Golder Associates Ltd.

2180 Meadowvale Boulevard
Mississauga, Ontario, Canada L5N 5S3
Telephone (905) 567-4444
Fax (905) 567-6561

PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT ANNE STREET UNDERPASS STRUCTURE SITE 30-347 HIGHWAY 400 WIDENING FROM 1 KM SOUTH OF HIGHWAY 89 TO HIGHWAY 11 G.W.P. 30-95-00, AGREEMENT NO. 3005-A-000074

Submitted to:

URS Cole, Sherman
75 Commerce Valley Drive East
Thornhill, Ontario
L3T 7N9

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January 2002 001-1143F-12

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PART A

PRELIMINARY FOUNDATION INVESTIGATION REPORT
ANNE STREET UNDERPASS
STRUCTURE SITE 30-347
HIGHWAY 400 WIDENING FROM 1 KM SOUTH
OF HIGHWAY 89 TO HIGHWAY 11
G.W.P. 30-95-00, AGREEMENT NO. 3005-A-000074

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1.0 INTRODUCTION

Golder Associates Ltd. has been retained by URS Cole, Sherman (Cole, Sherman) on behalf of the Ministry of Transportation, Ontario (MTO) to provide preliminary foundation engineering services for the ultimate widening of Highway 400 from 1 km south of Highway 89, northerly 30 km to Highway 11, in Simcoe County, Ontario. Foundation engineering services are required for the widening and / or replacement of eighteen existing overpass and underpass structures, as well as five structural culverts.

This report addresses the replacement of the existing Anne Street underpass structure which is located in Barrie. Existing subsurface data for this site from an investigation conducted for the Department of Highways, Ontario (DHO) in 1957 were used to determine the subsurface conditions for this preliminary design study. The 1957 report was prepared by Universal Geotechnique Limited (*"Report on Subsurface Exploration for Proposed Overpass at Anne Street and Highway 400, Barrie Ontario"*, dated 1957 – GEOCRES File No, 31D-182).

The terms of reference for the scope of work are outlined in Golder Associates' Proposal No. P01-1192, dated June 2000.

2.0 SITE DESCRIPTION

The existing two-span Anne Street underpass structure is located about 1 km north of Dunlop Street (Simcoe Road 90, formerly Highway 90) and less than 2 km south of Bayfield Street (Highway 26) in Barrie, Ontario. The MTO has designated this underpass as Structure Site 30-347.

At this structure site, the Highway 400 grade is at about Elevation 236 m, rising northward. Anne Street has been constructed in fill with approach embankments up to about 6 m in height; the Anne Street grade is at about Elevation 242 m over Highway 400.

The existing two-span underpass structure was constructed in the late 1950s. According to the general layout drawing for this contract, which was provided by Morrison Hershfield (the structural designers for this preliminary study), the existing structure is supported by driven steel H-piles. The underside of the abutment and pier pile caps is at about Elevation 232.5 m. The tip elevation of the H-piles is not known.

3.0 INVESTIGATION PROCEDURES

A subsurface investigation was carried out at this site for the Department of Highways, Ontario (DHO) in June and July of 1957, by Universal Geotechnique Limited. At that time, a total of six boreholes were advanced in the vicinity of the abutments and pier for the then-proposed structure. Boreholes 1 and 2 were located in the vicinity of the east abutment, Boreholes 3 and 4 were drilled near the west abutment, and Boreholes 5 and 6 were advanced at the approximate location of the central pier. Boreholes 1, 4, 5 and 6 were advanced to about 7.5 m depth, while Boreholes 2 and 3 were advanced to about 19 m and 15 m depth at the east and west abutments, respectively. All of the boreholes were advanced from approximately Highway 400 grade.

Samples of the overburden were obtained at 0.75 m to 1.5 m intervals of depth using 50 mm outside diameter split-spoon samplers in accordance with the Standard Penetration Test (SPT) procedure. The groundwater conditions in the open borehole were observed during and following the drilling operations. No laboratory testing was carried out in conjunction with this 1957 investigation.

The borehole locations and elevations, referenced to the geodetic datum, were established by DHO. Approximate northing and easting co-ordinates consistent with the MTM NAD83 survey system, currently in use on this project, have been determined by Golder Associates based on the borehole locations given in the 1957 report. The approximate borehole locations and northing and easting co-ordinates are shown on the attached Drawing 1.

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geological Conditions

This 30 km section of Highway 400 traverses, from south to north, the following physiographic regions as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, Third Edition, 1984): the Simcoe Lowlands; the Peterborough Drumlin Field; a second lobe of the Simcoe Lowlands; and the Simcoe Uplands. Along Highway 400, the Simcoe Lowlands are present from the southern limit of the project to just south of Innisfil Creek, and again from Essa Road (Simcoe Road 30, formerly Highway 27) to about 1 km north of Dunlop Street (Simcoe Road 90, formerly Highway 90). The Peterborough Drumlin Field occupies the belt between these lobes of the Simcoe Lowlands, extending from just south of Innisfil Creek, which is located about 1 km north of Highway 89, to Essa Road. The Simcoe Uplands extend from about 1 km north of Dunlop Street to beyond the northern limit of the project at Highway 11.

The two sections where Highway 400 crosses the Simcoe Lowlands consist of two lobes of a sand plain which include the shores of Kempenfelt Bay, the Nottawasaga River and Innisfil Creek. The surficial soils of these sections of the Simcoe Lowlands consist primarily of sand, although silt, clay or peat may be found in low-lying areas. The Anne Street underpass site is located within the Simcoe Lowlands physiographic region.

The surficial soils in the Peterborough Drumlin Field consist primarily of gravelly sand till or sand and gravel deposits. Drumlins (glacially-shaped hills) are more frequent in the southern portion of the section of the Peterborough Drumlin Field traversed by Highway 400. Deposits of silt, clay or peat may be found in the low-lying areas between drumlins.

The surficial soils in the Simcoe Uplands physiographic region are primarily sandy silt till deposits, known to contain occasional boulders. Low-lying areas may be infilled with shallow sand and gravel deposits, which are shoreline deposits of a former glacial lake that once flooded the area.

4.2 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes are given on the Record of Borehole sheets contained in Appendix A. The stratigraphic boundaries shown on the borehole records 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.

Boreholes 1 and 2 were advanced in the vicinity of the east abutment, Boreholes 3 and 4 were drilled near the west abutment, and Boreholes 5 and 6 were advanced at the approximate location of the central pier. The approximate locations and ground surface elevations for these borings are shown on the attached Drawing 1.

In summary, the soils below Highway 400 grade at this site consist of fill overlying a generally compact to dense deposit of sand and gravel to sandy silt, in turn underlain by a deposit of hard silty clay till. A detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Fill

The 1957 boreholes encountered between 2 m and 2.5 m of sand fill containing gravel, clay, organics and wood fragments. The base of this fill layer, as encountered in the boreholes, was at about Elevation 233 m to 234 m. The measured Standard Penetration Test (SPT) "N" values ranged from 9 to 29 blows per 0.3 m of penetration, indicating that the fill has a loose to compact relative density.

4.2.2 Sand and Gravel to Sandy Silt

Below the fill at about Elevation 233 m to 234 m, the boreholes encountered a deposit which contains layers ranging in composition from sand and gravel to sand to sandy silt. Evidence of bedding, and seams or interlayers of silty clay (particularly within the sandy silt portions of the deposit) are noted on the borehole records. The deposit was fully penetrated by the two deeper borings (Boreholes 2 and 3, at the east and west abutments, respectively) where it was about 12 m to 15 m in thickness.

The measured SPT "N" values ranged from 22 to 55 blows, but were typically between 22 and 40 blows per 0.3 m of penetration; the deposit therefore has a predominantly compact to dense relative density.

4.2.3 Silty Clay Till

In the deeper borings which were advanced at the east and west abutments, a silty clay deposit was encountered below the sand and gravel to sandy silt stratum. This deposit was described as a

till in the text of the 1957 report. The surface of the till was at Elevations 218 m and 222 m in Boreholes 2 and 3, respectively. The deposit was not fully penetrated by either boring, but was at least 1 m to 2 m thick at these borehole locations. The measured SPT "N" values of 52 and 62 blows per 0.3 m of penetration indicate that this till deposit has a hard consistency.

4.3 Groundwater Conditions

The water levels observed in the open boreholes following completion of the June / July 1957 drilling operations were measured to be between Elevation 233.5 m and 234.5 m, approximately 1 m to 2 m below then-existing ground surface and 1.5 m to 2.5 m below the current Highway 400 grade. It should be noted that groundwater levels are expected to fluctuate seasonally and are expected to rise during wet periods of the year.

GOLDER ASSOCIATES LTD.

Lisa C. Coyne, P.Eng.,
Geotechnical Engineer

Anne S. Poschmann, P.Eng.,
Principal

Fintan J. Heffernan, P.Eng.,
Designated MTO Contact

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PART B

PRELIMINARY FOUNDATION DESIGN REPORT
ANNE STREET UNDERPASS
STRUCTURE SITE 30-347
HIGHWAY 400 WIDENING FROM 1 KM SOUTH
OF HIGHWAY 89 TO HIGHWAY 11
G.W.P. 30-95-00, AGREEMENT NO. 3005-A-000074

5.0 ENGINEERING RECOMMENDATIONS

5.1 General

This section of the report provides preliminary foundation design recommendations for the replacement of the existing Anne Street underpass structure, associated with the widening of Highway 400. The recommendations are preliminary only and are based on interpretation of the factual data obtained from a limited number of boreholes advanced during the subsurface investigation at this site. The interpretation and recommendations provided are intended for planning purposes only, to provide the information necessary at this stage of the study. As such, where comments are made on construction they are provided only in order to highlight those aspects which could affect the planning of the project. Further foundation investigation will be required at this bridge site as part of the detailed design stage of the project.

It is understood that Highway 400 will be widened from its existing six-lane configuration to an interim configuration of eight lanes, and an ultimate configuration of ten lanes, and that an alternative for a twelve-lane express / collector system is under consideration between Molson Park Drive and Duckworth Street in Barrie. Throughout the project length, it is expected that the existing highway platform will be widened by between 13 m and 30 m. Replacement of the existing Anne Street underpass structure will be necessary.

Based on the general layout drawing for the existing two-span structure, the abutments and pier are supported on driven steel H-piles, with the underside of the abutment and pier pile caps at about Elevation 232.5 m. The Highway 400 grade is at about Elevation 236 m, while Anne Street has been constructed in fill with its grade at about Elevation 242 m over Highway 400.

5.2 Bridge Foundation Options

The soils below the Highway 400 level consist of about 2 m to 2.5 m of fill overlying a deposit of sand and gravel, sand, and silt, in turn underlain by a hard silty clay till deposit. The water level observed in the open boreholes at the time of the 1957 investigation was at about Elevation 233.5 m to 234.5 m (between 1.5 m and 2.5 m below the current Highway 400 grade).

Based on the thickness of the fill and the relatively high groundwater table in the granular subsoils, it is considered that shallow foundations (spread footings) are not a suitable option for support of the new underpass structure at this site. It is recommended that the new two-span structure be supported on driven steel H-piles; preliminary recommendations for these deep foundations are provided in the following sections.

5.3 Driven Steel H-Piles

It is recommended that the new two-span underpass structure be supported on steel H-piles driven to found within the hard silty clay till stratum, which was encountered below Elevation 218 m and 222 m at the east and west abutments, respectively. The top of this founding stratum, as encountered in the 1957 boreholes, is between 14 m and 18 m below Highway 400 grade, and about 20 m to 24 m below Anne Street grade. Based on the existing borehole information, it is expected that the depth where practical refusal to pile penetration will occur will be located below the base of the 1957 boreholes (i.e. below Elevation 216 m). In this regard, it is noted that additional borehole investigation work will be require at the proposed foundation locations during detailed design in order to confirm the thickness and consistency of the silty clay till founding stratum and establish design tip elevations.

It is recommended that the pile cap be maintained as high as possible, due to the relatively high groundwater level at the site. The pile length will vary due to the variable depth to this founding stratum; however, based on the above considerations and recommendations, for preliminary estimating purposes the piles can be considered to range from about 20 m to 25 m in length.

5.3.1 Axial Geotechnical Resistance

For preliminary design, the factored axial resistance at Ultimate Limit States (ULS) for steel HP 310 x 110 H-piles driven to found within the hard silty clay till stratum may be taken as 1,600 kN. The axial resistance at Serviceability Limit States (SLS) for 25 mm of settlement may be taken as 1,400 kN.

To achieve the above design resistances, the piles should be driven to a final set of no less than 15 blows per 25 mm of penetration using a hammer with rated energy of about 50 kJ, and not exceeding 60 kJ. Provision should be made to re-tap selected piles to confirm the set after adjacent piles have been driven, in accordance with MTO's current Special Provision.

5.3.2 Resistance to Lateral Loads

The lateral loading could be resisted fully or partially by the use of battered piles. If vertical piles are used, the resistance to lateral loading will have to be derived from the soil in front of the piles. If integral abutments are under consideration, there may also be a requirement for the piles to move sufficiently to accommodate the bridge deck deflections.

The resistance to lateral loading in front of the pile may be calculated using subgrade reaction theory where the coefficient of horizontal subgrade reaction, k_h, is based on the following equation:

$$k_h = \frac{n_h z}{B}$$

where n_h is the constant of subgrade reaction
z is the depth (m)
B is the pile diameter (m)

For the embankment fill and generally compact to dense sand and gravel to sandy silt soils through which the piles would be driven, the range in value of n_h may be taken as 5 MPa to 10 MPa in the structural analysis.

Group action for lateral loading should be considered when the pile spacing in the direction of the loading is less than six to eight pile diameters. Group action can be evaluated by reducing the coefficient of lateral subgrade reaction in the direction of loading by a reduction factor, R, as follows:

Pile Spacing in Direction of Loading d = Pile Diameter	*Subgrade Reaction Reduction Factor R*
8d	1.00
6d	0.70
4d	0.40
3d	0.25

5.3.3 Frost Protection

The pile caps should be provided with 1.5 m soil cover for frost protection.

5.4 Lateral Earth Pressures

The lateral pressures acting on the structure abutments and any associated retaining walls will depend on the type and method of placement of the backfill materials, on the nature of the soils behind the backfill and on the subsequent lateral movement of the structure. The following recommendations are made concerning the design of the abutments, in accordance with the OHBDC:

- Select free-draining granular fill meeting the specifications of OPSS Granular 'A' or Granular 'B' but with less than 5 per cent passing the 200 sieve should be used as backfill behind the abutments and walls. This fill should be compacted in loose lifts not greater than 200 mm in thickness to 95 per cent of the material's Standard Proctor maximum dry density in accordance with OPSS 501. Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill. Other aspects of the abutment granular backfill requirements with respect to sub-drains and frost taper should be in accordance with OPSD 3501.00 and 3504.00

- A compaction surcharge equal to 16 kPa should be included in the lateral earth pressures for the structural design of the abutment wall, in accordance with OHBDC Figure 6-7.4.3. Compaction equipment should be used in accordance with OPSS 501.06.

- The granular fill may be placed either in a zone with width equal to at least 1.5 m behind the back of the stem (Case I from OHBDC Figure 6-7.4.1) or within the wedge-shaped zone defined by a line drawn at 1.5 horizontal to 1 vertical (1.5H:1V) extending up and back from the rear face of the footing (Case II from OHBDC Figure 6-7.4.4).

- For Case I, the pressures are based on the existing and proposed embankment fill materials and the following parameters (unfactored) may be assumed:

Soil unit weight:	20 kN/m^3
Coefficients of lateral earth pressure:	
Active, K_a	0.35
At rest, K_o	0.50

- For Case II, the pressures are based on the granular fill as placed and the following parameters (unfactored) may be assumed:

	Granular 'A'	**Granular 'B' Type II**
Soil unit weight:	22 kN/m^3	21 kN/m^3
Coefficients of lateral earth pressure:		
Active, K_a	0.27	0.31
At rest, K_o	0.43	0.47

- If the wall support and superstructure allow lateral yielding of the stem, active earth pressures may be used in the geotechnical design of the structure. If the abutment support does not allow lateral yielding, at-rest earth pressures should be assumed for geotechnical design.

It should be noted that the above design recommendations and parameters assume level backfill and ground surface behind the abutment and retaining walls. Where there is sloping ground behind the walls, the coefficient of lateral earth pressure must be adjusted to account for the slope.

5.5 Embankment Design

Based on the topographic information on the Engineering and Title Records plates and on site reconnaissance, the existing approach embankment side slopes are formed at a gradient of about 2 horizontal to 1 vertical (2H:1V). If any widening of the local road embankment will be required, the new side slopes should be formed at a maximum gradient of 2H:1V. The widening of the embankment should be carried out using conventional fill placement and compaction practices, and benching of the existing embankment side slopes should be carried out to key in the new fill.

5.6 Design and Construction Considerations

5.6.1 Dewatering

The sand and gravel to sandy silt stratum which underlies the site is water-bearing; based on observation of the water levels in the open boreholes following the June / July 1957 drilling operations, the groundwater level varies from Elevation 233.5 m to 234.5 m at the site and may be higher during wet periods of the year. If the pile caps are placed below about Elevation 235 m, a dewatering scheme will be necessary to facilitate pile cap excavation, pile driving and concrete placement in dry conditions. The groundwater level should be lowered to at least 0.5 m below the underside of the pile caps prior to excavation and pile driving.

The cohesionless soils in which the footing or pile cap excavations will be formed are susceptible to disturbance from ponded water and construction traffic. Provision should be made in the Contract Documents for the placement of a lean concrete mat to protect the soils from such disturbance.

5.6.2 Excavation

The pile cap excavations will extend a minimum of 1.5 m below lowest surrounding grade, and would be carried out through the existing embankment fill and possibly the compact to dense sand and gravel to sandy silt deposit. Excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Occupational Health and Safety Act for Construction Activities. The fill and cohesionless native soils would be classified as Type II soils, assuming that proper dewatering control is in place for excavations taken below about Elevation 235 m. Temporary open-cut slopes should therefore be maintained no steeper than 1 horizontal to 1 vertical (1H:1V). Where space restrictions dictate, in particular adjacent to the existing Anne Street embankment, pile cap excavations could also be carried out within a braced excavation.

5.6.3 Obstructions

Although no cobbles or boulders were recorded on the records for the 1957 boreholes, it should be noted that cobbles and boulders are inherent in glaciolacustrine materials. Cobbles and boulders should therefore be expected during driving of the steel H-piles.

GOLDER ASSOCIATES LTD.

Lisa C. Coyne, P.Eng.,
Geotechnical Engineer

for Anne S. Poschmann, P.Eng.,
Principal

REGISTERED PROFESSIONAL ENGINEER
A. S. POSCHMANN
PROVINCE OF ONTARIO

for Fintan J. Heffernan, P.Eng.,
Designated MTO Contact

REGISTERED PROFESSIONAL ENGINEER
F. J. HEFFERNAN
PROVINCE OF ONTARIO

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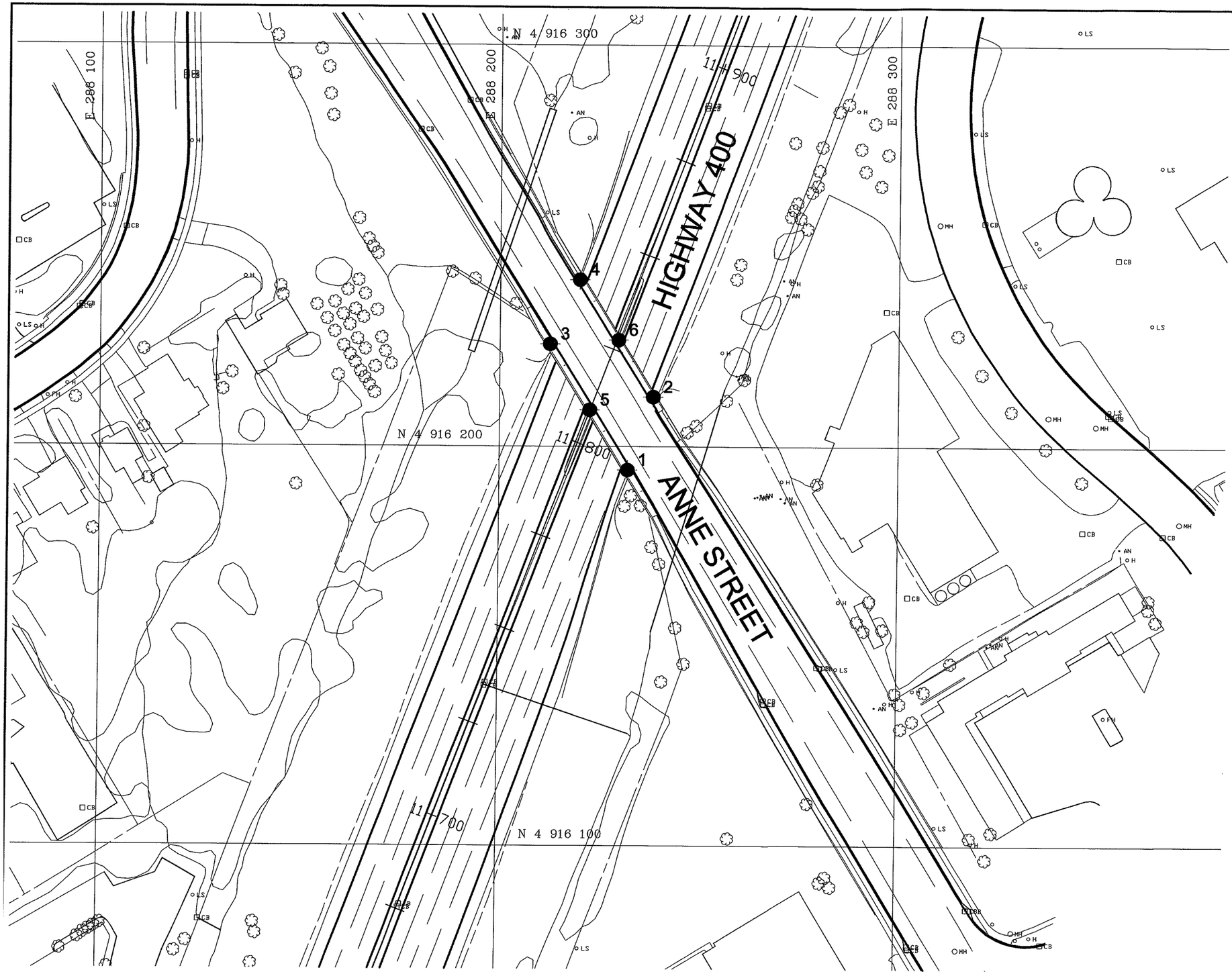
DIST HWY 400
CONT. No.
GWP No. 30-95-00

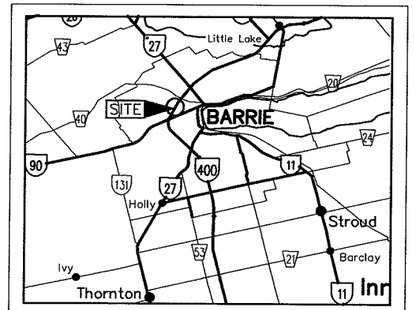
ANNE STREET UNDERPASS
HWY 400
BOREHOLE LOCATION PLAN

SHEET

Golder Associates

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA





LEGEND

- Borehole, previous investigation
- Borehole, present investigation

No.	ELEVATION	LOCATION NORTHING	LOCATION EASTING
1	235.3	4,916,194	288,232
2	235.5	4,916,212	288,239
3	235.8	4,916,226	288,213
4	236.0	4,916,242	288,220
5	235.1	4,916,209	288,223
6	235.5	4,916,227	288,229

REFERENCE
This drawing was created from digital file "50210.dwg" provided by URS Cole Sherman

0 10 20 30 40 50 100m
SCALE IN METRES

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

NO.	DATE	BY	REVISION

Geocres No.

HWY. No. 400		PROJECT NO.: 001-1143F	
SUBM'D. LCC	CHKD: ASP	DATE: JANUARY 2001	SITE 30-347
DRAWN: MHW	CHKD. LCC	APPD. ASP	DWG. 1

APPENDIX A

RECORDS OF BOREHOLES
1957 SUBSURFACE INVESTIGATION

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PRO Anne Street Overpass, Barrie, Ontario. ORDER NO. T.227/57

CLIENT Department of Highways, Ontario.

BOREHOLE NO. BH.1 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Plan INCLINATION Vertical BEARING ——

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Firm brown to grey clayey sand with some organic matter and fine to medium gravel. Probably FILL.	771.82 235.3m		• 1	Zero – 0.0m		12	Moist Low to medium dry strength.
				Free Water ▼			
Loose brown to grey sand with fine to medium gravel and some organic matter. Probably FILL.			• 2			9	Moist Low dry strength.
Dense brown to grey fine to coarse SAND with generally subrounded fine to medium gravel.			• 3			30	do
Dense brown grey generally fine calcareous SAND with fine to medium subrounded gravel.			• 4			33	do
Firm do			• 5			22	do
Dense brown grey fine to medium calcareous SAND with fine to medium subrounded gravel.	227.7m		• 6	25'-1" – 7.6m		37 (7")	do
			End of Borehole				

SCALE: 1" = 5'-0" • DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

UNIVERSAL GEOTECHNIQUE LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Anne Street Overpass, Barrie, Ontario, ORDER NO. 1,227/37

CLIENT Department of Highways, Ontario,

BOREHOLE NO. BH.2 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Plan INCLINATION Vertical BEARING ———

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Firm brown grey sand, clayey concentrations. Black organic matter. Probably FILL.	772.65 235.5m		1	Zero – 0.0m		20	Moist
Firm do			2	Free Water		15	do
do Iron staining			3			12	do
Dense grey brown fine to coarse calcareous SAND and fine to medium generally subrounded GRAVEL.	232.9m		4	8'-6" – 2.6m		32	Moist Low dry strength.
Dense brown sandy SILT with lenses of fine to medium SAND: Traces of bedding.	231.5m		5	13'-0" – 4.0m		31	Moist, Low to medium dry strength.
do Some iron staining			6			48	do
Firm brown grey fine to medium calcareous SAND. Lenses of fine subrounded to rounded gravel embedded in clay.	228.5m		7	23'-0" – 7.0m		26	Moist Low dry strength.
Dense brown grey fine to medium calcareous SAND with fine to medium gravel, generally subrounded.			8			30	do
do			9			35	do
do			10			-	Wash Sample
Dense grey generally fine calcareous SAND.	221.2m		11	47'-0" – 14.3m		47	Moist Low dry strength.

SCALE: 1" = 5'-0" • DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

FORM G-1A 800-6-64 UNITED SASKATCHEWAN (1964)

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Anne Street Overpass, Barrie, Ontario. ORDER NO. T.227/57

CLIENT Department of Highways, Ontario.

BOREHOLE NO. BH.2 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Plan INCLINATION Vertical BEARING ———

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Dense grey generally fine calcareous SAND.	220.3m			50'-0"	15.2m		
Very stiff grey calcareous silty CLAY.	217.7m		● 12	58'-6"	17.8m	62	Moist. Sand: Low dry strength. Clay: High dry strength.
	216.8m		End of Borehole	61'-6"	18.7m		

FORM G-1A 500-6-54 LITHO STAUNTON LTD.

SCALE: 1" = 5'-0" ● DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Anne Street Overpass, Barrie, Ontario. ORDER NO. T.227/57

CLIENT Department of Highways, Ontario.

BOREHOLE NO. BH.3 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Plan INCLINATION Vertical BEARING ——

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
	773.58			Zero	0.0m		
Firm brown sand, gravel, little clay and bits of wood. FILL.	235.8m		1			29	Moist
Firm brown sand and black organic matter. Probably FILL.			2			21	do
				6'-7"	Free Water		Wet
Firm grey to iron-stained yellow fine to medium SAND with fine to medium generally subrounded gravel.	233.8m		3		2.0m	27	Low dry strength.
do No iron staining.			4			33	Moist Low dry strength.
do			5			23	do
	230.2m			18'-6"	5.6m		
Dense grey generally fine calcareous silty SAND.			6			37	do
do Slight iron staining.			7			37	do
do No iron staining.			8			22	Wet Low dry strength.
	225.4m			34'-0"	10.4m		
Brown grey fine to medium calcareous SAND.			9				Wash Sample
Grey generally fine calcareous SAND.			10				Wash Sample
do Firm grey silty CLAY.	222.1m		11	45'-0"	13.7m	22	Moist Low dry strength.
Hard do	220.6m		12	50'-0"	15.2m	52	Last sample

End of Borehole

SCALE: 1" = 5'-0" • DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

FORM G-1A 500-6-54 (UNITED STANDARDS)

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Anne Street Overpass, Barrie, Ontario. ORDER NO. T.227/57

CLIENT Department of Highways, Ontario.

BOREHOLE NO. BH.4 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Plan INCLINATION Vertical BEARING ——

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Firm grey brown fine to medium somewhat clayey sand with gravel. Probably FILL.	774.26 236.0m		● 1	Zero – 0.0m		22	Moist
do With traces of organic matter. Probably FILL.			● 2	Free Water		17	Wet
Firm grey brown fine to coarse calcareous SAND and fine to medium generally subrounded GRAVEL.			● 3			22	Wet No dry strength.
Dense brown sandy SILT with thin lenses of clay. Exhibits bedding.	232.0m		● 4	13'-0" – 4.0m		33	Damp Low to medium dry strength.
Dense grey generally fine calcareous SAND.			● 5			34	Wash sample
Dense grey brown generally fine calcareous SAND with occasional fine gravel. Exhibits faint bedding and some iron staining.	228.2m		● 6	25'-6" – 7.8m End of Borehole		55	Moist. Low to medium dry strength.

SCALE : 1" = 5'-0" ● DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

FORM S-14 500-6-54
LITHO STATIONERY CO.

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Anne Street Overpass, Barrie, Ontario. ORDER NO. T.227/57

CLIENT Department of Highways, Ontario.

BOREHOLE NO. BH.5 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Plan INCLINATION Vertical BEARING ———

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
	771.38			Zero	0.0m		
Firm grey brown sand, gravel and little clay. Probably FILL.	235.1m		● 1			25	Moist
				Free Water			
do			● 2			26	Moist
With some organic matter.	233.0m			7'-0"	2.1m		
Firm grey brown fine to coarse SAND with fine to medium generally subrounded GRAVEL.			● 3			26	Wet No dry strength.
	231.4m			12'-0"	3.7m		
Firm brown sandy SILT with some gravel and clay bands.			● 4			24	Moist Low to medium dry strength.
Dense grey brown fine to medium calcareous SAND.			● 5			39	Moist Low dry strength.
do	227.5m		● 6	25'-1"	7.6m	39 (7")	Wet Low dry strength.
			End of Bor.hole				

SCALE: 1" = 5'-0" ● DISTURBED SAMPLE ■ UNDISTURBED SAMPLE

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SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Anne Street Overpass, Barrie, Ontario. ORDER NO. T-227/57

CLIENT Department of Highways, Ontario.

BOREHOLE NO. BH.6 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Plan INCLINATION Vertical BEARING ———

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
	772.48			Zero	0.0m		
Firm grey sand and black organic matter. Probably FILL.	235.5m		1			12	Moist
Firm grey and iron-stained yellow sand, little clay, Probably FILL.			2	Free Water		29	Moist
Dense medium to coarse calcareous SAND and fine to medium generally subrounded GRAVEL.			3			39	Wet No dry strength.
	231.5m			13'-0"	4.0m		
Very stiff brown sandy silty calcareous CLAY with fine to medium subangular to subrounded gravel.			4			30	Moist High dry strength.
Firm grey brown fine to coarse SAND and fine to medium subangular to subrounded GRAVEL.			5			25	Wet No dry strength.
Dense grey brown fine to medium calcareous SAND with gene. ..lly subrounded gravel.	227.7m		6	25'-6"	7.8m	37	Moist Low dry strength.
				End of Borehole			

SCALE: 1" = 5'-0" • DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

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