



FOUNDATION INVESTIGATION AND DESIGN REPORT
PROPOSED CULVERT REPLACEMENTS
CULVERT 2-443C on HWY 6, APPROX. 420m NORTH OF SDRD 10
TWP OF EASTNOR, ONTARIO

ASSIGNMENT #6
MTO WEST REGION CONTRACT #3006-E-0083
GWP 3082-07-00

MTO GEOCREs No. 41A-201

Submitted to:

Ministry of Transportation
South Western Region
3rd Floor Geotechnical Section
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1.0 INTRODUCTION

AMEC Earth & Environmental, a division of AMEC Americas Limited (AMEC), Consulting Geotechnical, Construction Quality Control and Environmental Engineers, was retained by the Ministry of Transportation (South Western Region) to conduct a foundation investigation for the replacement of Culvert 2-443C on Highway 6, in Eastnor Township, Ontario. Culvert 2-443C (also known as Culvert No. 15) is located on Hwy 6, approximately 420m north of Sideroad 10. The site location is shown on Figure 1 in Appendix A.

Three (3) boreholes were specified by the MTO in the vicinity of the existing culvert. Authorization to proceed with this investigation was given by Mr. Robert Mount, Project Soils Engineer for the South West Region, MTO, dated July 8, 2008. The work was carried out by AMEC according to the MTO Southwestern Region Terms of Reference Agreement #3006-E-0083 Assignment #6; Hwy 6 – Mar to Ferndale, Structural Culvert Replacements, Foundation Engineering.

Subsurface information from a previous project that was available was reviewed prior to carrying out the fieldwork for this project. The following information was reviewed at the MTO Foundation Library (GEOCRES), in Downsview, and used in preparing this report wherever applicable.

- ***“Foundation Investigation Report for Proposed New Bridge – Hwy #6 and Judge’s Creek, County of Bruce, Township of Eastnor, Lot 11, Conc. II & III, District #5 (Owen Sound)”***, Prepared by Department of Highways Ontario – Foundations Office, Dated September 1966. (GEOCRES Report #41A-53)

This investigation was carried out by means of a limited number of boreholes, in-situ tests and laboratory tests on selected samples. The factual results of the soil conditions encountered in the boreholes and laboratory tests, together with discussions and recommendations for design, are presented in this report.

In addition to revisions made to the draft report as per MTO review comments, the report has been updated to include new information from the preliminary design drawings supplied to AMEC.

2.0 SITE DESCRIPTION

The area surrounding the project site can best be described as agricultural. The adjacent lands consist of hay fields and fields used for animal grazing, with some farm houses. Areas of exposed bedrock can be seen in a number of spots throughout the area.

Typical site photographs of the culvert location can be found in Appendix C.

Culvert 2-443C is located on Hwy 6 at Sta(14+467), approximately 420m north of Sideroad 10, in Eastnor Township.

Based on the MTO Terms of Reference, the structure crosses under Hwy 6 and is a CSP arch culvert with dimensions for width, height and length of 3.36 x 2.12 x 25.0m. The highway at this location is two lane asphalt, with gravel shoulders and post and wire guardrails. It runs on top of an embankment built up above the surrounding grade with an approximate fill height above the culvert of 1.25m. The culvert lies across Hwy 6 near the base of the embankment, with obvert elevations of 192.100 and 191.910m for the inlet and outlet, respectively. The road embankment at the culvert location is approximately 3.4m above the surrounding grades.

The embankment slopes were covered with tall grasses and other low vegetation at the time of the fieldwork. The vegetation around the inlet and outlet of the culvert consisted of tall reeds.

The direction of flow is west to east, as per the MTO Terms of Reference. At the time of fieldwork, the soils in and around the culvert openings were generally moist to wet, although no free water was observed. The stain markings within the culvert indicate that water levels have reached up to approximately 0.5m above the pipe invert.

3.0 GEOLOGY

The Physiography of Southern Ontario by Chapman and Putnam (1984) indicates that the project site in Eastnor Township lies within the Bruce Peninsula. Much of the area has very shallow soils scattered on top of grey dolostone with the overburden consisting of mainly silt beds. Gravel bars, sand dunes, and a few drumlins made up of glacial till appear throughout the peninsula as well. As indicated in the following paragraph however, there are localized areas where bedrock lies at depth.

A previous foundation investigation (GEOCRETS Report #41A-53) for a site to the south of Culvert 2-443C indicates the following subsurface soils: very soft dark brown clayey silt and organic matter to approximately 2.0m, overlying very soft to firm clayey silt to approximately 17.0m, overlying very dense silty gravel to approximately 17.6m, overlying limestone bedrock.

4.0 INVESTIGATION PROCEDURES

4.1 Field Investigation

In accordance with the Terms of Reference for this investigation, three (3) borehole locations (BH4 to BH6) were staked and cleared.

Borehole BH4 was drilled through the existing road embankments adjacent to the culvert, to verify embankment fill material and soil conditions below the existing culvert, and to obtain sufficient foundation information for the replacement culvert. It extended to 11.1m below existing road grade.

Boreholes BH5 and BH6 extended to depths of 7.3 and 7.2m, respectively. The boreholes were drilled as close as possible to the culvert inlet and outlets, at the base of the embankment. Borehole locations were adjusted as required based on the proximity of overhead utilities, as well as drill rig access to steep slopes and ditches.

The borehole locations are presented in Figure 2 in Appendix A. The presence of fence lines, guardrails and overhead hydro lines necessitated moving the boreholes to south of the culvert.

The fieldwork was performed on August 25th and 26th, 2008 under the full-time supervision of experienced geotechnical personnel from AMEC. Prior to drilling, utility locates were carried out. Drilling operations were performed using a track-mounted drilling rig, outfitted with hollow stem augers.

Ground surface elevations at the borehole locations were also surveyed by AMEC personnel. The elevations were related to a temporary benchmark (TBM) which is "the pipe arch obvert at the west end of Culvert 2-443C". The inlet obvert elevation supplied to AMEC by the MTO is 192.100m.

Soil samples were taken at 0.75m intervals during the performance of Standard Penetration Test (SPT) in accordance with ASTM D1586. This consisted of freely dropping a 63.5kg hammer for a vertical distance of 0.76m to drive a 51mm diameter O.D. split-barrel (split spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30m was recorded as SPT 'N' value of the soil which indicated the consistency of cohesive soils or the relative density of non-cohesive soils.

Where appropriate, in-situ shear vane testing (MTO) was carried out through the soft, cohesive soils.

Combustible soil headspace vapour readings were measured for each soil sample recovered from the boreholes, using a portable vapour meter (GasTechtor™ 1238ME).

The groundwater levels were monitored during, and upon completion of the drilling operations. Upon completion of drilling, Boreholes BH4 and BH6 were backfilled with bentonite in accordance with the general requirements of Ont. Regulation 903. In accordance with the Terms of Reference, a standpipe piezometer was installed in Borehole BH5. The piezometer was constructed to a depth of 5.3m by placing 1.6m of bentonite, then 1.6m of screen with

sandpack, then riser with sandpack up to ground surface, as indicated on the borehole log. The standpipe piezometer construction was intended to detect any groundwater within the top, approximately 5 m depth. The conditions at the time the fieldwork was carried out were dry and the standpipe was decommissioned the day following installation. Therefore no casing or surface bentonite seal were installed.

The results of the in-situ and laboratory tests are presented in the corresponding Records of Boreholes (Appendix A) and Laboratory Test Results (Appendix B).

AMEC will retain the soil samples for a period of one year after completion of the Project, unless otherwise advised in writing by the Ministry.

4.2 Laboratory Tests

In accordance with the Terms of Reference for this investigation, the following tests were conducted:

- In-situ water content determination (12);
- Grain size distribution analysis (6)
- Atterberg Limits (6)
- pH, sulphate, chloride, electrical conductivity, resistivity and Redox potential

The results of the routine laboratory tests are included in the Record of Boreholes in Appendix A. The grain size distribution curves and Plasticity Chart are shown in Appendix B.

4.3 Miscellaneous

The boreholes were drilled by Determination Drilling and Soil Investigations, who are licensed well drillers. They were also responsible for decommissioning the piezometer. The drilling operations were supervised by Laura Cowan, E.I.T. of AMEC.

Upon completion of drilling, the soil samples were transported to AMEC's Laboratory in Hamilton for further examination and routine laboratory testing. Testing to determine the corrosivity of the soils to various materials was subcontracted to AGAT Laboratories, an accredited CAEL laboratory.

5.0 SUB-SURFACE CONDITIONS

The general soil profile through the road embankment consisted of sand and sand & gravel fill overlying very stiff to soft, silty clay, clayey silt and clay and silt, that extended to at least the maximum depths investigated.

The stratigraphic units and groundwater conditions at the borehole locations are discussed in the following sections. Detailed information is provided in the Record of Boreholes (Appendix A).

The following summary is to assist the designers of the project with an understanding of the anticipated soil conditions across the site. However, it should be noted that the soil and groundwater conditions may vary between the borehole locations.

5.1 Stratigraphy

Through the embankment in Borehole BH4 which was drilled through the shoulder, sand fill was encountered to a depth of approximately 1.7m below ground surface. The sand fill deposit contained some gravel, and was moist to wet. Underlying the sand fill, grey sand and gravel fill was encountered to a depth of 2.0m below ground surface. Boreholes BH5 and BH6, which were put down in the vicinity of the inlet and outlet of the existing culvert, encountered 150 and 130mm of topsoil, respectively.

Underlying the fill in Borehole BH4 and the topsoil in Boreholes BH5 and BH6, silty clay/clayey silt/clay and silt/silt with clay was encountered, extending to at least the maximum depths investigated. The deposit was brown, turning grey with depth, and contained traces of organics and rootlets.

Based on grain size/hydrometer analyses carried out and the MTO Classification system, the material category ranged from CL - 'Clay of Low Plasticity' to CL-ML - 'Clay/Silt of Low Plasticity' and CI - Clay of Intermediate Plasticity, as illustrated in the Table below.

Table 1 – Summary of Index testing

	%				Atterberg Limits	Classification
	>4.75mm	75µm to 4.75mm	2µm to 75µm	<2µm		
BH4-SS3	0	1	57	42	LL= 34, PL= 21, PI= 13	CL Clay of Low Plasticity
BH4-SS8	0	0	68	32	LL= 24, PL= 18, PI= 6	CL-ML Clay/Silt of Low Plasticity
BH5-SS4	0	0	68	32	LL= 28, PL= 20, PI= 8	CL Clay of Low Plasticity
BH5-SS8	0	0	73	27	LL= 23 PL= 18, PI= 5	CL-ML Clay/Silt of Low Plasticity
BH6-SS1	0	0	56	44	LL= 35, PL= 22, PI= 13	CI Clay of Intermediate Plasticity
BH6-SS7	0	0	68	32	LL= 24, PL= 18, PI=6	CL-ML Clay/Silt of Low Plasticity

The SPT 'N' values of the silty clay/clayey silt/clay and silt/silt with clay varied from 0 to 9 blows per 300mm. In situ shear vane testing (MTO) was carried out in each borehole, as summarized below, indicating a soft to very stiff consistency.

Table 2 – Summary of In Situ Shear Vane Test Results

Borehole #	Vane Test Depth (m)	Elevation (m)	Undisturbed Shear Strength (kPa)	Sensitivity
4	4.4	188.6	94	2.8
	6.7	186.3	72	2.2
5	2.7	188.0	100	3.0
	5.0	185.7	50	1.8
6	2.0	188.8	106	3.2
	5.9	184.9	22	2.0

Natural moisture contents ranged from 20 to 32%.

Split spoon sample #2 (1.6 to 2.0m) from Borehole BH6 was submitted for testing to determine the corrosivity of the soils to various materials. The laboratory test certificates can be found in Appendix B, and are summarized below.

<u>Soil Characteristic</u>	<u>Result</u>
Sulphide	<100 mg/kg
Sulphate	151 µg/g
Chloride	9.0 µg/g
pH	8.07
electrical conductivity	0.286 S/cm
Resistivity	3500 ohms-cm
Redox potential	226mV

5.2 Groundwater

Groundwater conditions in the boreholes were observed during drilling and upon completion of drilling. All of the boreholes remained open and dry upon completion.

A piezometer was installed in Borehole BH5, and the water level was measured the following day. A water level at 1.7m (elev. 189.0m) was recorded. The piezometer was decommissioned the day after installation (Aug 26th, 2008) as per Ministry of Environment Regulation 903. As a result, it is unlikely that the groundwater level in the standpipe reflects the long term groundwater level.

The groundwater at the site is anticipated to fluctuate seasonally and can be expected to be somewhat higher during the spring months and in response to major weather events / water levels in the creek.

5.3 Organic Vapour Measurements

No staining or petroleum odours were noted in the boreholes. Combustible soil headspace vapour readings were measured using a portable vapour meter (GasTechtor™ 1238ME),

calibrated to hexane and operated in methane exclusion mode. Combustible soil vapour headspace measurements for all of the soil samples recovered from the Boreholes BH4, BH5 and BH6 ranged from non-detect to 50 parts per million ("ppm").

6.0 DISCUSSION & RECOMMENDATIONS

Culvert 2-443C (also known as Culvert No. 15) is a CSP arch culvert with dimensions for width, height and length measuring 3.36 x 2.12 x 25.0m. The highway at this location runs on top of an embankment built up above the surrounding grade. The culvert lies across Hwy 6 near the base of the embankment. It is understood that the fill height at the culvert location is approximately 1.25m and that the road embankment at the culvert location is approximately 3.4m above the surrounding grades.

MTO proposes to replace the culvert. Preliminary plans provided to AMEC indicate that the existing CSP Arch culvert will be replaced with pre-cast box culvert sections.

6.1 Comparison of Alternative Foundation Types

Based on the conditions encountered in the boreholes drilled for this investigation, the preferred foundation type is a shallow system. A comparison of the possible foundation follows.

Table 3 Comparison of Foundation Types for Culvert Replacement

Foundation	Description	Advantages	Disadvantages	Risks / Consequences	Cost Comparison
Deep Foundation	Driven or drilled piles bearing on bedrock, supporting strip foundations (e.g. precast open bottom box or arch culvert). However, bedrock has not been encountered and additional borehole drilling will be required, or friction piles have to be used.	Little to no settlement. Erosion at inlet or outlet would have little effect on the structure	Requires specialist contractor (Contractor specializing in pile installation). Requires staging area for piling equipment - larger area of disturbance. Will require longest construction period and disruption to traffic. Will require formwork and reinforcing steel placement for footing construction	Will result in a 'hard' or unyielding spot in the road, leading to significant differential settlement. Risk of encountering cobbles/boulders, which may complicate pile installation. Bedrock elevation not accurately defined – difficult to determine pile lengths.	High
Shallow Foundation (Strip Footings)	Strip foundations supported on clay subgrade (e.g. open bottom box or arch culvert).	Use of standard excavation and construction equipment. No specialist contractor is required.	Will require formwork and reinforcing steel installation for footing construction. Erosion at inlet or outlet could affect	- Soft to very soft founding conditions may result in differential settlement and damage to structure.	Medium

Foundation	Description	Advantages	Disadvantages	Risks / Consequences	Cost Comparison
			structure.		
Shallow Foundation (granular or lean concrete on grade)	Support closed pipe or box culvert on lean concrete.	Use of standard excavation and construction equipment. No specialist contractor is required. No formwork or placement of reinforcing steel Will require short construction period and minimal disruption to traffic.	Will require shortest construction period and disruption to traffic. Erosion at inlet or outlet could affect structure.	Improper installation could result in poor hydraulic flow (low spots) and ponding within the culvert.	Low
Relining	Reline existing CSP arch with smaller arch and grout annulus	No disruption to traffic.	Requires specialist contractor (Contractor specializing in relining and grouting). Will result in reduced hydraulic capacity and gradient.	Lower flow rate.	Medium to High

Based on this comparison of the foundation alternatives, it is recommended that culvert replacement be carried out using a shallow foundation system (granular or lean concrete on grade). Cutoff walls should be provided at the inlet and outlet to minimize the potential for erosion beneath the culvert.

6.2 Foundation Design

Based on the conditions encountered in the boreholes drilled for this investigation, the soils at the proposed new culvert invert (elev. 189.84 to 189.65m) consist of firm to stiff silty clay/clayey silt/clay and silt/silt with clay. These soils should be capable of supporting the proposed new culvert at the existing location. The following design parameters may be used:

Factored Vertical Geotechnical Resistance at ULS	120 kPa
Geotechnical Reaction at SLS	80 kPa

A sliding resistance factor of 0.6 can be used. For sliding analysis, a friction factor of 0.3 should be used between the concrete and the native soils.

The recommended SLS bearing capacity is based on an anticipated total settlement less than 25 mm.

The proposed new culvert type is heavier than the existing CSP. It has not yet been confirmed that the road grade will remain the same. If no significant road grade increase is proposed, there will be small stress increase in the soil beneath and surrounding the culvert. Under these circumstances, settlement should be within acceptable limits.

If additional fills are to be placed to increase the road grade, provision may have to be made to expand (widen) the base of the embankment, to maintain stable slope profiles. The increase in embankment fill height would also result in additional long-term settlement of the soft to firm clays below the culvert.

6.3 Traffic Protection and Temporary Detours

For the replacement of Culvert 2-443C on Hwy 6, the following scenarios can be considered for construction:

- Scenario 1 - reduction of traffic to one-lane using staged open-cut construction, with construction of widened limits on the east/west side of Highway 6, as required to provide a temporary detour; or
- Scenario 2 - reduce traffic to one-lane using traffic protection (sheet piling) with no temporary detour required.

Construction of widened limits is discussed in Section 6.6.

Given the width of the culvert, the use of a trench box is not considered practical. Also, complete excavation and removal of the existing culvert section would be required before the trench box could be installed.

Based on the conditions encountered in the boreholes put down for this investigation, temporary cantilever sheetpiles or soldier piles with wood lagging may be used to support partially-removed embankments. Sheet piling could be driven (as required to maintain traffic on this road), on either side (north and south) of the existing CSP culvert. Lagging could be placed above the culvert to retain the fills, leaving access through the culvert. Excavation could then proceed to expose, cut and remove the culvert. Temporary support may be installed to support the cut edge of the culvert, just below the lagging.

A temporary shoring system should be designed using the following soil parameters.

Description		Value
Soil Bulk Unit Weight	Sand fill	21 kN/m ³
	Native silty clay / clay and silt	20 kN/m ³
Coefficient of Lateral Earth Pressure	$K_a = 0.36$ (active condition)	0.36
	$K_o = 0.54$ (at-rest condition)	0.54
	$K_p = 1.40$ (passive condition)	1.40*

Traffic Load Surcharge	12 kPa
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*Reduced to limit lateral movement

The groundwater level recorded in the standpipe piezometer (Record of Borehole BH5 in Appendix A) should be considered in the design of the temporary shoring system.

Reference should be made to SP 105S19 for protection systems. Detail design of a temporary shoring system is the responsibility of the Contractor.

Reference should be made to SP 422S01 for installation of pre-cast concrete box culverts.

6.4 Dewatering and Channel Diversion during Construction

Preliminary drawings provided by the Client indicate that the new culvert invert will lie at 189.84 to 189.65m. A ground water level at elevation 189.0m was recorded in the standpipe piezometer installed in Borehole BH 5. Due to the short period of time that the standpipe was in place, it is unlikely that the measured groundwater level reflects the long term level, and it could be higher.

Nevertheless, water flow through the cohesive soils is not immediate. Although some inflows can be expected from more permeable seams within the subgrade soils, the need for a sophisticated dewatering system is not anticipated. It is expected that these inflows can be controlled using properly filtered sumps.

At the time the fieldwork was carried out, no water was flowing through the culvert, although the sediment in and around the culvert openings was moist to wet. The highest water flows would be anticipated in early Spring (thaw), and recent precipitation events will have a significant impact on water flows through the culvert. Provision must be made to divert water flows from one side of the road to the other during construction.

For phased construction, the ditch flow can be collected from the upstream side and pumped to the downstream side. The hoses could be run through the portion of the culvert still in place (upstream half), then routed around to the north or south limit of the construction excavation for the downstream portion (or reversed if the upstream portion is replaced first).

6.5 Excavation and Backfill

Reference should be made to SP902S01 for earth excavation. Backfill and cover for the concrete culvert should conform to OPSD 803.010.

All organic soils and other deleterious materials must be removed from beneath the new culvert limits. All such materials should be excavated and wasted. It is recommended that the

subgrade be inspected. To prevent creating a pathway for water below the culvert, it is recommended that lean concrete be placed as bedding below the culvert.

Based on the proposed culvert type and unless the road grade will be significantly increased, a small camber below the centre of the culvert of 25mm should be considered.

Cutoff walls should be provided at the inlet and outlet to minimize the potential for flow beneath the culvert and associated erosion of the subgrade soils. Culvert inlet and outlet treatments should comply with MTO Standards. The installation of an inlet seal is not considered to be necessary.

A frost penetration depth of 1.4m should be used at this site.

6.6 Embankment Design and Construction

No obvious signs of instability were noted along the embankment slopes. Reconstruction of the embankment slopes should match the existing slopes and materials, having a steepest slope of 2H:1V. If steeper slopes are proposed, a stability analysis should be carried out to ensure a minimum Factor of safety of 1.5.

Similarly, if a grade build up is proposed, or if the geometry of any new, permanent embankment slope will be significantly different from what presently exists, the stability and settlement of the new embankments should be analysed during detailed design.

For widening of existing embankments, new fill should be constructed with benching according to OPSD – 208.010 (Benching of Earth Slopes).

6.7 Construction Comments

Any excavations should be carried out in accordance with the latest edition of the Ontario Occupational Health and Safety Act and Regulations for Construction Projects.

Based on the information in the boreholes, the sand fill and native silty clay/clayey silt/clay and silt/silt with clay, are considered to be Type 3 soils.

Placement and compaction for soil and granular as backfill or on slopes should be placed in accordance with SP 105S01.

The work should be protected from freezing. No pipes and bedding material should be placed on frozen native soils or fill.

Dewatering and channel diversion should proceed ahead of the excavation operation.

6.8 Soil Corrosion Potential

Split spoon sample #2 (1.6 to 2.0m) from Borehole 6 was submitted for testing to determine the corrosivity of the soils to various materials. The laboratory test certificates can be found in Appendix B, and are summarized below.

<u>Soil Characteristic</u>	<u>Result</u>
Sulphide	<100 mg/kg
Sulphate	151 µg/g (0.02%)
Chloride	9.0 µg/g
pH	8.07
electrical conductivity	0.286 S/cm
Resistivity	3500 ohms-cm
Redox potential	226mV

According to the American Waterworks Association, the degree of corrosion associated with a chloride concentration in the order of 10-25 µg/gm is considered “slightly corrosive” and a chloride concentration in the order of 25-100 µg/gm is considered “moderately corrosive”. The chloride concentration within the soil samples is associated with being less than “slightly corrosive” ($Cl^- = 9.0 \mu\text{g/gm}$).

CSA A23.1-04 describes the degree of sulphate exposure for concrete as being moderate for soils having sulphate values of between 0.10 and 0.20%, severe for values between 0.20 and 2.0%, and very severe for values over 2.0%. The use of special sulphate resistant cements is therefore not considered necessary based on these results.

The test results for resistivity, pH, redox potential, sulphides and moisture are used to evaluate the soil corrosivity to ductile iron piping as per ANSI/AWWA C105/A21.5-05. For each test carried out on the soils (resistivity, pH, redox potential, sulphides and moisture), the results are categorized according to their contribution to corrosivity. If the sum of the assigned points is equal to 10 or more, the soil is corrosive to ductile iron pipe, and protection against exterior corrosion should be provided. This system of evaluation is limited to soil corrosion and does not include consideration of stray direct current. As shown in Table 5, a trace result for sulphides has been assumed which produces a point score of 2.

Table 5

	Resistivity	pH	Redox Potential	Sulphides	Moisture	Total Point Value
BH 6, SS#2	3500 ohms-cm	8.07	226 mV	Trace	Poor	4
Points assigned to test result based on ANSI/AWWA C105/A21.5-05	0	0	0	2	2	

Based on these results, provision of protection against exterior corrosion due to soil is not required. However, a corrosion specialist should be retained to review the test result and provide recommendation for the most effective protection solutions.

6.9 Construction Inspection

It is recommended that a quality control program of inspection and testing be carried out during the construction phase of the project to confirm that the conditions encountered are consistent with design assumptions; and to confirm that the various project specifications and material requirements and handling are followed.

7.0 CLOSURE

The sub-soil information and recommendations contained in this report should be used solely for the purpose of foundation assessment of this site.

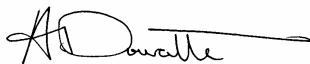
AMEC should be retained to review the recommendations provided in this report, once the details of the project are finalized and prior to the final design stage of the project.

The Limitations of Report, as quoted on the following page, is an integral part of this report.

We trust that the information presented in this report is complete within our terms of reference. If there are any further questions concerning this report, please do not hesitate to contact our office.

Sincerely,

AMEC Earth & Environmental,
A division of AMEC Americas Limited



Jane Doucette, P.Eng.
Senior Geotechnical Engineer



Prapote Boonsinsuk, Ph.D., P.Eng.
Project Reviewer



George Chow, P.Eng.
Designated Principal Contact

LIMITATIONS OF REPORT

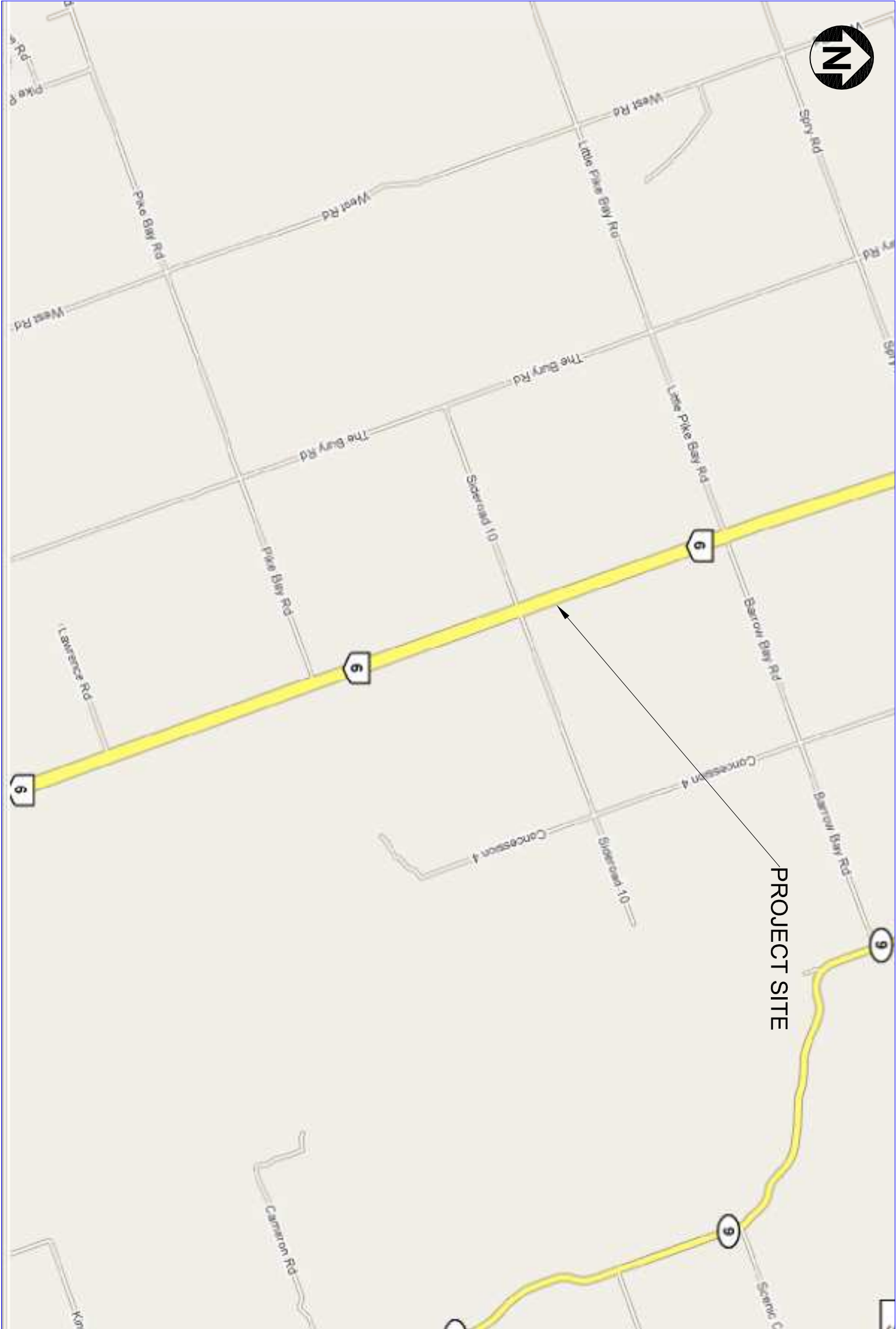
The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during the construction to confirm that the subsurface conditions across the site do not deviate materially from those encountered in the testholes.



The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report relating to potential construction problems and possible methods of construction are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

The benchmark and elevations mentioned in this report were obtained strictly for use by this office in the geotechnical design of the project. They should not be used by any other party for any other purpose.

FIGURES



AGREEMENT No.		
3006-E-0083		
G.W.P. No		
3082-07-00		
FOUNDATION INVESTIGATION HWY 6, 420m NORTH OF SIDEROAD 10 CULVERT 2-443C (Sta 14+467)		TB/210006 FIGURE 1
Dwg. Title:		
Site Location Plan		
 AIEEC Earth & Environmental, a Division of AIEEC Americas Limited		GEOCHES No. 41A-202
		SCALE: 1:40,000

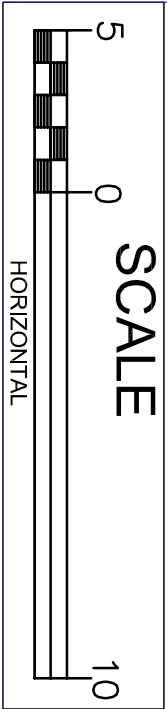
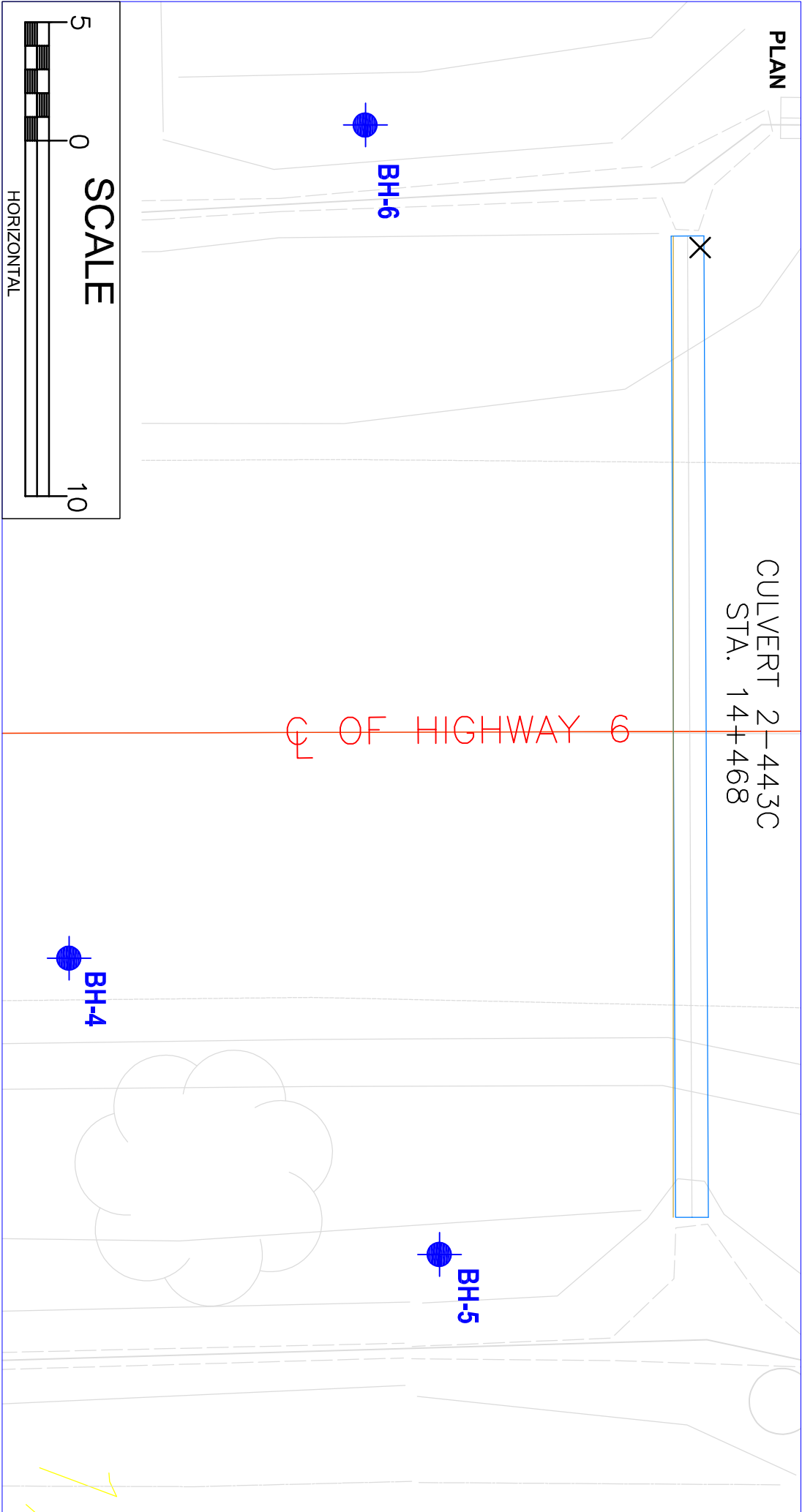
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

REFERENCE: Base map excerpt from
Google maps <<www.google.ca/maps>>

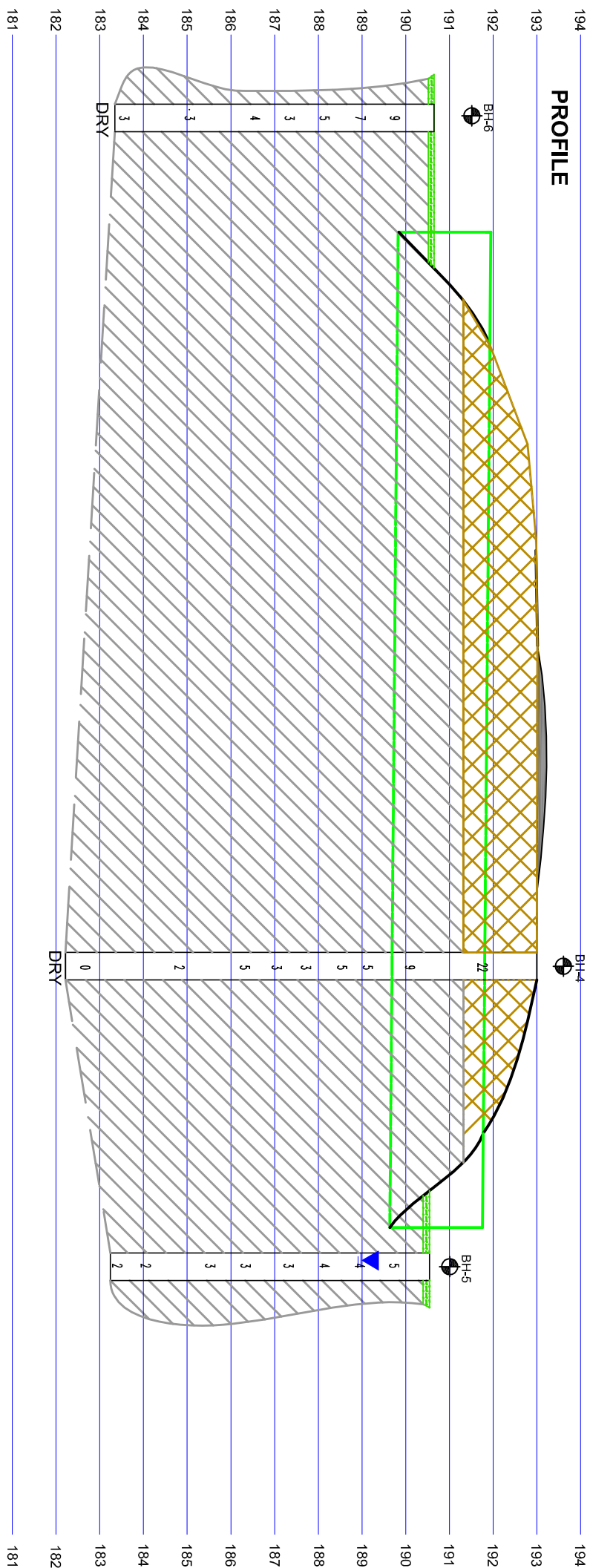


PLAN

CULVERT 2-443C
STA. 14+468



PROFILE



METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

3006-E-0083

3082-07-00

FOUNDATION INVESTIGATION
CULVERT 2-443C: HWY 6, 420m
North of Sideroad 10
(Sta 14+467)

TB7210006
FIGURE
2

Dwg. Title:

Interpolated Stratigraphical Cross Section

amec AMEC Earth & Environmental
a Division of AMEC Americas Limited

GEOCRES No. 41A-202



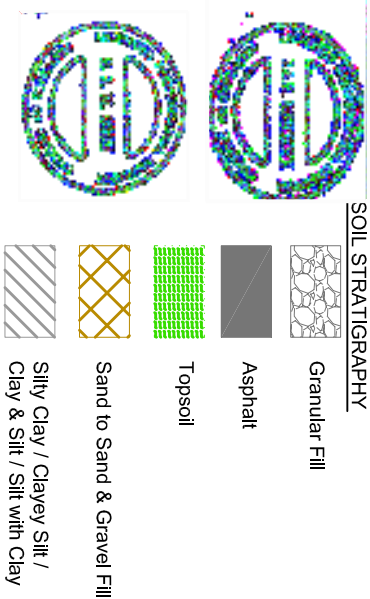
KEY PLAN

LEGEND			6 SPT "N" VALUE
WATER LEVEL			
BOREHOLE LOCATION			
TBM			
X TEMPORARY BENCHMARK			
BOREHOLE	STATION / OFFSET	ELEVATION (m)	
BH-4	Sta 14+449 / Rt 5.1 m	193.0	
BH-5	Sta 14+459 / Rt 13.2 m	190.7	
BH-6	Sta 14+457 / Lt 17.0 m	190.8	

NOTES:

- The boundaries between soil strata have been established only at borehole locations. Between boreholes, the boundaries are assumed from geological evidence and may be subject to considerable error.
- Borehole Locations referenced to MTO Stationing and Offset.
- Borehole Locations referenced to Inlet elevation 192.100 m, provided in project Terms of Reference.
- Profile details beyond and between borehole locations are approximate.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration. The proposed structure location is shown for illustration purposes only and may not be consistent with the final configuration as shown elsewhere in the contract documents.

SOIL STRATIGRAPHY





APPENDIX A

GENERAL REPORT NOTES RECORD OF BOREHOLES

GENERAL REPORT NOTES

DEFINITIONS OF PENETRATION RESISTANCE

Standard penetration resistance 'N': -- The number of blows required to advance a standard split spoon sampler 30 cm into the subsoil, driven by means of a 63.5 kg hammer falling freely a distance of 70 cm.

Dynamic penetration resistance: -- The number of blows required to advance a 50 mm, 60 degree cone, fitted to the end of drill rods, 30 cm into the subsoil, the driving energy being 475 Joules per blow.

SAMPLE TYPE ABBREVIATIONS USED IN BOREHOLE LOGS

S.S.	Split spoon	T.W.	Thinwall open	R.C.	Rock core	
A.S.	Auger sample	T.P.	Thinwall piston	W.S.	Washed sample	
	P.H.	Sample pushed hydraulically	P.M.	Sample pushed manually		

SOIL TEST SYMBOLS USED IN BOREHOLE LOGS

<input type="checkbox"/>	Standard penetration resistance	▼	Laboratory vane	○	Unconfined Compression
■	Dynamic penetration resistance	▲	Field vane	●	Undrained triaxial
	✕	Penetrometer		S	Sensitivity

CONVENTIONAL SOIL DESCRIPTIONS

COHESIVE (CLAYS ETC.)			GRANULAR (SANDS ETC.)	
<u>Consistency</u>	<u>'N' blows/30cm</u>	<u>c kPa</u>	<u>Denseness</u>	<u>'N' blows/30 cm</u>
Very Soft	0 - 2	0 - 12	Very Loose	0 - 4
Soft	2 - 4	12 - 25	Loose	4 - 10
Firm	4 - 8	25 - 50	Compact	10 - 30
Stiff	8 - 15	50 - 100	Dense	30 - 50
Very Stiff	15 - 30	100 - 200	Very Dense	>50
Hard	>30	> 200		

ABBREVIATIONS FOR MOISTURE CONDITIONS

sdtpl - slightly drier than the plastic limit.	swtpl - slightly wetter than the plastic limit.
dtpl - drier than the plastic limit.	wtpl - wetter than the plastic limit.
apl - about the plastic limit.	mwtp - much wetter than the plastic limit.

NOTE

The soil conditions, profiles, comments, conclusions and recommendations found in this report are based upon the samples recovered during the field work. Soils are heterogeneous materials and, consequently, variations (possibly extreme) may be encountered at site locations away from boreholes. During construction, competent, qualified inspection personnel should verify that no significant variations exist from the conditions described in this report.

RECORD OF BOREHOLE No 4

1 OF 1

PROJECT Structural Culvert Replacements LOCATION Culvert 2-443 C - Hwy 6, ORIGINATED BY LC
 CLIENT MTO SW Region - #3006-E-0083 Sta 14+449 ; o/s Rt 5.1 m COMPILED BY LC
 JOB NO. TB7210006 DATE 26 August 2008 CHECKED BY HS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST <input type="checkbox"/> DYNAMIC PENETRATION TEST <input checked="" type="checkbox"/>					WATER CONTENT (%)			OBSERVATIONS & REMARKS	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)									
								○ UNCONFINED	● QUICK TRIAXIAL	▲ FIELD VANE	✚ LAB VANE	10	20	30	40		50
193.0 0.0	Brown Sand FILL , some gravel, moist to wet.															Organic Vapour Measurement (OVM)	
			AUGER														
191.3 1.7	Grey Sand & Gravel FILL , moist, compact.		1	SS	22												OVM - 50ppm
191.0 2.0	Greyish Brown to Brown SILTY CLAY , stiff, moist.																
			2	NR	9												OVM - ND Approx. Culvert Invert
189.2 3.8	Grey CLAY & SILT , firm to stiff, moist.		3	SS	5												OVM - ND Vane - 95kPa Remould - 33kPa Sensitivity - 2.8
			VANE														OVM - ND
			4	SS	5												OVM - ND
187.7 5.3	soft to stiff, moist to wet.		5	SS	3												OVM - ND Vane - 72kPa Remould - 33kPa Sensitivity - 2.2
																OVM - ND	
		6	SS	3													
		VANE															
		7	SS	5													
184.6 8.4	CLAYEY SILT , very soft, wet.	8	SS	2												OVM - 10ppm	
181.9 11.1	BOREHOLE TERMINATED	9	SS	0												OVM - 10ppm Borehole open & dry to 11.1mbgs upon completion. SS3 75µm-4.75mm 1% 2µm-75µm 57% <2µm 42% LL=34 PL=21 PI=13 SS8 75µm-4.75mm 0% 2µm-75µm 68% <2µm 32% LL=24 PL=18 PI=6	

RECORD OF BOREHOLE No 5

1 OF 1


PROJECT Structural Culvert Replacements LOCATION Culvert 2-443 C - Hwy 6, ORIGINATED BY LC
 CLIENT MTO SW Region - #3006-E-0083 Sta 14+459 ; o/s Rt 13.2 m COMPILED BY LC
 JOB NO. TB7210006 DATE 25 August 2008 CHECKED BY HS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST <input type="checkbox"/> DYNAMIC PENETRATION TEST <input checked="" type="checkbox"/>					WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)						
								<input type="checkbox"/> UNCONFINED	<input type="checkbox"/> QUICK TRIAXIAL	<input type="checkbox"/> FIELD VANE	<input type="checkbox"/> LAB VANE			
190.7 190.6 0.2	150mm TOPSOIL Brown to grey SILTY CLAY , trace rootlets, firm to stiff, moist.		1	SS	5								Organic Vapour Measurement (OVM)	
			2	SS	4								Approx. Culvert Invert OVM - 20ppm OVM - 25ppm	
			3	SS	4								OVM - 20ppm OVM - ND	
187.7 3.0	Grey CLAYEY SILT , soft to firm, moist to wet.		4	SS	3								Vane - 100kPa Remould - 33kPa Sensitivity - 3.0	
			5	SS	3								OVM - ND	
			6	SS	3								OVM - ND Vane - 50kPa Remould - 28kPa Sensitivity - 1.8 OVM - ND	
184.6 6.1	SILT with CLAY , very soft, wet.		7	SS	2								OVM - ND	
183.4 7.3	BOREHOLE TERMINATED		8	SS	2								Borehole open & dry to 7.3mbgs upon completion. Water Level taken on Aug 26 = 1.66mbgs SS4 75µm-4.75mm 0% 2µm-75µm 68% <2µm 32% LL=28 PL=20 PI=8 SS8 75µm-4.75mm 0% 2µm-75µm 73% <2µm 27% LL=23 PL=18 PI=5	

RECORD OF BOREHOLE No 6

1 OF 1

PROJECT Structural Culvert Replacements LOCATION Culvert 2-443 C - Hwy 6, ORIGINATED BY LC
 CLIENT MTO SW Region - #3006-E-0083 Sta 14+457 ; o/s Lt 17.0 m COMPILED BY LC
 JOB NO. TB7210006 DATE 25 August 2008 CHECKED BY HS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST □ DYNAMIC PENETRATION TEST ■					WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)						
								○ UNCONFINED	● QUICK TRIAXIAL	▲ FIELD VANE	◆ LAB VANE			
190.8 190.9 0.1	130mm TOPSOIL Brown to grey CLAY & SILT , trace rootlets, stiff to firm, moist.		1	SS	9									Organic Vapour Measurement (OVM) Approx. Culvert Invert OVM - ND OVM - ND Vane - 106kPa Remould - 33kPa Sensitivity - 3.2 OVM - 15ppm OVM - ND OVM - ND OVM - ND Vane - 22kPa Remould - 11kPa Sensitivity - 2.0 OVM - ND
			2	SS	7									
				VANE										
			3	SS	5									
187.8 3.0	Grey, soft, moist to wet.		4	SS	3									
			5	SS	4									
			6	SS	3									
				VANE										
184.1 6.7	CLAYEY SILT , soft, wet.		7	SS	3								OVM - ND	
183.6 7.2	BOREHOLE TERMINATED												Borehole open & dry to 7.2mbgs upon completion. SS1 75µm-4.75mm 0% 2µm-75µm 56% <2µm 44% LL=35 PL=22 PI=13 SS7 75 µm to 4.75 mm - 0% 2 µm to 75 µm -68% <2µm -32% LL=24 PL=18 PI=6	

APPENDIX B

LABORATORY TEST RESULTS

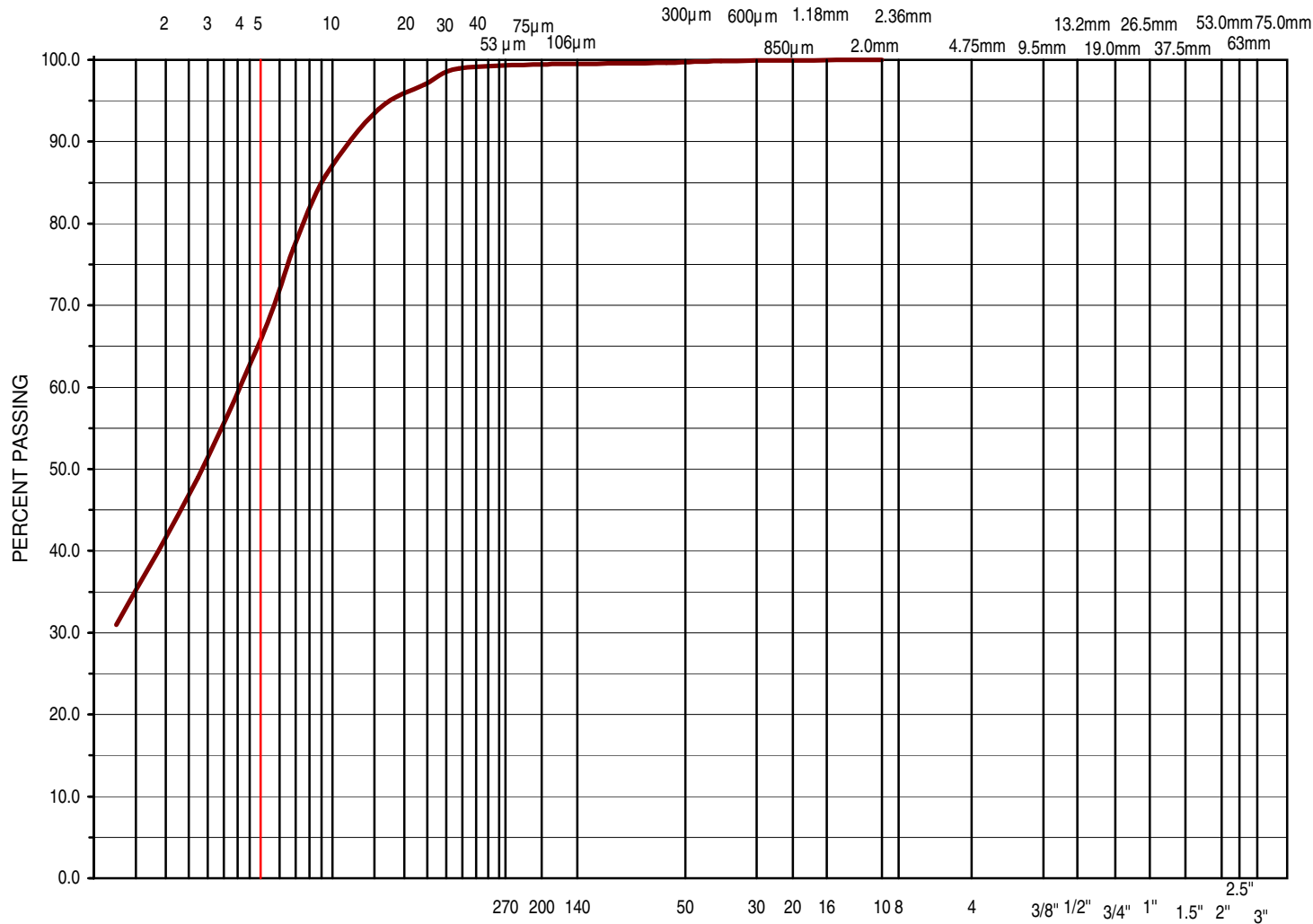
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 2

CLAY	SILT	SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse

MINISTRY SIEVE DESIGNATION

GRAIN SIZE IN MICROMETERS



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	99.92
0.425	99.84
0.25	99.68
0.106	99.48
0.075	99.44
0.0339	98.95
0.0242	96.95
0.0156	93.95
0.0094	85.95
0.0068	76.96
0.0052	66.96
0.0027	48.97
0.0012	30.98



GRAIN SIZE DISTRIBUTION

Clay & Silt

BH 4-3, 3.8-4.2m, Culvert #15

Lab No. S409

TB7210006

September 16, 2008

Prepared by: K. Zavitz

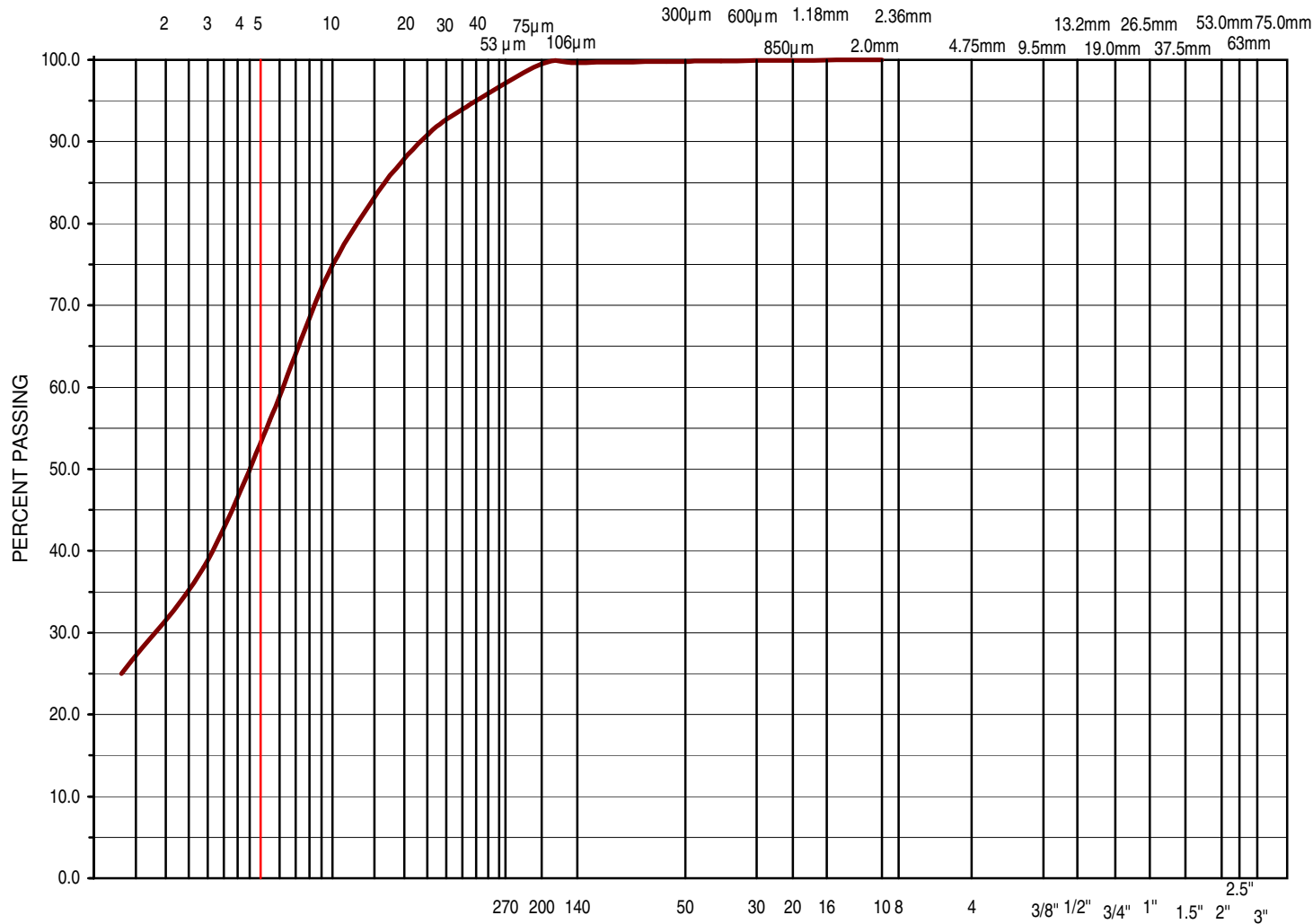
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 3

CLAY	SILT	SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse

MINISTRY SIEVE DESIGNATION

GRAIN SIZE IN MICROMETERS



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	99.91
0.425	99.85
0.25	99.79
0.106	99.65
0.075	99.53
0.0351	93.93
0.0252	90.93
0.0165	84.93
0.0100	74.94
0.0074	65.95
0.0055	55.96
0.0029	37.97
0.0013	24.98



GRAIN SIZE DISTRIBUTION

Clayey Silt

BH 4-8, 9.1-9.6m, Culvert #15

Lab No. S409

TB7210006

September 19, 2008

Prepared by: K. Zavitz

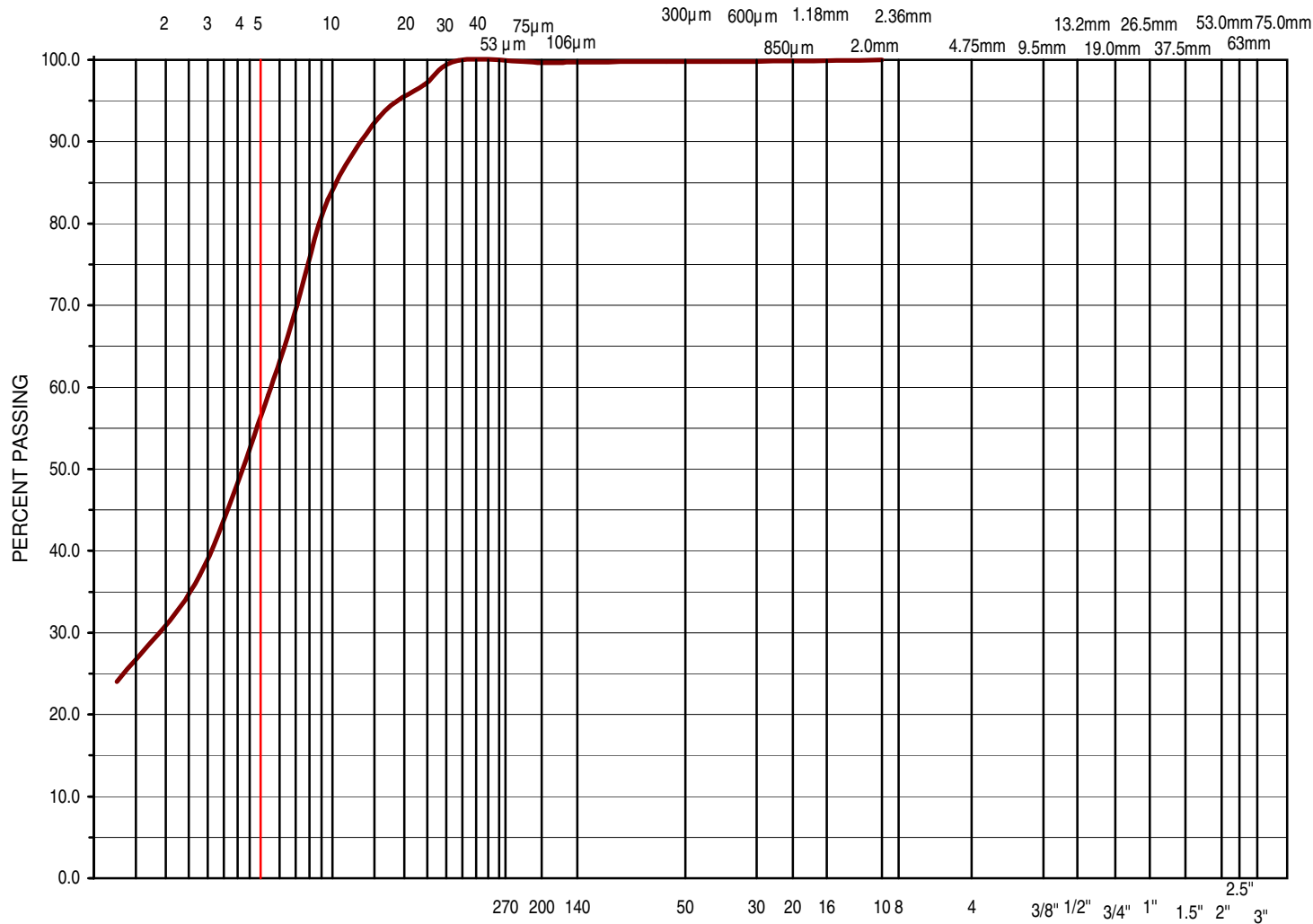
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 4

CLAY	SILT	SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse

MINISTRY SIEVE DESIGNATION

GRAIN SIZE IN MICROMETERS



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	99.84
0.425	99.82
0.25	99.78
0.106	99.72
0.075	99.68
0.0336	99.95
0.0242	96.95
0.0157	92.95
0.0096	82.96
0.0071	69.96
0.0054	58.97
0.0028	36.98
0.0012	23.99



GRAIN SIZE DISTRIBUTION

Clayey Silt

BH 5-4, 3.0-3.5m, Culvert #15

Lab No. S409

TB7210006

September 16, 2008

Prepared by: K. Zavitz

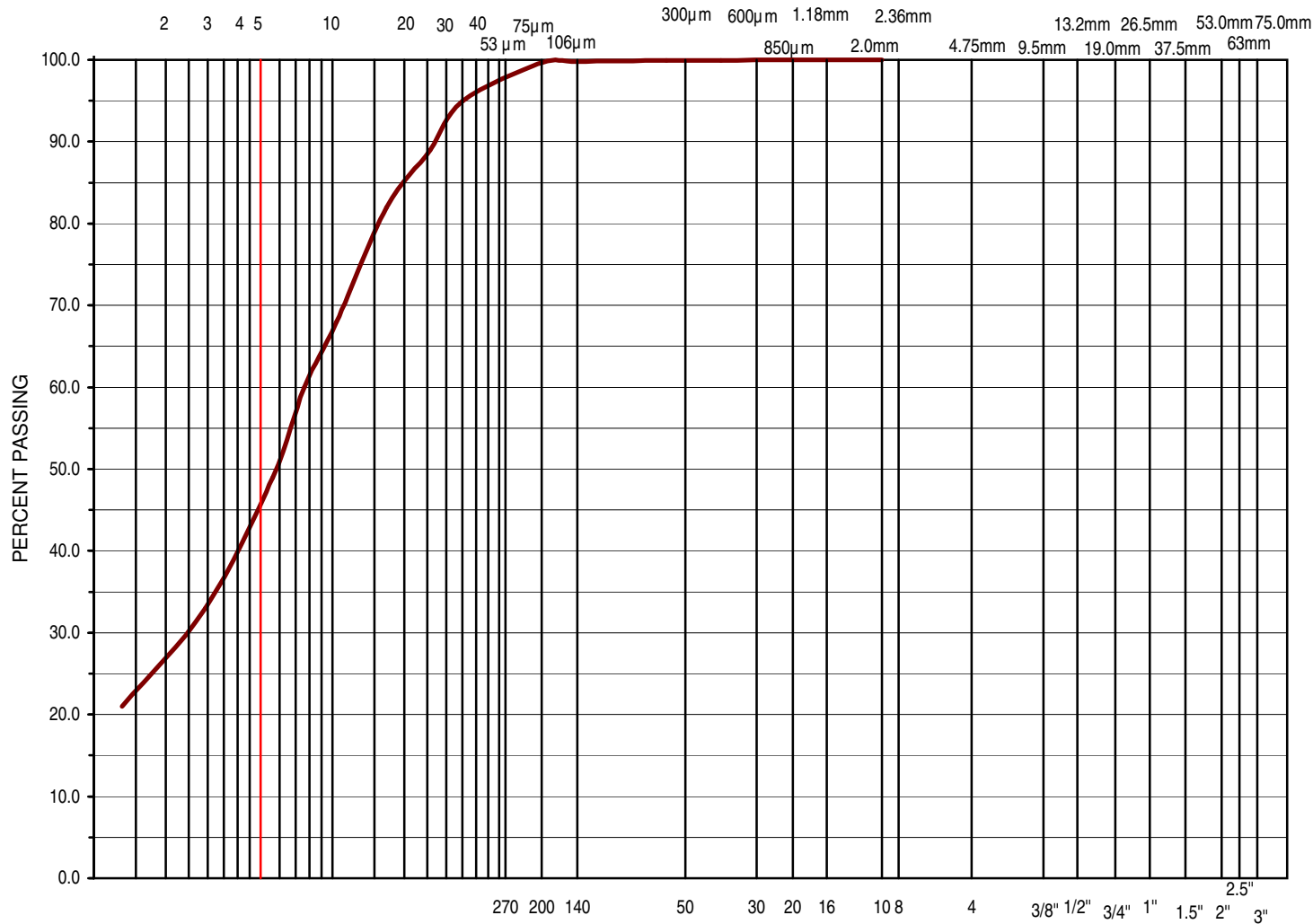
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 5

CLAY	SILT	SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse

MINISTRY SIEVE DESIGNATION

GRAIN SIZE IN MICROMETERS



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	99.98
0.425	99.96
0.25	99.94
0.106	99.78
0.075	99.64
0.0351	94.95
0.0256	88.95
0.0168	81.96
0.0104	67.96
0.0076	59.97
0.0056	48.97
0.0029	32.98
0.0013	20.99



GRAIN SIZE DISTRIBUTION

Clayey Silt

BH 5-8, 6.1-6.6m, Culvert #15

Lab No. S409

TB7210006

September 19, 2008

Prepared by: K. Zavitz

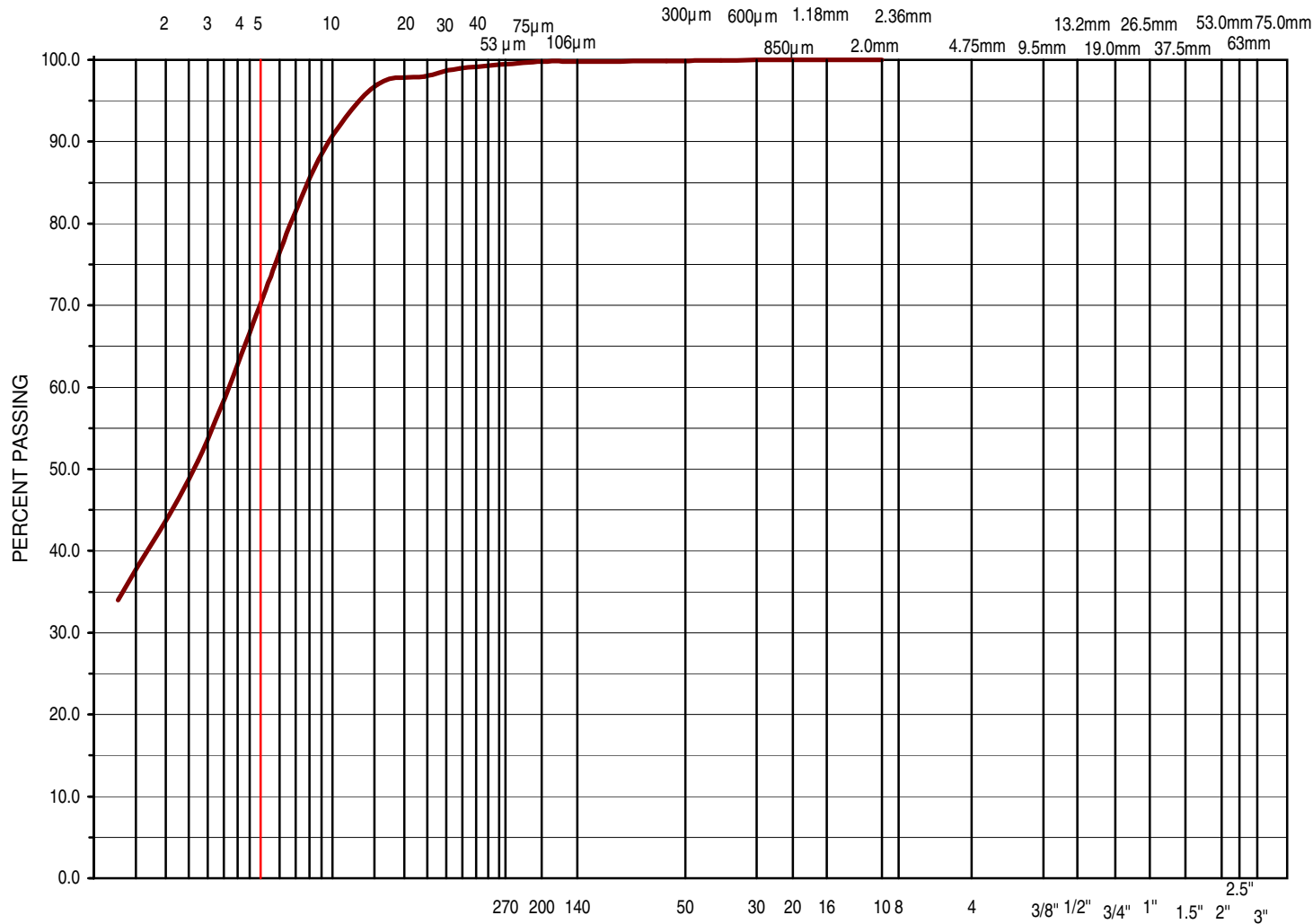
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 6

CLAY	SILT	SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse

MINISTRY SIEVE DESIGNATION

GRAIN SIZE IN MICROMETERS



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	99.98
0.425	99.92
0.25	99.88
0.106	99.80
0.075	99.78
0.0340	98.95
0.0242	97.95
0.0154	96.95
0.0096	89.95
0.0069	80.96
0.0051	70.96
0.0027	50.97
0.0013	33.98



GRAIN SIZE DISTRIBUTION

Clay & Silt

BH 6-1, 0.8-1.2m, Culvert #15

Lab No. S409

TB7210006

September 19, 2008

Prepared by: K. Zavitz

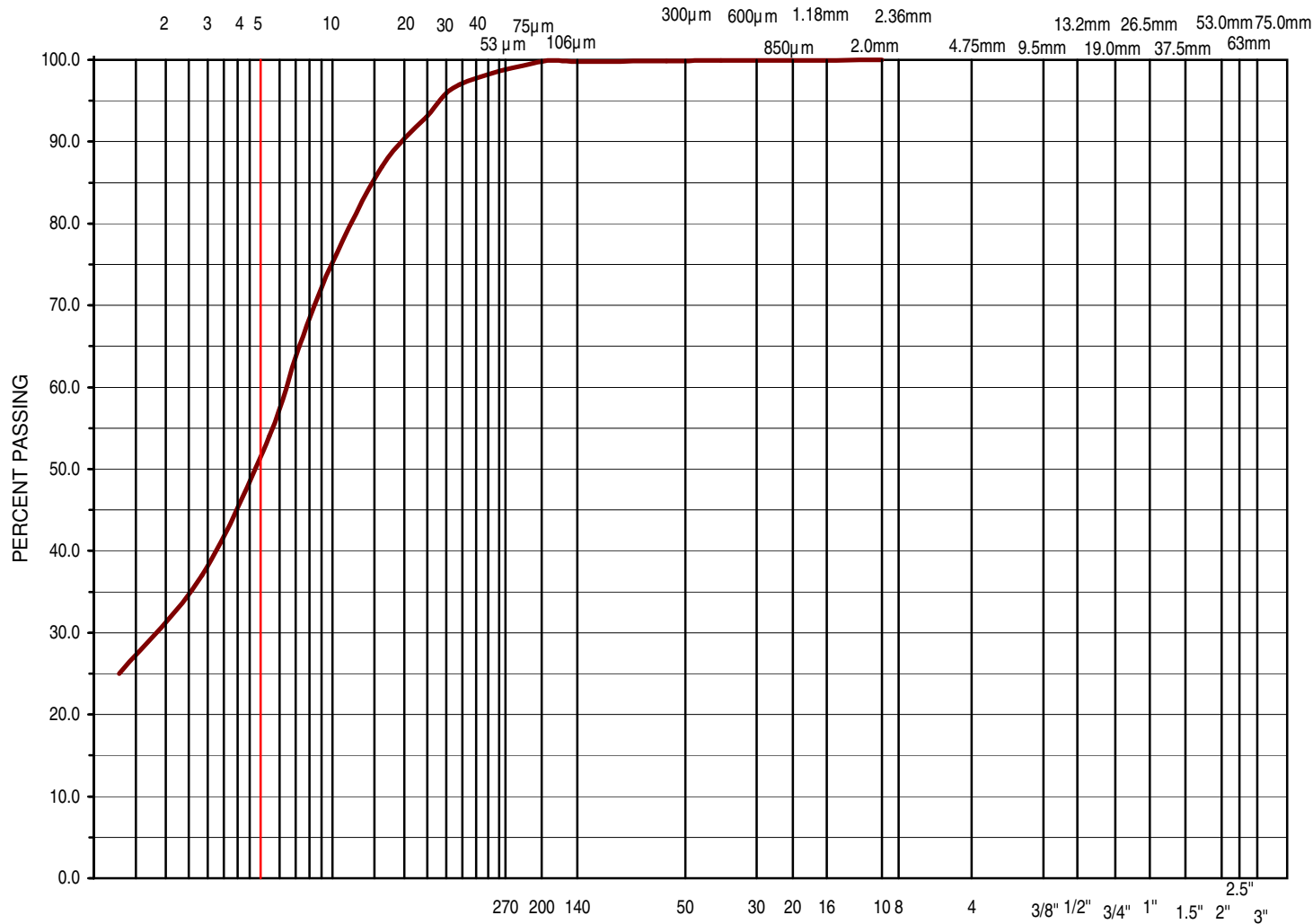
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 1

CLAY	SILT	SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse

MINISTRY SIEVE DESIGNATION

GRAIN SIZE IN MICROMETERS



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	99.96
0.425	99.92
0.25	99.88
0.106	99.82
0.075	99.78
0.0341	96.95
0.0247	92.95
0.0161	86.95
0.0099	74.96
0.0072	64.97
0.0054	53.97
0.0028	36.98
0.0013	24.99



GRAIN SIZE DISTRIBUTION

Clayey Silt

BH 6-7, 6.7-7.1m, Culvert #15

Lab No. S409

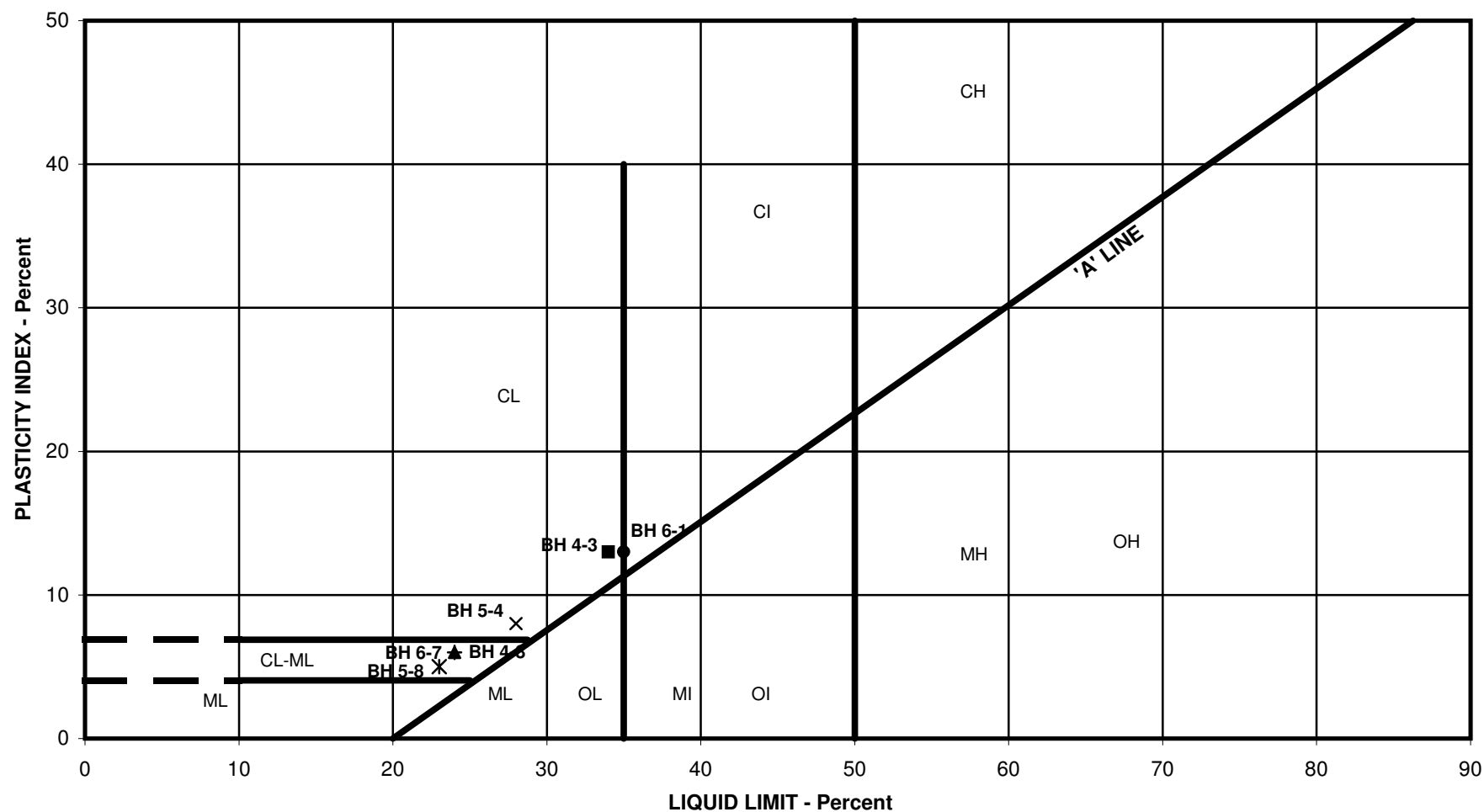
TB7210006

September 16, 2008

Prepared by: K. Zavitz

PLASTICITY CHART

BH 4-3: LL=34, PL=21, PI=13 ~ BH 6-7: LL=24, PL=18, PI=6 ~ BH 4-8: LL=24, PL=18, PI=6
 BH 5-4: LL=28, PL=20, PI=8 ~ BH 5-8: LL=23, PL=18, PI=5 ~ BH 6-1: LL=35, PL=22, PI=13



5835 COOPERS AVENUE
MISSISSAUGA, ON
CANADA L4Z 1Y2



PH: (905)712-5100
FAX: (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: AMEC EARTH & ENVIRONMENTAL
505 Woodward Avenue Unit 1
Hamilton, ON L8H6H6

ATTENTION TO: Hoda Seddik

PROJECT NO: TB 7210006

AGAT WORK ORDER: 08T293554

SOIL ANALYSIS REVIEWED BY: Yuri Kozlov, Analyst

DATE REPORTED: Sep 29, 2008

PAGES (INCLUDING COVER): 4

Should you require any information regarding this analysis please contact your client services representative at (905) 712 5100, or at 1-800-856-6261

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Member of: Association of Professional Engineers, Geologists and Geophysicists of Alberta (APEGGA)
Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

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Results relate only to the items tested

Page 1 of 4



Certificate of Analysis

AGAT WORK ORDER: 08T293554
PROJECT NO: TB 7210006

5835 COOPERS AVENUE
MISSISSAUGA, ON
CANADA L4Z 1Y2

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FAX: (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: AMEC EARTH & ENVIRONMENTAL

ATTENTION TO: Hoda Seddik

Corrosivity Package

DATE SAMPLED:	DATE RECEIVED: Sep 16, 2008			DATE REPORTED: Sep 29, 2008		SAMPLE TYPE: Soil
	Unit	G / S	RDL	BH#3 SS-4 1077314	BH#6 SS-2 1077318	
Sulphide *	mg/kg		100	3940	<100	
Sulphate (2:1)	µg/g		2.0	469	151	
Chloride (2:1)	µg/g		2.0	12.1	9.0	
pH (2:1)	N/A		NA	8.02	8.07	
Electrical Conductivity (2:1)	mS/cm		0.002	0.590	0.286	
Resistivity	ohmscm			1700	3500	
Redox Potential	mV		1	123	226	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
1077314- * Analysis subcontracted.
1077318

Certified By:



Quality Assurance

CLIENT NAME: AMEC EARTH & ENVIRONMENTAL

AGAT WORK ORDER: 08T293554

PROJECT NO: TB 7210006

ATTENTION TO: Hoda Seddik

Soil Analysis

RPT Date: Sep 29, 2008			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Corrosivity Package

Sulphate (2:1) (µg/g)	1	1077314	469	472	0.6%	< 2.0	94%	90%	110%	96%	90%	110%	96%	80%	120%
Chloride (2:1) (µg/g)	1	1077314	12.1	12.5	3.3%	< 2.0	99%	90%	110%	95%	90%	110%	93%	80%	120%
pH (2:1) (N/A)	1	1077314	8.02	7.93	1.1%		100%	80%	120%						
Electrical Conductivity (2:1) (mS/cm)	1	1077314	0.590	0.588	0.3%	< 0.002	100%	80%	120%						
Redox Potential (mV)	1	1077314	123	134	8.6%	< 1	104%	70%	130%		70%	130%		70%	130%

Certified By: _____

AGAT QUALITY ASSURANCE REPORT (V1)

Page 3 of 4

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Environmental Analytical Laboratories (CAEAL), for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Standards Council of Canada (SCC) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.caeal.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

Results relate only to the items tested

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MISSISSAUGA, ON
CANADA L4Z 1Y2



PH: (905)712-5100
FAX: (905)712-5122
<http://www.agatlabs.com>

Method Summary

CLIENT NAME: AMEC EARTH & ENVIRONMENTAL

AGAT WORK ORDER: 08T293554

PROJECT NO: TB 7210006

ATTENTION TO: Hoda Seddik

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulphide *		APHA 4500 S2 D	TITRATION
Sulphate (2:1)	INOR 1005	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Chloride (2:1)	INOR 1005	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR1031	McKeague 4.12 & SM 4500-H+ B	pH METER
Electrical Conductivity (2:1)	INOR 1036	McKeague 4.12 & SM 2510 B	EC METER
Resistivity	INOR 1036	CALCULATION	EC METER
Redox Potential		SM 2580 B	pH METER+REDOX ELECTRODE

APPENDIX C
SITE PHOTOGRAPHS

APPENDIX A - PHOTOGRAPHIC RECORD

PROJECT NO. TB7210006

PROJECT Hwy 6 Culvert Replacements - Culvert 15

LOCATION Hwy 6, Approximately 420m North of Sideroad 10, Sta(14+467)

	PHOTOGRAPH	1
	Culvert 15	
<p>General topography of area surrounding Culvert 15. (Looking North-East from East side of Hwy 6)</p>		

	PHOTOGRAPH	2
	Culvert 15	
<p>View of Culvert 15, looking North from East side of Hwy 6.</p>		

APPENDIX A - PHOTOGRAPHIC RECORD

PROJECT NO. TB7210006

PROJECT Hwy 6 Culvert Replacements - Culvert 15

LOCATION Hwy 6, Approximately 420m North of Sideroad 10, Sta(14+467)

	PHOTOGRAPH	3
	Culvert 15	
	View of East end of Culvert 15, looking East.	

	PHOTOGRAPH	4
	Culvert 15	
	View of West end of Culvert 15, looking West.	

APPENDIX A - PHOTOGRAPHIC RECORD

PROJECT NO. TB7210006

PROJECT Hwy 6 Culvert Replacements - Culvert 15

LOCATION Hwy 6, Approximately 420m North of Sideroad 10, Sta(14+467)

	<table border="1"> <tr> <td>PHOTOGRAPH</td> <td>5</td> </tr> </table>	PHOTOGRAPH	5
PHOTOGRAPH	5		
<table border="1"> <tr> <td>Culvert 15</td> </tr> </table>	Culvert 15		
Culvert 15			
<p>View of East end of Culvert 15, looking South.</p>			

	<table border="1"> <tr> <td>PHOTOGRAPH</td> <td>6</td> </tr> </table>	PHOTOGRAPH	6
PHOTOGRAPH	6		
<table border="1"> <tr> <td>Culvert 15</td> </tr> </table>	Culvert 15		
Culvert 15			
<p>View inside Culvert 15, looking West.</p>			