APPENDIX A

Soils Investigation Report

GEOTECHNICAL INVESTIGATION AND ENGINEERING REPORT FOR FERMOR AVENUE OUTFALL MAGER COMBINED SEWER DISTRICT SEWER SEPARATION WINNIPEG, MANITOBA

Prepared for
STANTEC
905 WAVERLEY STREET
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Prepared by
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December 7, 2010

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1.0 SUMMARY

The National Testing Laboratories Limited was retained to undertake a geotechnical investigation and conduct a slope stability analysis for a proposed LDS pipe outfall. The proposed alignment for the LDS pipe runs north of Fermor Avenue west of the Seine River. The outfall will be located approximately 10 m downstream of the existing pedestrian bridge over the Seine River. A site inspection was conducted on August 17, 2010 and a testhole was drilled on September 1 and 2, 2010. The geotechnical investigation revealed a general soil profile of topsoil underlain by clay and silt till. A silt layer was encountered at a shallow depth within the clay in the testhole. A stability analysis of the existing riverbank was undertaken and the analysis indicates the Factor of Safety against slope failure at the location of the proposed outfall is 1.4. Provided the recommendations in this report are followed, we endorse the proposed outfall construction and recommend a waterway permit be granted for this project.

2.0 TERMS OF REFERENCE

The National Testing Laboratories Limited was retained to undertake a geotechnical investigation and conduct a slope stability analysis for a proposed LDS pipe outfall on the Seine River. The scope of work for this project was outlined in an email provided to Hartley Katz on August 30, 2010.

3.0 PROJECT SITE

The LDS pipe will be installed north of Fermor Avenue west of the Seine River. The outfall will be located approximately 10 m downstream of the existing pedestrian bridge over the Seine River The proposed alignment for the LDS pipe and outfall are shown on the Testhole Location Plan provided in Appendix A. A topographical survey of the project site is provided in Appendix B.

4.0 SITE INSPECTION

Our geotechnical personnel conducted a site inspection on August 17, 2010. It was noted that the outfall will be located on an outside bend of the Seine River. The geometry of the riverbank near the outfall location consists of a very gently sloping upper bank at an elevation between 228.5 m and 229.0 m, and a lower bank with a slope of approximately 6H:1V. The elevation at the toe of the slope in the Seine River is approximately 224.5 m. No signs of significant previous slope movement were observed in the riverbank. Photographs of the riverbank at the proposed outfall location are provided in Appendix C.

5.0 GEOTECHNICAL INVESTIGATION

5.1 Testhole Drilling and Soil Sampling

The subsurface drilling and sampling program was conducted on September 1 and 2, 2010 with drilling services provided by Maple Leaf Enterprises Ltd. under the supervision of our geotechnical field personnel. One testhole (TH1) was drilled near the proposed outfall alignment at the location shown on the Testhole Location Plan provided in Appendix A. The testhole was drilled using a B20 Cricket skid-mounted drill rig equipped with 100 mm diameter solid stem augers. Due to mechanical problems with the drill rig, drilling of the testhole was completed on September 2. The testhole was drilled to auger refusal which was encountered on suspected boulders within the silt till at a depth of 14.6 m.

Representative soil samples were obtained directly off the augers at depth intervals ranging from 0.2 to 1.5 m. Upon completion of drilling, the testhole was examined for evidence of sloughing and groundwater seepage. The testhole was backfilled with auger cuttings and bentonite. The samples were visually classified in the field and returned to our soils laboratory for additional examination and testing.

5.2 Laboratory Testing

Water content and torvane tests were conducted on soil samples recovered from the testhole and the test results are shown on the testhole log provided in Appendix D. Two soil samples were selected for Atterberg limits testing and particle size analysis and the results are summarized in the following table.

Testhole ID	Depth (m)	Soil Type	Particle Size				Atterberg Limits		
			Gravel (%) 75 to 4.75 mm	Sand (%) <4.75 to 0.075 mm	Silt (%) <0.075 to 0.005 mm	Clay (%) <0.005mm	Liquid Limit	Plastic Limit	Plasticity Index
TH1	2.3	clay	0	0.3	1.4	98.3	102	26	76
TH1	7.6	clay	0	2.4	7.7	89.9	87	28	59

6.0 SUBSURFACE CONDITIONS

6.1 Soil Profile

The general soil stratigraphy at the site, as interpreted from the testhole log, consists of topsoil underlain by clay and silt till. A silt layer was encountered at a shallow depth within the clay.

Topsoil

Topsoil was encountered at the surface of the testhole. The topsoil layer was approximately 100 mm in thickness.

Clay

Clay was encountered beneath the topsoil. The clay varied in colour from black to brown to grey, was moist, and of high plasticity. Based on torvane readings obtained on samples recovered from the testhole, the strength of the clay decreases with increasing depth. Water contents of the clay ranged from 41 to 57%.

Silt

A layer of silt approximately 150 mm thick was encountered in the testhole below a depth of 0.45 m. The silt was tan, soft, moist, clayey, and of low plasticity. Water content of the silt was determined to be 38%.

Silt Till

Silt till was encountered beneath the clay at a depth of 12.8 m. Auger refusal was encountered within the silt till on suspected boulders at a depth of 14.6 m. The silt till was tan, dense, moist, and of low plasticity. Water contents of the silt till ranged from 13 to 19%.

6.2 Groundwater

No groundwater seepage or soil sloughing was observed during or upon completion of drilling. It should be noted that only short-term seepage and sloughing conditions were observed during the field-drilling program and that groundwater levels will normally fluctuate during the year and will be dependent upon precipitation, surface drainage, and the water level in the Seine River.

7.0 STABILITY ANALYSIS

A slope stability analysis for the existing riverbank profile was undertaken with the assistance of the computer model Slope/W, developed by GeoSlope. The stability analysis used the Morgenstern-Price generalized limit equilibrium solution with constant interslice force inclination. The Morgenstern-Price method simultaneously solves for force and moment equilibrium, and is considered to be the current industry state of practice. The computer model investigates a large number of potential failure surfaces and presents the results in the form of contours of computed Factor of Safety (FS) against sliding. The soil parameters used in this analysis are shown in the table below.

Soil Type	Unit Weight	Φ'	Effective Cohesion
Clay	17.5 kN/m^3	14°	4 kPa
Till	-	-	-

The soil parameters used in the analysis are considered reasonable estimates for Winnipeg lacustrine clays where no previous bank movements have occurred. This section of riverbank lies on an outside bend of the Seine River and our site inspection confirmed there has been no significant riverbank movement at the outfall location. The presence of lacustrine clay deposits is consistent with the anticipated stratigraphy of an outside bend of the river. The impact of the thin silt layer is considered negligible and was not included in the model for stability analysis. Additionally, overall strength provided by the silt layer would be higher than that of the clay, therefore any impact the silt layer would have on the overall bank stability would tend to increase the computed factor of safety. The till layer was modeled as impenetrable in the stability analysis. The LDS pipe and outfall were not included in the model as they are considered to have negligible impact on overall riverbank stability.

Two main seasonal scenarios were considered in the stability analyses. These include the river at summer level (elevation of 225.5 m) and at winter level (elevation of 225.0 m). The groundwater levels were assumed to be at ground surface, which represent a worst case scenario for bank stability. A summary of the two cases considered for the stability analysis is shown in the table below.

Scenario	Seine River Water Elevation	Estimated Factor of Safety
Summer	225.5 m	1.5
Winter	225.0 m	1.4

A minimum factor of safety of 1.4 is considered acceptable for construction of the proposed outfall. Based upon the modelled riverbank geometry, the soil shear strength parameters and the Seine River water levels, the estimated Factors of Safety for the critical slip surfaces are 1.5 for summer conditions and 1.4 for winter conditions. For both summer and winter conditions, the modeled critical failure surface viewed through a cross section of the riverbank begins near the top of the relatively flat upper bank area. Results of the slope stability analysis indicate the critical failure surface will intersect the top of the riverbank approximately 20 to 25 m from the Seine River. The critical failure surface extends along a concave-up arc towards the river and exits near the deepest point of the Seine River. Outputs from the stability analysis showing the critical failure surface are provided in Appendix E.

8.0 DISCUSSION AND RECOMMENDATIONS

The outfall will be located on the outside bend of the Seine River and consequently, this area of the riverbank will be subject to erosion. Although there is no evidence of slope failure at the proposed outfall location and the minimum computed Factor of Safety against slope failure for the existing riverbank is 1.4, erosion of the riverbank may reduce the slope stability in the future. The significant capital expenditures required to increase the stability of the riverbank are not justified where the risk of riverbank movement is low and the riverbank movement will only jeopardize the outfall. To accommodate potential riverbank movements and reduce the risk of pipe failure, it is recommended that a slip joint be provided at the location where the critical failure surface is expected to intercept the LDS pipe. Based upon the slope stability analysis, the critical failure surface intersects the top of the riverbank approximately 20 to 25 m from the Seine River. The recommended location for the slip joint for the LDS pipe is 7.5 m east of the manhole and is shown on the Testhole Location Plan provided in Appendix A. The slip joint design drawings provided by Stantec are provided in Appendix F.

The outfall pipe should conform to the existing bank geometry to reduce potential erosion of the riverbank adjacent to the outfall. Installation of riprap at the discharge point and on either side of the outfall is recommended to minimize erosion of the riverbank. It is also recommended that the riprap be extended to the pedestrian bridge located approximately 10 m upstream of the proposed outfall location.

Installation of the LDS pipe and outfall will not have any significant impact on the stability of the riverbank if appropriate precautions are taken during construction. It is our understanding the LDS pipe will be constructed by trenchless methods and the outfall will be constructed by open cut. Backfill of the open cut excavation has been proposed at a 10:1 slope over the pipe along an area extending approximately 2 m on either side of the pipe. Natural irregularities within this section of slope will be leveled which may require addition of some fill to the bank. Based on our review of the existing riverbank geometry and the relatively small area affected, the amount of fill required to obtain a 10:1 slope is minor and the impact to the stability is considered negligible. Materials excavated for the LDS pipe and outfall should be removed from the riverbank area immediately, excavated materials should not be stockpiled near the top of the riverbank. Backfill materials that may be required for construction should be stockpiled at least 20 m from the top of the riverbank. Trees can improve the stability of the riverbank and therefore, removal of trees during construction of the LDS pipe and outfall should be minimized. Provided the recommendations in this report are followed, we endorse

the proposed outfall construction and recommend a waterway permit be granted for this project.

9.0 CLOSURE

Professional judgments and recommendations are presented in this report. They are based partly on an evaluation of the technical information gathered during our site investigation and partly on our general experience with subsurface conditions in the area. We do not guarantee the performance of the project in any respect other than that our engineering work and judgment rendered meet the standards and care of our profession. It should be noted that the testhole may not represent potentially unfavourable subsurface conditions on the project site. If during construction soil conditions are encountered that vary from those discussed in this report, we should be notified immediately in order that we may evaluate effects, if any, on the proposed construction. The recommendations presented in this report are applicable only to this specific site. These data should not be used for other purposes.

We appreciate the opportunity to assist you in this project. Please call me if you have any questions regarding this report.

Prepared by

Aron Piamsalee, B. Sc., EIT
Geotechnical Engineering

Reviewed by

Don Flatt, M. Eng., P.Eng.
Senior Geotechnical Engineer

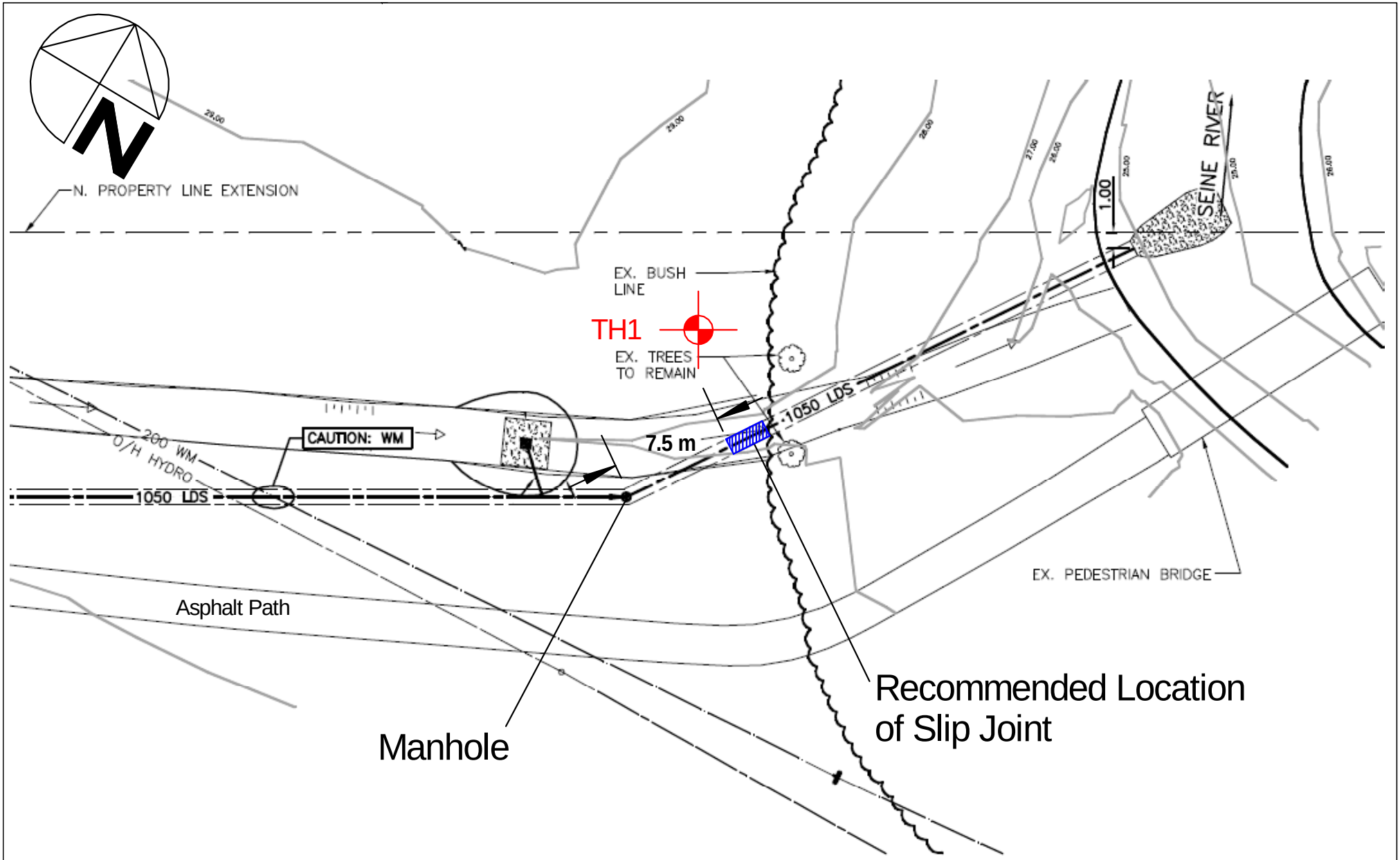
APEGM
Certificate of Authorization
The National Testing Laboratories Limited
No. 690 Date: Dec 7/10

PROVINCE OF MANITOBA
D.G. FLATT
Member
5062
REGISTERED PROFESSIONAL ENGINEER

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

APPENDIX A

TESTHOLE LOCATION PLAN



THE NATIONAL TESTING LABORATORIES LIMITED *Established in 1923*	Project No. STA-1034	Drawn by: AP	Figure: 1	Testhole Location Plan Fermor Avenue Outfall Mager Combined Sewer District Sewer Separation
	Date: Nov 17, 2010	Reviewed by: DF	Scale: NTS	

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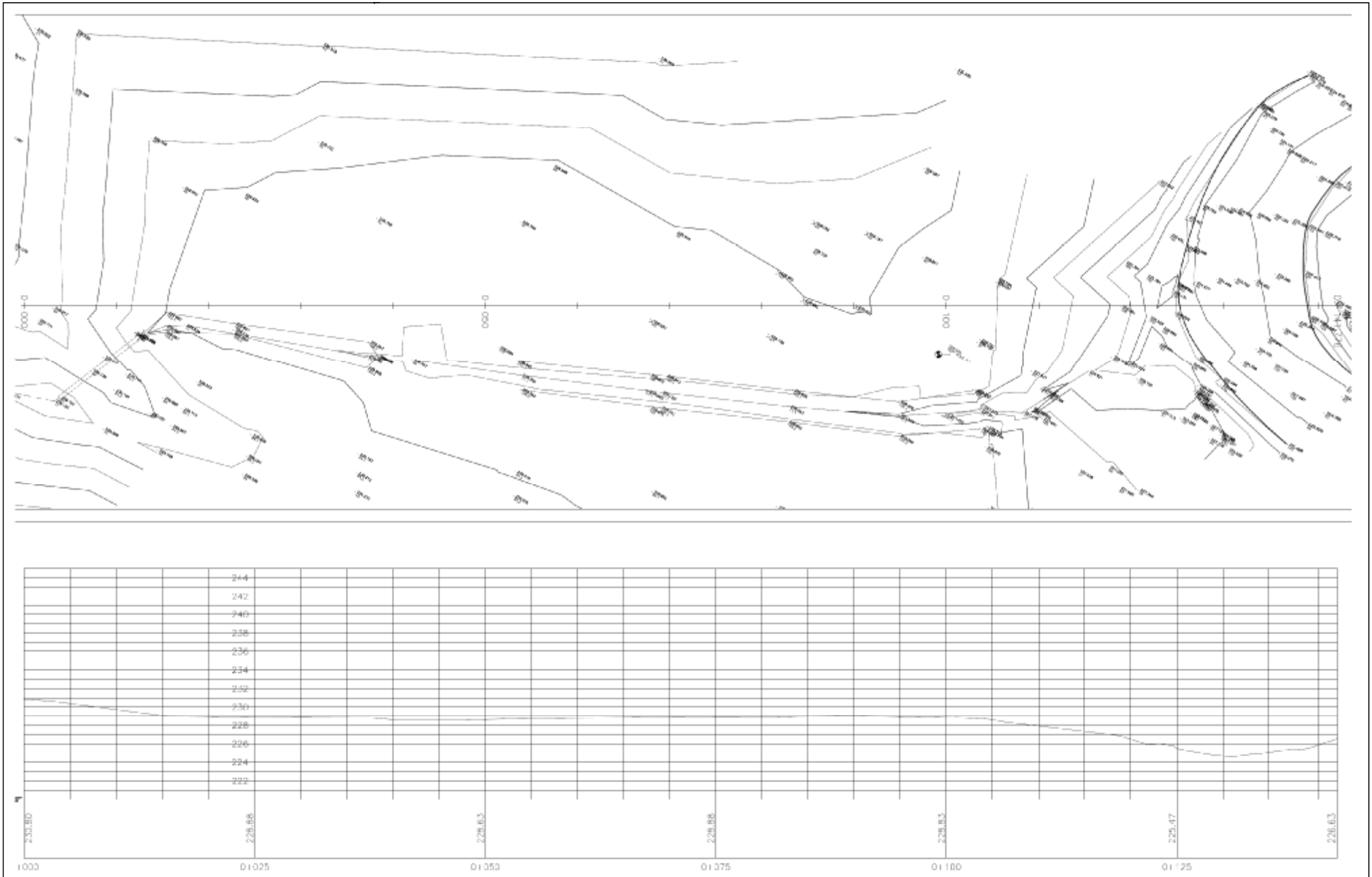
APPENDIX B

TOPOGRAPHICAL SURVEY



THE NATIONAL TESTING LABORATORIES LIMITED *Established in 1923*	Project No. STA-1034		Figure: 2	Topographical Survey Fermor Avenue Outfall Mager Combined Sewer District Sewer Separation
	Date: Nov 17, 2010		Scale: NTS	

APPENDIX C

SITE PHOTOGRAPHS

Photo 1: Grass covered upper bank area looking east towards the Seine River. Pedestrian path and drainage ditch visible on right side of photo.

Photo 2: Pedestrian bridge and west bank of the Seine River. Proposed LDS pipe outfall location near right side of photo.

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APPENDIX D

TESTHOLE LOG

TESTHOLE TH1

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Project Name: Fermor Avenue Outfall
Client: Stantec
Drilling Contractor: Maple Leaf Enterprises Ltd.
Drilling Method: B20 Cricket Rig, 100 mm Auger
Location: 14 U 636740.2 m E, 5524626.5 m N

Date Drilled: September 1-2, 2010
Depth of Testhole: 14.6 m
Logged by: Larry Presado
Reviewed by: Aron Piamsalee
Testhole Elevation: 228.7 m

Subsurface Profile				Laboratory Testing	
Elev. (m)	Depth (m)	Symbol	Description	Torvane Readings (kPa)	Water Content (%)
228.7	0		Ground Surface		
			Topsoil		
	1		**Clay** - black, firm, moist, high plasticity - trace organic material	94	48, 38, 41
	2		**Silt** - tan, soft, moist, low plasticity - clayey	67	44
	3		**Clay** - brown, stiff, moist, high plasticity - trace silt below 0.7 m - grey below 4.6 m - trace silt till inclusions below 12.2 m	54	47
	4				50
	5			44	50
	6			41	47
	7				46
	8			39	52
	9			30	56
	10			25	42
	11				
	12			25	57
215.9	13		**Silt Till** - tan, dense, moist, low plasticity - some coarse sand to fine gravel		19
	14				14
214.1	15		• No groundwater seepage or soil sloughing observed during or upon completion of drilling. • Auger refusal at 14.6 m on suspected boulder.		13
	16				

Torvane Readings (kPa): 0, 50, 100, 150, 200
Water Content (%): 0, 20, 40, 60, 80, 100

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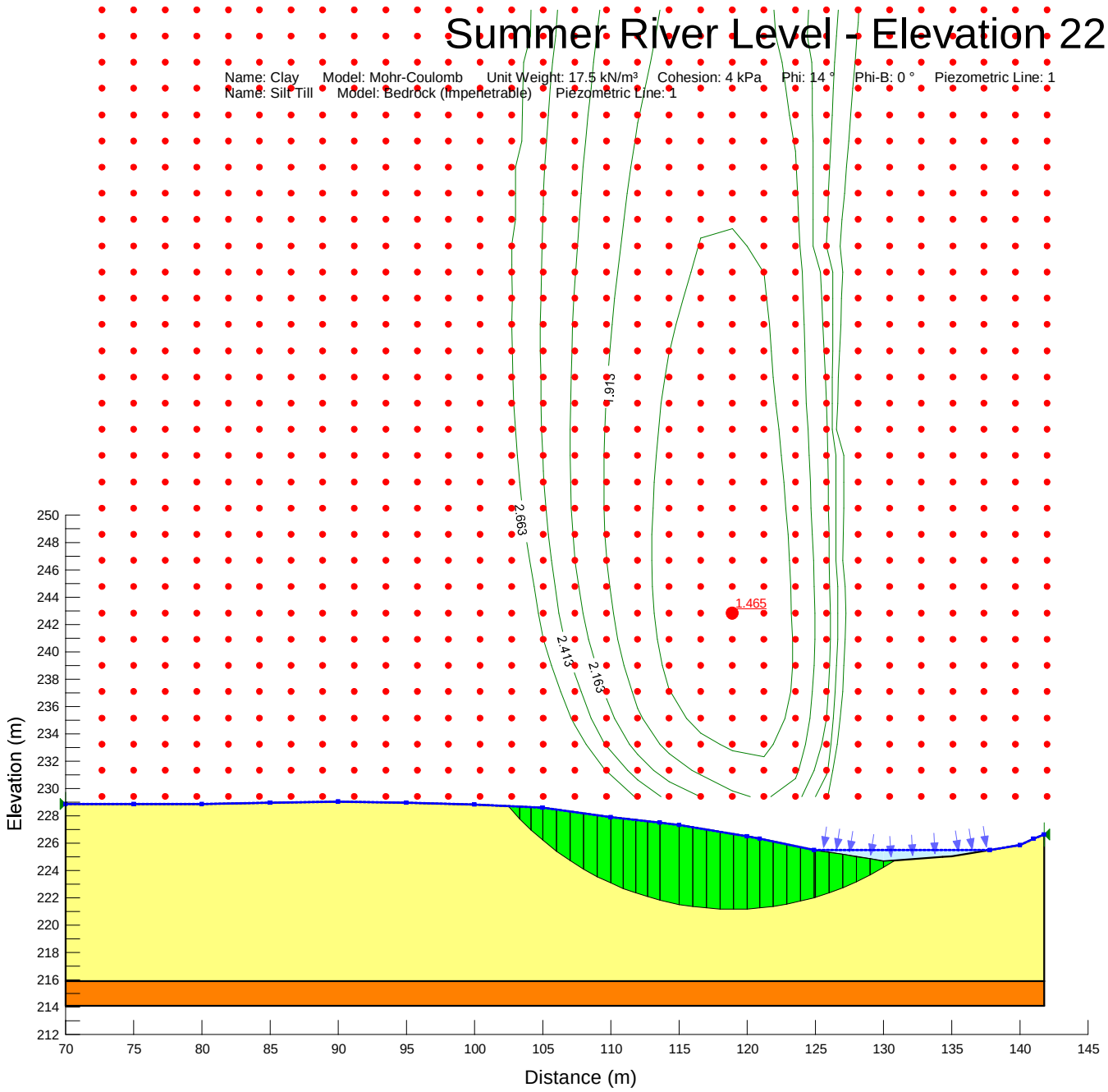
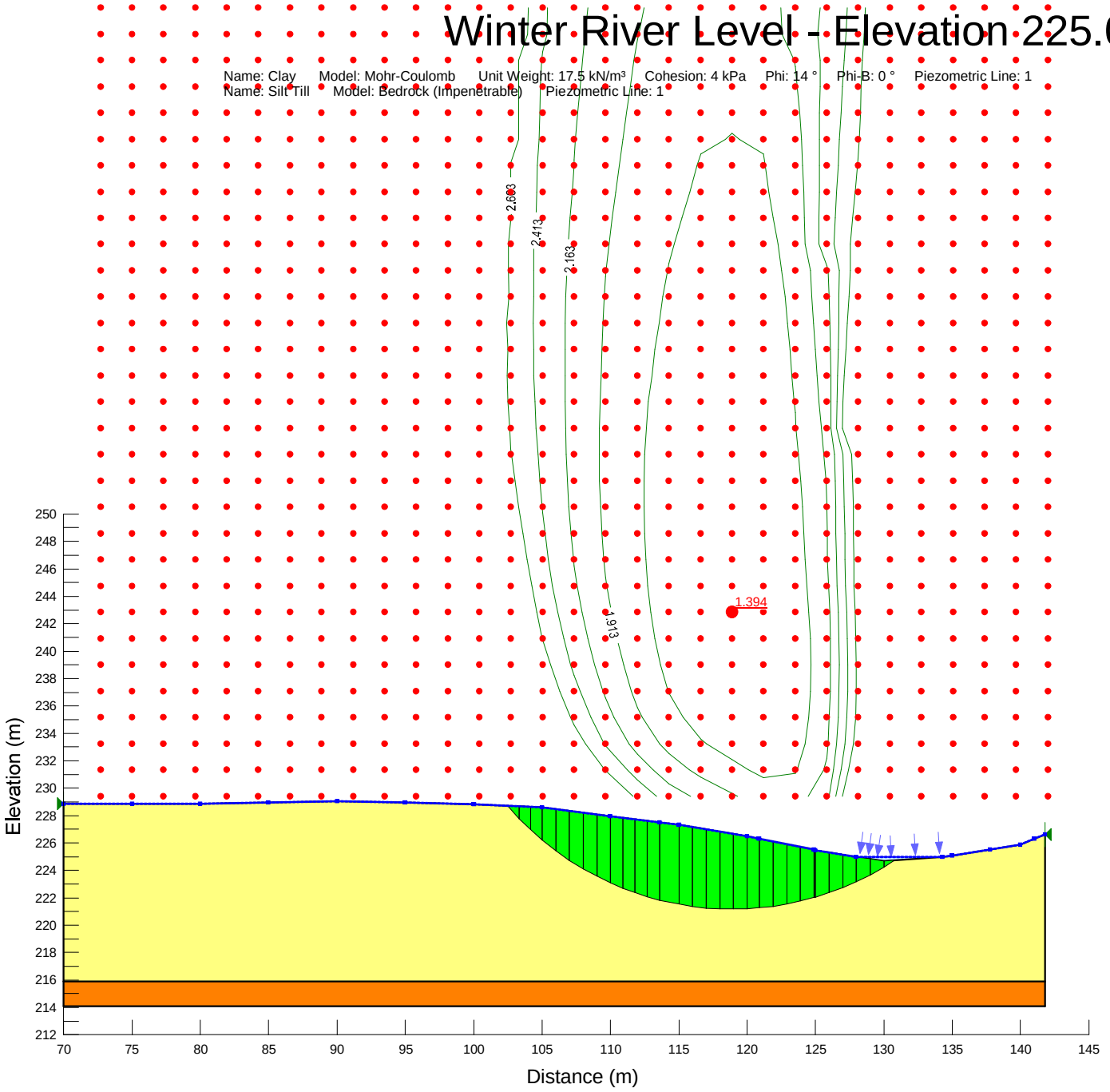
APPENDIX E

STABILITY ANALYSIS OUTPUTS

Summer River Level - Elevation 225.5 m



Winter River Level - Elevation 225.0 m



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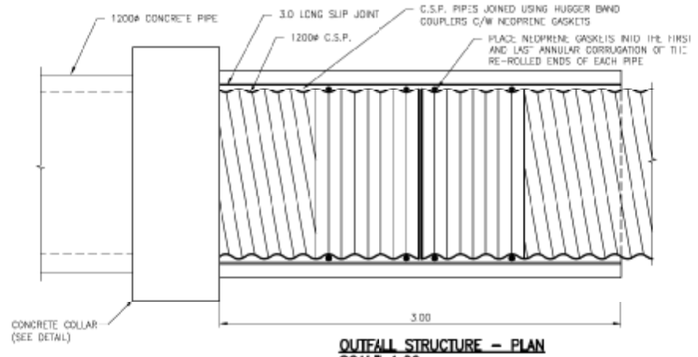
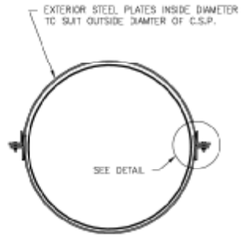
APPENDIX F

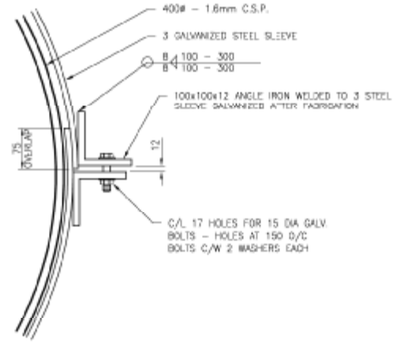
SLIP JOINT DESIGN DRAWING



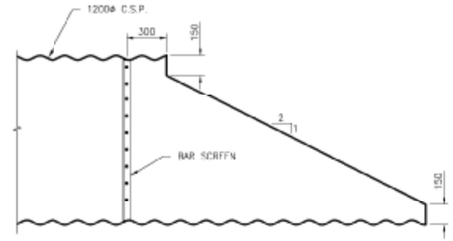
OUTFALL STRUCTURE – PLAN
SCALE 1:20



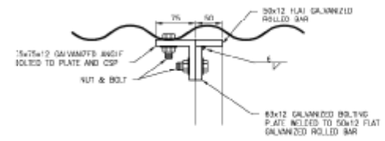
EXTERNAL SLIP JOINT – SECTION
SCALE 1:20



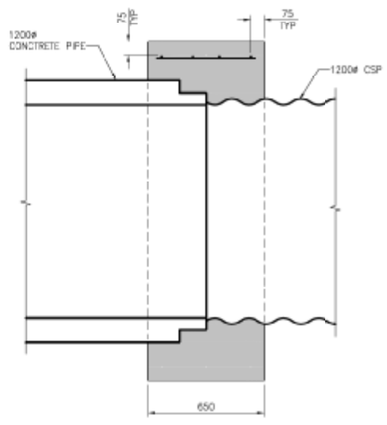
EXTERNAL SLIP JOINT – DETAIL
SCALE 1:5



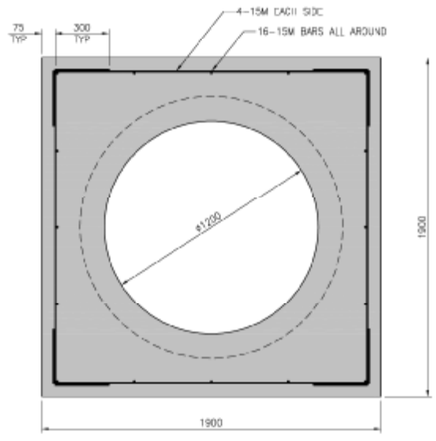
PIPE END – SECTION
SCALE 1:20



BAR SCREEN – DETAIL
SCALE 1:5

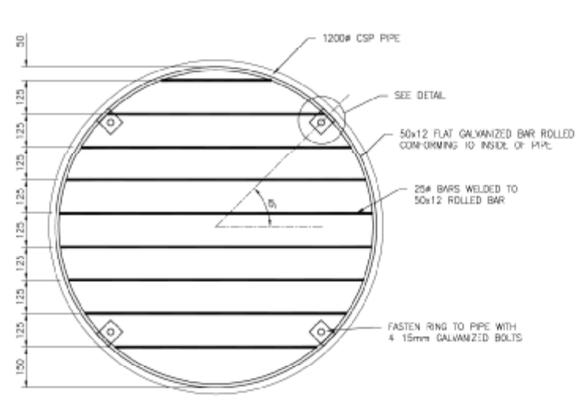


ELEVATION



SECTION

CONCRETE COLLAR
SCALE 1:15



BAR SCREEN
SCALE 1:10

BID OPPORTUNITY NO. XXX–2010

APEGM
Certificate of Authorization
Stantec Consulting Ltd.
No. 1301 Date:_____

LOCATION APPROVED
UNDERGROUND STRUCTURES

SUBWAY UNDERGROUND STRUCTURES COMMITTEE — DATE

NOTE:
LOCATION OF UNDERGROUND STRUCTURES AS SHOWN ARE BASED ON THE BEST INFORMATION AVAILABLE, BUT NO GUARANTEE IS GIVEN THAT ALL EXISTING UTILITIES ARE SHOWN OR THAT THE GIVEN LOCATIONS ARE EXACT. CONFIRMATION OF DIMENSIONS AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.

B.M. X
ELEV. X m

NO.	REVISIONS	DATE	BY

Stantec Consulting Ltd.
905 Waverley Street, Winnipeg, Manitoba
Tel 204-489-5900 Fax 204-453-9012

DESIGNED BY	J.C	CHECKED BY	H.K
DRAWN BY	D.M.L.	APPROVED BY	L.C.
HOR. SCALE: VERTICAL:		RELEASED FOR CONSTRUCTION:	
DATE	2010.07.26	DATE	

ENGINEER'S SEAL
PROVINCE OF MANITOBA
H.A. KATZ
REGISTERED PROFESSIONAL ENGINEER

CONSULTANT DRAWING NO.
C-245

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

DETAILS

MAGER COMBINED SEWER DISTRICT SEWER SEPARATION
CONTRACT NO. 3

SHEET	OF
13	X

DAD FILE DRAWING NUMBER
11890c-244-712.dwg

CITY DRAWING NUMBER
LD-XXXX

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DECIMALIZED NUMBERS INDICATE METRES

80/7128