

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 4032-37

DIST. 1 REGION

W.P. No. 92-78-02

CONT. No. 84-82

W. O. No.

STR. SITE No. 6-105-46

HWY. No. 2

LOCATION Little River (Tremblay Creek)  
Structure (Tilbury)

No. of PAGES - 1

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

# OVERSIZE DRAWING



# DOMINION SOIL INVESTIGATION INC.

CONSULTING SOIL & FOUNDATION ENGINEERS

3953 RIBERDY ROAD, WINDSOR, ONTARIO N8W 3W5

(519) 969-7530

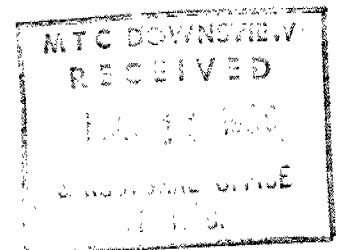
May 8, 1986

Ref. No. 84-10-W5

Wm. Settingington, Consulting Engineer  
c/o A.A. Boscarol & Associates Ltd.  
2881 Walker Road  
Windsor, Ontario  
N8W 3R2

Attention: Mr. G. Wolfe, P.Eng.

Re: Replacement Bridge at 3rd Concession Road and  
Little Creek - Township of Tilbury North, Ontario



Dear Sir:

In reply to your request of April 9, 1986, and confirmation on May 6, 1986, we provide the following information. The information presented in this letter supercedes the information provided in our letter dated February 7, 1986, structural dimensions of the replacement bridge have been revised since February 7, 1986.

1) The factored bearing capacity at ultimate limit states (U.L.S.) is:  $q_f = 4000$  p.s.f. The bearing capacity of serviceability states type II (S.L.S. II) is:  $q_s = 2000$  p.s.f.

2) The coefficient of active earth pressure for the U.L.S.  $(K_a)_f$  is 0.41; coefficient of active earth pressure for the S.L.S.,  $(K_a)_s$  is 0.33.

For retaining structures not exceeding 30 ft in height, the lateral earth pressure at rest will not exceed an equivalent fluid pressure of 75 p.s.f. per vertical foot and 65 p.s.f. per vertical foot for the U.L.S. and S.L.S. respectively.

STRUCTURE SITE No. 6-45



3) Since the soil cover at the toe of the abutment foundations has been provided solely for scour protection, passive resistance should not be used in the abutment design.

4) The frictional resistance to sliding along the base of the abutment foundation, 'F' may be calculated using the following:

$$F = 0.35 (W + P_v)$$

where W = weight of retaining wall and soil above footing

$P_v$  = the vertical component of the earth pressure

The value of 'F' cannot exceed 1000 p.s.f.

For U.L.S. the factored frictional resistance  $f\phi$  is equal to 80% of the actual available resistance, i.e.  $f\phi = 0.8 F$

5) The frictional resistance developed by the retained soil against the wingwall, 'F' can be calculated using the following:

$$F = 0.35 P_H$$

where  $P_H$  = the horizontal earth pressure developed on the wingwall

For U.L.S. the factored frictional resistance  $f\phi$  is equal to 80% of the actual available frictional resistance, i.e.  $f\phi = 0.8 F$

If additional questions arise, please do not hesitate to contact us.

Yours very truly,  
DOMINION SOIL INVESTIGATION INC.

T. O'Dwyer, P.Eng.



# DOMINION SOIL INVESTIGATION INC.

CONSULTING SOIL & FOUNDATION ENGINEERS

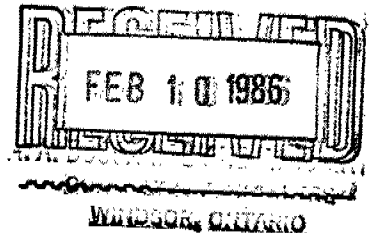
3953 RIBERDY ROAD, WINDSOR, ONTARIO N8W 3W5

(519) 969-7530

February 7, 1986

Ref. No. 84-10-W5

William J. Settrington Limited  
c/o A. A. Boscarior & Associates  
2881 Walker Road  
Windsor, Ontario  
N8W 3R2



Attention: Mr. A. Boscarior, P.Eng.

Re: Replacement Bridge Structure at  
3rd Concession Road & Little Creek - Township of Tilbury North

Dear Sir:

In reply to your letter, dated January 24, 1986, we have provided the following information.

- 1) The factored bearing capacity at ultimate limit states (U.L.S.) is:  $q_f = 5000$  p.s.f. The bearing capacity of serviceability states type II (S.L.S. II) is:  $q_s = 2400$  p.s.f.
- 2) The coefficient of active earth pressure for the U.L.S.  $(K_a)_f$ , is 0.41; coefficient of active earth pressure for the S.L.S.,  $(K_a)_s$  is 0.33.

For retaining structures not exceeding 30 ft in height, the lateral earth pressure at rest will not exceed an equivalent fluid pressure of 75 p.s.f. per vertical foot and 65 p.s.f. per vertical foot for the U.L.S. and S.L.S. respectively.

- 3) Since the soil cover at the toe of the abutment foundations has been provided solely for scour protection, passive resistance should not be used in the abutment design.



- 4) The frictional resistance to sliding, F, may be calculated using the following:

$$F = 0.35 (W + P_v)$$

where: W = weight of the retaining wall and soil above footing for cantilever and counterfort walls

$P_v$  = the vertical component of the earth pressure

The value of F must not exceed 1000 p.s.f.

If you have any questions regarding this letter, please do not hesitate to contact us.

Yours very truly,  
DOMINION SOIL INVESTIGATION INC.

T. O'Dwyer, P.Eng.

Report on the Soil Investigation  
for the Replacement Bridge Structure  
at 3rd Concession Road & Little Creek  
Township of Tilbury North

Prepared for:

William J. Setterington Limited  
Consulting Engineers & Surveyors  
209 Erie Street South  
Leamington, Ontario  
N8H 3C1

ATTENTION: Mr. William J. Setterington, P.Eng.

Prepared by:

Dominion Soil Investigation Inc.  
3953 Riberdy Road,  
Windsor N8W 3W5 Ontario

Ref. No. 84-10-W5

December 7, 1984



# DOMINION SOIL INVESTIGATION INC.

CONSULTING SOIL & FOUNDATION ENGINEERS

3953 RIBERDY ROAD, WINDSOR, ONTARIO N8W 3W5

(519) 969-7530

Ref. No.: 84-10-W5

William J. Settingington Limited  
Consulting Engineers & Surveyors  
209 Erie Street South  
Leamington Ontario  
N8H 3C1

ATTENTION: Mr. William J. Settingington, P. Eng.

Dear Sirs:

Re: Soil Investigation for Replacement Bridge Structure  
3rd Concession Road & Little Creek, Township of Tilbury North

## INTRODUCTION

In accordance with your request we submitted a proposal dated October 9, 1984 to carry out a soil investigation at the above site. On October 30, 1984 we received a verbal authorization from you to proceed with the investigation. The field work was completed on November 15, 1984.

The purpose of the investigation was to determine the subsurface conditions and relevant soil properties in order to provide recommendations for the design and construction of the foundations for a replacement bridge. We also assessed the site to determine potential construction difficulties as indicated by the borehole results.





### FIELD WORK

The field work consisted of two sampled boreholes advanced by a power auger machine equipped with hollow stem augers and conventional soil sampling equipment. The drilling was completed on November 15, 1984 under the supervision of a graduate soils engineer. The locations of the boreholes are indicated on the Borehole Location Plan (Enclosure 1).

Samples were taken by the Standard Penetration Test method at frequent intervals of depth and the results of these tests are presented on the Borehole Logs as 'N'-values. All of the samples obtained were sealed in air-tight containers and transferred to our laboratory for further examination and testing.

The ground surface elevations at the borehole locations were referenced to a geodetic benchmark. This benchmark, established by you, is the top of the existing curb at the centreline of the bridge and has an elevation of 585.87 feet.

### SUBSURFACE CONDITIONS

A detailed description of the soils encountered at each of the borehole locations is presented on the Borehole Logs enclosed and the following is a summary of these subsurface conditions.

Both boreholes penetrated the road surface. Borehole 1 encountered 10 inches of compact sand and gravel fill. Borehole 2 encountered 18 inches of compact sand and gravel fill then penetrated 4 inches of concrete and a further 8 inches of sand and gravel fill.

Beneath the road surface, the boreholes penetrated a major glacial deposit of silty and sandy clay that characteristically contain embedded sand and gravel. Borehole 1 encountered a weathered portion of sandy clay to 6.0 feet below the existing grade (Elevation 578.4 feet). This weathered zone is mottled brown in colour and Standard Penetration results of 13 blows per foot coupled with visual and tactile methods indicate this material has a 'stiff' consistency. Borehole 2 encountered a mottled brown-grey material varying from

'firm' to 'stiff' in consistency as determined from 'N'-values of 9 to 14 blows per foot. The weathered material encountered in Borehole 2 was found to extend to 11.0 feet below the existing grade (Elevation 574.2 feet).

Underlying the weathered zone the boreholes encountered a brown desiccated silty clay having a 'very stiff' to 'hard' consistency as determined from blow counts of 20 to 30 blows per foot. The brown material was found to extend from 13.5 to 15.5 feet below the existing grade (Elevation 571.4 to 569.7 feet).

Beyond the 'hard' to 'very stiff' brown crust the silty clay becomes grey. This grey material has a 'very stiff' consistency changing to 'stiff' at 17 to 22.5 feet below the existing grade (Elevation 567.9 to 562.7 feet). The grey colour is generally associated with permanently saturated conditions. The grey silty clay extends beyond the vertical limits of the investigation of 31.5 feet beneath the existing grade (Elevation 553.5+ feet).

#### GROUNDWATER CONDITIONS

Both of the boreholes bored dry and remained dry during the period of field work. The silty clay stratum penetrated has a relatively low permeability and consequently there is essentially no free flow of groundwater. Based on a visual and tactile examination of the soil samples the long term low ground water level coincides with the colour change from brown to grey in the silty clay at a depth of 13.5 to 15.5 feet below the existing grade.

#### DISCUSSION AND RECOMMENDATIONS

Measurements made at the site during the period of field work established the surface of the water at Elevation 573.9 feet and the water/soil interface of the creek bed at Elevation 571.9 feet.



## Foundations

The soil at this site have adequate strength to support the proposed replacement bridge on a conventional spread footing foundation. The base of this footing should however be located at least 4.0 feet beneath the present maximum scour depth (Elevation 571.9 feet). We anticipate that the foundation grade of the bridge would bear at Elevation 568+ feet and the footings would bear on the 'very stiff' grey silty clay.

The soil samples obtained from beneath the proposed bearing Elevation indicates that the 'very stiff' grey silty clay has an undrained shear strength of 1800 p.s.f.. Based on these values we recommend that the maximum allowable bearing pressure at the base of the bridge foundations should be limited to 3500 p.s.f.. A factor of safety of 3 against shear failure is incorporated in the maximum allowable bearing capacity given.

We estimate that the total settlement of spread footing foundations less than 8 feet wide designed in accordance with the preceeding recommendations would be subject to a total settlement of less than 1 inch. The silty clay found at both sides of the river is essentially similar with respect to its strength and compressibility characteristics and we estimate that differential settlement of the proposed bridge would be less than 3/4 inch.

## Lateral Earth Pressures

The abutments of the replacement bridge should be designed to support the lateral earth pressure from the fill behind these walls. The following expression can be used to evaluate the magnitude of this pressure:

where:

$$P_h = K(\gamma h + q)$$

$P_h$  = the lateral earth pressure at depth 'h'  
 $\gamma$  = the unit weight of the backfill material  
= 125 p.c.f. for granular backfill  
 $K$  = the coefficient of lateral earth pressure  
= 0.35 for granular material  
 $q$  = the surcharge loading (p.s.f.)



Adequate drainage should be provided behind the abutment walls to prevent the build up of hydrostatic pressure.

#### Construction

We do not anticipate unusual conditions with excavations at this site due to groundwater seepage.

Excavations deeper than 4 feet below grade should be cut back to a stable configuration in accordance with provincial safety regulations or alternatively the excavations would have to be shored and braced.

The silty clay bearing stratum is susceptible to deterioration if exposed to weather and especially water. Disturbance of the bearing stratum should be avoided. We recommend that an engineer from this office inspect and approve the exposed bearing soil in order to ensure that an adequate subgrade is exposed. It may be advisable to protect the exposed subgrade with a thin mat of lean concrete immediately after inspection and approval especially if the excavation will be open overnight.

Construction on the creek side of the abutments can be carried out within a bund constructed of the native silty clay soil found at this site. This embankment should be properly placed and compacted to ensure water tightness. The provision of adequate protection on the upstream face of the bund will be necessary to prevent erosion. Special care and construction should be given to ensuring that the stream channel retains adequate capacity after the placing of the cofferdam material.



LIMITATIONS OF REPORT

The limitations of this report are discussed in detail in Appendix A and this appendix constitutes an integral part of this report. We trust that this report is complete within our terms of reference however should there be any further questions concerning this work do not hesitate to contact us.

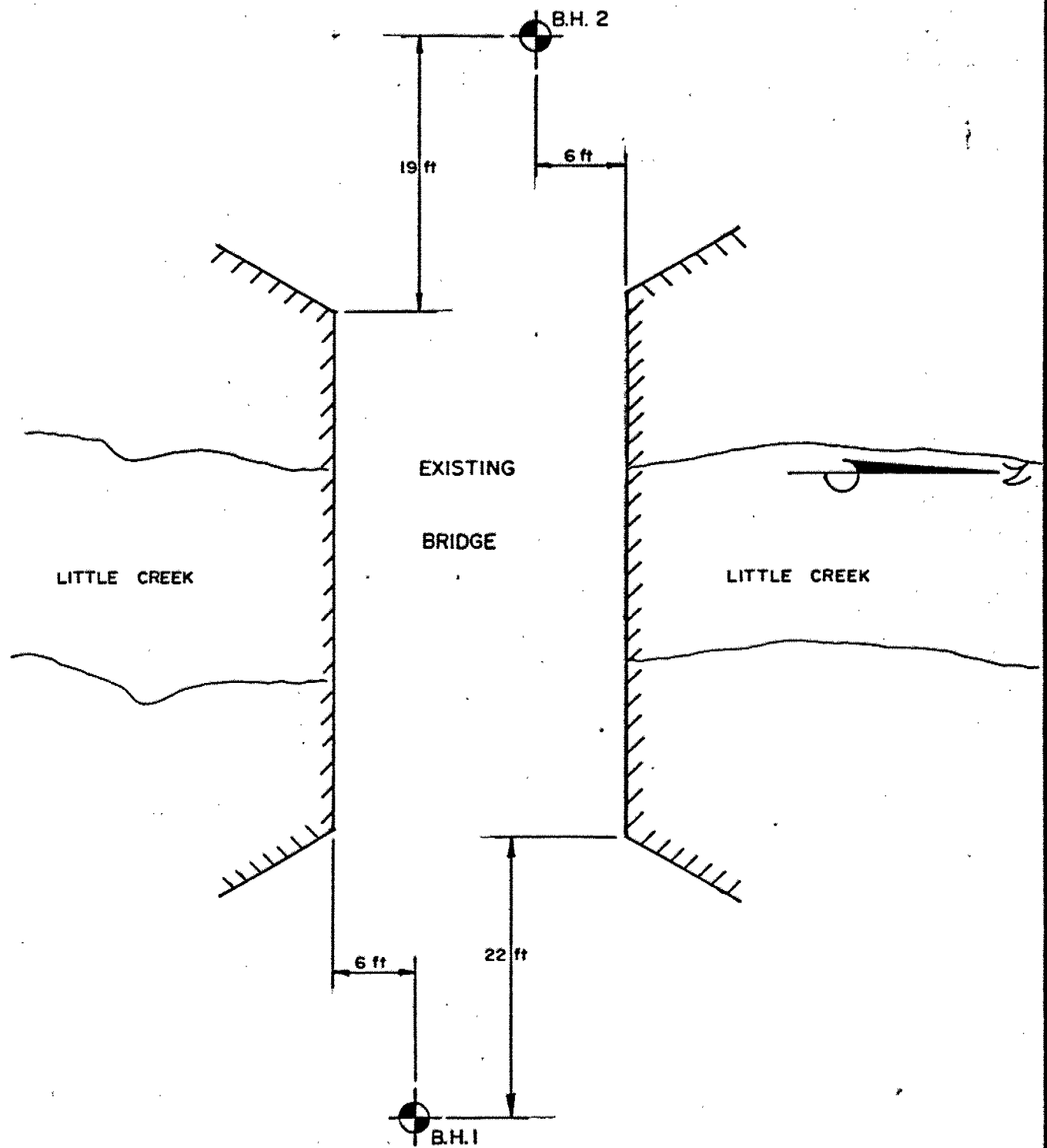
Yours very truly,  
DOMINION SOIL INVESTIGATION INC.

T. O'Dwyer, B.A.Sc.



N. Sitar, P.Eng.  
Windsor Branch Manager

Prep. By tod



BOREHOLE LOCATION PLAN

SCALE 1" = 10'

# LOG OF BOREHOLE 1

ENCL. Nº: 2

REF. Nº. 84-10-W5

CLIENT: William J. Settingington Ltd.

PROJECT: New Bridge Structure over Little Creek

LOCATION: 3<sup>rd</sup> Concession Road, Tilbury North Township

DATUM: Geodetic

## DRILLING DATA

Method: (H/S) Augering

Diameter: 6½"

Date: November 15, 1984



SUBSURFACE		PROFILE		SAMPLES			PENETRATION RESISTANCE 'N'					PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %	UNIT WT. p.c.f. or kN/m <sup>3</sup>
ELEVATION ft	DEPTH ft	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N'/ft Blows/ft 500 g	10	20	30	40	50			
5849	0.0	Ground Surface													
5841	0.8	10" Sand and gravel FILL													
		SANDY CLAY with silt mottled and gravel													
5789	6.0	<u>brown</u> brown	<u>stiff</u> very stiff		1	SS	13		o					18	
5774	7.5														
		SILTY CLAY													
					2	SS	34			o				17	134
5714	13.5	<u>brown</u> grey	<u>hard</u> very stiff		3	SS	20			o				19	130
					4	SS	15			o				20	131
5679	17.0				5	SS	8		o					21	
					6	SS	12			o				21	129
		with embedded sand and gravel													
					7	SS	11			o				21	131
					8	SS	11			o				22	127
5534	31.5	end of borehole													

Vertical Scale: 1" = 5'

DOMINION SOIL INVESTIGATION INC.

Drawn: tod Checked: ns

# LOG OF BOREHOLE 2

ENCL. No: 3

REF. No. 84-10-W5

CLIENT: William J. Setterington Ltd.

PROJECT: New Bridge Structure over Little Creek

LOCATION: 3<sup>rd</sup> Concession Road, Tilbury North Township

DATUM: Geodetic

## DRILLING DATA

Method: (H/S) Augering

Diameter: 6 1/2"

Date: November 15, 1984



SUBSURFACE		PROFILE		SAMPLES			PENETRATION RESISTANCE 'N'					PLASTIC LIMIT %	NATURAL WATER %	LIQUID LIMIT %	UNIT WT. pcf or kN/m <sup>3</sup>		
ELEVATION ft	DEPTH ft	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows/ft or 300mm	10	20	30	40					50	
								Undrained Shear Strength psf - kN/m <sup>2</sup> + Field Vane Test      • Compression Test									
Ground Surface																	
5852	0-0	Crushed Sand and Gravel															
5837	1-5	4" Concrete															
5827	2-5	Sand and Gravel FILL															
		SILTY CLAY															
				Borehole Open and Dry on Completion	1	SS	9										
5777	7-5	firm stiff															
		mottled brown-grey			2	SS	14										
5742	11-0	brown very stiff			3	SS	23										
					4	SS	20										
5697	15-5	grey with embedded sand and gravel			5	SS	24										
					6	SS	19										
5627	22-5	stiff			7	SS	13										
					8	SS	11										
5537	31-5	end of borehole															

Vertical Scale: 1" = 5'

DOMINION SOIL INVESTIGATION INC.

Drawn: tod Checked: ns



## APPENDIX A

### LIMITATIONS OF REPORT

The conclusions and recommendations presented in this report are based on the information determined at the test hole locations. Subsurface and groundwater conditions between and beyond these locations may differ from those encountered at the specific locations tested, and conditions may become apparent during construction which were not detected and could not be anticipated at the time of the site investigation. It is therefore recommended practise that the Soils Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those conditions encountered in the test holes.

The design recommendations provided in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not have been available at the time this report was prepared, we recommend that we be retained during the final stage of design to verify that the design is consistent with our recommendations, and that the assumptions made in our analyses are valid.

The comments given in this report on potential construction problems and possible methods of construction are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all of the factors that may affect construction methods and costs, (e.g. the thickness of surficial topsoil and fill layers can vary markedly and unpredictably). The contractors bidding this project or undertaking the construction, should therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work.



Ministry of  
Transportation and  
Communications

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# foundation investigation and design report

ENGINEERING MATERIALS OFFICE  
PAVEMENT & FOUNDATION DESIGN SECTION

WP 92-78-02 DIST 1  
HWY 2 STR SITE 6-105-46

Little River (Tremblay Creek) Replacement  
Structure

DISTRIBUTION

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GEOCRES

40J2-37

DATE

OCT 26 1982

# FOUNDATION INVESTIGATION REPORT

For

W.P. 92-78-02, Site 6-105-46

Little River (Tremblay Creek) Structure

Hwy. 2, District 1, Chatham

## INTRODUCTION:

This report summarizes the results of the foundation investigation required for the proposed replacement structure at this site.

The fieldwork was conducted during the period from 82 07 05 - 09, utilizing a continuous-flight auger machine equipped with 82 mm I.D. hollow-stem augers and a BX core barrel. This work consisted of 4 sampled boreholes/cone penetration tests. Bedrock was cored at 1 borehole.

## SITE DESCRIPTION

The site is located at the Hwy. 2 crossing of Little River (Lot II, Con. 3 & 4, Twp. of Tilbury North, County of Essex).

Physiographically, the site lies in the St. Clair Clay Plains, an area of low relief in which a till plain is generally covered by a thin deposit of lacustrine clay.

## SUBSURFACE CONDITIONS

### General

The Record of Borehole Sheets (Appendix) illustrate the conditions at the borehole locations. The locations and elevations of the boreholes, and stratigraphical profiles based on the borehole data are shown on Drawing No. 927802-A.

At this site, approximately 37 m of silty clay of low to intermediate plasticity overlies the limestone bedrock.

### Silty Clay (CL to CI)

The overburden at this site consists of silty clay of low to intermediate plasticity containing some sand and some to traces of gravel.

The surface (2.1 m thickness) of the deposit contains some to traces of organics. The consistency of the deposit generally increases with depth, ranging from firm to hard.

Figure 1 illustrates a typical grain size distribution for this deposit.

#### Bedrock

Refer to the Record of Borehole Sheets for bedrock elevations. The limestone bedrock is overlain by a transitional overburden zone (approximately 1.5 m in thickness) containing occasional limestone layers.

#### Groundwater

At the time of the field investigation, groundwater elevation was 176 m, approximately the same level as Little River (Temblay Creek).

## DISCUSSION AND RECOMMENDATIONS

### General

It is proposed to replace the existing bridge at this site with either a single span bridge or a box culvert.

Recommendations for foundation alternatives and general design data are provided below. The foundation alternative which leads to the least expensive design should be adopted.

#### Alternative 1 - Single Span Bridge

If practical, the existing footings should be utilized for the replacement structure. This approach would require that the new loadings do not exceed the original loadings on the footings.

If new footings are to be constructed, remove the old footings, excavate for the new footings, and cover (within 18 hours of exposure) the foundation soil with a 15 cm pad of mass concrete.

The new footings should be constructed at approximately the same elevation as the existing footings. According to the Structural Section, Southwestern Region, the elevation of the base of the existing footings is approximately 174.35 m.

#### Alternative 2 - Box Culvert

The suggested box culvert alternative is feasible from a foundations viewpoint.

If hydrologically acceptable, it may be possible to place the box culvert between the existing footings, without removing these footings. The exact footing locations would have to be determined if this approach is adopted.

If the box culvert is to extend over the existing footings, then remove the old footings.

The box culvert may be constructed directly on the foundation soil at a depth that provides sufficient frost protection. Any hydrological constraints should also be considered when determining the foundation depth. As the soil in the creek bed was not investigated, the material at the bottom of the excavation should be examined and all soft material should be removed. Cover the foundation soil with a 15 cm pad of mass concrete within 18 hours of exposure.

The culvert should be backfilled in accordance with current MTC standards (DD 809-B or DD 809-C).

#### General Design Data

For both alternatives (bridge and box culvert);

- a minimum cover of 1.2 m is required for frost protection (below the lowest adjacent soil or water level)
- the minimum cover required for scour protection should be determined by hydrological data
- for resistance to lateral forces, the adhesion between the base of the footings/culvert and the foundation soil = 60 kPa
- dewatering should not present a problem because of the impermeable nature of the foundation soil
- settlements should not be a problem as it is assumed that the new loading will be approximately equal to the existing loading
- the creek channel slopes should not be steeper than 2 horizontal to 1 vertical
- the creek channel slopes should be protected from erosion by suitable rip rap or other protection
- earth pressures should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. assuming a yielding foundation with  $K_a = 0.33$  for granular backfill

- the net safe bearing pressure = 200 kPa

For the purposes of the O.H.B.D.C.:

Factored Bearing Capacity at U.L.S. = 300 kPa

Bearing Capacity at S.L.S. Type II = 200 kPa

MISCELLANEOUS

The fieldwork for this project was carried out under the supervision of Mr. F. Colozza and Mr. B. Yiu (student field technicians). The report was written by Mr. D. H. Dundas, Project Foundations Engineer, and reviewed by Mr. K. G. Selby, Senior Foundations Engineer. The equipment used was owned and operated by Atcost Soil Drilling Inc.



*D. H. Dundas*

D. H. Dundas, P. Eng.  
Project Foundations Engineer

*K. G. Selby*

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



## APPENDIX

# RECORD OF BOREHOLE No 1

METRIC

W P 92-78-02 LOCATION Sta. 16 + 485, 6.0 m Rt. of Hwy. 2 ORIGINATED BY BY  
DIST 1 HWY 2 BOREHOLE TYPE Hollow Stem Auger COMPILED BY BY  
DATUM Geodetic DATE 82 07 05-07 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	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								
179.2	Ground Surface												
0.0													
	some/trace organics		1	TW	PH		178						
	-----		2	TW	PH		176						
	Silty Clay (CL to CI)						174						
	Some Sand						172						
	Trace Gravel		3	TW	PH		170						
	Firm to Hard						168						
			4	TW	PH		166						
			5	TW	PH		164						
							162						
			6	TW	PH		160						
							158						
							156						
							154						
			7	TW	PH		152						
							150						

148.7  
30.5

Cont

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (% STRAIN AT FAILURE

# RECORD OF BOREHOLE No 1 Cont

METRIC

W P 92-78-02 LOCATION Sta. 16 + 485, 6.0 m Rt. of Hwy. 2 ORIGINATED BY BY  
DIST 1 HWY 2 BOREHOLE TYPE Hollow Stem Auger COMPILED BY BY  
DATUM Geodetic DATE 82 07 05-07 CHECKED BY DD

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					
148.7	Cont.																
30.5	Silty Clay (CL to CI)						148										
	Some Sand																
	Trace Gravel						146										
	Firm to Hard		8	TW	PH												
							144										
							142										
	occ. limestone layers		9	RC	8%												
140.5																	
38.7	Bedrock		10	RC	100%		140										
	Limestone																
	Sound		11	RC	95%												
138.7																	
40.5	End of Borehole																

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 2

METRIC

W P 92-78-02 LOCATION Sta. 16 + 483, 7.0 m Lt. of Hwy. 2 ORIGINATED BY FC  
 DIST 1 HWY 2 BOREHOLE TYPE Hollow Stem Auger COMPILED BY FC  
 DATUM Geodetic DATE 82 07 07 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
178.5	Ground Surface									
	some organics	1	SS	7						
		2	SS	11						
	Silty Clay (CL to CI)	3	SS	13						4 23 40 33
	Some Sand	4	SS	17						16 11 37 36
	Trace/some Gravel	5	SS	10						5 16 37 42
	Firm to Hard	6	SS	11						
		7	SS	12						
		8	SS	11						
168.4										*C <sub>u</sub> > 107 kPa
10.1	End of Borehole									

OFFICE REPORT ON SOIL EXPLORATIONS

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

# RECORD OF BOREHOLE No 3

METRIC

W P 92-78-02 LOCATION Sta. 16 + 460, 7.0 m Lt. & Hwy. 2 ORIGINATED BY FC  
DIST 1 HWY 2 BOREHOLE TYPE Hollow Stem Auger COMPILED BY FC  
DATUM Geodetic DATE 82 07 08-09 CHECKED BY DD/2

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			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
178.7	Ground Surface							20 40 60 80 100	20 40 60 80 100					GR SA SI CL	
0.0															
	some/trace organics		1	SS	10										
			2	SS	8										
	Silty Clay (CL to CI)		3	SS	20										
	Some Sand		4	SS	18										
	Trace Gravel		5	SS	8										
	Firm to Hard		6	SS	7										
			7	SS	6										
			8	SS	5										
			9	SS	5										
			10	SS	5										
			11	SS	5										
			12	SS	6										
			13	SS	6										
			14	SS	7										
148.2															

Cont

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 3 Cont

METRIC

W P 92-78-02 LOCATION Sta. 16 + 460, 7.0 m Lt. of Hwy. 2 ORIGINATED BY FC  
DIST 1 HWY 2 BOREHOLE TYPE Hollow Stem Auger COMPILED BY FC  
DATUM Geodetic DATE 82 07 08-09 CHECKED BY DD

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			20	40	60	80	100					
148.2	Cont.																
30.5	Silty Clay (CL to CI)						148										
	Some Sand						146										
	Trace Gravel																
	Firm to Hard						144										
	occ. limestone layers																
141.7	Hard		15	SS	67/	25 cm	142										*C <sub>u</sub> > 107 kPa
37.0	Probable Bedrock																
	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 + 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 4

METRIC

W P 92-78-02 LOCATION Sta. 16 + 460, 6.0 m Rt. of Hwy. 2 ORIGINATED BY BY  
DIST 1 HWY 2 BOREHOLE TYPE Solid Stem Auger COMPILED BY BY  
DATUM Geodetic DATE 82 07 08 CHECKED BY DD

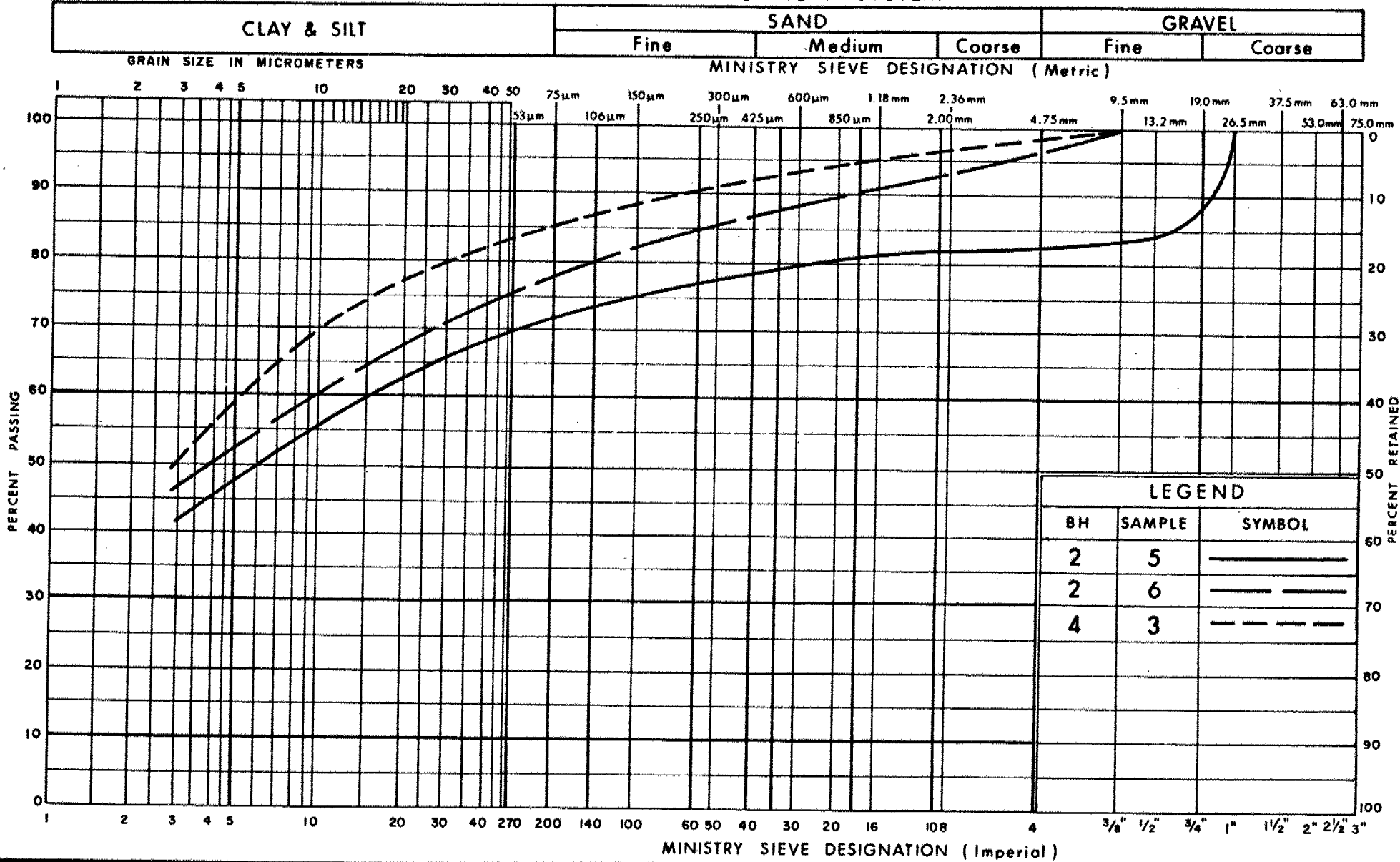
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
179.3	Ground Surface															
0.0																
	some organics		1	SS	5											
			2	SS	5											
	Silty Clay (CL to CI)		3	SS	12											2 14 44 40
	Some Sand		4	SS	18											1 15 46 38
	Trace Gravel		5	SS	11											
	Firm to Hard		6	SS	11											
			7	SS	10											
			8	SS	5											
169.2																
10.1	End of Borehole															

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

# UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SILTY CLAY  
SOME SAND, TRACE / SOME GRAVEL

FIG No 1  
W P 92 - 78 - 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

### 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
$S_t$	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						

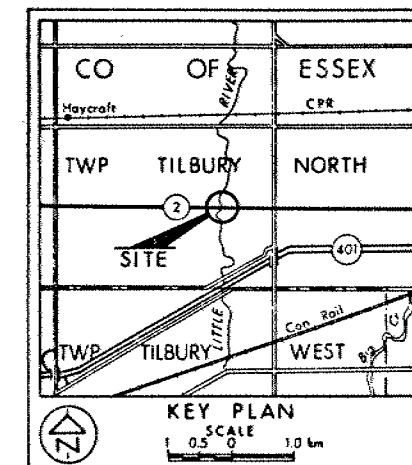
CONT No  
WP No 92-78-02

**LITTLE RIVER**  
(4.9 km W of Hwy 401)

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Srd Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 82 07

No	ELEVATION	STATION	OFFSET
1	179.2	16+485	6.0 m RT
2	178.5	16+483	7.0 m LT
3	178.7	16+460	7.0 m LT
4	179.3	16+460	6.0 m RT

NOTE

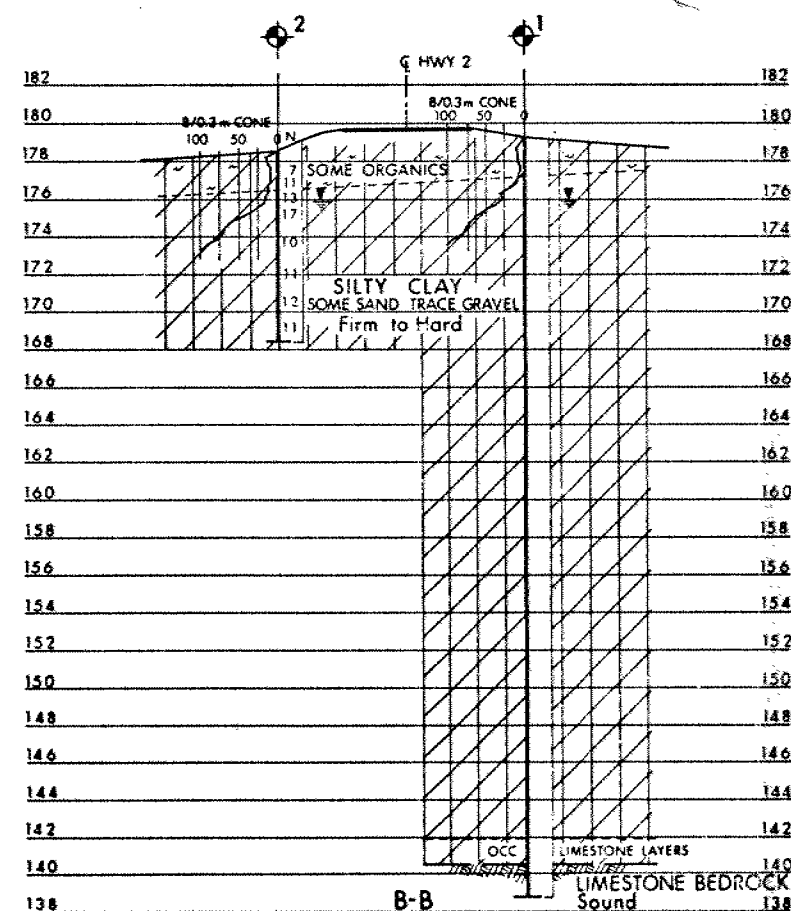
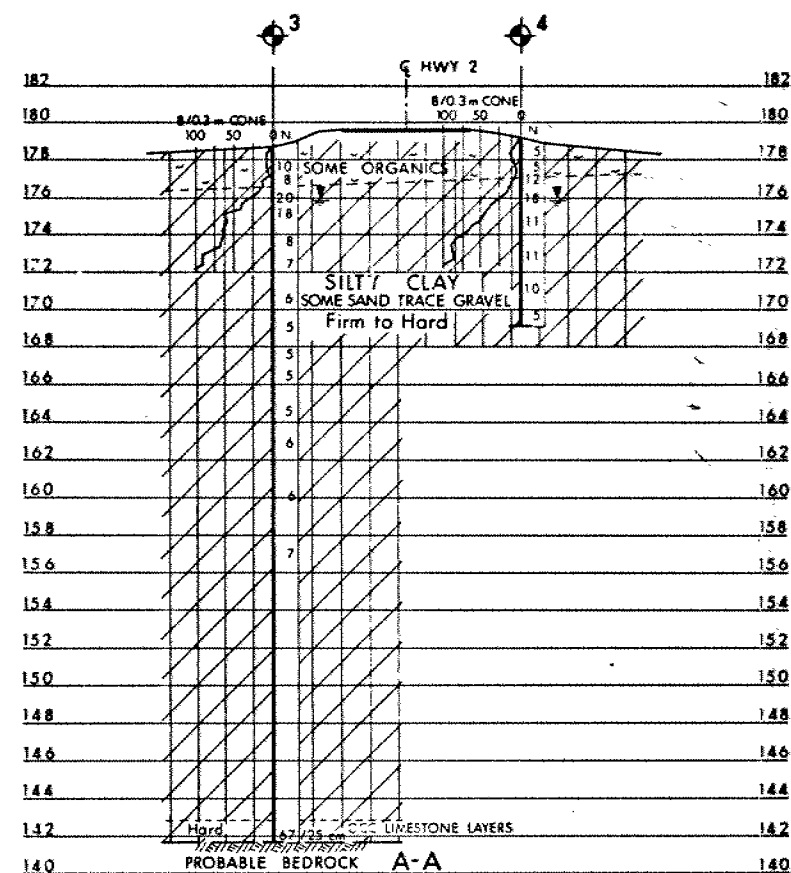
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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

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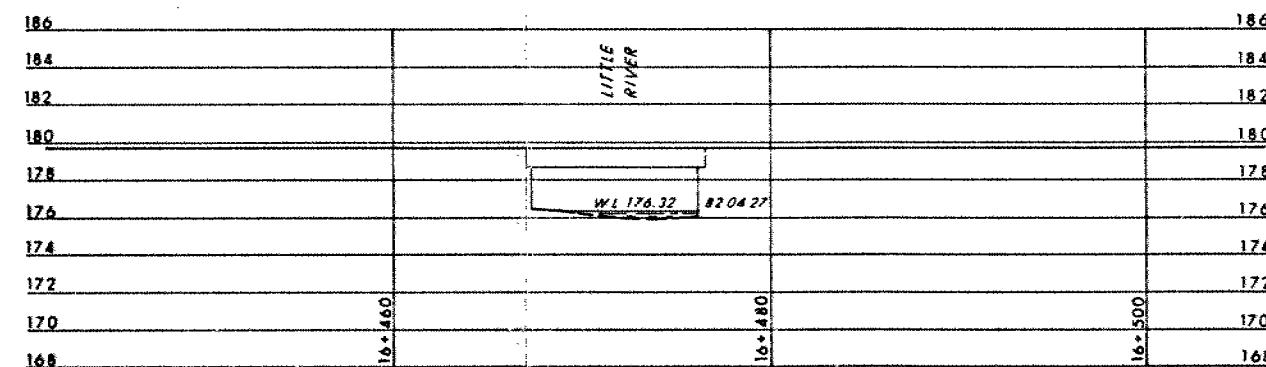
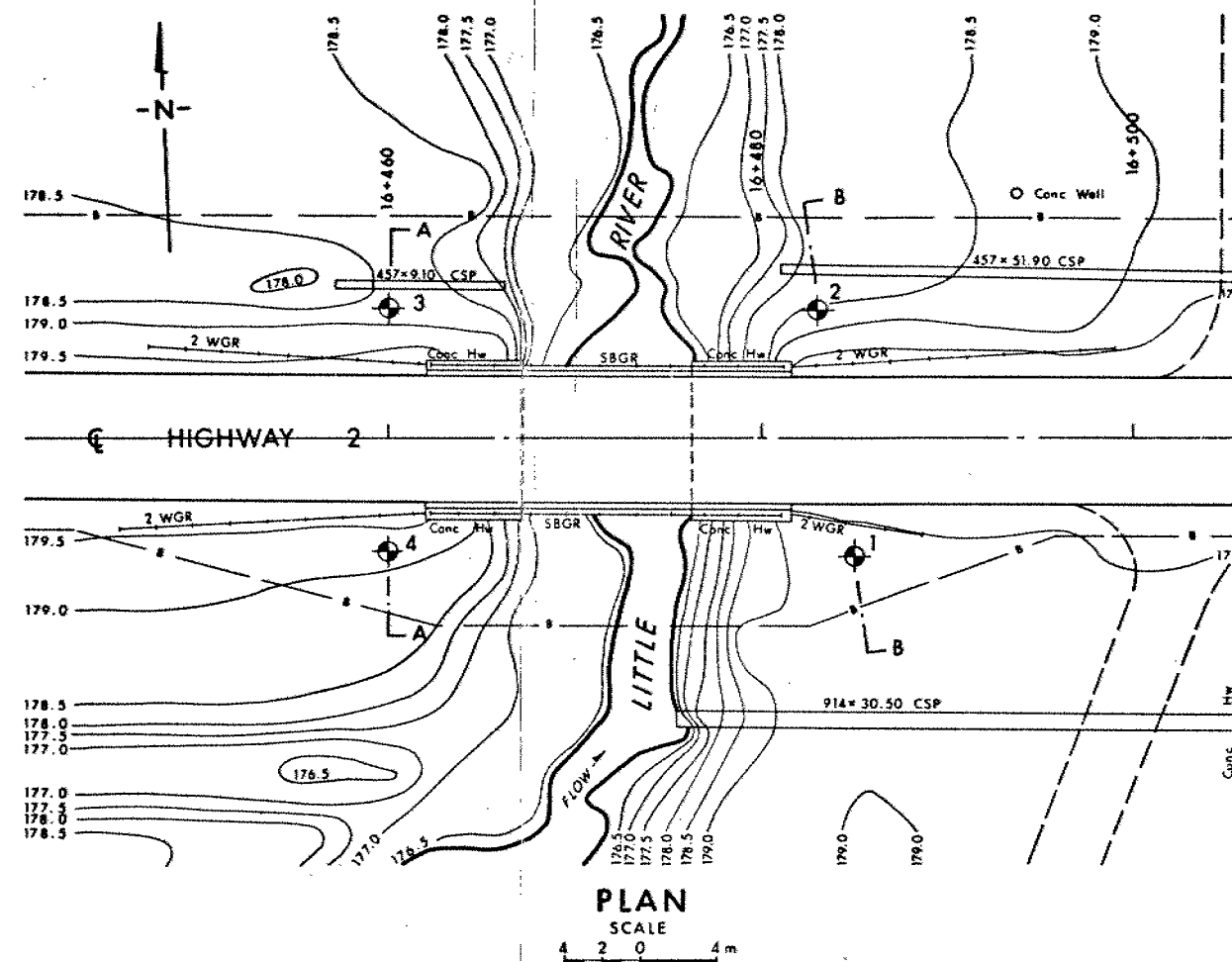
Geocres No 4012-37	
HWY No 2	DIST 1
SUBM'D D.D. CHECKED	DATE 82 10 15
DRAWN S.O. CHECKED	SITE 6-46
	DWG 927802-A

REF NO E-10007 82 05



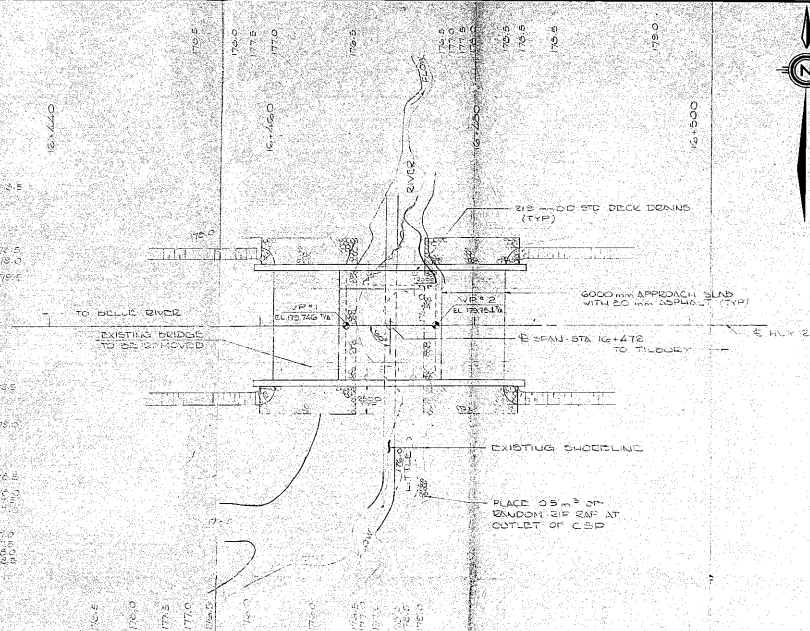
SECTIONS

SCALE 0 4 m

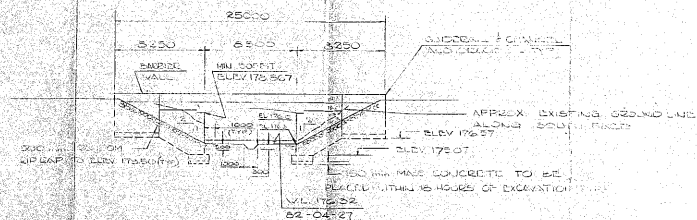


PROFILE - HWY 2

SCALE 0 4 m



PLAN  
1.200



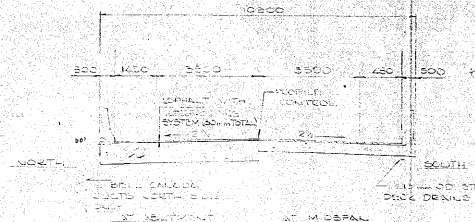
ELEVATION  
1200



**METRIG**

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

DISTRICT-1, HWY 2  
CONT No  
WP No 92-78-02  
LITTLE RIVER BRIDGE  
4.5M WEST OF HWY 201, I-28  
GENERAL ARRANGEMENT



## DECK SECTION

## NOTES

CLASS OF CONCRETE	
FOOTINGS, BASE CONCRETE & APPROACH SLABS	30 MPa
REMAINDER	30 MPa

CLEAR COVER TO REINFORCING STEEL	
FOOTINGS	100-25mm
BEAM/SLABS (W/ WALLS FRONT FACE)	50-20mm
BEAM/SLABS (W/ WALLS BACK FACE)	70-20mm
DECK (TOP)	70-20mm
DECK (BOTTOM & SIDES)	50-20mm
REMAINDER	70-20mm UNLESS OTHERWISE NOTED

STEEL

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

### CONSTRUCTION NOTES

BACKFILL SHALL BE PLACED SIMULTANEOUSLY  
DURING BOTH ADJUSTMENTS, KEEPING THE  
HEIGHT OF THE BACKFILL APPROXIMATELY  
THE SAME. NO MORE SHALL BE  
DIFFERENCES IN ELEVATIONS BE  
GREATER THAN 0.5 M.

PAILED, AND SUPPORTING THE DECK SHALL NOT BE REMOVED UNTIL AFTER THE SKEWERS ARE BEING PLACED BRING THE ASSEMBLY TO AT LEAST ELEV. 175.000

## LIST OF DRAWINGS

SPECIAL ASSIGNMENT  
 SOIL CLASSIFICATION & SOIL STRAT.  
 SOIL FRAME  
 MOVEMENT & SETTLING CALC.  
 PAVEMENT SLAB  
 APPROXIMATE SLAB  
 AS CONSTRUCTED ELEV & DIM.  
 FINISH DATE & SITE NUMBER DATA  
 STANDARD DETAILS  
 EROSION

DRAWING NOT TO BE SCALED  
1:50 mm. ON ORIGINAL DRAWING

REVISIONS					
	DATE	BY	DESCRIPTION		
DESIGN	J.P.M.	CHECK	LOADING	04BDC8B	DATE 02-29-01
DRAWING	G.C.	CHECK J.P.M.	SITE	G-105-425	DWG