January 12, 2017

DETAIL FOUNDATION INVESTIGATION REPORT

MICHIWAKENDA LAKE CULVERT
HIGHWAY 560, TOWNSHIP OF MACMURCHY, DISTRICT OF SUDBURY
MINISTRY OF TRANSPORTATION, ONTARIO
G.W.P 5434-15-00

Submitted to:
MMM Group Limited
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GEOCRES No.: 41P-69

Report Number: 1531057-WO3

Distribution:

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REPORT

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PART A

DETAIL FOUNDATION INVESTIGATION REPORT
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MINISTRY OF TRANSPORTATION, ONTARIO
G.W.P. 5434-15-00,

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by MMM Group Limited (MMM), on behalf of the Ministry of Transportation, Ontario (MTO) to provide detail foundation engineering services for the replacement of the Michiwakenda Lake triple culverts. The Michiwakenda Lake culverts are located in the Township of MacMurchy on Highway 560, with the central culvert located at about STA 12+147, approximately 10 km east of Shining Tree. The key plan showing the general location of this section of Highway 560 and the location of the investigated area are shown on Drawing 1.

2.0 SITE DESCRIPTION

The Michiwakenda Lake triple culverts consist of Corrugated Steel Pipe (CSP) construction, the details of which (i.e., width, height, length, etc.) are summarized in Table 1 following the text of the report.

The highway in the area of the culvert is generally flat and rises both to the north and south of the culvert site. The highway embankment, side slopes or outer zone appear to be constructed of rock fill and the highway surface grade is at about Elevation 364.2 m with no obvious signs of pavement distress over the culvert. The estimated invert of the existing culverts is at Elevations 360.1 m and 359.9 m at the inlet (west) and outlet (east) ends, respectively. Moderate to dense tree cover is present along the highway and lake shore. At the culvert location, the Michiwakenda Lake water levels were surveyed by Golder on September 14, 2016 at Elevation 360.2 m near the upstream end of the culverts and Elevation 359.6 m near the downstream end of the culverts. Select photographs from the site taken in September 2016 are shown on Photographs 1 to 3 following the text of this report.

3.0 INVESTIGATION PROCEDURES

3.1 Borehole Investigation

The borehole drilling program for this subsurface investigation was carried out between September 12 and 15, 2016, during which time two (2) boreholes (Boreholes MC-1 and MC-2) were advanced at approximately the locations shown on Drawing 1. The Boreholes were advanced using a truck-mounted CME-75 drill rig supplied and operated by Landcore Drilling Ltd. of Chelmsford, Ontario.

The boreholes were advanced using a combination of hollow stem augers, NW casing with wash boring techniques and NQ coring. Soil samples were obtained in the boreholes at approximately 0.75 m and 1.5 m intervals of depth, where possible, using 50 mm outer diameter split-spoon samplers driven by an automatic hammer, in accordance with the Standard Penetration Test (SPT) procedures (ASTM D1586). The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 38 mm. Therefore, particles or objects that may exist within the soils that are larger than this dimension will not be sampled or represented in the grain size distributions. The results of the in situ field tests (i.e., SPT ‘N’-values) as presented on the Record of Borehole sheets and in subsequent sections of this report are uncorrected. Samples of the bedrock were obtained using an ‘NQ’ size rock core barrel.

The groundwater level in the open boreholes was observed during the drilling operations as described on the Record of Borehole sheets in Appendix A. The boreholes were backfilled upon completion in accordance with Ontario Regulation 903 (Wells) (as amended).

The field work was supervised on a full-time basis by members of Golder's technical staff who; located the boreholes in the field; arranged for the clearance of underground services; supervised the drilling and sampling operations; logged the boreholes; and examined and cared for the soil and bedrock samples. The soil and bedrock samples were identified in the field, placed in labelled containers and transported to Golder's geotechnical laboratory in Sudbury for further examination and laboratory testing. Index and classification testing consisting of water content determinations and grain size distributions were carried out on selected soil samples. In addition, unconfined compressive strength tests were carried out on selected specimens of the bedrock core recovered from the boreholes. The geotechnical laboratory testing was completed according to MTO LS standards.

Classification of the rock mass quality of the bedrock with respect to the Rock Quality Designation (RQD) is described based on Table 3.10 in the Canadian Foundation Engineering Manual (CFEM, 2006)[1]. The degree of weathering of the bedrock samples and the strength classification of the intact rock mass, based on the field identification and UCS tests, are described in accordance with Table B.3 and Table B.6, respectively, of the International Society for Rock Mechanics (ISRM[2]) standard classification system. The classification of the rock with respect to the uniaxial compressive strength of the bedrock core samples is described based on Table 3.5 of CFEM (2006)[1].

The as-drilled borehole locations and ground surface elevations were measured and surveyed by member of our technical staff, referenced to the highway centerline and existing culvert and converted into Northing/Easting on the plan drawing. The ground surface elevation of the highway centerline was obtained from the profile drawing, provided by MMM. The MTM NAD83 (Zone 12) northing and easting coordinates, ground surface elevations referenced to Geodetic datum and borehole depths at each borehole location are presented on the Record of Borehole sheets in Appendix A and summarized below.

Borehole Number	MTM NAD83 Northing (m) (Latitude°)	MTM NAD83 Easting (m) (Longitude°)	Ground Surface Elevation (m)	Borehole Depth (m)
MC-1	5,274,536.7 (47.60965959)	289,889.4 (-81.19833648)	364.1	9.8
MC-2	5,274,520.6 (47.60951457)	289,880.5 (-81.19845432)	364.5	10.4

3.2 Geophysics Investigation

As part of the subsurface investigation program, a geophysical survey was carried out between August 31 and September 1, 2016. The geophysical survey consisted of an electrical resistivity imaging (ERI) survey to define the bedrock surface along selected survey lines on both sides of the embankment near the culvert ends. The interpreted bedrock surface infills along the geophysical survey lines (on either side of the highway embankment) are presented on Drawing 2 and it should be noted that due to terrain constraints (boulder surface at/near the culvert ends and nearshore lake bottom, and wooded/vegetated shoreline) and shallow depth of water (which made it not possible to navigate the boat) the geophysical survey lines could not be positioned any closer than

[1]Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

[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.

about 24 m and 19 m away from the culvert inlet and outlet ends, respectively, the Geophysical Survey Report is provided in Appendix A.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain (NOEGTS)[3] mapping, the subsoils in the vicinity of the Michiwakenda culvert site generally consist of ground moraine deposits comprised primarily of till. An outwash plain comprised primarily of sand to sandy gravel is located immediately east of the site, and a large bedrock knob (outcrop) is present directly north of the site, both of which are mapped approximately 2 km away. It is also noted that bedrock outcrops are present about 32 m northwest and northeast of the central culvert on the upstream and downstream sides of the culvert ends.

Based on geological mapping by the Ministry of Northern Development and Mines (Map 2543)[4], the site is underlain by bedrocks of the Neo-Archean to Mesoarchean Era, comprised of mafic to intermediate metavolcanic rocks consisting of basaltic and andesitic flows.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are given on the Record of Borehole and Record of Drillhole sheets contained in Appendix B. The results of geotechnical laboratory testing are contained in Appendix C. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic profiles on Drawings 1 and 2 are inferred from non-continuous sampling and the results of the geophysical survey, and therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations and the bedrock surface profile will vary between the geophysical profile lines and the elevations at which it was encountered at the borehole locations.

In summary, the subsoil conditions encountered at the site consist of sand and gravel fill (containing cobbles and inferred to contain boulders) underlain by sand and gravel to gravel which is in turn underlain by metavolcanic bedrock. Large pieces of rip rap (rock fill and/or cobbles/boulders) were observed at the culvert outlet and on the embankment side slopes as shown on Photographs 1 and 3. Further, organic deposits may be present adjacent to the toe of the embankment slopes at/near the culvert ends.

A more detailed description of the soil deposits, bedrock and groundwater conditions encountered in the boreholes is below.

[3] Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 41PNW.

[4] Ministry of Northern Development of Mines. Bedrock Geology of Ontario – East Central Sheet, Ontario Geological Survey – Map 2543.

Subsoil Conditions

Deposit/Layer Description	Boreholes	Deposit Thickness (m)	Deposit Elevation (m)	N Values (blows) / Consistency or Relative Density	Laboratory Testing
(FILL) Asphalt	MC-2	35 mm	364.5	-	-
(FILL) [1,2] Sand and Gravel, brown to grey, moist to wet; cobbles in places	MC-1 and MC-2	3.0 – 4.5	364.1 to 364.5	N = 8 – 67[2,3] **Loose to very dense**	w = 2% – 6% 2 MH (Fig. C1)
Silty Sand and Gravel to Gravel, brown to grey, wet	MC-1 and MC-2	2.6 – 3.6	361.1 – 360.0	N = 22 - 51[4] **Compact to very dense**	w = 3% – 7% 1 MH (Fig. C2)

Where:
N = SPT 'N'-value; number of blows for 0.3 m of penetration
w = Natural Moisture Content (%)
MH = Sieve and Hydrometer analysis

Notes:

[1] A hydrocarbon odour was noted in Borehole MC-1, Samples 1 and 2 within the fill deposit.

[2] Within the fill in Boreholes MC-1 and MC-2, hard/rough augering and bouncing of the split spoon sampler was encountered within the fill. Auger refusal was encountered at depths of 1.8 m and 2.4 m below ground surface in Boreholes MC-1 and MC-2, respectively, requiring NW casing and NQ coring techniques to advance the boreholes through the deposit. A 0.2 m diameter cobble was encountered at 2.6 m depth in Borehole MC-2.

[3] Within the fill in Boreholes MC-1 and MC-2, 'N'-values of 53 blows for 0.08 m of penetration and 20 blows for 0.03 m of penetration were recorded, respectively, inferred to be indicative of the presence of cobbles (or boulder size material) within the fill deposit. Poor recovery was noted in some samples.

[4] Within the sand and gravel deposit in Borehole MC-1, an 'N'-value of 48 blows for 0.10 m of penetration was recorded, inferred to be indicative of the presence of the cobbles or a boulder. Poor recovery and/or gravel blocking the spoon was noted in some samples.

Bedrock

Bedrock was cored in Boreholes MC-1 and MC-2 and two geophysical surveys were completed, near the west (inlet) and east (outlet) ends of the culverts. The depth to the bedrock surface and bedrock surface elevations encountered in the boreholes and the approximate bedrock elevation determined by the geophysical survey at the centerline approximate centerline of the culverts are presented below.

Borehole No.	Depth to Bedrock (below ground surface) (m)	Bedrock Surface Elevation (m)	Core Thickness (m)
MC-1	6.6	357.5	3.2
MC-2	7.1	357.4	3.3
Geophysical Survey Line 1 (West)	-	354.9[1]	-
Geophysical Survey Line 2 (East)	-	352.0[1]	-

Note:

[1] Approximate bedrock surface elevation at approximately the opposite ends of the central culvert of the set of three Michiwakenda Lake Culverts from the Geophysical Survey Report in Appendix A.

The retrieved core is described as grey, fine to medium grained, fresh to moderately weathered, metavolcanic bedrock, as presented on the Record of Drillhole sheets in Appendix B. Photographs of the retrieved bedrock core samples are shown on Figure C3. A summary description of the bedrock properties encountered in the boreholes is provided below.

Borehole No.	Total Core Recovery	Rock Quality Designation	Quality Classification Table 3.10 of CFEM 2006[6]	Uniaxial Compressive Strength (MPa)	Strength Classification Table 3.5 of CFEM 2006[3]
MC-1	91%-100%	21% - 42%	Very poor to poor	94 and 109	Strong to very strong
MC-2	100%	78% - 100%	Good to excellent	61 and 102	Strong to very strong

Groundwater Conditions

Unstabilized groundwater levels measured in the open boreholes upon completion of drilling are summarized below. Groundwater and lake water levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

Borehole No.	Depth to Groundwater Level (m)	Groundwater Elevation (m)
MC-1	Dry[1]	-
MC-2	4.0	360.5

[1] Boreholes MC-1 caved to a depth of about 4.6 m upon completion of drilling and was noted to be dry to the caved depth.

The lake water levels were surveyed by Golder on September 14, 2016 at Elevation 360.2 m on the upstream side of the culverts and Elevation 359.6 m on the downstream side of the culverts.

5.0 CLOSURE

The field drilling program was carried out under the supervision of Mr. Matt Thibeault, under the overall direction of Ms. Sarah Poot, P.Eng. This Detail Foundation Investigation Report was prepared by Mr. Kevin Wallin, E-I-T, and Ms. Sarah E. M. Poot, P.Eng., an Associate of Golder, provided a technical review of the report. Mr. Jorge M.A. Costa P.Eng., the Designated MTO Foundations Contact and Senior Consultant of Golder, conducted an independent quality control review of this report.

Report Signature Page

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KW/SEMP/JMAC/nh

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

CONT No.
GWP No. 5434-15-00

SHEET .

HIGHWAY 560
MICHIWAKENDA LAKE CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates

PLAN
SCALE
2 0 2 4 m

KEY PLAN
10 0 10 20 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)
REC	Recovery
▽	WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
MC-1	364.1	5274536.7	289889.4
MC-2	364.5	5274520.6	289880.5

NOTES

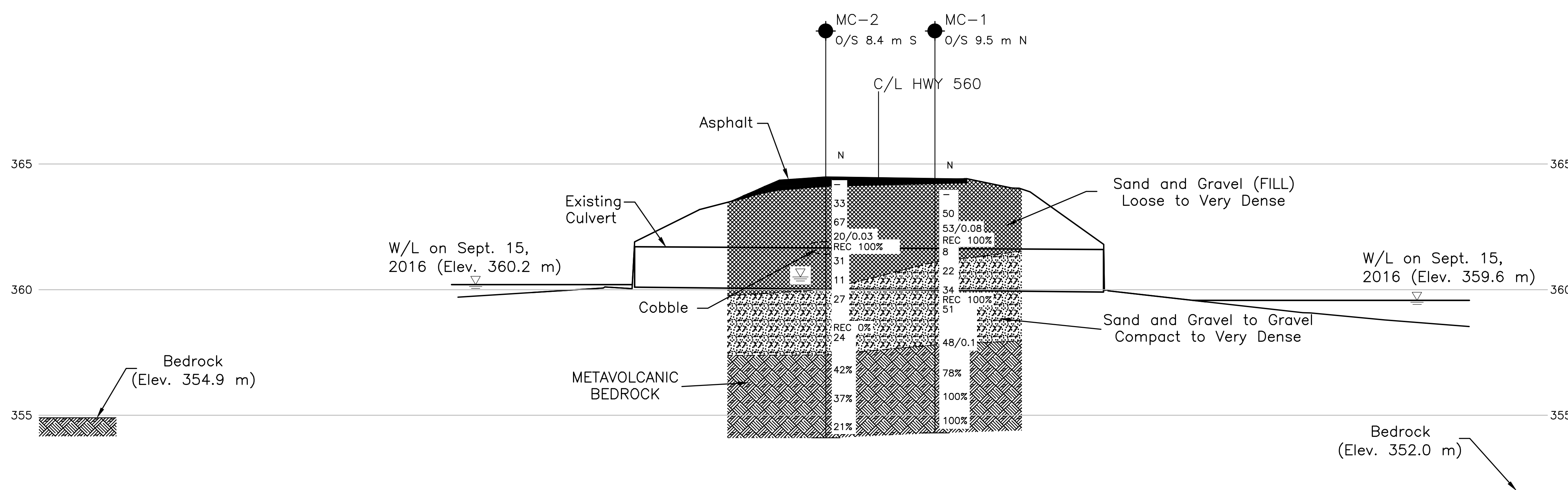
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

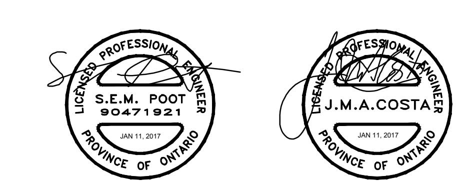
The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS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

REFERENCE

Base plans provided in digital format by MMM, drawing file no. Michiwakenda Lake Culverts.dwg.



A-A' 1 PROFILE
HORIZONTAL SCALE
2 0 2 4 m
2 0 2 4 m
VERTICAL SCALE



NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 41P-69

HWY. 560		PROJECT NO. 1531057	DIST. .
SUBM'D. .	CHKD. .	DATE: 1/11/2017	SITE: .
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. 1

MINISTRY OF TRANSPORTATION, ONTARIO

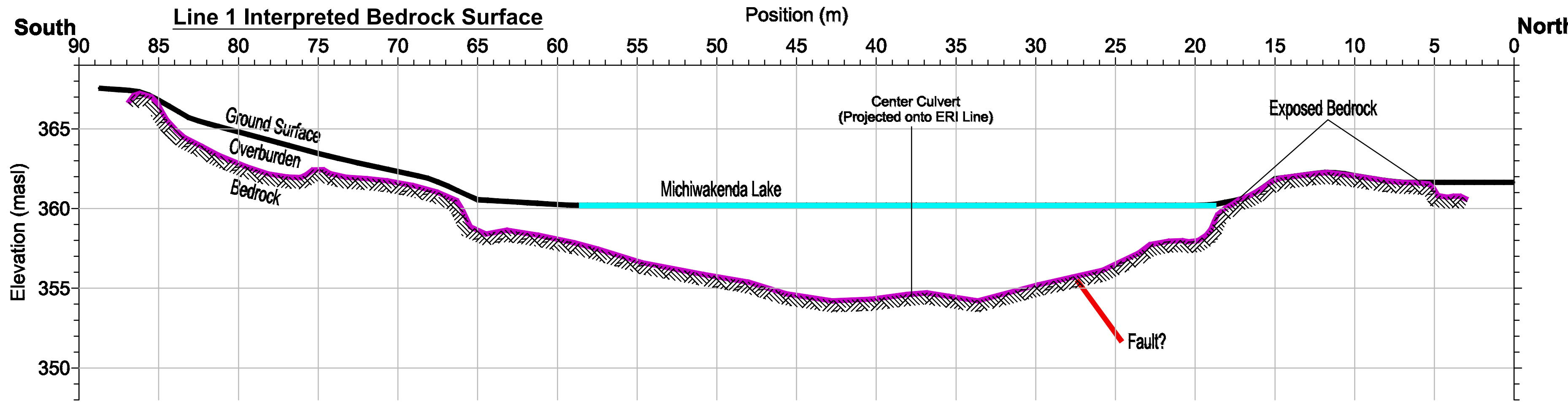
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5434-15-00

HIGHWAY 560
MICHIWAKENDA LAKE CULVERT
BEDROCK PROFILE FROM GEOPHYSICAL ERI SURVEY

SHEET

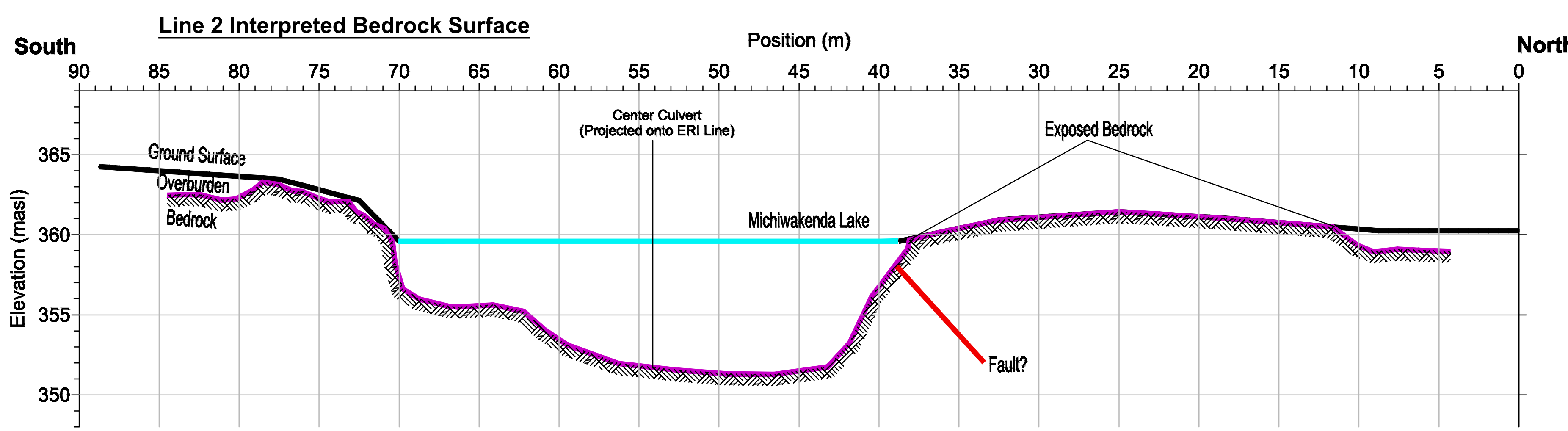
Golder Associates



LEGEND
- Ground Elevation (masl)
- Water Level (360.2 masl)
- Interpreted Bedrock Elevation (masl)

Profile (West Inlet)
ERI Survey Line 1
B-B' 1

HORIZONTAL SCALE 4 0 4 8 m
4 0 4 8 m VERTICAL SCALE



LEGEND
- Ground Elevation (masl)
- Water Level (359.6 masl)
- Interpreted Bedrock Elevation (masl)

Profile (East Outlet)
ERI Survey Line 2
C-C' 1

HORIZONTAL SCALE 4 0 4 8 m
4 0 4 8 m VERTICAL SCALE

Notes:

1. **This Drawing should be read in conjunction with Appendix A of the Foundation Investigation and Design Report for the Michiwakenda Lake Culvert, highway 560, Township of MacMurchy, District of Sudbury, Ministry of Transportation Ontario, G.W.P. 5434-15-00**
2. **The interpreted bedrock surface lines are valid only along the location of the survey lines (See Drawing 1).**

LICENSED PROFESSIONAL ENGINEER S.E.M. POOT 90471921 JAN 11, 2017 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.M.A.COSTA JAN 11, 2017 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 41P-69

HWY. 560		PROJECT NO. 1531057	DIST.
SUBM'D.	CHKD.	DATE: 1/11/2017	SITE:
DRAWN: PG/TB	CHKD. SEMP	APPD. JMAC	DWG. 2

PLOT DATE: January 11, 2017

Photograph 1: Michiwakenda Lake Culverts
West (Inlet) End (Taken by Golder on September 10, 2016)

Photograph 2: Michiwakenda Lake Culverts
Highway 560 Looking North (Taken by Golder on September 10, 2016)

Photograph 3: Michiwakenda Lake Culverts
East (Outlet) End (Taken by Golder on September 10, 2016)

APPENDIX A

Geophysical Survey Report

January 11, 2017

GEOPHYSICAL SURVEY FOR REPLACEMENT OF MICHIWAKENDA LAKE CULVERT ON HIGHWAY 560 G.W.P. 5434-15-00

FINAL REPORT

Submitted to:
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Report Number: 1531057/2000

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Golder Associates

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FIGURES

1.0 INTRODUCTION

This report presents the results of the geophysical survey completed by Golder Associates (Golder) on behalf of MMM, in support of a parallel foundation investigation comprised of borehole drilling, for the replacement of the set of three CSP culverts at Michiwakenda Lake. The field work was carried out at the location of the proposed culvert replacements at Station 12+147 where Highway 560 crosses Michiwakenda Lake in the District of Sudbury, Ontario.

The geophysical survey carried out consisted of an electrical resistivity imaging (ERI) survey to define the bedrock surface along either side of Highway 560. The investigation involved data acquisition both on shore and the lake.

2.0 GEOPHYSICAL METHODOLOGY

The electrical resistivity imaging (ERI) technique measures the electrical resistivity (reciprocal of conductivity) of the subsurface to infer rock/soil types, stratigraphy and soil conditions. The physical principles for this technique are the same as that established for direct-current (DC) resistivity, in which the apparent resistivity of the subsurface is calculated for increasing electrode separations by applying a current to the ground using two electrodes and measuring the potential difference (voltage) between two different electrodes. Apparent resistivity of the subsurface is calculated from the potential to current ratio multiplied by a constant. The constant is a function of the electrode spacing and geometry. The depth of investigation is a function of electrode separation, with larger electrode separations providing information from greater depths at the detriment of decreased resolution.

A schematic showing the electrode configuration and current/potential field for two types of electrode arrangements (Dipole-Dipole and Wenner) is shown below. For the dipole-dipole array, the electrodes are co-linear with a constant or stepped separation between A and B current electrodes and M and N potential electrodes. The distance between the B and M electrodes is the same as or an integer multiple of the A and B or M and N separation.

For the Wenner array, the electrodes are co-linear but with the potential electrodes (M and N) spaced between the current electrodes such that the electrode separations are the same. During a survey, a psuedo-section portraying the variation in apparent resistivity with depth is generated by both: taking measurements with increasing distance between the current and potential electrode pairs; and increasing the distance between the current and potential electrodes.

ERI differs from the traditional DC sounding techniques in that a “spread” of electrodes (typically 56, 72, or more) are positioned along a survey line and connected to a resistivity meter by a cable fitted with multiple take-outs. The resistivity meter is a computer-controlled device consisting of a current supply capable of producing switched +/- constant current and a high impedance voltmeter. A software routine is loaded on to the resistivity meter and the electrodes are switched on and off as required throughout the measurement process. This equipment and procedure allows for automated collection of high-density data along the entire spread. As the line of resistivity coverage is continued, cables from the start of the electrode array are moved (rolled) to the end and measurements are continued.

The result is a pseudo-section of apparent resistivity values versus apparent depth beneath the profile line. These data are then inverted to calculate a 2-dimensional resistivity model for the profile with modelled true depths and resistivity. RES2DINV is a computer program that will automatically determine a two-dimensional resistivity model for the subsurface using the data obtained from ERI surveys. Systems like the Syscal Switch 72 ERI System (IRIS Instruments, France) are used for this work.

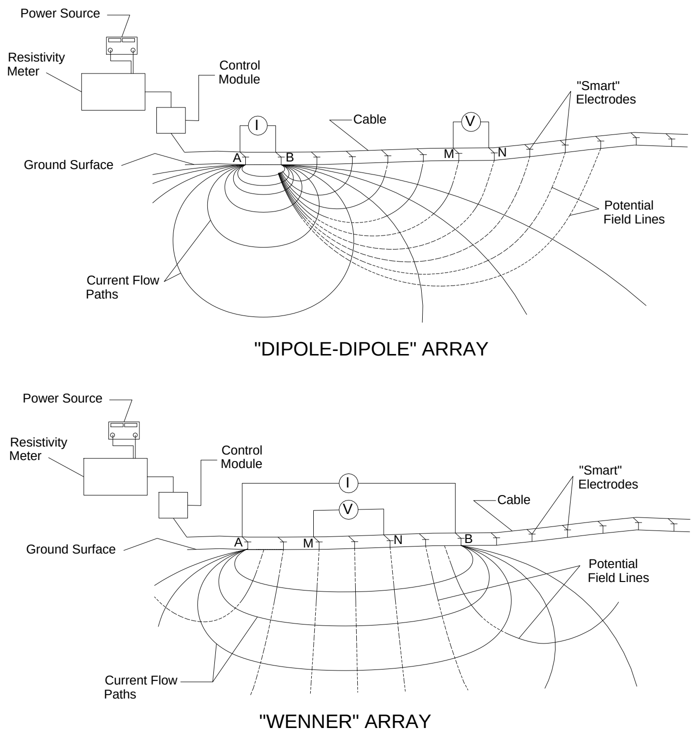

Plate 1: Electrical Resistivity typical survey array configurations.

3.0 FIELD WORK

The geophysical survey was carried out by Golder between August 31 and September 1, 2016 by staff from our Mississauga office. The GPR survey was conducted using an IRIS Syscal ERI Switchbox. Two survey lines were acquired to determine the bedrock profile in the vicinity of the existing culverts crossing underneath Highway 560 as shown on Figure 1. The positioning of the two ERI lines was based on access given the presence of water currents, topography, rocks and vegetation on either side of the embankment. Lines 1 and 2 were aligned sub-parallel on the west (inlet) and east (outlet) sides of Highway 560, respectively. Each line was conducted on both land and in the water with electrode spacings of 1.25 m resulting in line lengths of 88.75 metres. The ERI cable and electrodes were floated on the surface of the water for Line 1 (west side) using a rope and buoys. Given the shallow depth of water and the effort required to float the cable, the cable and electrodes were allowed to sink to the bottom of the lake for Line 2 (east side). Both ERI Lines 1 and 2 were oriented north-south with the start (0 metres) arbitrarily set to the north end. The approximate distances of the projected center culvert to each of the ERI survey lines are also indicated on Figure 1 for reference purposes which were measured on a map correlated relative to identifiable features in the field. The photographs below show the ERI cables for each of the ERI survey lines.

Plate 2: ERI Line 1 (West Side) Looking South

Plate 3: ERI Line 2 (East Side) Looking South

Data quality of the ERI data was assessed in the field at the time of the survey as part of our quality assurance/quality control program. Notes were recorded regarding the location of any rock outcroppings which can be used as bedrock control during interpretation of the ERI data. The position of the two survey lines and other ground surface features were picked up using a Trimble Geo7X GPS system with horizontal accuracy on the order of 0.5 metres.

Surface topography data were acquired using a Suunto Clinometer along each ERI line, including a control point located at the crest of the bedrock outcropping near the north end of Line 1. The elevation of the water surface for each line was obtained from the GPS data to correct all results to display in elevation units as metres above sea level (masl). Note that the vertical survey accuracy of the GPS system at this site was on the order of ±2 metres; hence, the elevation values of the results should be treated as relative, unless a survey elevation with higher accuracy can be provided and tied into the information provided here.

4.0 DATA PROCESSING

The ERI data was processed using the following steps:

1) The GPS data was converted to MTM NAD83, Zone 12N;

2) The topography data were applied to the two ERI survey lines;

3) Resistivity models were generated along each ERI survey line using RES2DINV (Geotomo LLC);

4) The data were gridded using the Surfer Surface Mapping System (Golden Software) using a Kriging algorithm with a 0.25 m grid cell size;

5) The gridded data was colour contoured, and figures prepared for presentation; and,

6) The bedrock reflector interpreted.

The ERI results are presented in profile view on Figures 2 and 3 for Lines 1 to 2, respectively. The ERI data acquired data to a depth of approximately 14 metres below ground surface. Since no borehole data were available regarding the depth of bedrock along the locations of the ERI survey lines collected during this investigation, the ERI data were interpreted using the exposed bedrock outcroppings at the north end of both ERI survey lines.

5.0 RESULTS

Highly resistive values (>5,000 Ohm-m) were computed where bedrock is exposed. These values are in general agreement with published values for electrical resistivity. In the water, the values drop below 200 Ohm-m (as expected), and below the lake and on the south shores the values range between 200 and 5,000 Ohm-m. The contour value of approximately 1,800 Ohm-m (orange to red on the scale) was interpreted as the bedrock surface.

In addition to mapping the bedrock topography, a possible fault line is identified on both ERI Line 1 and 2 as shown in Figures 2 and 3. The fault line is located at the north end of both survey lines and has the same general dip angle which suggests that it is the same feature.

Report Signature Page

We trust that this report meets your requirements at this time. If you have any questions, please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.

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Christopher Phillips, M.Sc.
Senior Geophysicist, P.Geo., Principal

PG/CRP/JMAC/jl

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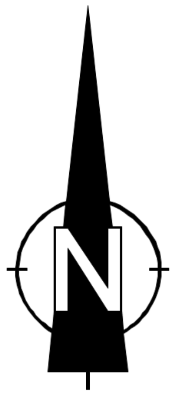
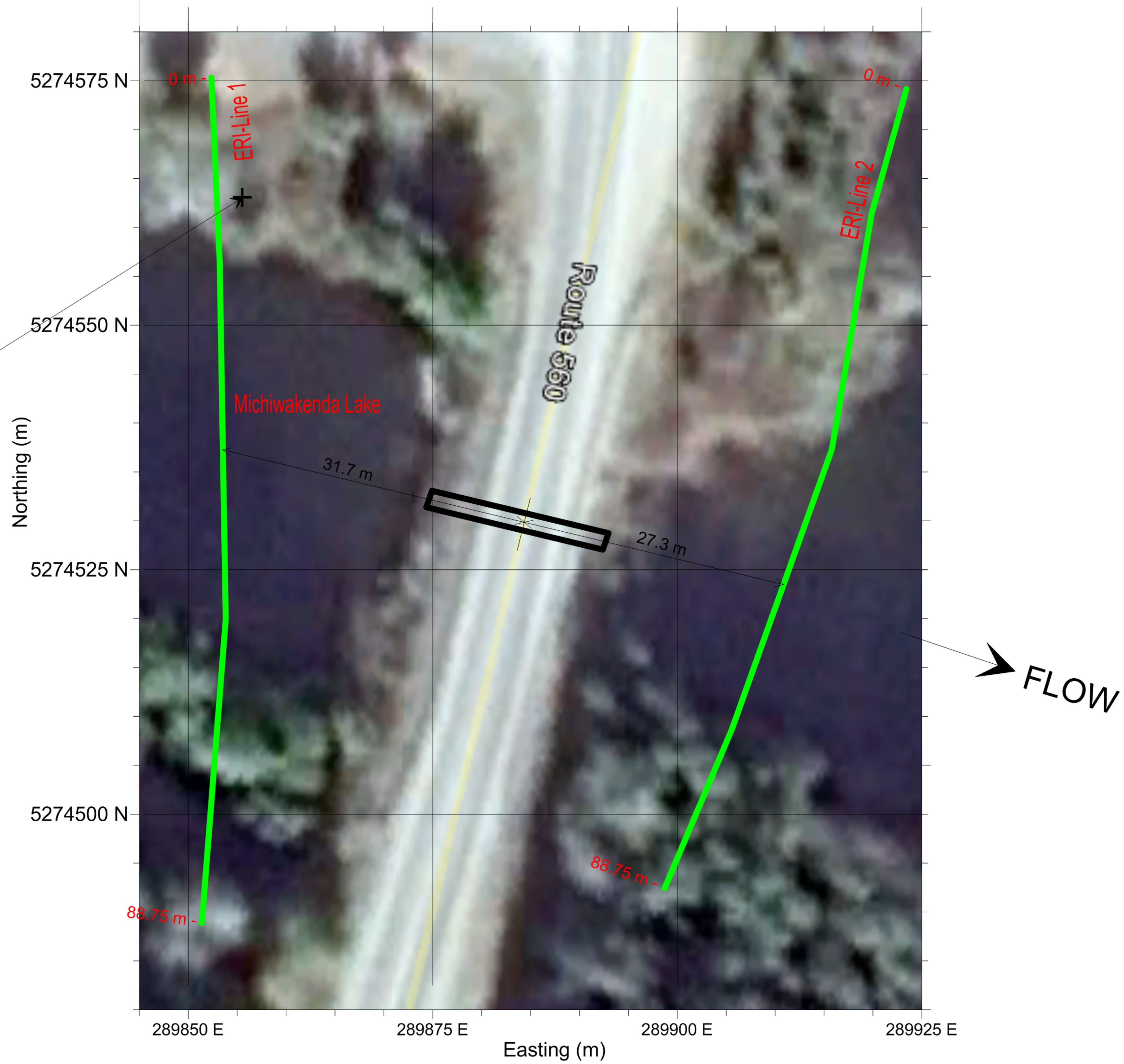
FIGURES



Control Pt - Looking South
(GPS Elevation = 362.5 masl)



Scale: (metres)

0 5 10 15 20 25

LEGEND

- ERI Survey Line
- Control Point
- Center Culvert

NOTES

1. This figure should be read in conjunction with the accompanying report
2. Data acquired with an IRIS Syscal ERI Switch 72
3. GPS coordinates presented in MTM NAD83 Zone 12

CLIENT
MMM

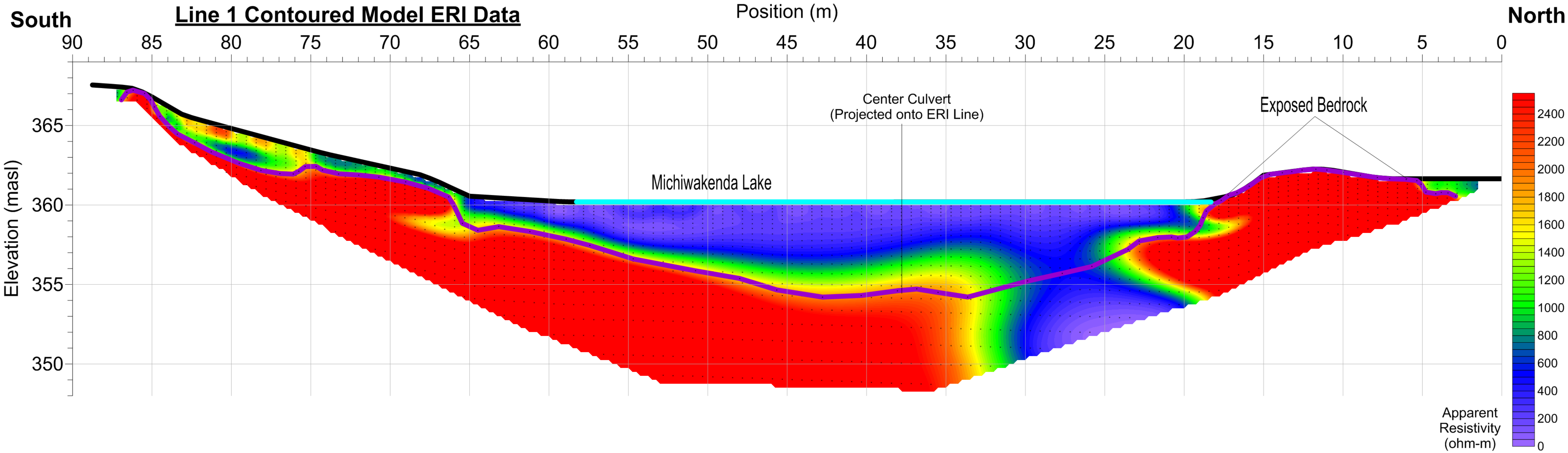
CONSULTANT
Golder Associates

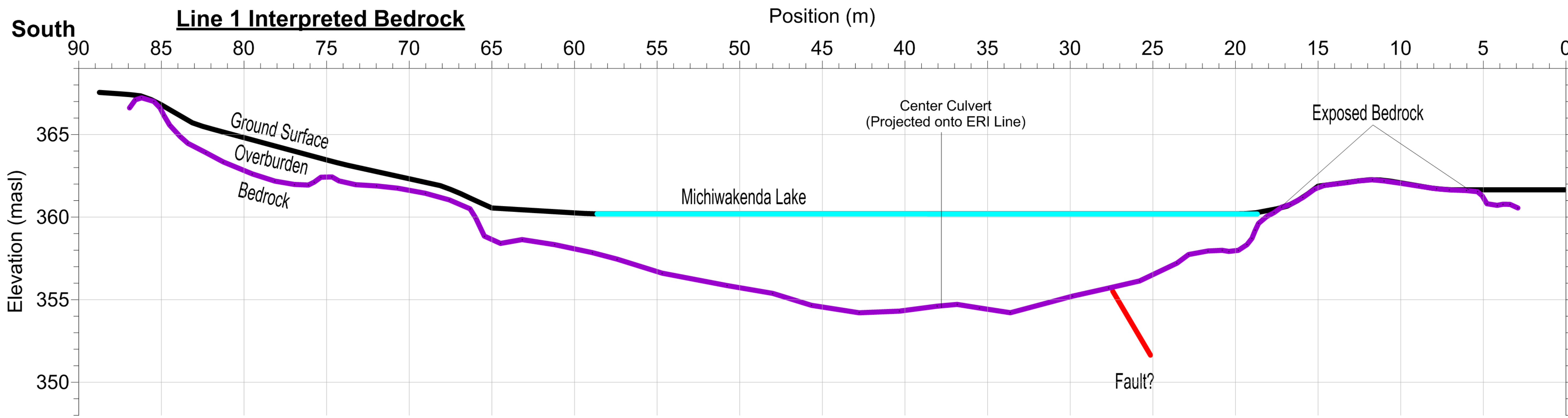
YYYY-MM-DD	2016-09-06
PREPARED	PG
DESIGN	CRP
REVIEW	CRP
APPROVED	CRP

PROJECT
REHABILITATION OF MICHIWAKENDA LAKE CULVERT ON HWY 560

TITLE
SURVEY AREA SHOWING ERI SURVEY LINES

PROJECT No.	PHASE	Rev.	FIGURE
1531057	2000		1





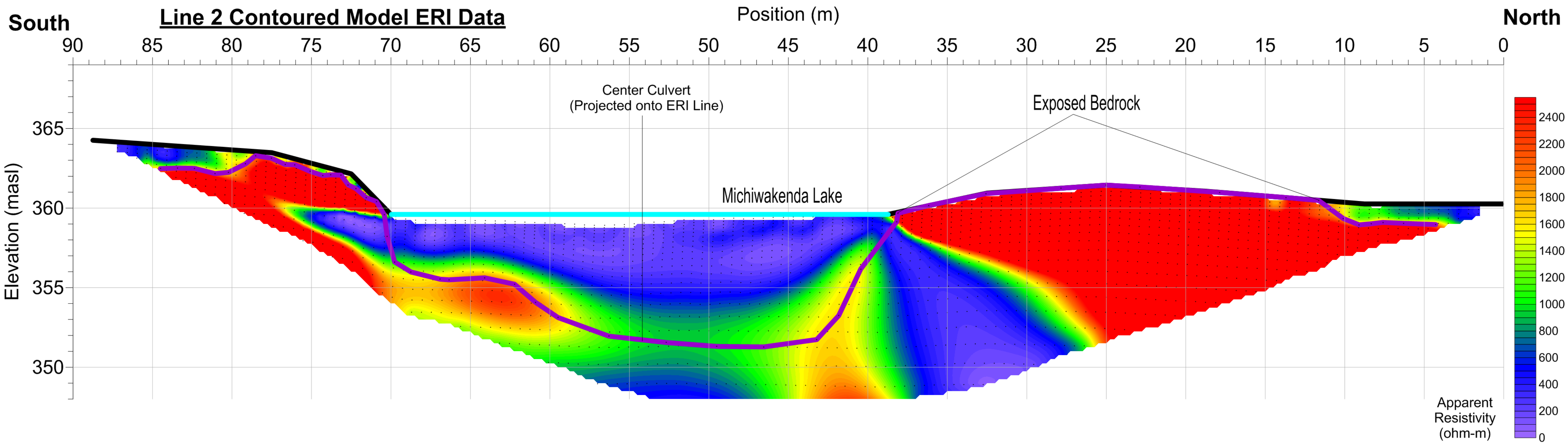
LEGEND

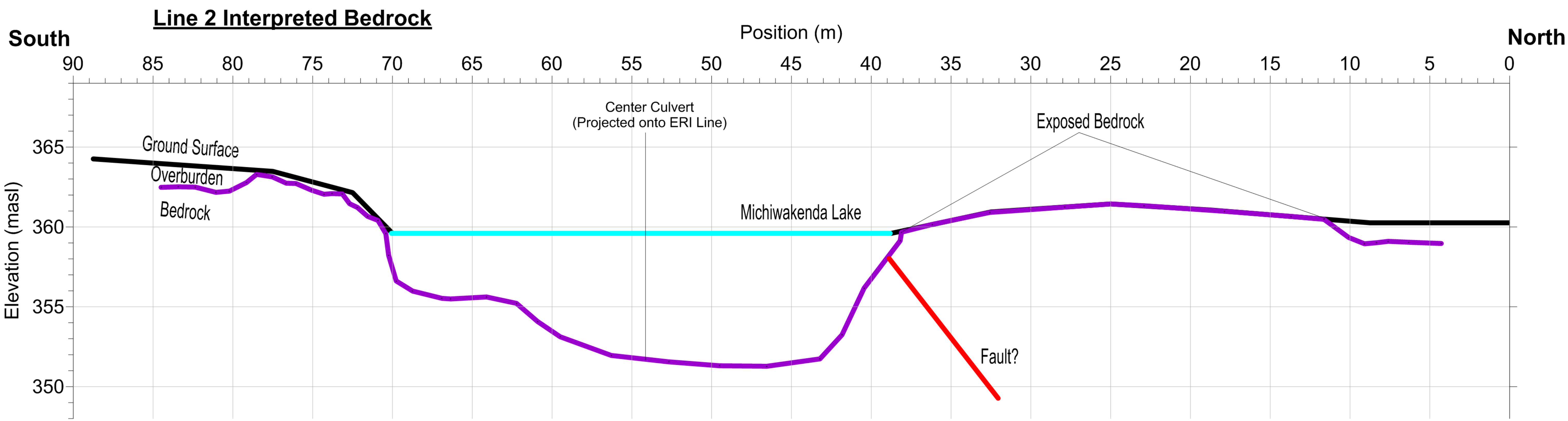
- Ground Elevation (masl)
- Water Level (360.2 masl)
- Interpreted Bedrock Elevation (masl)

NOTES

1. This figure should be read in conjunction with the accompanying report
2. Data acquired with an IRIS Syscal ERI Switch 72
3. GPS coordinates presented in MTM NAD83 Zone 12

CLIENT MMM		PROJECT REHABILITATION OF MICHIWAKENDA LAKE CULVERT ON HWY 560	
CONSULTANT Golder Associates	YYYY-MM-DD: 2016-09-06 PREPARED: PG DESIGN: CRP REVIEW: CRP APPROVED: CRP	TITLE LINE 1 ERI SURVEY RESULTS	
		PROJECT No.: 1531057 PHASE: 2000 Rev.	FIGURE: 2





LEGEND

- Ground Elevation (masl)
- Water Level (359.6 masl)
- Interpreted Bedrock Elevation (masl)

NOTES

1. This figure should be read in conjunction with the accompanying report
2. Data acquired with an IRIS Syscal ERI Switch 72
3. GPS coordinates presented in MTM NAD83 Zone 12

CLIENT
MMM

PROJECT
REHABILITATION OF MICHIWAKENDA LAKE CULVERT ON HWY 560

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-09-06
PREPARED	PG
DESIGN	CRP
REVIEW	CRP
APPROVED	CRP

TITLE
LINE 2 ERI SURVEY RESULTS

PROJECT No.	PHASE	Rev.	FIGURE
1531057	2000		3

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

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APPENDIX B

Record of Boreholes

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Dynamic Cone Penetration Resistance (DCPT); 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, 60º 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 cm^2 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) Cohesionless Soils

Density Index / Relative Density	**N — 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

Percent 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 (cohesionless) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand

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

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
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma$ - u)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_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 δ
c'	effective cohesion
c_u, s_u	undrained shear strength (ϕ = 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. $\tau = c' + \sigma' \tan \phi'$
2. shear strength = (compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery (TCR)
The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)
The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

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

DISCONTINUITY DATA

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

Dip with Respect to Core Axis
The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^o 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		

Golder Associates

RECORD OF BOREHOLE No MC-1

 METRIC

PROJECT 1531057
G.W.P. 5434-15-00
DIST ______ HWY 560
DATUM GEODETIC
LOCATION N 5274536.7; E 289889.4 (LAT. 47.60965959; LONG. -81.19833648)
BOREHOLE TYPE 108 mm I.D Hollow Stem Augers, NW Casing, NQ Coring
DATE September 12, 2016
ORIGINATED BY MT
COMPILED BY MT
CHECKED BY SEMP

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
364.1	GROUND SURFACE				364		
0.0	Sand and gravel , some silt, trace clay (FILL) Loose to very dense Brown Moist to wet	1	AS	-			
	Hydrocarbon odour in Samples 1 and 2.	2	SS	50	363	○	48 38 12 2
	Hard augering between ground surface and 1.8 m depth. Switched to casing/coring.	3	SS	53/0.08		○	
	Cobbles	1	RC	REC 100%	362		
	No recovery in Sample 4.	4	SS	8			
361.1 / 3.0	GRAVEL, trace sand Compact to very dense Brown Wet	5	SS	22	361		
	Piece of gravel blocking spoon in Sample 5.						
	Poor recovery in Samples 5, 6 and 7.	6	SS	34	360		
		2	RC	REC 100%			
		7	SS	51	359	○	
	No recovery in Sample 8.	8	SS	48/0.1	358		
357.5 / 6.6	METAVOLCANIC BEDROCK Bedrock cored from 6.6 m to 9.8 m depth. For coring details see Record of Drillhole MC-1.	1	RC	REC 91%	357		RQD = 42%
		2	RC	REC 100%	356		RQD = 37%
		3	RC	REC 100%	355		RQD = 21%
354.3 / 9.8	BOREHOLE						
	Note: 1. Borehole caved to 4.6 m depth (dry).						

Column headings: SOIL PROFILE (ELEV DEPTH, DESCRIPTION, STRAT PLOT); SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE; DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100; PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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

PROJECT: 1531057

RECORD OF DRILLHOLE: MC-1

LOCATION: N 5274536.7; E 289889.4 (LAT. 47.60965959; LONG. -81.19833648)

DRILLING DATE: September 12, 2016

DRILL RIG: CME 75

DRILLING CONTRACTOR: Landcore

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: ---

JN - Joint, FLT - Fault, SHR - 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, MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	DISCONTINUITY TYPE AND SURFACE DESCRIPTION	NOTES
		REFER TO PREVIOUS PAGE	357.5				
7	CME 75 NQ Coring	METAVOLCANIC BEDROCK Strong to very strong Moderate to slightly weathered Medium to fine grained Grey Highly fractured below 7.3 m depth.	6.6	1	- 0	BR JLPRRO JNIRRO JNIRRO JNIRRO	UCS = 109 MPa UCS = 94.4 MPa
8				2	- 0	BR	
9			354.3	3	- 0		
10		END OF DRILLHOLE Notes: 1. Inferred gravel from overburden fell into core hole between Runs 2 and 3 as casing not fully sealed at top of rock.	9.8				
11							
12							
13							
14							
15							
16							
17							
18							

SUD-RCK (LAT/LONG) 1531057.GPJ GAL-MISS.GDT 12/01/17 DATA INPUT:

DEPTH SCALE

1 : 60

Golder Associates

LOGGED: MT

CHECKED: SEMP

Golder Associates

RECORD OF BOREHOLE No MC-2

 METRIC

PROJECT 1531057

G.W.P. 5434-15-00

LOCATION N 5274520.6; E 289880.5 (LAT. 47.60951457; LONG. -81.19845432)

ORIGINATED BY MT

DIST ____ HWY 560

BOREHOLE TYPE 108 mm I.D Hollow Stem Augers, NW Casing, NQ Coring

COMPILED BY MT

DATUM GEODETIC

DATE September 14, 2016

CHECKED BY SEMP

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
364.5	GROUND SURFACE						
0.0	ASPHALT (35 mm)						
	Sand and gravel, trace to some silt, trace clay (FILL) Compact to very dense Grey Wet	1	AS	-			
		2	SS	33			
		3	SS	67			
	Spoon bouncing at 2.1 m and 2.4 m depth.	4	SS	20/0.03			
	Difficult augering from ground surface to 2.4 m depth, auger refusal, switched to casing/coring.	1	RC	REC 100%			
	200 mm diameter cobble at 2.6 m depth.	5	SS	31		○	54 35 10 1
	No recovery in Sample 6.	6	SS	11	▽		
360.0 / 4.5	Silty SAND and GRAVEL Compact Grey Wet	7	SS	27			
	Poor recovery in Sample 7.	2	RC	REC 0%			
		8	SS	24		○	36 41 20 3
357.4 / 7.1	METAVOLCANIC BEDROCK Bedrock cored from 7.1 m to 10.4 m depth. For coring details see Record of Drillhole MC-2.	1	RC	REC 100%			RQD = 78%
		2	RC	REC 100%			RQD = 100%
354.1		3	RC	REC 100%			RQD = 100%
10.4	BOREHOLE						

Note:

1. Water level at a depth of 4.0 m below ground surface (Elev. 360.5 m) upon completion of drilling.

Elevation scale: 364, 363, 362, 361, 360, 359, 358, 357, 356, 355

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100; PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ kN/m³

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF DRILLHOLE: MC-2

PROJECT: 1531057

SHEET 2 OF 2

LOCATION: N 5274520.6; E 289880.5 (LAT. 47.60951457; LONG. -81.19845432)

DRILLING DATE: September 15, 2016

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Landcore

JN - Joint, FLT - Fault, SHR - 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, MB - Mechanical Break, BR - Broken Rock

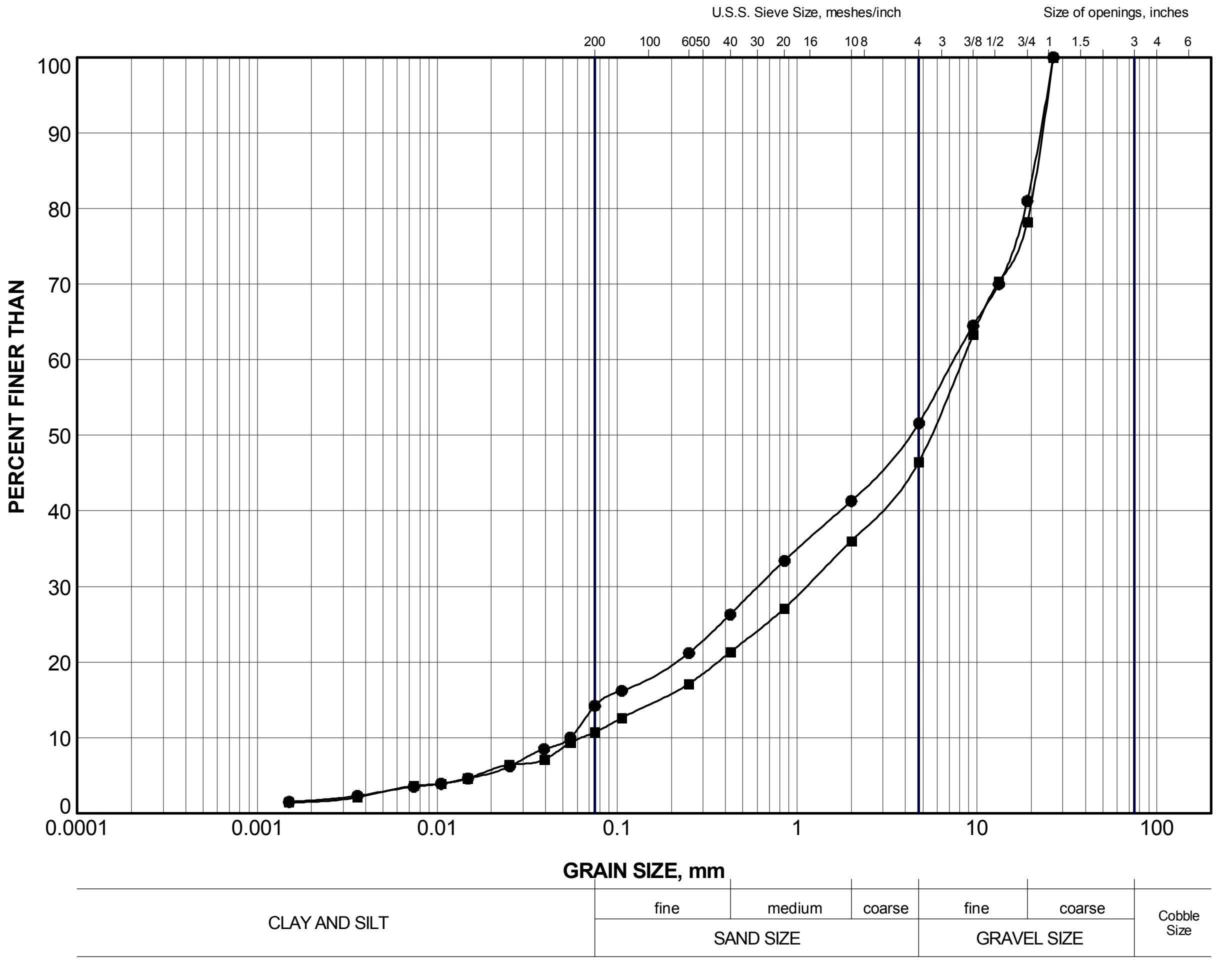
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX METRES	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES
		REFER TO PREVIOUS PAGE		357.4																
	CME 75 NQ Coring NW	METAVOLCANIC BEDROCK Strong to very strong Fresh Fine grained Grey		7.1	1	Grey 100							BR JNIRRO JNIRRO JNIRRO JNIRRO							
8													JNIRRO JNIRRO							
9					2	Grey 100							JNIRRO JNIRRO							UCS = 102 MPa
10				354.1	3	Grey 100							JNIRRO JNIRRO							UCS = 61.4 MPa
		END OF DRILLHOLE		10.4																

Depth scale: 11, 12, 13, 14, 15, 16, 17, 18, 19

APPENDIX C

Laboratory Test Results



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	MC-1	2	363.0
■	MC-2	5	361.2

PROJECT

HIGHWAY 560
MICHIWAKENDA LAKE CULVERT

TITLE

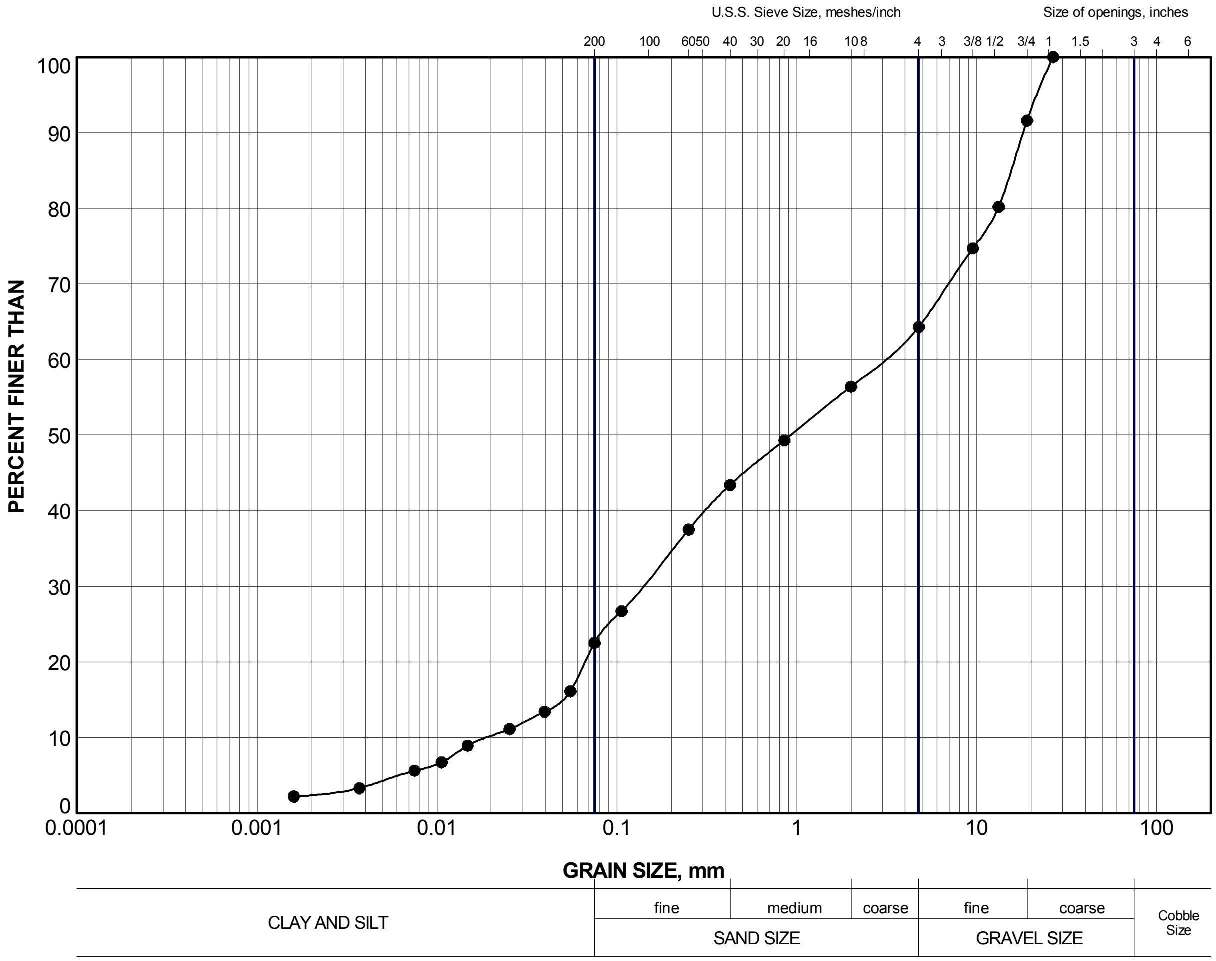
GRAIN SIZE DISTRIBUTION

SAND and GRAVEL (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.		1531057	FILE No.	1531057.GPJ
DRAWN	TB	Oct 2016	SCALE N/A	REV.
CHECK	SEMP	Oct 2016	FIGURE C1	
APPR	JMAC	Oct 2016		

SUD-MTO GSD GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	MC-2	8	358.1

PROJECT

HIGHWAY 560
MICHIWAKENDA LAKE CULVERT

TITLE

GRAIN SIZE DISTRIBUTION

SAND and GRAVEL

Golder Associates
SUDBURY, ONTARIO

PROJECT No.		1531057	FILE No.	1531057.GPJ
DRAWN	TB	Oct 2016	SCALE N/A	REV.
CHECK	SEMP	Oct 2016	FIGURE C2	
APPR	JMAC	Oct 2016		

SUD-MTO GSD GLDR_LDN.GDT

Borehole MC-1

Gravel and Cobbles Within Overburden

Top of Bedrock at 6.6 m Depth

Box 1: 6.6 m – 9.8 m

Borehole MC-2

Boulder Within Overburden

Top of Bedrock at 7.1 m Depth

Box 1: 7.1 m – 10.4 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

Scale

PROJECT

Michiwakenda Culvert
Highway 560
Shining Tree, ON

TITLE

Bedrock Core Photographs
Borehole MC-1 & MC-2

Golder Associates

PROJECT No.	1531057		FILE No.	----
DESIGN	MT	OCT 16	SCALE NTS	REV.
CADD	-- --			
CHECK	SEMP	OCT 16	**FIGURE C3**	
REVIEW	--			

REVISION DATE: October 14, 2016 BY: MT Project: 1531057

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