Stantec Consulting
Bedrock Investigation and Test Caisson
Kenaston Underpass Project
Winnipeg, Manitoba

Prepared by: UMA Engineering Ltd. 1479 Buffalo Place Winnipeg, MB. R3T 1L7

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11 October 2005

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## 1.0 Introduction

As authorized by Stantec Consulting, acting on behalf of their client, The City of Winnipeg, UMA Engineering Limited (UMA) completed geotechnical investigations for the Kenaston Underpass Project in Winnipeg, Manitoba. Two investigations were completed at the site by UMA. The first investigation focused on the overburden soil conditions, but also included one core hole into bedrock. Based on that information, a generalized geotechnical investigation report dated March 2005 was issued. Stantec had concluded from both a technical and economical perspective, that an additional investigation was justified in order to identify bedrock conditions for the design and construction of rock socketed foundations for the rail bridge. As a result, a further bedrock investigation, consisting of bedrock coring and a test caisson program was conducted to supplement the existing information.

The purpose of the geotechnical investigations was to determine the soil, bedrock and groundwater conditions at the bridge location, and on that basis, provide geotechnical recommendations for the design and construction of rock socketed caissons for the rail bridge.

Recommendations for the design and construction of rock socketed caissons for the rail bridge have been provided under separate cover. The purpose of this study is to provide the result of the core hole drilling and test caisson for tendering information purposes.

# 2.0 Bedrock Drilling and Test Caisson

The initial investigation conducted in December of 2004 included one test hole (TH-04-42) which included rock coring into the underlying bedrock. Between 11 and 25 August 2005, at total of four test holes (63 mm diameter) were advanced into bedrock by rock coring at selected locations near the proposed rail bridge (TH-05-01 to TH-05-04). The placement of the test holes was largely restricted as a result of the existing roadways, railways and services. All test hole drilling was completed by Paddock Drilling Ltd. of Brandon, Manitoba under the supervision of a representative of UMA.

In addition to the test holes, one 710 mm diameter test caisson was advanced adjacent to TH-05-02. The test caisson was completed by Subterranean (Manitoba) Ltd. under the supervision of a representative of UMA.

Test Hole TH-04-42 was advanced north of Wilkes and west of Kenaston. Bedrock was confirmed at a depth of about 20 m from grade and the core hole was advanced to a depth of about 37 m where drilling was terminated.

Test Hole TH-05-01 was completed north of the CN Tracks and west of Kenaston. Bedrock was confirmed at a depth of about 18.8 m from grade and the core hole was advanced to a depth of about 30.5 m where drilling was terminated.

Test Hole TH-05-02 was advanced south of the CN Tracks and west of Kenaston. Bedrock was confirmed at a depth of about 20 m from grade and the core hole was advanced to a depth of about 35 m where drilling was terminated in the limestone bedrock.

The test caisson was advanced immediately adjacent to TH-05-02. Consistent with TH-05-02, the bedrock contact was identified at a depth of about 20.1 m. The test caisson was advanced to a depth of about 30.5 m where drilling was terminated. Two pump test were completed at depths of about 23 and 30.5 m.

Test Hole TH-05-03 was completed north of the CN Tracks on the median of Kenaston Boulevard. Bedrock was identified at a depth of about 19.7 m from grade and the core hole was advanced to a depth of about 35 m where drilling was terminated.

Test Hole TH-05-04was advanced south of the CN Tracks and east of Kenaston. Bedrock was confirmed at a depth of about 19.5 m from grade and the core hole was advanced to a depth of about 30.5 m where drilling was terminated in the limestone bedrock.

All bedrock observed during drilling of the core holes and test caissons was visually classified on site by UMA's site representative. Continuous rock core samples were collected at the core holes. The rock cores collected were retained in wooden core boxes and transported to UMA's Winnipeg laboratory for detailed examination and testing.

# 3.0 Laboratory Assessments and Testing

The soil and rock core samples transported to the laboratory were visually examined by UMA's Project Engineer in order to supplement and confirm the field classifications. The Recovery and Rock Quality Designation (RQD) was determined for each core run and has been reported on the test hole logs. Uniaxial compressive strength testing was completed on several samples of the bedrock cores collected. The results of the uniaxial compressive strength testing have been included on the test hole logs opposite the appropriate sample depths.

## 4.0 Subsurface Conditions

#### 4.1 Bedrock Conditions

Carbonate (limestone) bedrock was identified at depths that varied between about 19 and 20 m below ground surface. The conditions of the bedrock at this location are not in some characteristics typical of the Winnipeg area. The bedrock has been observed to consist of an upper rock mass which is comprised of a weathered limestone and a lower rock mass which is comprised of a strong massive limestone. The two layers of bedrock are separated by a 300 to 900 mm thick infilling of clayey silt.

The upper rock mass is generally weathered, mottled yellow and grey, weak to medium strong with small pits and vugs. The upper 300 to 900 mm of the bedrock is generally highly fractured and disturbed. Core recovery in the upper rock mass was generally greater than 90%. The average RQD in the upper rock mass was about 55% and the uniaxial compressive strength ranged between about 38 and 100 MPa.

At a depth of about 25 to 27 m, a 300 to 900 mm thick infilling of clayey silt was identified at all of the test hole locations. While bedding planes infilled with silt and clay are common within the limestone bedrock in the Winnipeg area, it is uncommon to find this thickness of infilling as a stratigraphic unit between bedrock zones.

The lower rock mass generally consists of a massive intact white limestone that is strong to very strong. Core recovery in the lower rock mass was generally greater than 90%, with the exception of some cores that extended below about 30 m. The average RQD in the lower rock mass was about 70% and the uniaxial compressive strength ranged between about 45 and 180 MPa.

#### 4.2 Test Caisson

The test caisson was advanced using a 710 mm core barrel. Core recovery during the test caisson was excellent and no chopping of the bedrock was required to advance the caisson. As a result of the large size of the core barrel and the low speed of coring, the recovered rock cores were generally intact and appeared much better than the cores obtained from the small diameter core holes.

The caisson was visually examined between a depth of about 20.6 and 22.9 m from grade. Between this depth, the bedrock was observed to be weathered, pitted and vuggy. The limestone was weak to medium strong and while fractures were present, they were very tight.

Bedding planes about 150 mm thick and infilled with silt were identified within the test caisson at depths of about 25 and 30 m.

#### 4.3 Groundwater

Pumping rates were measured during the test caisson advancement at two depths. At a depth of about 23 m, seepage was only observed from behind the sleeve and the inflow of groundwater was about 0.4 l/s (7 gpm). At a depth of about 30.5 m the inflow of groundwater was about 3.1 l/s (50 gpm).

## 5.0 Closure

The findings of this study were based on the results of field and laboratory investigations, combined with an interpolation of soil, bedrock and groundwater conditions between core hole locations and the test caisson. The information provided within this study is provided for bidding purposes only. The contactor should form their own opinion of the site conditions based on the information provided within. It should be appreciated that conditions can be expected to vary across the site.

Respectfully Submitted,

UMA Engineering Ltd.

Reviewed by:

Giovanni Militano, M.Sc., P. Eng. Geotechnical Engineer



W.R. (Bill) Wiesner, M.Sc., P. Eng. Senior Geotechnical Engineer



Certificate of Authorization
UMA Engineering Ltd.
No. 256 Expiry: April 30, 2006

Appendix A

**Test Hole Information** 

PRO	JECT:	Kenaston Underpass - CN Bridg	е	CLIENT: S	Stantec Consulting		TE	ESTH	HOLE NO: Test Caiss	son
		: South of CN, West of Kenaston	. Adjacent to TH05-02		_		PI	ROJE	ECT NO.: 4231-040-0	9
		TOR: Subterranean			SoilMec R312-HD				ATION (m):	
SAME	PLET	YPE GRAB	SHELBY TUBE	SPLIT SPO	DON BULK	∠ NC	RE	COVE	RY CORE	
DEPTH (m)	SOIL SYMBOL		SOIL DESCI	RIPTION			SAMPLE TYPE	SAMPLE #	COMMENTS	DEPTH (m)
0		GRAVEL (FILL) - 300 mm CLAY (FILL)								
-1										1.
-2 -3		CLAY with occasional wet SILT layers	7						Very slight seepage from wet silt layers.	3-
-3		CLAY - brown to grey with depth - moist, stiff to firm with depth - high plastic								3 -
-4		ingri produc								4 -
-5 -6										5 -
-6										6-
-7										7-
-8										8 -
-9										9 –
-10			2, <u>2,</u>							10 -
-11										11 -
9 10 11 12 13		SILT (TILL) - light grey, loose, wet - trace sand, trace gravel, trace clay							Slight seepage from wet till at 11.6 m	12 -
13	000	- low plastic - damp, medium dense below 12.5 m								
					LOGGED BY: Giova	nni Militano	COI	MPLE	TION DEPTH: 30.48 m	
		UMA AECOM			REVIEWED BY:			MPLE	TION DATE: 27/9/05	
		1			PROJECT ENGINEE	R: Giovanni Militano			Page	1 of 3

		Kenaston Underpass - CN I		CLIENT: Stanted	Consulting		TE	STH	OLE NO: Test Caiss	on
		I: South of CN, West of Kena	aston. Adjacent to TH05-02	2			PF	ROJE	ECT NO.: 4231-040-09	9
		TOR: Subterranean			ec R312-HD - 710 m				TION (m):	
SAMI	PLE T	YPE GRAB	SHELBY TUBE	SPLIT SPOON	BULK	∠NC	RE(	COVE	RY CORE	_
DEPTH (m)	SOIL SYMBOL		SOIL DESC	CRIPTION			SAMPLE TYPE	SAMPLE #	COMMENTS	OEDTH (m)
13 -14	0505050	- small boulder / cobble at 13.1 n - dense below 13.1 m	1							1
		- boulder at 14.3 m							Chopped boulder at 14.3m.	
-15	90 90	- boulder at 14.9 m - very dense below 15.2 m							Chopped boulder at 14.9m. Very hard drilling and sleeve advancement	1
-16		- boulder at 15.7 m - granite boulder at 16.1 m							through till below 15.2 m. Chopped boulder at 15.7m. Chopped boulder at 16.1m.	1
-17	20000								Drill: 0 to 20.1 m - 6h	1
-18	05050	wat halow 40.0							Slight to moderate	1
-19	0000000	- wet below 18.6 m							seepage from wet silt till below 18.6 m.	1
-20	200	LIMESTONE BEDROCK - weathered							Slight to moderate seepage at bedrock interface.	2
-21		<ul> <li>mottled yellow and grey</li> <li>weak to medium strong</li> <li>pitted and vuggy</li> <li>very tight fractures</li> <li>intact below 20.3 m</li> </ul>							Drill: 20.1 to 21.3 m - 1h Sleeve bottom at 20.6 m	2
-22 -23 -24		down hole visual evaluation betwee - weathered, pitted and vuggy - weak to medium strong rock - intact, very tight fractures	en 20.6 and 22.9 m							2
-23		- broken bedrock, frequent vertica	and horizontal fractures below 2	22.9 m					Pump Test: 7 GPM. Water inflow from behind sleeve only. ~75% recovery between 22.9 and 24 m	2
-24		- intact, red below 24 m							ALLY GIRL AT IN	24
		SILT (150 mm) - low plastic, light of intact, mottled light yellow and w	rey, moist to wet, medium dense hite below 25 m			====				25
26				Loca	ED DV. C		25	15:		
		UMA AECON	1		ED BY: Giovanni Milita EWED BY:				TION DEPTH: 30.48 m TION DATE: 27/9/05	
		GIATA TALCON			ECT ENGINEER: Giov		UUN	III LE	HON DATE. 2/18/03	

PROJEC	T: Kenaston Underpass - CN Bridge	CLIENT: Stantec Consulting		TF	STH	OLE NO: Test Caiss	on
	DN: South of CN, West of Kenaston. Adjacent to TH05-0					ECT NO.: 4231-040-0	
CONTRA	ACTOR: Subterranean	METHOD: SoilMec R312-HD	710 mm Socket			TION (m):	
SAMPLE	TYPE GRAB SHELBY TUBE	SPLIT SPOON BULK	✓NO	_			
OEPTH (m)		RIPTION		SAMPLE TYPE	SAMPLE #	COMMENTS	DEPTH (m)
26	<del></del>	medium dense				Drill: 22.9 to 26.2 m - 2h	
-27	- massive, intact, white, strong below 26.8 m						27
-28	- very strong below 28 m - vertical fracture with light oxidation stains between 28 and 29.3 r					Drill: 28 to 29.3 m - 2h	28
-29						Drill: 29.3 to 30.5 m - 1.5h	29
-30	SILT (150 mm) - low plastic, light grey, moist to wet, medium dense - massive, intact, white, very strong below 30.2 m  Test caisson terminated at 30.5 m.					Pump Test: 50 GPM	30
-31	Concrete to 7.5 m, clay cuttings to surface.						31
32							32
33							33
34							34
35							35
36	0.5.						36 -
37							37 -
34 35 36 37 38							38 -
39		LOCOTE DV. C	: MELA-	000	10: -		
	UMA AECOM	LOGGED BY: Giovan				TION DEPTH: 30.48 m TION DATE: 27/9/05	
		PROJECT ENGINEE		001	n LL	Page 3	3 of 3

PROJECT: K	enaston Underpass - CN Bridg	e	CLIENT: Stantec	Consulting	Т	FSTH	IOLE NO: TH-05-01	
	North of CN Tracks, West of Ke		OLILIVI. Otalitec	Consumg			CT NO.: 4231-040-0	)9
CONTRACTO	R: Paddock Drilling		METHOD: Nodwe	ell - HQ (63 mm) Coring			TION (m):	
SAMPLE TYP	E GRAB	SHELBY TUBE	SPLIT SPOON	BULK	✓ NO RE		RY CORE	
BACKFILL TY	PE BENTONITE	GRAVEL	SLOUGH	GROUT	CUTTI	NGS	SAND	
SLOTTED PIEZOMETER	SOIL SYMBOL	SOIL DE	SCRIPTION		SAMPI F TYPE	SAMPLE #	COMMENTS	DEPTH (m)
0	CLAY (FILL) - silty - grey brown - moist, stiff, medium plasticity - trace organics to 0.6 m  CLAY - silty - brown to grey with depth							1-
-3	- moist, stiff to firm with depth, h	igh plasticity						3-
-4 -5								5 -
-6								6 -
-7								7-
-8 -9								9 -
-10		82 <u>8</u>						10 –
-11								11-
-12 - 00 00 00 00 00	SILT (TILL) - trace sand, trace clay, trace gra - light greyish brown - moist, compact to dense with de							12
	UMA AECOM		REVIE	ED BY: Kate Franklin WED BY: GM	CO		TION DEPTH: 30.48 m TION DATE: 24/8/05	1 of 3

-	PROJECT: Kenaston Underpass - CN Bridge  OCATION: North of CN Tracks, West of Kenaston				CLIENT: Stante	c Consulting		1		HOLE NO: TH-05-01	
			Paddock Drilling	Kenaston	METHOD: Not		_			ECT NO.: 4231-040-0 ATION (m):	19
SAME			GRAB	SHELBY TUBE	SPLIT SPOON	well - HQ (63 mm) Corin	g NO				
BACK		_		GRAVEL	SLOUGH	GROUT	CU			SAND	
DEPTH (m)	SLOTTED	SOIL SYMBOL		SOIL DE	SCRIPTION			SAMPLE TYPE	SAMPLE #	COMMENTS	DEPTH (m)
13 -14 -15 -16		<u> </u>	- light grey, very dense below - granite boulder 320 mm diar - occasional cobbles below 14	neter at 13.7 m							14 15 16
-18			- red brown below 18.2 m  LIMESTONE (BEDROCK) - weathered - mottled yellow and grey, with - weak to medium strong - pitted and vuggy						C19	Recovery: 100% RQD: 54% (fair)	19
-20			close to moderately close dis- evidence of water flow in ape- filling damp, no free water pri	ertures					C20	Recovery: 95% RQD: 66% (fair)	20
-22									C21	Recovery: 95% RQD: 48% (poor)	22
-21 -22 -23 -24 -25			CLAYEY SILT (400 mm)	**************************************					C22	Recovery: 95% RQD: 57% (fair)	24 -
26			Below 25.3 m: - massive - white			OFP DV. K. I. F. I.			C23	RQD: 62% (fair) Qu = 139.2 MPa	20
			UMA AECOM			GED BY: Kate Franklin EWED BY: GM				TION DEPTH: 30.48 m TION DATE: 24/8/05	
						JECT ENGINEER: Giovan		501		Page	2 of 3

PPA	IEC	· Kon	aston Underpass - CN Br	idae			77		_		IOLENIC TITLE	
			aston Underpass - CN Br th of CN Tracks, West of	0	CLIENT:	Stantec Cons	sulting				HOLE NO: TH-05-01	20
			Paddock Drilling	Nondolon	METUOD	A Maduell 1	0 /62 \ 0				ECT NO.: 4231-040-(	19
	_	TYPE	GRAB	SHELBY TUBE	SPLIT SE		Q (63 mm) Coring ∃BULK	NO			ATION (m):	
		TYPE		GRAVEL	SLOUGH		GROUT	CUT			SAND	
DAOI			DENTONITE	OIWAEE	IIII SECOGI	[	Jokoui	[Z]COI	TIN	GS	SAND	T-
DEPTH (m)	SLOTTED	SOIL SYMBOL		SOIL DE	ESCRIPTIO	ON			SAMPLE TYPE	SAMPLE #	COMMENTS	DEPTH (m)
26			strong     moderately close discontinu     no evidence of water flow in     no filling present	uities n apertures						C24	Recovery: 100% RQD: 89% (good) Qu = 180.2 MPa	27
28										C25	Recovery: 100% RQD: 74% (fair) Qu = 100.6 MPa	28
30										C26	Recovery: 60% RQD: 54% (fair)	3
31			END OF TEST HOLE AT 30. Notes:  1. Solid stem power auger to 2. HQ coring between 12.2 m  3. Standpipe installed at 30.5	12.2 m. and 30.5 m.	OCK.							3
32												3
33												3:
34	,											34
86												35
17												36
335 336 337 337 339 339 339 339 339 339 339 339												37
9						L						276
			UMA AECOM			REVIEWED BY	: Kate Franklin				TION DEPTH: 30.48 m TION DATE: 24/8/05	
			711.00			The state of the s	GINEER: Giovanni		VIVI	· LC	Page	3 of
											raye	0 0

		Kenaston Underpass - CN Bridg		CLIENT: S	tantec Co	nsulting				OLE NO: TH-05-02	
		South of CN Tracks, West of K OR: Paddock Drilling	enaston	LAMPIN LOS		110 (00 ) 0 ;				ECT NO.: 4231-040-0	9
SAMPI			∭SHELBY TUBE	SPLIT SPO	Nodwell -	HQ (63 mm) Coring	NO			TION (m): RY CORE	
DEPTH (m)	SOIL SYMBOL	_	SOIL DESC					SAMPLE TYPE	SAMPLE #	COMMENTS	DEDTH (m)
-1 -2 -3 -4 -5 -6 -7 -8 -9 -10 -11 -12 -13 -6		GRAVEL - trace sand, black and grey, CLAY (FILL) - silty - grey brown - moist, stiff, medium plasticity  CLAY - silty - brown to grey with depth - moist, stiff to firm with depth, high pla						S			77 88 99 100 111
12		SILT (TILL)									12
13 0	9,9	OIL! (IILL)			LOGGED	RV: Kata Eraphia		001	ADI E	TION DEDTH: 25.05	
		UMA AECOM				BY: Kate Franklin D BY: GM				TION DEPTH: 35.05 m TION DATE: 23/8/05	
		dill Accord		}		ENGINEER: Giovanni		UUI	nr'LE	Page	1 of

		Kenaston Underpass - CN B		CLIENT: Stantec Consulting				STH	HOLE NO: TH-05-02	
		: South of CN Tracks, West of	f Kenaston				PF	ROJE	ECT NO.: 4231-040-0	)9
		TOR: Paddock Drilling		METHOD	Nodwell - HQ (63 mm) Coring				TION (m):	
SAMF	PLET	YPE GRAB	SHELBY TUBE	SPLIT SF	POON BULK	NO	REC	COVE	RY CORE	
DEPTH (m)	SOIL SYMBOL		SOIL DESC	CRIPTION	I		SAMPLE TYPE	SAMPLE #	COMMENTS	DEPTH (m)
13 -14 -15	0505050505050 05050505050	trace sand, trace clay, trace grave light grey     moist, compact to dense with dep low plastic     occasional cobbles, light brown grave	th							14
16	0202020c									16
17	0000									17
18	00000									18
19	000000									19
20		LIMESTONE (BEDROCK) - weathered - mottled yellow and grey								20
-21		- weak to medium strong - heavily pitted and vuggy - close discontinuities - evidence of water flow in apertures - filling is dry and has low permeabil - some hematite alteration	s ity					C9	Recovery: 100% RQD: 61% (fair)	21 -
22								C10	Recovery: 100% RQD: 33% (poor)	22 -
22 23 24 25 26								C11	Recovery: 100% RQD: 18% (very poor)	23 -
25								C12	Recovery: 100% RQD: 80% (good)	25 -
		UMA AECOM			LOGGED BY: Kate Franklin REVIEWED BY: GM PROJECT ENGINEER: Giovanni M	(			TION DEPTH: 35.05 m TION DATE: 23/8/05	2 of 3

PRO.	JECT:	Kenaston Underpass - CN Bridge	CLIENT: Stantec Consulting	TE	STH	OLE NO: TH-05-02	
_		South of CN Tracks, West of Kenaston		PR	OJE	ECT NO.: 4231-040-0	9
_		FOR: Paddock Drilling	METHOD: Nodwell - HQ (63 mm) Coring			TION (m):	
SAMI	PLE T	PE GRAB SHELBY TUBE	SPLIT SPOON BULK ON	REC	OVE	RY CORE	1
DEPTH (m)	SOIL SYMBOL	SOIL DESCR	IPTION	SAMPLE TYPE	SAMPLE #	COMMENTS	DEPTH (m)
26 - - - - - 27		CLAYEY SILT (600 mm)  Below 26.5 m: - massive - white			C13	Recovery: 89% RQD: 56% (fair)	27
28		- strong - moderately close discontinuities - no evidence of water flow in apertures - filling is dry and has low permeability			C14	Recovery: 100% RQD: 91% (excellent) Qu = 157.1 MPa	28 -
—29 - - - - - 30					C15	Recovery: 100% RQD: 45% (poor) Qu = 121.4 MPa	29 - 30 -
-31 -32					C16	Recovery: 100% RQD: 83% (good) Qu = 86.1 MPa	31 -
-33					C17	Recovery: 95% RQD: 66% (fair) Qu = 110.9 MPa	33 -
-34					C18	Recovery: 50% RQD: 47% (poor)	34
-35 35 36		END OF TEST HOLE AT 35 m IN LIMESTONE BEDROCK. Notes:  1. Solid stem power auger to 13.7 m. 2. HQ coring between 13.7 m and 35 m. 3. Test hole not backfilled.					35 –
-37							37
-34 -35 -36 -37 -38							38
39		1	LOGGED BY: Kate Franklin	COM	IPLE	TION DEPTH: 35.05 m	-
		UMA AECOM	REVIEWED BY: GM			TION DATE: 23/8/05	
			PROJECT ENGINEER: Giovanni Militano			Page 3	3 of 3

OLAY (PILL) - stily - trace grave to 1.0 m - grey brown - most, stiff, medium plasticity  CLAY - stily - brown to grey with depth - most, stiff to firm with depth, high plasticity  CLAY - stily - brown to firm with depth, high plasticity  4  5  6  7  8  9  10			Kenaston Underpass - CN Brid		CLIENT: S	tantec Co	onsulting			-	OLE NO: <b>TH-05-03</b>	
SAMPLE TYPE  GRAB		_		Center) of Kenaston	1					-		9
SOIL DESCRIPTION  CLAY(FILL)-ally				MOUSI BY TUBE	METHOD:	Nodwell -	- HQ (63 mm) Coring					
CIAY (FILL) - silby - Insoo growed to L0 m - growed to L0 m - moial, stiff, medium plasticity  CIAY - silby - brown to grey with depth - moial, stiff to firm with depth - moial	SAMPLE	EIY	PE GRAB	MI SHETRA LORE	X SPLIT SPC	ON	BROTK	NOF	REC	OVER	RY LICORE	1
- trace growth of 1.0 m - groy brown - most, self, medium plasticity  - CLAY - sity - strown to groy with depth - most, self to firm with depth, high plasticity  - 4  - 5  - 6  - 7  - 8  - 9  - 10  - 11  - 12  - 13  - 14  - 15  - 15  - 16  - 17  - 18  - 19  - 10  - 10  - 11  - 12  - 13  - 14  - 15  - 15  - 16  - 17  - 18  - 19  - 10  - 10  - 11  - 12  - 13  - 14  - 15  - 15  - 16  - 17  - 17  - 18	DEPTH (m)	SOIL SYMBOL		SOIL DES	CRIPTION				SAMPLE TYPE	SAMPLE #	COMMENTS	DEPTH (m)
CLY-sulfy depth - moist, stiff to firm with depth, high plasticity  -4  -5  -6  -7  -8  -9  -10  -11  -12  -13  -14  -15  -15  -10  -10  -10  -11  -12  -13  -14  -15  -15  -15  -16  -17  -18  -19  -10  -10  -10  -11  -11  -12  -12  -13  -14  -15  -15  -16  -17  -18  -19  -10  -10  -10  -10  -10  -11  -11	-1		- trace gravel to 1.0 m - grey brown									2-
13  LOGGED BY: Kate Franklin COMPLETION DEPTH: 35.05 m  REVIEWED BY: GM COMPLETION DATE: 25/8/05	-3		CLAY - silty - brown to grey with depth - moist, stiff to firm with depth, high pl	asticity								3
LOGGED BY: Kate Franklin COMPLETION DEPTH: 35.05 m  REVIEWED BY: GM COMPLETION DATE: 25/8/05	4											4
TO BE A BECOM LOGGED BY: Kate Franklin COMPLETION DEPTH: 35.05 m  REVIEWED BY: GM COMPLETION DATE: 25/8/05	5											5
B  9  10  11  12  13  LOGGED BY: Kate Franklin COMPLETION DEPTH: 35.05 m  REVIEWED BY: GM COMPLETION DATE: 25/8/05	7											7
10 11 12 13 14 15 16 17 18 18 18 19 19 10 10 11 11 12 12 13 14 15 16 17 18 18 18 18 18 18 18 18 18 18 18 18 18	8											8
10 11 12 13 13 14 15 16 17 18 18 19 19 10 10 11 11 12 12 13 13 14 15 16 17 18 18 18 18 18 18 18 18 18 18 18 18 18	9											9
LOGGED BY: Kate Franklin COMPLETION DEPTH: 35.05 m REVIEWED BY: GM COMPLETION DATE: 25/8/05	10			* £								10 -
13  LOGGED BY: Kate Franklin COMPLETION DEPTH: 35.05 m  REVIEWED BY: GM COMPLETION DATE: 25/8/05	11											11 -
UMA AECOM  LOGGED BY: Kate Franklin  REVIEWED BY: GM  COMPLETION DEPTH: 35.05 m  REVIEWED BY: GM  COMPLETION DATE: 25/8/05	12											12 -
	13	1	UMA AECOM			REVIEWE	D BY: GM	C			TION DATE: 25/8/05	Tr.

.

PROJECT	: Kenaston Underpass - CN Bridge	CLIENT: Stantec Consulting		TES1	THOLE NO: TH-05-03	
LOCATIO	N: North of CN Tracks, Median (Center) of Kenaston				JECT NO.: 4231-040-0	09
CONTRAC	CTOR: Paddock Drilling	METHOD: Nodwell - HQ (63 n			/ATION (m):	
SAMPLE	TYPE GRAB SHELBY TUBE	SPLIT SPOON BULK	✓ NO F	ECOV	ERY CORE	
DEPTH (m) SOIL SYMBOL	SOIL DES	CRIPTION		SAMPLE IYPE	COMMENTS	DEPTH (m)
13				+		
-14 000 000 000 000 -15 000	SILT (TILL) - trace sand, trace clay, trace gravel - light grey brown - moist, compact to dense with depth - low plastic - trace cobbles, light brown grey, very dense below 13.7 m					14
-16 00 00 00 00 00 00 00 00 00 00 00 00 00						16
18 800	- red brown below 18.3 m					18
-19	LIMESTONE (BEDROCK) - weathered			C27	Recovery: 92% RQD: 92% (excellent)	19 -
	- mottled yellow and grey with white inclusions - weak to medium strong - pitted and vuggy - close to moderately close discontinuities - evidence of water flow in apertures - filling is damp, no free water present			C28	Recovery: 100% RQD: 89% (good)	21 -
22				C29	Recovery: 100% RQD: 62% (fair)	22 -
23				C30	Recovery: 90% RQD: 28% (poor)	23 –
22 23 24 25 26				C31	Recovery: 100% RQD: 63% (fair)	25 –
20		LOGGED BY: Kate F			ETION DEPTH: 35.05 m	
	UMA AECOM	REVIEWED BY: GM PROJECT ENGINEE		OMPL	ETION DATE: 25/8/05	2 of 3

PRO.	JECT:	Kenaston Underpass - CN	Bridge	CLIENT: S	Stantec Consulting		ESTI	HOLE NO: TH-05-03			
	LOCATION: North of CN Tracks, Median (Center) of Kenaston							PROJECT NO.: 4231-040-09			
_		TOR: Paddock Drilling			Nodwell - HQ (63 mm) Coring			ATION (m):			
SAM	SAMPLE TYPE GRAB SHELBY TUBE SPLIT SPOON BULK NO F							RY CORE			
DEPTH (m)	SOIL SYMBOL		SAMDI E TVDE	SAMPLE #	COMMENTS	DEPTH (m)					
- 26 27							C32	Recovery: 90% RQD: 21% (very poor)	27 -		
28		strong     moderately close to wide discording     no evidence of water flow in ap     no filling	ntinuities ertures				C33	Recovery: 95% RQD: 56% (fair) Qu = 123.6 MPa	28 -		
-29 30							C34	Recovery: 100% RQD: 52% (fair) Qu = 147.1 MPa	29 -		
31							C35	Recovery: 100% RQD: 80% (good) Qu = 104 MPa	31 -		
-33							C36	Recovery: 100% RQD: 79% (good) Qu = 45.6 MPa	33 -		
-34							C37	Recovery: 100% RQD: 90% (excellent) Qu = 116.4 MPa	34 -		
-36		END OF TEST HOLE AT 35 m IN Notes:  1. Solid stem power auger to 13.7 m and 3. Test hole backfilled with grout.	7 m. 1 35 m.						35 –		
-37									37		
35 35 36 -37 -38									38		
03					LOGGED BY: Kate Franklin			TION DEPTH: 35.05 m			
		UMA AECO!	М		REVIEWED BY: GM		MPLE	TION DATE: 25/8/05			
					PROJECT ENGINEER: Giovanni M	ılıtano		Page	3 of 3		

PROJECT: Kenaston Underpass - CN Bridge CLIENT: Stantec Consulting								TESTHOLE NO: TH-05-04					
-	LOCATION: South of CN Tracks, East of Kenaston								PROJECT NO.: 4231-040-09				
			Paddock Drilling	Mausi av suas		Nodwell - HQ (63 m	m) Coring	IO RE		TION (m):			
	SAMPLE TYPE GRAB SHELBY TUBE SPLIT SPOON BULK  BACKFILL TYPE BENTONITE GRAVEL SLOUGH GROUT							UTTIN		SAND			
BACK	KFILL	TYPE	BENTONITE	[.] GRAVEL	IIII SLOUGH	- A GROUT		1	103	SAND	Т		
DEPTH (m)	SLOTTED	SOIL SYMBOL		SOIL DE	SCRIPTIO	N		SAMPLE TYPE	SAMPLE #	COMMENTS	DEPTH (m)		
0			GRAVEL - some sand, trace silt, trace - brown	day									
-1			- moist, compact, angular								1-		
			CLAY (FILL) - silty - grey brown, moist, stiff, med	fium plasticity, trace organic	s to 0.6 m								
E-2		1	CLAY - silty - brown to grey with depth - moist, stiff to firm with depth	ı, high plasticity							2-		
3											3		
<u>-</u> 4											4		
-5 -5											5		
6											6		
-7 -7											7		
8											8-		
9											9-		
10				V. V.							10		
11											11-		
12											12		
13		.//				LOCCED BY: V-t-	Franklin	00	MDI	ETION DEDTU- 20 40	<u></u>		
5			UMA AECOM			LOGGED BY: Kate I REVIEWED BY: GM				ETION DEPTH: 30.48 m ETION DATE: 11/8/05	1		
8			GUIN MLCOM			PROJECT ENGINEE					1 of 3		

PROJECT: Kenaston Underpass - CN Bridge  LOCATION: South of CN Tracks, East of Kenaston  CONTRACTOR: Paddock Drilling  METHOD: Nodwell - HQ (63 mm) Coring								TESTHOLE NO: TH-05-04				
								JECT NO.: 4231-040-0	)9			
		-	III a		vell - HQ (63 mm) Co			VATION (m):				
	LE TYPE	GRAB	SHELBY TUBE	SPLIT SPOON	BULK	☑ NO R						
BACK	FILL TYPE	BENTONITE	GRAVEL	SLOUGH	GROUT	CUT	TINGS	SAND				
DEPTH (m)	SLOTTED PIEZOMETER SOIL SYMBOL		SOIL DE	SCRIPTION			SAMPLE TYPE	# COMMENTS	DEPTH (m)			
13		SILT (TILL) - trace sand, trace clay, trace - light grey - moist, compact to dense with - low plastic - limestone boulder 300 mm d	h depth						14			
15	60000 60808 80808	- very dense below below 14.0	0 m						15			
6									16			
17									17			
18	0.00000								18			
19	0000							Personal 70%	19			
20		LIMESTONE (BEDROCK)  - weathered  - mottled yellow, grey, and wh  - weak to medium strong	ite				C	Recovery: 70% RQD: 0% (very poor)	20			
21		<ul> <li>highly pitted and vuggy</li> <li>weakness on sponges/corals</li> <li>close to moderately close dis</li> <li>evidence of water flow, solut</li> <li>dry, low permeability filling</li> </ul>	scontinuities				C	RQD: 68% (fair) Qu = 99.7 MPa	21			
22							С	Recovery: 100% RQD: 64% (fair)	22			
23			6 & x				c	Recovery: 100% RQD: 70% (fair)	23			
24		Below 24.4 m: - mottled grey and yellow, less	e distinct mattling					Qu = 37.9 MPa	24			
21 22 23 24 24 26		- mottled grey and yellow, less - medium to strong, moderate - evidence of water flow in ape	y close discontinuities	y filling			C	Recovery: 100% RQD: 79% (good)	25			

						CLIENT: St	T: Stantec Consulting TESTHOLE NO: TH-05-0					
LOCATION: South of CN Tracks, East of Kenaston  CONTRACTOR: Paddock Drilling  METHO							" 116	\(\(\text{O}\) \(\text{O}\) \(\text{O}\)			ECT NO.: 4231-040-09	9
	_		_	Paddock Drilling GRAB	SHELBY TUBE	METHOD:		(63 mm) Coring BULK	NO R		ATION (m): ERY CORE	
SAMF			_	BENTONITE	GRAVEL		GROUT	CUTT		SAND		
DACK	T		FE	BENTONILE	OIVALE	SLOUGH				T		
DEPTH (m)	SLOTTED	PIEZOMETER	SOIL SYMBOL		SOIL DE	SCRIPTIO	N		TOVE	SAMPLE #	COMMENTS	DEPTH (m)
26 27		1.7		CLAYEY SILT (350 mm)  Below 26.3 m: - massive - white - strong						C6	Recovery: 54% RQD: 18% (very poor)	27
-28		HHHHHH		<ul> <li>moderately close discontinui</li> <li>water flow not possible in ap</li> <li>dry, low permeability filling</li> </ul>	ues ertures					C7	Recovery: 100% RQD: 57% (fair) Qu = 102.0 MPa	28
-29		нннн										29
30										C8	Recovery: 100% RQD: 48% (poor)	30
_31 				END OF TEST HOLE AT 30.5 Notes:  1. Solid stem power auger to 2. HQ coring between 12.2 m  3. Standpipe installed at 30.5	12.2 m. and 30.5 m.	DCK.						31
32												32
= -33 =												33
34												34
35												35
36					8.5							36
37												37
38												38
39												
ű.				104				/: Kate Franklin			LETION DEPTH: 30.48 m	1
				UMA   AECOM			PROJECT F	BY: GM NGINEER: Giovann		COMP	LETION DATE: 11/8/05 Page	3 of 3

PROJ	FCT	Kena	ston Underpass		CLIENT: Stant	ec Consultir	ng L	td.		TESTHO	LE NO: <b>TH-04-42</b>	
			h of Wilkes, West of Kena				PROJECT NO.: 4231-040-09					
			Paddock Drilling Ltd.		METHOD: Ack	cker - 125 mm Solid Stem Augers					ON (m): 234.291	
	SAMPLE TYPE GRAB SHELBY TUBE					■BU	ILK		<b>∠</b> NC	RECOVERY		
		TYPE	BENTONITE	GRAVEL	SLOUGH	GF	ROU	Γ	Library .	ITTINGS	SAND	
DEPTH (m)	SLOTTED			SOIL DESCRIPT	TION		SAMPLE TYPE	SAMPLE #	+ Torvane (	50 200 (Su) □  50 200 (Su) △  50 200  LIQUID	COMMENTS	ELEVATION (m)
0		1	SAND AND GRAVEL (FILL)	- brown, frozen								234
10 1 1 2 2 3 3 4 4 5 5 6 6 7 7 10 10 10 10 10 10 10 10 10 10 10 10 10	ASSA-086		CLAY (FILL) - silty, trace to some sand - dark grey to black - moist, very stiff, medium pla - mottled brown below 0.6 m - black, trace gravel, trace or					G112				233
Ē,		7	CLAY	games bolow 1.2 m					T			232 -
3			<ul> <li>silty, trace sand</li> <li>mottled brown and grey</li> <li>moist, very stiff, medium pla</li> <li>silt layer ~2 mm thick at 3.0</li> </ul>	asticity m			I	G113 T114				231
E-4			below 3.0 m: - no sand - brown - stiff, high plasticity					G115	Δ			230
5			trace silt inclusions     slightly mottled grey below	3.7 m				G116				229
E-0			- grey, trace silt inclusions be	elow 6.1 m				T117		<b>.</b>		228
E '			=					G118	Δ			227
9		//						G119	Δ			225
10			- trace silt (till) inclusions, tra	ice fine gravel below 9.1 m				T120 G121	<del></del>			224
E		1	SILT TILL				Ш	T122	Δ+ J Δ <b>A</b>	)		223
12		9000	- trace clay, trace sand - light grey - moist, loose, low plasticity					G123	9			222 -
13		900	below 12.5 m: - no clay, some sand to sand - light greyish pink	dy, trace gravel				G124	4			221
14		9000	- dry, dense, no plasticity - trace cobbles, trace granite - trace limestone boulders b					G125				220 -
15		900						G126				219 -
16		300		6-8- 				C127				218 -
THE TOTAL STATE OF THE TOTAL STA		900						C128				217 -
18		9000						C129				216 -
11 11 12 13 14 15 16 17 18 19 19 19 19 19 19 19 19 19 19 19 19 19		900						C130				215 -
2 = Z0	1.4	1 4N 4V	1			OGGED BY:					TION DEPTH: 37.20 m	n
90			UMA AECOM	1		REVIEWED B	_			COMPLE	TION DATE: 9/12/04	1 of 2
ŏ			J		F	PROJECT EN	GIN	EEK:	DIII VVIESNER		rage	1 01 2

PROJECT: Kenaston Underpass					CLIENT: St	antec Consulti	ng L	TESTHOLE NO: TH-04-42						
			h of Wilkes, West of Ker				PROJECT NO.: 4231-040-09							
CONT	RAC	TOR:	Paddock Drilling Ltd.			METHOD: Acker - 125 mm Solid Stem Augers					ELEVATION (m): 234.291			
SAMF	PLE T	YPE	GRAB	SHELBY TUBE	SPLIT SPO						NO RECOVERY CORE			
BACK	FILL	TYPE	BENTONITE	GRAVEL	SLOUGH	G	ROU	T		JTTINGS	SAND			
DEPTH (m)	SLOTTED	SOIL SYMBOL		SOIL DESCRIPT	ΓΙΟΝ		SAMPLE TYPE	SAMPLE #	□ Lab Vane (kPa) 50 100 1: △ Pocket Pen. (kPa) 50 100 1: PLASTIC M.C.	50 200 (Su) □ 50 200 (Su) △	COMMENTS	ELEVATION (m)		
20			LIMESTONE - light brownish grey to white	9							Recovery: 90 % RQD: 46%	214		
-21			<ul> <li>pitted, cemented</li> <li>signs of acidic dissolving a</li> <li>fractured and jointed</li> </ul>					C131				213		
22			- slight oxidation between 20 - core in 30 to 300 mm piece	us between 22.0 and 23.5 m				C132			Recovery: 90 % RQD: 20%	212		
-23			- core largely fractured < 10	0 mm lengths between 23.5 п	n and 25.0 m						Recovery: 85 % RQD: 42%	211 -		
-24				brown to white below 24.5 m			THE REAL PROPERTY.	C133			Recovery: 87 %	210 -		
E-25			**************************************	of weathering, fresh faces on filled with very fine grain silt m			No. of Concession, Name of Street, or other Persons, Name of Street, or ot	C134			RQD: 44%	209 -		
E-26							1				Recovery: 100 % RQD: 86%	208 -		
27								C135			Recovery: 100 %	207 -		
E-28								C136			RQD: 80%	206 -		
E-29 E-30											Recovery: 100 % RQD: 61%	205 -		
								C137			Recovery: 100 %	204 -		
-31 -32								C138			RQD: 57%	202 -		
33								C139				201 -		
34											Recovery: 100 % RQD: 79%	200 -		
35			- coring procedure lost water	er circulation at approximately	34.7 m			C140				199 -		
36				25 <u>8.</u> 07				C141			Recovery: 100 % RQD: 94%	198 -		
37			END OF TEST HOLE AT 3	7.2 m IN BEDROCK.						i	Recovery: 100 % RQD: 79%	197 -		
E-38			- Power auger refusal at 13 - HQ cored from 13.4 m to	37.2 m.		ely 6.0 m.						196 -		
39			- Standpipe piezometer (SF	-04-42) installed at 26.5 m de	epth.							195 -		
= 40			ı i		The second state of the se	LOGGED BY:	Kat	e Fran	nklin	COMPL	ETION DEPTH: 37.20 r	n		
			UMA AECON	1		REVIEWED B			The state of the s	COMPL	ETION DATE: 9/12/04	0 10		
3			and the same of th			PROJECT EN	GIN	EER:	Bill Wiesner		Page	2 of 2		