



TABLE 1
FOUNDATION ENGINEERING COMMENTS AND RECOMMENDATIONS

FOUNDATION ENGINEERING COMMENTS	PRELIMINARY FOUNDATION RECOMMENDATIONS
<p><u>North Abutment</u></p> <p>The preliminary data indicates that the north abutment location is underlain by a layer of hard cohesive silty clay followed by compact cohesionless sandy silt and sand soils. The depth to inferred bedrock surface is at 6.2 m below ground surface, elevation 253.9.</p> <p><u>Pier</u></p> <p>Earth cover, including a layer of hard clayey silt layer underlain by compact to dense cohesionless soils, at the centre pier extends to inferred bedrock surface, 8.8 m below ground surface, elevation 253.7. The approximate level of the proposed Highway 17 (future) platform is at about elevation 262.0.</p> <p><u>South Abutment</u></p> <p>Bedrock outcrop is visible at the south abutment at elevation 266.0.</p>	<ul style="list-style-type: none"> • Spread footings placed on the bedrock (south abutment), compact to dense cohesionless soils (pier and north abutment) • Spread footings on structural fill (north abutment)
	<ul style="list-style-type: none"> • Piles driven to bedrock at the north abutment and pier locations • At the south abutment, piles require the excavation of a trench into the bedrock • Boulders and steeply sloping bedrock surface would require additional supervision and possible additional piles

NOTES: (1) Preliminary foundation recommendations are subject to the detail design investigation.
 (2) The bedrock was not proven by rock coring due to access limitations imposed by the land owner.



TABLE 2
FOUNDATION OPTIONS, ADVANTAGES AND DISADVANTAGES

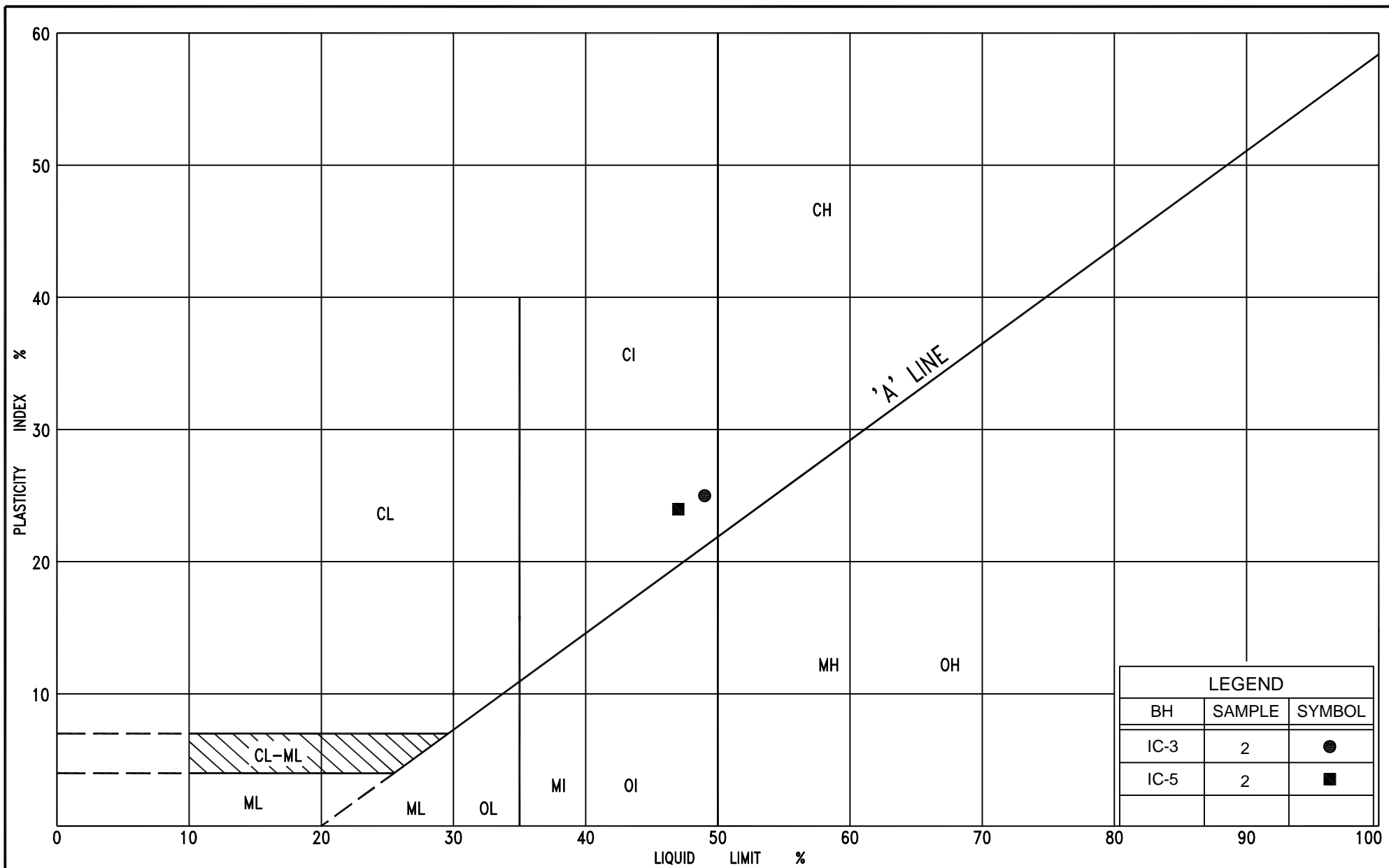
FOUNDATION OPTIONS	POSSIBLE LOCATIONS	ADVANTAGES	DISADVANTAGES
Spread Footing on Bedrock	South Abutment	<ul style="list-style-type: none"> • Lower construction cost than deep foundations • Mobilization of heavy equipment for pile driving is not required • Semi-integral abutment is feasible 	<ul style="list-style-type: none"> • Long-term maintenance costs of expansion joints for conventional abutment and deck design • Lower geotechnical resistances than for spread footings on structural fill
Spread Footings on Compact to Dense Soils	Pier or North Abutment	<ul style="list-style-type: none"> • Lower construction cost than deep foundations • Mobilization of heavy equipment for pile driving is not required • Semi-integral abutment is feasible 	<ul style="list-style-type: none"> • Long-term maintenance costs of expansion joints for conventional abutment and deck design • Lower geotechnical resistances than for spread footings on structural fill
Spread Footings on Structural Fill	North Abutment	<ul style="list-style-type: none"> • Lower construction cost than deep foundations • Mobilization of heavy equipment for pile driving is not required • Semi-integral abutment is feasible • Higher geotechnical resistance available on structural fill pad 	<ul style="list-style-type: none"> • Long-term maintenance costs of expansion joints for conventional abutment and deck design • Requires strict monitoring of structural fill pad construction

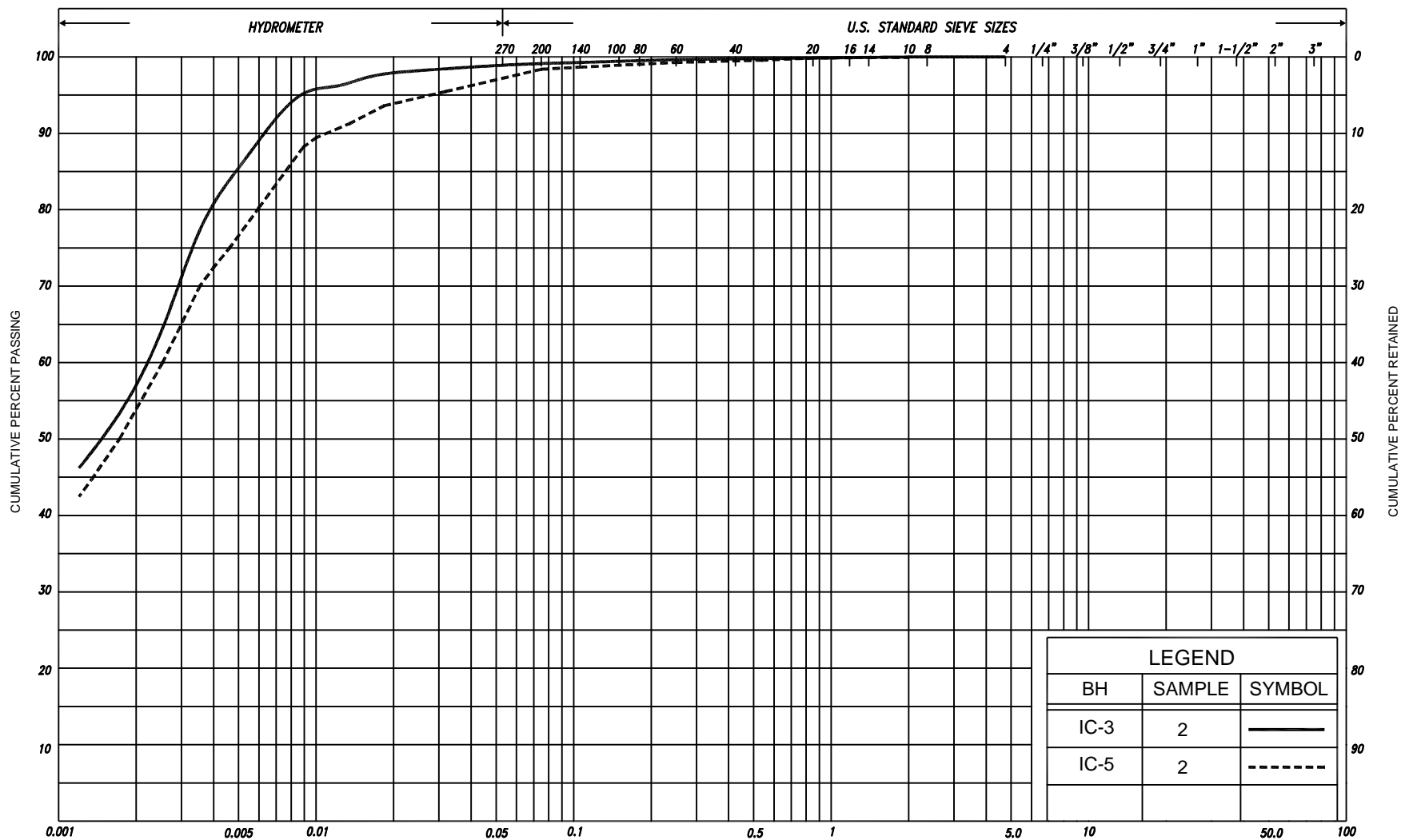


TABLE 2
FOUNDATION OPTIONS, ADVANTAGES AND DISADVANTAGES

FOUNDATION OPTIONS	POSSIBLE LOCATIONS	ADVANTAGES	DISADVANTAGES
Piles to Bedrock	Pier and North Abutment	<ul style="list-style-type: none"> • Negligible settlements of foundations • Integral abutment design is feasible 	<ul style="list-style-type: none"> • Heavy equipment for pile driving is required • Higher construction costs due to pile driving • Potential sloping bedrock may cause pile installation difficulties • Potential presence of large boulders may cause pile driving difficulties • At the south abutment, piles require the excavation of a trench into the bedrock • Boulders and steeply sloping bedrock surface would require additional supervision and possible additional piles

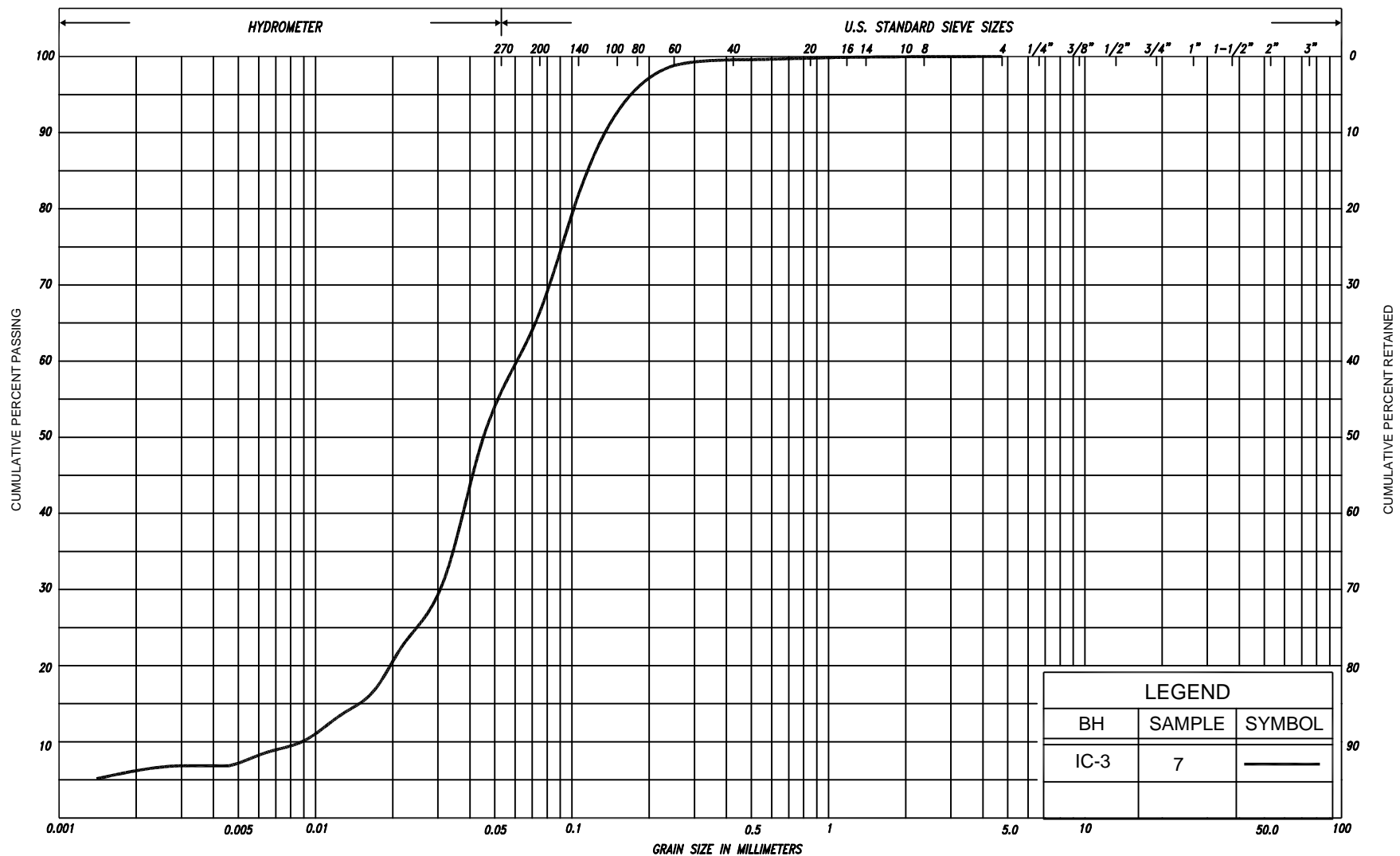
NOTES: (1) Preliminary foundation recommendations are subject to the detail design investigation.
 (2) The bedrock was not proven by rock coring due to access limitations imposed by the land owner.



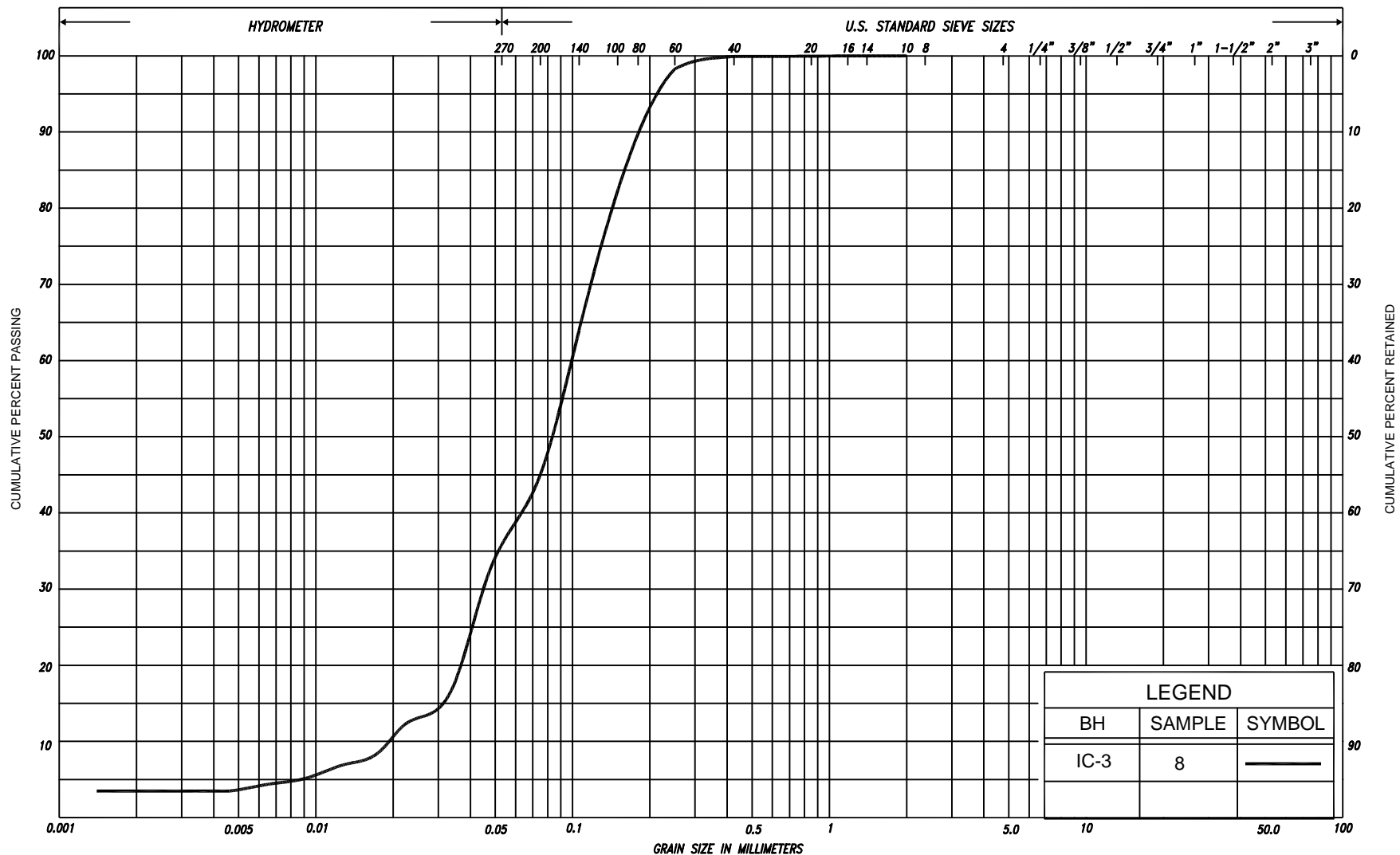


LEGEND		
BH	SAMPLE	SYMBOL
IC-3	2	————
IC-5	2	-----

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

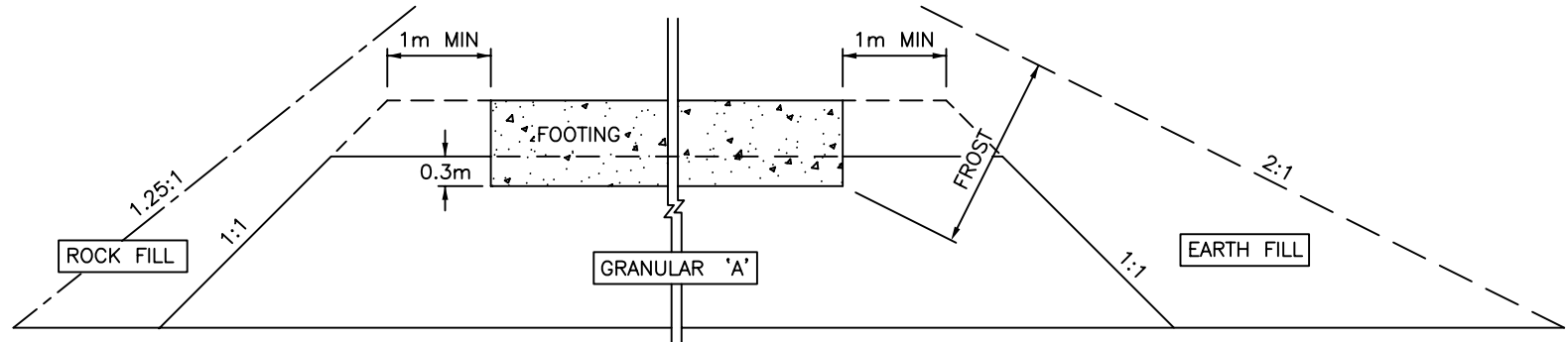


SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL		COBBLES	UNIFIED		
				SAND										
CLAY	FINE		MEDIUM	COARSE	FINE		MEDIUM		COARSE		GRAVEL		COBBLES	M.I.T.
	SILT													
CLAY		SILT		V. FINE	FINE	MED.	COARSE	GRAVEL						U.S. BUREAU
				SAND										



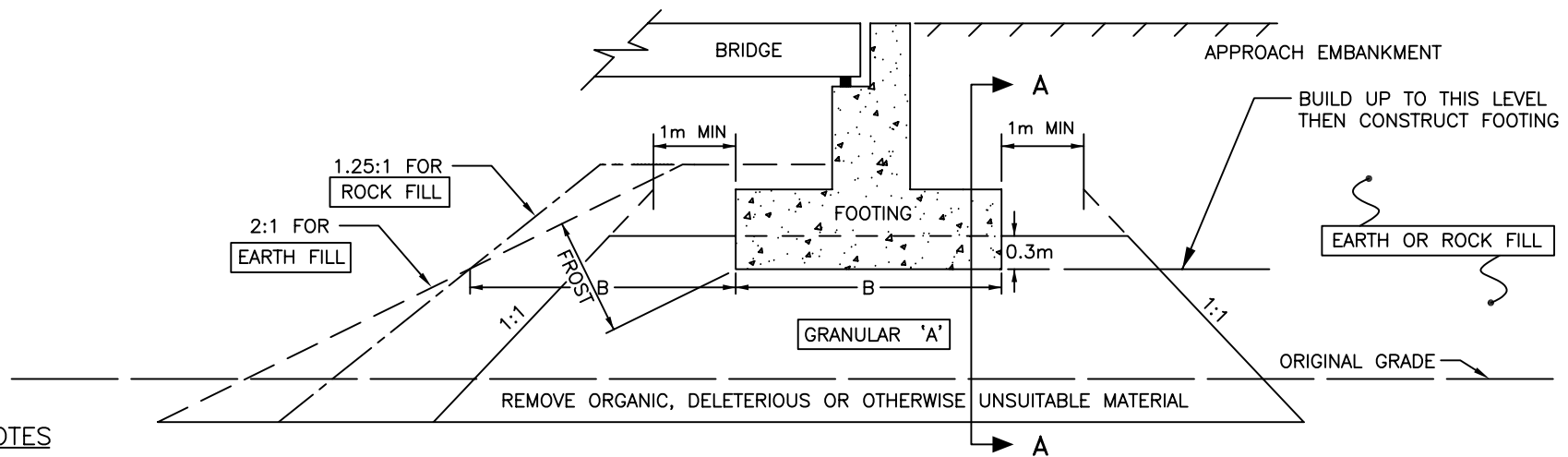
LEGEND		
BH	SAMPLE	SYMBOL
IC-3	8	—

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



CROSS SECTION A-A

NOT TO SCALE



LONGITUDINAL SECTION

NOT TO SCALE

NOTES

1. CONCEPT SHOWN DOES NOT INCLUDE A MIDHEIGHT BERM.
2. LIMITS OF GRANULAR 'A' CORE TO BE DEFINED BY A SITE SPECIFIC SURVEY.
3. REMOVE ORGANIC, DELETERIOUS OR OTHERWISE UNSUITABLE MATERIAL UNDER AREA OF COMPACTED GRANULAR 'A' AND EARTH OR ROCK FILL AS NOTED IN TEXT OF REPORT.
4. PLACE GRANULAR 'A' AND EARTH OR ROCK FILL ON APPROVED SUBGRADE TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.O. STANDARDS.
5. CONSTRUCT CONCRETE FOOTING.
6. PLACE REMAINDER OF GRANULAR 'A' AND EARTH OR ROCK FILL INCLUDING MIDHEIGHT BENCHES, AS REQUIRED.
7. REFER TO TEXT OF REPORT FOR FROST DEPTH.

FIGURE 1: ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE

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:

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^3	SEEPAGE FORCE
e	1, %	VOID RATIO						

RECORD OF BOREHOLE No IC-1

1 of 1

METRIC

G.W.P. 156-98-00 LOCATION Co-ords: 5 136 972 N; 277 355 E ORIGINATED BY F.P.
 DIST 54 HWY SMR 55 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.R.
 DATUM Geodetic (Realigned) DATE May 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					w _p	w	w _L	WATER CONTENT (%)	GR	SA		SI	CL			
						○ UNCONFINED			● QUICK TRIAXIAL	+	×	FIELD VANE	LAB VANE									
266.1	Ground Surface																					
0.0	Bedrock at surface																					
					</																	

RECORD OF BOREHOLE No IC-2

1 of 1

METRIC

G.W.P. 156-98-00 LOCATION Co-ords: 5 136 985 N; 277 340 E ORIGINATED BY F.P.
 DIST 54 HWY SMR 55 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.R.
 DATUM Geodetic (Realigned) DATE May 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					w _p w w _L			WATER CONTENT (%)	kN/m ³	GR		SA	SI	CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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METRIC

20
15 — 5 (%) STRAIN AT FAILURE
10

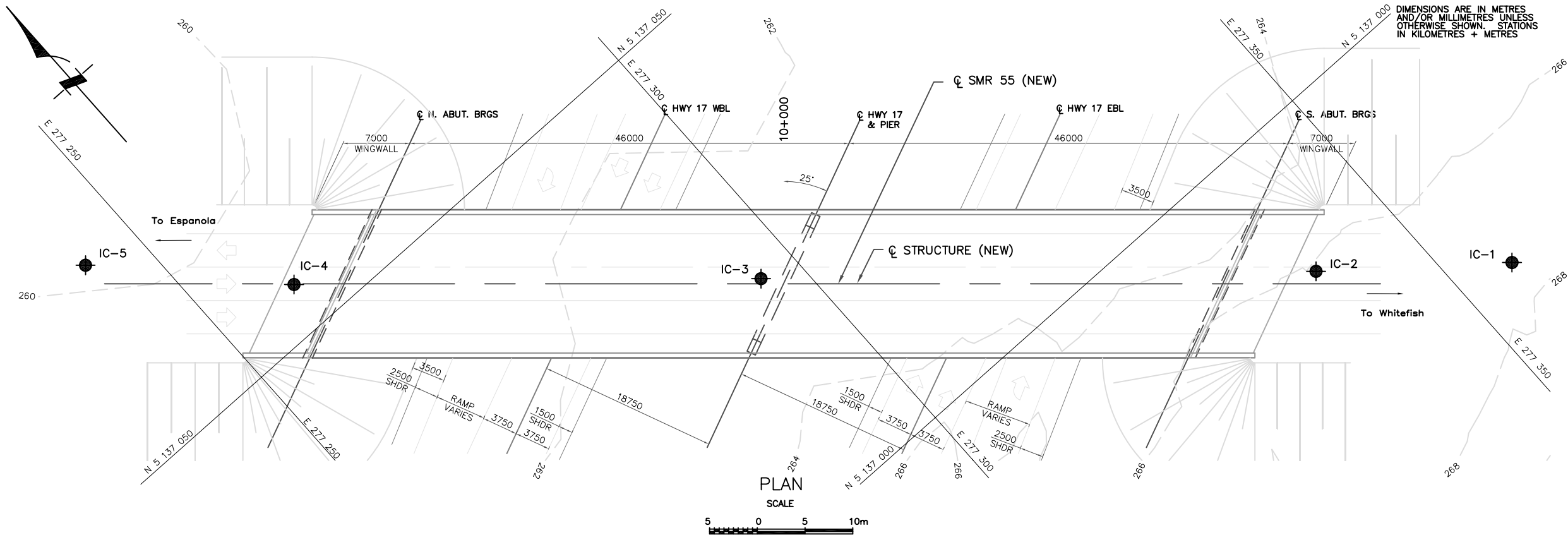
RECORD OF BOREHOLE No IC-5

1 of 1

METRIC

G.W.P. 156-98-00 LOCATION Co-ords: 5 137 071 N; 277 244 E ORIGINATED BY F.P.
 DIST 54 HWY SMR 55 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.R.
 DATUM Geodetic (Realigned) DATE May 04, 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												
259.7 0.0	Ground Surface								20	40	60	80	100								
259.5 0.2	Peat, fine fibrous Dark brown		1	SS	11		259								○						
	Silty clay, trace sand																				
	Very stiff Brown Moist		2	SS	18										100			0 2 44 54			
257.9 1.8	Sandy silt		3	SS	27		258								○						
	Compact Brown Wet																				
			4	SS	18		257								○						
			5	SS	16										○						
							256														
	silty sand seams																				
			6	SS	17		255								○						
	trace gravel cobbles						254														
253.6 6.1	End of borehole		7	SS	30/10cm																
	Refusal on probable bedrock																				
	Sample 7: sampler bouncing																				
	* Borehole dry																				
	One auger probe was advanced 3.0m south east of the borehole and reached refusal on probable bedrock at 7.3m depth																				

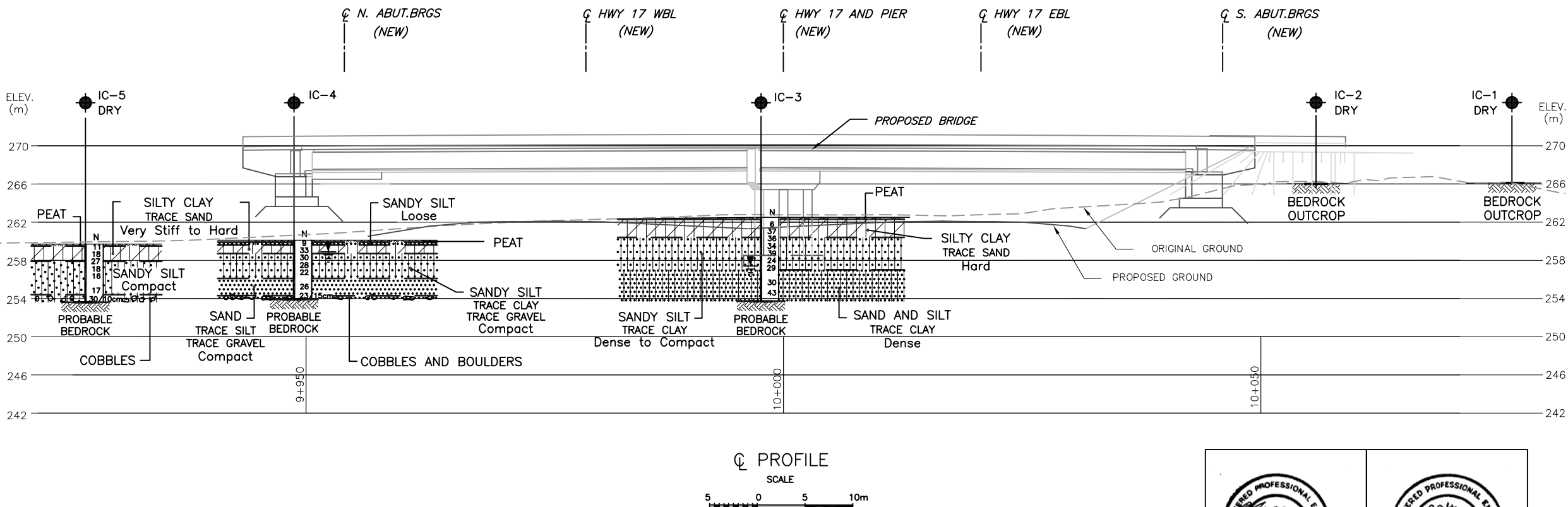
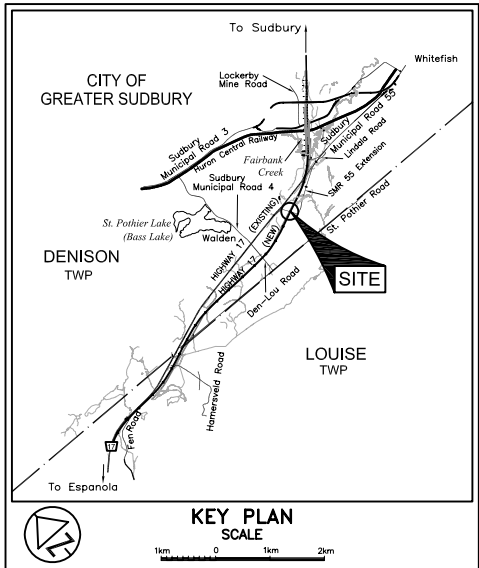



CONT No
GWP No 156-98-00

SMR 55 UNDERPASS
HIGHWAY 17
BOREHOLE LOCATIONS AND SOIL STRATA


SHEET

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS






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 May 2008




Head



ARTESIAN WATER



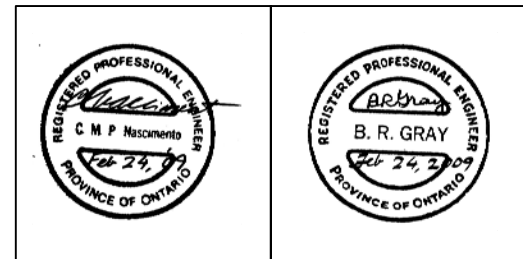
Encountered



PIEZOMETER

BH No	ELEVATION	CO-ORDINATES	
		NORTHINGS	EASTINGS
IC-1	266.1	5 136 972	277 355
IC-2	266.0	5 136 985	277 340
IC-3	262.5	5 137 023	277 296
IC-4	260.1	5 137 055	277 259
IC-5	259.7	5 137 071	277 244

NOTE:
THIS DRAWING IS FOR PRELIMINARY SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.



REF No. STANTEC Drawing; 165000581_SMR55-1_GA.dwg;
Dated MAY 23, 2008

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.	411-229
HWY No	17
SUBM'D	NSB
CHECKED	NR
DATE	FEB. 24, 2009
SITE	--
DRAWN	NA
CHECKED	CN
APPROVED	BRG
DWG	SMR55-1



APPENDIX A

Site Photographs



Photograph 1: View looking north from Sta. 10+075, bedrock exposed. Drill rig at borehole IC-3 location visible at the background of the photograph. (May 4, 2008)



Photograph 2: Close up view of rock formation at borehole IC-1. (May 4, 2008)



Photograph 3: Looking southerly at BH IC-3 while drilling auger probe to refusal near borehole to confirm inferred bedrock. (May 4, 2008)



Photograph 4: View south along future SMR 55 structure corridor. Dense woodland area visible at the background of the photograph. Borehole IC-5 located about 80 m opposite slope. (May 4, 2008)