REPORT

October 1, 2013

FOUNDATION INVESTIGATION REPORT

CULVERTS: SITE NO. 44-626/C1 AND C2 - CONTRACT 3
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 5404-05-00; WP 5404-05-01

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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 engineering services for two (2) culvert crossings (Site No. 44-626/C1 and 44-626/C2) within the Contract 3 limits of the new Highway 69 alignment to the north of the junction with Highway 529. The proposed work in Contract 3 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 project distance of 19.7 km. The foundation engineering components within the overall project limits include: 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; the Canadian Pacific Railway (CPR) and Canadian National Railway (CNR) structures; as well as a number of culvert crossings. The general location and extent of the various contracts as part of of the new Highway 69 four-laning alignment are shown on the Site Location 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 January 2009. Golder's proposal for foundation engineering services associated with the Contract 3 culvert crossing 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. The Base Plan showing the proposed horizontal alignment for the Contract 3 section of Highway 69 four-laning and the General Arrangement (GA) drawing showing the proposed culvert profiles were provided to Golder by URS on April 23, 2012 and July 5, 2012, respectively.

This report addresses the investigation carried out for the proposed Contract 3 culvert crossings only. The details of the Contract 3 culverts crossing the proposed Highway 69 SBL and NBL alignments are presented in Table 1. Separate reports address the foundation investigations for the related swamp crossings and high fill areas and bridge structures within the Contract 3 section of the project.

The purpose of this investigation is to establish the subsurface conditions along the proposed culvert alignments by methods of borehole drilling, rock coring, in situ testing and laboratory testing on selected samples. The culvert alignments were located in the field by Callon Dietz Inc., a professional surveying company retained by URS. The two (2) culvert alignments are located within a swamp crossing, designated as Swamp 301. The results of the swamp investigation is presented in a report titled:

- Foundation Investigation and Design Report, Swamp Crossings and High Fill Areas – Contract 3, 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 5404-05-00; WP 5404-05-01.

2.0 SITE DESCRIPTION

The overall proposed Highway 69 alignment is oriented generally in a south-north direction spanning the Township of Wallbridge to the south, the Township of Henvey and the Township of Mowat to the north. The Contract 3 section of the new four-lane Highway 69 alignment is also oriented generally in a south-north direction within the project limits, spanning withing the Township of Henvey for a total distance of about 6.7 km. The proposed culverts are located approximately 300 m from the southern limit of Contract 3, corresponding to approximately 6.5 km northwest of the junction between existing Highway 69 and Highway 529.

In general, the topography of the Contract 3 section of the project consists of rolling terrain, including sparsely to densely populated, treed areas and numerous bedrock outcrops separated by valleys, and swamps containing

areas of standing water and various types of vegetation and organic soils. The ground surface in the vicinity of the Contract 3 culvert alignments varies between about Elevation 182 m and Elevation 181 m, referenced to Geodetic datum. The ground surface in the general area of Contract 3 is gently sloping downward from northeast to southwest towards Georgian Bay.

3.0 INVESTIGATION PROCEDURES

3.1 Foundation Investigation

The investigation for the Contract 3 culvert crossings was carried out between February 8 and March 10, 2012, during which time a total of six (6) boreholes were advanced at or near the culvert alignments. In addition, one (1) borehole advanced on February 26 and 27, 2012 as part of the field investigation work carried out by Golder Associates Ltd. for the Contract 3 swamp crossings and high fill areas in Swamp 301 was utilized to supplement the culvert investigation. The methods of investigation for this supplemental borehole are provided in the report referenced in Section 1.0. The boreholes associated with each culvert alignment are summarized in Table 1 and are shown on Drawing A1 in Appendix A.

The field investigation was carried out using a track-mounted D25 drill rig supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. The boreholes were advanced through the overburden using 165 mm outside diameter (O.D.) solid-stem augers and/or 'NW' casing with wash boring techniques. Soil samples were obtained at intervals of depth of about 0.75 m, 1.5 m and 3.0 m, using a 50 mm O.D. split-spoon sampler driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586, Standard Test Method for Standard Penetration Test). Some samples of the cohesive soils in selected boreholes were obtained using 76 mm O.D. thin-walled 'Shelby' tubes (ASTM D1587, Standard Practice for Thin-Walled Tube Sampling) to provide relatively undisturbed samples. Field vane shear tests were carried out in cohesive soils for assessment of undrained shear strengths (ASTM D2573, Standard Test Method for Field Vane Strength Shear Test) using MTO standard 'N' size vanes. In addition, laboratory shear vane tests were performed on Shelby tube samples of the cohesive soil to measure undrained shear strengths. Samples of the bedrock were obtained in one borehole using an 'NQ' size rock core barrel. All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 Wells (as amended). Boreholes which exhibited artesian groundwater conditions during drilling were backfilled with a cement/barite grout mixture following measurement of the water level in the drill casing.

The culvert boreholes were advanced to depths up to 30.7 m below existing ground surface, including a Dynamic Cone Penetration Test (DCPT) in three (3) boreholes carried out from the bottom of the borehole to determine the depth to refusal. The majority of the boreholes were terminated on refusal to further split-spoon and casing advancement or dynamic cone penetration. These depths to refusal do not confirm bedrock surface elevations, but may be inferred to indicate potential proximity to the bedrock surface. In one (1) borehole advanced near the Culvert C301 NBL alignment, bedrock was cored for a depth of about 3.0 m, and the phototgraph of the recovered rock core samples is provided in Appendix A.

The groundwater conditions and water levels in the open boreholes were observed during and upon completion of the drilling operations and are described on the Record of Borehole sheets provided in Appendix A. Groundwater elevations as encountered in the boreholes may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized on completion of drilling. Furthermore, groundwater elevations are subject to seasonal fluctuations, variations in precipitation and local soil permeability.

The fieldwork 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 core 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, Atterberg limits and grain size distribution) was carried out on selected samples. In addition, a one-dimensional consolidation (oedometer) test was carried out on one (1) selected sample of the cohesive deposit obtained from one of the culvert boreholes and the summary of the consolidation test results is presented in Secion 4.0. It is noted that additional consolidation tests were carried out on samples obtained from the boreholes advanced within Swamp 301 and are provided in the report referenced in Section 1.0. The results of the laboratory testing on samples from the culvert boreholes and the results of the laboratoty testing on samples from the supplemental borehole are provided in Appendix A.

Classification of the rock mass quality of the bedrock with respect to the Rock Quality Designation (RQD) is described based on Table 3.10 of the Canadian Foundation Engineering Manual (CFEM, 2006)[1]. The degree of weathering of the bedrock samples (i.e. fresh to slightly weathered – W1 to W2) and the strength classification of the intact rock mass based on field identification (i.e. strong to extremely strong – R4 to R6) are described in accordance with the International Society for Rock Mechanics (ISRM,1985)[2] standard classification system.

The proposed centreline of the new highway alignment was staked in the field by Callon Dietz prior to drilling. The as-drilled borehole locations, in stations and offsets, were measured in reference to the stated centreline alignment and were subsequently converted into MTM NAD 83 coordinates in AutoCAD. Borehole elevations were surveyed by a member of our technical staff in reference to the ground surface elevations at the centreline median and to temporary benchmarks which were then surveyed by Callon Dietz upon completion of the fieldwork. The borehole locations given in the Record of Borehole sheets and shown on Drawing A1 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, gound surface elevations and drilled depths are as follows:

Borehole	Location (MTM NAD 83)		Ground Surface Elevation (m)	Borehole / DCPT Depth (m)
	Northing	Easting		
S301-03	5076355.4	223953.3	182.4	29.6
C301-S1	5076349.2	223937.5	181.2	25.0 / 30.5
C301-S2	5076373.2	223956.0	181.5	25.9 / 30.7
C301-S3	5076367.3	223942.8	181.5	26.5 / 27.9
C301-N1	5076376.5	223965.1	181.2	27.8
C302-N2	5076390.8	223972.2	181.6	20.0
C302-N3	5076396.4	223986.9	181.6	22.7

[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.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

As delineated in The Physiography of Southern Ontario[3], 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 typically 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[4]. Deposition of Paleozoic strata initially covered the bedrock and later erosion during glaciation exposed these Precambrian rocks.

4.2 General Overview of Local Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are presented on the Record of Borehole sheets and the laboratory test sheets provided in Appendix A. The results of the in situ field tests (i.e. SPT 'N'-values and undrained shear strengths from the field vanes) as presented on the Record of Borehole sheets and in Section 4 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets 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. Further, subsurface conditions will vary between and beyond the borehole locations.

The inferred soil stratigraphy as encountered in the boreholes advanced for the Contract 3 culverts is shown in profile on Drawing A2. The orientation (i.e. north, south, east, west) stated in the text of the report is typically referenced to project north and/or up-chainage (along the proposed Highway 69 alignment). For purposes of this report, Highway 69 is oriented in a north-south direction.

In general, the stratigraphy encountered at the various boreholes advanced for the two (2) culverts crossing the Highway SBL and NBL alignments is similar, generally consisting of alternating layers of cohesive and cohesionless soils, however, the thickness of the overburden (soil materials) is variable, ranging from about 20.0 m to about 30.5 m.

Detailed descriptions of the subsurface conditions encountered at the investigated culvert alignments are provided in the following sections of this report.

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[3] 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.

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

4.3 Highway 69 SBL and NBL – STA 13+810 (Culvert 301 – Site No. 44-626/C1 and C2)

The plan and profile along the Culvert 301 centreline showing the borehole locations and interpreted stratigraphy at approximately STA 13+810 in the Township of Henvey are shown on Drawings A1 and A2 in Appendix A. Two culverts are to extend across the proposed new Highway 69 Southbound Lanes (SBL) and Northbound Lanes (NBL) embankments within Swamp 301. The proposed embankments at the culvert locations are approximately 4.0 m high relative to the existing ground surface. A total of six (6) boreholes were advanced for the proposed Culvert C301 to investigate the subsurface conditions along the culvert alignments: three (3) broreholes (Boreholes C301-S1 to C301-S3) for the culvert crossing the Highway 69 SBL; and three (3) broreholes (Boreholes C301-N1 to C301-N3) for the culvert crossing Highway 69 NBL. In addition, one (1) borehole (Borehole S301-03) advanced at the centreline of the proposed Highway 69 SBL embankment for Swamp 301 was utilized to supplement the subsurface information along the Highway 69 SBL culvert alignment. The Record of Borehole sheets and associated results of the laboratory tests carried out on selected soil samples from these boreholes are included in Appendix A.

The topography of this section of the proposed Highway 69 alignment is comprised of a relatively flat to low-lying tree covered area. The ground cover in the culvert areas consists of a grassy field and creek bed with shrub and sparsely to moderately treed areas and bedrock outcrops in the surrounding areas.

The subsurface soils along the culvert alignments consist of topsoil or near surface deposit of sandy silt to silty sand, underlain by a thick deposit of cohesive soil comprised of clayey silt to clay, which is generally separated into an upper deposit and a lower deposit by a interlayers of silt to sandy silt to silty sand. The cohesive deposit is in turn underlain by deposits of silt to sandy silt, and sand and silt to silty sand to sand which extend to refusal or overlying granite gneiss bedrock.

4.3.1 Topsoil

An approximately 0.1 m to 0.2 m thick layer of topsoil was encountered at the ground surface in all the boreholes, except in Borehole C301-S2. The surface of topsoil across the boreholes ranges from about Elevations 182.4 m to 181.2 m.

The natural water content measured on one (1) specimen of topsoil is about 43 per cent.

4.3.2 Sandy Silt to Silty Sand

A near surface deposit of cohesionless soils comprised of dark brown to grey sandy silt, sand and silt and silty sand was encountered at the ground surface in Borehole C301-S2 and underlying the topsoil in Boreholes C301-N1 to C301-N3. The deposit contains trace to some clay in Borehole C301-N2 and it generally contains organics, roots, rootlets and wood fragments in all these boreholes. The top of this deposit ranges from about Elevations 181.5 m to 181.1 m and the thickness of the deposit ranges from about 0.6 m to 1.4 m.

The SPT ‘N’-values measured within this deposit range from 0 blows (weight of hammer) to 7 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on four (4) selected samples of this deposit ranges from about 21 per cent to 66 per cent.

The results of a grain size distribution analysis and an Atterberg limits test on a sample of the sand and silt deposit are presented on Figures C301-01A and C301-01B, respectively. The result of the Atterberg limits test measured a liquid limit of about 18 per cent, a plastic limit of about 12 per cent and a plasticity index of about 6 per cent, indicating that the fines portion of the sand and silt deposit consists of clayey silt to silt of slight plasticity.

4.3.3 Clayey Silt to Silty Clay (Upper Deposit)

A deposit of cohesive soil comprised of brown to grey (to black in the upper portion of Borehole C301-51) clayey silt to silty clay to sandy clayey silt was encountered underlying either the topsoil or the near surface deposit of sandy silt to silty sand in all the boreholes. The upper portion of the cohesive deposit in Boreholes S301-03, C301-S1 and C301-S3 (to a depth of about 1.5 m) contains organics and rootlets. In general, the deposit contains trace sand, trace gravel, silt to sandy silt to sand seams and in places contains silt to sandy silt pockets up to about 2.4 m thick at various depths across the boreholes. The top of this cohesive deposit ranges from about Elevations 182.3 m to 180.1 m, and the thickness of the cohesive deposit ranges from about 10.7 m to 14.7 m.

The SPT 'N'-values recorded within the cohesive deposit typically range from 0 blows (weight of hammer) to 4 blows per 0.3 m of penetration, but up to 11 blows per 0.3 m of penetration recorded within the upper portion of the cohesive deposit in places. In situ field vane tests carried out within the deposit measured undrained shear strengths ranging from about 10 kPa to greater than 96 kPa, but typically less than 40 kPa, and the sensitivity is calculated to range from about 1 to 7. The field vane tests results indicate that the silty clay to clayey silt deposit has a predominantly soft to firm consistency with some higher shear strengths and stiff consistency occurring near the lower section of the deposit.

The natural water content measured on thirty one (31) samples of this deposit ranges from about 21 per cent to 74 per cent, but are typically less than 40 per cent.

The results of grain size distribution tests completed on seven (7) samples of the clayey silt and silty clay portions of the cohesive deposit are shown on Figure A.C301-02A in Appendix A.

Atterberg limits tests were carried out on fifteen (15) samples of the cohesive deposit and measured liquid limits ranging from about 19 per cent to 48 per cent, plastic limits ranging from about 12 per cent to 20 per cent and plasticity indices ranging from about 4 per cent to 28 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figures A.C301-02B-1 and A.C301-02B-2 in Appendix A, and indicate that the material is classified as a clayey silt of low plasticity to silty clay of intermediate plasticity.

A laboratory consolidation test was carried out on one (1) specimen of the silty clay portion of the cohesive deposit obtained from a Shelby tube sample in Borehole C301-S2. A preconsolidation stress of about 125 kPa was estimated from the void ratio versus logarithmic pressure plot and from the total work versus pressure plot. A bulk unit weight of about 16 kN/m^3 and a specific gravity of about 2.77 were measured on the consolidation test specimen. Details of the test results are shown on Figure A.C301-03 in Appendix A, and the test results are summarized below.

Borehole Sample No.	Sample Depth / Elevation	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	C_c	C_r	e_o	c_v^* (cm^2/s)
Borehole C301-S2 Sample 4	2.8 m / 178.7 m	30	125	95	4.17	1.40	0.02	1.80	5.7×10^{-3}

Note: * For stress range between effective overburden stress and final stress due to 4.0 m high embankment, that is 30 kPa ≤ σ_v' ≤ 105 kPa

where: σ_{vo}' is the in situ vertical effective overburden stress in kPa
σ_p' is the preconsolidation stress in kPa
σ_v' is the vertical effective stress in kPa
OCR is the overconsolidation ratio
e_o is the nitial void ratio
C_c is the compression index
C_r is the recompression index
c_v is the coefficient of consolidation in cm^2/s

4.3.4 Silt to Sandy Silt

Within the upper cohesive deposit of clayey silt to silty clay, pockets of grey silt to sandy silt containing trace to some sand and trace to some clay were encountered at varying intervals between about Elevations 177.1 m and 169.9 m in Boreholes S301-03, C301-S2, C301-S3 and C301-N1 to C301-N3. The thickness of the silt to sandy silt pockets ranges from about 0.5 m to 2.4 m.

The SPT 'N'-values measured within the silt to sandy silt pockets range from 0 blows (weight of hammer) to 7 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on eight (8) samples of the silt to sandy silt pockets ranges from about 19 per cent to 29 per cent.

The results of grain size distribution tests completed on five (5) samples of the silt to sandy silt pockets are shown on Figure A.C301-04 in Appendix A.

Atterberg limits tests were carried out on three (3) specimens of the silt pockets. Two of the Atterberg limits tests yield liquid limits of about 16 per cent and 17 per cent, plastic limits of about 13 per cent and 15 per cent, and corresponding plasticity indices of about 3 per cent and 2 per cent, as presented on the plasticity chart on Figure A.C301-05 in Appendix A indicating the material to be silt of slight plasticity. The result of the other Atterberg limits test indicates the fines material of the silt to be non-plastic.

4.3.5 Silt to Sandy Silt (Interlayer)

An Approximately 1.1 m to 3.4 m thick interlayer of comprised of grey silt trace to some sand, to silty sand to sandy silt, all containing trace to some clay was encountered between the upper and lower cohesive deposits in all the boreholes except in Borehole C301-S3. The top of the silt to sandy silt interlayers ranges from about Elevations 169.8 m to 168.1 m.

The SPT 'N'-values measured within the silt to sandy interlayer range from 1 blow to 7 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on six (6) samples of this interlayer ranges from about 18 per cent to 23 per cent.

The results of grain size distribution tests completed on four (4) samples of the silt to sandy silt interlayer are presented on Figure A.C301-06 in Appendix A.

Atterberg limits tests were carried out on three (3) samples of the silt to sandy silt interlayer and measured liquid limits of about 17 per cent, plastic limits between about 14 per cent and 15 per cent and plasticity indices between about 2 per cent and 3 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A.C301-07 in Appendix A and indicate that the fines material of the silt to sandy silt interlayer is classified as silt of slight plasticity.

4.3.6 Clayey Silt to Clay (Lower Deposit)

A lower deposit of cohesive soil comprised of brown to grey clayey silt, silty clay and clay was encountered underlying the silt to sandy silt interlayer in Boreholes S301-03, C301-S1, C301-S2 and C301-N1 to C301-N3, and directly below the upper cohesive deposit in Borehole C301-S3. In some boreholes, the deposit contains trace sand and silt seams. The top of the cohesive deposit ranges from about Elevations 167.9 m to 165.7 m, and the thickness of the cohesive deposit ranges from about 2.8 m to 6.5 m.

The SPT 'N'-values recorded within the cohesive deposit range from 0 blows (weight of hammer) to 6 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 46 kPa to greater than 96 kPa, but generally greater than 50 kPa, and the sensitivity is calculated to range from about 2 to 5. The field vane tests results indicate that the clayey silt to clay deposit has a firm to stiff, but generally stiff consistency.

The natural water content measured on nine (9) specimens of this deposit ranges from about 22 per cent to 66 per cent, but are generally greater than 45 per cent.

Atterberg limits tests were carried out on eight (8) specimens of the lower cohesive deposit and indicate liquid limits ranging from about 26 per cent to 69 per cent, plastic limits ranging from about 16 per cent to 22 per cent and plasticity indices ranging from about 8 per cent to 48 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A.C301-08 in Appendix A and indicate the material to range from a clayey silt of low plasticity to a clay of high plasticity.

4.3.7 Silt to Sand

Underlying the lower cohesive deposit, all the boreholes encountered a grey cohesionless deposit comprised of an upper layer grading from silt some sand to sandy silt, and a lower layer grading from sand and silt to silty sand to sand trace silt. The deposit in places contains trace to some clay, trace to some gravel and sand seams. The top of the silt to sand deposit ranges from about Elevations 163.9 m to 161.4 m and the thickness of the deposit ranges from about 1.0 m to greater than 8.7 m, and may be up to about 11.3 m as inferred from the refusal at the Dynamic Cone Penetration Test carried out from the bottom of Boreholes C301-S1 to C301-S3. All boreholes except C301-N3 were terminated in this deposit.

The SPT 'N'-values recorded within this deposit range from 4 blows to 22 blows per 0.3 m of penetration, generally indicating a loose to compact relative density. An SPT 'N'-value of 57 blows per 0.18 m of penetration was recorded at the bottom of Borehole C301-N3 at the interface with the bedrock surface.

The natural water content measured on eleven (11) samples of this deposit ranges from 20 per cent to 34 per cent.

The grain size distributions of seven (7) samples of the silt to sandy silt to sand and silt portion of this deposit and three (3) samples of the silty sand to sand portion of this deposit are shown on Figures A.C301-09A and A.C301-09B in Appendix A. An Atterberg limits test on one (1) sample of the sandy silt portion of this deposit indicates that the fines material of this soil is non-plastic.

4.3.8 Bedrock / Refusal

Bedrock outcrops are present in the immediate vicinity of the investigated area. In Boreholes C301-S2, C301-S3 and C301-N1, the bedrock surface is inferred by either refusal to further split-spoon and casing advancement or dynamic cone penetration at depths between about 27.8 m and 30.7 m below the ground surface, between about Elevations 153.6 m and 150.8 m.

In Borehole C301-N3, bedrock was encountered and core samples were recovered as shown on the photograph presented on Figure A.C301-10 in Appendix A. The depth to the surface of the bedrock in this borehole is about 19.7 m below ground surface, corresponding to Elevation 161.9 m. The bedrock consists of granite gneiss and the core samples are described as fresh, foliated, medium crystalline, slightly porous, strong, grey, pink and black as presented on the Record of Drillhole sheet in Appendix A.

The Rock Quality Designation (RQD) measured on the two core runs is 86 per cent and 83 per cent, indicating a rock mass of good quality, in accordance with Table 3.10 of CFEM (2006). The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the rock core samples is 98 per cent and 100 per cent, and 93 per cent and 87 per cent, respectively.

4.3.9 Groundwater Conditions

In general, the soil samples taken in the boreholes were moist to wet. During the drilling operations, artesian conditions were observed in Boreholes C301-S1 to C301-S3 and C301-N1 when advancing the casing at depths between about 11.7 m and 21.3 m below ground surface, with the groundwater levels measured in the casing ranging between about 0.7 m and 1.1 m above ground surface, corresponding to about Elevations 181.9 m to 182.6 m, respectively. The groundwater levels measured in the open boreholes upon completion of drilling ranged from about 0.2 m to 1.7 m below ground surface, corresponding to about Elevations 181.4 m to 179.8 m.

5.0 CLOSURE

The drilling program was supervised by Mr. Matt Rhody, a senior technician with Golder and Mr. Alex Mayot, E.I.T. This report was prepared by Ms. T. Veronica Ayetan, P.Eng. and was reviewed by Mr. J. Paul Dittrich, Ph.D., P.Eng., a senior geotechnical engineer and Principal with Golder. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for this project and Principal with Golder, conducted an independent quality control review of the report.

Report Signature Page

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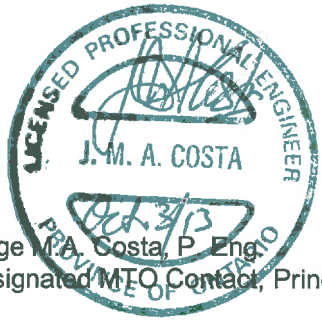

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https://capws.golder.com/sites/0911116014highway69FourLaning/Contract 3/Reporting/Final/Culverts/FINAL REPORT(ignore the other pdf)/09-1111-6014-3521 RPT 13Oct01 Highway 69 Culverts - Contract 3.docx

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Canadian Geotechnical Society. 2006. Canadian Foundation Engineering Manual, 4th Edition. The Canadian Geotechnical Society c/o BiTech Publisher Ltd, British Columbia.

Chapman, L.J., and Putnam, D.F. 1984. The Physiography of Southern Ontario, 3rd Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.

International Society for Rock Mechanics (ISRM), 1985. Suggested Method for Determining Point Load Strength, In: International Journal of Rock Mechanics and Mining Sciences and Geomechanics Abstracts, Vol. 22, No. 2, pp. 53–60.

ASTM International:

ASTM D1586	Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
ASTM D1587	Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
ASTM D2573	Standard Test Method for Field Vane Shear Test in Cohesive Soil

Ontario Geological Society. 1991. Geology of Ontario, Special Volume 4, Part 2. Eds. P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott. Ministry of Northern Development and Mines, Ontario.

Ontario Water Resources Act:

Ontario Regulation 903	Wells (as amended)

TABLES

Table 1 Summary of Culvert Details

Culvert Designation / Site Number	*Culvert Location (Associated Swamp)*	*Approximate Proposed Embankment Height[1] (m)*	*Culvert Type*	*Invert Elevation[2]*		*Culvert Dimensions[2]*			*Boreholes / DCPTs*
				East End of Culvert (m)	*West End of Culvert (m)*	*Width (m)*	*Height (m)*	*Length (m)*	
C301 Site No. 44-626/C2	Highway 69 SBL STA 13+810 (Swamp 301)	4.0	Box Culvert	180.60	180.59	3	2.4	32	4 Boreholes (S301-03 and C301-S1 to C301-S3)
C301 Site No. 44-626/C1	Highway 69 NBL STA 13+810 (Swamp 301)	4.0	Box Culvert	180.62	180.60	3	2.4	32	3 Boreholes (C301-N1 to C301-N3)

Notes: 1 Embankment height is approximate and is relative to original ground surface at the borehole locations.
2 Invert elevations and culvert dimensions as shown on profiles drawings provided by URS on July 5, 2012.

Prepared By: TVA **Reviewed By:** JPD/JMAC

DRAWINGS

MINISTRY OF TRANSPORTATION, ONTARIO

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

CONT No.
GWP No. 5404-05-00

SHEET

HIGHWAY 69
SITE LOCATION PLAN

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA

KEY PLAN
NOT TO SCALE

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

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 BRIDGE NBL & SBL (WP 5147-08-01 & WP 5148-08-01)
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 INTERCHANGE BRIDGE NBL & SBL (WP 5141-08-01 & WP 5142-08-01)
STILL RIVER BRIDGE NBL & SBL (WP 5139-08-01 & WP 5140-08-01)
CULVERT 301

CONTRACT 1 GWP 5344-08-00 WP 5344-08-01
CONTRACT 4 WP 5347-08-01
GWP 5347-08-00
CONTRACT 5 WP 5404-05-01
GWP 5404-05-00
CONTRACT 3 WP 5404-05-01
CONTRACT 2 WP 5404-05-01

PROPOSED HIGHWAY 69
EXISTING HIGHWAY 69
HIGHWAY 526

HENVEY
MOWAT
KEY RIVER
HENVEY INLET FIRST NATION
HENVEY INLET FN
HENVEY INLET FIRST NATION
HENVEY
GEORGIAN BAY
BRITT
HENVEY
WALLBRIDGE
MOWAT
WALLBRIDGE
HIGHWAY 522
CANADIAN NATIONAL RAILWAY
CANADIAN PACIFIC RAILWAY

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-128

HWY. 69		PROJECT NO. 09-1111-6014	DIST.
SUBM'D. TVA	CHKD. TVA	DATE: March 2013	SITE:
DRAWN: JFC	CHKD. CN	APPD. JPD/JMAC	DWG. 1

PLOT DATE: September 30, 2013
FILENAME: T:\Projects\2009\09-1111-6014 (URS, Hwy 69, Henvey)\-Dir- CONTRACT 3 (CULVERT)-STAMPED\09111160149H001.dwg

APPENDIX A

Highway 69 SBL and NBL – STA 13+810 (Culvert 301 – Site No. 44-626/C1 and C2)

MINISTRY OF TRANSPORTATION, ONTARIO

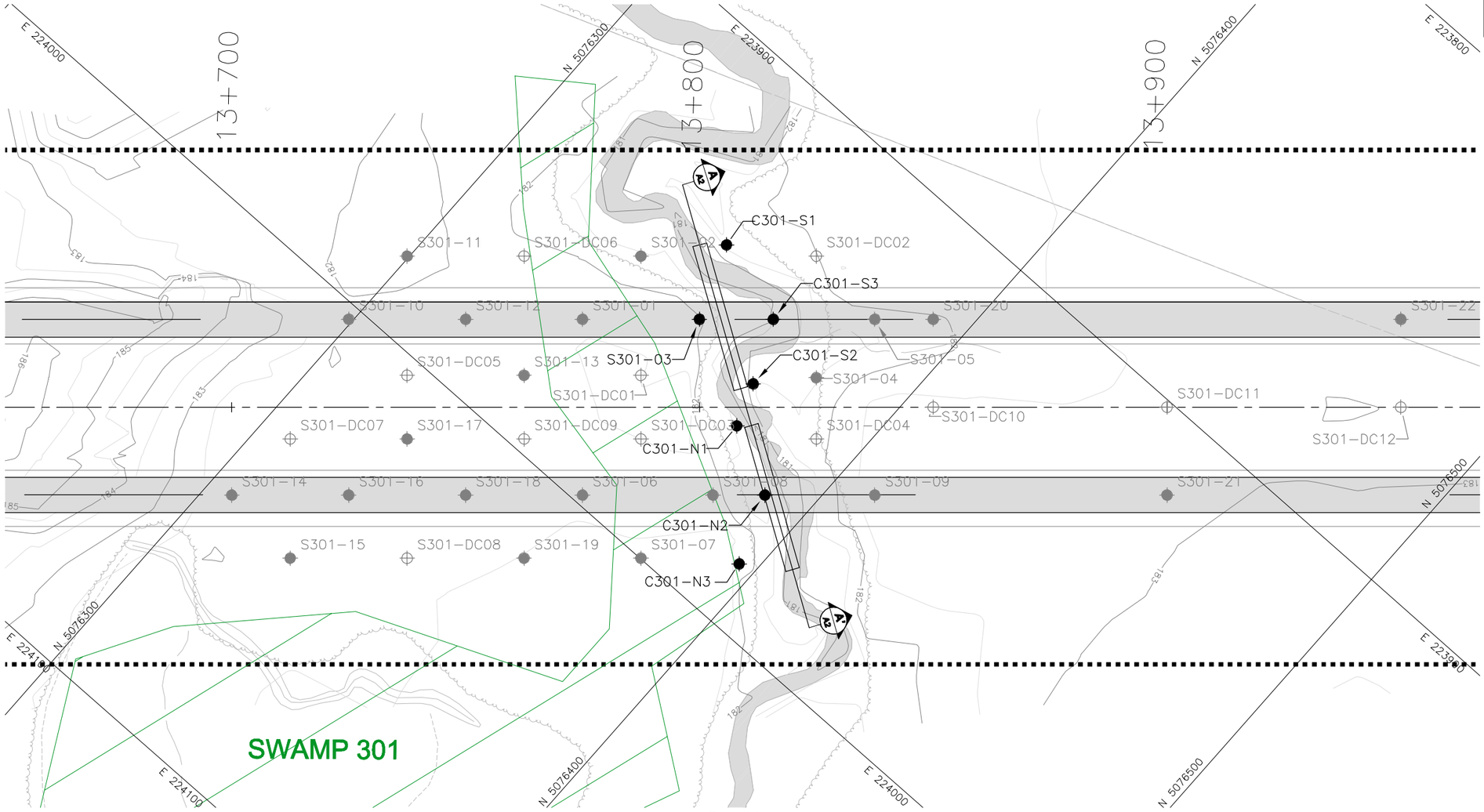
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 5404-05-01

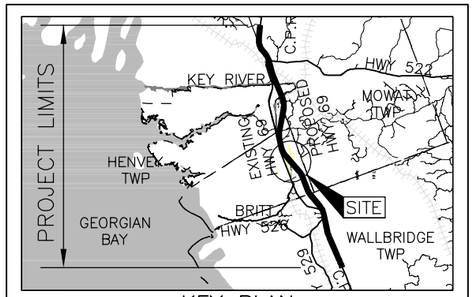
SHEET

HIGHWAY 69
CULVERT 301 STA 13+810
BOREHOLE LOCATIONS

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



PLAN
SCALE
10 0 10 20 m



KEY PLAN
SCALE
6 0 6 12 km

LEGEND

Borehole – Current Investigation

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
S301-03	182.4	5076355.4	223953.3
C301-S1	181.2	5076349.2	223937.5
C301-S2	181.5	5076373.2	223956.0
C301-S3	181.5	5076367.3	223942.8
C301-N1	181.2	5076376.5	223965.1
C301-N2	181.6	5076390.8	223972.2
C301-N3	181.6	5076396.4	223986.9

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 URS, drawing file nos. Alignment and Contours from Hwy69_Contour-Plan_C3.dwg, received April 23, 2012.

LICENSED PROFESSIONAL ENGINEER J. M. A. COSTA Oct. 1, 2013 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER T.V. AYETAN 100130071 Oct. 1, 2013 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41H-128

HWY. 69		PROJECT NO. 09-1111-6014	DIST.
SUBM'D. CC	CHKD. TVA	DATE: Oct. 2013	SITE: 44-626/C1&C2
DRAWN: DD/JFC	CHKD. CN	APPD. JPD/JMAC	DWG. A1

PLOT DATE: October 4, 2013
FILENAME: T:\Projects\2009\09-1111-6014 (URS, Hwy 69, Henvey)\-DH- CONTRACT 3 (CULVERT)-SWAMP301\09111160140A01.dwg

METRIC

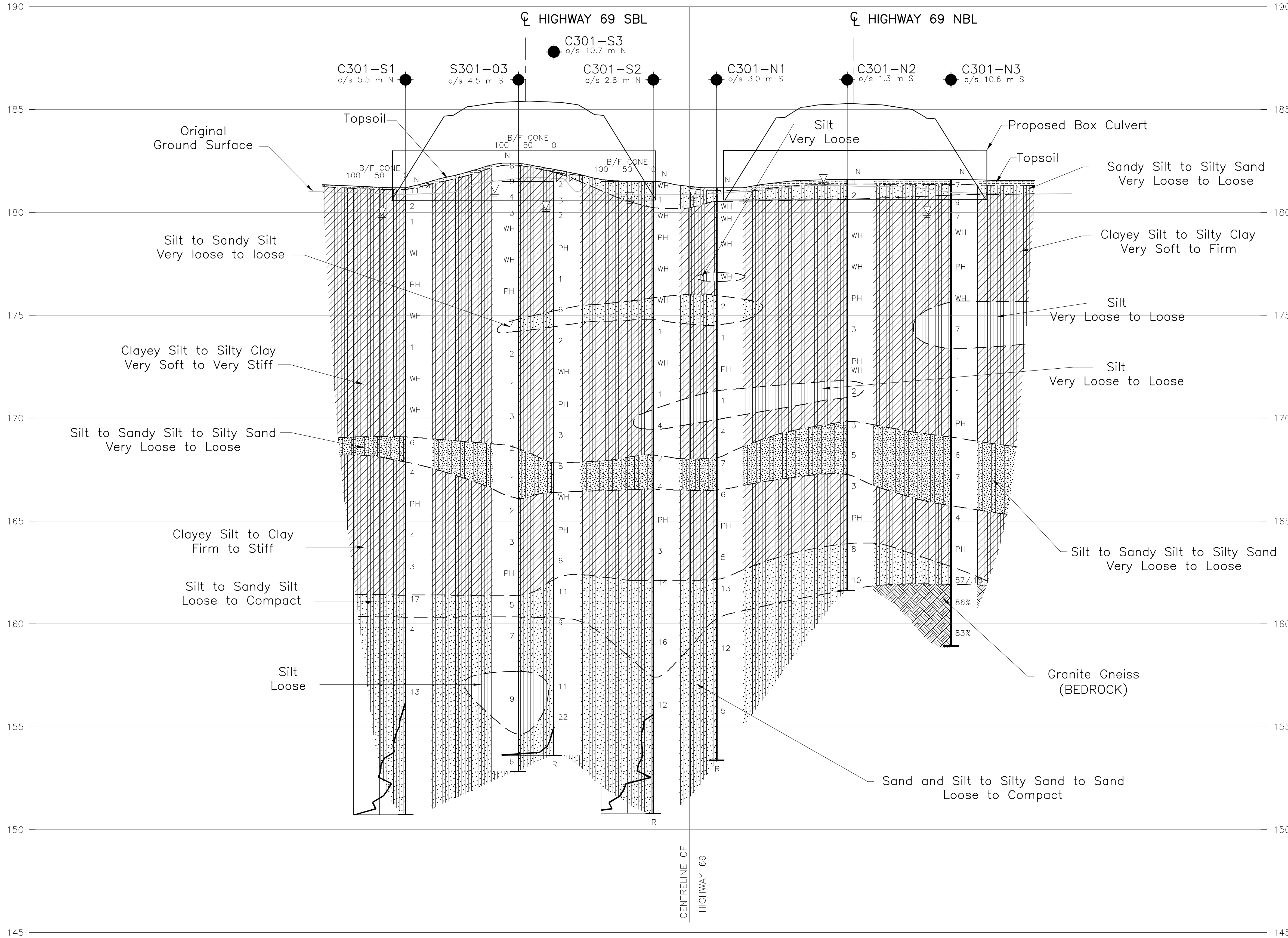
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 5404–05–01

HIGHWAY 69
CULVERT 301 13+810
SOIL STRATA

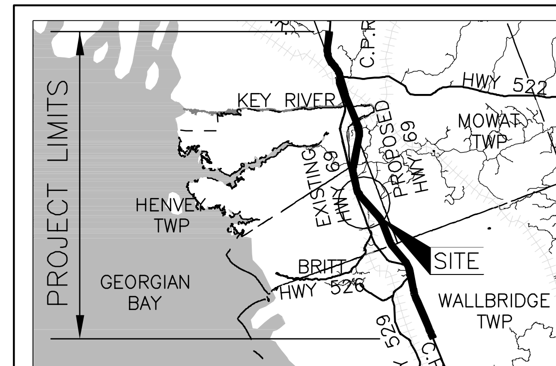
SHEET

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



A-A' / A1 CULVERT 301 AT STA 13+810
HIGHWAY 69

HORIZONTAL SCALE 5 0 5 10 m
2 0 2 4 m VERTICAL SCALE



KEY PLAN
SCALE 6 0 6 12 km

LEGEND

●	Borehole – Current Investigation
N	Standard Penetration Test Value
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
100%	Rock Quality Designation (RQD)
▽	WL upon completion of drilling
R	Refusal

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
S301–03	182.4	5076355.4	223953.3
C301–S1	181.2	5076349.2	223937.5
C301–S2	181.5	5076373.2	223956.0
C301–S3	181.5	5076367.3	223942.8
C301–N1	181.2	5076376.5	223965.1
C301–N2	181.6	5076390.8	223972.2
C301–N3	181.6	5076396.4	223986.9

NOTES

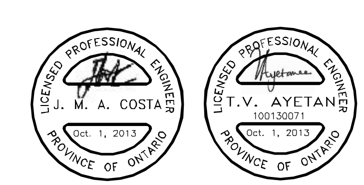
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

Cross–Section drawing provided in digital format by URS for Culvert 13+810.dwg, received July 5, 2012.



NO.	DATE	BY	REVISION

Geocres No. 41H–128

HWY. 69		PROJECT NO. 09–1111–6014	DIST.
SUBM'D. CC	CHKD. TVA	DATE: March 2013	SITE: 44–626/C1&C2
DRAWN: DD/JFC	CHKD. CN	APPD. JPD/JMAC	DWG. A2

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

I.	**GENERAL**
π	3.1416
ln x,	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety
II.	**STRESS AND STRAIN**
γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility
III.	**SOIL PROPERTIES**
(a)	**Index Properties**
$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

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

(a)	**Index Properties (continued)**
w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)
(b)	**Hydraulic Properties**
h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume
(c)	**Consolidation (one-dimensional)**
C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}
(d)	**Shear Strength**
τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
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 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)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive) 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	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 S301-03

SHEET 1 OF 3

METRIC

PROJECT 09-1111-6014
W.P. 5404-05-01
LOCATION N 5076355.4 ;E 223953.3
ORIGINATED BY ARM
DIST HWY 69
BOREHOLE TYPE NW Casing, Wash Boring
COMPILED BY TT
DATUM Geodetic
DATE February 26 and 27, 2012
CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.4	GROUND SURFACE								
0.0	TOPSOIL								
0.1	CLAYEY SILT, some sand, containing organics and rootlets Firm to stiff Brown Moist		1	SS	8		182		
			2	SS	9				
180.9						▽	181		
1.5	SILTY CLAY, trace sand Soft to firm Grey Wet		3	SS	4				
			4	SS	3		180		
			5	SS	WH		179		
			6	SS	WH		178		0 3 52 45
			7	TO	PH		177		
174.8							176		
7.6	SILT, some sand, trace to some clay Loose Grey Wet		8	SS	7		175		0 19 74 7
174.2									
8.2	CLAYEY SILT, trace sand Firm Grey Wet		9	SS	2		174		
			10	SS	1		173		
170.8							172		
11.6	SILTY CLAY, trace sand Stiff Grey Wet		11	SS	3		171		
							170		
168.7							169		
13.7	Sandy SILT, trace to some clay Very loose Grey Wet		12	SS	2		168		0 21 73 6

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH kPa (20 40 60 80 100)
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) (20 40 60)

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

Continued Next Page

Golder Associates

RECORD OF BOREHOLE No S301-03 SHEET 2 OF 3 METRIC

PROJECT 09-1111-6014 | W.P. 5404-05-01 | LOCATION N 5076355.4 ;E 223953.3 | ORIGINATED BY ARM
DIST | HWY 69 | BOREHOLE TYPE NW Casing, Wash Boring | COMPILED BY TT
DATUM Geodetic | DATE February 26 and 27, 2012 | CHECKED BY TZ

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 ● 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
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Sandy SILT, trace to some clay Very loose Grey Wet		13	SS	1		167				
166.1											
16.3	CLAY Stiff Grey Wet		14	SS	2		166				
							165	4 4			
			15	SS	3		164				
			16	TO	PH		163	2 3			
161.4							162	>96			
21.0	SILT, some sand, trace clay Loose Grey Wet		17	SS	5		161				0 18 77 5
159.8							160				
22.6	Silty SAND, trace gravel, trace clay Loose Grey Wet		18	SS	7		159				
157.7							158				
24.7	SILT, some sand, trace clay Loose Grey Wet		19	SS	9		157				0 15 81 4
154.7							156				
27.7	Silty SAND, trace gravel, trace clay Loose Grey wet						155				
152.8			20	SS	6		154				
29.6	END OF BOREHOLE						153				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S301-03

SHEET 3 OF 3

METRIC

PROJECT 09-1111-6014

W.P. 5404-05-01 LOCATION N 5076355.4 ;E 223953.3 ORIGINATED BY ARM

DIST HWY 69 BOREHOLE TYPE NW Casing, Wash Boring COMPILED BY TT

DATUM Geodetic DATE February 26 and 27, 2012 CHECKED BY TZ

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	w_P w w_L 20 40 60	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	NOTE: 1. Water level in open borehole at a depth of 1.5 m below ground surface (Elev. 180.9 m) upon completion of drilling.										

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

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

Golder Associates

RECORD OF BOREHOLE No C301-S1

SHEET 1 OF 3

METRIC

PROJECT 09-1111-6014
W.P. 5404-05-01
LOCATION N 5076349.2 ;E 223937.5
ORIGINATED BY ARM
DIST HWY 69
BOREHOLE TYPE NW Casing, Wash Boring
COMPILED BY TT
DATUM Geodetic
DATE February 10 and 14, 2012
CHECKED BY CN/TVA

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 ● 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
181.2	GROUND SURFACE										
0.0	TOPSOIL										
0.1	Sandy CLAYEY SILT, containing organics Soft to stiff Brown to black Moist		1	SS	11		181				
			2	SS	2	▽	180				0 26 58 16
179.7											
1.5	SILTY CLAY, trace sand Firm Grey Wet		3	SS	1		179	4, 3			
			4	SS	WH		178				
176.7							177	3, 2			
4.5	CLAYEY SILT, some sand Firm to stiff Grey Wet		5	TO	PH						0 15 69 16
							176	2, 2			
	Silt seams at a depth of 6.4 m		6	SS	WH		175				
			7	SS	1		174	1			
							173	4			
			8	SS	WH		172				0 17 62 21
							171	3, 3			
			9	SS	WH		170	3, 4			
169.0											
12.2	SILT, some sand, some clay Loose Grey Wet		10	SS	6		169				0 19 68 13
167.9							168				
13.3	SILTY CLAY, trace sand Stiff Grey Wet		11	SS	4		167	4			

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

PROJECT 09-1111-6014

RECORD OF BOREHOLE No C301-S1

SHEET 2 OF 3

METRIC

W.P. 5404-05-01 LOCATION N 5076349.2 ;E 223937.5 ORIGINATED BY ARM

DIST HWY 69 BOREHOLE TYPE NW Casing, Wash Boring COMPILED BY TT

DATUM Geodetic DATE February 10 and 14, 2012 CHECKED BY CN/TVA

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 γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY CLAY, trace sand Stiff Grey Wet		12	TO	PH		166				
164.9							165				
16.3	CLAY Stiff Brown Wet		13	SS	4		164				
			14	SS	3		163				
161.4							162				
19.8	SILT, some sand Compact Grey Wet		15	SS	17		161				
160.3							160				
20.9	Silty SAND, trace clay Loose to compact Grey Wet		16	SS	4		159				0 67 29 4
							158				
							157				
156.2			17	SS	13		156				
25.0	END OF BOREHOLE Dynamic Cone Penetration Test (DCPT)						155				
							154				
							153				
							152				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No C301-S1

SHEET 3 OF 3

METRIC

PROJECT 09-1111-6014
W.P. 5404-05-01
LOCATION N 5076349.2 ;E 223937.5
ORIGINATED BY ARM
DIST HWY 69
BOREHOLE TYPE NW Casing, Wash Boring
COMPILED BY TT
DATUM Geodetic
DATE February 10 and 14, 2012
CHECKED BY CN/TVA

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 γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
150.7							151				
30.5	END OF DCPT										

NOTES:

1. Artesian conditions encountered when casing advanced to a depth of 20.4 m below ground surface (Elev. 160.8 m), with the water level measured at about 0.9 m above ground surface (Elev. 182.1 m).

2. Water level in open borehole at a depth of 1.4 m below ground surface (Elev.179.8 m) upon completion of drilling.

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

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

Golder Associates

RECORD OF BOREHOLE No C301-S2

SHEET 1 OF 3

METRIC

PROJECT 09-1111-6014
W.P. 5404-05-01
LOCATION N 5076373.2 ;E 223956.0
ORIGINATED BY MR
DIST HWY 69
BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring
COMPILED BY BM
DATUM Geodetic
DATE March 7, 2012
CHECKED BY CN/TVA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.5	GROUND SURFACE								
0.0	Sandy SILT, containing organics, rootlets and wood fragments Very loose Dark brown to grey Wet		1	SS	WH	▽	181		
180.1			2	SS	1				
1.4	SILTY CLAY, trace sand Very soft to soft Grey Wet		3	SS	WH		180		0 2 50 48
177.9			4	TO	PH		179	15.9	
3.6	CLAYEY SILT, trace sand Soft Grey Wet		5	SS	WH		178		
175.9							177		
5.6	SILT, trace sand, trace clay Very loose Grey Wet		6	SS	WH		176		
174.8							175		
6.7	CLAYEY SILT, trace sand Soft to firm Grey Wet		7	SS	1		174		
			8	SS	WH		173		
			9	SS	1		172		
170.4							171		
11.1	SILT, some sand, some clay Loose Grey Wet		10A 10B	SS	4		170		0 18 68 14
169.5							169		
12.0	SILTY CLAY, trace to some sand Firm to stiff Grey Wet								
168.2							168		
13.3	SILT, trace sand, trace clay Very loose Grey Wet		11	SS	2				
167.5							167		
14.0	Silty SAND, trace clay Grey Wet								
166.6			12A						

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

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No C301-S2 SHEET 2 OF 3 METRIC

PROJECT 09-1111-6014
W.P. 5404-05-01
LOCATION N 5076373.2 ;E 223956.0
ORIGINATED BY MR
DIST HWY 69
BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring
COMPILED BY BM
DATUM Geodetic
DATE March 7, 2012
CHECKED BY CN/TVA

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 γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
14.9	SILTY CLAY Stiff Grey Wet		12B	SS	4		166				
			13	TO	PH		165				
163.8							164				
17.7	CLAYEY SILT, containing silt seams Stiff Brown to grey Wet		14	SS	3		163				
162.1							162				
19.4	SILT, some sand, trace to some clay Compact Grey Wet		15	SS	14		161				1 17 71 11
			16	SS	16		160				
157.4							159				
24.1	SAND, trace silt, trace gravel Compact Grey Wet						158				
			17	SS	12		157				
155.6							156				1 96 3 0
25.9	END OF BOREHOLE Dynamic Cone Penetration Test (DCPT)						155				
							154				
							153				
							152				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No C301-S2 SHEET 3 OF 3 **METRIC**

PROJECT 09-1111-6014
W.P. 5404-05-01 LOCATION N 5076373.2 ;E 223956.0 ORIGINATED BY MR
DIST HWY 69 BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring COMPILED BY BM
DATUM Geodetic DATE March 7, 2012 CHECKED BY CN/TVA

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
	--- CONTINUED FROM PREVIOUS PAGE ---										
150.8							151	144			
30.7	END OF DCPT Refusal to Further Penetration										

NOTES:

1. Vane tests carried out on Sample No. 4 are laboratory shear vanes performed on shelby tube sample.

2. Artesian conditions encountered when advanced casing to a depth of 11.7 m below ground surface (Elev. 169.8 m), with the water level measured at about 0.8 m above ground surface (Elev. 182.3 m).

3. Water level in open borehole at a depth of 0.9 m below ground surface (Elev. 180.6 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No C301-S3

SHEET 1 OF 3

METRIC

PROJECT 09-1111-6014
W.P. 5404-05-01
LOCATION N 5076367.3 ;E 223942.8
ORIGINATED BY ARM
DIST HWY 69
BOREHOLE TYPE NW Casing, Wash Boring
COMPILED BY TT
DATUM Geodetic
DATE February 8 and 9, 2012
CHECKED BY CN/TVA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
181.5	GROUND SURFACE						
0.0	TOPSOIL						
0.1	CLAYEY SILT, some sand, trace gravel, containing organics Soft Brown Moist		1	SS	2		
			2	SS	3	▽	
180.0							
1.5	SILTY CLAY, trace sand Firm Brown becoming grey at a depth of 3.4 m Wet		3	SS	2		
			4	TO	PH		
177.4							
4.1	CLAYEY SILT, trace sand Firm Grey Wet		5	SS	1		
175.1			6A 6B	SS	6		
6.4	SILT, some sand, trace to some clay Loose Grey Wet						
174.3							
7.2	CLAYEY SILT, trace sand Firm to stiff Grey Wet		7	SS	2		
			8	SS	WH		
			9	TO	PH		
			10	SS	3		
167.8							
13.7	SILT, trace to some clay Loose Grey Wet		11	SS	8		

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 γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

0 20 71 9
Non-Plastic

Continued Next Page

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

Golder Associates

PROJECT 09-1111-6014

RECORD OF BOREHOLE No C301-S3

SHEET 2 OF 3

METRIC

W.P. 5404-05-01 LOCATION N 5076367.3 ;E 223942.8 ORIGINATED BY ARM

DIST HWY 69 BOREHOLE TYPE NW Casing, Wash Boring COMPILED BY TT

DATUM Geodetic DATE February 8 and 9, 2012 CHECKED BY CN/TVA

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 γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
166.4											
15.1	SILTY CLAY, trace sand Stiff Grey Wet		12	SS	WH		166				
			13	TO	PH		165	3 3			
			14	SS	6		164	2 2			
162.1							163				
19.4	Sandy SILT, trace to some clay Compact Grey Wet		15	SS	11		162	>96			0 28 66 6 Non-Plastic
160.6							161				
20.9	SAND, trace silt, trace gravel Loose Grey Wet		16	SS	9		160				
158.3							159				
23.2	SAND and SILT, trace to some clay Compact Grey Wet		17	SS	11		158				0 42 49 9
			18	SS	22		157				
155.0							156				
26.5	END OF BOREHOLE Dynamic Cone Penetration Test (DCPT)						155				
153.6							154				
27.9	END OF DCPT Refusal to Further Penetration (105 Blows / 0.15 m)										

Continued Next Page

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

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

Golder Associates

RECORD OF BOREHOLE No C301-S3

SHEET 3 OF 3

METRIC

PROJECT 09-1111-6014

W.P. 5404-05-01 LOCATION N 5076367.3 ;E 223942.8 ORIGINATED BY ARM

DIST HWY 69 BOREHOLE TYPE NW Casing, Wash Boring COMPILED BY TT

DATUM Geodetic DATE February 8 and 9, 2012 CHECKED BY CN/TVA

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	w_P w w_L 20 40 60	γ kN/m^3	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	NOTES: 1. Artesian conditions encountered when casing advanced to a depth of 21.3 m below ground surface (Elev. 160.2 m), with the water level measured at about 1.1 m above ground surface (Elev. 182.6 m). 2. Water level in open borehole at a depth of 1.4 m below ground surface (Elev. 180.1 m) upon completion of drilling.										

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

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

Golder Associates

RECORD OF BOREHOLE No C301-N1

SHEET 1 OF 3

METRIC

PROJECT 09-1111-6014
W.P. 5404-05-01
LOCATION N 5076376.5 ;E 223965.1
ORIGINATED BY MR
DIST HWY 69
BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring
COMPILED BY BM
DATUM Geodetic
DATE March 5 and 6, 2012
CHECKED BY CN/TVA

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
181.2	GROUND SURFACE						181				
0.0	TOPSOIL										
0.1	Silty SAND, containing organics, wood fragments and roots		1	SS	1	▽					
180.5	Very loose						180				
0.7	Dark brown Moist		2	SS	WH						
	SILTY CLAY, trace sand Firm Grey Wet		3	SS	WH						
							179	6			
			4	SS	WH						
							178	7 5			
177.1											
4.1	SILT, trace to some sand, trace clay		5A 5B	SS	WH		177				
176.6	Very loose										
4.6	Grey Wet						176	4			
176.0	CLAYEY SILT, trace to some sand										
5.2	Firm Grey Wet										
	Sandy SILT, trace to some clay Very loose Grey Wet		6	SS	2		175				0 21 72 7
174.5											
6.7	CLAYEY SILT, trace to some sand Firm Grey Wet						174				
			7	SS	1						
							173	6 5			
			8	TO	PH						
							172	5 5			
171.3											
9.9	SILT, some sand, trace to some clay Very loose Grey Wet		9	SS	1		171				0 19 74 7
169.9											
11.3	CLAYEY SILT, trace to some sand, containing sandy silt seams Firm Grey Wet		10	SS	4		170				
168.1							169	6 5			
13.1	Sandy SILT, some clay Loose Grey Wet		11	SS	7		168				0 20 66 14
166.3											
			12A				167				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No C301-N1 SHEET 2 OF 3 METRIC

PROJECT 09-1111-6014 | W.P. 5404-05-01 | LOCATION N 5076376.5 ;E 223965.1 | ORIGINATED BY MR
DIST HWY 69 | BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring | COMPILED BY BM
DATUM Geodetic | DATE March 5 and 6, 2012 | CHECKED BY CN/TVA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---								
14.9	CLAY Stiff Brown to grey Moist		12B	SS	6		166		
							165		
			13	TO	PH				
163.8							164		
17.4	CLAYEY SILT, containing silt seams stiff Brown to grey Wet		14	SS	5		163		
162.1									
19.1	Sandy SILT Compact Grey Wet		15	SS	13		162		
160.0							161		
21.2	SAND, trace silt Loose to compact Grey Wet		16	SS	12		160		
							159		
							158		
							157		
			17	SS	5		156		0 98 2 0
							155		
153.4							154		
27.8	END OF BOREHOLE SPOON AND CASING REFUSAL		18	SS	50/0.0				

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

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No C301-N1

SHEET 3 OF 3

METRIC

PROJECT 09-1111-6014

W.P. 5404-05-01 LOCATION N 5076376.5 ;E 223965.1 ORIGINATED BY MR

DIST HWY 69 BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring COMPILED BY BM

DATUM Geodetic DATE March 5 and 6, 2012 CHECKED BY CN/TVA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ kN/m^3	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	WATER CONTENT (%) 20 40 60		

NOTES:

1. Water level in casing at a depth of 1.5 m below ground surface (Elev. 179.7 m) at 5:30 pm on March 5, 2012, when casing advanced to a depth of 19.4 m (Elev. 161.8 m).

2. Artesian conditons observed in casing with water level at 0.7 m above ground surface (Elev. 181.9 m) at 7:30 am on March 6, 2012.

3. Sand blow back encountered when advanced casing to a depth of 23.8 m below ground surface (Elev. 157.4 m).

4. Water level in open borehole at a depth of 0.5 m below ground surface (Elev. 180.7 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No C301-N2 SHEET 1 OF 2 METRIC

PROJECT 09-1111-6014
W.P. 5404-05-01
LOCATION N 5076390.8 ;E 223972.2
ORIGINATED BY MR
DIST HWY 69
BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring
COMPILED BY MAS
DATUM Geodetic
DATE March 9, 2012
CHECKED BY CN/TVA

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 ● 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
181.6	GROUND SURFACE										
0.0	TOPSOIL		1A	SS	1	▽	181				
181.0	Sandy SILT, trace clay, containing organics and rootlets		1B								
0.6	Very loose										
180.5	Grey		2A	SS	2						0 51 35 14
1.1	SAND and SILT, some clay		2B				180	6 6			
	Very loose										
	Brown to grey										
	Wet										
	SILTY CLAY, containing silt seams										
	Soft										
179.3	Grey						179				
2.3	Wet										
	CLAYEY SILT, trace sand		3	SS	WH						
	Soft to firm										
	Grey						178	6 6			
	Wet		4	SS	WH						0 5 70 25
							177				
								4 4			
			5	TO	PH		176				
							175	4 3			
			6	SS	3						
							174				
								6 5			
			7	TO	PH		173				
			8	SS	WH						
171.8							172				
9.8	SILT, trace sand, trace clay										
	Very loose										
	Grey										
171.1	Wet		9A	SS	2		171				
10.5	SILTY CLAY, containing silt and sand seams		9B								
	Firm										
	Grey							5			
	Wet						170	1			
169.8											
11.8	SILT, some sand, some clay		10	SS	3						0 18 62 20
	Very loose to loose						169				
	Grey										
	Wet										
			11	SS	5		168				
167.3											
14.3							167				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No C301-N2

SHEET 2 OF 2

METRIC

PROJECT 09-1111-6014
W.P. 5404-05-01
LOCATION N 5076390.8 ;E 223972.2
ORIGINATED BY MR
DIST HWY 69
BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring
COMPILED BY MAS
DATUM Geodetic
DATE March 9, 2012
CHECKED BY CN/TVA

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 (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	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
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY CLAY, containing silt seams Stiff Grey Wet		12	SS	3		166	+ 4, 4	○		
			13	TO	PH		165	+ 3, 3			
163.9											
17.7	Sandy SILT, trace to some clay, containing sand seams Loose to compact Grey Wet		14	SS	8		164				
							163				
161.6			15	SS	10		162		○		0 27 63 10
20.0	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 0.2 m below ground surface (Elev. 181.4 m) upon completion of drilling.										

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No C301-N3 SHEET 1 OF 2 METRIC

PROJECT 09-1111-6014
W.P. 5404-05-01
LOCATION N 5076396.4 ;E 223986.9
ORIGINATED BY MR
DIST HWY 69
BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring
COMPILED BY MAS
DATUM Geodetic
DATE March 10, 2012
CHECKED BY CN/TVA

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 ● 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
181.6	GROUND SURFACE										
0.0	TOPSOIL										
0.2	Silty SAND, containing organics and roots Loose Brown Moist		1A 1B	SS	7		181				
180.8											
0.8	CLAYEY SILT, trace sand, containing sand seams Firm Grey Wet		2	SS	9	▽	180				0 2 76 22
			3	SS	7						
			4	SS	WH		179				
			5	TO	PH		178	4 5			
							177	5 4			
175.8											
5.8	SILT, trace to some sand, trace clay Very loose to loose Grey Wet		6A 6B	SS	WH		176				
			7	SS	7		175				
173.4											
8.2	CLAYEY SILT, containing silt seams Firm Grey Wet		8	SS	1		174				
			9	SS	1		173	5 5			
			10	TO	PH		172	4 4			
169.1							171				
12.5	SILT, some sand, trace clay Loose Grey Wet		11	SS	6		170				
167.3							169				
14.3	Sandy SILT, trace clay Loose Grey Wet		12	SS	7		168				
							167				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No C301-N3

SHEET 2 OF 2

METRIC

PROJECT 09-1111-6014
W.P. 5404-05-01
LOCATION N 5076396.4 ;E 223986.9
ORIGINATED BY MR
DIST HWY 69
BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring
COMPILED BY MAS
DATUM Geodetic
DATE March 10, 2012
CHECKED BY CN/TVA

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
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Sandy SILT, trace clay Loose Grey Wet										
165.7							166				
15.9	CLAY Stiff Grey Wet		13	SS	4		165				
							164	5, 5			
			14	TO	PH						
162.9							163				
18.7	Sandy SILT, trace to some clay Compact Grey Wet										
161.9			15	SS	57/.18		162				0 23 67 10
19.7	Granite Gneiss (BEDROCK) Bedrock cored from depths of 19.7 m to 22.7 m For bedrock coring details, refer to Record of Drillhole C301-N3		1	RC	REC 98%		161				RQD = 86%
			2	RC	REC 100%		160				RQD = 83%
158.9							159				
22.7	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 1.7 m below ground surface (Elev. 179.9 m) upon completion of drilling.										

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

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

PROJECT: 03-1112-001 T-6000

RECORD OF DRILLHOLE: C301-N3

SHEET 1 OF 1

LOCATION: N 5076396.4 ;E 223986.9

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: D25 Track Mount

DRILLING CONTRACTOR: WALKER DRILLING

JN - Joint; FLT - Fault; SH - Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO - Foliation; CO - Contact; OR - Orthogonal; CL - Cleavage
PL - Planar; CU - Curved; UN - Undulating; ST - Stepped; IR - Irregular
PO - Polished; K - Slickensided; SM - Smooth; RO - Rough; VR - Very Rough
MB - Mechanical Break; BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 m (5 10 15 20)	DISCONTINUITY DATA: B Angle (0 30 60 90)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC 'Q' AVG.	NOTES
		Continued from Record of Borehole C301-N3		161.91																
20	NW Casing	GRANITE GNEISS Fresh, foliated, medium crystalline, slightly porous, strong, grey, pink and black		19.69	1											3				
21	NQRC March 10, 2012																			
22					2											2				
				158.92																
		END OF DRILLHOLE		22.68																
23																				
24																				
25																				
26																				
27																				
28																				
29																				

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MR

CHECKED: MAS/TVA

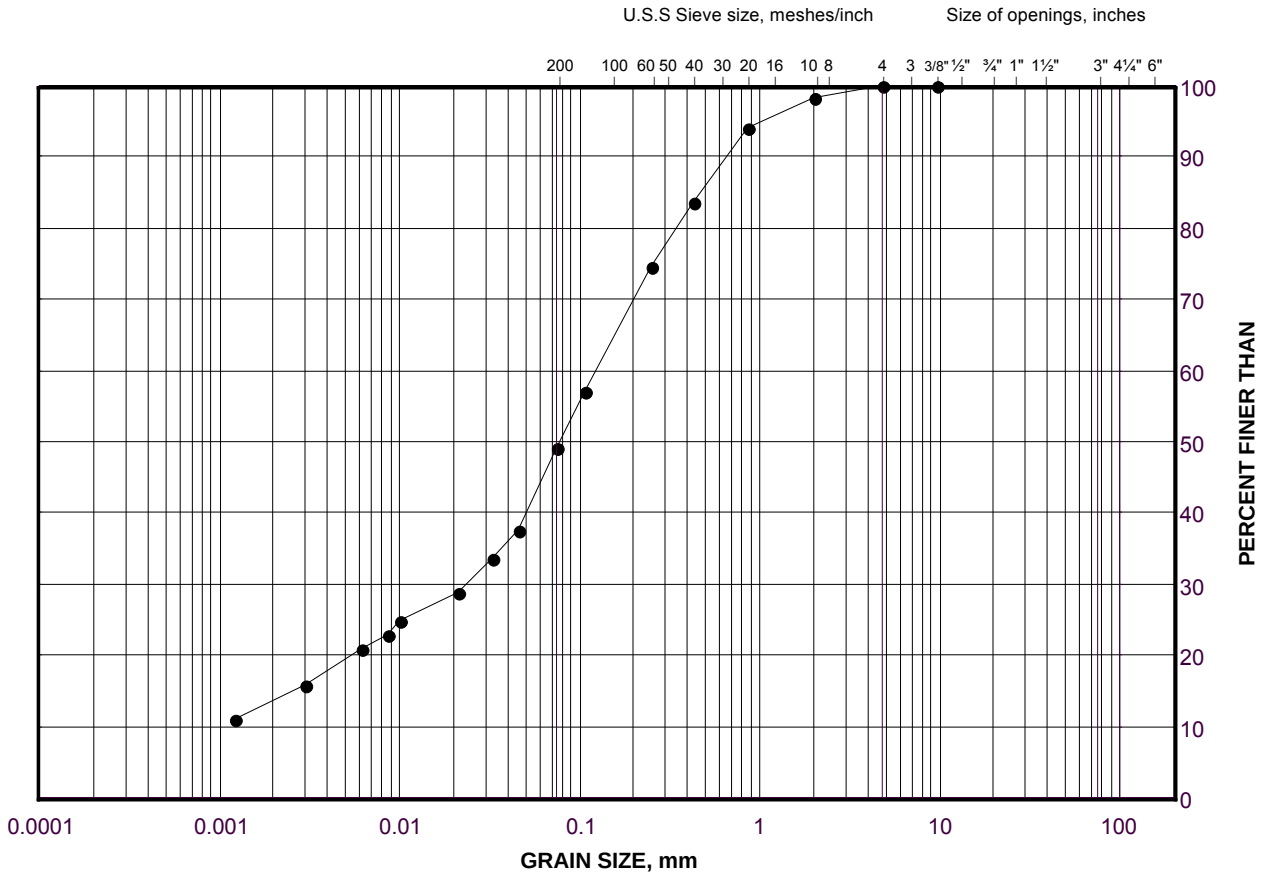
GTA-RCK 018 09-1111-6014.GPJ GAL-MISS.GDT 03/27/13 JFC

GRAIN SIZE DISTRIBUTION

Sand and Silt

Highway 69 (SBL and NBL) Culvert C301

FIGURE A.C301-01A



LEGEND

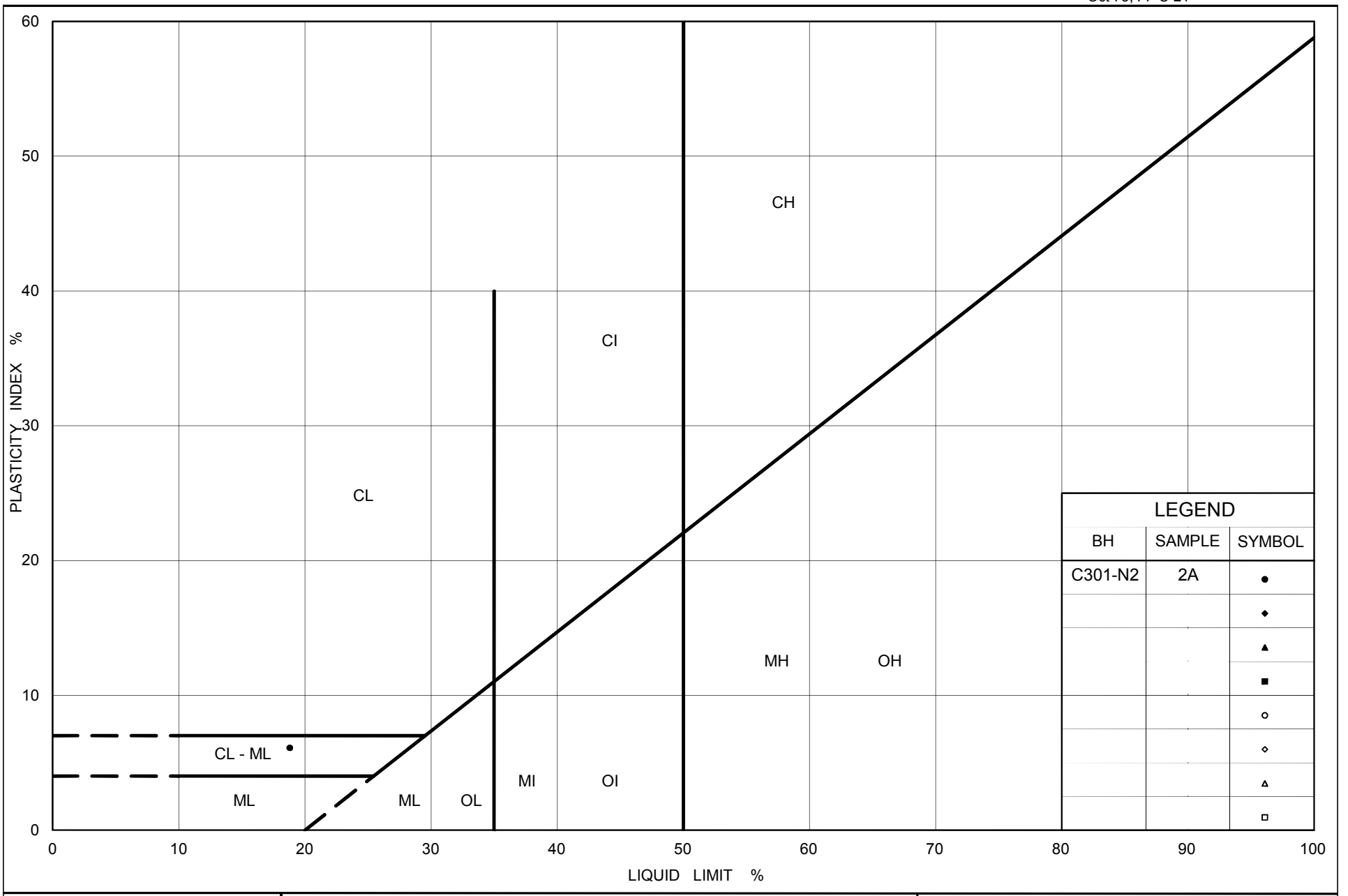
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C301-N2	2A	180.7

Project Number: 09-1111-6014

Checked By: TVA

Golder Associates

Date: 15-Feb-13



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt to Silt of Slight Plasticity (Sand and Silt)
Highway 69 (SBL and NBL) Culvert C301

Figure No. A.C301-01B

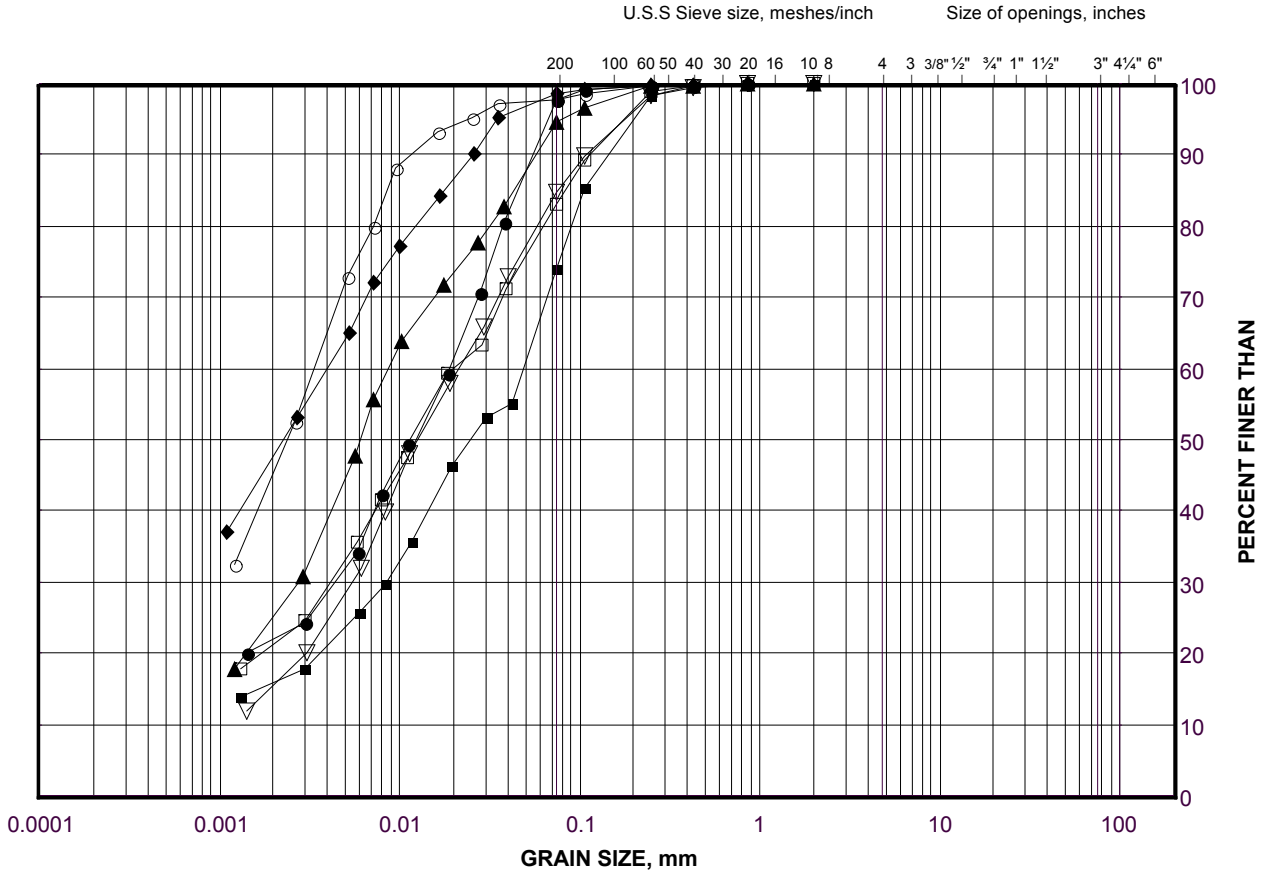
Project No. 09-1111-6014

Checked By: TVA

GRAIN SIZE DISTRIBUTION

Clayey Silt to Silty Clay (Upper Deposit)
Highway 69 (SBL and NBL) Culvert C301

FIGURE A.C301-02A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C301-N3	2	180.4
■	C301-S1	2	180.1
◆	C301-S2	3	179.7
▲	C301-N2	4	177.2
▽	C301-S1	5	176.4
❍	S301-03	6	177.5
□	C301-S1	8	171.8

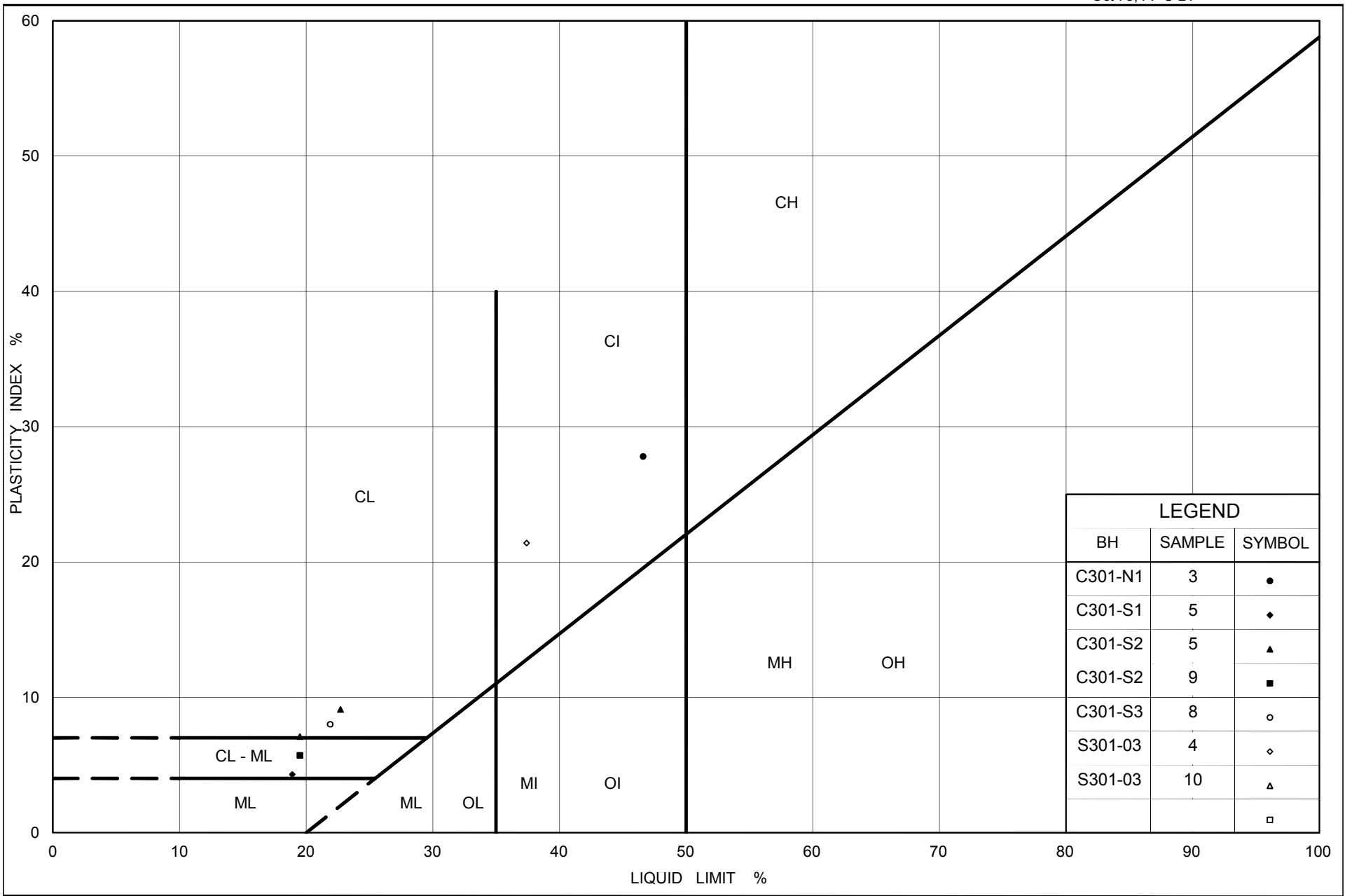
Project Number: 09-1111-6014

Checked By: TVA

Golder Associates

Date: 15-Feb-13

Oct 75, FF-S-21



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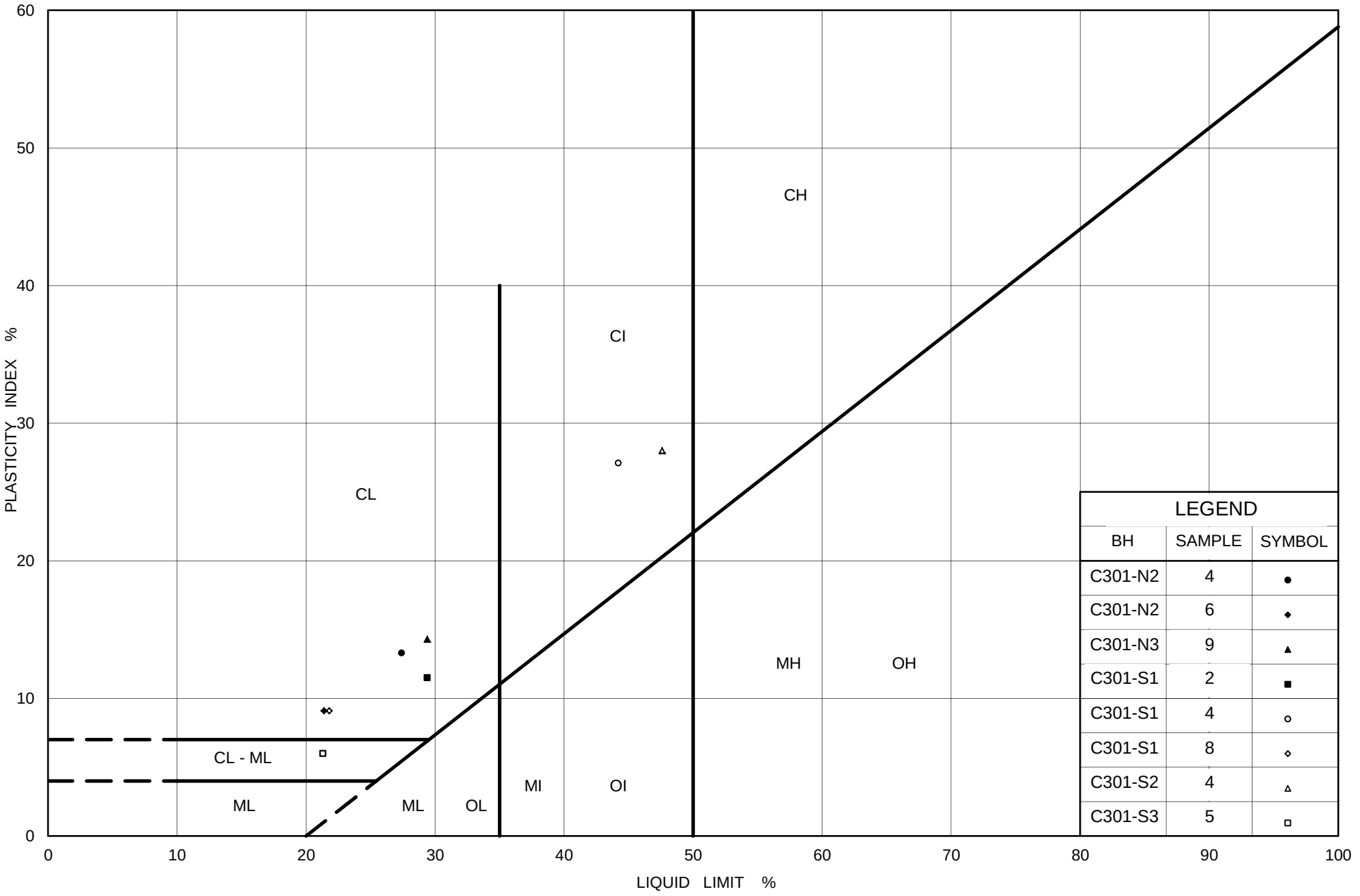
Ontario

PLASTICITY CHART
Clayey Silt to Silty Clay (Upper Deposit)
Highway 69 (SBL and NBL) Culvert C301

Figure No. A.C301-02B-1

Project No. 09-1111-6014

Checked By: TVA



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt to Silty Clay (Upper Deposit)
Highway 69 (SBL and NBL) Culvert C301

Figure No. A.C301-02B-2

Project No. 09-1111-6014

Checked By: TVA

CONSOLIDATION TEST SUMMARY
Highway 69 (SBL and NBL) Culvert C301

FIGURE A.C301-03
Sheet 1 of 4

SAMPLE IDENTIFICATION

Project Number	09-1111-6014	Sample Number	4
Borehole Number	C301-S2	Sample Depth, m	2.8

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	3		
Date Started	9/28/2012		
Date Completed	10/27/2012		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m^3	15.92
Sample Diameter, cm	6.32	Dry Unit Weight, kN/m^3	9.70
Area, cm^2	31.40	Specific Gravity, measured	2.77
Volume, cm^3	79.76	Solids Height, cm	0.907
Water Content, %	64.22	Volume of Solids, cm^3	28.47
Wet Mass, g	129.50	Volume of Voids, cm^3	51.29
Dry Mass, g	78.86	Degree of Saturation, %	98.7

TEST COMPUTATIONS

Stress kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	2.540	1.802	2.540				
5.92	2.535	1.796	2.538	7	1.95E-01	3.26E-04	6.23E-06
10.82	2.530	1.790	2.532	184	7.39E-03	4.26E-04	3.08E-07
20.63	2.523	1.782	2.526	487	2.78E-03	2.85E-04	7.76E-08
40.20	2.503	1.761	2.513	190	7.05E-03	3.88E-04	2.68E-07
20.84	2.508	1.766	2.506				
10.77	2.512	1.771	2.510				
20.61	2.508	1.766	2.510	90	1.48E-02	1.80E-04	2.62E-07
40.15	2.501	1.759	2.505	118	1.13E-02	1.27E-04	1.40E-07
79.27	2.470	1.724	2.485	240	5.46E-03	3.21E-04	1.72E-07
157.20	2.324	1.563	2.397	2940	4.14E-04	7.38E-04	2.99E-08
312.87	1.983	1.187	2.153	2160	4.55E-04	8.61E-04	3.84E-08
624.49	1.777	0.960	1.880	1033	7.25E-04	2.60E-04	1.85E-08
1248.90	1.625	0.792	1.701	595	1.03E-03	9.60E-05	9.70E-09
2494.56	1.501	0.655	1.563	454	1.14E-03	3.92E-05	4.38E-09
1248.90	1.507	0.662	1.504				
312.87	1.550	0.710	1.529				
79.27	1.606	0.771	1.578				
20.63	1.664	0.835	1.635				
5.92	1.693	0.868	1.679				

Note:
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.69	Unit Weight, kN/m^3	19.43
Sample Diameter, cm	6.32	Dry Unit Weight, kN/m^3	14.54
Area, cm^2	31.40	Specific Gravity, measured	2.77
Volume, cm^3	53.17	Solids Height, cm	0.907
Water Content, %	33.60	Volume of Solids, cm^3	28.47
Wet Mass, g	105.36	Volume of Voids, cm^3	24.70
Dry Mass, g	78.86		

Prepared By: LFG

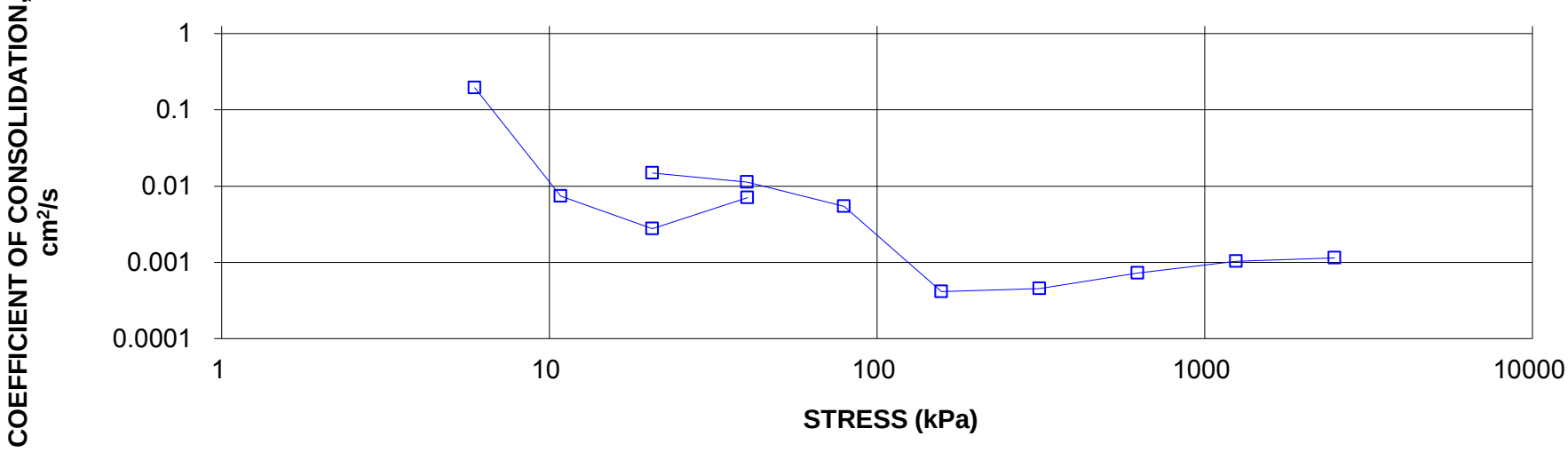
Golder Associates

Checked By: TVA

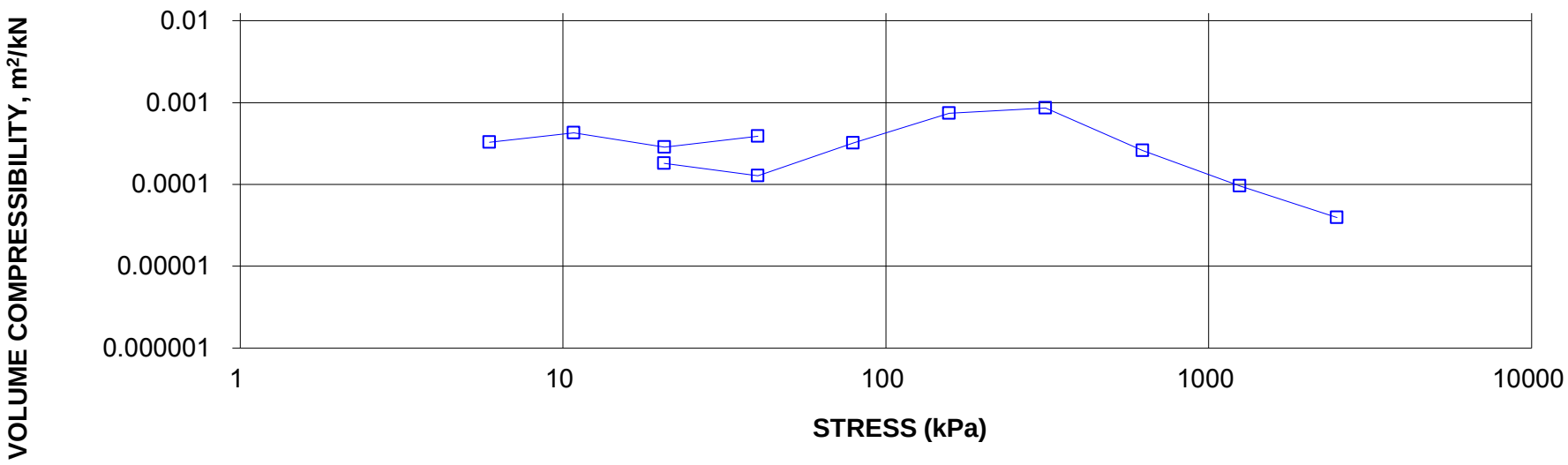
CONSOLIDATION TEST SUMMARY
Highway 69 (SBL and NBL) Culvert C301

FIGURE A.C301-03
Sheet 2 of 4

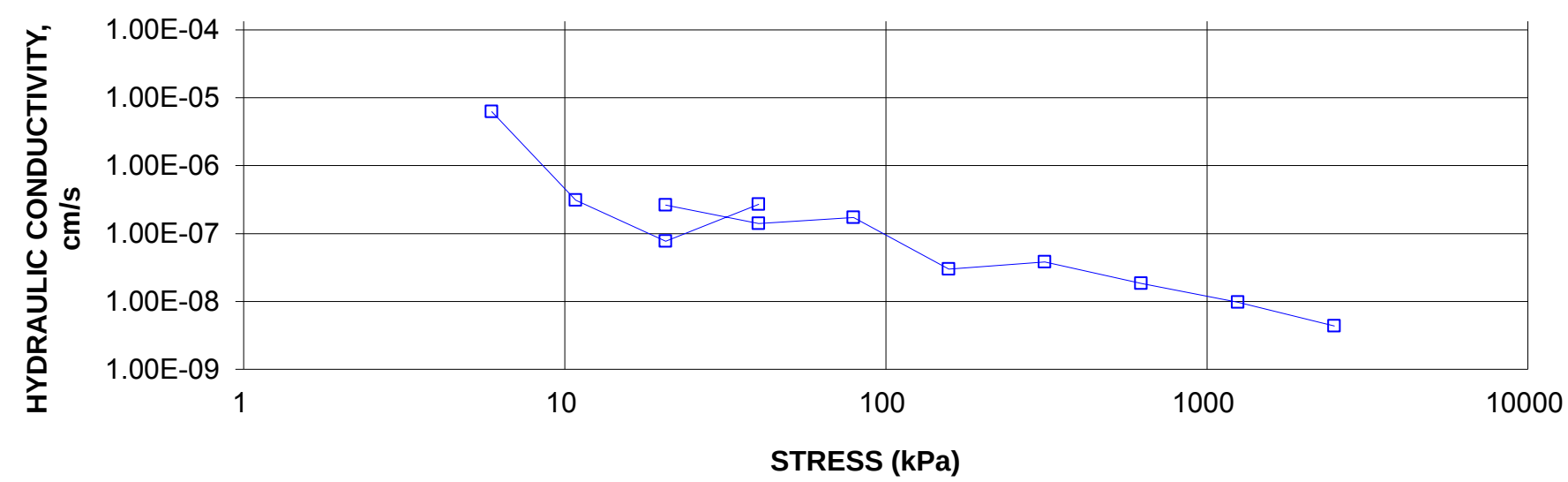
CONSOLIDATION TEST
CV cm^2/s VS STRESS (kPa)
BH C301-S2 SA 4



CONSOLIDATION TEST
MV m^2/kN vs STRESS (kPa)
BH C301-S2 SA 4



CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs STRESS
BH C301-S2 SA 4

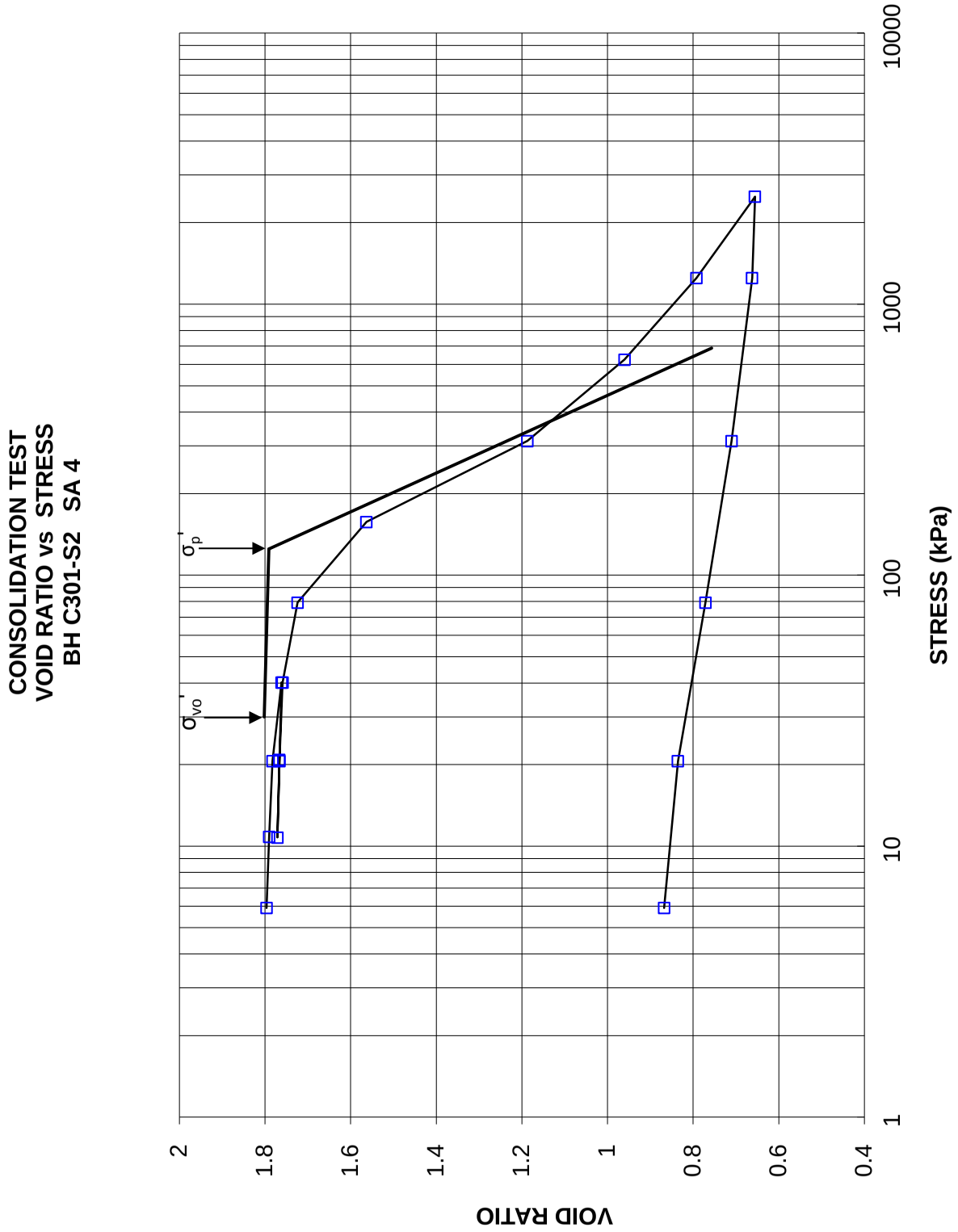


Project No. 09-1111-6014
Prepared By: LFG

Golder Associates

Checked By: TVA

CONSOLIDATION TEST VOID RATIO VS LOG STRESS	FIGURE A.C301-03 Sheet 3 of 4



Project No. 09-1111-6014

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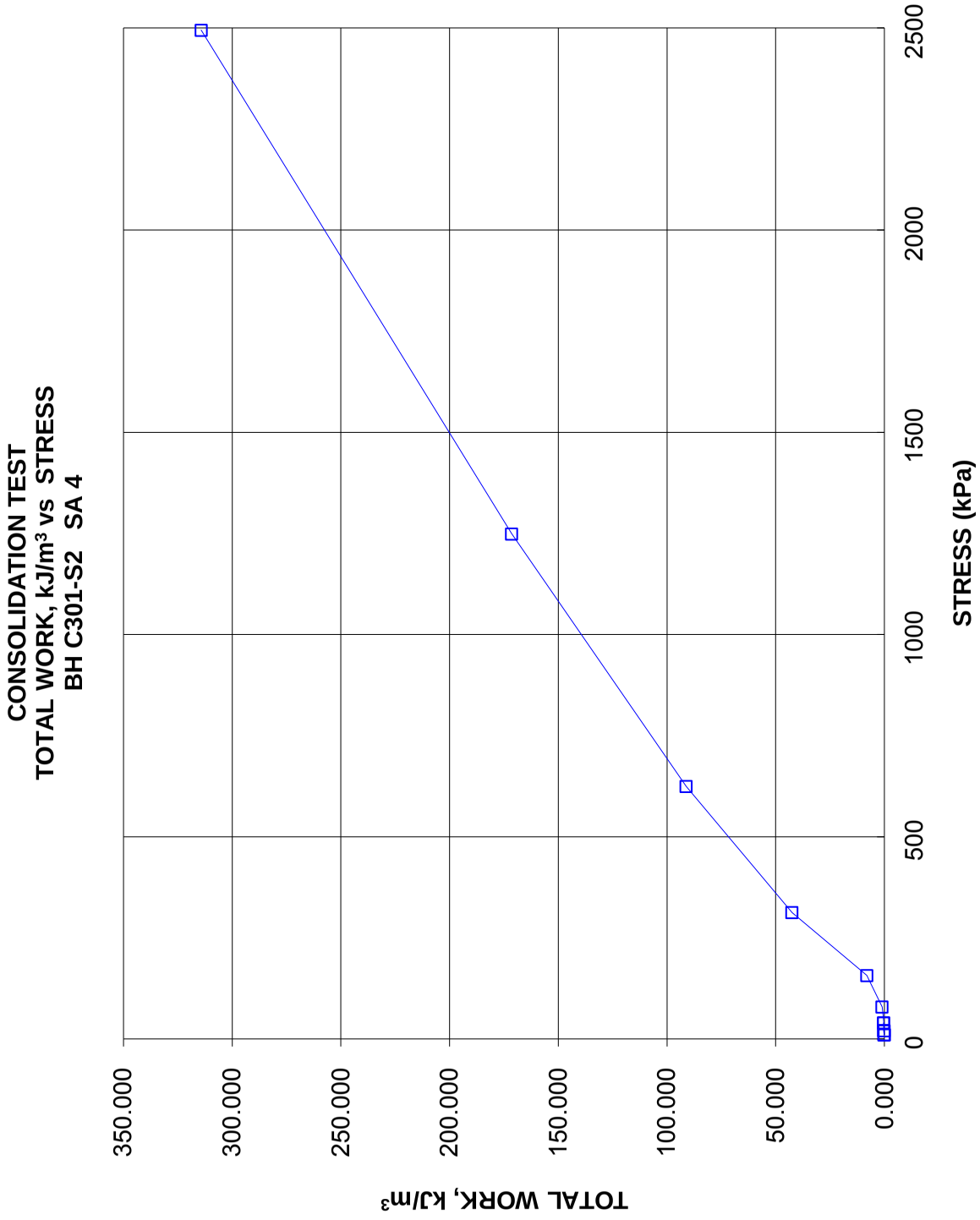
CONSOLIDATION TEST
TOTAL WORK VS STRESS

FIGURE A.C301-03
Sheet 4 of 4



Project No. 09-1111-6014

Prepared By: LFG

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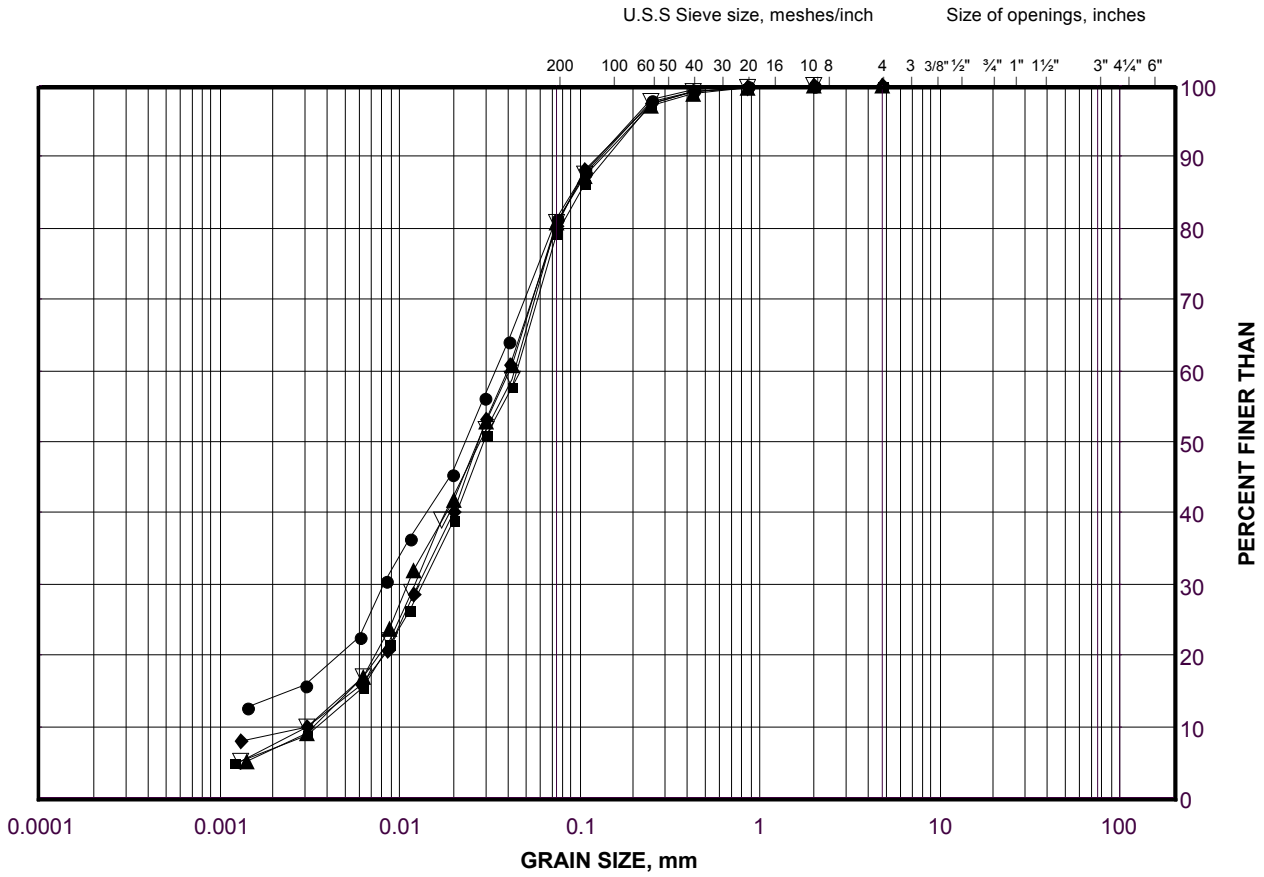
Checked By: TVA

GRAIN SIZE DISTRIBUTION

Silt to Sandy Silt (Pockets)
Highway 69 (SBL and NBL) Culvert C301

FIGURE A.C301-04



LEGEND

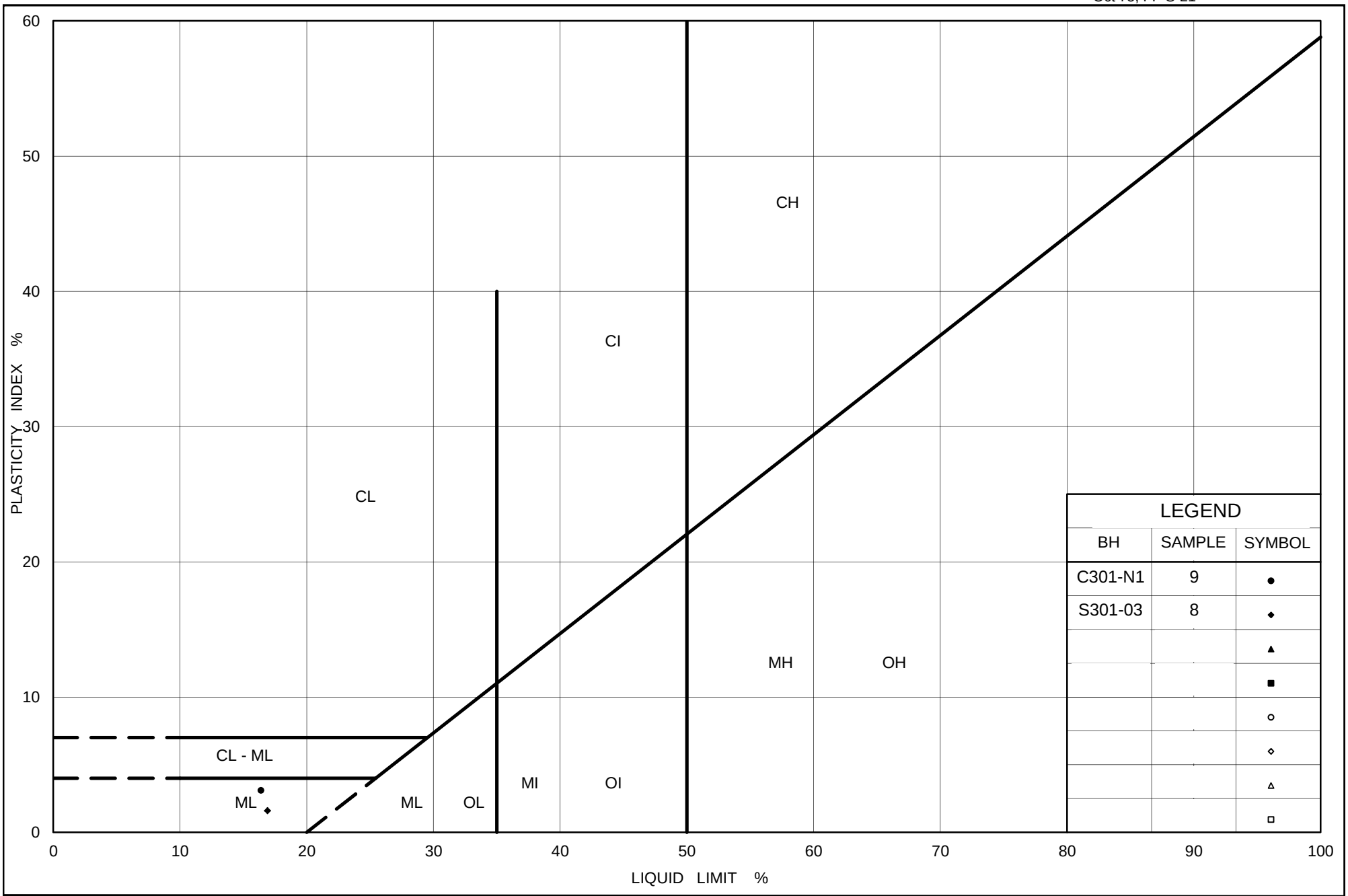
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C301-S2	10A	169.7
■	C301-N1	6	175.3
◆	C301-S3	6B	175.0
▲	S301-03	8	174.5
▽	C301-N1	9	170.7

Project Number: 09-1111-6014

Checked By: TVA

Golder Associates

Date: 15-Feb-13



Ministry of Transportation

Ontario

PLASTICITY CHART
Silt of Slight Plasticity (Pockets)
Highway 69 (SBL and NBL) Culvert C301

Figure No. A.C301-05

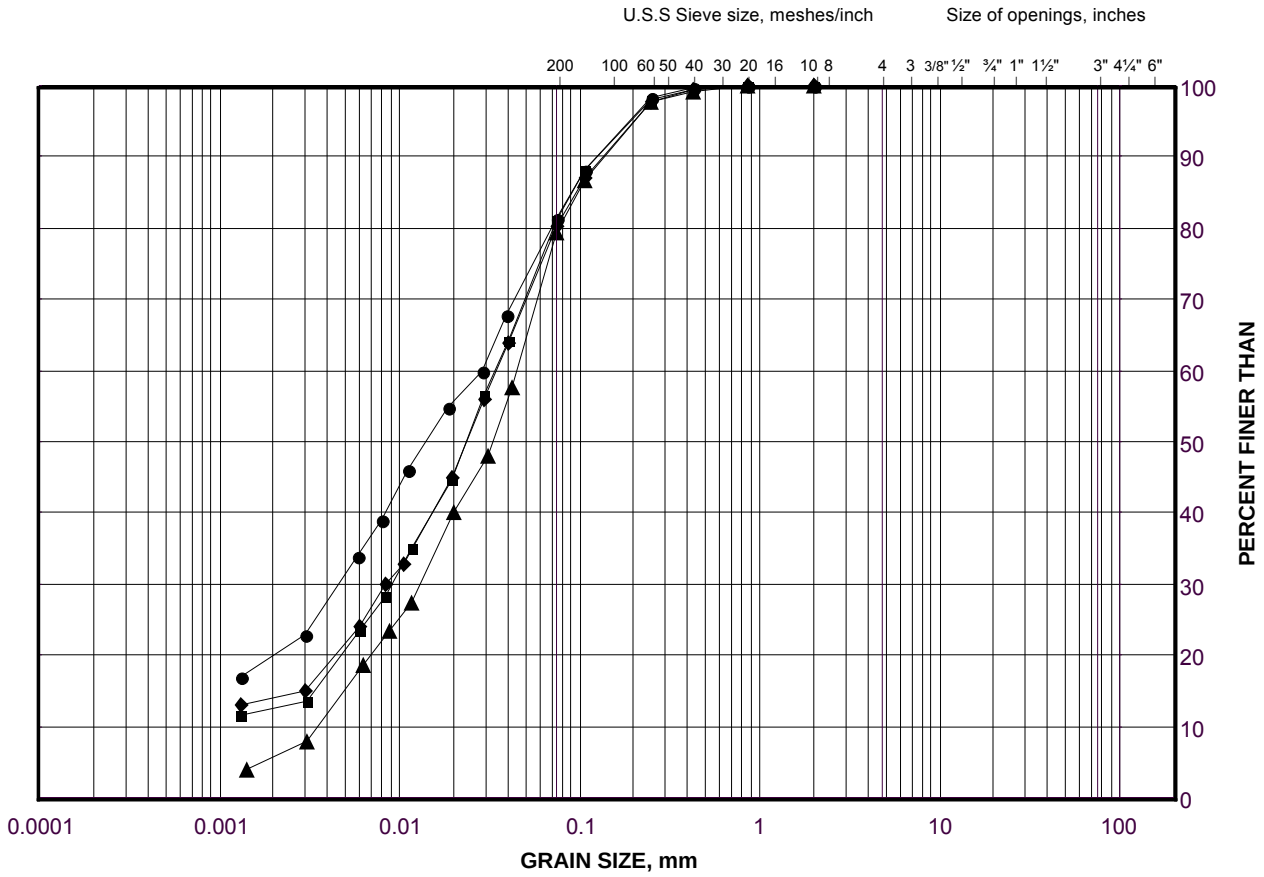
Project No. 09-1111-6014

Checked By: TVA

GRAIN SIZE DISTRIBUTION

Silt to Sandy Silt (Interlayer)
Highway 69 (SBL and NBL) Culvert C301

FIGURE A.C301-06



LEGEND

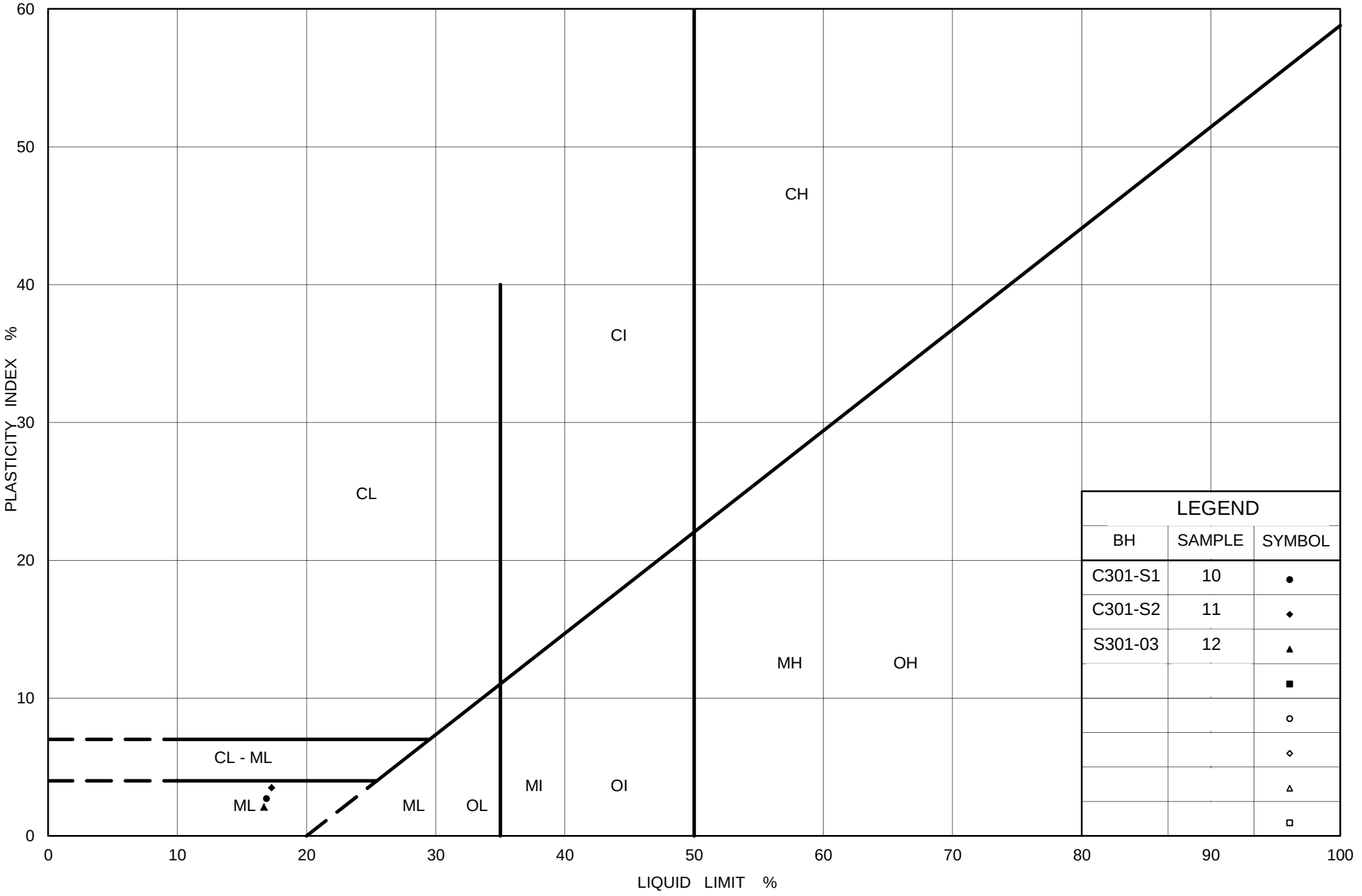
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C301-N2	10	169.6
■	C301-S1	10	168.7
◆	C301-N1	11	167.6
▲	S301-03	12	168.4

Project Number: 09-1111-6014

Checked By: TVA

Golder Associates

Date: 01-Feb-13



Ministry of Transportation

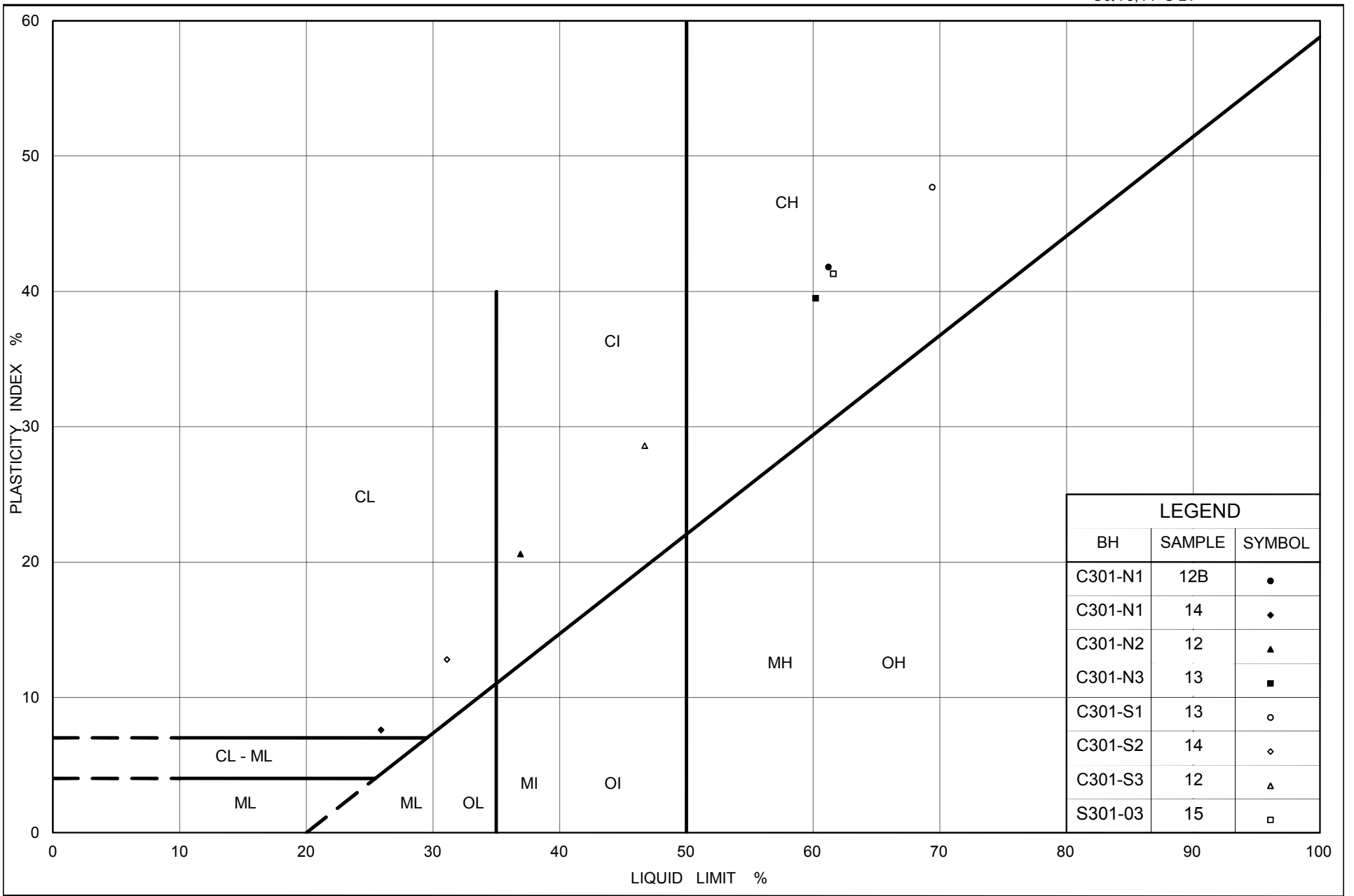
Ontario

PLASTICITY CHART
Silt to Sandy Silt of Slight Plasticity (Interlayer)
Highway 69 (SBL and NBL) Culvert C301

Figure No. A.C301-07

Project No. 09-1111-6014

Checked By: TVA



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt to Clay (Lower Deposit)
Highway 69 (SBL and NBL) Culvert C301

Figure No. A.C301-08

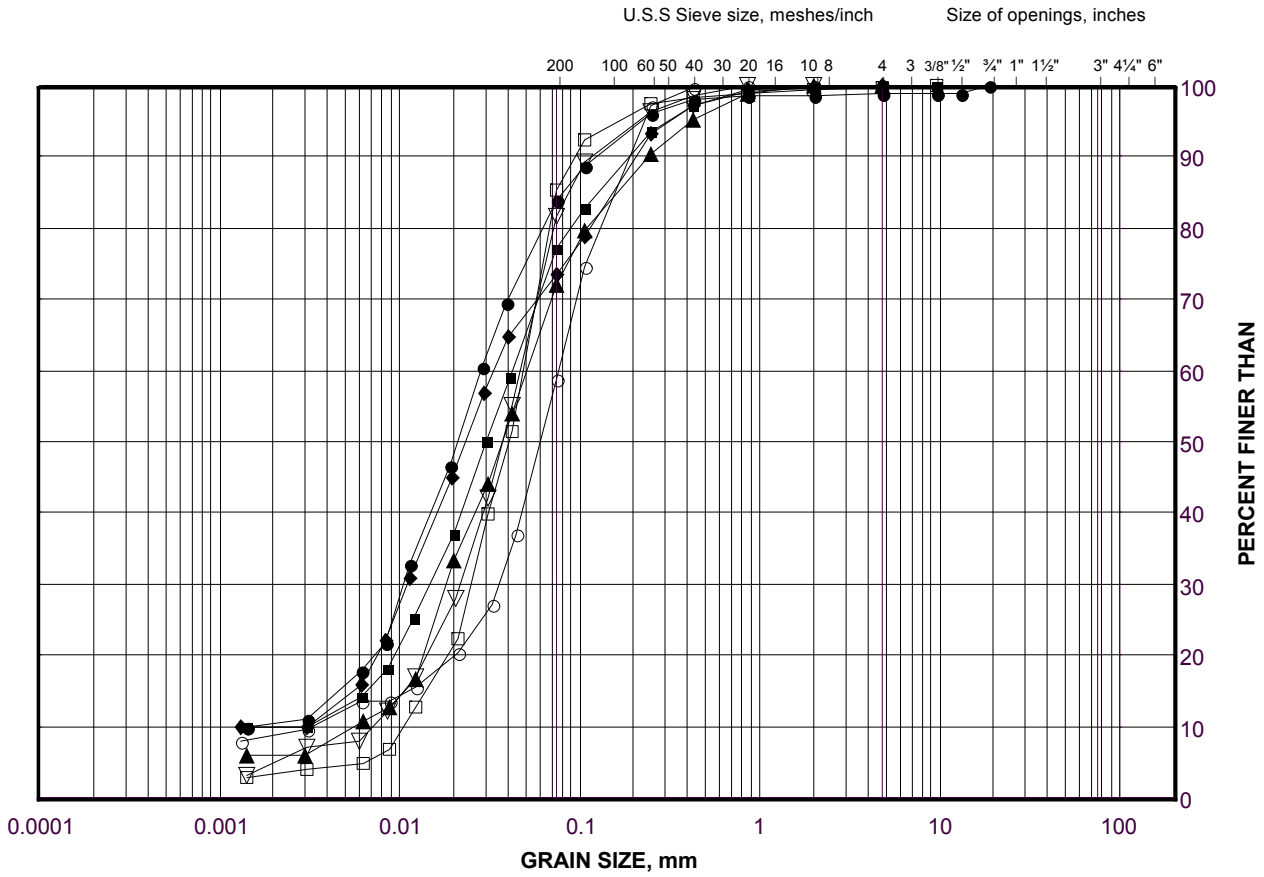
Project No. 09-1111-6014

Checked By: TVA

GRAIN SIZE DISTRIBUTION

Silt to Sandy Silt to Sand and Silt
Highway 69 (SBL and NBL) Culvert C301

FIGURE A.C301-09A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C301-S2	15	161.8
■	C301-N3	15	162.1
◆	C301-N2	15	161.9
▲	C301-S3	15	161.4
▽	S301-03	17	160.8
❍	C301-S3	17	156.8
□	S301-03	19	156.2

Project Number: 09-1111-6014

Checked By: TVA

Golder Associates

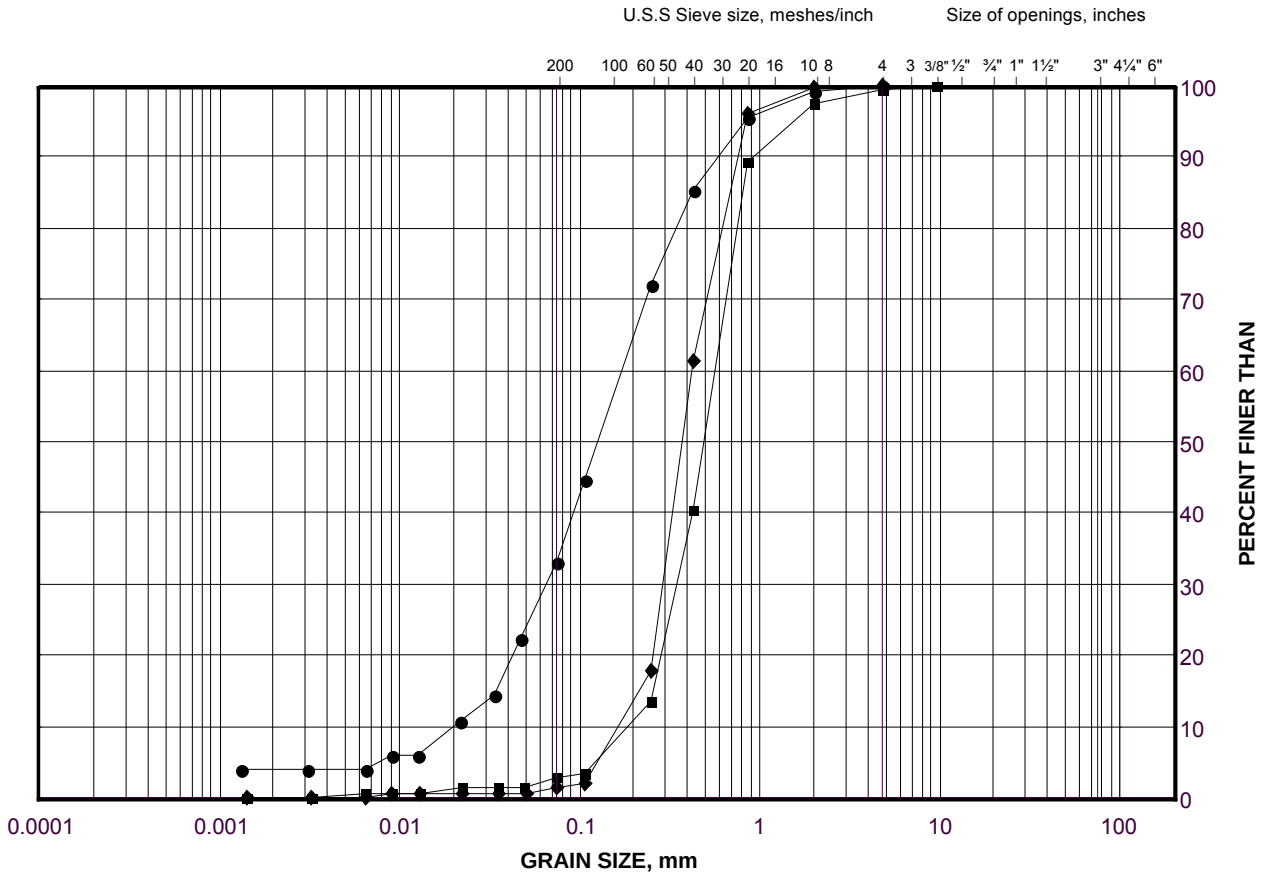
Date: 01-Feb-13

GRAIN SIZE DISTRIBUTION

Silty Sand to Sand

Highway 69 (SBL and NBL) Culvert C301

FIGURE A.C301-09B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C301-S1	16	159.6
■	C301-S2	17	155.9
◆	C301-N1	17	155.6

Project Number: 09-1111-6014

Checked By: TVA

Golder Associates

Date: 01-Feb-13

Borehole C301-N3

Box 1: 19.69 m – 22.68 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

Culverts
Highway 69 Four-Laning
GWP 5404-05-00; WP 5404-05-01

TITLE

Bedrock Core Photograph – C301–N3
Highway 69 (SBL and NBL) STA 13+810

Golder Associates

PROJECT No. 09-1111-6014			FILE No. ----		
DESIGN	MAS	FEB 13	SCALE	NTS	REV.
CADD	-- --				
CHECK	TVA	FEB 13	**FIGURE A.C301-10**		
REVIEW	JPD/JMAC	FEB 13			

REVISION DATE: April 13, 2011 BY: TVA Project: 09-1111-6014

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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