



FOUNDATION TECHNICAL MEMORANDUM

For

BRANT ROAD 25 UNDERPASS

HIGHWAY 403

MTO WEST REGION 59 STRUCTURE REHABILITATIONS

SITE 1-156, CONTRACT 8

GWP 3094-12-00

TOWNSHIP OF BURFORD

BRANT COUNTY, ONTARIO

PETO MacCALLUM LTD.
165 CARTWRIGHT AVENUE
TORONTO, ONTARIO
M6A 1V5
Phone: (416) 785-5110
Fax: (416) 785-5120
Email: toronto@petomaccallum.com

Distribution:

- 1 cc: MMM Group Limited for distribution to MTO + 1 digital copy (pdf)
 - Electronic Copy to MTO (David.Staseff@ontario.ca)
- 1 Electronic Copy to MTO
 - (Paul.Santos@ontario.ca; maha.almassri@ontario.ca)
- 1 Electronic Copy to MMM Group Limited
 - (LeitchS@mmm.ca) +1 digital copy (pdf)
- 1 cc: PML Kitchener
- 1 cc: PML Toronto

PML Ref.: 13KF006H-25
Index No.: 334FTM
Geocres No.: 40P2-27
June 12, 2017



TABLE OF CONTENTS

1. INTRODUCTION	1
2. PROJECT SITE BACKGROUND AND GEOLOGY	2
3. SOURCE OF INFORMATION	2
4. SITE RECONNAISSANCE	3
5. PREVIOUS FOUNDATION INVESTIGATION AND SUBSURFACE CONDITIONS	4
5.1 General	4
5.2 Organic Silty Sand	4
5.3 Sand	5
5.4 Clayey Silt to Silt	5
5.5 Silty Sand	6
5.6 Groundwater	6
6. FOUNDATION	6
6.1 Previous Foundation Recommendations	6
6.1.1 Abutments and Piers	7
6.1.2 Approach Fills	8
6.2 Assessment of Foundation Parameters	9
7. DISCUSSION	10
8. CLOSURE	11

Table 1 - List of Standard Specifications

Figure 1 – Key Plan

Appendix A – Previous Foundation Investigation Reports (GEOCRES 40P2-27)

Reference 1. Foundation Investigation Report for County Road 25 Underpass, 11.4 km West of Hwy. #24A, W.P. 162-60-01, Site No. 1-156, Hwy. #403, District #4 (Hamilton), Contract No. 81-43, Receive date February 3, 1982, GEOCRES No. 40P2-27

Reference 2. Foundation Investigation Report for the Proposed Underpass of Highway #403 at Brant County Road #25, 11 miles West of Brantford West Limits, District #4, Hamilton, W.O. 72-11034, W.P. 162-60-00, date May 24, 1972, GEOCRES No. 40P2-27



Reference 3. General Arrangement Drawing, Co. Rd. 25 Interch. U'Pass, DWG 1, Sheet 178, 11.4 Km west of Hwy. 24A, Site No. 1-156, District No. 4, Highway 403, W.P. 162-60-01, Contract No. 81-43, dated July, 1980.

Reference 4. Footing Layout & Reinforcing Drawing, Co. Rd. 25 Interch. U'Pass, DWG 3, Sheet 180, Site No. 1-156, W.P. 162-60-01, Contract No. 81-43, dated July, 1980

Appendix B – Site Photographs

FOUNDATION TECHNICAL MEMORANDUM

For

Brant Road 25 Underpass Highway 403
MTO West Region 59 Structure Rehabilitations
Site 1-156, Contract 8, GWP 3094-12-00
Township of Brantford
Brant 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 GEOCREST Library for the Brant Road 25 Underpass Highway 403. The Foundation Engineering recommendations from the initial 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 June 3, 2016, it is understood that the rehabilitation of the underpass structure will include conversion to semi-integral abutments.

The purpose of the technical memorandum is to summarize the subsurface and groundwater conditions and foundation recommendations based on available reports at the structure 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 Brant Road 25 Underpass Highway 403 is located about 17.6 km west of Brantford west limits in Brant County, Ontario. A key plan is shown in Figure 1.

The existing underpass is a two span post tensioned concrete voided slab structure that carries two through lanes over Highway 403. The immediate vicinity is relatively flat. Agricultural lands at the north and south sides were observed with some wooded areas in the vicinity of the structure.

Physiographically, the site of the underpass is located in the region referred to as Mount Elgin Ridges, consisting of a succession of ridges and vales. The ridges are moraines of pale brown calcareous clay or silty clay, while in the vales, it is common to find alluvium of gravel, sand or silt. The bedrock underlying the area consists of alternating layers of gray Shale and Dolostone of Salina Formation of Upper Silurian Epoch. The bedrock surface at the site location is between elevation 221.0 and 229.0 (Map 2035, Bedrock Topography of the Brantford Area, Southern Ontario, Ontario Department of Mines).

3. SOURCE OF INFORMATION

The following reports and drawings, appended in Appendix A, were available for review and information for the underpass structure, subsoil information and original foundation recommendations.

1. Foundation Investigation Report for County Road 25 Underpass, 11.4 km West of Hwy. #24A, W.P. 162-60-01, Site No. 1-156, Hwy. #403, District #4 (Hamilton), Contract No. 81-43, Pavement and Foundation Design Section, Ministry of Transportation and Communications, Receive date February 3, 1982, GEOCRE No. 40P2-27. (Reference 1)
2. Foundation Investigation Report for the Proposed Underpass of Highway #403 at Brant County Road #25, 11 miles West of Brantford West Limits, District #4, Hamilton, W.O. 72-11034, W.P. 162-60-00, Department of Transportation and Communications, date May 24, 1972, GEOCRE No. 40P2-27. (Reference 2)



3. General Arrangement Drawing, Co. Rd. 25 Interch. U'Pass, DWG 1, Sheet 178, 11.4 Km west of Hwy. 24A, Site No. 1-156, District No. 4, Highway 403, W.P. 162-60-01, Contract No. 81-43, dated July, 1980. (Reference 3)
4. Footing Layout & Reinforcing Drawing, Co. Rd. 25 Interch. U'Pass, DWG 3, Sheet 180, Site No. 1-156, W.P. 162-60-01, Contract No. 81-43, dated July, 1980. (Reference 4)

4. SITE RECONNAISSANCE

As part of the current foundation engineering assessment study, a site reconnaissance of the Brant Road 25 Underpass Highway 403 was carried out on August 28, 2015 by PML representative.

The site photographs present the current conditions of Brant Road 25 Underpass including visible portions of the abutments and pier, and abutment slope assessment based on visible areas, apparent areas of soil erosion and abutment slope cover.

The site inspection revealed that the vicinity of the underpass structure abutment locations was covered by vegetation. Both abutment front slopes were covered by concrete panels (Photographs 1 and 2). Numerous cracks were observed on the abutment walls. Sealant between the concrete panels degraded at locations where grasses were growing between the panels (Photographs 1 and 2). At the time of inspection, some of the weep holes in the abutment walls observed were clogged inside (Photographs 1 and 2). The piers at the time of site reconnaissance were observed with vertical surficial cracks with no spalling of concrete or exposure of rebar (Photograph 3). Both east and west slopes adjacent to the abutments were observed to be vegetated and no evidence of slope erosion was noted (Photographs 4 to 7). Cracks were observed on the east and west wingwalls of the north and south abutments (Photographs 4 to 7).



5. PREVIOUS FOUNDATION INVESTIGATION AND SUBSURFACE CONDITIONS

A revised foundation investigation report (Reference 1), included only the factual subsurface and groundwater conditions, was prepared by the Department of Transportation and Communications, dated February 3, 1982 (received by Pavement and Foundation Design Section). The general subsurface conditions presented in this section are based on the foundation investigation report referred in Reference 1.

The field investigation was carried from March 6 to 10, 1972. The investigation was carried out using a Bombardier-mounted with continuous flight hollow stem augers. The investigation included seven sampled boreholes 1, 4, 5, 8, 9, 12 and 13 accompanied with dynamic cone penetration tests (DCPTs), and seven DCPTs with no sampling in boreholes 2, 3, 6, 7, 10, 11 and 14. The sampled boreholes were investigated to depths of 3.0 to 11.6 m (10.0 to 38.3 ft.), elevation 251.5 to 259.7 (825.0 to 851.9 ft.). DCPTs were driven to practical refusal depth of 4.7 to 7.0 m (15.4 to 23.0 ft.), elevation 256.1 to 258.3 (840.3 to 847.4 ft.).

The Foundation Investigation Report (Reference 1) includes the Borehole Location and Soil Strata Drawing and Record of Borehole sheets. The general layout of the structure is shown in Reference 3.

5.1 General

In general, a major compact to very dense fine to medium sand was underlain by hard clayey silt to silt, except at the south side of the underpass structure, where compact to very dense silty sand was encountered under sand layer.

5.2 Organic Silty Sand

Localized 1.5 m thick surficial organic silty sand was encountered in borehole 1 which extended to 1.5 m (5.0 ft) below ground surface, elevation 261.8 (859.0 ft). One N value recorded was 4, indicating very loose compactness.



A grain size distribution result on a sample indicated that the sample contained 1% clay, 29% silt, 68% sand, and 2% gravel size particles. A moisture content determination of the sample was about 43%.

5.3 Sand

A sand layer was encountered surficially in boreholes 4, 5, 8, 9, 12 and 13, elevation 262.7 to 263.4 (861.9 to 864.3 ft) and below the organic silty sand in borehole 1 at 1.5 m (5.0 ft) below ground surface, elevation 261.8 (859.0 ft), which extended 3.0 to 9.1 m (10.0 to 30.0 ft) below ground surface, elevation 254.0 to 259.7 (833.3 to 851.9 ft). The 4.6 to 9.1 m thick sand layer was penetrated fully in boreholes 1, 4, 5, 8, 9 and 13 at 5.5 to 9.1 m (18.0 to 30.0 ft), elevation 254.0 to 257.4 (833.3 to 844.5 ft). Borehole 12 was terminated in the sand material at 3.0 m (10.0 ft), elevation 259.7 (851.9 ft). N values recorded for sand layer ranged from 10 to over 100, indicating compact to very dense. Two local N values of 9 and 5 were recorded in boreholes 1 and 5 probably due to hydraulic disturbance during sampling operations.

Grain size distribution results indicated that the selected samples contained 2 to 4% clay, 1 to 19% silt, 71 to 97% sand, and 0 to 8% gravel size particles. Moisture content determinations ranged from 16 to 21%.

5.4 Clayey Silt to Silt

A discontinuous 2.6 to 8.5 m thick hard clayey silt to silt was encountered in boreholes 1, 4, 5, 8 and 9 at 5.5 to 8.5 m (18.0 to 28.0 ft) below ground surface, elevation 254.7 to 257.4 (835.6 to 844.5 ft), which extended to termination depths of the boreholes at 8.7 to 10.9 m (28.5 to 35.8 ft), elevation 252.0 to 254.7, (826.7 to 835.8 ft). N values ranged from 84 to over 100.

A grain size distribution result indicated that the selected sample contained 10% clay, 83% silt and 7% sand size particles. The Atterberg liquid limits ranged between 19 and 29 and the plastic limit ranged between 12 and 18. The plasticity index values were between 7 and 14. Moisture content determinations ranged between 11 and 19%.



5.5 Silty Sand

A compact to very dense silty sand layer was encountered below the sand layer in borehole 13 at 9.1 m (30.0 ft), elevation 254.0 (833.3 ft), which extended to the termination depth 11.6 m (38.3 ft), elevation 251.5 (825.0 ft). Two N values recorded were 22 and 100 blows for 75 mm penetration.

A grain size distribution result indicated that the selected sample contained 6% clay, 32% silt, 61% sand and 1% gravel size particles. The Atterberg liquid limit was 21 and plastic limit was 17 with a plasticity index of 4, indicating low plasticity. Moisture content determinations were about 18%.

5.6 Groundwater

Groundwater was observed within all sampled boreholes during the site investigation. The stabilized groundwater level was at elevation 262.0 to 262.4 (860.0 to 861.0 ft), approximately 0.7 to 1.2 m (2.3 to 4.0 ft.) below ground surface level at the borehole locations.

6. FOUNDATION

6.1 Previous Foundation Recommendations

The previous foundation recommendations presented in the following sections are based on the original report (Reference 2). Two alternatives, as follows, were proposed for the crossing of Highway 403 line 'E' and Brant Road 25 (previously County Road 25).

- Alternative 1: A two span underpass structure with span lengths of 42.7 m (140.0 ft) each.
- Alternative 2: A five span underpass structure with 9.1 m (30.0 ft) long end spans and three 22.9 m (75 ft) middle spans.



The grade of Highway 403 was designed at elevation 264.0 (866.0 ft), approximately at the existing ground level at the time of the investigation. The top of the granular of the Brant Road 25 (previously County Road 25) was proposed to be at elevation 270.0 (886.0 ft). It was assumed that perched abutments would be constructed.

6.1.1 Abutments and Piers

Based on the encountered loose to compact sands in the uppermost portion and high groundwater level in the boreholes, the original foundation investigation report (Reference 2) indicated that the construction of spread footings for the structure was uneconomical. The report recommended that the footings at the abutments and piers be supported on HP 310 x 110 piles (12 BP @74 H piles) for both alternatives as it was deemed most practical. It was recommended that the piles were to be driven into hard clayey silt to silt deposit to approximate elevation 254.5 to 256.0 (835.0 to 840.0 ft) to support safe loads of 810.0 kN per pile (90.0 tons/pile). The report indicated that the design loads of the steel H-piles had to be determined during pile driving by means of the Hiley formula (M.T.C. Standard DD-1218 and DD-1219). It was indicated that the pile caps could be placed within the approach fills and recommended to provide a minimum cover of 1.2 m (4.0 ft) for the pile caps for frost protection. It was recommended that the approach fills at the abutment locations should be devoid of bouldery material.

Based on the General Arrangement Drawing (Reference 3), HP 310 x 110 piles (12 BP @74 H piles) were to be driven in accordance with Standard SS-103-11 to 900.0 kN (101.0 tons) per pile capacity. The drawing also notes that compacted boulder free fill (75 mm max) to be placed before driving piles. The Footing Layout & Reinforcing Drawing (Reference 4) indicated the top of the 800 and 1300 mm thick pile caps was to be at elevation 266.3 and 263.0 at the abutments and pier, respectively.



At the site location, groundwater level was observed at elevation 262.1 to 262.4 (860.0 to 861.0 ft) during the investigation. The report (Reference 2) indicated that excavation extending below the observed groundwater elevation may become unstable due to unbalanced hydrostatic heads. To avoid possible excavation bottoms from 'boiling', the report recommended a dewatering scheme for the excavation extending below the groundwater level.

The following table summarizes the pile data based on the Footing Layout & Reinforcing Drawing (Reference 4).

SUMMARY OF PILE DATA					
LOCATION	ROW	NUMBER REQUIRED	LENGTH, mm*	BATTER	PILE CUT-OFF ELEVATION, m
North Abutment	Front	10	14,750	1:3	265.850
	Middle	4	14,000	1:8	
	Back	2	14,000	Vertical	
Pier	North Side	3	10,250	1:10	262.050
	South Side	3	10,250	1:10	
	West Side	4	10,250	1:10	
	East Side	4	10,250	1:10	
	Centre	18	10,250	Vertical	
South Abutment	Front	10	14,750	1:3	265.850
	Middle	4	14,000	1:8	
	Back	2	14,000	Vertical	

*The theoretical length below cut-off.

6.1.2 Approach Fills

In the report (Reference 2), 6.1 to 6.7 m (20.0 to 22.0 ft) high approach fills were proposed. It was indicated that no stability problems were expected for the high approach fills provided that the approaches were constructed with 2 horizontal to 1 vertical slope. Based on the General Arrangement drawing (Reference 3), approximately 6.6 to 7.2 m of fill was anticipated in order to achieve the approach grade of Brant Road 25 (previously County Road 25).



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 reports, contract drawings and the updated geotechnical reaction at SLS and factored geotechnical resistance at ULS are provided.

FOUNDATION DESIGN PARAMETERS

FOUNDATION TYPE	RECOMMENDED PILE TIP	PREVIOUS WORKING STRESS VALUES ²	PREVIOUS EQUIVALENT LIMIT STATE DESIGN VALUES		LIMIT STATE DESIGN VALUES UPDATED TO CURRENT INDUSTRY PRACTICE ³	
		SAFE BEARING RESISTANCE/LOAD	SLS BEARING REACTION/LOAD	ULS FACTORED GEOTECHNICAL RESISTANCE/LOAD	SLS BEARING REACTION/LOAD	ULS FACTORED GEOTECHNICAL RESISTANCE/LOAD
HP 310x110 Piles (12 BP @74 H Piles)	254.5 to 256.0 (835 to 840 ft)	900 (kN)	900 (kN)	1100 (kN)	900 (kN)	1100 (kN)

- Notes:**
1. Founding elevation and loads are from References 2 and 3.
 2. Working stress design values in Reference 3. The Serviceability Limit State design values are based on the working stress. No field verifications were made.
 3. Resistance Factor = 0.4 for deep foundations (CFEM 4th edition)
Assumed Factor of Safety is 3 (CFEM 4th edition).

The Peak Ground Acceleration (PGA) for the site is 0.080 (National Building Code of Canada, 2015). The soil classification for seismic design should be in accordance with Clause 4.4.3.2 of the CHBDC (2014).

The bearing resistance for inclined loads should be reduced in accordance with the requirements of clause 6.10.4 of the CHBDC 2014 Edition.

The foundation frost penetration depth at the site is 1.2 m according to OPSD 3090.101.



7. DISCUSSION

It is understood that for the Brant Road 25 Underpass structure, the rehabilitation will include conversion to semi-integral abutments. From a geotechnical point of view, at the present time, foundation work for the underpass structure is not expected provided that the total load on the structure does not increase or decrease by more than 10%.

A temporary support system may be required for the rehabilitation of the underpass structure and the construction for temporary support system should conform to OPSS 404 and 539. The contractor is responsible for the selection, detailed design and performance of the roadway protection scheme. The contractor should monitor the movement of the roadway protection system.

It is recommended that a preliminary investigation be carried out to supplement geotechnical data for the design of temporary roadway protection.

Furthermore, it is suggested that the weep holes in the abutment walls should be maintained and cleaned at a regular interval to prevent any clogging of the holes. Any weep hole observed to be clogged currently should be cleaned out and maintained. Regular maintenance of the weep holes will keep the water flowing from behind the abutment walls and will mitigate hydrostatic pressure to build-up behind the abutment walls.



8. CLOSURE

This Technical Memorandum was prepared by Mr. N. Rahman, P.Eng, Project Engineer and was reviewed by Mr. B. R. Gray, M.Eng, P.Eng., Principal Consultant. Mr. R. Ng, MBA, PhD, 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



Brian R. Gray, M.Eng, P.Eng.
Principal Consultant



Robert Ng, MBA, PhD, P.Eng.
MTO Designated Principal Contact

NR/RN/BRG:nr-nk-an-ap

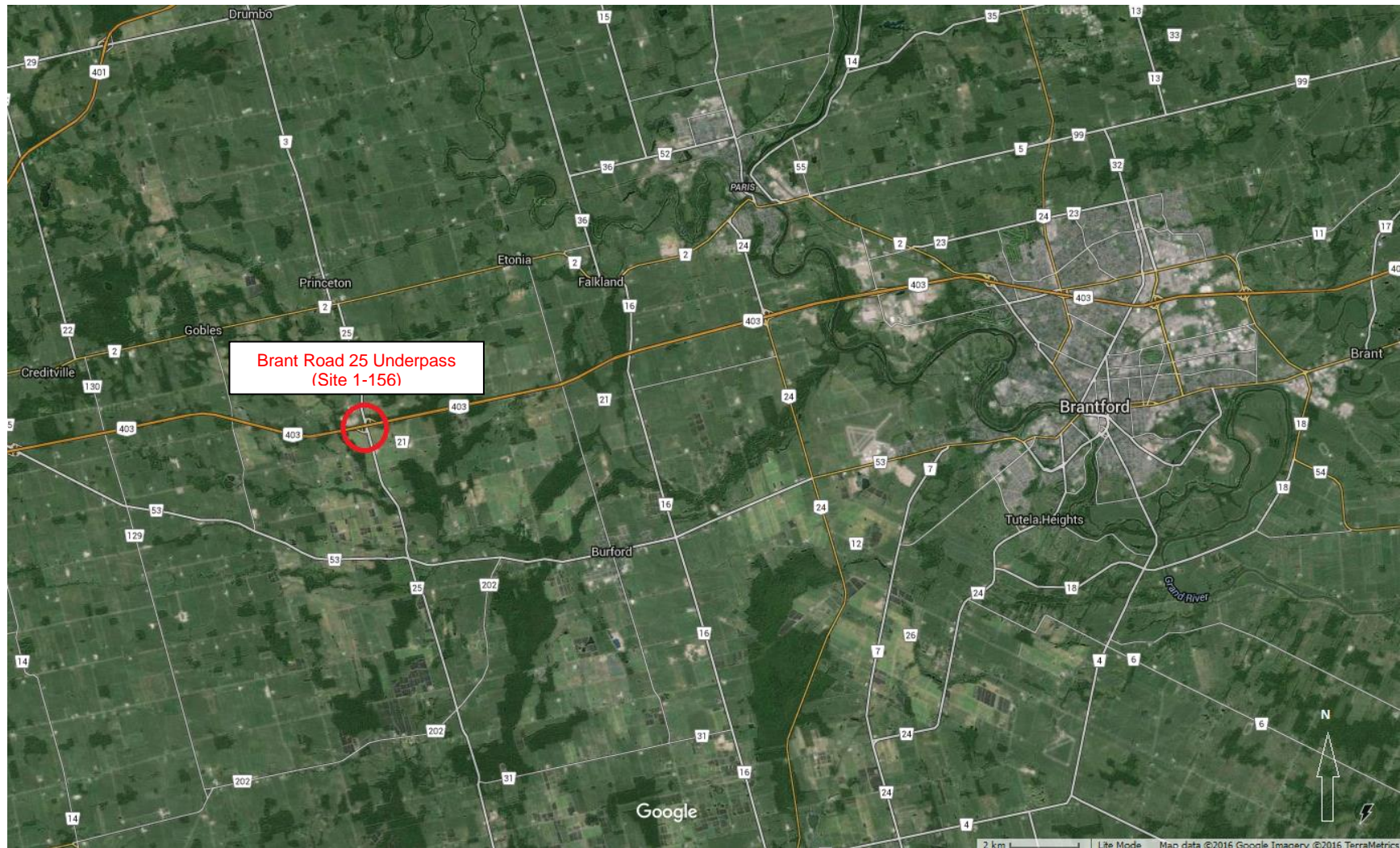


TABLE 1

LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT

DOCUMENT	TITLE
OPSS 404	Construction Specification for Support Systems
OPSS 539	Construction Specification for Temporary Protection Systems
OPSD 3090.101	Foundation Frost Depth for Southern Ontario

Figure 1 – Key Plan





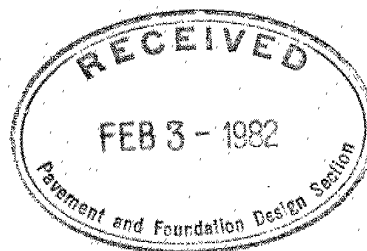
APPENDIX A

Previous Foundation Investigation Reports (GEOCRES 40P2-27)

- Reference 1. Foundation Investigation Report for County Road 25 Underpass, 11.4 km West of Hwy. #24A, W.P. 162-60-01, Site No. 1-156, Hwy. #403, District #4 (Hamilton), Contract No. 81-43, Receive date February 3, 1982, GEOCRES No. 40P2-27
- Reference 2. Foundation Investigation Report for the Proposed Underpass of Highway #403 at Brant County Road #25, 11 miles West of Brantford West Limits, District #4, Hamilton, W.O. 72-11034, W.P. 162-60-00, date May 24, 1972, GEOCRES No. 40P2-27
- Reference 3. General Arrangement Drawing, Co. Rd. 25 Interch. U'Pass, DWG 1, Sheet 178, 11.4 Km west of Hwy. 24A, Site No. 1-156, District No. 4, Highway 403, W.P. 162-60-01, Contract No. 81-43, dated July, 1980.
- Reference 4. Footing Layout & Reinforcing Drawing, Co. Rd. 25 Interch. U'Pass, DWG 3, Sheet 180, Site No. 1-156, W.P. 162-60-01, Contract No. 81-43, dated July, 1980

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 81-43



Ministry of
Transportation and
Communications

1

INDEX

<u>Page No.</u>	<u>Description</u>
1	Index
2	Abbreviations and Symbols
3	M. T. C. Soil Classification System
4 - 57	Foundation Investigation Reports For W. P. 161-60-01 County Road 16 Rev. Underpass W. P. 162-60-01 County Road 25 Underpass W. P. 71-62-01 Maple Road Underpass

Note: For purposes of the Contract these reports supercede all other foundation reports prepared by or for the Ministry in connection with the above mentioned projects.

FOUNDATION INVESTIGATION REPORT

For

County Road 25 Underpass
11.4Km West of Hwy. #24A
W.P. 162-60-01; Site No. 1 - 156
Hwy. #403, District #4 (HAMILTON)

INTRODUCTION

This report summarizes the results of a foundation investigation program carried out during the period of 72-03-06 and 72-03-10. The field work consisted of seven sampled boreholes accompanied with dynamic cone penetration tests. In addition, seven cone penetration tests were also carried out at other locations. The borings were advanced by means of a continuous flight auger machine equipped with 83mm I.D. hollow stem augers.

SITE DESCRIPTION AND GEOLOGY (At the time of the Field Investigation)

The immediate vicinity of the proposed crossing is fairly flat, occupied by farmlands. Along existing County Rd. #25, there are some brushes and shrubs. The farms are well cultivated, the prevailing crops appear to be tobacco.

Geologically, the area belongs to the Mount Elgin Ridges physiographic region, consisting of a succession of ridges and vales. The ridges are moraines of pale brown calcareous clay or silty clay, while in the vales it is common to find alluvium of gravel, sand or silt. The ridges are usually well drained, while poor drainage prevails in the hollows.

SUBSURFACE CONDITIONS (At the time of the Field Investigation)General:

The soilstratigraphy was found to consist of about two different types of deposits; sands and clayey silt to silt. The estimated stratigraphical profile is presented on Drawing No. 2. This drawing also shows the locations and elevations of the borings. Field and laboratory test results

are compiled on the record of borehole sheets.

Sand

The surficial deposit, identified as fine to medium sand with some silt and traces of gravel is extending to Elevation 253.9 - 257.3m a depth of some 5.5 - 8.5m. The relative density of this layer varies between loose to very dense, substantiated by penetration "N" values to 4 blows/0.3m to over 100 blows/0.3m. The relative density increases with depth. The laboratory determined natural moisture contents are fairly high, ranging from 16% to 21% and averaging 20% by dry weight. The grain size analyses yielded some 0 - 3% gravel, 68 - 97% sand, 1 - 29% silt and 2 - 4% clay size particles within the individual samples tested. At the locations of borings #1 and #2, the upper 1.5m portion of the main deposit may be classified as organic silty sand.

Clayey Silt to Silt

Underlying the sands a layer of grey clayey silt to silt with traces of sand was encountered, extending to the bottom of the boreholes, between Elevations 251.5 and 254.5. At the location of the proposed south abutment the deposit contained some 61% fine sand particles, consequently it has been identified as silty sand with traces of clay. Very high penetration resistances characterize the stratum, most of the penetration tests yielded "N" values over 100 blows/0.3m. The consistency of the layer was thus specified to be generally hard.

Several Atterberg limit tests were carried out on typical samples, resulting in plastic limits between 12% and 18% and liquid limits between 19% and 29%. The average sample contains more than 50% silt size particles.

Groundwater Conditions:

Groundwater level observations were undertaken during the field investigations. The established waterlevels are marked on the borelog sheets. The equilibrated water surface was found to lie at Elevation 262.3m only a few feet below the general ground level.

P. Payer
P. Payer, P. Eng.
Foundations Engineer



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

RECORD OF BOREHOLE No 1

METRIC

W P 162-60-01 LOCATION Sta. 9+955.4 o/e 8.5 m RT of E. Co. Rd. 25 ORIGINATED BY JR
DST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY PK
DATUM Geodetic DATE 1972 03 09 CHECKED BY

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNSATURATED NATURAL MOISTURE CONTENT W _p W W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	W VALUES			20	40	60	80	100			
262.3	Ground Level														
0.0	Organic Silty Sand Very Loose		1	SS	4		262								2 68 29 1
261.8	Black		2	SS	14										0 81 (19)
1.9	Fine to Medium Sand with Some Silt		3	SS	22										
	Compact to Very Dense		4	SS	21		260								1 90 (9)
			5	SS	61										
			6	SS	9										
	Brown		7	SS	1007	130 mm	258								
257.2															
6.4	Silt, Traces of Sand and Clay		8	SS	1007	150 mm	256								
	Hard Grey														
254.6			9	SS	141										
8.7	End of Borehole														

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

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 2

METRIC

W P 152-60-01 LOCATION Sta. 9+957.7 o/s 8.5 m LT of E. Co. Rd. 25 ORIGINATED BY PK
DIST 4 HWY 403 BOREHOLE TYPE Cone Penetration Test COMPIRED BY AXB
DATUM Geodetic DATE 1972 03 07 CHECKED BY GP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION [%]
DEPTH m	DESCRIPTION	TEST NUMBER	TYPE	IN VALUES								
262.9 0.0	Ground Level											
257.9 5.0	End of Cone Test											

+3, x5. Numbers refer to
Sensitivity

15 20 5 [%] STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4

METRIC

W.P. 162-60-01 LOCATION Sta. 9+966.4 o/w 8.5 m LT of E. Co. Rd. 25 ORIGINATED BY PK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY PK
DATUM Geodetic DATE 1972 03 07 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	NY VALUES			20	40	60	80	100				
253.0 0.0	Ground Level															
			1	SS	11		262									0 91 (9)
	Fine to Medium Sand		2	SS	26											
	Traces of Silt		3	SS	14		260									1 93 (6)
	Compact to Very Dense		4	SS	38											
	Brown		5	SS	48		258									1 93 (6)
			6	SS	80											
256.6 6.4			7	SS	100	250 mm	256									
	Clayey Silt to Silt															
	Traces of Sand		8	SS	100	250 mm										
	Hard Clay						254									
253.6 9.4	End of Borehole		9	SS	100	90 mm										0 7 83 10

3, x⁵: Numbers refer to Sensitivity 20
15-0.5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

METRIC

W.P. 162-60-01 LOCATION Sta. 9+988.0 o/a B.S. m RT of E. Co. Rd. 25
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger & Cone Test
DATUM Geodetic DATE 1972 03 09
ORIGINATED BY JB
COMPILED BY PK
CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIF WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
263.8 0.0	Ground Level																GR SA SI CL
	Silty Fine to Medium Sand to Sand, Traces of Gravel		1	SS	11		262										8 71 19 2
			2	SS	5												0 87 (13)
	Compact to Very Dense		3	SS	31		260										
	Brown		4	SS	23												
			5	SS	27												
			6	SS	18												
			7	SS	85		258										2 97 (1)
257.3 6.1	Clayey Silt to Silt Traces of Sand		8	SS	1007	150 mm	256										
254.7 8.7	Hard - Grey		9	SS	116												
	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6

METRIC

W/ P 162-60-01

LOCATION Sta. 9+989.4 o/s 8.5 m LT of g Co. Rd. 25

ORIGINATED BY JB

DIST 4 HWY 403

SCOREHOLE TYPE Cone Penetration Test

COMPILED BY AKB

DATUM Geodetic

DATE 1972 03 07

CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	SPT PLOT	NUMBER	TYPE			N _v VALUES	20						40
262.9	Ground Level													
0.0														
256.3	End of Cone Test													
6.6														

+3, x5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

12

RECORD OF BOREHOLE No 7

METRIC

W P 162-60-01 LOCATION Sta. 9+999.4 a/b 8.5 m RT of E. Co. Rd. 25 ORIGINATED BY JB
DIST 4 HWY 403 BOREHOLE TYPE Cone Penetration Test COMPILED BY AKB
DATUM Geodetic DATE 1972 03 10 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH O UNCONFINED + FIELD VANE * QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES									
263.0	Ground Level													
0.0														
256.7	End of Cone Test													
6.3														

3, x 5 Numbers refer to Sensitivity

20 15 10 (% STRAIN AT FAILURE

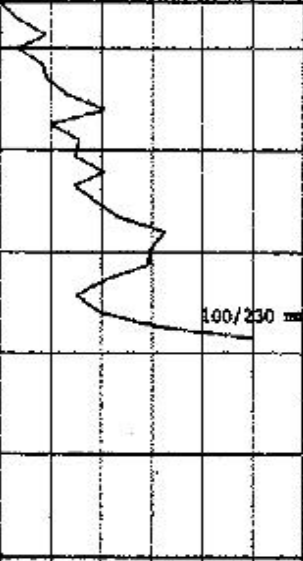
OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 8

METRIC

W P 162-60-01 LOCATION Sta. 10+000.7 o/s 8.5 m LT of E Co. Rd. 25 ORIGINATED BY PE
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY PE
DATUM Geodetic DATE 1972 03 06 CHECKED BY

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA, SI, CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20 40 60 80 100					
262.9 0.0	Ground Level												
	Fine to Medium Sand With Some Silt. Traces of Gravel Compact to Very Dense Brown		1	SS	22								0 93 (7) 3 87 (10)
			2	SS	19								
			3	SS	40								
			4	SS	29								
			5	SS	48								
			6	SS	50								
257.4 5.5	Clayey Silt to Silt Traces of Sand Hard Grey		7	SS	100/	200 mm							
			8	SS	84								
			9	SS	100/	160 mm							
			10	SS	100/	80 mm							
252.0 10.9	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15 \div 3 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 9

METRIC

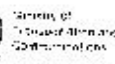
W.P. 162-60-01 LOCATION Sta. 10+010.8 o/e 8.5 m RT of & Co. Rd. 25 ORIGINATED BY JB
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY PK
DATUM Geodetic DATE 1972 03 08 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
FLEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
263.2	Ground Level																
0.0																	
	Fine to Medium Sand		1	SS	10		262										3 80 15 2
	Some Silt		2	SS	18												
	Traces of Clay		3	SS	14												
	Loose to Dense		4	SS	24		260										0 79 17 4
	Brown		5	SS	42												
			6	SS	100/80 mm		258										
			7	SS	100/100 mm		256										1 89 (10)
254.7	Clayey Silty to Silty		8	SS	100/150 mm												
254.4	End of Borehole																
8.8																	

3, x5. Numbers refer to
Sensitivity

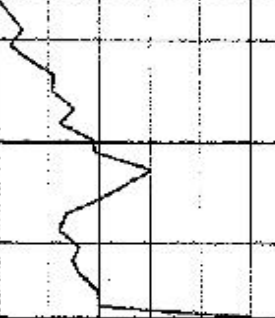
20
15
10
% STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



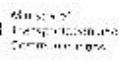
METRIC

W #	162-60-01	LOCATION	Sta. 10+012.2 o/s 8.5 m LT of C Co. Rd. 25	ORIGINATED BY	JB
DIST	4 HWY 403	BORE-HOLE TYPE	Cone Penetration Test	COMPILED BY	ARD
DATUM	Geodetic	DATE	1972 03 07	CHECKED BY	JP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE FLUT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PROF.	NUMBER	TYPE	"N" VALUES			25 40 60 80 100	Wp	W	WL			WATER CONTENT (%)
262.8 0.0	Ground Level						262 260 258							
256.5 6.3	End of Cone Test							100/230						

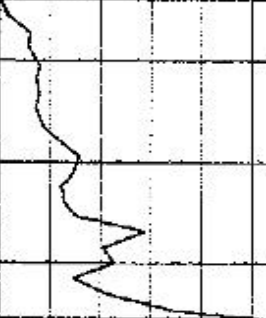
x^3, x^5 : Numbers refer to Sensitivity

15 ϕ 5 (%) STRAIN AT FAILURE



METRIC

W F	162-60-01	LOCATION	Sta. 10+033.7 o/e 8.5 m RT of G Co. Rd. 25	ORIGINATED BY	JB
DIST.	4	HWY	403	BOREHOLE TYPE	Cone Penetration Test
DATUM	Geodetic	DATE	1972 03 10	COMPILED BY	AKB
				CHECKED BY	GP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
FILE DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	20					
262.2 0.0	Ground Level						SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ■ QUICK TRIAXIAL x LAB VANE		WATER CONTENT (%)				GR SA SI CL
256.9 6.3	End of Cone Test												

+3, -5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 13

METRIC

W.P. 162-60-01 LOCATION Sta. 10+042.4 o/s 8.5 m RT of E Co. Rd. 25 ORIGINATED BY JE
DIS. 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY PR
DATUM Geodetic DATE 1972 03 08 CHECKED BY *JP*

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION [%]
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	VALUES	20 40 60 80 100						
263.1	Ground Level											
0.0												
	Fine to Medium Sand, Traces of Silt Compact to Very Dense Brown		1	SS	14							0 92 (8)
			2	SS	25							
			3	SS	31							
			4	SS	28							1 90 (9)
			5	SS	37							
			6	SS	16							
			7	SS	30							
			8	SS	88							
254.0			9	SS	119							
9.1	Silty Sand, Traces of Clay. Very Stiff to Hard		10	SS	27							
251.5			11	SS	1007							1 61 32 6
11.6	End of Borehole											

3, x 3: Numbers refer to
Sensitivity

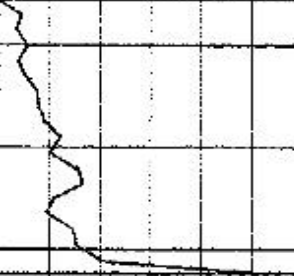
20
5-10 3 [%] STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 14

METRIC

W P 162-60-01 LOCATION Sta. 10+043.7 o/b 8.5 m LT of E. Co. Rd. 25 ORIGINATED BY JR
 DIST. 4 HWY 403 BOREHOLE TYPE Cone Penetration Test COMPILED BY AKB
 DATUM Geodetic DATE 1972 03 10 CHECKED BY GP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH O UNCUTTED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE						
262.4	Ground Level									
0.0						262				
						260				
						258				
257.5	End of Cone Test						100/230 mm			

$4^3 + x^5$: Numbers refer to Sensitivity

15 $\frac{20}{10}$ 5. (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

DOCUMENT MICROFILMING IDENTIFICATION

Reference 2

G.I.-30 SEPT. 1976

GEOCRES No. 40P2-27DIST. 4 REGION W.P. No. 162-60-01CONT. No. 81-43W. O. No. STR. SITE No. HWY. No. 403LOCATION Hwy 403 & Brantco Rd #25
underspanNo. of PAGES -
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MEMORANDUM

TO: A. P. Watt (4)
Southwestern Region
London

FROM: Foundations Office
Design Services Branch

ATTENTION: Mr. S. Jants

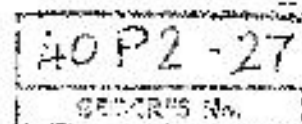
DATE: May 24, 1972

OUR FILE REF.

IN REPLY TO June 9, 1972

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For the Proposed Underpass at Hwy. #403
At Brant County Rd. #25
11 mi. West of Brantford West Limits
District #4 Hamilton
W.O. 72-11034 W.P. 102-60-00



Attached we are forwarding to you our detailed Foundation Investigation report on the subsoil conditions existing at the above-mentioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.

A.G. Steenoc

A.G. Steenoc
PRINCIPAL FOUNDATIONS ENGINEER

AGS/ht
Attach.

c.c. D.W. Farren
E.R. Davis
A. Rutka
H.A. Zenneburg
C. Robertson
R.J. Giroux
H.B. Roy
G.A. Wong
B.A. Singh
J. G. Tillotson
Foundations Files
Documents

TABLE OF CONTENTS

1. INTRODUCTION.
 2. DESCRIPTION OF THE SITE AND GEOLOGY.
 3. FIELD AND LABORATORY INVESTIGATION PROCEDURES.
 4. SUBSOIL CONDITIONS.
 5. GROUNDWATER CONDITIONS.
 6. DISCUSSION AND RECOMMENDATIONS.
 - 6.1) General.
 - 6.2) Foundations.
 7. MISCELLANEOUS.
-

FOUNDATION INVESTIGATION REPORT
For the Proposed Underpass Of Hwy. #403
At Brant County Rd. #25
11 mi. West of Brantford West Limits
District #4 Hamilton
W.O. 72-11034 W.P. 162-60-00

1. INTRODUCTION:

A foundation investigation was requested by Mr. S. Jants, Bridge Planning Technician, Southwestern Region, for the proposed underpass structure of Hwy. #403 at Brant County Rd. #25. The request was dated Feb. 9, 1972.

The subsequent field and laboratory investigations were carried out under the supervision of this Office, while the boreholes were located in the field and surveyed by personnel of the Engineering Survey Office of Southwestern Region.

The investigations are now completed, the results of which are presented in this report, together with recommendations concerning foundations.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The immediate vicinity of the proposed crossing is fairly flat, occupied by farmlands. Along existing County Rd. #25, there are some brushes and shrubs. The farms are well cultivated, the prevailing crops appear to be tobacco.

Geologically, the area belongs to the Mount Elgin Ridges physiographic region, consisting of a succession of ridges and vales. The ridges are moraines of pale brown calcareous clay or silty clay, while in the vales it is common to find alluvium of gravel, sand or silt. The ridges are usually well drained, while poor drainage prevails in the hollows.

3. FIELD AND LABORATORY INVESTIGATION PROCEDURES:

The field investigation consisted of some seven sampled boreholes and fourteen dynamic cone penetration tests. One borehole and two cone penetration tests were placed at each proposed footing location as shown on attached Drawing #72-11034A. The estimated

stratigraphical profile, based on the borcholes are also presented on the above drawing. Borcholes were carried out by means of a Bombardier-mounted continuous hollow stem auger (C.N.E.) taking samples at regular intervals. Samples were taken by 2 inch diameter split spoon samplers. The split spoons were driven by a 140 pound hammer, falling freely a distance of 30 inches. The number of hammer blows required to advance the sampler 18 inches into the soils are marked as standard penetration resistances. ("N" = blows/foot)

All the soil samples were visually examined and identified right after recovery and again upon arrival in the laboratory. Basic physical properties of the various layers were determined by performing laboratory tests such as natural moisture contents, Atterberg Limits and grain size analyses. Laboratory and field test results are compiled on the borelogs appended to this report.

4. SUBSOIL CONDITIONS:

Soil stratigraphy was found to consist of fine to medium sands underlain by clayey silt to silt.

The surficial deposit, identified as fine to medium sand with traces of silt and clay is extending to Elevation 833-844 feet, a depth of some 18-28 feet. The relative density of this layer varies between loose to very dense, substantiated by penetration "N" values of 4 blows/foot to over 100 blows/ft. The relative density increases with depth. The laboratory determined natural moisture contents are fairly high, ranging from 16% to 21% and averaging 20% by dry weight. The grain size analyses yielded some 0-3% gravel, 68-97% sand, 1-29% silt and 2-4% clay size particles within the individual samples tested.

Underlying the brown sands a layer of grey clayey silt to silt with traces of sand was encountered, extending to the bottom of the borcholes, between Elevations 825 feet and 835 feet. At the location of the proposed south abutment the deposit contained some 61% fine sand particles, consequently it has been identified as silty sand with traces of clay. Very high penetration resistances characterize the stratum, most of the penetration tests yielded "N" values over 100 blows/ft. The consistency of the layer was thus specified to be generally hard.

Several Atterberg limit tests were carried out on typical samples, resulting in plastic limit moisture contents between 12% and 18% and liquid limits between 19% and 29%. The average sample contains more than 50% silt size particles.

5. GROUNDWATER CONDITIONS:

Groundwater level observations were undertaken during the field investigations. The established waterlevels are marked on the borelog sheets. The equilibrium water surface was found to lie at Elevation 860-861 feet, only a few feet below the general ground level.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

Two alternative proposals are submitted for the crossing of King's Hwy. #403 line "E" and Brant County Rd. #25. One proposal calls for a 2-span underpass structure, with span lengths of 140 feet each. The second alternative considers an underpass of 5 spans, having 30 feet long end spans, the three middle spans being 75 feet each. The design grade of Hwy. #403 is Elevation 866 feet, roughly at the existing ground level, while the proposed top of granular of County Rd. #25 is Elevation 886 feet. It is surmised that perched abutments will be constructed. Subsoil was found to consist of a 20-30 feet deep deposit of loose to very dense sand with traces of silt, followed by very stiff to hard clayey silts to silts.

6.2) Foundations:

On account of the loose to compact relative density of the uppermost portion of the sands, combined with the high groundwater level, the construction of spread footings for the structure appears to be uneconomical. Footings for both proposals should, therefore, be supported on piles, driven into the hard clayey silt to silt deposit. The use of steel H piles would seem the most practical, and design loads of such piles should be determined during pile driving by means of the Hiley formula. (M.T.C. Standard DD-1218 and DD-1219) It is believed that eg. 12 BP @ 74 H piles driven to approximate Elevation 835 feet - 840 feet will support safe loads of 90 tons/pile.

A minimum cover of four feet should be provided for the pile caps, for frost protection. Since the groundwater level was observed to be around Elevation 860 feet - 861 feet, excavations extending below these elevations might become unstable under the unbalanced hydrostatic heads. In order to prevent the excavation bottoms from "boiling" a dewatering scheme will be necessary for the excavations extending below the groundwater level.

Pile caps for the perched abutments may be formed within the approach fills. No bouldery material should be placed at the locations of the abutments in the event of driving piles through the fills.

No stability problems are anticipated for the proposed 20-22 feet high approach fills, provided that they are built with 2 horizontal to 1 vertical slopes.

7. MISCELLANEOUS:

The field work carried out during March 6-10, 1972, was supervised by Mr. J. Bangs, Project Foundation Engineer. Equipment used was owned and operated by P.V.K. Drilling Company, Burford, Ontario. This report was written by Mr. A.K. Barsvary, Senior Foundations Engineer and reviewed by Mr. K.G. Selby, Supervising Foundations Engineer.

AKB/ht

A. K. Barsvary
A.K. Barsvary, P. Eng.

K. G. Selby
K.G. Selby, P. Eng.



May 23, 1972.

APPENDIX I

FOUNDATION SECTION

CHECKED BY

[illegible]

CHECKED BY _____

SOIL PROFILE			SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION	RESISTANCE	LIQUID LIMIT — w_L	BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FOOT	BLOWS / FOOT	20 40 60 80 100		
						SHEAR STRENGTH P.S.F.		w_p — w — w_L		
						○ UNCONFINED + FIELD VANE ■ QUICK TRIAXIAL x LAB. VANE		WATER CONTENT %		
853.4	Ground level.								P.C.F.	GR. SA. SI. CL.
850					850					
841.9					850					
21.5	End of cone test.						100/6"			

FOUNDATION SECTION

CHECKED BY

[illegible]

FOUNDATION SECTION.

CHECKED BY

[illegible]

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

DESIGN SERVICES BRANCH

RECORD OF BOREHOLE No. 7

FOUNDATION SECTION

JOB 72-11034

LOCATION Sta. 100 + 03 0/5 28' Lt. & County Rd. 25

ORIGINATED BY J.B.

W.P. 162-60

BORING DATE March 10, 1972

COMPILED BY A.K.B.

DATUM Cepedetic

BOREHOLE TYPE Cone Penetration only.

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w		BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WATER CONTENT % w_p ——— w ——— w_L			
663.0	Ground level.														
6.0						860									
						850									
642.2															
20.5	End of cone test.														

100/10"

○ UNCONFINED + FIELD VANE
 ● QUICK TRIAXIAL x LAB. VANE

CHECKED BY

FOUNDATION SECTION

RECORD OF BOREHOLE No. 8

[illegible]

CHECKED BY

[illegible]

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

DESIGN SERVICES BRANCH

RECORD OF BOREHOLE No. 12

FOUNDATION SECTION

JOB 72-11034

LOCATION Sta. 98 + 85 O/S 28' Rte. & County Rd. 25

ORIGINATED BY P.K.

W.P. 162-60

BORING DATE March 6, 1972

COMPILED BY P.K.

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BUCK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					WATER CONTENT %				
							20	40	60	80	100	w_p	w	w_L		
SHEAR STRENGTH P.S.F.							+ FIELD VANE x LAB. VANE									
861.9	Ground elevation.															
0.0	Fine to medium sand.					860										
	Traces of silt.		1	SS	16											
			2	SS	47											
	Compact to dense.		3	SS	50											
851.9																
10.0	End of borehole.					850										
842.1																
19.8	End of cone test.															

2 93 (5)


100/30"

FOUNDATION SECTION

CHECKED BY

[illegible]

FOUNDATION SECTION

CHECKED BY 

SOIL PROFILE			SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION	RESISTANCE	LIQUID LIMIT — w_L	BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE		BLOWS / FOOT	BLOWS / FOOT	WATER CONTENT — w		
862.4	Ground level.									
0.0										
844.7										
17.7	End of cone test.						100/9			

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE ('N') - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE (DPR) - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{c_v t}{d^2}$ (d , DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION
	INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

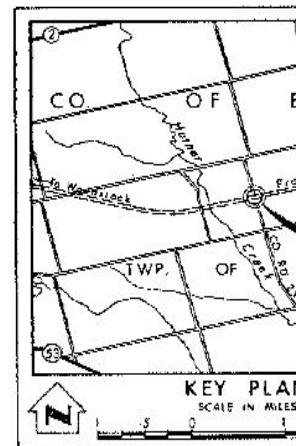
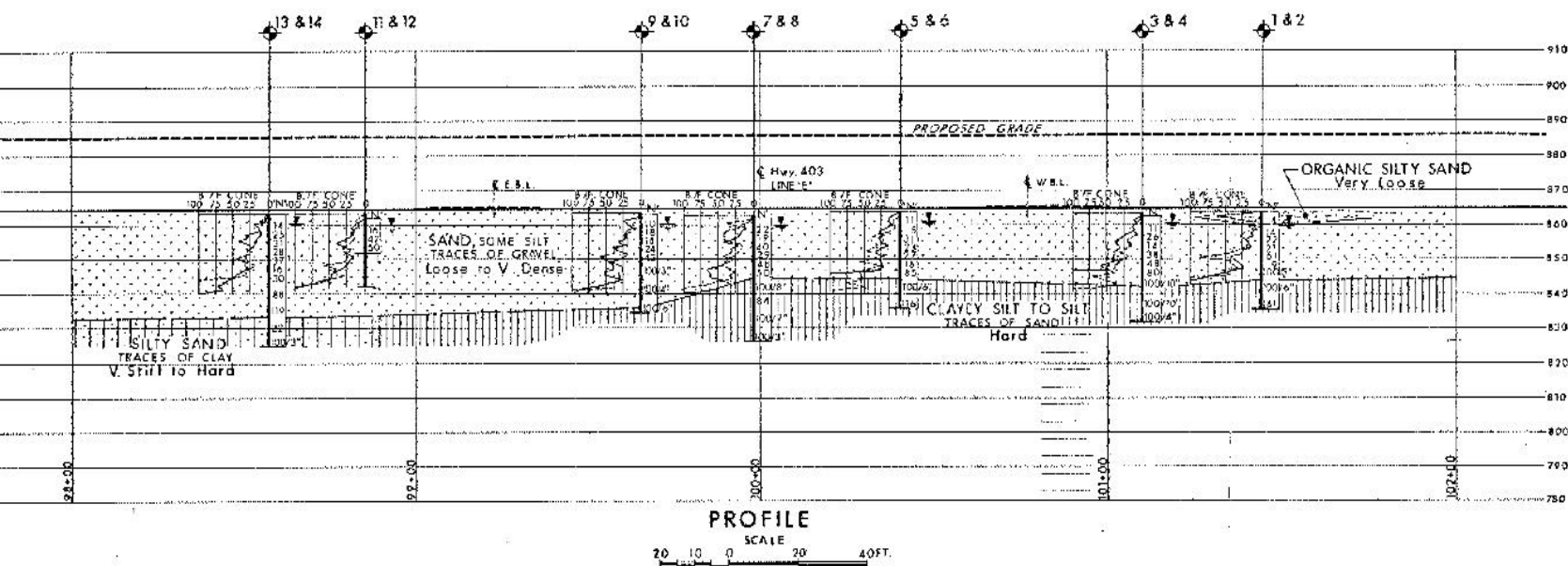
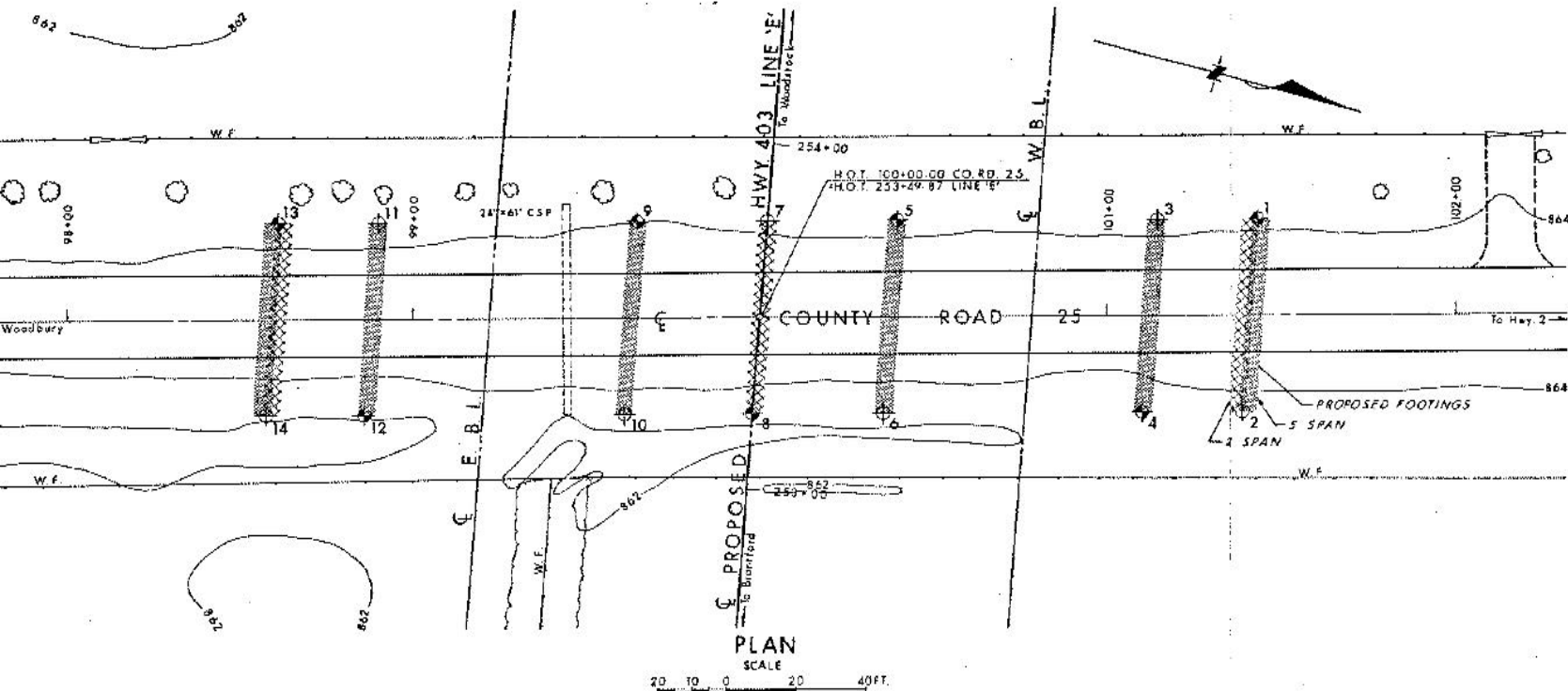
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL



LEGEND

- Bore Hole
- Cone Penetration Test
- Bore Hole & Cone
- Water Levels established by field investigation

NO.	ELEVATION	STATION
1	864.0	101+44
2	862.4	101+39
3	863.4	101+13
4	862.8	101+10
5	864.3	100+40
6	862.4	100+35
7	863.0	100+03
8	862.5	99+98
9	863.6	99+65
10	862.3	99+60
11	863.5	98+95
12	861.9	98+85
13	863.3	98+62
14	862.4	98+57

NOTE
The boundaries between soil strata have been determined from Bore Hole locations. Between Bore Holes the boundaries are from geological evidence and may be subject to change.

REVISIONS	DATE	BY	DES

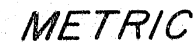
MINISTRY OF TRANSPORTATION
DESIGN SERVICES BRANCH

COUNTY ROAD


HIGHWAY NO. Prop. 403 LINE E'
CO. BRANT
TWP. BURFORD

BORE HOLE LOCATIONS

SUBMD. A.B. CHECKED BY W.P. NO. 162-60
DRAWN BY CHECKED BY JOB NO. 72-110
DATE June 1, 1972 SITE NO.
APPROVED BY [Signature] CONC. NO.



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

DIST. 4	Hwy. 408	
CONT No 81-43		
WP No 162-60-01		
<u>CO. RD. 25 INTERCH. U'PASS</u> <u>11.4 KM. WEST OF HWY. 32A</u> <u>GENERAL ARRANGEMENT</u>		SHEET 178

NOTES

CLASS OF CONCRETE

DECK & PIER COLUMN	35 MPQ
BARRIER WALLS	30 MPQ
REMAINDER	20 MPQ
OR AS NOTED ON THE DRAWING	

REINFORCING STEEL GRADE 400

BAR MARK WITH SUFFIX C DENOTES
COATED BAR.

CLEAR COVER TO REINFORCING STEEL

FOOTINGS, ABUTMENTS & PIER COLUMNS	75 mm
DECK TOP	50 mm
DECK BOTTOM	40 mm
OR AS NOTED ON THE DRAWINGS.	

CONSTRUCTION NOTES

THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEV. WITH A TOLERANCE OF ± 3 MM. NO CONCRETE SHALL BE PLACED ABOVE THE ABUT. BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED, STRESSED & CURED. TO ACHIEVE THE MIN. CLEAR COVER OF 50 MM SPECIFIED AT TOP OF DECK, THE TOP LAYER OF REINFORCEMENT SHALL BE PLACED PRIOR TO CONCRETING, WITH A CLEAR COVER OF 65 MM, ± 10 MM TOLERANCE.

CONCRETE QUANTITIES

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

CONCRETE IN ABUTMENTS &	
WINGWALLS	176 m ³
CONCRETE IN PIER	16 m ³
PRESTRESSED CONCRETE BRIDGE DECK	1129 m ³
CONCRETE IN BARRIER WALLS	42 m ³
CONCRETE IN APPROACH SLABS	51 m ³
CONCRETE IN SLOPE PAVINGS	38 m ³

REVISIONS				
	DATE	BY	DESCRIPTION	
	DESIGN K.Z.S.	CHECK <i>MK</i>	LOADING Hs 20-44	DATE 8/9/71
	DRAWING H.N.	CHECK K.Z.S.	SITE No 1-15C	DWG 1

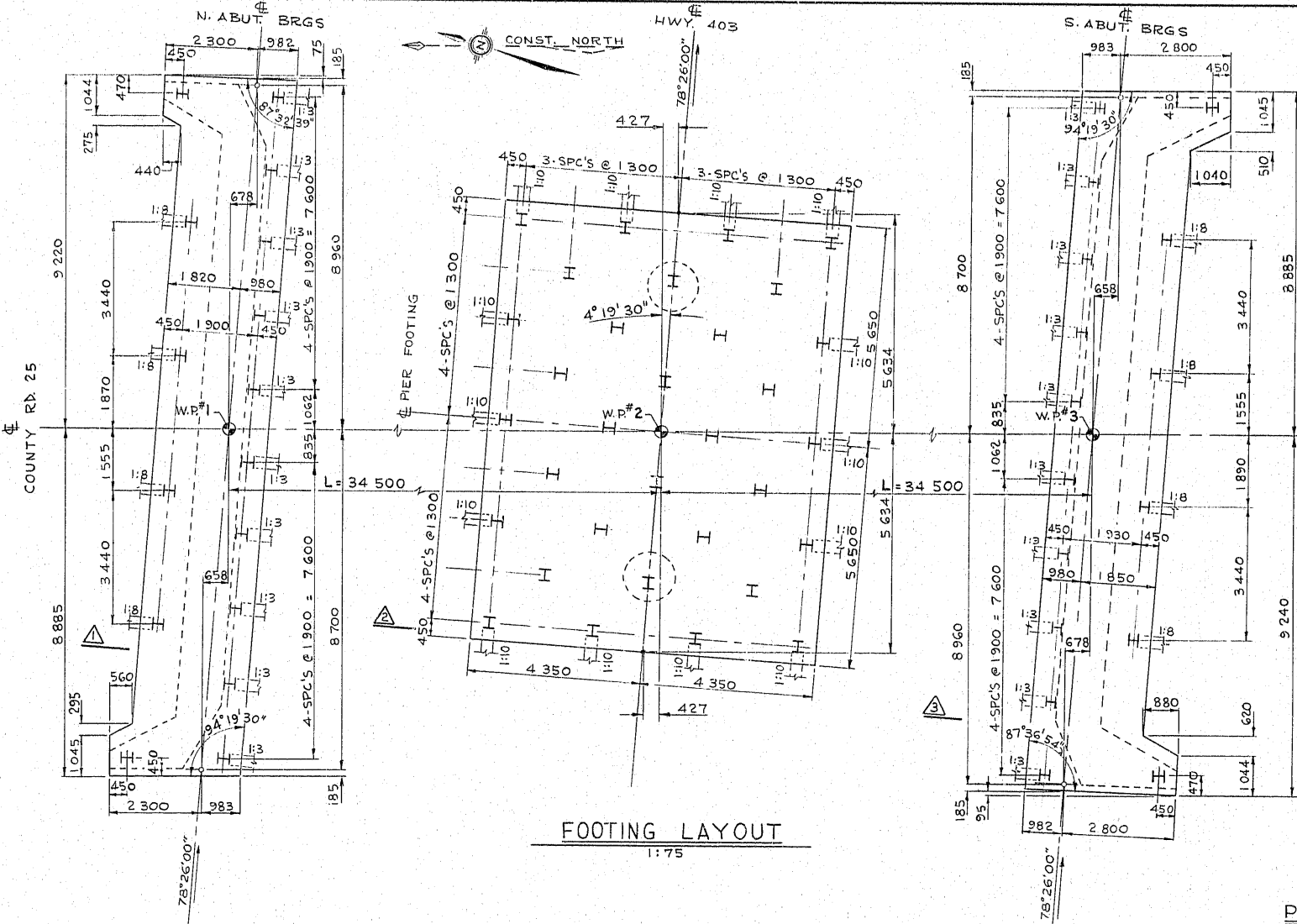
CONT No 81-13
WP No 162-60-01

COUNTY RD. 25 INTERCH. U'PASS
FOOTING LAYOUT & REINFORCING

SHEET
180

METRIC

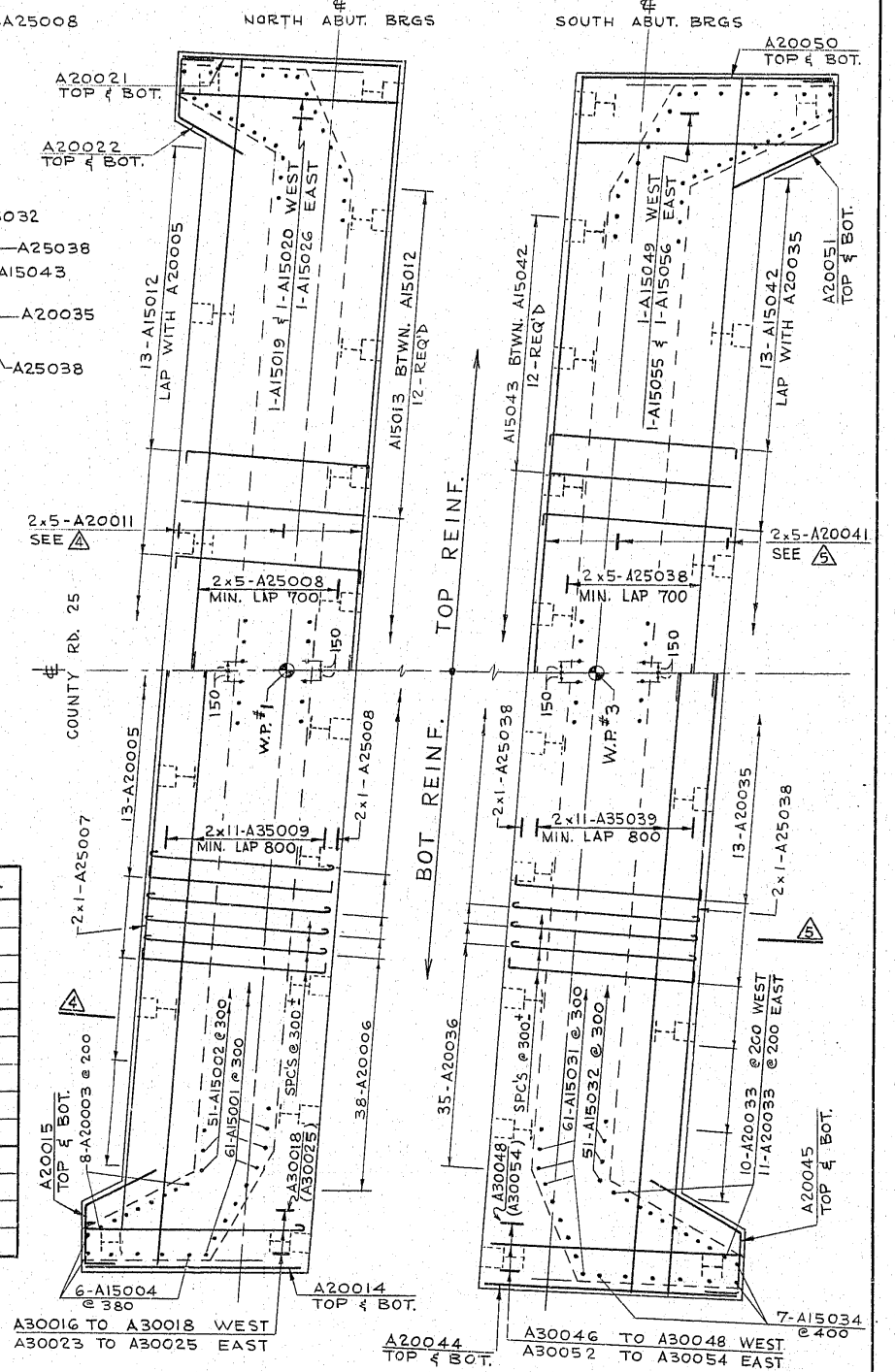
DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.



PILE DATA TABLE

LOCATION	ROW	Nº	LENGTH	BATTER
NORTH ABUTMENT	FRONT	10	14 750	1:3
	MIDDLE	4	14 000	1:8
	BACK	2	14 000	VERT.
PIER	NORTH SIDE	3	10 250	1:10
	SOUTH SIDE	3	10 250	1:10
	WEST SIDE	4	10 250	1:10
	EAST SIDE	4	10 250	1:10
	CENTRE	18	10 250	VERT.
SOUTH ABUTMENT	FRONT	10	14 750	1:3
	MIDDLE	4	14 000	1:8
	BACK	2	14 000	VERT.

- ALL PILES ARE HP310 x 110.
- DESIGN LOAD IS 0.9 MN PER PILE.
- PILE SPACING TO BE MEASURED AT UNDERSIDE OF FOOTING.
- PILE LENGTH SHOWN ON THE DRAWING IS THE THEORETICAL LENGTH BELOW CUT-OFF.



NOTE:

FOR REINF. OF PIER
FOOTING SEE PWG. 6

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN K.Z.S.	CHECK	LOADING H520-44	DATE 80/07
DRAWING G.F.M.S.	CHECK KA/KRS	SITE No 1-156	DWG 3

SITE 1-88-156-A-3



APPENDIX B

Site Photographs



Photograph 1: Looking at the south abutment of the Brant Road 25 Underpass Structure. Random cracks were observed on the abutment wall. Sealant between the concrete panels appeared degraded at locations where grasses are growing. Weep holes were observed in the abutment wall. The toe of the front slope was vegetated with localized erosion of soil at ground surface (August 28, 2015).



Photograph 2: Looking at the north abutment of the Brant Road 25 Underpass Structure. Random cracks were observed on the abutment wall. Sealant between the concrete panels appeared degraded at locations where grasses are growing. Weep holes were observed in the abutment wall. The toe of the front slope was vegetated with localized erosion of soil at ground surface (August 28, 2015).



Photograph 3: Looking north at the piers of the Brant Road 25 Underpass Structure. Vertical cracks were observed on the piers (August 28, 2015).



Photograph 4: Looking at the east wingwall and the adjacent slope of the south abutment of the Brant Road 25 Underpass Structure. Surficial cracks were observed on the wingwall. The slope is vegetated and effect of erosion on the slope face was not observed (August 28, 2015).



Photograph 5: Looking at the west wingwall and the adjacent slope of the south abutment of the Brant Road 25 Underpass Structure. Surficial cracks were observed on the wingwall. The slope is vegetated and effect of erosion on the slope face was not observed (August 28, 2015).



Photograph 6: Looking at the west wingwall and the adjacent slope of the north abutment of the Brant Road 25 Underpass Structure. Surficial cracks were observed on the wingwall. The slope is vegetated and effect of erosion on the slope face was not observed (August 28, 2015).



Photograph 7: Looking at the east wingwall and the adjacent slope of the north abutment of the Brant Road 25 Underpass Structure. Minor surficial cracks were observed on the wingwall. The slope is vegetated and effect of erosion on the slope face was not observed (August 28, 2015).