

Memorandum

| | | | |
|---------|--|----------------|------------------|
| To | Adnan Al-Hashimy | Page | 1 |
| CC | | | |
| Subject | Dauphin River, Manitoba – Harbour Basin Expansion Geotechnical Investigation | | |
| From | Faris Khalil | | |
| Date | April 26, 2010 | Project Number | 60149637 (4.2.1) |

1. Introduction

The Department of Fisheries and Oceans Canada (DFO) – Small Craft Harbour (SCH) is planning the expansion of the existing harbour at Dauphin River, Manitoba. The existing facility consists of a 4.9 x 30.0 m L-shaped timber crib wharf, a 2.4 x 2.4 m and a 2.4 x 4.2 m timber crib access platform and 16 float wharves. A fish packing plant operated by Freshwater Fish Marketing Corporation is located south of the existing facility with other community stakeholders on the north side. Two previous expansions have occurred at this site by excavating inland to create the harbour basin. According to SCH, bedrock was encountered during the previous expansion works and rock blasting was required to complete the work. It is also reported that the proposed expansion will result in relocation of some of the current utilities on site. No geotechnical investigation has been undertaken at the site previously.

SCH retained AECOM to provide consulting services for the implementation of the proposed expansion including a geotechnical investigation. The objective of the geotechnical investigation was to obtain information on the subsurface conditions and provide geotechnical recommendations for the design and construction of the proposed works. It is our understanding that the proposed basin dredge line is 215.5 m, or approximately 4.5 m below the existing grade from which test holes were advanced.

2. Geotechnical Investigations

Between March 30 and 31, 2010, twelve test holes (TH's 10-01 to 10-12) were drilled at the locations shown on the Test Hole Location Plan (Figure 01). Drilling was carried out by Maple Leaf Drilling Ltd. using a Volvo B40 truck mounted drill rig equipped with 125 mm diameter solid stem augers and NQ coring equipment. The intent of the drilling program was to advance test holes to a depth of 1.5 m beyond the design elevation (215.5) or to a depth of approximately 6.1 m below ground surface i.e. to about elevation 214 m.

The test holes were advanced to 6.1 m below existing ground, except TH10-03 and 10-09, which were advanced to 5.6 and 7.6 m below existing ground, respectively. Where auger refusal (AR) was encountered at depths shallower than 6.1 m in TH's 10-01 and 10-02, the test holes were offset horizontally by 1 to 2 m and re-drilled at least once in an attempt to achieve the target depth of 6.1 m. Auger refusal was reached in TH10-05 at a depth of 3.5 m beyond which rock coring was undertaken to a total depth of 6.1 m (2.6 m of core). Table 1 summarizes the pertinent information for each test hole.

Table 1. Summary of Test Hole Depths

| Test Hole | Existing Ground Elevation | Depth of Test Hole | Bottom of Test Hole | Depth Below Dredge line ¹ | Notes |
|-----------|---------------------------|--------------------|---------------------|--------------------------------------|---|
| | m | m | m | m | |
| 10-01 | 219.7 | 6.1 | 213.6 | 1.9 | 1 st attempt AR @ 2.4m 2 nd attempt AR @ 4.6m 3 rd attempt AR @ 6.1m |
| 10-02 | 219.8 | 6.1 | 213.7 | 1.8 | 1 st attempt AR @ 5.6m 2 nd attempt AR not encountered |
| 10-03 | 219.2 | 5.6 | 213.6 | 1.9 | AR @ 5.6m |
| 10-04 | 220.1 | 6.1 | 214.0 | 1.5 | AR not encountered |
| 10-05 | 219.1 | 6.1 | 213.0 | 2.5 | AR @ 3.5m Cored boulder from 3.5 - 4.1 m Cored bedrock from 4.1- 6.1m |
| 10-06 | 220.1 | 6.1 | 214.0 | 1.5 | AR not encountered |
| 10-07 | 219.8 | 6.1 | 213.7 | 1.8 | AR not encountered |
| 10-08 | 219.4 | 6.1 | 213.3 | 2.2 | AR not encountered |
| 10-09 | 221.2 | 7.6 | 213.6 | 1.9 | AR not encountered |
| 10-10 | 220.7 | 6.1 | 214.6 | 0.9 | AR not encountered |
| 10-11 | 221.1 | 6.1 | 215.0 | 0.5 | AR not encountered |
| 10-12 | 219.8 | 6.1 | 213.7 | 1.8 | 1 st attempt AR @ 5.6m 2 nd attempt AR not encountered |

¹ Dredge line is at elevation 215.5m

Disturbed samples (auger cuttings) were collected for further visual inspection and testing. Laboratory testing included the determination of moisture content, gradation, and Atterberg limits. Test hole logs have been prepared for each test hole to record the description and the relative position of the soil strata, location of samples obtained, field and laboratory test results, and other pertinent information. The test hole logs are attached in Appendix A.

3. Subsurface Conditions

The general soil profile in descending order is:

- Fill
- Topsoil
- Peat
- Clay, silt and sand (Alluvial)
- Silt Till
- Bedrock

The soil units encountered are described separately as follows:

Fill

A 0.5 to 2.5 m thick fill layer was encountered in all test holes except TH10-01 and 10-08. Generally the fill consists of three distinct but variable (thickness and sequence) layers of gravel, silt and clay. On average, approximately 0.2 m of gravel was encountered at ground surface in the test holes located close to the existing access road. Clay and silt fill containing variable amounts of sand, gravel and organics was encountered in the remaining test holes. The clay fill is moist, firm and of medium to high plasticity. The silt fill is moist, firm and of low plasticity.

Topsoil

Organic clay topsoil was encountered at the ground surface in TH's 10-01, 10-04 and 10-08 and below the fill in TH 10-05. The topsoil layer ranges in thickness from 0.1 m in TH 10-04 to 0.5 m in TH 10-01.

Peat

A layer of peat was encountered below the fill in TH's 10-06, 10-07, 10-10 and 10-11. The layer ranges in thickness from 0.2 to 0.9 m. The peat is black to brown, moist and fibrous.

Clay, silt and sand (Alluvial Deposit)

A deposit of alluvial clay, silt and sand was encountered below the fill and the peat in 7 test holes. The maximum encountered thickness of the alluvial deposit is about 2.5 m. The deposit ranges from coarse grained gravelly sand to non-plastic silt and clay of low to medium plasticity. Generally the deposit is moist to wet and of soft to firm consistency. Moisture content ranges from 15 to 27 percent. Average values of the liquid limit and plasticity index for the fine grained alluvial soil are 27 and 11, respectively. Results of a gradation test on an alluvial sand sample from TH10-11 are attached in Appendix A.

Silt Till

Till was encountered beneath the fill and alluvial deposits in all test holes, extending to the depth explored or to bedrock surface where the bedrock was encountered. The till consists of sandy, clayey silt containing trace to some gravel. The till is light brown, firm, moist to wet and of low plasticity to non-plastic. Moisture contents fall close to an average value of 15 percent. The average liquid limit and plasticity index are 18 and 8 percent, respectively. Results of a gradation test and grain size distribution charts are attached in Appendix A.

Bedrock

Limestone bedrock was encountered below the till in TH 10-05 and confirmed by core recovery. The auger refusal encountered in other test holes could be an indication of bedrock surface or hard soil with boulder content. The rock is a well foliated and fine to medium grained dolomitic limestone. The calculated rock quality designation (RQD) for the recovered core samples is 81 percent. The percent recovery of the core is 100 percent.

Sloughing and seepage occurred in the alluvial and till deposits during drilling. Immediately after drilling the groundwater levels 1.5 m below existing ground surface were measured. These levels were not stabilized however, and it should also be recognized that groundwater levels may fluctuate annually, seasonally or due to construction activities.

4. Slope Stability

A slope stability assessment was undertaken to determine a configuration for the bank cut slopes that would achieve an adequate Factor of Safety (FS) against slope instability. Stability analysis was completed using software developed by GeoSlope International Ltd.

Two conditions were considered for the analysis:

1. Long-term, post-construction stability using drained (i.e. effective stress) soil shear strength parameters in which the river water is assumed to be impounded against the slope face at elevation 217.7 m. For this condition, a minimum FS of 1.50 is set as a design objective.
2. Short-term stability using drained (i.e. effective stress) soil shear strength parameters in which the harbour basin is assumed to be dry. This scenario is representative of the end-of-construction condition in which the slope face is excavated and flattened to the required inclination and before the river flow has been allowed into the harbour basin. For this condition, a minimum FS of 1.3 was set as the design objective.

Simplifying assumptions were made to develop a typical cross section for the stability analyses. The soil profile was modeled as 3 m of alluvial soil underlain by silt till. The groundwater level within the riverbank was assumed to be 1.5 m below the ground surface at a 10 m setback from the slope edge and to vary linearly to match the river water level at the slope face. The soil parameters used in the analysis were based on correlations with soil index properties and our experience working with similar soil types. The strength parameters and groundwater conditions used in the analysis are summarized in Table 2.

Table 2. Soil Strength Parameters for Slope Stability Analysis

| Soil Type | Cohesion (kPa) | Friction Angle (degrees) | Bulk Unit Weight (kN/m ³) |
|------------------|----------------|--------------------------|---------------------------------------|
| Alluvial Deposit | 0 | 24 | 18 |
| Till | 5 | 30 | 19 |
| Rip-Rap | 0 | 30 | 20 |

The results of the stability analysis are graphically presented on Figures 02 and 03 attached. The results indicate that a slope cut at 3H:1V for the top 3 m and 1.5H:1V from 3 m to 4.5 m (at the dredge line) are expected to perform satisfactorily. For this configuration, the calculated FS's for short term and long term conditions are estimated to be greater than the design objectives of 1.3 and 1.5, respectively. The analysis assumes a 600 mm thick rip-rap and granular bedding layer are placed over the slope as erosion protection. Recommendations for rip-rap design and construction are provided in Section 5.0.

5. Rip-Rap

The riverbank slopes will require protection against potential erosion from river flow, ice, and debris impact and should be covered by an erosion protection layer. This erosion protection layer can be a 450 mm thick stone rip-rap placed over 150 mm of granular bedding. The granular bedding is required as a filter layer to protect against dispersion of the finer grained clay, silt, and fine sand on the cut slope. The bedding material should consist of well graded pit-run material conforming to the gradation shown in Table 3.

Stone rip-rap should be durable quarried (blast) rock of sufficient hardness to resist weathering and should be free of cracks and other blemishes. The following physical properties are recommended for the rip rap material:

1. Minimum bulk specific gravity of 2.6 (ASTM C217)
2. Maximum Los Angeles Abrasion loss of 35% (ASTM C131)
3. Maximum soundness loss of 185 (ASTM C88)
4. Maximum absorption of 2.5% (ASTM C127)

The stone rip-rap should be well graded having a full range and even distribution of sizes conforming to the gradation limits shown in Table 04. The surface to receive the rip-rap should be neatly shaped to the design lines prior to the placing of any bedding material and rip-rap. The stone rip-rap should be placed reasonably homogeneous with the larger rocks uniformly distributed and firmly in contact with the smaller rocks and spalls filling the voids between the larger rocks. Hand placement of chinking stone should be completed so that final surface is smooth and with minimum voids.

Table 3. Bedding Material Gradation

| Size Smaller Than (mm) | Percent Passing by Weight |
|------------------------|---------------------------|
| 75 | 90 - 100 |
| 28 | 80 - 100 |
| 5 | 40 - 80 |
| 0.315 | 10 - 35 |
| 0.075 | 5 - 30 |

Table 4. Stone Rip-Rap Gradation

| Size Smaller Than (mm) | Percent Passing |
|------------------------|-----------------|
| 350 | 100 |
| 200 | 15 - 50 |
| 100 | 0 - 15 |

6. Excavations

All excavations must comply with the Manitoba Workplace Safety and Health Regulations.

One of the objectives of the geotechnical investigation was to assess potential excavation difficulties of the overburden soils. Based on the subsurface conditions encountered during the geotechnical investigation, it is expected that excavation of overburden for the proposed expansion can be completed using conventional excavation equipment although boulders can be expected in the till and seepage may occur. In this regard, it may be necessary to stage the excavation work such that wet soils may drain or place a layer of crushed stone on the excavation face to prevent sloughing.

It is understood that previous expansion works at this site required bedrock excavation (blasting). In this regard, auger refusal, above the proposed dredge line, was only encountered at the northwest and northeast edges of the expansion area at TH10-01 and TH10-05 respectively. Auger refusal at depths below the proposed dredge line was encountered in the remaining test holes (Table 01). It is important to recognize however, that auger refusal could occur on bedrock or very dense soil (till) containing cobbles and boulders and therefore the presence of bedrock at the auger refusal depth can only be conclusively identified at TH 10-5 where coring was undertaken. Based on the results from our drilling program, the potential of encountering bedrock above the proposed dredge line in the majority of the proposed expansion area is considered low but cannot be precluded in particular given previous site experience and the natural variability of the bedrock surface elevation. The potential for encountering bedrock above the dredge line elevation appears to be the greatest along the north side

of the expansion area. In this regard, the basis for measurement and payment for rock excavation should be established in the contract preparation stage to recognize that rock excavations may be required during construction.

It is suggested that the excavation activities start from the west and advanced toward the east. A strip at least 5 m wide at the top should be left along the east boundary of the proposed expansion to act as an earth cofferdam that retains the river water and enables the excavations and other construction activities to take place. The excavation of this strip should take place at the final stages of the construction. Dewatering of the excavation will likely be required although it is expected that it can be handled by conventional construction equipment. All necessary measures for sediment and erosion control should be implemented to meet regulatory (DFO) requirements.

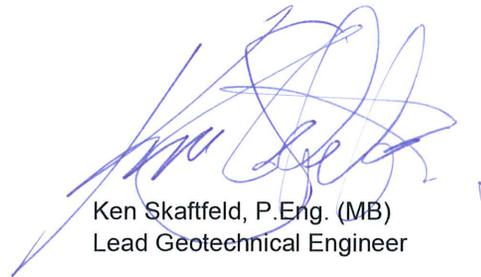
Respectfully submitted,

AECOM Canada Ltd.

Reviewed by:



Faris Khalil, M.Sc., P.Eng.
Senior Geotechnical Engineer

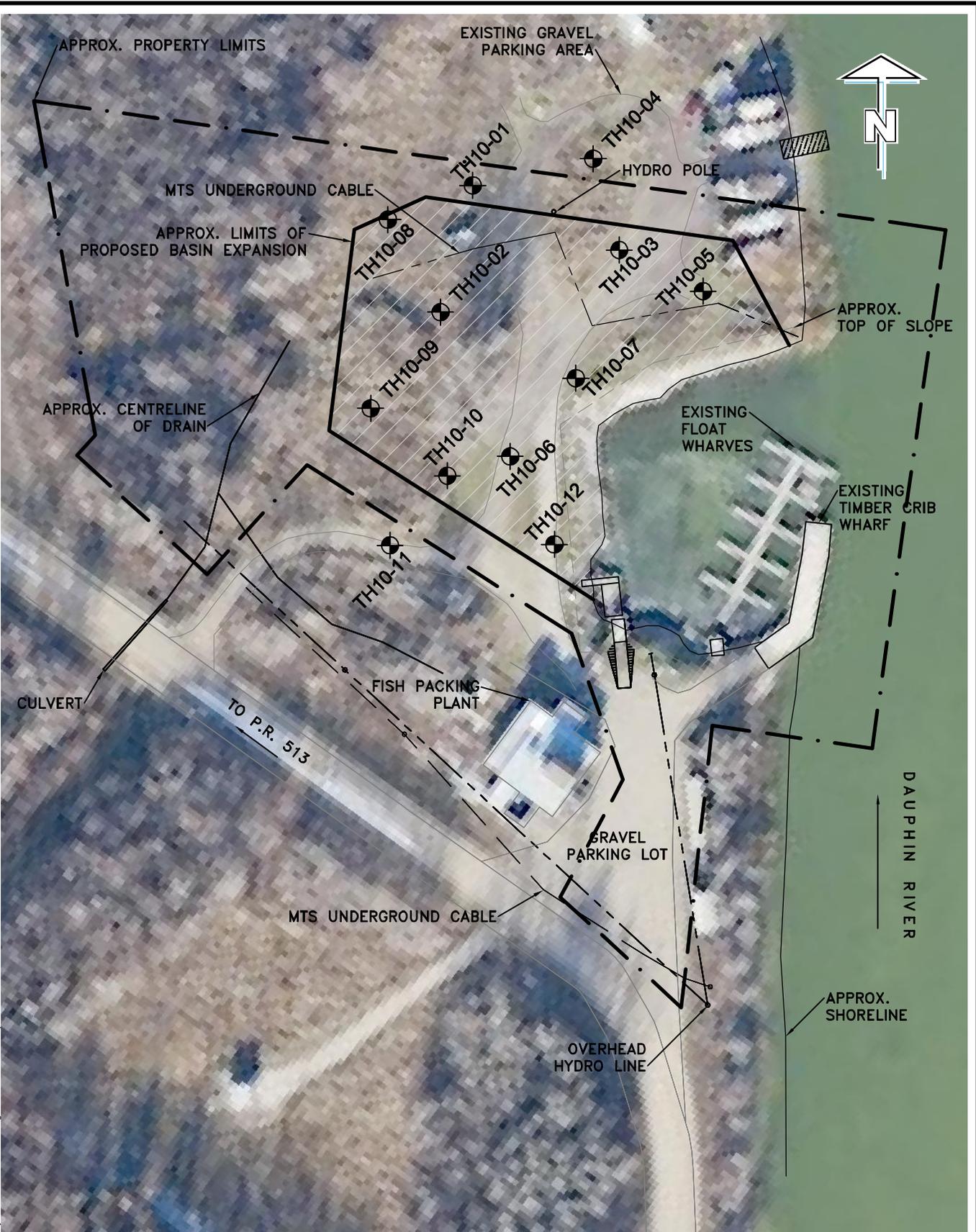


Ken Skafffeld, P.Eng. (MB)
Lead Geotechnical Engineer

Figures

ISS/REV: A
 AECOM FILE NAME: 060149637_01-B-F001_RX.dwg
 Saved By: cloustonec
 PLOT: 10/04/09 8:55:31 AM
 A SIZE 8.5" x 11" (215.9mm x 279.4mm)

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Fisheries and Oceans Canada
 Dauphin River Expansion

Test Hole Locations

Figure - 01



File Name: DauphinRiverHarbourExpansion_SlopeStability_0006.gsz
 Name: Alluvial Slope at 3:1 with Rip-Rap, No Water
 Date: 13/04/2010
 Method: Morgenstern-Price

Name: Till
 Model: Mohr-Coulomb
 Unit Weight: 19 kN/m³
 Cohesion: 5 kPa
 Phi: 30 °

Name: Alluvial
 Model: Mohr-Coulomb
 Unit Weight: 18 kN/m³
 Cohesion: 0 kPa
 Phi: 24 °

Name: Rip-Rap
 Model: Mohr-Coulomb
 Unit Weight: 20 kN/m³
 Cohesion: 0 kPa
 Phi: 30 °

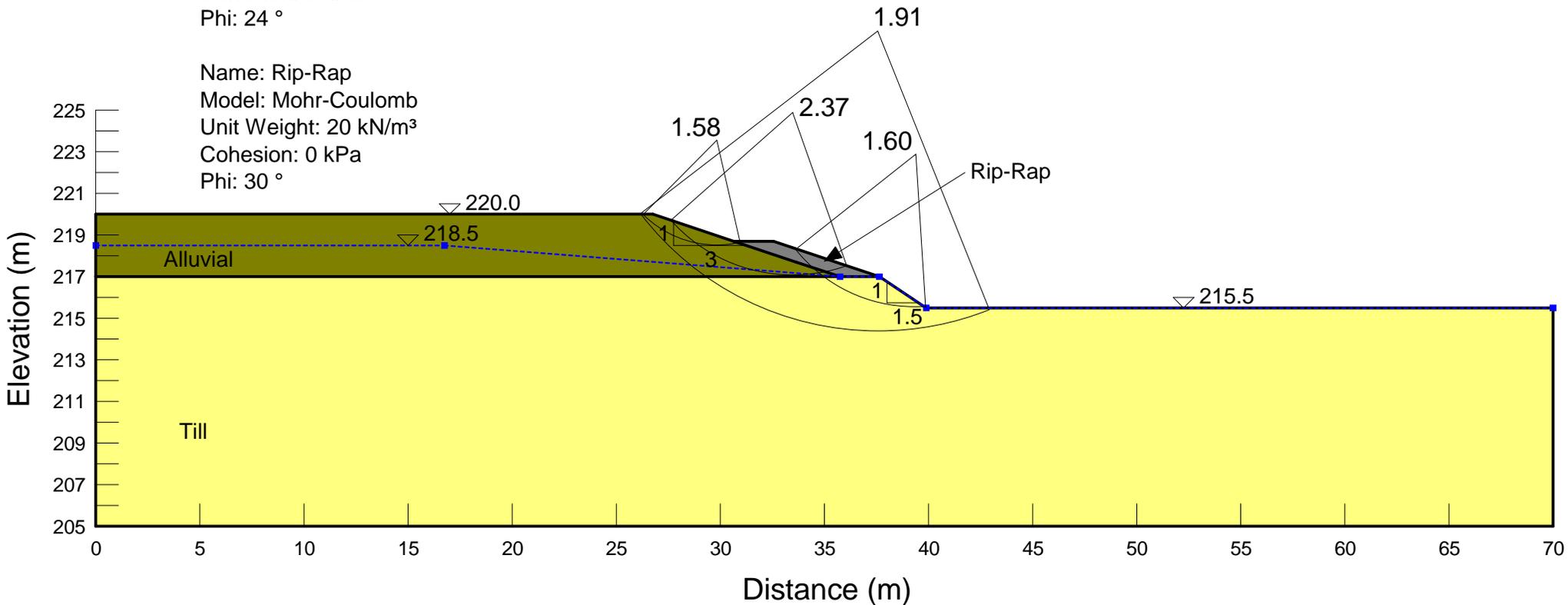


Figure 02: Results of Stability Analysis - Short Term Condition

File Name: DauphinRiverHarbourExpansion_SlopeStability_0005.gsz
 Name: Alluvial Slope at 3:1 with Rip-Rap
 Date: 13/04/2010
 Method: Morgenstern-Price

Name: Till
 Model: Mohr-Coulomb
 Unit Weight: 19 kN/m³
 Cohesion: 5 kPa
 Phi: 30 °

Name: Alluvial
 Model: Mohr-Coulomb
 Unit Weight: 18 kN/m³
 Cohesion: 0 kPa
 Phi: 24 °

Name: Rip-Rap
 Model: Mohr-Coulomb
 Unit Weight: 20 kN/m³
 Cohesion: 0 kPa
 Phi: 30 °

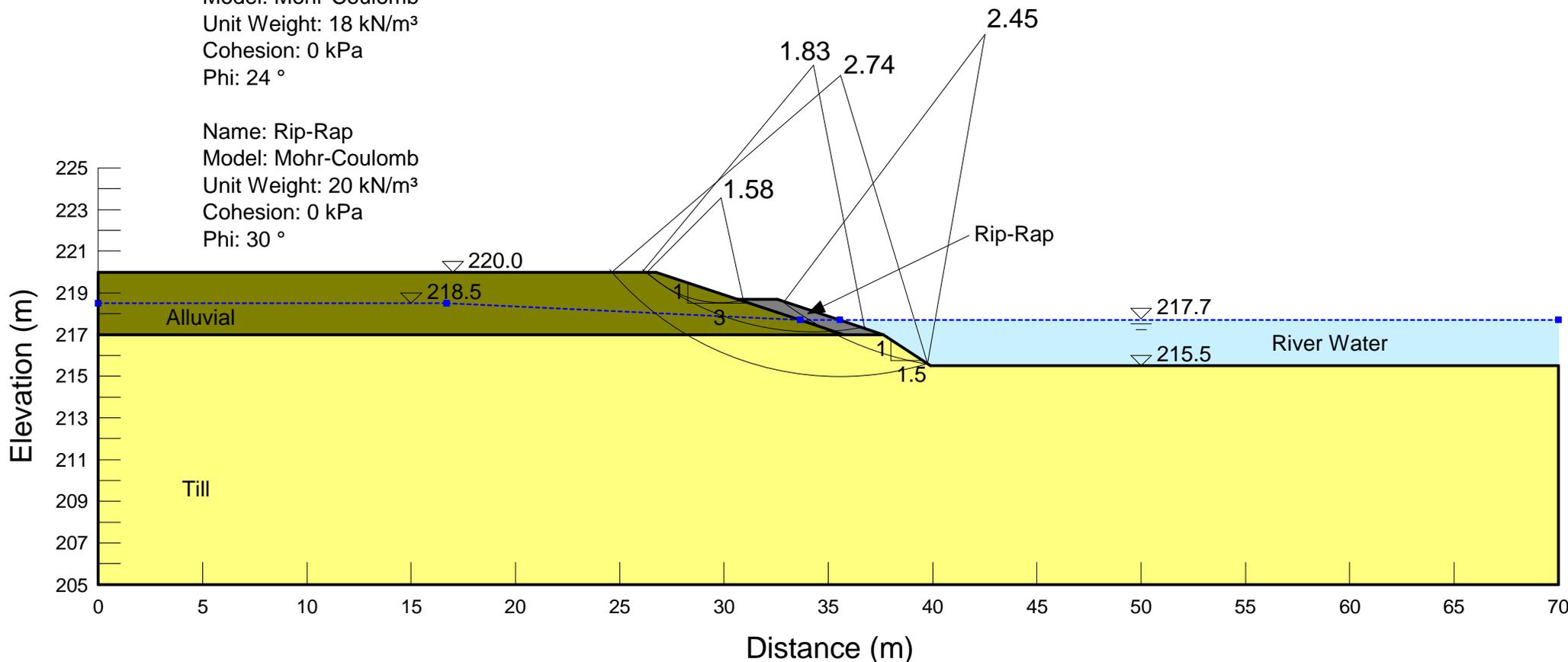
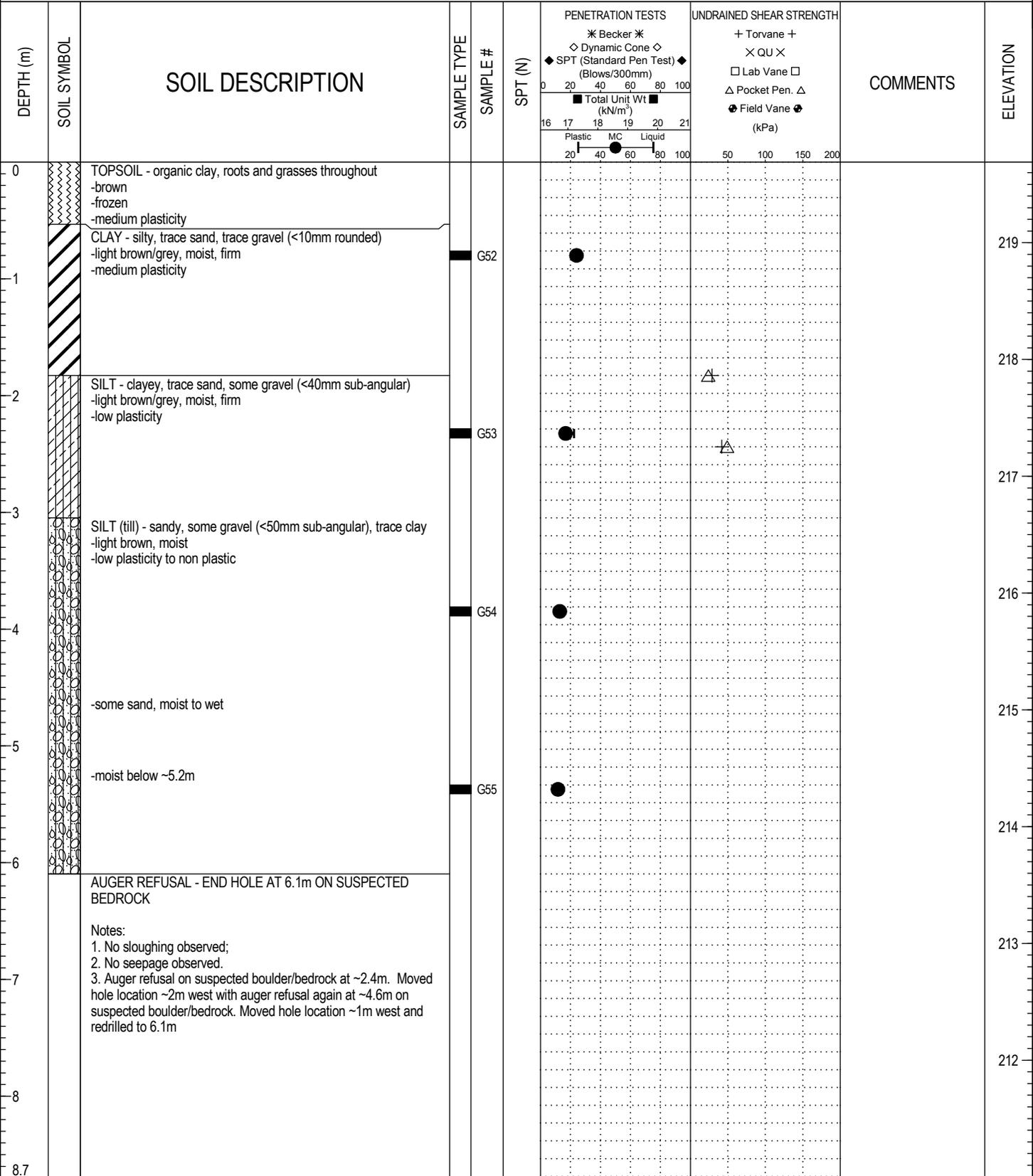


Figure 03: Results of Stability Analysis - Long Term Condition

Appendix A

Test Hole Logs

| | | |
|--|---|---|
| PROJECT: Dauphin River Harbour Basin Expansion | CLIENT: Department of Fisheries and Oceans | TESTHOLE NO: TH-10-01 |
| LOCATION: North-East quadrant N5756461 E563962.2 | | PROJECT NO.: 60149637 |
| CONTRACTOR: Maple Leaf Drilling Ltd | METHOD: 125mm SSA | ELEVATION (m): 219.69 |
| SAMPLE TYPE | <input checked="" type="checkbox"/> GRAB <input type="checkbox"/> SHELBY TUBE <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> BULK | <input checked="" type="checkbox"/> NO RECOVERY <input type="checkbox"/> CORE |



LOG OF TEST HOLE 60149637 DAUPHIN RIVER HARBOUR EXPANSION TH-10-01 TO TH-10-12.GPJ UMA WINN GDT 4/23/10



| | |
|--------------------------------|--------------------------|
| LOGGED BY: Jeremy Fiebelkorn | COMPLETION DEPTH: 6.10 m |
| REVIEWED BY: Faris Khalil | COMPLETION DATE: 3/31/10 |
| PROJECT ENGINEER: Faris Khalil | Page 1 of 1 |

| | | |
|--|---|-----------------------|
| PROJECT: Dauphin River Harbour Basin Expansion | CLIENT: Department of Fisheries and Oceans | TESTHOLE NO: TH-10-02 |
| LOCATION: Northern section N5756439 E563956.3 | | PROJECT NO.: 60149637 |
| CONTRACTOR: Maple Leaf Drilling Ltd | METHOD: 125mm SSA | ELEVATION (m): 219.79 |
| SAMPLE TYPE | <input checked="" type="checkbox"/> GRAB <input type="checkbox"/> SHELBY TUBE <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> BULK <input checked="" type="checkbox"/> NO RECOVERY <input type="checkbox"/> CORE | |

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE # | SPT (N) | PENETRATION TESTS | | UNDRAINED SHEAR STRENGTH | COMMENTS | ELEVATION |
|-----------|-------------|---|-------------|----------|---------|---|---|--------------------------|----------|-----------|
| | | | | | | * Becker * ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) ■ Total Unit Wt ■ (kN/m ³) | + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ● Field Vane ● (kPa) | | | |
| 0 | | CLAY (fill) - silty, trace sand, trace gravel (<20mm rounded) -brown -frozen | | | | | | | | |
| 1 | | SILT (fill) - some sand, trace gravel (<20mm rounded), trace clay -light brown, moist, firm -low plasticity | | G14 | ~45 | | | | | 219 |
| 2 | | SILT (fill) - clayey, some sand, some to trace gravel (<20mm sub-rounded) -light brown, moist -non-plastic to low plasticity | | G15 | ~55 | | | | | 218 |
| 3 | | Gravel - 5.9%, Sand - 16%, Silt - 47.2%, Clay - 30.9% | | G16 | ~65 | | | | | 217 |
| 4 | | -wet below ~3.0m | | G17 | ~75 | | | | | 216 |
| 5 | | -some gravel (<40mm sub-rounded) | | G18 | ~85 | | | | | 215 |
| 6 | | -moist below ~4.6m | | G19 | ~95 | | | | | 214 |
| 7 | | END HOLE AT 6.1m IN SILT TILL | | G20 | ~105 | | | | | 213 |
| 8 | | Notes: 1. Auger refusal at ~5.6m on suspected boulder/bedrock. Moved hole ~1.0m east and redrilled to 6.1m; 2. Sloughed to 3.8m; 3. Seepage in silt till at ~3.0m; 4. Water at ~1.5m below existing ground level after sloughing. | | | | | | | | 212 |

LOG OF TEST HOLE 60149637 DAUPHIN RIVER HARBOUR EXPANSION TH-10-01 TO TH-10-12.GPJ UMA WINN GDT 4/23/10



| | |
|--------------------------------|--------------------------|
| LOGGED BY: Jeremy Fiebelkorn | COMPLETION DEPTH: 6.10 m |
| REVIEWED BY: Faris Khalil | COMPLETION DATE: 3/30/10 |
| PROJECT ENGINEER: Faris Khalil | Page 1 of 1 |

| | | |
|--|---|-----------------------|
| PROJECT: Dauphin River Harbour Basin Expansion | CLIENT: Department of Fisheries and Oceans | TESTHOLE NO: TH-10-03 |
| LOCATION: North-East quadrant N5756450 E563989.3 | | PROJECT NO.: 60149637 |
| CONTRACTOR: Maple Leaf Drilling Ltd | METHOD: 125mm SSA | ELEVATION (m): 219.17 |
| SAMPLE TYPE | <input checked="" type="checkbox"/> GRAB <input type="checkbox"/> SHELBY TUBE <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> BULK <input checked="" type="checkbox"/> NO RECOVERY <input type="checkbox"/> CORE | |

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE # | SPT (N) | PENETRATION TESTS | UNDRAINED SHEAR STRENGTH | COMMENTS | ELEVATION |
|-----------|-------------|--|-------------|----------|---------|-------------------|--------------------------|----------|-----------|
| 0 | | GRAVEL (fill) - (<20mm angular) sandy, some silt -light brown, wet, loose | | | | | | | 219 |
| | | CLAY (fill) - silty, trace sand, trace gravel (<15mm rounded) -frozen to ~0.6m -grey, moist, firm -low to medium | | | | | | | |
| 1 | | SILT (till) - sandy, clayey, some gravel (<40mm sub-rounded) -light brown/grey, moist to wet -non-plastic to low plasticity | | G33 | | | | | 218 |
| | | | | G34 | | | | | |
| 2 | | | | G35 | | | | | 217 |
| | | | | G36 | | | | | |
| 3 | | | | G37 | | | | | 216 |
| | | | | G38 | | | | | |
| 4 | | | | | | | | | 215 |
| | | -gravelly (<40mm sub-angular) | | | | | | | |
| 5 | | | | | | | | | 214 |
| 6 | | AUGER REFUSAL - END HOLE AT 5.6m ON SUSPECTED BEDROCK | | | | | | | 213 |
| | | Notes: 1. Sloughed to 4.3m; 2. Seepage in silt layer at ~1.5m and ~4.3m; 3. Water at ~3.0m below existing ground level after sloughing. | | | | | | | |
| 7 | | | | | | | | | 212 |
| 8 | | | | | | | | | 211 |
| 8.7 | | | | | | | | | |

LOG OF TEST HOLE 60149637 DAUPHIN RIVER HARBOUR EXPANSION TH-10-01 TO TH-10-12.GPJ UMA WINN GDT 4/23/10



| | |
|--------------------------------|--------------------------|
| LOGGED BY: Jeremy Fiebelkorn | COMPLETION DEPTH: 5.64 m |
| REVIEWED BY: Faris Khalil | COMPLETION DATE: 3/30/10 |
| PROJECT ENGINEER: Faris Khalil | Page 1 of 1 |

PROJECT: Dauphin River Harbour Basin Expansion CLIENT: Department of Fisheries and Oceans TESTHOLE NO: TH-10-04
 LOCATION: North of property boundary N5756467 E563984.5 PROJECT NO.: 60149637
 CONTRACTOR: Maple Leaf Drilling Ltd METHOD: 125mm SSA ELEVATION (m): 220.10
 SAMPLE TYPE GRAB SHELBY TUBE SPLIT SPOON BULK NO RECOVERY CORE

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE # | SPT (N) | PENETRATION TESTS | UNDRAINED SHEAR STRENGTH | COMMENTS | ELEVATION |
|-----------|-------------|--|-------------------------------------|----------|---------|-------------------|--------------------------|----------|-----------|
| 0 | | TOPSOIL - grasses and roots throughout -brown/black, moist to wet, soft to firm | | | | | | | 220 |
| | | CLAY (fill) - silty -brown, moist, firm -medium plasticity | | | | | | | |
| 1 | | CLAY - silty, trace oxidation -grey mottled brown, moist, firm -low to medium plasticity | <input checked="" type="checkbox"/> | G56 | ~55 | | | | 219 |
| | | -some gravel (<20mm sub-rounded) | | | | | | | |
| 2 | | SILT - clayey, trace sand, some gravel (<25mm sub-rounded) -light brown/grey, wet to moist, soft to firm -low plasticity | <input checked="" type="checkbox"/> | G57 | ~65 | | | | 218 |
| | | -trace to some clay below ~2.4m | | | | | | | |
| 3 | | SILT (till) - sandy, some gravel (<25mm rounded), some clay -grey, wet -non-plastic to low plasticity | <input checked="" type="checkbox"/> | G58 | ~75 | | | | 217 |
| 4 | | -moist below ~4.1m | | | | | | | 216 |
| | | -trace oxidation | | | | | | | |
| 5 | | | <input checked="" type="checkbox"/> | G59 | ~85 | | | | 215 |
| 6 | | END HOLE AT 6.1m IN SILT TILL | | | | | | | 214 |
| 7 | | Notes: 1. No sloughing observed; 2. Seepage in silt till between ~2.4m and 4.0m; 3. Water at ~4.3m after drilling. | | | | | | | 213 |
| 8 | | | | | | | | | 212 |
| 8.7 | | | | | | | | | |

LOG OF TEST HOLE 60149637 DAUPHIN RIVER HARBOUR EXPANSION TH-10-01 TO TH-10-12.GPJ UMA WINN GDT 4/23/10



LOGGED BY: Jeremy Fiebelkorn COMPLETION DEPTH: 6.10 m
 REVIEWED BY: Faris Khalil COMPLETION DATE: 3/31/10
 PROJECT ENGINEER: Faris Khalil Page 1 of 1

| | | |
|--|--|-----------------------|
| PROJECT: Dauphin River Harbour Basin Expansion | CLIENT: Department of Fisheries and Oceans | TESTHOLE NO: TH-10-05 |
| LOCATION: North-East quadrant N5756443 E564004.8 | | PROJECT NO.: 60149637 |
| CONTRACTOR: Maple Leaf Drilling Ltd | METHOD: 125mm SSA, NQ Coring | ELEVATION (m): 219.11 |
| SAMPLE TYPE | <input checked="" type="checkbox"/> GRAB <input type="checkbox"/> SHELBY TUBE <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> BULK <input type="checkbox"/> NO RECOVERY <input type="checkbox"/> CORE | |

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE # | SPT (N) | PENETRATION TESTS | UNDRAINED SHEAR STRENGTH | COMMENTS | ELEVATION |
|-----------|-------------|--|-------------------------------------|----------|---------|-------------------|--------------------------|--|-----------|
| 0 | | GRAVEL (fill) - sandy, some silt, (<15mm angular) -light brown, moist to wet (top 0.2m), loose -frozen | | | | | | | 219 |
| 0.2 | | TOPSOIL - some roots and grasses -frozen to ~0.6m -brown/black, moist, firm | | | | | | | |
| 1 | | CLAY - silty -grey, moist, firm -medium plasticity -trace sand below ~1.1m | <input checked="" type="checkbox"/> | G21 | | | | | 218 |
| 1.5 | | SAND - (coarse grained <2mm) some gravel (<25mm rounded/sub-rounded) -grey, wet | <input checked="" type="checkbox"/> | G22 | | | | | |
| 2 | | SILT (till) - sandy, some clay, trace gravel (<20mm sub-rounded) -light brown, moist -non-plastic to low plasticity | <input checked="" type="checkbox"/> | G23 | | | | | 217 |
| 2.5 | | | <input checked="" type="checkbox"/> | G24 | | | | | |
| 3.5 | | Boulders from ~ 3.5m to 4.1m | | | | | | | 216 |
| 4 | | | <input checked="" type="checkbox"/> | C1 | | | | | 215 |
| 5 | | BEDROCK - Dolomitic Limestone -medium to fine grained, well foliated limestone. Numerous calcite/dolomite phenocrysts 1-2 mm. Laminations at 90 degrees to core axis. Planar fractures along lamination are rough and undulating. No alterations on core faces. -R3 medium strong -orientation 95 degrees -class 2 water flow -joints rough, undulating, unaltered -close spacing joints | <input checked="" type="checkbox"/> | C2 | | | | - difficult drilling at 4.3 -Rec = 100% -RQD = 81% | 214 |
| 6 | | END HOLE AT 6.1m IN BEDROCK | | | | | | | 213 |
| 7 | | Notes: 1. Sloughed to ~5.5m; 2. Seepage in sand layer at ~1.5m. | | | | | | | 212 |
| 8 | | | | | | | | | 211 |
| 8.7 | | | | | | | | | |

LOG OF TEST HOLE 60149637 DAUPHIN RIVER HARBOUR EXPANSION TH-10-01 TO TH-10-12.GPJ UMA WINN GDT 4/23/10



| | |
|--------------------------------|--------------------------|
| LOGGED BY: Jeremy Fiebelkorn | COMPLETION DEPTH: 6.10 m |
| REVIEWED BY: Faris Khalil | COMPLETION DATE: 3/30/10 |
| PROJECT ENGINEER: Faris Khalil | Page 1 of 1 |

PROJECT: Dauphin River Harbour Basin Expansion CLIENT: Department of Fisheries and Oceans TESTHOLE NO: TH-10-06
 LOCATION: South-East quadrant N5756412 E563969.1 PROJECT NO.: 60149637
 CONTRACTOR: Maple Leaf Drilling Ltd METHOD: 125mm SSA ELEVATION (m): 220.13
 SAMPLE TYPE GRAB SHELBY TUBE SPLIT SPOON BULK NO RECOVERY CORE

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE # | SPT (N) | PENETRATION TESTS | | UNDRAINED SHEAR STRENGTH | | COMMENTS | ELEVATION |
|-----------|-------------|--|-------------|----------|---------|---|---|--------------------------|--|----------|-----------|
| | | | | | | * Becker * ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) Total Unit Wt (kN/m ³) Plastic MC Liquid | + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ● Field Vane ● (kPa) | | | | |
| 0 | | GRAVEL (fill) - silty, some sand, (<25mm angular) -light brown, wet, loose CLAY (fill) - silty, some sand, some gravel (<30mm angular) -grey, moist, firm -medium plasticity | | | | | | | | | 220 |
| 1 | | -trace organics | | G60 | ● | | | | | | 219 |
| 2 | | PEAT - black/brown -moist, fibrous CLAY - silty, trace sand, trace gravel (<15mm sub-angular) -grey, moist, firm -medium to high plasticity -some sand inclusions (~25mm thick) below ~2.1m | | G61 | ● | | △+ | | | | 218 |
| 3 | | SAND - silty, some gravel (<25mm rounded) -grey, wet | | G62 | ● | | | | | | 217 |
| 4 | | SILT (till) - sandy, some clay, some gravel (<30mm sub-angular) -light brown, dry to moist -non-plastic to low plasticity | | G63 | ● | | | | | | 216 |
| 5 | | -wet | | G64 | ● | | | | | | 215 |
| 6 | | END HOLE AT 6.1m IN SILT TILL | | | | | | | | | 214 |
| 7 | | Notes: 1. Sloughed to ~4.0m; 2. Seepage in silt till at ~3.0m and 5.5m; 3. Water at ~2.4m after sloughing. | | | | | | | | | 213 |
| 8 | | | | | | | | | | | 212 |
| 8.7 | | | | | | | | | | | |

LOG OF TEST HOLE 60149637 DAUPHIN RIVER HARBOUR EXPANSION TH-10-01 TO TH-10-12.GPJ UMA WINN GDT 4/23/10



LOGGED BY: Jeremy Fiebelkorn COMPLETION DEPTH: 6.10 m
 REVIEWED BY: Faris Khalil COMPLETION DATE: 3/31/10
 PROJECT ENGINEER: Faris Khalil Page 1 of 1

PROJECT: Dauphin River Harbour Basin Expansion CLIENT: Department of Fisheries and Oceans TESTHOLE NO: TH-10-07
 LOCATION: Centre of the property N5756427 E563981.3 PROJECT NO.: 60149637
 CONTRACTOR: Maple Leaf Drilling Ltd METHOD: 125mm SSA ELEVATION (m): 219.75
 SAMPLE TYPE GRAB SHELBY TUBE SPLIT SPOON BULK NO RECOVERY CORE

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE # | SPT (N) | PENETRATION TESTS | | UNDRAINED SHEAR STRENGTH | COMMENTS | ELEVATION |
|-----------|-------------|---|-------------------------------------|----------|---------|---|---|--------------------------|----------|-----------|
| | | | | | | * Becker * ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) Total Unit Wt (kN/m³) | + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ● Field Vane ● (kPa) | | | |
| 0 | | GRAVEL (fill) - (<15mm angular), sandy, some silt -light brown/brown, moist to wet CLAY (fill) - silty, some fine-grained sand, trace gravel (<20mm sub-rounded), trace organics (wood chips) -grey, moist, firm -medium plasticity | <input checked="" type="checkbox"/> | G25 | | | | | | 219 |
| 1 | | PEAT - black/brown, moist, fibrous | <input checked="" type="checkbox"/> | G26 | | | | | | 218 |
| 2 | | SILT (till) - sandy, clayey, trace gravel (<15mm rounded/sub-rounded) -grey mottled light brown, moist to wet, soft -low plasticity | <input checked="" type="checkbox"/> | G27 | | | | | | 217 |
| 3 | | -moist below ~3.0m -non-plastic to low plasticity -some gravel (<40mm sub-angular) | <input checked="" type="checkbox"/> | G28 | | | | | | 216 |
| 4 | | -wet | <input checked="" type="checkbox"/> | G29 | | | | | | 215 |
| 5 | | | <input checked="" type="checkbox"/> | G30 | | | | | | 214 |
| 6 | | | <input checked="" type="checkbox"/> | G31 | | | | | | 213 |
| 6.1 | | | <input checked="" type="checkbox"/> | G32 | | | | | | 212 |
| 6.1 | | END HOLE AT 6.1m IN SILT TILL | | | | | | | | |
| 7 | | Notes: 1. Sloughed to 5.8m; 2. Seepage in silt till at 1.8m to 3.0m and at 4.0m to 6.1m; 3. Water at ~3.0m below existing ground level after sloughing. | | | | | | | | |

LOG OF TEST HOLE 60149637 DAUPHIN RIVER HARBOUR EXPANSION TH-10-01 TO TH-10-12.GPJ UMA WINN GDT 4/23/10



LOGGED BY: Jeremy Fiebelkorn COMPLETION DEPTH: 6.10 m
 REVIEWED BY: Faris Khalil COMPLETION DATE: 3/30/10
 PROJECT ENGINEER: Faris Khalil Page 1 of 1

PROJECT: Dauphin River Harbour Basin Expansion CLIENT: Department of Fisheries and Oceans TESTHOLE NO: TH-10-08
 LOCATION: North-West quadrant N5756456 E563946.6 PROJECT NO.: 60149637
 CONTRACTOR: Maple Leaf Drilling Ltd METHOD: 125mm SSA ELEVATION (m): 219.37

SAMPLE TYPE GRAB SHELBY TUBE SPLIT SPOON BULK NO RECOVERY CORE

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE # | SPT (N) | PENETRATION TESTS | | UNDRAINED SHEAR STRENGTH | | COMMENTS | ELEVATION |
|-----------|-------------|---|-------------------------------------|----------|---------|---|---|--------------------------|--|----------|-----------|
| | | | | | | * Becker * ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) ■ Total Unit Wt ■ (kN/m ²) | + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ● Field Vane ● (kPa) | | | | |
| 0 | | TOPSOIL - roots and grasses throughout -brown/black, wet, soft to firm | | | | | | | | | 219 |
| 0.5 | | CLAY - silty, trace sand, trace gravel (<10mm sub-rounded), trace oxidation -grey mottled light brown, moist, soft to firm -medium to high plasticity | <input checked="" type="checkbox"/> | G48 | 60 | | | | | | 218 |
| 2 | | SILT (till) - sandy, clayey to some clay, some gravel (<30mm sub-rounded) -light brown/grey, moist -non-plastic to low plasticity | <input checked="" type="checkbox"/> | G49 | 70 | | | | | | 217 |
| 2.5 | | Gravel - 7.9%, Sand - 29.4%, Silt - 39.9%, Clay - 22.9% -wet | <input checked="" type="checkbox"/> | G50 | 75 | | | | | | 216 |
| 5.5 | | -some gravel (<50mm sub-angular), trace cobbles | <input checked="" type="checkbox"/> | G51 | 80 | | | | | | 214 |
| 6.1 | | END HOLE AT 6.1m IN SILT TILL | | | | | | | | | 213 |
| 7 | | Notes: 1. Sloughed to 4.3m; 2. Seepage in silt till layer at ~2.4m and 5.5m; 3. Water at ~2.1m below existing ground level after sloughing. | | | | | | | | | 212 |
| 8 | | | | | | | | | | | 211 |

LOG OF TEST HOLE 60149637 DAUPHIN RIVER HARBOUR EXPANSION TH-10-01 TO TH-10-12.GPJ UMA WINN GDT 4/23/10



LOGGED BY: Jeremy Fiebelkorn COMPLETION DEPTH: 6.10 m
 REVIEWED BY: Faris Khalil COMPLETION DATE: 3/31/10
 PROJECT ENGINEER: Faris Khalil

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|--|---|-----------------------|
| PROJECT: Dauphin River Harbour Basin Expansion | CLIENT: Department of Fisheries and Oceans | TESTHOLE NO: TH-10-09 |
| LOCATION: Western section N5756421 E563943.4 | | PROJECT NO.: 60149637 |
| CONTRACTOR: Maple Leaf Drilling Ltd | METHOD: 125mm SSA | ELEVATION (m): 221.17 |
| SAMPLE TYPE | <input checked="" type="checkbox"/> GRAB <input type="checkbox"/> SHELBY TUBE <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> BULK <input checked="" type="checkbox"/> NO RECOVERY <input type="checkbox"/> CORE | |

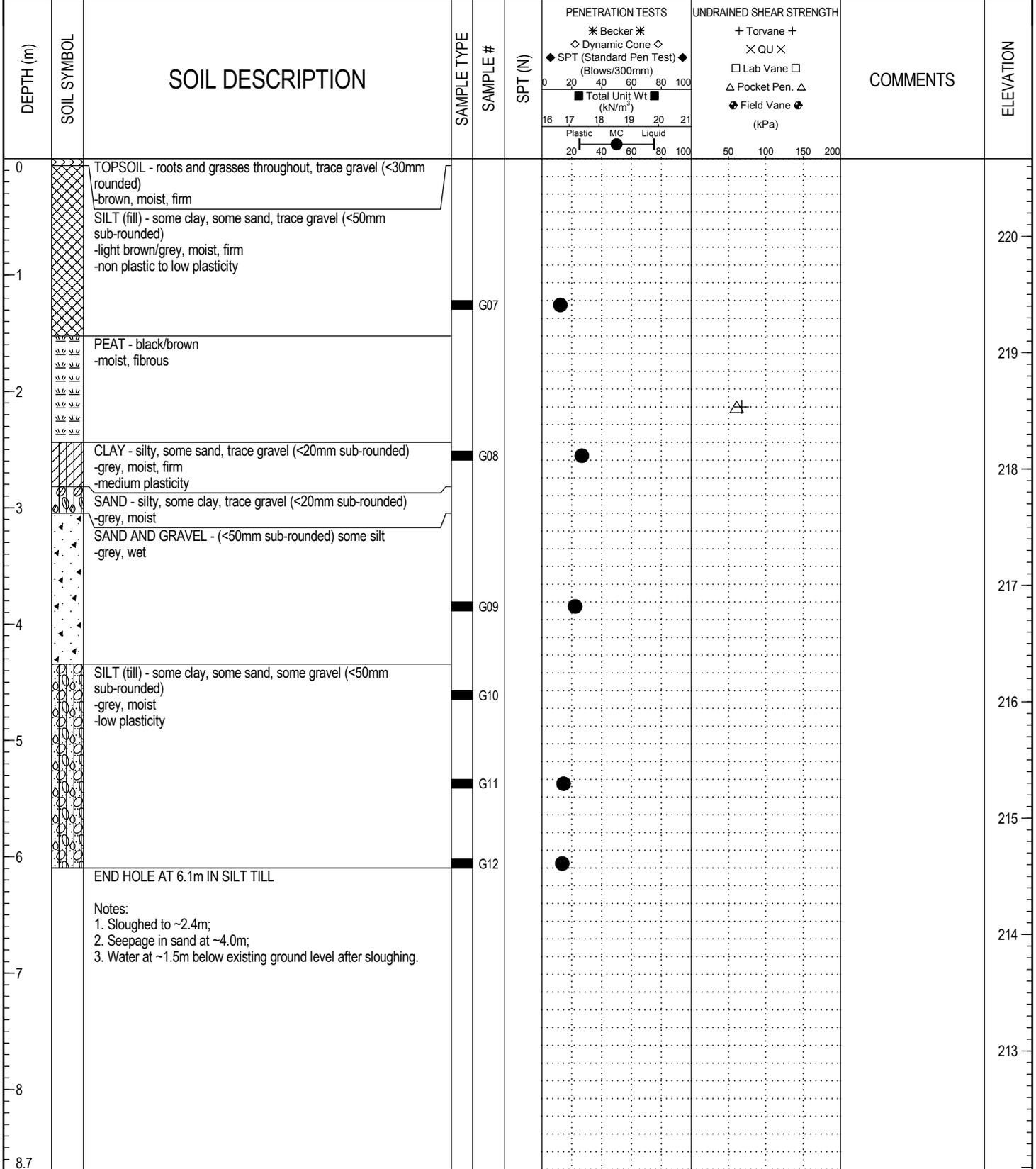
| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE # | SPT (N) | PENETRATION TESTS | | UNDRAINED SHEAR STRENGTH | | COMMENTS | ELEVATION |
|-----------|-------------|--|-------------|----------|---------|---|---|--------------------------|--|----------|-----------|
| | | | | | | * Becker * ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) Total Unit Wt (kN/m ³) Plastic MC Liquid | + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ● Field Vane ● (kPa) | | | | |
| 0 | | SILT (fill) - some sand, some gravel (<25mm sub-angular) -light brown, moist, firm -low plasticity | | | | | | | | | 221 |
| 1 | | CLAY (fill) - silty, some gravel (<15mm sub-angular), organics throughout -brown, moist, firm -medium plasticity | | | | | | | | | 220 |
| 2 | | CLAY - silty, trace sand, trace gravel (<10mm sub-rounded) -grey mottled light brown, moist, soft to firm -medium plasticity | | G43 | | | | | | | 219 |
| 3 | | | | G44 | | | | | | | 218 |
| 4 | | SILT (fill) - sandy, some clay, trace gravel (<25mm sub-angular) -grey, wet, firm -low plasticity | | | | | | | | | 217 |
| 5 | | -light brown/grey, moist, non-plastic | | | | | | | | | 216 |
| 6 | | Gravel - 8.9%, Sand - 32.1%, Silt - 40.9%, Clay - 18.2% | | | | | | | | | 215 |
| 7 | | -trace clay below ~6.1m, gray, low plasticity | | | | | | | | | 214 |
| 8 | | -wet | | G45 | | | | | | | 213 |
| 8.7 | | END HOLE AT 7.6m IN SILT TILL | | G46 | | | | | | | 213 |
| | | Notes: 1. Sloughed to 4.3m; 2. Seepage in silt layer at ~4.0m and 7.3m; 3. Water at ~3.0m below existing ground level after sloughing; 4. Large boulders (500mm to 800mm) visible at surface, likely spoil fill from previous excavation | | G47 | | | | | | | 213 |

LOG OF TEST HOLE 60149637 DAUPHIN RIVER HARBOUR EXPANSION TH-10-01 TO TH-10-12.GPJ UMA WINN GDT 4/23/10



| | |
|--------------------------------|--------------------------|
| LOGGED BY: Jeremy Fiebelkorn | COMPLETION DEPTH: 7.62 m |
| REVIEWED BY: Faris Khalil | COMPLETION DATE: 3/31/10 |
| PROJECT ENGINEER: Faris Khalil | Page 1 of 1 |

PROJECT: Dauphin River Harbour Basin Expansion CLIENT: Department of Fisheries and Oceans TESTHOLE NO: TH-10-10
 LOCATION: South-west quadrant N5756409 E563957.5 PROJECT NO.: 60149637
 CONTRACTOR: Maple Leaf Drilling Ltd METHOD: 125mm SSA ELEVATION (m): 220.67
 SAMPLE TYPE GRAB SHELBY TUBE SPLIT SPOON BULK NO RECOVERY CORE



LOG OF TEST HOLE 60149637 DAUPHIN RIVER HARBOUR EXPANSION TH-10-01 TO TH-10-12.GPJ UMA WINN GDT 4/23/10



LOGGED BY: Jeremy Fiebelkorn COMPLETION DEPTH: 6.10 m
 REVIEWED BY: Faris Khalil COMPLETION DATE: 3/30/10
 PROJECT ENGINEER: Faris Khalil Page 1 of 1

PROJECT: Dauphin River Harbour Basin Expansion CLIENT: Department of Fisheries and Oceans TESTHOLE NO: TH-10-11
 LOCATION: South of property boundary N5756396 E563947 PROJECT NO.: 60149637
 CONTRACTOR: Maple Leaf Drilling Ltd METHOD: 125mm SSA ELEVATION (m): 221.09
 SAMPLE TYPE GRAB SHELBY TUBE SPLIT SPOON BULK NO RECOVERY CORE

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE # | SPT (N) | PENETRATION TESTS | | UNDRAINED SHEAR STRENGTH | COMMENTS | ELEVATION |
|-----------|-------------|--|-------------------------------------|----------|---------|---|---|--------------------------|----------|-----------|
| | | | | | | * Becker * ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) ■ Total Unit Wt ■ (kN/m ²) | + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ● Field Vane ● (kPa) | | | |
| 0 | | GRAVEL (fill) - silty, some sand, (<20mm angular) -light brown, moist to wet, loose SILT (fill) - some sand, some gravel (<15mm sub-rounded), some cobbles (<100mm rounded) -light brown, dry to moist -low plasticity | <input checked="" type="checkbox"/> | G39 | ● | | | | | 221 |
| 1 | | CLAY (fill) - silty, some sand, some gravel (<20mm sub-angular) -grey, moist, firm -low to medium plasticity | <input checked="" type="checkbox"/> | G40 | ● | | | | | 220 |
| 2 | | PEAT - black/brown, moist, fibrous | <input checked="" type="checkbox"/> | G41 | | | | | | 219 |
| 3 | | SAND - some silt, some clay, trace gravel (<15mm sub-angular) -grey, moist to wet -fine to coarse grained | <input checked="" type="checkbox"/> | G42 | | | | | | 218 |
| 4 | | Gravel - 4.7%, Sand - 58.9%, Silt - 17.4%, Clay - 19.1% | <input checked="" type="checkbox"/> | G41 | ● | | | | | 217 |
| 5 | | SILT (till) - some sand, some clay, some gravel (<25mm sub-angular) -light brown/grey, moist -low plasticity | <input checked="" type="checkbox"/> | G42 | ● | | | | | 216 |
| 6 | | END HOLE AT 6.1m IN SILT TILL | | | | | | | | 215 |
| 7 | | Notes: 1. Sloughed to 1.8m; 2. Seepage in sand layer at ~3.0m - 4.5m; | | | | | | | | 214 |
| 8 | | | | | | | | | | 213 |
| 8.7 | | | | | | | | | | |

LOG OF TEST HOLE 60149637 DAUPHIN RIVER HARBOUR EXPANSION TH-10-01 TO TH-10-12.GPJ UMA WINN GDT 4/23/10



LOGGED BY: Jeremy Fiebelkorn COMPLETION DEPTH: 6.10 m
 REVIEWED BY: Faris Khalil COMPLETION DATE: 3/31/10
 PROJECT ENGINEER: Faris Khalil Page 1 of 1

| | | |
|--|---|-----------------------|
| PROJECT: Dauphin River Harbour Basin Expansion | CLIENT: Department of Fisheries and Oceans | TESTHOLE NO: TH-10-12 |
| LOCATION: South-East quadrant N5756396 E563977.3 | | PROJECT NO.: 60149637 |
| CONTRACTOR: Maple Leaf Drilling Ltd | METHOD: 125mm SSA | ELEVATION (m): 219.80 |
| SAMPLE TYPE | <input checked="" type="checkbox"/> GRAB <input type="checkbox"/> SHELBY TUBE <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> BULK <input checked="" type="checkbox"/> NO RECOVERY <input type="checkbox"/> CORE | |

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE # | SPT (N) | PENETRATION TESTS | | UNDRAINED SHEAR STRENGTH | | COMMENTS | ELEVATION |
|-----------|-------------|--|-------------|----------|---------|---|---|--------------------------|--|----------|-----------|
| | | | | | | * Becker * ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) Total Unit Wt (kN/m ³) Plastic MC Liquid | + Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ● Field Vane ● (kPa) | | | | |
| 0 | | CLAY (fill) - silty, trace sand, trace gravel (<25mm rounded) -frozen to ~0.5m -brown, moist -medium plasticity -moist below ~0.5m | | | | | | | | | |
| 0.5 | | SILT (fill) - some sand, trace clay, trace gravel (<20mm rounded) -light brown, moist, firm -low plasticity | | G01 | | | | | | | 219 |
| 1.5 | | SILT (till) - some sand, some gravel (<40mm sub-rounded), some clay -light brown, moist, compact -non plastic to low plasticity | | G02 | | | | | | | 218 |
| 2.5 | | | | G03 | | | | | | | 217 |
| 3.5 | | -wet below ~3.0m (seepage into hole) | | G04 | | | | | | | 216 |
| 4.5 | | | | G05 | | | | | | | 215 |
| 5.5 | | -moist below ~4.6m | | G06 | | | | | | | 214 |
| 6.1 | | END HOLE AT 6.1m IN SILT TILL | | | | | | | | | 213 |
| 7.0 | | Notes: 1. Auger refusal at 5.6m on suspected boulder/bedrock. Redrilled hole ~1m east to 6.1m without refusal; 2. Hole sloughed to 3.8m; 3. Seepage in till layer at ~3.0m - 4.5m; 4. Water at 1.5m below existing ground level after sloughing. | | | | | | | | | 212 |

LOG OF TEST HOLE 60149637 DAUPHIN RIVER HARBOUR EXPANSION TH-10-01 TO TH-10-12.GPJ UMA WINN GDT 4/23/10



| | |
|--------------------------------|--------------------------|
| LOGGED BY: Jeremy Fiebelkorn | COMPLETION DEPTH: 6.10 m |
| REVIEWED BY: Faris Khalil | COMPLETION DATE: 3/30/10 |
| PROJECT ENGINEER: Faris Khalil | Page 1 of 1 |