



FOUNDATION INVESTIGATION AND DESIGN REPORT

for

**OJIBWAY CANYON – SWAMP CROSSING
HIGHWAY 69 FOUR-LANING
FROM 3.8 KM NORTH OF HWY 522
TO 11.9 KM NORTH OF HWY 522
G.W.P. 5203-06-00
DISTRICT 54, SUDBURY, ONTARIO**

PHASE 3: STA. 13+400 TO 21+500 (TOWNSHIP OF MOWAT)

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PML Ref.: 06TF033C-1
Index No.: 1861FIR and 1862FDR
Geocres No.: 41H-243
November 19, 2009



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for

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HIGHWAY 69 FOUR-LANING
FROM 3.8 KM NORTH OF HWY 522
TO 11.9 KM NORTH OF HWY 522
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FOUNDATION INVESTIGATION REPORT

for

Ojibway Canyon – Swamp Crossing

Highway 69 Four-Laning

From 3.8 km North of Hwy 522

To 11.9 km North of Hwy 522

G.W.P. 5203-06-00

District 54, Sudbury, Ontario

PHASE 3: Sta. 13+400 to 21+500 (Township of Mowat)

1. INTRODUCTION

This report summarizes the results of the foundation investigation carried out for the swamp crossing located at the Ojibway Canyon which is within the phase 3 limits of the realignment and four-laning of the section of Highway 69 that extends from 3.8 km north of Highway 522 to 11.9 km north of Highway 522, District 54, Sudbury. Peto MacCallum Ltd. (PML) conducted the foundation investigation for McCormick Rankin Corporation (MRC) on behalf of the Ministry of Transportation of Ontario (MTO).

PML previously conducted foundation investigations for swamp and high fill crossings (PML Ref: 06TF033C) for the realignment and four-laning of the approximately 6.9 km long section of Highway 69 that extends from approximate Sta. 13+400 to 20+300 (Mowat Township), new Highway 69. A total of 14 swamp crossings were previously assigned for foundation investigation within the Phase 3 limits. For ease of reference, PML identified the swamp crossings by sequential numbers in the 300 series from 301 to 314. In this report, the single swamp crossing located at Ojibway Canyon at between approximate Sta. 20+775 and 20+837.5, for an approximate total length of 62.5 m was designated swamp 315.

All elevations in this report are expressed in metres.



2. SITE DESCRIPTION AND GEOLOGY

Realignment and four-laning of Highway 69 is planned about 50 km south of Sudbury.

The Ojibway canyon is running along west/east direction and its north and south edges are nearly vertical rock faces. The ground cover at the bottom of the canyon comprises grasses and typical swamp vegetation, bushes, stands of trees, exposed bedrock, and visible stream. Talus bedrock boulders exist at the toe of each of the nearly vertical rock face at the limits of the Ojibway Canyon. Boulders are also strewn across the floor of the canyon.

The bedrock outcrops at many locations throughout the site. The slopes of the bedrock at the north and the south edges of the 10 to 14 m high canyon vary from west to east and range between 50 to 80° with the horizontal.

Boulders exposed at the surface and spread throughout the site. An open water is visible across floor of the canyon.

The study area is located in the Precambrian Laurentian peneplane. The topography of study area is irregular with shallow bedrock sections and deep swamp deposits. Pleistocene lacustrine/fluvial deposits and recent swamp sediments have been laid down in depressions and are probably associated with the Nipissing post-glacial stage of the Great Lakes.

Metasedimentary rocks of the Huronian Supergroup and gneisses of the Grenville Province underlie the alignment. The area has undergone considerable folding, intrusive activity, regional metamorphism and faulting.

3. INVESTIGATION PROCEDURES

The field subsurface investigation for the Ojibway Canyon crossing was carried out during the period from February 17 to May 11, 2009 and comprised a total of 15 test holes (9 boreholes, 4 dynamic cone tests and 2 manual probes) were advanced. The data from subsurface



investigation for culvert C8 and two bridge piers comprised 5 and 2 boreholes, respectively is also considered relevant to the current swamp investigation since these boreholes were drilled within the foundation swamp limits. Three test holes, designated D7-2, D7-3 and D7-3A, drilled on March 2004 within swamp limits are also considered relevant to this swamp investigation.

The test hole numbers for the swamp, culvert and piers were identified by 315-1 through 315-15, C8-1 through C8-5, and P1-SBL and P2-NBL, respectively. Test holes for swamp crossing were numbered sequentially from left to right in the direction of increasing chainage. The test hole locations at the crossing are shown on Drawing 315-1. The records of the test holes are appended.

The test borehole locations were established in accordance with the MTO requirements indicated in the RFP and in general accordance with the requirements of the MTO Northeastern Region Pavement Design Practices and Guidelines (May 20, 1997). Callon Dietz Inc., Ontario Land Surveyors laid out the reference lines of the new highway in the field and these lines were used by PML to select the borehole locations. The ground surface elevations at the boreholes were provided by Callon Dietz Inc., Ontario Land Surveyors.

The boreholes were advanced using continuous flight hollow and solid stem augers, manual probe and NW washboring, powered by track-mounted D-50 and CME-55 drill rigs. The equipment was supplied and operated by a specialist drilling contractor working under the full-time supervision of members of PML engineering staff. The test holes were taken into competent native soils, auger refusal or where bedrock was encountered. The boreholes C8-1, C8-3, C8-3, P1-SBL and P2-NBL were taken to the bedrock and extended 3.1 to 4.7 m into bedrock using rotary diamond drilling methods.

Representative soil samples were recovered at frequent depth intervals using a conventional split spoon sampler during drilling. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata.



An approximate 3.1 to 4.7 m length of rock cores were recovered using NQ rock coring equipment. A PML senior geologist examined and classified the recovered rock core samples. Detailed descriptions of the recovered rock core are provided in Table A.

The groundwater conditions at the borehole locations were assessed during drilling by visual examination of the soil, the sampler and drill rods as the samples were retrieved and, when appropriate, by measurement of the water level in the open borehole.

Upon completion of drilling, all the boreholes were backfilled with a bentonite/cement mixture in accordance with the MTO and MOE Reg. 903 guidelines for borehole abandonment procedures.

Soils were identified in the field in accordance with the MTO Soil Classification procedures. The recovered samples were returned to our laboratory for detailed visual examination and classification. The laboratory testing programme consisted of moisture content determinations and grain size distribution analyses. The soil samples recovered at the site were either very little or none due to the presence of cobbles and boulders; therefore, only a limited number of grain size distribution analyses were conducted. Atterberg plasticity limits was not attempted on any sample since the soils were identified to be cohesionless (non-plastic) by visual and tactile examination. The laboratory testing program comprised the following tests:

- Natural moisture content determinations (14)
- Grain size analyses (8)

The results of the laboratory natural moisture content determinations and grain size distribution analyses are shown on the Record of Borehole Sheets. The grain size distribution charts are presented on Figures 315-1, C8-GS-1 and P1-GS-1.



4. SUMMARIZED SUBSURFACE CONDITIONS

4.1 General

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, soil boundary elevations, standard penetration resistance values, and groundwater observations. The results of laboratory grain size distribution analyses and moisture content determinations are also shown on the Record of Borehole sheets.

The borehole locations and soil strata are shown on Drawing 315-1 and 315-2, respectively. The boundaries between soil strata have been established at the borehole locations only. Between and beyond the boreholes, the boundaries are assumed and may vary.

The subsurface stratigraphy revealed in the boreholes generally comprised a surficial peat/topsoil unit, or snow/ice layer overlying a peat unit. The peat/topsoil units were underlain by cohesionless sand soils which in turn mantled probable bedrock or bedrock. Locally, the peat unit mantled bedrock. Bedrock was contacted at depths of 2.8 to 5.2 m (elevations 182.3 to 185.2). Boulders were at surface of the bottom of the canyon and were contacted at shallow depths. The shallow boulders covered most of the site as inferred by auger refusal at the majority of the test holes. Groundwater was observed at 0.3 to 0.8 m depths (elevations 186.2 and 187.7) and open water was visible across the floor of the canyon.

A description of the subsurface stratigraphy is summarised in the following subsections of the report.

4.2 Snow/Ice

A 300 and 800 mm thick snow/ice layer was surficially contacted in test holes 315-1, 315-4, 315-5, 315-6, 315-7, 315-8, 315-9, 315-11, 315-14, C8-2 through C8-5, P2-NBL, D7-2, D7-3 and D7-3A.



4.3 Peat/Topsoil

The surficial peat/topsoil units contacted in test holes 305-3, 315-10, 315-12, C8-1 and P1-SBL and beneath the snow/ice layer in boreholes 315-1, 315-4, 315-5, 315-6, 315-9, 315-11, 315-14, C8-2 through C8-5 and P2-NBL were 200 to 500 mm thick and were penetrated at elevations 186.6 to 189.5.

A localized 0.3m thick organic clayey silt was encountered beneath the peat unit at 0.8 m depth (elevation 186.9) in borehole C8-4 and extended to 1.1 m depth (elevation 186.6).

4.4 Sand

Underlying the peat/topsoil units at 0.4 to 0.8 m depths (elevations 186.6 and 189.5) in boreholes 315-1, 315-4, 315-5, 315-6, 315-9, 315-11, 315-12 315-14 C8-1, C8-3, C8-5, P1-SBL and P2-NBL and the organic clayey silt at 1.1 m depth (elevation 186.6) in borehole C8-4, a cohesionless sand deposit was contacted. The deposit was 0.4 and 4.7 m thick and extended to the probable bedrock or proved bedrock at 2.8 and 5.2 m depths (elevations 182.3 and 185.2).

The sand deposit contains some to with gravel trace to with silt trace clay, and cobbles and boulders. The relative density of the deposit was compact to dense. The N values ranged from 13 to 35 blows. High N values were recorded but reflect the presence of cobbles and boulders or interface of soil with bedrock. A single low N value of 4 was also recorded and probably due to hydraulic disturbance during sampling. The moisture content of the sand deposit ranged between 10 and 22.

The results of grain size distribution analyses conducted on representative samples of the sand deposit are presented in Figures 315-GS-1, C8-GS-1 and P1-GS-1.

4.5 Boulders

Talus bedrock boulders were at toe of near vertical rock face at the limits of the canyon at elevations 189.3 and 191.6 in boreholes 315-2 and 315-15, respectively. Boulders were below



peat layer at 0.6 and 1.2m depths, elevations 187.0 and 187.3 in test holes C8-2 and D7-2 where test holes terminated. Boulders were also encountered within sand deposit.

4.6 Bedrock

Bedrock was exposed at elevation 188.7 in test hole 315-13. Bedrock was contacted and proved in boreholes C8-1, C8-3, C8-5, P1-SBL and P2-NBL at depths of 2.8 to 5.2 m (elevations 182.3 to 185.2). In test holes 315-3, 315-6, 315-7, 315-10 and C8-4, the bedrock was inferred by refusal at depths ranging from 2.5 to 4.6 m (elevations 183.1 to 185.4).

Generally, the bedrock and probable bedrock surfaces encountered in the drilled boreholes for swamp, culvert and piers slope gently downward at about 3° from west end borehole C8-1 (elevation 185.2) to middle portion of the site borehole C8-3 (elevation 182.8) then become relatively flat between middle portion to east end of the site borehole C8-5 (elevation 182.3).

The retrieved rock cores comprise dark green to black and grey gabbro and exhibited high strength. A detailed description of the rock cores retrieved from boreholes C8-1, C8-3, C8-5, P1-SBL and P2-NBL is given in Table A appended.

The measured core recovery was in a range of 95 to 100%. The RQD determined from the rock cores was in a range of 63 to 100, thus indicating a fair to excellent quality rock. Locally, in borehole C8-3, the RQD determined from rock cores at upper zone, 4.9 to 7.6 m depths (elevations 182.8 to 180.1), was 15 and 29 % indicating a very poor to poor quality rock. This is due to presence of very close to close spaced cross joints in the rock.

4.7 Groundwater

Groundwater was observed in boreholes 315-1, 315-6, 315-9, C8-1 to C8-5, P1-SBL and P2-NBL at depths of 0.3 to 0.8 m (elevations 186.2 to 187.7) upon completion of drilling. The groundwater levels at the site are subject to seasonal fluctuations and precipitation patterns.



5. MISCELLANEOUS

The field work was carried out under the supervision of Mr. F. Portela, and the direction of Mr. C.M.P. Nascimento, P.Eng., Senior Project Engineer. Walker Drilling Ltd. supplied the drilling equipment. The laboratory work was carried out in the PML laboratory in Toronto. This report was prepared by Mr. Idib (Adeeb) Sadoun, MSc, P.Eng., and Mr. C.M.P. Nascimento, P.Eng. and was independently reviewed by Mr. B. R. Gray, MEng, P.Eng., MTO Designated Principal Contact.

Yours very truly

Peto MacCallum Ltd.

**NOTE: Hard copies signed
and stamped**

Carlos M. P. Nascimento, P.Eng.
Senior Project Engineer

**NOTE: Hard copies signed
and stamped**

Brian R. Gray, MEng, P.Eng.
MTO Designated Principal Contact

CN/BRG:AS:nk



TABLE A
ROCK CORE DESCRIPTIONS

LOCATION (BH)	CORE RECOVERY				CORE DESCRIPTION	
	RC	DEPTH (m)	REC (%)	RQD (%)	DEPTH (m)	DESCRIPTION
C8-1	5	2.8 – 3.1	100	73	2.8 – 5.9	GABBRO: Dark green to black and grey, fine to medium crystalline, high strength, slightly weathered to unweathered, close to moderate spaced flat to dipping cross joints, rough planar with occasional horizontal slickensides, with some vertical fissures, tight to open to 1 mm, generally slightly altered with black silty infilling, occasional white scale, fair to excellent quality.
	6	3.1 – 4.3	100	70		
	7	4.3 – 5.9	100	99		
C8-3	7	4.9 – 6.0	98	15	4.9 – 8.1	GABBRO: Dark green to black and grey, fine to medium crystalline, high strength, slightly weathered to unweathered, very close to close spaced (moderate below 7.2 m) flat to dipping cross joints, rough planar with occasional horizontal slickensides, with numerous vertical fissures (some compound), tight to open (5 mm), generally slightly altered with black silty infilling, very poor to poor becoming excellent quality.
	8	6.0 – 7.6	100	29		
	9	7.6 – 8.1	100	100		
C8-5	7	5.2 – 6.3	100	100	5.2 - 8.3	GABBRO: Dark green to black and grey, fine to medium crystalline, high strength, slightly weathered to unweathered, close to moderate spaced flat to dipping (locally vertical) cross joints, rough planar, locally open (to 1 mm), tight to slightly altered with black silt infilling, occasional green scale on parting surface, good to excellent quality.
	8	6.3 – 7.2	100	85		
	9	7.2 – 8.3	100	95		

RQD = Rock Quality Designation

Originated: JFW
 Compiled: FP
 Checked: AS / CN

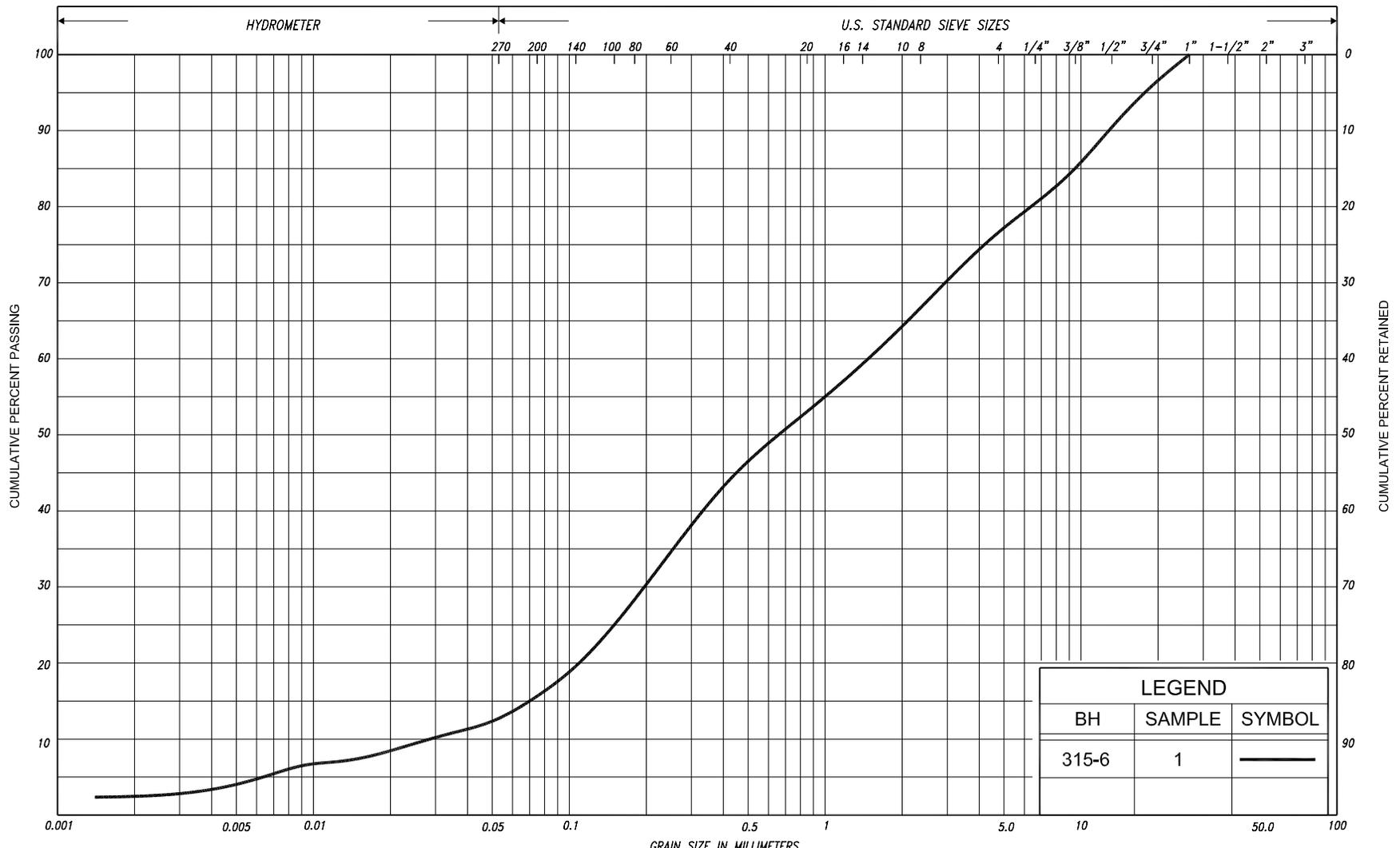


TABLE A
ROCK CORE DESCRIPTIONS

LOCATION (BH)	CORE RECOVERY				CORE DESCRIPTION	
	RC	DEPTH (m)	REC (%)	RQD (%)	DEPTH (m)	DESCRIPTION
Bridge Pier - SBL Sta. 20+803, o/s 18.8 LT CL (P1-SBL)	5	5.0 – 6.1	100	86	5.0 – 9.7	GABBRO: Dark green to black and grey, fine to medium crystalline, high strength, slightly weathered to unweathered, close to moderate spaced flat to dipping cross joints, rough planar with occasional horizontal slickensides, with some vertical fissures, tight to open to 1 mm, generally slightly altered with black silty infilling, occasional white scale, good to excellent quality.
	6	6.1 – 7.6	95	91		
	7	7.6 – 9.1	100	88		
	8	9.1 – 9.7	96	85		
Bridge Pier - NBL Sta. 20+809, o/s 18.8 RT CL (P2-NBL)	5	4.9 – 6.2	96	87	4.9 – 8.9	GABBRO: Dark green to black and grey, fine to medium crystalline, high strength, slightly weathered to unweathered, close to moderate (locally wide) spaced flat to dipping (locally vertical) cross joints, rough planar (locally with horizontal slickensides, tight to slightly altered with black silty infilling, occasional white scale, fair to excellent quality.
	6	6.2 – 6.9	100	96		
	7	6.9 – 7.6	100	100		
	8	7.6 – 8.9	100	63		

RQD = Rock Quality Designation

Originated: JFW
 Compiled: FP
 Checked: AS / CN



LEGEND		
BH	SAMPLE	SYMBOL
315-6	1	—

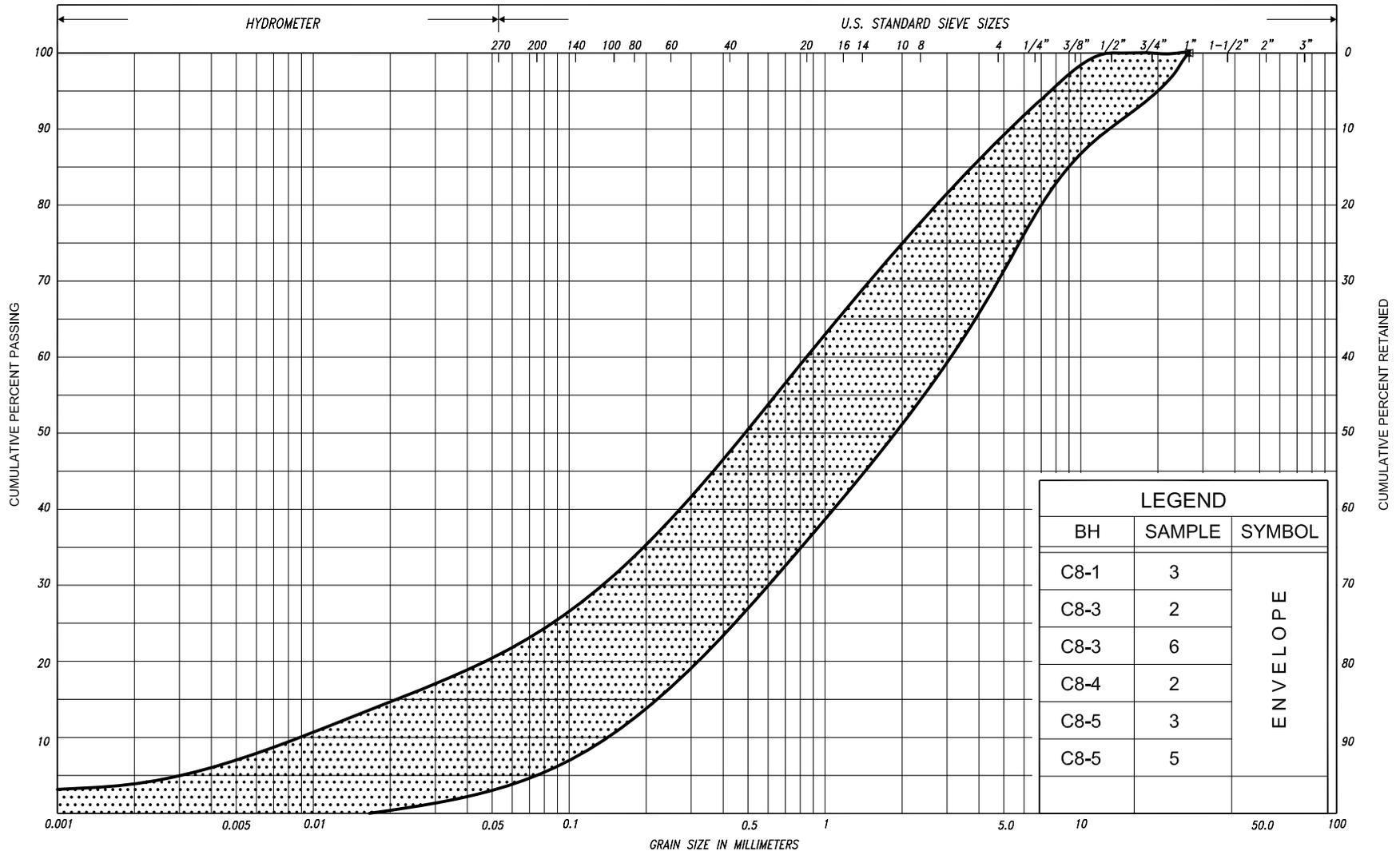
SILT & CLAY		FINE SAND		MEDIUM SAND		COARSE SAND		GRAVEL		COBBLES	UNIFIED
CLAY	FINE SILT	MEDIUM SILT	COARSE SILT	FINE SAND	MEDIUM SAND	COARSE SAND	GRAVEL		COBBLES	M.I.T.	
CLAY	SILT		V. FINE SAND	FINE SAND	MED. SAND	COARSE SAND	GRAVEL			U.S. BUREAU	

GRAIN SIZE DISTRIBUTION

SAND, with gravel, some silt, trace clay



FIG No.	315-GS-1
HWY:	69
G.W.P. No.	5203-06-00



LEGEND		
BH	SAMPLE	SYMBOL
C8-1	3	ENVELOPE
C8-3	2	
C8-3	6	
C8-4	2	
C8-5	3	
C8-5	5	

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

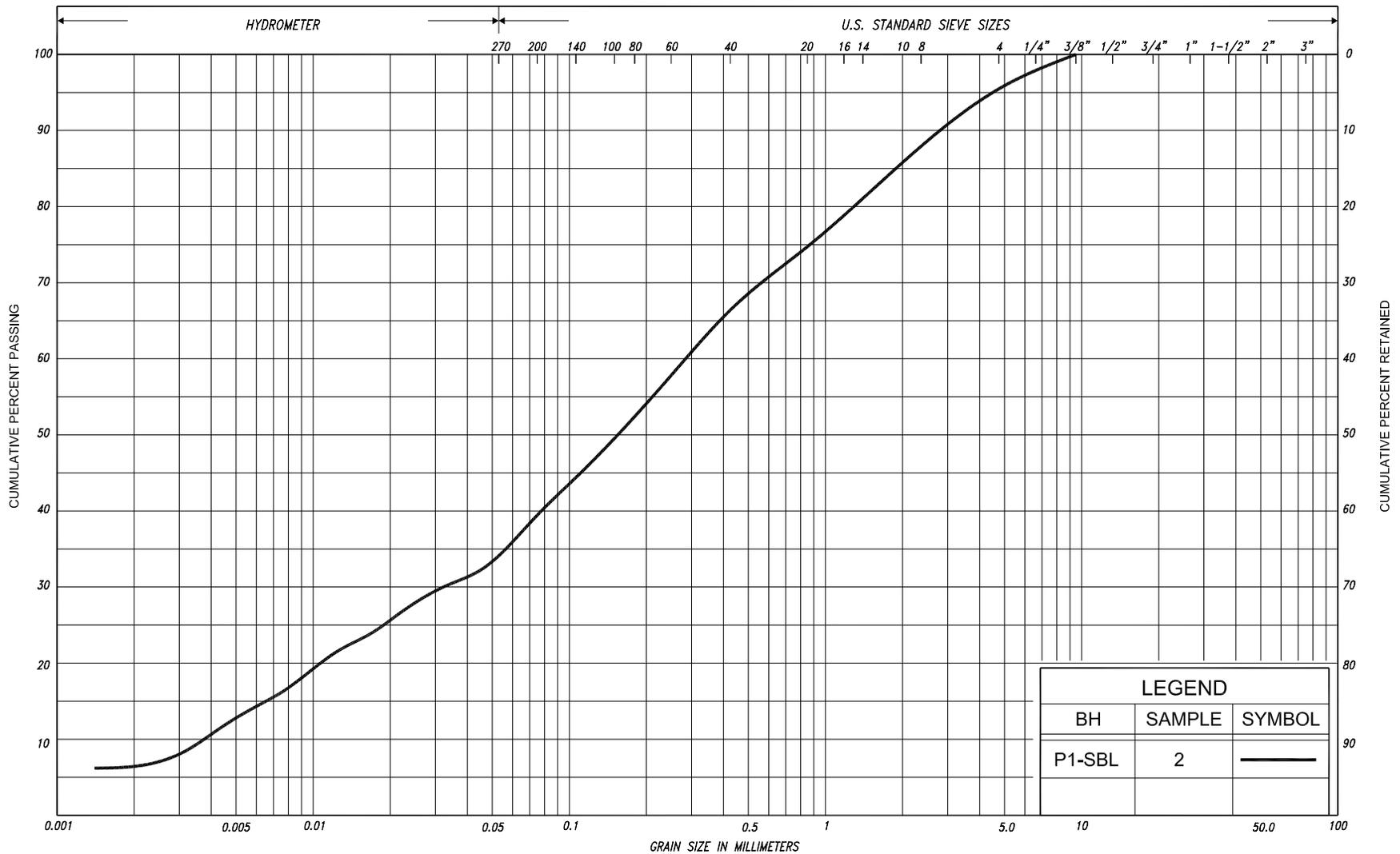
GRAIN SIZE DISTRIBUTION

SAND, some to with gravel
trace to some silt, trace clay

FIG No. C8-GS-1

HWY: 69

G.W.P. No. 5203-06-00



LEGEND		
BH	SAMPLE	SYMBOL
P1-SBL	2	—

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

GRAIN SIZE DISTRIBUTION

SILTY SAND, trace gravel, trace clay



FIG No.	P1-GS-1
HWY:	69
G.W.P. No.	5203-06-00

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
WS	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
r_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 = $\frac{w_L - w_p}{I_p}$	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 315-1 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+780, o/s 18.8m Rt. CL Med. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.
 DATUM Geodetic DATE March 01, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	SHEAR STRENGTH kPa	
											○ UNCONFINED	+	FIELD VANE						
											● QUICK TRIAXIAL	×	LAB VANE						
											WATER CONTENT (%)								
											20	40	60						
188.1	Top of Ice																		
0.0	Snow and ice																		
187.3																			
0.8	Peat, coarse fibrous																		
187.0																			
1.1	Dark brown																		
186.4	Sand, some gravel cobbles and boulders																		
1.7	Grey Wet																		
	End of borehole																		
	Refusal on probable boulders																		

* 2009 03 01
 ▽ Water level observed during drilling
 ▼ Water level measured after drilling

RECORD OF BOREHOLE No 315-2

1 of 1

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+787, o/s 19.0m Lt. CL Med. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Manual Probe COMPILED BY A.S.
 DATUM Geodetic DATE May 11, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
189.3	Ground Surface																
0.0	Boulders at surface																
	* Borehole dry																
	Note: Nearly vertical rock face about 5.0m south of borehole location.																

RECORD OF BOREHOLE No 315-4 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+787.5, o/s 58.0m Rt. CL Med. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY A.S.
 DATUM Geodetic DATE March 01, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	W _p
187.6	Top of Ice																	
0.0	Snow and ice																	
187.2																		
0.4	Peat, coarse fibrous																	
186.8	Dark brown					187												
0.8	Sand, with gravel cobbles and boulders																	
186.1	Brown Moist																	
1.5	End of borehole																	
	Refusal on probable boulders																	
	* Borehole dry																	

RECORD OF BOREHOLE No 315-5 1 of 1 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+795, o/s 55.0m Lt. CL Med. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.
 DATUM Geodetic DATE March 02, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
189.1	Top of Ice															
0.0	Snow and ice					189										
188.6																
0.5	Topsoil															
188.3																
0.8	Sand, some gravel cobbles and boulders		1	SS	30/5cm	188										
187.6	Compact Brown Moist															
1.5	End of borehole															
	Refusal on probable boulders															
	Sample 1: Sampler bouncing															
	* Borehole dry															

RECORD OF PENETRATION TEST No 315-7

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+812.5, o/s 58.0m Lt. CL Med. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY A.S.
 DATUM Geodetic DATE February 17, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
188.6 0.0	Top of Snow Probable snow and ice Probable peat Probable sand Compact															
185.1 3.5	End of dynamic cone penetration test Refusal on probable bedrock															

RECORD OF PENETRATION TEST No 315-8

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+812.5, o/s 58.0m Rt. CL Med. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY A.S.
 DATUM Geodetic DATE March 01, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
187.9 0.0	Top of Ice Snow and ice															
	Probable peat															
186.7	Probable sand															
1.2	Compact End of dynamic cone penetration test Refusal on probable boulders									120/8cm						

RECORD OF BOREHOLE No 315-9

1 of 1

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+814 CL ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.
 DATUM Geodetic DATE March 01, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
187.6	Top of Snow															
0.0	Snow and ice															
187.1	Peat, coarse fibrous															
0.5	Dark brown															
186.8																
0.8	Sand, some gravel cobbles and boulders															
185.8	Compact Grey Wet		1	SS	15/3cm											
1.8	End of borehole Refusal on probable boulders Sample 1: Sampler bouncing															

* 2009 03 01
 ▽ Water level observed during drilling
 ▼ Water level measured after drilling

RECORD OF PENETRATION TEST No 315-10 1 of 1 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+820 CL ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY A.S.
 DATUM Geodetic DATE March 02, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
187.6 0.0	Ground Surface Probable peat Probable sand with gravel Compact															
184.9 2.7	End of dynamic cone penetration test Refusal on probable bedrock															

RECORD OF BOREHOLE No 315-11

1 of 1

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+820, o/s 12.8m Rt. CL Med. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.
 DATUM Geodetic DATE March 01, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
189.3	Top of Ice															
0.0 189.0	Snow and ice															
0.3 188.7	Topsoil															
0.6 188.1	Sand, some gravel cobbles and boulders Brown Moist															
1.2	End of borehole Refusal on probable boulders															
	* Borehole dry															

RECORD OF BOREHOLE No 315-12 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+821, o/s 18.8m Lt. CL Med. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.
 DATUM Geodetic DATE March 02, 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			20	40	60	80	100					
188.3 0.0	Ground Surface																
188.1 0.2	Topsoil																
187.7 0.6	Sand, with gravel cobbles and boulders																
	End of borehole Refusal on probable boulders																
	* Borehole dry																

RECORD OF BOREHOLE No 315-13

1 of 1

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+830, o/s 51.0m Rt. CL Med. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Manual Probe COMPILED BY A.S.
 DATUM Geodetic DATE March 27, 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	20			40	60	80	100						
191.2	Ground Surface																
0.0	Bedrock at surface																
	* Borehole dry																

RECORD OF BOREHOLE No 315-14

1 of 1

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+833, o/s 60.0m Lt. CL Med. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.
 DATUM Geodetic DATE March 02, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
190.3	Top of Ice															
0.0	Snow and ice															
189.7																
0.6	Topsoil															
189.5																
0.8	Sand, some gravel cobbles and boulders															
189.1																
1.2	Brown Moist End of borehole Refusal on probable boulders															
	* Borehole dry															

RECORD OF BOREHOLE No 315-15

1 of 1

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+837.5 CL ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Manual Probe COMPILED BY A.S.
 DATUM Geodetic DATE March 30, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	20			40	60	80	100	20					
191.6	Ground Surface																
0.0	Boulders at surface																
	* Borehole dry																
	Note: Nearly vertical rock face about 1.0m north of borehole location.																

RECORD OF BOREHOLE No C8-1 1 of 1 **METRIC**

G.W.P. 5203-06-00 LOCATION Coords: 5 096 737.5 N; 221 518.9 E ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and NQ Diamond Coring COMPILED BY A.S.
 DATUM Geodetic DATE February 18 and March 02, 2009 CHECKED BY B.R.G.

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
188.0	Ground Surface																	
0.0	Peat, coarse fibrous		1	SS	1													
187.6	Dark brown Wet		2	SS	15													
0.4	Sand some gravel, trace silt cobbles and boulders		3	SS	28													16 75 (9)
	Compact to dense Brown Wet Grey		4	SS	35													
185.2	Gabbro bedrock		5	RC NQ	REC 100%													RQD 73%
2.8	Slightly weathered to unweathered		6	RC NQ	REC 100%													RQD 70%
	Hight strength		7	RC NQ	REC 100%													RQD 99%
	Fair to excellent quality																	
182.1	End of borehole																	
5.9	Sample 2: Sampler bouncing																	

RECORD OF BOREHOLE No C8-2 1 of 1 **METRIC**

Coords: 5 096 738.2 N; 221 538.6 E

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+805.7, o/s 38.3m Lt CL Med. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.
 DATUM Geodetic DATE March 02, 2009 CHECKED BY B.R.G.

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
188.5	Top of Ice															
0.0	Snow and Ice															
187.8						188										
0.7	Peat, coarse fibrous		1	CS	-											
187.3	Dark brown															
1.2	End of borehole Refusal on probable boulders															

* 2009 03 02
 ▽ Water level observed during drilling
 ▼ Water level measured after drilling

RECORD OF BOREHOLE No C8-4 1 of 1 **METRIC**

G.W.P. 5203-06-00 LOCATION Coords: 5 096 740.9 N; 221 615.5 E
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers ORIGINATED BY F.P.
 DATUM Geodetic DATE March 01, 2009 COMPILED BY A.S.
 CHECKED BY B.R.G.

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
187.7	Top of Snow																
0.0	Snow and ice																
187.3																	
0.4	Peat, coarse fibrous Dark brown Wet					▽*											
186.9																	
0.8	Organic clayey silt Dark grey Wet		1	SS	21												
186.6																	
1.1	Sand some gravel, trace silt cobbles and boulders		2	SS	31												13 82 5 0
	Compact to Grey Wet dense		3	SS	32												
			4	SS	23												
			5	SS	20/25cm												
183.3	End of borehole																
4.4	Refusal on probable bedrock																
	Sample 5: Sampler bouncing																
	* 2009 03 01																
	▽ Water level observed during drilling																
	▽ Water level measured after drilling																

RECORD OF BOREHOLE No C8-5 1 of 1 **METRIC**

Coords: 5 096 741.7 N; 221 635.2 E

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 20+798, o/s 58m Rt CL Med. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and NQ Diamond Coring COMPILED BY A.S.
 DATUM Geodetic DATE February 26, 2009 CHECKED BY B.R.G.

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
187.5	Top of Snow																	
0.0	Snow and ice																	
187.1																		
0.4	Peat, coarse fibrous																	
186.9	Dark brown																	
0.6	Sand some gravel, trace silt cobbles and boulders		1	SS	30													
	Compact Grey Wet		2	SS	21													
			3	SS	15													11 83 (6)
	with gravel some silt, trace clay		4	SS	13													
			5	SS	27													24 61 12 3
			6	SS	25													
182.3	Gabbro bedrock																	
5.2	Slightly weathered to unweathered		7	RC NQ	REC 100%													RQD 100%
	Hight strength		8	RC NQ	REC 100%													RQD 85%
	Good to excellent quality		9	RC NQ	REC 100%													RQD 95%
179.2	End of borehole																	
8.3																		

RECORD OF BOREHOLE No P2-NBL 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Coords: 5 096 748.1 N; 221 594.9 E ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and NQ Diamond Coring COMPILED BY A.S.
 DATUM Geodetic DATE February 24 and 25, 2009 CHECKED BY B.R.G.

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
187.4	Top of Snow																	
0.0 187.1	Snow/ice																	
0.3 186.6	Peat, coarse fibrous Dark brown		1	CS	-	▽*												
0.8 186.6	Sand with gravel, trace silt cobbles and boulders Compact Brown Wet		2	SS	26													
			3	SS	20/8cm													
			4	SS	15/15cm													
182.5 4.9	Gabbro bedrock Slightly weathered to unweathered High strength Fair to excellent quality		5	RC NQ	REC 96%													RQD 87%
			6	RC NQ	REC 100%													RQD 96%
			7	RC NQ	REC 100%													RQD 100%
			8	RC NQ	REC 100%													RQD 63%
178.5 8.9	End of borehole																	

RECORD OF BOREHOLE No D7-2

1 of 1

METRIC

G.W.P. 5378-02-00 LOCATION Hwy. 69 Sta. 20+800, o/s 0.4m Lt. ORIGINATED BY R.E.
 Co-ords. 5 096 737 N; 221 577 E
 DIST 54 HWY 69 BOREHOLE TYPE Casing + Washboring COMPILED BY R.E.
 DATUM Geodetic DATE March 09, 2004 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
187.6	Top of Ice																
0.0	Snow/Ice																
187.0	End of borehole						187										
0.6	Refusal on probable bedrock or boulder																
	Boulders observed near borehole location																

RECORD OF PENETRATION TEST No D7-3

1 of 1 METRIC

G.W.P. 5378-02-00 LOCATION Hwy. 69 Sta. 20+808, o/s 50.8m Lt. Co-ords. 5 096 739 N; 221 526 E ORIGINATED BY R.E.
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY R.E.
 DATUM Geodetic DATE March 09, 2004 CHECKED BY C.N.

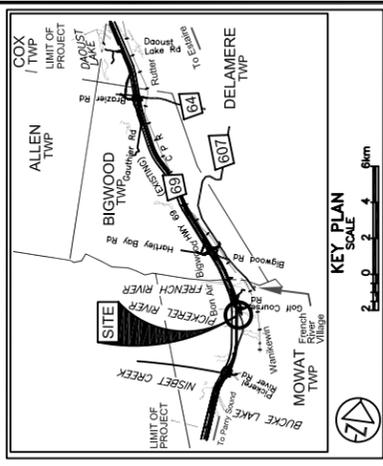
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
188.4 0.0	Top of Ice Snow/Ice															
187.8 0.6	End of dynamic cone penetration test Refusal on probable bedrock or boulder Boulders observed near dynamic cone penetration test location									120/0cm						

RECORD OF PENETRATION TEST No D7-3A

1 of 1 METRIC

G.W.P. 5378-02-00 LOCATION Hwy. 69 Sta. 20+809, o/s 49.7m Lt. Co-ords. 5 096 740 N; 221 527 E ORIGINATED BY R.E.
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY R.E.
 DATUM Geodetic DATE March 09, 2004 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
188.4 0.0	Top of Ice Snow/Ice															
187.8 0.6	End of dynamic cone penetration test Refusal on probable bedrock or boulder Boulders observed near dynamic cone penetration test location									120/0cm						



LEGEND

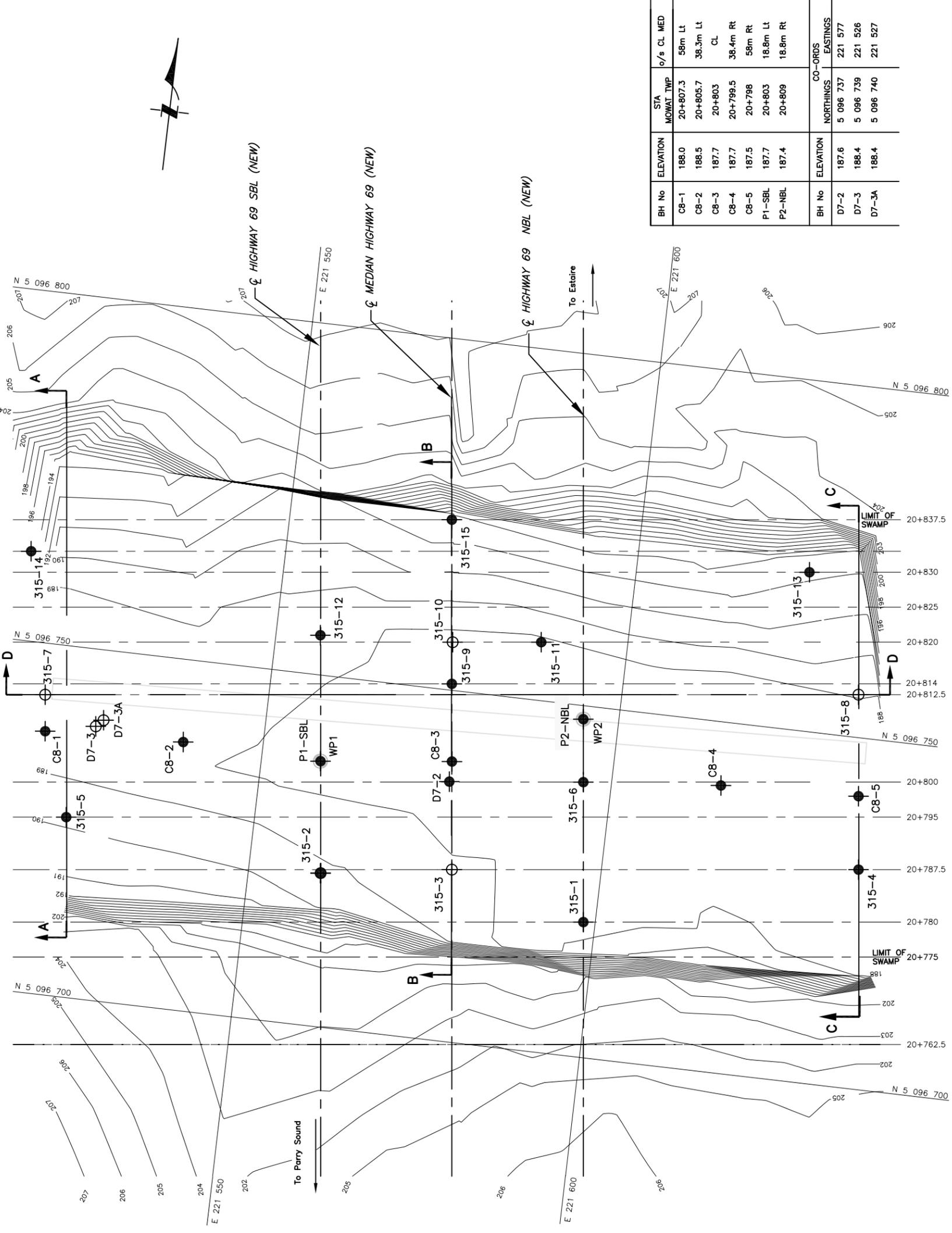
- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N** Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE** Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation Feb, Mar and May 2009
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	STA MOWAT TWP	o/s CL MED
315-1	188.1	20+780	18.8m Rt.
315-2	189.3	20+787	19.0m Lt.
315-3	187.9	20+787.5	CL
315-4	187.6	20+787.5	58.0m Rt.
315-5	189.1	20+795	55.0m Lt.
315-6	187.7	20+800	18.8m Rt.
315-7	188.6	20+812.5	58.0m Lt.
315-8	187.9	20+812.5	58.0m Rt.
315-9	187.6	20+814	CL
315-10	187.6	20+820	CL
315-11	189.3	20+820	12.8m Rt.
315-12	188.3	20+821	18.8m Lt.
315-13	191.2	20+830	51.0m Rt.
315-14	190.3	20+833	60.0m Lt.
315-15	191.6	20+837.5	CL

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. 41H-243
 HWY No 69
 SUBMIT MIN CHECKED AS DATE NOV. 18, 2009 SITE
 DRAWN NA CHECKED CN APPROVED BRG DWG 315-1



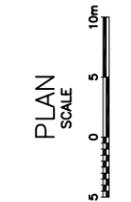
BH No	ELEVATION	STA MOWAT TWP	o/s CL MED
C8-1	188.0	20+807.3	58m Lt
C8-2	188.5	20+805.7	38.3m Lt
C8-3	187.7	20+803	CL
C8-4	187.7	20+799.5	38.4m Rt
C8-5	187.5	20+798	58m Rt
P1-SBL	187.7	20+803	18.8m Lt
P2-NBL	187.4	20+809	18.8m Rt

BH No	ELEVATION	NORTHINGS	EASTINGS
D7-2	187.6	5 096 737	221 577
D7-3	188.4	5 096 739	221 526
D7-3A	188.4	5 096 740	221 527

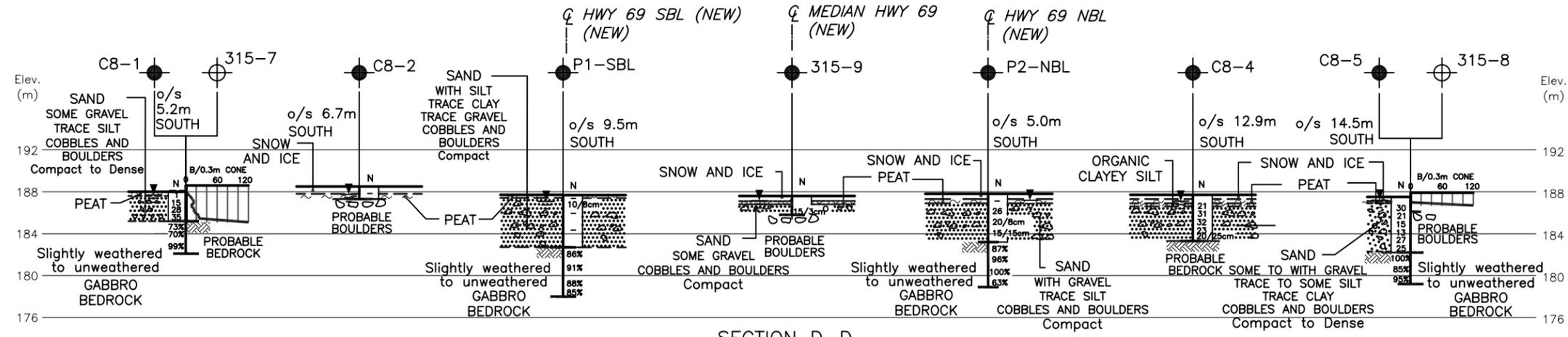
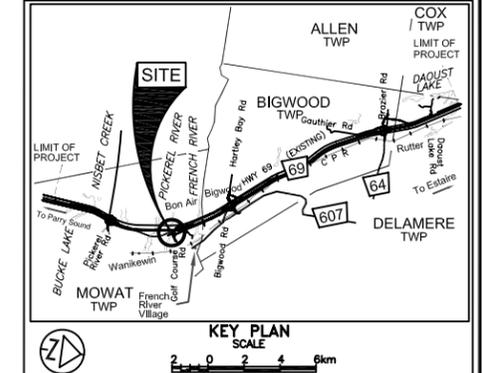

 REGISTERED PROFESSIONAL ENGINEER
 B. R. GRAY
 MAY 18, 2009
 PROVINCE OF ONTARIO


 REGISTERED PROFESSIONAL ENGINEER
 C.M.P. MacCallum
 MAY 18, 2009
 PROVINCE OF ONTARIO

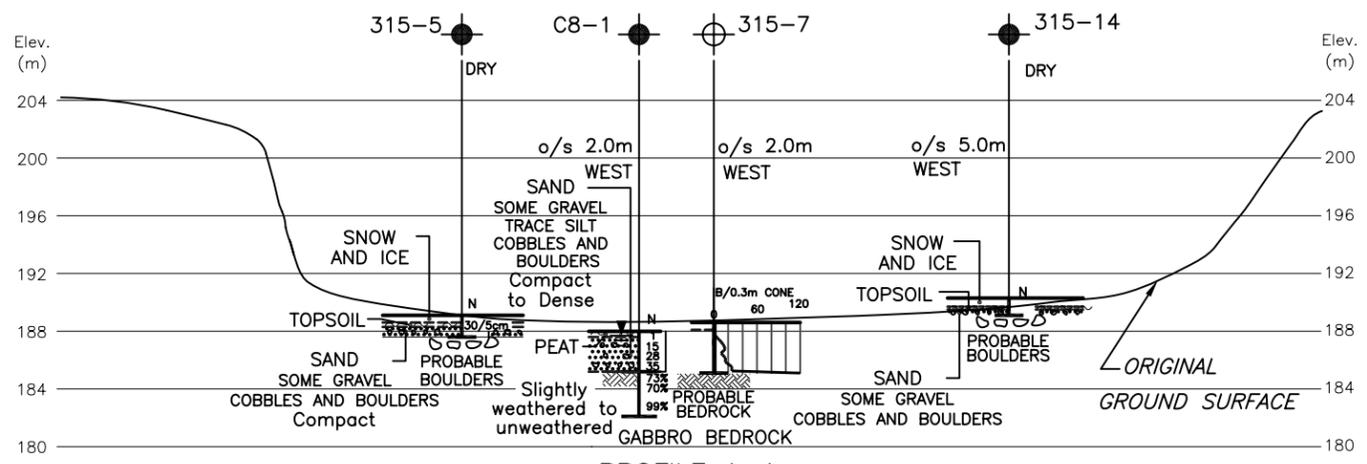
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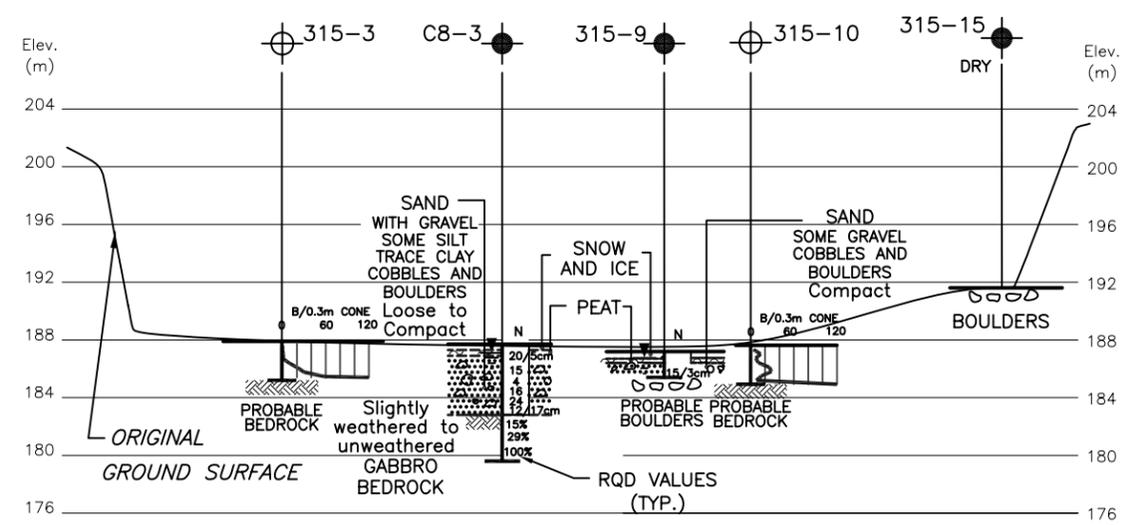
- NOTES:**
- DRAWING 315-1 SHOULD BE READ IN CONJUNCTION WITH THE TEXT AND THE RECORD OF BOREHOLE LOGS.
 - REFER TO DRAWING 315-2 FOR PROFILES A-A, B-B, C-C AND SECTION D-D.
 - THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
 - D7 SERIES BOREHOLE/CONE STATIONS AND OFFSETS ARE ADJUSTED TO NEW ALIGNMENT OF HWY 69 (NEW).
 - D7 SERIES BOREHOLES DATA WERE TAKEN FROM PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT PREPARED BY PML (PML REFERENCE: 04TF008 - MID) GEOCRETS NO. 411-171, DATED MAY 31, 2004.
 - DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.



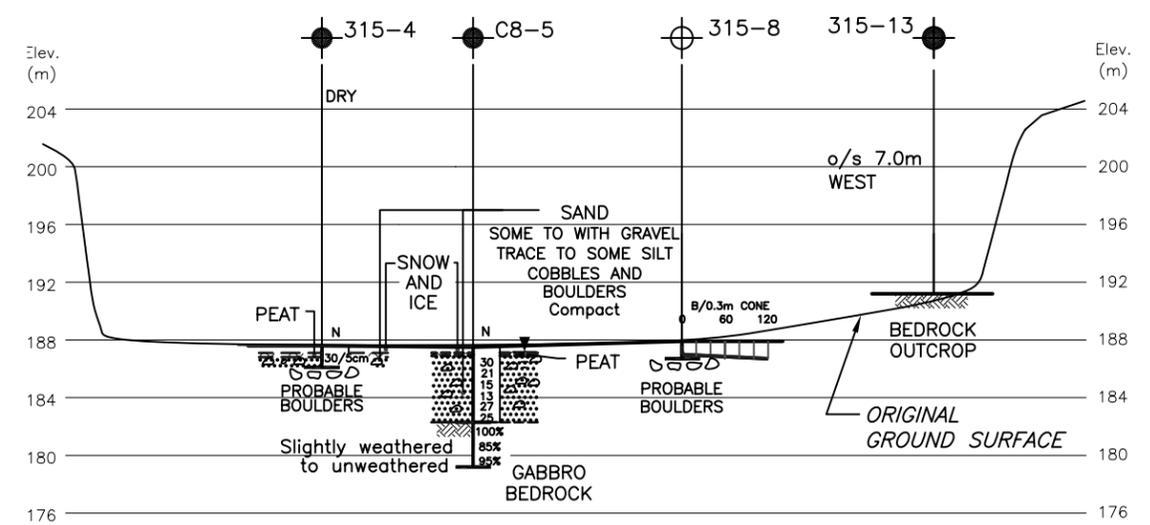
SECTION D-D



PROFILE A-A



PROFILE B-B



PROFILE C-C

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 Feb, Mar and May 2009
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	STA MOWAT TWP	o/s CL MED
SEE DRAWING 315-1 FOR DETAILS			

- NOTES:
- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT AND THE RECORD OF BOREHOLE LOGS.
 - REFER TO DRAWING 315-1 FOR BOREHOLE LOCATIONS PLAN
 - THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
 - DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.



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

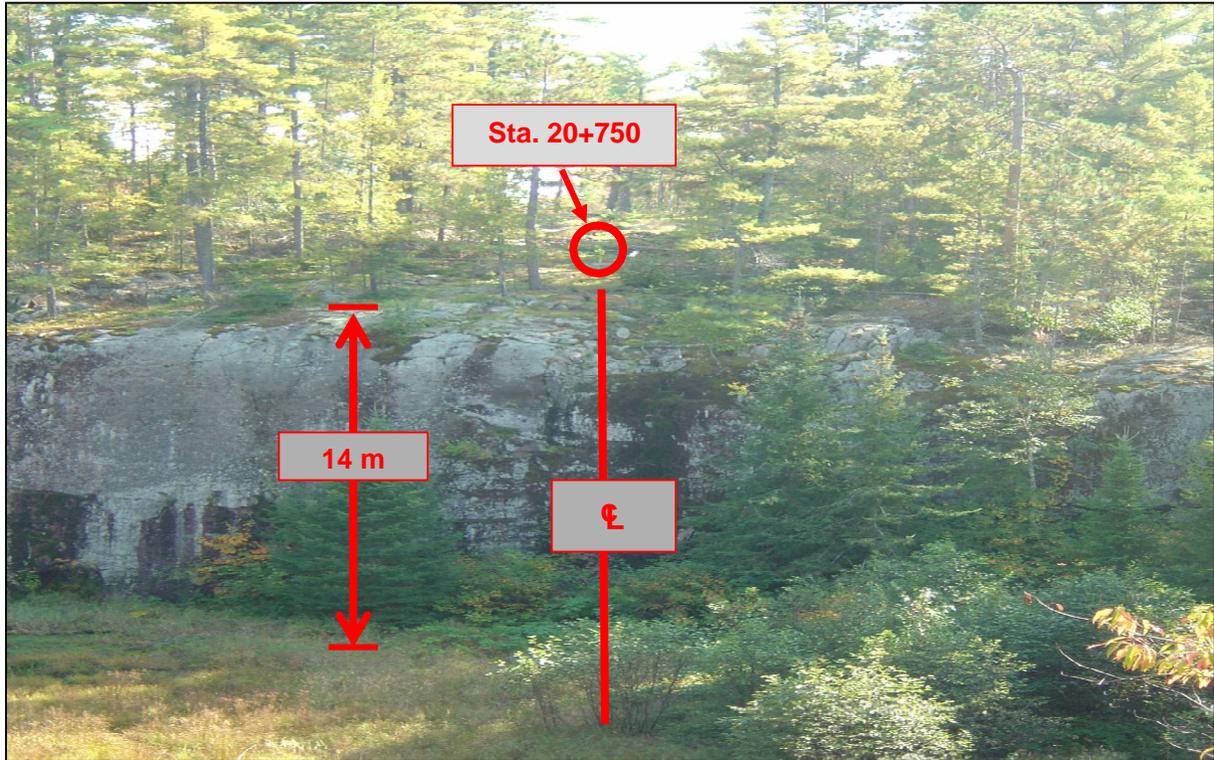
REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 41H-243
HWY No 69 DIST 54
SUBM'D MN CHECKED AS DATE NOV. 18, 2009 SITE --
DRAWN NA CHECKED CN APPROVED BRG DWG 315-2

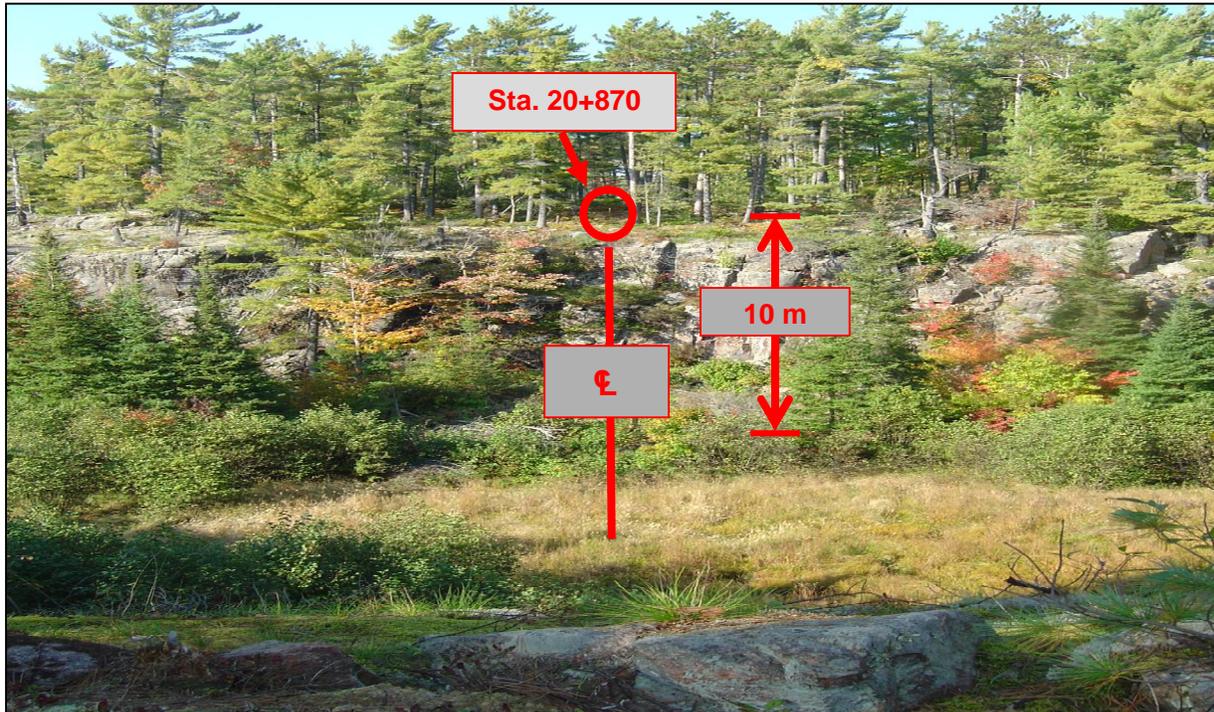


APPENDIX A

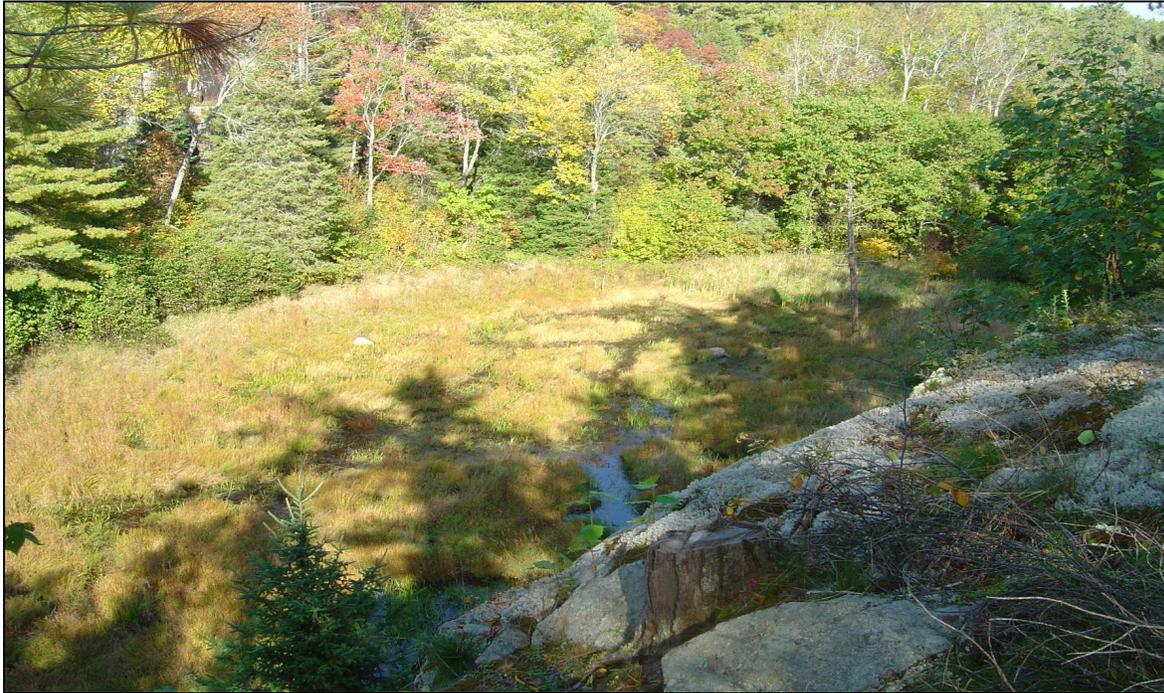
SITE PHOTOGRAPHS



Photograph 1 VIEW: Looking south along median from about Sta. 20+845 across the Ojibway Canyon. Stake at Sta. 20+750 visible on 14 m high bedrock exposure. (September 26, 2008)



Photograph 2 VIEW: Looking north along median from about Sta. 20+770 across Ojibway Canyon. Stake at Sta. 20+870 visible on 10 m high vertical bedrock exposure. Talus bedrock boulders visible at toe of slope. (September 26, 2008)



Photograph 3 VIEW: Looking east (toward existing Highway 69) from south side of Ojibway Canyon at about SBL Sta. 20+765. Swamp with open water visible across floor of canyon. (September 26, 2008)



Photograph 4 VIEW: Facing north at rock face north edge of the Canyon boulders strewn throughout. (March 27, 2009)



Photograph 5 VIEW: Facing north to rock face at the south edge of the canyon. (March 27, 2009)

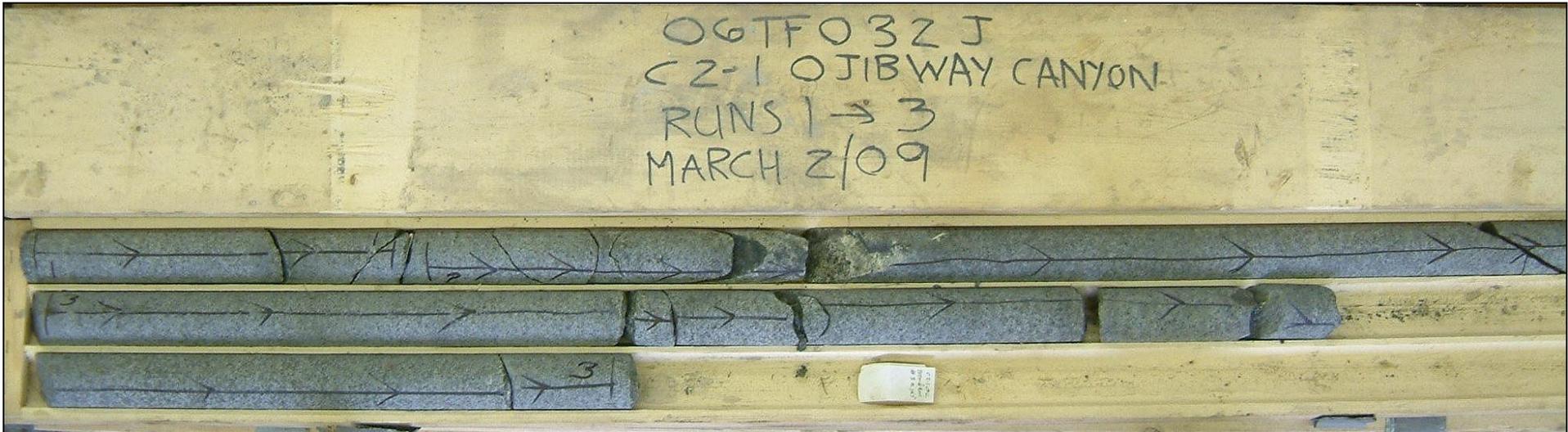


Photograph 6 VIEW: Shovel probe location at Sta. 20+787, 19LT, surface boulders throughout area. (March 27, 2009)



APPENDIX B

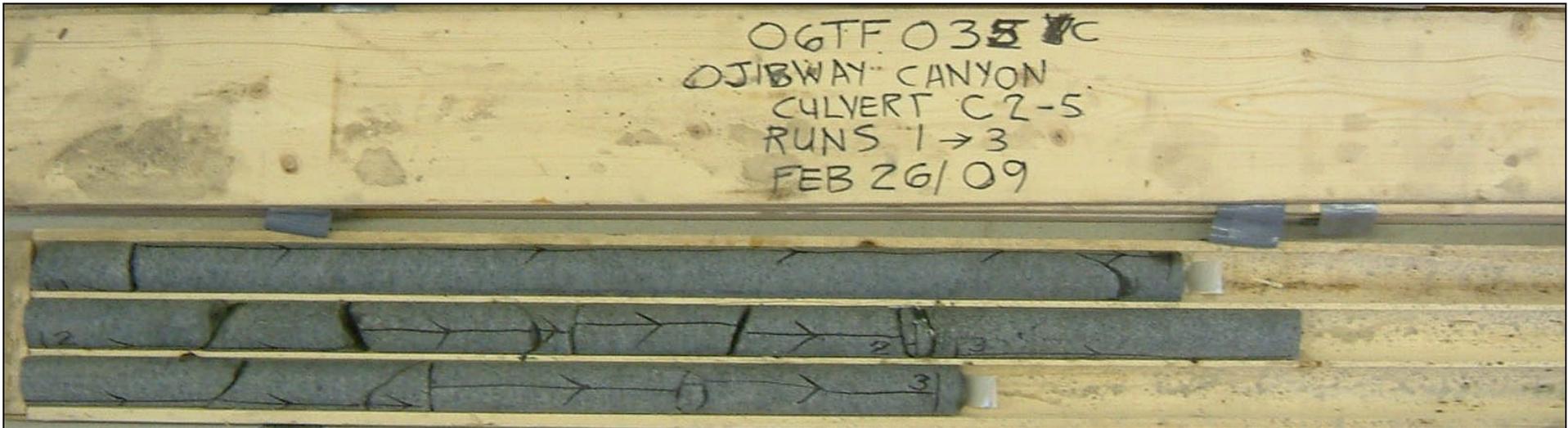
ROCK CORE PHOTOGRAPHS



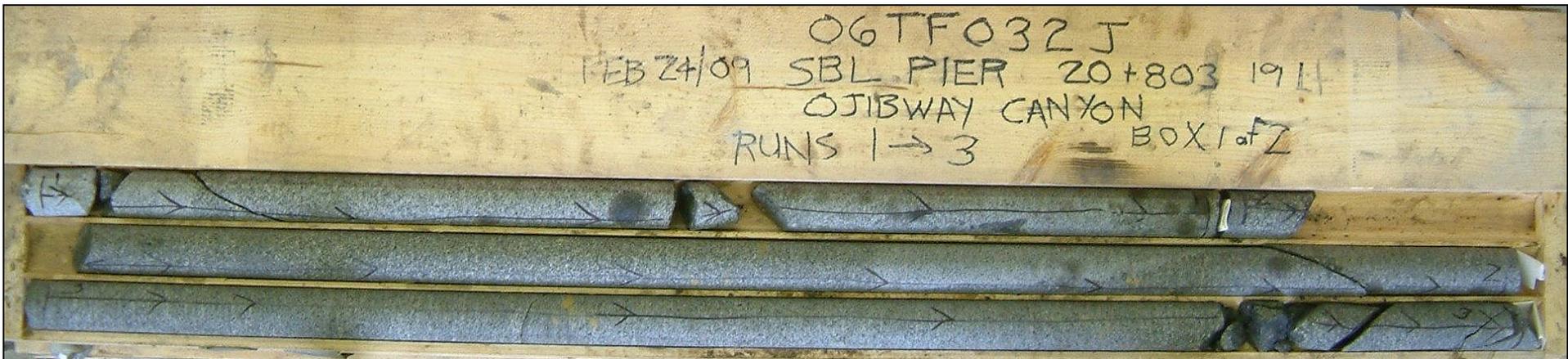
Photograph 1: Culvert C8, borehole C8-1, RC-5 to RC-7. RQD ranged from 70 to 99%. Rock quality ranged from fair to excellent.



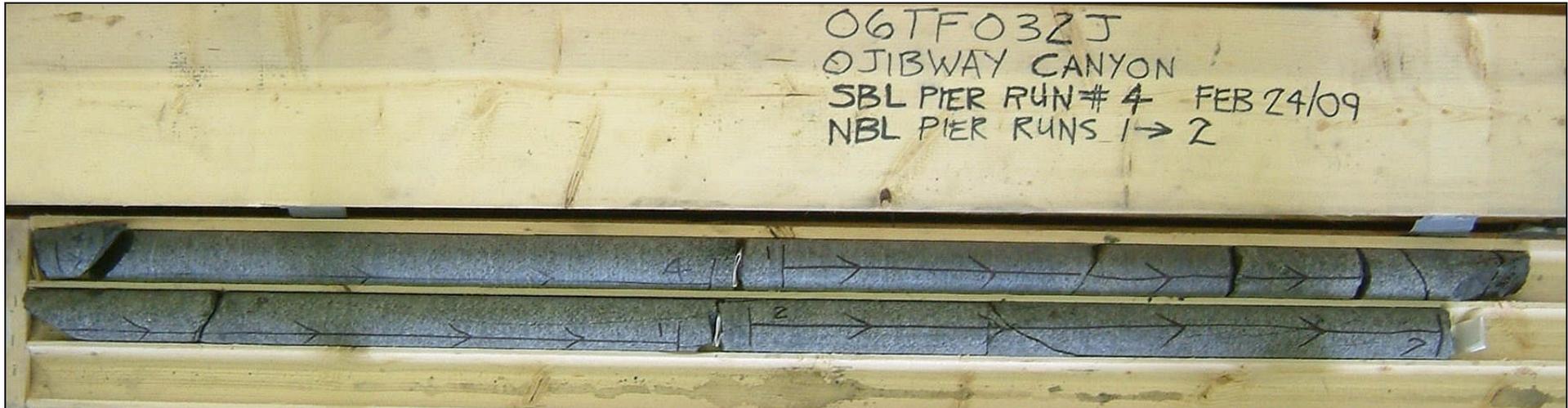
Photograph 2: Culvert C8, borehole C8-3, RC-7 to RC-9. RQD ranged from 15 to 100%. Rock quality ranged from very poor to excellent.



Photograph 3: Culvert C8, borehole C8-5, RC-7 to RC-9. RQD ranged from 85 to 100%. Rock quality ranged from good to excellent.



Photograph 4: Bridge Pier 1 at Sta. 20+803 (SBL), borehole P1-SBL, samples RC-5 to RC-8. RQD ranged from 85 to 91%. Rock quality ranged from good to excellent.



Photograph 5: Bridge Pier 2 at Sta. 20+809 (NBL), borehole P2-NBL, samples RC-5 to RC-8. RQD ranged from 63 to 100%. Rock quality ranged from fair to excellent.