

APPENDIX 'A'

GEOTECHNICAL REPORT

MEMORANDUM

TO: Craig Rowbotham
FROM: Kyle Hamilton, David Anderson
DATE: January 3, 2017
FILE NO: 16-0107-010
RE: East Winnipeg CRRC - Geotechnical Investigation and Assessment – Rev 1

1.0 SCOPE OF WORK

The engineering services that have been provided for this project are identified below:

- **Utility and Site Clearances:** 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.
- **Test hole Drilling and Soil Sampling:** An on-site drilling program was completed to investigate the subsurface and groundwater conditions at the site. The drilling program consisted of advancing one (1) deep test hole to power auger refusal and 11 shallow test holes to a depth of 6 m. Environmental monitoring wells were installed in four (4) shallow test holes and one (1) Casagrande tipped standpipe piezometer was installed in the deep test hole.
- **Summary Geotechnical Memo:** The following information is provided and/or discussed in this summary geotechnical memo:
 - Detailed test hole logs of site stratigraphy incorporating field observations, laboratory test results and estimated depth of groundwater.
 - Considerations for both shallow and deep foundations, including Ultimate Limit States (ULS) bearing capacity and skin friction values in accordance with the 2010 National Building Code of Canada.
 - Considerations for the storm water retention pond, retaining walls, pavements, exterior walkways and site preparation including drainage.
 - Considerations for floor slabs, construction excavations, shoring and other structures
 - Estimates of active and passive earth pressure coefficients of the soils assessed.
 - Considerations for cement type and concrete requirements as they relate to sulphate levels in the existing soil.
 - Estimates of freeze – thaw susceptibility and evaluation of potential soil expansion and its effect on slabs at-grade.
 - General considerations for excavations and subsurface drainage.
 - Estimated total and differential settlement for the considered foundation system due to compressible soil, liquefaction and consolidation.

2.0 INVESTIGATION PROGRAM

2.1 TEST HOLE DRILLING AND SOIL SAMPLING PROGRAM

A drilling and sampling program consisting of one (1) deep test hole and 11 shallow test holes was completed from August 16 to 17, 2016. Drilling services were provided by Maple Leaf Drilling Ltd. of Winnipeg, Manitoba with continuous KGS Group supervision. All test holes were completed using an ACKER MP5 track mounted drill rig equipped with 125 mm diameter solid stem continuous flight augers. The locations of the test holes are shown on Figure 1 with the approximate UTM coordinates (Zone 14) and ground elevations for the test holes provided on Table 1.

Representative disturbed soil samples were obtained in all test holes at 1.5 m (5 ft) intervals, or at any change in soil strata. Soil samples were collected directly off the auger flights and visually classified in the field in accordance with the modified Unified Soil Classification System (USCS). Clay samples were field tested with a Field Torvane to evaluate consistency and estimate the undrained shear strength. Standard Penetration Tests (SPTs) were performed in the till to determine the relative in-situ density.

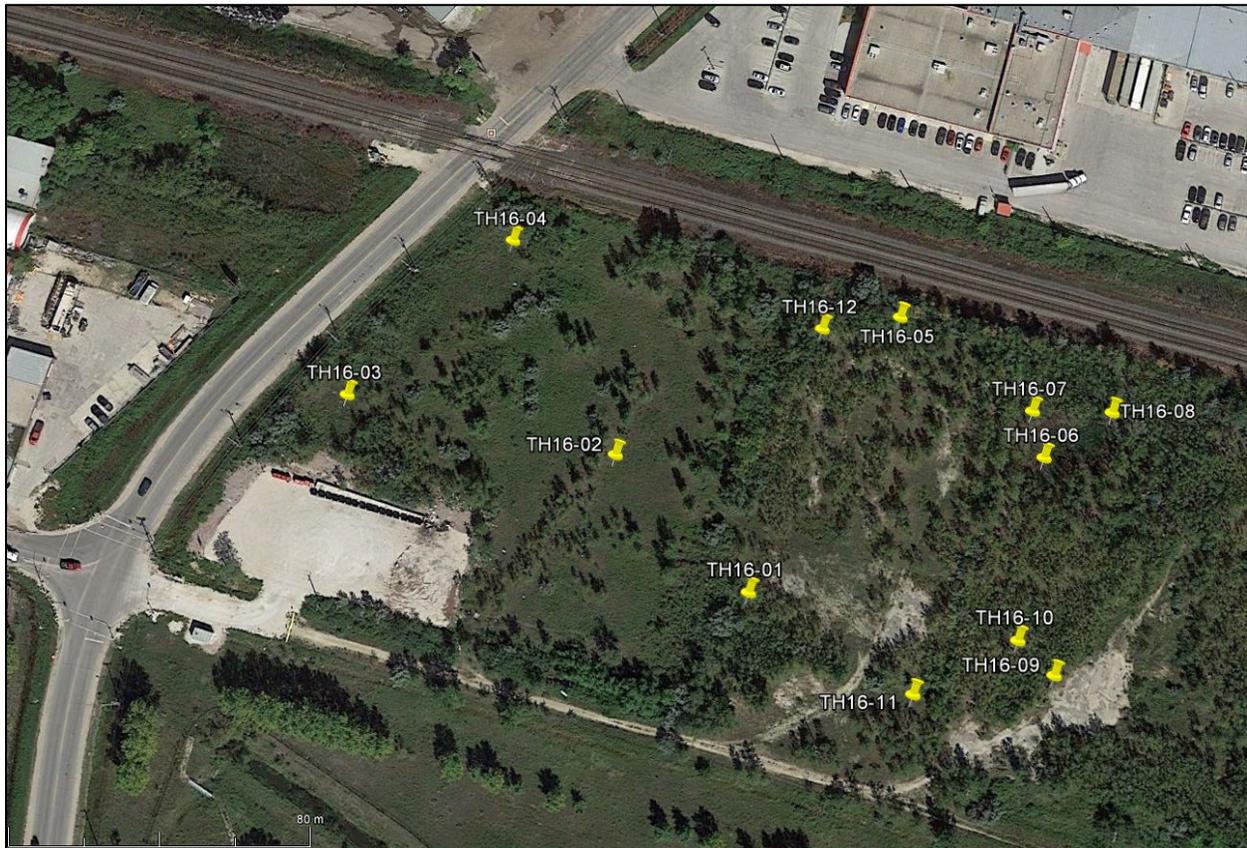
Upon completion of drilling, the test holes were examined for indications of sloughing, squeezing and seepage, and then backfilled to grade. Detailed summary soil logs incorporating all field observations details are provided in Appendix A.

**TABLE 1
 APPROXIMATE TEST HOLE COORDINATES AND ELEVATIONS**

| TEST HOLE ID | APPROXIMATE UTM COORDINATES | | GROUND ELEVATION (m) | DEPTH TO TILL (m) | POWER AUGER REFUSAL (m) |
|--------------|-----------------------------|---------|----------------------|-------------------|-------------------------|
| | NORTHING | EASTING | | | |
| TH16-01 | 5528631 | 638148 | 232.6 | 16.2 | 18.8 |
| TH16-02 | 5528668 | 638110 | 232.6 | - | - |
| TH16-03 | 5528683 | 638034 | 232.0 | - | - |
| TH16-04 | 5528729 | 638078 | 232.4 | - | - |
| TH16-05 | 5528709 | 638189 | 232.3 | - | - |
| TH16-06 | 5528670 | 638229 | 232.7 | - | - |
| TH16-07 | 5528683 | 638226 | 232.5 | - | - |
| TH16-08 | 5528683 | 638521 | 232.9 | - | - |
| TH16-09 | 5528611 | 638231 | 233.0 | - | - |
| TH16-10 | 5528620 | 638221 | 232.9 | - | - |
| TH16-11 | 5528605 | 638193 | 232.7 | - | - |
| TH16-12 | 5528705 | 638167 | 232.5 | - | - |

Note: Ground elevations interpolated from existing KGS Group site plan.

**FIGURE 1
APPROXIMATE TEST HOLE LOCATIONS**



2.2 INSTRUMENTATION

Four (4) environmental monitoring wells were installed in TH16-01, TH16-02, TH16-08 and TH16-10 at a depth of 6 m and were numbered MW-01, MW-02, MW-03 and MW-04, respectively. Additionally, one (1) Casagrande tipped standpipe piezometer was installed in TH16-01 at a depth of 17.4 m in the silt till to monitor the groundwater conditions of the underlying till at the site. Details of the instrumentation installations are provided on the test hole logs in Appendix A.

2.3 LABORATORY TESTING

A diagnostic laboratory testing program was performed on select representative soil samples to determine the relevant engineering properties of the subsurface soils which included 12 moisture content tests.

Laboratory testing was completed at a Standards Council of Canada accredited soil testing laboratory in Winnipeg, Manitoba in accordance with ASTM Standards. The results of the laboratory testing are included on the test hole logs in Appendix A.

2.4 STRATIGRAPHY AND GROUNDWATER CONDITIONS

2.4.1 Site Stratigraphy

In general, the stratigraphy at the site has been interpreted by KGS Group to consist of fill overlying high plastic silty clay underlain by silt till. The thickness of the fill was variable throughout the site ranging from 0.5 m to 2.0 m. A silt layer with a consistent thickness ranging from 0.9 m to 1.4 m was encountered in all test holes separating the upper and lower silty clay. An isolated layer of organic clay was encountered from 1.0 m and 2.1 m below ground surface in TH16-08, northeast of the existing wetland area. Auger refusal was encountered in TH16-01 at 18.8 m below existing ground surface on suspected boulders or bedrock. Shallow auger refusal occurred when drilling through the surficial fill in TH16-06 and TH16-12 at a depth of 0.46 m due to the presence of concrete debris.

Fill

Fill was encountered below ground surface in all the test holes. The thickness of the fill varied from 0.5 m in TH16-07 to 2.0 m in TH16-09. The fill was highly variable and ranged from silty clay to granular fill. The fill was typically damp, stiff to very stiff in consistency, of intermediate to high plasticity, and contained some sand and gravel, concrete debris, wood debris, bricks, glass, cinders, wire, plastic and nails. The undrained shear strength of the silty clay fill, as estimated by the Field Torvane was greater than 100 kPa. The moisture content of the fill varied between 11% and 27%.

The fill in the area of TH16-09 was covered by a 25 mm thick asphalt pavement cap.

Silty Clay (CH)

Native silty clay was generally encountered below the fill from 0.5 m to 2.0 m below existing ground surface. The upper silty clay was dark brown in colour, damp, stiff to very stiff in consistency, of high plasticity and contained trace medium to coarse grained sand and trace fine grained gravel. The lower silty clay was mottled dark grey and dark brown, damp to moist, firm to stiff, becoming soft with depth, of high plasticity and contained trace silt inclusions. The upper and lower silty clay deposits were separated by a 0.9 m to 1.4 m thick layer of silt, encountered at 2.1 m to 4.1 m below existing ground surface. The undrained shear strength of the upper clay, as estimated by the Field Torvane, varied throughout the strata from 60 kPa to greater than 100 kPa. The undrained shear strength of the lower clay decreased with depth from 50 kPa to 15 kPa. The moisture content of the clay varied between 19% and 28%.

Organic Clay (OH)

Organic clay was encountered below the fill in TH16-08, northeast of the existing wetland area. The organic clay was black in colour, damp, stiff, of high plasticity and contained trace rootlets. The organic clay was approximately 1.0 m thick and was encountered 1.1 m below existing ground surface. The undrained shear strength of the organic clay, as estimated by the Field Torvane ranged from 50 kPa to 65 kPa.

Silt (ML)

Silt was encountered in all test holes between the upper and lower silty clay deposits at a depth ranging from 2.1 m to 4.1 m below existing ground surface. The silt layer had a consistent thickness ranging from 0.9 m to 1.4 m. The silt was grey and brown in colour, moist and of low to no plasticity. The moisture content of the silt varied between 18% and 20%.

Silt Till

Silt till was encountered below the silty clay in TH16-01 at a depth of 16.2 m below existing ground surface. Power auger refusal occurred at 18.8 m below existing ground surface on suspected boulders or bedrock.

The silt till was grey, damp to moist, compact becoming very dense with depth and contained some sand and trace gravel. Uncorrected SPT values within the silt till were 14 blows per 300 mm.

2.4.2 Groundwater Conditions

Seepage and sloughing was encountered while drilling within and below the silt layer in all the test holes.

Four (4) environmental monitoring wells were installed in TH16-01, TH16-02, TH16-08 and TH16-10 in the silty clay at a depth of 6.0 m and were numbered MW-01, MW-02, MW-03 and MW-04, respectively. Additionally, one (1) Casagrande tipped standpipe piezometer was installed in TH16-01 at a depth of 17.4 m in the silt till to monitor the groundwater conditions of the underlying till at the site. A protective above ground casing was installed to safeguard the instrumentation installed in each test hole. Details of the instrumentation installations are provided on the test hole logs in Appendix A.

Table 2 summarizes the piezometric monitoring completed to date. In general, the groundwater at the site is interpreted to have a downward hydraulic gradient through the clays down to the till. Based on previous experience, groundwater levels will fluctuate seasonally and following precipitation events, hence the actual water level at the time of construction could differ from those reported in this memo.

**TABLE 2
 PIEZOMETRIC MONITORING DATA**

| Test hole | TH16-01 | | TH16-02 | TH16-08 | TH16-10 |
|--------------------|---------------------------|---------------|---------------|---------------|---------------|
| Monitoring Well | MW-01A | MW-01B | MW-02 | MW-03 | MW-04 |
| Top of Pipe (m) | 233.41 | 233.36 | 233.36 | 233.66 | 233.71 |
| Ground Elev. (m) | 232.6 | 232.6 | 232.6 | 232.9 | 232.9 |
| Tip Elev. (m) | 226.5 | 226.5 | 226.5 | 226.8 | 226.8 |
| Monitoring Zone | Silt Till | Silty Clay | Silty Clay | Silty Clay | Silty Clay |
| Date | Piezometric Elevation (m) | | | | |
| September 15, 2016 | 222.35 | 229.81 | 230.33 | 231.19 | 230.07 |

2.5 POTENTIAL DIFFICULT GROUND CONDITIONS

During the test hole drilling investigation, groundwater infiltration and test hole sloughing was encountered in all test holes within and below the silt layer. The groundwater inflows and subsequent sloughing in these areas will have to be dealt with during construction. In the event that water inflows are encountered, it is anticipated that they may be controlled by conventional high capacity pumping equipment and the use of casing, sheet piling or shallow temporary cut slopes on excavation faces. Shoring or temporary cut slopes greater than 1.5 m deep or below the water table must be designed by a qualified geotechnical engineer.

3.0 FOUNDATION CONSIDERATIONS

Shallow foundations are not considered a suitable foundation alternative. Shallow footing foundations bearing directly on either the fill or overburden clay will not perform satisfactorily due to the expansive nature of the clay (the ability of the clay to swell or shrink under varying seasonal groundwater conditions) and the potential differential settlements that would occur as a result.

The foundation considerations described in this memo follow the Limit States Design (LSD) guidelines. Limit States Design requires consideration of two (2) main loading states: Ultimate Limit States and Serviceability Limit States. The Ultimate Limit States (ULS) are primarily concerned with collapse mechanisms of the structure and safety, and the Serviceability Limits States (SLS) present conditions or mechanisms that restrict or constrain the intended use, function or occupancy of the structure under expected service or working loads. For pile foundation design, each loading state prescribes Geotechnical Resistance Factors (Φ) that are based upon the method used to evaluate pile capacity to obtain the Factored Serviceability Limit State (SLS) and Factored Ultimate Limit State (ULS) pile capacity values. A Geotechnical Resistance Factor of (Φ) of 0.4 has been applied to the factored ULS and SLS values presented below.

3.1 CAST-IN-PLACE CONCRETE FRICTION PILES

Cast-in-place concrete piles may be used to support the proposed building foundation loads. For design purposes, the upper 2.5 m of pile length below final ground elevation of piles potentially exposed to frost and extending through the fill should be neglected when determining pile capacities. For piles not exposed to frost the upper 2.0 m of pile length below final grade should be neglected. It should be noted that this applies to piles installed in the native silty clay only, and the fill or organic material should be assumed to provide no support. Exterior piles should have a minimum length of 8 m, with the full depth reinforcement to resist frost jacking.

Friction piles may be designed based upon the estimated Ultimate Limit State (ULS) and Serviceability Limit State (SLS) skin friction values provided on Table 3. A geotechnical resistance factor (Φ) of 0.4 has been applied to the estimated average factored resistance values. Piles that are designed to be friction piles should be designed to resist the load by shaft resistance only. The contribution from end bearing should be ignored in the pile capacity calculations.

**TABLE 3
 LIMIT STATE DESIGN VALUES - AVERAGE FACTORED SKIN FRICTION VALUES
 FOR C.I.P. PILES UNDER COMPRESSIVE LOADING**

| Depth Below Grade (m) | Serviceability Limit State (SLS) Values (kPa) | Ultimate Limit State (ULS) Values (kPa) |
|-----------------------|---|---|
| 0 m to 2.5 m | 0 | 0 |
| 2.5 m to 8.0 m | 10.5 | 13 |
| Below 8.0 m | 6 | 8 |

Notes:

- 1) Values apply for piles installed in the native silty clay only, and not fill material.

The potential exists for sloughing of the bore hole during the installation of the cast-in-place concrete piles at this site. Temporary steel sleeves should be used as required during pile installation in an effort to maintain the drill shaft in a clean and dry state. The concrete should be poured immediately following the drilling of each shaft. Should heavy groundwater inflow be encountered, concrete placement should be completed using tremie or pump-in methods, or alternatively driven piles should be used if seepage cannot be controlled. Drilling and concrete placement for the piles should be inspected by experienced geotechnical personnel to verify the soil conditions and proper installation of the piles.

3.2 ADDITIONAL CONSIDERATIONS FOR PILE FOUNDATIONS

Additional considerations for the design and construction of the pile foundations are provided below:

- (a) The spacing between adjacent piles should be a minimum of 3 pile diameters, as measured from centre to centre.
- (b) In addition to piles acting individually, friction piles can act as a group when closely spaced, less than 3 pile diameters apart. Group action occurs when the soil between adjacent piles is dragged down and shaft resistance develops around the perimeter of the group only. If it is necessary to space piles closer than 3 pile diameters apart, the capacity of these piles acting as a group will need to be evaluated once final geometry and spacing of the piles is known.
- (c) To minimize the potential for uplift due to frost action and/or swelling of the clay, all piles should have a minimum embedded length of 8 m with reinforcing over the full length of the cast-in-place pile.
- (d) Since seepage and sloughing may occur within and below the silt deposit, full-length steel sleeves should be maintained on site and utilized as required during construction to maintain the pile shaft and base in a clean dry state.
- (e) When seepage is encountered, which cannot be controlled by sleeves during piling, removal of the water from the pile holes prior to pouring concrete or placing concrete by tremie methods may be required. At all times during removal of the steel sleeve, a head of concrete shall be maintained sufficiently above the sleeve bottom to limit sloughing and seepage into the pile hole from the adjacent ground.

- (f) The reinforcement and concrete should be placed immediately following the drilling of each pile to prevent disturbance to the foundation soil during subsequent construction activity. Where this is not possible on the day of drilling, the pile hole should be refilled and later redrilled, once concrete is ready to place.
- (g) A full time inspection by experienced geotechnical personnel should be completed throughout construction of foundations to ensure that the design capacities indicated in this memo are achieved. Detailed construction records should also be kept by qualified personnel throughout construction.
- (h) All concrete piles should utilize CSA Type 50 sulphate resistant cement.
- (i) A minimum of 150 mm thick void space should be provided beneath all structural elements including pile caps and grade beams to accommodate the expansive nature of the underlying soil.

3.3 POTENTIAL SETTLEMENT CAST-IN-PLACE CONCRETE FRICTION PILES

Given the existing clay material on site is generally firm to very stiff in consistency, the potential settlement of cast-in-place frictional piles is expected to be minor (less than 10 mm).

4.0 DESIGN CONSIDERATIONS FOR OTHER STRUCTURES

4.1 STRUCTURAL SLAB-ON-GRADE FLOOR

The slab-on-grade floor founded on the native silty clay may be assigned a factored bearing capacity of 100 kPa. The following should be considered for this alternative:

- Sub-excavate the surficial soils to the subgrade design elevation and proof-roll compact the native soil subgrade. A non-woven geotextile should also be placed on the subgrade prior to sub-base placement.
- A minimum 150 mm thick layer of granular base and 300 mm thick layer of sub-base should be placed immediately below the slab.
- All granular should be placed in maximum 150 mm thick lifts and compacted to 98% Standard Proctor Maximum Dry Density (SPMDD). Granular base and sub-base materials should meet Standard Materials Specifications.
- A minimum of 150 mm void space should be constructed under all structural elements including pile caps and grade beams to accommodate the expansive nature of the underlying soil.
- The final ground elevation around the perimeter of the buildings should be sloped away at a minimum 2% grade, to protect against surface water ponding.

Both seasonal movement and/or differential settlement and potential cracking of the concrete slab may occur over time with grade supported slabs given the variability of the fill and given the highly expansive nature of the native clay. This alternative should be selected only if some movement and differential settlement is acceptable. Differential settlements of 50 to 100 mm do

routinely occur for floor slabs poured directly on grade in these clays but can be greater. Where this is deemed unacceptable a structural slab supported on intermediate piles should be utilized.

4.2 PAVEMENT STRUCTURE

On the basis of the soil conditions encountered during drilling and subject to inspection by qualified geotechnical personnel, the public and operational asphalt concrete pavement structures for the community resource recovery center can be designed on the basis of the values provided in Table 4 and Table 5.

**TABLE 4
 PUBLIC VEHICLE AREA – ASPHALT CONCRETE PAVEMENT SECTIONS**

| PAVEMENT STRUCTURE | THICKNESS | % COMPACTION |
|---------------------------------------|---|------------------|
| Asphaltic Concrete | 100 mm | 98% Marshall |
| Base Course (20 mm crushed limestone) | 150 mm | 100% Std Proctor |
| Sub-base (50 mm crushed limestone) | 250 mm | 100% Std Proctor |
| Subgrade | - Proof-rolled with heavy sheepsfoot roller - Place non-woven geotextile | |

**TABLE 5
 OPERATIONAL VEHICLE AREA – ASPHALT CONCRETE PAVEMENT SECTIONS**

| PAVEMENT STRUCTURE | THICKNESS | % COMPACTION |
|---------------------------------------|---|------------------|
| Asphaltic Concrete | 100 mm | 98% Marshall |
| Base Course (20 mm crushed limestone) | 150 mm | 100% Std Proctor |
| Sub-base (50 mm crushed limestone) | 350 mm | 100% Std Proctor |
| Subgrade | - Proof-rolled with heavy sheepsfoot roller - Place non-woven geotextile | |

The subgrade should be sub-excavated to the design elevation and proof-rolled using a heavy sheepsfoot roller to achieve a minimum compaction of 98% Standard Proctor Maximum Dry Density (SPMDD). The subgrade should be inspected by qualified geotechnical personnel prior to the placement of the overlying granular base. Areas that exhibit unsuitable deflection or unsuitable soils such as organic matter, silts or soft clays should be sub-excavated as directed by the geotechnical personnel and replaced with compacted granular subbase to 100% SPMDD. Non-woven geotextile fabric should be placed as a separator between the clay subgrade and compacted granular fill.

The granular base course and subbase materials should include organic-free, non-frozen, aggregate conforming to the City of Winnipeg Specifications (CW3110). Sieve analysis and compaction testing of the granular base and subgrade materials should be conducted by qualified geotechnical personnel to ensure that the materials supplied and percent compactions are in accordance with design specifications.

For the hot mix asphaltic concrete, gradation analysis of the aggregates compaction testing and Marshall testing should be undertaken. This will provide data to confirm that the asphaltic concrete pavement complies with the project specification.

Slab-on-grade concrete pads can be utilized for isolated areas where larger static wheel loads may exist. Exterior grade supported concrete slabs (including sidewalks) will be subjected to seasonal vertical movements related to frost action and varying seasonal groundwater conditions. Connection and tie-in details between the exterior concrete slabs and rigid structures element such as grade beams, pile caps or interior slabs should account for this potential vertical movement. To minimize the frost heave movements, consideration should be given to the use of rigid synthetic insulation, extending outward laterally (2 m (min) length and 100 mm (min) thickness) and beneath the structure.

4.3 EXTERIOR SIDEWALKS

Based on the soil conditions encountered during the site investigation and the City of Winnipeg Standard Construction Specification, the concrete pavement structure for exterior sidewalks can be designed on the basis of the section provided in Table 5 below.

**TABLE 6
 EXTERIOR SIDEWALK SECTIONS**

| PAVEMENT STRUCTURE | THICKNESS | % COMPACTION |
|---|-----------|-----------------|
| Residential | | |
| Concrete (reinforcing can be omitted) | 100 mm | N/A |
| Sub-base (20 mm crushed limestone) | 75 mm | 95% Std Proctor |
| Crossing in or adjacent to industrial or commercial zone | | |
| Reinforced Concrete | 150 mm | N/A |
| Sub-base (50 mm crushed limestone) | 150 mm | 95% Std Proctor |

Sidewalk construction should be performed in accordance with City of Winnipeg Standard Construction Specification CW 3325 – Portland Cement Concrete Sidewalk.

4.4 LATERAL EARTH PRESSURE

For design purposes the soils may be assigned active, passive and at-rest lateral earth pressure coefficients as shown in Table 6.

**TABLE 7
 LATERAL EARTH PRESSURE COEFFICIENTS**

| BACKFILL MATERIAL | ϕ' | K_a | K_p | K_o |
|-----------------------------|---------|-------|-------|-------|
| Silty Clay, Silty Clay Fill | 20° | 0.5 | 2.0 | 0.7 |
| Silt, Silt Till | 30° | 0.3 | 3.0 | 0.5 |
| Well Graded Granular Fills | 35° | 0.3 | 3.7 | 0.4 |

5.0 OTHER DESIGN CRITERIA

5.1 TEMPORARY CONSTRUCTION EXCAVATIONS AND SHORING

Construction excavation details were not available at the time of preparation of this memo. Preliminary guidance for temporary excavations is provided on Table 7.

**TABLE 8
PRELIMINARY GUIDANCE FOR TEMPORARY EXCAVATIONS**

| HEIGHT OF EXCAVATION (m) | SIDE SLOPE |
|-----------------------------|------------|
| 0 – 1.5 | 1H : 1V |
| 1.5 – 3.0 | 2H : 1V |
| 3.0 – 5.0 | 3H : 1V |
| 5.0 – 6.5 | 4H : 1V |

If excavation is to be performed adjacent to the existing streets or infrastructure temporary shoring or bracing will be required. Suitable options include steel piling and timber lagging or driven steel sheet piling. Notwithstanding Table 7, any excavation deeper than 1.5 m should be reviewed and designed prior to construction by an experienced professional engineer with an expertise in geotechnical engineering.

Due to the silt layer, the soil may be susceptible to sloughing from wetting and mechanical disturbance. All open excavation side slopes should be covered to prevent saturation of the soil and all surface runoff should be directed away from excavations. All surcharge loads such as stockpiled soil, equipment, etc. should be kept a minimum of 10 m away from the edge of excavations.

During the site investigations seepage and sloughing occurred when drilling through and below the silt layer. Therefore potential localized groundwater inflows into an excavation below the water table are likely whenever the silt deposit is encountered, which may require temporary pumping as well as potential shoring. Design of the above measures depends on the size, depth and extent of the excavation.

5.2 FROST PENETRATION

The depth of frost penetration will vary depending on air temperature, ground cover, the type of any fill material used during development and other factors. Surficial soils at this site consisted of silty clay and granular fills.

The expected depth of frost penetration has been estimated assuming a design freezing index of 2680°C days, taken as the coldest winter over a ten (10) year period. The estimated maximum depth of frost penetration is 2.5 m assuming bare ground and no insulation cover. The clay soils can heave upon freezing and that consideration must be considered in the foundation design. Good site drainage must also be maintained after development.

Well graded granular materials should be utilized as structural backfill material as they are less susceptible to the effects of frost heave than fine grained silt and clay materials. Polystyrene insulation can be used as a thermal insulator to minimize any effects that frost could potentially have on foundations or slabs.

The depth of burial (minimum 2.5 m) of water lines or other lines that cannot be allowed to freeze should consider local practice. Shallow lines can be protected using a heat trace or closed cell extruded polystyrene insulation. The amount and extent of insulation required will be dependent on several factors including the thermal regime around the pipe, the depth of burial, surface conditions, and fluid temperature, if present.

5.3 TYPE OF CEMENT FOR CONCRETE MIX

All concrete should be made with high sulphate-resistant cement (HS or HSb), and all cast-in-place piles and pile caps 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, CSA A23.1-04 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, CSA A23.1-04.

5.4 SITE SURFACE DRAINAGE

Exterior grades adjacent to all buildings and retaining walls should be sloped a minimum 2% to promote positive drainage away from the perimeter of all structures and to protect against surface water ponding. Roadways, parking lots, unloading areas and landscaping within a zone of approximately 2 m of the exterior perimeter of any structure should be sloped at a minimum gradient of 5% to compensate for future loss of grade that may result from potential settlement. Downspouts should be positively directed away from structures and beyond the backfill zone.

5.5 SITE SUBSURFACE DRAINAGE

A permanent subdrain system should be installed around the exterior of underground walls, including retaining walls. Internal drainage should also be given consideration with a perforated weeping tile wrapped with filter sock in a granular (pea gravel or crushed rock) trench directing flows to a central sump pit. All granular fill placed within the weeping tile trench should be free draining. The ground surface next to the building or retaining wall should be positively graded to promote surface runoff away from the structure. All subsurface drainage should be in accordance with locally accepted practices.

5.6 SETTLEMENT OF EMBANKMENT FILL

Given that the existing material on site ranges from very stiff to soft silty clay, the potential settlement of any constructed embankment on site may be up to 10% of the height of the embankment fill above existing ground surface.

6.0 STORM WATER RETENTION POND

6.1 POND EXCAVATION

Earthwork design should utilize a cut/fill balance approach if the excavated pond material is not needed for other purpose such as landscaping, etc. The clay material excavated from the pond can be utilized for construction of the pond berms. A detailed geotechnical slope stability analysis of the final pond geometry and groundwater conditions is necessary and was not completed at this time as the geometry of the pond has not been determined. For preliminary purposes, Table 8 may be used as a guideline for safe side slopes of the pond.

TABLE 9
RECOMMENDED MINIMUM SIDE SLOPES FOR POND

| HEIGHT OF SLOPE (m) | RECOMMENDED SIDE SLOPE |
|---------------------|------------------------|
| 0 –1.5 | 3H : 1V |
| 1.5 –3.0 | 4H : 1V |
| > 3 | 5H : 1V |

6.2 POND LINER

A suitable liner type for the proposed pond is a compacted clay liner. The compacted clay liner may be constructed from suitable material sourced from the pond excavation or other excavations on site. The compacted clay liner should be placed on both the base and interior slopes of the pond. The clay material shall be spread and compacted to 98% Standard Proctor Maximum Dry Density (SPMDD) in layers not exceeding 200 mm in thickness to form a homogenous, low permeability layer.

7.0 STATEMENT OF LIMITATIONS THIRD PARTY USE OF REPORT

This memo has been prepared for KGS Group to whom this report has been addressed and any use a third party makes of this report, 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 report.

7.1 STATEMENT OF LIMITATIONS

The geotechnical investigation findings and recommendations of this report were prepared in accordance with generally accepted professional engineering principles and practices. The findings and recommendations are based on the results of field and laboratory investigations, combined with an interpolation of soil and groundwater conditions found at and within the depth of the test holes drilled by KGS Group at this site. If conditions encountered during construction appear to be different from those shown by the test holes drilled by KGS Group or if the assumptions stated herein are not in keeping with the design, the office should be notified in order that the recommendations can be reviewed and modified if necessary.

Prepared by:



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KH/jr

Reviewed by:



David Anderson, M.Sc., P.Eng.
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APPENDIX A
TEST HOLE LOGS

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT EAST WINNIPEG CRRC
SITE Corner of Panet and Mission
LOCATION Building
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Track Mounted Drill Rig

JOB NO. 16-0107-010
GROUND ELEV. 232.59
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 16/08/2016
UTM (m) N 5,528,631
 E 638,148

| ELEVATION (m) | DEPTH | | GRAPHICS | DESCRIPTION AND CLASSIFICATION | PIEZ. LOG | DEPTH (m) | SAMPLE NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △ | Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆ | | |
|---------------|-------|------|----------|--|-----------|-----------|---------------|------------|---|---|----|------|
| | (m) | (ft) | | | | | | | | PL | MC | LL |
| 233.0 | | | | SILTY CLAY FILL - Dark brown to black, damp, very stiff, high plasticity, some sand, some gravel. | | | | | | | | |
| 231.2 | 1 | | | GRANULAR FILL - Reddish brown, damp, compact to dense, wood debris, pieces of bricks, glass. | | | | | | | | >100 |
| 231 | | 5 | | SILTY CLAY (CH) - Brown, damp, very stiff, high plasticity, trace medium to coarse grained sand, trace fine grained gravel. | | | | | | | | >100 |
| 230 | | 2 | | - Brown below 2.44 m. | | | | | | | | >100 |
| 229.7 | | 3 | | SILT (ML) - Grey and brown, moist, no to low plasticity. | | 3.0 | | | | | | >100 |
| 229 | | | | | | | S05 | | | | | |
| 228.8 | | 4 | | SILTY CLAY (CH) - Mottled dark grey and dark brown, damp to moist, firm to stiff, high plasticity, trace silt inclusions. | | | | | | | | |
| 228 | | 15 | | - Firm below 4.88 m. | | | S06 | | | | | |
| 227 | | 5 | | | | | S07 | | | | | |
| 226 | | 6 | | | | | S08 | | | | | |
| 225 | | 20 | | | | | S09 | | | | | |
| 224 | | 7 | | - Firm to soft below 7.62 m. | | | S10 | | | | | |
| 223 | | 8 | | | | | S11 | | | | | |
| | | 9 | | - Soft below 9.14 m. | | | S12 | | | | | |
| | | 30 | | | | | S13 | | | | | |

GEO TECHNICAL - SOIL LOG U:\FMS\16-0107-010\EAST WINNIPEG CRRC GEO.GPJ

SAMPLE TYPE  Auger Grab

CONTRACTOR **Maple Leaf Drilling Ltd.** INSPECTOR **K. HAMILTON**

APPROVED **D. ANDERSON**

DATE **4/10/16**

| ELEVATION (m) | DEPTH | | GRAPHICS | DESCRIPTION AND CLASSIFICATION | PIEZ. LOG | DEPTH (m) | SAMPLE TYPE NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △ | Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆ | | | | |
|---------------|-------|------|----------|--------------------------------|-----------|---|--------------------|------------|---|---|----|----|--|--|
| | (m) | (ft) | | | | | | | | PL | MC | LL | | |
| | | | | | | | | | 20 40 60 | 20 40 60 80 | | | | |
| 222 | | 35 | | | | | | | | | | | | |
| 221 | 11 | | | | | | | S14 | | | | | | |
| 220 | 12 | 40 | | | | | | | | | | | | |
| 219 | 13 | | | | | | | S15 | | | | | | |
| 218 | 14 | 45 | | | | | | | | | | | | |
| 217 | 15 | | | | | | | S16 | | | | | | |
| 216.4 | 16 | 50 | | | | | | | | | | | | |
| 216 | 17 | 55 | | | | SILT TILL - Grey, damp to mposit, compact, some sand, trace gravel. | | S17 | | | | | | |
| 215 | 18 | 60 | | | | - Very dense below 18.29 m. | | S18 | 100 | ▲ 5 ▲ 6 ▲ 8 | | | | |
| 214 | 19 | 65 | | | | AUGER REFUSAL ON SUSPECTED BOULDERS OR BEDROCK AT 18.75 m | | S19 | 100 | ▲ 10 ▲ 50 | | | | |
| 213.8 | | | | | | | | | | | | | | |
| 213 | 20 | 70 | | | | Notes: 1. Test hole remained open to 3.05 m below grade after drilling. 2. Water at 3.05 m below grade after drilling. 3. SPT at 15.24 m below grade refused at the end of the 2nd set. Limestone pieces were observed in the split spoon. 4. Installed Cassagrande tipped piezometer at 17.37 m below grade. 5. Backfilled test hole with bentonite chips from 3.05 m below grade to grade. | | | | | | | | |
| 211 | 21 | | | | | | | | | | | | | |

SAMPLE TYPE Auger Grab

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
K. HAMILTON

APPROVED
D. ANDERSON

DATE
4/10/16

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT EAST WINNIPEG CRRC
SITE Corner of Panet and Mission
LOCATION Centre
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Track Mounted Drill Rig

JOB NO. 16-0107-010
GROUND ELEV. 232.57
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 17/08/2016
UTM (m) N 5,528,668
 E 638,110

| ELEVATION (m) | DEPTH | | GRAPHICS | DESCRIPTION AND CLASSIFICATION | PIEZ. LOG | DEPTH (m) | SAMPLE TYPE NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △ | Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆ | | |
|---------------|-------|------|----------|---|-----------|-----------|--------------------|------------|---|---|----|------|
| | (m) | (ft) | | | | | | | | PL | MC | LL |
| 232.2 | | | | SILTY CLAY FILL - Dark brown to black, damp, very stiff, high plasticity, some sand, some gravel. | | | | | | | | |
| 231.2 | 1 | | | CINDERS - Black, damp. | | 1.2 | S01 | | | | | >100 |
| 231 | | 5 | | SILTY CLAY (CH) - Brown, damp, stiff, high plasticity, trace medium to coarse grained sand, trace fine grained gravel. | | 1.5 | S02 | | | | | >100 |
| 229.5 | | 10 | | SILT (ML) - Grey and brown, moist, no to low plasticity. | | | S03 | | | | | |
| 228.9 | | 15 | | SILTY CLAY (CH) - Mottled dark grey and dark brown, damp to moist, stiff, high plasticity, trace silt inclusions. - Firm below 4.27 m. | | | S04 | | | | | |
| 228 | | 20 | | | | | S05 | | | | | |
| 227 | | 25 | | | | | S06 | | | | | |
| 226.5 | | 30 | | | | | S07 | | | | | |
| 226 | | | | END OF TEST HOLE AT 6.2 m | | 6.1 | S08 | | | | | |
| 225 | | | | Notes: 1. Test hole remained open to 3.05 m below grade after drilling. 2. Water at 3.05 m below grade after drilling. 3. Installed 50 mm monitoring well from 1.52 m to 6.2 m below grade. 4. Backfilled test hole with sand from 3.05 m to 1.22 m below grade and bentonite chips to grade. | | | | | | | | |
| 224 | | | | | | | | | | | | |
| 223 | | | | | | | | | | | | |

SAMPLE TYPE Auger Grab

CONTRACTOR **Maple Leaf Drilling Ltd.** INSPECTOR **K. HAMILTON**

APPROVED **D. ANDERSON**

DATE **4/10/16**

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT EAST WINNIPEG CRRC
SITE Corner of Panet and Mission
LOCATION Northwest
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Track Mounted Drill Rig

JOB NO. 16-0107-010
GROUND ELEV. 232.38
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 16/08/2016
UTM (m) N 5,528,729
 E 638,078

| ELEVATION (m) | DEPTH | | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲ | DYNAMIC CONE (N) blows/ft △ | Cu POCKET PEN (kPa) ★ | | Cu TORVANE (kPa) ◆ | |
|---------------|-------|-------|------------------|---|--------------------|------------|------------------------|-----------------------------|-----------------------|----|--------------------|------|
| | (m) | (ft) | | | | | | | 20 | 40 | 60 | 80 |
| 233.3 | | | [Cross-hatched] | SILTY CLAY FILL - Brown, damp, stiff, high plasticity, some sand, some gravel. | | | | | | | | |
| 232.3 | 1 | 3.3 | [Diagonal lines] | SILTY CLAY (CH) - Brown, damp, stiff, high plasticity, trace medium to coarse grained sand, trace fine grained gravel. - Black below 1.07 m. - Brown below 1.37 m. | S01 | | | | | | | |
| 231.3 | 5 | 16.4 | [Diagonal lines] | | S02 | | | | | | | |
| 229.9 | 2 | 34.5 | [Diagonal lines] | | S03 | | | | | | | |
| 229.0 | 3 | 51.5 | [Vertical lines] | SILT (ML) - Grey and brown, moist, no to low plasticity. | S04 | | | | | | | >100 |
| 229.0 | 4 | 68.6 | [Diagonal lines] | SILTY CLAY (CH) - Mottled dark grey and dark brown, damp to moist, stiff, high plasticity, trace silt inclusions. | S05 | | | | | | | |
| 228.0 | 5 | 85.6 | [Diagonal lines] | - Firm below 4.88 m. | S06 | | | | | | | |
| 227.0 | 6 | 102.7 | [Diagonal lines] | | S07 | | | | | | | |
| 226.3 | 6 | 120.0 | [Diagonal lines] | | S08 | | | | | | | |
| 226.0 | 7 | 137.1 | | END OF TEST HOLE AT 6.1 m | | | | | | | | |
| 225.0 | 8 | 154.2 | | Notes: 1. Test hole remained open to 2.9 m below grade after drilling. 2. Water at 2.9 m below grade after drilling. 3. Backfilled test hole with bentonite chips from 2.9 m to 2.13 m below grade, cuttings from 2.13 m to 0.76 m and bentonite chips from 0.76 m to grade. | | | | | | | | |
| 224.0 | 9 | 171.3 | | | | | | | | | | |
| 223.0 | | | | | | | | | | | | |

SAMPLE TYPE  Auger Grab

CONTRACTOR Maple Leaf Drilling Ltd. **INSPECTOR** K. HAMILTON

APPROVED D. ANDERSON

DATE 4/10/16

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT EAST WINNIPEG CRRC
SITE Corner of Panet and Mission
LOCATION North
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Track Mounted Drill Rig

JOB NO. 16-0107-010
GROUND ELEV. 232.33
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 17/08/2016
UTM (m) N 5,528,709
 E 638,189

| ELEVATION (m) | DEPTH | | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △ | Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆ | |
|---------------|-------|------|----------|--|--------------------|------------|---|---|------|
| | (m) | (ft) | | | | | | PL | MC |
| 232 | 1 | | | SILTY CLAY FILL - Dark brown, damp, very stiff, high plasticity, some sand, some gravel. | S01 | | | | >100 |
| 231.0 | 5 | | | SILTY CLAY (CH) - Dark brown, damp, stiff, high plasticity, trace medium to coarse grained sand, trace fine grained gravel. | S02 | | | | |
| 230 | 2 | | | - Brown below 2.74 m. | | | | | |
| 229.3 | 3 | 10 | | SILT (ML) - Grey and brown, moist, no to low plasticity. | S03 | | | | |
| 229 | 4 | | | | | | | | |
| 227.8 | 5 | 15 | | SILTY CLAY (CH) - Mottled dark grey and dark brown, damp to moist, stiff, high plasticity, trace silt inclusions. - Firm below 4.88 m. | S04 | | | | |
| 227 | 6 | 20 | | END OF TEST HOLE AT 6.1 m | | | | | |
| 226.2 | 7 | 25 | | Notes: 1. Test hole remained open to 3.05 m below grade after drilling. 2. Water at 2.59 m below grade after drilling. 3. Backfilled test hole with bentonite chips from 3.05 m to 2.29 m below grade, cuttings from 2.29 m to 0.76 m and bentonite chips from 0.76 m to grade. | | | | | |
| 226 | 8 | | | | | | | | |
| 225 | 9 | 30 | | | | | | | |
| 224 | | | | | | | | | |
| 223 | | | | | | | | | |

SAMPLE TYPE Auger Grab

CONTRACTOR **Maple Leaf Drilling Ltd.**
 INSPECTOR **C. FRIESEN**

APPROVED **D. ANDERSON**

DATE **4/10/16**

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT EAST WINNIPEG CRRC
SITE Corner of Panet and Mission
LOCATION North Pond 1
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Track Mounted Drill Rig

JOB NO. 16-0107-010
GROUND ELEV. 232.68
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 17/08/2016
UTM (m) N 5,528,670
 E 638,229

| ELEVATION (m) | DEPTH | | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲ | DYNAMIC CONE (N) blows/ft △ | Cu POCKET PEN (kPa) ★ | | Cu TORVANE (kPa) ◆ | |
|---------------|-------|------|----------|---|--------------------|------------|------------------------|-----------------------------|-----------------------|----|--------------------|----|
| | (m) | (ft) | | | | | | | PL | MC | LL | PL |
| 232.5 | | | | SAND AND GRAVEL FILL - Yellow to orange, damp, dense to very dense, pieces of bricks. | | | | | | | | |
| 232 | 1 | | | SILTY CLAY FILL - Dark brown, damp, stiff, high plasticity, some sand, some gravel. | S01 | | | | | | | |
| 231.2 | | 5 | | SILTY CLAY (CH) - Dark brown, damp, stiff, high plasticity, trace medium to coarse grained sand, trace fine grained gravel. | | | | | | | | |
| 231 | | | | | S02 | | | | | | | |
| 230 | 3 | 10 | | | | | | | | | | |
| 229.2 | | | | SILT (ML) - Grey and brown, moist, no to low plasticity. | | | | | | | | |
| 229 | | | | | S03 | | | | | | | |
| 228.3 | | 15 | | SILTY CLAY (CH) - Mottled dark grey and dark brown, damp to moist, firm to stiff, high plasticity, trace silt inclusions. | | | | | | | | |
| 228 | | | | | | | | | | | | |
| 227 | 5 | | | | | | | | | | | |
| 226.6 | | 20 | | END OF TEST HOLE AT 6.1 m | | | | | | | | |
| 226 | | | | Notes: 1. Refused on concrete rubble at 0.46 m below grade. Moved 2 m towards the pond and continued drilling. 2. Test hole remained open to 4.57 m below grade after drilling. 3. Water at 3.81 m below grade after drilling. 4. Backfilled test hole with bentonite chips from 4.57 m to 3.05 m below grade, cuttings from 3.05 m to 0.76 m and bentonite chips from 0.76 m to grade. | | | | | | | | |
| 225 | | 25 | | | | | | | | | | |
| 224 | | | | | | | | | | | | |
| 223 | | 30 | | | | | | | | | | |

SAMPLE TYPE  Auger Grab

CONTRACTOR **Maple Leaf Drilling Ltd.**

INSPECTOR **C. FRIESEN**

APPROVED **D. ANDERSON**

DATE **4/10/16**

GEO-TECHNICAL-SOIL LOG U:\FMS\16-0107-010\EAST WINNIPEG CRRC GEO.GPJ

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT EAST WINNIPEG CRRC
SITE Corner of Panet and Mission
LOCATION North Pond 2
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Track Mounted Drill Rig

JOB NO. 16-0107-010
GROUND ELEV. 232.51
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 17/08/2016
UTM (m) N 5,528,683
 E 638,226

| ELEVATION (m) | DEPTH | | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲ | DYNAMIC CONE (N) blows/ft △ | Cu POCKET PEN (kPa) ★ | | | Cu TORVANE (kPa) ◆ | | | |
|---------------|-------|------|----------|--|--------------------|------------|------------------------|-----------------------------|-----------------------|----|----|--------------------|--|--|--|
| | (m) | (ft) | | | | | | | PL | MC | LL | | | | |
| 232.1 | | | | SILTY CLAY FILL - Dark brown, damp, stiff, high plasticity, some sand, some gravel, some cinders. | | | | | | | | | | | |
| 232 | | | | SILTY CLAY (CH) - Dark brown, damp, stiff, high plasticity, trace medium to coarse grained sand, trace fine grained gravel. | | | | | | | | | | | |
| 231 | 1 | 5 | | | S01 | | | | | | | | | | |
| 230 | 2 | 10 | | - Brown below 2.74 m. | S02 | | | | | | | | | | |
| 229.2 | 3 | 15 | | SILT (ML) - Grey and brown, moist, no to low plasticity. | | | | | | | | | | | |
| 229 | 4 | 20 | | | S03 | | | | | | | | | | |
| 222.8 | 5 | 25 | | SILTY CLAY (CH) - Mottled dark grey and dark brown, damp to moist, stiff, high plasticity, trace silt inclusions. | | | | | | | | | | | |
| 227 | 6 | 30 | | - Firm to stiff below 5.18 m. | S04 | | | | | | | | | | |
| 226.4 | 6 | 20 | | END OF TEST HOLE AT 6.1 m | | | | | | | | | | | |
| 226 | 7 | 25 | | Notes: 1. Test hole remained open to 3.66 m below grade after drilling. 2. Water at 3.66 m below grade after drilling. 3. Backfilled test hole with bentonite chips from 3.66 m to 2.9 m below grade, cuttings from 2.9 m to 0.76 m and bentonite chips from 0.76 m to grade. | | | | | | | | | | | |
| 225 | 8 | 30 | | | | | | | | | | | | | |
| 224 | 9 | 30 | | | | | | | | | | | | | |
| 223 | | | | | | | | | | | | | | | |

SAMPLE TYPE  Auger Grab

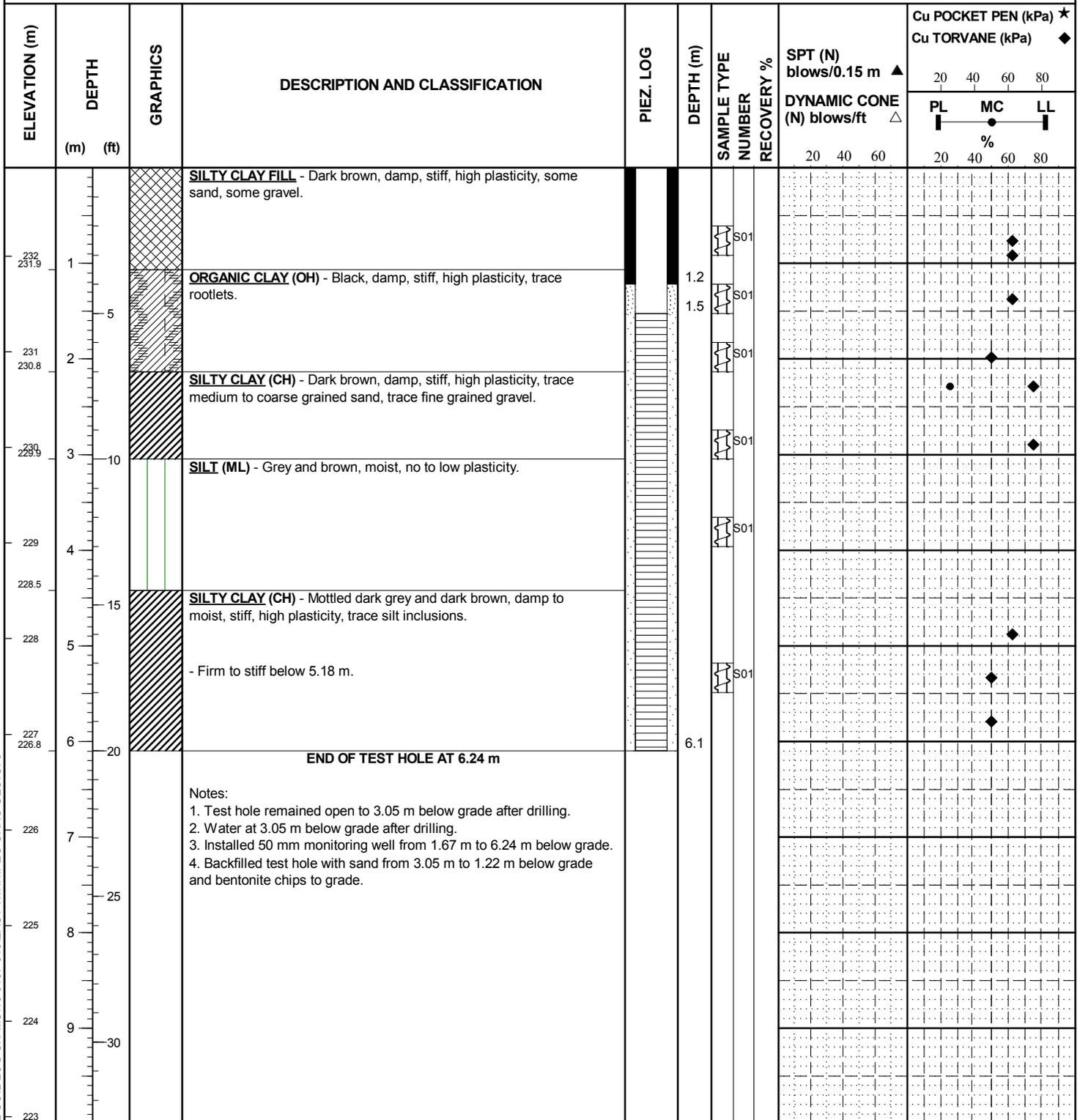
CONTRACTOR Maple Leaf Drilling Ltd. **INSPECTOR** K. HAMILTON

APPROVED D. ANDERSON

DATE 4/10/16

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT EAST WINNIPEG CRRC
SITE Corner of Panet and Mission
LOCATION North Pond 3
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Track Mounted Drill Rig

JOB NO. 16-0107-010
GROUND ELEV. 232.93
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 17/08/2016
UTM (m) N 5,528,683
 E 638,521



GEOTECHNICAL-SOIL LOG U:\FMS\16-0107-010\EAST WINNIPEG CRRC GEO.GPJ

SAMPLE TYPE Auger Grab

 CONTRACTOR **Maple Leaf Drilling Ltd.** INSPECTOR **K. HAMILTON**

 APPROVED **D. ANDERSON**

 DATE **4/10/16**

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT EAST WINNIPEG CRRC
SITE Corner of Panet and Mission
LOCATION South Pond 1
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Track Mounted Drill Rig

JOB NO. 16-0107-010
GROUND ELEV. 232.96
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 17/08/2016
UTM (m) N 5,528,611
 E 638,231

| ELEVATION (m) | DEPTH | | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲ | DYNAMIC CONE (N) blows/ft △ | Cu POCKET PEN (kPa) ★ | | Cu TORVANE (kPa) ◆ | | |
|---------------|-------|------|----------|--|---|------------|------------------------|-----------------------------|-----------------------|----|--------------------|------|----|
| | (m) | (ft) | | | | | | | 20 | 40 | 60 | 80 | PL |
| 232.9 | | | | ASPHALT | | | | | | | | | |
| | | | | SILTY CLAY FILL - Black, damp, very stiff, high plasticity, some sand, some gravel, with cinders, wood debris (potential creosote rail tie), hydrocarbon odour. | S01 | | | | | | | | |
| 232 | 1 | | | - Silt - Grey, damp, no to low plasticity from 1.07 m to 1.22 m. | S02 | | | | | | | >100 | |
| 231.4 | 2 | | | SILTY CLAY (CH) - Dark brown, damp, stiff, high plasticity, trace medium to coarse grained sand, trace fine grained gravel. | S03 | | | | | | | >100 | |
| 230 | 3 | 10 | | | | | | | | | | | |
| 229 | 4 | | | | SILT (ML) - Grey and brown, moist, no to low plasticity. | S04 | | | | | | | |
| 228.8 | 5 | 15 | | SILTY CLAY (CH) - Mottled dark grey and dark brown, damp to moist, stiff, high plasticity, trace silt inclusions. | S05 | | | | | | | | |
| 227 | 6 | 20 | | | END OF TEST HOLE AT 6.1 m | | | | | | | | |
| 226.9 | 7 | | | Notes: 1. Test hole remained open to 5.03 m below grade after drilling. 2. Water at 4.42 m below grade after drilling. 3. Backfilled test hole with bentonite chips from 5.03 m to 4.27 m below grade, cuttings from 4.27 m to 0.76 m and bentonite chips from 0.76 m to grade. | | | | | | | | | |
| 226 | 8 | 25 | | | | | | | | | | | |
| 225 | 9 | 30 | | | | | | | | | | | |
| 224 | | | | | | | | | | | | | |
| 223 | | | | | | | | | | | | | |

SAMPLE TYPE Auger Grab

CONTRACTOR **Maple Leaf Drilling Ltd.** INSPECTOR **K. HAMILTON**

APPROVED **D. ANDERSON**

DATE **4/10/16**

GEO-TECHNICAL-SOIL LOG U:\FMS\16-0107-010\EAST WINNIPEG CRRC GEO.GPJ

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT EAST WINNIPEG CRRC
SITE Corner of Panet and Mission
LOCATION South Pond 2
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Track Mounted Drill Rig

JOB NO. 16-0107-010
GROUND ELEV. 232.90
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 17/08/2016
UTM (m) N 5,528,620
 E 638,221

| ELEVATION (m) | DEPTH | | GRAPHICS | DESCRIPTION AND CLASSIFICATION | PIEZ. LOG | DEPTH (m) | SAMPLE TYPE NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △ | Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆ | |
|---------------|-------|------|------------------|--|-----------|-----------|--------------------|------------|---|---|----|
| | (m) | (ft) | | | | | | | | PL | MC |
| 232 | 1 | | [Cross-hatched] | SILTY CLAY FILL - Dark brown, damp, very stiff, high plasticity, some sand, some gravel. | | | | | | | |
| 231.4 | 5 | | | - Black, with cinders below 1.22 m. | | 1.2 | | | | | |
| 231 | 2 | | [Diagonal lines] | SILTY CLAY (CH) - Dark brown, damp, stiff, high plasticity, trace medium to coarse grained sand, trace fine grained gravel. | | 1.5 | | | | | |
| 230 | 3 | 10 | | | | | S02 | | | | |
| 229.5 | 4 | | [Vertical lines] | SILT (ML) - Grey and brown, moist, no to low plasticity. | | | S03 | | | | |
| 229 | 4 | | | | | | | | | | |
| 228.3 | 5 | 15 | [Diagonal lines] | SILTY CLAY (CH) - Mottled dark grey and dark brown, damp to moist, firm, high plasticity, trace silt inclusions. | | | | | | | |
| 228 | 5 | | | | | | | | | | |
| 227 | 6 | 20 | | END OF TEST HOLE AT 6.1 m | | 6.1 | S04 | | | | |
| 226.8 | 6 | | | | | | | | | | |
| 226 | 7 | | | Notes: 1. Test hole remained open to 3.66 m below grade after drilling. 2. Water at 3.66 m below grade after drilling. 3. Backfilled test hole with bentonite chips from 3.66 m to 2.9 m below grade, cuttings from 2.9 m to 0.76 m and bentonite chips from 0.76 m to grade. | | | | | | | |
| 225 | 8 | 25 | | | | | | | | | |
| 224 | 9 | 30 | | | | | | | | | |
| 223 | | | | | | | | | | | |

SAMPLE TYPE  Auger Grab

CONTRACTOR **Maple Leaf Drilling Ltd.** INSPECTOR **K. HAMILTON**

APPROVED **D. ANDERSON**

DATE **4/10/16**

GEO-TECHNICAL-SOIL LOG U:\FMS\16-0107-010\EAST WINNIPEG CRRC GEO.GPJ

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT EAST WINNIPEG CRRC
SITE Corner of Panet and Mission
LOCATION South Pond 3
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Track Mounted Drill Rig

JOB NO. 16-0107-010
GROUND ELEV. 232.69
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 17/08/2016
UTM (m) N 5,528,605
 E 638,193

| ELEVATION (m) | DEPTH | | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲ | DYNAMIC CONE (N) blows/ft △ | Cu POCKET PEN (kPa) ★ | | Cu TORVANE (kPa) ◆ | |
|---------------|-------|------|------------------|---|--------------------|------------|------------------------|-----------------------------|-----------------------|----|--------------------|------|
| | (m) | (ft) | | | | | | | 20 | 40 | 60 | 80 |
| 232 | 1 | | [Cross-hatched] | SILTY CLAY FILL - Dark brown, damp, very stiff, high plasticity, some sand, some gravel, brick debris. | S01 | | | | | | | >100 |
| 231.2 | 5 | | | - Black, with cinders, wood debris, glass, plastic, nail, wire below 1.22 m. | S02 | | | | | | | >100 |
| 231 | 2 | | [Diagonal lines] | SILTY CLAY (CH) - Dark brown, damp, very stiff, high plasticity, trace medium to coarse grained sand, trace fine grained gravel. | S03 | | | | | | | >100 |
| 230 | | | | | | | | | | | | >100 |
| 229.6 | 3 | 10 | [Vertical lines] | SILT (ML) - Grey and brown, moist, no to low plasticity. | | | | | | | | >100 |
| 229 | | | | | | | | | | | | |
| 228.7 | 4 | | [Diagonal lines] | SILTY CLAY (CH) - Mottled dark grey and dark brown, damp to moist, stiff, high plasticity, trace silt inclusions. | | | | | | | | |
| 228 | 5 | 15 | | - Firm below 4.88 m. | S04 | | | | | | | |
| 227 | | | | | | | | | | | | |
| 226.6 | 6 | 20 | | END OF TEST HOLE AT 6.1 m | | | | | | | | |
| 226 | 7 | | | Notes: 1. Test hole remained open to 2.9 m below grade after drilling. 2. Water at 2.9 m below grade after drilling. 3. Backfilled test hole with bentonite chips from 2.9 m to 2.13 m below grade, cuttings from 2.13 m to 0.76 m and bentonite chips from 0.76 m to grade. | | | | | | | | |
| 225 | 8 | 25 | | | | | | | | | | |
| 224 | 9 | 30 | | | | | | | | | | |
| 223 | | | | | | | | | | | | |

SAMPLE TYPE  Auger Grab

CONTRACTOR **Maple Leaf Drilling Ltd.** INSPECTOR **K. HAMILTON**

APPROVED **D. ANDERSON**

DATE **4/10/16**

GEO-TECHNICAL-SOIL LOG U:\FMS\16-0107-010\EAST WINNIPEG CRRC GEO.GPJ

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT EAST WINNIPEG CRRC
SITE Corner of Panet and Mission
LOCATION North
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Track Mounted Drill Rig

JOB NO. 16-0107-010
GROUND ELEV. 232.46
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 17/08/2016
UTM (m) N 5,528,705
 E 638,167

| ELEVATION (m) | DEPTH | | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲ | DYNAMIC CONE (N) blows/ft △ | Cu POCKET PEN (kPa) ★ | | Cu TORVANE (kPa) ◆ | |
|---------------|-------|------|----------|--|-------------|--------|------------|------------------------|-----------------------------|-----------------------|----|--------------------|----|
| | (m) | (ft) | | | | | | | | PL | MC | LL | PL |
| 232.3 | | | XXXX | SAND AND GRAVEL FILL | | | | | | | | | |
| 232 | | | | AUGER REFUSAL ON CONCRETE RUBBLE AT 0.46 m | | | | | | | | | |
| | 1 | | | Notes: 1. Test hole remained open to 0.46 m below grade after drilling. 2. No water encountered after drilling. 3. Backfilled test hole with cuttings to grade. | | | | | | | | | |
| 231 | 5 | | | | | | | | | | | | |
| | 2 | | | | | | | | | | | | |
| 230 | | | | | | | | | | | | | |
| | 3 | 10 | | | | | | | | | | | |
| 229 | | | | | | | | | | | | | |
| | 4 | | | | | | | | | | | | |
| 228 | | | | | | | | | | | | | |
| | 5 | 15 | | | | | | | | | | | |
| 227 | | | | | | | | | | | | | |
| | 6 | 20 | | | | | | | | | | | |
| 226 | | | | | | | | | | | | | |
| | 7 | | | | | | | | | | | | |
| 225 | | | | | | | | | | | | | |
| | 8 | 25 | | | | | | | | | | | |
| 224 | | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | |
| 223 | 30 | | | | | | | | | | | | |

SAMPLE TYPE

CONTRACTOR Maple Leaf Drilling Ltd. **INSPECTOR** K. HAMILTON

APPROVED D. ANDERSON

DATE 4/10/16