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G.I.-30 SEPT. 1976

GEOCRES No. 41I00-118

DIST. 17 REGION

W.P. No. 122-79-02

CONT. No. 86-206

W. O. No.

STR. SITE No. 46-203

HWY. No. 637

LOCATION Wanapitei River

No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

CONT 86-206

Pile #7 - B.H. 812
W. Pier footing

Pile #7. B.H. 809
E. abut. -

#6 - B.H. 800
W. abut

#5 - B.H. 814
E. Pier Footing

#13 - 800 (B.H.
W. ABUT

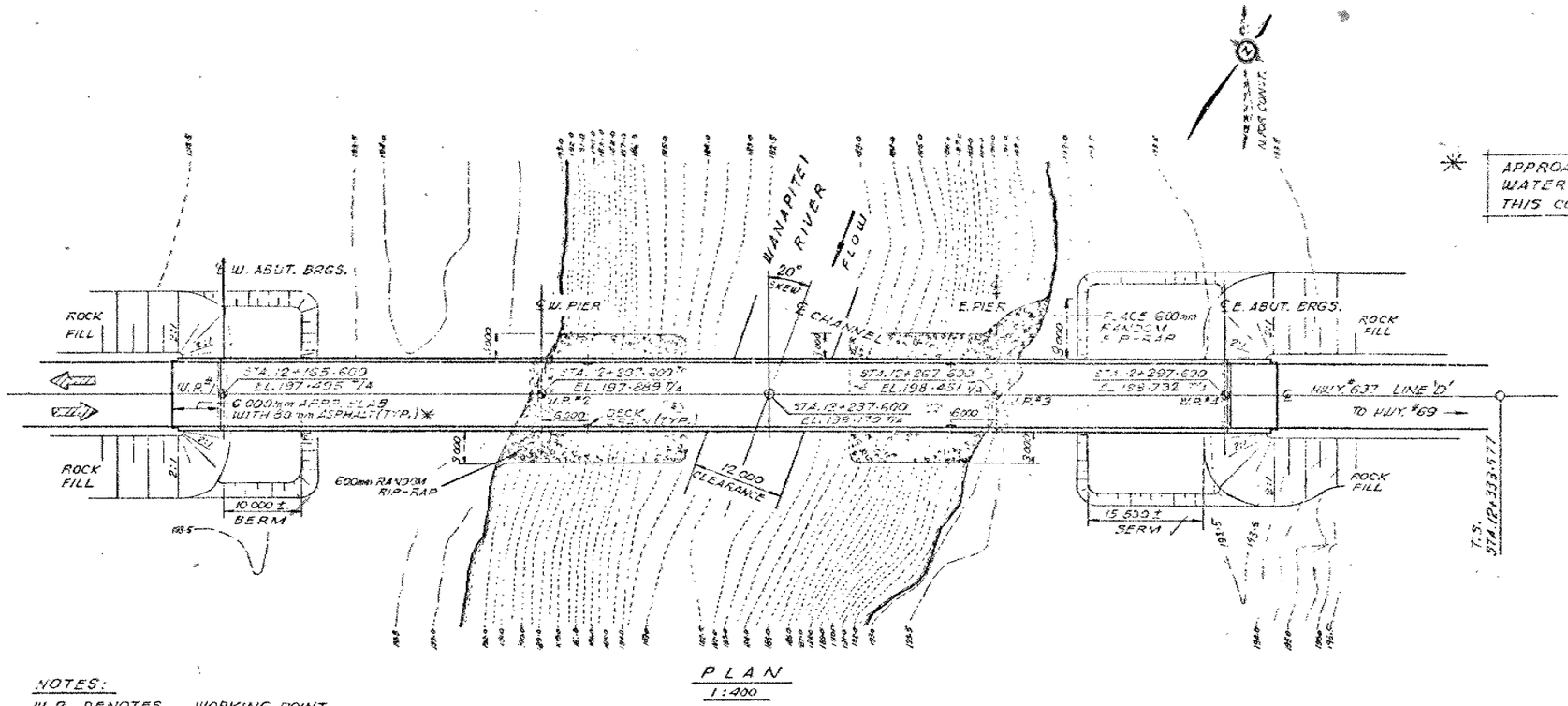
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

DIST. 17
CONT No
WP No 122-79-02

WANAPITEI RIVER
BRIDGE
15.0 km EAST OF HWY. # 69
GENERAL ARRANGEMENT

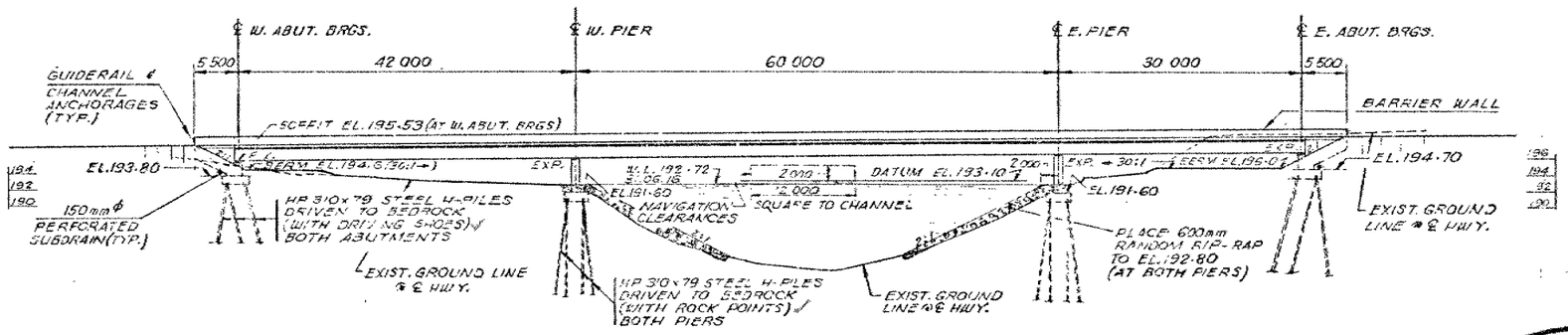
SHEET



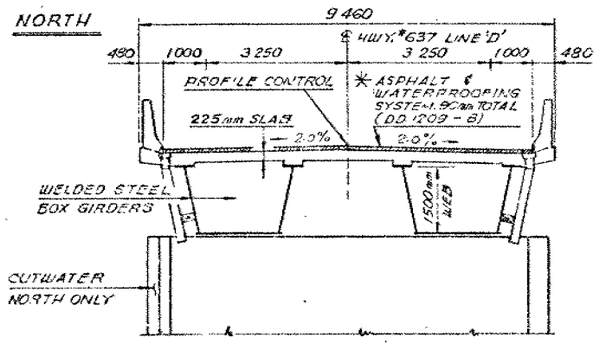
PLAN
1:400

NOTES:
W.P. DENOTES WORKING POINT
T/A DENOTES TOP OF ASPHALT

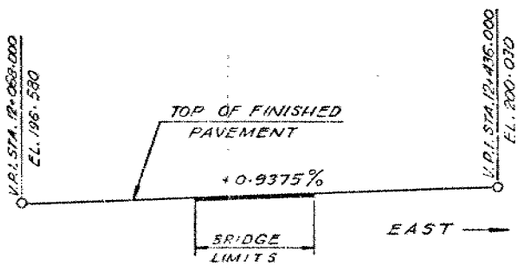
* APPROACH SLABS, ASPHALT AND WATERPROOFING NOT PART OF THIS CONTRACT



ELEVATION
1:400



TYP. DECK SECTION
1:75



PROFILE ℄ HWY. # 637 LINE 'D'
N.T.S.

NOTES

REINFORCING STEEL

REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED.
BARS MARKED WITH THE SUFFIX 'C' SHALL BE COATED BARS.

CLASS OF CONCRETE

FOOTINGS & APPROACH SLABS ____ 20 MPa
REMAINDER ____ 30 MPa

CLEAR COVER TO REINFORCING STEEL

FOOTINGS ____ 100 ± 25 mm
ABUTMENTS & WINGWALLS:
FRONT FACE ____ 60 ± 20 mm
BACK FACE ____ 70 ± 20 mm
PIERS ____ 80 ± 20 mm
DECK:
TOP ____ 70 ± 20 mm
BOTTOM ____ 40 ± 10 mm
BARRIER WALLS ____ 70 ± 20 mm
APPROACH SLABS ____ 70 ± 20 mm
UNLESS OTHERWISE NOTED ON DRAWINGS

CONSTRUCTION NOTES

THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF ± 3 mm.

LIST OF DRAWINGS

Forms O.K.
Unwatering Item ✓ Yes

BM 194.007
GEODETIC DATUM
N & W IN SW ROOT
0.35 BIRCH
30.0 RT 12+267.1

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS					
DATE	BY	DESCRIPTION			
DESIGN	CHECK	LOADING		DATE	
DRAWING	CHECK	SITE No		DWG	

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

DIST. No 17

CONT No

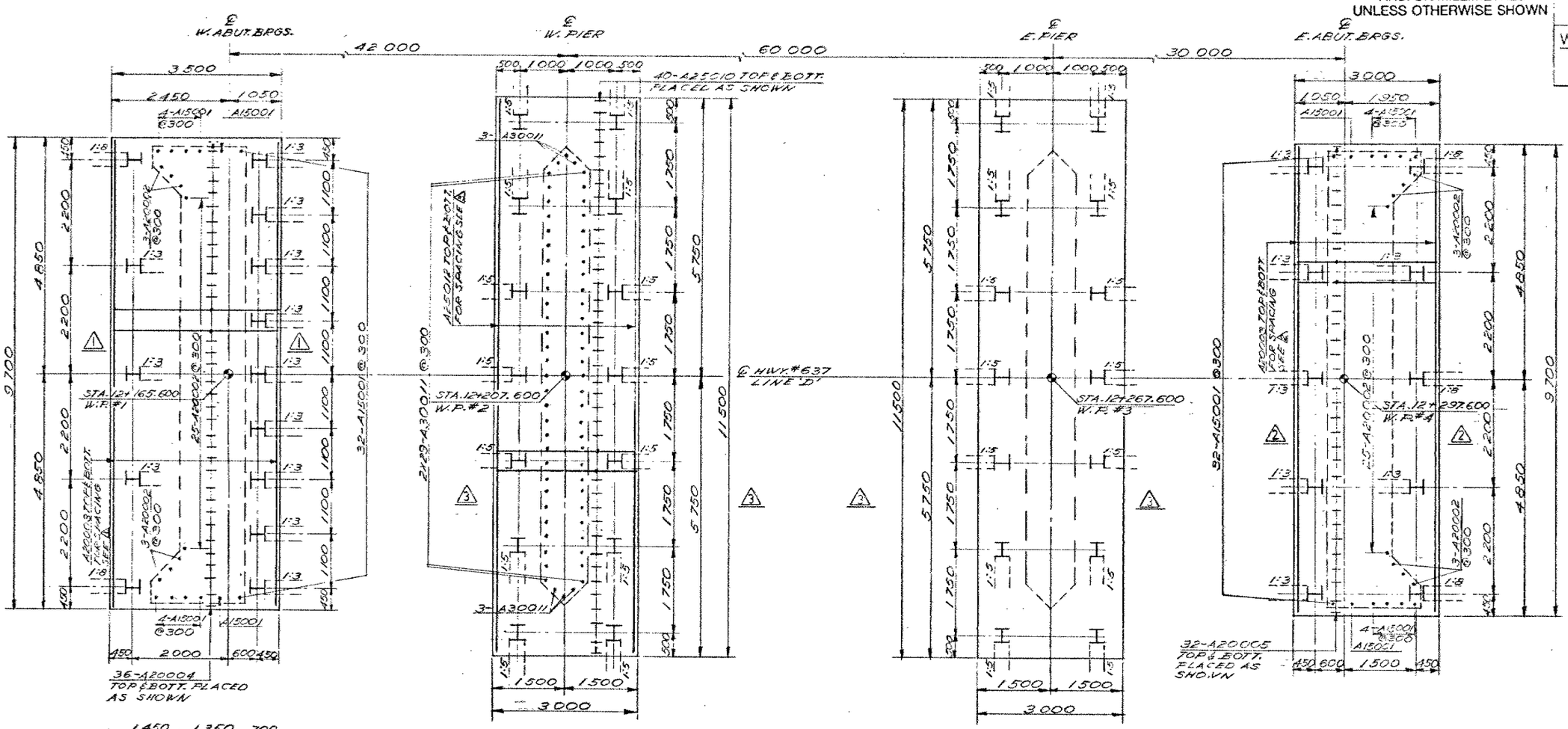
WP No 122-79-02

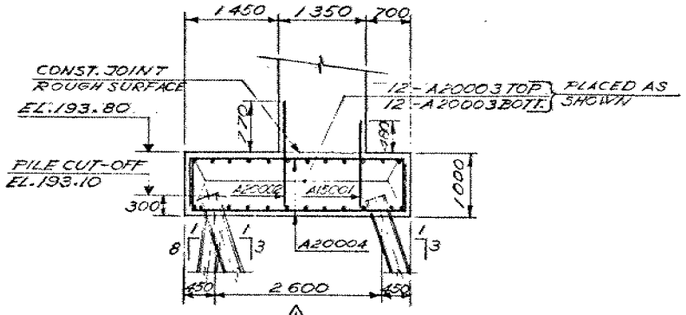
WANAPITEI RIVER BRIDGE

15.7 KM. WEST OF HWY. #69

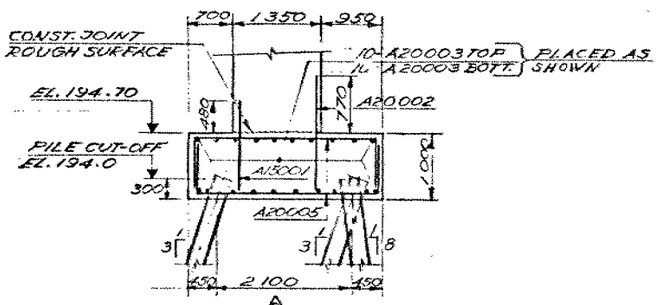
FOOTING LAYOUT

SHEET



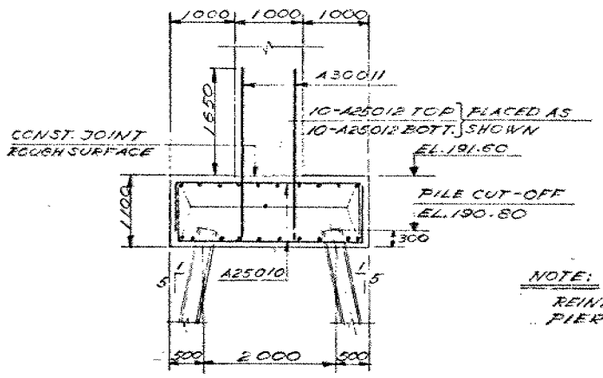


① 1:20



② 1:20

FOOTING LAYOUT



③ 1:20

NOTE:

REINFORCEMENT IN WEST & EAST PIER FOOTINGS ARE SIMILAR.

LIST OF STEEL H-PILES

LOCATION	TYPE	NO. REQ'D	LENGTH	PILE DESIGN DATA		REMARKS
				LOAD@S.L.S TYPE II	FACTORED CAPACITY@U.L.S.	
W. ABUTMENT	HP310X79	14	12 500	725 kN	980 kN	WITH DRIVING SHOES
W. PIER	HP310X79	14	10 000	850 kN	1150 kN	WITH ROCK POINTS
E. PIER	HP310X79	14	9 500	850 kN	1150 kN	WITH ROCK POINTS
E. ABUTMENT	HP310X79	10	9 000	725 kN	980 kN	WITH DRIVING SHOES

NOTE:

- PILE LENGTHS SHOWN ARE THEORETICAL LENGTHS BELOW CUT-OFF ELEVATIONS.
- PILES TO BE DRIVEN TO BEDROCK

ONTARIO ASSOCIATION OF CERTIFIED ENGINEERING TECHNICIANS AND TECHNOLOGISTS — CIVIL — P.O. LAVI

SCALE 1:50 UNLESS NOTED OTHERWISE

DRAWING NOT TO BE SCALED

100 mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	CHECK	LOADING	DATE
DRAWING	CHECK	SITE No 45-403	DWG

FOUNDATION INVESTIGATION REPORT

for

W.P. 122-79-02 Site 46-203
Hwy. 637 Line "D"
District 17 (Sudbury) Northern Region

TABLE OF CONTENTS

FOUNDATION INVESTIGATION REPORT

for

W.P. 122-79-02 Site 46-203
Hwy. 637 Line "D"
Wanapitei River Crossing
District 17, (Sudbury) Northern Region

1. INTRODUCTION

Warnock Hersey Professional Services Limited have been retained by the Ontario Ministry of Transport and Communications, under Agreement No. 4242-9081-229 to provide geotechnical services in connection with the above project. The purpose of the investigation was to establish the subsoil and bedrock stratigraphy, as well as the relevant soil parameters affecting the design and construction of the proposed bridge structure and approach embankments.

2. SITE CONDITIONS & GEOLOGY

The site is located 10 km west of Highway 69 where Highway 637 intersects the Wanapitei River. The existing crossing consists of two temporary Bailey bridges, supported on rock outcrops and spanning narrows above the river rapids. The proposed new crossing has been realigned approximately 300 meters upstream where the river is comparatively broad (60 meters) and slow moving, and is flanked by a flat swampy flood plain. The actual level of the river is controlled by the downstream rapids which are formed by outcroppings of Precambrian granite rocks of meta-sedimentary origin.

The regional topography is typical Shield terrain consisting of knobby hills and rock ridges interspersed with hollows and swamps. Several prominent outcroppings and rock scarps are evident, which largely control the course of the river.

3. FIELD AND LABORATORY WORK

The exploratory work included the drilling and sampling of 5 boreholes by means of hollow stem augers and wash boring techniques as well as core drilling of the bedrock in selected boreholes. In addition, numerous cone penetrations and auger probes were carried out for profiling and further definition of the bedrock surface. The field work on land was carried out by a bombardier mounted C.M.E. 55 and simutaneously over the ice by a B.B.S. 1 skid mounted drill.

Previous drilling at this site included two boreholes with rock coring near the shores of the river under W.P. 18-79-00.

Layout of the recent boreholes was performed by our staff using chainage stakes established by an M.T.C. survey crew at the commencement of the field work. Surface elevations were referenced to a geodetic bench mark by our staff at the completion of the job.

Sampling of the boreholes included retrieval of split spoon and thin wall tube samples in the overburden, as well as rock coring of the underlying bedrock at selected locations. In addition, field vanes were performed at regular intervals of depth in some land boreholes, and exclusively in one of these boreholes.

The recovered samples were sealed and/or placed in air tight containers and returned to our laboratory for classification and testing purposes. The laboratory testing programme included :

- natural moistures,
- quick triaxials,
- atterberg limits,
- grain size analyses,
- loss on ignition and
- consolidation tests

The results are variously reported on the borehole logs and the accompanying figures.

4. SUBSURFACE CONDITIONS

4.1. General

The site is underlain by 6 to 9 meters of overburden comprised for the most part of soft to stiff compressible organic silt. A discontinuous 1 to 2 meter layer of sand and gravel generally underlies the organic silt except at the west abutment location. Some cobble and boulder sizes are contained within the sand and gravel layer particularly on the east side of the river.

The bedrock profile along the centre line generally parallels the river bed slope at an additional depth of 6 to 9 meters. The interpolated bedrock valley however, runs skew to the river channel, with the actual slopes being somewhat steeper than indicated on the centre line profile.

4.2. Organic Silt

The flood plain and river bed are underlain by an organic silt deposit having a thickness of 6 to 8 meters. In profile, the organic silt layer parallels the general surface and river bed trend, largely as the result of a coincident bedrock valley below the river channel.

The organic silt is a relatively homogenous mottled brown to dark grey, soft to firm amorphous soil throughout most of its depth with a slight clay content near its base. The undrained shear strength as measured by the field vane test ranges from 27 to 61 kPa with a numerical average of 36 kPa. Undrained shear strengths determined by triaxial tests are somewhat lower ranging from 13.5 to 33.5 kPa with a numerical average of 24.0 kPa. Natural moisture contents vary from approximately 30 to 50 percent at the river banks, and from approximately 40 to 60 percent below the river channel. Atterberg limit tests yield liquid limits of approximately 25 to 51 percent and plasticity indices of 2 to 16 percent, indicating the material to be an organic soil of generally low plasticity except near its base where the plasticity is intermediate. The actual organic content

4.2. Organic Silt (Cont'd)

as determined by loss on ignition varies from 2.5 to 7.2 percent by weight. On the basis of the above tests, the soil is classified as a soft to firm organic silt, becoming an organic silty clay with depth, and being stiff locally.

The consolidation characteristics of the organic silt were determined by means of two one-dimensional oedometer tests. The results are shown in Figure 3. It has been mentioned that the organic silt becomes more plastic with depth, grading into an organic silty clay. The differences in compressibility of the organic silt and organic silty clay are clearly demonstrated by the consolidation tests. The more plastic soil from borehole 1 exhibits a C_c value of 0.33, which is twice that obtained for the less plastic soil from borehole 13. It should also be noted that the upper less plastic zones exhibit some preconsolidation of about 100 kPa whereas the more plastic soil shows almost no evidence of preconsolidation. It is assumed therefore that some cementation effects are involved in the observed preconsolidation of the organic silt portion of the deposit.

4.3 Silty Sand and Gravel

A silty sand and gravel layer of 1 to 2 meters thickness immediately overlies the bedrock on the east side of the river and below the river channel organic silt deposit. Occassional cobble and boulder sizes are indicated within this layer, particularly in the vicinity of the east abutment. The sand and gravel layer was entirely absent below the west bank of the river.

The sand and gravel occurs in a compact to dense state. A minor artesian head of approximately 0.5 meters above the river level was noted in this layer.

4.4 Bedrock

The bedrock topography consists of a moderately steep bedrock valley which roughly coincides with and runs skew to the river channel. As a result, the bedrock slope is somewhat steeper than indicated by the centre line profile of Drawing 1227902-A. Actual bedrock depths vary from approximately 5 to 10 meters in the vicinity of the abutments and from 12 to 15 meters below the river level at the pier locations.

Local bedrock slopes calculated from available data generally indicate a range of slope dips of approximately 45^{o} to 26^{o} while only a modest dip occurs near the east abutment location.

During the course of the field work the sloping character of the rock was evidenced by the bending of drill rods during the cone test and the discrepancies between cone refusal and auger refusal. In addition, a tendency for the augers to corkscrew was also noted upon contact with bedrock, which indicated a sloping rock surface.

The bedrock is a fine to medium grained granitic rock of possible meta-sedimentary origin. Intrusive felsic stringers and dykes are also present within the rock, notably at borehole 2 where they constituted the entire 1.5 meter core run.

The rock is generally of sound quality with minor fracturing and jointing. Some weathering is also evident particularly within the intrusive felsic rock of borehole 2. The rock quality designation (RQD) ranges from approximately 50 to 90 percent.

5. Groundwater

The groundwater was recorded at or slightly above the recorded river level except for the minor artesian head noted in the sand and gravel layer above the bedrock. The groundwater thus is controlled by the river, whose level is believed to fluctuate within a relatively narrow range due to the damming effect of the downstream rapids.

6. DISCUSSION AND RECOMMENDATIONS

6.1 General

It is proposed to construct a 3 span structure on the new Highway 637 alignment located approximately 300 meters upstream of the present crossing. The approved grading plan indicates the deck level to be approximately 4 meters above the prevailing water level while the approach embankments will have a height of 3.0 to 3.5 meters above the flood plain. The two abutments are to be situated approximately 10 meters in from the shore while the two piers will be in the river in approximately 5 to 7 meters of water.

The investigation has confirmed the presence of a 6 to 8 meter thick surficial deposit of compressible, soft to firm organic silt, which is locally stiff and which becomes more plastic with depth. This deposit is underlain by a relatively thin sand and gravel stratum overlying a meta-sedimentary granitic bedrock. The bedrock surface slopes onto the river channel, at a skew to the channel alignment. These soil and rock conditions preclude the use of conventional shallow footings for the support of the structure. Hence deep foundation alternatives only are discussed.

6.2 Foundation Design

The recommended foundation support for the structure is steel H piles driven to refusal at the surface of the bedrock. Such piles must be equipped with Oslo tips to bite into the sloping bedrock. The presence of cobbles and boulders at the east abutment indicates some potential for driving obstruction. However, since their occurrence appears localized and the depth distribution minimal, such obstructions are not expected to be a significant factor. It is also expected that the pile tip Oslo driving points will be beneficial in this regards. Therefore, it is recommended that all steel H piles be equipped with Oslo tips as per MTC standard DD-3304.

6. DISCUSSION AND RECOMMENDATIONS (Cont'd)

6.2 Foundation Design (Cont'd)

The pile capacity may be assumed to be proportional to the cross-sectional area of the pile chosen. For example, 310 HP @ 110 steel piles, driven to the bedrock surface (see drawing 1227902-2), may be designed for the following capacities :

	at abutment	at piers
Safe Capacity	900 kN	1,100 kN
Factored Capacity at U.L.S.	1,500 kN	1,600 kN
Capacity at S.L.S. Type II	900 kN	1,100 kN

The lower values at the abutments allow for negative skin friction loads on the piles due to fill settlement. However, if preloading or surcharging is elected to induce major settlements of the approaches prior to construction of the structure, the higher capacities may be used also at the approach locations.

For the calculation of the lateral resistance of battered piles, the factored coefficient of passive earth pressure within the organic silt $(k_p)_f$ may be taken as 1.74, corresponding to a ϕ_f value of 16^o. The emperical rules in Clause C.6.8.3.8 of the OHBDC commentary may be used to determine the effective depth and width of the passive pressure zone.

If inclined loadings are involved, the organic silt should be treated as a cohesive soil for the determination of the reduction factor R_i from Figure 6.8.3.4.3 of the OHBD Code.

6. DISCUSSION AND RECOMMENDATIONS (Cont'd)

6.3 Approach Embankments

The approach embankments will have a height of approximately 3.0 to 3.5 meters resulting in a maximum loading of approximately 65 kPa. Due to the span ratios already selected for the structure, the front of the embankments will be set back from the river's edge allowing for a 9 to 10 m. wide bench between the toe of fill and the edge of the river.

6.3.1 Stability

The undrained shear strength of the organic silt soil was found to have an average value of 36 kPa by the field vane tests and 24 kPa by laboratory triaxial tests. Assuming for calculation purposes, a shear value of 24 kPa for the organic silts, the factor of safety for a 2 to 1 embankment slope and a 9m bench width at grade is greater than 1.3 assuming $\phi = 0$ and using total stress stability analyses (Bishop's method). This is illustrated in attached sketch 230-2808-SK1. Therefore, the embankment will be stable as proposed provided that its side slopes are constructed at a ratio of 2 horizontal to 1 vertical. Any contributing resistance from any underlying geotextiles has been disregarded in these calculations.

6.3.2 Settlement

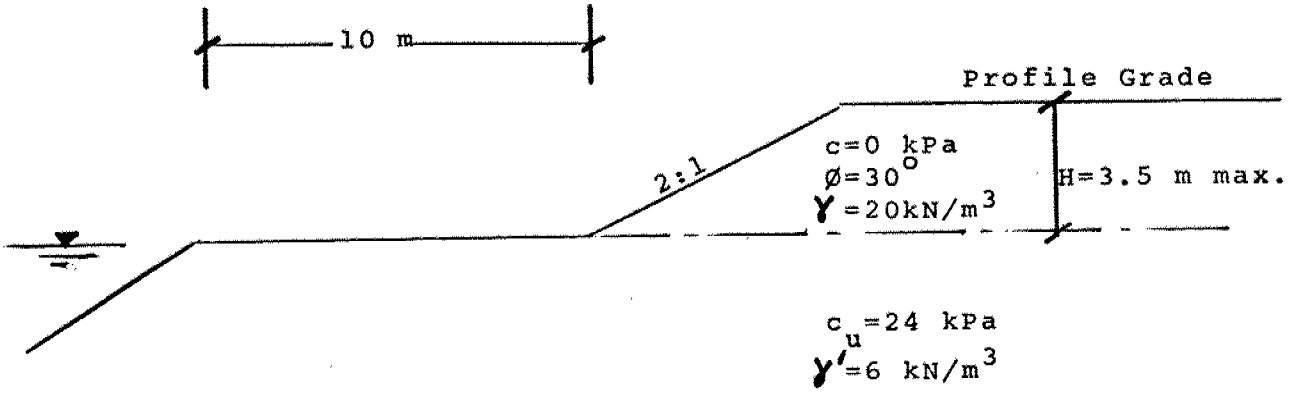
The compressible nature of the organic silt subsoils will result in settlement of the approach embankments. Calculations based on the consolidation test results indicate that these settlements will be in the order of 300 mm with 90% of this settlement occurring within approximately 6 months time, for the c_v values obtained from these tests. However, it is well known that in organic soils, the actual settlements often far exceed the computed settlements by a factor of 1.5 to 2.0.

6. DISCUSSION AND RECOMMENDATIONS (Cont'd)

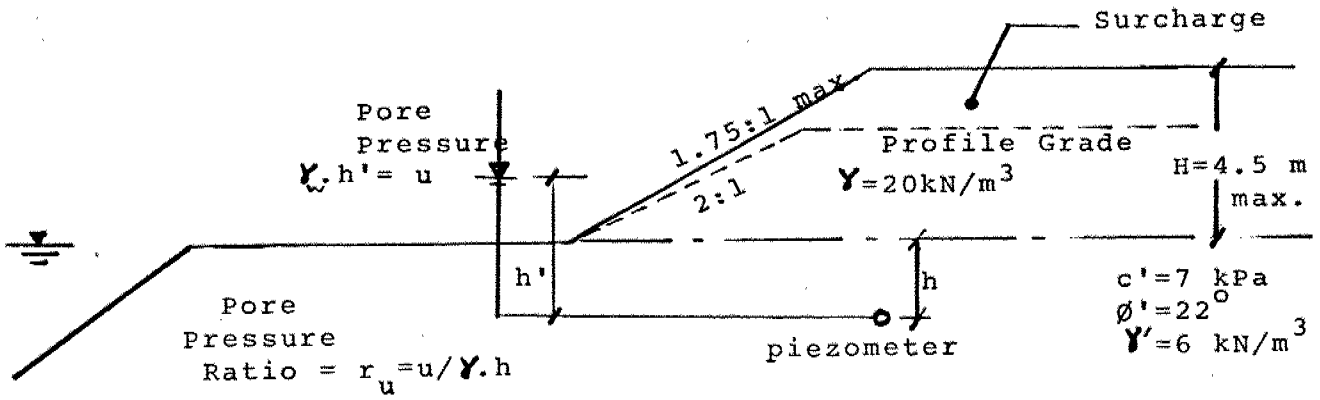
6.3.2 Settlement (Cont'd)

Primarily, this is due to the fact that the one dimensional consolidation test restraints lateral strain; however, in the field, such restraint is not available and therefore some lateral squeezing does occur. Therefore, we believe that actual settlements of the approach fills will be more in the neighbourhood of 450 to 600 mm. The time rate for such settlements to occur depends on the time rate of dissipation of excess pore pressures within the organic soil. Again, experience indicates that such excess pore pressures dissipate much more slowly than indicated by laboratory tests. Hence, settlements of a major magnitude could continue beyond 6 months and may last a year or more.

In order to overcome future maintenance problems, it is recommended that consideration be given to preloading of the approaches, with surcharging if possible. Surcharging of the fills above their design grades is controlled by the preconsolidation of the subsoil and stability considerations. A safe surcharge of 1 metre over and above the design profile grade is possible. We recommended therefore that the approach fills be initially built to a maximum height of 4.5 metres with side slopes no steeper than 1.75 horizontal to 1.0 vertical. Careful monitoring of the pore pressures beneath the embankment is recommended to ensure stability in the effective stress mode. A ϕ value of 22^{o} and c' = 7 kPa should be assumed for the organic silt for effective stress analysis. Our calculations show that embankments of up to 4.5 m in height will be stable ($FS \geq 1.5$) provided the pore pressure ratio r_u is less than 0.5 after construction to full height.



(a) Sketch illustrating Total Stress Analysis assumptions



(b) Sketch illustrating Effective Stress Analysis Parameters. To monitor stability, pore pressure ratio, r_u, must not exceed 0.5 for a factor of safety of 1.5 or greater.

Wamock Hersey Professional Services Ltd.

STABILITY ANALYSES CONSIDERATIONS - HWY 637 - WANAPITEI RIVER

DATE: June 1982	SCALE:	DRAWN: CM	DWG. No. 230-2808-sk1

6. DISCUSSION AND RECOMMENDATIONS (Cont'd)

6.3.2 Settlement (Cont'd)

It is therefore recommended that the fill settlements be monitored and subsoil pore pressures be used to control construction of the fills. The fills should be left in place for as long a period as practical, but in no case for less than 6 months.

6.3.3 Construction

Since the approach fill will likely be constructed of imported rock or granular materials, it may be appropriate at this site to consider the use of geotextiles to serve as a separator. For this function, any non-woven type needle punched brand will suffice. If rock fill is to be used, the geotextile chosen must also possess a high tensile strength.

Consideration should be given to close cutting (and not grubbing) within the plan limits of the approach fills, followed by the placement of the geotextile and a 300 mm of sand cushion to facilitate movement of construction traffic and equipment. However, depending on the groundwater level at the time of construction, such a sand cushion may not be very effective, since it will loosen under wheel loads for a high groundwater table condition. Therefore, it may prove more economical and practical to specify a geotextile separator with an option of a sand cushion. If a fairly thick (>5 mm) brand of geotextile is chosen, it will also provide some drainage in the plane of the fabric, thus relieving excess pore pressures in the overlying sand cushion.

6. DISCUSSION AND RECOMMENDATIONS (Cont'd)

6.3.3 Construction (Cont'd)

In the areas where piles are to be driven, no rock fill should be placed. Also, the fill material should be free of any particle sizes larger than 50 mm. Piles may be driven through any underlying geotextiles without ill effects to the intended use of the geotextile as a separator.

7. EARTH PRESSURES

For granular fills, earth pressures on abutments and wing walls may be calculated using the following values :

@ U.L.S.	8.0 kPa/m
@ S.L.S. Type II	6.5 kPa/m

Report by B. D'Onofrio, P. Eng.

Respectfully submitted,

Warnock Hersey Professional Services Ltd.

C. Mirza, P. Eng.
Manager
Geotechnical Services

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

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	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				k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL	e_{max}	1,%	VOID RATIO IN LOOSEST STATE			

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 1 METRIC

W P 122-79-02 LOCATION Sta. 12 + 190, ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger, BX Rock Core COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 15 CHECKED BY C.M.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 10 20 30 40 50	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.0	Top of snowpack										
0.0	250mm snow, Organic silt Firm Mottled Brown to dark grey with clayey zones		1	SS	2	▼	192			17.8	Om=2.6% Po=34.1kPa e_o= 1.18 c_c= 0.33 Om=7.3%
			2	TW	PH						
			3	SS	2						
			4	TW	PH						
			5	SS	2		190				
			6	TW	PH					17.4	Om=4.0% 0 2 (98)
			7	SS	1						
			8	TW	PH		188				
186.8			9	SS							
7.2	Granitized Meta-sediment, Fine to Med.Grained Felsic Stringers Sound		10	RC Bx	100% Rec		186				RQD=67%
			11	RC Bx	100% Rec		184				RQD=97%
183.3											
10.7	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2

METRIC

W P 122-79-02 LOCATION Sta. 12 + 197.5 o/s 5.0 Lt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test + Bx Rock Core COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 16 CHECKED BY C.M.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.8	Ground Level										
0.0	Probable Organic silt						192				
							190				
188.2								30/150mm			
5.6	Intrusive felsic dyke, Fractured and weathered		1	RC Bx	100% Rec		188				RQD=82%
186.6											
7.2	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3

METRIC

W P 122-79-02 LOCATION Sta. 12 + 193.5 o/s 5.0 Rt ℄ Hwy.637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test & Auger COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 16 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	Wp W WL	γ	GR SA SI CL
193.9	Top of Snowpack										
0.0	250mm snow										
	Probable Organic silt						192				
							190				
							188				
185.0							186				
8.9	Auger refusal Probable Bedrock						184	50/25mm			
183.2											
10.7	Cone refusal Lower 3 meter rod severly bent										

SHEAR STRENGTH
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

WATER CONTENT (%)

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4 METRIC

W P 122-79-02 LOCATION Sta. 12 + 202.5 ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger - Continuous Vanes COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 1.0 2.0 3.0 4.0 5.0 (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
193.7	Top of Snowpack										
0.0	250 mm Snow										
	Probable Organic Silt						192	+12, +6			
								+7, +6			
							190	+4, +5			
								+4			
							188	+5, +5			
							186	+4, +4			
183.6							184				
10.1	Refusal to Augering Probable Bedrock End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 5 METRIC

W P 122-79-02 LOCATION Sta. 12 + 217 o/s 4.0 Lt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
193.0	Ice Surface										
0.0	Water						192				
							190				
188.0	River Bottom						188	Rods sank under own weight.			
5.0	Probable Organic Silt						186				
							184				
181.0							182				
180.7	Probable Sand, gravel							100/150mm			
12.3	Refusal Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 6 METRIC

W P 122-79-02 LOCATION Sta. 12 + 220.6 o/s 2.5 Lt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.
DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.
DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.0	Ice Surface										
0.0	Water						192				
							190				
							188				
185.3	River Bottom						186				
7.7	Probable Organic silt						184				
							182				
179.5							180	50/150mm			
13.5 / 178.5	Probable Silty sand and gravel										
14.5	Refusal Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 7

METRIC

W P 122-79-02 LOCATION Sta. 12 + 214.6 o/s 2.5 Rt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 16 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
193.0	Ice Surface										
0.0	Water						192				
							190				
188.0	River Bottom						188	Rods sank under own weight			
5.0	Probable Organic silt						186				
							184				
							182				
179.3							180				
178.7	Probable sand and gravel							50/150mm			
14.3	Refusal Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 8 METRIC

W P 122-79-02 LOCATION Sta. 12 + 218 o/s 4.0 Rt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Wash Bore, Bx Rock Core COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 15 & 16 CHECKED BY C.M.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, * QUICK TRIAXIAL, + FIELD VANE, x LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.0	Ice Surface										
0.0	Water						192				
							190				
							188				
185.8	River Bottom						186				
7.2	Organic Silt, occ. fine sand seams Traces of Wood and Peat, soft, Brown to Grey		1	SS	0				WL		
			2	SS	0		184		W		
			3	SS	0		182		W		
			4	SS	1				WL		
178.5			5	SS	5		180		WL		
14.5 177.5	Silty Sand & Gravel Compact Brown		6	SS	22		178		W		30 60 (10)
15.5	Granitized Meta-sediment, Felsic Stringers & Dykes Minor Fracturing		7	RC Bx	100% Rec						RQD = 70%
175.1	Sound		8	RC Bx	100% Rec		176				RQD = 50%
17.9	End of Borehole										

+3, x5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 9 METRIC

W P 122-79-02 LOCATION Sta. 12 + 256.6 o/s 3.0 Lt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Wash Bore, Cone Test and Bx Rock Core COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 & 18 CHECKED BY C.M.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.0	Ice Surface										
0.0	Water						192				
							190				
							188				
186.2	River Bottom						186				
6.8	Organic silt Soft Brown to Grey							Rods sank under own weight			
			1	SS	0		184				
			2	SS	0		182				
			3	SS	0						0 1 (99)
179.0							180				
14.0	Silty Sand & Gravel Compact, Brown		4	SS	13					○	
177.9							178				
15.1	Granitized Meta-sediment, Fine to Medium grained Felsic Stringers Hard, Fractured		5	RC Bx	Rec 100%						RQD = 15%
			6	RC Bx	100% Rec			175/250mm			RQD = 50%
175.4			7	RC Bx	100%		176				RQD = 5%
17.6	End of Borehole Lower 3M Rod bent during driving of cone										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 10 METRIC

W P 122-79-02 LOCATION Sta. 12 + 260.6 o/s 2.5 Lt ℄ Hwy 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH o UNCONFINED • QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
193.0	Ice Surface										
0.0	Water						192				
							190				
188.1	River Bottom						188				
4.9	Probable Organic silt						186	Rods sank under own weight			
181.0							184				
12.0	Probable Silty Sand and Gravel						182				
178.5							180				
14.5	Refusal Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 11 METRIC

W P 122-79-02 LOCATION Sta. 12 + 254.6 o/s 2.5 Rt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
193.0	Ice Surface										
0.0	Water						192				
							190				
							188				
186.3	River Bottom						186	Rods sank under own weight			
6.7	Probable Organic silt						184				
							182				
179.7							180	100/75mm			
13.3	Probable Silty Sand and Gravel										
178.9											
14.1	Refusal Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 12 METRIC

W P 122-79-02 LOCATION Sta. 12 + 258 o/s 4.0 Rt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
193.0	Ice Surface										
0.0	Water						192				
							190				
188.2	River Bottom										
4.8	Probable Organic Silt						188	Rods sank under own weight			
							186				
							184				
182.8											
10.2	Probable Silty Sand and Gravel						182				
181.4											
11.6	Refusal Probable Bedrock							50/0mm			

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 13 METRIC

W P 122-79-02 LOCATION Sta. 12 + 272.5 ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (10 20 30 40 50) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
194.3	Top of Snowpack										
0.0	250mm snow Organic Silt Soft Mottled Brown to Dark Grey Occ. plant remains		1	SS	2	▼	194				0 15 (85)
			2	TW	PH					18.9	Om=2.5%
			3	SS	2		192				
			4	TW	PH						Om=5.6%
			5	SS	1		190				
			6	TW	PH						Om=3.5%
			7	SS	1						P_o=53.6kPa e_o=1.03 C_c=0.18
			8	TW	PH		188				
			9	SS	0						0 1 (99)
186.0			10	TW	PH		186				
8.3	Silty Sand & Gravel Occ. Cobble, Compact, Brown		11	SS	18						
184.7											
9.6	Refusal to Augering Spoon bent at bottom sample. Probable Bedrock										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 14 METRIC

W P 122-79-02 LOCATION Sta. 12 + 281.6 o/s 5.0 Lt ℄ Hwy 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	Wp W W_L	γ	GR SA SI CL
194.1	Top of Snowpack							SHEAR STRENGTH: o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	WATER CONTENT (%)		
0.0	250mm snow										
	Probable Organic silt						192				
							190				
							188				
186.5											
7.6	Probable Silty Sand and Gravel						186				
185.1											
9.0	Refusal Lower 3m rod, bent Probable Bedrock							150/200mm			

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 15 METRIC

W P 122-79-02 LOCATION Sta. 12 + 277.6 o/s 5.0 Rt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT Wp / 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	WATER CONTENT (%)		GR SA SI CL
194.2	Top of Snowpack										
0.0	250mm snow										
	Probable Organic silt						192				
							190				
188.0											
6.2	Probable silty sand and gravel						188	50/75mm			
186.7											
7.5	Refusal Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 : Numbers refer to Sensitivity

20 / 15 ⊹ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 16

METRIC

W P 122-79-02 LOCATION Sta. 12 + 285 ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
194.1	Top of Snowpack										
0.0	250mm Snow Probable Organic silt						192				
189.4							190	30/150mm			
4.7	Refusal Possible boulder										

+3, x5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

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Ontario

RECORD OF BOREHOLE No 103 (Formerly BH # 3 WP 18-79-00) METRIC

W P 122-79-02 LOCATION Sta. 12 + 198.4, ℄ Hwy. 637 Line "D" ORIGINATED BY R.B.

DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core & Cone Test COMPILED BY R.B.

DATUM Geodetic DATE 1980 09 05 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH o UNCONFINED • QUICK TRIAXIAL + FIELD VANE × LAB VANE 10 20 30 40 50	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
193.5	Ground Surface										
0.0	Organic Silty Clay Stiff to Firm		1	SS	5	▼	192				
			2	SS	2						
			3	TW	PH		190			17.3	0 5 89 6 ℄ = 1.186 P_c^o = 65kPa C_c = 0.323
			4	SS	2						
			5	TW	PH		188			17.1	
187.3			6	SS	43/15cm						
6.3	Granite Bedrock		7	BXL RC	Rec 90%		186	Hammer Bouncing			RQD = 60%
185.6											
7.9	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 104 (Formerly BH # 4 / WP 18-79-00) METRIC

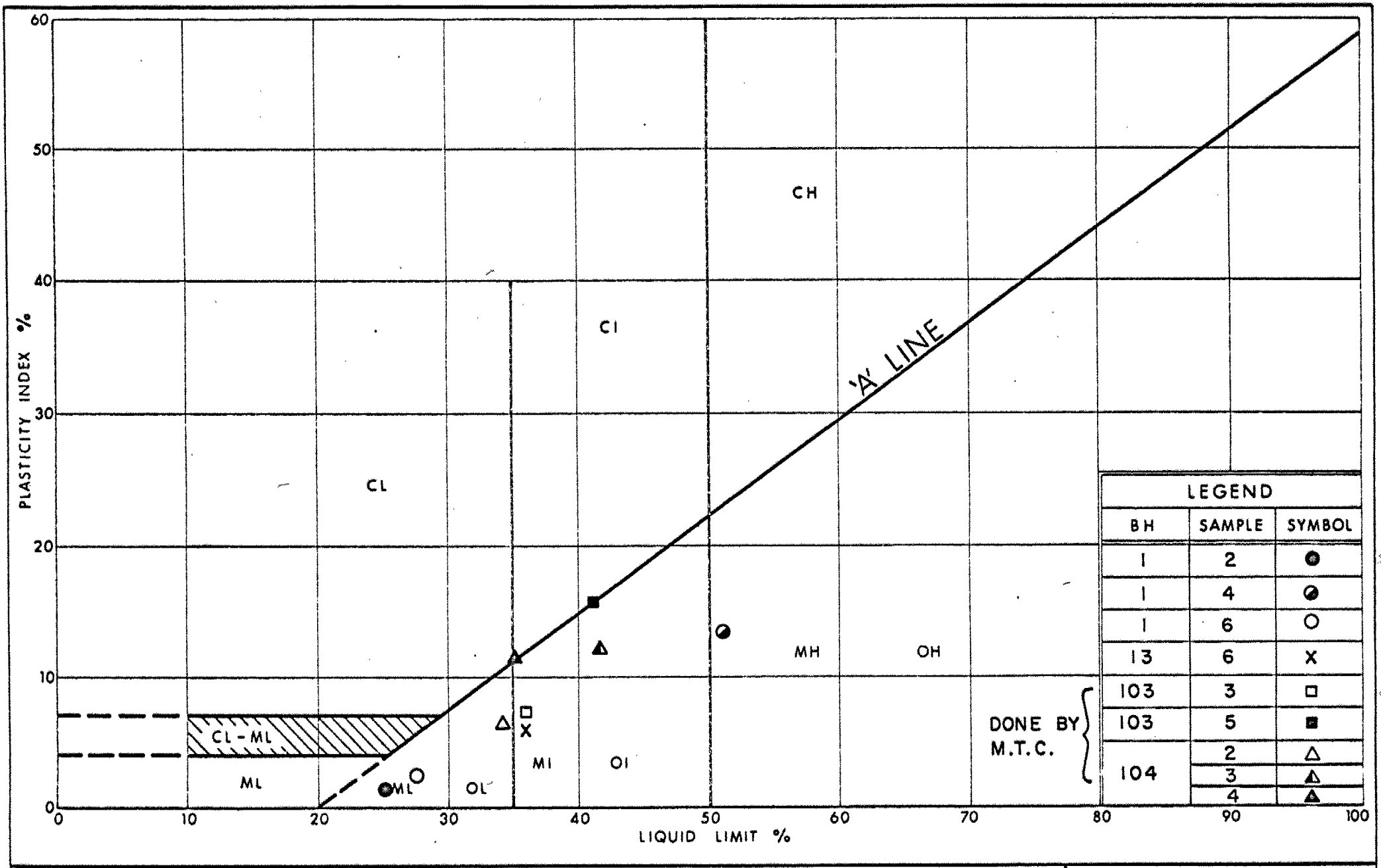
W P 122-79-02 LOCATION Sta. 12 + 282.8, o/s 1.8m Rt. ℄ Hwy.637 Line"D" ORIGINATED BY R.B.
DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core & Cone Test COMPILED BY R.B.
DATUM Geodetic DATE 1980 09 06 CHECKED BY C.M.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 10 20 30 40 50	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.7	Ground Level										
0.0	Organic Silty Clay Stiff to Firm		1	SS	6		192				0 9 80 11
			2	SS	3						
			3	TW	PH		190			17.0	0 9 85 6 ℄ = 1.106 P_c = 65kPa C_c = 0.273 G_m = 2.77
			4	SS	2						
187.7			5	TW	PH		188				
6.0	Boulder		6	RC	Rec 90%						
187.0											
6.7	Silty Fine Sand Loose		7	SS	5						
185.8			8	SS	41/31cm		186	Hammer Bouncing			
7.9	Granite Bedrock		9	BXL RC	Rec 80%						RQD = 95%
184.2											
9.5	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

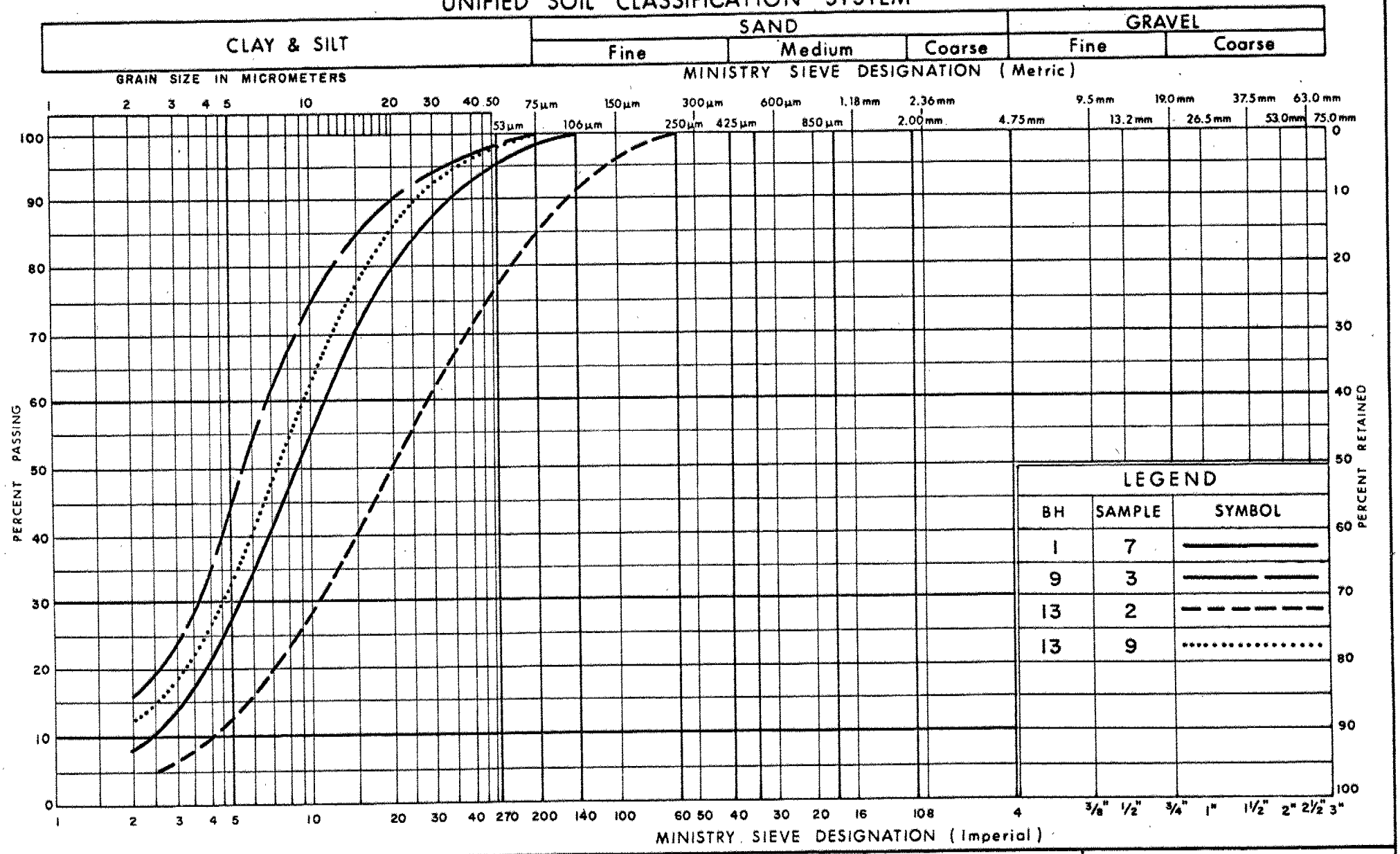


Ministry of Transportation and Communications
Ontario

PLASTICITY CHART
ORGANIC SILT

FIG No 1
W P 122-79-02
WANAPITEI RIVER

UNIFIED SOIL CLASSIFICATION SYSTEM



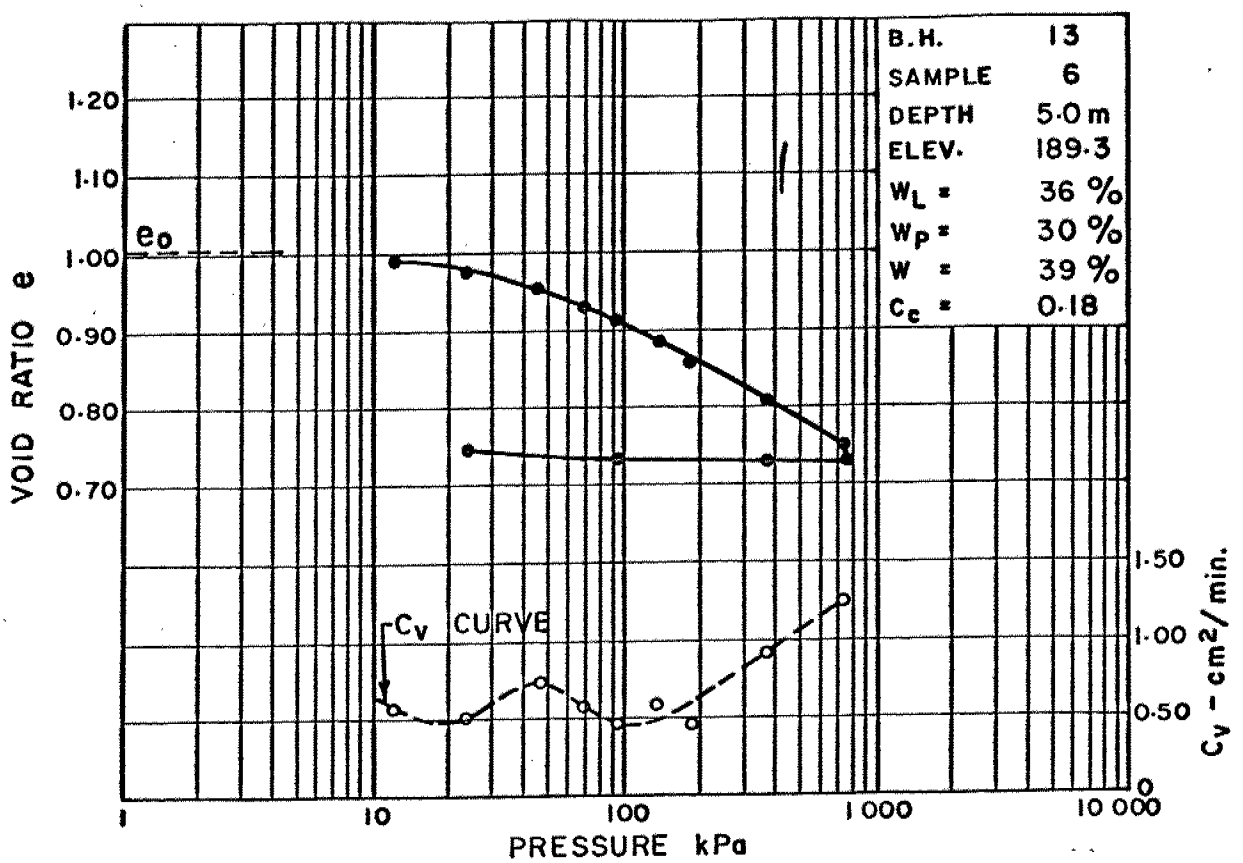
Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

ORGANIC SILT

FIG No 2
W P 122-79-02
WANAPITEI RIVER

VOID RATIO - PRESSURE CURVES



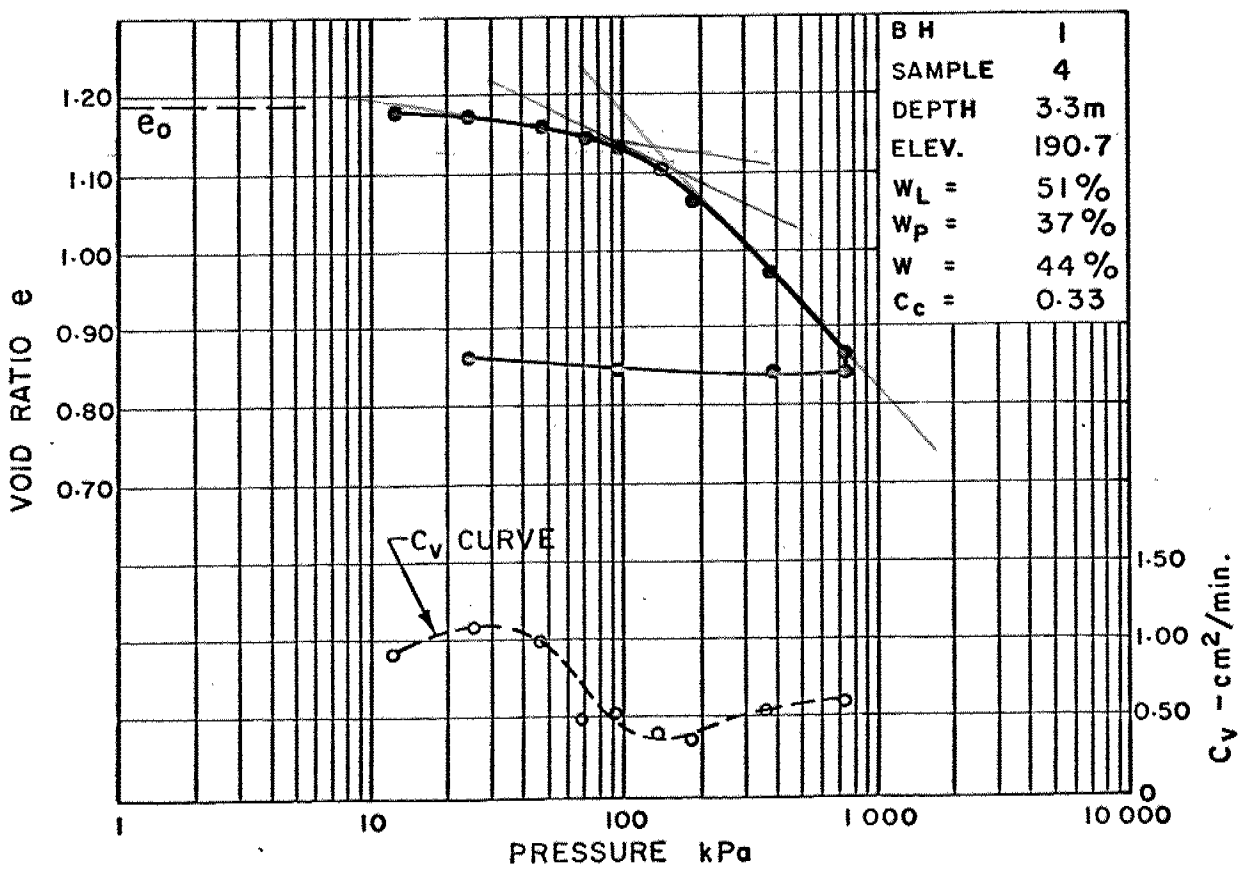
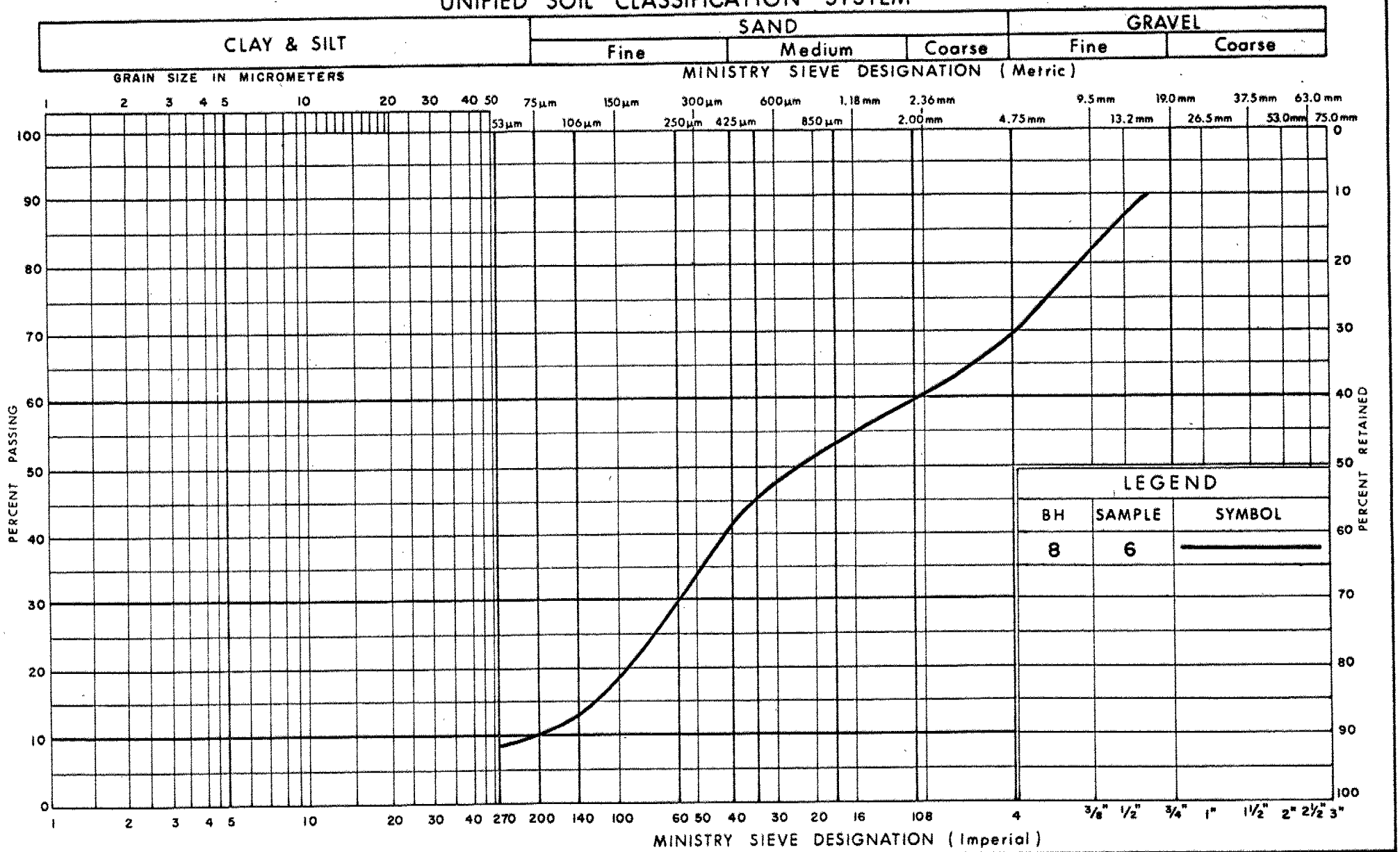


Fig. No. 3 WP 122-79-02

WANAPITEI RIVER

UNIFIED SOIL CLASSIFICATION SYSTEM

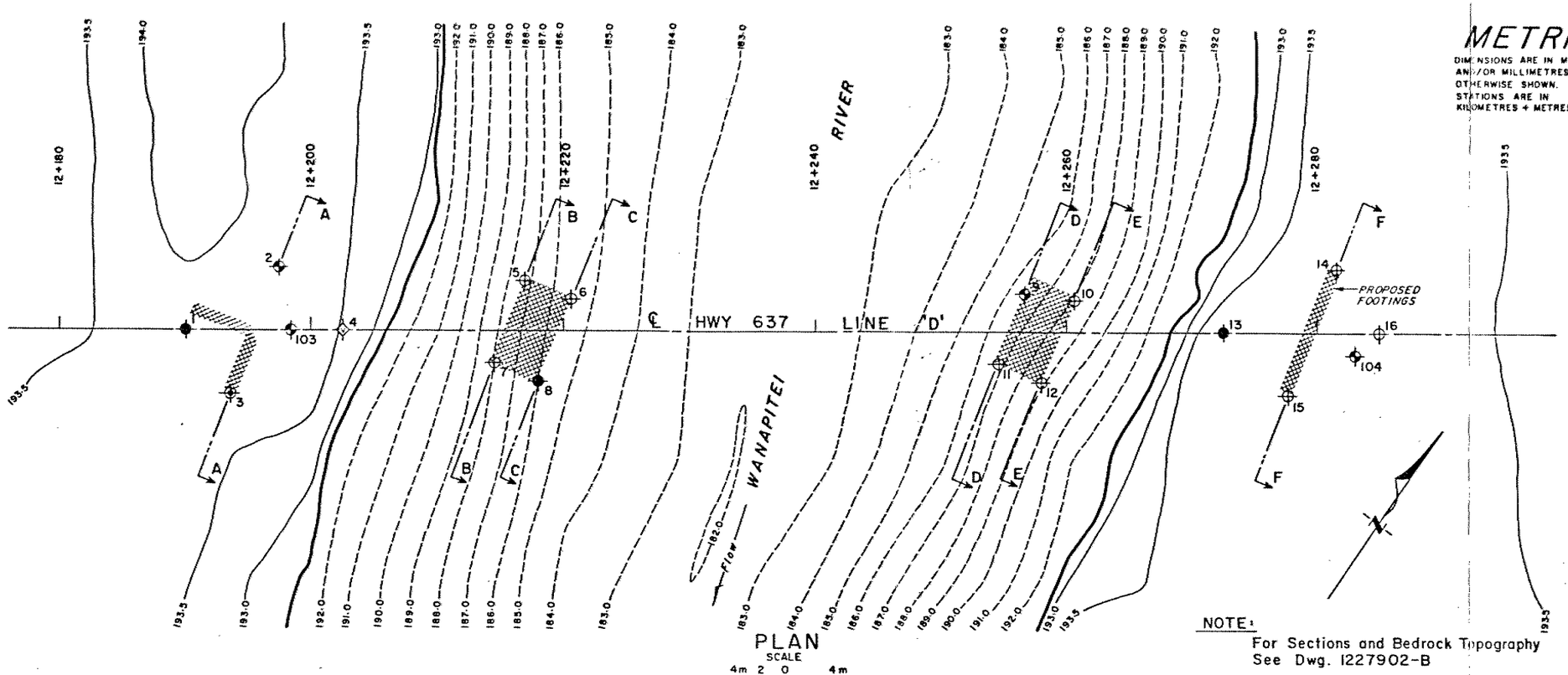


Ministry of Transportation and Communications
Ontario

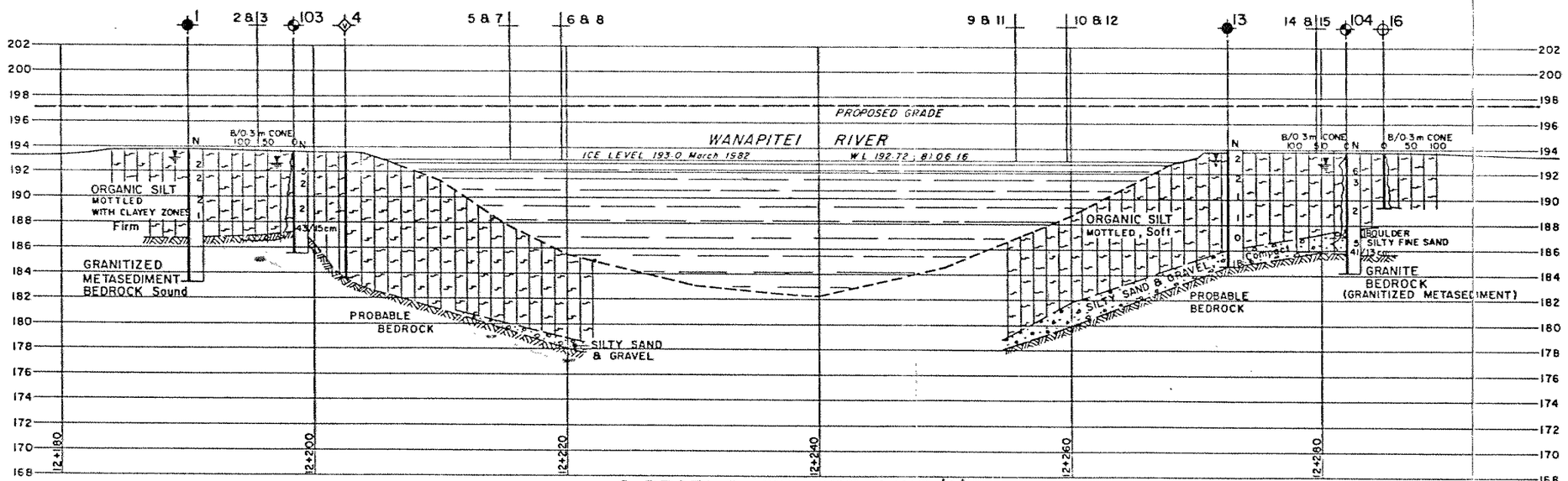
GRAIN SIZE DISTRIBUTION
SILTY SAND AND GRAVEL

FIG No 4
W P 122-79-02
WANAPITEI RIVER

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO 82-87-2000 8-79



NOTE:
For Sections and Bedrock Topography
See Dwg. 1227902-B



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

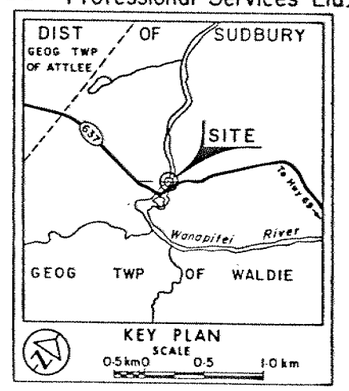
CONT No
WP No 122-79-02

WANAPITEI RIVER

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

Warnock Hersey
Professional Services Ltd.



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & 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 1982 03
  W.L. for Boreholes 103 & 104; 80 09
- Cone Test and Auger Hole
- Vane Test and Auger Hole

No	ELEVATION	STATION	OFFSET
1	194·0	12+190·0	℄
2	193·8	12+197·5	5·0 m Lt
3	193·9	12+193·5	5·0 m Rt
4	193·7	12+202·5	℄
5	193·0	12+217·0	4·0 m Lt
6	193·0	12+220·6	2·5 m Lt
7	193·0	12+214·6	2·5 m Rt
8	193·0	12+218·0	4·0 m Rt
9	193·0	12+256·6	3·0 m Lt
10	193·0	12+260·6	2·5 m Lt
11	193·0	12+254·6	2·5 m Rt
12	193·0	12+258·0	4·0 m Rt
13	194·3	12+272·5	℄
14	194·1	12+281·6	5·0 m Lt
15	194·2	12+277·6	5·0 m Rt
16	194·1	12+285·0	℄
103	193·5	12+198·4	℄
104	193·7	12+282·8	1·8 m Rt

DONE BY MTC 1980 09

NOTE:
Any difference between elevations listed and drawn is due to presence of snowpack on ground.

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

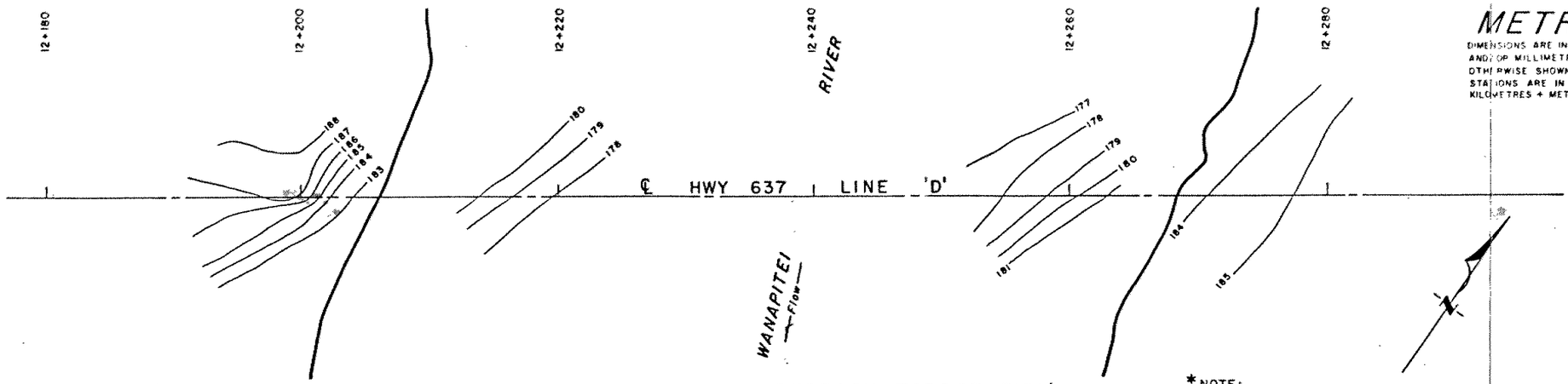
REVISIONS

DATE	BY	DESCRIPTION

Geocres No

HWY No 637 LINE 'D'		DIST 17
SUBMD C M	CHECKED	DATE 1982 05 19	SITE 46-203
DRAWN J T	CHECKED	APPROVED	DWG 1227902-A

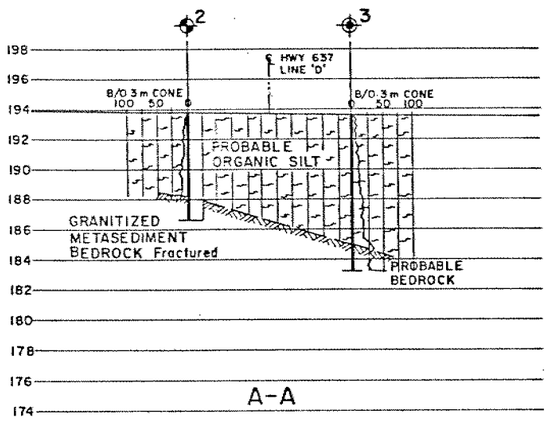
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO 08-87-5CRM 4-79



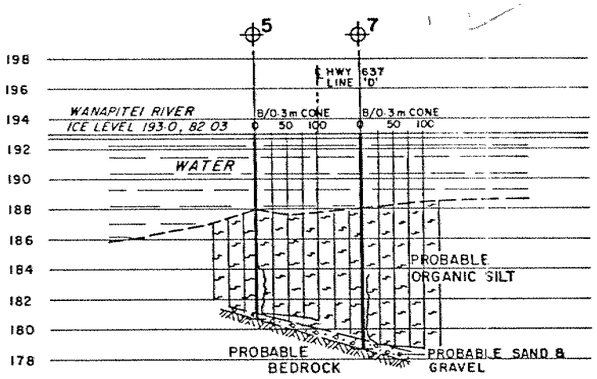
PLAN SHOWING BEDROCK TOPOGRAPHY*

SCALE
4m 2 0 4m

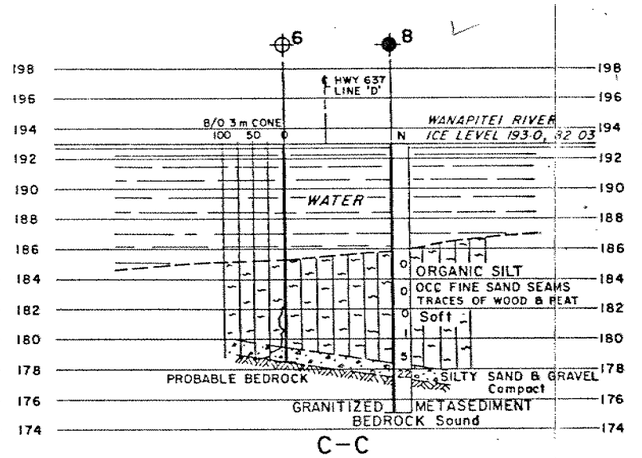
*NOTE: Bedrock contours are inferred from data at each Borehole or Cone Test location. In between, the rock elevations could vary by as much as 1.0m ±



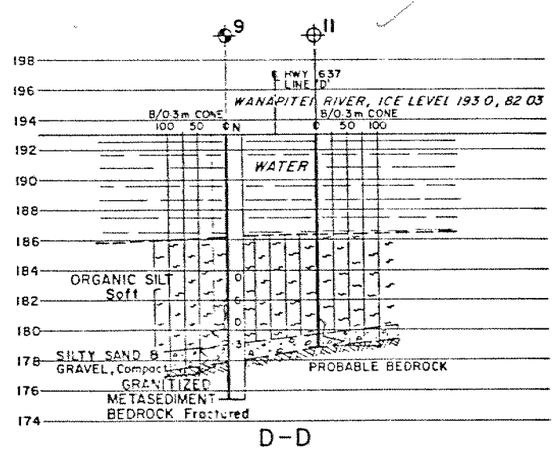
A-A



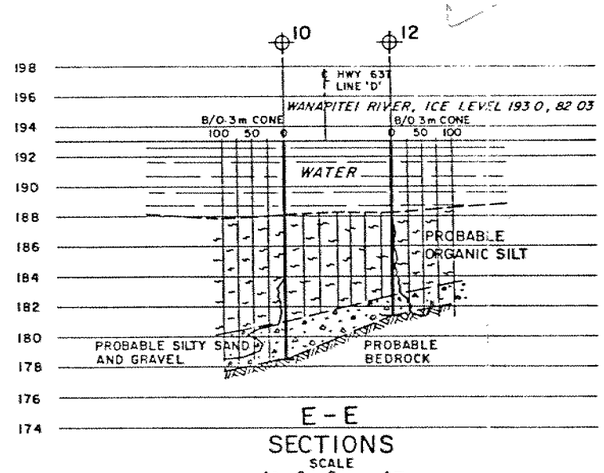
B-B



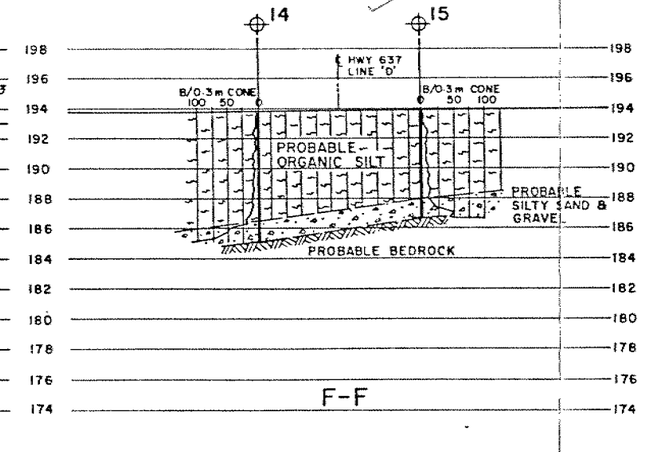
C-C



D-D



E-E



F-F

SECTIONS
SCALE
4m 2 0 4m

CONT No
WP No 122-79-02

WANAPITEI RIVER

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

Warnock Hersey
Professional Services Ltd.

SEE DWG 1227902-A

KEY PLAN
SCALE

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 1982 03
- Cone Test and Auger Hole

No	ELEVATION			

-≡NOTE≡-
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS		
DATE	BY	DESCRIPTION

Geocres No

HWY No 637 LINE 'D'		DIST 17
SUBMD C M	CHECKED	DATE 1982 05 19 SITE 46-2
DRAWN J T	CHECKED	APPROVED DWG 122790 -B

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 122-79-02 DIST 17

HWY 637 STR SITE 46-203

Wanapitei River Crossing

DISTRIBUTION

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GEOCRES 41I00-118

DATE OCT 18 1984

FOUNDATION INVESTIGATION REPORT

For

Wanapitei River Crossing

W.P. 122-79-02, Site 46-203

Hwy. 637, Line 'D'

District 17, Sudbury

INTRODUCTION:

This report summarizes the factual information obtained from three foundation investigations carried out at the site mentioned above. The report also provides recommendations for the revised structure foundations and related earthworks along with remedial measures for the failed west approach embankment. The most recent fieldwork was carried out following the slope failure of the west abutment approach fill. The fieldwork consisted of 13 sampled boreholes ranging in depth from 4.4 to 14.0 m and 2 dynamic cone tests, carried out between 84-03-26 and 84-04-04. The boreholes were advanced by means of hollow stem augers on land and wash boring techniques on the river.

Previous drilling at this site included 7 sampled boreholes and 11 dynamic cone penetration tests carried out from 82 03 15 to 82 03 18 and 80 09 05 to 80 09 06. The boreholes were advanced by means of hollow stem augers and washboring techniques. Bedrock was proven in 5 boreholes by obtaining up to 3.5 m of BXL rock core. The boreholes and cone tests ranged in depth from 4.7 to 17.9 m.

SITE DESCRIPTION

The site is located 10 km west of Hwy. 69 at the crossing of Hwy. 637 over the Wanapitei River, in the Geographic Township of Waldie, District of Sudbury. The proposed crossing is located on a slow flowing relatively wide 60 m section of the river flanked by a flat swampy floodplain to the west. The proposed structure site is approximately 300 m upstream of the existing crossing. The present crossing consists of two Bailey bridges founded on bedrock outcrops. The rock outcrops at the existing structures control the upstream water level.

The regional topography is typical Canadian Shield terrain consisting of knobby hills and rock ridges interspersed with hollows and swamps. Several rock outcroppings and scraps are evident in the area and tend to control the course of the river.

History of the Failure

The original foundation investigation for this project was carried out by Warnock Hersey Professional Services Ltd. who were retained by the Ministry's Foundation Design Section. The report by Warnock Hersey predicted substantial settlement of the structure approach fills due to consolidation of a deposit of organic silt to organic silty clay. A number of recommendations were made to reduce or eliminate these settlements. The alternative selected to reduce long term settlement was to surcharge and construct the approach fills approximately one year prior to construction of the structure.

The approach fills were constructed under Ministry Contract 83-213 awarded on June 8, 1983, and included the roadway grading on either end of the structure extending approximately 2.2 km west and 2.2 km east. Construction of the surcharged approach fills was completed on 83 10 10 just before noon with the slope failure of the front face occurring on the same day in the early afternoon.

The photograph below was taken 3 days following the failure.

View of the Failure of the West Approach Embankment.

Recommendations for temporary remedial measures were provided by this office in our memorandums of 83 10 31 and 84 01 05, both of which are appended. The suggested option of spanning the distressed area was accepted and the structure was lengthened by 36 m, 25 m on the west end and 11 m on the east end.

A supplimentary foundation investigation was undertaken upon receipt of the preliminary general arrangement drawing for the lengthened structure. The additional investigation was carried out to provide recommendations for the remedial measures of the failed west embankment and to provide recommendations for the foundations and related earthworks of the lengthened structure. Preliminary recommendations based on our supplimentary investigation were issued in our memorandum of 1984 06 14.

SUBSURFACE CONDITIONS

General

The subsurface conditions across the site are generally uniform. A 1.2 to 1.8 m surficial layer of soft to firm inorganic silt of slight plasticity to silty clay was generally encountered within the flood plain of the river. The dominant deposit across the site is a soft to stiff organic silt to organic silty clay. This organic stratum ranges in thickness from 3 to 12.2 m. Underlying the organic deposit is either granite bedrock or a 0.3 to 2.5 m layer of compact to very dense silty sand.

Two borings were advanced through the east and west approach embankments and 3.7 to 5.5 m of silty clay fill material was encountered. The eastern approach fill is underlain by subsoils as described above. The western approach fills are underlain by subsoils which vary from those encountered across the rest of the site. The silty clay fill at the west approach is underlain by 3 m of sand fill. Underlying the sand fill is a 3.7 m layer of organic silty clay, and a 1.8 m deposit of silty clay with sand some gravel. Overlying bedrock is a 1.7 m stratum of sand with silt some gravel.

The boundaries between the various soil types, insitu and laboratory test results are shown on the attached Record of Borehole Sheets. The locations and elevations of the boreholes and estimated stratigraphical profile and sections based on the borehole data are shown on Drawing No. 1227902-A,B included in the Appendix.

The various subsoil types encountered are described in the following paragraphs.

Fill - Silty Clay some Sand trace Gravel

A cohesive fill material was encountered in the east and west approach embankments. The thickness of the fill varies from 3.7 to 5.5 m at the borehole locations (BH 800 & 809). The approach embankments were constructed under Ministry Contract No. 83-213.

The fill material is generally comprised of silty clay with occasional pockets of sand. Atterberg limit testing on samples from the fill indicate the silty clay to vary from a low to intermediate plasticity. The results of the Atterberg tests are plotted on Fig. 1.

A grain size distribution test carried out on a sample from the deposit is shown graphicly on Fig. 2.

Standard Penetration Test 'N' values ranging from 6 to 18 indicate the fill has been subjected to a moderate degree of compaction.

Fill - Sand trace of Gravel and Silt

This granular fill material was encountered immediately below the cohesive fill in the most westerly investigated area of the site (BH 800). The stratum is 3.0 m thick and appears to be backfill for the muskeg excavation carried out under the west approach fill.

This fill material is predominantly sand containing traces of gravel and silt. Occasional pockets of silt and silty clay were encountered within the deposit. One grain size distribution test was carried out on a sample and the results are plotted on Fig. 2.

Based on 'N' values ranging from 2 to 3, it appears that the fill was not subjected to any compaction.

Inorganic Silt to Silty Clay

The surficial deposit of inorganic silt to silty clay was generally encountered across the site except within the river channel and a few locations on the river banks. The deposit varies from a silt of slight plasticity to a silty clay of low plasticity, and appears to be an alluvial deposit. Traces of sand and root structures were generally found within the stratum.

An atterberg limit test carried out on a sample from this deposit indicates the material to be a silt of slight plasticity (ML zone). The results of this test are plotted on Fig. 1.

Results of grain size distribution tests completed on samples from this stratum are plotted on Fig. 3.

Generally the deposit is assessed to be of a cohesive nature with consistency ranging from soft to firm based on Standard Penetration Test 'N' values ranging from 2 to 6.

Organic Silt to Organic Silty Clay

This cohesive stratum is the dominant deposit across the site and was encountered at the surface or immediately below the surficial deposits of inorganic silt to silty clay or fill material. The thickness of the stratum varies from 3.0 to 12.2 m. The deposit is comprised of organic silt with traces of sand in the upper portion and changing to an organic silty clay with depth. Lenses or pockets of black organics were encountered throughout the deposit.

The results of Atterberg Limit Tests carried out on samples from the organic silt and organic silty clay are shown on the Plasticity Chart, Fig. 4 and are summarized below.

Organic Silt of Low Plasticity trace of Sand

			Range	Average
Natural Moisture Content	(w)	%	24-48	40%
Liquid Limit	(w_L)	%	25-35	31%
Plastic Limit	(w_P)	%	21-32	25%
Plasticity Index	(I_P)	%	2-10	6%

Organic Silty Clay

			Range	Average
Natural Moisture Content	(w)	%	35-53	45%
Liquid Limit	(w_L)	%	35-52	42%
Plastic Limit	(w_P)	%	24-38	27%
Plasticity Index	(I_P)	%	6-29	15%

The Atterberg Limits indicate that the deposit is organic and generally varies from a low to medium plasticity. In addition, testing to determine the percentage of organic matter by weight was carried out on 12 samples. This testing yielded organic contents ranging from 1.9 to 7.3% with an average of 3.8%, indicating the deposit is highly organic in nature.

The consolidation characteristics of this deposit were determined by means of five one-dimensional consolidation tests. The results are plotted on Fig. 5 and 6 for 3 tests with a summary for all tests listed below.

		Range	Average
Preconsolidation Pressure (Pc) kPa		34 - 78	59
Compression Index	(Cc)	0.18 - 0.33	0.28
Initial Void Ratio	(e_o)	1.03 - 1.311	1.163

Grain size distribution testing carried out on samples from this deposit are plotted on Fig. 7.

Undrained shear strengths as measured by in-situ vane testing were found to range from 15 to 97 kPa in extreme cases, but generally ranged from 25 to 55 kPa with an average strength of 35 kPa. Undrained shear strengths determined by triaxial tests are somewhat lower averaging 24 kPa and generally ranging from 12 to 33 kPa with an extreme case of 42 kPa. Based on the undrained shear strength testing the deposit is assessed to range from a soft to stiff consistency, generally being firm.

Sand with Silt some Gravel

A 0.3 to 2.5 m deposit of sand with silt some gravel was encountered in various locations overlying bedrock. The stratum does not appear to be continuous across the site with no generally observed patterns. Occasional cobbles or boulders were encountered within this deposit on the east side (BH #13, 10, and 810).

Grain size distribution tests carried out on samples from this stratum are plotted on Fig. 8 and indicate the deposit to be composed of a coarse grained granular material.

Based on Standard Penetration Test 'N' values ranging from 5 to 39 the deposit has a denseness ranging from loose to dense but is generally compact.

Silty Clay with Sand some Gravel

This stratum was only encountered at the most westerly investigated portion of the site (BH 800), and was found between the organic silty clay and the sand with silt. The deposit is 1.8 m thick.

An atterberg test carried out on a sample indicates the deposit to be silty clay of medium plasticity. The results are plotted on Fig. 1.

Interpretation of an 'N' value of 22 blows indicates the consistency of the deposit is very stiff.

Bedrock

The bedrock varies in elevation considerably over the site and is steeply sloping in the vicinity of the river banks. The bedrock elevation ranges from 177.5 to 189.1 with the lowest elevations being encountered within the river and the highest elevations on the west bank.

Bedrock slopes in the area of the river banks calculated from available data indicate dips ranging from 50° at the west river bank to 30° at the east river bank. The bedrock dips outside the limits of the river banks appear to be much more modest, approximately 15 to 20°.

The sloping nature of the bedrock was evidenced during drilling by the bending of drill rods and a tendency for augers to corkscrew upon contact with bedrock.

The bedrock is a fine to medium grained rock of possible meta-sedimentary origin. Intrusive felsic stringers and dykes are also present within the rock, notably at BH 2 where they constituted the entire 1.5 m core run.

The rock is generally of sound quality with minor fracturing and jointing. Some weathering is also evident particularly within the intrusive felsic rock of borehole 2. The rock quality designation (RQD) ranges from approximately 50 to 90 percent.

Groundwater

The groundwater levels recorded were generally slightly above or below the river level at elevation 193.2. The groundwater level is probably controlled by the river level.

DISCUSSION AND RECOMMENDATIONS

General

The realigned Hwy. 637 will require the construction of a new 3 span structure over the Wanapitei River and will replace the two existing Baily bridges.

The approach fills to the proposed structure were placed in advance under Ministry Contract 83-213. Construction of the surcharged west approach fill was completed on 83 10 10, followed by a slope failure of the front face the same day. A visit to the site was made by this office on 83 10 13 and temporary remedial measures were recommended in our memorandum of 83 10 31. Discussions with the structural office took place and it was agreed that the distressed area be spanned. The preliminary General Arrangement Drawing P2 indicates the structure to be lengthened by 36 m with the two piers and abutments being relocated. The following recommendations are provided for the revised structure.

Structure Foundations

We recommend the structure be founded on end bearing steel H Piles. An HP 310 x 110 or an HP 310 x 79 pile may be designed for the following loads.

	Factored Axial Capacity (kN)	Bearing Capacity at the S.L.S. Type II (kN)
East and West Abutment		
HP 310 x 110	1360	980
HP 310 x 79	980	725
East and West Piers		
HP 310 x 110	1600	1150
HP 310 x 79	1150	850

The loadings given for the west and east abutments have been reduced to allow for negative skin friction due to settlement of the approach fills.

The following pile tip elevations may be used for estimating purposes:

	Elevation
West Abutment	181.5
West Pier	181.0
East Pier	181.5
East Abutment	185.4

Piles driven at the pier locations should be equipped with Oslo points as bedrock is sloping at these locations. Piles at the abutments should be equipped with reinforced tips.

Dewatering will be required to construct the pier foundations as they are located within the river. Dewatering of the abutment excavations may be required depending on the founding level of the pile caps and the elevation of the water table which flunctuates with the river level.

The abutments should be backfilled with a free draining granular material, and earth pressures against the wall may be computed as per Subsection 6.6.1.2.2 of the O.H.B.C.D. Manual.

The underside of all footing elements should be provided with a minimum of 1.8 m of earth cover for frost protection purposes.

Slope Stability

The west abutment approach fill should be provided with a berm on the front slope extending the full width of the embankment. The berm should extend from approximately Sta. 12+165 to 12+175 with an elevation of 194.6. This berm is required to ensure stability of the embankment. The low lying area on the west river bank created by the slope failure should be filled in and graded to tie into the existing conditions on either side.

The east approach fill which was placed under Contract 83-213 will have to be cut down, as the east abutment has been relocated 11 m east of the previously proposed location. The embankment should be cut down to approximately elevation 195 in front of the abutment, providing a berm. No stability problems are anticipated on the east approach embankment.

Settlement

Compressible subsoils underly both the approach embankments which will result in settlement of the fills. Settlement of the west approach fill is anticipated to be in the order of 100 mm, when the final embankment configuration is constructed. To minimize the long term settlements of the west approach it is recommended that the embankment be constructed to its final geometry prior to pile driving and left in place for as long a period as possible before construction of the abutment. This will help reduce the long term settlements of the west approach.

Settlement of the east fill should be minimal as a surcharged embankment has been in place since October of 1983.

MISCELLANIOUS

The fieldwork for this investigation was carried out under the supervision of Mr. D. Thanasse, Student Engineer, using equipment owned and operated by Master Soil Investigation, Toronto. The report was written by Mr. H. Sturm, Project Foundations Engineer and reviewed by Mr. M. Devata, Chief Foundations Engineer.

H. J. Sturm, P. Eng.
Project Foundations Engineer

M. Devata, P. Eng.
Senior Foundations Engineer (East)

APPENDIX

memorandum

Ontario

To: S. McCombie
Head, Structural Section
Northern Region

Date: 1984 01 05

From: Foundation Design Section
Room 315, Central Building

Re: Wanapitei River Bridge
W.P. 122-79-02, Site 46-203
District #17

We are currently evaluating remedial measures for the west approach fill at the structure noted above. One suggested option is to extend the structure to span over the distressed area. Our preliminary assessment indicates that the west abutment should be relocated 25 m to the west and that the east abutment should not be relocated. In order to complete our investigation for remedial measures, we would appreciate receiving your comments with regard to pier locations if the structure is extended as described above.

M. MacLean

M. MacLean, P. Eng.
Foundations Engineer

MM/mmj

c.c. - G. Radkowski
S. Wilson
J. McDougall

memorandum

Ontario

To: J. McDougal
Head, Geotechnical Section
North Bay

Date: 1983 10 31

Atten: B. McLuhan

From: Foundation Design Section
Room 315, Central Building

Re: Embankment Failure
Hwy. 637 West Approach Fill
to Wanapitei River

Further to our verbal recommendations of 83 10 31, we hereby confirm that in order to maintain the integrity of the west approach fill it will be necessary to excavate the recently placed fill as follows:

- From the toe of the existing fill back to Sta 12 + 173.0 excavate to elevation 193.5 across the full embankment width
- Sta 12 + 173.0 to 12 + 167 excavate to 2:1 slope.
- Sta 12 + 167 to 12 + 161 excavate to elevation 195.0 across the full embankment width.
- Sta 12 + 161 to Sta 12 + 155 ($\pm$) excavate to 2:1 slope.

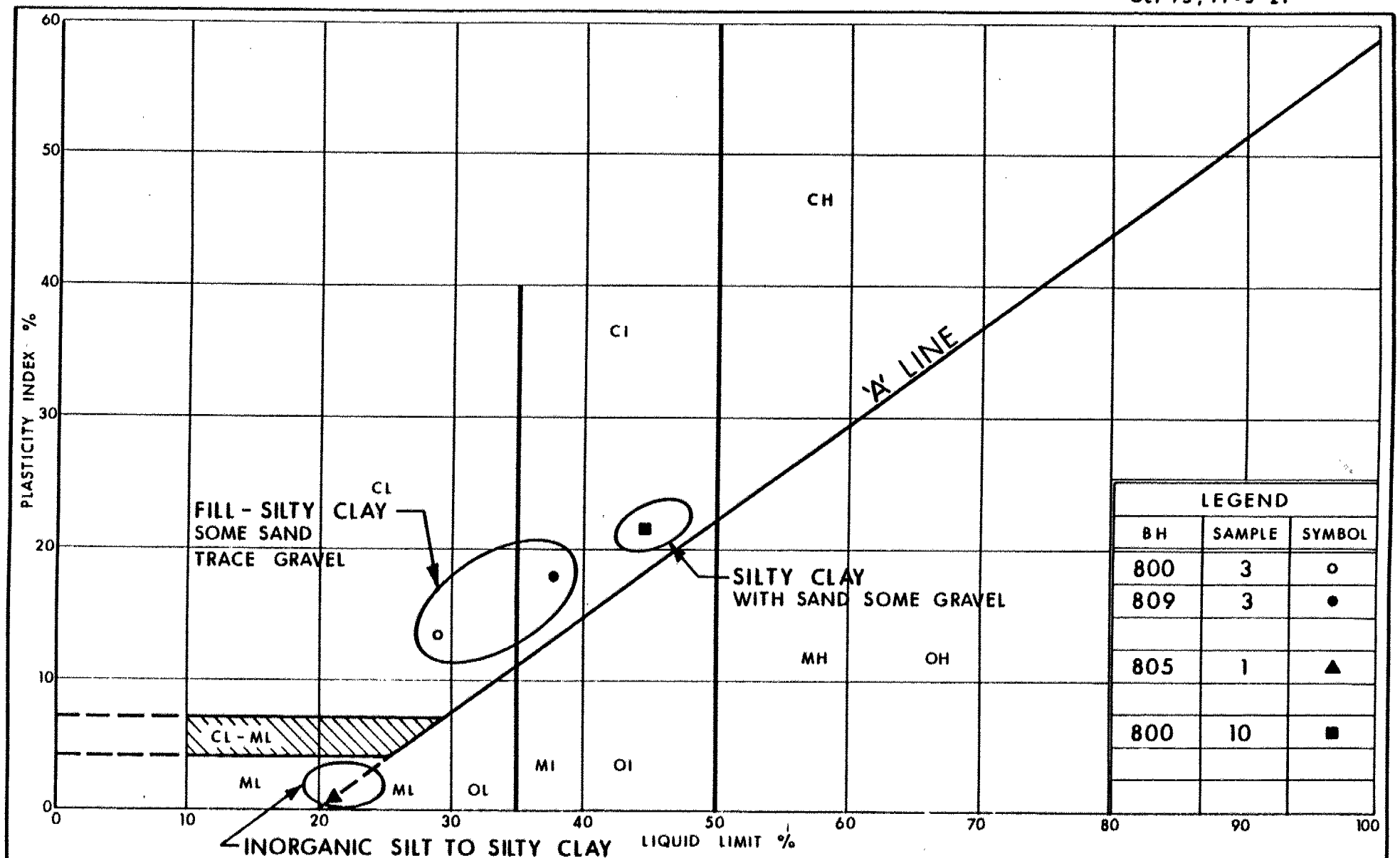
As discussed, these measures should be carried out as soon as possible since scour will result in additional instability of the existing slope.

The excavated material should be removed and placed in an area remote from the west approach fill.

M. MacLean, P. Eng.
Foundations Engineer

MM/mmj

c.c. - S. Wilson

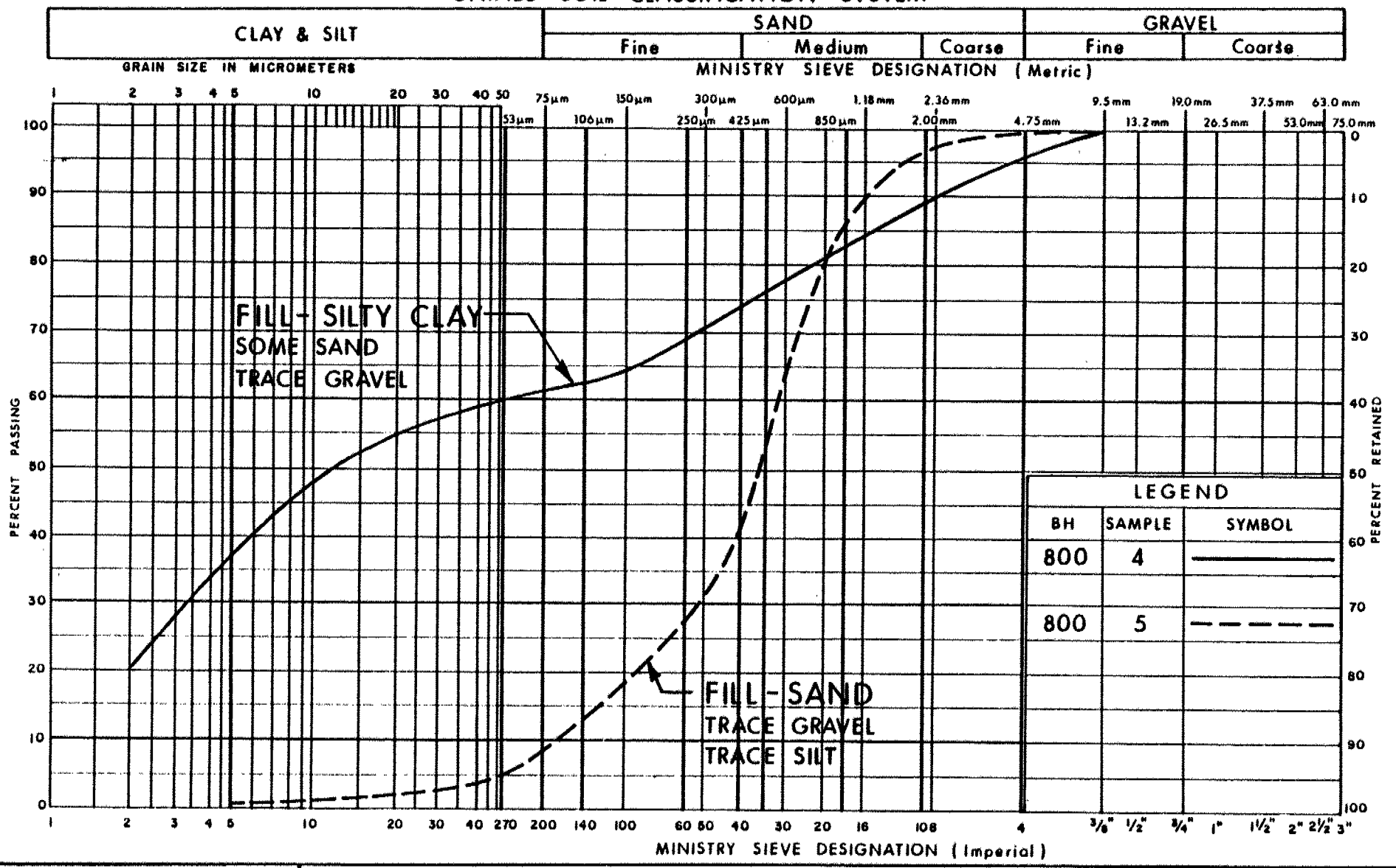


Ministry of Transportation and Communications
Ontario

PLASTICITY CHART

FIG No 1
W P 122-79-02

UNIFIED SOIL CLASSIFICATION SYSTEM

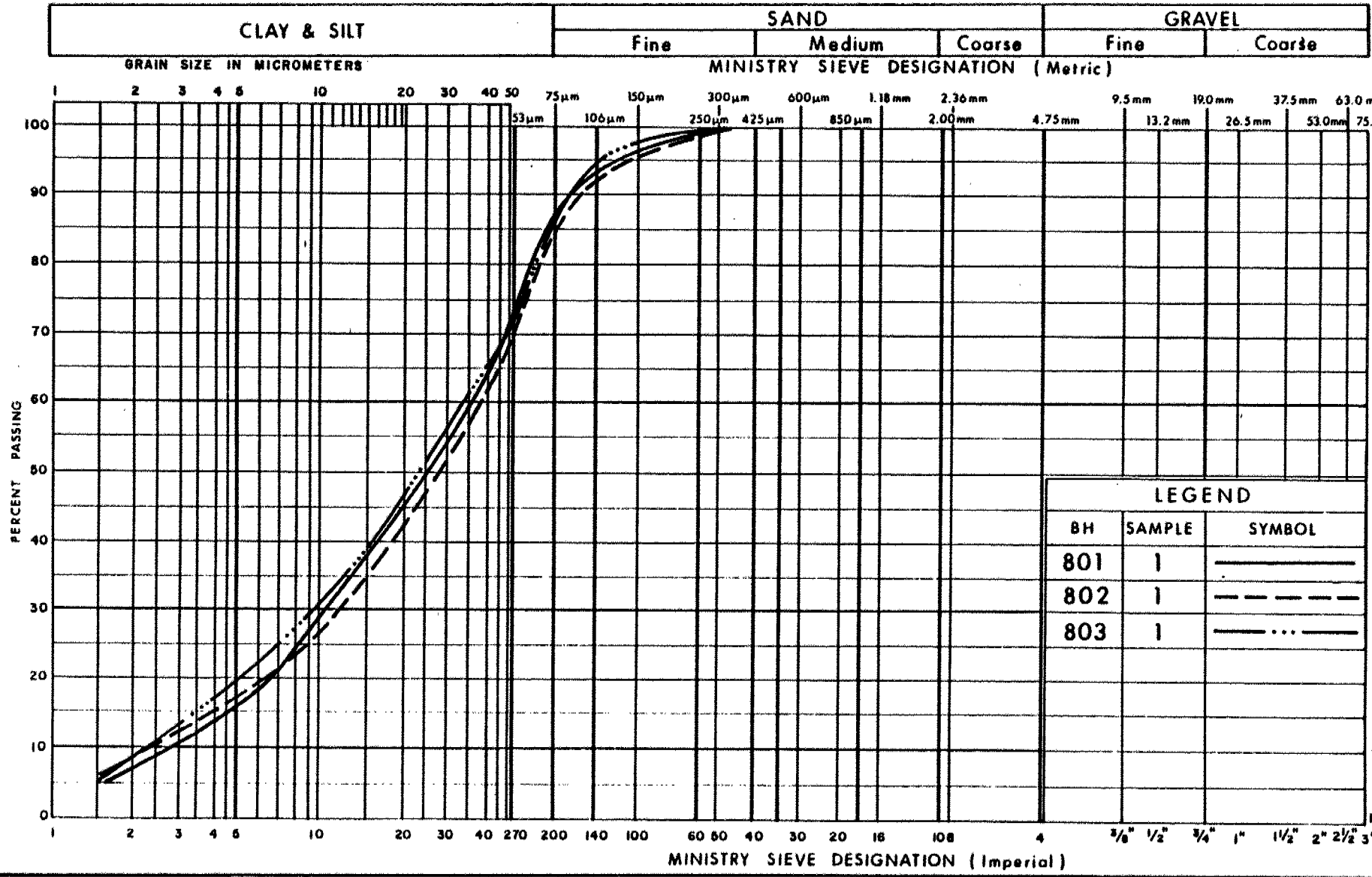


Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

FIG No 2
W P 122-79-02

UNIFIED SOIL CLASSIFICATION SYSTEM



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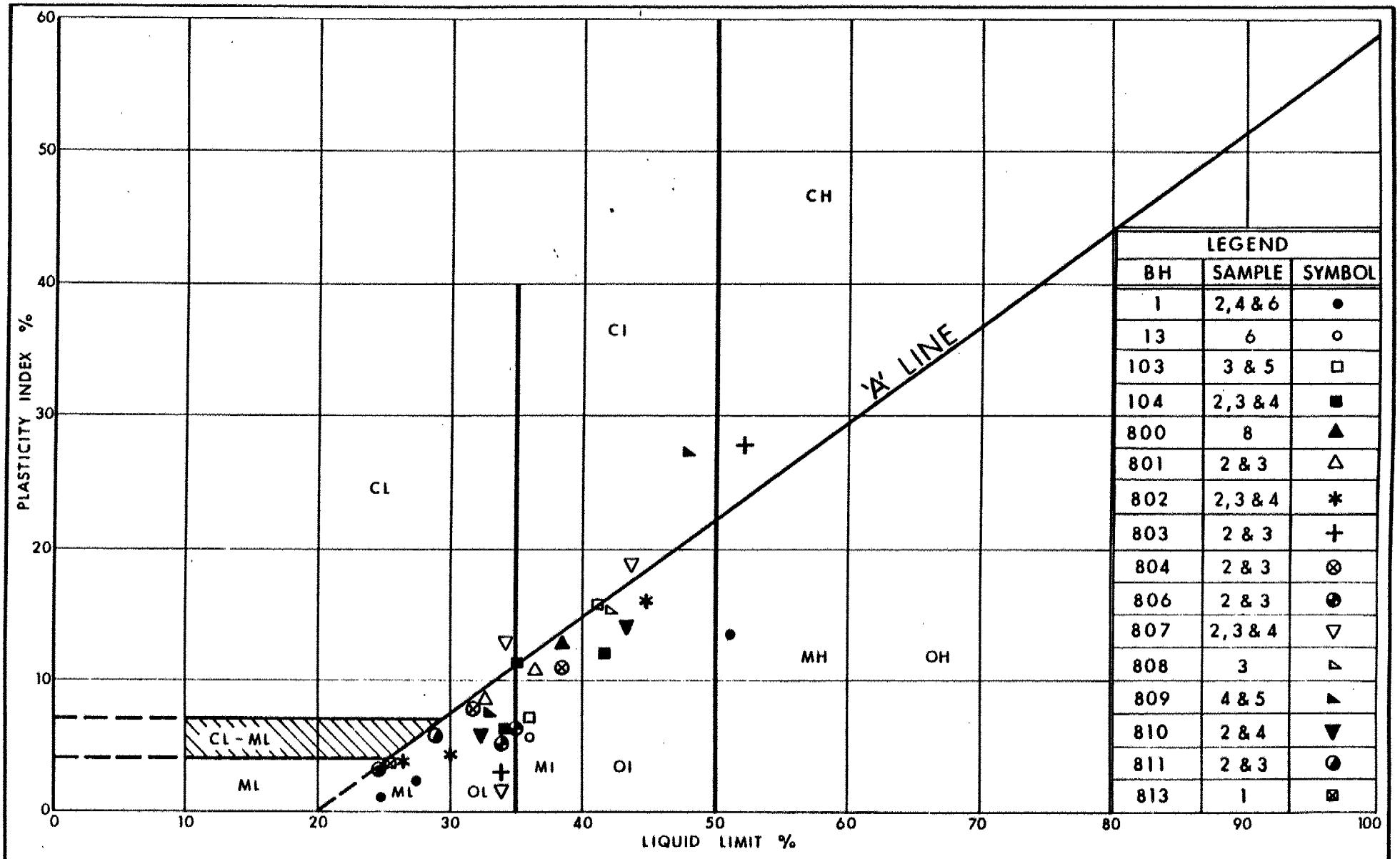
Ontario

GRAIN SIZE DISTRIBUTION
INORGANIC SILT TO SILTY CLAY

FIG No 3
W P 122-79-02

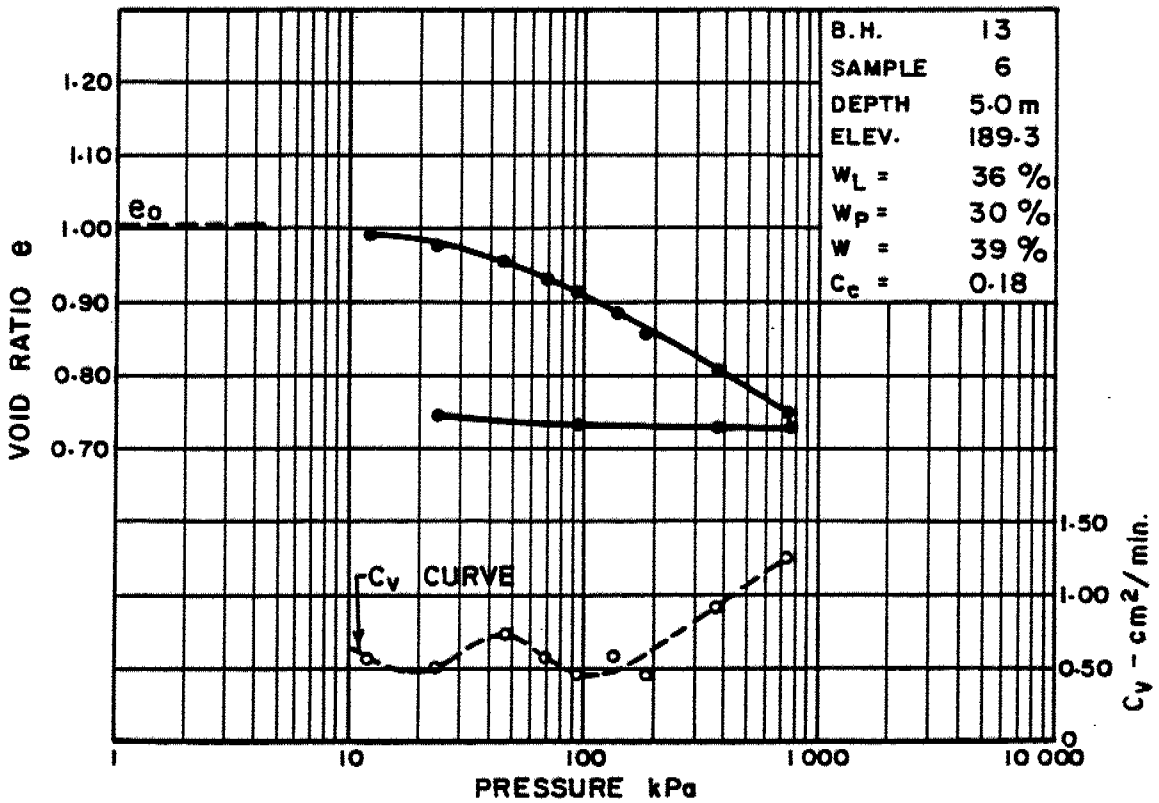


Ministry of Transportation and Communications
Ontario

PLASTICITY CHART
ORGANIC SILT TO ORGANIC SILTY CLAY

FIG No 4
WP 122-79-02

VOID RATIO - PRESSURE CURVES



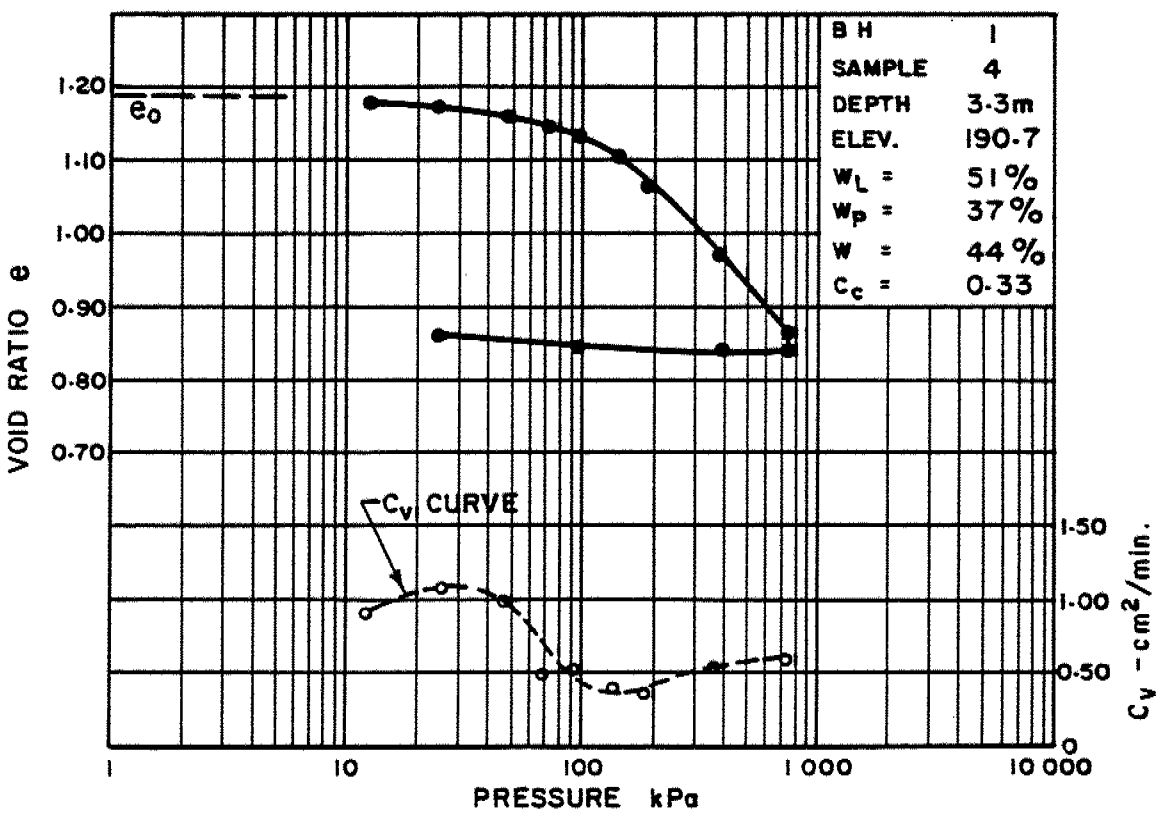


Fig. No. 5 WP 122-79-02

VOID RATIO - PRESSURE CURVE

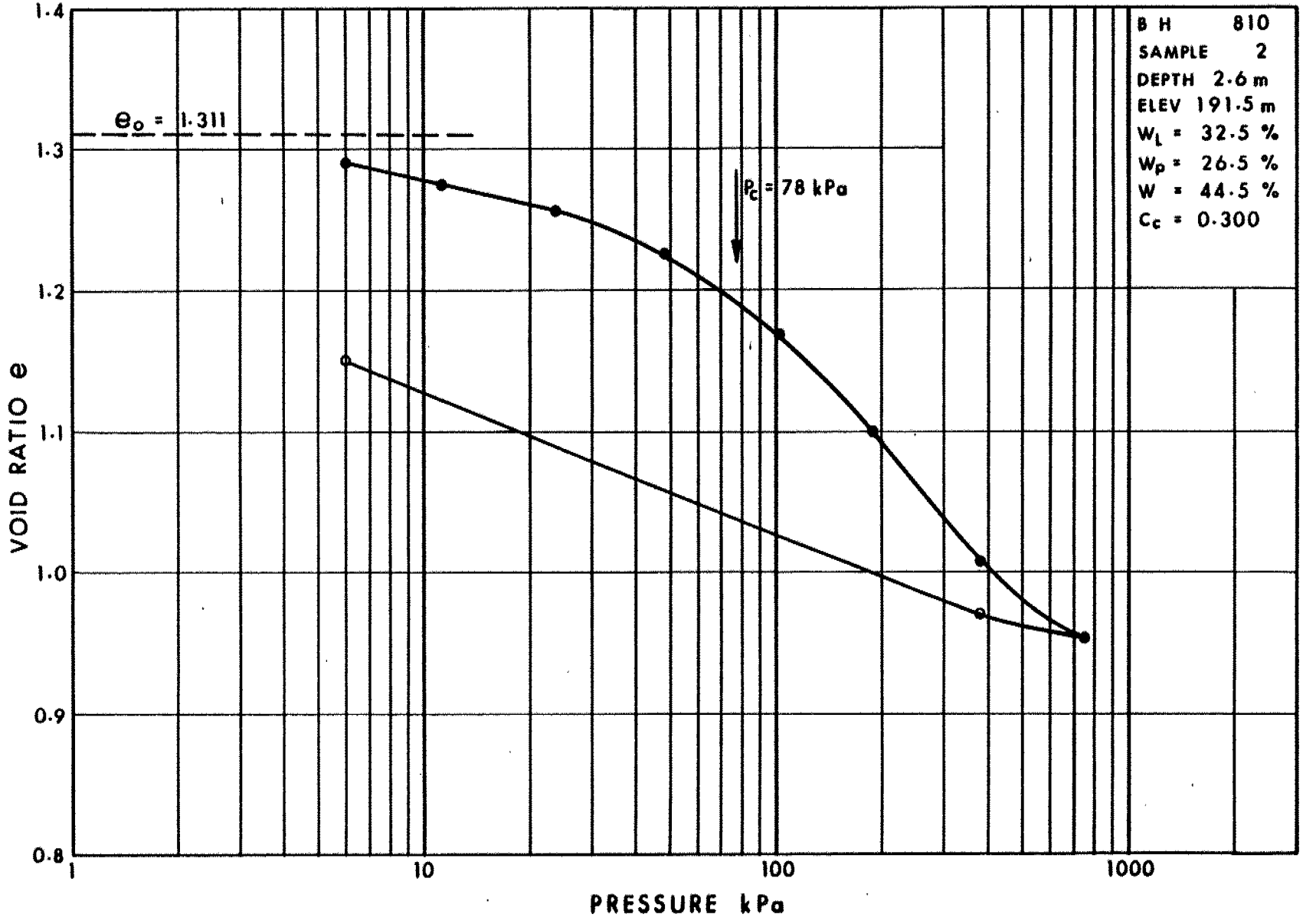
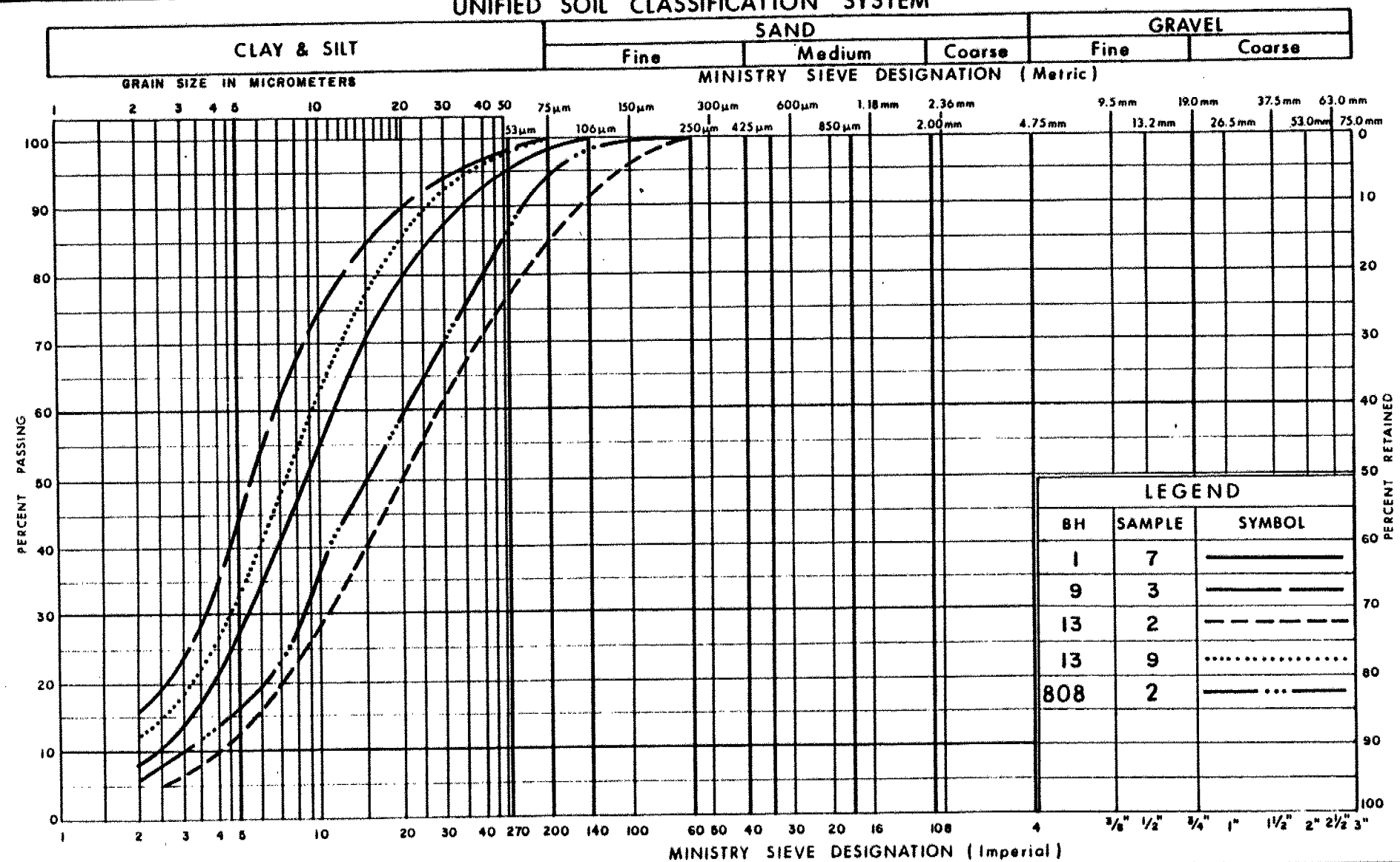


FIG 6

WP 122-79-02

UNIFIED SOIL CLASSIFICATION SYSTEM



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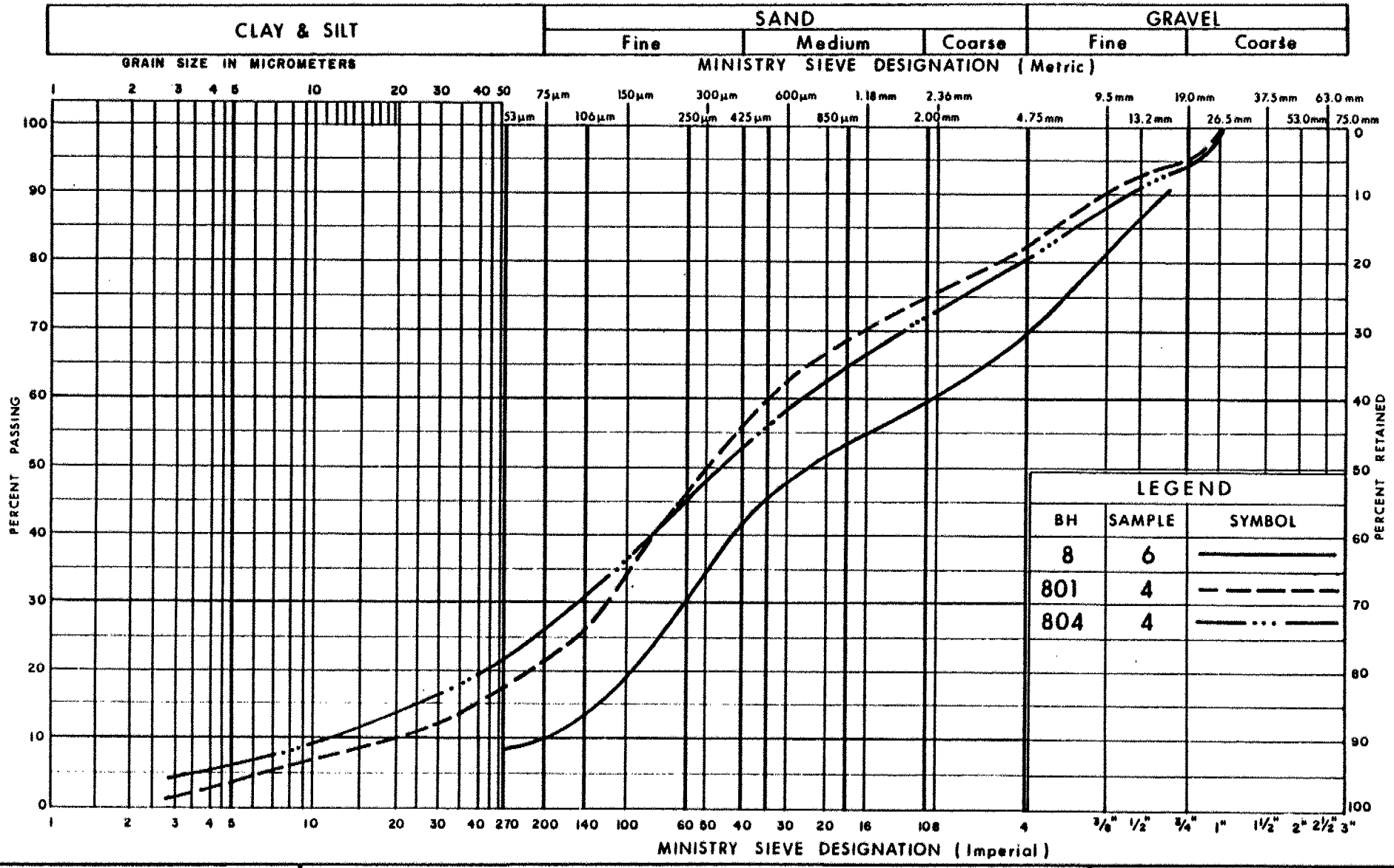
Ontario

GRAIN SIZE DISTRIBUTION
ORGANIC SILT TO ORGANIC SILTY CLAY

FIG No 7
WP 122-79-02

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

SAND, WITH SILT SOME GRAVEL

FIG No 8

W P 122-79-02

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

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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE

e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

Ministry of Transportation and Communications Ontario

RECORD OF BOREHOLE No 1 METRIC

W P 122-79-02 LOCATION Sta. 12 + 190, ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger, BX Rock Core COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 15 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100 / 10 20 30 40 50	20 40 60		GR SA SI CL
194.0	Top of snowpack										
0.0	250mm snow, Organic silt Firm Mottled Brown to dark grey with clayey zones		1	SS	2		192			17.8	Om=2.6% Po=34.1kPa e_o = 1.18 C_c = 0.33 Om=7.3%
			2	TW	PH						
			3	SS	2						
			4	TW	PH		190			17.4	Om=4.0% 0 2 (98)
			5	SS	2						
			6	TW	PH						
			7	SS	1		188				
186.8			8	TW	PH						
			9	SS							
7.2	Granitized Meta-sediment, Fine to Med.Grained Felsic Stringers Sound		10	RC Bx	100% Rec		186				RQD=67%
			11	RC Bx	100% Rec		184				RQD=97%
183.3											
10.7	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 122-79-02 LOCATION Sta. 12 + 197.5 o/s 5.0 Lt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test + Bx Rock Core COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 16 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT W_p / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
193.8	Ground Level										
0.0	Probable Organic silt						192				
188.2							190	30/150mm			
5.6	Intrusive felsic dyke, Fractured and weathered		1	RC Bx	100% Rec		188				RQD=82%
186.6											
7.2	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 122-79-02 LOCATION Sta. 12 + 193.5 o/s 5.0 Rt ℄ Hwy.637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test & Auger COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 16 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
193.9	Top of Snowpack										
0.0	250mm snow										
	Probable Organic silt						192				
							190				
							188				
185.0							186				
8.9	Auger refusal Probable Bedrock						184	50/25mm			
183.2											
10.7	Cone refusal Lower 3 meter rod severly bent										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4 METRIC

W P 122-79-02 LOCATION Sta. 12 + 202.5 ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger - Continuous Vanes COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (10 20 30 40 50) o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
193.7	Top of Snowpack										
0.0	250 mm Snow							+12, +6			
							192	+7, +6			
	Probable Organic Silt						190	+4, +5			
							188	+4, +5, +5			
							186	+4, +4			
183.6							184				
10.1	Refusal to Augering Probable Bedrock End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5 METRIC

W P 122-79-02 LOCATION Sta. 12 + 217 o/s 4.0 Lt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
193.0	Ice Surface										
0.0	Water						192				
							190				
188.0	River Bottom						188	Rods sank under own weight.			
5.0	Probable Organic Silt						186				
							184				
181.0							182				
180.7	Probable Sand, gravel							100/150mm			
12.3	Refusal Probable Bedrock										

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 6 METRIC

W P 122-79-02 LOCATION Sta. 12 + 220.6 o/s 2.5 Lt ℄ Hwy. 637 Line "D" ORIGINATED BY R.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE			GR SA SI CL
193.0 0.0	Ice Surface										
	Water						192				
							190				
							188				
185.3	River Bottom						186				
7.7	Probable Organic silt						184				
179.5							182				
13.5 178.5	Probable Silty sand and gravel						180	50/150mm			
14.5	Refusal Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 7 METRIC

W P 122-79-02 LOCATION Sta. 12 + 214.6 o/s 2.5 Rt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 16 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
193.0	Ice Surface										
0.0	Water						192				
							190				
188.0	River Bottom						188	Rods sank under own weight			
5.0	Probable Organic silt						186				
							184				
							182				
179.3							180				
178.7	Probable sand and gravel							50/150mm			
14.3	Refusal Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 8 METRIC

W P 122-79-02 LOCATION Sta. 12 + 218 o/s 4.0 Rt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Wash Bore, Bx Rock Core COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 15 & 16 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT Wl WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
193.0	Ice Surface										
0.0	-						192				
	Water						190				
							188				
185.8	River Bottom						186				
7.2	Organic Silt, occ. fine sand seams Traces of Wood and Peat, soft, Brown to Grey		1	SS	0				o		
			2	SS	0		184		o		
			3	SS	0		182		•		
			4	SS	1				o		
178.5			5	SS	5		180		o		
14.5	Silty Sand & Gravel										
177.5	Compact Brown		6	SS	22		178		o		30 60 (10)
15.5	Granitized Meta-sediment, Felsic Stringers & Dykes Minor Fracturing		7	RC Bx	100% Rec		176				RQD = 70%
175.1	Sound		8	RC Bx	100% Rec						RQD = 50%
17.9	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 9 METRIC

W P 122-79-02 LOCATION Sta. 12 + 256.6 o/s 3.0 Lt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Wash Bore, Cone Test and Bx Rock Core COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 & 18 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
193.0	Ice Surface										
0.0	Water						192				
							190				
							188				
186.2	River Bottom						186				
6.8	Organic silt Soft Brown to Grey		1	SS	0		184	Rods sank under own weight	○		
			2	SS	0		182		○		
			3	SS	0		180		○		0 1 (99)
179.0			4	SS	13					○	
14.0	Silty Sand & Gravel Compact, Brown						178				
177.9											
15.1	Granitized Meta-sediment, Fine to Medium grained Felsic Stringers		5	RC Bx	Rec 100%						RQD = 15%
			6	RC Bx	100% Rec			175/250mm			RQD = 50%
175.4	Hard, Fractured		7	RC Bx	100%		176				RQD = 5%
17.6	End of Borehole Lower 3M Rod bent during driving of cone										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 10 METRIC

W P 122-79-02 LOCATION Sta. 12 + 260.6 o/s 2.5 Lt ℄ Hwy 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100) / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
193.0	Ice Surface										
0.0	Water						192, 190				
188.1	River Bottom						188	Rods sank under own weight			
4.9	Probable Organic silt						186, 184, 182				
181.0											
12.0	Probable Silty Sand and Gravel						180				
178.5											
14.5	Refusal Probable Bedrock										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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Ontario

RECORD OF BOREHOLE No 11 METRIC

W P 122-79-02 LOCATION Sta. 12 + 254.6 o/s 2.5 Rt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY G.M.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.0	Ice Surface										
0.0	Water						192				
							190				
							188				
186.3	River Bottom										
6.7	Probable Organic silt						186	Rods sank under own weight			
							184				
							182				
179.7							180				
13.3 178.9	Probable Silty Sand and Gravel							100/75mm			
14.1	Refusal Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 12 METRIC

W P 122-79-02 LOCATION Sta. 12 + 258 o/s 4.0 Rt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
193.0	Ice Surface										
0.0	Water						192				
							190				
188.2	River Bottom						188	Rods sank under own weight			
4.8	Probable Organic Silt						186				
							184				
182.8											
10.2	Probable Silty Sand and Gravel						182				
181.4											
11.6	Refusal Probable Bedrock							50/0mm			

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 13

METRIC

W P 122-79-02 LOCATION Sta. 12 + 272.5 ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 10 20 30 40 50	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI Cl
194.3	Top of Snowpack										
0.0	250mm snow Organic Silt Soft Mottled Brown to Dark Grey Occ. plant remains		1	SS	2	▽	194		○		0 15 (85
			2	TW	PH			●	○	18.9	Om=2.5%
			3	SS	2		192	×3	+3 ○		
			4	TW	PH			●	○		Om=5.6%
			5	SS	1				○		
			6	TW	PH		190	+4	+1 ○		Om=3.5%
			7	SS	1			+4	○		P_o=53.6kPa e_o=1.03 C_c=0.18
			8	TW	PH		188				
			9	SS	0			+4	○		0 1 (99
186.0			10	TW	PH						
8.3	Silty Sand & Gravel						186				
184.7	Occ. Cobble, Compact, Brown		11	SS	18				○		
9.6	Refusal to Augering Spoon bent at bottom sample. Probable Bedrock										

+³, ×⁵ : Numbers refer to Sensitivity

15 ◇ 5 (%) STRAIN AT FAILURE (20 / 10)

OFFICE REPORT ON SOIL EXPLORATION

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Ontario

RECORD OF BOREHOLE No 14 METRIC

W P 122-79-02 LOCATION Sta. 12 + 281.6 o/s 5.0 Lt ℄ Hwy 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT Wl / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
194.1	Top of Snowpack										
0.0	250mm snow										
	Probable Organic silt						192				
							190				
							188				
186.5											
7.6	Probable Silty Sand and Gravel						186				
185.1											
9.0	Refusal Lower 3m rod, bent Probable Bedrock							150/200mm			

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 15 METRIC

W P 122-79-02 LOCATION Sta. 12 + 277.6 o/s 5.0 Rt ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.2	Top of Snowpack										
0.0	250mm snow										
	Probable Organic silt						192				
							190				
188.0											
6.2	Probable silty sand and gravel						188	50/75mm			
186.7											
7.5	Refusal Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 (20 / 10) 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 16 METRIC

W P 122-79-02 LOCATION Sta. 12 + 285 ℄ Hwy. 637 Line "D" ORIGINATED BY B.D.

DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.

DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT N 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
194.1	Top of Snowpack										
0.0	250mm Snow Probable Organic silt						192 190	30/150mm			
189.4											
4.7	Refusal Possible boulder										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications Ontario

RECORD OF BOREHOLE No 103 (Formerly BH # 3) (WP 18-79-00) METRIC

W P 122-79-02 LOCATION Sta. 12 + 198.4, ℄ Hwy. 637 Line "D" ORIGINATED BY R.B.

DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core & Cone Test COMPILED BY R.B.

DATUM Geodetic DATE 1980 09 05 CHECKED BY C.Y.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, x LAB VANE) (10 20 30 40 50)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
193.5	Ground Surface										
0.0	Organic Silty Clay Stiff to Firm		1	SS	5		192				
			2	SS	2						
			3	TW	PH		190			17.3	0 5 89 6 e_o = 1.186 P_c = 65kPa C_c = 0.323
			4	SS	2						
187.3			5	TW	PH		188			17.1	
6.3			6	SS	43/15cm						
	Granite Bedrock		7	BXL RC	Rec 90%		186	Hammer Bouncing			RQD = 60%
7.9	End of Borehole										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 104 (Formerly BH #4 / WP 18-79-00) METRIC

W P 122-79-02 LOCATION Sta. 12 + 282.8, o/s 1.8m Rt. ℄ Hwy.637 Line"D" ORIGINATED BY R.B.

DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core & Cone Test COMPILED BY R.B.

DATUM Geodetic DATE 1980 09 06 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, x LAB VANE) (10 20 30 40 50)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
193.7	Ground Level										
0.0	Organic Silty Clay Stiff to Firm		1	SS	6		192		o		0 9 80 11
			2	SS	3				H-O-H		
			3	TW	PH			p +4	H-O-H		0 9 85 6
							190	+3		17.0	e_o = 1.106 P_c = 65kPa
			4	SS	2				o		C_c = 0.273
187.7			5	TW	PH		188	+3			Om= 2.77
6.0 187.0	Boulder		6	RC	Rec 90%			+3			
6.7 185.8	Silty Fine Sand Loose		7	SS	5						
			8	SS	41/31cm		186	Hammer Bouncing			
7.9 184.2	Granite Bedrock		9	BXL RC	Rec 80%						RQD = 95%
9.5	End of Borehole										

+3, x5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 800 METRIC

W P 122-79-02 LOCATION Sta. 12 + 166.0; ℄ Hwy. 637 Line D ORIGINATED BY DT & HS
DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DT
DATUM Geodetic DATE 84 03 26 - 27 CHECKED BY GP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH o UNCONFINED + FIELD VANE • QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.5	Ground Surface										
0.0	Silty Clay (Fill) some sand trace gravel Occasional Pockets of Sand		1	SS	9						
			2	SS	8	▼	194				
	Firm to Stiff		3	SS	15						
191.8			4	SS	6		192				5 35 39 21
3.7	Sand (Fill) trace gravel and silt Occasional Pockets of Silty Clay Very Loose		5	SS	2						0 90 10 0
			6	SS	2		190				
188.8			7	SS	3						
6.7	Organic Silty Clay		8	SS	3		188				
	Soft		9	SS	3		186				
185.1											
10.4	Silty Clay with Sand some gravel Very Stiff		10	SS	22		184				
183.3											
12.2	Sand with silt Loose some gravel Very Dense		11	SS	6						
181.6			12	SS	45/150mm		182				16 40 39 5
13.9	End of Borehole Refusal to Auger Probable Bedrock										

$+^3$, x^5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 801 METRIC

W P 122-79-02 LOCATION Sta. 12 + 174.0; O/S 150 m RT ℄ Hwy. 637 Line D ORIGINATED BY DT
DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
DATUM Geodetic DATE 84 03 29 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (10 20 30 40 50) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.5	Ground Surface										
0.0	Inorganic Silt some sand trace clay		1	SS	5						0 13 81 6
192.1	Firm						192	+5	○		
1.4			2	SS	2			+3	⊢ ○		
	Organic Silt trace sand to Organic Silty Clay		3	TW	PH		190	●	⊢ ○	17	
								+3			
							188	+6			
	Firm						186	+6			
								+4			
183.0							184				
10.5	Sand, some gravel some silt		4	SS	39				○		18 60 22 0
181.8	Dense						182				
11.7	End of Borehole Refusal to Auger Probable Bedrock										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 802 METRIC

W P 122-79-02 LOCATION Sta. 12 + 184.0; O/S 16.0 m RT ℄ Hwy. 637 Line D ORIGINATED BY DT & HS

DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT

DATUM Geodetic DATE 84 03 28 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (10 20 30 40 50) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.2	Ground Surface										
0.0	Inorganic Silt some sand trace clay & roots		1	SS	2						0 15 77 8
191.7	Soft						192	+52	○		
1.5	Organic Silt trace sand to Organic Silty Clay Occasional Pockets of Black Organics		2	SS	2			+4	⊢○		
			3	TW	PH		190	+3	⊢ ○	18.1	
							188	+4			
	Firm						186	+4			
							184	+4			
			4	SS	3			+2	⊢○		
181.6					-		182				
11.6	End of Borehole Refusal to Auger Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 803 METRIC

W P 122-79-02 LOCATION Sta. 12 + 180.0; O/S 30.0 m RT ℄ Hwy. 637 Line D ORIGINATED BY DT & HS
DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
DATUM Geodetic DATE 1984 03 28 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 10 20 30 40 50	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.3	Ground Surface										
0.0	Inorganic Silt some sand trace clay & roots Soft		1	SS	2		192	+24	○		0 15 76 9
191.8											
1.5	Organic Silt trace sand to Organic Silty Clay Occasional lenses of Black Organics Firm		2	SS	2		190	×6	⊢ ○		O.M.* = 3.9%
			3	TW	PH			●	⊢●	15.9	
							188	+4			
							186	+4			
							184	+4			
181.9							182	+4			
11.4	End of Borehole Refusal to Auger Probable Bedrock * O.M. = percentage of organic matter by weight										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 804 METRIC

W P 122-79-02 LOCATION Sta. 12 + 170.0; O/S 26.0 m RT ℄ Hwy. 637 Line D ORIGINATED BY DT
DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
DATUM Geodetic DATE 84 03 29 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, x LAB VANE; 10 20 30 40 50)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.6	Ground Surface										
0.0	Inorganic Silt some sand trace clay		1	SS	3						
192.1	Soft						192	+9			
1.5			2	SS	2			+4			
	Organic Silt trace of sand to Organic Silty Clay		3	TW	PH		190			16.3	
								+4			
							188	+3			
							186	+3			
	Firm							2			
							184				
								+2			
180.5							182				
13.1	Sand some gravel										
179.6	some silt Compact		4	SS	29		180		o		19 55 23 3
14.0	End of Borehole										
	Refusal to Auger Probable Bedrock										

$+^3$, x^5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 805 METRIC

W P 122-79-02 LOCATION Sta. 12 + 176.0 ; O/S 38.3 m RT ℄ Hwy. 637 Line D ORIGINATED BY DT & HS
DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
DATUM Geodetic DATE 84 03 28 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 10 20 30 40 50	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
193.6	Ground Surface										
0.0	Inorganic Silt trace sand and fibrous organics		1	SS	4						
191.8	Firm										
1.8	Organic Silt trace sand to Organic Silty Clay		2	SS	2		192	+7 +4	○ ○		O.M.* =3.6%
			3	SS	4		190	+3			
							188	+4			
	Firm to Stiff						186	2			
							184	+4			
181.3							182	+2			
12.3	End of Borehole										
	Refusal to Auger Probable Bedrock										
	* O.M. = percentage of organic matter by weight										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 806 METRIC

W P 122-79-02 LOCATION Sta. 12 + 175.0; O/S 10.0 m LT ℄Hwy. 637 Line D ORIGINATED BY DT
DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
DATUM Geodatic DATE 84 03 30 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 10 20 30 40 50	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.9	Ground Surface										
0.0	Inorganic Silty Clay some sand trace gravel		1	SS	6	*		+11 97 kPa			
192.5	pieces of wood Firm						192				
1.4	Organic Silt trace sand to Organic Silty Clay Firm		2	SS	3			+3			
			3	TW	PH		190				17.0
							188	+4 −			
185.4			4	SS	100/50 mm		186	6			
8.5	Sand, some gravel some silt										
184.3	Dense		5	SS	31						
9.6	End of Borehole Refusal to Auger Probable Bedrock										

* Note: Groundwater Level not established

+³, ×⁵ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 807 METRIC

W P 122-79-02 LOCATION Sta. 12 + 184.0; O/S 10.0 m LT ℄ Hwy. 637 Line D ORIGINATED BY DT
DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
DATUM Geodetic DATE 84 04 02 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 10 20 30 40 50	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.7	Ground Surface										
0.0	Inorganic Silty Clay some sand, trace					*					
192.5	fibrous organics Firm		1	SS	5						
1.2	Organic Silt trace sand to Organic Silty Clay Pockets of Organics Stiff to Firm		2	SS	3		192	+3 70 kPa; ×5	H O		O.M.**=4.0%
			3	TW	PH		190	● ×6	O	17.4	
187.5			4	SS	100/100mm		188		O		
6.2	End of Borehole Refusal to Auger Probable Bedrock										

* Note Groundwater Level not established

** O.M. = Percentage of organic matter by weight

+³, ×⁵ : Numbers refer to Sensitivity

20
15 ⊹ S (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 808 METRIC

W P 122-79-02 LOCATION Sta. 12 + 200.0; O/S 10.0 m LT ℄ Hwy. 637 Line D ORIGINATED BY DT
DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
DATUM Geodetic DATE 84 04 02 CHECKED BY

ELEV / DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (10 20 30 40 50) o UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.5	Ground Surface										
0.0	Inorganic Silt, some sand, trace of roots					*					
192.1	Soft		1	SS	2						
1.4	Organic Silt trace sand to Organic Silty Clay Stiff		2	SS	2		192	+10			0 5 90 5
189.1	some gravel		3	SS	76/180 mm		190				
4.4	End of Borehole										

Refusal to Auger
Probable Bedrock

* Note:
Groundwater Level not established

OFFICE REPORT ON SOIL EXPLORATION

+3,*x5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 809 METRIC

W P 122-79-02 LOCATION Sta. 12 + 297.6; ℄ Hwy. 637 Line D ORIGINATED BY DT
DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
DATUM Geodetic DATE 84 04 04 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 10 20 30 40 50	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
199.0	Ground Surface										
0.0	Silty Clay (Fill) some sand trace gravel trace of fibrous organics					*	198				
			1	SS	18						
	Stiff to Very Stiff						196				
			2	SS	10						
							194				
193.5			3	SS	15						
5.5	Organic Silt trace of wood and fibrous organics to Organic Silty Clay						192		o		O.M.** = 3.5%
			4	SS	17						
			5	SS	3			+1			
	Soft to Stiff						190	+1			
186.8							188	+3			
12.2	Probable Sand some gravel										
185.4							186				
13.6	End of Borehole Refusal to Auger Probable Bedrock										

* Note: Groundwater level not established

** O.M. = percentage of organic matter by weight

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 810 METRIC

W P 122-79-02 LOCATION Sta. 12 + 270.5; O/S 6.1 m RT ℄ Hwy. 637 Line D ORIGINATED BY DT
DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
DATUM Geodetic DATE 84 04 04 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, x LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.1	Ground Surface										
0.0	Inorganic Silt trace sand & roots Soft		1	SS	2		194				
192.7											
1.4	Organic Silt trace sand occasional pockets of Black organics to Organic Silty Clay Soft to Stiff		2	TW	PH		192			16.5	Pc = 78 kPa e_o = 1.311 Cc = 0.300
			3	SS	2		190				
			4	SS	2		188				
183.6							186				
10.5	Sand some gravel Occasional cobbles Very Dense		5	SS	100/ 25 mm		184				
182.5											
11.6	End of Borehole Refusal to Auger Probable Bedrock										

$+^3$, x^5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 811 METRIC

W P 122-79-02 LOCATION Sta. 12 + 193.4; O/S 16.0 m RT ℄ Hwy. 637 Line D ORIGINATED BY DT
DIST 17 HWY 637 BOREHOLE TYPE Wash Bore COMPILED BY DT
DATUM Geodetic DATE 84 04 02 - 03 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.2	Water Surface										
0.0 / 192.6	Water										
0.6	Organic Silt trace sand to Soft		1	SS	1		192	+5			O.M.* = 1.9%
			2	SS	1			+3			
	Organic Silty Clay Firm		3	TW	PH		190	+3		17.3	
	Occasional pockets of Black organics						188	+3			
							186	+3			
							184	+3			
	Stiff						182	+3			
180.4								+4			
12.8	End of Borehole Probable Bedrock										

* O.M. = percentage of organic matter by weight

+³, ×⁵ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 812 METRIC

W P 122-79-02 LOCATION Sta. 12 + 208.6; O/S 4.5 m RT ℄ Hwy. 637 Line D ORIGINATED BY DT
DIST 17 HWY 637 BOREHOLE TYPE Dynamic Cone Test COMPILED BY DT
DATUM Geodetic DATE 84 04 02 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.2	Water Surface										
0.0	Water						192				
191.1	River Bottom							cone sank under the weight of the rods			
2.1	Probable Organic Silt to Organic Silty Clay						190				
							188				
							186				
							184				
							182				
181.2											
12.0	End of Cone Test Probable Bedrock							100/ 150 mm			

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ○ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 813 METRIC

W P 122- 79-02 LOCATION Sta. 12 + 205.2; O/S 4.6 m LT ℄ Hwy. 637 Line D ORIGINATED BY DT
DIST 17 HWY 637 BOREHOLE TYPE Wash Bore COMPILED BY DT
DATUM Geodetic DATE 84 04 03 CHECKED BY [illegible]

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.2	Water Surface										
0.0	Water										
191.4	River Bottom						192				
1.8	Organic Silt trace sand to Organic Silty Clay with fine roots and pockets of black organics		1	SS	1			5	I o		
			2	TW	PM		190	+4	o	16.	
								+4			
							188	+7			
							186	+3			
							184	+3			
								+3			
181.0							182				
12.2	End of Borehole Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 814 METRIC

W P 122-79-02 LOCATION Sta. 12 + 267.8; O/S 10.6 m Lt ℄ Hwy. 637 Line D ORIGINATED BY DT
DIST 17 HWY 637 BOREHOLE TYPE Dynamic Cone Test COMPILED BY DT
DATUM Geodetic DATE 84 04 03 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.2	Water Surface										
0.0	Water						192				
190.2	River Bottom										
3.0	Probable Organic Silt to Organic Silty Clay						190	cone sank under the weight of the rods			
							188				
							186				
							184				
							182				
179.6							180				
13.6	End of Cone Test Probable Bedrock							125/	200		

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

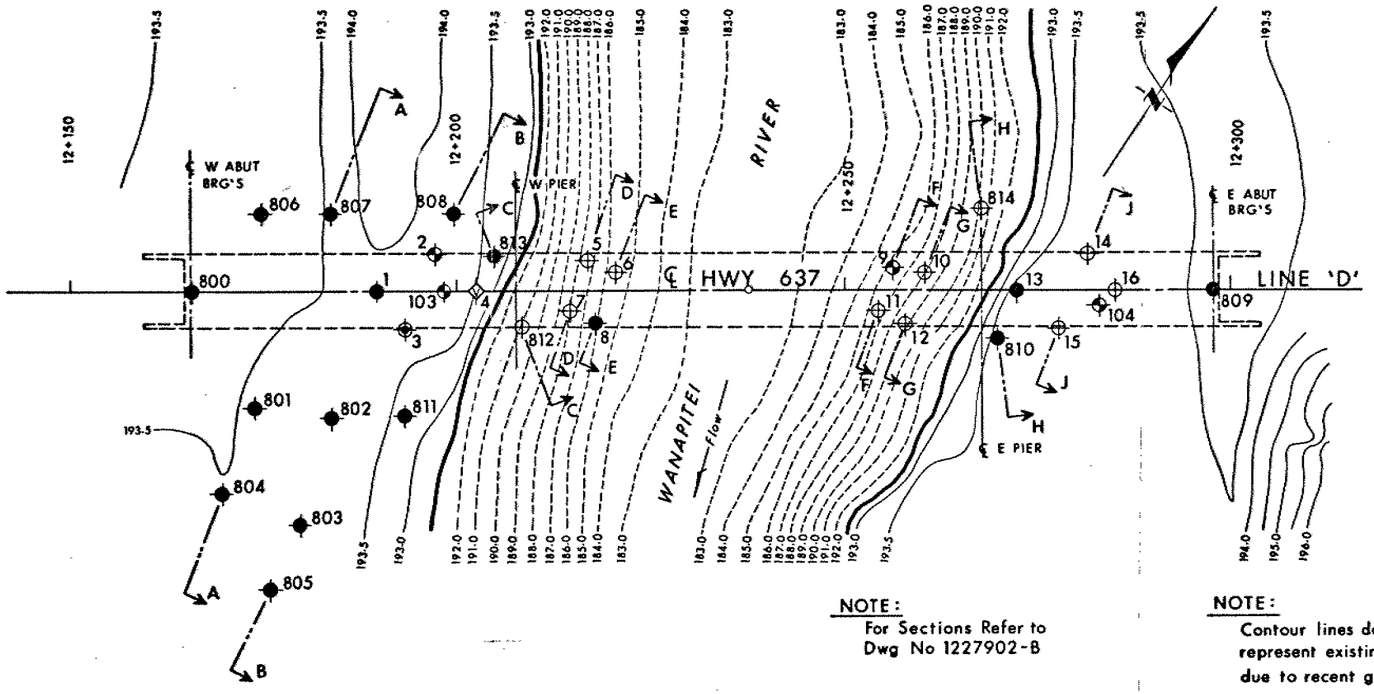
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PH-0-207 82 04

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

CONT No
WP No 122-79-02

WANAPITEI RIVER BRIDGE
(15.0 km West of Hwy 69)
BORE HOLE LOCATIONS & SOIL STRATA

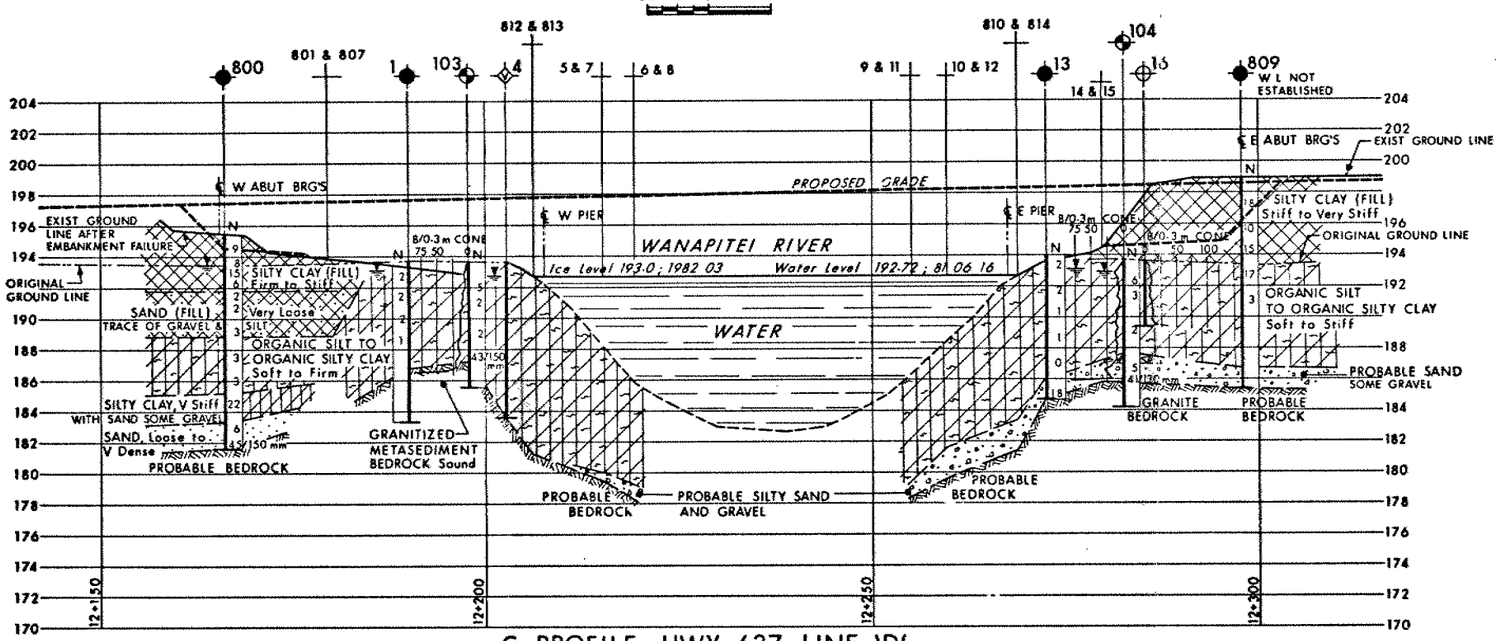
SHEET



NOTE:
For Sections Refer to Dwg No 1227902-B

NOTE:
Contour lines do not accurately represent existing ground surface due to recent grading operations.

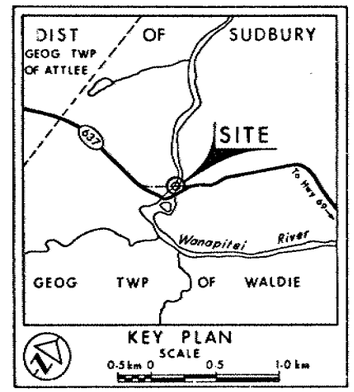
PLAN
SCALE 8m 4 0 8m



℄ PROFILE HWY 637 LINE 'D'
SCALE HOR 8m 4 0 8m
VERT 4m 2 0 4m

No	ELEVATION	STATION	OFFSET
103	193·5	12+198·4	℄
104	193·7	12+282·8	1·8 m Rt
800	195·5	12+166·0	℄
801	193·5	12+174·0	15·0 m Rt
802	193·2	12+184·0	16·0 m Rt
803	193·3	12+180·0	30·0 m Rt
804	193·6	12+170·0	26·0 m Rt
805	193·6	12+176·0	38·3 m Rt
806	193·9	12+175·0	10·0 m Lt
807	193·7	12+184·0	10·0 m Lt
808	193·5	12+200·0	10·0 m Lt
809	199·0	12+297·6	℄
810	194·1	12+270·5	6·1 m Rt
811	193·2	12+193·4	16·0 m Rt
812	193·2	12+208·6	4·5 m Rt
813	193·2	12+205·2	4·6 m Lt
814	193·2	12+267·8	10·6 m Lt

HOLES DONE BY: M T C



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & 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 1980 09 ; 1982 03 and 1984 03
- Cone Test and Auger Hole
- Vane Test and Auger Hole

No	ELEVATION	STATION	OFFSET
1	194·0	12+190·0	℄
2	193·8	12+197·5	5·0 m Lt
3	193·9	12+193·5	5·0 m Rt
4	193·7	12+202·5	℄
5	193·0	12+217·0	4·0 m Lt
6	193·0	12+220·6	2·5 m Lt
7	193·0	12+214·6	2·5 m Rt
8	193·0	12+218·0	4·0 m Rt
9	193·0	12+256·6	3·0 m Lt
10	193·0	12+260·6	2·5 m Lt
11	193·0	12+254·6	2·5 m Rt
12	193·0	12+258·0	4·0 m Rt
13	194·3	12+272·5	℄
14	194·1	12+281·6	5·0 m Lt
15	194·2	12+277·6	5·0 m Rt
16	194·1	12+285·0	℄

HOLES DONE BY: WARNOCK HERSEY

NOTE:
Any difference between elevations listed and drawn is due to presence of snowpack on ground.

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION

Geocres No 411-118

HWY No 637 LINE 'D'			DIST 17
SUBM'D H S	CHECKED	DATE 1984 10 12	SITE 46-203
DRAWN CP	CHECKED	APPROVED	DWG 1227902-A

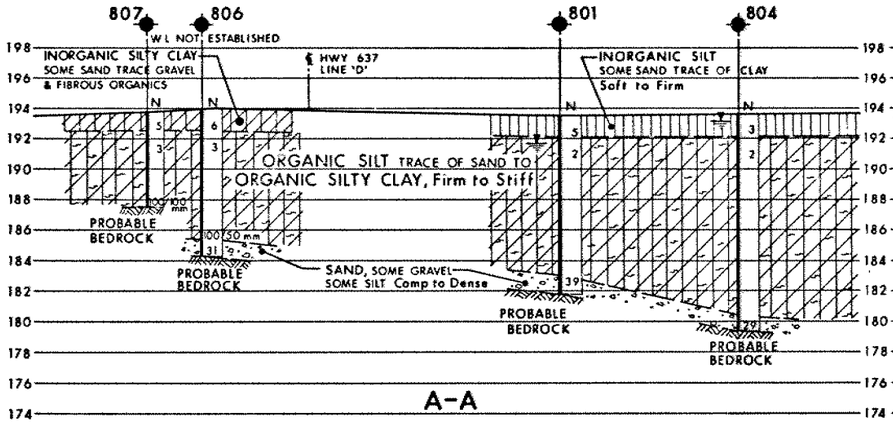
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PH-D-207 82 04

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

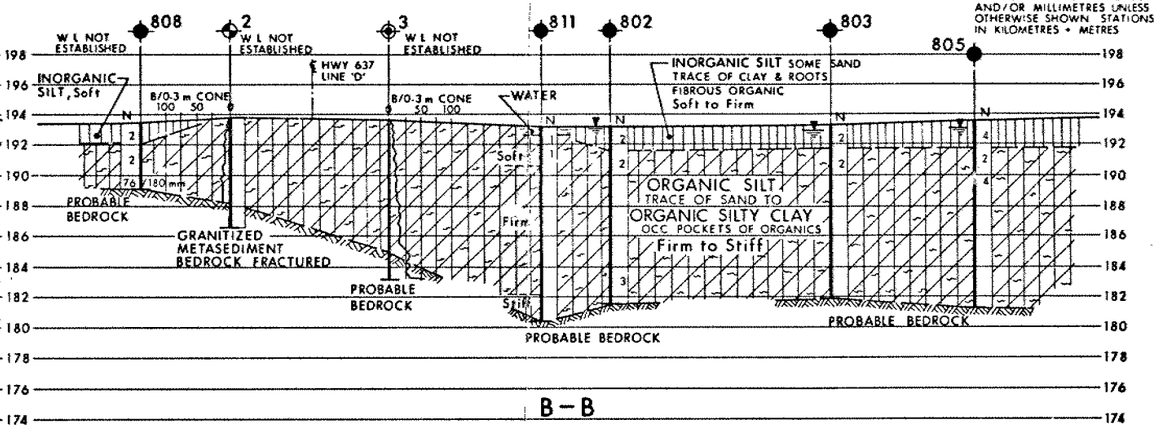
CONT No
WP No 122-79-02

WANAPITEI RIVER BRIDGE
(15.0 km West of Hwy 69)
BORE HOLE LOCATIONS & SOIL STRATA

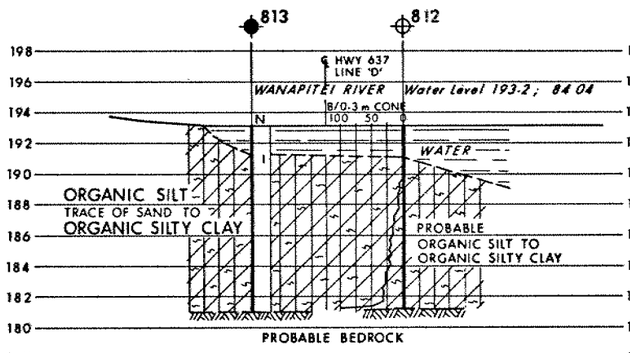
SHEET



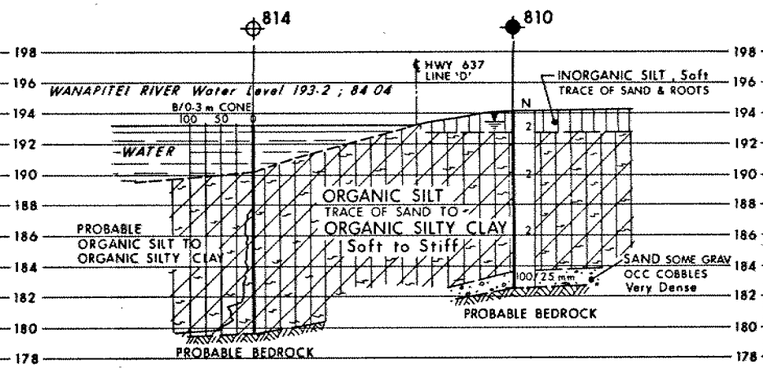
A–A



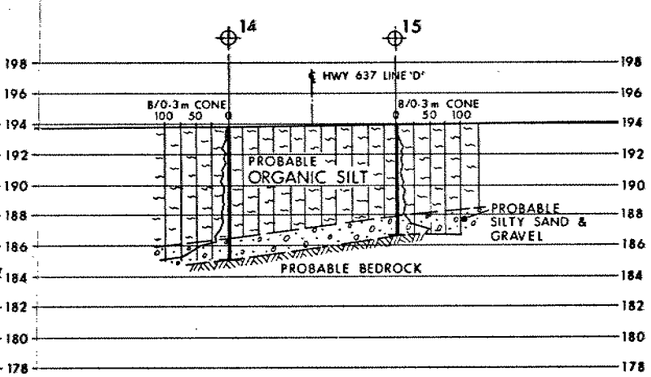
B–B



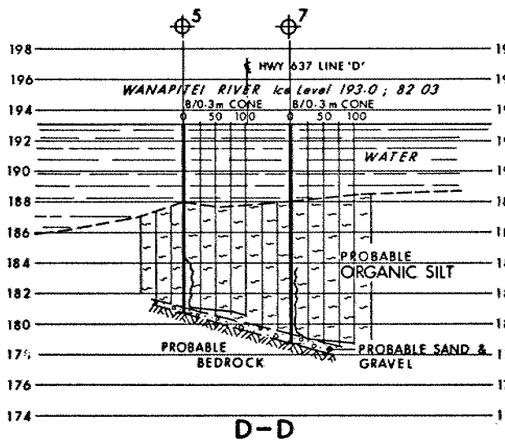
C–C



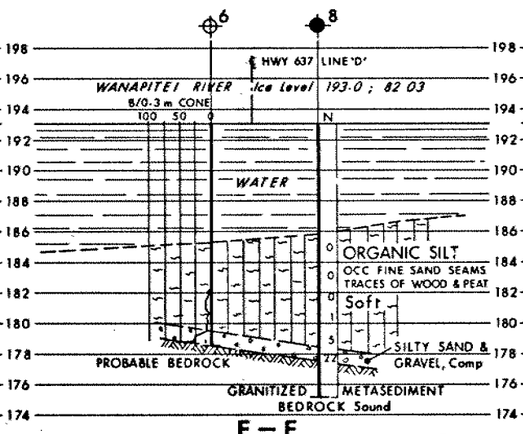
H–H



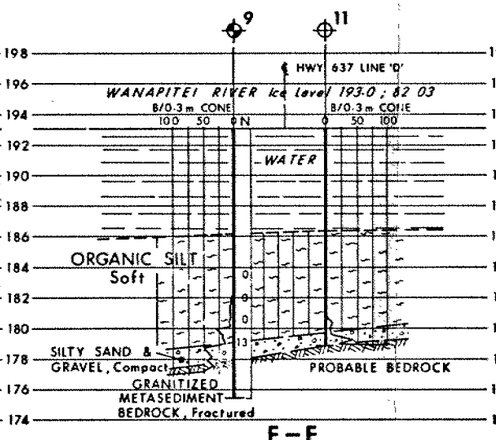
J–J



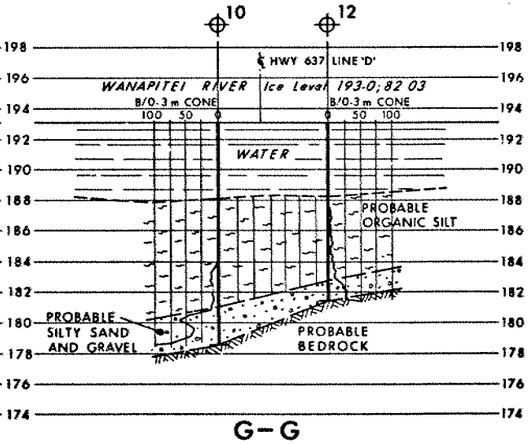
D–D



E–E



F–F



G–G

SECTIONS
SCALE
4m 2 0 4m

SEE DWG No 1227902-A

KEY PLAN
SCALE

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & 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 1982 03 and 1984 03 and 04
- Cone Test and Auger Hole

No	ELEVATION		

NOTE :
FOR PLAN, PROFILE AND BOREHOLE LOCATIONS REFER TO DWG No 1227902-A

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION

Geocres No 41 I - 118

HWY No 637 LINE 'D'			DIST 17
SUBM'D H S	CHECKED	DATE 1984 10 05	SITE 46-203
DRAWN	CHECKED	APPROVED	DWG 1227902-B