

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 40I12-21

DIST. 2 REGION                     

W.P. No. 185-77-02

CONT. No. 82-36

W. O. No.                     

STR. SITE No. 5-41

HWY. No. 76

LOCATION Crinan Creek Structure  
Widening

No of PAGES -                     

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.                     

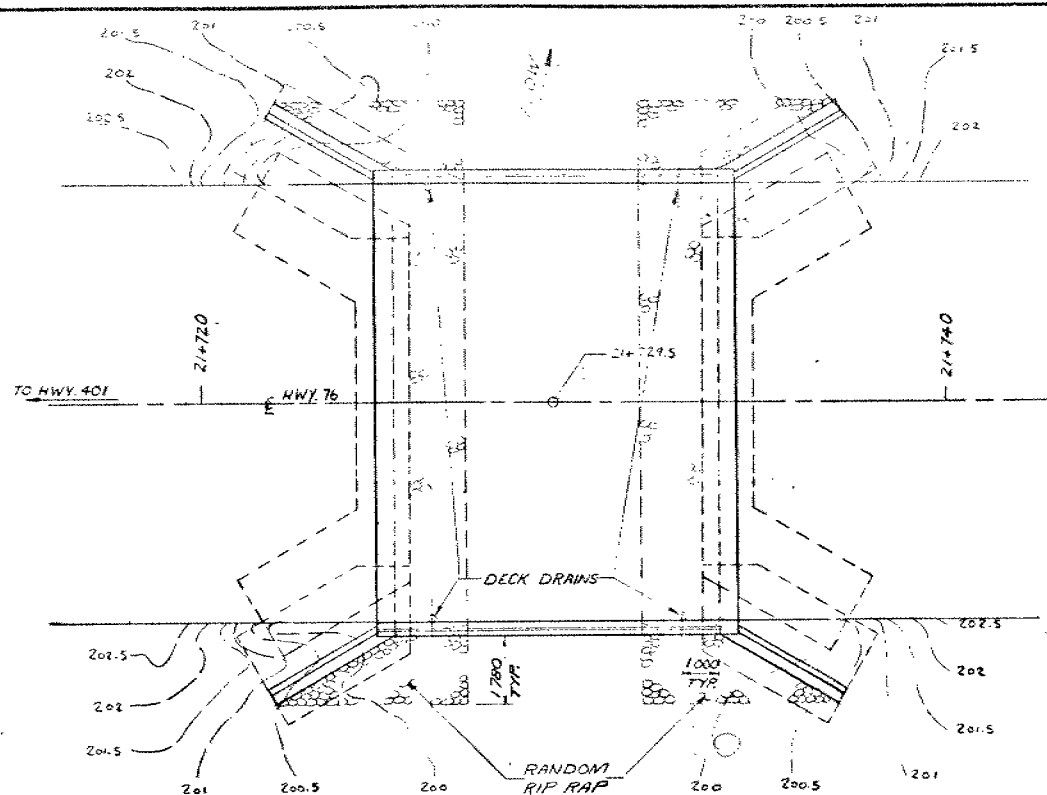
REMARKS:                     

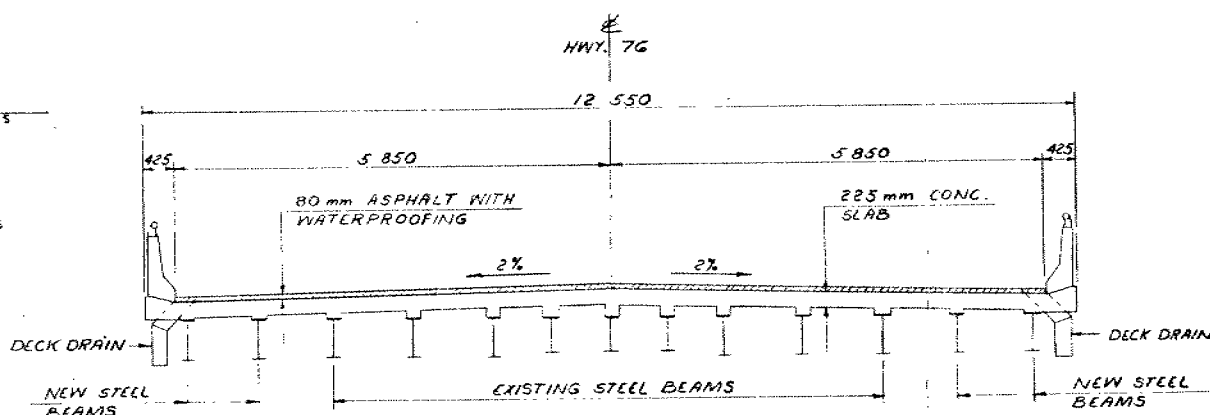
                    

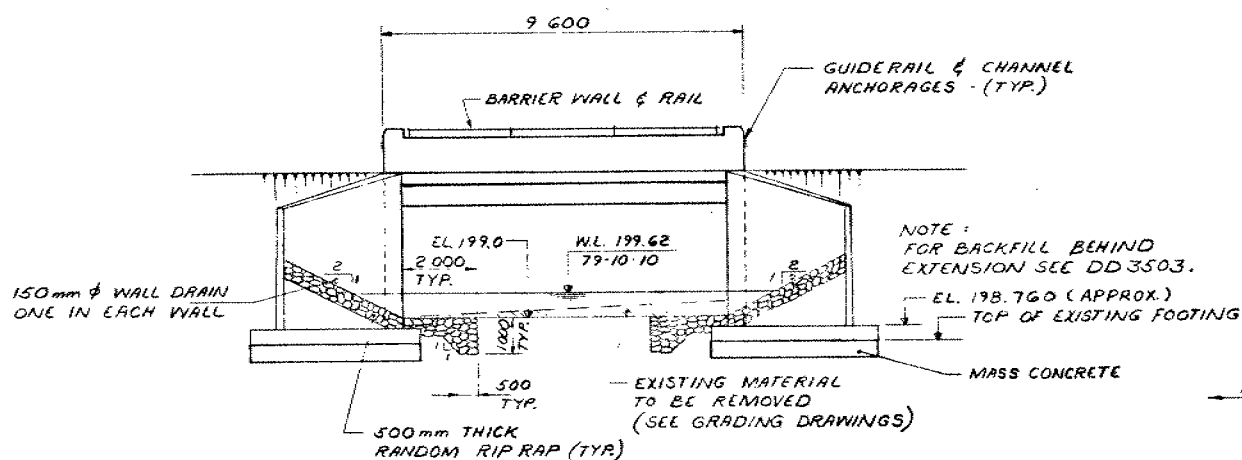
G.I.-30 SEPT. 1976



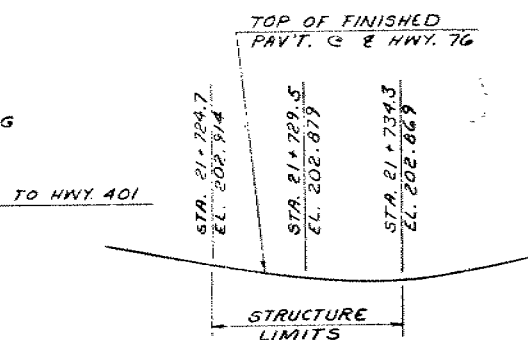
PLAN  
1:100



TYPICAL DECK SECTION  
1:50



ELEVATION  
1:100



PROFILE OF HWY. 76  
N.T.S.

METRIC

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

DIST. NO. 2  
CONT No  
WP No 85-77-02

CRINAN CREEK BRIDGE  
WIDENING & DECK REPLACEMENT  
GENERAL ARRANGEMENT

SHEET

### GENERAL NOTES:

#### CLASS OF CONCRETE

DECK & BARRIER WALLS - 30 MPa  
REMAINDER - 20 MPa

#### CLEAR COVER TO REINFORCING STEEL

FOOTINGS - 100 ± 25 mm  
ABUTMENTS & RETAINING WALLS -  
FRONT SURFACES - 80 ± 20 mm  
BACK SURFACES - 60 ± 20 mm  
DECK - BOTTOM - 40 ± 10 mm  
DECK - TOP & BARRIER WALLS - 70 ± 20 mm

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

#### CONSTRUCTION NOTES

BACKFILL SHALL BE PLACED SIMULTANEOUSLY  
BEHIND BOTH ABUTMENTS, KEEPING THE  
HEIGHT OF BACKFILL APPROXIMATELY  
THE SAME. AT NO TIME SHALL THE  
DIFFERENCE IN ELEVATIONS BE GREATER  
THAN 600 mm.

DIMENSIONS OF EXISTING STRUCTURE  
SHALL BE VERIFIED IN THE FIELD.

### CONCRETE QUANTITIES:

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

1. CONCRETE IN ABUTMENTS AND  
RETAINING WALLS — 35 m<sup>3</sup>
2. CONCRETE IN DECK — 32 m<sup>3</sup>
3. CONCRETE IN BARRIER WALLS — 4 m<sup>3</sup>

### STRUCTURAL STEEL QUANTITIES:

STRUCTURAL STEEL — 3.4 TONNES

### SUGGESTED CONSTRUCTION SEQUENCE

1. INSTALL TEMPORARY TIMBER STRUTS  
FOR LONGITUDINAL BRACING
2. REMOVE CONCRETE DECK AND TWO  
STEEL CHANNELS
3. REMOVE PORTION OF CONCRETE BEARING  
SEATS, ABUTMENT WALLS AND RETAINING  
WALLS.
4. COMPLETE ABUTMENTS.
5. ERECT STEEL BEAMS.
6. COMPLETE CONCRETE DECK.
7. REMOVE TEMPORARY TIMBER STRUTS.
8. PAINT EXPOSED PORTION OF EXISTING  
STEEL BEAMS.
9. CONSTRUCT RETAINING WALLS.
10. WATERPROOF AND PAVE DECK.
11. PLACE RANDOM RIP-RAP.

### LIST OF DRAWINGS:

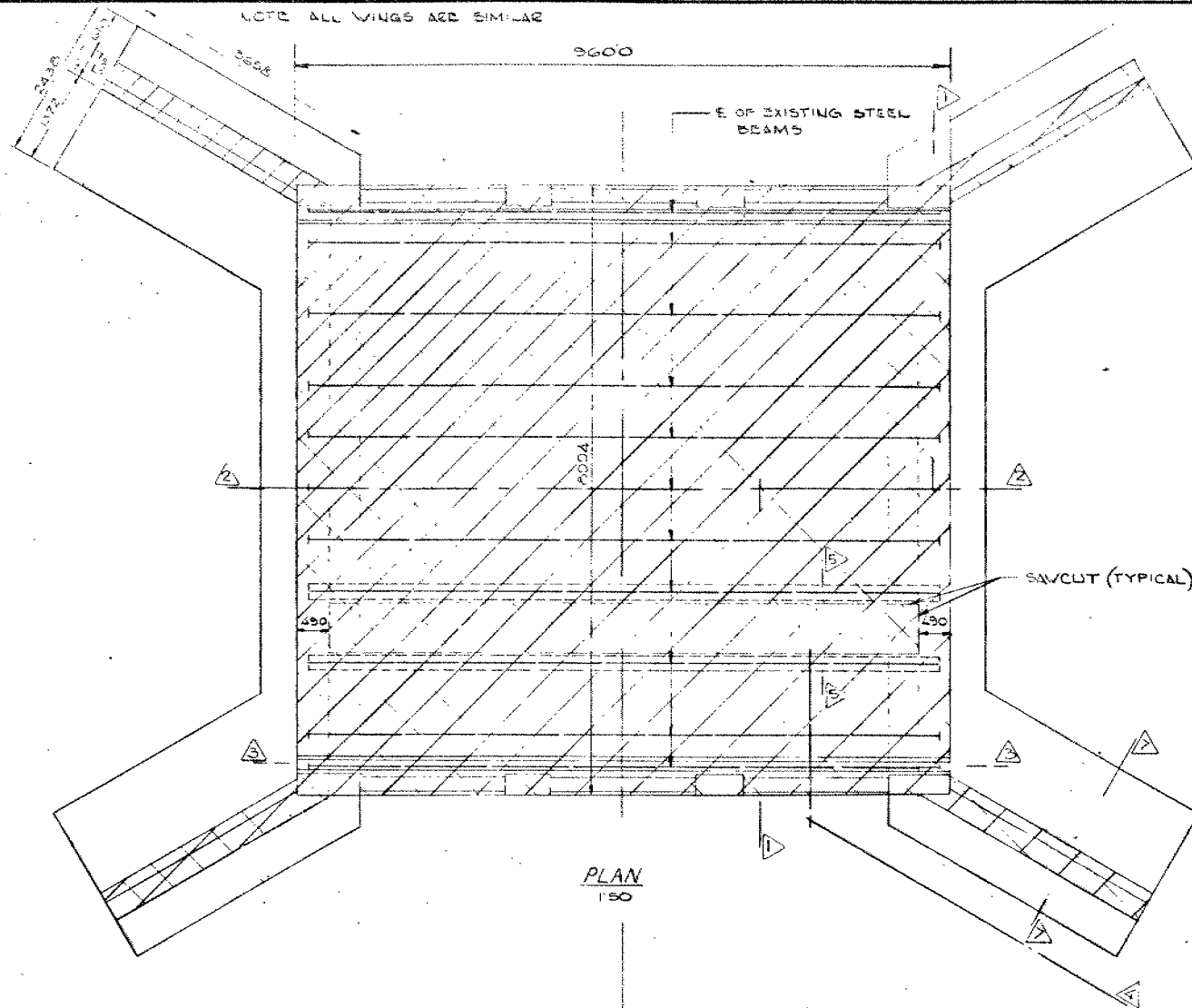
- 5-41-1 GENERAL ARRANGEMENT
- 2 BURE HOLE LOCATIONS & SOIL STRATA
- 3 REMOVAL DETAILS
- 4 FOOTINGS, ABUTMENTS & RETAINING WALLS
- 5 DECK & BEAM DETAILS
- 6 BARRIER WALL WITH RAILING
- 7 RAILING FOR BARRIER WALL
- 8 STANDARDS NO. 1
- 9 BRIDGE DATE & SITE NUMBER DATA
- 5-41-10 AS CONSTRUCTED ELEV. & DIM.



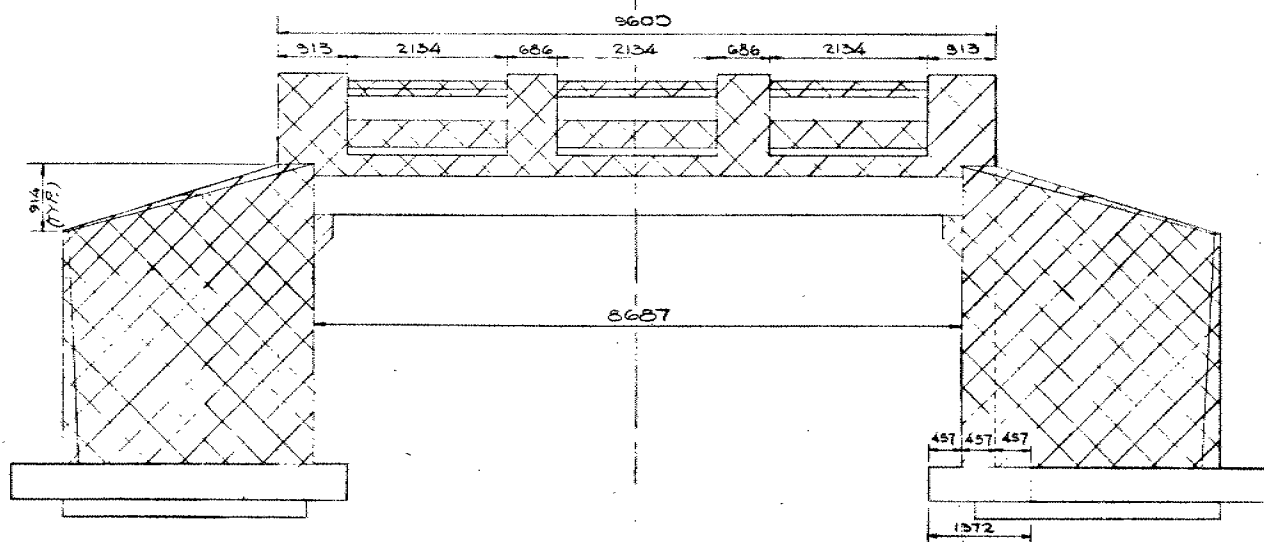
DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	1985	1	1
CHECK	1985	2	2
LOADING	1985	3	3
DATE	1985	4	4
DRAWING	1985	5	5
CHECK	1985	6	6
SITE No	1985	7	7
DWG	1985	8	8

NOTE ALL WINGS ARE SIMILAR



PLAN  
1:50



ELEVATION  
1:50

**METRIC**

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

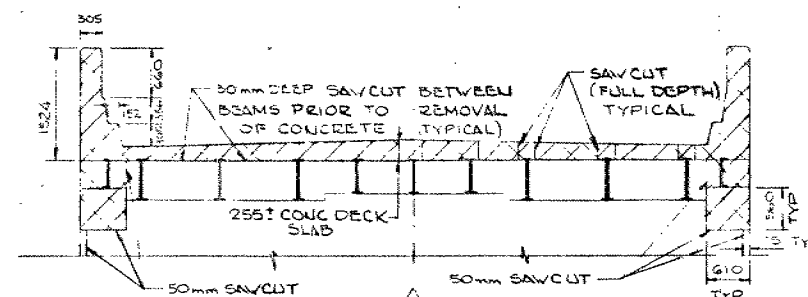
CONT No  
WP No 185-77-02

CRINAN CREEK BRIDGE

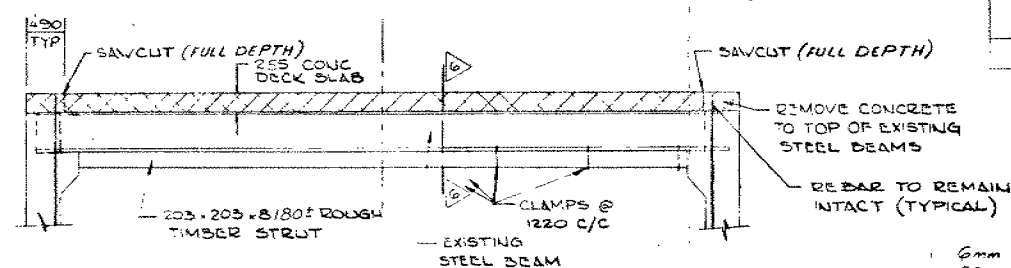
DECKING AND DECK REPLACEMENT

REMOVAL DETAILS

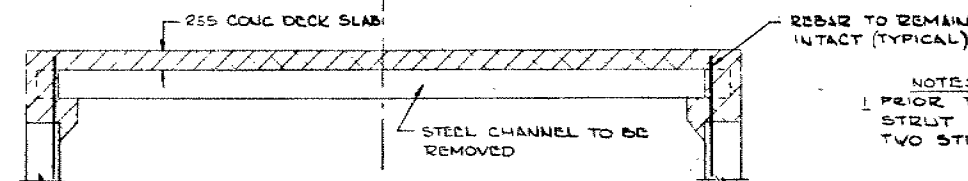
SHEET



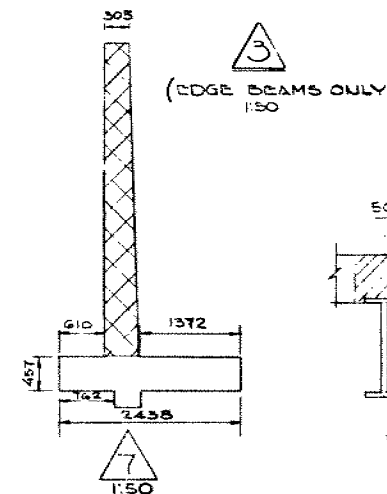
1  
1:50



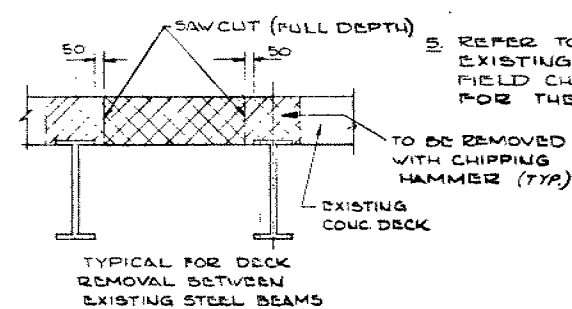
2  
1:50



3  
1:50



4  
1:50



5  
1:20

- NOTES**
- 1 PRIOR TO REMOVAL OF CONCRETE, INSTALL A TIMBER STRUT UNDER EACH EXISTING STEEL BEAM EXCEPT TWO STEEL CHANNELS.
  - 2 REMOVAL OF CONCRETE IN STRUCTURE IS SHOWN BY THIS SYMBOL
  - 3 ADJUSTMENT REINFORCING STEEL TO REMAIN INTACT EXCEPT THOSE IN THE WING WALLS ARE TO BE CUT-OFF FLUSH WITH CONCRETE TO BE LEFT IN PLACE.
  - 4 WHERE DOVEL PROJECTIONS ARE SHOWN FROM CONCRETE TO BE LEFT IN PLACE, THE REINFORCING STEEL IS TO BE EXPOSED, STRAIGHTENED.
  - 5 REFER TO ORIGINAL DRAWING FOR DETAILS OF EXISTING STRUCTURE. THE CONTRACTOR SHALL FIELD CHECK ALL DIMENSIONS REQUIRED FOR THE REMOVAL OF CONCRETE.



DRAWING NOT TO BE SCALED  
500mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	4/8/77	CHK	LOADING - 5.20-44
DRAWING	4/8/77	CHK	SITE No 5-41
			DATE 03-78
			DWG 3

# FOUNDATION INVESTIGATION REPORT

CONTRACT NO 82-36



Ministry of  
Transportation and  
Communications

Index

<u>Page No.</u>	<u>Description</u>
1	Index
2	Abbreviations & Symbols
3 - 12	Foundation Investigation Report For W.P. 185-77-02, Site 5-41 Crinan Creek Structure Widening

NOTE: For purposes of the Contract this report supercedes all other foundation reports done 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 (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	T W ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	T W ADVANCED MANUALLY
TW	THINWALL OPEN	FS	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
$S_f$	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

Crinan Creek Structure Widening  
W.P. 185-77-02, Site 5-41  
Hwy. 76, District 2, London

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### INTRODUCTION

This report contains the results of a foundation investigation at the aforementioned site. Field work consisted of 2 sampled boreholes and 2 dynamic cone penetration tests advanced during the period between December 10 to 15, 1980. A muskeg vehicle mounted auger machine was employed using both hollow and solid stem continuous flight augers to advance boreholes to depths of 21.8 and 24.8 metres.

### SITE DESCRIPTION

The site is located on Hwy. 76 at the crossing of Crinan Creek, approximately 4.5 km north of the Hwy. 401 and Hwy. 76 interchange in the Twp. of Aldborough, County of Elgin. The Village of West Lorne is approximately 6 km southwest of the site.

The surrounding terrain consists of gently rolling fields and pastures. The creek provides drainage for the surrounding fields.

Crinan Creek originates some 10 km east of the site and drains into the Thames River about 3 km west of the site. The creek has created a shallow meandering U-shaped valley with a creek width of about 5 metres at the existing bridge and a depth of 0.5 metres. Water staining on the abutments indicate that during spring runoffs, water levels may rise as much as 1.0 metre above normal water levels to an elevation of approximately 201.4 metres.

The existing structure is a 8.0 x 8.5 metre single span steel beam bridge, constructed with earth embankments about 3.5 metres high. Both approaches and the bridge show no visual signs of distress.

Physiographically, the site lies in the Ekfrid Clay Plain. This plain consists of pale greyish-brown silty till, which was probably transported from higher up the Thames Valley. This soil is highly calcareous due to the parent limestone of the Norfolk formation.

#### SUBSURFACE CONDITIONS

Uniform conditions were found to exist across the site. Below a thin layer of topsoil, a silty clay till (CI) with grey leached fissures and seams was encountered to an approximate depth of 10 metres. Below this depth a clayey silt (CL) with leached fissures and traces of sand and fine gravel was explored for a maximum depth of 25 metres. Bedrock was not encountered during the investigation.

Detailed descriptions along with the boundaries between the soil types are illustrated on the Record of Borehole Sheets. From this information, an estimated stratigraphical profile is shown on Contract Drawing No. 2.

Soil types encountered are briefly described as follows.

#### Silty Clay (CI)

Underlying a thin veneer of topsoil, is a layer of silty clay till encountered to a depth of about 10 metres. Traces of fine sand are found throughout this layer, as are leached seams and fissures. Typical grain size distribution curves for this deposit are shown on figure 2. A cone test was performed at each borehole location and refusal was met in this layer at approximately 3 metres below the surface.

Laboratory testing performed on material of this deposit gave the following results:

<u>Properties</u>	<u>Range</u>	<u>Average</u>
Natural Moisture Content (w)%	17-22	20
Liquid Limit (w <sub>L</sub> )%	36-41	39
Plastic Limit (w <sub>p</sub> )%	16-18	17
Plasticity Index (I <sub>p</sub> )%	21-25	23
Bulk Density (kN/m <sup>3</sup> )	20	
Undrained Shear Strength (Cu) as performed by laboratory		
Unconfined Compression Test (kPa)	201-217	



The results of the Atterberg Limit Testing are illustrated on the Plasticity Chart, Figure 1. Based on these results, the strata is classified as inorganic silty clay (CI) of medium plasticity. Two laboratory unconfined compression tests gave values, for the undrained shear strength, of 201 and 217 kPa. These results, plus interpretation of Standard Penetration Test 'N' values ranging from 17 to 28, indicate the stratum as having a hard consistency.

#### Silty Clay (CL)

Immediately below the silty clay (CI) stratum of medium plasticity and explored to a maximum depth of 25 metres, is a deposit of silty clay (CL). Similar to the upper layer, this stratum also has the leached fissures and seams. Some sand and traces of fine gravel are also found throughout this stratum. Typical grain size distribution curves for this deposit are shown on Figure 3.

Laboratory testing performed on this deposit material is tabulated as follows:

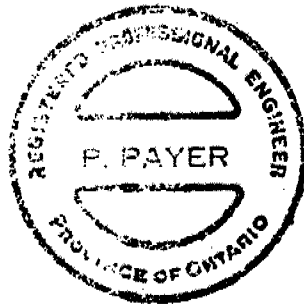
<u>Properties</u>	<u>Range</u>	<u>Average</u>
Natural Moisture Content (w)%	10-18	14
Liquid Limit (w <sub>L</sub> )%	29-33	31
Plastic Limit (w <sub>p</sub> )%	14-17	15
Plasticity Index (I <sub>p</sub> )%	15-18	16
Bulk Density (kN/m <sup>3</sup> )	22	
Undrained Shear Strength (Cu) as performed by laboratory.		
Unconfined Compression Test (kPa)	183-300	

The results indicate an inorganic silty clay (CL) of low plasticity. Results are plotted on the Plasticity Chart, Figure 1.

Undrained shear strength values from laboratory results range from 183-300 kPa and were found to increase with depth, indicating a stratum of very stiff to hard consistency but generally hard.

#### Groundwater

Groundwater was not encountered during the actual field investigation, although borehole locations were close to the creek's edge. No seepage into the borehole was apparent during augering operations.



P. Payer, P. Eng.  
Foundation Engineer

K. G. Selby, P. Eng.  
Senior Foundations Engineer

APPENDIX



Ministry of  
Transportation and  
Communications  
Ontario

# RECORD OF BOREHOLE No 1

METRIC

8

W P 185-77-02 LOCATION Sta. 21+734.0, 8.0 m Rt. ORIGINATED BY R.M.  
DIST 2 HWY 76 BOREHOLE TYPE Hollow Stem Augers COMPILED BY R.M.  
DATUM Geodetic DATE 80-12-10 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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	50 100 150 200 250					
199.8	Ground Surface													
0.0			1	SS	25									0 5 41 54
	Brown to Grey		2	SS	22									0 6 39 55
	Silty Clay (CI)		3	SS	18									
	Trace of Fine Sand		4	TW	PH									0 9 41 50
	(Till)		5	SS	17									
	Leached Fissures		6	SS	23									
	& Seams Throughout		7	SS	28									
	Occasional Cobbles													
	Hard		8	SS	24									
190.0			9	SS	28									
9.8			10	SS	27									
	Grey Silty Clay (CL)		11	SS	31									
	Some Sand, Trace		12	SS	33									
	of Fine Gravel,		13	SS	45									
	Leached Fissures		14	SS	41									
	& Seams, Occasional		15	TW	PH									
	Cobbles		16	SS	59									
	Very Stiff to Hard													
178.0														
21.8	End of Borehole													
	*Note: Borehole dry during augering operations. No seepage apparent.													

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 2

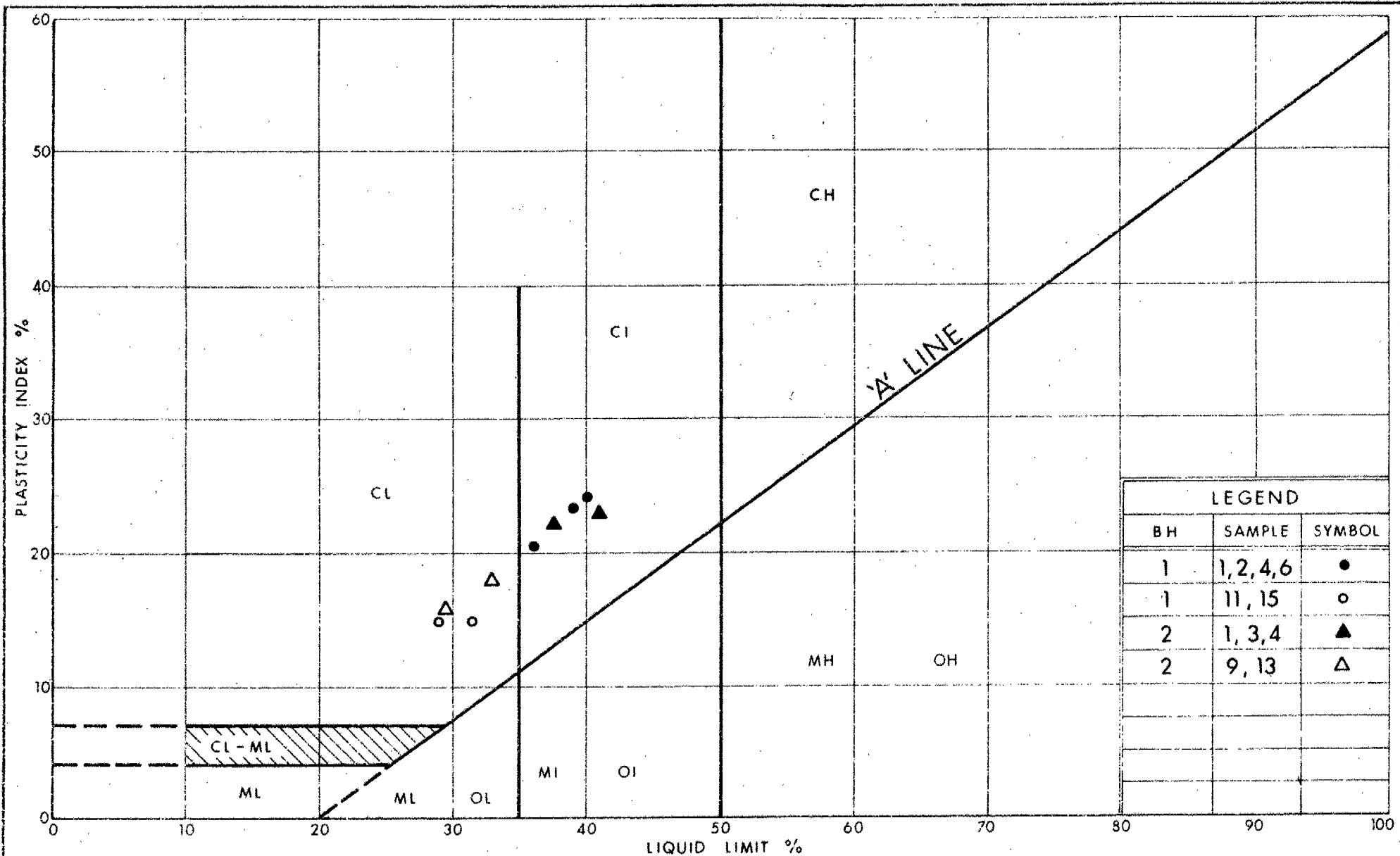
METRIC

9

W P 185- 77-02 LOCATION Sta. 21+724.2, 10.3 m Lt. ORIGINATED BY R.M.  
DIST 2 HWY 76 BOREHOLE TYPE Solid Stem Auger COMPILED BY R.M.  
DATUM Geodetic DATE 80-12-11 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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
200.5	Ground Surface												
0.0													
			1	SS	21								0 5 45 50
			2	SS	25								0 6 43 51
			3	SS	26								0 6 42 52
	Brown to Grey Silty Clay (CI)		4	TW	PH								
	Trace of Fine Sand (Till)		5	SS	23								
	Leached Fissures & Seams Throughout		6	SS	21								
	Occasional Cobbles		7	SS	22								
	Hard		8	SS	18								
191.4			9	TW	PH								
9.1			10	SS	25								
	Grey Silty Clay (CL)		11	SS	23								
	Some Sand, Trace of Fine Gravel (Till)		12	SS	45								
	Leached Fissures & Seams		13	SS	38								
	Occasional Cobbles		14	SS	35								
	Very Stiff to Hard		15	SS	41								
			16	SS	41								
			17	SS	47								
			18	SS	48								
175.7			19	SS	46								
24.8	End of Borehole												
	*Note: Borehole dry during augering operations. No seepage apparent.												

OFFICE REPORT ON SOIL EXPLORATION



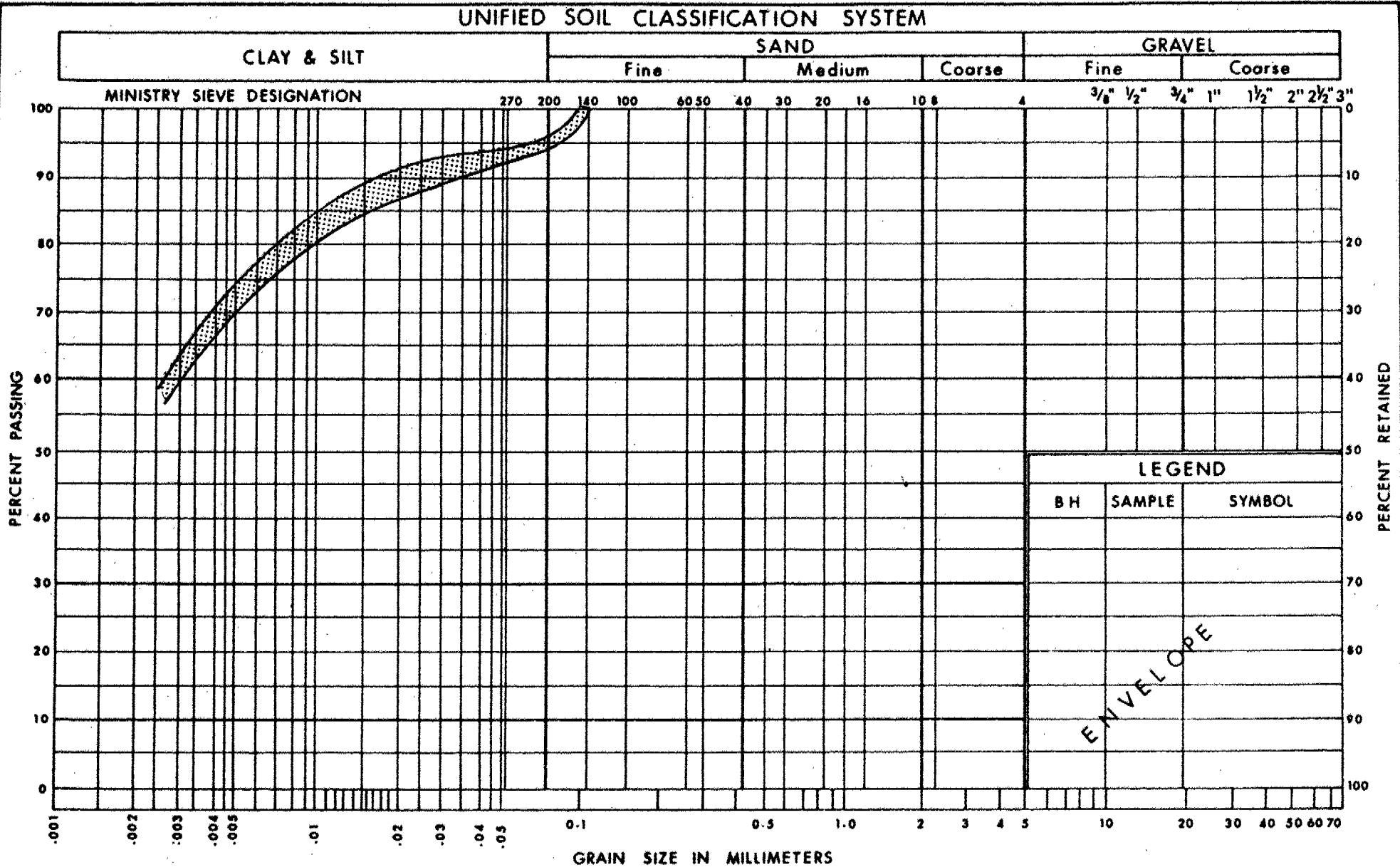
Ontario

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# PLASTICITY CHART SILTY CLAY (TILL)

FIG No 1

W P 185-77-02



**Ministry of  
Transportation and  
Communications**

## GRAIN SIZE DISTRIBUTION SILTY CLAY

MEDIUM PLASTICITY. TRACE OF FINE SAND

FIG No 2

W P 185-77-02





ENGINEERING MATERIALS OFFICE  
PAVEMENT & FOUNDATION DESIGN SECTION

WP 185-77-02

DIST 2

HWY 76

STR SITE 5-41

Crinan Creek Structure Widening

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## FOUNDATION INVESTIGATION REPORT

For

Crinan Creek Structure Widening  
W.P. 185-77-02, Site 5-41  
Hwy. 76, District 2, London

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### INTRODUCTION

This report contains the results of a foundation investigation at the aforementioned site. Field work consisted of 2 sampled boreholes and 2 dynamic cone penetration tests advanced during the period between December 10 to 15, 1980. A muskeg vehicle mounted auger machine was employed using both hollow and solid stem continuous flight augers to advance boreholes to depths of 21.8 and 24.8 metres.

### SITE DESCRIPTION

The site is located on Hwy. 76 at the crossing of Crinan Creek, approximately 4.5 km north of the Hwy. 401 and Hwy. 76 interchange in the Twp. of Aldborough, County of Elgin. The Village of West Lorne is approximately 6 km southwest of the site.

The surrounding terrain consists of gently rolling fields and pastures. The creek provides drainage for the surrounding fields.

Crinan Creek originates some 10 km east of the site and drains into the Thames River about 3 km west of the site. The creek has created a shallow meandering U-shaped valley with a creek width of about 5 metres at the existing bridge and a depth of 0.5 metres. Water staining on the abutments indicate that during spring runoffs, water levels may rise as much as 1.0 metre above normal water levels to an elevation of approximately 201.4 metres.

The existing structure is a 8.0 x 8.5 metre single span steel beam bridge, constructed with earth embankments about 3.5 metres high. Both approaches and the bridge show no visual signs of distress.

Physiographically, the site lies in the Ekfrid Clay Plain. This plain consists of pale greyish-brown silty till, which was probably transported from higher up the Thames Valley. This soil is highly calcareous due to the parent limestone of the Norfolk formation.

#### SUBSURFACE CONDITIONS

Uniform conditions were found to exist across the site. Below a thin layer of topsoil, a silty clay till (CI) with grey leached fissures and seams was encountered to an approximate depth of 10 metres. Below this depth a clayey silt (CL) with leached fissures and traces of sand and fine gravel was explored for a maximum depth of 25 metres. Bedrock was not encountered during the investigation.

Detailed descriptions along with the boundaries between the soil types are illustrated on the Record of Borehole Sheets. From this information, an estimated stratigraphical profile is shown on Drawing #1857702-A.

Soil types encountered are briefly described as follows.

#### Silty Clay (CI)

Underlying a thin veneer of topsoil, is a layer of silty clay till encountered to a depth of about 10 metres. Traces of fine sand are found throughout this layer, as are leached seams and fissures. Typical grain size distribution curves for this deposit are shown on figure 2. A cone test was performed at each borehole location and refusal was met in this layer at approximately 12 metres below the surface.

Laboratory testing performed on material of this deposit gave the following results:

<u>Properties</u>	<u>Range</u>	<u>Average</u>
Natural Moisture Content (w)%	17-22	20
Liquid Limit (w <sub>L</sub> )%	36-41	39
Plastic Limit (w <sub>p</sub> )%	16-18	16
Plasticity Index (I <sub>p</sub> )%	21-25	23
Bulk Density (kN/m <sup>3</sup> )	20	
Undrained Shear Strength (Cu) as performed by laboratory		
Unconfined Compression Test (kPa)	201-217	

The results of the Atterberg Limit Testing are illustrated on the Plasticity Chart, Figure 1. Based on these results, the strata is classified as inorganic silty clay (CI) of medium plasticity. Two laboratory unconfined compression tests gave values, for the undrained shear strength, of 201 and 217 kPa. These results, plus interpretation of Standard Penetration Test 'N' values ranging from 17 to 28, indicate the stratum as having a hard consistency.

#### Silty Clay (CL)

Immediately below the silty clay (CI) stratum of medium plasticity and explored to a maximum depth of 25 metres, is a deposit of silty clay (CL). Similar to the upper layer, this stratum also has the leached fissures and seams. Some sand and traces of fine gravel are also found throughout this stratum. Typical grain size distribution curves for this deposit are shown on Figure 3.

Laboratory testing performed on this deposit material is tabulated as follows:

<u>Properties</u>	<u>Range</u>	<u>Average</u>
Natural Moisture Content (w)%	10-18	14
Liquid Limit (w <sub>L</sub> )%	29-33	31
Plastic Limit (w <sub>p</sub> )%	14-17	15
Plasticity Index (I <sub>p</sub> )%	15-18	16
Bulk Density (kN/m <sup>3</sup> )	22	
Undrained Shear Strength (Cu) as performed by laboratory.		
Unconfined Compression Test (kPa)	183-300	

The results indicate an inorganic silty clay (CL) of low plasticity. Results are plotted on the Plasticity Chart, Figure 1.

Undrained shear strength values from laboratory results range from 183-300 kPa and were found to increase with depth, indicating a stratum of very stiff to hard consistency but generally hard.

#### Groundwater

Groundwater was not encountered during the actual field investigation, although borehole locations were close to the creek's edge. No seepage into the borehole was apparent during augering operations.

## DISCUSSION AND RECOMMENDATIONS

Present program planning, proposes the widening of the present Crinan Creek structure 1.5 metres on both the east and west side. The grade and the span length will be maintained as that of the existing structure.

### Details of Existing Structure

The existing structure is a single span steel beam bridge with a concrete deck. The structure is founded on spread footings 0.5 metres in depth. Elevations for these footings are not available, but from structural drawings the approximate elevation for the top of the footings is 198.7. This leaves an average of about 1.5 metres of soil cover.

Embankments are at a maximum depth of 3.5 metres, measured from creek bottom.

### Structure Foundations

The proposed widened portion of the structure should be supported on spread footings in a similar manner as the present structure. To insure that the widened portion's load performance occurs uniformly, spread footings should be constructed with the following considerations:

- footings should be founded at a minimum elevation corresponding to the depth of the existing structure foundation or carried down to undisturbed subsoil conditions.
- minimal settlement is anticipated with the proposed footing and abutment widenings. Consideration of normal construction joints with dowels connecting the proposed widened footing and abutment to the existing structure should be made.
- although no dewatering problems are anticipated due to the impervious nature of the subsoils, precautions should be made to divert creek water during construction procedures. This may be achieved through the use of an impermeable dyke.

Footings so founded can be designed for a safe bearing pressure of 200 kPa.

#### Approach Embankment Widening

Any widening of approach fills must be benched and keyed into the existing fill slope as per MTC specifications. No stability problems are anticipated using fills constructed with a slope of 2:1.

Backfill for the abutments should be composed of free draining granular material placed and compacted as per current MTC standards, with provisions made for adequate drainage. It should be noted that the use of heavy vibratory equipment should be restricted so that damage to existing and widened abutments will not occur.

To estimate the lateral earth pressures exerted on the abutment walls by the granular backfill, the following parameters are assumed:

Lateral earth pressure coefficient  $K_o = 0.5$

Unit weight of backfill  $\gamma = 20 \text{ kN/m}^3$

An adhesion value of 95 kPa between the footing base and underlying subsoil may be assumed in calculating the resistance to sliding.

#### MISCELLANEOUS

The fieldwork for this report was carried out under the supervision of Mr. R. Moore, Student Technician, using equipment rented from Master Soil Investigation, London.

This report was prepared by Mr. R. Moore under the supervision of Mr. T. Kazmierowski, Project Foundations Engineer, and reviewed by Mr. K. Selby, Senior Foundations Engineer.



1981 02 03

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R. Moore  
Student Technician

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Project Foundations Engineer

*K. G. Selby*  
K.G. Selby  
Senior Foundations Engineer

## APPENDIX

## RECORD OF BOREHOLE No 1

W P 185-77-02 LOCATION Sta. 21+734.0, 8.0 m Rt. ORIGINATED BY R.M.  
DIST 2 HWY 76 BOREHOLE TYPE Hollow Stem Augers COMPILED BY R.M.  
DATUM Geodetic DATE 80-12-10 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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE						
199.8 0.0	Ground Surface														
	Brown to Grey Silty Clay (CI)  Trace of Fine Sand  (Till)  Leached Fissures & Seams Throughout Occasional Cobbles Hard		1	SS	25									0 5 41 54	
			2	SS	22									0 6 39 55	
			3	SS	18										
			4	TW	PH									0 9 41 50	
			5	SS	17										
			6	SS	23										
			7	SS	28										
			8	SS	24										
190.0 9.8	Grey Silty Clay (CL)  Some Sand, Trace of Fine Gravel, Leached Fissures & Seams, Occasional Cobbles  Very Stiff to Hard		9	SS	28										
			10	SS	27										
			11	SS	31										
			12	SS	33										
			13	SS	45										
			14	SS	41										
			15	TW	PH										
			16	SS	59										
178.0 21.8	End of Borehole														
	*Note: Borehole dry during augering operations. No seepage apparent.														

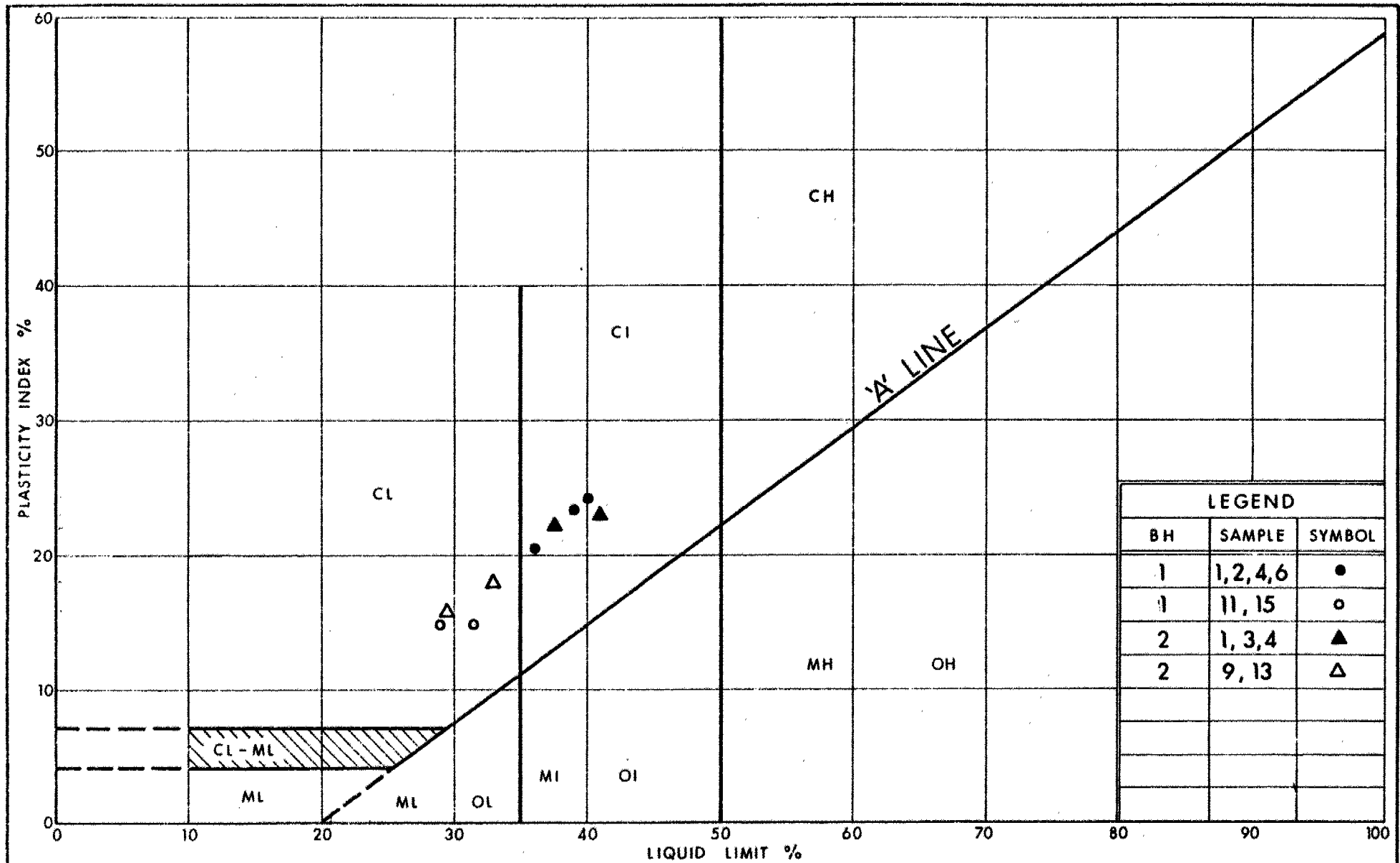
+3, x5: Numbers refer to Sensitivity



## RECORD OF BOREHOLE No 2

W P 185- 77-02 LOCATION Sta. 21+724.2, 10.3 m Lt. ORIGINATED BY R.M.  
DIST 2 HWY 76 BOREHOLE TYPE Solid Stem Auger COMPILED BY R.M.  
DATUM Geodetic DATE 80-12-11 CHECKED BY \_\_\_\_\_

[illegible]



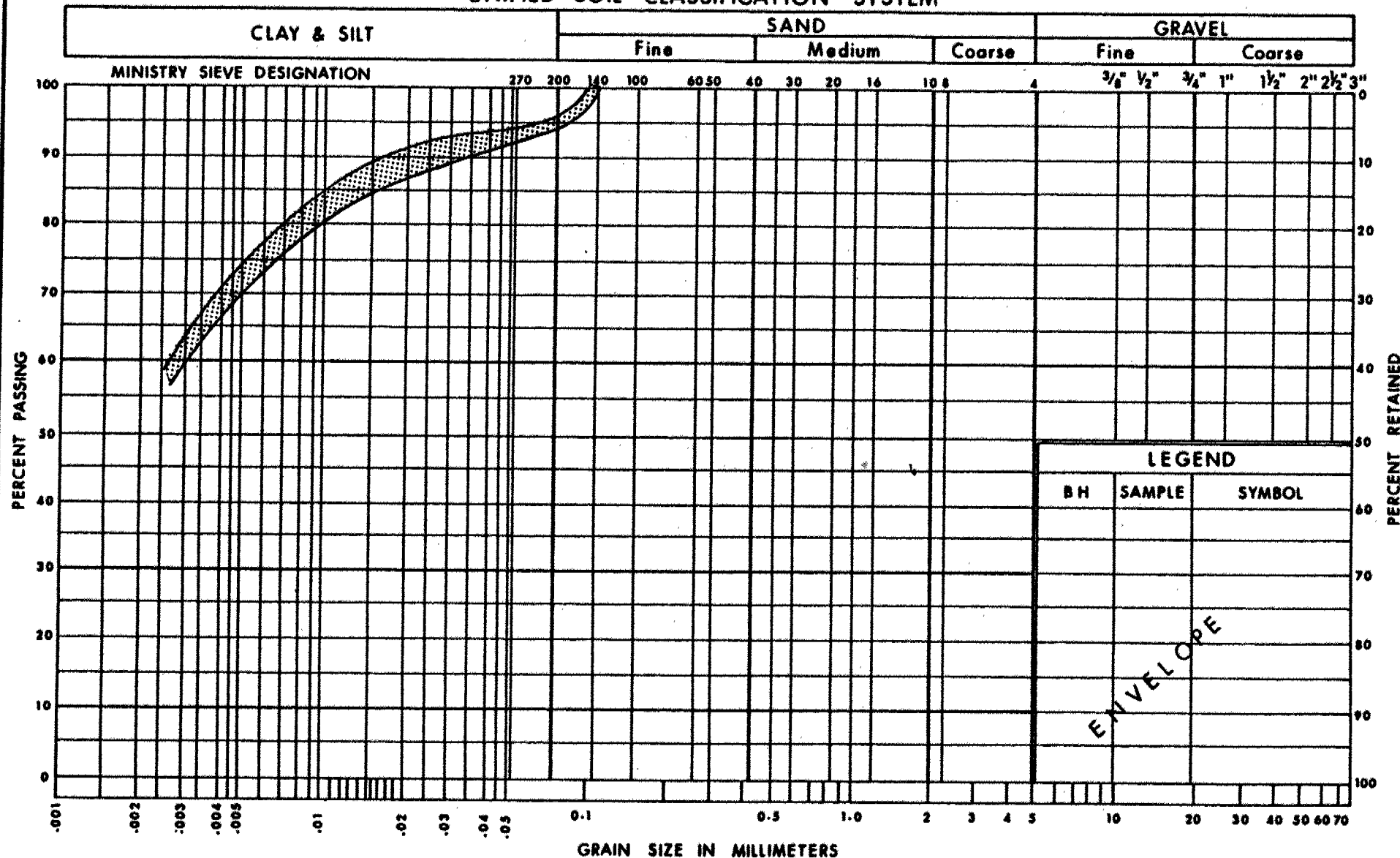
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# PLASTICITY CHART SILTY CLAY (TILL)

FIG No 1

W P 185-77-02

# UNIFIED SOIL CLASSIFICATION SYSTEM



## Ontario

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Communications**

GRAIN SIZE DISTRIBUTION  
SILTY CLAY

MEDIUM PLASTICITY. TRACE OF FINE SAND

FIG No 2

**W P 185-77-02**



# GRAIN SIZE DISTRIBUTION SILTY CLAY

FIG No 3

W P 185-77-02

## 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 (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### 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
$\sigma'_{v0}$	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						

**METRIC**

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

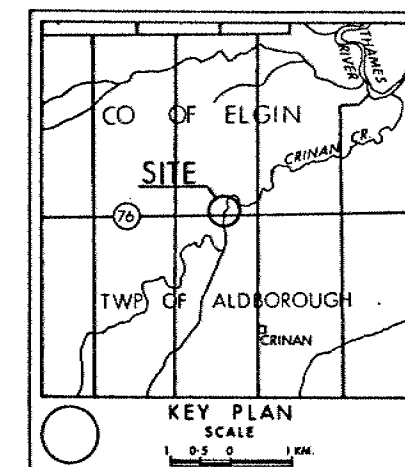
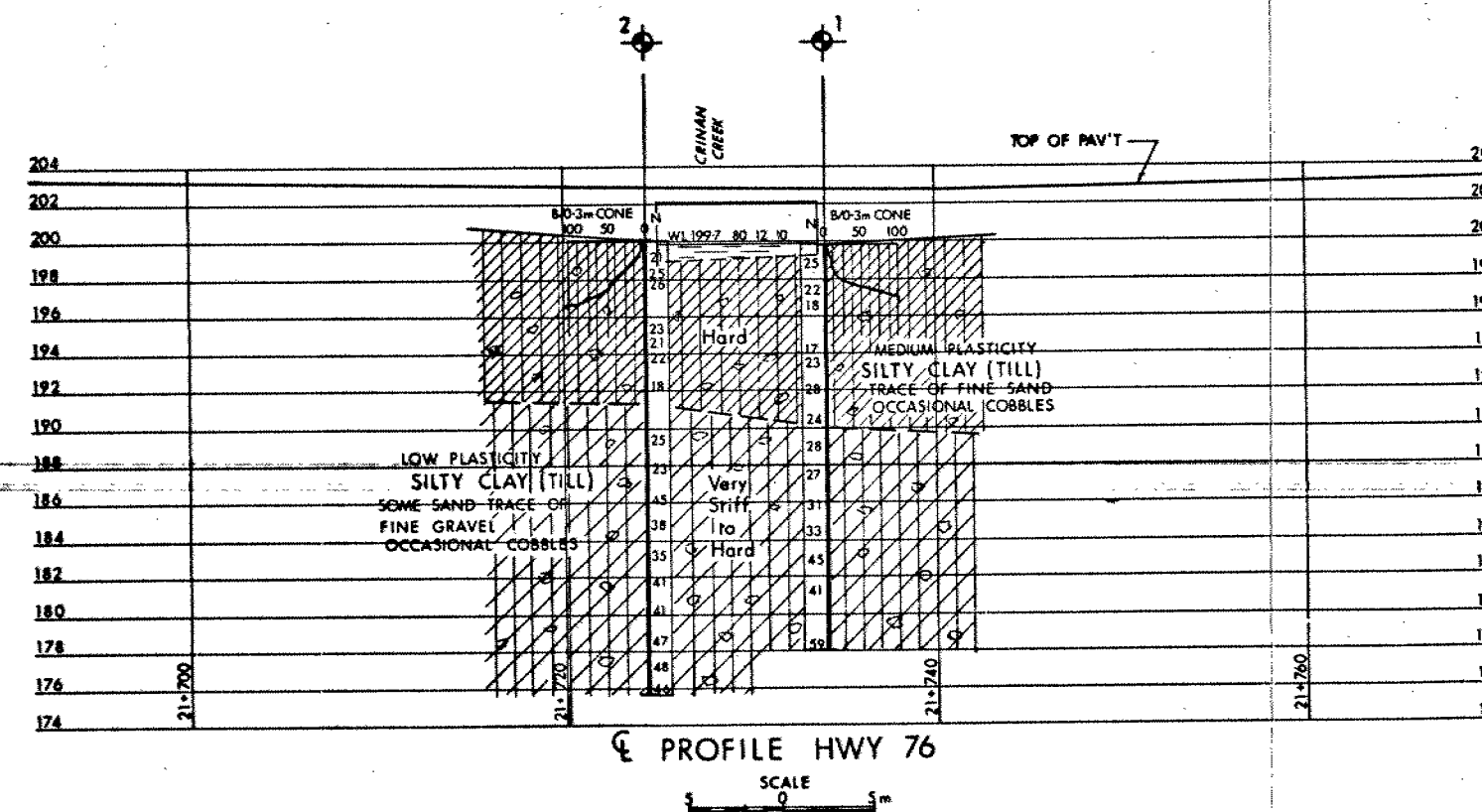
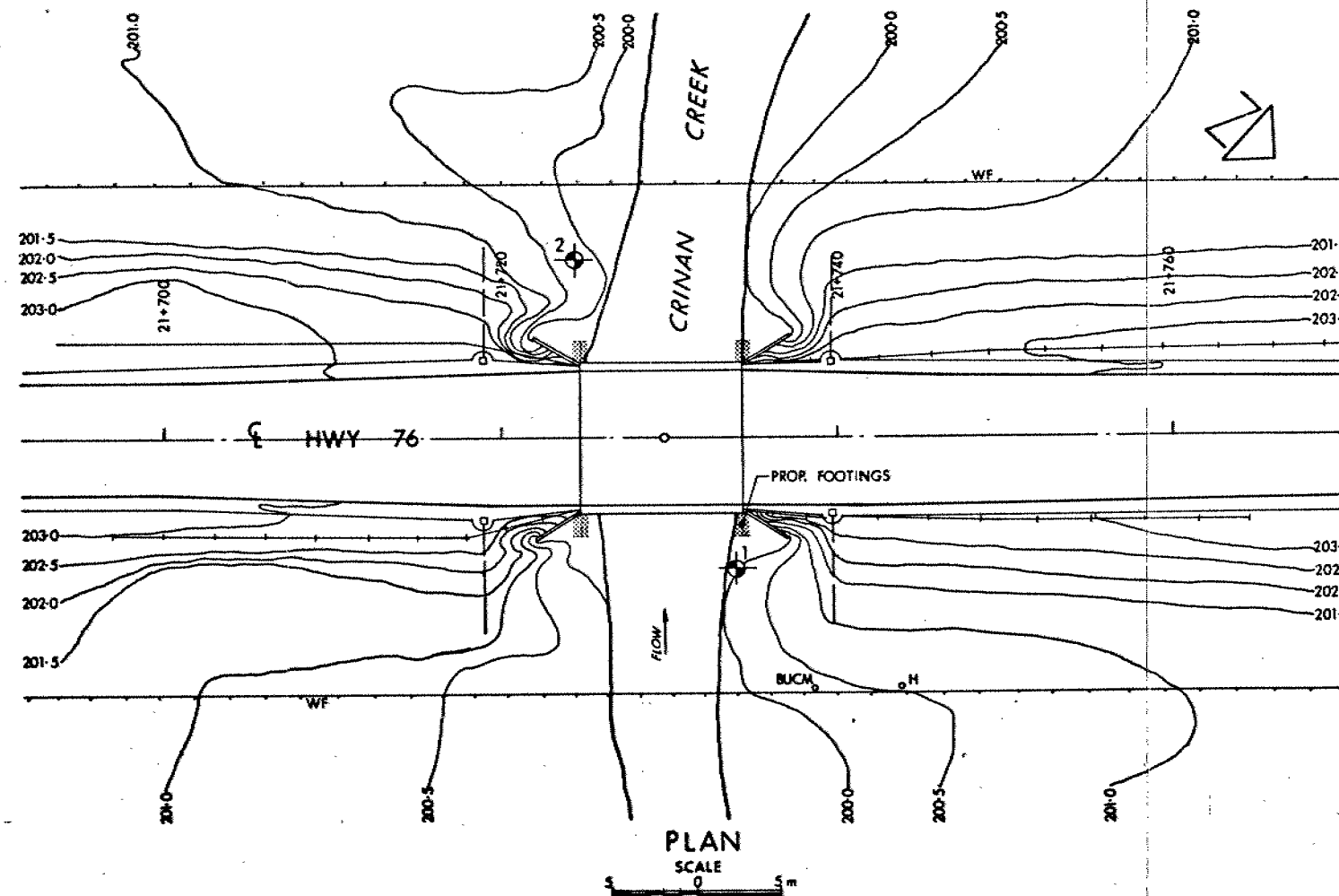
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WP No 185-77-02

CRINAN CREEK & HWY 76 CROSSING

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



**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
- Boreholes Dry

No	ELEVATION	STATION	OFFSET
1	199.8	21+734.0	8.0 RT
2	200.5	21+724.2	10.3 LT

**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	40112-21
HWY No	76
SUBM'DR. M. CHECKED	DATE 01 15
DRAWNOL. J. CHECKED	APPROVED
DIST	2
SITE	5-41
DWG	1857701-A