

REPORT

Subsurface Conditions Baseline Report

Trenchless Watermain Crossing West of Dixie Road, QEW Widening from East of Cawthra Road to The East Mall, Cities of Mississauga and Etobicoke, Ministry of Transportation, Ontario, GWP 2102-13-00 & 2432-13-00

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by AECOM Canada Ltd. (AECOM) on behalf of the Ministry of Transportation, Ontario (MTO) to prepare this Subsurface Conditions Baseline Report (SCBR) for a watermain replacement west of Dixie Road, associated with the widening of Queen Elizabeth Way (QEW) from Cawthra Road to The East Mall in Mississauga and Etobicoke, in the Regional Municipality of Peel and City of Toronto, Ontario. This report consolidates and summarizes the results of geotechnical explorations and testing carried out at the site. This report is to be read together with the Contract Drawings and Specifications (Contract Documents) prepared by the project designers (AECOM) and the MTO. Bidders shall refer to the Contract Documents for the order of precedence in the event of conflicting information.

The purpose of this report is to describe and summarize the subsurface conditions anticipated at the project site and to establish the baseline subsurface conditions for the Contract. It forms the basis on which to judge whether or not the conditions encountered during construction are materially different from those anticipated at the time of bidding.

This report provides figures that summarize data and presents baseline subsurface conditions and geotechnical engineering parameters. For individual test results, the bidder is to refer to the Foundation Investigation Report for this watermain crossing, prepared by Golder. Where alignments and stations are shown on the figures or referenced in the text, they are based on the General Arrangement drawings provided by AECOM. The stations referred to in this SCBR are approximate and the Contractor is expected to refer to the Contract Documents for the exact station, coordinates and details of existing and proposed features, structures and buried utilities.

This SCBR is intended to:

- Provide a subsurface conditions baseline for bidding the work;
- Assist the project Owner in reviewing the Contractor's submittals; and,
- Establish a subsurface conditions baseline that will be used to resolve disputes and claims related to subsurface conditions.

This SCBR has been prepared for a Design-Bid-Build construction contract for the installation of the reinforced concrete pressure pipe for the watermain at the above-noted site and does not provide discussions on the anticipated ground behaviour in relation to specific construction means and methods because the Contractor is responsible for and will select the construction means and methods. This report does describe anticipated natural soil behaviour in the absence of any support or modification provided by the Contractor's means and methods. Therefore, the content of this report departs from typical practice, and this SCBR is not to be considered the equivalent of a Geotechnical Baseline Report, as defined in ASCE (2007).

The provision of baseline conditions in the Contract is not a warranty that the baseline conditions will be encountered; rather, the baseline conditions represent a contractual basis for the Owner and the Contractor to use when interpreting the differing site conditions clause in the General Conditions and Special Conditions of the Contract. The Contractor is to rely on this report for bidding and construction planning purposes related to anticipated ground and groundwater conditions and the Contractor is to plan construction and select equipment to fully address the expected baseline conditions identified in this report.

This SCBR is applicable only to the watermain installation section that will cross beneath the QEW using tunnelling methods and is not applicable to other elements of the QEW Widening from East of Cawthra Road to the East Mall.

2.0 SITE AND PROJECT DESCRIPTION

The new watermain installation is proposed under the QEW from the North Service Road, between Dixie Road Overpass and Dixie Road, to the South Service Road, west of Liveoak Drive in the City of Mississauga, Ontario. Residential areas are located to the south and north of the QEW right-of-way in the area of the watermain crossing; a now-abandoned gas station site is located at the north shaft of the crossing. The QEW grade at the site is approximately Elevation 107 m, and the present ground surface on either side of the QEW is at approximately Elevations 106 and 107 m on the south and north sides of the highway, respectively, rising to about elevation 108 m further north of the highway.

3.0 SOURCES OF INFORMATION

The documents listed in this section have been used in developing the SCBR, but these are not to be considered part of the SCBR and these publications are referenced herein for information purposes only.

Where precise determination of deposit boundaries or geotechnical engineering parameters are necessary for the safety and stability of the works, or for other construction concerns, or in instances where specialized geotechnical engineering properties of soils or rock are required but are not presented in the SCBR, these boundaries and parameters are to be identified and determined by supplementary investigations and testing by the Contractor prior to construction. This SCBR provides baseline conditions only for the physical subsurface conditions and does not provide baseline conditions for the chemistry of the soil, rock or groundwater.

3.1 Subsurface Data

Subsurface data gathered from multiple sources have been used in development of this report. The principal source of data is the Foundation Investigation Report, referenced below. The subsurface materials as characterized in the Foundation Investigation Report were defined at specific sample locations within the boreholes, and the Contractor is expected to review the specific subsurface data available in the Foundation Investigation Report. However, the interpretation of geotechnical engineering properties and parameters for the deposits and the stratigraphy as interpreted between samples provided in this SCBR are the baselines for this project. In the event of conflict between the Foundation Investigation Report and the SCBR, the SCBR shall be given precedence for the purpose of tendering and evaluating claims related to ground conditions.

- Golder Associates Ltd. "Foundation Investigation Report, Trenchless Sanitary Crossing West of Dixie Road, QEW Widening from East of Cawthra Road to the East Mall, Cities of Mississauga and Etobicoke, Ministry of Transportation, Ontario, GWP 2102-13-00 & 2432-13-00", August 2021, GEOCREs No. 30M11-314.

3.2 Geological References

The geological publications referenced in this document and listed below are for general information purposes only.

- Brennand, T. A. "Urban Geology of Toronto and Surrounding Area" in *Urban Geology of Canadian Cities*. GAC Special Paper 42, pp. 323-352. Karrow, P.F., and White O.L., Editors, Geological Association of Canada Special Paper 42, Geological Association of Canada, Newfoundland, 1998.
- Chapman, L.J. and Putnam, D.F. *The Physiography of Southern Ontario*. 3rd Edition, Ontario Geological Survey, Special Volume 2, 1984. Ontario Ministry of Natural Resources.

3.3 Publications

The publications referenced in this document, as listed below, are for general information purposes only.

- ASCE (2007). *Geotechnical Baseline Reports for Construction: Suggested Guidelines*. The Technical Committee on Geotechnical Reports of the Underground Technology Research Council, R.J. Essex, chairman, ASCE, Reston, VA, 62 pp.
- Boone, S.J., Westland, J., Busbridge, J.R., and Garrod, B. (1998). "Prediction of Boulder Obstructions", In *Tunnels and Metropolises, Proceedings of World Tunnel Congress 1998*, Sao Paulo, Brazil. A. Negro and A. Ferreira, Editors, Balkema, Rotterdam, pp. 817-822.
- Canadian Geotechnical Society (2006). *Canadian Foundation Engineering Manual*, 4th Edition. BiTech Publishers Ltd., Richmond, British Columbia.
- Heuer, R. E. (1974). "Important Ground Parameters in Soft Ground Tunneling", in *Proceedings Specialty Conference on Subsurface Explorations for Underground Excavations and Heavy Construction*, ASCE, Reston, VA., pp. 152-167.
- Kulhawy, F.H. and P.W. Mayne. (1990). *Manual on Estimating Soil Properties for Foundation Design*. Report EPRI-EL6800. Palo Alto, CA, Electric Power Research Institute.
- Ministry of the Environment Ontario (2005). Water Well Information System, Version 2.01. Hydrogeology of Southern Ontario, Second Edition. http://www.ene.gov.on.ca/envision/techdocs/4800e_index.htm
- Poot, S., Boone, S.J., Westland, J., and Pennington, B. (2000). "Predicted Boulder Frequency Compared to Field Observations During Construction", in *Proceedings of the 50th Canadian Geotechnical Conference*, Montreal, pp. 47-54.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The interpreted and simplified stratigraphic profile shown on Drawing 2 is the baseline stratigraphy for this project and is a simplification of the subsurface conditions encountered at and between the borehole locations.

Although interpreted strata boundaries are illustrated on Drawing 2, it must be understood that the stratigraphic boundaries illustrated on Drawing 2 are inferred from non-continuous sampling, observations of drilling progress and results of Standard Penetration Tests, and therefore represent transitions between soil types rather than exact planes of geological change; actual contacts between deposits will typically be gradational as a result of natural geologic processes. Further, the boundaries shown on Drawing 2 are illustrated for the indicated section line and are based on projection of the subsurface data onto this line. Variations in the deposit boundaries and the boundaries of major intra-deposit zones from those illustrated must be anticipated both along and perpendicular to the profile line. Therefore, the contractor's selection of construction equipment and procedures must be made to accommodate variations in the deposit boundaries as described in this SCBR. Where precise determination of deposit boundaries is necessary for the safety and stability of the works, or for other construction concerns, they are to be verified by supplementary investigations and testing by the Contractor prior to construction.

In summary, the stratigraphy at the borehole locations along this watermain alignment consists of a layer of asphaltic concrete and/or surficial non-cohesive fill underlain by a layer of non-cohesive fill at the highway. Topsoil and native sandy clayey silt exists at surface outside the highway shoulders. The surficial pavement structure, fill,

topsoil and native sandy clayey silt is underlain by a deposit of sand to silty sand, which is in turn underlain by a sandy clayey silt till deposit. All boreholes are underlain by interbedded shale and limestone bedrock.

Within this SCBR, the stratigraphy is defined and described based on the likely geologic origin, grain size distribution, plasticity characteristics and relative elevation. This approach is used to avoid geologic unit classifications based on geologic age or stage of glacial advance. In some instances, geologic nomenclature, although correct in defining the geologic origin and age of a particular layer, does not necessarily convey indications of material type or potential engineering behaviour. Precedence in this SCBR has therefore been given to naming the different soil layers based on relative elevation, grain size distribution and plasticity characteristics.

4.2 Baseline Engineering Characteristics of Soil

This section of the SCBR provides baseline geotechnical engineering parameters to be used for design of temporary works and for selection of equipment and construction methods. The baseline geotechnical engineering parameters presented are those considered relevant for the proposed installation of a primary liner. Baseline values are provided consistent with 10th, 50th, and 90th percentiles, as a means for quantitatively describing the statistical distribution of the parameter values and their natural variability. In some cases, the percentiles are based directly on statistical evaluation of available data and, in other cases, these values are supplemented by judgement based on local and regional experience with these soil and rock types. While the 50th percentile value can be used for some design purposes, the range represented by the 10th to 90th percentiles must also be considered as variability in physical properties is intrinsic to the nature of earth materials and is to be taken into account for estimating quantities, selection of equipment, and selection of construction means and methods.

Engineering Classes A to D, specific to this report and identified with colours on the baseline stratigraphic profile, group soil types in relation to anticipated natural behaviour during construction if exposed and in the absence of support or other modification provided through the Contractor's means and methods. The Engineering Classes used in this report are described in Table A following the text of this SCBR and in subsequent sections of this SCBR.

4.2.1 Pavement

At the one borehole (21-36) advanced through the existing pavement structure, an approximately 150 millimetre (mm) thick layer of asphalt pavement was encountered at ground surface. While asphalt pavement materials were encountered within one of the boreholes, this SCBR does not provide baseline characterizations of thicknesses, extents or locations of pavement materials.

4.2.2 Fill (Class A)

An approximately 1.5 to 2.0 m thick layer of fill was encountered at ground surface at Borehole 21-35, directly below ground surface at 21-35 and underlying the asphaltic concrete at Borehole 21-36. The surface of the fill was encountered at depths ranging from 0 m to 0.6 m below ground surface (between Elevations 106.4 m and 106.9 m). The fill is comprised of sand with varying amounts of silt. The fill is considered to be associated with the local road structure, QEW construction, nearby utility trenches and development of the adjacent residential and commercial lands.

A baseline grain size distribution envelope of Fill (Class A) is presented on Figure 1. Baseline classification and engineering parameters for Fill (Class A) are provided in Table 1 below, based on the site-specific data as well as experience with similar fill deposits in the project vicinity.

Table 1: Baseline Geotechnical Parameters for Fill (Class A)

Parameter	10 th Percentile ¹	50 th Percentile ¹	90 th Percentile ¹
SPT "N"-Value ²	5	13	25
Water Content, w_n (%)	5	9	18
D ₁₀ (mm)	0.003	0.017	0.130
D ₆₀ (mm)	0.120	0.170	3.500
Coefficient of Uniformity, C_u	10	40	96
Wet Unit Weight, kN/m^3	18	19	21
Effective Angle of Internal Friction, ϕ' (degrees)	26	28	30
Estimated Permeability, k (m/s)	1×10^{-6}	1×10^{-5}	1×10^{-5}

- 1) While for any given sample, percentages of gradation categories (e.g., gravel, sand, fines) will add to 100 per cent, percentile values do not necessarily add to 100 per cent because these statistics represent ranges of separate measurement parameters.
- 2) Baseline blow counts are based on SPT "N"-values measured for 0.3 m of penetration; for tests that did not penetrate a full 0.3 m, the blow count values were increased in proportion to the fraction of a standard 0.3 m penetration actually achieved, to a maximum equivalent SPT "N"-value of 150 blows per 0.3 m. Where a value of 150 blows per 0.3 m penetration is indicated within this report, this must also be interpreted that these values represent effective refusal to penetration of SPT equipment.

4.2.3 Native Cohesive Deposits (Class B)

A 0.5 m thick layer of Native Cohesive Deposits consisting of sandy clayey silt was encountered at surface in Borehole NW5-9, and inferred in Borehole 21-34. The Native Cohesive Deposit was encountered between Elevations 108.0 m and 107.5 m.

Baseline values for other geotechnical engineering parameters for the Native Cohesive Deposits are provided in Table 2 below, based on the site-specific data as well as experience with similar deposits in the project vicinity.

Table 2: Baseline Geotechnical Parameters for Cohesive Deposits (Class B)

Parameter	10 th Percentile ¹	50 th Percentile ¹	90 th Percentile ¹
SPT "N"-Value ¹	25	40	50
Water Content, w_n (%)	15	19	30
Wet Unit Weight, kN/m^3	19	20	21
Effective Angle of Internal Friction, ϕ' (degrees)	32	34	36
Estimated Permeability, k (m/s)	1×10^{-8}	5×10^{-8}	1×10^{-7}

- 3) Baseline blow counts are based on SPT "N"-values measured for 0.3 m of penetration; for tests that did not penetrate the full 0.3 m, the blow count values were increased in proportion to the fraction of a standard 0.3 m penetration actually achieved to a maximum equivalent SPT "N"-value of 150 blows per 0.3 m. Where a value of 150 blows per 0.3 m penetration is indicated within this report, this must also be interpreted that these values represent effective refusal to penetration of standard penetration testing equipment.

4.2.4 Native Granular Deposits (Class C)

A 0.7 to 2.8 m thick layer of Native Granular Deposits consisting of varying proportions of sand with varying amounts of silt and gravel was encountered underlying the fill at Boreholes 21-35, 21-36, underlying the topsoil at Borehole 21-37 and below the native clayey silt at Boreholes 21-34 and NW5-9. The surface of the Native Granular Deposits was encountered between Elevations 104.8 to 107.5 m.

A baseline grain size distribution envelope of the Native Granular Deposits (Class C) is presented on Figure 2. Baseline classification and engineering parameters for the Native Granular Deposits Soils (Class C) are provided in Table 2 below, based on the site-specific data as well as experience with similar native deposits in the project vicinity.

Table 3: Baseline Geotechnical Parameters for Native Granular Deposits (Class C)

Parameter	10 th Percentile ¹	50 th Percentile ¹	90 th Percentile ¹
SPT "N"-Value ²	7	22	39
Water Content, w_n (%)	7	16	22
D_{10} (mm)	0.015	0.065	0.105
D_{60} (mm)	0.060	0.800	4.75
Coefficient of Uniformity, C_u	4	12	45
Wet Unit Weight, kN/m^3	18	20	21
Effective Angle of Internal Friction, ϕ' (degrees)	27	32	37
Estimated Permeability, k (m/s)	7×10^{-6}	3×10^{-5}	6×10^{-5}

- 1) While for any given sample, percentages of gradation categories (e.g., gravel, sand, fines) will add to 100 per cent, percentile values do not necessarily add to 100 per cent because these statistics represent ranges of separate measurement parameters.
- 2) Baseline blow counts are based on SPT "N"-values measured for 0.3 m of penetration; for tests that did not penetrate the full 0.3 m, the blow count values were increased in proportion to the fraction of a standard 0.3 m penetration actually achieved to a maximum equivalent SPT "N"-value of 150 blows per 0.3 m. Where a value of 150 blows per 0.3 m penetration is indicated within this report, this must also be interpreted that these values represent effective refusal to penetration of standard penetration testing equipment.

4.2.5 Glacial Till/ Highly Weathered Bedrock (Class D)

A 0.4 m thick Glacial Till deposit was encountered underlying the Native Granular Deposits in Borehole 21-37. The Glacial Till deposit consists of sandy clayey silt with varying proportions of sand and gravel. The surface of the Glacial Till was encountered at an Elevation of 102.5 m.

The baseline grain size distribution envelope for the Glacial Till (Class D) deposit is presented on Figure 3. The baseline envelope for Atterberg Limits is presented on Figure 4, which indicates that these materials are generally low plasticity. Above the groundwater level, the Glacial Till will be fissured and have a blocky structure when exposed. Baseline values for other geotechnical engineering parameters for the Glacial Till are provided in Table 3 below, based on the site-specific data as well as experience with similar deposits in the project vicinity.

The presence of cobbles and boulders in the Glacial Till was not directly inferred based on observations during drilling, however based on local knowledge of this geologic layer presence of cobbles and boulders should be expected. Baseline characterization of cobbles and boulders is provided in a later section of this SCBR.

Table 4: Baseline Geotechnical Parameters for Glacial Till (Class D)

Parameter	10 th Percentile ¹ .	50 th Percentile ¹ .	90 th Percentile ¹ .
SPT "N"-Value ² .	50	100	150
Water Content, w_n (%)	10	14	18
Plastic Limit, PL (%)	NP	15	18
Liquid Limit, LL (%)	NP	23	29
Plasticity Index, PI	NP	8	11
D ₁₀ (mm)	<0.001	<0.001	0.004
D ₆₀ (mm)	0.020	0.100	0.400
Coefficient of Uniformity, Cu	>20	>100	100
Wet Unit Weight, kN/m ³	19	20	21
Effective Angle of Internal Friction, ϕ' (degrees)	33	35	36
Estimated Permeability, k (m/s)	1×10^{-8}	1×10^{-8}	1×10^{-8}

- 1) While for any given sample, percentages of gradation categories (e.g., gravel, sand, fines) will add to 100 per cent, percentile values do not necessarily add to 100 per cent because these statistics represent ranges of separate measurement parameters.
- 2) Baseline blow counts are based on SPT "N"-values measured for 0.3 m of penetration; for tests that did not penetrate the full 0.3 m, the blow count values were increased in proportion to the fraction of a standard 0.3 m penetration actually achieved to a maximum equivalent SPT "N"-value of 150 blows per 0.3 m. Where a value of 150 blows per 0.3 m penetration is indicated within this report, this must also be interpreted that these values represent effective refusal to penetration of standard penetration testing equipment.

4.2.6 Shale Bedrock

Shale was encountered and core samples were recovered in Boreholes 21-34 to 21-37 and MP-2 between depths of 2.2 m to 3.9 m below ground surface (Elevations 104.3 m to 102.1 m). The Shale is highly weathered to fresh, very thinly to thinly laminated, fine-grained to very fine-grained, non-porous, weak and grey with very strong to medium strong limestone interbeds. Baseline values for engineering parameters for the Shale are provided in Table 5 below.

Table 5: Baseline Parameters for Shale

Parameter	10 th Percentile ¹ .	50 th Percentile ¹ .	90 th Percentile ¹ .
Total Core Recovery (TCR), %	80	100	100
Solid Core Recovery (SCR), %	74	100	100
Rock Quality Designation (RQD), %	20	75	100
Unconfined Compressive Strength (UC), MPa	8	19	20
Estimated Permeability, k (m/s)	1×10^{-8}	1×10^{-7}	1×10^{-6}

4.2.6.1 Hard Layers

For baseline purposes the relative proportion of cored shale versus cored harder limestone or siltstone layers referred to as “hard layers” within the bedrock as logged in the drillholes is shown in Plate 1. The frequency is based on the percentage of hard layers in each drill run cored and does not include the completely to moderately weathered shale bedrock that was sampled in split-spoons. The data used for this assessment was based on the information obtained from drillholes 21-34, 21-35, 21-36, 21-37 and MP-2 located along the proposed watermain alignment.

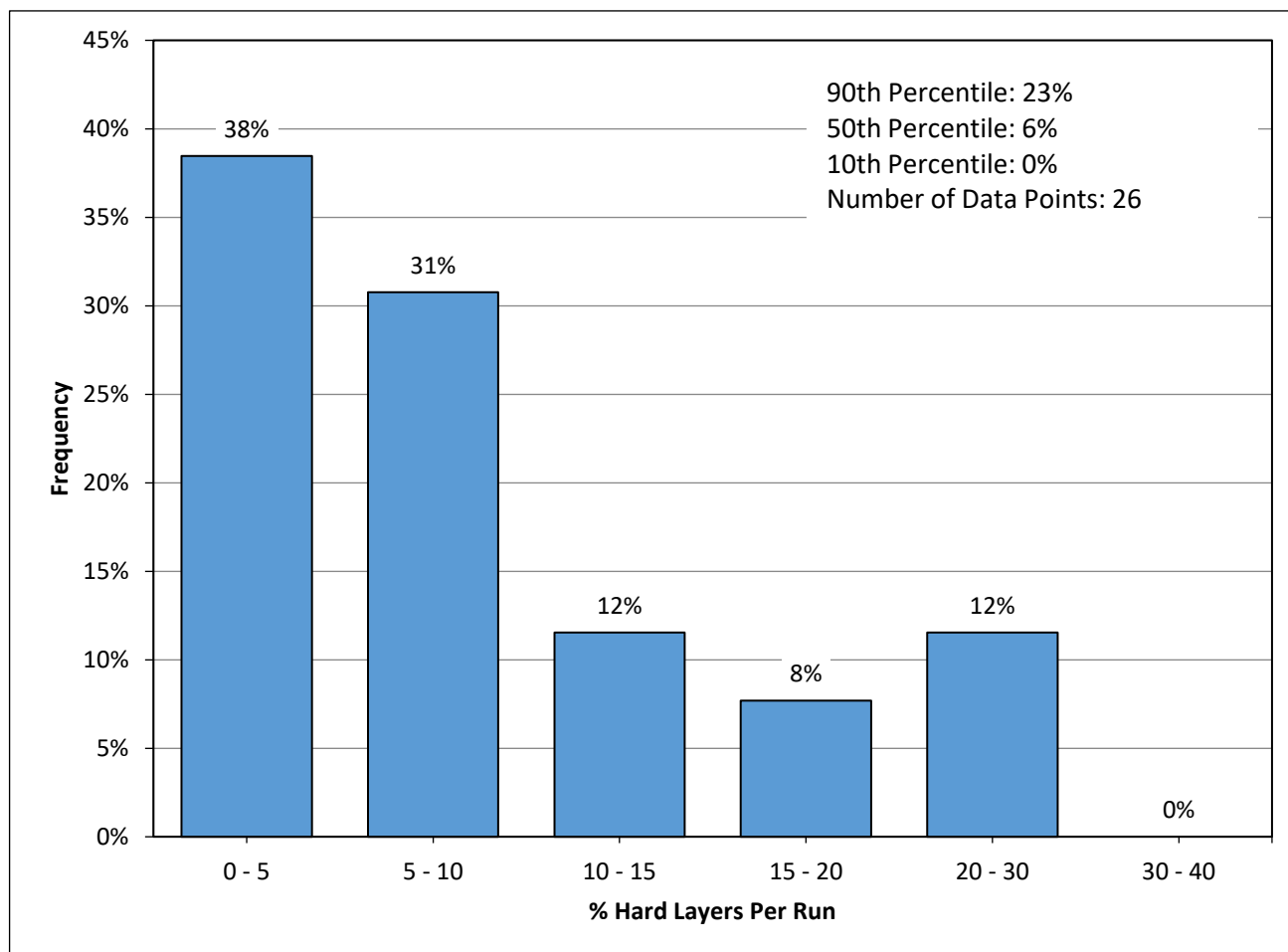


Plate 1: Baseline Distribution of the Percentage of Hard Layers

For the purposes of this baseline, the maximum thickness for these hard layers refers to a discrete interbed of pure limestone or siltstone. For baseline purposes, Plate 2 shows the frequency for the thickness of the “hard layers” that can be expected to be encountered within the bedrock.

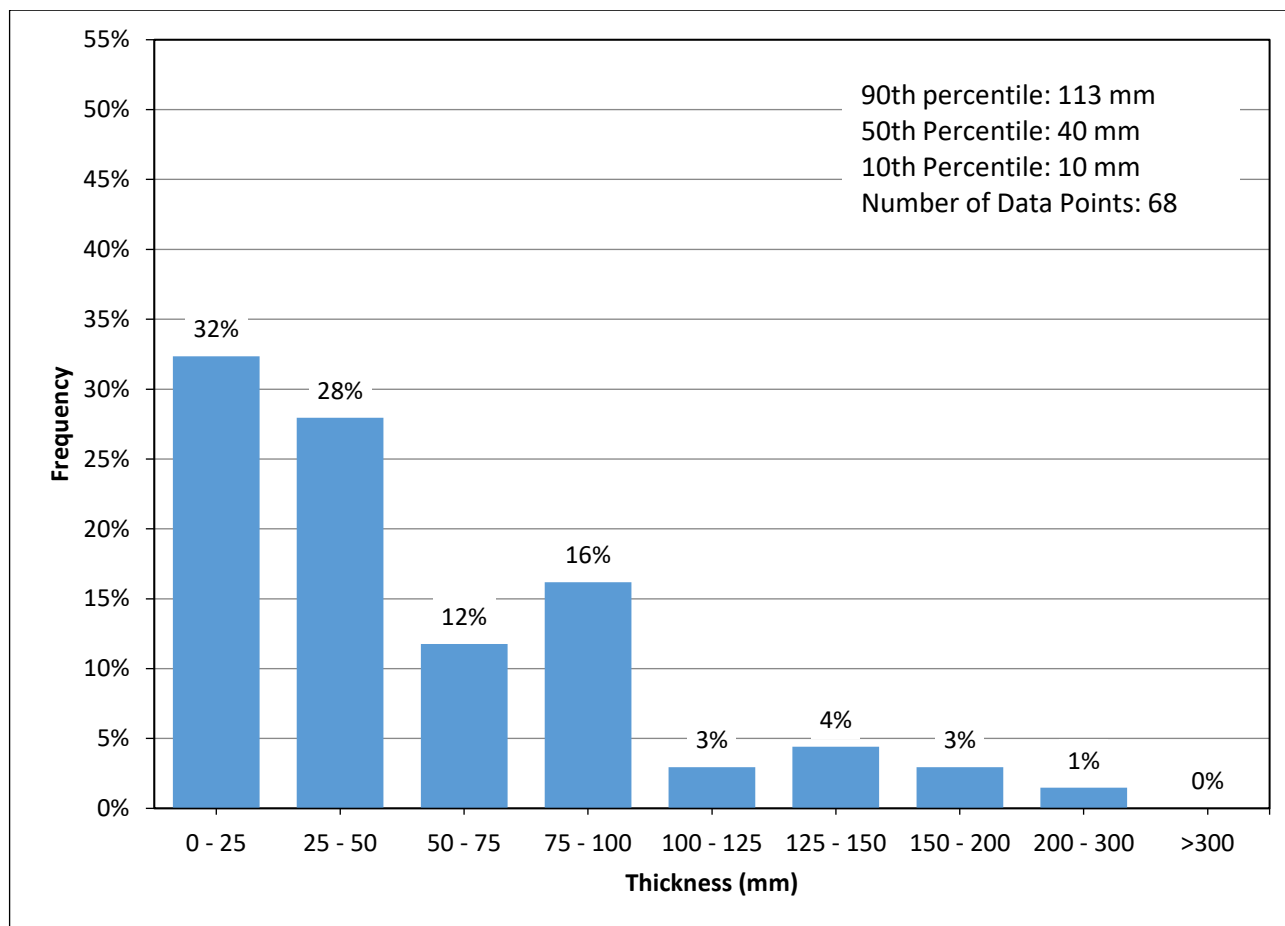


Plate 2: Baseline Distribution of the Hard Layer Thicknesses

4.2.6.2 *Natural Gas*

Methane and hydrogen sulphide are known to be present in the shale bedrock of the Georgian Bay formation and have been encountered in the soils of Southern Ontario, typically in granular layers capped by cohesive tills.

Methane forms an explosive mixture with air and is a potential hazard for excavation and construction work and it should be assumed that it will be encountered in the bedrock and soil at this site. Changes in groundwater pressure which may be caused by dewatering or seepage into excavations/underground spaces can lead to migration/release of gaseous or dissolved methane. Therefore, the absence of methane in a particular area should not be construed to indicate that there is no risk of the presence of methane in the future or in other site areas.

The tunnel should be considered, according to the OHSAA Underground Construction (Tunneling) Regulations (29 CFR Part 1926.800, "Tunnels and Shafts.") as "potentially gassy".

For baseline purposes it should be assumed that methane gas could be encountered anywhere along the tunnel alignment or in the shafts. For baseline purposes the Contractor should expect to encounter gas in numerous small pockets that can be vented within 2 hours and up to a total of 4 hours in a 24 hour period.

As a consequence of this designation, the Specifications include specific provisions for gas monitoring and specific requirements for selected underground equipment.

4.3 Groundwater Conditions

Water levels were observed in the open boreholes upon completion of drilling operations and were between 1.5 m and 3.8 m below ground surface (between Elevations 105.9 m and 103.5 m) in the boreholes. However, the water level observed in the open boreholes during and/or upon completion of drilling does not necessarily represent the longer-term, stabilized groundwater level at the site. Standpipe piezometers were installed in Boreholes 21-34 and 21-37, and the measured groundwater levels in the standpipe piezometers are summarized in the table below:

Table 6: Recorded Groundwater Levels in Standpipe Piezometer

Borehole No.	Depth to Water Level (m)	Groundwater Elevation (m)	Date of Measurement
21-34	1.8	105.9	February 2, 2021
	2.4	105.3	April 4, 2021
	2.5	105.2	July 2, 2021
	2.5	105.2	July 7, 2021
21-37	1.9	103.5	February 24, 2021
	1.9	103.5	May 10, 2021

A baseline groundwater level is provided on Drawing 2. For baseline purposes, groundwater levels are to be expected to fluctuate seasonally in response to changes in precipitation and snow melt to as much as 1 m above or below the baseline groundwater level. Any water infiltrating through the roadway and embankment fill is also expected to be inhibited by and therefore perched within the Fill and Granular Deposits overlying the Glacial Till.

4.4 Cobbles, Boulders and Other Obstructions

With the exception of processed (crushed and screened) sand and gravel road base, the materials through which construction will be performed are glacially derived and therefore will contain cobbles and boulders. Cobbles are defined as rock fragments that cannot pass through a screen with 75 mm square openings, but that are less than 300 mm in maximum dimension. Boulders are defined as rock fragments with their maximum dimension equal to or greater than 300 mm. Boulders and cobbles were not sampled or cored in the boreholes advanced at the site; however, based on past experience within the Greater Toronto Area, the combined total volume of individual boulders, known as the Boulder Volume Ratio (BVR), within glacial till soils typically ranges between 0.15 percent and 0.3 percent of the excavated volume. Typically, the size distribution of boulders is such that between 5 and 10 boulders of varying sizes are found for every cumulative cubic metre of boulder rock. The number of boulders per cubic metre of cumulative boulder volume encountered is the Boulder Number Ratio (BNR). For baseline purposes, the BVR, BNR and Boulder Maximum Size values are provided in

Table 7 below.

Table 7: Baseline Boulder Parameters

Parameter	Granular Deposits (Class B)	Glacial Till and Clayey Silt Residual Soils (Class C and D)
Boulder Volume Ratio (BVR)	0.02%	0.3%
Boulder Number Ratio (BNR)	10	10
Boulder Maximum Size (m ³)	0.5	1.0

For example, using the BVR and BNR provided above for an excavated volume of 100 cubic metres (m³) of Glacial Till (Class C) (by drilling or other excavation equipment), a cumulative 0.3 m³ of boulder rock manifested in approximately 3 boulders will be anticipated. For baseline purposes, where calculations result in a fractional number of boulders, the number is to be rounded up to the nearest integer. The Contractor is to consider penetration, breaking, or removal of cobbles routine requirements of construction and not to be accounted for separately. For baseline purposes, as part of the boulder volumes given in Table 7 above, one boulder with a diameter between 0.8 m and 1.0 m should be expected to be encountered along the tunnel alignment.

For baseline purposes, the cobbles and boulders will be composed of gneissic and dioritic rocks of the Canadian Shield. The uniaxial compressive strength of the rock forming cobbles and boulders will range from about 120 MPa to 200 MPa (10th and 90th percentiles) with a 50th percentile value of about 180 MPa.

The date of construction of the original QEW, North Service Road and South Service Road fill placement is unknown; as well, typical construction practices with regards to clearing and grubbing of the site prior to fill placement at the time of construction are unknown. No records of construction of the highway or local roadways (site records/journals, photographs, as-constructed drawings, etc.) were available at the time of writing this SCBR. For baseline purposes it is to be expected that where construction penetrates fill materials there will be debris consisting of broken concrete, reinforcing bars, logs, stumps and brush from previous clearing and grubbing operations and cobbles and boulders buried in the fill. The contractor must select a construction method that is capable of removing these types of obstructions in fill materials.

5.0 EXISTING UTILITIES

Utilities present along the project alignment, including but not limited to lighting, communications cables, storm sewers, and natural gas pipelines, must be accurately located and either protected or relocated. Depending upon the location, utilities relocated to avoid the trenchless construction could be affected by the settlement trough created by excavations required for trenchless construction. The Contractor is responsible for protecting existing and newly relocated utilities from settlement and horizontal displacement. Protection of utilities, support of excavations, instrumentation and monitoring have been specified elsewhere in the Contract Documents to control, measure and document the amount of displacement at these sites.

6.0 CLASSIFICATION OF ANTICIPATED GROUND BEHAVIOUR

This section of the SCBR describes the Engineering Classes of the various soil types as identified along the proposed primary liner alignment, and their anticipated behaviour if exposed and unsupported. The interpreted baseline stratigraphy and the baseline piezometric level along the watermain alignment are shown on Drawing 2.

The anticipated ground behaviour presented in this report is described using the Ground Behaviour Classification System provided below in Table 8. The Tunnelman's Ground Classification System (Heuer, 1974), as derived from the original system by Terzaghi (1950), has been used as a basis to describe the anticipated behaviour of the ground. No account is taken in the given classifications of the supporting pressure provided to the face by tunneling equipment and fluids or to the response of the ground to support or modifications that are selected and implemented by the Contractor (e.g., dewatering, shoring, tunneling systems, etc.); the intent of using the Engineering Classes is to describe the behaviour of the material if exposed during excavation and tunneling without provision of support or ground modifications.

Table 8: Ground Behaviour Classification

Classification and Descriptive Terms	Sub-Classification	Behaviour
Firm		Excavation face(s) can be cut without initial support
Ravel, Raveling	Slow raveling	Chunks or flakes of material begin to drop out of the excavation face(s) sometime after the ground has been exposed, due to loosening, overstress, fissures, and "brittle" fracture (ground separates or breaks along distinct surfaces, as opposed to squeezing ground). In fast raveling ground, the process starts within a few minutes; otherwise the ground is slow raveling.
	Fast raveling	
Squeeze, Squeezing		Ground squeezes or extrudes plastically from excavation face(s) without visible fracturing or loss of continuity, without perceptible increase in water content, and exhibits ductile plastic yield and flow.
Run, Running	Cohesive-running	Apparent cohesion in moist sand, silt, or mixtures of these, or weak cementation in any non-cohesive soil, allows the material to stand for a brief period of raveling, before it breaks down and degrades to running or flowing behaviour.
	Running	Dry non-cohesive materials without cohesion are unstable at a slope greater than their angle of repose (approximately 30 to 35 degrees). When exposed at steeper slopes, the soils run like granulated sugar or dune sand until the slope flattens to the angle of repose. Soil exhibiting such behaviour is running.
Flow, Flowing		A mixture of soil and water flows from excavation face(s) like a viscous fluid. The material can flow for great distances, completely filling excavations or tunnels in some cases.

In granular soils, face stability is commonly assessed using groundwater conditions, soil gradation, variability in gradation and in situ density. The “fines content” (combined silt and clay-size fraction of soil) for the Class A through D soils is described in Section 4.2. While the fines content is conventionally useful for assisting with interpretation of soil behaviour, in the Greater Toronto Area granular soils can commonly include a significant “fines” content and yet also run, ravel or flow (depending on water content) contrary to conventional interpretations of likely behaviour because the “fines” can consist primarily of relatively uniformly graded silt. Therefore, the baseline behaviour descriptions and classifications provided in this report have been developed specifically for this project.

The Fill and Class C Granular Deposit will flow upon exposure where these are below the baseline piezometric groundwater level and exhibit ravelling to fast ravelling behaviours above the ground water level. Excavation through the Glacial Till (Class D) and Cohesive Soils (Class B) will also encounter water-bearing granular layers that will flow upon initial exposure where these are below the baseline groundwater level. Excavation difficulties such as lumping, balling and sticking to equipment are to be expected where zones/lenses with higher silt and clay contents are encountered within the Cohesive Soils (Class B) and Glacial Till (Class D).

7.0 CLOSURE

This Subsurface Conditions Baseline Report was prepared by Golder Associates Ltd., with input and consultation by the project designer, AECOM, on behalf of the Ministry of Transportation, for the proposed realignment of the watermain located under the QEW from the North Service Road, between Dixie Road Overpass and Dixie Road, to the South Service Road, west of Liveoak Drive in the City of Mississauga, Ontario. It is intended for use by bidders of G.W.P. 2102-13-00.

Golder Associates Ltd.




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Geotechnical Engineer




William (Bill) Cavers, P.Eng.
MTO Foundations Designated Contact

KNN/WBC/hdw

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Tables

TABLE A – DESCRIPTION OF ENGINEERING SOIL CLASSES

Engineering Soil Class	Colour Code	Soil Type Description	Description of Engineering Class	Major Deposits	Behaviour of Engineering Classes
A		<ul style="list-style-type: none"> Silty Sand Fill Sand and Gravel Fill 	<ul style="list-style-type: none"> Near-surface materials placed by man-made processes, with random and broad compositions Fill can include natural and man-made materials related to highway embankment construction, containing varying fractions of gravel silt, sand and clay, along with organic material and other debris. 	Fill	<ul style="list-style-type: none"> Above groundwater levels, slow raveling. Below groundwater levels, fast raveling. Groundwater flows from and within coarser layers will decrease following exposure. Rapid support of these materials and groundwater control are required to control the behaviour of these materials. Sand and gravel components of material are abrasive.
B		<ul style="list-style-type: none"> Clayey Silt 	<ul style="list-style-type: none"> Near-surface materials. Above groundwater levels, the clayey silt is anticipated to be fissured from various weathering processes and have a “blocky” structure when exposed. 	Native Cohesive Deposit	<ul style="list-style-type: none"> Above groundwater levels, firm to slow raveling Below groundwater levels, firm to fast raveling. Material behaviour in exposed areas will be sensitive to variation in water content and construction traffic.

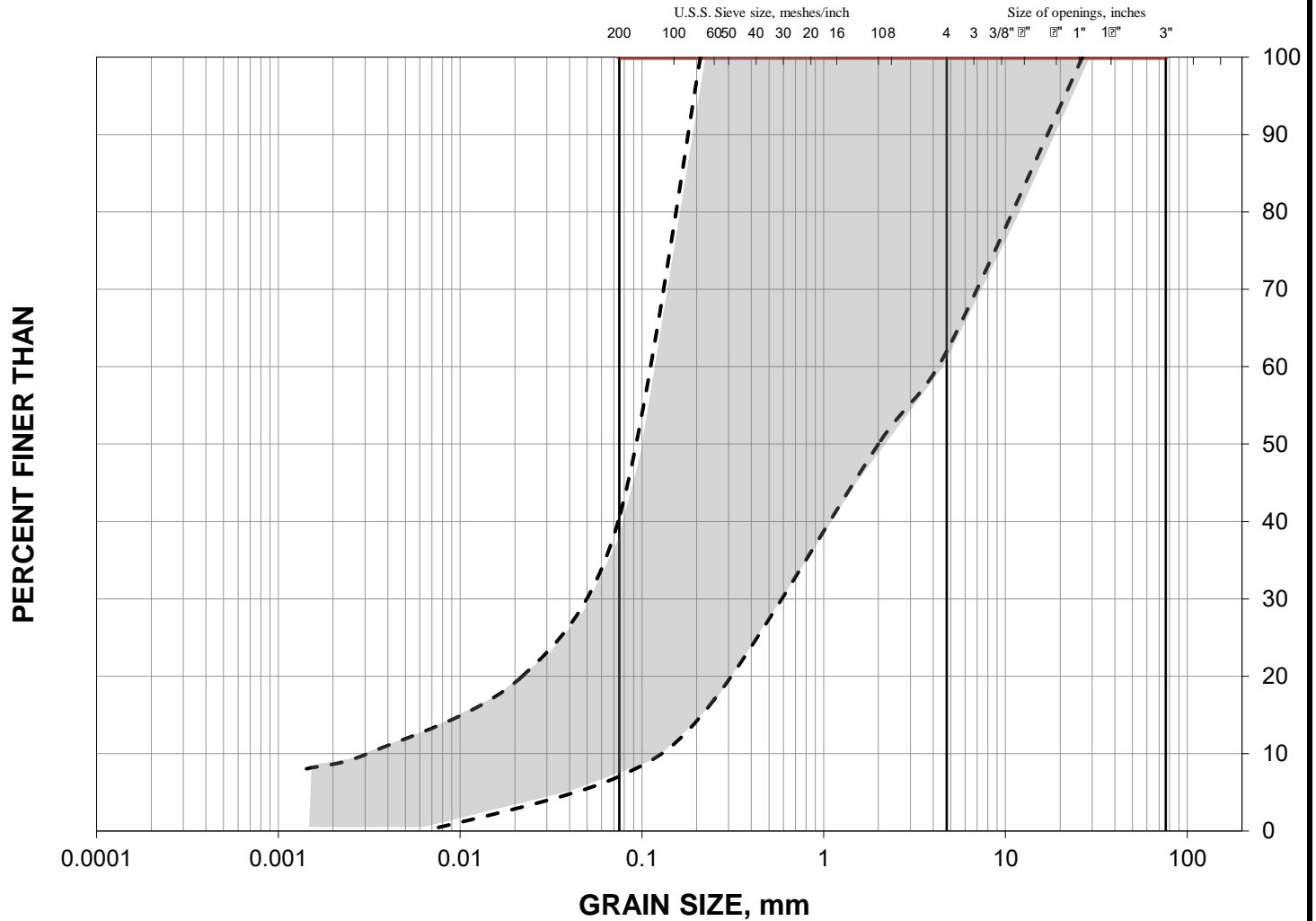
Engineering Soil Class	Colour Code	Soil Type Description	Description of Engineering Class	Major Deposits	Behaviour of Engineering Classes
B		<ul style="list-style-type: none"> Silty Sand Sand Silt and Sand – Silt Gravel and Sand – Gravelly Sand 	<ul style="list-style-type: none"> Broadly-graded gravelly sand, sandy gravel, silty sand, sand, sand and silt– silty sand containing 0% to 37% gravel. Fines content between about 7% and 94%. Content of clay-size fraction equal to or less than about 6%. Non-plastic. Cobbles and boulders (weathered rock) are expected within these soil types. The material varies in permeability from 4×10^{-5} m/s to 6×10^{-5} m/s. 	Native Granular Deposit	<ul style="list-style-type: none"> Above groundwater levels, slow raveling to fast raveling upon drying. Below groundwater levels, these materials fast raveling to flowing. Rapid support of these materials and groundwater control are required to control the behaviour of these materials. Sand and gravel components of material are abrasive.
C		<ul style="list-style-type: none"> Clayey Silt Glacial Till Sandy Clayey Silt Glacial Till Clayey Silt and Sand Glacial Till 	<ul style="list-style-type: none"> Broadly-graded, low plasticity soils ranging from clayey silt to clayey silt and sand, containing trace to some gravel and rock fragments. Above groundwater levels, the glacial till is anticipated to be fissured from various weathering processes and have a “blocky” structure when exposed. The plasticity index of this soil class will be about 13 per cent. The material varies in permeability and contains fissures Cobbles and boulders are expected within these soils. 	Glacial Till	<ul style="list-style-type: none"> Above groundwater levels, firm to slow raveling Below groundwater levels, firm to fast raveling. Material behaviour in exposed areas will be sensitive to variation in water content and construction traffic. Sand and gravel components are abrasive.

1. Colour shade may vary from those illustrated on the interpreted profiles due to variation in plotting/printer settings.
2. Refer to the Baseline Engineering Characteristics of the Soils section in the Subsurface Condition Baseline Report for further details on the soil type.

Figures

**Baseline Grain Size Distribution
Fill
(Class A)**

FIGURE 1



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

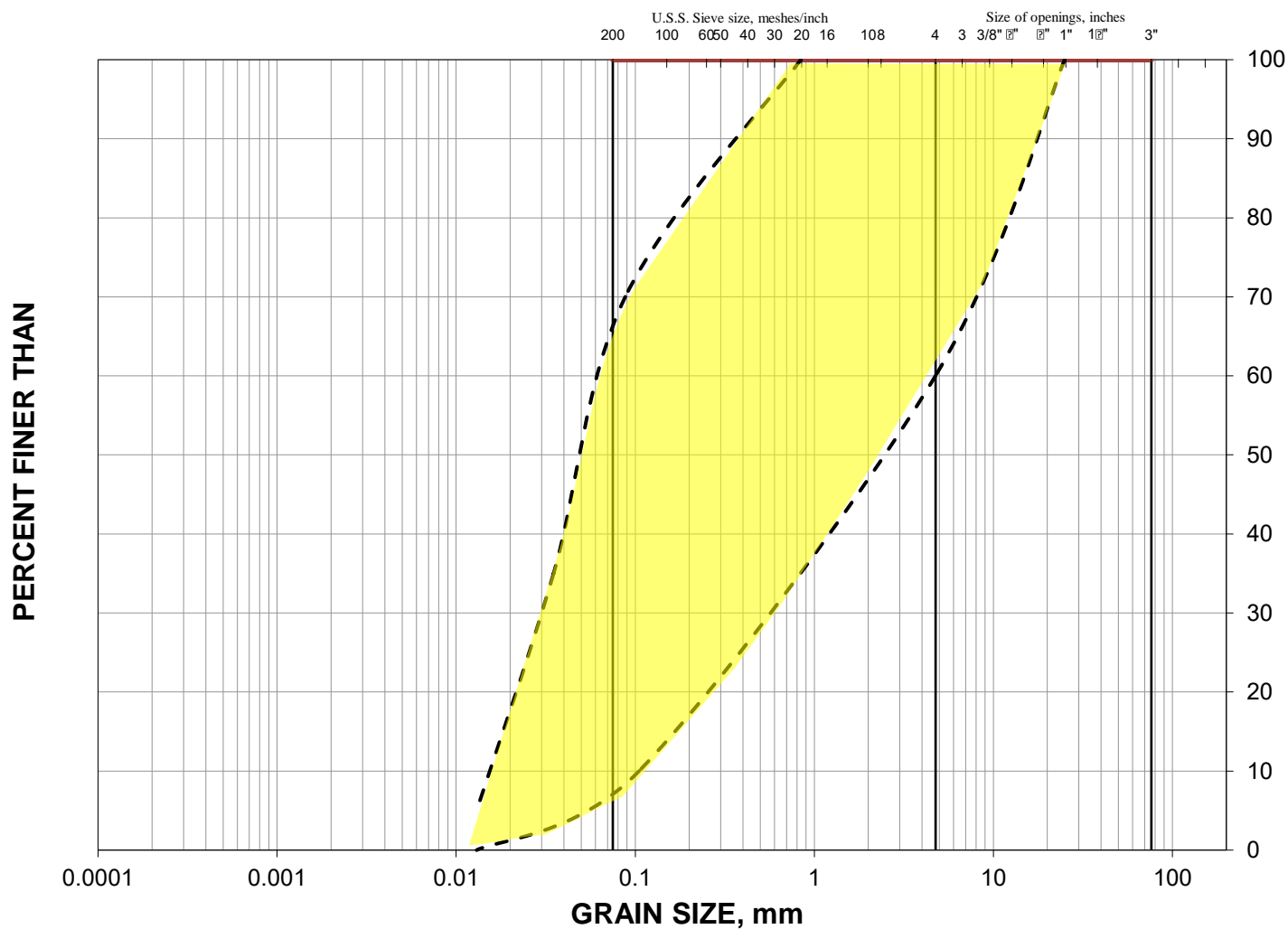
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Project: 1530382

Golder Associates

Drawn: KM
Checked: WC

**Baseline Grain Size Distribution
Native Granular Deposits
(Class C)**

FIGURE 2



	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		

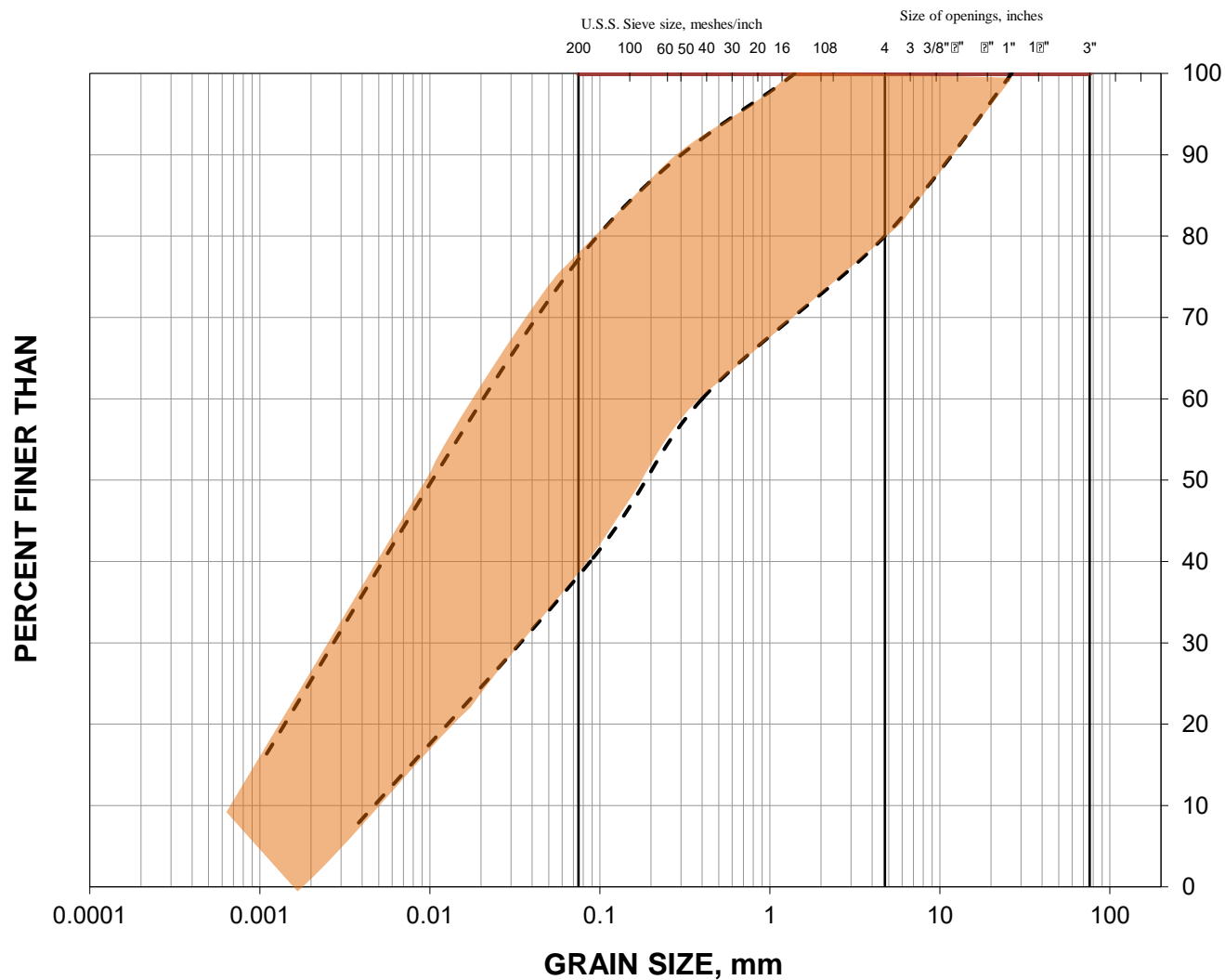
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**Baseline Grain Size Distribution
Glacial Till
(Class D)**

FIGURE 3

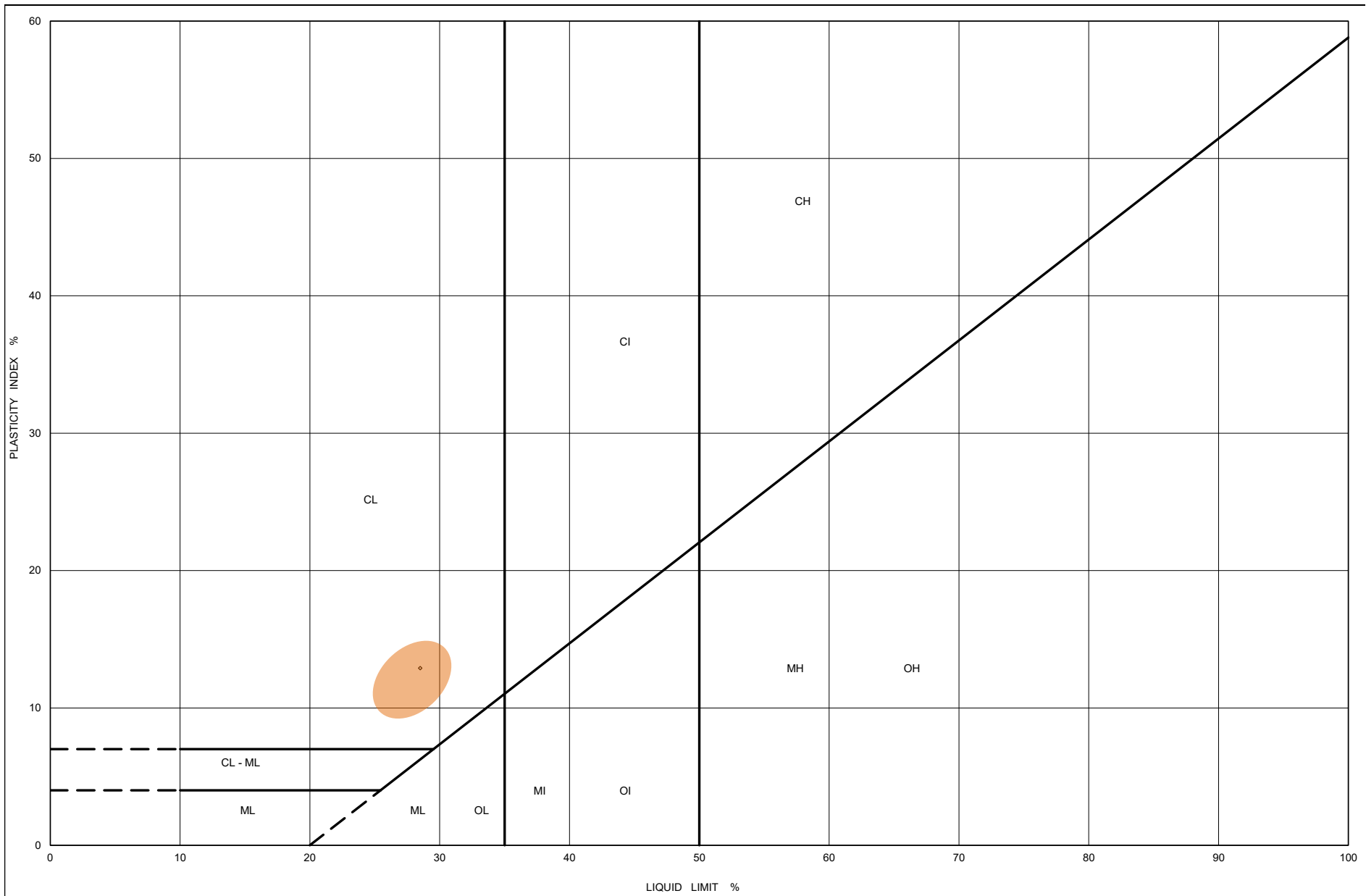


	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

Date: Dec, 2021
Project: 1530382

Golder Associates

Drawn: KM
Checked: WC



Ministry of Transportation

Ontario

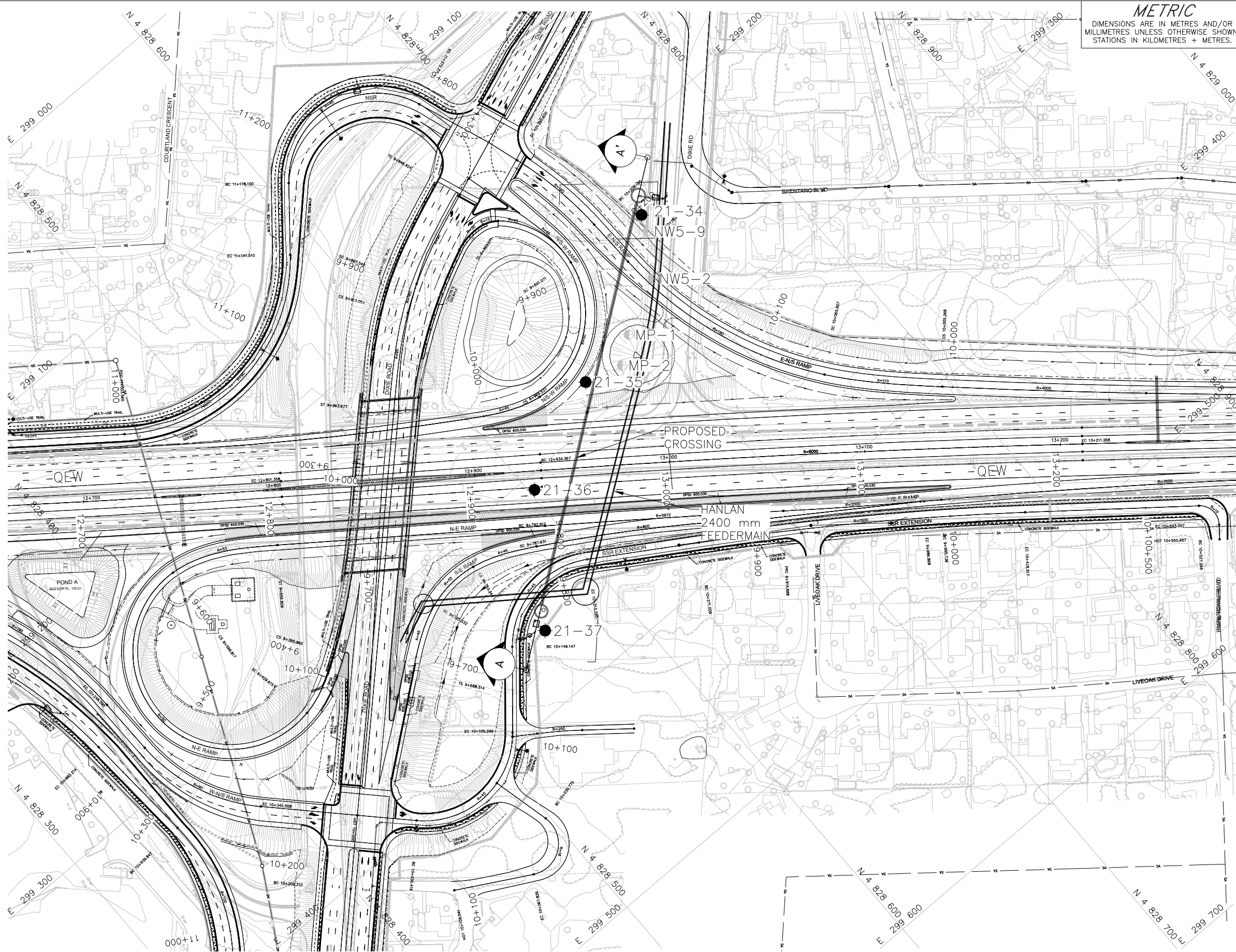
PLASTICITY CHART Glacial Till (Class D)

Figure No. 4

Project No. 1530382/7000

Checked By: KM

Drawings

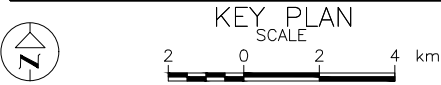
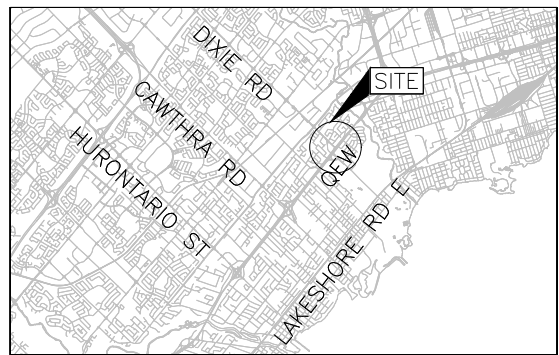


METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. 2102-13-00 & 2432-13-00
GWP No.

QEW—CAWTHRA TO EAST MALL WIDENING
TRENCHLESS WATERMAIN CROSSING WEST OF ROAD

BOREHOLE LOCATIONS



LEGEND

●

Borehole — Current Investigation

●

Borehole — Previous Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
21-34	107.7	4828735.4	299235.7
21-35	106.4	4828658.3	299282.2
21-36	107.0	4828602.6	299307.1
21-37	105.4	4828560.0	299365.4
NW5-9	108.0	4828732.2	299244.1
NW5-2	107.9	4828718.6	299264.2
MP-1	107.2	4828690.7	299278.1
MP-2	106.9	4828677.9	299287.8

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

Retaining walls plans provided in digital format by AECOM, drawing file nos. 04_Retaining Wall_New_24-887W.dwg and 07_Retaining Wall_NewPortion_24-888W.dwg, received January 18, 2018, R.Wall New 24-8XXW.dwg, received April 19, 2018.

Watermain plan provided in digital format by AECOM, drawing file no. QEW_DixieC_UTL_PROP_WATERMAIN.dwg, received March 16, 2021.

Base plans provided in digital format by AECOM, drawing file nos. QEW_DixieC_base.dwg and QEW_DixieC_plan.dwg, dated July 20, 2016, received Dec. 06, 2016.

Design plans provided in digital format by AECOM, drawing file nos. QEW_DixieC_base.dwg and QEW_DixieC_plan.dwg, dated July 20, 2016, received Dec. 06, 2016.

Existing ground contours provided in digital format by AECOM, drawing file no. QEW_DixieC_Contours3D.dwg, received Nov. 08, 2016, contour interval 0.5 m.

Key plan base data — MNRF LIO, obtained 2015.

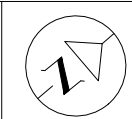
Hanlan Watermain plan provided in digital format by AECOM, drawing file no. WS_18_CONT2.dwg, received April 9, 2021.



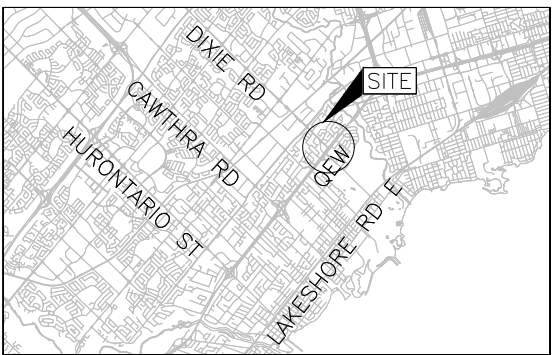
NO.	DATE	BY	REVISION
Geocres No. 30M11-320			
HWY. QEW	PROJECT NO. 1530382-7000		DIST. Central
SUBM'D. KN	CHKD. KM	DATE: 01/24/2022	SITE: —
DRAWN: ZS/SA	CHKD. KM	APPD. WC	DWG. 1

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

CONT No. 2102-13-00 & 2432-13-00
GWP No.

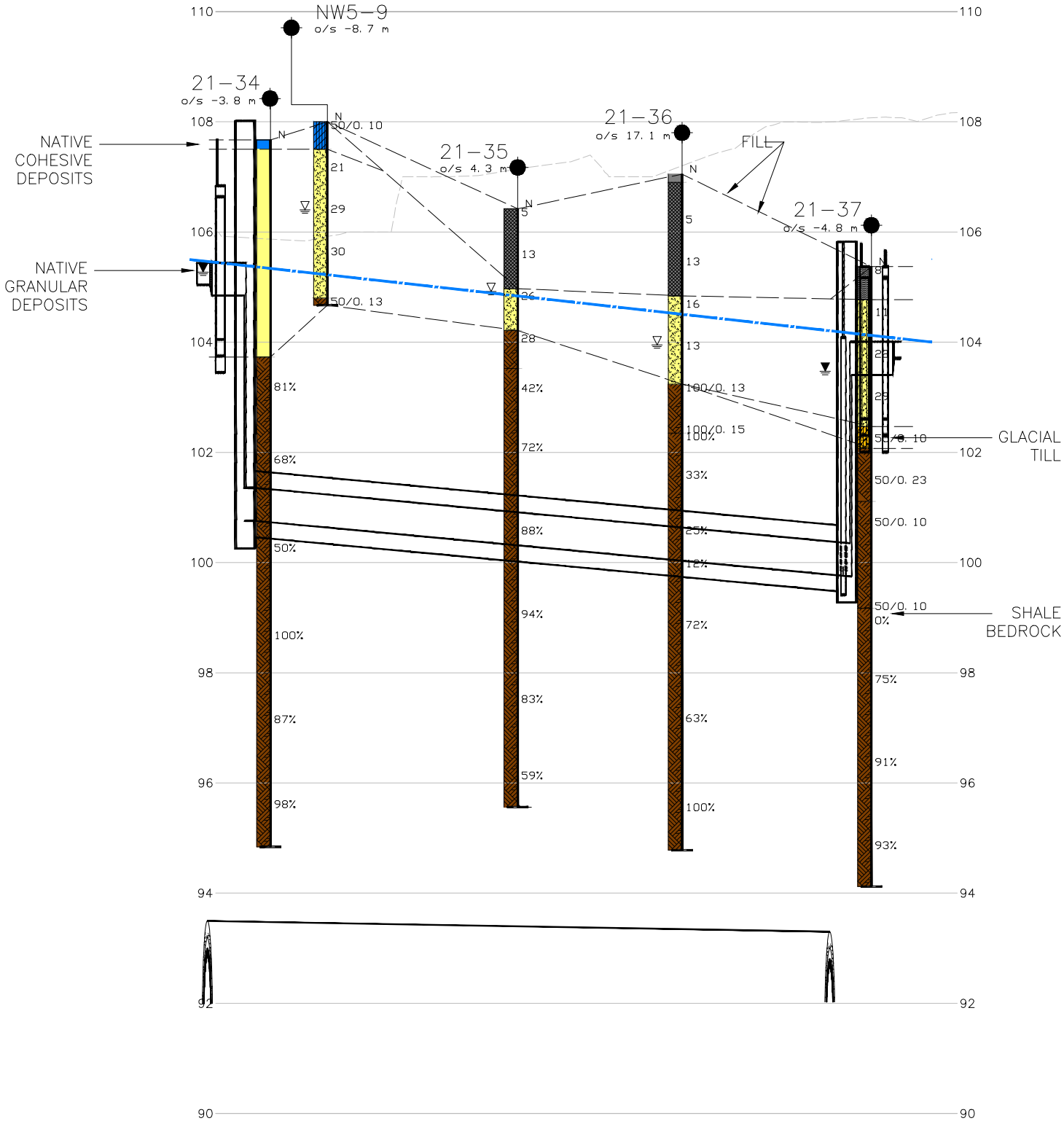


QEW—CAWTHRA TO EAST MALL WIDENING
TRENCHLESS WATERMAIN CROSSING WEST OF DIXIE ROAD
INTERPRETED BASELINE
STRATIGRAPHIC PROFILE



KEY PLAN
SCALE
2 0 2 4 km

LEGEND	
Class A	Asphalt Topsoil Fill
Class B	Sandy Clayey Silt
Class C	Sand to Silty Sand
Class D	Clayey silt (Till)
Class E	Shale (Bedrock)
— — —	Baseline Major Soil Deposit or Bedrock Boundary
— — —	Interpreted Piezometric Water Level



LEGEND			
●	Borehole — Current Investigation		
●	Borehole — Previous Investigation		
N	Standard Penetration Test Value		
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)		
100%	Rock Quality Designation (RQD)		
≡	WL in piezometer, measured on April 21, 2021		
≡	WL upon completion of drilling		

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
21-34	107.7	4828735.4	299235.7
21-35	106.4	4828658.3	299282.2
21-36	107.0	4828602.6	299307.1
21-37	105.4	4828560.0	299365.4
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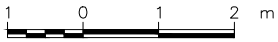
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PROFILE A-A'
VERTICAL SCALE



HORIZONTAL SCALE



NO.	DATE	BY	REVISION
Geocres No. 30M11-320			
HWY. QEW	PROJECT NO. 1530382-7000		DIST. Central
SUBM'D. KN	CHKD. KM	DATE: 01/24/2022	SITE: —
DRAWN: ZS/SA	CHKD. KM	APPD. WC	DWG. 2



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