

REPORT

Foundation Investigation and Design Report

Culvert CV01 Replacement

QEW Widening from East of Cawthra Road to The East Mall

Cities of Mississauga and Etobicoke, Ontario

MTO GWP 2102-13-00

Submitted to:

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PART A

FOUNDATION INVESTIGATION REPORT
CULVERT CV01 REPLACEMENT
QEW WIDENING FROM EAST OF CAWTHRA ROAD TO THE EAST MALL
CITIES OF MISSISSAUGA AND ETOBICOKE
MTO GWP 2102-13-00

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 widening of Queen Elizabeth Way (QEW) from Cawthra Road to The East Mall in the Cities of Mississauga and Etobicoke, Regional Municipality of Peel/City of Toronto, Ontario.

This report addresses the results of the foundation investigation carried out for the replacement of Culvert CV01. The purpose of this investigation is to establish the subsurface soil and bedrock conditions at the proposed culvert location by borehole drilling, rock coring and laboratory testing on selected soil and rock core samples.

2.0 SITE DESCRIPTION

Culvert CV01 crosses under the QEW between Westfield Drive and Insley Road in the City of Mississauga, Ontario. Residential areas are located to the south and northwest of the QEW right-of-way in the area of the culvert; a now-abandoned gas station site is located immediately northeast of the culvert outside the QEW right-of-way. The QEW grade at the site is approximately Elevation 103 m, and the present ground surface on either side of the QEW is at approximately Elevation 103 m.

3.0 INVESTIGATION PROCEDURES

The field work for this subsurface investigation was carried out on September 27, 2016 during which time two boreholes were advanced – one at each end of the culvert on North Service Road and South Service Road. The boreholes, designated as Boreholes CV01-1 and CV01-2, were advanced at the locations shown on Drawing 1.

The borehole investigation was carried out using a truck-mounted CME 75 drill rig, supplied and operated by Davis Drilling of Milton, Ontario. Boreholes CV01-1 and CV01-2 were advanced to depths of 9.3 m and 7.5 m below existing ground surface, respectively, including coring of bedrock for core lengths of 4.6 m and 2.9 m, respectively. The boreholes were advanced through the overburden using 108 mm outside diameter solid stem augers and NW casing. 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 by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586-08)¹. Samples of the bedrock were obtained using an 'NQ' size rock core barrel and coring techniques.

The groundwater conditions and water levels in the open boreholes were observed during the drilling operations. All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903, Wells (as amended).

The field work was observed by members of Golder's engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, and logged the boreholes. The samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's Mississauga geotechnical laboratory where the samples underwent further visual

¹ ASTM D1586-08a – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of the soil.

examination and laboratory testing. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected samples, in accordance with MTO and/or ASTM Standards, as appropriate.

One selected bedrock core sample was submitted to Maxxam Analytics (Maxxam) of Mississauga, Ontario which is a Standards Council of Canada (SCC) accredited laboratory for chemical analysis. The sample of bedrock core was crushed and homogenized by Maxxam prior to testing and the homogenized sample was analyzed for a suite of corrosivity parameters, including conductivity, resistivity, soluble chloride, soluble sulphate and pH.

The locations and the ground surface elevations of the as-drilled boreholes were obtained using a GPS Trimble XH 3.5G, having an accuracy of 0.1 m in the vertical direction and 0.1 m in the horizontal direction. The borehole locations given in the borehole/drillhole 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, ground surface elevations and drilled depths are summarized below.

| Borehole No. | Location (MTM NAD 83) | | Ground Surface Elevation (m) | Borehole Depth (m) |
|--------------|----------------------------|---------------------------|------------------------------|--|
| | Northing (Latitude) | Easting (Longitude) | | |
| CV01-1 | 4,827,716.2 (43.589532) | 298,574.2 (-79.577100) | 103.3 | 9.3 (Including 4.6 m of bedrock core) |
| CV01-2 | 4,827,685.1 (43.589074) | 298,603.1 (-79.576743) | 103.0 | 7.5 (Including 2.9 m of bedrock core) |

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The project area is located within the Iroquois Plain physiographic region, as delineated in The Physiography of Southern Ontario (Chapman and Putman, 1984)². The glacial Iroquois Plain stretches along the northern shoreline of Lake Ontario, extending from the Niagara Escarpment in the west to the Scarborough Bluffs in the east. The Iroquois Plain soils consist of glaciolacustrine sediments deposited in Lake Iroquois, primarily comprising sands, silts and gravels, with a shallow cover of till remaining over the bedrock. The Georgian Bay Formation, which underlies the study area, consists mainly of blue-grey shale, containing siltstone, sandstone and limestone interbeds. Outcrops of this formation are commonly found along water courses on the west side of Toronto and in Mississauga, notably in the Humber River, Mimico Creek, Etobicoke Creek and Credit River valleys.

4.2 Subsurface Conditions

Subsurface soil, bedrock and groundwater conditions as encountered in the boreholes, and the results of the geotechnical laboratory tests carried out on selected soil samples are presented on the borehole and drillhole records provided in Appendix A. Photographs of the recovered bedrock core samples are presented on Figures A1 and A2 in Appendix A. The results of the in-situ field tests (i.e., SPT “N”-values) as presented on the borehole records and in sub-sections of Section 4.2 are uncorrected. Lists on abbreviations and symbols and lithological,

² Chapman, L.J. and Putman, D.F., 1984, The Physiography of Southern Ontario, Ontario Geological Society, Special Volume 2, Third Edition. Accompanied by Map p. 2715, Scale 1:600,000.)

geotechnical rock description terminology, field estimation of rock hardness and rock weathering classification are also included in Appendix A to assist in the interpretation of the borehole and drillhole records. The results of the geotechnical laboratory testing on the soil samples are also presented in Appendix B. The analytical laboratory test report is included in Appendix C and the test results are summarized in Section 4.2.7.

Stratigraphic boundaries shown on the borehole records and on the stratigraphic profile on Drawing 1 are inferred from non-continuous sampling, observations of drilling progress and the results of the Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Furthermore, subsurface conditions will vary between and beyond the borehole locations. It should be noted that the interpreted stratigraphy shown on Drawing 1 is a simplification of the subsurface conditions.

In general, the subsurface conditions in the area of the proposed culvert replacement consist of a layer of asphalt underlying a layer of non-cohesive fill associated with the existing road structure. The fill is underlain by a deposit of silty sand to sand, in turn underlain by a clayey silt residual soil deposit. The cohesive residual soil deposit is underlain by shale bedrock. A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Asphalt

An approximately 150 mm thick layer of asphalt was encountered immediately below ground surface in both Boreholes CV01-1 and CV01-2.

4.2.2 Fill

A 0.2 m to 0.3 m thick layer of non-cohesive fill, consisting of sand and gravel, was encountered underlying the asphalt in both boreholes advanced during this current investigation. The surface of the fill was encountered at about Elevations 103.1 m and 102.8 m in Boreholes CV01-1 and CV01-2, respectively.

4.2.3 Silty Sand to Sand

A 1.8 m to 2.4 m thick silty sand to sand deposit was encountered underlying the fill in both boreholes. The top of the silty sand to sand deposit was encountered at about Elevations 102.9 m and 102.5 m, corresponding to depths of 0.4 m and 0.3 m below ground surface in Boreholes CV01-1 and CV01-2, respectively.

The deposit varies in composition from brown to grey silty sand to sand, some silt, containing trace to some gravel and trace to some clay. Trace rootlets were encountered within this deposit in Borehole CV01-2.

The Standard Penetration Test (SPT) “N”-values measured within the silty sand to sand deposit range from 4 blows to 11 blows per 0.3 m of penetration, indicating a loose to compact relative density.

Grain size distribution tests were carried out on one sample of the silty sand portion of the deposit and one sample of the sand portion of the deposit and the results are shown on Figure B1 in Appendix B. The water content measured on four samples of the silty sand to sand deposit ranges between about 11% and 20%.

4.2.4 Residual Soil

A 1.5 m and 0.8 m thick deposit of residual soil was encountered underlying the silty sand to sand deposit in Boreholes CV01-1 and CV01-2, respectively. The top of the residual soil deposit was encountered at depths of about 2.2 m and 2.9 m below ground surface (about Elevations 101.1 m and 100.1 m), in Boreholes CV01-1 and CV01-2, respectively. The residual soil deposit consists of clayey silt containing trace to some sand, and trace to some gravel with shale and limestone fragments throughout. Residual soil is a heterogenous mix of fully weathered bedrock that is disintegrated into a soil-like material that no longer retains the structure of the parent bedrock.

The SPT “N”-values measured within the residual soil deposit range from 23 blows to 27 blows per 0.3 m of penetration, suggesting a very stiff consistency.

Atterberg limits testing was carried out on two samples of the residual soil matrix, with measured liquid limits of about 26%, plastic limits of about 16%, and corresponding plasticity indices of 10%. These results, which are plotted on a plasticity chart on Figure B2 in Appendix B, indicate that the residual soil deposit consists of clayey silt of low plasticity. The water content measured on five samples of the residual soil deposit range between about 7% and 11%.

4.2.5 Shale Bedrock

The upper portion of the bedrock was sampled by split-spoon and the bedrock was confirmed by rock coring in Boreholes CV01-1 and CV01-2. The depths to bedrock below ground surface, as inferred from augering / split spoon sampling and bedrock coring, and the corresponding bedrock surface elevation are summarized below.

| Borehole No. | Highly Weathered Bedrock | | Length of Bedrock Split-Spoon Sampled (m) | Moderately Weathered to Fresh Bedrock | | Length of Bedrock Cored (m) |
|--------------|--------------------------|---------------|---|---------------------------------------|---------------|-----------------------------|
| | Depth (m) | Elevation (m) | | Depth (m) | Elevation (m) | |
| CV01-1 | 3.7 – 7.0 | 99.6 – 96.3 | 1.0 | 7.0 – 9.3 | 96.3 – 94.1 | 4.6 |
| CV01-2 | 3.7 – 4.6 | 99.3 – 98.4 | 0.9 | 4.6 – 7.5 | 98.4 – 95.5 | 2.9 |

Highly weathered shale bedrock is inferred to be present at a depth of 3.7 m below ground surface (Elevations 99.6 m and 99.3 m), in Boreholes CV01-1 and CV01-2, respectively, based on drilling behaviour, observations of drilling cuttings and split-spoon sampling. The thickness of the highly weathered bedrock zone is inferred to be 3.3 m thick in Borehole CV01-1 based on both augering/sampling and coring, and 0.9 m thick at Borehole CV01-2 based on the results of augering and split-spoon sampling.

The SPT “N”-values measured within the upper, highly weathered portion of the shale bedrock are 46 blows per 0.3 m of penetration and 100 blows for 0.15 m of penetration, suggesting a hard consistency as well as potentially resistance to or blockages of sampling equipment by fragments of rock.

The water content measured on two samples of the inferred highly weathered shale bedrock is approximately 7 per cent and 8 per cent.

Based on a review of the bedrock core samples, the bedrock consists of shale of the Georgian Bay formation. In general, the bedrock samples are described as moderately to highly weathered, very thinly laminated, fine grained, non-porous, weak, grey, with medium strong limestone and interbeds at varying intervals and thicknesses, as presented in the drillhole records in Appendix A, and shown on the photographs of the recovered core samples on Figures A1 and A2 in Appendix A. The degree of weathering of the bedrock samples (i.e. highly to moderately weathered – W4 to W3), and the strength classification of the intact rock mass based on field identification (i.e.,

very weak to weak – R1 to 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 about 47 per cent to 70 per cent, indicating a rock mass of poor to fair quality as per Table 3.10 of CFEM (2006)⁴. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered range between 90 per cent and 100 per cent and between 0 per cent and 84 per cent, respectively.

4.2.6 Groundwater Conditions

The overburden samples obtained from the boreholes were generally moist, although the sand samples transitioned to wet below a depth of approximately 2.1 m (Elevation 100.9 m) in Borehole CV01-2. Although the boreholes were “dry” immediately upon completion of drilling prior to rock coring, based on the soil colour and moisture conditions, it is anticipated that the groundwater level may be at approximately Elevation 100 m to 101.5 m. The groundwater level was measured at Elevation 102.4 m in a nearby borehole. It should be noted that the groundwater level in the area is subject to seasonal fluctuations and precipitation events and should be expected to be higher during wet periods of the year. Further, at this site, the ground conditions consist of relatively permeable granular soils overlying relatively low-permeability fine-grained residual materials and bedrock of variable weathering and fracturing. Infiltrating precipitation and meltwater will tend to pool within the granular soils as it is inhibited from penetrating the lower permeability materials below.

4.2.7 Analytical Test Results

A bedrock core sample taken from Borehole CV01-1 was submitted for analysis of parameters used to assess the potential corrosivity of the site soils to steel and deterioration of concrete. The detailed test results are presented in Appendix C and summarized as follows:

| Parameter | Borehole CV01-1 |
|-------------------------|-----------------|
| pH | 8.14 |
| Resistivity (ohm-cm) | 1,000 |
| Conductivity (umho/cm) | 965 |
| Chlorides (ug/g) | 260 |
| Soluble Sulphate (ug/g) | 320 |

⁴ Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual (CFEM), 4th Edition. The Canadian Geotechnical Society, BiTech Published Ltd., British Columbia.

5.0 CLOSURE

This Foundation Investigation Report was prepared by Shantanu Kar, P.Eng, a geotechnical engineer with Golder, and Lisa Coyne, P.Eng., a Principal and MTO Foundations Designated Contact for Golder, conducted a technical and quality control review of the report.

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PART B

FOUNDATION DESIGN REPORT
CULVERT CV01 REPLACEMENT
QEW WIDENING FROM EAST OF CAWTHRA ROAD TO THE EAST MALL
CITIES OF MISSISSAUGA AND ETOBICOKE
GWP 2102-13-00

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides detailed foundation engineering recommendations for design of the proposed culvert replacement associated with the widening of the Queen Elizabeth Way (QEW) from Cawthra Road to The East Mall in Mississauga and Etobicoke, Ontario. These recommendations are based on interpretation of the factual data obtained from the boreholes, field testing and laboratory testing. The discussion and recommendations presented are intended to provide the designer with sufficient information to assess the feasible culvert alternative types and carry out the design of the culvert foundations.

The foundation investigation report, discussion and recommendations are intended for the use of MTO and their designer and shall not be used or relied upon for any other purpose or by any other parties, including the construction or design-build contractor. The contractor must make their own interpretation based on the factual data in Part A (Foundation Investigation Report) of this report. Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project and for which special provisions may be required in the Contract Documents. Those requiring information on aspects of construction must make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling, and the like.

6.2 Pipe Culvert Replacement

The existing 900 mm high by 1200 mm wide reinforced concrete box culvert is to be replaced with a larger pipe culvert. Trenchless methods were examined, as presented in Golder's draft Foundation Design Report dated April 2021; however, based on the culvert diameter, the lowest invert elevations from a drainage perspective and the resulting limited cover above the pipe below the QEW surface, together with the mixed subsurface conditions, trenchless methods were considered to present significant risks and therefore were not selected for this culvert replacement. Accordingly, the construction staging has been developed to incorporate open-cut replacement methods using dewatering (as necessary) coupled with rapid excavation and pipe placement, with temporary protection systems parallel to QEW to separate the stages.

The replacement culvert will consist of a 1500 mm diameter pipe with its invert at approximately Elevation 100.1 m at the upstream (north) end, and Elevation 99.9 m at the downstream (south) end; a short section of 1350 mm diameter pipe is required on the north side of QEW. The existing QEW grade at this site is at approximately Elevation 102.9 m to 103.2 m, and the final grade will be at approximately Elevation 103.0 m to 103.3 m. The culvert invert is therefore about 2.9 m to 3.1 m below the existing QEW grade.

For this vertical culvert alignment, the excavation will extend through sand and gravel fill, loose to compact silty sand to sand (classified as OHSA Type 3 soil assuming appropriate dewatering), and very stiff clayey silt residual soil (classified as OHSA Type 2 or 3 soil), just above the surface of the shale bedrock, as shown on the stratigraphic profile on Drawing 1. Temporary protection systems along QEW between the stages will extend through these materials and into the shale bedrock, which contains interbeds of stronger limestone.

The groundwater level associated with the silty sand to sand deposit is anticipated to be at approximately Elevation 101 m to 101.5 m, which is near the interface with the underlying clayey silt residual soil near the north end of the culvert, and about 1 m to 1.5 m above this interface near the south end of the culvert. Therefore, groundwater control will be required during excavation through the silty sand to sand deposit for construction of the culvert replacement.

6.3 Culvert Bedding, Cover and Backfill

The bedding, cover, and backfill for the CV01 culvert pipe should be compatible with the type and class of pipe, the surrounding subsoil/bedrock conditions and anticipated loading conditions and should be designed in accordance with OPSD 802 (*Rigid Pipe Bedding, Cover, and Backfill*), as presented in OPSD 802.031 for construction in Type 3 soil.

The bedding and cover material should consist of material as specified in OPSS.PROV 401 (*Trenching, Backfilling, and Compacting*). Clear stone should not be used as bedding or cover material. Bedding may consist of OPSS.PROV 1010 (*Aggregates*) Granular 'A', Granular B Type I, II or III, or OPSS 1359 unshrinkable fill. All bedding and cover material should be placed in loose lifts and uniformly compacted to at least 95% of the material's Standard Proctor Maximum Dry Density (SPMDD), in accordance with OPSS.PROV 501 (*Compacting*), as amended by SP 105S22.

Within roadways, it is recommended that backfill consist of OPSS.PROV 1010 Granular A, Granular B Type II or III, or unshrinkable fill, placed and compacted in accordance with OPSS.PROV 401. Native site soils or excavated cohesive and non-cohesive fills may be used for trench backfill for any portions of CV01 outside of the QEW lanes, provided they are free of topsoil, organic material or other deleterious materials and have an appropriate water content for compaction purposes; such materials should also be placed and compacted in accordance with OPSS.PROV 401.

6.4 Corrosion Assessment and Protection

Soil corrosivity may affect concrete pipes, steel pipes and reinforcing steel and other concrete elements buried in soil. Generally, the corrosivity to a structure depends on the soil resistivity, hydrogen ion concentration, salt (chloride and sulphate) concentrations and redox potential. Although only one shale bedrock sample was tested for corrosivity parameters at the CV01 site, the potential for sulphate attack and corrosion potential have been assessed based on corrosivity testing on native soils elsewhere on this project. It is ultimately up to the designer to assess and select the appropriate construction materials, including the exposure class and ensuring that all aspects of CSA A23.1-14 Section 4.1.1 "Durability Requirements" are followed when designing concrete elements.

Sulphate concentrations in the native soils on this project are generally below 0.1%, which is below the exposure class of S-3 (Moderate – 0.1 to 0.2%) in CSA A23.1 Table 3 ("Additional requirements for concrete subjected to sulphate attack") with respect to potential for sulphate attack on concrete; further, the degree of sulphate attack is considered "Negligible" according to MTO's Gravity Pipe Design Guidelines Table 7.2 (MTO, 2014). Therefore, when the designer is selecting the exposure class for the structure, the effects of sulphates from within the native soil deposits and bedrock around the culvert may not need to be considered.

The measured pH in the shale bedrock at this site is not considered detrimental to culvert durability according to MTO's *Gravity Pipe Design Guidelines*; however, other tested samples of native soil throughout the project area have higher pH values. Where resistivity values are below 2,000 ohm-cm, as is generally the case for the shale and near-shale soils including residual soil, the soil corrosiveness is classed as "Severe" in accordance with Table 3.2 of MTO's Gravity Pipe Design Guidelines. As CV01 will also be located under the roadway and may be exposed to de-icing salt, it is recommended that the concrete in the precast elements be designed for a "C" type exposure class as defined by CSA A23.1 Table 1.

6.5 Construction Considerations

6.5.1 Excavation

Based on the design drawings, the culvert invert will be between about 2.9 m and 3.0 m below existing ground surface. Excavations will extend through sand and gravel fill material, native loose to compact silty sand to sand deposit and into the very stiff clayey silt residual soil deposit. The groundwater level is expected to be between approximately Elevation 101 m and 101.5 m, above the interface of the silty sand to sand deposit with the underlying clayey silt residual soil.

All excavation work should be carried out in accordance with the Occupational Health and Safety Act and Regulations (OSHA) and as outlined in OPSS.PROV 902 (*Excavating and Backfilling – Structures*). Properly dewatered granular fill and native silty sand to sand soils are classified as Type 3 soils; if not dewatered, such soils would be classified as Type 4. The native clayey silt residual soil above the groundwater level or properly dewatered is considered Type 2 soil, although the upper portion of the deposit may be Type 3 soil. Temporary excavations (i.e., those which are open for a relatively short time period) above the groundwater level in Type 4 materials should be made with side slopes no steeper than 3 horizontal to 1 vertical (3H:1V). Temporary excavations within Type 2 and Type 3 soils should be made with side slopes no steeper than 1H:1V. Depending upon the construction procedures adopted by the contractor, actual groundwater seepage conditions, the success of the contractor's groundwater control methods and weather conditions at the time of construction, some flattening and/or blanketing of the slopes may be required.

Where the side slopes of cut-and-cover excavations are required to be steepened to limit the extent of the excavation, some form of trench support will be required. The excavations could be carried out using a vertical excavation that is supported using a properly engineered prefabricated support system (i.e., trench box) for personnel protection that can tolerate lateral movement of the soil deposits, or by temporary protection systems (discussed in Section 6.5.3 below) where restriction of lateral movements is required; this latter condition will apply parallel to the QEW between stages to protect the travelled lanes. It must be emphasized that a trench box provides protection for construction personnel but does not provide any lateral support for adjacent excavation walls, underground services or existing structures. It is imperative that underground services and existing structures adjacent to the trench excavations be accurately located prior to construction and adequate support provided where required. It is also critical that groundwater control be implemented to control the saturated zones of silty sand to sand in the excavation sides, to prevent sloughing/flowing of this material from behind the walls of the trench box.

6.5.2 Groundwater Control

It is anticipated that groundwater will be encountered at approximately Elevation 100 m to 101.5 m, within the silty sand to sand deposit “perched” on top of the underlying clayey silt residual soil. Therefore, dewatering is expected to be required to control the excavation sides through the silty sand to sand deposit during excavation for the replacement of this culvert. The groundwater level in the silty sand to sand deposit should be lowered to as near as practicable to the interface with the underlying clayey silt residual soil deposit. Notwithstanding good workmanship during dewatering, it will be very difficult to dewater the upper cohesionless layers fully to the residual soil; some seepage, which could result in migration of fine particles, is considered likely at this interface. Blanketing the slope with free draining materials, such as Granular A, to bracket the interface may be required.

Dewatering should be carried out in accordance with OPSS.PROV 517 (*Construction Specification for Dewatering*) and SP517F01 (*Dewatering System*). It is recommended that the requirement for a dewatering design engineer be specified, but that the requirement for inspection be set as “Not Applicable” in Table A in SP517F01. Construction water takings greater than 50 m³/day are regulated by the Ministry of the Environment, Conservation and Parks (MECP). Certain takings of groundwater and stormwater for construction dewatering purposes with a combined total less than 400 m³/day qualify for self-registration on the MECP’s Environmental Activity and Sector Registry (EASR); a Water Taking Plan and a Discharge Plan are required by the MECP if water is taken in accordance with an EASR. A Category 3 PTTW would be required for water takings in excess of 400 m³/day.

6.5.3 Temporary Protection Systems

Temporary protection systems will be required parallel to QEW to separate the travelled lanes of QEW from the active excavation area for replacement of the culvert in segments, associated with the construction staging. It is anticipated that a soldier pile and lagging system will be required, with the steel H-piles installed in pre-drilled holes within the weak to medium strong shale bedrock (which contains stronger interlayers of limestone), and with internal bracing (struts), anchors or rakers as needed for lateral support. A driven interlocking sheet pile system fitted with internal bracing, anchors or rakers may also be feasible as the Standard Penetration Test “N”-values are generally less than about 50 blows per 0.3 m of penetration; however, the sheet piles will likely be unable to penetrate fully through the residual soil and will not penetrate into bedrock (where the bedrock required coring). An interlocking sheet pile system has an advantage with respect to controlling groundwater seepage that is expected in the silty sand to sand deposit. However, where a soldier pile and lagging system is adopted, groundwater seepage and the potential loss of fine soil particles can be mitigated by backing the lagging with filter cloth in areas where the temporary shoring intercepts zones of perched groundwater or seepage, and directing this seepage to a positive discharge point.

The temporary protection system should be designed and constructed in accordance with OPSS.PROV 539 (*Temporary Protection Systems*). The lateral movement of the temporary shoring system should meet Performance Level 2 as specified in OPSS.PROV 539 (*Temporary Protection Systems*), provided that any adjacent utilities within the zone of influence of the shoring system can tolerate this magnitude of deformation.

The design of temporary support systems is the responsibility of the contractor. However, for design considerations, where the support to the wall is provided by corner bracing and wales or rakers, the wall design should be based on conventional active and passive earth pressure distributions using the design parameters given below as well as applicable groundwater pressures. The internal bracing or raker supports must be designed to accommodate the loads applied from earth pressures, water pressures and surcharge pressures from area, line or point loads as well as the effects of sloping ground behind the system. Passive toe restraint to the soldier piles may be determined using conventional passive earth pressure distribution acting over an equivalent width equal to three times the soldier pile socket diameter provided that the soldier piles are separated by more than three times the socket diameter.

| Soil Type | Unit Weight | Internal Angle of Friction | Undrained Shear Strength | Coefficient of Lateral Earth Pressure | | |
|--------------------------------------|----------------------|----------------------------|--------------------------|---------------------------------------|-------------------------|-------------------------|
| | (kN/m ³) | (Degrees) | S _u (kPa) | Active, K _a | At Rest, K _o | Passive, K _p |
| Existing sand and gravel fill | 19 | 28 | -- | 0.36 | 0.53 | 2.77 |
| Loose to compact silty sand to sand | 19 | 28 | -- | 0.36 | 0.53 | 2.77 |
| Very stiff clayey silt residual soil | 21 | 34 | 150 | 0.28 | 0.44 | 3.54 |

Notes:

1. The lateral earth pressure coefficients presented above are based on a horizontal surface adjacent to the excavation, consistent with QEW and local road geometry. If sloped surfaces are present, the coefficients showed must be corrected by the shoring designer accordingly.
2. The total passive resistance below the base of the excavation (i.e., within the shored excavation and / or adjacent to the temporary protection system, may be calculated based on the value of K_p indicated above but reduced by an appropriate factor that considers the allowable wall movement in accordance with Figure C6.16 of the CHBDC (2014) to account for the fact that a large strain would be required for mobilization of the full passive resistance.

7.0 CLOSURE

This Foundation Design Report was prepared by Michael Beadle, P.Eng., a senior geotechnical engineer with Golder. Lisa Coyne, P.Eng., a Principal and MTO Foundations Designated Contact, conducted a technical and quality control review of the Foundation Design Report.

Golder Associates Ltd.



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

MEB/LCC/ml

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Canadian Geotechnical Society. 2006. *Canadian Foundation Engineering Manual (CFEM)*, 4th Edition. The Canadian Geotechnical Society, BiTech Publisher Ltd., British Columbia.

Canadian Standards Association (CSA) CAN/CSA – A23.1-14

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.

International Society for Rock Mechanics Commission on Test Methods, 1985. *Int. J. Rock Mech.Min. Sci. & Geomech. Abstr.* Vol 22, No. 2, pp. 51-60.

Ministry of Transportation Ontario. 2014. *Gravity Pipe Design Guideline*. Drainage and Hydrology Design and Contract Standards Office.

Ontario Provincial Standard Drawings:

| | |
|---------------|--|
| OPSD 802.031 | Rigid Pipe Bedding, Cover and Backfill, Type 3 Soil – Earth Excavation |
| OPSD 810.010 | General Rip-Rap Layout for Sewer and Culvert Outlets |
| OPSD 3090.101 | Foundation Frost Penetration Depth for Southern Ontario |

Ontario Provincial Standard Specifications:

| | |
|----------------|--|
| OPSS.PROV 401 | Construction Specification for Trenching, Backfilling, and Compacting |
| OPSS.PROV 501 | Construction Specification for Compacting |
| OPSS.PROV 539 | Construction Specification for Temporary Protection Systems |
| OPSS.PROV 1010 | Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material |
| OPSS PROV 1539 | Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material Unshrinkable Fill |

ASTM International:

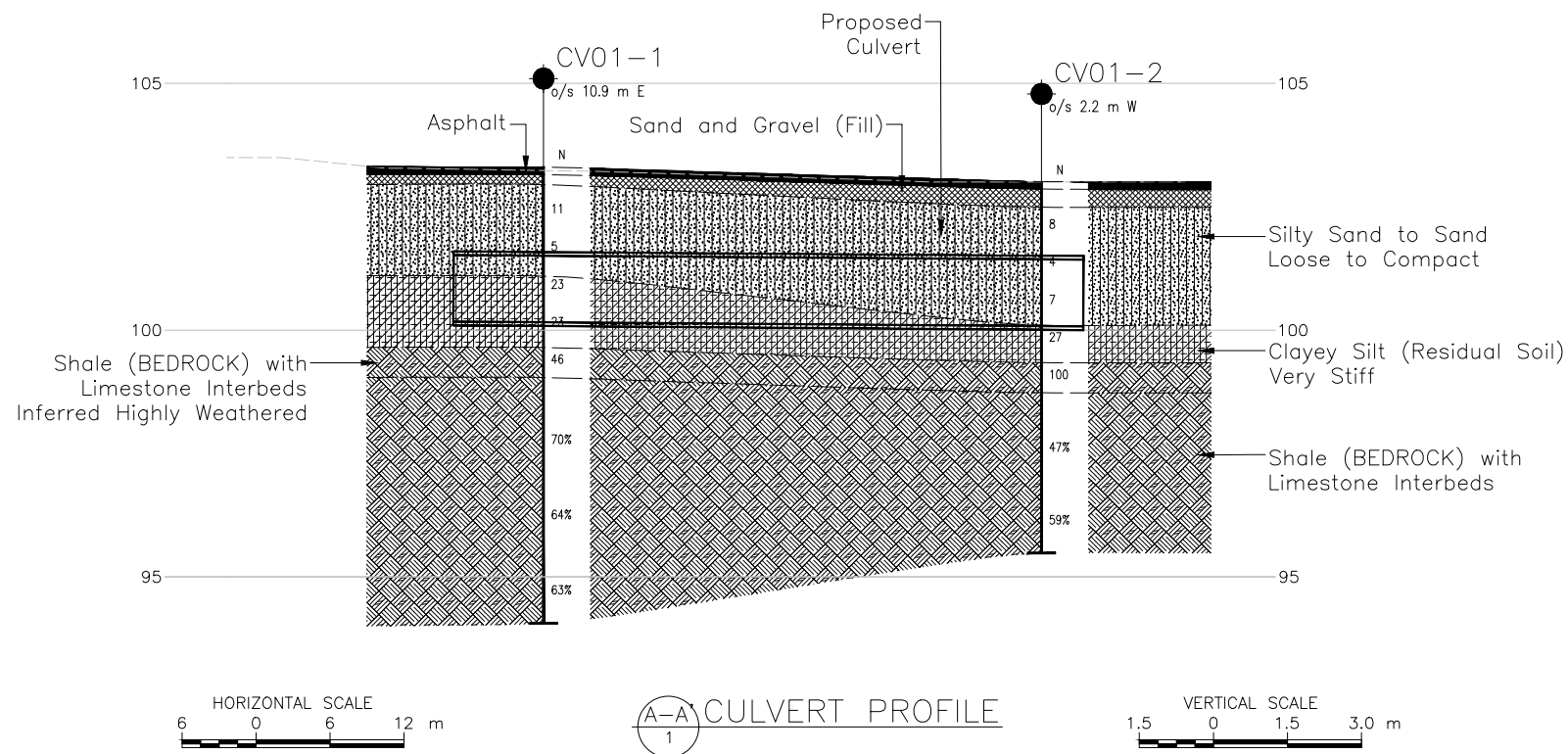
| | |
|------------|---|
| ASTM D1586 | Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils |
|------------|---|

Ontario Water Resources Act:

| | |
|------------------------|--------------------|
| Ontario Regulation 903 | Wells (as amended) |
|------------------------|--------------------|

Ontario Occupational Health and Safety Act:

| | |
|---------------------------|------------------------------------|
| Ontario Regulation 213/91 | Construction Projects (as amended) |
|---------------------------|------------------------------------|



| | | | | | |
|-----------------------|------|-----------|---------------------|--|---------------|
| | | | | | |
| | | | | | |
| | | | | | |
| NO. | DATE | BY | REVISION | | |
| Geocres No. 30M11-316 | | | | | |
| HWY. QEW | | | PROJECT NO. 1530382 | | DIST. CENTRAL |
| SUBM'D. SK | | CHKD. SK | DATE: 11/22/2021 | | SITE: |
| DRAWN: MR/DD | | CHKD. LCC | APPD. LCC | | DWG. 1 |

APPENDIX A

**Borehole/Drillhole Records and
Bedrock Core Photographs**

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

| Description | Bedding Plane Spacing |
|---------------------|-----------------------|
| 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

| Description | Spacing |
|------------------|------------------|
| 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

| Term | Size* |
|---------------------|-------------------------|
| 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 | |

FIELD ESTIMATION OF ROCK HARDNESS

| Grade | Description | Field Identification | Approx. Range of UCS (MPa) |
|-------|------------------------|--|----------------------------|
| R0 | Extremely Weak Rock | Indented by thumbnail | 0.25 - 1 |
| R1 | Very Weak Rock | Material can be peeled or shaped with a knife. Crumbles under firm blows from geological hammer. | 1 - 5 |
| R2 | Weak Rock | Knife cuts material but too hard to shape into triaxial specimens or material can be peeled with a knife with difficulty. Shallow (<5mm) indentations made by firm blows from pick of a geological hammer. | 5 - 25 |
| R3 | Moderately Strong Rock | Cannot be peeled or scraped with a knife. Hand held specimens can be fractured with single firm blow of geological hammer. | 25 - 50 |
| R4 | Strong Rock | Hand held specimen requires more than one blow of geological hammer to fracture. | 50 - 100 |
| R5 | Very Strong Rock | Hand held specimen requires many blows of geological hammer to fracture. | 100 - 250 |
| R6 | Extremely Strong Rock | Specimen can only be chipped under repeated hammer blows, rings when hit. | > 250 |

Notes:

1. Hand held specimens should have height approximately 2 times the diameter.
2. Materials having a uniaxial compressive strength of less than approximately 0.5 MPa and cohesionless materials should be classified using soil classification systems.
3. Rocks with a uniaxial compressive strength below 25 MPa (i.e. below R2) are likely to yield highly ambiguous results under point load testing.

Reference:

- Brown, 1981. "Suggested Methods for Rock Characterization Testing and Monitoring", International Society for Rock Mechanics.
- Hoek, E., Kaiser, P.K., Bawden, W.F., 1995. "Support of Underground Excavations in Hard Rock", Balkema, Rotterdam.

ROCK WEATHERING CLASSIFICATION

| Term | Symbol | Description | Discoloration Extent | Fracture Condition | Surface Characteristics |
|----------------------|--------|--|--|--|---|
| Residual soil | W6 | All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported. | Throughout | N/A | Resembles soil |
| Completely weathered | W5 | 100% of rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact. | Throughout | Filled with alteration minerals | Resembles soil |
| Highly weathered | W4 | More than 50% of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones. | Throughout | Filled with alteration minerals | Friable and possibly pitted |
| Moderately weathered | W3 | Less than 50% of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones. Visible texture of the host rock still preserved. Surface planes are weathered (oxidized or carbonate filling) even when breaking the "intact rock". | >20% of fracture spacing on both sides of fracture | Discoloured, may contain thick filling | Partial to complete discoloration, not friable except poorly cemented rocks |
| Slightly weathered | W2 | Discoloration indicates weathering of rock material on discontinuity surfaces (usually oxidized). Less than 5% of rock mass altered. | <20% of fracture spacing on both sides of fracture | Discoloured, may contain thin filling | Partial discoloration |
| Fresh | W1 | No visible sign of rock material weathering. | None | Closed or discoloured | Unchanged |

Reference:

Brown, 1981. "Suggested Methods for Rock Characterization Testing and Monitoring", International Society for Rock Mechanics.

| PROJECT 1530382 | | RECORD OF BOREHOLE No CV01-1 | | | | SHEET 1 OF 2 | | METRIC | | | | | | | | |
|-------------------------------|--|--|---------|------|------------|-------------------------|-----------------|--|--|--|--|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| G.W.P. 2102-13-00; 2432-13-00 | | LOCATION N 4827716.2; E 298574.2 MTM NAD 83 ZONE 10 (LAT. 43.589532; LONG. -79.577100) | | | | ORIGINATED BY PKS | | | | | | | | | | |
| DIST Central HWY QEW | | BOREHOLE TYPE CME 75, 108 mm O.D. Continuous Flight Solid Stem Augers | | | | COMPILED BY ACK | | | | | | | | | | |
| DATUM Geodetic | | DATE September 27, 2016 | | | | CHECKED BY SMM | | | | | | | | | | |
| 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 | | | | | | | | |
| 103.3 | GROUND SURFACE | | | | | | | | | | | | | | | |
| 0.0 | ASPHALT (150 mm) | | | | | | | | | | | | | | | |
| 102.9 | Sand and gravel (FILL) Brown Moist | | | | | | | | | | | | | | | |
| 0.4 | Silty SAND, trace gravel, trace to some clay Loose to compact Brown Moist | | 1 | SS | 11 | | | | | | | | | | | |
| | | | 2 | SS | 5 | | | | | | | | | | | |
| 101.1 | CLAYEY SILT, some sand, trace to some gravel, containing shale fragments (RESIDUAL SOIL) Very stiff to hard Grey Moist | | 3 | SS | 23 | | | | | | | | | | | |
| 2.2 | | | 4 | SS | 23 | | | | | | | | | | | |
| 99.6 | Inferred highly weathered, grey, extremely weak SHALE (BEDROCK) (Georgian Bay Formation) | | 5 | SS | 46 | | | | | | | | | | | |
| 3.7 | | | | | | | | | | | | | | | | |
| 98.6 | Highly weathered to a depth of 7.00 m to moderately weathered below a depth of 7.00 m Bedrock cored from depths of 4.7 m to 9.3 m. For bedrock coring details refer to Record of Drillhole CV01-1. | | 1 | RC | REC 94% | | | | | | | | | | | RQD = 70% |
| 4.7 | | | 2 | RC | REC 90% | | | | | | | | | | | RQD = 64% |
| | | | 3 | RC | REC 100% | | | | | | | | | | | RQD = 63% |
| 94.1 | END OF BOREHOLE | | | | | | | | | | | | | | | |
| 9.3 | | | | | | | | | | | | | | | | |

Continued Next Page

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

GTA-MTO 001 S:\CLIENTS\MTQ\QEW-DIXIE\02_DATAGINT\QEW-DIXIE.GPJ GAL-GTA.GDT 19-5-27



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

GTA-MTO 001 S:\CLIENTS\MTO\QEW-DIXIE\02 DATA\GINT\QEW-DIXIE.GPJ GAL-GTA.GDT 19-5-27

SHEET 1 OF 1

DATUM: Geodetic

DRILL RIG: CME 75 (Truck Mounted)

DRILLING CONTRACTOR: Davis Drilling Ltd.

[illegible]



GTA-MTO001 S:\CLIENTS\MTO\QEW-DIXIE\02 DATA\GINT\QEW-DIXIE.GPJ GAL-GTA.GDT 19-5-27

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

SHEET 1 OF 1

DATUM: Geodetic

DRILL RIG: CME 75 (Truck Mounted)

DRILLING CONTRACTOR: Davis Drilling Ltd.

[illegible]

 BROKEN CORE
 CLAY SEAM
 LIMESTONE
 LOST CORE

LOGGED: PKS
CHECKED: CEC/AB

Bedrock Core Photograph – BH CV01-1

Figure A1

4.67 m to 9.25 m
Dry



0.10 m

Box 1-2

Date: May 2017
Project: 1530382

Golder Associates

Drawn: AB
Chkd: ACK

Bedrock Core Photograph – BH CV01-2

Figure A2

4.57 m to 7.52 m
Dry



0.10 m

Date: May 2017
Project: 1530382

Golder Associates

Drawn: AB
Chkd: ACK

APPENDIX B

Geotechnical Laboratory Test Results

Silty Sand to Sand

U.S.S Sieve size, meshes/inch

Size of openings, inches

PERCENT FINER THAN

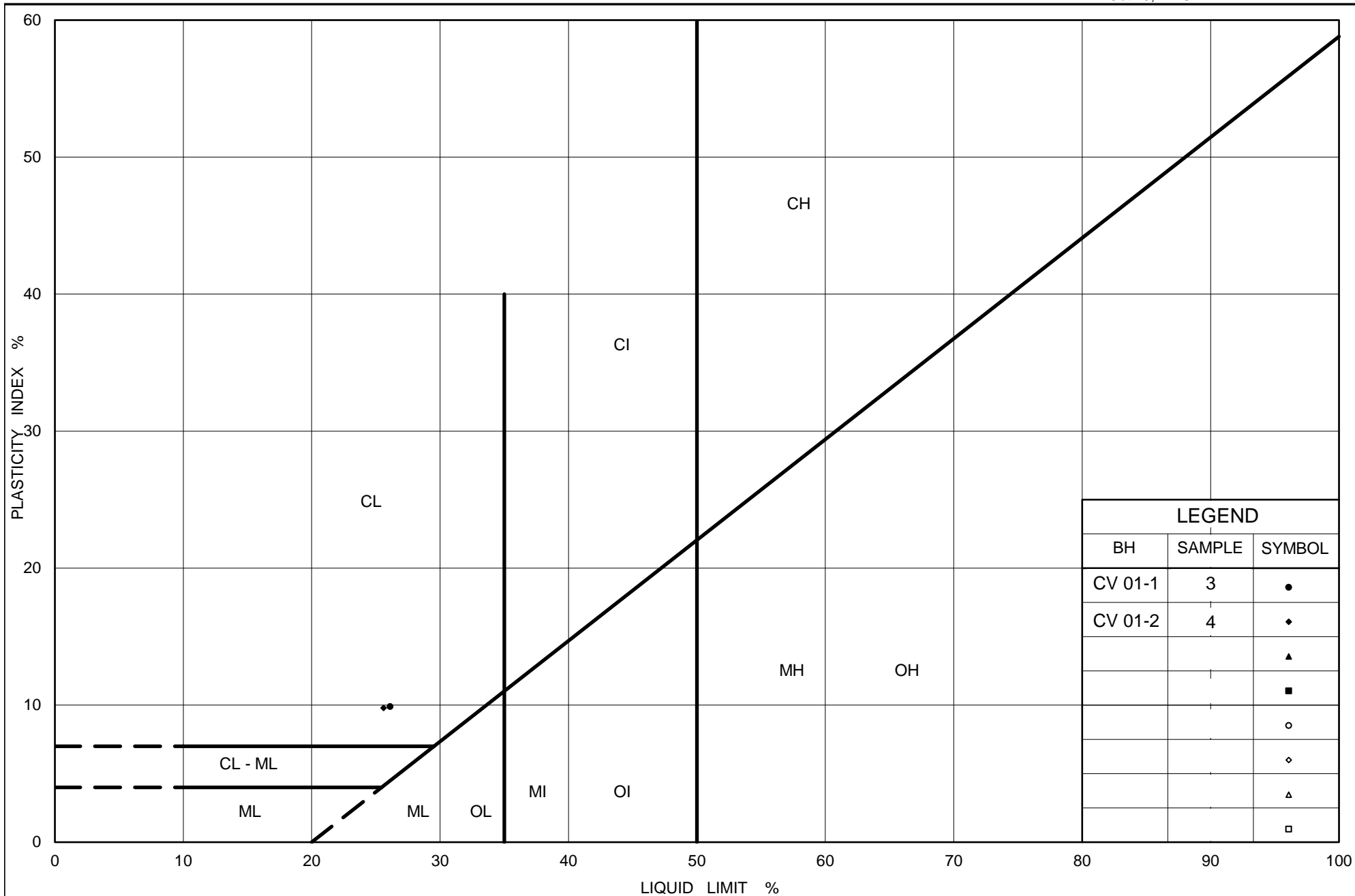
GRAIN SIZE, mm

| Grain Size (mm) | U.S.S Sieve Size (meshes/inch) | Size of Opening (inches) | Percent Finer Than (No. 1) | Percent Finer Than (No. 2) |
|-----------------|--------------------------------|--------------------------|----------------------------|----------------------------|
| 0.0075 | 20 | 0.0075 | 10 | 8 |
| 0.015 | 10 | 0.015 | 15 | 12 |
| 0.03 | 60 | 0.03 | 18 | 15 |
| 0.06 | 30 | 0.06 | 22 | 18 |
| 0.075 | 20 | 0.075 | 35 | 25 |
| 0.15 | 10 | 0.15 | 50 | 30 |
| 0.3 | 60 | 0.3 | 65 | 45 |
| 0.6 | 30 | 0.6 | 75 | 60 |
| 1.2 | 15 | 1.2 | 85 | 75 |
| 2.5 | 8 | 2.5 | 90 | 85 |
| 5.0 | 4 | 5.0 | 95 | 90 |
| 7.5 | 3 | 7.5 | 98 | 95 |
| 15.0 | 1.5 | 15.0 | 100 | 100 |

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

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | CV 01-2 | 1 | 101.9 |
| ■ | CV 01-1 | 2 | 101.5 |

Date: 05-Jul-17



Ministry of Transportation

Ontario

PLASTICITY CHART

Clayey Silt (Residual Soil)

Figure No. B2

Project No. 1530382

Checked By:

APPENDIX C

Analytical Laboratory Test Results

Your Project #: 1530382
Site Location: QEW-CAWTHRA
Your C.O.C. #: 70344

Attention: Alysha Kobylinski

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

Report Date: 2016/11/19
Report #: R4252452
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B605411

Received: 2016/11/10, 17:14

Sample Matrix: SOLID
Samples Received: 5

| Analyses | Date | | Date Analyzed | Laboratory Method | Reference |
|-------------------------|----------|------------|---------------|-------------------|-----------------|
| | Quantity | Extracted | | | |
| Chloride (20:1 extract) | 5 | N/A | 2016/11/16 | CAM SOP-00463 | EPA 325.2 m |
| Conductivity | 5 | N/A | 2016/11/16 | CAM SOP-00414 | OMOE E3530 v1 m |
| pH CaCl2 EXTRACT | 5 | 2016/11/16 | 2016/11/16 | CAM SOP-00413 | EPA 9045 D m |
| Resistivity of Soil | 5 | 2016/11/10 | 2016/11/17 | CAM SOP-00414 | SM 22 2510 m |
| Sulphate (20:1 Extract) | 5 | N/A | 2016/11/16 | 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.

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.

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.

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 #: 1530382
Site Location: QEW-CAWTHRA
Your C.O.C. #: 70344

Attention: Alysha Kobylinski

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

Report Date: 2016/11/19
Report #: R4252452
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B6O5411
Received: 2016/11/10, 17:14

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

=====

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.

RESULTS OF ANALYSES OF SOLID

| | | | | | | | |
|----------------------|--------------|--------------------------|--------------------------------------|-----------------|------------------------------|------------|-----------------|
| Maxxam ID | | DKV715 | DKV715 | | DKV716 | | |
| Sampling Date | | 2016/11/03 | 2016/11/03 | | 2016/11/10 | | |
| COC Number | | 70344 | 70344 | | 70344 | | |
| | UNITS | RW3-3-4.33M-4.43M | RW3-3-4.33M-4.43M Lab-Dup | QC Batch | OHS-4-SA4-2.29M-2.59M | RDL | QC Batch |

| | | | | | | | |
|--|---------|------|-----|---------|------|----|---------|
| Calculated Parameters | | | | | | | |
| Resistivity | ohm-cm | 2000 | | 4745989 | 850 | | 4745989 |
| Inorganics | | | | | | | |
| Soluble (20:1) Chloride (Cl) | ug/g | <20 | | 4748291 | 500 | 20 | 4748291 |
| Conductivity | umho/cm | 499 | | 4749169 | 1180 | 2 | 4749169 |
| Available (CaCl ₂) pH | pH | 8.18 | | 4750330 | 7.92 | | 4750333 |
| Soluble (20:1) Sulphate (SO ₄) | ug/g | 250 | 230 | 4748348 | 270 | 20 | 4748348 |
| RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate | | | | | | | |

| | | | | | | | |
|----------------------|--------------|--|-----------------|------------------------------|----------------------------|------------|-----------------|
| Maxxam ID | | DKV716 | | DKV717 | DKV718 | | |
| Sampling Date | | 2016/11/10 | | 2016/11/10 | 2016/11/03 | | |
| COC Number | | 70344 | | 70344 | 70344 | | |
| | UNITS | OHS-4-SA4-2.29M-2.59M Lab-Dup | QC Batch | OHS-5-SA5-3.81M-4.42M | CV01-01-8.74M-8.80M | RDL | QC Batch |

| | | | | | | | |
|--|---------|------|---------|------|------|----|---------|
| Calculated Parameters | | | | | | | |
| Resistivity | ohm-cm | | 4745989 | 1400 | 1000 | | 4745989 |
| Inorganics | | | | | | | |
| Soluble (20:1) Chloride (Cl) | ug/g | | 4748291 | 40 | 260 | 20 | 4748291 |
| Conductivity | umho/cm | | 4749169 | 720 | 965 | 2 | 4749169 |
| Available (CaCl ₂) pH | pH | 7.90 | 4750333 | 7.86 | 8.14 | | 4750330 |
| Soluble (20:1) Sulphate (SO ₄) | ug/g | | 4748348 | 560 | 320 | 20 | 4748348 |
| RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate | | | | | | | |

Maxxam Job #: B605411
Report Date: 2016/11/19

Golder Associates Ltd
Client Project #: 1530382
Site Location: QEW-CAWTHRA
Sampler Initials: AJ

RESULTS OF ANALYSES OF SOLID

| | | | | |
|----------------------------------|--------------|-----------------------------|------------|-----------------|
| Maxxam ID | | DKV719 | | |
| Sampling Date | | 2016/11/03 | | |
| COC Number | | 70344 | | |
| | UNITS | CV02/3-1-5.27M-5.32M | RDL | QC Batch |
| Calculated Parameters | | | | |
| Resistivity | ohm-cm | 1500 | | 4745989 |
| Inorganics | | | | |
| Soluble (20:1) Chloride (Cl) | ug/g | 100 | 20 | 4748291 |
| Conductivity | umho/cm | 682 | 2 | 4749169 |
| Available (CaCl2) pH | pH | 8.01 | | 4750330 |
| Soluble (20:1) Sulphate (SO4) | ug/g | 250 | 20 | 4748348 |
| RDL = Reportable Detection Limit | | | | |
| QC Batch = Quality Control Batch | | | | |

TEST SUMMARY

Maxxam ID: DKV715
Sample ID: RW3-3-4.33M-4.43M
Matrix: SOLID

Collected: 2016/11/03
Shipped:
Received: 2016/11/10

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|-------------------------|-----------------|---------|------------|---------------|---------------------|
| Chloride (20:1 extract) | KONE/EC | 4748291 | N/A | 2016/11/16 | Alina Dobreanu |
| Conductivity | AT | 4749169 | N/A | 2016/11/16 | Tahir Anwar |
| pH CaCl2 EXTRACT | AT | 4750330 | 2016/11/16 | 2016/11/16 | Neil Dassanayake |
| Resistivity of Soil | | 4745989 | 2016/11/17 | 2016/11/17 | Automated Statchk |
| Sulphate (20:1 Extract) | KONE/EC | 4748348 | N/A | 2016/11/16 | Deonarine Ramnarine |

Maxxam ID: DKV715 Dup
Sample ID: RW3-3-4.33M-4.43M
Matrix: SOLID

Collected: 2016/11/03
Shipped:
Received: 2016/11/10

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|-------------------------|-----------------|---------|-----------|---------------|---------------------|
| Sulphate (20:1 Extract) | KONE/EC | 4748348 | N/A | 2016/11/16 | Deonarine Ramnarine |

Maxxam ID: DKV716
Sample ID: OHS-4-SA4-2.29M-2.59M
Matrix: SOLID

Collected: 2016/11/10
Shipped:
Received: 2016/11/10

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|-------------------------|-----------------|---------|------------|---------------|---------------------|
| Chloride (20:1 extract) | KONE/EC | 4748291 | N/A | 2016/11/16 | Alina Dobreanu |
| Conductivity | AT | 4749169 | N/A | 2016/11/16 | Tahir Anwar |
| pH CaCl2 EXTRACT | AT | 4750333 | 2016/11/16 | 2016/11/16 | Neil Dassanayake |
| Resistivity of Soil | | 4745989 | 2016/11/17 | 2016/11/17 | Automated Statchk |
| Sulphate (20:1 Extract) | KONE/EC | 4748348 | N/A | 2016/11/16 | Deonarine Ramnarine |

Maxxam ID: DKV716 Dup
Sample ID: OHS-4-SA4-2.29M-2.59M
Matrix: SOLID

Collected: 2016/11/10
Shipped:
Received: 2016/11/10

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|------------------|-----------------|---------|------------|---------------|------------------|
| pH CaCl2 EXTRACT | AT | 4750333 | 2016/11/16 | 2016/11/16 | Neil Dassanayake |

Maxxam ID: DKV717
Sample ID: OHS-5-SA5-3.81M-4.42M
Matrix: SOLID

Collected: 2016/11/10
Shipped:
Received: 2016/11/10

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|-------------------------|-----------------|---------|------------|---------------|---------------------|
| Chloride (20:1 extract) | KONE/EC | 4748291 | N/A | 2016/11/16 | Alina Dobreanu |
| Conductivity | AT | 4749169 | N/A | 2016/11/16 | Tahir Anwar |
| pH CaCl2 EXTRACT | AT | 4750330 | 2016/11/16 | 2016/11/16 | Neil Dassanayake |
| Resistivity of Soil | | 4745989 | 2016/11/17 | 2016/11/17 | Automated Statchk |
| Sulphate (20:1 Extract) | KONE/EC | 4748348 | N/A | 2016/11/16 | Deonarine Ramnarine |

Maxxam Job #: B605411
Report Date: 2016/11/19

Golder Associates Ltd
Client Project #: 1530382
Site Location: QEW-CAWTHRA
Sampler Initials: AJ

TEST SUMMARY

Maxxam ID: DKV718
Sample ID: CV01-01-8.74M-8.80M
Matrix: SOLID

Collected: 2016/11/03
Shipped:
Received: 2016/11/10

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|-------------------------|-----------------|---------|------------|---------------|---------------------|
| Chloride (20:1 extract) | KONE/EC | 4748291 | N/A | 2016/11/16 | Alina Dobreanu |
| Conductivity | AT | 4749169 | N/A | 2016/11/16 | Tahir Anwar |
| pH CaCl2 EXTRACT | AT | 4750330 | 2016/11/16 | 2016/11/16 | Neil Dassanayake |
| Resistivity of Soil | | 4745989 | 2016/11/17 | 2016/11/17 | Automated Statchk |
| Sulphate (20:1 Extract) | KONE/EC | 4748348 | N/A | 2016/11/16 | Deonarine Ramnarine |

Maxxam ID: DKV719
Sample ID: CV02/3-1-5.27M-5.32M
Matrix: SOLID

Collected: 2016/11/03
Shipped:
Received: 2016/11/10

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|-------------------------|-----------------|---------|------------|---------------|---------------------|
| Chloride (20:1 extract) | KONE/EC | 4748291 | N/A | 2016/11/16 | Alina Dobreanu |
| Conductivity | AT | 4749169 | N/A | 2016/11/16 | Tahir Anwar |
| pH CaCl2 EXTRACT | AT | 4750330 | 2016/11/16 | 2016/11/16 | Neil Dassanayake |
| Resistivity of Soil | | 4745989 | 2016/11/17 | 2016/11/17 | Automated Statchk |
| Sulphate (20:1 Extract) | KONE/EC | 4748348 | N/A | 2016/11/16 | Deonarine Ramnarine |

GENERAL COMMENTS

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

| | |
|-----------|--------|
| Package 1 | 14.0°C |
|-----------|--------|

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1530382
Site Location: QEW-CAWTHRA
Sampler Initials: AJ

| QC Batch | Parameter | Date | Matrix Spike | | SPIKED BLANK | | Method Blank | | RPD | |
|----------|-------------------------------|------------|--------------|-----------|--------------|-----------|--------------|---------|-----------|-----------|
| | | | % Recovery | QC Limits | % Recovery | QC Limits | Value | UNITS | Value (%) | QC Limits |
| 4748291 | Soluble (20:1) Chloride (Cl) | 2016/11/16 | NC | 70 - 130 | 108 | 70 - 130 | <20 | ug/g | 0.49 | 35 |
| 4748348 | Soluble (20:1) Sulphate (SO4) | 2016/11/16 | NC | 70 - 130 | 107 | 70 - 130 | <20 | ug/g | 9.4 | 35 |
| 4749169 | Conductivity | 2016/11/16 | | | 99 | 90 - 110 | <2 | umho/cm | 0.93 | 10 |
| 4750330 | Available (CaCl2) pH | 2016/11/16 | | | 99 | 97 - 103 | | | 0.28 | N/A |
| 4750333 | Available (CaCl2) pH | 2016/11/16 | | | 99 | 97 - 103 | | | 0.26 | N/A |

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.

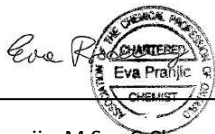
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

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 spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of 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).



Ewa Pranjić, M.Sc., C.Chem, 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.

70344

Page 1 of 1

| INVOICE INFORMATION | | | | REPORT INFORMATION (if differs from invoice) | | | | PROJECT INFORMATION | | | | MAXXAM NUMBER | |
|--|-----------------------|--------------|------------------|--|---|--------------------------------|------------|--|--|-------------------|-------------------------|---|--|
| Company Name: <u>Golder Associates</u> | | | | Company Name: | | | | Quotation #: | | | | CHAIN OF CUSTODY # 00 | |
| Contact Name: <u>Alysha Kobylinski</u> | | | | Contact Name: | | | | P.O. #: <u>530382</u> | | | | | |
| Address: <u>6925 CENTURY AVE, SUITE 100</u> <u>MISSISSAUGA, ON</u> | | | | Address: | | | | Project#: <u>GEW - CAWTHRA</u> | | | | | |
| Phone: <u>647-618-1364</u> Fax: <u>905-507-6561</u> | | | | Phone: | | | | Site Location: <u>QEW - CAWTHRA</u> | | | | | |
| Email: <u>Alysha.Kobylinski@golder.com</u> | | | | Fax: | | | | Site #: | | | | | |
| ***Note: For MOE Regulated Drinking Water samples, please use the Drinking Water CoC.*** | | | | | | | | | | | | | |
| Regulation 153 (2011) | | | | Other Regulations | | | | ANALYSIS REQUESTED (Please be specific) | | | | TURNAROUND TIME (TAT) REQUIRED | |
| Table 1 | Res/Park | Med/Fine | COCME | Sanitary Sewer Bylaw | MOE Regulated Drinking Water? (Y/N) Metals Field Filtered? (Y/N) CORROSIVITY PACKAGE | | | | PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS. | | | | |
| Table 2 | Ind/Comm | Coarse | Reg. 558 | Storm Sewer Bylaw | | | | | | | | | |
| Table 3 | Agri/Other | For RSC | MISA | Municipality: | | | | | | | | | |
| Table | | Yes | PWQO | | | | | | | | | | |
| | X No | | Other (specify): | | | | | | | | | | |
| Include Criteria on Certificate of Analysis (Y/N)? | | | | | | | | | | | | Regular (Standard) TAT: (5-7 working days for most tests) <input checked="" type="checkbox"/> | |
| SAMPLES MUST BE KEPT COOL (<10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM. | | | | | | | | | | | | Rush TAT: ***Samples must be received by 3pm to guarantee your TAT*** | |
| | | | | | | | | | | | | Rush Confirmation #: PN <input type="checkbox"/> 1 day <input type="checkbox"/> 2 days <input type="checkbox"/> 3 days | |
| | | | | | | | | | | | | Date Req'd: | |
| | | | | | | | | | | | | TATs for certain tests are > 5 days. Please contact your Project Manager for details. | |
| Sample Identification | | | | Date Sampled | Time Sampled | Matrix (GW, SW, Soil, etc.) | # of Cont. | | | | COMMENTS / TAT COMMENTS | | |
| 1 | RW 3-3-4.33m-4.43m | NOV 3, 2016 | AM | ROCK | N | N | X | 1 | | | | | |
| 2 | OHS-4-SA4-2.29m-2.59m | NOV 10, 2016 | AM | SOIL | N | N | X | 1 | | | | | |
| 3 | OHS-6-SA5-3.81m-4.42m | Nov 10, 2016 | AM | SOIL | N | N | X | 1 | | | | | |
| 4 | CV01-01-8.74m-8.80m | NOV 3, 2016 | AM | ROCK | N | N | X | 1 | | | | | |
| 5 | CV02/3-1-5.27m-5.32m | NOV 3, 2016 | AM | ROCK | N | N | X | 1 | | | | | |
| 6 | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | |
| *RELINQUISHED BY (Signature/Print) | | | | Date (YYYY/MM/DD) | Time: | RECEIVED BY: (Signature/Print) | | | | Date (YYYY/MM/DD) | Time: | #JARS USED AND NOT SUBMITTED | Laboratory Use Only |
| Amelia Jewison | | | | 2016/11/10 | 17:10 | [Signature] | | | | 2016/11/10 | 17:14 | | Custody Seal Yes No Present Intact Temperature (°C) on Receipt: 16/12/14°C |

*MANDATORY SECTIONS IN GREY MUST BE FILLED OUT. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

COC-1004 (10/11) - ENV. ENG.

Maxxam Analytics International Corporation c/o Maxxam Analytics

White: Maxxam

Yellow: Mail Pink: Client



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