

REPORT ON

FOUNDATION INVESTIGATION
FISH CREEK (NORTH) BRIDGE REPLACEMENT
HIGHWAY 23, SITE 25-224, GWP 313-94-00
AGREEMENT NUMBER 3005-A-000078

Submitted to:

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LIST OF ABBREVIATIONS

LIST OF SYMBOLS

RECORD OF BOREHOLES

FIGURE 1 – Site Location Map

DRAWING 1 - Fish Creek (North) Bridge, Site 25-224, Borehole Locations and Soil Strata

DRAWING 2 - Fish Creek (North) Bridge, Site 25-224, Soil Strata and Cross Sections

APPENDIX A - Laboratory Test Data (Figures A-1 to A-4)

APPENDIX B - Site Photographs

PART A –FOUNDATION INVESTIGATION REPORT
FISH CREEK (NORTH) BRIDGE REPLACEMENT
HIGHWAY 23, SITE 25-224, GWP 313-94-00
AGREEMENT NUMBER 3005-A-000078

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by TSH Engineers Architects Planners (TSH) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation at the sites of three proposed Highway 23 bridge replacements over Fish Creek near Kirkton, Ontario. This report addresses the north bridge (Site 25-224). MTO has assigned Geocres No. 40P6-18 to this site.

The purpose of the foundation investigation is to determine the subsurface conditions at the site of the proposed replacement bridge, approaches and detour bridge by drilling boreholes, and carrying out in-situ tests and laboratory tests on selected samples. The terms of reference for the scope of work are outlined in our Total Project Management proposal P01-1047, dated February 2000. The work was carried out in accordance with our Quality Control Plan for Foundation Design Services, Agreement No. 3005-A-000078, dated March 2000.

TSH provided Golder with preliminary drawings for the three Highway 23 crossings of Fish Creek. The centreline and stations of the proposed alignments were surveyed by others prior to commencing the foundation field investigation program. The General Arrangement plans showing the proposed abutment layout of the replacement structures and detours had been provided to us in digital format on December 12, 2000.

2.0 SITE DESCRIPTION

The project area covered by this report extends along Highway 23 at the crossing with Fish Creek approximately 1.4 kilometres north of Kirkton, Ontario (see Figure 1). The highway runs approximately northeast-southwest and the creek flows in a southerly direction towards the North Branch of the Thames River.

The existing bridge deck is at elevation 305.1 metres, the water level in the creek is currently at about elevation 302.1 metres and the creek bed is at about elevation 301.1 metres.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between November 10 and 29, 2000. At that time nine boreholes were put down at the site of the proposed replacement bridge and detour. The boreholes were drilled and sampled to depths ranging from about 3.5 to 16.5 metres. The borehole locations are shown in plan on Drawing 1.

The investigation was carried out using truck and all terrain vehicle mounted CME 75 and CME 750 drill rigs supplied and operated by Lantech Drilling Services Inc. The boreholes were advanced using 208 millimetre outside diameter continuous flight hollow stem augers. In the boreholes, samples of the overburden were obtained at regular intervals of depth using 50 millimetre outside diameter split spoon samplers in accordance with the Standard Penetration Test (SPT) procedures. In-situ vane shear tests and cone penetration tests were also carried out in select boreholes. Groundwater conditions in the open boreholes were observed throughout the drilling operations. Piezometers were installed in four boreholes to permit monitoring of the groundwater levels at the site. All of the boreholes were backfilled using MTO recommended procedures. Water levels in the installations were obtained on November 29, December 13 and December 20, 2000 to determine stabilized levels.

The field work was supervised on a full-time basis by a member of our engineering staff who located the boreholes in the field, directed the drilling, sampling and in-situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in labeled containers and transported back to our laboratory in London, Ontario for further examination. Index and classification tests consisting of grain size analyses, Atterberg limits tests and water content determinations were carried out on selected samples. The results of the field and laboratory testing are given on the Record of Borehole sheets and in Appendix A. Site photographs taken during the drilling operations are provided in Appendix B.

The as drilled borehole locations and elevations were surveyed by Golder staff using the coordinate system and benchmarks on the drawings provided by TSH. The elevations at the borehole locations were referenced to a cut cross on the south end of the bridge at Station 18+587.1, 6.0 metres right. The benchmark is numbered 310 and is understood to have an elevation of 305.032 metres, referred to geodetic datum.

4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY

4.1 Site Geology

The site lies within the physiographic region of Southwestern Ontario known as the Stratford Till Plain, specifically an area known as the Lucan Moraine. The soil conditions in the area generally consist of stoney and bouldery clayey silt till. The region is underlain by limestone of the Dundee formation. The rock surface is typically found at depths of about 14 to 21 metres below the ground surface.

4.2 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Record of Borehole sheets and Appendix A following the text of this report. The stratigraphic boundaries shown on the borehole sheets are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations.

In summary, the subsoils at the site generally consist of variable thicknesses of fill, topsoil and organic materials to about elevations 300.3 to 302.6 metres underlain by 4.3 to 7.3 metres of silt and/or clayey silt and 6.7 to 9.6 metres of sand and gravel. These layers were underlain by sandy silt till materials starting between elevation 295.4 and 298.0 metres.

Locations and elevations of the borings, together with the interpreted stratigraphical profile and sections, are shown on the attached Drawings 1 and 2. A detailed description of the subsurface conditions encountered in the boreholes for this investigation is provided on the Record of Borehole sheets and is summarized in the following sections.

4.2.1 Topsoil and Fill

Topsoil and/or fill layers were encountered in all of the boreholes. Topsoil layers 0.2 to 0.4 metres thick were encountered at ground surface in boreholes 4, 7 and 8 and beneath layers of fill in boreholes 2, 3, 5, 6 and 9. Standard penetration tests in the topsoil indicated N values of 2 to 5 blows per 0.3 metres penetration and water contents between about 20 and 52 per cent.

Layers of sand and gravel fill underlain by generally clayey silt fill were encountered at ground surface or beneath surficial topsoil layers in boreholes 1 to 6 and 9. The granular fill in boreholes 1, 2, 3, 5 and 6 is associated with the granular shoulders for Highway 23. Cobbles and/or boulders were noted in the fill layers in boreholes 1, 3, 5, 6 and 9. The fill layers were 2.0 to 4.0 metres thick and had N values between 3 and 51 blows per 0.3 metres of penetration and water contents between 11 and 27 per cent.

4.2.2 Organic Deposits

The top portion of the silt deposits between elevation 300.8 and 302.1 metres in boreholes 2, 3, 4, 7 and 8 contained varying amounts of organic materials. In borehole 2, a 0.8 metre thick layer of organic silt was encountered. The organic silt had an N value of 3 blows per 0.3 metres penetration and a water content of about 92 per cent. In borehole 7, a 0.2 metre thick layer of peat was encountered. The peat had an N value of 2 blows per 0.3 metre penetration and a water content of about 57 per cent.

4.2.3 Layered Silt and Clayey Silt

Beneath the topsoil and organic deposits in boreholes 2, 3, 5 to 8 and 9 and the fill in borehole 4, layers of silt and clayey silt 1.1 to 3.9 metres thick were encountered. The deposit contains frequent interlayers of silt and clayey silt. Boreholes 6 and 7 were terminated in the deposit at elevations of 301.9 and 296.5 metres after exploring it for 0.8 and 3.5 metres, respectively. Cone penetration testing was carried out in borehole 7. The deposit had standard penetration test N values of 2 to 10 blows per 0.3 metres penetration and cone penetration values of 1 to 39 blows per 0.3 metres of penetration at the bottom of borehole 7 indicating a very loose to loose density in the silt and very soft to firm density in the clayey silt. Two in-situ vane shear tests carried out in borehole 8 indicated undrained shear strengths of 67 and 72 kilopascals, indicating a stiff consistency of the clayey silt layers.

Figure A-1 in Appendix A shows the gradation curves for two samples of the deposit from boreholes 7 and 8. Measured water contents of the samples from this deposit were between about 21 and 38 per cent, with an average of about 26 per cent. The average plastic and liquid limits for two samples of the clayey silt interlayers were 21 and 28 per cent, respectively, with an average plasticity index of 7 per cent. The Atterberg limits test results are summarized on a Plasticity Chart, Figure A-4.

4.2.4 Sand and Gravel

In Boreholes 2 to 5, 8 and 9, a 0.3 to 2.7 metres thick layer of wet sand and gravel was encountered between the silt and till deposits at about elevation 295.4 to 299.2 metres. The sand and gravel layers had standard penetration test N values of 14 to 56 blows per 0.3 metres penetration indicating a compact to very dense density. Water contents were between about 10 and 14 per cent

4.2.5 Sandy Silt Till

Boreholes 2 to 5, 8 and 9 encountered brown and grey sandy silt till and/or silty sand till, trace to some clay, below elevation 295.4 to 298.0 metres and were terminated in the till stratum at elevations between 288.4 and 296.5 metres after penetrating it for some 1.6 to 9.5 metres. Boreholes 3 and 9 were terminated after refusal to further auger penetration within the till at elevations of 288.4 and 296.1 metres, respectively. The till deposit had varying amounts of cobbles and boulders and had standard penetration test N values of 26 blows per 0.3 metres penetration to 100 blows per 75 millimetres penetration indicating a generally dense to very dense density. Figures A-2 and A-3 in Appendix A show gradation curves for samples of the sandy silt till and silty sand till deposits, respectively.

The water contents of selected till samples were between about 6 and 11 per cent. The average plastic and liquid limits for the sandy silt till, based on 2 samples tested, are 12 and 17 per cent, respectively, with an average plasticity index of 5 per cent. A single Atterberg limit determination for a sample of the silty sand till from borehole 8 indicated that the material was non-plastic. The Atterberg limits of the till deposit are summarized on a Plasticity Chart, Figure A-4.

4.3 Groundwater Conditions

Water levels were noted in the open boreholes during and upon completion of the drilling operations. These levels are shown on the attached Record of Borehole sheets. A standpipe was installed in borehole 3 and piezometers were sealed in boreholes 3, 4 and 9 to permit the monitoring of the groundwater levels at the site. Details of the piezometer installations and water level measurements are shown on the attached Record of Borehole sheets.

Water was noted during drilling in all of the open boreholes, except Boreholes 1 and 6, at elevations between 291.2 and 301.2 metres. The encountered water levels and those measured in the standpipe and piezometers on November 29, 2000 and December 13 and 20, 2000 are summarized in the following table. On the latter dates the water levels were at elevations 301.2 to 302.1. It should be noted that the groundwater level is subject to seasonal fluctuations.

<i>Borehole Number</i>	<i>Installation</i>	<i>Ground Surface Elevation (m)</i>	<i>Groundwater Level Encountered During Drilling</i>		<i>Water Levels in Piezometers</i>			
					<i>November 29, 2000</i>		<i>December 13/20, 2000</i>	
			<i>Depth (m)</i>	<i>Elevation (m)</i>	<i>Depth (m)</i>	<i>Elevation (m)</i>	<i>Depth (m)</i>	<i>Elevation (m)</i>
1		304.67	Dry					
2		304.73	6.10	298.63				
3	Standpipe Piezometer	304.90	7.01	297.89	2.90 3.35	302.00 301.55	3.20 3.72	301.70 301.18
4	Piezometer	303.69	5.49	298.20	3.81	299.88	1.55	302.14
5		305.25	7.32	297.93				
6		305.36	Dry					
7		302.56	1.37	301.19				
8		302.45	11.27	291.18				
9	Piezometer	304.53	5.33	299.20	2.65	301.88	2.99	301.54

The measured water level in the creek was at elevation 302.10 metres on December 13, 2000.

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APPENDIX A

LABORATORY TEST DATA (FIGURES A-1 TO A-4)

APPENDIX B

SITE PHOTOGRAPHS