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FOUNDATION INVESTIGATION REPORT

Culvert Replacements - Highway 519 Detail Design of Highway 519 from Highway 17 Easterly to Dubreuilville, 30.7 km Ministry of Transportation, Ontario G.W.P. 327-99-00

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REPORT





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PART A

**FOUNDATION INVESTIGATION REPORT
CULVERT REPLACEMENTS – HIGHWAY 519
DETAIL DESIGN OF HIGHWAY 519 FROM HIGHWAY 17
EASTERLY TO DUBREUILVILLE, 30.7 KM
MINISTRY OF TRANSPORTATION, ONTARIO
G.W.P. 327-99-00**



1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by D.M. Wills and Associates Limited (D.M. Wills) on behalf of Ministry of Transportation, Ontario (MTO) to provide Foundation Engineering services for the replacement of four centerline culverts on Highway 519 as part of the detail design of Highway 519 from Highway 17 easterly to Dubreuilville for about 30.7 km. The approximate locations of the culverts are shown on the Index Plan, Drawing 1 and are summarized in Table 1, following the text of this report.

The Terms of Reference and the Scope of Work for the foundation investigation are outlined in MTO's Request for Proposal, dated March 2015. Golder's proposal for the foundation engineering services associated with the Twin Lake culvert replacements is contained in Section 6.8 of D.M. Wills' Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated July 22, 2015.

This report addresses the investigation carried out for four culverts which originally were identified as potential culvert replacements. The location of two of the culverts were subsequently revised, as per the scope change to culvert locations dated April 5, 2016. The foundation investigation and design associated with the Twin Lake culvert for this assignment is presented in a separate report.

2.0 SITE DESCRIPTION

The four culverts identified for replacement are located on Highway 519 in the Townships of Dambrossio and Dumas. The existing culvert locations and details (size, length, type, etc.) are summarized in Table 1.

In general, the topography in the area of each individual culvert consists of rolling terrain, including sparsely to densely populated treed areas. The highway surface at the boreholes advanced through the existing Highway 519 embankment at the culvert locations, ranges from Elevation 444.7 m to 421.4 m to 423.4 m to 439.2 m (Geodetic datum) travelling in the east to west direction.

3.0 INVESTIGATION PROCEDURES

The fieldwork for the foundation investigations associated with the proposed replacement of the four culverts was carried out between July 6 and 21, 2016 during which time a total of 18 boreholes were advanced at, or in the immediate vicinity of the culvert alignments as summarized below and in Table 1. The borehole locations are shown in plan on Drawings A1 to D1 in Appendices A to D.

The field investigation was carried out using a truck-mounted CME 55 truck-mounted drill rig and portable drilling equipment which were supplied and operated by Landcore Drilling of Sudbury, Ontario and OGS Drilling Inc. of Almonte, Ontario, respectively.

Boreholes completed with the CME 55 truck-mounted drill rig were advanced through overburden using nominal 152 mm diameter solid stem augers. The boreholes completed with the portable equipment were advanced through the overburden using BW sized casing with wash boring techniques. Boreholes that were completed with rock coring were advanced using BW or NW size casing and a BQ or thin wall, NQ size, core barrel depending on the type/size of drilling equipment utilized to advance the boreholes. Soil samples were obtained continuously or at intervals of depth up to about 1.5 m using nominal 50 mm outside diameter (O.D.) split-spoon samplers operated by an automatic hammer on the drill rig, performed in accordance with Standard Penetration Test (SPT)



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procedures (ASTM D1586). Boreholes advanced by portable equipment employed either a full-weight or a third (1/3) weight hammer lifted manually and dropped from the SPT height. Where a third weight hammer was used, the 'N'-values were corrected for the lower energy drive.

All open boreholes were backfilled with bentonite upon completion in accordance with R.R.O. 1990, Regulation 903 (Wells) (as amended). The groundwater conditions and water levels in the open boreholes were observed during the drilling operations and are described on the Record of Borehole sheets in Appendices A to D. It should be noted that the groundwater levels encountered in the boreholes may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized on completion of drilling. Furthermore the groundwater levels are expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring and periods of precipitation.

A sample of creek water was obtained during the field investigation at the culvert locations, and submitted to a specialist analytical laboratory under chain of custody procedures for corrosivity package testing. The results of the Analytical testing are included in Appendix E.

The fieldwork 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, logged the boreholes, and examined the soil samples. The soil and bedrock core 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 examination and laboratory testing. Rock quality (i.e., TCR, SCR, RQD, weathering and strength index), discontinuity characteristics and classification data were recorded in the field based on visual inspection of the recovered rock cores upon extraction from the core barrel. Classification testing (water content, organic content, Atterberg limits and grain size distribution) was carried out on selected soil samples, and strength testing (point load index) were completed on selected rock samples. All of the laboratory tests were carried out to MTO Laboratory Standards and/or ASTM Standards, as appropriate. The results of the laboratory testing are summarized on the Record of Borehole sheets and presented in the laboratory test figures in Appendices A to D.

Classification of the rock mass quality of the bedrock with respect to the Rock Quality Designation (RQD) is described based on Table 3.10 of the Canadian Foundation Engineering Manual (CFEM)¹. The degree of weathering of the bedrock samples and the strength classification of the intact rock mass based on field identification are described in accordance with the International Society for Rock Mechanics (ISRM)² standard classification system. Point load strength index tests, both perpendicular to the core axis (diametral) and along the core axis (axial) were performed on selected samples of the rock core to provide an indication of the point load strength index (Is_{50}) of the rock. The bedrock strength was classified with respect to strength based on the Is_{50} values as suggested in Table 3.5 of CFEM¹.

Temporary benchmarks were placed in the field by Tulloch Engineering. The as-drilled borehole locations, in stations and offsets, were measured in reference to the roadway station given on the temporary benchmarks and were subsequently converted into MTM NAD 83 (Zone 13) coordinates in AutoCAD. Borehole elevations were surveyed by a member of our technical staff in reference to the temporary benchmark elevations. The borehole locations shown on Drawings A1 to D1 are positioned relative to MTM NAD 83 northing and easting coordinates

¹ Canadian Foundation Engineering Manual. 2006. Fourth Edition, Canadian Geotechnical Society

² 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.



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and the ground surface elevations are referenced to Geodetic datum. The borehole locations, ground surface elevations and drilled depth are summarized below.

Culvert ID and Culvert Location	Borehole	Location (m)		Ground/Water Surface Elevation (m)	Depth of Borehole/DCPT (m)
		Northing	Easting		
C22 STA 16+205 (Township of Dambrossio)	C22-1	5,354,529.0	242,097.7	441.2	7.6 / 9.4
	C22-2	5,354,514.7	242,092.2	444.7	12.8
	C22-3	5,354,510.8	242,097.8	444.5	12.8 / 13.6
	C22-4	5,354,497.4	242,090.8	440.3	6.6
C29 STA 18+561 (Township of Dambrossio)	C29-1	5,354,347.8	244,409.1	416.9	3.4*
	C29-2	5,354,342.2	244,395.7	421.4	8.1*
	C29-3	5,354,336.3	244,395.9	421.3	10.0*
	C29-4	5,354,330.1	244,377.6	415.7	2.4*
C41 STA 12+038 (Township of Dumas)	C41-1	5,355,499.0	247,386.5	417.5	2.5*
	C41-2	5,355,481.2	247,400.1	423.4	10.0*
	C41-3	5,355,482.0	247,407.3	423.2	12.2*
	C41-4	5,355,469.8	247,414.9	419.3	3.7 / 3.8
	C41-5	5,355,467.7	247,410.6	419.8	1.1
	C41-6	5,355,465.3	247,409.4	420.7	1.2
C59 STA 20+540 (Township of Dumas)	C59-1	5,355,885.1	254,586.5	336.7	3.7 / 4.3
	C59-2	5,355,867.1	254,588.0	339.7	13.8*
	C59-3	5,355,867.3	254,596.6	339.2	13.5*
	C59-4	5,355,851.7	254,603.1	333.9	2.9

Note: * Includes between 0.3 m and 3.6 m lengths of bedrock coring.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Highway 519 is located in the Abitibi Uplands physiographic region, within the Canadian Shield as delineated by the Geomorphic Systems of North America³. The Abitibi Uplands generally slopes down towards Hudson Bay and is typically characterized by low broad hills with gently sloping, rolling or undulating topography and subdued relief. This region is underlain by massive, mainly crystalline rocks covered by Quaternary glaciofluvial outwash and till deposits typically consisting of gravel and sand, associated proglacial river and deltaic deposits, as well as more recent organic deposits within the depressions between bedrock knobs⁴.

Highway 519 is located directly north of the Michipicoten greenstone belt, within the Pukaskwa batholith within the Wawa Subprovince⁵. The bedrock in the western section of Highway 519 between about STA 12+300 (Township of Dambrossio) and 13+000 (Township of Dumas) consists of granite-granodiorite. The bedrock in the eastern section of Highway 519 from about STA 14+200 (Township of Dumas) to the town of Dubreuilville, generally

³ Graf, W. L. 1987. *Geomorphic systems of North America*. Geological Society of America, Inc.: Boulder, Colorado.

⁴ The Ministry of Natural Development and Mines, Ontario, 2016. OGSEarth: Quaternary Geology [Electronic Map] 1:1,000,000.

⁵ Williams H. R., Stott G. M., Heather K. B., Muir T. L. and Sage R. P. 1991. Wawa subprovince; in *Geology of Ontario*, Ontario Geological Survey, Special Volume 4, Part 1, p.485-539.



consists of tonalite-granodiorite. Along Highway 519 the granite-granodiorite and tonalite-granodiorite rock masses are separated by an approximately 1 km wide band of metasedimentary rock. Diabase dykes associated with the Matachewan dike swarm are present along the length of Highway 519 and generally have a strike perpendicular to the highway.

4.2 General Overview of Local Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil and bedrock core samples, are presented on the Record of Borehole sheets and the laboratory test sheets in Appendices A to D. The results of the in situ field testing (i.e. SPT 'N'-values) as presented in the Record of Borehole sheets and in Section 4.3 are uncorrected except for the application of the energy correction to the SPT values obtained by the 1/3 weight hammer. The stratigraphic boundaries shown on the Record of Boreholes sheets are inferred from non-continuous sampling, observations of drilling progress and in situ testing and are approximate. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations. Where applicable, the thickness of the overburden in the investigated areas as also inferred from the resistance to DCPT results as shown on the Record of Borehole sheets and stratigraphic profiles/cross-section in Appendices A to D.

In general, the stratigraphy encountered at the various culvert sites investigated is similar, however, the thickness of the stratigraphic units is variable. The stratigraphy from ground surface to refusal generally consists of surficial layers of organic silt, sand and gravel fill and rock fill associated with Highway 519, underlain by sand and gravel deposits, which are underlain by bedrock of various types (e. g. basalt, andesite, granite). The inferred stratigraphy as encountered in the boreholes and DCPTs advanced at the culvert locations are shown on Drawings A1 to D1 in Appendices A to D.

Detailed descriptions of the subsurface conditions at each culvert crossings are provided in the following sections of this report. Where relatively significant thicknesses of overburden were encountered, the various soil types are described in detail for each main deposit or stratum.

4.3 Culvert C22 – STA 16+205 (Township of Dambrossio)

The plan and profile along the centreline of the existing culvert C22 located at STA 16+205 showing the borehole locations and interpreted stratigraphy are presented on Drawing A1. The height of the embankment at the culvert location is between 4.0 m and 4.5 m and the existing culvert is an approximately 29 m long, 1.2 m diameter corrugated steel pipe (CSP). A total of four boreholes were completed to investigate the subsurface conditions at the culvert location: two boreholes (Boreholes C22-1 and C22-4) were advanced near the ends of the existing culvert; and two boreholes (Boreholes C22-2 and C22-3) were advanced through the Highway 519 embankment, on the west and east sides of the existing culvert alignment, respectively. Photographs of the site are shown on Figures A1-A and A1-B in Appendix A.

4.3.1 Water

Water to a depth of 0.9 m was encountered at Elevation 441.2 m in Borehole C22-1.



4.3.2 Embankment Fill

An approximately 200 mm thick layer of asphalt was encountered at the roadway surface in Boreholes C22-2 and C22-3. Embankment fill 0.6 m to 6.0 m thick was encountered at below the water, at ground surface, or below the asphalt pavement between Elevations 444.7 m and 440.3 m in Boreholes C22-2 to C22-4. The embankment fill generally consists of sand, trace to some gravel and sand and gravel. Cobbles and boulders of approximately 0.2 m to 0.3 m diameter were encountered in Borehole C22-2 and are inferred to be present within the fill in Boreholes C22-3 and C22-4. Where fill was encountered at the toes of the embankment, in Boreholes C22-1 and C22-4, it contains trace organics.

The SPT 'N'-values measured within the embankment fill deposit generally range between 11 blows and 95 blows per 0.3 m of penetration, indicating a compact to very dense relative density. A SPT 'N'-value of 2 blows per 0.3 m of penetration was measured at the surface in Borehole C22-4, indicating a very loose relative density.

The natural water content measured on five samples of the embankment fill ranges between about 4 per cent and 18 per cent. The natural water content measured on a sample of the sandy silt, trace organics, is about 20 per cent.

The results of grain size distribution tests completed on two samples of the fill are shown on Figure A2 in Appendix A.

4.3.3 Organic Silt

A 0.4 m to 2.4 m thick deposit of organic silt was encountered below the fill in Boreholes C22-1 to C22-4 between Elevations 439.7 m and 438.5 m. The organic silt generally contains trace to some sand and wood fragments.

The SPT 'N'-values measured within the organic silt deposit range between 1 blow and 15 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency.

The natural water content measured on nine samples of the organic silt deposit range between about 39 per cent and 151 per cent. The organic content measured on seven samples of the organic silt deposit are between about 6 per cent and 28 per cent.

An Atterberg limits test was carried out on a sample of the organic silt and measured a liquid limit of about 49 per cent and a plastic limit of about 31 per cent corresponding, to a plasticity index of about 18 per cent. The test result, which is plotted on a plasticity chart on Figure A3 in Appendix A, indicates that the material tested is an organic silt of intermediate plasticity.

4.3.4 Sand to Gravelly Sand

A sand to gravelly sand deposit was encountered below the organic silt deposit between Elevation 438.6 m and 437.2 m in Boreholes C22-1 to C22-4. A 0.7 m thick pocket of sand and gravel was encountered between the organic silt and the sand to gravelly sand deposit in Borehole C22-4 at Elevation 437.3 m. In Borehole C22-2 trace organic material was found in the upper 0.8 m thick zone of the deposit. The deposit was penetrated into for a thickness ranging between 3.6 m and 6.7 m to the borehole termination depths within this deposit.



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The SPT 'N'-values measured within the sand to gravelly sand deposit range between 4 blows and 62 blows per 0.3 m of penetration, indicating a loose to very dense relative density. A SPT 'N'-value of 21 blows per 0.3 m of penetration was measured within the sand and gravel pocket, indicating a compact relative density.

The natural water content measured on eight samples of the sand to gravelly sand deposit are between about 5 per cent and 38 per cent. The organic content measured on an upper sample of the sand deposit in Borehole C22-2 is about 2 per cent. The natural water content measured on a sample of the sand and gravel pocket is about 10 per cent.

The results of grain size distribution tests completed on five samples of the sand to gravelly sand deposit are shown on Figure A4 in Appendix A. The results of a grain size distribution test completed on a sample of the sand and gravel pocket is shown on Figure A5 in Appendix A.

4.3.5 Refusal

DCPT's advanced from the bottom of Boreholes C22-1 and C22-3 encountered refusal at depths of 9.4 m and 13.6 m below ground surface, corresponding to Elevations 431.8 m and 430.9 m, respectively.

4.3.6 Groundwater Conditions

The water level was measured in Boreholes C22-2 to C22-4 upon completion of drilling operations at depths between 0.7 m and 4.7 m below ground surface, ranging from Elevation 440.1 m to 439.6 m. Creek water was encountered above ground surface in Borehole C22-1 at Elevation 441.2 m.

4.4 Culvert C29 – STA 18+561 (Township of Dambrossio)

The plan and profile along the centreline of the existing culvert C29 at STA 18+561 showing the borehole locations and interpreted stratigraphy are presented on Drawing B1. The height of the embankment at the culvert location is between about 4.5 m and 5.5 m and the existing culvert is an approximately 30 m long, 1.4 m diameter CSP. A total of four boreholes were completed to investigate the subsurface conditions at the culvert location: two boreholes (Boreholes C29-1 and C29-4) were advanced near the ends of the existing culvert; and two boreholes (Boreholes C29-2 and C29-3) were advanced through the Highway 519 embankment, on the west and east of the existing culvert alignment, respectively. Photographs of the site are shown on Figures B1A and B1B in Appendix B.

4.4.1 Water

Water to a depth of 0.6 m was encountered at Elevation 416.9m in Borehole C29-1.

4.4.2 Embankment Fill

An approximately 90 mm thick layer of asphalt was encountered at the roadway surface in Boreholes C29-2 and C29-3. Embankment fill, 2.1 m to 7.6 m thick was encountered below the asphalt pavement at Elevation 415.7 m in Borehole C29-4 and at ground surface at Elevations 421.3 m and 421.2 m in Boreholes C29-2 and C29-3,



respectively. The upper portion of embankment fill, directly beneath the asphalt consists of an upper 1.1 m to 1.3 m thick layer of silty sand to gravelly sand. Below the silty sand to gravelly sand fill the embankment is comprised of rock fill consisting of cobbles and boulders in a gravelly silty sand to gravelly sand to sand and gravel matrix. Boulders between 0.3 m and 1.2 m in size were encountered within the rock fill.

The SPT 'N'-values measured within the embankment granular fill deposit generally range between 5 blows and 62 blows per 0.3 m of penetration, indicating a loose to very dense relative density. SPT 'N'-values measured where cobbles and/or boulders are present range from of 64 blows per 0.25 m of penetration to 40 blows per 0.03 m of penetration.

The natural water content measured on seven samples of the embankment fill ranges between about 2 per cent and 16 per cent.

The results of grain size distribution tests completed on a sample of the upper fill and a sample of the rock fill matrix are shown on Figures B2 and B3 in Appendix B, respectively.

4.4.3 Sand to Sand and Gravel to Sandy Gravel

A 0.6 m and 1.8 m thick deposit of sand to sand and gravel to sandy gravel was encountered below the water in Borehole C29-1 and below the embankment fill in Borehole C29-3 at Elevations 416.3 m and 414.0 m, respectively. The top 0.6 m of the sand portion of the deposit encountered in Borehole C29-1 contains trace organics.

The SPT 'N'-values measured within the sand to sandy gravel deposit range between 25 blows and 136 blows per 0.3 m of penetration, indicating a compact to very dense relative density. SPT 'N'-values of 50 blows per 0.15 m of penetration and 160 blows per 0.04 m of penetration were measured immediately above the bedrock surface interface.

The natural water content and organic content measured on a sample of the sand trace organics portion of the deposit is about 26 per cent and 5 per cent, respectively. The natural water content measured on three samples of the sand and gravel to sandy gravel deposit ranges between about 6 per cent and 7 per cent.

The results of grain size distribution tests completed on two samples of the sand and gravel to sandy gravel deposit are shown on Figure B4 in Appendix B.

4.4.4 Bedrock

Bedrock was encountered in Boreholes C29-1 to C29-4 at depths ranging from 2.1 m to 7.9 m below ground surface, between Elevations 413.9 m and 413.4 m and cored for depths of between 0.3 m and 2.1 m.

Based on the review of the bedrock core samples, the bedrock consists of basalt and diorite and is generally described as slightly weathered, crystalline, white to black, fine to medium grained, non-porous, strong (R_4 , $50 \text{ MPa} < \text{UCS} < 100 \text{ MPa}$) to very strong (R_5 , $100 \text{ MPa} < \text{UCS} < 250 \text{ MPa}$). The bedrock descriptions are shown on the Record of Drillhole sheets and the photographs of core samples are shown on Figure B5, in Appendix B.

The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered are 100 per cent and between 0 per cent and 50 per cent, respectively. The Rock Quality Designation (RQD) of the core samples



obtained ranges from 0 per cent to 58 per cent, indicating a rock mass of very poor to fair quality as per Table 3.10 of the CFEM (2006).

Point load strength index tests were carried out on selected samples of the bedrock core. The corrected point load strength index values (Is_{50}) are presented in Table B1 and on the Record of Drillhole sheets in Appendix B are 8.6 MPa and 6.2 MPa for the axial and diametral tests, respectively. Based on the laboratory Point Load strength index, the bedrock is classified as very strong ($R5, 100 \text{ MPa} < \text{UCS} < 250 \text{ MPa}$).

4.4.5 Groundwater Conditions

The water level was measured in Boreholes C29-2 to C29-4 upon completion of drilling operations at depths between 0.7 m and 5.4 m below ground surface, ranging from Elevation 416.2 m to 415.0 m. Creek water was encountered above ground surface in Borehole C29-1 at Elevation 416.9 m.

4.5 Culvert C41 – STA 12+038 (Township of Dumas)

The plan and profile along the centreline of the existing culvert C41 at STA 12+038 showing the borehole locations and interpreted stratigraphy are presented on Drawing C1. The height of the embankment at the culvert location is between about 4 m and 6 m and the existing culvert is an approximately 34 m long, 760 mm diameter CSP. A total of six boreholes were completed to investigate the subsurface conditions at the culvert location: two boreholes (Boreholes C41-1 and C41-4) were advanced near the ends of the existing culvert; two boreholes (Boreholes C41-2 and C41-3) were advanced through the Highway 519 embankment on the east and west sides of the existing culvert alignment, respectively; and two boreholes (Boreholes C41-4 and C41-5) were advanced at the south toe of Highway 519 near the culvert inlet to confirm borehole refusal, assuming Highway 519 runs west to east. Photographs of the site are shown in Figure C1 in Appendix C.

4.5.1 Embankment Fill / Peat / Topsoil

An approximately 50 mm and 80 mm layer of asphalt was encountered at the roadway surface in Boreholes C29-3 and C29-4, respectively. Embankment fill, 1.1 m to 9.1 m thick was encountered at ground surface and below the asphalt pavement between Elevations 423.3 m and 419.3 m in Boreholes C41-2 to C41-5. The upper portion of embankment fill, directly beneath the asphalt consists of a 0.5 m thick layer of silty sand. Below the silty sand fill rock fill consisting of cobbles and boulders in a silty sand to sand to sand and gravel matrix was encountered in Boreholes C29-2 to C29-4. Cobbles and boulders between 0.1 m and 0.3 m in diameter were encountered within the rock fill. The fill encountered in Borehole C41-5 consists of sand and gravel. A 0.1 m thick layer of peat was encountered at ground surface in Borehole C41-1 at Elevation 417.5 m; and a 0.2 m thick layer of topsoil encountered at ground surface in Borehole C41-6 at Elevation 420.7 m.

The SPT 'N'-values measured within the embankment fill deposit, at depths where it was possible to carry out such tests on rock fill, generally range between 3 blows and 62 blows per 0.3 m of penetration, indicating a very loose to very dense relative density. SPT 'N'-values measured where cobbles and/or boulders were encountered or immediately above the bedrock surface range from 50 blows per 0.15 m of penetration to 50 blows per 0.03 m of penetration. The SPT 'N'-values measured within the topsoil and silty sand fill in Borehole C41-5 are 3 blows and 26 blows per 0.3 m of penetration, indicating a very loose to compact relative density.



The natural water content measured on six samples of the embankment fill ranges between about 2 per cent and 17 per cent. The organic content measured on a sample of the embankment fill is about 3 per cent.

The results of grain size distribution tests completed on two samples of the rock fill granular material matrix are shown on Figure C2 in Appendix C.

4.5.2 Silty Sand to Gravelly Sand to Sand and Gravel

A 1.0 m to 2.3 m thick deposit of silty sand to gravelly sand to sand and gravel was encountered below the peat in Borehole C41-1, below the topsoil in Borehole C41-6 and below the embankment fill in Borehole C41-2, between Elevation 420.5 m and 416.6 m. Cobbles and boulders between 0.1 m and 0.3 m in diameter were encountered within the gravelly sand to sand and gravel deposit. Organics were encountered within the silty sand deposit in Borehole C41-6, within the gravelly sand deposit to a depth of 0.6 m in Borehole C41-1, as well as within the rock fill matrix in Borehole C41-2.

The SPT 'N'-values measured within the silty sand to gravelly sand to sand and gravel deposit range between 6 blows and 48 blows per 0.3 m of penetration, indicating a loose to dense relative density. SPT 'N'-values of 18 blows per 0.28 m of penetration and 50 blows per 0.1 m of penetration were measured at or near the bedrock surface.

The natural water content measured on five samples of the sand and gravel to sandy gravel deposit ranges between about 10 per cent and 14 per cent.

The results of grain size distribution tests completed on three samples of the gravelly sand to sand and gravel portion of the deposit are shown on Figure C3 in Appendix C.

4.5.3 Bedrock / Refusal

Bedrock was encountered in Boreholes C41-1 to C41-3 at depths ranging from 2.1 m to 9.2 m below ground surface, between Elevations 415.4 m and 414.0 m, and cored for depths of 0.4 m to 3.0 m. A DCPT advanced from the bottom of Borehole C41-4 encountered refusal to further penetration at a depth of 3.8 m, corresponding to Elevation 415.5 m. Boreholes C41-5 and C41-6 were terminated at depths of 1.1 m and 1.2 m due to the drill rods/split-spoon sampler sliding on inferred obstructions / refusal conditions.

Based on the review of the bedrock core samples, the bedrock consists of granite, andesite and basalt. The granite and andesite are generally described as fresh, crystalline, white, pink, grey and black, medium grained, non-porous, very strong (R5, 100 MPa < UCS < 250 MPa) to extremely strong (R6, UCS > 250 MPa). The basalt is described as fresh, crystalline black, fine grained, non-porous, strong (R4, 50 MPa < UCS < 100 MPa). The bedrock descriptions are shown on the Record of Drillhole sheets and the photographs of rock core samples are shown in Figure C4 in Appendix C.

The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered are 100 per cent and between 73 per cent and 100 per cent, respectively. The Rock Quality Designation (RQD) of the core samples ranges from 62 per cent to 100 per cent, indicating a rock mass of fair to excellent quality as per Table 3.10 of the CFEM (2006).



Point load strength index tests were carried out on selected samples of the bedrock core. The corrected point load strength index values (Is_{50}) presented in Table C1 and on the Record of Drillhole sheets in Appendix C are 9.6 MPa and 11.8 MPa for the axial and diametral tests, respectively. Based on the laboratory Point Load strength index, the bedrock is classified as very strong (R5, 100 MPa < UCS < 250 MPa) to extremely strong (R6, UCS > 250 MPa).

4.5.4 Groundwater Conditions

The water level was measured in Boreholes C41-1 to C41-5 upon completion of drilling operations at depths between 0 m and 5.1 m below ground surface, ranging from Elevation 419.8 m and 417.0m. Borehole C41-6 was dry upon completion of drilling.

4.6 Culvert C59 – STA 20+540 (Township of Dumas)

The plan and profile along the centreline of the existing culvert C59 at STA 20+540 showing the borehole locations and interpreted stratigraphy are presented on Drawing D1. The height of the embankment at the culvert location is about 5.5 m and the existing culvert is an approximately 36 m long, 760 mm diameter CSP. A total of four boreholes were completed to investigate the subsurface conditions at the culvert location: two boreholes (Boreholes C59-1 and C59-4) were advanced near the ends of the existing culvert and two boreholes (Boreholes C59-2 and C59-3) were advanced through the Highway 519 embankment, on the west and east sides of the existing culvert alignment, respectively, assuming Highway 519 runs west to east. Photographs of the site are shown in Figure D1 in Appendix D.

4.6.1 Embankment Fill / Topsoil

An approximately 80 mm layer of asphalt was encountered at the roadway surface in Boreholes C59-2 and C59-3. Embankment fill, 2.1 m to 6.6 m thick was encountered at ground surface and below the asphalt pavement between Elevations 339.6 m and 336.7 m in Boreholes C59-1 to C59-3. The upper portion of embankment fill, directly beneath the asphalt consists of a 0.5 m thick layer of silty sand. The fill from ground surface in Borehole C59-1 and below the silty sand fill in Boreholes C59-2 and C59-3 is rock fill consisting of cobbles and boulders between 0.1 m and 0.9 m in diameter in a silty sand, gravelly sand and sand and gravel matrix. A 0.2 m layer of topsoil was encountered at ground surface in Borehole C59-4 at Elevation 333.9 m.

The SPT 'N'-values measured within the embankment fill deposit generally range between 3 blows and 23 blows per 0.3 m of penetration, indicating a very loose to compact relative density. SPT 'N'-values measured where cobble and/or boulder size materials were encountered range from of 50 blows per 0.02 m of penetration to 11 blows per 0.13 m of penetration.

The natural water content measured on five samples of the embankment fill ranges between about 2 per cent and 14 per cent.

The results of grain size distribution tests completed on two samples of the gravelly sand to sand and gravel rock fill matrix are shown on Figure D2 in Appendix D.



4.6.2 Silt and Sand to Sand

A 0.3 m to 1.4 m thick non-cohesive deposit comprised of silt and sand, silty sand, gravelly silty sand and sand was encountered below the embankment fill and/or topsoil in Boreholes C59-2 to C59-4 between Elevations 333.7 m and 332.5 m. A 0.5 m thick pocket of sandy clayey silt was encountered between the embankment fill and silt and sand deposit in Borehole C59-2 at Elevation 333.0 m; and a 0.5 m pocket of sandy organic silt was encountered within the non-cohesive deposit in Borehole C59-4 at Elevation 333.3 m.

The SPT 'N'-values measured within the silt and sand to sand deposit are 2 blows and 22 blows per 0.3 m of penetration, indicating a very loose to compact relative density. SPT 'N'-values of 36 blows and 8 blows per 0.3 m of penetration were measured within the sandy clayey silt and sandy organic silt pockets, suggesting a hard consistency and loose relative density, respectively.

The natural water content measured on a sample of the silt and sand to sand deposit is about 15 per cent. The natural water content measured on a sample of the sandy clayey silt pocket is about 17 per cent. The natural water content and organic content measured on a sample of the sandy organic silt are about 45 per cent and 10 per cent, respectively.

The result of a grain size distribution test completed on a sample of the silt and sand component of the deposit is shown on Figure D3 in Appendix D.

An Atterberg limits test was carried out on a sample of the sandy clayey silt pocket and measured a liquid limit of about 22 per cent and a plastic limit of about 17 per cent, corresponding to a plasticity index of about 5 per cent. The test result, which is plotted on a plasticity chart on Figure D4 in Appendix D, indicates that the material tested may be classified as a clayey silt of low plasticity.

4.6.3 Gravelly Sand to Sand and Gravel

A 1.5 m to 3.2 m thick deposit of gravelly sand to sand and gravel was encountered between Elevations 334.6 m and 331.9 m below the embankment fill in Borehole C59-1 and below the silt and sand to sand deposit in Boreholes C59-2 to C59-4. Cobbles and boulders 0.2 m and 0.3 m in diameter were encountered and inferred to be present in Boreholes C59-3 and C59-2, respectively. Interlayers consisting of silty sand trace organics and sand 0.1 m and 0.2 m thick were encountered within the gravelly sand to sand and gravel deposit at Elevation 333.7 m and 331.2 in Boreholes C59-1 and C59-4, respectively. The deposit was penetrated into for 1.5 m and 1.6 m in Boreholes C59-1 and C59-4, respectively.

SPT 'N'-values ranging between 14 blows and 66 blows per 0.3 m of penetration were measured within the gravelly sand to sand and gravel deposit, indicating a compact to very dense relative density. SPT 'N'-values of 78 blows per 0.23 m penetration, 100 blows per 0.25 m penetration and 100 blows per 0.03 m penetration were measured on inferred cobbles and/or boulders or on the bedrock surface interface in Boreholes C59-2 and C59-4..

The natural water content measured on six samples of the gravelly sand to sand and gravel deposit ranges between about 2 per cent and 14 per cent.

The results of grain size distribution tests completed on four samples of the gravelly sand to sand and gravel deposit are shown on Figure D5 in Appendix D.



4.6.4 Bedrock / Refusal

Bedrock was encountered in Boreholes C59-2 and C59-3 at depths of 10.2 m and 10.5 m below ground surface, at Elevations 329.5 m and 328.7 m and cored for depths of 3.6 m and 3 m, respectively. Refusal to further penetration of a DCPT advanced from the bottom of Borehole C59-1 and refusal to split-spoon advancement in Borehole C59-4 was encountered within the gravelly sand to sand and gravel deposit at depths of 4.3 m (Elevation 332.4 m) and 2.9 m (Elevation 331.0 m) in the respective boreholes.

Based on the review of the bedrock core samples, the bedrock consists of diorite and granite. The diorite is described as slightly weathered to fresh, crystalline black and white, medium grained, non-porous, very strong (R5, 100 MPa < UCS < 250 MPa) to extremely strong (R6, UCS > 250 MPa). The granite is described as fresh, crystalline, white to pink, medium grained, non-porous, strong (R4, 50 MPa < UCS < 100 MPa). The bedrock descriptions are shown on the Record of Drillhole sheets and the photographs of rock core samples are shown in Figure D6, in Appendix D.

The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the core samples recovered range between 77 per cent and 100 per cent and between 5 per cent and 97 per cent, respectively. The Rock Quality Designation (RQD) based on the borehole data generally ranges from 86 per cent to 97 per cent, indicating a rock mass of good to excellent quality as per Table 3.10 of the CFEM (2006). The first run of the rock from Borehole C59-2 had an RQD of 0 per cent indicating that the upper portion of the rock mass can be considered very poor quality.

Point load strength index tests were carried out on selected samples of the bedrock core. The corrected point load strength index values (Is_{50}) presented in Table C1 and on the Record of Drillhole sheets in Appendix C are 11.3 MPa and 5.1 MPa for the axial and diametral tests, respectively. Based on the laboratory Point Load strength index, the bedrock is classified as very strong (R5, 100 MPa < UCS < 250 MPa) to extremely strong (R6, UCS > 250 MPa).

4.6.5 Groundwater Conditions

The water level was measured in Boreholes C59-2 to C59-4 upon completion of drilling operations at depths between 0.1 m and 5.9 m below ground surface, ranging from Elevations 334.3 m to 333.3 m.

5.0 CLOSURE

Mr. Lubomir Kosci, P.Eng., and Ms. Madison Kennedy supervised the borehole investigation program. This report was prepared by Ms. Madison Kennedy, B.A.Sc., and was reviewed by Mr. Christopher Ng, P.Eng., a senior geotechnical engineer and an Associate of Golder. Mr. Jorge M. A. Costa, P.Eng., a Senior Consultant with Golder and Designated MTO Foundations Contact conducted an independent quality control review of this report.

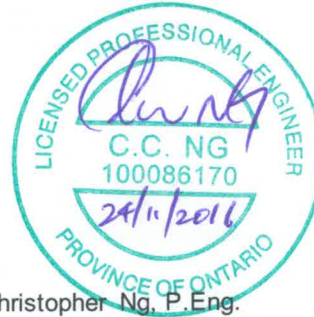


FOUNDATION REPORT - CULVERT REPLACEMENT - HIGHWAY 519

Report Signature Page

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ASTM International:

ASTM D1586	Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
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Ontario Water Resources Act:

Ontario Regulation 903 Wells (as amended)



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

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

(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

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_s :

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 Soils

Density Index	N
Relative Density	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



LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING 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	



TABLES



FOUNDATION REPORT - CULVERT REPLACEMENT - HIGHWAY 519

Table 1: Summary of Existing Culvert Details

Culvert Location (Township)	Culvert ID	Approximate Height of Embankment ¹	Existing Culvert			Approximate Invert Elevation ²		Boreholes	Dynamic Core Penetration Tests
			Type	Approximate Dimension	Approximate Length	Inlet of Culvert ³	Outlet of Culvert ³		
STA 16+205 (Dambrossio)	C22	4.0 m to 4.5 m (Earth Fill)	CSP	1.2 m Diameter	29.2 m	440.1 m (North End)	439.7 m (South End)	4 Boreholes (C22-1 to C22-4)	Advanced from the bottom of Boreholes C22-1 and C22-3
STA 18+561 (Dambrossio)	C29	4.5 m to 5.5 m (Earth Fill / Rock Fill)	CSP	1.4 m Diameter	30.0 m	416.4 m (North End)	416.1 m (South end)	4 Boreholes (C29-1 to C29-4)	N/A
STA 12+038 (Dumas)	C41	4 m to 6 m (Rock Fill)	CSP	760 mm Diameter	34.1 m	419.1 m (South End)	417.4 m (North End)	6 Boreholes (C41-1 to C41-6)	Advanced from the bottom of Borehole C41-4
STA 20+540 (Dumas)	C59	5.5 m (Rock Fill)	CSP	760 mm Diameter	35.8 m	335.3 m (North End)	333.8 m (South End)	4 Boreholes (C59-1 to C59-4)	Advanced from the bottom of Borehole C59-1

- Notes:
1. Embankment height is relative to existing ground surface level at the toe of embankment adjacent to the culvert.
 2. Culvert invert elevations are estimated based on the top of culvert surveys and culvert dimensions provided by MTO.
 3. Culvert ends are referenced based on Highway 519 oriented west to east.

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 Checked By: CN
 Review ed By: JMAC

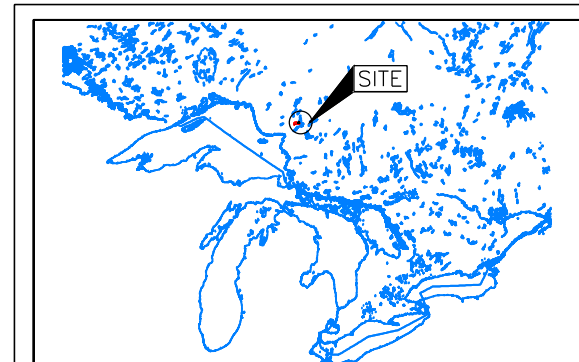


DRAWINGS

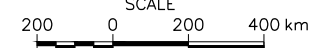
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HIGHWAY 519
DEEP FILL CULVERTS
INDEX PLAN



KEY PLAN



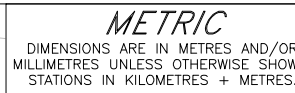
Base plans and sections provided in digital format by D.M.Wills Associates, drawing file nos. 4539- HWY 519- BP (New Survey).dwg and Foundations X-Sec sent to Chris Ng July 8.dwg, received March 11, 2016.
Base data - CANVEC, obtained 2016.

-	-	-	-	-	-	-	-	-	-
NO.	DATE	BY	REVISION						
Geocres No. 42C-39									
HWY. 519				PROJECT NO. 1521770				DIST. .	
SUBM'D. MCK			CHKD. MCK		DATE: 9/29/2016			SITE:	
DRAWN: MR			CHKD. CN		APPD. JMAC			DWG. 1	

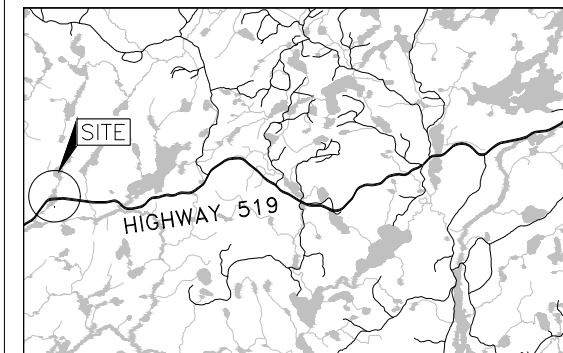


APPENDIX A

Culvert C22 – STA 16+205 (Township of Dambrossio)



**Golder
Associates**





KEY PLAN

SCALE



LEGEND

- | | |
|---|--|
|  | Borehole – Current Investigation |
| N | Standard Penetration Test Value |
| 16 | Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow) |
|  | WL upon completion of drilling |
| R | Refusal to Further Penetration |

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
C22-1	441.2	5354529.0	242097.7
C22-2	444.7	5354514.7	242092.2
C22-3	444.5	5354510.8	242097.8
C22-4	440.3	5354497.4	242090.8

NOTES

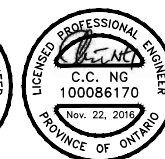
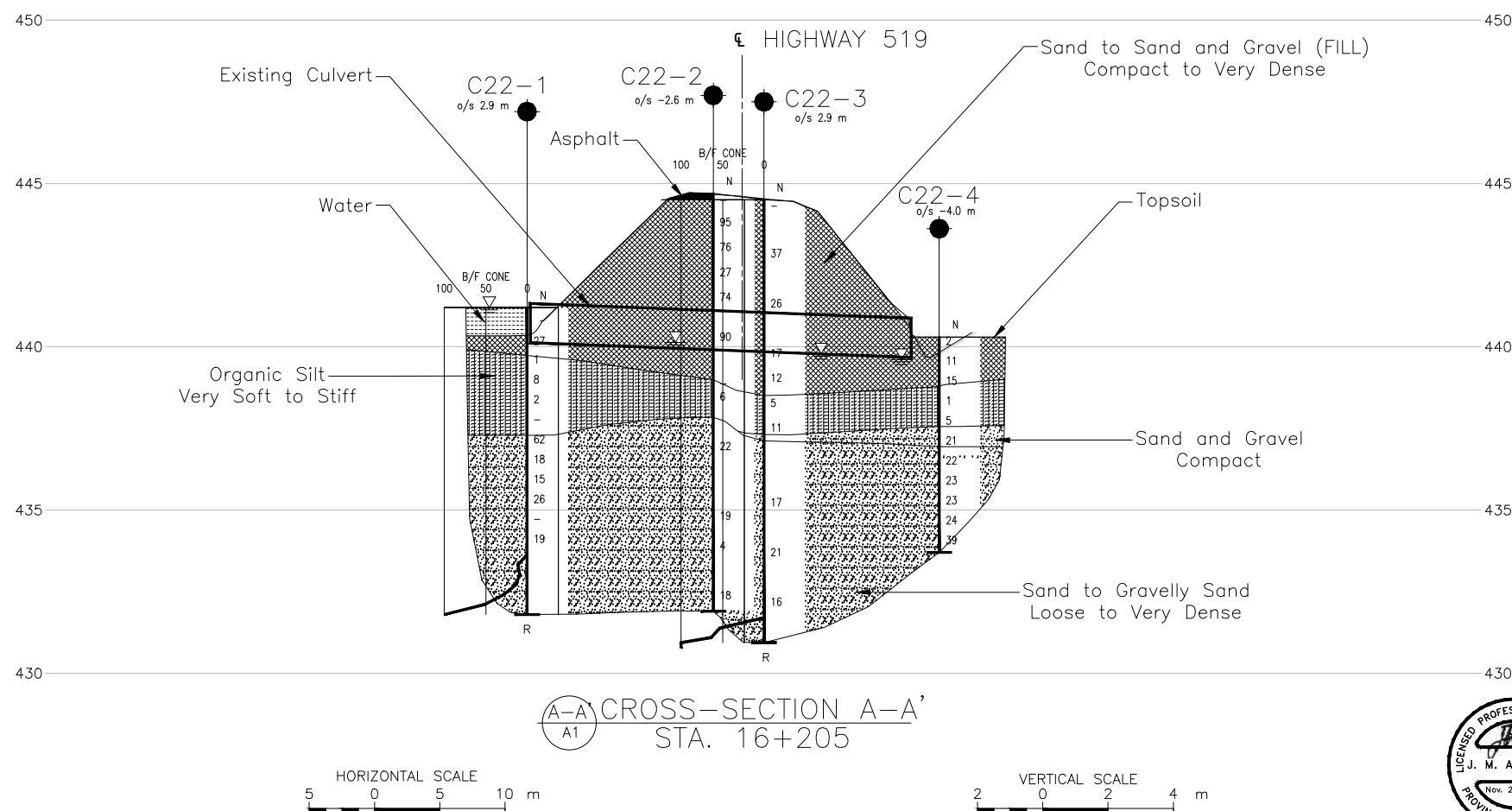
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans and sections provided in digital format by D.M.Wills Associates, drawing file nos. 4539- HWY 519- BP (New Survey).dwg and Foundations X-Sec sent to Chris Ng July 8.dwg, received March 11, 2016.



NO.	DATE	BY	REVISION
Geocres No. 42C-39			
HWY. 519		PROJECT NO. 1521770	DIST. .
SUBM'D. MCK	CHKD. MCK	DATE: 9/2/2016	SITE: .
DRAWN: MR	CHKD. CN	APPD. JMAC	DWG. A1

PROJECT 1521770		RECORD OF BOREHOLE No C22-1		SHEET 1 OF 1		METRIC														
G.W.P. 327-99-00		LOCATION N 5354529.0 ; E 242097.7		ORIGINATED BY LK																
DIST _____ HWY 519		BOREHOLE TYPE Portable Equipment, BW Casing, Manual Hammer		COMPILED BY MR																
DATUM Geodetic		DATE July 19 and 20, 2016		CHECKED BY ACK/MCK																
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL			
							20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× REMOULDED	W _p	W	W _L	20 40 60			20 40 60		
441.2	WATER SURFACE						441													
0.0	WATER																			
440.3							440													
0.9	Sand, some gravel, trace organics (FILL)		1	SS	27															
439.7	Compact																			
1.5	Grey to black Wet		2	SS	1															
	ORGANIC SILT, trace sand, trace gravel, trace wood pieces, rootlets and shells		3	SS	8															
	Very soft to firm		4	SS	2															
	Black to grey		5	AS	-															
	Moist to wet																			
437.3			6	SS	62		437													
3.9	SAND, trace to some silt, trace to some gravel		7	SS	18															
	Compact to very dense		8	SS	15		436													
	Grey		9	SS	26															
	Wet		10	WS	-		435													
			11	SS	19															
433.6							434													
7.6	END OF BOREHOLE																			
	Dynamic Cone Penetration Test (DCPT)						433													
431.8							432													
9.4	END OF DCPT																			
	REFUSAL TO FURTHER PENETRATION (>100 Blows / 0.25 m) (HAMMER BOUNCING)																			

PROJECT 1521770		RECORD OF BOREHOLE No C22-2		SHEET 1 OF 1		METRIC														
G.W.P. 327-99-00		LOCATION N 5354514.7 ; E 242092.2		ORIGINATED BY LK																
DIST _____ HWY 519		BOREHOLE TYPE 150 mm Solid Stem Augers, NW Casing		COMPILED BY MR																
DATUM Geodetic		DATE July 12, 2016		CHECKED BY ACK/MCK																
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL			
								20 40 60 80 100	20 40 60 80 100	20 40 60	W _p	W	W _L	kN/m ³						
444.7	PAVEMENT SURFACE																			
0.0	ASPHALT (200 mm)																			
0.2	Sand, some gravel to sand and gravel, some silt, some cobbles (FILL) Compact to very dense Grey to brown Moist to wet - 0.2 m cobble encountered at a depth of 0.1 m - Augers grinding at a depth of 3.0 m (Elev. 441.7 m)		1	AS	-		444													
			2	SS	95															
			3	SS	76		443										19 67 13 1			
			4	SS	27		442													
			5	SS	74		441													
			6A	SS	90		440													
439.0	ORGANIC SILT Black-brown Moist		6B	AS	-		439										OC = 23.8%			
438.6	SAND, trace silt, trace organics Loose Brown to black Wet		7	SS	6		438										OC = 2.1%			
437.8	SAND, some gravel, trace to some silt Loose to compact Grey Wet		8	SS	22		437										12 79 8 1			
			9	SS	19		436													
			10	SS	4		435													
			11	SS	18		434													
431.9	END OF BOREHOLE						433													
12.8	NOTE: 1. Water level in open borehole at a depth of 4.6 m below ground surface (Elev. 440.1 m) upon completion of drilling.						432													

PROJECT 1521770		RECORD OF BOREHOLE No C22-3		SHEET 1 OF 2		METRIC														
G.W.P. 327-99-00		LOCATION N 5354510.8 ; E 242097.8		ORIGINATED BY LK																
DIST _____ HWY 519		BOREHOLE TYPE 150 mm Solid Stem Augers, NW Casing		COMPILED BY MR																
DATUM Geodetic		DATE July 12, 2016		CHECKED BY ACK/MCK																
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m ³	GR SA SI CL			
							20 40 60 80 100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p — W — W _L 20 40 60							
444.5	PAVEMENT SURFACE																			
0.0	ASPHALT (250 mm)																			
444.2			1	AS	-		444													
0.3	Sand, trace to some gravel, trace to some silt, inferred cobbles (FILL) Compact to dense Brown Dry to wet		2	SS	37		443													
							442													
			3	SS	26		441													
			4	SS	17		440													
439.2							439													
5.3	Sand, some gravel, trace organics (FILL) Compact Black Wet		5	SS	12		438													
438.5			6	SS	5		437													
6.0	ORGANIC SILT, trace to some sand, trace wood fragments Firm to stiff Black to grey Wet		7A 7B 7C	SS	11		436													
437.2			8	SS	17		435													
7.3	Gravelly SAND, some silt Compact Grey Wet		9	SS	21		434													
			10	SS	16		433													
431.7							432													
12.8	END OF BOREHOLE Dynamic Cone Penetration Test (DCPT)						431													
430.9																				
13.6																				

Continued Next Page

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

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PROJECT <u>1521770</u>	RECORD OF BOREHOLE No C22-3	SHEET 2 OF 2	METRIC
G.W.P. <u>327-99-00</u>	LOCATION <u>N 5354510.8 ; E 242097.8</u>	ORIGINATED BY <u>LK</u>	
DIST <u> </u> HWY <u>519</u>	BOREHOLE TYPE <u>150 mm Solid Stem Augers, NW Casing</u>	COMPILED BY <u>MR</u>	
DATUM <u>Geodetic</u>	DATE <u>July 12, 2016</u>	CHECKED BY <u>ACK/MCK</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	w _p	w	w _L		GR	SA	SI	CL	
	<div>END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.15 m) (HAMMER BOUNCING)</div> <div>NOTE: 1. Water level in open borehole at a depth of 4.7 m below ground surface (Elev. 439.8 m) upon completion of drilling.</div>																				

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PROJECT 1521770			RECORD OF BOREHOLE No C22-4			SHEET 1 OF 1			METRIC								
G.W.P. 327-99-00			LOCATION N 5354497.4 ; E 242090.8			ORIGINATED BY LK											
DIST _____ HWY 519			BOREHOLE TYPE Portable Equipment, BW Casing, Manual Hammer			COMPILED BY MR											
DATUM Geodetic			DATE July 19, 2016			CHECKED BY ACK/MCK											
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									
440.3	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL		1	SS	2	▽	440										
	Sand, some gravel, trace organics, inferred cobbles (FILL) Very loose to compact Grey to brown Moist to wet		2	SS	11		439										
438.8			3A	SS	15												
1.5	ORGANIC SILT		3B	SS			438										
	Very soft to stiff Black to grey Moist		4	SS	1												
			5A	SS	5												
437.3			5B	SS													
3.0	SAND and GRAVEL, trace to some silt		5C	SS													
	Compact Grey Wet		6	SS	21		437										
436.6			7	SS	22												
3.7	SAND, trace to some silt, trace to some gravel		8	SS	23		436										
	Compact to dense Grey Wet		9	SS	23												
			10	SS	24	435											
			11	SS	39	434											
433.7	END OF BOREHOLE																
6.6	NOTE: 1. Water level in open borehole at a depth of 0.7 m below ground surface (Elev. 439.6 m) upon completion of drilling.																

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North side of Highway 519 at about STA 16+205 (Dambrossio), Culvert C22, looking north-west July 8, 2016.



North side of Highway 519 at about STA 16+205 (Dambrossio), Culvert C22, looking south-west. July 8, 2016.

PROJECT

**Highway 519—Culvert Replacements
G.W.P. 327-99-00**

TITLE

**Site Photographs
Culvert C22—STA 16+205 (Township of Dambrossio)
Highway 519**



PROJECT No. 1521770

FILE No. — —

DESIGN

MCK

SEPT 16

SCALE

NTS

REV.

CADD

— —

CHECK

CN

SEPT 16

REVIEW

JMAC

SEPT 16

FIGURE A1-A



South side of Highway 519 at about STA 16+205 (Dambrossio), Culvert C22, looking south-west July 8, 2016.



South side of Highway 519 at about STA 16+205 (Dambrossio), Culvert C22, looking north-west. July 8, 2016.

PROJECT

**Highway 519—Culvert Replacements
G.W.P. 327-99-00**

TITLE

**Site Photographs
Culvert C22—STA 16+205 (Township of Dambrossio)
Highway 519**



PROJECT No. 1521770

FILE No. — —

DESIGN

MCK

SEPT 16

SCALE

NTS

REV.

CADD

— —

CHECK

CN

SEPT 16

REVIEW

JMAC

SEPT 16

FIGURE A1-B

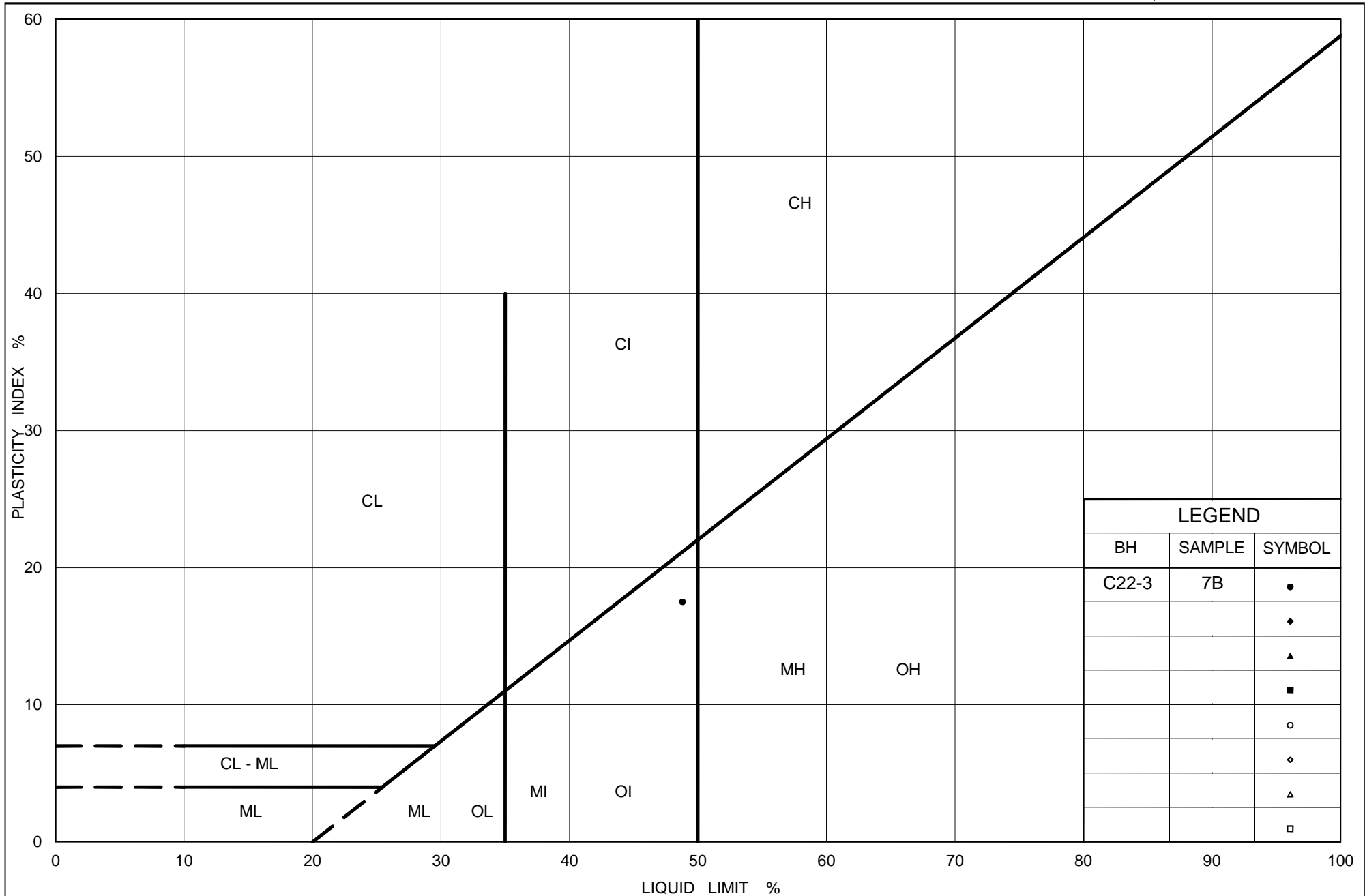
Sand (FILL)

FIGURE A2



SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C22-2	3	442.9
■	C22-3	4	439.6

Date: 21-Sep-16



Ministry of Transportation

Ontario

PLASTICITY CHART Organic Silt

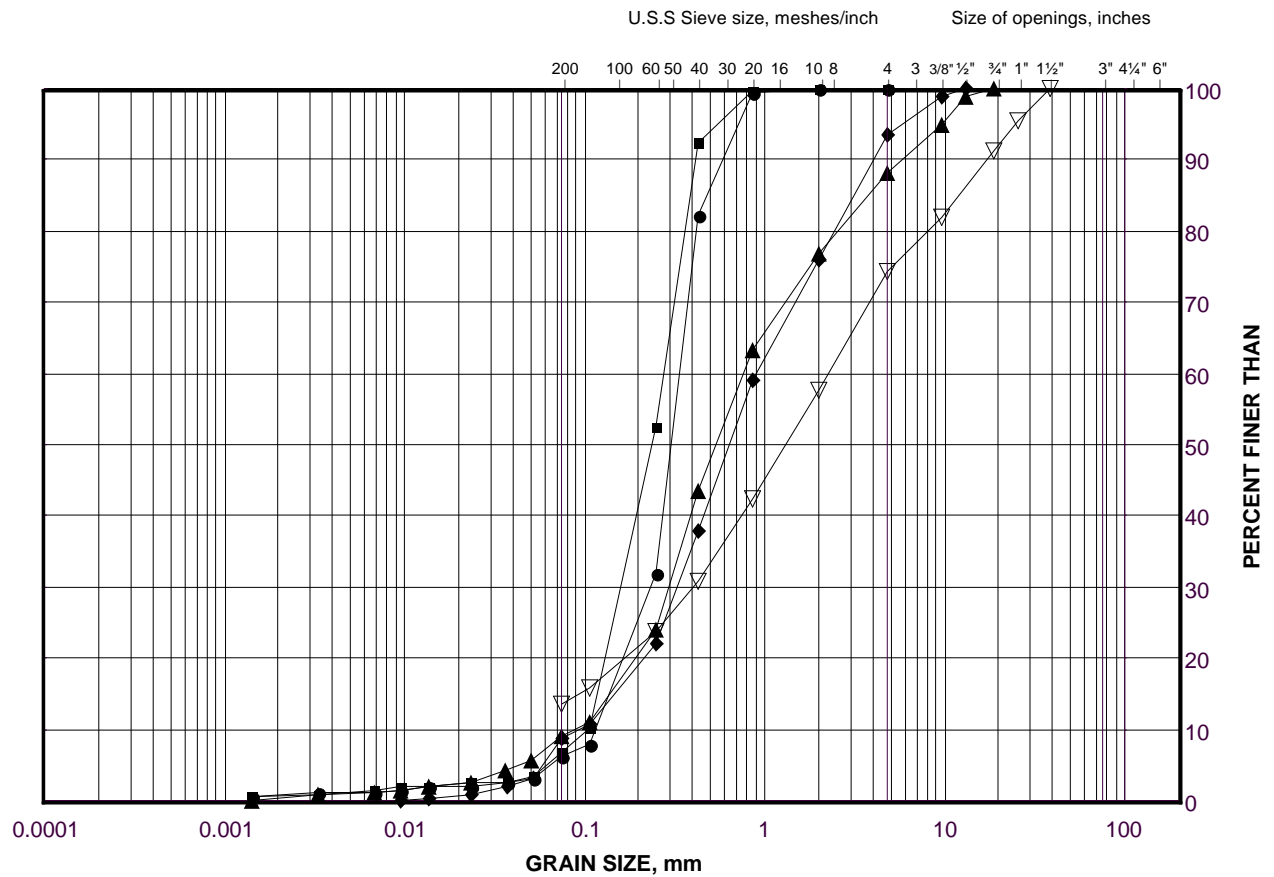
Figure No. A3

Project No. 1521770

Checked By: MCK

Sand to Gravelly Sand

FIGURE A4



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C22-4	11	434.0
■	C22-1	7	436.4
◆	C22-4	8	435.8
▲	C22-2	8	436.8
▽	C22-3	9	433.5

Project Number: 1521770

Checked By: MCK_____

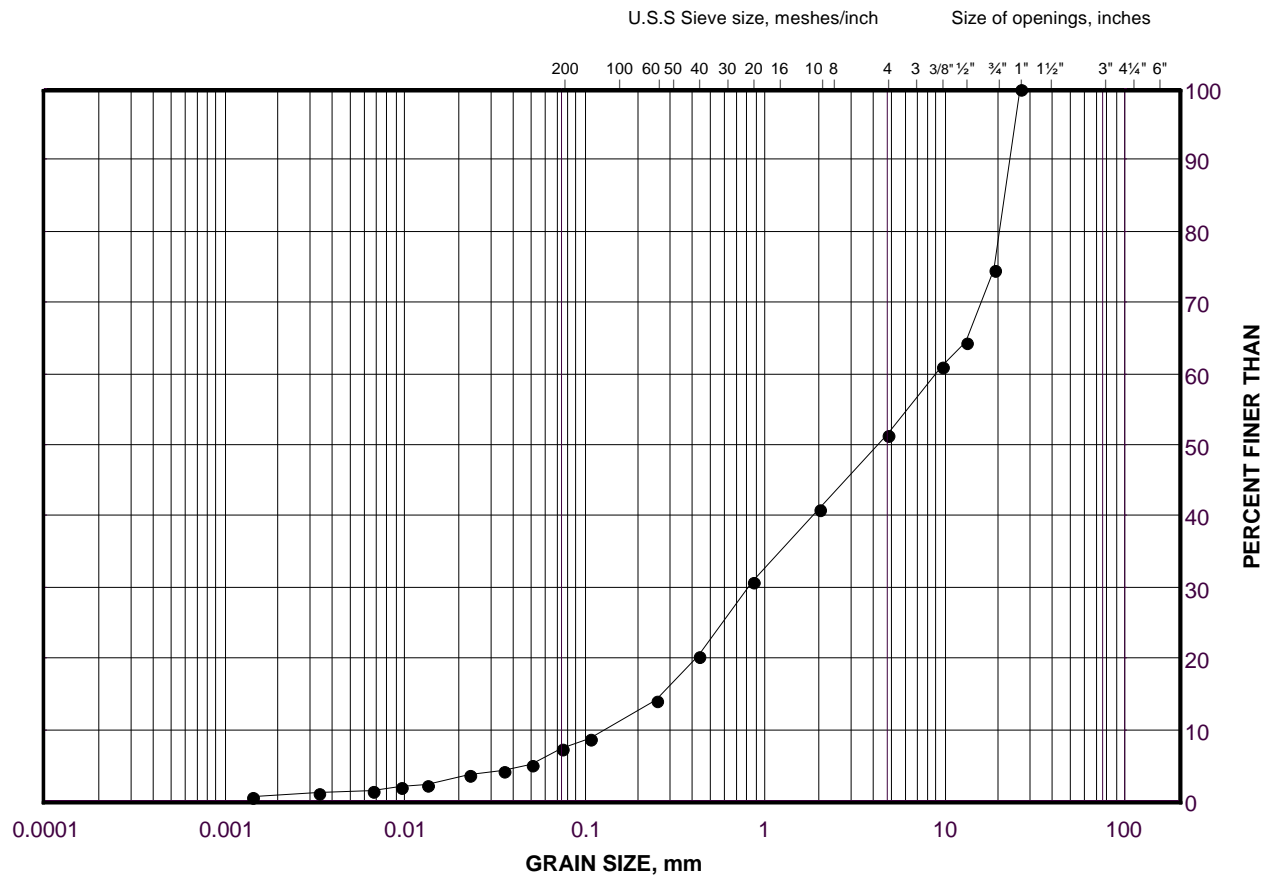
Golder Associates

Date: 21-Sep-16

GRAIN SIZE DISTRIBUTION

Sand and Gravel

FIGURE A5



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C22-4	6	436.9

Project Number: 1521770

Checked By: MCK

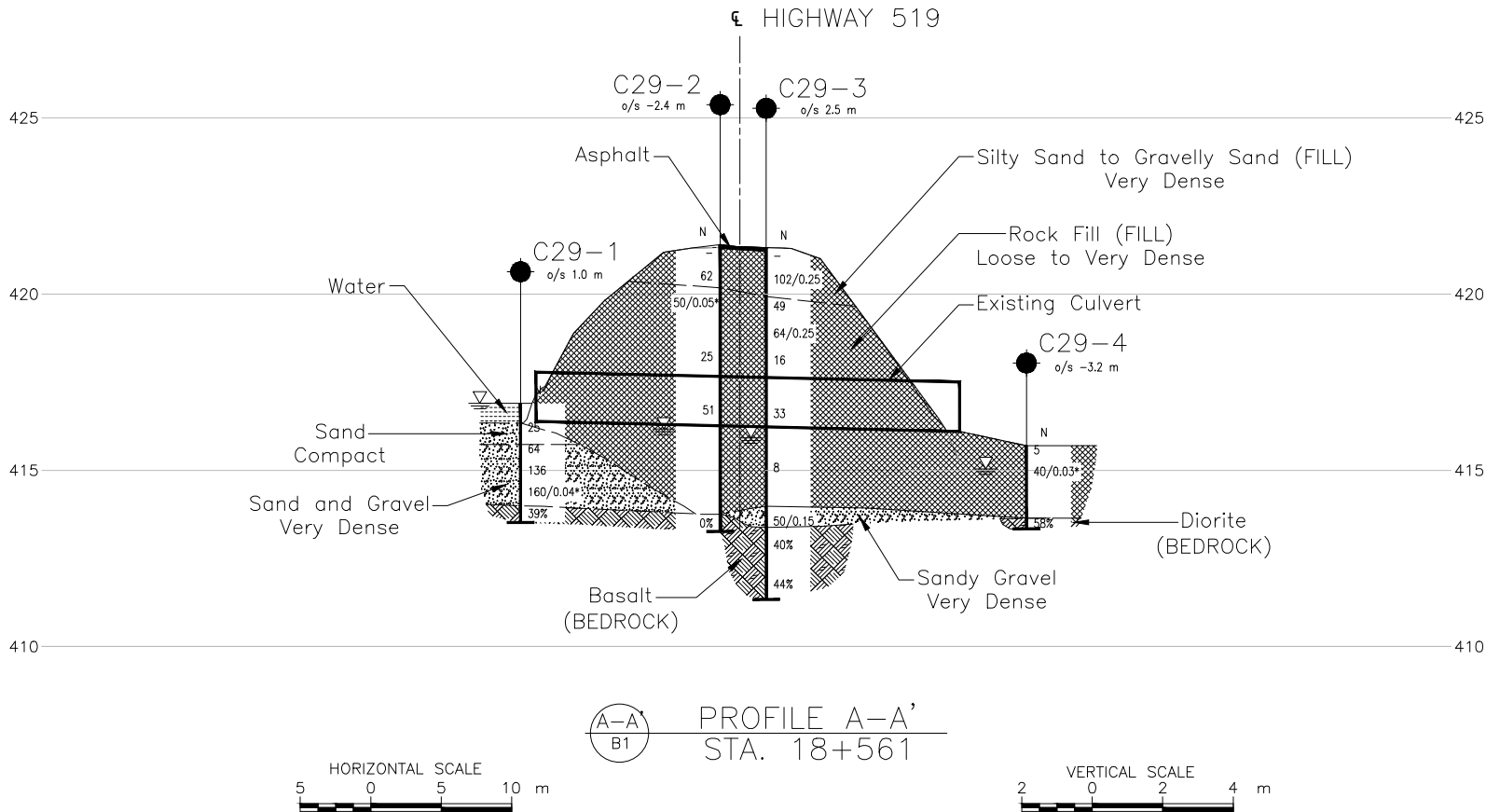
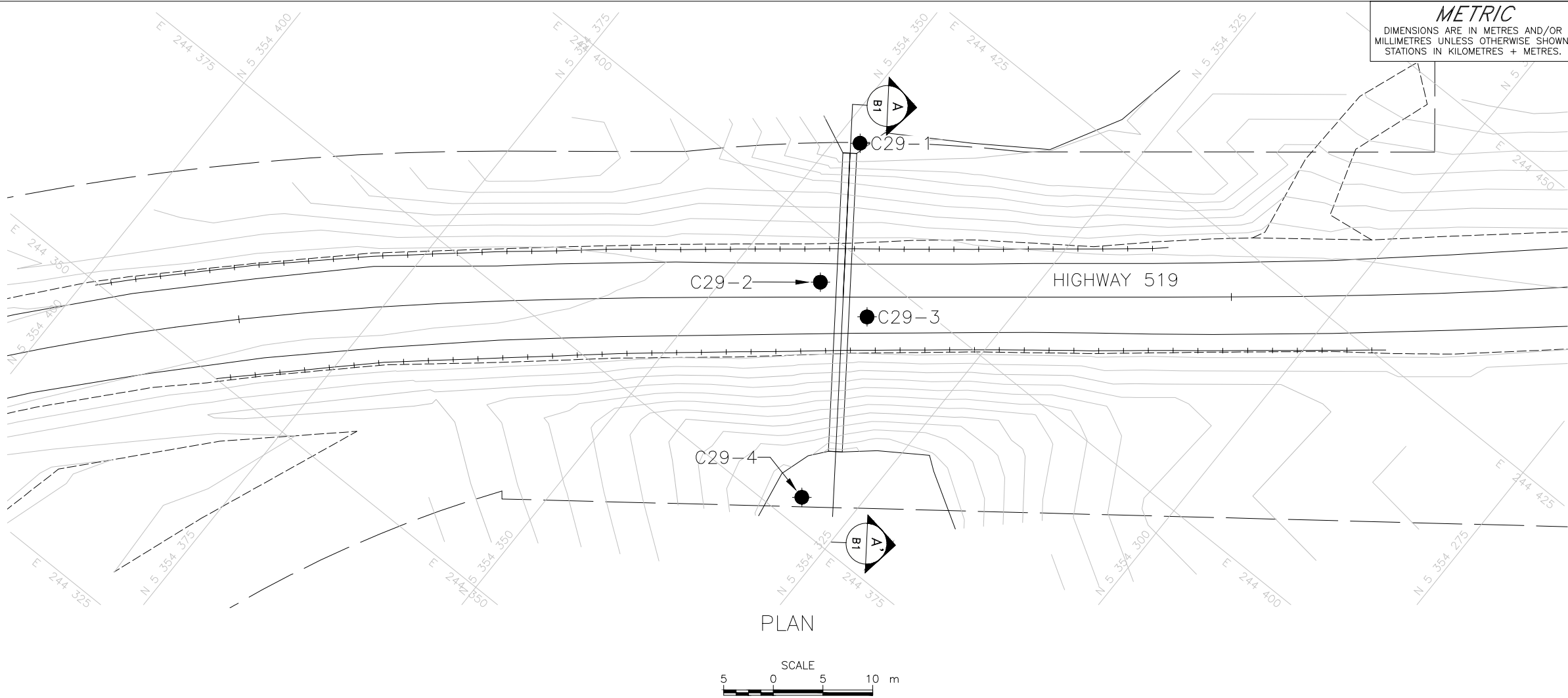
Golder Associates

Date: 21-Sep-16



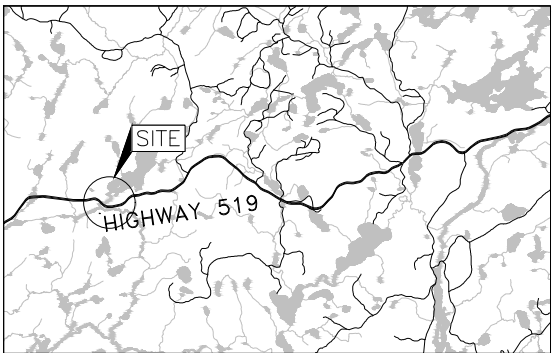
APPENDIX B

Culvert C29 – STA 18+561 (Township of Dambrossio)



CONT No.
GWP No. 327-99-00

HIGHWAY 519
CULVERT C29 STA. 18+561
BOREHOLE LOCATIONS AND
SOIL STRATA



KEY PLAN
SCALE
2.5 0 2.5 5 km

LEGEND

- Borehole - Current 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 upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
C29-1	416.9	5354347.8	244409.1
C29-2	421.4	5354342.2	244395.7
C29-3	421.3	5354336.3	244395.9
C29-4	415.7	5354330.1	244377.6

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.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans and sections provided in digital format by D.M.Wills Associates, drawing file nos. 4539- HWY 519- BP (New Survey).dwg and Foundations X-Sec sent to Chris Ng July 8.dwg, received March 11, 2016.

NO.	DATE	BY	REVISION
Geocres No. 42C-39			
HWY. 519		PROJECT NO. 1521770	DIST. .
SUBM'D. MCK	CHKD. MCK	DATE: 9/2/2016	SITE: .
DRAWN: MR	CHKD. CN	APPD. JMAC	DWG. B1

PROJECT 1521770		RECORD OF BOREHOLE No C29-1				SHEET 1 OF 1		METRIC									
G.W.P. 327-99-00		LOCATION N 5354347.8 ; E 244409.1				ORIGINATED BY MCK/LK											
DIST _____ HWY 519		BOREHOLE TYPE Portable Equipment, BW Casing, Manual Hammer				COMPILED BY MR											
DATUM Geodetic		DATE July 16 and 17, 2016				CHECKED BY ACK/MCK											
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									
416.9	WATER SURFACE							20	40	60	80	100					
0.0	WATER																
416.3							416										
0.6	SAND, some gravel, containing organics Compact Brown		1	SS	25												
415.7	Wet																
1.2	SAND and GRAVEL, some silt Very dense Brown to grey Wet		2	SS	64		415										
			3	SS	136												
			4	SS	160/0.04*		414										
413.9	BASALT (BEDROCK)																
413.5			1	RC	REC 100%												
3.4	Bedrock cored from depths of 3.0 m to 3.4 m. For bedrock coring details refer to Record of Drillhole C29-1. END OF BOREHOLE * Spoon bouncing																

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PROJECT: 1521770

RECORD OF DRILLHOLE: C29-1

SHEET 1 OF 1

LOCATION: N 5354347.8 ;E 244409.1

DRILLING DATE: July 17, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Hilti Portable Equipment

DRILLING CONTRACTOR: OGS Drilling Inc.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										NOTES				
								RECOVERY			FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA					HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load Index (MPa)	RMC -Q AVG	
								TOTAL CORE %	SOLID CORE %	R.Q.D. %		B Angle	DIP w.r.t CORE AXIS DIP	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn		10 10 10 10			
	NQ RC	Continued from Record of Borehole C29-1		413.88																		
		Slightly weathered, crystalline, black, fine-grained, non-porous, very strong BASALT		3.02	1																	
	Thin Wall Coring	END OF DRILLHOLE		413.52																		
				3.38																		
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						

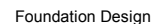
DEPTH SCALE

1 : 50



LOGGED: MCK/LK

CHECKED: ACK/MCK



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

PROJECT: 1521770

RECORD OF DRILLHOLE: C29-2

SHEET 1 OF 1

LOCATION: N 5354342.2 ;E 244395.7

DRILLING DATE: July 15, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 55

DRILLING CONTRACTOR: Landcore Drilling Inc.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.																NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
								RECOVERY				R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA						HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load Index (MPa)		RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
								TOTAL CORE %	SOLID CORE %	B Angle	DIP w.r.t. CORE AXIS			TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 10 10 10	10 10 10 10																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
		GROUND SURFACE		413.75																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															

DEPTH SCALE

1 : 50



LOGGED: LK

CHECKED: ACK/MCK

PROJECT		1521770		RECORD OF BOREHOLE		No C29-3		SHEET 1 OF 1		METRIC							
G.W.P.		327-99-00		LOCATION		N 5354336.3 ; E 244395.9		ORIGINATED BY		LK							
DIST		HWY 519		BOREHOLE TYPE		150 mm Continuous Flight Solid Stem Augers, NQ/NW Casing, Wash Boring		COMPILED BY		MR							
DATUM		Geodetic		DATE		July 13, 2016		CHECKED BY		ACK/MCK							
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									
421.3	PAVEMENT SURFACE							20	40	60	80	100					
0.0	ASPHALT (90 mm)																
0.1	Silty sand, some gravel (FILL) Very dense Brown Dry		1	AS	-												
			2	SS	102/0.25												
419.9																	
1.4	Gravelly silty sand to sand and gravel, trace to some silt, cobbles throughout (ROCK FILL) Loose to very dense Greyish brown Moist to wet		3	SS	49												
			4	SS	64/0.25												
			5	SS	16												
			6	SS	33												
			7	SS	8												
			8	SS	50/0.15												
414.0	Sandy GRAVEL, trace to some silt Very dense Grey Wet																
7.3																	
413.4	BASALT (BEDROCK)		1	RC	REC 100%												
7.9	Bedrock cored from depths of 7.9 m to 10.0 m. For bedrock coring details refer to Record of Drillhole C29-3.		2	RC	REC 100%												
411.3	END OF BOREHOLE																
10.0	NOTE: 1. Water level in open borehole at a depth of 5.4 m below ground surface (Elev. 415.9 m) upon completion of drilling.																

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SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Landcore Drilling Inc.

CHECKED: ACK/MCK

PROJECT 1521770		RECORD OF BOREHOLE No C29-4				SHEET 1 OF 1		METRIC									
G.W.P. 327-99-00		LOCATION N 5354330.1 ; E 244377.6				ORIGINATED BY LK											
DIST _____ HWY 519		BOREHOLE TYPE Portable Equipment, BW Casing, Manual Hammer				COMPILED BY MR											
DATUM Geodetic		DATE July 17 and 18, 2016				CHECKED BY ACK/MCK											
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									
415.7	GROUND SURFACE							20	40	60	80	100					
0.0	Cobbles and boulders within a gravelly sand to sand and gravel matrix (ROCK FILL) Loose to very dense Grey to brown Moist to wet		1	SS	5	▽	415										
			2	SS	40/0.03		414										
413.6	DIORITE (BEDROCK)		1	RC	REC 100%												RQD = 58%
413.3	Bedrock cored from depths of 2.1 m to 2.4 m. For bedrock coring details refer to Record of Drillhole C29-4. END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 0.7 m below ground surface (Elev. 415.0 m) upon completion of drilling. 2. Two additional boreholes were advanced about 0.5 m south and 0.4 m north of borehole C29-4 to assess the presence of cobbles/boulders. Refusal at shallow depth was encountered. Surficial cobbles and boulders were also observed in the area. *Spoon bouncing																
2.4																	

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PROJECT: 1521770

RECORD OF DRILLHOLE: C29-4

SHEET 1 OF 1

LOCATION: N 5354330.1 ;E 244377.6

DRILLING DATE: July 18, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Hilti Portable Equipment

DRILLING CONTRACTOR: OGS Drilling Inc.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.														NOTES
							FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle °	DIP w.r.t CORE AXIS °	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q AVG	
		Continued from Record of Borehole C29-4		413.64																	
	NQ RC	Slightly weathered, crystalline, black and white, coarse grained, non-porous, very strong DIORITE		2.06	1																
	Thin Wall Coring	END OF DRILLHOLE		413.34																	
				2.36																	
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					

DEPTH SCALE

1 : 50



LOGGED: LK

CHECKED: ACK/MCK


GTA-RCK 018 S:\CLIENTS\MTOWHWY_519\02_DATA\GINT\HWY_519.GPJ GAL-MISS.GDT 11/22/16



North side of Highway 519 at about STA 18+561
(Dambrossio), Culvert C29, looking north. July 8, 2016.



North side of Highway 519 at about STA 18+561 (Dambrossio),
Culvert C29, looking north. July 8, 2016.

PROJECT	Highway 519—Culvert Replacements G.W.P. 327-99-00					
TITLE	Site Photographs Culvert C29—STA 18+561 (Township of Dambrossio) Highway 519					
			PROJECT No. 1521770		FILE No. — —	
			DESIGN	MCK	SEPT 16	SCALE
			CADD	— —		NTS
			CHECK	CN	SEPT 16	REV.
			REVIEW	JMAC	SEPT 16	
FIGURE B1-A						



South side of Highway 519 at about STA 18+561 (Dambrossio), Culvert C29, looking south-west July 8, 2016.



South side of Highway 519 at about STA 18+561 (Dambrossio), Culvert C29, looking north-east. July 8, 2016.

PROJECT

**Highway 519—Culvert Replacements
G.W.P. 327-99-00**

TITLE

**Site Photographs
Culvert C29—STA 18+561 (Township of Dambrossio)
Highway 519**

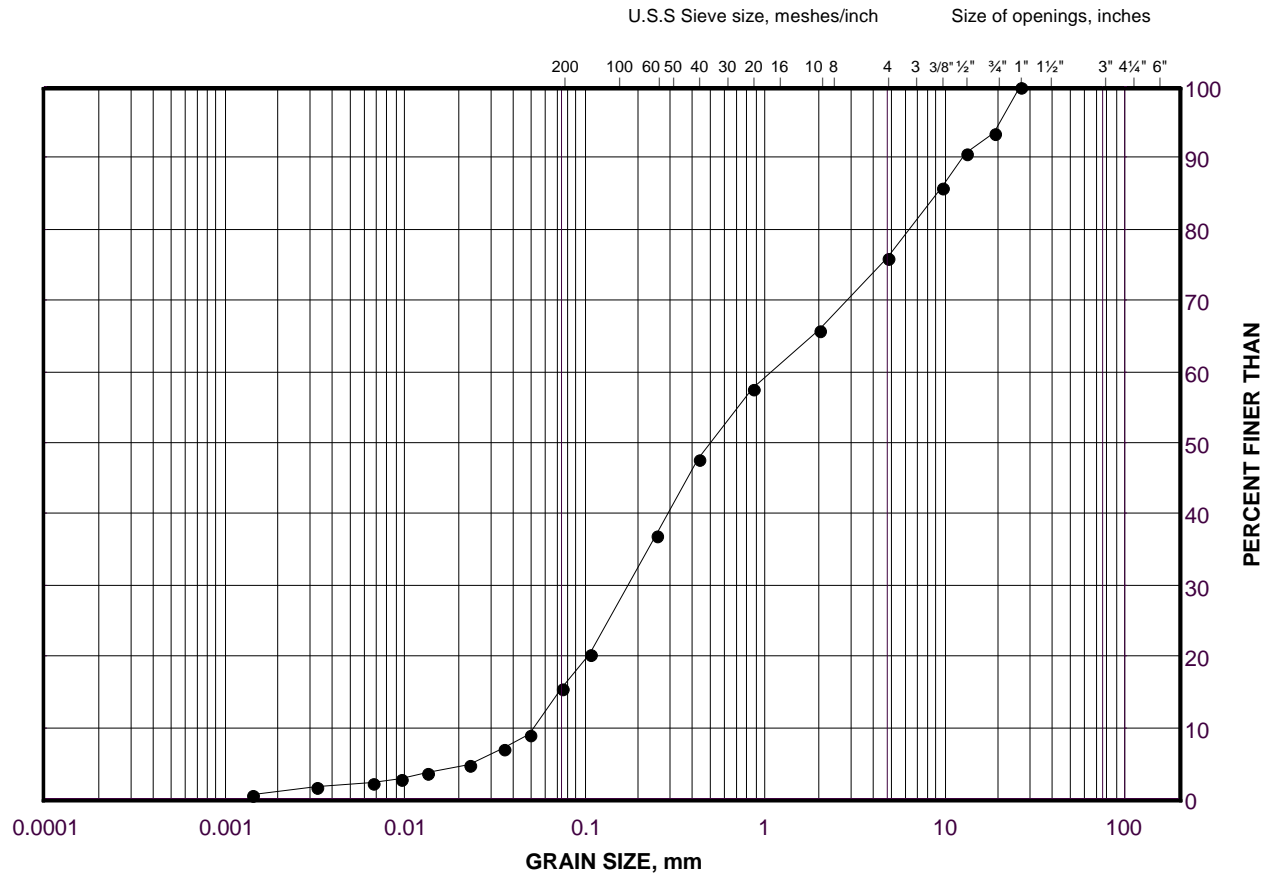


PROJECT No. 1521770			FILE No. — —		
DESIGN	MCK	SEPT 16	SCALE	NTS	REV.
CADD	— —		FIGURE B1-B		
CHECK	CN	SEPT 16			
REVIEW	JMAC	SEPT 16			

GRAIN SIZE DISTRIBUTION

Gravelly Sand (FILL)

FIGURE B2



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C29-2	2A	420.4

Project Number: 1521770

Checked By: MCK

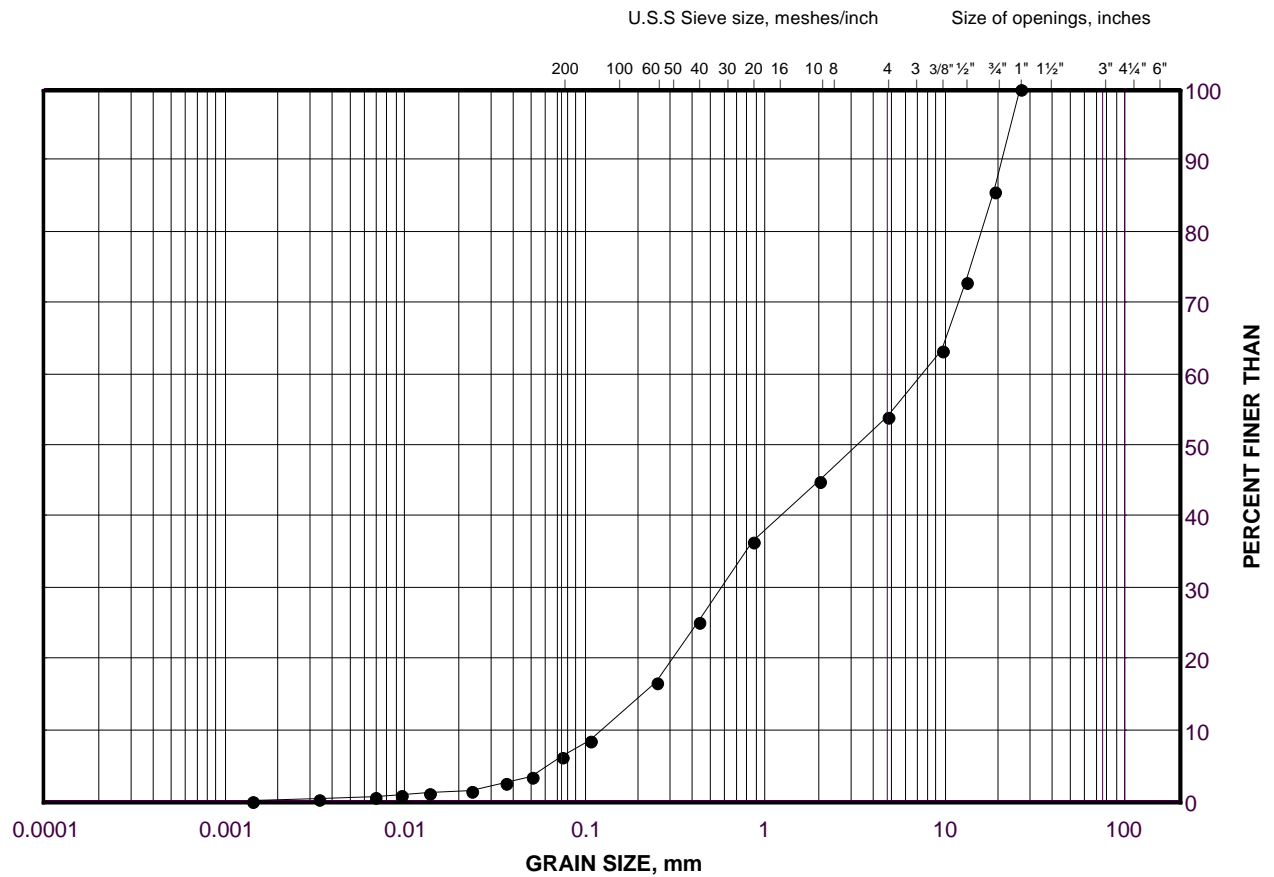
Golder Associates

Date: 21-Sep-16

GRAIN SIZE DISTRIBUTION

Sand and Gravel Matrix (ROCK FILL)

FIGURE B3



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C29-3	5	417.9

Project Number: 1521770

Checked By: MCK

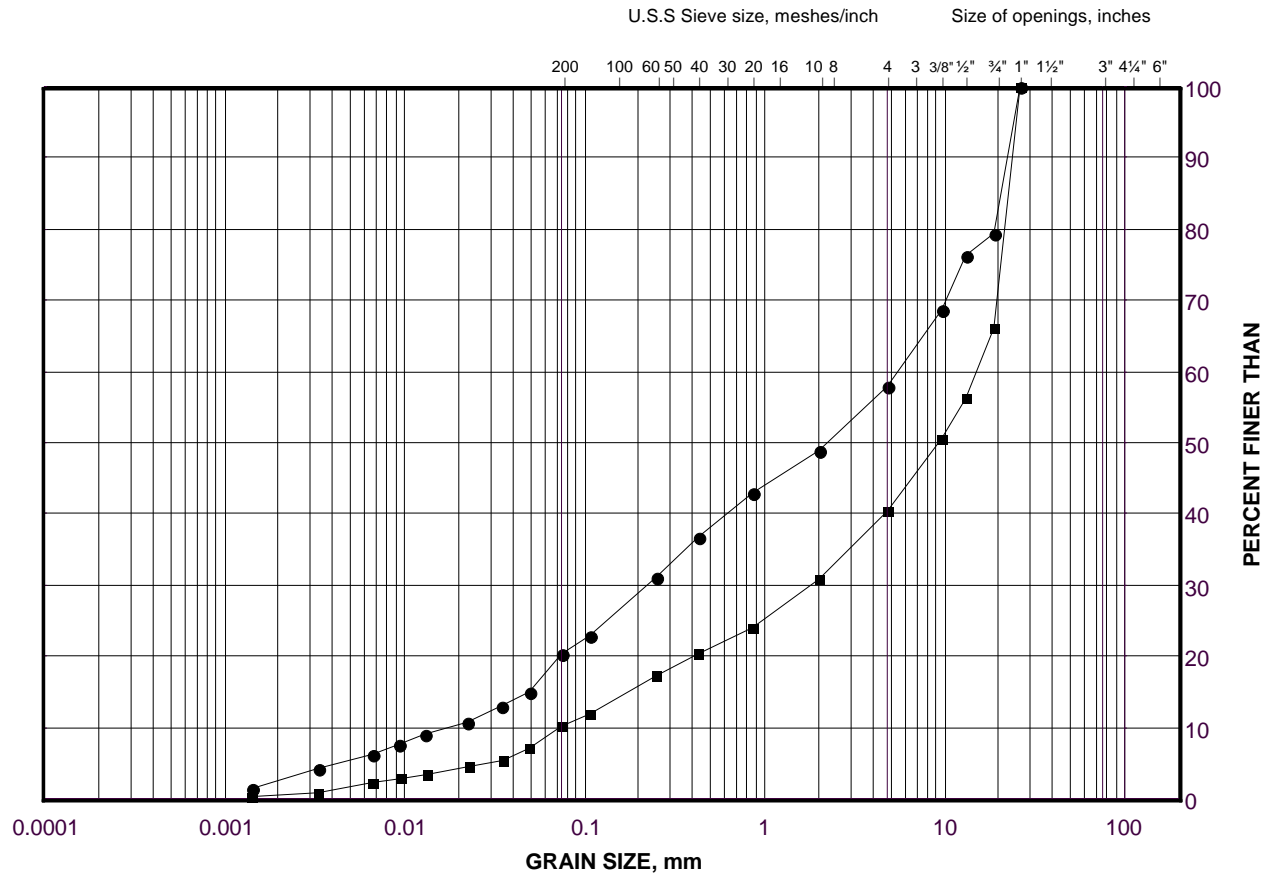
Golder Associates

Date: 21-Sep-16

GRAIN SIZE DISTRIBUTION

Sand and Gravel to Sandy Gravel

FIGURE B4



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C29-1	3	414.8
■	C29-3	8	413.6

Project Number: 1521770

Checked By: MCK

Golder Associates

Date: 21-Sep-16

Borehole C29-1



Box 1: 3.02 m – 3.38 m

Borehole C29-2



Box 1: 7.65 m – 8.13 m

Borehole C29-3



Box 1: 7.92 m – 9.96 m

Borehole C29-4



Box 1: 2.06 m – 2.36 m

0 m	0.25 m	0.5 m	0.75 m	1.0 m	1.25 m	1.5 m
0 ft	1 ft	2 ft	3 ft	4 ft	5 ft	

PROJECT					
Highway 519 Culvert Replacements GWP 327-99-00					
TITLE					
Bedrock Core Photographs – Highway 519 Boreholes C29-1 to C29-4					
PROJECT No. 1521770			FILE No. ----		
DESIGN	MK	SEP 16	SCALE	NTS	REV.
CADD	--		FIGURE B5		
CHECK	CN	SEP 16			
REVIEW	JMAC	SEP 16			



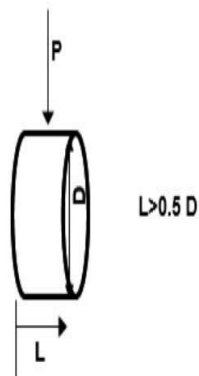
TABLE B1
SUMMARY OF POINT LOAD TESTS ON ROCK SAMPLES

PROJECT NO. 1521770						
DATE September 2016						
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)
C29-3	1	8.3	413.0	Basalt	Axial	8.6
C29-3	1	8.3	413.0	Basalt	Diametral	6.2
<p>(1) $Is_{50} \times C$ (actual value will have to be confirmed by UCS testing), from ISRM ("Suggested Methods for Determining Point Load Strength", International Society for Rock Mechanics Commission on Testing Methods, Int. J. Rock. Mech. Min. Sci. and Geomechanical Abstr., Vol 22, No. 2 1985, pp. 51-60.</p> <p>(2) Actual distance between point load cones at time of failure.</p>						

DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

note: Diametral tests are perpendicular to core axis

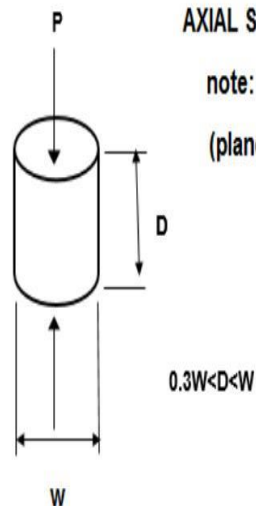
(planes of weakness)



AXIAL SPECIMEN SHAPE REQUIREMENTS

note: Axial tests are parallel to core axis

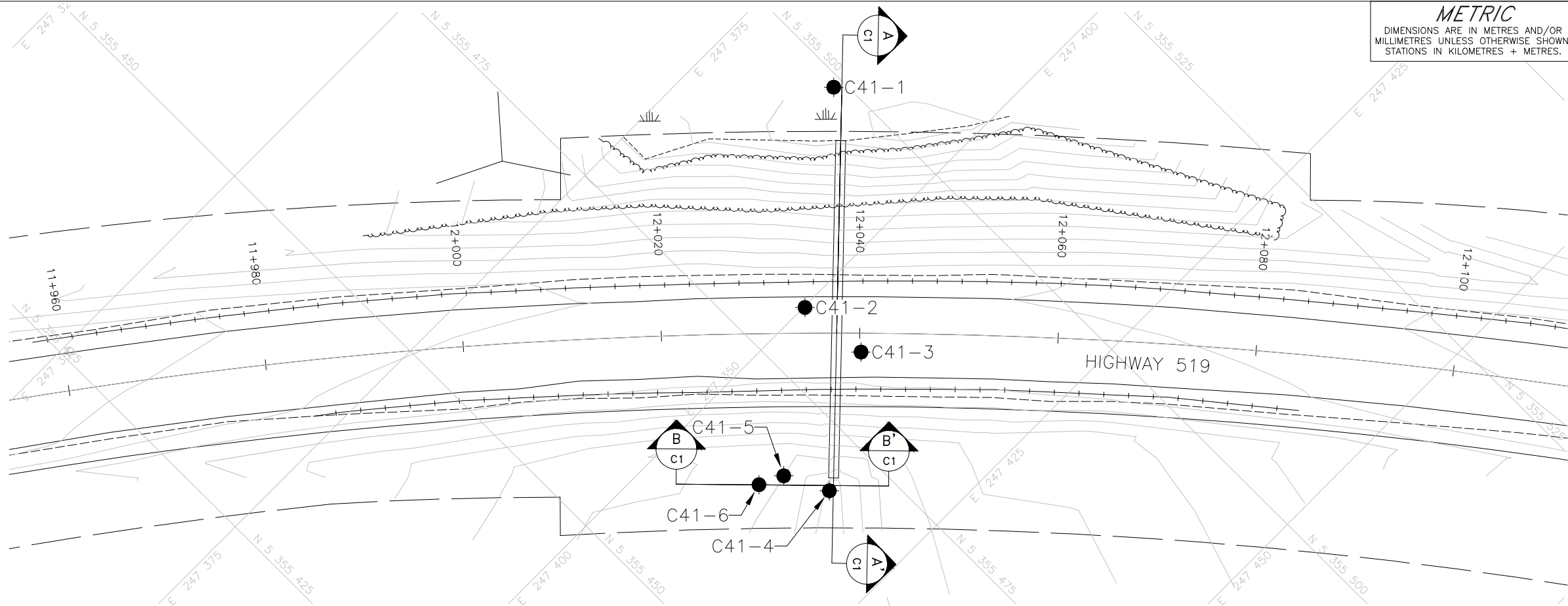
(planes of weakness)



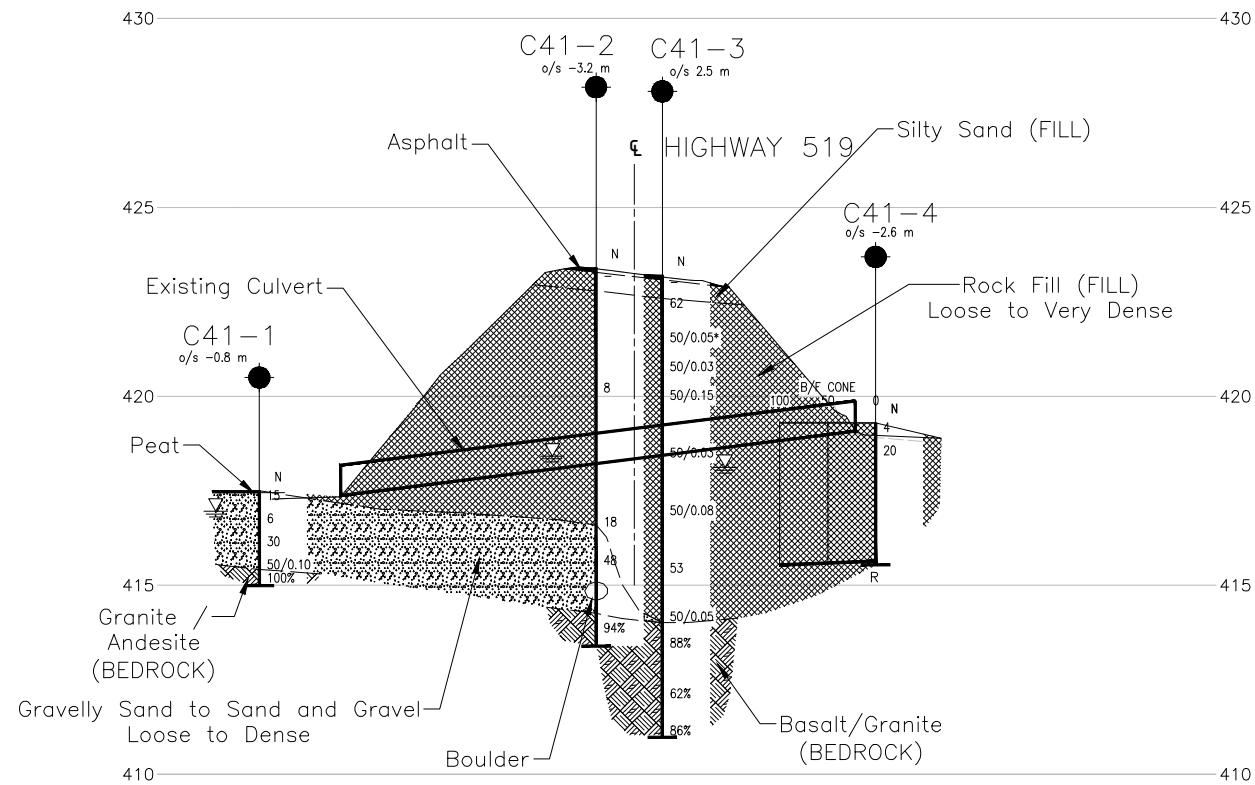
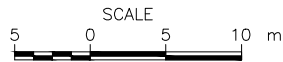


APPENDIX C

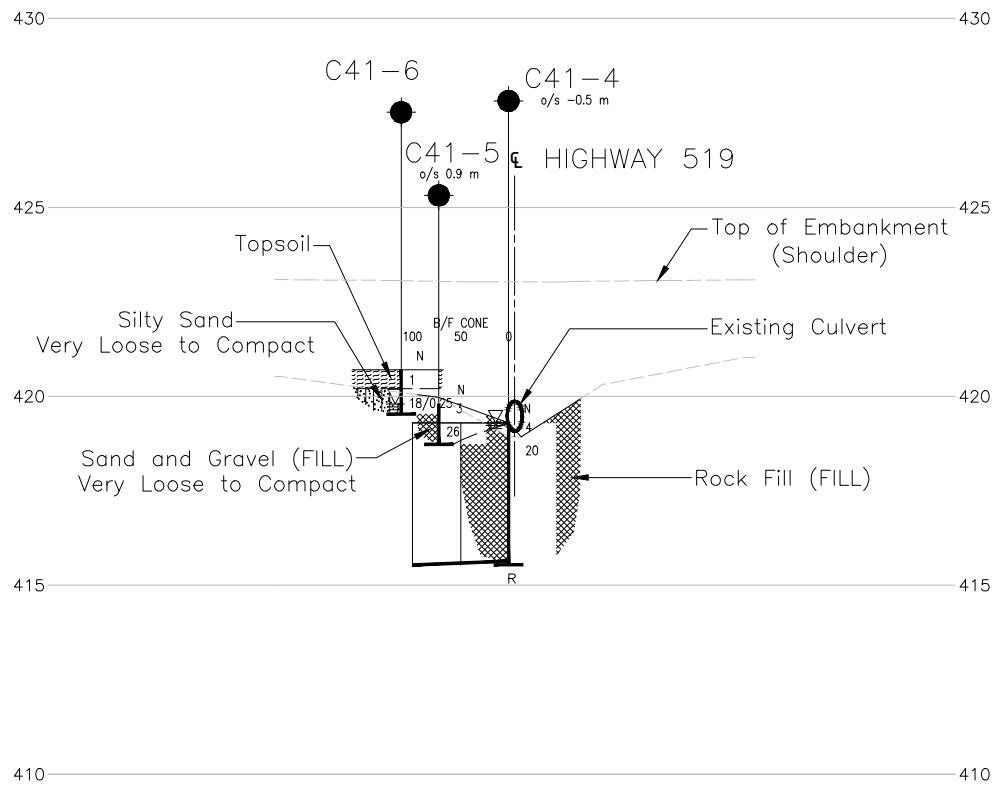
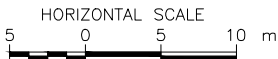
Culvert C41 – STA 12+038 (Township of Dumas)



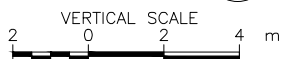
PLAN



PROFILE A-A'
STA. 12+038



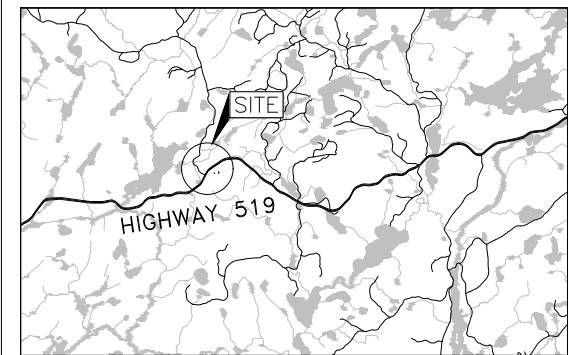
CROSS-SECTION B-B'
STA. 12+038



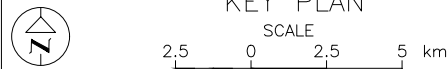
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. 327-99-00
GWP No. 327-99-00

HIGHWAY 519
CULVERT C41 STA. 12+038
BOREHOLE LOCATIONS AND
SOIL STRATA



KEY PLAN



LEGEND

- Borehole - Current 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 upon completion of drilling
- R Refusal to Further Penetration

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
C41-1	417.5	5355499.0	247386.5
C41-2	423.4	5355481.2	247400.1
C41-3	423.2	5355482.0	247407.3
C41-4	419.3	5355469.8	247414.9
C41-5	419.8	5355467.7	247410.6
C41-6	420.7	5355465.3	247409.4

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.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans and sections provided in digital format by D.M.Wills Associates, drawing file nos. 4539- HWY 519- BP (New Survey).dwg and Foundations X-Sec sent to Chris Ng July 8.dwg, received March 11, 2016.



NO.	DATE	BY	REVISION
1	2016-07-08	MR	Initial Design
2	2016-07-11	MR	Revised Design
3	2016-07-11	MR	Final Design

Geocres No. 42C-39

HWY. 519	PROJECT NO. 1521770	DIST. .
SUBM'D. MCK	CHKD. MCK	DATE: 9/2/2016
DRAWN: MR	CHKD. CN	APPD. JMAC
		DWG. C1

PROJECT 1521770		RECORD OF BOREHOLE No C41-1				SHEET 1 OF 1		METRIC										
G.W.P. 327-99-00		LOCATION N 5355499.0 ; E 247386.5				ORIGINATED BY MCK												
DIST _____ HWY 519		BOREHOLE TYPE Portable Equipment, BW Casing, Manual Hammer				COMPILED BY MR												
DATUM Geodetic		DATE July 15, 2016				CHECKED BY ACK/MCK												
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
417.5	GROUND SURFACE							20	40	60	80	100						
8.9	PEAT Black		1A	SS	15	▽	417										29 55 (16)	
	Gravelly SAND, trace to some silt, trace organics to a depth of 0.6 m		1B	SS	6		417											
	Loose to dense Grey to brown Wet		2	SS	6		416											24 68 7 1
	- 0.1 m cobble encountered at a depth of 1.5 m		3	SS	30		416											
415.4			4	SS	50/0.10													
2.1	GRANITE / ANDESITE (BEDROCK)		1	RC	REC 100%		415										RQD = 100%	
415.0																		
2.5	Bedrock cored from depths of 2.1 m to 2.6 m.																	
	For bedrock coring details refer to Record of Drillhole C41-1. END OF BOREHOLE																	
	NOTE: 1. Water level in open borehole at a depth of 0.5 m below ground surface (Elev. 417.0 m) upon completion of drilling.																	

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PROJECT: 1521770

RECORD OF DRILLHOLE: C41-1

SHEET 1 OF 1

LOCATION: N 5355499.0 ;E 247386.5


DRILLING DATE: July 15, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Hilti Portable Equipment

DRILLING CONTRACTOR: OGS Drilling Inc.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										NOTES				
								RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA							HYDRAULIC CONDUCTIVITY K, cm/sec		Diametral Point Load Index (MPa)	RMC -Q AVG
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn		10 10 10 10 10	10 10 10 10 10		
								80 80 80 80 80	80 80 80 80 80													
	NQ RC July 15, 2016	Continued from Record of Borehole C41-1 Fresh, crystalline, pink, medium grained, non-porous, very strong to extremely strong GRANITE Fresh, crystalline, white and black, medium grained, non-porous, very strong ANDESITE END OF DRILLHOLE		415.42 2.99 2.14 414.99 2.51	1																	
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						

DEPTH SCALE

1 : 50



LOGGED: MCK

CHECKED: ACK/MCK

GTA-RCK 018 S:\CLIENTS\MTOWHWY_519\02_DATA\GINT\HWY_519.GPJ GAL-MISS.GDT 11/22/16

PROJECT 1521770			RECORD OF BOREHOLE No C41-2			SHEET 1 OF 1			METRIC							
G.W.P. 327-99-00			LOCATION N 5355481.2 ; E 247400.1			ORIGINATED BY LK										
DIST _____ HWY 519			BOREHOLE TYPE 150 mm Cont. Flight Solid Stem Augers, NW Casing			COMPILED BY MR										
DATUM Geodetic			DATE July 15 and 16, 2016			CHECKED BY ACK/MCK										
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								
423.4	PAVEMENT SURFACE															
0.0	ASPHALT (80 mm)															
422.8	Silty sand, some gravel (FILL) Brown Dry		1	AS	-											
0.6	Cobbles and boulders within a silty sand to sand some silt, some gravel matrix, trace organics (ROCK FILL) Loose to compact Greyish brown Wet															
	Auger grinding at a depth of 1.3 m															
	Depth to Cobble/ Boulder (m)															
	Elev. (m)															
	Size (m)															
	0.7 422.7 0.3															
	2.0 421.4 0.1		2	SS	8											
	2.2 421.2 0.1															
	2.3 421.1 0.1															
	5.2 418.2 0.3															
	6.1 417.3 0.3															
	Auger grinding at depth of 6.1 m															
416.6	SAND and GRAVEL, trace to some silt, containing cobbles and boulders Compact to dense Grey Wet		3A													
6.8			3B	SS	18											
	Depth to Cobble/ Boulder (m)															
	Elev. (m)															
	Size (m)															
	8.3 415.1 0.5															
	8.9 414.5 0.1		4	SS	48											
414.3	Auger grinding at depth of 9.1 m															
9.1	BASALT (BEDROCK)															
413.4	Bedrock cored from depths of 9.1 m to 10.0 m.		1	RC	REC 100%											
10.0	For bedrock coring details refer to Record of Drillhole C41-2. END OF BOREHOLE															
	NOTE: 1. Water level in open borehole at a depth of 5.0 m below ground surface (Elev. 418.4 m) upon completion of drilling.															

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[illegible]

DEPTH SCALE

1 : 50

LOGGED: LK

CHECKED: ACK/MCK

PROJECT 1521770		RECORD OF BOREHOLE No C41-3		SHEET 1 OF 1		METRIC											
G.W.P. 327-99-00		LOCATION N 5355482.0; E 247407.3		ORIGINATED BY LK													
DIST _____ HWY 519		BOREHOLE TYPE 150 mm Cont. Flight Solid Stem Augers, NW Casing		COMPILED BY MR													
DATUM Geodetic		DATE July 10 and 11, 2016		CHECKED BY ACK/MCK													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	γ	GR	SA	SI	CL
423.2	PAVEMENT SURFACE																
8.9	ASPHALT (50 mm)		1	AS	-		423										
422.6	Silty sand, some gravel (FILL) Greyish brown Moist		2	SS	62		422										
0.6	Auger grinding at a depth of 0.6 m		3	SS	50/0.05		421										
	Cobbles and boulders within a silty sand, some gravel to sand and gravel matrix (ROCK FILL) Very dense Greyish brown Moist		4	SS	50/0.03		420										
			5	SS	50/0.15		419										
			6	SS	50/0.03		418										
	Depth to Cobble/ Boulder (m)						417										
	2.5						416										
	3.8						415										
	3.9						414										
	4.2						413										
	5.5						412										
	5.7						411										
	6.2																
			7	SS	50/0.08												
			8	SS	53												
414.0	GRANITE (BEDROCK)		9	SS	50/0.05		414										
9.2	Bedrock cored from depths of 9.2 m to 12.2 m. For bedrock coring details refer to Record of Drillhole C41-3.		1	RC	REC 100%		413										RQD = 88%
			2	RC	REC 100%		412										RQD = 62%
411.0	END OF BOREHOLE		3	RC	REC 100%		411										RQD = 86%
12.2	NOTE: 1. Water level in open borehole at a depth of 5.1 m below ground surface (Elev. 418.1 m) upon completion of drilling.																

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Landcore Drilling Inc.

CHECKED: ACK/MCK

PROJECT 1521770		RECORD OF BOREHOLE No C41-4				SHEET 1 OF 1		METRIC										
G.W.P. 327-99-00		LOCATION N 5355469.8 ; E 247414.9				ORIGINATED BY MCK/LK												
DIST _____ HWY 519		BOREHOLE TYPE Portable Equipment, BW Casing, Third Weight Manual Hammer				COMPILED BY MR												
DATUM Geodetic		DATE July 15, 20 and 21, 2016				CHECKED BY MCK												
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
419.3	GROUND SURFACE							20	40	60	80	100						
0.0	Cobbles and boulders within a silty sand, some gravel matrix (ROCK FILL) Loose to compact Brown Moist		1	SS	4	▽	419											
			2	SS	20		418											
							417											
							416											
415.6	END OF BOREHOLE Dynamic Cone Penetration Test (DCPT)																	
3.8	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.10 m) (HAMMER BOUNCING)																	
	NOTES: 1. Water level in open borehole at ground surface (Elev. 419.3 m) upon completion of drilling. 2. Borehole advanced using portable equipment with a third-weight hammer. SPT 'N'-values shown have been adjusted to reflect values that would be obtained using a standard weight hammer.																	

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PROJECT 1521770		RECORD OF BOREHOLE No C41-5				SHEET 1 OF 1		METRIC									
G.W.P. 327-99-00		LOCATION N 5355467.7 ; E 247410.6				ORIGINATED BY MCK											
DIST _____ HWY 519		BOREHOLE TYPE Portable Equipment, BW Casing, Third Weight Manual Hammer				COMPILED BY MR											
DATUM Geodetic		DATE July 15, 2016				CHECKED BY MCK											
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									
419.8	GROUND SURFACE							20	40	60	80	100					
0.0	Sand and gravel, some silt (FILL) Very loose to compact Brown Wet		1	SS	3												
418.7			2	SS	26	419											
1.1	END OF BOREHOLE RODS / SPLIT-SPOON SLIDING NOTES: 1. Water level in open borehole at a ground surface (Elev. 419.8 m) upon completion of drilling. 2. Borehole terminated due to drilling rods following the slope of the natural ground surface. 3. Borehole advanced using portable equipment with a third-weight hammer. SPT 'N'-values shown have been adjusted to reflect values that would be obtained using a standard weight hammer.																

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PROJECT 1521770		RECORD OF BOREHOLE No C41-6				SHEET 1 OF 1		METRIC									
G.W.P. 327-99-00		LOCATION N 5355465.3 ; E 247409.4				ORIGINATED BY MCK											
DIST _____ HWY 519		BOREHOLE TYPE Portable Equipment, BW Casing, Third Weight Manual Hammer				COMPILED BY MR											
DATUM Geodetic		DATE July 15, 2016				CHECKED BY MCK											
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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
420.7	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL																
0.2	Silty SAND, some gravel, trace organics Very loose to compact Brown Moist		1	SS	1		420										
419.5			2	SS	18/0.25												
1.2	END OF BOREHOLE RODS / SPLIT-SPOON SLIDING																
NOTES: 1. Open borehole dry upon completion of drilling. 2. Borehole terminated due to drilling rods following the slope of the natural ground surface. 3. Borehole advanced using portable equipment with a third-weight hammer. SPT 'N'-values shown have been adjusted to reflect values that would be obtained using a standard weight hammer.																	

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North side of Highway 519 at about STA 12+038 (Dumas), Culvert C41, looking south-west July 16, 2016.



South side of Highway 519 at about STA 12+038 (Dumas), Culvert C41, looking east. July 8, 2016.

PROJECT

**Highway 519—Culvert Replacements
G.W.P. 327-99-00**

TITLE

**Site Photographs
Culvert C41— STA 12+038 (Township of Dumas)
Highway 519**

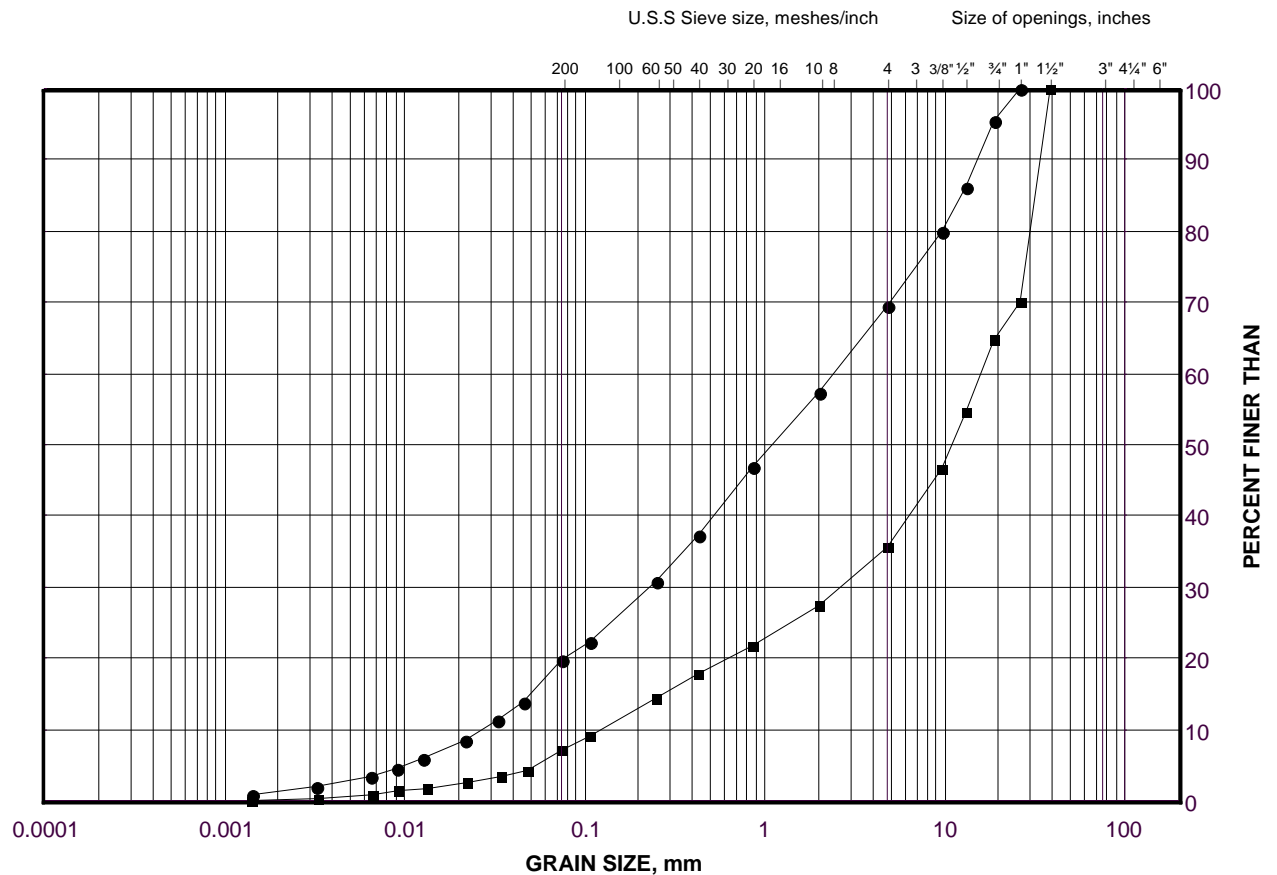


PROJECT No. 1521770			FILE No. — —		
DESIGN	MCK	SEPT 16	SCALE	NTS	REV.
CADD	— —		FIGURE C1		
CHECK	CN	SEPT 16			
REVIEW	JAMC	SEPT 16			

GRAIN SIZE DISTRIBUTION

Silty Sand to Sand and Gravel Matrix (ROCK FILL)

FIGURE C2



Borehole C41-1



Box 1: 2.08 m – 2.51 m

Borehole C41-2

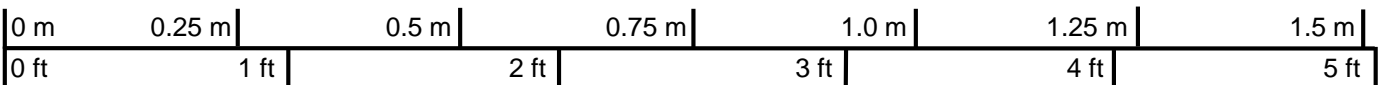


Box 1: 9.14 m – 10.01 m

Borehole C41-3



Box 1: 9.19 m – 12.22 m




PROJECT					
Highway 519 Culvert Replacements GWP 327-99-00					
TITLE					
Bedrock Core Photographs – Highway 519 Boreholes C41-1 to C41-3					
			PROJECT No. 1521770		FILE No. ----
			DESIGN	MK	SEP 16
			CADD	-- --	
			CHECK	CN	SEP 16
			REVIEW	JMAC	SEP 16
			FIGURE C4		

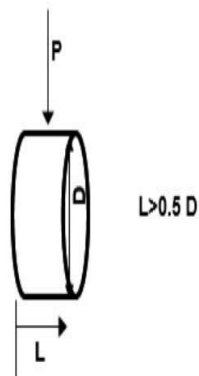
TABLE C1
SUMMARY OF POINT LOAD TESTS ON ROCK SAMPLES

PROJECT NO. 1521770						
DATE September 2016						
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)
C41-3	1	9.8	410.7	Granite	Axial	9.6
C41-3	1	9.8	410.7	Granite	Diametral	11.8
<p>(1) $Is_{50} \times C$ (actual value will have to be confirmed by UCS testing), from ISRM ("Suggested Methods for Determining Point Load Strength", International Society for Rock Mechanics Commission on Testing Methods, Int. J. Rock. Mech. Min. Sci. and Geomechanical Abstr., Vol 22, No. 2 1985, pp. 51-60.</p> <p>(2) Actual distance between point load cones at time of failure.</p>						

DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

note: Diametral tests are perpendicular to core axis

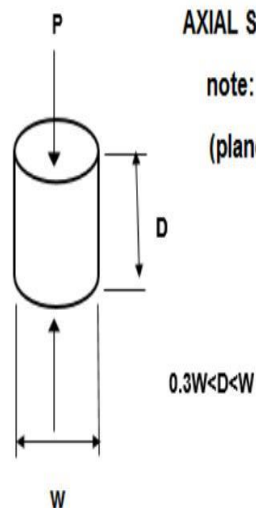
(planes of weakness)



AXIAL SPECIMEN SHAPE REQUIREMENTS

note: Axial tests are parallel to core axis

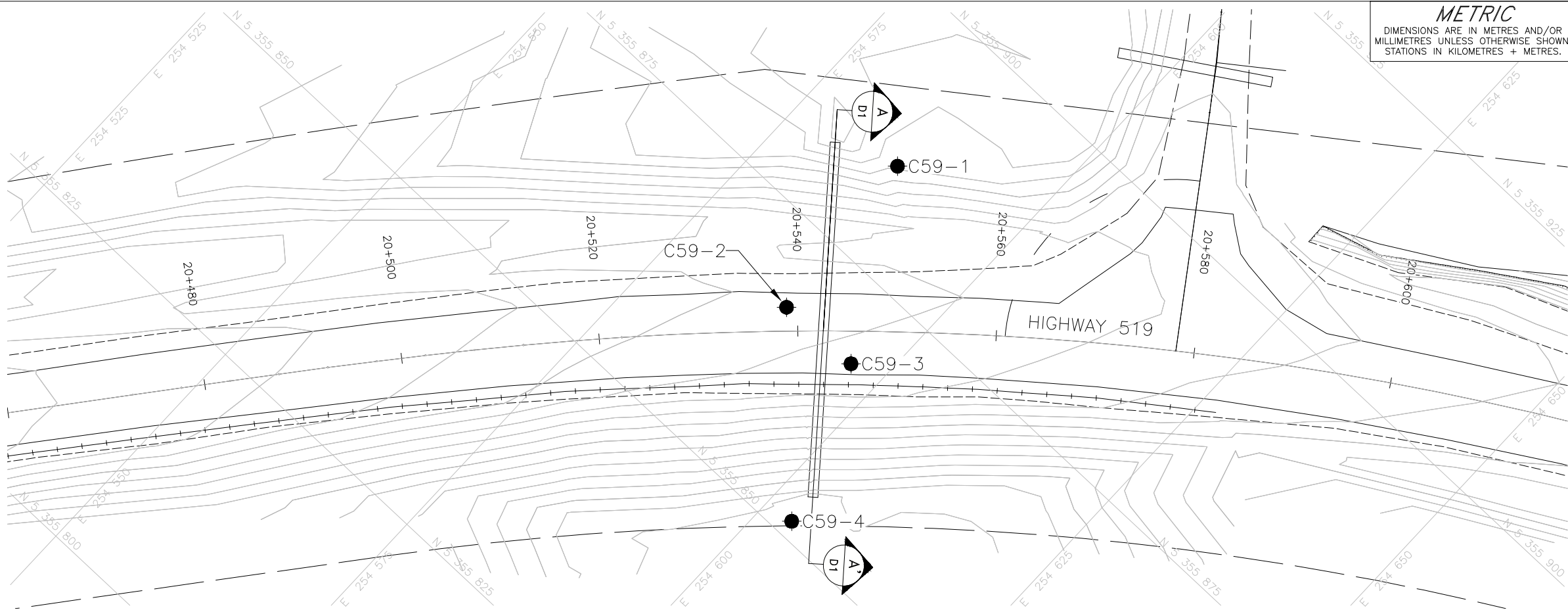
(planes of weakness)



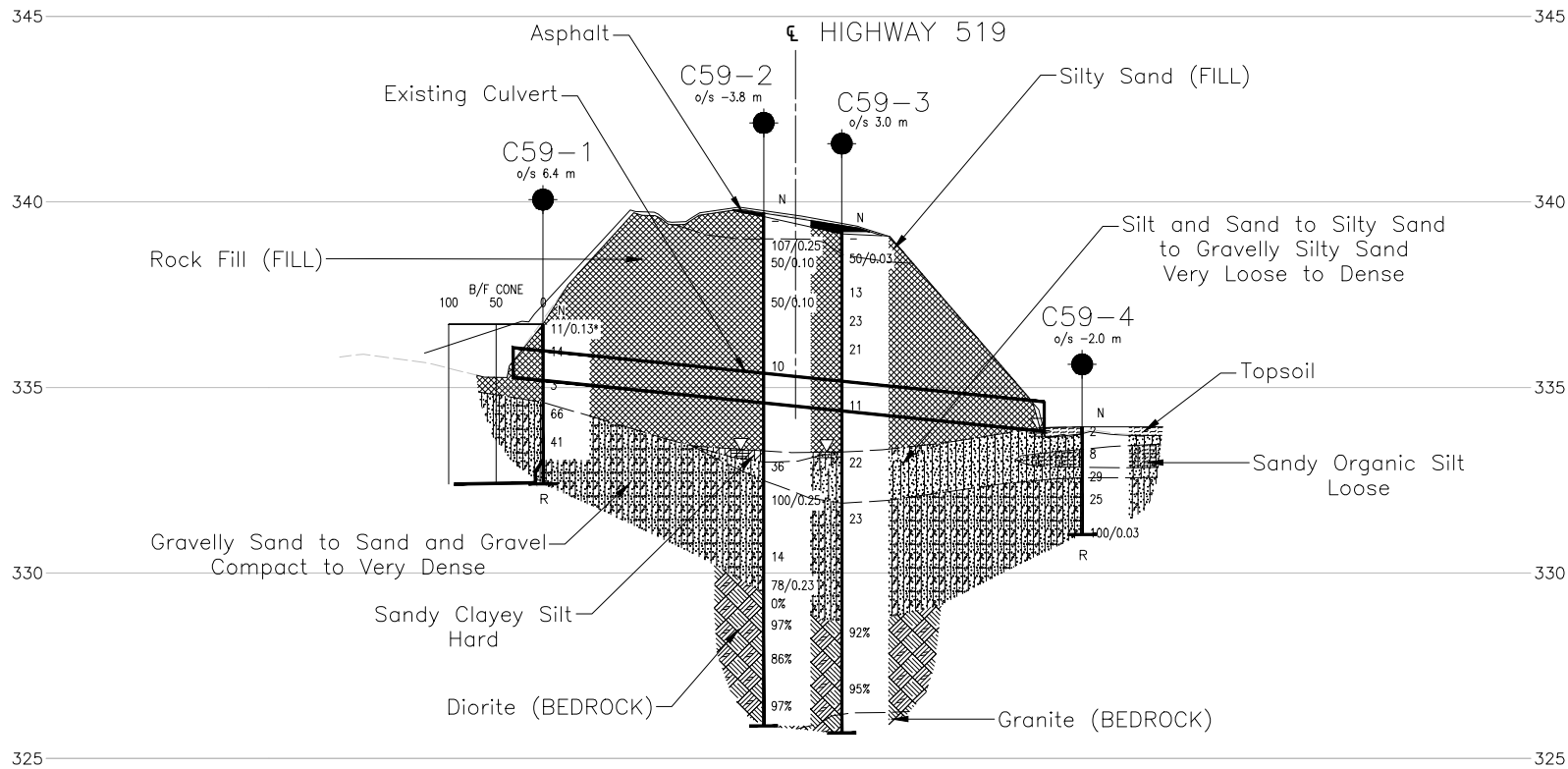
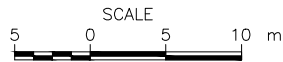


APPENDIX D

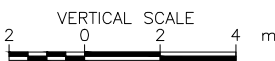
Culvert C59 – STA 20+540 (Township of Dumas)



PLAN



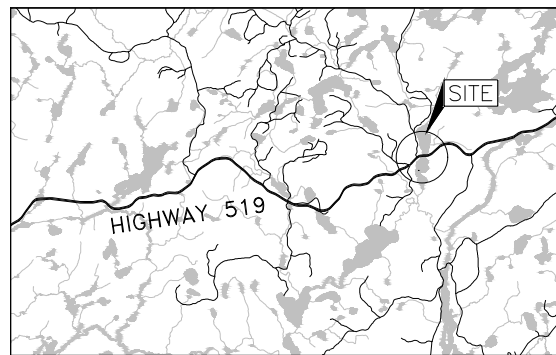
PROFILE A-A'
STA. 20+540



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

CONT No. .
GWP No. 327-99-00

HIGHWAY 519
CULVERT C59 STA. 20+540
BOREHOLE LOCATIONS AND
SOIL STRATA



KEY PLAN
SCALE
2.5 0 2.5 5 km

LEGEND

- Borehole - Current 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 upon completion of drilling
- R Refusal to Further Penetration

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
C59-1	336.7	5355885.1	254586.5
C59-2	339.7	5355867.1	254588.0
C59-3	339.2	5355867.3	254596.6
C59-4	333.9	5355851.7	254603.1

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.


The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans and sections provided in digital format by D.M.Wills Associates, drawing file nos. 4539- HWY 519- BP (New Survey).dwg and Foundations X-Sec sent to Chris Ng July 8.dwg, received March 11, 2016.



NO.	DATE	BY	REVISION
Geocres No. 42C-39			
HWY. 519	PROJECT NO. 1521770		DIST. .
SUBM'D. MCK	CHKD. MCK	DATE: 9/2/2016	SITE: .
DRAWN: MR	CHKD. CN	APPD. JMAC	DWG. D1

PROJECT 1521770		RECORD OF BOREHOLE No C59-1				SHEET 1 OF 1		METRIC									
G.W.P. 327-99-00		LOCATION N 5355885.1 ; E 254586.5				ORIGINATED BY MCK											
DIST _____ HWY 519		BOREHOLE TYPE Portable Equipment, BW Casing, Manual Hammer				COMPILED BY MR											
DATUM Geodetic		DATE July 13 and 14, 2016				CHECKED BY ACK/MCK											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)
336.7	GROUND SURFACE																
0.0	Cobbles and boulders within a sand and gravel matrix, trace organics (wood fragments and logs) (ROCK FILL) Loose to very dense Brown Moist to wet		1	SS	11/0.13												
			2	SS	14												
			3	SS	3												
334.6	Gravelly SAND to SAND and GRAVEL Dense to very dense Grey Wet																
2.1			4	SS	66											25 65 (10)	
	- 0.1 m layer of silty sand, trace organics was encountered at a depth of 3.0 m		5	SS	41											39 51 (10)	
333.0	END OF BOREHOLE Dynamic Cone Penetration Test (DCPT)																
3.7																	
332.4	END OF DCPT REFUSAL TO FURTHER PENETRATION (94 Blows / 0.05 m) (HAMMER BOUNCING)																
4.3	NOTE: 1. Water level not recorded. * Spoon bouncing																

PROJECT 1521770		RECORD OF BOREHOLE No C59-2		SHEET 1 OF 2		METRIC													
G.W.P. 327-99-00		LOCATION N 5355867.1 ; E 254588.0		ORIGINATED BY LK															
DIST _____ HWY 519		BOREHOLE TYPE 150 mm Cont. Flight Solid Stem Augers, NW Casing		COMPILED BY MR															
DATUM Geodetic		DATE July 6, 2016		CHECKED BY ACK/MCK															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa			WATER CONTENT (%)			γ					
								20 40 60 80 100	○ UNCONFINED + FIELD VANE	20 40 60	W _p	W	W _L	kN/m ³	GR SA SI CL				
339.7	PAVEMENT SURFACE																		
0.0	ASPHALT (80 mm)																		
339.1	Silty sand, some gravel (FILL) Brown Dry		1	AS	-														
0.6	Cobbles and boulders within a silty sand, trace to some gravel to gravelly sand, trace to some silt matrix (ROCK FILL) Compact to very dense Brown to grey Moist		2	SS	107/0.25		339												
			3	SS	50/0.10		338												
			4	SS	50/0.10		337												
							336												
							335												
							334												
							333												
							332												
							331												
							330												
333.0	Sandy CLAYEY SILT, trace organics Hard Black Moist		6A	SS	36		333												
332.5			6B																
332.2	SILT and SAND, trace to some gravel Brown Wet		7	SS	100/0.25		332												
7.5	SAND and GRAVEL, some inferred cobbles Compact to very dense Brown Wet		8	SS	14		331												
			9	SS	78/0.23		330												
329.5	DIORITE (BEDROCK)		1	RC	REC 77%		329								RQD = 0%				
10.2	Bedrock cored from depths of 10.2 m to 13.8 m. For bedrock coring details refer to Record of Drillhole C59-2.		2	RC	REC 100%		328								RQD = 97%				
			3	RC	REC 98%		327								RQD = 86%				
			4	RC	REC 98%		326								RQD = 97%				
325.9	END OF BOREHOLE																		
13.8																			

Continued Next Page

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

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

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SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Landcore Drilling Inc.

CHECKED: ACK/MCK

PROJECT 1521770		RECORD OF BOREHOLE No C59-3		SHEET 1 OF 1		METRIC																							
G.W.P. 327-99-00		LOCATION N 5355867.3 ; E 254596.6		ORIGINATED BY LK																									
DIST _____ HWY 519		BOREHOLE TYPE 150 mm Cont. Flight Solid Stem Augers, NW Casing		COMPILED BY MR																									
DATUM Geodetic		DATE July 9 and 10, 2016		CHECKED BY ACK/MCK																									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION	20	40	60	80	100	W _p	W	W _L	γ	GR	SA	SI	CL									
339.2	PAVEMENT SURFACE																												
0.0	ASPHALT (80 mm)		1	AS	-		339																						
338.6	Silty sand, some gravel (FILL) Brown Dry		2	SS	50/0.03																								
0.6	Cobbles and boulders within a gravelly sand to sand and gravel, some silt matrix (ROCK FILL) Compact Brown Wet		3	SS	13		338																						
	Depth to Elev. Size Boulder (m) (m) (m) 0.6 338.6 0.3 5.6 333.6 0.3		4	SS	23		337																						
			5	SS	21		336																						
			6	SS	11		335																						
							334																						
333.3	SILT and SAND, trace to some gravel to Gravelly Silty SAND, some inferred cobbles Compact Black to grey Wet		7A	SS	22		333																						
			7B				332																						
331.9	SAND and GRAVEL, trace to some silt, some cobbles and boulders Compact Grey Wet		8	SS	23		331																						
	Depth to Elev. Size Cobble/ (m) (m) Boulder (m) 8.6 330.6 0.2 8.8 330.4 0.3 9.1 330.1 0.2						330																						
							329																						
328.7	DIORITE/GRANITE (BEDROCK)						328																						
10.5	Bedrock cored from depths of 10.5 m to 13.5 m. For bedrock coring details refer to Record of Drillhole C59-3.		1	NQ RC	REC 100%		327																						
			2	NQ RC	REC 100%		326																						
325.7	END OF BOREHOLE																												
13.5	NOTE: 1. Water level in open borehole at a depth of 5.9 m below ground surface (Elev. 333.3 m) upon completion of drilling.																												

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SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Landcore Drilling Inc.

CHECKED: MCK

PROJECT		RECORD OF BOREHOLE		No C59-4		SHEET 1 OF 1		METRIC	
G.W.P. 327-99-00		LOCATION		N 5355851.7 ; E 254603.1		ORIGINATED BY		MCK	
DIST		HWY 519		BOREHOLE TYPE		Portable Equipment, BW Casing, Manual Hammer		COMPILED BY	
DATUM		Geodetic		DATE		July 12 and 13, 2016		CHECKED BY	
								ACK/MCK	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20	40	60	80	100	20	40	60		
333.9	GROUND SURFACE																
0.0	TOPSOIL																
0.2	SAND, trace organics		1	SS	2												
333.3	Loose																
0.6	Grey		2A	SS	8												
332.8	Wet		2B														
332.5	SANDY ORGANIC SILT																
1.4	Loose																
	Black																
	Moist		3	SS	29												
	Silty SAND, trace clay, trace organics																
	Loose																
	Grey		4	SS	25												
	Wet																
331.0	Gravelly SAND to SAND and GRAVEL, trace to some silt		5	SS	100/0.03												
2.9	Compact to dense																
	Brown to grey																
	Wet																
	- Containing a 0.2 m sand layer at a depth of 2.7 m																
	END OF BOREHOLE																
	SPLIT-SPOON REFUSAL																
	NOTE:																
	1. Water level in open borehole at a depth of 0.1 m below ground surface (Elev. 333.8 m) upon completion of drilling.																



North side of Highway 519 at about STA 20+540 (Dumas), Culvert C59, looking north-west July 14, 2016.



South side of Highway 519 at about STA 20+540 (Dumas), Culvert C59, looking south-east. July 12, 2016.

PROJECT

**Highway 519—Culvert Replacements
G.W.P. 327-99-00**

TITLE

**Site Photographs
Culvert C41— STA 12+038 (Township of Dumas)
Highway 519**

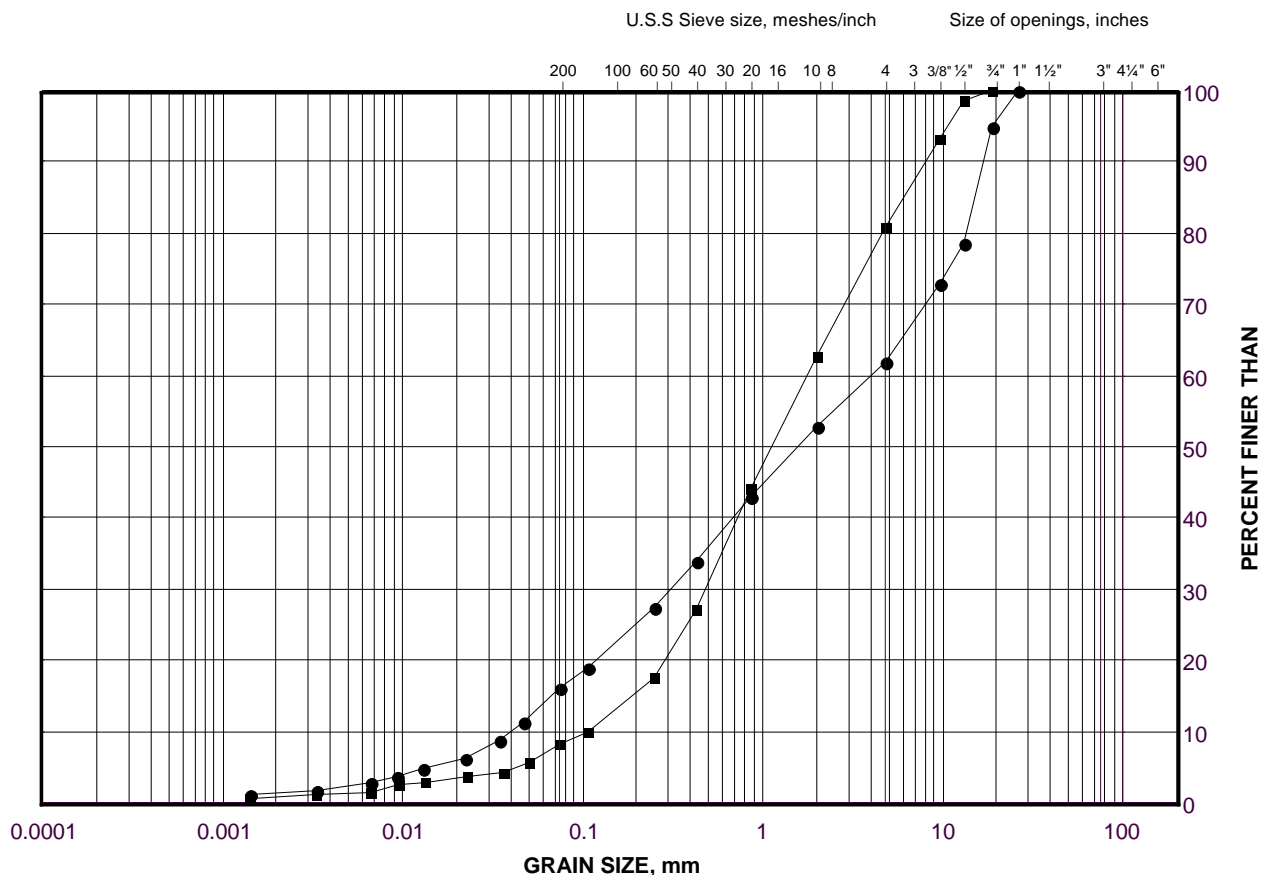


PROJECT No. 1521770			FILE No. — —		
DESIGN	MCK	SEPT 16	SCALE	NTS	REV.
CADD	— —		FIGURE D1		
CHECK	CN	SEPT 16			
REVIEW	JMAC	SEPT 16			

GRAIN SIZE DISTRIBUTION

Gravelly Sand to Sand and Gravel Matrix (ROCK FILL)

FIGURE D2



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C59-3	5	335.8
■	C59-2	5	335.4

Project Number: 1521770

Checked By: MCK

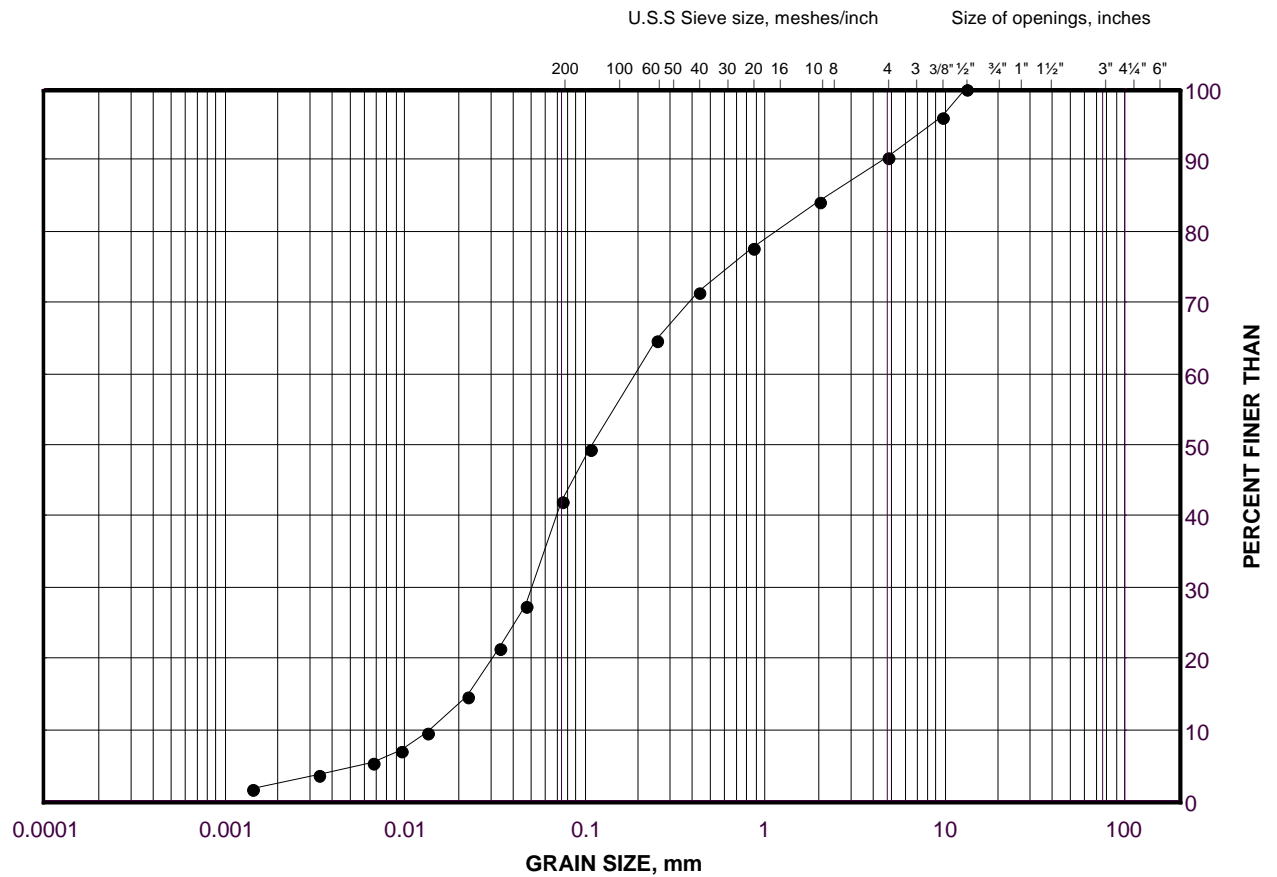
Golder Associates

Date: 21-Sep-16

GRAIN SIZE DISTRIBUTION

Silt and Sand

FIGURE D3



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

LEGEND

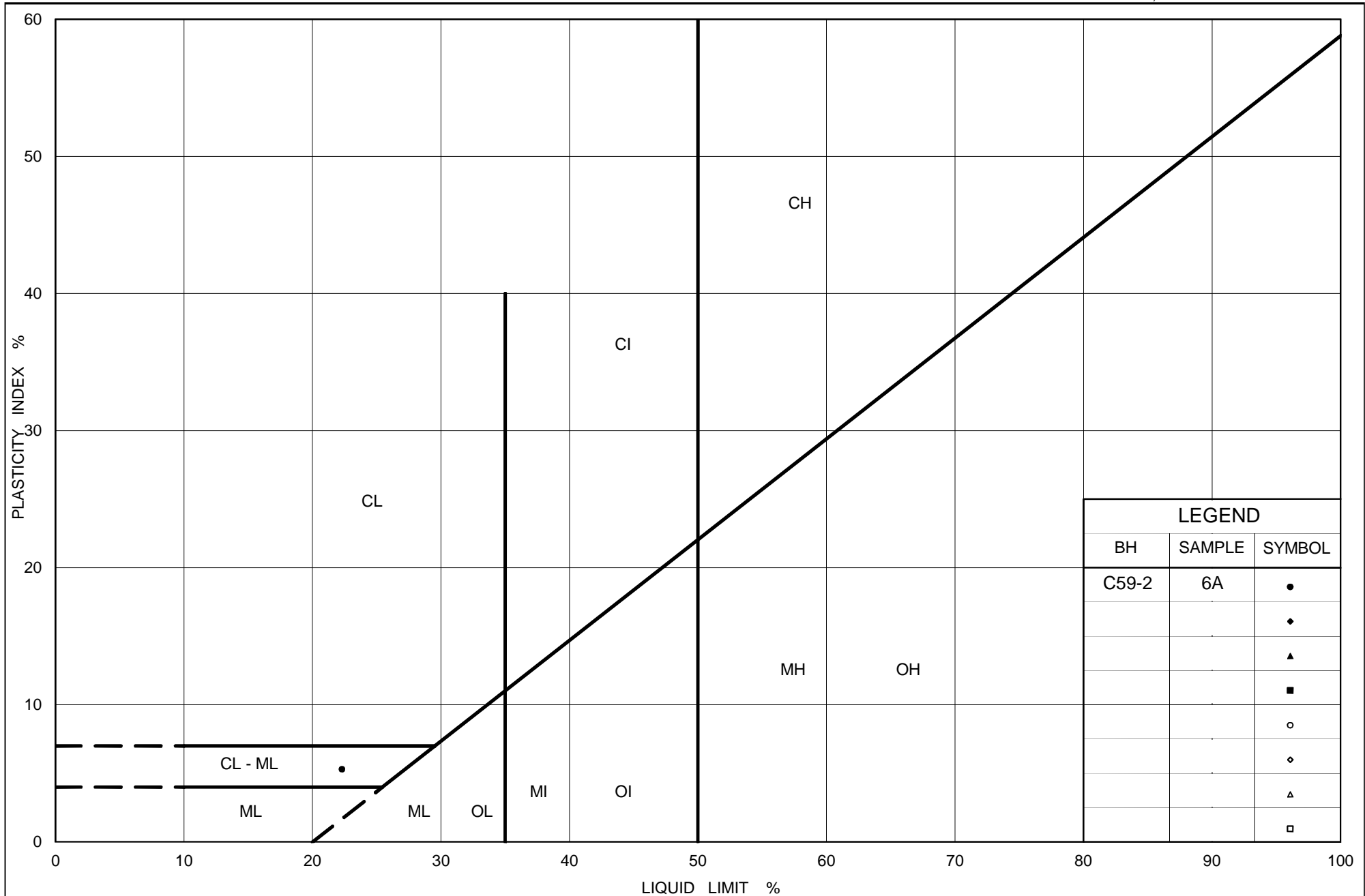
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C59-3	7B	332.6

Project Number: 1521770

Checked By: MCK

Golder Associates

Date: 21-Sep-16



Ministry of Transportation

Ontario

PLASTICITY CHART

Sandy Clayey Silt

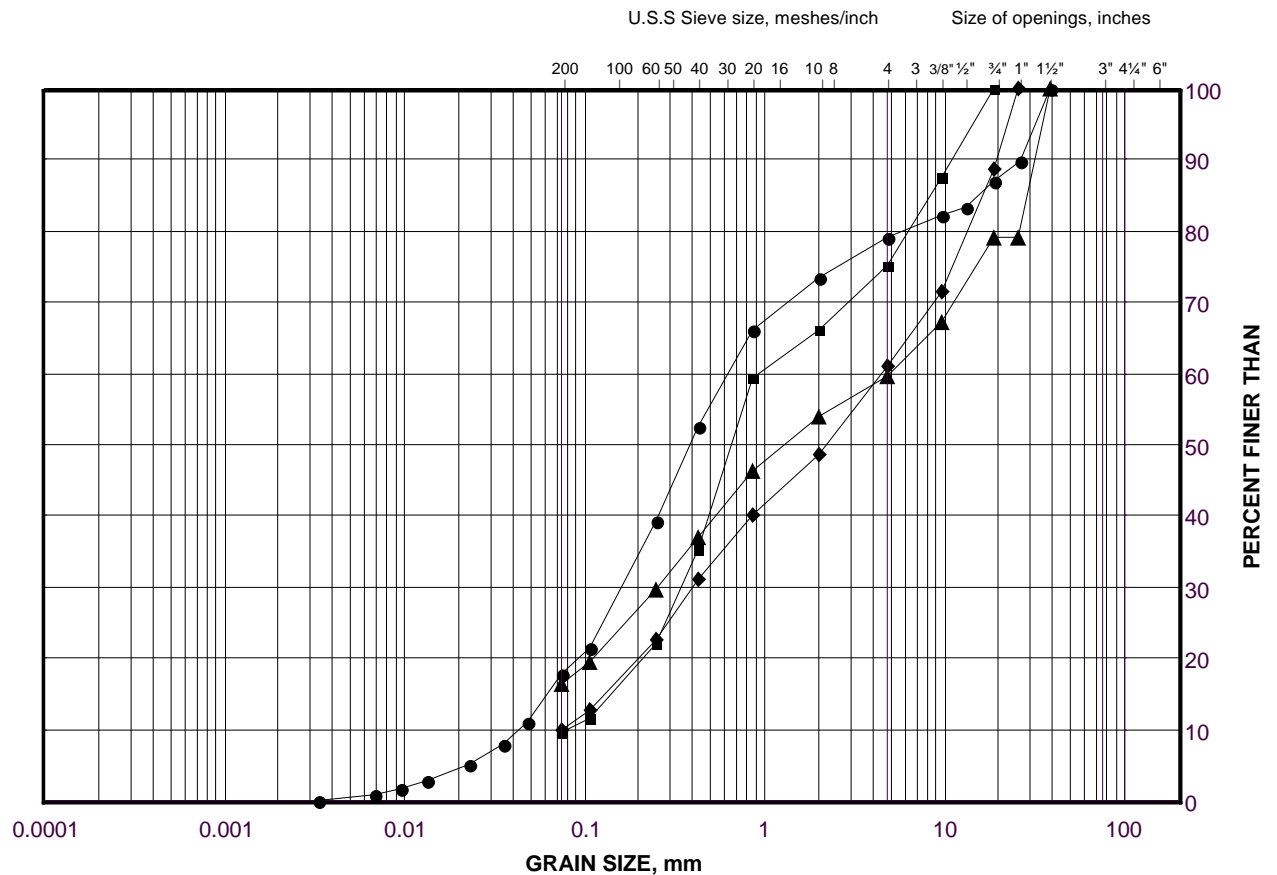
Figure No. D4

Project No. 1521770

Checked By: MCK

Gravelly Sand to Sand and Gravel

FIGURE D5



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C59-4	4	333.8
■	C59-1	4	334.1
◆	C59-1	5	333.3
▲	C59-4	5	331.1

Project Number: 1521770

Checked By: MCK_____

Golder Associates

Date: 21-Sep-16

Borehole C59-2



Box 1: 10.24 m – 13.82 m

Borehole C59-3



Box 1: 10.52 m – 13.51 m

0 m	0.25 m	0.5 m	0.75 m	1.0 m	1.25 m	1.5 m
0 ft	1 ft	2 ft	3 ft	4 ft	5 ft	

PROJECT					
Highway 519 Culvert Replacements GWP 327-99-00					
TITLE					
Bedrock Core Photographs – Highway 519 Boreholes C59-2 and C59-3					
PROJECT No. 1521770			FILE No. ----		
DESIGN	MK	SEP 16	SCALE	NTS	REV.
CADD	--		FIGURE D6		
CHECK	CN	SEP 16			
REVIEW	JMAC	SEP 16			



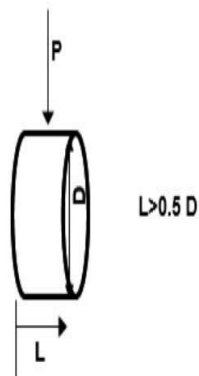
TABLE D1
SUMMARY OF POINT LOAD TESTS ON ROCK SAMPLES

PROJECT NO. 1521770						
DATE September 2016						
Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)
C59-3	1	11.0	330.2	Diorite	Axial	11.3
C59-3	1	11.0	330.2	Diorite	Diametral	5.1
<p>(1) $I_{s50} \times C$ (actual value will have to be confirmed by UCS testing), from ISRM ("Suggested Methods for Determining Point Load Strength", International Society for Rock Mechanics Commission on Testing Methods, Int. J. Rock. Mech. Min. Sci. and Geomechanical Abstr., Vol 22, No. 2 1985, pp. 51-60.</p> <p>(2) Actual distance between point load cones at time of failure.</p>						

DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

note: Diametral tests are perpendicular to core axis

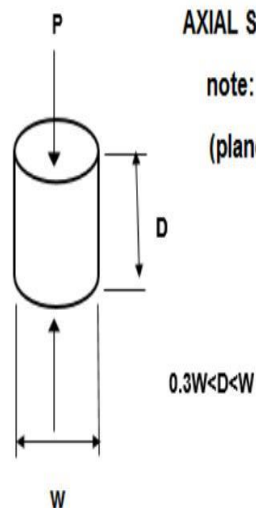
(planes of weakness)



AXIAL SPECIMEN SHAPE REQUIREMENTS

note: Axial tests are parallel to core axis

(planes of weakness)





APPENDIX E

Analytical Test Results

Your Project #: 1521770
Your C.O.C. #: 568328-01-01

Attention:Chris Ng

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

Report Date: 2016/07/20
Report #: R4073825
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B6E9276

Received: 2016/07/18, 17:15

Sample Matrix: Water
Samples Received: 5

Analyses	Date		Date Analyzed	Laboratory Method	Reference
	Quantity	Extracted			
Chloride by Automated Colourimetry	5	N/A	2016/07/20	CAM SOP-00463	EPA 325.2 m
Conductivity	5	N/A	2016/07/19	CAM SOP-00414	SM 22 2510 m
pH	5	N/A	2016/07/19	CAM SOP-00413	SM 4500H+ B m
Resistivity of Water	5	2016/07/18	2016/07/20	CAM SOP-00414	SM 22 2510 m
Sulphate by Automated Colourimetry	5	N/A	2016/07/20	CAM SOP-00464	EPA 375.4 m

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

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

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

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ema Gitej, Senior Project Manager

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 WATER

Maxxam ID		CSN276	CSN277		CSN278	CSN278		CSN279			
Sampling Date		2016/07/17 10:30	2016/07/17 10:20		2016/07/17 08:20	2016/07/17 08:20		2016/07/17 09:00			
COC Number		568328-01-01	568328-01-01		568328-01-01	568328-01-01		568328-01-01			
	UNITS	C22	C29	RDL	C41	C41 Lab-Dup	RDL	C59	RDL	QC Batch	MDL

Calculated Parameters											
Resistivity	ohm-cm	19000	18000		820			11000		4583855	
Inorganics											
Conductivity	umho/cm	53	56	1.0	1200		1.0	88	1.0	4584773	0.20
pH	pH	6.97	7.31		7.07			7.32		4584771	
Dissolved Sulphate (SO ₄)	mg/L	<1.0	<1.0	1.0	4.9	4.7	1.0	<1.0	1.0	4585013	0.10
Dissolved Chloride (Cl)	mg/L	3.8	3.2	1.0	320	320	4.0	<1.0	1.0	4585005	0.30
RDL = Reportable Detection Limit											
QC Batch = Quality Control Batch											
Lab-Dup = Laboratory Initiated Duplicate											

Maxxam ID		CSN280			
Sampling Date		2016/07/17 09:30			
COC Number		568328-01-01			
	UNITS	C60	RDL	QC Batch	MDL
Calculated Parameters					
Resistivity	ohm-cm	12000		4583855	
Inorganics					
Conductivity	umho/cm	82	1.0	4584773	0.20
pH	pH	7.79		4584771	
Dissolved Sulphate (SO ₄)	mg/L	<1.0	1.0	4585013	0.10
Dissolved Chloride (Cl)	mg/L	<1.0	1.0	4585005	0.30
RDL = Reportable Detection Limit					
QC Batch = Quality Control Batch					

TEST SUMMARY

Maxxam ID: CSN276
Sample ID: C22
Matrix: Water

Collected: 2016/07/17
Shipped:
Received: 2016/07/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride by Automated Colourimetry	KONE	4585005	N/A	2016/07/20	Deonarine Ramnarine
Conductivity	AT	4584773	N/A	2016/07/19	Surinder Rai
pH	AT	4584771	N/A	2016/07/19	Surinder Rai
Resistivity of Water		4583855	2016/07/20	2016/07/20	Automated Statchk
Sulphate by Automated Colourimetry	KONE	4585013	N/A	2016/07/20	Deonarine Ramnarine

Maxxam ID: CSN277
Sample ID: C29
Matrix: Water

Collected: 2016/07/17
Shipped:
Received: 2016/07/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride by Automated Colourimetry	KONE	4585005	N/A	2016/07/20	Deonarine Ramnarine
Conductivity	AT	4584773	N/A	2016/07/19	Surinder Rai
pH	AT	4584771	N/A	2016/07/19	Surinder Rai
Resistivity of Water		4583855	2016/07/20	2016/07/20	Automated Statchk
Sulphate by Automated Colourimetry	KONE	4585013	N/A	2016/07/20	Deonarine Ramnarine

Maxxam ID: CSN278
Sample ID: C41
Matrix: Water

Collected: 2016/07/17
Shipped:
Received: 2016/07/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride by Automated Colourimetry	KONE	4585005	N/A	2016/07/20	Deonarine Ramnarine
Conductivity	AT	4584773	N/A	2016/07/19	Surinder Rai
pH	AT	4584771	N/A	2016/07/19	Surinder Rai
Resistivity of Water		4583855	2016/07/20	2016/07/20	Automated Statchk
Sulphate by Automated Colourimetry	KONE	4585013	N/A	2016/07/20	Deonarine Ramnarine

Maxxam ID: CSN278 Dup
Sample ID: C41
Matrix: Water

Collected: 2016/07/17
Shipped:
Received: 2016/07/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride by Automated Colourimetry	KONE	4585005	N/A	2016/07/20	Deonarine Ramnarine
Sulphate by Automated Colourimetry	KONE	4585013	N/A	2016/07/20	Deonarine Ramnarine

Maxxam ID: CSN279
Sample ID: C59
Matrix: Water

Collected: 2016/07/17
Shipped:
Received: 2016/07/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride by Automated Colourimetry	KONE	4585005	N/A	2016/07/20	Deonarine Ramnarine
Conductivity	AT	4584773	N/A	2016/07/19	Surinder Rai
pH	AT	4584771	N/A	2016/07/19	Surinder Rai
Resistivity of Water		4583855	2016/07/20	2016/07/20	Automated Statchk
Sulphate by Automated Colourimetry	KONE	4585013	N/A	2016/07/20	Deonarine Ramnarine

TEST SUMMARY

Maxxam ID: CSN280
Sample ID: C60
Matrix: Water

Collected: 2016/07/17
Shipped:
Received: 2016/07/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride by Automated Colourimetry	KONE	4585005	N/A	2016/07/20	Deonarine Ramnarine
Conductivity	AT	4584773	N/A	2016/07/19	Surinder Rai
pH	AT	4584771	N/A	2016/07/19	Surinder Rai
Resistivity of Water		4583855	2016/07/20	2016/07/20	Automated Statchk
Sulphate by Automated Colourimetry	KONE	4585013	N/A	2016/07/20	Deonarine Ramnarine

GENERAL COMMENTS

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

Package 1	6.0°C
-----------	-------

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1521770
Sampler Initials: MK

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
4584771	pH	2016/07/19			102	98 - 103			0.38	N/A
4584773	Conductivity	2016/07/19			100	85 - 115	<1.0	umho/cm	0.23	25
4585005	Dissolved Chloride (Cl)	2016/07/20	NC	80 - 120	102	80 - 120	<1.0	mg/L	1.2	20
4585013	Dissolved Sulphate (SO4)	2016/07/20	99	75 - 125	99	80 - 120	<1.0	mg/L	NC	20

N/A = Not Applicable

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).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

VALIDATION SIGNATURE PAGE

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



Brad Newman, 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.

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name: #1326 Golder Associates Ltd		Company Name:		Quotation #: B63104		Maxxam Job #:	
Attention: Chris Ng		Attention: Chris Ng		P.O. #: 1521770		Bottle Order #:	
Address: 6925 Century Ave Suite 100		Address:		Project:		COC #:	
Mississauga ON L5N 7K2		Address:		Project Name:		Project Manager:	
Tel: (905) 567-4444 Fax: (905) 567-6561		Tel:		Site #:		Ema Gitej	
Email: chris_ng@golder.com		Email: chris_ng@golder.com		Sampled By: Madison Kennedy		C#568328-01-01	

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)		Other Regulations		Special Instructions		Field Filtered (please circle): Metals / Hg / Cr VI	Corrosivity Package for Water	ANALYSIS REQUESTED (PLEASE BE SPECIFIC)										# of Bottles	Comments
Table 1	Res/Park	Medium/Fine	CCME	Sanitary Sewer Bylaw															
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>														
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>														
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>														
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>														
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>														
Include Criteria on Certificate of Analysis (Y/N)?																			
Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix															
1	C22	16/07/17	10:30 am	Surface Water	N	X									1				
2	C29	2016/07/17	10:20 am	Surface Water	N	X									1				
3	C41	2016/07/17	8:20 am	Surface Water	N	X									1				
4	C59	2016/07/17	9:00 am	Surface Water	N	X									1				
5	C60	2016/07/17	9:30 am	Surface Water	N	X									1				
6																			
7																			
8																			
9																			
10																			

18-Jul-16 17:15
Ema Gitej
B6E9276
SD3 ENV-710

* RELINQUISHED BY: (Signature/Print)		Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)		Date: (YY/MM/DD)	Time	# jars used and not submitted	Laboratory Use Only				
Madison Kennedy		16/07/18	5:12	SHARINE DALE		2016/07/18	17:15		Time Sensitive	Temperature (°C) on Receipt	Custody Seal	Yes	No
										4/7/7	Present		
											Intact		

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

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

White: Maxxam Yellow: Client

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit golder.com

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