

FOUNDATION INVESTIGATION REPORT

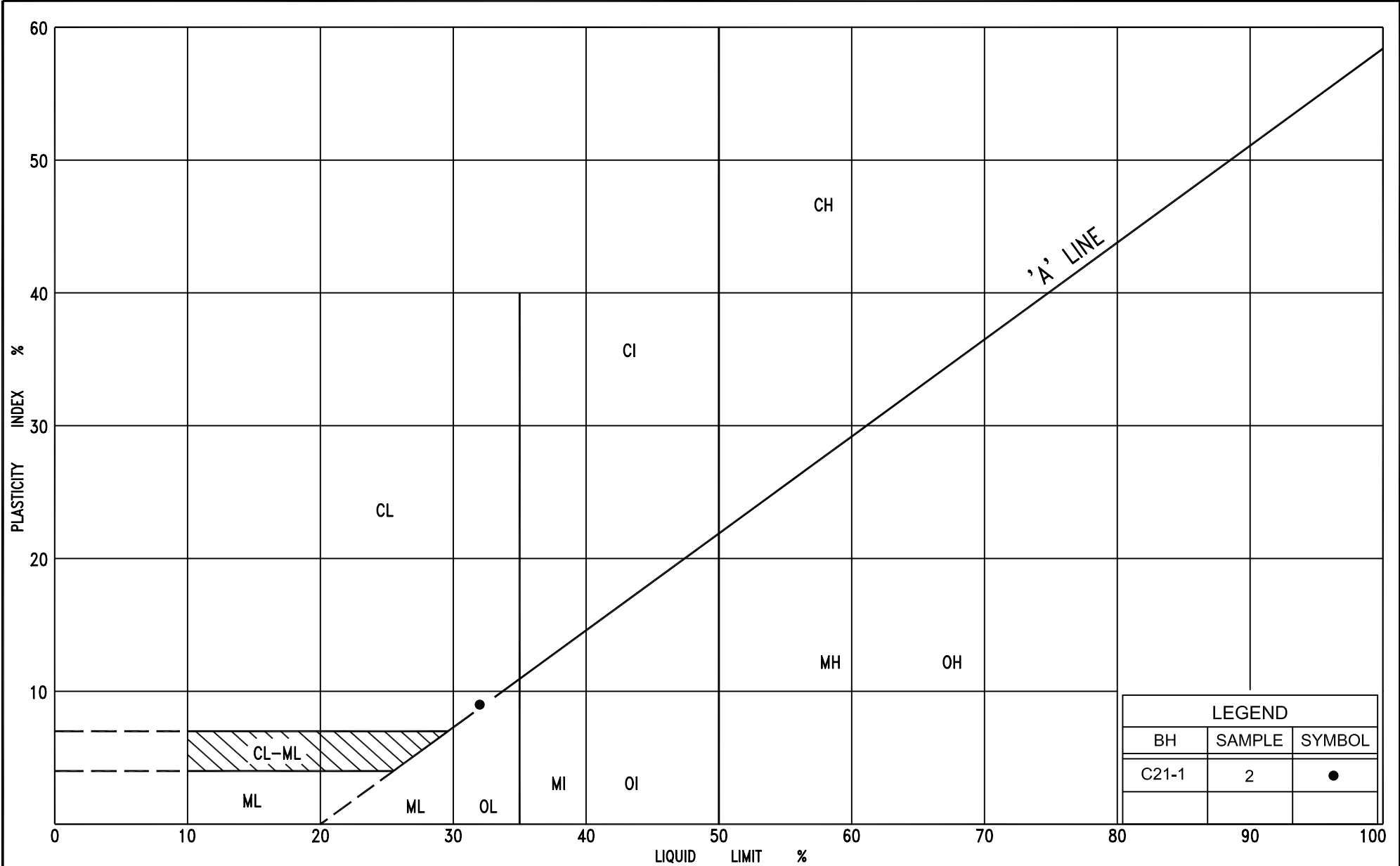
CULVERTS FOR PHASE 2 SECTION

HIGHWAY 69 FOUR LANING FOR 21.5 km
FROM 4.5 km NORTH OF HIGHWAY 64
TO 8.7 km NORTH OF HIGHWAY 637

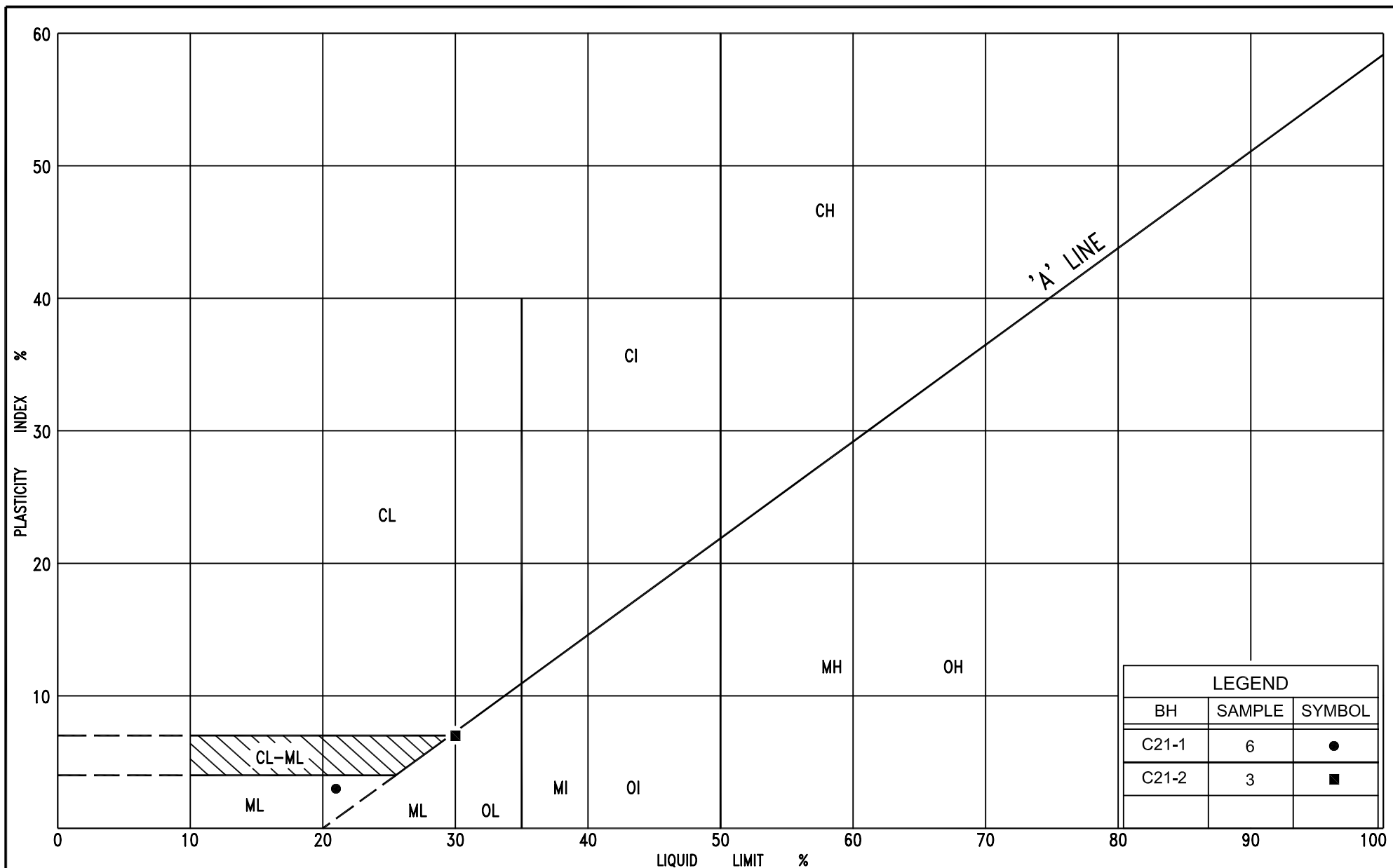
DISTRICT 54, SUDBURY, ONTARIO
G.W.P. NO. 5218-06-00
CONTRACT NO. 2009-5131

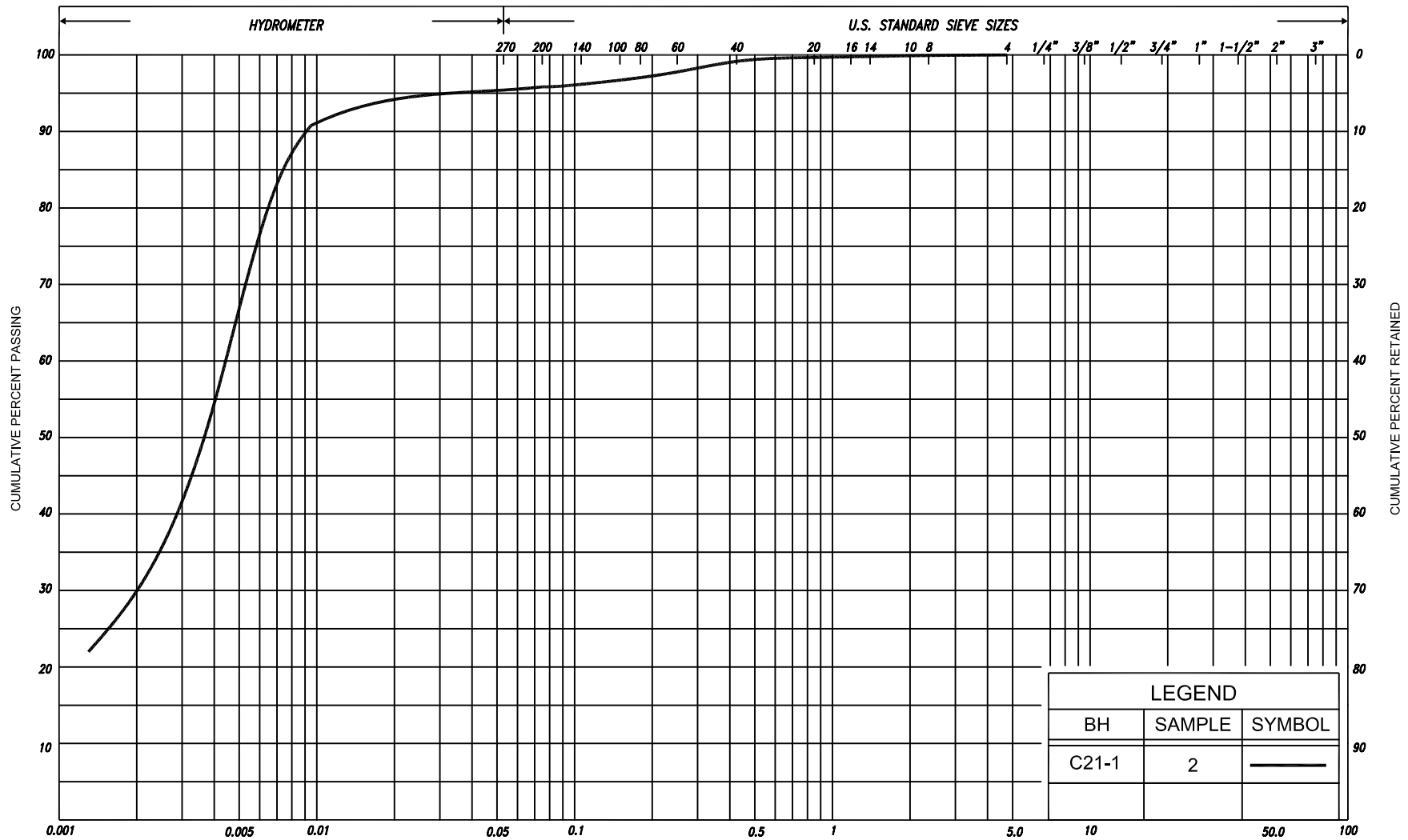
ATTACHMENT 2

Culvert at Sta. 18+325 (SBL and NBL) (C21), Servos Township



LEGEND		
BH	SAMPLE	SYMBOL
C21-1	2	●





SILT & CLAY			FINE			MEDIUM			COARSE			GRAVEL			COBBLES	UNIFIED
						SAND										M.I.T.
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL									
			SILT	V. FINE	FINE	MED.	COARSE	GRAVEL								
CLAY			SILT	SAND			GRAVEL									U.S. BUREAU

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, trace sand

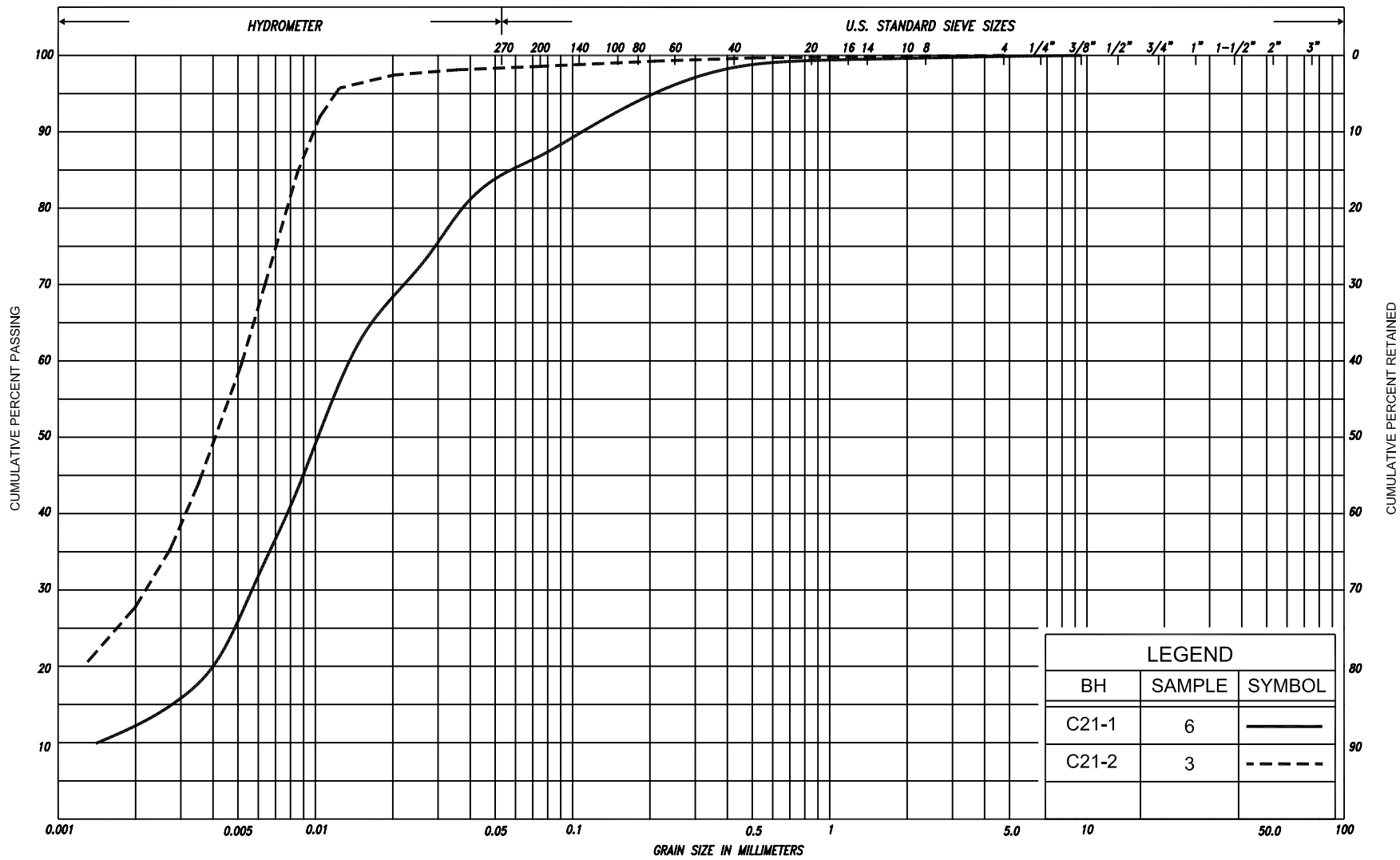
FIG No. C21-GS-1

HWY: 69

G.W.P. No. 5218-06-00



Ministry of
Transportation
Ontario



LEGEND		
BH	SAMPLE	SYMBOL
C21-1	6	————
C21-2	3	-----

SILT & CLAY				FINE SAND			MEDIUM SAND		COARSE SAND		GRAVEL		COBBLES	UNIFIED
														M.I.T.
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE							COBBLES	
														U.S. BUREAU
				V. FINE	FINE	MED.	COARSE							

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	n	1, %	POROSITY	e_{max}	1, %	VOID RATIO IN LOOSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	w	1, %	WATER CONTENT	e_{min}	1, %	VOID RATIO IN DENSEST STATE
ρ_w	kg/m^3	DENSITY OF WATER	S_r	%	DEGREE OF SATURATION	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
γ_w	kN/m^3	UNIT WEIGHT OF WATER	w_L	%	LIQUID LIMIT	D	mm	GRAIN DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_p	%	PLASTIC LIMIT	D_n	mm	n PERCENT - DIAMETER
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_s	%	SHRINKAGE LIMIT	C_u	1	UNIFORMITY COEFFICIENT
ρ_d	kg/m^3	DENSITY OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	h	m	HYDRAULIC HEAD OR POTENTIAL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	q	m^3/s	RATE OF DISCHARGE
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	v	m/s	DISCHARGE VELOCITY
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	DTPL		DRIER THAN PLASTIC LIMIT	i	1	HYDRAULIC GRADIENT
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	APL		ABOUT PLASTIC LIMIT	k	m/s	HYDRAULIC CONDUCTIVITY
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL	WTPL		WETTER THAN PLASTIC LIMIT	j	kN/m^3	SEEPAGE FORCE
e	1, %	VOID RATIO						

RECORD OF BOREHOLE No C21-1

1 of 1

METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 122 737.4 N; 320 583.5 E
Hwy 69 (New), Sta. 18+368, o/s 42.0m Lt. CL ORIGINATED BY F.P.
DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. and Rotary Diamond Drilling COMPILED BY A.S.
DATUM Geodetic DATE December 02, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE					w _p w w _L					
								● QUICK TRIAXIAL × LAB VANE										
214.9	Ground Surface							20	40	60	80	100						
0.0	Silty sand, trace gravel organics		1	SS	3										○			
214.3	Very loose Brown (FILL) Moist																	
0.6	Clayey silt, trace sand		2	SS	13		214						150	●	14			0 4 66 30
	Stiff Brown/ Moist grey																	
	silt, trace clay , trace sand layers		3	SS	6		213								○			
			4	SS	6		212								○			
212.0	Silt, some sand some clay, trace gravel																	
2.9	Loose Grey Wet		5	SS	9		211								○			1 12 75 12
			6	SS	7		210								10			
210.0	Migmatite Bedrock																	
4.9	Unweathered High strength Good quality		7	RC NQ	REC 100%		209											RQD 87%
			8	RC NQ	REC 97%		208											RQD 80%
207.0	End of borehole						207											
7.9																		
										</								

METRIC

Hwy 69 (New), Sta. 18+325 CL

ORIGINATED BY F.P.

COMPILED BY A.S.

CHECKED BY C.N.

ON_MOT VER3 06TF055 CONTRACT 2.GPJ ON_MOT.GDT 5/27/2009 1:02:37 PM

RECORD OF BOREHOLE No C21-3

1 of 1

METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 122 742.3 N; 320 705.4 E
 DIST 54 HWY 69 BOREHOLE TYPE Test Pit ORIGINATED BY F.P.
 DATUM Geodetic DATE February 20, 2009 COMPILED BY A.S.
 CHECKED BY C.N.

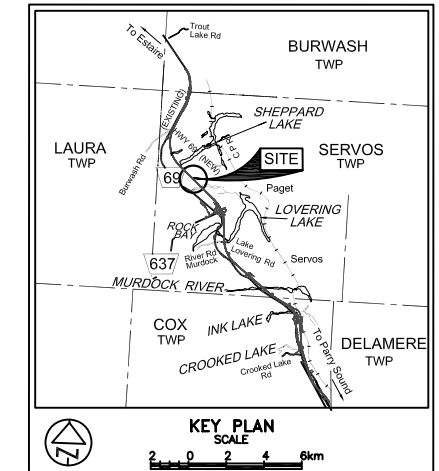
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
214.1 0.0	Top of Ice					*	214	20	40	60	80	100	20	40	60		
213.9 0.2	Ice							○ UNCONFINED	+	FIELD VANE	○ UNCONFINED	+	FIELD VANE				
213.5 0.6	Peat, coarse fibrous							● QUICK TRIAXIAL	×	LAB VANE	● QUICK TRIAXIAL	×	LAB VANE				
	Dark brown																
	Silty clay						213										
	Grey Moist						212										
211.5 2.6	End of borehole																
	Refusal on probable bedrock																
	* Borehole dry																

RECORD OF BOREHOLE No C21-3A 1 of 1 METRIC

Coords: 5 122 737.8 N; 320 701.3 E
Hwy 69 (New), Sta. 18+281, o/s 37.0m Rt. CL

G.W.P. 5218-06-00 LOCATION ORIGINATED BY F.P.
DIST 54 HWY 69 BOREHOLE TYPE Test Pit COMPILED BY A.S.
DATUM Geodetic DATE February 20, 2009 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE																	
214.2 0.0	Top of Ice						20	40	60	80	100						
214.0 0.2	Ice																
	Peat, coarse fibrous																
213.5 0.7	Dark brown Silty clay, trace sand																
	Grey Moist brown																
212.4 1.8	End of borehole Refusal on probable bedrock																
	* Borehole dry																



LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation Dec 2008
500 Series Dec 2006 and Apr 2007
- Head
- ARTESIAN WATER
Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
C21-1	214.9	5 122 737.4	320 583.5
C21-2	213.6	5 122 743.0	320 640.1
C21-3	214.1	5 122 742.3	320 705.4
C21-3A	214.2	5 122 737.8	320 701.3

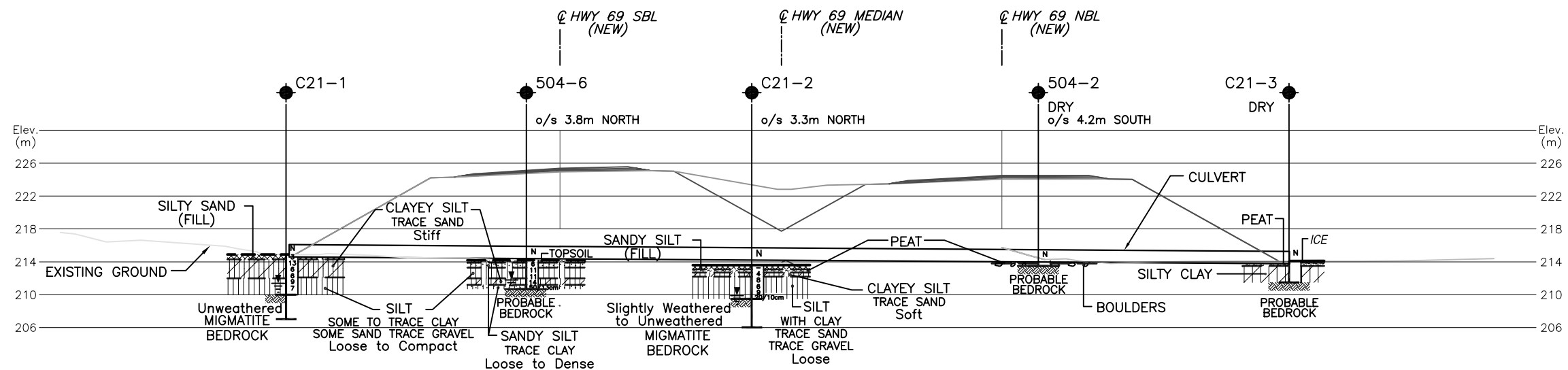
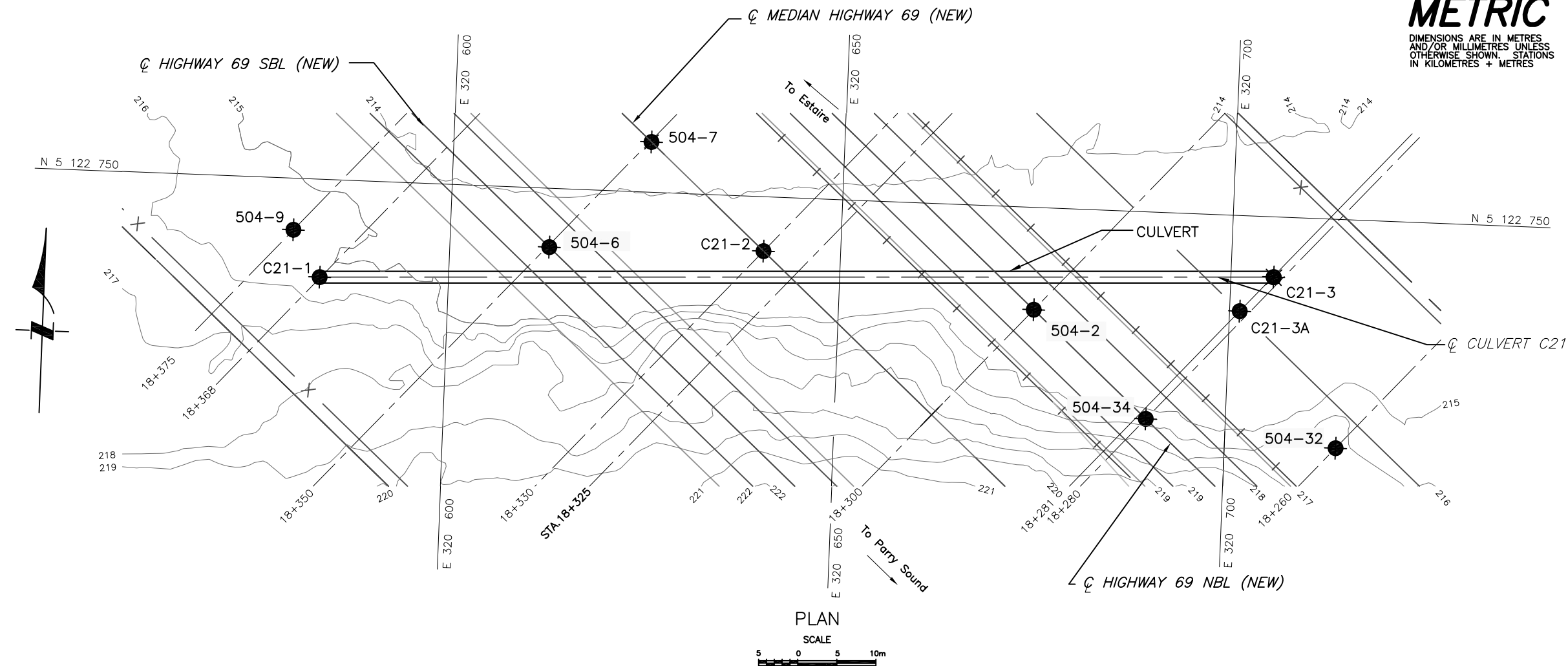
BH No	ELEVATION	STA SERVOS TWP	o/s CL MED
504-2	214.1	18+300	19.0m Rt.
504-6	214.2	18+350	18.8m Lt.
504-7	213.4	18+350	CL
504-9	215.2	18+375	40.0m Lt.
504-32	216.2	18+260	33.0m Rt.
504-34	216.0	18+280	19.0m Rt.

— NOTE —
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 411-235

HWY No	69	DIST	54
SUBM'D	AS	CHECKED	AS
DRAWN	NA	CHECKED	CN
DATE	MAY 27, 2009	APPROVED	BRG
SITE	---	LDWG	C21



PROFILE CULVERT AT STA. 18+325 (C21)



REF No.: TSH DRAWINGS C2-HWY69-DES.dwg and
C2-CULVERT-XS-18+225-SERVOS.dwg Received
on October 07, 2008; Hwy 69 Servos Contract
2 Lidar Contours.dwg dated December 19, 2007;

NOTES:

- CULVERT AT STA. 18+325 WAS DESIGNATED C21 BY PML.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

Culvert at Sta. 18+435 (SBL and NBL) (JUC), Servos Township

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	n	1, %	POROSITY	e_{\max}	1, %	VOID RATIO IN LOOSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	w	1, %	WATER CONTENT	e_{\min}	1, %	VOID RATIO IN DENSEST STATE
ρ_w	kg/m^3	DENSITY OF WATER	S_r	%	DEGREE OF SATURATION	I_D	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
γ_w	kN/m^3	UNIT WEIGHT OF WATER	w_L	%	LIQUID LIMIT	D	mm	GRAIN DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_p	%	PLASTIC LIMIT	D_n	mm	n PERCENT - DIAMETER
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_s	%	SHRINKAGE LIMIT	C_u	1	UNIFORMITY COEFFICIENT
ρ_d	kg/m^3	DENSITY OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	h	m	HYDRAULIC HEAD OR POTENTIAL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	q	m^3/s	RATE OF DISCHARGE
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	v	m/s	DISCHARGE VELOCITY
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	DTPL		DRIER THAN PLASTIC LIMIT	i	1	HYDRAULIC GRADIENT
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	APL		ABOUT PLASTIC LIMIT	k	m/s	HYDRAULIC CONDUCTIVITY
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL	WTPL		WETTER THAN PLASTIC LIMIT	j	kN/m^2	SEEPAGE FORCE
e	1, %	VOID RATIO						

RECORD OF BOREHOLE No JUC-1

1 of 1

METRIC

Coords: 5 122 793.9 N; 320 544.7 E

G.W.P. 5218-06-00 LOCATION Hwy 69 (New), Sta. 18+435, o/s 26.0m Lt. CL ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. and Rotary Diamond Drilling COMPILED BY A.S.
 DATUM Geodetic DATE December 04 & 05, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE													
218.7	Ground Surface							20	40	60	80	100		20	40	60		GR	SA	SI	CL
0.0 218.4 0.3	Peat, fine fibrous Dark brown		1	CS	-		218														
	Sandy silt trace clay, trace gravel cobbles and boulders																				
	Very dense Brown Wet		2	SS	20/8cm																
217.1 1.6	Granitic Gneiss Bedrock		3	RC NQ	REC 100%		217													RQD 100%	
	Unweathered																				
	High strength		4	RC NQ	REC 100%		216													RQD 100%	
	Excellent quality																				
			5	RC NQ	REC 100%		215													RQD 100%	
214.3 4.4	End of borehole																				
	Sample 2: Sampler bouncing																				
	* Borehole charged with drilling water																				
	C.F.S.S.A. denotes Continuous Flight Solid Stem Augers																				

RECORD OF BOREHOLE No JUC-2 1 of 1 METRIC																	
G.W.P. 5218-06-00		LOCATION		Coords: 5 122 811.2 N; 320 562.9 E Hwy 69 (New), Sta. 18+433, o/s 1.0m Lt. CL				ORIGINATED BY F.P.									
DIST 54 HWY 69		BOREHOLE TYPE		Rotary Diamond Drilling				COMPILED BY A.S.									
DATUM Geodetic		DATE		December 04, 2008				CHECKED BY C.N.									
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)				
216.2	Ground Surface						20	40	60	80	100						
0.0	Granitic Gneiss Bedrock Unweathered High strength Fair to good quality		1	RC NQ	REC 96%	216											RQD 69%
			2	RC NQ	REC 92%	215											RQD 76%
			3	RC NQ	REC 100%	214											RQD 90%
213.1	End of borehole																
3.1	* Borehole charged with drilling water																

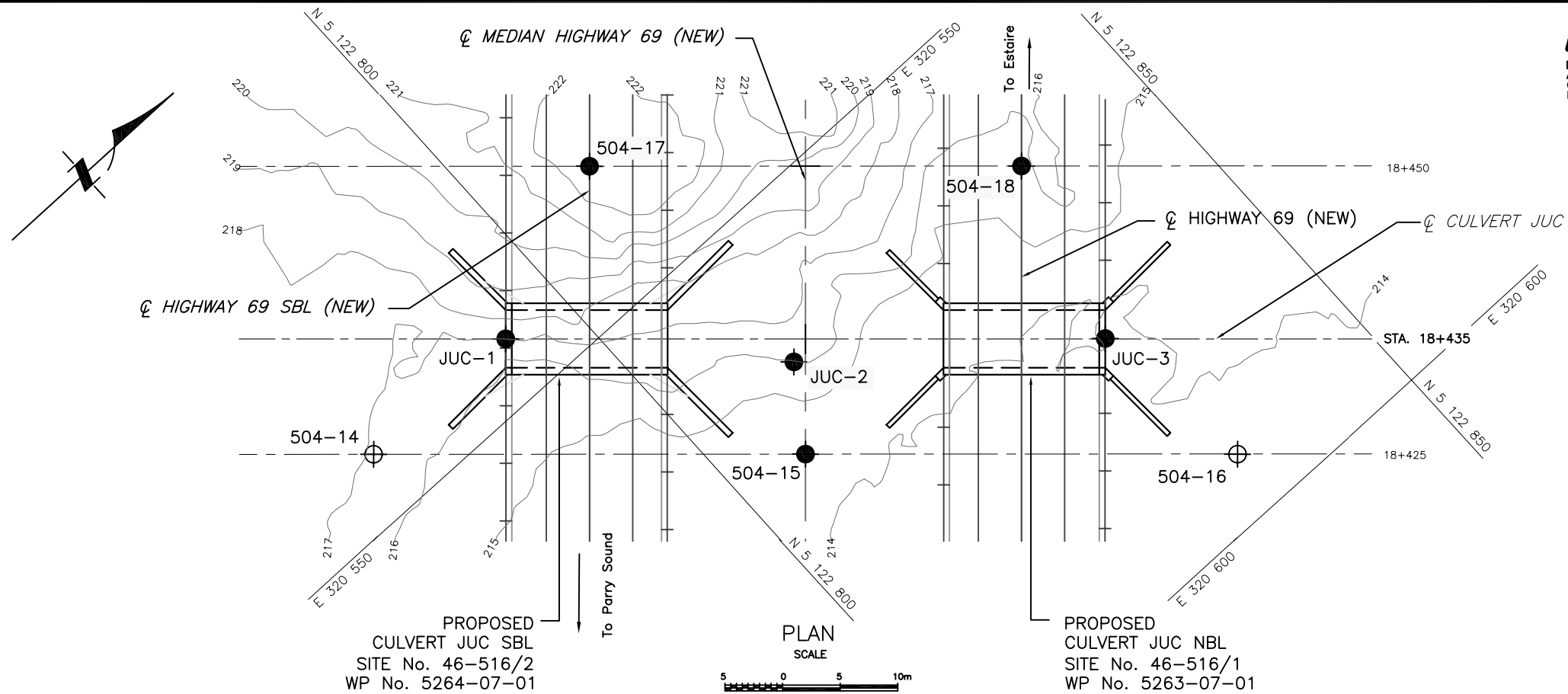
RECORD OF BOREHOLE No JUC-3

1 of 1


METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 122 832.7 N; 320 579.5 E
Hwy 69 (New), Sta. 18+435, o/s 26.0m Rt. CL ORIGINATED BY F.P.
DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. and Rotary Diamond Drilling COMPILED BY A.S.
DATUM Geodetic DATE December 04, 2008 CHECKED BY C.N.

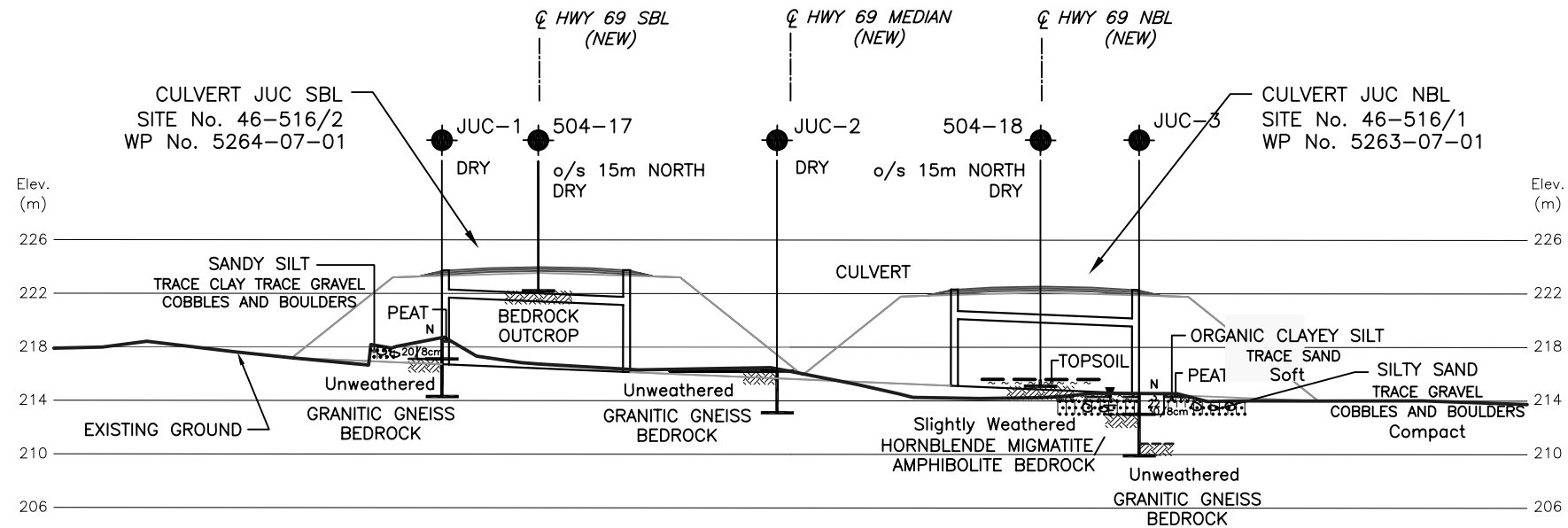
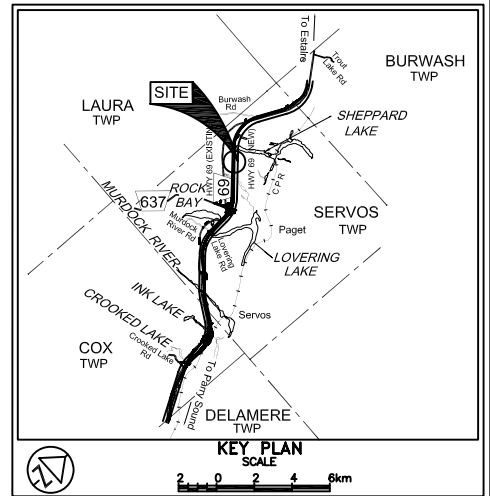
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					w _p w w _L					
214.6	Ground Surface						20	40	60	80	100							
0.0	Peat, fine fibrous		1	SS	3	▽	214											
214.3	Dark brown																	
0.3	Organic clayey silt, trace sand																	
214.0	Soft Dark Moist		2	SS	22													
0.6	Silty sand, trace gravel cobbles and boulders																	
	Compact Brown Wet		3	SS	30/8cm													
213.0	Hornblende Migmatite/ Amphibolite Bedrock						213											RQD 91%
1.6	Slightly weathered		4	RC NQ	REC 95%													
	High strength																	
	Good to excellent quality						212											RQD 88%
			5	RC NQ	REC 98%													
	Granitic Gneiss Bedrock						211											
	Unweathered		6	RC NQ	REC 88%													RQD 63%
	High strength																	
209.9	Fair quality						210											
4.7	End of borehole																	
	Sample 3: Sampler bouncing																	
											</							












METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No	WP No 5263-07-01 5264-07-01	 SHEET 382
CULVERTS AT STA. 18+435 (JUC)		
HIGHWAY 69 FOUR-LANING - SERVOS TWP		
BOREHOLE LOCATIONS AND SOIL STRATA		

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS



PROFILE \varnothing CULVERTS AT STA. 18+435 (JUC)

LEGEND				
	Borehole			
	Dynamic Cone Penetration Test (Cone)			
	Borehole & Cone			
N	Blows/0.3m (Std. Pen Test, 475 J/blow)			
CONE	Blows/0.3m (60° Cone, 475 J/blow)			
	W L at time of investigation Dec 2008			
	500 Series Feb and Dec 2006			
	Head			
	ARTESIAN WATER			
	Encountered			
	PIEZOMETER			
BH No	ELEVATION	COORDINATES		
		NORTHINGS	EASTINGS	
JUC-1	218.7	5 122 793.9	320 544.7	
JUC-2	216.2	5 122 811.2	320 562.9	
JUC-3	214.6	5 122 832.7	320 579.5	
BH No	ELEVATION	STA SERVOS TWP	o/s CL MED	
504-14	216.7	18+425	37.5m Lt.	
504-15	214.2	18+425	CL	
504-16	213.7	18+425	37.5m Rt.	
504-17	222.2	18+450	18.8m Lt.	
504-18	215.6	18+450	18.8m Rt.	

— NOTE —
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 411-235				
HWY No	69	CHECKED AS	DATE MAY 27, 2009	DIST 54
SUBM'D	AS	CHECKED CN	APPROVED BRG	SITE 46-516/1&2
DRAWN	NA	CHECKED CN	APPROVED BRG	DWG JUC

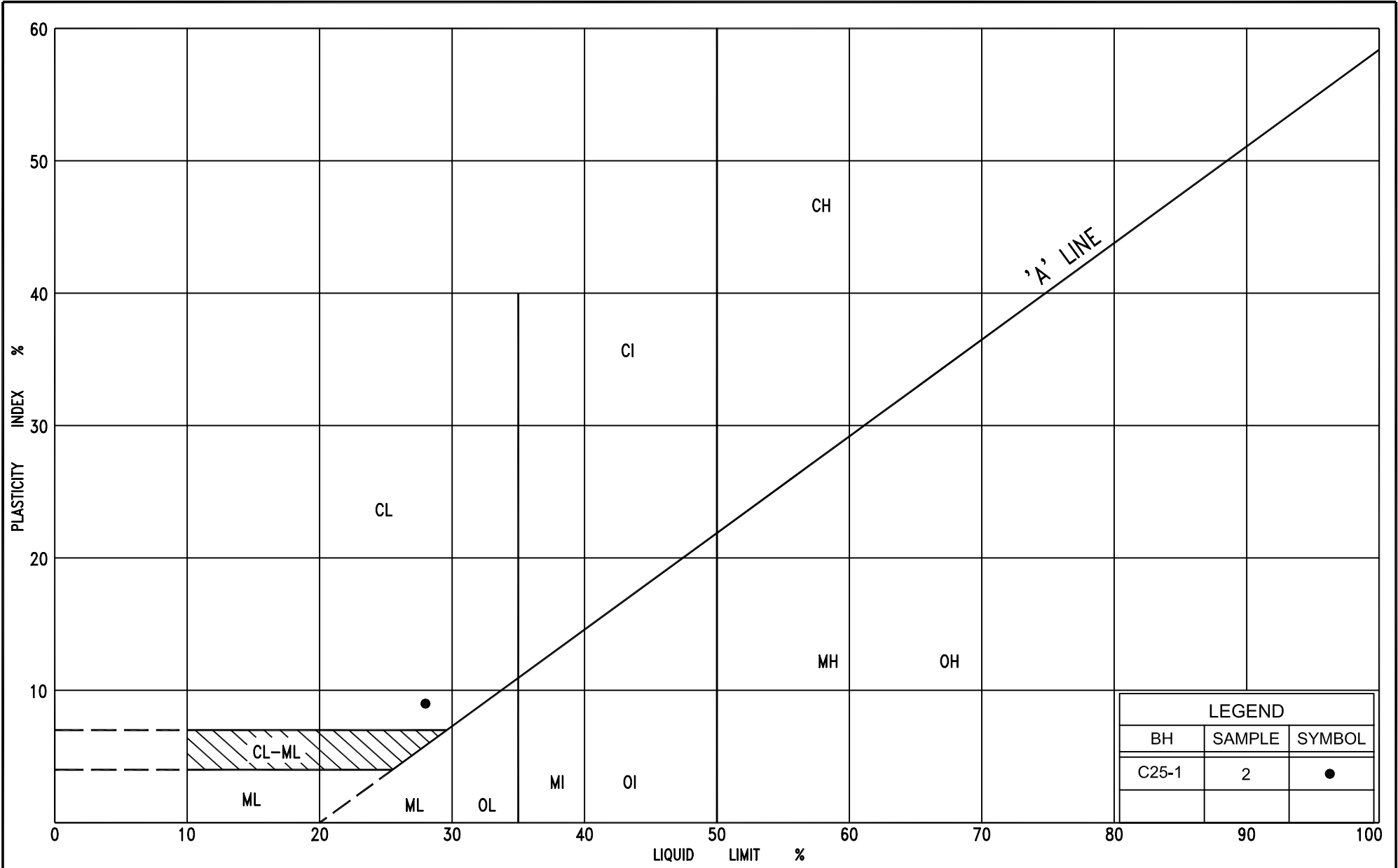
NOTES:

- CULVERT AT STA. 18+435 WAS DESIGNATED AS JUC CULVERT BY PML.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

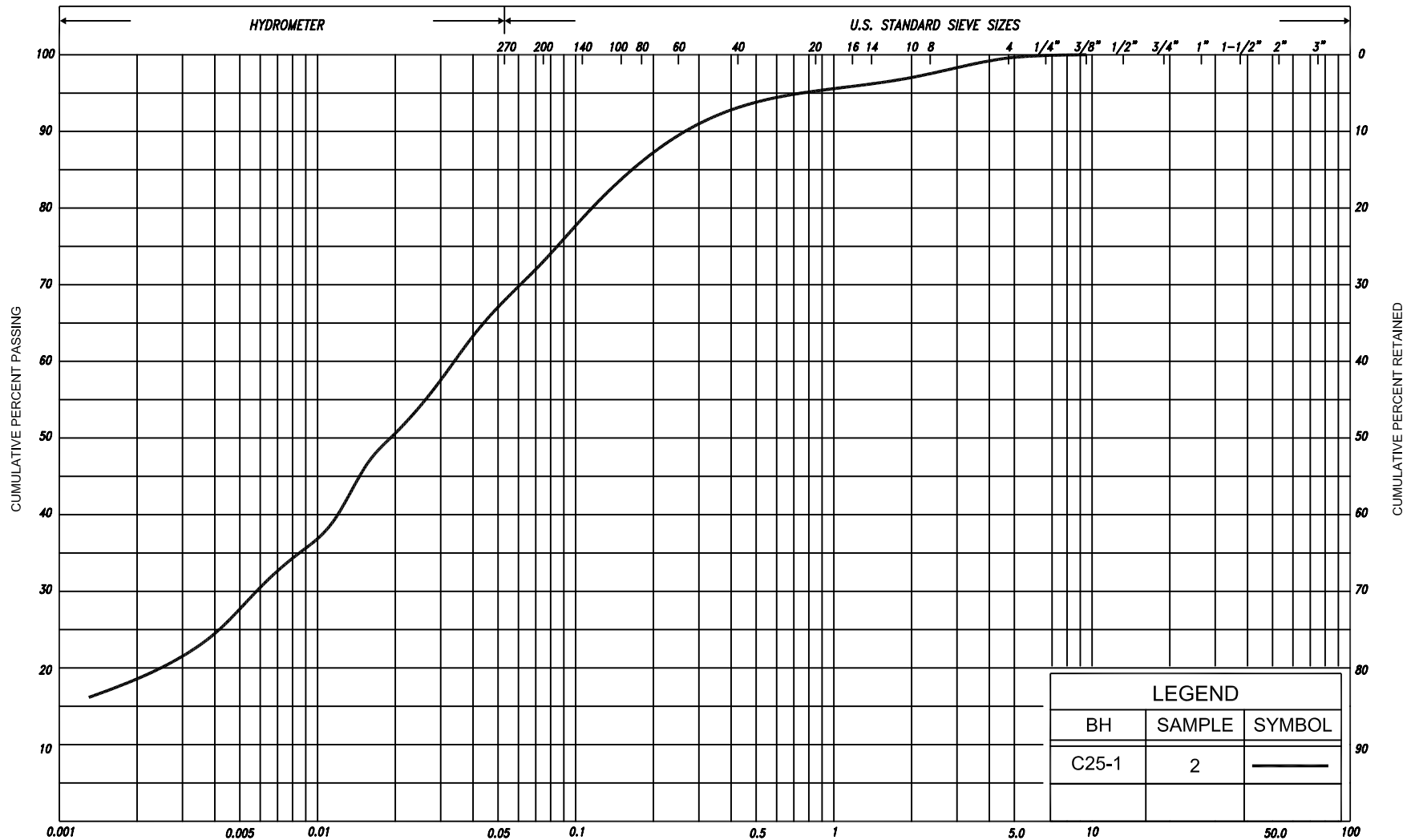


REF No.: TSH DRAWINGS: C2-HWY69-DES.dwg; Received on October 07, 2008; 42-91088-SMALL ANIMAL CROSSING-NBL(SBL)-1-GA.dwg; Hwy 69 Servos Contract 2 Lidar Contours.dwg dated December 19, 2007;

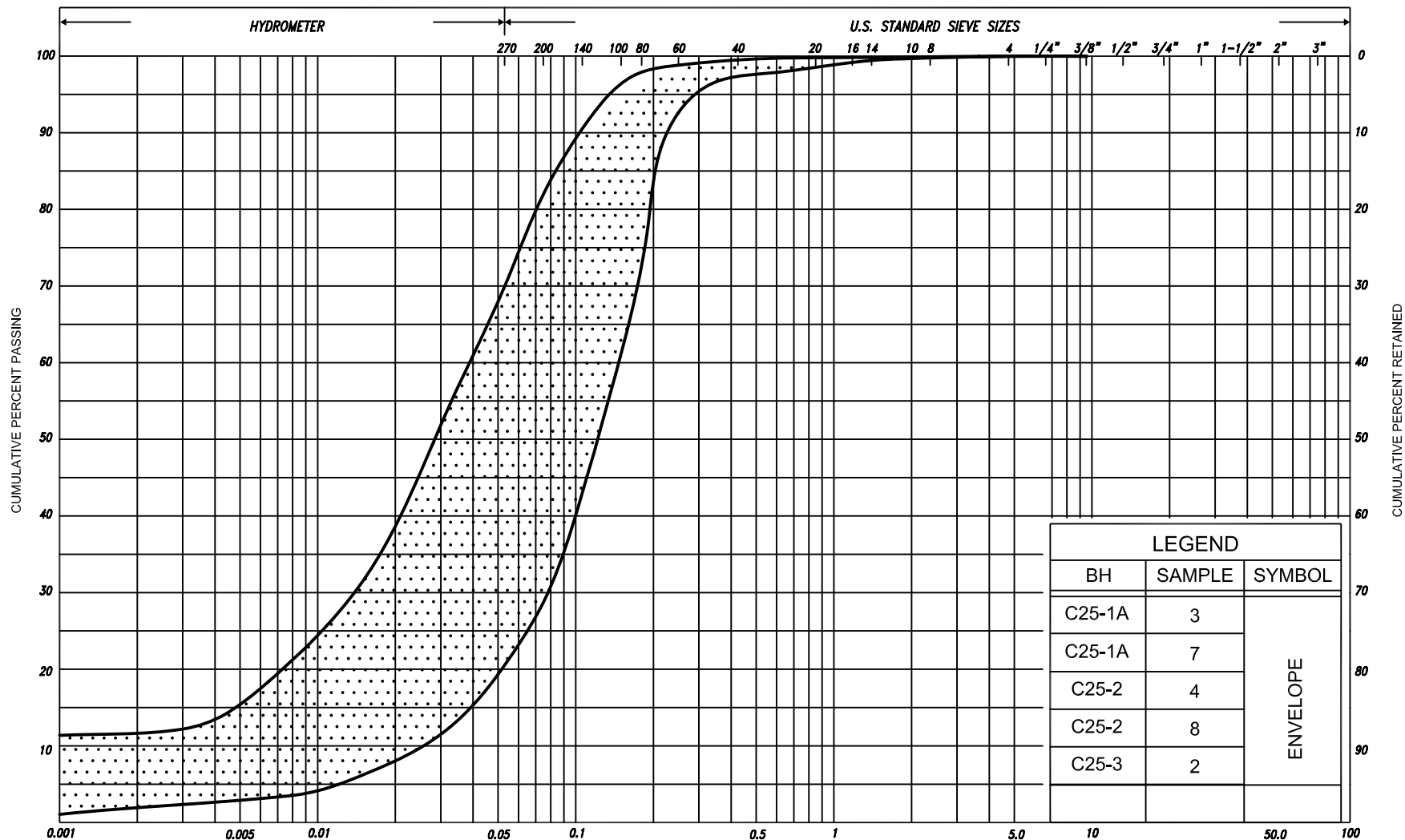
Culvert at Sta. 20+880 (SBL) and 20+892 (NBL) (C25), Servos Township



LEGEND		
BH	SAMPLE	SYMBOL
C25-1	2	●



SILT & CLAY				FINE			MEDIUM		COARSE		GRAVEL			COB BLES	UNIFIED		
				SAND													
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM		COARSE		GRAVEL			COBBLES	M.I.T.
	SILT						SAND										
CLAY		SILT			V. FINE		FINE		MED.		COARSE		GRAVEL				U.S. BUREAU
				SAND													



SILT & CLAY					FINE		MEDIUM		COARSE		GRAVEL			COBBLES	UNIFIED		
					SAND												
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM		COARSE		GRAVEL			COBBLES	M.I.T.
	SILT																
CLAY		SILT			V. FINE	FINE	MED.	COARSE		GRAVEL							U.S. BUREAU
					SAND												

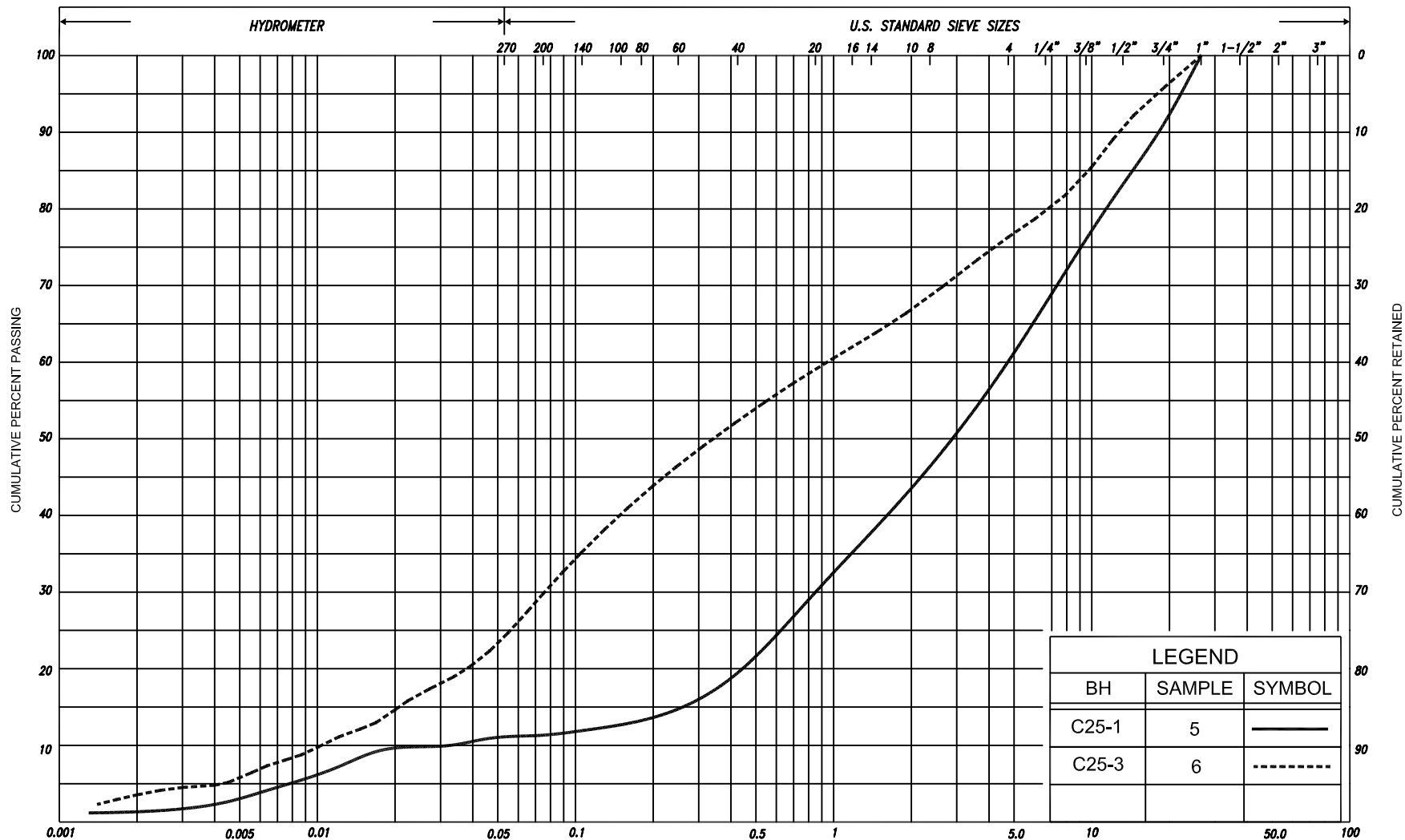
GRAIN SIZE DISTRIBUTION

SILT, some sand to SAND, with silt, trace to some clay

FIG No. C25 -GS-2

HWY: 69

G.W.P. No. 5218-06-00



SILT & CLAY				FINE		MEDIUM		COARSE		GRAVEL			COBBLES	UNIFIED		
				SAND												
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM		COARSE		GRAVEL	COBBLES	M.I.T.	
	SILT															
CLAY			SILT			V. FINE		FINE		MED.		COARSE		GRAVEL		U.S. BUREAU
						SAND										

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	n	1, %	POROSITY	e_{max}	1, %	VOID RATIO IN LOOSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	w	1, %	WATER CONTENT	e_{min}	1, %	VOID RATIO IN DENSEST STATE
ρ_w	kg/m^3	DENSITY OF WATER	S_r	%	DEGREE OF SATURATION	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
γ_w	kN/m^3	UNIT WEIGHT OF WATER	w_L	%	LIQUID LIMIT	D	mm	GRAIN DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_p	%	PLASTIC LIMIT	D_n	mm	n PERCENT - DIAMETER
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_s	%	SHRINKAGE LIMIT	C_u	1	UNIFORMITY COEFFICIENT
ρ_d	kg/m^3	DENSITY OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	h	m	HYDRAULIC HEAD OR POTENTIAL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	q	m^3/s	RATE OF DISCHARGE
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	v	m/s	DISCHARGE VELOCITY
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	DTPL		DRIER THAN PLASTIC LIMIT	i	1	HYDRAULIC GRADIENT
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	APL		ABOUT PLASTIC LIMIT	k	m/s	HYDRAULIC CONDUCTIVITY
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL	WTPL		WETTER THAN PLASTIC LIMIT	j	kN/m^3	SEEPAGE FORCE
e	1, %	VOID RATIO						

RECORD OF BOREHOLE No C25-1

1 of 1

METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 124 865.3 N; 319 457.8 E
Hwy 69 (New), Sta. 20+880, o/s 37.0m Lt. CL ORIGINATED BY M.R.
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling COMPILED BY A.S.
DATUM Geodetic DATE December 02, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE		● QUICK TRIAXIAL						× LAB VANE		
217.7	Ground Surface							20	40	60	80	100								
0.0	Organic clayey silt with sand, trace gravel Very soft Dark Moist to soft brown		1	SS	2	▽*	217										1 26 55 18			
			2	SS	4		216													
			3	SS	1		215													
	organic sand and silt layer						214													
215.0	Very loose		4	SS	3		213													
2.7	Sand and gravel, some silt trace clay Compact Brown Wet		5	SS	21		212													
			6	SS	16/10cm	211										40 48 10 2				
213.1							210													
4.6	Migmatite Bedrock Slightly weathered to unweathered High strength Good to excellent quality		7	RC NQ	REC 88%		209													
			8	RC NQ	REC 100%		208													
210.1	End of borehole						207													
7.6	Sample 6: Sampler bouncing * 2008 12 02 ▽ Water level observed during drilling C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers						206													

RECORD OF BOREHOLE No C25-1A

1 of 1

METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 124 860.5 N; 319 484.4 E
Hwy 69 (New), Sta. 20+880, o/s 10.0m Lt. CL ORIGINATED BY M.R.
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling COMPILED BY A.S.
DATUM Geodetic DATE November 30, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)							
								○ UNCONFINED + FIELD VANE					w _p w w _L							
								● QUICK TRIAXIAL × LAB VANE												
218.1	Ground Surface						20	40	60	80	100									
0.0	Organic clayey silt with sand		1	SS	1	▽	218													
217.6	Very soft Dark brown Silt trace sand, trace clay Loose to Brown Wet Compact to grey some sand		2	SS	5		217													
0.5			3	SS	17		216													
			4	SS	25		215													
			5	SS	30		214													
			6	SS	27		213													
214.0	Sand and silt trace clay		7	SS	WH**		212													
4.1	Very loose Grey Wet						211													
212.5	Migmatite Bedrock Unweathered High strength Excellent quality		8	RC NQ	REC 100%		210													
5.6			9	RC NQ	REC 100%															
			10	RC NQ	REC 100%															
209.3	End of borehole																			
8.8																				
	* 2008 11 30																			
	▽ Water level observed during drilling																			
	WH** Denotes penetration due to weight of rods and hammer																			
	C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers																			

RECORD OF BOREHOLE No C25-2

1 of 1

METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 124 862.5 N; 319 489.9 E
Hwy 69 (New), Sta. 20+883, o/s 5.0m Lt. CL ORIGINATED BY M.R.
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY A.S.
DATUM Geodetic DATE November 29, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE								○		
218.4	Ground Surface						20	40	60	80	100									
0.0	Organic clayey silt with sand decayed wood		1	SS	2	★	218								○					
	Very soft Dark Wet to firm brown		2	SS	5	▽★	217								○					
217.2	Silt with sand, trace clay						216													
1.2	Compact Brown Wet Grey		3	SS	16		215							○						
			4	SS	16		214							○						
			5	SS	14		213							○						
			6	SS	13		212							○						
			7	SS	18		211							○						
212.9	Sand with silt, trace clay						210													
5.5	Very loose Grey Wet		8	SS	WH**		209													
211.7	End of borehole						208													
6.7	Probable sand,with silt Compact to dense						207													
207.6	End of dynamic cone penetration test						206													
10.8	Refusal on probable bedrock						205													
	* 2008 11 29						204													
	▽ Water level observed during drilling						203													
	★ Water level measured after drilling						202													
	WH** Denotes penetration due to weight of rods and hammer						201													
	C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers						200													

METRIC

Coords: 5 124 877.2 N; 319 531.9 E

G.W.P. 5218-06-00	LOCATION
-------------------	----------

Hwy 69 (New), Sta. 20+905, o/s 37.0m Lt. CL

ORIGINATED BY M.R.

DIST 54 HWY 69

BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling

COMPILED BY A.S.

DATUM Geodetic

DATE November 28, 2008

 CHECKED BY C.N.

[illegible]

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No

GWP No 5218-06-00

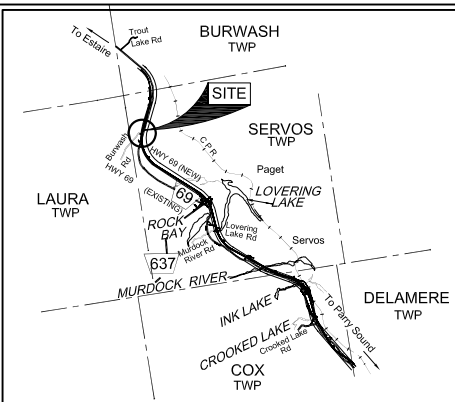
CULVERTS AT STA. 20+880 (SBL)
AND STA. 20+892 (NBL) (C25)

HIGHWAY 69 FOUR-LANING - SERVOS TWP
BOREHOLE LOCATIONS AND SOIL STRATA

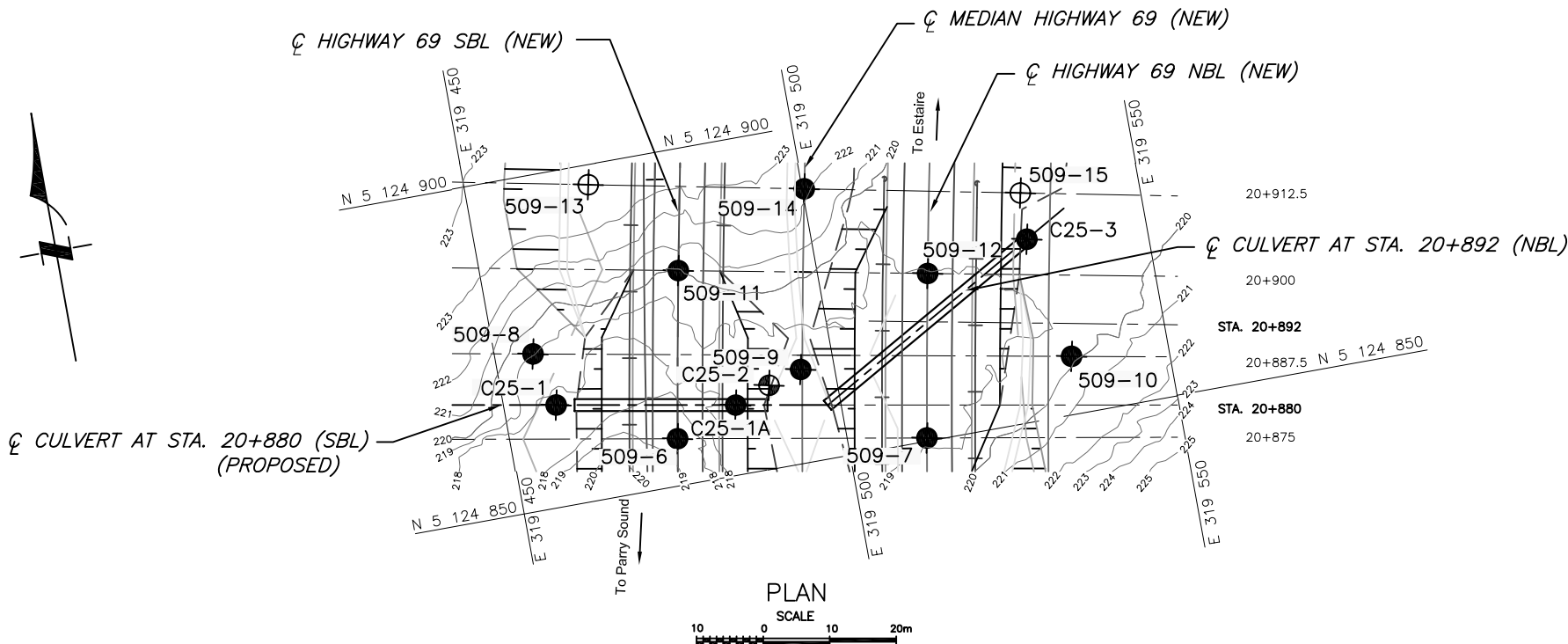


SHEET

PML Peto MacCallum Ltd
CONSULTING ENGINEERS



KEY PLAN
SCALE
2 0 2 4 6 km



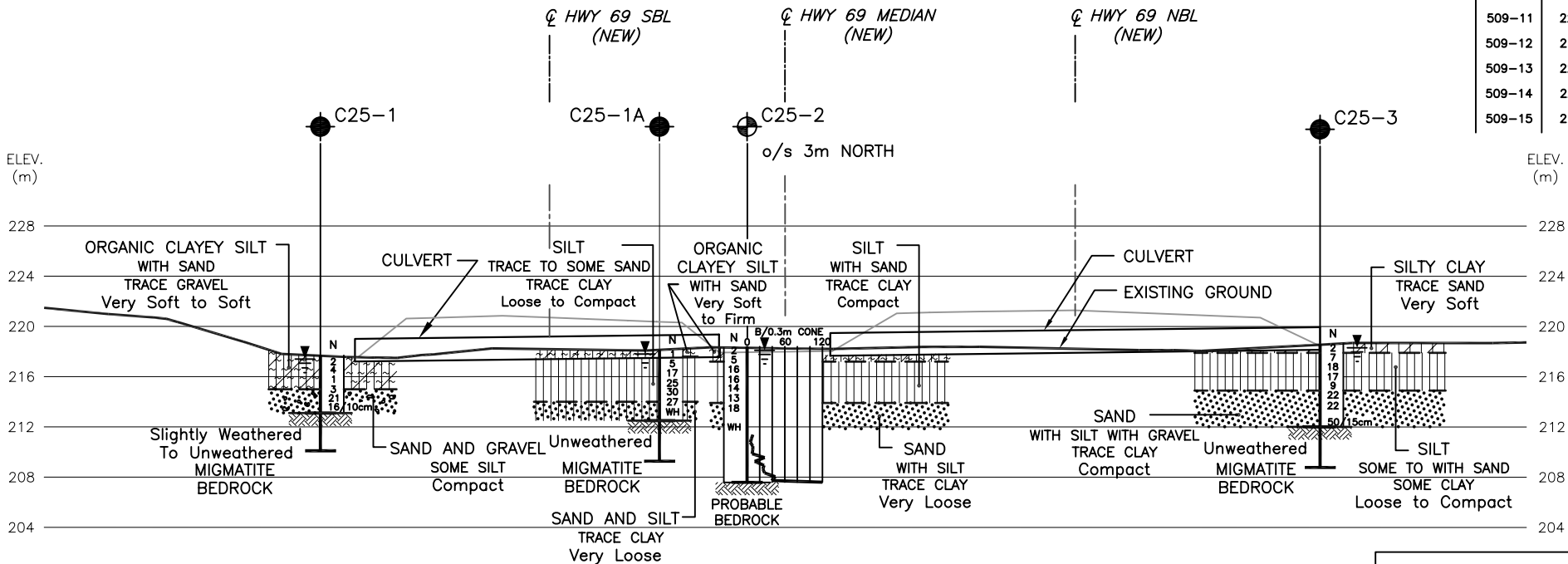
(Legend Continued)

BH No	ELEVATION	STA SERVOS TWP	o/s CL MED
509-6	218.4	20+875	18.8m Lt.
509-7	218.9	20+875	18.8m Rt.
509-8	219.1	20+887.5	40.5m Lt.
509-9	218.6	20+887.5	CL
509-10	219.7	20+887.5	40.5m Rt.
509-11	220.4	20+900	18.8m Lt.
509-12	218.6	20+900	18.8m Rt.
509-13	223.2	20+912.5	32.5m Lt.
509-14	221.9	20+912.5	CL
509-15	218.5	20+912.5	32.5m Rt.

LEGEND	
	Borehole
	Dynamic Cone Penetration Test (Cone)
	Borehole & Cone
N	Blows/0.3m (Std. Pen Test, 475 J/blow)
CONE	Blows/0.3m (60° Cone, 475 J/blow)
WH	Penetration due to weight of hammer and rods
	W L at time of investigation Nov-Dec 2008 500 series Jan-Feb 2007
	Head
	ARTESIAN WATER Encountered
	PIEZOMETER

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
C25-1	217.7	5 124 865.3	319 457.8
C25-1A	218.1	5 124 860.5	319 484.4
C25-2	218.4	5 124 862.5	319 489.9
C25-3	218.6	5 124 877.2	319 531.9

(Legend Continues)



PROFILE \varnothing CULVERTS AT STA. 20+880 (SBL) AND STA. 20+892 (NBL) (C25)

NOTES:

- CULVERTS AT STA. 20+880 (SBL) AND STA. 20+892 (NBL) WERE DESIGNATED C25 BY PML.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.



REF No.: TSH DRAWINGS C2-HWY69-DES.dwg and
C2-CULVERT-20880-20892-SERVOS Received on
October 07, 2008; Hwy 69 Servos Contract 2
Lidar Contours.dwg dated December 19, 2007;

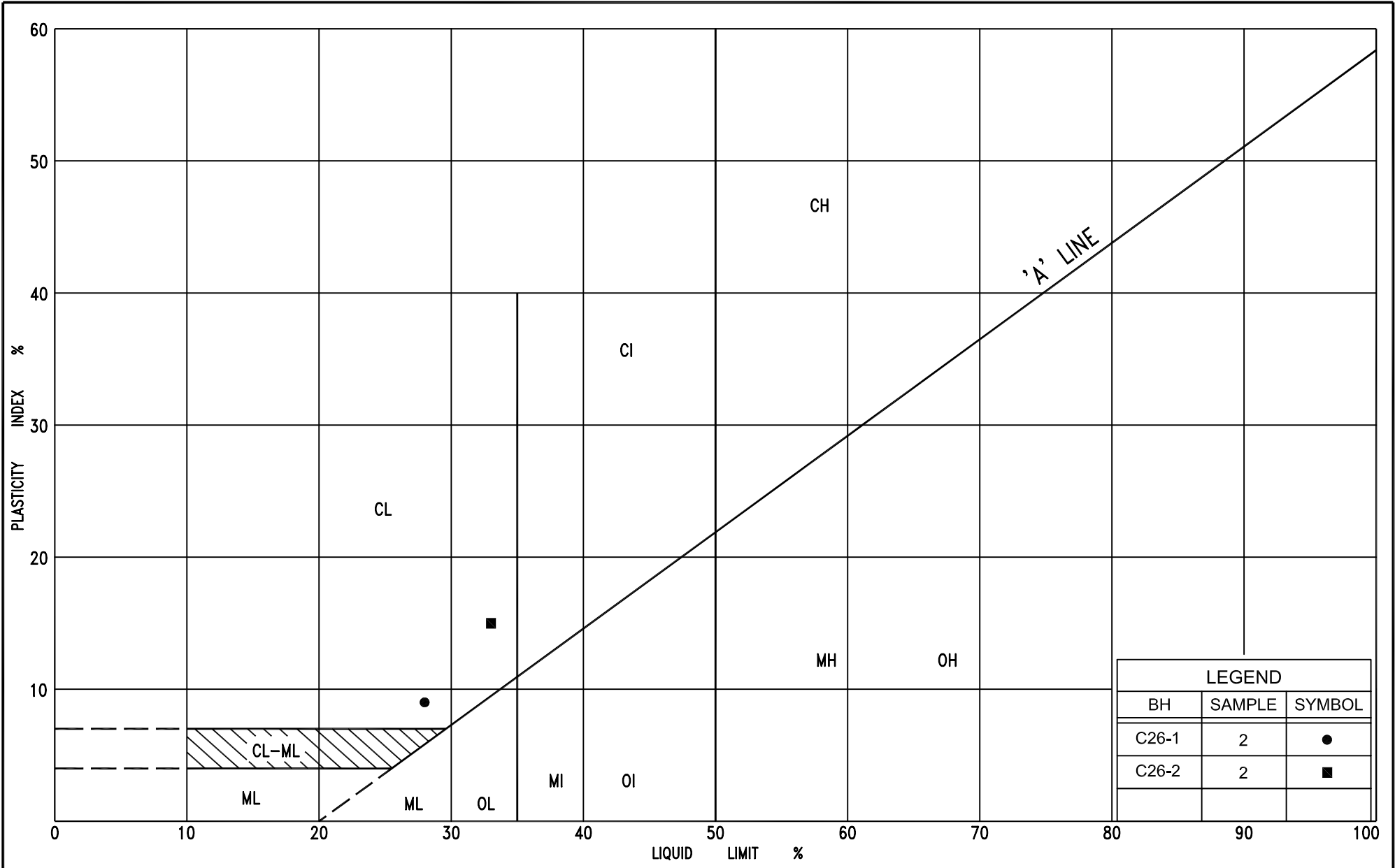
- NOTE -
The boundaries between soil strata have been established
only at Borehole locations. Between Boreholes the
boundaries are assumed from geological evidence.

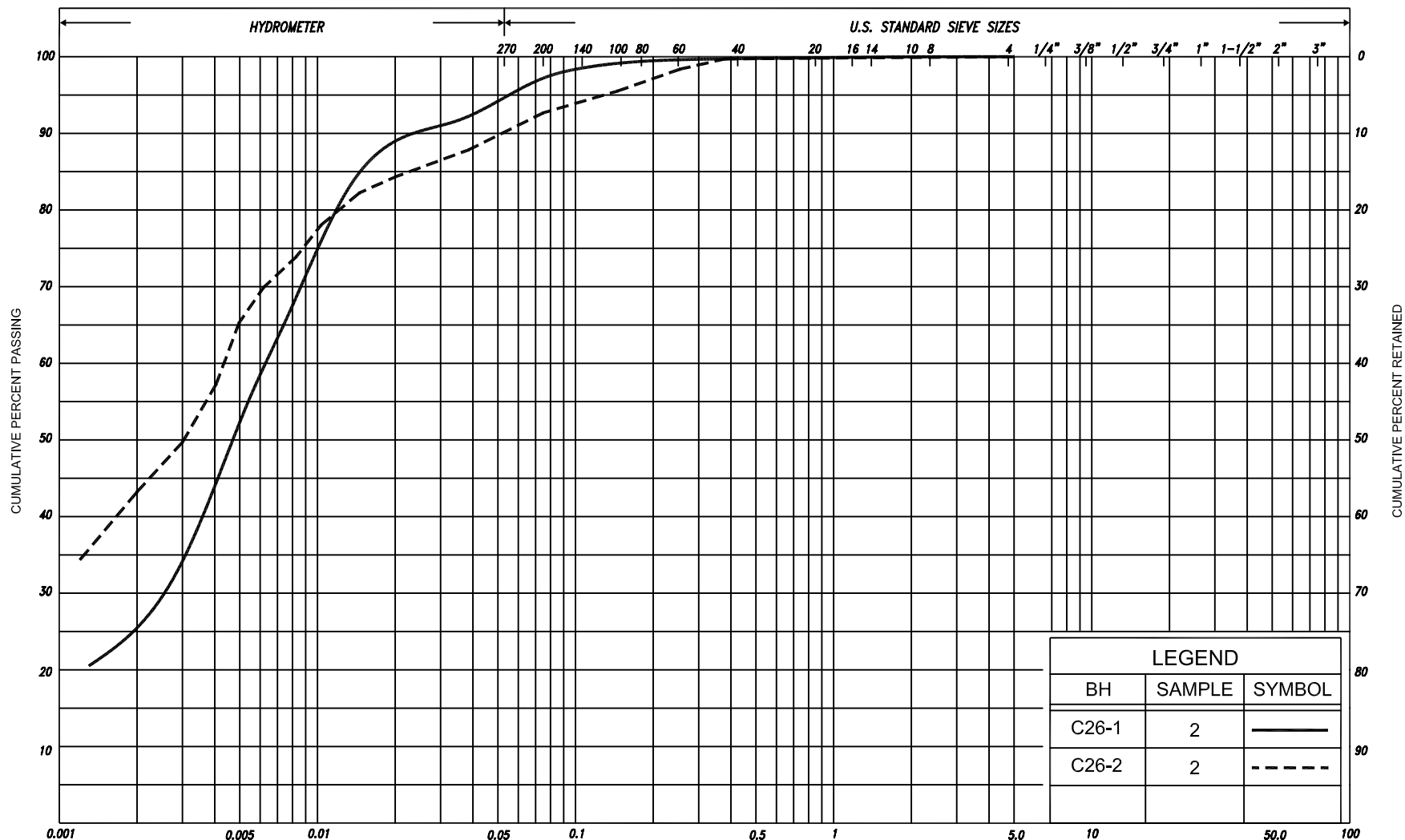
REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 411-235

HWY No	69	DIST	54
SUBM'D	AS	CHECKED	AS
DATE	MAY 27, 2009	SITE	---
DRAWN	NA	CHECKED	CN
APPROVED	BRG	DWG	C25

Culvert at Sta. 21+207 (SBL) and 21+199 (NBL) (C26), Servos Township

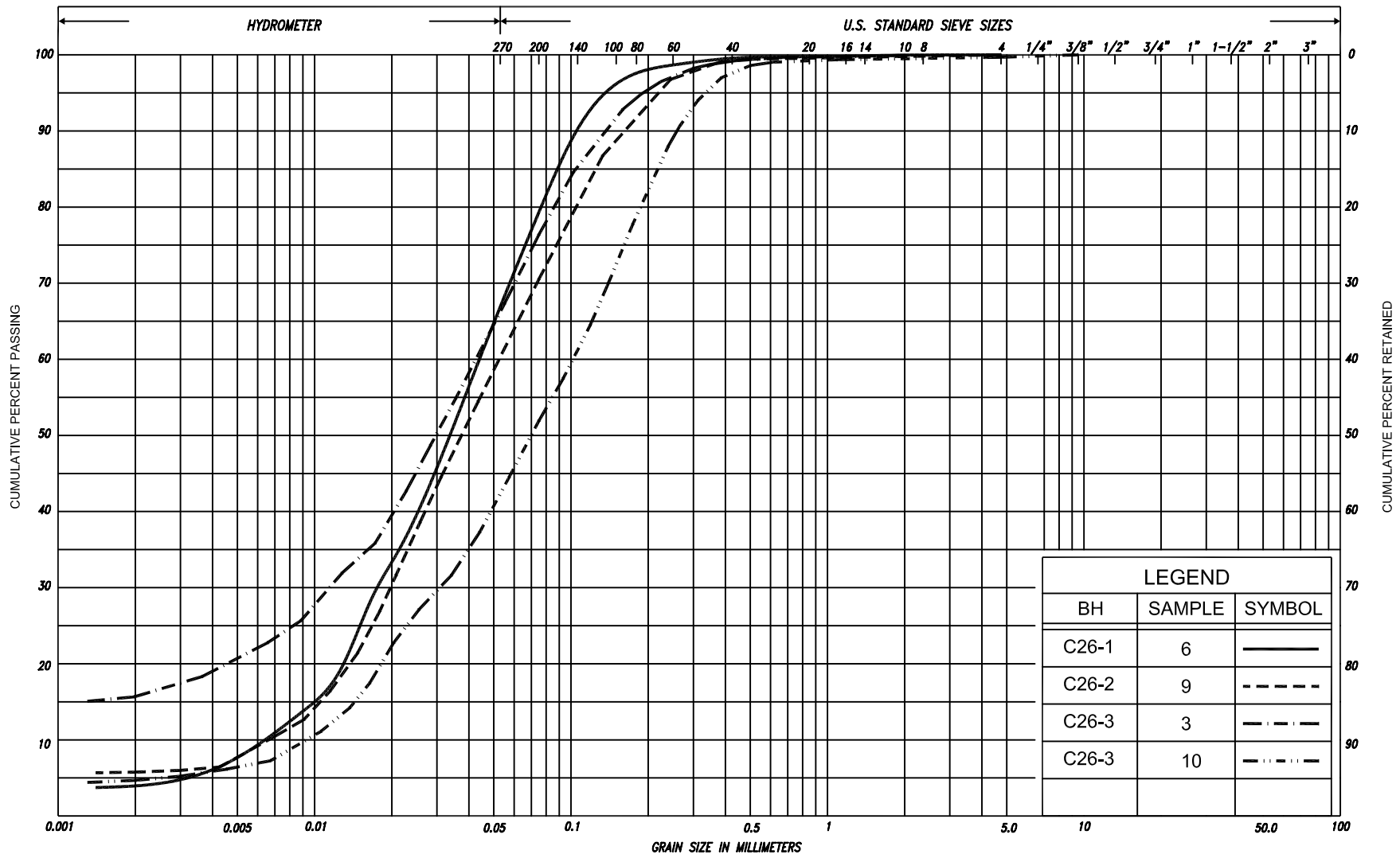




SILT & CLAY				FINE SAND			MEDIUM SAND		COARSE SAND	GRAVEL		COBBLES	UNIFIED
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE				GRAVEL		COBBLES	M.I.T.
		SILT		V. FINE	FINE	MED.	COARSE			GRAVEL			U.S. BUREAU
CLAY				SAND									

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, trace sand



SILT & CLAY				FINE SAND			MEDIUM SAND		COARSE SAND		GRAVEL		COBBLES	UNIFIED
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL		GRAVEL		GRAVEL		COBBLES	M.I.T.
CLAY		SILT		V. FINE	FINE	MED.	COARSE	GRAVEL		GRAVEL		GRAVEL		U.S. BUREAU

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	n	1, %	POROSITY	e_{max}	1, %	VOID RATIO IN LOOSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	w	1, %	WATER CONTENT	e_{min}	1, %	VOID RATIO IN DENSEST STATE
ρ_w	kg/m^3	DENSITY OF WATER	S_r	%	DEGREE OF SATURATION	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
γ_w	kN/m^3	UNIT WEIGHT OF WATER	w_L	%	LIQUID LIMIT	D	mm	GRAIN DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_p	%	PLASTIC LIMIT	D_n	mm	n PERCENT - DIAMETER
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_s	%	SHRINKAGE LIMIT	C_u	1	UNIFORMITY COEFFICIENT
ρ_d	kg/m^3	DENSITY OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	h	m	HYDRAULIC HEAD OR POTENTIAL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	q	m^3/s	RATE OF DISCHARGE
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	v	m/s	DISCHARGE VELOCITY
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	DTPL		DRIER THAN PLASTIC LIMIT	i	1	HYDRAULIC GRADIENT
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	APL		ABOUT PLASTIC LIMIT	k	m/s	HYDRAULIC CONDUCTIVITY
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL	WTPL		WETTER THAN PLASTIC LIMIT	j	kN/m^3	SEEPAGE FORCE
e	1, %	VOID RATIO						

RECORD OF BOREHOLE No C26-1

1 of 1

METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 125 191.6 N; 320 539.8 E
Hwy 69 (New), Sta. 21+208, o/s 47.0m Lt. CL ORIGINATED BY M.R.
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY A.S.
DATUM Geodetic DATE November 26, 2008 CHECKED BY C.N.

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)										
						○ UNCONFINED + FIELD VANE					w _p w w _L										
						● QUICK TRIAXIAL × LAB VANE															
222.6	Ground Surface								20	40	60	80	100								
0.0	Clayey silt, trace sand		1	SS	10	▽*	222									○				0 3 72 25	
	Stiff Brown Moist		2	SS	12												○				
221.2	Silt trace sand, trace clay		3	SS	26		221										○				
1.4	Compact Brown Moist to dense to wet		4	SS	24		220										○				
	with sand		5	SS	41		219										○				
	Grey		6	SS	17		218										○				
			7	SS	23		217										○				
			8	SS	40		216										○				
215.3	Sand and silt						215														
7.3	Very dense Grey Wet		9	SS	50																
214.7	End of borehole																				
7.9																					
	* 2008 11 26																				
	▽ Water level observed during drilling																				

METRIC

— CHECKED BY C.N.

20
15 —○— 5 (%) STRAIN AT FAILURE
10

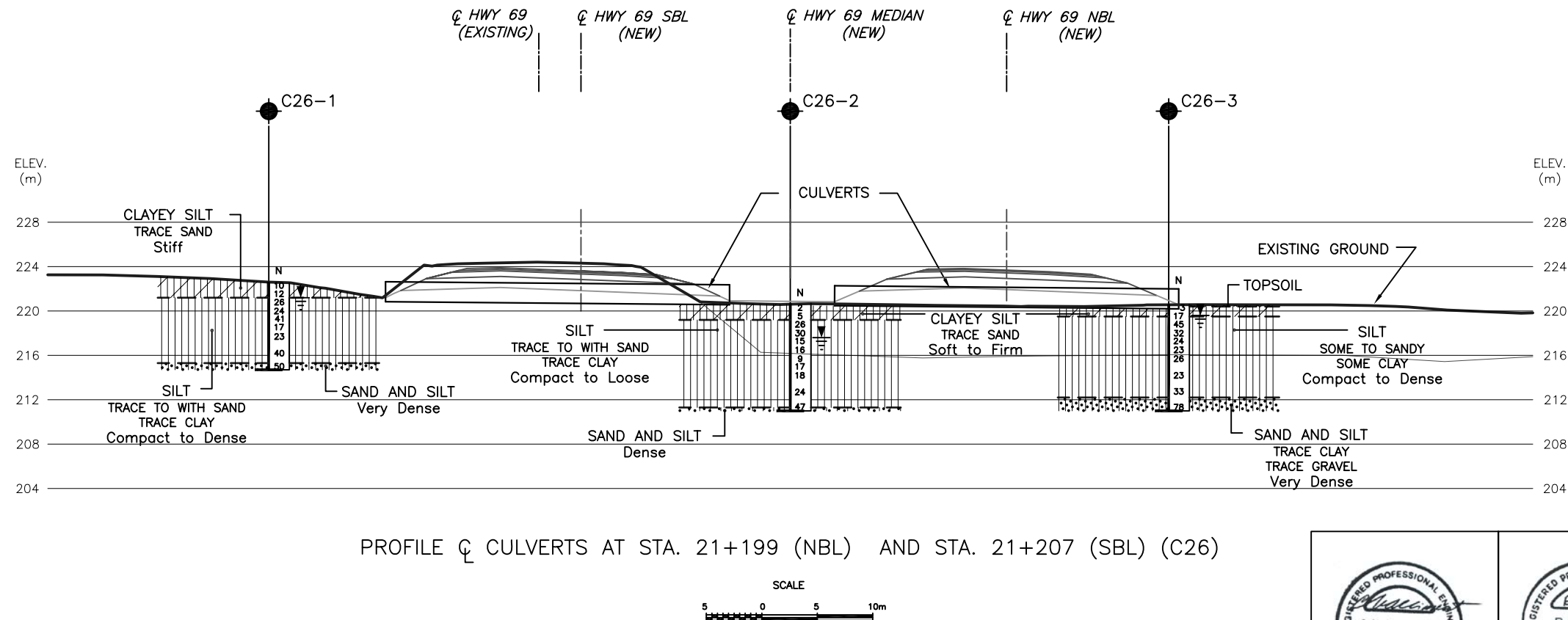
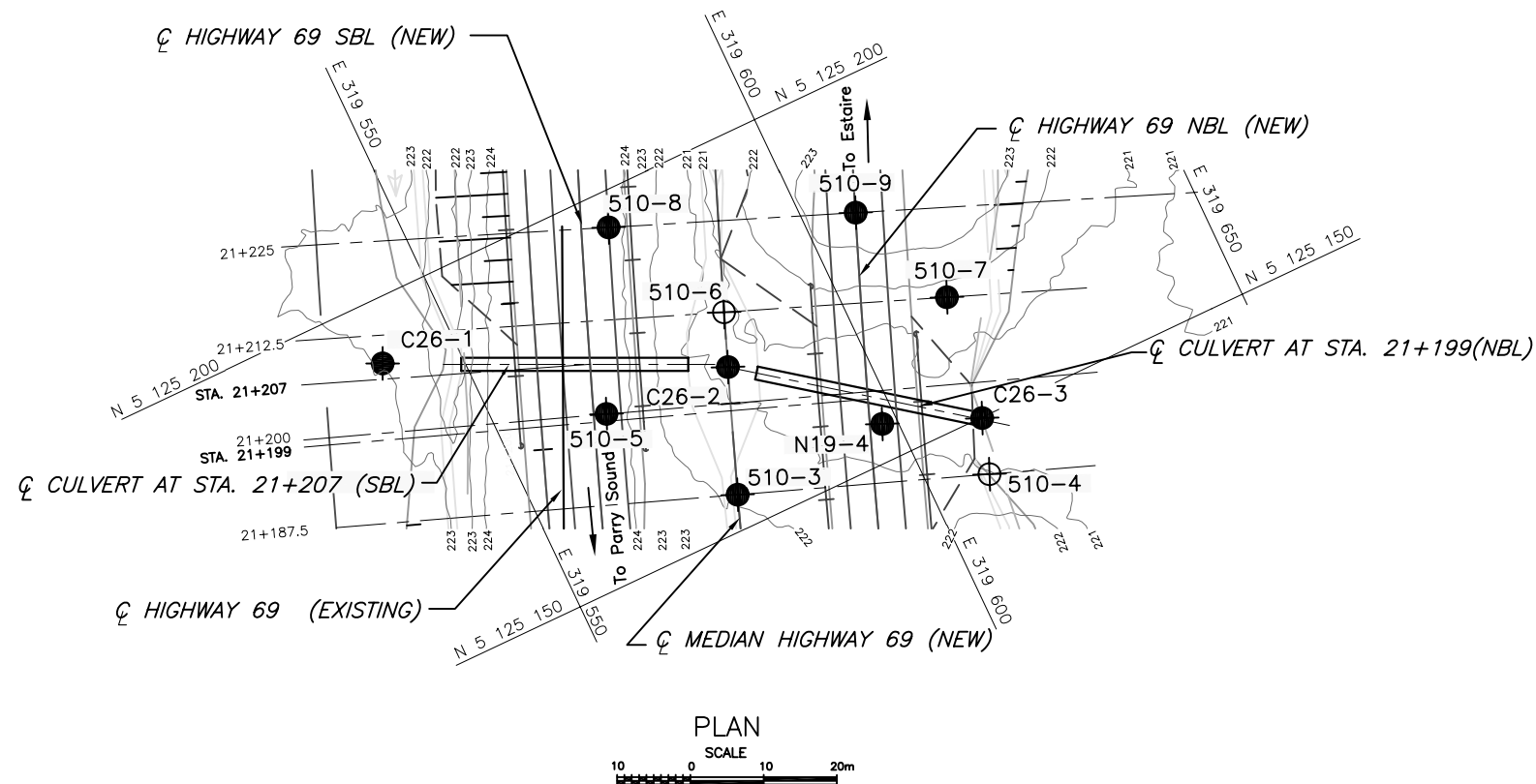
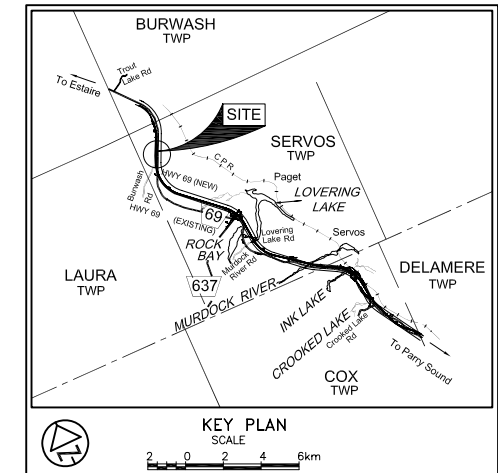
RECORD OF BOREHOLE No C26-3

1 of 1

METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 125 149.9 N; 319 610.6 E
Hwy 69 (New), Sta. 21+195, o/s 34.1m Rt. CL ORIGINATED BY M.R.
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY A.S.
DATUM Geodetic DATE November 27, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p W W _L							
								○ UNCONFINED + FIELD VANE					○ UNCONFINED + FIELD VANE							
								● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)							
220.6	Ground Surface						20	40	60	80	100									
0.0	Topsoil		1	SS	3									o						
220.4	Clayey silt, trace sand																			
0.2	Soft Brown Moist																			
219.5			2	SS	17									o						
1.1	Silt with sand, some clay																			
	Compact Grey Moist to dense to wet		3	SS	45									o				0 24 60 16		
			4	SS	32									o						
			5	SS	24									o						
			6	SS	23									o						
	some sand																			
			7	SS	26									o						
			8	SS	23									o						
	sandy silt layers																			
			9	SS	33									o						
212.2																				
8.4	Sand and silt trace clay, trace gravel																			
	Very dense Grey Wet																			
211.0			10	SS	78													1 47 47 5		
9.6	End of borehole																			



LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation Nov 2008
500 Series Feb and Sept 2007
N19 Series Mar 2004
- Head
- ARTESIAN WATER
Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
C26-1	222.6	5 125 191.6	319 539.8
C26-2	220.6	5 125 171.0	319 582.2
C26-3	220.6	5 125 149.9	319 610.6
N19-4	220.6	5 125 155	319 598
BH No	ELEVATION	STA SERVOS TWP	o/s CL MED
510-3	221.8	21+187.5	CL
510-4	221.1	21+187.5	34.5m Rt.
510-5	224.3	21+200	17.0m Lt.
510-6	220.8	21+212.5	CL
510-7	221.6	21+212.5	30.5m Rt.
510-8	224.3	21+225	15.0m Lt.
510-9	222.9	21+225	18.8m Rt.

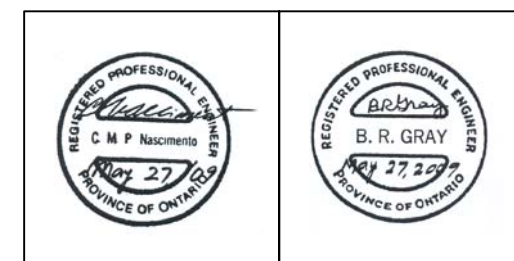
NOTE
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 411-235			
HWY No	69	DIST	54
SUBM'D	AS	CHECKED	AS
DRAWN	NA	CHECKED	CN
DATE	MAY 27, 2009	APPROVED	BRG
SITE	---	LDWG	C26

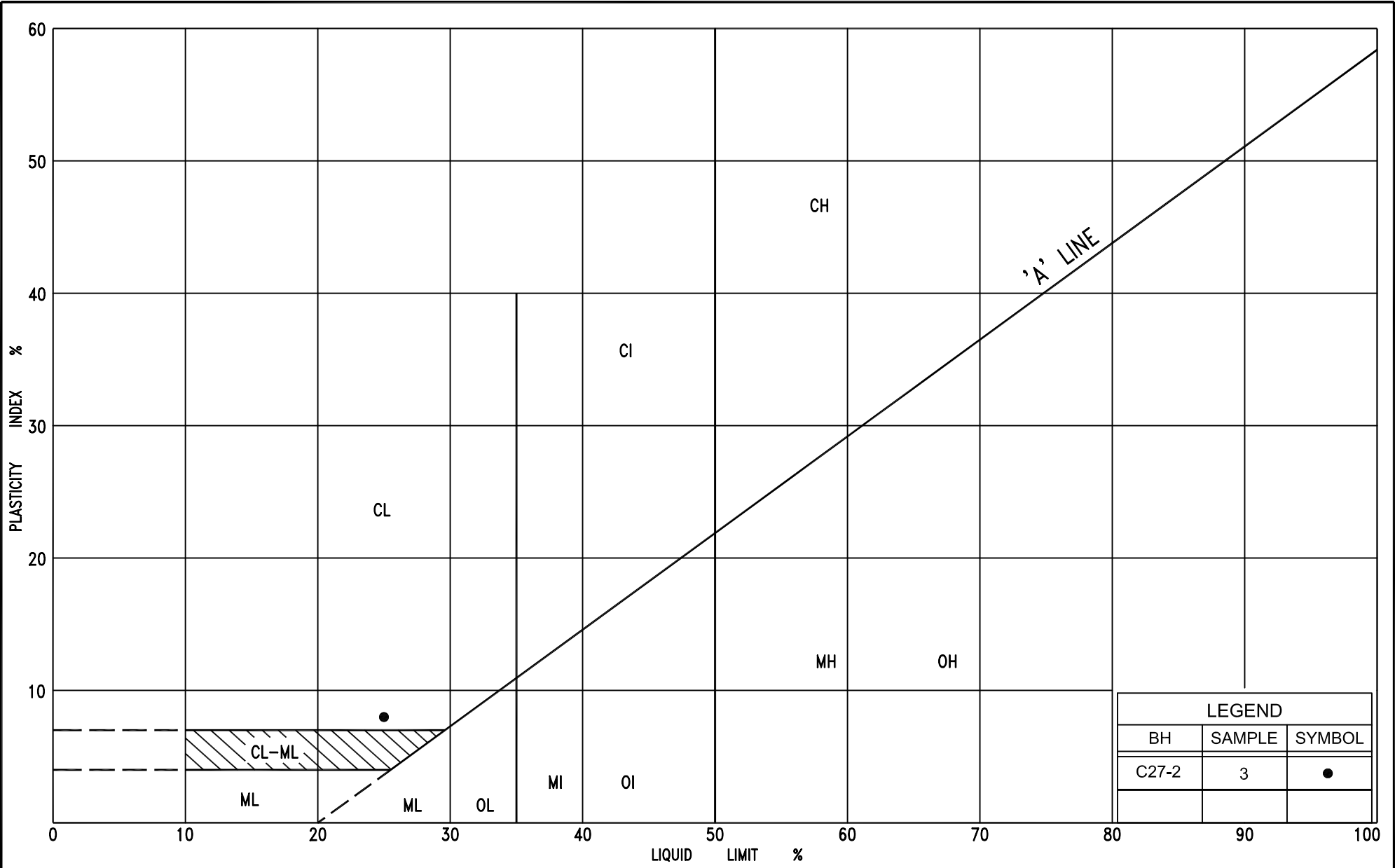
NOTES:

- CULVERTS AT STA. 21+199 (NBL) AND STA. 21+207 (SBL) WERE DESIGNATED C26 BY PML.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.



REF No.: TSH DRAWINGS C2-HWY69-DES.dwg and C2-CULVERT-21207-21199-SERVOS.dwg Received on October 07, 2008; Hwy 69 Servos Contract 2 Lidar Contours.dwg dated December 19, 2007;

Culvert at Sta. 10+178 (SBL) and 10+192 (NBL) (C27), Burwash Township



Ministry of
Transportation
Ontario

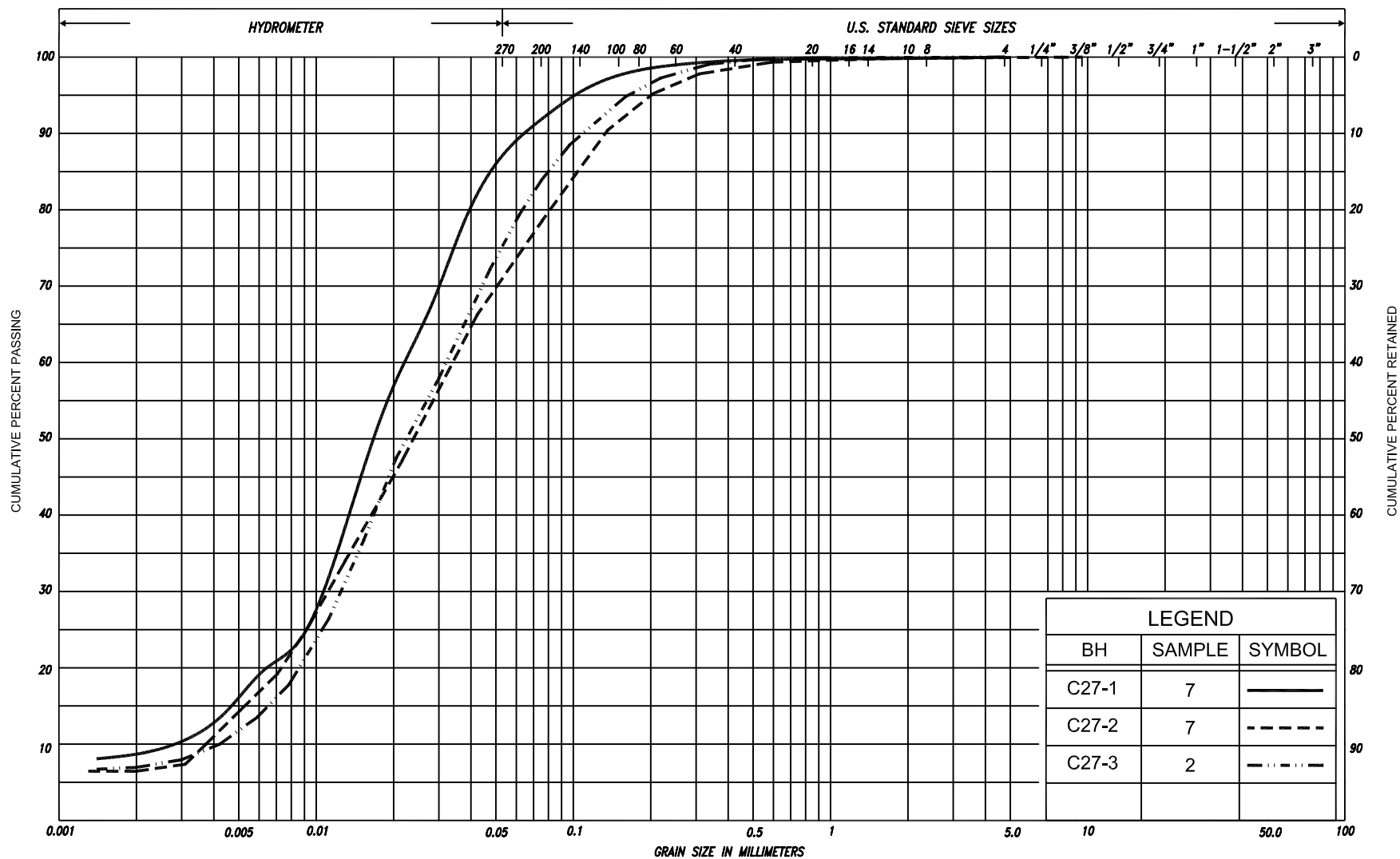
PLASTICITY CHART

CLAYEY SILT, trace sand

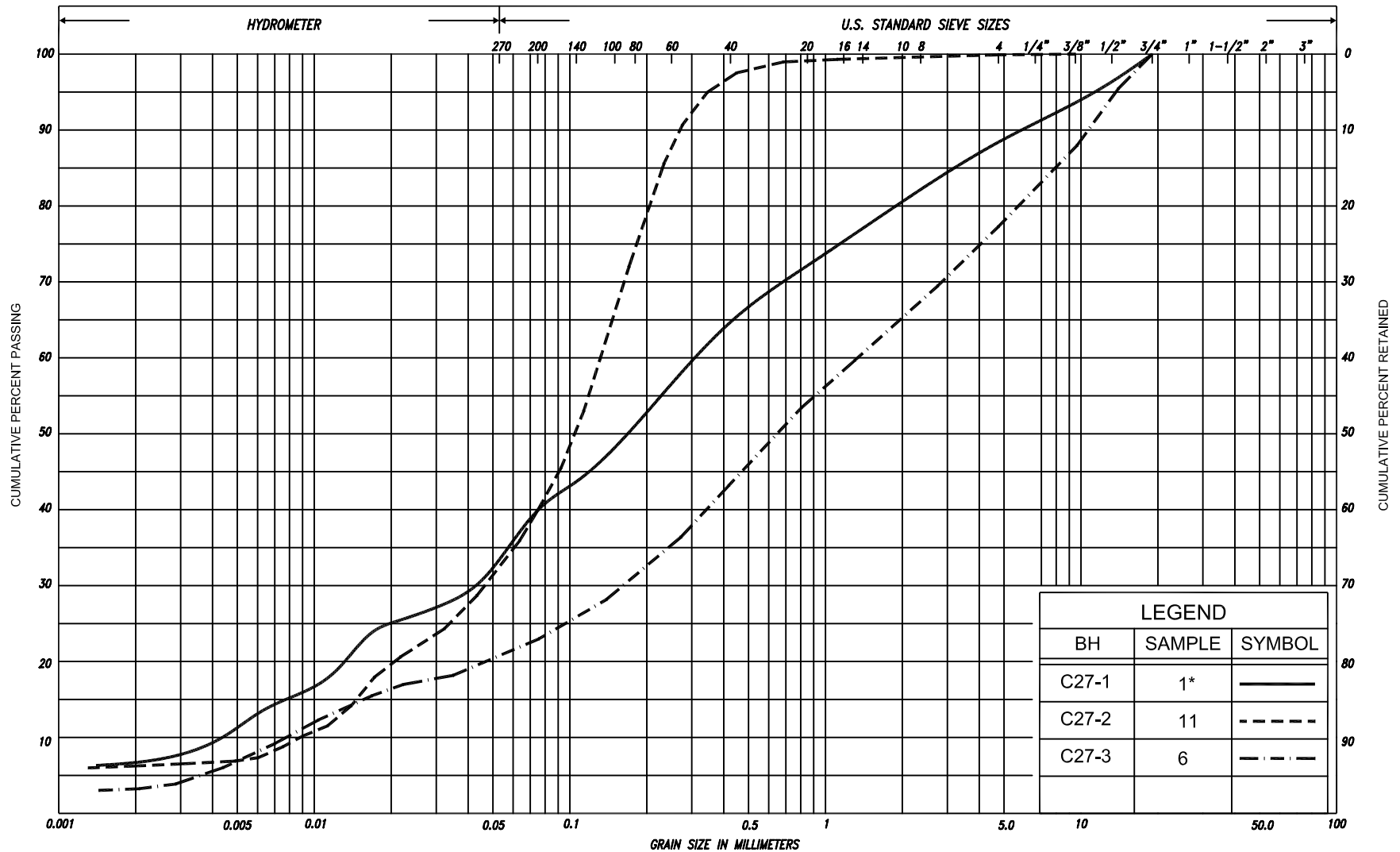
FIG No. C27 -PC-1

HWY: 69

G.W.P. No. 5218-06-00



SILT & CLAY				SAND			GRAVEL		COBBLES	UNIFIED
				FINE	MEDIUM	COARSE				
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL		COBBLES	M.I.T.
				V. FINE	FINE	MED.	COARSE	GRAVEL		U.S. BUREAU
				SAND						



SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL		COBBLES	UNIFIED
CLAY	FINE		MEDIUM		COARSE		SAND		GRAVEL		COBBLES	M.I.T.
	SILT		FINE		MEDIUM		COARSE					
CLAY		SILT		V. FINE	FINE	MED.	COARSE	GRAVEL				U.S. BUREAU

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	n	1, %	POROSITY	e_{\max}	1, %	VOID RATIO IN LOOSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	w	1, %	WATER CONTENT	e_{\min}	1, %	VOID RATIO IN DENSEST STATE
ρ_w	kg/m^3	DENSITY OF WATER	S_r	%	DEGREE OF SATURATION	I_D	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
γ_w	kN/m^3	UNIT WEIGHT OF WATER	w_L	%	LIQUID LIMIT	D	mm	GRAIN DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_p	%	PLASTIC LIMIT	D_n	mm	n PERCENT - DIAMETER
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_s	%	SHRINKAGE LIMIT	C_u	1	UNIFORMITY COEFFICIENT
ρ_d	kg/m^3	DENSITY OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	h	m	HYDRAULIC HEAD OR POTENTIAL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	q	m^3/s	RATE OF DISCHARGE
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	v	m/s	DISCHARGE VELOCITY
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	DTPL		DRIER THAN PLASTIC LIMIT	i	1	HYDRAULIC GRADIENT
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	APL		ABOUT PLASTIC LIMIT	k	m/s	HYDRAULIC CONDUCTIVITY
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL	WTPL		WETTER THAN PLASTIC LIMIT	j	kN/m^2	SEEPAGE FORCE
e	1, %	VOID RATIO						

RECORD OF BOREHOLE No C27-1										1 of 1		METRIC				
G.W.P. 5218-06-00			LOCATION			Coords: 5 126 407.1 N; 320 101.0 E Hwy 69 (New), Sta. 10+168, o/s 47.4m Lt. CL			ORIGINATED BY M.R.							
DIST 54 HWY 69			BOREHOLE TYPE Continuous Flight Hollow Stem Augers						COMPILED BY A.S.							
DATUM Geodetic			DATE November 25, 2008						CHECKED BY C.N.							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa									
223.5	Ground Surface						20	40	60	80	100					
0.0	Silty sand some gravel, trace clay Very loose Brown Moist (FILL)		1	SS	2											12 48 34 6
222.1	Organic sandy silt to organic clayey silt decayed wood Soft Dark Moist to firm amorphous peat layers		2	SS	3											
1.4			3	SS	4											
			4	SS	6											
			5	SS	6											
219.1	Silt trace sand, trace clay Loose Grey Moist to wet Compact		6	SS	7											
4.4			7	SS	26											0 8 83 9
			8	SS	18											
			9	SS	14											
			10	SS	18											
213.7	End of borehole															
9.8																
<p>* 2008 11 25</p> <p>▽ Water level observed during drilling</p>																

RECORD OF BOREHOLE No C27-2

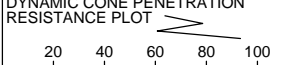

1 of 2

METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 126 402.6 N; 320 151.3 E
Hwy 69 (New), Sta. 10+185 CL ORIGINATED BY M.R.
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY A.S.
DATUM Geodetic DATE November 16, 17 and 18, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
223.4	Ground Surface													
0.0	Silty clay, trace sand		1	SS	1		223							
	Very soft Brown Moist to soft organic silty clay layers		2	SS	3		222							
222.0							222							
1.4	Clayey silt, trace sand		3	SS	11		221							
	Stiff to Grey Moist very stiff		4	SS	9		220							
			5	SS	16		219							
			6	SS	9		218							
218.2							217							
5.2	Silt, with sand trace clay, trace gravel		7	SS	7		216							
	Compact Grey Wet		8	SS	9		215							
			9	SS	7		214							
							213							
	boulders some sand silty sand layers		10	SS	4		212							
211.5							211							
11.9	Silty sand trace clay, trace gravel silt layers		11	SS	10		210							
	Compact Grey Wet to loose		12	SS	6									
209.1														
14.3	End of borehole													

Cont'd

RECORD OF BOREHOLE No C27-2										2 of 2		METRIC			
G.W.P. 5218-06-00			LOCATION			Coords: 5 126 402.6 N; 320 151.3 E Hwy 69 (New), Sta. 10+185 CL			ORIGINATED BY M.R.						
DIST 54 HWY 69			BOREHOLE TYPE			C.F.H.S.A. and Dynamic Cone Penetration Test			COMPILED BY A.S.						
DATUM Geodetic			DATE			November 16, 17 and 18, 2008			CHECKED BY C.N.						
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE				W _p	W	W _L	γ	GR SA SI CL
							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			WATER CONTENT (%)					
208.4	* 2008 11 16  Water level observed during drilling C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers Dynamic cone penetration test was driven 1.5m east from the original location, augered 3.1m to 10.7m. Split spoon samples were taken at 10.7, 12.2 and 13.7m (missing from original borehole)														

RECORD OF BOREHOLE No C27-2A

1 of 1

METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 126 400.5 N; 320 175.6 E
Hwy 69 (New), Sta. 10+194, o/s 23.0m Rt. CL ORIGINATED BY M.R.
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY A.S.
DATUM Geodetic DATE November 25, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER	CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				SHEAR STRENGTH kPa										WATER CONTENT (%)		
									○ UNCONFINED		+ FIELD VANE								○		
									● QUICK TRIAXIAL		× LAB VANE										
224.6	Ground Surface							20	40	60	80	100									
0.0	Silty clay, trace sand organics		1	SS	1	▽	224								○						
	Very Soft Brown Moist																				
	Stiff		2	SS	14		223								○						
			3	SS	8		222														
	Grey		4	SS	14		221								○						
221.6	Clayey silt, trace sand		5	SS	12		220								○						
3.0	Stiff Grey Moist to firm																				
			6	SS	7		219								○						
			7	SS	8		218								○						
219.4	Silt trace sand, trace clay		8	SS	10		217								○						
5.2	Compact Grey Moist to wet																				
			9	SS	5		216								○						
			10	SS	13																
215.8	Sand and gravel some silt																				
8.8	Very dense Brown Wet		11	SS	50																
215.2	End of borehole																				
9.4	Sample 5: Lon"N" value due to hydraulic disturbance																				
	* 2008 11 25																				
	▽ Water level observed during drilling																				
	■ Penetrometer test																				

Sample 5: Lon"N" value due
to hydraulic disturbance

* 2008 11 25

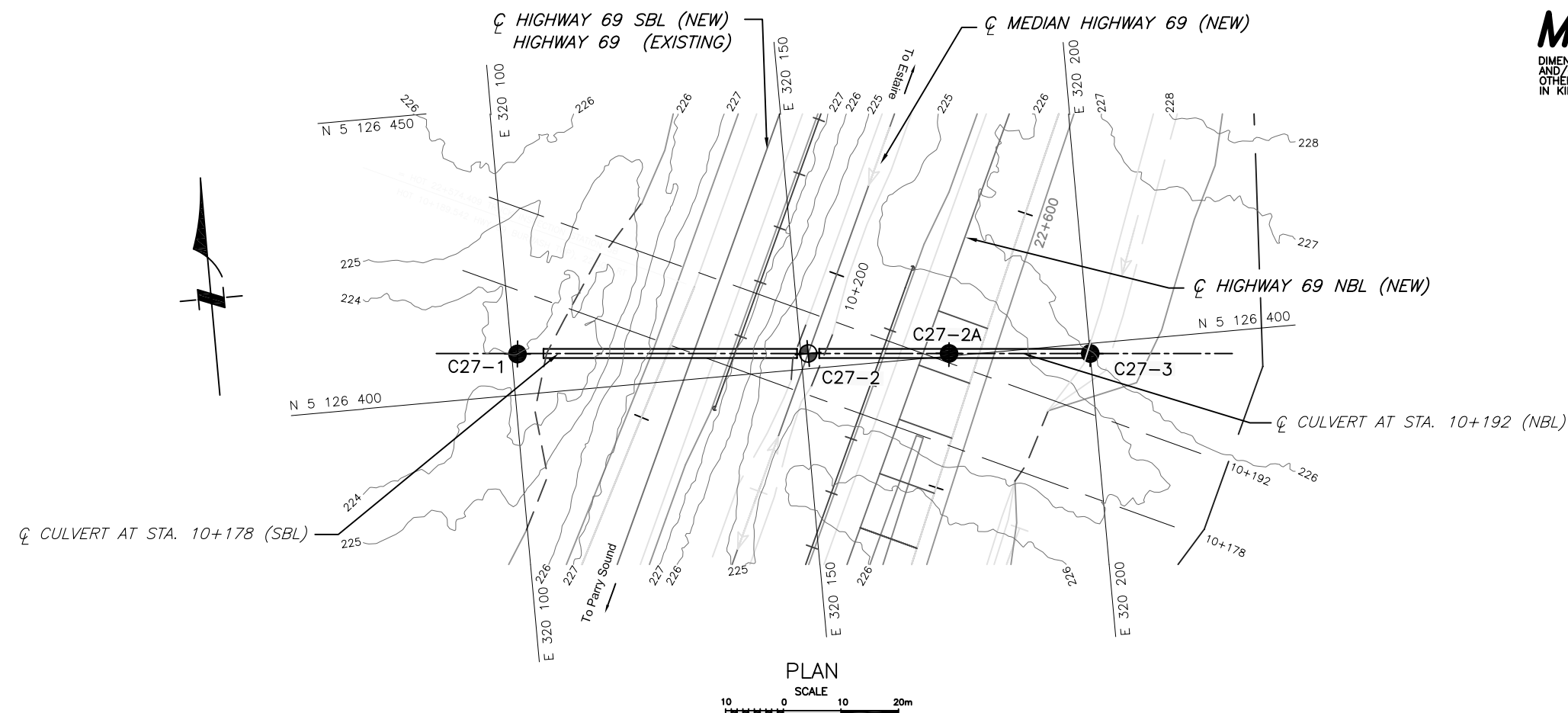
▽ Water level observed
during drilling

■ Penetrometer test

METRIC

— CHECKED BY C.N.

20
15 — 5 (%) STRAIN AT FAILURE
10

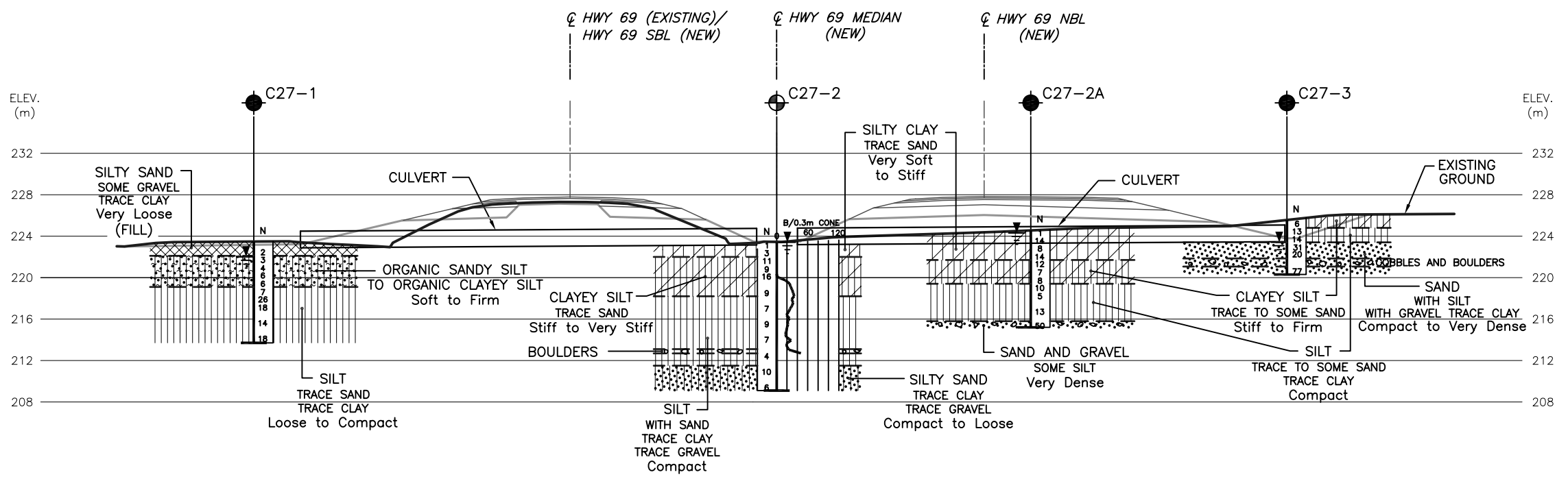
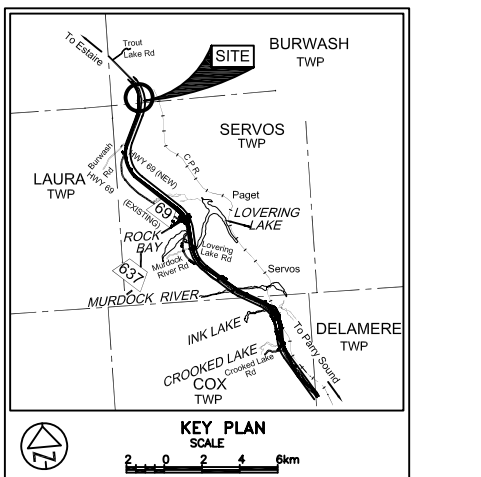


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No
GWP No 5218-06-00

CULVERTS AT STA. 10+178 (SBL)
AND STA. 10+192 (NBL) (C27)
HIGHWAY 69 FOUR-LANING - BURWASH TOWNSHIP
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



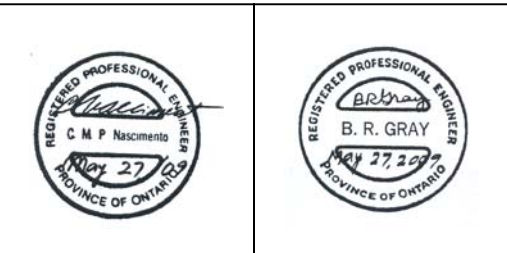
PROFILE \varnothing CULVERTS AT STA. 10+178 (SBL) AND STA. 10+192 (NBL) (C27)

LEGEND			
	Borehole		
	Dynamic Cone Penetration Test (Cone)		
	Borehole & Cone		
N	Blows/0.3m (Std. Pen Test, 475 J/blow)		
CONE	Blows/0.3m (60° Cone, 475 J/blow)		
	W L at time of investigation Nov 2008		
	Head		
	ARTESIAN WATER		
	Encountered		
	PIEZOMETER		
BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
C27-1	223.5	5 126 407.1	320 101.0
C27-2	223.4	5 126 402.7	320 151.3
C27-2A	224.6	5 126 400.5	320 175.6
C27-3	225.5	5 126 398.3	320 200.0

— NOTE —
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

DATE	BY	DESCRIPTION

Geocres No. 411-235			
HWY No	69	CHECKED AS	DIST 54
SUBM'D	AS	CHECKED AS	DATE MAY 27, 2009
DRAWN	NA	CHECKED CN	APPROVED BRG
		SITE	---
		DWG	C27



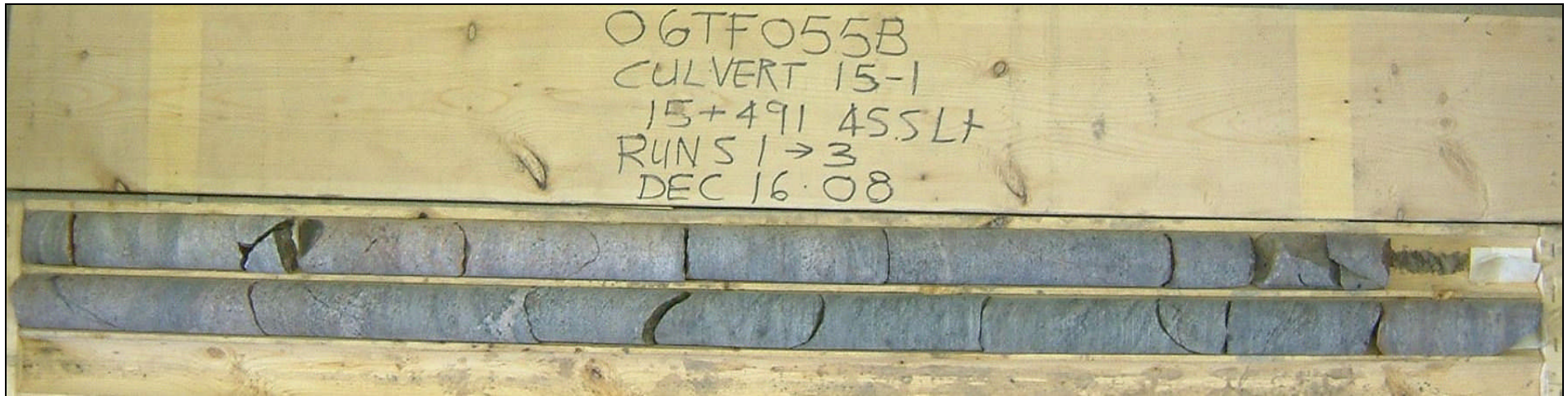
REF No.: TSH DRAWINGS C2-HWY69-DES.dwg and C2-CULVERT-10178-10192-BURWASH.dwg Received on October 07, 2008; Hwy 69 Servos Contract 2 Lidar Contours.dwg dated December 19, 2007;

- NOTES:
- CULVERTS AT STA. 10+178 (SBL) AND 10+192 (NBL) WERE DESIGNATED C27 BY PML.
 - THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

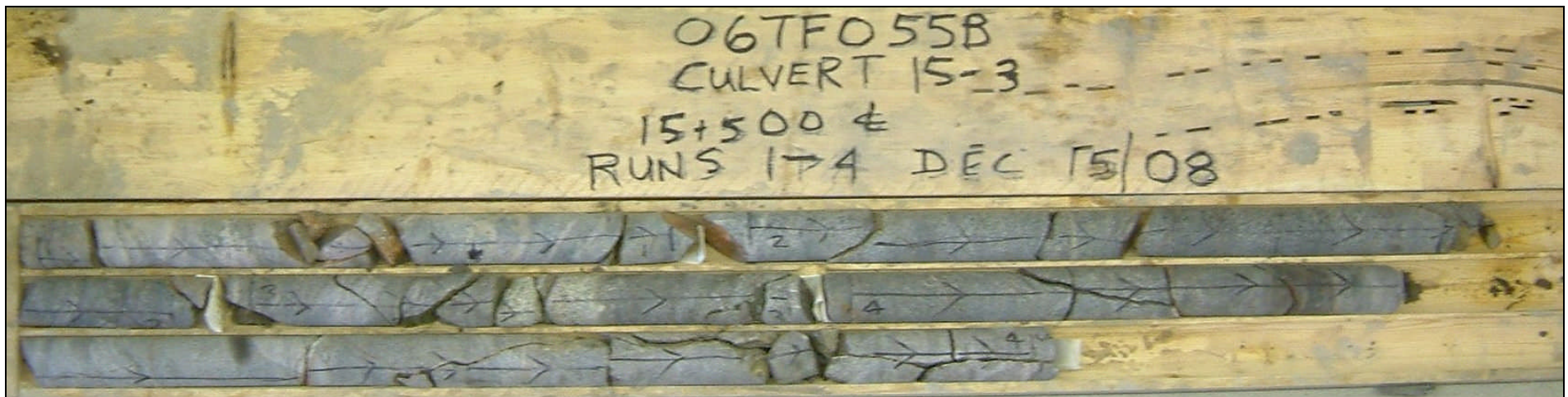


APPENDIX A

Rock Core Photographs



Photograph 1: Culvert C15, borehole C15-1, samples RC-4 to RC-6



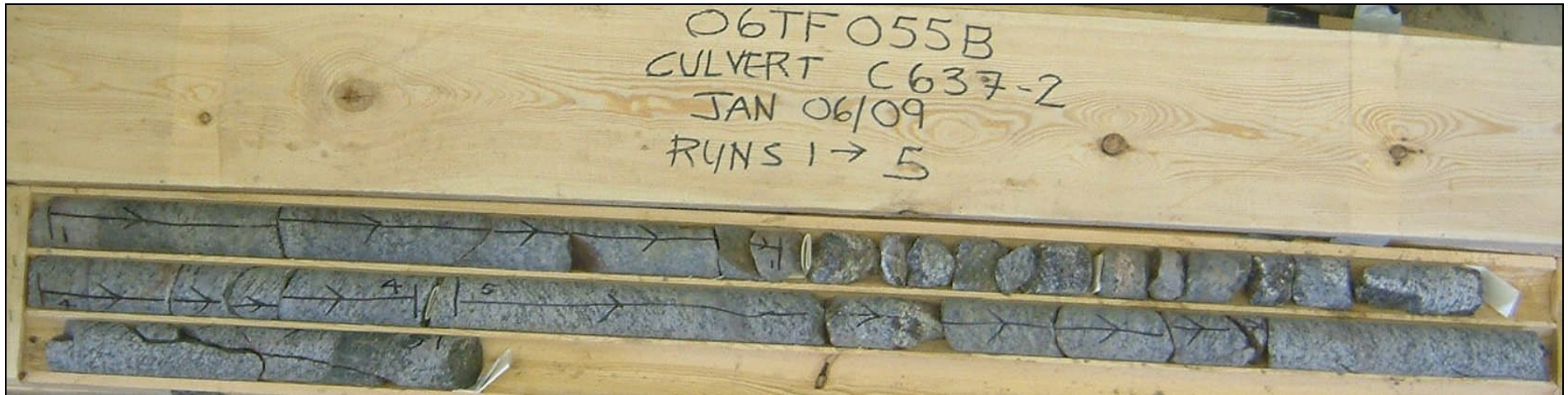
Photograph 2: Culvert C15, borehole C15-3, samples RC-4 to RC-7



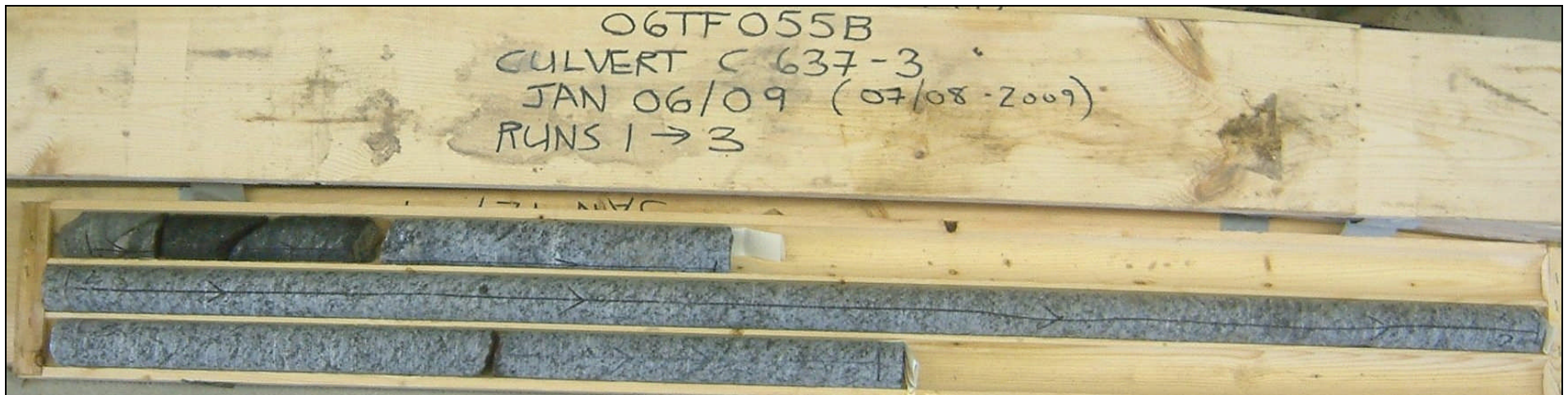
Photograph 3: Culvert C15, borehole C15-5, samples RC-10 to RC-12



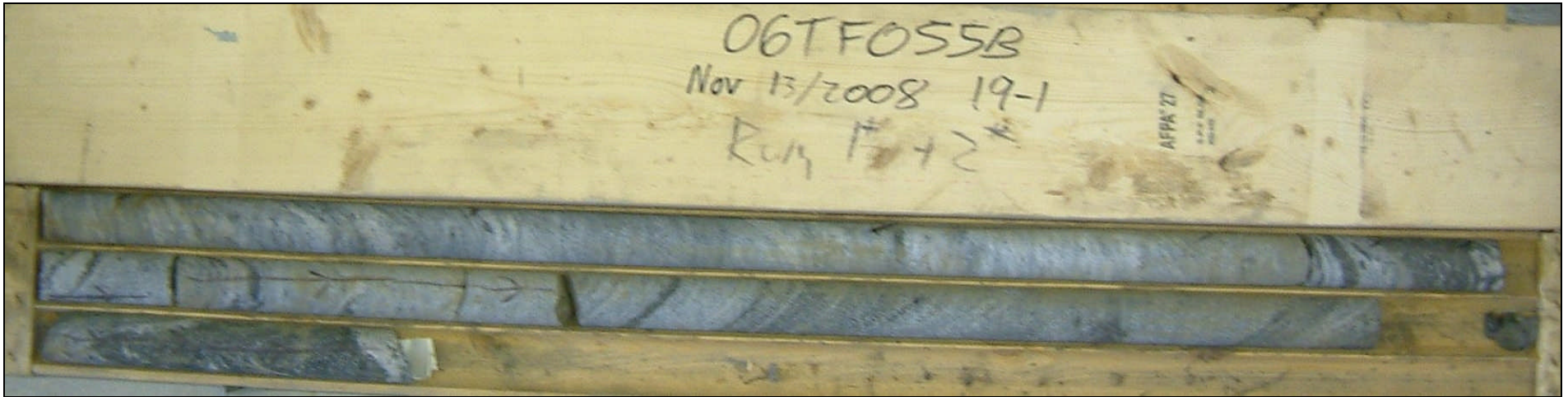
Photograph 4: Culvert C637, borehole C637-1, samples RC-4 to RC-6



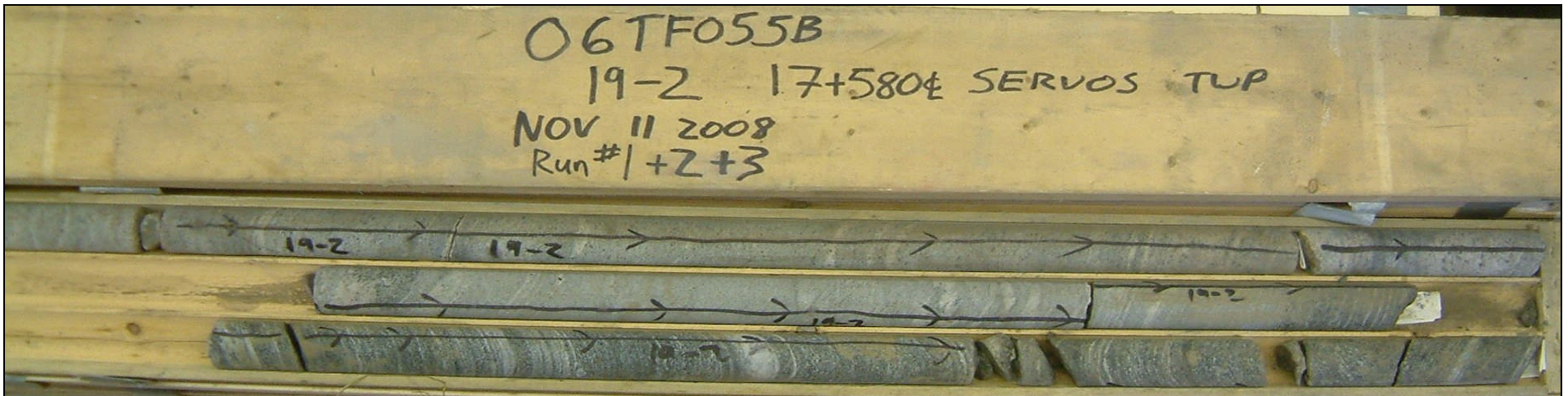
Photograph 5: Culvert C637, borehole C637-2, samples RC-6 to RC-10



Photograph 6: Culvert C637, borehole C637-3, samples RC-7 to RC-9



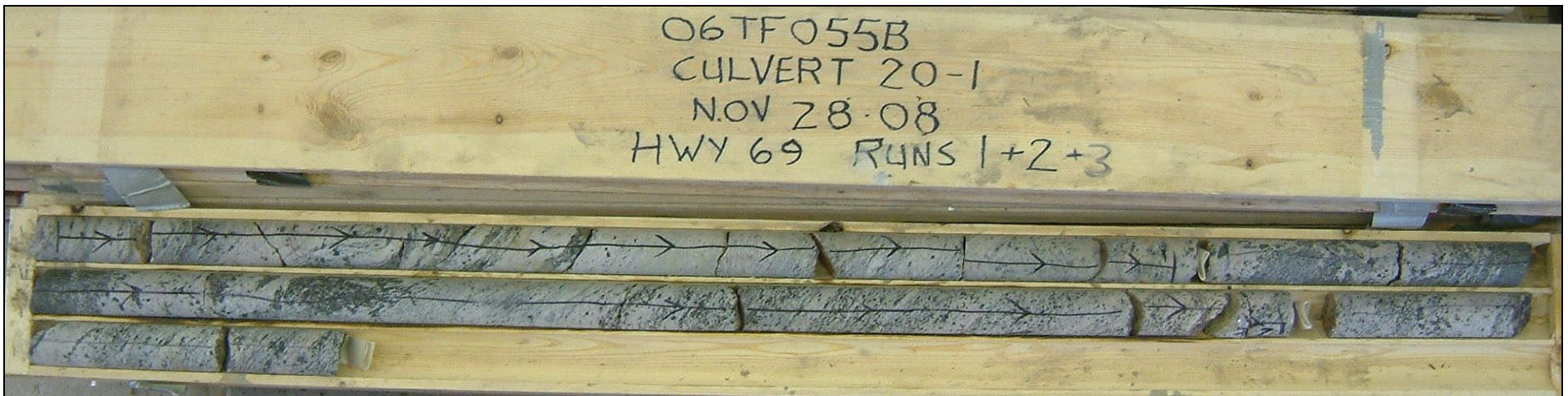
Photograph 7: Culvert C19, borehole C19-1, samples RC-4 and RC-5



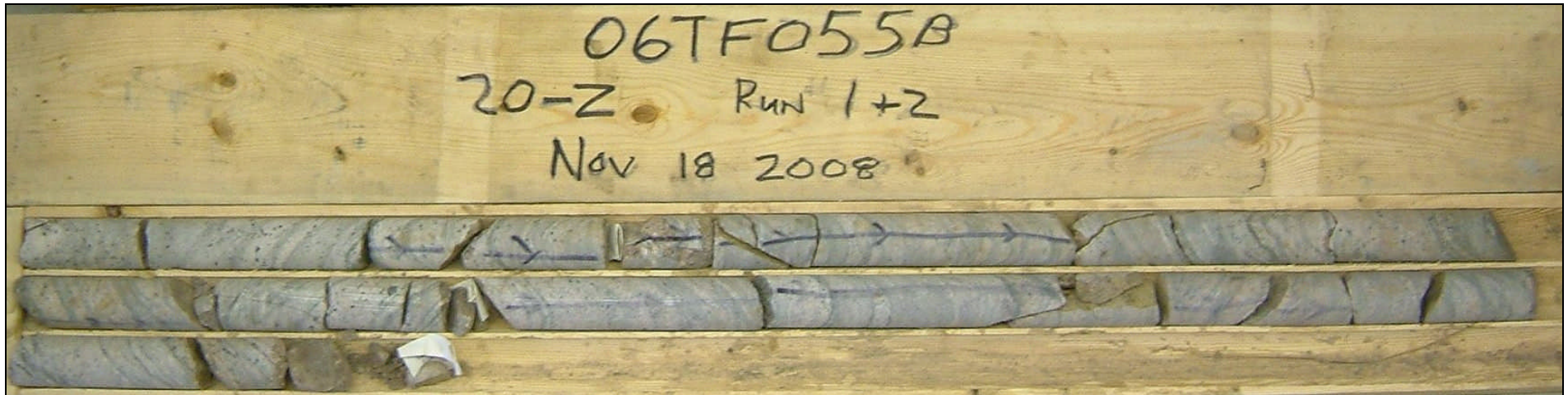
Photograph 8: Culvert C19, borehole C19-2, samples RC-2 to RC-4



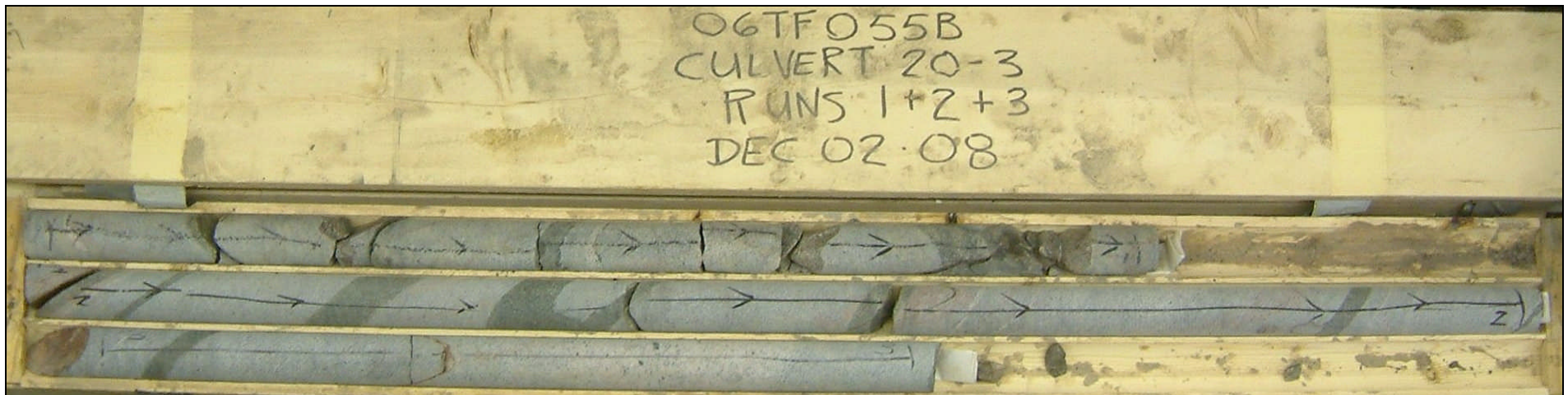
Photograph 9: Culvert C19, borehole C19-3, samples RC-3 to RC-5



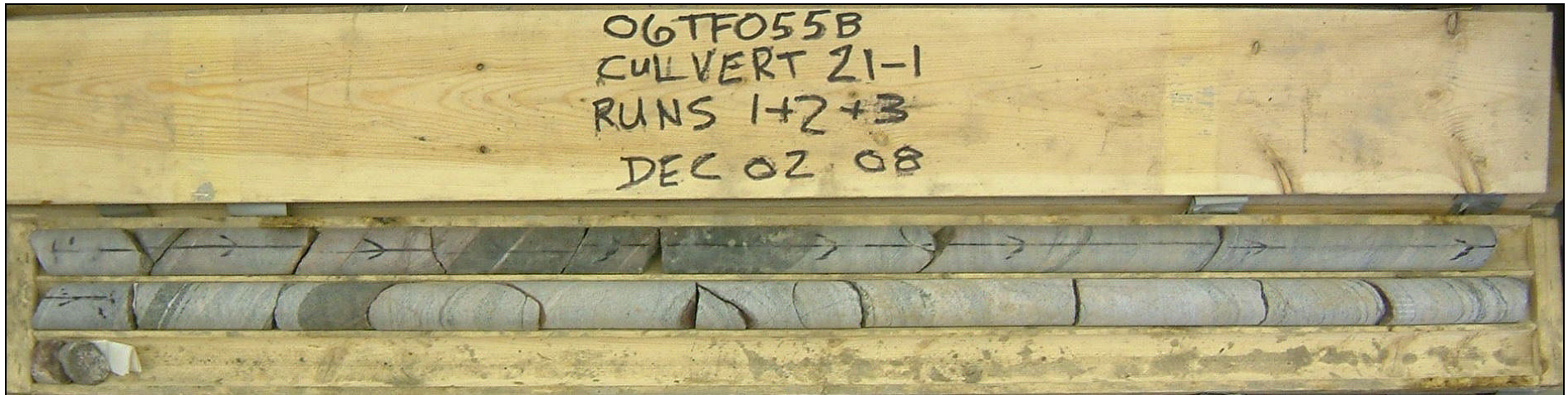
Photograph 10: Culvert C20, borehole C20-1, samples RC-1 to RC-3



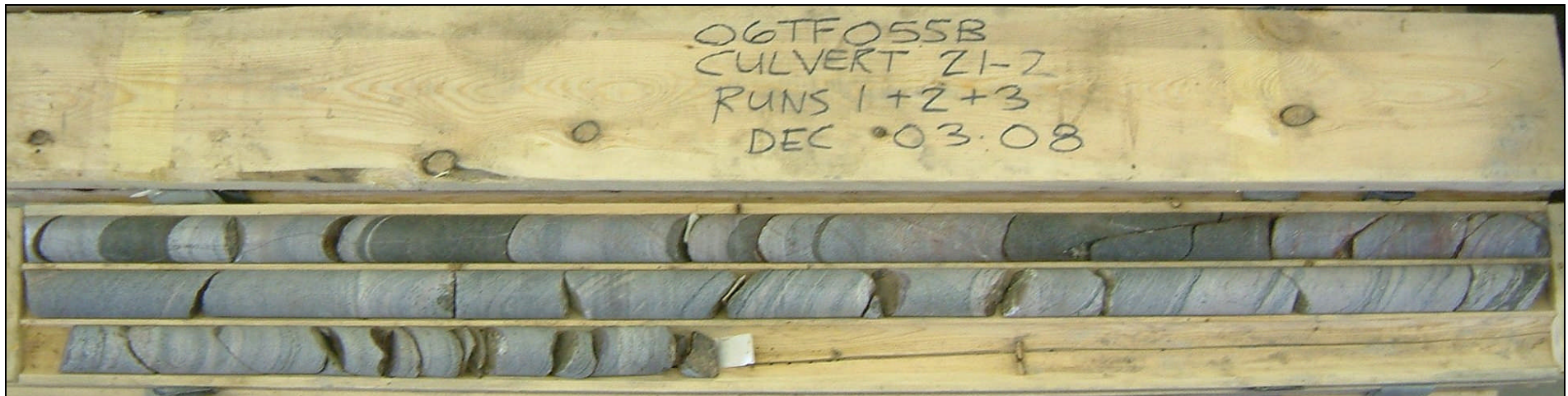
Photograph 11: Culvert C20, borehole C20-2, samples RC-3 to RC-5



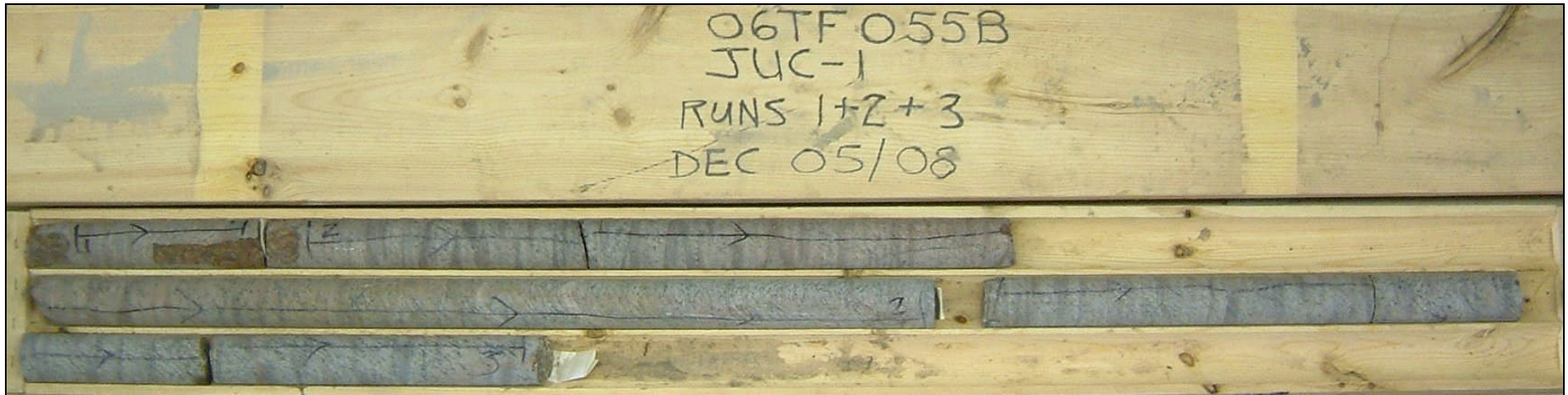
Photograph 12: Culvert C20, borehole C20-3, samples RC-1 to RC-3



Photograph 13: Culvert C21, borehole C21-1, samples RC-7 and RC-8



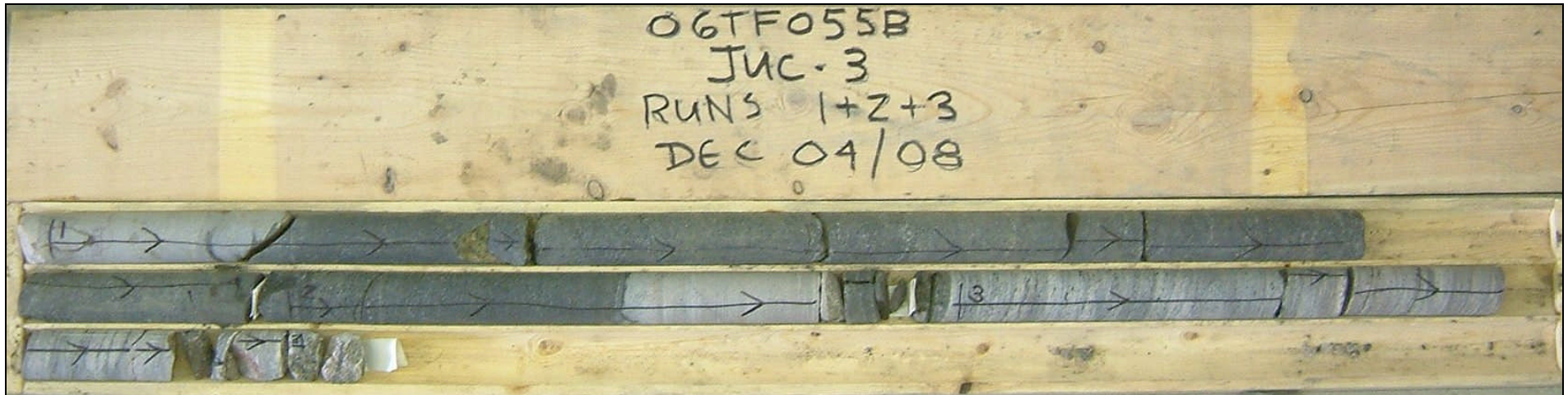
Photograph 14: Culvert C21 borehole C21-2, samples RC-7 to RC-9



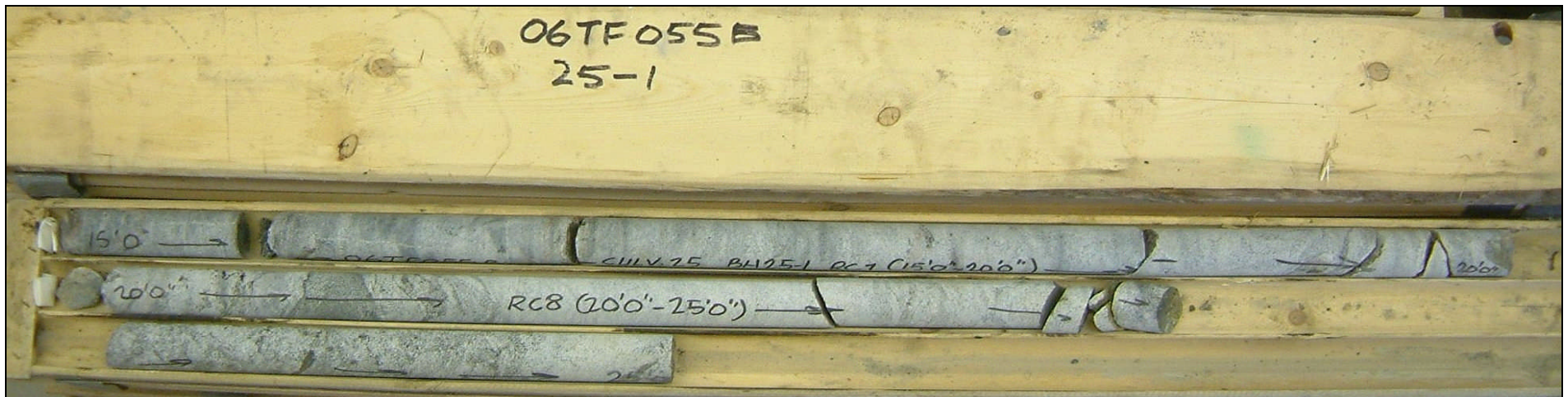
Photograph 15: Culvert JUC, borehole JUC-1, samples RC-3 to RC-5



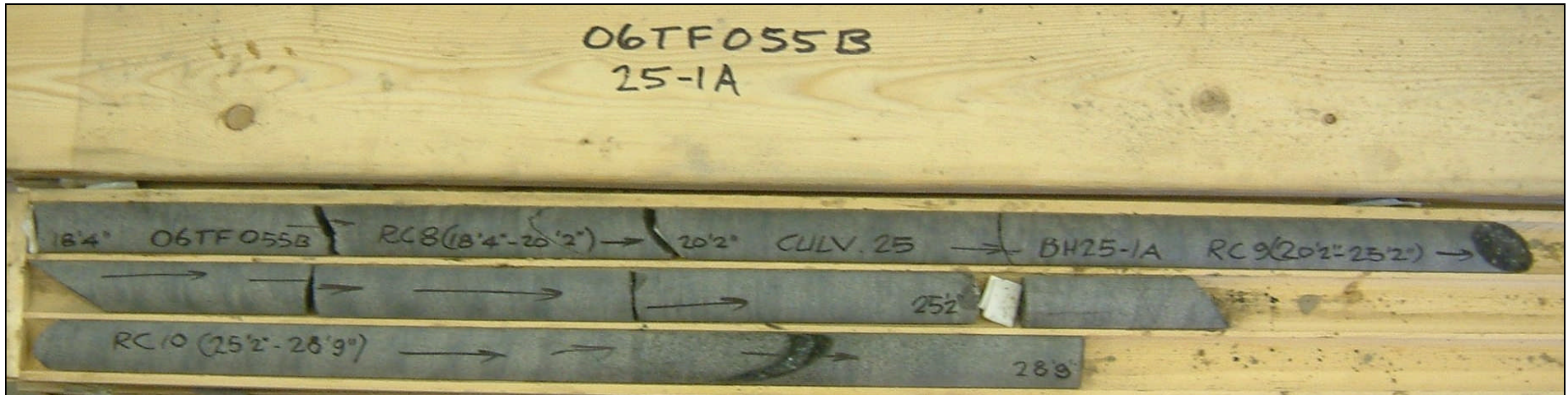
Photograph 16: Culvert JUC, borehole JUC-2, samples RC-1 to RC-3



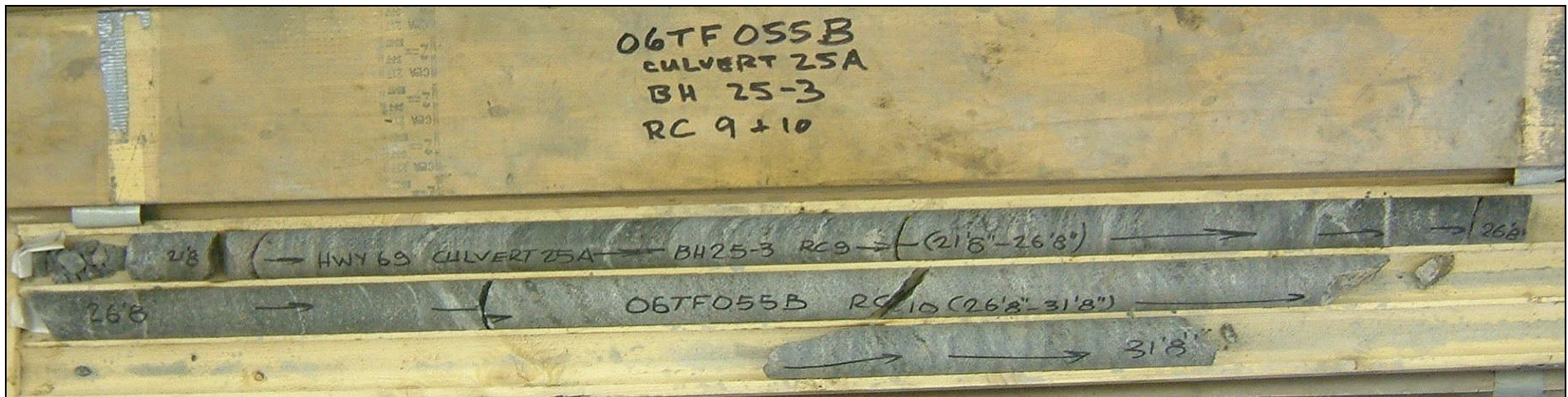
Photograph 17: Culvert JUC, borehole JUC-3, samples RC-4 to RC-6



Photograph 18: Culvert C25, borehole C25-1, samples RC-7 and RC-8



Photograph 19: Culvert C25, borehole C25-1A, samples RC-8 to RC-10



Photograph 20: Culvert C25, borehole C25-3, samples RC-9 and RC-10