

Appendix D: Geotechnical Investigation



Oxford County

Geotechnical Investigation

FINAL

Project Name Geotechnical Investigation for Part of Oxford Road 16

Project Number KCH-00227972-GE

Prepared By:

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Date Submitted October 2015

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Oxford County

Geotechnical Investigation

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Date Submitted: October 2015

Legal Notification

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1. Introduction

As requested, **exp** Services Inc. (**exp**) has conducted a geotechnical investigation to determine the asphalt and granular thicknesses along Oxford Road 16, from Kintore to Township of Zorra 31st Line. It is understood that the proposed work program will consist of road rehabilitation. This report summarizes the results of the geotechnical investigation and provides geotechnical engineering guidelines to assist with the design and construction of the proposed project.

1.1 Terms of Reference

The geotechnical investigation was generally performed in accordance with our proposal P15-225, dated July 15, 2015. This investigation was authorized by Oxford County through Purchase Order PO2015-01165 dated August 14, 2015.

The purpose of this investigation was to examine the asphalt and granular thicknesses along the various roads listed above by drilling widely spaced sampled boreholes, and based on an interpretation of the factual data, to provide engineering guidelines for the geotechnical design of road rehabilitation, in accordance with information provided by Oxford County.

This report is provided on the basis of the terms of reference presented above and on the assumption that the design will be in accordance with applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning geotechnical aspects of the codes and standards, this office should be contacted to review the design.

The information in this report in no way reflects on the environmental aspects of the soil. Should specific information in this regard be needed, additional testing may be required.

2. Methodology

The fieldwork was carried out on August 20, 2015. In general, the geotechnical investigation consisted of the drilling of a total of thirteen (13) boreholes to a depth of approximately 2 m. The approximate locations of the boreholes are shown in Appendix A.

Underground utility locates were carried out for each road section prior to the drilling fieldwork being carried out. Traffic control during the drilling was conducted in general conformance with Ministry of Transportation, Ontario Traffic Manual Book 7 – Temporary Conditions.

The boreholes were advanced using truck-mounted equipment operated by a specialist contractor.

Within the boreholes, Standard Penetration Tests (SPTs) were performed to assess the compactness of the underlying soils and to obtain representative samples. Where needed, auger samples were also collected. During the drilling, the stratigraphy in the boreholes was examined and logged in the field by exp geotechnical personnel. Short-term groundwater level observations within the open boreholes and the natural moisture contents of recovered soil samples were recorded on the borehole logs.

After the completion of the field analysis, the test holes were then backfilled and surfaced with a layer of "cold patch" asphalt.



Representative samples of the various soil strata encountered at the test locations were taken to our laboratory in our Cambridge Office for further examination by a geotechnical engineer and laboratory classification testing. Laboratory testing included *in situ* moisture contents and one composite grain size analysis from each road section.

3. Site and Subsurface Conditions

3.1 Site Description

The proposed work is along the following road section:

• **Oxford Road 16**– from Kintore to Township of Zorra 31st Line

The roadway surface along this section presently has fair flexible pavement conditions as observed during the drilling.

3.2 Soil Stratigraphy

In general, sandy silt and/or sandy silt till was encountered below the asphalt and granular fill. The detailed stratigraphy encountered in each borehole is described in the attached borehole logs and summarized in the table below. It must be noted that boundaries of soil indicated are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purposes of geotechnical design and should not be interpreted as exact planes of geological change. Thicknesses should not be used for design purposes.



TABLE 1

Summary of Existing Pavement Structure and Subgrade

Borehole Location	Approximate Asphalt Thickness, (mm)	Approximate Granular Fill Depth (mm)	Subgrade Description
BH1*	n/a	1600	Sandy Silt Till
BH2	150	400	Sandy Silt
BH3	150	600	Sandy Silt
BH4	150	600	Sandy Silt
BH5	150	300	Sandy Silt
BH6	75	600	Sandy Silt and Sandy Silt Till
BH7	150	300	Sandy Silt
BH8	150	400	Sandy Silt
BH9	150	500	Sandy Silt and Sandy Silt Till
BH10	150	500	Sandy Silt Fill and Sandy Silt
BH11	150	400	Sandy Silt and Sandy Silt Till
BH12	100	500	Sandy Silt
BH13	225	700	Sandy Silt Till

* Borehole had to be drilled off edge of shoulder due to utility conflicts.

3.2 Existing Subgrade

As noted in the borehole logs and Table 1, the subgrade along the road section generally consists of sandy silt or sandy silt till. The compactness condition/consistency is generally stiff or loose to compact. Locally, the granular base is underlain by sandy silt fill containing traces of gravel, organics, and asphalt fragments. Grain size analyses were conducted on selected composite samples of the native subgrade material from each road section, with results presented in Appendix C.

A grain size analysis was conducted on a selected sample of the subgrade at Borehole 6 and 7 on Oxford Road 16. The results indicate the subgrade at these locations consists of 62% silt, 23% sand, 8% gravel, and 7% clay.

3.3 Groundwater Conditions

The boreholes were generally dry upon completion. It is noted that insufficient time was allowed to observe the stabilized groundwater levels.

It is further noted that the depth to the groundwater table may vary in response to climatic or seasonal conditions, and, as such, may differ at the time of construction, with higher levels in wet seasons. Capillary rise effects should also be anticipated within fine-grained soils.



4. Discussion and Recommendations

4.1 General

Along each road section, the average Granular Base Equivalencies (GBE), asphalt (ASP) thicknesses, and granular base/subbase (GB) thicknesses of the existing pavement structures were all found to be at or above the recommended configuration for the specified class of roads. A summary of the findings is given in the table below.

Road Designation	Average Asphalt Thickness (mm)	Average Granular Thickness (mm)	Average Granular Base Equivalency GBE* (mm)	Recommended GBE (mm)	2012/2013 Traffic (AADT)
Rural	145	483	614	685	2483

TABLE 2Summary of Existing Pavement Structure and Traffic

* For existing GBE, Equivalency Factors used: 2.00 for existing asphalt, 0.67 for old granular, medium subgrade for GBE calculation.

** Recommended GBE based on existing pavement structure design drawings for each road section, provided by Oxford County.

4.2 Pavement Rehabilitation

The results of the investigation show that the average asphalt thickness along this road section is close to the Oxford County design requirement. However, the overall GBE along this section is less than required and is attributed to a lower granular base thickness. Assuming that overall road grade changes are not possible, full reconstruction may be considered. Alternatively an asphalt overlay of 35 to 40 mm of HL3 would increase the GBE to the required thickness.

4.3 General Comments

For localized re-construction, assuming that grade changes are not allowed for the roadways, the best option is the removal of the existing asphalt along with some of the underlying granular fill, and removed from site. The existing pavement structure would be cut to below the existing subgrade level to receive the new pavement structures.

The proposed pavement area to be reconstructed or added should be stripped of all asphalt and other obviously unsuitable material. The exposed subgrade must then be proof rolled. Any soft spots revealed by this or any other observations must be sub excavated and backfilled with approved granular material compacted to 100 percent Standard Proctor Maximum Dry Density (SPMDD). All fill required to backfill service trenches, or to raise the subgrade to design levels must conform to current County Standards or O.P.S. Standards. Preferably, native materials should be used to maintain uniform subgrade conditions, provided that adequate compaction can be achieved. Where native materials are too wet and/or unsuitable for reuse, imported granular material should be used to backfill under roads, driveways, sidewalks, curb and gutters as per current County Standards or O.P.S. Standards. Where free-draining backfill is required, and for backfill in confined areas, Granular 'B' Type II fill is recommended.



Disposal of excavated materials should conform to the current Ministry of the Environment Guidelines and Regulations.

Good drainage provisions will optimize pavement performance. Accordingly, the subgrade in areas to be paved should be crowned and shaped to promote drainage. The final grading plan should be reviewed prior to finalizing the design requirement.

Where the new pavement joins the existing pavement, a straight vertical joint should be placed to receive the new asphalt as a transition joint. The transition joint should be routed and sealed.

Provided the preceding recommendations are followed, the pavement thickness design requirements given in Table 3 are recommended. A function design life of about fifteen years has been used to establish the pavement design. This represents the number of years to the first major rehabilitation, assuming regular maintenance is carried out. If recommendations on street classification other than those specified are required, **exp** should be contacted for further comments.



TABLE 3

Suggested Flexible Pavement Thickness Design*

Road Section	Asphalt Wearing Course (HL3 or HL4) (mm)	Asphalt Binder Course (HL8) (mm)	Granular Base (OPSS Granular 'A') (mm)	Granular Subbase (Granular 'B') (mm)
Oxford Road 16	HL-4 40	60	150	500

- 1. If construction is undertaken under adverse weather conditions such as wet/freezing subgrade preparation, the granular sub-base requirements should be reviewed at that time by the geotechnical engineer.
- 2. A program of in-place density testing must be carried out to verify that satisfactory levels of compaction are being achieved.
- 3. Granular base/sub-base should be compacted to 100% Standard Proctor maximum dry density. Asphaltic concrete should be compacted per OPS requirements.
- 4. Minimum overlay should be 40 mm for mill and overlay option for shoulder or edge repair.

*Based on Oxford County design drawings, included in Appendix D.

Additional comments on the construction of roadways are as follows:

- 1. The most severe loading conditions on pavement areas and the subgrade may occur during construction. Consequently, special provisions such as restricted lanes, half-loads during paving, etc., may be required, especially if construction is carried out during unfavourable weather.
- 2. It is recommended that **exp** be retained to review the final pavement structure designs and drainage plans prior to construction to ensure that they are consistent with the recommendations of this report.

4.3 Curbs and Gutters

The following recommendations are provided should curbs and gutters need to be locally replaced or constructed on an as needed basis. The concrete for the curbs and gutters should be proportioned, mixed placed and cured in accordance with the requirements of OPSS 353 and OPSS 1350, and the required CSA standards.

During cold weather, the freshly placed concrete should be covered with insulating blankets to protect against freezing.



4.4 Inspection and Testing

An effective inspection and testing program is an essential part of construction monitoring. The Inspection and Testing Program for road reconstruction typically includes the following items:

- Subbase examination prior to asphalt placement;
- Inspection of the asphalt placement;
- Inspection, compaction, and materials testing for subbase, base and surface asphalt, including laboratory testing on asphalt sampling to confirm conformance to project specifications and standards;
- Inspection, compaction, and materials testing for concrete curb and gutter, including laboratory testing on concrete sampling to confirm conformance to project specifications and standards.



5. General Comments

The comments given in this report are intended only for the guidance of design engineers. The number of test holes required to determine the localized underground conditions between test holes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

Exp Services Inc. should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not afforded the privilege of making this review, exp Services Inc. will assume no responsibility for interpretation of the recommendations in this report.

We trust that this report is satisfactory to your present requirements and we look forward to assisting you in the completion of this project. Should you have any questions, please contact the office at your convenience.



Appendix A

Borehole Location Maps

-----exp Services Inc. Earth and Environmental Division - Geotechnical



APPROXIMATE BOREHOLE LOCATIONS - OXFORD ROAD 16



Appendix **B**

Borehole Logs

NOTES ON SAMPLE DESCRIPTIONS

 All descriptions included in this report follow the 'modified' Massachusetts Institute of Technology (M.I.T.) soil classification system. The laboratory grain-size analysis also follows this classification system. Others may designate the Unified Classification System as their source; a comparison of the two is shown for your information. Please note that, with the exception of those samples where the grain size analysis has been carried out, all samples are classified visually and the accuracy of the visual examination is not sufficient to differentiate between the classification systems or exact grain sizing. The M.I.T. system has been modified and the **exp** classification includes a designation for cobbles above the 75 mm size and boulders above the 200 mm size.

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- 2. Fill: Where fill is designated on the borehole log, it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description therefore, may not be applicable as a general description of the site fill material. All fills should be expected to contain obstructions such as large concrete pieces or subsurface basements, floors, tanks, even though none of these obstructions may have been encountered in the borehole. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact and correct composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. The fill at this site has been monitored for the presence of methane gas and the results are recorded on the borehole logs. The monitoring process neither indicates the volume of gas that can be potentially generated or pinpoints the source of the gas. These readings are to advise of a potential or existing problem (if they exist) and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic waste that renders the material unacceptable for deposition in any but designated land fill sites; unless specifically stated, the fill on the site has not been tested for contaminants that may be considered hazardous. This testing and a potential hazard study can be carried out if you so request. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common, but not detectable using conventional geotechnical procedures.
- 3. Glacial Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process, the till must be considered heterogeneous in composition and as such, may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (75 to 200 mm in diameter) or boulders (greater than 200 mm diameter) and therefore, contractors may encounter them during excavation, even if they are not indicated on the borehole logs. It should be appreciated that normal sampling equipment can not differentiate the size or type of obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited area; therefore, caution is essential when dealing with sensitive excavations or dewatering programs in till material.

BOREHOLE LOG

Sheet 1 of 1

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CLIENT County of Oxford

PROJECT NO. **KCH-00227972-GE** DATUM Local

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Sheet 1 of 1

BOREHOLE LOG

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PROJECT Oxford County Roads

CLIENT County of Oxford

DATUM Local

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Sheet 1 of 1

BOREHOLE LOG

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PROJECT Oxford County Roads

CLIENT County of Oxford

DATUM Local

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Sheet 1 of 1

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BOREHOLE LOG

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PROJECT	Oxford County	Roads

DRILL TYPE/METHOD Solid Stem

CLIENT County of Oxford

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	Ň		P L O T	L O G	Ē	Ē	R	or RQD	<u>S</u>					-				w _L				l		
(m)	(m)		¥				(mm) or	(%)			S			Va	lue			Dyn	ami			e		
-0 -		ASPHALT , ~.100 m					`or´ (%)		(kN/m3)	\square		1(⊤†)	<u> </u>	20) 	· 	30		40			┝	
	0.10				77					\square										Щ				
		FILL, ~Brown sand & gravel, damp, compact																						
					0														Π			Ħ	-	
										\vdash									+	++-		H		
-						S1	350	17		\square		þ		-•	\blacksquare			++	\parallel			#	-	
	0.50																			Ш				
		FILL, Grey/brown, sandy silt, some gravel, moist, compact			Ø																			
-										H										Ħ		Ħ	-	
	0.76				4					\vdash		+	-		+			++	+	+		H		
	0.10	SANDY SILT, Bark brown/black, trace clay,			\square					\square												<u> </u>	-	
		trace gravel, moist, firm																						
						S2	50	6																
-1						32	50	0			T									T		П		
										\vdash										++-		H		
					2					\vdash					+	+		+	++	+		#	-	
																				Щ				
																							-	
		becoming grey/brown, mottled yellow, sandy								⊢									+	╈		H		
		silt with thin fine sand seams								\vdash	\square	+	-		+				+	+		H	-	
																				Щ		\square		
_						S3	350	7							9									
	1.98											T							\square			Ħ		
-2		End of Borehole at 1.98 m depth																		- <u>-</u> -			-	
																							-	
																							-	
										L													Ц	
NOT	<u>'ES</u>						SAMPLE LEGEND ⊠ AS Auger Sample ⊠ SS Split Sp Ⅲ Rock Core (eq. BQ_NQ_etc.)																	
1) B	orehole i	nterpretation requires assistance by exp before u ogs must be read in conjunction with exp Repor	ise by c	others.		OTHER TESTS									VN Vane Sample									
K	CH-0022	23655-GE. For definition of terms used on logs,	see she	ets pr	ior to	r to G Specific Gravity C Consolidation										-								
	gs.				H Hydrometer S Sieve Analysis CD Consolidated Drained Triaxial CU Consolidated Undrained Triaxial																			
2) U	pon com	pletion, borehole open to 1.98 m and dry.				ΥU PFi	nit We eld Pe	eight ermeabil	UU itv LIG									aine sior		riax	kial			
						K La	ab Per	meabilit		S D						p	pression							
P Field Per K Lab Perr WATER LE ♀ Apparer										eas	ure	he			Ā	_	Art	esia	an (<u>.</u>	No	ntes	•	

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BOREHOLE LOG

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PROJECT	Oxford County	y Roads

CLIENT County of Oxford

DATUM Local

DR		PE/METHOD <u>Solid Stem</u>		DAT	ES:	Boring	Au	gust 20), 2015	<u> </u>			vv	ate	r Le	vel				
	Ę		s			SAN	PLES		BU						STR					
DUPTH		STRATA DESCRIPTION	STRATA PLOT	WELL LOG	TYPE	NUZBER	RUCOVURY	N VALUE (blows) or RQD	BULK DERS-FY		Pe	Field netr tterb	ome	eter 100 Lin W _P	nits a	■ To and W _L	Moi	ne 200 istu	kPa re	
(m)	(m)		Ť				(mm) or (%)	(%)	Ý (kN/m3)		SF	т N 10		ue 2 <u>0</u>	×	Dyn 30	nami	ic C 40	one	
-0 -	0.23	ASPHALT , ~.225 m							(
	0.60	FILL, ~Brown sand & gravel, damp, dense				S1	375	33			0						•			
-		SANDY SILT TILL, Grey/brown, trace fine to coarse grained gravel, trace clay, moist, stiff to very stiff																		
-1						S2	225	12												
	1.98	sand seams at depth				S3	450	24				0			•					2 <u>8</u> 8_
-2		End of Borehole at 1.98 m depth																		-
B K lo	orehole i orehole l CH-0022 gs.	nterpretation requires assistance by exp before us Logs must be read in conjunction with exp Report 3655-GE. For definition of terms used on logs, so pletion, borehole open to 1.98 m and dry.	se by a ee she	others.	ior to	⊠ β □ F OTH GS HH SSi YU PFi KLa WAT	AS Auc Rock C ER TE pecific ydrom eve Au eve Au nit We eld Pe	Gravity eter nalysis sight ermeability EVELS	ple ⊠ BQ, N C C C C U U U		etc. nso Cons Cons Jncc Jncc Jncc) iolida iolida ionsol infine it Sh	ion ated ated idat ed C	Dra Un ed l	aine drai Jndi pres	VN d Tr ned raine ssion	l Va iaxia Tria ed T n	ne ŝ al ixial riax		ple

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BOREHOLE LOG

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PROJECT	Oxford County Roads	

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DATUM Local

PROJECT NO. <u>KCH-00227972-GE</u>

DR	ILL TYF	PE/METHOD Solid Stem		DAT	ES:																		
	E		<u>s</u>			SA	MPLE	S	BU		_												Τ
	ELEVAT-0	STRATA DESCRIPTION	ST R A T A	WELL.	TYPE	NUXBUR	RUCONURN	N VALUE (blows)			Pe	ene	etro	m	ete 10(e r 0		To	Sei orva	ne 20	0 k	Pa	
	Ч Ор	DESCRIPTION	P L O T	L OG	Ē		F	or RQD					1.00	яg				WL		1311	110		
(m)	(m)		Ť				(mm or (%)	(,,,,	 Y (kN/m3)		SI	РТ 10		Val	ue 20			Dyn 3 <u>0</u>	am	ic (4(1e	
-0 -		ASPHALT , ~.150 m							(Π			Ē	Π				TÎ		╢	┢
	0.15	FILL, Brown sand & gravel, some cobbles,	$\times \times \times$		77							Ħ				Ħ				Ħ		+	
		damp to moist, compact	\bigotimes													T				Ħ		+	1 -
																							-
	0.45	SANDY SILT, Grey/brown, mottled, trace				S1	350) 19		0					•	Ħ				Ħ			1-
		clay, trace gravel, moist to very moist, firm																					
																							-
-1						S2	200) 5			•									Ī			
																				\parallel		\parallel	
																						\parallel	
					77									_								++	_
														+						\parallel		++	
							10-					$\left \right $		+						+		++	-
						S	187	8			-		+			+	+		+	╢	+	++	
	1.00	becoming sandy silt till										\square		+		+			+	+		++	-
-2	1.98	End of Borehole at 1.98 m depth	· · .																				+-
																							-
																							-
			•					LEGEND		SS	ss	plit	S	200	on			ST	Sh	elh	νт	ube	ـــــ ع
NOTES ⊠ AS Auger Sample										.)	. ~1			ļ		VN	l Va	ine	Sa	mp	le		
K	orehole L CH-0022 Igs.	ogs must be read in conjunction with exp Report 3655-GE. For definition of terms used on logs, se	ee shee	ets pri	ior to	5 G		ic Gravity		Cor					ıп	rair	hed	∣ Tr	iavi	al			
	•	pletion, borehole open to 1.98 m and dry.				S γ P	Sieve J Unit W Field F	Analysis	Cl Ul ity UC		on: nco nco	soli ons onf	ida soli ine	teo da d	l U ted Cor	ndr Ur	rain ndra	ed aine	Tria ed T	axia		I	
						WA		EVELS	DS Direct Shear Measured T Artesian (see Note										iote	s)			

Sheet 1 of 2

BOREHOLE LOG

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PROJECT Oxford County Roads	
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CLIENT County of Oxford

DATUM Local

DRILL TYPE/METHOD Solid Stem DATES: Boring August 20, 2015 Water Level ____ SAMPLES B SHEAR STRENGTH Т

	E		s			SAM	PLES		B	SHEAR STRENGTH	Т
P	ш_ш>∢⊢-Оz		ST R A T A	W			RE	N	B U L K	 ➡ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane 	
D E P T H	Ă	STRATA	Î	W E L L	Ţ	N	RHCONHRY	VALUE		100 200 kPa	
Ĥ	0 N	DESCRIPTION	Р	L O G	T P E	NUXBUR	Ĕ	(blows) or		Atterberg Limits and Moisture	
	۳ (m)		ļ	Ğ		Ē	Y (mm)	RQD	ĬŤ	W _P W W _L	
(m)	(11)		'				or (%)	(%)	Y (kN/m3)	• SPT N Value × Dynamic Cone 10 20 30 40	
-0 -		ASPHALT , ~.150 m									
	0.15				77)						
-		FILL, ~Brown sand & gravel, some cobbles, damp to moist, compact									
-						01	100	22			┝┫╶
						S1	400	22			H
-	0.61	SANDY SILT, Grey/brown, mottled, trace									-
		clay, trace fine gravel, moist, firm to stiff									
-											┝┨╶
-1						S2	300	8		┣	┝┨╶┥
-											╞┥╺
_											
_											
_						S3		10			
-2	1.98	Find of Donahala of 4 00 va douth			4						Щ
2		End of Borehole at 1.98 m depth									
_											
		Continued Next Page						EGEND		SS Split Spoon ■ ST Shelby Tub	e
<u>NО</u> 1) В	orehole i	nterpretation requires assistance by exp before us	se by o	others.		🛛 🕁 F	Rock C	ore (eg	BQ, N	Q, etc.)	
BK	orehole L CH-0022	ogs must be read in conjunction with exp Report 3655-GE. For definition of terms used on logs, so	ee she	ets pr	or to	GS		Gravity		Consolidation	
lc	gs.					S Si	ydrom eve Ar	nalysis	CL	D Consolidated Drained Triaxial U Consolidated Undrained Triaxial	
2) U	pon com	oletion, borehole open to 1.98 m and dry.				P Fi	nit We eld Pe ab Peri	ight rmeabil meabilit	ity U0	U Unconsolidated Undrained Triaxial C Unconfined Compression S Direct Shear	
							ER LE	VELS nt	¥ Me	easured 🛋 Artesian (see Note	es)

DEPTH

(m)

-3

-4

BOREHOLE LOG

Sheet 2 of 2

PROJECT Oxford County Roads PROJECT NO. KCH-00227972-GE CLIENT County of Oxford DATUM Local DRILL TYPE/METHOD Solid Stem DATES: Boring August 20, 2015 Water Level SHEAR STRENGTH SAMPLES BU Е STRATA S Field Vane Test (#=Sensitivity) WELL LEVAT-ON L K RECOVERY ▲ Penetrometer ■ Torvane Ν NUMBER VALUE DENSITY **STRATA** T Y P E 40 80 kPa (blows) L OG DESCRIPTION Atterberg Limits and Moisture PL Q or W_P W W_L RQD 0 (m) (mm) (%) • SPT N Value × Dynamic Cone `or (%) 30 40 kN/m3) 10 20 End of Borehole at 1.98 m depth

F											
Borehole KCH-002 logs.	interpretation requires assistance by exp before us Logs must be read in conjunction with exp Report 23655-GE. For definition of terms used on logs, se npletion, borehole open to 1.98 m and dry.	,	or to	OTH OTH OTH GS HH SSi γU PFi KLa	S Auc Rock C ER TE pecific ydrom eve Ar nit We eld Per ab Per	Core (eg. STS Gravity eter nalysis ight rmeability meability	iple ⊠ . BQ, N C C U ity U	U Consolid	tion lated Dra lated Un olidated U ned Com	ST Shelby Tube WN Vane Samp ained Triaxial drained Triaxial Undrained Triaxial pression	
					ER LE	EVELS	¥ N	leasured	Ă	Artesian (see Note	s)

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BOREHOLE LOG

*exp.

PROJECT	Oxford C	ounty Roads

CLIENT County of Oxford

DATUM Local

_ PROJECT NO. __KCH-00227972-GE

1	nsitivity) ane 200 kPa isture
Image: Description Image: Descri	ane 200 kPa isture ic Cone
$ \begin{array}{c c} & & & \\ (m) & & \\ (m) & & \\ \end{array} $	isture ic Cone
$ \begin{array}{c c} & & & \\ (m) & & \\ (m) & & \\ \end{array} $	ic Cone
(m) (m) Y • SPT N Value × Dynau (%) Y • SPT N Value × Dynau 10 20 30	
C ⁰ ASPHALT, ~.150 m	
0.15	
FILL, ~Brown sand & gravel, some cobbles, moist, dense	
SANDY SILT, Grey/brown, mottled, trace clay, trace fine gravel, moist to very moist, firm	
	+++++
	+++++++++++++++++++++++++++++++++++++++
S3 7	
1.98	
-2 End of Borehole at 1.98 m depth	-
	-
	-
SAMPLE LEGEND NOTES SAMPLE LEGEND SAMPLE	elby Tube
1) Borehole interpretation requires assistance by exp before use by others	ine Sample
Borehole Logs must be read in conjunction with exp Report KCH-00223655-GE. For definition of terms used on logs, see sheets prior to logs. CC Consolidation H Hydrometer CD Consolidated Drained Tria:	al
2) Upon completion, borehole open to 1.98 m and dry. γ Unit Weight UU Unconsolidated Undrained Ti	axial
P Field Permeability UC Unconfined Compression K Lab Permeability DS Direct Shear	uniul
WATER LEVELS	(see Notes)

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BOREHOLE LOG

*exp.

PROJECT Oxford County Roads	
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CLIENT County of Oxford

DATUM Local

_ PROJECT NO. _ KCH-00227972-GE

DF	RILL TYF	PE/METHOD Solid Stem		DAT	ES	S: B	oring	Au	gust 20), 2015	5				W	/at	er l	Lev	el					
	E		S				SAM	PLES		BU	Γ							TRE					~	Γ
DE	ELEVAT-		STRATA	W E L L				№шСО≻шК≻	N	B U L K				etr				est (■	To			vity	9	
	Î	STRATA				T Y P E	Ŭ M	ŏ	VALUE (blows)	DE						10					200		'a	
	Ó N	DESCRIPTION	P L O T	L O G		P E	NUMBER	E R Y	or (1	Atte	ərd	erg			sai V N		VIOI	stu	re		
(m) -0 -	(m)		Ŷ	0			ĸ	(mm) or (%)	(%)	Ť Y (kN/m3)		• 9		. N 0	Va	⊢ lue 20)	×c	⊣ Dyna 30	ami	ic C 40	on	Э	
U		ASPHALT , ~.150 m																						
	0.15	FILL, ~Brown sand & gravel, moist, compact	XXX																					
-			\times														Π							-
	0.35	FILL, Grey/brown sandy silt, trace gravel,	\times																		Ħ			
-		trace clay, moist, stiff					S1	400	19		H	0				•	Ħ			Ħ	Ħ			-
			\times								H										Ħ			
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			>>>								\vdash							++			\square		\vdash	
-											⊢		-					+		$\left \right $	┼┼	$\left \right $	\square	-
			\times								╟										+		\vdash	
-1							S2	350	9		⊢		•								+		\vdash	-
			\times								⊢		-								╟			
-	1.22		XX								\vdash	+	_	_	\vdash	$\left \right $	+	┢		\parallel	╢	$\left \right $	\vdash	-
		SANDY SILT , Reddish brown, trace clay, moist, stiff with sand seams									\vdash										⊢		\square	
-											\parallel									\square	⊢		\square	-
					77						\mid										⊢			
-																					\parallel			
																					\parallel			
-							S3	300	8		\square		•	c							\parallel			
																					\parallel			
-2	1.98	End of Borehole at 1.98 m depth									μ										Ш			-
-																								-
_																								
NO	TES						A	S Aug	EGEND ger Sam	ple 🛛	s	ss	Spl	it S	ро	on	l		ST	She	elby	ν Tι	ıbe	
1) B	orehole i	nterpretation requires assistance by exp before us	e by o	thers.			🔟 F	Rock Č ER TE	ore (eg.	BQ, N	Q,	ete	c.)				ļ	ים	VN	Va	ne S	Sar	nple	Э
н К Ц	CH-0022	ogs must be read in conjunction with exp Report 3655-GE. For definition of terms used on logs, se	e she	ets pr	ior	to	G S		Gravity					dati lida		ים וּ	rair	ned	Trie	avir	al			
	ogs. Ioon com	pletion, borehole open to 1.98 m and dry.					S Si	eve Ar hit We	nalysis	CL	J	Cor	nso	lida	ateo	U b	ndr	aine aine aine	ed ⁻	Tria	ixia			
2,0	P011 0011						Р Fi	eld Pe	rmeabili	ity U0	cι	Jno	con	fine	ed (Cor		ress			nd)	d		
									meability EVELS	y DS	ЪL	лге	Ct	Sh	ear									
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BOREHOLE LOG

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PROJECT Oxford County Roads

CLIENT County of Oxford

DATUM Local

____ PROJECT NO. _____ KCH-00227972-GE

DR		PE/METHOD Solid Stem		DATES: Boring August 20, 2015									Water Level											
	E		ş				SAM	PLES		BULK							STR				41. 41	- - >	Т	
DE	ELEVAT-ON		STRATA	W E L L				REC	N	L K						ter	Tes		-Se orv			ιy)		
	Ť	STRATA	Ā			T Y P E	Ŭ	Ŏ	VALUE (blows)	D E						QΟ	••	1				Pa	4	
	O N	DESCRIPTION	P	L O G		E	NUXBUR	RHCONHRY	or RQD	□Ⅲℤ℅ ー⊢≻		A	tte	rbe	rg I V	Lim N _P	nits W	anc W	1 MC L	DIST	ure			
(m) -0 -	(m)		L Q T				ĸ	(mm) or (%)	(%)	Ť Y (kN/m3)		SI	PT 10			ie 20	×	Dy 30		nic 4	-	ne		
Ũ	0.08	ASPHALT, ~.075 m																						
		FILL, ~Brown sand & gravel, moist, compact											Π				Π							
-													Π										-	
			\bigotimes				S1	300	14				Ħ										-	
-	0.50				Ø		51	300	14			0	Ħ				$^{++}$							
	0.50	FILL, Dark brown/black, sandy silt, trace											Ħ										-	
-		organics, moist, compact																						
	0.76				22								+	╁			++						-	
-		SANDY SILT, Grey/brown, trace clay, trace gravel, mottled, moist, stiff											+	+			++						- -	
		5											$\left \right $	+			+						-	
-1							S2	250	9				•	+			++							
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-					4								\square				++							
														\square			++						_	
-													\square											
	1.52																							
-		SANDY SILT TILL, Grey/brown, trace clay, trace gravel, moist, very stiff	P																				_	
-							S3	450	28				þ				<u> </u> '	•				:	<u>38</u> 4_	
			E																					
-2	1.98	End of Porobolo at 1.09 m donth	T.		4																		+_	
2		End of Borehole at 1.98 m depth																						
_																								
_																								
NOT	TES					\neg	×Α	S Aug	EGEND ger Sam	ple 🛛				Sp	oor	า						ube		
 Borehole interpretation requires assistance by exp before use by oth Borehole Logs must be read in conjunction with exp Report 				thers.			🔲 F		ore (eg.					-				V	N V	ane	Sa	amp	le	
K	CH-0022	logs must be read in conjunction with exp Report 3655-GE. For definition of terms used on logs, se	ee she	ets pr	ior 1		G Sp		Gravity	C				atio dat		Dra	aine	тh	riav	rial				
	ogs. pon com	pletion, borehole open to 1.98 m and dry.					S Si	eve Ar nit We	nalysis	Cl	JС	ons	soli	dat	ed	Uno	drai Jnd	nec	l Tr	iaxi		.1		
_, 0							P Fi	eld Pe	rmeabili meability	ty UC	υC	nco	onfi		d C		pre			1110	1710			
							WAT	ER LE	VELS							_								
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BOREHOLE LOG

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PROJECT	Oxford Cour	nty Roads

CLIENT County of Oxford

_____ DATUM <u>Local</u>

DF	RILL TYF	PE/METHOD Solid Stem		DAT	ES	: В	oring	Au	gust 20), 2015				<u>۱</u>	Na	ter	Le	/el					
	E		ş				SAM	PLES		BU LK	SHEAR STRENGTH S Field Vane Test (#=Sensitivity)												
P	ELEVAT-		ST R A T A	W E L L				RECONER	N	K			net					Toi			ily)		
DUPTH	Ť	STRATA				T Y P E	Ŭ M	ŏ	VALUE (blows)	Ę					1(kPa	1	
	Ó N	DESCRIPTION	P L Q T	L O G		E	NUMBER	RY	or RQD	DENS-TY		A	ller	ber			N N	nd M W _L	nois	aur	e		
(m) -0 -	(m)		Ť				N	(mm) or (%)	(%)	T Y (kN/m3)		SF	יד א 10	I Va	alue 2			Dyna 30		c Co 40	>ne		
•	o / =	ASPHALT , ~.150 m																	Ш	Ш	Щ		
-	0.15	FILL, ~Brown sand & gravel, damp, compact																	Ш	Ш	Щ	∐.	
	0.33																		Ш				
_	0.00	FILL, Grey brown, sandy silt, trace clay, moist, compact																				∐.	
							S1	375	11		0		•						Ш				
_																				Ш		∐.	
																			Ш				
_	0.76	SANDY SILT, Grey/brown, trace clay, trace																				∐.	
		SANDY SILT, Grey/brown, trace clay, trace gravel, mottled, moist, stiff with fine sand seams																					
-1							S2	250	9										Ш			Ш_	
_																			Ш			∐.	
		changes to light brown colour and becomes firm at bottom																					
_																						∐.	
																			Ш				
_																						Ц.	
																			Ш				
_							S3	50	8										Ш			∐.	
																			Ш				
-2	1.98	End of Borehole at 1.98 m depth			4														Ш			Щ_	
-		Lid of Borenoie at 1.30 in deput																					
-																						-	
-																						.	
NOTES					SAMPLE LEGEND AS Auger Sample ⊠ SS Split Spoon ■ S																		
 Borehole interpretation requires assistance by exp before use by or Borehole Logs must be read in conjunction with exp Report KCH-00223655-GE. For definition of terms used on logs, see sheet 							OTH	ER TE									Ш	VN '	van	e S	am	pie	
	CH-0022	3655-GE. For definition of terms used on logs, se	ee she	ets pr	ior t	to	G SI H H	oecific /drom	Gravity eter		Cor					Drai	ned	Tria	axia	I			
	-	pletion, borehole open to 1.98 m and dry.					S Si γ Ui P Fi	eve Ar hit We eld Pe	nalysis ight rmeabili	Cl Ul ity UC		ons ncc ncc	olic nsc nfir	late blida ned	ed L ate Cc	Jnd d Ui	rain ndra	ed T aine sion	Γria> d Tr	xial	al		
							WAT	ER LE	meability EVELS		S Di			nea	ır								
							ΣA	ppare	nt	¥ Me	eas	ure	d		Ż	T I	Arte	esia	n (s	ee	Note	es)	

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BOREHOLE LOG

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PROJECT Oxford County Roads

CLIENT County of Oxford

DATUM Local
DATES: Boring August 20, 2015 Water Level

DR		PE/METHOD Solid Stem	DATES: Boring August 20, 2015 Water Level s SAMPLES B SHEAR STRENGT																				
	E		ş		BULK	SHEAR STRENGTH S Field Vane Test (#=Sensitivity)																	
E	ELEVAT		STRATA	W E L L			N	RHCONHRY	N							eter				van		(i uy)	
D E P T H		STRATA DESCRIPTION			T P E			Ŏ	VALUE (blows)	DENN		Δ	tte	rhe		100 1 in		an	d N	2 Nois		kPa e	<u> </u>
	Ó N		P L O T	L O G	Ē		DER		or RQD	S I								V			rtai	•	
(m) -0 -	(m)		Ť					(mm) or (%)	(%)	۱ ۲ (kN/m3)		SI	PT	N \		ue 20	~~ ~+-	< D 3			: Co 40	one	
	o / -	ASPHALT , ~.150 m																					
	0.15	FILL, ~Brown sand & gravel, damp, compact																				\parallel	
														+									H
	0.45								10				\parallel	+	+	+	+					++	
		FILL, Brown to dark brown, sandy silt, trace fine gravel, trace organics, moist, compact					S1	300	19				\parallel	+									\mathbf{H}
														+									-
											\vdash		$\left \right $	+	+	+	+			+		+	Η
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-1							S2	225	11														-
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			\bigotimes																				
-	1.52																						
	1.02	SANDY SILT, Grey/brown, trace clay, trace gravel, mottled, moist to very moist, firm																					
							S3	400	6			۰	\parallel	¢									Ц.
														\parallel									
-2	1.98	End of Borehole at 1.98 m depth																					Ц_
																							-
																							-
			1	l							ـــــــــــــــــــــــــــــــــــــ		nlii	· C-		n	_	•	от (She	lby	Tub	_ _
<u>NО</u> 1) В	orehole i	nterpretation requires assistance by exp before us	e by o	thers.			🛛 R	lock C	jer Sam ore (eg.					. sp	00	11						Tub am	
Borehole Logs must be read in conjunction with exp Report KCH-00223655-GE. For definition of terms used on logs, see sheet logs.						0	G Sp	ER TE pecific /drom/	Gravity							Dr	ain	<u></u> од .	Tria	ixial			
	•	pletion, borehole open to 1.98 m and dry.					S Si	eve Ar hit We	nalysis	Cl	JС	ons	sol	ida	ted	Un	Idra	aine	ed T	ria>	cial	al	
							Υ Unit Weight UU Unconsolidated Undrained Triaxi. P Field Permeability UC Unconfined Compression K Lab Permeability DS Direct Shear									~.							
						1	WAT		VELS	, ⊻ Me				-		Ā	Д	Arte	sia	n (s	ee	Note	es)

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Sheet 1 of 1

BOREHOLE LOG

*exp

PROJECT	Oxford	County	Road

C

PROJECT Oxford County Roads CLIENT County of Oxford														CH	-002	2279	72-	GE				
		PE/METHOD Solid Stem		DAT	ES:	DATUM Local Boring August 20, 2015 Water Level																
	Ē		s			SAM	PLES	-	В													
DEPTH	ELEVAT-OZ	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	T Y E	NUZBER	RECOVERY	N VALUE (blows) or RQD	BULK DERS-FY		Per	hetro	ome 1 erg	ter 00	∎ ts a	Tor nd N	iensi vano 20 Moist	e Q0 k	Pa			
(m) -0	(m)		Ť				(mm) or (%)	(%)	T Y (kN/m3)	•		T N 10	Valu	је 20		⊣ Dyna 3¦0	mic 4	Coi I0	ne			
-0-		ASPHALT , ~.150 m																				
-	0.15	FILL, ~Brown sand & gravel, damp, compact																		_		
-	0.50					S1	350	22		¢	,			•								
-		FILL, Grey/brown, sandy silt, trace fine gravel, trace organics, trace clay, moist, compact																		_		
-	0.76	SANDY SILT, Grey/brown, trace clay, moist,																				
		firm				S2	300	7												_		
-1						52	300	1				\prod								-		
-												+					++-			-		
											+	+					+			-		
-																				-		
_	1.52	SANDY SILT TILL, Grey/brown, trace clay, trace gravel, moist, stiff	201																	-		
-						S3		13				•	o							396		
																				_		
-2	1.98	End of Borehole at 1.98 m depth	d'A																	╪		
-																						
-																						
			I	L				EGEND			_									1		
 NOTES 1) Borehole interpretation requires assistance by exp before use by ot Borehole Logs must be read in conjunction with exp Report KCH-00223655-GE. For definition of terms used on logs, see shee logs. 2) Upon completion, borehole open to 1.98 m and dry. 						□ F OTH GS HH SS	☑ AS Auger Sample ☑ SS Split Spoon ■ ST Shelt □ Rock Core (eg. BQ, NQ, etc.) □ VN Vane OTHER TESTS G Specific Gravity C Consolidation H Hydrometer CD Consolidated Drained Triaxial S Sieve Analysis CU Consolidated Undrained Triaxial Y Unit Weight UU Unconsolidated Undrained Triaxial								e Sa ial	imp						
						γ Unit WeightUU Unconsolidated Undrained TriaxialP Field PermeabilityUC Unconfined CompressionK Lab PermeabilityDS Direct Shear																

UU Unconsolidated Undrained Triaxial

y	UC Unconfined Compression
	DC Direct Cheer

▼ Measured

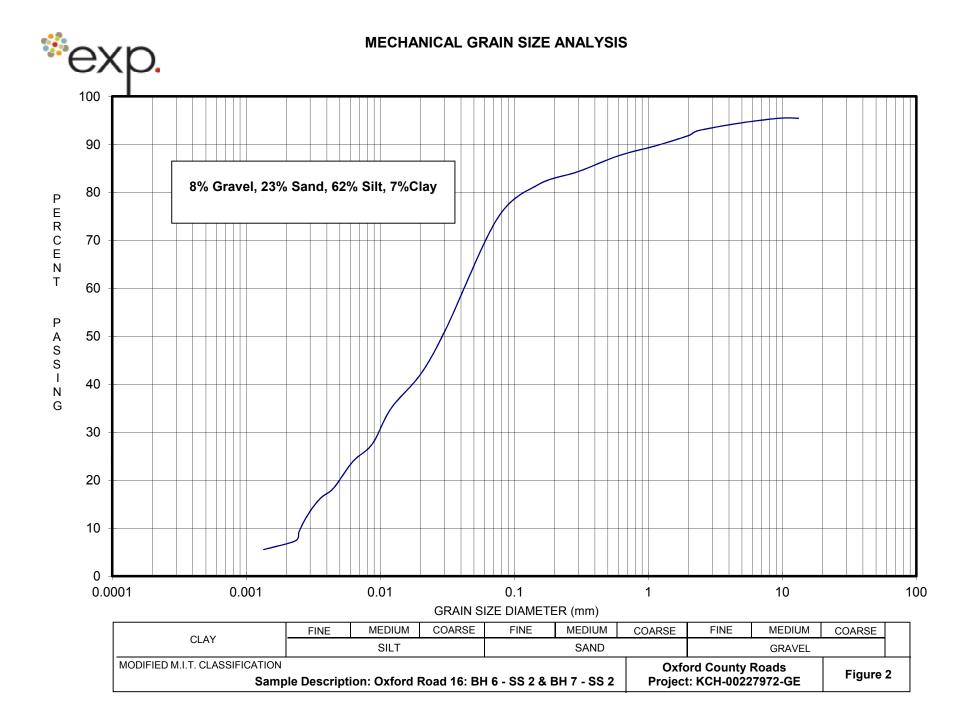
WATER LEVELS ⊈ Apparent

- DS Direct Shear
 - ▲ Artesian (see Notes)



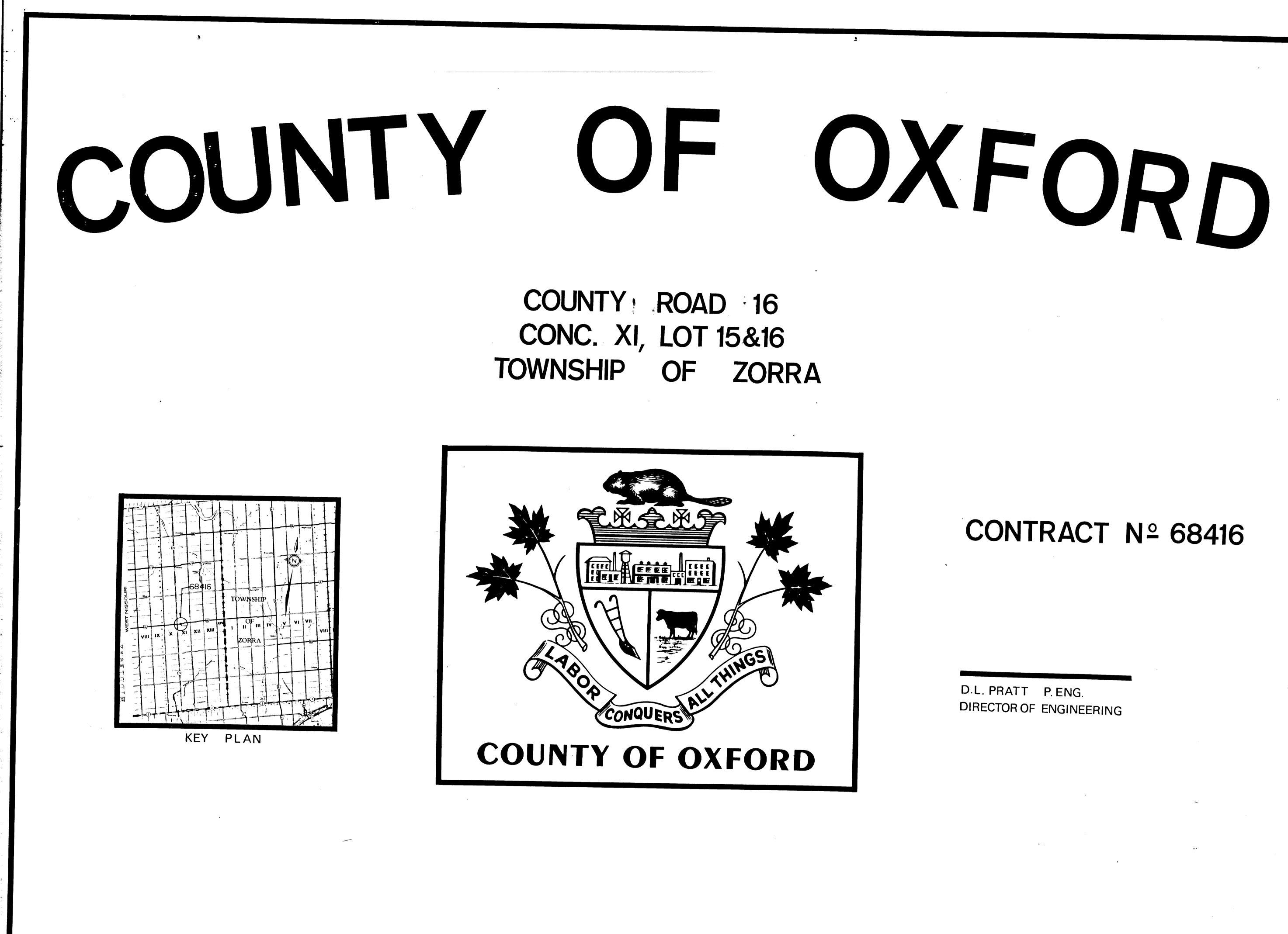
Appendix C

Grain Size Analyses





Appendix D Oxford County Pavement Design for Road 16





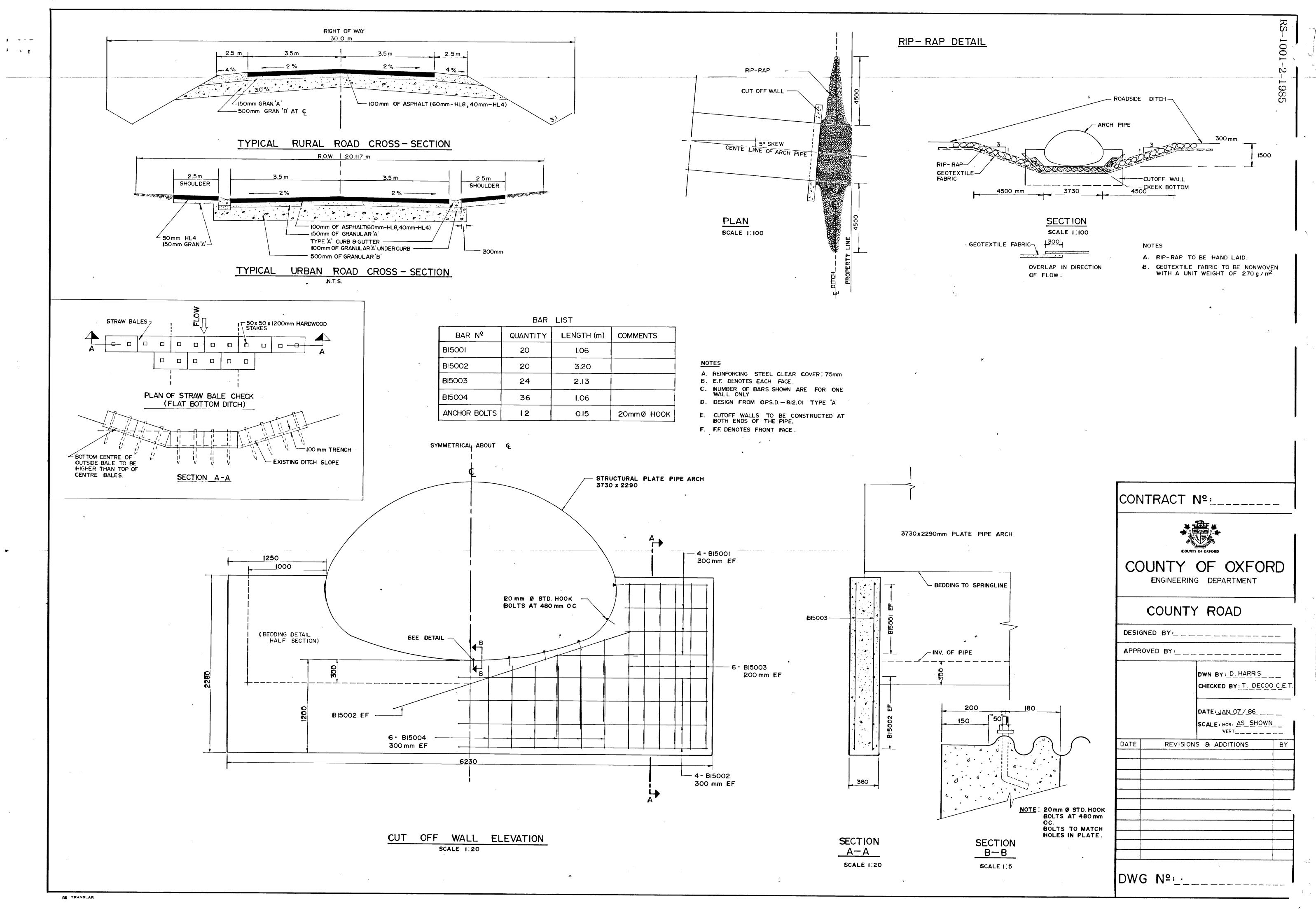


D.L. PRATT P. ENG. DIRECTOR OF ENGINEERING



CONTRACT Nº 68416

DWG. Nº 68416-1



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