

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 316-189

DIST. 9 REGION

W.P. No. 145-74-06

CONT. No. 82-25

W. O. No.

STR. SITE No. 3-555

HWY. No. 16N

LOCATION Cranberry Creek

(2.5 km North of Reg. Rd. 13)

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

# FOUNDATION INVESTIGATION REPORT

CONTRACT NO 82-25



Ministry of  
Transportation and  
Communications

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NOTE: For purposes of the contract this report supersedes all other foundation reports prepared by or for the Ministry in connection with the above-mentioned project.



## EXPLANATION OF TERMS USED IN REPORT

2

**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
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	m <sup>3</sup> /s	RATE OF DISCHARGE
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m <sup>3</sup>	SEEPAGE FORCE
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						

## FOUNDATION INVESTIGATION REPORT

For

Cranberry Creek Structure  
Highway 16N, Site: 3-355  
W.P. 145-75-06  
North Gower, Ontario

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### INTRODUCTION

The services of Golder Associates, Consulting Geotechnical Engineers, were retained by the Ministry to carry out a foundation investigation at the above-mentioned site.

The purpose of the investigation was to determine the general subsurface conditions across the site by means of sampled borings, and based on an interpretation of the factual information obtained, to provide engineering recommendations regarding the geotechnical aspects of the proposed crossing. This report summarizes the factual information obtained from this investigation.

The field work for this investigation was carried out on May 25 and 26, 1981 at which time 3 sampled boreholes (numbers 1 to 3) and an augerhole (number 4) were put down using a track mounted hollow stem auger drilling machine.

Borehole 3 was terminated within the overburden soils at a depth of 6.7 metres. The remaining boreholes and augerhole encountered auger refusal on what is probably the bedrock surface at 7.3 to 9.5 metre depth.

## DESCRIPTION OF SITE AND GEOLOGY

The crossing will carry the proposed Highway 16N over Cranberry Creek south of North Gower in the Township of Rideau, Ontario. The site is designated as Site 3-355, District 9, Ottawa.

The ground surface is the area of the crossing in flat, low lying and poorly drained. During periods of low flow, the Cranberry Creek channel is only some 4 to 5 metres wide; because of the topography however, the channel width increases significantly during the spring and other prolonged wet periods of the year. In the vicinity of the crossing and to the south, the ground is covered with tall swamp grasses. Immediately to the north of the channel the ground surface rises in the form of a knoll or ridge and is a grassed pasture.

The site is located within the physiographic region known as the North Gower Drumlin Field which is characterized by scattered glacial till drumlins and ridges; the area between the ridges has generally been infilled with deposits of silt and clay. From previous investigations it is known that the surficial soils in the area of the crossing consist of alluvium or peat overlying silty clay; the rise in the ground surface immediately to the north of the site is composed of glacial till. Bedrock in the area of the site is shown to consist of limestone and dolomite of the Oxford formation.

## SUBSURFACE CONDITIONS

### Subsoil

The detailed subsurface stratigraphy encountered in each borehole and augerhole put down during this investigation is shown on the Record of Borehole and Augerhole sheets which follow this text. The locations of the borings together with soils profiles illustrating the subsurface conditions at the proposed crossing are shown on Drawing No. 2. It should be noted that

the soil boundaries shown on the Record of Borehole sheets and on the drawing have been referred from non-continuous samples and observations during augering and do not necessarily indicate an exact plane of geological change.

#### Summarized Stratigraphy

The areas adjacent to the Cranberry Creek channel are underlain by some 0.85 to 1.85 metres of peat. The peat is followed by a stratum of silty clay to clay which varies in thickness from about 1.2 to 2 metres at the north bank to about 4.5 metres on the south side of the channel. The clay strata is underlain by some 1.5 to 3 metres of sand and gravel containing cobbles and a trace of silt, which in turn is followed by sandy silt glacial till. Auger refusal on what is probably the bedrock surface was encountered at about 9.5 metre depth (elevation 76) on the south side and at about 7.3 metre depth (elevation 78.8) on the south side of the channel.

A detailed description of the subsurface conditions encountered follows:

#### Peat

The flat lying, poorly drained land adjacent to Cranberry Creek is underlain by some 0.85 to 1.85 metres of dark brown fibrous peat. Standard penetration values of 1 blow per 0.3 metres indicate the soft consistency of this organic soil.

#### Silty Clay to Clay

Underlying the peat cover, all borings encountered a stratum of silty clay. The thickness of this stratum increased from about 1.2 to 2 metres on the north side of the channel

(boreholes 1, 3 and 101) to about 4.5 metres on the south side (borehole 2 and augerhole 4.) The upper 0.5 to 1.5 metres of the stratum has been weathered to form a stiff to very stiff crust of grey brown silty clay. An undrained shear strength value of 63 kilopascals was measured by in situ vane testing in the lower portion of the weathered stratum. A natural moisture content determination on the weathered clay gave a value of 45 per cent.

Beneath the weathered zone the color of the clay changes to grey and its consistency reduces to soft to firm. In situ vane testing within this layer measured undrained shear strengths of 17 to 40 kilopascals, with sensitivity ranging from 3 to 20. Atterberg limit testing indicates that the grey silty clay to clay is a moderate to highly plastic soil (CI - CH) with maximum liquid limit of 65 and corresponding plasticity index of 43. The natural moisture content of the grey clay increases with depth from about 40 to 77 per cent and is typically in excess of the liquid limit.

#### Sand and Gravel

The silty clay to clay stratum is underlain by some 1.5 to 3 metres of sand and gravel. From the grading test results on Figure 1, this layer consists of sand and gravel with a trace to some silt. Cobble sizes were also encountered when augering through this deposit. Standard penetration testing within this layer generally measured N values of 23 to 46 blows per 0.3 metres, indicating a compact to dense state of denseness.

#### Glacial Till

Beneath the sand and gravel the borings encountered a layer of glacial till, all of the borings being terminated after penetrating some 2 metres of the glacial till. The glacial



till consists of grey sandy silt with some gravel, clay and cobble and boulder sizes. Standard penetration (N) values of 33 to 57 blows per 0.3 metres within this layer indicate a dense to very dense state of denseness. The natural moisture content of the glacial till was about 10 per cent.

Borehole 2 and augerhole 4 on the southside of the channel encountered auger refusal on what is probably the bedrock surface at about 9.5 metre depth (elevation 76.) Borehole 1, on the north side, met refusal to augering at 7.3 metre depth (elevation 78.8.)

#### Groundwater

The groundwater levels were measured on July 6, 1981 in the standpipes installed in the boreholes. At this time the water level in boreholes 1, 3 and 101 was at about a 0.15 to 0.6 metre depth (about elevation 85.7.) This corresponds closely to the water level in the adjacent Cranberry Creek. On July 6, 1981, the ground surface at borehole 2 and augerhole 4 was below the creek water level.



T. Kazmierowski, P. Eng.  
Foundations Engineer



M. Devata, P. Eng.  
Senior Foundations Engineer

## APPENDIX

# RECORD OF BOREHOLE No 1

METRIC

9

W P 145-74-06 LOCATION Sta. 13+881, o/s 5.5 m Rt. ORIGINATED BY DJS  
DIST 9 HWY 16N BOREHOLE TYPE Hollow Stem, Wash Boring COMPILED BY DN  
DATUM Geodetic DATE 1981 05 25 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
86.13	Ground Level																GR SA SI CL
0.00	Peat, organic material. Dark Brown Soft				July 6/81		86										
							85										
84.30			1	SS	1/5												
1.83	Silty clay to Clay, Wash.																
84.00	Grey Brown Very Stiff																
2.13	Silty Clay to Clay Grey Firm						84										
82.47			2	SS	1		83										
3.66	Sand and gravel, some silt and cobbles. Compact to Dense		3	SS	28		82										37 50 13 0
81.10			4	SS	46												
5.03	Glacial till, sandy silt, some gravel, clay and boulders. Compact to Dense						81										
			5	SS	46		80										
78.81							79										
7.32	End of Borehole Refusal to augering						78										

+3, x5: 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 2

METRIC

10

W P 145-74-06

LOCATION Sta. 13+852, o/s 5.6 m Lt.

ORIGINATED BY DJS

DIST 9 HWY 16N

BOREHOLE TYPE Hollow Stem, Wash Boring

COMPILED BY DN

DATUM Geodetic

DATE 1981 05 26

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
85.50	Ground Level																
0.00	Peat, organic																
	Dark Brown																
84.65																	
0.85	Silty clay, weathered. To Clay																
	Grey Brown Very Stiff		1	SS	4												
83.12																	
2.38	Silty clay To Clay																
	Grey Soft to Firm		2	SS	1												
			3	SS	PM												
79.89																	
5.61	Sand and gravel, some cobbles, trace silt.																
	Grey Compact		4	SS	23												
77.73																	
7.77	Glacial till, sandy silt, some gravel and clay, occasional boulder.		5	SS	39												
	Grey Dense																
75.96			6	SS	38/0.15m												
9.54	End of Borehole Refusal to augering																

+3, x5: Numbers refer to  
Sensitivity

20  
15 + 5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

**METRIC**

11

ORIGINATED BY DJS

COMPILED BY DN

CHECKED BY \_\_\_\_\_

+3, x5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION



## METRIC

12

W P 145-74-06 LOCATION Sta. 13+858, o/s 6.2 m Rt ORIGINATED BY DJS  
DIST 9 HWY 16N BOREHOLE TYPE Hollow Stem COMPILED BY DN  
DATUM Geodetic DATE 1981 05 26 CHECKED BY \_\_\_\_\_

[illegible]

+3, x5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION



Ministry of  
Transportation and  
Communications  
Ontario

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 101 (STATION 13+880 E)

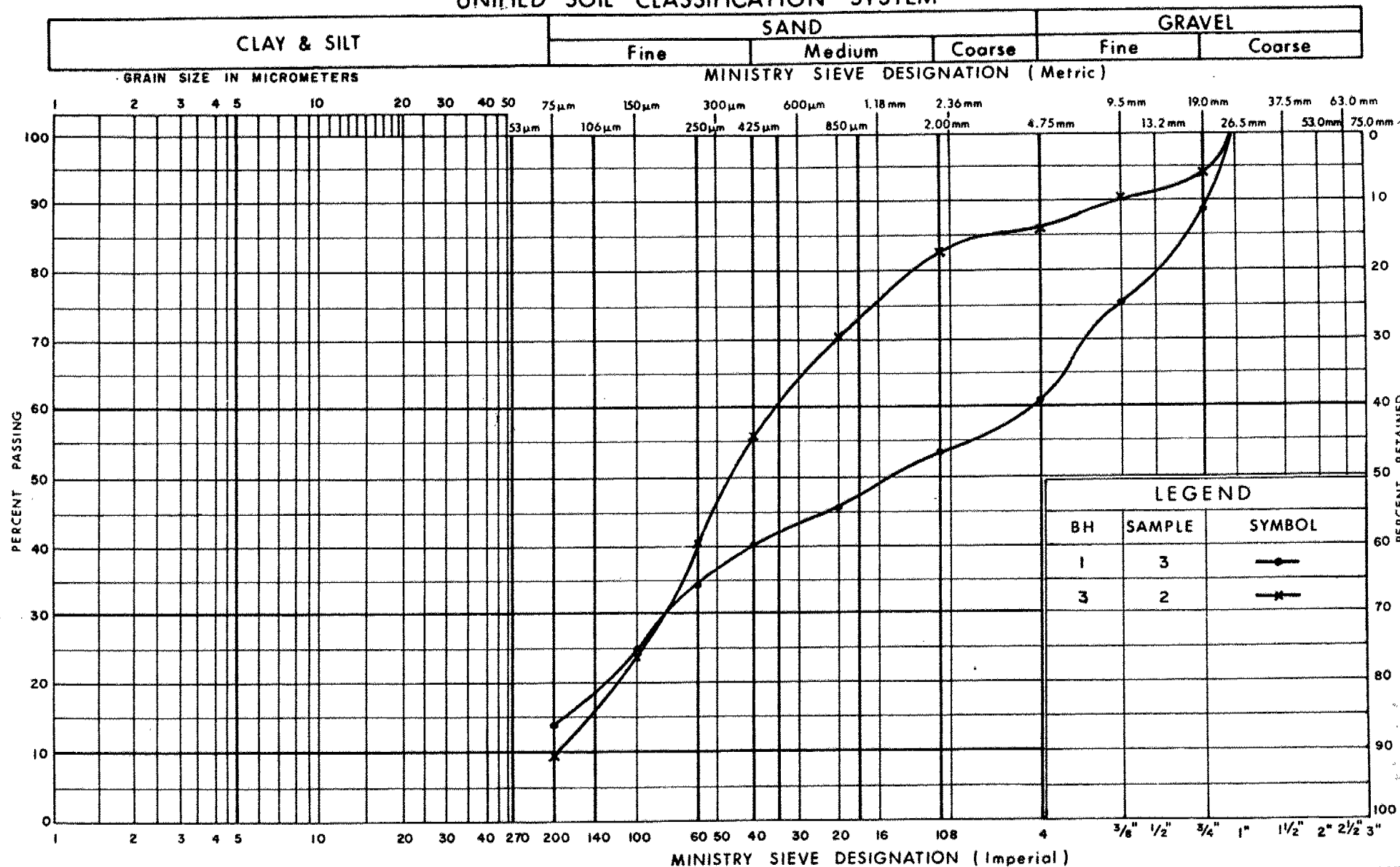
13

W P 145-74-06 LOCATION Sta. 13+880, E ORIGINATED BY PH  
DIST 9 HWY 16N BOREHOLE TYPE Hollow Stem, Power Auger COMPILED BY DN  
DATUM Geodetic DATE 1981 03 02 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60					
86.20	Ground Level													
0.00	Peat, fibrous. Black					1981 04 24								
84.52			1	SS	1							390	Org 140%	
1.68	Silty clay to clay		2	SS	PL									
83.76	Grey Stiff													
2.44	Silty clay to clay													
82.48	Grey Firm		3	SS	PM									
3.72	Glacial till, sand and gravel, trace to some silt, occasional coarse sand layer.		4	SS	15	Standpipe								
81.17	Grey Compact		5	SS	20									
5.03	End of Borehole													

+3, x5: Numbers refer to  
Sensitivity 20  
15 5 (%) STRAIN AT FAILURE  
10

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

**GRAIN SIZE DISTRIBUTION**  
**SAND AND GRAVEL**  
**TRACE TO SOME SILT**

FIG No 1

W P 145-74-06





## Golder Associates

CONSULTING GEOTECHNICAL AND MINING ENGINEERS

REPORT

TO

MINISTRY OF TRANSPORTATION  
& COMMUNICATIONS

GEOTECHNICAL INVESTIGATION  
CRANBERRY CREEK STRUCTURE  
Highway 16N, Site 3-355

W.P. 145-74-06

NORTH GOWER

ONTARIO

Distribution:

14 copies - Ministry of Transportation  
& Communications  
Downsview, Ontario

2 copies - Golder Associates  
Ottawa, Ontario

29 July, 1981

811-2111

*189*  
*GEOCREES N° 31G-188*

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## ABSTRACT

This report contains the results of an investigation to determine the subsurface conditions at the site of the proposed crossing of Cranberry Creek by Highway 16N, south-east of North Gower, Ontario. Geotechnical recommendations are given for foundation design of the crossing structure and the roadway approach fills.

The boreholes indicated that this low lying site is underlain by about 2 metres of soft peat soils. This organic covering is followed by a stratum of silty clay, the thickness of which increases in a north to south direction. The clay is in turn followed by compact sand and gravel and then dense sandy silt glacial till. Auger refusal on what is probably the bedrock surface was encountered at depths of about 9.5 metres and 7.3 metres on the south and north sides respectively. The groundwater level was found to correspond to the stream level.

It is recommended that the groundwater control necessary for excavation to founding or pile cap level be accomplished by diverting the flow in Cranberry Creek and then constructing an interlocked sheeted cell which extends down through the silty clay and sand and gravel to toe into the glacial till. Water could then be pumped from within the cell to the required level.

It is recommended that the excavation for shallow foundations be taken down through the clay to the sand and gravel; the allowable bearing pressure would be 200 kilopascals. Alternatively the structure could be supported on end bearing piles driven to a final set within the dense glacial till or on bedrock. Steel H-sections would be a suitable type of pile. The pile tips should be reinforced to avoid damage when driving through boulders within the glacial till.

It is estimated that the 2 metre high approach fills may undergo settlements of about 25 to 40 millimetres and that concrete approach slabs be used as a transition between the roadway approaches and the crossing structure.

July 1981  
811-2111

## 1. INTRODUCTION

Golder Associates, Consulting Geotechnical and Mining Engineers, have been retained by the Ministry of Transportation and Communications, Ontario to carry out a geotechnical investigation at the site of the proposed crossing of Cranberry Creek by the proposed Highway 16N near North Gower, Ontario. Preliminary details of the proposed crossing were provided to us by Mr. M.S. Devata, P.Eng, Supervisory Engineer, Soil Mechanics Section, Ministry of Transportation and Communications, Downsview, Ontario. The proposed scope of the investigation was outlined in our proposal letter of May 11, 1981 to Mr. M.S. Devata.

The purpose of the investigation was to determine the general subsurface conditions across the site by means of sampled borings, and based on an interpretation of the factual information obtained, to provide engineering recommendations regarding the geotechnical aspects of the proposed crossing, including any special construction considerations which could influence design decisions.

This report is presented in two parts. Part A details the factual results of the borings while Part B gives our interpretation of this data and recommendations for the geotechnical design of the proposed work. It is noted that a borehole was put down at this site for preliminary evaluation purposes as part of Golder Associates report 811-2006 "Soils Design Report for Highway 416", dated June 1981. This information has been utilized in Parts A and B of this report.

## 2. DESCRIPTION OF SITE AND GEOLOGY

The proposed crossing will carry the proposed Highway 16N over Cranberry Creek south of North Gower in the Township of Rideau, Ontario. The site is designated as Site 3-355, District 9, Ottawa.

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The ground surface is the area of the crossing in flat, low lying and poorly drained. During periods of low flow, the Cranberry Creek channel is only some 4 to 5 metres wide; because of the topography however, the channel width increases significantly during the spring and other prolonged wet periods of the year. In the vicinity of the crossing and to the south, the ground is covered with tall swamp grasses. Immediately to the north of the channel the ground surface rises in the form of a knoll or ridge and is a grassed pasture.

The site is located within the physiographic region known as the North Gower Drumlin Field which is characterized by scattered glacial till drumlins and ridges; the area between the ridges has generally been infilled with deposits of silt and clay. From previous investigations it is known that the surficial soils in the area of the crossing consist of alluvium or peat overlying silty clay; the rise in the ground surface immediately to the north of the site is composed of glacial till. Bedrock in the area of the site is shown to consist of limestone and dolomite of the Oxford formation.

PART A

SUBSURFACE CONDITIONS

---

### 3. SUBSURFACE CONDITIONS

#### 3.1 Subsoil

The detailed subsurface stratigraphy encountered in each borehole and augerhole put down during this investigation is shown on the Record of Borehole and Augerhole sheets which follow this text. The locations of the borings together with soils profiles illustrating the subsurface conditions at the proposed crossing are shown on Drawing 1457406-A. It should be noted that the soil boundaries shown on the Record of Borehole sheets and on the drawing have been referred from non-continuous samples and observations during augering and do not necessarily indicate an exact plane of geological change.

##### 3.1.1 Summarized Stratigraphy

The areas adjacent to the Cranberry Creek channel are underlain by some 0.85 to 1.85 metres of peat. The peat is followed by a stratum of silty clay which varies in thickness from about 1.2 to 2 metres at the north bank to about 4.5 metres on the south side of the channel. The clay strata is underlain by some 1.5 to 3 metres of sand and gravel containing cobbles and a trace of silt, which in turn is followed by sandy silt glacial till. Auger refusal on what is probably the bedrock surface was encountered at about 9.5 metre depth (elevation 76) on the south side and at about 7.3 metre depth (elevation 78.8) on the south side of the channel.

##### 3.1.2 Peat

The flat lying, poorly drained land adjacent to Cranberry Creek is underlain by some 0.85 to 1.85 metres of dark brown fibrous peat. Standard penetration values of 1 blow per 0.3 metres indicate the soft consistency of this organic soil.

### 3.1.3 Silty Clay

Underlying the peat cover, all borings encountered a stratum of silty clay. The thickness of this stratum increased from about 1.2 to 2 metres on the north side of the channel (boreholes 1, 3 and 101) to about 4.5 metres on the south side (borehole 2 and augerhole 4). The upper 0.5 to 1.5 metres of the stratum has been weathered to form a stiff to very stiff crust of grey brown silty clay. An undrained shear strength value of 63 kilopascals was measured by in situ vane testing in the lower portion of the weathered stratum. A natural moisture content determination on the weathered clay gave a value of 45 per cent.

Beneath the weathered zone the color of the clay changes to grey and its consistency reduces to soft to firm. In situ vane testing within this layer measured undrained shear strengths of 17 to 40 kilopascals, with sensitivity ranging from 3 to 20. Atterburg limit testing indicates that the grey silty clay is a highly plastic soil, with a liquid limit of 65 and corresponding plasticity index of 43. The natural moisture content of the grey clay increases with depth from about 40 to 77 per cent and is typically in excess of the liquid limit.

### 3.1.4 Sand and Gravel

The silty clay is underlain by some 1.5 to 3 metres of sand and gravel. From the grading test results on Figure 1, this layer consists of sand and gravel with a trace to some silt. Cobble sizes were also encountered when augering through this deposit. Standard penetration testing within this layer generally measured N values of 23 to 46 blows per 0.3 metres, indicating a compact to dense state of packing.

### 3.1.5 Glacial Till

Beneath the sand and gravel the borings encountered a layer of glacial till, all of the borings being terminated



after penetrating some 2 metres of the glacial till. The glacial till consists of grey sandy silt with some gravel, clay and cobble and boulder sizes. Standard penetration (N) values of 33 to 57 blows per 0.3 metres within this layer indicate a dense to very dense state of packing. The natural moisture content of the glacial till was about 10 percent.

Borehole 2 and augerhole 4 on the south side of the channel encountered auger refusal on what is probably the bedrock surface at about 9.5 metre depth (elevation 76). Borehole 1, on the north side, met refusal to augering at 7.3 metre depth (elevation 78.8).

### 3.2 Groundwater

The groundwater levels were measured on July 6, 1981 in the standpipes installed in the boreholes. At this time the water level in boreholes 1, 3 and 101 was at about a 0.15 to 0.6 metre depth (about elevation 85.7). This corresponds closely to the water level in the adjacent Cranberry Creek. On July 6, 1981, the ground surface at borehole 2 and augerhole 4 was below the creek water level.

PART B

DISCUSSIONS AND RECOMMENDATIONS

#### 4. DESCRIPTION OF PROJECT

This section of the report presents our interpretation of the factual data obtained from the boreholes. This information is provided for the guidance of the design engineers and is based on our present understanding of the project. It is recommended that the final design of the crossing structure be discussed with the geotechnical engineer to ensure that the recommendations given in this report are applicable to the actual design requirements.

Planning is underway for the crossing of Cranberry Creek by the proposed Highway 16N. Preliminary details of the project were provided to us on a marked up copy of M.T.C. Plan E-7000-1, "Bridge Site Plan, Proposed Crossing at Cranberry Creek and Highway 416 N.B.L. Line 'C', dated March 1981.

It is understood that in initial consideration of this crossing, the preferable structure type is a concrete box culvert having a 6 metre opening width. The proposed profile grade is elevation 87.6, some 1.7 to 2 metres above the existing ground surface. Concrete approach slabs 6 metres in width are to be provided.

#### 5. EXCAVATION

Excavation to the proposed founding level at about elevation 83 will be carried down through the peat cover and will generally terminate within the firm grey silty clay. In the area of borehole 3 however, excavation to this level will encounter the water bearing sand and gravel deposit which underlies the clay stratum. Although water inflow through the clay soils will be fairly minor, water inflow through the peat and sand and gravel strata will be considerable. With reference to Drawing 1457406-A it is expected that the thickness of the clay stratum in the area of the south structure foundations will be less than that shown

on section A-A and can be interpolated between sections A-A and B-B. Because of the excess hydrostatic pressures which exist in the sand and gravel deposit and the thin covering of clay which will remain between the base of the excavation and the top of the sand and gravel, it is also expected that basal heave and disturbance of the clay soils will occur unless positive groundwater control measures are implemented.

Prior to construction, it is recommended that Cranberry Creek be directed away from the structure area. It is suggested that the required groundwater control could be most effectively achieved by constructing a cell of interlocking steel sheeting around the structure area. The sheeting should be driven down through the compact sand and gravel stratum and toed into the underlying relatively impervious glacial till. Filtered sump wells could then be installed within the sand and gravel and pumped prior to excavation to lower the water pressure within the sheeted cell to below the proposed founding level (see Section 6 of this report).

If sheeting is not installed, the above groundwater control could also possibly be achieved; however, it is anticipated that the time which would be required to achieve the necessary lowering would be considerably longer and that an intercepting ditch and a series of sumps or wells would be needed.

## 6. FOUNDATIONS

### 6.1 Shallow Foundation

The loads which will be experienced by the underlying soils due to construction of the crossing will be the weight of the structure itself, the weight of the 2 metres of grade raise filling to reach proposed profile grade, and the difference in unit weights between the excavated peat and the replacement earth backfill. The load imposed by the earth fills

will consume a considerable portion of the allowable bearing pressure of the firm grey silty clay soil. Also, the borings indicate that at elevation 83, the structure would be partly supported on the firm clay and partly on the compact sand and gravel.

In order to utilize spread footing foundations for the crossing and to reduce the danger of detrimental total and/or differential settlement across the structure, it is recommended that the structure base or foundation elements be taken down through the silty clay to the underlying sand and gravel at about elevation 81 to 82. The groundwater level in the sand and gravel should in this case be lowered to just below founding level as discussed in Section 5. Alternatively, the excavated area could be raised to the founding level at about elevation 83 using a well graded sand and gravel fill conforming to M.T.C. Granular 'A' specifications, compacted to at least 95 percent of the maximum standard Proctor dry density. For purposes of design, the allowable bearing pressure for either the compact, native sand and gravel above the lowered groundwater level or the well compacted granular fill pad may be taken as 200 kilopascals.

With regard to the proposed headwall/wingwall structure, it would also be necessary to place their foundations on the native sand and gravel or on a well compacted granular pad above the sand and gravel in order to achieve post construction settlements which would be compatible with the main structure. This could be avoided by not using a headwall structure, but instead extending the main structure beyond the edges of the roadway as necessary and shaping earth fill at the ends of the structure opening. In this case, rip-rap protection should be provided to the lower portion of the embankment fills adjacent to the creek channel.

## 6.2 PILE FOUNDATIONS

As an alternative to excavation of the silty clay to reach the underlying sand and gravel stratum, the crossing structure could be founded on a pile foundation. With this foundation solution, an open frame culvert or bridge structure would probably be incorporated into the design. Steel H-piles, driven to end bearing, would be a suitable pile type at this site. It is considered that some of the steel H-piles would probably achieve a final set within the dense glacial till, while others may penetrate to the underlying bedrock surface which is indicated to exist at about elevation 76 to 79. The tips of the piles should be reinforced to minimize any structural damage caused by driving through the cobbles and boulders within the glacial till. The allowable pile load would depend on the pile section chosen. For preliminary design purposes the allowable load on an HP310 by 110 driven to a final set of 15 blows for the last 25 millimetres of penetration with a hammer developing at least 40 kilojoules of energy per blow may be taken as 1150kN. For purposes of Limit State Design, the capacity of the piles at the serviceability limit state Type II may also be taken as 1000kN. The factored capacity in the ultimate limit state would be 1650kN.

The use of concrete approach slabs to such a structure is highly recommended in order to minimize the effects of differential settlement between the rigid pile supported structure and the flexible earth approach fills.

It is noted that even with a pile foundation some form of groundwater control, as discussed previously in Section 5, will be required to excavate for construction of the pile caps.

## 7. ABUTMENTS

Abutment pile caps and/or footings should be provided with at least 1.5 metres of cover for frost protection. The abutment walls or culvert side walls should be back-filled for a horizontal distance of at least 1.5 metres with a free draining, non-frost susceptible granular material, such as that meeting M.T.C. Granular 'C' grading specifications. This backfill should be placed and compacted in shallow lifts. With effective drainage of this granular backfill to prevent the buildup of hydrostatic or ice pressures, rigid walls should be designed using an at rest earth pressure coefficient,  $k_0$ , of 0.5 and a total unit weight of 21.2 kN per cubic metre. This value of  $k_0$  provides some allowance for stresses induced by compaction. If some movement at the top of the wall may be tolerated, an active earth pressure coefficient ( $k_a$ ) value of 0.3 may be used.

In terms of Limit State design, earth pressures should be calculated as specified in Section 6.6.1.2.2 of the new Bridge Design Code.

## 8. ROADWAY APPROACH FILL

As presently proposed the roadway approach grade to the structure will be at elevation 87.6, which is some 1.7 to 2.1 metres above the present ground surface level. This grade raise will cause some consolidation settlement of the underlying clay stratum, the magnitude of which will depend on the thickness and consolidation characteristics of the layer. Although laboratory oedometer testing was not carried out to determine these characteristics, it is considered that this applied load will be in the recompression range and, as such, post construction settlements should be of the order of about 25 to 40 millimetres. In order to minimize the effects of differential settlements between the approaches and the structure, the proposed

approach slab technique should be used.

In preparation for construction of the roadway approach fills to this structure, all peat should be stripped full base width from the roadway area. The grade should then be raised with acceptable granular materials, placed in relatively thin even lifts and compacted to at least 95 percent of the maximum standard Proctor dry density using suitable vibratory compaction equipment.

Some groundwater inflow from the peat soils adjacent to the roadway area may be expected. In order to adequately compact the granular fills in place in these wet conditions, it may be necessary to increase the thickness of the lower lift of fill somewhat to avoid softening of the subgrade by compaction operations.

GOLDER ASSOCIATES

PAS:RAM:sb  
811-2111



A handwritten signature in dark ink, appearing to read "P.A. Smolkin".

P.A. Smolkin, P.Eng.



APPENDIX A

INVESTIGATION PROCEDURES

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INVESTIGATION PROCEDURES

The field work for this investigation was carried out on May 25 and 26, 1981 at which time 3 sampled boreholes (numbers 1 to 3) and an augerhole (number 4) were put down using a track mounted hollow stem auger drilling machine supplied and operated by the F.E. Johnston Drilling Co. Ltd. of Ottawa. At this time the lateral extent of Cranberry Creek on its south side was such that it was necessary to shift two of the borings from their originally proposed locations.

Borehole 3 was terminated within the overburden soils at a depth of 6.7 metres. The remaining boreholes and augerhole encountered auger refusal on what is probably the bedrock surfact at 7.3 to 9.5 metre depth. The sand and gravel material encountered in boreholes 1 to 3 tended to blow into the hollow stem augers when the centre plug was removed, necessitating the conversion to augering ahead without the centre plug and then carrying out a wash boring within the auger stem. Standard penetration tests (N values) were carried out within the overburden soils and samples recovered at 0.76 to 1.52 metre intervals of depth using a conventional 51 millimetre OD split spoon(ss) sample. In situ vane tests were carried out where possible to determine the undrained shear strength profile of the silty clay soils. Standpipes were sealed into boreholes 1 and 3 to permit measurement of the groundwater levels.

Details of the drilling and sampling operations carried out in each of the boreholes and augerhole are given on the Record of Borehole and Augerhole sheets following the text of this report. A detailed log of borehole 101, put down for preliminary planning purposes during our soils investigation along the proposed Highway 416 alignment (Golder Associates Report 811-2006), is also included in this report. The field work was supervised throughout by a member of our

engineering staff who directed the drilling, sampling, and in situ testing operations, logged the boreholes, and packaged the samples. The samples recovered from the boreholes were sealed in watertight jars and returned to our laboratory in Ottawa for detailed examination and classification testing. The results of the laboratory testing are given on the Record of Borehole sheets and on Figure 1.

The locations of the borings are given on the Record of Borehole and Augerhole sheets and are shown on Drawing 1457406-A, located in the pocket following the text of this report. The test hole locations were set out in the field by us with reference to staking set out by the Ministry. The elevations of the ground surface at the borehole locations were also determined by us with reference to a bench mark set by the Ministry. This bench mark, consisting of a nail and washer in the west root of a 0.20 metre maple tree, 45.2 metres right of Station 13+762.6, was given to us as elevation 86.056 (metres), referred to Geodetic datum.

## 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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$kPa^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	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
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_f$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### PHYSICAL PROPERTIES OF SOIL

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

# RECORD OF BOREHOLE No 1

METRIC

W P 145-74-06 LOCATION Sta. 13+881, o/s 5.5 m Rt. ORIGINATED BY DJ5  
DIST 9 HWY 16N BOREHOLE TYPE Hollow Stem, Wash Boring COMPILED BY DN  
DATUM Geodetic DATE 1981 05 25 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
86.13	Ground Level																
0.00	Peat, organic material. Dark Brown Soft				July 6/81		86										
							85										
84.30																	
1.83	Silty clay, weathered.		1	SS	1												
84.00	Grey Brown Very Stiff				5												
2.13	Silty Clay						84										
	Grey Firm																
							83										
82.47			2	SS	1												
3.66	Sand and gravel, some silt and cobbles. Grey Compact to Dense		3	SS	28		82										
81.10			4	SS	46		81										
5.03	Glacial till, sandy silt, some gravel, clay and boulders. Grey Compact to Dense						80										
			5	SS	46												
78.81							79										
7.32	End of Borehole Refusal to augering						78										

# RECORD OF BOREHOLE No 2

METRIC

W P 145-74-06 LOCATION Sta. 13+852, o/s 5.6 m Lt. ORIGINATED BY DJS  
DIST 9 HWY 16N BOREHOLE TYPE Hollow Stem, Wash Boring COMPILED BY DN  
DATUM Geodetic DATE 1981 05 26 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa									
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 25 50 75 100 125					20 40 60						
85.50	Ground Level																
0.00	Peat, organic																
	Dark Brown																
84.65																	
0.85	Silty clay, weathered.																
	Grey Brown Very Stiff																
			1	SS	4												
83.12																	
2.38	Silty clay.																
	Grey Soft to Firm																
			2	SS	1												
			3	SS	PM												
79.89																	
5.61	Sand and gravel, some cobbles, trace silt.																
	Grey Compact																
			4	SS	23												
77.73																	
7.77	Glacial till, sandy silt, some gravel and clay, occasional boulder.																
	Grey Dense																
			5	SS	39												
75.96																	
			6	SS	38/0.15m												
9.54	End of Borehole Refusal to augering																

+3, x5: Numbers refer to Sensitivity

20  
15 5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 3

METRIC

W P 145-74-06 LOCATION Sta. 13+874, o/s 6.0 m Lt. ORIGINATED BY DJS  
DIST 9 HWY 16N BOREHOLE TYPE Hollow Stem, Wash Boring COMPILED BY DN  
DATUM Geodetic DATE 1981 05 26 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
85.89	Ground Level																
0.00	Peat, organic. Dark Brown		July	6/81		Surface Seal											
84.49							85										
1.40	Silty clay. Grey Brown becoming Grey					Bentonite Seal	84										
83.30																	
2.59	Sand and gravel, some cobbles, trace silt.  Grey Dense to Very Dense		1	SS	30	Native Backfill	83										
			2	SS	85		82										
			3	SS	31		81										
80.40			4	SS	57		80										
5.49	Glacial till, sandy silt, some gravel, clay and boulders.  Dense to Very Dense		5	SS	33	Standpipe											
79.18																	
6.71	End of Borehole						79										



# RECORD OF AUGERHOLE No 4

METRIC

W P 145-74-06 LOCATION Sta. 13+858, o/s 6.2 m Rt ORIGINATED BY DJS  
DIST 9 HWY 16N BOREHOLE TYPE Hollow Stem COMPILED BY DN  
DATUM Geodetic DATE 1981 05 26 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH									
							20	40	60	80	100						
85.47	Ground Level																
0.00	Peat, organic.																
	Dark Brown																
84.17																	
1.3±	Probably silty clay, grey brown, weathered.																
83.17																	
2.3±	Probably silty clay, grey.																
79.97																	
5.5±	Probably sand, gravel and cobbles.																
77.97																	
7.5±	Probably glacial till, sandy silt, gravel, clay.																
75.96																	
9.51	End of Augerhole Refusal to Augering																



## RECORD OF BOREHOLE No 101 (STATION 13+880 G.)

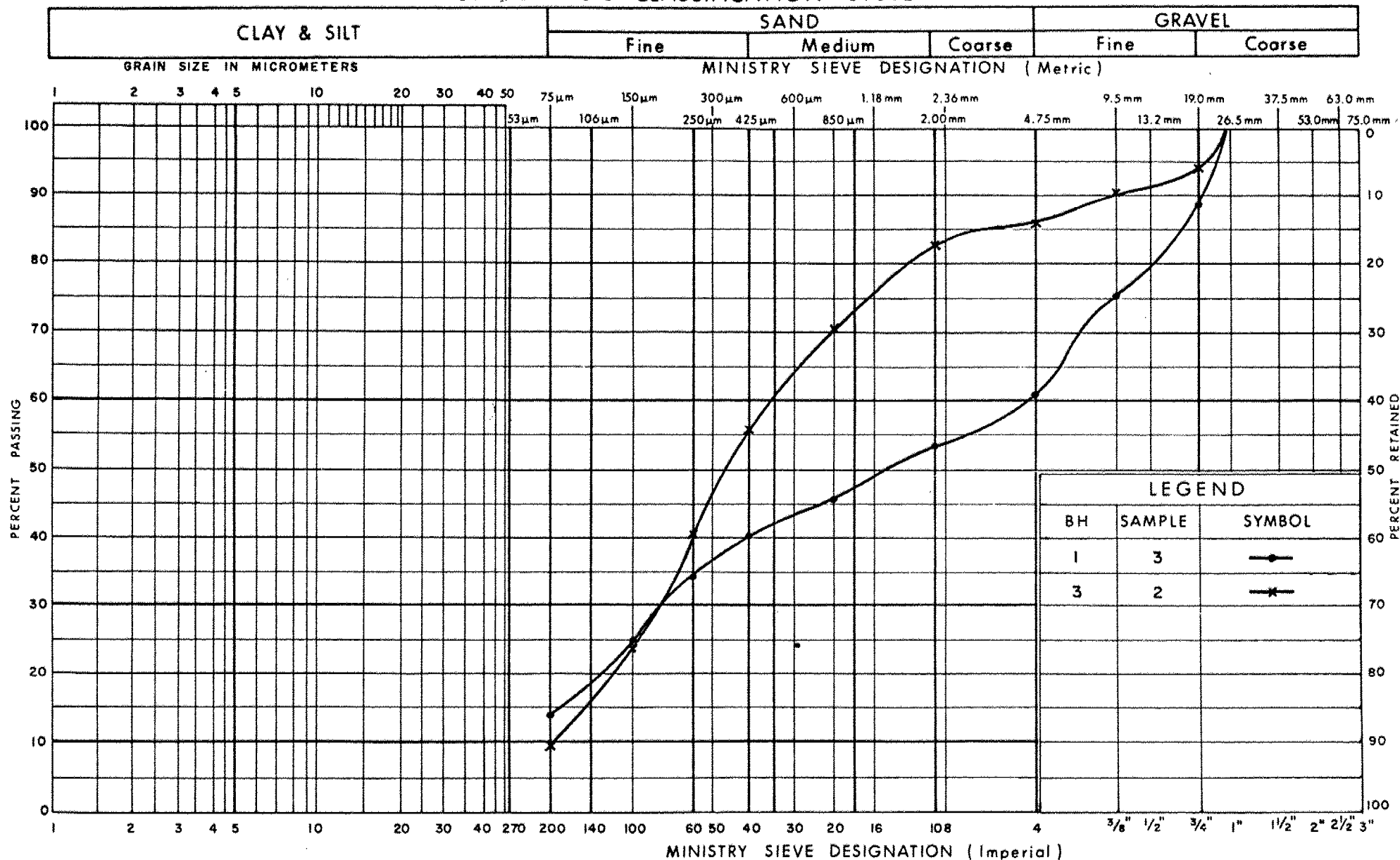
W P 145-74-06 LOCATION Sta. 13+880, 2 ORIGINATED BY PH  
DIST 9 HWY 16N BOREHOLE TYPE Hollow Stem, Power Auger COMPILED BY DN  
DATUM Geodetic DATE 1981 03 02 CHECKED BY \_\_\_\_\_

[illegible]

**+3, x5** : Numbers refer to Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SAND AND GRAVEL  
TRACE TO SOME SILT

FIG No 1

W P 145-74-06

**METRIC**

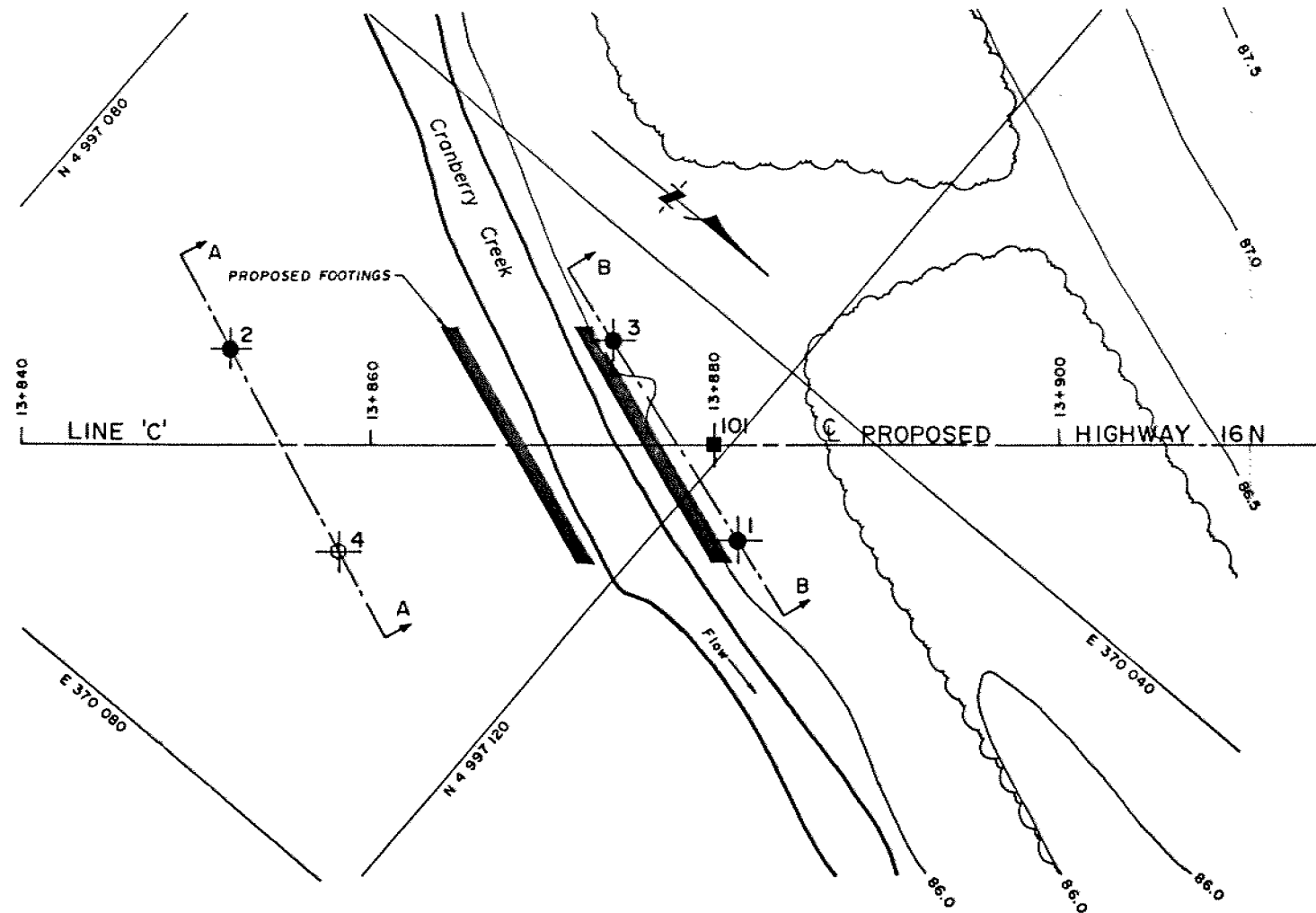
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN.  
STATIONS ARE IN  
KILOMETRES AND METRES.

CONT No  
WP No 145-74-06

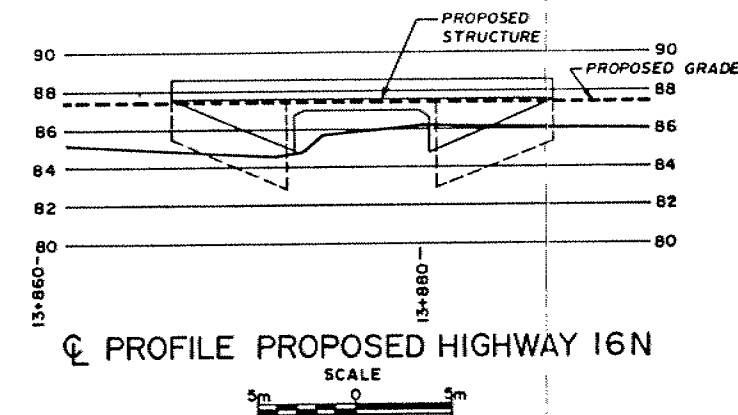
CRANBERRY CREEK  
(2.5 km North of Reg Road 13)  
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

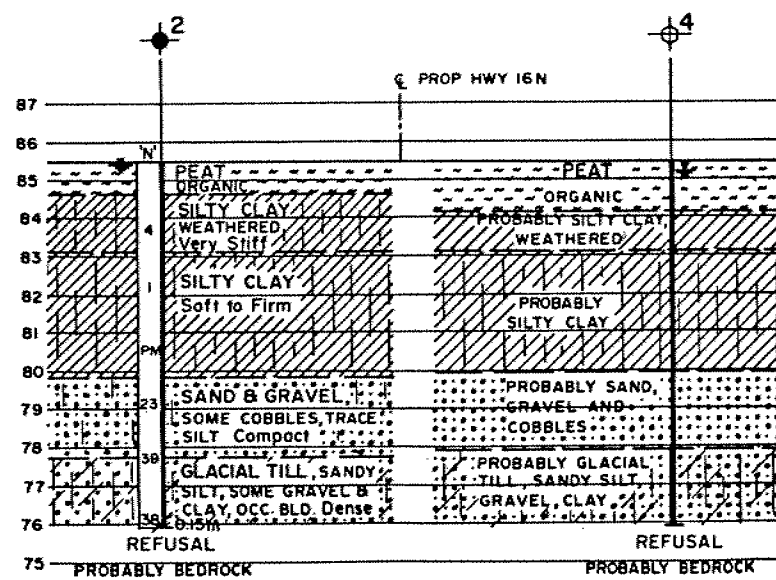


PLAN  
SCALE  
0 5m 5m



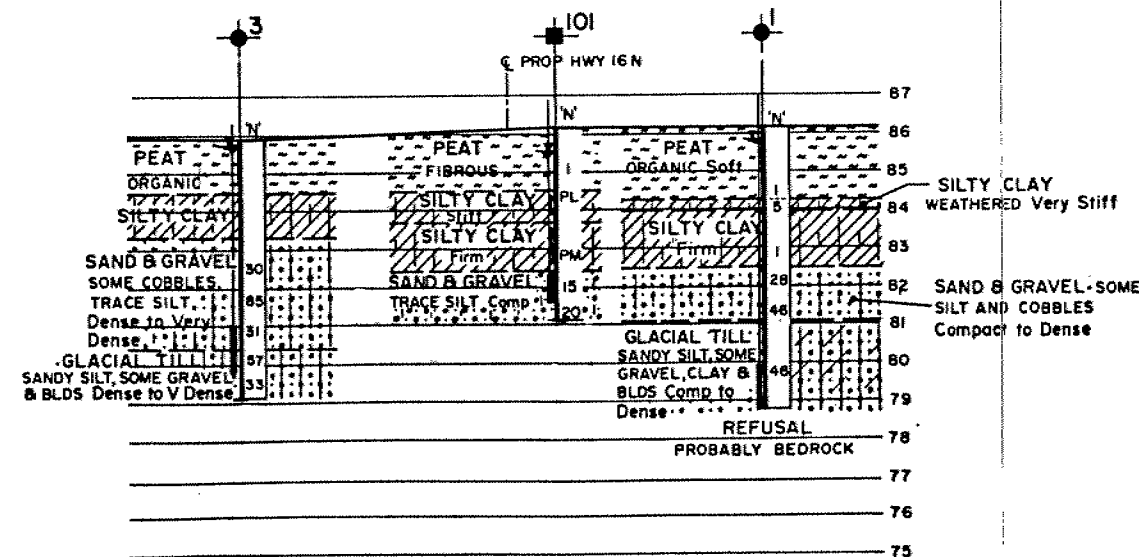
PROFILE PROPOSED HIGHWAY 16N

SCALE  
0 5m 5m



A-A

SCALE  
0 5m 5m



B-B

**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 1981 03
- ⊕ Auger Hole
- Bore Hole previous investigation
- ⊥ Standpipe

No	ELEVATION	STATION	OFFSET
1	86.13	13+881	5.5m Rt
2	85.50	13+852	5.6m Lt
3	85.89	13+874	6.0m Lt
4	85.47	13+858	6.2m Rt
101	86.2 ±	13+880	℄

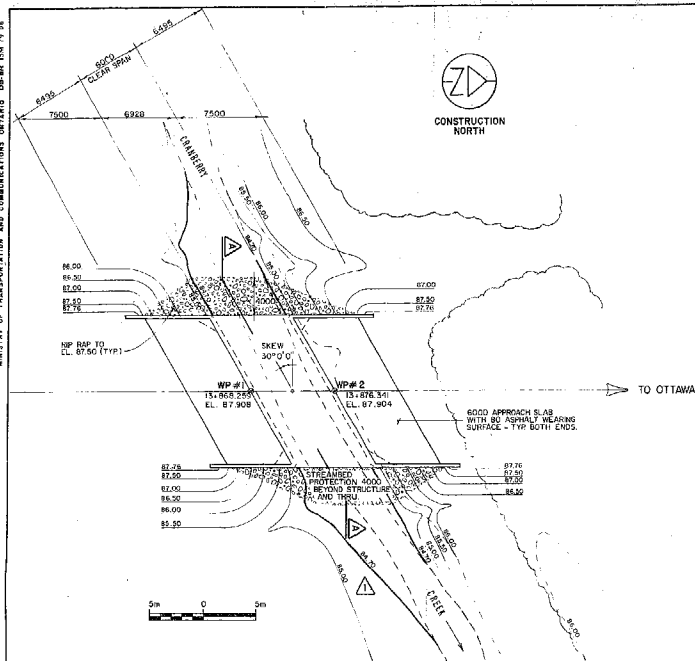
**NOTE**

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

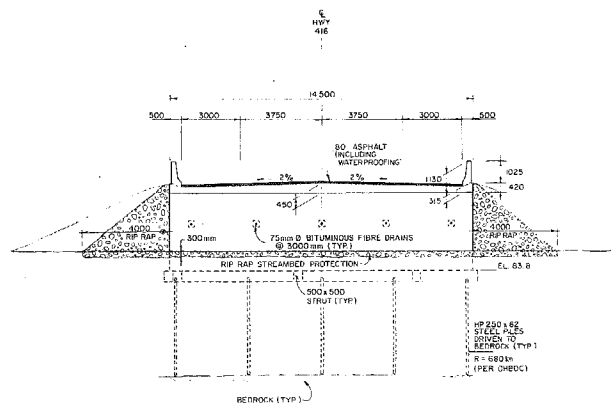
Geocres No 316-189			
HWY No 16N	CHECKED	DATE 1981 08 05	DIST 9
SUBWD	CHECKED	APPROVED	SITE 3-355
DRAWN DN	CHECKED		DWG 1457406-A

REF No E-7000-1; 1981 03

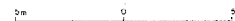


CONSTRUCTION  
NORTH

TO OTTAWA



BEDROCK (TYP) )



STRUCTURE  
STA. 13+672.30  
FL 87.806  
FINISHED PAVEMENT

# PROFILE OF HIGHWAY 16N

METRIC

DIMENSIONS ARE IN MILLIMETRES  
UNLESS OTHERWISE SHOWN.  
ELEVATIONS, COORDINATES, CURVE  
AND ALIGNMENT DATA ARE IN METRES.  
STATIONS ARE IN KILOMETRES + METRES

DIST	No	9 - OTTAWA
CONT	No	
WP	No	145-74-06



**CRANBERRY CREEK STRUCTURE**  
HIGHWAY 16N, 2.5KM NORTH OF REGIONAL ROAD 13

**GENERAL ARRANGEMENT**

11



**J.L. Richards & Associates Limited**  
Consulting Engineers & Planners  
8841 Lady Elen Place, OTTAWA, Canada

## NOTES

## CLASS OF CONCRETE

DECK, BARRIER WALLS AND ABUTMENTS . . . . .	30 MPa
REMAINDER . . . . .	20 MPa

CLEAR COVER TO REINFORCING

FOOTINGS	100 # 25
DECK - TOP	70 # 20
BOTTOM	50 # 10
ABUTMENTS, WINGWALLS AND BARRIER WALLS	80 # 20
APPROACH SLABS	40 # 10

### CONSTRUCTION NOTES

BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS, KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATIONS BE GREATER THAN 0.5m.

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

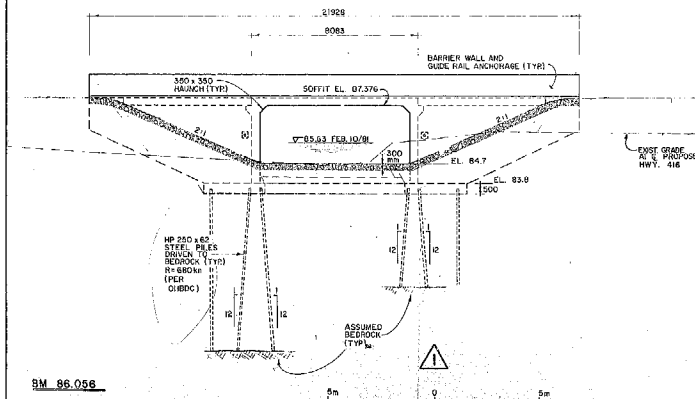
### CONCRETE QUANTITIES

CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS:

1- CONCRETE IN ABUTMENTS .....	68.1 m <sup>3</sup>
2- CONCRETE IN WINGWALLS .....	42.9 m <sup>3</sup>
3- CONCRETE IN DECK .....	44.8 m <sup>3</sup>
4- CONCRETE IN BARRIER WALLS .....	12.8 m <sup>3</sup>
5- CONCRETE IN APPROACH SLABS .....	43.5 m <sup>3</sup>

## LIST OF DRAWINGS

- 1- GENERAL ARRANGEMENT
- 2- SUGGESTED UNWATERING SCHEME,  
BOREHOLE LOCATIONS & SOIL STRATA
- 3- ABUTMENTS AND WINGWALLS
- 4- RIGID FRAME DETAILS
- 5- PILE DRIVING- DROP HAMMERS
- 6- PILE DRIVING- STEAM AND DIESEL HAMMERS
- 7- HARRIER WALL
- 8- 6000mm APPROACH SLAB
- 9- BRIDGE DATE & SITE NUMBER DATA
- 10- PLASTIC FIGURES
- 11- AS CONSTRUCTED ELEV. & DIM.



**NOTE**

- WP DENOTES WORKING POINT  
• TP DENOTES TOP OF PAVEMENT

3M 86,056

GEODETIC DATUM:  
N & W IN NW ROOT OF 200 MAPLE.  
45.2 METRES RIGHT OF STA. 13+762.6 NB.

DECK WATERPROOFING AND PAVING  
ARE NOT PART OF THE BRIDGE CONTRACT

DRAWING NOT TO BE SCALED

100 mm ON ORIGINAL DRAWING

REVIEWS					
	DATE	BY	DESCRIPTION		
	DESIGN	GAC	CHECK	LOADING DBHCC A75	DATE APRIL
	DRAWING	ARM	CHECK GAC	SIYE No 3-353	DWS
				JLR No. B-7094-1	