REPORT

**January 12, 2016**

# FOUNDATION INVESTIGATION REPORT

## CULVERT AT STA 10+405 - CONTRACT 5
## HIGHWAY 69 FOUR-LANING FROM 1.7 KM NORTH OF HIGHWAY 529 NORTHERLY TO 3.9 KM NORTH OF HIGHWAY 522
## MINISTRY OF TRANSPORTATION, ONTARIO
## GWP 5005-10-00

**Submitted to:**
URS Canada Inc.
30 Leek Crescent, 4th Floor
Richmond Hill, Ontario
L4B 4N4

**GEOCRES NO: 41H-157**

**Report Number:** 09-1111-6014-5521

**Distribution:**

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2 Copies – URS Canada Inc., Richmond Hill, Ontario
1 Copy – Golder Associates Ltd., Mississauga, Ontario

Golder Associates

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# PART A

## FOUNDATION INVESTIGATION REPORT

## CULVERT AT STA 10+405 – CONTRACT 5

## HIGHWAY 69 FOUR-LANING FROM 1.7 KM NORTH OF HIGHWAY 529 NORTHERLY TO 3.9 KM NORTH OF HIGHWAY 522

## MINISTRY OF TRANSPORTATION, ONTARIO

## GWP 5005-10-00

**January 12, 2016**
**Report No.** 09-1111-6014-5521

Golder Associates

# 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. (URS) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation investigation services for the proposed Highway 69 culvert at STA 10+405, which is within the Contract 5 limits of the new Highway 69 alignment. The proposed work in Contract 5 is part of the four-laning of Highway 69 from 1.7 km north of Highway 529 northerly to 3.9 km north of Highway 522, for a total distance of 19.7 km, which includes: high fill embankments and embankments over swamps; the Canadian National Railway (CNR) re-alignment; the Bekanon Road and Highway 522 interchanges and structures; the Still River, Straight Lake and Key River structures and the Canadian Pacific Railway and CNR overpass structures. The culvert at STA 10+405 is to be located approximately 550 m east of the existing Highway 69. The general location of this proposed culvert along the new Highway 69 four-laning alignment is shown on the Index Plan on Drawing 1.

The Terms of Reference and the scope of work for the foundation investigation are outlined in MTO's Request for Proposal, dated December 2008. Golder's proposal for foundation engineering services associated with the Contract 5 culvert is contained in Section 6.8 of URS's 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 April 19, 2010.

This report addresses the investigation carried out for the Contract 5 culvert only. Separate reports address the foundation investigations for the related swamp crossings, high fill areas and bridge structures for the project.

The purpose of this investigation is to establish the subsurface conditions at the proposed culvert location, by borehole drilling, in situ testing and laboratory testing on selected soil samples. The highway centreline was located in the field by Callon Dietz Inc. (Callon Dietz), a professional surveying company retained by URS. The investigation area is shown in plan on Drawing 2.

# 2.0 SITE DESCRIPTION

The proposed Highway 69 alignment is oriented generally in a south-north direction spanning the Township of Wallbridge to the south, and the Township of Henvey and the Henvey Inlet First Nation Reserve No. 2 and the Township of Mowat to the north. The Contract 5 section of the new four-lane Highway 69 alignment is also oriented generally in a south-north direction within the overall project limits, for a total distance of 1.6 km in the Henvey Inlet First Nation Reserve No. 2. The proposed culvert at STA 10+405 is located near the northern limit of the Contract 5 highway alignment, just south of Key River and at a location corresponding to approximately 10.1 km north of the junction between the existing Highway 69 and Highway 526.

In general, the topography of this section of the overall project limits consists of rolling terrain, including sparsely or densely populated tree covered areas, and numerous bedrock outcrops separated by valleys and swamps containing areas of standing water and various types of vegetation and organic soils. The proposed culvert is located in a swamp (S503), which has been flooded due to the presence of a beaver dam at the northwest end (outlet) of the swamp. In general, the ground surface slopes down to the north, with higher ground and bedrock outcrops containing a low-lying area vegetated with brush and sparse trees.

## 3.0 INVESTIGATION PROCEDURES

The fieldwork for the subsurface investigation along the proposed culvert alignment was carried out between July 29 and August 7, 2013, during which time a total of six boreholes and eleven dynamic cone penetration tests (DCPT) were advanced at the locations shown on Drawing 2. The Record of Borehole/DCPT sheets and the results of the laboratory testing are presented in Appendix A.

The boreholes were advanced using portable drilling equipment supplied and operated by Landcore Drilling Sudbury, Ontario.

The boreholes were advanced through the water/overburden from a floating platform or ground surface using HQ casing with wash boring techniques. In general, soil samples were obtained at intervals of depth between about 0.75 m and 1.5 m, using a 50 mm outside diameter split-spoon sampler operated by a manual hammer on the drilling equipment, performed in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586). Field vane shear tests were conducted in cohesive soils for determination of undrained shear strengths (ASTM D2573) using an MTO Standard 'N'-size vane. The groundwater conditions were observed during the drilling operations and all boreholes were backfilled upon completion in accordance with Ontario Regulation 903, Wells (as amended).

The field work was observed by members of our 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 and cared for the soil and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, organic content, grain size distribution and Atterberg limits) was carried out on selected soil samples. The plotted results of the laboratory tests of grain sized distribution and Atterberg limits are included in Appendix B.

The as-drilled borehole locations and ground surface elevations were measured and surveyed by members of our technical staff, referenced to the highway centreline staked by Callon Dietz, and converted into northing/easting coordinates on the plan drawing. The ground surface elevations at the borehole locations were obtained relative to the elevation markings on the alignment stakes. The locations given on the Record of Borehole/Drillhole sheets and shown on Drawing 2 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, ground surface elevations and drilled depths are summarized below.

| Borehole Number | MTM NAD83 Northing (m) | MTM NAD83 Easting (m) | Water/Ground Surface Elevation (Bottom Elevation) (m) | Borehole/DCPT Depth (Depth from Bottom of Water) (m) |
|---|---|---|---|---|
| C501-01 | 5084002.9 | 222566.9 | 183.1 | 2.5 |
| C501-02 | 5083985.9 | 222610.0 | 183.7 | 2.0 |
| C501-03 | 5083970.7 | 222609.7 | 185.2* (184.1) | 2.0 (0.9) |
| C501-04 | 5083935.0 | 222652.6 | 185.8* (184.9) | 5.5 (4.6) |
| C501-05 | 5083918.0 | 222673.9 | 185.8* (185.0) | 5.0 (4.2) |

| Borehole Number | MTM NAD83 Northing (m) | MTM NAD83 Easting (m) | Water/Ground Surface Elevation (Bottom Elevation) (m) | Borehole/DCPT Depth (Depth from Bottom of Water) (m) |
|---|---|---|---|---|
| C501-06 | 5083901.0 | 222695.4 | 185.8* (185.0) | 12.5 (11.7) |
| C501-DC01 | 5083916.5 | 222675.4 | 185.8* (~184.9) | 4.8 (~3.9) |
| C501-DC02 | 5083919.4 | 222672.5 | 185.8* (~184.9) | 4.7 (~3.8) |
| C501-DC03 | 5083933.6 | 222654.0 | 185.8* (~184.9) | 5.6 (~4.7) |
| C501-DC04 | 5083936.3 | 222651.1 | 185.8* (~184.9) | 5.1 (~4.2) |
| C501-DC05A | 5084003.6 | 222566.2 | 183.1 | 2.7 |
| C501-DC05B | 5084002.2 | 222567.6 | 183.1 | 2.6 |
| C501-DC06A | 5083986.6 | 222587.6 | 183.7 | 2.1 |
| C501-DC06B | 5083985.2 | 222589.0 | 183.7 | 2.0 |
| C501-DC07A | 5083969.6 | 222609.0 | 185.2* | 2.1 |
| C501-DC07B | 5083968.2 | 222610.4 | 185.2* | 2.0 |
| C501-DC07C | 5083970.3 | 222611.1 | 185.2* | 1.5 |

*Water surface; Borehole Depth includes water column.

# 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

## 4.1 Regional Geology

As delineated in The Physiography of Southern Ontario[1], this section of the new Highway 69 lies within the physiographic region known as the Georgian Bay Fringe, which extends along the east side of Georgian Bay through the Parry Sound and Muskoka areas, then eastward from Muskoka in patches into the area north of the Kawartha Lakes.

This part of the Georgian Bay Fringe physiographic region was never submerged during periods of glacial recession. As a result, the surficial soils in this area consist of very shallow deposits of sand, silt and clay underlain by metamorphic bedrock and numerous bare knobs and ridges of bedrock are present throughout the area. Localized low-lying swampy areas, containing peat and/or organic soils overlying soft/loose native soils, sometimes to significant depth, are present in valleys between the bedrock knobs and ridges.

The bedrock in the area consists typically of crystalline gneisses of the Britt Domain of the Central Gneiss Belt, a subdivision of the Grenville Structural Province, as described in Geology of Ontario, OGS Special Volume 4[2]. Deposition of Paleozoic strata initially covered the bedrock and later erosion during glaciation exposed these Precambrian rocks.

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

[2] Geology of Ontario, 1991. Ontario Geological Society Special Volume 4, Part 2. Ministry of Northern Development and Mines, Ontario.

## 4.2 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 samples, are presented on the Record of Borehole sheets and on the laboratory test figures provided in Appendix A and Appendix B, respectively. The results of the in situ test (i.e., SPT 'N'-values and undrained shear strengths from field vanes) as presented on the Record of Borehole sheets, on the stratigraphic profiles and in Section 4 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets and on the stratigraphic profile are inferred from non-continuous sampling, observations of drilling progress and the results of SPTs and in situ testing. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Furthermore, subsurface conditions will vary between and beyond the borehole locations. It should be noted that the interpreted stratigraphy shown on Drawing 3 is a simplification of the subsurface conditions.

A detailed description of the subsurface conditions encountered in the boreholes at the culvert is provided in the following sections. The groundwater and pond water levels are subject to seasonal fluctuations and precipitation events, and should be expected to be higher during wet periods of the year.

### 4.2.1 Water

The standing water surface at the time of drilling Boreholes C501-03 to C501-06 and during DCPTs C501-DC01 to C501-DC04, C501-DC7A to C501-DC7C was at Elevations 185.8 m and 185.2 m, as applicable at the specific borehole/DCPT, and the depth of water at the boreholes ranged from 0.8 m to 1.1 m.

### 4.2.2 Topsoil/Peat

A 0.2 m and 0.3 m thick deposit of dark brown to brown topsoil was encountered in Boreholes C501-01 and C501-02 at Elevations 183.1 m and 183.7 m, respectively. In Boreholes C501-03 to C501-06, a 0.3 m to 1.4 m thick deposit of peat was encountered at the bottom of the ponded water between Elevations 185.0 m and 184.1 m.

The SPT 'N'-values measured within the peat range from 0 blows (i.e., weight of hammer) to 2 blows per 0.3 m of penetration, suggesting that the peat deposit has a very soft consistency.

The natural water content measured on one sample of the topsoil is 41 per cent, and on two samples of the peat deposit is 60 per cent and 383 per cent.

### 4.2.3 Clayey Silt

A 1.2 m thick cohesive deposit of clayey silt was encountered underlying the peat deposit in Borehole C501-04 at Elevation 184.6 m. The cohesive deposit contains trace organics, wood fragments and rootlets.

An SPT 'N'-value of 1 blow per 0.3 m of penetration was measured across the interface with the overlying peat deposit and within the clayey silt deposit, suggesting a very soft consistency.

The natural water content measures on a sample of the clayey silt deposit is about 65 per cent.

An Atterberg limits test on a sample of the cohesive deposit measured a liquid limit of about 32 per cent, a plastic limit of about 19 per cent, and a corresponding plasticity index of about 13 per cent. The test result is plotted on the plasticity chart on Figure B1 and indicates that the material is classified as clayey silt of low plasticity.

### 4.2.4 Organic Silt to Clayey Organic Silt

A 0.6 m to 5.1 m thick deposit of dark brown to dark grey organic silt to clayey organic silt was encountered in Boreholes C501-01 and C501-04 to C501-06 between Elevations 184.7 m to 182.9 m.

The SPT 'N'-values measured within the organic deposit are between 0 blows (i.e., weight of hammer) and 3 blows per 0.3 m of penetration. In situ field vane tests carried out within the organic deposit measured undrained shear strengths ranging between 18 kPa and 23 kPa, and the sensitivity is calculated to range between 3 and 6. The SPT 'N'-values and field vane test results suggest that the organic silt to clayey organic silt deposit has a very soft to soft consistency.

The natural water content measured on samples of the organic deposit ranges from 72 per cent to 207 per cent. The organic content measured on four samples of the deposit is between about 6 per cent and 15 per cent.

Atterberg limits tests were carried out on two samples of the deposit and measured liquid limits of about 80 per cent, plastic limits of about 43 per cent and 61 per cent and plasticity indices of about 19 per cent and 37 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B2 in Appendix B and together with the organic content indicate the material is classified as organic silt to clayey organic silt of high plasticity.

### 4.2.5 Silt and Sand

In Boreholes C501-03 and C501-06 a 0.6 m and 5.2 m thick deposit of grey gravely silt and sand to silt and sand was encountered at Elevations 183.8 m and 178.5 m, respectively.

The SPT 'N'-values measured in the deposit range from 3 blows to 13 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on two samples of the deposit is 12 per cent to 23 per cent.

The results of grain size distribution tests completed on two samples of this deposit are shown on Figure B3 in Appendix B.

### 4.2.6 Sand to Sand and Gravel

In Boreholes C501-01, C501-02, C501-04 and C501-05, a 0.5 m to 2.5 m thick deposit of sand to sand and gravel was encountered between Elevations 183.4 m and 181.3 m.

The SPT 'N'-values measured within the deposit range from 3 blows to 62 blows per 0.3 m of penetration, indicating a very loose to very dense relative density.

The natural water content measured on three samples of the sand portion of the deposit ranges from 17 per cent to 45 per cent and on two samples of the sand and gravel portion of the deposit is 18 per cent and 23 per cent.

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

### 4.2.7 Refusal

Refusal to further casing and/or split-spoon advancement in the boreholes and refusal to further penetration in the DCPTs was encountered at depths between 1.5 m and 12.5 m below ground or water surface, corresponding to between Elevations 183.7 m and 173.3 m.

### 4.2.8 Groundwater Conditions

The water level in Boreholes C501-01 and C501-02 was measured at 0.5 m below ground surface upon completion of drilling, corresponding to Elevations 182.6 m and 183.2 m. The ponded water level in Boreholes C501-03 to C501-06 was measured upon completion of drilling each borehole at Elevation 185.8 m at three borehole locations on July 29 and 30, 2013, and at Elevation 185.2 m at one borehole on August 7, 2013.

## 5.0 CLOSURE

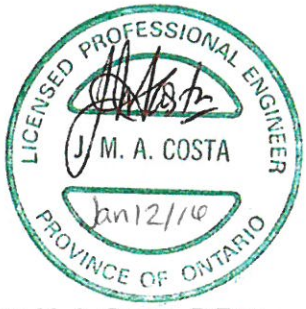
The drilling program was directed by Indulis Dumpis. This report was prepared by Mr. Tibor Berecz, M.Sc. Civil Eng., and reviewed by Mr. André Bom, P.Eng., a senior geotechnical engineer and Associate of Golder. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for this project and Principal of Golder, conducted an independent quality control review of the report.

# Report Signature Page

**GOLDER ASSOCIATES LTD.**

Tibor Berecz, M.Sc. Civil Eng.


André Bom, P.Eng.
Senior Geotechnical Engineer, Associate




Jorge M. A. Costa., P.Eng.
Designated MTO Contact, Principal

TB/AB/JPD/JMAC/kp

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MINISTRY OF TRANSPORTATION, ONTARIO

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STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5005-10-00

HIGHWAY 69

INDEX PLAN

SHEET
.

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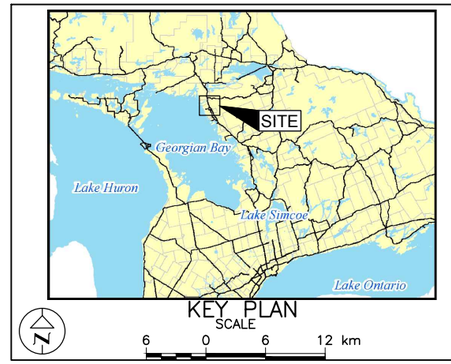


KEY PLAN
SCALE
6 0 6 12 km

E 210000
E 220000
E 230000
N 5090000
N 5080000
N 5070000

C.N.R.
C.P.R.
HENVEY
MOWAT

HIGHWAY 522 INTERCHANGE UNDERPASS
(WP 5151-08-01)

CNR OVERPASS BRIDGE AT HIGHWAY 522
(WP 5152-08-01)

CNR OVERPASS BRIDGE NBL & SBL
(WP 5149-08-01 & WP 5150-08-01)

KEY RIVER

KEY RIVER BRIDGE NBL & SBL
(WP 5147-08-01 & WP 5148-08-01)

CULVERT AT STA. 10+405
(WP 5405-05-01)

STRAIGHT LAKE BRIDGE NBL & SBL
(WP 5145-08-01 & WP 5146-08-01)

CPR OVERPASS NBL & SBL
(WP 5143-08-01 & WP 5144-08-01)

BEKANON ROAD OVERPASS BRIDGE NBL & SBL
(WP 5141-08-01 & WP 5142-08-01)

STILL RIVER BRIDGE NBL & SBL
(WP 5139-08-01 & WP 5140-08-01)

CONTRACT 1
GWP 5344-08-00
WP 5344-08-01

CONTRACT 4
WP 5347-08-01

GWP 5347-08-00

CONTRACT 5
GWP 5005-10-00

CONTRACT 3
WP 5404-05-01

GWP 5404-05-00

CONTRACT 2
WP 5404-05-01

EXISTING HIGHWAY 69

PROPOSED HIGHWAY 69

HIGHWAY 522

HIGHWAY 526

CANADIAN NATIONAL RAILWAY

CANADIAN PACIFIC RAILWAY

HENVEY INLET FIRST NATION

HENVEY INLET

HENVEY

MOWAT

WALLBRIDGE

GEORGIAN BAY

HENVEY TWP

BRITT

MOWAT TWP

WALLBRIDGE TWP

PLAN
SCALE
1 0 1 2 km

REFERENCE
Base Data – MNR NRVIS, obtained 2004, CANMAP v2008
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Datum : NAD 83 Projection : MTM Zone 10

| NO. | DATE | BY | REVISION |
|---|---|---|---|

Geocres No. 41H-157

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| SUBM'D. MCK | CHKD. MCK | DATE: 8/12/2015 | SITE: . |
| DRAWN: JFC | CHKD. AB | APPD. JMAC | DWG. 1 |

PLOT DATE: January 7, 2016
FILENAME: T:\Projects\2009\09-1111-6014 (URS, Hwy 69, Henvey)\~YA~ (Contract 5 Culvert)\09111160149001.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

**METRIC**
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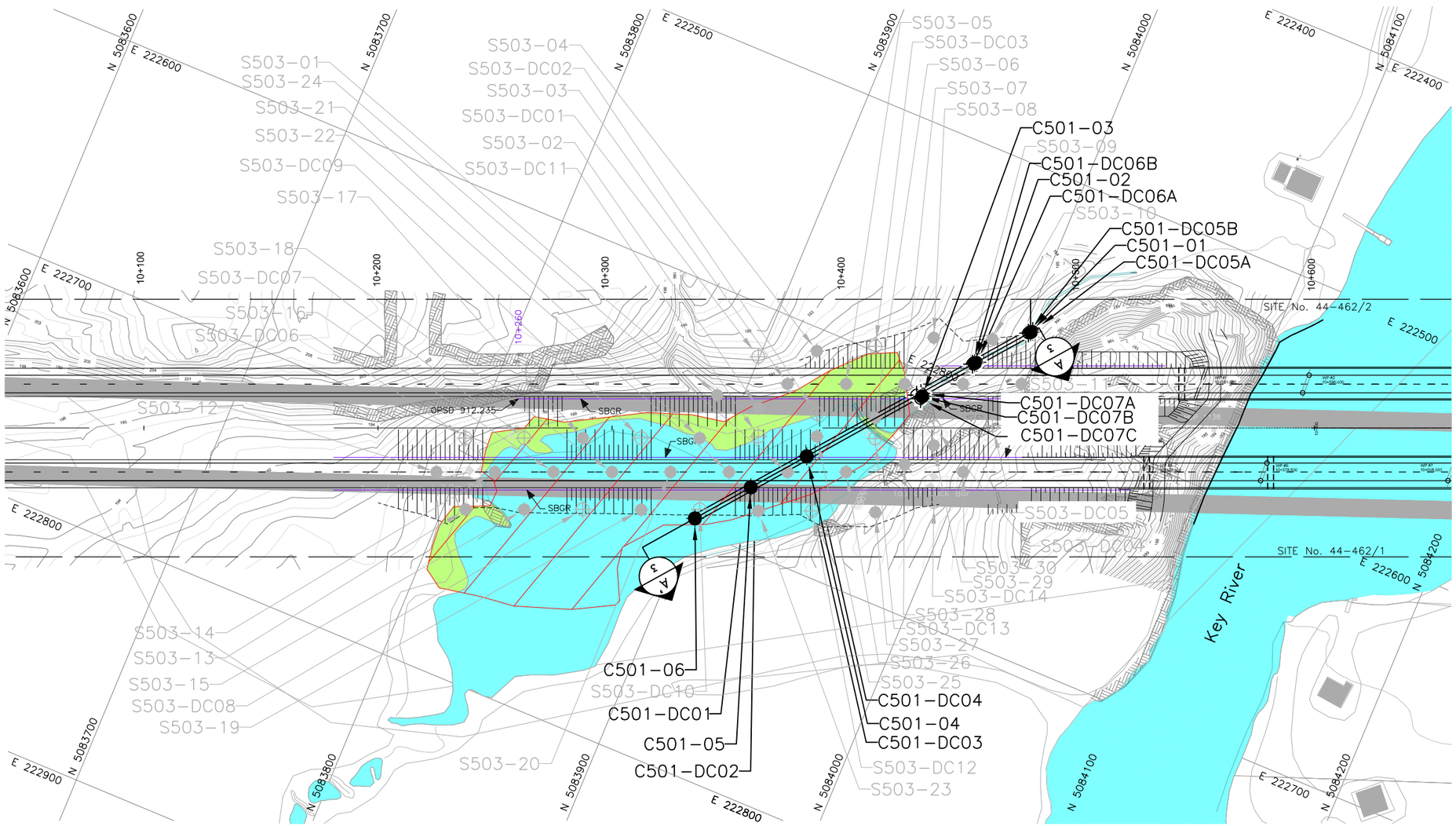
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5005-10-00

HIGHWAY 69
CULVERT AT STA. 10+405
BOREHOLE LOCATIONS

SHEET

Golder Associates




PLAN
SCALE
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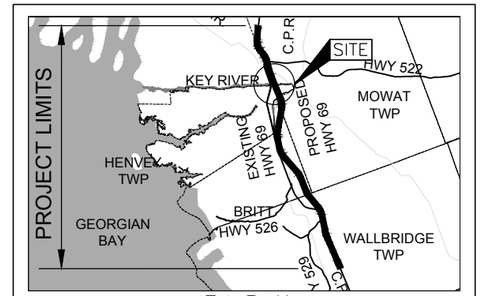



## LEGEND

- Borehole – Current Investigation
- Borehole – Previous Investigation
- Dynamic Cone Penetration Test – Current Investigation
- Dynamic Cone Penetration Test – Previous Investigation

| BOREHOLE CO-ORDINATES | | | |
|---|---|---|---|
| No. | ELEVATION | NORTHING | EASTING |
| C501-01 | 183.1 | 5084002.9 | 222566.9 |
| C501-02 | 183.7 | 5083985.9 | 222588.3 |
| C501-03 | 185.2 | 5083970.7 | 222610.0 |
| C501-04 | 185.8 | 5083935.0 | 222652.6 |
| C501-05 | 185.8 | 5083918.0 | 222673.9 |
| C501-06 | 185.8 | 5083901.0 | 222695.4 |

| BOREHOLE CO-ORDINATES | | | |
|---|---|---|---|
| No. | ELEVATION | NORTHING | EASTING |
| C501-DC01 | 185.8 | 5083916.5 | 222675.4 |
| C501-DC02 | 185.8 | 5083919.4 | 222672.5 |
| C501-DC03 | 185.8 | 5083933.6 | 222654.0 |
| C501-DC04 | 185.8 | 5083936.3 | 222651.1 |
| C501-DC05A | 183.1 | 5084003.6 | 222566.2 |
| C501-DC05B | 183.1 | 5084002.2 | 222567.6 |
| C501-DC06A | 183.7 | 5083986.6 | 222587.6 |
| C501-DC06B | 183.7 | 5083985.2 | 222589.0 |
| C501-DC07A | 185.2 | 5083969.6 | 222609.0 |
| C501-DC07B | 185.2 | 5083968.2 | 222610.4 |
| C501-DC07C | 185.2 | 5083970.3 | 222611.1 |

## 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.

LICENSED PROFESSIONAL ENGINEER
J.J. M. A. COSTA
Jan. 08, 2016
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
A.J.K. BOM
100075715
Jan. 08, 2016
PROVINCE OF ONTARIO

## REFERENCE

Base plans provided in digital format by URS, drawing file nos. Alignment and Contours from Hwy69_Contour-Plan_C3.dwg, received April 23, 2012, Existing Ground Surface cut from contour drawing file. Hwy69_Contour-Plan_C5.dwg received August 31, 2012 and the Existing and Proposed Grade obtained from drawing file Hwy 69_profile March 2012.dwg, recieved March 14, 2012.

Geocres No. 41H-157

| | | | |
|---|---|---|---|
| HWY. 69 | PROJECT NO. 09-1111-6014 | | DIST. . |
| SUBM'D. MCK | CHKD. AB | DATE: 8/12/2015 | SITE: . |
| DRAWN: JFC | CHKD. . | APPD. JMAC | DWG. 2 |

PLOT DATE: January 7, 2016
FILENAME: I:\Projects\2009\09-1111-6014 (URS, Hwy 69, Henvey)\-ra- (Contract 5 Culvert)\091116014002.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

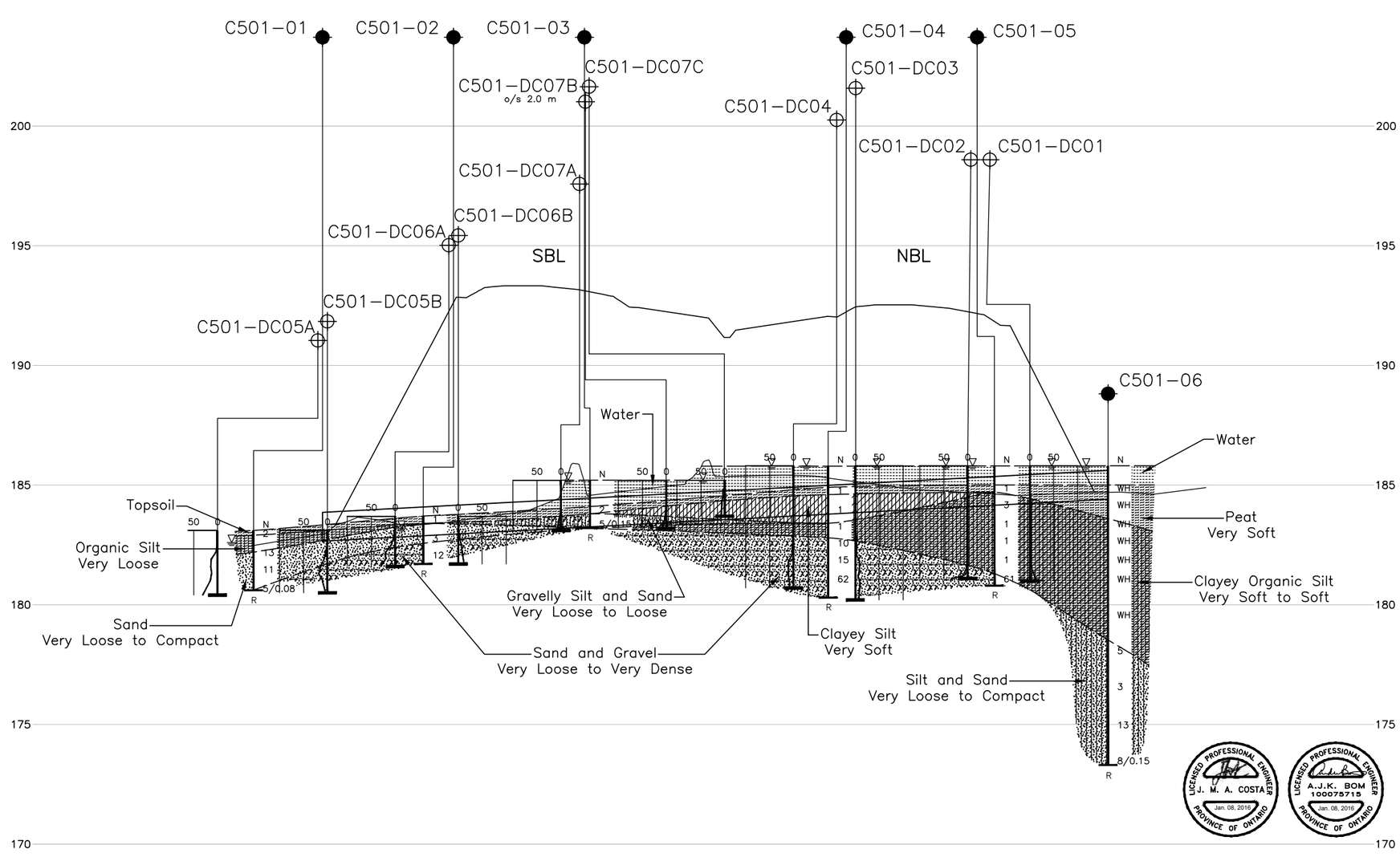
**METRIC**
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

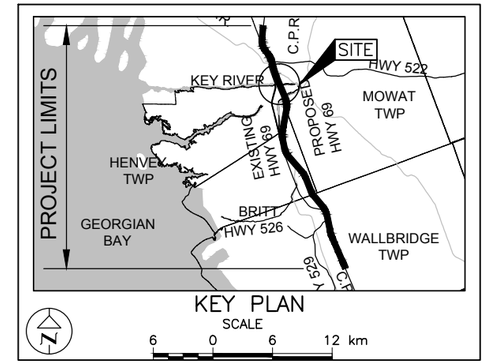
CONT No.
GWP No. 5005-10-00

HIGHWAY 69
CULVERT AT STA. 10+405
SOIL STRATA

SHEET

Golder Associates




## LEGEND

- Borehole – Current Investigation
- Dynamic Cone Penetration Test – 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

| BOREHOLE CO-ORDINATES | | | |
|---|---|---|---|
| No. | ELEVATION | NORTHING | EASTING |
| C501-01 | 183.1 | 5084002.9 | 222566.9 |
| C501-02 | 183.7 | 5083985.9 | 222588.3 |
| C501-03 | 185.2 | 5083970.7 | 222610.0 |
| C501-04 | 185.8 | 5083935.0 | 222652.6 |
| C501-05 | 185.8 | 5083918.0 | 222673.9 |
| C501-06 | 185.8 | 5083901.0 | 222695.4 |

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| C501-DC02 | 185.8 | 5083919.4 | 222672.5 |
| C501-DC03 | 185.8 | 5083933.6 | 222654.0 |
| C501-DC04 | 185.8 | 5083936.3 | 222651.1 |
| C501-DC05A | 183.1 | 5084003.6 | 222566.2 |
| C501-DC05B | 183.1 | 5084002.2 | 222567.6 |
| C501-DC06A | 183.7 | 5083986.6 | 222587.6 |
| C501-DC06B | 183.7 | 5083985.2 | 222589.0 |
| C501-DC07A | 185.2 | 5083969.6 | 222609.0 |
| C501-DC07B | 185.2 | 5083968.2 | 222610.4 |
| C501-DC07C | 185.2 | 5083970.3 | 222611.1 |

A-A' 2 CULVERT PROFILE A-A'

HORIZONTAL SCALE 10 0 10 20 m
VERTICAL SCALE 2 0 2 4 m

LICENSED PROFESSIONAL ENGINEER J. M. A. COSTA Jan. 08, 2016 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER A.J.K. BOM 100075715 Jan. 08, 2016 PROVINCE OF ONTARIO

## 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.

| NO. | DATE | BY | REVISION |
|---|---|---|---|
| . | . | . | . |

Geocres No. 41H-157

| | | | |
|---|---|---|---|
| HWY. 69 | PROJECT NO. 09-1111-6014 | | DIST. , |
| SUBM'D. MCK | CHKD. MCK | DATE: 8/12/2015 | SITE: , |
| DRAWN: JFC | CHKD. AB | APPD. JMAC | DWG. 3 |

PLOT DATE: January 7, 2016
FILENAME: T:\Projects\2009\09-1111-6014 (URS, Hwy 69, Henvey)\~tx~ (Contract 3 Culvert)\09111601419003.dwg

# APPENDIX A

## Record of Boreholes and DCPTs

# LIST OF SYMBOLS

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

## I. GENERAL

| | |
|---|---|
| $\pi$ | 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

| | |
|---|---|
| $\gamma$ | shear strain |
| $\Delta$ | change in, e.g. in stress: $\Delta\sigma$ |
| $\varepsilon$ | linear strain |
| $\varepsilon_v$ | volumetric strain |
| $\eta$ | coefficient of viscosity |
| $\upsilon$ | Poisson's ratio |
| $\sigma$ | total stress |
| $\sigma'$ | effective stress ($\sigma' = \sigma - u$) |
| $\sigma'_{vo}$ | initial effective overburden stress |
| $\sigma_1, \sigma_2, \sigma_3$ | principal stress (major, intermediate, minor) |
| $\sigma_{oct}$ | mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$ |
| $\tau$ | 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 |
| $\gamma'$ | 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 $\rho$. Unit weight symbol is $\gamma$ 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 |
| $C_\alpha$ | 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 |
| $\sigma'_p$ | pre-consolidation stress |
| OCR | over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$ |

### (d) Shear Strength

| | |
|---|---|
| $\tau_p, \tau_r$ | peak and residual shear strength |
| $\phi'$ | effective angle of internal friction |
| $\delta$ | angle of interface friction |
| $\mu$ | 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 $\tau = c' + \sigma' \tan\phi'$

2 shear strength = (compressive strength)/2

# LIST OF ABBREVIATIONS

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

## I. SAMPLE TYPE

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

## II. PENETRATION RESISTANCE

**Standard Penetration Resistance (SPT), N:**

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

**Dynamic Cone Penetration Resistance; $N_d$:**

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 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) Non-Cohesive (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 | $c_u$, $s_u$ 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) |
| $\gamma$ | 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

## 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
FLT Fault
SH Shear
VN Vein
FR Fracture
SY Stylolite
BD Bedding
FO Foliation
CO Contact
AXJ Axial Joint
KV Karstic Void
MB Mechanical Break

PL Planar
CU Curved
UN Undulating
IR Irregular
K Slickensided
PO Polished
SM Smooth
SR Slightly Rough
RO Rough
VR Very Rough

Golder Associates

# RECORD OF BOREHOLE No C501-01

SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-6014 | G.W.P. 5005-10-01 | DIST | HWY 69 | DATUM Geodetic

LOCATION N 5084002.9 ;E 222566.9 | BOREHOLE TYPE Portable Equipment, NQ Casing, Wash Boring | DATE August 6, 2013

ORIGINATED BY ID | COMPILED BY AV | CHECKED BY CN

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES: NUMBER | SAMPLES: TYPE | SAMPLES: "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT w / LIQUID LIMIT $w_L$ — WATER CONTENT (%) (20 40 60) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 183.1 | GROUND SURFACE | | | | | | | | | | |
| 0.0 | TOPSOIL | | 1A | SS | 2 | ▽ | 183 | | | | |
| 0.2 | Dark brown ORGANIC SILT, some sand, roots Very loose | | 1B | | | | | | ○ | OC=6.2% | |
| 182.2 | Dark brown to grey | | 2A | SS | 13 | | 182 | | ○ | | 11 68 18 3 |
| 0.9 | Wet SAND, trace to some silt, trace to some gravel, trace clay Compact Grey Wet | | 2B | | | | | | | | |
| | | | 3 | SS | 11 | | | | ○ | | |
| 180.6 | | | 4 | SS | 5/0.08 | | 181 | | | | |
| 2.5 | END OF BOREHOLE SPLIT-SPOON AND CASING REFUSAL | | | | | | | | | | |

NOTE:

1. Water level in open borehole at a depth of 0.5 m below ground surface (Elev. 182.6 m) upon completion of drilling.

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

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# RECORD OF BOREHOLE No C501-02

SHEET 1 OF 1

**METRIC**

PROJECT 09-1111-6014
G.W.P. 5005-10-01
LOCATION N 5083985.9 ;E 222588.3
ORIGINATED BY ID
DIST HWY 69
BOREHOLE TYPE Portable Equipment, HQ Casing, Wash Boring
COMPILED BY AV
DATUM Geodetic
DATE August 6, 2013
CHECKED BY CN

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES: NUMBER | SAMPLES: TYPE | SAMPLES: "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) (20 40 60) | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 183.7 | GROUND SURFACE | | | | | | | | | | |
| 0.0 / 183.4 | TOPSOIL<br>Dark brown | | 1A<br>1B | SS | 1 | ▽ | | | | | |
| 0.3 | SAND, trace to some gravel, some silt, trace to some clay, trace organics<br>Very loose<br>Grey<br>Wet | | 2A<br>2B | SS | 3 | | 183 | | | | 9 71 13 7 |
| 1.1 / 182.6 | SAND and GRAVEL<br>Very loose to compact<br>Grey<br>Wet | | 3 | SS | 12 | | 182 | | | | |
| 2.0 / 181.7 | END OF BOREHOLE<br>SPLIT-SPOON AND CASING REFUSAL | | | | | | | | | | |

NOTE:

1. Water level in open borehole at a depth of 0.5 m below ground surface (Elev. 183.2 m) upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates

# RECORD OF BOREHOLE No C501-03

SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-6014
G.W.P. 5005-10-01 LOCATION N 5083970.7 ;E 222610.0 ORIGINATED BY ID
DIST HWY 69 BOREHOLE TYPE Portable Equipment, HQ Casing, Wash Boring COMPILED BY AV
DATUM Geodetic DATE August 7, 2013 CHECKED BY CN

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT w / LIQUID LIMIT $w_L$ — WATER CONTENT (%) (20 40 60) | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 185.2 | WATER SURFACE | | | | | ▽ | | | | | |
| 0.0 | WATER | | | | | | 185 | | | | |
| 184.1 | | | | | | | | | | | |
| 183.8 | PEAT (Fibrous) Very soft Dark brown Wet | | 1A | SS | 2 | | 184 | | | | |
| 1.4 | | | 1B | | | | | | | | |
| 183.2 | Gravelly SILT and SAND, trace clay Very loose to loose Grey Wet | | 2 | SS | 5/0.15 | | | | ○ | | 21 33 43 3 |
| 2.0 | END OF BOREHOLE SPLIT-SPOON AND CASING REFUSAL | | | | | | | | | | |

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

Golder Associates

# RECORD OF BOREHOLE No C501-04

SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-6014 | G.W.P. 5005-10-01 | DIST | HWY 69 | DATUM Geodetic

LOCATION N 5083935.0 ;E 222652.6 | BOREHOLE TYPE Portable Equipment, HQ Casing, Wash Boring | DATE July 30, 2013

ORIGINATED BY ID | COMPILED BY MCK/AV | CHECKED BY CN

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES: NUMBER | SAMPLES: TYPE | SAMPLES: "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 185.8 | WATER SURFACE | | | | | ▽ | | | | | |
| 0.0 | WATER | | | | | | | | | | |
| 184.9 | | | | | | | 185 | | | | |
| 184.6 | PEAT (Fibrous) Very soft Dark brown Wet | | 1A 1B | SS | 1 | | | | | | |
| 1.2 | CLAYEY SILT, trace organics, trace wood fragments and rootlets Very soft Dark grey Wet | | 2 | SS | 1 | | 184 | | | | |
| 183.4 | | | | | | | | | | | |
| 2.4 | Clayey ORGANIC SILT Very soft Grey Wet | | 3 | SS | 1 | | 183 | | 111.2 | OC = 8.7% | |
| 182.8 | | | | | | | | | | | |
| 3.0 | SAND and GRAVEL Compact to very dense Grey Wet | | 4 | SS | 10 | | | | | | |
| | | | 5 | SS | 15 | | 182 | | | | |
| | | | 6 | SS | 62 | | 181 | | | | |
| 180.3 | | | | | | | | | | | |
| 5.5 | END OF BOREHOLE SPLIT-SPOON AND CASING REFUSAL | | | | | | | | | | |

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

Golder Associates

# RECORD OF BOREHOLE No C501-05

SHEET 1 OF 1

**METRIC**

PROJECT 09-1111-6014

G.W.P. 5005-10-01 LOCATION N 5083918.0 ;E 222673.9 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, HQ Casing, Wash Boring COMPILED BY AV

DATUM Geodetic DATE July 29 and 30, 2013 CHECKED BY CN

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ / WATER CONTENT (%) | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 185.8 | WATER SURFACE | | | | | ▽ | | | | | |
| 0.0 | WATER | | | | | | | | | | |
| 185.0 | | | | | | | 185 | | | | |
| 184.7 | PEAT (Fibrous) Very soft Brown Wet | | 1A 1B | SS | 1 | | | | | | |
| 1.1 | ORGANIC SILT, trace to some sand, trace wood fragments and roots to a depth of 2.1 m Very soft to soft Dark grey Wet | | 2 | SS | 3 | | 184 | | | | |
| | | | 3 | SS | 1 | | 183 | | 168.4 ○ OC=14.8% | | |
| | | | 4 | SS | 1 | | | + 5 5 | | | |
| | | | 5 | SS | 1 | | 182 | | 149.4 ○ | | |
| 181.3 | | | | | | | | | | | |
| 4.5 | SAND and GRAVEL Very dense Grey Wet | | 6 | SS | 61 | | 181 | | | | |
| 180.8 | | | | | | | | | | | |
| 5.0 | END OF BOREHOLE SPLIT-SPOON REFUSAL | | | | | | | | | | |

NOTE:

1. An additional borehole was advanced South of Borehole C501-05 to carry out in situ field vanes between depths of 2.4 m and 3.9 m below ground surfae (Elev. 182.6 m and 181.1 m) and to obtain Shelby tube samples at depths of 1.3 m and 3.0 m below peat surface (Elev. 183.7 m and 182.0 m).

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

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# RECORD OF BOREHOLE No C501-06

SHEET 1 OF 2

**METRIC**

PROJECT 09-1111-6014

G.W.P. 5005-10-01 LOCATION N 5083901.0 ;E 222695.4 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, HQ Casing, Wash Boring COMPILED BY MCK/AV

DATUM Geodetic DATE July 29, 2013 CHECKED BY CN

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ / WATER CONTENT (%) | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 185.8 | WATER SURFACE | | | | | ▽ | | | | | |
| 0.0 | WATER | | | | | | | | | | |
| 185.0 | | | | | | | 185 | | | | |
| 0.8 | PEAT (Fibrous)<br>Very soft<br>Dark brown<br>Wet | | 1 | SS | WH | | | | | | |
| | | | 2 | SS | WH | | 184 | | 383.2 | | |
| 183.6 | | | | | | | | | | | |
| 2.2 | Clayey ORGANIC SILT<br>Soft<br>Grey<br>Wet | | 3 | SS | WH | | | | 207.3 | | |
| | | | 4 | SS | WH | | 183 | 6 | | | |
| | | | 5 | SS | WH | | 182 | 6 | 169.7 80 | | OC=11.8% |
| | | | 6 | SS | WH | | 181 | | | | |
| | | | | | | | | 4 | | | |
| | | | 7 | SS | WH | | 180 | | | | |
| 178.5 | | | | | | | 179 | 3 | | | |
| 7.3 | SILT and SAND, trace gravel, trace clay<br>Very loose to compact<br>Grey<br>Wet | | 8 | SS | 5 | | 178 | | | | |
| | | | 9 | SS | 3 | | 177 | | ○ | | 0 36 63 1 |
| | | | 10 | SS | 13 | | 176 | | | | |
| 173.3 | | | 11 | SS | 8/0.15 | | 175 | | | | |
| 12.5 | END OF BOREHOLE<br>SPLIT-SPOON AND CASING REFUSAL | | | | | | 174 | | | | |

Continued Next Page

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

Golder Associates

# RECORD OF BOREHOLE No C501-06

SHEET 2 OF 2

**METRIC**

PROJECT 09-1111-6014

G.W.P. 5005-10-01 LOCATION N 5083901.0 ;E 222695.4 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, HQ Casing, Wash Boring COMPILED BY MCK/AV

DATUM Geodetic DATE July 29, 2013 CHECKED BY CN

| SOIL PROFILE | | | SAMPLES | | | 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 (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | GR SA SI CL |
| | *--- CONTINUED FROM PREVIOUS PAGE ---* | | | | | | | | | | |
| | NOTE:<br><br>1.An additional borehole was advanced about 1.5 m South of Borehole C501-06 to carry out in situ field vane at depths of 2.9 m and 3.2 m below ground surface (Elev. 182.1 m and Elev. 181.8 m) and to obtain a Shelby tube sample at a depth of 1.8 m below ground surface (Elev. 183.2 m). | | | | | | | | | | |

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

Golder Associates

# RECORD OF DCPT No C501-DC01

SHEET 1 OF 1

**METRIC**

PROJECT 09-1111-6014
G.W.P. 5005-10-01
LOCATION N 5083916.5 ;E 222675.4
ORIGINATED BY ID
DIST HWY 69
BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test
COMPILED BY AV
DATUM Geodetic
DATE July 30, 2013
CHECKED BY CN

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa | PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%) | UNIT WEIGHT | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 40 60 80 100<br>○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED<br>20 40 60 80 100 | $w_P$ $w$ $w_L$<br>20 40 60 | $\gamma$ kN/m³ | GR SA SI CL |
| 185.8 WATER SURFACE | | | | | | ▽ | | | | | |
| 0.0 | Dynamic Cone Penetration Test (DCPT) | | | | | | 185<br>184<br>183<br>182 | | | | |
| 181.0 | | | | | | | 181 | | | | |
| 4.8 | END OF DCPT<br>Refusal to Further Penetration (30 Blows / 0.0 m)<br><br>NOTE:<br><br>1. Dynamic Cone Penetration Test was advanced through 0.9 m of water. | | | | | | | | | | |

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates

# RECORD OF DCPT No C501-DC02

SHEET 1 OF 1

**METRIC**

PROJECT 09-1111-6014

G.W.P. 5005-10-01 LOCATION N 5083919.4 ;E 222672.5 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY AV

DATUM Geodetic DATE July 30, 2013 CHECKED BY CN

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ / WATER CONTENT (%) | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | GR SA SI CL |
| 185.8 | WATER SURFACE | | | | | ▽ | | | | | |
| 0.0 | Dynamic Cone Penetration Test (DCPT) | | | | | | 185 | | | | |
| | | | | | | | 184 | | | | |
| | | | | | | | 183 | | | | |
| | | | | | | | 182 | | | | |
| 181.1 | | | | | | | | | | | |
| 4.7 | END OF DCPT<br>Refusal to Further Penetration (30 Blows / 0.15 m)<br><br>NOTE:<br><br>1. Dynamic Cone Penetration Test was advanced through 0.9 m of water. | | | | | | | | | | |

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

Golder Associates

# RECORD OF DCPT No C501-DC03

SHEET 1 OF 1

**METRIC**

PROJECT 09-1111-6014
G.W.P. 5005-10-01
LOCATION N 5083933.6 ;E 222654.0
ORIGINATED BY ID
DIST HWY 69
BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test
COMPILED BY AV
DATUM Geodetic
DATE July 31, 2013
CHECKED BY CN

| SOIL PROFILE ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ / WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 185.8 | WATER SURFACE | | | | | ▽ | | | | | |
| 0.0 | Dynamic Cone Penetration Test (DCPT) | | | | | | 185 | | | | |
| | | | | | | | 184 | | | | |
| | | | | | | | 183 | | | | |
| | | | | | | | 182 | | | | |
| | | | | | | | 181 | | | | |
| 180.2 | | | | | | | | | | | |
| 5.6 | END OF DCPT<br>Refusal to Further Penetration (30 Blows / 0.0 m)<br><br>NOTE:<br><br>1. Dynamic Cone Penetration Test was advanced through 0.9 m of water. | | | | | | | | | | |

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/1/15

Golder Associates

# RECORD OF DCPT No C501-DC04

SHEET 1 OF 1

**METRIC**

PROJECT 09-1111-6014

G.W.P. 5005-10-01 LOCATION N 5083936.3 ;E 222651.1 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY AV

DATUM Geodetic DATE July 31, 2013 CHECKED BY CN

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT<br>20 40 60 80 100<br>SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED<br>20 40 60 80 100 | PLASTIC LIMIT $w_P$ NATURAL MOISTURE CONTENT $w$ LIQUID LIMIT $w_L$<br>WATER CONTENT (%)<br>20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | GR SA SI CL |
| 185.8 | WATER SURFACE | | | | | ▽ | | | | | |
| 0.0 | Dynamic Cone Penetration Test (DCPT) | | | | | | 185<br>184<br>183<br>182<br>181 | | | | |
| 180.7 | | | | | | | | | | | |
| 5.1 | END OF DCPT<br>Refusal to Further Penetration<br><br>NOTE:<br><br>1. Dynamic Cone Penetration Test was advanced through 0.9 m of water. | | | | | | | | | | |

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates

# RECORD OF DCPT No C501-DC05A

SHEET 1 OF 1

**METRIC**

PROJECT 09-1111-6014

G.W.P. 5005-10-01 LOCATION N 5084003.6 ;E 222566.2 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY AV

DATUM Geodetic DATE August 6, 2013 CHECKED BY CN

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT<br>20 40 60 80 100<br>SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED<br>20 40 60 80 100 | PLASTIC LIMIT $w_P$ NATURAL MOISTURE CONTENT $w$ LIQUID LIMIT $w_L$<br>WATER CONTENT (%)<br>20 40 60 | UNIT WEIGHT $\gamma$ kN/m$^3$ | REMARKS & GRAIN SIZE DISTRIBUTION (%)<br>GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | |
| 183.1 | GROUND SURFACE | | | | | | | | | | |
| 0.0 | Dynamic Cone Penetration Test (DCPT) | | | | | | 183<br>182<br>181 | | | | |
| 180.4 | | | | | | | | | | | |
| 2.7 | END OF DCPT<br>Refusal to Further Penetration<br>(31 Blows / 0.25 m) | | | | | | | | | | |

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

Golder Associates

# RECORD OF DCPT No C501-DC05B

SHEET 1 OF 1

**METRIC**

PROJECT 09-1111-6014

G.W.P. 5005-10-01 LOCATION N 5084002.2 ;E 222567.6 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY AV

DATUM Geodetic DATE August 6, 2013 CHECKED BY CN

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT<br>20 40 60 80 100<br>SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED<br>20 40 60 80 100 | PLASTIC LIMIT $w_P$ NATURAL MOISTURE CONTENT $w$ LIQUID LIMIT $w_L$<br>WATER CONTENT (%)<br>20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | GR SA SI CL |
| 183.1 | GROUND SURFACE | | | | | | | | | | |
| 0.0 | Dynamic Cone Penetration Test (DCPT) | | | | | | 183<br>182<br>181 | | | | |
| 180.5 | | | | | | | | | | | |
| 2.6 | END OF DCPT<br>Refusal to Further Penetration | | | | | | | | | | |

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

Golder Associates

# RECORD OF DCPT No C501-DC06A

SHEET 1 OF 1

**METRIC**

PROJECT 09-1111-6014

G.W.P. 5005-10-01 LOCATION N 5083986.6 ;E 222587.6 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY AV

DATUM Geodetic DATE August 6, 2013 CHECKED BY CN

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT<br>20 40 60 80 100<br>SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED<br>20 40 60 80 100 | PLASTIC LIMIT $w_P$ NATURAL MOISTURE CONTENT $w$ LIQUID LIMIT $w_L$<br>WATER CONTENT (%)<br>20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%)<br>GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | |
| 183.7 | GROUND SURFACE | | | | | | | | | | |
| 0.0 | Dynamic Cone Penetration Test (DCPT) | | | | | | 183<br>182 | | | | |
| 181.6 | | | | | | | | | | | |
| 2.1 | END OF DCPT<br>Refusal to Further Penetration<br>(30 Blows / 0.0 m) | | | | | | | | | | |

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

Golder Associates

# RECORD OF DCPT No C501-DC06B

SHEET 1 OF 1

**METRIC**

PROJECT 09-1111-6014

G.W.P. 5005-10-01 LOCATION N 5083985.2 ;E 222589.0 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY AV

DATUM Geodetic DATE August 6, 2013 CHECKED BY CN

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT<br>20 40 60 80 100<br>SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED<br>20 40 60 80 100 | PLASTIC LIMIT $w_P$ NATURAL MOISTURE CONTENT $w$ LIQUID LIMIT $w_L$<br>WATER CONTENT (%)<br>20 40 60 | UNIT WEIGHT $\gamma$ kN/m$^3$ | REMARKS & GRAIN SIZE DISTRIBUTION (%)<br>GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | |
| 183.7 | GROUND SURFACE | | | | | | | | | | |
| 0.0 | Dynamic Cone Penetration Test (DCPT) | | | | | | 183<br>182 | | | | |
| 181.7 | | | | | | | | | | | |
| 2.0 | END OF DCPT<br>Refusal to Further Penetration | | | | | | | | | | |

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

Golder Associates

# RECORD OF DCPT No C501-DC07A

SHEET 1 OF 1

**METRIC**

PROJECT 09-1111-6014

G.W.P. 5005-10-01 LOCATION N 5083969.6 ;E 222609.0 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY AV

DATUM Geodetic DATE August 7, 2013 CHECKED BY CN

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) (20 40 60) | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | GR SA SI CL |
| 185.2 | WATER SURFACE | | | | | | | | | | |
| 0.0 | Dynamic Cone Penetration Test (DCPT) | | | | | | 185 | | | | |
| | | | | | | | 184 | | | | |
| 183.1 | | | | | | | | | | | |
| 2.1 | END OF DCPT<br>Refusal to Further Penetration<br><br>1. Dynamic Cone Penetration Test was advanced through 1.0 m of water. | | | | | | | | | | |

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

Golder Associates

# RECORD OF DCPT No C501-DC07B

SHEET 1 OF 1

**METRIC**

PROJECT 09-1111-6014

G.W.P. 5005-10-01 LOCATION N 5083968.2 ;E 222610.4 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY AV

DATUM Geodetic DATE August 7, 2013 CHECKED BY CN

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) (20 40 60) | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | GR SA SI CL |
| 185.2 | WATER SURFACE | | | | | | | | | | |
| 0.0 | Dynamic Cone Penetration Test (DCPT) | | | | | | 185 | | | | |
| | | | | | | | 184 | | | | |
| 183.2 | | | | | | | | | | | |
| 2.0 | END OF DCPT<br>Refusal to Further Penetration<br><br>1. Dynamic Cone Penetration Test was advanced through 1.0 m of water. | | | | | | | | | | |

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

Golder Associates

# RECORD OF DCPT No C501-DC07C SHEET 1 OF 1 METRIC

PROJECT 09-1111-6014
G.W.P. 5005-10-01 LOCATION N 5083970.3 ;E 222611.1 ORIGINATED BY ID
DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY AV
DATUM Geodetic DATE August 7, 2013 CHECKED BY CN

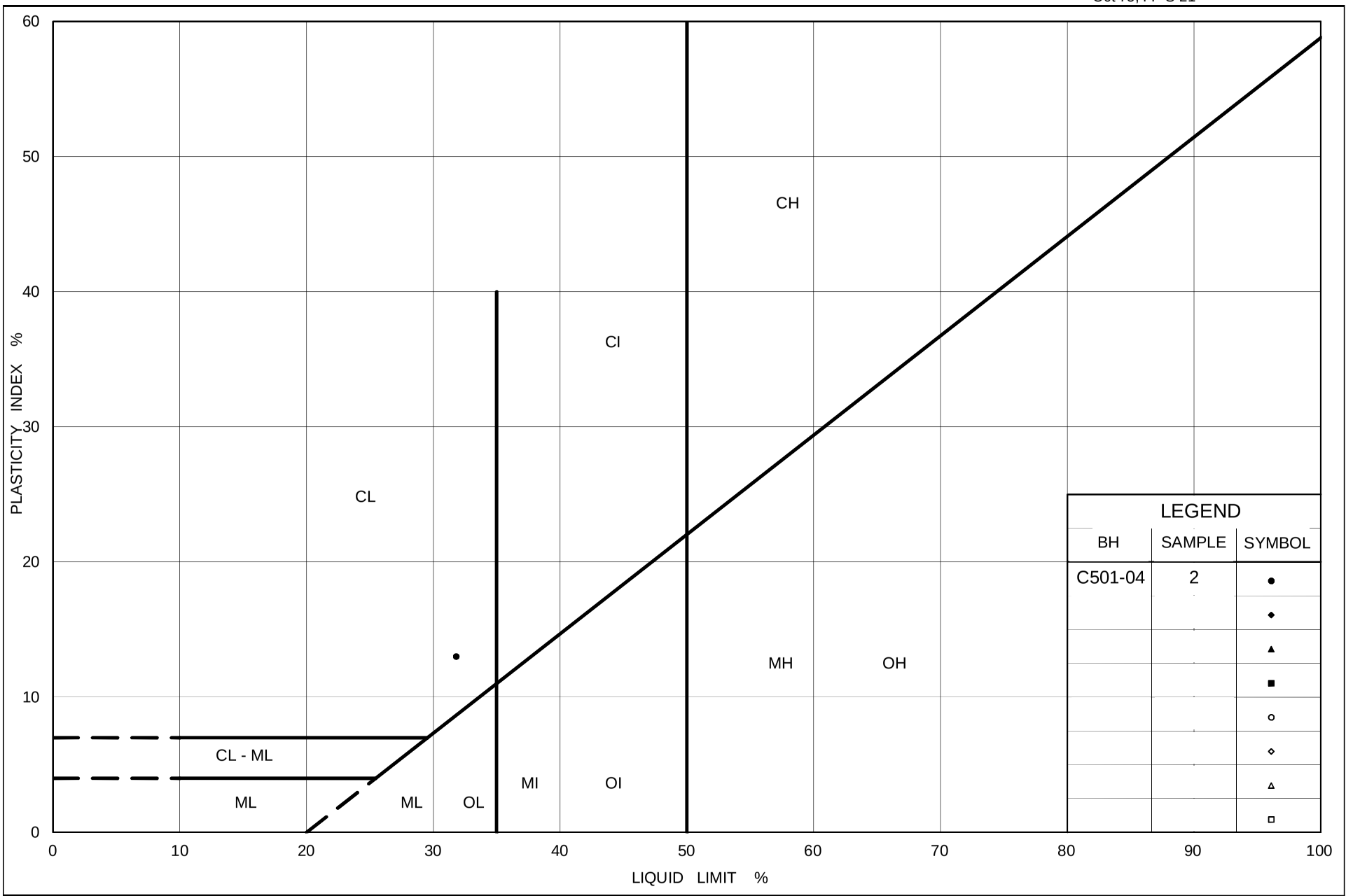
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | |
| 185.2 | WATER SURFACE | | | | | ▽ | | | | | |
| 0.0 | Dynamic Cone Penetration Test (DCPT) | | | | | | 185 | | | | |
| 183.7 | | | | | | | 184 | | | | |
| 1.5 | END OF DCPT Refusal to Further Penetration (Hammer Bouncing) | | | | | | | | | | |

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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/1/15

# APPENDIX B

## Laboratory Test Results




Ministry of Transportation

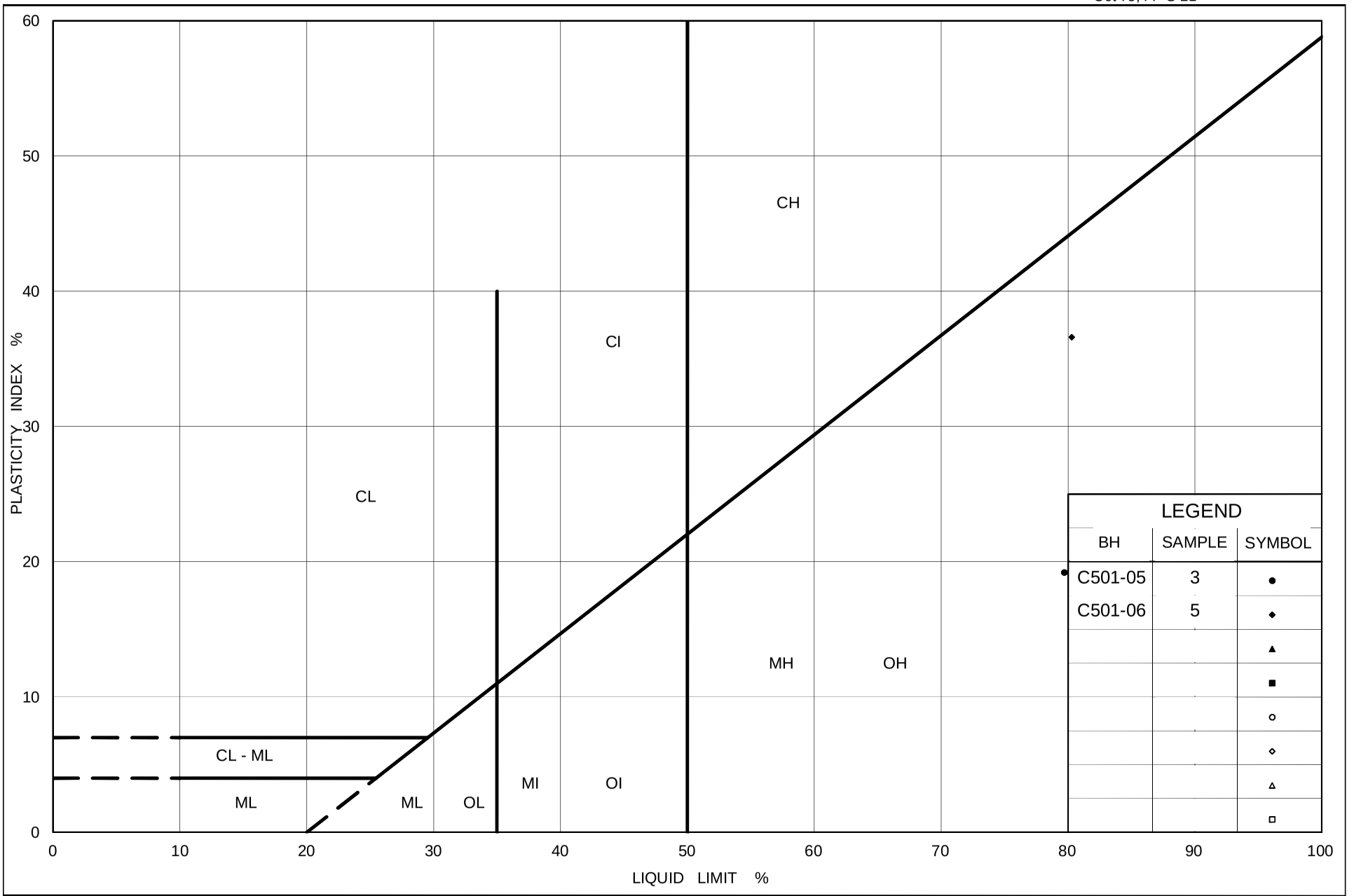
Ontario

# PLASTICITY CHART
## CLAYEY SILT

Figure No. B1

Project No. 09-1111-6014

Checked By: AB




Ministry of Transportation

Ontario

# PLASTICITY CHART
## ORGANIC SILT

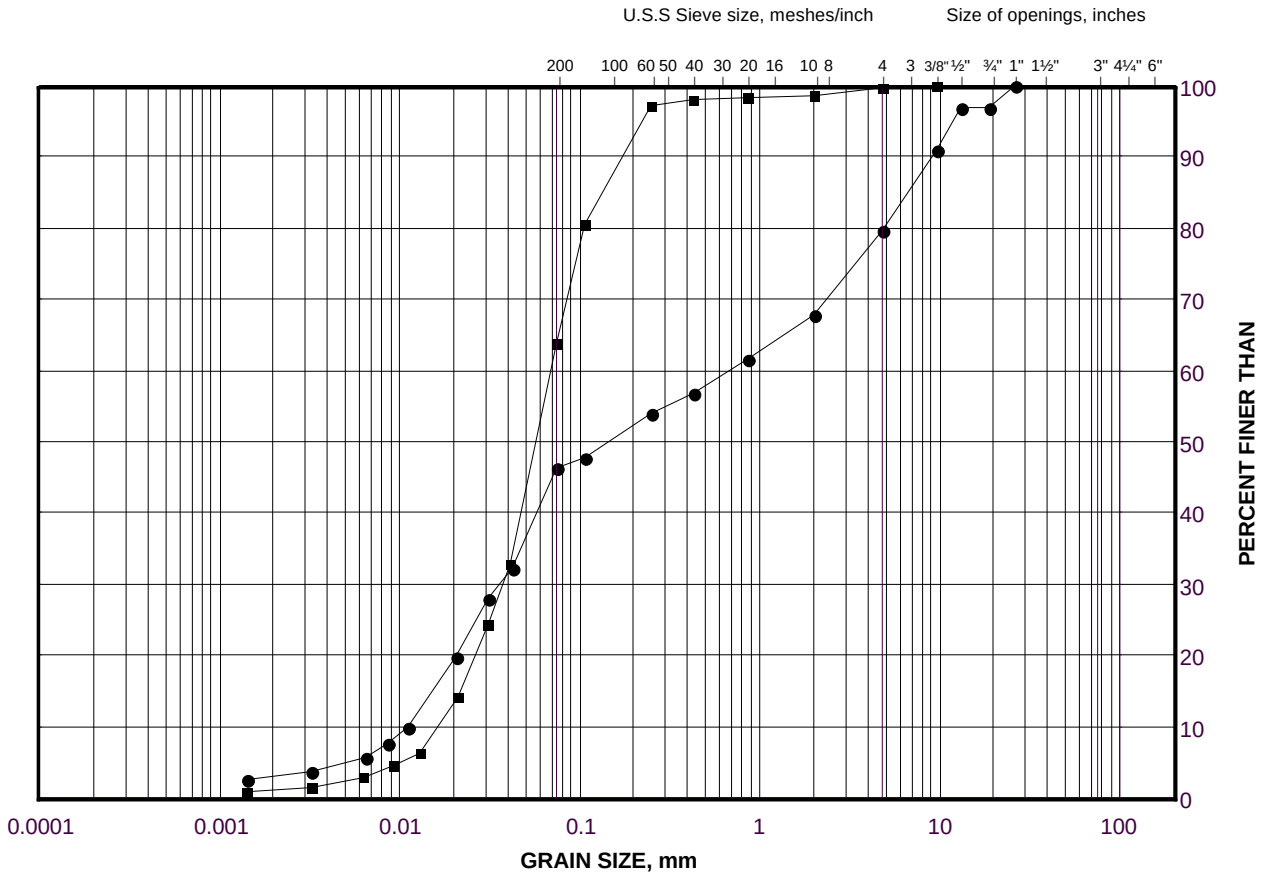
Figure No. B2

Project No. 09-1111-6014

Checked By: AB

# GRAIN SIZE DISTRIBUTION
SILT and SAND

FIGURE B3




## LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|---|---|---|---|
| ● | C501-03 | 2 | 183.2 |
| ■ | C501-06 | 9 | 176.4 |

Project Number: 09-1111-6014

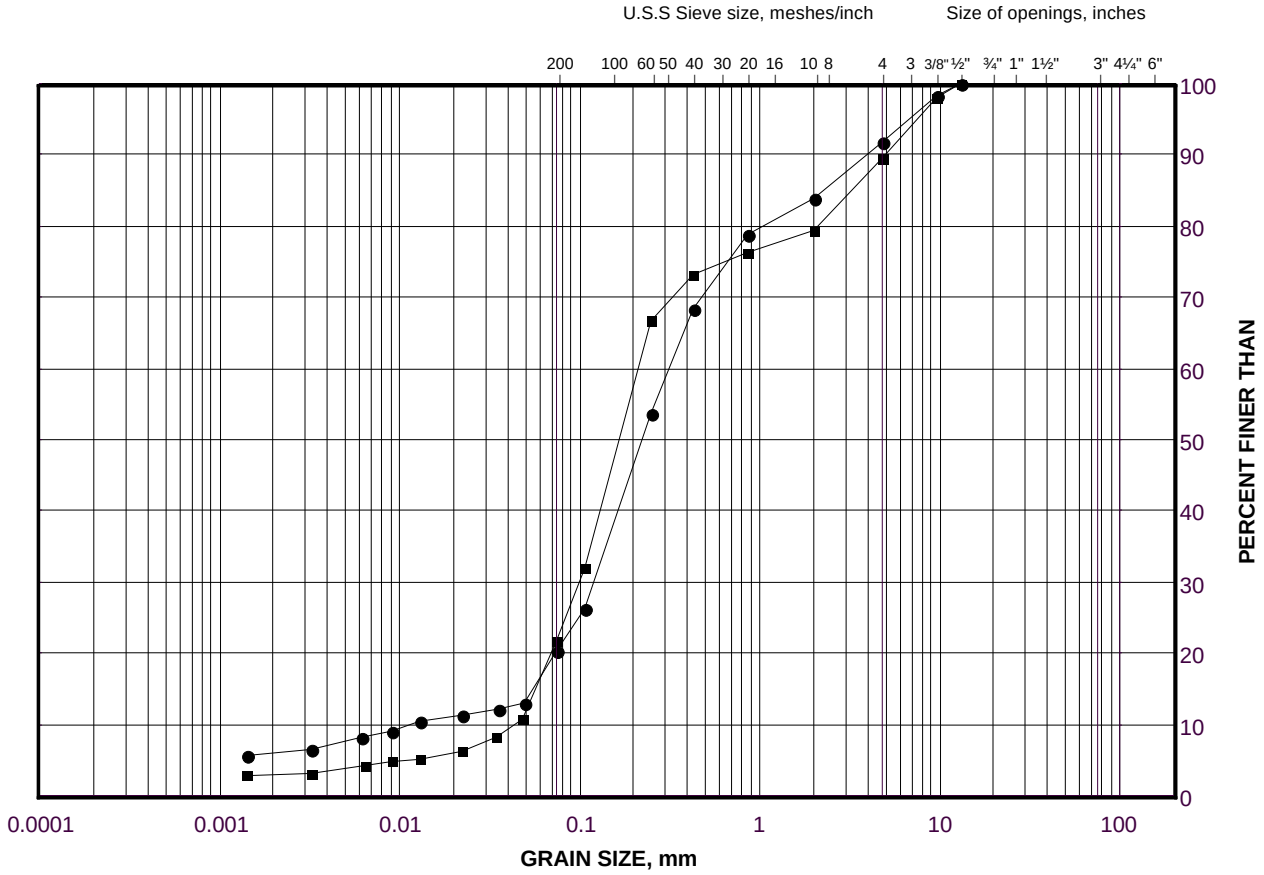
Checked By: AB

**Golder Associates**

Date: 27-Jul-15

# GRAIN SIZE DISTRIBUTION
SAND

FIGURE B4




## LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|---|---|---|---|
| ● | C501-02 | 2A | 182.8 |
| ■ | C501-01 | 2B | 181.9 |

Project Number: 09-1111-6014

Checked By: AB

**Golder Associates**

Date: 27-Jul-15

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.


| | |
|---|---|
| Africa | + 27 11 254 4800 |
| Asia | + 86 21 6258 5522 |
| Australasia | + 61 3 8862 3500 |
| Europe | + 356 21 42 30 20 |
| North America | + 1 800 275 3281 |
| South America | + 55 21 3095 9500 |

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