

GEORES No 31B-80

FOUNDATION INVESTIGATION REPORT

**W.P. 177-89-00
SNOWMOBILE UNDERPASS
HWY 416, NBL STA. 13+790
HWY 416, SBL STA. 13+772
DISTRICT 9, OTTAWA**

MINISTRY OF TRANSPORTATION ONTARIO

SUBMITTED TO

TOTTEN SIMS HUBICKI ASSOCIATES

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PROJECT NO. 10990

FOUNDATION INVESTIGATION REPORT

TO

TOTTEN SIMS HUBICKI ASSOCIATES

ON

W.P. 177-89-00

SNOWMOBILE UNDERPASS

HWY 416, NBL STA. 13+790

HWY 416, SBL STA. 13+772

DISTRICT 9, OTTAWA

MINISTRY OF TRANSPORTATION ONTARIO

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for

W.P. 177-89-00

Snowmobile Underpass

HWY 416, NBL STA. 13+790

HWY 416, SBL STA. 13+772

District 9, Ottawa

1.0 INTRODUCTION

This report presents the results of a geotechnical foundation investigation carried out for the proposed snowmobile underpass to be constructed as part of the Highway 416 construction (W.P. 177-89-00). The work was carried out in accordance with our proposal dated September 3, 1997. Authorization to proceed was provided by Mr. D.R. Woods, P.Eng., of Totten Sims Hubicki Associates (TSH) in a letter dated October 9, 1997.

This report has been prepared specifically and solely for the project described herein. It contains factual information obtained from this investigation pertaining to the subsurface conditions.

2.0 SITE DESCRIPTION AND GEOLOGY

The proposed snowmobile crossing is located approximately 2.7 km north of Highway 401. The site location is shown on the Key Plan provided in Appendix 2 (Drawing No. 10990-1).

The proposed snowmobile underpasses lie within the Hwy 416 corridor. The Hwy 416 NBL are present in the form of the current Hwy 16. The future Hwy 416 SBL is located within a wooded area. Ditches are present on both sides of the existing Hwy 16.

The topography in the area generally slopes downward towards a swamp area to the south to southeast of the project site. Drainage in the immediate area is provided by highway ditches. Physiographically, the site lies within the area known as the Glengarry Till Plain. The surface consists of morainic ridges and drumlines together with intervening clay flats and swamps. Bedrock underlying the site consists of Ordovician dolostone of the Oxford Formation.



3.0 PROCEDURE

3.1 Field Investigation

The site soil conditions were investigated through a borehole drilling investigation and laboratory testing. The field work for this investigation was carried out on October 21, 1997.

Prior to the onset of the drilling investigation, the borehole locations were cleared of underground utilities by the appropriate agencies. A total of three (3) boreholes, designated as 97-1 through 97-3, were put down during the field investigation. The approximate locations of the boreholes are shown on Drawing 10990-2, provided in Appendix 2.

The boreholes were advanced using a track mounted CME 55 drill rig. The boreholes were advanced to a maximum depth of 6 m. The subsurface conditions were identified in the field by our personnel while carrying out Standard Penetration Tests (SPT) (ASTM D1586). The SPT were carried out at regular intervals and the recovered soil samples were returned to our laboratory for detailed classification and testing. The subsurface conditions are described in detailed in the Borehole Records presented in Appendix 1.

All soil samples recovered were stored in moisture proof containers and were returned to our laboratory for classification and testing.

Prior to completing the investigation, the boreholes were backfilled by replacing (and tamping in layers) the augered material.

3.2 Survey

Borehole locations were established in the field by Jacques Whitford personnel relative to existing site features such as existing culverts and edge of pavement. The ground surface elevation at the borehole locations was surveyed relative to a known elevation of 98.47 m geodetic at the centreline of existing Hwy 16 (Hwy 416 NBL) at station 13+785.



3.3 Laboratory Testing

All samples returned to the laboratory were subjected to detailed visual classification by a geotechnical engineer. Selected samples were tested for moisture content and grain size distribution. One representative soil sample was submitted for pH and chloride testing to assess the potential for corrosion of buried steel. All soil samples will be stored for a period of three months after issuance of the final report. Unless otherwise directed, the stored samples will be disposed of after this period.

4.0 RESULTS OF THE INVESTIGATION

4.1 Subsurface Profile

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records provided in Appendix 1. An explanation of the symbols and terms used to describe the Borehole Records is also provided. In general, the observed stratigraphy included rootmat, overlying clayey silt or glacial till. Bedrock was not encountered in any of the boreholes.

4.1.1 Sand

A thick deposit of sand, trace silt was encountered below the surficial organic layer at all borehole locations. The sand was generally brown near the surface, changing to grey with depth. The SPT N-values ranged from 3 to 20, indicating a loose to compact deposit. The moisture content of 9 samples tested ranged from 6 % to 27 % with an average of 18 %. Grain-size analysis carried out on three samples of the sand indicated that it contained 0 % gravel, 86 to 96 % sand and 4 to 14 % silt sized particles. The sand deposit generally extended to elevation 89 to 90 m.

4.1.2 Glacial Till

A deposit of glacial till was encountered in Borehole 97-1, underlying the sand deposit. The glacial till consisted of a mixture of silt, sand, clay and gravel. The SPT N-values within the till ranged from 11 to greater than 50 for only 150 mm of penetration (split spoon refusal), indicating a compact to dense material. The moisture content of a representative sample of the till was 15 %.

4.1.3 Clayey Silt

Clayey silt was encountered beneath the sand deposits in Boreholes 97-2 and 97-3. A grain size distribution analysis carried out on the clayey silt indicated that it contained 12 % sand, 62 % silt and 26 % clay sized particles. The moisture content ranged from 20 % to 24 %, based on the two samples tested.

4.1.4 Bedrock

Bedrock was not encountered at any of the borehole locations.

4.2 Groundwater

Groundwater levels were observed in the open boreholes at the time of drilling. The observed water levels are summarized in the table below.

Borehole	Water Level (m bgs)	Groundwater Elevation (m)
97-1	1.5	92.4
97-2	2.3	92.3
97-3	0.8	92.8

Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Proposed Development

It is understood that the Ministry of Transportation of Ontario (MTO) plans to construct underpass structures beneath Highway 416 to accommodate snowmobiles crossing the highway. Preliminary design information provided by TSH indicates that the underpasses will consist of 4.3 m diameter structural plate corrugated steel pipe culverts, crossing the southbound lanes (SBL) and northbound lanes (NBL). The SBL culvert will be located at station 13+790 and be 46.9 m in length. The NBL culvert will also be located at station 13+790 and be 41.5 m in length. The culvert ends will be bevelled.



5.2 Geotechnical Assessment

Structural plate corrugated steel pipe (SPCSP) culverts are proposed for the snowmobile crossing. The crossings are to be located within a fill section of the highway with anticipated embankment heights of 5.5 m to 6.5 m.

The proposed culvert invert elevations are close to the existing grades away from the roadway embankments, and therefore, the culverts are anticipated to be founded on the upper loose to compact sand deposits described on the Borehole Records.

It is anticipated that installation of the Hwy 416 SBL culvert will be carried out during the new highway construction and that the NBL culvert will be installed using open cut techniques. Dewatering could be required during culvert installation depending on excavation depths. In addition, control of water within the ditches along the existing Hwy 16 may be required depending on the construction schedule.

The embankment fills are anticipated to be up to 6.0 m in height, and constructed with 2.0 H:1.0 V sideslopes. No embankment stability problems associated with subgrade soils are anticipated.

Installations of the culvert within the NBL will result in a net reduction in stress within the subgrade soils, and therefore, negligible settlement (total or differential) is expected.

Settlement of the SBL culvert, due to embankment loading is expected to be in the order of 25 to 35 mm at the centreline of the highway and in the order of 5 mm at the bottom edges of the sideslopes.

Cambering of the culverts to accommodate anticipated settlements is not considered to be a requirement. However, the internal grade or drainage pattern required within the culverts should be designed such that the above settlements do not negatively impact or reverse the drainage direction.

The following sections are recommendations for the design and construction of the proposed SPCSP culvert snowmobile crossing.

5.3 Site Grading and Preparation

All organic soils, and other deleterious materials must be removed from beneath the proposed culverts. Where deleterious materials are encountered, the material should be excavated, wasted and replaced with earth fill. The lateral extent of such excavation should include all deleterious material within an imaginary line drawn at an angle of 1 horizontal to 1 vertical, downward and away from the vertical edges of the SPCSP, to the competent native soil.



Stripping of deleterious materials should be inspected by geotechnical personnel to ensure that all unsuitable materials are removed prior to placement of concrete or Select Subgrade Material (SSM). The exposed subgrade surface should be surface compacted using a large vibrating roller to 95 % of Standard Proctor maximum dry density.

If required for grading purposes, earth fill should consist of Select Subgrade Material (SSM), placed in lifts no greater than 300 mm and compacted to at least 95 % Standard Proctor Maximum Dry Density (SPMDD).

5.4 Excavation, Bedding and Backfill for Culverts

Excavation and backfill for the SPCSP culverts should conform to OPSD-802.010. Side slopes for open cut excavations should conform to Occupational Health and Safety Act regulations.

Bedding should be placed in accordance with the pipe design requirements. It is recommended that a minimum of 150 mm to 200 mm of OPSS Granular A be placed below the pipe invert as bedding material. Pipe backfill within the embedment zone should consist of OPSS Granular A material. The embedment zone includes a minimum of 500 mm vertical and side cover. These materials should be compacted to at least 95 % of SPMDD. Backfill material for culvert frost treatment should be carried out in accordance with OPSD-803.030 and OPSD-803.031. A depth of frost penetration, f , equal to 1.2 m should be used at this site.

5.5 Culvert Headwalls (If Required)

Concrete culvert headwalls may be founded on spread footings placed on the native sand. The following parameters may be used for design:

Factored bearing capacity at ULS	150 kPa
Bearing capacity at SLS	100 kPa

The above recommended factored bearing capacity at ULS assumes a footing width no greater than 2 m.

Sliding resistance between the concrete and the sand should be calculated in accordance with Section 6-8.4.3 of the OHBDC 3rd Edition using an unfactored friction coefficient of 0.4.

The headwalls should be backfilled with free draining material such as OPSS Granular A or Granular B, to prevent hydrostatic pressure build-up.



Compaction of the granular backfill near the walls should be carried out using hand-operated equipment to prevent overstressing the abutment walls. Weep holes should be provided in retaining walls to drain any accumulated water within the backfill.

6.0 CLOSURE

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review our recommendations when the drawings and specifications are complete.

A soil investigation is a limited sampling of a site. The conclusions given herein are based on information gathered at the specific borehole locations and can only be extrapolated to an undefined limited area around these locations. The extent of the limited area depends on the soil and groundwater conditions, as well as the history of the site reflecting natural, construction, and other activities. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information and its effects on the above conclusions.

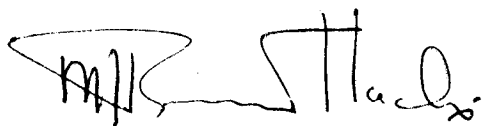
We trust the information presented herein meets your present requirements. Should you have any questions or require additional information, please do not hesitate to contact us.

Yours very truly,

JACQUES, WHITFORD LIMITED



Paul Carnaffan, M.Eng., P.Eng.



J.G.A. Raymond Haché, M.Sc., P.Eng.



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

MECHANICAL PROPERTIES OF SOIL

u_w	kPa	PORE WATER PRESSURE	m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
e_u	1	PORE PRESSURE RATIO	C_c	1	COMPRESSION INDEX
σ	kPa	TOTAL NORMAL STRESS	C_s	1	SWELLING INDEX
σ'	kPa	EFFECTIVE NORMAL STRESS	C_a	1	RATE OF SECONDARY CONSOLIDATION
τ	kPa	SHEAR STRESS	C_v	m ² /s	COEFFICIENT OF CONSOLIDATION
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES	H	m	DRAINAGE PATH
ϵ	%	LINEAR STRAIN	T_v	1	TIME FACTOR
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS	U	%	DEGREE OF CONSOLIDATION
E	kPa	MODULUS OF LINEAR DEFORMATION	σ'_{v0}	kPa	EFFECTIVE OVERBURDEN PRESSURE
G	kPa	MODULUS OF SHEAR DEFORMATION	σ'_p	kPa	PRECONSOLIDATION PRESSURE
μ	1	COEFFICIENT OF FRICTION	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_i	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

STRESS AND STRAIN

PHYSICAL PROPERTIES OF SOIL

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

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

<i>Topsoil</i>	-	mixture of soil and humus capable of supporting good vegetative growth
<i>Peat</i>	-	fibrous aggregate of visible and invisible fragments of decayed organic matter
<i>Till</i>	-	unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	-	any materials below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

<i>Desiccated</i>	-	having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
<i>Fissured</i>	-	having cracks, and hence a blocky structure
<i>Varved</i>	-	composed of regular alternating layers of silt and clay
<i>Stratified</i>	-	composed of alternating successions of different soil types, e.g. silt and sand
<i>Layer</i>	-	> 75 mm
<i>Seam</i>	-	2 mm to 75 mm
<i>Parting</i>	-	< 2 mm
<i>Well Graded</i>	-	having wide range in grain sizes and substantial amounts of all intermediate particle sizes
<i>Uniformly Graded</i>	-	predominantly of one grain size

Terminology describing soils on the basis of grain size and plasticity is based on the Unified Soil Classification System (USCS) (ASTM D-2488). The classification excludes particles larger than 76 mm (3 inches). This system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

<i>Trace, or occasional</i>	Less than 10%
<i>Some</i>	10-20%

The standard terminology to describe cohesionless soils includes the compactness (formerly "relative density"), as determined by laboratory test or by the Standard Penetration Test 'N' - value.

Relative Density	'N' Value	Compactness %
<i>Very Loose</i>	< 4	< 15
<i>Loose</i>	4-10	15-35
<i>Compact</i>	10-30	35-65
<i>Dense</i>	30-50	65-85
<i>Very Dense</i>	> 50	> 85

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests, or occasionally by standard penetration tests.

Consistency	Undrained Shear Strength		'N' Value
	kips/sq. ft.	kPa	
<i>Very Soft</i>	<0.25	<12.5	<2
<i>Soft</i>	0.25-0.5	12.5-25	2-4
<i>Firm</i>	0.5-1.0	25-50	4-8
<i>Stiff</i>	1.0-2.0	50-100	8-15
<i>Very Stiff</i>	2.0-4.0	100-200	15-30
<i>Hard</i>	>4.0	>200	>30

ROCK DESCRIPTION

Rock Quality Designation (RQD)

The classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures.

RQD

ROCK QUALITY

90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

Terminology describing rock mass:

Spacing (mm)	Bedding, Laminations, Bands	Discontinuities
2000-6000	<i>Very Thick</i>	<i>Very Wide</i>
600-2000	<i>Thick</i>	<i>Wide</i>
200-600	<i>Medium</i>	<i>Moderate</i>
60-200	<i>Thin</i>	<i>Close</i>
20-60	<i>Very Thin</i>	<i>Very Close</i>
<20	<i>Laminated</i>	<i>Extremely Close</i>
<6	<i>Thinly Laminated</i>	

Strength Classification	Uniaxial Compressive Strength (MPa)
<i>Very Low</i>	1-25
<i>Low</i>	25-50
<i>Medium</i>	50-100
<i>High</i>	100-200
<i>Very High</i>	>200

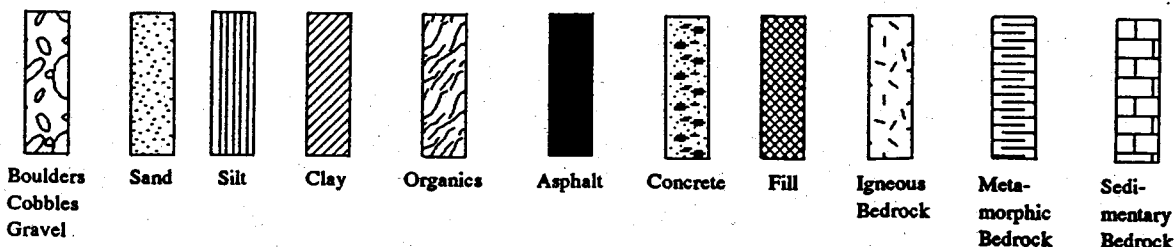
Terminology describing weathering:

<i>Slight</i>	-	Weathering limited to the surface of major discontinuities. Typically iron stained.
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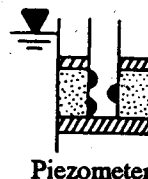
<i>Moderate</i>	-	Weathering extends throughout rock mass. Rock is not friable.
<i>High</i>	-	Weathering extends throughout rock mass. Rock is friable.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:



WATER LEVEL MEASUREMENT



SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)	BS	Bulk sample
ST	Shelby tube or thin wall tube	WS	Wash sample
PS	Piston sample	HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond drilling bits.

N - VALUE

Numbers in this column are the results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and 'N' values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75).

OTHER TESTS

S	Sieve analysis	H	Hydrometer analysis
G _s	Specific gravity of soil particles	γ	Unit weight
k	Permeability (cm/sec)	C	Consolidation
	Single packer permeability test; test interval from depth shown to bottom of borehole	CD	Consolidated drained triaxial
	Double packer permeability test; test interval as indicated	CU	Consolidated undrained triaxial with pore pressure measurements
	Falling head permeability test using casing	UU	Unconsolidated undrained triaxial
	Falling head permeability test using well point or piezometer	DS	Direct shear
		Q _u	Unconfined compression
		I _p	Point Load Index (I _p on Borehole Record equals I _p (50); the index corrected to a reference diameter of 50 mm)

RECORD OF BOREHOLE No 97-3

1 OF 1

METRIC

W.P. 177-89-00 LOCATION Hwy 416 - Snowmobile Underpass ORIGINATED BY C.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY C.L.
 DATUM Geodetic DATE 97.10.21 CHECKED BY P.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
93.6 0.0	Loose to compact, brown to brownish grey, SAND, trace silt - some organic matter		1	BS			93							0/86/13/0
			2	SS	4		92							
			3	SS	13		91							
			4	SS	10		90							
	- silt seams		5	SS	5		89							
			6	SS	16		88							
89.0 4.6	Compact to dense, grey, CLAYEY SILT to SANDY SILT		7	SS	16									
87.6 6.0	End of Borehole		8	SS	40									

RECORD OF BOREHOLE No 97-2

1 OF 1

METRIC

W.P. 177-89-00 LOCATION Hwy 416- Snowmobile Underpass ORIGINATED BY C.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY C.L.
 DATUM Geodetic DATE 97.10.21 CHECKED BY P.C.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
94.7 0.0	Loose, brown, SAND, trace silt		1	BS									0/96/4/0
			2	SS	3								
			3	SS	6								
			4	SS	10								
91.6 3.1	Compact, brown to grey, SAND, trace to some silt		5	SS	18								
			6	SS	10								
			7	SS	12								
89.4 5.3	Grey, CLAYEY SILT, some sand		8	SS	12								
88.7 6.0	End of Borehole												0/13/61/26

RECORD OF BOREHOLE No 97-1

1 OF 1

METRIC

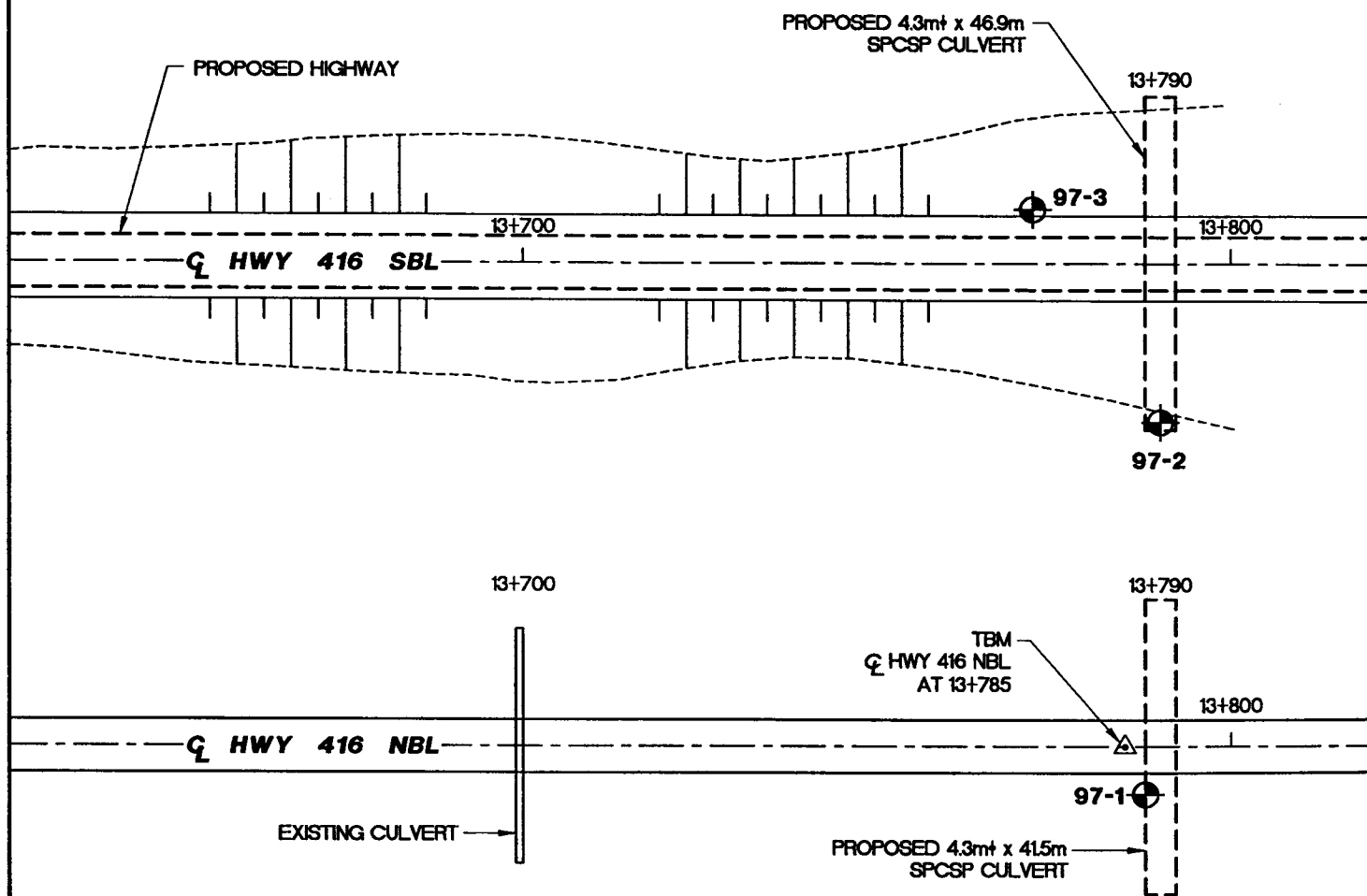
W.P. 177-89-00 LOCATION Hwy 416 - Snowmobile Underpass, Approx. Station 13+790 ORIGINATED BY C.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY C.L.
 DATUM Geodetic DATE 97.10.21 CHECKED BY P.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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		
93.9	90 mm TOPSOIL		1	BS										
93.8	Loose, dark brown, SAND, some silt													
93.1														
0.8	Loose to compact, reddish-brown to greyish-brown, SAND, trace silt		2	SS	13									
			3	SS	7									
			4	SS	20									
90.8	Compact to dense, grey, silt and sand, some clay, some gravel: TILL		5	SS	11									
3.1			6	SS	26									
			7	SS										
			8	SS										
87.8														
6.1	End of Borehole ref = >50 blows for 150mm													



KEY PLAN
1 : 250 000





LEGEND:



BOREHOLE



TEMPORARY BENCHMARK

TOTTEN SIMS HUBICKI
W.P. 177-89-00, HWY 416 SNOWMOBILE UNDERPASS
BOREHOLE LOCATION PLAN
EDWARDSBURGH TOWNSHIP, ONTARIO

Scale:
1 : 1000

Date:
97/11/24

Dwg. No.:
10990-2

Dwn. by:
GBB

Appd.:



Jacques
Whitford