



**Submitted To AECOM Canada Ltd.
189 Wyld Street Suite 103, North Bay, Ontario P1B 1Z2
On Behalf of the Ontario Ministry of Transportation**

**Dewatering System
Crooked Creek Culvert
Site No. 47-003
GWP 5131-08-00**

**Highway 66
8.0 km West of Highway 11**

FINAL DEWATERING SYSTEM REPORT

Date: December 6, 2013
Ref. N°: 13/05/13073-F9

Geocres No. 42A-97

LVM | MERLEX

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Crooked Creek Culvert
Site No. 47-003
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Final Dewatering System Report

Prepared by:

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LVM inc.'s subcontractors who may have accomplished work either on site or in laboratory are duly qualified as stated in our Quality Manual's procurement procedure. Should you require any further information, please contact your Project Manager."

Client:

AECOM Canada Ltd.

189 Wyld Street, Suite 103

North Bay, Ontario

P1B 1Z2

Attention: **Mr. Al Rose**

REVISION AND PUBLICATION REGISTER		
Revision N°	Date	Modification And/Or Publication Details
00	2013-09-10	DRAFT Report Issued
01	2013-12-06	Final Report Issued

REPORT DISTRIBUTION	
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1 hard copy	File

1 INTRODUCTION

LVM | MERLEX has been retained by AECOM Canada Ltd., on behalf of the Ministry of Transportation of Ontario (MTO), to provide design information for a potential dewatering system required for rehabilitation of an existing culvert. This culvert is located at Crooked Creek, on Highway 66, some 8.0 km West of Highway 11, in the Township of Eby, Site No. 47-003.

The project was specified by the MTO in the RFP/TPM documentation Agreement No. 5012-E-0025. The terms of reference for the scope of work are outlined in LVM | MERLEX's Proposal P-13-022, dated February, 2013. The factual information for this site was provided in the Foundation Investigation Report (FIR) prepared in 2008 by Shaheen & Peaker Limited (S&P), Geocres No. 42A-71. This report on dewatering system is to be read in conjunction with the Foundation Investigation and Design Report (FIDR) for this project.

2 HISTORICAL SUBSURFACE INFORMATION

A foundation investigation was carried out for the Crooked Creek Culvert in 2007, by Shaheen & Peaker Limited (S&P). The factual information from this investigation was provided in the FIR, Geocres No. 42A-71. Based on the information provided, the surficial geology of the area consists of glaciolacustrine fine grained deposits (i.e. silt, clay, and varved clay). The topography of the Site is generally flat.

The highway embankment centreline elevation varies from elevation 301.2 to 301.5m in the area of the culvert. Based upon the above referenced FIR, the subsurface conditions consist of a pavement structure overlying granular embankment fill described as sand to sandy gravel, in a loose to dense level of compactness. A 1.2 m thick layer of rock fill was encountered in the lower part of the embankment fills at Borehole No. S1. The embankment fills were some 3.5 to 4.3 m in height above original grade, at the culvert location. The boreholes advanced at the culvert ends, in the area of the required dewatering system, indicate the subsurface conditions consisted of a granular (sand) fill, some 1.4 to 1.6 m thick, underlain by a relatively thin (0.7 to 1.0 m thick) stratum of clayey silt to silty clay. This stratum was underlain by a relatively deep deposit of silt. The silt deposit was described as generally loose silt containing occasional firm to stiff cohesive (i.e. clayey) seams and zones. The silt deposit was encountered to depths of 14.2 to 18.3 m, elevation 285.8 to 283.0 m respectively. The silt deposit is underlain by a soft to stiff clayey silt deposit which is in turn underlain by rock fragments overlying bedrock at depths of 23.7 to 31.7 m (elevation 275.7 to 269.6 m respectively). For reference purposes, the historical borehole logs and borehole plan, by S&P have been included in Appendix 2.

2.1 GROUNDWATER DATA

Based on the historical information provided in the FIR, the groundwater level was recorded at elevations 296 to 298 m. A site review was carried out by LVM | Merlex, during preparation of

this report, and the water level in the creek was recorded at approximately elevation 298.2 m. During the site review, a beaver dam was observed upstream of the culvert. It appears that this dam retains approximately a 1 metre head of water.

3 DISCUSSION AND RECOMMENDATIONS

3.1 GENERAL

The culvert at this location is a 6.3x3.9 m Structural Plate Corrugated Steel Pipe Arch (SPCSPA), some 26.2 m in length. Flow through the culvert is from left to right (i.e. north to south) (see Photo Essay, Appendix 1). Based on the borehole data from the S&P foundation investigation, the soils at the inlet and outlet consist of some 150 mm of organics underlain by some 1.5 to 1.7 m of sand fill overlying the native soils which consist of a generally loose to compact silt stratum overlying very soft to soft clayey silts and sands overlying bedrock at depth.

It is understood that, based on the December 2007 Structural Evaluation Report, the pipe arch is structurally adequate to carry all loads as per the CHBDC. However the lower zone of the arch, at and below normal water line, has experienced some section loss due to corrosion. Present plans propose a culvert rehabilitation consisting of installing a concrete liner (lower half of pipe) and constructing cut-off walls, which will likely consist of steel sheet piling attached to the concrete liner.

In order to carry out this work geotechnical information for a dewatering system is required.

It should be noted that the Crooked Creek Culvert location is posted as a fish sanctuary.

3.2 DEWATERING

The culvert must be maintained in a dewatered condition during culvert rehabilitation. The groundwater level, in the fall of 2007, was recorded at approximately elevations 296 to 298 m during the field investigation carried out by S&P. The water level at the culvert was recorded at 298.2 m during our site review in July 2013. Dewatering, in accordance with OPSS 517 and 518, will be required during rehabilitation activities.

A slow flow was observed through the culvert at the time of the current site review. The water level in the creek was some 1.9 m above the culvert invert, at the outlet end. A relatively long beaver dam is present at a distance of some 20 m upstream of the culvert site. It appeared that the beaver dam was retaining a 1 m head of water. It is imperative that the integrity of the beaver dam be maintained during construction.

In order to dewater the culvert location a cofferdam will be required at the inlet and outlet. It is understood that in consideration of the 6.3 m width of the arch it would be possible to construct a cofferdam along the centre of the culvert allowing work in the dry on one side and permit bypass flow along the other side. Since the existing culvert is a closed SPCSPA, a gravity type cofferdam (i.e. sand bag or other sufficiently narrow gravity cofferdam system) could be used

along the center of the culvert to control flow to one side. Considering the corrugated cross section of the existing culvert, a seal (i.e. bentonite seal) would likely be required between the gravity cofferdam and existing culvert, for the dam to effectively contain water. A sheet pile wall fixed to the interior of the existing culvert could also be considered. Another option would be to use a small diameter bypass culvert/pipe inside, and located to one side, to allow bypass pumping through one half of the existing culvert while work is carried out on the opposite side.

As previously noted, a beaver dam is present a short distance upstream of the culvert. Due to safety concerns, associated with a breach in the beaver dam at the time of construction, a complete cofferdam at the inlet and outlet with bypass pumping through a temporary bypass pipe installed through the existing embankment is the preferred method of bypassing flow.

Considering the hydrostatic pressure associated with a 2 m head of water, a temporary gravity type or sheet pile type cofferdam would be appropriate at this location. To resist the 2 m hydrostatic pressure, a circular sheet pile wall will attain structural stability from its geometry and depth of penetration of the sheets, therefore may require minimal interior bracing. To minimize seepage below the cofferdam, the sheets should extend to a depth below the inside base equal to the depth of water above the base. It is likely that the depth of sheet penetration will be controlled by structural considerations and not seepage.

If a gravity type cofferdam (earth fill with a low permeable core) is considered, environmental constraints will control, specifically since this is a fish sanctuary. As such, a sand bag/metre bag or auquadam type dam may have to be used to minimize the risk of earth fines increasing the turbidity of the natural water course. Depending upon the base width of the cofferdam seepage may develop below the temporary sand bag wall, specifically close to the existing embankment slope where a sand deposit, some 1.5 m deep, was present overlying the lower permeable silt stratum. This may require pumping from filtered sumps within the dewater area.

Conceptual cofferdam sketches have been included in Appendix 3.

As noted above the beaver dam, located some 20 m upstream is holding back some 1 m head of water. Whichever type of cofferdam system is constructed, the cofferdam capacity must be sufficient to accommodate an increased sudden flow should the beaver dam be breached.

4 STATEMENT OF LIMITATIONS

The design recommendations given in this geotechnical report are applicable only to the project described in the text and only if constructed substantially in accordance with details of alignment and elevations stated in the report. Since all details of the design may not be known, in our analysis certain assumptions had to be made. The actual conditions may however, vary from those assumed, in which case changes and modifications may be required to our geotechnical recommendations. We recommend, therefore, that we be retained and provided the opportunity during the design stage to review the design drawings, site survey information, proposed elevations, etc. to verify that they are consistent with our recommendations or the assumptions made in our analysis. It is further recommended that we be retained to review the final design drawings and specifications relative to the geotechnical recommendations.

If, during construction, conditions in the field vary from those assumed at the design stage, an engineer from this office must be notified immediately.

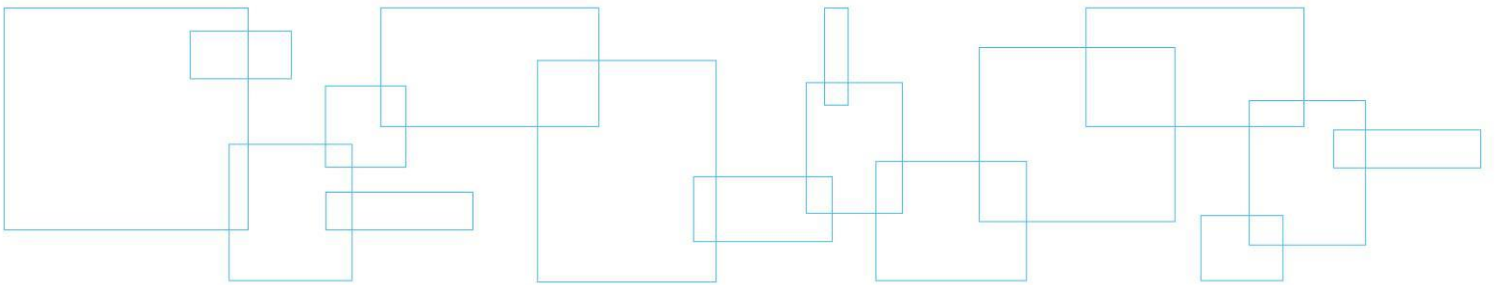
Proper subgrade preparation, groundwater control, compaction, etc. are all critical aspects of the bearing capacity of native soils. It must be noted that different aspects of the geotechnical design are based on the assumption that LVM | MERLEX will be retained during site preparation and construction of the proposed works to ensure that both the geotechnical site characteristics and the construction operations/techniques are consistent with our recommendations. Should LVM | MERLEX not be involved during the full construction phase, our liability is strictly limited to the factual information contained herein only.

Section 3 of this reported is intended for the use of the client and the design team only and is not intended to be included in the tender documents. Inclusion of the factual information (Sections 1 to 5 inclusive) in the tender documents is furnished merely for the general information of bidders and is not in any way warranted or guaranteed by or on behalf of the owner or the owner's consultants and its subconsultants or the consultants' or subconsultants' employees, and neither the owner nor its consultants or its employees shall be liable for any representations negligent or otherwise contained in the documents.

Appendix 1 Photo Essay

Enclosure No. 1:

Photo Essay



Culvert Inlet – Looking North

Photo: 1



Culvert Outlet – Looking South

Photo: 2



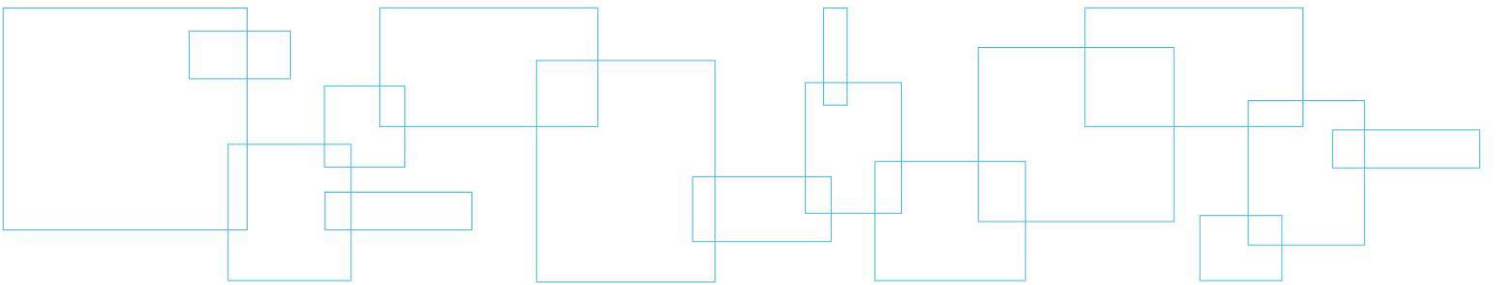
Project: Hwy 66 – Crooked Creek Culvert

Photos Provided By: LVM

Date: July 2013

Appendix 2 Historic Data

Shaheen and Peaker 2007 Borehole Data and Location Plan



NOTES:
FOR DETAILED SUBSURFACE CONDITIONS
REFER TO RECORD OF BOREHOLE SHEETS.

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
ARE IN KILOMETRES + METRES.

CONT No.
GWP: 448-98-00
Hwy 66- Crooked Creek Culvert
Town of Eby, ON
BOREHOLE LOCATIONS



SHAHEEN & PEAKER LIMITED



KEY PLAN
N.T.S

LEGEND

Borehole

No.	ELEV.	CO-ORDINATES	
		NORTH	EAST
C1	299.4	5322594.0	361406.8
C2	300.0	5322554.7	361411.1
C3	301.3	5322580.7	361412.3
D1	300.0	5322690.4	361499.9
D2	300.1	5322657.2	361469.5
D3	299.9	5322621.6	361434.2
D4	298.9	5322542.8	361362.0
D5	299.8	5322507.4	361329.5
S1	301.5	5322556.3	361390.2
S2	301.2	5322600.8	361434.9

NOTE

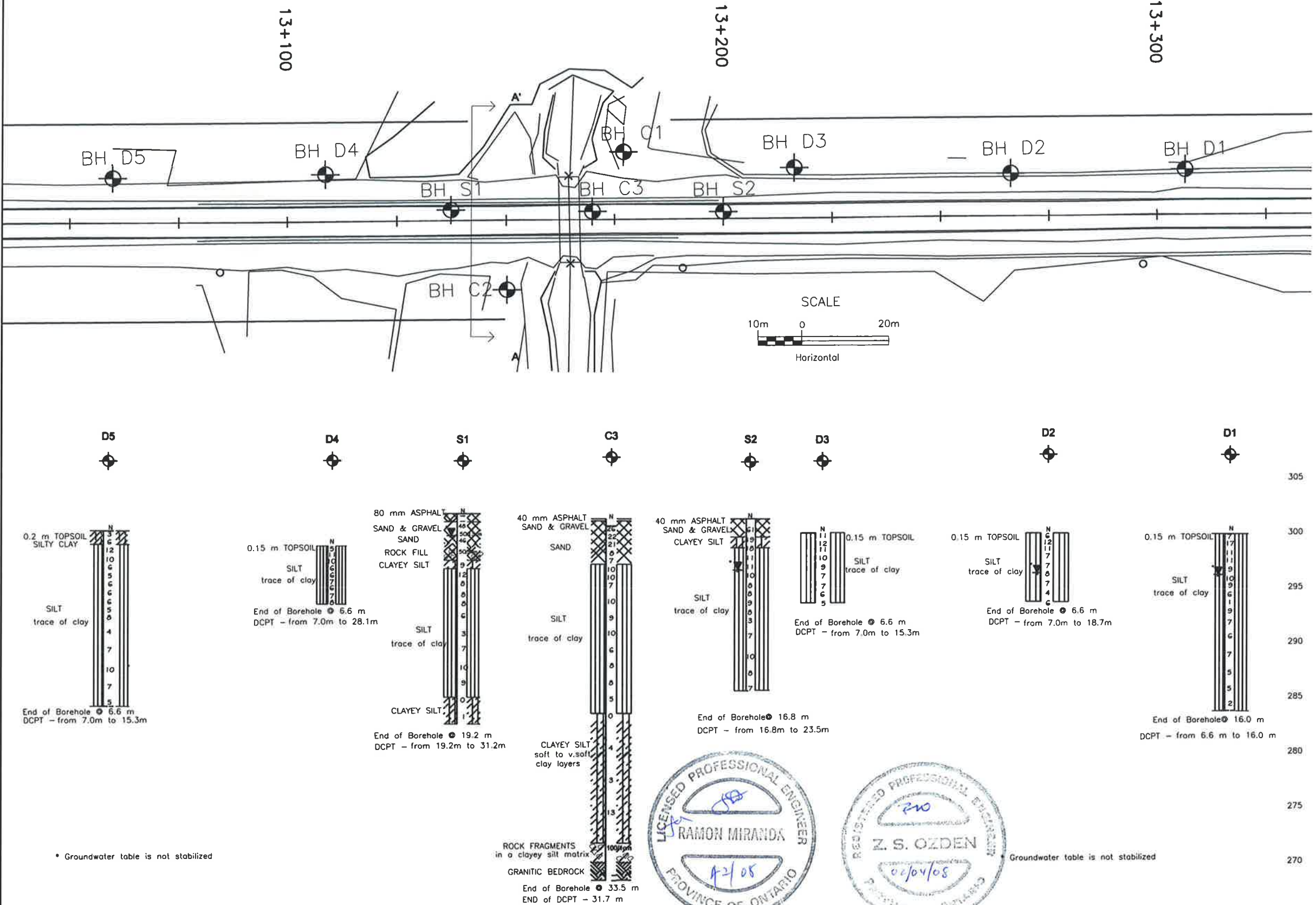
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

REV.	DATE	BY	DESCRIPTION

Geocres No. 42A - 71

SPT 1201			DIST
SUBM'D	CHECKED	DATE Jan, 2008	SITE
DRAWN GR	CHECKED RM	APPROVED ZO	DWG 2



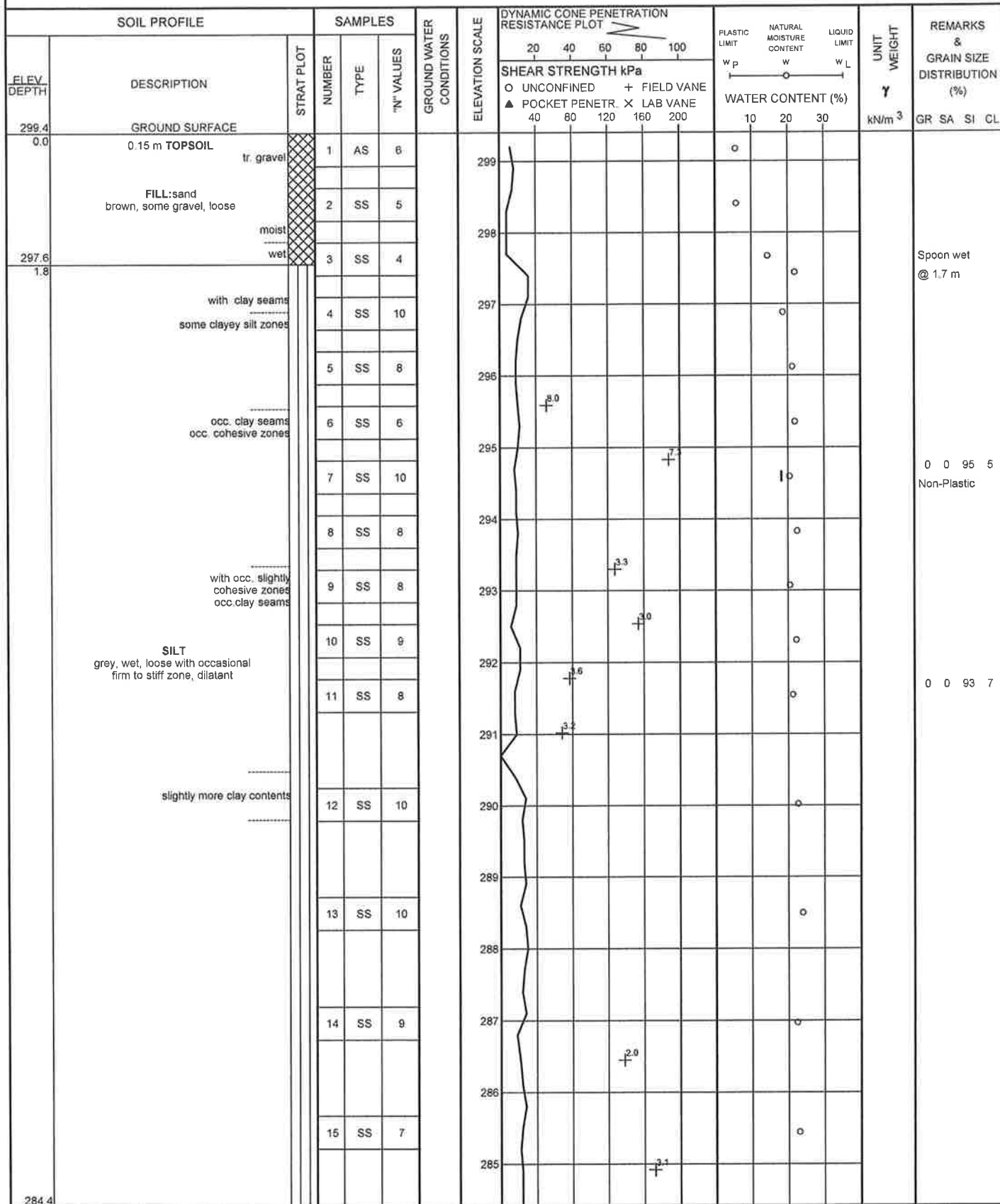
SPT 1201

RECORD OF BOREHOLE No C1

1 OF 2

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+176 14.5 m Lt C/L ORIGINATED BY ZI
DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger & N-type Wash Boring & NQ Coring COMPILED BY GR
DATUM Geodetic DATE 10/3/2007 10/11/2007 CHECKED BY ZO



Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

SPT 1201

2 OF 2

METRIC

+³, ×³: Numbers refer to Sensitivity

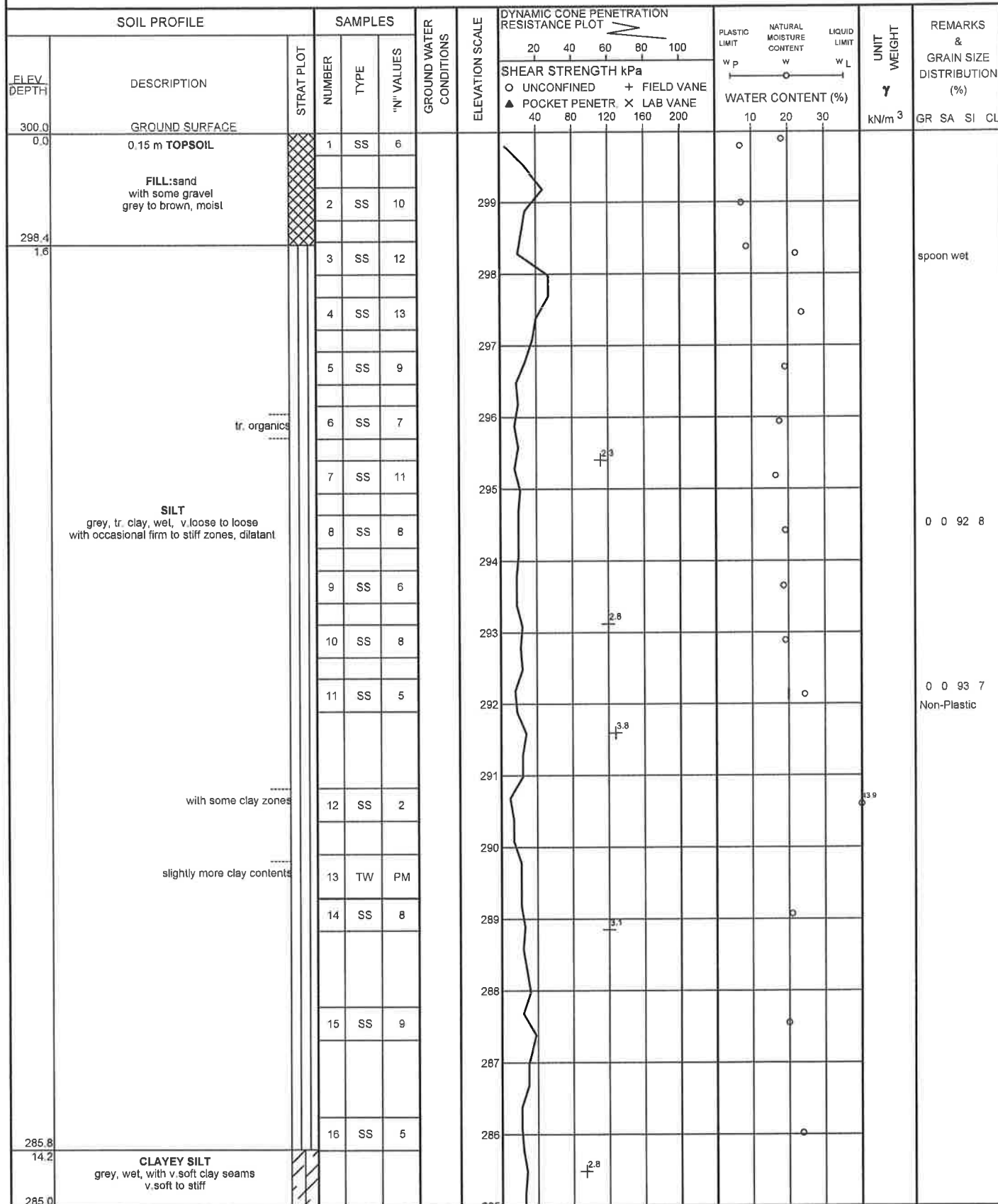
SPT 1201

RECORD OF BOREHOLE No C2

1 OF 3

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+150 15 m Rt C/L ORIGINATED BY ZI
DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger & N-type Wash Boring & NQ Coring COMPILED BY GR
DATUM Geodetic DATE 10/25/2007 10/28/2007 CHECKED BY ZO



Continued Next Page

+ 3, X 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

SPT 1201

2 OF 3

METRIC

GWP <u>448-98-00</u>		LOCATION <u>Crooked Creek Culvert - Sta. 13+150 15 m Rt C/L</u>	ORIGINATED BY <u>ZI</u>
DIST <u> </u>	HWY <u>66</u>	BOREHOLE TYPE <u>Hollow Stem Auger & N-type Wash Boring & NQ Coring</u>	COMPILED BY <u>GR</u>
DATUM <u>Geodetic</u>	DATE <u>10/25/2007</u>	<u>10/28/2007</u>	CHECKED BY <u>ZO</u>

[illegible]

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

SPT 1201

3 OF 3

METRIC

GWP <u>448-98-00</u>		LOCATION <u>Crooked Creek Culvert - Sta. 13+150 15 m Rt C/L</u>	ORIGINATED BY <u>ZI</u>
DIST <u> </u>	HWY <u>66</u>	BOREHOLE TYPE <u>Hollow Stem Auger & N-type Wash Boring & NQ Coring</u>	COMPILED BY <u>GR</u>
DATUM <u>Geodetic</u>	DATE <u>10/25/2007</u>	<u>10/28/2007</u>	CHECKED BY <u>ZO</u>

[illegible]

$+^3, \times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

SPT 1201

1 OF 3

METRIC

GWP	448-98-00	LOCATION	Crooked Creek Culvert - Sta. 13+170 1.5 m Lt C/L	ORIGINATED BY	
DIST		HWY	66	BOREHOLE TYPE	Hollow Stem Auger & NQ Coring
DATUM	Geodetic	DATE	10/11/2007 10/14/2007	CHECKED BY	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa				
301.3 0.0	GROUND SURFACE		1	AS							
	40 mm ASPHALT		2	AS							
300.5 0.8	0.18 m SAND & GRAVEL grey to brown, moist		3	SS	26						
	0.57 m SAND grey to brown, moist		4	SS	22						
		tr. gravel	5	SS	21						
		some gravel	6	SS	8						
	FILL:sand brown, moist	compact	7	SS	7						
		loose	8	SS	10						
297.0 4.3			9	SS	10						
			10	SS	7						
	SILT grey, trace of clay, wet, dilatant loose with occasional firm to stiff zones		11	SS	10						
			12	SS	9						
		slightly more clay contents	13	TW	PM						
			14	SS	10						
			15	SS	6						
		with occ. clay zones	16	SS	8						
286.3											

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$+^3, \times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

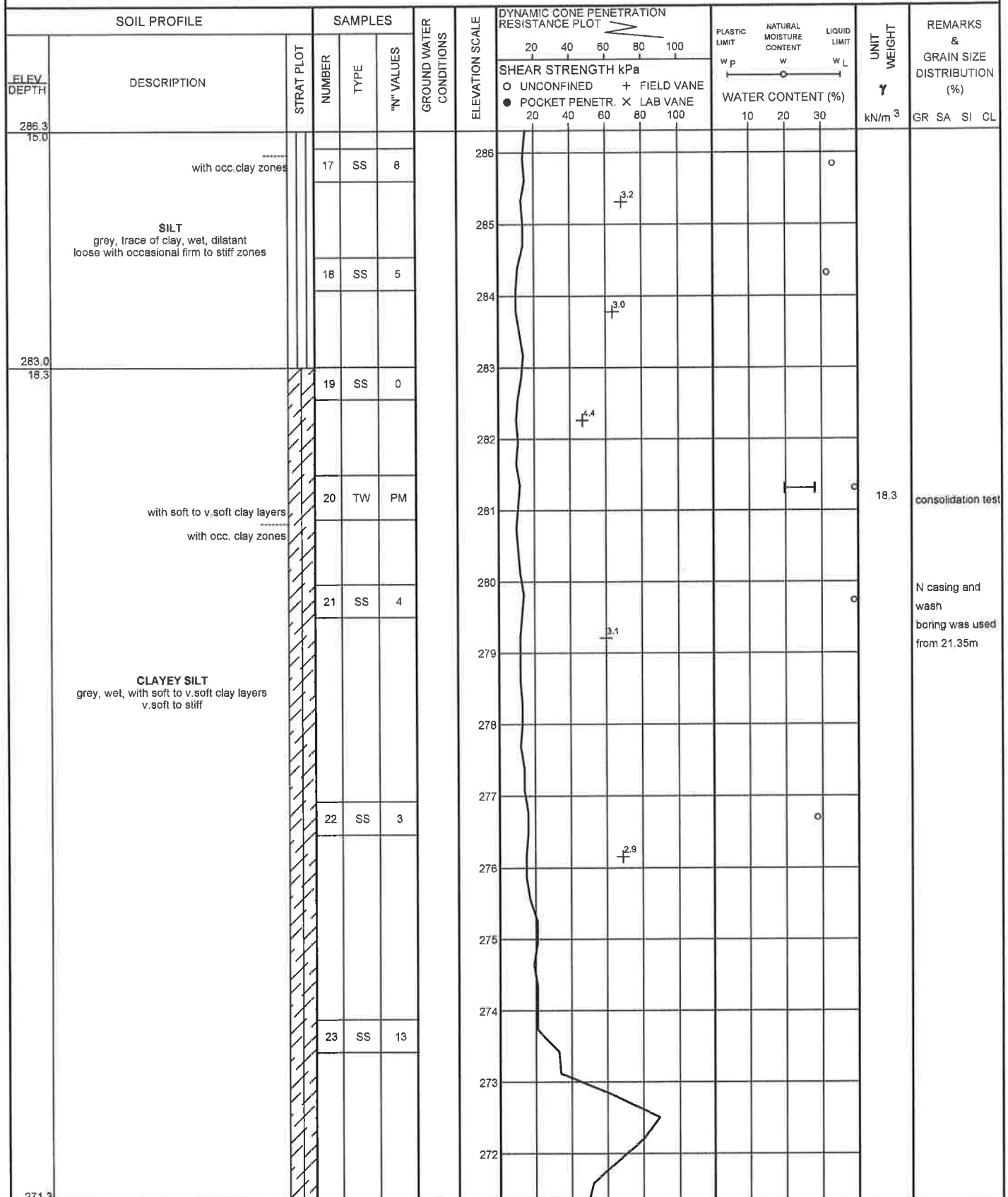
SPT 1201

RECORD OF BOREHOLE No C3

2 OF 3

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+170 1.5 m Lt C/L ORIGINATED BY
DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger & NQ Coring COMPILED BY
DATUM Geodetic DATE 10/11/2007 10/14/2007 CHECKED BY



Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

SPT 1201

RECORD OF BOREHOLE No C3

3 OF 3

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+170 1.5 m Lt C/L ORIGINATED BY _____
 DIST _____ HWY 66 BOREHOLE TYPE Hollow Stem Auger & NQ Coring COMPILED BY _____
 DATUM Geodetic DATE 10/11/2007 10/14/2007 CHECKED BY _____

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20					
271.3 30.0	CLAYEY SILT grey, wet		24	CC	100/100								100/7.6cm DCPT
270.8 30.5			25	RC	TCR=32% RQD=0%								
269.6 31.7	ROCK FRAGMENTS in a clayey silt matrix	26	RC	TCR=48% RQD=0%									
267.8 33.5	GRANITIC BEDROCK pink foliated	27	RC	TCR = 100% RQD = 100%									
End of Borehole Water level in Borehole Oct 12, 2007 - 13.1 m Oct 15, 2007 - 4.0 m End of DCPT - 31.7 m (El. 269.6 m)													

+³, X³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

SPT 1201

RECORD OF BOREHOLE No D1

1 OF 2

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+310 11 m Lt C/L / Sta 13+308 14 m Lt C/L ORIGINATED BY ZI
DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GR
DATUM Geodetic DATE 10/15/2007 10/29/2007 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
300.0	GROUND SURFACE												
0.0	0.15 m TOPSOIL		1	SS	7								
			2	SS	17								
			3	SS	11								
	grey to brown		4	SS	11								
	grey		5	SS	9								
			6	SS	10								
			7	SS	9								
			8	SS	6								
			9	SS	1								
	occ. clay seams		10	SS	9								
	SILT wet, dilatant loose to compact		11	SS	7								
			12	SS	6								
			13	SS	7								
			14	SS	5								
			15	SS	5								
285.0													

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

SPT 1201

RECORD OF BOREHOLE No D1

2 OF 2

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+310 11 m Lt C/L / Sta 13+308 14 m Lt C/L ORIGINATED BY ZI
 DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GR
 DATUM Geodetic DATE 10/15/2007 10/29/2007 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
285.0 15.0	occ. clay seams		16	SS	2		285					45.8	
284.0 16.0	SILT wet, dilatant												
	End of Borehole @ 6.6 m on Oct 16, 2007 Water level in borehole - 3.7m upon completion Borehole was moved and redrilled to 15.7 m on Oct 29, 2007												

+³, ×³: Numbers refer to
Sensitivity

20
15
10
5
(%) STRAIN AT FAILURE

SPT 1201

1 OF 2

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+265 11 m Lt C/L ORIGINATED BY ZI
 DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GR
 DATUM Geodetic DATE 10/16/2007 CHECKED BY ZO

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

SPT 1201

2 OF 2

METRIC

GWP	448-98-00	LOCATION	Crooked Creek Culvert - Sta. 13+265 11 m Lt C/L	ORIGINATED BY	ZI
DIST	HWY 66	BOREHOLE TYPE	Hollow Stem Auger	COMPILED BY	GR
DATUM	Geodetic	DATE	10/16/2007	CHECKED BY	ZO

+³, ×³: Numbers refer to Sensitivity

SPT 1201

RECORD OF BOREHOLE No D3

1 OF 2

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+215 13 m Lt C/L ORIGINATED BY ZI
DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GR
DATUM Geodetic DATE 10/16/2007 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
299.9 0.0	GROUND SURFACE												
	0.15 m TOPSOIL		1	SS	11								
	moist / brown wet / grey		2	SS	12		299						
			3	SS	11		298						
			4	SS	10		297						
	SILT dilatant, loose to compact		5	SS	9		296						
			6	SS	7		295						
			7	SS	7		294						
			8	SS	6		293						
293.3 6.8	End of Borehole @6.6m		9	SS	5		292						
							291						
							290						
							289						
							288						
							287						
							286						
							285						

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

SPT 1201

RECORD OF BOREHOLE No D3

2 OF 2

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+215 13 m LI C/L ORIGINATED BY ZI
DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GR
DATUM Geodetic DATE 10/16/2007 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _P	W	W _L		
284.9																	
284.6																	
15.3	End of Borehole @6.6m Borehole dry upon completion (not stabilized) DCPT was performed from 7.0 m to 15.3 m						284										

+³, X³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

SPT 1201

RECORD OF BOREHOLE No D4

1 OF 2

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+108 13 m Lt C/L ORIGINATED BY ZI
DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GR
DATUM Geodetic DATE 10/17/2007 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	W _P W W _L	WATER CONTENT (%)				
298.9 0.0	GROUND SURFACE													
	0.15 m TOPSOIL		1	SS	5									
			2	SS	11		298							0 2 91 7
			3	SS	10		297							
		brown grey	4	SS	6		296							0 2 92 6
	SILT trace of clay, wet, dilatant		5	SS	6		295							no recovery
			6	SS	7		294							
			7	SS	6		293							
			8	SS	7		292							
292.3 6.6	End of Borehole @6.6m		9	SS	8		291							no recovery
							290							
							289							
							288							
							287							
							286							
							285							
							284							

Continued Next Page

+ 3 . X 3: Numbers refer to
Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

SPT 1201

RECORD OF BOREHOLE No D4

2 OF 2

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+108 13 m Lt C/L ORIGINATED BY ZI
 DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GR
 DATUM Geodetic DATE 10/17/2007 CHECKED BY ZO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
283.9												
283												
282												
281												
280												
279												
278												
277												
276												
275												
274												
273												
272												
271												
270.4												
28.5	End of Borehole @6.6m DCPT was performed from 7.0 m to 28.1 m											100/6cm DCPT

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

SPT 1201

RECORD OF BOREHOLE No D5

1 OF 2

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta 13+060 13 m Lt C/L / Sta 13+062 13 m Lt C/L ORIGINATED BY ZI
 DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GR
 DATUM Geodetic DATE 10/16/2007 10/29/2007 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
299.8 0.0	GROUND SURFACE							20 40 60 80 100						
	0.2 m TOPSOIL		1	SS	3			40 80 120 160 200						
	SILTY CLAY brown, moist, soft to firm		2	SS	6		299							
298.6 1.2			3	SS	12		298							
		brown ----- grey	4	SS	10		297							
			5	SS	6									no recovery
			6	SS	5		296	3.4						
			7	SS	6		295	3.3						
			8	SS	6			3.5						no recovery
			9	SS	6		294	2.8						
			10	SS	5		293	3.1						
			11	SS	8		292	3.4						
							291	3.5						
		tr. clay	12	SS	4		290	3.4						
							289	3.7						
			13	SS	7		288							
							287							
			14	SS	10		286							
							285	3.5						
284.8		tr. clay	15	SS	7									

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

SPT 1201

RECORD OF BOREHOLE No D5

2 OF 2

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+060 13 m Lt C/L / Sta 13+062 13 m Lt C/L ORIGINATED BY ZI
DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GR
DATUM Geodetic DATE 10/16/2007 10/29/2007 CHECKED BY ZO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa	WATER CONTENT (%)	W _p	W		
284.8 15.0	SILT trace of clay, wet loose to compact, dilatent		16	SS	5		20 40 60 80 100	20 40 60 80 100	10 20 30				
284.1 15.7							○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE						
End of Borehole @ 6.6 m - Oct 16, 2007 DCPT was performed from 7.0m to 15.3m - Oct 16, 2007 Borehole moved and redrilled from 7.2 m to 15.7 m - Oct 29, 2007						284	3.6						

+³, X³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

SPT 1201

RECORD OF BOREHOLE No S1

1 OF 3

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+137 1.4 m Lt C/L ORIGINATED BY ZI
DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger & N-type Wash Boring COMPILED BY GR
DATUM Geodetic DATE 10/2/2007 10/4/2007 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
FLYV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	40 80 120 160 200	W _p W W _L	WATER CONTENT (%)		
301.5	GROUND SURFACE												
0.0	80mm ASPHALT		1	AS	---		301						
300.8	0.19 m SAND & GRAVEL		2	AS	---								
0.8	brown, moist												
	0.48 m SAND		3	SS	48								
	brown to grey, trace of gravel, moist												
	FILL:sand		4	SS	50/13cm		300						
	brown, trace of gravel												
298.8			5	SS	46		299						
2.8	FILL:sandy gravel												
298.4	brown, wet		6	SS	60/3cm								
3.1							298						
	FILL:rock		7	RC									
	granite, with some sand & gravel												
297.2							297						
4.3	CLAYEY SILT		8	SS	9								
	with some peat, trace of rootlets												
296.5	trace of sand, with some gravel, wet						296						
5.0			9	SS	12								
			10	SS	8		295						
			11	SS	8								
							294						
			12	SS	8								
							293						
			13	SS	6		292						
							291						
			14	SS	3								
							290						
			15	SS	7		289						
							288						
			16	SS	10								
							287						
286.5													

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

SPT 1201

2 OF 3

METRIC

GWP	448-98-00	LOCATION	Crooked Creek Culvert - Sta. 13+137 1.4 m Lt C/L	ORIGINATED BY	ZI
DIST	HWY 66	BOREHOLE TYPE	Hollow Stem Auger & N-type Wash Boring	COMPILED BY	GR
DATUM	Geodetic	DATE	10/2/2007 10/4/2007	CHECKED BY	ZO

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

SPT 1201

RECORD OF BOREHOLE No S1

3 OF 3

METRIC

GWP 448-98-00 LOCATION Crooked Creek Culvert - Sta. 13+137 1.4 m Lt C/L ORIGINATED BY ZI
 DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger & N-type Wash Boring COMPILED BY GR
 DATUM Geodetic DATE 10/2/2007 10/4/2007 CHECKED BY ZO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100	20 40 60 80 100	W _P W W _L	10 20 30		
271.5													
270.3						271							
31.2	End of Borehole @ 19.2 m DCPT was performed from 19.2 m to 31.2 m Water level in Borehole Oct 02, 2007 - 3.2 m Oct 03, 2007 - 1.8 m												100/5cm DCPT

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

SPT 1201

1 OF 2

METRIC

+³, ×³: Numbers refer to Sensitivity

SPT 1201

RECORD OF BOREHOLE No S2

2 OF 2

METRIC

GWP 446-98-00 LOCATION Crooked Creek Culvert - Sta. 13+200 1.5 m Lt C/L ORIGINATED BY ZI
DIST HWY 66 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GR
DATUM Geodetic DATE 10/14/2007 CHECKED BY ZO

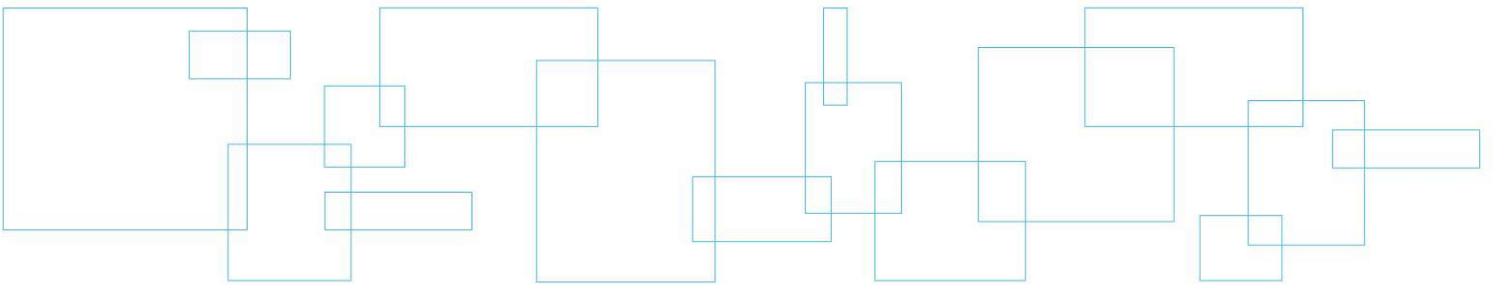
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
286.2 15.0	SILT trace of clay, wet, dilatant loose to compact with occasional firm to stiff zones		15	SS	7	286	○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE	20 40 60 80 100	10 20 30				
285.5 15.7							285	284	283	282	281	280	279
277.7 23.5	End of Borehole @ 16.8 m DCPT was performed from 16.8 m to 23.5 m * Water level @ 4.3 m upon completion (not stabilized)											100/2.5cm DCPT	

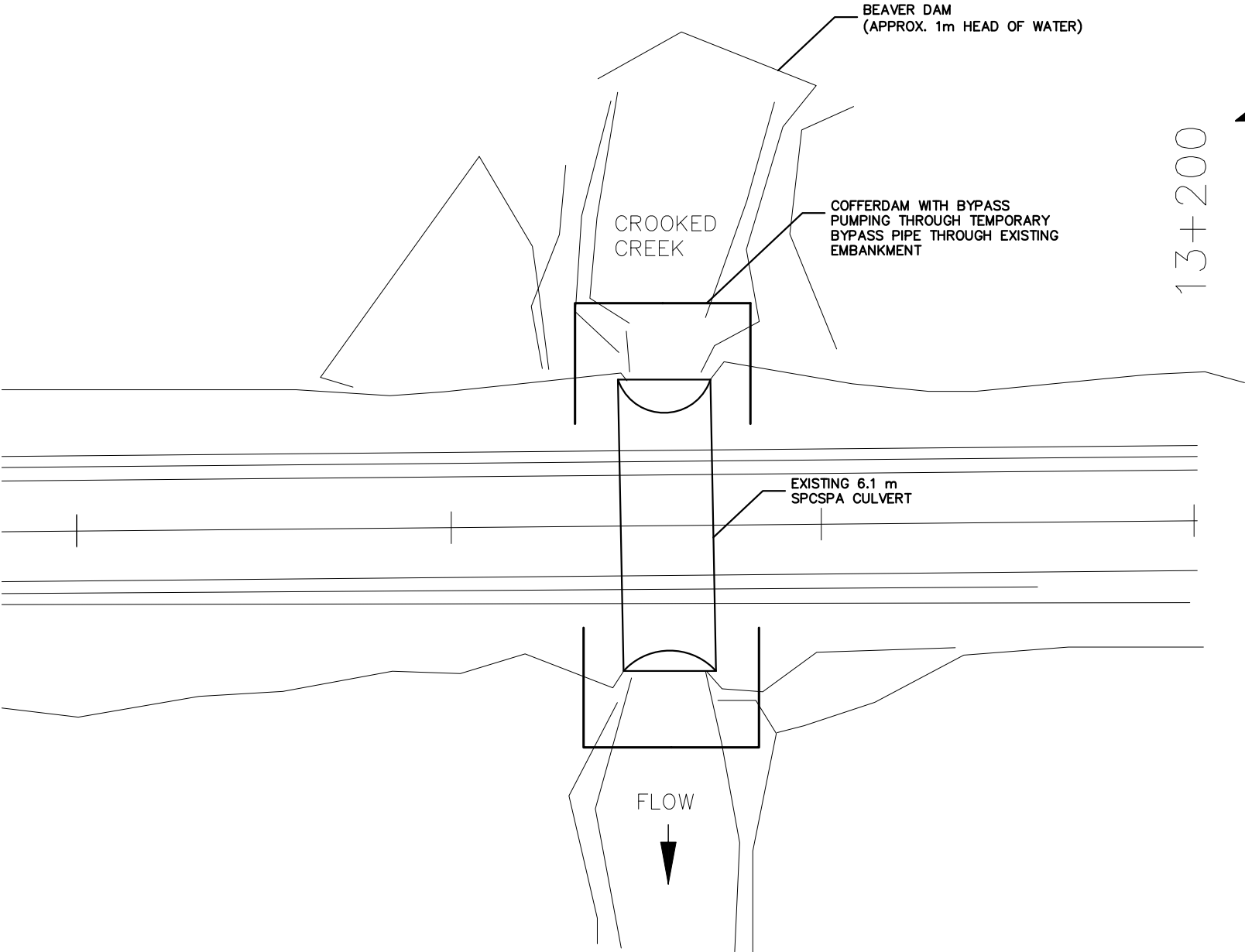
+³, X³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

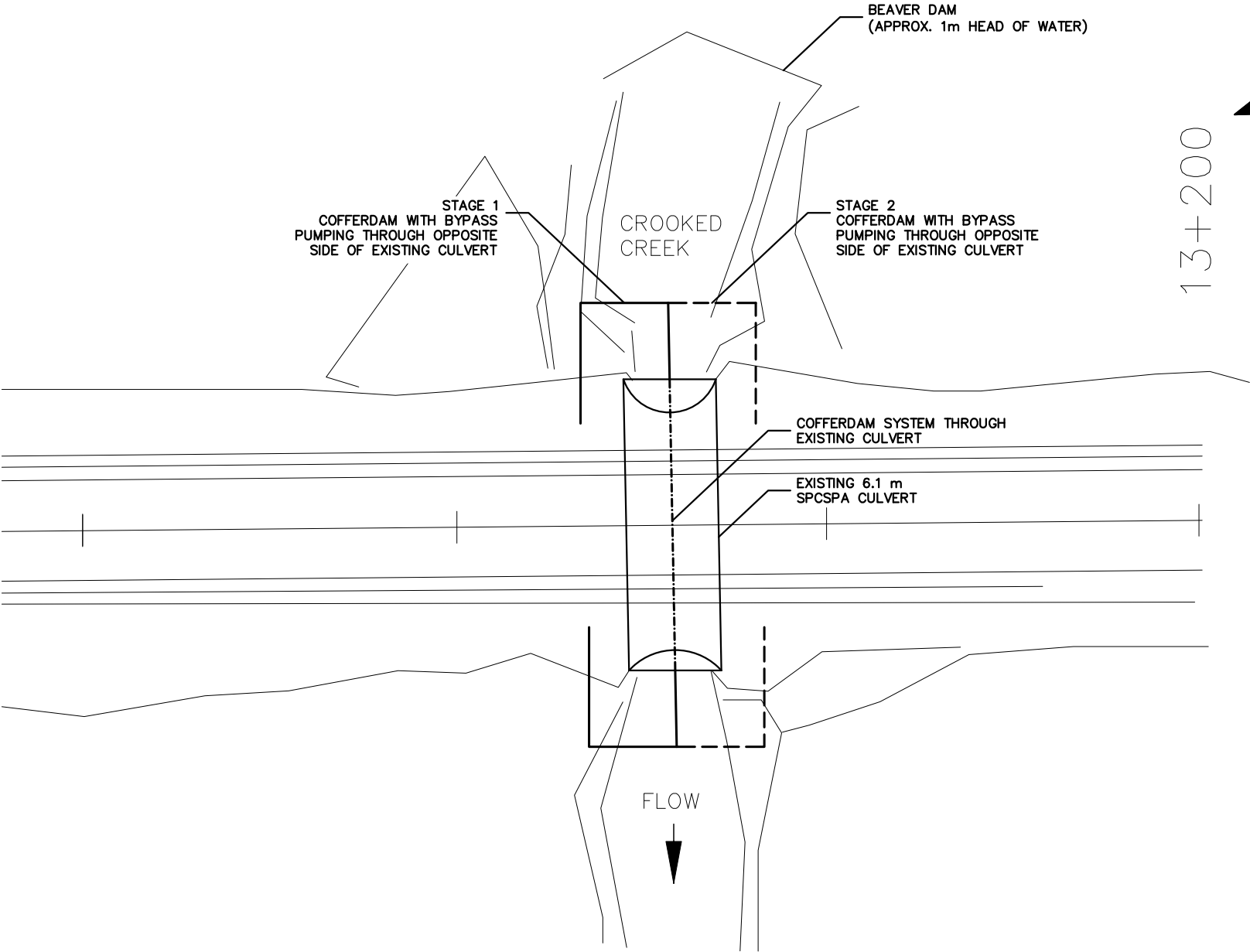
Appendix 3 Design Data

Sketch Nos. 1 and 2: Conceptual Cofferdam Sketch





Not to Scale



Not to Scale