KGS GROUP

KONTZAMANIS ▪ GRAUMANN ▪ SMITH ▪ MACMILLAN INC.
CONSULTING ENGINEERS & PROJECT MANAGERS

July 20, 2005 File No. 05-107-07

City of Winnipeg
Water and Waste Department
1500 Plessis Road
Winnipeg, Manitoba
R3C 5G6

ATTENTION: Mr. Darcy Strandberg, C.E.T.
Project Manager

RE: Geotechnical Investigation
Proposed Gate Chamber – Le Marie Street

Dear Mr. Strandberg:

KGS Group was authorized by the City of Winnipeg Water and Waste Department to undertake a geotechnical site investigation for the proposed gate chamber to be located at the existing Le Marie Outfall on the Seine River. This letter report details the results of our investigation including a summary of soil and groundwater conditions at the site plus geotechnical design considerations for temporary shoring, lateral earth pressure, and backfill. Comments received from the City regarding our draft letter report are included with this letter.

1.0 BACKGROUND

It is our understanding the new gate chamber will consist of cast-in-place concrete construction located approximately 3 m south of the existing gate chamber at the site. The base of the chamber will be located approximately 7 m below grade and a braced or strutted excavation will be used for construction.

2.0 SITE INVESTIGATION

On June 14, 2005 KGS Group supervised the drilling of one (1) test hole to 8.2 m depth below existing ground surface at the location of the proposed chamber. The test hole was advanced using 125 mm diameter solid stem augers with representative soil samples collected directly off the auger flights at 1.5 m intervals or at changes in stratigraphy. Drilling services were provided by Paddock Drilling Ltd. of Brandon, MB. with continuous KGS Group supervision. Laboratory testing was performed on select soil samples and included moisture content analysis and Atterberg limit testing.

STRUCTURAL■GEOTECHNICAL■ENVIRONMENTAL■HYDRAULICS■HYDROGEOLOGY■MUNICIPAL■MECHANICAL■ELECTRICAL
3RD FLR. – 865 WAVERLEY ST., WINNIPEG, MANITOBA, R3T 5P4 PH: (204) 896-1209 FAX: (204) 896-0754
560 SQUIER PLACE, THUNDER BAY, ONTARIO, P7B 6M2 PH: (807) 345-2233 FAX: (807) 345-3433

3.0 SITE CONDITIONS

3.1 Stratigraphy

In general, the stratigraphy at the site consisted of a clay fill over a native silty clay. The clay fill extended to a depth of 0.2 m below ground surface and consisted of intermediate plasticity clay. Underlying the clay fill, native silty clay extended to a depth of 8.2 m below ground surface. The silty clay was brownish grey in colour above the depth of 1.1 m and brownish tan below. In general, the silty clay was of low to high plasticity above 1.2 m and of high plasticity below, soft to stiff in consistency, contained a trace of fine to medium grained sand, and trace silt pockets and seams throughout the deposit. The natural moisture content of the silty clay ranged from 26.2% to 53.1%, with an overall average of 48%. The undrained shear strength of the silty clay ranged from 28 to 65 kPa, with an overall average of 40 kPa as measured from the field Torvane. The undrained shear strength generally decreased with depth. A summary soil log for the site is attached.

3.2 Groundwater Conditions

No groundwater infiltration or caving of the test hole side walls was observed during the test hole drilling. The brown-grey transition in the clay was observed at approximately 7.1 m below existing grade and is indicative of the lowest groundwater level that has occurred at the site in the past. KGS Group is in the process of completing an additional test hole at the site which will include installation of a standpipe piezometer in the underlying glacial till. The measured groundwater level from the piezometer will be reported to the City in a supplemental letter when available.

Groundwater levels vary seasonally and in response to precipitation such that future groundwater conditions at the site may vary from those observed at the time of this site investigation.

4.0 GEOTECHNICAL CONSIDERATIONS

4.1 Temporary Shoring

It is our understanding that temporary shoring will be used to support the side walls of the gate chamber excavation. Due to the depth of the excavation, space limitations, and close vicinity of the existing gate chamber strutted or braced walls are considered a suitable type of shoring. The detailed design of the temporary shoring depends upon the final geometry of the excavation, the type of shoring utilized, and construction details. Design considerations should include the following:

- The shoring should be designed to resist the lateral earth pressure of the clay fill and silty clay soils, groundwater pressures, and the surcharge load from construction equipment.

- An assessment of the potential for basal heave and blowout at the base of the excavation. Groundwater monitoring information from the standpipe piezometer that will be installed at the site shortly will be provided when available. Depending on the actual groundwater levels at the time of construction measures may be to counteract the risk of

blowout, such as by temporary construction dewatering below the base of the proposed excavation.

- The design of any required temporary construction dewatering measures should include an evaluation of the potential settlement implications below the adjacent structures which are likely supported by foundations bearing directly on the silty clay. This includes the adjacent gate chamber and underground piping.

- The vertical spacing of the internal struts should be designed and installed to minimize the potential for lateral and vertical soil movement, which could be detrimental to the existing infrastructure at the site.

- The removal of the temporary shoring and backfilling between the existing ground and the new gate chamber should be completed to minimize the potential for lateral and vertical ground movements.

- No stockpiling of excavated materials should be permitted adjacent to the excavation.

A registered professional engineer who is experienced with the design of braced excavations and the related soil and groundwater considerations should complete the shoring design.

4.2 Backfill

Free draining granular backfill should be placed around the chamber walls for a minimum width of 0.6 m and covered with a low permeability clay cap at ground surface. All backfill should be placed in maximum 150 mm thick lifts and compacted to a minimum of 95% Standard Proctor maximum dry density (SPMDD).

4.3 Lateral Earth Pressure

Providing the gate chamber is constructed using the backfill recommendations outlined above the permanent walls of the chamber may be designed using an at-rest earth pressure coefficient of 0.7 and the following expression, which assumes a triangular pressure distribution:

$$P_o = K_o (\gamma' H + q) + u$$

where:

P_o = Lateral earth pressure at-rest condition for restrained wall at a given depth (kPa)

K_o = Coefficient of earth pressure at-rest (assume 0.7)

γ' = Effective unit weight of retained soil (below water table $\gamma' = \gamma_{bulk} - \gamma_{water}$, above water table $\gamma' = \gamma_{bulk}$)

γ_{bulk} = Bulk unit weight of soil (for clays assume γ_{bulk} = 19 KN/m^3, for sands and gravels assume γ_{bulk} = 21 KN/m^3)

γ_{water} = Unit weight of water (9.81 KN/m^3)

H = Depth of wall below final grade (m)

q = Any surcharge pressure at ground surface (kPa)

u = net porewater pressure acting on wall (kPa)

4.4 Mat Slab

A mat slab foundation bearing on the native silty clay is suitable to support the proposed gate chamber. A design net allowable bearing capacity of 85 kPa may be used for a mat slab located at approximately 7 m below ground surface. Excessive wetting or drying of the clay subgrade in the base of the excavation should be avoided during construction to reduce the potential for swelling and shrinkage of the soil. In this regard placement of a lean mix concrete slab (mud slab) over the exposed bearing surface should be considered immediately following excavation.

4.5 Uplift

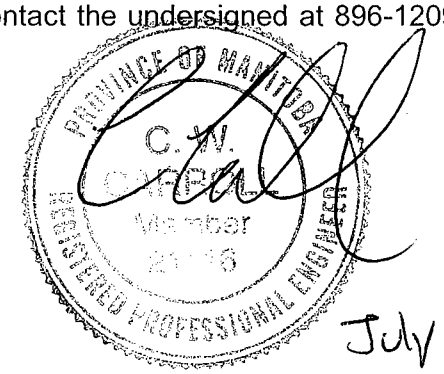
Based on the observed brown-grey interface within the clay soil at the site and our previous geotechincal engineering experience with subsurface conditions in the Winnipeg area it is likely that the piezometric level within the clay soil is the ranges from approximately 5 to 7 m below ground surface. Taking into account the proposed embedment depth of the gate chamber and anticipated weight of the structure we do not expect that there will be any special requirements to resist potential hydraulic uplift forces acting on the base slab. We are currently in the process of verifying groundwater levels at the site by installing a standpipe piezometer. The additional groundwater monitoring information may be used to verify potential uplift pressures and will be forwarded in a supplemental letter when available.

5.0 SUMMARY

We have completed a geotechnical site investigation for the proposed gate chamber expansion at the Le Marie Outfall. The stratigraphy at the site consisted of clay fill overlying silty clay. Geotechnical design considerations for temporary shoring, backfill, lateral earth pressure, and foundations are included.

We thank you for the opportunity to provide engineering services on this project. If you have any questions please contact the undersigned at 896-1209 or Dr. Rob Kenyon, P. Eng. of our office.

Yours truly,



July 20/05

Chris Carroll, P. Eng.
Geotechnical Engineer
CC/jr
cc: Mr. Kas Zurek, P. Eng., Design and Construction Engineer

KGS GROUP

SUMMARY LOG

HOLE NO.
TH-02 Le Maire St.

SHEET 1 of 1

CLIENT CITY OF WINNIPEG

PROJECT 2005 OUTFALL GATE CHAMBER UPGRADES - GEOTECHNICAL INVESTIGATIONS

SITE LE MAIRE STREET

LOCATION ±3 m south of existing chamber

DRILLING METHOD 125 mm ø Solid Stem Auger (Truck Mounted)

JOB NO. 05-107-07
GROUND ELEV.
WATER ELEV.
DATE DRILLED 14-Jun-05
UTM N 5514007
E 632245

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆
	0			**CLAY FILL** - Greyish-black, damp, intermediate plasticity, trace fine to coarse grained gravel, trace coarse grained sand, trace silt seams and nodules, trace oxidation, trace organic matter.		1			
				SILTY CLAY (CI-CH) - Brownish-grey, moist, stiff, intermediate to high plasticity, trace fine to medium grained sand, trace organic matter.		2			
	1			**SILTY CLAY (CL-CI)** - Brownish-tan, moist, soft, low to intermediate plasticity, trace fine grained sand, trace silt pockets and seams, trace organic matter.		3			
		5		**SILTY CLAY (CH)** - Tan/brown, moist, firm, high plasticity, trace silt pockets and nodules.					
	2			- Trace gypsum pockets (~20 mm thick) from 2.13 to 2.59 m.		4			
	3	10							
	4					5			
		15							
	5								
						6			
	6	20							
	7			- Grey below 7.21 m.		7			
		25							
	8					8			
				END OF HOLE AT 8.23 m					
	9	30		Notes: 1. No water in test hole at completion of drilling. 2. Test hole backfilled with cuttings and bentonite to surface.					

SAMPLE TYPE Auger Grab

CONTRACTOR Paddock Drilling Ltd.

INSPECTOR B. P. ARPIN

APPROVED

DATE 20-07-05

SPT & TORVANE P:\PROJECTS\2005\05-0107-07\GEO\LOGS\05-107-07 LOGS.GPJ

2.0 GROUNDWATER CONDITONS

A summary of the groundwater levels measured at each site is shown in Table 1 below. This information is submitted to supplement the groundwater information included in our original July 20, 2005 letter reports.

TABLE 1
SUMMARY OF MEASURED GROUNDWATER LEVELS
2005 OUTFALL GATE CHAMBER UPGRADING PROGRAM

SITE	Rowandale Crescent	LeMaire Street	Rue Notre Dame	Kavanagh Street	Evans Street	Falconer Bay	Blackmore Avenue
TEST HOLE	TH-01A	TH-02A	TH-04A	TH-06A	TH-09A	TH-10A	TH-11A
STRATUM	Till	Till	Till	Till	Till	Till	Till
DATE	Measured Groundwater Level (m) [1]						
26-Jul-05	-	-	10.67	-	-	-	-
2-Aug-05	4.88	6.72	11.55	5.44	Dry	7.31	4.67

Notes:
"-" = No Data
1. All measured groundwater levels are below existing grade at test hole locations.

Groundwater levels vary seasonally and in response to precipitation such that future groundwater conditions at the site may vary from those reported herein.

3.0 SUMMARY

Standpipe piezometer installations and groundwater level monitoring has been performed at seven (7) sites for the 2005 Gate Chamber Upgrading Program. Measured groundwater levels are reported herein and supplement our original geotechnical letter reports dated July 20, 2005.

We thank you for the opportunity to provide engineering services on this project. If you have any questions please contact the undersigned at 896-1209 or Dr. Rob Kenyon, P. Eng. of our office.

Yours truly,

Chris Carroll, P. Eng.
Geotechnical Engineer

CC/jr
Attachment

cc: Mr. Kas Zurek, P. Eng., Design and Construction Engineer

KGS GROUP

SUMMARY LOG

HOLE NO.
TH-02A Le Maire St.

CLIENT CITY OF WINNIPEG
PROJECT 2005 OUTFALL GATE CHAMBER UPGRADES - GEOTECHNICAL INVESTIGATIONS
SITE LE MAIRE STREET
LOCATION ±3 m south of existing chamber
DRILLING METHOD 125 mm ø Solid Stem Auger (Truck Mounted)

JOB NO. 05-107-07.02.1000
GROUND ELEV.
WATER ELEV.
DATE DRILLED 26-Jul-05
UTM N 5514007
E 632246

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆
										40 80 120	20 40 60 80
				CLAY FILL - Greyish-black, damp, intermediate plasticity, trace fine to coarse grained gravel, trace coarse grained sand, trace silt seams and nodules, trace oxidation, trace organic matter.		0.3		1			PL MC LL % 20 40 60 80
				SILTY CLAY (CI-CH) - Brownish-grey, moist, stiff, intermediate to high plasticity, trace fine to medium grained sand, trace organic matter.				2			
	1			**SILTY CLAY (CL-CI)** - Brownish-tan, moist, soft, low to intermediate plasticity, trace fine grained sand, trace silt pockets and seams, trace organic matter.				3			
		5		**SILTY CLAY (CH)** - Tan/brown, moist, firm, high plasticity, trace silt pockets and nodules.							
	2			- Trace gypsum pockets (~20 mm thick) from 2.13 to 2.59 m.				4			
	3	10									
	4							5			
		15									
	5										
	6	20						6			
	7			- Grey below 7.21 m.				7			
		25						8			
	8			- Moist to wet, soft below 8.23 m.							
	9	30						9			

SAMPLE TYPE Auger Grab

CONTRACTOR Paddock Drilling Ltd.
INSPECTOR B. P. ARPIN
APPROVED
DATE 09-08-05

SPT & TORVANE P:\PROJECTS\2005\05-0107-07\GEO\LOGS\05-107-07 LOGS (EXPANDED).GPJ

KGS GROUP

SUMMARY LOG

HOLE NO.
TH-02A Le Maire St.

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲ 40 80 120	Cu TORVANE (kPa) ◆ 20 40 60 80 / PL MC LL / % 20 40 60 80
	11 35					10			
	12 40					11			
	13 45		**SILTY CLAY (CI)** - Light grey, wet, very soft, intermediate plasticity, trace fine to coarse grained gravel.			12			
	14		**TILL** - Mixture of silt, clay, fine to coarse grained sand and gravel. Greyish tan, wet, very soft, low plasticity.			13			
	15 50		- Tan, dry to damp, loose to compact, low plasticity, mixture of fine to coarse grained sand and gravel below 14.94 m.			14			
	16				15.7 15.8 16.0 16.3 16.5				
	17 55		**AUGER REFUSAL AT 16.46 m**						
	18 60		Notes: 1. Soil stratigraphy from 0 to 8.23 m depth based on previous TH-02 completed on June 14, 2005. 2. Installed Casagrande standpipe to a depth of 16.31 m. Top of pipe is 0.13 m below ground surface elevation. 3. Water level measured at 6.59 m below top of pipe when monitored on August 2, 2005.						
	19								
	20 65								
	21 70								

SAMPLE TYPE Auger Grab

CONTRACTOR **Paddock Drilling Ltd.**

INSPECTOR **B. P. ARPIN**

APPROVED

DATE 09-08-05

Winnipeg

GEOTECHNICAL ENGINEER'S REPORT
IN SUPPORT OF WATERWAYS APPLICATION
LEMAY AVENUE ADDITION
TO EXISTING GATE CHAMBER

APRIL, 2004

KGS GROUP

KONTZAMANIS ▪ GRAUMANN ▪ SMITH ▪ MACMILLAN INC.
CONSULTING ENGINEERS & PROJECT MANAGERS

KGS GROUP

KONTZAMANIS ▪ GRAUMANN ▪ SMITH ▪ MACMILLAN INC.
CONSULTING ENGINEERS & PROJECT MANAGERS

April 13, 2004 File No. 04-107-01

The City of Winnipeg
Water and Waste Department
1500 Plessis Road
Winnipeg, Manitoba
R2C 5G6

ATTENTION: Mr. D. Strandberg
Engineering Technologist
Design and Contract Branch

RE: Geotechnical Engineer's Report
In Support of Waterways Application
Lemay Avenue Addition to Existing Gate Chamber

Dear Mr. Strandberg:

Please find enclosed three copies of our geotechnical report for the proposed addition to the existing gate chamber near Lemay Avenue and Avenue Lord. Two copies of this report are being sent along with a Waterway's Permit Application to Mr. Don Kingerski, P.Eng., Riverbank Management Engineer.

The scope of work included:

- geotechnical site investigation
- riverbank stability impact assessment

KGS Group thanks the City of Winnipeg for the opportunity to have provided services on this interesting project. Please contact Rob Kenyon, P.Eng. or the undersigned if you have questions.

Sincerely,

John G. McKay, P.Eng.
Senior Geotechnical Engineer

JM/
Enclosure

STRUCTURAL • GEOTECHNICAL • ENVIRONMENTAL • HYDRAULICS • HYDROGEOLOGY • MUNICIPAL • MECHANICAL • ELECTRICAL
3RD FLR. – 865 WAVERLEY ST., WINNIPEG, MANITOBA, R3T 5P4 PH: (204) 896-1209 FAX: (204) 896-0754
560 SQUIER PLACE, THUNDER BAY, ONTARIO, P7B 6M2 PH: (807) 345-2233 FAX: (807) 345-3433

TABLE OF CONTENTS

PAGE

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation and slope stability impact assessment for proposed construction near the Lemay Avenue outfall. This report is intended to accompany a Waterway Permit Application.

Authorization to proceed with this work was received from Mr. Darcy Strandberg of the Winnipeg Water and Waste Department.

The site is within 107 m horizontal distance from the normal summer water edge of the Seine River and in accordance with the City Waterway By-law, a Waterway Permit is required for new construction.

The scope of work was described in KGS Group's December 4, 2003 proposal and included a geotechnical site investigation, slope stability impact assessment and report.

2.0 BACKGROUND

The site is located in St. Norbert in Winnipeg, Manitoba. The addition to the gate chamber is located about 10 m east of the edge of the intersection of Lemay Avenue and Avenue Lord. At the time of the fieldwork the site was snow covered. The overall slope from the top of bank to the river elevation is about 5:1 (7 m height over about 35 m horizontal distance).

The Flood Protection Level at nearby section 221 is 232.68 m (City of Winnipeg Interim Flood Risk Map, Jan 24, 1980, File Number 11-1-1560, Environment Canada Inland Waters; Manitoba, Department of Natural Resources Water Resources Branch).

The project is understood to comprise the design and construction of an addition to an existing gate chamber approximately 60 m away from the Red River. Figure 1 presents a plan and section showing the existing gate chamber and testhole location. The ground surface is approximately 232.0 m.

Geologic Survey of Canada unpublished map, Surficial Geology of Southern Manitoba describes the surficial soils at the site as postglacial alluvial sediments, 'gravelly, sand, sand silt, organic detritus; 1 to 3 m thick; sediments reworked by existing streams and deposited primarily as bars.'

3.0 FIELD AND LABORATORY WORK

On January 8, 2004, KGS Group supervised the drilling of one testhole at the site. The hole was drilled with a track mounted drill rig contracted from Paddock Drilling Ltd. The hole was advanced using 125 mm solid stem augers to 18.8 m below existing ground surface. Auger flight and split spoon samples were recovered for laboratory testing. Standard Penetration Tests (SPT's) were performed in the till. A protective steel casing and 25 mm PVC standpipe with Casagrande tip were installed in the testhole. Installation details are presented on the testhole log in Appendix A. Ground surface elevations are referenced to geodetic. Survey data was provided by the City of Winnipeg. Natural moisture content tests were performed at NTL Laboratories Ltd. on soil samples collected from the testhole. Test results are shown on the testhole log.

4.0 GEOTECHNICAL SITE STRATIGRAPHY

4.1 SOIL CONDITIONS

The soils logged from the testhole are summarized as follows:

- **Topsoil**- approximately 300 mm thick.
- **Lean Clay (Fill)-** Unified Soil Classification System modifier CL, silty, trace sand, low plastic, approximately 1.5 m thick (not including topsoil).
- **Lean Clay (Alluvium)-** CL, firm, silty, low plastic, damp to saturated, grey. Several thin layers of gravel and sand were noted at about 14.0 m depth. The alluvium was approximately 13.4 m thick.
- **Silt[1] (Till)**- ML, compact, trace gravel, low to non plastic, saturated to damp, tan. Encountered at elevation of 216.8 m or 15.2 m depth.

4.2 GROUNDWATER CONDITIONS

Groundwater was measured at 14.96 m below ground (elevation 217.04 m) upon completion on January 8 and 8.84 m (elevation 223.16 m) on February 13, 2004. The piezometer response zone is in the till.

Groundwater elevations vary seasonally and in response to river levels and precipitation.

[1] When more than 50% by mass is silt sized (passing the number 200 sieve) or smaller the soil is called CLAY when the plasticity index is greater than 7%, CLAY-SILT when the plasticity index is between 4 and 7%, and SILT when the plasticity index is less than 4% according to the Unified Classification System and the accompanying plasticity chart.

5.0 EXISTING RIVERBANK STABILITY ASSESSMENT

The riverbank is near an inside bend and is likely a lateral accretion deposit or alluvium comprised of predominantly silt sized particles with lesser amounts of sand, clay and gravel. Alluvium is relatively stronger than high plastic glaciolacustrine deposits which comprise most of the Winnipeg riverbanks. Although not anticipated, changes in river dynamics could undercut this bank and lead to instability.

Active slope instability was not observed in Foto Flight stereo air photos FF98096, numbers 110, 111 and 112, October 23, 1998.

5.1 IMPACT OF PROPOSED CONSTRUCTION ON RIVERBANK STABILITY

The impact of the proposed construction on the stability of the bank is not significant. Ground surface grades will not change. The proposed construction is about 60 m from the river and 24 m from top of bank. This is beyond where anticipated slip surfaces would reach. Backfill will be cohesive and relatively impervious clay soils and well compacted. Recommended backfill is general engineered fill (95% maximum standard Proctor dry density at 0 to +3% of optimum moisture content, maximum compacted lift thickness 200 mm).

5.2 WATERWAYS PERMIT RECOMMENDATION

The proposed construction will not endanger the stability of the riverbank, will not impede water flow and will not adversely alter the waterway. Therefore, KGS Group recommends that a Waterways permit be granted.

6.0 LIMITATIONS

Geotechnical recommendations presented herein are based on findings in one testhole, previous available information and site observations. Excavation recommendations are not included. It is the Contractor's responsibility to ensure that excavations are properly designed and do not impact adjacent structures.

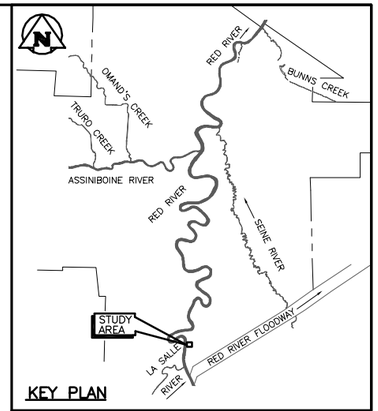
If conditions other than those reported are noted, KGS Group should be given the opportunity to review current recommendations. The recommendations presented herein may not be valid if an adequate level of monitoring is not provided during construction, or if relevant building code requirements are not met. This report does not include any recommendations related to contaminants in soil or groundwater. Environmental issues are not included in this scope of work.

This report has been prepared for the exclusive use of the City of Winnipeg for specific application to the addition to the gate chamber near Lemay Avenue. KGS Group makes no representations to any party with whom KGS Group has not entered into a contract. This report has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty is made, either expressed or implied.

FIGURE

PLAN AND SECTION SHOWING LOCATION OF TESTHOLE

24x36B



LEGEND

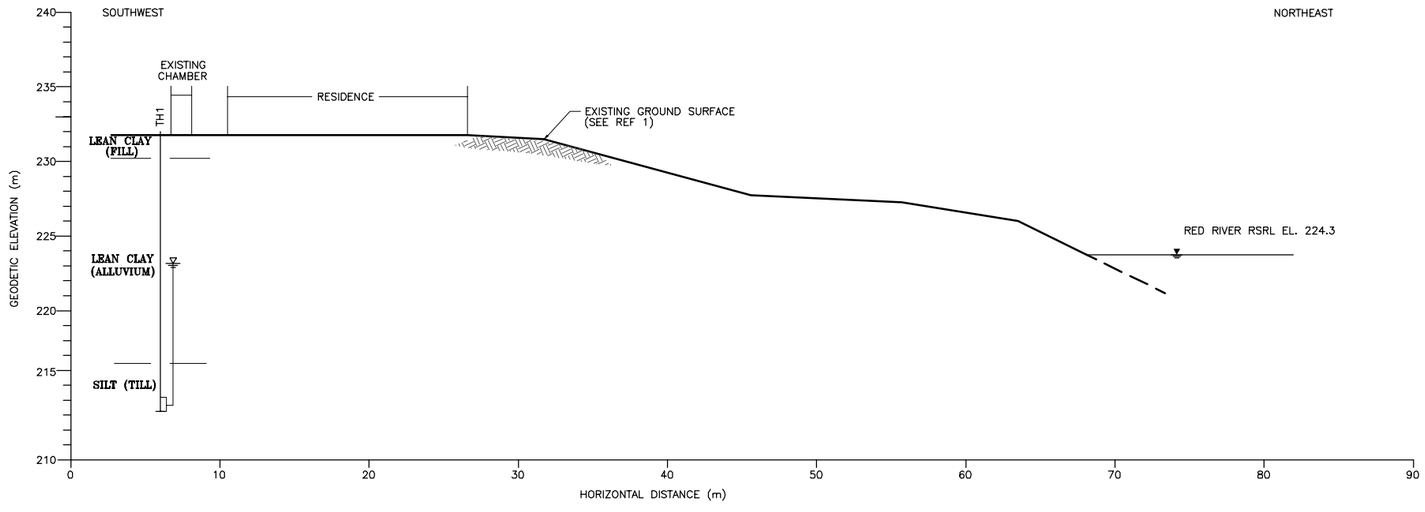
- PROPERTY LINE
- 5514450 N — UTM GRID LINE (NAD 83)
- LDS — SEWER LINE
- 227 — GROUND CONTOUR (GEODETIC, m)
- TH1 — TEST HOLE (KGS GROUP, JAN.9/2004)
- STRATIGRAPHIC BOUNDARY
- GROUND WATER ELEVATION (FEB. 13/2004)
- MONITORING ZONE

REFERENCES

1. ORTHO-DIGITAL BASE MAPPING, CITY OF WINNIPEG, 1999.

0 4 8 12 16 20m

SCALE: 1:200 METRIC 24"x36"
1:400 METRIC 11"x17"



A — SECTION
SCALE: 1:200 (24x36)
1:400 (11x17)

NO.	D / M / Y	DESCRIPTION	BY
A	29/03/04	ISSUED WITH FINAL REPORT	

REVISIONS / ISSUE

A. SECTION LETTER OR DETAIL NUMBER
B. DRAWING WHERE SECTION OR DETAIL IS DRAWN
OR
DRAWING WHERE SECTION OR DETAIL WAS INDICATED
— SECTION OR DETAIL SHOWN ON SAME DRAWING

KGS GROUP
CONSULTING ENGINEERS & PROJECT MANAGERS
WINNIPEG (204) 896-1209
THUNDER BAY (807) 345-2233

CLIENT: CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

PROJECT:
SEWER OUTFALL UPGRADE
LEMAY AVENUE
ST. NORBERT, MB

DWG. DESCRIPTION:
PLAN AND SECTION SHOWING
LOCATION OF TESTHOLE

ENG. STAMP

DESIGNED: BY: JMc CHECKED: RKe
DRAWN: BY: TE CHECKED:
APPROVED:
SCALE: AS NOTED
DATE: MARCH 2004
KGS DWG. NO. 04-107-01(4) 01
CLIENT DWG. NO. .
REV: A

FIGURE 1

KGS FILE NO.: P:\Projects\2004\04-0107-01\Geo\Dwgs\LEMAY (4)\04-107-01(4)-06.dwg
24"x36"/PLOT SCALE:1:2

APPENDIX A

TESTHOLE LOG

KGS GROUP

SUMMARY LOG

HOLE NO. **TH-1**

CLIENT CITY OF WINNIPEG
PROJECT SEWER OUTFALL UPGRADING
SITE LEMAY
LOCATION
DRILLING METHOD 125 mm ø Solid Stem Auger

JOB NO. **04-107-01**
GROUND ELEV. **232.00 m**
WATER ELEV. **223.16 m (13-Feb-04)**
DATE DRILLED **08 Jan 04**
UTM N
E

ELEVATION m (ft)	DEPTH (m) (ft)	DESCRIPTION AND CLASSIFICATION	DEPTH (m)
231.7		**TOPSOIL**	
231	1 5	**LEAN CLAY (FILL) (CL)**- Light black, damp, low plasticity, silty, trace sand, trace gravel.	0.9
230.2		**LEAN CLAY (ALLUVIUM) (CL)**- Olive grey, damp, firm, low plasticity, silty, trace sand.	
230	2		
229	3 10		
228	4		
227	5 15	- Hole squeezing between 4.88 and 9.14 m.	
226	6 20	- Mottled below 6.10 m.	
225	7		
224	8 25		
223	9 30	- Grey below 8.23 m.	
222	10	- Increasing silt content at 9.75 m.	
221	11 35	- Water seepage into hole at 10.67 m. - With silt at 10.67 m. - Trace coarse grained sand and gravel from 11.3 to 11.6 m.	
220	12 40		
219	13		13.4
218	14 45	- Thin sand and gravel layers at 14.02 m.	
217	15		
216.8	50	**SILT (TILL) (ML)** - Tan, saturated, compact, low to non plastic, some sand, trace subangular gravel (<25 mm ø).	
216	16		
215	17 55		17.8
214	18		18.3
213.3	60	- Damp.	18.6
213	19	**END OF HOLE AT 18.75 m**	18.7
212	20 65	Notes: 1. Installed Casagrande standpipe at 18.59 m depth. Pipe consists of Schedule 40 PVC 25 mm ID, with 0.3 m screen zone. 2. Lockable protective steel casing installed at ground surface. 3. Groundwater depth at 14.96 m below ground surface on January 12, 2004. 4. Groundwater depth at 8.84 m below ground surface on February 13, 2004.	
211	21 70		
210	22		
	75		

SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆
			20 40 60	20 40 60 80
Auger Grab	1			PL MC LL
	2			%
	3			20 40 60 80
	4			
	5			
	6			
	7			
	8			
	9			
	10			
Split Spoon	11	56	▲35	

SAMPLE TYPE Auger Grab Split Spoon

CONTRACTOR **Paddock Drilling Ltd.**
INSPECTOR **N. PRIVAT**
APPROVED _____ DATE 24-06-04

SPT & TORVANE P:\PROJECTS\2004\04-010-2\GEO\LOGS\04-107-01.GPJ

KGS GROUP

KONTZAMANIS ▪ GRAUMANN ▪ SMITH ▪ MACMILLAN INC.
CONSULTING ENGINEERS & PROJECT MANAGERS

July 20, 2005 File No. 05-107-07

City of Winnipeg
Water and Waste Department
1500 Plessis Road
Winnipeg, Manitoba
R3C 5G6

ATTENTION: Mr. Darcy Strandberg, C.E.T.
Project Manager

RE: Geotechnical Investigation
Proposed Gate Chamber – Rue Notre Dame

Dear Mr. Strandberg:

KGS Group was authorized by the City of Winnipeg Water and Waste Department to undertake a geotechnical site investigation for the proposed gate chamber construction at the existing Rue Notre Dame Outfall on the Seine River. This letter report details the results of our investigation including a summary of soil and groundwater conditions at the site plus geotechnical design considerations for temporary shoring, lateral earth pressure, and backfill. Comments received from the City with respect to our draft letter report are included with this letter.

1.0 BACKGROUND

It is our understanding the proposed gate chamber will consist of cast-in-place concrete and be located approximately 7 m east of the existing walkway on the riverbank. The base of the chamber will be located approximately 7.9 m below grade and a braced or strutted excavation will be used for construction.

2.0 SITE INVESTIGATION

On June 13, 2005 KGS Group supervised the drilling of one (1) test hole to 8.2 m depth below existing ground surface at the approximate location of the proposed chamber. The test hole was advanced using 125 mm diameter solid stem augers with representative soil samples collected directly off the auger flights at 1.5 m intervals or at changes in stratigraphy. Drilling services were provided by Paddock Drilling Ltd. of Brandon, MB. with continuous KGS Group supervision. Laboratory testing was performed on select soil samples and included moisture content analysis and Atterberg limit testing.

STRUCTURAL■GEOTECHNICAL■ENVIRONMENTAL■HYDRAULICS■HYDROGEOLOGY■MUNICIPAL■MECHANICAL■ELECTRICAL
3RD FLR. – 865 WAVERLEY ST., WINNIPEG, MANITOBA, R3T 5P4 PH: (204) 896-1209 FAX: (204) 896-0754
560 SQUIER PLACE, THUNDER BAY, ONTARIO, P7B 6M2 PH: (807) 345-2233 FAX: (807) 345-3433

3.0 SITE CONDITIONS

3.1 Stratigraphy

In general, the stratigraphy at the site consisted of a clay fill over native silty clay. The clay fill extended to a depth of 0.3 m below ground surface and consisted of intermediate to high plasticity clay. Underlying the clay fill, native silty clay extended to a depth of 8.2 m below ground surface. The silty clay was greyish brown in colour to 6.1 m depth and grey below. In general, the silty clay was of intermediate to high plasticity, firm to stiff in consistency, contained a trace of fine to coarse grained sand above the depth of 2.0 m, and trace silt pockets and seams throughout the deposit. The natural moisture content of the silty clay ranged from 33.9% to 52.0%, with an overall average of 46%. The undrained shear strength of the silty clay ranged from 28 to 65 kPa, with an overall average of 40 kPa as measured from the field Torvane. A summary soil log for the site is attached.

3.2 Groundwater Conditions

No groundwater infiltration or caving of the test hole side walls was observed during the test hole drilling. The brown-grey transition in the clay was observed at approximately 6.1 m below existing grade and is indicative of the lowest groundwater level that has occurred at the site in the past. KGS Group is in the process of completing an additional test hole at the site, which will include installation of a standpipe piezometer in the underlying glacial till. The measured groundwater level from the piezometer will be reported to the City in a supplemental letter when available.

Groundwater levels vary seasonally and in response to precipitation such that future groundwater conditions at the site may vary from those observed at the time of this site investigation.

4.0 GEOTECHNICAL CONSIDERATIONS

4.1 Temporary Shoring

It is our understanding that temporary shoring will be used to support the side walls of the gate chamber excavation. Due to the depth of the excavation, space limitations, and close vicinity of the Seine River strutted or braced walls are considered a suitable type of shoring for construction. The detailed design of the temporary shoring depends upon the final geometry of the excavation, the type of shoring utilized, and construction details. Design considerations should include the following:

- The shoring should be designed to resist the lateral earth pressure of the clay fill and silty clay soils, groundwater pressures, and the surcharge load from construction equipment.

- An assessment of the potential for basal heave and blowout at the base of the excavation. Groundwater monitoring information from the standpipe piezometer that will be installed at the site shortly will be provided when available. Depending on the actual groundwater levels at the time of construction measures may be to counteract the risk of

blowout, such as by temporary construction dewatering below the base of the proposed excavation.

- The design of any required temporary construction dewatering measures should include an evaluation of the potential settlement implications below the adjacent structures which are likely supported by foundations bearing directly on the silty clay.

- The vertical spacing of the internal struts should be designed and installed to minimize the potential for lateral and vertical soil movement, which could be detrimental to the existing infrastructure at the site.

- The removal of the temporary shoring and backfilling between the existing ground and the new gate chamber should be completed to minimize the potential for lateral and vertical ground movements.

- No stockpiling of excavated materials should be permitted adjacent to the excavation.

A registered professional engineer who is experienced with the design of braced excavations and the related soil and groundwater considerations should complete the shoring design.

4.2 Backfill

Free draining granular backfill should be placed around the chamber walls for a minimum width of 0.6 m and covered with a low permeability clay cap at ground surface. All backfill should be placed in maximum 150 mm thick lifts and compacted to a minimum of 95% Standard Proctor maximum dry density (SPMDD).

4.3 Lateral Earth Pressure

Providing the gate chamber is constructed using the backfill recommendations outlined above the permanent walls of the chamber may be designed using an at-rest earth pressure coefficient of 0.7 and the following expression, which assumes a triangular pressure distribution:

$$P_o = K_o (\gamma' H + q) + u$$

where:

P_o = Lateral earth pressure at-rest condition for restrained wall at a given depth (kPa)

K_o = Coefficient of earth pressure at-rest (assume 0.7)

γ' = Effective unit weight of retained soil (below water table $\gamma' = \gamma_{bulk} - \gamma_{water}$, above water table $\gamma' = \gamma_{bulk}$)

γ_{bulk} = Bulk unit weight of soil (for clays assume γ_{bulk} = 19 KN/m^3, for sands and gravels assume γ_{bulk} = 21 KN/m^3)

γ_{water} = Unit weight of water (9.81 KN/m^3)

H = Depth of wall below final grade (m)

q = Any surcharge pressure at ground surface (kPa)

u = net porewater pressure acting on wall (kPa)

4.4 Mat Slab

A mat slab foundation bearing on the native clay is suitable to support the proposed gate chamber. A design net allowable bearing capacity of 85 kPa may be used for a mat slab located at approximately 7.9 m below ground surface. Excessive wetting or drying of the clay subgrade in the base of the excavation should be avoided during construction to reduce the potential for swelling and shrinkage of the soil. In this regard placement of a lean mix concrete slab (mud slab) over the exposed bearing surface should be considered immediately following excavation.

4.5 Uplift

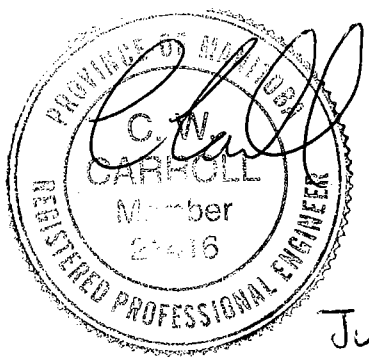
Based on the observed brown-grey interface within the clay soil at the site and our previous geotechincal engineering experience with subsurface conditions in the Winnipeg area it is likely that the piezometric level within the clay soil is the ranges from approximately 5 to 7 m below ground surface. Taking into account the proposed embedment depth of the gate chamber and the anticipated weight of the structure we do not anticipate that there will be any special requirements to resist potential hydraulic uplift pressure acting on the base slab. However we are currently in the process of verifying groundwater levels at the site by installing a standpipe piezometer. The additional groundwater monitoring information may be used to verify potential uplift pressures will be forwarded in a supplemental letter report when available.

5.0 SUMMARY

We have completed a geotechnical site investigation for the proposed gate chamber expansion at the Rue Notre Dame Outfall. The stratigraphy at the site consisted of clay fill overlying silty clay. Geotechnical design considerations for temporary shoring, backfill, lateral earth pressure, and foundations are included.

We thank you for the opportunity to provide engineering services on this project. If you have any questions please contact the undersigned at 896-1209 or Dr. Rob Kenyon, P. Eng. of our office.

Yours truly,



Chris Carroll, P. Eng.
Geotechnical Engineer

July 20/05

CC/jr
cc: Mr. Kas Zurek, P. Eng., Design and Construction Engineer

KGS GROUP

SUMMARY LOG

HOLE NO.
TH-04 Rue Notre Dame

SHEET 1 of 1

CLIENT CITY OF WINNIPEG

PROJECT 2005 OUTFALL GATE CHAMBER UPGRADES - GEOTECHNICAL INVESTIGATIONS

SITE RUE NOTRE DAME

LOCATION ±7 m east of existing walkway

DRILLING METHOD 125 mm ø Solid Stem Auger (Truck Mounted)

JOB NO. 05-107-07
GROUND ELEV.
WATER ELEV.
DATE DRILLED 13-Jun-05
UTM N 5528771
E 635438

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆
	0	0		**CLAY FILL** - Greyish-black, damp, firm, intermediate to high plasticity, trace fine grained gravel, trace coarse grained sand, trace silt, trace organic matter.	AG	1			
				SILTY CLAY (CH) - Greyish-brown, damp, stiff, high plasticity, trace fine grained sand, trace silt pockets, nodules and seams, trace organic matter.					
	1	5		**SILTY CLAY (CI-CH)** - Light grey, damp, firm, intermediate to high plasticity, trace fine grained gravel, trace medium to coarse grained sand, trace silt, trace organics.	AG	2			
					AG	3			
	2	10		**CLAY (CH)** - Brownish-tan, damp, firm, high plasticity, trace silt pockets, seams and nodules, trace organic matter.	AG	4			
					AG	5			
	3	15							
	4				AG	6			
	5	20			AG	7			
	6			- Grey, moist below 6.10 m.	AG	8			
					AG	9			
	7	25							
	8			**END OF HOLE AT 8.23 m**	AG	10			
	9	30							

Notes:
1. No water in test hole at completion of drilling.
2. Test hole backfilled with cuttings and bentonite to surface.

SAMPLE TYPE AG Auger Grab

CONTRACTOR Paddock Drilling Ltd.
INSPECTOR B. P. ARPIN
APPROVED
DATE 20-07-05

SPT & TORVANE P:\PROJECTS\2005\05-0107-07\GEOLOGS\05-107-07 LOGS.GPJ

2.0 GROUNDWATER CONDITONS

A summary of the groundwater levels measured at each site is shown in Table 1 below. This information is submitted to supplement the groundwater information included in our original July 20, 2005 letter reports.

TABLE 1
SUMMARY OF MEASURED GROUNDWATER LEVELS
2005 OUTFALL GATE CHAMBER UPGRADING PROGRAM

SITE	Rowandale Crescent	LeMaire Street	Rue Notre Dame	Kavanagh Street	Evans Street	Falconer Bay	Blackmore Avenue
TEST HOLE	TH-01A	TH-02A	TH-04A	TH-06A	TH-09A	TH-10A	TH-11A
STRATUM	Till	Till	Till	Till	Till	Till	Till
DATE	Measured Groundwater Level (m) [1]						
26-Jul-05	-	-	10.67	-	-	-	-
2-Aug-05	4.88	6.72	11.55	5.44	Dry	7.31	4.67

Notes:
"-" = No Data
1. All measured groundwater levels are below existing grade at test hole locations.

Groundwater levels vary seasonally and in response to precipitation such that future groundwater conditions at the site may vary from those reported herein.

3.0 SUMMARY

Standpipe piezometer installations and groundwater level monitoring has been performed at seven (7) sites for the 2005 Gate Chamber Upgrading Program. Measured groundwater levels are reported herein and supplement our original geotechnical letter reports dated July 20, 2005.

We thank you for the opportunity to provide engineering services on this project. If you have any questions please contact the undersigned at 896-1209 or Dr. Rob Kenyon, P. Eng. of our office.

Yours truly,

Chris Carroll, P. Eng.
Geotechnical Engineer

CC/jr
Attachment

cc: Mr. Kas Zurek, P. Eng., Design and Construction Engineer

KGS GROUP

SUMMARY LOG

HOLE NO.
TH-04A Rue Notre Dame

CLIENT CITY OF WINNIPEG

PROJECT 2005 OUTFALL GATE CHAMBER UPGRADES - GEOTECHNICAL INVESTIGATIONS

SITE RUE NOTRE DAME

LOCATION ±7 m east of existing walkway

DRILLING METHOD 125 mm ø Solid Stem Auger (Truck Mounted)

JOB NO. 05-107-07.02.1000
GROUND ELEV.
WATER ELEV.
DATE DRILLED 26-Jul-05
UTM N 5528780
E 635441

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲ (40 80 120)	Cu TORVANE (kPa) ◆ (20 40 60 80) PL MC LL % (20 40 60 80)
	0			**CLAY FILL** - Greyish-black, damp, firm, intermediate to high plasticity, trace fine grained gravel, trace coarse grained sand, trace silt, trace organic matter.		0.3		1			
				SILTY CLAY (CH) - Greyish-brown, damp, stiff, high plasticity, trace fine grained sand, trace silt pockets, nodules and seams, trace organic matter.				2			
	1	5		**SILTY CLAY (CI-CH)** - Light grey, damp, firm, intermediate to high plasticity, trace fine grained gravel, trace medium to coarse grained sand, trace silt, trace organics.				3			
	2			**CLAY (CH)** - Brownish-tan, damp, firm, high plasticity, trace silt pockets, seams and nodules, trace organic matter.				4			
	3	10						5			
	4							6			
		15									
	5							7			
	6	20		- Grey, moist below 6.10 m.				8			
								9			
	7										
		25									
	8			**SILTY CLAY (CI-CH)** - Grey, wet, soft to very soft, intermediate to high plasticity, trace silt pockets.				10			
	9	30						11			

SAMPLE TYPE ⊠ Auger Grab

CONTRACTOR Paddock Drilling Ltd.

INSPECTOR B. P. ARPIN

APPROVED

DATE 09-08-05

SPT & TORVANE P:\PROJECTS\2005\05-0107-07\GEO\LOGS\05-107-07 LOGS (EXPANDED).GPJ

KGS GROUP

SUMMARY LOG

HOLE NO.
TH-04A Rue Notre Dame

SHEET 2 of 2

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲ 40 80 120	Cu TORVANE (kPa) ◆ 20 40 60 80 / PL MC LL % 20 40 60 80
	11 35					12			
	12 40		**TILL** - Mixture of silt, medium to coarse grained sand and fine to coarse grained gravel. Grey, wet, very soft, intermediate plasticity.			13			
	13 45		- Tan, damp to wet, loose to dense, non plastic, trace clay below 12.95 m.			14			
	14					15			
	15 50				14.9 15.1 15.2 15.5 15.7				
	16		**AUGER REFUSAL AT 15.70 m**						
	55 17		Notes: 1. Soil stratigraphy from 0 to 8.23 m depth based on previous TH-04 completed on June 13, 2005. 2. Water level at 10.67 m below ground surface upon completion of drilling. 3. Installed Casagrande standpipe to a depth of 15.54 m. Top of pipe is 0.12 m below ground surface elevation. 4. Water level measured at 11.43 m below top of pipe when monitored on August 2, 2005.						
	18 60								
	19								
	65 20								
	21 70								

SAMPLE TYPE Auger Grab

CONTRACTOR Paddock Drilling Ltd.

INSPECTOR B. P. ARPIN

APPROVED

DATE 09-08-05

SPT & TORVANE P:\PROJECTS\2005\05-0107-07\GEO\LOGS\05-107-07 LOGS (EXPANDED).GPJ

KGS GROUP

KONTZAMANIS ▪ GRAUMANN ▪ SMITH ▪ MACMILLAN INC.
CONSULTING ENGINEERS & PROJECT MANAGERS

July 20, 2005 File No. 05-0107-07

City of Winnipeg
Water and Waste Department
1500 Plessis Road
Winnipeg, Manitoba
R3C 5G6

ATTENTION: Mr. Darcy Strandberg, C.E.T.
Project Manager

RE: Geotechnical Investigation
Proposed Gate Chamber – Rowandale Crescent Outfall

Dear Mr. Strandberg:

KGS Group was authorized by the City of Winnipeg Water and Waste Department to undertake a geotechnical site investigation for the proposed gate chamber construction at the existing Rowndale Crescent Outfall on the Red River. This letter report details the results of our investigation including a summary of soil and groundwater conditions at the site plus geotechnical design considerations for temporary shoring, lateral earth pressure, and backfill. Comments received from the City with respect to our draft letter report are included with this letter.

1.0 BACKGROUND

It is our understanding the proposed gate chamber will consist of cast-in-place concrete and be located approximately 3 m west of the existing manhole on the riverbank. The base of the gate chamber will be located approximately 7.8 m below grade and a braced or strutted excavation will be used for construction.

2.0 SITE INVESTIGATION

On June 13, 2005 KGS Group supervised the drilling of one (1) test hole to 7.9 m depth below existing ground surface at the approximate location of the proposed chamber. The test hole was advanced using 125 mm diameter solid stem augers with representative soil samples collected directly off the auger flights at 1.5 m intervals or at changes in stratigraphy. Drilling services were provided by Paddock Drilling Ltd. of Brandon, MB. with continuous KGS Group supervision. Laboratory testing was performed on select soil samples and included moisture content analysis and Atterberg limit testing.

STRUCTURAL■GEOTECHNICAL■ENVIRONMENTAL■HYDRAULICS■HYDROGEOLOGY■MUNICIPAL■MECHANICAL■ELECTRICAL
3RD FLR. – 865 WAVERLEY ST., WINNIPEG, MANITOBA, R3T 5P4 PH: (204) 896-1209 FAX: (204) 896-0754
560 SQUIER PLACE, THUNDER BAY, ONTARIO, P7B 6M2 PH: (807) 345-2233 FAX: (807) 345-3433

3.0 SITE CONDITIONS

3.1 Stratigraphy

In general, the stratigraphy at the site consisted of silty clay fill over a native silty clay overlying clayey silts and sands. The silty clay fill extended to a depth of 3.2 m below ground surface. The material was of low to intermediate plasticity, firm in consistency and contained trace medium to coarse grained gravel and organic matter. Underlying the fill, native silty clay extended to a depth of 4.6 m. The silty clay was grey in colour above the depth of 3.6 m and brownish grey below. The silty clay was of low to high plasticity, very soft to stiff in consistency, and contained a trace of fine to medium grained sand and trace organics throughout the deposit. The natural moisture content of the silty clay ranged from 26.6% to 28.1%, with an overall average of 27%. The undrained shear strength of the silty clay ranged from 10 to 75 kPa, with an overall average of 42 kPa as measured from the field Torvane. The undrained shear strength generally decreased with depth.

Underlying the silty clay were layers of clayey silts and sands approximately +/- 1.2 m thick extending to a depth of 7.9 m. The clayey silts and sands were brownish grey in colour, of low to intermediate plasticity, very soft to soft in consistency, and contained a trace of fine grained sand. Natural moisture content of the clayey silts and sands ranged from 28.2% to 35.7%, with an overall average of 32%. A summary soil log for the site is attached.

3.2 Groundwater Conditions

No groundwater infiltration or caving of the test hole side walls was observed during the test hole drilling. KGS Group is in the process of completing an additional test hole at the site, which will include installation of a standpipe piezometer in the underlying glacial till. The measured groundwater level from the piezometer will be reported to the City in a supplemental letter when available.

Groundwater levels vary seasonally and in response to precipitation such that future groundwater conditions at the site may vary from those observed at the time of this site investigation.

4.0 GEOTECHNICAL CONSIDERATIONS

4.1 Temporary Shoring

It is our understanding that temporary shoring will be used to support the side walls of the gate chamber excavation. Due to the depth of the excavation, space limitations, and close vicinity of the Red River strutted or braced walls are considered a suitable type of shoring for construction. The detailed design of the temporary shoring depends upon the final geometry of the excavation, the type of shoring utilized, and construction details. Design considerations should include the following:

- The shoring should be designed to resist the lateral earth pressure of the silty clay and the clayey silts and sands as well as groundwater pressures, and the surcharge load from construction equipment.

- An assessment of the potential for basal heave and blowout at the base of the excavation. Groundwater monitoring information from the standpipe piezometer that will be installed at the site shortly will be provided when available. Depending on the actual groundwater levels at the time of construction measures may be to counteract the risk of blowout, such as by temporary construction dewatering below the base of the proposed excavation.

- The design of any required temporary construction dewatering measures should include an evaluation of the potential settlement implications below any adjacent structures which could be supported by shallow foundations. This includes the adjacent manhole and underground piping.

- The vertical spacing of the internal struts should be designed and installed to minimize the potential for lateral and vertical soil movement, which could be detrimental to the existing infrastructure at the site.

- The removal of the temporary shoring and backfilling between the existing ground and the new gate chamber should be completed to minimize the potential for lateral and vertical ground movements.

- No stockpiling of excavated materials should be permitted adjacent to the excavation.

A registered professional engineer who is experienced with the design of braced excavations and the related soil and groundwater considerations should complete the shoring design.

4.2 Backfill

Free draining granular backfill should be placed around the chamber walls for a minimum width of 0.6 m and covered with a low permeability clay cap at ground surface. All backfill should be placed in maximum 150 mm thick lifts and compacted to a minimum of 95% Standard Proctor maximum dry density (SPMDD).

4.3 Lateral Earth Pressure

Providing the gate chamber is constructed using the backfill recommendations outlined above the permanent walls of the chamber may be designed using an at-rest earth pressure coefficient of 0.7 and the following expression, which assumes a triangular pressure distribution:

$$P_o = K_o (\gamma' H + q) + u$$

where:

P_o = Lateral earth pressure at-rest condition for restrained wall at a given depth (kPa)

K_o = Coefficient of earth pressure at-rest (assume 0.7)

γ' = Effective unit weight of retained soil (below water table $\gamma' = \gamma_{bulk} - \gamma_{water,}$ above water table $\gamma' = \gamma_{bulk}$)

γ_{bulk} = Bulk unit weight of soil (for clays and silts assume γ_{bulk} = 19 KN/m^3, for sands and gravels assume γ_{bulk} = 21 KN/m^3)

γ_{water} = Unit weight of water (9.81 KN/m^3)

H = Depth of wall below final grade (m)

q = Any surcharge pressure at ground surface (kPa)

u = net porewater pressure acting on wall (kPa)

4.4 Mat Slab

A mat slab foundation bearing on the native clayey sand or clayey silt suitable to support the proposed gate chamber. A design net allowable bearing capacity of 75 kPa may be used for a mat slab located at approximately 7.8 m below ground surface. The clayey silt soil encountered at the site is susceptable to a reduction in shear strength if the soil becomes saturated due to rainwater or runoff as well as excessive mechanical disturbance. In this regard placement of a lean mix concrete slab (mud slab) over the exposed bearing surface should be considered immediately following excavation.

4.5 Uplift

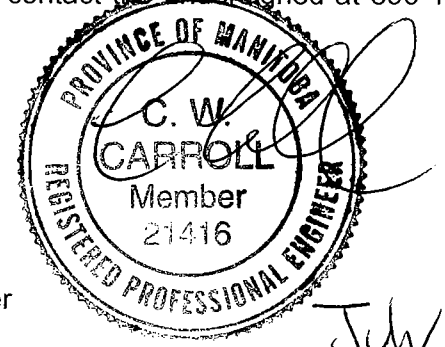
Taking into account the proposed embedment depth of the gate chamber and anticipated weight of the structure we do not anticipate there will be any special requirements to resist potential hydraulic uplift forces acting on the base slab. However we are currently in the process of verifying groundwater levels at the site by installing a standpipe piezometer. The additional groundwater monitoring information may be used to verify potential uplift pressures will be forwarded in a supplemental letter report when available.

5.0 SUMMARY

We have completed a geotechnical site investigation for the proposed gate chamber expansion at the Rowandale Crescent Outfall. The stratigraphy at the site consisted of clay fill over silty clay overlying clayey silts and clayey sands. Geotechnical design considerations for temporary shoring, backfill, lateral earth pressure, and foundations are included.

We thank you for the opportunity to provide engineering services on this project. If you have any questions please contact the undersigned at 896-1209 or Dr. Rob Kenyon, P. Eng. of our office.

Yours truly,



Chris Carroll, P. Eng.
Geotechnical Engineer

July 20/05

CC/jr
cc: Mr. Kas Zurek, P. Eng., Design and Construction Engineer

KGS GROUP

SUMMARY LOG

HOLE NO.
TH-01 Rowandale Crescent

CLIENT CITY OF WINNIPEG

PROJECT 2005 OUTFALL GATE CHAMBER UPGRADES - GEOTECHNICAL INVESTIGATIONS

SITE ROWANDALE CRESCENT

LOCATION ±3 m from centreline of existing manhole

DRILLING METHOD 125 mm ø Solid Stem Auger (Truck Mounted)

JOB NO. 05-107-07
GROUND ELEV.
WATER ELEV.
DATE DRILLED 13-Jun-05
UTM N 5533618
E 636417

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆
				TOPSOIL - Black, damp, with organic matter, trace medium to coarse grained sand.		1			
	1	5		**SILTY CLAY FILL** - Brown, damp, firm, low to intermediate plasticity, trace medium to coarse grained sand, trace organic matter.		2			
	2			- Grey, intermediate plasticity below 1.83 m.		3			
	3	10		**SILTY CLAY (CI-CH)** - Grey, damp, stiff, intermediate to high plasticity, trace medium grained sand, trace organic matter.		4			
	4			**SILTY CLAY (CL-CI)** - Brownish-grey, moist, very soft, low to intermediate plasticity, trace fine grained sand.		5			
	5	15		**CLAYEY SILT** - Brownish-grey, saturated, very soft, low plasticity, trace fine grained sand.		6			
	6	20		**CLAYEY SAND** - Brownish-grey, saturated, very soft, low plasticity clay, fine grained sand.		7			
	7	25		**CLAYEY SILT** - Brownish-grey, moist, soft, intermediate plasticity.		8			
	8			**END OF HOLE AT 7.92 m**					
	9	30		Notes: 1. No water in test hole at completion of drilling. 2. Test hole backfilled with cuttings and bentonite to surface.					

SPT scale: 40 80 120
Cu TORVANE scale: 20 40 60 80
PL MC LL
% scale: 20 40 60 80

SAMPLE TYPE Auger Grab

CONTRACTOR Paddock Drilling Ltd.
INSPECTOR B. P. ARPIN
APPROVED
DATE 20-07-05

SPT & TORVANE P:\PROJECTS\2005\05-0107-07\GEO\LOGS\05-107-07 LOGS.GPJ

2.0 GROUNDWATER CONDITONS

A summary of the groundwater levels measured at each site is shown in Table 1 below. This information is submitted to supplement the groundwater information included in our original July 20, 2005 letter reports.

TABLE 1
SUMMARY OF MEASURED GROUNDWATER LEVELS
2005 OUTFALL GATE CHAMBER UPGRADING PROGRAM

SITE	Rowandale Crescent	LeMaire Street	Rue Notre Dame	Kavanagh Street	Evans Street	Falconer Bay	Blackmore Avenue
TEST HOLE	TH-01A	TH-02A	TH-04A	TH-06A	TH-09A	TH-10A	TH-11A
STRATUM	Till	Till	Till	Till	Till	Till	Till
DATE	Measured Groundwater Level (m) [1]						
26-Jul-05	-	-	10.67	-	-	-	-
2-Aug-05	4.88	6.72	11.55	5.44	Dry	7.31	4.67

Notes:
"-" = No Data
1. All measured groundwater levels are below existing grade at test hole locations.

Groundwater levels vary seasonally and in response to precipitation such that future groundwater conditions at the site may vary from those reported herein.

3.0 SUMMARY

Standpipe piezometer installations and groundwater level monitoring has been performed at seven (7) sites for the 2005 Gate Chamber Upgrading Program. Measured groundwater levels are reported herein and supplement our original geotechnical letter reports dated July 20, 2005.

We thank you for the opportunity to provide engineering services on this project. If you have any questions please contact the undersigned at 896-1209 or Dr. Rob Kenyon, P. Eng. of our office.

Yours truly,

Chris Carroll, P. Eng.
Geotechnical Engineer

CC/jr
Attachment

cc: Mr. Kas Zurek, P. Eng., Design and Construction Engineer

KGS GROUP

SUMMARY LOG

HOLE NO.
TH-01A Rowandale Crescent

CLIENT CITY OF WINNIPEG

PROJECT 2005 OUTFALL GATE CHAMBER UPGRADES - GEOTECHNICAL INVESTIGATIONS

SITE ROWANDALE CRESCENT

LOCATION ±3 m from centreline of existing manhole

DRILLING METHOD 125 mm ø Solid Stem Auger (Truck Mounted), Hollow Stem Auger

JOB NO. 05-107-07.02.1000
GROUND ELEV.
WATER ELEV.
DATE DRILLED 26-Jul-05
UTM N 5533614
E 636415

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆
				TOPSOIL - Black, damp, with organic matter, trace medium to coarse grained sand.		0.3		1			
	1	5		**SILTY CLAY FILL** - Brown, damp, firm, low to intermediate plasticity, trace medium to coarse grained sand, trace organic matter.				2			
	2			- Grey, intermediate plasticity below 1.83 m.				3			
	3	10		**SILTY CLAY (CI-CH)** - Grey, damp, stiff, intermediate to high plasticity, trace medium grained sand, trace organic matter.				4			
	4			**SILTY CLAY (CL-CI)** - Brownish-grey, moist, very soft, low to intermediate plasticity, trace fine grained sand.				5			
	5	15		**CLAYEY SILT** - Brownish-grey, saturated, very soft, low plasticity, trace fine grained sand.				6			
	6	20		**CLAYEY SAND** - Brownish-grey, saturated, very soft, low plasticity clay, fine grained sand.				7			
	7	25		**CLAYEY SILT** - Brownish-grey, moist, soft, intermediate plasticity.				8			
	8			**SILTY CLAY (CL-CI)** - Grey, moist, very soft to soft, low to intermediate plasticity, some fine grained sand, trace silt.				9			
	9	30									

SPT (N) blows/0.30 m ▲: 40 80 120
Cu TORVANE (kPa) ◆: 20 40 60 80
PL MC LL
%: 20 40 60 80

SAMPLE TYPE Auger Grab

CONTRACTOR Paddock Drilling Ltd.
INSPECTOR B. P. ARPIN
APPROVED
DATE 09-08-05

SPT & TORVANE P:\PROJECTS\2005\05-0107-07\GEOLOGS\05-107-07 LOGS (EXPANDED).GPJ

KGS GROUP

SUMMARY LOG

HOLE NO.
TH-01A Rowandale Crescent

ELEVATION (m)	DEPTH (m)	(ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆
	11	35		- Wet between 11.13 to 12.65 m.			10		40 80 120	20 40 60 80
	12	40					11			PL MC LL
	13	45					12			% 20 40 60 80
	14			**SANDY CLAY** - Dark gray, moist, soft, intermediate plasticity, trace silt.						
	15	50					13			
	16									
		55					14			
	17			**MIXTURE OF SILTY AND SANDY CLAY** - Grey, wet, very soft, low to intermediate plasticity, some coarse grained sand and fine grained gravel.						
	18	60		**TILL** - Mixture of silt, clay, coarse grained sand and fine to coarse grained gravel. Tan and grey, wet, very soft, low plasticity.		18.4	15			
						18.6				
						18.7				
	19					19.1	16			
						19.2				
		65		**AUGER REFUSAL AT 19.20 m**						
	20			Notes: 1. Soil stratigraphy from 0 to 7.92 m depth based on previous TH-01 completed on June 13, 2005. 2. Test hole walls were sloughing in below 8 m depth, preventing the installation of the standpipe. Moved 1 m southwest of testhole and used hollow stem auger to install a Casagrande standpipe on July 27, 2005. Tip at 19.05 m depth. Top of pipe is 0.15 m below ground surface elevation. 4. Water level measured at 4.73 m below top of pipe when monitored on August 2, 2005.						
	21	70								

SAMPLE TYPE Auger Grab

CONTRACTOR Paddock Drilling Ltd.

INSPECTOR B. P. ARPIN

APPROVED

DATE 09-08-05

SPT & TORVANE P:\PROJECTS\2005\05-0107-07\GEO\LOGS\05-107-07 LOGS (EXPANDED).GPJ