TECHNICAL MEMORANDUM

DATE March 21, 2011
Revised March 25, 2011

PROJECT No. 09-1132-0084-4002-M01

TO Mr. John Gawley, M.Eng., P.Eng., Associate
Dillon Consulting Limited

FROM Mr. Dirka U. Prout, P.Eng
Mr. Philip R. Bedell, P.Eng.
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FOUNDATION ENGINEERING REVIEW (GEOCRES NO. 40I12-29)
DUART ROAD UNDERPASS, SITE NO. 13-264
REHABILITATION OF 4 UNDERPASSES ON HIGHWAY 401
GWP 273-97-00

This technical memorandum summarizes the results of a foundation engineering review carried out for the design of the proposed rehabilitation of the Highway 401 Duart Road underpass structure (Site No. 13-264), located in the Municipality of Chatham-Kent, Ontario. The site location is shown on the Key Plan, Figure 1.

Based on the information provided, rehabilitation of the bridge will include replacement of the deck and conversion of the existing conventional abutments to semi-integral abutments. The foundation engineering review was carried out to document the nature of the embankment fill and to ascertain if semi-integral abutments are suitable for this structure.

1.0 Investigation Procedures

The field work for this investigation was carried out on November 11, 2010 at which time two boreholes, numbered 101 and 102, were drilled into the approach fill adjacent to the abutments at the locations shown on the Location Plan, Figure 1. The asphalt and reinforced concrete approach slabs were cored at the borehole locations to permit auger penetration into the approach fill. The table below summarizes the borehole locations, ground surface elevations at the borehole locations and borehole depths.

Borehole	Location (m)		Ground Surface Elevation	Borehole Depth
	Northing	Easting	(m)	(m)
101	4 711 337	362 837	224.66	5.03
102	4 711 293	362 885	224.66	5.03

The investigation was carried out using a truck-mounted B57 power auger supplied and operated by a specialist drilling contractor. Samples of the approach fill were obtained at suitable intervals of depth in the boreholes using 50 millimetre outside diameter split spoon sampling equipment and an automatic trip hammer in accordance with the standard penetration test (SPT) procedure (ASTM 1586). The boreholes were terminated 5.0 metres below the existing pavement surface. Groundwater conditions encountered in the boreholes during the drilling operations are indicated on the Record of Borehole sheets. Both boreholes were backfilled in accordance with current MTO requirements and Ontario Regulation 372/07.

Field work was monitored on a full-time basis by an experienced member of our engineering staff who located the boreholes in the field, monitored the drilling, sampling and in situ testing operations and recorded all observations of subsurface conditions. The samples were identified in the field, placed in labelled containers and transported to our London laboratory for further examination and testing. Index and classification tests, consisting of water content determinations and grain size distribution analyses, were carried out on selected samples. The results of the testing are shown on the Record of Borehole sheets and summarized in Appendix A.

Information from the geotechnical investigation completed for the existing overpass structure was also used in preparation of this technical memorandum. Data from boreholes 1A and 1 through 4, inclusive, from Geocres Report No. 40I12-11 were used to supplement the current data. Dynamic cone penetration tests were also conducted adjacent to these boreholes.

The Record of Borehole sheets for the previous boreholes are presented in Appendix B. The table below summarizes the approximate locations, ground surface elevations and depths of the previous boreholes:

Borehole	Approximate Location (m)		Ground Surface Elevation	Borehole Depth
	Northing	Easting	(m)	(m)
1	4 711 329	362 854	217.60	10.97
1A	4 711 331	362 853	217.60	9.45
2	4 711 311	362 857	217.69	10.36
3	4 711 299	362 866	217.38	13.11
4	4 711 321	362 845	217.48	12.50

The locations of the previous boreholes are shown on Figure 1. The locations of the previous boreholes should be considered approximate since the locations were referenced to measurements from the centreline of the Highway 401 (at the time) and the drawings included in the Geocres Report identified above. It should be noted that the soil conditions shown on the previous Records of Boreholes may have been modified by subsequent construction activities and that soil classification methods and standards may also differ from those used for the investigation completed for this bridge rehabilitation project.

2.0 Subsurface Conditions

2.1 Soil Conditions

In summary, the boreholes drilled into the approach fill adjacent to the abutments encountered the existing pavement structure and approach slab above granular fill materials used to construct the existing approach embankments.

The soil conditions encountered in previous boreholes 1A, and 1 to 4 (Geocres No. 40I12-11) generally consisted of fill and topsoil overlying surficial layers of sand and silty clay above an extensive deposit of silty clay till.

Asphaltic pavement was encountered at the pavement surface in boreholes 101 and 102. The asphalt thickness was 95 and 105 millimetres at the north and south abutments, respectively. Reinforced concrete approach slabs were encountered beneath the asphaltic pavement and were 295 and 255 millimetres thick at the north and south abutments, respectively. Voids, 30 to 65 millimetres thick, were encountered beneath the approach slabs at the north and south abutments, respectively. Beneath the voids, granular roadbase and subbase materials were encountered. The thickness of the granular roadbase could only be confirmed at borehole 101. The granular roadbase was 340 millimetres thick in borehole 101. At borehole 102, the granular roadbase was indistinguishable from the underlying granular fill used for the approach embankment.

Approach embankment fill was encountered below the pavement structure in boreholes 101 and 102. The fill consisted of sand and gravel and sand. Boreholes 101 and 102 were terminated in the fill at approximate elevation 219.6 metres, about 1.9 to 2.2 metres above the former ground surface elevation. The approach embankment fill ranged from very loose to compact with N values of 2 to 28 blows per 0.3 metres. Samples of the fill had water contents of 5 to 16 per cent. Grain size distribution curves for the fill are provided on Figure A-1.

The subsurface conditions described below are based on the data included in the original investigation (Geocres No. 40I12-11) and are considered representative of conditions below the existing embankment and below termination of boreholes 101 and 102.

Sand and gravel fill, and silty sand and gravel fill was encountered in the boreholes drilled during the original investigation (Geocres No. 40I12-11) at the ground surface at the time of the investigation. The combined thickness of the granular fill and underlying topsoil in boreholes 1 and 3 (40I12-11) were reported as 1.3 and 1.0 metres, respectively. The granular fill was 0.4 metres thick at borehole 2 (40I12-11) and 0.8 metres thick in borehole 4 (40I12-11). A possible fill layer with significant clay content was encountered at elevation 216.7 metres in borehole 4 (40I12-11).

Loose topsoil was encountered beneath the fill in boreholes 1, 2 and 3 (40I12-11). The thickness of the topsoil was not identified on the Record of Borehole sheets but it was reported that the maximum thickness was 0.8 metres and had N values ranging from 6 to 10 blows per 0.3 metres.

A 1.7 to 2.4 metre thick layer of sand was encountered beneath the topsoil in boreholes 1, 2 and 3 (40I12-11) and beneath the fill in borehole 4 (40I12-11) at elevations 216.3 to 216.4 metres. The loose to compact sand layer had N values ranging from 6 to 18 blows per 0.3 metres. A water content of 31 per cent was measured for a sample of sand that contained organic matter.

Discrete 0.2 metre thick layers of silty clay with organic matter were encountered in the sand in boreholes 2 and 3 (40I12-11) from elevation 214.3 and 214.0 metres, respectively. The sand in borehole 4 (40I12-11) was interlayered with silty clay from elevation 214.7 metres.

Glacial till was encountered at depth underlying silty clay or sand layers at elevations 213.8 to 214.6 metres. The glacial till was described as silty clay on the original Record of Borehole sheets, but has been re-interpreted to be clayey silt based on the results of the Atterberg limits testing. All of the (40I12-11) boreholes were terminated in the glacial till after exploring it for some 6.8 to 9.5 metres. The stiff to hard glacial till had N values of 12 to 33 blows per 0.3 metres and water contents of 15 to 19 per cent.

2.2 Groundwater Conditions

A wet soil sample was encountered in borehole 102 at a depth of 2.3 metres below ground surface, or elevation 222.4 metres, likely reflecting surface water infiltration being impeded by local changes in fill permeability. Borehole 101 did not encounter wet soils or groundwater during and upon completion of drilling.

Groundwater levels encountered within the native sand layer found in boreholes 1 to 4 (40I12-11) during drilling for the original investigation ranged from about elevation 215.9 to 216.1 metres.

3.0 Discussion

3.1 Existing Structure

The Duart Road underpass was built in 1964. At the time of construction, Duart Road was known as Muirkirk Road. Information on the existing structure was obtained from a review of the design drawings, Department of Highways Ontario (DHO) Drawing No. D-4635-1 entitled "Plan and Elevation: Muirkirk Underpass" dated November 1960, DHO Drawing No. D-4635-2 entitled "Footing & Pier Details" dated November 1960", DHO Drawing No. D-4635-3 entitled "Abutments, Wing Walls & End Posts" dated November 1960 and Geocres Report No. 40I12-11. The underpass structure is comprised of a four span, simply-supported steel beam structure with a reinforced concrete deck. The overpass structure is approximately 62 metres long and about 10.4 metres wide.

The design information indicates that the abutments are founded on concrete-filled steel tube piles having an outer diameter (O.D.) of 324 millimetres and a wall thickness of 6.3 millimetres. The working stress design load provided on DHO Drawing No. D-4635-2 was 267 kilonewtons (kN) per pile. The pile cut-off and tip elevations are 222.2 and 211.8 metres, respectively. The existing embankments are up to approximately 7 metres high.

3.2 Geotechnical Resistances for Existing Foundations

The factored geotechnical resistances at Ultimate Limit States (ULS) and geotechnical resistance at Serviceability Limit States (SLS) including shaft and tip resistances provided in the table below can be utilized for a structural assessment of the existing structure.

						Geotechnical Resistances	
Location	**Foundation Type**	**Cut-Off Elevation**	**Pile Tip Elevation**	**Pile Length**	**Founding Strata**	**Factored ULS**	**SLS**
		(m)	**(m)**	**(m)**			
North and South Abutments	Tube Pile	222.20	211.84	10.36	Stiff to hard clayey silt till	330 kN	275 kN

It should be noted that the pile tip elevations as well as the pile lengths are based only on the design drawings as no construction records or as-built information was available.

The stratigraphy presented in the table below has been simplified for the purpose of estimating lateral pile load resistance and deformation within structural models. The horizontal pile behaviour can be estimated using the following equation and ranges in subgrade reaction coefficient where:

k_s = coefficient of horizontal subgrade reaction (MPa/m)

$= n_h (z/d)$ for cohesionless soils

$= \frac{67 S_u}{d}$ for cohesive soils

d = pile width or diameter (m)

n_h, = constant of horizontal subgrade reaction (MPa/m)

z = depth below ground surface grade (m)

Soil Type	Elevation (m)		n_h	S_u
	From	To	(MPa/m)	(MPa)
Loose fill (sand and sand and gravel)	Surface	221	-	-
Compact fill (sand and gravel – north abutment; sand – south abutment)	221	216	5 - 10	-
Loose to compact sand	216	214	1 – 3	-
Very stiff to hard clayey silt till	214	212	-	0.15 – 0.22
Stiff to very stiff clayey silt till	212	204	-	0.08 - 0.13

The lateral geotechnical resistance for the existing 324 millimetre O.D. steel tube piles can be taken as 135 kilonewtons (factored) at ULS and 50 kilonewtons at SLS taking group effects into consideration based on the pile spacing of 2.13 metres (6.6 pile diameters). The SLS value corresponds to a lateral pile head deflection of 10 millimetres for fixed-head conditions.

3.3 Conversion to Semi-Integral Abutments

It is understood that the existing conventional abutments are to be converted to semi-integral abutments. The configuration of the existing piled abutment foundations features a row of vertical steel tube piles and a row of battered steel tube piles at each abutment. The piles in each row are spaced approximately 2.13 metres apart, or approximately 6.6 times the pile diameter. The battered piles are inclined at 5 vertical to 1 horizontal.

Based on foundation engineering considerations, the existing foundations and subsurface conditions are considered to be compatible with a semi-integral abutment design. The Structural Section of the MTO has indicated that the dead load for the deck will increase approximately five (5) per cent after conversion of the existing conventional abutments to semi-integral abutments. The existing foundations and subsurface conditions are acceptable provided that this increase in dead load represents no more than three (3) per cent of the original working load of 267 kilonewtons.

3.4 Construction Considerations

Treatment of Backfill Behind the Abutment

The original design required that the fill behind the abutment above elevation 222.2 metres to be free draining. The existing fill in this area consists of very loose to loose sand and gravel with trace to some silt with some 20 per cent passing the 75 micron sieve. The results of the deck condition survey indicate voids below the north and south approach slabs of 30 and 65 millimetres, respectively. The existing granular fill should be subexcavated and replaced with Granular B Type III with a maximum of 5 per cent material passing the 75 micron sieve.

Temporary Protection Systems

Temporary protection systems may be required to permit conversion of the existing abutments and will be required for replacement of the backfill behind the abutment, particularly if staged construction will be carried out. These systems are to support the sides of the excavation and permit the use of vertical cuts. The temporary excavation support system should be designed and constructed in accordance with Ontario Provincial Standard Specification (OPSS) 539. The lateral movement of the temporary shoring system should meet Performance Level 2. The following parameters can be used to design the supporting systems:

SOIL TYPE	COEFFICIENT OF EARTH PRESSURE			INTERNAL ANGLE OF FRICTION	UNIT WEIGHT
	Active, K_a	At Rest, K_o	Passive, K_p	(degrees)	(kN/m^2)
Loose Granular Fill	0.40	-	-	25	19.0
Compact Granular Fill	0.33	0.50	3.0	30	19.0
Loose to Compact Sand	0.33	0.50	3.0	30	19.0
Very stiff to hard clayey silt till	0.33	0.50	3.0	30	21.0
Stiff to very stiff clayey silt till	0.35	0.52	2.9	29	21.0

The earth pressure coefficients noted above are based on a horizontal surface adjacent to the excavation. If sloped surfaces are present, the coefficients should be adjusted accordingly.

We trust that this technical memorandum is adequate for your present requirements. Should you require more information, or if more detail is required at this time, please do not hesitate to contact this office at your convenience.

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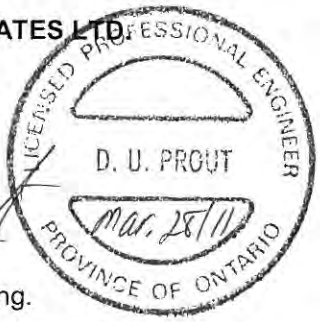

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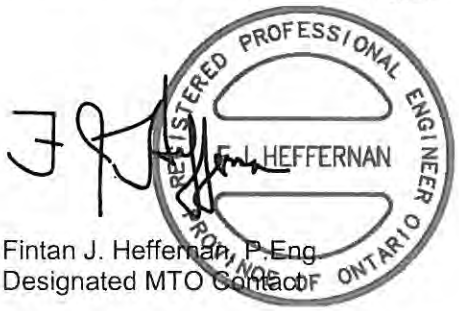
Senior Consultant



Fintan J. Heffernan, P.Eng.
Designated MTO Contact

Attachments: Records of Boreholes
Figure 1
Appendices A and B

DB/DUP/PRB/FJH/ly/sll

n:\active\2009\1132 - geotechnical\1132-0000\09-1132-0084 dillon - hwy 401 & 402 bridges - sw ontario\ph 4000 - gwp 273-97-00 hwy 401 (2011)\ph 4002 - fdn input (site 13-264)\memos\m01\0911320084-4002-m01 mar 25 11 (revised) duart rd underpass.docx

Golder Associates

Golder Associates
London, Ontario

PROJECT 09-1132-0084-4002

RECORD OF BOREHOLE No 101

1 OF 1

METRIC

W.P. GWP 273-97-00 LOCATION N 4711336.5 :E 362837.1 ORIGINATED BY DB

DIST HWY HWY 401 BOREHOLE TYPE SOLID STEM AUGER. COMPILED BY AMG

DATUM GEODETIC DATE November 11, 2010 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
224.66	PAVEMENT SURFACE										
0.10	ASPHALT										
	CONCRETE (Approach Slab)										
0.42	VOID (30mm)										
223.90	FILL, sand and gravel, crushed Brown						224				
0.76	FILL, sand and gravel, trace to some silt Very Loose to Loose Brown		1	SS	8				○		
			2	SS	2		223		○		
222.56											
2.10	FILL, sand, trace clay, some silt, trace gravel Very Loose Brown		3	SS	3		222		○		
			4	SS	4				○		9 73 13 5
221.00							221				
3.66	FILL, sand and gravel, trace clay, some silt Compact Brown		5	SS	20				○		
219.63			6	SS	22		220		○		22 59 14 5
5.03	END OF BOREHOLE										
	Borehole dry during drilling on November 11, 2010.										

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

LDN_MTO_02 09-1132-0084-4002.GPJ GLDR_LON.GDT 16/03/11

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PROJECT 09-1132-0084-4002

RECORD OF BOREHOLE No 102

1 OF 1

METRIC

W.P. GWP 273-97-00 LOCATION N 4711292.9 ;E 362884.8 ORIGINATED BY DB

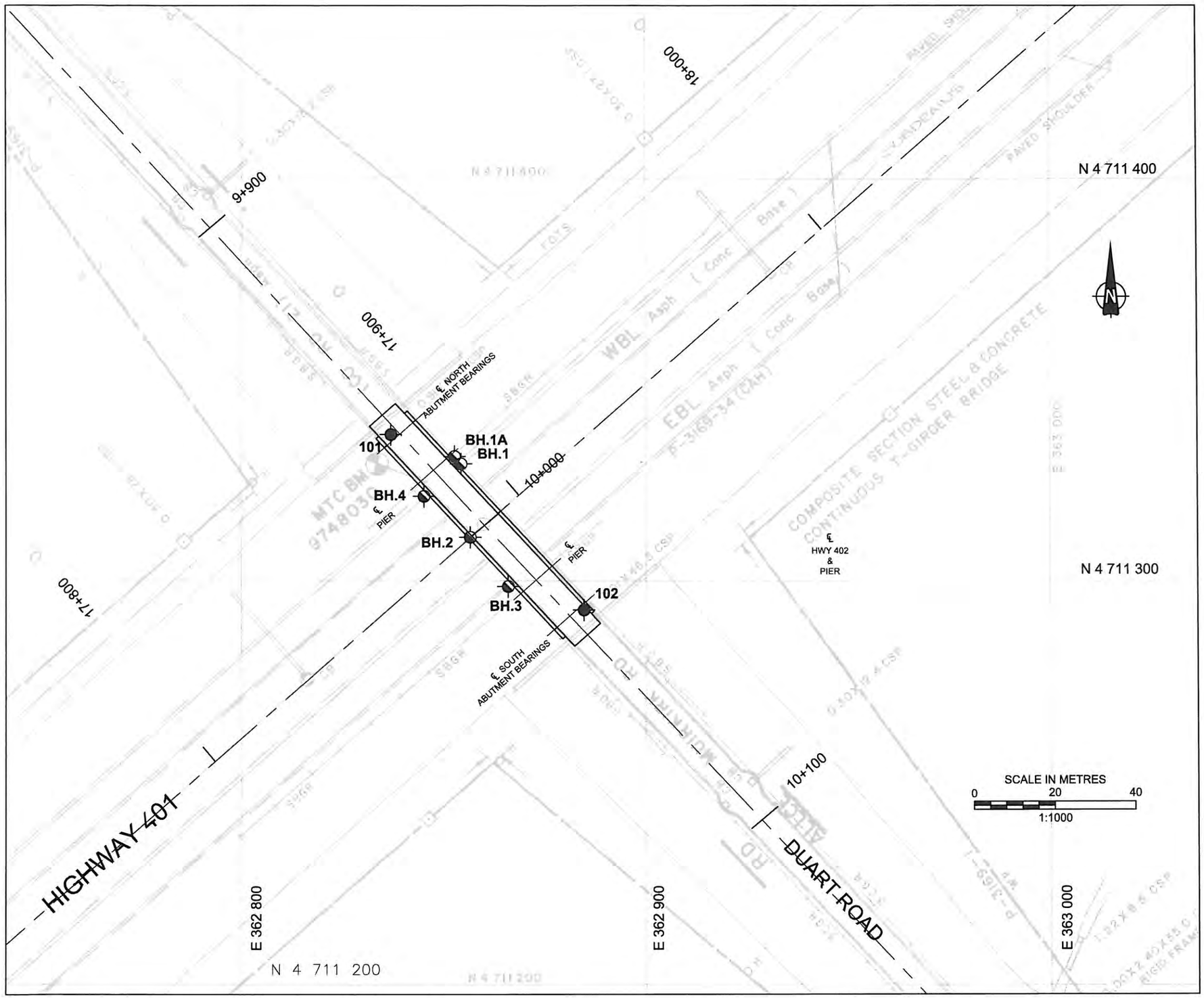
DIST HWY HWY 401 BOREHOLE TYPE SOLID STEM AUGER. COMPILED BY AMG

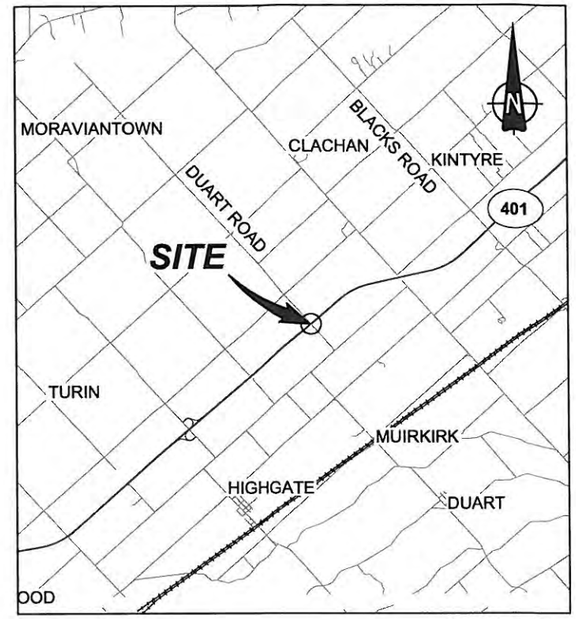
DATUM GEODETIC DATE November 11, 2010 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
224.66	PAVEMENT SURFACE										
0.10	ASPHALT										
	CONCRETE (Approach Slab)										
0.44	VOID (65mm)										
	FILL, sand and gravel, trace to some silt Loose Brown		1	SS	9		224		○		
			2	SS	6		223		○		
			3	SS	4				○		
221.76							222				
2.90	FILL, sand, trace clay, some silt, trace gravel, trace topsoil Compact Brown		4	SS	24				○		5 73 16 6
221.00							221				
3.66	FILL, sand, trace clay, some silt,										
220.64	trace to some gravel, trace rootlets Compact Brown		5	SS	24				○ ○		
4.02	FILL, sand, trace clay, some silt, trace gravel Compact Brown		6	SS	28		220		○		
219.63											
5.03	END OF BOREHOLE Wet soil encountered at about elev. 222.4m during drilling on November 11, 2010.										

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

LDN_MTO_02 09-1132-0084-4002.GPJ GLDR_LON.GDT 16/03/11





KEY PLAN

LEGEND

- Borehole
- Borehole - Investigation By Others (Geocres No. 40I12-11)

REFERENCE

DRAWING BASED ON PLAN PROVIDED BY DILLON AND CANMAP STREETFILES V2008.4.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE ONLY.

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
101	224.66	4 711 336.5	362 837.1
102	224.66	4 711 292.9	362 884.8
(Geocres No. 40I12-11)			
BH.1	217.60	4 711 329.2	362 854.4
BH.1A	217.60	4 711 331.0	362 852.8
BH.2	217.69	4 711 311.0	362 856.7
BH.3	217.38	4 711 298.8	362 866.0
BH.4	217.47	4 711 321.1	362 845.3

Geocres No. 40I12-29

PROJECT
DUART ROAD UNDERPASS (SITE 13-264)
REHABILITATION OF 4 UNDERPASSES ON HIGHWAY 401
GWP 273-97-00

TITLE
LOCATION AND KEY PLANS

Golder Associates
LONDON, ONTARIO

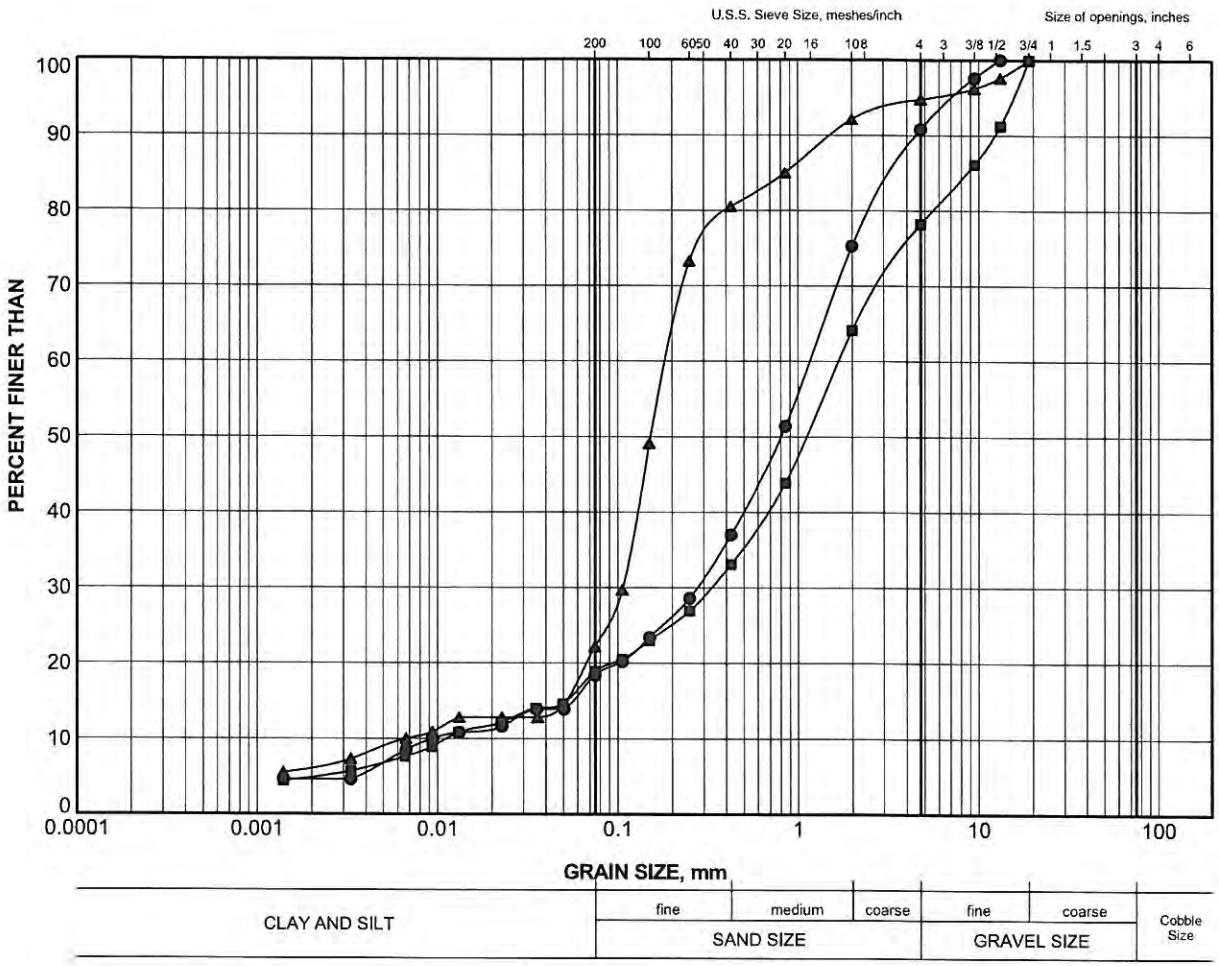
PROJECT No.	09-1132-0084		FILE No	0911320084-4002-M01001
			SCALE	AS SHOWN
CADD	AGIWF	Mar. 16/10	REV.	
CHECK				

FIGURE 1

Drawing file: 0911320084-4002-M01001.dwg Mar 16, 2011 - 10:58am

APPENDIX A

LABORATORY TEST DATA



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	101	4	221.4
■	101	6	219.9
▲	102	4	221.4

PROJECT

DUART ROAD UNDERPASS (SITE 13-264)
REHABILITATION OF 4 UNDERPASSES ON HIGHWAY 401
GWP 273-97-00

TITLE

GRAIN SIZE DISTRIBUTION

FILL

Golder Associates
LONDON, ONTARIO

PROJECT No.		09-1132-0084	FILE No. 0911320084-4002-M010A1
			SCALE N/A REV.
DRAWN	AG\WF	Mar. 16/11	
CHECK			FIGURE A-1

LDN_MTO_FORMAT GLDR_LDN.GDT

APPENDIX B

RECORDS OF PREVIOUS BOREHOLES AND LABORATORY DATA (GEOCRES REPORT NO. 40I12-11)

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92-59) ORDER NO. T.429/60

CLIENT Ontario Department of Highways

BOREHOLE NO. BH.1 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING ——

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown sand with gravel, FILL.	713.9			Zero			
Loose brown loam with some organic matter. TOP SOIL.			1	4'-3"	Free Water	10	Damp.
Loose grey fine to medium SAND.			2			7	Moist. No dry strength.
Loose to firm grey fine to medium SAND with some fine gravel.			3	9'-9"		15	Wet. No dry strength.
Hard brown silty CLAY with fine to medium subangular gravel.			4			26	Damp. High dry strength.
Very stiff do			5			13 (9")	do
do			6			13	do
Stiff do			7			13	do
do			8			14	do
do			9			13	do
do			10	36'-0" End of Borehole		12	do

SCALE: 1" = 5'-0" ● DISTURBED SAMPLE ■ UNDISTURBED SAMPLE

FORM G-1A 800 LISTED STATIONERY CO. LTD.

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92-59) ORDER NO. T.429/60

CLIENT Ontario Department of Highways

BOREHOLE NO. BH.1A DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING ——

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
	713.9			Zero			
Same as BH.1							
				14'-0"			
Very stiff brown silty CLAY with fine to medium subangular gravel.			• 1			20	Damp. High dry strength.
			ST1				No recovery
			ST2				No recovery
			• 2			13	No recovery
Stiff brown silty CLAY with fine to medium subangular gravel.			• 3	31'-0"		13	Moist. High dry strength.
			End of Borehole				

SCALE: 1" = 5'-0" • DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92-59) ORDER NO. T.429/60

CLIENT Ontario Department of Highways

BOREHOLE NO. BH.2 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING ——

DESCRIPTION OF STRATA	ELEVATION	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown sand and gravel. FILL.	714.2		Zero			
			1'-3"			
Loose dark brown loam with organic matter. TOP SOIL.		● 1			9	Damp.
Loose dark grey fine to medium somewhat silty SAND.		● 2	Free Water		7	Moi. . Low dry strength.
do With some fine gravel.		● 3			6	Wet. Low dry strength.
Firm dark grey brown silty CLAY with black organic concentrations.		● 4	11'-3" 11'-9"		13	Moist. High dry strength.
Hard brown silty CLAY with fine to medium subangular gravel.		● 5			33	Damp. High dry strength.
do		● 6			32	do
Very stiff do		● 7			18	do
Stiff do		● 8			14	Moist. High dry strength.
do		ST1	34'-0"			do 3" recovery

SCALE: 1" = 5'-0" ● DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92/59) ORDER NO. T.429/60

CLIENT Ontario Department of Highways

BOREHOLE NO. BH.3 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING ———

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown silty sand with gravel, some organic matter. FILL.	713.2			Zero			
Loose brown sandy clay, organic concentrations, probably TOP SOIL			• 1	3'-3"		6	Damp.
				Free Water			Moist.
Firm dark brown somewhat silty fine SAND.			• 2			17	Low dry strength.
do							Wet.
With fine gravel.			• 3			18	No dry strength.
do							do
Stiff grey silty CLAY with some shells, traces of bedding.			• 4	11'-3" 11'-9"		13	Moist. High dry strength.
Hard brown silty CLAY with fine to medium subangular gravel.			• 5			33	Damp High dry strength.
Very stiff do			• 6			32	do
do			• 7			26	do
Stiff to very stiff do			• 8			23	do
Stiff do			• 9			15	do
			• 10			17	No recovery
do			• 11			20	Damp.
do			• 12	43'-0"		14	High dry strength.
				End of Borehole			do

SCALE: 1" = 5'-0" • DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92-59) ORDER NO. T.429/60

CLIENT Ontario Department of Highways

BOREHOLE NO. BH.4 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING ———

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Dark brown silty sand and gravel. FILL.	713.5			Zero			
			1	2'-6"		8	Damp.
Brown clayey sand and gravel iron stained. Probably FILL.				Free Water			Moist.
Firm grey fine to medium somewhat silty SAND.			2			17	Low dry strength.
			3	9'-0"		12	Clay: Moist. High dry strength.
Loose grey SAND with layers of grey silty clay with dark organic concentrations.							
do			4	12'-0"		23	do Clay: Damp. High dry strength.
Stiff to very stiff brown silty CLAY with fine to medium subangular gravel.							
Very stiff brown silty CLAY with fine to medium subangular gravel.			5			23	Damp. High dry strength.
do			6			20	do
			ST1				No recovery
Stiff do			7			19	Damp. High dry strength.
			ST2				No recovery
do			8			19	Damp. High dry strength.
do			9			17	do
			ST3				No recovery.
			ST4				No recovery.
			10	41'-0"		19	No recovery.
				End of Borehole			

SCALE: 1" = 5'-0" ● DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

PROJECT Crossing County Road to Duart & Hwy. 401

TITLE Laboratory Tests (W.P. 92-59)

DRG. NO. _____ ORDER NO. T.429/60

UNIVERSAL GEOTECHNIQUE LIMITED

TABLE N° 1

SUMMARY OF LABORATORY TESTS

Borehole N°	Sample N°	Elevation	Natural Density lbs./cu.ft.	Natural Moisture Content %	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compression Strength lbs./sq.ft.
BH.1	4	702.0		19.2				
	6	696.5	140	17.6				* 7300
	8	688.0		18.5				
	10	678.0		17.8				
BH.1A	1	696.0	138	17.2				* 8000
BH.2	4	702.0		35.0				
	5	699.5		17.8				
	6	697.5		15.2				
	7	693.0		17.9				
	8	685.5		18.2				
	ST.1	680.5		18.5	29.2	15.2	14	
BH.3	4	701.0		30.3				
	5	698.5	139	16.0				* 6000
	6	694.0	137	15.6				8000
	7	688.5	144	17.8				8000
	8	683.5	137	18.8	29.5	14.7	14.8	* 5000
								* 3900 (remould)
	11	670.0	144	19.0	29.2	14.0	15.2	* 4700
								* 2800 (remould)
BH.4	3	703.5	117	30.7				* 1300

* At 20% Strain