Memorandum

To:	Colin Siepman, M.Eng., P.Eng.	Date:	January 7, 2025
		Project No.:	24-0107-005
From:	David Anderson, M.Sc., P.Eng.	Prepared By:	Tanveer Mubarik, M.Eng., P.Eng.
Re:	Geotechnical Assessment Memorandum for Doncaster Outfall Gate Chamber – Rev01		

1.0 INTRODUCTION

This memorandum presents a summary of the site evaluation conducted by KGS Group and offers suggestions for the design and construction of the Doncaster Outfall Gate Chamber.

2.0 SCOPE OF WORK

The scope of works for the geotechnical engineering services were completed in accordance with KGS Group's proposal # 24-000-0492, dated March 2024.

2.1 Geotechnical Scope of Work

The geotechnical engineering services completed for this assignment included the following.

Utility Locate and Site Clearance: KGS Group completed all public utility clearances for site access, including identification and locating all public underground and overhead utilities prior to commencement of the subsurface investigation.

Geotechnical Investigation: An on-site hand auger test hole was completed to determine the subsurface soils and groundwater conditions within the footprint of the proposed chamber expansion.

Geotechnical Assessment: A geotechnical assessment of the site conditions including considerations for the proposed chamber expansion works is summarized in this report and includes the following.

- Design parameters for the outfall chamber expansion works include Ultimate Limit State (ULS) and Serviceability Limit State (SLS) bearing capacity.
- Information is provided on frost depth, potential for frostjacking and mitigation measures, active and passive earth pressure coefficients, comments on temporary excavation, shoring and dewatering, and type of cement for concrete mix.

3.0 GEOTECHNICAL ENGINEERING PROGRAM

3.1 Hand Auger Program

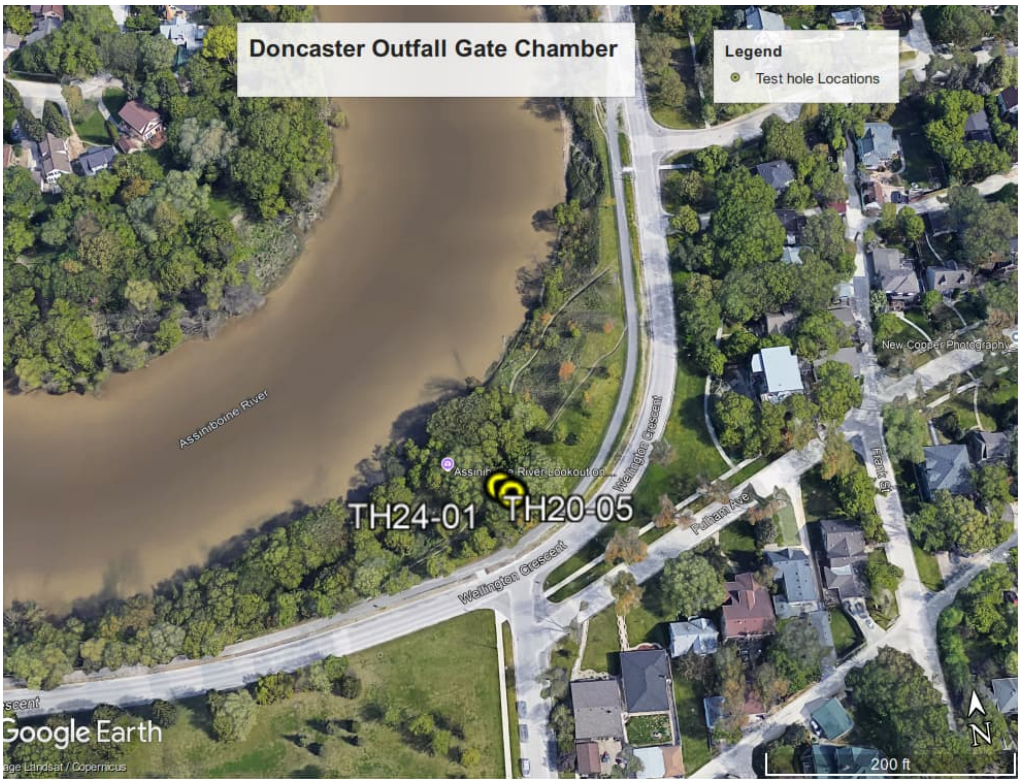
At the preliminary design stage KGS Group undertook a geotechnical hand auger exploration to understand the soil conditions above the Doncaster Gate Chamber within the footprint of the proposed chamber expansion. One (1) hand auger test hole (TH24-01) was completed on the upstream side of the gate chamber on June 25, 2024.

In general, the soil stratigraphy at the site has been interpreted by KGS Group to consist of lean clay fill overlying high plasticity clay fill. The clay fill was assessed stiff to very stiff.

The soil conditions encountered to the depth of exploration comprised lean clay fill overlying high plasticity clay fill. Clay fill was utilized as backfill above the gate chamber during its initial construction.

Soil conditions were observed consistent with the drilling conducted for the Wellington Crescent Riverbank, Path, and Roadway Project. A test hole (TH20-05) was drilled to the west of the gate chamber, reaching clay till at an elevation of 227.1 meters, with refusal encountered in silt till at an elevation of 224.9 meters. Test hole logs (TH20-05) and (TH24-01) are provided in Appendix A, and approximate test hole locations are shown on Figure 01.

FIGURE 01: TEST HOLE LOCATIONS



3.2 Commentary on Existing Geotechnical Conditions

Historically, this site has experienced deep seated riverbank movements as evidenced by a headscarp immediately downslope of Wellington Crescent. This movement has been documented to be occurring in a slope inclinometer installed at the site in 2020 for the Wellington Crescent Riverbank, Path and Roadway Project.

Subsequently in the winter of 2020/2021, the City of Winnipeg undertook the installation of riverbank works at the Doncaster Gate Chamber as a part the Wellington Crescent Riverbank, Path and Roadway Project to provide protection to this key infrastructure at this location. These works consisted of the installation of a 3 m wide trench rockfill shear key, shoreline rockfill riprap blanket, and riverbank offloading along an approximate 85 m length of riverbank. These works are shown on DWG P-3536-15 of City of Winnipeg Tender 568-2020. Since installation of these works and the continued monitoring of instrumentation at the site, which were last read in June 2024, there has been very minimal additional bank movement measured.

The additional weight of the gate chamber addition will be designed to be carried by the underlying till material and therefore will not provide any additional load to the riverbank. Since, stability works have been constructed to protect the site previously, as noted above, and the gate chamber addition applying no additional loading to the riverbank, no additional riverbank stability works are required for the proposed gate chamber addition.

4.0 GEOTECHNCIAL DESIGN CONSIDERATIONS

4.1 Outfall Chamber Foundation

The foundation considerations described in this report follow Limit State Design (LSD) guidelines. Limit State Design requires consideration of two (2) main loading states: Ultimate Limit State (ULS) and Serviceability Limit State (SLS). The ULS are primarily concerned with collapse mechanisms of the structure and safety, and the SLS present conditions or mechanisms that restrict or constrain the intended use, function, or occupancy of the structure under expected service or working loads.

Design parameters listed in the Section 4.1 presents the unfactored ULS design values and represent the nominal (ultimate) geotechnical resistance, R_n. The appropriate geotechnical resistance factors (Φ) should be applied to determine the factored geotechnical resistance as presented in the following equation:

$$\Phi R_n \geq \Sigma \alpha_i S_{ni}$$

Where:

- Φ – geotechnical resistance factor
- R_n – nominal (ultimate) geotechnical resistance
- $\Sigma \alpha_i S_{ni}$ – summation of the factored overall load effects for a given load combination

The proposed outfall chamber works will be supported by a reinforced concrete base slab bearing on a lean-mix concrete working slab, bearing directly on the in-situ native silt till soil. The working and base slabs can be designed on the native silt till with a factored ULS and SLS bearing capacities of 300 and 150 kPa, respectively. A geotechnical resistance factor (Φ) of 0.5 should be applied to the provided ULS value to

determine the factored geotechnical resistance. The provided SLS value is expected to limit settlements to less than 25 mm; however, some movement is expected and all mechanical connections to the valve chamber should be designed to accommodate such displacement.

The following recommendations should be applied for preparation of the subgrade:

- Excavate to the subgrade design elevation and proof-roll compact the subgrade. If soft spots or areas of unsuitable deflections are encountered, the subgrade should be sub-excavated an additional 300 mm and replaced with compacted granular.
- The granular should be placed in 150 mm thick lifts and compacted to 98% Standard Proctor Maximum
- Dry Density (SPMDD). All granular material shall conform to the City of Winnipeg Standard Material Specifications.
- Inspection of the prepared subgrade foundation should be provided by experienced geotechnical personnel prior to construction of the lean-mix working slab.

4.2 Lateral Earth Pressure

The active, passive, and at-rest earth pressure coefficients provided in Table 1 below can be used in the design of temporary shoring or any below grade walls. It is anticipated that excavations will encounter the high plasticity clay (fill) and silt till units.

TABLE 1: EARTH PRESSURE COEFFICIENTS

Material	Bulk Unit Weight (kN/m^3)	ϕ'	K_a	K_p	K_o
Granular	22	32	0.307	3.255	0.470
Fill (Clay)	18	17	0.548	1.826	0.708
Silt Till	21	30	0.333	3.000	0.500

Surface live loads should be included if a significant loading is applied within a distance equal to that of the excavation wall height. The lateral earth pressure due to the surface live load should be equal to 50% of the vertical pressure due to the surface live load.

4.3 Temporary Excavation, Shoring and Dewatering

Temporary excavations may be required to facilitate the construction of the proposed outfall chamber expansion. All excavation works are required to be performed in accordance with the Manitoba Workplace Safety and Health Act and Regulation.

Excavations performed adjacent to existing roadway or infrastructure, require temporary shoring or bracing. Excavations deeper than 1.5 m are required to be designed and approved prior to construction by an experienced professional engineer with an expertise in geotechnical engineering. The shoring design should account for all applicable surcharge loads. Openings and voids behind shoring lagging or sheet piles will be backfilled with free draining granular materials.

The high plasticity clay fill soils are known to be water bearing and are susceptible to strength loss when subjected to mechanical disturbance and sloughing from wetting. All open excavation side slopes should prevent saturation of the soil, and all surface runoffs should be directed away from the excavations. All surcharge loads such as stockpiled soil, equipment, etc., should be maintained a minimum of 10 m away from the edge of excavations.

It is anticipated that the high plastic characteristics of the overlying clay fill materials will restrict water infiltration and conventional pumping techniques will likely manage any potential water infiltration.

4.4 Frost Penetration

The expected depth of frost penetration has been estimated assuming a design freezing index of 2589°C days, taken as the coldest winter over a 10 year period. The estimated maximum depth of frost penetration is 2.5 m assuming no insulation cover.

Well graded granular materials with less than 5% fines should be used as backfill material as they are less susceptible to the effects of frost heave than clay type soil material. Soil in contact with foundation elements can freeze to the foundations and develop adfreeze bonding, which can result in uplift forces. The 5th Edition of the Canadian Foundation Engineering Manual (CFEM 2023) recommends the following adfreeze bond stresses for soil and foundation materials:

- 65 kPa for fine grained soils frozen to wood or concrete;
- 100 kPa for fine grained soils frozen to steel; and
- 150 kPa for saturated gravel frozen to steel.

4.5 Type of Cement for Concrete Mix

All concrete should be made with high sulphate-resistant cement (HS or HSb), and all concrete footings should have a minimum specified 28-day compressive strength of 35 MPa and class of exposure of S-1 corresponding to very severe sulphate attack. A maximum water to cement ratio of 0.40 should be specified in accordance with Table 2 of CSA A23.1 for concrete with very severe sulphate exposure (S1). Concrete which may be exposed to freezing and thawing should be adequately air entrained to improve freeze-thaw durability in accordance with Table 4 of CSA A23.1.

STATEMENT OF LIMITATIONS AND CONDITIONS

Limitations

This memorandum has been prepared for City of Winnipeg in accordance with the agreement between KGS Group and City of Winnipeg (the "Agreement"). This memorandum represents KGS Group's professional judgment and exercising due care consistent with the preparation of similar documents. The information, data, recommendations and conclusions in this memorandum are subject to the constraints and limitations in the Agreement and the qualifications in this memorandum. This memorandum must be read as a whole, and sections or parts should not be read out of context.

This memorandum is based on information made available to KGS Group by City of Winnipeg. Unless stated otherwise, KGS Group has not verified the accuracy, completeness or validity of such information, makes no representation regarding its accuracy and hereby disclaims any liability in connection therewith. KGS Group shall not be responsible for conditions/issues it was not authorized or able to investigate or which were beyond the scope of its work. The information and conclusions provided in this memorandum apply only as they existed at the time of KGS Group's work.

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Any use a third party makes of this memorandum or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this memorandum.

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TM/cs

Attached

Approved By:

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Senior Geotechnical Engineer

APPENDIX A

Test hole Logs

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KEY TO SYMBOLS

LITHOLOGIC SYMBOLS

- Asphalt
- Clay (CH, high plasticity)
- Clay (CI, intermediate plasticity)
- Clay Till
- Concrete
- Fill (made ground)
- Poorly Graded Gravel (GP)
- Silt Till
- Silty Sand (SM)
- Poorly Graded Sand (SP)
- Topsoil

SAMPLER SYMBOLS

Auger Grab

Core Barrel

Split Barrel

SPT Split Spoon

WELL CONSTRUCTION SYMBOLS

Bentonite Grout

Slope Inclinometer (grout)

ABBREVIATIONS

LL - Liquid Limit
PL - Plastic Limit
PI - Plastic Index
MC - Moisture Content
DD - Dry Density
NP - Non-Plastic
-200 - Percent Passing No. 200 Sieve
TV - Torvane (kPa)
PP - Pocket Penetrometer (kPa)
PSA - Particle Size Analysis
TOC - Top Of Casing

PN - Pneumatic Piezometer
VW - Vibrating Wire Piezometer
PID - Photoionization Detector
ppm - Parts Per Million
▽ Water Level During Drilling
▼ Water Level Upon Completion of Drilling
▼ Water Level Remeasured/Static

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CLIENT	**CITY OF WINNIPEG - PUBLIC WORKS**	**PROJECT NO.**	18-0107-011
PROJECT NAME	Wellington Cres. - Riverbank, Path and Road Works	**LOCATION**	Winnipeg, MB

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TEST HOLE LOG

HOLE NO.
TH24-01

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	24-0107-005
PROJECT	**Doncaster Outfall Gate Chamber Upgrades**	**SURFACE ELEV.**	232.71 m
LOCATION	Winnipeg, Manitoba	**START DATE**	6-25-2024
DESCRIPTION	1 m South of Gate Chamber	**UTM (m)**	N 5,526,103
DRILL RIG / HAMMER	Hand Auger		E 628,753 Zone 14
METHOD(S)	0.0 m to 1.5 m: 75 mm ø Hand Auger		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	SAMPLE TYPE	NUMBER
				LEAN CLAY - 457 mm, Black, damp, soft, low plasticity, with roots, some fine sand, trace medium sand.			S1
					232.3		
				FAT CLAY - Black to dark grey, damp, firm, high plasticity, with roots, trace laminated silt.			S2
232				- Stiff, some fine sand, trace medium sand below 0.6 m.			
				- Trace fine sand, trace roots below 0.8 m.			
	1.0			- Very stiff, trace coarse sand, trace fine gravel below 1.1 m.			
				- Light grey to brown below 1.3 m.			S3
					231.2		
		5		Notes: 1. End of test hole at 1.5 m. 2. Test hole backfilled with auger cuttings.			
231							
	2.0						
230							
	3.0	10					

PL MC LL
Cu TORVANE (kPa) ◆
qu POCKET PEN (kPa) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80

WATER LEVELS

CONTRACTOR **KGS Group**
INSPECTOR **R. NAUTH**
APPROVED
DRAFT
DATE

KGS_LOG_U:\FMS\24-0107-005\24-0107-005 DONCASTER OUTFALL CHAMBER_GINT_LOGS_DRAFT_JUNE 26, 2024.GPJ

KGS GROUP

TEST HOLE LOG

HOLE NO.
TH20-05

CLIENT	**CITY OF WINNIPEG - PUBLIC WORKS**	**PROJECT NO.**	18-0107-011
PROJECT	**Wellington Cres. - Riverbank, Path and Road Works**	**SURFACE ELEV.**	232.56 m
LOCATION	Winnipeg, MB	**TOC STICK-UP / ELEV.**	0.00 m / 232.56 m (Inclinometer)
DESCRIPTION	Upper Bank, at Doncaster Street, west of gate chamber	**DATE DRILLED**	8/21/2020
DRILL RIG / HAMMER	Acker MP8 with Auto-Hammer	**UTM (m)**	N 5,526,106.4
METHOD(S)	0.0 m to 3.0 m: 125 mm ø SSA		E 628,750.38
	3.0 m to 7.3 m: 150 mm ø HSA - switched due to Installing inclinometer		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	PIEZO. LOG DIAGRAM	PIEZO. LOG DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
232	0	0		**TOPSOIL/ORGANICS** - Black, dry, friable, some rootlets, some sand/gravel.	232.1								
	1	5		**CLAY FILL** - Dark grey, dry to damp, very stiff, intermediate plasticity, trace organics/rootlets, trace silt inclusions, some gypsum inclusions.						S1			
231	2			- Stiff, silt inclusions (100 mm thick) below 2.1 m.						S2			
										S3			
230	3	10		- Silty inclusion (50 mm thick) at 3.2 m.	229.4								
229				**CLAY (CH)** - Mottled grey/brown, damp, stiff, high plasticity, trace to some silt inclusions (up to 25 mm dia.), trace fine gravel, trace fine to coarse grained sand.						S4	100		
	4	15											
228										S5			
	5			- Silt seam (50 mm thick) at 4.9 m.			Vibrating Wire 68312	5.0					
				- Silt seam (140 mm thick) at 5.2 m. - Trace fine gravel below 5.3 m.	227.1					S6	100		
227				**CLAY TILL** - Light brown to grey, damp, firm, intermediate plasticity, with silt, some fine to coarse grained sand, trace fine grained gravel.	226.5	▼				S7			
	6	20		- Increased moisture below 5.9 m.	226.2					S8	100		
226				**SAND TILL** - Light brown, damp, fine grained sand, trace silt.									
	7			**SILT TILL** - Light brown, dry, very dense, very compact, some sand, trace fine gravel.			Vibrating Wire 68311	7.2					
225		25			224.9			7.3 7.6		S9	100	54 60	+100
	8			Notes: 1. End of test hole at 7.6 m. 2. Power auger refusal encountered in till at a depth of 7.3 m. 3. Test hole remained open to 7.6 m upon completion of drilling. 4. Slope inclinometer installed to a depth of 7.3 m. 5. Test hole backfilled with cement-bentonite grout. 6. Seperate hole drilled for the installation of VW piezometers (0.6 m east).								
224													
	9	30											
223													
	10												
222		35											

PL MC LL
Cu TORVANE (kPA) ◆
Cu POCKET PEN (kPA) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80

WATER LEVELS ▼ **Upon Completion of Drilling** 6.10 m

CONTRACTOR
Paddock Drilling

INSPECTOR
N. BRAY

APPROVED
C. ROBAK

DATE
9/11/2020

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