



FOUNDATION INVESTIGATION REPORT
PROPOSED CULVERT REPLACEMENTS
CULVERT 2-441C (CULVERT 14) at HWY 6 & 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 2-441C in Eastnor Township, Ontario. Culvert 2-441C (also known as Culvert No. 14) is located on Sideroad 10 at Hwy 6, approximately 23km north of Wiarton. 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 design discussions and recommendations, are presented in this report.

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 2-441C is located on Sideroad 10 where it intersects Highway 6, approximately 23km north of Wiarton, in Eastnor Township. The culvert is located at Sta(14+052), approximately 11m east of the Hwy 6 centreline.

Based on the MTO Terms of Reference, the structure crosses under Sideroad 10 and is a CSP arch culvert with dimensions for width, height and length of 3.36 x 2.12 x 20.7m. The road at this location is a two lane gravel road and runs on top of an embankment built up above the surrounding grade with an approximate fill height above the culvert of 0.5m. The culvert lies across Sideroad 10 near the base of the embankment, with top of culvert elevations of 191.840m and 191.645m for the inlet and outlet, respectively. The road embankment at the culvert location is approximately 2.4 m 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 south to north, as per the MTO Terms of Reference. At the time of the fieldwork, the soils in and around the culvert openings were generally wet, although no free water was observed. The stain markings within the culvert indicate that water levels have reached up to approximately 0.6m above the 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 (GEOCRES Report #41A-53) for a site slightly north of Culvert 2-441C indicate 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 borehole locations (BH 1 to BH 3) were staked and cleared.

One borehole was drilled through the existing road embankment (BH1) 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 a depth of 11.1 m below existing road grade.

Boreholes BH 2 and BH 3 extended to depths of 6.6 and 7.3m, respectively. They 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 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 north end of Culvert 2-441C". Based the outlet elevation supplied to AMEC by the MTO, the elevation of TBM is 191.645m.

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 vane) 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 BH 1 and BH 3 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 BH 2. The piezometer was constructed to a depth of 4.6m by placing 1.4m 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 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 fill overlying silty clay/clay & silt/silt with clay 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 BH 1, surficial sand fill was encountered to a depth of approximately 1.6m below ground surface. The sand fill deposit contained some silt and gravel, and was moist. Boreholes BH 2 and BH 3 which were put down in the vicinity of the inlet and outlet, encountered 80 and 130mm of topsoil, respectively.

Underlying the fill in Borehole BH 1 and the topsoil in Boreholes BH 2 and BH 3, silty clay/clay & silt/silt with clay was encountered, extending to at least the maximum depths investigated. The silty clay/clay & silt/silt with clay deposit was brown, turning grey with depth, and contained traces of organic matter, rootlets and gravel.

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', 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		
BH1-SS3	0	0	65	35	LL= 28, PL= 19, PI= 9	CL Clay of Low Plasticity
BH1-SS9	0	0	71	29	LL= 24, PL= 18, PI= 6	CL-ML Clay/Silt of Low Plasticity
BH2-SS2	0	0	57	43	LL= 33, PL= 20, PI= 13	CL Clay of Low Plasticity
BH2-SS7	0	1	73	26	LL= 24 PL= 18, PI= 6	CL-ML Clay/Silt of Low Plasticity
BH3-SS2	0	0	57	43	LL= 31, PL= 20, PI= 11	CL Clay of Low Plasticity
BH3-SS6	0	0	71	29	LL= 27, PL= 19, PI= 8	CL Clay of Low Plasticity

The SPT 'N' values of the silty clay varied from 2 to 10 blows for 300mm. In situ shear vane testing (MTO vane) was carried out in each borehole, as summarized below, indicating the silty clay/clay & silt/silt with clay to be of a stiff to firm consistency.

Table 2 – Summary of In Situ Shear Vane Test Results

Borehole #	Vane Test Depth (m)	Elevation (m)	Undisturbed Shear Strength (kPa)	Sensitivity
1	3.5	188.5	72	2.2
	9.1	182.9	33	2.0
2	3.8	186.2	61	1.8
	5.3	184.7	66	1.7
3	3.5	187.4	66	2.0
	6.6	184.3	72	2.2

Natural moisture contents ranged from 21 to 29%.

Split spoon sample #4 (3.0 to 3.4m) from Borehole BH 3 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.

Soil Characteristic	Result
Sulphide	3940 mg/kg
Sulphate	469 µg/g
Chloride	12.1 µg/g
pH	8.02
Electrical Conductivity	0.590mS/cm
Resistivity	1700 ohms-cm
Redox potential	123mV

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 BH 2, and the water level was measured the following day. A water level at 3.3m (elev. 186.7m) 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 BH 1, BH 2 and BH 3 ranged from non-detect to 50 parts per million ("ppm").

6.0 CLOSURE

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

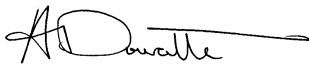
AMEC should be retained to review the recommendations provided in this report, once the details of the project are finalized and prior to the final design stage of the project.

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

The information presented in this report is complete within AMEC's terms of reference. If there are any further questions concerning this report, please do not hesitate to contact the undersigned.

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 2441C (Sta 14+467)		TB7210006 FIGURE 1
Dwg. Title: Site Location Plan		
 AMEC Earth & Environmental, a Division of AMEC Americas Limited		GEODESIES No. 414-201 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>>



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.	mwtpl - 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 1

1 OF 1


PROJECT Structural Culvert Replacements LOCATION Culvert 2-441 C - Sideroad 10 & Hwy 6, ORIGINATED BY LC
 CLIENT MTO SW Region - #3006-E-0083 Sta 14+058 ; o/s 21.0 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 <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				
192.0 0.0	Brown Sand FILL , some silt & gravel, moist.													Organic Vapour Measurement (OVM)	
			AUGER												
190.4 1.6	Brown SILTY CLAY , trace to some organics, stiff, moist.		1	SS	10									OVM - 50ppm Approx. Culvert Invert OVM - ND Vane - 72kPa Remould - 33kPa Sensitivity - 2.2 OVM - ND	
			2	NR	3										
			VANE												
188.0 4.0	Grey CLAY & SILT , wet, soft to firm.		3	SS	3									OVM - ND OVM - ND OVM - ND OVM - ND OVM - ND	
			4	SS	4										
			5	SS	2										
			6	SS	3										
			7	SS	3										
			8	SS	1										
185.1 6.9	Trace gravel.		7	SS	3									OVM - 10ppm Vane - 33kPa Remould - 17kPa Sensitivity - 2.0	
			VANE												
181.3 10.7	SILT with CLAY , very soft, wet.		9	SS	2									OVM - 10ppm	
180.9 11.1	BOREHOLE TERMINATED													Borehole open & dry to 11.1mbgs upon completion. SS3 75 µm-4.75mm 0% 2µm-75µm 65% <2µm 35% LL=28 PL=19 PI=9 SS9 75µm-4.75mm 0% 2µm-75 µm 71% <2µm 29% LL=24 PL=18 PI=6	

RECORD OF BOREHOLE No 3

1 OF 1

PROJECT Structural Culvert Replacements LOCATION Culvert 2-441 C - Sideroad 10 & Hwy 6, ORIGINATED BY LC
 CLIENT MTO SW Region - #3006-E-0083 Sta 14+036 ; o/s Rt 19.0 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 <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			
190.9 0.1	130mm TOPSOIL Brown to grey SILTY CLAY , trace gravel & rootlets, firm, dry.		1	SS	6									Organic Vapour Measurement (OVM)
189.4 1.5	CLAY & SILT , firm, dry.		2	SS	8									OVM - 30ppm Approx. Culvert Invert
188.9 2.0	Soft to stiff, wet.													OVM - 20ppm
			3	SS	4									OVM - 10ppm
			4	SS	2									OVM - 10ppm Vane - 67kPa Remould - 33kPa Sensitivity - 2.0 OVM - 10ppm
			VANE											
			5	SS	3									OVM - 10ppm
186.3 4.6	SILT with CLAY , soft to stiff, wet.		6	SS	4									OVM - 10ppm
		7	SS	3									OVM - 10ppm Vane - 72kPa Remould - 33kPa Sensitivity - 2.2 OVM - 10ppm	
		VANE												
183.6 7.3	BOREHOLE TERMINATED		8	SS	6								Borehole open & dry to 7.3mbgs upon completion.	
													SS2 75µm-4.75mm 0% 2 µm-75µm 57% <2µm 43% LL=31 PL=20 PI=11 SS6 75µm-4.75mm 0% 2µm-75 µm 72% <2µm 28% LL=27 PL=19 PI=8	



APPENDIX B

LABORATORY TEST RESULTS

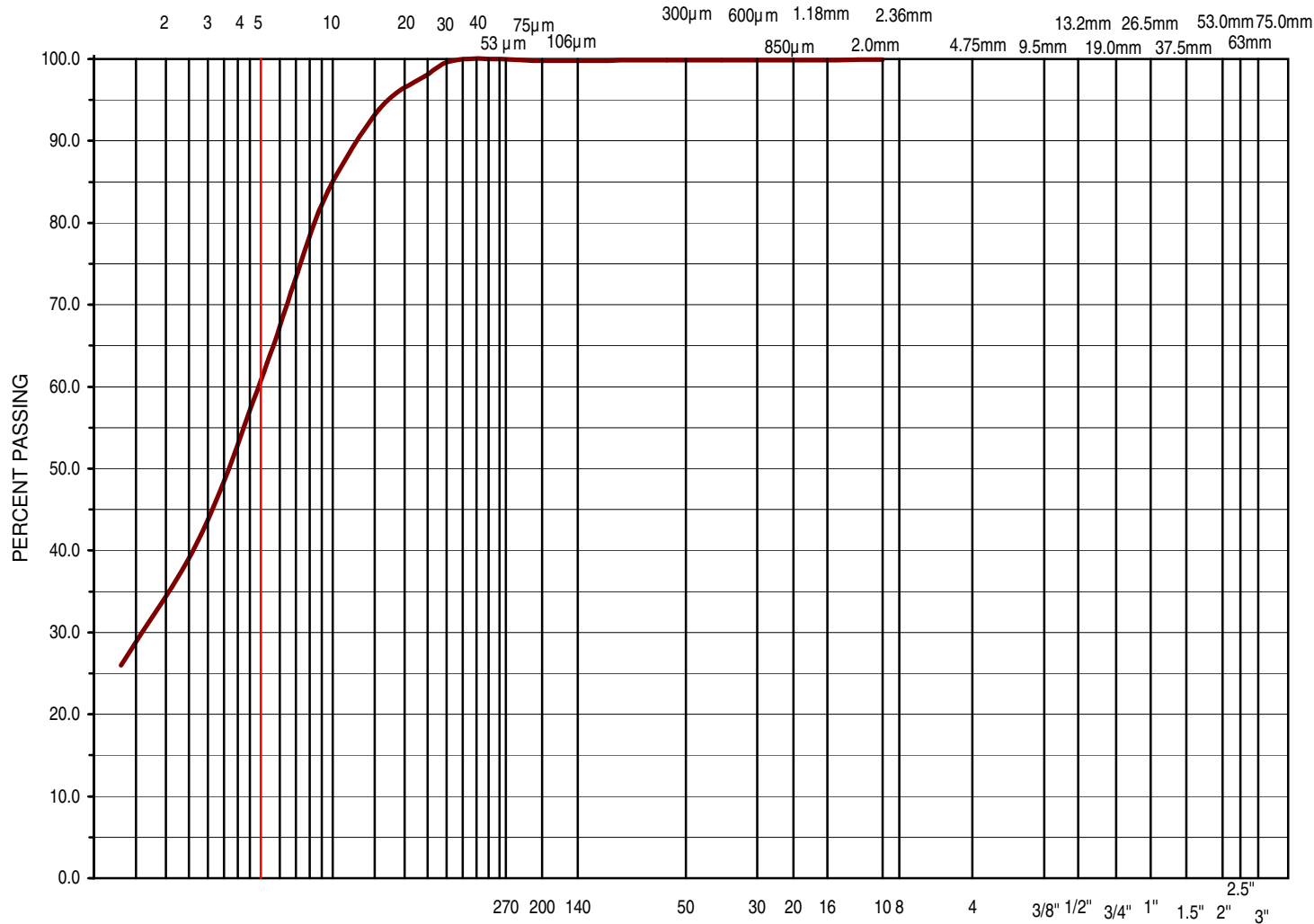
UNIFIED SOIL CLASSIFICATION SYSTEM

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	99.89
0.425	99.87
0.25	99.85
0.106	99.77
0.075	99.77
0.0338	99.90
0.0242	97.90
0.0157	93.91
0.0096	83.92
0.0071	73.93
0.0053	62.94
0.0028	41.96
0.0013	25.97



GRAIN SIZE DISTRIBUTION

Clay & Silt

BH 1-3, 4.0-4.4m, Culvert #14

Lab No. S409

TB7210006

September 19, 2008

Prepared by: K. Zavitz

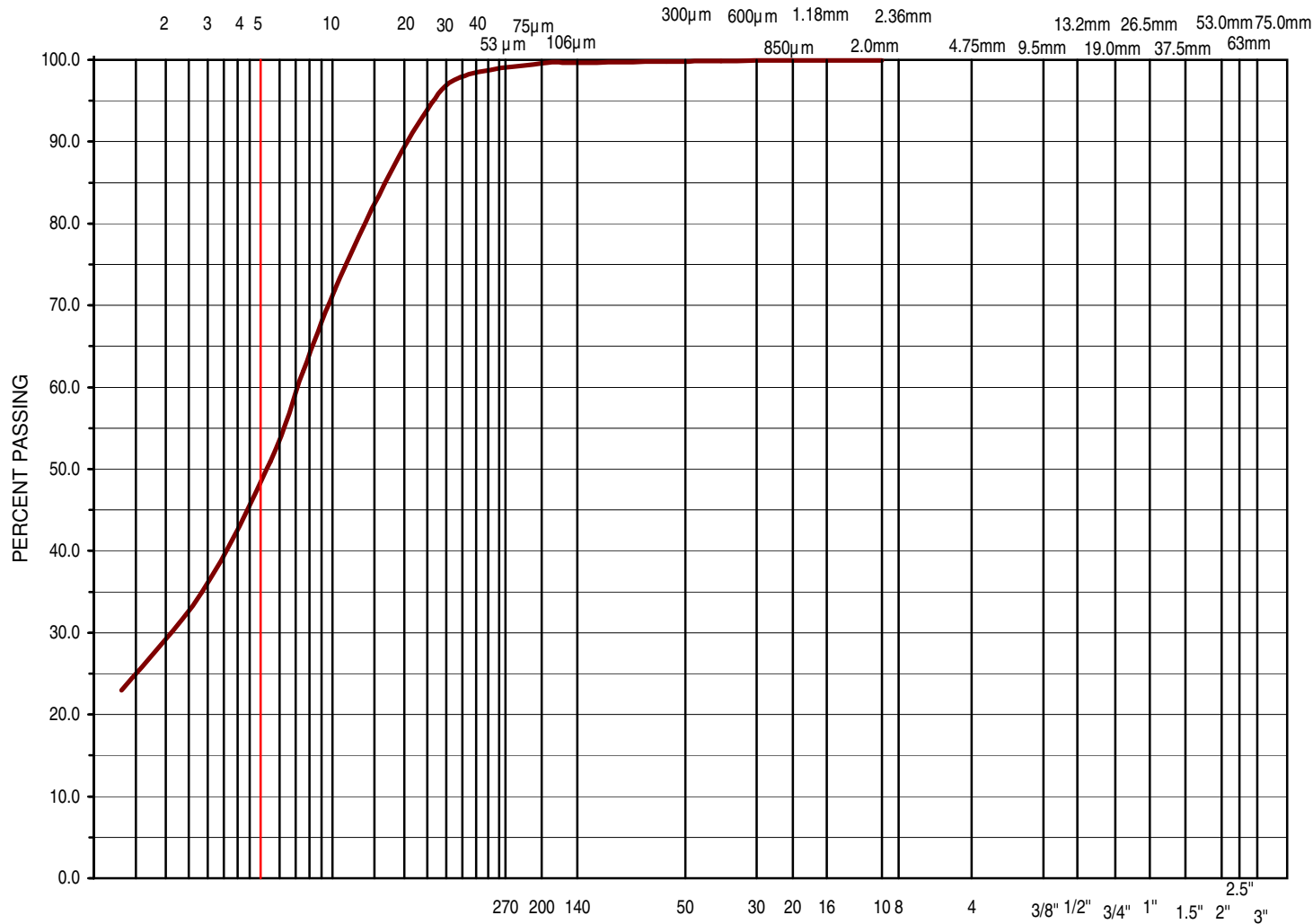
UNIFIED SOIL CLASSIFICATION SYSTEM

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	99.9
0.85	99.92
0.425	99.86
0.25	99.76
0.106	99.62
0.075	99.60
0.0344	97.89
0.0249	93.89
0.0166	84.90
0.0102	71.92
0.0075	61.93
0.0055	50.94
0.0028	34.96
0.0013	22.97



GRAIN SIZE DISTRIBUTION

Clayey Silt

BH 1-9, 10.7-11.1m, Culvert #14

Lab No. S409

TB7210006

September 19, 2008

Prepared by: K. Zavitz

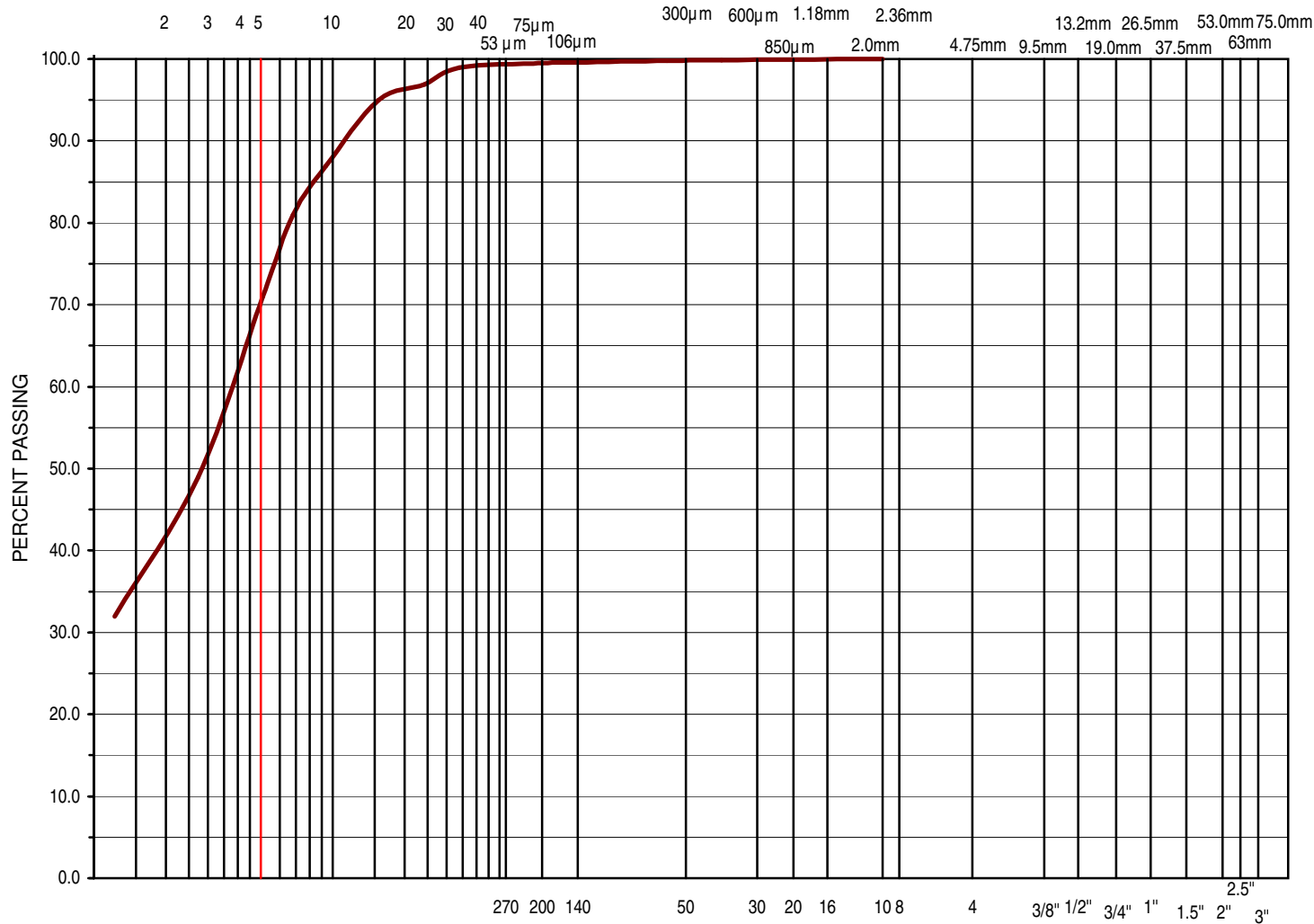
UNIFIED SOIL CLASSIFICATION SYSTEM

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	99.90
0.425	99.84
0.25	99.76
0.106	99.58
0.075	99.54
0.0339	98.93
0.0242	96.93
0.0155	94.93
0.0094	86.94
0.0068	80.94
0.0051	70.95
0.0027	48.97
0.0012	31.98



GRAIN SIZE DISTRIBUTION

Clay & Silt

BH 2-2, 0.8-1.2m, Culvert #14

Lab No. S409

TB7210006

September 16, 2008

Prepared by: K. Zavitz

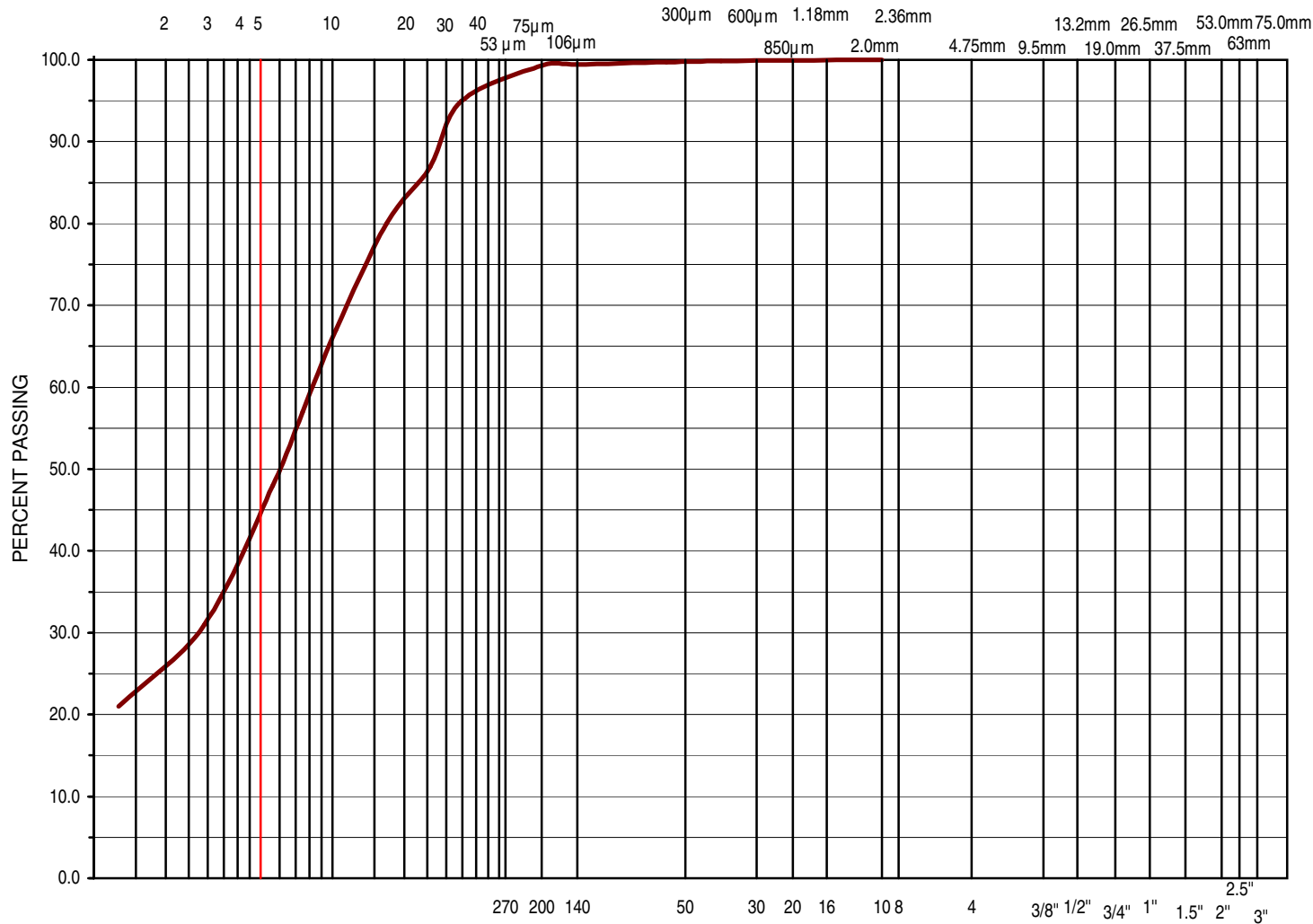
UNIFIED SOIL CLASSIFICATION SYSTEM

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	99.96
0.425	99.86
0.25	99.70
0.106	99.44
0.075	99.32
0.0347	94.95
0.0256	86.95
0.0168	79.96
0.0103	66.96
0.0075	56.97
0.0056	47.97
0.0029	30.98
0.0013	20.99

GRAIN SIZE DISTRIBUTION

Clayey Silt

BH 2-7, 6.1-6.5m, Culvert #14

Lab No. S409

TB7210006

September 16, 2008

Prepared by: K. Zavitz



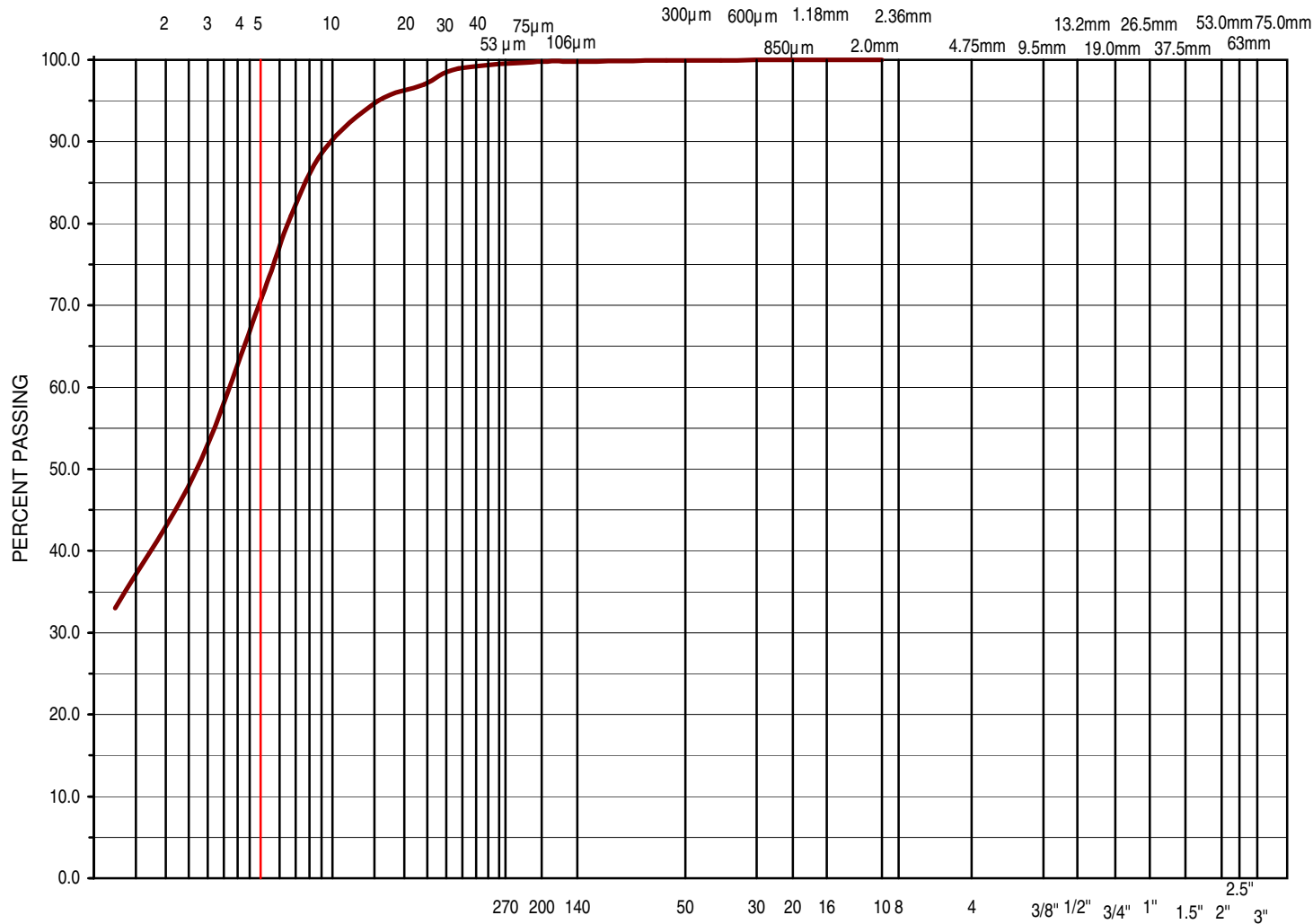
UNIFIED SOIL CLASSIFICATION SYSTEM

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	99.92
0.106	99.82
0.075	99.80
0.0337	98.95
0.0241	96.95
0.0154	94.95
0.0092	88.95
0.0067	80.96
0.0051	70.96
0.0027	49.97
0.0012	32.98



GRAIN SIZE DISTRIBUTION

Clay & Silt

BH 3-2, 1.5-2.0m, Culvert #14

Lab No. S409

TB7210006

September 16, 2008

Prepared by: K. Zavitz

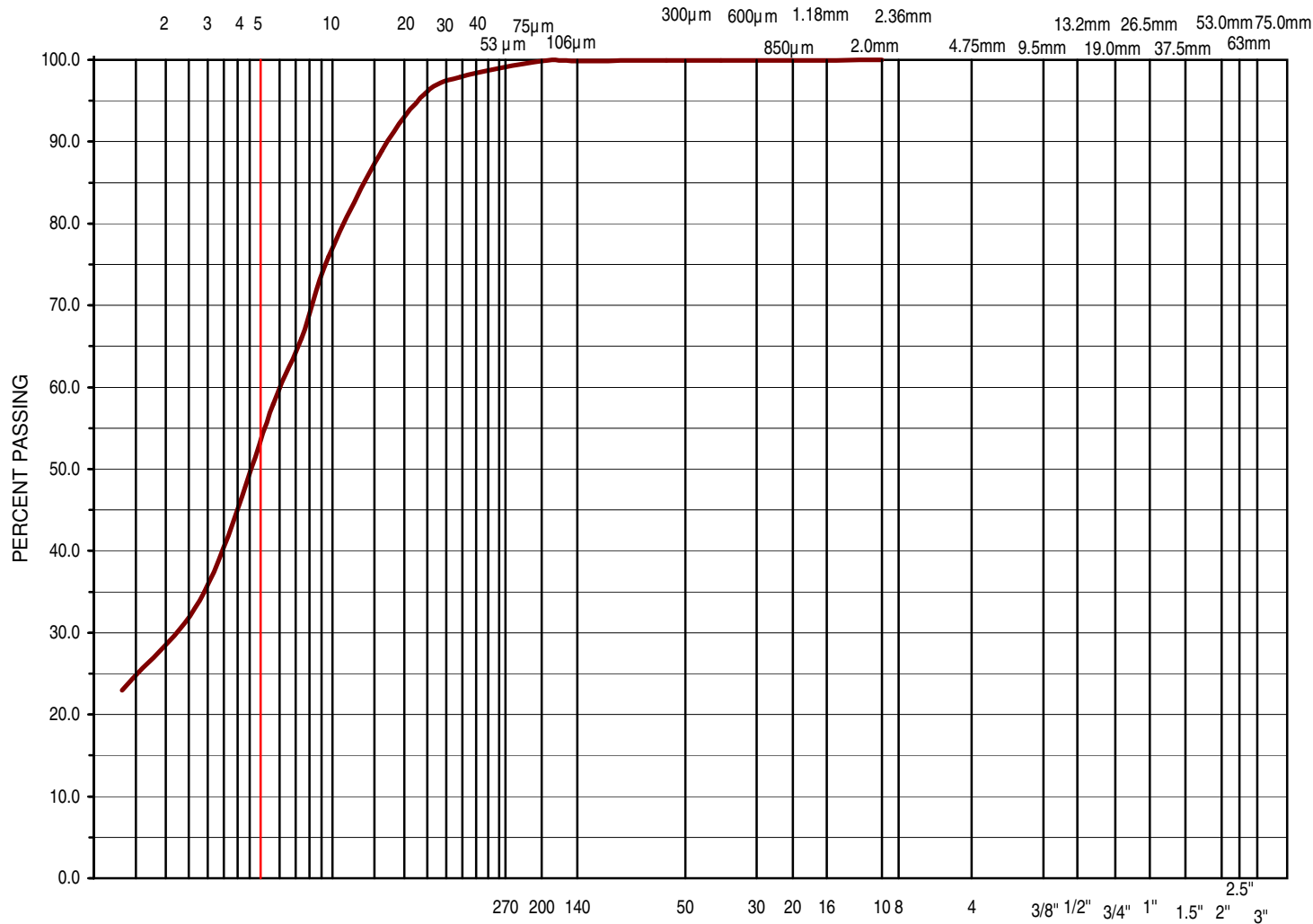
UNIFIED SOIL CLASSIFICATION SYSTEM

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	99.94
0.425	99.92
0.25	99.90
0.106	99.84
0.075	99.84
0.0343	97.93
0.0245	95.93
0.0161	88.93
0.0096	75.94
0.0074	65.95
0.0057	57.96
0.0029	34.97
0.0013	22.98

GRAIN SIZE DISTRIBUTION

Clayey Silt

BH 3-6, 4.7-5.0m, Culvert #14

Lab No. S409

TB7210006

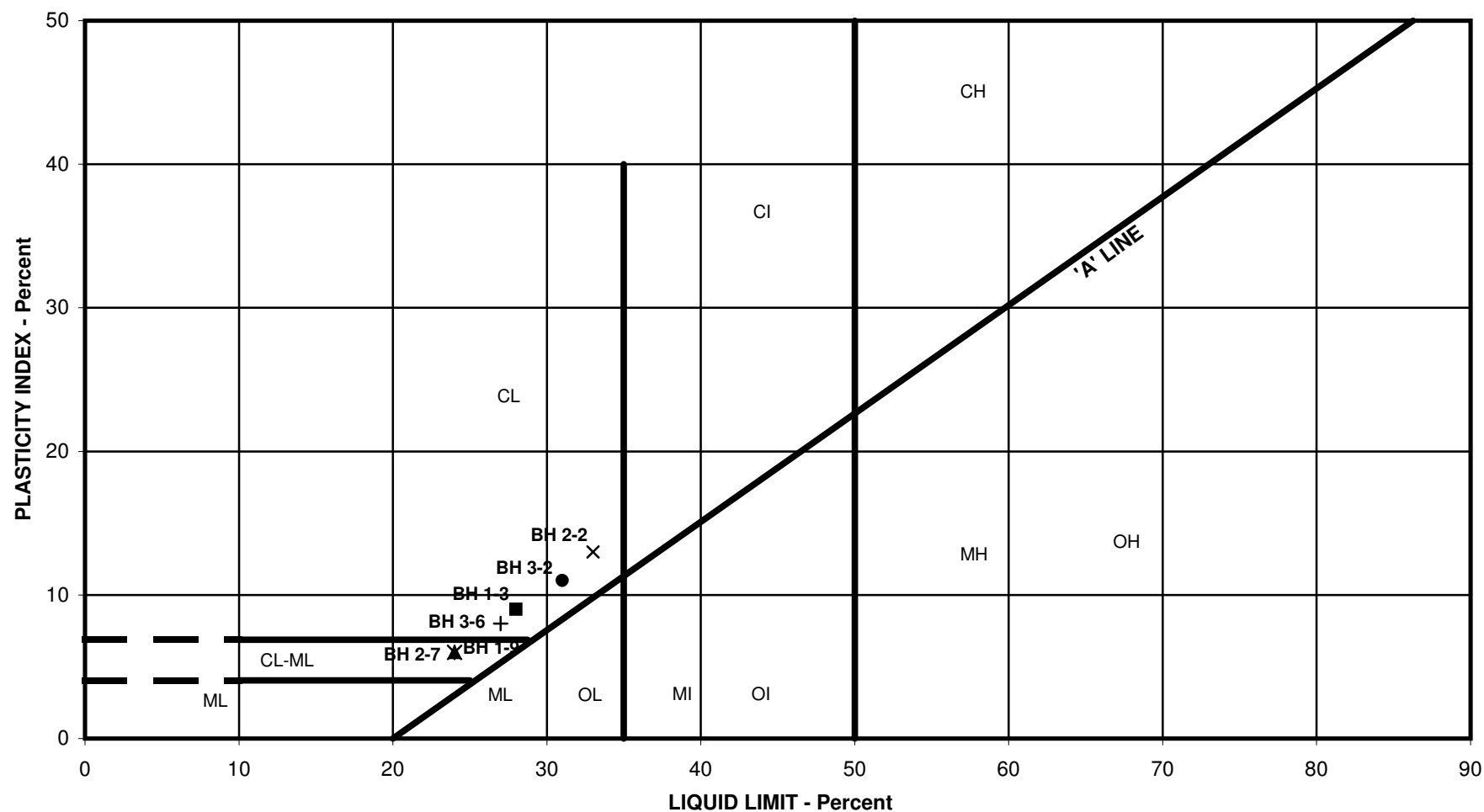
September 19, 2008

Prepared by: K. Zavitz



PLASTICITY CHART

BH 1-3: LL=28, PL=19, PI=9 ~ BH 1-9: LL=24, PL=18, PI=6 ~ BH 3-2: LL=31, PL=20, PI=11 ~ BH 3-6: LL=27, PL=19, PI=8
 BH 2-2: LL=33, PL=20, PI=13 ~ BH 2-7: LL=24, PL=18, PI=6



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)

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

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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<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-
1077318 * Analysis subcontracted.

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

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Results relate only to the items tested

5835 COOPERS AVENUE
MISSISSAUGA, ON
CANADA L4Z 1Y2



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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 14

LOCATION Sideroad 10 & Hwy 6, Sta(14+052)

	PHOTOGRAPH	1
	Culvert 14	
<p>General topography of area surrounding Culvert 14. (Looking West from East side of Hwy 6 at Sideroad 10)</p>		

	PHOTOGRAPH	2
	Culvert 14	
<p>View from Sideroad 10 & Hwy 6 intersection, looking East.</p>		

APPENDIX A - PHOTOGRAPHIC RECORD

PROJECT NO. TB7210006

PROJECT Hwy 6 Culvert Replacements - Culvert 14

LOCATION Sideroad 10 & Hwy 6, Sta(14+052)

	PHOTOGRAPH	3
	Culvert 14	
	View of South end of Culvert 14, looking South.	

	PHOTOGRAPH	4
	Culvert 14	
	View of North end of Culvert 14, looking North.	

APPENDIX A - PHOTOGRAPHIC RECORD

PROJECT NO. TB7210006

PROJECT Hwy 6 Culvert Replacements - Culvert 14

LOCATION Sideroad 10 & Hwy 6, Sta(14+052)

	<table border="1"> <tr> <td>PHOTOGRAPH</td> <td>5</td> </tr> </table>	PHOTOGRAPH	5
	PHOTOGRAPH	5	
<table border="1"> <tr> <td>Culvert 14</td> </tr> <tr> <td>View of North end of Culvert 14, looking East.</td> </tr> </table>	Culvert 14	View of North end of Culvert 14, looking East.	
Culvert 14			
View of North end of Culvert 14, looking East.			

	<table border="1"> <tr> <td>PHOTOGRAPH</td> <td>6</td> </tr> </table>	PHOTOGRAPH	6
	PHOTOGRAPH	6	
<table border="1"> <tr> <td>Culvert 14</td> </tr> <tr> <td>View inside Culvert 14, looking South.</td> </tr> </table>	Culvert 14	View inside Culvert 14, looking South.	
Culvert 14			
View inside Culvert 14, looking South.			