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

August 15, 2007

File No. 07-0107-10

City of Winnipeg
Water and Waste Department
110-1199 Pacific Avenue
Winnipeg, Manitoba
R3E 3S8

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

RE: Site Investigation – Rainbow Stage Gate Chamber
2007 Outfall Gate Chamber Construction Program

Dear Mr. Strandberg:

This letter summarizes the results of KGS Group's geotechnical site investigation at the Rainbow Stage Gate Chamber including soil stratigraphy and groundwater monitoring. Information regarding lateral earth pressure coefficients, potential for blowout of the base of the excavation and suitable backfill soils are also included.

This information is submitted further to our letter of Proposal for Engineering Services dated June 21st, 2007.

1.0 BACKGROUND

It is our understanding that the new gate chamber at the Rainbow Stage Gate Chamber will incorporate new flap gates, positive gates and pump chambers and will be constructed at a proposed depth of 5.5 m at this location.

2.0 SITE INVESTIGATION

On July 11th, 2007 KGS Group supervised the drilling of one test hole (TH07-01) at the site located approximately 4 m south of the manhole at the site. The UTM coordinates of the test hole are noted on the test hole log, as measured by a handheld GPS unit. The test hole was drilled with the Acker MP5-T truck mounted drill rig operated by Paddock Drilling Ltd. of Brandon, Manitoba. The test hole was advanced using 125 mm solid stem augers to 17.37 m± below the existing ground surface. Representative soil samples were collected directly off auger flights at 1.5 m intervals or at changes in soil stratigraphy. All samples were visually inspected for material type and classified according to the Unified Soil Classification System. Clay samples were tested with a field Torvane to estimate undrained shear strength.

STRUCTURAL■GEOTECHNICAL■ENVIRONMENTAL■HYDRAULICS■HYDROGEOLOGY■MUNICIPAL■MECHANICAL■ELECTRICAL
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Laboratory testing was performed on select soil samples and included moisture content analyses and Atterberg Limit testing. Upon completion of the drilling, the test hole was examined for indications of squeezing and seepage. A Casagrande tip standpipe piezometer was installed in the till to measure piezometric levels.

A soil log incorporating all field observations and laboratory testing is attached to this letter.

3.0 STRATIGRAPHY

KGS Group's interpretation of the stratigraphy is based upon the test hole (TH07-01) drilled at the site and is outlined below.

Topsoil

A thin layer of topsoil approximately 0.1 m± was encountered at the existing ground surface. The topsoil was black organic, firm, and contained a trace amount of rootlets.

Silty Clay Fill

The topsoil was underlain by a layer of silty clay fill, which extended to approximately 2.1 m± below grade. The silty clay fill was dark brown in colour, of intermediate plasticity, moist, firm, contained some to with silt and trace amounts of rootlets, wood, gravel, coarse sand and oxidation.

Silty Clay – Alluvial Origin

A 2.5 m± thick layer of silty clay of alluvial origin was encountered below the fill and extended to 4.6 m± below grade. The silty clay was brown, moist, firm to stiff, of intermediate plasticity, and contained some to with silt and trace amounts of sand and oxidation. The undrained shear strength of this deosit, as estimated by the Field Torvane, ranged from 55 to 85 kPa. Moisture content of the alluvial clay ranged from 30% to 31%. Atterberg Limit testing from 2.7 m depth indicated a Liquid Limit of 56% and a Plasticity Index of 35% with the material being classified as CH based on the results.

Silty Sand

A silty sand was encountered from a depth of 4.3 to 5.5 m±. The sand was brown, coarse grained, wet, poorly graded, and contained some to with silt and a trace amounts of clay.

Silt

A silt was encountered below the silty sand and extended to a depth of 9.5 m± below grade. The silt was brown, wet, loose, with poorly graded fine grained sand and trace clay. The silt became grey below 7.0 m± and pockets of clay were encountered between 7.0 m± and 7.6 m± and between 8.2 m± and 9.2 m±.

Sand

The silt was underlain by a layer of sand from 9.5 m± to 10.4 m±. The sand was grey, poorly graded medium grained sand with trace to some fine grained sand.

Clay – Lacustrine Origin

Clay of lacustrine origin was encountered below the sand and extended to a depth of 16.2 m± below grade. The clay was grey, moist, soft to firm, of high plasticity and contained trace silt nodules. In general the clay became softer with depth and till inclusions below 14.3 m±. The undrained shear strength of this deposit, as estimated from the Field Torvane, ranged from 25 to 35 kPa, with an overall average of 29 kPa. Moisture content analyses of the lacustrine clay ranged from 39% to 60% with an average of 54%. Atterberg Limit testing from a depth of 13.4 m indicated a Liquid Limit of 85% and a Plasticity Index of 66%, with the material being classified as CH based upon the results.

Clay Till

Clay till was present below the lacustrine clay and extended to a depth of 17.4 m± where power auger refusal was encountered. The till was grey to pink, moist, compact to dense, of intermediate to high plasticity, and contained trace amounts of sand, gravel and silt.

Squeezing and sloughing of the test hole was observed below a depth of 4.6 m± during test hole drilling. Water infiltration into the test hole was observed at a depth of 4.6 m± from the silty sand layer.

4.0 GROUNDWATER CONDITONS

The groundwater level was measured twice. The water level was first read immediately after the installation of the piezometer and the groundwater level was 7.04 m below ground surface. A subsequent groundwater level of 5.44 m below ground surface was observed on July 27, 2007.

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

5.0 CONSTRUCTION CONSIDERATIONS

5.1 Basal Heave and Blowout

Based upon a proposed depth of excavation of 5.5 m for the proposed gate chamber and the measured groundwater conditions at this location, the estimated factor of safety against blowout of the base of the excavation is 1.7. Squeezing and sloughing of the test hole was noted below a depth of 4.6 m± where a silty sand layer was encountered during drilling. Difficult conditions should be anticipated during excavation below this depth as water infiltration and/or sloughing of the excavation walls may occur. Conventional pumping equipment and sheet piling should control potential water infiltration and sloughing.

5.2 Lateral Earth Pressure Coefficients

Estimated lateral earth pressure coefficients of the soil are summarized in the table below for soils within the depth of the proposed excavation of approximately 5.5 m.

Table 1 – Active, Passive and At-Rest Lateral Earth Pressure Coefficients

Soil Type	Estimated Friction Angle (Φ')	Ka	Kp	Ko
Clay Fill	18°	0.61	1.64	0.76
Silty Clay	18°	0.61	1.64	0.76
Silty Sand	25°	0.41	2.44	0.58
Silt	22°	0.46	2.17	0.63

Note : Ka = Active Earth Pressure
Kp = Passive Earth Pressure
Ko = Earth Pressure At-Rest

5.3 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).

6.0 SUMMARY

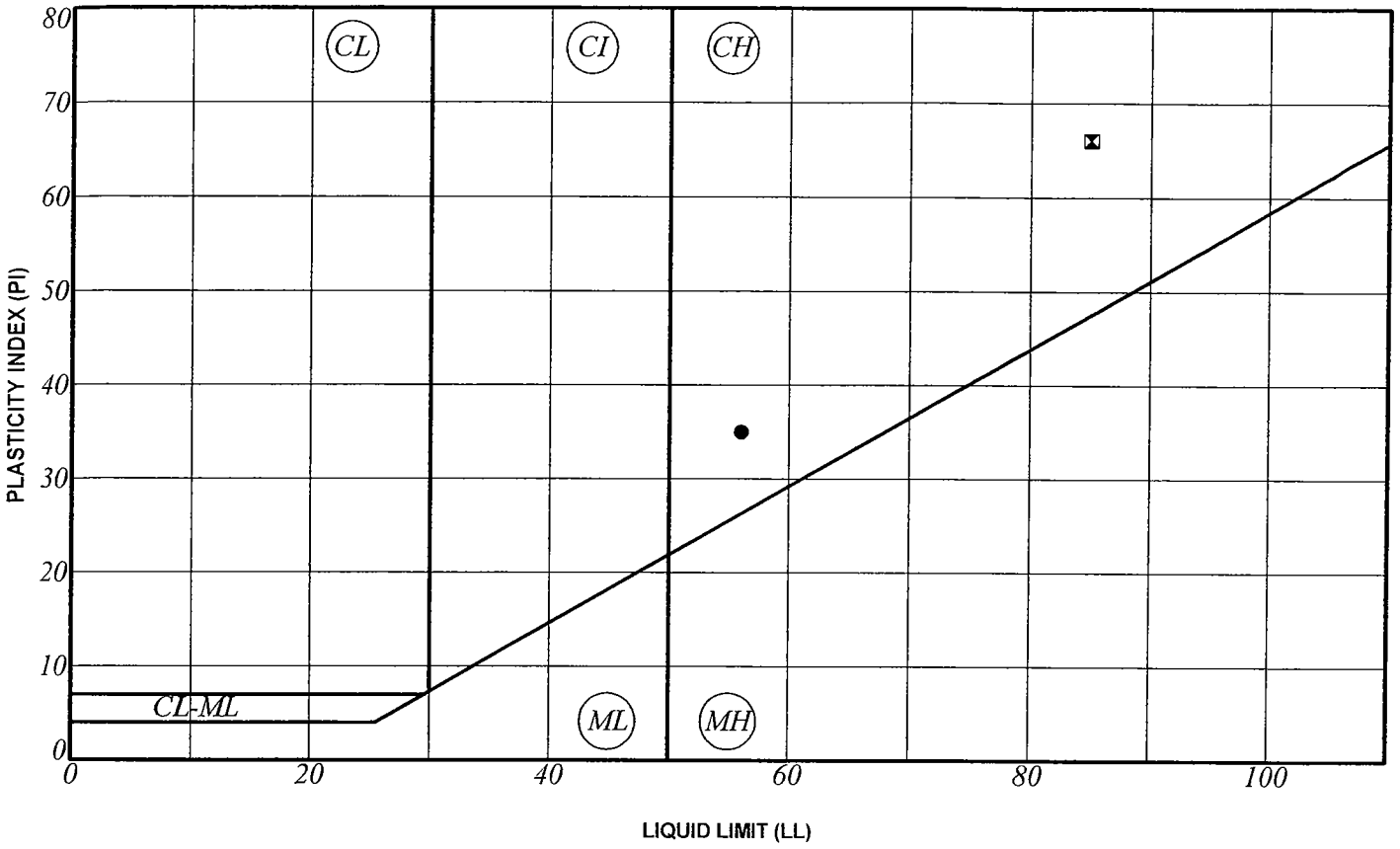
We have completed a geotechnical site investigation for the proposed gate chamber expansion at the Rainbow Stage Gate Chamber. The stratigraphy at the site generally consisted of topsoil over silty clay fill underlain by clay of alluvial origin over silty sand underlain by silt and sand over till. Construction Design considerations for basal heave and blowout, lateral earth pressure coefficients and backfill are included.

KGS Group thanks you for the opportunity to provide engineering services on this project. If you have any questions please contact the undersigned at 896-1209.

Yours truly,

David Anderson, M. Sc., P. Eng.
Geotechnical Engineer

RD/ja



SYMBOL	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	% SAND	% SILT	% CLAY	% MC	CLASSIFICATION
●	TH07-01	2.7		56	21	35				31.1	
⊠	TH07-01	13.4		85	19	66				59.5	

Notes:
ML - Low Plasticity Silt
MH - High Plasticity Silt
CL-ML - Silty Clay
CL - Low Plasticity Clay
CI - Intermediate Plasticity Clay
CH - High Plasticity Clay
LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index
MC - Moisture Content

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CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

2007 GATE CHAMBER UPGRADES

A-LINE PLOT

Aug 2007	Figure 1	Page 1 of 1

A-LINE PLOT (MAY 2004) 07-107-10LOGS.GPJ GEN_FT_M.GDT 15/8/07

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SUMMARY LOG

HOLE NO. **TH07-01**

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT 2007 GATE CHAMBER UPGRADES
SITE Rainbow Stage (Gate Chamber)
LOCATION 4 m South of Manhole at the Site
DRILLING METHOD 125 mm ø Solid Stem Auger, Acker MP5-T

JOB NO. 07-107-10
GROUND ELEV.
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 11-Jul-07
UTM (m) N 5,533,792
E 636,236

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (40 80 120)	POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
	1	5		**TOPSOIL** - Black, organics, trace rootlets.						
				SILTY CLAY FILL (CI) - Dark brown, moist, firm, intermediate plasticity, some to with silt, trace coarse grained sand, trace gravel, trace oxidation, trace rootlets, trace wood pieces.			S1			
	2			**SILTY CLAY (ALLUVIAL) (CI)** - Brown, moist, firm to stiff, intermediate plasticity, lean clay, some to with silt, trace sand, trace oxidation.						
	3	10					S2			
	4			- Lighter brown, softer below 4.27 m.						
		15		- Water table at 4.27 m.			S3			
	5			**SILTY SAND (SM)** - Brown, wet, loose, poorly graded coarse grained sand, some to with silt, trace clay.			S4			
	6	20		**SILT (ML)** - Brown, wet, soft to very soft, low plasticity, with poorly graded fine grained sand, trace clay.			S5			
	7			- Grey, increased clay pockets below 7.01 m.						
		25		- No clay, increased fine grained sand below 7.62 m.			S6			
	8			- Clay pockets below 8.23 m.						
	9	30		**SAND (SP)** - Grey, wet, loose, poorly graded medium grained sand, trace to some fine grained sand.			S7			

SAMPLE TYPE Auger Grab

CONTRACTOR Paddock Drilling Ltd.
INSPECTOR D. ANDERSON
APPROVED _____ DATE 13/8/07

SPT & TORVANE 2 P:\PROJECTS\2007\07-0107-10\GEO\LOGS\07-107-10LOGS.GPJ

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SUMMARY LOG

HOLE NO. **TH07-01**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
	11	35		**CLAY (LACUSTRINE) (CH)** - Grey, moist, soft to firm, high plasticity, massive structure, fat clay, trace silt nodules.			S	S8			
							S	S9			
				- Becoming softer with depth.							
	12	40					S	S10			
	13										
		45					S	S11			
	14			- Trace till inclusions below 14.33 m.							
	15	50					S	S12			
	16			**CLAY TILL** - Grey to pink, moist, firm to dense, intermediate to high plasticity, trace silt, trace sand, trace gravel.		16.3 16.5	S	S13			
		55									
	17					17.4					
				AUGER REFUSAL AT 17.37 m.							
	18	60		Note: 1. Water level measured at 7.04 m below ground surface in standpipe after drilling. 2. Test hole sloughed and squeezed below 4.57 m. 3. Installed Casagrande standpipe at 17.37 m with 1.03 m stickup. 4. Water infiltration into test hole at 4.57 m.							
	19										
		65									
	20										
	21	70									

SAMPLE TYPE S Auger Grab

CONTRACTOR Paddock Drilling Ltd.

INSPECTOR D. ANDERSON

APPROVED _____ DATE 13/8/07