



Foundation Investigation Report

Airport Road Connection Structure

QEW/Glendale Avenue Interchange Improvements

Niagara-on-the-Lake, Ontario

MTO GWP 2423-15-00

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AECOM

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by AECOM on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the detail design of the Airport Road connection structure for the QEW/Glendale Avenue interchange improvements in the Town of Niagara-on-the-Lake, Regional Municipality of Niagara (Assignment No. 2016-E-0029-002), located as shown on the attached Key Plan on Drawing 1.

This report addresses the foundation investigation carried out to support the design of the new Airport Road connection structure under Glendale Avenue. This report was developed based on the results from a 2018 investigation and laboratory testing.

The Terms of Reference for the foundation engineering services are outlined in MTO's Work Item Order No. 2016-E-0029-002, dated July 2017, which forms part of the Consultant's Assignment for the Central Region Large Value Retainer under Agreement No. 2016-E-0029-002.

2.0 SITE DESCRIPTION

The existing Glendale Avenue underpass and interchange is located east of the Garden City Skyway and west of the General Brock Parkway (Highway 405) - Queen Elizabeth Way (QEW) interchange in the Town of Niagara-on-the-Lake, Ontario. For the purposes of this report, QEW is assumed to be oriented in an east-west direction, and Glendale Avenue in a north-south direction. Commercial developments are located in the southwest and northwest quadrants of the interchange, Niagara College is located in the southeast quadrant of the interchange, and an undeveloped vegetated area present in the northeast quadrant of the interchange.

Prior to 2007, a three-span bridge supported on spread footings was present along the existing Glendale Avenue, to carry Glendale Avenue over a then-existing North Service Road, on a similar alignment to the proposed Airport Road connection structure. Based on the available information, the abutments for this former structure were founded at approximately Elevation 116.8 m, and the pier footings were founded at approximately Elevation 112.5 m. In 2007, the bridge superstructure was demolished, with the former bridge span infilled with earth fill material. Based on the demolition contract drawings provided by Niagara Region, it is understood that the former abutment and pier footings, abutment foreslopes and the former road structure were left in place. Information regarding this former bridge structure and its demolition is included in Appendix A.

The proposed new Airport Road connection from Glendale Avenue will implement a new S-W loop ramp in the northeast quadrant of the interchange. The ramp will be connected to Airport Road via a single-span structure that allows the ramp to pass under Glendale Avenue. The new connector road will be 9.25 m wide to carry two lanes of traffic. The existing ground surface at the proposed structure site varies from approximately Elevation 117 m to 118 m, and the approximately 4 m high Glendale Avenue embankment (with its grade at about Elevation 121.0 m to 121.5 m) is present at the western end of the proposed structure.

3.0 INVESTIGATION PROCEDURES

The field work for the Airport Road connection structure investigation was carried out between July 23 and August 24, 2018, and between September 17 and October 30, 2018. During this time a total of five boreholes (designated as Boreholes ARB-1 to ARB-4, and HF-1) were advanced within the footprint of the proposed Airport Road connection structure. The borehole locations are shown on Drawing 1.

Boreholes ARB-1 to ARB-4 and HF-1 were drilled using 152 mm outer diameter hollow-stem augers by a CME-55 track-mounted drill rig, supplied and operated by Geo-Environmental Drilling of Halton Hills, Ontario. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth using a 50 mm outer diameter split-spoon sampler driven with an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586)¹.

Borehole ARB-1 was advanced through the Glendale Avenue embankment to a depth of 4.0 m and encountered auger refusal. Boreholes ARB-2 to ARB-4 were advanced to depths of 29 m to 36.3 m below existing ground surface, including bedrock coring in Boreholes ARB-2 and ARB-3. Boreholes HF-1 was advanced to a depth of 16.5 m. Boreholes details are provided in the borehole and drillhole records in Appendix B.

The groundwater conditions in the open boreholes were observed during and immediately following the drilling operations. A standpipe piezometer was installed in Borehole ARB-4 to permit monitoring of the water level. The installed piezometer consists of a 50 mm diameter PVC pipe, with a 1.5 m slotted screen within a filter sand pack sealed within the clayey silt deposit about 2 m above the bottom of the borehole. The borehole and annulus surrounding the piezometer pipe above the filter sand pack were backfilled to near ground surface with bentonite pellets, and the upper 200 mm of the borehole was capped with cold patch asphalt to the roadway surface. Boreholes ARB-1 to ARB-3 and HF-1 were backfilled to ground surface with bentonite, and the upper 200 mm of Boreholes ARB-1 and ARB-2 were sealed to the roadway surface with cold patch asphalt upon completion, in accordance with Ontario Regulation 903, Wells (as amended).

The field work was monitored on a full-time basis by a member of Golder's technical staff who located the boreholes in the field, directed the sampling and in situ testing operations, logged the boreholes and examined the soil samples. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for further visual review and geotechnical laboratory testing on selected samples, consisting of natural moisture content, Atterberg limits and grain size distribution conducted in accordance with MTO and / or ASTM Standards as applicable.

The borehole locations and elevations were surveyed by Callon Dietz Surveying using survey equipment with a horizontal and vertical accuracy of 0.05 m. The locations given in the borehole records and shown on Drawing 1 are positioned relative to MTM NAD 83 (Zone 10) northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, including in geographic (latitude / longitude) coordinates, the ground surface elevations and borehole drilled depths are summarized below.

Borehole No.	Foundation Element	MTM NAD83		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing (m) (Latitude)	Easting (m) (Longitude)		
ARB-1	North Abutment	4,779,855.5 (43.158062)	332,139.8 (-79.163817)	121.0	4.6
ARB-2	South Abutment	4,779,841.8 (43.157938)	332,133.3 (-79.163898)	121.5	36.3
ARB-3	North Abutment	4,779,841.4 (43.157933)	332,172.2 (-79.163420)	117.7	33.2

¹ ASTM D1586 – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of Soils.

Borehole No.	Foundation Element	MTM NAD83		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing (m) (Latitude)	Easting (m) (Longitude)		
ARB-4	South Abutment	4,779,827.2 (43.157806)	332,176.8 (-79.163365)	117.1	29.0
HF-1	Centre	4,779,836.5 (43.157890)	332,159.9 (-79.163572)	116.5	16.5

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This section of the QEW lies within the physiographic region known as the Iroquois Plain, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984) 2 and *Urban Geology of Canadian Cities* (Menzies and Taylor, 1998) 3.

The Iroquois Plain extends around the western shores of Lake Ontario; on the south side of the lake, in the St. Catharines area, the Plain is located between the present Lake Ontario shorebluffs and the foot of the Niagara Escarpment. The Plain is comprised of the flat to undulating lakebed and beaches of the former glacial Lake Iroquois, which occupied this area during the last glacial recession.

The surficial soils in the Iroquois Plain are typically comprised of glaciolacustrine clays and silts. The surficial sands, silts and clays are underlain by an extensive till deposit; portions of the till are considered to be “water-lain” (that is, formed by sediment rain-out either from a floating ice margin or from iceberg dumping), resulting in a predominantly massive, matrix-supported structure, as well as relatively thin sand to silt stringers or interlayers. This extensive till deposit may be underlain by or interlayered with a lower glaciolacustrine clay deposit, although this glaciolacustrine layer is absent in some portions of the Iroquois Plain in the St. Catharines area. Finally, the till and/or glaciolacustrine layer may be underlain by a lower till unit, that typically has increasing gravel content with proximity to the underlying bedrock (Menzies and Taylor, 1998).

The overburden soils are underlain by red shale bedrock of the Queenston Formation. This shale formation contains siltstone interlayers as well as “occasional patches of gypsum” (Menzies and Taylor, 1998).

4.2 General Overview of Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes of the current investigation including piezometer installation details and water level readings, and the results of the in situ and laboratory tests are provided on the borehole and drillhole records in Appendix B. The results of the in-situ field tests (i.e., SPT “N”-values) as presented on the borehole records and in Section 4 are uncorrected. The Standard Penetration Test “N”-values from current investigation are based on use of an automatic hammer and the values are reported with

² Chapman, L.J. and Putnam, D.F. 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P. 2715, Scale 1:600,000.

³ Menzies, J., and Taylor, E.M., 1998. *Urban Geology of St. Catharines-Niagara Falls, Region Niagara*. In *Urban Geology of Canadian Cities*, Geological Association of Canada Special Paper 42, Ed. P.F. Karrow and O.L. White.

no adjustment in this report, although it is recognized that SPT “N” values obtained using an automatic hammer are frequently lower than those obtained using a manual hammer (CFEM, 2006)⁴. The results of the geotechnical laboratory testing on soil samples are also presented on the laboratory test figures in Appendix C. The results of the analytical testing are provided in Appendix D.

The stratigraphic boundaries shown on the borehole records and on the stratigraphic profile on Drawings 1 and 2 are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Variation in the stratigraphic boundaries between and beyond boreholes will exist and is to be expected; however, the factual data presented on the borehole records governs any interpretation of the site conditions.

In general, the subsurface soils encountered consist of surficial layers of topsoil and asphalt, underlain by non-cohesive and cohesive fill material; one of the boreholes encountered the substructure that was left in place from the former North Service Road bridge on Glendale Avenue, which was demolished in 2007. The fill materials are underlain by a silty clay to clay deposit (consisting of a very stiff to hard crust and becoming firm to stiff with depth) which is in turn underlain by deposits of generally hard clayey silt, hard clayey silt to silty clay till, and/or dense to very dense sand and silt, overlying shale bedrock.

4.2.1 Topsoil

A 50 mm to 102 mm thick layer of topsoil was encountered from ground surface in Boreholes ARB-3, ARB-4 and HF-1. The topsoil was classified based on visual and textural observations; organic content testing was not carried out during the current investigations.

4.2.2 Asphalt

Boreholes ARB-1 and ARB-2 were advanced through the Glendale Avenue embankment and encountered between 120 mm and 150 mm of asphalt at ground surface.

4.2.3 Fill (Including Former Structure Foundations)

Fill was encountered underlying the topsoil or asphalt at all borehole locations advanced for the proposed structure. Borehole ARB-1 terminated within the fill at a depth of 4.6 m due to auger refusal on a concrete obstruction; the last sample in the borehole also contained concrete fragments. After review of historic documentation, it was determined that Borehole ARB-1 had been advanced along the former North Service Road alignment, and encountered the substructure of a former bridge that was demolished under a 2007 Niagara Region contract. Based on the demolition drawings, the abutment and pier footings and abutment slope were left in place when this former bridge was decommissioned, and the bridge span infilled with earth fill. Information regarding this former bridge structure and its demolition is contained in Appendix A.

In general, a thick layer of non-cohesive fill is present below the asphalt in Borehole ARB-2 and below the cohesive fill in Borehole ARB-1 on the east abutment of Airport Road. This fill ranges from 1.2 m to 3.6 m, and consists of sand and gravel, some silt and trace clay. An 800 mm thick layer of non-cohesive fill was also encountered at a depth of 5.6 m in Borehole ARB-2. The SPT “N”-values measured within these non-cohesive fill layers range from 5 blows to 65 blows per 0.3 m of penetration, indicating a variable, loose to very dense relative density.

⁴ Canadian Geotechnical Society, 2006. *Canadian Foundation Engineering Manual*, 4th Edition.

The majority of the fill at the site is cohesive, generally consisting of silty clay, but also varying to clay to clayey silt, containing trace to some sand and gravel, along with trace rootlets. The cohesive fill layer is approximately 0.9 m to 4.2 m in thickness, and extends to approximately Elevation 115.9 m to 114.1 m in the boreholes. The SPT “N”-values measured within the cohesive fill range from 6 blows to 29 blows per 0.3 m of penetration, indicating a firm to very stiff consistency.

The results of grain size distribution tests completed on one sample of the cohesive fill and one sample of the non-cohesive fill are presented on Figure C-1 in Appendix C. Atterberg limits testing was carried out on three samples of the cohesive fill and measured liquid limits about 39 to 50 per cent, plastic limits ranging from about 19 to 22 per cent, and plasticity indices of about 20 to 28 per cent, indicating that the fines portion of the fill has intermediate plasticity as presented on the plasticity chart on Figure C-2 in Appendix C. The water content measured in the fill materials ranges from 19 per cent to 26 per cent, and field observations indicate moist to wet conditions.

4.2.4 Silty Clay to Clay

An extensive cohesive deposit consisting of silty clay to clay was encountered below the fill in Boreholes ARB-2, ARB-3, ARB-4 and HF-1. The surface of this deposit was encountered at depths ranging from about 1.4 m to 6.4 m (between about Elevation 115.1 m and 114.1 m). The thickness of the deposit ranges from about 13.7 m to 17.0 m where it was fully penetrated, and the deposit extends to depths between about 16.5 m and 20.1 m (between Elevation 101.4 m and 97.6 m) below existing ground surface.

The deposit consists of a stiffer upper “crust” zone, and becomes less stiff with depth, as follows:

- The SPT “N”-values recorded within the cohesive upper “crust” of this deposit, above approximately Elevation 108 m, range from 5 blows to 30 blows per 0.3 m of penetration but are generally between about 10 blows and 15 blows per 0.3 m of penetration, indicating a firm to hard consistency. In situ vane tests carried out within this upper portion of the deposit measured undrained shear strengths greater than 96 kPa. The in situ field vane test results together with the SPT “N”-values indicate that the upper crust has a predominantly very stiff consistency.
- The SPT “N”-values measured within the lower portion of the deposit generally range from 0 blows (weight of hammer) to 12 blows per 0.3 m of penetration, suggesting a soft to stiff consistency. In situ vane tests carried out within the lower portion of this deposit measured undrained shear strengths generally ranging from about 24 kPa to greater than 96 kPa, but typically greater than 80 kPa. The sensitivity generally ranges from about 1.3 to 3.7. The in situ field vane tests results together with the SPT “N”-values indicate that the lower portion of the silty clay to clay deposit has a predominantly stiff consistency.

The results of grain size distribution testing completed on thirteen samples are shown on Figures C-3A and C-3B in Appendix C. The deposit generally contains trace to some sand and trace to some gravel with trace sand seams; a varved structure was observed within the lower portion of the deposit in some of the boreholes.

Atterberg limits testing carried out on thirteen samples of the cohesive deposit measured liquid limits ranging from about 28 per cent to about 55 per cent, plastic limits ranging from about 16 per cent to about 23 per cent, and plasticity indices ranging from about 11 per cent to about 31 per cent. These results indicate that the deposit predominantly consists of silty clay to clay of intermediate to high plasticity as presented on the plasticity charts on Figures C-4A and C-4B in Appendix C; however, as shown on these figures, two tested samples are classified as

clayey silt of low plasticity. The natural water contents measured on samples of this deposit range from about 18 per cent to 44 per cent.

Laboratory consolidation tests were carried out on three samples of the cohesive deposit obtained from thin-walled Shelby tubes in Borehole GAU-2, GAU-5 and GAU-6, which were drilled as part of the 2018 investigations for the Glendale Avenue underpass replacement located immediately south of this structure. The results from these three tests have been considered in selecting the design parameters for this cohesive deposit at the Airport Road connection structure.

A pre-consolidation stress ranging between about 309 kPa and 344 kPa was estimated from the void ratio versus logarithmic pressure plots and from the total work versus pressure plots. Unit weights ranging between about 18.6 kN/m³ and 19.6 kN/m³ and specific gravities between about 2.72 and 2.78 were measured on the consolidation test samples. The over-consolidation ratio (OCR) ranges from 1.2 to 1.7. Details of the test results are shown on Figures C-5A-D, C-6A-D and C-7A-D in Appendix C, and the test results are summarized below.

Borehole and Sample No.	Sample Depth / Elevation	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	C_c	C_r	e_o	c_v^1 (cm ² /s)
GAU-2 Sample 16	18.3 m / 104.1 m	261	309	48	1.19	0.42	0.01	0.83	1.4×10^{-3} 1.5×10^{-3}
GAU-5 Sample 13	15.2 m / 101.6 m	235	325	90	1.38	0.28	0.02	0.68	1.8×10^{-3} 2.9×10^{-3}
GAU-6 Sample 10	10.7 m / 105.6 m	199.8	343.9	144	1.72	0.34	0.09	0.84	3.7×10^{-3} 3.1×10^{-3}

Notes:

- Two coefficients of consolidation (c_v) have been presented for each sample. The first value (top line) is based on a stress range below the effective overburden stress (i.e., within the over consolidated stress range). The second value (bottom line) is based on a stress range between the effective overburden stress and the final stress due to 8 m high embankment and a 4.5 m high embankment.

σ_{vo}' is the in situ vertical effective overburden stress in kPa

σ_p' is the pre-consolidation stress in kPa

OCR is the over-consolidation ratio

e_o is the initial void ratio

C_c is the compression index

C_r is the recompression index

c_v is the coefficient of consolidation in cm²/s

4.2.5 Clayey Silt

A cohesive deposit comprised of clayey silt to sandy clayey silt was encountered underlying the silty clay to clay deposit in Boreholes ARB-2 to ARB-4. The cohesive deposit is generally varved (typically comprised of silty clay with thin clayey silt and silt laminae), but also includes homogenous zones of silty clay, and in Borehole ARB-3 this deposit has a till-like appearance. The surface of this cohesive deposit was encountered at depths between about 17.1 m and 20.1 m below ground surface (Elevations 101.4 m to 97.6 m). This deposit is approximately 2.9 m to 6.0 m thick as encountered in the boreholes, extending to about Elevation 95.8 m to 94.0 m.

The SPT "N"-values measured within the upper portion of this clayey silt deposit in Boreholes ARB-2 and ARB-4 are 2 blows and 12 blows per 0.3 m of penetration, indicating a soft to stiff consistency; in situ vane tests carried out immediately below the 2-blow sample measured undrained shear strengths of about 75 kPa to 85 kPa and sensitivity values of about 1.6 and 2.0, indicating that this upper portion of the deposit is generally stiff. In the

remainder of the deposit, the SPT “N” values range from 70 blows to greater than 100 blows (e.g., 50 blows per 0.13 m of penetration, and 50 blows per 0.08 m of penetration), indicating a hard consistency.

The results of grain size distribution tests completed on three samples of the cohesive deposit are shown on Figure C-8 in Appendix C.

Atterberg limits tests were carried out on three samples of this cohesive deposit and measured liquid limits ranging from about 21 per cent to 31 per cent, plastic limits ranging from about 13 per cent to 18 per cent and plasticity indices ranging from about 8 per cent to 14 per cent. The results of the Atterberg limits tests are shown on the plasticity charts on Figure C-9 in Appendix C, and indicate that the cohesive deposit can be classified as clayey silt of low plasticity.

4.2.6 Boulder

A granite boulder was encountered in Borehole ARB-2 near the base of the clayey silt deposit, above the silt and sand to silt deposit. The boulder was penetrated by coring for 0.2 m. Although not encountered in other boreholes, cobbles and boulders should be anticipated in the glacially-derived soils at this site.

4.2.7 Silt and Sand to Silt

A silt and sand to silt deposit was encountered underlying the clayey silt deposit in Boreholes ARB-2 to ARB-4. This deposit varies in composition from silt and sand, to sandy silt, to silt containing trace to some sand, and trace to some clay. The surface of this deposit was encountered at depths ranging from about 23.0 m to 25.7 m (between Elevations 95.6 m and 94.0 m) and the deposit extends to depths of about 28.9 m to 32.6 m (approximately Elevation 88.8 m to 88.9 m). The deposit thickness varies from about 5.7 m to 5.9 m.

The SPT “N”-values measured within this deposit range from 54 blows to greater than 100 blows per 0.3 m of penetration, indicating a very dense compactness condition.

The results of grain size distribution testing carried out on three samples of this deposit are shown on Figure C-10 in Appendix C. Atterberg limits testing was carried out on one sample of the silt deposit and measured a liquid limit of about 21 per cent, plastic limit about 18 per cent, and a plasticity index about 3 per cent. The results of the Atterberg limits test are shown on a plasticity chart on Figure C-11 in Appendix C, and indicate that the silt deposit can be classified as having slight plasticity. The natural water content measured in samples of this deposit ranges from about 9 to 20 per cent.

4.2.8 Lower Clayey Silt Till/Residual Soil

A layer of clayey silt till/residual soil was encountered below the silt deposit and immediately overlying shale bedrock in Borehole ARB-3. The surface of this layer was encountered at a depth of 28.9 m (Elevation 88.8 m), and the layer is about 1.1 m thick. The deposit is described as containing some sand and some shale fragments.

One SPT “N”-value of 50 blows for 0.05 m of penetration was measured within this layer, suggesting a hard consistency.

4.2.9 Shale Bedrock

Bedrock was encountered in Boreholes ARB-2 and ARB-3, below the silt and sand to silt or clayey silt residual soil deposits, respectively. The depth to bedrock below ground surface and the corresponding bedrock surface elevations at each borehole location (from north to south) are summarized below.

Borehole No.	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Comments
ARB-2	32.6	88.9	Bedrock cored for 3.7 m
ARB-3	30.0	87.7	Bedrock cored for 3.2 m

In general, the bedrock surface as encountered in the boreholes advanced in the area of the proposed Airport Road connection structure varies from about Elevation 87.7 m to 88.9 m.

Based on a review of the bedrock core samples, the bedrock consists of shale of the Queenston Formation. In general, the bedrock samples are described as moderately weathered to slightly weathered to fresh, very thin to medium bedded, fine grained, faintly to non-porous, weak, grey, with very thin to thin medium strong limestone interbeds at varying intervals, as presented on the drillhole records in Appendix B. Bedrock core photographs are included in Appendix C.

Typically, the upper portion of the bedrock surface is weathered and transitions to slightly weathered to fresh at depth. The degree of weathering of the bedrock samples (e.g. slightly weathered –W2), and the strength classification of the intact rock mass based on field identification (e.g. weak – R2) are described in accordance with the International Society for Rock Mechanics (ISRM3) standard classification system.

The Rock Quality Designation (RQD) measured on the core samples ranges from 52 per cent to 100 per cent, with the lowest RQD of 52 per cent measured in the first core run below the bedrock surface in Borehole ARB-2. The RQD values indicate a rock mass of fair to excellent quality, as classified per Table 3.10 of CFEM (2006)⁴. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered range between 59 per cent and 100 per cent and between 52 per cent and 100 per cent, respectively.

Uniaxial compression (UC) tests (ASTM D7012) were carried out on selected core samples from boreholes advanced at the Glendale Avenue underpass immediately to the south of the Airport Road connector structure location. The uniaxial compressive strength (UCS) and bulk density of the intact samples are summarized below, and the details are presented in the Rock Laboratory Test Result report from Geomechanica in Appendix C.

Borehole Number	Sample Depth Interval (m)	Sample Elevation Interval (m)	Uniaxial Compressive Strength (UCS) (MPa)	Bulk Density (g/cm ³)
GAU-3 (Run #2)	32.0 – 32.2	87.1 to 86.8	13.7	2.66
GAU-5 (Run #2)	29.6 – 29.8	87.2 to 87.0	25.7	2.66
GAU-7 (Run #3)	32.6 – 32.8	83.5 to 83.3	24.5	2.56

Based on the laboratory UCS tests, in accordance with Table 3.5 in CFEM (2006)⁴, the shale bedrock is generally classified as weak (R2, 5 MPa < UCS < 25 MPa). This bedrock formation contains moderately strong interlayers of limestone/dolostone, and such conditions should be expected even where such interlayers have not been specifically encountered in the boreholes.

4.3 Groundwater Conditions

The groundwater levels in the open boreholes were measured upon completion of drilling operations; these measurements are shown on the borehole records in Appendix B, but do not represent the stabilized groundwater level at the site. A piezometer was installed in Borehole ARB-4, and the measured groundwater level is summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Groundwater (m)	Groundwater Elevation (m)	Date
ARB-4	117.1	14.3	102.8	25-Oct-18
		9.3	107.8	26-Nov-18
		9.1	108.9	07-May-19

This measured groundwater level at approximately Elevation 109 m is associated with the lower silt and sand to silt deposit. Based on piezometers installed at the Glendale Avenue underpass site immediately to the south, the groundwater table within the silty clay to clay deposit was measured to be approximately Elevation 111 m to 112 m. The groundwater level will be subject to seasonal fluctuations and should be expected to be higher during the spring season or during and following periods of heavy precipitation.

4.4 Analytical Testing Results

Two selected samples from Boreholes ARB-2 and ARB-3 were assessed for potential corrosivity of the soil from ; this data has been supplemented with testing results on three selected samples from boreholes at the Glendale Avenue underpass site immediately to the south. Detailed analytical test results are included in Appendix D and the test results are summarized below:

Borehole Number / Sample Number	pH	Resistivity (ohm-cm)	Electrical Conductivity ($\mu\text{mho/cm}$)	Chloride ($\mu\text{g/g}$)	Soluble Sulphates ($\mu\text{g/g}$)
GAU-2 / 11	7.82	390	2570	51	3400
GAU-5 / 6	7.97	460	2160	120	2600
GAU-6 / 11	7.99	390	2150	49	2900
ARB-2 / 5	7.78	1600	643	77	400
ARB-3 / 6	8.03	560	1790	22	2800

5.0 CLOSURE

This Foundation Investigation Report was prepared by Ms. Manisha Ahuja, P.Eng., P.E., a geotechnical engineer with Golder. Ms. Lisa Coyne, P.Eng., a Principal and MTO Foundations Designated Contact of Golder, conducted an independent technical and quality control review of this report.

Golder Associates Ltd.



Manisha Ahuja, P.Eng., P.E.
Geotechnical Engineer




Lisa Coyne, P.Eng.
Principal, MTO Designated Foundations Contact

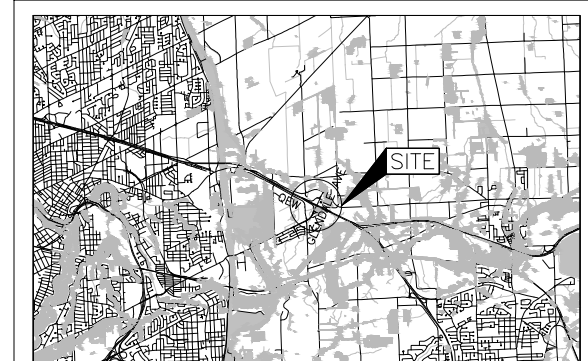
MA/LCC/rb

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[https://golderassociates.sharepoint.com/sites/15994g/6. deliverables/wo 002 - glendale interchange/foundations/4. airport rd/3. final/1671430 wo2 fidr 2019-05-15 airport rd connection structure.docx](https://golderassociates.sharepoint.com/sites/15994g/6.%20deliverables/wo%20002%20-%20glendale%20interchange/foundations/4.%20airport%20rd/3.%20final/1671430%20wo2%20fidr%202019-05-15%20airport%20rd%20connection%20structure.docx)



QEW/GLENDALE AVENUE INTERCHANGE IMPROVEMENTS
AIRPORT ROAD CONNECTION STRUCTURE
BOREHOLE LOCATION AND SOIL
STRATA








KEY PLAN
SCALE



2 0 2 4 km

LEGEND

- | | |
|---|--|
|  | Borehole — Current Investigation |
|  | Seal |
|  | Piezometer |
| N | Standard Penetration Test Value |
| 16 | Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow) |
| R | Refusal |
| 100% | Rock Quality Designation (RQD) |
|  | WL in piezometer, measured on May 7, 2019 |
|  | WL upon completion of drilling |

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
ARB-1	121.0	4779855.5	332139.8
ARB-2	121.5	4779841.8	332133.3
ARB-3	117.7	4779841.4	332172.2
ARB-4	117.1	4779827.2	332176.8
HF-1	116.5	4779836.5	332159.9

NOTES

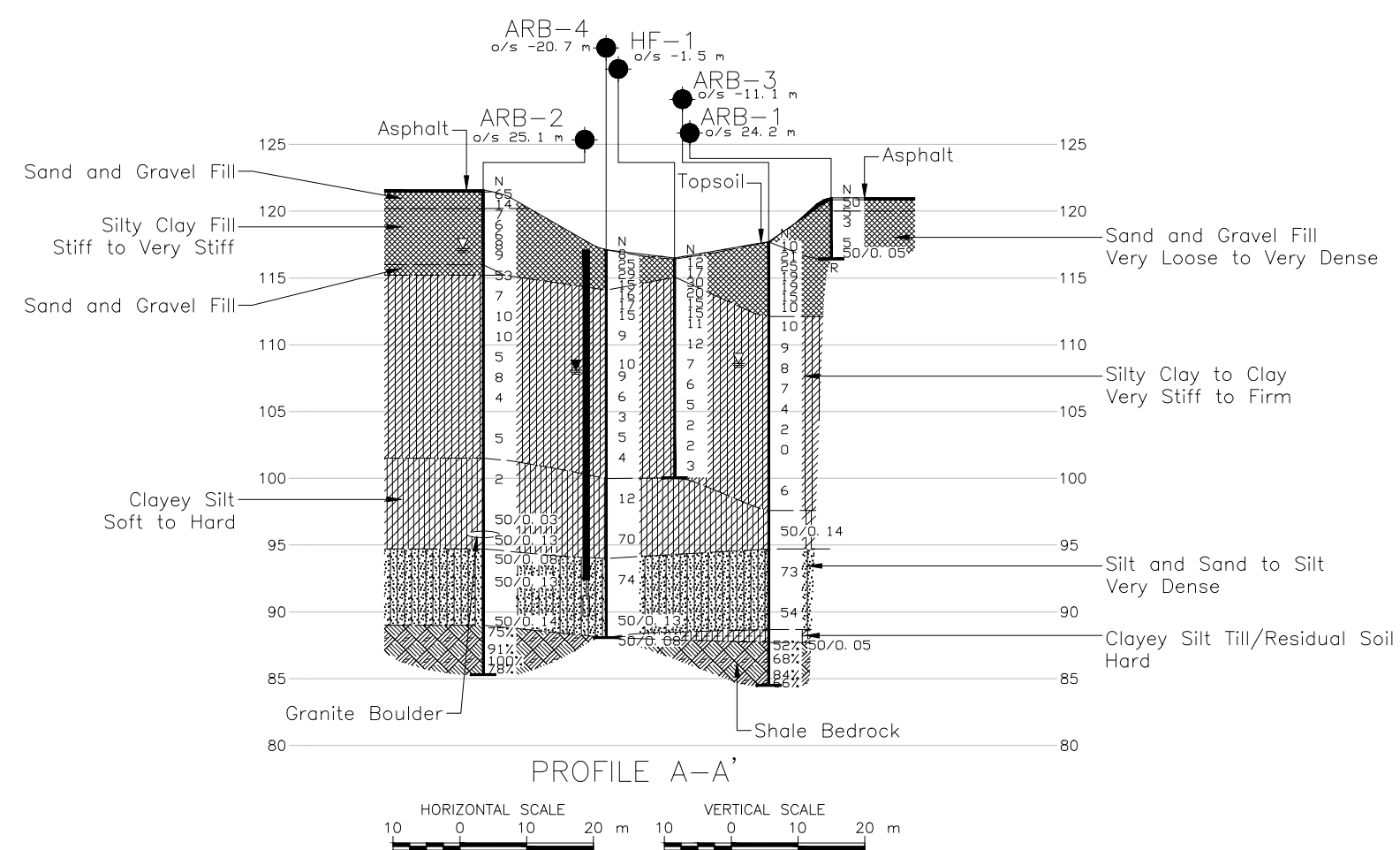
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

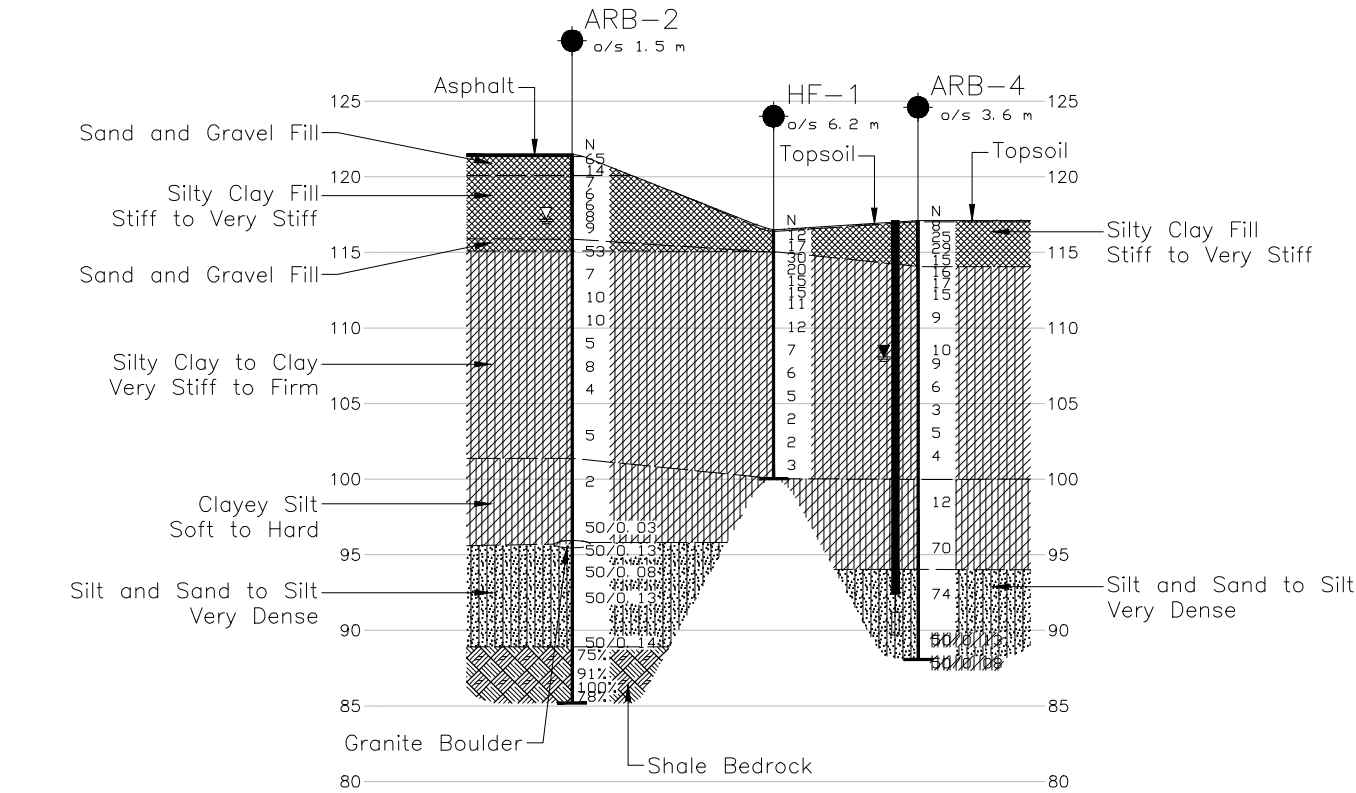
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

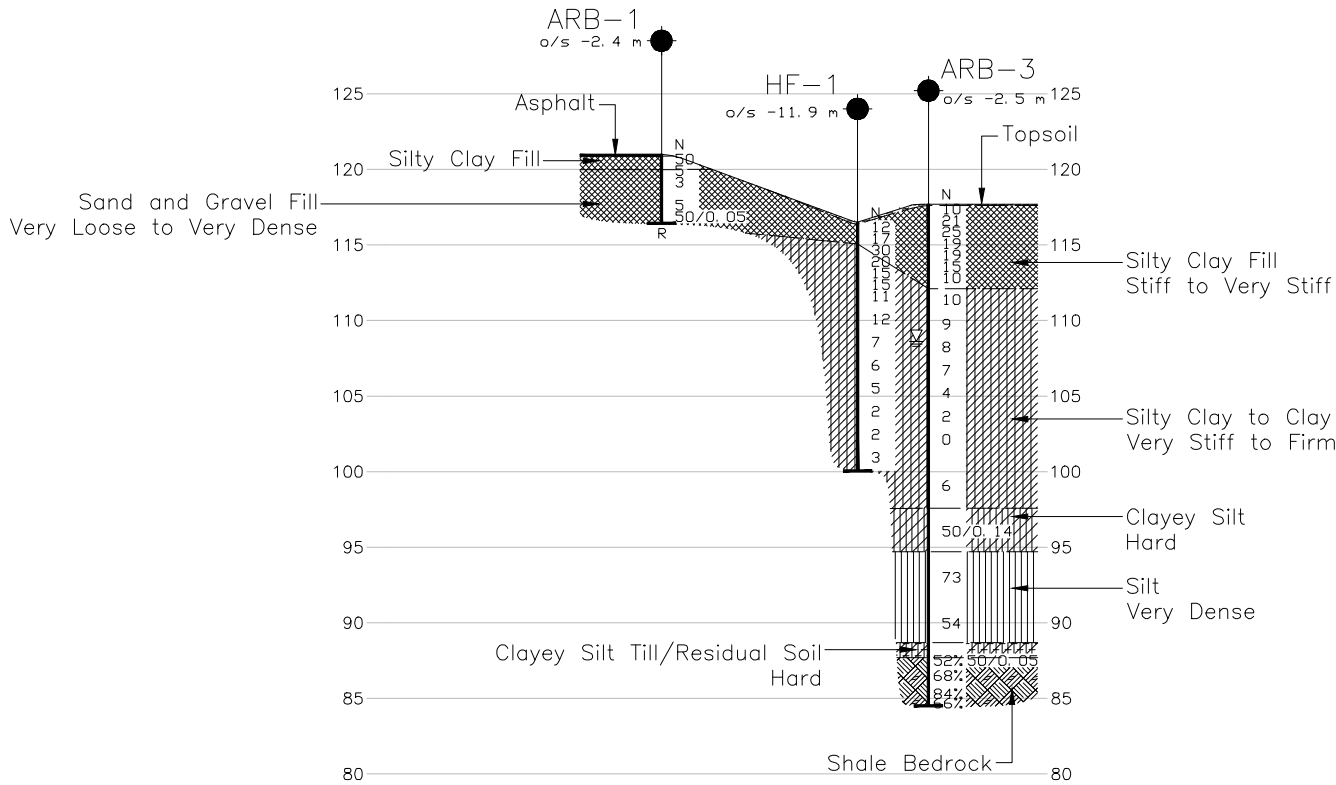
Base plans provided in digital format by Aecom, drawing file nos. X_Base.dwg, X_Property.dwg, York Roundabout_1 Lane.dwg, Diverging Diamond.dwg and Diverging Diamond with Airport Rd connection.dwg, received October 23, 2018.

NO.		DATE		BY		REVISION	
Geocres No. 30M3-310							
HWY. QEW				PROJECT NO. 1671430		DIST.	
SUBM'D. NK		CHKD. MA		DATE: 05/10/2019		SITE:	
DRAWN: DD		CHKD. MA		APPD. LCC		DWG. 1	

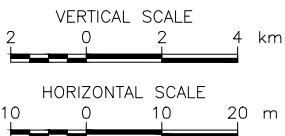




CROSS SECTION B-B'
SOUTH ABUTMENT



CROSS SECTION C-C'
NORTH ABUTMENT

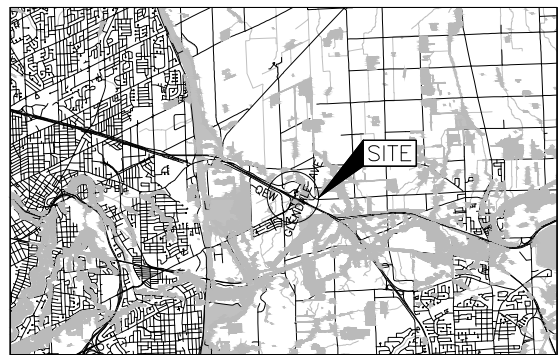


METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No.2423-15-00

QEW/GLENDALE AVENUE INTERCHANGE IMPROVEMENTS
AIRPORT ROAD CONNECTION STRUCTURE

SHEET



KEY PLAN
SCALE
2 0 2 4 km

LEGEND

- Borehole - Current Investigation
- ⊞ Seal
- ⊞ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R Refusal
- 100% Rock Quality Designation (RQD)
- ≡ WL in piezometer, measured on May 7, 2019
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BOREHOLE CO-ORDINATES			
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HF-1	116.5	4779836.5	332159.9

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

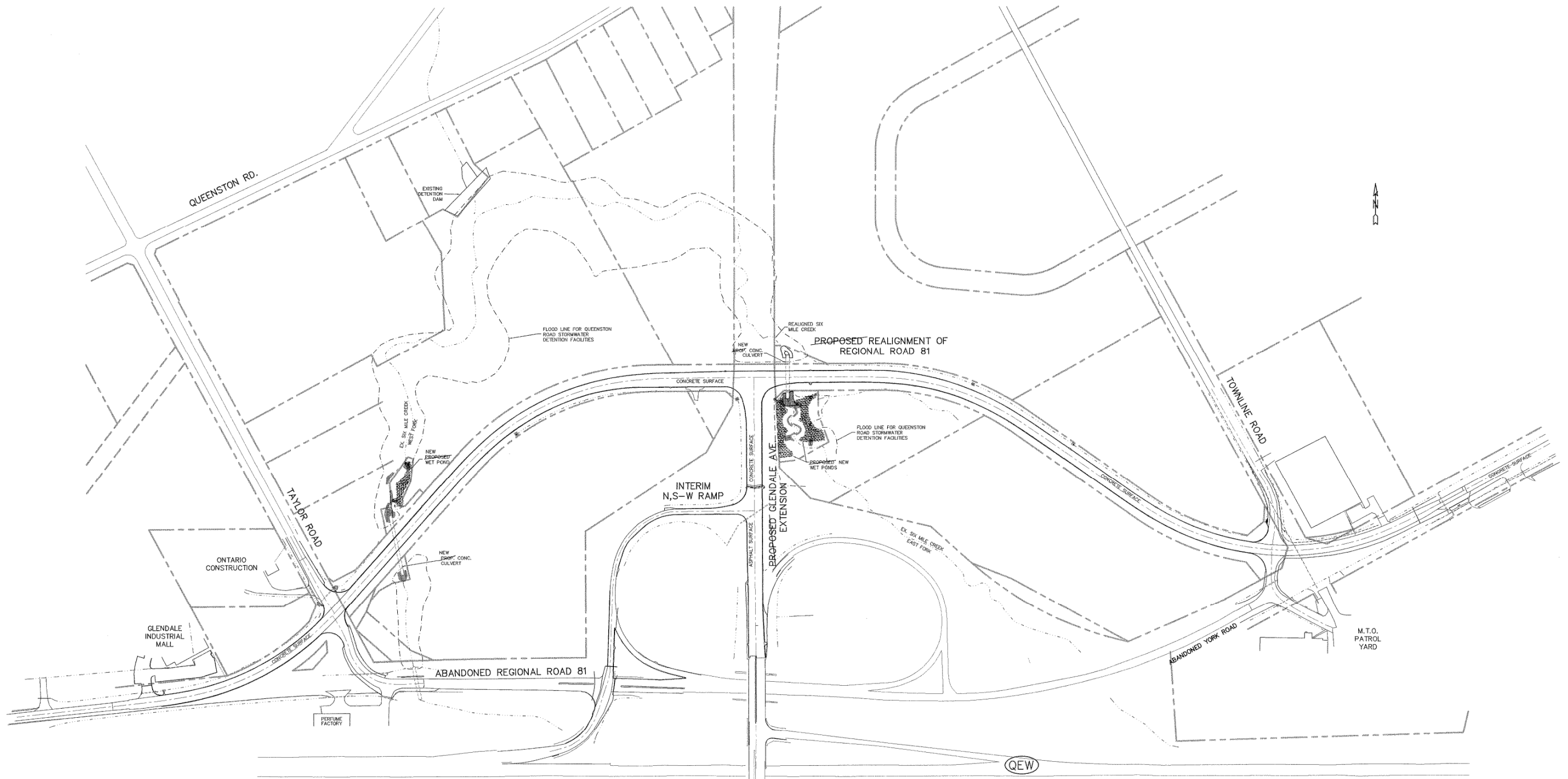
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NO.	DATE	BY	REVISION
Geocres No. 30M3-310			
HWY.	QEW	PROJECT NO.	1671430
SUBM'D.	NK	CHKD.	MA
DRAWN:	SW	CHKD.	MA
DATE:	05/10/2019	APPD.	LCC
SITE:		DWG.	2

APPENDIX A

Former Structure Information



NOTE:
 THE INFORMATION ON THIS CONSTRUCTION DRAWING IS DERIVED FROM LIMITED SPOT CHECKS MADE DURING THE CONSTRUCTION REVIEW PROCESS AND IN SOME INSTANCES FROM INFORMATION PROVIDED BY THE CONTRACTOR OR OTHERS. THEREFORE, MPS REINDERS NIAGARA DOES NOT ACCEPT ANY RESPONSIBILITY FOR THE COMPLETENESS OF THE INFORMATION SHOWN ON THIS DRAWING NOR FOR THE WAY IN WHICH THIS INFORMATION IS USED BY OTHERS. THOSE USING THIS DRAWING SHALL SATISFY THEMSELVES REGARDING THE ACCURACY OF THE SAME AND SHALL REPORT ANY CONFLICTING INFORMATION TO MPS REINDERS NIAGARA INC. IMMEDIATELY.

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C:\6875\6875-g2_48.dwg Mon Oct 26 16:24:12 1998

NO.	REVISION	DATE	INIT.
4	CONSTRUCTION RECORD REVISION	15 JAN 96	DAA
3	FLOOD LINE EXTENDED	29 MAY 95	DAA
2	ISSUED FOR CONSTRUCTION	28 MAR 95	DAA
1	ISSUED FOR TENDER	23 SEP 94	DAA
0	ISSUED FOR APPROVAL	30 JUN 94	JDT

drawn by:
J.D.T.
 design by:
H.E.K.
 approved by:
P.A.M.
 date:
SEP 94

MPS Reinders Niagara Inc.
 Architects, Engineers, & Planners
 phone: (905) 984-8676
 fax: (905) 682-5896

drawing title
**GENERAL
 ARRANGEMENT
 PLAN**

PUBLIC WORKS DEPARTMENT

REALIGNMENT
 OF
YORK ROAD
 (Regional Road 81)
 NIAGARA-ON-THE-LAKE

scale 1:2000	revision # 4
drawing no. 6875-G2	contract no. RN. 94-21

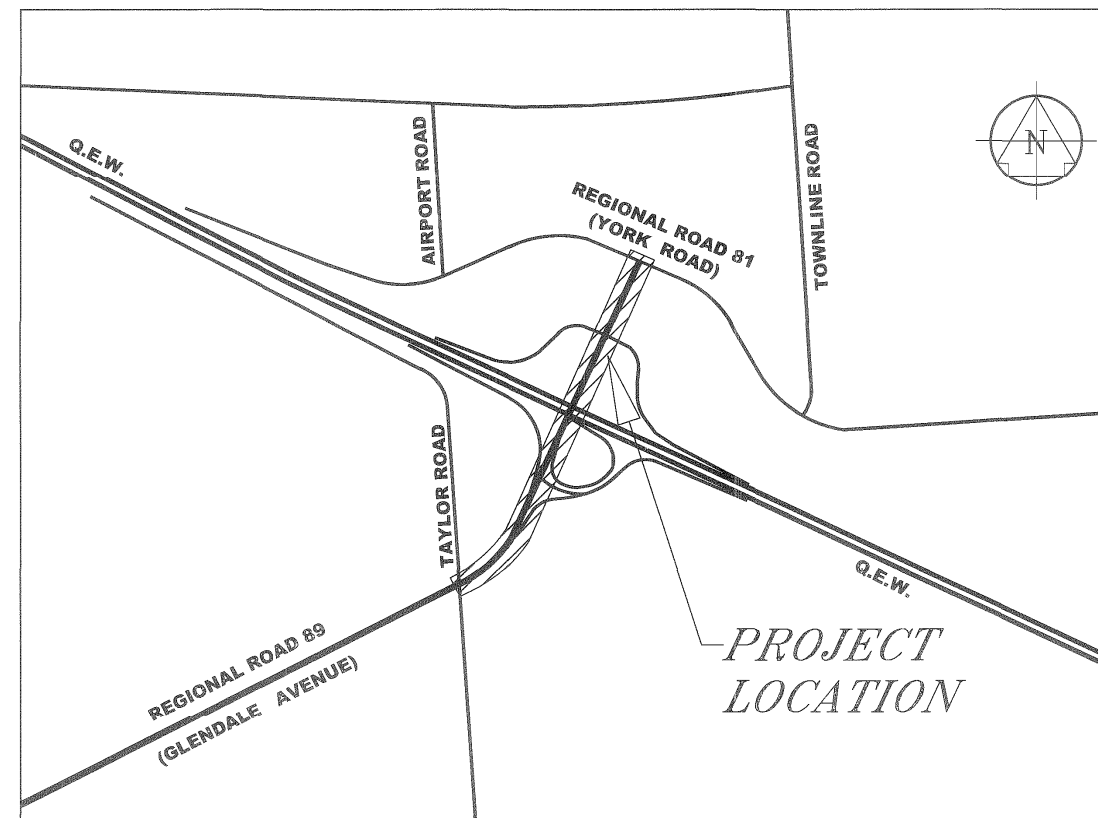
1522



**The Regional Municipality of Niagara
Public Works Department**

**GLENDALE AVENUE (REGIONAL ROAD 89) BRIDGE DEMOLITION,
ROAD AND SIDEWALK CONSTRUCTION
from YORK ROAD (REGIONAL ROAD 81)
to TAYLOR ROAD
in the Town of NIAGARA-ON-THE-LAKE**

**IAN NEVILLE, M.P.A., P.ENG.
DIRECTOR OF PUBLIC WORKS**



KEY PLAN - (Not to Scale)

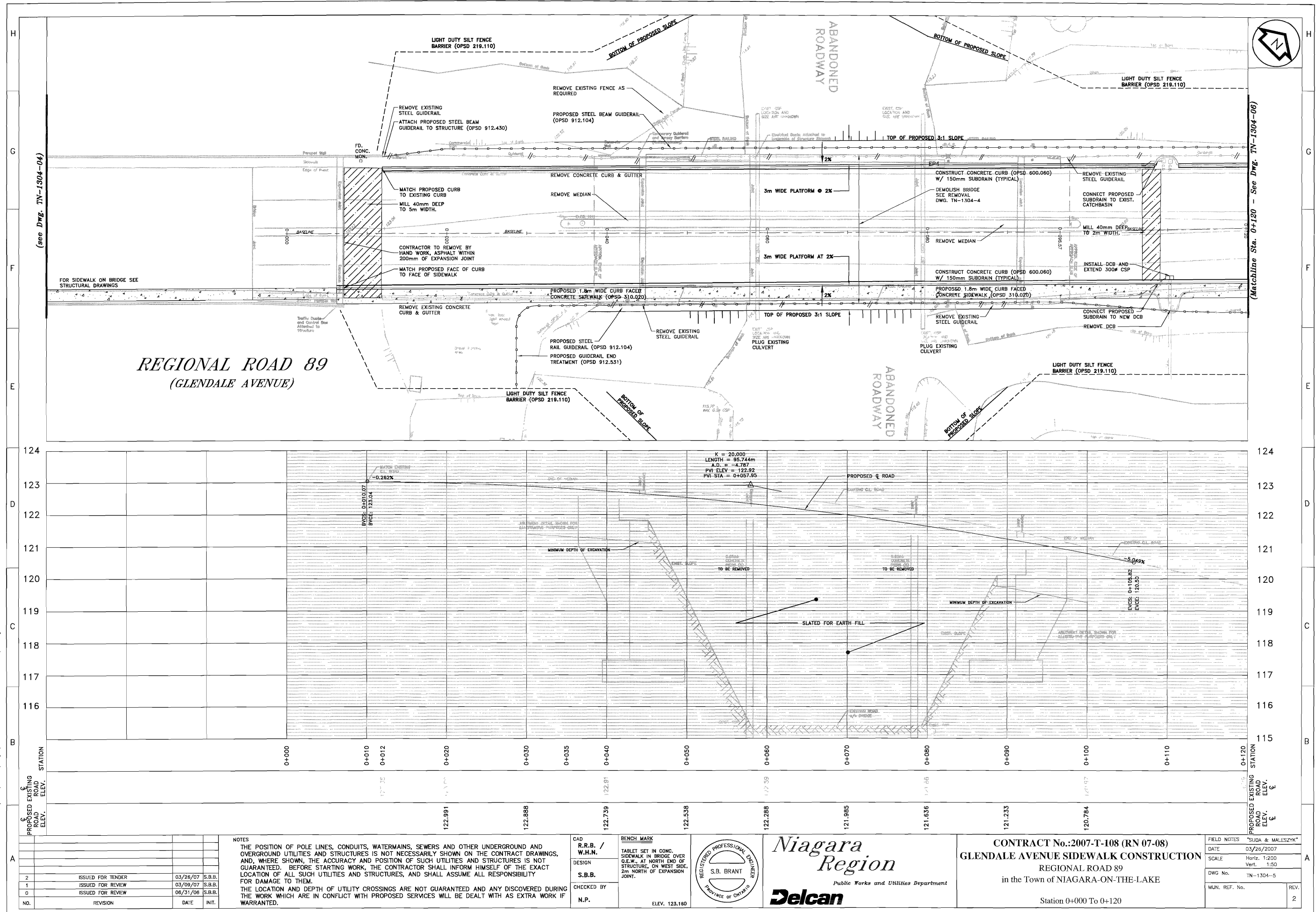
**PETER PARTINGTON
REGIONAL CHAIR**

Delcan

**CONTRACT NO.: 2007-T-108
(RN 07-08)**

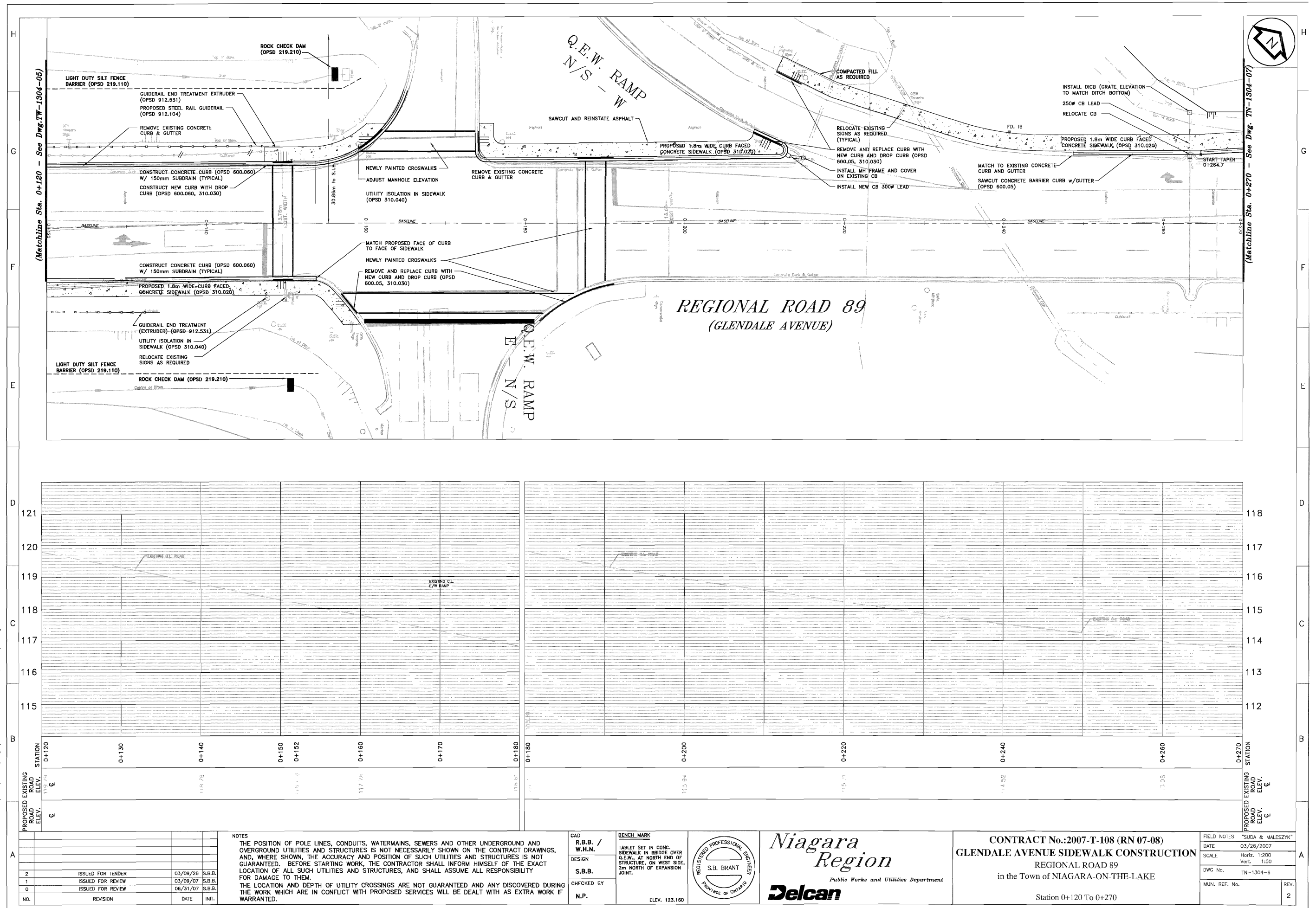
ISSUED FOR TENDER
MARCH 26, 2007

CONTRACT No.: RN. 2007-T-108 (RN 07-08)
GLENDALE AVENUE SIDEWALK CONSTRUCTION
REGIONAL ROAD 89
in the Town of NIAGARA-ON-THE-LAKE

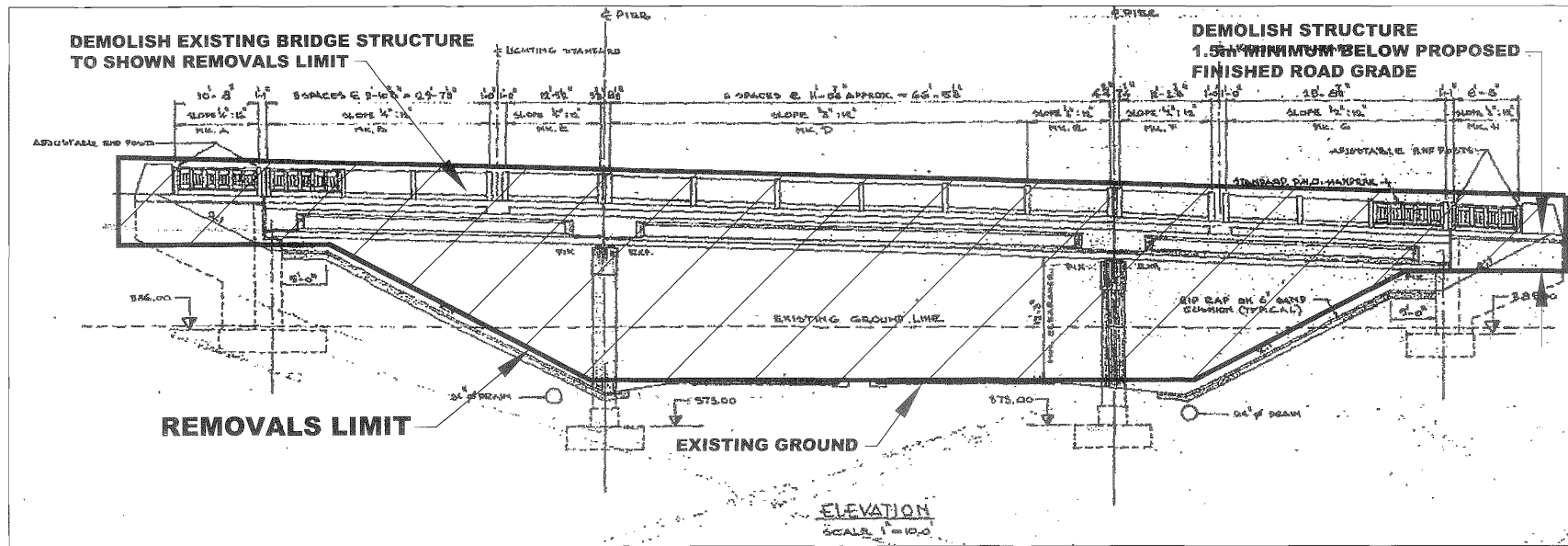
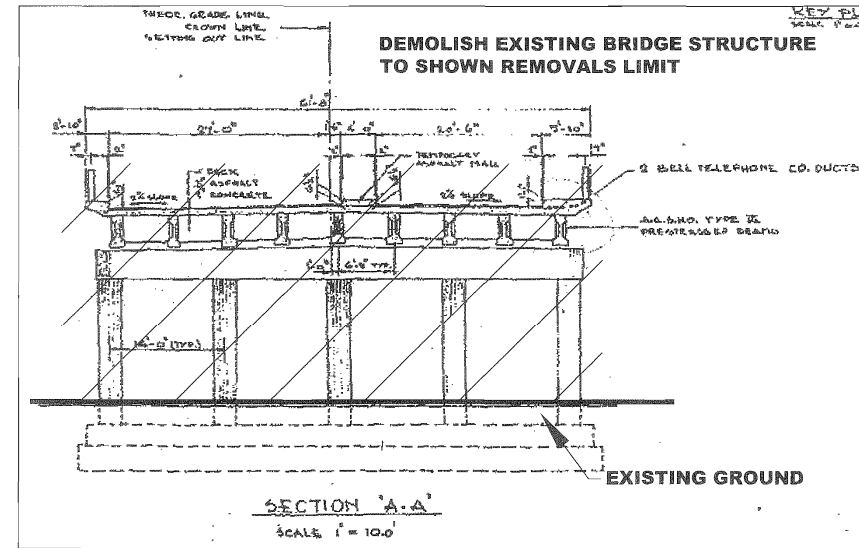
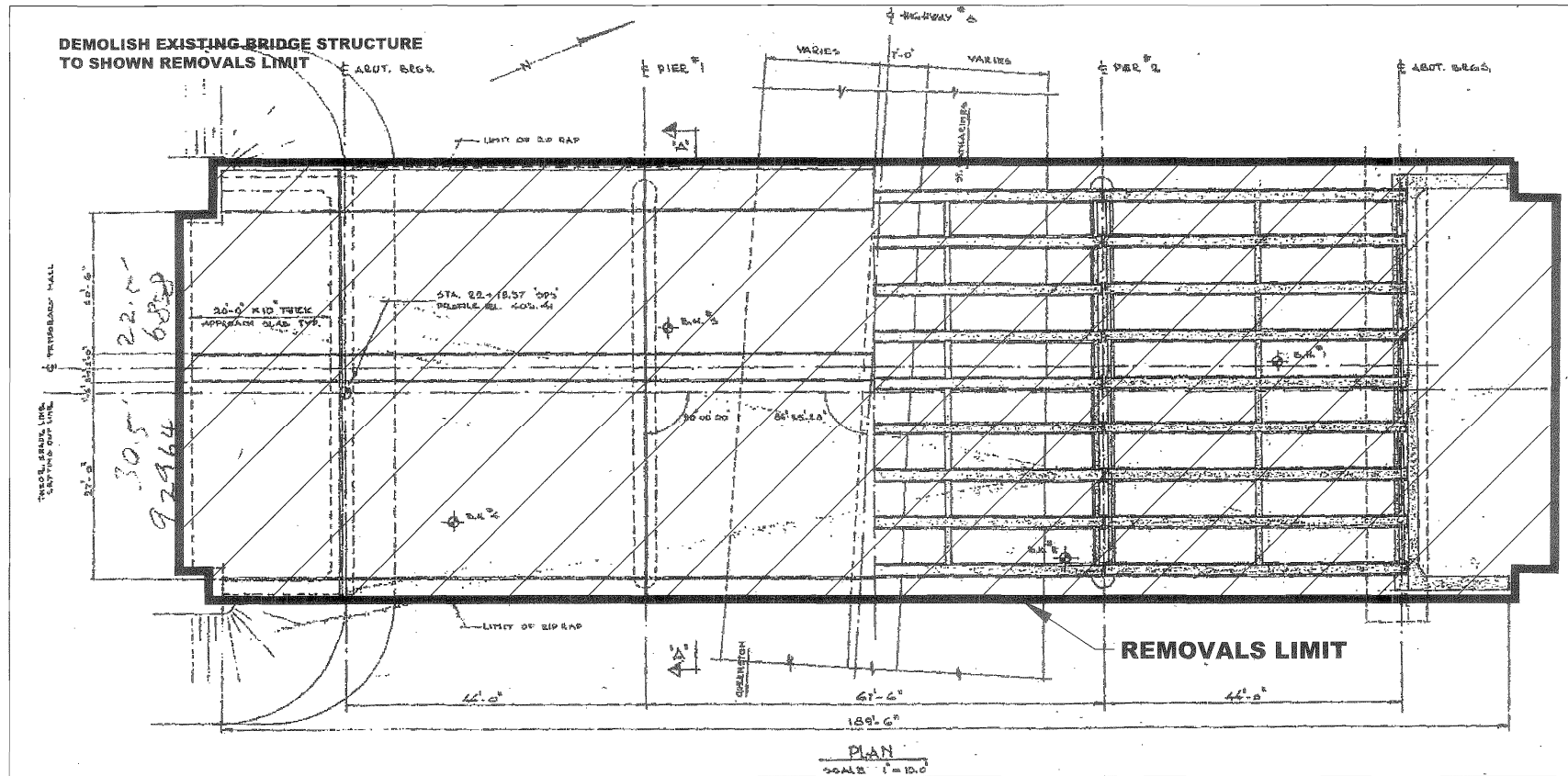


MARCH 26, 2007

IN 1964-5 FEAR WITH FAMILIES 01000 10 01120

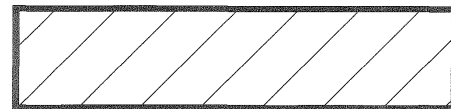


J:\DATA\1304\VF\#5\GAD FILES\.....Glendale Avenue Sidewalk - Detailed Design.dwg
XREF = J:\DATA\1304\VF\#5\GAD FILES\.....Glendale - QEW Baseplan.dwg



NOTES:
BACKGROUND DRAWING FROM THE ORIGINAL "GENERAL ARRANGEMENT" PLAN

DENOTES AREAS TO BE REMOVED/DEMOLISHED



NO.	REVISION	DATE	INIT.
2	ISSUED FOR TENDER	03/26/07	S.B.B.
1	ISSUED FOR REVIEW	03/09/07	S.B.B.
0	ISSUED FOR	01/01/02	S.B.B.

NOTES

THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND, WHERE SHOWN, THE ACCURACY AND POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL RESPONSIBILITY FOR DAMAGE TO THEM.

THE LOCATION AND DEPTH OF UTILITY CROSSINGS ARE NOT GUARANTEED AND ANY DISCOVERED DURING THE WORK WHICH ARE IN CONFLICT WITH PROPOSED SERVICES WILL BE DEALT WITH AS EXTRA WORK IF WARRANTED.

CAD
R.R.B. /
W.H.N.

DESIGN
S.B.B.

CHECKED BY
N.P.

BENCH MARK
TABLET SET IN CONC.
SIDEWALK IN BRIDGE OVER
Q.E.W. AT NORTH END OF
STRUCTURE, ON WEST SIDE,
2m NORTH OF EXPANSION
JOINT.

ELEV. 123.160



Niagara Region
Public Works and Utilities Department
Delcan

CONTRACT No.:2007-T-108 (RN 07-08)
GLENDALE AVENUE SIDEWALK
REGIONAL ROAD 81 - (GLENDALE AVENUE)
in the TOWN OF NIAGARA-ON-THE-LAKE

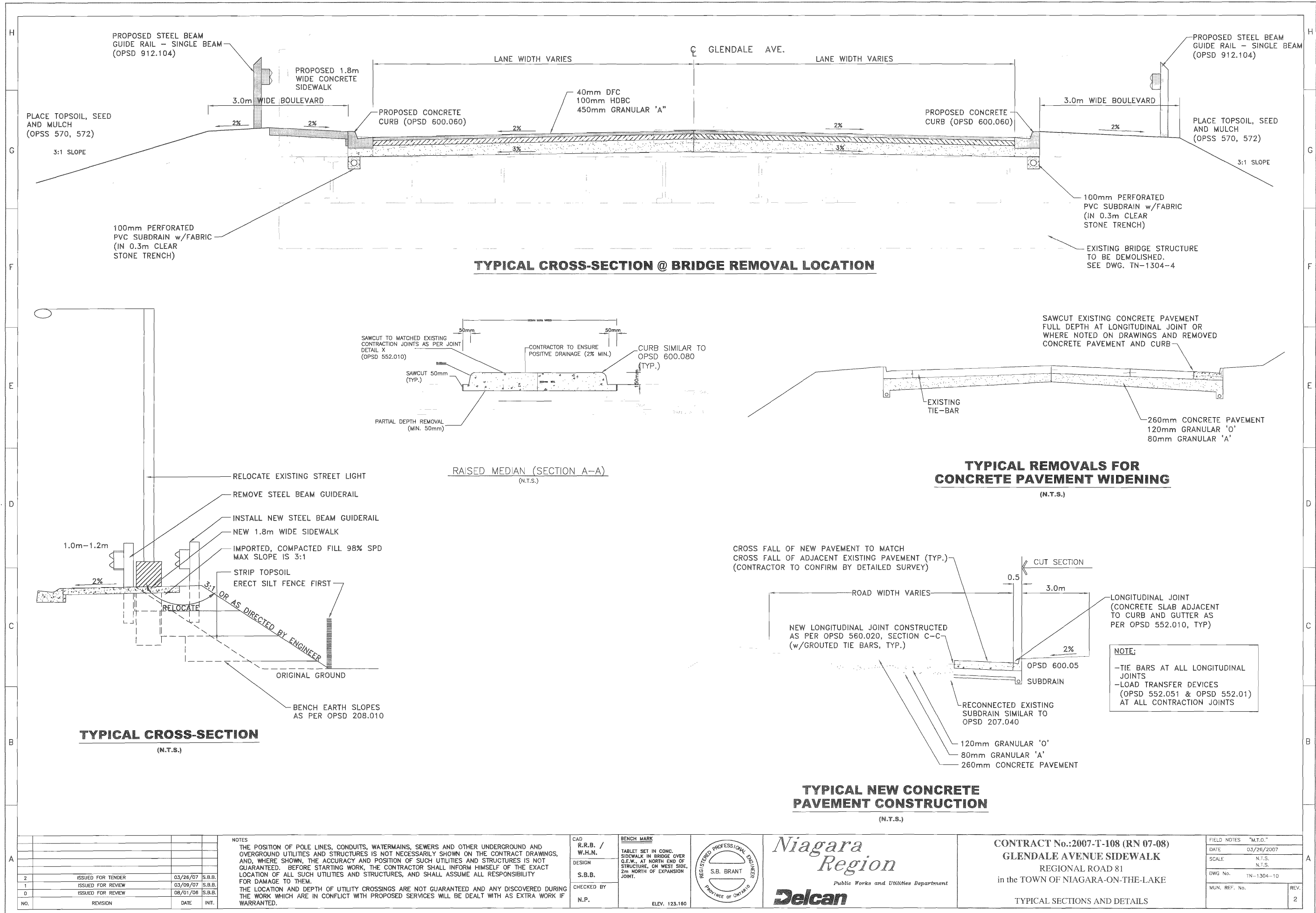
DEMOLITION PLAN

FIELD NOTES	"M.T.O."
DATE	03/26/2007
SCALE	Horiz. 1:200 Vert. 1:50
DWG No.	TN-1304-9
MUN. REF. No.	
REV.	2

ISSUED FOR TENDER
MARCH 26, 2007

TN-1304-9 REMOVALS PLAN GLENDALE AVENUE

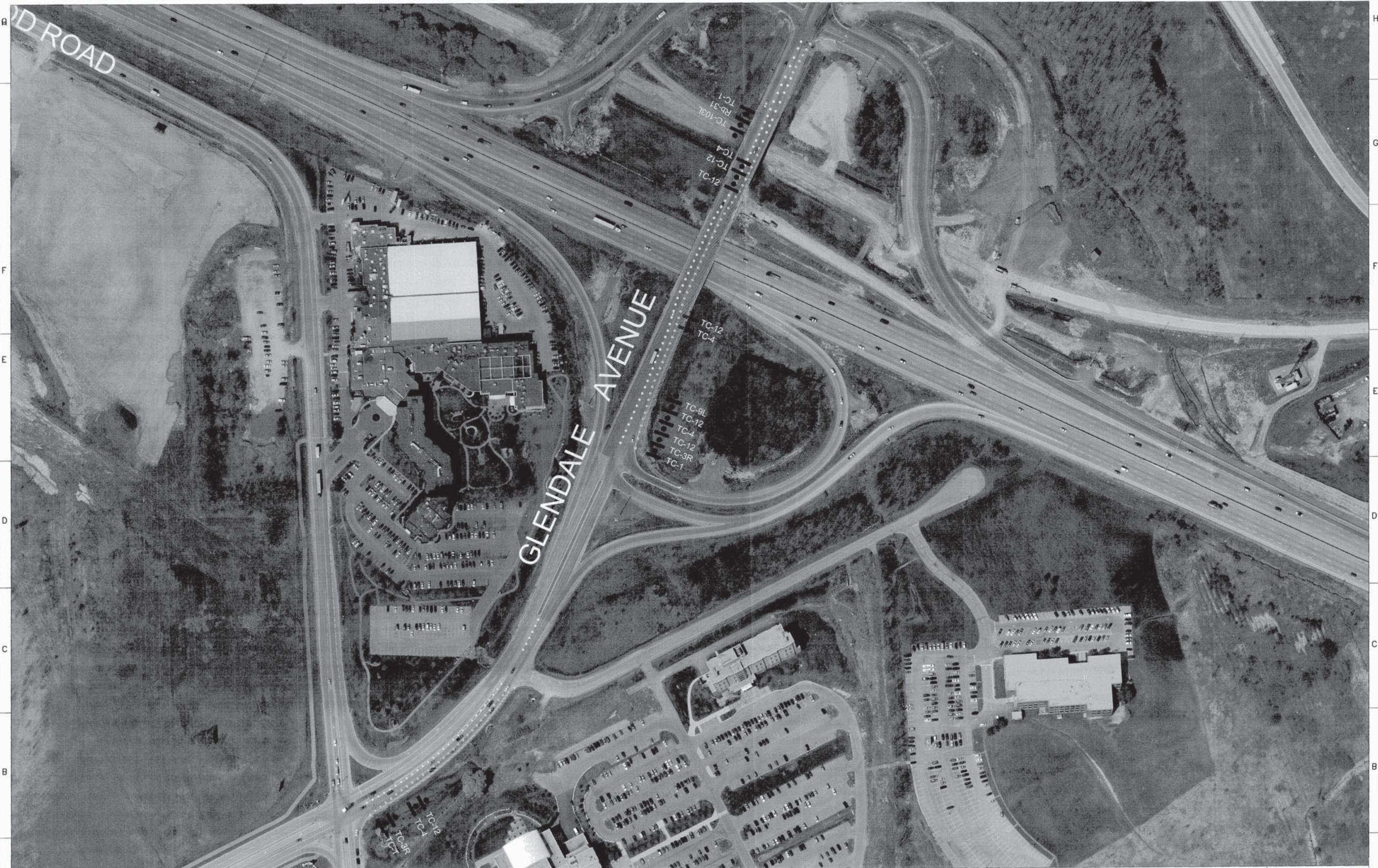
J:\DATA\1304\1304.MXD #1304.MXD - Detailed Design.dwg
XREF = J:\DATA\1304\1304.MXD #1304.MXD - QEW Baseplan.dwg



ISSUED FOR TENDER
MARCH 26, 2007

TN-1304-10
TYPICAL SECTIONS AND DETAILS
GLENDALE AVENUE

\\DATA\TN1304\VF #0\CAD FILES.....Glendale Avenue Sidewalk - Detailed Design.dwg
XREF = \\DATA\TN1304\VF #0\CAD FILES.....Glendale - QEW Baseplan.dwg



NO.	REVISION	DATE	INT.

NOTES
THIS PLAN IS SCHEMATIC ONLY. IN ALL CASES, THE ONTARIO TRAFFIC MANUAL "BOOK 7 - TEMPORARY CONDITIONS" TAKES PRECEDENCE.

CAD
R.R.B. /
W.H.N.
DESIGN
S.B.B.
CHECKED BY
N.P.
BENCH MARK
TABLET SET IN CONC.
SIDEWALK IN BRIDGE OVER
Q.E.W., AT NORTH END OF
STRUCTURE, ON WEST SIDE,
2m NORTH OF EXPANSION
JOINT.
ELEV. 123.160



Niagara Region
Public Works and Utilities Department
Delcan

CONTRACT No.:2007-T-108 (RN 07-08)
GLENDALE AVENUE SIDEWALK CONSTRUCTION
REGIONAL ROAD 89
in the Town of NIAGARA-ON-THE-LAKE
CONSTRUCTION STAGE 2

FIELD NOTES "SUDA & MALESZYK"
DATE 03/26/07
SCALE N.T.S.
DWG No. TN-1304-STAGE2
MUN. REF. No.
REV. 0

TN-1304-STAGE2
GLENDALE AVENUE SIDEWALK
CONSTRUCTION STAGE 1 AND DETOUR PLAN

ISSUED FOR TENDER
MARCH 26, 2007



APPENDIX B

Borehole Records

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$,	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_c	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_{α}	secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1
2

$\tau = c' + \sigma' \tan \phi'$
shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Compactness	N
Condition	Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils Consistency

	C_u, S_u	
	kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

<u>Description</u>	<u>Bedding Plane Spacing</u>
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

<u>Description</u>	<u>Spacing</u>
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

<u>Term</u>	<u>Size*</u>
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN Joint	PL Planar
FLT Fault	CU Curved
SH Shear	UN Undulating
VN Vein	IR Irregular
FR Fracture	K Slickensided
SY Stylolite	PO Polished
BD Bedding	SM Smooth
FO Foliation	SR Slightly Rough
CO Contact	RO Rough
AXJ Axial Joint	VR Very Rough
KV Karstic Void	
MB Mechanical Break	

PROJECT		1671430 WO2		RECORD OF BOREHOLE No ARB-1		SHEET 1 OF 1		METRIC										
G.W.P.		2423-15-00		LOCATION		N 4779855.5; E 332139.8 MTM NAD 83 ZONE 10 (LAT. 43.158062; LONG. -79.163817)		ORIGINATED BY JP										
DIST		Central HWY QEW		BOREHOLE TYPE		152 mm O.D. Hollow Stem Augers; CME 55 Track Mounted Drill Rig		COMPILED BY EN										
DATUM		Geodetic		DATE		October 26, 2018		CHECKED BY LCC										
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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
121.0	GROUND SURFACE							20	40	60	80	100						
0.0	ASPHALT (120 mm)																	
0.1	Silty clay, some sand (FILL) Firm Brown Moist		1	SS	50													
120.0			2A	SS	5													
1.0	Sand and gravel, some silt, trace to some clay (FILL) Very loose to very dense Brown Moist		2B	SS	5													
			3A	SS	3													
			3B	SS	3													
			4	SS	5													
			5	SS	50/0.05													
116.4																		
4.6	END OF BOREHOLE																	
NOTES:																		
1. Borehole terminated at 4.6 m due to auger refusal on an obstruction.																		
2. Open borehole dry on completion of drilling.																		

GTA-MTO 001 S:\CLIENTS\MTQEW-GLENDALE\02_DATA\GINTQEW-GLENDALE.GPJ GAL-GTA.GDT 19-4-23

PROJECT 1671430 WO2		RECORD OF BOREHOLE No ARB-2		SHEET 1 OF 3		METRIC	
G.W.P. 2423-15-00		LOCATION N 4779841.8; E 332133.3 MTM NAD 83 ZONE 10 (LAT. 43.157938; LONG. -79.163898)		ORIGINATED BY JP			
DIST Central HWY QEW		BOREHOLE TYPE 152 mm O.D. Hollow Stem Augers; CME 55 Track Mounted Drill Rig		COMPILED BY EN			
DATUM Geodetic		DATE October 26, 29 and 30, 2018		CHECKED BY LCC			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
121.5	GROUND SURFACE																
0.0	ASPHALT (150 mm)																
0.2	Sand and gravel, some silt to silty (FILL) Compact to very dense Brown Moist		1	SS	65		121										
			2	SS	14												
120.1							120										
1.4	Silty clay, some sand to sandy, trace to some gravel, trace organics at 4.0 m (FILL) Firm to stiff Brown, oxidation staining at 4.9 m Moist		3	SS	7												
			4	SS	6		119										
			5	SS	6		118							6 13 44 35			
			6	SS	8												
			7	SS	9		117										
115.9							116										
5.6	Sand and gravel, some silt, trace to some clay (FILL) Very dense Red-brown to black Moist		8A 8B 8C	SS	53		115										
115.1	- Concrete fragments between 6.1 m to 6.2 m																
6.4	SILTY CLAY to CLAY, trace to some sand, trace gravel Stiff to firm Brown grey to grey below 14.8 m Moist to wet below 14.8 m - Rootlets encountered at 8.0 m.		9	SS	7		114							2 7 36 55			
			10	SS	10		113										
			11	SS	10		112										
			12	SS	5		111							0 3 35 62			
			13	SS	8		110										
							109										
							108										
							107										
	- Red sand pockets at 14.0 m and 14.3 m.													0 3 35 62			

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTQEW-GLENDALE\02_DATA\INTQEW-GLENDALE.GPJ GAL-GTA.GDT 19-4-26

PROJECT <u>1671430 WO2</u>		RECORD OF BOREHOLE No ARB-2		SHEET 2 OF 3		METRIC	
G.W.P. <u>2423-15-00</u>		LOCATION <u>N 4779841.8; E 332133.3 MTM NAD 83 ZONE 10 (LAT. 43.157938; LONG. -79.163898)</u>		ORIGINATED BY <u>JP</u>			
DIST <u>Central</u> HWY <u>QEW</u>		BOREHOLE TYPE <u>152 mm O.D. Hollow Stem Augers; CME 55 Track Mounted Drill Rig</u>		COMPILED BY <u>EN</u>			
DATUM <u>Geodetic</u>		DATE <u>October 26, 29 and 30, 2018</u>		CHECKED BY <u>LCC</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED					
--- CONTINUED FROM PREVIOUS PAGE ---														
	SILTY CLAY to CLAY, trace to some sand, trace gravel Stiff to firm Brown grey to grey below 14.8 m Moist to wet below 14.8 m		14	SS	4		106							
							105							
							104							
			15	SS	5		103							
							102							
101.4							101							
20.1	CLAYEY SILT, some sand, trace gravel Soft to stiff Grey Wet		16	SS	2		100							3 17 50 30
							99							
							98							
			17	SS	50/0.08		97							
95.8	- Auger refusal at a depth of 25.7 m, switch to rock coring						96							
25.9	GRANITE boulder Grey		18	SS	50/0.13		95							
	Sandy SILT, some clay Very dense Red-grey Moist						94							
94.6							93							
26.9	SILT and SAND, trace to some clay, trace to some gravel Very dense Red Moist		19	SS	50/0.08		92							
			20	SS	50/0.13									1 55 38 6

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\TOQEW-LENDALE\02_DATA\INTOQEW-LENDALE.GPJ GAL-GTA.GDT 19-4-26

PROJECT		1671430 WO2		RECORD OF BOREHOLE No ARB-2				SHEET 3 OF 3				METRIC						
G.W.P.		2423-15-00		LOCATION		N 4779841.8; E 332133.3 MTM NAD 83 ZONE 10 (LAT. 43.157938; LONG. -79.163898)				ORIGINATED BY JP								
DIST		Central HWY QEW		BOREHOLE TYPE		152 mm O.D. Hollow Stem Augers; CME 55 Track Mounted Drill Rig				COMPILED BY EN								
DATUM		Geodetic		DATE		October 26, 29 and 30, 2018				CHECKED BY LCC								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)					
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100						
	SILT and SAND, trace to some clay, trace to some gravel Very dense Red Moist																	
	- Rock fragments at a depth of about 32 m		21	SS	50/0.14													
88.9																		
32.6	SHALE (BEDROCK)																	
	Bedrock cored from 32.6 m to 36.3 m		1	RC	REC 100%													RQD = 75%
	For rock coring details refer to Record of Drillhole ARB-2		2	RC	REC 96%													RQD = 91%
			3	RC	REC 100%													RQD = 100%
			4	RC	REC 100%													RQD = 78%
85.2																		
36.3	END OF BOREHOLE																	
	NOTE: 1. Water level in open borehole at a depth of 4.3 m (Elev. 117.2 m) during drilling.																	

GTA-MTO 001 S:\CLIENTS\MTQEW-LENDALE\02_DATA\INTQEW-LENDALE.GPJ GAL-GTA.GDT 19-4-26

PROJECT: 1671430 WO2

RECORD OF DRILLHOLE: **ARB-2**

SHEET 1 OF 1

LOCATION: N 4779841.77 ;E 332133.32

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME55 Truck-Mount

DRILLING CONTRACTOR: Geo-Environmental

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY																		FEATURES	PIEZOMETER	
							RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA					WEATH- ERING INDEX					Diametral Point Load Index (MPa)						
							TOTAL CORE %	SOLID CORE %			DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jzon	W1	W2	W3	W4	W5	W6	W7	W8	W9			W10
							00																				


PROJECT <u>1671430 WO2</u>		RECORD OF BOREHOLE No ARB-3		SHEET 2 OF 3		METRIC	
G.W.P. <u>2423-15-00</u>		LOCATION <u>N 4779841.4; E 332172.2 MTM NAD 83 ZONE 10 (LAT. 43.157933; LONG. -79.163420)</u>		ORIGINATED BY <u>JP</u>			
DIST <u>Central</u> HWY <u>QEW</u>		BOREHOLE TYPE <u>152 mm O.D. Hollow Stem Augers; CME 55 Track Mounted Drill Rig</u>		COMPILED BY <u>EN</u>			
DATUM <u>Geodetic</u>		DATE <u>October 22 and 23, 2018</u>		CHECKED BY <u>LCC</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								20 40 60 80 100	20 40 60 80 100	10 20 30				
	--- CONTINUED FROM PREVIOUS PAGE ---													
	SILTY CLAY, trace sand, trace gravel Stiff to firm Red-grey Moist		14	SS	0		102	1.5				42		0 3 41 56
							101	1.8 1.4						
							100							
			15	SS	6		99							
							98							
97.6							97							
20.1	SANDY CLAYEY SILT, some gravel Hard Red-grey Moist		16	SS	50/0.14		96						18 24 43 15	
							95							
94.7							94							
23.0	SILT, trace to some clay, trace sand Very dense Red to grey Moist		17	SS	73		93						0 3 86 11	
							92							
							91							
			18	SS	54		90							
							89							
88.8							88							
28.9	CLAYEY SILT, some sand, some shale fragments (TILL/RESIDUAL SOIL) Hard Red to grey Moist		19	SS	50/0.05									
87.7														

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTQEW-LENDALE\02_DATA\INTQEW-LENDALE.GPJ GAL-GTA.GDT 19-4-26

PROJECT		1671430 WO2		RECORD OF BOREHOLE No ARB-3				SHEET 3 OF 3				METRIC					
G.W.P.		2423-15-00		LOCATION		N 4779841.4; E 332172.2 MTM NAD 83 ZONE 10 (LAT. 43.157933; LONG. -79.163420)				ORIGINATED BY JP							
DIST		Central HWY QEW		BOREHOLE TYPE		152 mm O.D. Hollow Stem Augers; CME 55 Track Mounted Drill Rig				COMPILED BY EN							
DATUM		Geodetic		DATE		October 22 and 23, 2018				CHECKED BY LCC							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
	--- CONTINUED FROM PREVIOUS PAGE ---																
30.0	SHALE (BEDROCK)		1	RC	REC 100%											RQD = 52%	
	Bedrock cored from 30.0 m to 33.2 m.																
	For rock coring details refer to Record of Drillhole ARB-3.		2	RC	REC 100%												RQD = 68%
			3	RC	REC 88%												RQD = 84%
84.5			4	RC	REC 100%												RQD = 66%
33.2	END OF BOREHOLE																
	NOTE: 1. Water level measured at a depth of 9.1 m (Elev. 108.6 m) on completion of drilling.																

GTA-MTO 001 S:\CLIENTS\MTQ\QEW-LENDALE\02_DATA\INT\QEW-LENDALE.GPJ GAL-GTA.GDT 19-4-26

PROJECT: 1671430 WO2

RECORD OF DRILLHOLE: **ARB-3**

SHEET 1 OF 1

LOCATION: N 4779841.38 ;E 332172.17

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME55 Track-Mount

DRILLING CONTRACTOR: Geo-Environmental

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY																FEATURES	PIEZOMETER																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
						RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25 m	DIP w.r.t CORE AXIS	DISCONTINUITY DATA				WEATH- ERING INDEX						Diametral Point Load Index (MPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
						TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jzon	W1	W2	W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
30		Continued from Record of Borehole ARB-3		87.70																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					

DEPTH SCALE

1 : 50



GOLDER

LOGGED: JP

CHECKED: EN

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PROJECT 1671430 WO2		RECORD OF BOREHOLE No ARB-4		SHEET 1 OF 3		METRIC	
G.W.P. 2423-15-00		LOCATION N 4779827.2; E 332176.8 MTM NAD 83 ZONE 10 (LAT. 43.157806; LONG. -79.163365)		ORIGINATED BY JP			
DIST Central HWY QEW		BOREHOLE TYPE 152 mm O.D. Hollow Stem Augers; CME 55 Track Mounted Drill Rig		COMPILED BY EN			
DATUM Geodetic		DATE October 24 and 25, 2018		CHECKED BY LCC			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
								20 40 60 80 100	20 40 60 80 100					
117.1	GROUND SURFACE													
0.9	TOPSOIL (50 mm)		1	SS	8									
	Silty clay to clay, trace to some sand, trace rootlets (FILL)		2	SS	25									
	Stiff to very stiff		3	SS	29									
	Brown		4	SS	15									
	Moist													
114.1			5	SS	16									
3.1	SILTY CLAY to CLAY, trace to some gravel, trace to some sand		6	SS	17									
	Very stiff to stiff		7	SS	15									
	Brown to red-brown to red-grey													
	Moist		8	SS	9									
			9	SS	10									
			10	SS	9									
			11	SS	6									
			12	SS	3									
			13	SS	5									

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+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTQEW-LENDALE\02_DATA\INTQEW-LENDALE.GPJ GAL-GTA.GDT 19-5-10

PROJECT		1671430 WO2		RECORD OF BOREHOLE No ARB-4		SHEET 2 OF 3		METRIC														
G.W.P.		2423-15-00		LOCATION		N 4779827.2; E 332176.8 MTM NAD 83 ZONE 10 (LAT. 43.157806; LONG. -79.163365)		ORIGINATED BY JP														
DIST		Central HWY QEW		BOREHOLE TYPE		152 mm O.D. Hollow Stem Augers; CME 55 Track Mounted Drill Rig		COMPILED BY EN														
DATUM		Geodetic		DATE		October 24 and 25, 2018		CHECKED BY LCC														
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ			GR SA SI CL			
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p — W — W _L 10 20 30			kN/m ³						
102.0	SILTY CLAY to CLAY, trace to some gravel, trace to some sand Very stiff to stiff Brown to red-brown to red-grey Moist		14	SS	4		102															
							101															
							100															
100.0	CLAYEY SILT, trace to some sand, trace gravel Stiff to hard Red-grey Moist		15	SS	12		99															
99.0							98															
							97															
							96															
			16	SS	70		95															
94.0	SILT, trace to some sand, trace gravel, trace to some clay		17	SS	74		94															
23.1							93															
							92															
							91															
							90															
	- Shale fragments below a depth of 27.4 m.		18	SS	50/0.13		89															
88.1			19	SS	50/0.08																	
29.0																						

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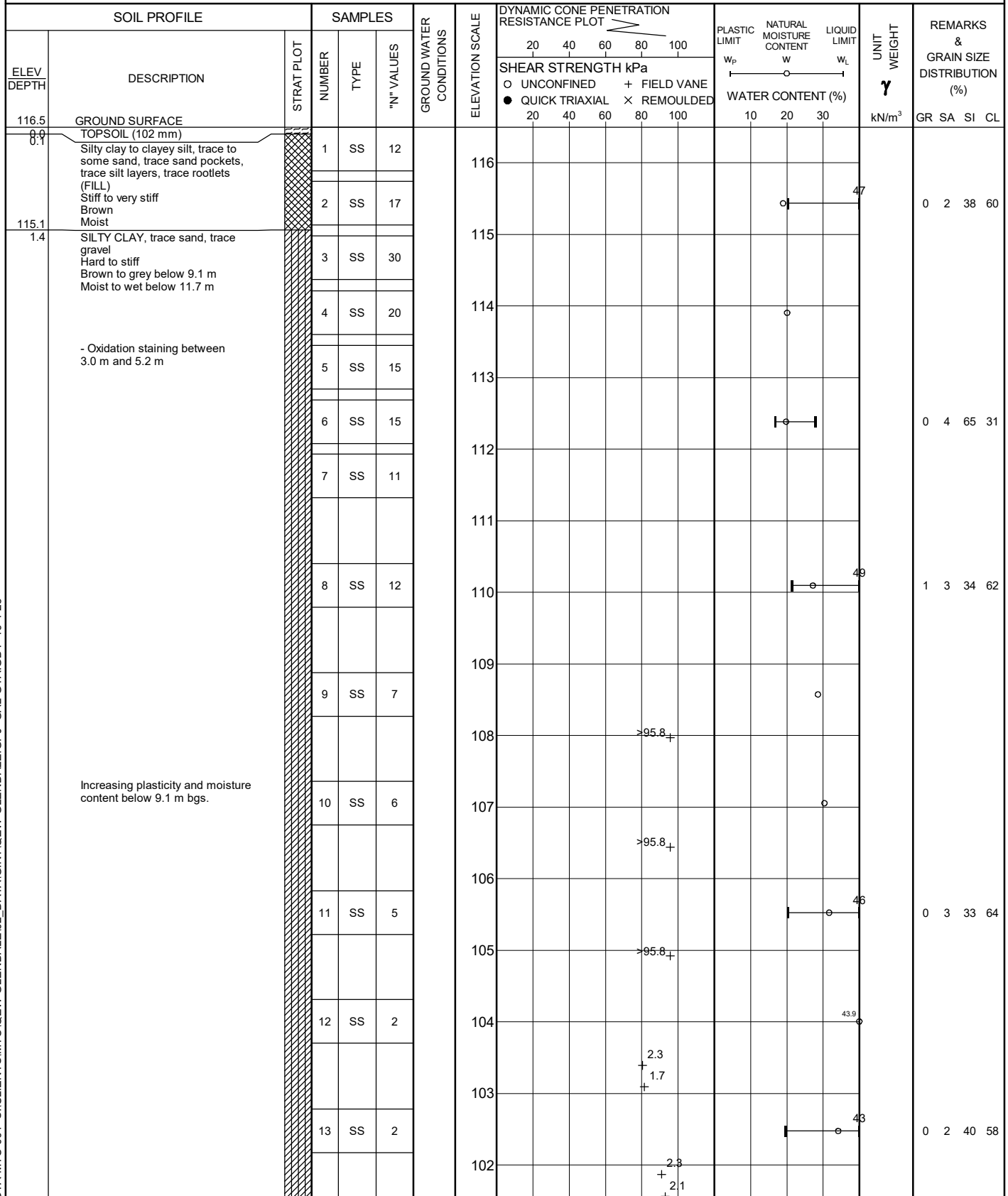
+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTQEW-LENDALE\02_DATA\INTQEW-LENDALE.GPJ GAL-GTA.GDT 19-5-10



+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

PROJECT 1671430 WO2		RECORD OF BOREHOLE No HF-1		SHEET 1 OF 2	METRIC
G.W.P. 2423-15-00		LOCATION N 4779836.5; E 332159.9 MTM NAD 83 ZONE 10 (LAT. 43.157890; LONG. -79.163572)		ORIGINATED BY KN	
DIST Central HWY QEW		BOREHOLE TYPE 152 mm Hollow Stem Augers; CME 55 Track-mounted Drill Rig		COMPILED BY KG	
DATUM Geodetic		DATE September 20, 2014		CHECKED BY LCC	



Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTQEW-LENDALE\02_DATA\GINTQEW-LENDALE.GPJ GAL-GTA.GDT 19-4-23

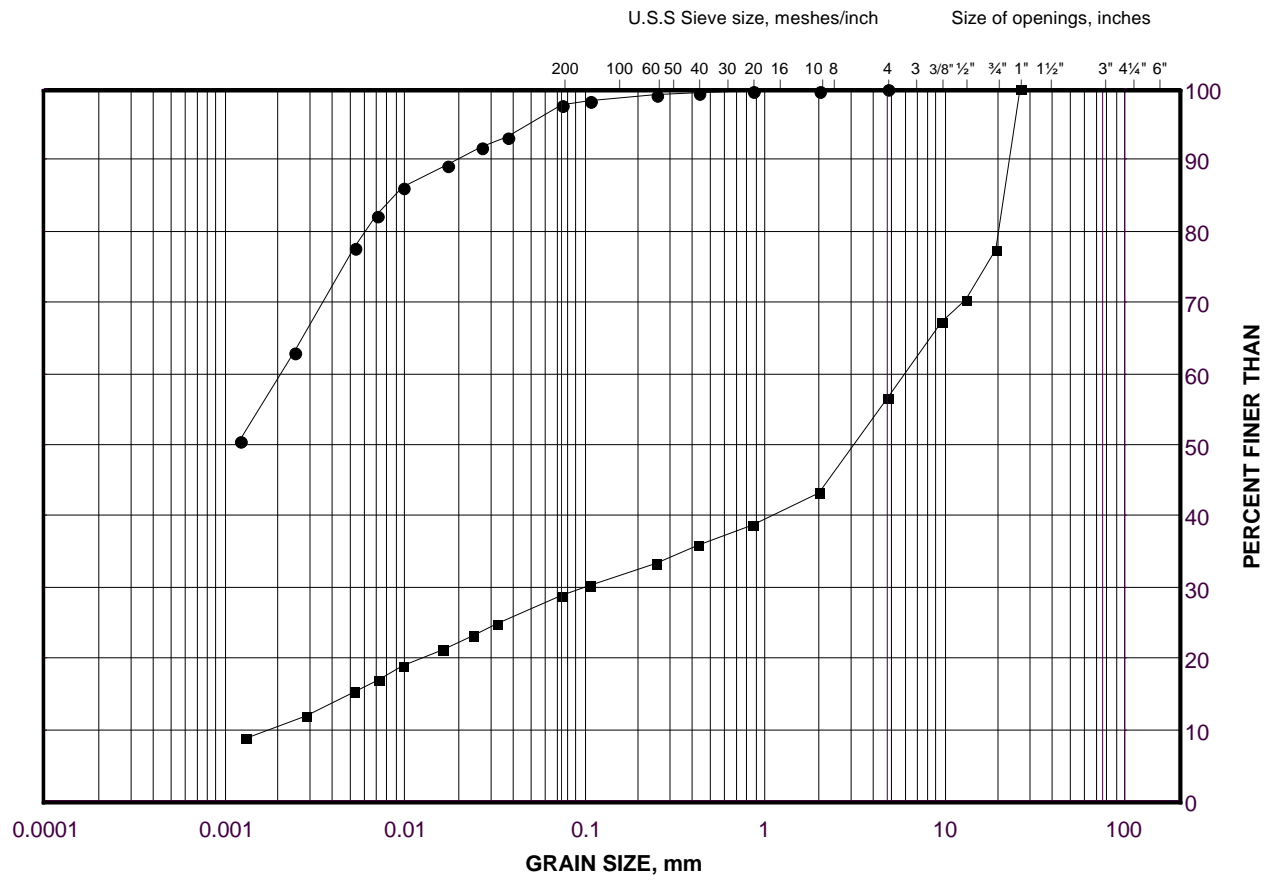
PROJECT <u>1671430 WO2</u>				RECORD OF BOREHOLE No HF-1				SHEET 2 OF 2				METRIC					
G.W.P. <u>2423-15-00</u>				LOCATION <u>N 4779836.5; E 332159.9 MTM NAD 83 ZONE 10 (LAT. 43.157890; LONG. -79.163572)</u>				ORIGINATED BY <u>KN</u>									
DIST <u>Central</u> HWY <u>QEW</u>				BOREHOLE TYPE <u>152 mm Hollow Stem Augers; CME 55 Track-mounted Drill Rig</u>				COMPILED BY <u>KG</u>									
DATUM <u>Geodetic</u>				DATE <u>September 20, 2014</u>				CHECKED BY <u>LCC</u>									
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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	--- CONTINUED FROM PREVIOUS PAGE ---																
100.0	SILTY CLAY, trace sand, trace gravel Hard to stiff Brown to grey below 9.1 m Moist to wet below 11.7 m		14	SS	3		101										
16.5	END OF BOREHOLE																
	NOTES: 1. Open borehole dry upon completion of drilling. 2. Borehole open to 15.2 m below ground surface on removal of augers.																

APPENDIX C

Geotechnical Laboratory Test Results

Silty Clay to Clay Fill and Sand and Gravel Fill

FIGURE C-1



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

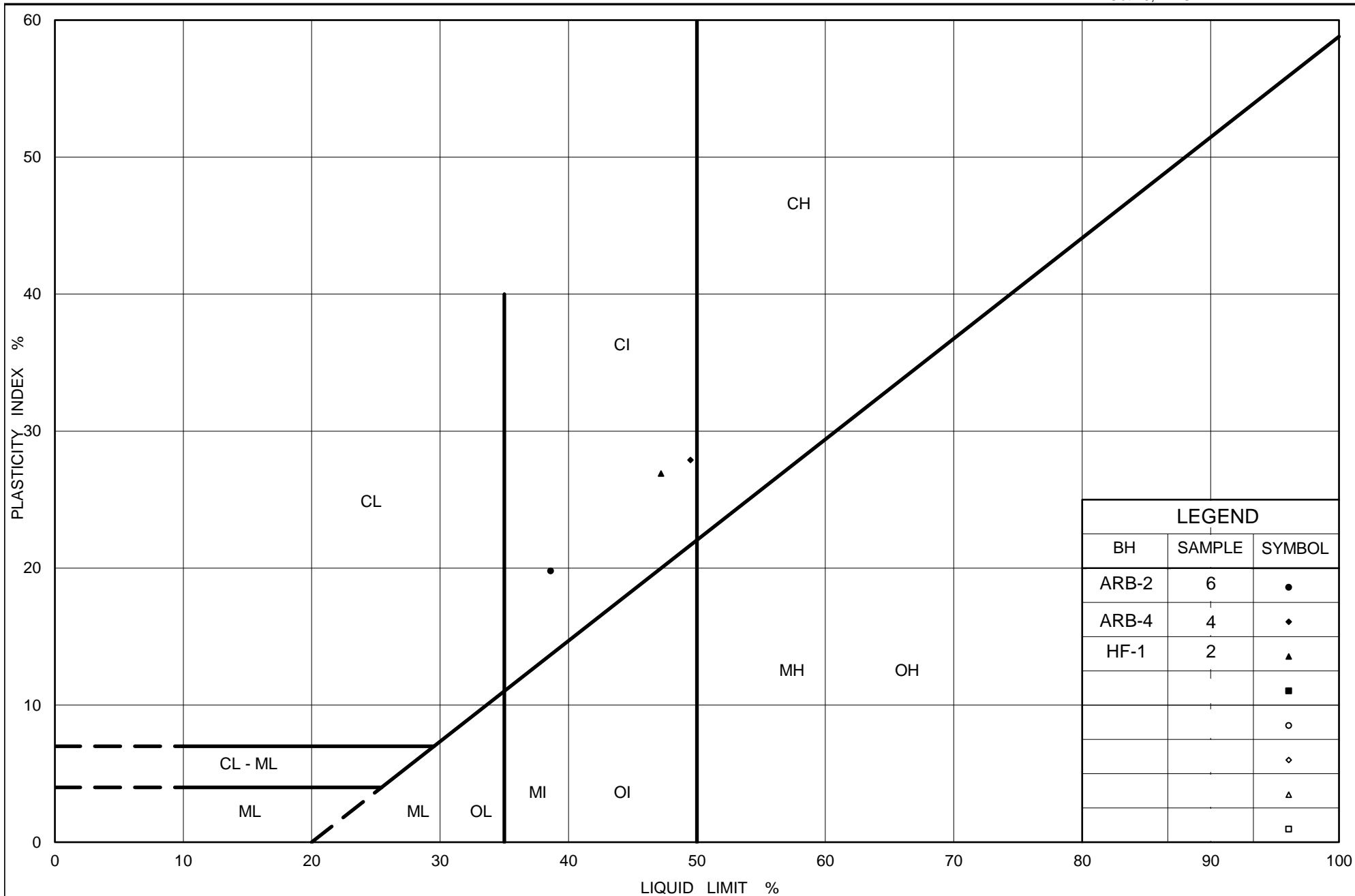
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	HF-1	2	115.5
■	ARB-1	3B	119.3

Project Number: 1671430

Checked By: MA/LCC

Golder Associates

Date: 22-Apr-19



Ministry of Transportation

Ontario

PLASTICITY CHART

Silty Clay to Clay Fill

Figure No. C-2

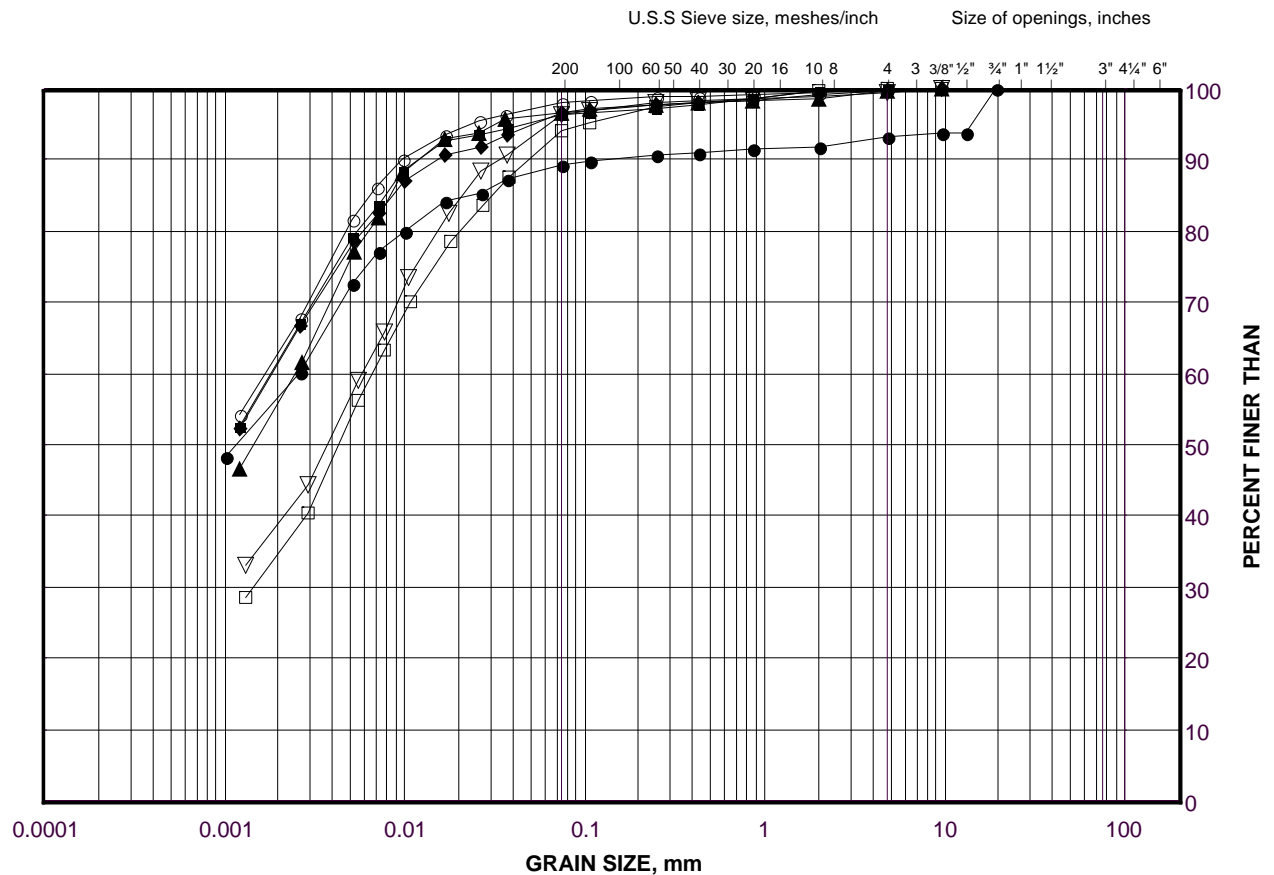
Project No. 1671430 (WO 002)

Checked By: MA/LCC

GRAIN SIZE DISTRIBUTION

Silty Clay to Clay

FIGURE C-3A



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ARB-4	10	107.7
■	ARB-2	11	110.5
◆	ARB-2	13	107.5
▲	ARB-3	14	102.2
▽	ARB-3	5	114.3
○	ARB-3	8	111.4
□	ARB-4	8	110.7

Project Number: 1671430

Checked By: MA/LCC

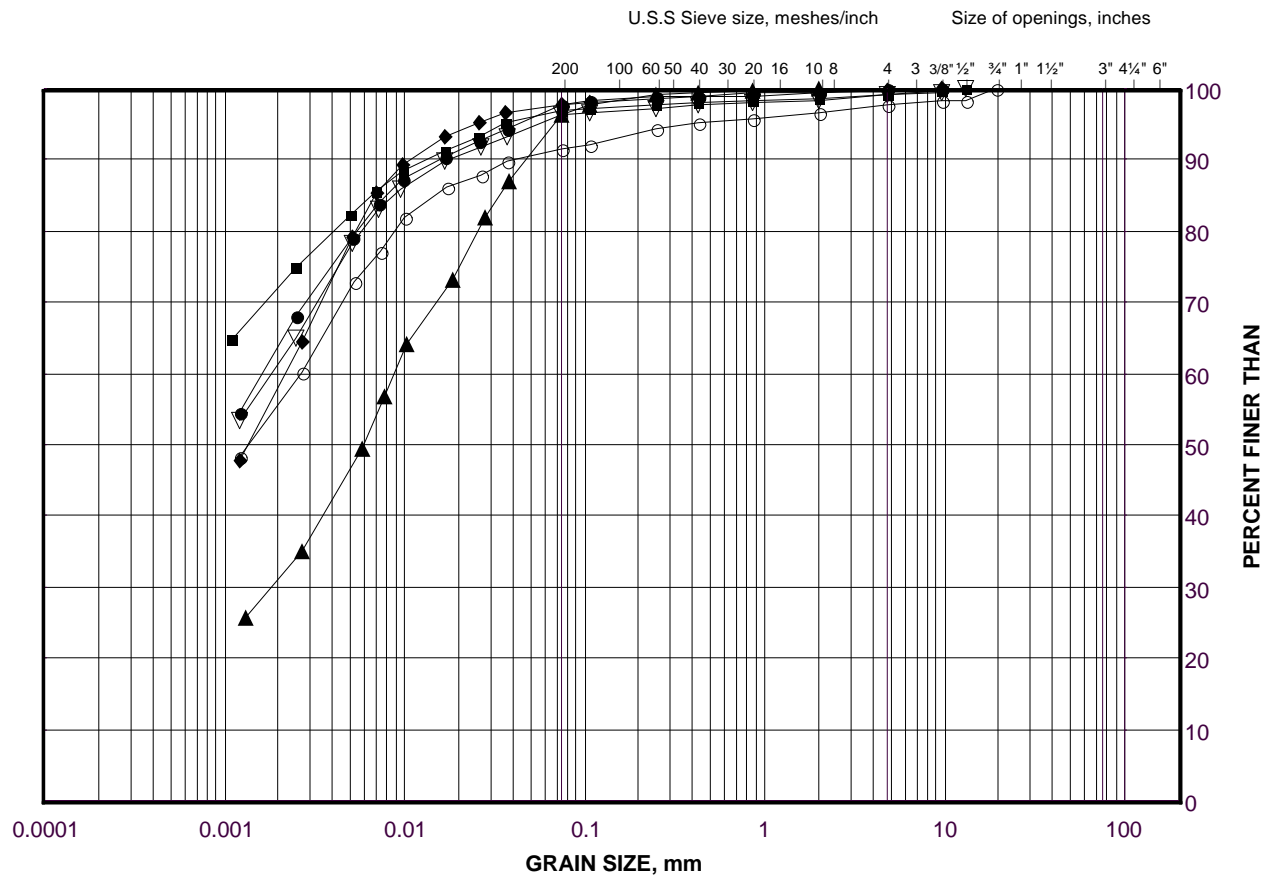
Golder Associates

Date: 22-Apr-19

GRAIN SIZE DISTRIBUTION

Silty Clay to Clay

FIGURE C-3B



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

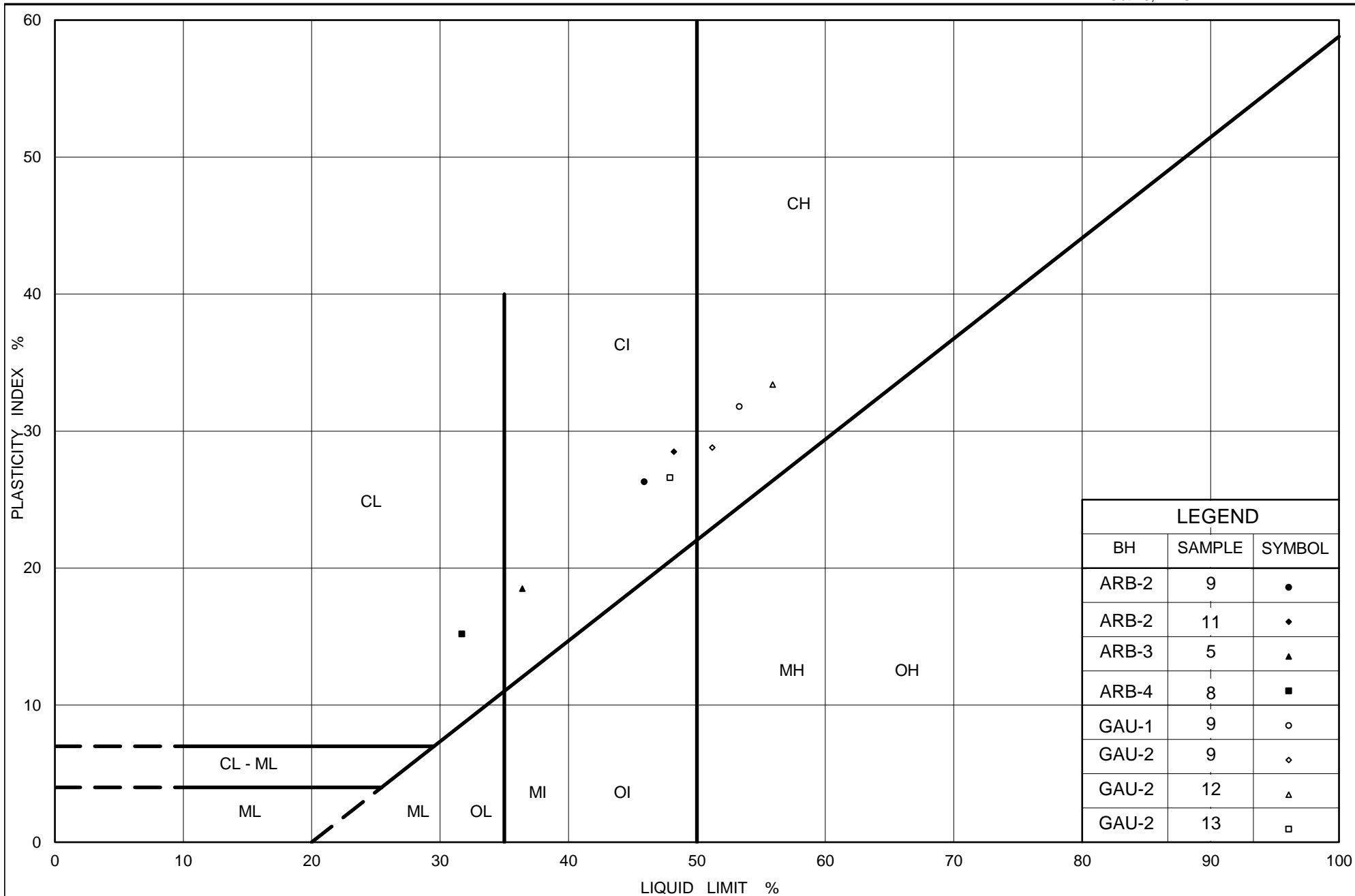
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	HF-1	11	105.5
■	ARB-4	12	104.6
◆	HF-1	13	102.5
▲	HF-1	6	112.4
▽	HF-1	8	110.1
○	ARB-2	9	113.6

Project Number: 1671430

Checked By: MA/LCC

Golder Associates

Date: 22-Apr-19



Ministry of Transportation

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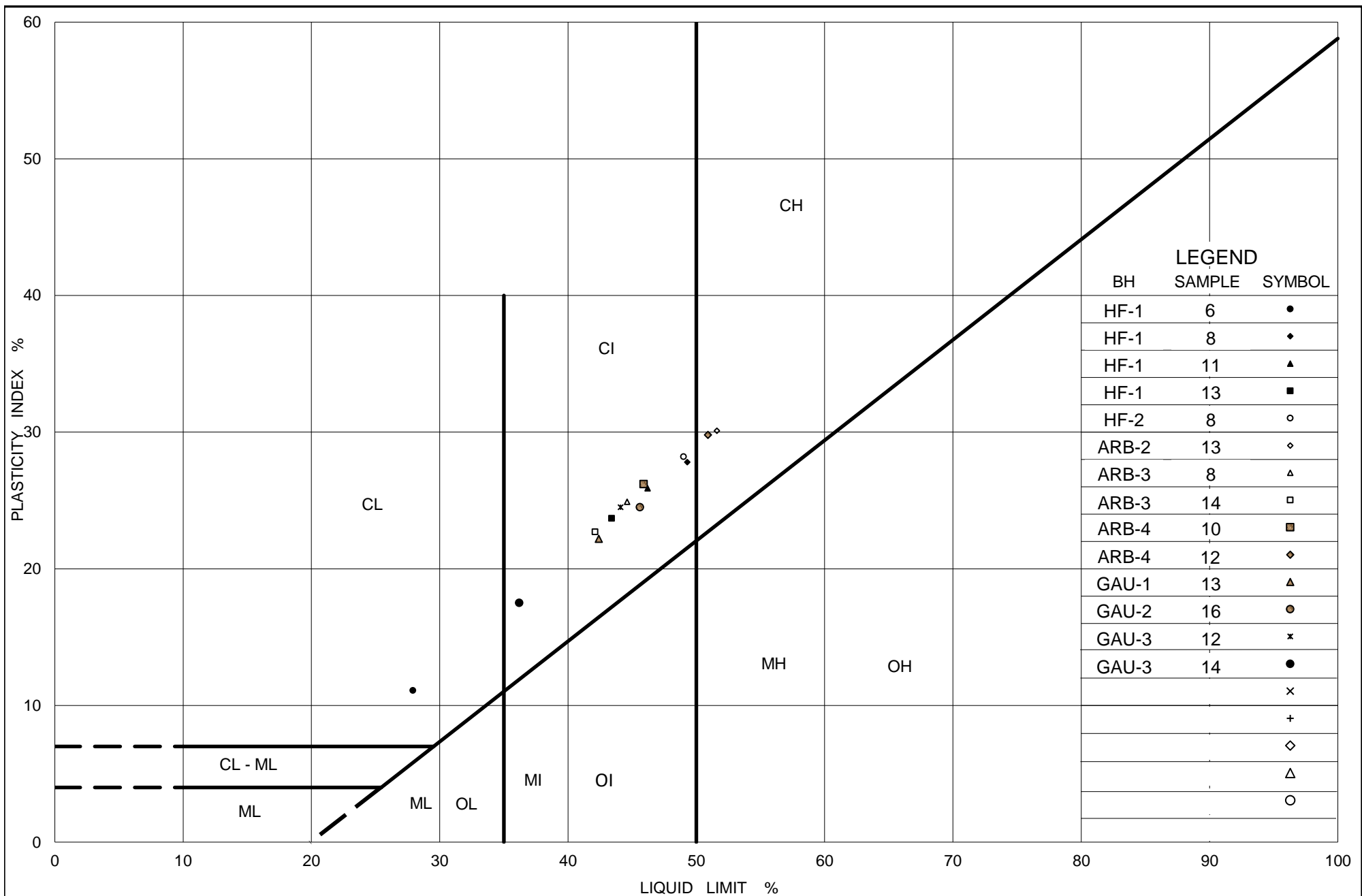
PLASTICITY CHART

Silty Clay to Clay

Figure No. C-4A

Project No. 1671430 (WO 002)

Checked By: MA/LCC



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PLASTICITY CHART Silty Clay to Clay

Figure No. C-4B

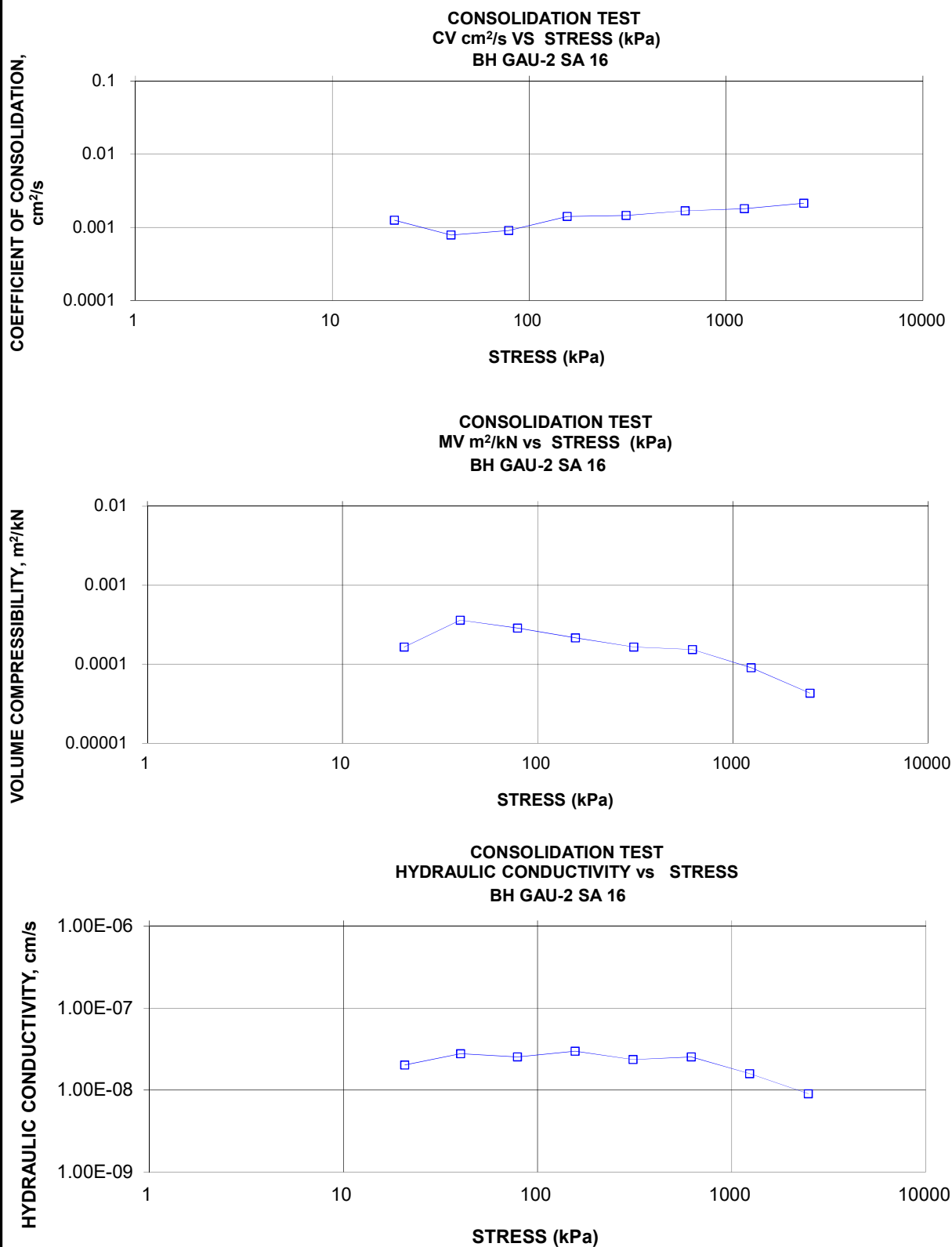
Project No. 1671430 (WO 002)

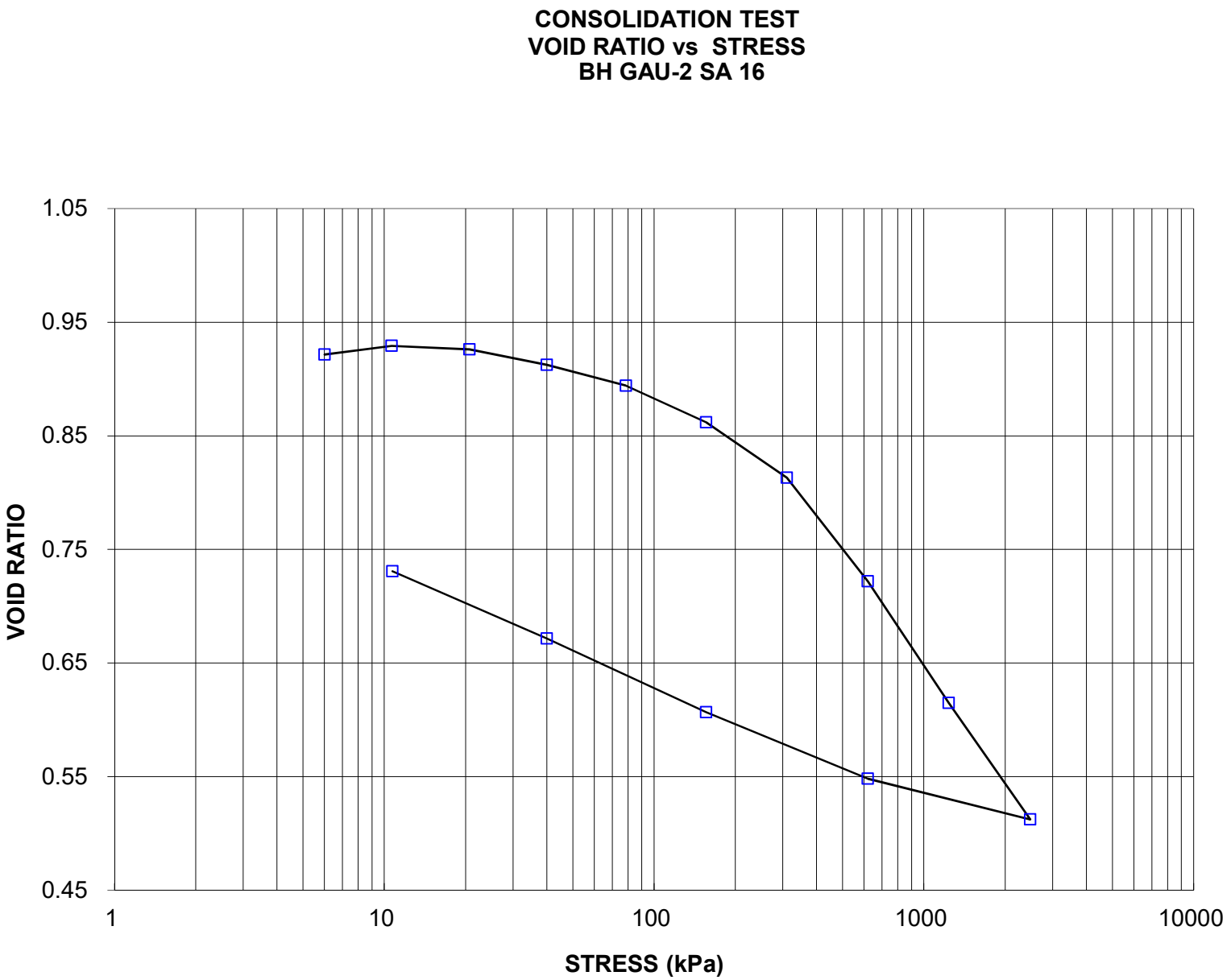
Checked By: MA/LCC

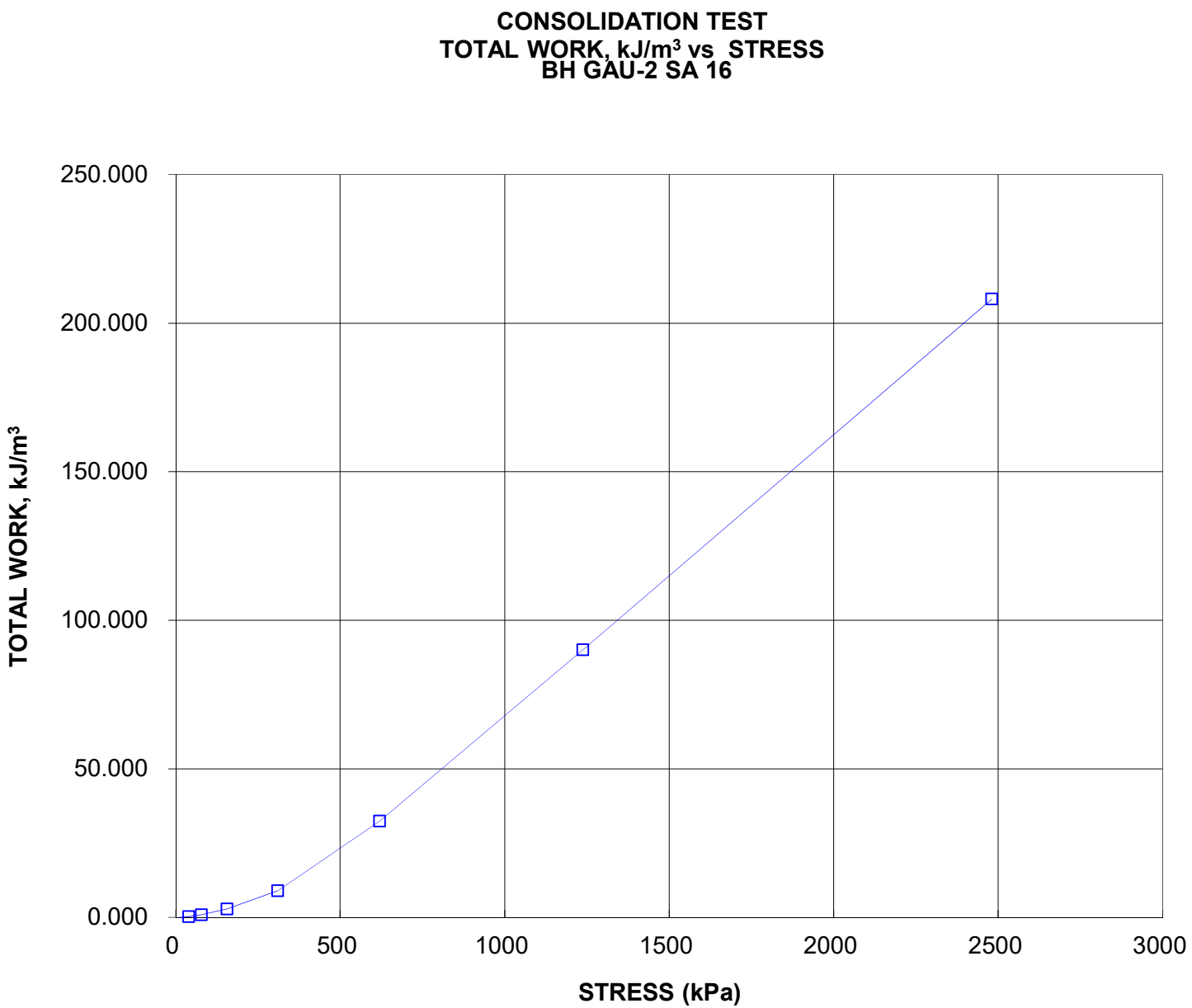
<div style="display: flex; justify-content: space-between;"> <div style="text-align: center;"> CONSOLIDATION TEST SUMMARY ASTM D2435/D2435M </div> <div style="text-align: center;"> FIGURE C-5A </div> </div>				
SAMPLE IDENTIFICATION				
Project Number	1671430(WO002)	Sample Number	16	
Borehole Number	GAU-2	Sample Depth, ft	18.29-18.90	
TEST CONDITIONS				
Test Type	Laboratory Standard	Load Duration, hr	24	
Oedometer Number	2			
Date Started	10/06/2018			
Date Completed	10/19/2018			
SAMPLE DIMENSIONS AND PROPERTIES - INITIAL				
Sample Height, cm	2.54	Unit Weight, kN/m ³	18.61	
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m ³	13.94	
Area, cm ²	31.65	Specific Gravity, measured	2.72	
Volume, cm ³	80.29	Solids Height, cm	1.325	
Water Content, %	33.55	Volume of Solids, cm ³	41.95	
Wet Mass, g	152.38	Volume of Voids, cm ³	38.35	
Dry Mass, g	114.1	Degree of Saturation, %	99.8	
TEST COMPUTATIONS				
	Corr.	Average		
Stress	Height	Void	Height	t ₉₀
kPa	cm	Ratio	cm	sec
				cv.
				m ² /s
				mv
				m ² /kN
				k
				cm/s
0.00	2.537	0.914	2.537	
6.01	2.547	0.922	2.542	
10.64	2.557	0.929	2.552	
20.68	2.553	0.926	2.555	1109
40.08	2.535	0.913	2.544	1750
78.73	2.510	0.894	2.523	1500
156.03	2.468	0.862	2.489	936
310.38	2.403	0.813	2.436	866
619.74	2.282	0.722	2.343	694
1237.93	2.141	0.615	2.211	578
2480.25	2.005	0.512	2.073	427
619.74	2.052	0.548	2.028	
156.03	2.130	0.607	2.091	
40.08	2.216	0.672	2.173	
10.72	2.294	0.731	2.255	
<p>Note:</p> <p>Consolidation loading and unloading schedule assigned by the client.</p> <p>cv and k are approximate only based on t₉₀ estimated from Square Root of Time Method (ASTMD2435/2435M)</p> <p>Specimen swelled under 10.64kPa.</p>				
SAMPLE DIMENSIONS AND PROPERTIES - FINAL				
Sample Height, cm	2.29	Unit Weight, kN/m ³	20.04	
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m ³	15.41	
Area, cm ²	31.65	Specific Gravity, measured	2.72	
Volume, cm ³	72.61	Solids Height, cm	1.325	
Water Content, %	30.04	Volume of Solids, cm ³	41.95	
Wet Mass, g	148.37	Volume of Voids, cm ³	30.66	
Dry Mass, g	114.1			
<div style="display: flex; justify-content: space-between;"> <div>Prepared By: LH</div> <div style="text-align: center;">Golder Associates</div> <div>Checked By:</div> </div>				

CONSOLIDATION TEST SUMMARY

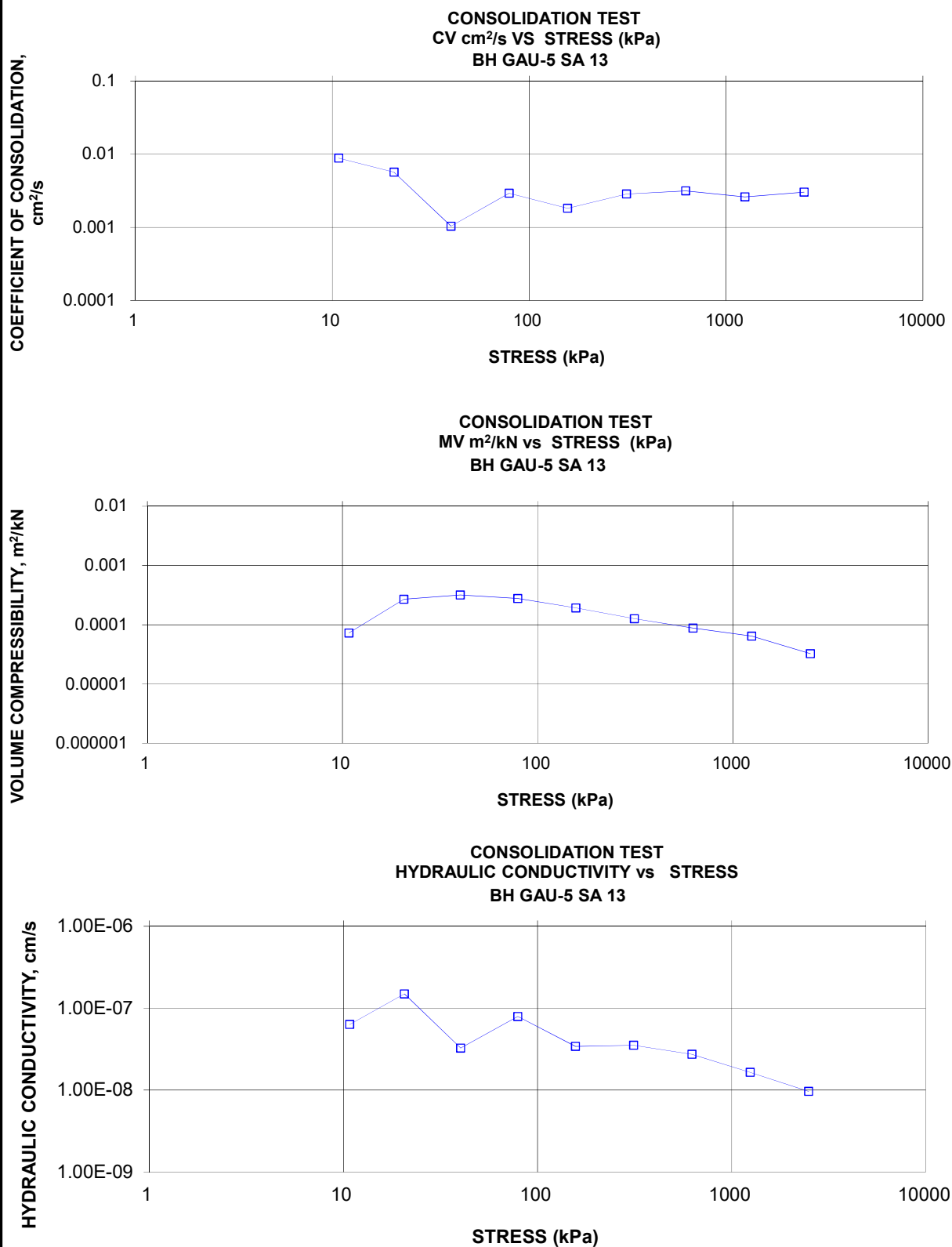
FIGURE C-5B

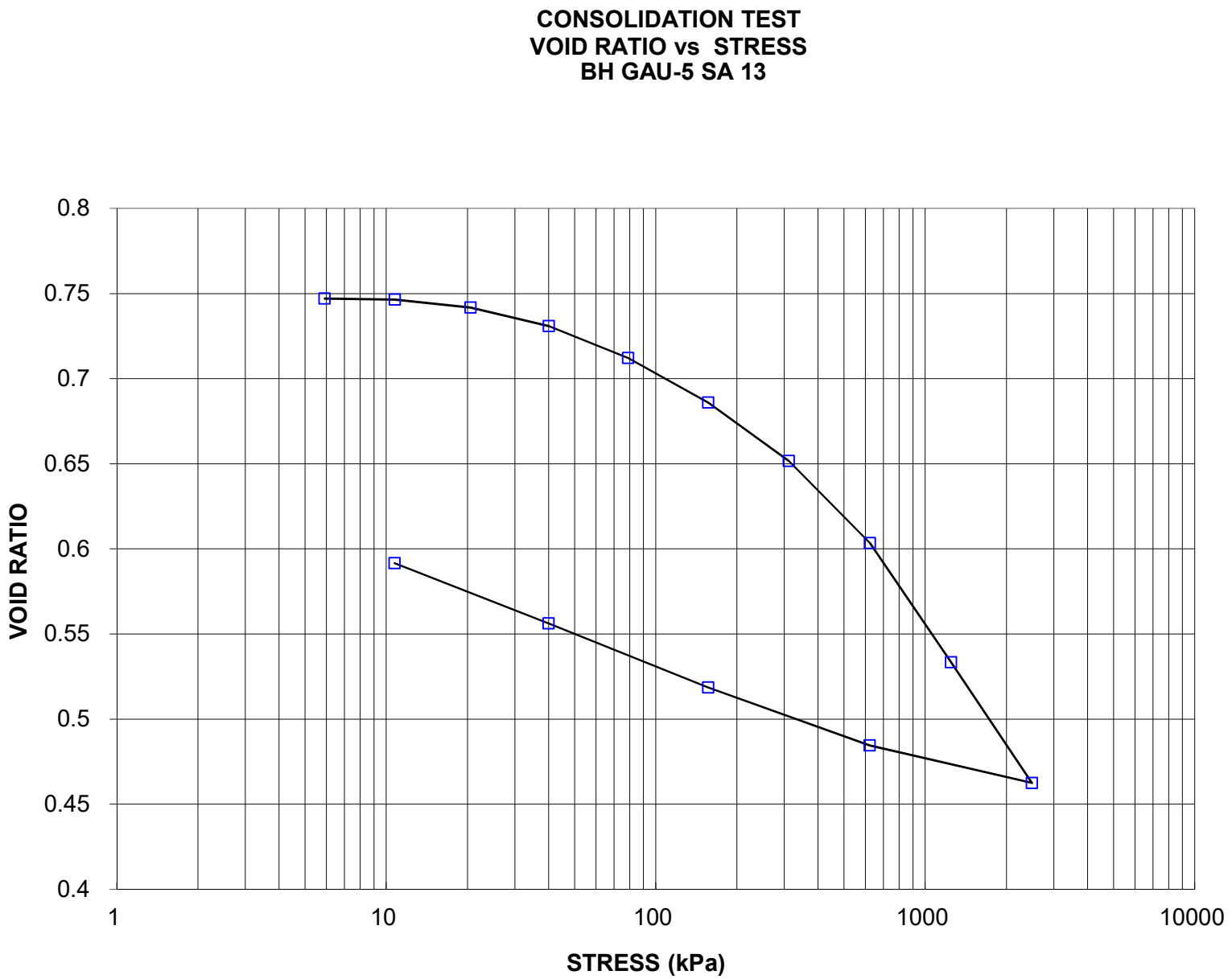


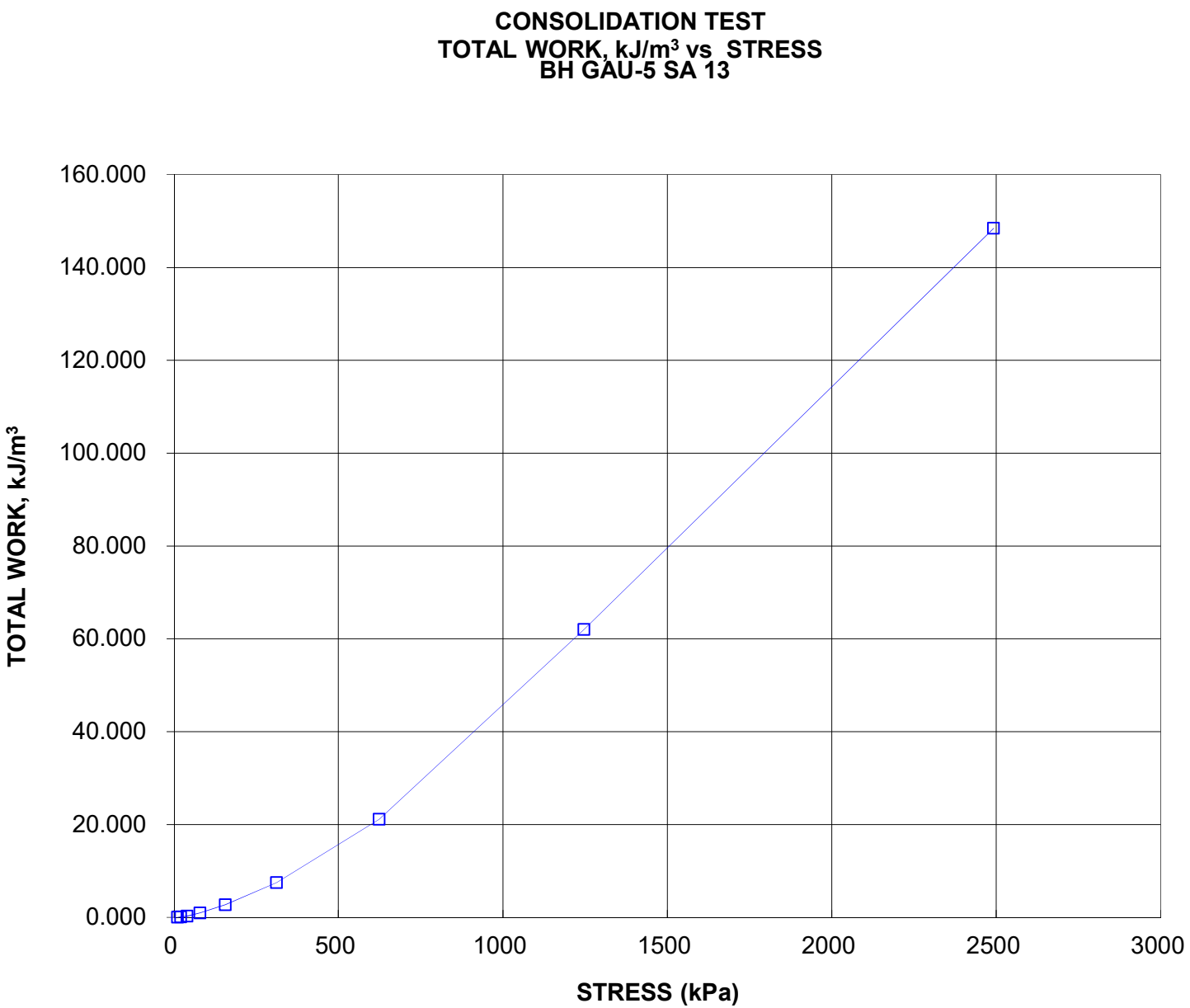




<div style="display: flex; justify-content: space-between;"> <div style="text-align: center;"> CONSOLIDATION TEST SUMMARY ASTM D2435/D2435M </div> <div style="text-align: center;"> FIGURE C-6A </div> </div>				
SAMPLE IDENTIFICATION				
Project Number	1671430(WO002)	Sample Number	13	
Borehole Number	GAU-5	Sample Depth, ft	15.24-15.70	
TEST CONDITIONS				
Test Type	Laboratory Standard	Load Duration, hr	24	
Oedometer Number	3			
Date Started	10/05/2018			
Date Completed	10/18/2018			
SAMPLE DIMENSIONS AND PROPERTIES - INITIAL				
Sample Height, cm	2.53	Unit Weight, kN/m ³	19.56	
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m ³	15.38	
Area, cm ²	31.48	Specific Gravity, measured	2.74	
Volume, cm ³	79.74	Solids Height, cm	1.450	
Water Content, %	27.16	Volume of Solids, cm ³	45.64	
Wet Mass, g	159.03	Volume of Voids, cm ³	34.10	
Dry Mass, g	125.06	Degree of Saturation, %	99.6	
TEST COMPUTATIONS				
	Corr.	Average		
Stress	Height	Void	Height	t ₉₀
kPa	cm	Ratio	cm	sec
				cv.
				mv
				k
				cm ² /s
				m ² /kN
				cm/s
0.00	2.533	0.747	2.533	
5.91	2.533	0.747	2.533	
10.77	2.532	0.746	2.533	154
20.58	2.525	0.742	2.529	240
40.10	2.510	0.731	2.518	1297
79.04	2.482	0.712	2.496	454
156.70	2.445	0.686	2.463	711
312.22	2.395	0.652	2.420	437
624.00	2.325	0.603	2.360	375
1246.74	2.223	0.533	2.274	421
2491.94	2.120	0.462	2.172	332
623.06	2.152	0.485	2.136	
156.70	2.202	0.519	2.177	
40.05	2.256	0.556	2.229	
10.74	2.308	0.592	2.282	
<p>Note:</p> <p>Consolidation loading and unloading schedule assigned by the client.</p> <p>cv and k are approximate only based on t₉₀ estimated from Square Root of Time Method (ASTMD2435/2435M)</p> <p>Specimen swelled under 5.91kPa.</p>				
SAMPLE DIMENSIONS AND PROPERTIES - FINAL				
Sample Height, cm	2.31	Unit Weight, kN/m ³	20.78	
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m ³	16.88	
Area, cm ²	31.48	Specific Gravity, measured	2.74	
Volume, cm ³	72.64	Solids Height, cm	1.450	
Water Content, %	23.08	Volume of Solids, cm ³	45.64	
Wet Mass, g	153.93	Volume of Voids, cm ³	27.00	
Dry Mass, g	125.06			
<div style="display: flex; justify-content: space-between;"> <div>Prepared By: LH</div> <div>Golder Associates</div> <div>Checked By:</div> </div>				







CONSOLIDATION TEST SUMMARY**FIGURE C-7A****ASTM D2435/D2435M****SAMPLE IDENTIFICATION**

Project Number	1671430(WO002)	Sample Number	10
Borehole Number	GAU-6	Sample Depth, ft	10.67-11.28

TEST CONDITIONS

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	4		
Date Started	10/05/2018		
Date Completed	10/17/2018		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m ³	18.98
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m ³	14.34
Area, cm ²	31.45	Specific Gravity, measured	2.78
Volume, cm ³	79.88	Solids Height, cm	1.336
Water Content, %	32.37	Volume of Solids, cm ³	42.01
Wet Mass, g	154.60	Volume of Voids, cm ³	37.87
Dry Mass, g	116.79	Degree of Saturation, %	99.8

TEST COMPUTATIONS

Stress kPa	Corr. Height cm	Void Ratio	Average		t ₉₀ sec	cv. cm ² /s	mv m ² /kN	k cm/s
	Height cm		Height cm					
0.00	2.540	0.901	2.540					
5.94	2.555	0.913	2.548					
10.80	2.570	0.924	2.563					
20.57	2.570	0.924	2.570	317	4.42E-03	2.01E-05	8.72E-09	
40.14	2.557	0.914	2.563	778	1.79E-03	2.51E-04	4.41E-08	
79.10	2.534	0.897	2.545	756	1.82E-03	2.37E-04	4.31E-08	
156.94	2.507	0.877	2.520	360	3.74E-03	1.36E-04	4.97E-08	
312.60	2.467	0.846	2.487	413	3.17E-03	1.02E-04	3.16E-08	
624.05	2.391	0.790	2.429	452	2.77E-03	9.53E-05	2.58E-08	
1251.00	2.219	0.661	2.305	554	2.03E-03	1.08E-04	2.15E-08	
2495.95	2.074	0.553	2.147	470	2.08E-03	4.59E-05	9.35E-09	
624.05	2.122	0.589	2.098					
157.01	2.200	0.647	2.161					
40.13	2.288	0.713	2.244					
10.78	2.365	0.770	2.326					

Note:

Consolidation loading and unloading schedule assigned by the client.

cv and k are approximate only based on t₉₀ estimated from Square Root of Time Method (ASTMD2435/2435M)

Specimen swelled under 10.80kPa.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

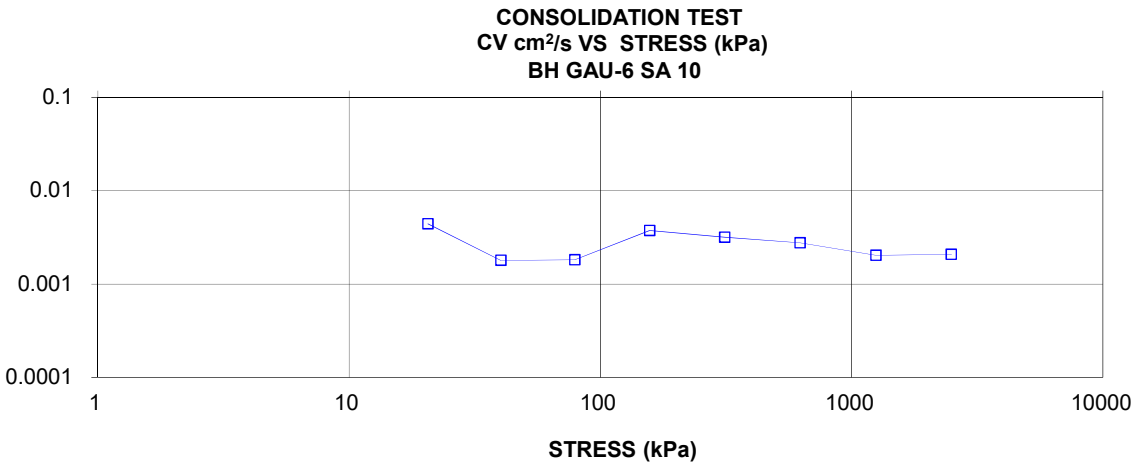
Sample Height, cm	2.36	Unit Weight, kN/m ³	19.90
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m ³	15.40
Area, cm ²	31.45	Specific Gravity, measured	2.78
Volume, cm ³	74.38	Solids Height, cm	1.336
Water Content, %	29.20	Volume of Solids, cm ³	42.01
Wet Mass, g	150.89	Volume of Voids, cm ³	32.37
Dry Mass, g	116.79		

Prepared By: LH

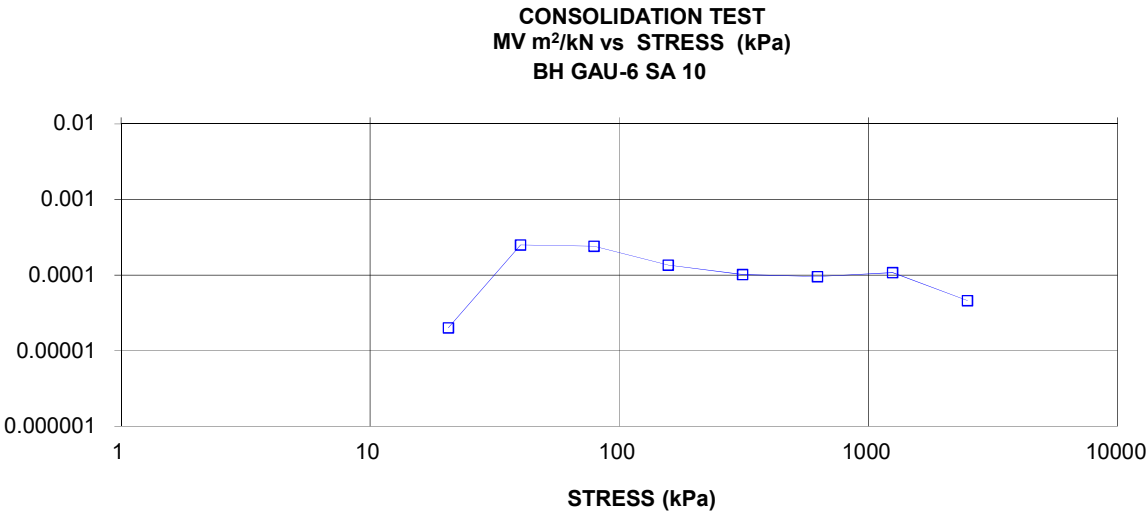
Golder Associates

Checked By:

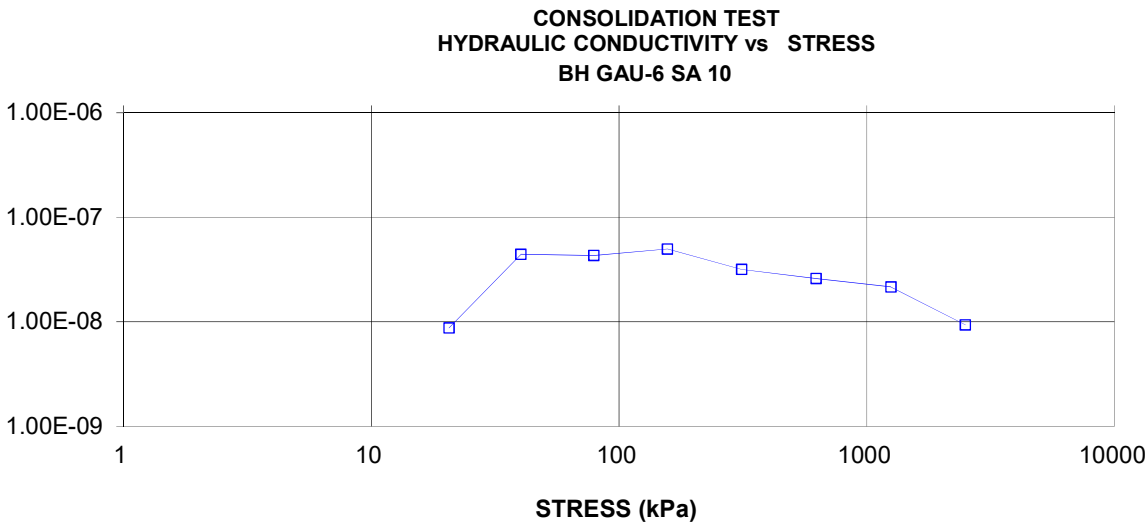
COEFFICIENT OF CONSOLIDATION,
cm²/s

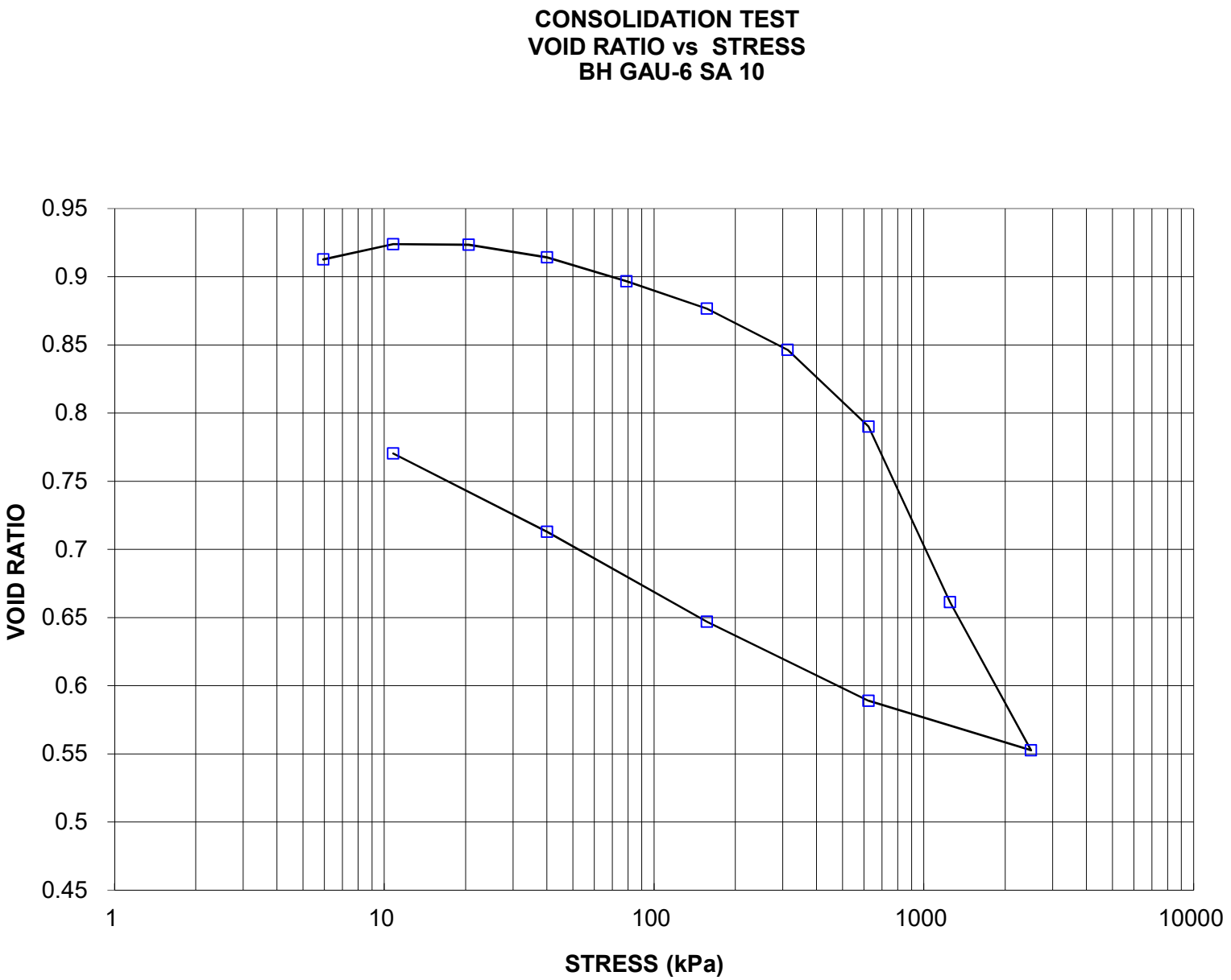


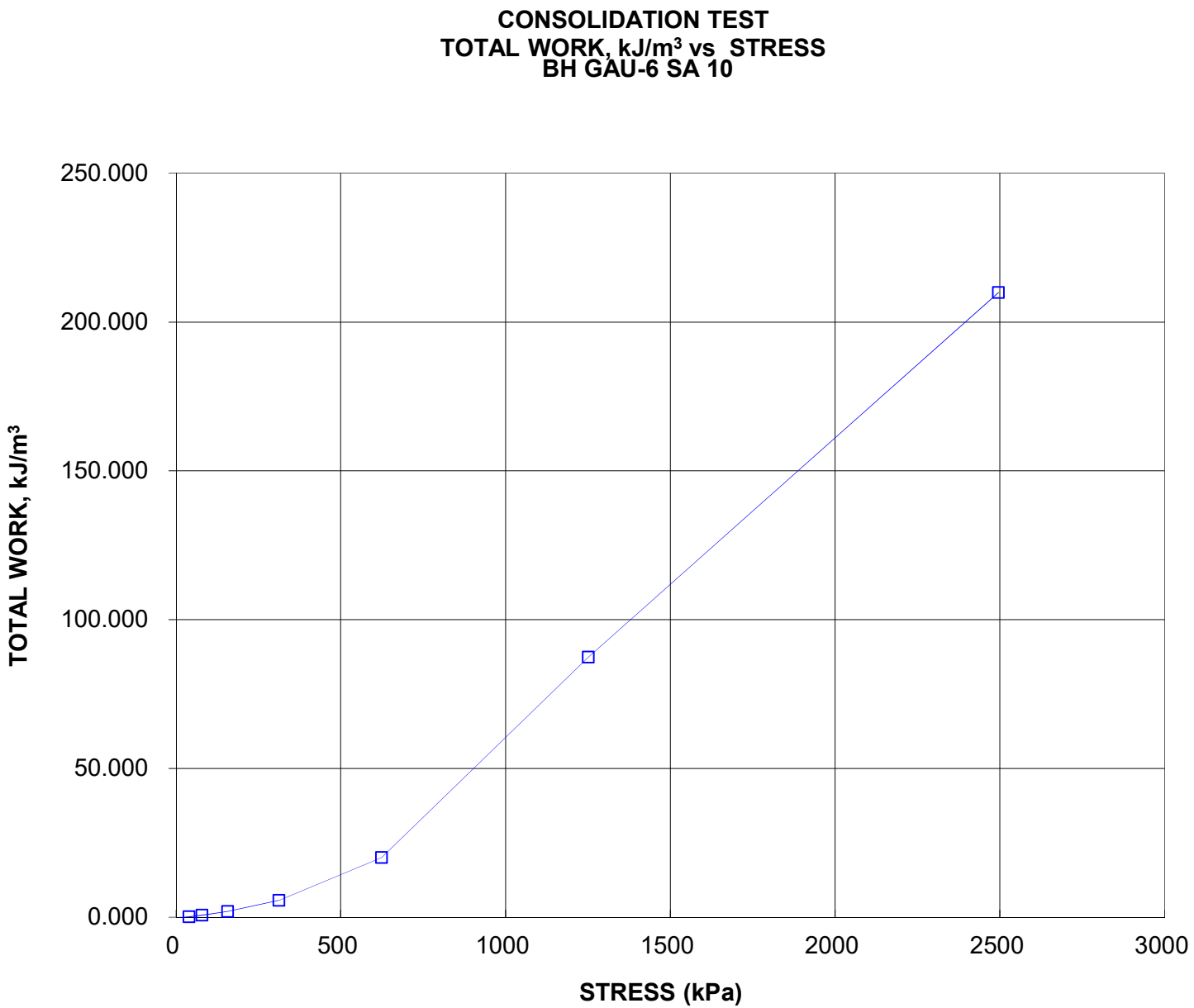
VOLUME COMPRESSIBILITY, m²/kN



HYDRAULIC CONDUCTIVITY, cm/s



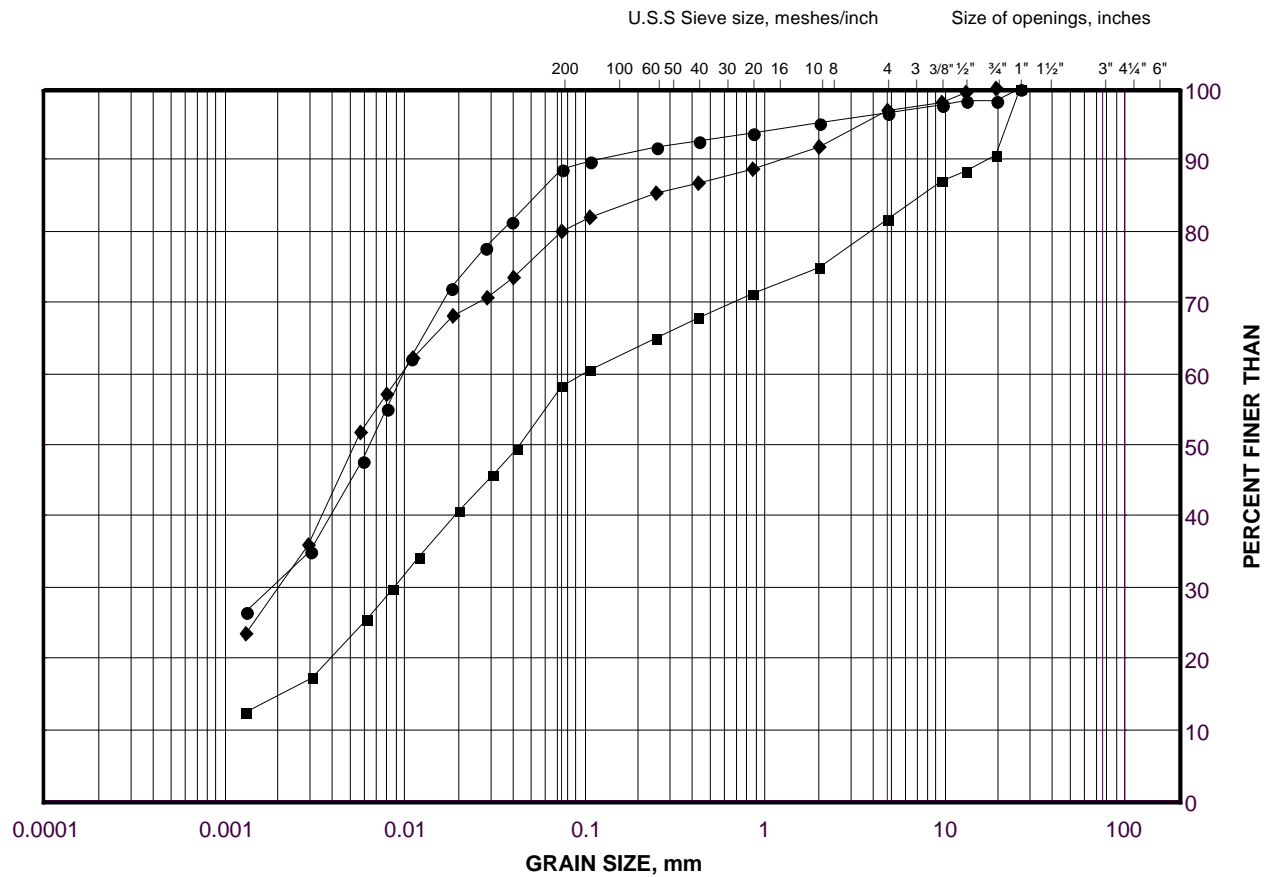




GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE C-8



LEGEND

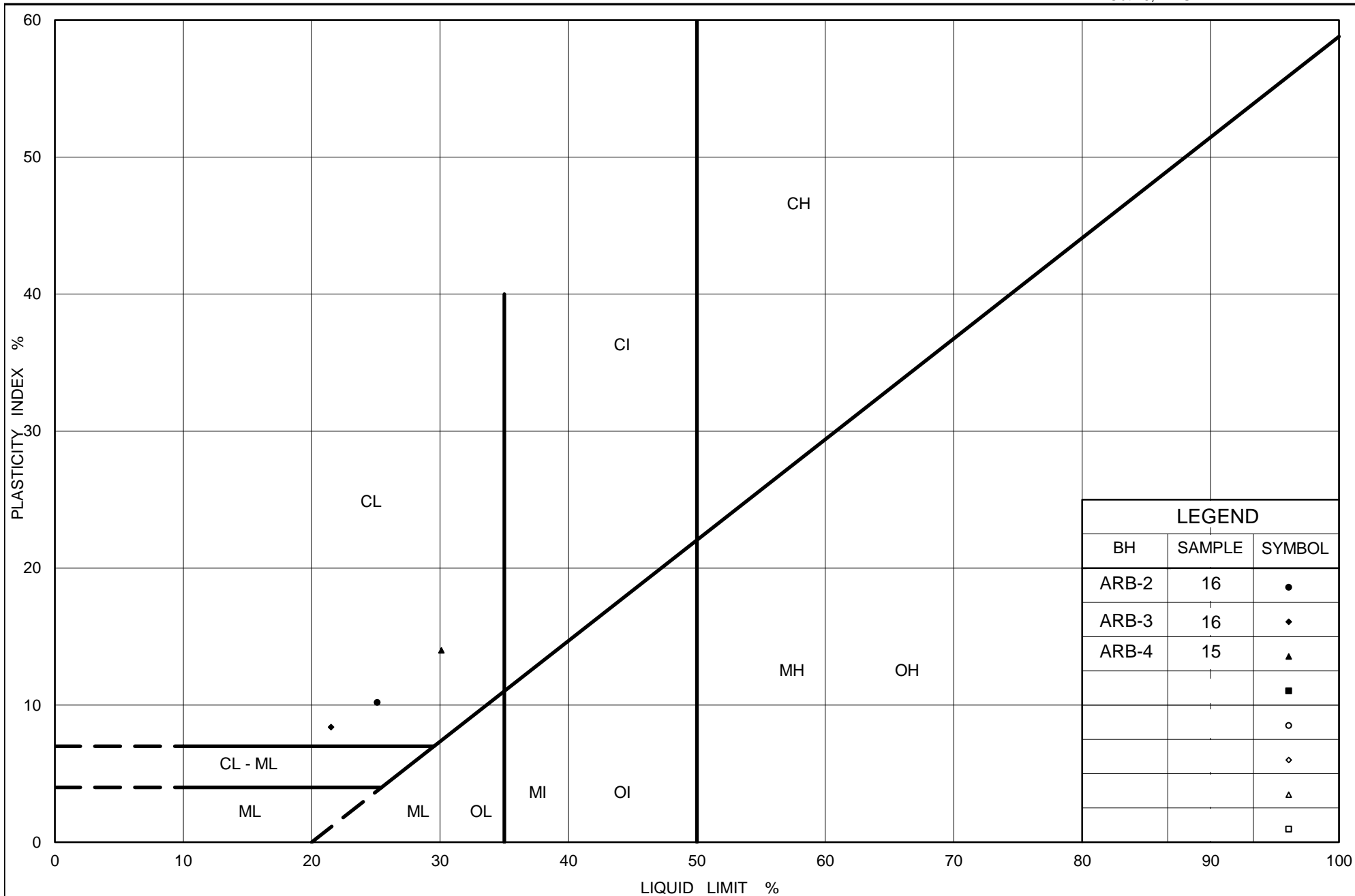
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ARB-4	15	98.5
■	ARB-3	16	96.2
◆	ARB-2	16	99.8

Project Number: 1671430

Checked By: MA/LCC

Golder Associates

Date: 22-Apr-19



Ministry of Transportation

Ontario

PLASTICITY CHART

Clayey Silt

Figure No. C-9

Project No. 1671430 (WO 002)

Checked By: MA/LCC

Silt and Sand to Silt

U.S.S Sieve size, meshes/inch

Size of openings, inches

PERCENT FINER THAN

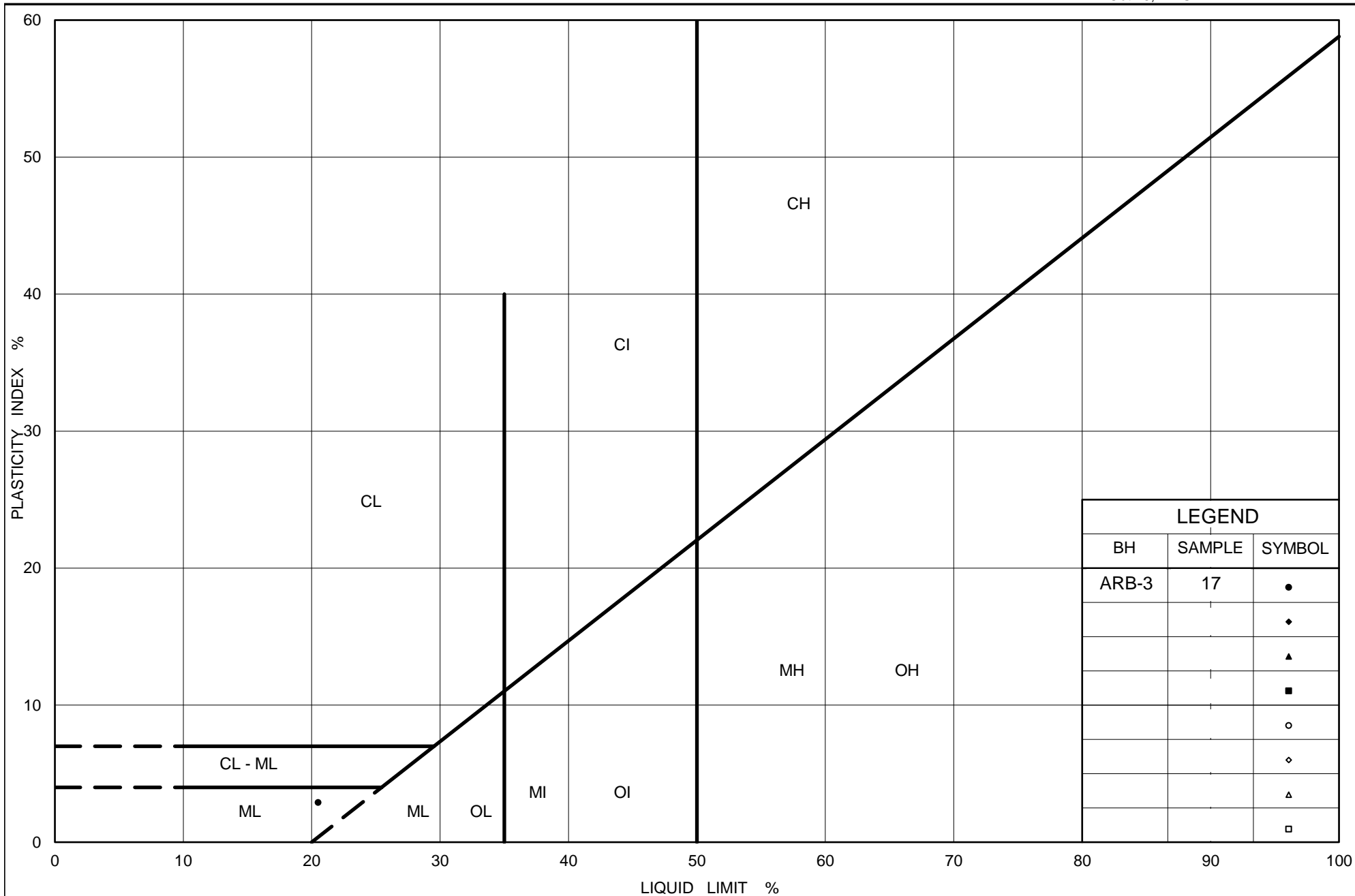
GRAIN SIZE, mm

Grain Size (mm)	Percent Finer (%) - Squares	Percent Finer (%) - Circles	Percent Finer (%) - Diamonds
0.075	100	100	100
0.15	100	100	100
0.3	100	100	100
0.6	100	100	100
1.2	100	100	100
2.5	100	100	100
5.0	100	100	100
10.0	100	100	100
20.0	100	100	100
40.0	100	100	100
80.0	100	100	100
150.0	100	100	100
300.0	100	100	100
600.0	100	100	100
1200.0	100	100	100
2500.0	100	100	100
5000.0	100	100	100
10000.0	100	100	100
20000.0	100	100	100
40000.0	100	100	100
80000.0	100	100	100
160000.0	100	100	100
320000.0	100	100	100
640000.0	100	100	100
1280000.0	100	100	100
2560000.0	100	100	100
5120000.0	100	100	100
10240000.0	100	100	100
20480000.0	100	100	100
40960000.0	100	100	100
81920000.0	100	100	100
163840000.0	100	100	100
327680000.0	100	100	100
655360000.0	100	100	100
1310720000.0	100	100	100
2621440000.0	100	100	100
5242880000.0	100	100	100
10485760000.0	100	100	100
20971520000.0	100	100	100
41943040000.0	100	100	100
83886080000.0	100	100	100
167772160000.0	100	100	100
335544320000.0	100	100	100
671088640000.0	100	100	100
1342177280000.0	100	100	100
2684354560000.0	100	100	100
5368709120000.0	100	100	100
10737418240000.0	100	100	100
21474836480000.0	100	100	100
42949672960000.0	100	100	100
85899345920000.0	100	100	100
171798691840000.0	100	100	100
343597383680000.0	100	100	100
687194767360000.0	100	100	100
1374389534720000.0	100	100	100
2748779069440000.0	100	100	100
5497558138880000.0	100	100	100
10995116277760000.0	100	100	100
21990232555520000.0	100	100	100
43980465111040000.0	100	100	100
87960930222080000.0	100	100	100
175921860444160000.0	100	100	100
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703687441776640000.0	100	100	100
1407374883553280000.0	100	100	100
2814749767106560000.0	100	100	100
5629499534213120000.0	100	100	100
11258999068426240000.0	100	100	100
22517998136852480000.0	100	100	100
45035996273704960000.0	100	100	100
90071992547409920000.0	100	100	100
180143985094819840000.0	100	100	100
360287970			

SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ARB-4	17	92.5
■	ARB-3	17	93.0
◆	ARB-2	20	92.4

Date: 22-Apr-19



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PLASTICITY CHART

Silt

Figure No. C-11

Project No. 1671430 (WO 002)

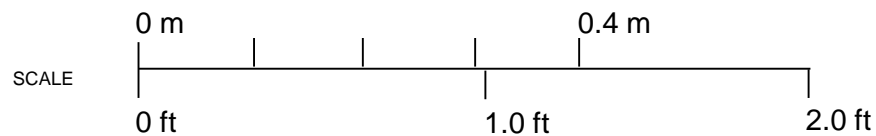
Checked By: MA/LCC



Borehole ARB-2: Bedrock cored between depths of about 32.6 m to 36.3 m



Borehole ARB-3: Bedrock cored between depths of about 30.0 m to 33.2 m



January 22, 2019

Mr. Eric Naylor
Golder Associates Ltd.
6925 Century Avenue, Suite #100
Mississauga, Ontario
Canada L5N 7K2

Re: UCS testing
(Golder Project No. 1671430 WO-2)

Dear Mr. Naylor:

On November 15, 2018 six (6) HQ-sized samples were received by Geomechanica Inc. via drop-off by Golder Personnel. These samples were identified as being from Golder project 1671430 WO-2 (QEW Niagara). From these samples, three (3) UCS tests were completed.

Details regarding the steps of specimen preparation and testing along with the test results and photographs of the test specimens before and after testing are presented in the accompanying laboratory report and spreadsheet.

Sincerely,



Bryan Tatone Ph.D., P. Eng.

Geomechanica Inc.
Tel: (647) 478-9767
Email: bryan.tatone@geomechanica.com

Rock Laboratory Testing Results

A report submitted to:

Eric Naylor
Golder Associates Ltd.
6925 Century Avenue, Suite #100
Mississauga, Ontario
Canada L5N 7K2

Prepared by:

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January 22, 2019

Project number: 1671430-W02

Abstract

This document summarizes the results of rock laboratory testing, including the results of 3 Uniaxial Compressive Strength (UCS) tests. These samples are from a drilling investigation for the QEW Niagara Project (Golder Project No. 1671430-WO2). Results including uniaxial compressive strength (UCS) along with photographs of samples before and after testing are presented herein.

In this document:

1 Uniaxial Compressive Strength Tests	1
Appendices	3

1 Uniaxial Compressive Strength Tests

1.1 Overview

This section summarizes the results of uniaxial compressive strength (UCS) testing of HQ-sized specimens. The testing was performed in Geomechanica's rock testing laboratory using a 150 ton (1.3 MN) Forney loading frame equipped with pressure-compensated control valve to maintain an axial displacement rate of approximately 0.100 mm/min (Figure 1). The preparation and testing of each specimen included the following:

1. Unwrapping of the core sample, inspecting it for damage, and re-wrapping it in electrical tape to minimize exposure to moisture during subsequent specimen preparation.
2. Diamond cutting of core sample to obtain cylindrical specimens with an appropriate length (length:diameter = 2:1) and nearly parallel end faces.
3. Diamond grinding of specimen to obtain flat (within ± 0.025 mm) and parallel end faces (within 0.25°).
4. Placing specimen into the loading frame, applying a 1 kN axial load, and removing the electrical tape.
5. Axially loading the specimens to rupture while continuously recording axial force and axial deformation to determine the peak strength (UCS).



Figure 1: Forney loading frame setup for uniaxial compression testing.

Using a precision V-block mounted on the magnetic chuck of the surface grinder, test specimens met the end flatness, end parallelism, and perpendicularity criteria set out in ASTM D4543-08. The side straightness criteria, as checked with a feeler gauge, was met for all samples and the minimum length:diameter criteria was met for all specimens unless noted otherwise in Table 1. Testing of the specimens followed ASTM D7012-14 Method C with the following exceptions:

- Rather than a spherical seat diameter equal to 1 to 2 times the specimen diameter, the setup used here employed a 25.4 mm diameter high precision ball bearing and seat. Despite the smaller diameter, this seat could move freely to accommodate small angular rotations in any direction, as needed, and therefore did not appreciably influence the results.

1.2 Results

The testing results are summarized in Table 1. Please note that additional specimen details and measurements are provided in the summary spreadsheet that accompanies this report.

Table 1: Summary of Uniaxial Compression test results.

Sample	Depth (m)	Bulk density ρ (g/cm ³)	UCS (MPa)	Lithology	Failure description
GAU-3	32.03 - 32.23	2.659	13.7	Red mudstone	1
GAU-5	29.64 - 29.80	2.659	25.7	Red mudstone with green reduction zone	1
GAU-7	32.62 - 32.85	2.669	24.5	Red mudstone	1
Average		2.663	21.3		
Standard deviation		0.005	5.4		

¹ Axial splitting failure

1.3 Specimen photographs



Photographs of the specimens prior to and after testing are presented in the Appendix.

Appendices



Specimen sheets

- GAU-3
- GAU-5
- GAU-7



Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	1671430-W02												
Sample	GAU-3	Depth	32.03 - 32.23												
<div>Specimen parameters</div> <table><tr><td>Diameter (mm) ^a</td><td>63.14</td></tr><tr><td>Length (mm) ^a</td><td>125.56</td></tr><tr><td>Bulk density ρ (g/cm³)</td><td>2.659</td></tr><tr><td>UCS (MPa)</td><td>13.7</td></tr><tr><td>Lithology</td><td>Red mudstone</td></tr><tr><td>Failure description ^b</td><td>1</td></tr></table>		Diameter (mm) ^a	63.14	Length (mm) ^a	125.56	Bulk density ρ (g/cm ³)	2.659	UCS (MPa)	13.7	Lithology	Red mudstone	Failure description ^b	1	<div>Prior to testing</div> 	<div>After testing</div> 
Diameter (mm) ^a	63.14														
Length (mm) ^a	125.56														
Bulk density ρ (g/cm ³)	2.659														
UCS (MPa)	13.7														
Lithology	Red mudstone														
Failure description ^b	1														
<div>^a Additional specimen measurement/details provides in accompanying summary spreadsheet.</div> <div>^b Failure description: ¹ Axial splitting failure;</div>															
Remarks:															
Performed by	BSAT	Date	2018-12-18												

Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	1671430-W02
Sample	GAU-5	Depth	29.64 - 29.80
Specimen parameters		Prior to testing	After testing
Diameter (mm) ^a	62.84		
Length (mm) ^a	125.14		
Bulk density ρ (g/cm ³)	2.659		
UCS (MPa)	25.7		
Lithology	Red mudstone with green reduction		
Failure description ^b	1		
^a Additional specimen measurement/details provides in accompanying summary spreadsheet.			
^b Failure description: ¹ Axial splitting failure;			
Remarks:			
Performed by	BSAT	Date	2018-12-18

Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	1671430-W02												
Sample	GAU-7	Depth	32.62 - 32.85												
<div><div>Specimen parameters</div><table><tr><td>Diameter (mm) ^a</td><td>63.22</td></tr><tr><td>Length (mm) ^a</td><td>127.52</td></tr><tr><td>Bulk density ρ (g/cm³)</td><td>2.669</td></tr><tr><td>UCS (MPa)</td><td>24.5</td></tr><tr><td>Lithology</td><td>Red mudstone</td></tr><tr><td>Failure description ^b</td><td>1</td></tr></table></div>		Diameter (mm) ^a	63.22	Length (mm) ^a	127.52	Bulk density ρ (g/cm ³)	2.669	UCS (MPa)	24.5	Lithology	Red mudstone	Failure description ^b	1	<div>Prior to testing</div> 	<div>After testing</div> 
Diameter (mm) ^a	63.22														
Length (mm) ^a	127.52														
Bulk density ρ (g/cm ³)	2.669														
UCS (MPa)	24.5														
Lithology	Red mudstone														
Failure description ^b	1														
<div><div>^a Additional specimen measurement/details provides in accompanying summary spreadsheet.</div><div>^b Failure description: ¹ Axial splitting failure;</div></div>															
Remarks:															
Performed by	BSAT	Date	2018-12-18												

APPENDIX D

Analytical Laboratory Test Results

Your Project #: 1671430-W02
Your C.O.C. #: 641804-06-01

Attention: Nikol Kochmanova

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2018/12/12
Report #: R5522779
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8W6764

Received: 2018/12/06, 12:29

Sample Matrix: Soil
Samples Received: 3

Analyses	Date		Date Analyzed	Laboratory Method	Reference
	Quantity	Extracted			
Chloride (20:1 extract)	3	N/A	2018/12/12	CAM SOP-00463	EPA 325.2 m
Conductivity	3	N/A	2018/12/12	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl ₂ EXTRACT	3	2018/12/11	2018/12/11	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	3	2018/12/06	2018/12/12	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	3	N/A	2018/12/12	CAM SOP-00464	EPA 375.4 m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ema Gitej, Senior Project Manager

Your Project #: 1671430-W02
Your C.O.C. #: 641804-06-01

Attention: Nikol Kochmanova

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2018/12/12
Report #: R5522779
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8W6764

Received: 2018/12/06, 12:29

Email: EGitej@maxxam.ca

Phone# (905)817-5829

=====

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

SOIL CORROSIVITY PACKAGE (SOIL)

Maxxam ID		IMF982	IMF983			IMF983			IMF984		
Sampling Date		2018/08/20	2018/08/01			2018/08/01			2018/08/15		
COC Number		641804-06-01	641804-06-01			641804-06-01			641804-06-01		
	UNITS	GAU5-SS6	GAU6-SS9	RDL	QC Batch	GAU6-SS9 Lab-Dup	RDL	QC Batch	GAU2-SS11	RDL	QC Batch

Calculated Parameters

Resistivity	ohm-cm	460	470		5875238				390		5875238
-------------	--------	-----	-----	--	---------	--	--	--	-----	--	---------

Inorganics

Soluble (20:1) Chloride (Cl-)	ug/g	120	49	20	5883832				51	20	5883832
Conductivity	umho/cm	2160	2150	2	5883994				2570	2	5883994
Available (CaCl2) pH	pH	7.97	7.99		5881793				7.82		5881793
Soluble (20:1) Sulphate (SO4)	ug/g	2600	2900	100	5883876	3000	100	5883876	3400	100	5883876

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

Maxxam ID		IMF984		
Sampling Date		2018/08/15		
COC Number		641804-06-01		
	UNITS	GAU2-SS11 Lab-Dup	RDL	QC Batch
Inorganics				
Soluble (20:1) Chloride (Cl-)	ug/g	52	20	5883832
RDL = Reportable Detection Limit				
QC Batch = Quality Control Batch				
Lab-Dup = Laboratory Initiated Duplicate				

TEST SUMMARY

Maxxam ID: IMF982
Sample ID: GAU5-SS6
Matrix: Soil

Collected: 2018/08/20
Shipped:
Received: 2018/12/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5883832	N/A	2018/12/12	Deonarine Ramnarine
Conductivity	AT	5883994	N/A	2018/12/12	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5881793	2018/12/11	2018/12/11	Gnana Thomas
Resistivity of Soil		5875238	2018/12/12	2018/12/12	Anastassia Hamanov
Sulphate (20:1 Extract)	KONE/EC	5883876	N/A	2018/12/12	Deonarine Ramnarine

Maxxam ID: IMF983
Sample ID: GAU6-SS9
Matrix: Soil

Collected: 2018/08/01
Shipped:
Received: 2018/12/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5883832	N/A	2018/12/12	Deonarine Ramnarine
Conductivity	AT	5883994	N/A	2018/12/12	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5881793	2018/12/11	2018/12/11	Gnana Thomas
Resistivity of Soil		5875238	2018/12/12	2018/12/12	Anastassia Hamanov
Sulphate (20:1 Extract)	KONE/EC	5883876	N/A	2018/12/12	Deonarine Ramnarine

Maxxam ID: IMF983 Dup
Sample ID: GAU6-SS9
Matrix: Soil

Collected: 2018/08/01
Shipped:
Received: 2018/12/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphate (20:1 Extract)	KONE/EC	5883876	N/A	2018/12/12	Deonarine Ramnarine

Maxxam ID: IMF984
Sample ID: GAU2-SS11
Matrix: Soil

Collected: 2018/08/15
Shipped:
Received: 2018/12/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5883832	N/A	2018/12/12	Deonarine Ramnarine
Conductivity	AT	5883994	N/A	2018/12/12	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5881793	2018/12/11	2018/12/11	Gnana Thomas
Resistivity of Soil		5875238	2018/12/12	2018/12/12	Anastassia Hamanov
Sulphate (20:1 Extract)	KONE/EC	5883876	N/A	2018/12/12	Deonarine Ramnarine

Maxxam ID: IMF984 Dup
Sample ID: GAU2-SS11
Matrix: Soil

Collected: 2018/08/15
Shipped:
Received: 2018/12/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5883832	N/A	2018/12/12	Deonarine Ramnarine

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	5.3°C
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Conductivity Analysis: Analysis was performed past sample holding time. This may increase the variability associated with these results.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1671430-W02
Sampler Initials: KNE

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5881793	Available (CaCl ₂) pH	2018/12/11			100	97 - 103			0.10	N/A
5883832	Soluble (20:1) Chloride (Cl ⁻)	2018/12/12	NC	70 - 130	102	70 - 130	<20	ug/g	0.57	35
5883876	Soluble (20:1) Sulphate (SO ₄)	2018/12/12	NC	70 - 130	104	70 - 130	<20	ug/g	4.4	35
5883994	Conductivity	2018/12/12			103	90 - 110	<2	umho/cm	0.65	10

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Anastassia Hamanov, Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics <small>5740 Campbell Road, Mississauga, Ontario Canada L5N 2L8 Tel: (905) 817-5700 Toll-free 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca</small>										CHAIN OF CUSTODY RECORD																																																																																																																																	
INVOICE TO:										REPORT TO:										PROJECT INFORMATION:										Laboratory Use Only:																																																																																																													
Company Name: #1326 Golder Associates Ltd Attention: Accounts Payable Address: 6925 Century Ave Suite 100 Mississauga ON L5N 7K2 Tel: (905) 567-4444 x Fax: (905) 567-6561 x Email: AP_CustomerService@golder.com										Company Name: Golder Associates Ltd. Attention: Nikol Kochmanova Address: " Tel: " Fax: " Email: Nikol-Kochmanova@golder.com										Quotation #: 870916 P.O. #: " Project: 1671430-W02 Project Name: " Site #: " Sampled By: KN/EN										Maxxam Job #: " Bottle Order #: 641804 COC #: " Project Manager: Ema Gitej C#641804-06-01																																																																																																													
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY										ANALYSIS REQUESTED (PLEASE BE SPECIFIC)										Turnaround Time (TAT) Required: Please provide advance notice for rush projects																																																																																																																							
Regulation 153 (2011) <input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Medium/Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> For RSC <input type="checkbox"/> Table "										Other Regulations <input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> Reg 558 <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> MISA Municipality " <input type="checkbox"/> PWQO <input type="checkbox"/> Other "										Special Instructions Field Filtered (please circle): Metals / Hg / Cr VI Standard Corrosion Package										Regular (Standard) TAT: (will be applied if Rush TAT is not specified): Standard TAT = 5-7 Working days for most tests. Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.																																																																																																													
Include Criteria on Certificate of Analysis (Y/N)?										Job Specific Rush TAT (if applies to entire submission) Date Required: " Time Required: " Rush Confirmation Number: " (call lab for #)										# of Bottles Comments																																																																																																																							
<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th>Sample Barcode Label</th> <th>Sample (Location) Identification</th> <th>Date Sampled</th> <th>Time Sampled</th> <th>Matrix</th> <th>Field Filtered</th> <th>Metals</th> <th>Hg</th> <th>Cr VI</th> <th>Standard Corrosion</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>GAU5-SS6</td> <td>2018/8/20</td> <td>AM</td> <td>SOIL</td> <td>X</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>2</td> <td>GAU6-SS9</td> <td>2018/08/01</td> <td>AM</td> <td>SOIL</td> <td>X</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>3</td> <td>GAU2-SS11</td> <td>2018/08/15</td> <td>AM</td> <td>SOIL</td> <td>X</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr><td>4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>6</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>7</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>9</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>10</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> </tbody> </table>										Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered	Metals	Hg	Cr VI	Standard Corrosion	1	GAU5-SS6	2018/8/20	AM	SOIL	X					2	GAU6-SS9	2018/08/01	AM	SOIL	X					3	GAU2-SS11	2018/08/15	AM	SOIL	X					4										5										6										7										8										9										10																													
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																																								Time Sensitive										Temperature (°C) on Reel 8/3/5										Custody Seal <input checked="" type="checkbox"/> Present <input type="checkbox"/> Intact										Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>																																																																					
<small>* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.</small>										<small>* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.</small>										<small>** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.</small>										White: Maxxa Yellow: Client										SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM																																																																																																			

Your Project #: 1671430 W02
Site Location: QEW GLENDALE
Your C.O.C. #: 641804-11-01

Attention: Nikol Kochmanova

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2019/01/23
Report #: R5567997
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B915672

Received: 2019/01/18, 10:35

Sample Matrix: Soil
Samples Received: 2

Analyses	Date		Date Analyzed	Laboratory Method	Reference
	Quantity	Extracted			
Chloride (20:1 extract)	2	N/A	2019/01/23	CAM SOP-00463	EPA 325.2 m
Conductivity	2	N/A	2019/01/22	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	2	2019/01/22	2019/01/22	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	2	2019/01/19	2019/01/22	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	2	N/A	2019/01/23	CAM SOP-00464	EPA 375.4 m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

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Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your Project #: 1671430 W02
Site Location: QEW GLENDALE
Your C.O.C. #: 641804-11-01

Attention: Nikol Kochmanova

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2019/01/23
Report #: R5567997
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B915672
Received: 2019/01/18, 10:35

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ema Gitej, Senior Project Manager
Email: EGitej@maxxam.ca
Phone# (905)817-5829

=====

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RESULTS OF ANALYSES OF SOIL

Maxxam ID		IUD596		IUD597		
Sampling Date		2018/10/26		2018/10/22		
COC Number		641804-11-01		641804-11-01		
	UNITS	ARB2 SA5	RDL	ARB3 SA6	RDL	QC Batch
Calculated Parameters						
Resistivity	ohm-cm	1600		560		5936840
Inorganics						
Soluble (20:1) Chloride (Cl-)	ug/g	77	20	22	20	5940294
Conductivity	umho/cm	643	2	1790	2	5940019
Available (CaCl2) pH	pH	7.78		8.03		5939853
Soluble (20:1) Sulphate (SO4)	ug/g	400	20	2800	100	5940279
RDL = Reportable Detection Limit						
QC Batch = Quality Control Batch						

Maxxam Job #: B915672
Report Date: 2019/01/23

Golder Associates Ltd
Client Project #: 1671430 W02
Site Location: QEW GLENDALE
Sampler Initials: JMP

TEST SUMMARY

Maxxam ID: IUD596
Sample ID: ARB2 SA5
Matrix: Soil

Collected: 2018/10/26
Shipped:
Received: 2019/01/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5940294	N/A	2019/01/23	Deonarine Ramnarine
Conductivity	AT	5940019	N/A	2019/01/22	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5939853	2019/01/22	2019/01/22	Gnana Thomas
Resistivity of Soil		5936840	2019/01/22	2019/01/22	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5940279	N/A	2019/01/23	Deonarine Ramnarine

Maxxam ID: IUD597
Sample ID: ARB3 SA6
Matrix: Soil

Collected: 2018/10/22
Shipped:
Received: 2019/01/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5940294	N/A	2019/01/23	Deonarine Ramnarine
Conductivity	AT	5940019	N/A	2019/01/22	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5939853	2019/01/22	2019/01/22	Gnana Thomas
Resistivity of Soil		5936840	2019/01/22	2019/01/22	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5940279	N/A	2019/01/23	Deonarine Ramnarine

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	9.0°C
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pH, Chloride, Sulphate, Conductivity/Resistivity: Sample submitted and analyzed past the recommended sample hold time. This may increase the variability associated with these results.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1671430 W02
Site Location: QEW GLENDALE
Sampler Initials: JMP

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5939853	Available (CaCl ₂) pH	2019/01/22			100	97 - 103			1.0	N/A
5940019	Conductivity	2019/01/22			103	90 - 110	<2	umho/cm	0.68	10
5940279	Soluble (20:1) Sulphate (SO ₄)	2019/01/23	117	70 - 130	108	70 - 130	<20	ug/g	NC	35
5940294	Soluble (20:1) Chloride (Cl ⁻)	2019/01/23	112	70 - 130	103	70 - 130	<20	ug/g	NC	35

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Anastassia Hamanov, Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.



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CHAIN OF CUSTODY RECORD

Page of

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name: #1326 Golder Associates Ltd		Company Name: <u>Nikol Kochmanova</u>		Quotation #: B70916		Maxxam Job #:	
Attention: Accounts Payable		Attention: <u>Nikol Kochmanova</u>		P.O. #: <u>1671430 W02</u>		Bottle Order #:	
Address: 6925 Century Ave Suite 100		Address: <u>Mississauga ON L5N 7K2</u>		Project: <u>QEW Golder</u>		COC #:	
Tel: (905) 567-4444 x Fax: (905) 567-6561 x		Tel: <u>nikol.kochmanova@golder.com</u>		Site #: <u>JMP</u>		Project Manager:	
Email: AP_CustomerService@golder.com		Email: <u>nikol.kochmanova@golder.com</u>		Sampled By: <u>JMP</u>		C#541804-11-01	

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY						ANALYSIS REQUESTED (PLEASE BE SPECIFIC)										Turnaround Time (TAT) Required: Please provide advance notice for rush projects							
Regulation 153 (2011)			Other Regulations			Special Instructions			Field Filtered (please circle): Metals / Hg / Cr VI	Community (pH, Cl, SO ₄ , EC, Residuality)											Regular (Standard) TAT: (will be applied if Rush TAT is not specified): Standard TAT = 5-7 Working days for most tests. Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details. Job Specific Rush TAT (if applies to entire submission) Date Required: _____ Time Required: _____ Rush Confirmation Number: _____ (call lab for #)		
Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Medium/Fine <input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Reg 558 <input type="checkbox"/> Storm Sewer Bylaw Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> For RSC <input type="checkbox"/> MISA Municipality _____ Table _____ <input type="checkbox"/> PWQO _____ _____ <input type="checkbox"/> Other _____																							
Include Criteria on Certificate of Analysis (Y/N)?																							
Sample Barcode Label		Sample (Location) Identification		Date Sampled		Time Sampled		Matrix												# of Bottles		Comments	
1		ARB2 SAS		Oct 26 '18		AM		Soil												1			
2		ARB3 SA6		Oct 22 '18		AM		Soil												1			
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							

18-Jan-19 10:35

Ema Gitej



B915672

CA2 ENV-835

* RELINQUISHED BY: (Signature/Print)		Date: (YY/MM/DD)		Time		RECEIVED BY: (Signature/Print)		Date: (YY/MM/DD)		Time		# jars used and not submitted		Laboratory Use Only	
<u>Ema Gitej</u>		19/01/18		10:30 AM		<u>Ema Gitej</u>		20/01/18		10:35				Time Sensitive	
														Temperature (°C) on Receipt	
														Intact	
														Custody Seal	
														Present	
														Yes	
														No	

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/MP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

White: Maxxa Yellow: Client



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