneous, plutonic rock that are bounded by shear zones and areas of extensive granulation, representing extensive cataclastic deformation. Abundant, extensive micro shears are filled with biotite and may represent planes of preferential weakness.





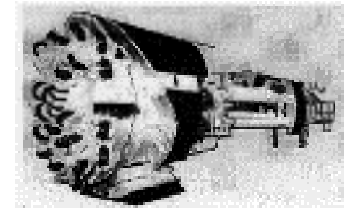
RC-13-009 227.0-227.4. Horsetailing shear zones with biotite concentrations (dark brown) surround pockets of granulated quartz (yellow, light gray) and plagioclase (dark gray). Field of view 2.4 mm at 40X, taken under crossed polars.



RC-13-009 227.0-227.4. Large, blocky crystals of plagioclase (gray, with dusty yellow sericite alteration) interlock along corners, defining angular interstices that are filled with quartz (light gray) or intergrown aggregates of quartz (light yellow/off-white). Field of view 2.4 mm at 40X, taken under crossed polars.



**EARTH MECHANICS INSTITUTE**  
 Department of Mining Engineering  
 Colorado School of Mines  
**Thin Section Petrographic Analysis**



<b>Project:</b> <u>SR-710 North Study</u>	
<b>Location:</b> <u>Los Angeles, California</u>	<b>Client:</b> <u>CH2M Hill</u>
<b>Formation:</b> <u>unknown</u>	<b>Core ID:</b> <u>RC-13-009 266.0-266.4</u>
<b>Date Studied:</b> <u>June 17, 2013</u>	<b>Studied by:</b> <u>Sandin E. Phillipson</u>

*Classification*

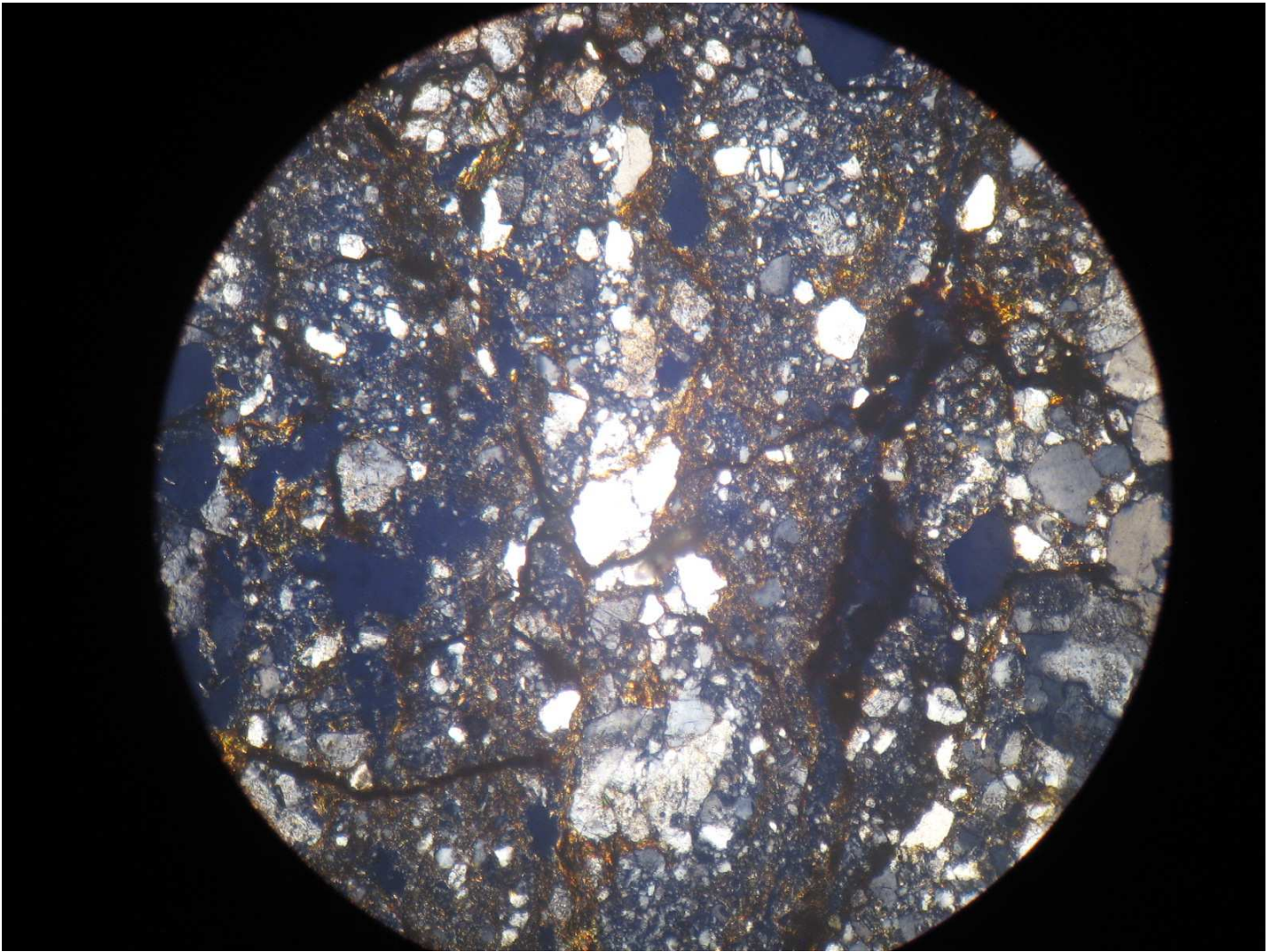
<b>Rock type:</b> <u>igneous</u>	<b>Alteration:</b> <u>widespread, heavy sericite</u>
<b>Texture:</b> <u>numerous micro shears; granulation</u>	<b>Rock Name:</b> <u>tonalite</u>

*Description of Individual Minerals*

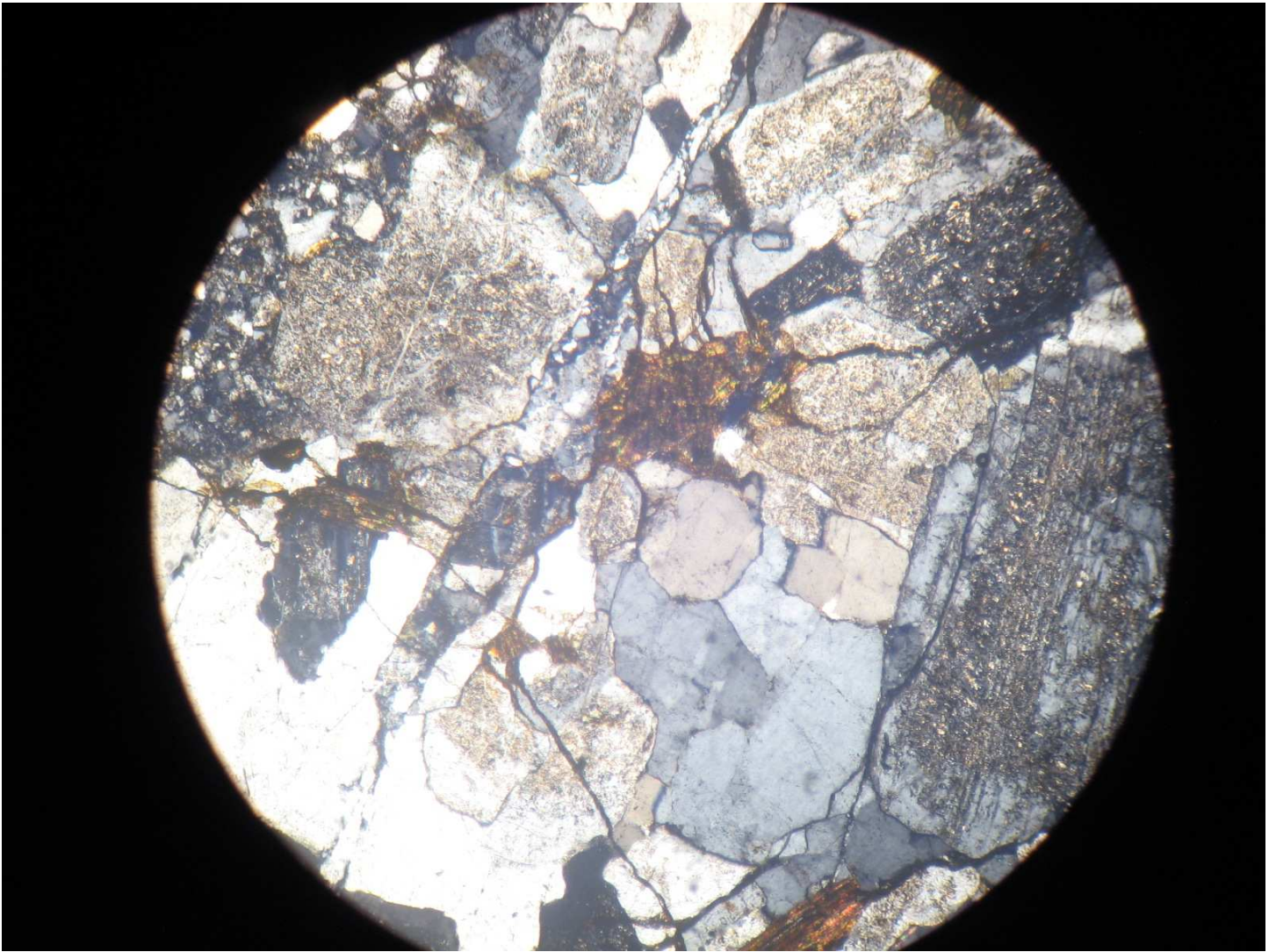
Minerals	Mineral Content (%)	Mohs Hardness	Grain Size (mm)	Description and Comments
Plagioclase	67	6	.04-1.9	Blocky and rectangular crystals interlock along intergrown corners, defining large, angular interstices that are filled with irregular aggregates of intergrown quartz; fine-grained, equigranular grains are intermixed with similarly-sized plagioclase grains in granulated areas within and adjacent to shear zones; crystals generally exhibit heavy sericite alteration.
Quartz	21	7	.02-1.4	Large, intergrown aggregates occupy large, angular interstices between blocky plagioclase phenocrysts, sometimes encasing the corners or ends of plagioclase lathes; more commonly, small, angular, irregularly-shaped quartz crystals occupy small interstices between intergrown plagioclase lathes; similarly-sized, fine grained quartz and plagioclase are intermixed in granulated zones adjacent to shearing.
Biotite	12	2.5-3	.02-1.5	Ragged-edged clusters are sporadically distributed, with individual clusters generally isolated within angular interstices between large, blocky plagioclase phenocrysts; individual flakes are isolated between plagioclase and quartz crystals, and fine-grained aggregates are strung out and concentrated in shear zones or within fine-grained, quartzo-feldspathic granulated aggregates.

Weighted Average: 5.85

**Remarks:** This sample is characterized by an original igneous texture represented by blocky and rectangular plagioclase crystals that are intergrown or impinge upon each other at corners, with interstices filled by quartz and biotite. The original igneous texture has been overprinted by a network of shear zones resulting in granulation of adjacent areas of quartz and plagioclase, with accompanying concentration of biotite along micro faults.



RC-13-009 266.0-266.4. Horsetailing shear zones filled with biotite (dark brown) cut through a heavily granulated area of angular quartz (white, light yellow) and plagioclase (gray). Field of view 2.4 mm at 40X, taken under crossed polars.



RC-13-009 266.0-266.4. Rectangular and blocky crystals of plagioclase (gray, with dusty yellow sericite alteration) interlock along straight boundaries, defining interstices that are filled with quartz (white, yellow). Pockets of biotite (speckled yellow-brown) are isolated in interstices between quartz and plagioclase. Field of view 2.4 mm at 40X, taken under crossed polars.

APPENDIX D.3

## Previous Laboratory Test Results

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# Final Geotechnical Summary Report SR-710 Tunnel Technical Study Los Angeles County, California



Prepared For:  
California Department of Transportation  
100 South Main Street  
Los Angeles, CA 90012

Prepared By:  
CH2M HILL  
6 Hutton Centre Drive, Suite 700  
Santa Ana, CA 92707

April 2010

**Volume I of V**





**MOISTURE CONTENT**  
ASTM D 2216


Project Name: **SR-710 Tunnel Technical Study**  
 Project No.: **378312.04.09.01**

Tested By: V. Juliano  
 Date: 04/03/09  
 Checked By: J. Ward  
 Date: 04/08/09

Boring No.	R-09-Z1-B8	R-09-Z1-B8			
Sample No.	S04	S06			
Depth (ft)	15-16.5	25-26.5			
Sample Type	SPT	SPT			
Sample Description	Olive yellow to dark brown sandy silts (ML)	Dark brown lean clay (CL)			
Wt. wet soil + container (g)	773.50	388.00			
Wt. dry soil + container (g)	649.20	312.60			
Weight of container (g)	108.43	76.12			
<b>Moisture Content (%)</b>	<b>23.0</b>	<b>31.9</b>			

Boring No.					
Sample No.					
Depth (ft)					
Sample Type					
Sample Description					
Wt. wet soil + container (g)					
Wt. dry soil + container (g)					
Weight of container (g)					
<b>Moisture Content (%)</b>					



Boring No.	R-09-Z1-B8	R-09-Z1-B8	R-09-Z1-B8	R-09-Z1-B8	R-09-Z1-B8			
Sample No.	O11	O13	O15A	S18	C33			
Depth (ft.)	50-55	60-65	70-75	85-86.5	159.25-160			
Sample Type	Drive	Drive	Drive	Drive	Core			
Soil Identification	Olive yellow lean clay (CL)	Sample missing	Sample missing	Sample missing	Dark olive lean clay'stone' (CL)			
Pocket Penetrometer (tons/ft <sup>2</sup> )	>4.50 / 4.50				>4.00			
Weight Soil + Rings / Tube (g)	1464.40				814.30			
Weight of Rings / Tube (g)	535.50				0.00			
Average Length (in.)	5.996				5.345			
Average Diameter (in.)	2.375				2.399			
Wet. Wt. of Soil + Cont. (g)	193.30				112.80			
Dry Wt. of Soil + Cont. (g)	169.40				99.35			
Weight of Container (g)	60.40				36.70			
Container No.								
<b>Wet Density</b>	133.2				128.4			
<b>Moisture Content (%)</b>	<b>21.9</b>				<b>21.5</b>			
<b>Dry Density (pcf)</b>	<b>109.3</b>				<b>105.7</b>			
<b>Degree of Saturation (%)</b>	109.1				97.5			
		<b>MOISTURE &amp; DENSITY of SOILS</b> <b>ASTM D 2216 &amp; ASTM D 2937</b>			Project Name: <u>SR-710 Tunnel Technical Study</u>			
					Project No.: <u>378312.04.09.01</u>			
					Client Name: <u>CH2M Hill</u>			
					Tested By: <u>V. Juliano</u>		Date: <u>05/09/09</u>	




**MOISTURE CONTENT**  
ASTM D 2216


Project Name: **SR-710 Tunnel Technical Study**  
Project No.: **378312.04.09.01**

Tested By: A. Santos  
Date: 05/19/09  
Checked By: J. Ward  
Date: 05/27/09

Boring No.	R-09-Z2-B5	R-09-Z2-B5	R-09-Z2-B5	R-09-Z2-B5	R-09-Z2-B5
Sample No.	S2	S3	S6	S10	S15
Depth (ft)	10	15	30	50	75
Sample Type	SPT	SPT	SPT	SPT	SPT
Sample Description	Dark olive lean clay with sand (CL)s	Olive brown silty sand (SM)	Olive brown sandy silt s(ML)	Olive brown silty sand (SM)	Olive brown lean clay (CL)
Wt. wet soil + container (g)	405.30	590.50	630.10	770.80	611.60
Wt. dry soil + container (g)	351.70	516.50	511.50	653.80	518.10
Weight of container (g)	75.27	76.20	76.10	106.90	77.20
<b>Moisture Content (%)</b>	<b>19.4</b>	<b>16.8</b>	<b>27.2</b>	<b>21.4</b>	<b>21.2</b>

Boring No.	R-09-Z2-B5	R-09-Z2-B5			
Sample No.	S17	S19			
Depth (ft)	85	95			
Sample Type	SPT	SPT			
Sample Description	Olive brown lean clay (CL)	Sample missing			
Wt. wet soil + container (g)	477.30				
Wt. dry soil + container (g)	406.50				
Weight of container (g)	76.10				
<b>Moisture Content (%)</b>	<b>21.4</b>				

Boring No.	R-09-Z3-B2	R-09-Z3-B2	R-09-Z3-B2	R-09-Z3-B2	R-09-Z3-B2	R-09-Z3-B2	R-09-Z3-B2	R-09-Z3-B2
Sample No.	O4	S5	O9	S11	S17	S20	C23	C27
Depth (ft.)	11.8-12.3	15-16.5	31.3-31.8	40-41.5	55-56	64.2-65.7	71.5-75	81.5-85
Sample Type	Drive	SPT	Drive	SPT	SPT	SPT	Core	Core
Soil Identification	Olive poorly-graded sand with silt and gravel (SP-SM)g	Yellowish brown well-graded sand with silt and gravel (SW-SM)g	Olive well-graded sand with silt and gravel (SW-SM)g	Yellowish brown silty sand (SM)	Yellowish brown well-graded sand with silt and gravel (SW-SM)g	Yellowish brown silty sand (SM)	Olive brown silty sand (SM)	Yellowish brown poorly-graded sand with gravel (SM)g
Pocket Penetrometer (tons/ft <sup>2</sup> )	>4.00		>4.00					
Weight Soil + Rings / Tube (g)	1527.10		1526.70					
Weight of Rings / Tube (g)	541.00		527.00					
Average Length (in.)	6.013		5.950					
Average Diameter (in.)	2.367		2.375					
Wet. Wt. of Soil + Cont. (g)	1083.80	923.00	1106.00	704.00	795.30	968.60	346.10	3917.80
Dry Wt. of Soil + Cont. (g)	996.50	852.30	1022.10	621.20	724.30	832.70	311.70	3433.40
Weight of Container (g)	108.50	82.60	107.90	79.10	75.60	74.70	78.10	231.80
Container No.								
<b>Wet Density</b>	142.0		144.5					
<b>Moisture Content (%)</b>	<b>9.8</b>	<b>9.2</b>	<b>9.2</b>	<b>15.3</b>	<b>10.9</b>	<b>17.9</b>	<b>14.7</b>	<b>15.1</b>
<b>Dry Density (pcf)</b>	<b>129.3</b>		<b>132.3</b>					
<b>Degree of Saturation (%)</b>	87.3		90.5					
 <b>MOISTURE &amp; DENSITY of SOILS</b> <b>ASTM D 2216 &amp; ASTM D 2937</b>	Project Name: <u>SR-710 Tunnel Technical Study</u> Project No.: <u>378312.04.09.01</u> Client Name: <u>CH2M Hill</u> Tested By: <u>V. Juliano</u> Date: <u>05/09/09</u>							

Boring No.	R-09-Z3-B2	R-09-Z3-B2	R-09-Z3-B2	R-09-Z3-B2	R-09-Z3-B2			
Sample No.	S30	S34	C37	C39	C41			
Depth (ft.)	90-91.5	100-101.5	106.5-110	111.5-115	116.5-120			
Sample Type	SPT	SPT	Core	Core	Core			
Soil Identification	Yellowish brown silty sand (SM)	Yellowish brown silty sand (SM)	Yellowish brown silty sand (SM)	Reddish brown silty sand (SM)	Yellowish brown clayey sand (SC)			
Pocket Penetrometer (tons/ft <sup>2</sup> )								
Weight Soil + Rings / Tube (g)								
Weight of Rings / Tube (g)								
Average Length (in.)								
Average Diameter (in.)								
Wet. Wt. of Soil + Cont. (g)	1047.60	966.80	911.40	596.60	586.50			
Dry Wt. of Soil + Cont. (g)	922.90	843.30	787.00	543.20	525.30			
Weight of Container (g)	108.90	108.40	110.60	77.40	76.80			
Container No.								
<b>Wet Density</b>								
<b>Moisture Content (%)</b>	<b>15.3</b>	<b>16.8</b>	<b>18.4</b>	<b>11.5</b>	<b>13.6</b>			
<b>Dry Density (pcf)</b>								
<b>Degree of Saturation (%)</b>								
	<b>MOISTURE &amp; DENSITY of SOILS</b> <b>ASTM D 2216 &amp; ASTM D 2937</b>			Project Name: <u>SR-710 Tunnel Technical Study</u>				
				Project No.: <u>378312.04.09.01</u>				
				Client Name: <u>CH2M Hill</u>				
				Tested By: <u>V. Juliano</u>		Date: <u>05/09/09</u>		

# MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

Sample <u>Identification</u>	<u>Depth, ft.</u>	Material <u>Type</u>	Dry Unit <u>Weight, lb/ft.<sup>3</sup></u>	Moisture <u>Content, %</u>
Z3-B2, C49	146.75-148	Quartzite	159.8	0.3
Z3-B2, C54	171.4-171.7	Quartzite	155.0	0.4
Z3-B2, C68	227.8-228.1	Quartzite	156.1	2.5

Test Method: ASTM D2216, ASTM D2937


<b>PROJECT NUMBER:</b> 09-144	April 10, 2009	
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5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762  
 Phone: (916) 939-3460 FAX: (916) 939-3507

SR-710 Tunnel Technical Study


#378312.04.09.01


Boring No.	R-09-Z3-B4	R-09-Z3-B4	R-09-Z3-B4	R-09-Z3-B4	R-09-Z3-B4	R-09-Z3-B4	R-09-Z3-B4	R-09-Z3-B4
Sample No.	S-3	S-8	S-10	S-13	S-15	C-20	C-22	C-32
Depth (ft.)	15.0	40.0	50.0	65.0	75.0	94-100	105-110	155-160
Sample Type	Drive	Drive	Drive	Drive	Drive	Drive	Drive	Drive
Soil Identification	Yellowish brown silty sand (SM)	Olive silt with sand (ML)s	Yellowish brown silty sand (SM)	Yellowish brown silty sand (SM)	Yellowish brown silty sand (SM)	Brown silty sand (SM)	Yellowish brown silty sand (SM)	Yellowish brown poorly-graded sand with silt (SP-SM)
Pocket Penetrometer (tons/ft <sup>2</sup> )	3.75 / 3.75	>4.50	>4.50					
Weight Soil + Rings / Tube (g)	966.50	984.10	1247.30					
Weight of Rings / Tube (g)	213.20	215.30	261.84					
Average Length (in.)	5.008	5.005	6.024					
Average Diameter (in.)	2.409	2.409	2.409					
Wet. Wt. of Soil + Cont. (g)	980.20	844.10	915.90	537.20	157.30	822.90	728.00	692.30
Dry Wt. of Soil + Cont. (g)	851.00	697.50	801.40	448.80	140.90	743.10	650.70	616.10
Weight of Container (g)	107.60	77.40	75.80	72.30	61.50	75.50	75.20	76.60
Container No.								
<b>Wet Density</b>	125.7	128.4	136.7					
<b>Moisture Content (%)</b>	<b>17.4</b>	<b>23.6</b>	<b>15.8</b>	<b>23.5</b>	<b>20.7</b>	<b>12.0</b>	<b>13.4</b>	<b>14.1</b>
<b>Dry Density (pcf)</b>	<b>107.1</b>	<b>103.8</b>	<b>118.1</b>					
<b>Degree of Saturation (%)</b>	81.8	102.4	99.7					
	<b>MOISTURE &amp; DENSITY of SOILS</b> <b>ASTM D 2216 &amp; ASTM D 2937</b>			Project Name: <u>SR-710 Tunnel Technical Study</u>				
				Project No.: <u>378312.04.09.01</u>				
				Client Name: <u>CH2M Hill</u>				
				Tested By: <u>V. Juliano</u>		Date: <u>04/27/09</u>		

Boring No.	R-09-Z3-B6	R-09-Z3-B6	R-09-Z3-B6	R-09-Z3-B6	R-09-Z3-B6			
Sample No.	S1	S2	C27	C52	C53			
Depth (ft.)	5.0	10.0	173.0	299.0	304.5			
Sample Type	Drive	Drive	Core (bag)	Core (bag)	Core (bag)			
Soil Identification	Brown silty sand (SM)	Dark olive silty sand with gravel (SM)g	Light gray silty sand with gravel (SM)g	Light gray silty sand with gravel (SM)g	Light gray silty sand (SM)			
Pocket Penetrometer (tons/ft <sup>2</sup> )		>4.00						
Weight Soil + Rings / Tube (g)		1049.80						
Weight of Rings / Tube (g)		215.40						
Average Length (in.)		5.033						
Average Diameter (in.)		2.409						
Wet. Wt. of Soil + Cont. (g)	470.10	1079.70	2167.70	1141.10	1477.50			
Dry Wt. of Soil + Cont. (g)	446.50	1004.60	1971.80	1088.20	1334.50			
Weight of Container (g)	78.00	108.80	217.40	218.30	111.20			
Container No.								
<b>Wet Density</b>		138.6						
<b>Moisture Content (%)</b>	<b>6.4</b>	<b>8.4</b>	<b>11.2</b>	<b>6.1</b>	<b>11.7</b>			
<b>Dry Density (pcf)</b>		<b>127.8</b>						
<b>Degree of Saturation (%)</b>		71.1						
 <b>Leighton</b>	<b>MOISTURE &amp; DENSITY of SOILS</b> <b>ASTM D 2216 &amp; ASTM D 2937</b>			Project Name: <u>SR-710 Tunnel Technical Study</u>				
				Project No.: <u>378312.04.09.01</u>				
				Client Name: <u>CH2M Hill</u>				
				Tested By: <u>V. Juliano</u>		Date: <u>04/27/09</u>		

Boring No.	R-09-Z3-B8	R-09-Z3-B8	R-09-Z3-B8	R-09-Z3-B8	R-09-Z3-B8	R-09-Z3-B8		
Sample No.	C-3	C-5	C-7	C-12	C-20	C-27		
Depth (ft.)	10-11.5	20-21.5	29.2-30	52.6-53.2	88-88.6	116.2-116.9		
Sample Type	Tube	Tube	Core	Core	Core	Core		
Soil Identification	Olive brown lean clay (CL), disturbed	Olive brown fat clay (CH)	Yellowish brown fat clay'stone' (CH)	Dark yellowish brown silt'stone' (ML)	Dark gray silt'stone' (ML)	Grayish brown silt'stone' (ML)		
Pocket Penetrometer (tons/ft <sup>2</sup> )		>4.50	>4.50	>4.50	>4.50	>4.50		
Weight Soil + Rings / Tube (g)		925.40	638.00	795.80	581.20	416.40		
Weight of Rings / Tube (g)		542.50	0.00	0.00	0.00	0.00		
Average Length (in.)		2.585	4.378	5.167	3.818	2.408		
Average Diameter (in.)		2.372	2.425	2.460	2.365	2.425		
Wet. Wt. of Soil + Cont. (g)	260.50	469.10	717.70	872.80	658.10	492.10		
Dry Wt. of Soil + Cont. (g)	224.18	396.10	591.00	731.30	592.00	453.40		
Weight of Container (g)	76.90	75.70	80.30	77.50	77.20	75.80		
Container No.								
<b>Wet Density</b>		127.7	120.2	123.4	132.0	142.6		
<b>Moisture Content (%)</b>	<b>24.7</b>	<b>22.8</b>	<b>24.8</b>	<b>21.6</b>	<b>12.8</b>	<b>10.2</b>		
<b>Dry Density (pcf)</b>		<b>104.0</b>	<b>96.3</b>	<b>101.5</b>	<b>117.0</b>	<b>129.4</b>		
<b>Degree of Saturation (%)</b>		99.1	89.3	88.4	78.6	91.3		
 <b>Leighton</b>	<b>MOISTURE &amp; DENSITY of SOILS</b> <b>ASTM D 2216 &amp; ASTM D 2937</b>			Project Name: <u>SR-710 Tunnel Technical Study</u>				
				Project No.: <u>378312.04.9.01</u>				
				Client Name: <u>CH2M Hill</u>				
				Tested By: <u>A. Santos</u>		Date: <u>05/19/09</u>		



Boring No.	R-09-Z3-B11	R-09-Z3-B11	R-09-Z3-B11	R-09-Z3-B11	R-09-Z3-B11	R-09-Z3-B11		
Sample No.	0-3	0-5	0-7	0-9	0-12	0-14		
Depth (ft.)	11.5-16	21-26	31-36	41-46	61-66	71-76		
Sample Type	Drive	Drive	Drive	Drive	Drive	Drive		
Soil Identification	Olive silty sand (SM)	Olive brown poorly-graded sand with silt and gravel (SP-SM)g	Olive silty sand (SM)	Olive poorly-graded sand with silt (SP-SM)	Olive well-graded sand with silt and gravel (SW-SM)g	Olive silty sand (SM)		
Pocket Penetrometer (tons/ft <sup>2</sup> )	>4.50	N/A	4.25 / 4.00	0.75 / 1.50	N/A	2.25		
Weight Soil + Rings / Tube (g)	1426.00	1302.60	1351.90	1333.40	1530.30	1347.30		
Weight of Rings / Tube (g)	535.50	525.80	535.50	535.50	544.90	535.50		
Average Length (in.)	6.003	5.617	6.001	5.758	5.615	5.735		
Average Diameter (in.)	2.375	2.375	2.375	2.375	2.375	2.375		
Wet. Wt. of Soil + Cont. (g)	600.40	852.60	231.70	502.90	1091.20	445.80		
Dry Wt. of Soil + Cont. (g)	540.40	775.50	210.25	426.20	1006.30	381.80		
Weight of Container (g)	72.50	77.90	59.70	75.30	108.20	79.40		
Container No.								
<b>Wet Density</b>	127.6	118.9	117.0	119.2	150.9	121.7		
<b>Moisture Content (%)</b>	<b>12.8</b>	<b>11.1</b>	<b>14.2</b>	<b>21.9</b>	<b>9.5</b>	<b>21.2</b>		
<b>Dry Density (pcf)</b>	<b>113.1</b>	<b>107.1</b>	<b>102.4</b>	<b>97.8</b>	<b>137.9</b>	<b>100.5</b>		
<b>Degree of Saturation (%)</b>	70.5	52.0	59.5	81.5	114.7	84.3		
		<b>MOISTURE &amp; DENSITY of SOILS</b> <b>ASTM D 2216 &amp; ASTM D 2937</b>			Project Name: <u>SR-710 Tunnel Technical Study</u> Project No.: <u>378312.04.09.01</u> Client Name: <u>CH2M Hill</u> Tested By: <u>V. Juliano</u> Date: <u>04/03/09</u>			

Boring No.	R-09-Z3-B11	R-09-Z3-B11	R-09-Z3-B11	R-09-Z3-B11	R-09-Z3-B11	R-09-Z3-B11	R-09-Z3-B11	R-09-Z3-B11
Sample No.	O-16	S-17	O-18	O-20	C-24	C-25	C-27	C-30
Depth (ft.)	81-86	86.0	91-96	101-102	116.4-116.9	125-125.5	131.5-132	150.5-151
Sample Type	Drive	SPT	Drive	Drive	Core	Core	Core	Core
Soil Identification	Olive brown poorly-graded sand with silt (SP-SM)	Olive brown silty sand (SM)	Yellowish brown sandy silt s(ML)	Dark olive brown clayey sand (SC)	Olive yellow silty sand with gravel (SM)g	Olive yellow silty sand (SM)	Dark olive brown sandy lean clay s(CL)	Olive brown well-graded sand with silt (SW-SM)
Pocket Penetrometer (tons/ft <sup>2</sup> )	>4.50		3.50	>4.50				
Weight Soil + Rings / Tube (g)	1418.40		1389.50	1527.70				
Weight of Rings / Tube (g)	526.40		546.00	529.30				
Average Length (in.)	5.836		6.001	6.005				
Average Diameter (in.)	2.375		2.375	2.375				
Wet. Wt. of Soil + Cont. (g)	966.70	714.30	951.20	1104.60	952.50	912.20	853.30	827.10
Dry Wt. of Soil + Cont. (g)	834.30	623.60	812.30	1015.00	859.80	830.20	700.70	734.20
Weight of Container (g)	75.80	82.70	111.20	109.30	75.90	76.70	107.10	75.10
Container No.								
<b>Wet Density</b>	131.4		120.9	143.0				
<b>Moisture Content (%)</b>	<b>17.5</b>	<b>16.8</b>	<b>19.8</b>	<b>9.9</b>	<b>11.8</b>	<b>10.9</b>	<b>25.7</b>	<b>14.1</b>
<b>Dry Density (pcf)</b>	<b>111.9</b>		<b>100.9</b>	<b>130.1</b>				
<b>Degree of Saturation (%)</b>	93.1		79.7	90.4				
	<b>MOISTURE &amp; DENSITY of SOILS</b> <b>ASTM D 2216 &amp; ASTM D 2937</b>				Project Name: <u>SR-710 Tunnel Technical Study</u>			
					Project No.: <u>378312.04.09.01</u>			
					Client Name: <u>CH2M Hill</u>			
				Tested By: <u>A. Santos</u>		Date: <u>05/13/09</u>		

# MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

<b>Sample</b>		<b>Wet Unit</b>	<b>Dry Unit</b>	<b>Moisture</b>	<b>Material</b>
<u>Identification</u>	<u>Depth, ft.</u>	<u>Weight, lb/ft.<sup>3</sup></u>	<u>Weight, lb/ft.<sup>3</sup></u>	<u>Content, %</u>	<u>Type</u>
Z3-B8, C37	156.3 - 156.5	146.6	135.9	7.9	sandstone

Test Method: ASTM D2216, ASTM D2937

**PROJECT NUMBER:** 09-144      May 12, 2009



5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762  
 Phone: (916) 939-3460 FAX: (916) 939-3507

**SR-710 Tunnel Technical  
 Study**

#378312.04.09.01

# MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

<u>Sample Identification</u>	<u>Depth, ft.</u>	<u>Wet Unit Weight, lb/ft.<sup>3</sup></u>	<u>Dry Unit Weight, lb/ft.<sup>3</sup></u>	<u>Moisture Content, %</u>	<u>Material Type</u>
Z3-B12, C41	190.8-191.3	114.1	93.6	22.0	Shale

Test Method: ASTM D2216, ASTM D2937


**PROJECT NUMBER:** 09-144      April 2, 2009



5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762  
Phone: (916) 939-3460 FAX: (916) 939-3507

**SR-710 Tunnel Technical Study**


#378312.04.09.01


Boring No.	R-09-Z3-B12	R-09-Z3-B12	R-09-Z3-B12	R-09-Z3-B12	R-09-Z3-B12	R-09-Z3-B12	R-09-Z3-B12	
Sample No.	S5	S7	S9	S11	S15	C21	C38	
Depth (ft.)	25.0	35.0	45.0	55.0	75.0	101-101.5	178.3-178.9	
Sample Type	Drive	Drive	Drive	Drive	Drive	Core	Core	
Soil Identification	Yellowish brown silty sand (SM)	Yellowish brown silt with sand (ML)s	Dark grayish brown silty sand (SM)	Dark grayish brown poorly-graded sand with silt (SP-SM)	Olive brown lean clay with sand (CL)s	Olive lean clay with sand (CL)s	Olive lean clay (CL)	
Pocket Penetrometer (tons/ft <sup>2</sup> )	4.00	2.00	2.00	2.00 / 3.50	>4.50	>4.50	N/A	
Weight Soil + Rings / Tube (g)	796.30	979.50	786.70	790.40	1194.90	1542.40	326.70	
Weight of Rings / Tube (g)	177.60	222.00	177.60	177.60	266.40	0.00	0.00	
Average Length (in.)	4.00	5.00	4.00	4.00	6.00	5.918	Calculated volume = 191.8 cc	
Average Diameter (in.)	2.416	2.416	2.416	2.416	2.416	3.241		
Wet. Wt. of Soil + Cont. (g)	330.40	829.60	289.50	333.50	383.30	1648.20	403.80	
Dry Wt. of Soil + Cont. (g)	274.10	665.70	240.60	273.00	326.40	1423.00	343.20	
Weight of Container (g)	39.13	108.00	39.10	39.61	53.70	106.80	77.10	
Container No.								
<b>Wet Density</b>	128.5	125.9	126.5	127.3	128.6	120.3	106.3	
<b>Moisture Content (%)</b>	<b>24.0</b>	<b>29.4</b>	<b>24.3</b>	<b>25.9</b>	<b>20.9</b>	<b>17.1</b>	<b>22.8</b>	
<b>Dry Density (pcf)</b>	<b>103.7</b>	<b>97.3</b>	<b>101.8</b>	<b>101.1</b>	<b>106.4</b>	<b>102.8</b>	<b>86.6</b>	
<b>Degree of Saturation (%)</b>	103.4	108.3	100.0	104.9	96.4	72.2	65.0	
		<b>MOISTURE &amp; DENSITY of SOILS</b> <b>ASTM D 2216 &amp; ASTM D 2937</b>			Project Name: <u>SR-710 Tunnel Technical Study</u>			
					Project No.: <u>378312.04.09.01</u>			
					Client Name: <u>CH2M Hill</u>			
					Tested By: <u>A. Santos</u>		Date: <u>03/06/09</u>	

# MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

<u>Sample Identification</u>	<u>Depth, ft.</u>	<u>Wet Unit Weight, lb/ft.<sup>3</sup></u>	<u>Dry Unit Weight, lb/ft.<sup>3</sup></u>	<u>Moisture Content, %</u>	<u>Material Type</u>
Z3-B12, C41	190.8-191.3	114.1	93.6	22.0	Shale

Test Method: ASTM D2216, ASTM D2937

<b>PROJECT NUMBER:</b> 09-144	April 2, 2009	<b>SR-710 Tunnel Technical Study</b>  #378312.04.09.01
 SIERRA TESTING LABORATORIES, INC. GEOTECHNICAL AND MATERIALS TESTING SERVICES  5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762 Phone: (916) 939-3460 FAX: (916) 939-3507		

Boring No.	R-09-Z4-B4	R-09-Z4-B4	R-09-Z4-B4	R-09-Z4-B4	R-09-Z4-B4	R-09-Z4-B4		
Sample No.	S-3	S-5	S-7	S-10	S-13	S-17		
Depth (ft.)	15.0	25.0	35.0	50.0	65.0	85.0		
Sample Type	Drive	Drive	Drive	SPT	Drive	SPT		
Soil Identification	Yellowish brown sandy silty clay s(CL-ML)	Yellowish brown silty sand (SM)	Yellowish brown sandy silty clay s(CL-ML)	Yellowish brown silty sand with gravel (SM)g	Brown silty sand (SM)	Yellowish brown fat clay (CH)		
Pocket Penetrometer (tons/ft <sup>2</sup> )	3.50 / 3.50	>4.50	4.00 / 4.00		>4.50			
Weight Soil + Rings / Tube (g)	1224.70	952.70	1204.50		1023.20			
Weight of Rings / Tube (g)	260.40	207.42	260.04		207.38			
Average Length (in.)	6.024	5.005	6.025		5.004			
Average Diameter (in.)	2.409	2.409	2.409		2.409			
Wet. Wt. of Soil + Cont. (g)	573.50	189.40	892.70	740.20	693.30	392.30		
Dry Wt. of Soil + Cont. (g)	496.00	162.50	764.60	667.60	616.70	322.90		
Weight of Container (g)	75.90	37.00	108.60	77.60	80.10	74.20		
Container No.								
<b>Wet Density</b>	133.8	124.5	131.0		136.3			
<b>Moisture Content (%)</b>	<b>18.4</b>	<b>21.4</b>	<b>19.5</b>	<b>12.3</b>	<b>14.3</b>	<b>27.9</b>		
<b>Dry Density (pcf)</b>	<b>113.0</b>	<b>102.5</b>	<b>109.6</b>		<b>119.2</b>			
<b>Degree of Saturation (%)</b>	101.2	89.8	98.0		93.2			
		<b>MOISTURE &amp; DENSITY of SOILS</b> <b>ASTM D 2216 &amp; ASTM D 2937</b>			Project Name: <u>SR-710 Tunnel Technical Study</u> Project No.: <u>378312.04.09.01</u> Client Name: <u>CH2M Hill</u> Tested By: <u>V. Juliano</u> Date: <u>04/27/09</u>			



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By: S. Felter    Date: 04/06/09  
 Project No.: 378312.04.09.01                              Checked By: J. Ward    Date: 04/08/09  
 Exploration No.: R-09-Z1-B8                              Depth (feet): 40-45  
 Sample No.: S09  
 Soil Identification: Olive brown silty, clayey sand (SC-SM)

Container No.:	VI	Moisture Content of Total Air - Dry Soil	
		Wt. of Air-Dried Soil + Cont.(g)	806.60
Wt. of Container (g)	220.10	Wt. of Dry Soil + Cont. (g)	0.00
Dry Wt. of Soil (g)	586.50	Wt. of Container No. _____ (g)	1.00
		Moisture Content (%)	0.00

After Wet Sieve	Container No.	VI
	Wt. of Dry Soil + Container (g)	552.10
	Wt. of Container (g)	220.10
	Dry Wt. of Soil Retained on # 200 Sieve (g)	332.00

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000	0.00	100.0
3/8"	9.500	2.00	99.7
#4	4.750	20.10	96.6
#8	2.360	34.60	94.1
#16	1.180	53.50	90.9
#30	0.600	85.50	85.4
#50	0.300	159.90	72.7
#100	0.150	246.60	58.0
#200	0.075	324.50	44.7
PAN			

GRAVEL: **3 %**  
 SAND: **52 %**  
 FINES: **45 %**  
 GROUP SYMBOL: **SC-SM**

Cu = D60/D10 = \_\_\_\_\_

Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: \_\_\_\_\_



GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

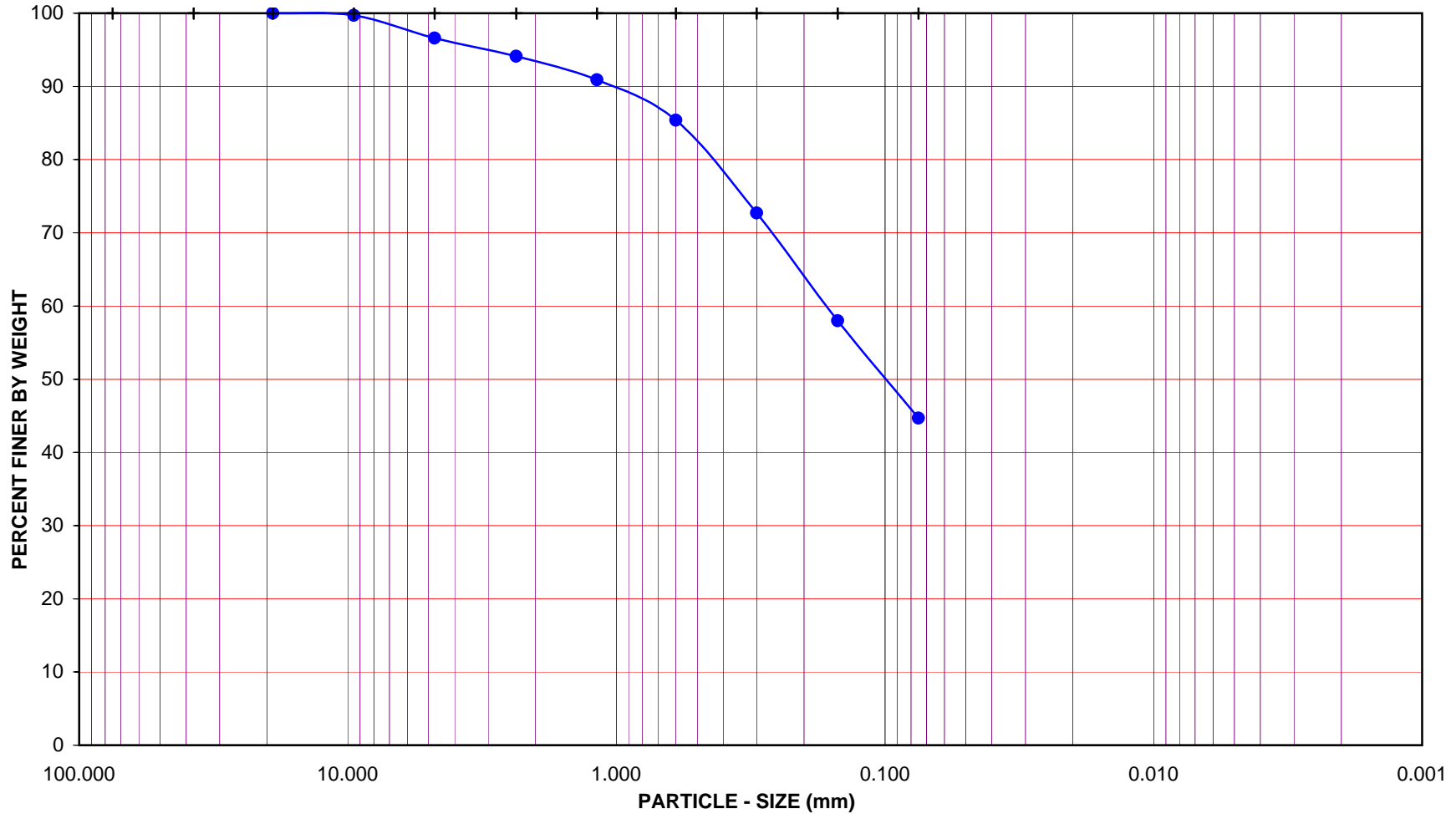
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8"

U.S. STANDARD SIEVE NUMBER

#4 #8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z1-B8

Sample No.: S09

Depth (feet): 40-45

Soil Type : SC-SM

Soil Identification: Olive brown silty, clayey sand (SC-SM)

**GR:SA:FI : (%)      3 : 52 : 45**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

Apr-09



## PARTICLE-SIZE ANALYSIS of SOILS

### ASTM D 422

Project Name: [SR-710 Tunnel Technical Study](#)      Tested By: [V. Juliano](#)    Date: [04/06/09](#)  
 Project No.: [378312.04.09.01](#)                                      Checked By: [J. Ward](#)    Date: [04/08/09](#)  
 Exploration No.: [R-09-Z1-B8](#)                                      Depth (feet): [15-16.5](#)  
 Sample No.: [S04](#)  
 Soil Identification: [Olive yellow to dark brown sandy silt s\(ML\)](#)

		Moisture Content of Total Air - Dry Soil	
Container No.:	936	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	649.20	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	108.43	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	540.77	Moisture Content (%)	0.00

After Wet Sieve	Container No.	936
	Wt. of Dry Soil + Container (g)	271.30
	Wt. of Container (g)	108.43
	Dry Wt. of Soil Retained on # 200 Sieve (g)	162.87

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500	0.00	100.0
3/4"	19.000	14.30	97.4
3/8"	9.500	28.67	94.7
#4	4.750	41.11	92.4
#8	2.360	52.32	90.3
#16	1.180	65.39	87.9
#30	0.600	79.31	85.3
#50	0.300	98.23	81.8
#100	0.150	126.46	76.6
#200	0.075	161.50	70.1
PAN			

GRAVEL: 8 %  
 SAND: 22 %  
 FINES: 70 %  
 GROUP SYMBOL: s(ML)

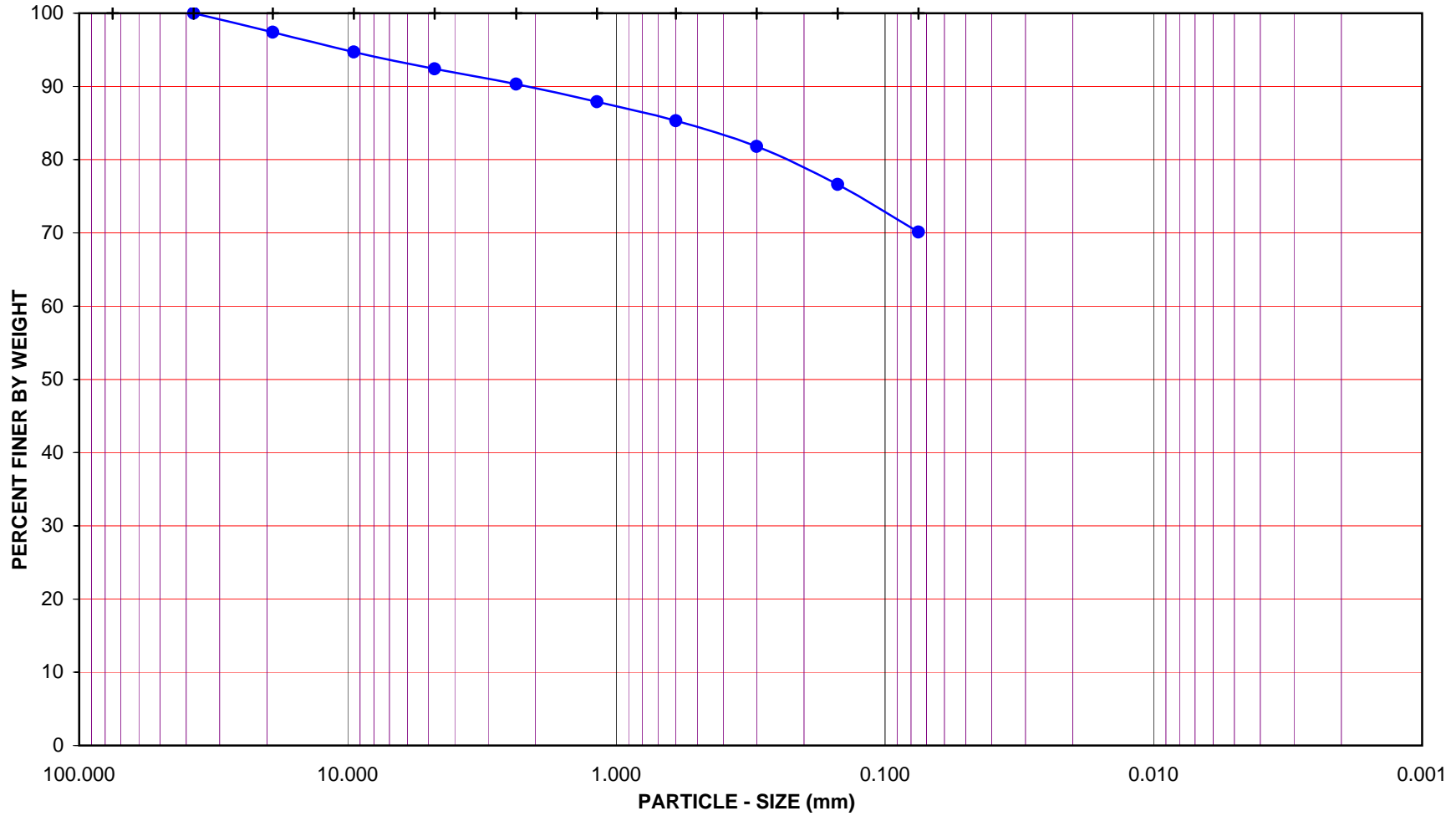
Cu = D60/D10 = \_\_\_\_\_

Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: \_\_\_\_\_

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

U.S. STANDARD SIEVE OPENING      U.S. STANDARD SIEVE NUMBER      HYDROMETER  
 3.0"    1 1/2"    3/4"    3/8"    #4    #8    #16    #30    #50    #100    #200



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z1-B8

Sample No.: S04

Depth (feet): 15-16.5

Soil Type : s(ML)

Soil Identification: Olive yellow to dark brown sandy silt s(ML)

**GR:SA:FI : (%)      8 : 22 : 70**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

Apr-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/11/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/14/09  
 Exploration No.: R-09-Z1-B8  
 Sample No.: C17      Depth (feet) : 80-80.75  
 Soil Identification: Dark olive silt'stone' (ML)

<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>  <b>ML</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>2</b>				
<b>% Fines</b>	<b>98</b>				
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	78.85
Wt.of Air-Dry Soil + Cont. (g)	631.00	Wt. of Container No.____ (g)	1.00	1.00	77.27
Wt. of Container	77.00	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	554.00	Wt. of Dry Soil (g)			1.58

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.00	100.0
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.00	100.0	100.0
No. 30	0.00	100.0	100.0
No. 50	0.02	100.0	100.0
No. 100	0.05	99.9	99.9
No. 200	1.22	97.6	97.6
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 50.55      Wt. of Dry Soil (g) 50.55

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
12-May-09	7:48	0		5.5			
	7:50	2	22.1	5.5	42.5	72.6	0.0283
	7:53	5	22.1	5.5	36.0	59.9	0.0189
	8:03	15	21.7	5.5	31.5	51.0	0.0115
	8:18	30	21.9	5.5	24.5	37.3	0.0085
	8:48	60	21.8	5.5	20.5	29.4	0.0062
	9:48	120	21.8	5.5	18.0	24.5	0.0044
	11:58	250	21.7	5.5	15.0	18.6	0.0031
13-May-09	7:48	1440	22.0	5.5	12.0	12.8	0.0013

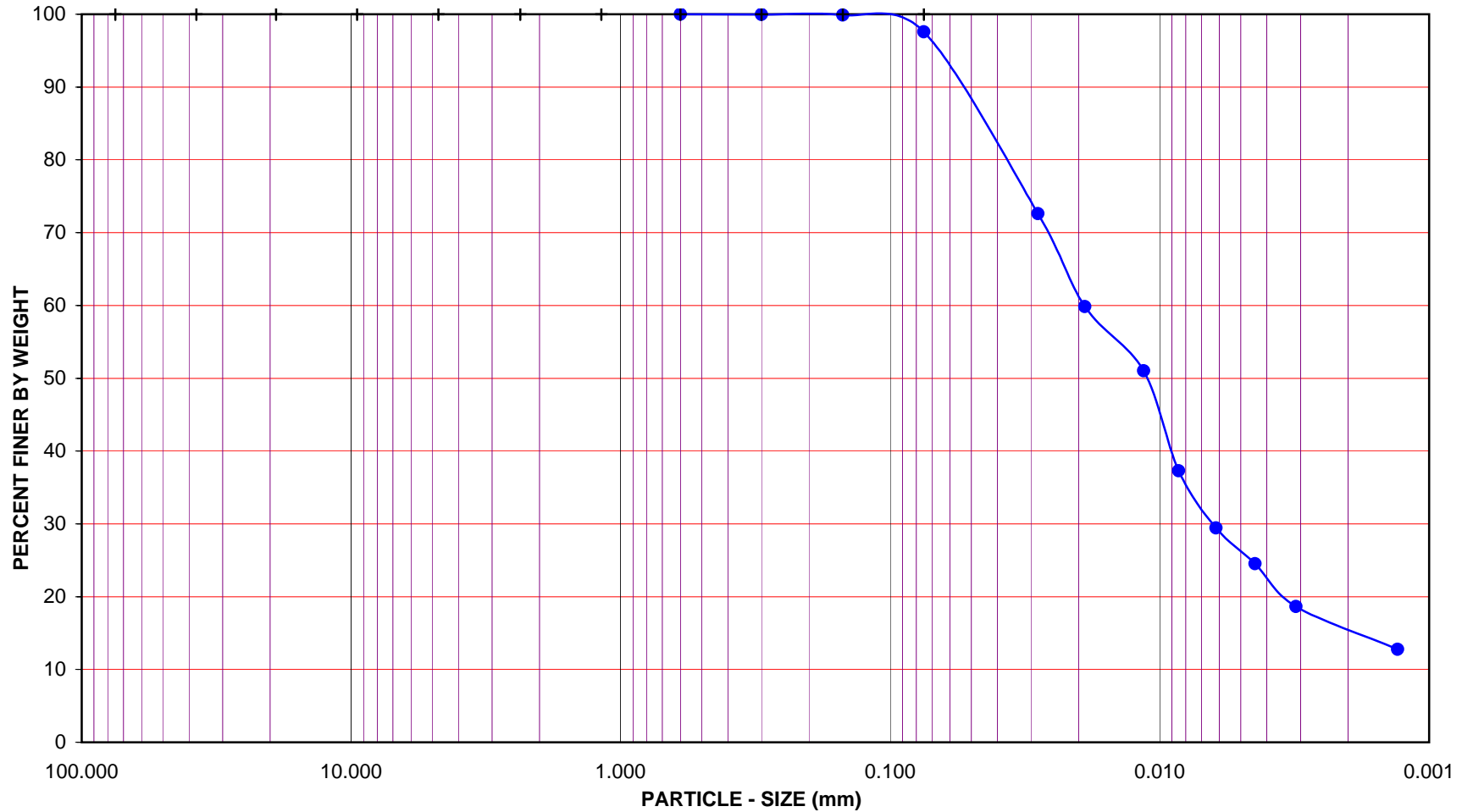
GRAVEL				SAND				FINES			
COARSE		FINE		CRSE	MEDIUM	FINE		SILT		CLAY	

U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4 #8 #16 #30 #50 #100 #200

U.S. STANDARD SIEVE NUMBER

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z1-B8

Sample No.: C17

Depth (feet): 80-80.75

Soil Type: ML

Soil Identification: Dark olive silt'stone' (ML)

**GR:SA:FI : (%) 0 : 2 : 98**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)      Tested By : [V. Juliano](#)      Date: [05/11/09](#)  
 Project No. : [378312.04.09.01](#)      Data Input By: [J. Ward](#)      Date: [05/14/09](#)  
 Exploration No.: [R-09-Z1-B8](#)  
 Sample No.: [C23](#)      Depth (feet) : [109-109.7](#)  
 Soil Identification: [Dark olive lean clay'stone' \(CL\)](#)

<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>  <b>CL</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>3</b>				
<b>% Fines</b>	<b>97</b>				

Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	77.75
Wt.of Air-Dry Soil + Cont. (g)	748.50	Wt. of Container No.____ (g)	1.00	1.00	76.15
Wt. of Container	75.20	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	673.30	Wt. of Dry Soil (g)			1.60

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.00	100.0
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.00	100.0	100.0
No. 30	0.05	99.9	99.9
No. 50	0.10	99.8	99.8
No. 100	0.18	99.6	99.6
No. 200	1.37	97.3	97.3
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 50.18
Wt. of Dry Soil (g) 50.18

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
12-May-09	7:44	0		5.5			
	7:46	2	22.1	5.5	42.0	72.2	0.0284
	7:49	5	22.1	5.5	34.5	57.3	0.0192
	7:59	15	21.8	5.5	28.5	45.5	0.0117
	8:14	30	21.8	5.5	24.0	36.6	0.0085
	8:44	60	21.8	5.5	21.0	30.6	0.0062
	9:44	120	21.7	5.5	17.5	23.7	0.0044
	11:54	250	21.5	5.5	15.5	19.8	0.0031
13-May-09	7:44	1440	21.9	5.5	11.5	11.9	0.0013

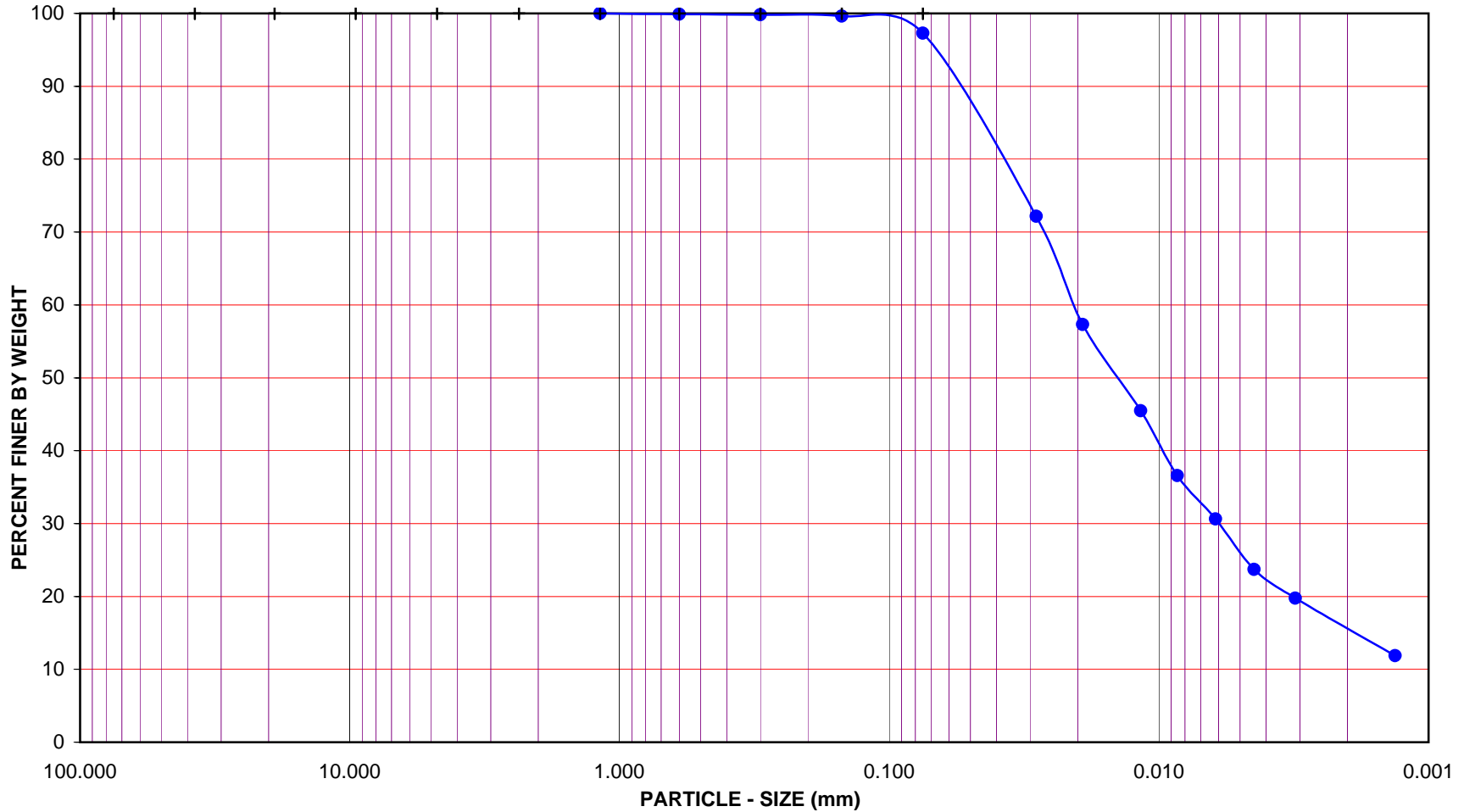
GRAVEL				SAND				FINES			
COARSE		FINE		CRSE	MEDIUM		FINE		SILT		CLAY

U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4 #8 #16 #30 #50 #100 #200

U.S. STANDARD SIEVE NUMBER

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z1-B8

Sample No.: C23

Depth (feet): 109-109.7

Soil Type : CL

Soil Identification: Dark olive lean clay'stone' (CL)

**GR:SA:FI : (%) 0 : 3 : 97**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/11/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/14/09  
 Exploration No.: R-09-Z1-B8  
 Sample No.: C26      Depth (feet) : 120-120.4  
 Soil Identification: Dark olive lean clay'stone' (CL)

<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>  <b>CL</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>4</b>				
<b>% Fines</b>	<b>96</b>				
Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	79.08
Wt. of Air-Dry Soil + Cont. (g)	742.90	Wt. of Container No. ___ (g)	1.00	1.00	76.85
Wt. of Container	72.90	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	670.00	Wt. of Dry Soil (g)			2.23

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.00	100.0
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.05	99.9	99.9
No. 30	0.08	99.8	99.8
No. 50	0.14	99.7	99.7
No. 100	0.22	99.6	99.6
No. 200	1.89	96.3	96.3
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 50.71      Wt. of Dry Soil (g) 50.71

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
12-May-09	7:40	0		5.5			
	7:42	2	22.1	5.5	41.5	70.4	0.0286
	7:45	5	22.1	5.5	34.0	55.8	0.0192
	7:55	15	22.1	5.5	28.0	44.0	0.0116
	8:10	30	21.8	5.5	24.5	37.2	0.0085
	8:40	60	21.7	5.5	21.0	30.3	0.0062
	9:40	120	21.7	5.5	19.0	26.4	0.0044
	11:50	250	21.4	5.5	16.0	20.5	0.0031
13-May-09	7:40	1440	21.9	5.5	12.0	12.7	0.0013



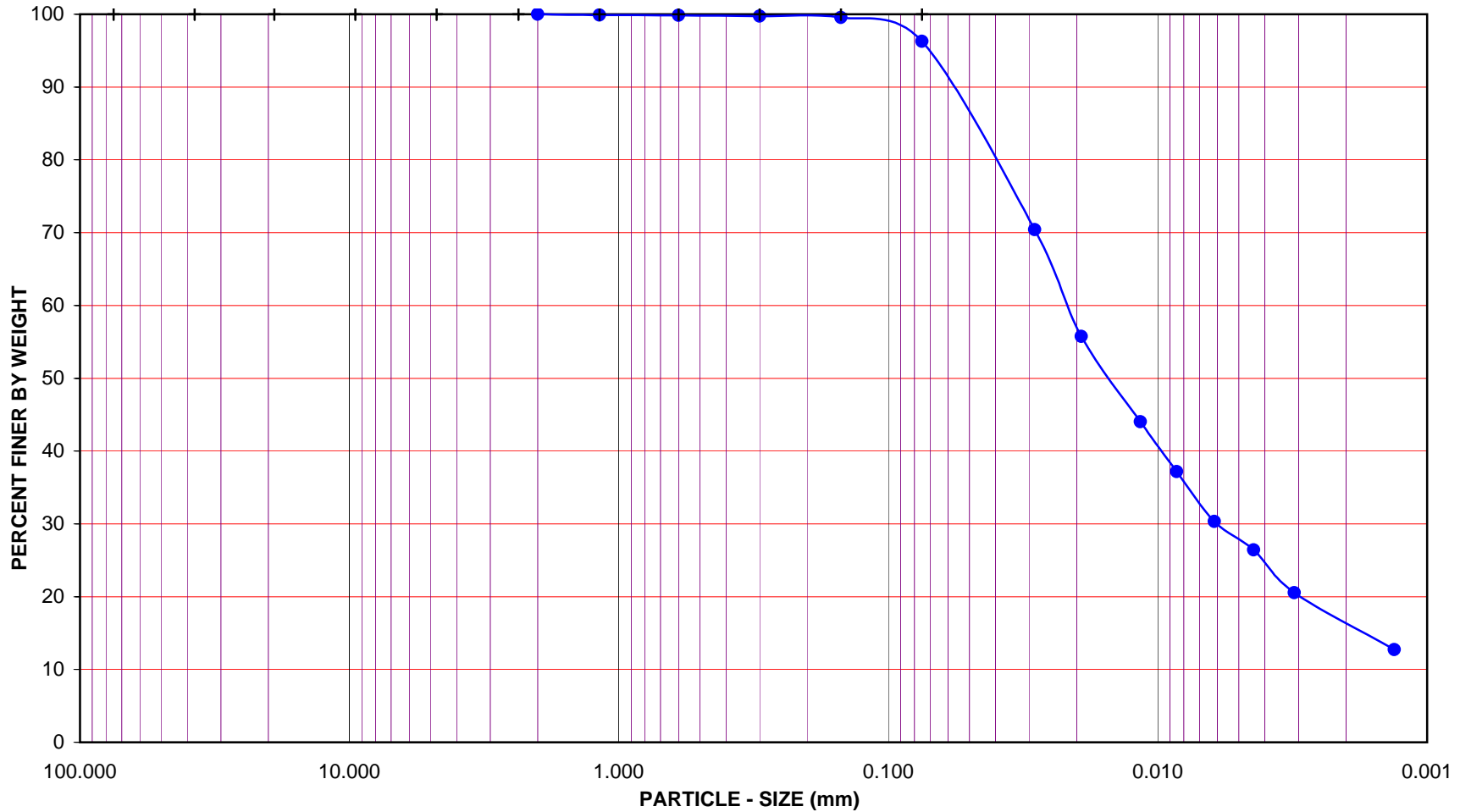
GRAVEL				SAND						FINES	
COARSE		FINE		CRSE	MEDIUM		FINE		SILT		CLAY

U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4 #8 #16 #30 #50 #100 #200

U.S. STANDARD SIEVE NUMBER

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z1-B8

Sample No.: C26

Depth (feet): 120-120.4

Soil Type : CL

Soil Identification: Dark olive lean clay'stone' (CL)

**GR:SA:FI : (%) 0 : 4 : 96**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



## PARTICLE-SIZE ANALYSIS of SOILS

### ASTM D 422

Project Name: [SR-710 Tunnel Technical Study](#)  
 Project No.: [378312.04.09.01](#)  
 Exploration No.: [R-09-Z2-B5](#)  
 Sample No.: [S6](#)  
 Soil Identification: [Olive brown sandy silt s\(ML\)](#)

Tested By: [A. Santos](#) Date: [05/20/09](#)  
 Checked By: [J. Ward](#) Date: [05/27/09](#)  
 Depth (feet): [30.0](#)

		Moisture Content of Total Air - Dry Soil	
Container No.:	780	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	511.50	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	76.10	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	435.40	Moisture Content (%)	0.00

After Wet Sieve	Container No.	780
	Wt. of Dry Soil + Container (g)	278.50
	Wt. of Container (g)	76.10
	Dry Wt. of Soil Retained on # 200 Sieve (g)	202.40

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000		
3/8"	9.500		
#4	4.750	0.00	100.0
#8	2.360	0.90	99.8
#16	1.180	2.80	99.4
#30	0.600	18.30	95.8
#50	0.300	63.40	85.4
#100	0.150	131.70	69.8
#200	0.075	191.60	56.0
PAN			

GRAVEL: 0 %  
 SAND: 44 %  
 FINES: 56 %  
 GROUP SYMBOL: s(ML)

Cu = D60/D10 = \_\_\_\_\_  
 Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: \_\_\_\_\_

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

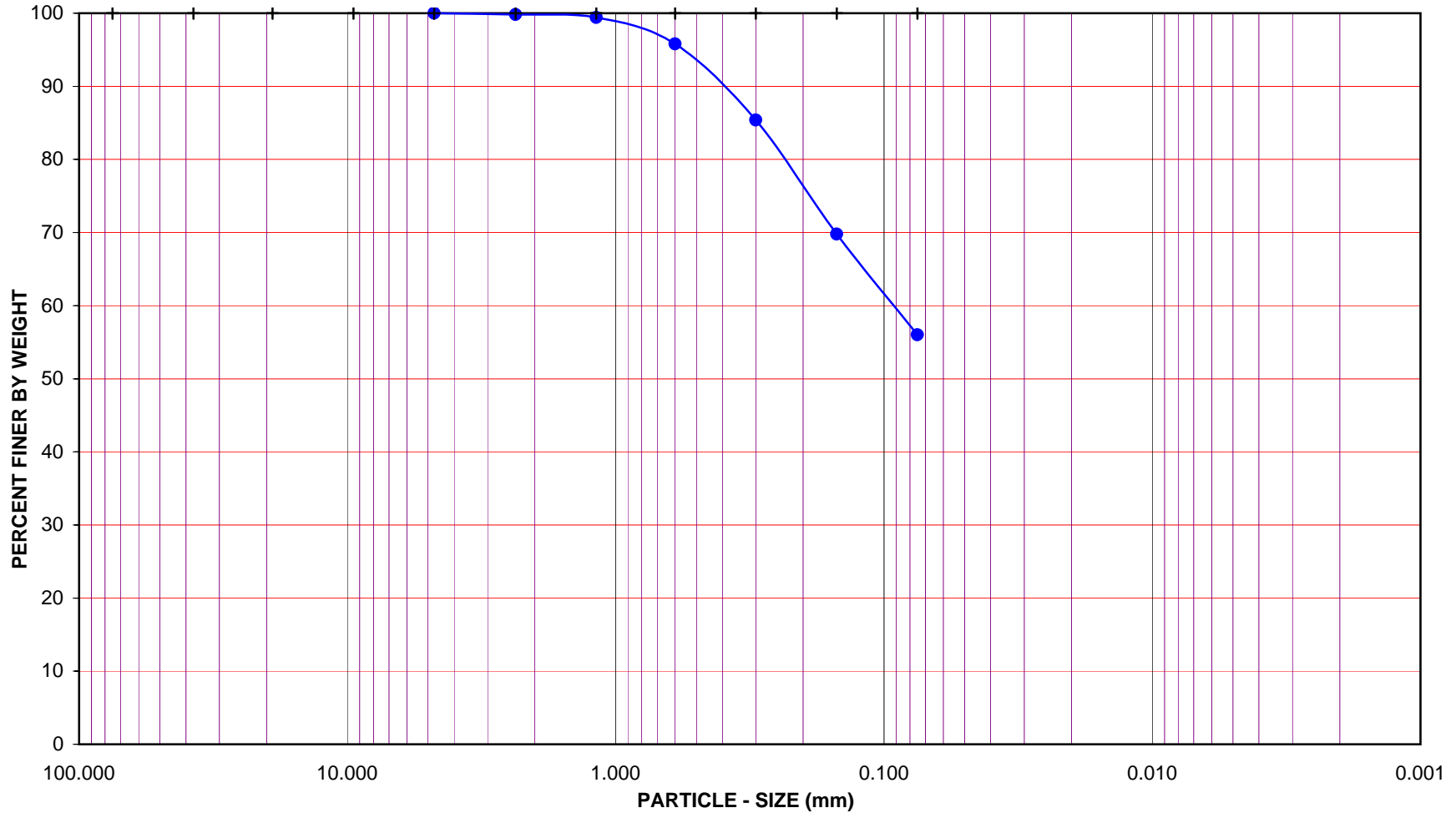
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8"

U.S. STANDARD SIEVE NUMBER

#4 #8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z2-B5

Sample No.: S6

Depth (feet): 30.0

Soil Type : s(ML)

Soil Identification: Olive brown sandy silt s(ML)

**GR:SA:FI : (%) 0 : 44 : 56**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)  
 Project No.: [378312.04.09.01](#)  
 Exploration No.: [R-09-Z2-B5](#)  
 Sample No.: [S10](#)  
 Soil Identification: [Olive brown silty sand \(SM\)](#)

Tested By: [A. Santos](#) Date: [05/20/09](#)  
 Checked By: [J. Ward](#) Date: [05/27/09](#)  
 Depth (feet): [50.0](#)

		Moisture Content of Total Air - Dry Soil	
Container No.:	912	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	653.80	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	106.90	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	546.90	Moisture Content (%)	0.00

After Wet Sieve	Container No.	912
	Wt. of Dry Soil + Container (g)	477.70
	Wt. of Container (g)	106.90
	Dry Wt. of Soil Retained on # 200 Sieve (g)	370.80

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000	0.00	100.0
3/8"	9.500	9.10	98.3
#4	4.750	14.30	97.4
#8	2.360	18.10	96.7
#16	1.180	24.50	95.5
#30	0.600	39.90	92.7
#50	0.300	107.30	80.4
#100	0.150	266.80	51.2
#200	0.075	362.80	33.7
PAN			

GRAVEL: **3 %**  
 SAND: **63 %**  
 FINES: **34 %**  
 GROUP SYMBOL: **SM**

Cu = D60/D10 = \_\_\_\_\_

Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: \_\_\_\_\_

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

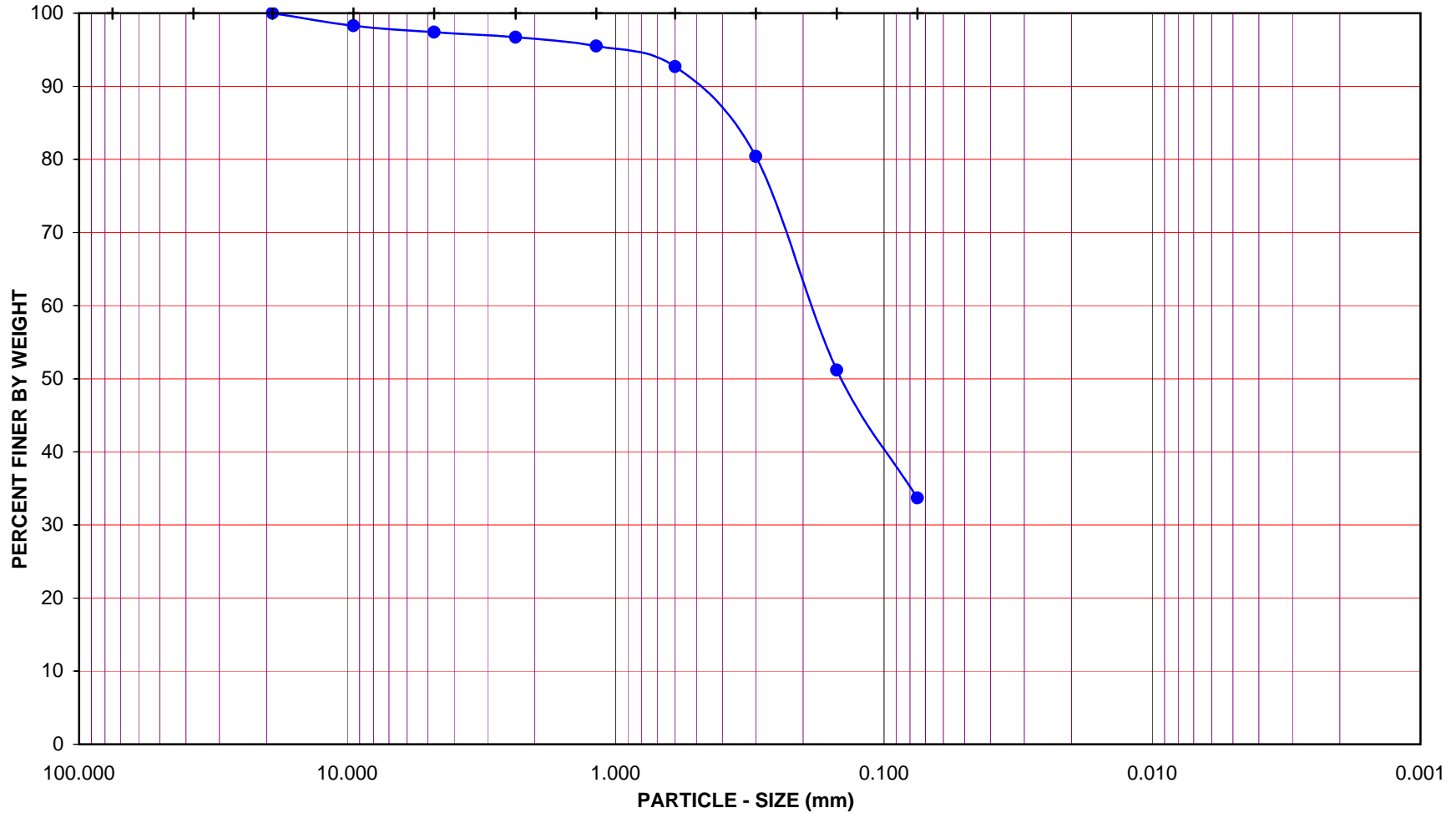
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8"

U.S. STANDARD SIEVE NUMBER

#4 #8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z2-B5

Sample No.: S10

Depth (feet): 50.0

Soil Type : SM

Soil Identification: Olive brown silty sand (SM)

**GR:SA:FI : (%)      3 : 63 : 34**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/28/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 06/06/09  
 Exploration No.: R-09-Z2-B5  
 Sample No.: C28      Depth (feet) : 148-148.6  
 Soil Identification: Yellowish brown fat clay (CH)

<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>  <b>CH</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>4</b>				
<b>% Fines</b>	<b>96</b>				

Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	78.55
Wt. of Air-Dry Soil + Cont. (g)	552.00	Wt. of Container No. ___ (g)	1.00	1.00	76.29
Wt. of Container	109.00	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	443.00	Wt. of Dry Soil (g)			2.26

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.00	100.0
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.00	100.0	100.0
No. 30	0.03	100.0	100.0
No. 50	0.09	99.9	99.9
No. 100	0.44	99.3	99.3
No. 200	2.18	96.4	96.4
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 60.63
Wt. of Dry Soil (g) 60.63

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
02-Jun-09	9:00	0		6.5			
	9:02	2	21.6	6.5	49.0	69.5	0.0271
	9:05	5	21.6	6.5	41.0	56.4	0.0184
	9:15	15	21.7	6.5	32.5	42.5	0.0114
	9:30	30	21.4	6.5	28.0	35.2	0.0083
	10:00	60	21.5	6.5	24.0	28.6	0.0060
	11:00	120	21.6	6.5	21.0	23.7	0.0044
	13:10	250	21.8	6.5	18.0	18.8	0.0031
03-Jun-09	9:00	1440	21.5	6.5	13.5	11.5	0.0013

GRAVEL				SAND				FINES			
COARSE		FINE		CRSE	MEDIUM		FINE		SILT		CLAY

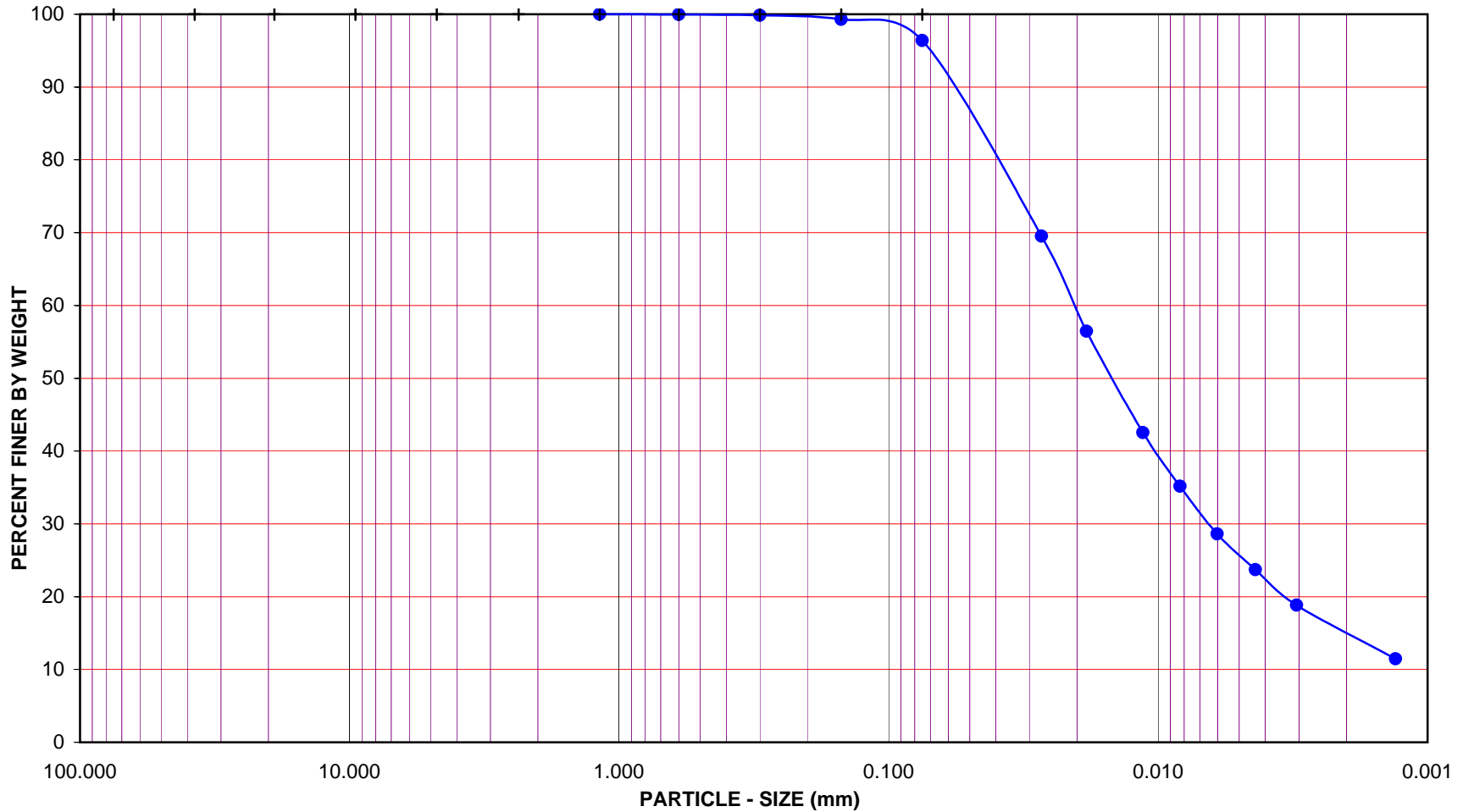
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z2-B5

Sample No.: C28

Depth (feet): 148-148.6

Soil Type : CH

Soil Identification: Yellowish brown fat clay (CH)

**GR:SA:FI : (%) 0 : 4 : 96**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

Jun-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/28/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 06/06/09  
 Exploration No.: R-09-Z2-B5  
 Sample No.: C36      Depth (feet) : 176.6-177.2  
 Soil Identification: Very dark olive silt'stone' (ML)

<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>  <b>ML</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>3</b>				
<b>% Fines</b>	<b>97</b>				
Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	78.08
Wt. of Air-Dry Soil + Cont. (g)	772.90	Wt. of Container No. ___ (g)	1.00	1.00	76.20
Wt. of Container	110.10	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	662.80	Wt. of Dry Soil (g)			1.88

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.00	100.0
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.00	100.0	100.0
No. 30	0.00	100.0	100.0
No. 50	0.01	100.0	100.0
No. 100	0.05	99.9	99.9
No. 200	1.68	97.0	97.0
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 55.56      Wt. of Dry Soil (g) 55.56

Deflocculant 125 cc of 4% Solution

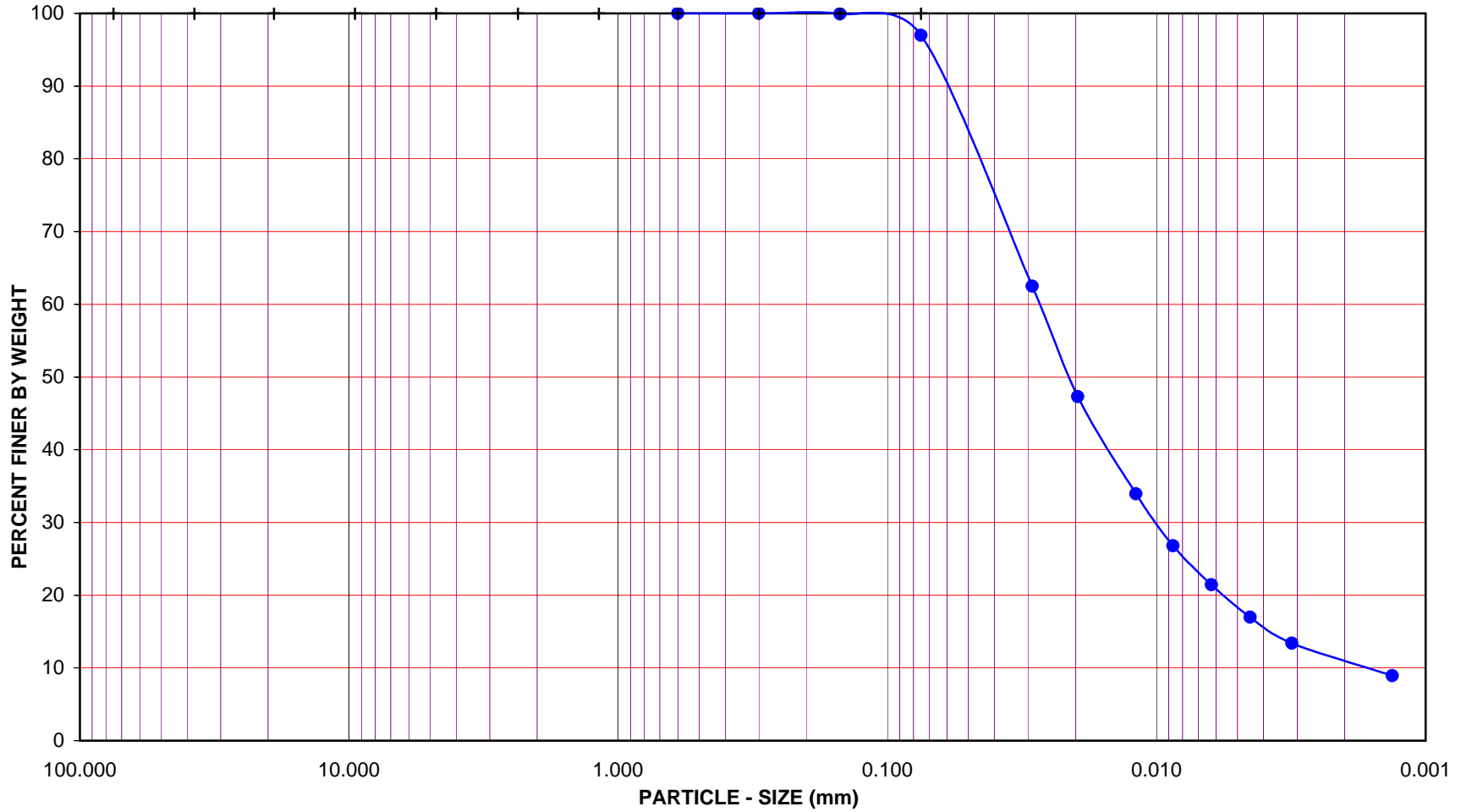
Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
02-Jun-09	9:12	0		6.5			
	9:14	2	21.7	6.5	41.5	62.5	0.0289
	9:17	5	21.6	6.5	33.0	47.3	0.0196
	9:27	15	21.4	6.5	25.5	33.9	0.0119
	9:42	30	21.6	6.5	21.5	26.8	0.0087
	10:12	60	21.6	6.5	18.5	21.4	0.0062
	11:12	120	21.5	6.5	16.0	17.0	0.0045
	13:22	250	21.8	6.5	14.0	13.4	0.0031
03-Jun-09	9:12	1440	21.5	6.5	11.5	8.9	0.0013



GRAVEL				SAND						FINES	
COARSE		FINE		CRSE	MEDIUM		FINE		SILT		CLAY

U.S. STANDARD SIEVE OPENING      U.S. STANDARD SIEVE NUMBER      HYDROMETER

3.0"    1 1/2"    3/4"    3/8"    #4    #8    #16    #30    #50    #100    #200



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z2-B5

Sample No.: C36

Depth (feet) : 176.6-177.2

Soil Type : ML

Soil Identification: Very dark olive silt'stone' (ML)

**GR:SA:FI : (%)      0 : 3 : 97**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

Jun-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/22/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/27/09  
 Exploration No.: R-09-Z2-B5  
 Sample No.: S21      Depth (feet) : 105.0  
 Soil Identification: Olive brown lean clay (CL)

% Gravel	0	Soil Type	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
% Sand	5				
% Fines	95				
<b>CL</b>					
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	78.31
Wt.of Air-Dry Soil + Cont. (g)	358.10	Wt. of Container No.____ (g)	1.00	1.00	75.47
Wt. of Container	75.18	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	282.92	Wt. of Dry Soil (g)			2.84

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.00	100.0
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.06	99.9	99.9
No. 30	0.14	99.7	99.7
No. 50	0.24	99.6	99.6
No. 100	0.59	98.9	98.9
No. 200	2.79	95.0	95.0
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 55.43
Wt. of Dry Soil (g) 55.43

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
26-May-09	8:00	0		6.0			
	8:02	2	21.6	6.0	43.5	67.1	0.0284
	8:05	5	21.6	6.0	38.0	57.3	0.0189
	8:15	15	21.3	6.0	32.0	46.5	0.0114
	8:30	30	21.4	6.0	30.5	43.8	0.0082
	9:00	60	21.5	6.0	28.0	39.4	0.0059
	10:00	120	21.0	6.0	26.0	35.8	0.0042
	12:10	250	21.2	6.0	24.0	32.2	0.0030
27-May-09	8:00	1440	21.4	6.0	20.0	25.1	0.0013

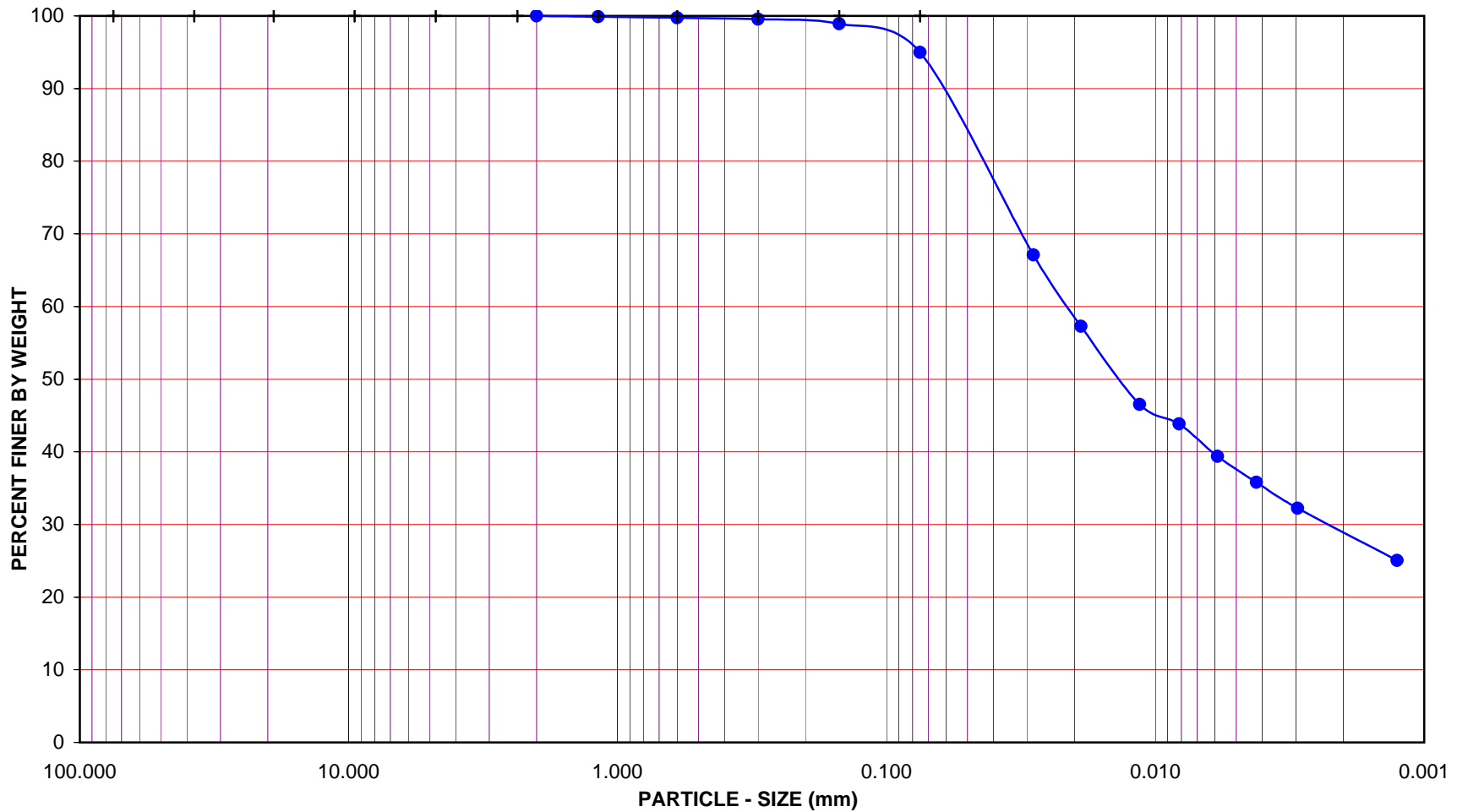
GRAVEL				SAND						FINES	
COARSE		FINE		CRSE	MEDIUM		FINE		SILT		CLAY

U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4 #8 #16 #30 #50 #100 #200

U.S. STANDARD SIEVE NUMBER

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z2-B5

Sample No.: S21

Depth (feet): 105.0

Soil Type : CL

Soil Identification: Olive brown lean clay (CL)

**GR:SA:FI : (%) 0 : 5 : 95**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By: V. Juliano      Date: 05/11/09  
 Project No.: 378312.04.09.01      Checked By: J. Ward      Date: 05/15/09  
 Exploration No.: R-09-Z3-B2      Depth (feet): 15-16.5  
 Sample No.: S5  
 Soil Identification: Yellowish brown well-graded sand with silt and gravel (SW-SM)g

		Moisture Content of Total Air - Dry Soil	
Container No.:	538	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	852.30	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	82.60	Wt. of Container No._____ (g)	1.00
Dry Wt. of Soil (g)	769.70	Moisture Content (%)	0.00

After Wet Sieve	Container No.	538
	Wt. of Dry Soil + Container (g)	795.80
	Wt. of Container (g)	82.60
	Dry Wt. of Soil Retained on # 200 Sieve (g)	713.20

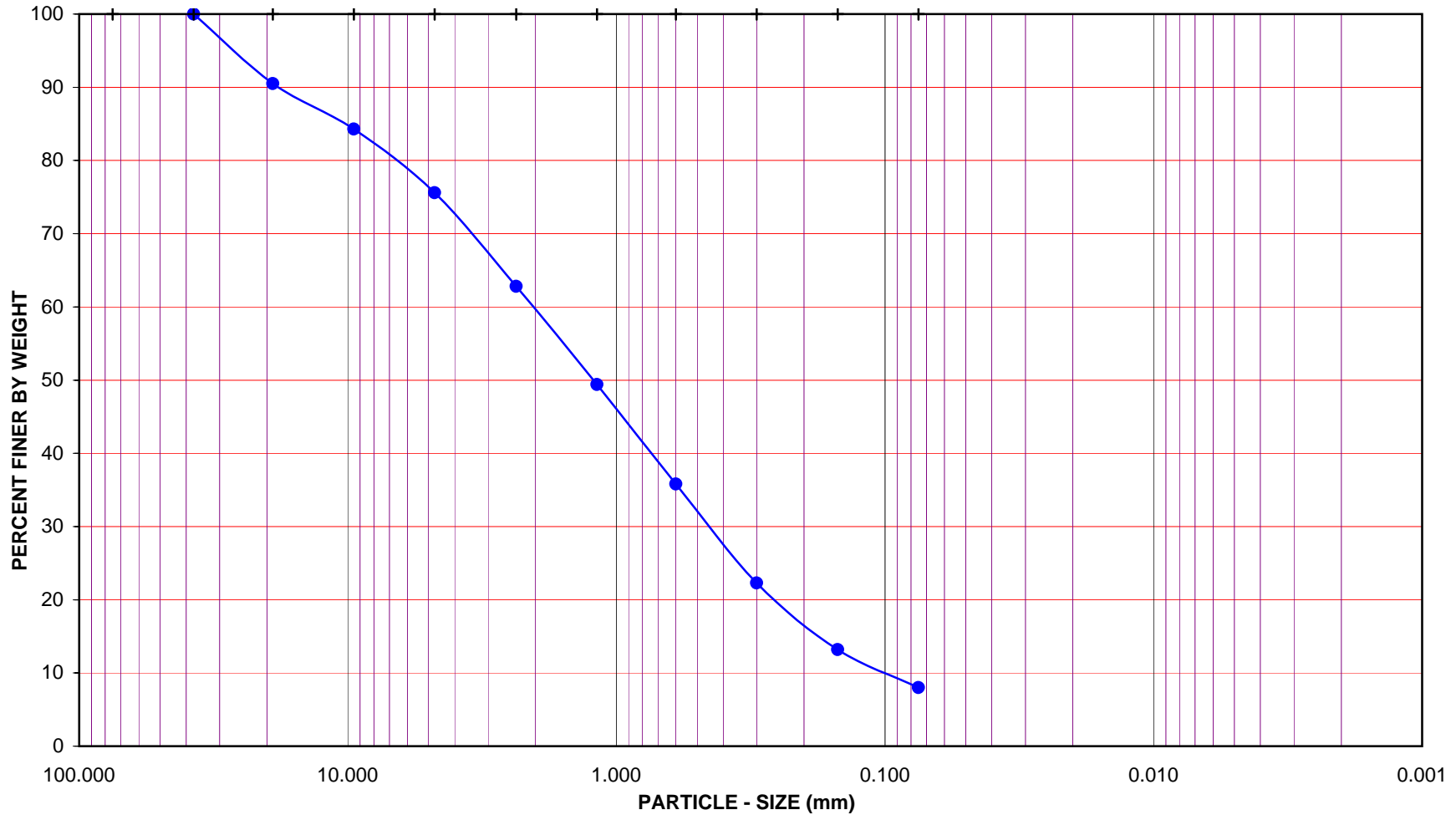
U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500	0.00	100.0
3/4"	19.000	73.20	90.5
3/8"	9.500	120.70	84.3
#4	4.750	188.00	75.6
#8	2.360	286.50	62.8
#16	1.180	389.50	49.4
#30	0.600	494.00	35.8
#50	0.300	597.90	22.3
#100	0.150	667.90	13.2
#200	0.075	708.00	8.0
PAN			

GRAVEL: **24 %**  
 SAND: **68 %**  
 FINES: **8 %**

GROUP SYMBOL: **(SW-SM)g**       $C_u = D_{60}/D_{10} = \underline{20.00}$   
 $C_c = (D_{30})^2/(D_{60}*D_{10}) = \underline{0.97}$

Remarks: Insufficient sample mass available to meet the ASTM specification for this material

GRAVEL			SAND				FINES					
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY				
U.S. STANDARD SIEVE OPENING			U.S. STANDARD SIEVE NUMBER				HYDROMETER					
3.0"	1 1/2"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200		



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B2

Sample No.: S5

Depth (feet): 15-16.5

Soil Type : (SW-SM)g

Soil Identification: Yellowish brown well-graded sand with silt and gravel (SW-SM)g

**GR:SA:FI : (%)      24 : 68 : 8**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By: V. Juliano    Date: 05/11/09  
 Project No.: 378312.04.09.01                              Checked By: J. Ward    Date: 05/15/09  
 Exploration No.: R-09-Z3-B2                              Depth (feet): 31.3-31.8  
 Sample No.: S9  
 Soil Identification: Olive well-graded sand with silt and gravel (SW-SM)g

		Moisture Content of Total Air - Dry Soil	
Container No.:	952	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	1022.10	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	107.90	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	914.20	Moisture Content (%)	0.00

After Wet Sieve	Container No.	952
	Wt. of Dry Soil + Container (g)	973.70
	Wt. of Container (g)	107.90
	Dry Wt. of Soil Retained on # 200 Sieve (g)	865.80

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500	0.00	100.0
3/4"	19.000	183.80	79.9
3/8"	9.500	280.90	69.3
#4	4.750	366.10	60.0
#8	2.360	468.20	48.8
#16	1.180	585.30	36.0
#30	0.600	683.10	25.3
#50	0.300	759.40	16.9
#100	0.150	820.70	10.2
#200	0.075	861.20	5.8
PAN			

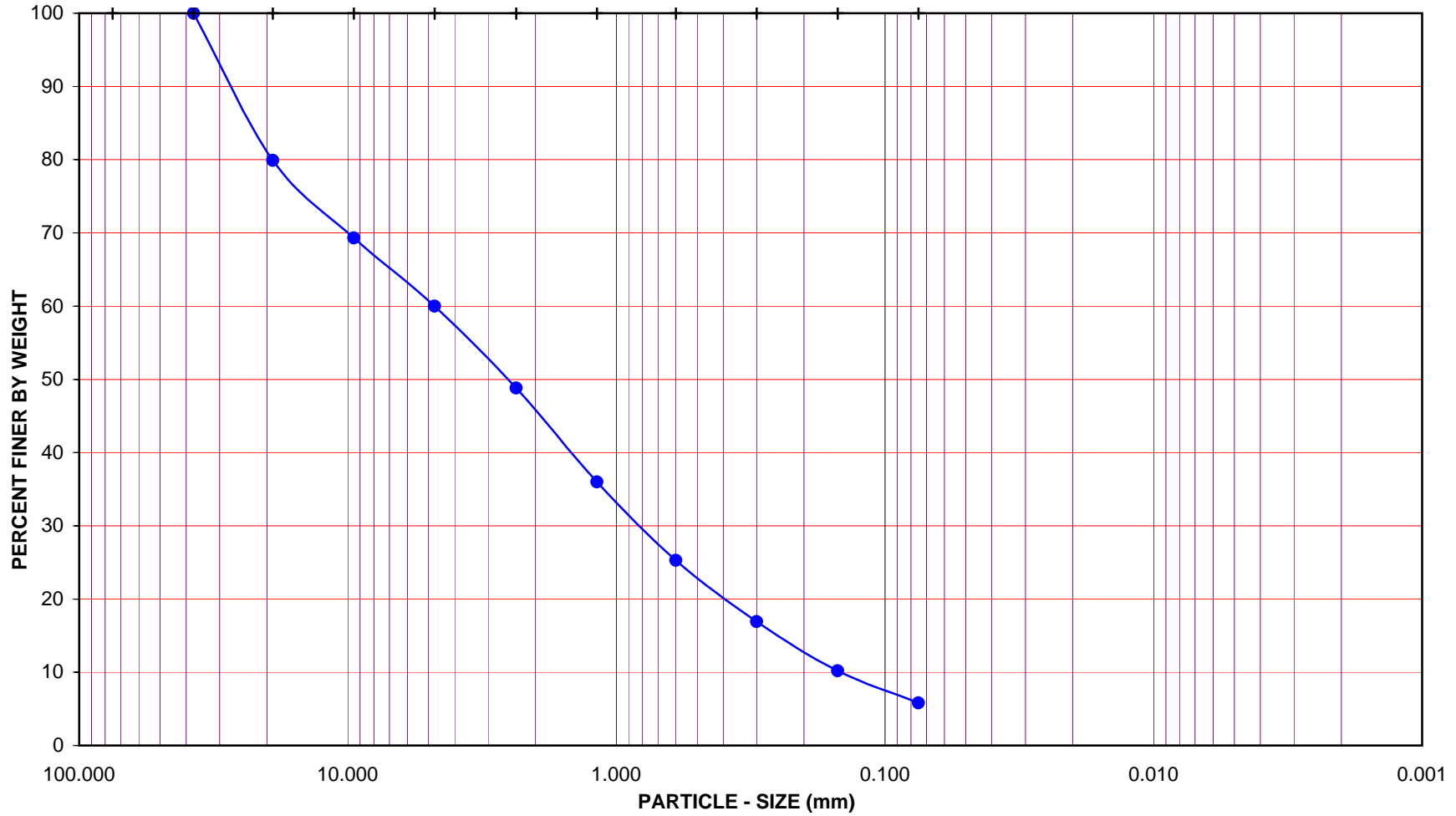
GRAVEL: **40 %**  
 SAND: **54 %**  
 FINES: **6 %**

GROUP SYMBOL: **(SW-SM)g**       $C_u = D_{60}/D_{10} = \underline{33.93}$   
 $C_c = (D_{30})^2 / (D_{60} * D_{10}) = \underline{1.04}$

Remarks: Insufficient sample mass available to meet the ASTM specification for this material

GRAVEL				SAND				FINES					
COARSE		FINE		COARSE		MEDIUM		FINE		SILT		CLAY	

U.S. STANDARD SIEVE OPENING      U.S. STANDARD SIEVE NUMBER      HYDROMETER  
 3.0"    1 1/2"    3/4"    3/8"    #4    #8    #16    #30    #50    #100    #200



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B2

Sample No.: S9

Depth (feet): 31.3-31.8

Soil Type : (SW-SM)g

Soil Identification: Olive well-graded sand with silt and gravel (SW-SM)g

**GR:SA:FI : (%)      40 : 54 : 6**



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**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By: V. Juliano    Date: 05/11/09  
 Project No.: 378312.04.09.01                              Checked By: J. Ward    Date: 05/15/09  
 Exploration No.: R-09-Z3-B2                              Depth (feet): 55-56  
 Sample No.: S17  
 Soil Identification: Yellowish brown well-graded sand with silt and gravel (SW-SM)g

		Moisture Content of Total Air - Dry Soil	
Container No.:	752	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	724.30	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	75.60	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	648.70	Moisture Content (%)	0.00

After Wet Sieve	Container No.	752
	Wt. of Dry Soil + Container (g)	682.70
	Wt. of Container (g)	75.60
	Dry Wt. of Soil Retained on # 200 Sieve (g)	607.10

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000	0.00	100.0
3/8"	9.500	37.30	94.3
#4	4.750	124.40	80.8
#8	2.360	224.00	65.5
#16	1.180	333.50	48.6
#30	0.600	428.50	33.9
#50	0.300	507.30	21.8
#100	0.150	567.70	12.5
#200	0.075	602.30	7.2
PAN			

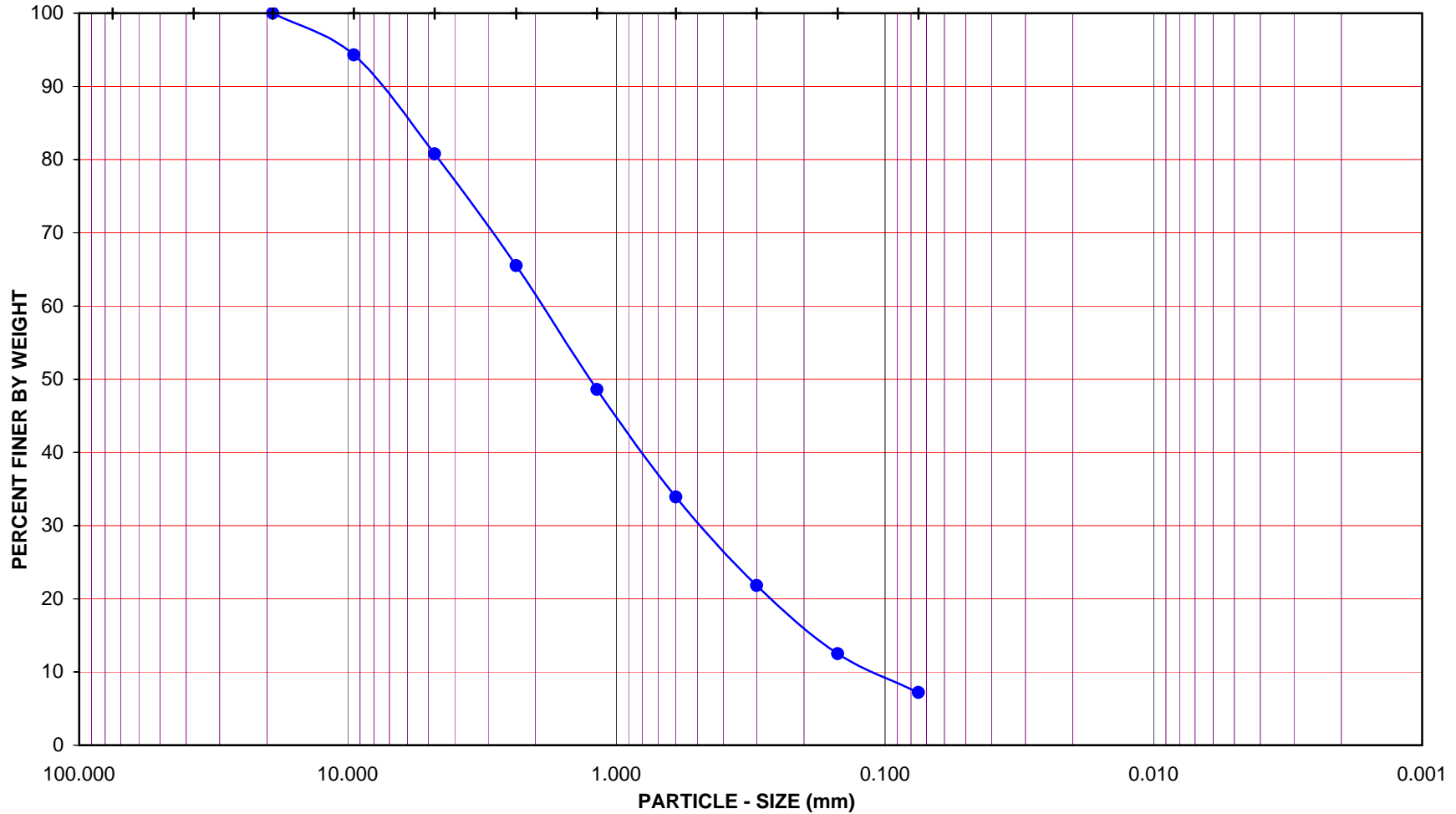
GRAVEL: **19 %**  
 SAND: **74 %**  
 FINES: **7 %**

GROUP SYMBOL: **(SW-SM)g**       $C_u = D_{60}/D_{10} = \underline{16.36}$   
 $C_c = (D_{30})^2 / (D_{60} * D_{10}) = \underline{1.26}$

Remarks: Insufficient sample mass available to meet the ASTM specification for this material



GRAVEL			SAND				FINES					
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY				
U.S. STANDARD SIEVE OPENING			U.S. STANDARD SIEVE NUMBER				HYDROMETER					
3.0"	1 1/2"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200		



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B2

Sample No.: S17

Depth (feet): 55-56

Soil Type : (SW-SM)g

Soil Identification: Yellowish brown well-graded sand with silt and gravel (SW-SM)g

**GR:SA:FI : (%)      19 : 74 : 7**



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**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)  
 Project No.: [378312.04.09.01](#)  
 Exploration No.: [R-09-Z3-B2](#)  
 Sample No.: [S20](#)  
 Soil Identification: [Yellowish brown silty sand \(SM\)](#)

Tested By: [V. Juliano](#) Date: [05/11/09](#)  
 Checked By: [J. Ward](#) Date: [05/15/09](#)  
 Depth (feet): [64.2-65.7](#)

		Moisture Content of Total Air - Dry Soil	
Container No.:	NG-18	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	832.70	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	74.70	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	758.00	Moisture Content (%)	0.00

After Wet Sieve	Container No.	NG-18
	Wt. of Dry Soil + Container (g)	650.60
	Wt. of Container (g)	74.70
	Dry Wt. of Soil Retained on # 200 Sieve (g)	575.90

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000		
3/8"	9.500	0.00	100.0
#4	4.750	6.70	99.1
#8	2.360	19.70	97.4
#16	1.180	63.10	91.7
#30	0.600	150.90	80.1
#50	0.300	280.00	63.1
#100	0.150	440.30	41.9
#200	0.075	562.50	25.8
PAN			

GRAVEL: **1 %**  
 SAND: **73 %**  
 FINES: **26 %**  
 GROUP SYMBOL: **SM**

Cu = D60/D10 = \_\_\_\_\_  
 Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: \_\_\_\_\_

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

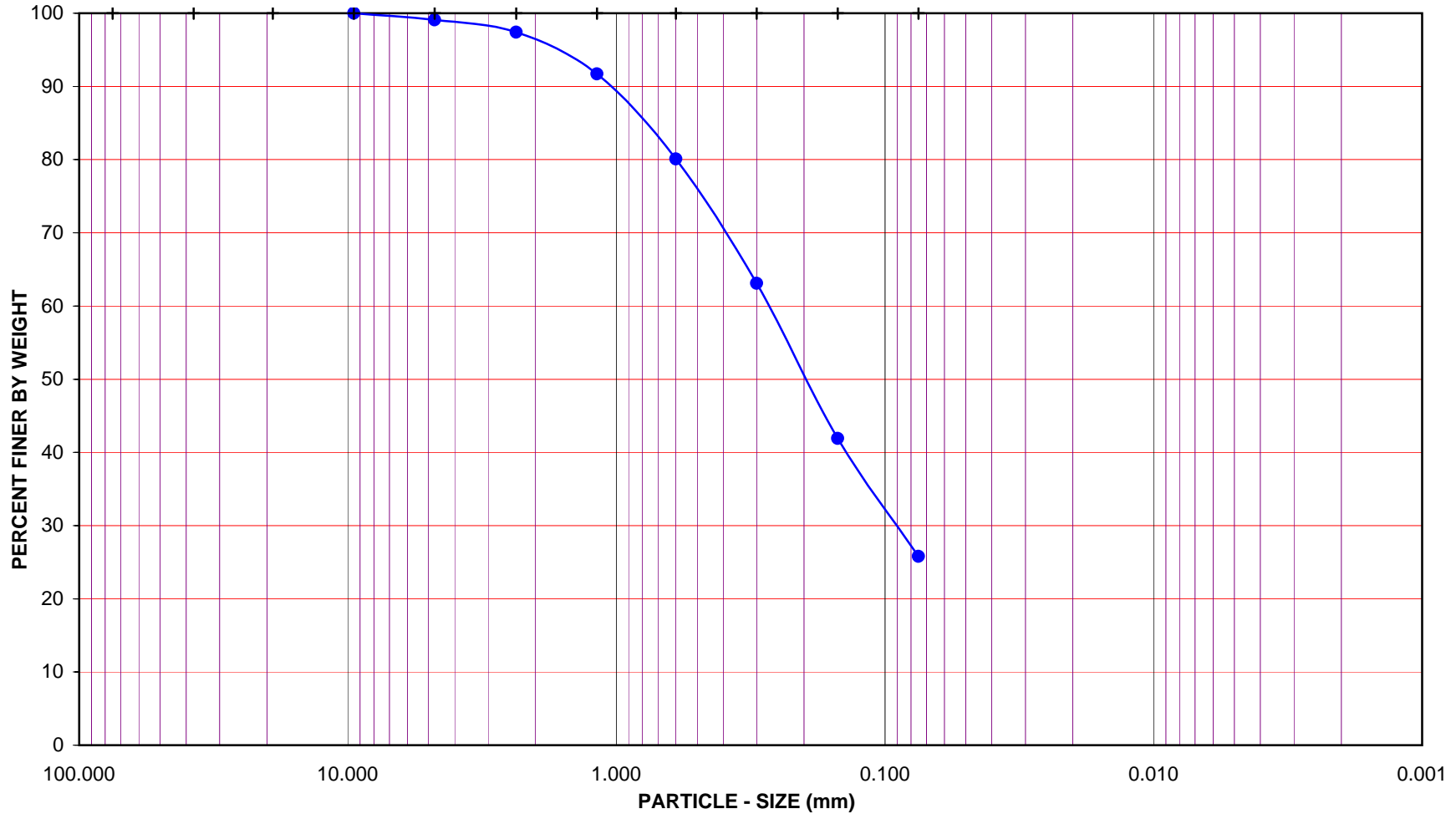
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B2

Sample No.: S20

Depth (feet): 64.2-65.7

Soil Type : SM

Soil Identification: Yellowish brown silty sand (SM)

**GR:SA:FI : (%) 1 : 73 : 26**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



## PARTICLE-SIZE ANALYSIS of SOILS ASTM D 422

Project Name: [SR-710 Tunnel Technical Study](#)

Tested By: [V. Juliano](#) Date: [05/11/09](#)

Project No.: [378312.04.09.01](#)

Checked By: [J. Ward](#) Date: [05/15/09](#)

Exploration No.: [R-09-Z3-B2](#)

Depth (feet): [81.5-85](#)

Sample No.: [C27](#)

Soil Identification: [Yellowish brown poorly-graded sand with gravel \(SP\)g](#)

Calculation of Dry Weights	Whole Sample	Sample Passing #4	Moisture Contents	Whole Sample	Sample passing #4
Container No.:	MK-25	746	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00
Wt. Air-Dried Soil + Cont.(g)	3433.40	736.40	Wt. of Dry Soil + Cont. (g)	0.00	0.00
Wt. of Container (g)	231.80	76.80	Wt. of Container No._____(g)	1.00	1.00
Dry Wt. of Soil (g)	3201.60	659.60	Moisture Content (%)	0.00	0.00

Passing #4 Material After Wet Sieve	Container No.	746
	Wt. of Dry Soil + Container (g)	711.10
	Wt. of Container (g)	76.80
	Dry Wt. of Soil Retained on # 200 Sieve (g)	634.30

U. S. Sieve Size		Cumulative Weight of Dry Soil Retained (g)		Percent Passing (%)
	(mm.)	Whole Sample	Sample Passing #4	
6"	152.400			
3"	75.000	0.00		100.0
1 1/2"	37.500	242.90		92.4
3/4"	19.000	403.80		87.4
3/8"	9.500	562.80		82.4
#4	4.750	722.70		77.4
#8	2.360		49.70	71.6
#16	1.180		145.10	60.4
#30	0.600		319.60	39.9
#50	0.300		511.60	17.4
#100	0.150		600.50	6.9
#200	0.075		631.50	3.3
PAN				

GRAVEL: **23 %**

SAND: **74 %**

FINES: **3 %**

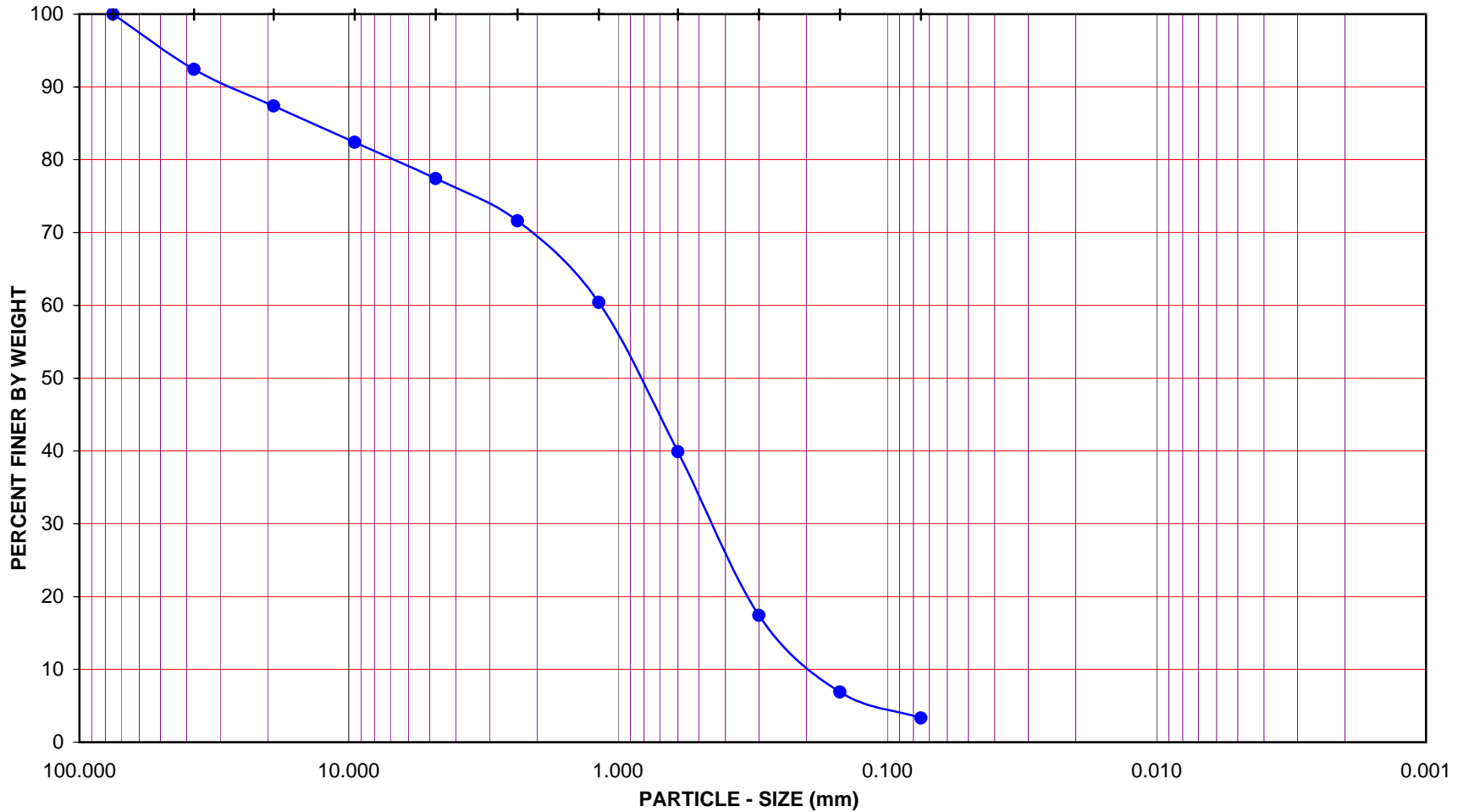
GROUP SYMBOL **(SP)g**

$$Cu = D_{60}/D_{10} = \underline{6.00}$$

$$Cc = (D_{30})^2/(D_{60}*D_{10}) = \underline{0.81}$$

Remarks: Insufficient sample mass available to meet the ASTM specification for this material

GRAVEL				SAND						FINES		
COARSE		FINE		COARSE	MEDIUM		FINE		SILT		CLAY	
U.S. STANDARD SIEVE OPENING				U.S. STANDARD SIEVE NUMBER						HYDROMETER		
3.0"	1 1/2"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200		



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B2

Sample No.: C27

Depth (feet): 81.5-85

Soil Type : (SP)g

Soil Identification: Yellowish brown poorly-graded sand with gravel (SP)g

**GR:SA:FI : (%)      23 : 74 : 3**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



## PARTICLE-SIZE ANALYSIS of SOILS

### ASTM D 422

Project Name: [SR-710 Tunnel Technical Study](#)  
 Project No.: [378312.04.09.01](#)  
 Exploration No.: [R-09-Z3-B2](#)  
 Sample No.: [S30](#)  
 Soil Identification: [Yellowish brown silty sand \(SM\)](#)

Tested By: [V. Juliano](#) Date: [05/11/09](#)  
 Checked By: [J. Ward](#) Date: [05/15/09](#)  
 Depth (feet): [90-91.5](#)

		Moisture Content of Total Air - Dry Soil	
Container No.:	935	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	922.90	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	108.90	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	814.00	Moisture Content (%)	0.00

After Wet Sieve	Container No.	935
	Wt. of Dry Soil + Container (g)	768.20
	Wt. of Container (g)	108.90
	Dry Wt. of Soil Retained on # 200 Sieve (g)	659.30

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000	0.00	100.0
3/8"	9.500	7.50	99.1
#4	4.750	37.80	95.4
#8	2.360	91.20	88.8
#16	1.180	189.10	76.8
#30	0.600	335.70	58.8
#50	0.300	462.90	43.1
#100	0.150	565.30	30.6
#200	0.075	648.30	20.4
PAN			

GRAVEL: **5 %**  
 SAND: **75 %**  
 FINES: **20 %**  
 GROUP SYMBOL: **SM**

$C_u = D_{60}/D_{10} =$  \_\_\_\_\_

$C_c = (D_{30})^2/(D_{60} \cdot D_{10}) =$  \_\_\_\_\_

Remarks: Insufficient sample mass available to meet the ASTM specification for this material

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

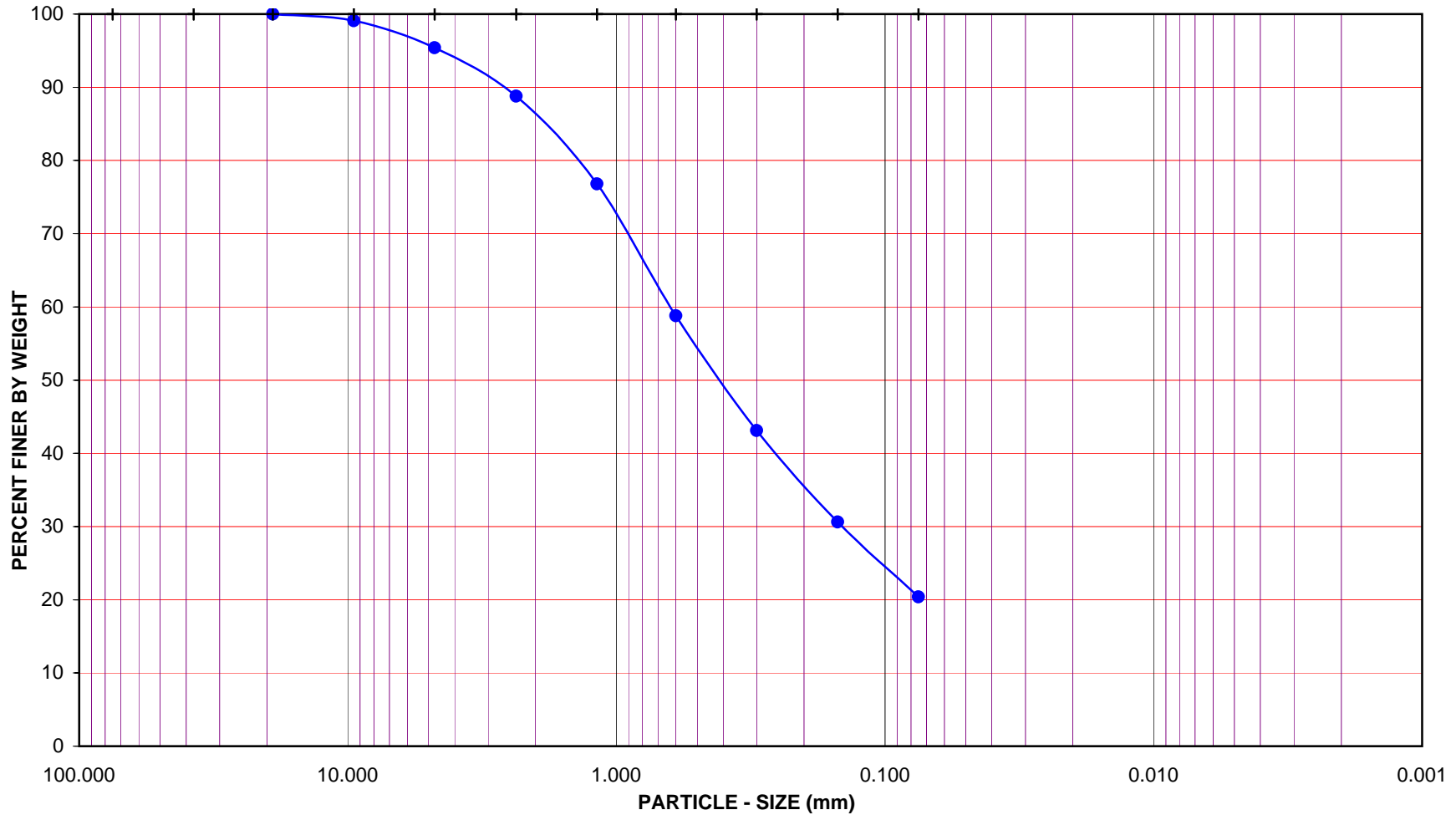
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8"

U.S. STANDARD SIEVE NUMBER

#4 #8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B2

Sample No.: S30

Depth (feet): 90-91.5

Soil Type : SM

Soil Identification: Yellowish brown silty sand (SM)

**GR:SA:FI : (%)      5 : 75 : 20**



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**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)  
 Project No.: [378312.04.09.01](#)  
 Exploration No.: [R-09-Z3-B2](#)  
 Sample No.: [S34](#)  
 Soil Identification: [Yellowish brown silty sand \(SM\)](#)

Tested By: [V. Juliano](#) Date: [05/11/09](#)  
 Checked By: [J. Ward](#) Date: [05/15/09](#)  
 Depth (feet): [100-101.5](#)

		Moisture Content of Total Air - Dry Soil	
Container No.:	929	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	843.30	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	108.40	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	734.90	Moisture Content (%)	0.00

After Wet Sieve	Container No.	929
	Wt. of Dry Soil + Container (g)	689.80
	Wt. of Container (g)	108.40
	Dry Wt. of Soil Retained on # 200 Sieve (g)	581.40

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000		
3/8"	9.500	0.00	100.0
#4	4.750	9.30	98.7
#8	2.360	37.20	94.9
#16	1.180	110.60	85.0
#30	0.600	209.70	71.5
#50	0.300	343.70	53.2
#100	0.150	482.00	34.4
#200	0.075	571.70	22.2
PAN			

GRAVEL: **1 %**  
 SAND: **77 %**  
 FINES: **22 %**  
 GROUP SYMBOL: **SM**

Cu = D60/D10 = \_\_\_\_\_

Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: Insufficient sample mass available to meet the ASTM specification for this material



GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

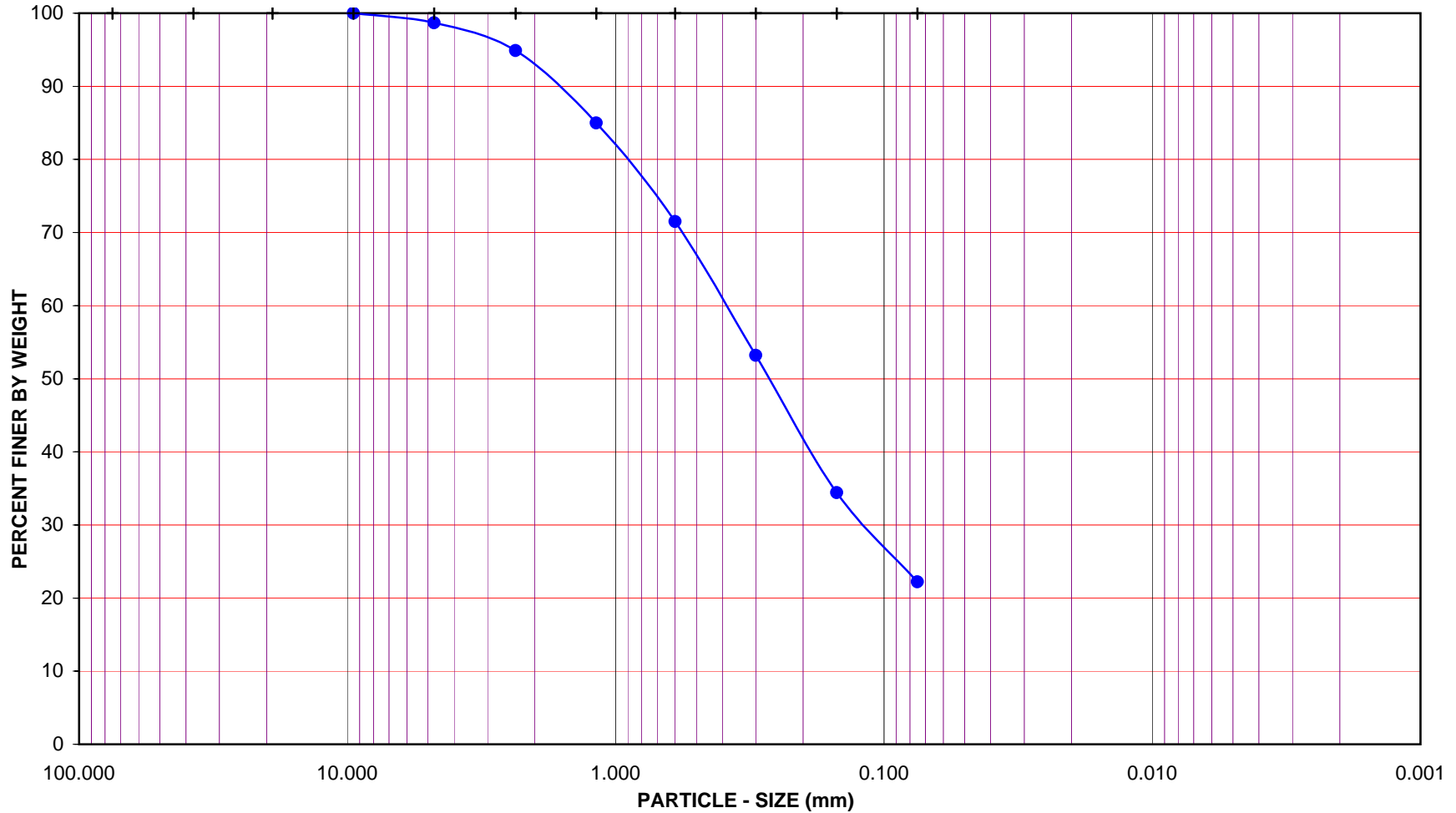
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B2

Sample No.: S34

Depth (feet): 100-101.5

Soil Type : SM

Soil Identification: Yellowish brown silty sand (SM)

**GR:SA:FI : (%)      1 : 77 : 22**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)  
 Project No.: [378312.04.09.01](#)  
 Exploration No.: [R-09-Z3-B2](#)  
 Sample No.: [C39](#)  
 Soil Identification: [Reddish brown silty sand \(SM\)](#)

Tested By: [V. Juliano](#) Date: [05/11/09](#)  
 Checked By: [J. Ward](#) Date: [05/15/09](#)  
 Depth (feet): [111.5-115](#)

		Moisture Content of Total Air - Dry Soil	
Container No.:	1490	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	543.20	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	77.40	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	465.80	Moisture Content (%)	0.00

After Wet Sieve	Container No.	1490
	Wt. of Dry Soil + Container (g)	403.80
	Wt. of Container (g)	77.40
	Dry Wt. of Soil Retained on # 200 Sieve (g)	326.40

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000	0.00	100.0
3/8"	9.500	27.10	94.2
#4	4.750	52.90	88.6
#8	2.360	90.90	80.5
#16	1.180	140.00	69.9
#30	0.600	192.10	58.8
#50	0.300	239.20	48.6
#100	0.150	283.20	39.2
#200	0.075	322.00	30.9
PAN			

GRAVEL: **11 %**  
 SAND: **58 %**  
 FINES: **31 %**  
 GROUP SYMBOL: **SM**

Cu = D60/D10 = \_\_\_\_\_

Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: Insufficient sample mass available to meet the ASTM specification for this material

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

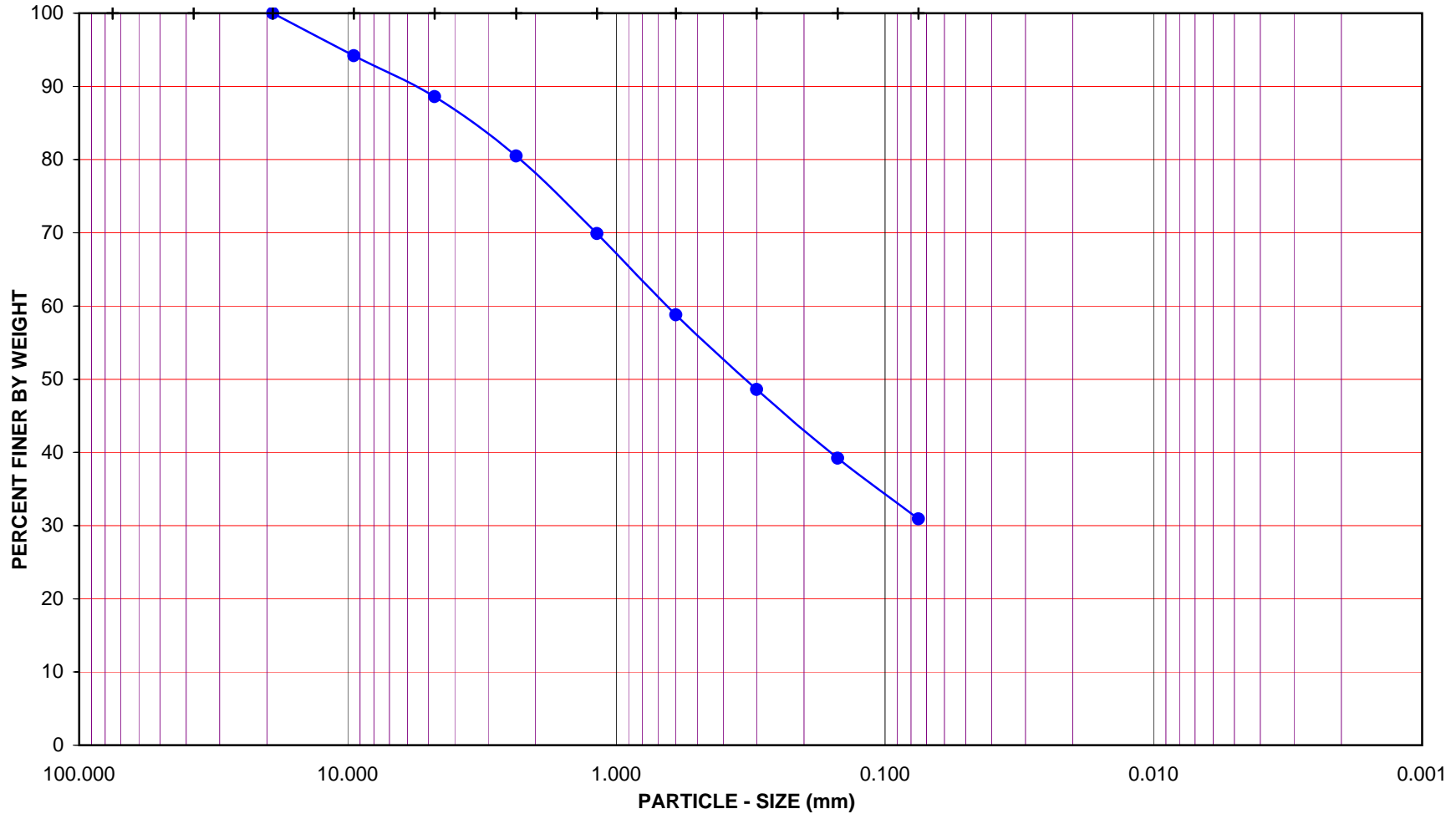
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B2

Sample No.: C39

Depth (feet): 111.5-115

Soil Type : SM

Soil Identification: Reddish brown silty sand (SM)

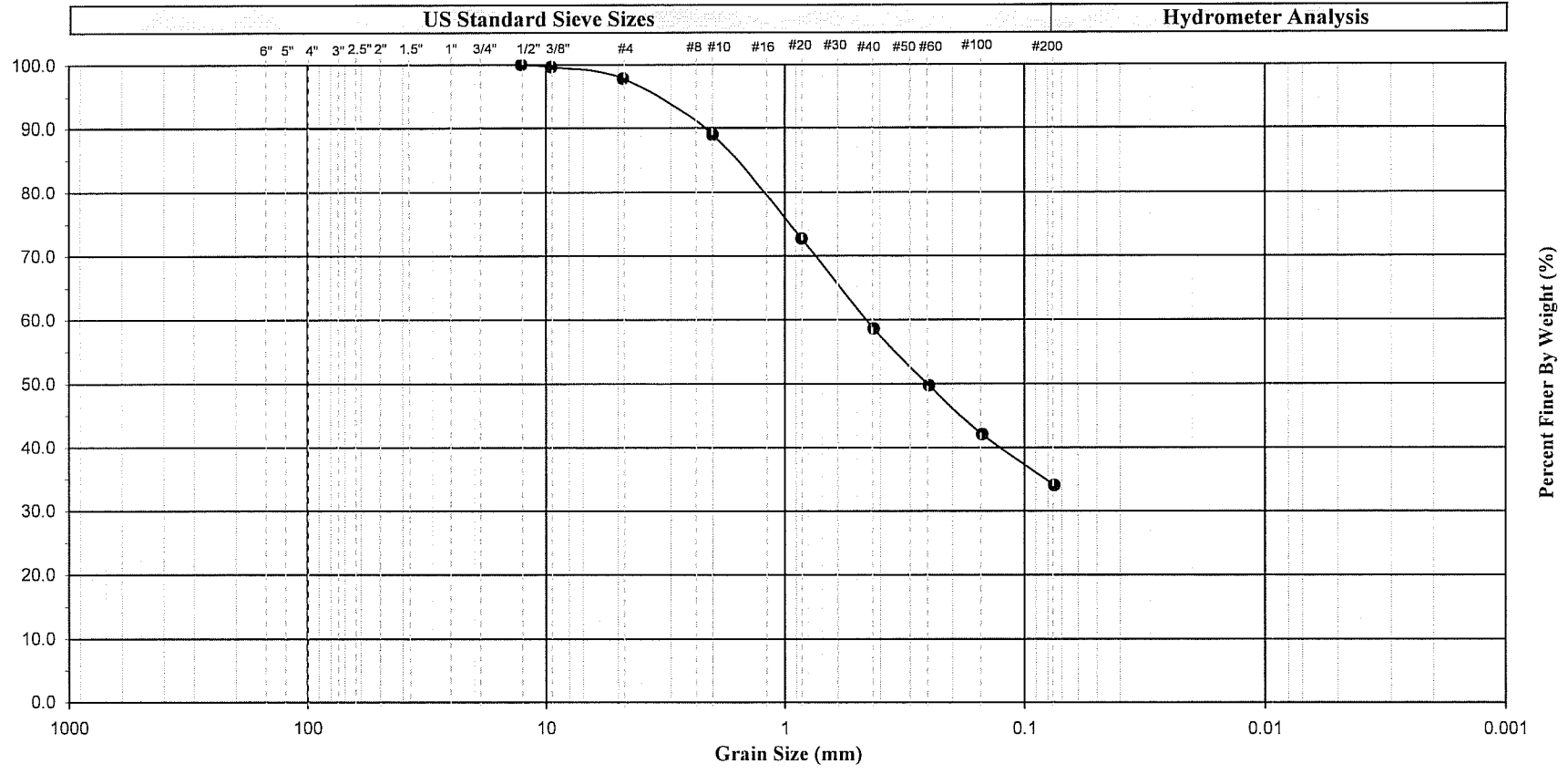
**GR:SA:FI : (%)      11 : 58 : 31**



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**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Boring Number	Sample Number	Depth		Soil Color	Soil Description	U.S.C.S.
			(ft)	(m)			
●	Z3-B3	C-28	246.4		White with light gray	Clayey sand	SC
Remark	excluded 1 piece 1.75" gravel						



**Earth Mechanics, Inc.**  
Geotechnical and Earthquake Engineering

**CH2MHill/SR-710 Tunnel Site  
Investigation T.O.4**

Project No. : 08-169      Date : 03/23/09

**GRAIN SIZE ANALYSIS**  
(ASTM D-422-63)

Figure No. :



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 04/28/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/06/09  
 Exploration No.: R-09-Z3-B4  
 Sample No.: S-3      Depth (feet) : 15.0  
 Soil Identification: Yellowish brown silty sand (SM)

% Gravel	2	Soil Type	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
% Sand	60	<b>SM</b>			
% Fines	38				
Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	122.69
Wt. of Air-Dry Soil + Cont. (g)	851.00	Wt. of Container No. ___ (g)	1.00	1.00	72.55
Wt. of Container	107.60	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	743.40	Wt. of Dry Soil (g)			50.14

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	7.32	99.0
No. 4	13.01	98.2
No. 10	22.21	97.0
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	97.0
No. 16	0.87	98.9	96.0
No. 30	3.45	95.7	92.8
No. 50	10.14	87.3	84.7
No. 100	28.99	63.8	61.9
No. 200	49.03	38.8	37.7
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 80.15      Wt. of Dry Soil (g) 80.15

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
30-Apr-09	8:52	0		6.5			
	8:54	2	21.6	6.5	24.5	21.6	0.0329
	8:57	5	21.6	6.5	21.0	17.4	0.0213
	9:07	15	21.7	6.5	17.0	12.6	0.0126
	9:22	30	21.8	6.5	15.0	10.2	0.0090
	9:52	60	22.1	6.5	13.5	8.4	0.0064
	10:52	120	22.1	6.5	11.5	6.0	0.0045
	13:02	250	21.8	6.5	10.5	4.8	0.0032
01-May-09	8:52	1440	21.9	6.5	9.5	3.6	0.0013

GRAVEL			SAND				FINES	
COARSE	FINE		CRSE	MEDIUM	FINE		SILT	CLAY

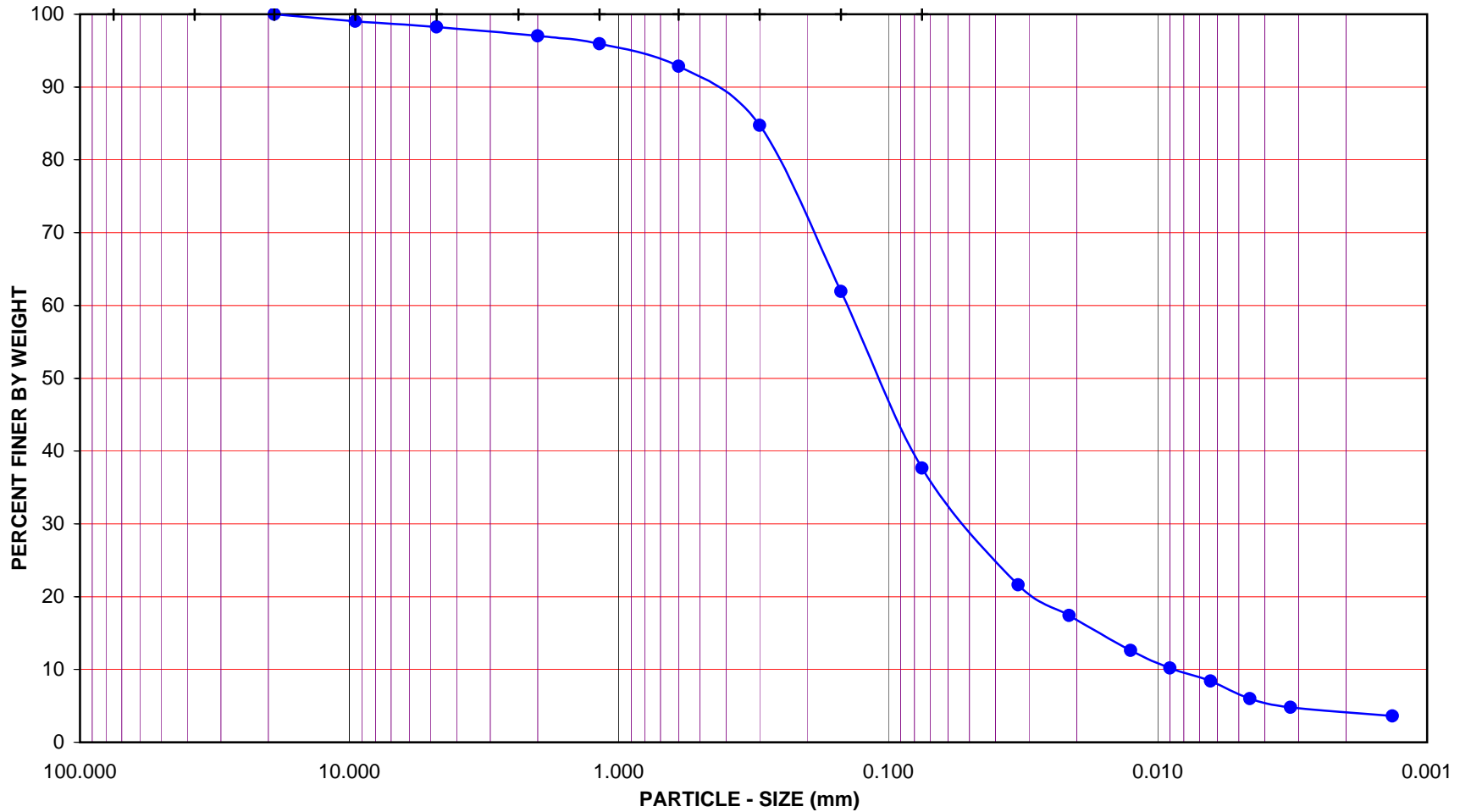
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B4

Sample No.: S-3

Depth (feet): 15.0

Soil Type: SM

Soil Identification: Yellowish brown silty sand (SM)

**GR:SA:FI : (%)      2 : 60 : 38**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 04/28/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/06/09  
 Exploration No.: R-09-Z3-B4  
 Sample No.: S-8      Depth (feet) : 40.0  
 Soil Identification: Olive silt with sand (ML)s

<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>  <b>(ML)s</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>22</b>				
<b>% Fines</b>	<b>78</b>				

Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	88.81
Wt. of Air-Dry Soil + Cont. (g)	697.50	Wt. of Container No. ___ (g)	1.00	1.00	76.31
Wt. of Container	77.40	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	620.10	Wt. of Dry Soil (g)			12.50

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.00	100.0
No. 10	3.70	99.4
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	99.4
No. 16	0.56	99.0	98.4
No. 30	1.88	96.6	96.0
No. 50	3.46	93.8	93.2
No. 100	6.15	88.9	88.4
No. 200	11.95	78.4	78.0
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 55.39
Wt. of Dry Soil (g) 55.39

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
30-Apr-09	8:48	0		6.5			
	8:50	2	21.6	6.5	38.0	56.1	0.0298
	8:53	5	21.6	6.5	31.0	43.6	0.0199
	9:03	15	21.7	6.5	24.5	32.0	0.0120
	9:18	30	21.8	6.5	21.5	26.7	0.0087
	9:48	60	22.1	6.5	18.0	20.5	0.0062
	10:48	120	22.0	6.5	16.0	16.9	0.0044
	12:58	250	21.8	6.5	13.0	11.6	0.0032
01-May-09	8:48	1440	21.9	6.5	10.0	6.2	0.0013

GRAVEL			SAND				FINES	
COARSE	FINE		CRSE	MEDIUM	FINE		SILT	CLAY

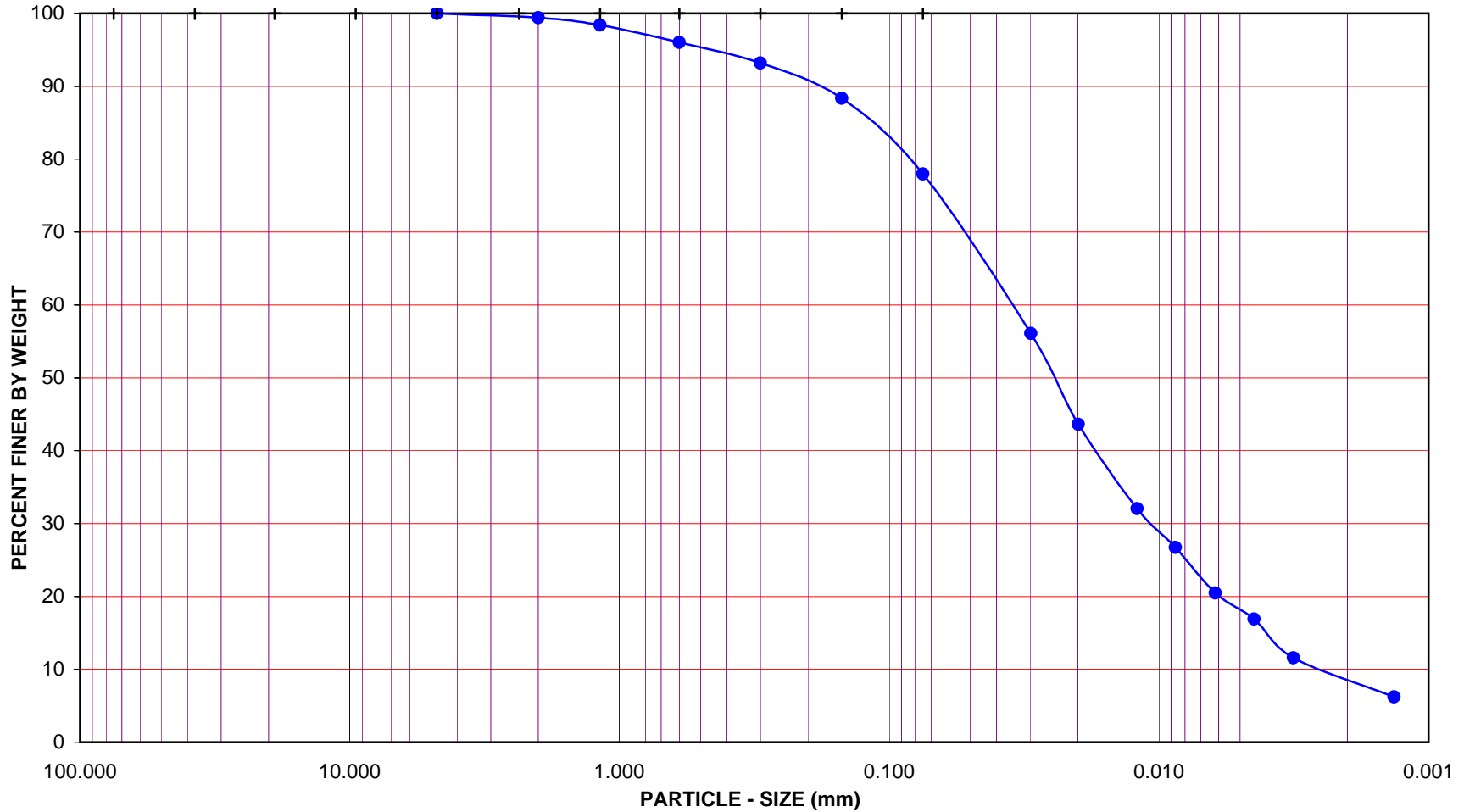
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B4

Sample No.: S-8

Depth (feet): 40.0

Soil Type : (ML)s

Soil Identification: Olive silt with sand (ML)s

**GR:SA:FI : (%) 0 : 22 : 78**



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**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09





**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)  
 Project No.: [378312.04.09.01](#)  
 Exploration No.: [R-09-Z3-B4](#)  
 Sample No.: [S-10](#)  
 Soil Identification: [Yellowish brown silty sand \(SM\)](#)

Tested By: [V. Juliano](#) Date: [04/28/09](#)  
 Checked By: [J. Ward](#) Date: [05/12/09](#)  
 Depth (feet): [50.0](#)

		Moisture Content of Total Air - Dry Soil	
Container No.:	778	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	558.30	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	75.80	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	482.50	Moisture Content (%)	0.00

After Wet Sieve	Container No.	778
	Wt. of Dry Soil + Container (g)	365.30
	Wt. of Container (g)	75.80
	Dry Wt. of Soil Retained on # 200 Sieve (g)	289.50

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500	0.00	100.0
3/4"	19.000	17.70	96.3
3/8"	9.500	26.80	94.4
#4	4.750	37.80	92.2
#8	2.360	51.40	89.3
#16	1.180	65.90	86.3
#30	0.600	85.60	82.3
#50	0.300	129.80	73.1
#100	0.150	207.30	57.0
#200	0.075	282.10	41.5
PAN			

GRAVEL: **8 %**  
 SAND: **50 %**  
 FINES: **42 %**  
 GROUP SYMBOL: **SM**

$C_u = D_{60}/D_{10} =$  \_\_\_\_\_

$C_c = (D_{30})^2/(D_{60}*D_{10}) =$  \_\_\_\_\_

Remarks: Insufficient sample mass available to meet the ASTM specification for this material

GRAVEL			SAND					FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT		CLAY

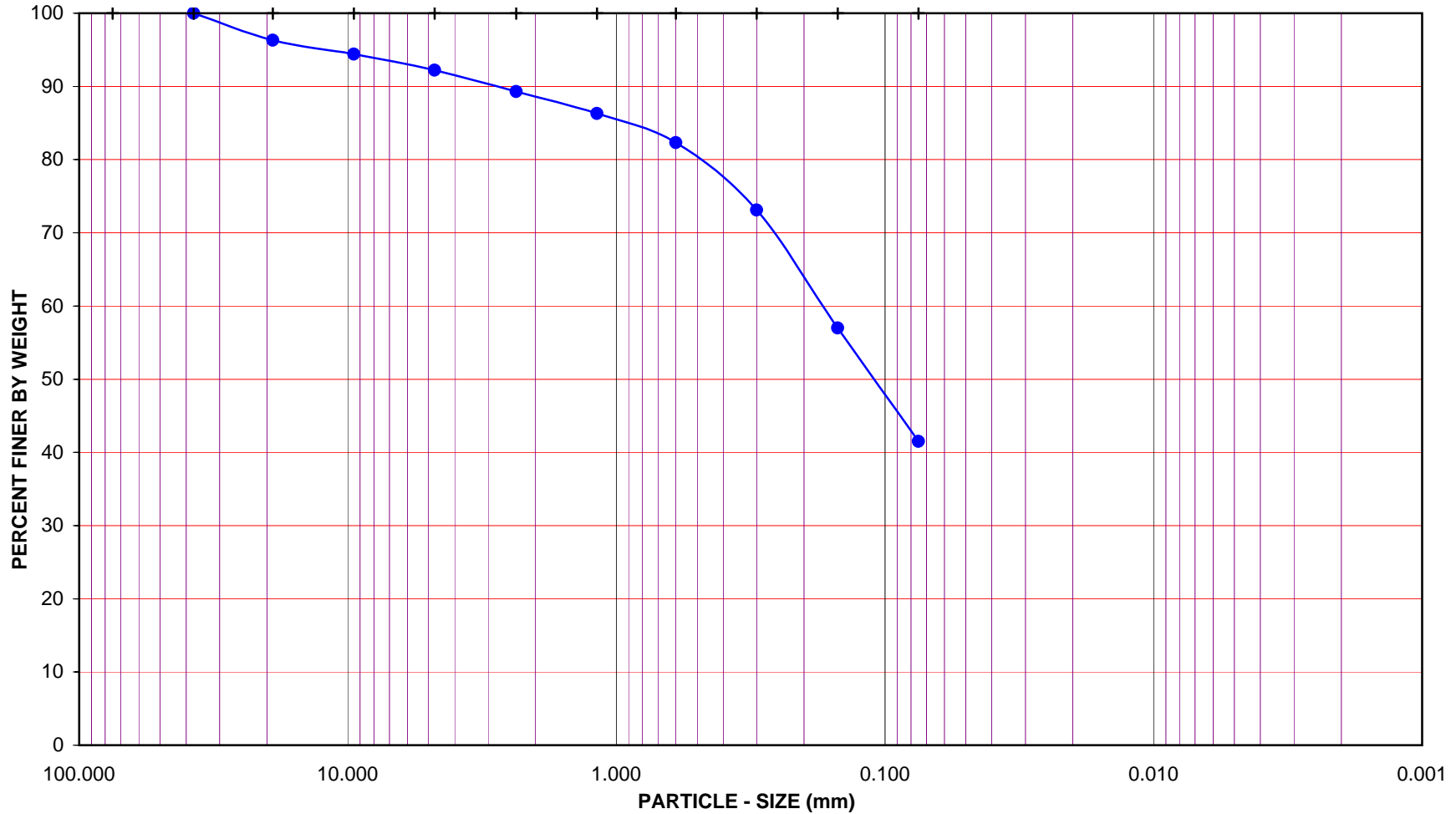
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B4

Sample No.: S-10

Depth (feet): 50.0

Soil Type : SM

Soil Identification: Yellowish brown silty sand (SM)

**GR:SA:FI : (%)      8 : 50 : 42**



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**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)  
 Project No.: [378312.04.09.01](#)  
 Exploration No.: [R-09-Z3-B4](#)  
 Sample No.: [S-13](#)  
 Soil Identification: [Yellowish brown silty sand \(SM\)](#)

Tested By: [V. Juliano](#) Date: [04/28/09](#)  
 Checked By: [J. Ward](#) Date: [05/06/09](#)  
 Depth (feet): [65.0](#)

		Moisture Content of Total Air - Dry Soil	
Container No.:	166	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	448.80	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	72.30	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	376.50	Moisture Content (%)	0.00

After Wet Sieve	Container No.	166
	Wt. of Dry Soil + Container (g)	291.50
	Wt. of Container (g)	72.30
	Dry Wt. of Soil Retained on # 200 Sieve (g)	219.20

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000	0.00	100.0
3/8"	9.500	2.70	99.3
#4	4.750	3.90	99.0
#8	2.360	5.40	98.6
#16	1.180	7.10	98.1
#30	0.600	8.20	97.8
#50	0.300	10.80	97.1
#100	0.150	58.80	84.4
#200	0.075	194.40	48.4
PAN			

GRAVEL: **1 %**  
 SAND: **51 %**  
 FINES: **48 %**  
 GROUP SYMBOL: **SM**

Cu = D60/D10 = \_\_\_\_\_

Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: Insufficient sample mass available to meet the ASTM specification for this material

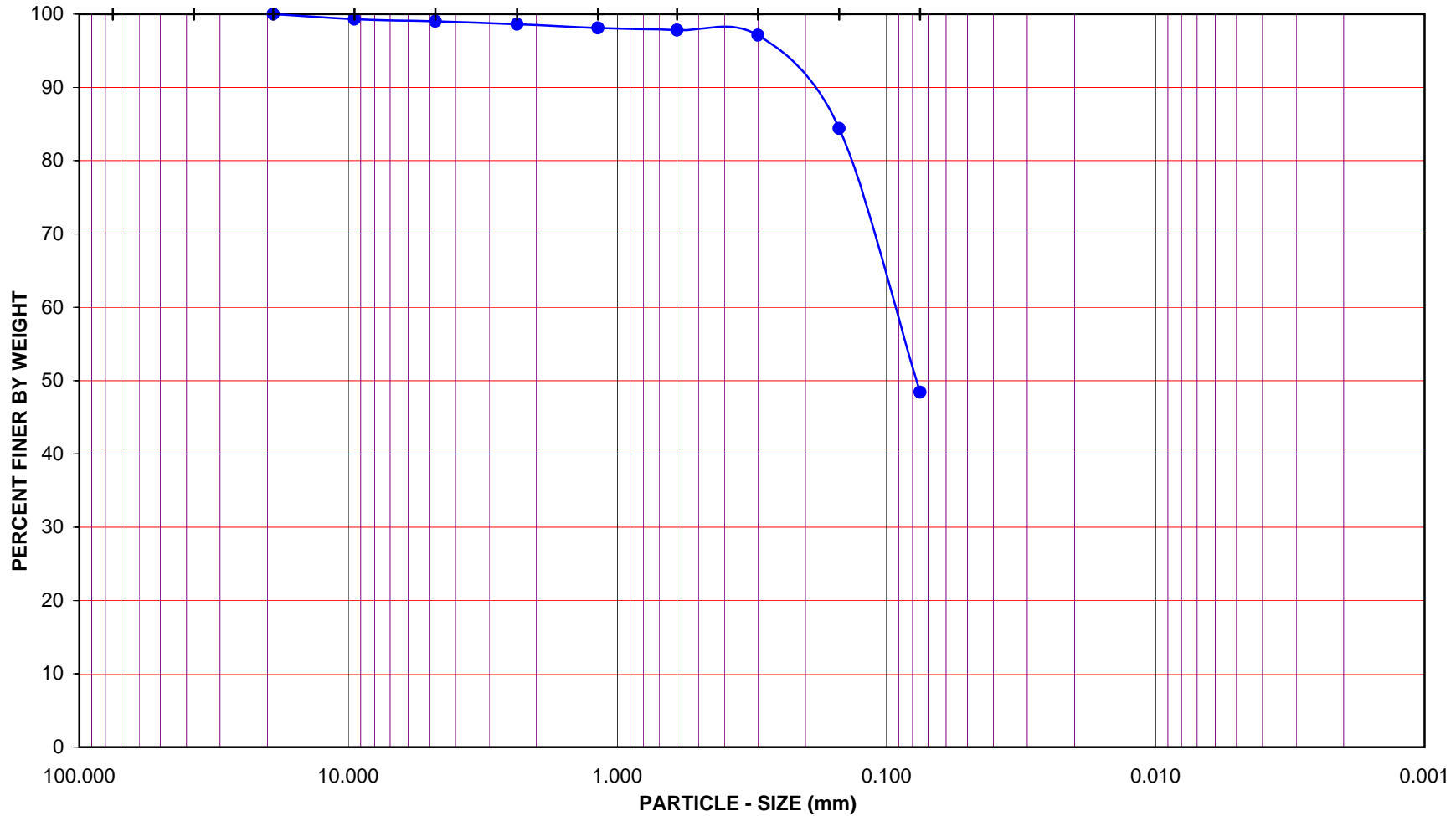
GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4 #8 #16 #30 #50 #100 #200

U.S. STANDARD SIEVE NUMBER

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B4

Sample No.: S-13

Depth (feet): 65.0

Soil Type : SM

Soil Identification: Yellowish brown silty sand (SM)

**GR:SA:FI : (%) 1 : 51 : 48**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 04/28/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/06/09  
 Exploration No.: R-09-Z3-B4  
 Sample No.: C-20      Depth (feet) : 94-100  
 Soil Identification: Brown silty sand (SM)

	% Gravel	2	Soil Type	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
	% Sand	65	<b>SM</b>			
	% Fines	33				
Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00		
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	130.60	
Wt. of Air-Dry Soil + Cont. (g)	743.10	Wt. of Container No. ___ (g)	1.00	1.00	75.17	
Wt. of Container	75.50	Moisture Content (%)	0.00	0.00		
Dry Wt. of Soil (g)	667.60	Wt. of Dry Soil (g)				55.43

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	4.38	99.3
No. 4	15.79	97.6
No. 10	49.10	92.6
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	92.6
No. 16	4.65	94.5	87.6
No. 30	12.62	85.1	78.8
No. 50	23.71	72.0	66.7
No. 100	39.68	53.1	49.2
No. 200	54.64	35.4	32.8
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 84.62
Wt. of Dry Soil (g) 84.62

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
30-Apr-09	8:56	0		6.5			
	8:58	2	21.6	6.5	26.5	21.7	0.0325
	9:01	5	21.7	6.5	22.5	17.4	0.0211
	9:11	15	21.8	6.5	20.0	14.7	0.0124
	9:26	30	21.9	6.5	18.0	12.5	0.0088
	9:56	60	22.1	6.5	16.0	10.3	0.0063
	10:56	120	22.1	6.5	15.0	9.2	0.0045
	13:06	250	21.7	6.5	13.5	7.6	0.0032
01-May-09	8:56	1440	21.9	6.5	11.5	5.4	0.0013

GRAVEL			SAND				FINES	
COARSE	FINE		CRSE	MEDIUM	FINE		SILT	CLAY

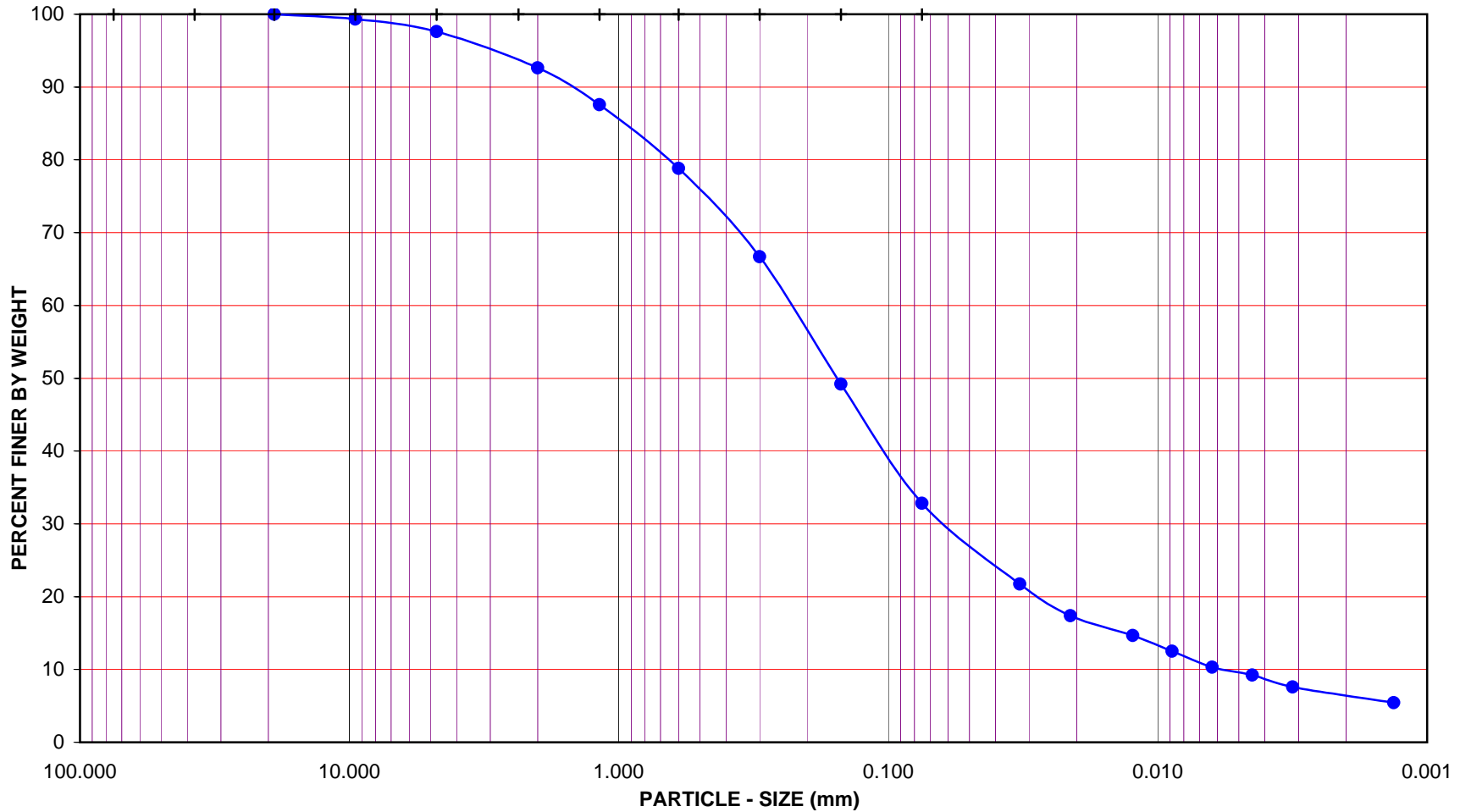
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B4

Sample No.: C-20

Depth (feet): 94-100

Soil Type : SM

Soil Identification: Brown silty sand (SM)

**GR:SA:FI : (%)      2 : 65 : 33**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)  
 Project No.: [378312.04.09.01](#)  
 Exploration No.: [R-09-Z3-B4](#)  
 Sample No.: [C-22](#)  
 Soil Identification: [Yellowish brown silty sand \(SM\)](#)

Tested By: [V. Juliano](#) Date: [04/28/09](#)  
 Checked By: [J. Ward](#) Date: [05/06/09](#)  
 Depth (feet): [105-110](#)

Container No.:	745	Moisture Content of Total Air - Dry Soil	
		Wt. of Air-Dried Soil + Cont.(g)	650.70
Wt. of Container (g)	75.20	Wt. of Dry Soil + Cont. (g)	0.00
Dry Wt. of Soil (g)	575.50	Wt. of Container No. _____ (g)	1.00
		Moisture Content (%)	0.00

After Wet Sieve	Container No.	745
	Wt. of Dry Soil + Container (g)	408.30
	Wt. of Container (g)	75.20
	Dry Wt. of Soil Retained on # 200 Sieve (g)	333.10

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000		
3/8"	9.500	0.00	100.0
#4	4.750	4.30	99.3
#8	2.360	12.40	97.8
#16	1.180	28.30	95.1
#30	0.600	51.90	91.0
#50	0.300	91.00	84.2
#100	0.150	197.20	65.7
#200	0.075	324.00	43.7
PAN			

GRAVEL: **1 %**  
 SAND: **55 %**  
 FINES: **44 %**  
 GROUP SYMBOL: **SM**

Cu = D60/D10 = \_\_\_\_\_  
 Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: \_\_\_\_\_

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

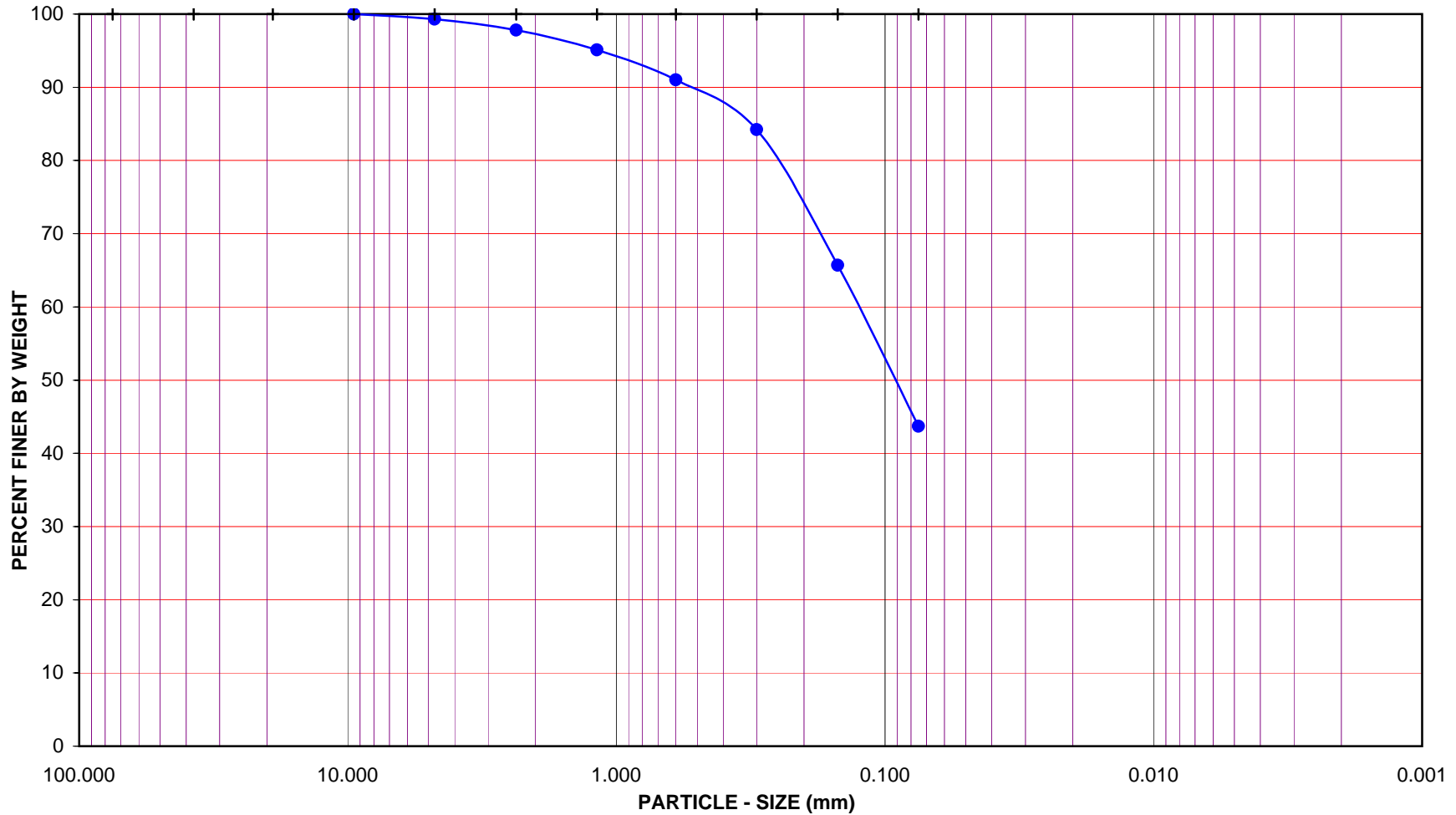
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B4

Sample No.: C-22

Depth (feet): 105-110

Soil Type : SM

Soil Identification: Yellowish brown silty sand (SM)

**GR:SA:FI : (%) 1 : 55 : 44**



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**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09





**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By: V. Juliano    Date: 04/28/09  
 Project No.: 378312.04.09.01                              Checked By: J. Ward    Date: 05/06/09  
 Exploration No.: R-09-Z3-B4                              Depth (feet): 155-160  
 Sample No.: C-32  
 Soil Identification: Yellowish brown poorly-graded sand with silt (SP-SM)

		Moisture Content of Total Air - Dry Soil	
Container No.:	737	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	616.10	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	76.60	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	539.50	Moisture Content (%)	0.00

After Wet Sieve	Container No.	737
	Wt. of Dry Soil + Container (g)	581.10
	Wt. of Container (g)	76.60
	Dry Wt. of Soil Retained on # 200 Sieve (g)	504.50

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500	0.00	100.0
3/4"	19.000	18.30	96.6
3/8"	9.500	37.70	93.0
#4	4.750	48.60	91.0
#8	2.360	52.20	90.3
#16	1.180	61.60	88.6
#30	0.600	147.20	72.7
#50	0.300	372.00	31.0
#100	0.150	471.30	12.6
#200	0.075	503.90	6.6
PAN			

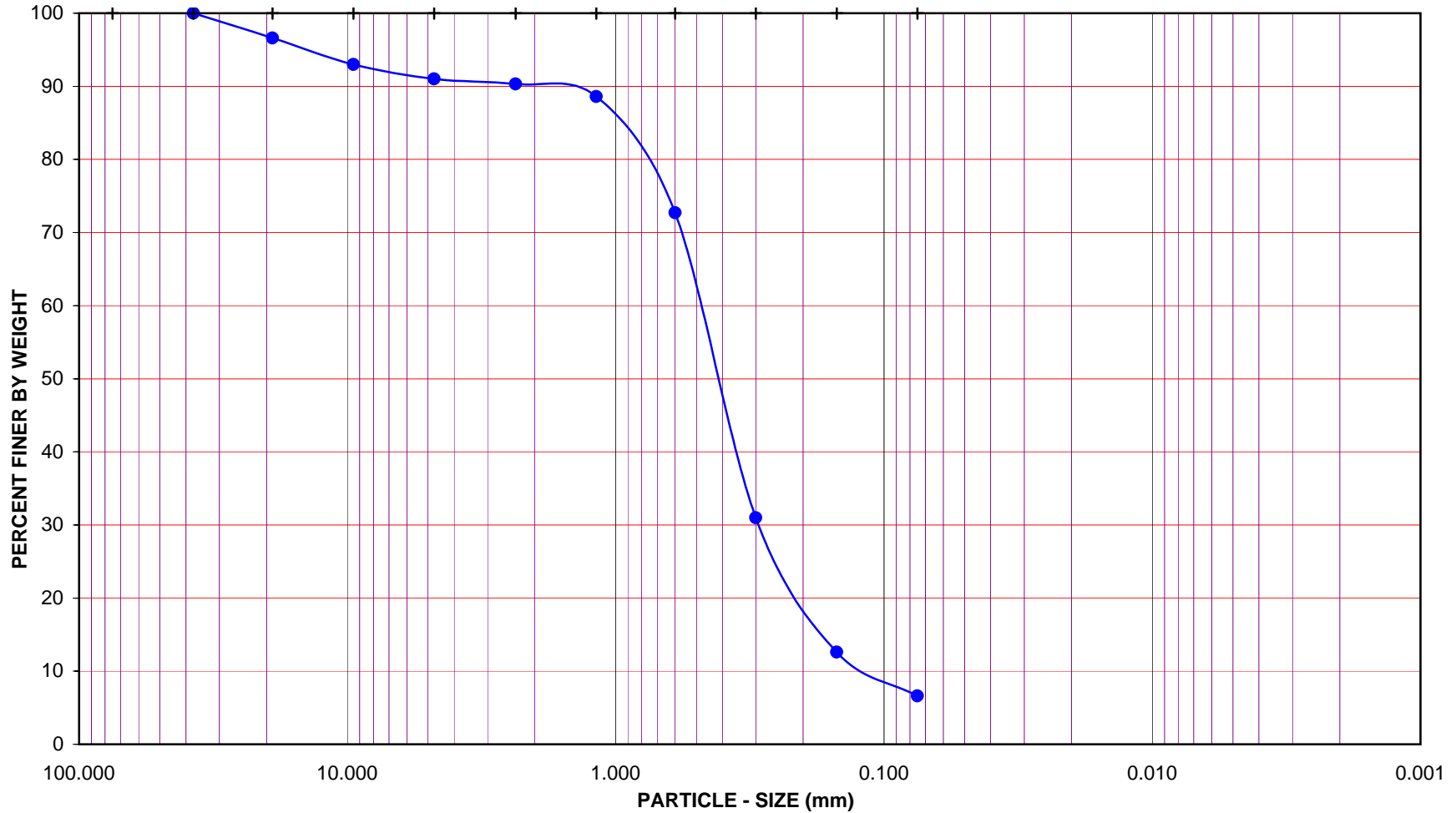
GRAVEL: **9 %**  
 SAND: **84 %**  
 FINES: **7 %**  
 GROUP SYMBOL: **SP-SM**

$C_u = D_{60}/D_{10} = \underline{3.77}$

$C_c = (D_{30})^2/(D_{60}*D_{10}) = \underline{1.32}$

Remarks: Insufficient sample mass available to meet the ASTM specification for this material

GRAVEL			SAND					FINES				
COARSE		FINE	COARSE	MEDIUM	FINE		SILT	CLAY				
U.S. STANDARD SIEVE OPENING			U.S. STANDARD SIEVE NUMBER					HYDROMETER				
3.0"	1 1/2"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200		



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B4

Sample No.: C-32

Depth (feet): 155-160

Soil Type : SP-SM

Soil Identification: Yellowish brown poorly-graded sand with silt (SP-SM)

**GR:SA:FI : (%)      9 : 84 : 7**



**PARTICLE - SIZE DISTRIBUTION**  
**ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)      Tested By: [V. Juliano](#)    Date: [04/28/09](#)  
 Project No.: [378312.04.09.01](#)                                      Checked By: [J. Ward](#)    Date: [05/07/09](#)  
 Exploration No.: [R-09-Z3-B6](#)                                      Depth (feet): [10.0](#)  
 Sample No.: [S2](#)  
 Soil Identification: [Dark olive silty sand with gravel \(SM\)g](#)

Container No.:	R-2	Moisture Content of Total Air - Dry Soil	
		Wt. of Air-Dried Soil + Cont.(g)	1004.60
Wt. of Container (g)	108.80	Wt. of Dry Soil + Cont. (g)	0.00
Dry Wt. of Soil (g)	895.80	Wt. of Container No. _____ (g)	1.00
		Moisture Content (%)	0.00

After Wet Sieve	Container No.	R-2
	Wt. of Dry Soil + Container (g)	865.10
	Wt. of Container (g)	108.80
	Dry Wt. of Soil Retained on # 200 Sieve (g)	756.30

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500	0.00	100.0
3/4"	19.000	71.90	92.0
3/8"	9.500	157.10	82.5
#4	4.750	245.90	72.5
#8	2.360	330.10	63.2
#16	1.180	414.60	53.7
#30	0.600	504.20	43.7
#50	0.300	616.70	31.2
#100	0.150	704.50	21.4
#200	0.075	752.10	16.0
PAN			

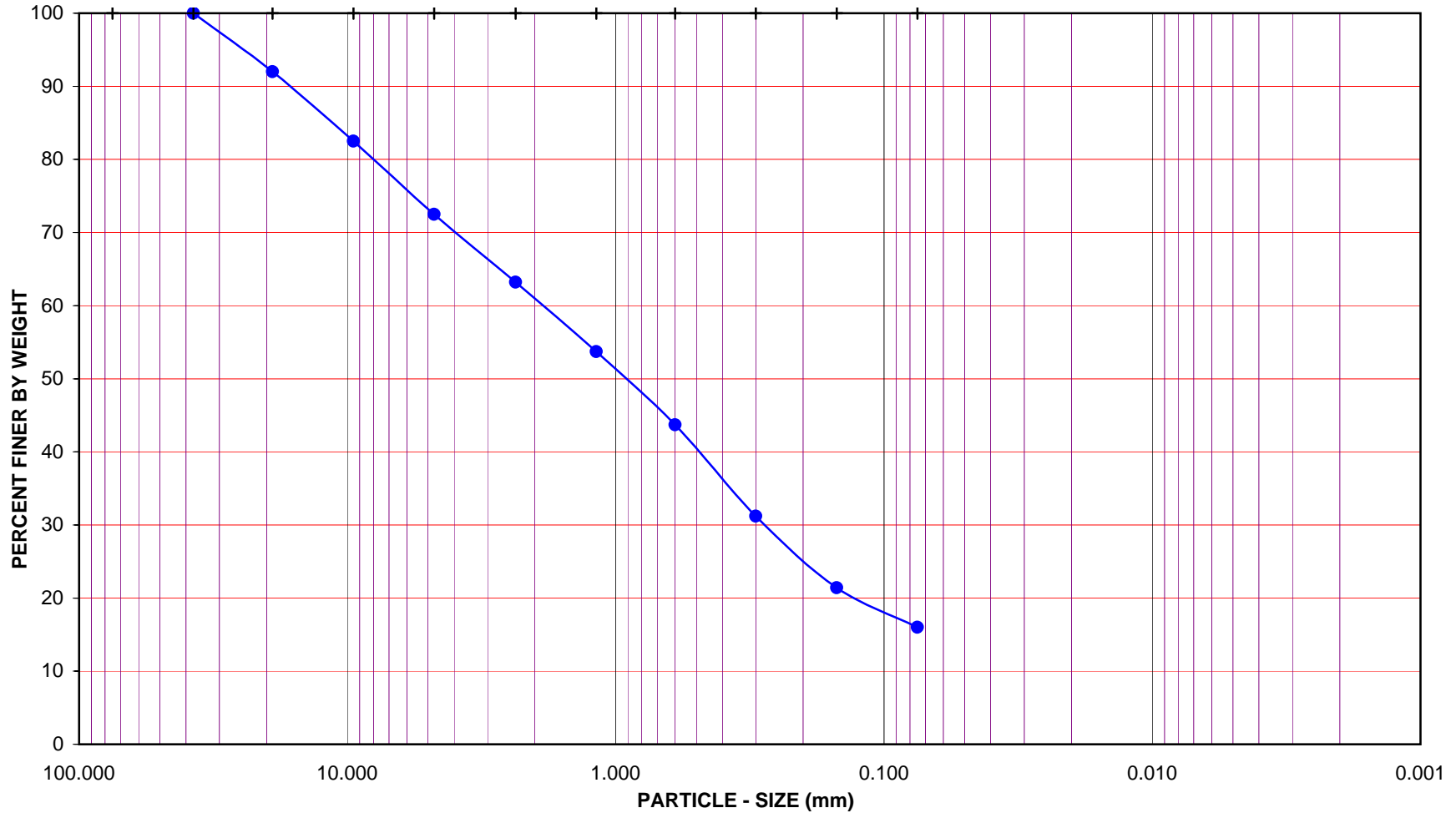
GRAVEL: **28 %**  
 SAND: **56 %**  
 FINES: **16 %**  
 GROUP SYMBOL: **(SM)g**

Cu = D60/D10 = \_\_\_\_\_

Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: Insufficient sample mass available to meet the ASTM specification for this material

GRAVEL				SAND				FINES				
COARSE		FINE		COARSE	MEDIUM	FINE		SILT		CLAY		
U.S. STANDARD SIEVE OPENING				U.S. STANDARD SIEVE NUMBER				HYDROMETER				
3.0"	1 1/2"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200		



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B6

Sample No.: S2

Depth (feet): 10.0

Soil Type : (SM)g

Soil Identification: Dark olive silty sand with gravel (SM)g

**GR:SA:FI : (%)      28 : 56 : 16**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)  
 Project No.: [378312.04.09.01](#)  
 Exploration No.: [R-09-Z3-B6](#)  
 Sample No.: [S1](#)  
 Soil Identification: [Brown silty sand \(SM\)](#)

Tested By: [V. Juliano](#) Date: [04/28/09](#)  
 Checked By: [J. Ward](#) Date: [05/07/09](#)  
 Depth (feet): [5.0](#)

		Moisture Content of Total Air - Dry Soil	
Container No.:	531	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	446.50	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	78.00	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	368.50	Moisture Content (%)	0.00

After Wet Sieve	Container No.	531
	Wt. of Dry Soil + Container (g)	320.50
	Wt. of Container (g)	78.00
	Dry Wt. of Soil Retained on # 200 Sieve (g)	242.50

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000	0.00	100.0
3/8"	9.500	4.90	98.7
#4	4.750	13.20	96.4
#8	2.360	31.90	91.3
#16	1.180	67.10	81.8
#30	0.600	111.30	69.8
#50	0.300	158.70	56.9
#100	0.150	203.90	44.7
#200	0.075	240.70	34.7
PAN			

GRAVEL: **4 %**  
 SAND: **61 %**  
 FINES: **35 %**  
 GROUP SYMBOL: **SM**

$C_u = D_{60}/D_{10} =$  \_\_\_\_\_

$C_c = (D_{30})^2/(D_{60} \cdot D_{10}) =$  \_\_\_\_\_

Remarks: Insufficient sample mass available to meet the ASTM specification for this material

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

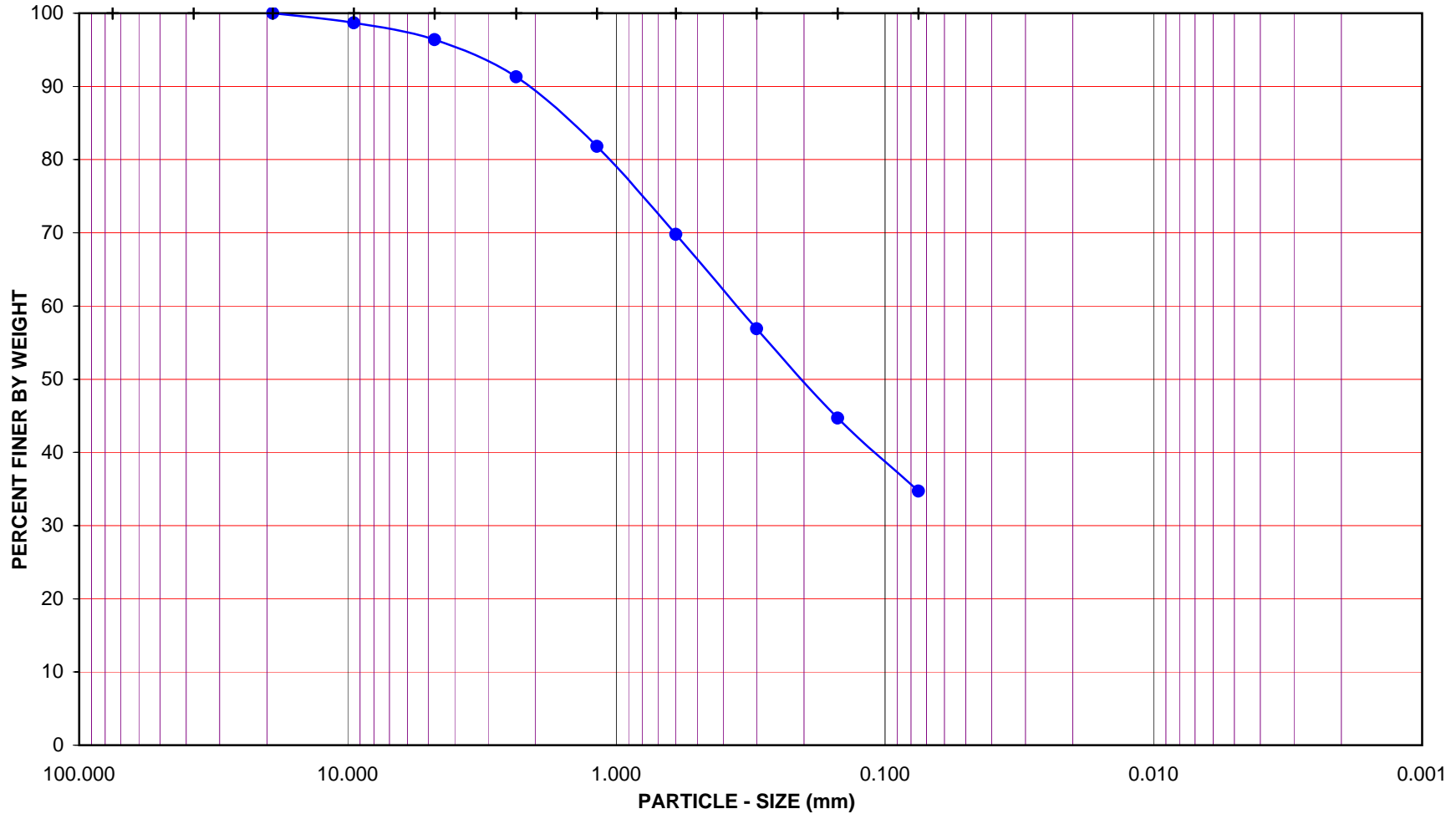
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B6

Sample No.: S1

Depth (feet): 5.0

Soil Type : SM

Soil Identification: Brown silty sand (SM)

**GR:SA:FI : (%)      4 : 61 : 35**



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**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/01/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/15/09  
 Exploration No.: R-09-Z3-B6  
 Sample No.: C27      Depth (feet) : 173.0  
 Soil Identification: Light gray silty sand with gravel (SM)g

	% Gravel	16	Soil Type	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
	% Sand	65	<b>(SM)g</b>			
	% Fines	19				
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	0.00		
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	154.13	
Wt.of Air-Dry Soil + Cont. (g)	1971.80	Wt. of Container No.____ (g)	1.00	1.00	77.33	
Wt. of Container	217.40	Moisture Content (%)	0.00	0.00		
Dry Wt. of Soil (g)	1754.40	Wt. of Dry Soil (g)				76.80

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	92.42	94.7
⅜"	197.21	88.8
No. 4	278.70	84.1
No. 10	458.50	73.9
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	73.9
No. 16	8.74	91.3	67.4
No. 30	22.14	77.9	57.5
No. 50	39.02	61.0	45.0
No. 100	59.40	40.6	30.0
No. 200	74.18	25.8	19.1
Pan			

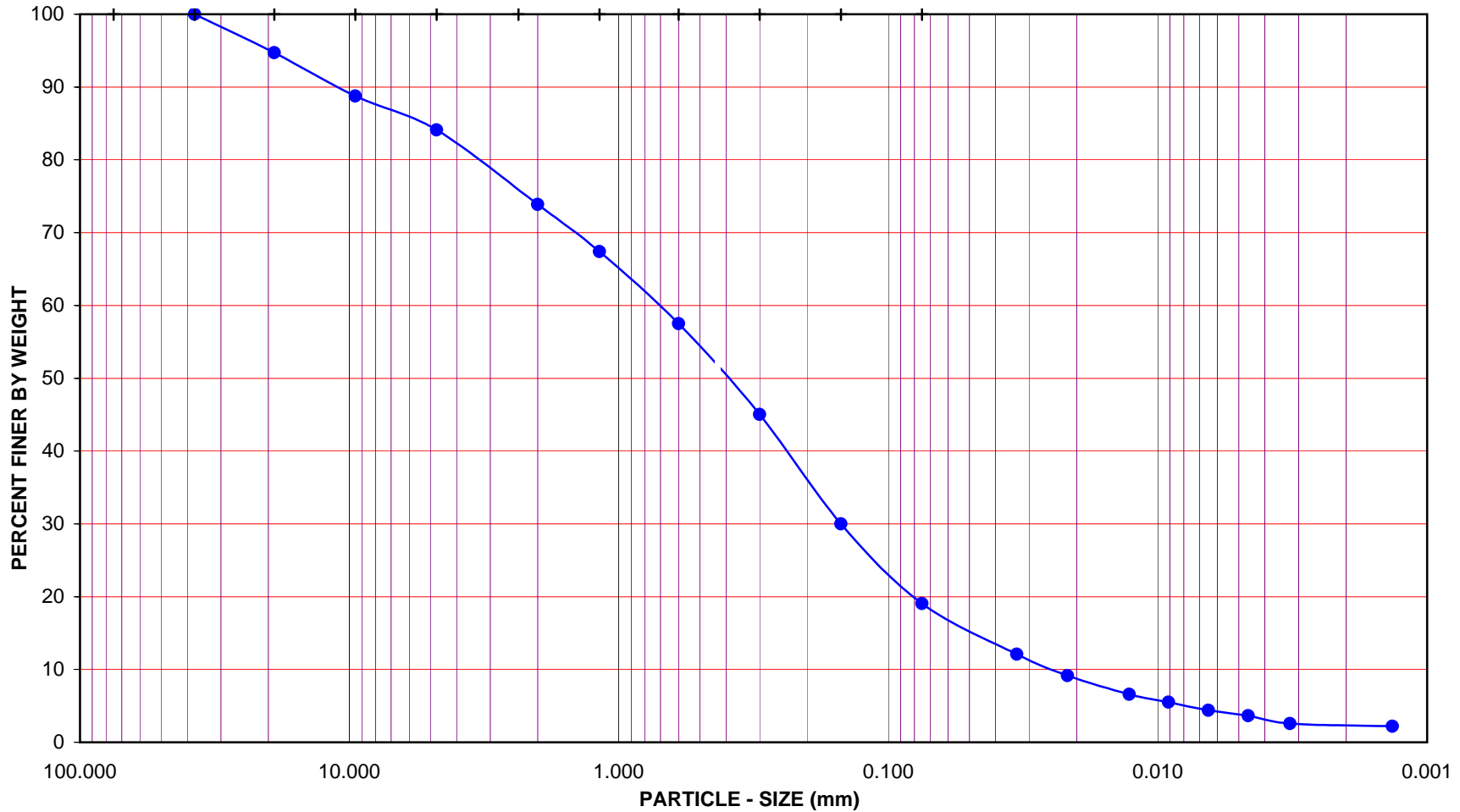
**Hydrometer**

Wt. of Air-Dry Soil (g) 100.00
Wt. of Dry Soil (g) 100.00

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
08-May-09	8:27	0		6.0			
	8:29	2	21.1	6.0	22.5	12.1	0.0333
	8:32	5	21.1	6.0	18.5	9.2	0.0216
	8:42	15	21.4	6.0	15.0	6.6	0.0127
	8:57	30	21.1	6.0	13.5	5.5	0.0091
	9:27	60	21.3	6.0	12.0	4.4	0.0065
	10:27	120	21.6	6.0	11.0	3.7	0.0046
	12:37	250	21.5	6.0	9.5	2.6	0.0032
09-May-09	8:27	1440	21.1	6.0	9.0	2.2	0.0013

GRAVEL				SAND						FINES	
COARSE		FINE		CRSE	MEDIUM		FINE		SILT		CLAY
U.S. STANDARD SIEVE OPENING				U.S. STANDARD SIEVE NUMBER						HYDROMETER	
3.0"	1 1/2"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200	



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B6

Sample No.: C27

Depth (feet): 173.0

Soil Type : (SM)g

Soil Identification: Light gray silty sand with gravel (SM)g

**GR:SA:FI : (%)      16 : 65 : 19**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09





# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/01/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/15/09  
 Exploration No.: R-09-Z3-B6  
 Sample No.: C52      Depth (feet) : 299.0  
 Soil Identification: Light gray silty sand with gravel (SM)g

	% Gravel	22	Soil Type	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
	% Sand	56	<b>(SM)g</b>			
	% Fines	22				
Specific Gravity (Assumed)	2.70		Wt.of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99		Dry Wt. of Soil + Cont. (g)	0.00	0.00	148.70
Wt.of Air-Dry Soil + Cont. (g)	1088.20		Wt. of Container No.____ (g)	1.00	1.00	79.45
Wt. of Container	218.30		Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	869.90		Wt. of Dry Soil (g)			69.25

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	91.10	89.5
⅜"	140.73	83.8
No. 4	195.32	77.5
No. 10	284.80	67.3
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	67.3
No. 16	7.17	92.8	62.4
No. 30	20.35	79.7	53.6
No. 50	35.02	65.0	43.7
No. 100	52.19	47.8	32.2
No. 200	66.71	33.3	22.4
Pan			

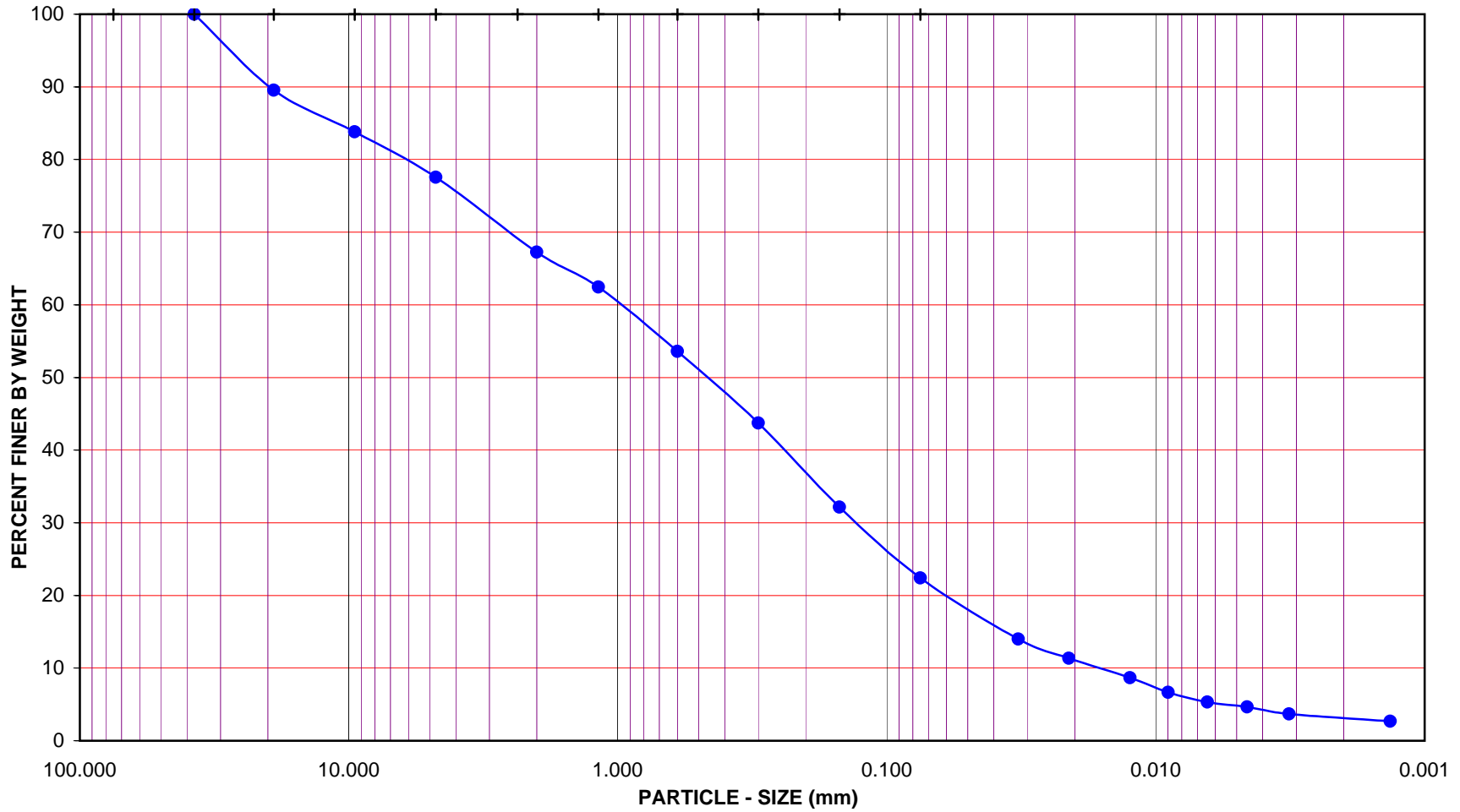
**Hydrometer**

Wt. of Air-Dry Soil (g) 100.02
Wt. of Dry Soil (g) 100.02

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
08-May-09	8:31	0		6.0			
	8:33	2	21.1	6.0	27.0	14.0	0.0324
	8:36	5	21.2	6.0	23.0	11.3	0.0210
	8:46	15	21.3	6.0	19.0	8.7	0.0125
	9:01	30	21.2	6.0	16.0	6.7	0.0090
	9:31	60	21.4	6.0	14.0	5.3	0.0064
	10:31	120	21.4	6.0	13.0	4.7	0.0046
	12:41	250	21.5	6.0	11.5	3.7	0.0032
09-May-09	8:31	1440	21.1	6.0	10.0	2.7	0.0013

GRAVEL				SAND						FINES		
COARSE		FINE		CRSE	MEDIUM		FINE		SILT		CLAY	
U.S. STANDARD SIEVE OPENING				U.S. STANDARD SIEVE NUMBER						HYDROMETER		
3.0"	1 1/2"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200		



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B6

Sample No.: C52

Depth (feet): 299.0

Soil Type : (SM)g

Soil Identification: Light gray silty sand with gravel (SM)g

**GR:SA:FI : (%)      22 : 56 : 22**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 04/28/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/07/09  
 Exploration No.: R-09-Z3-B6  
 Sample No.: C53      Depth (feet) : 304.5  
 Soil Identification: Light gray silty sand (SM)

<b>% Gravel</b>	<b>9</b>	<b>Soil Type</b>  <b>SM</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>58</b>				
<b>% Fines</b>	<b>33</b>				

Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	127.21
Wt. of Air-Dry Soil + Cont. (g)	1334.50	Wt. of Container No. ___ (g)	1.00	1.00	77.25
Wt. of Container	111.20	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	1223.30	Wt. of Dry Soil (g)			49.96

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	42.10	96.6
⅜"	74.10	93.9
No. 4	113.60	90.7
No. 10	168.60	86.2
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	86.2
No. 16	3.12	96.1	82.9
No. 30	10.10	87.4	75.4
No. 50	21.01	73.9	63.7
No. 100	36.34	54.8	47.2
No. 200	49.42	38.5	33.2
Pan			

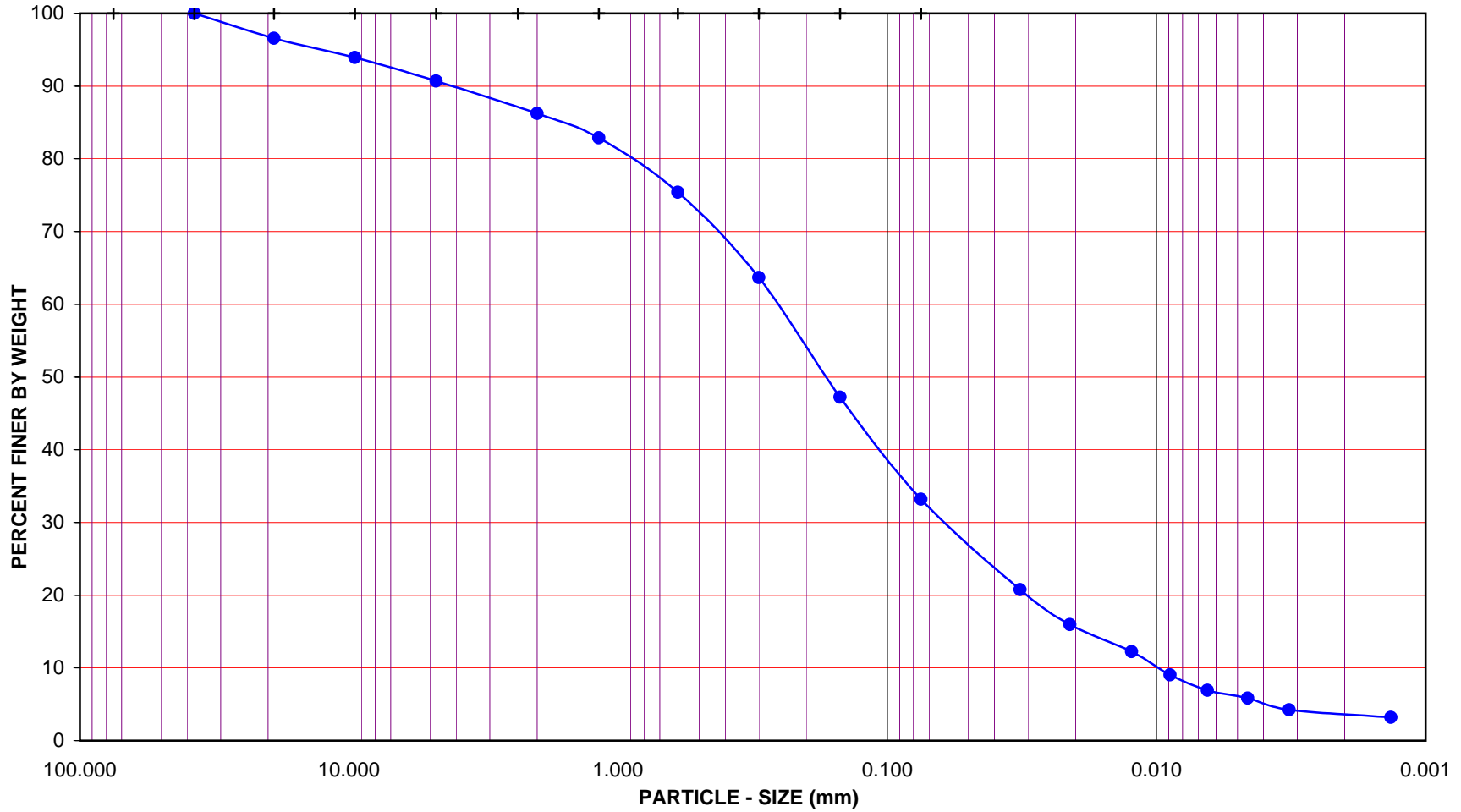
**Hydrometer**

Wt. of Air-Dry Soil (g) 80.38
Wt. of Dry Soil (g) 80.38

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
30-Apr-09	10:18	0		6.5			
	10:20	2	22.3	6.5	26.0	20.7	0.0321
	10:23	5	22.4	6.5	21.5	16.0	0.0210
	10:33	15	22.0	6.5	18.0	12.2	0.0124
	10:48	30	22.0	6.5	15.0	9.0	0.0089
	11:18	60	21.8	6.5	13.0	6.9	0.0065
	12:18	120	21.9	6.5	12.0	5.9	0.0046
	14:28	250	21.7	6.5	10.5	4.3	0.0032
01-May-09	10:18	1440	21.5	6.5	9.5	3.2	0.0013

GRAVEL				SAND						FINES		
COARSE		FINE		CRSE	MEDIUM		FINE		SILT		CLAY	
U.S. STANDARD SIEVE OPENING				U.S. STANDARD SIEVE NUMBER						HYDROMETER		
3.0"	1 1/2"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200		



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B6

Sample No.: C53

Depth (feet): 304.5

Soil Type : SM

Soil Identification: Light gray silty sand (SM)

**GR:SA:FI : (%)      9 : 58 : 33**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)

Tested By: [V. Juliano](#) Date: [05/17/09](#)

Project No.: [378312.04.09.01](#)

Checked By: [J. Ward](#) Date: [05/26/09](#)

Exploration No.: [R-09-Z3-B11](#)

Depth (feet): [116.4-116.9](#)

Sample No.: [C-24](#)

Soil Identification: [Olive yellow silty sand with gravel \(SM\)g](#)

Calculation of Dry Weights	Whole Sample	Sample Passing #8	Moisture Contents	Whole Sample	Sample passing #8
Container No.:	778	788	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00
Wt. Air-Dried Soil + Cont.(g)	859.80	285.10	Wt. of Dry Soil + Cont. (g)	0.00	0.00
Wt. of Container (g)	75.80	75.90	Wt. of Container No.____(g)	1.00	1.00
Dry Wt. of Soil (g)	784.00	209.20	Moisture Content (%)	0.00	0.00

Passing #8 Material After Wet Sieve	Container No.	788
	Wt. of Dry Soil + Container (g)	234.50
	Wt. of Container (g)	75.90
	Dry Wt. of Soil Retained on # 200 Sieve (g)	158.60

U. S. Sieve Size		Cumulative Weight of Dry Soil Retained (g)		Percent Passing (%)
	(mm.)	Whole Sample	Sample Passing #4	
6"	152.400			
3"	75.000			
1 1/2"	37.500	0.00		100.0
3/4"	19.000	26.16		96.7
3/8"	9.500	56.85		92.7
#4	4.750	122.91		84.3
#8	2.360	202.70		74.1
#16	1.180		29.01	63.8
#30	0.600		68.43	49.9
#50	0.300		105.86	36.6
#100	0.150		138.04	25.2
#200	0.075		158.01	18.1
PAN				

GRAVEL: **16 %**

SAND: **66 %**

FINES: **18 %**

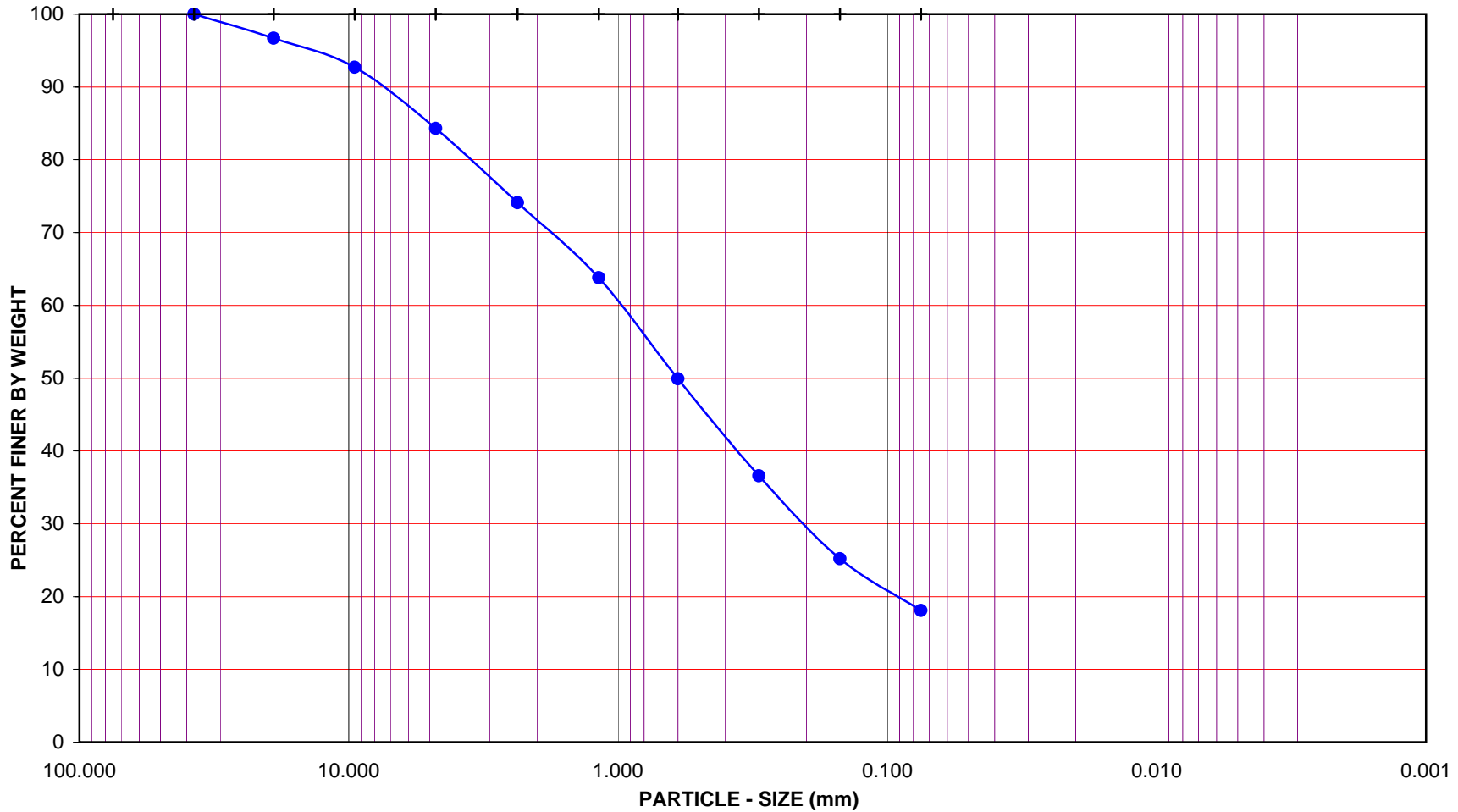
GROUP SYMBOL **(SM)g**

Cu = D60/D10 = \_\_\_\_\_

Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: Insufficient sample mass available to meet the ASTM specification for this material

GRAVEL			SAND					FINES				
COARSE		FINE	COARSE	MEDIUM	FINE		SILT	CLAY				
U.S. STANDARD SIEVE OPENING			U.S. STANDARD SIEVE NUMBER					HYDROMETER				
3.0"	1 1/2"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200		



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B11

Sample No.: C-24

Depth (feet): 116.4-116.9

Soil Type : (SM)g

Soil Identification: Olive yellow silty sand with gravel (SM)g

**GR:SA:FI : (%)      16 : 66 : 18**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)  
 Project No.: [378312.04.09.01](#)  
 Exploration No.: [R-09-Z3-B11](#)  
 Sample No.: [C-25](#)  
 Soil Identification: [Olive yellow silty sand \(SM\)](#)

Tested By: [A. Santos](#) Date: [05/14/09](#)  
 Checked By: [J. Ward](#) Date: [05/26/09](#)  
 Depth (feet): [125-125.5](#)

		Moisture Content of Total Air - Dry Soil	
Container No.:	737	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	830.20	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	76.70	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	753.50	Moisture Content (%)	0.00

After Wet Sieve	Container No.	737
	Wt. of Dry Soil + Container (g)	726.50
	Wt. of Container (g)	76.70
	Dry Wt. of Soil Retained on # 200 Sieve (g)	649.80

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000	0.00	100.0
3/8"	9.500	4.00	99.5
#4	4.750	27.40	96.4
#8	2.360	72.90	90.3
#16	1.180	156.60	79.2
#30	0.600	304.60	59.6
#50	0.300	466.80	38.0
#100	0.150	581.90	22.8
#200	0.075	642.60	14.7
PAN			

GRAVEL: **4 %**  
 SAND: **81 %**  
 FINES: **15 %**  
 GROUP SYMBOL: **SM**

Cu = D60/D10 = \_\_\_\_\_

Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: \_\_\_\_\_

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

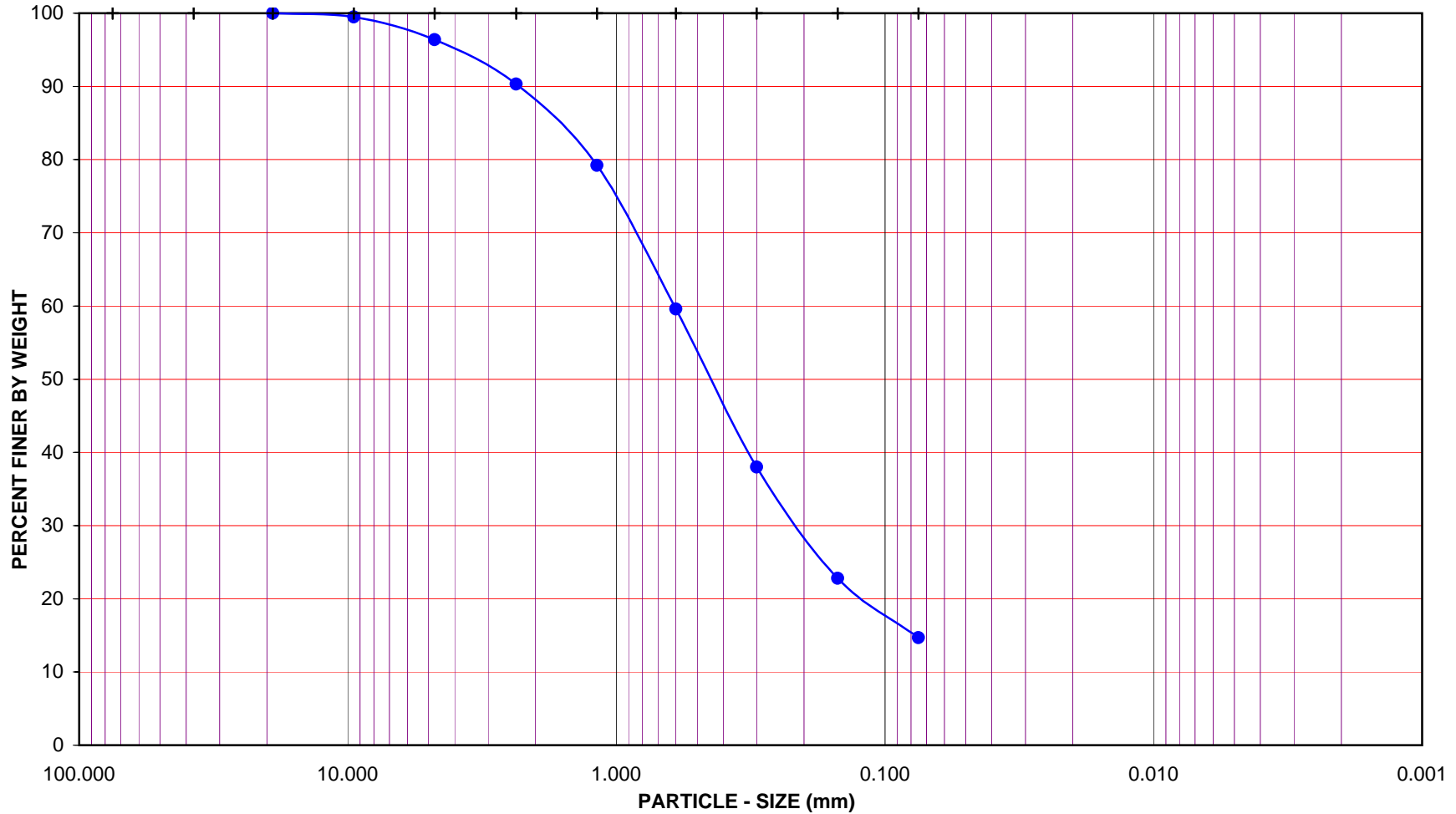
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8"

U.S. STANDARD SIEVE NUMBER

#4 #8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B11

Sample No.: C-25

Depth (feet): 125-125.5

Soil Type : SM

Soil Identification: Olive yellow silty sand (SM)

**GR:SA:FI : (%)      4 : 81 : 15**



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**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09





**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)      Tested By: [A. Santos](#)    Date: [05/14/09](#)  
 Project No.: [378312.04.09.01](#)                                      Checked By: [J. Ward](#)    Date: [05/26/09](#)  
 Exploration No.: [R-09-Z3-B11](#)                                      Depth (feet): [150.5-151](#)  
 Sample No.: [C-30](#)  
 Soil Identification: [Olive brown well-graded sand with silt \(SW-SM\)](#)

Container No.:	K-14	Moisture Content of Total Air - Dry Soil	
		Wt. of Air-Dried Soil + Cont.(g)	734.20
Wt. of Container (g)	75.10	Wt. of Dry Soil + Cont. (g)	0.00
Dry Wt. of Soil (g)	659.10	Wt. of Container No. _____ (g)	1.00
		Moisture Content (%)	0.00

After Wet Sieve	Container No.	K-14
	Wt. of Dry Soil + Container (g)	682.20
	Wt. of Container (g)	75.10
	Dry Wt. of Soil Retained on # 200 Sieve (g)	607.10

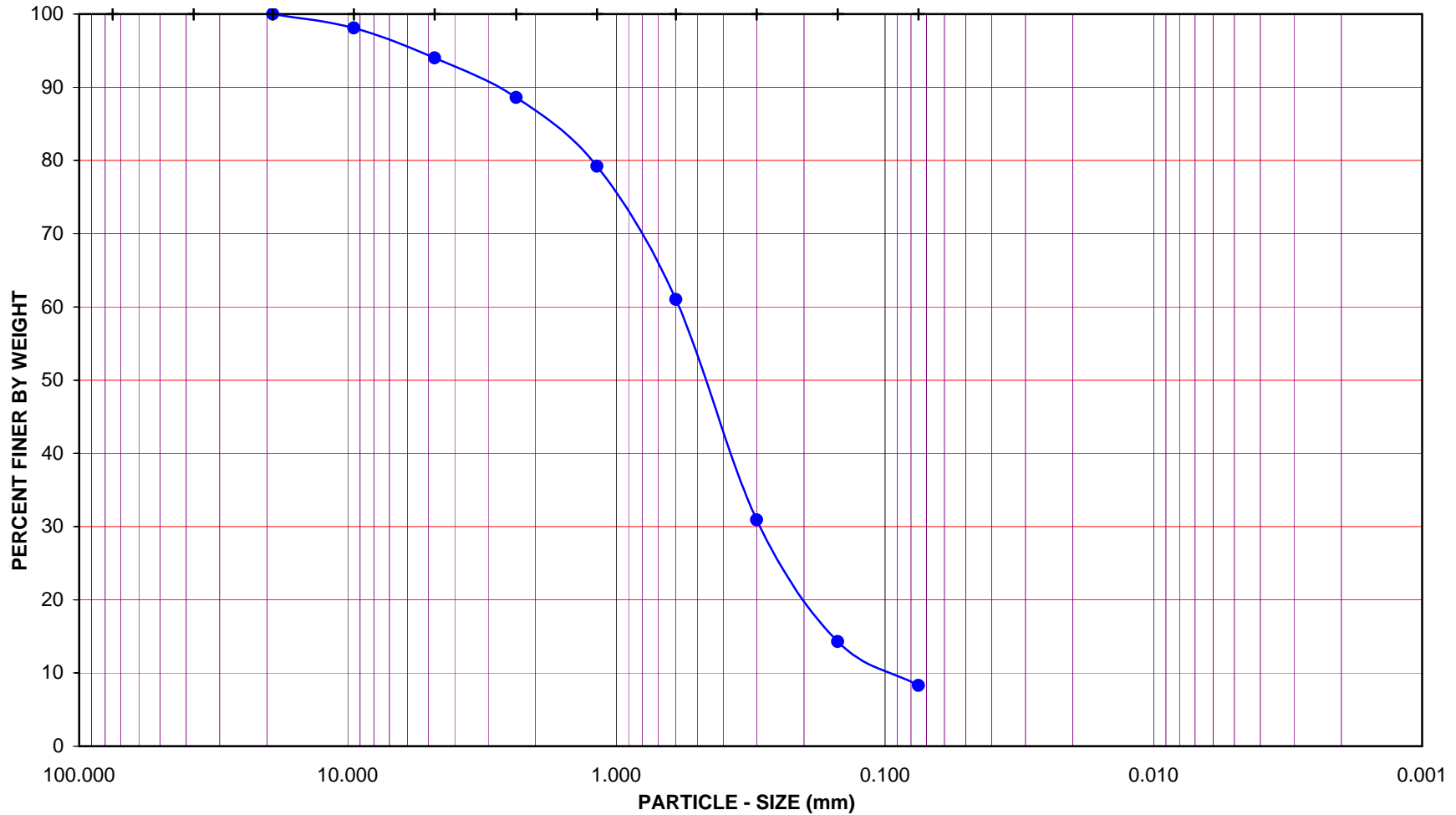
U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000	0.00	100.0
3/8"	9.500	12.80	98.1
#4	4.750	39.40	94.0
#8	2.360	75.00	88.6
#16	1.180	137.20	79.2
#30	0.600	257.00	61.0
#50	0.300	455.40	30.9
#100	0.150	564.80	14.3
#200	0.075	604.50	8.3
PAN			

GRAVEL: **6 %**  
 SAND: **86 %**  
 FINES: **8 %**  
 GROUP SYMBOL: **SW-SM**

Cu = D60/D10 = 5.90  
 Cc = (D30)<sup>2</sup>/(D60\*D10) = 1.43

Remarks: \_\_\_\_\_

GRAVEL			SAND				FINES		
COARSE		FINE	COARSE	MEDIUM	FINE		SILT	CLAY	
U.S. STANDARD SIEVE OPENING			U.S. STANDARD SIEVE NUMBER				HYDROMETER		
3.0"	1 1/2"	3/4"	#4	#8	#16	#30	#50	#100	#200



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B11

Sample No.: C-30

Depth (feet): 150.5-151

Soil Type : SW-SM

Soil Identification: Olive brown well-graded sand with silt (SW-SM)

**GR:SA:FI : (%)      6 : 86 : 8**



**PARTICLE - SIZE DISTRIBUTION**  
**ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)  
 Project No.: [378312.04.09.01](#)  
 Exploration No.: [R-09-Z3-B11](#)  
 Sample No.: [O-3](#)  
 Soil Identification: [Olive silty sand \(SM\)](#)

Tested By: [V. Juliano](#) Date: [04/06/09](#)  
 Checked By: [J. Ward](#) Date: [04/29/09](#)  
 Depth (feet): [11.5-16](#)

Container No.:	1955	Moisture Content of Total Air - Dry Soil	
		Wt. of Air-Dried Soil + Cont.(g)	540.40
Wt. of Container (g)	72.50	Wt. of Dry Soil + Cont. (g)	0.00
Dry Wt. of Soil (g)	467.90	Wt. of Container No. _____ (g)	1.00
		Moisture Content (%)	0.00

After Wet Sieve	Container No.	1955
	Wt. of Dry Soil + Container (g)	399.50
	Wt. of Container (g)	72.50
	Dry Wt. of Soil Retained on # 200 Sieve (g)	327.00

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000	0.00	100.0
3/8"	9.500	6.65	98.6
#4	4.750	13.85	97.0
#8	2.360	20.40	95.6
#16	1.180	29.89	93.6
#30	0.600	51.22	89.1
#50	0.300	115.70	75.3
#100	0.150	251.40	46.3
#200	0.075	324.40	30.7
PAN			

GRAVEL: **3 %**  
 SAND: **66 %**  
 FINES: **31 %**  
 GROUP SYMBOL: **SM**

Cu = D60/D10 = \_\_\_\_\_  
 Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: \_\_\_\_\_

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

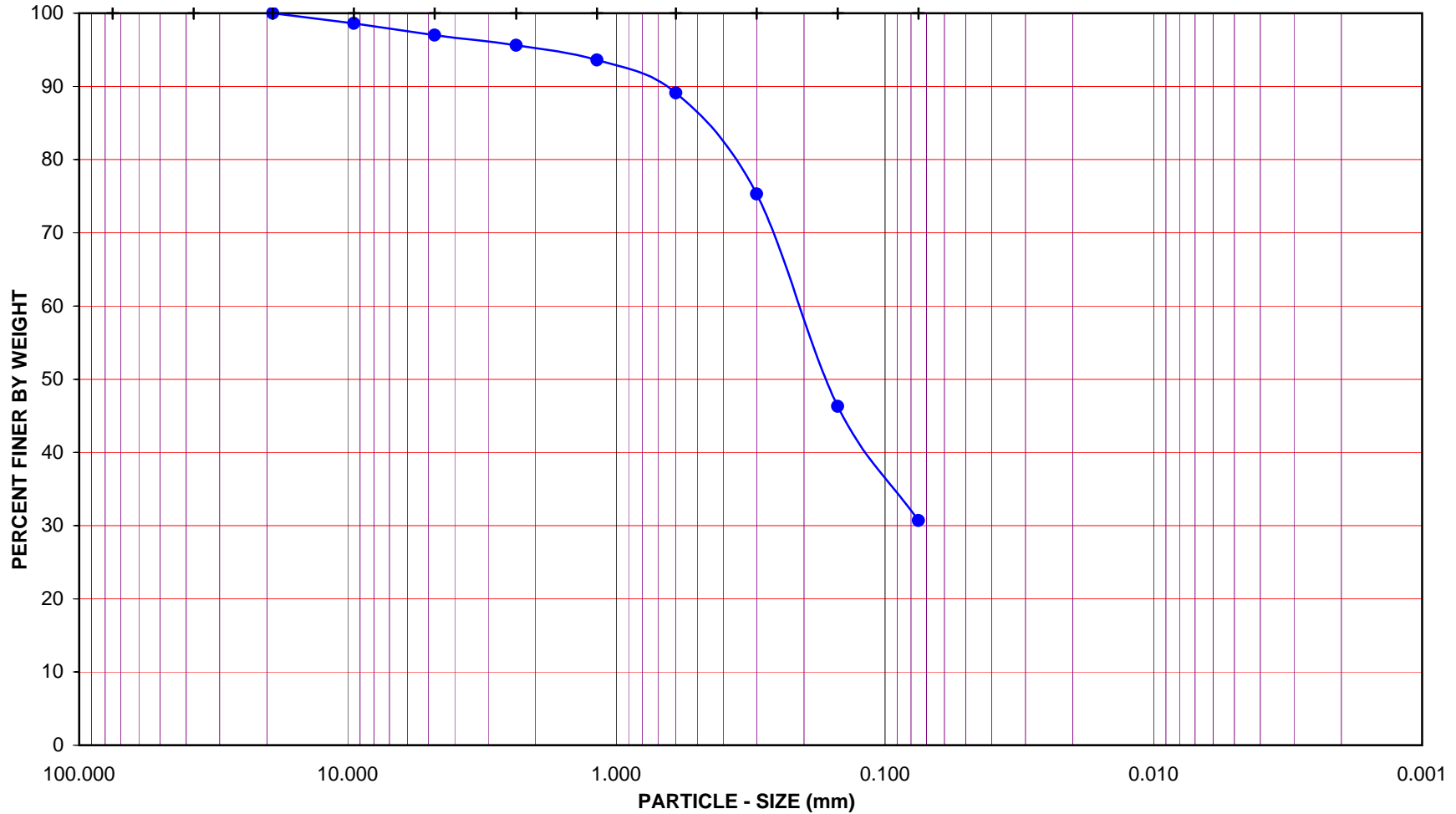
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8"

U.S. STANDARD SIEVE NUMBER

#4 #8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B11

Sample No.: O-3

Depth (feet): 11.5-16

Soil Type : SM

Soil Identification: Olive silty sand (SM)

**GR:SA:FI : (%)      3 : 66 : 31**



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**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

Apr-09



## PARTICLE-SIZE ANALYSIS of SOILS

### ASTM D 422

Project Name: [SR-710 Tunnel Technical Study](#)      Tested By: [V. Juliano](#)    Date: [04/06/09](#)  
 Project No.: [378312.04.09.01](#)                                      Checked By: [J. Ward](#)      Date: [04/29/09](#)  
 Exploration No.: [R-09-Z3-B11](#)                                      Depth (feet): [41-46](#)  
 Sample No.: [O-9](#)  
 Soil Identification: [Olive poorly-graded sand with silt \(SP-SM\)](#)

Container No.:	Q	Moisture Content of Total Air - Dry Soil	
		Wt. of Air-Dried Soil + Cont.(g)	426.20
Wt. of Container (g)	75.30	Wt. of Dry Soil + Cont. (g)	0.00
Dry Wt. of Soil (g)	350.90	Wt. of Container No. _____ (g)	1.00
		Moisture Content (%)	0.00

After Wet Sieve	Container No.	Q
	Wt. of Dry Soil + Container (g)	394.30
	Wt. of Container (g)	75.30
	Dry Wt. of Soil Retained on # 200 Sieve (g)	319.00

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000		
3/8"	9.500	0.00	100.0
#4	4.750	1.41	99.6
#8	2.360	3.72	98.9
#16	1.180	7.52	97.9
#30	0.600	22.16	93.7
#50	0.300	107.73	69.3
#100	0.150	255.60	27.2
#200	0.075	315.70	10.0
PAN			

GRAVEL:                                      **0 %**  
 SAND:                                         **90 %**  
 FINES:                                        **10 %**  
 GROUP SYMBOL:                         **SP-SM**

$C_u = D_{60}/D_{10} = \underline{\quad 3.33 \quad}$   
 $C_c = (D_{30})^2/(D_{60} \cdot D_{10}) = \underline{\quad 1.20 \quad}$

Remarks: \_\_\_\_\_

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

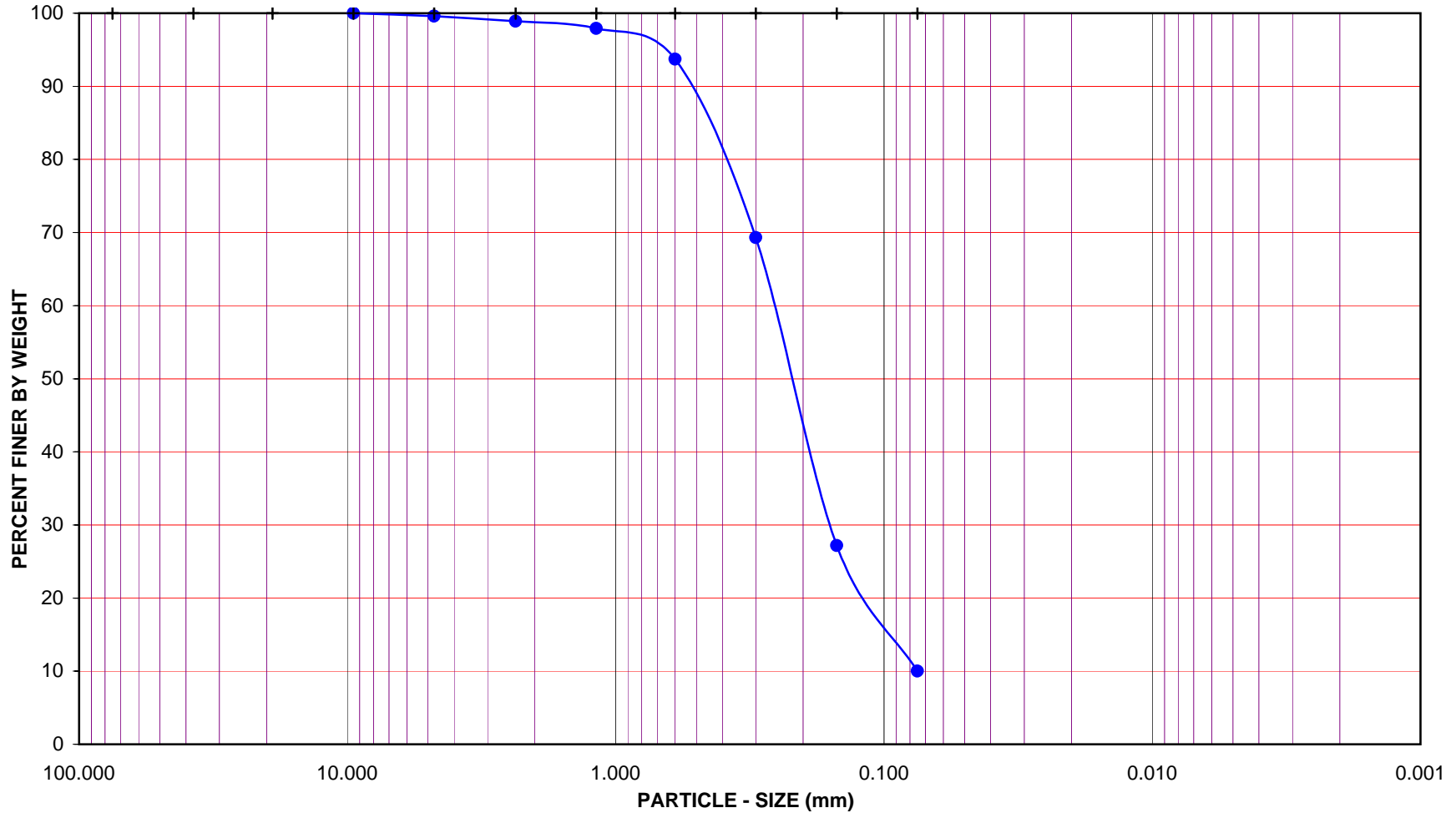
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8"

U.S. STANDARD SIEVE NUMBER

#4 #8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B11

Sample No.: O-9

Depth (feet): 41-46

Soil Type : SP-SM

Soil Identification: Olive poorly-graded sand with silt (SP-SM)

**GR:SA:FI : (%) 0 : 90 : 10**



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**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

Apr-09



## PARTICLE-SIZE ANALYSIS of SOILS

### ASTM D 422

Project Name: [SR-710 Tunnel Technical Study](#)      Tested By: [V. Juliano](#)    Date: [04/06/09](#)  
 Project No.: [378312.04.09.01](#)                                      Checked By: [J. Ward](#)    Date: [04/29/09](#)  
 Exploration No.: [R-09-Z3-B11](#)                                      Depth (feet): [61-66](#)  
 Sample No.: [O-12](#)  
 Soil Identification: [Olive well-graded sand with silt and gravel \(SW-SM\)g](#)

		Moisture Content of Total Air - Dry Soil	
Container No.:	934	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	1006.30	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	108.20	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	898.10	Moisture Content (%)	0.00

After Wet Sieve	Container No.	934
	Wt. of Dry Soil + Container (g)	945.60
	Wt. of Container (g)	108.20
	Dry Wt. of Soil Retained on # 200 Sieve (g)	837.40

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500	0.00	100.0
3/4"	19.000	61.04	93.2
3/8"	9.500	155.17	82.7
#4	4.750	263.80	70.6
#8	2.360	385.10	57.1
#16	1.180	524.80	41.6
#30	0.600	624.90	30.4
#50	0.300	705.90	21.4
#100	0.150	782.50	12.9
#200	0.075	831.30	7.4
PAN			

GRAVEL: 29 %  
 SAND: 64 %  
 FINES: 7 %

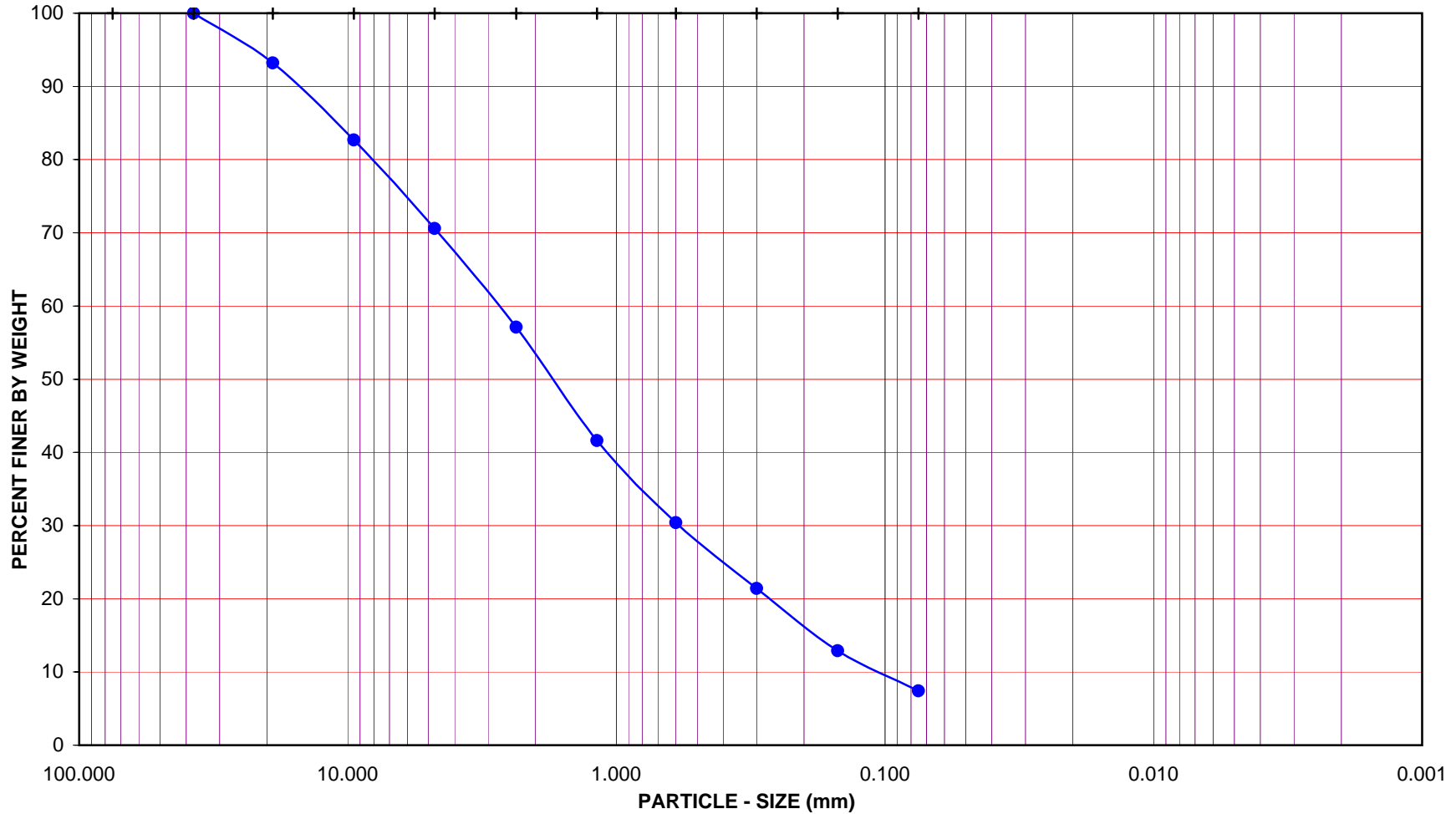
GROUP SYMBOL: (SW-SM)g

$C_u = D_{60}/D_{10} = \underline{24.55}$

$C_c = (D_{30})^2/(D_{60}*D_{10}) = \underline{1.21}$

Remarks: \_\_\_\_\_

GRAVEL			SAND					FINES				
COARSE		FINE	COARSE	MEDIUM	FINE		SILT	CLAY				
U.S. STANDARD SIEVE OPENING			U.S. STANDARD SIEVE NUMBER					HYDROMETER				
3.0"	1 1/2"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200		



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B11

Sample No.: O-12

Depth (feet): 61-66

Soil Type : (SW-SM)g

Soil Identification: Olive well-graded sand with silt and gravel (SW-SM)g

**GR:SA:FI : (%)      29 : 64 : 7**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

Apr-09





# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/17/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/26/09  
 Exploration No.: R-09-Z3-B11  
 Sample No.: C-27      Depth (feet) : 131.5-132.0  
 Soil Identification: Dark olive brown sandy lean clay s(CL)

<b>% Gravel</b>	<b>1</b>	<b>Soil Type</b>  <b>s(CL)</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>35</b>				
<b>% Fines</b>	<b>64</b>				

Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	N/A
Wt. of Air-Dry Soil + Cont. (g)	700.70	Wt. of Container No. ___ (g)	1.00	1.00	N/A
Wt. of Container	107.00	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	593.70	Wt. of Dry Soil (g)			N/A

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	3.33	99.4
No. 10	12.82	97.8
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	97.8
No. 16	1.77	97.5	95.4
No. 30	5.47	92.2	90.2
No. 50	10.82	84.6	82.7
No. 100	17.60	74.9	73.3
No. 200	24.56	65.0	63.6
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 70.08
Wt. of Dry Soil (g) 70.08

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
18-May-09	10:27	0		6.0			
	10:29	2	21.5	6.0	42.0	49.9	0.0288
	10:32	5	21.6	6.0	37.5	43.6	0.0189
	10:42	15	21.4	6.0	32.5	36.7	0.0114
	10:57	30	21.6	6.0	27.5	29.8	0.0083
	11:27	60	21.7	6.0	24.0	24.9	0.0060
	12:27	120	21.5	6.0	20.5	20.1	0.0044
	14:37	250	21.7	6.0	18.5	17.3	0.0031
19-May-09	10:27	1440	21.2	6.0	14.0	11.1	0.0013

GRAVEL			SAND				FINES	
COARSE	FINE		CRSE	MEDIUM	FINE		SILT	CLAY

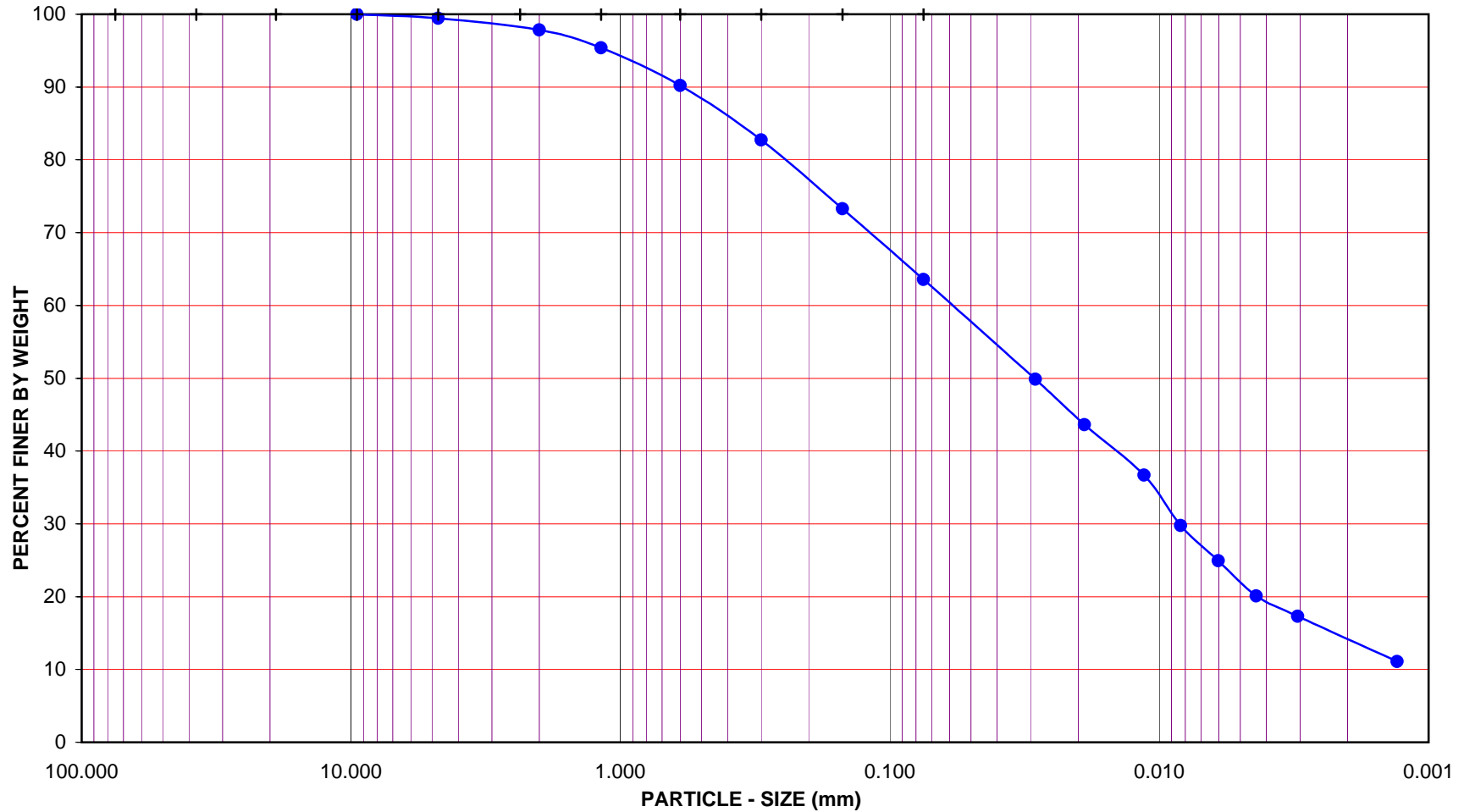
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B11

Sample No.: C-27

Depth (feet) : 131.5-132.0

Soil Type : s(CL)

Soil Identification: Dark olive brown sandy lean clay s(CL)

**GR:SA:FI : (%) 1 : 35 : 64**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/14/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/29/09  
 Exploration No.: R-09-Z3-B11  
 Sample No.: C-35      Depth (feet) : 171.5-172.25  
 Soil Identification: Light olive brown fat clay'stone' with sand (CH)s

<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>  <b>(CH)s</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>18</b>				
<b>% Fines</b>	<b>82</b>				

Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	N/A
Wt.of Air-Dry Soil + Cont. (g)	1209.30	Wt. of Container No.____ (g)	1.00	1.00	N/A
Wt. of Container	0.00	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	1209.30	Wt. of Dry Soil (g)			N/A

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.00	100.0
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.01	100.0	100.0
No. 30	0.05	99.9	99.9
No. 50	0.31	99.4	99.4
No. 100	2.34	95.4	95.4
No. 200	9.05	82.1	82.1
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 50.66
Wt. of Dry Soil (g) 50.66

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
18-May-09	10:15	0		6.0			
	10:17	2	21.4	6.0	39.5	65.6	0.0294
	10:20	5	21.4	6.0	36.0	58.7	0.0192
	10:30	15	21.5	6.0	32.5	51.9	0.0114
	10:45	30	21.3	6.0	31.0	49.0	0.0081
	11:15	60	21.4	6.0	28.5	44.1	0.0058
	12:15	120	21.5	6.0	26.5	40.1	0.0042
	14:25	250	21.7	6.0	25.0	37.2	0.0029
19-May-09	10:15	1440	21.2	6.0	21.0	29.4	0.0013

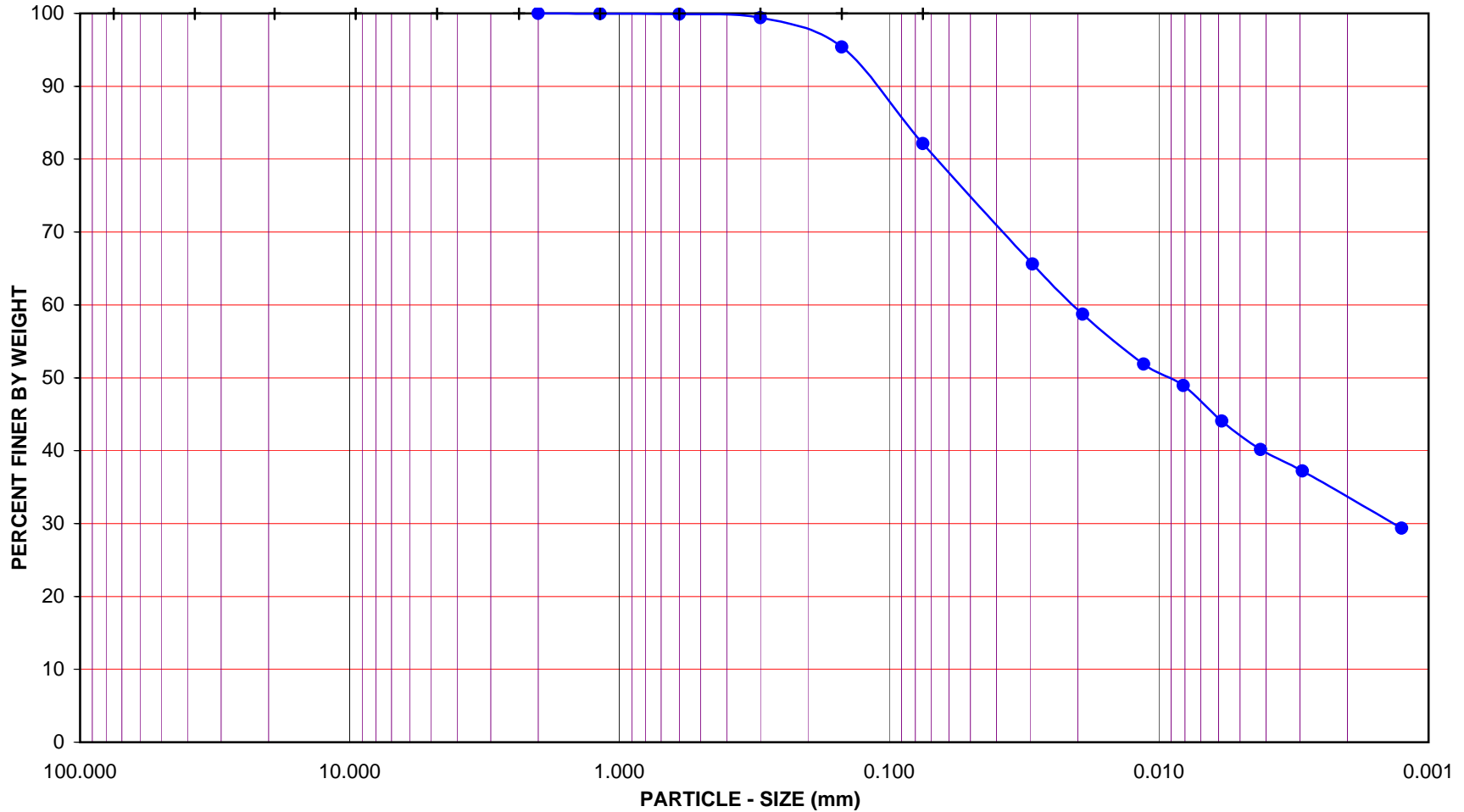
GRAVEL				SAND						FINES	
COARSE		FINE		CRSE	MEDIUM		FINE		SILT		CLAY

U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4 #8 #16 #30 #50 #100 #200

U.S. STANDARD SIEVE NUMBER

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B11

Sample No.: C-35

Depth (feet): 171.5-172.25

Soil Type : (CH)s

Soil Identification: Light olive brown fat clay'stone' with sand (CH)s

**GR:SA:FI : (%) 0 : 18 : 82**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)

Tested By : V. Juliano

Date: 04/06/09

Project No. : [378312.04.09.01](#)

Data Input By: J. Ward

Date: 04/29/09

Exploration No.: [R-09-Z3-B11](#)

Sample No.: O-14

Depth (feet) : 71-76

Soil Identification: [Olive silty sand \(SM\)](#)

<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>  <b>SM</b>
<b>% Sand</b>	<b>61</b>	
<b>% Fines</b>	<b>39</b>	

Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
0.00	0.00	137.01
1.00	1.00	75.25
0.00	0.00	
		61.76

Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	137.01
Wt. of Air-Dry Soil + Cont. (g)	381.80	Wt. of Container No. ___ (g)	1.00	1.00	75.25
Wt. of Container	79.40	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	302.40	Wt. of Dry Soil (g)			61.76

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.46	99.8
No. 10	0.56	99.8
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	99.8
No. 16	0.10	99.9	99.7
No. 30	0.28	99.7	99.5
No. 50	1.90	98.1	97.9
No. 100	23.70	76.3	76.2
No. 200	61.32	38.8	38.7
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g)

100.19

Wt. of Dry Soil (g)

100.19

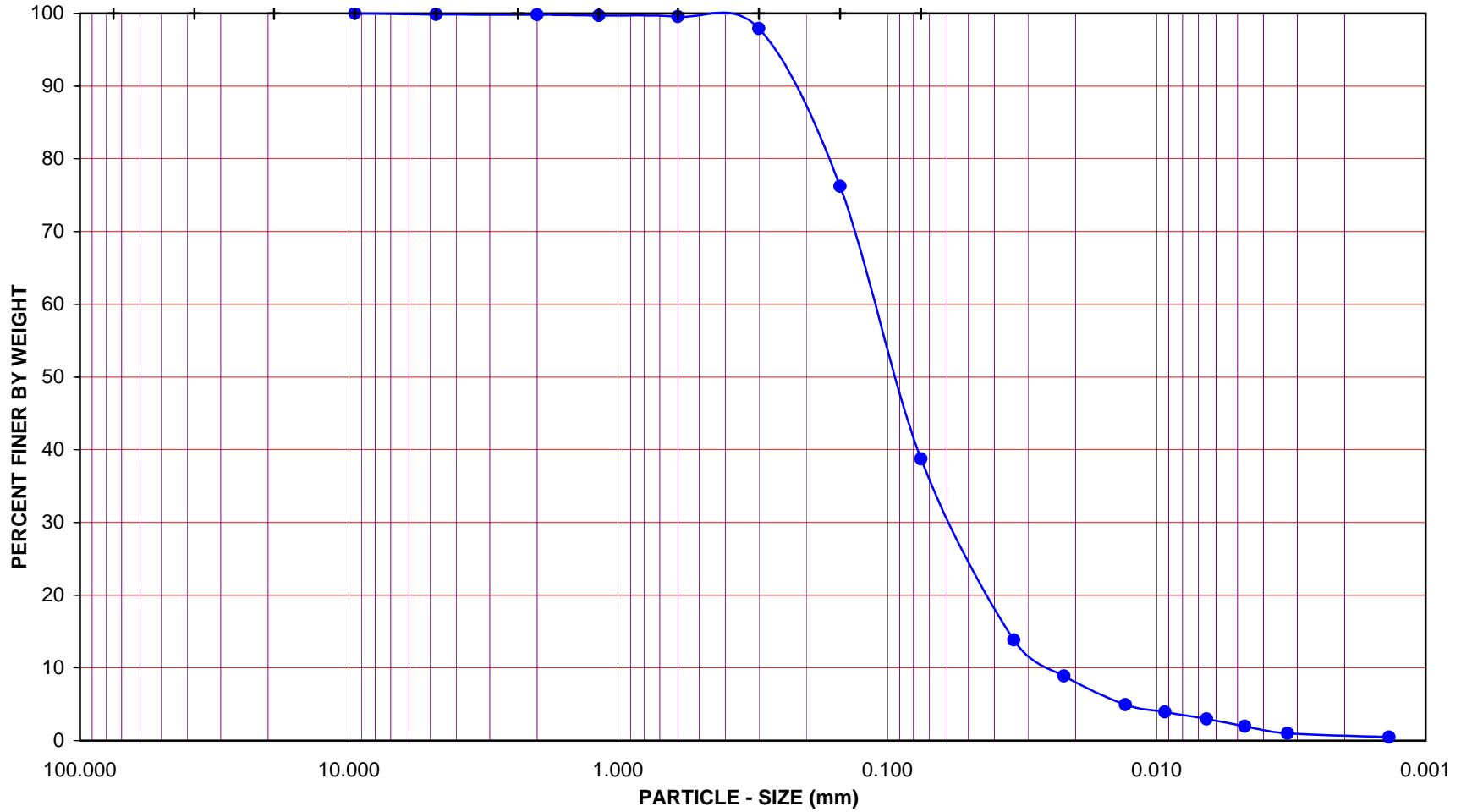
Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
07-Apr-09	8:20	0		6.0			
	8:22	2	21.4	6.0	20.0	13.8	0.0339
	8:25	5	21.4	6.0	15.0	8.9	0.0221
	8:35	15	21.4	6.0	11.0	4.9	0.0131
	8:50	30	21.6	6.0	10.0	4.0	0.0093
	9:20	60	22.0	6.0	9.0	3.0	0.0065
	10:20	120	21.8	6.0	8.0	2.0	0.0047
	12:32	252	21.8	6.0	7.0	1.0	0.0033
08-Apr-09	8:20	1440	21.7	6.0	6.5	0.5	0.0014

GRAVEL			SAND					FINES	
COARSE		FINE	CRSE	MEDIUM	FINE		SILT	CLAY	

U.S. STANDARD SIEVE OPENING      U.S. STANDARD SIEVE NUMBER      HYDROMETER

3.0"    1 1/2"    3/4"    3/8"    #4    #8    #16    #30    #50    #100    #200



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B11

Sample No.: O-14

Depth (feet): 71-76

Soil Type: SM

Soil Identification: Olive silty sand (SM)

**GR:SA:FI : (%)      0 : 61 : 39**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

Apr-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/17/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/26/09  
 Exploration No.: R-09-Z3-B11  
 Sample No.: O-18      Depth (feet) : 91-96  
 Soil Identification: Yellowish brown sandy silt s(ML)

<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>  <b>s(ML)</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>44</b>				
<b>% Fines</b>	<b>56</b>				

Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	N/A
Wt. of Air-Dry Soil + Cont. (g)	812.30	Wt. of Container No. ____ (g)	1.00	1.00	N/A
Wt. of Container	111.10	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	701.20	Wt. of Dry Soil (g)			N/A

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.00	100.0
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.00	100.0	100.0
No. 30	0.05	99.9	99.9
No. 50	0.40	99.5	99.5
No. 100	9.40	89.0	89.0
No. 200	37.24	56.5	56.5
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 85.52
Wt. of Dry Soil (g) 85.52

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
18-May-09	10:39	0		6.0			
	10:41	2	21.4	6.0	23.0	19.7	0.0332
	10:44	5	21.3	6.0	19.0	15.1	0.0216
	10:54	15	21.6	6.0	14.0	9.3	0.0128
	11:09	30	21.6	6.0	12.0	7.0	0.0092
	11:39	60	21.6	6.0	10.5	5.2	0.0066
	12:39	120	21.5	6.0	10.0	4.6	0.0046
	14:49	250	21.7	6.0	9.5	4.1	0.0032
19-May-09	10:39	1440	21.3	6.0	9.0	3.5	0.0013

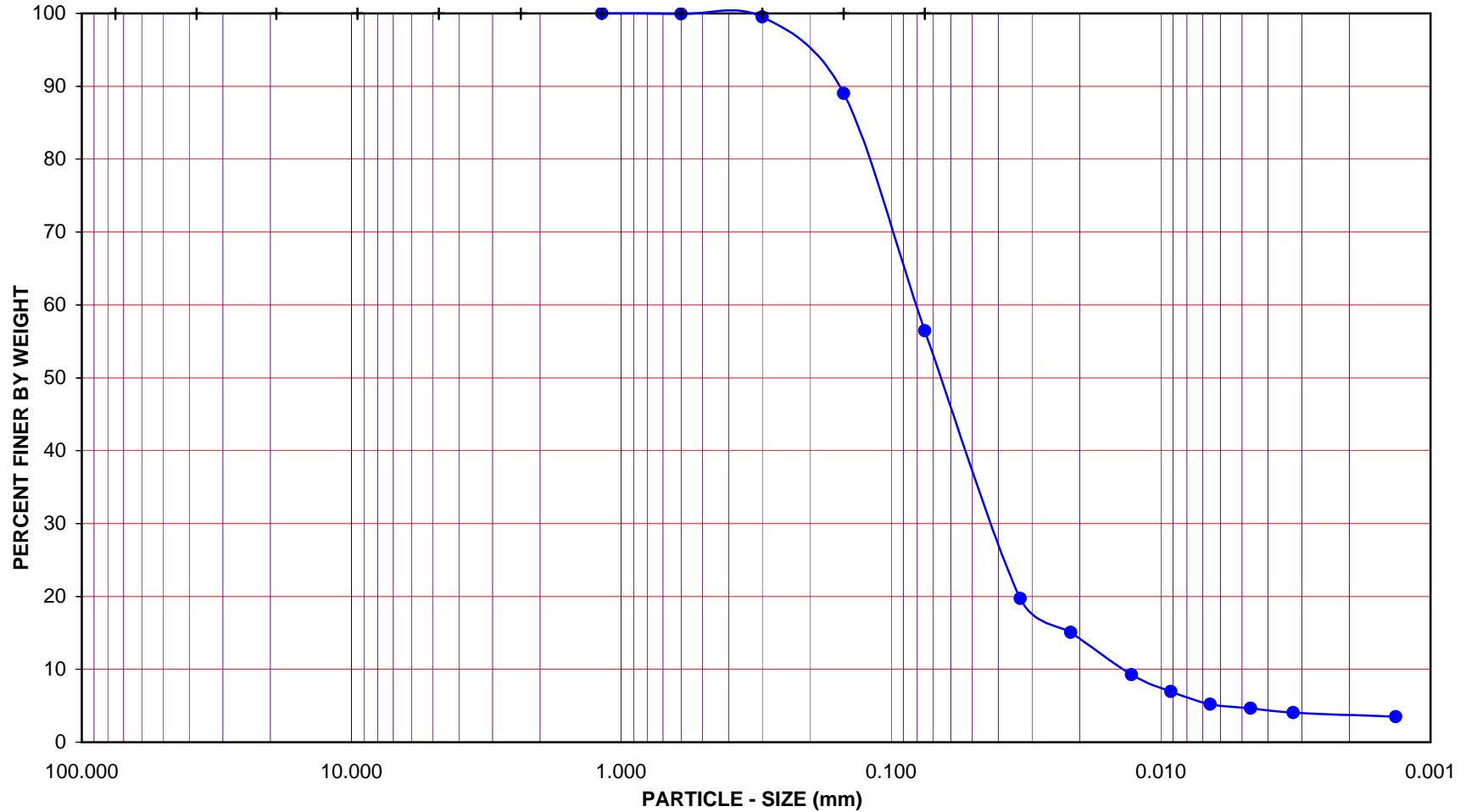
GRAVEL				SAND						FINES	
COARSE		FINE		CRSE	MEDIUM		FINE		SILT		CLAY

U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4 #8 #16 #30 #50 #100 #200

U.S. STANDARD SIEVE NUMBER

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B11

Sample No.: O-18

Depth (feet): 91-96

Soil Type : s(ML)

Soil Identification: Yellowish brown sandy silt s(ML)

**GR:SA:FI : (%) 0 : 44 : 56**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09





**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By: S. Felter    Date: 04/01/09  
 Project No.: 378312.04.09.01                              Checked By: J. Ward    Date: 04/08/09  
 Exploration No.: R-09-Z3-B12                              Depth (feet): 45.0  
 Sample No.: S9  
 Soil Identification: Dark grayish brown silty sand (SM)

Container No.:	936	Moisture Content of Total Air - Dry Soil	
		Wt. of Air-Dried Soil + Cont.(g)	463.70
Wt. of Container (g)	108.40	Wt. of Dry Soil + Cont. (g)	0.00
Dry Wt. of Soil (g)	355.30	Wt. of Container No. _____ (g)	1.00
		Moisture Content (%)	0.00

After Wet Sieve	Container No.	936
	Wt. of Dry Soil + Container (g)	391.70
	Wt. of Container (g)	108.40
	Dry Wt. of Soil Retained on # 200 Sieve (g)	283.30

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000		
3/8"	9.500		
#4	4.750		
#8	2.360		
#16	1.180		
#30	0.600	0.00	100.0
#50	0.300	4.10	98.8
#100	0.150	156.10	56.1
#200	0.075	275.80	22.4
PAN			

GRAVEL: **0 %**  
 SAND: **78 %**  
 FINES: **22 %**  
 GROUP SYMBOL: **SM**

Cu = D60/D10 = \_\_\_\_\_  
 Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: \_\_\_\_\_

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

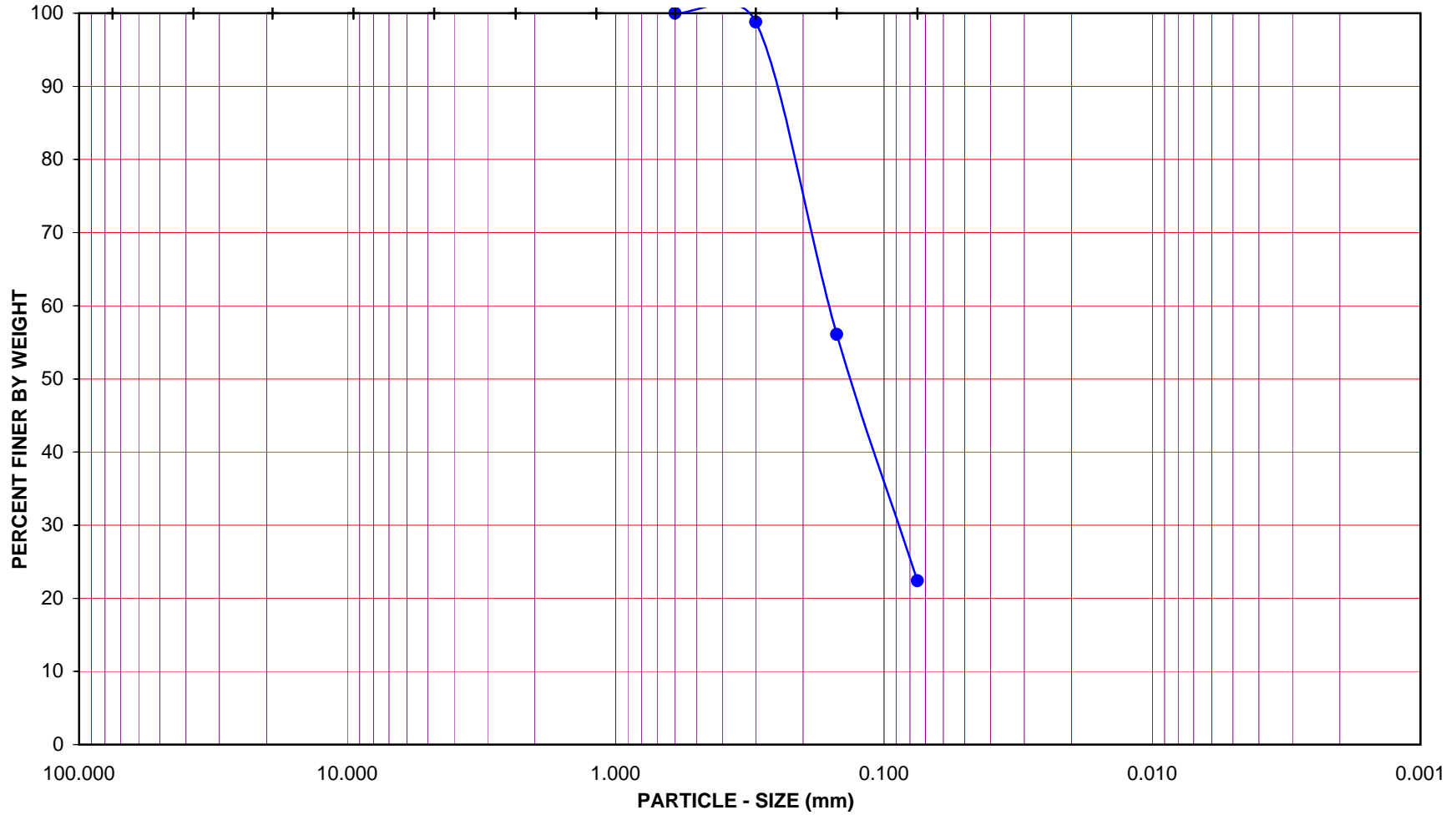
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8"

U.S. STANDARD SIEVE NUMBER

#4 #8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B12

Sample No.: S9

Depth (feet): 45.0

Soil Type : SM

Soil Identification: Dark grayish brown silty sand (SM)

**GR:SA:FI : (%)      0 : 78 : 22**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

Apr-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 04/23/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/11/09  
 Exploration No.: R-09-Z3-B12  
 Sample No.: C21      Depth (feet) : 101-101.5  
 Soil Identification: Olive lean clay with sand (CL)s

	% Gravel	1	Soil Type	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
	% Sand	19	<b>(CL)s</b>			
	% Fines	80				
Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00		
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	85.98	
Wt. of Air-Dry Soil + Cont. (g)	1423.00	Wt. of Container No. ___ (g)	1.00	1.00	76.10	
Wt. of Container	106.80	Moisture Content (%)	0.00	0.00		
Dry Wt. of Soil (g)	1316.20	Wt. of Dry Soil (g)				9.88

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	1.10	99.9
No. 4	6.70	99.5
No. 10	12.70	99.0
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	99.0
No. 16	0.14	99.7	98.8
No. 30	0.44	99.1	98.2
No. 50	1.10	97.8	96.9
No. 100	3.52	93.0	92.1
No. 200	9.62	81.0	80.2
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 50.60
Wt. of Dry Soil (g) 50.60

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
30-Apr-09	10:10	0		6.5			
	10:12	2	22.3	6.5	40.5	66.0	0.0288
	10:15	5	22.3	6.5	36.0	57.3	0.0189
	10:25	15	22.4	6.5	33.0	51.5	0.0112
	10:40	30	21.8	6.5	31.5	48.5	0.0081
	11:10	60	21.7	6.5	29.5	44.7	0.0058
	12:10	120	21.7	6.5	28.5	42.7	0.0041
	14:20	250	21.6	6.5	28.0	41.7	0.0029
01-May-09	10:10	1440	21.5	6.5	23.5	33.0	0.0012

GRAVEL				SAND						FINES	
COARSE		FINE		CRSE	MEDIUM		FINE		SILT		CLAY

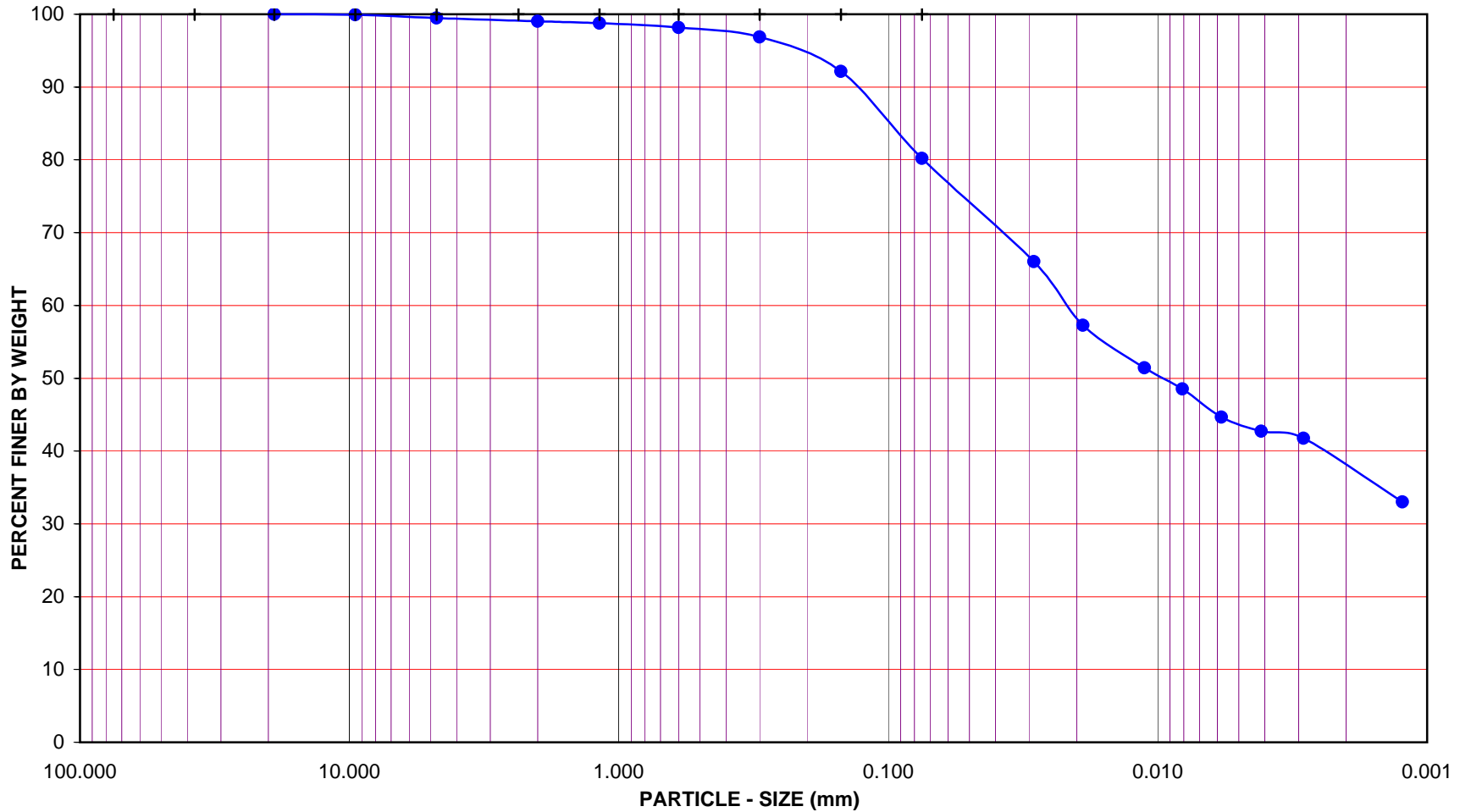
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B12

Sample No.: C21

Depth (feet): 101-101.5

Soil Type : (CL)s

Soil Identification: Olive lean clay with sand (CL)s

**GR:SA:FI : (%) 1 : 19 : 80**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)      Tested By : V. Juliano      Date: 04/22/09  
 Project No. : [378312.04.09.01](#)      Data Input By: J. Ward      Date: 05/11/09  
 Exploration No.: [R-09-Z3-B12](#)  
 Sample No.: [C27](#)      Depth (feet) : [124.3-125.2](#)  
 Soil Identification: [Olive fat clay'stone' \(CH\)](#)

<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>  <b>CH</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>4</b>				
<b>% Fines</b>	<b>96</b>				

Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	76.05
Wt. of Air-Dry Soil + Cont. (g)	729.60	Wt. of Container No. ___ (g)	1.00	1.00	74.29
Wt. of Container	110.50	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	619.10	Wt. of Dry Soil (g)			1.76

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.70	99.9
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	99.9
No. 16	0.05	99.9	99.8
No. 30	0.18	99.6	99.5
No. 50	0.38	99.2	99.1
No. 100	0.76	98.5	98.4
No. 200	1.72	96.6	96.5
Pan			

**Hydrometer**

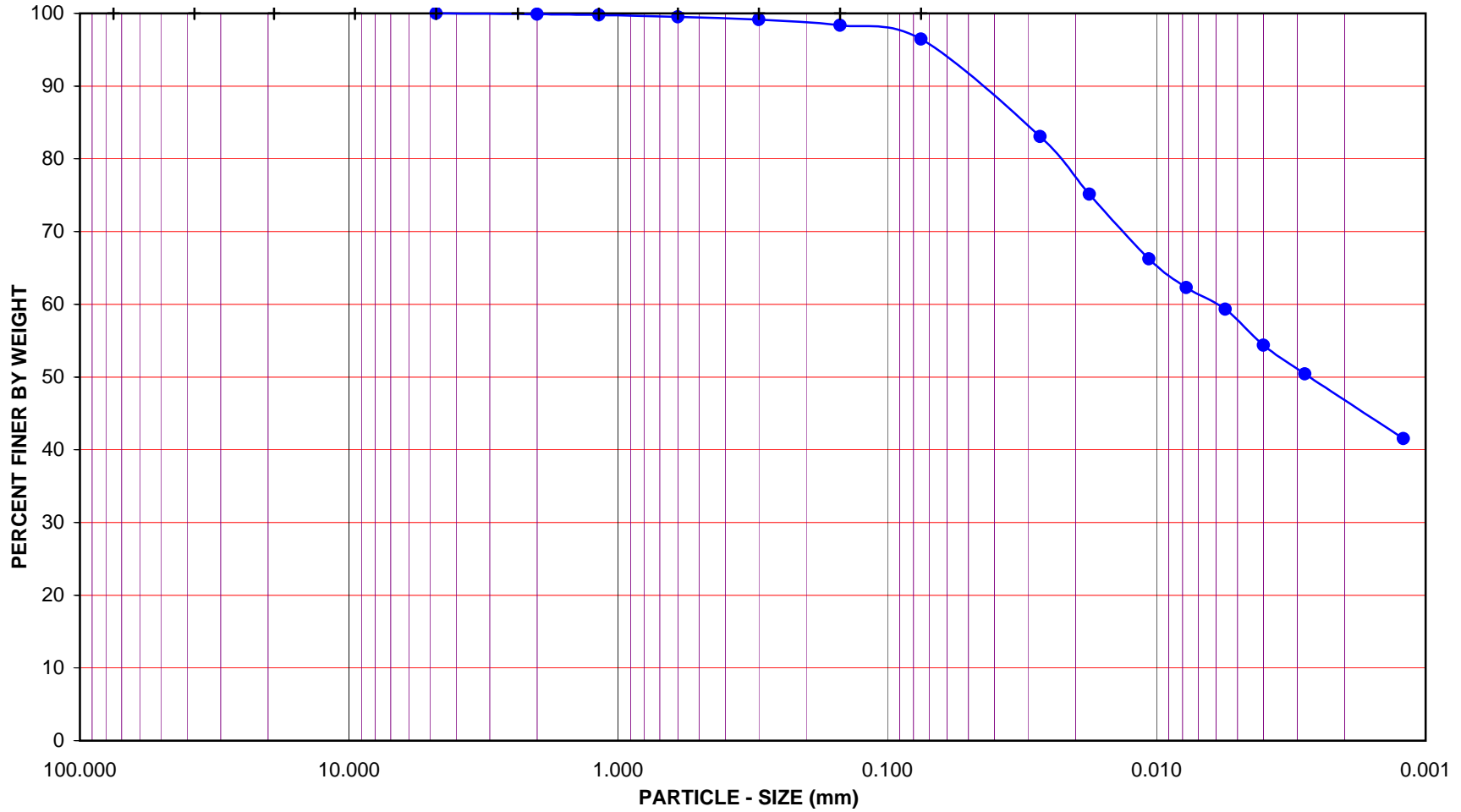
Wt. of Air-Dry Soil (g) 50.11
Wt. of Dry Soil (g) 50.11

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
23-Apr-09	11:19	0		5.5			
	11:21	2	22.3	5.5	47.5	83.1	0.0271
	11:24	5	22.3	5.5	43.5	75.1	0.0178
	11:34	15	22.1	5.5	39.0	66.2	0.0107
	11:49	30	21.9	5.5	37.0	62.3	0.0077
	12:19	60	21.6	5.5	35.5	59.3	0.0056
	13:19	120	21.4	5.5	33.0	54.4	0.0040
	15:29	250	21.4	5.5	31.0	50.4	0.0028
24-Apr-09	11:19	1440	21.7	5.5	26.5	41.5	0.0012

GRAVEL				SAND				FINES			
COARSE		FINE		CRSE	MEDIUM		FINE	SILT		CLAY	

U.S. STANDARD SIEVE OPENING      U.S. STANDARD SIEVE NUMBER      HYDROMETER  
 3.0"    1 1/2"    3/4"    3/8"    #4    #8    #16    #30    #50    #100    #200



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B12

Sample No.: C27

Depth (feet) : 124.3-125.2

Soil Type : CH

Soil Identification: Olive fat clay'stone' (CH)

**GR:SA:FI : (%)      0 : 4 : 96**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 04/24/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/11/09  
 Exploration No.: R-09-Z3-B12  
 Sample No.: C29      Depth (feet) : 140-140.6  
 Soil Identification: Olive lean clay'stone' (CL)

% Gravel	1	Soil Type	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
% Sand	4				
% Fines	95				
<b>CL</b>					
Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	84.44
Wt. of Air-Dry Soil + Cont. (g)	1331.30	Wt. of Container No.____ (g)	1.00	1.00	82.66
Wt. of Container	108.20	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	1223.10	Wt. of Dry Soil (g)			1.78

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	6.81	99.4
No. 10	22.26	98.2
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	98.2
No. 16	0.06	99.9	98.1
No. 30	0.11	99.8	98.0
No. 50	0.20	99.6	97.8
No. 100	0.52	99.1	97.3
No. 200	1.74	96.8	95.1
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 55.14
Wt. of Dry Soil (g) 55.14

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
30-Apr-09	10:14	0		6.5			
	10:16	2	22.3	6.5	51.0	78.6	0.0261
	10:19	5	22.3	6.5	47.0	71.5	0.0172
	10:29	15	22.2	6.5	42.0	62.7	0.0104
	10:44	30	21.9	6.5	38.0	55.6	0.0077
	11:14	60	21.8	6.5	34.0	48.6	0.0056
	12:14	120	21.9	6.5	31.0	43.3	0.0041
	14:24	250	21.6	6.5	29.0	39.7	0.0028
01-May-09	10:14	1440	21.5	6.5	20.0	23.8	0.0013

GRAVEL			SAND					FINES	
COARSE	FINE		CRSE	MEDIUM	FINE		SILT		CLAY

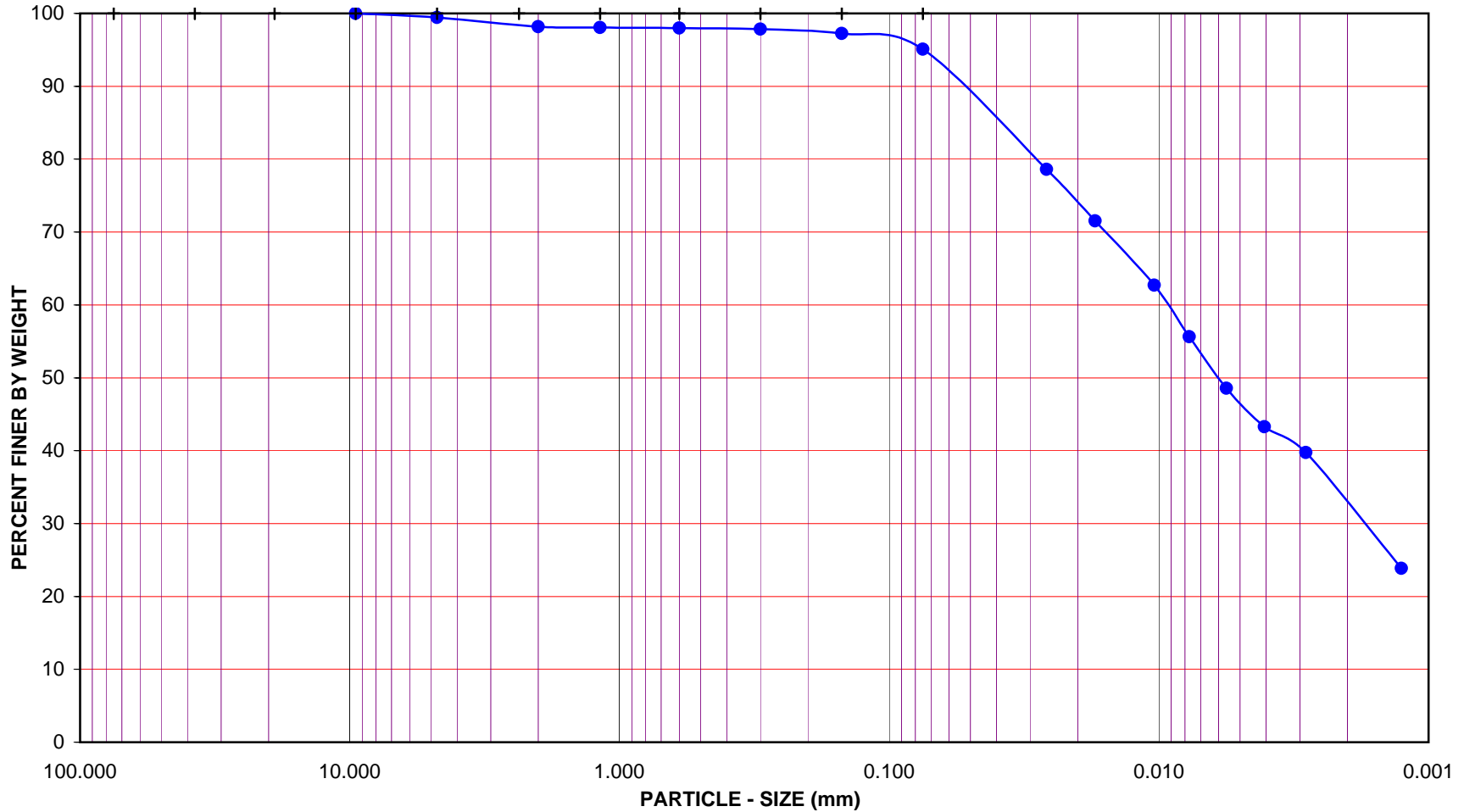
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B12

Sample No.: C29

Depth (feet): 140-140.6

Soil Type : CL

Soil Identification: Olive lean clay'stone' (CL)

**GR:SA:FI : (%) 1 : 4 : 95**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09





# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : A. Santos      Date: 03/10/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 04/08/09  
 Exploration No.: R-09-Z3-B12  
 Sample No.: S7      Depth (feet) : 35.0  
 Soil Identification: Yellowish brown silt with sand (ML)s

	<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>			
	<b>% Sand</b>	<b>25</b>	<b>(ML)s</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
	<b>% Fines</b>	<b>75</b>				
Specific Gravity (Assumed)	2.70		Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99		Dry Wt. of Soil + Cont. (g)	0.00	0.00	102.48
Wt. of Air-Dry Soil + Cont. (g)	665.70		Wt. of Container No. ___ (g)	1.00	1.00	76.33
Wt. of Container	108.00		Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	557.70		Wt. of Dry Soil (g)			26.15

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.08	100.0
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.00	100.0	100.0
No. 30	0.02	100.0	100.0
No. 50	0.23	99.8	99.8
No. 100	3.64	96.4	96.4
No. 200	25.20	74.9	74.9
Pan			

**Hydrometer**

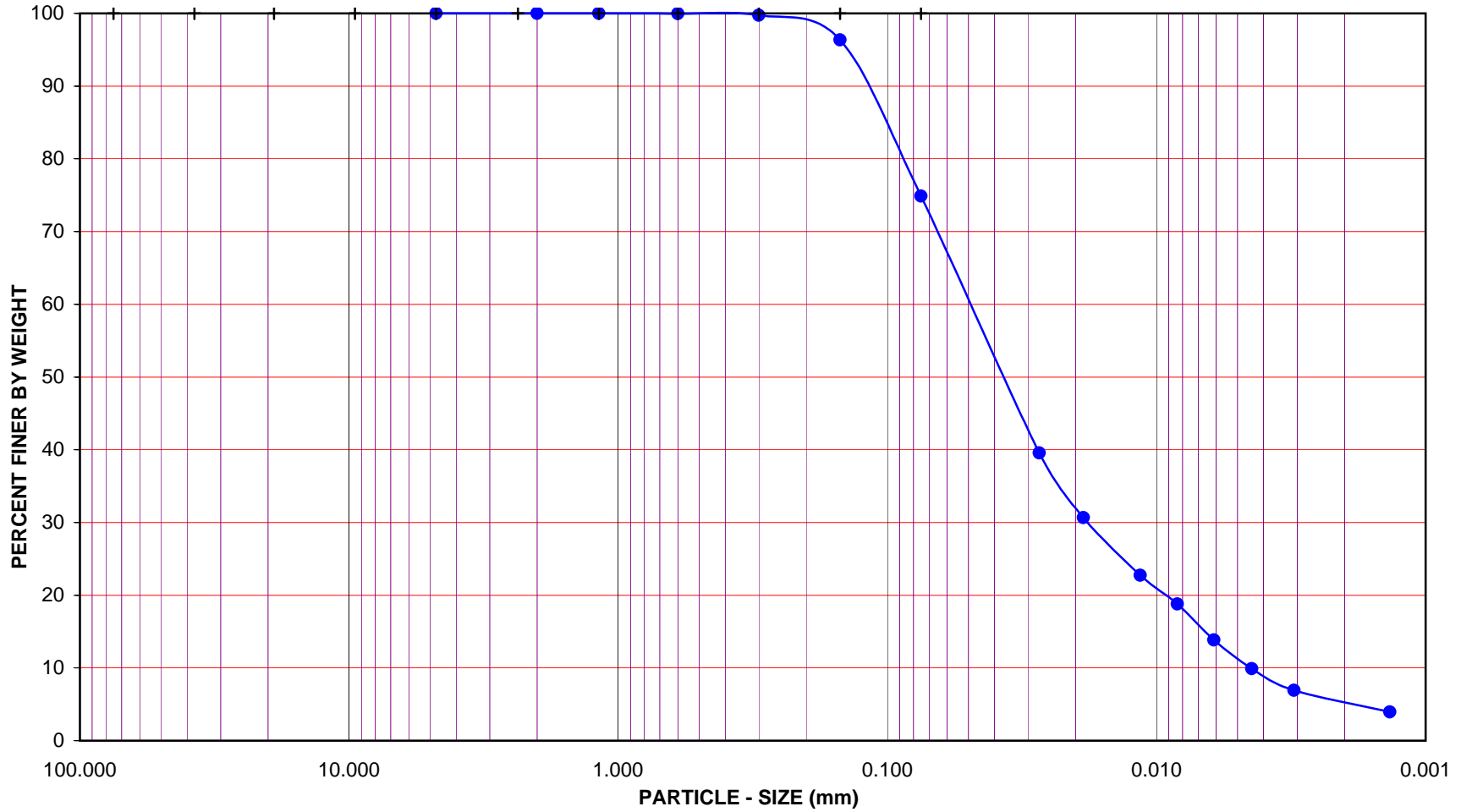
Wt. of Air-Dry Soil (g) 100.30
Wt. of Dry Soil (g) 100.30

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
12-Mar-09	9:36	0		8.0			
	9:38	2	21.0	8.0	48.0	39.6	0.0272
	9:41	5	21.0	8.0	39.0	30.7	0.0187
	9:51	15	21.0	8.0	31.0	22.7	0.0115
	10:06	30	21.1	8.0	27.0	18.8	0.0084
	10:36	60	21.4	8.0	22.0	13.8	0.0061
	11:36	120	21.8	8.0	18.0	9.9	0.0044
	13:46	250	22.5	8.0	15.0	6.9	0.0031
13-Mar-09	9:36	1440	19.9	8.0	12.0	4.0	0.0014

GRAVEL				SAND						FINES	
COARSE		FINE		CRSE	MEDIUM		FINE		SILT		CLAY

U.S. STANDARD SIEVE OPENING      U.S. STANDARD SIEVE NUMBER      HYDROMETER  
 3.0"    1 1/2"    3/4"    3/8"    #4    #8    #16    #30    #50    #100    #200



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B12

Sample No.: S7

Depth (feet): 35.0

Soil Type : (ML)s

Soil Identification: Yellowish brown silt with sand (ML)s

**GR:SA:FI : (%)      0 : 25 : 75**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

Apr-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : A. Santos      Date: 04/01/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 04/08/09  
 Exploration No.: R-09-Z3-B12  
 Sample No.: S15      Depth (feet) : 75.0  
 Soil Identification: Olive brown lean clay with sand (CL)s

<b>% Gravel</b>	<b>1</b>	<b>Soil Type</b>  <b>(CL)s</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>16</b>				
<b>% Fines</b>	<b>83</b>				

Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	84.56
Wt. of Air-Dry Soil + Cont. (g)	614.30	Wt. of Container No. ___ (g)	1.00	1.00	76.15
Wt. of Container	106.90	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	507.40	Wt. of Dry Soil (g)			8.41

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	4.43	99.1
No. 10	7.47	98.5
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	98.5
No. 16	0.07	99.9	98.4
No. 30	0.24	99.5	98.1
No. 50	0.71	98.6	97.2
No. 100	2.48	95.2	93.8
No. 200	8.00	84.4	83.1
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 51.25
Wt. of Dry Soil (g) 51.25

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
02-Apr-09	10:15	0		8.0			
	10:17	2	21.5	8.0	39.0	59.1	0.0295
	10:20	5	21.5	8.0	35.0	51.5	0.0193
	10:30	15	21.6	8.0	32.0	45.8	0.0114
	10:49	34	21.6	8.0	30.0	42.0	0.0077
	11:15	60	21.7	8.0	28.5	39.1	0.0058
	12:15	120	21.8	8.0	27.5	37.2	0.0042
	14:25	250	22.4	8.0	26.0	34.3	0.0029
03-Apr-09	10:15	1440	21.6	8.0	24.0	30.5	0.0012

GRAVEL			SAND				FINES	
COARSE	FINE		CRSE	MEDIUM	FINE		SILT	CLAY

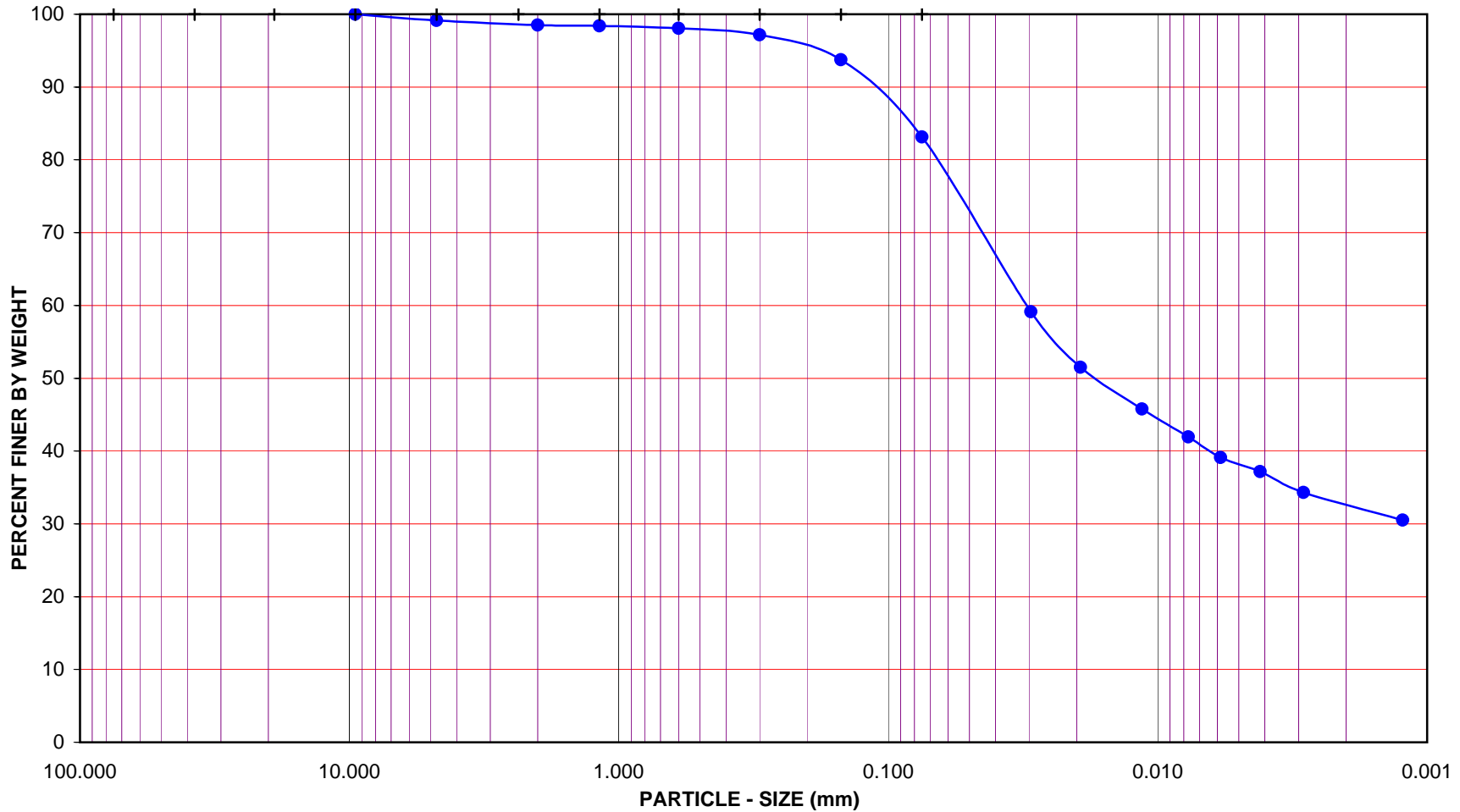
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z3-B12

Sample No.: S15

Depth (feet): 75.0

Soil Type : (CL)s

Soil Identification: Olive brown lean clay with sand (CL)s

**GR:SA:FI : (%) 1 : 16 : 83**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

Apr-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By: V. Juliano    Date: 04/28/09  
 Project No.: 378312.04.09.01                              Checked By: J. Ward    Date: 05/07/09  
 Exploration No.: R-09-Z4-B4                              Depth (feet): 50.0  
 Sample No.: S-10  
 Soil Identification: Yellowish brown silty sand with gravel (SM)g

		Moisture Content of Total Air - Dry Soil	
Container No.:	544	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	667.60	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	77.60	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	590.00	Moisture Content (%)	0.00

After Wet Sieve	Container No.	544
	Wt. of Dry Soil + Container (g)	575.90
	Wt. of Container (g)	77.60
	Dry Wt. of Soil Retained on # 200 Sieve (g)	498.30

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500	0.00	100.0
3/4"	19.000	32.30	94.5
3/8"	9.500	53.80	90.9
#4	4.750	88.90	84.9
#8	2.360	130.40	77.9
#16	1.180	189.70	67.8
#30	0.600	275.10	53.4
#50	0.300	373.10	36.8
#100	0.150	449.50	23.8
#200	0.075	494.80	16.1
PAN			

GRAVEL: **15 %**  
 SAND: **69 %**  
 FINES: **16 %**  
 GROUP SYMBOL: **(SM)g**

Cu = D60/D10 = \_\_\_\_\_

Cc = (D30)<sup>2</sup>/(D60\*D10) = \_\_\_\_\_

Remarks: Insufficient sample mass available to meet the ASTM specification for this material

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

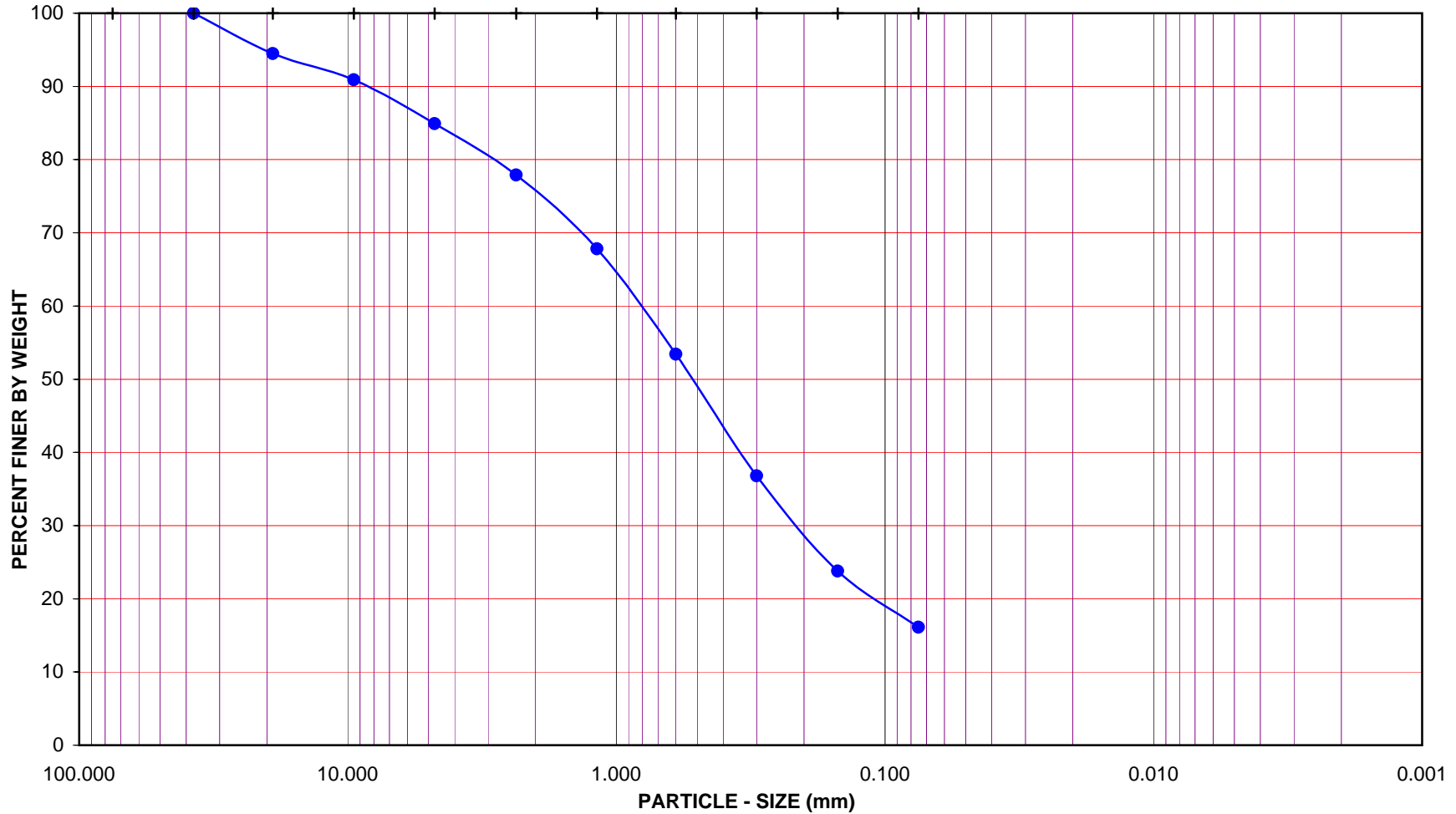
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z4-B4

Sample No.: S-10

Depth (feet): 50.0

Soil Type : (SM)g

Soil Identification: Yellowish brown silty sand with gravel (SM)g

**GR:SA:FI : (%)      15 : 69 : 16**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



**PARTICLE-SIZE ANALYSIS of SOILS**  
**ASTM D 422**

Project Name: [SR-710 Tunnel Technical Study](#)  
 Project No.: [378312.04.09.01](#)  
 Exploration No.: [R-09-Z4-B4](#)  
 Sample No.: [S-13](#)  
 Soil Identification: [Brown silty sand \(SM\)](#)

Tested By: [V. Juliano](#) Date: [04/28/09](#)  
 Checked By: [J. Ward](#) Date: [05/07/09](#)  
 Depth (feet): [65.0](#)

		Moisture Content of Total Air - Dry Soil	
Container No.:	524	Wt. of Air-Dry Soil + Cont. (g)	0.00
Wt. of Air-Dried Soil + Cont.(g)	616.70	Wt. of Dry Soil + Cont. (g)	0.00
Wt. of Container (g)	80.10	Wt. of Container No. _____ (g)	1.00
Dry Wt. of Soil (g)	536.60	Moisture Content (%)	0.00

After Wet Sieve	Container No.	524
	Wt. of Dry Soil + Container (g)	416.60
	Wt. of Container (g)	80.10
	Dry Wt. of Soil Retained on # 200 Sieve (g)	336.50

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
6"	152.400		
3"	75.000		
1 1/2"	37.500		
3/4"	19.000	0.00	100.0
3/8"	9.500	1.90	99.6
#4	4.750	4.60	99.1
#8	2.360	11.50	97.9
#16	1.180	22.50	95.8
#30	0.600	47.50	91.1
#50	0.300	109.50	79.6
#100	0.150	231.20	56.9
#200	0.075	331.60	38.2
PAN			

GRAVEL: **1 %**  
 SAND: **61 %**  
 FINES: **38 %**  
 GROUP SYMBOL: **SM**

$C_u = D_{60}/D_{10} =$  \_\_\_\_\_

$C_c = (D_{30})^2/(D_{60}*D_{10}) =$  \_\_\_\_\_

Remarks: Insufficient sample mass available to meet the ASTM specification for this material

GRAVEL			SAND				FINES	
COARSE	FINE		COARSE	MEDIUM	FINE		SILT	CLAY

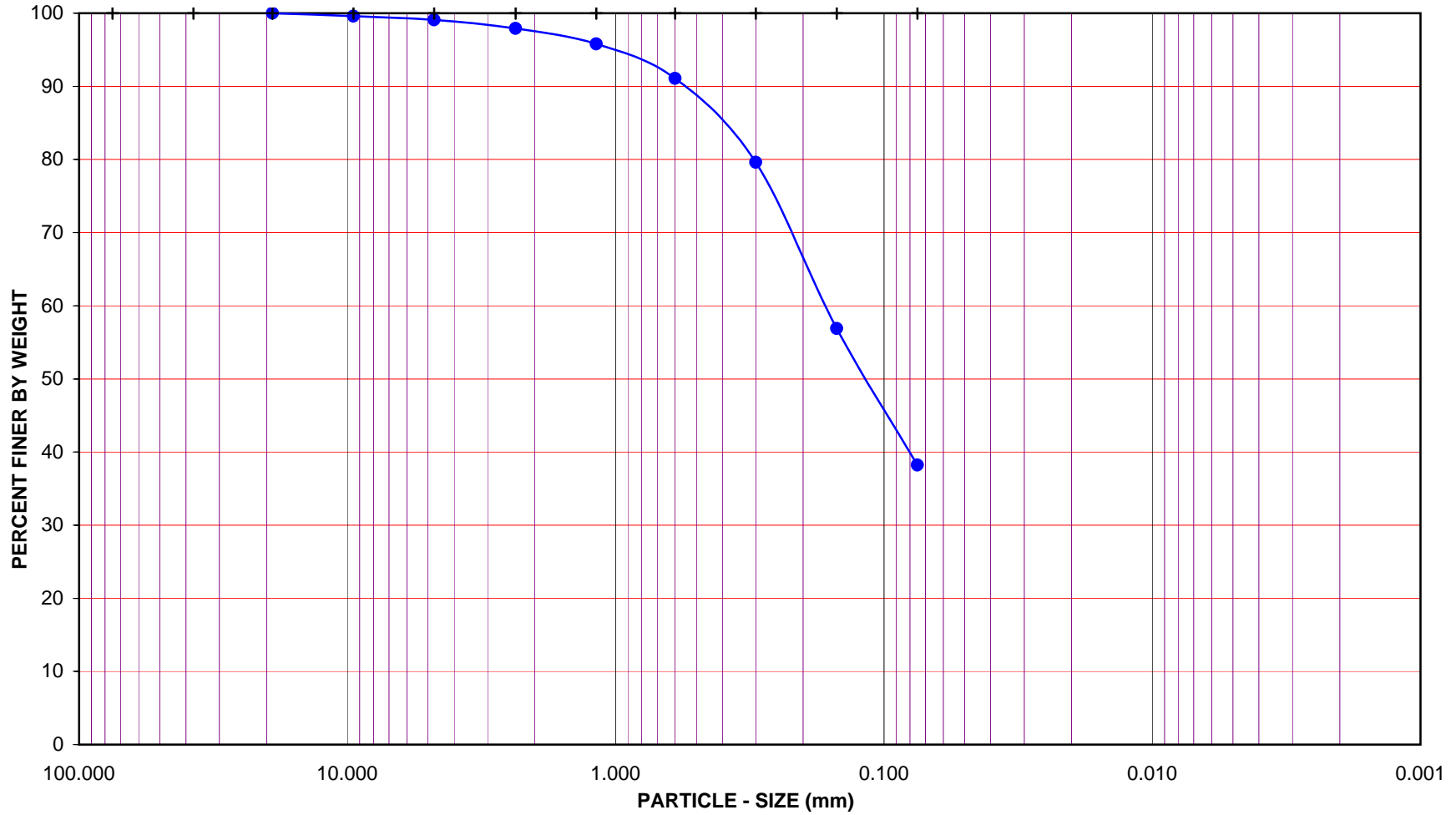
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8"

U.S. STANDARD SIEVE NUMBER

#4 #8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z4-B4

Sample No.: S-13

Depth (feet): 65.0

Soil Type : SM

Soil Identification: Brown silty sand (SM)

**GR:SA:FI : (%) 1 : 61 : 38**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09





# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/06/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/21/09  
 Exploration No.: R-09-Z4-B4  
 Sample No.: C-19      Depth (feet) : 97.5-98.3  
 Soil Identification: Yellow fat clay'stone' (CH)

<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>  <b>CH</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>1</b>				
<b>% Fines</b>	<b>99</b>				

Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	75.90
Wt. of Air-Dry Soil + Cont. (g)	589.60	Wt. of Container No. ___ (g)	1.00	1.00	75.13
Wt. of Container	78.40	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	511.20	Wt. of Dry Soil (g)			0.77

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.00	100.0
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.00	100.0	100.0
No. 30	0.00	100.0	100.0
No. 50	0.04	99.9	99.9
No. 100	0.11	99.8	99.8
No. 200	0.65	98.7	98.7
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 50.18
Wt. of Dry Soil (g) 50.18

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
08-May-09	8:15	0		6.0			
	8:17	2	21.3	6.0	46.5	80.1	0.0277
	8:20	5	21.3	6.0	40.5	68.2	0.0185
	8:30	15	21.1	6.0	34.0	55.4	0.0112
	8:45	30	21.2	6.0	30.0	47.4	0.0082
	9:15	60	21.3	6.0	27.0	41.5	0.0059
	10:15	120	21.5	6.0	24.0	35.6	0.0043
	12:25	250	21.5	6.0	21.5	30.6	0.0030
09-May-09	8:15	1440	21.1	6.0	18.0	23.7	0.0013

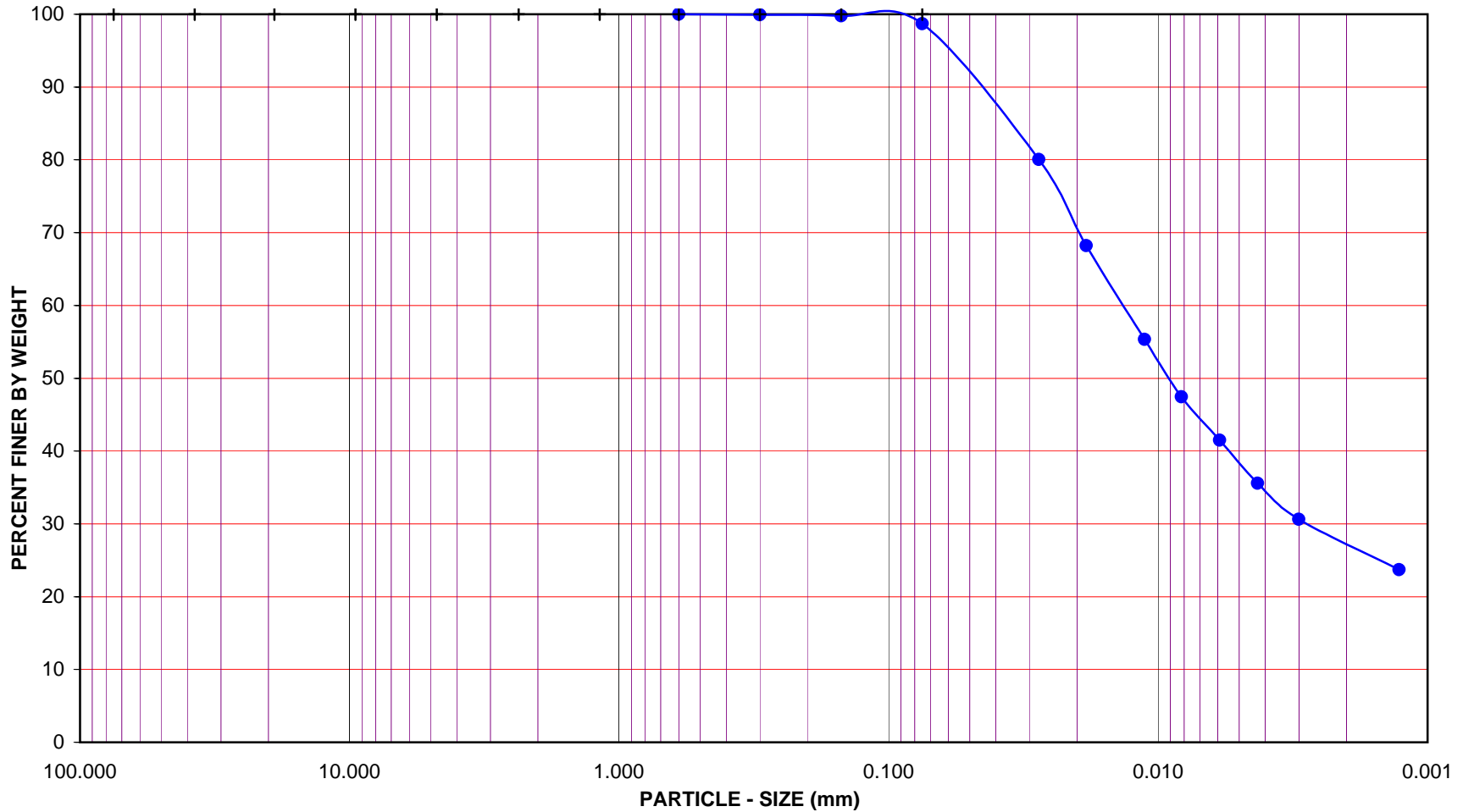
GRAVEL				SAND				FINES			
COARSE		FINE		CRSE	MEDIUM	FINE		SILT		CLAY	

U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4 #8 #16 #30 #50 #100 #200

U.S. STANDARD SIEVE NUMBER

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z4-B4

Sample No.: C-19

Depth (feet) : 97.5-98.3

Soil Type : CH

Soil Identification: Yellow fat clay'stone' (CH)

**GR:SA:FI : (%)      0 : 1 : 99**



Leighton

**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 04/28/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/07/09  
 Exploration No.: R-09-Z4-B4  
 Sample No.: S-3      Depth (feet) : 15.0  
 Soil Identification: Yellowish brown sandy silty clay s(CL-ML)

<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>  <b>s(CL-ML)</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>31</b>				
<b>% Fines</b>	<b>69</b>				
Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	93.96
Wt. of Air-Dry Soil + Cont. (g)	496.00	Wt. of Container No.____ (g)	1.00	1.00	75.97
Wt. of Container	75.90	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	420.10	Wt. of Dry Soil (g)			17.99

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	0.00	100.0
No. 10	1.03	99.8
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	99.8
No. 16	0.28	99.5	99.2
No. 30	1.01	98.2	97.9
No. 50	2.95	94.6	94.4
No. 100	7.87	85.7	85.5
No. 200	17.12	68.9	68.8
Pan			

**Hydrometer**      Wt. of Air-Dry Soil (g) 55.10      Wt. of Dry Soil (g) 55.10  
 Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
30-Apr-09	8:44	0		6.5			
	8:46	2	21.6	6.5	33.5	48.5	0.0309
	8:49	5	21.6	6.5	29.0	40.4	0.0201
	8:59	15	21.7	6.5	24.0	31.4	0.0121
	9:14	30	21.8	6.5	23.0	29.6	0.0086
	9:44	60	22.0	6.5	21.0	26.0	0.0061
	10:44	120	21.9	6.5	19.5	23.3	0.0044
	12:54	250	21.8	6.5	17.5	19.8	0.0031
01-May-09	8:44	1440	21.7	6.5	15.0	15.3	0.0013

GRAVEL				SAND				FINES			
COARSE		FINE		CRSE	MEDIUM		FINE	SILT		CLAY	

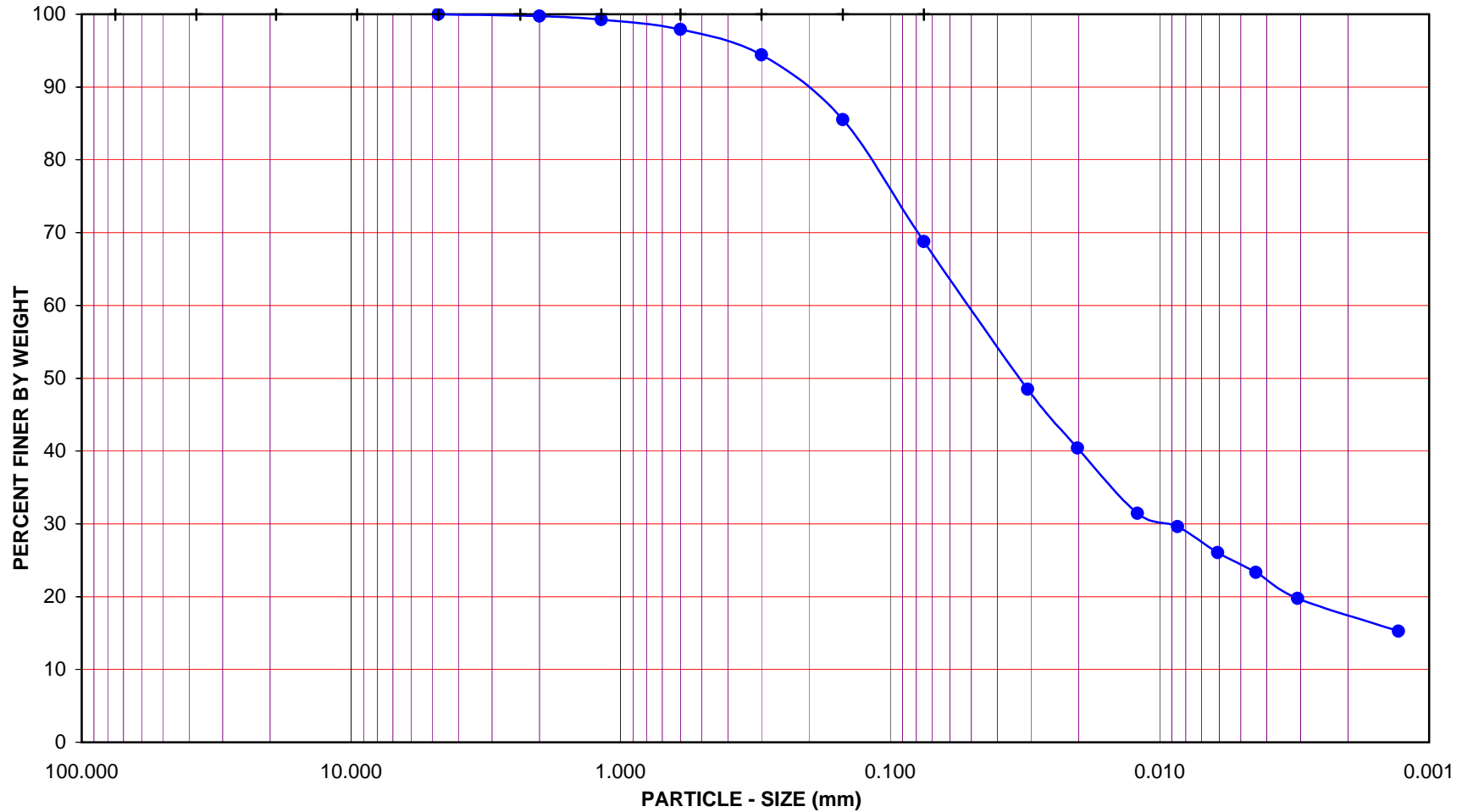
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z4-B4

Sample No.: S-3

Depth (feet): 15.0

Soil Type : s(CL-ML)

Soil Identification: Yellowish brown sandy silty clay s(CL-ML)

**GR:SA:FI : (%) 0 : 31 : 69**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



# PARTICLE-SIZE ANALYSIS OF SOILS

**ASTM D 422**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 04/28/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/12/09  
 Exploration No.: R-09-Z4-B4  
 Sample No.: S-7      Depth (feet) : 35.0  
 Soil Identification: Yellowish brown sandy silty clay s(CL-ML)

<b>% Gravel</b>	<b>0</b>	<b>Soil Type</b>  <b>s(CL-ML)</b>	Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
<b>% Sand</b>	<b>43</b>				
<b>% Fines</b>	<b>57</b>				

Specific Gravity (Assumed)	2.70	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	113.26
Wt. of Air-Dry Soil + Cont. (g)	764.60	Wt. of Container No. ___ (g)	1.00	1.00	79.18
Wt. of Container	108.60	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	656.00	Wt. of Dry Soil (g)			34.08

Coarse Sieve		
U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
¾"	0.00	100.0
⅜"	0.00	100.0
No. 4	2.21	99.7
No. 10	6.21	99.1
Pan		

Sieve after Hydrometer & Wet Sieve			
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	99.1
No. 16	0.42	99.5	98.5
No. 30	2.35	97.1	96.1
No. 50	9.89	87.6	86.8
No. 100	22.80	71.5	70.8
No. 200	33.77	57.8	57.3
Pan			

**Hydrometer**

Wt. of Air-Dry Soil (g) 80.06
Wt. of Dry Soil (g) 80.06

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
30-Apr-09	8:40	0		6.5			
	8:42	2	21.6	6.5	41.5	43.0	0.0289
	8:45	5	21.6	6.5	36.5	36.8	0.0191
	8:55	15	21.6	6.5	30.5	29.5	0.0115
	9:10	30	21.8	6.5	27.0	25.2	0.0084
	9:40	60	22.0	6.5	23.0	20.3	0.0060
	10:40	120	21.8	6.5	20.0	16.6	0.0044
	12:50	250	21.7	6.5	17.0	12.9	0.0031
01-May-09	8:40	1440	21.7	6.5	12.0	6.8	0.0013

GRAVEL			SAND				FINES	
COARSE	FINE		CRSE	MEDIUM	FINE		SILT	CLAY

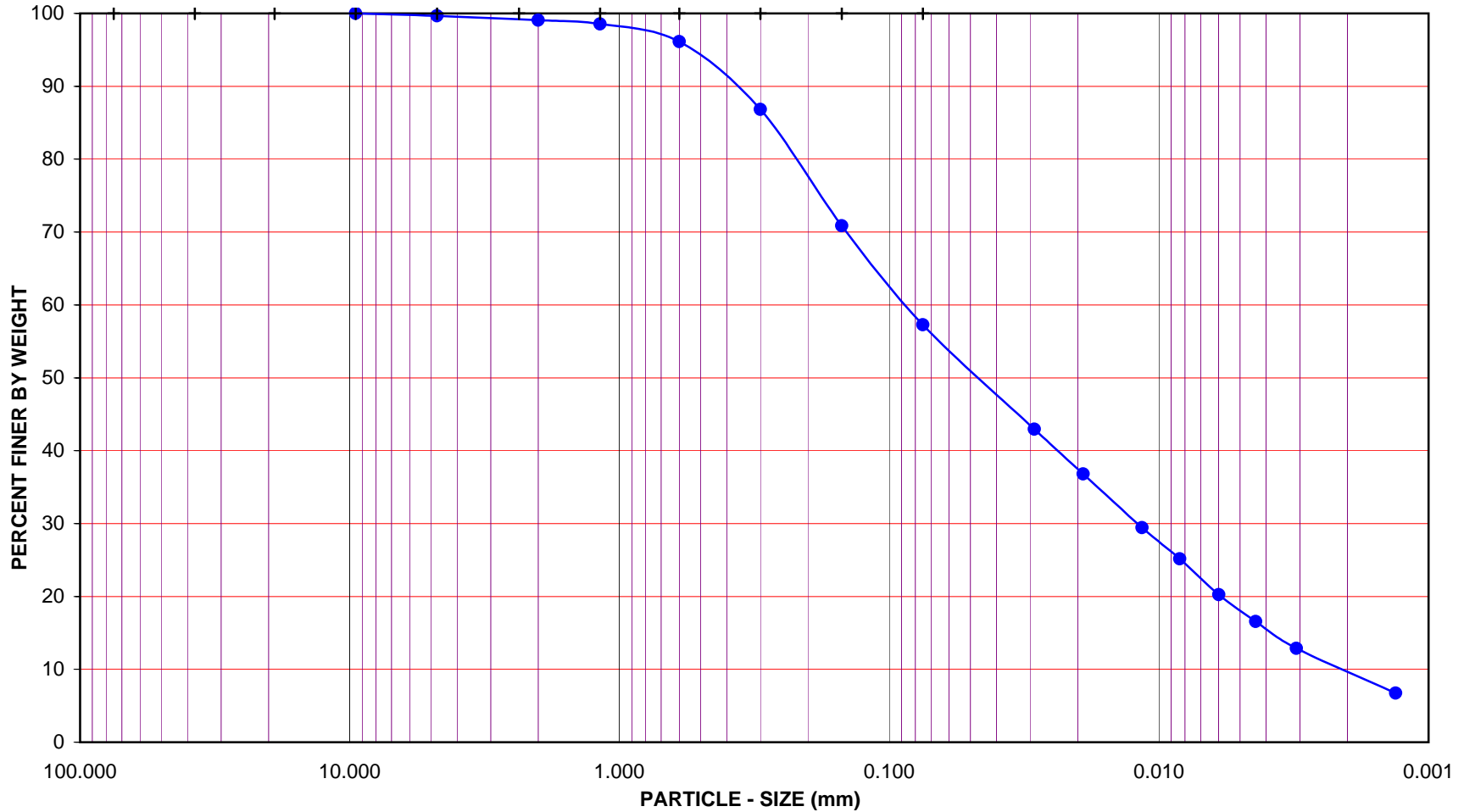
U.S. STANDARD SIEVE OPENING

3.0" 1 1/2" 3/4" 3/8" #4

U.S. STANDARD SIEVE NUMBER

#8 #16 #30 #50 #100 #200

HYDROMETER



Project Name: SR-710 Tunnel Technical Study

Project No.: 378312.04.09.01

Exploration No.: R-09-Z4-B4

Sample No.: S-7

Depth (feet): 35.0

Soil Type : s(CL-ML)

Soil Identification: Yellowish brown sandy silty clay s(CL-ML)

**GR:SA:FI : (%) 0 : 43 : 57**



**PARTICLE - SIZE  
DISTRIBUTION  
ASTM D 422**

May-09



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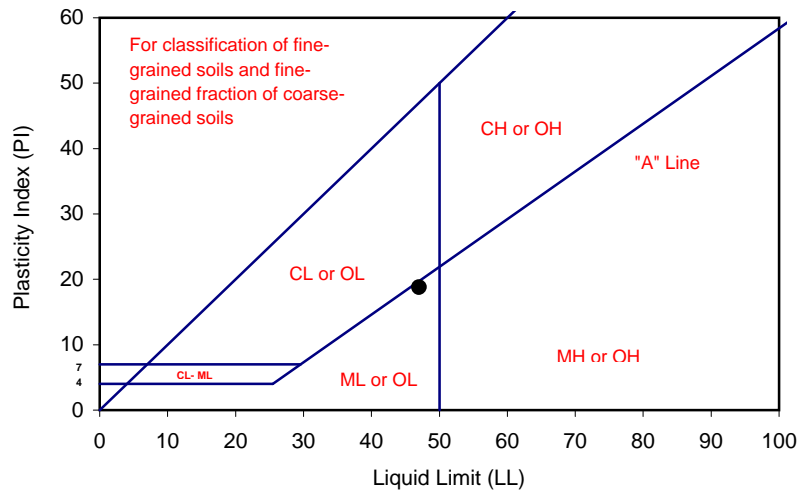
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: G. Bathala Date: 05/12/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/14/09  
 Boring No.: R-09-Z1-B8 Checked By: J. Ward  
 Sample No.: C17 Depth (ft.) 80-80.75  
 Soil Identification: Dark olive silt'stone' (ML)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	29	22	16
Wet Wt. of Soil + Cont. (g)	10.90	12.70	12.47	12.45	11.24	13.06
Dry Wt. of Soil + Cont. (g)	8.74	10.15	8.95	8.88	7.95	9.05
Wt. of Container (g)	1.10	1.08	1.12	1.05	1.07	1.05
Moisture Content (%) [W <sub>n</sub> ]	28.27	28.11	44.96	45.59	47.82	50.13

<b>Liquid Limit</b>	<b>47</b>
<b>Plastic Limit</b>	<b>28</b>
<b>Plasticity Index</b>	<b>19</b>
<b>Classification</b>	<b>ML</b>



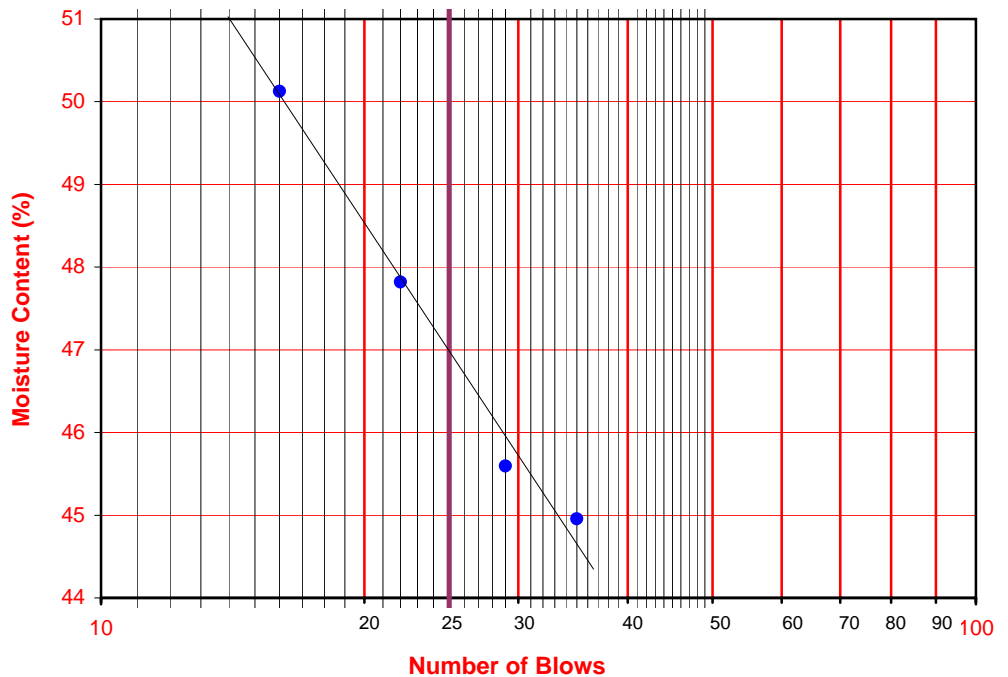
PI at "A" - Line =  $0.73(LL-20)$  = 19.71

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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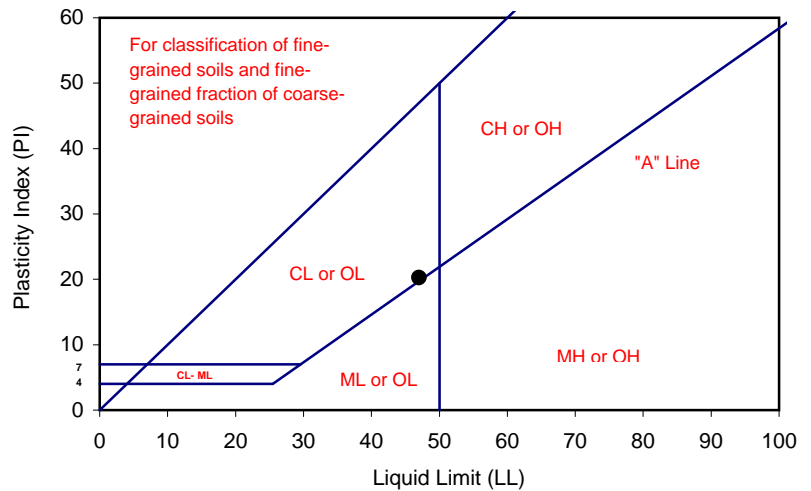
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/12/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/14/09  
 Boring No.: R-09-Z1-B8 Checked By: J. Ward  
 Sample No.: C23 Depth (ft.) 109-109.7  
 Soil Identification: Dark olive lean clay'stone' (CL)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			28	22	16	
Wet Wt. of Soil + Cont. (g)	10.95	10.99	13.81	14.25	14.09	
Dry Wt. of Soil + Cont. (g)	8.86	8.90	9.78	10.01	9.86	
Wt. of Container (g)	1.06	1.08	1.05	1.02	1.06	
Moisture Content (%) [W <sub>n</sub> ]	26.79	26.73	46.16	47.16	48.07	

<b>Liquid Limit</b>	<b>47</b>
<b>Plastic Limit</b>	<b>27</b>
<b>Plasticity Index</b>	<b>20</b>
<b>Classification</b>	<b>CL</b>



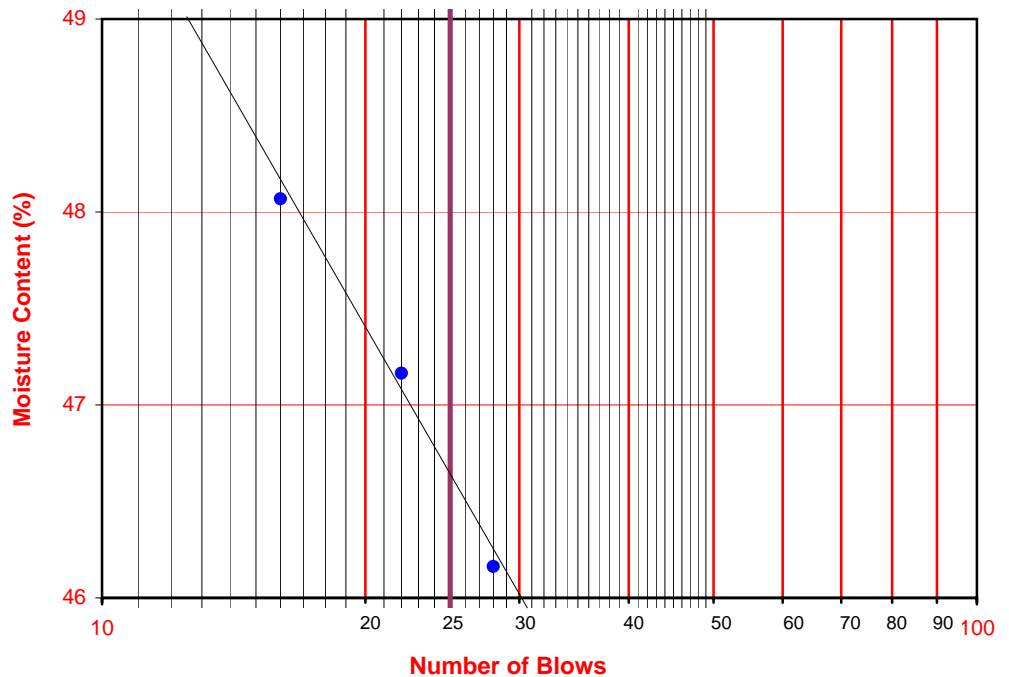
PI at "A" - Line =  $0.73(LL-20)$  19.71

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test







# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/13/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/14/09  
 Boring No.: R-09-Z1-B8 Checked By: J. Ward  
 Sample No.: C26 Depth (ft.) 120-120.4  
 Soil Identification: Dark olive lean clay'stone' (CL)

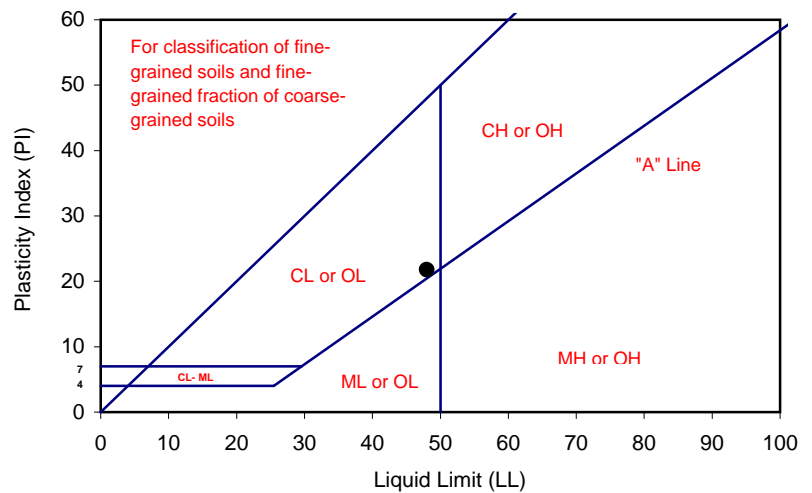
TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	28	22	
Wet Wt. of Soil + Cont. (g)	8.72	9.23	14.48	14.53	16.71	
Dry Wt. of Soil + Cont. (g)	7.14	7.52	10.33	10.25	11.59	
Wt. of Container (g)	1.07	1.05	1.06	1.09	1.05	
Moisture Content (%) [W <sub>n</sub> ]	26.03	26.43	44.77	46.72	48.58	

<b>Liquid Limit</b>	<b>48</b>
<b>Plastic Limit</b>	<b>26</b>
<b>Plasticity Index</b>	<b>22</b>
<b>Classification</b>	<b>CL</b>

PI at "A" - Line =  $0.73(LL-20)$  20.44

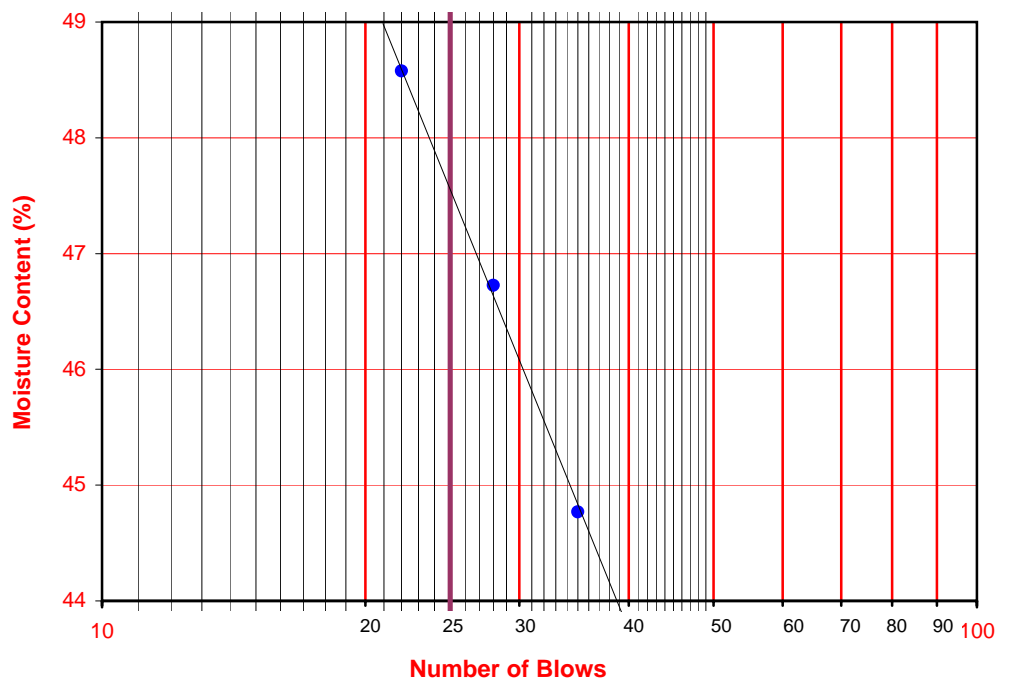
One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$



## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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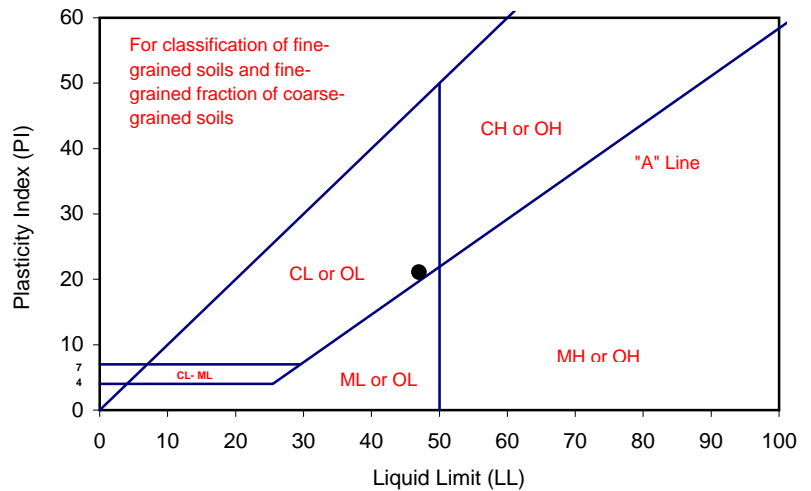
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/12/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/14/09  
 Boring No.: R-09-Z1-B8 Checked By: J. Ward  
 Sample No.: C33 Depth (ft.) 159.25-160  
 Soil Identification: Dark olive lean clay'stone' (CL)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	28	21	
Wet Wt. of Soil + Cont. (g)	9.24	9.76	13.43	14.68	16.16	
Dry Wt. of Soil + Cont. (g)	7.55	7.97	9.59	10.34	11.25	
Wt. of Container (g)	1.05	1.04	1.03	1.01	1.06	
Moisture Content (%) [W <sub>n</sub> ]	26.00	25.83	44.86	46.52	48.18	

<b>Liquid Limit</b>	<b>47</b>
<b>Plastic Limit</b>	<b>26</b>
<b>Plasticity Index</b>	<b>21</b>
<b>Classification</b>	<b>CL</b>



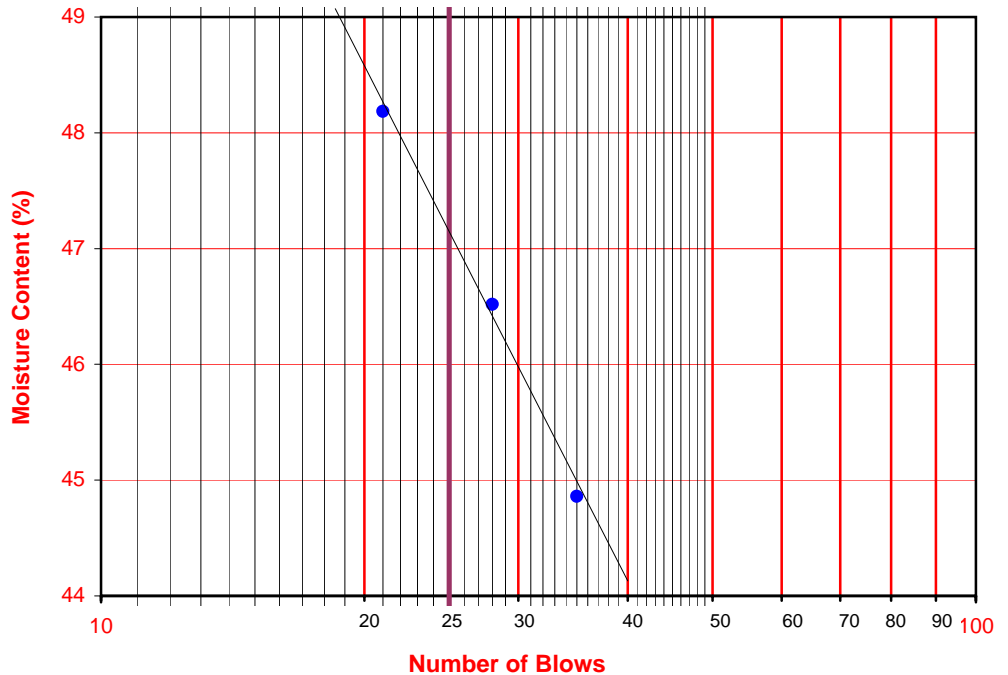
PI at "A" - Line =  $0.73(LL-20)$  19.71

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





Leighton

# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 04/06/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 04/08/09  
 Boring No.: R-09-Z1-B8 Checked By: J. Ward  
 Sample No.: S06 Depth (ft.) 25-26.5  
 Soil Identification: Dark brown lean clay (CL)

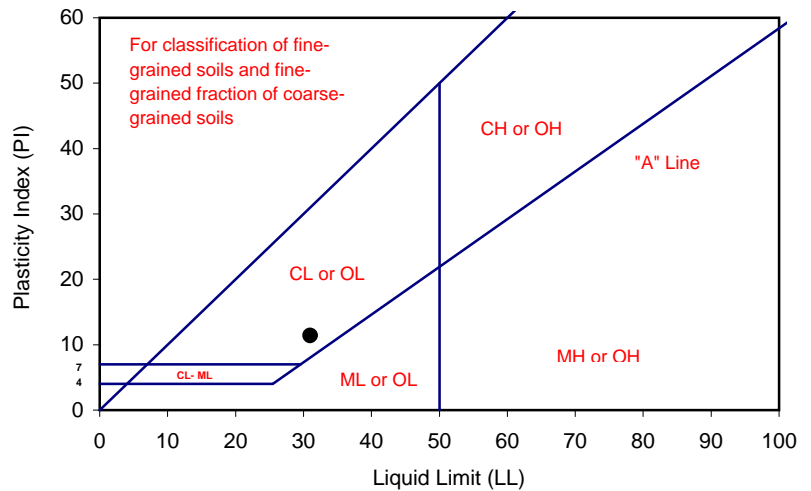
TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	28	21	
Wet Wt. of Soil + Cont. (g)	9.59	9.08	15.44	14.68	14.63	
Dry Wt. of Soil + Cont. (g)	8.20	7.76	12.10	11.46	11.34	
Wt. of Container (g)	1.07	1.05	1.03	1.00	1.06	
Moisture Content (%) [W <sub>n</sub> ]	19.50	19.67	30.17	30.78	32.00	

<b>Liquid Limit</b>	<b>31</b>
<b>Plastic Limit</b>	<b>20</b>
<b>Plasticity Index</b>	<b>11</b>
<b>Classification</b>	<b>CL</b>

PI at "A" - Line =  $0.73(LL-20)$  8.03

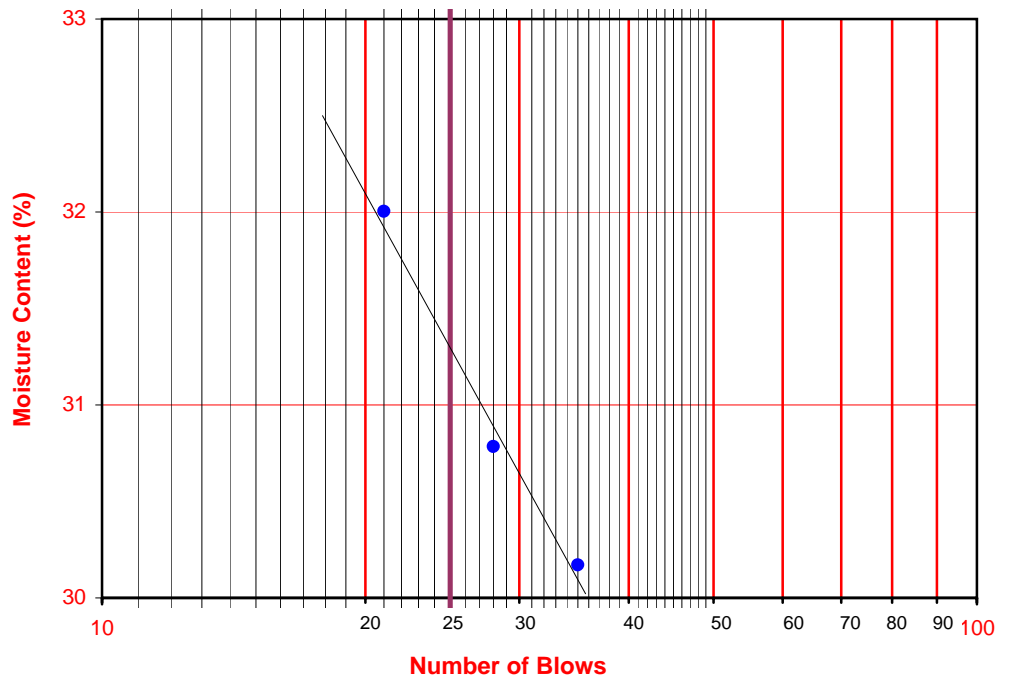
One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$



## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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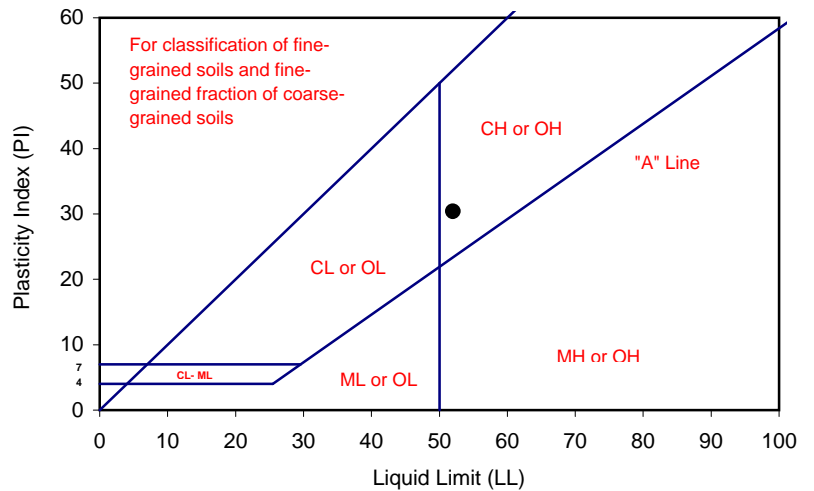
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/27/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 06/01/09  
 Boring No.: R-09-Z2-B5 Checked By: J. Ward  
 Sample No.: S15 Depth (ft.) 75.0  
 Soil Identification: Olive brown fat clay (CH)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			34	27	19	
Wet Wt. of Soil + Cont. (g)	9.46	9.57	14.31	15.20	18.48	
Dry Wt. of Soil + Cont. (g)	7.98	8.05	9.85	10.40	12.46	
Wt. of Container (g)	1.08	1.08	1.05	1.08	1.11	
Moisture Content (%) [W <sub>n</sub> ]	21.45	21.81	50.68	51.50	53.04	

<b>Liquid Limit</b>	<b>52</b>
<b>Plastic Limit</b>	<b>22</b>
<b>Plasticity Index</b>	<b>30</b>
<b>Classification</b>	<b>CH</b>



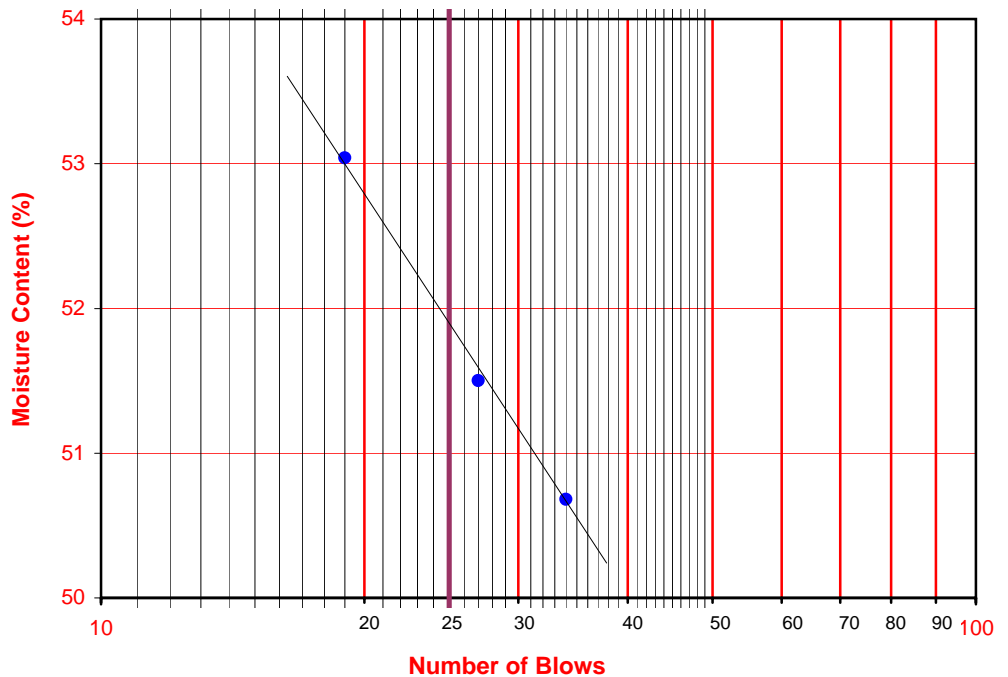
PI at "A" - Line =  $0.73(LL-20)$  23.36

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





Leighton

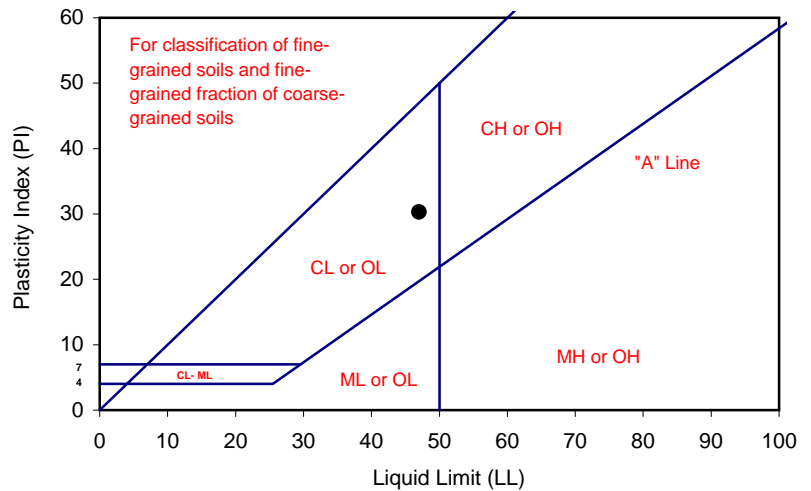
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: F. Tabibkhoei Date: 06/02/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 06/03/09  
 Boring No.: R-09-Z2-B5 Checked By: J. Ward  
 Sample No.: O21 Depth (ft.) 105-106.5  
 Soil Identification: Olive brown lean clay (CL)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			22	32	35	
Wet Wt. of Soil + Cont. (g)	39.74	51.46	48.87	52.76	59.41	
Dry Wt. of Soil + Cont. (g)	37.54	48.64	41.11	43.88	48.52	
Wt. of Container (g)	24.55	31.57	24.65	24.69	24.76	
Moisture Content (%) [W <sub>n</sub> ]	16.94	16.52	47.14	46.27	45.83	

<b>Liquid Limit</b>	<b>47</b>
<b>Plastic Limit</b>	<b>17</b>
<b>Plasticity Index</b>	<b>30</b>
<b>Classification</b>	<b>CL</b>



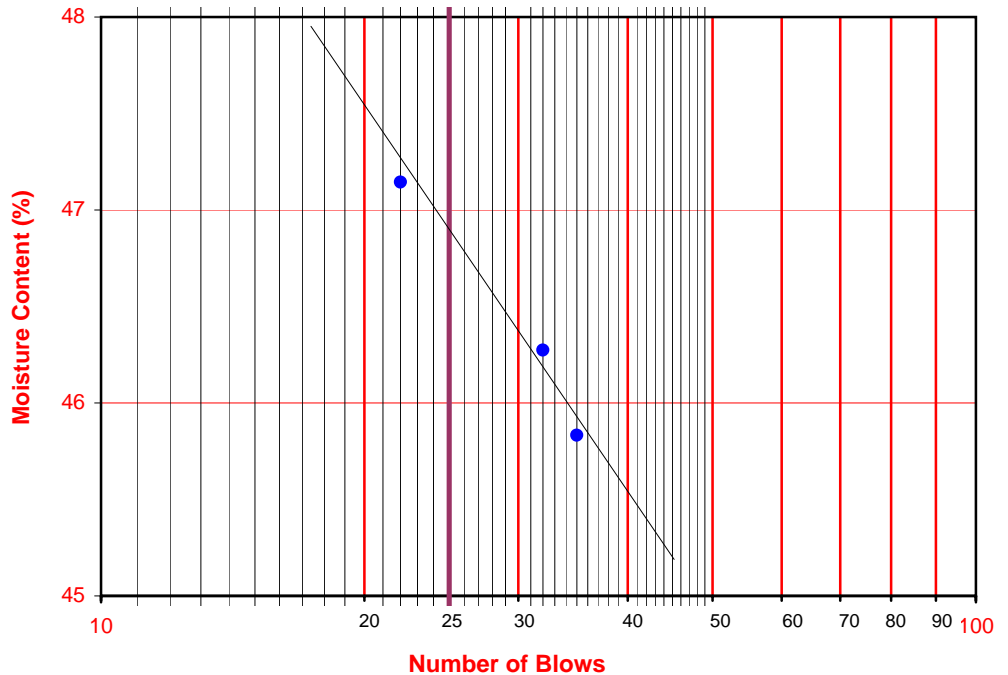
PI at "A" - Line =  $0.73(LL-20)$  19.71

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





Leighton

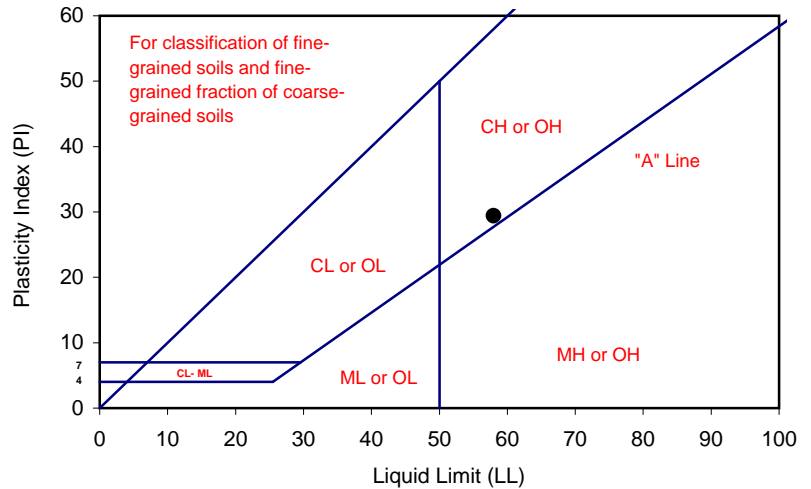
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: G. Bathala Date: 05/27/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 06/01/09  
 Boring No.: R-09-Z2-B5 Checked By: J. Ward  
 Sample No.: O25 Depth (ft.) 125.0  
 Soil Identification: Light olive brown fat clay (CH)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	26	19	
Wet Wt. of Soil + Cont. (g)	12.21	12.56	10.86	11.48	11.92	
Dry Wt. of Soil + Cont. (g)	9.73	9.99	7.33	7.68	7.86	
Wt. of Container (g)	1.05	1.01	1.02	1.04	1.08	
Moisture Content (%) [Wn]	28.57	28.62	55.94	57.23	59.88	

<b>Liquid Limit</b>	<b>58</b>
<b>Plastic Limit</b>	<b>29</b>
<b>Plasticity Index</b>	<b>29</b>
<b>Classification</b>	<b>CH</b>



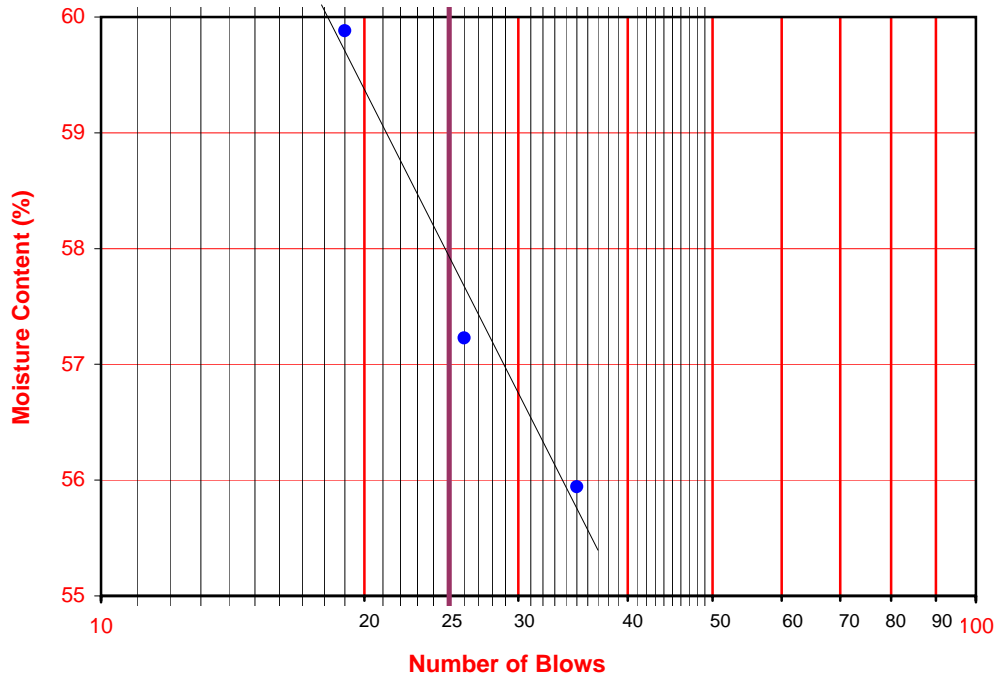
PI at "A" - Line =  $0.73(LL-20)$  27.74

One - Point Liquid Limit Calculation

$$LL = Wn(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





Leighton

# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/12/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/15/09  
 Boring No.: R-09-Z3-B2 Checked By: J. Ward  
 Sample No.: S4 Depth (ft.) 11.8-12.3  
 Soil Identification: Yellowish brown poorly-graded gravel with silt and sand (GP-GM)s

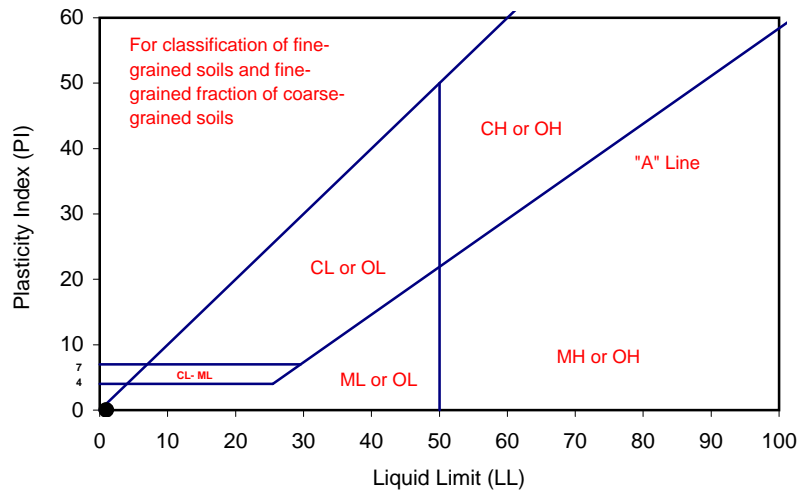
TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			8			
Wet Wt. of Soil + Cont. (g)	<b>Cannot be rolled:</b>		17.57	<b>Cannot get more than 8 blows:</b>		
Dry Wt. of Soil + Cont. (g)	<b>NonPlastic</b>		14.52	<b>NonPlastic</b>		
Wt. of Container (g)			1.10			
Moisture Content (%) [Wn]			22.73			

<b>Liquid Limit</b>	<b>NP</b>
<b>Plastic Limit</b>	<b>NP</b>
<b>Plasticity Index</b>	<b>NP</b>
<b>Classification</b>	<b>NP</b>

PI at "A" - Line =  $0.73(LL-20)$  =

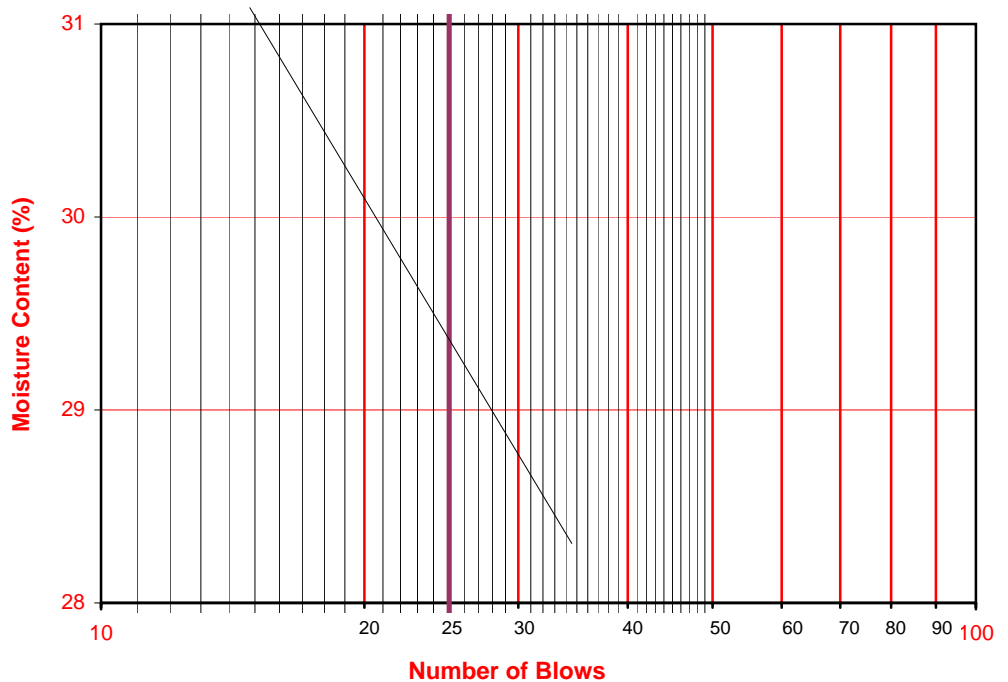
One - Point Liquid Limit Calculation

$$LL = Wn(N/25)^{0.12}$$



## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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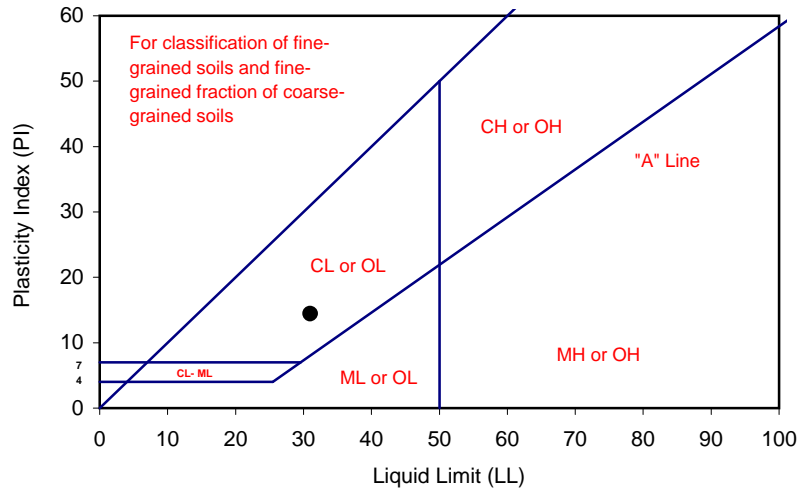
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: G. Bathala Date: 05/13/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/15/09  
 Boring No.: R-09-Z3-B2 Checked By: J. Ward  
 Sample No.: C41 Depth (ft.) 116.5-120  
 Soil Identification: Yellowish brown clayey sand (SC)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	27	20	
Wet Wt. of Soil + Cont. (g)	13.16	12.54	12.92	14.70	15.49	
Dry Wt. of Soil + Cont. (g)	11.43	10.92	10.24	11.52	12.02	
Wt. of Container (g)	1.05	1.06	1.07	1.04	1.07	
Moisture Content (%) [W <sub>n</sub> ]	16.67	16.43	29.23	30.34	31.69	

<b>Liquid Limit</b>	<b>31</b>
<b>Plastic Limit</b>	<b>17</b>
<b>Plasticity Index</b>	<b>14</b>
<b>Classification</b>	<b>CL</b>



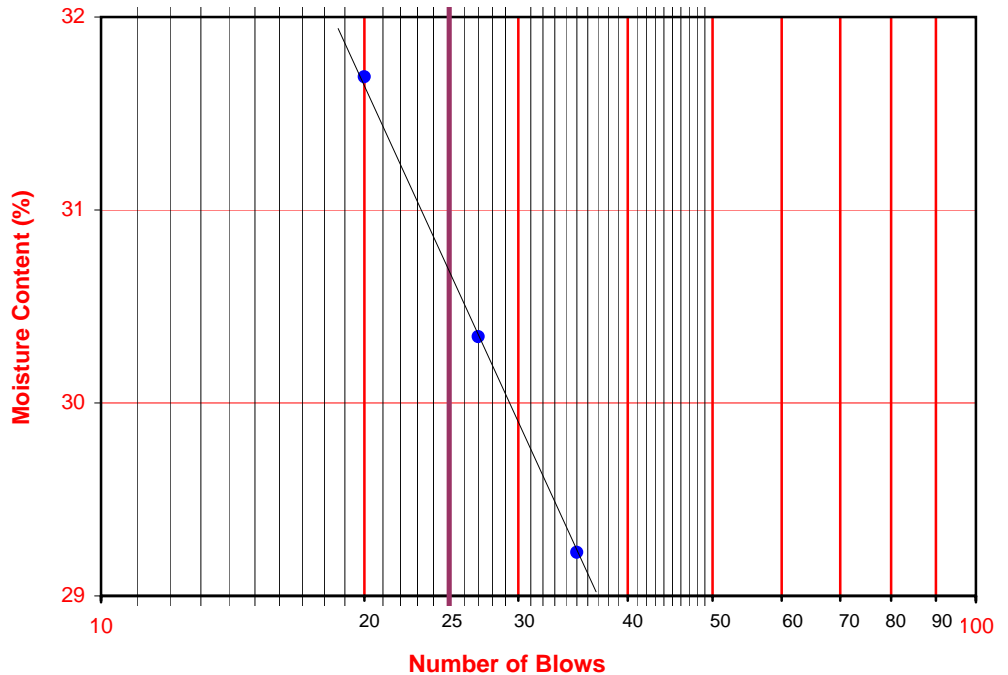
PI at "A" - Line =  $0.73(LL-20)$  8.03

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test







Leighton

# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/06/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/12/09  
 Boring No.: R-09-Z3-B4 Checked By: J. Ward  
 Sample No.: S-3 Depth (ft.) 15.0  
 Soil Identification: Yellowish brown silty sand (SM)

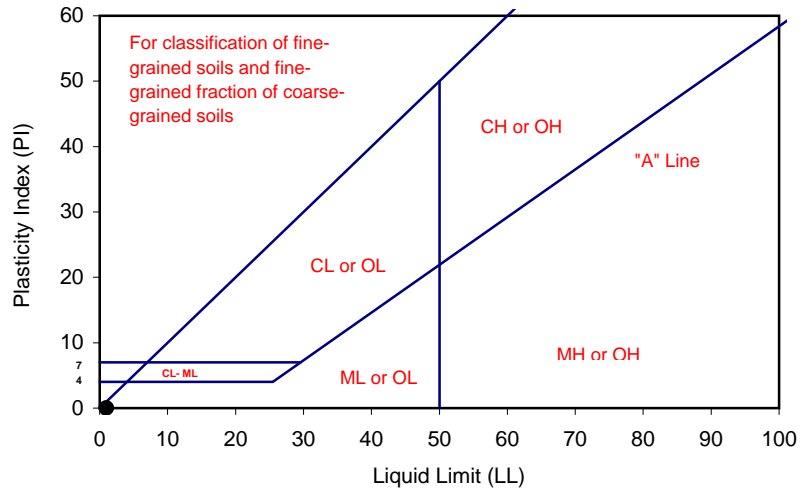
TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			7			
Wet Wt. of Soil + Cont. (g)	<b>Cannot be rolled:</b>		16.51	<b>Cannot get more than 7 blows:</b>		
Dry Wt. of Soil + Cont. (g)	<b>NonPlastic</b>		13.31	<b>NonPlastic</b>		
Wt. of Container (g)			1.05			
Moisture Content (%) [W <sub>n</sub> ]			26.10			

<b>Liquid Limit</b>	<b>NP</b>
<b>Plastic Limit</b>	<b>NP</b>
<b>Plasticity Index</b>	<b>NP</b>
<b>Classification</b>	<b>NP</b>

PI at "A" - Line =  $0.73(LL-20)$  =

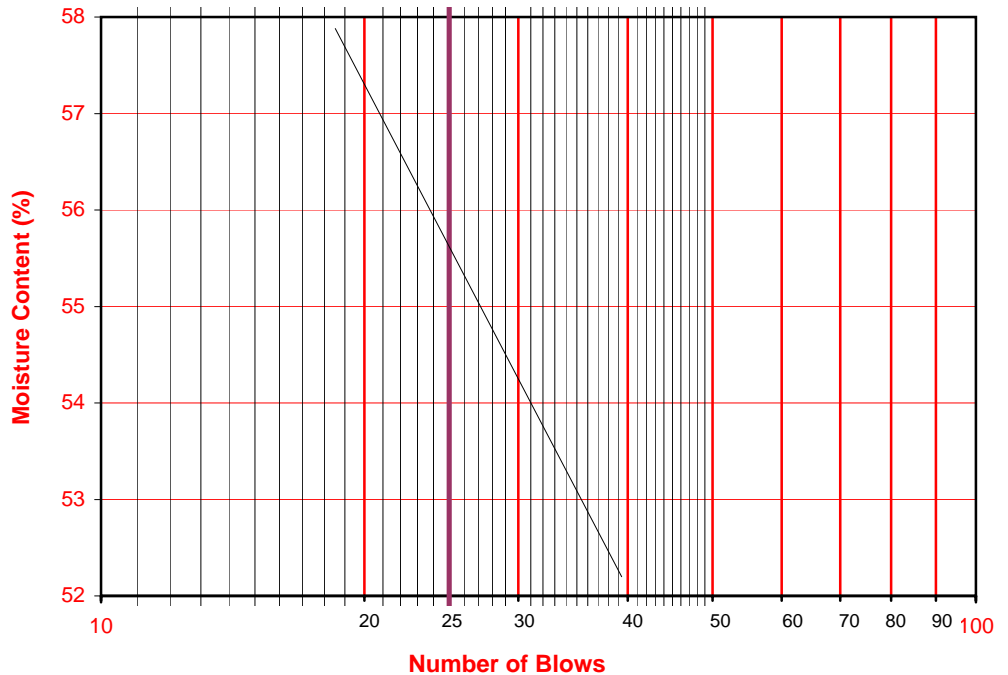
One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$



## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/04/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/06/09  
 Boring No.: R-09-Z3-B4 Checked By: J. Ward  
 Sample No.: S-8 Depth (ft.) 40.0  
 Soil Identification: Olive silt with sand (ML)s

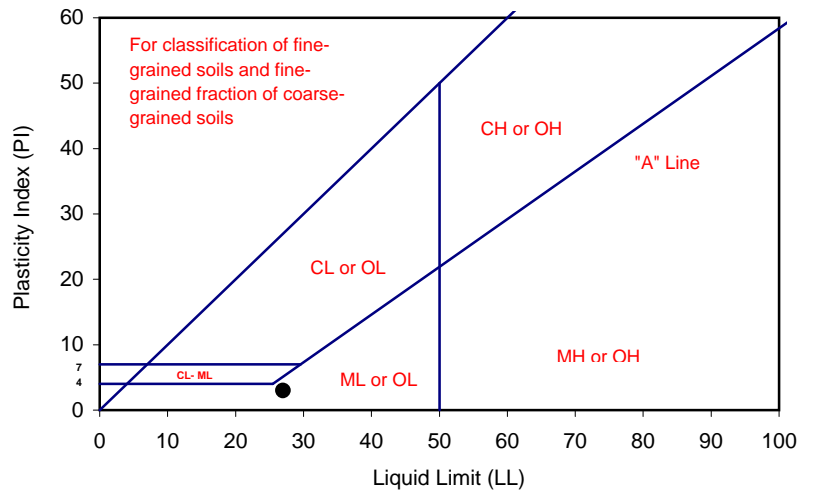
TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			28	23	18	
Wet Wt. of Soil + Cont. (g)	12.57	13.20	14.86	10.40	14.17	
Dry Wt. of Soil + Cont. (g)	10.33	10.84	11.95	8.41	11.30	
Wt. of Container (g)	1.01	1.02	1.03	1.09	1.06	
Moisture Content (%) [W <sub>n</sub> ]	24.03	24.03	26.65	27.19	28.03	

<b>Liquid Limit</b>	<b>27</b>
<b>Plastic Limit</b>	<b>24</b>
<b>Plasticity Index</b>	<b>3</b>
<b>Classification</b>	<b>ML</b>

PI at "A" - Line =  $0.73(LL-20)$  5.11

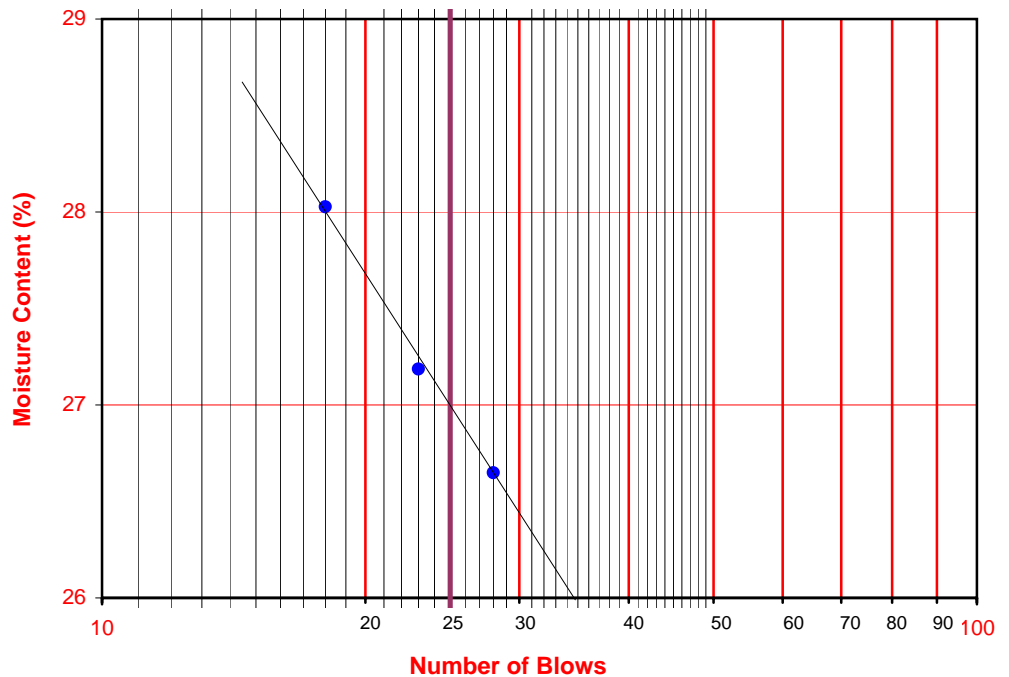
One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$



## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





Leighton

# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/06/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/12/09  
 Boring No.: R-09-Z3-B4 Checked By: J. Ward  
 Sample No.: S-10 Depth (ft.) 50.0  
 Soil Identification: Yellowish brown silty sand (SM)

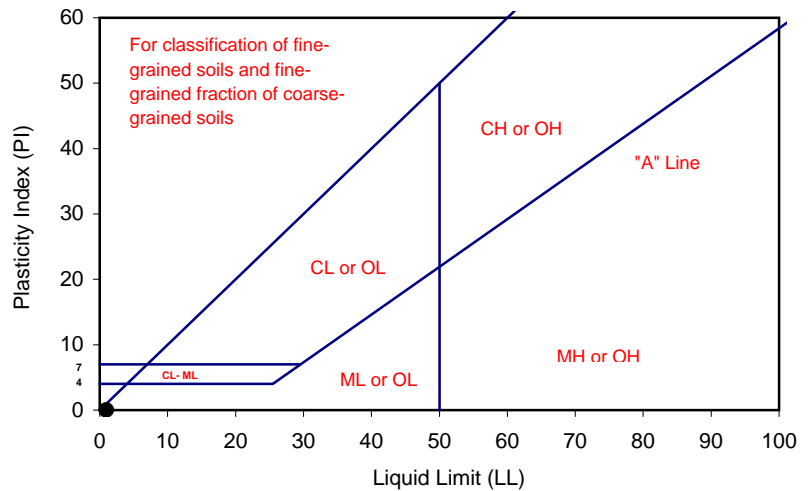
TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			9			
Wet Wt. of Soil + Cont. (g)	<b>Cannot be rolled:</b>		13.44	<b>Cannot get more than 9 blows:</b>		
Dry Wt. of Soil + Cont. (g)	<b>NonPlastic</b>		10.69	<b>NonPlastic</b>		
Wt. of Container (g)			1.12			
Moisture Content (%) [Wn]			28.74			

<b>Liquid Limit</b>	<b>NP</b>
<b>Plastic Limit</b>	<b>NP</b>
<b>Plasticity Index</b>	<b>NP</b>
<b>Classification</b>	<b>NP</b>

PI at "A" - Line =  $0.73(LL-20)$  =

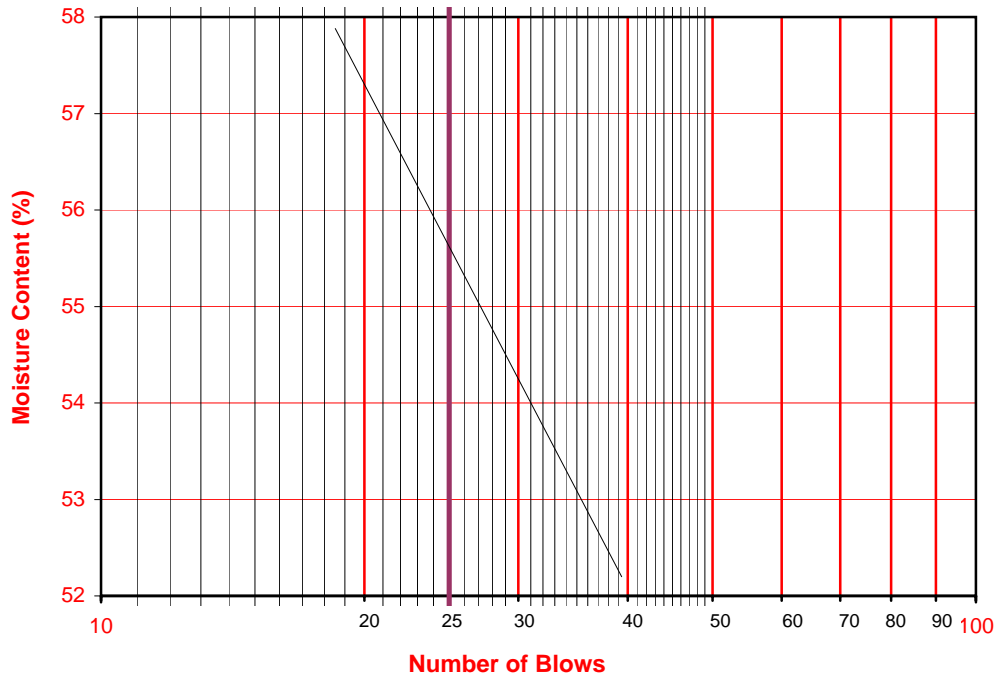
One - Point Liquid Limit Calculation

$$LL = Wn(N/25)^{0.12}$$



## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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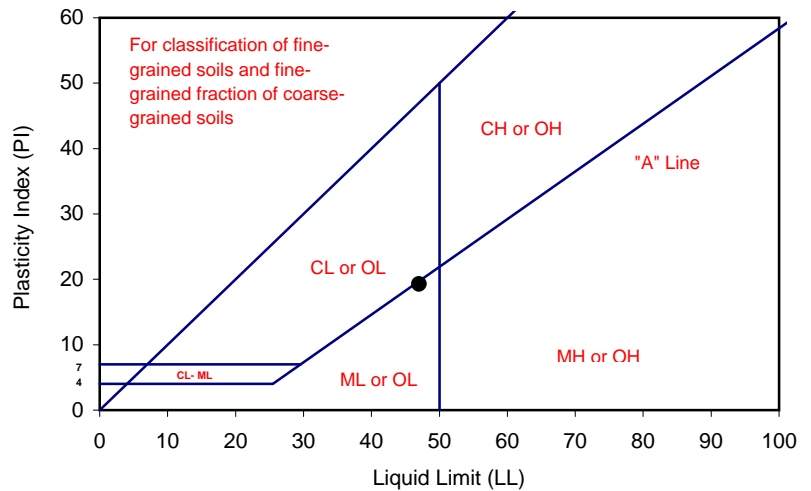
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 06/08/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 06/09/09  
 Boring No.: R-09-Z3-B8 Checked By: J. Ward  
 Sample No.: C-12 Depth (ft.) 52.6-53.2  
 Soil Identification: Dark yellowish brown silt'stone' (ML)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	27	20	
Wet Wt. of Soil + Cont. (g)	10.23	10.35	15.65	15.09	16.02	
Dry Wt. of Soil + Cont. (g)	8.24	8.32	11.08	10.60	11.11	
Wt. of Container (g)	1.02	1.04	1.06	1.05	1.00	
Moisture Content (%) [W <sub>n</sub> ]	27.56	27.88	45.61	47.02	48.57	

<b>Liquid Limit</b>	<b>47</b>
<b>Plastic Limit</b>	<b>28</b>
<b>Plasticity Index</b>	<b>19</b>
<b>Classification</b>	<b>ML</b>



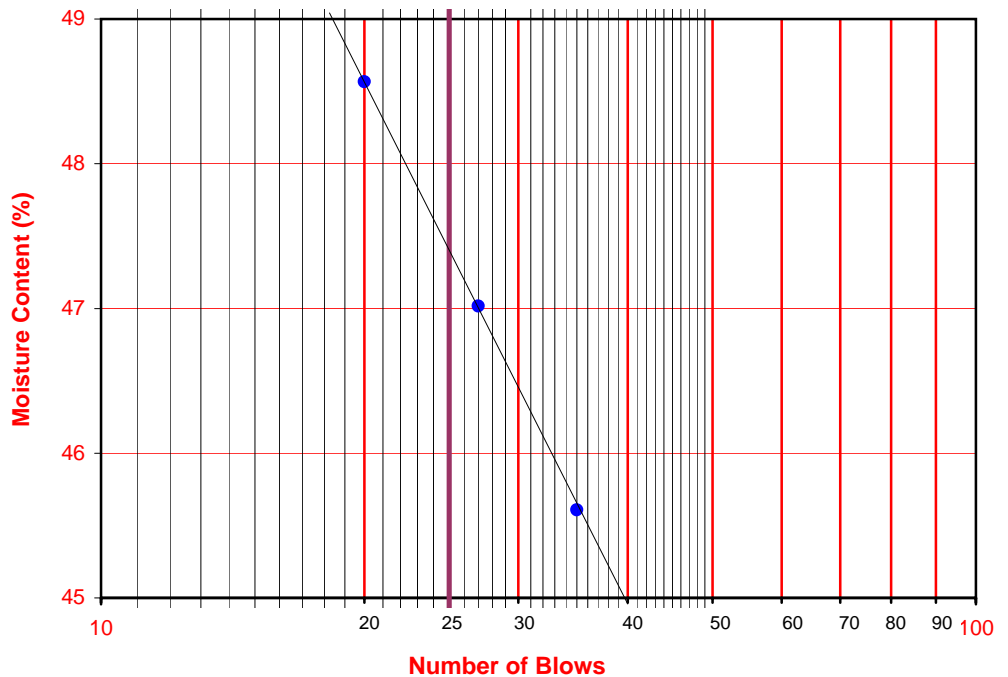
PI at "A" - Line =  $0.73(LL-20)$  19.71

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





Leighton

# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: F. Tabibkhoei Date: 06/02/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 06/06/09  
 Boring No.: R-09-Z3-B8 Checked By: J. Ward  
 Sample No.: C-7 Depth (ft.) 29.2-30  
 Soil Identification: Yellowish brown fat clay'stone' (CH)

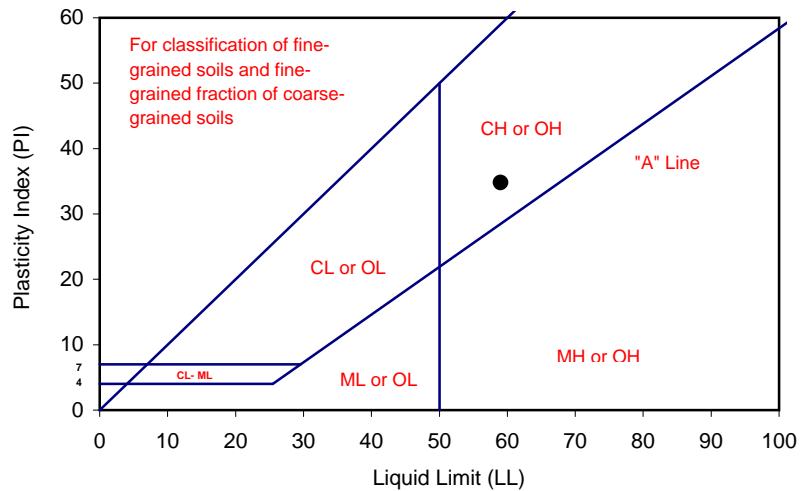
TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	26	18	
Wet Wt. of Soil + Cont. (g)	42.27	47.72	48.30	45.84	43.60	
Dry Wt. of Soil + Cont. (g)	38.92	44.49	39.90	40.48	36.35	
Wt. of Container (g)	25.05	31.15	24.97	31.35	24.66	
Moisture Content (%) [Wn]	24.15	24.21	56.26	58.71	62.02	

<b>Liquid Limit</b>	<b>59</b>
<b>Plastic Limit</b>	<b>24</b>
<b>Plasticity Index</b>	<b>35</b>
<b>Classification</b>	<b>CH</b>

PI at "A" - Line =  $0.73(LL-20)$  28.47

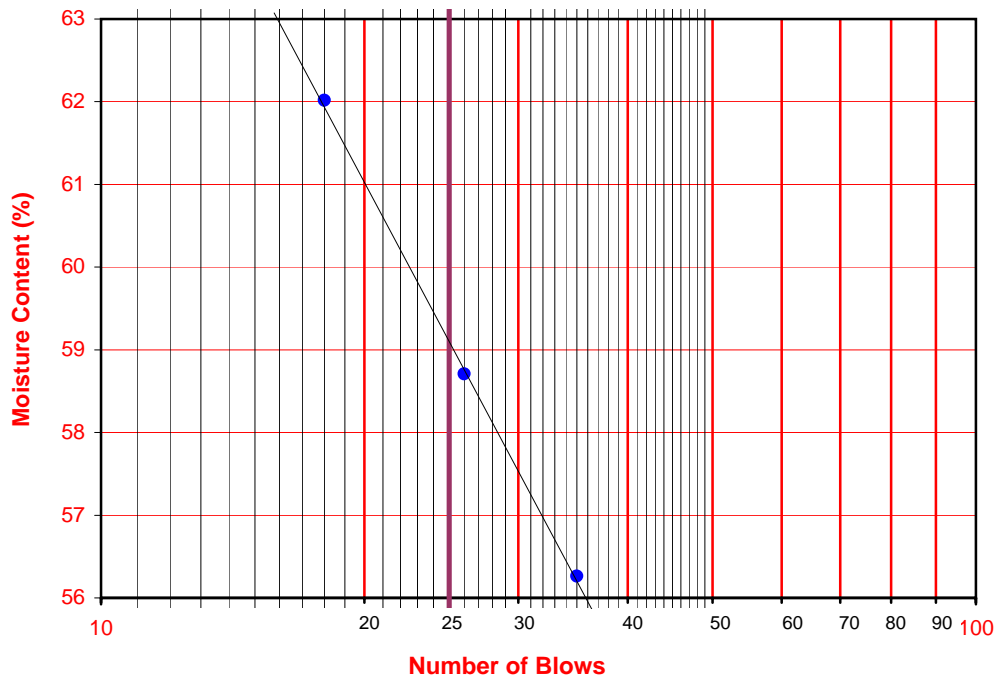
One - Point Liquid Limit Calculation

$$LL = Wn(N/25)^{0.12}$$



## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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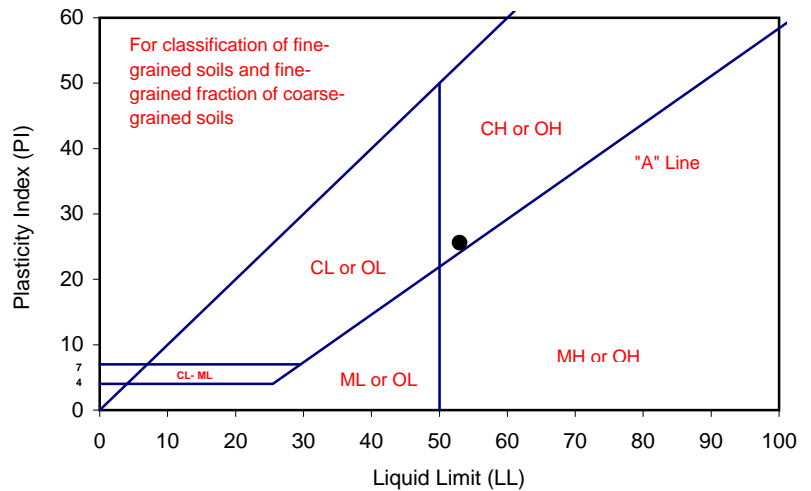
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: G. Bathala Date: 05/27/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 06/06/09  
 Boring No.: R-09-Z3-B8 Checked By: J. Ward  
 Sample No.: C-5 Depth (ft.) 20-21.5  
 Soil Identification: Olive brown fat clay (CH)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	30	25	18
Wet Wt. of Soil + Cont. (g)	12.89	13.51	12.53	11.64	12.59	14.03
Dry Wt. of Soil + Cont. (g)	10.34	10.84	8.74	8.06	8.57	9.39
Wt. of Container (g)	1.06	1.07	1.05	1.09	1.06	1.07
Moisture Content (%) [W <sub>n</sub> ]	27.48	27.33	49.28	51.36	53.53	55.77

<b>Liquid Limit</b>	<b>53</b>
<b>Plastic Limit</b>	<b>27</b>
<b>Plasticity Index</b>	<b>26</b>
<b>Classification</b>	<b>CH</b>



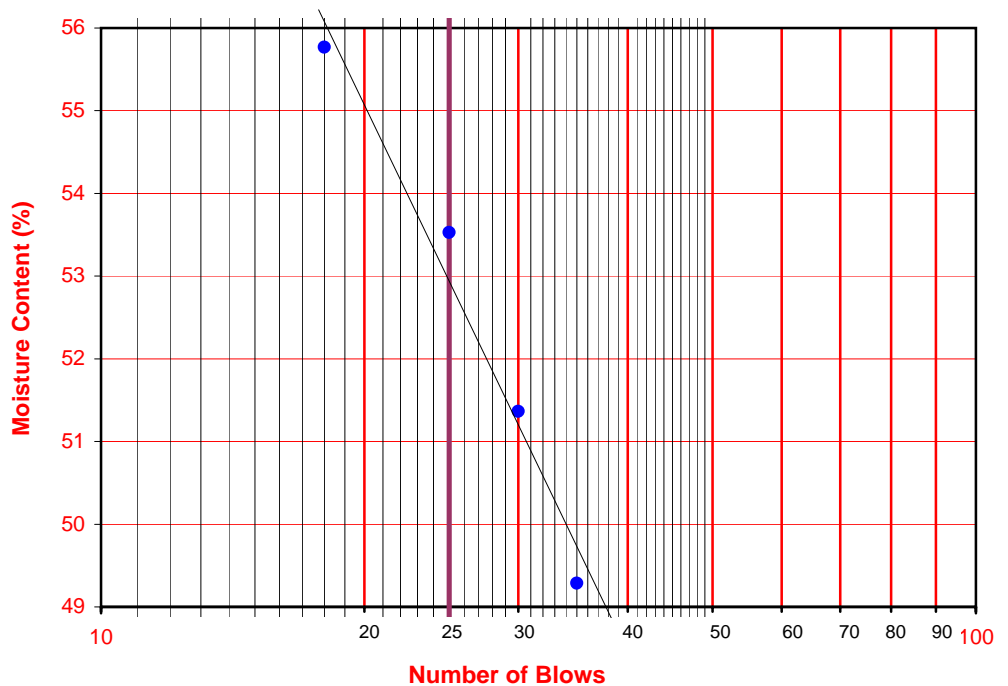
PI at "A" - Line =  $0.73(LL-20)$  24.09

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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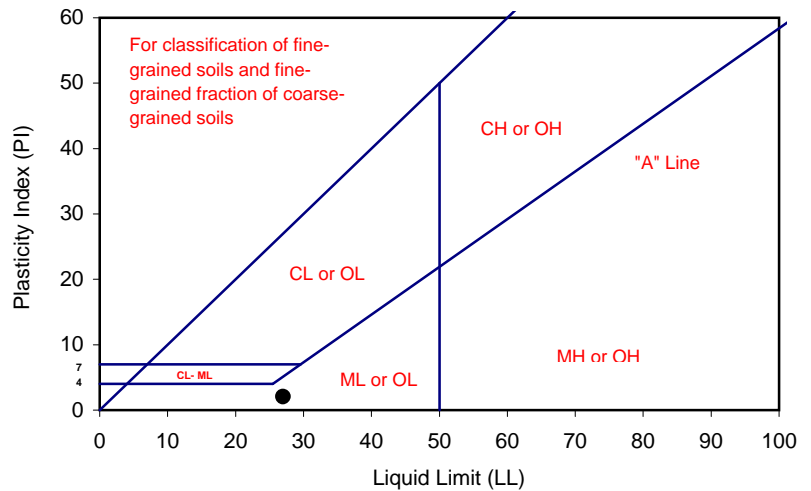
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/21/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/29/09  
 Boring No.: R-09-Z3-B11 Checked By: J. Ward  
 Sample No.: C-24 Depth (ft.) 116.4-116.9  
 Soil Identification: Olive yellow silty sand with gravel (SM)g

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			29	23	17	
Wet Wt. of Soil + Cont. (g)	11.23	10.83	13.51	15.81	13.04	
Dry Wt. of Soil + Cont. (g)	9.19	8.88	10.91	12.62	10.35	
Wt. of Container (g)	1.03	1.05	1.06	1.02	1.06	
Moisture Content (%) [W <sub>n</sub> ]	25.00	24.90	26.40	27.50	28.96	

<b>Liquid Limit</b>	<b>27</b>
<b>Plastic Limit</b>	<b>25</b>
<b>Plasticity Index</b>	<b>2</b>
<b>Classification</b>	<b>ML</b>



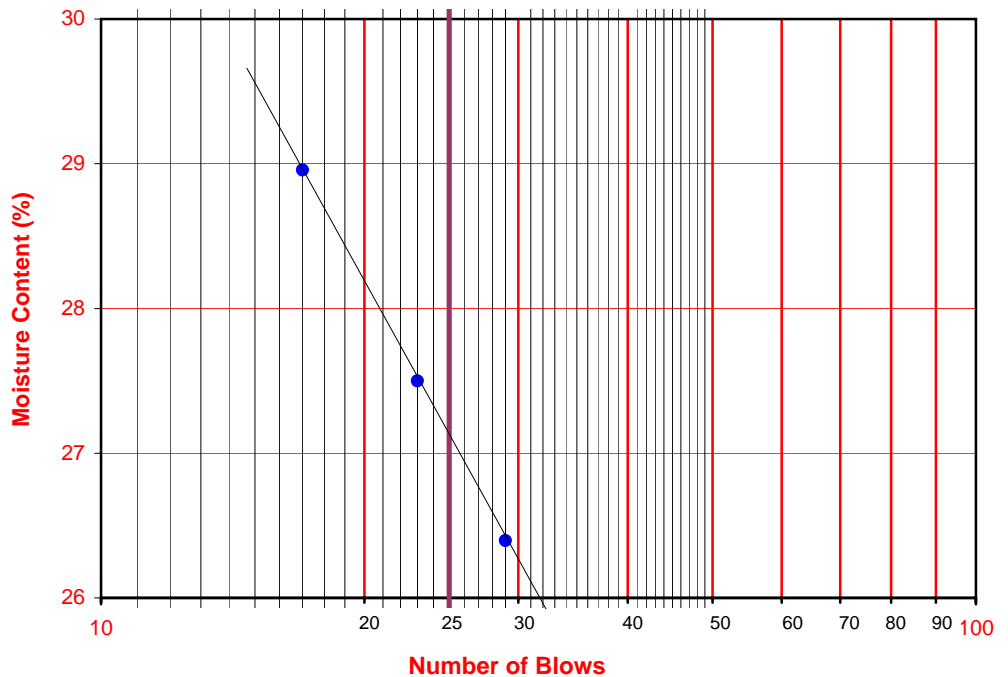
PI at "A" - Line =  $0.73(LL-20)$  = 5.11

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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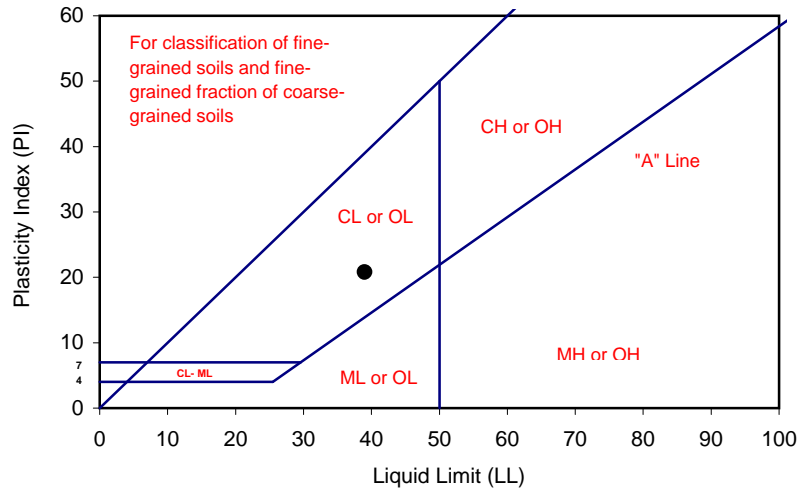
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: F. Tabibkhoei Date: 05/28/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/29/09  
 Boring No.: R-09-Z3-B11 Checked By: J. Ward  
 Sample No.: C-27 Depth (ft.) 131.5-132  
 Soil Identification: Dark olive brown sandy lean clay s(CL)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			29	25	21	
Wet Wt. of Soil + Cont. (g)	45.60	45.91	48.90	44.61	47.16	
Dry Wt. of Soil + Cont. (g)	43.47	43.63	42.23	38.97	40.65	
Wt. of Container (g)	31.70	31.18	24.14	24.65	24.97	
Moisture Content (%) [Wn]	18.10	18.31	36.87	39.39	41.52	

<b>Liquid Limit</b>	<b>39</b>
<b>Plastic Limit</b>	<b>18</b>
<b>Plasticity Index</b>	<b>21</b>
<b>Classification</b>	<b>CL</b>



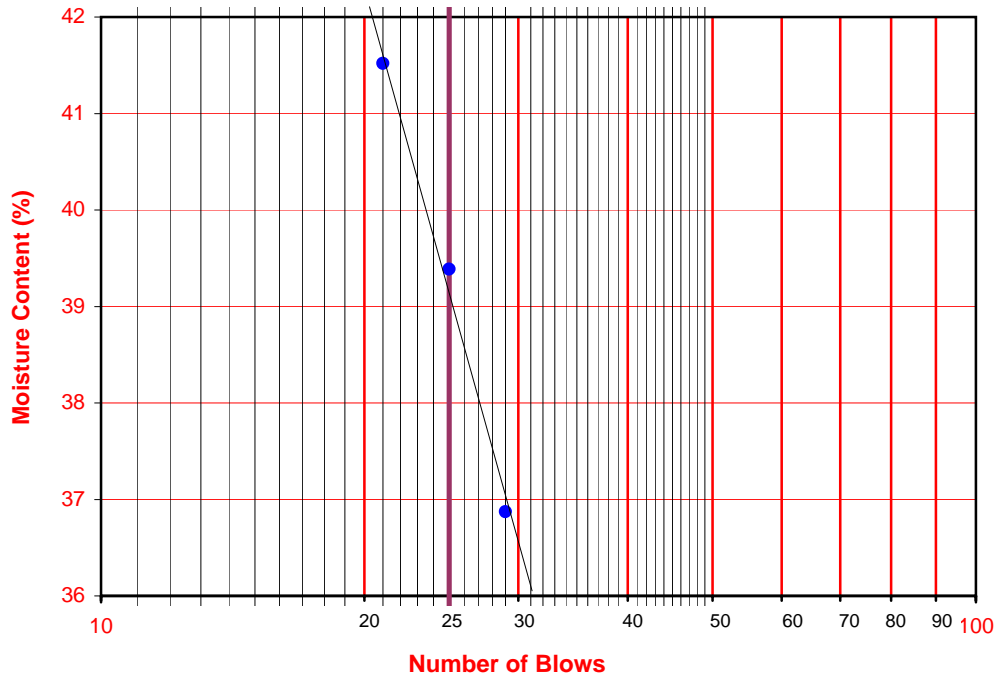
PI at "A" - Line =  $0.73(LL-20)$  13.87

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test







Leighton

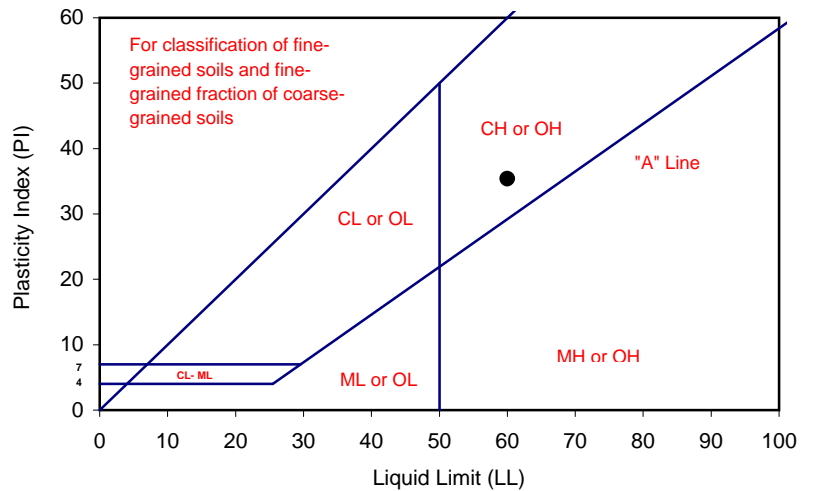
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: G. Bathala Date: 05/28/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/29/09  
 Boring No.: R-09-Z3-B11 Checked By: J. Ward  
 Sample No.: C-35 Depth (ft.) 171.5-172.25  
 Soil Identification: Light olive brown fat clay'stone' with sand (CH)s

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	29	21	16
Wet Wt. of Soil + Cont. (g)	14.89	13.37	12.29	12.21	13.15	11.85
Dry Wt. of Soil + Cont. (g)	12.17	10.93	8.20	8.05	8.52	7.64
Wt. of Container (g)	1.08	1.04	1.04	1.05	1.05	1.07
Moisture Content (%) [W <sub>n</sub> ]	24.53	24.67	57.12	59.43	61.98	64.08

<b>Liquid Limit</b>	<b>60</b>
<b>Plastic Limit</b>	<b>25</b>
<b>Plasticity Index</b>	<b>35</b>
<b>Classification</b>	<b>CH</b>



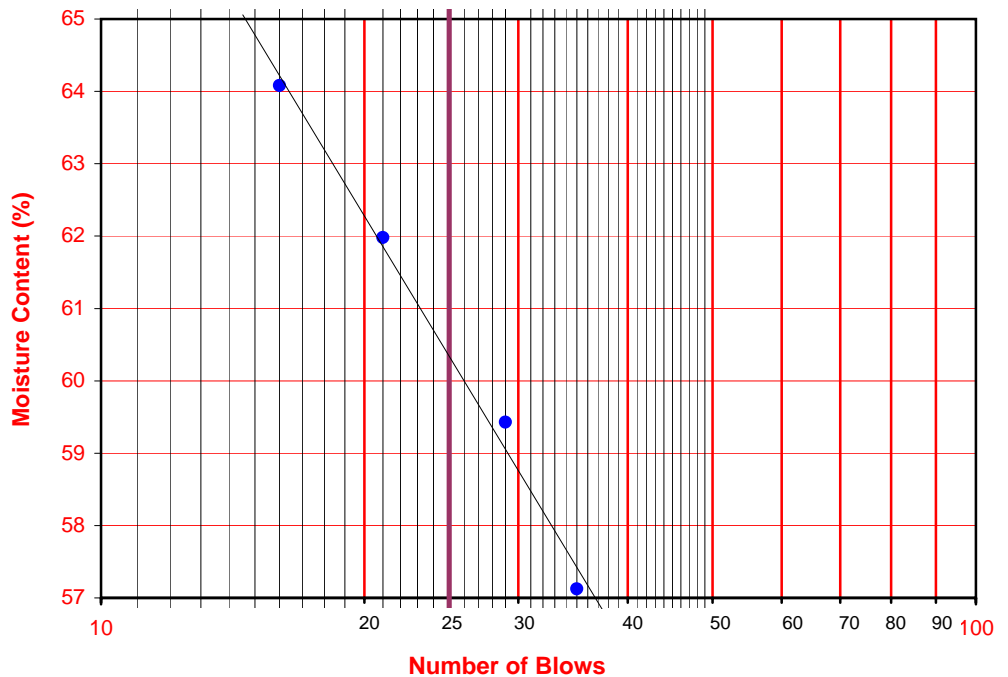
PI at "A" - Line =  $0.73(LL-20)$  = 29.2

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





Leighton

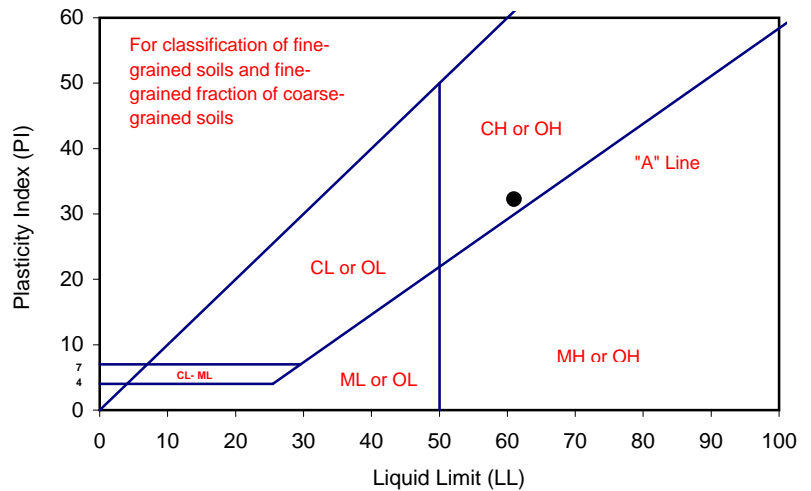
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: F. Tabibkhoei Date: 06/04/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 06/05/09  
 Boring No.: R-09-Z3-B11 Checked By: J. Ward  
 Sample No.: C-44 Depth (ft.) 217.5-218  
 Soil Identification: Olive gray sandy fat clay'stone' s(CH) (fat clay'stone' with a diagonal layer of sand)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	26	22	17
Wet Wt. of Soil + Cont. (g)	48.83	40.86	39.59	48.89	46.75	58.84
Dry Wt. of Soil + Cont. (g)	44.99	37.32	34.16	42.17	38.21	48.01
Wt. of Container (g)	31.59	25.03	24.74	31.18	24.53	31.21
Moisture Content (%) [Wn]	28.66	28.80	57.64	61.15	62.43	64.46

<b>Liquid Limit</b>	<b>61</b>
<b>Plastic Limit</b>	<b>29</b>
<b>Plasticity Index</b>	<b>32</b>
<b>Classification</b>	<b>CH</b>



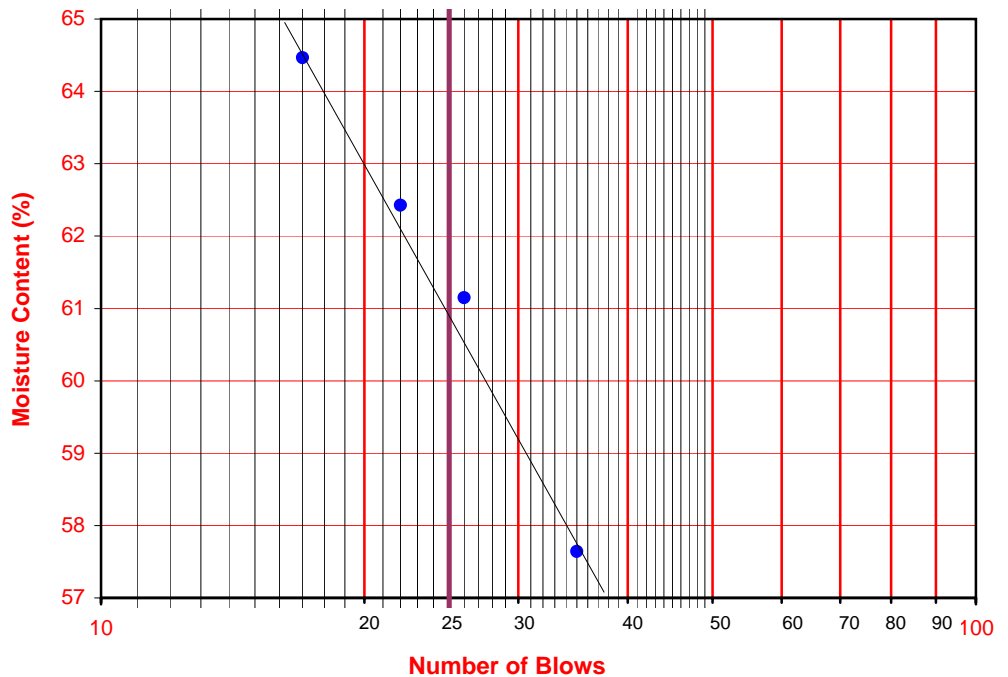
PI at "A" - Line =  $0.73(LL-20)$  29.93

One - Point Liquid Limit Calculation

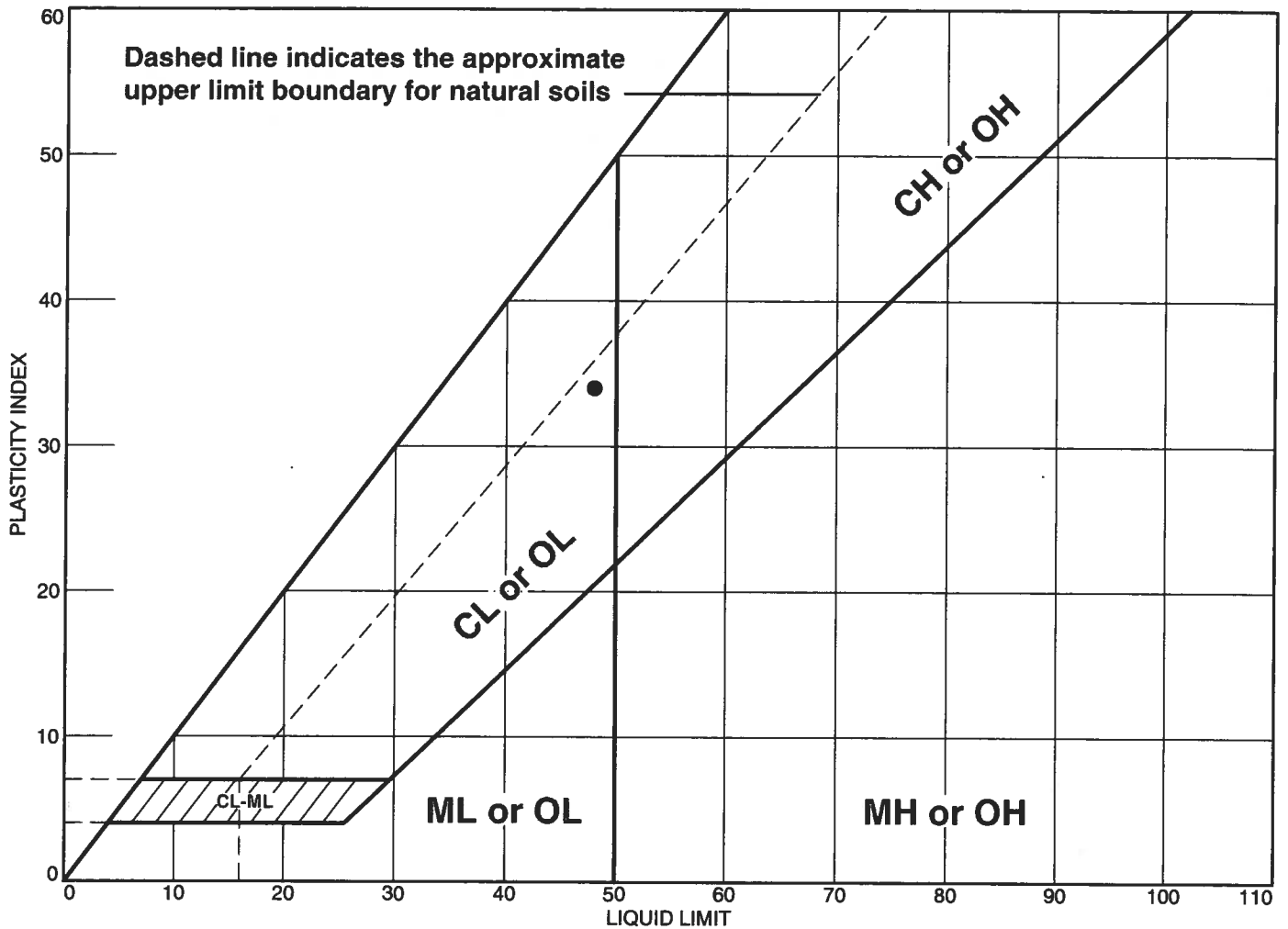
$$LL = Wn(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test



# LIQUID AND PLASTIC LIMITS TEST REPORT



MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
● Mudstone	48	14	34			

**Project No.** 09-144      **Client:** CH2MHill  
**Project:** SR-710 Tunnel Technical Study  
 #378312.04.09.01  
**● Loc.:** R-09-Z3-B11, C49      **Depth:** 245.25-246.0      **Sample No.:** S11037

**SIERRA TESTING LABS, INC.**

El Dorado Hills, CA

**Remarks:**

Figure



Leighton

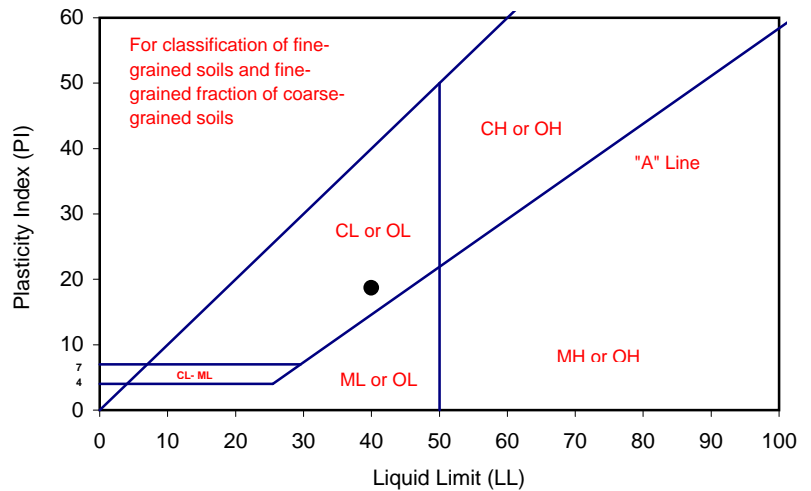
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 06/04/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 06/05/09  
 Boring No.: R-09-Z3-B11 Checked By: J. Ward  
 Sample No.: C-53 Depth (ft.) 259.3-260  
 Soil Identification: Dark olive lean clay'stone' (CL)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	28	21	
Wet Wt. of Soil + Cont. (g)	9.33	9.09	13.47	14.11	13.90	
Dry Wt. of Soil + Cont. (g)	7.89	7.67	10.11	10.48	10.17	
Wt. of Container (g)	1.08	1.04	1.07	1.08	1.06	
Moisture Content (%) [W <sub>n</sub> ]	21.15	21.42	37.17	38.62	40.94	

<b>Liquid Limit</b>	<b>40</b>
<b>Plastic Limit</b>	<b>21</b>
<b>Plasticity Index</b>	<b>19</b>
<b>Classification</b>	<b>CL</b>



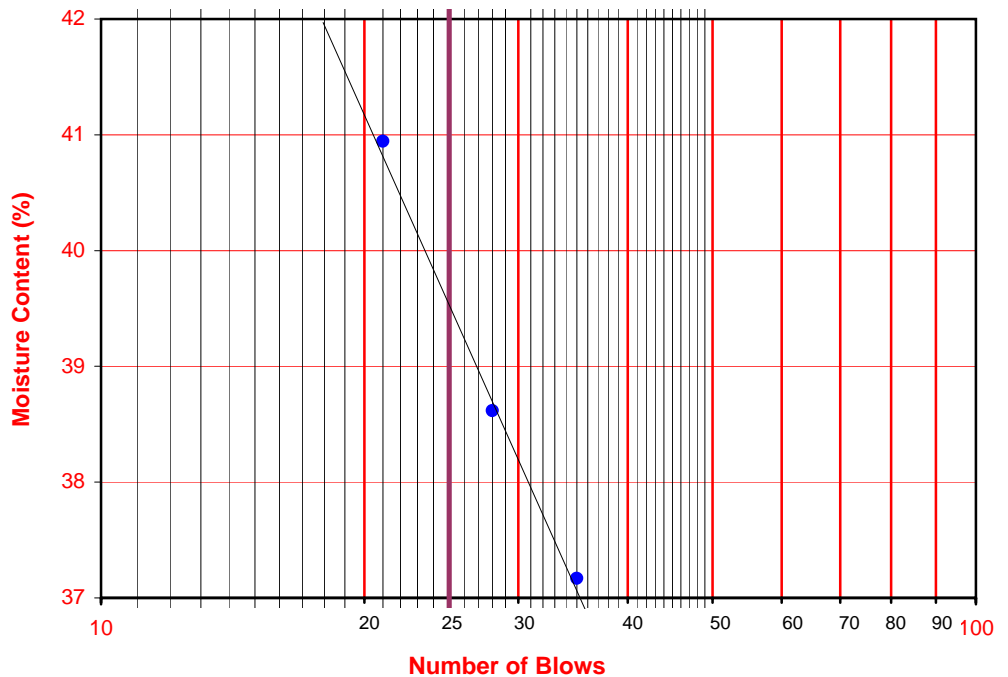
PI at "A" - Line =  $0.73(LL-20)$  = 14.6

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 04/06/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 04/29/09  
 Boring No.: R-09-Z3-B11 Checked By: J. Ward  
 Sample No.: O-5 Depth (ft.) 21-26  
 Soil Identification: Olive brown poorly-graded sand with silt and gravel (SP-SM)g

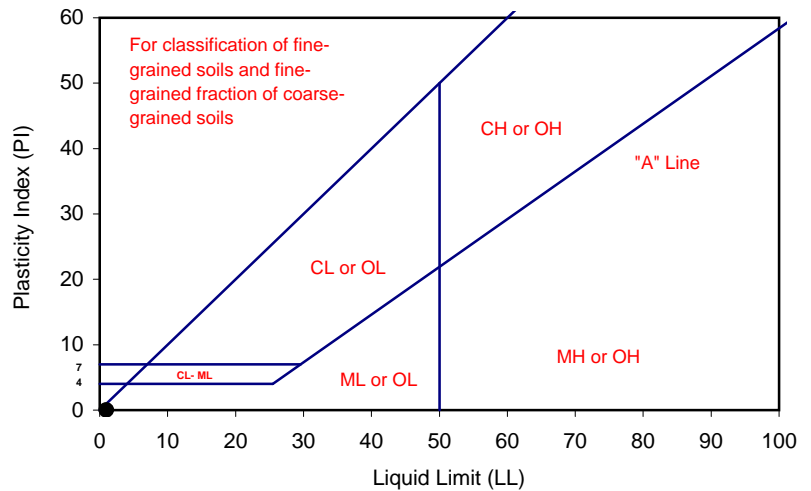
TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			7			
Wet Wt. of Soil + Cont. (g)	<b>Cannot be rolled:</b>		14.59	<b>Cannot get more than 7 blows:</b>		
Dry Wt. of Soil + Cont. (g)	<b>NonPlastic</b>		11.83	<b>NonPlastic</b>		
Wt. of Container (g)			1.08			
Moisture Content (%) [Wn]			25.67			

<b>Liquid Limit</b>	<b>NP</b>
<b>Plastic Limit</b>	<b>NP</b>
<b>Plasticity Index</b>	<b>NP</b>
<b>Classification</b>	<b>NP</b>

PI at "A" - Line =  $0.73(LL-20)$  =

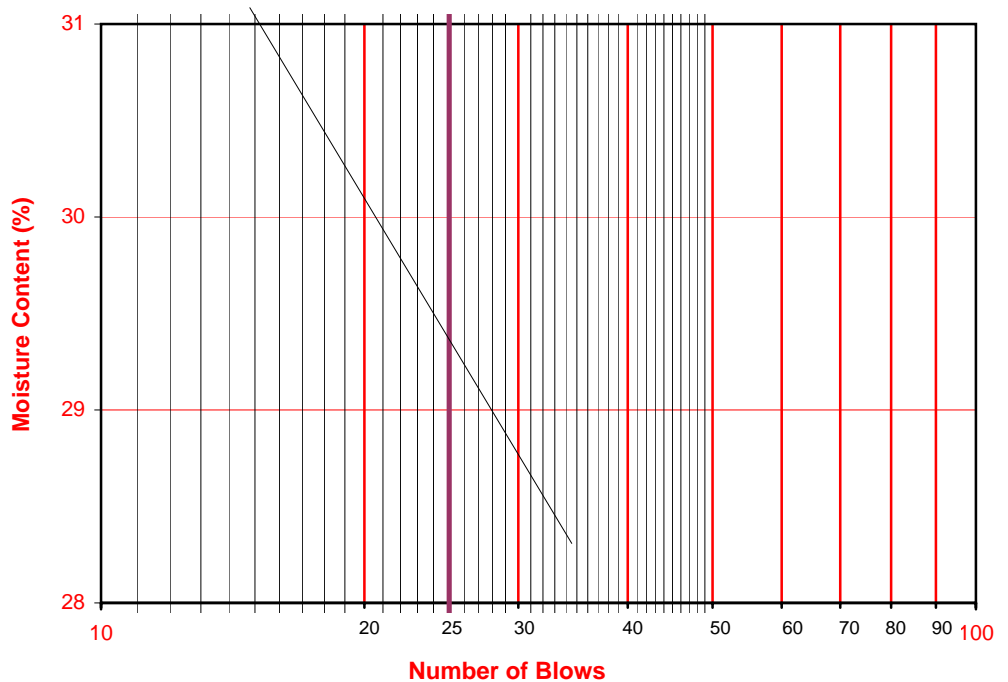
One - Point Liquid Limit Calculation

$$LL = Wn(N/25)^{0.12}$$



## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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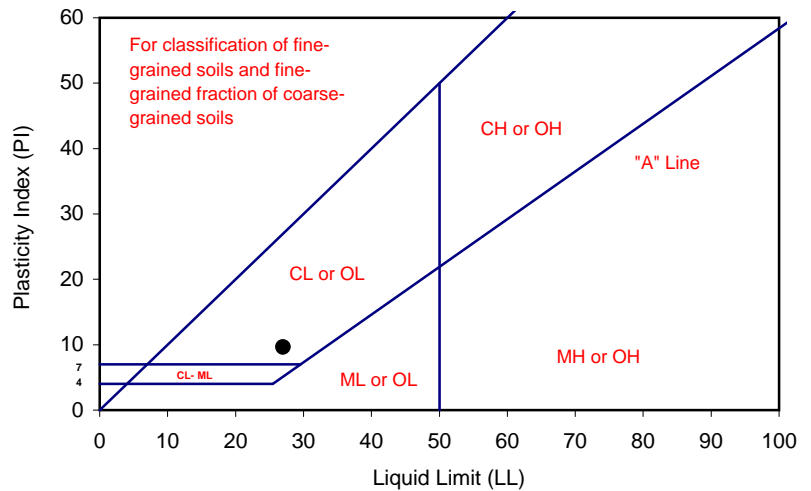
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: F. Tabibkhoei Date: 05/28/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/29/09  
 Boring No.: R-09-Z3-B11 Checked By: J. Ward  
 Sample No.: O-20 Depth (ft.) 101-102  
 Soil Identification: Dark olive brown clayey sand (SC)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			28	23	15	
Wet Wt. of Soil + Cont. (g)	49.18	40.16	46.38	54.52	54.35	
Dry Wt. of Soil + Cont. (g)	46.52	37.88	41.90	49.61	47.67	
Wt. of Container (g)	31.41	24.57	24.75	31.67	25.05	
Moisture Content (%) [W <sub>n</sub> ]	17.60	17.13	26.12	27.37	29.53	

<b>Liquid Limit</b>	<b>27</b>
<b>Plastic Limit</b>	<b>17</b>
<b>Plasticity Index</b>	<b>10</b>
<b>Classification</b>	<b>CL</b>



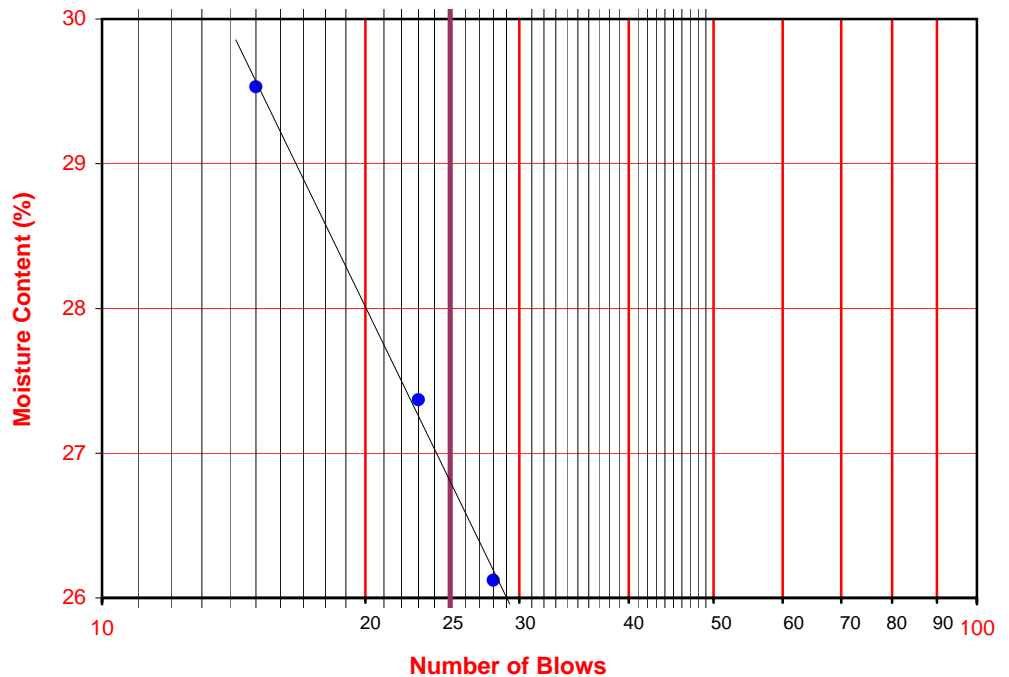
PI at "A" - Line =  $0.73(LL-20)$  5.11

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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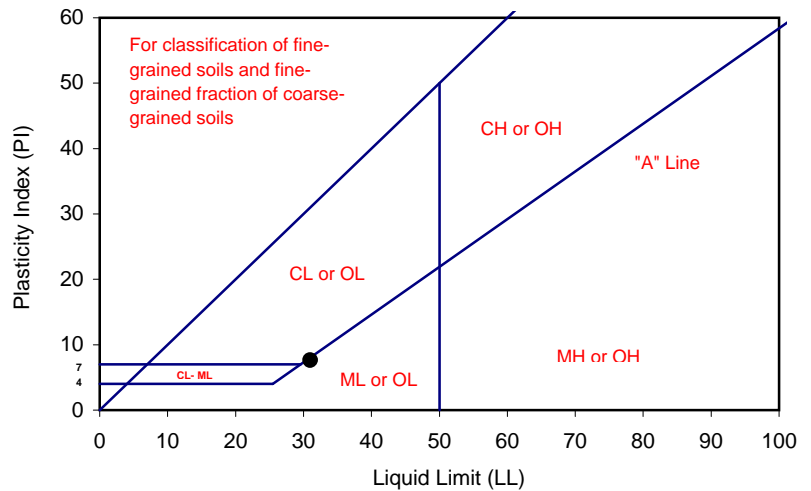
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: F. Tabibkhoei Date: 05/27/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/29/09  
 Boring No.: R-09-Z3-B11 Checked By: J. Ward  
 Sample No.: S-17 Depth (ft.) 86.0  
 Soil Identification: Olive brown silty sand (SM)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	26	21	
Wet Wt. of Soil + Cont. (g)	44.69	36.82	49.02	44.04	57.21	
Dry Wt. of Soil + Cont. (g)	42.18	34.53	44.95	39.50	51.01	
Wt. of Container (g)	31.41	24.76	31.15	24.74	31.61	
Moisture Content (%) [W <sub>n</sub> ]	23.31	23.44	29.49	30.76	31.96	

<b>Liquid Limit</b>	<b>31</b>
<b>Plastic Limit</b>	<b>23</b>
<b>Plasticity Index</b>	<b>8</b>
<b>Classification</b>	<b>ML</b>



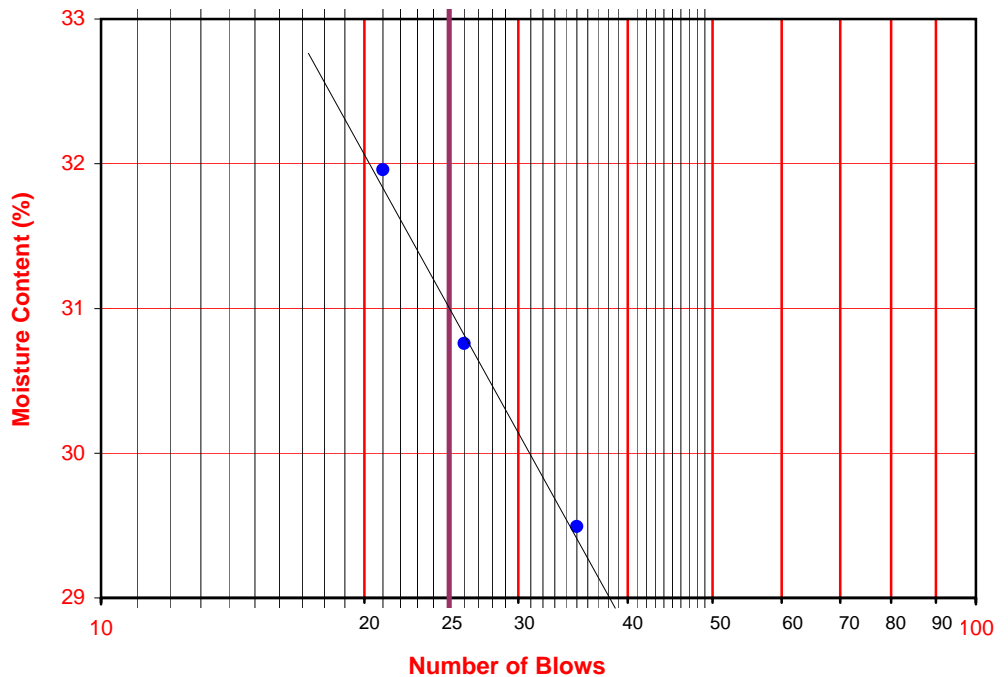
PI at "A" - Line =  $0.73(LL-20)$  8.03

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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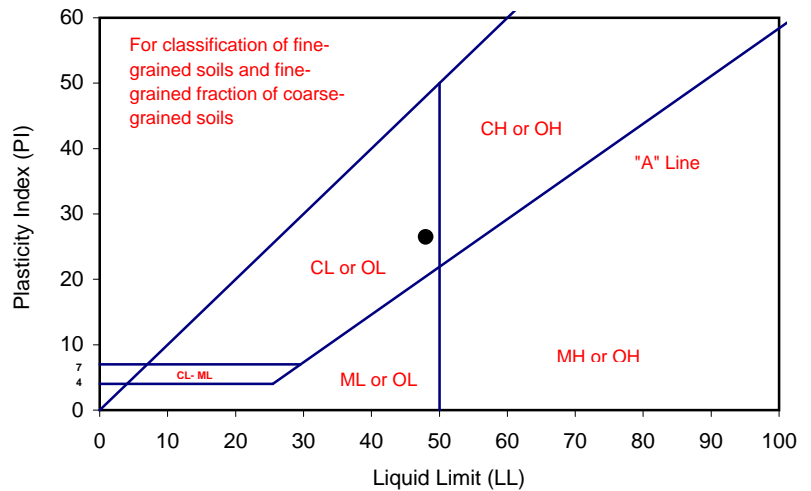
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 04/28/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/11/09  
 Boring No.: R-09-Z3-B12 Checked By: J. Ward  
 Sample No.: C21 Depth (ft.) 101-101.5  
 Soil Identification: Olive lean clay with sand (CL)s

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	28	21	
Wet Wt. of Soil + Cont. (g)	8.68	8.31	13.66	14.08	16.69	
Dry Wt. of Soil + Cont. (g)	7.33	7.03	9.66	9.86	11.53	
Wt. of Container (g)	1.06	1.08	1.05	1.05	1.05	
Moisture Content (%) [W <sub>n</sub> ]	21.53	21.51	46.46	47.90	49.24	

<b>Liquid Limit</b>	<b>48</b>
<b>Plastic Limit</b>	<b>22</b>
<b>Plasticity Index</b>	<b>26</b>
<b>Classification</b>	<b>CL</b>



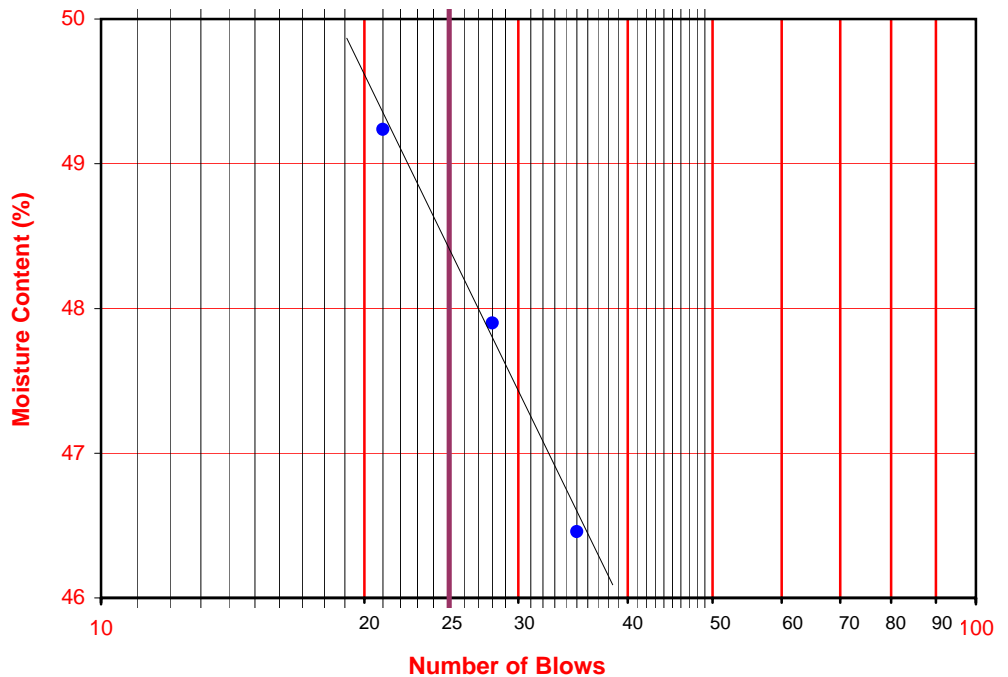
PI at "A" - Line =  $0.73(LL-20)$  20.44

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 04/23/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/11/09  
 Boring No.: R-09-Z3-B12 Checked By: J. Ward  
 Sample No.: C23 Depth (ft.) 109-109.8  
 Soil Identification: Yellowish brown fat clay'stone' (CH)

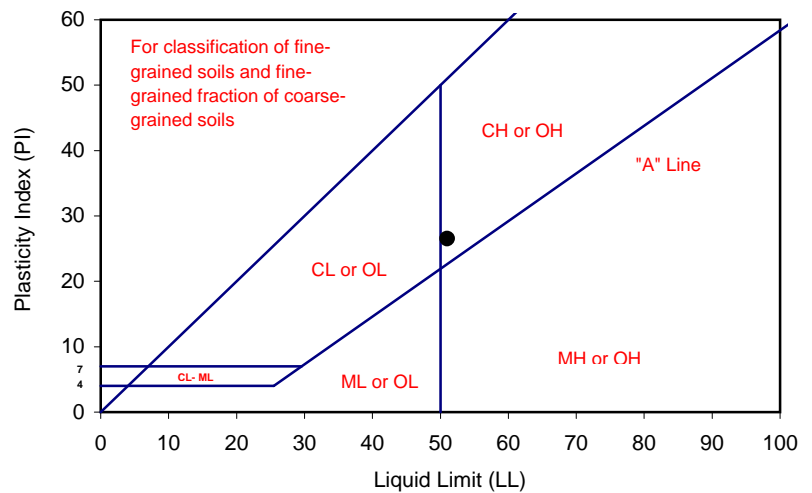
TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			33	26	19	
Wet Wt. of Soil + Cont. (g)	8.65	8.48	11.42	12.07	14.56	
Dry Wt. of Soil + Cont. (g)	7.17	7.00	7.97	8.35	9.88	
Wt. of Container (g)	1.05	1.02	1.02	1.11	1.06	
Moisture Content (%) [W <sub>n</sub> ]	24.18	24.75	49.64	51.38	53.06	

<b>Liquid Limit</b>	<b>51</b>
<b>Plastic Limit</b>	<b>24</b>
<b>Plasticity Index</b>	<b>27</b>
<b>Classification</b>	<b>CH</b>

PI at "A" - Line =  $0.73(LL-20)$  22.63

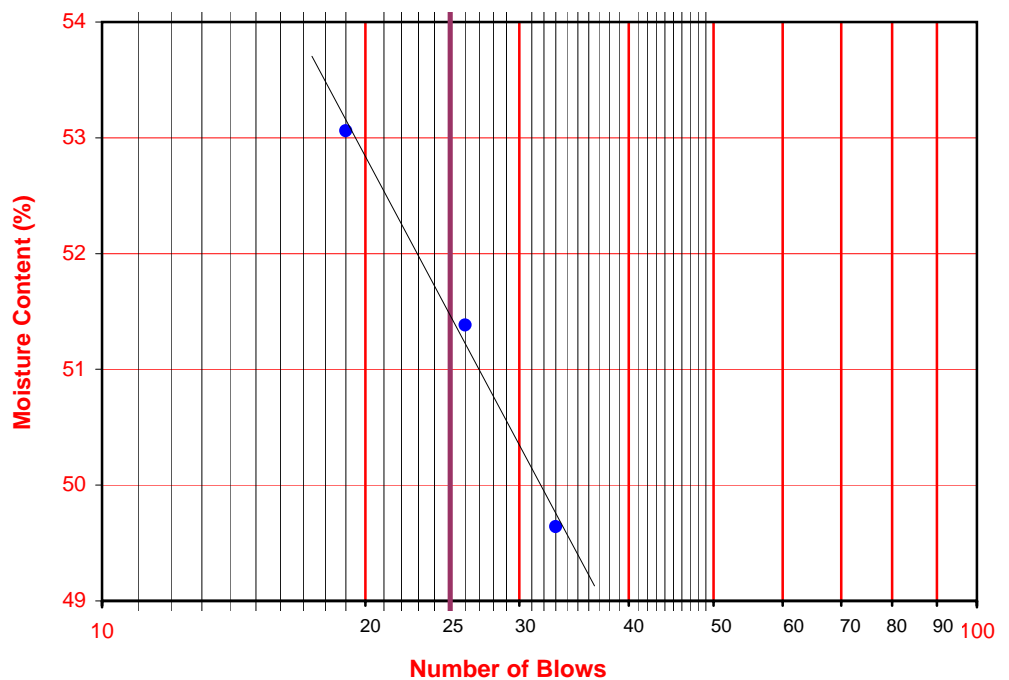
One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$



## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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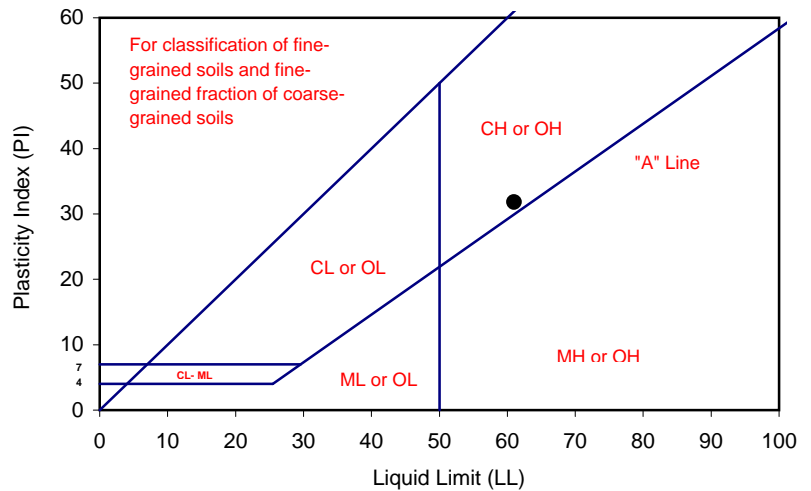
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 04/24/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/11/09  
 Boring No.: R-09-Z3-B12 Checked By: J. Ward  
 Sample No.: C27 Depth (ft.) 124.3-125.2  
 Soil Identification: Olive fat clay'stone' (CH)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	28	21	
Wet Wt. of Soil + Cont. (g)	9.92	9.51	14.05	14.37	13.55	
Dry Wt. of Soil + Cont. (g)	7.93	7.60	9.16	9.32	8.77	
Wt. of Container (g)	1.11	1.06	1.05	1.03	1.02	
Moisture Content (%) [W <sub>n</sub> ]	29.18	29.20	60.30	60.92	61.68	

<b>Liquid Limit</b>	<b>61</b>
<b>Plastic Limit</b>	<b>29</b>
<b>Plasticity Index</b>	<b>32</b>
<b>Classification</b>	<b>CH</b>



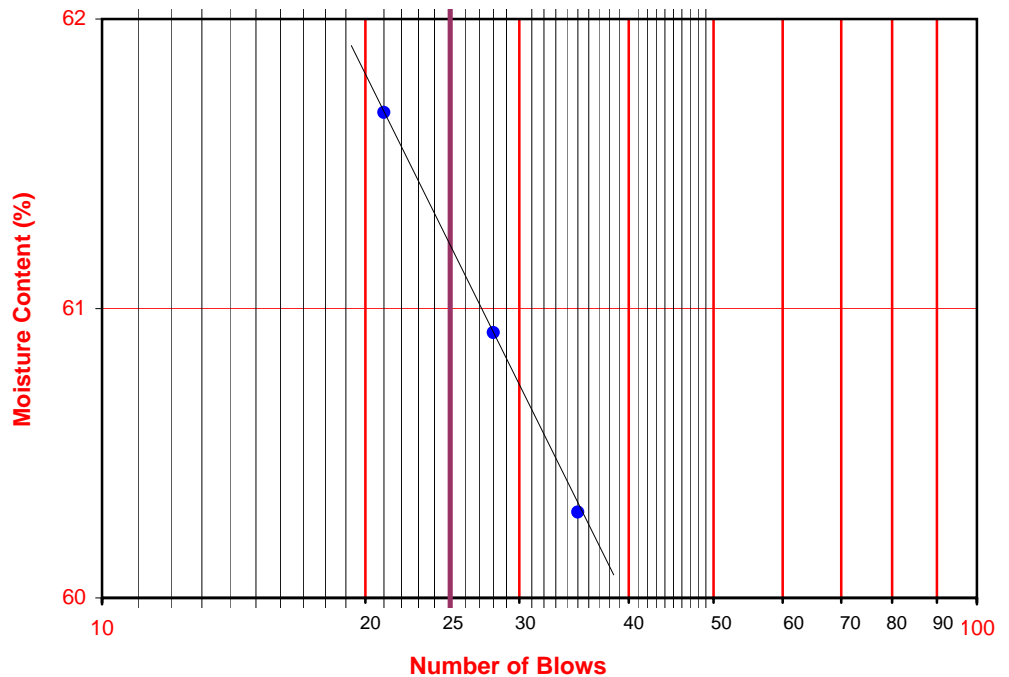
PI at "A" - Line =  $0.73(LL-20)$  29.93

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: ACS/VJ Date: 04/10/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/11/09  
 Boring No.: R-09-Z3-B12 Checked By: J. Ward  
 Sample No.: S7 Depth (ft.) 35.0  
 Soil Identification: Yellowish brown silt with sand (ML)s

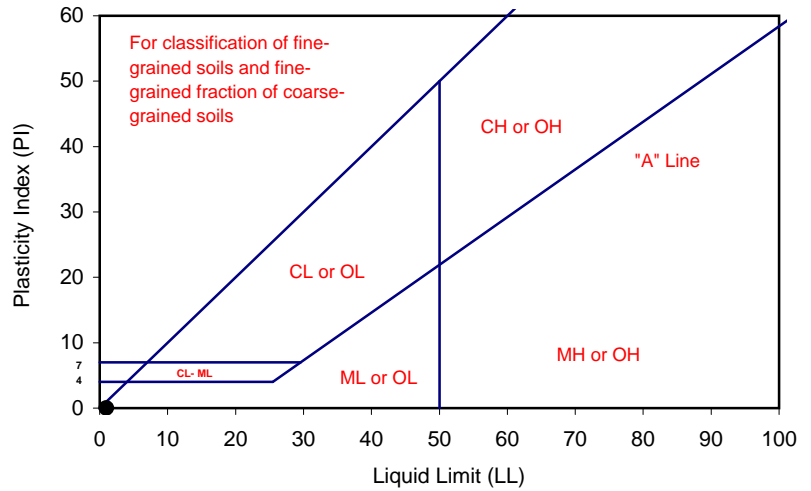
TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			5			
Wet Wt. of Soil + Cont. (g)	<b>Cannot be rolled:</b>		23.49	<b>Cannot get more than 5 blows:</b>		
Dry Wt. of Soil + Cont. (g)	<b>NonPlastic</b>		18.19	<b>NonPlastic</b>		
Wt. of Container (g)			1.03			
Moisture Content (%) [W <sub>n</sub> ]			30.89			

<b>Liquid Limit</b>	<b>NP</b>
<b>Plastic Limit</b>	<b>NP</b>
<b>Plasticity Index</b>	<b>NP</b>
<b>Classification</b>	<b>NP</b>

PI at "A" - Line =  $0.73(LL-20)$  =

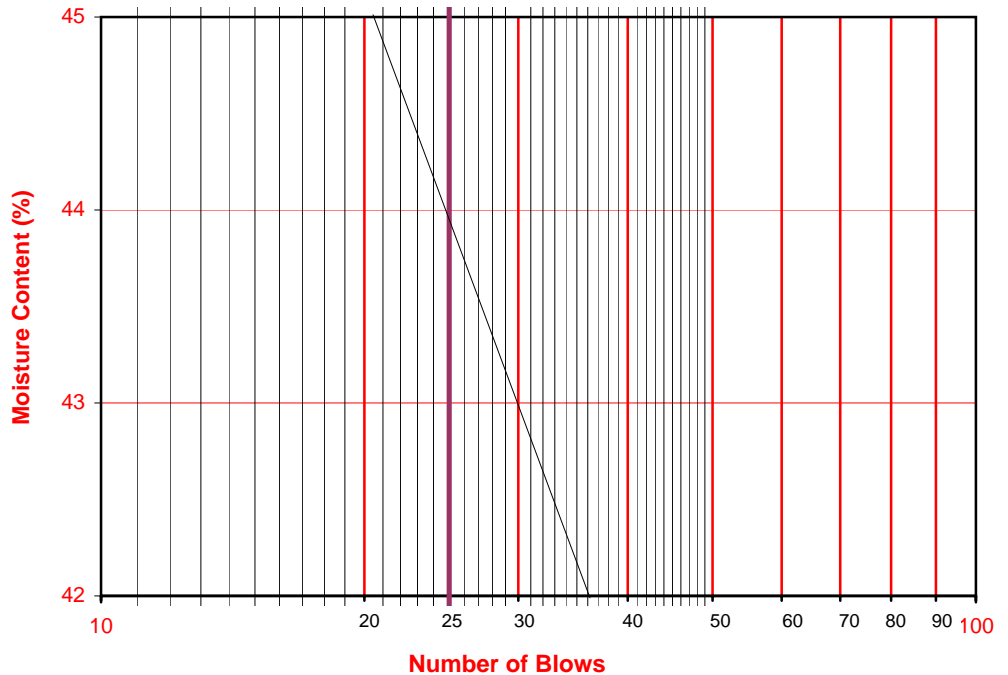
One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$



## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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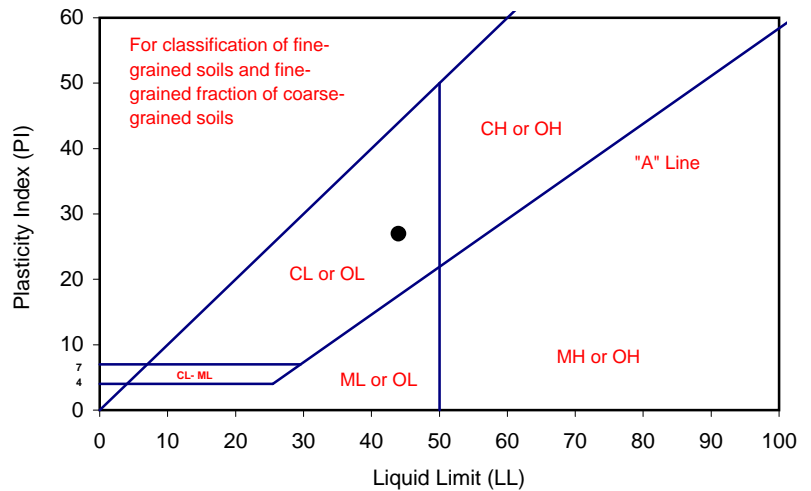
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: A. Santos Date: 04/02/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 04/08/09  
 Boring No.: R-09-Z3-B12 Checked By: J. Ward  
 Sample No.: S15 Depth (ft.) 75.0  
 Soil Identification: Olive brown lean clay with sand (CL)s

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			34	25	21	
Wet Wt. of Soil + Cont. (g)	10.10	9.26	21.50	20.53	23.09	
Dry Wt. of Soil + Cont. (g)	8.79	8.07	15.41	14.58	16.26	
Wt. of Container (g)	1.06	1.12	1.01	1.05	1.04	
Moisture Content (%) [W <sub>n</sub> ]	16.95	17.12	42.29	43.98	44.88	

<b>Liquid Limit</b>	<b>44</b>
<b>Plastic Limit</b>	<b>17</b>
<b>Plasticity Index</b>	<b>27</b>
<b>Classification</b>	<b>CL</b>



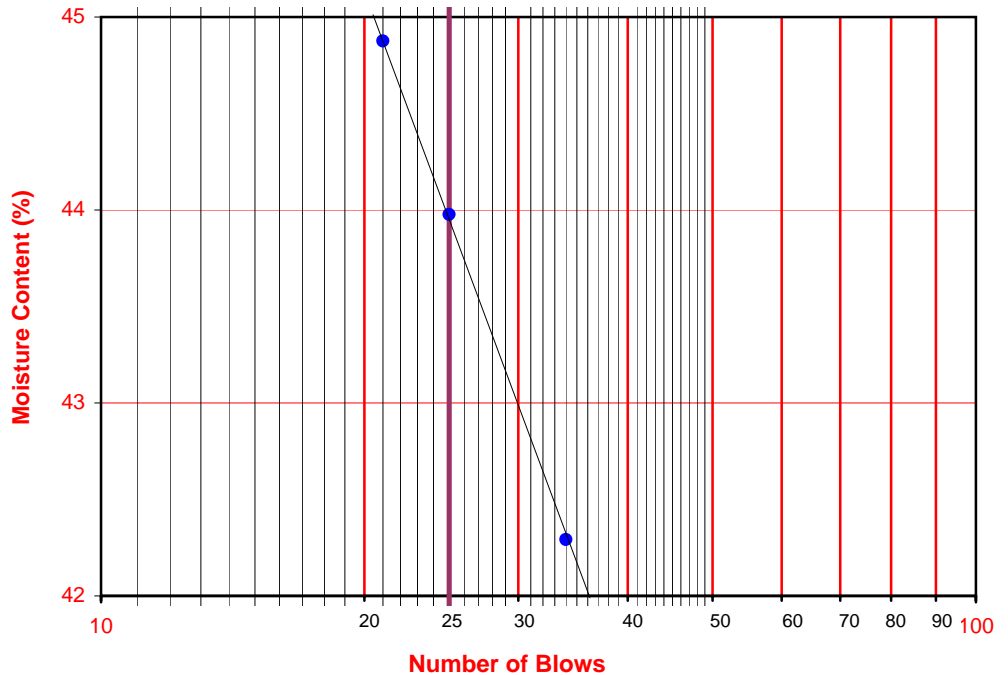
PI at "A" - Line =  $0.73(LL-20)$  17.52

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





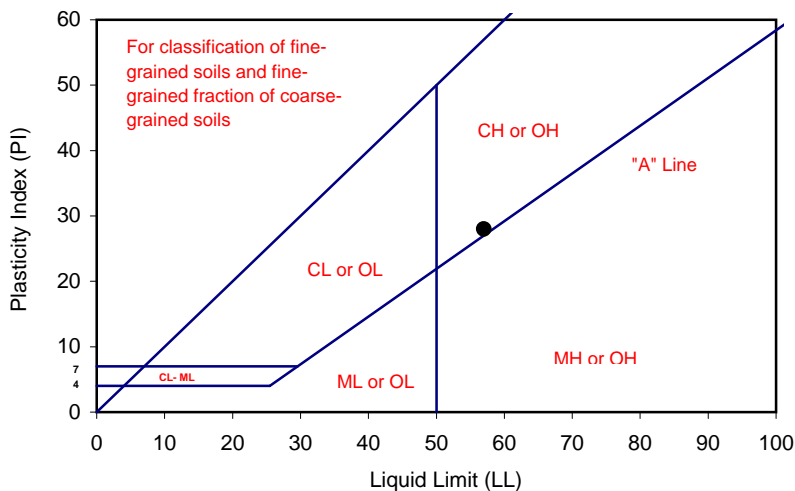
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/20/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/21/09  
 Boring No.: R-09-Z4-B4 Checked By: J. Ward  
 Sample No.: C-19 Depth (ft.) 97.5-98.3  
 Soil Identification: Yellow fat clay'stone' (CH)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	28	21	
Wet Wt. of Soil + Cont. (g)	9.21	9.15	12.36	13.44	15.70	
Dry Wt. of Soil + Cont. (g)	7.36	7.35	8.39	8.99	10.29	
Wt. of Container (g)	1.06	1.07	1.03	1.06	1.10	
Moisture Content (%) [Wn]	29.37	28.66	53.94	56.12	58.87	

<b>Liquid Limit</b>	<b>57</b>
<b>Plastic Limit</b>	<b>29</b>
<b>Plasticity Index</b>	<b>28</b>
<b>Classification</b>	<b>CH</b>



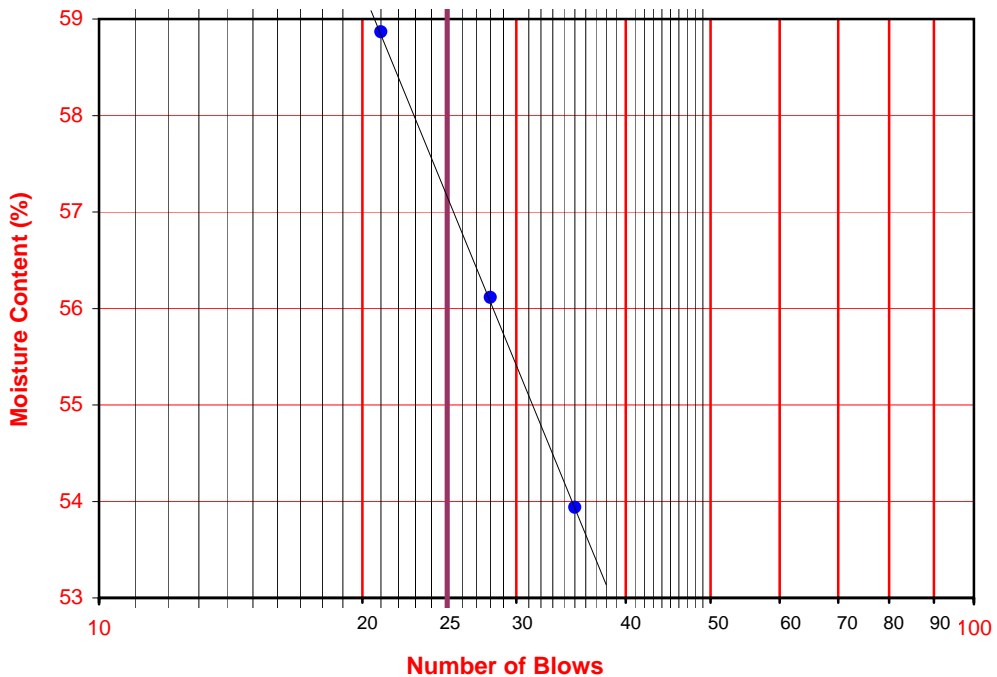
PI at "A" - Line =  $0.73(LL-20)$  = 27.01

One - Point Liquid Limit Calculation

$$LL = Wn(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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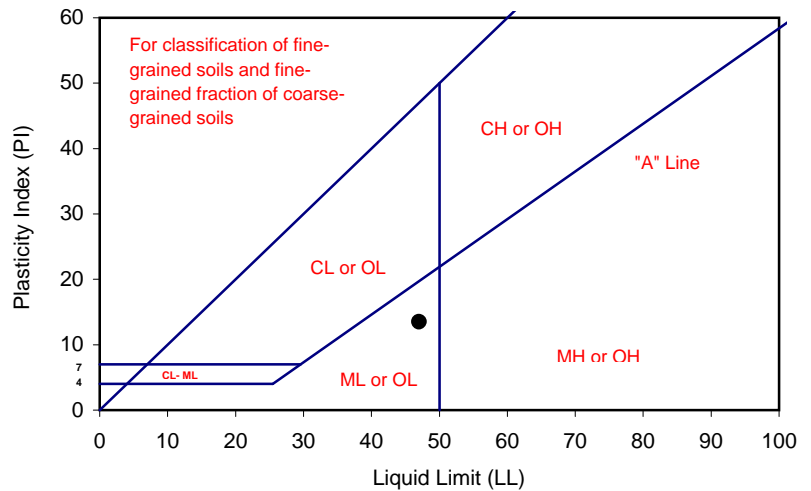
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/20/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/21/09  
 Boring No.: R-09-Z4-B4 Checked By: J. Ward  
 Sample No.: C-24 Depth (ft.) 126.5-127.3  
 Soil Identification: Dark olive silt'stone' (ML)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			29	23	17	
Wet Wt. of Soil + Cont. (g)	9.98	9.61	15.49	15.37	14.48	
Dry Wt. of Soil + Cont. (g)	7.76	7.44	10.93	10.77	10.11	
Wt. of Container (g)	1.03	1.06	1.12	1.04	1.06	
Moisture Content (%) [W <sub>n</sub> ]	32.99	34.01	46.48	47.28	48.29	

<b>Liquid Limit</b>	<b>47</b>
<b>Plastic Limit</b>	<b>33</b>
<b>Plasticity Index</b>	<b>14</b>
<b>Classification</b>	<b>ML</b>



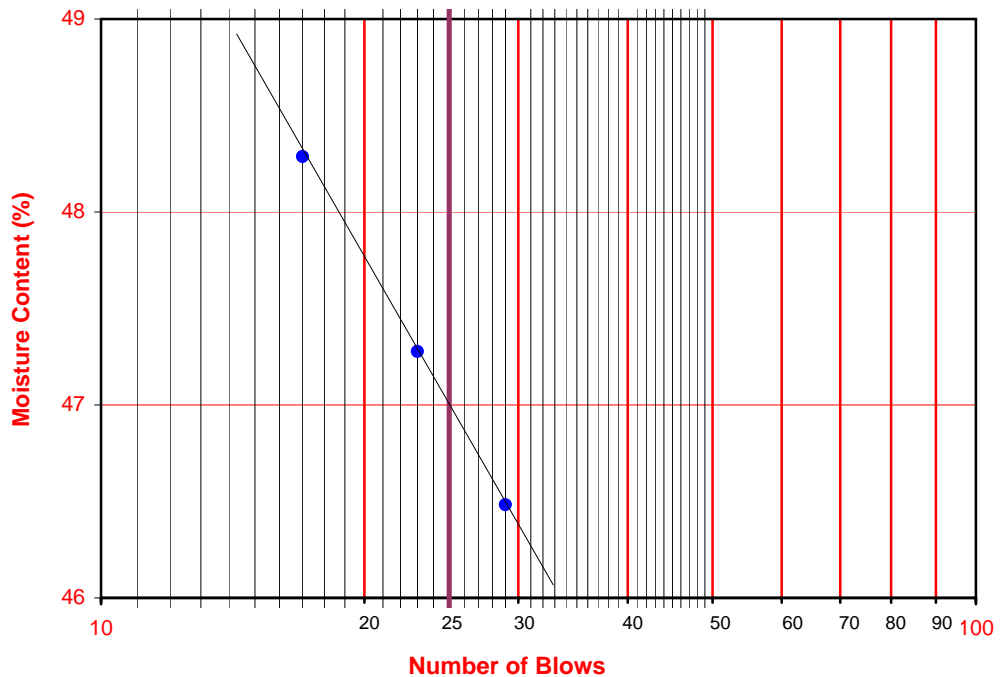
PI at "A" - Line =  $0.73(LL-20)$  = 19.71

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





Leighton

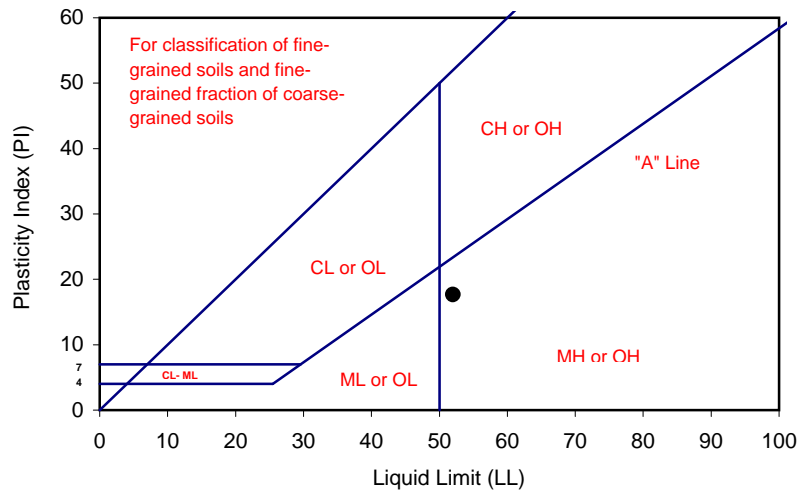
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/20/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/21/09  
 Boring No.: R-09-Z4-B4 Checked By: J. Ward  
 Sample No.: C-33 Depth (ft.) 185.2-185.9  
 Soil Identification: Dark olive elastic silt'stone' (MH)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	27	19	
Wet Wt. of Soil + Cont. (g)	8.58	8.99	12.95	14.07	15.48	
Dry Wt. of Soil + Cont. (g)	6.65	6.96	8.97	9.62	10.43	
Wt. of Container (g)	1.02	1.06	1.07	1.04	1.06	
Moisture Content (%) [Wn]	34.28	34.41	50.38	51.86	53.90	

<b>Liquid Limit</b>	<b>52</b>
<b>Plastic Limit</b>	<b>34</b>
<b>Plasticity Index</b>	<b>18</b>
<b>Classification</b>	<b>MH</b>



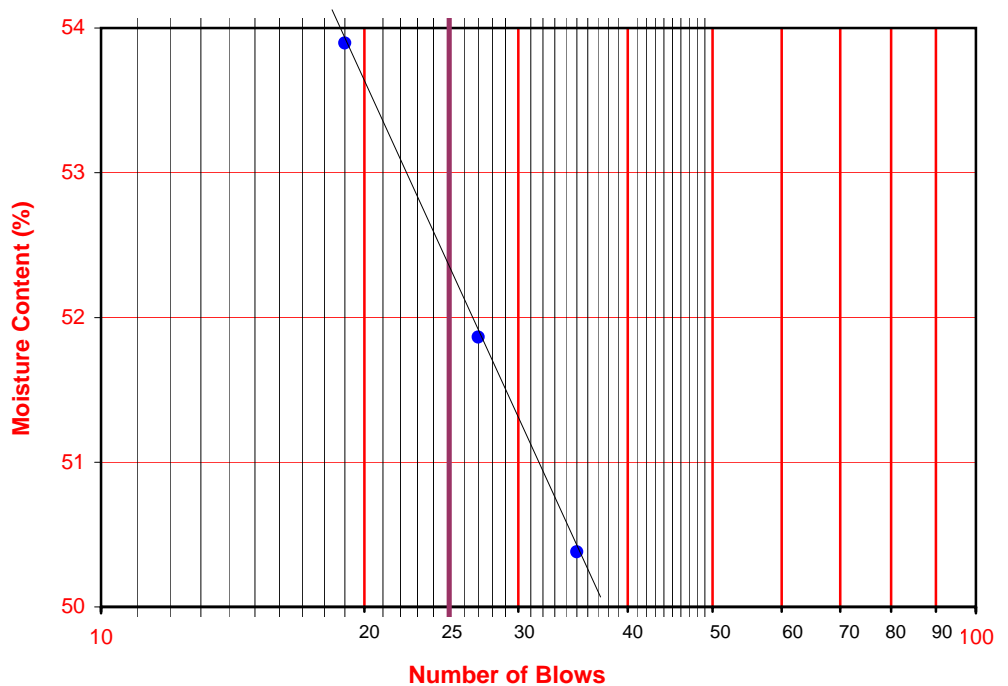
PI at "A" - Line =  $0.73(LL-20)$  = 23.36

One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.12}$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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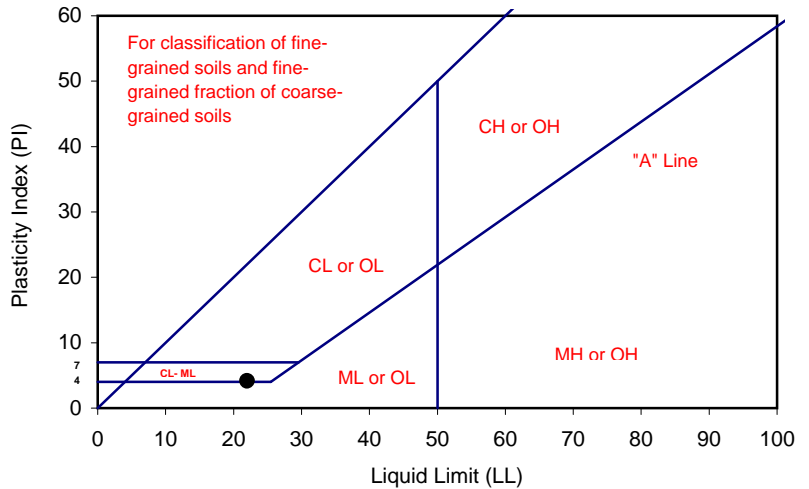
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/04/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/07/09  
 Boring No.: R-09-Z4-B4 Checked By: J. Ward  
 Sample No.: S-3 Depth (ft.) 15.0  
 Soil Identification: Yellowish brown sandy silty clay s(CL-ML)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			28	22	16	
Wet Wt. of Soil + Cont. (g)	11.02	11.03	16.60	13.65	19.74	
Dry Wt. of Soil + Cont. (g)	9.52	9.51	13.79	11.30	16.17	
Wt. of Container (g)	1.06	1.04	1.06	1.06	1.10	
Moisture Content (%) [W <sub>n</sub> ]	17.73	17.95	22.07	22.95	23.69	

<b>Liquid Limit</b>	<b>22</b>
<b>Plastic Limit</b>	<b>18</b>
<b>Plasticity Index</b>	<b>4</b>
<b>Classification</b>	<b>CL-ML</b>



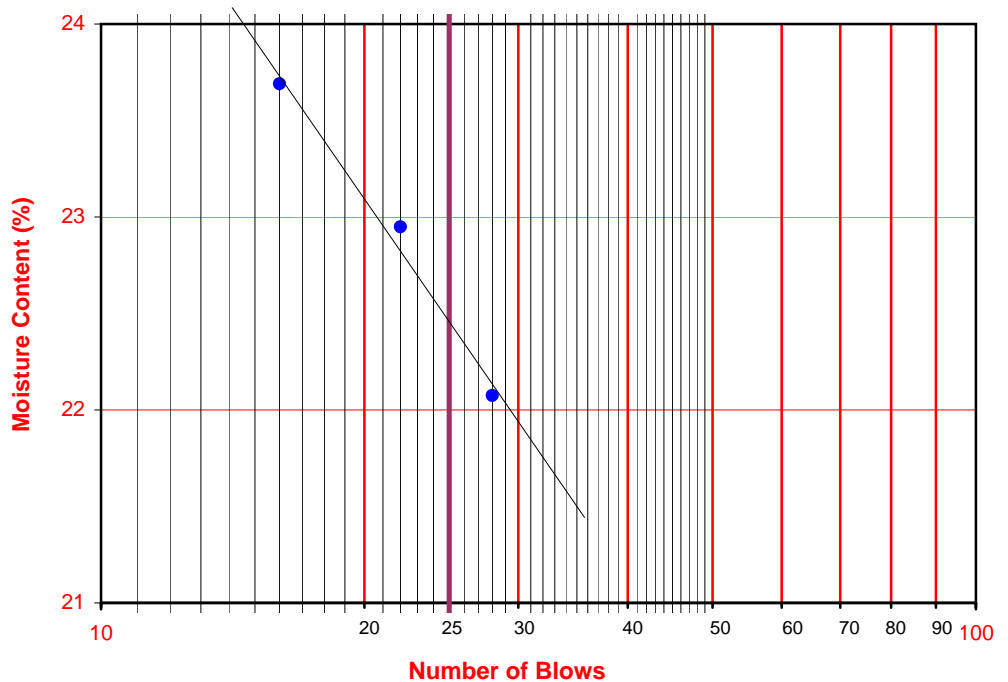
PI at "A" - Line =  $0.73(LL-20)$  1.46

One - Point Liquid Limit Calculation

$LL = W_n(N/25)^{0.12}$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test







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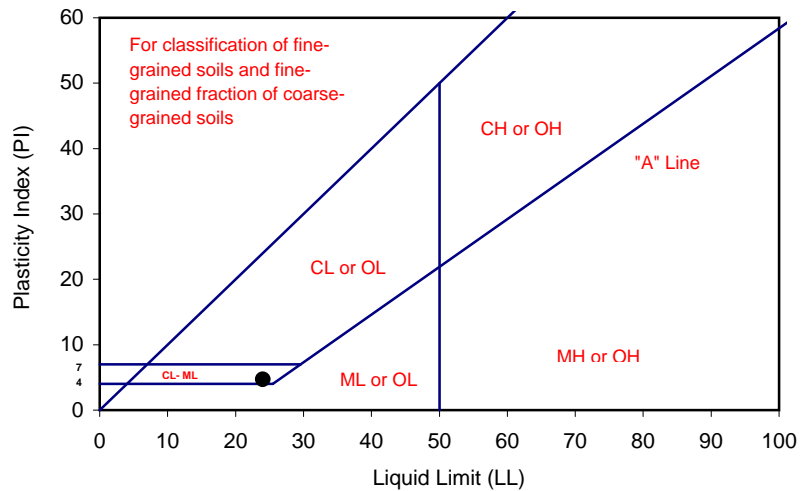
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 04/29/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/12/09  
 Boring No.: R-09-Z4-B4 Checked By: J. Ward  
 Sample No.: S-7 Depth (ft.) 35.0  
 Soil Identification: Yellowish brown sandy silty clay s(CL-ML)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			30	23	16	
Wet Wt. of Soil + Cont. (g)	11.08	10.49	14.67	14.98	15.19	
Dry Wt. of Soil + Cont. (g)	9.46	8.96	12.02	12.23	12.30	
Wt. of Container (g)	1.06	1.03	1.01	1.06	1.05	
Moisture Content (%) [W <sub>n</sub> ]	19.29	19.29	24.07	24.62	25.69	

<b>Liquid Limit</b>	<b>24</b>
<b>Plastic Limit</b>	<b>19</b>
<b>Plasticity Index</b>	<b>5</b>
<b>Classification</b>	<b>CL-ML</b>



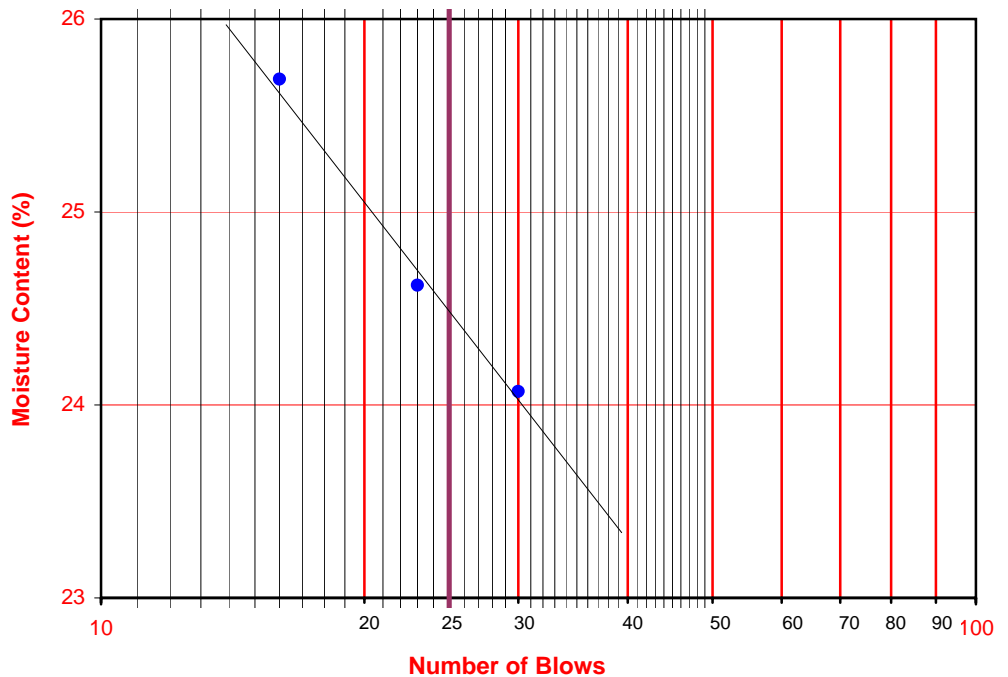
PI at "A" - Line =  $0.73(LL-20)$  2.92

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





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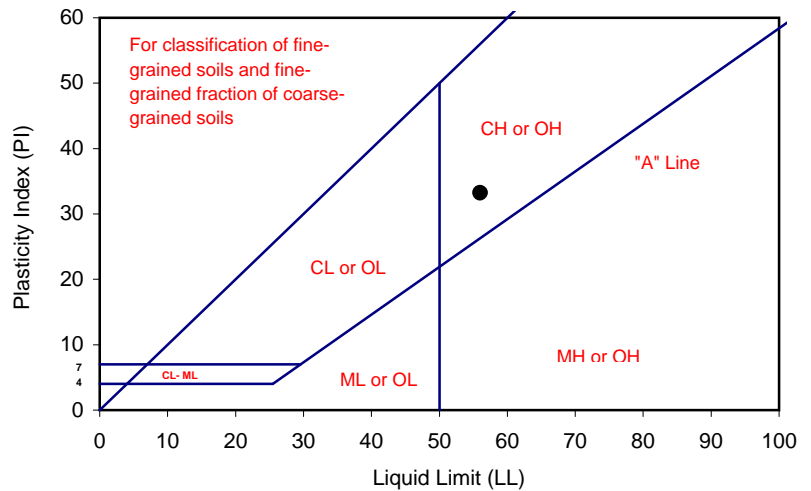
# ATTERBERG LIMITS

ASTM D 4318

Project Name: SR-710 Tunnel Technical Study Tested By: V. Juliano Date: 05/04/09  
 Project No. : 378312.04.09.01 Input By: J. Ward Date: 05/12/09  
 Boring No.: R-09-Z4-B4 Checked By: J. Ward  
 Sample No.: S-17 Depth (ft.) 85.0  
 Soil Identification: Yellowish brown fat clay (CH)

TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			35	28	20	
Wet Wt. of Soil + Cont. (g)	9.73	9.84	13.61	14.56	12.67	
Dry Wt. of Soil + Cont. (g)	8.12	8.21	9.26	9.78	8.44	
Wt. of Container (g)	1.03	1.08	1.05	1.06	1.05	
Moisture Content (%) [W <sub>n</sub> ]	22.71	22.86	52.98	54.82	57.24	

<b>Liquid Limit</b>	<b>56</b>
<b>Plastic Limit</b>	<b>23</b>
<b>Plasticity Index</b>	<b>33</b>
<b>Classification</b>	<b>CH</b>



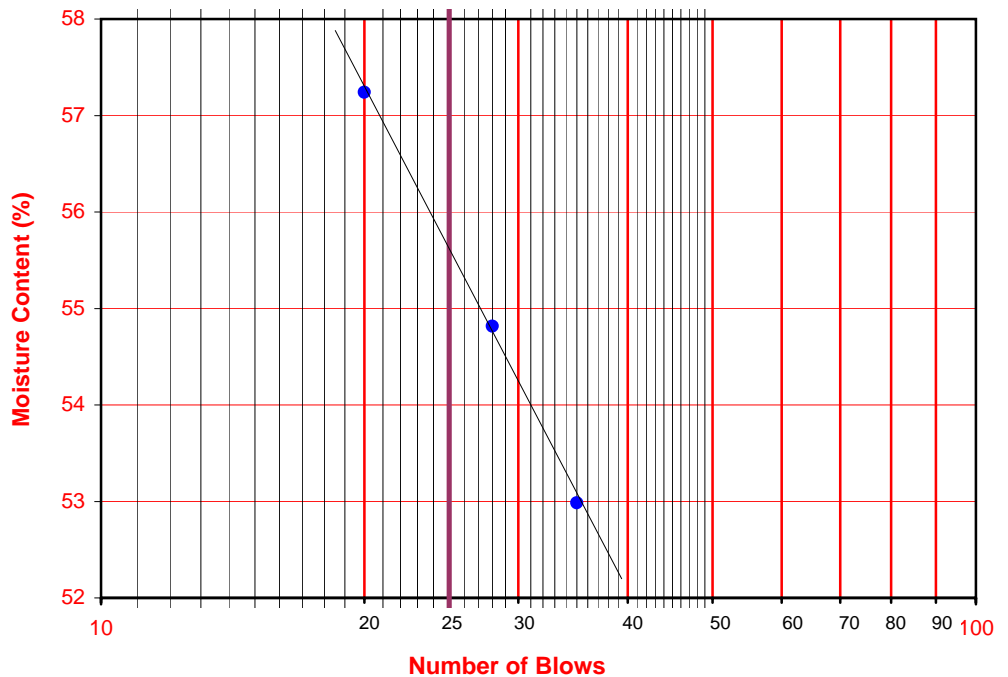
PI at "A" - Line =  $0.73(LL-20)$  26.28

One - Point Liquid Limit Calculation

$$LL = W_n(N/25)^{0.12}$$

## PROCEDURES USED

- Wet Preparation  
Multipoint - Wet
- Dry Preparation  
Multipoint - Dry
- Procedure A  
Multipoint Test
- Procedure B  
One-point Test





**TESTS for SULFATE CONTENT  
CHLORIDE CONTENT and pH of SOILS**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/11/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/14/09

Boring No.	R-09-Z1-B8	R-09-Z1-B8		
Sample No.	C26	C33		
Sample Depth (ft)	120-120.4	159.25-160		
Soil Identification:	Dark olive lean clay'stone' (CL)	Dark olive lean clay'stone' (CL)		
Wet Weight of Soil + Container (g)	127.70	113.90		
Dry Weight of Soil + Container (g)	115.70	104.80		
Weight of Container (g)	39.10	60.60		
Moisture Content (%)	15.67	20.59		
Weight of Soaked Soil (g)	100.30	100.60		

**SULFATE CONTENT, DOT California Test 417, Part II**

Beaker No.	10	13		
Crucible No.	31	32		
Furnace Temperature (°C)	830	830		
Time In / Time Out	7:40 / 8:25	7:40 / 8:25		
Duration of Combustion (min)	45	45		
Wt. of Crucible + Residue (g)	19.0027	19.1792		
Wt. of Crucible (g)	18.9790	19.1653		
Wt. of Residue (g) (A)	0.0237	0.0139		
PPM of Sulfate (A) x 41150	975.26	571.99		
<b>PPM of Sulfate, Dry Weight Basis</b>	<b>1156</b>	<b>720</b>		

**CHLORIDE CONTENT, DOT California Test 422**

ml of Chloride Soln. For Titration (B)	30	30		
ml of AgNO3 Soln. Used in Titration (C)	0.7	0.8		
PPM of Chloride (C -0.2) * 100 * 30 / B	50	60		
<b>PPM of Chloride, Dry Wt. Basis</b>	<b>59</b>	<b>76</b>		

**pH TEST, DOT California Test 532/643**

pH Value	6.18	6.26		
Temperature °C	20.4	20.3		



## SOIL RESISTIVITY TEST

**DOT CA TEST 532 / 643**

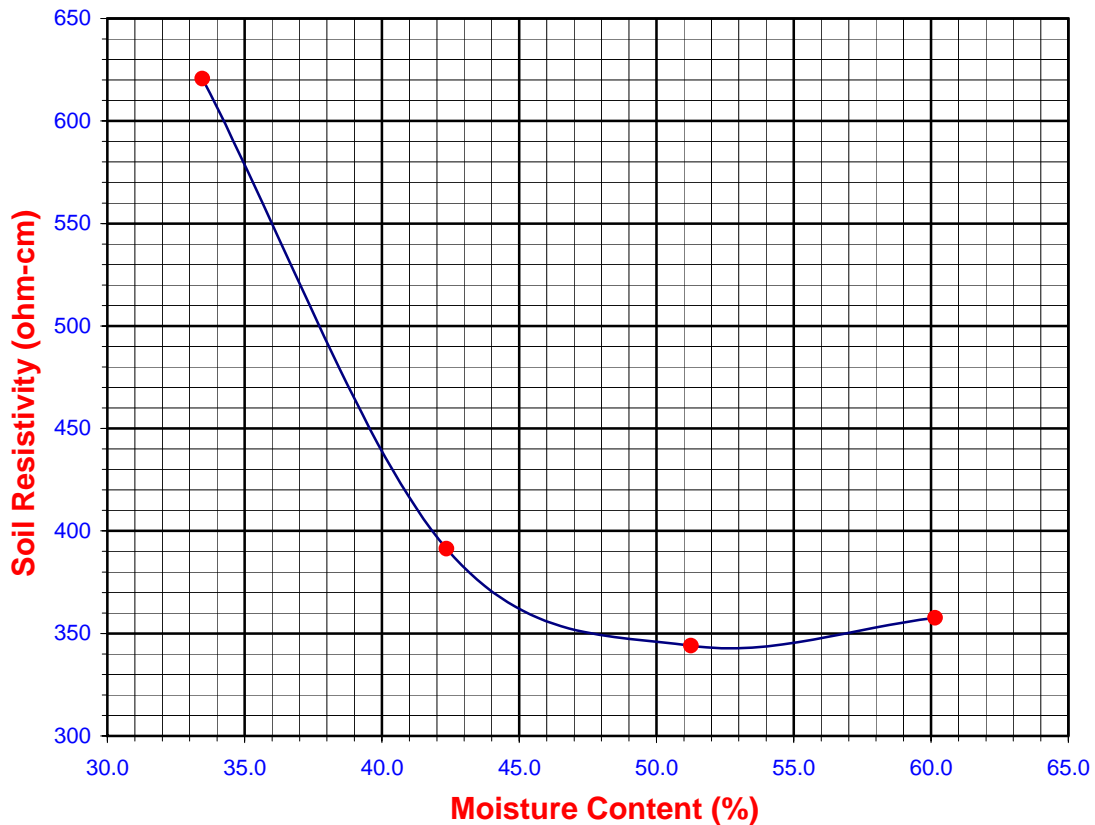
Project Name: SR-710 Tunnel Technical Study  
 Project No. : 378312.04.09.01  
 Boring No.: R-09-Z1-B8  
 Sample No. : C26  
 Soil Identification: Dark olive lean clay'stone' (CL)

Tested By : V. Juliano Date: 05/14/09  
 Data Input By: J. Ward Date: 05/14/09  
 Depth (ft.) : 120-120.4

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	200	33.46	92	621
2	300	42.36	58	391
3	400	51.26	51	344
4	500	60.15	53	358
5				

Moisture Content (%) (MCi)	15.67
Wet Wt. of Soil + Cont. (g)	127.70
Dry Wt. of Soil + Cont. (g)	115.70
Wt. of Container (g)	39.10
Container No.	
Initial Soil Wt. (g) (Wt)	1300.00
Box Constant	6.746
$MC = (((1+MCi/100) \times (Wa/Wt+1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
<b>343</b>	<b>52.6</b>	<b>1156</b>	<b>59</b>	<b>6.18</b>	<b>20.4</b>





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## SOIL RESISTIVITY TEST

**DOT CA TEST 532 / 643**

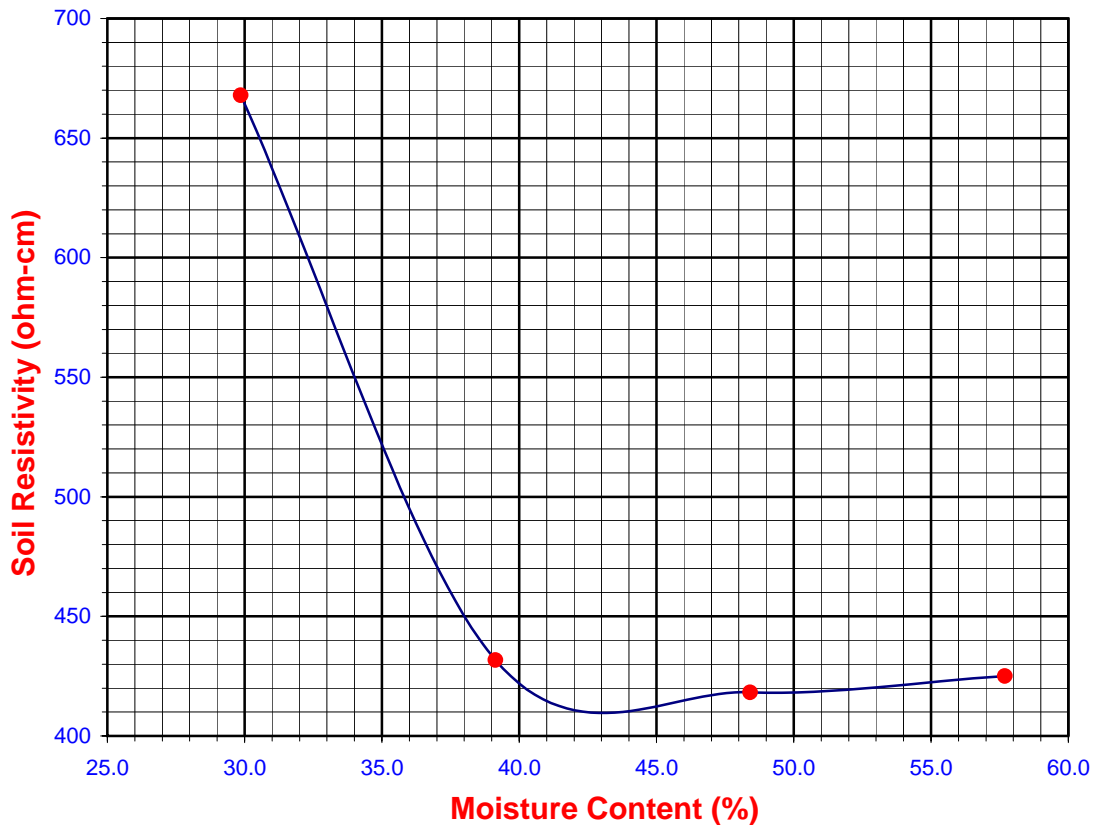
Project Name: SR-710 Tunnel Technical Study  
 Project No. : 378312.04.09.01  
 Boring No.: R-09-Z1-B8  
 Sample No. : C33  
 Soil Identification: Dark olive lean clay'stone' (CL)

Tested By : V. Juliano Date: 05/14/09  
 Data Input By: J. Ward Date: 05/14/09  
 Depth (ft.) : 159.25-160

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	100	29.86	99	668
2	200	39.14	64	432
3	300	48.42	62	418
4	400	57.69	63	425
5				

Moisture Content (%) (Mci)	20.59
Wet Wt. of Soil + Cont. (g)	113.90
Dry Wt. of Soil + Cont. (g)	104.80
Wt. of Container (g)	60.60
Container No.	
Initial Soil Wt. (g) (Wt)	1300.00
Box Constant	6.746
$MC = (((1 + Mci / 100) \times (Wa / Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
<b>410</b>	<b>43.0</b>	<b>720</b>	<b>76</b>	<b>6.26</b>	<b>20.3</b>





### CORROSION TEST RESULTS

Client Name: CH2M Hill  
Project Name: SR-710 Tunnel Technical Study  
Project No.: 378312.04.09.01

AP Job No.: 29-0603  
Date: 06/04/09

Boring No.	Sample No.	Depth (ft)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
R-09-Z3-B8	C-54	218-221	Claystone	1600	7.5	5188	64

NOTES: Resistivity Test and pH: California Test Methods 532 and 643  
Sulfate Content : California Test Method 417  
Chloride Content : California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested



**TESTS for SULFATE CONTENT  
CHLORIDE CONTENT and pH of SOILS**

Project Name: SR-710 Tunnel Technical Study Tested By : V. Juliano Date: 05/14/09  
 Project No. : 378312.04.09.01 Data Input By: J. Ward Date: 05/26/09

Boring No.	R-09-Z3-B11			
Sample No.	C-35			
Sample Depth (ft)	171.5-172.25			
Soil Identification:	Light olive brown (CH)s			
Wet Weight of Soil + Container (g)	0.00			
Dry Weight of Soil + Container (g)	0.00			
Weight of Container (g)	1.00			
Moisture Content (%)	0.00			
Weight of Soaked Soil (g)	100.40			

**SULFATE CONTENT, DOT California Test 417, Part II**

Beaker No.	9			
Crucible No.	26			
Furnace Temperature (°C)	830			
Time In / Time Out	8:05 / 8:50			
Duration of Combustion (min)	45			
Wt. of Crucible + Residue (g)	18.8789			
Wt. of Crucible (g)	18.8767			
Wt. of Residue (g) (A)	0.0022			
PPM of Sulfate (A) x 41150	90.53			
<b>PPM of Sulfate, Dry Weight Basis</b>	<b>91</b>			

**CHLORIDE CONTENT, DOT California Test 422**

ml of Chloride Soln. For Titration (B)	30			
ml of AgNO <sub>3</sub> Soln. Used in Titration (C)	0.5			
PPM of Chloride (C -0.2) * 100 * 30 / B	30			
<b>PPM of Chloride, Dry Wt. Basis</b>	<b>30</b>			

**pH TEST, DOT California Test 532/643**

<b>pH Value</b>	<b>6.86</b>			
<b>Temperature °C</b>	<b>20.1</b>			



## SOIL RESISTIVITY TEST

**DOT CA TEST 532 / 643**

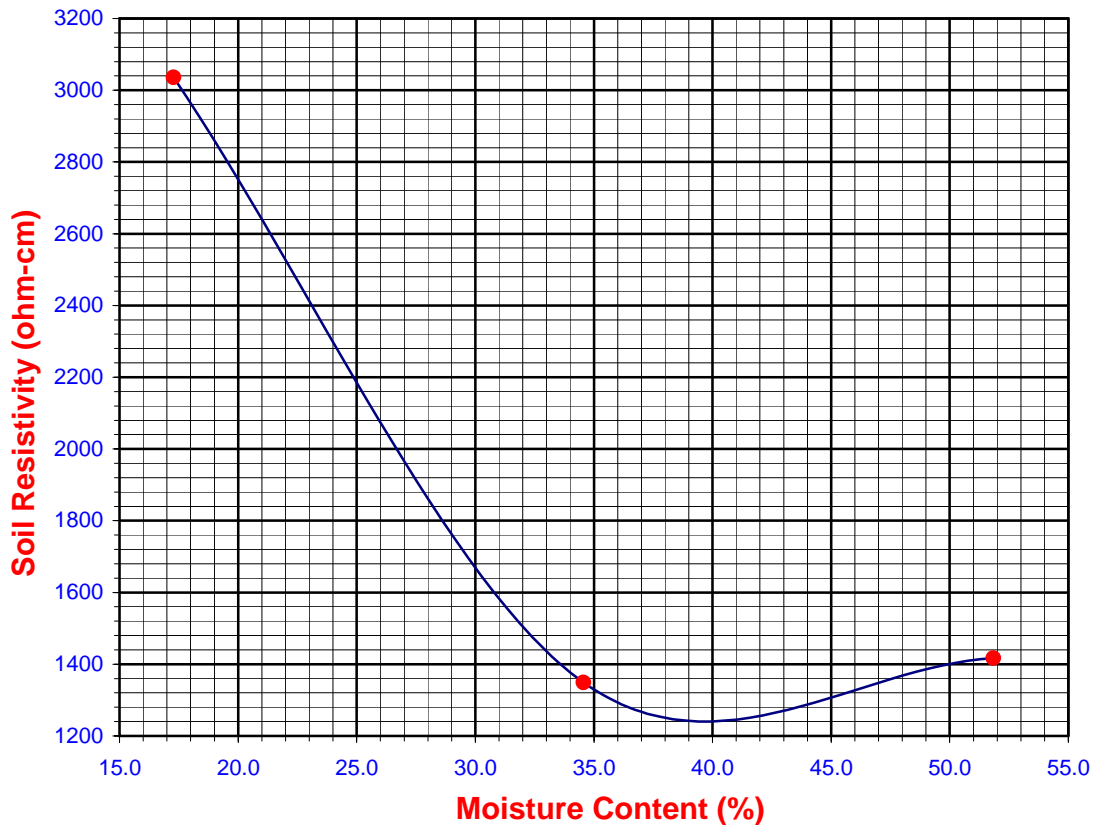
Project Name: SR-710 Tunnel Technical Study  
 Project No. : 378312.04.09.01  
 Boring No.: R-09-Z3-B11  
 Sample No. : C-35  
 Soil Identification: Light olive brown (CH)s

Tested By : V. Juliano Date: 05/15/09  
 Data Input By: J. Ward Date: 05/26/09  
 Depth (ft.) : 171.5-172.25

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	150	17.28	450	3036
2	300	34.56	200	1349
3	450	51.84	210	1417
4				
5				

Moisture Content (%) (Mci)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	868.00
Box Constant	6.746
$MC = (((1 + Mci / 100) \times (Wa / Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II		DOT CA Test 532 / 643	
<b>1240</b>	<b>39.7</b>	<b>91</b>	<b>30</b>	<b>6.86</b>	<b>20.1</b>







## TESTS for SULFATE CONTENT CHLORIDE CONTENT and pH of SOILS

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/06/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/27/09

Boring No.	R-09-Z3-B12	R-09-Z3-B12		
Sample No.	C34	C51		
Sample Depth (ft)	164.9-165.5	229.2-229.7		
Soil Identification:	Olive yellow lean clay'stone' (CL)	Olive silt'stone' (ML)		
Wet Weight of Soil + Container (g)	124.50	151.00		
Dry Weight of Soil + Container (g)	110.70	140.00		
Weight of Container (g)	60.70	68.90		
Moisture Content (%)	27.60	15.47		
Weight of Soaked Soil (g)	100.20	100.20		

### SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	9	11		
Crucible No.	23	25		
Furnace Temperature (°C)	830	830		
Time In / Time Out	7:40 / 8:25	7:40 / 8:25		
Duration of Combustion (min)	45	45		
Wt. of Crucible + Residue (g)	18.4160	18.8932		
Wt. of Crucible (g)	18.4145	18.8768		
Wt. of Residue (g) (A)	0.0015	0.0164		
PPM of Sulfate (A) x 41150	61.73	674.86		
<b>PPM of Sulfate, Dry Weight Basis</b>	<b>85</b>	<b>798</b>		

### CHLORIDE CONTENT, DOT California Test 422

ml of Chloride Soln. For Titration (B)	30	30		
ml of AgNO <sub>3</sub> Soln. Used in Titration (C)	0.5	0.7		
PPM of Chloride (C -0.2) * 100 * 30 / B	30	50		
<b>PPM of Chloride, Dry Wt. Basis</b>	<b>41</b>	<b>59</b>		

### pH TEST, DOT California Test 532/643

pH Value	7.76	7.41		
Temperature °C	19.8	19.8		



## SOIL RESISTIVITY TEST

**DOT CA TEST 532 / 643**

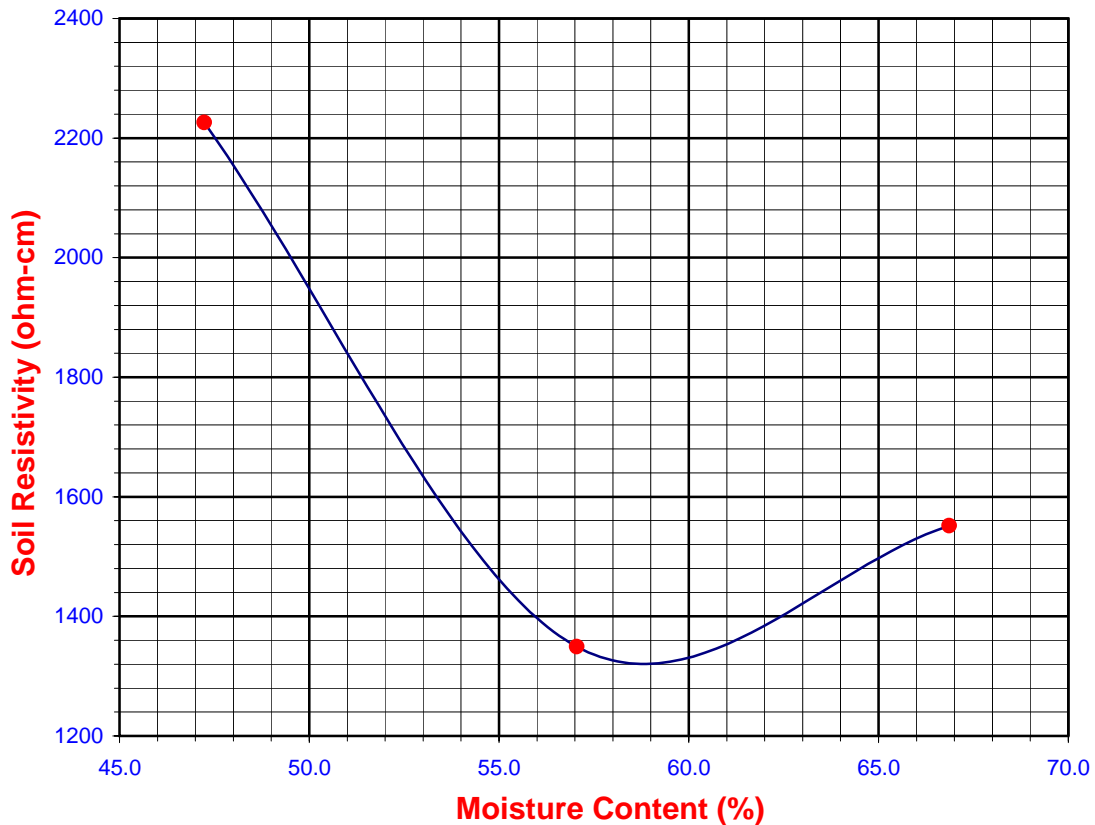
Project Name: SR-710 Tunnel Technical Study  
 Project No. : 378312.04.09.01  
 Boring No.: R-09-Z3-B12  
 Sample No. : C34  
 Soil Identification: Olive yellow lean clay'stone' (CL)

Tested By : V. Juliano Date: 05/13/09  
 Data Input By: J. Ward Date: 05/27/09  
 Depth (ft.) : 164.9-165.5

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	200	47.23	330	2226
2	300	57.05	200	1349
3	400	66.86	230	1552
4				
5				

Moisture Content (%) (Mci)	27.60
Wet Wt. of Soil + Cont. (g)	124.50
Dry Wt. of Soil + Cont. (g)	110.70
Wt. of Container (g)	60.70
Container No.	
Initial Soil Wt. (g) (Wt)	1300.00
Box Constant	6.746
$MC = (((1 + Mci / 100) \times (Wa / Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II		DOT CA Test 532 / 643	
<b>1320</b>	<b>58.7</b>	<b>85</b>	<b>41</b>	<b>7.76</b>	<b>19.8</b>





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## SOIL RESISTIVITY TEST

**DOT CA TEST 532 / 643**

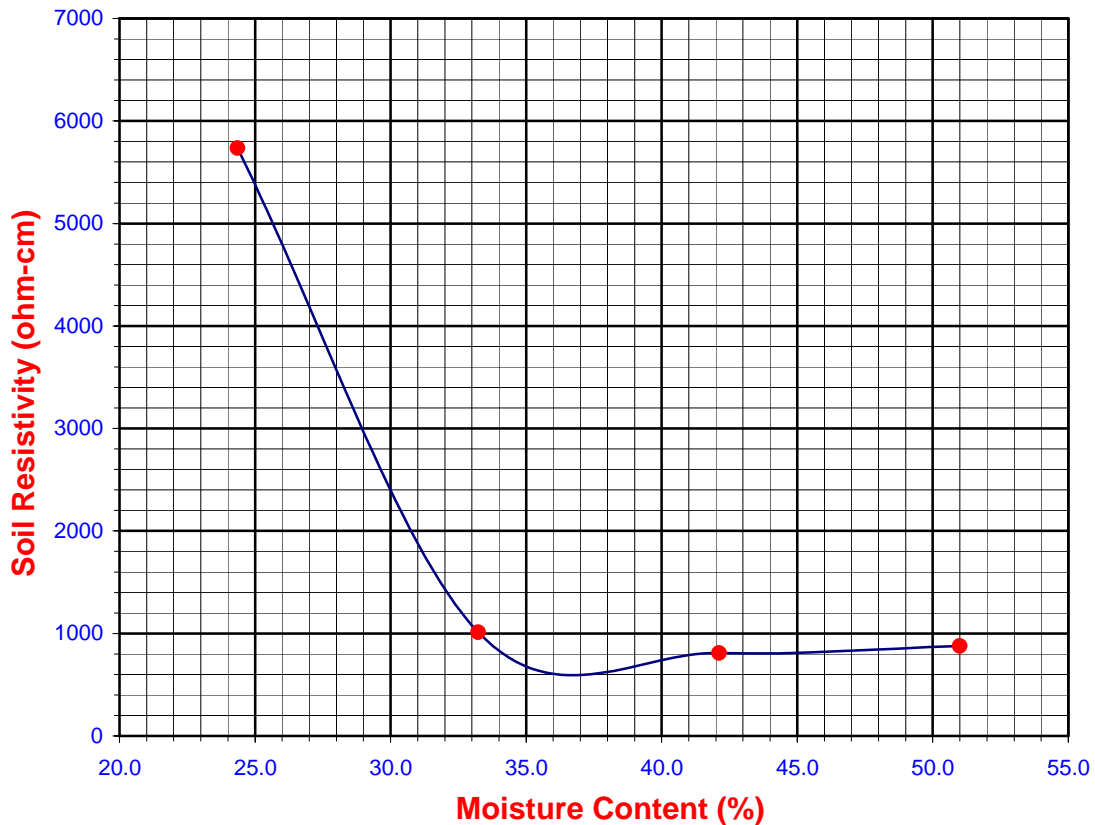
Project Name: SR-710 Tunnel Technical Study  
 Project No. : 378312.04.09.01  
 Boring No.: R-09-Z3-B12  
 Sample No. : C51  
 Soil Identification: Olive silt'stone' (ML)

Tested By : V. Juliano Date: 05/13/09  
 Data Input By: J. Ward Date: 05/27/09  
 Depth (ft.) : 229.2-229.7

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	100	24.35	850	5734
2	200	33.24	150	1012
3	300	42.12	120	810
4	400	51.00	130	877
5				

Moisture Content (%) (Mci)	15.47
Wet Wt. of Soil + Cont. (g)	151.00
Dry Wt. of Soil + Cont. (g)	140.00
Wt. of Container (g)	68.90
Container No.	
Initial Soil Wt. (g) (Wt)	1300.00
Box Constant	6.746
$MC = (((1 + Mci / 100) \times (Wa / Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
<b>600</b>	<b>36.7</b>	<b>798</b>	<b>59</b>	<b>7.41</b>	<b>19.8</b>





**TESTS for SULFATE CONTENT  
CHLORIDE CONTENT and pH of SOILS**

Project Name: SR-710 Tunnel Technical Study Tested By : V. Juliano Date: 05/06/09  
 Project No. : 378312.04.09.01 Data Input By: J. Ward Date: 05/21/09

Boring No.	R-09-Z4-B4	R-09-Z4-B4		
Sample No.	C-19	C-38		
Sample Depth (ft)	97.5-98.3	220.5-221.5		
Soil Identification:	Yellow fat clay'stone' (CH)	Dark olive silt'stone' (ML)		
Wet Weight of Soil + Container (g)	0.00	0.00		
Dry Weight of Soil + Container (g)	0.00	0.00		
Weight of Container (g)	1.00	1.00		
Moisture Content (%)	0.00	0.00		
Weight of Soaked Soil (g)	100.10	100.30		

**SULFATE CONTENT, DOT California Test 417, Part II**

Beaker No.	6	8		
Crucible No.	15	18		
Furnace Temperature (°C)	830	830		
Time In / Time Out	7:40 / 8:25	7:40 / 8:25		
Duration of Combustion (min)	45	45		
Wt. of Crucible + Residue (g)	20.3168	19.8312		
Wt. of Crucible (g)	20.3163	19.7354		
Wt. of Residue (g) (A)	0.0005	0.0958		
PPM of Sulfate (A) x 41150	20.58	3942.17		
<b>PPM of Sulfate, Dry Weight Basis</b>	<b>21</b>	<b>3942</b>		

**CHLORIDE CONTENT, DOT California Test 422**

ml of Chloride Soln. For Titration (B)	30	30		
ml of AgNO <sub>3</sub> Soln. Used in Titration (C)	0.4	0.8		
PPM of Chloride (C -0.2) * 100 * 30 / B	20	60		
<b>PPM of Chloride, Dry Wt. Basis</b>	<b>20</b>	<b>60</b>		

**pH TEST, DOT California Test 532/643**

<b>pH Value</b>	<b>6.57</b>	<b>4.63</b>		
<b>Temperature °C</b>	<b>20.7</b>	<b>20.6</b>		



## SOIL RESISTIVITY TEST

**DOT CA TEST 532 / 643**

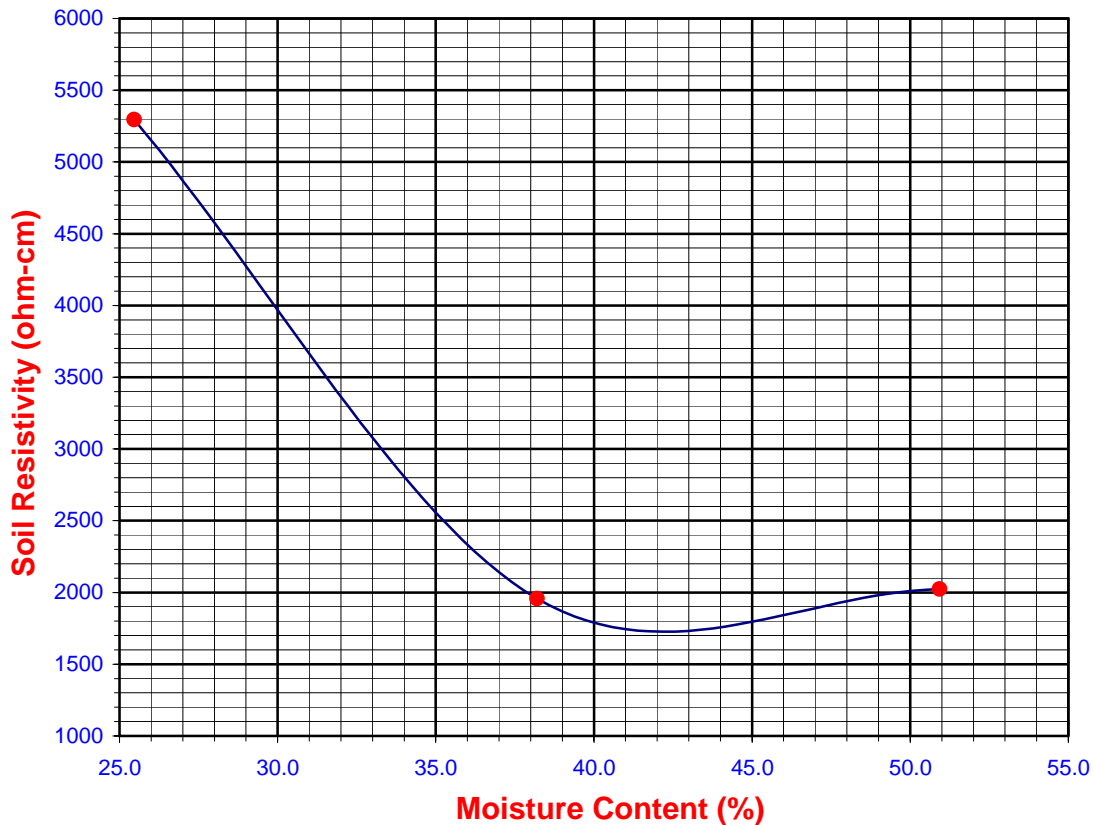
Project Name: SR-710 Tunnel Technical Study  
 Project No. : 378312.04.09.01  
 Boring No.: R-09-Z4-B4  
 Sample No. : C-19  
 Soil Identification: Yellow fat clay'stone' (CH)

Tested By : V. Juliano Date: 05/15/09  
 Data Input By: J. Ward Date: 05/21/09  
 Depth (ft.) : 97.5-98.3

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	300	25.47	785	5296
2	450	38.20	290	1956
3	600	50.93	300	2024
4				
5				

Moisture Content (%) (Mci)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	1178.00
Box Constant	6.746
$MC = (((1 + Mci / 100) \times (Wa / Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
<b>1720</b>	<b>42.2</b>	<b>21</b>	<b>20</b>	<b>6.57</b>	<b>20.7</b>





Leighton

## SOIL RESISTIVITY TEST

DOT CA TEST 532 / 643

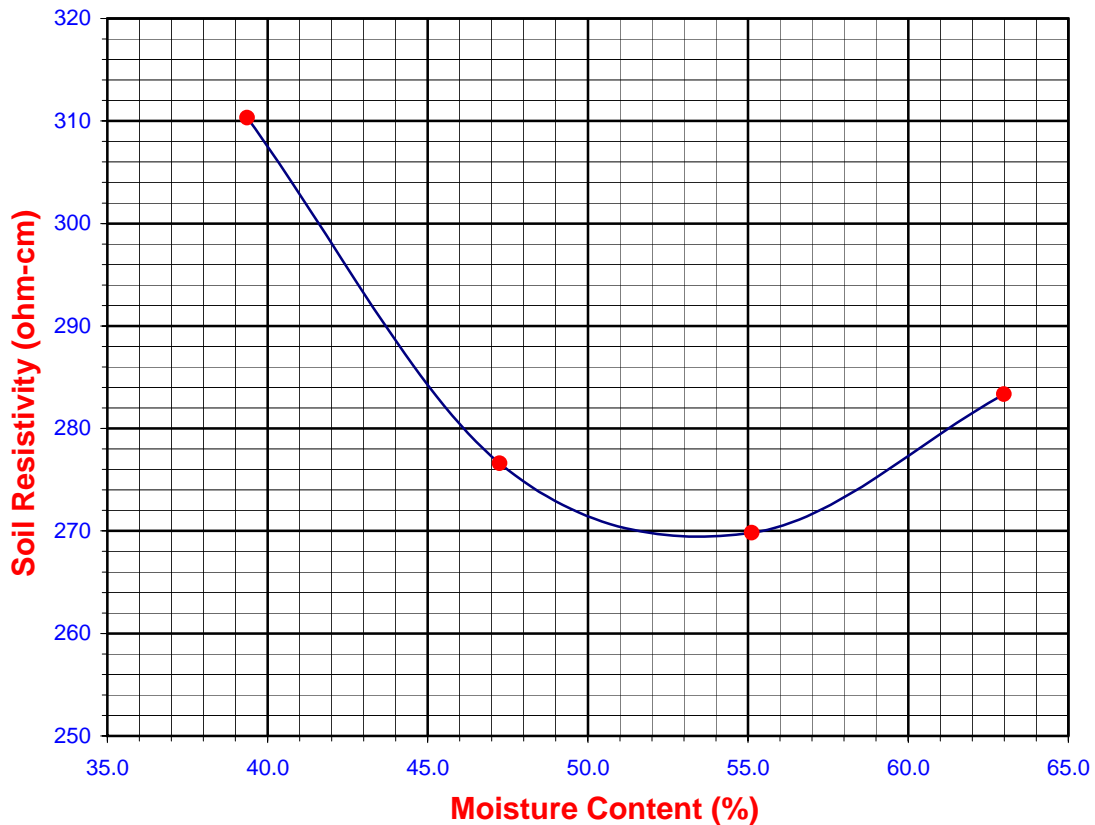
Project Name: SR-710 Tunnel Technical Study  
 Project No. : 378312.04.09.01  
 Boring No.: R-09-Z4-B4  
 Sample No. : C-38  
 Soil Identification: Dark olive silt'stone' (ML)

Tested By : V. Juliano Date: 05/15/09  
 Data Input By: J. Ward Date: 05/21/09  
 Depth (ft.) : 220.5-221.5

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	500	39.37	46	310
2	600	47.24	41	277
3	700	55.12	40	270
4	800	62.99	42	283
5				

Moisture Content (%) (Mci)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	1270.00
Box Constant	6.746
$MC = (((1 + Mci / 100) \times (Wa / Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
<b>269</b>	<b>53.4</b>	<b>3942</b>	<b>60</b>	<b>4.63</b>	<b>20.6</b>





**TESTS for SULFATE CONTENT  
CHLORIDE CONTENT and pH of SOILS**

Project Name: SR-710 Tunnel Technical Study      Tested By : V. Juliano      Date: 05/11/09  
 Project No. : 378312.04.09.01      Data Input By: J. Ward      Date: 05/14/09

Boring No.	R-09-Z1-B8	R-09-Z1-B8		
Sample No.	C26	C33		
Sample Depth (ft)	120-120.4	159.25-160		
Soil Identification:	Dark olive lean clay'stone' (CL)	Dark olive lean clay'stone' (CL)		
Wet Weight of Soil + Container (g)	127.70	113.90		
Dry Weight of Soil + Container (g)	115.70	104.80		
Weight of Container (g)	39.10	60.60		
Moisture Content (%)	15.67	20.59		
Weight of Soaked Soil (g)	100.30	100.60		

**SULFATE CONTENT, DOT California Test 417, Part II**

Beaker No.	10	13		
Crucible No.	31	32		
Furnace Temperature (°C)	830	830		
Time In / Time Out	7:40 / 8:25	7:40 / 8:25		
Duration of Combustion (min)	45	45		
Wt. of Crucible + Residue (g)	19.0027	19.1792		
Wt. of Crucible (g)	18.9790	19.1653		
Wt. of Residue (g) (A)	0.0237	0.0139		
PPM of Sulfate (A) x 41150	975.26	571.99		
<b>PPM of Sulfate, Dry Weight Basis</b>	<b>1156</b>	<b>720</b>		

**CHLORIDE CONTENT, DOT California Test 422**

ml of Chloride Soln. For Titration (B)	30	30		
ml of AgNO3 Soln. Used in Titration (C)	0.7	0.8		
PPM of Chloride (C -0.2) * 100 * 30 / B	50	60		
<b>PPM of Chloride, Dry Wt. Basis</b>	<b>59</b>	<b>76</b>		

**pH TEST, DOT California Test 532/643**

pH Value	6.18	6.26		
Temperature °C	20.4	20.3		



## SOIL RESISTIVITY TEST

**DOT CA TEST 532 / 643**

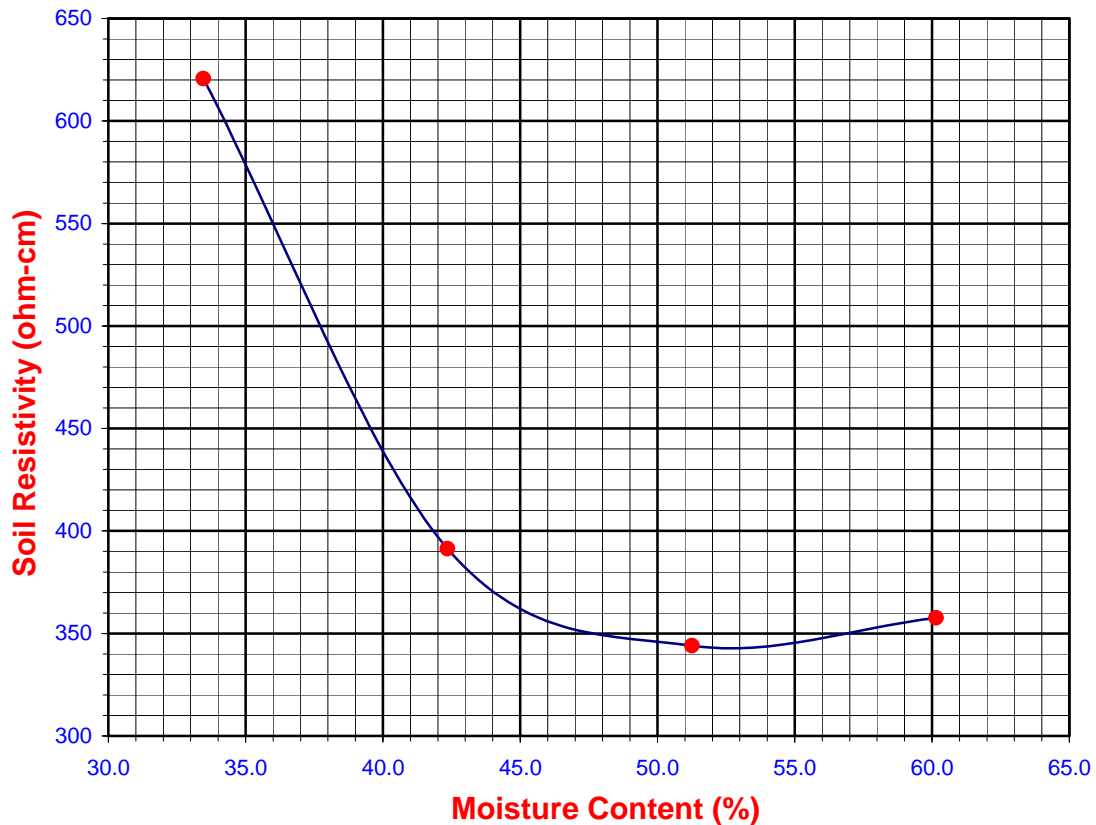
Project Name: SR-710 Tunnel Technical Study  
 Project No. : 378312.04.09.01  
 Boring No.: R-09-Z1-B8  
 Sample No. : C26  
 Soil Identification: Dark olive lean clay'stone' (CL)

Tested By : V. Juliano Date: 05/14/09  
 Data Input By: J. Ward Date: 05/14/09  
 Depth (ft.) : 120-120.4

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	200	33.46	92	621
2	300	42.36	58	391
3	400	51.26	51	344
4	500	60.15	53	358
5				

Moisture Content (%) (MCi)	15.67
Wet Wt. of Soil + Cont. (g)	127.70
Dry Wt. of Soil + Cont. (g)	115.70
Wt. of Container (g)	39.10
Container No.	
Initial Soil Wt. (g) (Wt)	1300.00
Box Constant	6.746
$MC = (((1+MCi/100) \times (Wa/Wt+1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
<b>343</b>	<b>52.6</b>	<b>1156</b>	<b>59</b>	<b>6.18</b>	<b>20.4</b>







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## SOIL RESISTIVITY TEST

DOT CA TEST 532 / 643

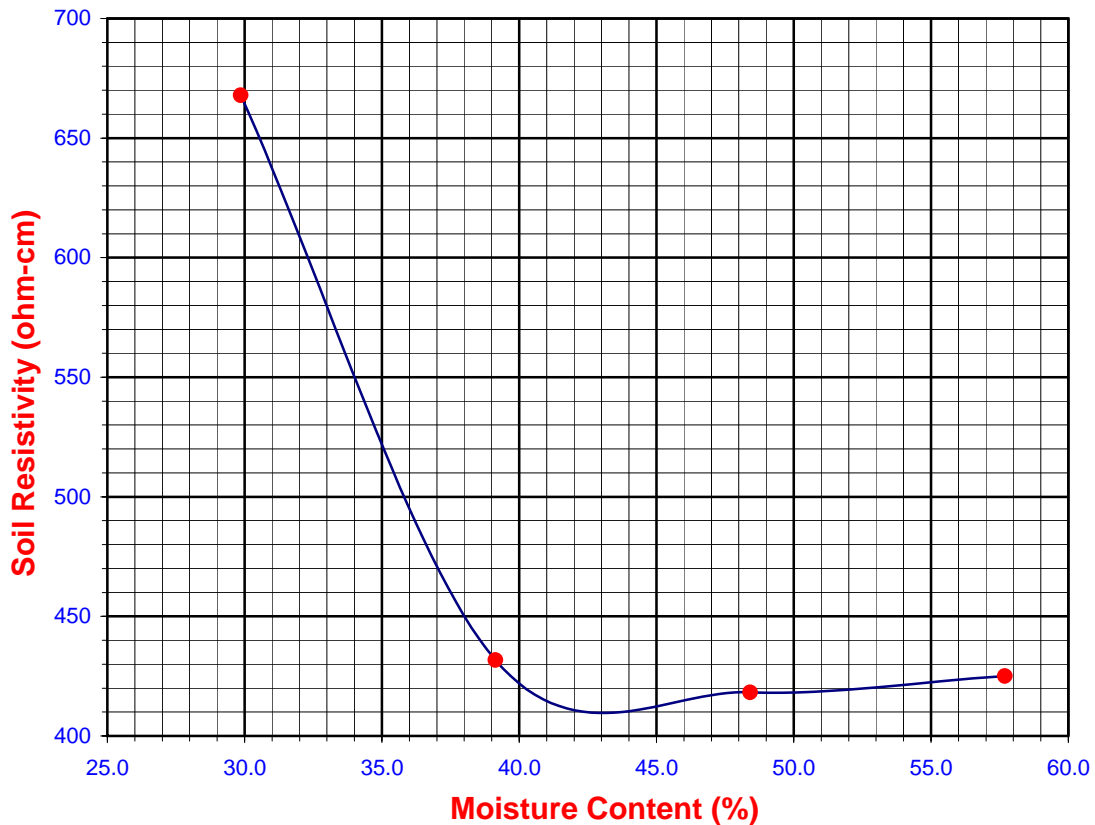
Project Name: SR-710 Tunnel Technical Study  
 Project No. : 378312.04.09.01  
 Boring No.: R-09-Z1-B8  
 Sample No. : C33  
 Soil Identification: Dark olive lean clay'stone' (CL)

Tested By : V. Juliano Date: 05/14/09  
 Data Input By: J. Ward Date: 05/14/09  
 Depth (ft.) : 159.25-160

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	100	29.86	99	668
2	200	39.14	64	432
3	300	48.42	62	418
4	400	57.69	63	425
5				

Moisture Content (%) (Mci)	20.59
Wet Wt. of Soil + Cont. (g)	113.90
Dry Wt. of Soil + Cont. (g)	104.80
Wt. of Container (g)	60.60
Container No.	
Initial Soil Wt. (g) (Wt)	1300.00
Box Constant	6.746
$MC = (((1 + Mci / 100) \times (Wa / Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
<b>410</b>	<b>43.0</b>	<b>720</b>	<b>76</b>	<b>6.26</b>	<b>20.3</b>





### CORROSION TEST RESULTS

Client Name: CH2M Hill  
 Project Name: SR-710 Tunnel Technical Study  
 Project No.: 378312.04.09.01

AP Job No.: 29-0603  
 Date: 06/04/09

Boring No.	Sample No.	Depth (ft)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
R-09-Z3-B8	C-54	218-221	Claystone	1600	7.5	5188	64

NOTES:        Resistivity Test and pH: California Test Methods 532 and 643  
                  Sulfate Content :        California Test Method 417  
                  Chloride Content :        California Test Method 422  
                  ND = Not Detectable  
                  NA = Not Sufficient Sample  
                  NR = Not Requested



## TESTS for SULFATE CONTENT CHLORIDE CONTENT and pH of SOILS

Project Name: SR-710 Tunnel Technical Study Tested By : V. Juliano Date: 05/06/09  
 Project No. : 378312.04.09.01 Data Input By: J. Ward Date: 05/27/09

Boring No.	R-09-Z3-B12	R-09-Z3-B12		
Sample No.	C34	C51		
Sample Depth (ft)	164.9-165.5	229.2-229.7		
Soil Identification:	Olive yellow lean clay'stone' (CL)	Olive silt'stone' (ML)		
Wet Weight of Soil + Container (g)	124.50	151.00		
Dry Weight of Soil + Container (g)	110.70	140.00		
Weight of Container (g)	60.70	68.90		
Moisture Content (%)	27.60	15.47		
Weight of Soaked Soil (g)	100.20	100.20		

### SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	9	11		
Crucible No.	23	25		
Furnace Temperature (°C)	830	830		
Time In / Time Out	7:40 / 8:25	7:40 / 8:25		
Duration of Combustion (min)	45	45		
Wt. of Crucible + Residue (g)	18.4160	18.8932		
Wt. of Crucible (g)	18.4145	18.8768		
Wt. of Residue (g) (A)	0.0015	0.0164		
PPM of Sulfate (A) x 41150	61.73	674.86		
<b>PPM of Sulfate, Dry Weight Basis</b>	<b>85</b>	<b>798</b>		

### CHLORIDE CONTENT, DOT California Test 422

ml of Chloride Soln. For Titration (B)	30	30		
ml of AgNO <sub>3</sub> Soln. Used in Titration (C)	0.5	0.7		
PPM of Chloride (C -0.2) * 100 * 30 / B	30	50		
<b>PPM of Chloride, Dry Wt. Basis</b>	<b>41</b>	<b>59</b>		

### pH TEST, DOT California Test 532/643

pH Value	7.76	7.41		
Temperature °C	19.8	19.8		



## SOIL RESISTIVITY TEST

**DOT CA TEST 532 / 643**

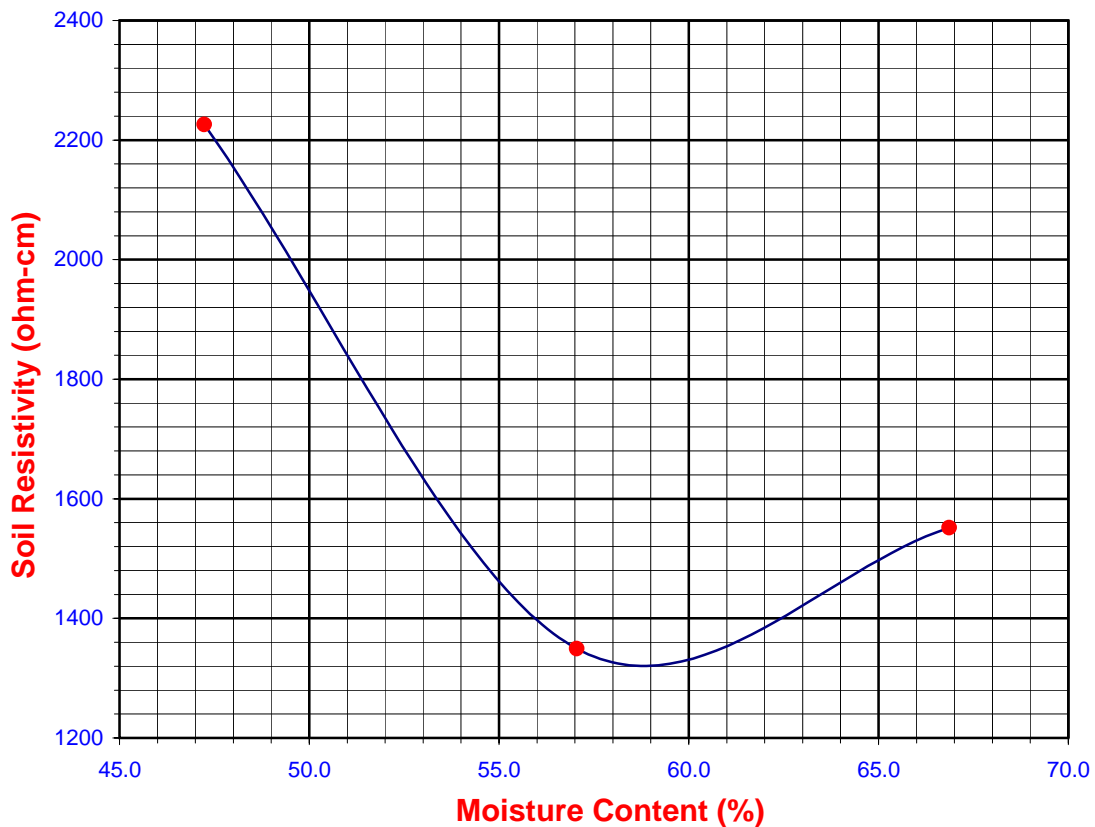
Project Name: SR-710 Tunnel Technical Study  
 Project No. : 378312.04.09.01  
 Boring No.: R-09-Z3-B12  
 Sample No. : C34  
 Soil Identification: Olive yellow lean clay'stone' (CL)

Tested By : V. Juliano Date: 05/13/09  
 Data Input By: J. Ward Date: 05/27/09  
 Depth (ft.) : 164.9-165.5

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	200	47.23	330	2226
2	300	57.05	200	1349
3	400	66.86	230	1552
4				
5				

Moisture Content (%) (Mci)	27.60
Wet Wt. of Soil + Cont. (g)	124.50
Dry Wt. of Soil + Cont. (g)	110.70
Wt. of Container (g)	60.70
Container No.	
Initial Soil Wt. (g) (Wt)	1300.00
Box Constant	6.746
$MC = (((1 + Mci / 100) \times (Wa / Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II		DOT CA Test 532 / 643	
<b>1320</b>	<b>58.7</b>	<b>85</b>	<b>41</b>	<b>7.76</b>	<b>19.8</b>





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## SOIL RESISTIVITY TEST

DOT CA TEST 532 / 643

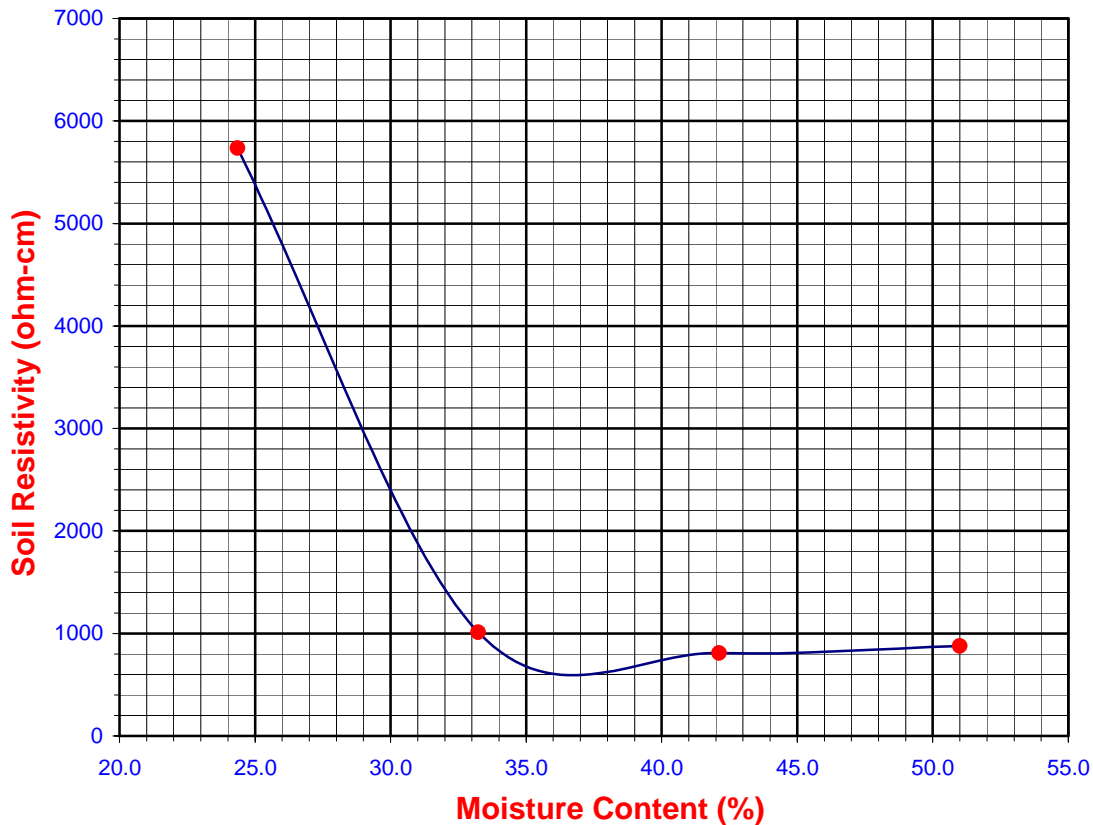
Project Name: SR-710 Tunnel Technical Study  
 Project No. : 378312.04.09.01  
 Boring No.: R-09-Z3-B12  
 Sample No. : C51  
 Soil Identification: Olive silt'stone' (ML)

Tested By : V. Juliano Date: 05/13/09  
 Data Input By: J. Ward Date: 05/27/09  
 Depth (ft.) : 229.2-229.7

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	100	24.35	850	5734
2	200	33.24	150	1012
3	300	42.12	120	810
4	400	51.00	130	877
5				

Moisture Content (%) (Mci)	15.47
Wet Wt. of Soil + Cont. (g)	151.00
Dry Wt. of Soil + Cont. (g)	140.00
Wt. of Container (g)	68.90
Container No.	
Initial Soil Wt. (g) (Wt)	1300.00
Box Constant	6.746
$MC = (((1 + Mci / 100) \times (Wa / Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
<b>600</b>	<b>36.7</b>	<b>798</b>	<b>59</b>	<b>7.41</b>	<b>19.8</b>





## TESTS for SULFATE CONTENT CHLORIDE CONTENT and pH of SOILS

Project Name: SR-710 Tunnel Technical Study Tested By : V. Juliano Date: 05/06/09  
 Project No. : 378312.04.09.01 Data Input By: J. Ward Date: 05/21/09

Boring No.	R-09-Z4-B4	R-09-Z4-B4		
Sample No.	C-19	C-38		
Sample Depth (ft)	97.5-98.3	220.5-221.5		
Soil Identification:	Yellow fat clay'stone' (CH)	Dark olive silt'stone' (ML)		
Wet Weight of Soil + Container (g)	0.00	0.00		
Dry Weight of Soil + Container (g)	0.00	0.00		
Weight of Container (g)	1.00	1.00		
Moisture Content (%)	0.00	0.00		
Weight of Soaked Soil (g)	100.10	100.30		

### SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	6	8		
Crucible No.	15	18		
Furnace Temperature (°C)	830	830		
Time In / Time Out	7:40 / 8:25	7:40 / 8:25		
Duration of Combustion (min)	45	45		
Wt. of Crucible + Residue (g)	20.3168	19.8312		
Wt. of Crucible (g)	20.3163	19.7354		
Wt. of Residue (g) (A)	0.0005	0.0958		
PPM of Sulfate (A) x 41150	20.58	3942.17		
<b>PPM of Sulfate, Dry Weight Basis</b>	<b>21</b>	<b>3942</b>		

### CHLORIDE CONTENT, DOT California Test 422

ml of Chloride Soln. For Titration (B)	30	30		
ml of AgNO <sub>3</sub> Soln. Used in Titration (C)	0.4	0.8		
PPM of Chloride (C -0.2) * 100 * 30 / B	20	60		
<b>PPM of Chloride, Dry Wt. Basis</b>	<b>20</b>	<b>60</b>		

### pH TEST, DOT California Test 532/643

pH Value	6.57	4.63		
Temperature °C	20.7	20.6		



## SOIL RESISTIVITY TEST

**DOT CA TEST 532 / 643**

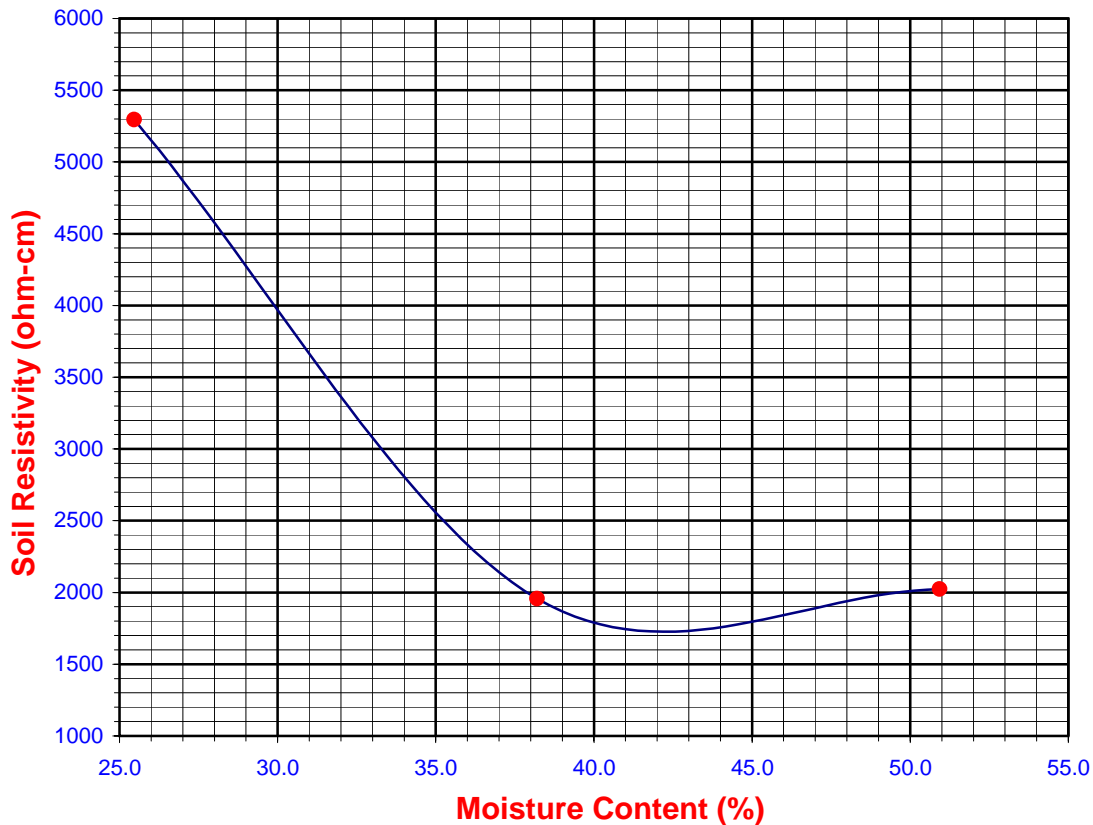
Project Name: SR-710 Tunnel Technical Study  
 Project No. : 378312.04.09.01  
 Boring No.: R-09-Z4-B4  
 Sample No. : C-19  
 Soil Identification: Yellow fat clay'stone' (CH)

Tested By : V. Juliano Date: 05/15/09  
 Data Input By: J. Ward Date: 05/21/09  
 Depth (ft.) : 97.5-98.3

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	300	25.47	785	5296
2	450	38.20	290	1956
3	600	50.93	300	2024
4				
5				

Moisture Content (%) (Mci)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	1178.00
Box Constant	6.746
$MC = (((1 + Mci / 100) \times (Wa / Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
<b>1720</b>	<b>42.2</b>	<b>21</b>	<b>20</b>	<b>6.57</b>	<b>20.7</b>





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## SOIL RESISTIVITY TEST

DOT CA TEST 532 / 643

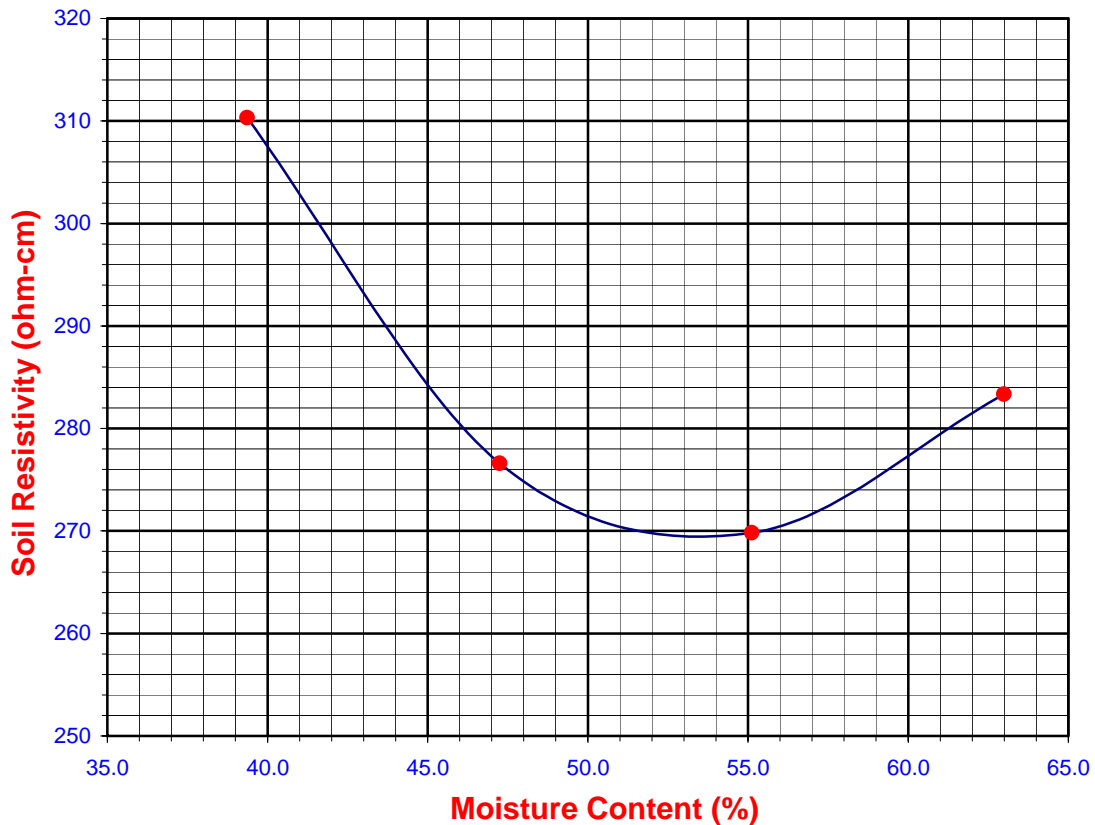
Project Name: SR-710 Tunnel Technical Study  
 Project No. : 378312.04.09.01  
 Boring No.: R-09-Z4-B4  
 Sample No. : C-38  
 Soil Identification: Dark olive silt'stone' (ML)

Tested By : V. Juliano Date: 05/15/09  
 Data Input By: J. Ward Date: 05/21/09  
 Depth (ft.) : 220.5-221.5

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	500	39.37	46	310
2	600	47.24	41	277
3	700	55.12	40	270
4	800	62.99	42	283
5				

Moisture Content (%) (Mci)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	1270.00
Box Constant	6.746
$MC = (((1 + Mci / 100) \times (Wa / Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
<b>269</b>	<b>53.4</b>	<b>3942</b>	<b>60</b>	<b>4.63</b>	<b>20.6</b>







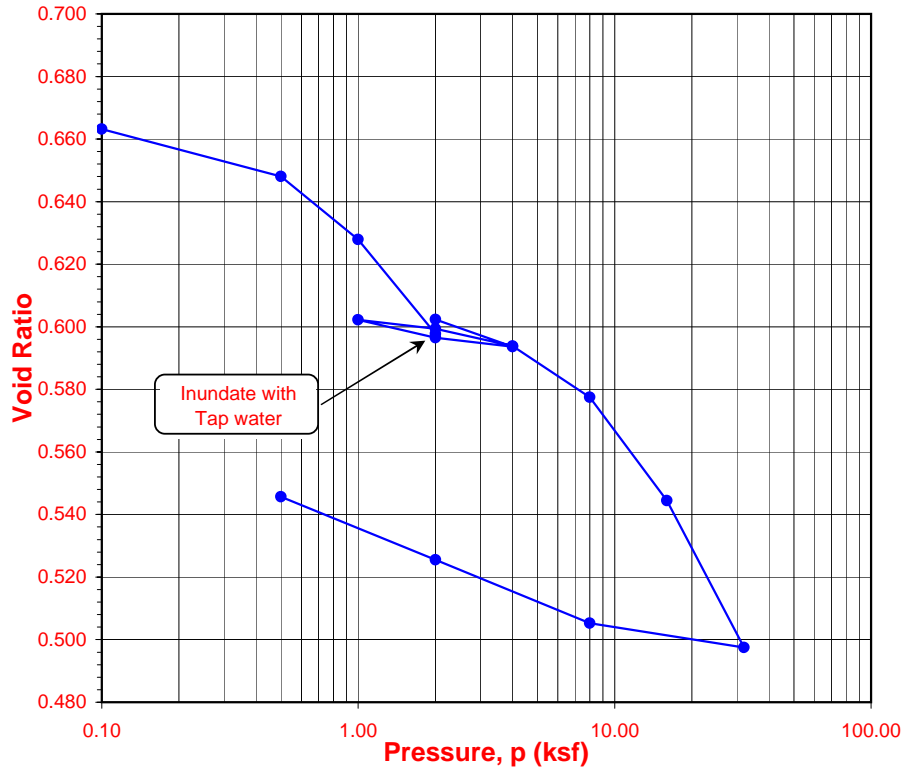
# ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

(ASTM D 2435)

Project Name: SR-710 Tunnel Technical Study  
 Project No.: 378312.04.09.01  
 Boring No.: R-09-Z2-B5  
 Sample No.: O21  
 Soil Identification: Olive brown lean clay (CL)

Tested By: G. Bathala Date: 05/26/09  
 Checked By: J. Ward Date: 06/17/09  
 Depth (ft.): 105.0  
 Sample Type: Drive

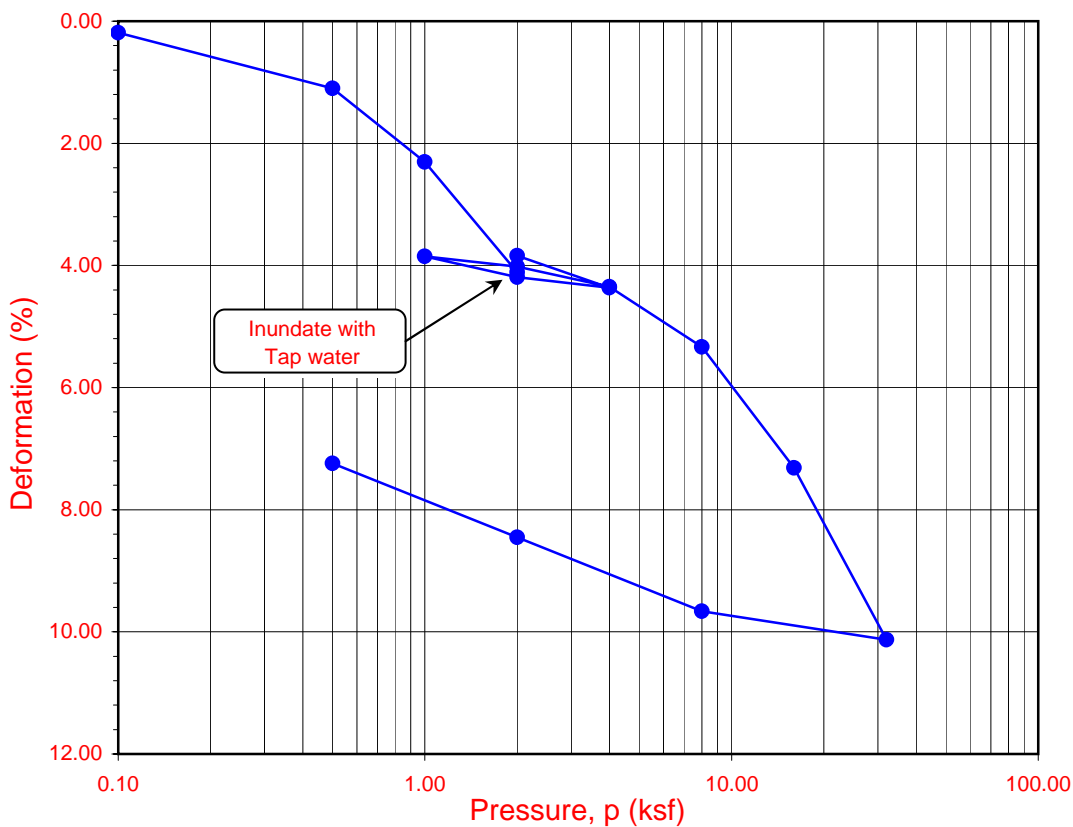
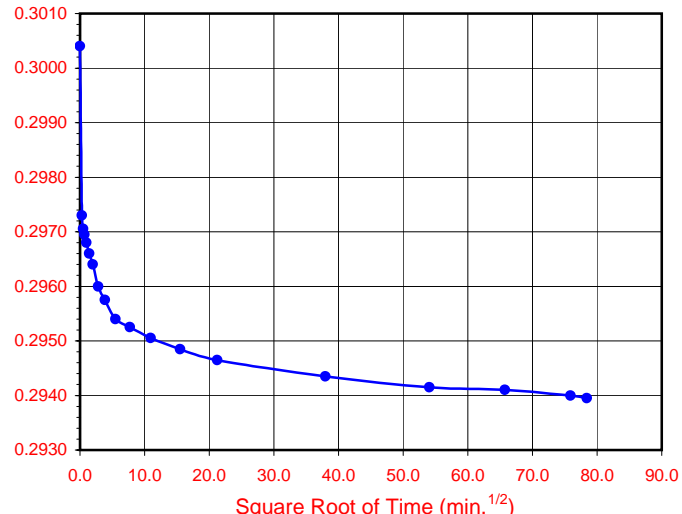
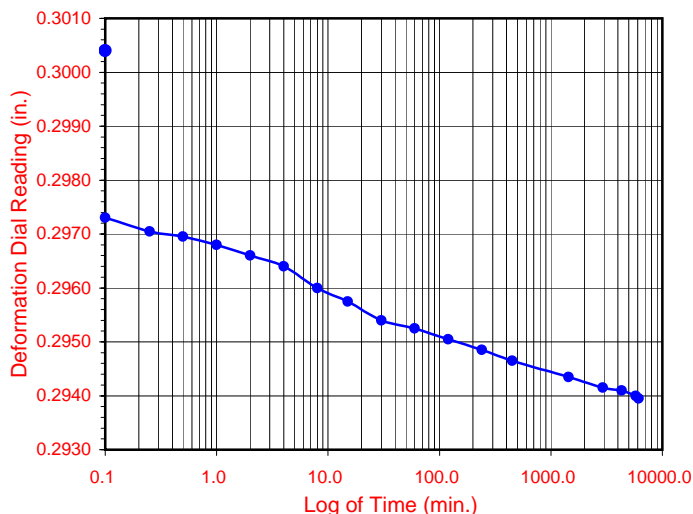
Sample Diameter (in.)	1.878
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	135.65
Weight of Ring (g)	42.17
Height after consol. (in.)	0.9276
<b>Before Test</b>	
Wt. Wet Sample+Cont. (g)	122.21
Wt. of Dry Sample+Cont. (g)	101.47
Weight of Container (g)	24.91
Initial Moisture Content (%)	27.1
Initial Dry Density (pcf)	101.2
Initial Saturation (%)	110
Initial Vertical Reading (in.)	0.3411
<b>After Test</b>	
Wt. of Wet Sample+Cont. (g)	172.70
Wt. of Dry Sample+Cont. (g)	156.50
Weight of Container (g)	39.56
Final Moisture Content (%)	21.67
Final Dry Density (pcf)	110.9
Final Saturation (%)	112
Final Vertical Reading (in.)	0.2650
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43



Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.3392	0.9981	0.00	0.19	0.663	0.19
0.50	0.3291	0.9880	0.10	1.20	0.648	1.10
1.00	0.3166	0.9755	0.15	2.46	0.628	2.31
2.00	0.2977	0.9566	0.23	4.35	0.598	4.12
2.00	0.3004	0.9593	0.23	4.07	0.602	3.84
4.00	0.2940	0.9529	0.35	4.72	0.594	4.37
2.00	0.2964	0.9553	0.28	4.47	0.597	4.19
1.00	0.3003	0.9592	0.23	4.08	0.602	3.85
2.00	0.2983	0.9572	0.26	4.28	0.599	4.02
4.00	0.2941	0.9530	0.35	4.70	0.594	4.35
8.00	0.2826	0.9415	0.52	5.86	0.577	5.34
16.00	0.2604	0.9193	0.76	8.08	0.544	7.32
32.00	0.2292	0.8881	1.06	11.19	0.498	10.13
8.00	0.2374	0.8963	0.71	10.38	0.505	9.67
2.00	0.2517	0.9106	0.49	8.94	0.526	8.45
0.50	0.2650	0.9239	0.37	7.61	0.546	7.24

Time Readings @ 4.0 ksf				
Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
6/1/09	8:30:00	0.0	0.0	0.3004
6/1/09	8:30:06	0.1	0.3	0.2973
6/1/09	8:30:15	0.2	0.5	0.2971
6/1/09	8:30:30	0.5	0.7	0.2970
6/1/09	8:31:00	1.0	1.0	0.2968
6/1/09	8:32:00	2.0	1.4	0.2966
6/1/09	8:34:00	4.0	2.0	0.2964
6/1/09	8:38:00	8.0	2.8	0.2960
6/1/09	8:45:00	15.0	3.9	0.2958
6/1/09	9:00:00	30.0	5.5	0.2954
6/1/09	9:30:00	60.0	7.7	0.2953
6/1/09	10:30:00	120.0	11.0	0.2951
6/1/09	12:30:00	240.0	15.5	0.2949
6/1/09	16:00:00	450.0	21.2	0.2947
6/2/09	8:30:00	1440.0	37.9	0.2944
6/3/09	9:10:00	2920.0	54.0	0.2942
6/4/09	8:30:00	4320.0	65.7	0.2941
6/5/09	8:30:00	5760.0	75.9	0.2940
6/5/09	15:00:00	6150.0	78.4	0.2940

Time Readings @ 4.0 ksf



Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
<b>R-09-Z2-B5</b>	<b>O21</b>	<b>105.0</b>	<b>27.1</b>	<b>21.7</b>	<b>101.2</b>	<b>110.9</b>	<b>0.666</b>	<b>0.546</b>	<b>110</b>	<b>112</b>

Soil Identification: Olive brown lean clay (CL)



**ONE-DIMENSIONAL CONSOLIDATION  
PROPERTIES of SOILS  
(ASTM D 2435)**

Project No.: 378312.04.09.01

SR-710 Tunnel Technical Study



Leighton

**DIRECT SHEAR TEST**  
Consolidated Drained - ASTM D 3080

Project Name: [SR-710 Tunnel Technical Study](#)  
Project No.: [378312.04.09.01](#)  
Boring No.: [R-09-Z1-B8](#)  
Sample No.: [O-9](#)  
Soil Identification: [Olive brown silty, clayey sand \(SC-SM\)](#)

Tested By: [F. Tabibkhoei](#)  
Checked By: [J. Ward](#)  
Sample Type: [Drive](#)  
Depth (ft.): [40-45](#)

Date: [04/02/09](#)  
Date: [04/08/09](#)

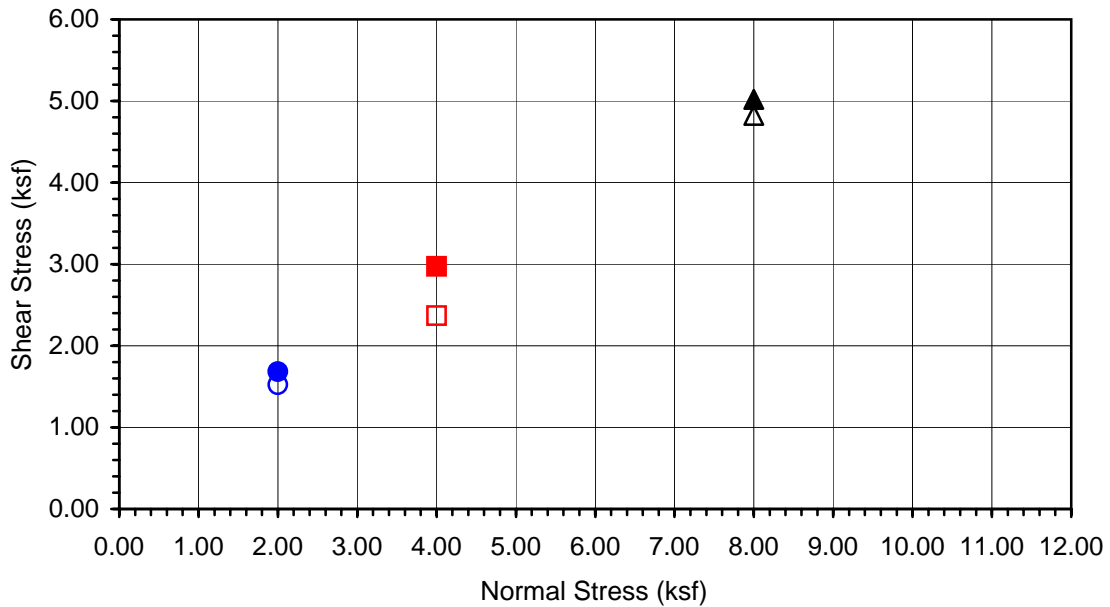
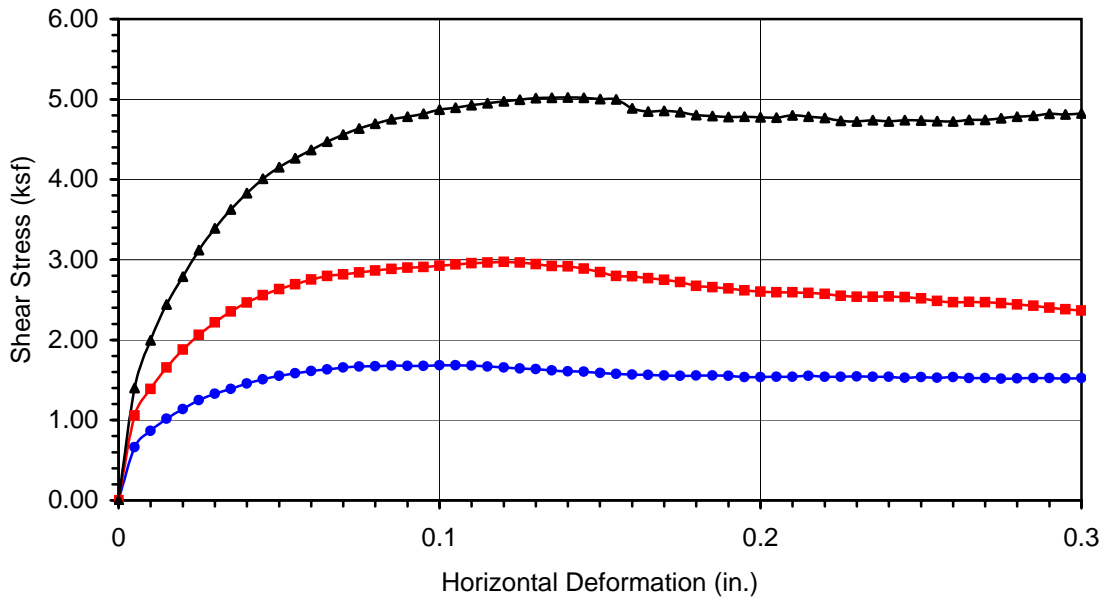
Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	202.64	204.45	205.29
Weight of Ring(gm):	44.95	43.17	43.41

**Before Shearing**

Weight of Wet Sample+Cont.(gm):	259.61	259.61	259.61
Weight of Dry Sample+Cont.(gm):	221.30	221.30	221.30
Weight of Container(gm):	38.48	38.48	38.48
Vertical Rdg.(in): Initial	0.0000	0.2760	0.2545
Vertical Rdg.(in): Final	-0.0177	0.3023	0.2949

**After Shearing**

Weight of Wet Sample+Cont.(gm):	196.12	198.66	195.96
Weight of Dry Sample+Cont.(gm):	169.26	175.24	172.96
Weight of Container(gm):	39.03	39.24	38.58
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43



<b>Boring No.</b>	<b>R-09-Z1-B8</b>
<b>Sample No.</b>	<b>C!9</b>
<b>Depth (ft)</b>	<b>40-45</b>
<u>Sample Type:</u>	
Drive	
<u>Soil Identification:</u>	
Olive brown silty, clayey sand (SC-SM)	

Normal Stress (kip/ft <sup>2</sup> )	2.000	4.000	8.000
Peak Shear Stress (kip/ft <sup>2</sup> )	● 1.682	■ 2.974	▲ 5.021
Shear Stress @ End of Test (ksf)	○ 1.522	□ 2.367	△ 4.823
Deformation Rate (in./min.)	0.0025	0.0025	0.0025
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	20.96	20.96	20.96
Dry Density (pcf)	108.4	110.9	111.3
Saturation (%)	102.0	108.8	110.0
Soil Height Before Shearing (in.)	0.9823	0.9737	0.9596
Final Moisture Content (%)	20.6	17.2	17.1



Leighton

**DIRECT SHEAR TEST RESULTS**  
Consolidated Drained - ASTM D 3080

Project No.: 378312.04.09.01

SR-710 Tunnel Technical Study

04-09

# POINT LOAD STRENGTH INDEX OF ROCK

<u>Sample Identification</u>	<u>Lab Sample Number</u>	<u>Depth, ft.</u>	<u>Type of Test</u>	<u>Point Load, lb.</u>	<u>Index Strength psi</u>	<u>Size Correction Factor</u>	<u>Corrected Point Load, psi</u>	<u>Sample Type</u>
R-09-Z3-B2, C49	S11029	146.75-148.0	diametral	633	112	1.0880	122	Quartzite
R-09-Z3-B2, C54	S11030	171.4-171.7	diametral	286	50	1.0930	54	Quartzite
R-09-Z3-B2, C68	S11031	227-228.1	diametral	127	22	1.0900	24	Quartzite

Test Method: ASTM D5731

Sample Type: Rock Core

<b>PROJECT NUMBER:</b>	<b>09-144</b>	April 22, 2009
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SR-710 Tunnel Technical Study



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# POINT LOAD STRENGTH INDEX OF ROCK

<u>Sample Identification</u>	<u>Lab Sample Number</u>	<u>Depth, ft.</u>	<u>Type of Test</u>	<u>Point Load, lb.</u>	<u>Index Strength</u> <u>psi</u>	<u>Size Correction</u> <u>Factor</u>	<u>Corrected Point Load, psi</u>	<u>Sample Type</u>
R-09-Z3-B4, C45	S11259	220.5 - 221.8	axial	25	5	1.046	6	Andesite
R-09-Z3-B4, C48	S11260	236.5 - 237	diametral	1557	150	1.248	187	Diorite
R-09-Z3-B4, C52	S11261	248.7 - 249.1	diametral	395	39	1.240	49	Diorite
R-09-Z3-B4, C56	S11262	270 - 270.5	diametral	873	85	1.245	106	Diorite
R-09-Z3-B4, C57	S11263	272 - 273.2	diametral	1041	103	1.240	128	Diorite

Test Method: ASTM D5731

Sample Type: Rock Core

**PROJECT NUMBER: 09-144**

April 22, 2009

SR-710 Tunnel Technical Study



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# POINT LOAD STRENGTH INDEX OF ROCK

<u>Sample Identification</u>	<u>Lab Sample Number</u>	<u>Depth, ft.</u>	<u>Type of Test</u>	<u>Point Load, lb.</u>	<u>Index Strength psi</u>	<u>Size Correction Factor</u>	<u>Corrected Point Load, psi</u>	<u>Sample Type</u>
R-09-Z3-B6, C 28	S11285	175.0 - 175.3	diametral	226	24	1.223	29	conglom.
R-09-Z3-B6, C 32	S11286	198.3 - 198.7	diametral	129	12	1.262	15	conglom.
R-09-Z3-B6, C 34	S11288	209.5 - 210.0	diametral	471	45	1.248	57	conglom.
R-09-Z3-B6, C 35	S11289	216.2 - 216.5	diametral	106	10	1.254	13	conglom.
R-09-Z3-B6, C 36	S11291	221.0 - 222	diametral	167	16	1.256	20	conglom.
R-09-Z3-B6, C 36	S11292	222.3 - 222.6	diametral	173	16	1.252	21	conglom.
R-09-Z3-B6, C 37	S11293	227.0 - 228.0	irregular lump	235	25	1.216	31	conglom.
R-09-Z3-B6, C 43	S11294	254.0 - 254.4	diametral	1052	106	1.235	131	diorite
R-09-Z3-B6, C 52	S211298	298.0 - 298.5	diametral	33	3	1.261	4	conglom.

Test Method: ASTM D5731

Sample Type: Rock Core

**PROJECT NUMBER: 09-144**

April 22, 2009

**SR-710 Tunnel Technical Study**



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# POINT LOAD STRENGTH INDEX OF ROCK

<u>Sample Identification</u>	<u>Lab Sample Number</u>	<u>Depth, ft.</u>	<u>Type of Test</u>	<u>Point Load, lb.</u>	<u>Index Strength psi</u>	<u>Size Correction Factor</u>	<u>Corrected Point Load, psi</u>	<u>Sample Type</u>
R-09-Z3-B6, C44	S11296	257.5 - 257.8	diametral	1456	139	1.250	174	conglom.
R-09-Z3-B6, C49	S11738	283.8 - 284.2	diametral	163	16	1.245	20	conglom.

Test Method: ASTM D5731

Sample Type: Rock Core

<b>PROJECT NUMBER:</b> 09-144	April 22, 2009
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**SR-710 Tunnel Technical Study**



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# POINT LOAD STRENGTH INDEX OF ROCK

<u>Sample Identification</u>	<u>Lab Sample Number</u>	<u>Depth, ft.</u>	<u>Type of Test</u>	<u>Point Load, lb.</u>	<u>Index Strength psi</u>	<u>Size Correction Factor</u>	<u>Corrected Point Load, psi</u>	<u>Sample Type</u>
R-09-Z3-B8, C65	S12429	265.7 - 266.4	Diametral	1488	267	1.085	290	siltstone

Test Method: ASTM D5731

Sample Type: Rock Core

**PROJECT NUMBER: 09-144**

May 12, 2009

**SR-710 Tunnel Technical Study**



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# POINT LOAD STRENGTH INDEX OF ROCK

<u>Sample Identification</u>	<u>Lab Sample Number</u>	<u>Depth, ft.</u>	<u>Type of Test</u>	<u>Point Load, lb.</u>	<u>Index Strength psi</u>	<u>Size Correction Factor</u>	<u>Corrected Point Load, psi</u>	<u>Sample Type</u>
R-09-Z3-B8, C37	S11871	156.3 - 156.5	axial	807	153	1.071	164	sandstone
R-09-Z3-B8, C40	S11872	166.4 - 166.7	diametral	856	163	1.071	174	sandstone

Test Method: ASTM D5731

Sample Type: Rock Core

**PROJECT NUMBER: 09-144**

May 12, 2009

**SR-710 Tunnel Technical Study**



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# POINT LOAD STRENGTH INDEX OF ROCK

<u>Sample Identification</u>	<u>Lab Sample Number</u>	<u>Depth, ft.</u>	<u>Type of Test</u>	<u>Point Load, lb.</u>	<u>Index Strength psi</u>	<u>Size Correction Factor</u>	<u>Corrected Point Load, psi</u>	<u>Sample Type</u>
R-09-Z3-B12, C62	S12431	272.5 - 273	axial	124	11	1.263	14	Shale

Test Method: ASTM D5731

Sample Type: Rock Core

**PROJECT NUMBER:** 09-144

May 1, 2009

SR-710 Tunnel Technical Study



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# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: April 20, 2009

Material Type: Mudstone

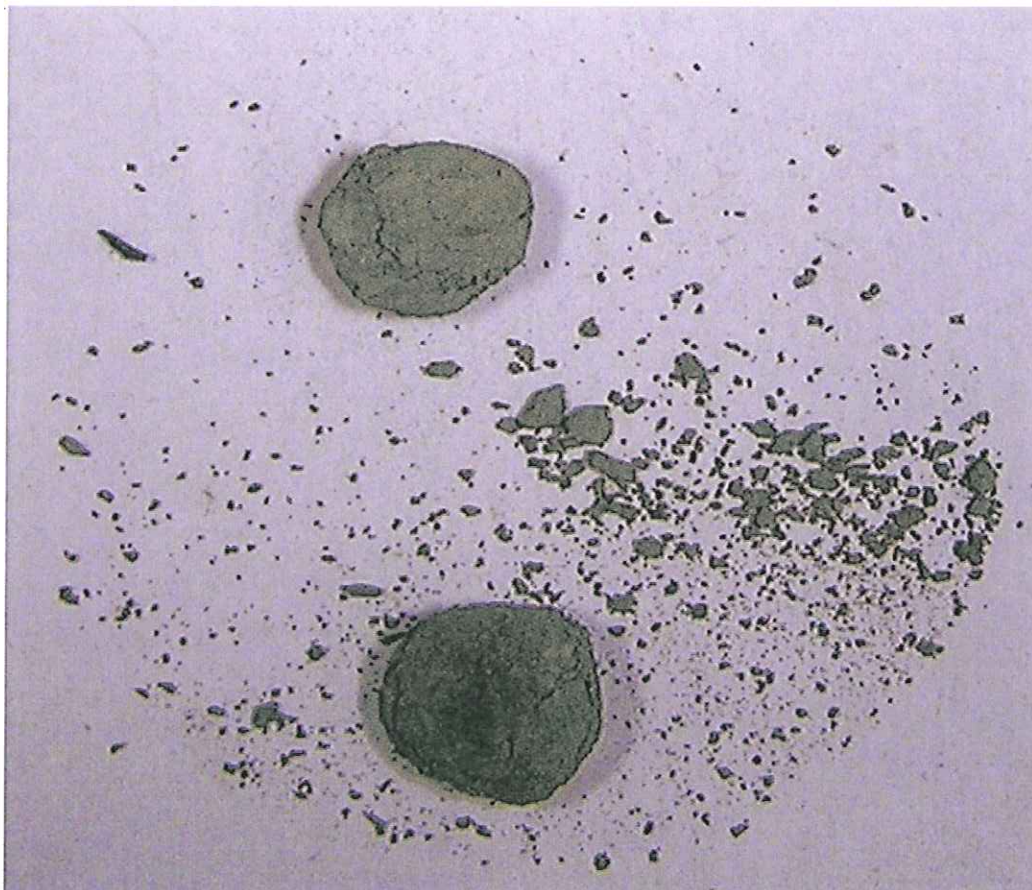
Lab Sample No.: S11025

Date Received: 4/10/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z1-B8, C28	133.1-134	20.4	23.0	2.0	Type III



- Type I :** Retained specimen remains virtually unchanged.  
**Type II :** Retained specimen consists of large and small fragments.  
**Type III :** Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: April 20, 2009

Material Type: Mudstone

Lab Sample No.: S11026

Date Received: 4/10/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z1-B8, C31	147.9-148.5	20.6	21.8	<b>12.9</b>	<b>Type II</b>



**Type I** : Retained specimen remains virtually unchanged.

**Type II** : Retained specimen consists of large and small fragments.

**Type III** : Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS



Project Name: SR-710 Tunnel Technical Study  
Project No.: 09-144  
Report Date: April 20, 2009

Client: CH2MHill

Material Type: Mudstone

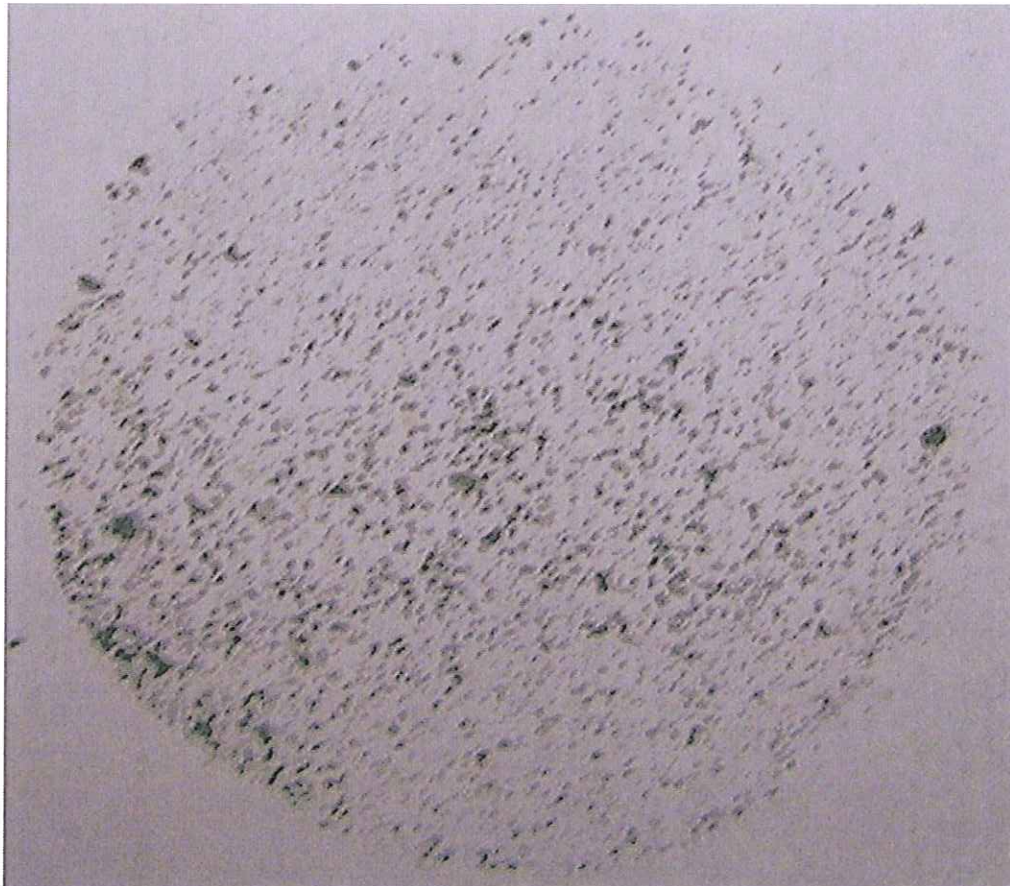
Lab Sample No.: S11027

Date Received: 4/10/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z1-B8, C37	175-175.75	21.0	21.7	0.0	Type III



- Type I :** Retained specimen remains virtually unchanged.
- Type II :** Retained specimen consists of large and small fragments.
- Type III :** Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS



Project Name: SR-710 Tunnel Technical Study  
Project No.: 09-144  
Report Date: April 24, 2009

Client: CH2MHill

Material Type: Mudstone

Lab Sample No.: S11028

Date Received: 4/10/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z1-B8, C41	195-196.25	20.8	21.7	56.8	Type II



- Type I :** Retained specimen remains virtually unchanged.
- Type II :** Retained specimen consists of large and small fragments.
- Type III :** Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: siltstone

Lab Sample No.: S11864

Date Received: 5/12/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z2-B5, C39	188-188.8	20.4	22.0	69	Type II



**Type I :** Retained specimen remains virtually unchanged.

**Type II :** Retained specimen consists of large and small fragments.

**Type III :** Retained specimen is exclusively small fragments.



# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: mudstone

Lab Sample No.: S11865

Date Received: 5/12/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z2-B5, C43	203.4-204.2	20.4	22.0	29	Type II



**Type I** : Retained specimen remains virtually unchanged.

**Type II** : Retained specimen consists of large and small fragments.

**Type III** : Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: mudstone

Lab Sample No.: S11866

Date Received: 5/12/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z2-B5, C53	240.5-241.2	20.5	21.1	43	Type II



**Type I** : Retained specimen remains virtually unchanged.

**Type II** : Retained specimen consists of large and small fragments.

**Type III** : Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS



Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: mudstone

Lab Sample No.: S11867

Date Received: 5/12/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z2-B5, C65	291.8-292.4	20.4	30.9	46	Type II



**Type I** : Retained specimen remains virtually unchanged.

**Type II** : Retained specimen consists of large and small fragments.

**Type III** : Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS



Project Name: SR-710 Tunnel Technical Study  
Project No.: 09-144  
Report Date: April 27, 2009

Client: CH2MHill

Material Type: Rock Core

Lab Sample No.: S11295

Date Received: 4/22/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z3-B6, C 43	257.2-257.5	20.6	3.1	66.1	Type II

**Type I :** Retained specimen remains virtually unchanged.

**Type II :** Retained specimen consists of large and small fragments.

**Type III :** Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: siltstone

Lab Sample No.: S11870

Date Received: 5/12/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z3-B8, C33	140.4-141.1	20.5	9.2	92.2	Type II



**Type I :** Retained specimen remains virtually unchanged.

**Type II :** Retained specimen consists of large and small fragments.

**Type III :** Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: claystone

Lab Sample No.: S11874

Date Received: 5/12/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z3-B8, C46	192.2-192.6	20.5	10.5	94.7	Type II



**Type I :** Retained specimen remains virtually unchanged.

**Type II :** Retained specimen consists of large and small fragments.

**Type III :** Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS



Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: siltstone

Lab Sample No.: S11876

Date Received: 5/12/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z3-B8, C51	205.1-205.7	20.4	8.1	95.1	Type II



**Type I :** Retained specimen remains virtually unchanged.

**Type II :** Retained specimen consists of large and small fragments.

**Type III :** Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS



Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: siltstone

Lab Sample No.: S11877

Date Received: 5/12/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z3-B8, C56	227.5-228	20.5	8.5	98	Type I



**Type I** : Retained specimen remains virtually unchanged.

**Type II** : Retained specimen consists of large and small fragments.

**Type III** : Retained specimen is exclusively small fragments.



# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS



Project Name: SR-710 Tunnel Technical Study  
Project No.: 09-144  
Report Date: April 22, 2009

Client: CH2MHill

Material Type: Shale

Lab Sample No.: S10964

Date Received: 4/2/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z3-B12, C41	190.8-191.3	20.2	22.0	87.4	Type II



- Type I :** Retained specimen remains virtually unchanged.  
**Type II :** Retained specimen consists of large and small fragments.  
**Type III :** Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS



Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: April 22, 2009

Material Type: Shale

Lab Sample No.: S10965

Date Received: 4/2/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z3-B12, C47	213.9-214.5	20.2	19.3	84.8	Type II



**Type I :** Retained specimen remains virtually unchanged.

**Type II :** Retained specimen consists of large and small fragments.

**Type III :** Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: June 5, 2009

Material Type: shale

Lab Sample No.: S12430

Date Received: 6/1/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z3-B12, C54	242.4-242.9	21.0	17.6	88	Type II



**Type I :** Retained specimen remains virtually unchanged.

**Type II :** Retained specimen consists of large and small fragments.

**Type III :** Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: June 5, 2009

Material Type: shale

Lab Sample No.: S12431

Date Received: 6/1/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z3-B12, C62	272.5-273	20.7	16.6	90	Type II



**Type I** : Retained specimen remains virtually unchanged.

**Type II** : Retained specimen consists of large and small fragments.

**Type III** : Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: April 25, 2009

Material Type: Siltstone

Lab Sample No.: S11264

Date Received: 4/22/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z4-B4, C28	150-157.5	21.0	17.4	<b>61.0</b>	<b>Type II</b>



**Type I :** Retained specimen remains virtually unchanged.

**Type II :** Retained specimen consists of large and small fragments.

**Type III :** Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: April 25, 2009

Material Type: Siltstone

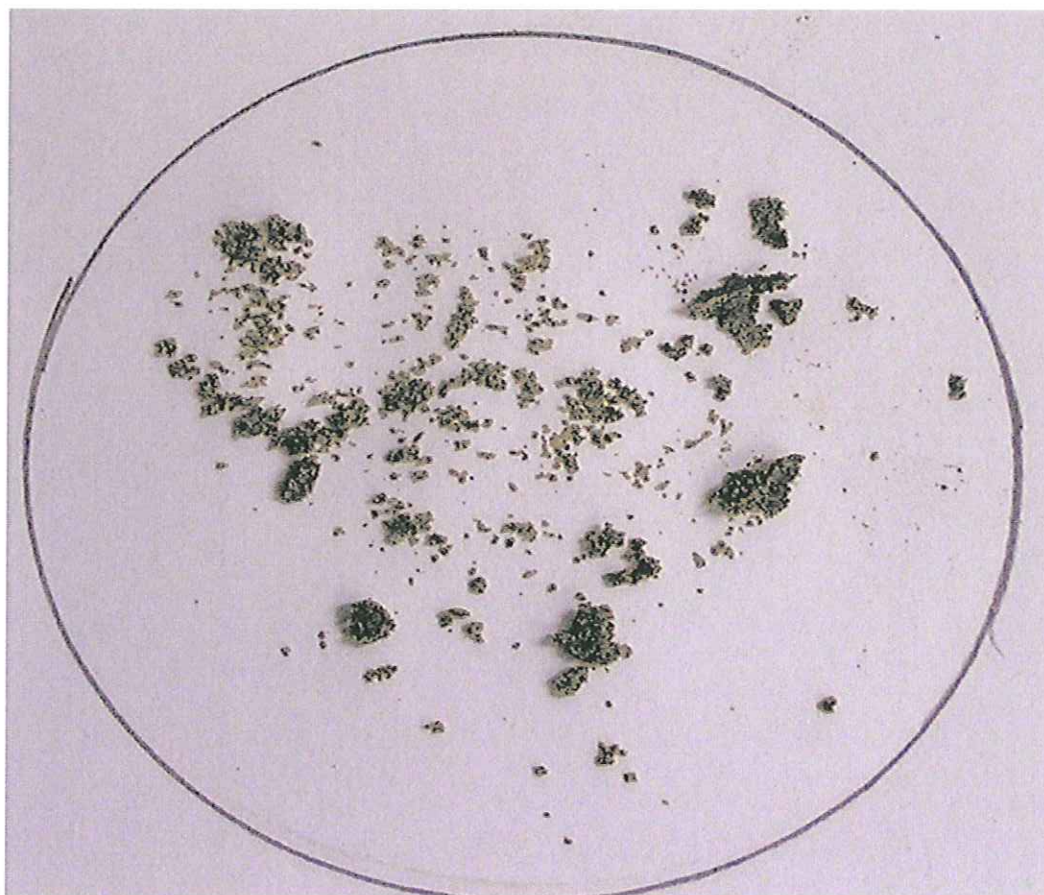
Lab Sample No.: S11265

Date Received: 4/22/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z4-B4, C35	198.5-199.5	21.0	18.3	0.6	Type III



**Type I :** Retained specimen remains virtually unchanged.

**Type II :** Retained specimen consists of large and small fragments.

**Type III :** Retained specimen is exclusively small fragments.

# SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: April 25, 2009

Material Type: Siltstone

Lab Sample No.: S11266

Date Received: 4/22/09

Test Method: ASTM D 4644

## Test Results

Sample ID.	Sample Depth, ft.	Avg. Water Temp. @ Testing, C	Moisture Content @ Testing	Slake Durability Index	Description of Sample After Testing
R-09-Z4-B4, C40	234-235	21.0	13.7	12.8	Type III



**Type I :** Retained specimen remains virtually unchanged.

**Type II :** Retained specimen consists of large and small fragments.

**Type III :** Retained specimen is exclusively small fragments.

## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z1-B8  
 Sample No.: C17  
 Sample Description: Dark olive lean clay'stone' (CL)

Tested by: A. Santos      Date: 05/08/09  
 Checked by: J. Ward      Date: 05/12/09  
 Sample Type: Core  
 Depth(ft): 80-80.75

Diameter (in)	1	2.285
	2	2.305
	3	2.345
	Average	2.312
Height (in)	1	5.192
	2	5.184
	3	5.189
	Average	5.188
Weight of Sample + Tube / Rings (g)		698.10
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		774.30
Weight of Dry Sample + Container (g)		631.70
Weight of Container (g)		77.00
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		52.1
Rate of Deformation (in/min)		0.012

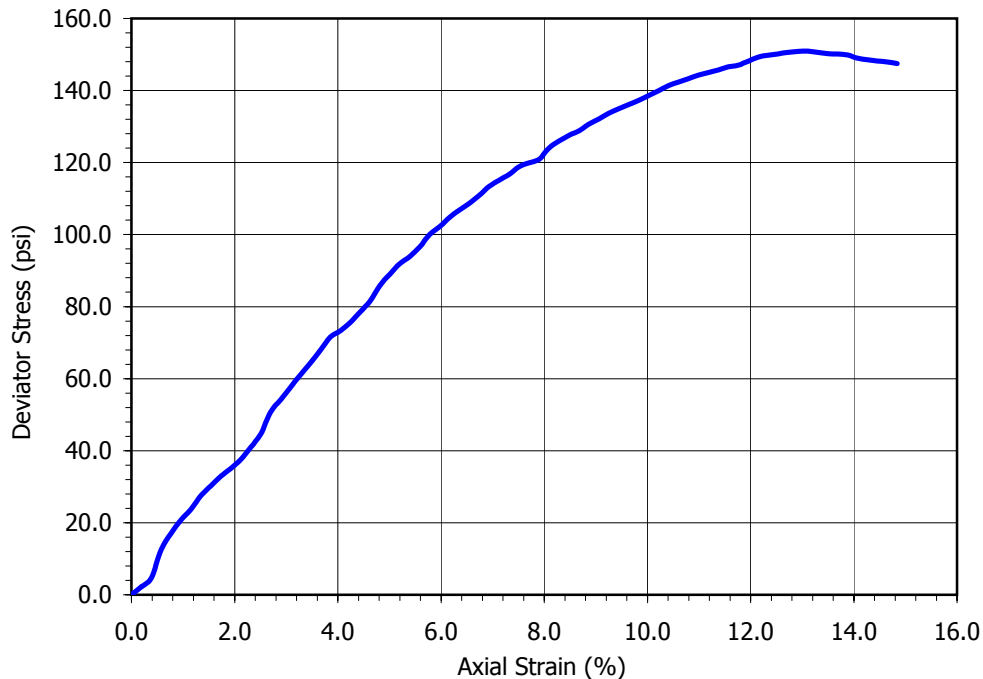


Sample Properties	
Moisture Content (%)	25.71
Dry Density (pcf)	97.2
Void Ratio	0.734
% Saturation	94.6

At Failure*	
Deviator stress (psi)	150.94
Minor principal total stress (psi)	52.10
Major principal total stress (psi)	203.04
Axial strain (%)	13.11

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**





## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z1-B8  
 Sample No.: C23  
 Sample Description: Dark olive lean clay'stone' (CL)

Tested by: A. Santos      Date: 05/08/09  
 Checked by: J. Ward      Date: 05/12/09  
 Sample Type: Core  
 Depth(ft): 109-109.7

Diameter (in)	1	2.470
	2	2.473
	3	2.475
	Average	2.473
Height (in)	1	5.220
	2	5.218
	3	5.218
	Average	5.218
Weight of Sample + Tube / Rings (g)		830.20
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		904.10
Weight of Dry Sample + Container (g)		748.50
Weight of Container (g)		75.20
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		69.5
Rate of Deformation (in/min)		0.012

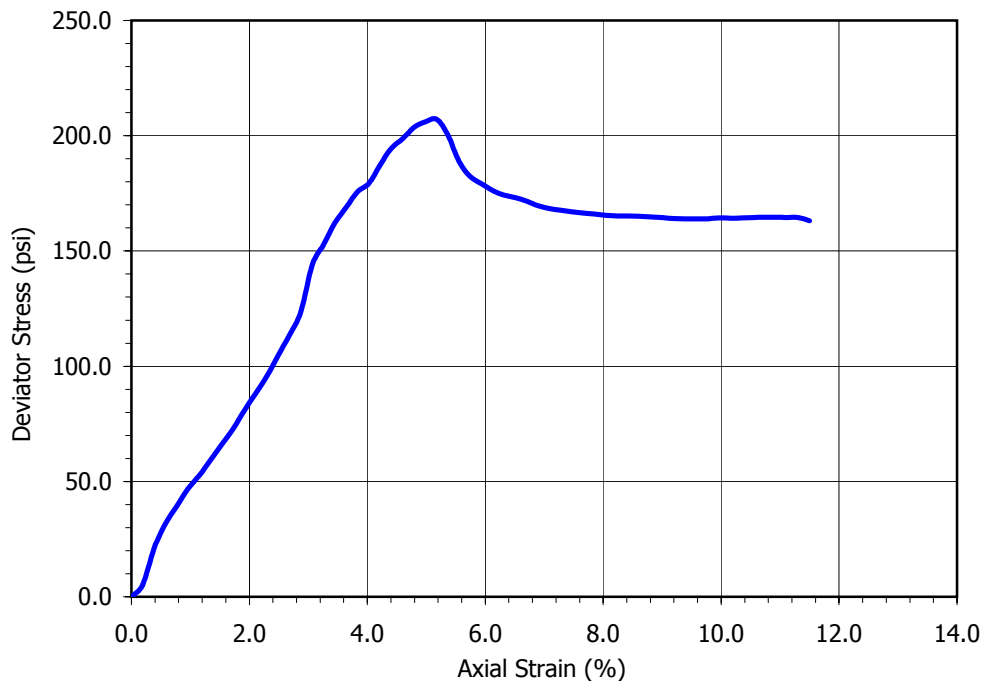


Sample Properties	
Moisture Content (%)	23.11
Dry Density (pcf)	102.5
Void Ratio	0.643
% Saturation	97.0

At Failure*	
Deviator stress (psi)	207.08
Minor principal total stress (psi)	69.50
Major principal total stress (psi)	276.58
Axial strain (%)	5.17

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z1-B8  
 Sample No.: C26  
 Sample Description: Dark olive lean clay'stone' (CL)

Tested by: A. Santos      Date: 05/08/09  
 Checked by: J. Ward      Date: 05/12/09  
 Sample Type: Core  
 Depth(ft): 119.5-120

Diameter (in)	1	2.430
	2	2.431
	3	2.437
	Average	2.433
Height (in)	1	5.262
	2	5.272
	3	5.268
	Average	5.267
Weight of Sample + Tube / Rings (g)		815.00
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		886.50
Weight of Dry Sample + Container (g)		742.90
Weight of Container (g)		72.90
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		76.4
Rate of Deformation (in/min)		0.012

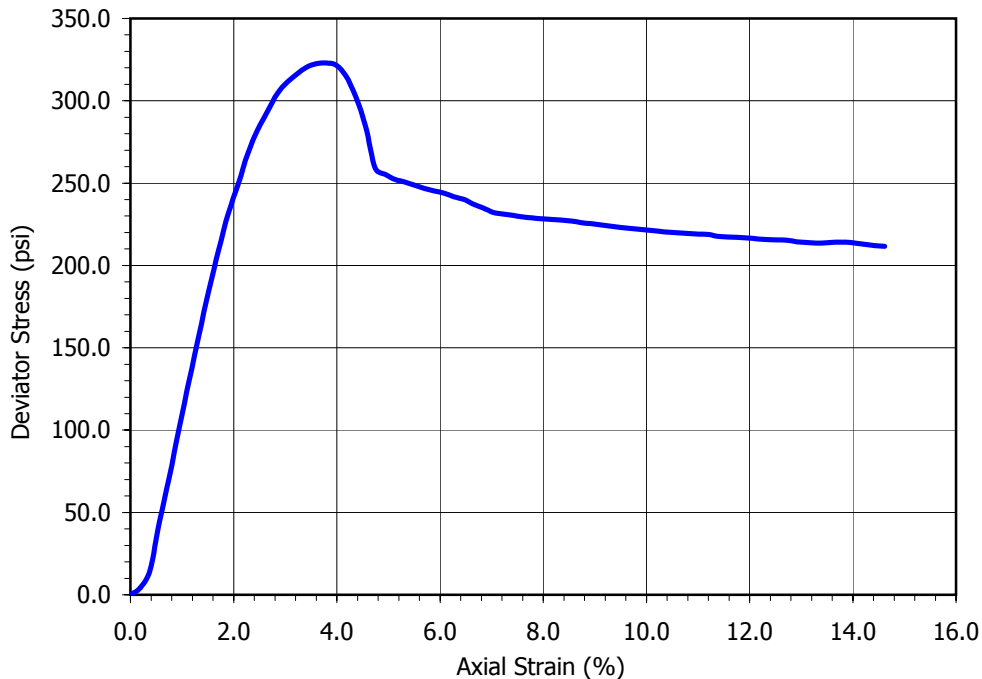


Sample Properties	
Moisture Content (%)	21.43
Dry Density (pcf)	104.4
Void Ratio	0.613
% Saturation	94.4

At Failure*	
Deviator stress (psi)	322.96
Minor principal total stress (psi)	76.40
Major principal total stress (psi)	399.36
Axial strain (%)	3.80

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z1-B8  
 Sample No.: C39  
 Sample Description: Dark olive silt'stone' (ML)

Tested by: A. Santos      Date: 05/08/09  
 Checked by: J. Ward      Date: 05/12/09  
 Sample Type: Core  
 Depth(ft): 189.25-190

Diameter (in)	1	2.400
	2	2.402
	3	2.405
	Average	2.402
Height (in)	1	5.185
	2	5.183
	3	5.183
	Average	5.184
Weight of Sample + Tube / Rings (g)		764.00
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		837.30
Weight of Dry Sample + Container (g)		688.90
Weight of Container (g)		75.90
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		121.5
Rate of Deformation (in/min)		0.012

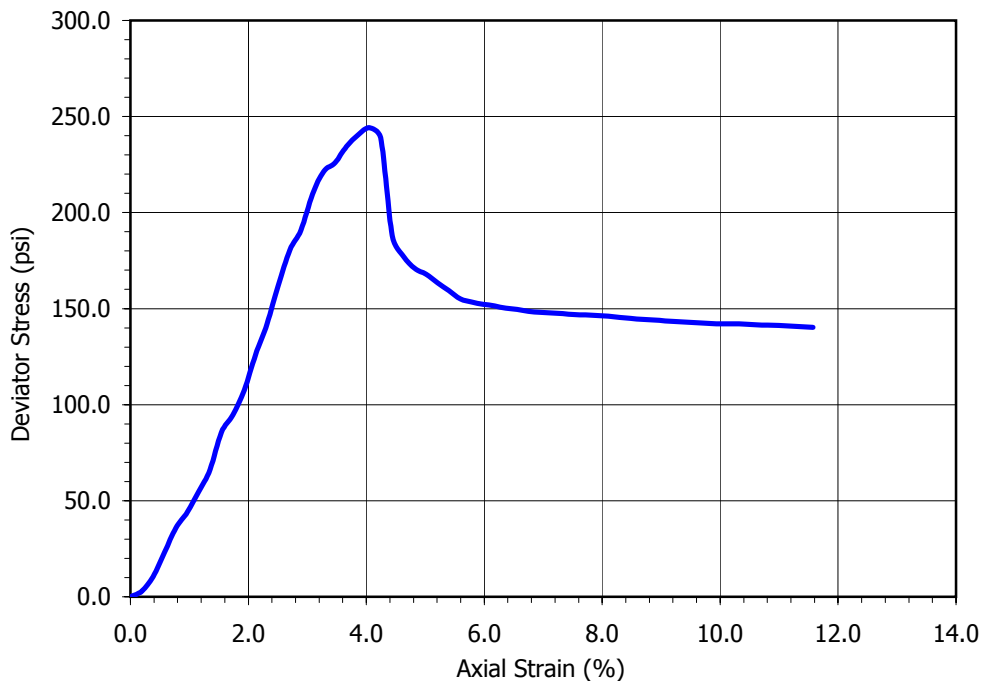


Sample Properties	
Moisture Content (%)	24.21
Dry Density (pcf)	99.7
Void Ratio	0.689
% Saturation	94.8

At Failure*	
Deviator stress (psi)	244.26
Minor principal total stress (psi)	121.50
Major principal total stress (psi)	365.76
Axial strain (%)	4.05

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z2-B5  
 Sample No.: C28  
 Sample Description: Yellowish brown fat clay (CH)

Tested by: A. Santos      Date: 05/27/09  
 Checked by: J. Ward      Date: 06/01/09  
 Sample Type: Drive  
 Depth(ft): 148-148.6

Diameter (in)	1	2.450
	2	2.430
	3	2.425
	Average	2.435
Height (in)	1	4.548
	2	4.541
	3	4.543
	Average	4.544
Weight of Sample + Tube / Rings (g)		619.30
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		727.60
Weight of Dry Sample + Container (g)		552.00
Weight of Container (g)		109.00
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		97.2
Rate of Deformation (in/min)		0.012

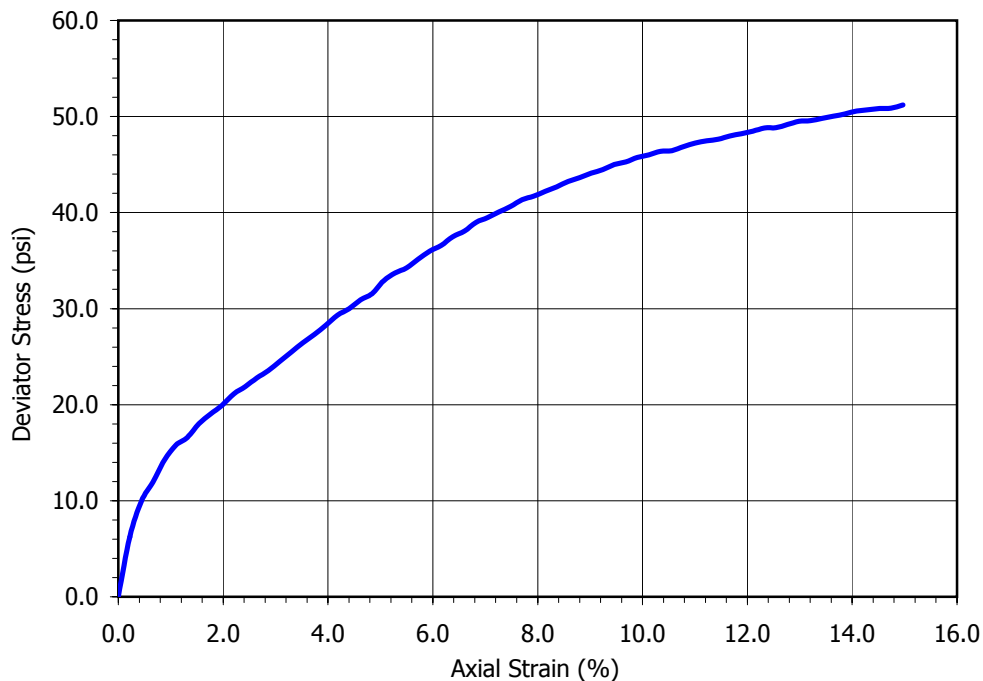


Sample Properties	
Moisture Content (%)	39.64
Dry Density (pcf)	79.8
Void Ratio	1.110
% Saturation	96.4

At Failure*	
Deviator stress (psi)	51.19
Minor principal total stress (psi)	97.20
Major principal total stress (psi)	148.39
Axial strain (%)	14.97

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No.: 378312.04.09.01  
 Boring No.: R-09-Z2-B5  
 Sample No.: C47  
 Sample Description: Dark olive silt'stone' (ML)

Tested by: A. Santos      Date: 05/28/09  
 Checked by: J. Ward      Date: 06/01/09  
 Sample Type: Drive  
 Depth(ft): 217.5-218.3

Diameter (in)	1	2.376
	2	2.375
	3	2.378
	Average	2.376
Height (in)	1	5.143
	2	5.146
	3	5.144
	Average	5.144
Weight of Sample + Tube / Rings (g)		750.60
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		1336.60
Weight of Dry Sample + Container (g)		1103.20
Weight of Container (g)		106.90
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		142.4
Rate of Deformation (in/min)		0.012

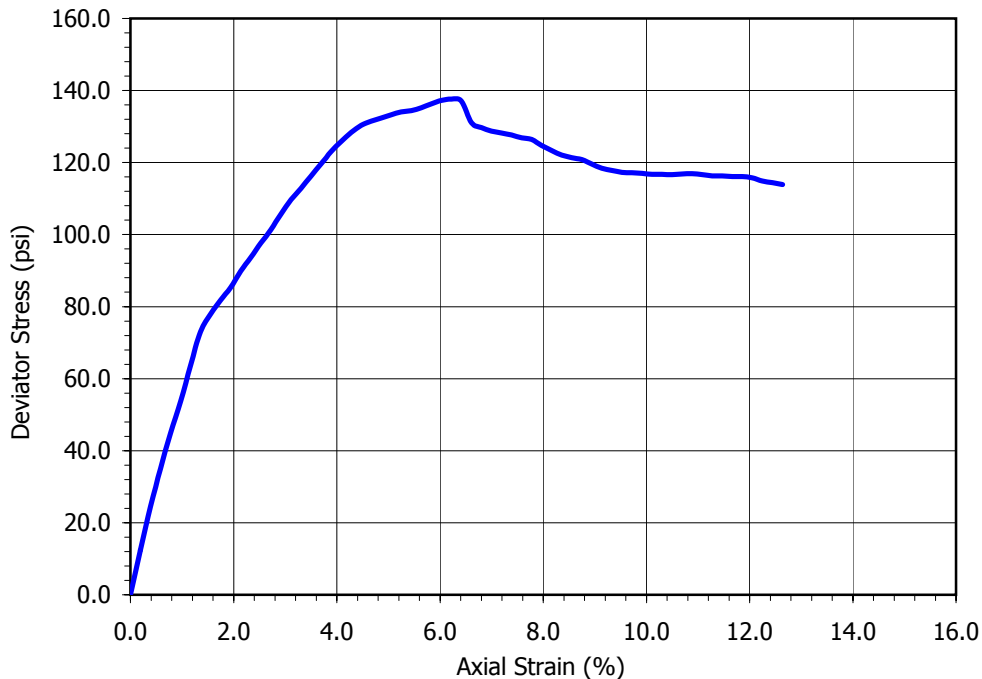


Sample Properties	
Moisture Content (%)	23.43
Dry Density (pcf)	101.5
Void Ratio	0.659
% Saturation	96.0

At Failure*	
Deviator stress (psi)	137.60
Minor principal total stress (psi)	142.40
Major principal total stress (psi)	280.00
Axial strain (%)	6.22

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No.: 378312.04.09.01  
 Boring No.: R-09-Z2-B5  
 Sample No.: C59  
 Sample Description: Dark olive silt'stone' (ML)

Tested by: A. Santos      Date: 05/28/09  
 Checked by: J. Ward      Date: 06/01/09  
 Sample Type: Drive  
 Depth(ft): 265-265.6

Diameter (in)	1	2.445
	2	2.425
	3	2.415
	Average	2.428
Height (in)	1	4.661
	2	4.664
	3	4.673
	Average	4.666
Weight of Sample + Tube / Rings (g)		698.70
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		806.70
Weight of Dry Sample + Container (g)		673.70
Weight of Container (g)		109.05
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		154.0
Rate of Deformation (in/min)		0.012

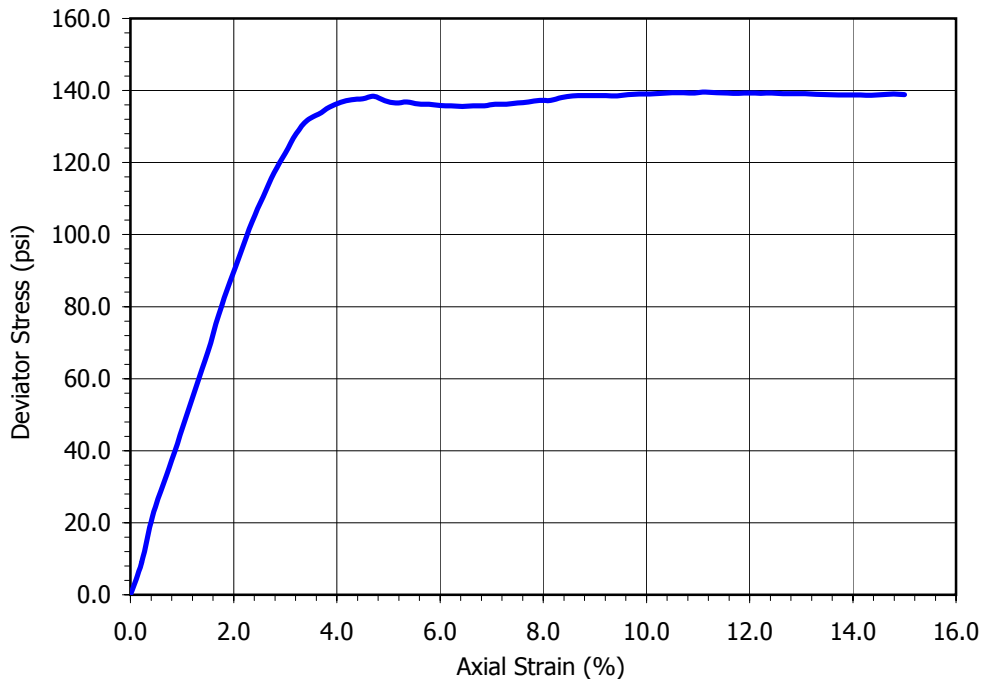


Sample Properties	
Moisture Content (%)	23.55
Dry Density (pcf)	99.7
Void Ratio	0.690
% Saturation	92.2

At Failure*	
Deviator stress (psi)	139.53
Minor principal total stress (psi)	154.00
Major principal total stress (psi)	293.53
Axial strain (%)	11.14

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z2-B5  
 Sample No.: O21  
 Sample Description: Olive brown lean clay (CL)

Tested by: A. Santos      Date: 05/20/09  
 Checked by: J. Ward      Date: 05/27/09  
 Sample Type: Drive  
 Depth(ft): 105

Diameter (in)	1	1.908
	2	1.906
	3	1.910
	Average	1.908
Height (in)	1	3.748
	2	3.731
	3	3.739
	Average	3.739
Weight of Sample + Tube / Rings (g)		355.40
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		427.80
Weight of Dry Sample + Container (g)		358.10
Weight of Container (g)		75.20
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		69.5
Rate of Deformation (in/min)		0.012

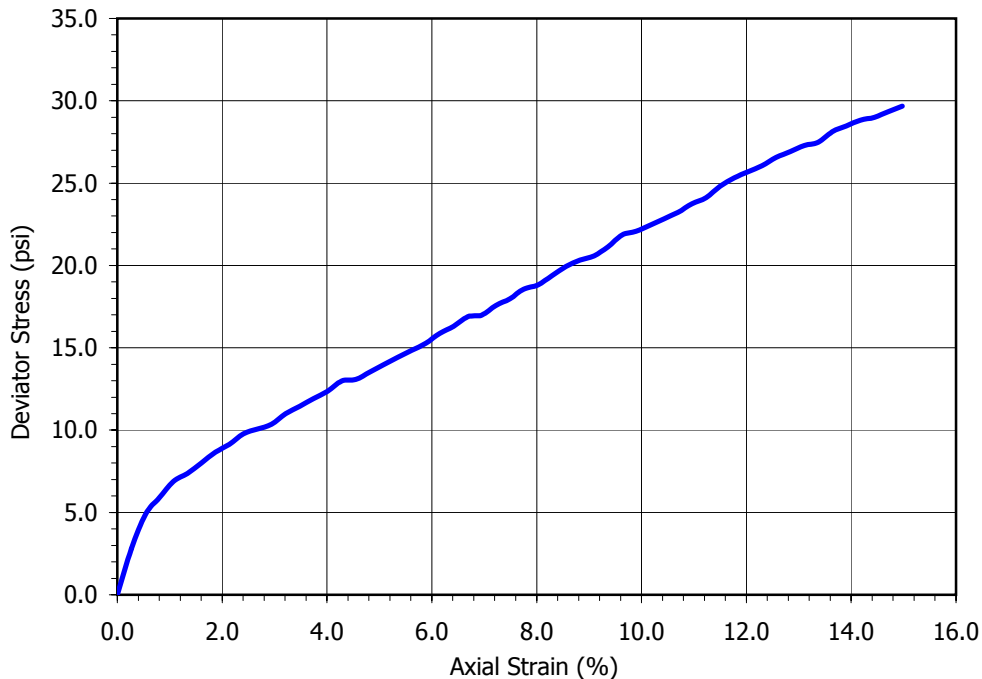


Sample Properties	
Moisture Content (%)	24.64
Dry Density (pcf)	101.6
Void Ratio	0.658
% Saturation	101.1

At Failure*	
Deviator stress (psi)	29.67
Minor principal total stress (psi)	69.50
Major principal total stress (psi)	99.17
Axial strain (%)	14.98

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z2-B5  
 Sample No.: O25  
 Sample Description: Light olive brown fat clay (CH)

Tested by: A. Santos      Date: 05/20/09  
 Checked by: J. Ward      Date: 05/27/09  
 Sample Type: Drive  
 Depth(ft): 125

Diameter (in)	1	1.902
	2	1.900
	3	1.901
	Average	1.901
Height (in)	1	3.868
	2	3.869
	3	3.868
	Average	3.868
Weight of Sample + Tube / Rings (g)		349.50
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		425.50
Weight of Dry Sample + Container (g)		348.40
Weight of Container (g)		76.70
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		80.0
Rate of Deformation (in/min)		0.012

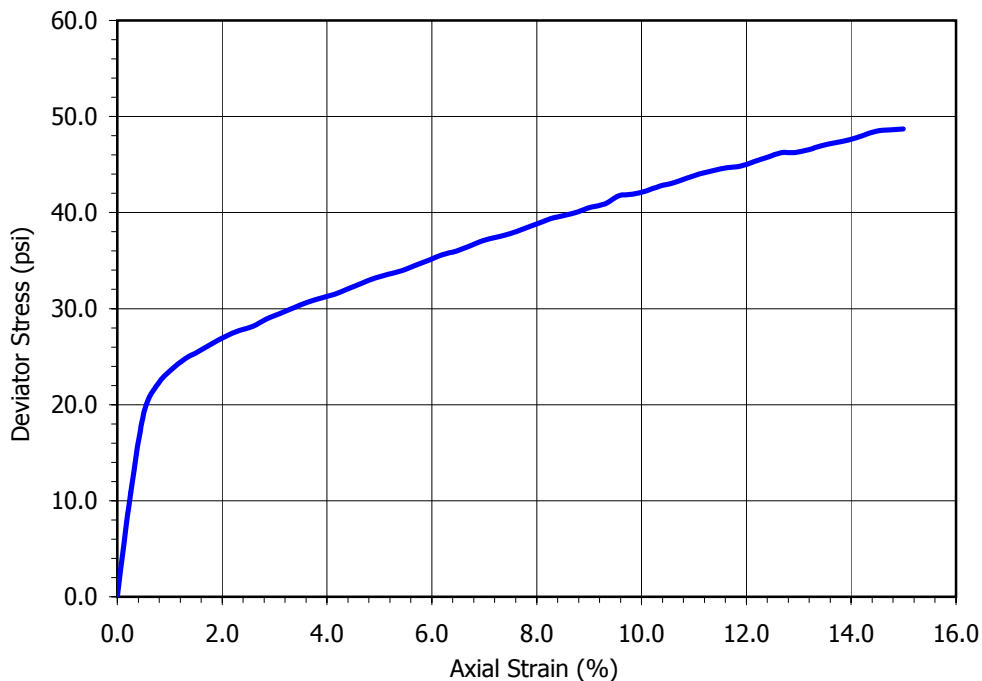


Sample Properties	
Moisture Content (%)	28.38
Dry Density (pcf)	94.5
Void Ratio	0.784
% Saturation	97.8

At Failure*	
Deviator stress (psi)	48.72
Minor principal total stress (psi)	80.00
Major principal total stress (psi)	128.72
Axial strain (%)	14.99

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**





## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No.: 378312.04.09.01  
 Boring No.: R-09-Z3-B11  
 Sample No.: C-35  
 Sample Description: Light olive brown fat clay'stone' with sand (CH)s

Tested by: A. Santos      Date: 05/10/09  
 Checked by: J. Ward      Date: 05/13/09  
 Sample Type: Core  
 Depth(ft): 171.5-172.25

Diameter (in)	1	2.500
	2	2.475
	3	2.455
	Average	2.477
Height (in)	1	5.101
	2	5.111
	3	5.108
	Average	5.107
Weight of Sample + Tube / Rings (g)		815.90
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		1596.00
Weight of Dry Sample + Container (g)		1299.40
Weight of Container (g)		107.80
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		111.1
Rate of Deformation (in/min)		0.012

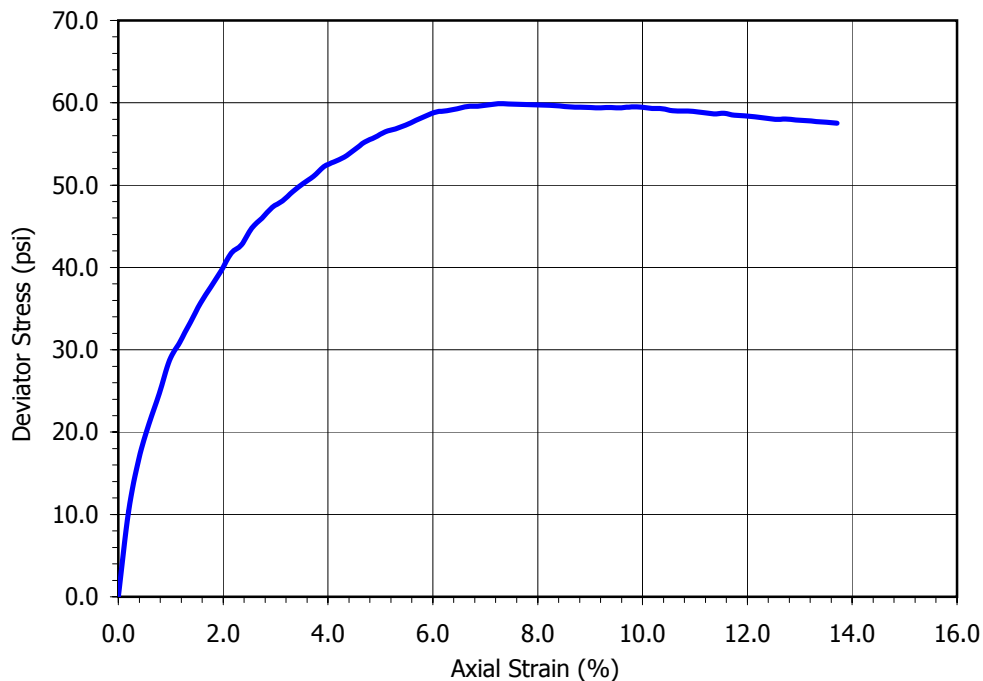


Sample Properties	
Moisture Content (%)	24.89
Dry Density (pcf)	101.2
Void Ratio	0.665
% Saturation	101.0

At Failure*	
Deviator stress (psi)	59.89
Minor principal total stress (psi)	111.10
Major principal total stress (psi)	170.99
Axial strain (%)	7.25

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z3-B11  
 Sample No.: C-44  
 Sample Description: Olive gray sandy fat clay'stone' s(CH) (fat clay'stone' with a diagonal layer of sand)

Tested by: A. Santos      Date: 05/10/09  
 Checked by: J. Ward      Date: 05/26/09  
 Sample Type: Core  
 Depth(ft): 217.5-218

Diameter (in)	1	2.460
	2	2.445
	3	2.440
	Average	2.448
Height (in)	1	5.070
	2	5.071
	3	5.072
	Average	5.071
Weight of Sample + Tube / Rings (g)		769.30
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		879.60
Weight of Dry Sample + Container (g)		741.40
Weight of Container (g)		109.40
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		138.9
Rate of Deformation (in/min)		0.012

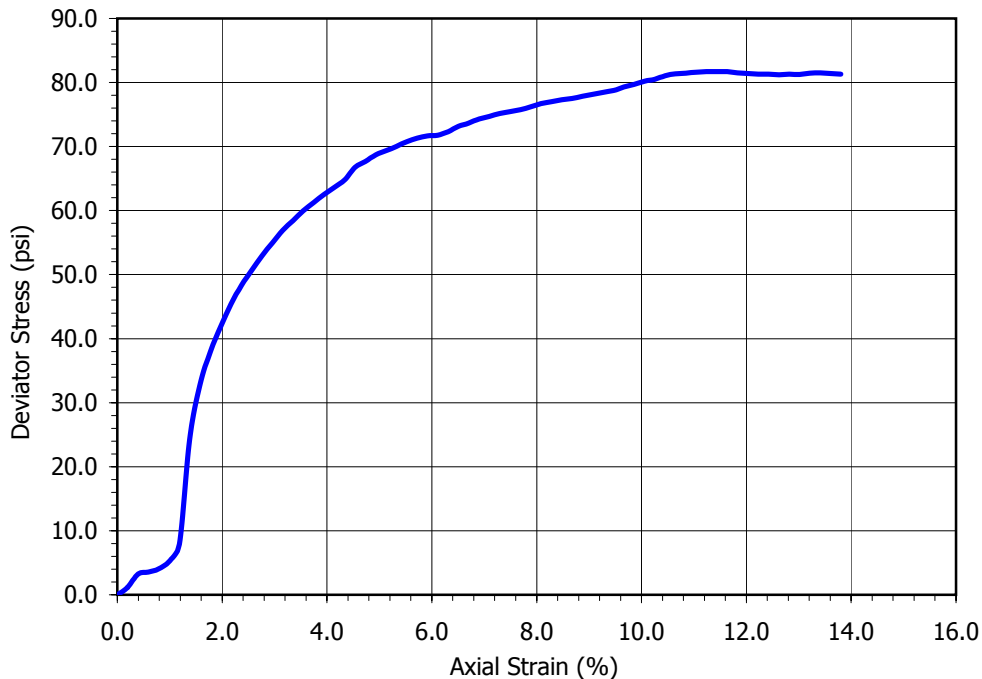


Sample Properties	
Moisture Content (%)	21.87
Dry Density (pcf)	100.7
Void Ratio	0.673
% Saturation	87.8

At Failure*	
Deviator stress (psi)	81.72
Minor principal total stress (psi)	138.90
Major principal total stress (psi)	220.62
Axial strain (%)	11.24

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z3-B11  
 Sample No.: C-53  
 Sample Description: Dark olive lean clay'stone' (CL)

Tested by: A. Santos      Date: 05/08/09  
 Checked by: J. Ward      Date: 05/26/09  
 Sample Type: Core  
 Depth(ft): 259.3-260

Diameter (in)	1	2.482
	2	2.480
	3	2.475
	Average	2.479
Height (in)	1	4.573
	2	4.591
	3	4.594
	Average	4.586
Weight of Sample + Tube / Rings (g)		764.80
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		820.50
Weight of Dry Sample + Container (g)		724.20
Weight of Container (g)		82.60
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		153.0
Rate of Deformation (in/min)		0.012

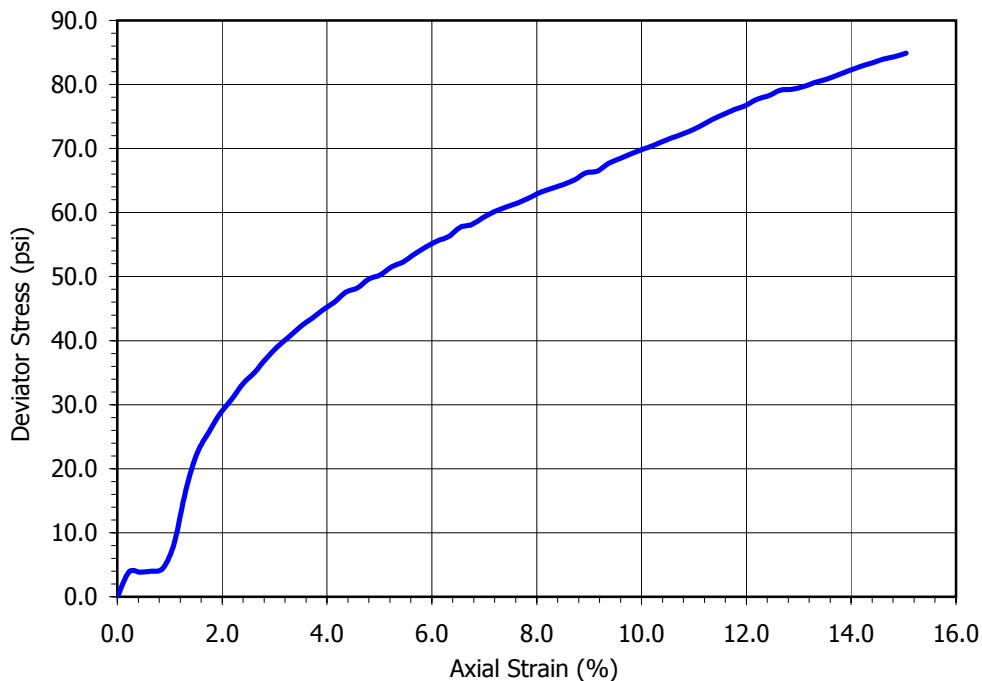


Sample Properties	
Moisture Content (%)	15.01
Dry Density (pcf)	114.5
Void Ratio	0.472
% Saturation	85.8

At Failure*	
Deviator stress (psi)	84.90
Minor principal total stress (psi)	153.00
Major principal total stress (psi)	237.90
Axial strain (%)	15.05

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No.: 378312.04.09.01  
 Boring No.: R-09-Z3-B12  
 Sample No.: C23  
 Sample Description: Yellowish brown fat clay'stone' (CH)

Tested by: A. Santos      Date: 04/16/09  
 Checked by: J. Ward      Date: 04/20/09  
 Sample Type: Core  
 Depth(ft): 109-109.8

Diameter (in)	1	3.182
	2	3.185
	3	3.186
	Average	3.184
Height (in)	1	6.671
	2	6.668
	3	6.675
	Average	6.671
Weight of Sample + Tube / Rings (g)		1621.70
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		1728.90
Weight of Dry Sample + Container (g)		1426.80
Weight of Container (g)		108.30
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		13.0
Rate of Deformation (in/min)		0.026

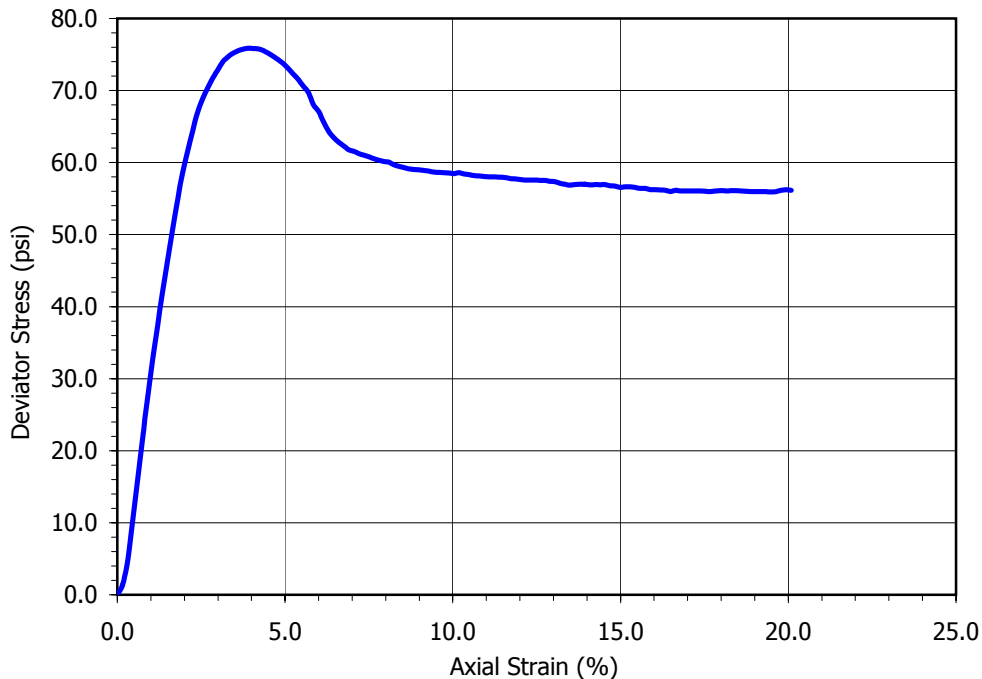


Sample Properties	
Moisture Content (%)	22.91
Dry Density (pcf)	94.6
Void Ratio	0.781
% Saturation	79.2

At Failure*	
Deviator stress (psi)	75.87
Minor principal total stress (psi)	13.00
Major principal total stress (psi)	88.87
Axial strain (%)	3.90

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z3-B12  
 Sample No.: C27  
 Sample Description: Olive fat clay'stone' (CH)

Tested by: A. Santos      Date: 04/17/09  
 Checked by: J. Ward      Date: 04/20/09  
 Sample Type: Core  
 Depth(ft): 125.5-130.8

Diameter (in)	1	3.318
	2	3.310
	3	3.305
	Average	3.311
Height (in)	1	6.810
	2	6.813
	3	6.801
	Average	6.808
Weight of Sample + Tube / Rings (g)		1818.90
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		1927.30
Weight of Dry Sample + Container (g)		1545.20
Weight of Container (g)		108.00
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		104.2
Rate of Deformation (in/min)		0.026

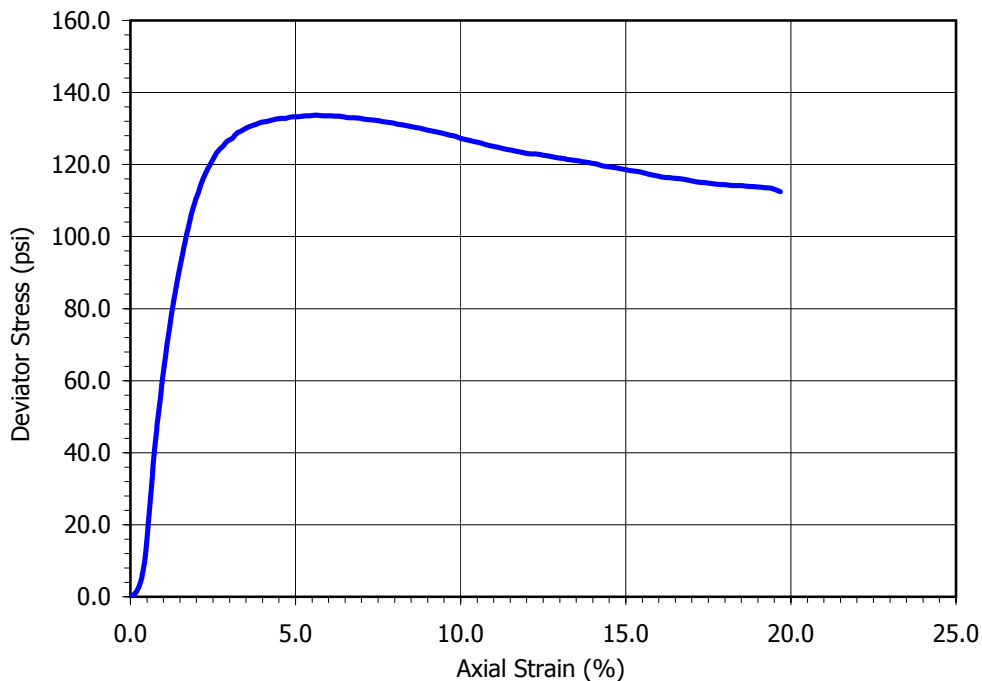


Sample Properties	
Moisture Content (%)	26.59
Dry Density (pcf)	93.4
Void Ratio	0.804
% Saturation	89.3

At Failure*	
Deviator stress (psi)	133.66
Minor principal total stress (psi)	104.20
Major principal total stress (psi)	237.86
Axial strain (%)	5.58

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No.: 378312.04.09.01  
 Boring No.: R-09-Z3-B12  
 Sample No.: C30  
 Sample Description: Olive lean clay'stone' (CL)

Tested by: A. Santos      Date: 04/23/09  
 Checked by: J. Ward      Date: 04/28/09  
 Sample Type: Core  
 Depth(ft): 140-140.6

Diameter (in)	1	3.213
	2	3.205
	3	3.212
	Average	3.210
Height (in)	1	6.506
	2	6.505
	3	6.515
	Average	6.508
Weight of Sample + Tube / Rings (g)		1570.40
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		1687.10
Weight of Dry Sample + Container (g)		1331.30
Weight of Container (g)		108.83
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		90.3
Rate of Deformation (in/min)		0.030

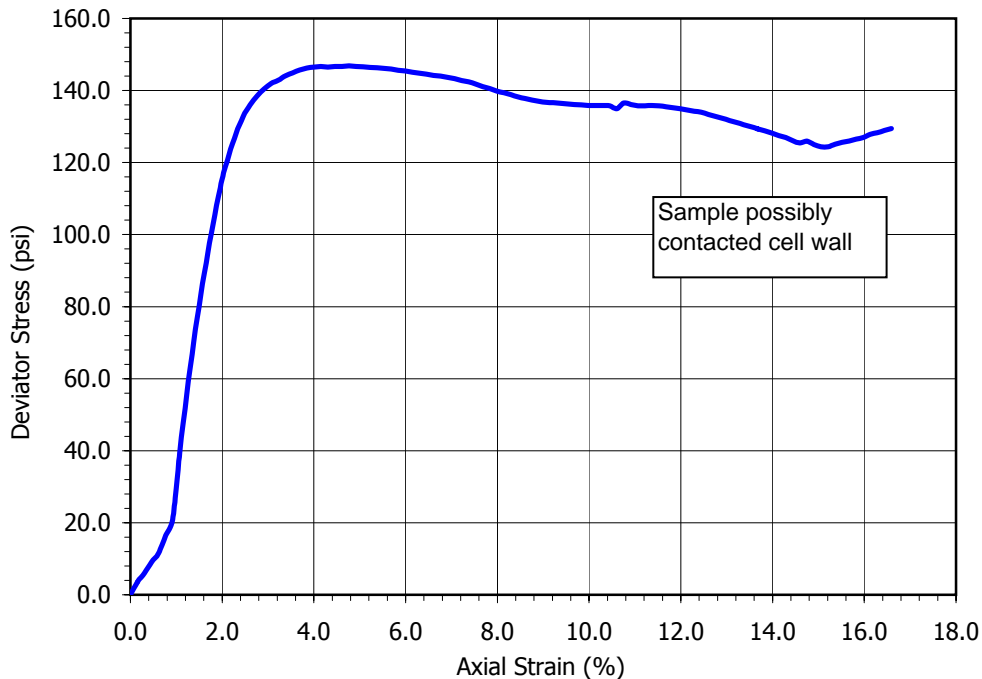


Sample Properties	
Moisture Content (%)	29.11
Dry Density (pcf)	88.0
Void Ratio	0.915
% Saturation	85.9

At Failure*	
Deviator stress (psi)	146.81
Minor principal total stress (psi)	90.30
Major principal total stress (psi)	237.11
Axial strain (%)	4.76

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



# Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z4-B4  
 Sample No.: C-19  
 Sample Description: Yellow fat clay'stone' (CH)

Tested by: A. Santos      Date: 04/29/09  
 Checked by: J. Ward      Date: 04/30/09  
 Sample Type: Core  
 Depth(ft): 97.5-98.3

Diameter (in)	1	3.270
	2	3.250
	3	3.265
	Average	3.262
Height (in)	1	6.590
	2	6.602
	3	6.590
	Average	6.594
Weight of Sample + Tube / Rings (g)		1738.00
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		1843.70
Weight of Dry Sample + Container (g)		1479.70
Weight of Container (g)		108.50
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		62.5
Rate of Deformation (in/min)		0.012

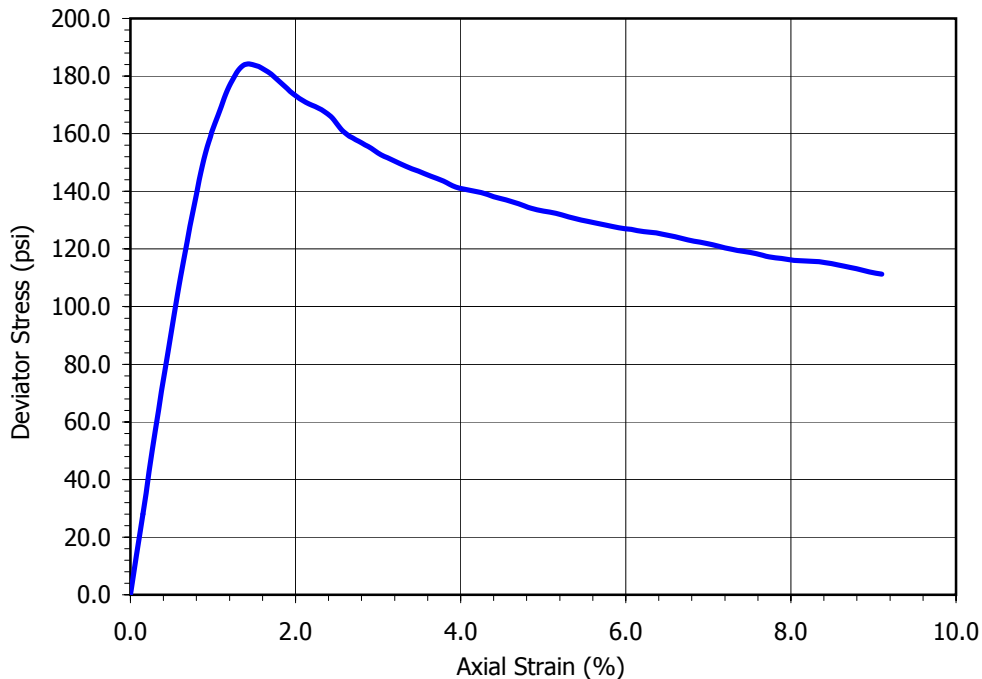


Sample Properties	
Moisture Content (%)	26.55
Dry Density (pcf)	95.0
Void Ratio	0.774
% Saturation	92.6

At Failure*	
Deviator stress (psi)	183.69
Minor principal total stress (psi)	62.50
Major principal total stress (psi)	246.19
Axial strain (%)	1.36

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z4-B4  
 Sample No.: C-26  
 Sample Description: Dark olive silt'stone' (ML)

Tested by: A. Santos      Date: 04/28/09  
 Checked by: J. Ward      Date: 04/29/09  
 Sample Type: Core  
 Depth(ft): 139.2-140.2

Diameter (in)	1	3.248
	2	3.250
	3	3.230
	Average	3.243
Height (in)	1	6.600
	2	6.599
	3	6.596
	Average	6.598
Weight of Sample + Tube / Rings (g)		1713.50
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		1819.70
Weight of Dry Sample + Container (g)		1563.80
Weight of Container (g)		109.50
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		90.3
Rate of Deformation (in/min)		0.012

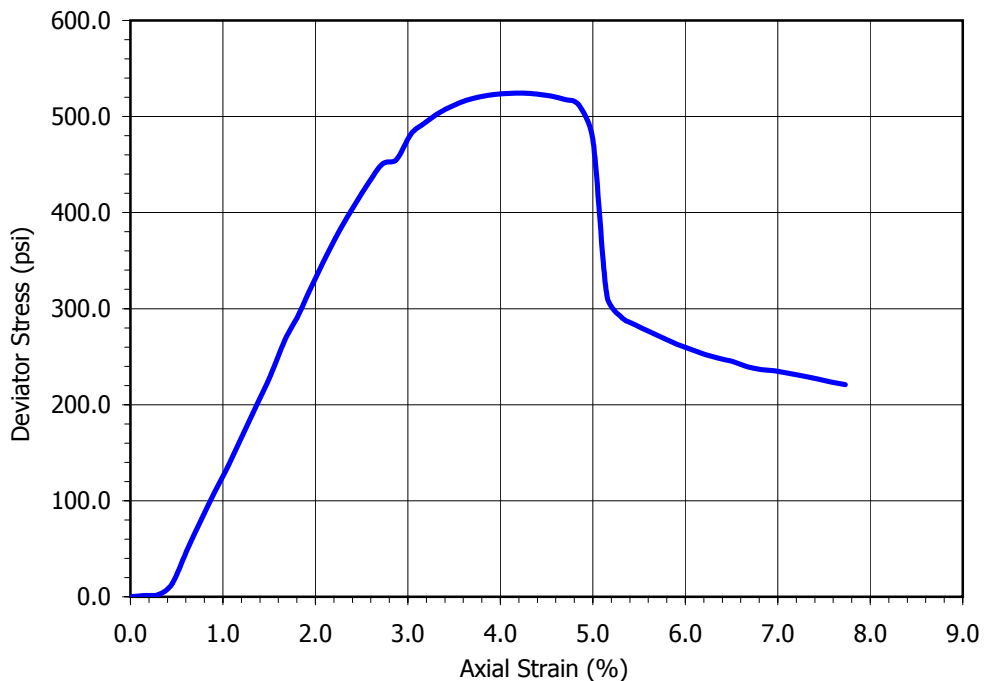


Sample Properties	
Moisture Content (%)	17.60
Dry Density (pcf)	101.9
Void Ratio	0.654
% Saturation	72.7

At Failure*	
Deviator stress (psi)	524.28
Minor principal total stress (psi)	90.30
Major principal total stress (psi)	614.58
Axial strain (%)	4.24

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**





## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z4-B4  
 Sample No.: C-38  
 Sample Description: Dark olive silt'stone' (ML)

Tested by: A. Santos      Date: 04/29/09  
 Checked by: J. Ward      Date: 04/30/09  
 Sample Type: Core  
 Depth(ft): 220.5-221.5

Diameter (in)	1	3.231
	2	3.230
	3	3.236
	Average	3.232
Height (in)	1	6.659
	2	6.650
	3	6.645
	Average	6.651
Weight of Sample + Tube / Rings (g)		1744.10
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		1848.50
Weight of Dry Sample + Container (g)		1557.90
Weight of Container (g)		106.86
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		142.5
Rate of Deformation (in/min)		0.012

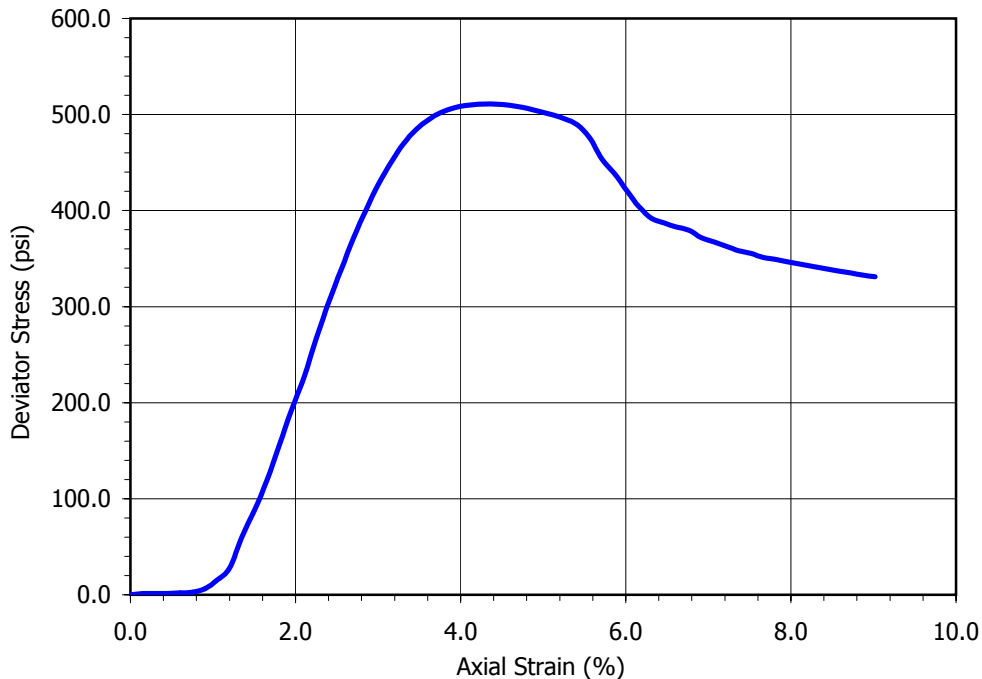


Sample Properties	
Moisture Content (%)	20.03
Dry Density (pcf)	101.4
Void Ratio	0.661
% Saturation	81.8

At Failure*	
Deviator stress (psi)	511.00
Minor principal total stress (psi)	142.50
Major principal total stress (psi)	653.50
Axial strain (%)	4.36

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



## Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name: SR-710 Tunnel Technical Study  
 Project No: 378312.04.09.01  
 Boring No.: R-09-Z4-B4  
 Sample No.: C-44  
 Sample Description: Dark olive silt'stone' (ML)

Tested by: A. Santos      Date: 04/29/09  
 Checked by: J. Ward      Date: 04/30/09  
 Sample Type: Core  
 Depth(ft): 262.5-263.4

Diameter (in)	1	3.230
	2	3.235
	3	3.240
	Average	3.235
Height (in)	1	6.627
	2	6.615
	3	6.621
	Average	6.621
Weight of Sample + Tube / Rings (g)		1765.70
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		1871.30
Weight of Dry Sample + Container (g)		1567.80
Weight of Container (g)		108.46
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		153.0
Rate of Deformation (in/min)		0.012

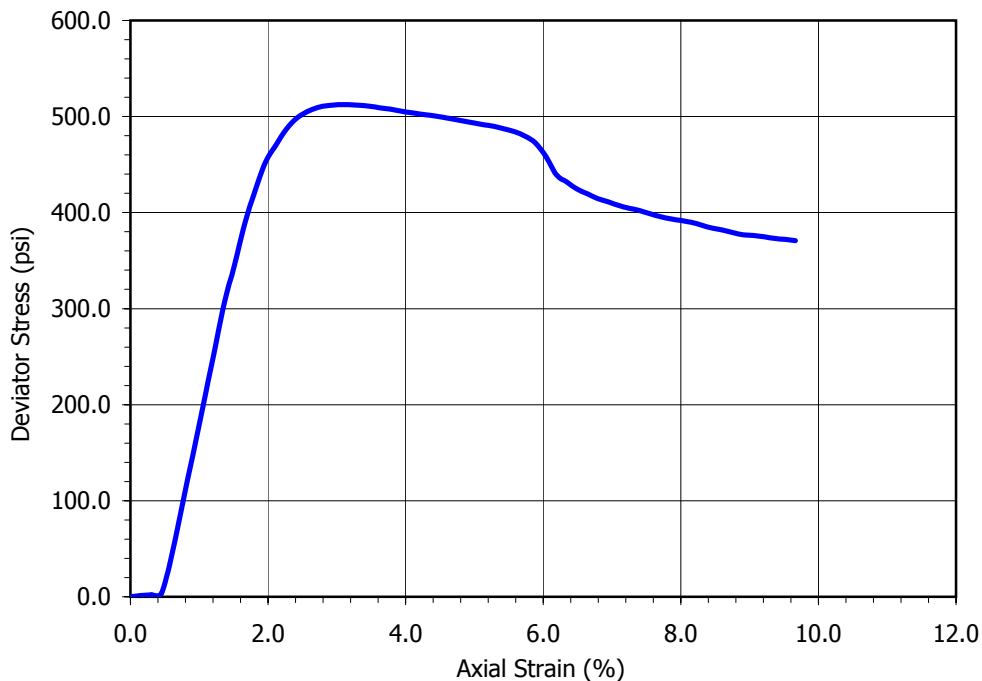


Sample Properties	
Moisture Content (%)	20.80
Dry Density (pcf)	102.3
Void Ratio	0.647
% Saturation	86.9

At Failure*	
Deviator stress (psi)	512.41
Minor principal total stress (psi)	153.00
Major principal total stress (psi)	665.41
Axial strain (%)	3.17

\* Stress values have been corrected for membrane effects

**Stress - Strain Curve**



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 10, 2009

Client: CH2MHill

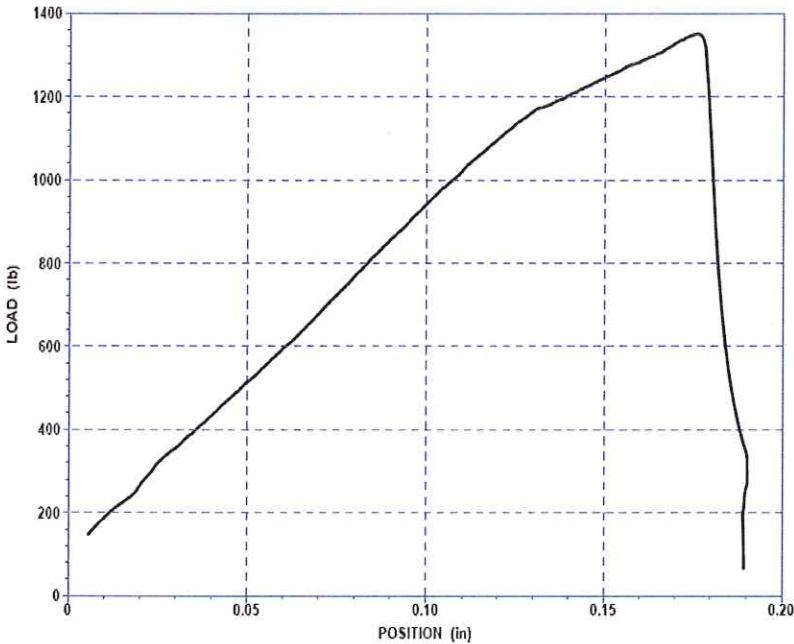
Material Type: Mudstone  
 Date Cast: n/a  
 Date Tested: 4/10/09  
 Age, Days: n/a

Depth: 133.1-134

Test Method: ASTM D4832, D1633, D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z1-B8, C28		2.41	4.7	123.3	100.2	23.0	299



Elastic Modulus (psi)*:	7940
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\*using secant elastic modulus formula

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 10, 2009

Client: CH2MHill

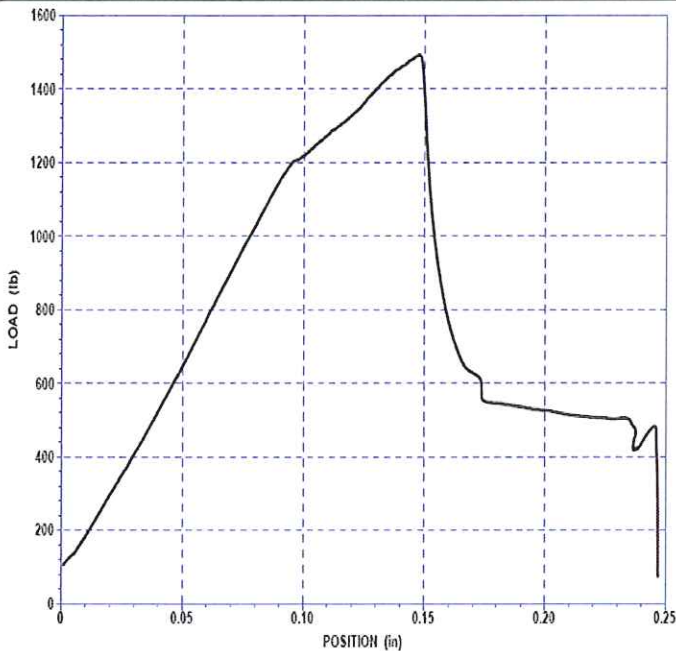
Material Type: Mudstone  
 Date Cast: n/a  
 Date Tested: 4/10/09  
 Age, Days: n/a

Depth: 147.9-148.5

Test Method: ASTM D4832, D1633, D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z1-B8, C31		2.42	4.6	127.8	104.9	21.8	324



Elastic Modulus (psi)\*: **10,009**

\*using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 10, 2009

Client: CH2MHill

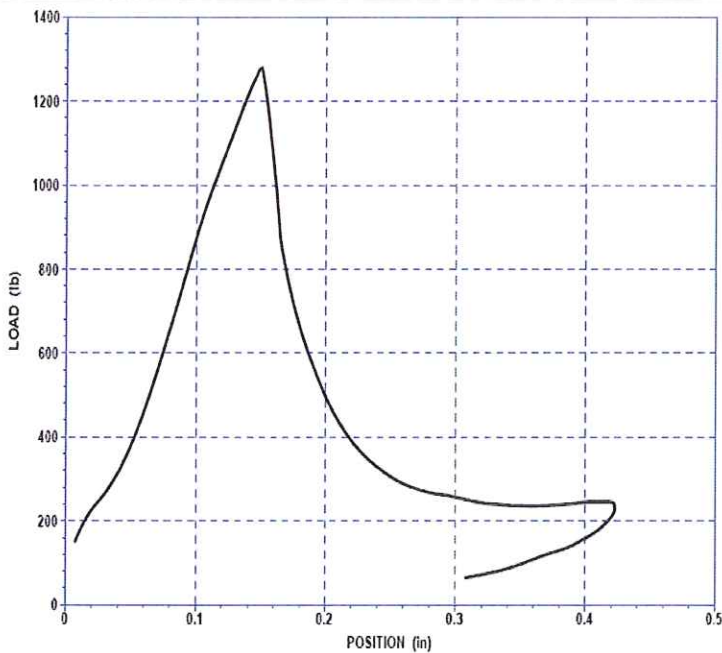
Material Type: Mudstone  
 Date Cast: n/a  
 Date Tested: 4/10/09  
 Age, Days: n/a

Depth: 175-175.75

Test Method: ASTM D4832, D1633, D7012  
 Moisture Condition At Testing: Ambient

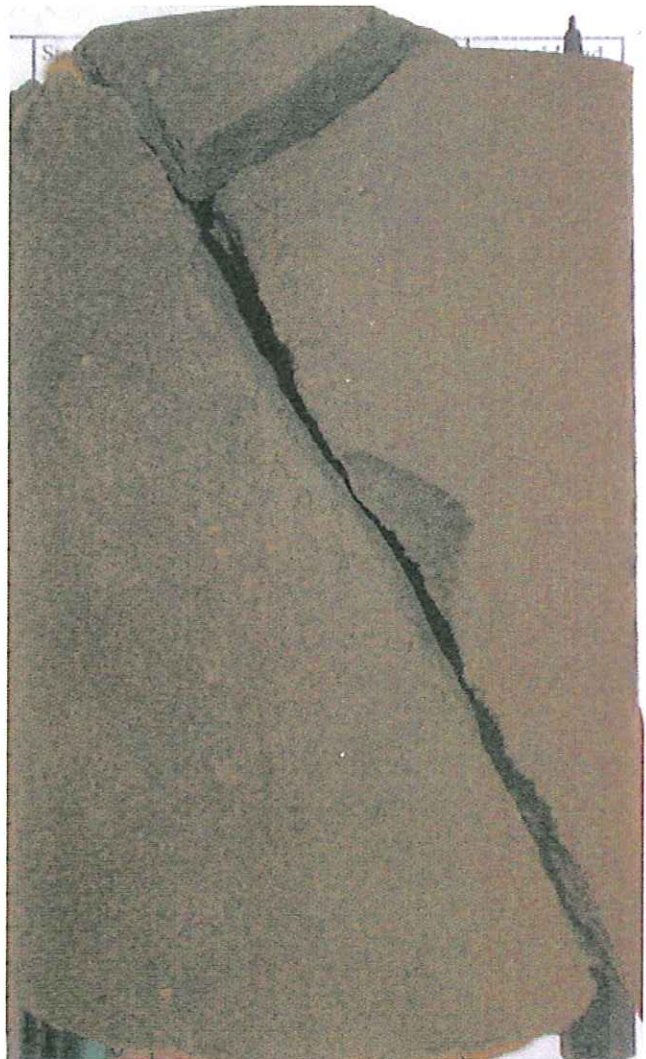
## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z1-B8, C37		2.42	4.7	124.3	102.2	21.7	289



Elastic Modulus (psi)*:	8,792
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\*using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 10, 2009

Client: CH2MHill

Material Type: Mudstone  
 Date Cast: n/a  
 Date Tested: 4/10/09  
 Age, Days: n/a

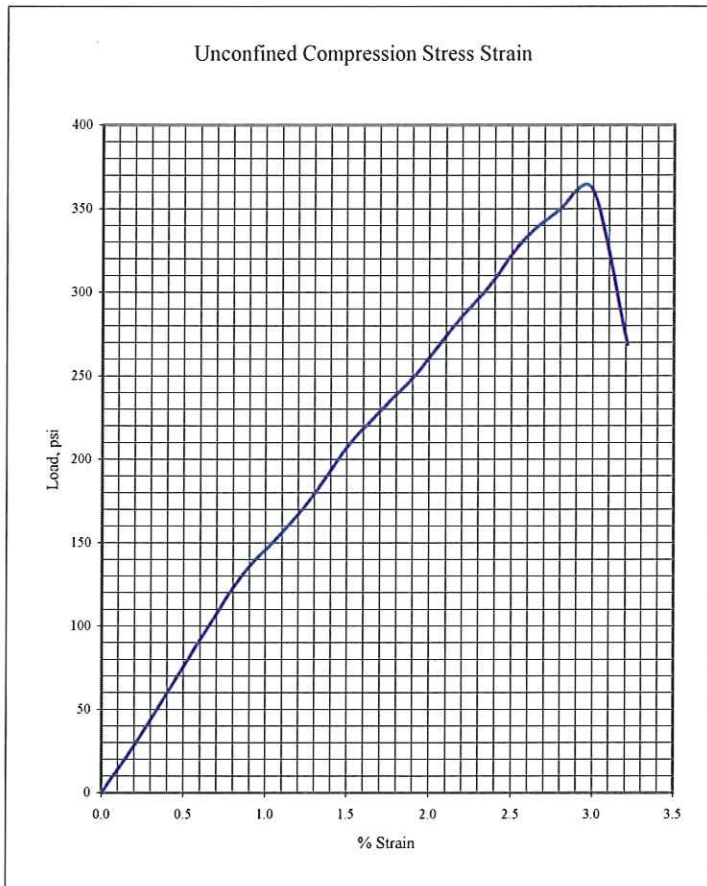
Depth: 195-196.25

Test Method: ASTM D4832, D1633, D7012

Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z1-B8, C41		2.32	4.7	123.7	101.6	21.7	361



<b>Elastic Modulus (psi)*:</b>	<b>12052</b>
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\*using secant elastic modulus formula

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: Siltstone

Depth: 188-188.8

Date Cast: n/a

Date Tested: 5/12/09

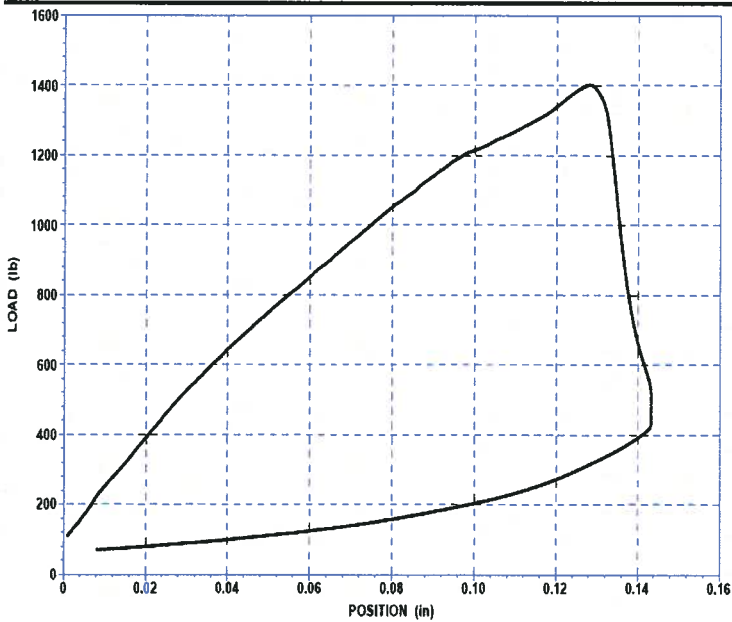
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

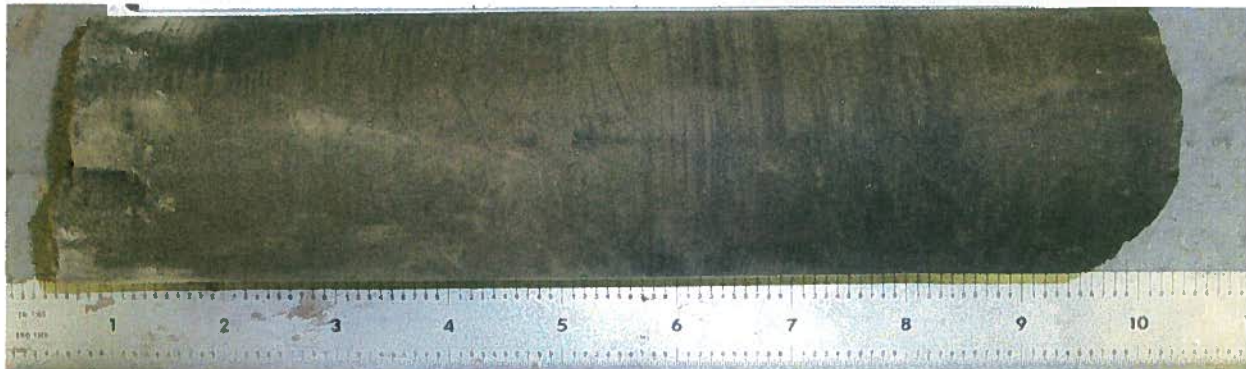
## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z2-B5, C39		2.40	4.8	128.4	106.5	20.6	311



<b>Elastic Modulus (psi)*:</b>	<b>11,556</b>
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\* using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: May 12, 2009

Client: CH2MHill

Material Type: Mudstone

Depth: 203.4-204.2

Date Cast: n/a

Date Tested: 5/12/09

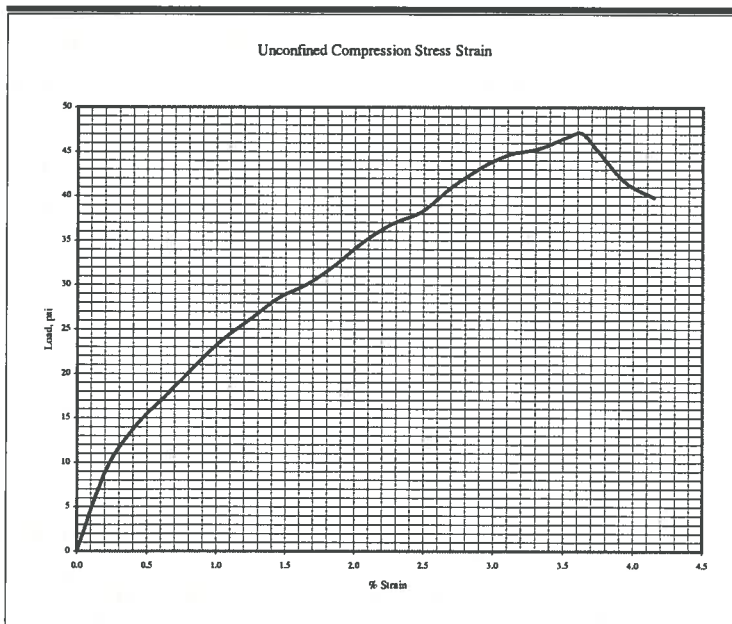
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z2-B5, C43		2.40	4.8	127.6	104.6	22.0	47



<b>Elastic Modulus (psi)*:</b>	<b>1,292</b>
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\* using secant elastic modulus formula





# UNCONFINED COMPRESSIVE STRENGTH

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: Mudstone

Depth: 240.5-241.2

Date Cast: n/a

Date Tested: 5/12/09

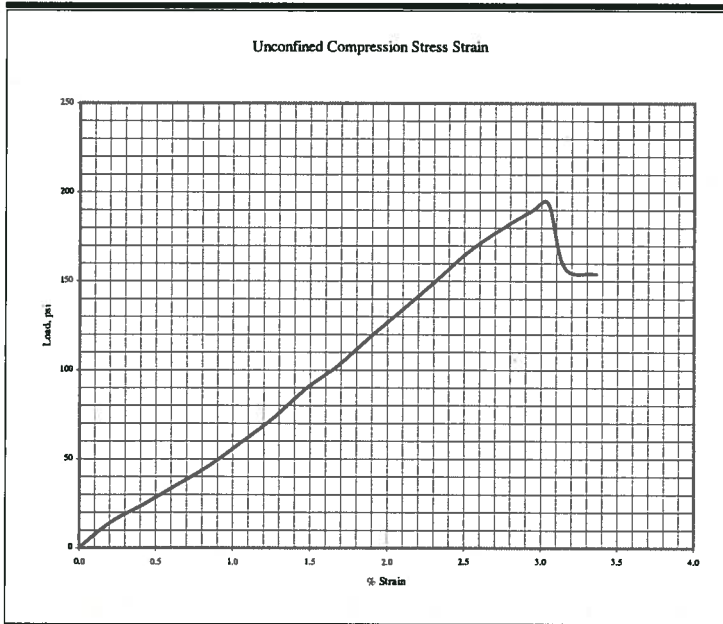
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

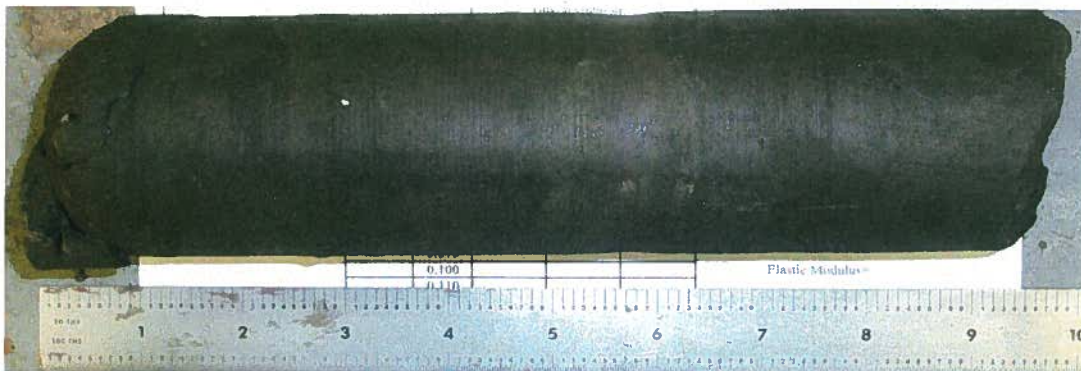
## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z2-B5, C53	0	2.36	4.8	131.7	108.8	21.1	194



**Elastic Modulus (psi)\*:** 6,409

\* using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: Mudstone

Depth: 291.8-292.4

Date Cast: n/a

Date Tested: 5/12/09

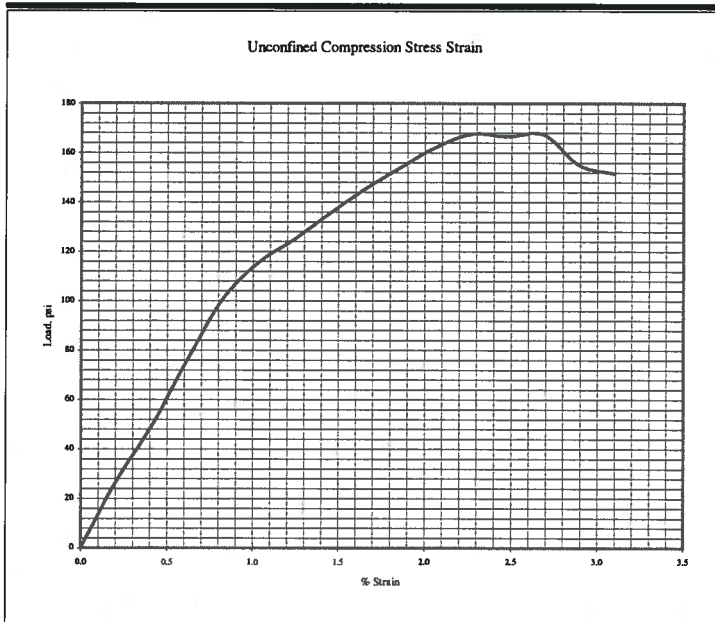
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

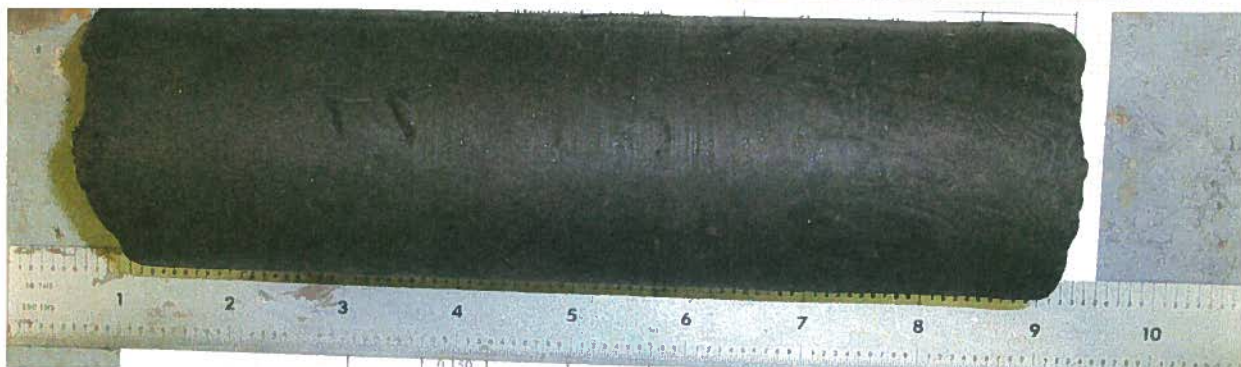
## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z2-B5, C65		2.40	4.8	115.0	87.8	30.9	168

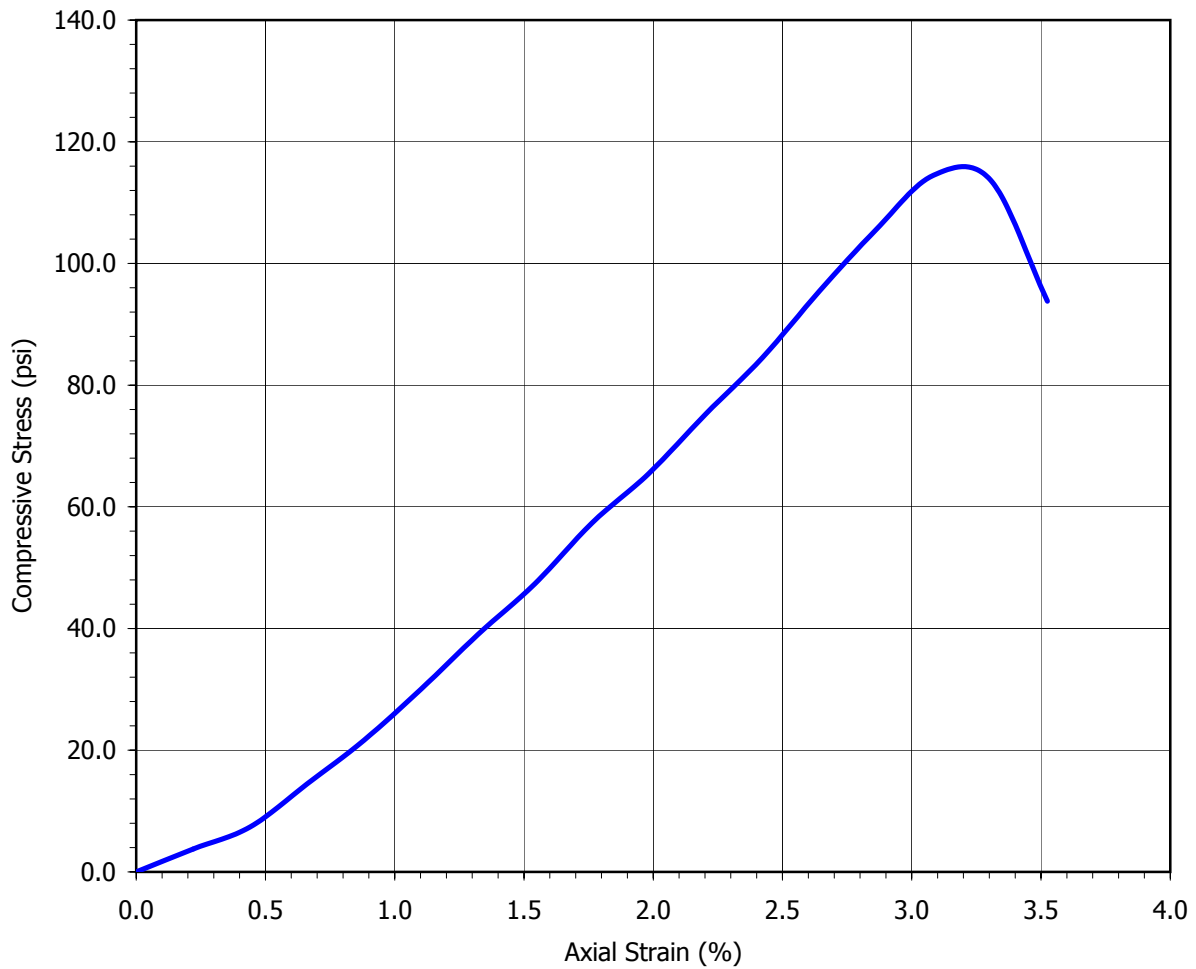


<b>Elastic Modulus (psi)*:</b>	<b>6,188</b>
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\* using secant elastic modulus formula







Boring No.: R-09-Z2-B5  
 Sample No.: C36  
 Depth (ft): 176.6-177.2  
 Soil Type: Core  
 Sample Description: Very dark olive silt'stone' (ML)

Sample Diameter (in.)	2.442
Sample Height (in.)	4.539
Initial Moisture Content (%)	23.30
Dry Density (pcf)	100.8
Specific Gravity (assumed)	2.7
Saturation (%)	93.7
Rate of Deformation (in/min)	0.0120
Height / Diameter Ratio	1.86

At Failure

<b>Compressive Strength (psi)</b>	<b>114.50</b>
Axial Strain (%)	3.08



**Unconfined Compressive Strength  
 of Cohesive Soil  
 ASTM D 2166**

Project No.: 378312.04.09.01

**SR-710 Tunnel Technical Study**

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 22, 2009

Client: CH2MHill

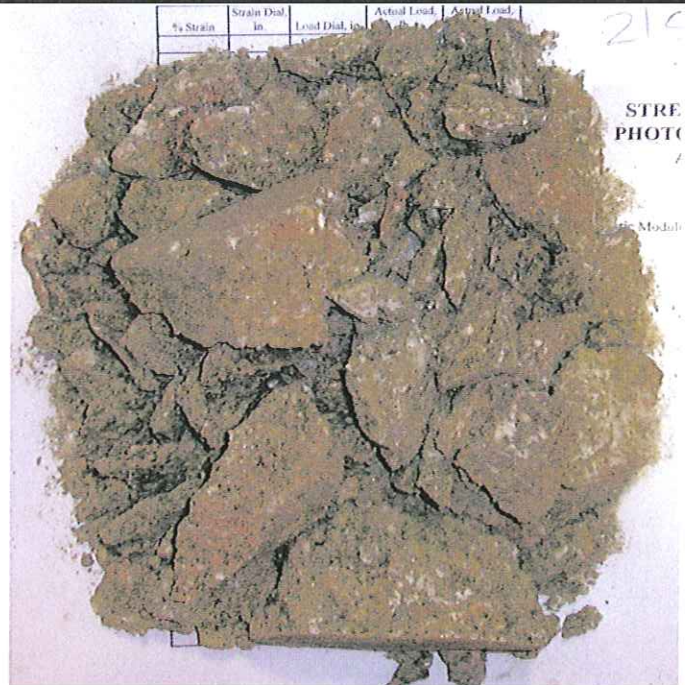
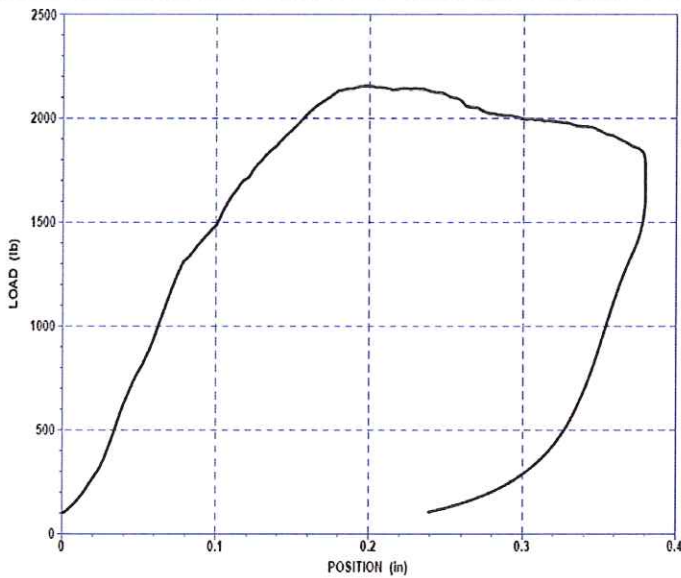
Material Type: Core  
 Date Cast: n/a  
 Date Tested: 4/22/09  
 Age, Days: n/a

Depth: 220.5-221.8

Test Method: ASTM D4832, D1633, D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B4, C45		3.14	3.7	260.7	254.1	2.6	254



Elastic Modulus (psi)*:	4,576
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\* using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 22, 2009

Client: CH2MHill

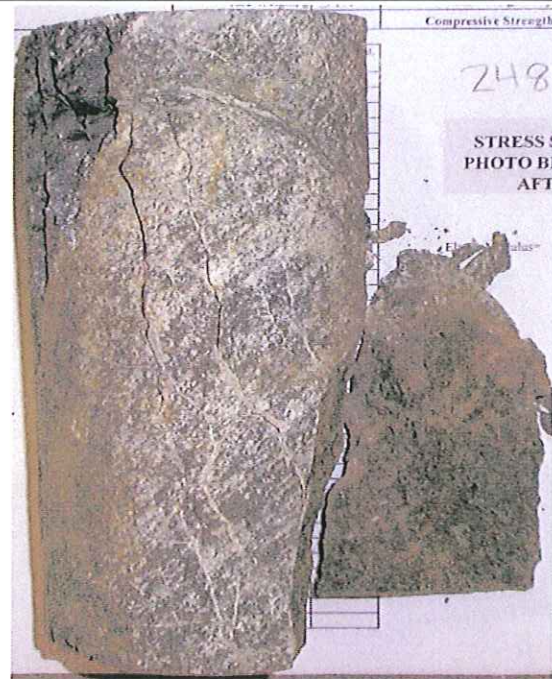
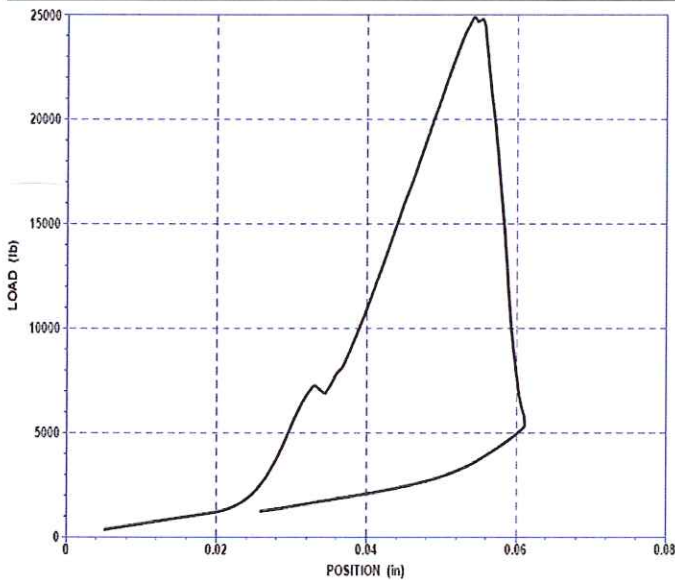
Material Type: Core  
 Date Cast: n/a  
 Date Tested: 4/22/09  
 Age, Days: n/a

Depth: 272-273.2

Test Method: ASTM D4832, D1633, D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B4, C57		3.25	6.5	91.5	90.4	1.2	2998



Elastic Modulus (psi)*:	358,181
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\* using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 22, 2009

Client: CH2MHill

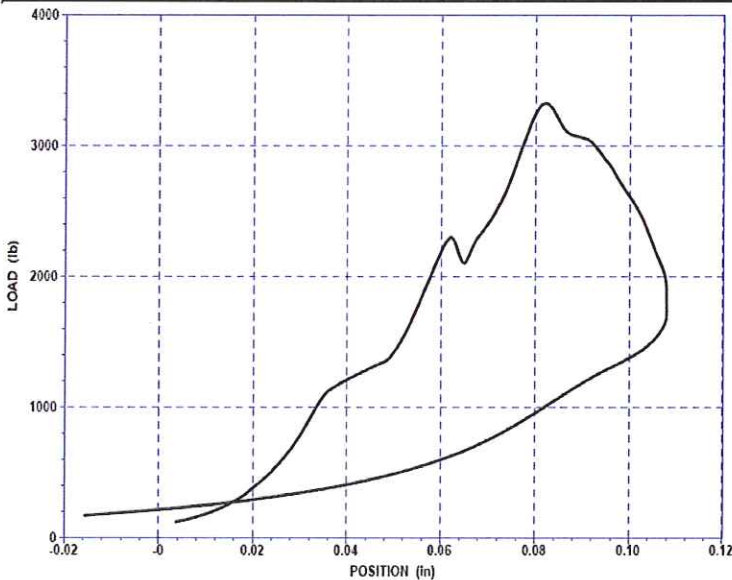
Material Type: Core  
 Date Cast: n/a  
 Date Tested: 4/22/09  
 Age, Days: n/a

Depth: 217.8-218.6

Test Method: ASTM D4832, D1633, D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B4, C43		3.23	5.9	164.3	162.2	1.2	406



Elastic Modulus (psi)\*: 28,965

\* using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 22, 2009

Client: CH2MHill

Material Type: Core

Depth: 209-209.5

Date Cast: n/a

Date Tested: 4/22/09

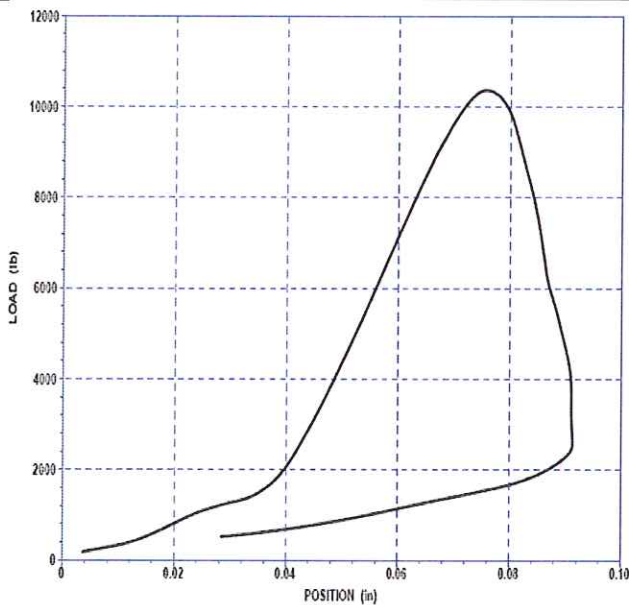
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B6, C <sup>34</sup>		3.26	6.4	152.0	145.8	4.2	1243



Elastic Modulus (psi)\*: 105,745

\* using secant elastic modulus formula





# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 22, 2009

Client: CH2MHill

Material Type: Core

Depth: 218-218.6

Date Cast: n/a

Date Tested: 4/22/09

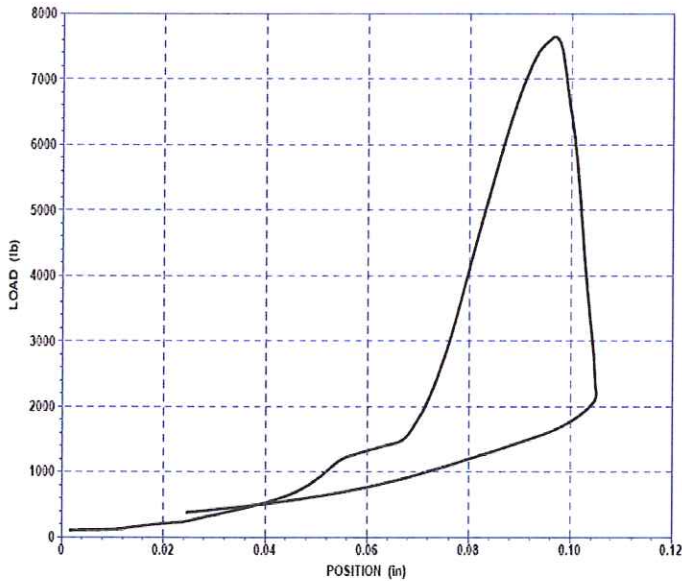
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B6, C35		3.29	6.5	151.7	148.8	1.9	899



Elastic Modulus (psi)*:	60,487
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\* using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 22, 2009

Client: CH2MHill

Material Type: Core

Depth: 221-222

Date Cast: n/a

Date Tested: 4/22/09

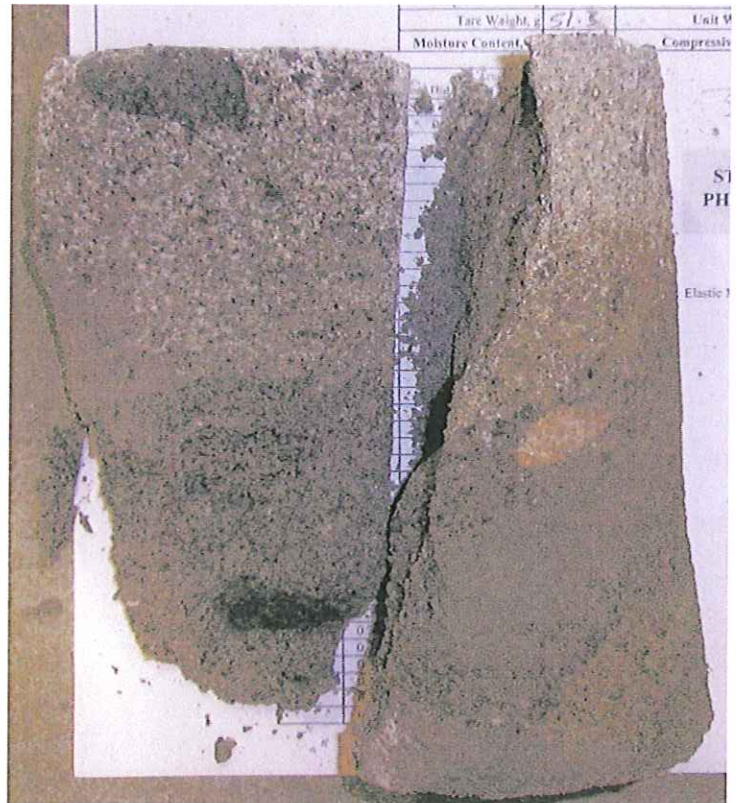
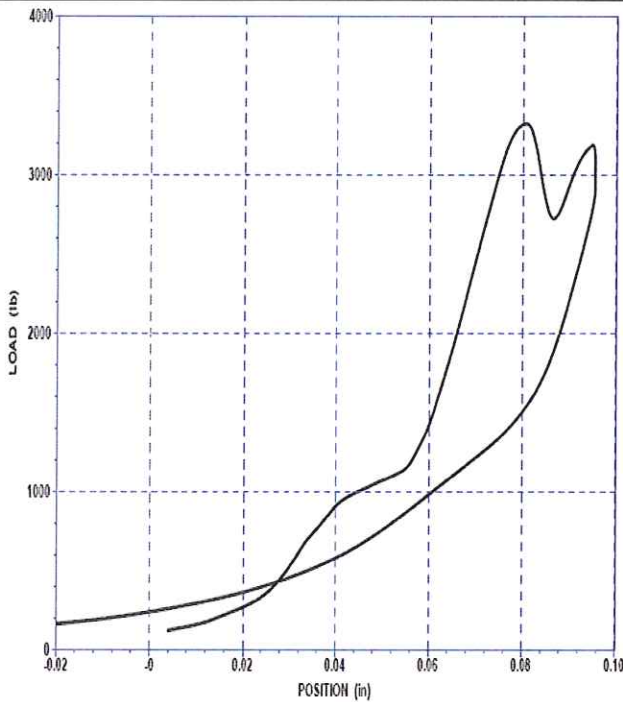
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B6, C 35		3.28	6.5	146.3	141.8	3.1	393



Elastic Modulus (psi)*:	31,599
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\* using secant elastic modulus formula

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 22, 2009

Client: CH2MHill

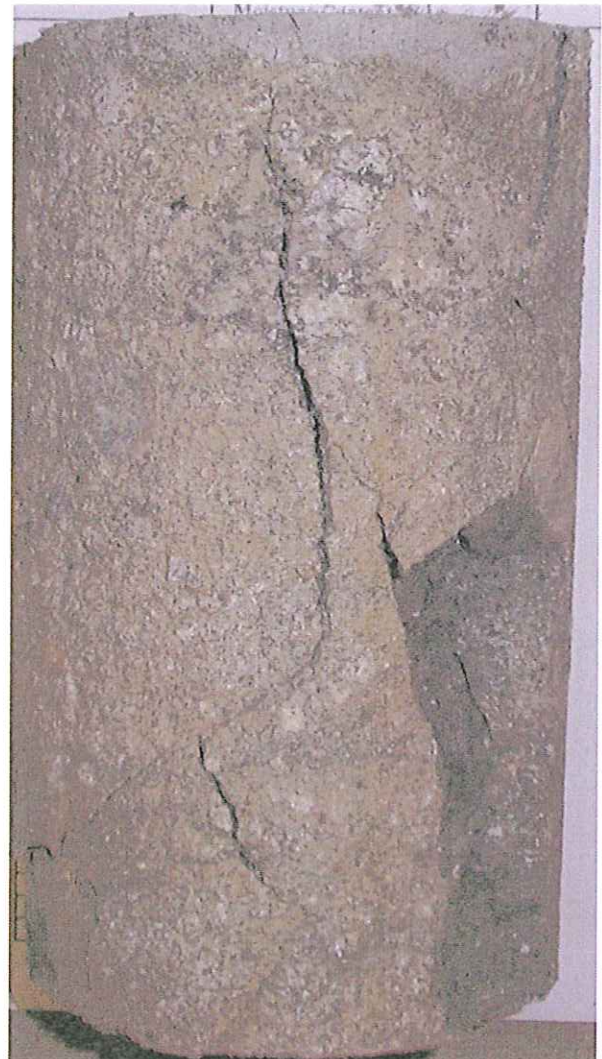
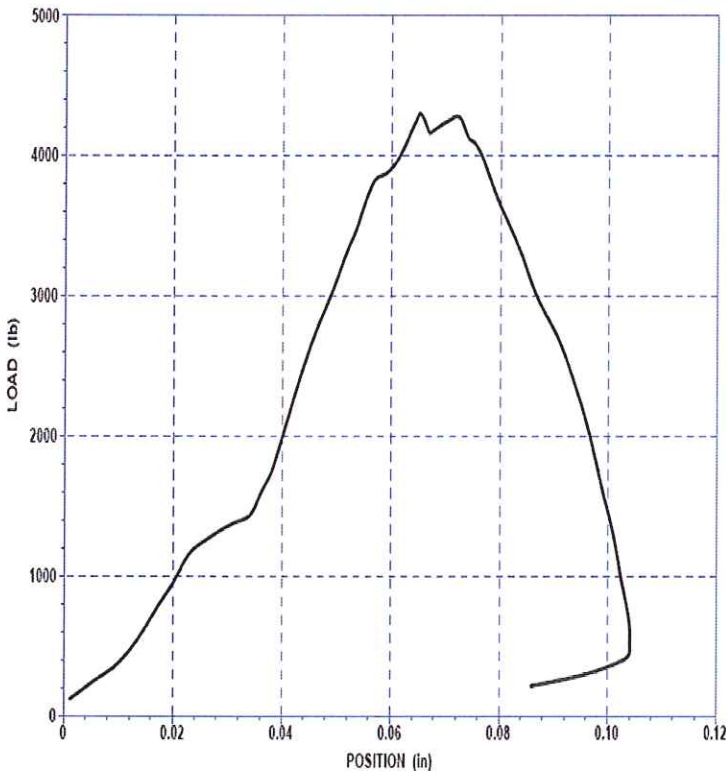
Material Type: Core  
 Date Cast: n/a  
 Date Tested: 4/22/09  
 Age, Days: n/a

Depth: 227-228

Test Method: ASTM D4832, D1633, D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B6, C	37	3.25	6.5	155.7	152.0	2.4	523



Elastic Modulus (psi)*:	51,713
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\* using secant elastic modulus formula

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 22, 2009

Client: CH2MHill

Material Type: Core

Depth: 258.2-258.8

Date Cast: n/a

Date Tested: 4/22/09

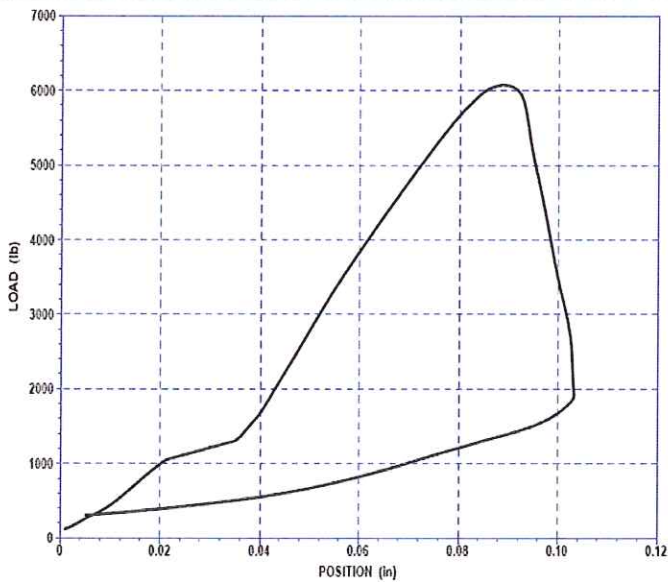
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B6, C	44	3.17	6.3	156.9	153.7	2.0	770



Elastic Modulus (psi)*:	54,499
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\* using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: siltstone

Depth: 174.1-174.7

Date Cast: n/a

Date Tested: 5/12/09

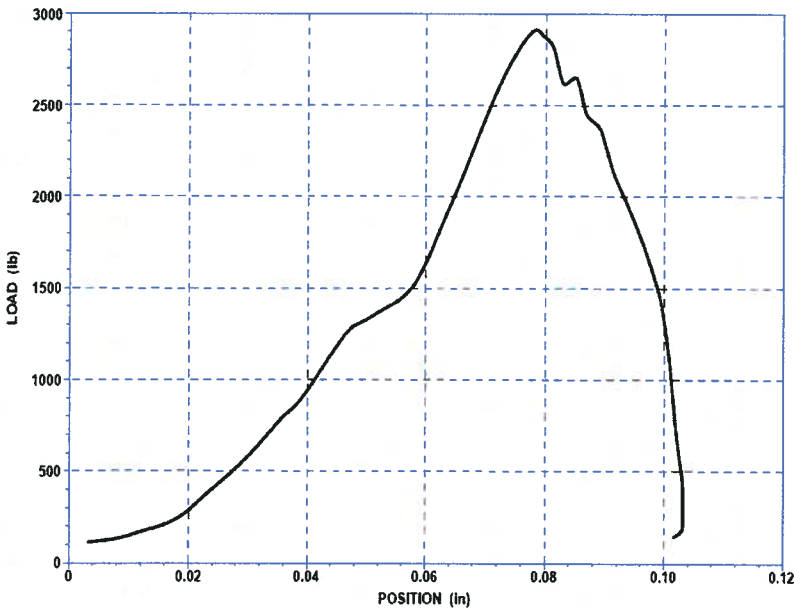
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

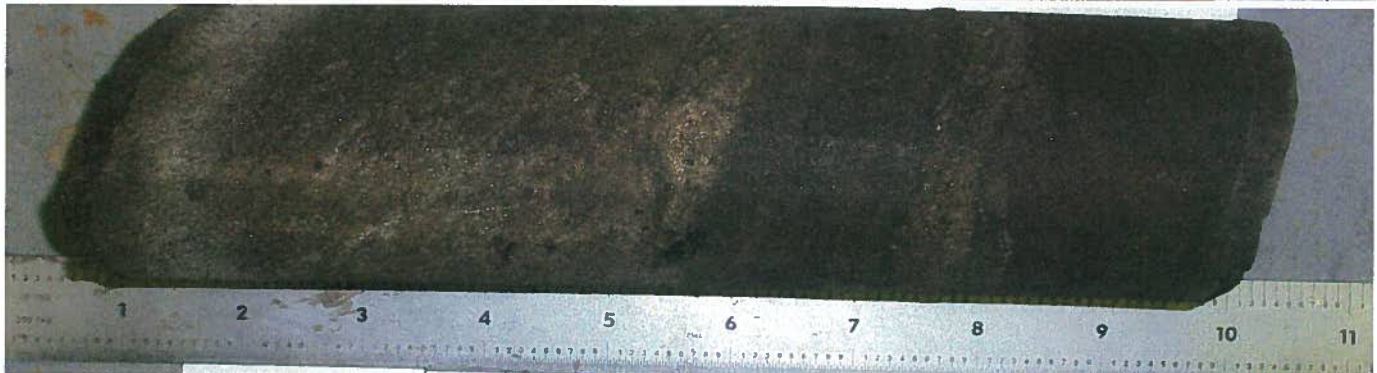
## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B8, C42		2.37	4.8	146.7	137.4	6.8	663



<b>Elastic Modulus (psi)*:</b>	<b>40,489</b>
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\* using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: siltstone

Depth: 196.7-197.3

Date Cast: n/a

Date Tested: 5/12/09

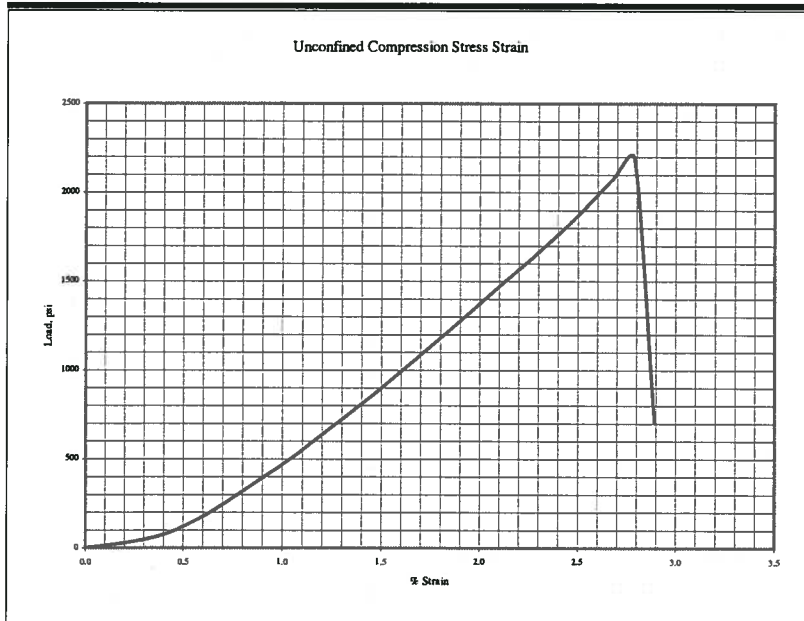
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B8, C48		2.39	4.8	141.6	131.0	8.1	2193



<b>Elastic Modulus (psi)*:</b>	<b>77,963</b>
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\* using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: siltstone

Depth: 205.1-205.7

Date Cast: n/a

Date Tested: 5/12/09

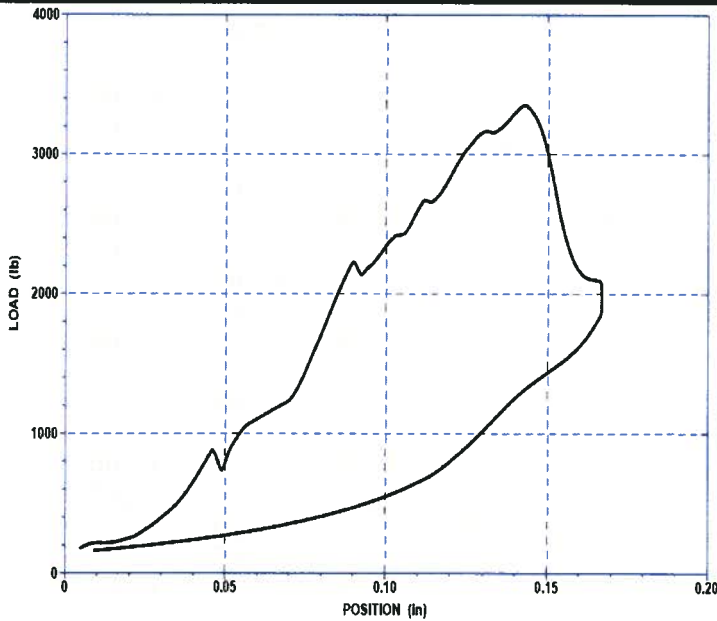
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

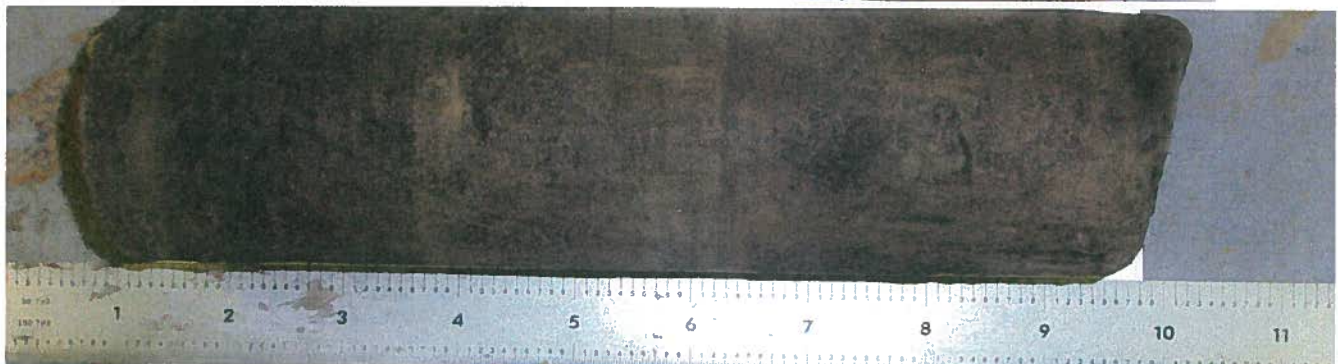
## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B8, C51		2.35	4.8	143.4	132.7	8.1	774



<b>Elastic Modulus (psi)*:</b>	<b>25,933</b>
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\* using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: May 12, 2009

Client: CH2MHill

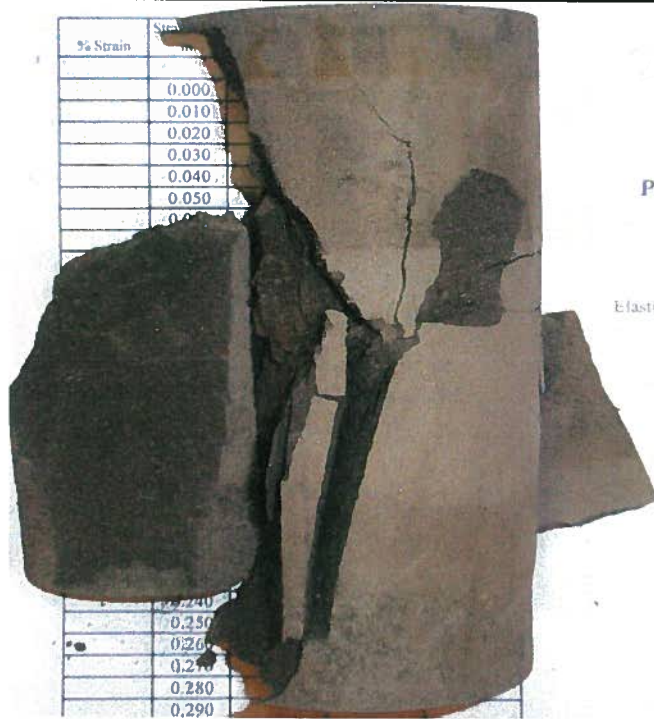
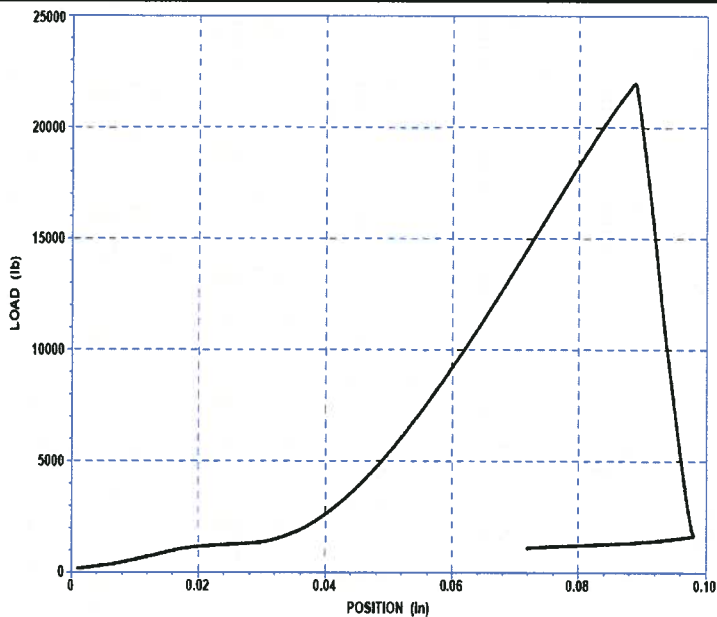
Material Type: siltstone  
 Date Cast: n/a  
 Date Tested: 5/12/09  
 Age, Days: n/a

Depth: 235.3-236

Test Method: ASTM D4832, D1633, D7012  
 Moisture Condition At Testing: Ambient

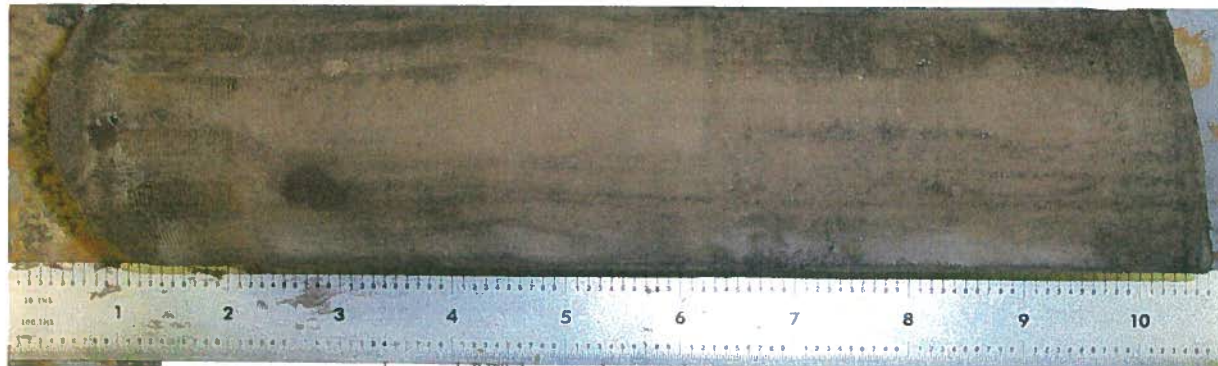
## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B8, C58		2.40	4.9	143.1	135.1	5.9	4898



**Elastic Modulus (psi)\*: 268,481**

\* using secant elastic modulus formula





# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: May 12, 2009

Material Type: siltstone

Depth: 256-256.7

Date Cast: n/a

Date Tested: 5/12/09

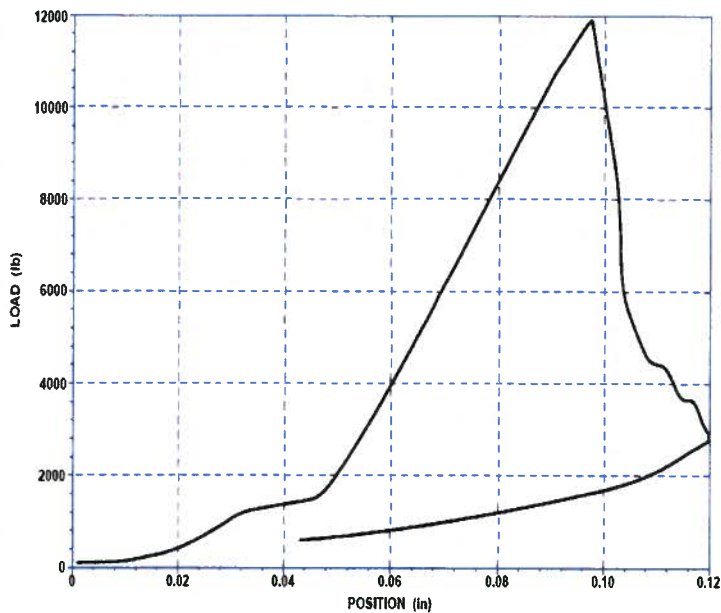
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B8, C63		2.40	4.8	140.5	131.6	6.7	2641



<b>Elastic Modulus (psi)*:</b>	<b>130,559</b>
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\* using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 2, 2009

Client: CH2MHill

Material Type: Core

Depth: 213.9-214.5

Date Cast: n/a

Date Tested: 4/2/09

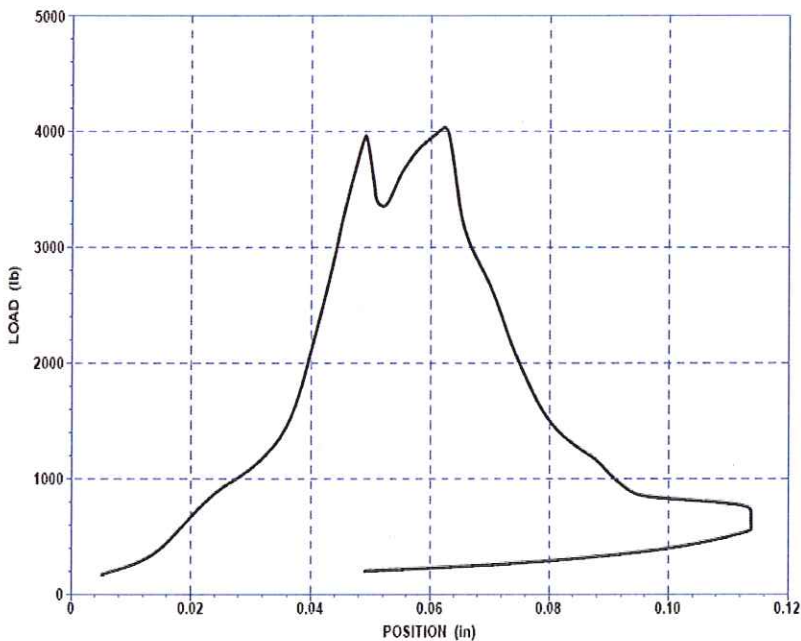
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B12, C47		3.10	5.9	125.8	105.5	19.3	503



Elastic Modulus (psi)\*: 47332

\*using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH

Project Name: SR-710 Tunnel Technical Study

Client: CH2MHill

Project No.: 09-144

Report Date: April 2, 2009

Material Type: Core

Depth: 248.9-249.9

Date Cast: n/a

Date Tested: 4/2/09

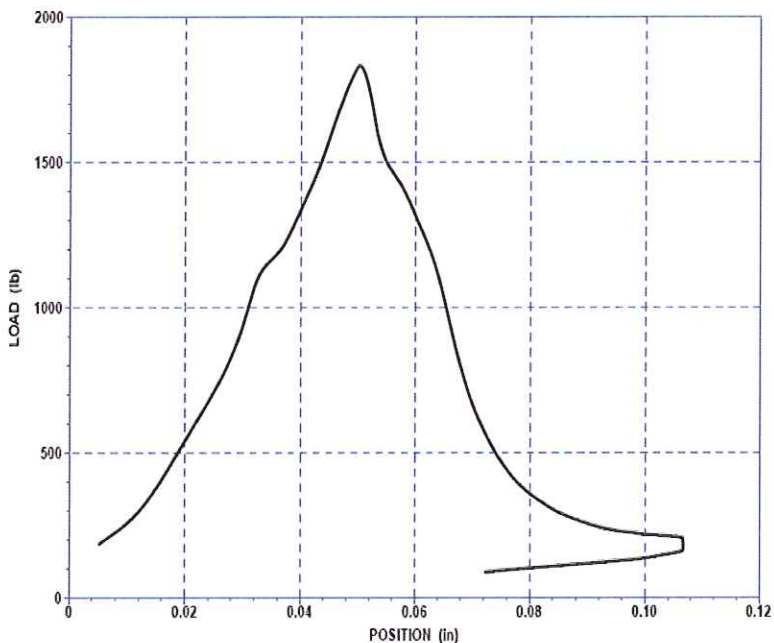
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

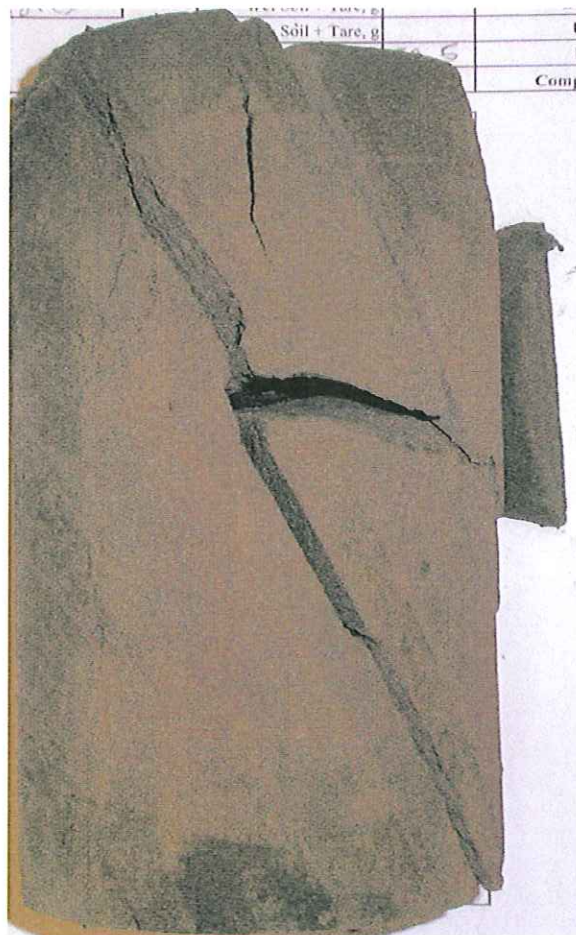
## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B12, C56		3.15	6.0	122.7	102.5	19.7	232



Elastic Modulus (psi)\*: 27241

\*using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 2, 2009

Client: CH2MHill

Material Type: Shale

Depth: 213.9-214.5

Date Cast: n/a

Date Tested: 4/2/09

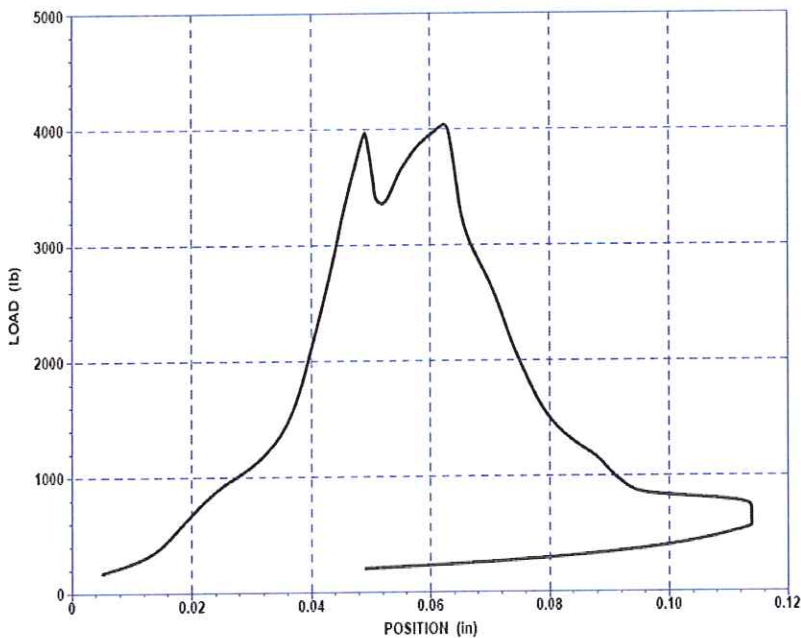
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B12, C47		3.10	5.9	125.8	105.5	19.3	503



Elastic Modulus (psi)\*: 47332

\*using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 2, 2009

Client: CH2MHill

Material Type: Shale

Depth: 248.9-249.9

Date Cast: n/a

Date Tested: 4/2/09

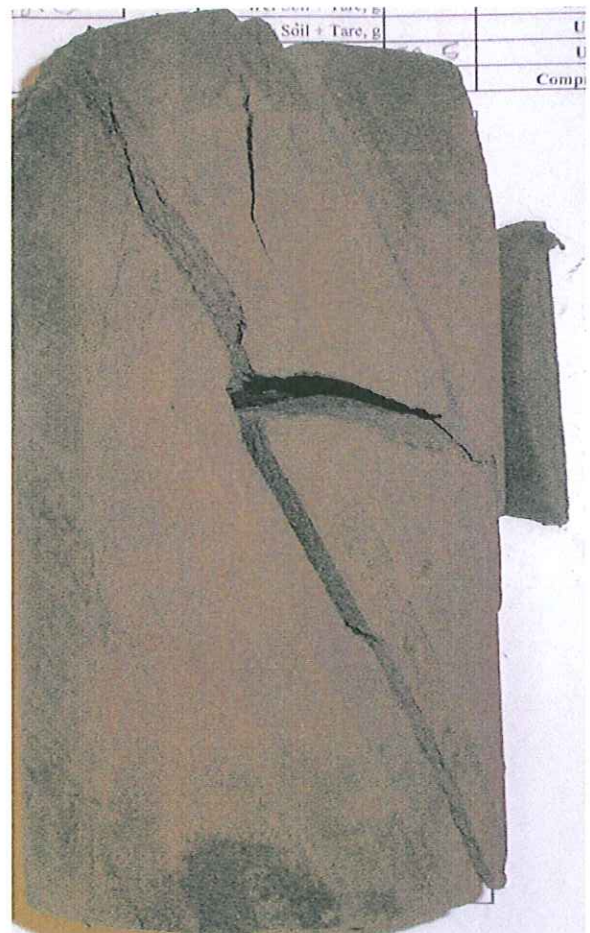
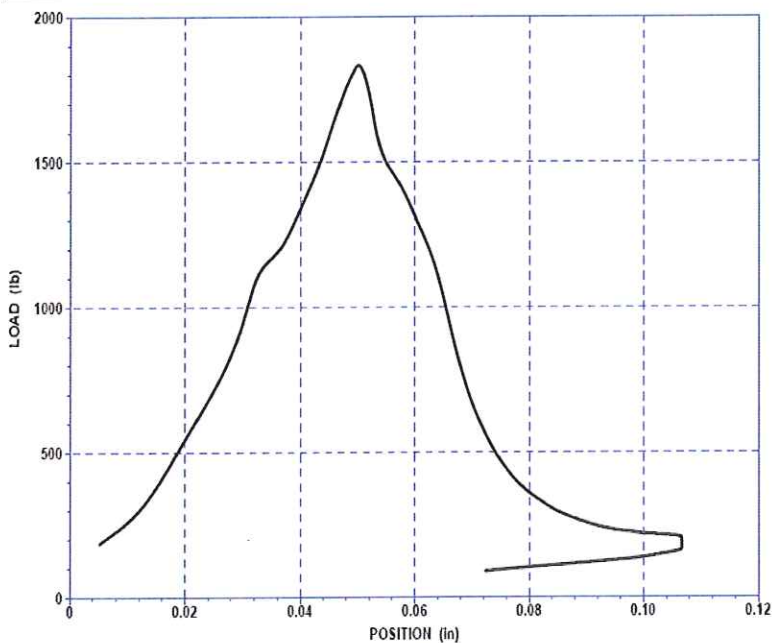
Test Method: ASTM D4832, D1633, D7012

Age, Days: n/a

Moisture Condition At Testing: Ambient

## Test Results

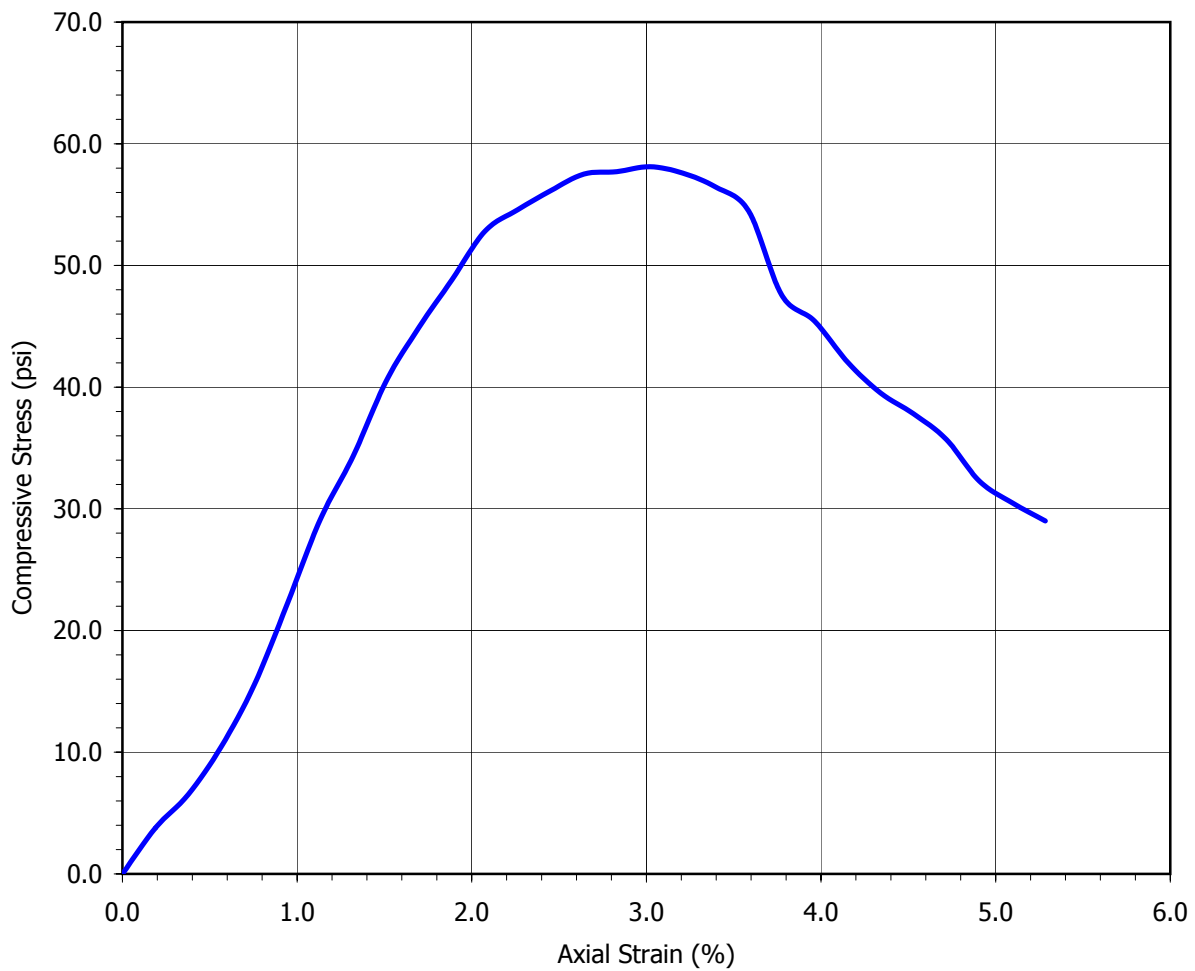
Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z3-B12, C56		3.15	6.0	122.7	102.5	19.7	232



**Elastic Modulus (psi)\*: 27241**

\*using secant elastic modulus formula





Boring No.:	R-09-Z3-B11
Sample No.:	C-37
Depth (ft):	184.7-185.5
Soil Type:	Core
Sample Description:	Olive brown lean clay'stone' (CL)

Sample Diameter (in.)	2.440
Sample Height (in.)	5.299
Initial Moisture Content (%)	21.96
Dry Density (pcf)	102.8
Specific Gravity (assumed)	2.7
Saturation (%)	92.9
Rate of Deformation (in/min)	0.0120
Height / Diameter Ratio	2.17

At Failure

<b>Compressive Strength (psi)</b>	<b>58.11</b>
Axial Strain (%)	3.02



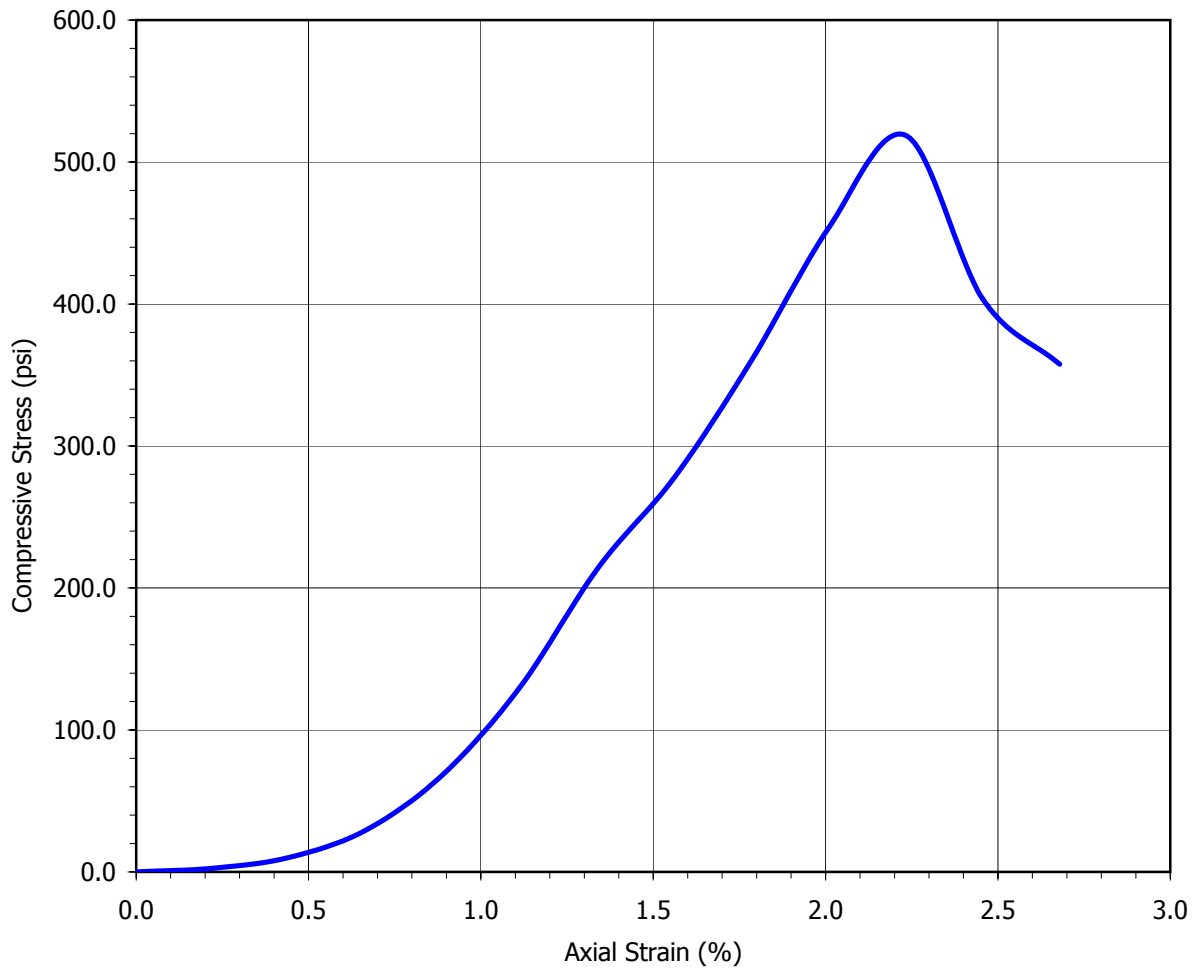
**Unconfined Compressive Strength  
of Cohesive Soil  
ASTM D 2166**

Project No.: 378312.04.09.01

**SR-710 Tunnel Technical Study**







Boring No.:	R-09-Z3-B12
Sample No.:	C61
Depth (ft):	267.5-269.9
Soil Type:	Core
Sample Description:	Dark olive gray shale

Sample Diameter (in.)	3.157
Sample Height (in.)	4.479
Initial Moisture Content (%)	11.53
Dry Density (pcf)	101.2
Specific Gravity (assumed)	2.7
Saturation (%)	46.8
Rate of Deformation (in/min)	0.0120
Height / Diameter Ratio	1.42

At Failure

<b>Compressive Strength (psi)</b>	<b>518.71</b>
Axial Strain (%)	2.23



Leighton

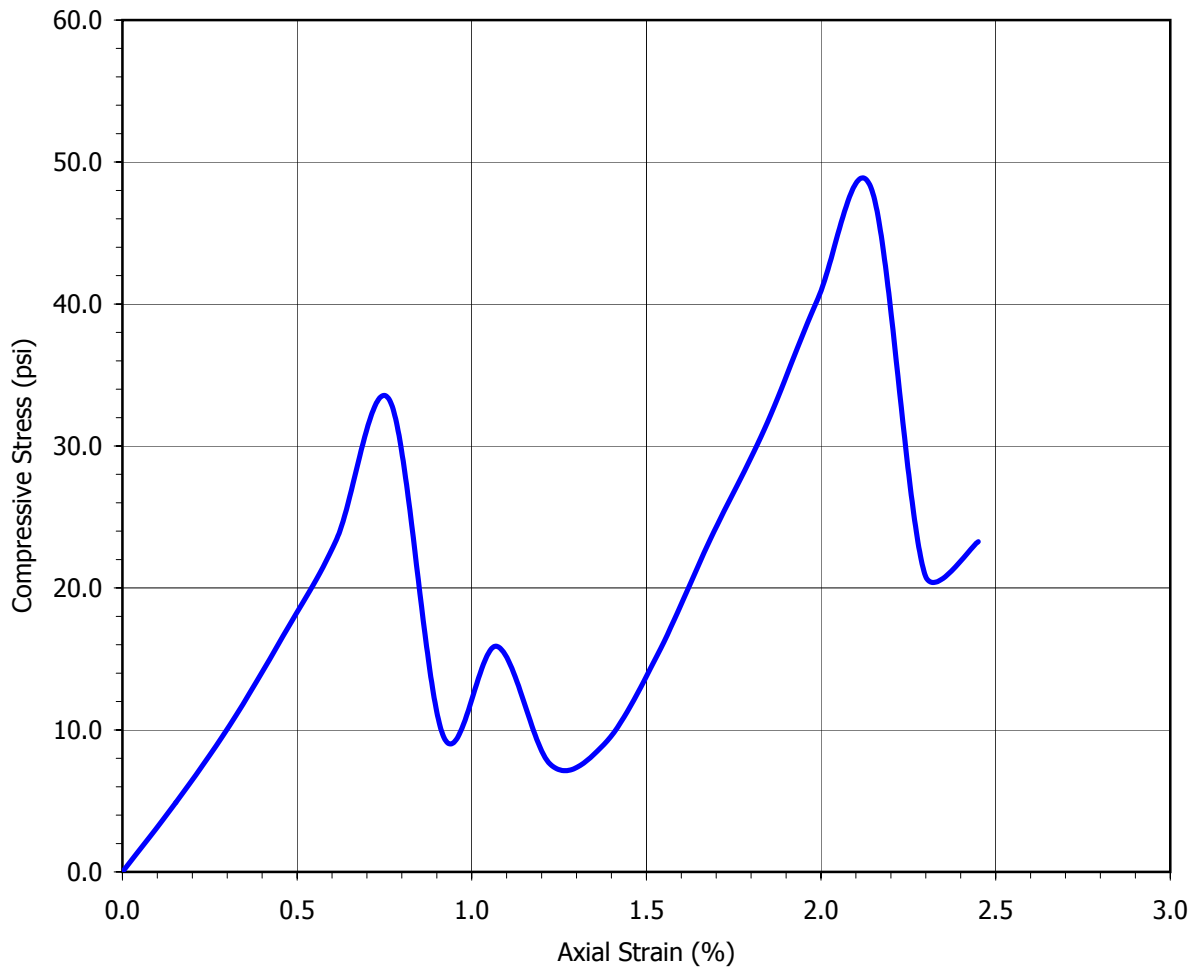
**Unconfined Compressive Strength  
of Cohesive Soil  
ASTM D 2166**

Project No.:

378312.04.09.01

**SR-710 Tunnel Technical Study**





Boring No.: R-09-Z3-B12  
 Sample No.: C44  
 Depth (ft): 201.5-202.8  
 Soil Type: Core  
 Sample Description: Olive gray silty sand'stone' (SM)

Sample Diameter (in.)	3.212
Sample Height (in.)	6.530
Initial Moisture Content (%)	16.30
Dry Density (pcf)	92.0
Specific Gravity (assumed)	2.7
Saturation (%)	53.0
Rate of Deformation (in/min)	0.0120
Height / Diameter Ratio	2.03

At Failure

<b>Compressive Strength (psi)</b>	<b>48.14</b>
Axial Strain (%)	2.14



**Note: peaks in stress-strain graph correspond to the compressive strength of individual diagonal layers**



Leighton

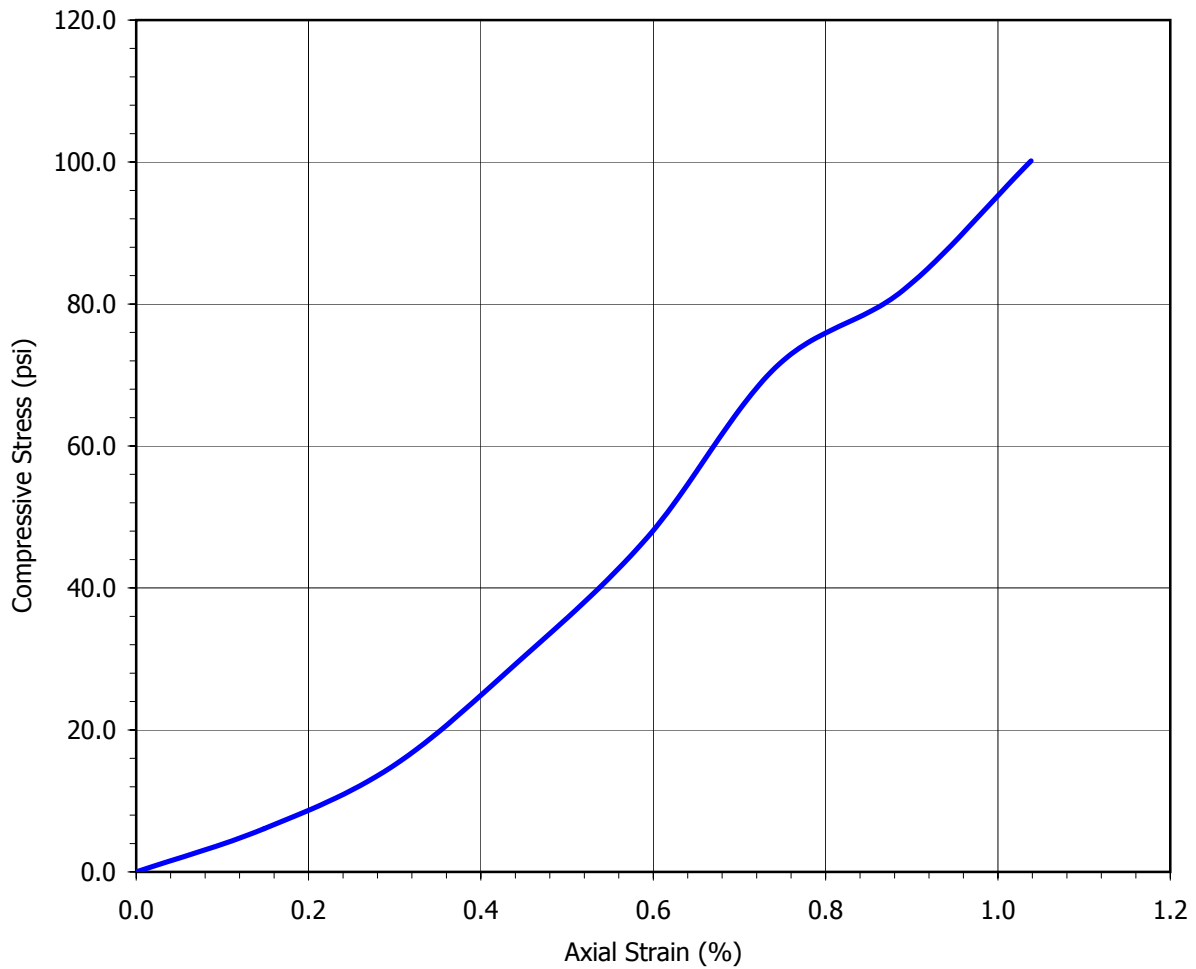
**Unconfined Compressive Strength  
 of Cohesive Soil  
 ASTM D 2166**

Project No.:

378312.04.09.01

**SR-710 Tunnel Technical Study**





Boring No.:	R-09-Z3-B12
Sample No.:	C40
Depth (ft):	185.8-190.8
Soil Type:	Core
Sample Description:	Dark olive shale

Sample Diameter (in.)	3.157
Sample Height (in.)	6.741
Initial Moisture Content (%)	20.43
Dry Density (pcf)	93.0
Specific Gravity (assumed)	2.7
Saturation (%)	67.9
Rate of Deformation (in/min)	0.0200
Height / Diameter Ratio	2.14

At Failure

<b>Compressive Strength (psi)</b>	<b>100.17</b>
Axial Strain (%)	1.04



**Unconfined Compressive Strength  
of Cohesive Soil  
ASTM D 2166**

Project No.: 378312.04.09.01

**SR-710 Tunnel Technical Study**

# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 22, 2009

Client: CH2MHill

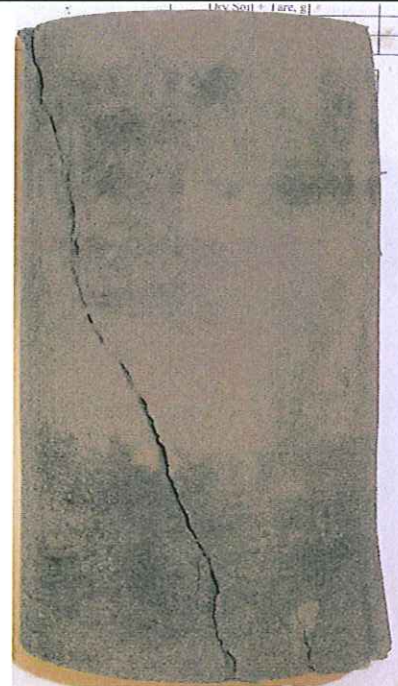
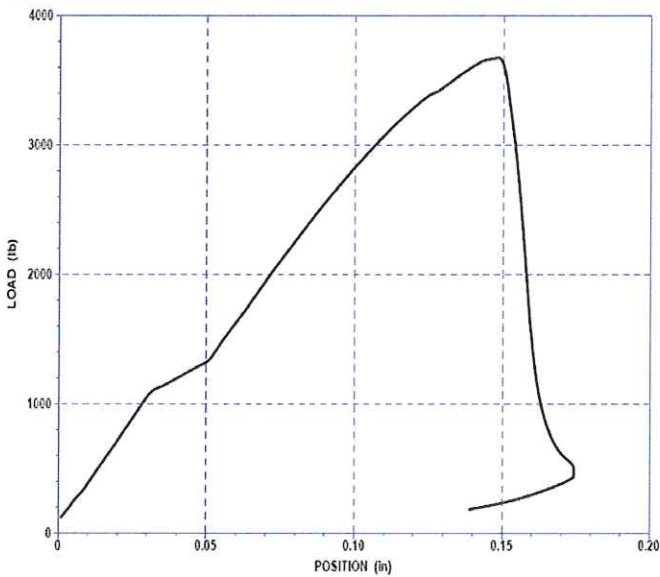
Material Type: Siltstone  
 Date Cast: n/a  
 Date Tested: 4/22/09  
 Age, Days: n/a

Depth: 156.3-157.1

Test Method: ASTM D4832, D1633, D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z4-B4, C28		3.22	6.5	123.1	104.9	17.4	451



Elastic Modulus (psi)*:	19,445
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\* using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 22, 2009

Client: CH2MHill

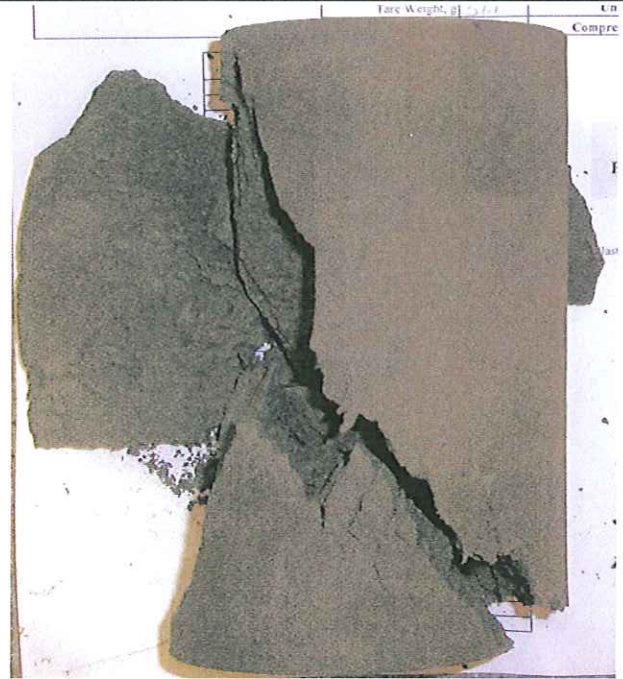
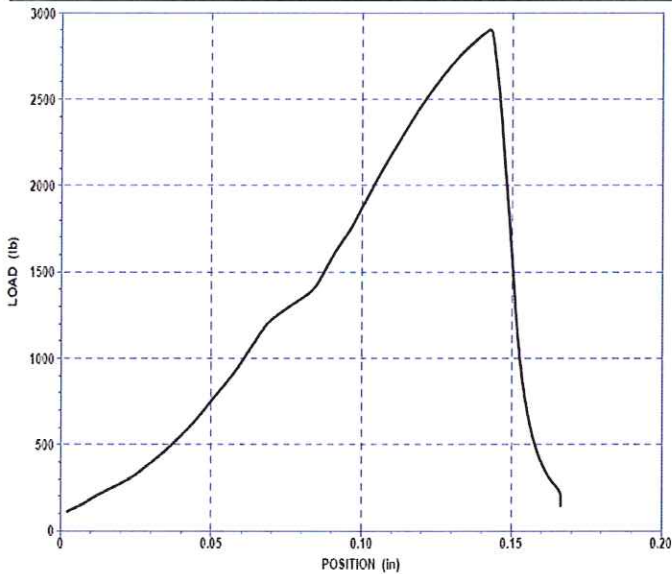
Material Type: Siltstone  
 Date Cast: n/a  
 Date Tested: 4/22/09  
 Age, Days: n/a

Depth: 198.5-199.5

Test Method: ASTM D4832, D1633, D7012  
 Moisture Condition At Testing: Ambient

## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z4-B4, C35		3.25	6.4	122.1	103.2	18.3	351



Elastic Modulus (psi)*:	15,617
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\* using secant elastic modulus formula



# UNCONFINED COMPRESSIVE STRENGTH



Project Name: SR-710 Tunnel Technical Study  
 Project No.: 09-144  
 Report Date: April 22, 2009

Client: CH2MHill

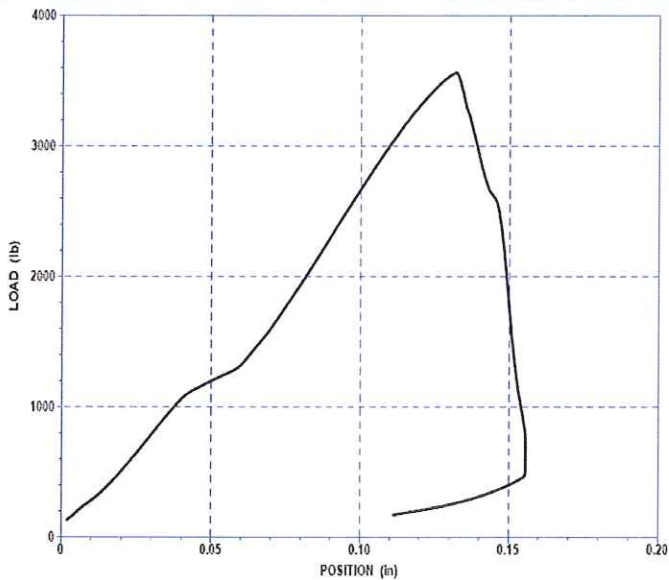
Material Type: Siltstone  
 Date Cast: n/a  
 Date Tested: 4/22/09  
 Age, Days: n/a

Depth: 235-235

Test Method: ASTM D4832, D1633, D7012  
 Moisture Condition At Testing: Ambient

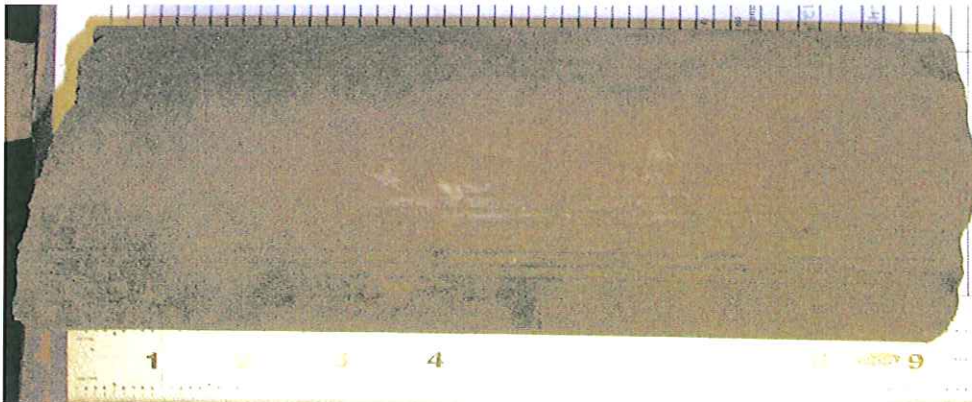
## Test Results

Sample ID.	Sample Location	Diameter, in.	Height, in.	Wet Unit Weight, pcf	Dry Unit Weight, pcf	Moisture Content, %	Unconfined Compressive Strength, psi
R-09-Z4-B4, C40		3.20	6.3	120.0	105.6	13.7	444



Elastic Modulus (psi)*:	21,073
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\* using secant elastic modulus formula





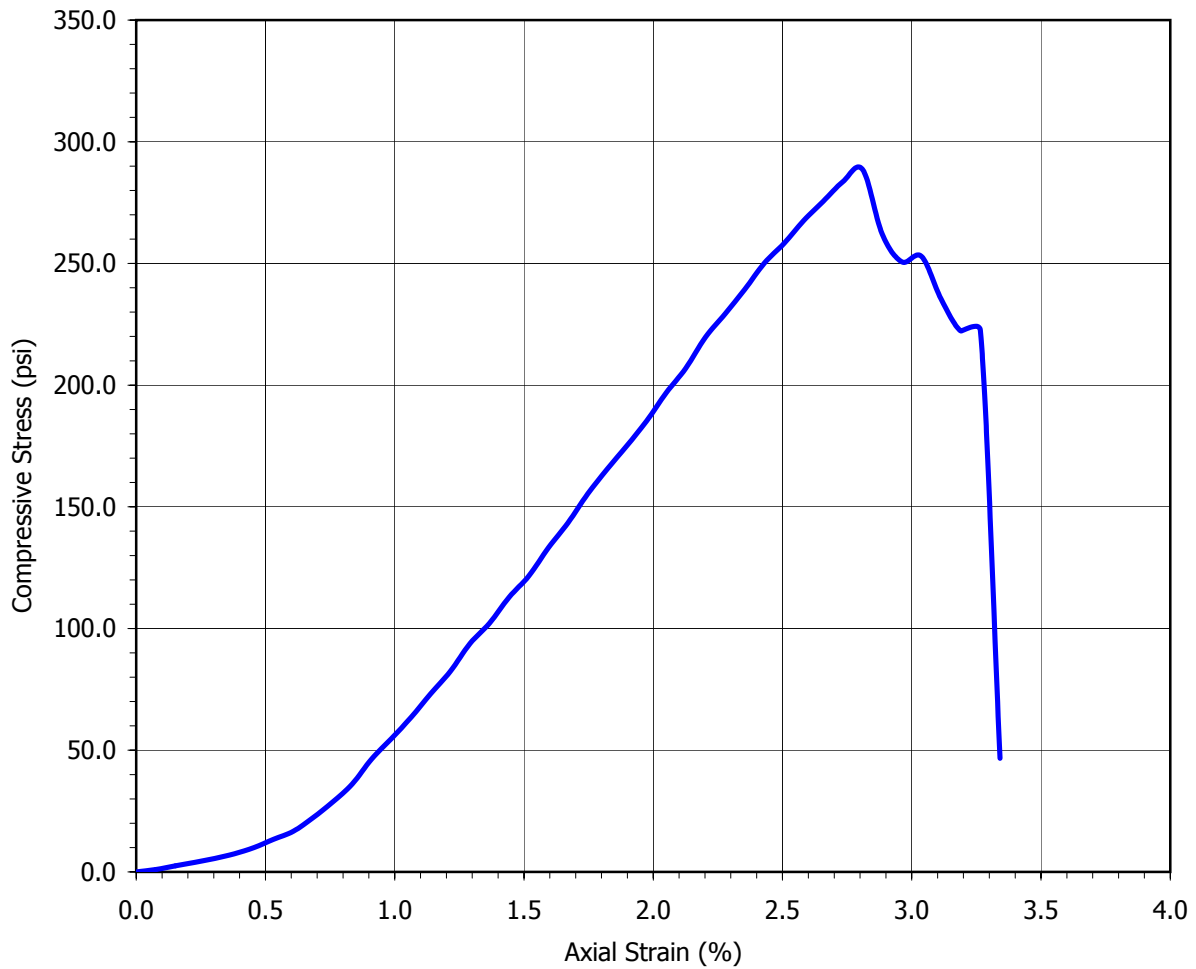


**UNCONFINED COMPRESSIVE STRENGTH**  
**of COHESIVE SOIL**  
**ASTM D 2166**

Project Name: SR-710 Tunnel Technical Study Tested by: A. Santos Date: 04/29/09  
 Project No.: 378312.04.09.01 Checked by: J. Ward Date: 04/30/09  
 Boring No.: R-09-Z4-B4 Sample Type: Core  
 Sample No.: C-24 Depth (ft): 126.5-127.3  
 Sample Description: Dark olive silt'stone' (ML)

Weight of Sample + Tube / Rings (g)	1754.60	Sample Measurements	
Weight of Tube / Rings (g)	0.00	Diameter (in)	3.265
Wet Weight of Soil + Container (g)	1692.40		3.250
Dry Weight of Soil + Container (g)	1429.30		3.252
Weight of Container (g)	110.70	Area (sq.in.)	8.325
Load Surcharge (lb)	2.20	Height (in)	6.583
Rate of Deformation (in/min)	0.012		6.580
Specific Gravity (Assumed)	2.70		6.592

Axial Deformation (in.)	Load (lb.)	Compressive Stress (psi)	Axial Strain (%)	Axial Deformation (in.)	Load (lb.)	Compressive Stress (psi)	Axial Strain (%)
0.0000	0.0	0.00	0.000	0.1300	1571.0	185.25	1.97
0.0050	6.0	0.98	0.076	0.1350	1671.0	196.87	2.05
0.0100	18.5	2.48	0.152	0.1400	1758.0	206.95	2.13
0.0150	30.5	3.92	0.228	0.1450	1868.0	219.71	2.20
0.0200	44.0	5.53	0.304	0.1500	1951.0	229.28	2.28
0.0250	60.0	7.44	0.380	0.1550	2038.0	239.31	2.35
0.0300	81.5	10.01	0.456	0.1600	2132.0	250.14	2.43
0.0350	110.0	13.41	0.532	0.1650	2203.0	258.26	2.51
0.0400	137.5	16.68	0.607	0.1700	2285.0	267.65	2.58
0.0450	184.0	22.21	0.683	0.1750	2354.0	275.51	2.66
0.0500	238.0	28.63	0.759	0.1800	2425.0	283.59	2.73
0.0550	301.0	36.12	0.835	0.1850	2470.0	288.63	2.81
0.0600	388.0	46.45	0.911	0.1900	2245.0	262.15	2.89
0.0650	458.0	54.74	0.987	0.1950	2148.0	250.64	2.96
0.0700	532.0	63.49	1.063	0.2000	2169.0	252.89	3.04
0.0750	614.0	73.18	1.139	0.2050	2021.0	235.47	3.11
0.0800	692.0	82.38	1.215	0.2100	1909.0	222.26	3.19
0.0850	789.0	93.82	1.291	0.2150	1913.0	222.55	3.27
0.0900	860.0	102.16	1.367	0.2200	400.0	46.70	3.34
0.0950	951.0	112.85	1.443				
0.1000	1026.0	121.64	1.519				
0.1050	1125.0	133.24	1.595				
0.1100	1212.0	143.42	1.671				
0.1150	1314.0	155.35	1.747				
0.1200	1402.0	165.60	1.822				
0.1250	1484.0	175.14	1.898				



Boring No.: R-09-Z4-B4  
 Sample No.: C-24  
 Depth (ft): 126.5-127.3  
 Soil Type: Core  
 Sample Description: Dark olive silt'stone' (ML)

Sample Diameter (in.)	3.256
Sample Height (in.)	6.585
Initial Moisture Content (%)	19.95
Dry Density (pcf)	101.7
Specific Gravity (assumed)	2.7
Saturation (%)	82.0
Rate of Deformation (in/min)	0.0120
Height / Diameter Ratio	2.02

At Failure

<b>Compressive Strength (psi)</b>	<b>288.63</b>
Axial Strain (%)	2.81



**Unconfined Compressive Strength  
 of Cohesive Soil**  
 ASTM D 2166

Project No.: 378312.04.09.01

SR-710 Tunnel Technical Study

**Earth Mechanics Institute**

**Client: CH2MHILL**

**Project Number: 378312.04.09.01**

**Project Name: SR-710 Tunnel Technical Study**



**Colorado School of Mines**

**Mining Engineering Department**

Date: 4/17/2009	Rock Type	Cerchar Abrasivity Index
Sample ID		
R-09-Z3-B1_C-57@264.1	Igneous	4.2
R-09-Z3-B4_C-52@249.5-250.1	Igneous	2.6
R-09-Z3-B6_C-29@195.7	Igneous	3.9

|

**Pictures of Samples Before and After  
Cerchar Abrasivity Index Test**

**Project Name:** SR-710 Tunnel Technical Study

**Project No.:** 378312.04.09.01

**Sample ID:** R-09-Z3-B4\_C-52@249.5-250.1



Before



After

**Pictures of Samples Before and After  
Cerchar Abrasivity Index Test**

**Project Name:** SR-710 Tunnel Technical Study

**Project No.:** 378312.04.09.01

**Sample ID:** R-09-Z3-B6\_C-29@195.7



Before



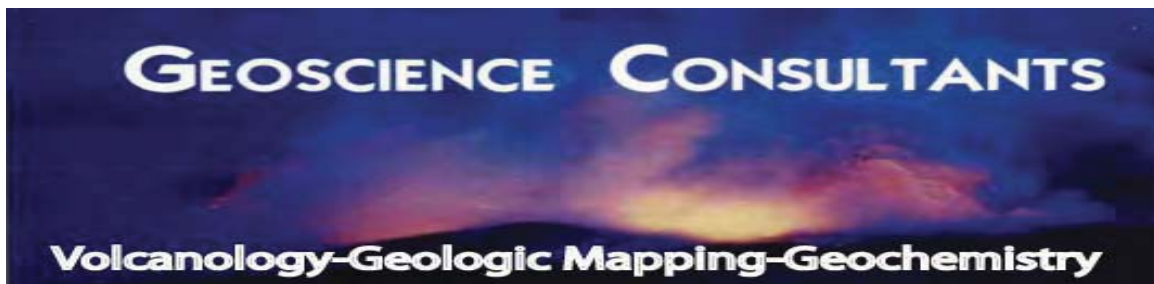
After

# Petrographic Thin Section Analysis

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*SR-710 Tunnel Technical Study  
Los Angeles County, California*

**Prepared by:**



Gene Smith  
Racheal Johnsen

August 3, 2009

## *Summary of preparation, analytical procedures, and major rock types found:*

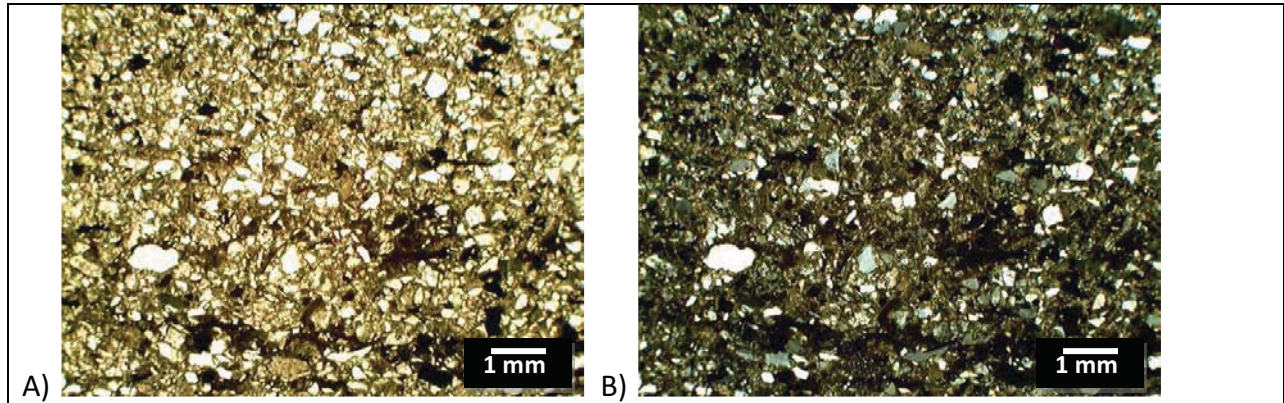
We examined twenty-six core samples from borings used to characterize subsurface geology for the SR 710 project. Core samples were broken to fist-size samples or, if too weak, sent as whole core to Quality Thin Sections in Tucson, Arizona for preparation of 30 micron thick petrographic sections. Once the sections were returned to the university, each of the sections was analyzed using a Nikon Labophot Pol transmitted light petrographic microscope with a 10 power ocular and either a 2 or 4 power objective.

The petrographic microscope is used to identify minerals and rock textures. The microscope uses both plane polarized and polarized light to determine the optical properties of minerals. In plane polarized light, mineral textures and color are best observed. A particularly interesting phenomena observed in plane polarized light is pleochroism. This term refers to the change in color of a mineral depending on its optical orientation. For example, the mineral biotite can change color from light brown to dark brown. Pleochroism is very helpful for identifying certain minerals. Polarized light viewing allows for the determination of optical properties including the mineral crystallography. Using cross-polars, interference colors can be observed. These colors are formed by the interference of light waves as they pass through two optical polars oriented at right angles to each other. Because interference colors are very distinctive they are an important tool for mineral identification. Samples are first viewed in plane polarized and then polarized light. Mineral size is determined by comparison with a stage micrometer. Mineral abundances are estimated by visual observation. Photomicrographs of each thin section were taken at either 20x or 40x magnification for inclusion in the report.

Rock types found in the thin sections include: immature arkosic sandstone, siltstone, mudstone, shale, quartz-bearing diorite, quartz monzonite, and brecciated quartz monzonite. One sample of mylonite may reflect a shear zone related to faulting.

R-09-Z1B4 287-287.2'

Siltstone/very fine-grained sandstone



**Figure 1.** Photomicrographs of R-09-Z1B4 283-287.2' in A) Plane-polarized light and B) Cross-polarized light. 20x magnification. Scale bar approximate.

Large pieces of opaque material cover about 15% of the slide. The matrix is composed predominantly of calcite with some 2-3 mm thick hematite layers. Slide contains shells and plagioclase, potassium feldspar, biotite, and quartz fragments. There is a small (1-2 mm diameter) quartzite clast.

Plagioclase/Potassium feldspar – difficult to distinguish the feldspars at this size; <0.5 mm, grains are broken (anhedral) and some exhibit albite twinning

Quartz – <0.5 mm, broken (anhedral), has biotite inclusions

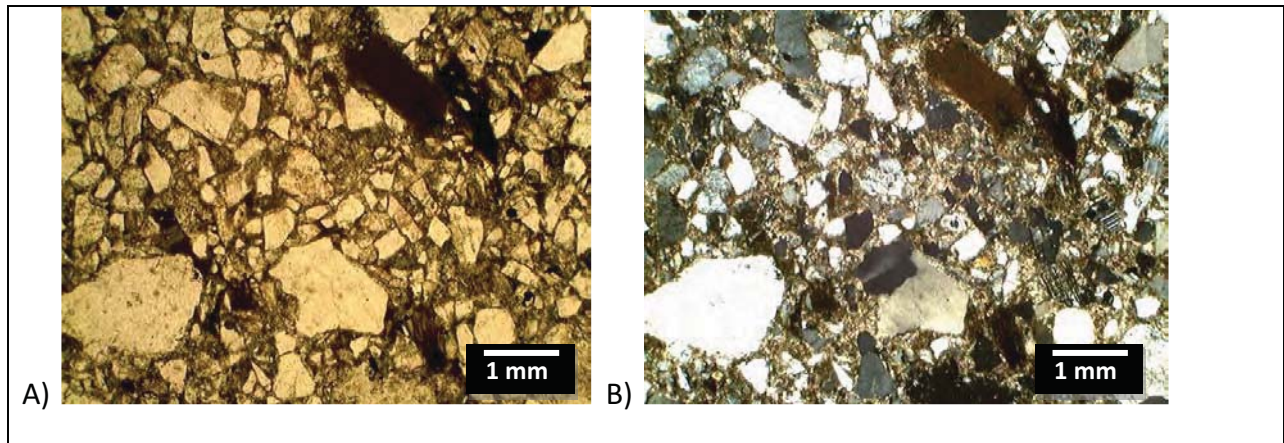
Biotite – anhedral to subhedral, shows evidence of strain, pleochroic medium to dark brown

Mineral	Percentage
Matrix	20
Plagioclase/Potassium feldspar	40
Quartz	15
Biotite	10
Opaques	15



R-09-Z1B5 455.2-455.8'

Coarse-grained granitic arkosic sandstone with crystal and rock fragments up to 3 mm in size



**Figure 2.** Photomicrograph of R-09-Z1B5 455.2-455.8'. A) Section in plane polarized light at 40x magnification. B) Section in cross-polarized light at 40x magnification. Scale bar approximate.

Quartz – highly fractured and anhedral (no crystal faces). Cut by veins of calcite. Shows undulatory extinction (evidence of strain).

Plagioclase – fractured anhedral grains with albite twinning. Grains up to 1 mm in size isolated in matrix.

Orthoclase – anhedral grains up to 2 mm in size with well developed perthitic texture.

Biotite – small (<0.5 mm) subhedral (one or two crystal faces remain) grains isolated in the matrix. Pleochroic light brown to dark brown. Chlorite occurs rarely as an alteration of biotite.

Muscovite – subhedral to euhedral grains up to 1 mm in length.

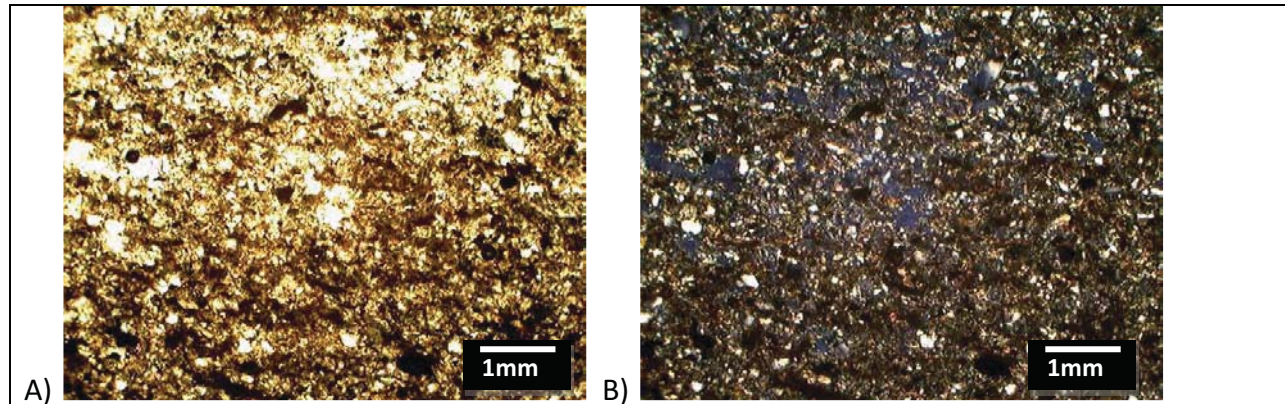
Iron oxide – very small (<1 mm) anhedral opaque grains (black in color). Probably magnetite or ilmenite.

Comments:

Crystals and rock fragments are surrounded by matrix mainly composed of calcite. Grains are almost completely broken from any rock fragments. The degree of disaggregation is more complete than most of the other arkosic samples.

Percentages of total rock:

Quartz	12
Plagioclase	14
Potassium feldspar	19
Biotite	2
Iron Oxide	1
Muscovite	<1
Chlorite	<1
Matrix	50



**Figure 3.** Photomicrograph of R-09-Z1B6 324.4-325.1'. A) Section in plane polarized light at 40x magnification. B) Section in cross-polarized light at 40x magnification. Scale bar approximate.

Finely bedded siltstone. Bedding at the millimeter scale and composed of iron oxide rich bands alternating with iron oxide poor bands. Matrix minerals are not identifiable but probably fine grained clay minerals and iron oxide.

Quartz – very small (<1 mm) grains. Grains vary from round to splinter shaped and are completely surrounded by fine grained matrix.

Plagioclase – a few small (<1 mm) anhedral grains showing albite twinning.

Chlorite – very small anhedral to subhedral grains, pleochroic light green to dark green.

Iron oxide – both reddish hematite and opaque (black) magnetite are present.

Matrix is composed of fine grained clays minerals, iron oxide and minor calcite. Larger grains are surrounded in matrix. Banding prominent in hand specimen is poorly seen in thin section. It is composed mainly of iron oxide rich and iron oxide poor bands. Quartz appears to be equally distributed throughout the slide and its abundance is not controlled by bedding.

Comments:

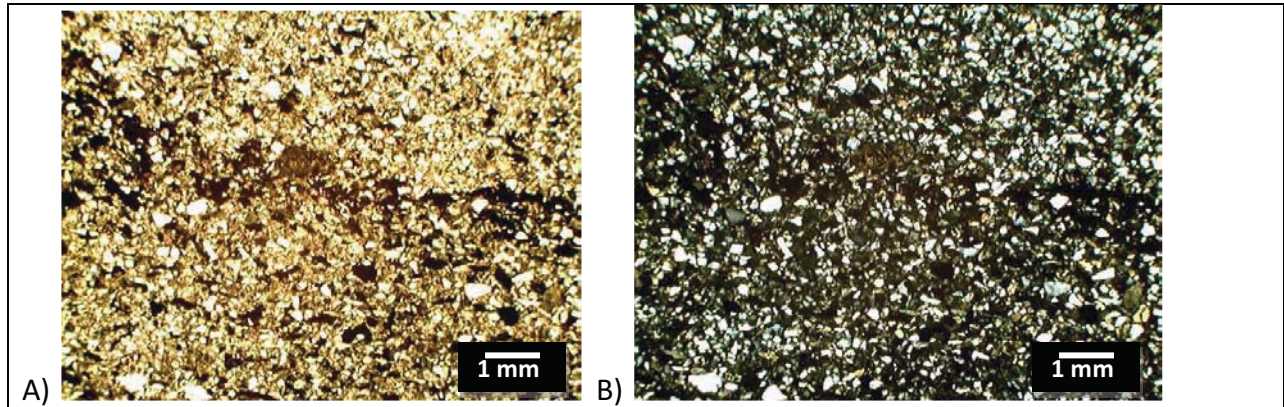
A fine-grained siltstone close to shale in texture.

Percentages of total rock:

Quartz	20
Plagioclase	2
Chlorite	<1
Iron oxide	1
Matrix	76

R-09-Z1B7 249.2-249.8'

Immature plagioclase-rich sandstone: Arkosic sandstone



**Figure 4.** Photomicrographs of R-09-Z1B7 249.2-249.8' in A) Plane-polarized light and B) Cross-polarized light. 20x magnification. Scale bar approximate.

Finely bedded, includes small laminated layers of hematite cement with opaque iron oxide and rare fossils (2%); Matrix within laminated layers nearly 95%, but in rest of section matrix comprises <5% of slide; minor amount of calcite; includes fragments of minerals—mostly plagioclase.

Biotite – 0.5-1 mm, anhedral to subhedral, shows evidence of strain, altering to chlorite, pleochroic medium to dark brown

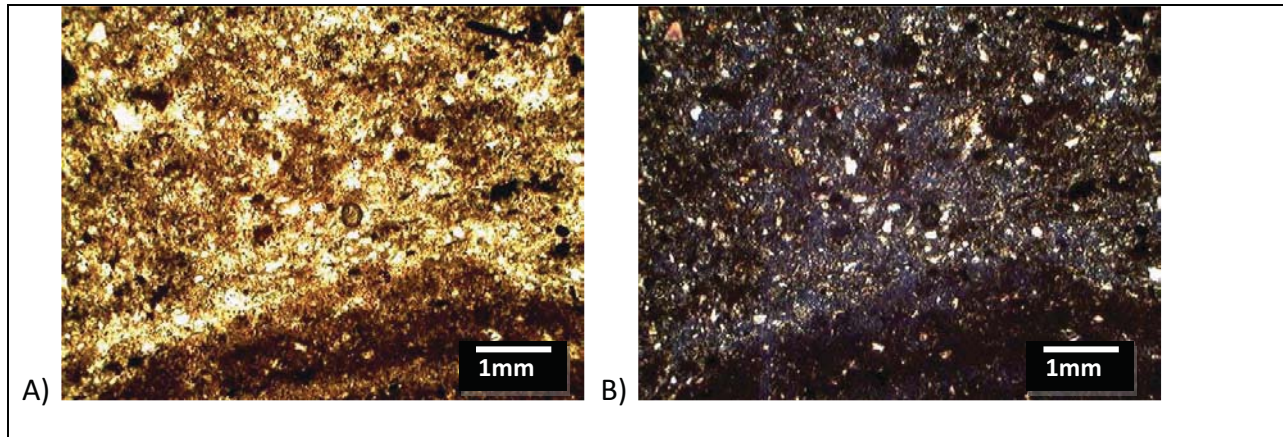
Chlorite – alteration product of biotite

Quartz – <0.5 mm, anhedral to subhedral, fractured

Plagioclase – angular (anhedral), mostly <0.5 mm, some grains 1-1.5 mm, exhibits carlsbad and albite twinning, some grains zoned

Muscovite – subhedral, high birefringence

Mineral	Percentage
Biotite	30
Chlorite	1
Quartz	20
Plagioclase	41
Muscovite	<1
Calcite	2



**Figure 5.** Photomicrograph of R-09-Z1B8 147.5-147.9'. A) Section in plane polarized light at 40x magnification. B) Section in cross-polarized light at 40x magnification. Scale bar approximate.

Siltstone with red-brown iron oxide rich matrix. Finely bedded/laminated.

Quartz – abundant small (<1 mm) angular grains embedded in fine grained iron oxide rich matrix.

Plagioclase – rare small (<1mm) angular grains showing albite twinning.

Chlorite – small (<1 mm) grains, angular, green color but pleochroic light green to darker green.

Iron oxide – present as both iron oxide in matrix and irregular grains of opaque iron oxide (probably magnetite) up to 1 mm in size.

Comments:

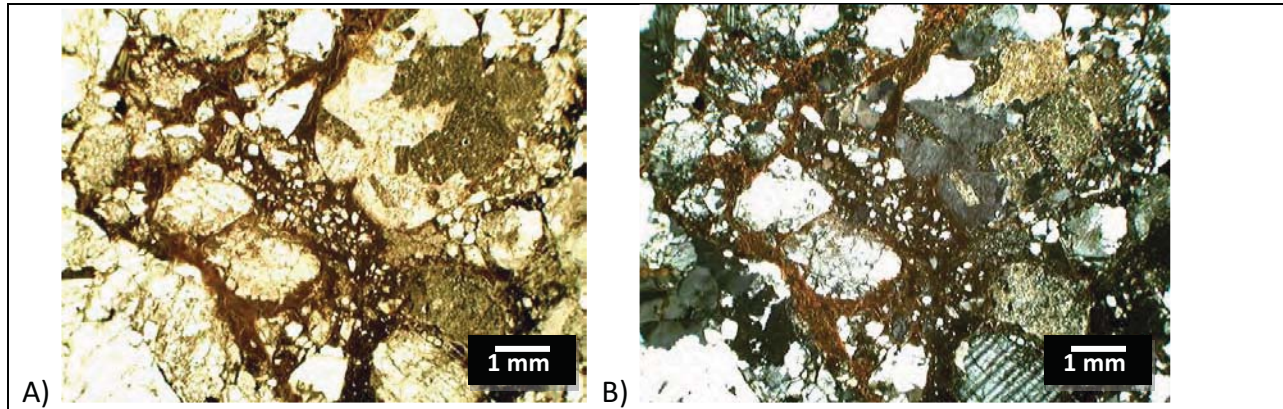
Matrix contains irregular streaks of darker iron oxide possibly mixed with organic material. Grains are matrix supported.

Percentages of total rock:

Quartz	20
Plagioclase	<1
Chlorite	<1
Matrix with iron oxide	78

R-09-Z2B2 230-230.2'

Brecciated plutonic rock – Quartz monzonite or diorite source



**Figure 6.** Photomicrographs of R-09-Z2B2 230-230.2' in A) Plane-polarized light and B) Cross-polarized light. 20x magnification. Scale bar approximate.

Hematite matrix with large clasts of quartz monzonite and broken single grains.

Potassium feldspar – 3-4 mm, anhedral, altering to sericite, sometimes twinned

Plagioclase – 1.5 mm, fragmented, anhedral, some grains zoned, many exhibiting albite twins

Quartz – fractured, anhedral, showing undulatory extinction

Biotite – <1.5 mm, altering to chlorite, shows evidence of strain, subhedral, pleochroic light to medium brown

Titanite (Sphene) – <0.5 mm, subhedral, high relief

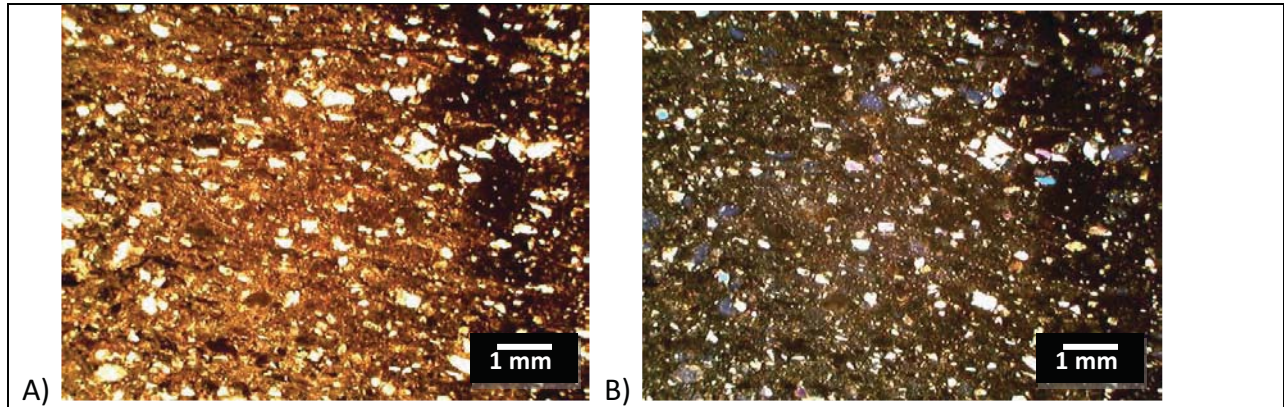
Chlorite – alteration product of biotite

Hornblende – found in some of the fragments

<b>Mineral</b>	<b>Percentage</b>
Matrix	40
Potassium feldspar	25
Plagioclase	20
Quartz	7
Biotite	5
Titanite	1
Chlorite	1
Hornblende	1

R-09-Z2B3 116-116.4'

Finely laminated siltstone/sandstone



**Figure 7.** Photomicrographs of R-09-Z2B3 116-116.4' in A) Plane-polarized light and B) Cross-polarized light. 20x magnification. Scale bar approximate.

Matrix has hematite and possibly clay minerals as primary cement. Rock includes plagioclase and quartz and a large vein of hematite crosses much of the slide.

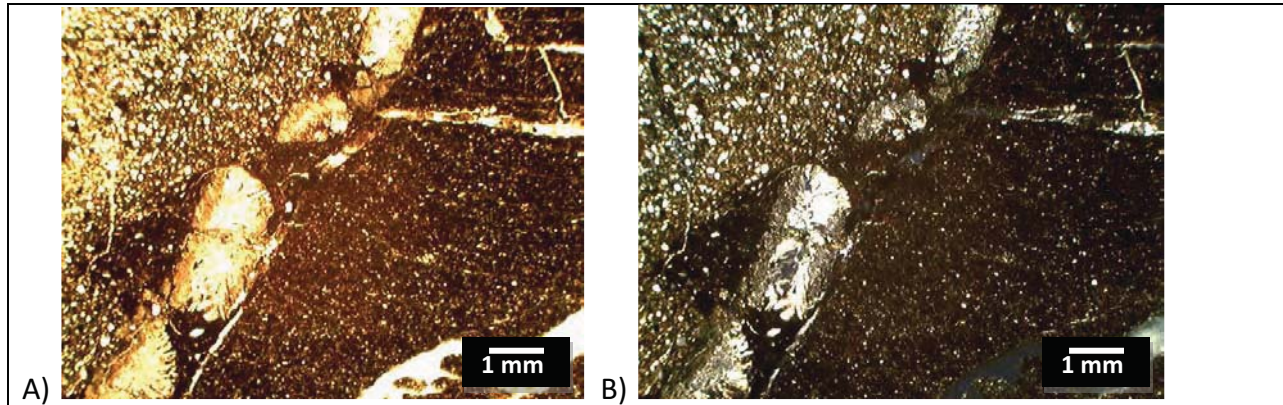
Plagioclase – <0.5 mm, broken (anhedral), albite twinning

Quartz – <0.5 mm, broken (anhedral)

Mineral	Percentage
Matrix	70
Plagioclase	18
Quartz	12

R-09-Z2B4 319-319.3'

Mudstone/Siltstone



**Figure 8.** Photomicrographs of R-09-Z2B4 319-319.3' in A) Plane-polarized light and B) Cross-polarized light. 20x magnification. Scale bar approximate.

Finely laminated with iron oxide (hematite) and clay cement/matrix. Contains very small fragments of quartz and plagioclase that are difficult to distinguish except where plagioclase is twinned. Black iron oxide (magnetite or ilmenite) constitutes less than one percent of the slide.

Sample contains a large lens of sandstone containing angular fragments of quartz (80%), plagioclase (20%), and a very small amount of hornblende (<1%).

Border between sandstone lens and mudstone has nodules containing radiating crystals. These have not been positively identified, but could be calcite or some form of silica.

Mineral assemblage of mudstone:

Mineral	Percentage
Matrix	>95
Quartz and plagioclase	<5

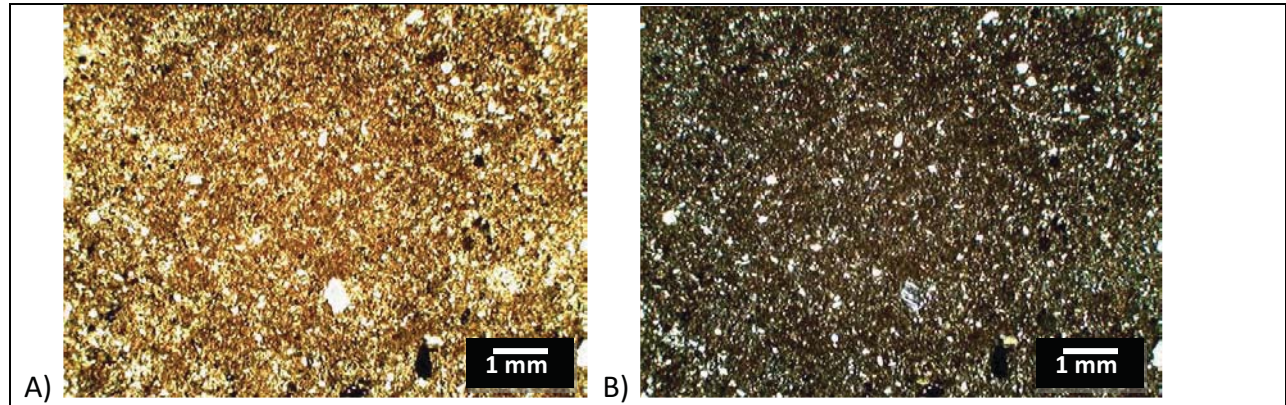
Mineral assemblage of sandstone lens:

Mineral	Percentage
Quartz	80
Plagioclase	20
Hornblende	<1



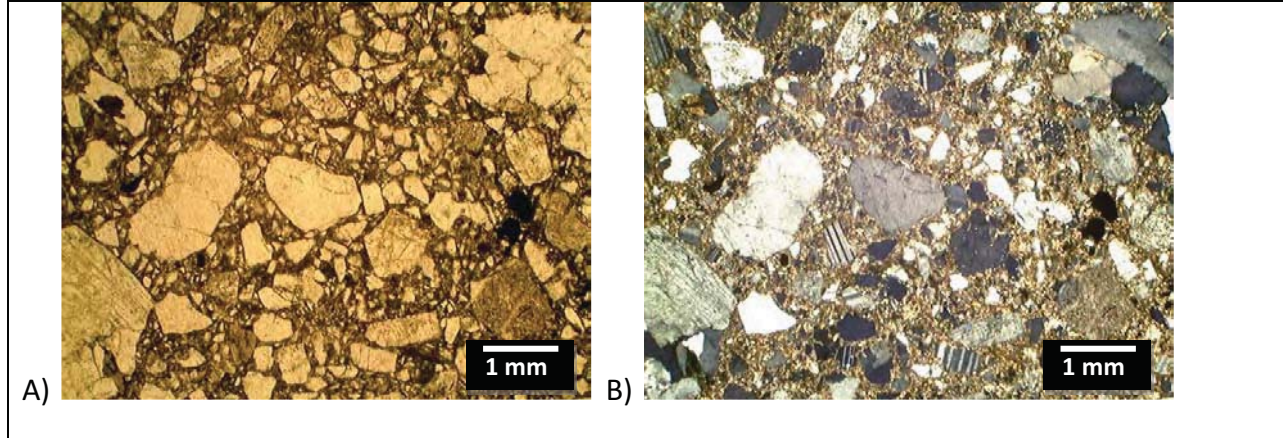
R-09-Z2B5 231.8-232'

Mudstone



**Figure 9.** Photomicrographs of R-09-Z2B5 231.8-232' in A) Plane-polarized light and B) Cross-polarized light. 20x magnification. Scale bar approximate.

Sample is mostly massive with very vague indication of bedding. Cement is hematite and comprises about 20% of the rock. Grains are mostly too small to identify, but they appear to be predominantly plagioclase and quartz. There are a few 0.5 mm diameter plagioclase grains. There are some grains of biotite which are altering to chlorite and a couple of potassium feldspar grains. There are gastropods and shell fragments. Opaque iron oxide covers about 2% of the slide.



**Figure 10.** Photomicrograph of R-09-Z3B1 174.0'. A) Section in plane polarized light at 40x magnification. B) Section in cross-polarized light at 40x magnification. Scale bar approximate.

Coarse-grained granitic arkosic sandstone with crystal and rock fragments up to 2 mm in size. Rock fragments of diorite and sandstone.

Quartz – highly fractured and anhedral. Cut by veins of calcite. Shows undulatory extinction.

Plagioclase – fractured anhedral grains with albite twinning. Grains up to 2 mm, intergrown with quartz or isolated in matrix.

Potassium feldspar (probably orthoclase) – altered anhedral grains up to 2 mm in size. Show irregular extinction and alteration to sericite (a fine grained mica).

Biotite – small (<0.5 mm) subhedral grains intergrown in rock fragments with quartz and feldspar. Pleochroic light brown to dark brown.

Titanite (sphene) – small (<1 mm) grains isolated in matrix. No more than two grains observed in thin section.

Iron oxide – very small (<1 mm) anhedral opaque grains (black in color). Probably magnetite or ilmenite.

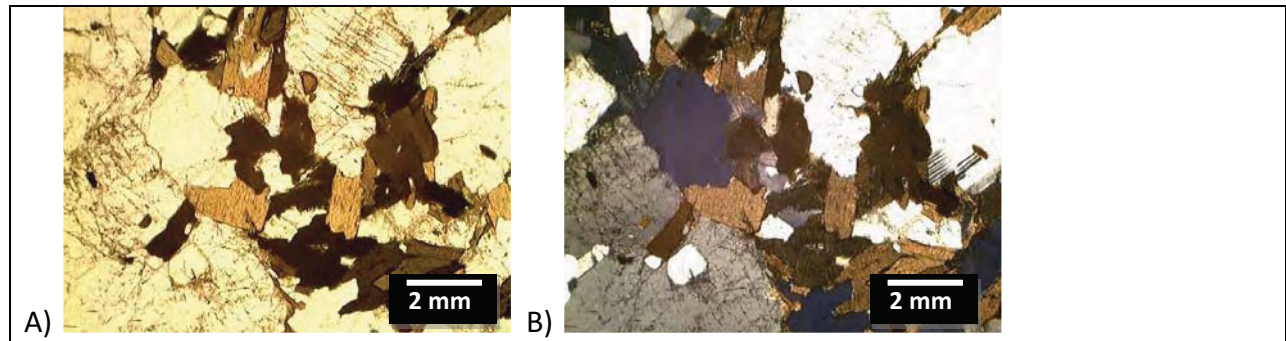
Comments:

Crystals and rock fragments form most of the rock. Matrix is composed of fine to medium grained calcite. The rock represents erosion of a quartz diorite source rock and based on grain size and mineralogy is close its source area.

Percentages of total rock:

Quartz	23
Plagioclase	35
Potassium feldspar	8
Biotite	2
Iron Oxide	1
Titanite	<1
Matrix mainly composed of calcite	30

R-09-Z3B1 178.6-179.2'



**Figure 11.** Photomicrograph of R-09-Z3B1 178.6-179.2'. A) Section in plane polarized light at 40x magnification. B) Section in cross-polarized light at 40x magnification. Scale bar approximate.

Quartz Diorite – Plutonic rock with allotriomorphic-granular texture (poorly formed grains with an interlocking relationship with each other).

Quartz – anhedral grains (up to 4 mm) with undulatory extinction.

Plagioclase – very large (up to 5 mm) anhedral to subhedral grains with albite twinning.

Biotite – anhedral grains (1 to 2 mm in size) showing pleochroism from light brown to dark brown. Biotite is locally altered to chlorite.

Hornblende – anhedral to subhedral grains (3 to 4 mm in size) pleochroic green brown to dark green. Hornblende is commonly associated with biotite crystals and in places it appears that biotite is replacing hornblende.

Chlorite – commonly an alteration of biotite—green, small (1 mm) and anhedral.

Titanite (sphene) – several large (up to 4 mm) subhedral grains. High relief and highly fractured.

Iron oxide – small anhedral opaque grains. Either magnetite or ilmenite.

Comments:

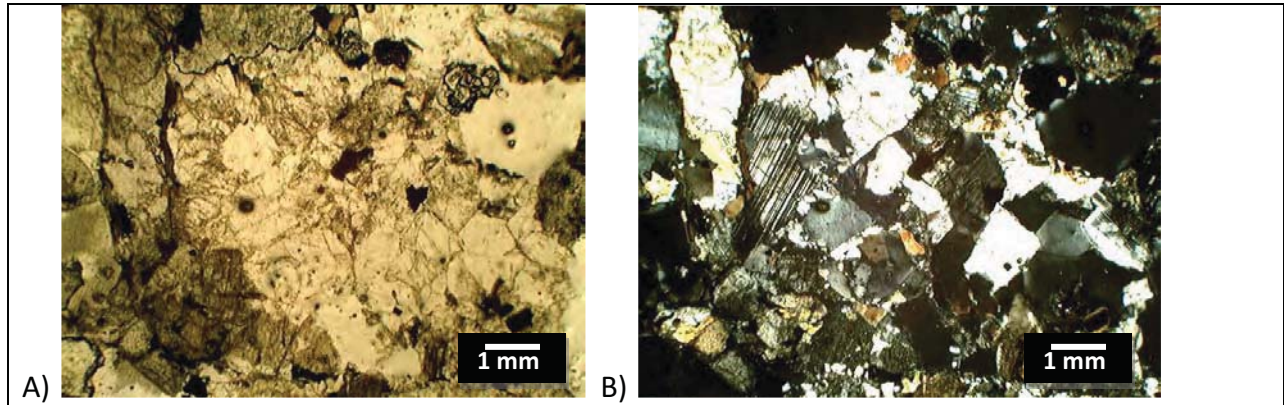
A relatively unaltered plutonic rock best classified as a quartz diorite. This rock is very similar to R-09-Z3-B6 195.5' except the feldspars are more abundant.

Percentages of total rock:

Quartz	14
Plagioclase	35
Biotite	30
Hornblende	20
Chlorite	<1
Titanite	<1
Iron Oxide	<1

R-09-Z3B1 238.8-239.2'

### Brecciated Quartz Monzonite



**Figure 12.** Photomicrographs of R-09-Z3B1 238.8-239.2' in A) Plane-polarized light and B) Cross-polarized light. 20x magnification. Scale bar approximate.

Rock highly fractured and altered. Biotite is the primary mafic mineral. Other minerals include plagioclase, potassium feldspar, and quartz.

Biotite – 1-3 mm, anhedral to subhedral, altering to chlorite

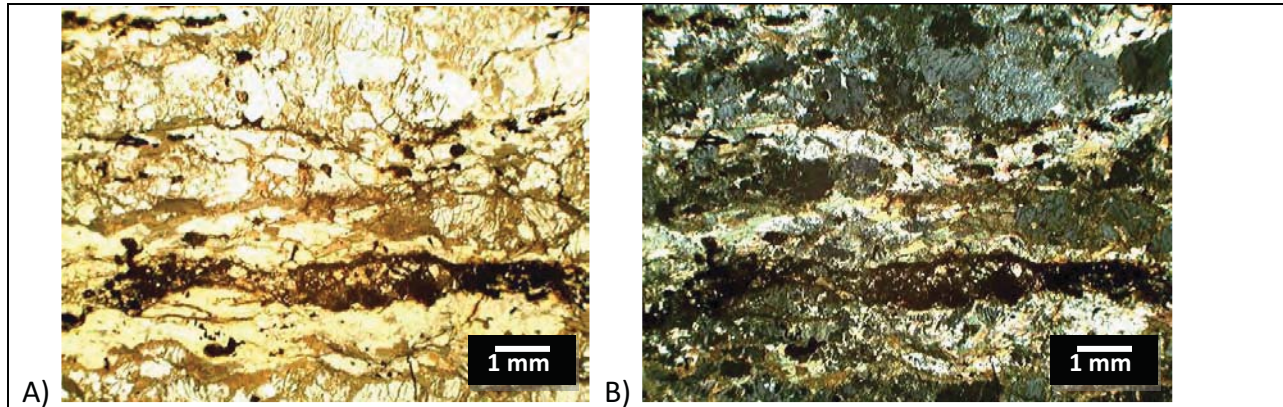
Plagioclase – 2-5 mm, anhedral to subhedral, altered, exhibits albite and carlsbad twinning, sometimes zoned

Potassium feldspar – 3-5 mm, anhedral, altering to sericite

Quartz – 1-5 mm, anhedral, exhibits undulatory extinction, contains inclusions of apatite

Mineral	Percentage
Biotite	10
Plagioclase	49
Potassium feldspar	25
Quartz	15
Chlorite	1
Opauques	<1

Mylonite – Sheared granitic or metamorphic rock



**Figure 13.** Photomicrographs of R-09-Z3B2 122-123' in A) Plane-polarized light and B) Cross-polarized light. 20x magnification. Scale bar approximate.

Intense shearing with secondary growth of biotite and muscovite. Orthoclase feldspar is broken but remains as augen (rounded grains) or lenses in the mylonite. One part of the slide is relatively unaltered, but has intergrown muscovite and biotite.

Potassium feldspar (orthoclase) – lenses of augen; grains internally broken, some grains show replacement of orthoclase by muscovite and fine-grained biotite/chlorite; larger grains show weak exsolution; fractures in orthoclase are perpendicular to the shearing direction

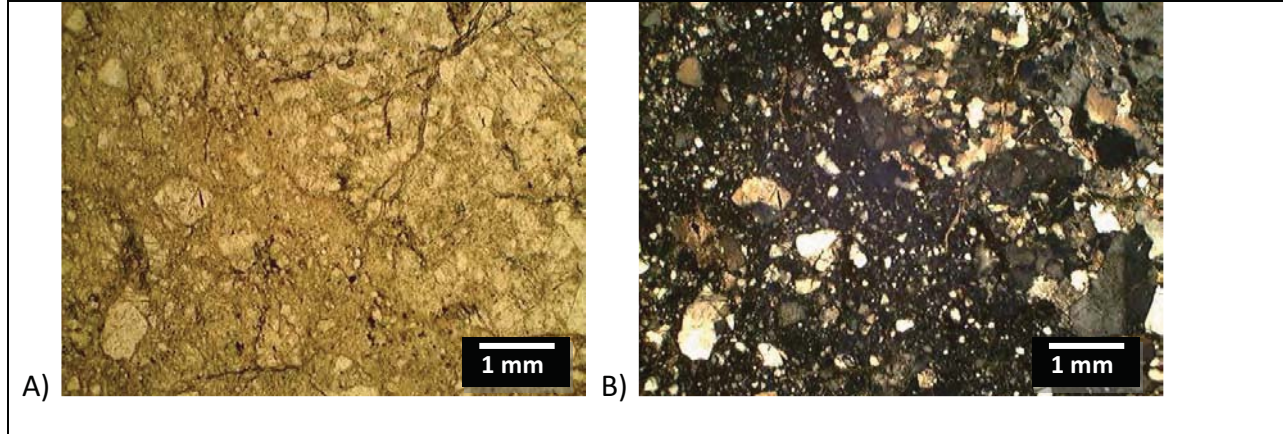
Biotite – subhedral grains in matrix, pleochroic light to medium brown, sometimes altered to chlorite

Muscovite – large subhedral grains, growing at about 30 degrees to or in the direction of shear

Chlorite – alteration product of biotite, light to medium green pleochroism

Iron oxide –as opaque magnetite/ilmenite and as reddish hematite in fractures

Mineral	Percentage
Potassium feldspar (orthoclase)	40
Biotite	30
Muscovite	26
Chlorite	2
Iron oxide	2



**Figure 14.** Photomicrograph of R-09-Z3B2 228.1-228.3'. A) Section in plane polarized light at 40x magnification. B) Section in cross-polarized light at 40x magnification. Scale bar approximate.

Coarse grained granitic arkosic sandstone with crystal and brecciated rock fragments up to 6 mm in size

Quartz – highly fractured and anhedral grains with undulatory extinction. Grains are broken and commonly crossed by veins of calcite and grains of chlorite

Potassium feldspar (probably orthoclase) – highly altered broken and fractured anhedral grains up to 2 mm in size. Show irregular extinction, perthitic texture, and alteration to fine grained mica (sericite).

Muscovite – rare small (<0.5 mm) subhedral grains.

Chlorite – subhedral, green to light green in color, probably formed by the alteration of biotite.

Iron oxide – very small (<1 mm) anhedral opaque grains (black in color). Probably magnetite or ilmenite.

Calcite – common in veins and matrix.

Comments:

Crystals and rock fragments form most of the rock. Matrix is composed of fine to medium grained calcite. Rock fragments and grains are intensely fractured. Because calcite cement fills fractures, the brecciation occurred after deposition but before being infiltrated with calcite.

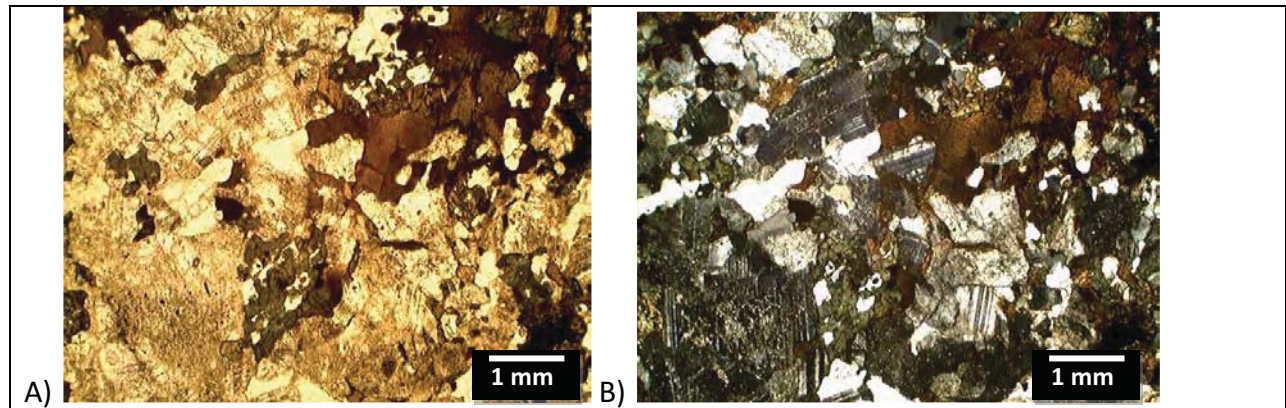


Percentages of total rock:

-

Quartz	32
Potassium feldspar	20
Muscovite	<1
Iron Oxide	1
Chlorite	2
Matrix	45

R-09-Z3B4 235-235.4'



**Figure 15.** Photomicrograph of R-09-Z3B4 235-235.4'. A) Section in plane polarized light at 40x magnification. B) Section in cross-polarized light at 40x magnification. Scale bar approximate.

Quartz Diorite – Plutonic rock with allotriomorphic-granular texture.

Quartz – anhedral grains (up to 2 mm) with undulatory extinction and showing embayed margins.

Plagioclase – large (up to 5 mm) interlocking anhedral to subhedral grains with albite twinning.

Biotite – anhedral grains (1 to 2 mm in size) showing pleochroism from light brown to dark brown. Biotite is locally altered to chlorite.

Hornblende – anhedral to subhedral grains (2 mm in size) pleochroic green brown to dark green.

Chlorite – commonly an alteration of biotite—green, up to 2 mm in size and anhedral.

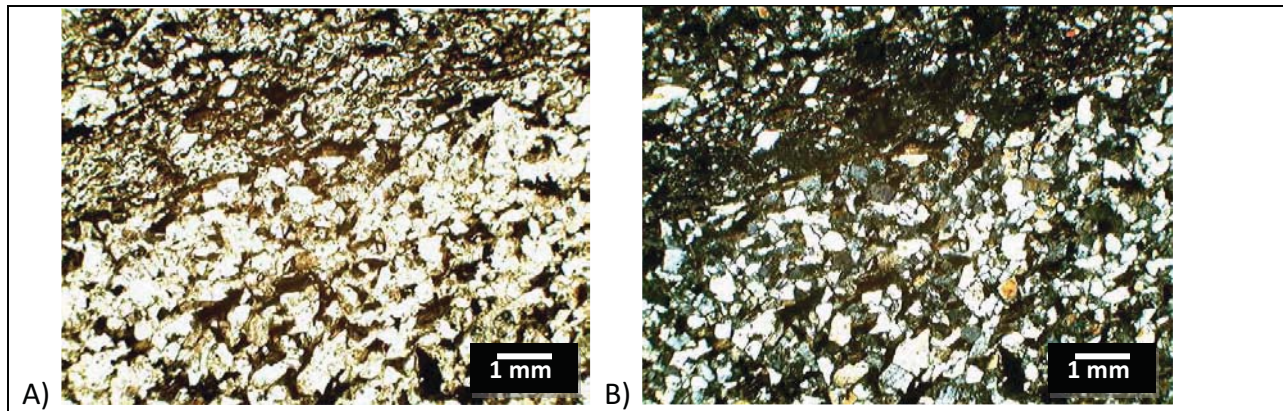
Iron oxide – small anhedral opaque grains. Either magnetite or ilmenite.

Comments:

An altered quartz diorite with feldspars commonly altered to fine-grained mica (sericite) and veins of calcite. Differs from the other Quartz Diorite samples in that the quartz is smaller and feldspar is more abundant.

Percentages of total rock:

Quartz	8
Plagioclase	42
Biotite	18
Hornblende	29
Chlorite	2
Iron Oxide	<1
Calcite	1



**Figure 16.** Photomicrograph of R-09-Z3B5 324-324.4'. A) Section in plane polarized light at 20x magnification. B) Section in cross-polarized light at 20x magnification. Scale bar approximate.

Arkosic sandstone interbedded with siltstone

Grain supported arkosic sandstone containing angular grains of quartz, plagioclase, and biotite. Biotite is commonly aligned parallel to bedding.

Quartz – broken grains <1 mm in size. Grains show undulatory extinction.

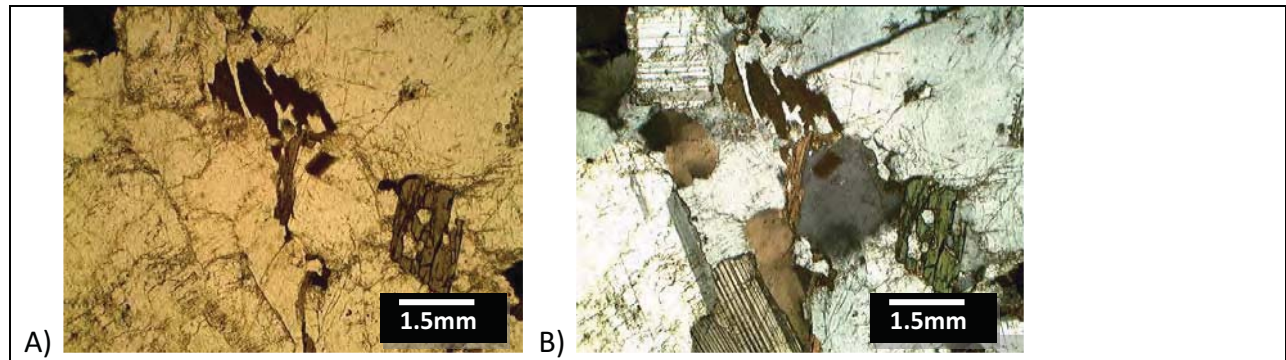
Plagioclase – angular grains exhibiting albite twinning. Plagioclase grains are usually smaller than quartz.

Biotite – shredded grains commonly aligned parallel to bedding. Pleochroic light brown to nearly black; biotite altering to chlorite.

Iron oxide (opaques) – angular opaque grains up to 1 mm in size.

Mineral	Percentage
Quartz	70
Plagioclase	25
Biotite	4
Iron oxide	1

R-09-Z3B6 195.5'



**Figure 17.** Photomicrograph of R-09-Z3B6 195.5'. A) Section in plane polarized light at 40x magnification. B) Section in cross-polarized light at 40x magnification. Scale bar approximate.

Quartz Diorite – Plutonic rock with allotriomorphic-granular texture (poorly formed grains with an interlocking relationship with each other).

Quartz – anhedral large grains (up to 3 mm). Polycrystalline (composed of intergrown crystals) with undulatory extinction.

Plagioclase – very large (up to 5 mm) anhedral grains with albite twinning.

Biotite – anhedral grains (1 to 2 mm in size) showing pleochroism from light brown to dark brown.

Hornblende – anhedral to subhedral grains (3- 4 mm in size) pleochroic green brown to dark green. Hornblende is commonly broken and surrounded by swarms of biotite crystals (perhaps representing a reaction rim).

Chlorite – commonly an alteration of hornblende—green, small (1 mm) and anhedral.

Titanite (sphene) – several large (up to 4 mm) anhedral grains. High relief (stands out in slide) and highly fractured.

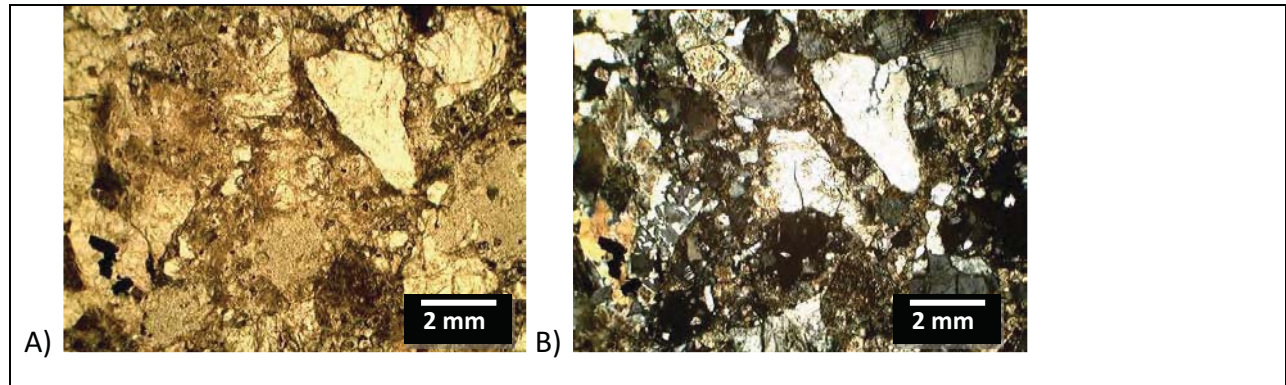
Iron oxide – small anhedral opaque grains. Either magnetite or ilmenite.

Comments:

A relatively unaltered plutonic rock best classified as a quartz diorite.

Percentages of total rock:

Quartz	20
Plagioclase	30
Biotite	25
Hornblende	24
Chlorite	<1
Titanite	<1
Iron Oxide	<1



**Figure 18.** Photomicrograph of R-09-Z3B6 257.8-258.2'. A) Section in plane polarized light at 40x magnification. B) Section in cross-polarized light at 40x magnification. Scale bar approximate.

Highly fractured and brecciated Quartz Diorite with grains cemented by calcite.

Quartz – anhedral grains (up to 4 mm) with undulatory extinction and polycrystalline texture. Quartz is commonly intergrown with plagioclase.

Plagioclase – very large (up to 5 mm) anhedral to subhedral grains with albite twinning.

Orthoclase – large grains (up to 4 mm) showing perthitic texture and Carlsbad twins.

Biotite – anhedral grains (1 to 2 mm in size) showing pleochroism from light brown to dark brown. Biotite is locally altered to chlorite.

Hornblende – anhedral to subhedral grains (3- 4 mm in size) pleochroic green brown to dark green.

Chlorite – commonly an alteration of biotite—green, small (1 mm) and anhedral.

Titanite (sphene) – several large (up to 4 mm) subhedral to euhedral (well formed) grains. High relief and highly fractured.

Iron oxide – small anhedral opaque grains. Either magnetite or ilmenite.

Xenoliths (or clasts) of fine grained volcanic rock containing plagioclase and hornblende phenocrysts? It is unclear whether these are foreign inclusions (xenoliths) or clasts.

Calcite – abundant as cement about grains and rock fragments. Fine grained (<1 mm) crystals.

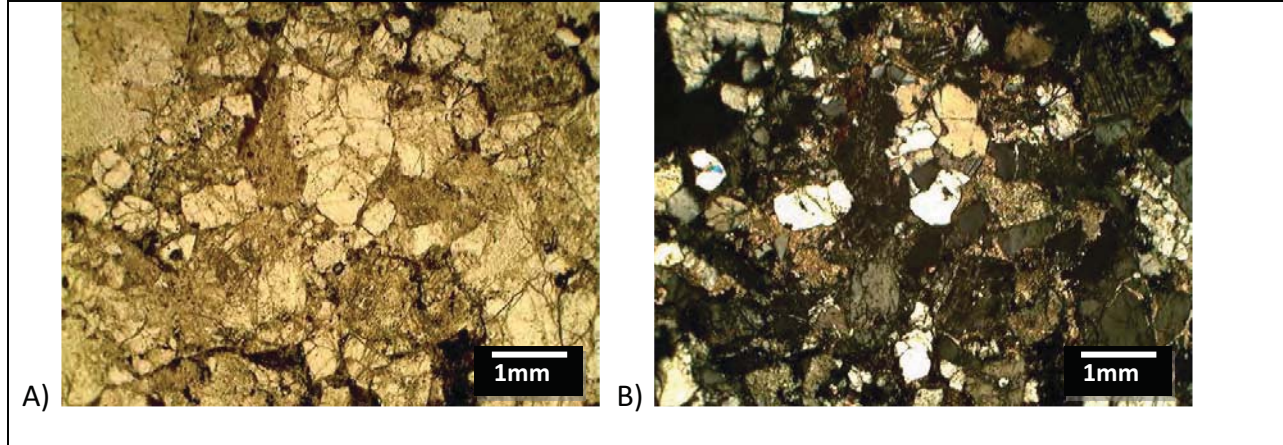
Comments:

This rock is either a brecciated Quartz Diorite or a coarse grained arkosic conglomerate. In the first case the rock would have been fractured and broken without transport. In the second case fragments were transported a short distance from the source and deposited.

Percentages of total rock:

Quartz	13
Plagioclase	45
Orthoclase	20
Biotite	10
Hornblende	3
Chlorite	<1
Titanite	<1
Iron Oxide	<1
Xenoliths	<1
Calcite	5





**Figure 19.** Photomicrographs of R-09-Z3B7 263.2'. A) Section in plane polarized light at 40x magnification. B) Section in cross-polarized light at 40x magnification. Scale bar approximate.

Coarse-grained granitic arkosic sandstone with crystal and rock fragments up to 2 mm in size

Quartz – highly fractured and anhedral (no crystal faces). Cut by veins of calcite. Shows undulatory extinction (evidence of strain).

Plagioclase – fractured anhedral grains with albite twinning. Grains up to 0.7 mm intergrown with quartz or isolated in matrix.

Potassium feldspar (probably orthoclase) – highly altered anhedral grains up to 1 mm in size. Show irregular extinction and alteration to sericite (a fine grained mica).

Biotite – small (<0.5 mm) subhedral (one or two crystal faces remain) grains intergrown in rock fragments with quartz and feldspar. Pleochroic light brown to dark brown.

Iron oxide – very small (<1 mm) anhedral opaque grains (black in color). Probably magnetite or ilmenite.

Comments:

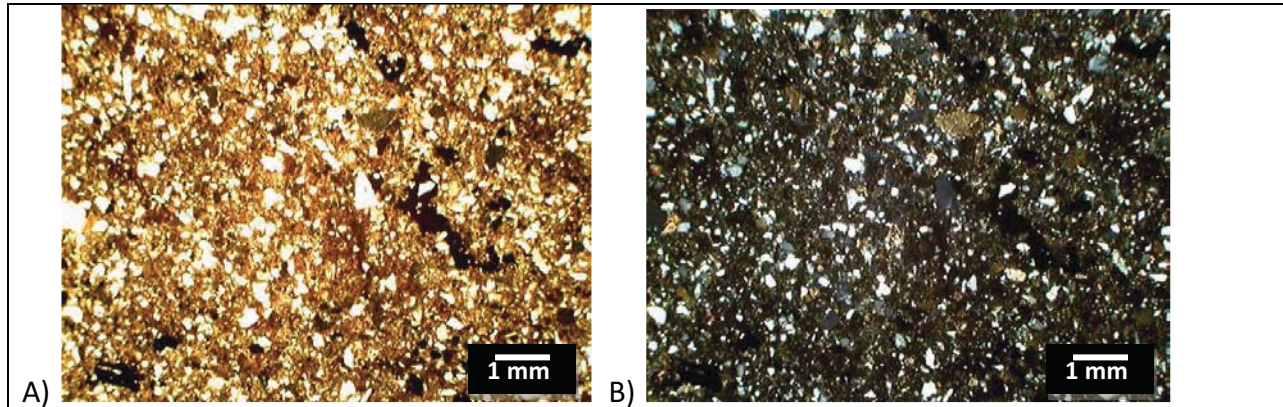
Crystals and rock fragments form most of the rock. Matrix is composed of fine to medium grained calcite. The rock represents erosion of a quartz monzonite source rock and based on grain size and mineralogy is close its source area.

Percentages of total rock:

Quartz	48
Plagioclase	40
Potassium feldspar	5
Biotite	2
Iron Oxide	1
Matrix	3

R-09-Z3B8 215.7-216'

Very fine-grained arkosic sandstone/Greywacke



**Figure 20.** Photomicrographs of R-09-Z3B8 215.7-216' in A) Plane-polarized light and B) Cross-polarized light. 20x magnification. Scale bar approximate.

Matrix composed of hematite and contains calcite and rare shell fragments.

Quartz – <0.5 mm, fragmented (anhedral) and fractured

Plagioclase – <0.5 mm, fragmented (anhedral), some grains exhibit albite twinning

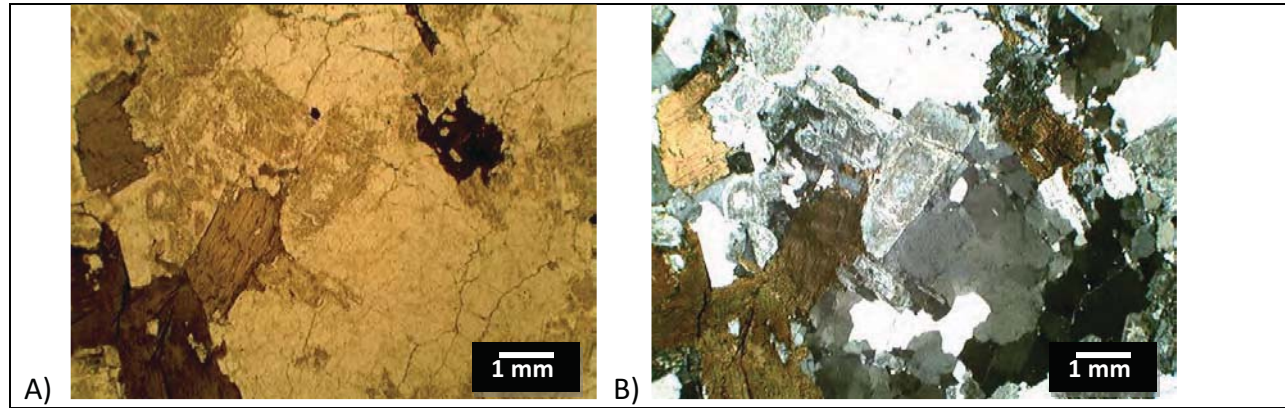
Hornblende and clinopyroxene – ~0.5 mm, anhedral to subhedral, difficult to distinguish

Calcite – found as alteration of pyroxene and in vugs, also in shell (?) fragments

Mineral	Percentage
Matrix	53
Quartz	17
Plagioclase	15
Hornblende and clinopyroxene	2
Calcite	8
Opagues (Magnetite?)	5

R-09-Z3B9 282.5-282.8'

Plutonic igneous rock – Quartz Monzonite



**Figure 21.** Photomicrographs of R-09-Z3B9 282.5-282.8' in A) Plane-polarized light and B) Cross-polarized light. 20x magnification. Scale bar approximate.

Biotite – 1-4 mm, subhedral (preservation of some crystal faces), pleochroic light to medium brown, shows evidence of strain, some grains are altering to chlorite.

Hornblende – 1.5-2 mm, anhedral (none of original crystal form preserved), pleochroic medium to dark brown

Plagioclase – 2 mm, anhedral to subhedral, albite and Carlsbad twins, some grains zoned

Potassium feldspar – 2-3 mm, subhedral, altering to sericite

Quartz – individual grains 1 mm, intergrown, anhedral, most show undulatory extinction, some have titanite (sphene) inclusions

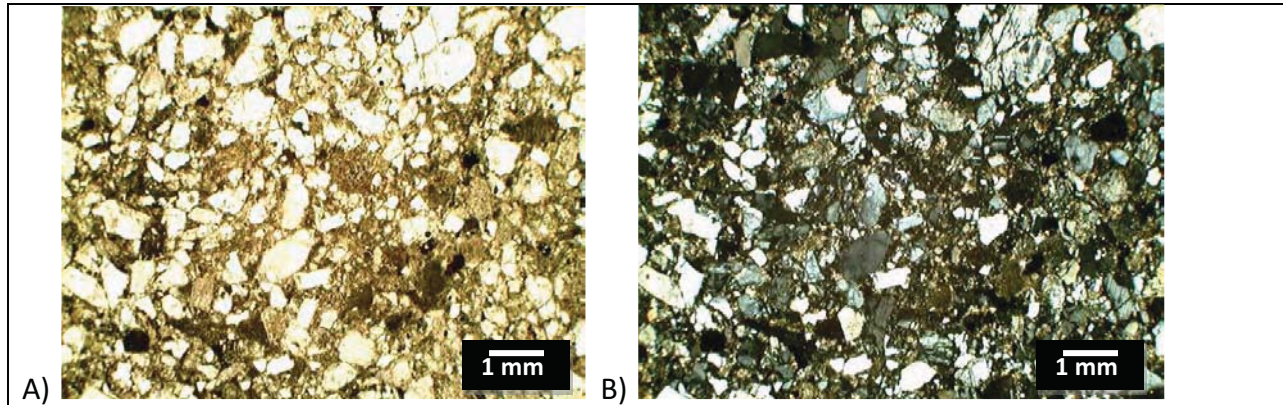
Chlorite – 1 mm, anhedral, alteration product of biotite

Calcite – some formation in veins

Mineral	Percentage
Biotite	15
Hornblende	5
Plagioclase	25
Potassium feldspar	35
Quartz	18
Chlorite	1
Calcite	1
Iron oxide (Magnetite or Ilmenite)	<1

R-09-Z3B10 306.8-307'

Coarse-grained arkosic sandstone



**Figure 22.** Photomicrographs of R-09-Z3B10 306.8-307' in A) Plane-polarized light and B) Cross-polarized light. 20x magnification. Scale bar approximate.

Matrix composed of calcite and some hematite. Opaque iron oxides (magnetite and ilmenite) ubiquitous in section.

Plagioclase – 1 mm, angular (anhedral), many grains exhibit albite twinning and some are zoned

Quartz – 0.5-1 mm, angular (anhedral), intergrown, many grains show undulatory extinction

Potassium feldspar – 1 mm, angular (anhedral) grains, some with no twins, some with tartan twinning (microcline), often altering to sericite

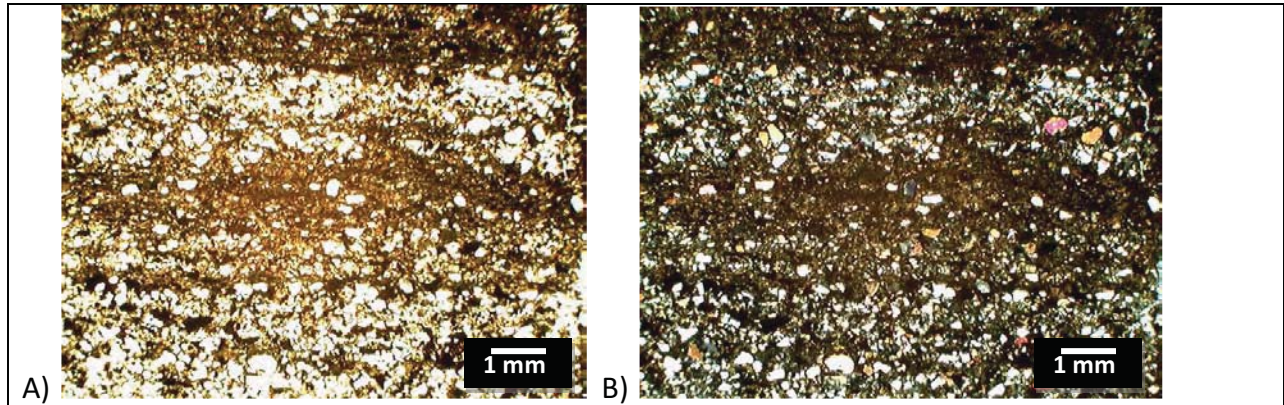
Biotite – 0.5-0.75 mm, subhedral, mostly altered to chlorite

Chlorite – found as an alteration product of biotite

Mineral	Percentage
Matrix	5
Plagioclase	48
Quartz	14
Potassium feldspar	20
Biotite	10
Chlorite	1
Opaques	2

R-09-Z3B11 210.1-210.6'

Siltstone/Sandstone



**Figure 23.** Photomicrographs of R-09-Z3B11 210.1-210.6' in A) Plane-polarized light and B) Cross-polarized light. 20x magnification. Scale bar approximate.

Section contains alternating layers of siltstone and sandstone:

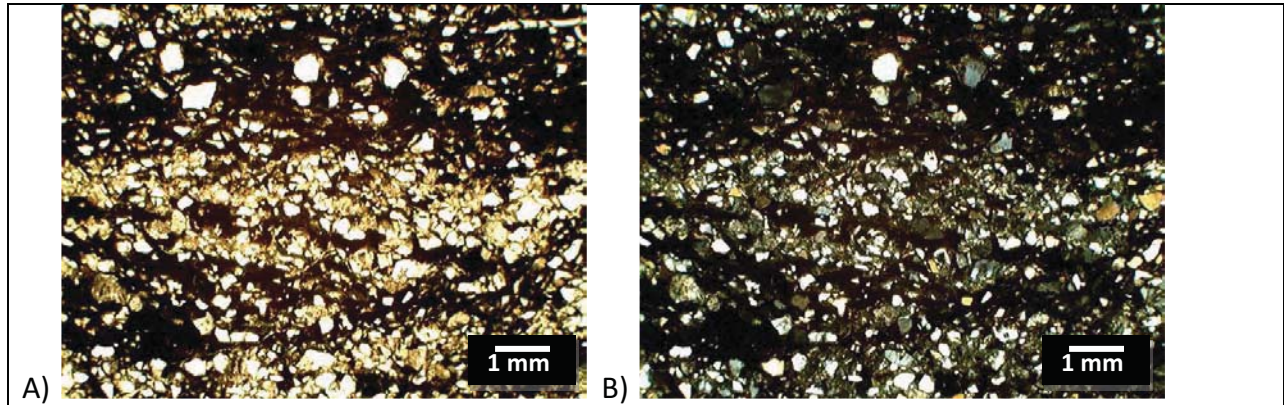
Siltstone has hematite matrix, is finely laminated, and contains 40 to 80% matrix, depending on the layer. Grains include plagioclase and quartz. Plagioclase is often twinned and is angular; quartz is also angular (broken) and exhibits undulatory extinction.

Sandstone contains nearly no matrix, just a small amount of hematite and calcite. The sandstone layers are 2-4 mm thick and are composed of plagioclase (60%) and quartz (40%).

Entire slide is fractured. Both sandstone and siltstone layers contain a small amount of opaque iron oxides.

R-09-Z3B11 232-232.6'

Mudstone



**Figure 24.** Photomicrographs of R-09-Z3B11 232-232.6' in A) Plane-polarized light and B) Cross-polarized light. 20x magnification. Scale bar approximate.

Alternating light and dark layers. Darker layers are finely laminated with hematite and clay cement. Lighter layers lack structure and have a calcite cement with a bit of hematite. Grains are often imbricated and highly fragmented. Chlorite alteration of minerals is common.

Biotite – <0.5 mm, subhedral, altering to chlorite, shows evidence of strain, pleochroic medium to dark brown

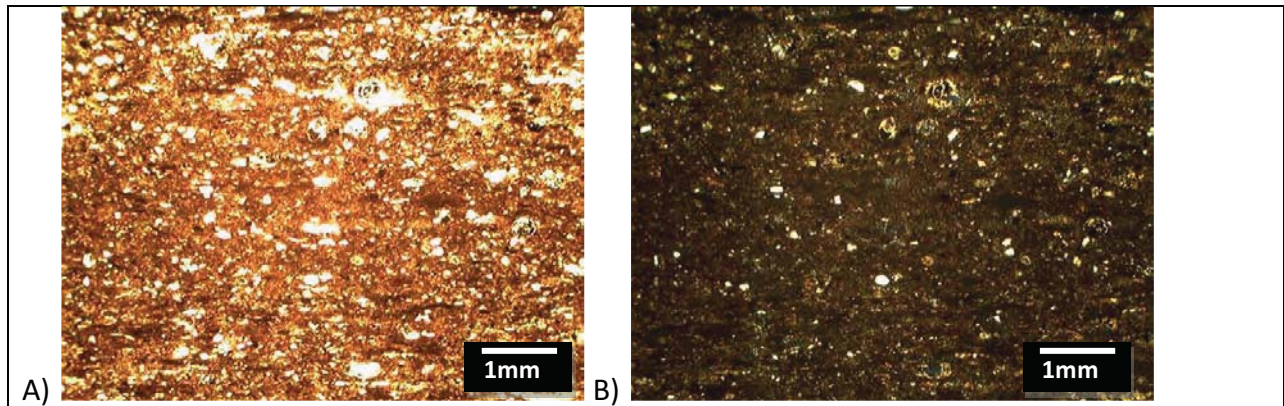
Chlorite – alteration product of biotite, pleochroic pink to green

Plagioclase/Potassium feldspar – <0.5 mm, difficult to distinguish between the feldspars, some grains exhibit albite twinning, angular (anhedral)

Quartz – anhedral, fractured

Muscovite – anhedral, high birefringence, clear in plane-polarized light

<b>Mineral</b>	<b>Percentage</b>
Matrix	15
Biotite	20
Chlorite	5
Plagioclase/Potassium feldspar	45
Quartz	10
Muscovite	5



**Figure 25.** Photomicrograph of R-09-Z3B12 239-239.8'. A) Section in plane polarized light at 40x magnification. B) Section in cross-polarized light at 40x magnification. Scale bar approximate.

Fine-grained shale or siltstone. Planar bedded with bedding at the millimeter scale. Bedding is defined by lens shaped areas of iron oxide, calcite and quartz. Several beds (1 mm in width) are composed entirely of very small quartz grains.

Quartz – rounded to splinter shaped grains surrounded by matrix.

Plagioclase – angular grains showing albite twinning. Grains are surrounded by matrix.

Calcite – forms lens shaped aggregates aligned along bedding planes. Also found in permineralized gastropods and shell fragments.

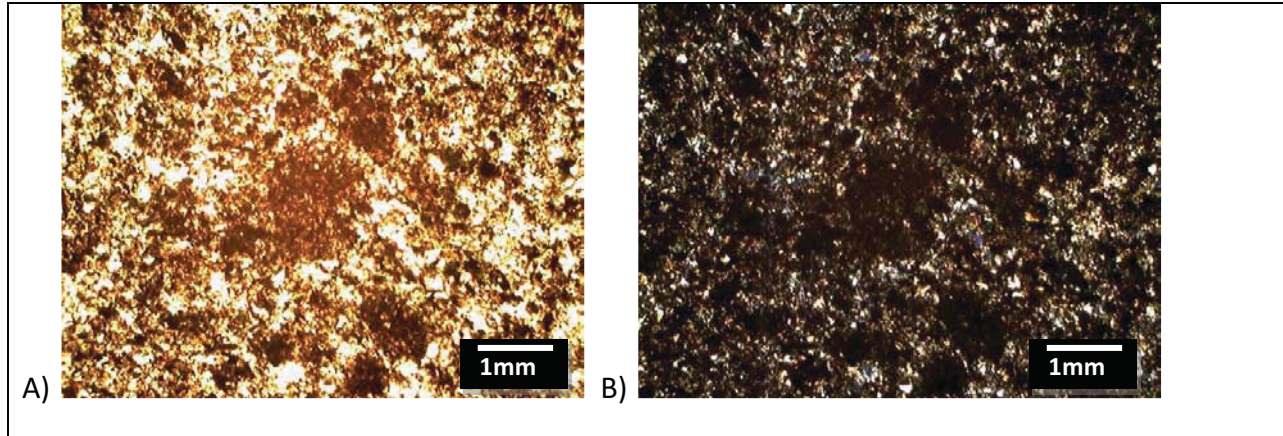
Iron oxide – the major mineral in the matrix is reddish in color. Small grains of opaque angular magnetite are also present.

Matrix – bedding at the millimeter scale mostly composed of iron oxide and calcite, but some thin beds are composed entirely of very fine quartz grains.

Percentages of total rock:

Quartz	12
Plagioclase	<1
Calcite	8
Matrix composed on iron oxide	79





**Figure 26.** Photomicrograph of R-09-Z4B4 200.5-201'. A) Section in plane polarized light at 40x magnification. B) Section in cross-polarized light at 40x magnification. Scale bar approximate.

Siltstone with red-brown iron oxide rich matrix.

Quartz – small (<1 mm) angular grains embedded in fine grained iron oxide rich matrix.

Plagioclase – rare small (< 1mm) angular grains showing albite twinning.

Chlorite – (<1 mm) grains, angular, green color but pleochroic light green to darker green.

Iron oxide – present as both iron oxide in matrix and irregular grains of opaque iron oxide (probably magnetite) up to 1 mm in size. Opaque iron oxide also occurs as irregular clots randomly distributed in matrix.

Comments:

Matrix contains irregular clots of darker opaque iron oxide.

Percentages of total rock:

Quartz	12
Plagioclase	<1
Chlorite	<1
Matrix with iron oxide	86


# Petrographic Report #WUK

May 18, 2009

for

Hubert Law  
Earth Mechanics, Inc.  
17660 Newhope St., Ste. E  
Fountain Valley, CA 92708

by



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Michael DePangher, Ph.D.  
Spectrum Petrographics, Inc.

## Key to Petrographic and Photomicrographic Descriptions

Clay minerals common in altered rocks must often be identified by X-ray diffraction either because their optic properties are not diagnostic or because they are too fine grained to be reliably identified by optical methods. The term "clay" is used herein to denote fine grained phyllosilicates in general. Under ideal conditions, it is often possible to optically discriminate between 4 major groups: kaolinite, smectite, mica (including illite), and chlorite. This is done whenever conditions permit.

The term "sericite" is applied to fine grained colorless phyllosilicates that show upper 2nd order maximum interference colors. These could include muscovite, illite, paragonite, lepidolite, margarite, clintonite, pyrophyllite, and talc. The term "intermediate clay" is applied to fine grained very pale or colorless phyllosilicates that show upper 1st order maximum interference colors. These are probably dominated by chlorite, smectite, and mixed-layer illite/smectite.

The term "opaques" is used to refer to all materials opaque (and sometimes semi-opaque) to transmitted light. The term "FEOH" is herein used to indicate fine grained, yellowish to reddish brown, earthy materials of varying opacity in transmitted light. FEOH is probably mostly Fe oxyhydroxides but may sometimes include sphalerite, realgar, orpiment, jarosite, a number of Mn oxyhydroxides, and organic matter.

A question mark after a rock or mineral name in a petrographic description means that there is uncertainty about the identification of that rock or mineral.

Particle size distributions are given as (A-B  $\mu\text{m}$ ), where A and B are the median and largest particle sizes, respectively, in microns. A question mark (?) in the position of A or B indicates that the value of A or B was indeterminate, probably because of excessively large or small particle size or statistically insignificant numbers of particles.

Mineral abundances are visual estimates for an entire slide. For multi-lithologic materials (cuttings, etc...), mineralogy, textures, and alteration are described only for the dominant lithology.

Section preparation codes are as follows: (1) Format: 27 x 46 mm, 51 x 76 mm, or 1" round; (2) Finish: standard lapping (STD) or polished (POL); (3) Stains: sodium cobaltinitrite (SCN), alizarin red S (ARS), potassium ferricyanide (PF), and barium chloride + potassium rhodizonate (BCPR); and (4) Cover: none, permanent Loctite acrylic (PLA), or removable Canada Balsam (RCB).

Photomicrograph captions/labels contain the following items of information in consecutive order separated by forward slashes: (1) sample identification; (2) film roll number; (3) frame number; (4) illumination; (5) field of view (FOV); and (6) the job identification number. "PPL" indicates plane-polarized light; "XPL" indicates cross-polarized light; "R" indicates reflected light. "550" means that a 550 nanometer wavelength plate was inserted in the light path. "C" indicates that the substage condenser was in (sometimes used for Fe-oxides). "O" indicates substage condenser in an oblique position. These various illuminations can be combined. "CON" indicates conoscopic illumination. POL means that a polarizing filter was used with the lens, and DAY means the sample was photographed in diffused daylight.

Features on photomicrographs are indicated by the number of the feature in the ALTERATION section of the text or by a mineral name abbreviation: **Q**uartz, **P**lagioclase, **K**-feldspar, **s**ericite, **b**iotite, **f**erroan **c**alcite, **a**ctinolite.

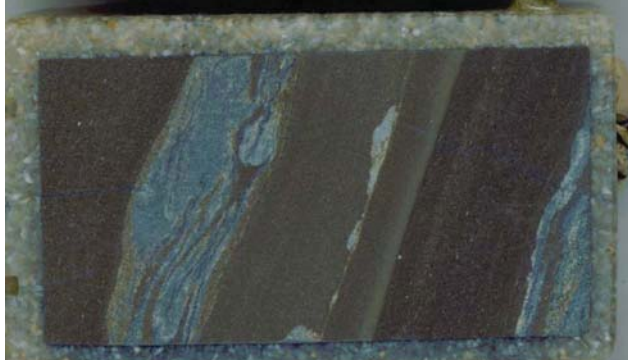
For hypertext links to images to function properly, the images must reside in the same folder as the report.

Comments

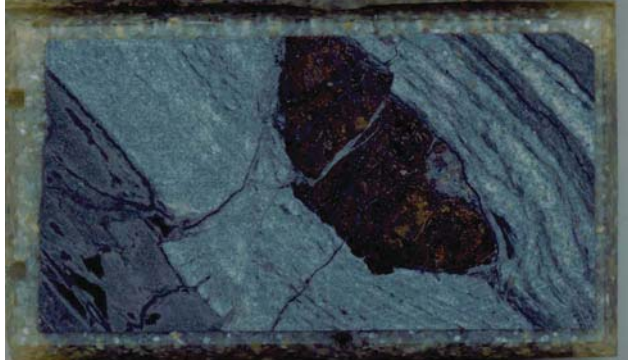
R-09-Z1B3-104



R-09-Z1B3-154



R-09-Z2B1-129



R-09-Z3B3-271



**SAMPLE #** R-09-Z1B3-104

**ROCK NAME** ALTERED SANDSTONE -- probably formed by alteration (secondary dolomite + clay + ferroan dolomite) of a fine to medium lithic arkose (McBride, 1963) protolith, probably derived from a source area dominated by quartz monzonite.

**MINERALS** Quartz (28%) + plagioclase (28%) + K-feldspar (26%) + biotite (10%) + dolomite (5%) + clay (2%) + ferroan dolomite (1%) + collophane (<1%) + muscovite (<1%) + garnet (<1%).

**TEXTURES** Clastic sedimentary, non-directed fabric.

Detrital Framework Grains (94%) are angular, 250-2120 µm, monocrystalline [quartz (25%) + plagioclase (25%) + K-feldspar (25%)] + polycrystalline lithic fragments of quartz monzonite (5%) + various volcanic rocks (3%) + carbonate (1%). Contacts between grains are tangential.

Matrix (0%) was not observed.

Cement (6%) is composed of dolomite + ferroan dolomite.

**ALTERATION** The following alteration features are present but of indeterminate relative ages: (1) plagioclase weakly altered to clay.

**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: SCN (top ½) + [ARS + PF] (right ½) Cover: PLA

**PHOTOS**

**R-09-Z1B3-104** 09015\_02.jpg/XPL/FOV = 4.00 x 5.83 mm/WUK ALTERED SANDSTONE showing typical appearance.



**SAMPLE #** R-09-Z1B3-154

**ROCK NAME** CARBONACEOUS SILTY CLAYSTONE

**MINERALS** Clay (50%) + carbonaceous matter (15%) + quartz (15%) + K-feldspar (15%) + opaques (5%).

**TEXTURES** Clastic sedimentary. Fine laminae define a moderately directed fabric.

Detrital Framework Grains (30%) are angular, 50-100 µm, monocrystalline [quartz (15%) + K-feldspar (15%)]. Contacts between grains are floating.

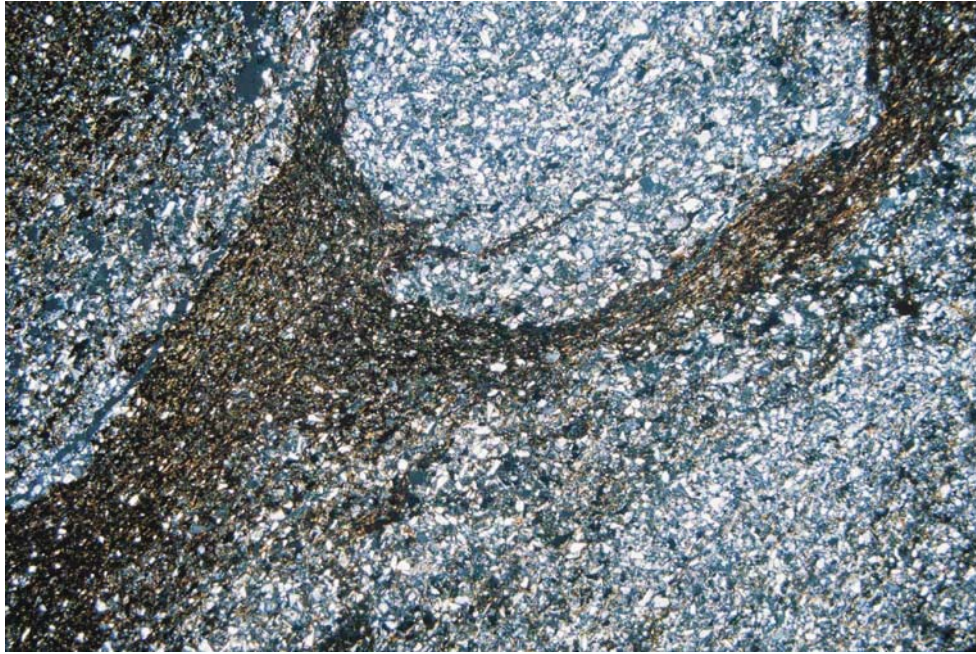
Matrix/Cement (0%) is composed of clay + carbonaceous matter + opaques.

**ALTERATION** The following alteration features are also present but of indeterminate relative ages: (1) weak deformation, possibly as a soft sediment.

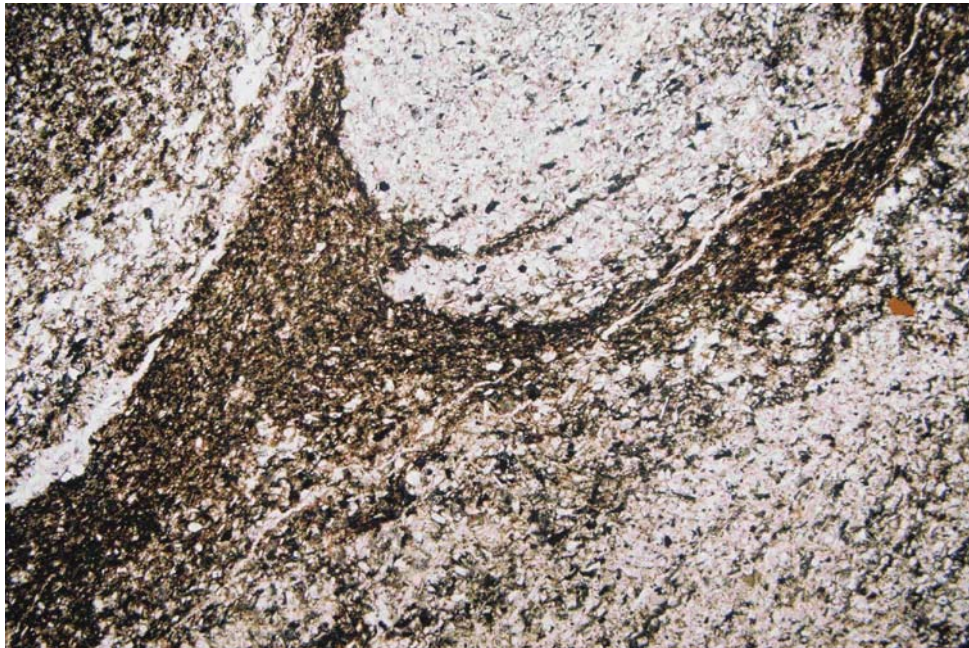
**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: SCN (top ½) + [ARS + PF] (right ½) Cover: PLA

**PHOTOS**

**R-09-Z1B3-154** 9015\_04.jpg/XPL/FOV = 4.00 x 5.83 mm/WUK CARBONACEOUS SILTY CLAYSTONE showing typical finely laminated appearance (same view as 09015\_05.jpg).



**R-09-Z1B3-154** 09015\_05.jpg/PPL/FOV = 4.00 x 5.83 mm/WUK CARBONACEOUS SILTY CLAYSTONE showing typical finely laminated appearance (same view as 09015\_04.jpg).





**SAMPLE #** R-09-Z2B1-129

**ROCK NAME** ALTERED SANDSTONE -- probably formed by alteration (secondary calcite + ferroan dolomite) and cataclasis of a very fine to fine feldspathic litharenite (McBride, 1963) protolith.

**MINERALS** Collophane (19%) + calcite (17%) + ferroan dolomite (13%) + quartz (13%) + K-feldspar (12%) + carbonaceous matter (10%) + clay (10%) + biotite (5%) + opaques (<1%).

**TEXTURES** Clastic sedimentary. Fine bedding defines a weakly directed fabric.

Detrital Framework Grains (50%) are angular, 125-400 µm, monocrystalline [quartz (13%) + K-feldspar (12%) + biotite (5%)] + a single large lithic fragment (?) of polycrystalline fossiliferous collophane (20%). Contacts between grains are floating to tangential.

Matrix (20%) is composed of clay + carbonaceous matter + opaques.

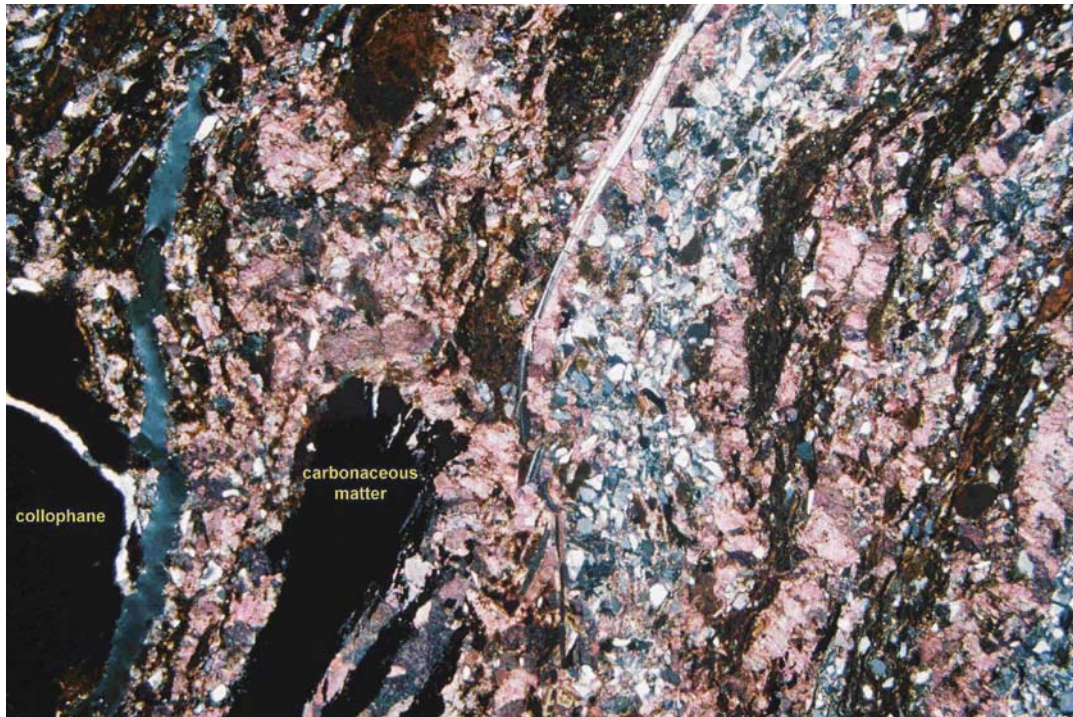
Cement (30%) is composed of calcite + ferroan dolomite.

**ALTERATION** Alteration features in relative chronological order from oldest to youngest are: (1) veins and cement of calcite + ferroan dolomite; and (2) cataclasis.

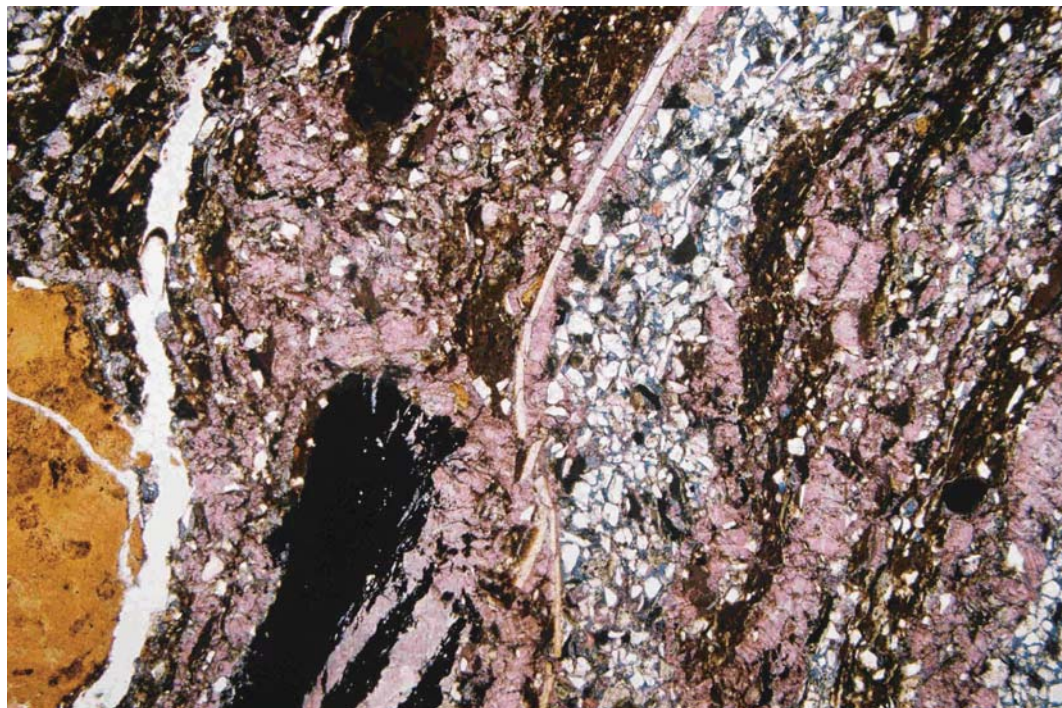
**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: SCN (top ½) + [ARS + PF] (right ½) Cover: PLA

**PHOTOS**

**R-09-Z2B1-129** 9015\_06m.jpg/XPL/FOV = 4.00 x 5.83 mm/WUK **ALTERED SANDSTONE** showing typical appearance (same view as 09015\_07.jpg).



**R-09-Z2B1-129** 09015\_07.jpg/PPL/FOV = 4.00 x 5.83 mm/WUK **ALTERED SANDSTONE** showing typical appearance (same view as 09015\_06m.jpg).



**SAMPLE #** R-09-Z3B3-271

**ROCK NAME** ALTERED DIORITE -- probably formed by hydrothermal alteration (secondary chlorite + clay + calcite/ferroan calcite + rutile + apatite + opaques + clinozoisite) of a fine grained diorite shallow intrusive.

**MINERALS** Plagioclase (40%) + hornblende (29%) + chlorite (8%) + quartz (8%) + biotite (5%) + clay (3%) + calcite/ferroan calcite (3%) + K-feldspar (1%) + rutile (1%) + apatite (1%) + opaques (1%) + clinozoisite (<1%).

**TEXTURES** Phaneritic, holocrystalline, allotriomorphic, fine grained. Very weak deformation has produced a weakly directed fabric.

**ALTERATION** The following alteration features are also present but of indeterminate relative ages: (1) plagioclase weakly altered to clay; (2) hornblende moderately altered to chlorite + ferroan calcite + rutile ± apatite ± clinozoisite; (3) biotite weakly altered to chlorite + rutile + opaques; and (4) veins of calcite + chlorite.

**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: SCN (top 1/2) + [ARS + PF] (right 1/2) Cover: PLA

**PHOTOS**

**R-09-Z3B3-271** 9015\_08.jpg/XPL/FOV = 4.00 x 5.83 mm/WUK ALTERED DIORITE showing typical appearance (same view as 09015\_09.jpg).



**R-09-Z3B3-271** 09015\_09.jpg/PPL/FOV = 4.00 x 5.83 mm/WUK ALTERED DIORITE showing typical appearance (same view as 09015\_08.jpg).





**Earth Mechanics, Inc.**

Geotechnical and Earthquake Engineering

# **TECHNICAL DATA REPORT FOR THE PROPOSED 710 FREEWAY TUNNELS FEASIBILITY**

## **TASK 3.1 - SOIL BORING PROGRAM**

**Prepared For:**

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March 20, 2006

EMI Project No. 05-109

**Table D-1. Soil Corrosivity Test Results**

Boring No.	Sample No.	Depth (ft)	Predominant Soil Type	pH	Sulfate Content (ppm)	Chloride Content (ppm)	Minimum Resistivity (ohm-cm)
06-1	S-16	140	CL	7.25	200	130	1000
06-2	S-11	110	CL	7.85	50	150	1500
06-3	S-6	60	SP	7.51	50	155	2600
06-3	S-6a	60	SP	7.59	90	165	2300

**Table D-2. Washing #200 Sieve Test Results**

Boring No.	Sample No.	Depth (ft)	Predominant Soil Type	Percentage of		
				Gravel	Sand	Fines
06-1	S-6	60	SM	4	69	27
06-2	S-9A	90	SM	0	52	48
06-3	S-5	50	SM	1	63	36

**Table D-3. Direct Shear Test Results**

Boring No.	Sample No.	Depth (ft)	Predominant Soil Type	Peak		Ultimate	
				Friction Angle (deg)	Strength Intercept (ksf)	Friction Angle (deg)	Strength Intercept (ksf)
06-1	D-11A	110.5	SC	33.2	1.37	29.0	0.97
06-1	D-15A	135	CL	29.9	1.03	30.8	0.25
06-2	D-8B	80.5	SM	33.1	2.05	31.2	0.57
06-3	D-4	40	SP	44.2	0.37	36.5	0.02

**Table D-4. Atterberg Limit Test Results**

Boring No.	Sample No.	Depth (ft)	Predominant Soil Type	Percentage of		
				Liquid Limit	Plastic Limit	Plasticity Index
06-1	D-11A	110.5	CL	34	16	18
06-1	D-13B	125	CL	36	21	15
06-1	D-15A	135	CL	36	20	16
06-2	S-11	110	CL	34	21	13

**Table D-5. Unconfined Compressive Strength Test Results**

Boring No.	Sample / Run No.	Depth (ft)	Soil / Rock Type	Sample / Core Diameter (in)	Unconfined Compressive Strength (psi)	Axial Strain Level at Failure
06-1	D-13A	125	Lean Clay with Sand	2.415	69	10.09
06-1	D-15B	135	Lean Clay with Sand	2.413	45	11.03
06-1	15	198-199	Claystone / Siltstone	2.166	291*	3.6
06-2	D-10	100	Lean Clay with Sand	2.412	42	1.70
06-2	10	144.6-145.2	Altered Volcanic	1.754	1,426	-
06-2	10	147-148	Altered Volcanic	1.76	1,386*	2.37
06-2	12	155.8-156.5	Diorite	1.765	177*	6.15
06-2	17	177-178	Diorite	1.769	159	-
06-2	21	197.65-198.25	Diorite	1.767	366*	8.62
06-3	3	84.9-85.0	Weathered Conglomerate	1.763	8,488	-
06-3	20	168.75-169.25	Bedded Siltstone	1.768	2,753*	11.4
06-3	30	202.5-203.2	Fresh Conglomerate	1.762	2,101*	11.7

**Notes:**

- \* Monotonic stress-strain curve data to failure was recorded and is shown in this Appendix.
- Other details including rate of loading, core density and moisture, and failure mode are shown in later this Appendix.

**Table D-6. Point Load Test Results**

Boring No.	Sample Depth (ft)	Sample Length (ft)	Sample Dia. (ft)	Pressure @ Failure (psi)	Unconf. Comp. Strength (psi)	Sample Description
06-2	174.0	24	45	100 <sup>(1)</sup>	1,170	Valid test; broke straight across. Topanga Fm, coarse sandstone breccia of diorite pebbles and cobbles; weath'd, mod. hard to soft.
06-2	186.8	21	45	100	1,170	Valid test, broke across with very little pressure. Moist. Typical weath'd Topanga sandstone/conglomerate; mod. soft to mod. hard sandstone, weath'd, oxidized and altered; pebbles harder than sandstone matrix and only slightly weathered.
06-2	189.8	15	45	100	1,170	Invalid test. Same rock with same characteristics, but fracture had dark oxidation indicating preexisting incipient joint with rough, stepped surface. Another joint at top of sample has strong striae @ 30° rake.
06-2	197.3	17	45	175	2,047	Valid test, broke straight across. Same rock as above, moist.
06-3	200.0	20	45	175	2,047	Invalid test, broke partly along existing joints Rock is diorite, moist, mod. hard, mod. weath'd, slight ring when struck but can break by hand with light pressure. End of sample has joint with striae @ 45° rake.
06-3	85.3	19	45	700	8,189	Valid test; broke through both diorite pebbles and matrix. Topanga Fm conglomerate in coarse (2-3 mm) sandstone matrix; black and white diorite pebbles (8- and 10-cm) within light yellowish-brown sandstone matrix; dry, mod. weath'd, soft to mod. hard matrix, mod. hard to hard pebbles. <sup>(2)</sup>
06-3	106.5	32	45	250	2,925	Valid test, broke straight across, no preexisting joints. Topanga conglomerate: pebbles (2-3 cm) in coarse sand matrix; soft to mod. soft; mod. weath'd sandstone matrix, exterior of feldspar grains are altered to white powder; oxidized to light yellowish-brown. Pebbles are harder, less weath'd, and light gray. <sup>(2)</sup>
06-3	118.3	12	45	650	7,604	Invalid test, broke along 60o angle on incipient but rough, stepped joint; broke around grains. Augite-diorite cobble (23cm) of Topanga conglomerate. Unweath'd to slightly weath'd black and white speckled rock with sphene (?)
06-3	139.1	12	45	2700	31,585	Valid test, broke straight across. Light-colored granite cobble within Topanga conglomerate; un weath'd, very hard.
06-3	197.2	12	45	1500	17,547	Valid test, broke straight across. This is biotite-diorite cobble within Topanga Fm; crystal size 1-2 mm, unweath'd, hard, no oxidation.
06-3	202.2	8	45	450	5,264	Valid test, broke straight across. Sandstone of Topanga Fm, gray, no oxidation, dry, mod. hard, slightly to mod. weath'd. Feldspar grains on fracture are opaque, white, and powdery suggesting alteration due to weathering.

Notes:

1. Maximum pressure measured.
2. See sample photographs shown on next page.



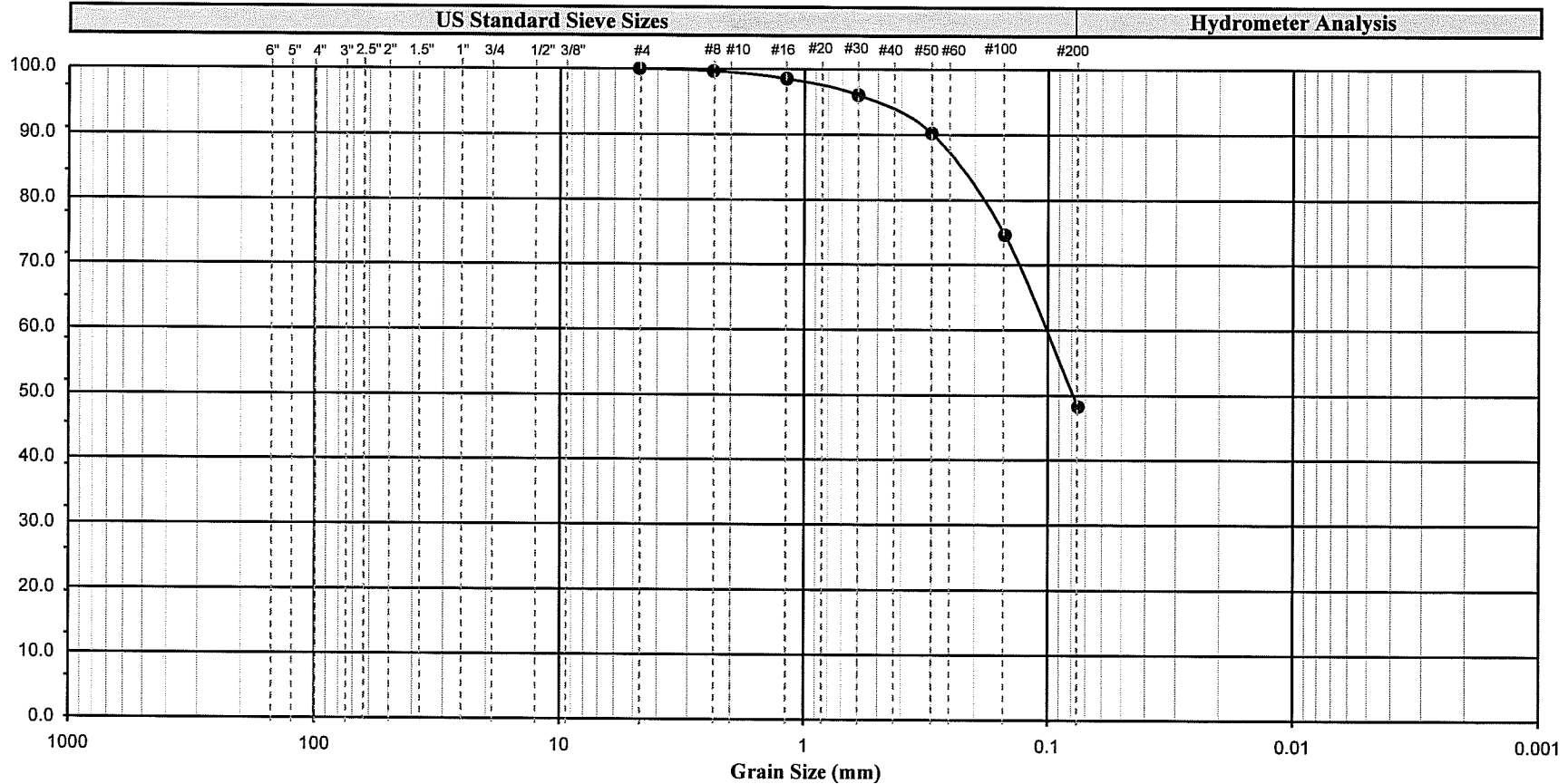


Failed core from 06-3, 106.5 ft depth



Core from 06-3, 85.3 ft depth

**Sample Cores Tested in PLT Device**



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Boring Number	Sample Number	Depth				Soil Color	Soil Description	U.S.C.S.
			(ft)		(m)				
●	06-2	S-9A	9.0	10.5	2.75	3.20	Dark Brown	Silty sand	SM
Remark									



**Earth Mechanics, Inc.**  
Geotechnical and Earthquake Engineering

**Route 710 Tunnel Feasibility**

Project No. : 05-109

Date : 02/19/06

**GRAIN SIZE ANALYSIS**  
(ASTM D-422-63)

# UNCONFINED COMPRESSION TEST

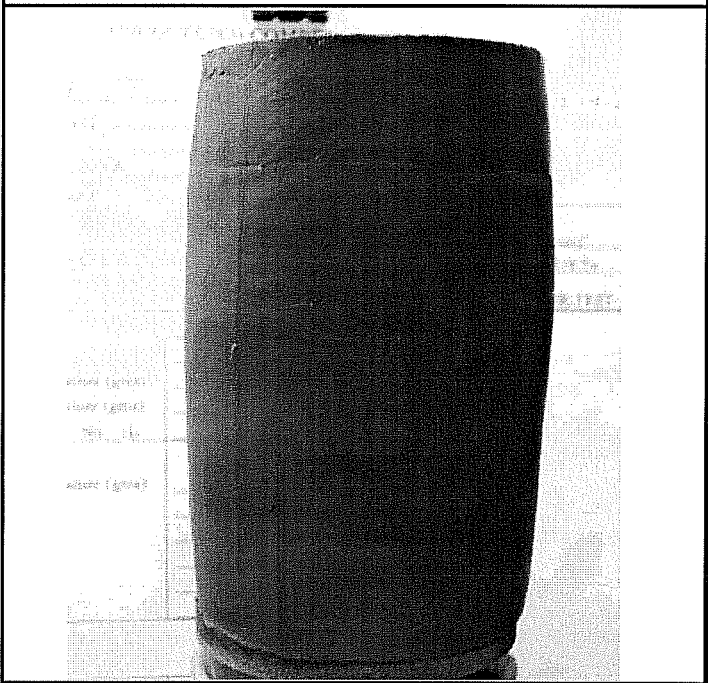
ASTM D2166

<b>Project Name:</b>	Route 710 Tunnel Feasibility	<b>Project No:</b>	05-109
<b>Boring No.:</b>	06-1	<b>Tested by:</b>	R.J.
<b>Depth (ft):</b>	125	<b>Checked by:</b>	
<b>Sample No.:</b>	D-13A	<b>Sample Type:</b>	R
<b>Sample Description:</b>		Reddish Brown, Lean CLAY With Sand (CL)	

	1	2	3	Average:	
Diameter (in.):	2.415	2.415	2.416		2.415
Height (in.):	4.983	4.977	4.950		4.970

Moisture Content Calculation	
Wt. Wet Sample + Container (gms):	238.22
Wt. Dry Sample + Container (gms):	209.64
Container (gms)                      No.    16	57.42
Moisture Content (%)	<b>18.8</b>

**SKETCH / PHOTO AFTER TEST:**  
 PHOTO FILE NAME:                      D:\05-109 710 Tunnel\100\_2649.JPG



Density and Saturation	
Wt. Wet Sample + Container (gms)	1028.01
Container (gms)	228.94
Wet Density (pcf)	<b>133.6</b>
Dry Density (pcf)	<b>112.4</b>
Void Ratio	<b>0.498</b>
% Saturation	<b>101.7</b>

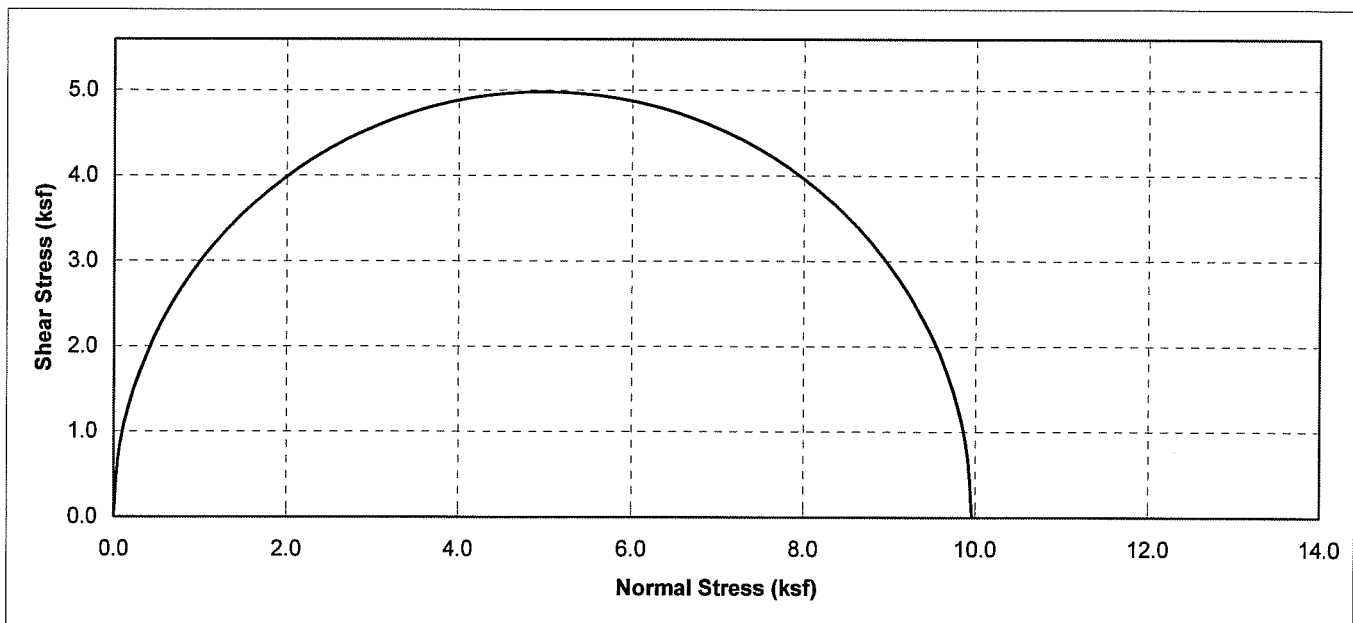
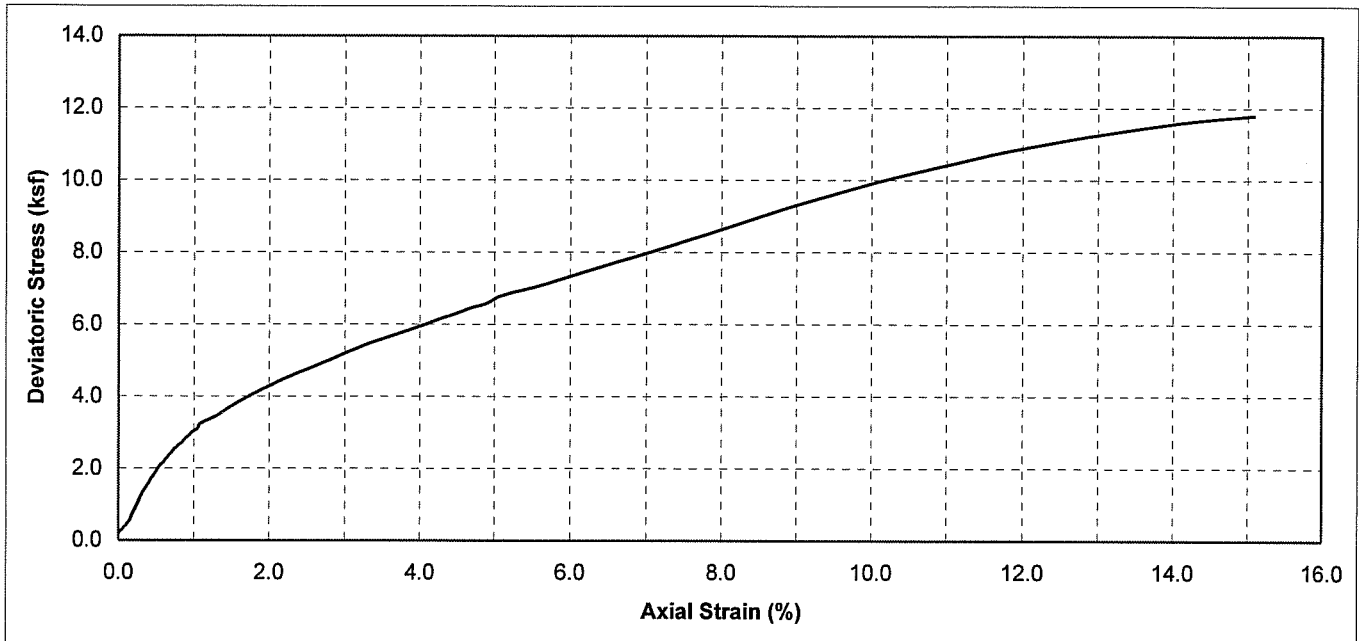
Assume Gs=2.70

Test Data Filename:                      05109061d13a.trx


Shear	
Rate of Deformation (% strain / min) =	<b>1</b>
Confining Stress (ksf):	<b>0.00</b>

At Failure	
Deviator Stress (ksf)	<b>9.97</b>
Eff. Minor Principal Stress (ksf)=	<b>0.00</b>
Eff. Major Principal Stress (ksf)=	<b>9.97</b>
Axial Strain (%)=	<b>10.09</b>

**Failure Criterion: criterion 2 is used**  
 1. the maximum deviator stress within 15% strain  
 2. the stress at 10% strain for no peak stress.



Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	Max. Dev. Stress (ksf)	Initial Saturation (%)
06-1	D-13A	125	Reddish Brown, Lean CLAY With Sand (CL)	112.4	18.78	0.00	9.97	101.7

 <b>Earth Mechanics, Inc.</b> Geotechnical and Earthquake Engineering	<b>Route 710 Tunnel Feasibility</b>	
	<b>UNCONFINED COMPRESSION TEST (ASTM D2166)</b>	
<b>Project No. :</b> 05-109	<b>Date :</b> 02/19/06	

# UNCONFINED COMPRESSION TEST

ASTM D2166

<b>Project Name:</b>	Route 710 Tunnel Feasibility	<b>Project No:</b>	05-109
<b>Boring No.:</b>	06-1	<b>Tested by:</b>	R.J.
<b>Depth (ft):</b>	135	<b>Checked by:</b>	
<b>Sample No.:</b>	D-15B	<b>Sample Type:</b>	R
<b>Sample Description:</b>		Dark Brown, Lean CLAY With Sand (CL)	

	1	2	3	Average:	
Diameter (in.):	2.412	2.413	2.413		2.413
Height (in.):	4.980	4.965	4.952		4.966

Moisture Content Calculation		
Wt. Wet Sample + Container (gms):		218.08
Wt. Dry Sample + Container (gms):		189.46
Container (gms)	No. 19	58.19
Moisture Content (%)		<b>21.8</b>

**SKETCH / PHOTO AFTER TEST:**  
 PHOTO FILE NAME: D:\05-109 710 Tunnel\100\_2650.JPG



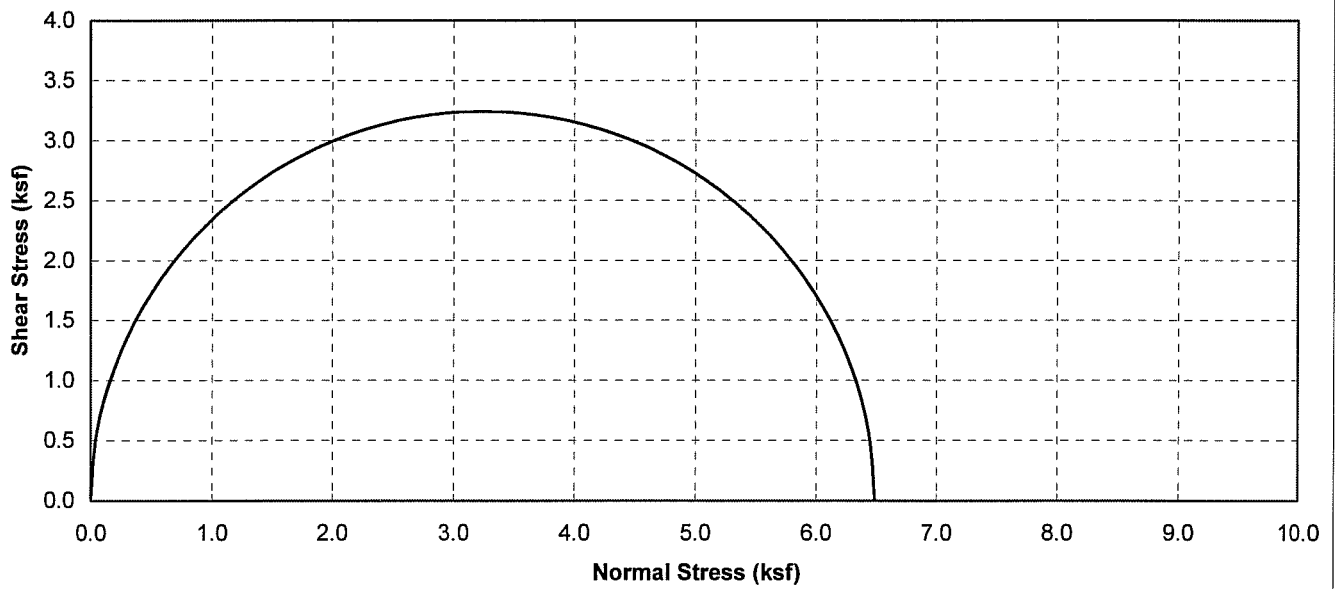
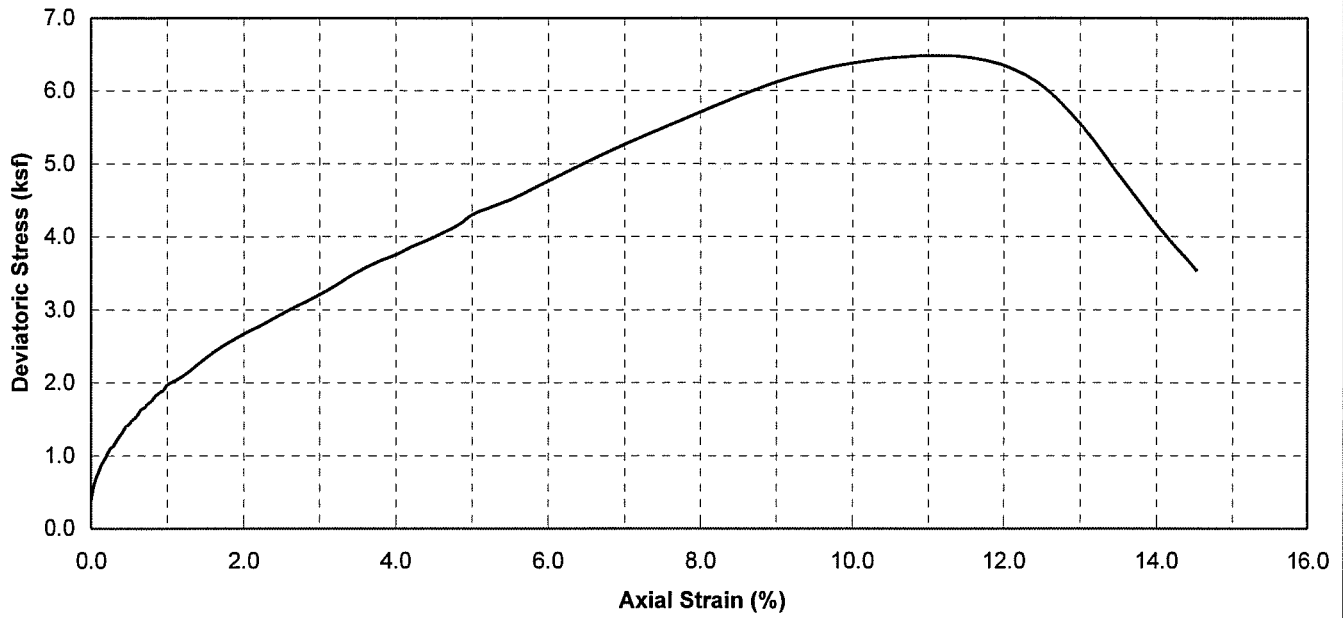
Density and Saturation	
Wt. Wet Sample + Container (gms)	1002.44
Container (gms)	228.94
Wet Density (pcf)	<b>129.7</b>
Dry Density (pcf)	<b>106.5</b>
Void Ratio	<b>0.582</b>
% Saturation	<b>101.1</b>

Assume Gs=2.70

Test Data Filename:	05109061d15b.trx
---------------------	------------------

Shear	
Rate of Deformation (% strain / min) =	<b>1</b>
Confining Stress (ksf):	<b>0.00</b>
<b>Failure Criterion: <u>criterion 1 is used</u></b>	
1. the maximum deviator stress within 15% strain	
2. the stress at 10% strain for no peak stress.	

At Failure	
Deviator Stress (ksf)	<b>6.49</b>
Eff. Minor Principal Stress (ksf)=	<b>0.00</b>
Eff. Major Principal Stress (ksf)=	<b>6.49</b>
Axial Strain (%)=	<b>11.03</b>



Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	Max. Dev. Stress (ksf)	Initial Saturation (%)
06-1	D-15B	135	Dark Brown, Lean CLAY With Sand (CL)	106.5	21.80	0.00	6.49	101.1



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**Route 710 Tunnel Feasibility**

**UNCONFINED COMPRESSION TEST**  
(ASTM D2166)

Project No. : 05-109

Date : 02/19/06

# UNCONFINED COMPRESSION TEST

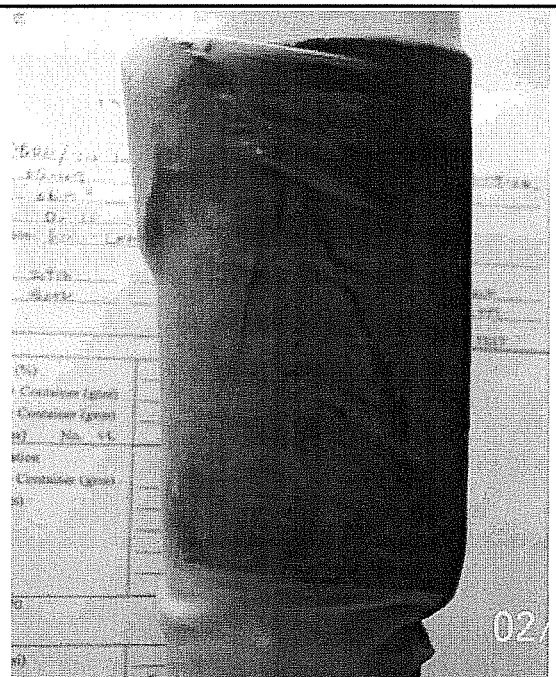
ASTM D2166

<b>Project Name:</b>	Route 710 Tunnel Feasibility	<b>Project No:</b>	05-109
<b>Boring No.:</b>	06-2	<b>Tested by:</b>	R.J.
<b>Depth (ft):</b>	100	<b>Checked by:</b>	
<b>Sample No.</b>	D-10	<b>Sample Type:</b>	R
<b>Sample Description:</b>	Brown, Lean CLAY With Sand (CL)		

	1	2	3	
Diameter (in.):	2.412	2.411	2.412	Average: <u>2.412</u>
Height (in.):	5.002	5.003	4.987	Average: <u>4.997</u>

Moisture Content Calculation			
Wt. Wet Sample + Container (gms):			229.64
Wt. Dry Sample + Container (gms):			206.09
Container (gms)	No. 36		58.08
Moisture Content (%)			<b>15.9</b>

**SKETCH / PHOTO AFTER TEST:**  
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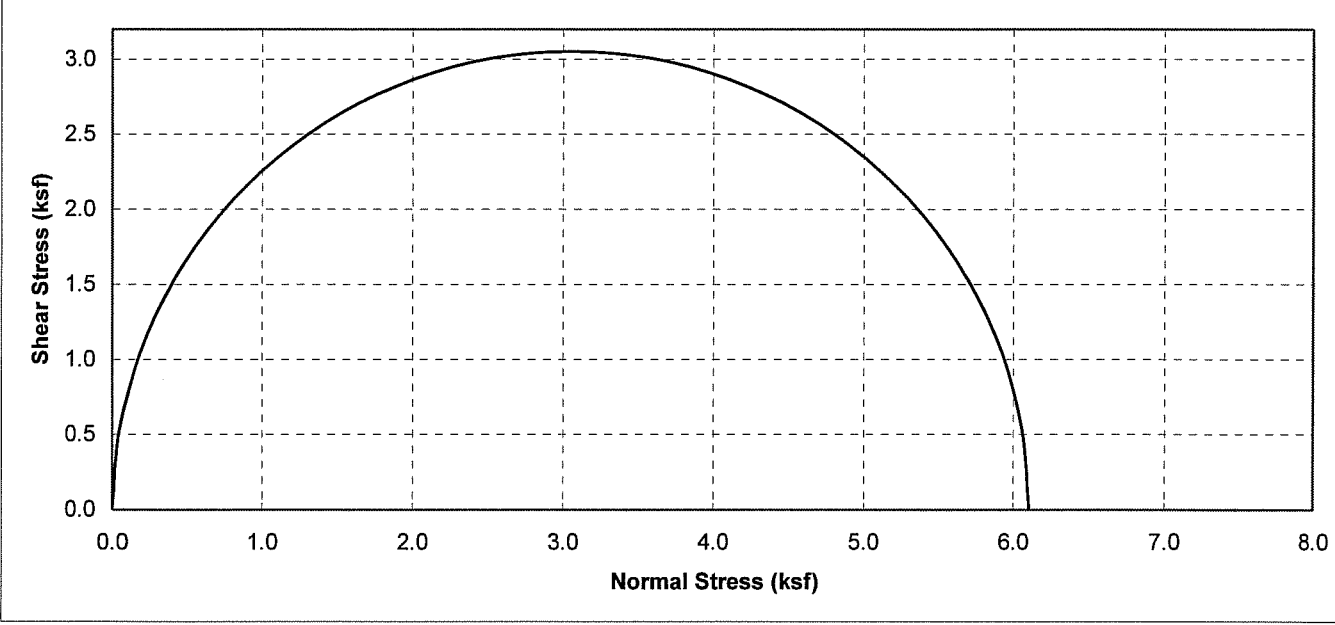
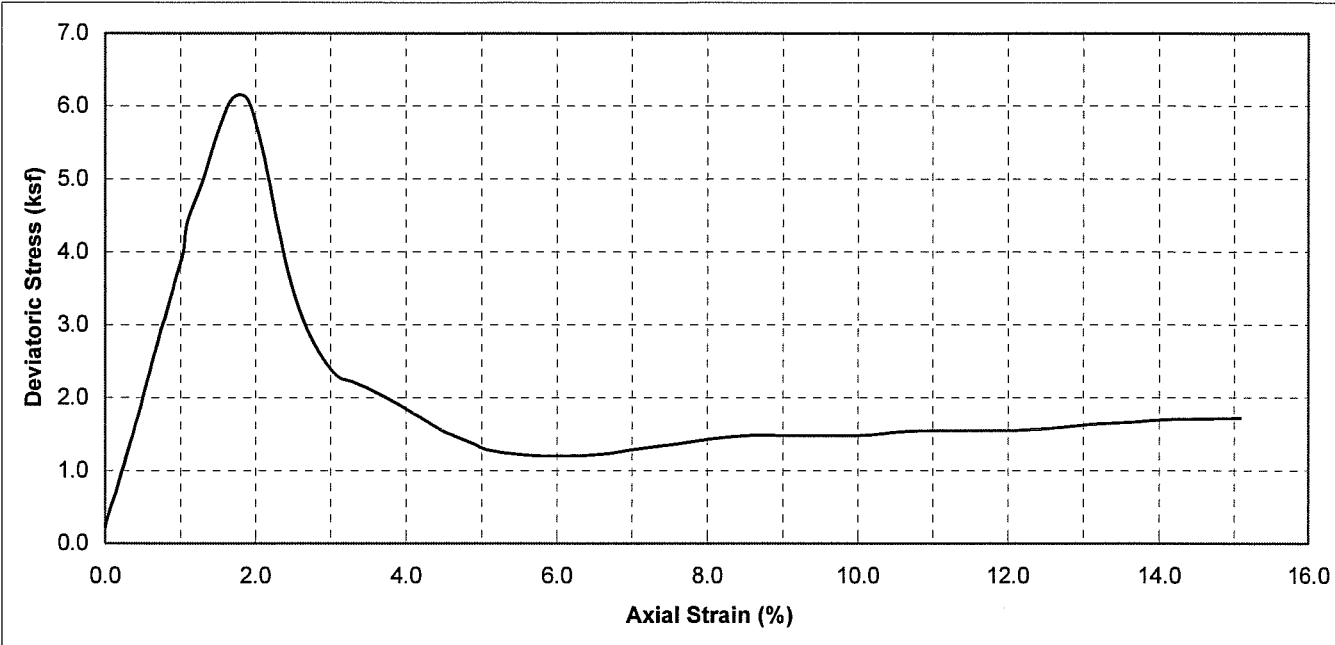
Density and Saturation	
Wt. Wet Sample + Container (gms)	1041.35
Container (gms)	228.94
Wet Density (pcf)	<b>135.5</b>
Dry Density (pcf)	<b>116.9</b>
Void Ratio	<b>0.442</b>
% Saturation	<b>97.3</b>

Assume Gs=2.70


Test Data Filename: 05109062d10.trx

Shear	
Rate of Deformation (% strain / min) =	<b>1</b>
Confining Stress (ksf):	<b>0.00</b>
<b>Failure Criterion: <u>criterion 1 is used</u></b>	
1. the maximum deviator stress within 15% strain	
2. the stress at 10% strain for no peak stress.	

At Failure	
Deviator Stress (ksf)	<b>6.11</b>
Eff. Minor Principal Stress (ksf)=	<b>0.00</b>
Eff. Major Principal Stress (ksf)=	<b>6.11</b>
Axial Strain (%)=	<b>1.70</b>



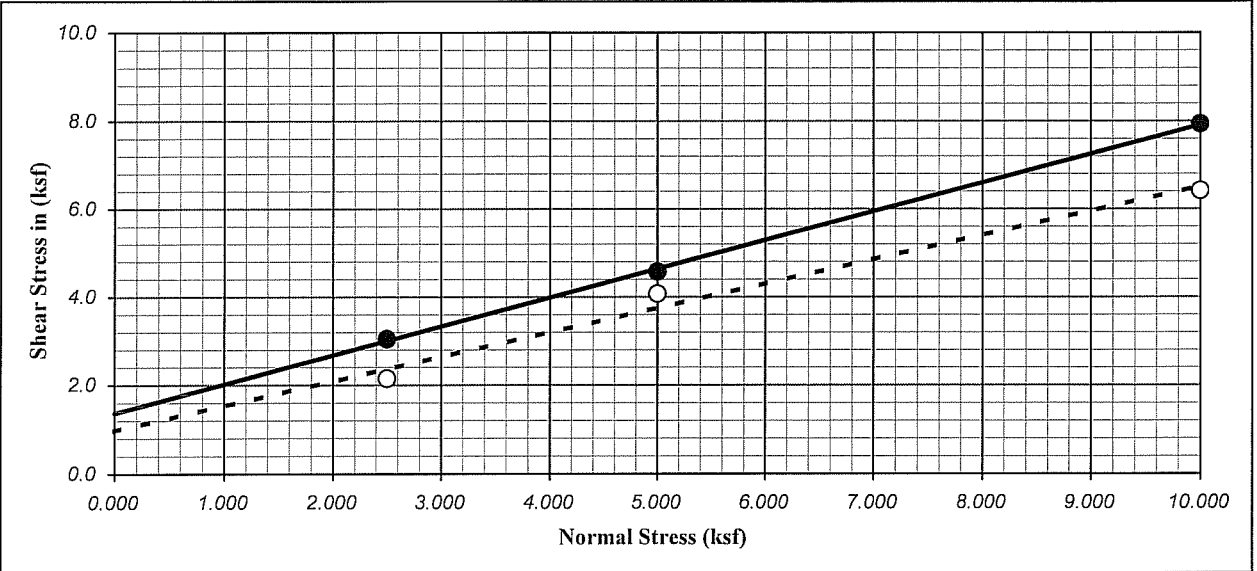
Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	Max. Dev. Stress (ksf)	Initial Saturation (%)
06-2	D-10	100	Brown, Lean CLAY With Sand (CL)	116.9	15.91	0.00	6.11	97.3


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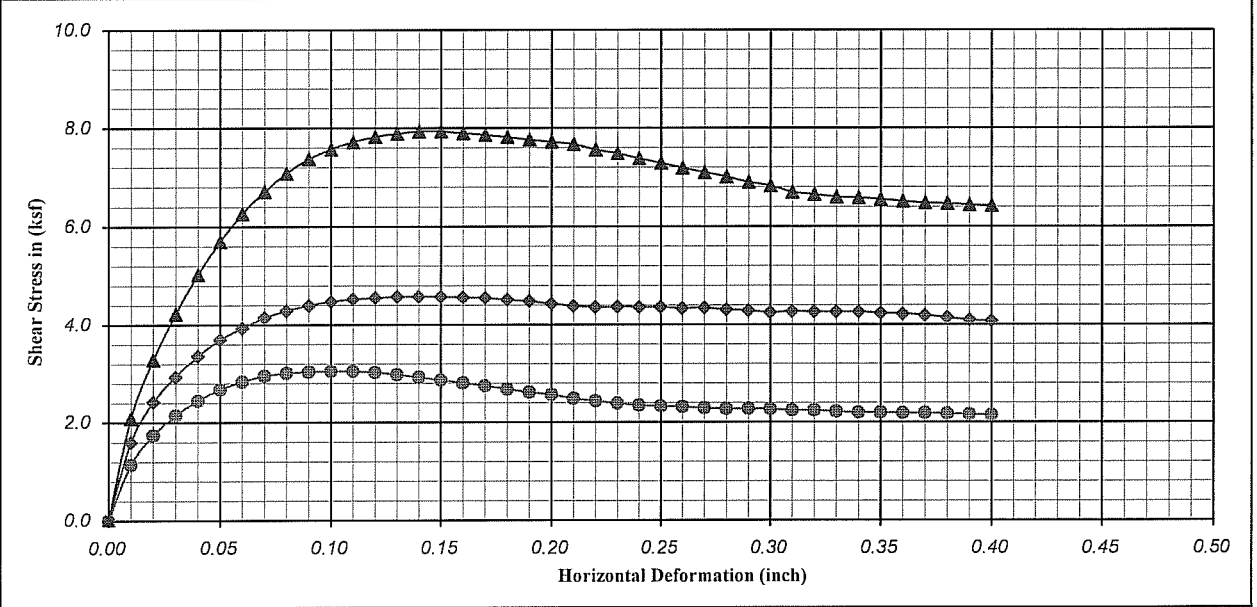
Project No. : 05-109      Date : 02/19/06

**Route 710 Tunnel Feasibility**  
**UNCONFINED COMPRESSION TEST**  
 (ASTM D2166)





Ultimate : ○ Shear Type : Field Moisture Undisturbed Peak : ●



Boring No. : 06-1	Strength Intercept (C) : 1.37 (ksf)		Peak	0.97 (ksf)		Ultimate				
Sample No. : D-11A	65.52 (kPa)			46.56 (kPa)						
Depth (ft/m) : 110.5 / 33.70	Friction Angle (φ) : 33.19 Degree		29.04 Degree							
Description : Clayey Sand with trace pea gravel (SC)	Shear Rate (inch/minute) : 0.02									
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY		VOID RATIO	NORMAL STRESS		PEAK STRESS		ULTIMATE STRESS	
		(pcf)	(kN/m <sup>3</sup> )		(ksf)	(kPa)	(ksf)	(kPa)	(ksf)	(kPa)
●	14.66	113.46	17.86	0.49	2.50	119.70	3.05	145.94	2.15	102.85
◆	20.21	106.00	16.69	0.59	5.00	239.40	4.57	218.91	4.07	194.78
▲	15.61	116.04	18.26	0.45	10.00	478.80	7.93	379.74	6.42	307.34



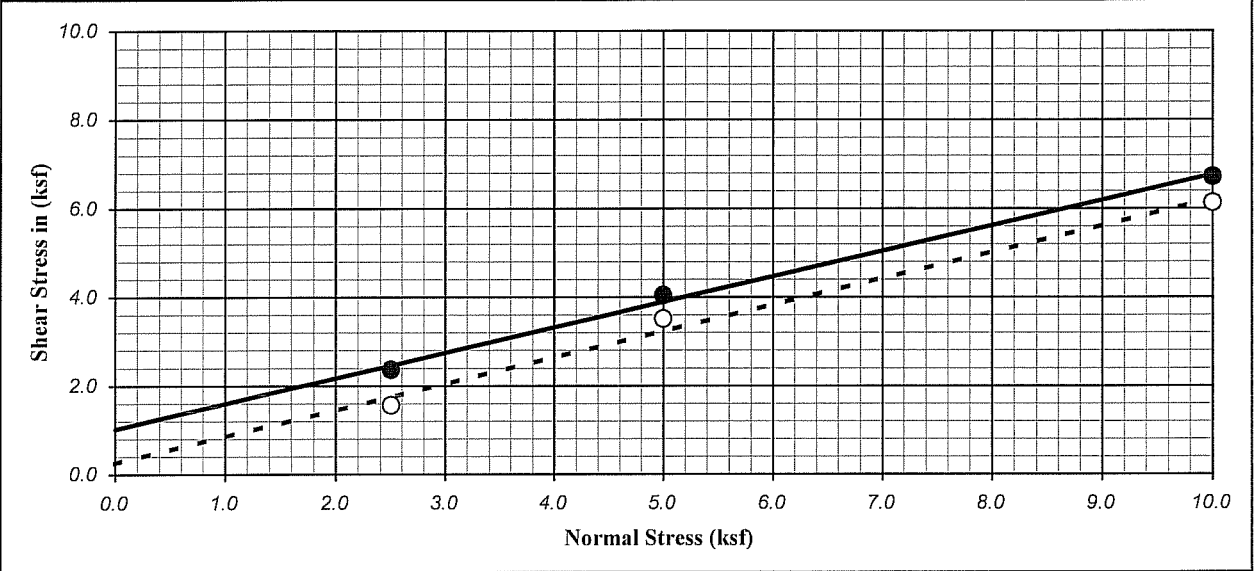
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**Route 710 Tunnel Feasibility**

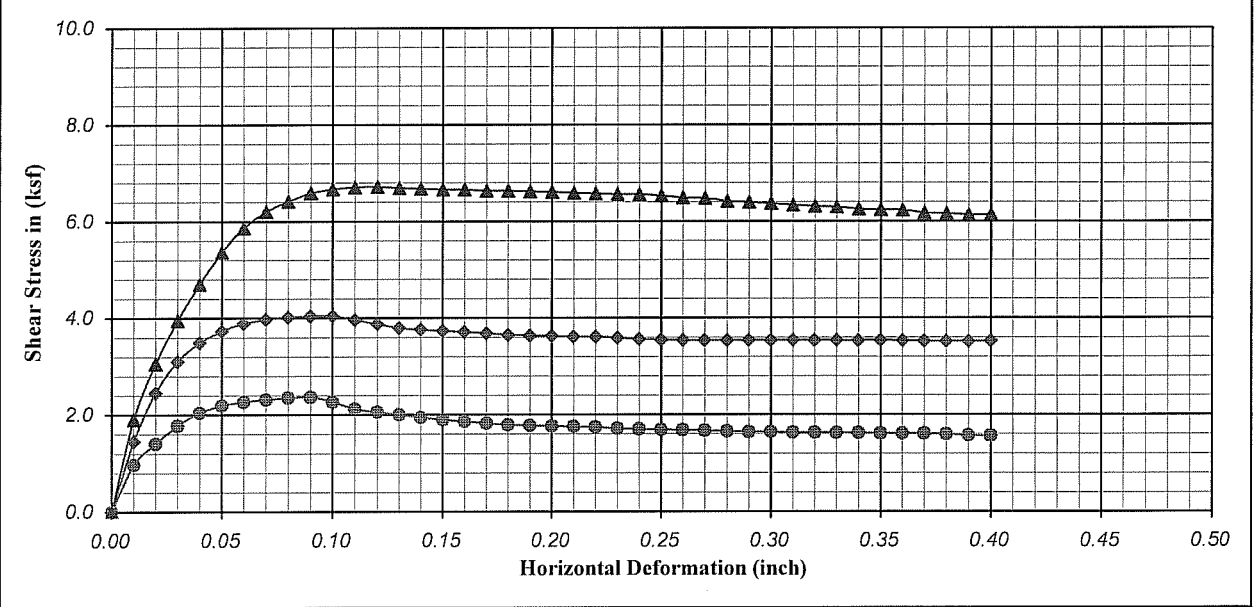
**DIRECT SHEAR TEST (ASTM D-3080)**

Project No. : 05-109

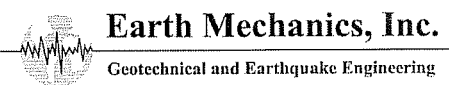
Date : 02/16/06



Ultimate : ○      Shear Type : *Field Moisture*      *Undisturbed*      Peak : ●



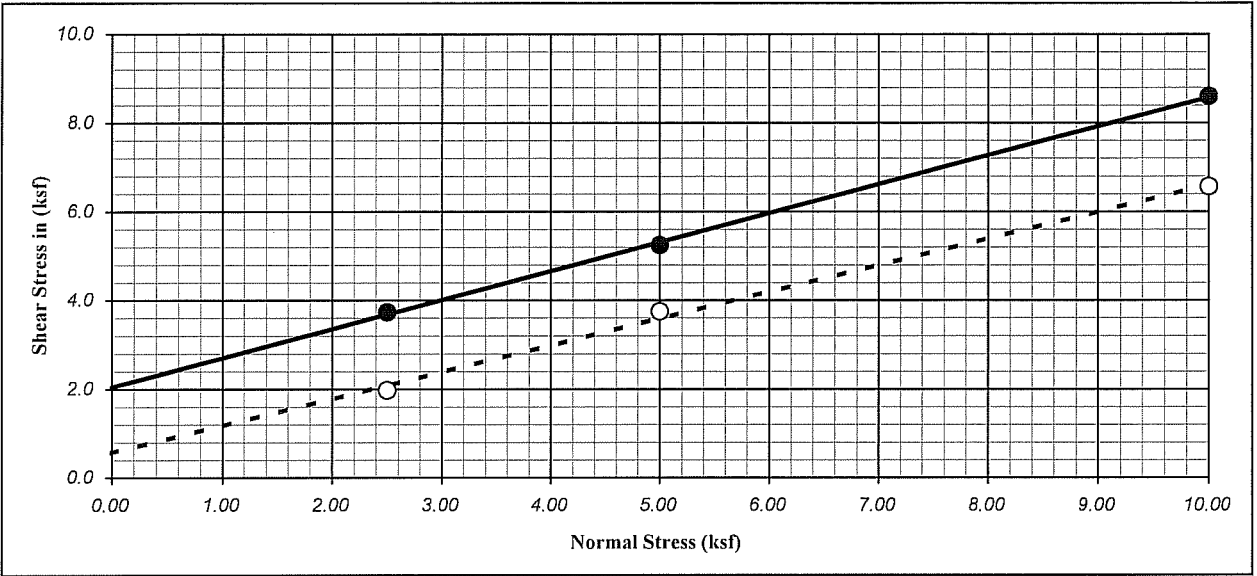
Boring No. : 06-1	Strength Intercept (C) : 1.03 (ksf)		Peak	0.25 (ksf)		Ultimate				
Sample No. : D-15A	49.15 (kPa)			12.09 (kPa)						
Depth (ft/m) : 135.0 / 41.18	Friction Angle (φ) : 29.86 Degree		30.84 Degree							
Description : Sandy Clay (CL)						Shear Rate (inch/minute) : 0.01				
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY		VOID RATIO	NORMAL STRESS		PEAK STRESS		ULTIMATE STRESS	
		(pcf)	(kN/m <sup>3</sup> )		(ksf)	(kPa)	(ksf)	(kPa)	(ksf)	(kPa)
●	23.41	102.33	16.11	0.65	2.50	119.70	2.36	113.19	1.56	74.69
◆	21.46	106.13	16.70	0.59	5.00	239.40	4.04	193.63	3.52	168.35
▲	20.45	107.42	16.91	0.57	10.00	478.80	6.72	321.71	6.13	293.55



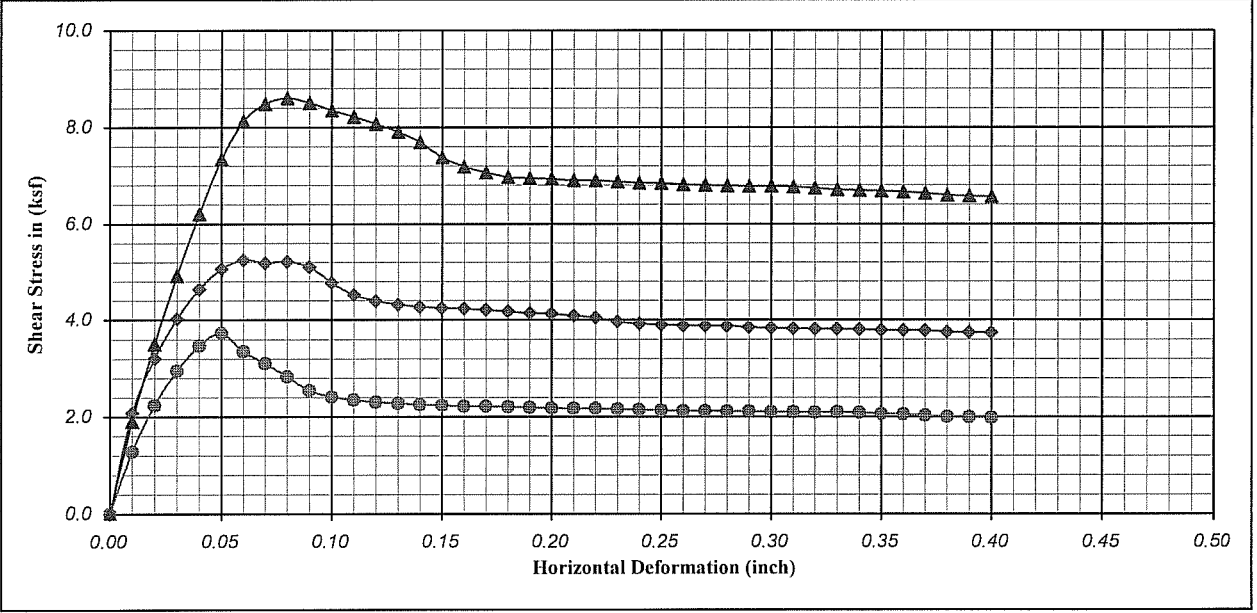
**Route 710 Tunnel Feasibility**

**DIRECT SHEAR TEST (ASTM D-3080)**

Project No. : 05-109      Date : 02/16/06



Ultimate : ○      Shear Type : *Field Moisture*      *Undisturbed*      Peak : ●



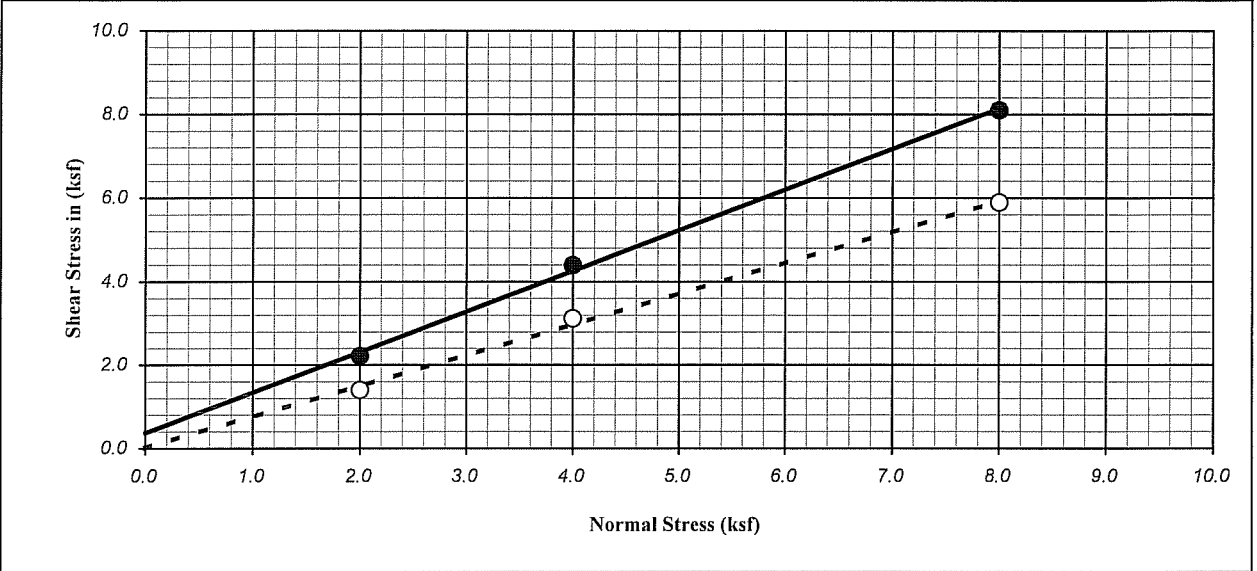
Boring No. : 06-2	Strength Intercept (C) :	2.05	(ksf)	Peak	0.57	(ksf)	Ultimate			
Sample No. : D-8B		98.27	(kPa)		27.32	(kPa)				
Depth (ft/m) : 80.5   24.55	Friction Angle ( φ ) :	33.13	Degree		31.15	Degree				
Description : <i>Silty Sand (SM)</i>	Shear Rate (inch/minute) : 0.02									
SYMBOL	MOISTURE	DRY DENSITY		VOID	NORMAL STRESS		PEAK STRESS		ULTIMATE STRESS	
	CONTENT (%)	(pcf)	(kN/m <sup>3</sup> )		RATIO	(ksf)	(kPa)	(ksf)	(kPa)	(ksf)
●	11.48	123.15	19.38	0.37	2.50	119.70	3.73	178.69	1.98	94.80
◆	12.80	121.77	19.17	0.38	5.00	239.40	5.24	251.08	3.74	179.26
▲	12.07	123.63	19.46	0.36	10.00	478.80	8.60	411.91	6.56	314.24



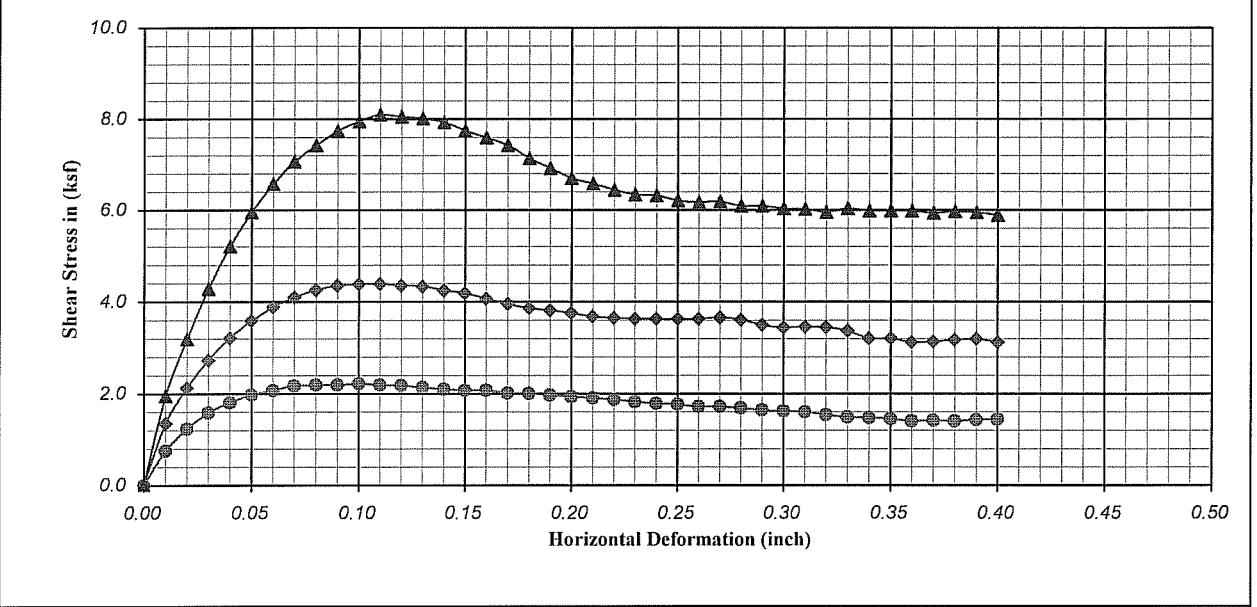
**Route 710 Tunnel Feasibility**

**DIRECT SHEAR TEST (ASTM D-3080)**

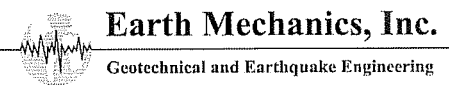
Project No. : 05-109      Date : 02/16/06



Ultimate : ○      Shear Type : *Field Moisture*      *Undisturbed*      Peak : ●



Boring No. : 06-3	Strength Intercept (C) : 0.37 (ksf)	Peak : 0.02 (ksf)	Ultimate							
Sample No. : D-4	17.55 (kPa)	0.89 (kPa)								
Depth (ft/m) : 40.0   12.20	Friction Angle (φ) : 44.19 Degree	36.50 Degree								
Description : <i>Poorly Graded Sand with Gravel (SP)</i>	Shear Rate (inch/minute) : 0.02									
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY		VOID RATIO	NORMAL STRESS		PEAK STRESS		ULTIMATE STRESS	
		(pcf)	(kN/m <sup>3</sup> )		(ksf)	(kPa)	(ksf)	(kPa)	(ksf)	(kPa)
●	9.55	116.21	18.29	0.45	2.00	95.76	2.22	106.29	1.40	67.22
◆	8.34	125.31	19.72	0.35	4.00	191.52	4.39	210.29	3.12	149.39
▲	9.69	121.30	19.09	0.39	8.00	383.04	8.10	387.78	5.89	282.06



Route 710 Tunnel Feasibility

DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 05-109      Date : 02/19/06



PROJECT NO. : EMI#05-109

DATE : 15-Feb-06

PROJECT NAME : 710 TUNNELS FEASIBILITY

TESTED BY : RMC

BORING NO. : 06-2 SAMPLE NO. / DEPTH : 144.6' TO 145.2'

LITHOLOGIC DECIPTION OF THE ROCK : ROCK CORE / BEDDED SILTSTONE AS MARKED

SOIL SPECMEN MEASUREMENTS :

DIAMETER,  $D_o$  (In.) : 1.754 WET WEIGHT,(Gms.): 334.6 VOLUME,( Ft.<sup>3</sup>) : 0.00494  
 INITITAL AREA,  $A_o$  ( Ft.<sup>2</sup>): 0.0168 DRY WEIGHT,(Gms.): 306.9 DRY DENSITY,(Pcf.): 136.9  
 INITIAL LENGTH,  $L_o$ ( In.): 3.533 MOISTURE CONT.,%: 9.04 L / D RATIO : 2.01

STRAIN RATE : 0.05 (IN./MIN.) 1.42 (%/MIN.)

SPECIMEN NO.	AREA ( FT. <sup>2</sup> )	AXIAL LOAD ( LBS.)	COMPRESSIVE STRENGTH
			( PSI)
1	0.0168	3449.0	1426
2			
3			
AVERAGE			1426

SPECIMEN SKETCH AFTER FAILURE



SPECIMEN NO.	AREA ( FT. <sup>2</sup> )	AXIAL LOAD ( LBS.)	COMPRESSIVE STRENGTH
			( PSI)
1			
2			
3			
AVERAGE			

SPECIMEN SKETCH AFTER FAILURE



SPECIMEN NO.	AREA ( FT. <sup>2</sup> )	AXIAL LOAD ( LBS.)	COMPRESSIVE STRENGTH
			( PSI)
1			
2			
3			
AVERAGE			

SPECIMEN SKETCH AFTER FAILURE



REMARKS : \_\_\_\_\_



**ZEISER KLING CONSULTANTS, INC.**

1221 E. Dyer Road, Suite 105; Santa Ana, CA 92705  
 Tel: (714) 755-1355; Fax: (714) 755-1366

UNCONFINED COMPRESSIVE STRENGTH  
 OF INTACT ROCK CORE SPECIMEN  
 (ASTM D2938 - 95)







PROJECT NO. : EMI#05-109

DATE : 15-Feb-06

PROJECT NAME : 710 TUNNELS FEASIBILITY

TESTED BY : RMC

BORING NO. : 06-2 SAMPLE NO. / DEPTH : 177' TO 178'

LITHOLOGIC DECIPTION OF THE ROCK : ROCK CORE / DIORITE AS MARKED

**SOIL SPECMEN MEASUREMENTS :**

DIAMETER,  $D_o$  (In.) : 1.769 WET WEIGHT,(Gms.): 350.63 VOLUME,( Ft.<sup>3</sup>) : 0.00517  
 INITITAL AREA,  $A_o$  ( Ft.<sup>2</sup>): 0.0171 DRY WEIGHT,(Gms.): 333.6 DRY DENSITY,(Pcf.): 142.3  
 INITIAL LENGTH,  $L_o$ ( In.): 3.633 MOISTURE CONT.,%: 5.1 L / D RATIO : 2.05

STRAIN RATE : 0.05 (IN./MIN.) 1.38 (%/MIN.)

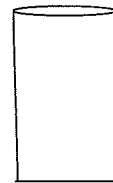
SPECIMEN NO.	AREA ( FT. <sup>2</sup> )	AXIAL LOAD ( LBS.)	COMPRESSIVE STRENGTH
			(PSI)
1	0.0171	392.2	159
2			
3			
AVERAGE			159

SPECIMEN SKETCH AFTER FAILURE



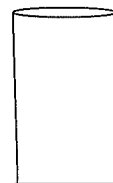
1			
2			
3			
AVERAGE			

SPECIMEN SKETCH AFTER FAILURE



1			
2			
3			
AVERAGE			

SPECIMEN SKETCH AFTER FAILURE



REMARKS : \_\_\_\_\_  
 \_\_\_\_\_



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 Tel: (714) 755-1355; Fax: (714) 755-1366

**UNCONFINED COMPRESSIVE STRENGTH  
 OF INTACT ROCK CORE SPECIMEN  
 (ASTM D2938 - 95)**



PROJECT NO. : EMI#05-109

DATE : 15-Feb-06

PROJECT NAME : 710 TUNNELS FEASIBILITY

TESTED BY : RMC

BORING NO. : 06-3 SAMPLE NO. / DEPTH : 84.9' to 85'

LITHOLOGIC DECIPTION OF THE ROCK : ROCK CORE / WEATHERED CONGLOMERATE AS MARKED

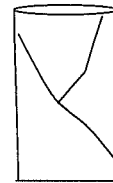
SOIL SPECMEN MEASUREMENTS :

DIAMETER,  $D_o$  (In.) : 1.763 WET WEIGHT,(Gms.): 370.69 VOLUME,( Ft.<sup>3</sup>) : 0.00515  
 INITITAL AREA,  $A_o$  ( Ft.<sup>2</sup>) : 0.0170 DRY WEIGHT,(Gms.): 364.9 DRY DENSITY,(Pcf.): 156.0  
 INITIAL LENGTH,  $L_o$  (In.): 3.649 MOISTURE CONT.,%: 1.6 L / D RATIO : 2.07

STRAIN RATE : 0.05 (IN./MIN.) 1.37 (%/MIN.)

SPECIMEN NO.	AREA ( FT. <sup>2</sup> )	AXIAL LOAD ( LBS.)	COMPRESSIVE STRENGTH
			( PSI)
1	0.0170	20779.0	8488
2			
3			
AVERAGE			8488

SPECIMEN SKETCH AFTER FAILURE



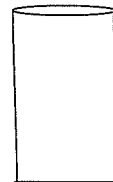
SPECIMEN NO.	AREA ( FT. <sup>2</sup> )	AXIAL LOAD ( LBS.)	COMPRESSIVE STRENGTH ( PSI)
1			
2			
3			
AVERAGE			

SPECIMEN SKETCH AFTER FAILURE



SPECIMEN NO.	AREA ( FT. <sup>2</sup> )	AXIAL LOAD ( LBS.)	COMPRESSIVE STRENGTH ( PSI)
1			
2			
3			
AVERAGE			

SPECIMEN SKETCH AFTER FAILURE



REMARKS : \_\_\_\_\_



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**UNCONFINED COMPRESSIVE STRENGTH  
 OF INTACT ROCK CORE SPECIMEN  
 (ASTM D2938 - 95)**





## **APPENDIX E**

### **PETROGRAPHIC TESTING**



# Vancouver Petrographics Ltd.

8080 GLOVER ROAD, LANGLEY, B.C. V1M 3S3  
PHONE: 604-888-1323 • FAX: 604-888-3642  
email: vanpetro@vanpetro.com  
Website: www.vanpetro.com

Report for: Bruce A. Schell,  
Consulting Geologist  
3775 Carmel Ave.,  
IRVINE,  
California 92606  
U.S.A.

Report 060204

March 17, 2006

## SAMPLES:

A suite of 7 rock samples from the San Gabriel Basin (Project 24-129-1), as numbered below, was submitted for sectioning and petrographic description. Typical portions of each sample were prepared as standard thin sections.

Sample	Bore Hole	Depth (ft)
1	06-2	121.0
2	06-2	125.5-126.0
3	06-2	138.6-139.0
4	06-2	144.0-144.3
5	06-2	198.2-198.5
6	06-3	173.5
7	06-3	200.4-200.8

## SUMMARY:

Samples 1 and 6 are arkosic sandstones, composed of angular mineral grains and minor lithic fragments in a dominant size range of 50 - 500 microns. The principal mineral constituents in both samples are plagioclase and quartz, with biotite as a minor accessory. Sample 1 is distinctive in that it also has a high content of carbonate, which forms a cement to the sand grains and also occurs as cross-cutting veinlets. In Sample 6 there is no carbonate; the sand grains occur in close contact, and the only apparent cement is a minor interstitial silt component.

Samples 3 and 7 are coarser sediments, rich in lithic fragments and classifiable as arkosic conglomerates. They are similar to the sandstones (Samples 1 and 6) in overall mineralogy and the dominance of angular clasts, but contain, in addition, pebbles ranging up to 1 cm or more in size. Most of these coarser clasts are recognizable as typical quartz diorite, and the finer sandy/silty component as a product of disaggregation of that rock type. Minor accessory proportions of volcanic clasts of probable andesitic composition are

also present. These rocks are silt-cemented and devoid of carbonate.

Samples 2 and 5 are mineralogically similar to the sandstones and conglomerates, but their textures suggest that they are not of sedimentary origin. Sample 5, in particular, has the features of a fresh, intrusive-type granodiorite composed of a medium-grained intergrowth of plagioclase and quartz with accessory biotite and hornblende; it is cut by a network of thin fractures and zones of microbrecciation. The texture of Sample 2 somewhat resembles that of the conglomerates, but is believed to represent the result of cataclastic deformation of quartz diorite. It shows a crude foliation defined by zones of resistant remnants, which grade to intervening areas of more or less finely comminuted material.

These two samples could represent the parent material from which the arkosic sediments of the suite were derived.

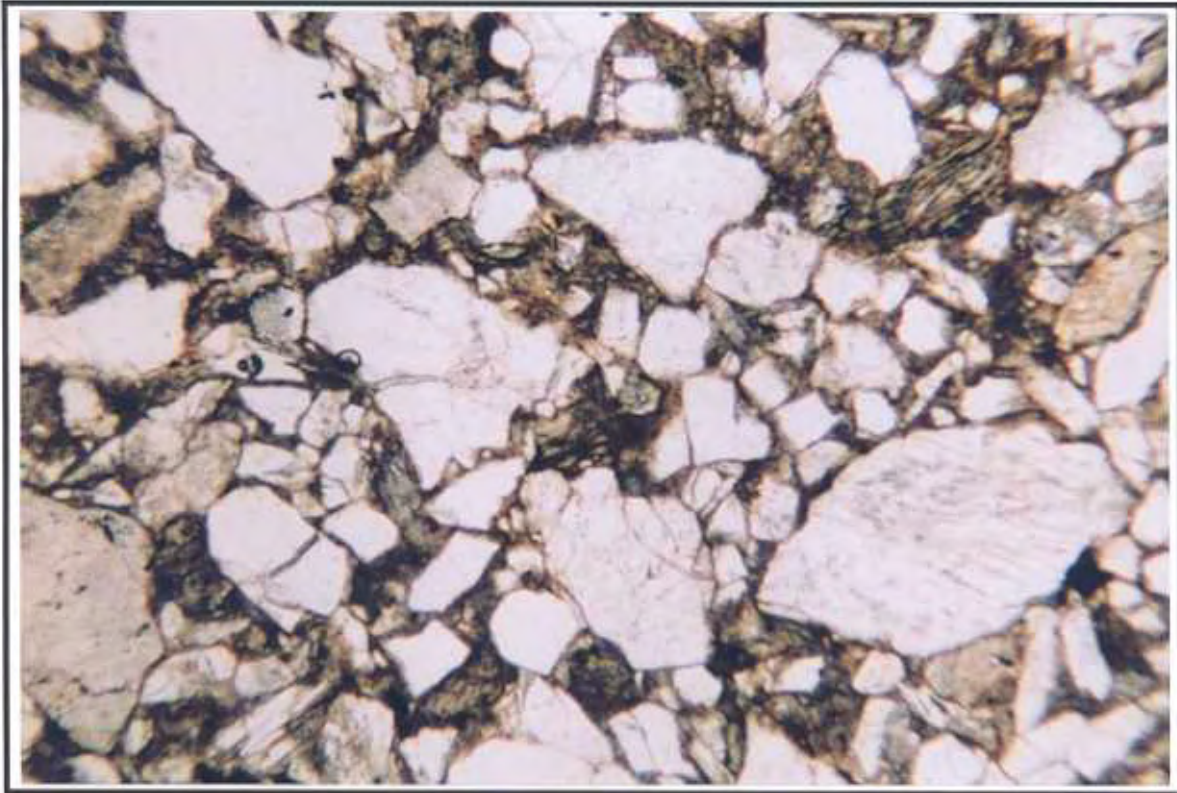
Sample 4 is of quite different mineralogy from the others, being a fine-grained, sparsely porphyritic igneous rock of volcanic or sub-volcanic origin. It shows intersertal texture, and is of andesite to basalt composition. Somewhat similar rocks are represented as occasional clasts in the sandstones and conglomerates of the suite.

Individual sample descriptions and a suite of illustrative photomicrographs are attached.

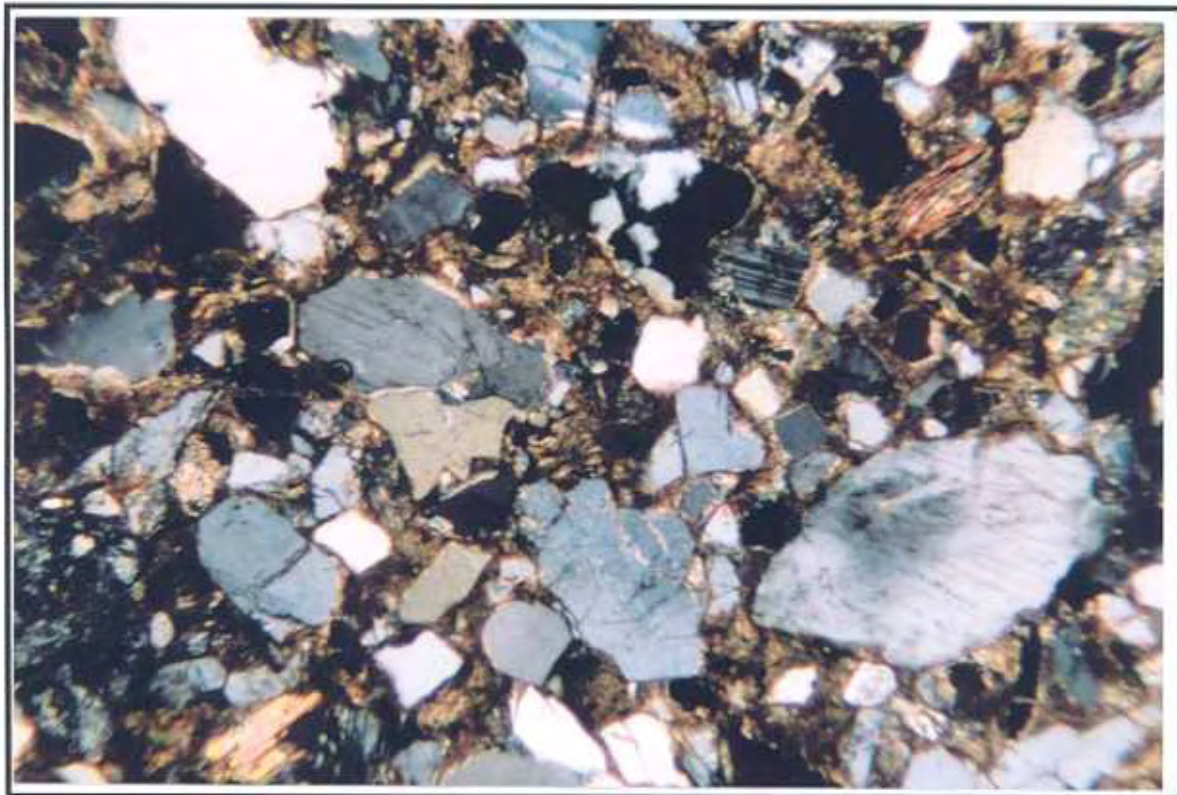


J.F. Harris Ph.D.





Plane Polarized



Cross Polarized

Figure E-1. Photomicrograph of Sample 1: Boring 06-2, 121 Feet

SAMPLE 1: 06-2 121 ft CARBONATE-CEMENTED ARKOSIC SANDSTONE

Estimated mode

Clasts

Quartz	22
Plagioclase	35
Chert/Felsite	2
Biotite	2
Carbonate	2

Matrix

Carbonate	30
Limonite	trace

Veinlets

Carbonate	7
Limonite	trace

The macroscopic appearance of this rock (see off-cut) is that of an arenaceous sediment.

Thin section examination shows that the constituent clasts consist of mineral grains of quartz and plagioclase plus minor carbonate, minor biotite, and lithic fragments. They range in size from 1 mm down to 50 microns or so, and are mostly sharply angular in shape.

The freshness of most of the plagioclase clasts is a striking feature.

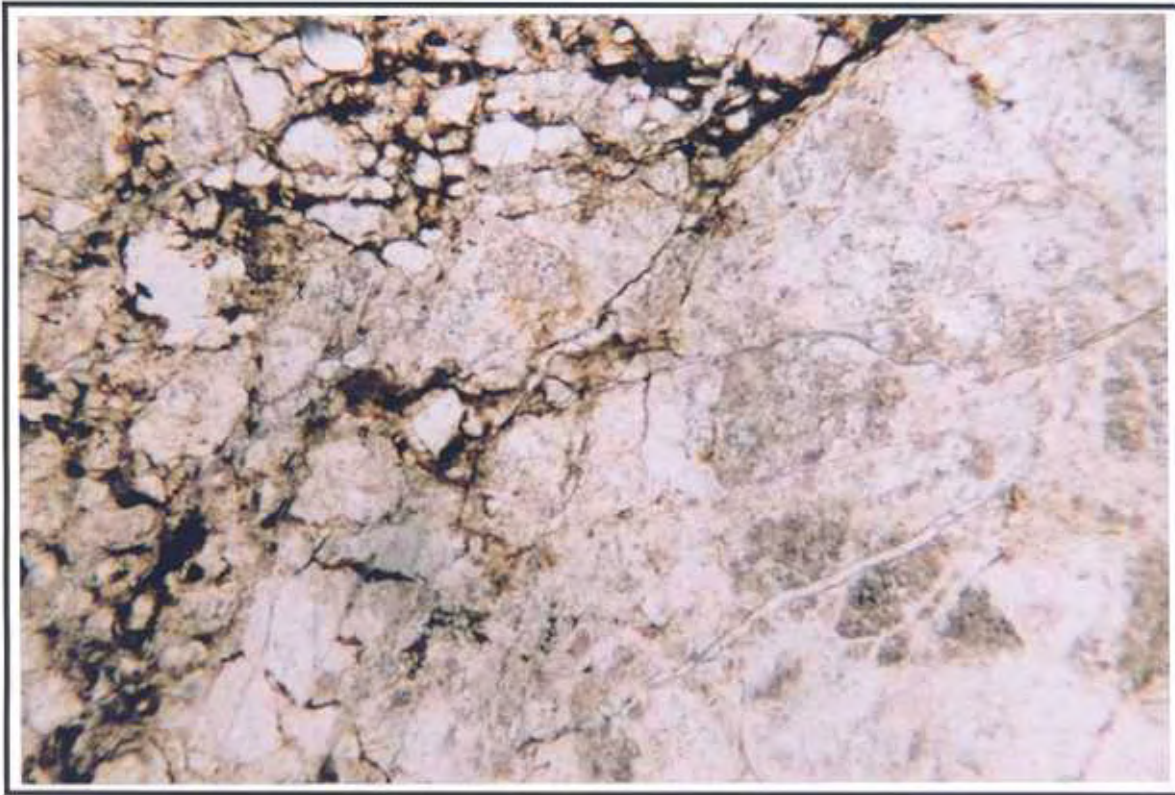
The clasts are mainly equidimensional, and there is no recognizable oriented fabric. This random orientation is true also of the scattered flakes of biotite which are a minor accessory.

A few of the coarser clasts are polygranular, and are recognizable as fragments of apparent quartz diorite. Other lithic clasts include minutely microgranular rocks of felsitic character, and carbonate rocks.

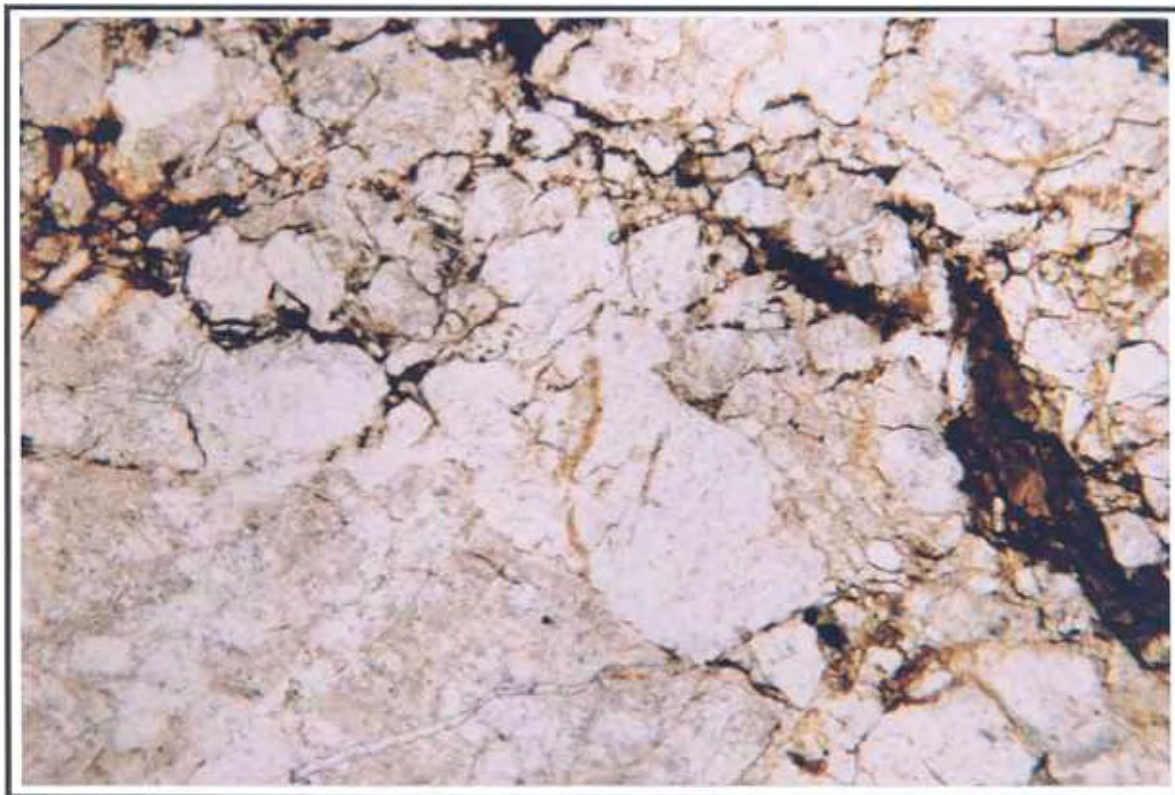
The various clasts typically show rather loose packing, and are seldom seen in contact. They are now cemented by an abundant matrix of fine-grained, brownish carbonate. There is some evidence of marginal replacement of clasts by the carbonate cement.

The sectioned area is traversed by multi-directional veinlets of carbonate, ranging in thickness from 0.1 - 1.5 mm. A few of these are coated with films of limonite, which also occurs as a localized, faint, diffuse staining in the body of the rock

The carbonate veinlets are strongly reactive to 10% HCl, indicating calcitic composition. Reaction with the carbonate clasts and cement is more subdued, and these may include a component of dolomite or ankerite.



Plane Polarized



Plane Polarized

Figure E-2. Photomicrograph of Sample 2: Boring 06-2, 125 Feet

**SAMPLE 2: 06-2 125.5 - 126.0 ft. CRUSHED QUARTZ DIORITE(?)**

Estimated mode

Plagioclase	58
Quartz	25
Biotite	5
Carbonate	12
Limonite	trace

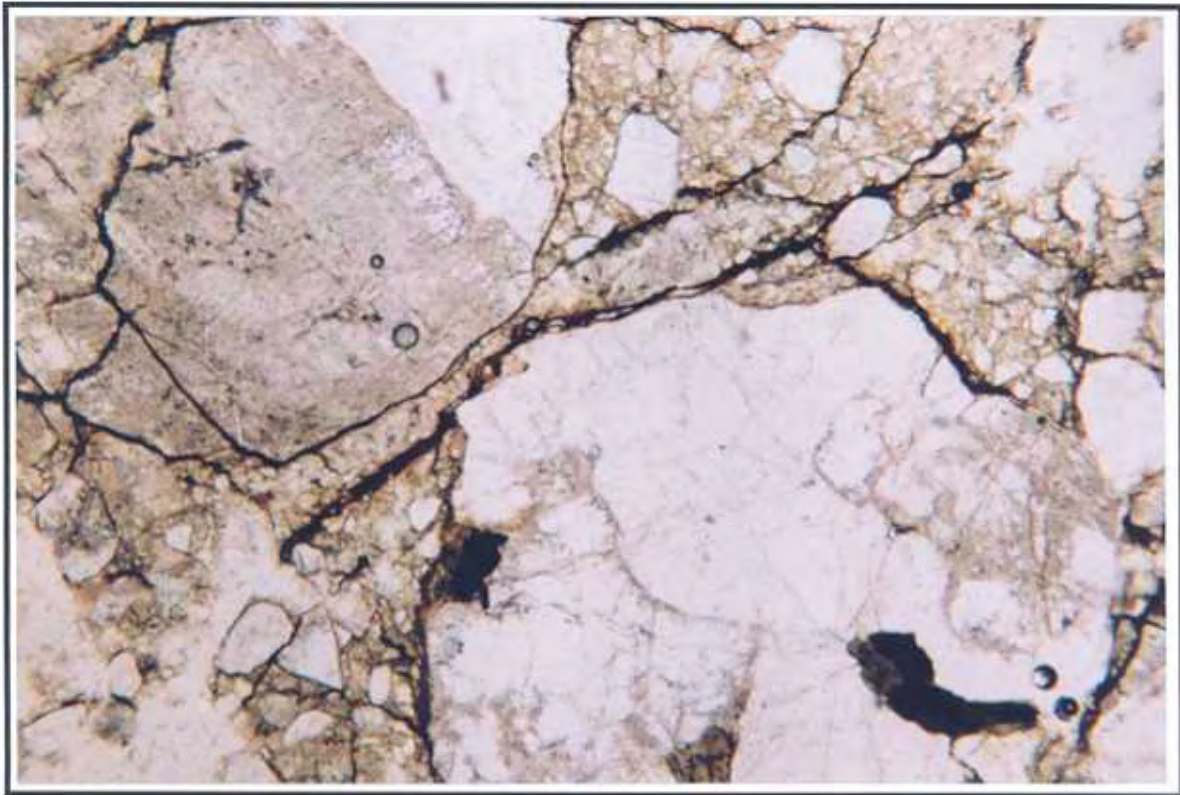
The off-cut corresponding to the sectioned portion of this sample differs strongly in macroscopic appearance from that of Sample 1. It is more heterogenous; the average clast size is larger; and there is a perceptible foliation. The latter is apparently defined by the parallel orientation of coarser clasts or aggregates thereof, alternating with finer material.

Thin section examination confirms the textural heterogeneity, and suggests that this rock may be of cataclastic rather than clastic character, representing a strongly crushed and brecciated granitoid rock of quartz diorite composition. The degree of crushing shows small-scale variations, with relatively coherent protolithic remnants up to 1 cm or so in size, occurring within finely granulated material of grain size ranging down to 10 - 100 microns (see photos).

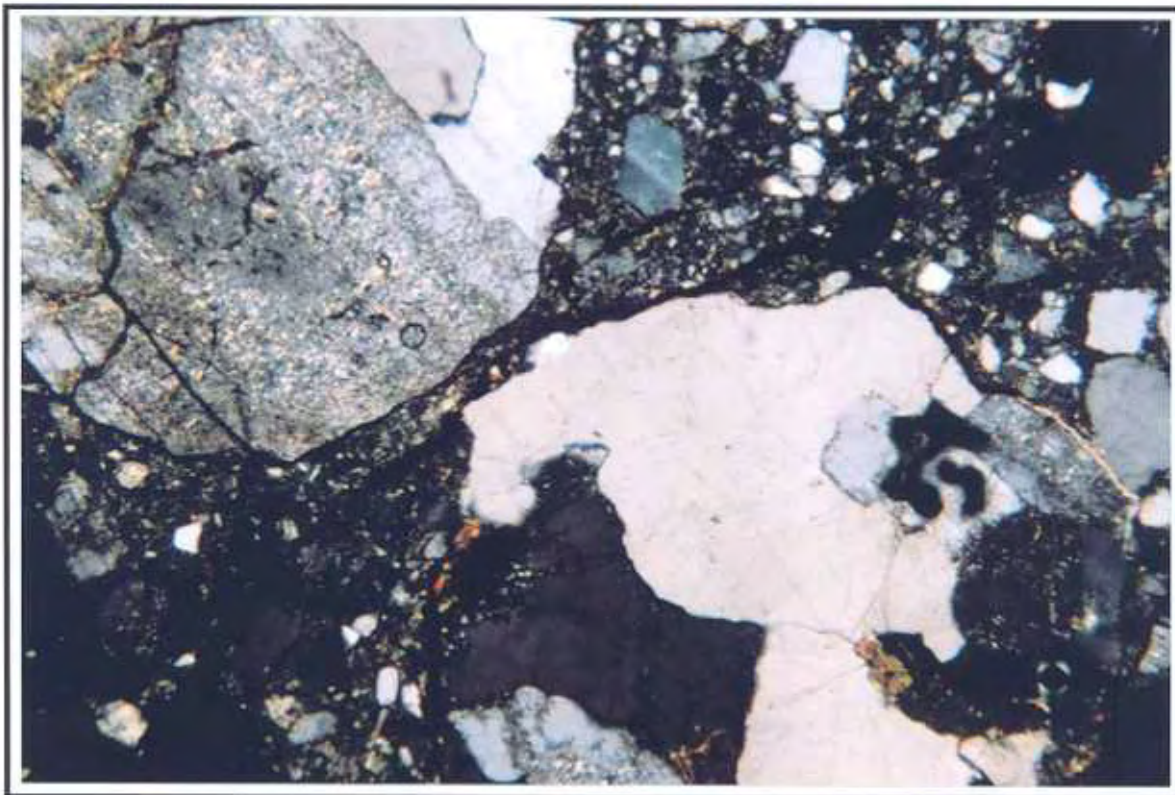
An alternate interpretation would be that this is a form of conglomerate, with coarse pebbles cemented by a finer wacke-like component. However, the outlines of the coarser lithic remnants show an apparent partial gradation to the finer material which seems less consistent with a conglomerate character than with the crushed quartz diorite model (compare photos with those of Samples 3 and 7).

The more finely comminuted areas have a matrix/interstitial phase which apparently consists of a mixture of minutely foliaceous biotite and earthy limonite.

Carbonate is abundant in some areas of the rock. It occurs as small, random pockets in the finer areas, and as swarms of veinlets cutting some of the coarser, clast-like remnants. In addition, one corner of the slide incorporates an irregular segregation of finely granular carbonate which may be of replacement origin (incorporating what appear to be pseudomorphed clasts). This segregation includes open vugs fringed by sparry carbonate.



Plane Polarized



Cross Polarized

Figure E-3. Photomicrograph of Sample 3: Boring 06-2, 139 Feet

SAMPLE 3: 06-2 138.6 - 139.0 ft. ARKOSIC CONGLOMERATE

Estimated mode

Quartz	35
Plagioclase	57
Sericite	3
Biotite	5
Carbonate	trace
Limonite	trace

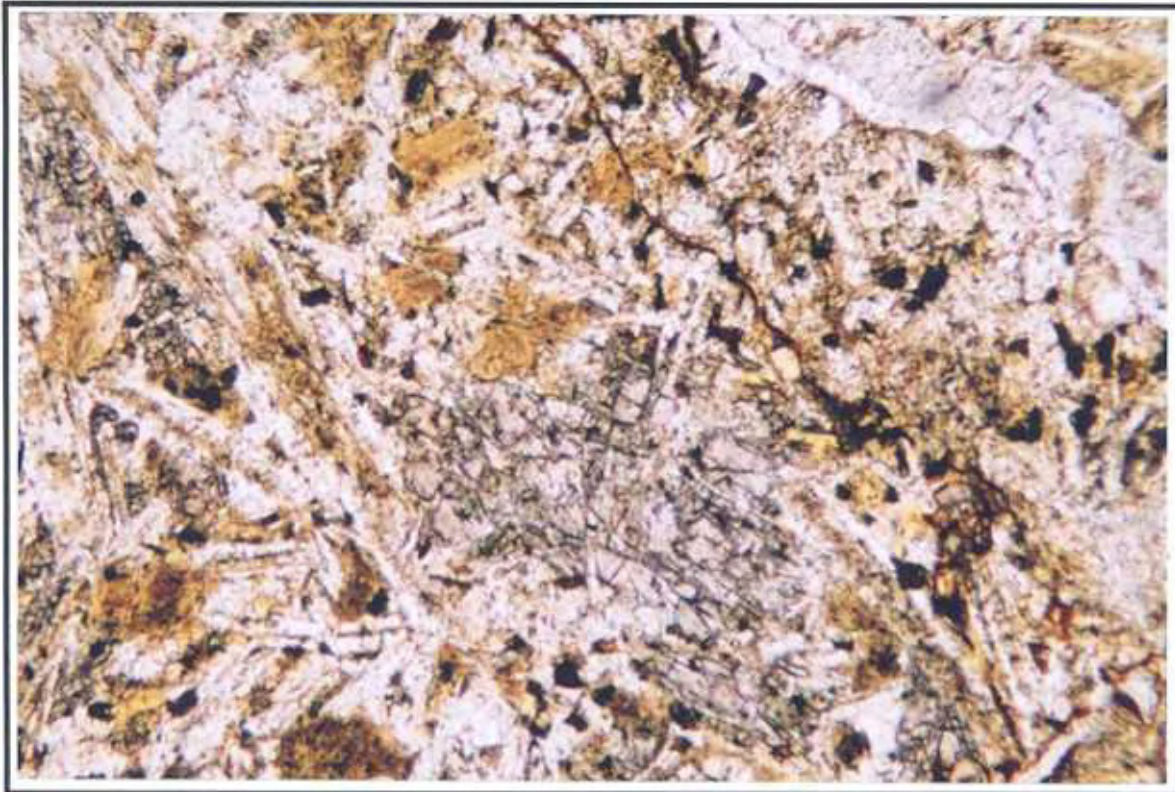
The macroscopic appearance of the off-cut of this sample is intermediate between that of Sample 1 and Sample 2. It has the look of a poorly sorted clastic rock, though with a wider size range and greater mean clast size than Sample 1. It lacks the oriented fabric and altered look of Sample 2.

Thin section examination shows that clasts are much better defined than in Sample 2, and appear to represent sub-rounded pebbles, ranging in size from 1 - 8 mm or so, set in a finer sandy/silty clastic matrix of grain size 10 - 500 microns (see photos).

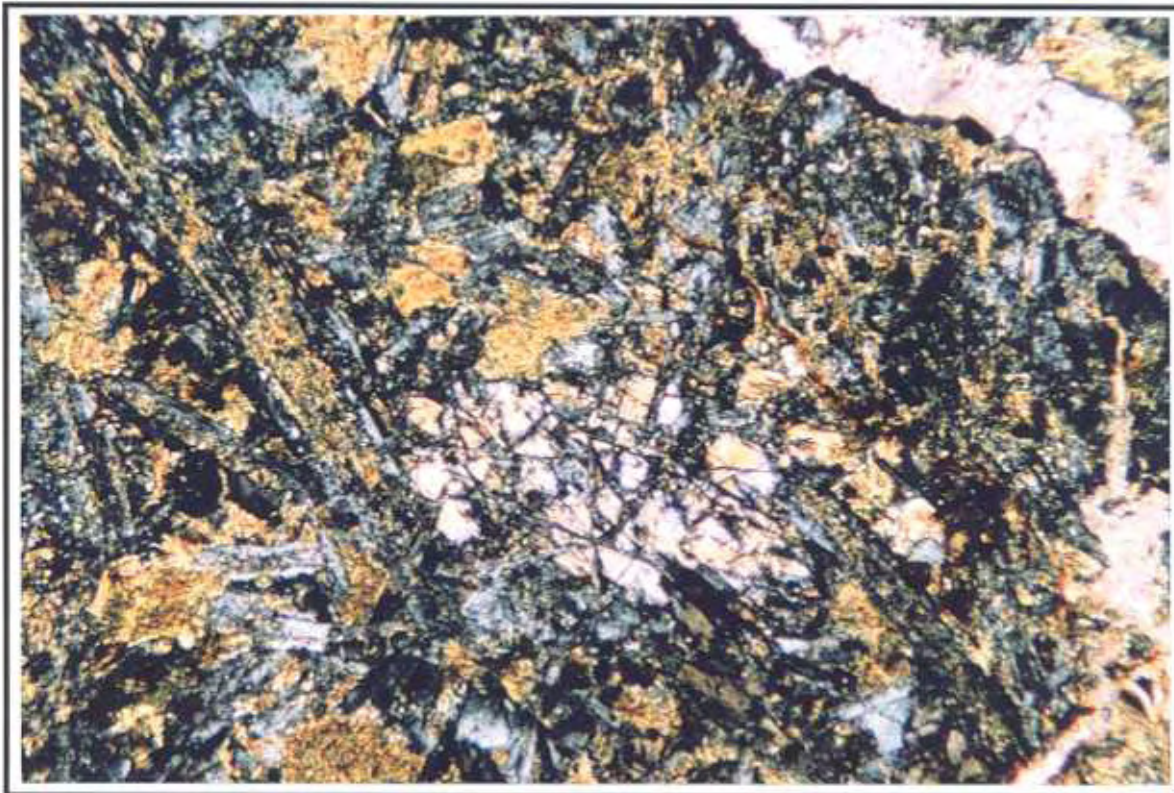
The coarser pebbles are clearly recognizable as typical intrusive-type quartz diorite, consisting essentially of an anhedral intergrowth of mildly sericitized plagioclase and quartz on a scale of 0.2 - 2.0 mm. Brown biotite is a minor accessory, and there is sometimes a little carbonate as hairline veinlets and intergranular pockets.

The fine matrix phase appears to show similar mineral proportions, consistent with a finely disaggregated quartz diorite. It is devoid of the carbonate cement which is a prominent constituent in Sample 1.

A little limonite delineates pebble outlines and fills hairline fractures.



Plane Polarized



Cross Polarized

Figure E-4. Photomicrograph of Sample 4: Boring 06-2, 144 Feet

SAMPLE 4: 06-2 144.0 - 144.3 ft.      ALTERED MAFIC VOLCANIC

Estimated mode

Plagioclase	50
Sericite	trace
Pyroxene	7
Altered glass	38
Carbonate veinlets	5
Limonite	trace

The macroscopic appearance of this sample (see off-cut) is that of a soft, altered rock lacking recognizable clastic or fragmental character,

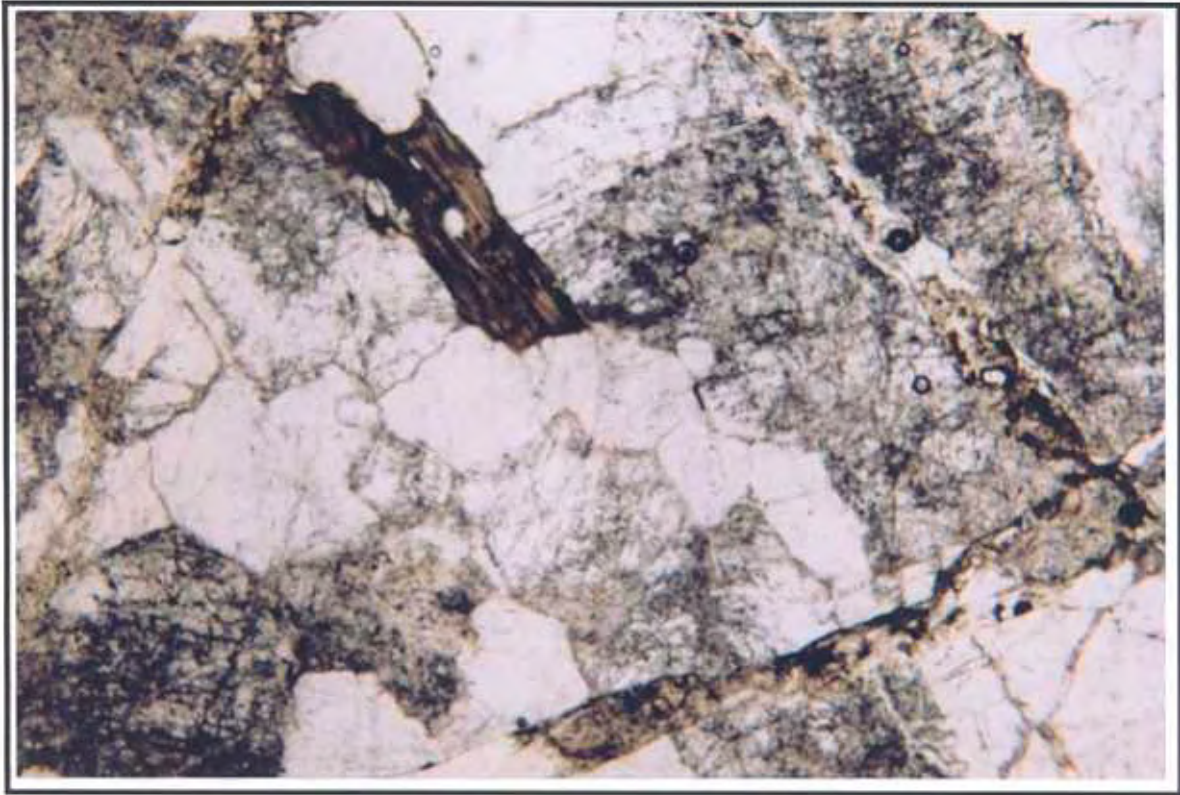
Thin section examination confirms that it is something quite different from the other rocks of the suite. It consists of a meshwork intergrowth of slender laths of plagioclase, 50 - 100 microns in length, and a brown interstitial phase having the appearance of altered mafic glass. The latter is mainly cryptocrystalline, but locally shows a minutely felted texture.

Small granular clumps of pale brown pyroxene are a widespread minor accessory. There are also sparsely scattered, coarser phenocrystic bodies of partially sericitized plagioclase, pyroxene, and what was probably once hornblende.

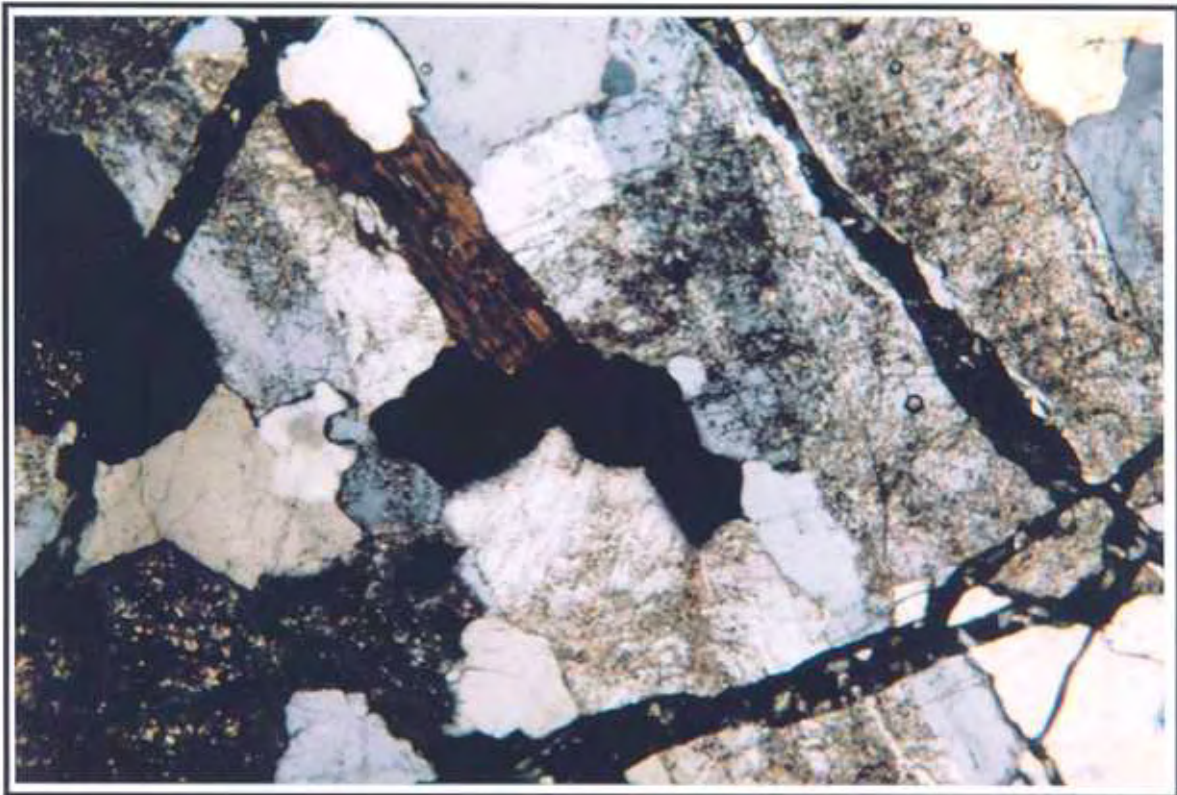
The sectioned area is traversed by multidirectional veinlets of sparry carbonate, 0.1 - 1.0 mm in thickness. These are often more or less strongly stained by limonite.

The mineralogy, and the intersertal, sparsely porphyritic texture of this rock clearly indicate that it is a mafic igneous rock of dioritic to basaltic composition.





Plane Polarized



Cross Polarized

Figure E-5. Photomicrograph of Sample 5: Boring 06-2, 198 Feet

SAMPLE 5: 06-2 198.2 - 198.5 ft. FRACTURED QUARTZ DIORITE

Estimated mode

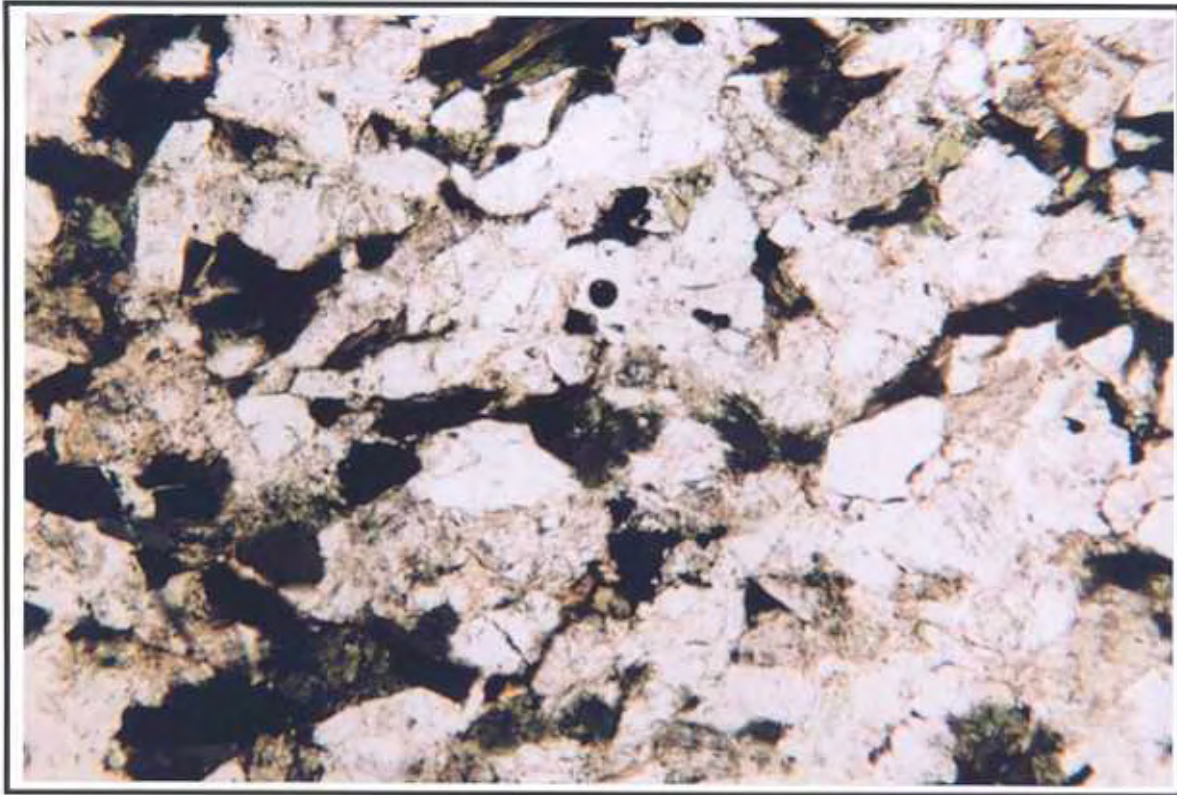
Quartz	28
Plagioclase	65
Sericite	3
Biotite	3
Hornblende	1
Epidote	trace
Limonite	trace

The off-cut corresponding to the sectioned area of this sample shows extensive pitting, suggesting altered, poorly coherent character.

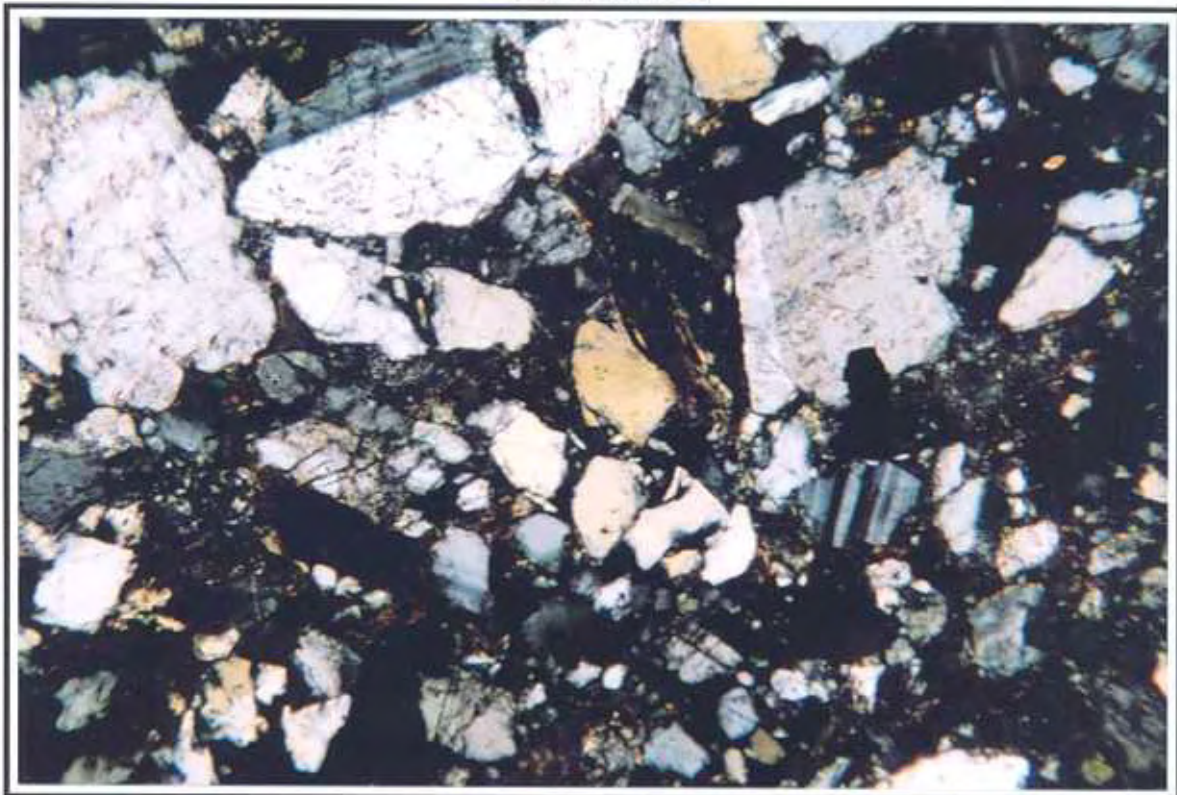
The thin section examination contradicts this impression, revealing that the sample is actually a rather fresh granitoid igneous rock of typical intrusive textural aspect, having the composition of quartz diorite.

It consists essentially of an anhedral intergrowth of quartz and mildly sericitized plagioclase, on a scale of 0.2 - 3.0 mm. Minor mafic accessories are biotite (somewhat altered) and lesser hornblende (generally fresh).

The rock is cut by a network of sharply defined, thin fractures - sometimes filled with finely brecciated material, and/or coated by limonite. This feature is probably the cause of the blocky incoherence and pitting observed in the off-cut.



Plane Polarized



Cross Polarized

Figure E-6. Photomicrograph of Sample 6: Boring 06-3, 173.5 Feet

SAMPLE 6: 06-3 173.5 ft. ARKOSIC SANDSTONE

Estimated mode

Quartz	24
Plagioclase	60
Sericite	2
Biotite	10
Hornblende	2
Epidote	trace
Siltstone)	2
Felsite)	

The off-cut of this sample closely resembles that of Sample 1.

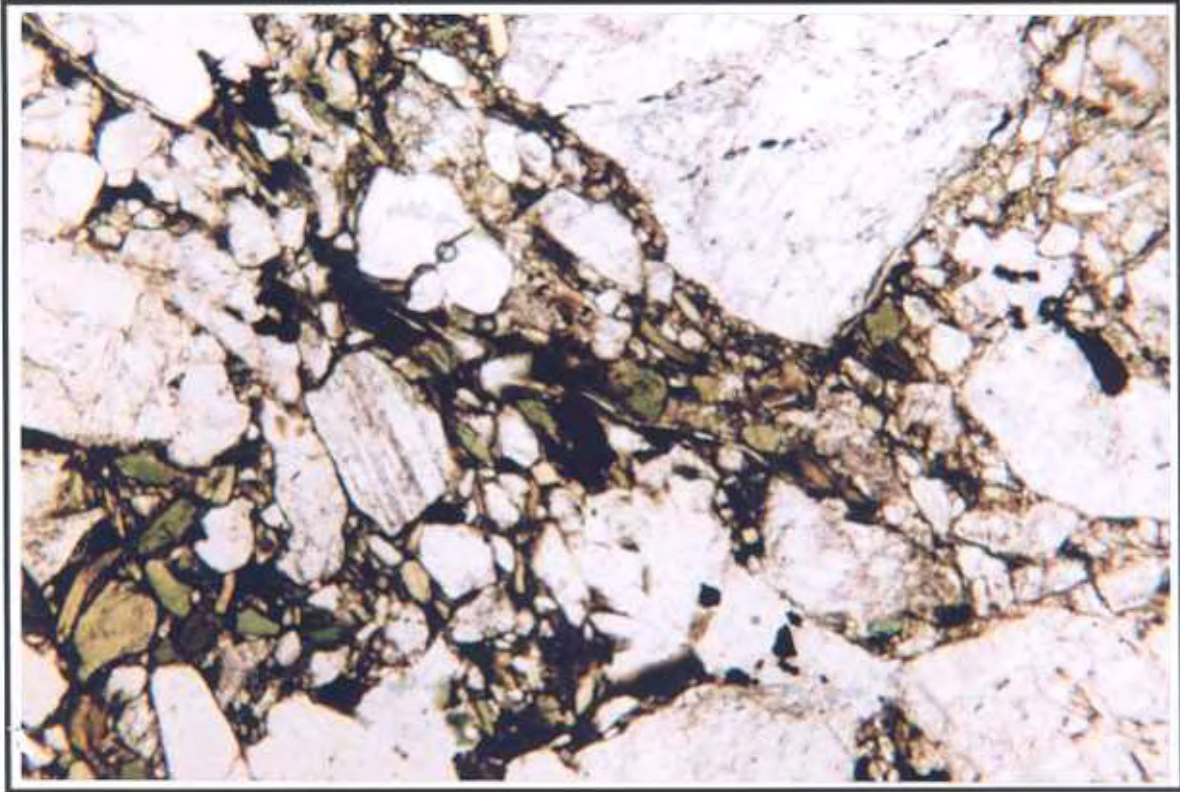
Thin section examination reveals that, it is an arkosic sandstone or wacke of similar overall grain size to Sample 1. However, it differs from that sample in that it is devoid of carbonate cement (and carbonate clasts). The constituent sand grains occur in close contact - the only recognizable cementing phase being minor local development of silt-sized material.

The overall composition also differs somewhat from Sample 1. The ratio of quartz to plagioclase is lower, and the proportion of biotite substantially higher. In addition, a minor component of hornblende is recognizable in the present sample

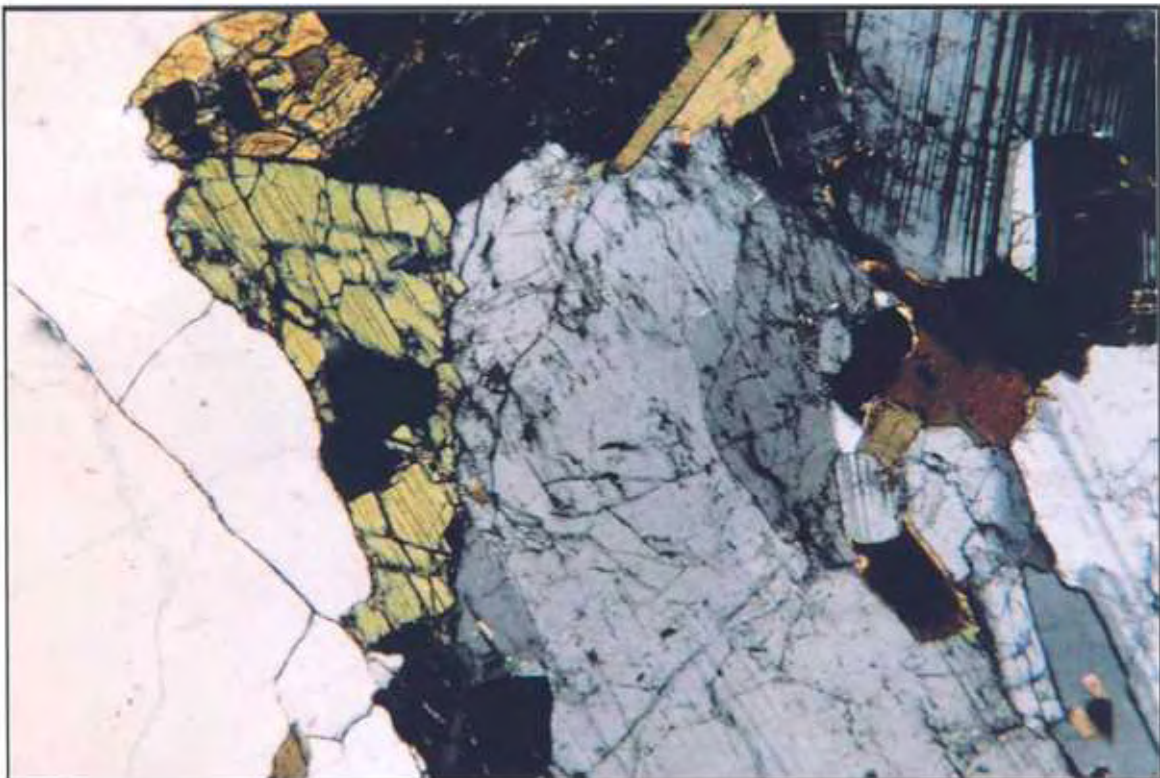
The bulk of the clasts are silt to fine sand grains in the 50 - 500 micron size range. However, there are also scattered coarser clasts (plagioclase crystal fragments, and lithic fragments of quartz diorite) up to 2.0 mm in size. As in Sample 1, grain shapes are typically sharply angular to sub-angular.

The plagioclase grains range from fresh to partially sericitized. The accessory mafics are typically fresh.

The accessory biotite in this rock exhibits a very weak preferred orientation.



Plane Polarized



Cross Polarized

Figure E-7. Photomicrograph of Sample 7: Boring 06-3, 200.5 Feet

**SAMPLE 7: 06-3 200.4 - 200.8 ft. QUARTZ DIORITIC CONGLOMERATE**

Estimated mode

Plagioclase	52
Quartz	22
Biotite	13
Hornblende	7
Sericite	1
Andesitic clasts	5

It is clear from the macroscopic features of the off-cut that this sample is a coarse-grained clastic rock. About 50% of the sectioned area is occupied by part of a large clast of quartz diorite >3.5 cm in size. In the remainder of the slide, the clasts show a wide size range from 8 mm down to about 0.02 m (20 microns).

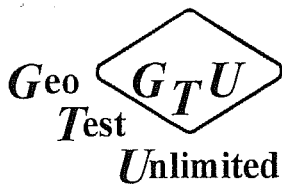
The fragments making up this rock mostly show partial rounding, and their mineralogy suggests that the majority represent various degrees of disaggregation of the quartz dioritic lithotype exemplified by the coarsest clast.

The latter consists essentially of an anhedral intergrowth of quartz and fresh plagioclase in a grain size range of 0.2 - 5.0 mm. Biotite and hornblende, closely associated as clumps and grains up to 1.5 mm in size, are the principal accessories. Opaque (Fe/Ti) oxides and traces of apatite are the remaining constituents. All minerals are markedly fresh.

The smaller clasts in this rock are intergrowths of the above minerals or disaggregated mineral grains therefrom. The rock is tightly self-cemented, with progressively finer material, down to the finest silt, packed interstitially between the gravel and coarse sand-sized clasts.

A minor proportion of the clasts are recognizable as fragments of felsitic volcanic material. One example in the sectioned area is a relatively large (1 cm) pebble of a microlitic andesite containing small phenocrysts of biotite and hornblende. This is of similar general composition to the lithotype represented by Sample 4.

**APPENDIX F**  
**SLAKE DURABILITY TESTING**



## **Slake Durability Test for Weak Rock (in accordance with ASTM D4644)**

### **Test Equipment**

The samples are reduced to the required size using a hammer and anvil or a point load tester. The samples are weighed with a PC2200 Mettler precision scale, and the samples are dried in an Imperial III Lab Line oven. The slake durability test apparatus was built by GTU following the specifications in the ASTM test procedure.

### **Test Procedure**

The rock sample is first broken down into pieces with weights between 40 and 60 grams. Then 10 of these pieces are collected resulting in a total sample weight of 450-550 g. A photograph is then taken to record the initial appearance of the sample.

The slake apparatus drum is weighed and the sample is added to the drum to obtain a collective weight. The sample is dried in the drum for greater than 16 hr, and then reweighed to obtain the initial water content and the initial dry weight of the sample.

The drum is placed in the drive apparatus and water added to the appropriate level (0.8 inches from the drum axis). Then the drum is rotated at a rate of 20 rpm for a period of ten minutes. The drum is removed and dried in the oven for greater than 16 hr. to obtain the first cycle dry weight of the sample.

The sample and drum is reinstalled in the drive apparatus and the process repeated. After the second drying and weighing, the final condition of the sample is recorded with a photograph.

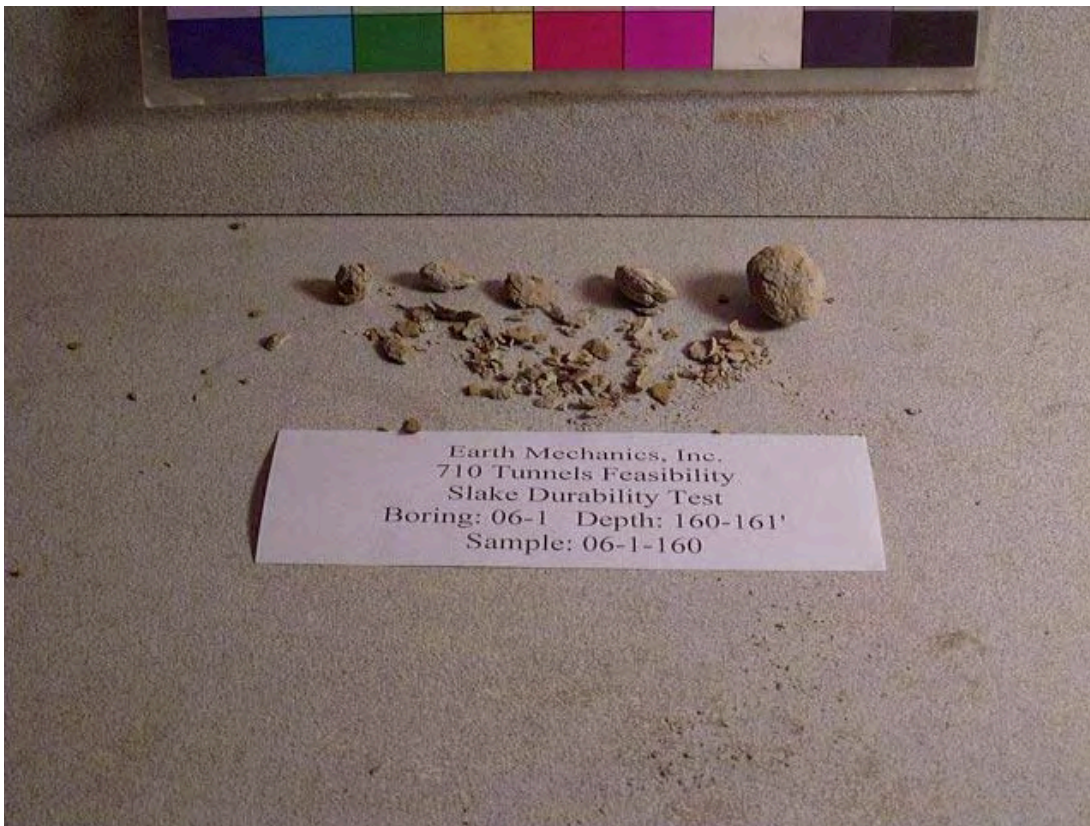
The classification of the material (Type I being a relatively unaltered material, Type II being a sample which has degraded somewhat leaving both large sample pieces and small chips, or Type III being a sample which has slaked to the extent that no large pieces remain) is determined after the second cycle. The slake durability index is calculated as the dry weight following the second abrasion cycle divided by the initial dry weight (times 100).

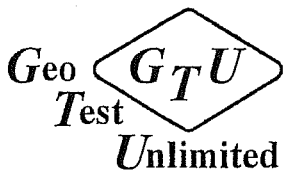


**Table E-1. Slake Durability Test Results**

<b>Boring No.</b>	<b>Run No.</b>	<b>Depth (ft)</b>	<b>Rock Type</b>	<b>Slake Durability Index (%)</b>
06-1	6	160 to 161	Weak, laminated (cemented) Siltstone	2.5
06-1	15	199 to 199.9	Siltstone-Claystone	26.7

Note: See photographs on next two pages showing rock samples prior to and after testing.





DATA SHEET  
Slake Durability Test (ASTM D4644)

Date: 3/7-10/06  
Technician: A. Bro

Client : Earth  
Job : #218 - 710 Tunnels Feasibility  
Sample ID: 06-1-160 (Boring 16-1)  
Sample Depth: 160-161"

Sample Description: light grayish tan laminated siltstone -  
very weakly cemented - alternatively could be classified  
as weakly cemented silt. Friable and easy to break with  
the fingers

Sample Description Following the Test: one medium size rounded pieces plus  
several small 5/8" disc shaped chips (TYPE II)

Empty Drum Weight # 2 : 1503.5g  
Initial Wet Sample Weight (w/drum) : 2023.7g  
Initial Dry Sample Weight (16hr@110C) : 1900.2g  
Weight of water : 123.5  
Water content : 31.1%

	RUN 1	RUN 2	RUN 3
Water Temperature before (C):	<u>27°</u>	<u>20°</u>	
Water Temperature after (C):	<u>26°</u>	<u>27°</u>	<u>N/A</u>
Dry Sample Weight (w/drum after 10 min of tumbling @20 rpm)	<u>1557.0</u>	<u>1513.6</u>	

Initial dry weight (W<sub>i</sub>): 396.7  
Final dry weight (W<sub>f</sub>): 10.1  
Slake Durability Index (I<sub>d</sub>=W<sub>f</sub>/W<sub>i</sub> x 100): 2.5%





DATA SHEET  
Slake Durability Test (ASTM D4644)

Date: 3/7-10/06  
Technician: A. Bro

Client : Earth Mechanics  
Job : #218 - 710 Tunnels Feasibility  
Sample ID: 06-1-199 (Boring 06-1)  
Sample Depth: 199-199.9'  
Sample Description: Dark gray layered clayey siltstone stronger than 06-1-160, but you can still break it by hand.

Sample Description Following the Test: Most pieces remained intact but reduced in volume. Traveled with several smaller broken-off pieces. (TYPE II)

Empty Drum Weight #3 : 1534.9 g  
Initial Wet Sample Weight (w/drum) : 2071.2 g  
Initial Dry Sample Weight (16hr@110C) : 1972.7 g  
Weight of water : 98.5  
Water content : 22.5%

	RUN 1	RUN 2	RUN 3
Water Temperature before (C):	<u>27°</u>	<u>30°</u>	<u>N/A</u>
Water Temperature after (C):	<u>26°</u>	<u>27°</u>	<u>N/A</u>
Dry Sample Weight (w/drum after 10 min of tumbling @20 rpm)	<u>1815.3</u>	<u>1651.7</u>	<u>N/A</u>

Initial dry weight (W<sub>i</sub>): 437.8  
Final dry weight (W<sub>f</sub>): 116.8  
Slake Durability Index (I<sub>d</sub>=W<sub>f</sub>/W<sub>i</sub> x 100): 26.7%



**PHASE II GEOTECHNICAL FEASIBILITY  
OF THE PROPOSED  
INTERSTATE 710 FREEWAY EXTENSION  
THROUGH THE MONTEREY HILLS  
LOS ANGELES COUNTY, CALIFORNIA  
CONTRACT NO. 07A0406, TASK ORDER NO. 2**

**PREPARED FOR:**

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**PREPARED BY:**

Ninyo & Moore Geotechnical and Environmental Sciences Consultants  
9272 Jeronimo Road, Suite 123A  
Irvine, California 92618

March 25, 1999  
Project No. 201769-01

## APPENDIX B

### LABORATORY TESTING

#### **Classification**

Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D 2488-93. Soil classifications are indicated on the logs of the exploratory excavations in Appendix A.

#### **Moisture Content**

The moisture content of samples obtained from the exploratory excavations was evaluated in accordance with ASTM D 2216-92. The test results are presented on the logs of the exploratory excavations in Appendix A.

#### **In-Place Moisture and Density Tests**

The moisture content and dry density of relatively undisturbed samples obtained from the exploratory excavations were evaluated in general accordance with ASTM D 2937-94. The test results are presented on the logs of the exploratory excavations in Appendix A.

#### **Gradation Analysis**

Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D 422-63. The grain-size distribution curves are shown on Figures B-1 through B-4. These test results were utilized in evaluating the soil classifications in accordance with the Unified Soil Classification System.

#### **Atterberg Limits**

Tests were performed on selected representative fine-grained soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D 4318-95. These test results were utilized to evaluate the soil classification in accordance with the Unified Soil Classification System. The test results and classifications are shown on Figure B-5.

#### **Direct Shear Tests**

Direct shear tests were performed on undisturbed (and remolded) samples in general accordance with ASTM D 3080-90 to evaluate the shear strength characteristics of selected materials. The samples were inundated during shearing to represent adverse field conditions. The results are shown on Figures B-6 through B-12.

### **Expansion Index Tests**

The expansion index of selected materials was evaluated in general accordance with U.B.C. Standard No. 18-2. Specimens were molded under a specified compactive energy at approximately 50 percent saturation (plus or minus 1 percent). The prepared 1-inch thick by 4-inch diameter specimens were loaded with a surcharge of 144 pounds per square foot and were inundated with tap water. Readings of volumetric swell were made for a period of 24 hours. The results of these tests are presented on Figure B-13.

### **Maximum Dry Density and Optimum Moisture Content Tests**

The maximum dry density and optimum moisture content of selected representative soil samples were evaluated in general accordance with ASTM D 1557-91. The results of these tests are summarized on Figure B-14.

### **Soil Corrosivity Tests**

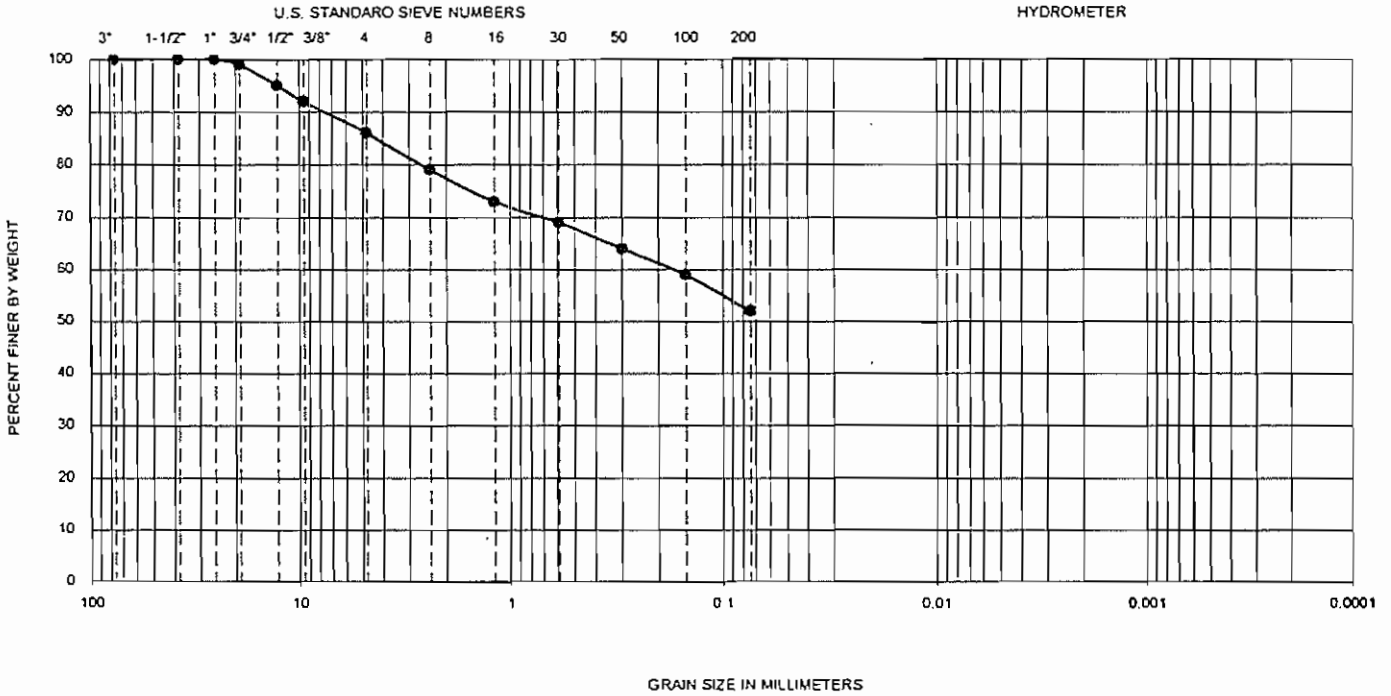
Soil pH, and minimum resistivity tests were performed on representative samples in general accordance with California Test (CT) 643. The chloride content of selected samples was evaluated in general accordance with CT 422. The sulfate content of selected samples was evaluated in general accordance with CT 417. The test results are presented on Figure B-15.

### **Sand Equivalent**

Sand equivalent (SE) tests were performed on selected representative samples in general accordance with ASTM D 2419-95. The SE value reported on Figure B-16 is the ratio of the coarse- to fine-grained particles in the selected samples.



GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay



Symbol	Hole No.	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D <sub>10</sub>	D <sub>30</sub>	D <sub>60</sub>	C <sub>u</sub>	C <sub>c</sub>	Passing No. 200 (%)	U.S.C.S
●	B-1	3.0-5.0	42	21	21	-	-	-	-	-	52	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422-63

**Ninyo & Moore**

**GRADATION TEST RESULTS**

INTERSTATE 710 EXTENSION  
LOS ANGELES COUNTY, CALIFORNIA

PROJECT NO.

201769-01

DATE

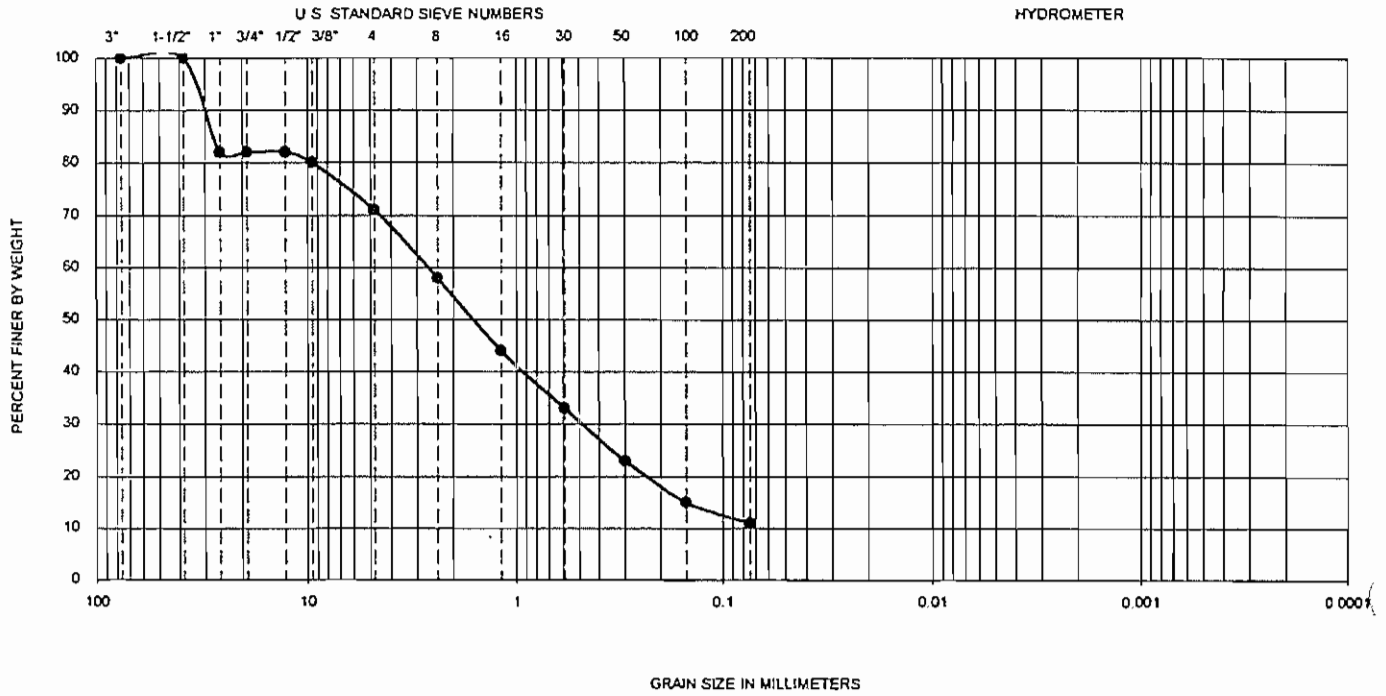
3/99

FIGURE

B-1

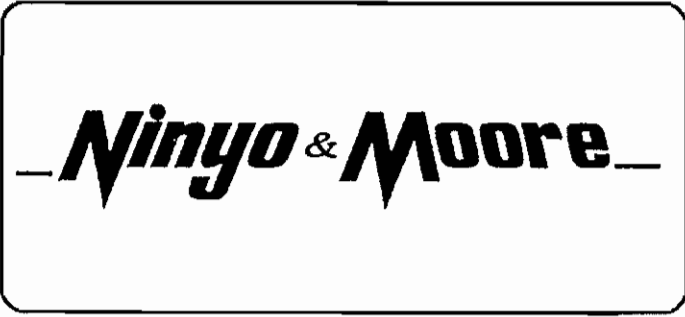


GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay



Symbol	Hole No.	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D <sub>10</sub>	D <sub>30</sub>	D <sub>60</sub>	C <sub>u</sub>	C <sub>c</sub>	Passing No. 200 (%)	U.S.C.S
●	B-4	30.0-33.0	--	--	--	0.06	0.50	2.50	41.7	1.7	11	SW-SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422-63



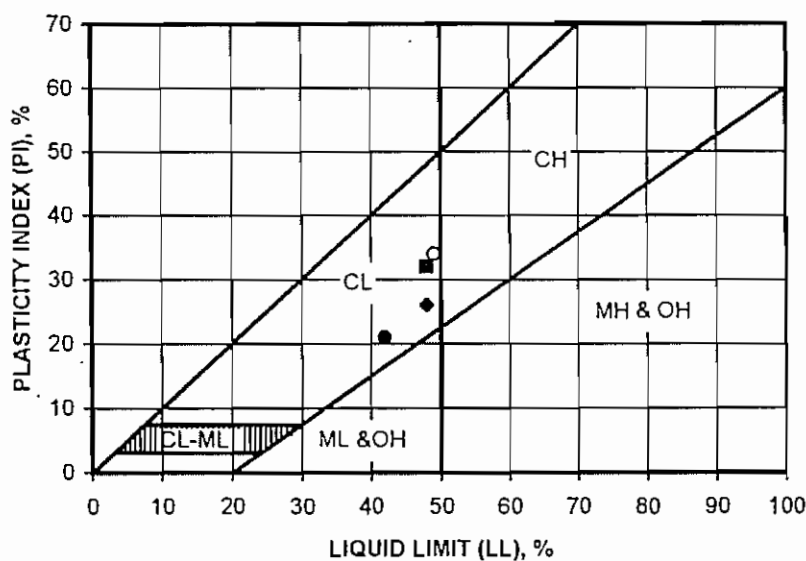
## GRADATION TEST RESULTS

INTERSTATE 710 EXTENSION  
LOS ANGELES COUNTY, CALIFORNIA

PROJECT NO.	DATE	FIGURE
201769-01	3/99	B-4

SYMBOL	LOCATION	DEPTH (FT)	LL (%)	PL (%)	PI (%)	U.S.C.S. CLASSIFICATION (Minus No. 40 Sieve Fraction)	U.S.C.S. (Entire Sample)
●	B-1	3.0-5.0	42	21	21	CL	CL
■	B-1	30.0-31.5	48	16	32	CL	CL
◆	B-2	10.0-11.0	48	22	26	CL	Claystone
○	B-3	29.0-30.5	49	15	34	CL	CL

NP - Indicates non-plastic

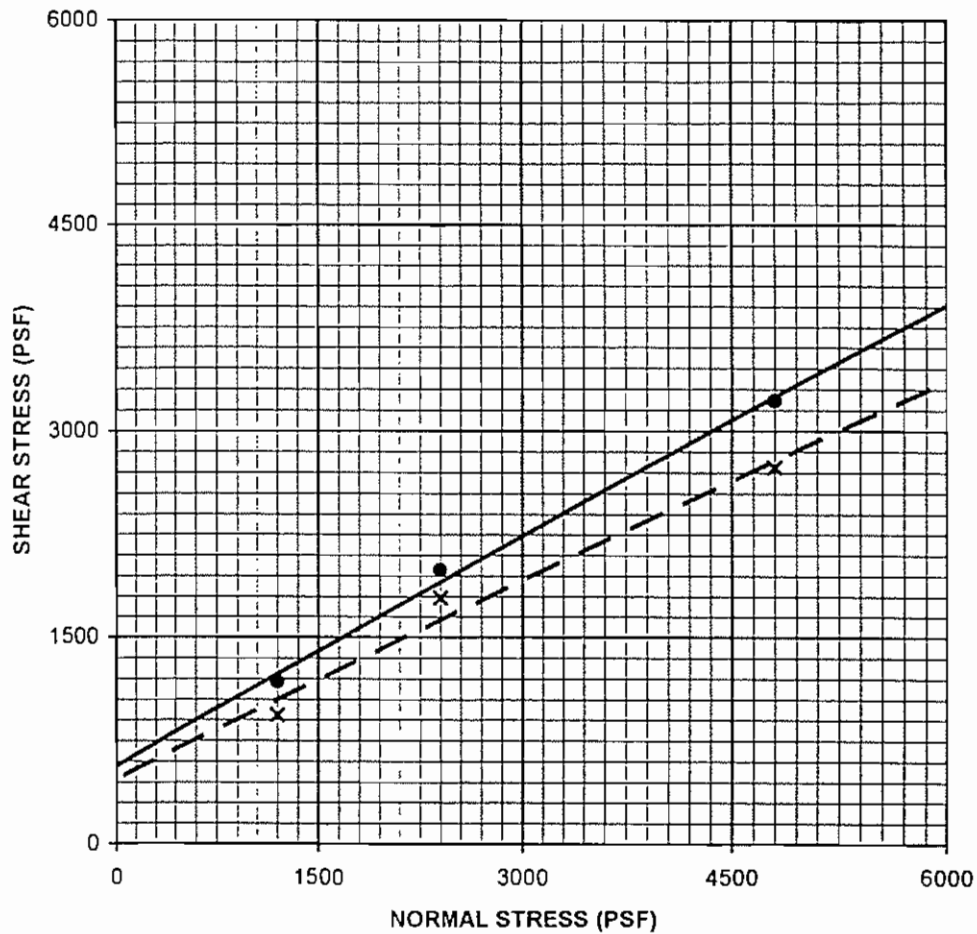


PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318-95

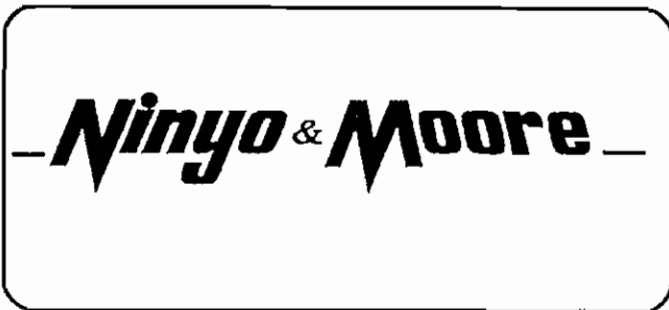


**ATTERBERG LIMITS TEST RESULTS**  
 INTERSTATE 710 EXTENSION  
 LOS ANGELES COUNTY, CALIFORNIA

PROJECT NO.	DATE	FIGURE
201769-01	3/99	B-5



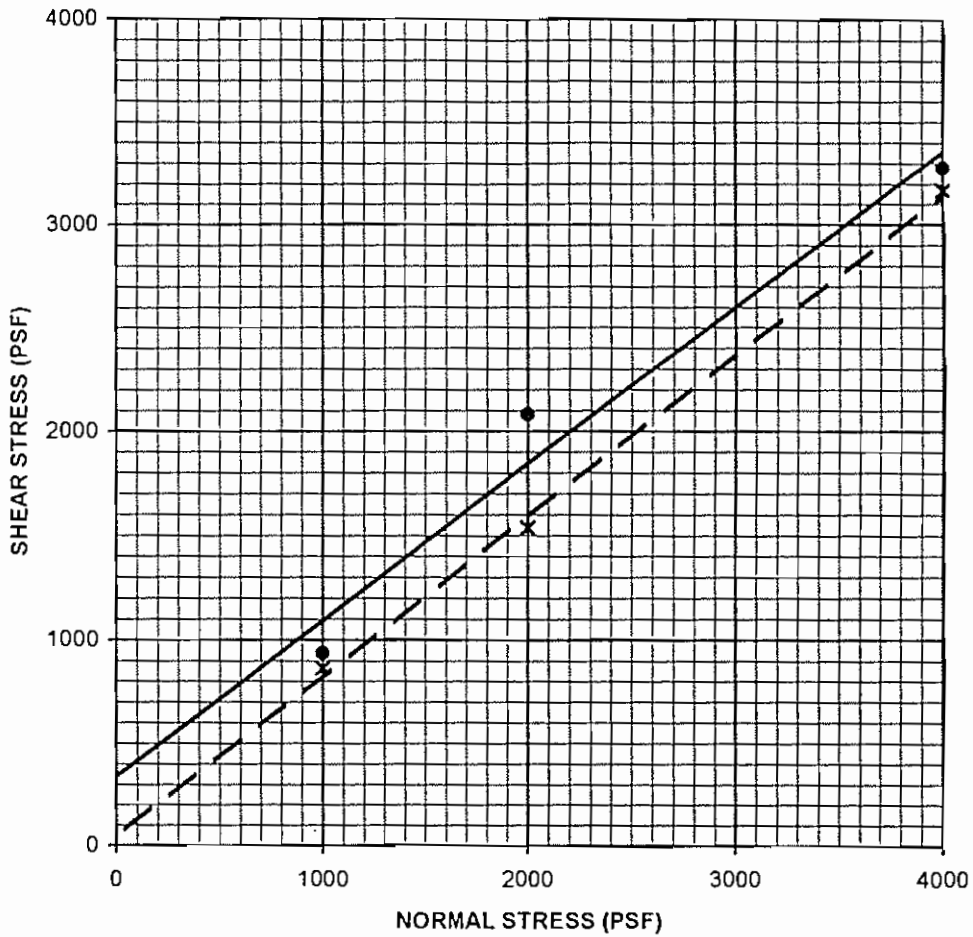
Description	Symbol	Boring Number	Depth (ft)	Shear Strength	Cohesion (psf)	Friction Angle (deg)	Soil Type
Sandy Clay	●	B-1	20.0-21.5	Peak	560	29	CL
Sandy Clay	x	B-1	20.0-21.5	Ultimate	460	26	CL



**DIRECT SHEAR TEST RESULTS**  
**INTERSTATE 710 EXTENSION**  
**LOS ANGELES COUNTY, CALIFORNIA**

<b>PROJECT NO.</b>	<b>DATE</b>
201769-01	3/99

<b>FIGURE</b>
B-6



Description	Symbol	Boring Number	Depth (ft)	Shear Strength	Cohesion (psf)	Friction Angle (deg)	Soil Type
Topanga Fm.*	●	B-2	8.0-9.0	Peak	340	37	Siltstone to Claystone
Topanga Fm.*	x	B-2	8.0-9.0	Ultimate	50	38	Siltstone to Claystone

\*Remolded to 90% relative compaction

### DIRECT SHEAR TEST RESULTS

INTERSTATE 710 EXTENSION  
LOS ANGELES COUNTY, CALIFORNIA

PROJECT NO.

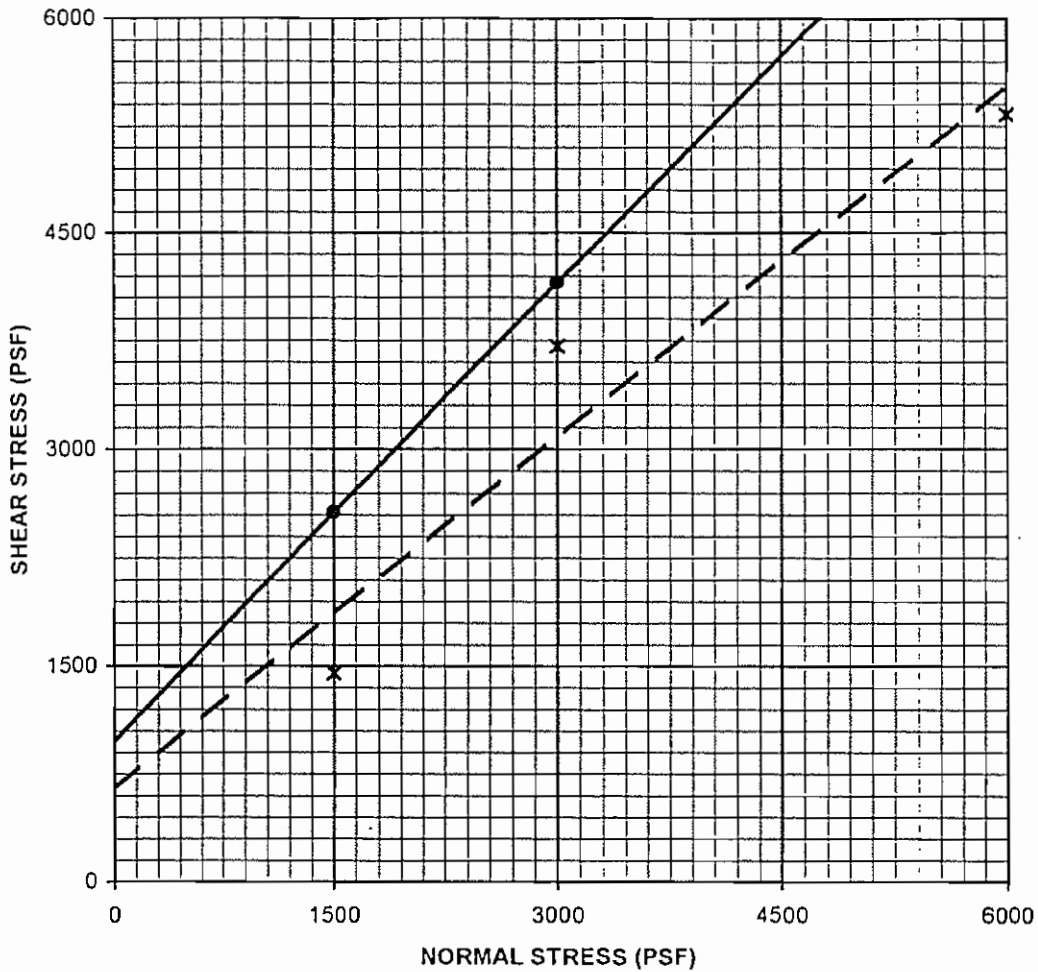
201769-01

DATE

3/99

FIGURE

B-7



Description	Symbol	Boring Number	Depth (ft)	Shear Strength	Cohesion (psf)	Friction Angle (deg)	Soil Type
Topanga Fm.	●	B-2	25.0-26.0	Peak	980	47	Siltstone
Topanga Fm.	x	B-2	25.0-26.0	Ultimate	640	39	Siltstone

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**DIRECT SHEAR TEST RESULTS**

INTERSTATE 710 EXTENSION  
LOS ANGELES COUNTY, CALIFORNIA

PROJECT NO.

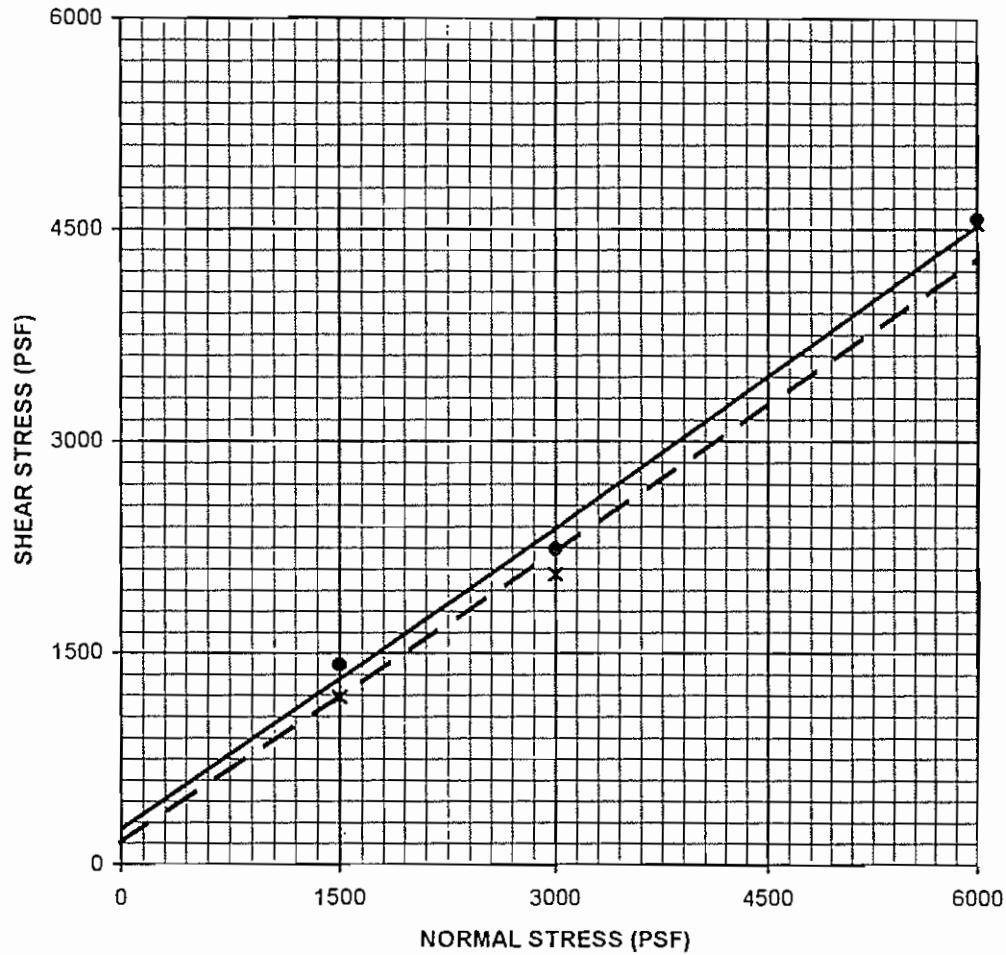
201769-01

DATE

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FIGURE

B-8



Description	Symbol	Boring Number	Depth (ft)	Shear Strength	Cohesion (psf)	Friction Angle (deg)	Soil Type
Silty Sand	●	B-4	24.0-25.0	Peak	250	35	SM
Silty Sand	x	B-4	24.0-25.0	Ultimate	150	34	SM

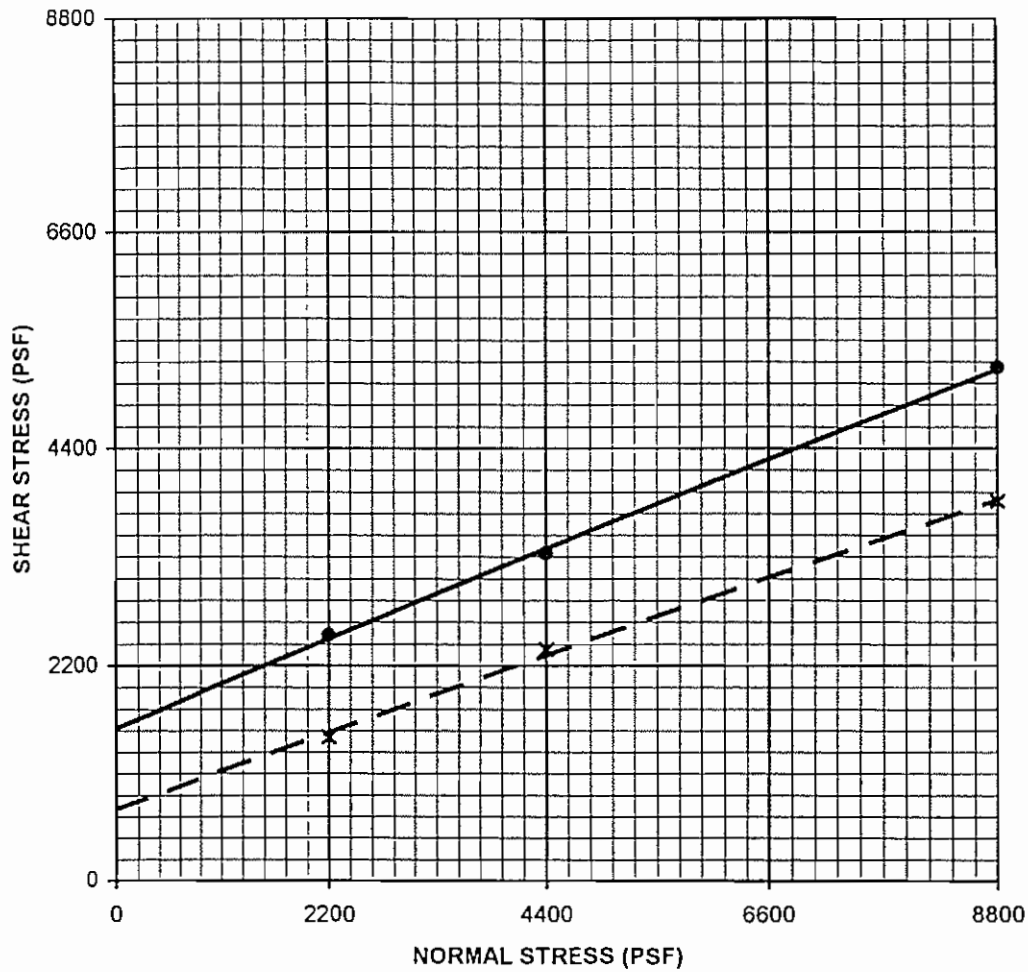


**DIRECT SHEAR TEST RESULTS**  
 INTERSTATE 710 EXTENSION  
 LOS ANGELES COUNTY, CALIFORNIA

<b>PROJECT NO.</b>	<b>DATE</b>
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<b>FIGURE</b>
B-11





Description	Symbol	Boring Number	Depth (ft)	Shear Strength	Cohesion (psf)	Friction Angle (deg)	Soil Type
Silty Clay	●	B-4	39.0-40.5	Peak	1570	22	CL
Silty Clay	x	B-4	39.0-40.5	Ultimate	730	20	CL



**DIRECT SHEAR TEST RESULTS**  
**INTERSTATE 710 EXTENSION**  
**LOS ANGELES COUNTY, CALIFORNIA**

<b>PROJECT NO.</b>	<b>DATE</b>
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<b>FIGURE</b>
B-12

## EXPANSION INDEX TEST RESULTS

SAMPLE LOCATION	SAMPLE DEPTH (FT)	INITIAL MOISTURE (%)	COMPACTED DRY DENSITY (PCF)	FINAL MOISTURE (%)	VOLUMETRIC SWELL (IN)	EXPANSION INDEX	EXPANSION POTENTIAL
B-2	8.0-9.0	18.9	97.5	32.6	0.0001	0	Very Low
B-4	5.0-7.0	15.7	91.0	33.4	0.0641	64	Medium

PERFORMED IN GENERAL ACCORDANCE WITH UBC STANDARD 18-2

***Ninyo & Moore***

### EXPANSION INDEX TEST RESULTS

INTERSTATE 710 EXTENSION  
LOS ANGELES COUNTY, CALIFORNIA

PROJECT NO.

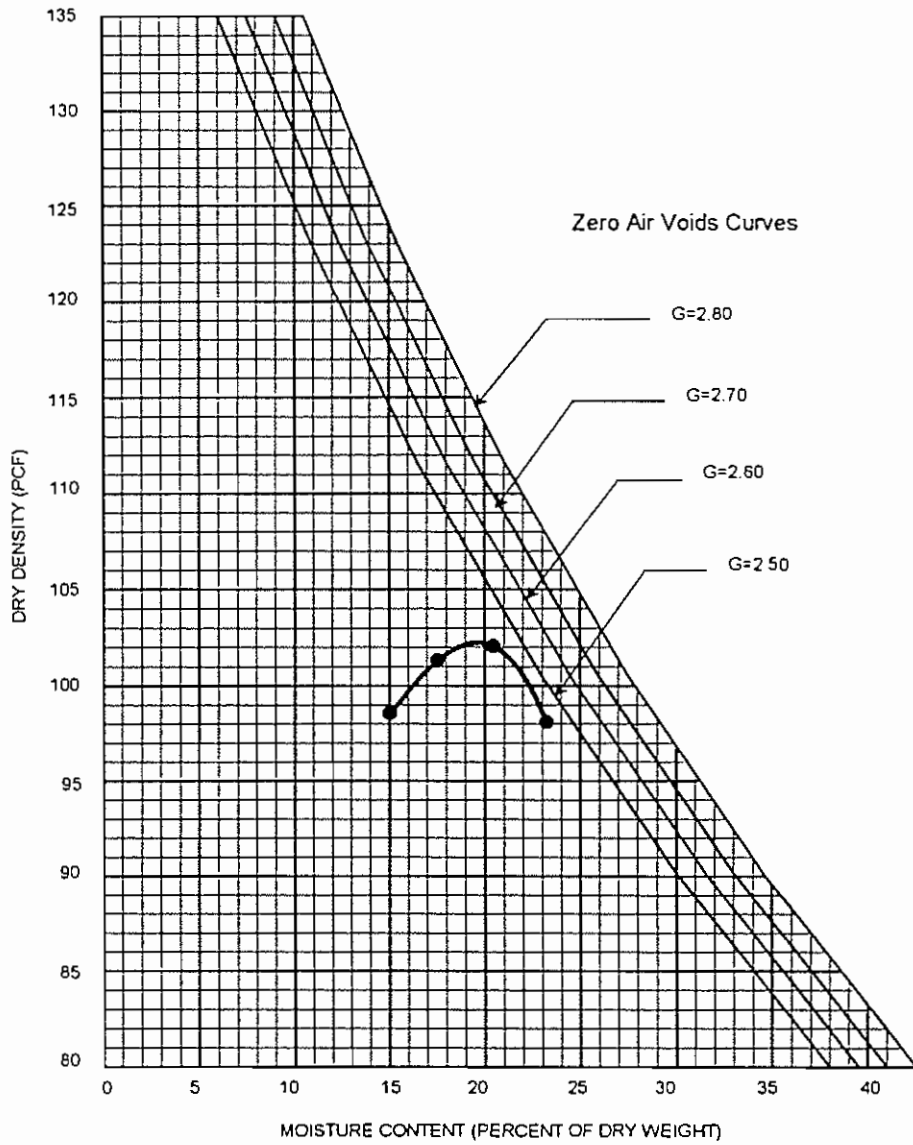
201769-01

DATE

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FIGURE

B-13



SAMPLE LOCATION	DEPTH (FT)	SOIL DESCRIPTION	MAXIMUM DENSITY (PCF)	OPTIMUM MOISTURE CONTENT (%)
B-2	8.0-9.0	Brown Siltstone	102.0	19.0

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 1557-91



**MAXIMUM DENSITY TEST RESULTS**

INTERSTATE 710 EXTENSION  
LOS ANGELES COUNTY, CALIFORNIA

PROJECT NO.	DATE	FIGURE
201769-01	3/99	B-14

## CORROSIVITY TEST RESULTS

SAMPLE LOCATION	SAMPLE DEPTH (FT)	pH *	RESISTIVITY * (ohm-cm)	WATER-SOLUBLE SULFATE CONTENT IN SOIL ** (ppm)	CHLORIDE CONTENT *** (ppm)
B-1	20.0-22.0	7.3	1,450	20	100
B-2	8.0-9.0	7.9	2,510	10	25
B-4	49.0-50.5	7.7	1,320	10	40

\* PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 643

\*\* PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 417

\*\*\* PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 422

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### CORROSIVITY TEST RESULTS

INTERSTATE 710 EXTENSION  
LOS ANGELES COUNTY, CALIFORNIA

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FIGURE

B-15