



FOUNDATION TECHNICAL MEMORANDUM

For

**GOVERNMENT DRAIN BRIDGE NO. 2 EBL ON HIGHWAY 401
MTO WEST REGION 59 STRUCTURE REHABILITATIONS
SITE 13-152-1, CONTRACT 7
GWP 3084-11-00
GEOGRAPHICAL TOWNSHIP OF RALEIGH
KENT COUNTY, ONTARIO**

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FOUNDATION TECHNICAL MEMORANDUM

For

Government Drain Bridge No. 2 EBL, Highway 401
MTO West Region 59 Structure Rehabilitations
Contract 7, GWP 3084-11-00
Geographical Township of Raleigh
Kent County, Ontario

1. INTRODUCTION

The Foundation Engineering Services for the present project involve the detail foundation investigation and design for the rehabilitation of 59 structures in MTO West Region along Highways 4, 6, 401, 402 and 403. Ten (10) Group Work Projects (GWP's) are contemplated to be completed between 2014 and 2020.

This technical memorandum summarizes the factual results of geotechnical data based on the review and compilation of existing subsurface information from relevant reports in the MTO GEOCREC Library for the Highway 401 Government Drain Bridge No. 2 EBL (Eastbound Lanes). The drain was originally a branch of Jeanette Creek. The Foundation Engineering recommendations from the existing bridge foundation reports are summarized with reference to the "Canadian Highway Bridge Design Code" (CHBDC) and follow in general the "Guidelines for Professional Engineers providing Geotechnical Engineering Services".

From the Minutes of Meeting Report, dated July 24, 2014, it is understood that the bridge will be rehabilitated in a single stage using median crossovers.

The purpose of the Technical Memorandum is to summarize the subsurface and groundwater conditions and foundation recommendations based on available reports at the bridge location for the design project team's reference.

The elevations in this report are expressed in meters, unless otherwise noted.



2. PROJECT SITE BACKGROUND AND GEOLOGY

The Government Drain Bridge No. 2 EBL on Highway 401 is located about 4.8 km south of Chatham in the Geographic Township of Raleigh, Kent County, Ontario. The Government Drain No. 2 was originally a branch of Jeanette Creek, which was later dredged and widened into a drainage channel. A key plan is shown in Figure 1.

The existing structure is a single span reinforced concrete rigid frame structure that carries two lanes of Highway 401 Eastbound traffic. The surrounding areas around the site location are generally flat farming lands on both sides of Highway 401.

Physiographically, the site is located on the St. Clair Clay Plains which were inundated by Glacial Lakes Whittlesey and Warren. These plains are covered by relatively deep typically very stiff clayey silt and silty clay till deposits. The bedrock underlying the site area belongs to Kettle Point Formation of Upper Devonian period. The bedrock surface lies at about 23 to 38 m (75 to 125 ft.) below ground surface in the Geographical Township of Raleigh area (Quaternary Geology of the Chatham-Wheatley Area, Southern Ontario, 1995).

3. SOURCE OF INFORMATION

The following foundation report and drawing, appended in Appendix A, were available for review and provided information for the bridge structure, subsoil information and original foundation recommendations.

1. Foundation Report, Proposed Hwy 401, Line "C" and Drainage Ditch Crossing Lot 7, Con. VI, Twp. of Raleigh – Approx. 3 miles south of Chatham, District No. 1, W. P. 11-59, W.J. F-59-6, Materials and Research Section, Department of Highways Ontario, dated May 8, 1959. GEOCRETS NO. 40J08-004. (Reference 1)
2. Raleigh Township Bridge No. 12 - General Plan and Elevation, The King's Highway No. 401, District No. 1, Lot 7, Con. VI, Twp. of Raleigh, TWP #103-152-1-A, W.P.11-59, Department of Highways Ontario, dated September 1959. (Reference 2)



4. SITE RECONNAISSANCE

As part of the current foundation engineering assessment study, a site reconnaissance of the Government Drain Bridge No. 2 EBL was carried out on October 20, 2013. A photographic record of the site visit is attached in Appendix B.

The adjacent slopes of the abutments were observed to be vegetated and visually stable (Photograph 1). No erosion of the slope faces was observed. Further, scouring of the adjacent slope toes was also not observed at this bridge structure location. The front earth slopes of the east and west abutment walls (Photographs 2 and 3) were exposed. The exposed earth was observed to be affected by scouring, most likely due to repeated cycle of fluctuation of the creek water level throughout the season. No obvious major cracks were observed on the abutment walls except for some surface cracks. The weep holes observed in the abutment walls were open (Photographs 2 and 3).

At the time of the site reconnaissance, the water level of the drain was about 0.5 m deep and the direction of the water flow was towards the north.

5. PREVIOUS INVESTIGATIONS AND SUMMARIZED SUBSURFACE CONDITIONS

The site is located on Highway 401 in the Geographic Township of Raleigh, Kent County, Ontario. The general subsurface conditions presented in this section are based on the Foundation Report, GEOCRE 40J08-004 dated May 8, 1959.

The original investigation was carried out where bridges for Highway 401, Line 'C' over the drainage ditch in Lot 7, Con. VI in the Township of Raleigh were proposed.

The foundation report includes the borehole location plan (Drawing No. F59-6A), Record of Borehole sheets and summary of the Field and Laboratory tests. It should be noted that the Summary of the Field and Laboratory Tests copy was defective and some values were illegible.

The foundation investigation comprised four boreholes which were drilled between January 28 and February 7, 1959. The boreholes were drilled to depths of 8.2 to 9.7 m. Three dynamic cone penetration tests (DCPTs) were conducted adjacent to the location of boreholes 2, 3 and 4. The DCPTs were penetrated from the ground surface to depths of 6.1 to 6.7 m, elevations 170.7 to 173.4 (560 to 569 ft.).



The investigation was carried out by using a skid-mounted core drill machine. Conventional wash boring procedures were followed and samples were recovered at depths required. In cohesive subsoil, 50 mm (2 in.) diameter thin wall samplers were utilized to obtain undisturbed samples.

Subsurface Conditions

A 600 mm thick surficial frozen topsoil layer was encountered in the four boreholes and extended to elevation 176.8 to 178.9 (580 to 587 ft.). Below this topsoil layer, a deep deposit of very silty clay brown to gray stratum was encountered, which extended to borehole termination depths of 8.2 to 9.8 m, elevation 167.6 to 170.4 (550 to 559 ft.). The upper 3.0 m (10 ft.) of the silty clay stratum had been oxidized giving its brownish color, below which the color was predominately grey.

The stiff to hard consistency of the silty clay appeared to be the result of desiccation. The stratum was explored to a depth of 9.8 m (32 ft.), elevation 167.6 (550 ft.). Based on the similarity in geological formation as well as subsoil conditions between this sites and all other sites in this area which were previously investigated, it was assumed that clay of softer consistency than sampled would be encountered at approximate elevation 167.6 (550 ft.) and below. Bedrock was not encountered in any of the four boreholes.

Laboratory shear strength tests showed an average value of 86.2 kPa (1800 psf), with values typically ranging from 80.0 to 410.8 kPa (1670 to 8580 psf). Consolidation characteristics of the silty clay layer obtained during laboratory tests were 7.3×10^{-5} m²/kN (0.007 sq.ft./ton) for coefficient of volume compressibility and 1.3×10^{-2} m²/day for coefficient of consolidation.

N values typically ranged from 15 to 73, with a local N value of 8 in borehole 3. Generally, the silty clay samples contained 42 to 48% clay, 28% silt, 18% sand and 6 to 12% fine to medium gravel sized particles throughout the stratum. The Atterberg liquid limits obtained ranged from 25.8 to 68.5 and the plastic limits ranged between 14.3 and 34.4 for the silty clay samples. The plasticity index value ranged from 10.7 to 34.1. Further, the unit weight of the silty clay samples varied from 18.5 to 21.5 kN/m³. Moisture content determinations ranged from 14.8 to 26.5%. Based on the moisture content determinations and Atterberg limits, the silty clay below 3.0 m (10 ft.) appeared to be saturated and preconsolidated.



Groundwater

Groundwater was observed in boreholes 1 to 3 during the field investigation at 2.6 to 2.9 m (8.5 to 9.5 ft.), elevations 174.7 to 176.9 (573.0 to 580.5 ft.), which corresponded to the seasonal water level of the drainage canal. No artesian condition or water bearing sand seams were encountered.

6. FOUNDATION

6.1 Previous Foundation Recommendations

The foundation report recommended that spread footings could be founded at about elevation 174.3 (572 ft.) or lower. The stiff to hard silty clay layer at that elevation was assessed to be competent, based on the laboratory test results, to provide adequate support for 2.1 to 3.0 m (7 to 10 ft.) wide footings. For footings of 2.1 to 3.0 m (7 to 10 ft.) wide, an allowable bearing pressure of 240 kPa (2.5 tsf) including a safety factor of 3 were recommended for the design of the spread footings. However, in order to avoid undesirable undermining of the foundation footings due to stream erosion, scour, and to allow for future deepening of the channel, it was recommended that the footings be founded at approximate elevation 171.9 (564 ft.), about 2.4 m (8 ft.) below the channel bed elevation.

The ultimate settlement under the footings, due to the application of 240 kPa (2.5 psf), was estimated to be in the order of 100 mm (4 in.). It was anticipated that the settlement would take place mainly due to the consolidation of the soft to firm clay layer at considerable depth. In view of the uniform soil condition at the site, little differential settlement between abutments was anticipated for a single span structure. Based on the investigation, it was anticipated that there would be no excessive seepage problems during excavation and placing of footings due to the low permeability of the silty clay. Further, it was anticipated that if seepage did occur, seepage inflow into excavations would be local and of minor quantities. The report anticipated that the proposed grade line would not cause any approach fill stability problem.

Based on the Reference 2 drawing, titled 'Raleigh Township Bridge No. 12 - General Plan and Elevation', dated September 1959, the footings were to be founded at about elevation 173.7 (570 ft.). Further, it was indicated that steel sheet piles (Type AP3) were to be driven to approximate elevation 171.0 (561 ft.). However, during the site reconnaissance, the presence of sheet piles could



not been verified visually. The original ground slopes were shown to be cut back at 2H:1V at the bridge site location.

6.2 Assessment of Foundation Parameters

Based on the previous investigation and subsurface conditions encountered, the following table summarizes the foundation design parameters that were recommended in the previous report and the updated geotechnical reaction at SLS and factored geotechnical resistance at ULS are provided.

FOUNDATION DESIGN PARAMETERS

Foundation and Type	Elevation of Footings (m)	Previous Safe Bearing Resistance (tsf) ¹	Previous Equivalent Limit State Design Values		Limit State Design Values Updated to current industry practices ²	
			SLS Geotechnical Reaction (kPa)	ULS Factored Geotechnical Resistance (kPa)	SLS Geotechnical Reaction (kPa)	ULS Factored Geotechnical Resistance (kPa)
East Abutment on Spread Footing	173.7 (570 ft.)	2.5	240	360	350	525
West Abutment on Spread Footing						

- Notes:**
- Working stress design values. The Ultimate Limit State design values are based on the working stress. No field verifications were made.
 - Resistance Factor = 0.5 for shallow foundation (CFEM 4th edition)
 Assumed Factor of Safety is 3 (CFEM 4th edition)

The seismic site coefficient for the conditions at this site is 1.0 (soil profile Type 1, Canadian Highway Bridge Design Code (CHBDC) 2006 Edition, clause 4.4.6). The bearing resistance for inclined loads should be reduced in accordance with the requirements of clause 6.7.4 of the CHBDC. The foundation frost penetration depth at the site is 1.2 m according to OPSD 3090.101.



7. DISCUSSION

From a geotechnical point of view, at the present time, foundation work for the Government Drain Bridge No. 2 EBL structure is not expected provided that the total dead load on the bridge does not increase or decrease by more than 10%.

It is understood that the bridge will be rehabilitated in a single stage using median crossovers.

Further, it is suggested that the weep holes in the abutment walls should be maintained and cleaned on a regular basis to prevent any clogging of the holes. Regular maintenance of the weep holes will keep the water flowing from behind the abutment walls and will mitigate hydrostatic pressure from building up behind the abutment walls.

In addition to rehabilitating the bridge, the earth in front of the abutment walls may be protected from erosion and the edge of the slope toes from scouring effects with rock protection, rip-rap or equivalent materials. The aggregate materials should conform to OPSS.PROV 1004 and the construction of the rock protection, rip-rap or equivalent should conform to OPSS 511.



8. CLOSURE

This Technical Memorandum was prepared by Mr. Nazibur Rahman, P.Eng with the assistance of Mr. Mansoor Khorsand, EIT and was reviewed by Mr. Robert Ng, PhD, P.Eng. Mr. Brian R. Gray, MEng, P.Eng., MTO Designated Principal Contact conducted an independent review of the report.

We trust this memo is sufficient for your immediate needs. Please do not hesitate to contact us if you have any inquiries and/or comments.

Yours very truly,

Peto MacCallum Ltd.



Nazibur Rahman, P.Eng.
Project Engineer, Geotechnical Services



Robert Ng, MBA, PhD, P.Eng.
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NR/RN/BRG:jk



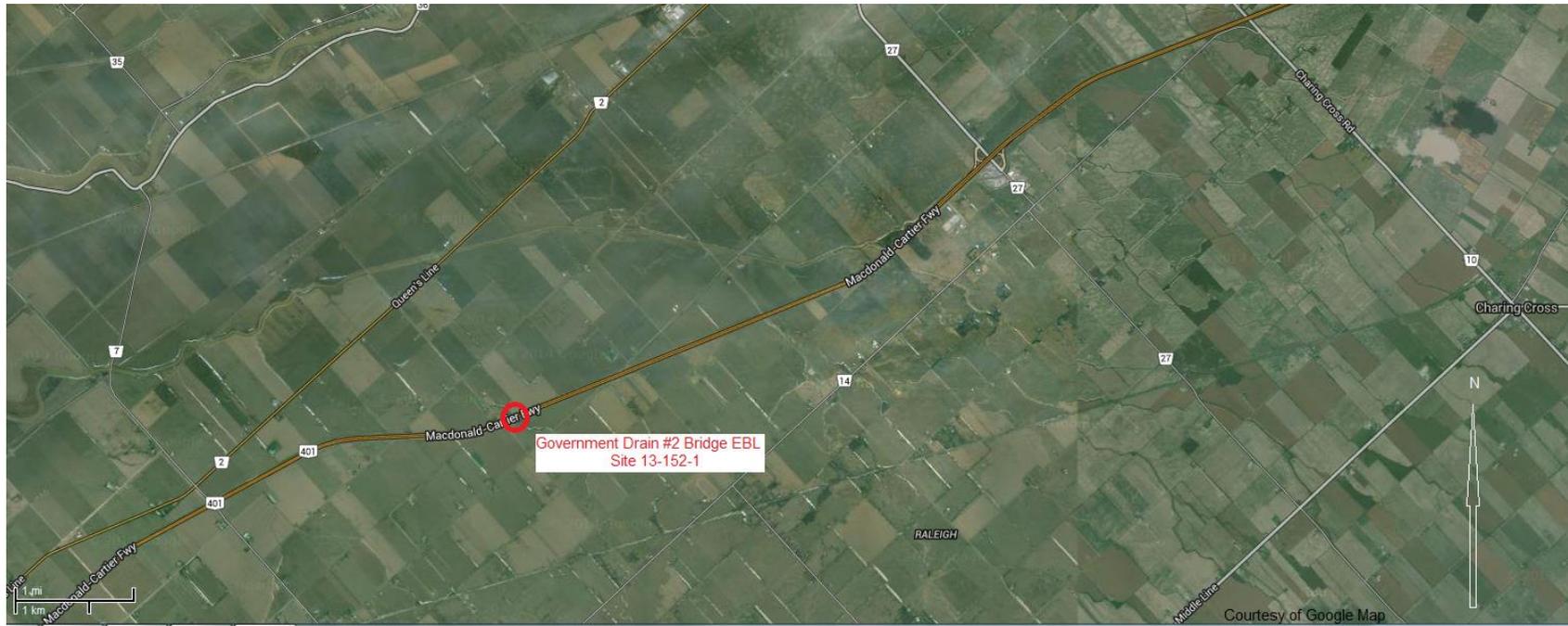
TABLE 1

LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT

DOCUMENT	TITLE
OPSS 511	Construction Specification for Rip-Rap, Rock Protection, and Granular Sheeting
OPSS.PROV 1004	Material Specification for Aggregates - Miscellaneous
OPSD 3090.101	Foundation Frost Depth for Southern Ontario



Figure 1 – Key Plan





APPENDIX A

Foundation Report at Government Drain Bridge No. 2 (GEOCRE5 40J08-004)

General Plan and Elevation - Raleigh Township Bridge No. 12, dated September 1959

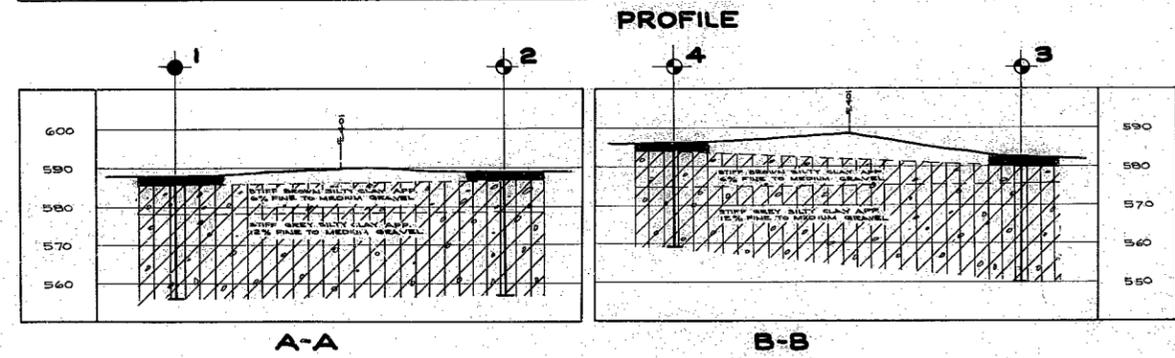
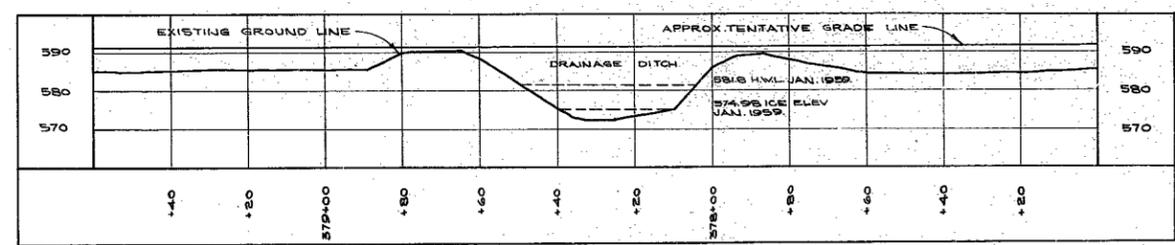
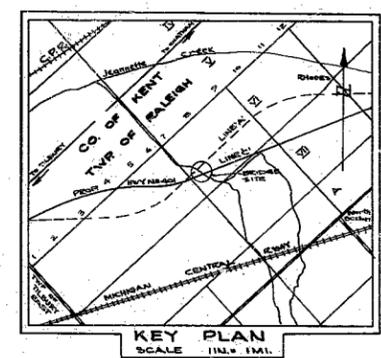
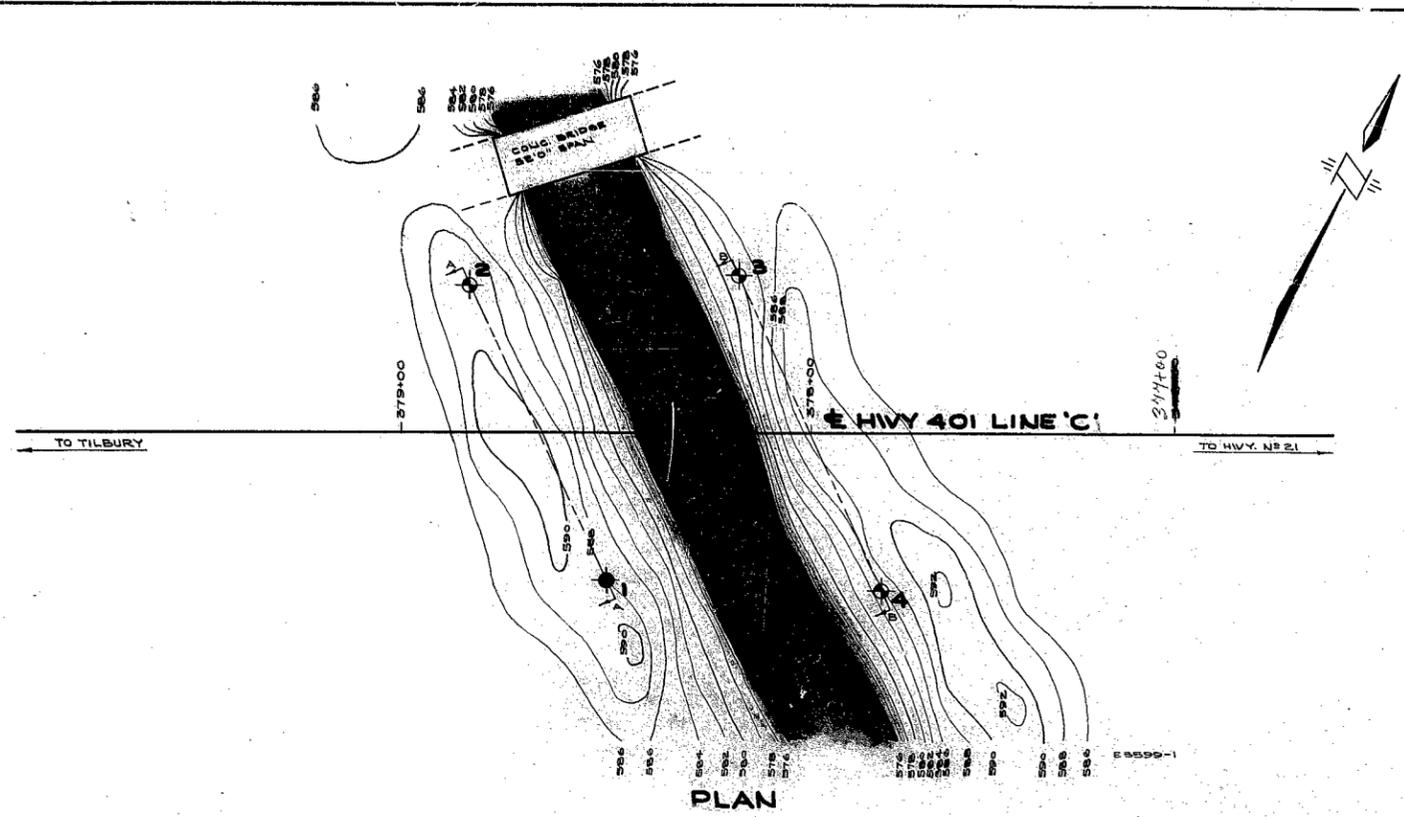
W.P. 11-59

HWY. 401

SOUTH OF

CHATHAM

4038-4



LEGEND

BORE HOLE

PENETRATION HOLE

BORE & PENETRATION HOLE

HOLE NO.	ELEVATION	STATION	DISTANCE FROM E
1	585.0'	278+47	58' LT.
2	589.0'	278+52	58' LT.
3	582.0'	278+13	41' RT.
4	586.0'	277+76	41' 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 AND MAY BE SUBJECT TO CONSIDERABLE ERROR.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION

**DRAINAGE DITCH
PROPOSED CROSSING**

SHOWING POSITIONS & ELEVATIONS OF HOLES

HWY. 401 DISTRICT 1 COUNTY KENT
TOWNSHIP RALEIGH LOT 7 CON. VI
LOCATION APP. 3 MI. S. OF CHATHAM

DRAWN BY: T. MELLORE CHECKED BY: [Signature] W.P. 11-509
DATE: APR. 29/59 APPROVED BY: [Signature] DRAWING NO. F59-CA
SCALE: 1" = 20'

40J 8-4
GEOCRE No.

FOUNDATION REPORT

on

Hwy. 401, Line 'C' and
Drainage Ditch Crossing,
Lot 7, Con. VI, Twp. of
Haleigh - Approximately
3 Miles South of Chatham.

Site Plan No. E 3599-1

Chainage: Sta. 378+25

Distribution:

Mr. A. M. Foye,
Bridge Engineer. (2)

Mr. E. A. Tregaskes,
Construction Engineer. (1)

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London Regional Office. (1)

Mr. P. Karrow,
Department of Mines. (1)

Foundation Section. (1)

File. (1)

.....

.....

Mr. A. M. Teye,
Bridge Engineer.

May 8, 1959.

Materials & Research Section. Ditch Crossing, Twp. of Raleigh -

Re: FOUNDATION REPORT -
Hwy. 401, Line 'C' & Drainage

W.D. 11-59 -- District #1.

Attention: Mr. S. McCombie.

Enclosed herewith is our Foundation Report showing the
subsoil conditions at the above noted site. Reference to the
contents of the report shows that the site is covered by stiff
silty clay underlain by deep deposits of soft to medium silty
clay.

For your convenience, recommendations pertinent to the
foundation design are summarized as follows:-

1. Subsoil conditions are such that at elevation 57 $\frac{1}{2}$ ' or below
in the stiff silty clay, for footings typically 7' to 10'
wide, a safe footing pressure of 2 1/2 t.s.f. can be used
for spread footing design. In order to avoid undesirable
undermining of the footings due to stream erosion and scour
action and to allow for future deepening of the channel,
it is recommended that footings be founded at elev. 56' or
below.
2. Long-term settlements resulting from abutment loading have
been estimated as of the order of 4 inches. For a single-
span structure, the resultant differential settlements are
considered tolerable.
3. No excessive seepage problems with respect to footing ex-
cavations are anticipated.
4. The proposed grade line does not present any approach fill
stability problems. Bank slopes on the upstream side of
the structure should be protected by rip-rap.

If you require any clarification of data and recommendations
contained in the report, please contact our office.

Under
incl.

cc:

Messrs. A. Teye H. Tregaskes
 C. Ramsey C. Howell
 J. Roy Dr. S. Harrow
 Foundation Office - File

L. S. Rodeman,
PRINCIPAL ENGINEER & SUPERVISOR
OF

Abraham Ch
A. Loh,
FOUNDATION ENGR.

INTRODUCTION:

Presented in this report are the results of a subsoil investigation carried out at a structure location approximately 3 miles South of Chatham where proposed Hwy. 401 Line 'C' crosses the drainage ditch in Lot 7, Con. VI, Township of Raleigh - (Sta. 378+25, Site Plan No. S 3599-1). This report contains the results of field and laboratory findings and recommendations for the foundation of the proposed structure.

The field work commenced on January 28, 1959 and was completed on February 7, 1959.

DESCRIPTION OF THE SITE AND GEOLOGY:

The site and its surrounding area, are generally flat farmlands; the areas on both sides of the drain are presently under cultivation. The drain was originally a branch of Jeannette Creek which has been dredged and widened into a drainage channel. At the time of the investigation the drainage channel and its banks were covered with ice and snow.

Physiographically, the site is located on the St. Clair Clay Plains which were inundated by Glacial Lakes Whittlesey and Warren. According to available geological information, these extensive plains, covering a large area of South-Western Ontario, are covered by deep deposits of clay, underlain by limestone bedrock. At this site, the upper 10 feet of the clay stratum has been subjected to oxidation resulting in its present brownish colour.

cont'd. / 2...

DESCRIPTION OF FIELD & LABORATORY WORK:

Field work consisted of 4 sampled boreholes, carried out by a skid-mounted coredrill machine adapted for soil sampling. Conventional wash boring procedures were followed and samples were recovered at depths required. 2" I.D. thin walled Shelby tube samplers were used in the cohesive subsoil. In addition, a dynamic cone penetration profile was obtained adjacent to Borings 2, 3 & 4.

Upon receipt in the laboratory, samples were visually examined and identified. Routine index tests were performed on selected representative samples. Laboratory test results have been presented in the borehole logs and detailed in tabular form.

The location plan and subsoil profile are presented in Drawing No. F-59-6a.

SUBSOIL CONDITIONS:

Subsoil conditions at this site are similar to all other sites previously investigated in this area. Reference to the borehole logs shows that the site is underlain by a stiff silty clay stratum, the upper zone of which has been subjected to oxidation. According to our boring data in this locality, the stiff silty clay stratum is underlain by a thick stratum of soft to medium silty clay, which extends to a considerable depth over bedrock.

In each of the sampled boreholes, the frozen topsoil was found to be underlain by the stiff silty clay stratum. The upper 10 feet of the clay stratum has been oxidized to its present brownish colour. Below the oxidized zone the colour is predominantly grey. The stiff condition of the clay stratum is believed

SUBSOIL CONDITIONS: (cont'd.)

to be the result of desiccation. This stratum was explored to a depth of 32 feet below the existing ground surface (i.e., Elev. 550') to confirm the stiff nature of the clay. In view of the similarity in geological formation as well as subsoil conditions between this site and all other sites in this area previously investigated, it is felt justified to assume that the soft to medium clay stratum would most likely be encountered at some depth below Elev. 550'.

In general, the stiff clay contains 28% silt, 18% sand and 6% to 12% fine to medium gravel throughout. Average unit weight and moisture content were found to be 132 p.c.f. and 18%, respectively. Liquid and plastic limits averaged 28% and 16%. Laboratory shear strength tests show an average of 1500 p.s.f. to be representative for the 32 ft. layer. A plot of shear strength versus depth has been presented and is included in this report under Appendix I. Judging from its moisture content and Atterberg limits, the stiff silty clay appears to be saturated and preconsolidated.

Laboratory and field test results have been summarized in Table No. I and are included in this report under Appendix I.

WATER CONDITIONS:

Water levels in the boreholes recorded during the boring program, indicate that the ground water table at the site is at approximately Elevations 574' to 581', which corresponds to the seasonal creek water level of the drainage canal. No artesian water conditions or water-bearing sand seams of any significance

cont'd. /4 ...

WATER CONDITIONS: (cont'd.) ...

were encountered in the borings. In view of the low permeability of the clay, no seepage problems are anticipated during footing excavations. If seepage does occur, seepage inflow into excavations will be local and of minor quantities, only.

FOUNDATION CONSIDERATIONS:

The stiff silty clay stratum is competent to provide adequate foundation support for the proposed structure. Laboratory and field test results are such that spread footing support can be obtained in the stiff clay at elevation 57±' or below. At this elevation or below, for footings of 7' to 10' in width, a bearing pressure of 2 1/2 t.s.f. incorporating a safety factor of 3 can be used for spread footing design. Consideration should be given to founding footings below the stream bed elevation in order to protect them from stream erosion and scour, and to allow for future deepening of the channel. Footings founded at Elev. 56±' (approx. 8 ft. below stream bed elevation) are believed to have adequate protection against erosion and scour.

Ultimate settlements under the footings, consequent upon application of a 1/2 t.s.f. bearing pressure will be of the order of 4 inches. This is mainly due to the fact that the stresses caused by the applied load will influence the deep deposits of soft to medium clay for a considerable depth. In view of the relatively uniform soil conditions at the site, little differential settlement need be anticipated of a single-span structure since each abutment will virtually settle the same amount.

FOUNDATION CONSIDERATIONS: (cont'd.) ...

No excessive seepage problems during excavations and placing of footings are anticipated.

The proposed grade line presents no approach fill stability problems.

CONCLUSIONS & RECOMMENDATIONS:

- (1) The site is underlain by stiff silty clay followed by deep deposits of soft to medium silty clay.
- (2) Subsoil conditions are such that spread footing support can be obtained in the stiff clay stratum at Elev. 57 $\frac{1}{2}$ ' or below. At this elevation or below, for footings of 7' to 10' in width, a bearing pressure of 2 1/2 t.s.f. can be used for spread footing design. In order to avoid undesirable undermining of the footings due to stream erosion and scour, and to allow for future deepening of the channel, it is recommended that footings be founded at Elev. 56' or below.
- (3) Long-term settlements under the footings as a result of application of 2 1/2 t.s.f. bearing pressure, have been estimated as of the order of 4 inches. For a single-span structure, little differential settlement need be anticipated since each abutment will virtually settle the same amount.

cont'd. /6 ...

CONCLUSIONS & RECOMMENDATIONS: (cont'd.) ...

- (4) No excessive seepage problems with respect to footing excavations are anticipated.

- (5) The proposed grade line does not present any approach fill stability problems. Bank slopes on the upstream side of the structure should be protected by rip-rap.

A. Loh

A. Loh,
FOUNDATION ENGR.

APPENDIX I.

SUMMARY OF FIELD & LABORATORY TESTS

JOB 1-1-59
WP 11-59

PILE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET RESIST (BLOWS/FT)	MOIST CONT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	UNSATURATED SWELLING (%)	UNIT WEIGHT (PCF)	REMARKS
1	T1	3'-5'	Stiff brown silty clay.	25	26.5	34.4	68.5	2200	118.0	Approximately 6% fine medium gravel throughout
"	T2	6'-8'	" " "	35	17.1	19.1	31.6	5570	127.3	
"	T3	9'-11'	" " "	48	16.6	17.7	32.0	6150	135.2	
"	T4	15'-17'	Stiff grey silty clay.	49	21.2	15.0	27.4	2125	129.3	Approximately 12% fine medium gravel throughout
"	T5	20'-22'	" " "	46	21.8	15.7	26.8	2220	134.0	
"	T6	25'-27'	" " "	33	21.6	14.3	25.8	1670	129.5	
"	T7	30'-32'	" " "	33	19.4	16.5	27.2	2490	134.0	
2	T1	3'-5'	Stiff brown silty clay.	31	18.7	-	-	4920	131.2	Approximately 6% fine medium gravel throughout
"	T2	6'-8'	" " "	47	15.5	18.7	33.6	8590	132.7	
"	T3	9'-11'	" " "	62	14.8	16.8	29.1	6870	134.0	
"	T4	15'-17'	Stiff grey silty clay.	44	17.2	16.2	28.9	2800	135.0	Approximately 12% fine medium gravel throughout
"	T5	20'-22'	" " "	31	17.2	-	-	-	133.2	
"	T6	25'-27'	" " "	26	18.1	15.9	29.0	1800	131.8	
"	T7	30'-32'	" " "	28	18.1	-	-	2420	134.1	
3	T1	3'-5'	Stiff brown silty clay.	17	25.0	24.7	48.5	1940	122.0	Approximately 6% fine medium gravel throughout
"	T2	6'-8'	" " "	50	16.8	-	-	7210	135.6	
"	T3	9'-11'	" " "	8	16.1	16.1	24.6	3270	135.0	
"	T4	15'-17'	Stiff grey silty clay.	21	17.9	16.3	26.8	1000	132.2	Approximately 12% fine medium gravel throughout
"	T5	20'-22'	" " "	22	24.2	-	-	420	131.0	
"	T6	25'-27'	" " "	10	18.1	17.5	29.1	1015	129.6	
"	T7	30'-32'	" " "	26	18.1	-	-	-	131.8	

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

cont'd. / 2 ...

SUMMARY OF FIELD & LABORATORY TESTS

JOB F-59-6

W.P. 11-59.

WELL NO.	SAMP. NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. SLOWLY	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH PSI	UNIT WEIGHT PCF	REMARKS	
4	T1	3'-5'	Stiff brown silty clay.	15	23.1	-	-	-	126	Approximately 6% fine to medium gravel throughout.	
"	T2	6'-8'	" " " "	73	16.7	18.7	32.2	6900	136.3		
"	T3	10'-12'	" " " "	43	16.4	16.9	28.0	3100	135.0		
"	T4	15'-17'	Stiff grey silty clay.	59	16.9	16.6	27.8	2170	131.8		Approximately 12% fine to medium gravel throughout.
"	T5	20'-22'	" " " "	29	17.9	-	-	2580	134.0		
"	T6	25'-27'	" " " "	48	18.3	16.3	27.0	1920	131.8		
T1 - denotes thin walled Shelby sample.											
<u>Consolidation Characteristics:-</u>											
Coefficient of volume compressibility										0.01 sq.ft./ton.	
Coefficient of consolidation										0.14 sq.ft./day.	

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

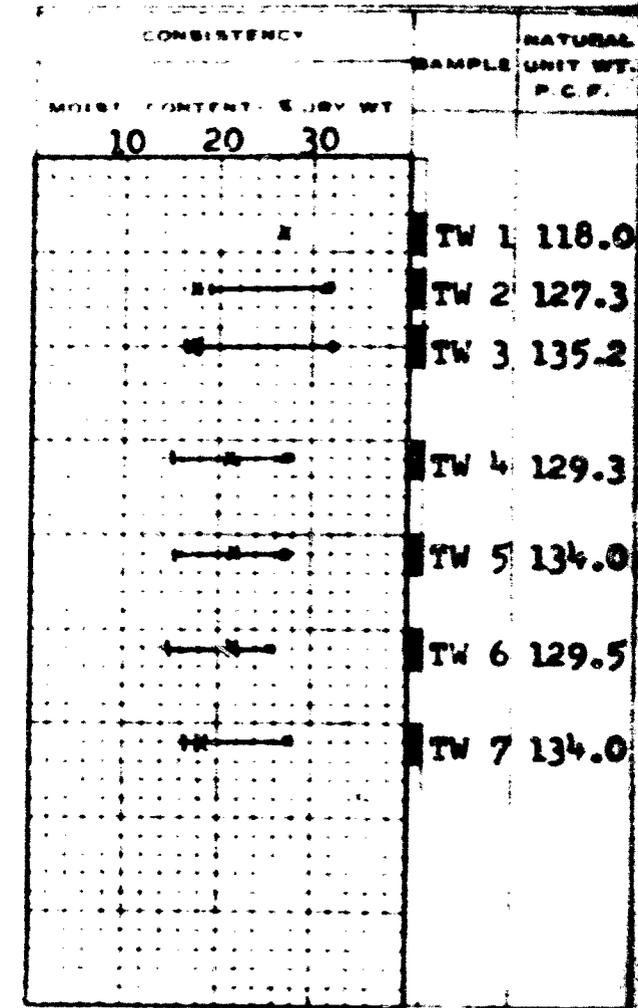
W.P. 11-59 BORE HOLE NO. 1
 JOB P-59-6 STATION 378+47 (38' Lt.)
 DATUM Geodetic COMPILED BY B.K.
 BORING DATE Jan. 28/59 CHECKED BY A.L.

2" DIA SPLIT TUBE
 2" SHELBY TUBE
 2" SPLIT TUBE
 2" DIA CONE
 2" SHELBY CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Qu) — O
 VANE TEST (C) AND SENSITIVITY (S) — +
 NATURAL MOISTURE AND LIQUIDITY INDEX — LI
 LIQUID LIMIT — X
 PLASTIC LIMIT — I

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ground Level	589.0	
	FROZEN TOPSOIL	586.0	
	Stiff brown silty clay - approx. 6% fine to medium gravel.		
	W.L. <u>▽ 578.5</u>		
	Stiff grey silty clay - Approx. 12% fine to medium gravel.		
	End of Borehole.	556.0	32.0



DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

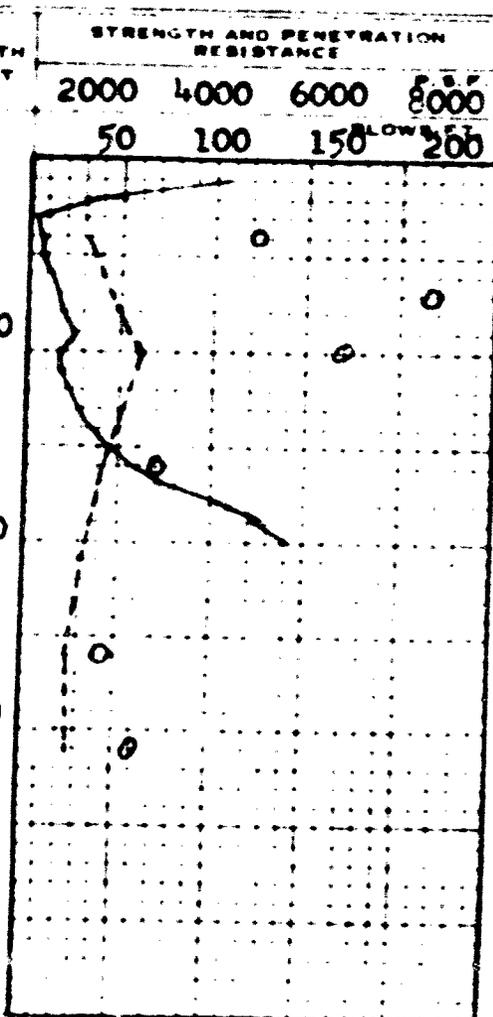
W.P. 11-59. BORE HOLE NO. 2
 JOB F-50-6 STATION 378+82 (38' Rt.)
 DATUM Geodetic COMPILED BY B.K.
 BORING DATE Feb. 3/59. CHECKED BY A.L.

2" DIA SPLIT TUBE
 2" SHELBY TUBE
 2" SPLIT TUBE
 2" DIA CONE
 2" SHELBY
 CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Q_u) — O
 VANE TEST (C) AND SENSITIVITY (S) — +
 NATURAL MOISTURE AND LIQUIDITY INDEX — LI
 LIQUID LIMIT — L
 PLASTIC LIMIT — P

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ground Level.	583.0	
	Top of Soil	581.0	
	Stiff brown silty clay - Approx. 6% fine to medium gravel.	W.L. 580.5	
		578.5	
	Stiff grey silty clay - Approx. 12% fine to medium gravel.		
	End of Borehole.	657.0	



SAMPLE	NATURAL UNIT WT. P.C.F.	CONSISTENCY		
		MOIST. CONTENT	S.E.R.Y. WT.	
		10	20	30
TW 1	131.2			
TW 2	132.7			
TW 3	134.0			
TW 4	135.0			
TW 5	133.2			
TW 6	131.8			
TW 7	134.1			

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

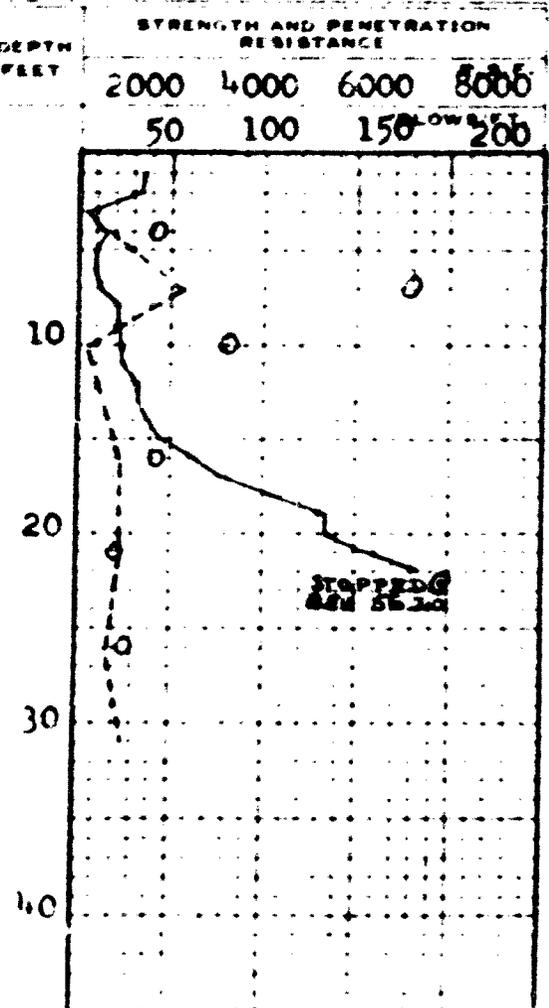
W.P. 11-59 BORE HOLE NO. 3.
 JOB F-59-6. STATION 378+13 (41' Pt.)
 DATUM Geodetic COMPILED BY B.K.
 BORING DATE Feb. 4/59. CHECKED BY A.L.

2" DIA SPLIT TUBE
 2" SHELBY TUBE
 2" SPLIT TUBE
 2" DIA CONE
 2" SHELBY
 CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Qu) O
 VANE TEST (C) AND SENSITIVITY (S) +
 NATURAL MOISTURE AND LIQUIDITY INDEX X
 LIQUID LIMIT
 PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ground Level.	582.0	
	FROZEN TOPSOIL	582.0	
	Stiff brown silty clay - Approx. 6% fine to med. gravel.	W.L. 574.0	
		571.4	
	Stiff grey silty clay - Approx. 12% fine to medium gravel.		
	End of Borehole.	532.0	32.0



CONSISTENCY			SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT % DRY WT				
10	20	30		
			TW 1	122.0
			TW 2	135.6
			TW 3	137.0
			TW 4	133.2
			TW 5	132.0
			TW 6	129.6
			TW 7	133.8

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

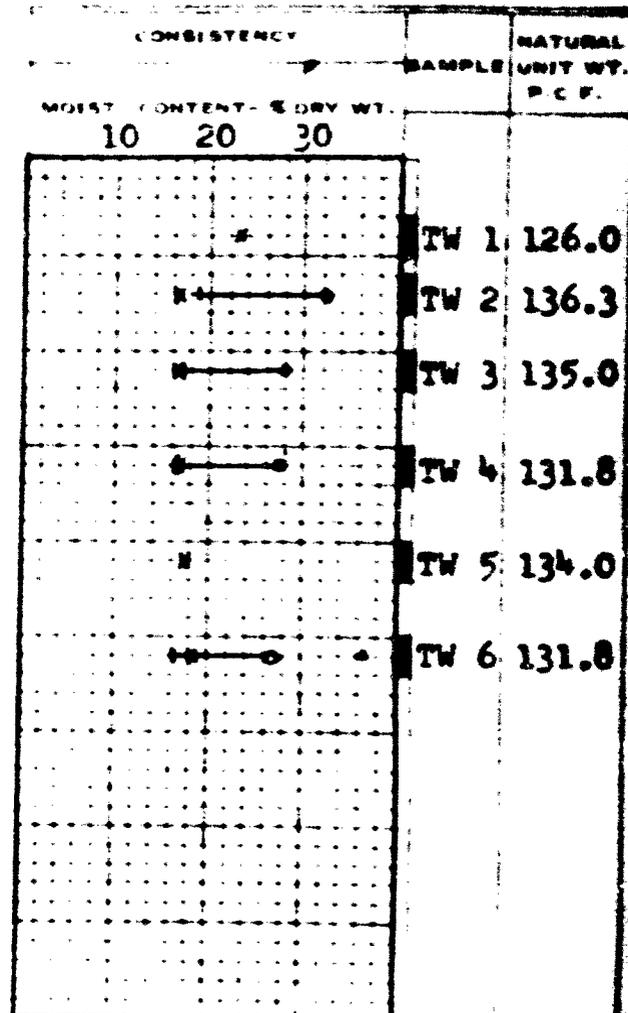
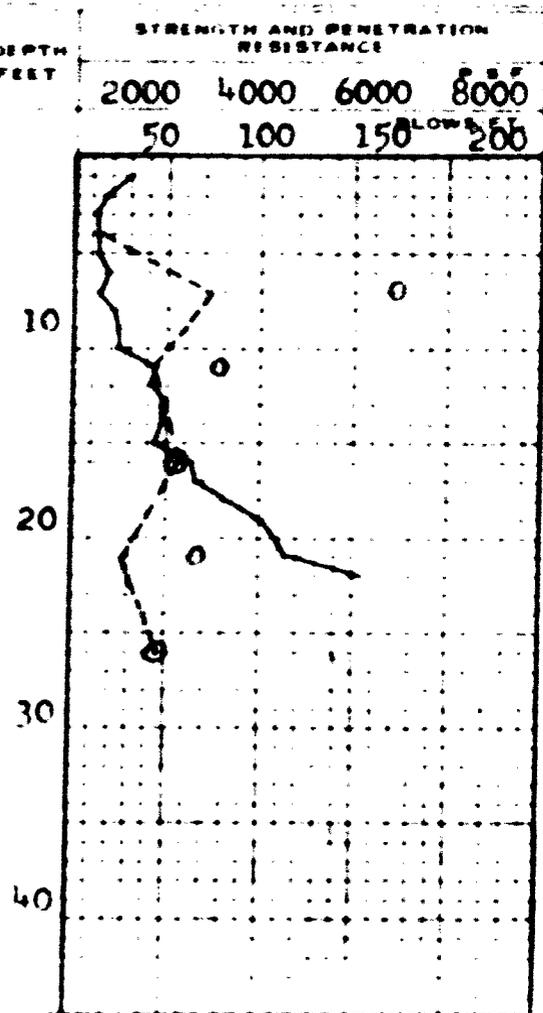
W.P. 11-59 BORE HOLE NO. 4
 JOB P-59-6 STATION 377+76 (41' Lt.)
 DATUM Geodetic COMPILED BY B.K.
 BORING DATE Feb. 5/59. CHECKED BY A.L.

2" DIA SPLIT TUBE
 2" SHELBY TUBE
 2" SPLIT TUBE
 2" DIA CONE
 2" SHELBY
 CASING

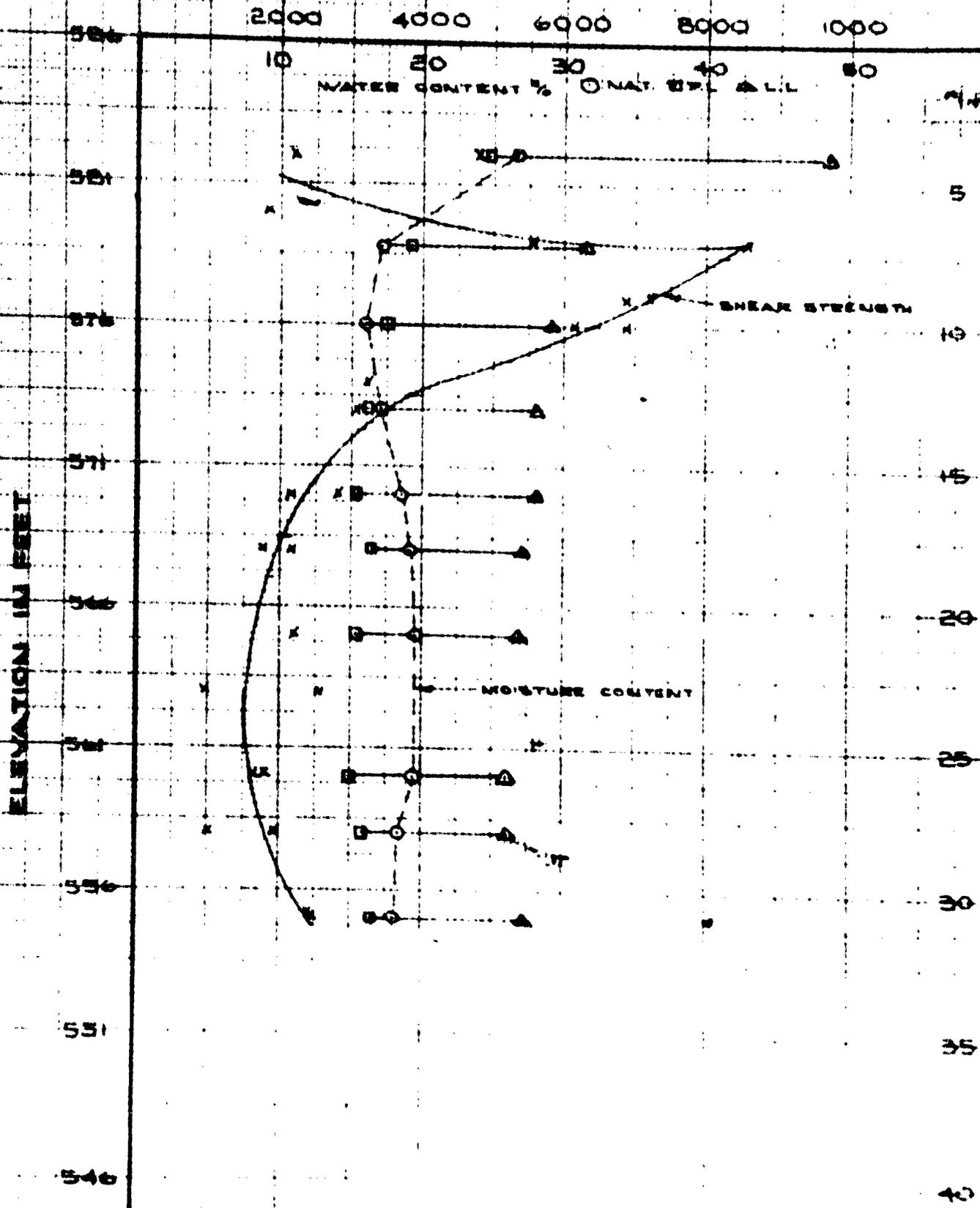
LEGEND

UNCONFINED COMPRESSION (Qu) — O
 VANE TEST (C) AND SENSITIVITY (S) — +
 NATURAL MOISTURE AND LIQUIDITY INDEX — LI
 LIQUID LIMIT — X
 PLASTIC LIMIT —

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
↓	Ground Level	586.0	
■	FROZEN TOPSOIL	584.0	
▨	Stiff brown silty clay - Approx. 6% fine to med. gravel.	575.0	
▨	Stiff grey silty clay - Approx. 12% fine to medium gravel.		
	End of Borehole.	559.0 27.0	



SHEAR STRENGTH IN P.S.F.



SKEW ANGLE = 25°-00'
 SIN. 0.422618
 TAN. 0.466308
 COS. 0.906708
 SEC. 1.103378

NOTES:

NOTE TO DISTRICT ENGINEER: Concrete work on this structure must not be commenced until monuments to fix control points have been erected and checked by the District Engineer.

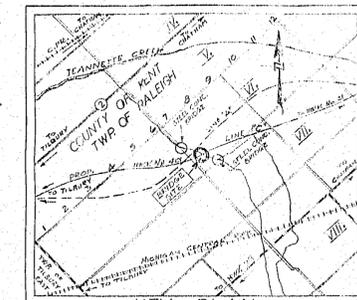
NOTE TO CONTRACTOR: Structure to be built in accordance with form No 9 and the special provisions, extra copies of which may be obtained from the Dist. Eng. and the Bridge Engineer. All Construction Joints must be approved by the Bridge Engineer.

CONCRETE MIX: Minimum Strength @ 28 days for Footings - 2500 psi, all other Structure - 3000 psi. An approved admixture supplied by the Department will be added to all concrete as specified by the Engineer. Maximum size of aggregate: Footings 1 1/2", Structures 1", above Curbs 3/4"

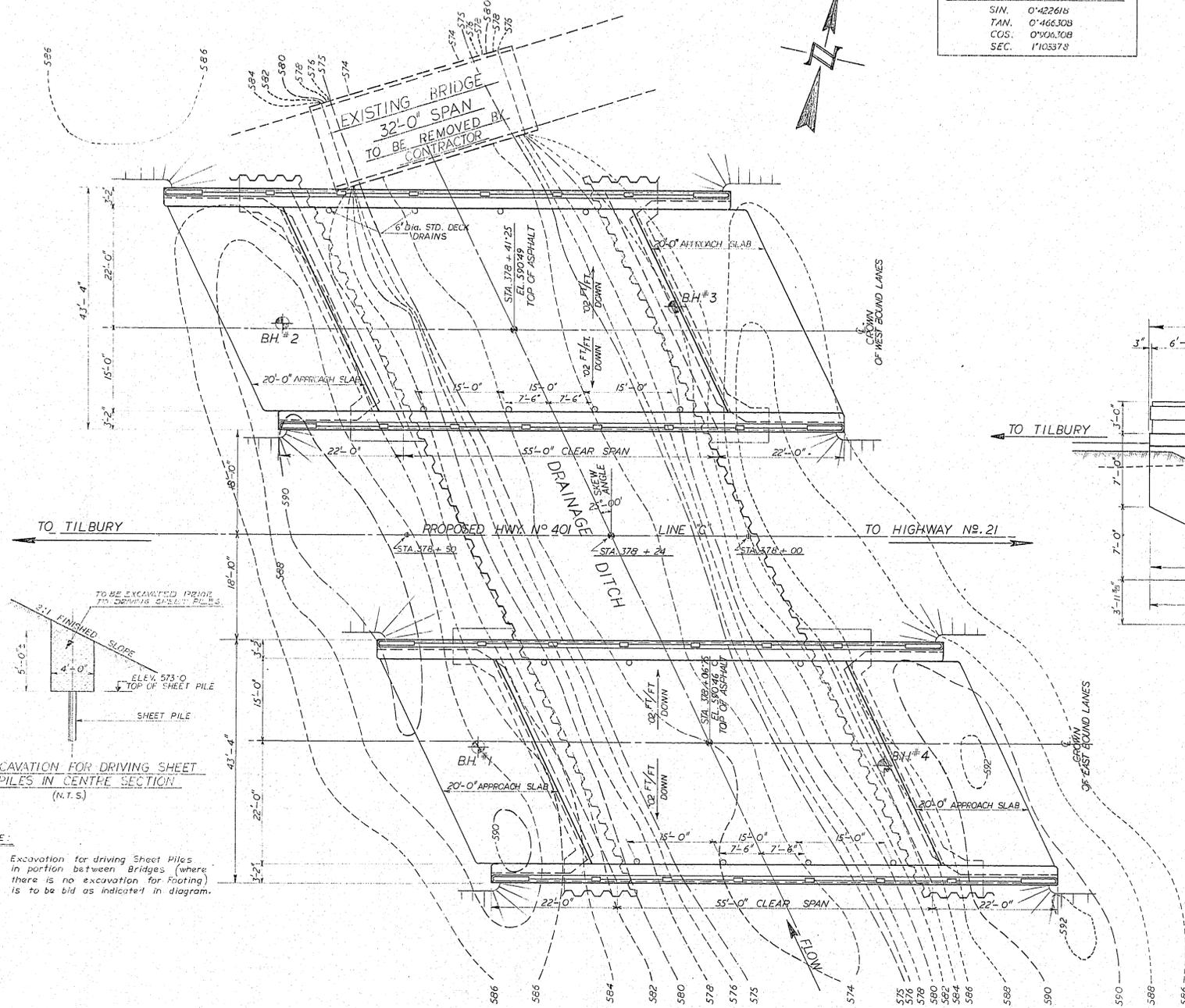
BORING DATA: The complete soil investigation report BA-894 may be examined at the Bridge Office, 280 Davenport Road, Toronto. The Department does not guarantee the accuracy of this report or the abridged version shown on these plans.

CONSTRUCTION NOTES:
 1) All exposed adgas to be given 1" chamfer
 2) Do not remove falsework under Wingwalls until Curbs are poured and have attained 28 days strength.
 3) Contractor to cut off Deck Drains 3" below bottom of Deck concrete.

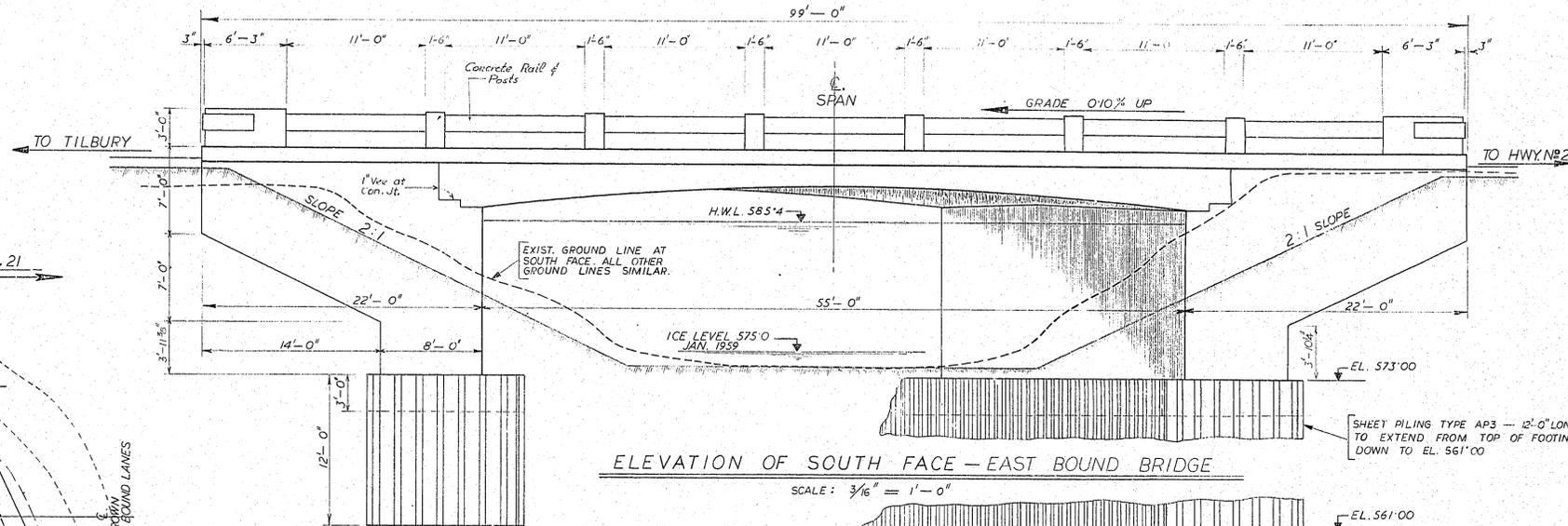
REINFORCING STEEL: (Minimum cover): 3" to surfaces in contact with earth & water, 2" elsewhere. Deck and guardrail as shown.



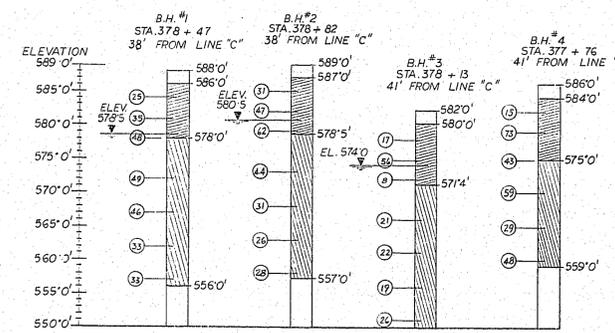
KEY PLAN
SCALE: 1 in. = 1 MI.



PLAN VIEW
SCALE: 1 in. = 10 ft.



ELEVATION OF SOUTH FACE - EAST BOUND BRIDGE
SCALE: 3/16" = 1'-0"



LEGEND:

- TOP SOIL
- ▨ STIFF BROWN SILTY CLAY APPROX. 6% FINE TO MEDIUM GRAVEL.
- ▩ STIFF GREY SILTY CLAY APPROX. 12% FINE TO MEDIUM GRAVEL.
- PENET'N RESIST. BLOWS PER FT.
- GROUND WATER LEVEL.

NOTE:
Excavation for driving Sheet Piles in portion between Bridges (where there is no excavation for footing) is to be bid as indicated in diagram.

LIST OF DRAWINGS:

1. GENERAL PLAN AND ELEVATION
2. FOOTING PLAN & SHEET PILE DETAILS
3. DETAILS OF FRAME & WING-WALLS
4. APPROACH SLAB
5. REINFORCING STEEL SCHEDULE
- 6.

NO.	FOR	DATE

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	CHECK	CONTRACT NUMBER	LOADING	DRAWING NUMBER
J.B.C.	J.B.	64-257	63-254	60-35
R.M.V.	J.B.			

WP 11-59

DEPARTMENT OF HIGHWAYS-ONTARIO
BRIDGE OFFICE-TORONTO

RALEIGH TWP. BRIDGE
No 12

THE KING'S HIGHWAY No. 401 DIST. NO. 1
CO. KENT
TWP. RALEIGH LOT 7 CON. VI.

GENERAL PLAN AND ELEVATION

APPROVED: *[Signature]* BRIDGE ENGINEER

DESIGN ENGINEER



APPENDIX B

Site Photographs



Photograph 1: Looking south at the Government Drain Bridge #2 EBL structure from the median of Highway 401. Both adjacent slopes were observed to be densely vegetated. Erosion of the slope faces was not observed. (October 20, 2013)



Photograph 2: Looking south at the east abutment wall of the bridge structure. Scouring of the exposed earth was observed. Weep holes in the abutment wall were open and wet. (October 20, 2013)



Photograph 3: Looking at the west abutment wall of the bridge structure from the east abutment wall. Scouring/erosion of the exposed earth were observed. Weep holes in the abutment wall were open and wet. (October 20, 2013)