# OXTOBY – HOWLAND ACREAGE
# CONCEPT PLAN - SERVICING REPORT

*Prepared By:*

PASQUINI & ASSOCIATES
ENGINEERING · GEOMATICS

#300, 929 – 11th Street SE
Calgary, AB T2G 0R4

*Prepared For:*

Oxtoby/Howland

File: 276 901 1

July 28, 2020

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## LIST OF FIGURES

## 1.0 INTRODUCTION

On behalf of Oxtoby/Howland, Pasquini & Associates (PA) is pleased to present this servicing report addressing post development servicing of the lands comprising the Oxtoby/Howland acreage. The lands are situated within Foothills County with the legal description Block 5, Plan 9912130 within the SW ¼ of Section 5-22-29-W4. The subject lands are situated on the north side of Dunbow Road, some 500 m east of Heritage Lake Drive and comprise an area of approximately 9.87 ha (24.39 acres). The lands are directly bounded by other privately owned parcels and in an overall sense by the existing Hamlet of Heritage Pointe.

A concept plan showing proposed development of the subject lands is shown on Sheet S4. This report presents an overview of deep utility servicing (sanitary, water, and storm) of the subject lands based on this proposed development concept plan.

## 2.0 SITE CHARACTERISTICS

The natural topography of the subject lands generally slopes in south to north, west to east directions. The elevation difference ranges from about 1050.0 m in the southwest to 1022.5 m in the northeast. Slopes within the broader, south half of the lands range from about 3.0% to 4.0%. A notable feature of the lands is an existing pond in the northeast which collects predevelopment drainage from the subject lands as well as other surrounding lands within the area. Slopes around the west side of the existing pond and extending north within the narrower, north portion of the subject lands are steeper, ranging from about 15.0% (6.7:1) to 50.0% (2:1).

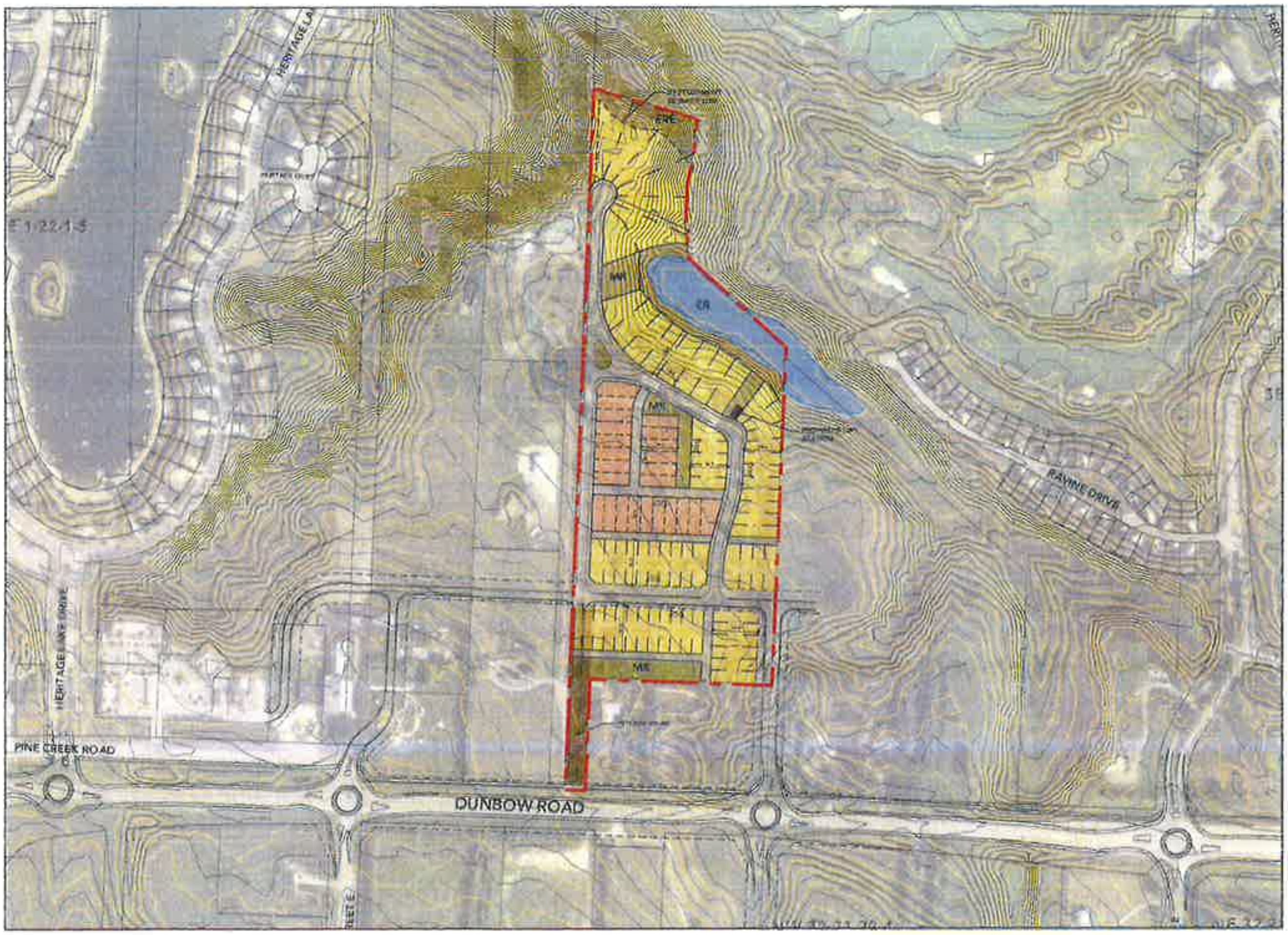
A predevelopment geotechnical and slope stability report was prepared for the subject lands by McIntosh Lalani Engineering Ltd. under a separate cover (Geotechnical & Pre-Grading Slope Stability Report - Oxtoby Howland Ranch, File 02001385.000, July 17, 2020). The geotechnical report assessed general subsurface soil conditions for design and construction of the proposed development and established a pre-grading slope stability setback line for consideration as part of proposed development adjacent the steeper sloped areas. This line is noted on Sheet S4.

Predevelopment drainage from the subject lands and other surrounding lands collects in the existing pond which discharges north into an existing drainage course that meanders through the Heritage Pointe Golf Course, ultimately discharging into Pine Creek.

## 3.0 DEEP UTILITY SERVICING

Land uses in the proposed concept plan (Sheet S4) include single family and villa type residential development, municipal and environmental reserve, as well as roadways and lanes. Based on the land use, an anticipated total of 87 residential units and an assumed occupancy of 3.3 persons per unit, the population of the development is estimated to be 290 people.

The proposed development will be serviced by the existing Foothills Wastewater and Water Systems operated by Corix Utilities. Servicing is proposed through extension of the respective systems from existing infrastructure servicing the Heritage Pointe development. The deep utility



TOWNSHIP
planning + design inc.

**CLIENT**
OXTOBY / HOWLAND

**PROJECT NUMBER**
19-024

**LEGAL ADDRESS**
SW 5-22-29 W4
BLOCK 5 PLAN 9912100
24.35 AC (9.8x HA)

**DATE**
2020-0[illegible]-22

**STATISTICS**

| | | |
|---|---|---|
| Total Site Area | 24.29 ac | [illegible] |
| [illegible] | [illegible] | [illegible] |
| Site Area | [illegible] | [illegible] |
| Single-family / Villas | 10.76 ac<br>2.70 ac | 4.36 ha<br>1.09 ha |
| Municipal Reserve | [illegible] | [illegible] |
| Roads | 5.88 ac | [illegible] |

Average Lot Sizes
[illegible]

Total Frontage = 1108 m

DUE DILIGENCE REPORT : OXTOBY / HOWLAND
CONCEPT PLAN

SCALE
1:2500

SHEET
S4
Concept Plan

servicing strategy for the concept plan area is described below based on previous discussion with Corix Utilities.

### 3.0.1 Sanitary

Sanitary servicing of the concept plan area would occur through the installation of sanitary sewer pipes along proposed roadways and utility rights-of-way within and outside the concept plan area. Based on a preliminary review of post development grades, sanitary sewer pipes would convey flows by gravity to a low point in the northeast corner of the development (Figure SAN-1). A small lift station (similar to others installed to service the Heritage Pointe/Artesia developments) would be constructed in the vicinity of this low point to pump sanitary flows via a force main into the existing downstream sanitary system. The force main alignment would generally run east below the existing pond, through adjacent golf course and/or privately owned lands, discharging into the existing sanitary sewer pipe along Ravine Drive.

It is understood that there is sufficient capacity available in the existing downstream sanitary sewer system through the Heritage Pointe development for servicing of the concept plan area. Determination of available capacity and a final alignment for the force main will occur as part of subsequent planning and/or detail design stages in collaboration with Corix Utilities, approving authorities and any other affected landowners or parties. Utility rights-of-way and easements may have to be negotiated between affected parties.

### 3.0.2 Water

Water servicing of the concept plan area would occur through the installation of water mains along proposed roadways and utility rights-of-way within and outside the concept plan area Two off-site water main connections are required into the existing system servicing the Heritage Pointe development in order to create a looped water main network which provides sufficient flow volume and redundancy for servicing of the concept plan area. Options for potential water main alignments and connections are shown on Figure WAT-1.

One water main connection is required southwest of the subject lands into the water main leaving the Lake Reservoir site (west of the building). This connection would have demand drawn from the Lake Reservoir capacity which is greater than alternate connections where demand might otherwise be drawn from the Water Treatment Plant capacity. A possible alignment (Option 1) for this water main connection is east from the Lake Reservoir tie, through two adjacent parcels (one of which is understood to be privately owned) to the southwest boundary of the concept plan area. In the event this alignment is not supported by affected landowners, an alternate alignment for the water main from the Lake Reservoir tie-in location that can be considered is south to Dunbow Road, east along Dunbow Road then north along the existing access to the subject lands (Option 2). This alignment resides within the public realm; however, is not preferred given it would be longer, require more infrastructure, and is a more complex construction given installation would be required along the existing roadway.

A second water main connection for consideration is an extension from the north cul-de-sac of the concept plan area, west to the existing water main along Heritage Lake Drive. The alignment of this connection is through two adjacent privately owned parcels and would require support of the affected landowners.

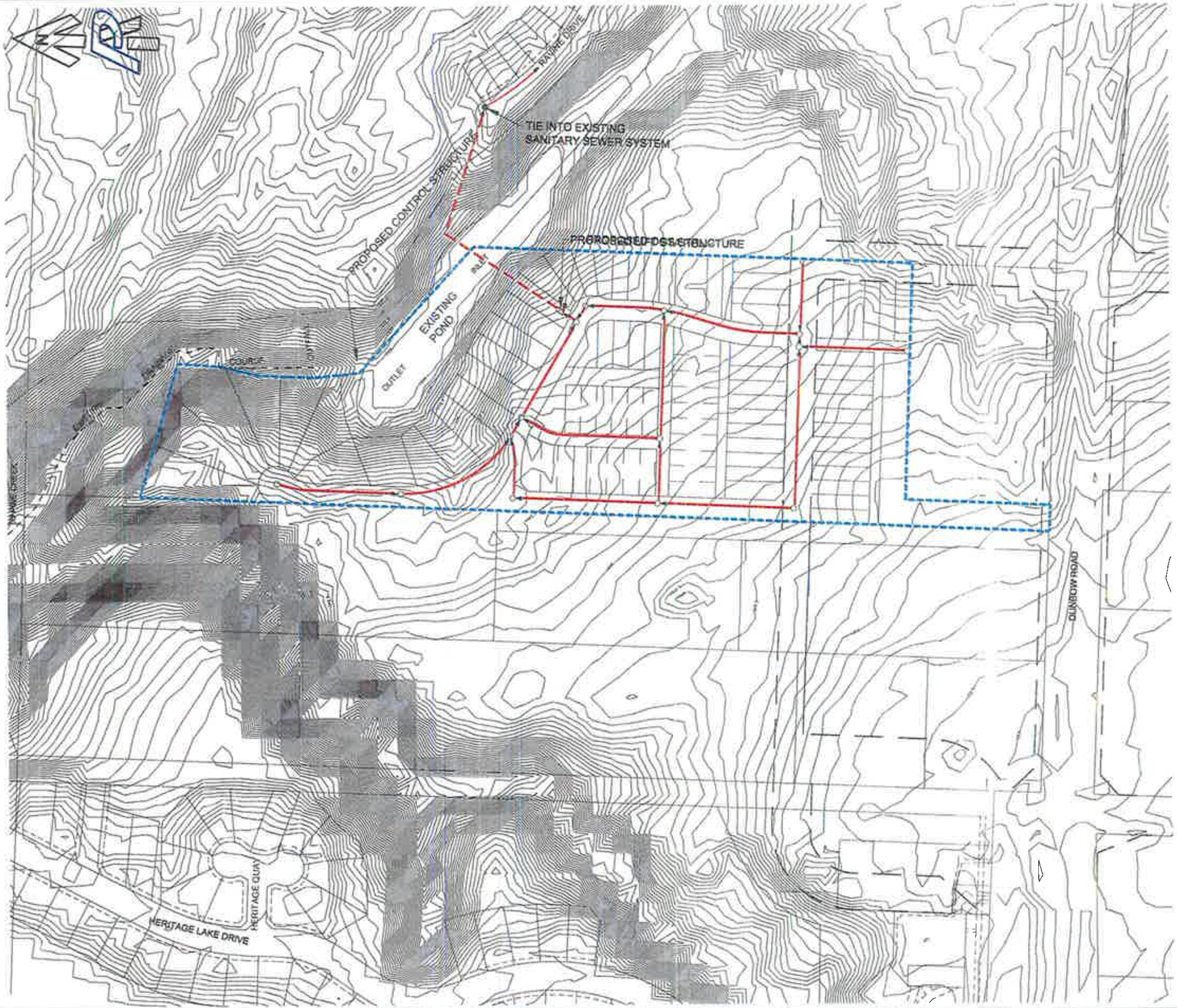


FIGURE SAN-1
PRELIMINARY SANITARY
SERVICING CONCEPT

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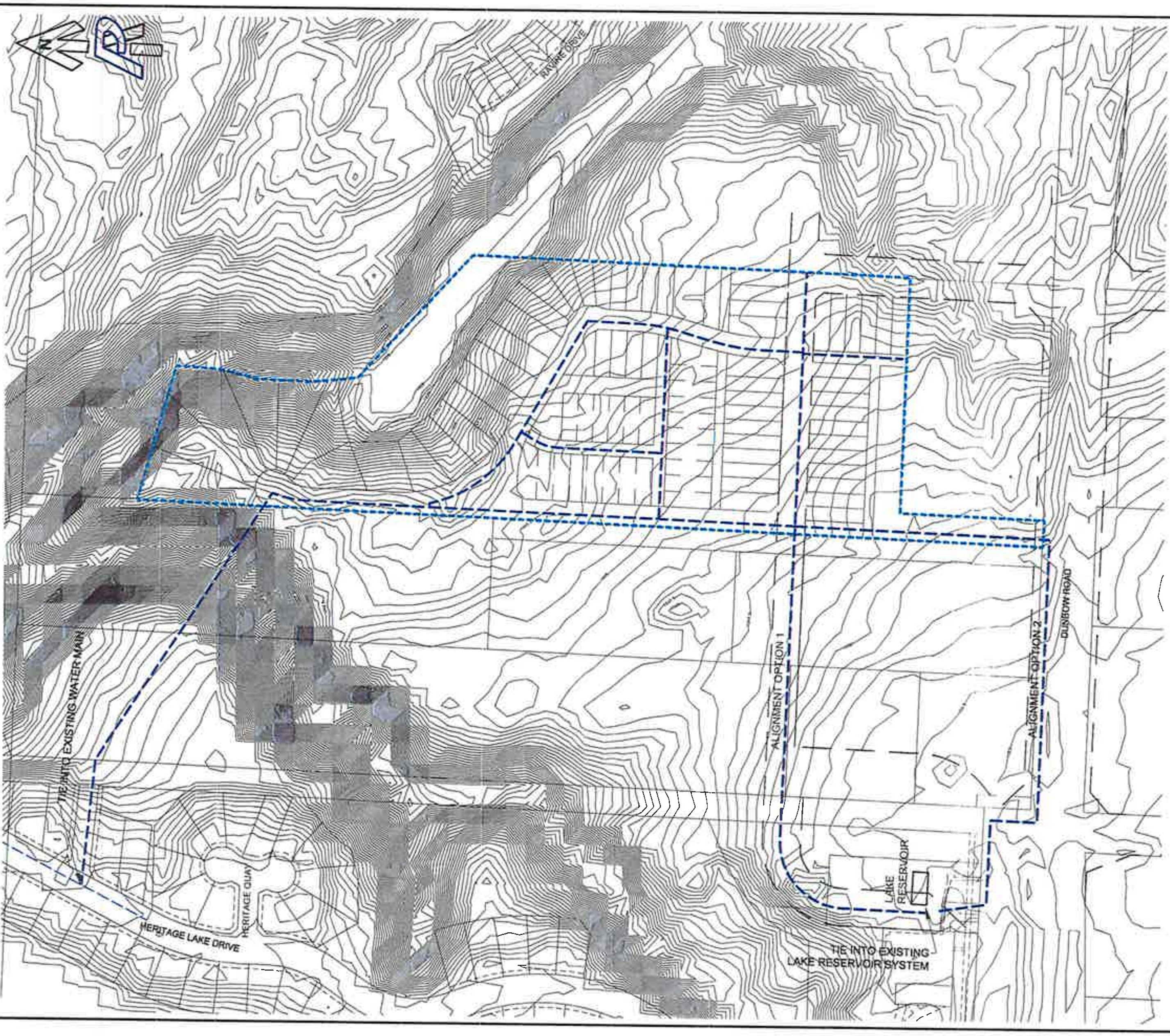

- CONCEPT PLAN BOUNDARY
- PROPOSED WATER MAIN
- EXISTING WATER MAIN

# FIGURE WAT-1
# PRELIMINARY WATER SERVICING CONCEPT

0 30 60 90 m SCALE 1:3000

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Proposed lots in the southeast corner of the concept plan area can be serviced by a single water main feed off the looped system given the number of lots to be serviced by a sole connection are few.

Determination of water usage demands, available water capacity, and final alignments of water main connections will occur as part of subsequent planning and/or detail design stages in collaboration with Corix Utilities, approving authorities and any other affected landowners or parties. Utility rights-of-way and easements may have to be negotiated between affected parties.

### 3.0.3 Storm

Storm servicing of the concept plan area would occur through storm sewer pipes installed along proposed roadways and utility rights-of-way within and outside the concept plan area. Based on a preliminary review of post development grades, storm sewer pipes (similar to sanitary) would convey flows by gravity to a low point in the northeast corner of the development (Figure ST-1). A storm sewer pipe installed along an alignment parallel to the sanitary force main would eventually discharge drainage into the existing storm pond through an inlet proposed on the west side of the pond. Water quality improvement of discharge into the storm pond would occur through the installation of an oil grit separator (OGS) type device (or equivalent) in advance of the pond inlet. Discharge from the storm pond would take place through an outlet control structure and pipe to be installed near the north end of the storm pond. The storm pond will both control the quantity and improve the quality of discharge prior to release into the existing drainage course and the receiving stream (Pine Creek).

A staged master drainage plan (SMDP) addressing the stormwater management strategy can be prepared as part of subsequent planning and/or detail design stages in consultation with approving authorities and any other affected parties or stakeholders. The proposed stormwater management strategy will be formulated with consideration to applicable design criteria for runoff rates and volumes to Pine Creek.

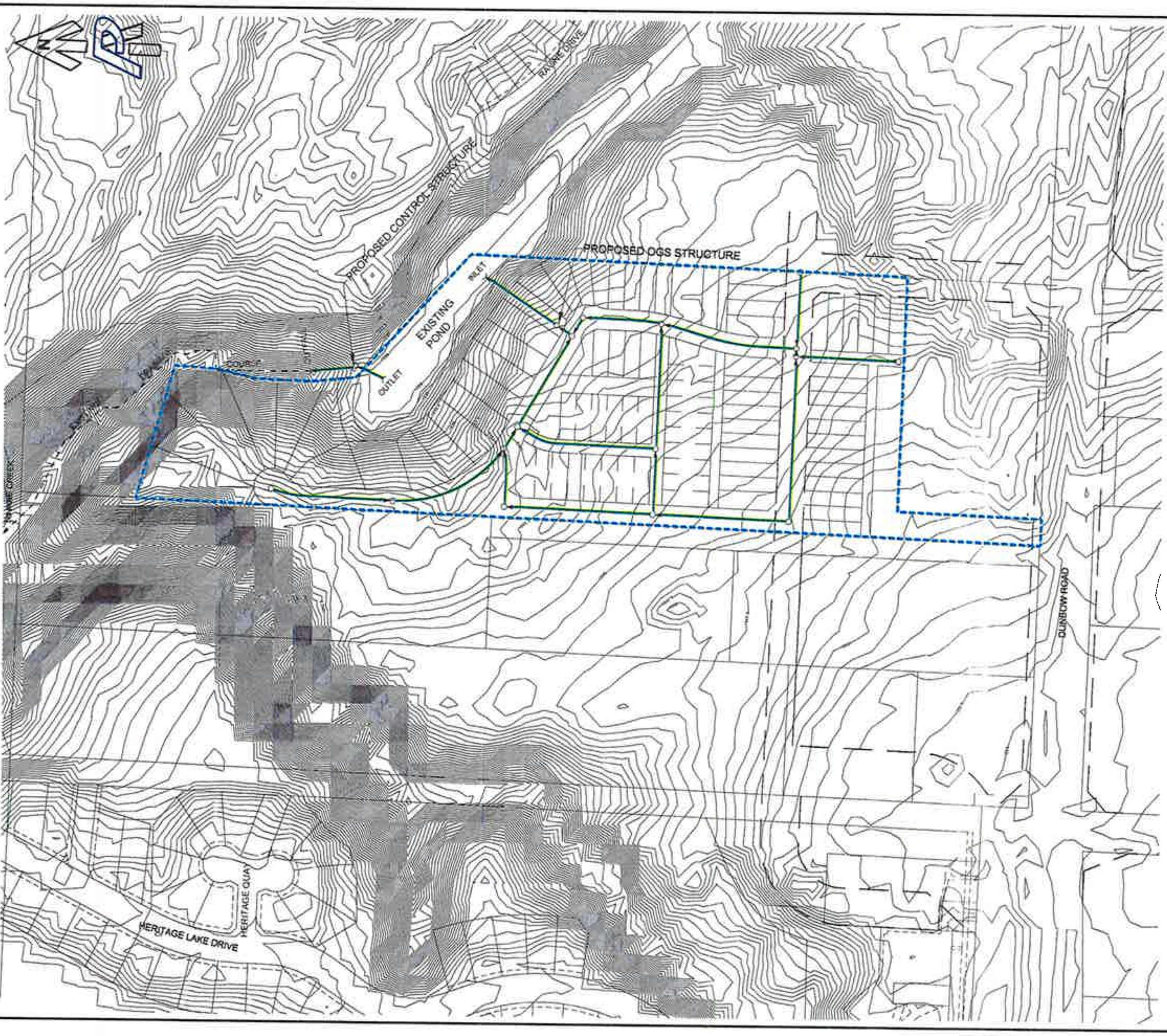
## 4.0 SHALLOW UTILITY SERVICING

It is anticipated that shallow utility servicing (gas, electrical, telecommunication, and cable) can be provided through the extension of shallow utility infrastructure from existing development and regional facilities near the concept plan area. Shallow utility provides will be engaged as part of subsequent planning and/or detail design stages to determine shallow utility requirements and whether any upgrades of regional infrastructure will be necessary.

## 5.0 CLOSING

It is presumed that Corix Utilities, who operate the existing wastewater and water systems, will undertake appropriate review and analysis to assess the feasibility of the proposed sanitary and water servicing strategies, determine infrastructure requirements by the developer and/or the utility provider, and confirm whether any upgrades of the existing systems are necessary.

A stormwater management study (i.e. SMDP) can be prepared as part of subsequent planning and/or detail design stages to formally overview and assess the proposed stormwater management strategy for the concept plan area.



- CONCEPT PLAN BOUNDARY
- PROPOSED STORM SEWER PIPE

# FIGURE ST-1
# PRELIMINARY STORM SERVICING CONCEPT

0 30 60 90 m SCALE 1:3000

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# APPENDIX 1

## Support Information


Corix Utilities - Foothills Sewer System, Calgary AB
System Valve
Manhole
Lift Station
Pressurized Main
Gravity Main
200 0 200 Meters
Created By Maddison Verhelst
November 12, 2010

- Foothills Water System, Calgary AB

Created By Maddison Verheist
November 12, 2019

**From:** Sean Twomey
**To:** Tony Pasquini; Franca Petrucci; Mike White
**Cc:** Carolina Oxtoby (cjox@shaw.ca); "Kristi Beunder"
**Subject:** RE: Oxtoby-Howland - Property - Servicing Discussion
**Date:** May 5, 2020 8:50:39 AM
**Attachments:** image001.png

---

Tony,
Few notes below.
Seán

Seán Twomey, P.Eng, MBA
*Vice President, Operations – Canadian Utilities*

Corix Utilities
*C: 403-700-1563*
Visit us at http://www.corix.com

**From:** Tony Pasquini <tpasquini@pasquini.ca>
**Sent:** Friday, May 1, 2020 9:29 AM
**To:** Franca Petrucci <Franca.Petrucci@corix.com>; Mike White <Mike.White@corix.com>; Sean Twomey <Sean.Twomey@corix.com>
**Cc:** Carolina Oxtoby (cjox@shaw.ca) <cjox@shaw.ca>; 'Kristi Beunder' <Kristi@twpplanning.com>
**Subject:** FW: Oxtoby-Howland - Property - Servicing Discussion

Following is a general summary of key points discussed as part of the conference call meeting April 28, 2020 regarding servicing of the subject land.

Sanitary Servicing

- Based on the initial concept plan and a preliminary review of grading, it is anticipated all sanitary flows from the proposed development will be conveyed via a gravity sewer pipe system to a low point in the northeast (figure attached). A small lift station would be constructed in this vicinity (similar to others within the existing Heritage Pointe/Artesia developments) to pump sanitary flows via a force main northeast to the sanitary sewer pipe along Ravine Drive. The general alignment of the proposed force main is through adjacent golf course lands and avoids encroachment into private landowner parcels. The final alignment is to be confirmed and negotiated with affected parties.

Water Servicing

- Two water main connections into the existing system are required in order to create a looped system.
- Options for potential alignments are shown on the attached figure. Corix noted that one connection in the southwest into the main leaving the Lake Reservoir site (west of the

building) is required as this will have the demand being drawn from the Lake Reservoir capacity which***[ST]*** has more capacity than the~~ is larger than the ~~Water Treatment Plant. Two possible alignments for this connection can be considered. ① - ④ is an alignment west through two adjacent parcels (one of which is a private landowner parcel) which would require a utility right-of-way and easement be negotiated. In the event this alignment is not supported by private landowners or an agreement cannot be negotiated, an alternate alignment from the Lake Reservoir watermain tie-in location has to be considered. ① - ② - ③ - ④ is an alternate alignment south to Dunbow Road, east along Dunbow Road then north along the existing access to the subject lands. This alignment is along the public realm but is less preferred as it is longer and would require more infrastructure and installation along an existing roadway which results in a greater cost for the water main installation.

- A second connection is required to the north. One connection west to Heritage Lake Drive can be contemplated ⑤ - ⑥; though, this connection is again through two adjacent parcels (may be private landowners) which would require a utility right-of-way and easement be negotiated. Alternate alignments that can be considered is a connection to the water main along Ravine Drive ⑥ - ⑧ or ⑦ - ⑧. The alignment ⑦ - ⑧ is preferred as it is shorter and follows a similar alignment as the proposed sanitary force main.***[ST]*** This option may not be an possible as point #8 is feed from the Water Treatment Plant and may result in drawing down that reservoir capacity which would be problematic during operations.
- The lots along the south boundary of the subject lands can possibly be serviced by a single (or dual if necessary) water main connection from ④ - ⑨.

Other

- It is understood that any upgrades to ***[ST]*** vertical assets - ~~regional~~ sanitary and water infrastructure (if necessary) would be the responsibility of Corix.
- All other infrastructure required for sanitary and water servicing of the subject lands (e.g. sanitary sewer pipe extensions, sanitary lift station and force main, water main extensions) would be developer funded infrastructure. Corix noted they can assist in securing endeavours on the infrastructure.***[ST]*** Please clarify.
- Further discussion with Corix as regards infrastructure costs can follow later (upon servicing strategies and alignments being confirmed) to determine whether other landowners may become future benefitting parties from the infrastructure and as a result, whether Corix or Foothills County would subsequently partake in any cost sharing of off-site servicing infrastructure.
- Corix previously provided a memo which overviews water and wastewater connection fees (letter attached). This will be discussed further at later stages of the project.

It is our understanding that Corix will undertake appropriate review and analysis to assess the feasibility of the proposed sanitary and watermain extensions and connections and subsequently advise as to feasibility and minimum requirements.***[ST]*** Corix will cover the costs of this work if the project proceeds. Please be cognizant of the developers preferred connections in the analysis. If there are any questions, please contact the undersigned.

Thanks

**Tony Pasquini,** P.Eng.
Vice President
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E: tpasquini@pasquini.ca

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**From:** Tony Pasquini
**Sent:** April 28, 2020 10:18 AM
**To:** 'Franca Petrucci' <Franca.Petrucci@corix.com>; 'Mike.White@corix.com' <Mike.White@corix.com>
**Cc:** Carolina Oxtoby (cjox@shaw.ca) <cjox@shaw.ca>; Kristi Beunder <Kristi@twpplanning.com>
**Subject:** FW: Development of our Acreage

Hello

Further to the e-mail provided previously below, we have added questions/comments in green. These can perhaps help direct conversation in our scheduled meeting today.

Thanks

**Tony Pasquini,** P.Eng.
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**From:** Franca Petrucci <Franca.Petrucci@corix.com>
**Sent:** April 16, 2020 4:46 PM
**To:** Tony Pasquini <tpasquini@pasquini.ca>; 'Kristi Beunder' <Kristi@twpplanning.com>
**Cc:** Mike White <Mike.White@corix.com>
**Subject:** FW: Development of our Acreage

Hi Tony and Kristi,
Please see attached. I have also included Mike White, manager of the Foothills system, and who has worked on these drawings (thanks Mike!).

Our notes on the layout are as follows: (Note: you don't need to follow the suggested routes we've laid out, but you will need to connect to the system where we have identified)

Potable Water Notes:

- We would like the development to be a looped distribution system. To accomplish this, Tie-in's would be from the North end of the development into Heritage Lake Drive. As well to the south into the main leaving the Lake Reservoir just west of the building.
    - Would it be possible for a water tie to occur into the bulb at the end of Ravine Drive (similar the sanitary forcemain tie) as opposed to Heritage Lake Drive? This avoids having to procure a utility right-of-way/easement through the two parcels west of the subject lands (in the event they are not supportive). This may perhaps allow for a shorter off-site watermain extension. It may be that the watermain along Ravine Drive is not adequately sized to allow for this tie.
    - Although preferable for a south connection into the main leaving the Lake Reservoir (west of the building), a tie at this location will again warrant the requirement for a utility right-of-way/easement through the two parcels west of the subject lands. In the event they are not supportive, is the option to tie into the watermain along Dunbow Road via the existing access to the subject lands an option that can be considered (again is there a capacity issue)? Otherwise, a different alignment has to be determined for a new watermain from the Lake Reservoir watermain tie-in location (e.g. south to Dunbow Road, east along Dunbow Road then north along the existing access to the subject lands. This would be more costly).
- Having the tie in on the Lake side of the community will have the demand being drawn from the Lake reservoir capacity which is larger than the Water treatment plant. The previous suggestion would have it tied into the water plant. The Main along Dunbow road only feeds water one direction towards the Lake reservoir.
    - Is the issue with a tie into the watermain along Dunbow Road one of capacity? If not, perhaps two watermain extensions along the existing access to the subject lands from Dunbow Road can be considered. One watermain tie could direct flow north into the subject lands. This watermain would meander through the proposed development along the roadway alignments then extend back south along the existing access (parallel to the inflow extension) tying back into the existing watermain along Dunbow Road (where flows would continue west). If this is not viable, the inflow tie along Dunbow Road could again be contemplated with the watermain through the subject lands extended to a second tie to the north (options previously described) to complete a looped system.
- The future roadway to the West of the Lake reservoir (Where I have the tie in drawn) is a concern. The actual space available will have this roadway dangerously close to the Buried Storage Tanks of the Lake reservoir. As well the Electrical Utility for the commercial Buildings #1 and 2 is located in this Green space. Elimination or relocation might be required.
    - The feasibility of the roadway alignment and the watermain extension has to be investigated to greater detail.

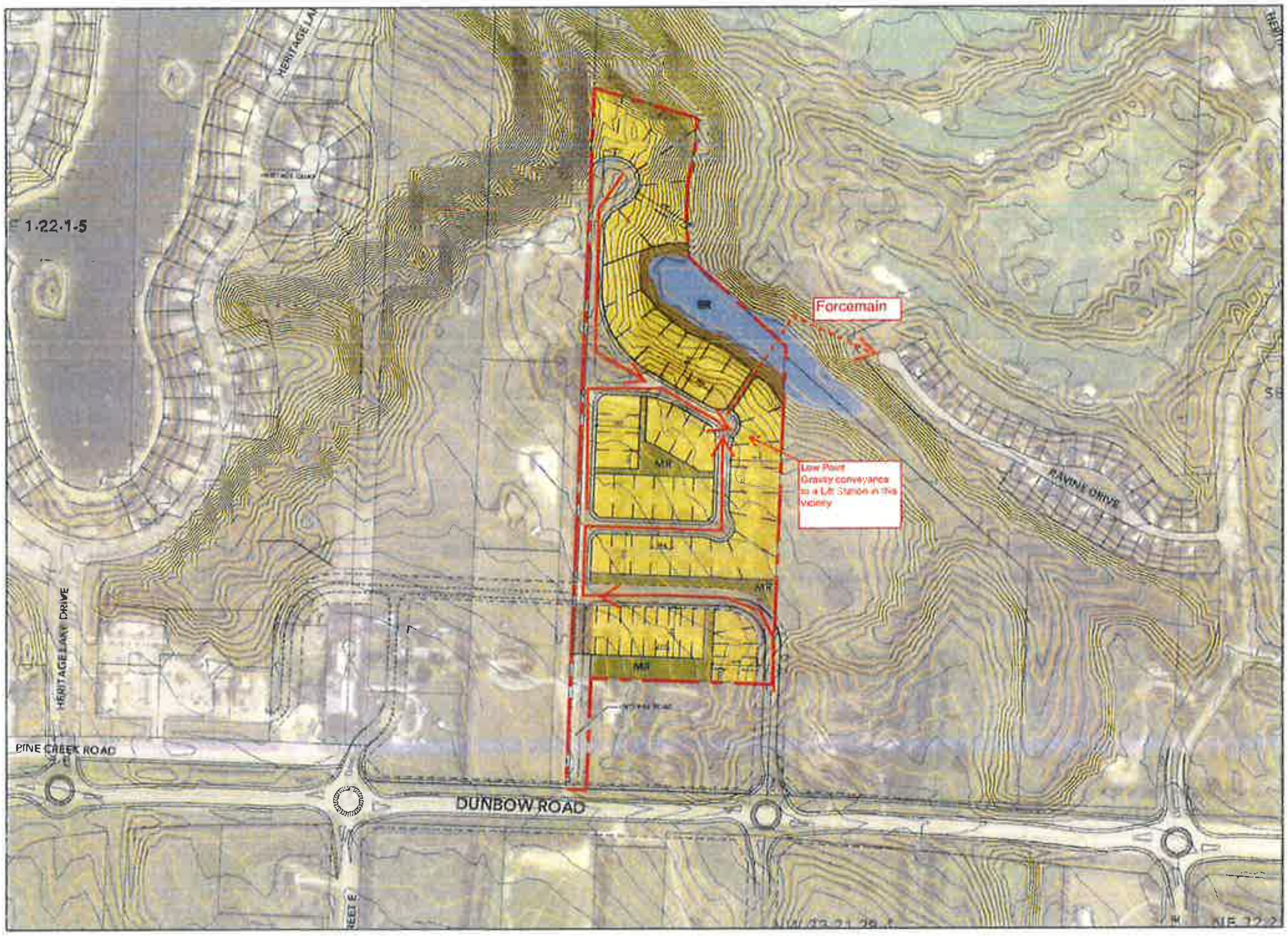
Sanitary Notes:

- We suggest the Tie in be to the East and drop into the manhole at the end of Ravine Drive. There are 2 main reasons for this;
    - The Inverted Syphon that is located on the Lake side of the community is already at capacity. Without upgrades or changing the syphon to a lift station, adding more homes to this area is not a preferred option at this time. There is as well historical flow issues along Ridge Pointe Drive which added volume could cause more problems.
    - This Lift station on Ravine Drive is underutilized. There are very low run hours and influent volumes throughout the year. The suggested force main flows avoid the troubled areas in the collection system, and is a much shorter installation distance for the developer.
        - Concur with this sanitary servicing strategy. Installation of a forcemain across the northeast pond may warrant specific construction methods.

Please reach out if you have any further questions.
Thanks,
Franca

Franca Petrucci, BA, MBA
Director, Business Development
Corix Utilities Inc.
Cell: 778-349-0971
www.corix.com

*Cell: 403-651-8947*



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CLIENT
**LANDSTAR**

PROJECT NUMBER
[illegible]

LEGAL ADDRESS
[illegible]

DATE
[illegible]

STATISTICS
[illegible]

DUE DILIGENCE REPORT : OXOTBY LANDS
CONCEPT PLAN

SCALE
[illegible]

SHEET
**S4**
[illegible]

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**CLIENT**
LANDSTAR

**PROJECT NUMBER**
19-034

**LEGAL ADDRESS**
SW 5-22-29 W4,
BLOCK 5, PLAN 9912130
34.39 AC (9.87 HA)

**DATE**
2019-12-17

**STATISTICS**

| | | |
|---|---|---|
| Total Site Area | 34.39 ac | 9.87 ha |
| Environmental Reserve (ER) | 7.37 ac | 2.939 ha |
| Site Area | 27.02 ac | 8.93 ha |
| Residential | 13.95 ac | 5.64 ha |
| Municipal Reserve | 1.82 ac | 0.73 ha |
| Roads | 6.32 ac | 2.56 ha |

Average Lot Sizes
56.0m x 25.0m
50.0m x 25.0m
40.0m x 20.0m
45.0m x 12.0m
Total 3858 units

DUE DILIGENCE REPORT : OXOTBY LANDS
CONCEPT PLAN

N SCALE
1:3500

SHEET
**S4**
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ENGINEERING LTD.

02001385.000

Geotechnical & Pre-Grading Slope Stability Report

# Oxtoby Howland Ranch

Foothills County, Alberta

Prepared For

Carolina Oxtoby & Doug Howland
c/o Pasquini & Associates Consulting Ltd.

Submitted On

July 17, 2020

# Table of Contents

## 1.0 INTRODUCTION

This report presents the results of a geotechnical investigation and pre-grading slope stability assessment conducted by McIntosh•Lalani Engineering Ltd. (M•L) for a proposed residential development in Foothills County, Alberta. This preliminary evaluation was undertaken at the request of Mr. Tony Pasquini, on behalf of Carolina Oxtoby and Doug Howland. The objective of this evaluation was to assess the general subsurface soil conditions at the site for the design and construction of a proposed residential development. This assessment was also completed to provide a pre grading slope stability setback line along the perimeter of the development.

## 2.0 PROJECT AND SITE DETAILS

The project is understood to include the design and construction of a residential development on an approximated 9.87 hectare site. The development is in its preliminary stages, and is to be an amendment to the Heritage Pointe community of Foothills County, Alberta. The site is bounded by a ravine and storm collection pond along the north side of the property. As such, a development setback distance along the north property line was required for design.

The site is located on the north side of Dunbow Road approximately 800 metres east of Highway 2A. The site is bounded by Heritage Pointe to the west, north and east. An escarpment divides the area from the southern boundary of the existing Heritage Pointe residential.

### 2.1 EXISTING SLOPE STABILITY ASSESSMENTS

A previous slope stability assessment was completed for the subject site, completed by Geo Engineering (M.S.T.) Ltd., for Almor Engineering Associated Ltd, submitted August 4, 2004 (Geo 2004). Soil stratigraphy interpretation and similar soil stability theology was used from this report, in conjunction with a drilling program to provide an updated development setback. Should there be any discrepancies from this report and the Geo 2004 report, the information provided in this report should govern.

### 2.2 TOPOGRAPHY

The property is roughly 800 metres in the north-south direction and 200 metres in the east-west direction. The southern half of the site is relatively flat, extending approximately 250 metres from the south property line. Moving further north, the property divides into two sections. To the east, the land drops down to a storm retention pond. The developable area wraps around the west side of the retention pond. To the west, the land comes up in elevation to be of the same elevation as that of some acreages bounding the west side of the property. Along the north property line the land the property drops down to a valley. The spillway of the retention pond is tied to this valley, and acts as the overflow route for the pond.

Along the north property line, the slopes exceed 2H:1V in gradient. This slope tapers off to approximately 6H:1V as it wraps around the north property, around the west side of the pond, and along the south side of the pond. Within the remaining development, site gradients do not exceed 10Horizontal:1Vertical.

### 2.3 SITE RECONNAISSANCE

A site reconnaissance of the escarpments within the property was completed by a representative of M•L. South and west of the pond, the slopes are lightly treed with poplar trees. The slopes are covered by native grasses and shrubs, with slopes not exceeding 3Horizontal to 1Vertical. Animal burrows are evident throughout. Wrapping along the north property line, the slopes exceed 2Horizontal:1Vertical. A dense coverage of spruce and poplar trees, as well as shrubs and grasses exist within the native slope. The slope drops down into a valley; on the other side of the valley the land comes back up to the existing Heritage Pointe residential area. There is no indication of rock outcrops on the development side of the valley. There are little to no indications of slope instability in the face of the slope. The side slope is heavily vegetated with pine trees and mature shrubs on the slope, with no signs of seepage. On the other side of the valley (not within this development), there is evidence of rock outcropping near the bottom 4 metres of the valley. There is also significant sloughing along the face of the slope at the bottom of the valley. Some failure planes as tall as 5.0 metres exist.

At the bottom of the valley, running water is evident, due to the spillway of the existing pond east of the property. Vegetation and natural log dams suggest that the bottom of the valley has been filled with water as deep as 1.5 metres.

It should be noted that, although not encountered in the boreholes drilled, it is evident that there are deleterious soils near the top of slope of the most northern edge of development. Some buried concrete and debris is scattered throughout the area.

## 3.0 FIELDWORK

The fieldwork consisted of advancing eight (8) boreholes within the subject property. Four of the boreholes were advanced along the north property line, along the valley edge and south side of the pond, to depths up to 13.7 to 18.2 metres below current site grades. The remaining four boreholes were advanced within the southern half of the development, to a maximum depth of 9.1 metres below current site grades. The boreholes were advanced using a track-mounted solid-stem auger drilling rig contracted from All Service Drilling Inc. of Airdrie, Alberta. The boreholes were advanced between the dates of April 27th and 28th, 2020.

Borehole locations were selected by representatives of M•L to be evenly distributed along the top of slope, subject to suitable surface conditions for the equipment and personnel and clearance from any buried or overhead utilities. Locations of the boreholes are illustrated in Drawing 20-1385.000.G01 following the text of this report. Borehole logs are presented in Appendix A.

Upon completion of the boreholes, wells consisting of PVC standpipes were installed for future groundwater level monitoring. The wells were isolated with bentonite seals and backfilled with drill cuttings. The approximated elevations of the boreholes are indicated on the attached Borehole Logs.

### 3.1 LABORATORY TESTING

Laboratory testing including moisture content testing, Atterberg Limits testing, soluble sulphate testing, organic content and hydrometers has been completed on selected samples recovered from the boreholes for the development. The results of these tests, along with any subsequent recommendations, are presented throughout this report.

## 4.0 SUBSURFACE CONDITIONS

The general subsurface stratigraphy of the site consisted of alternating layers of sandy gravel, silt and sand and silty clay soils within the top 12 metres, followed by a dense layer of glacial till and bedrock. The following summarizes the encountered soil stratigraphy of the subject site.

A more detailed soil description is presented in the borehole logs which are included in Appendix A.

At the time this report was prepared, information on subsurface stratigraphy was available only at discrete borehole locations. Conditions were extrapolated and interpolated from the borehole locations to develop recommendations. Adequate monitoring should be provided during construction to check that these assumptions are reasonable.

### 4.1 TOPSOIL

Topsoil was encountered at the surface in seven of the eight boreholes advanced. The thicknesses of the topsoil generally ranged from 125 mm to 300 mm at the site. Buried topsoil, with a thickness of approximately 675 mm thick, was encountered in borehole No.4, at a depth of approximately 1.0 metres.

The thickness of organic soil deposits can vary widely across the site. Organic soil thicknesses tend to be deepest in low-lying areas, and deeper as you move down the slopes, which do not have suitable surface conditions for the drill rig or crew. The encountered topsoil thicknesses from the boreholes should not be used for topsoil stripping volume calculations without being supplemented by observations from hand-dug test pits. This would be particularly prudent with this site depending on the location of developable land relative to the slope in the northern half of the property.

## 4.2 FILL SOILS

Fill soils, consisting of silty sand with gravel, was encountered on one borehole drilled along the south edge of the pond. Buried topsoil was encountered below the fill soils. The fill was stiff, and contained some amounts of sand, and was low in plasticity. The fill soil extended to a depth of approximately 1.0 metres below current site grades.

Although not encountered within the boreholes, some deleterious fills are evident throughout the most northern portion of the development near the top of slope. Concrete and buried debris is evident in the immediate area.

## 4.3 SOIL STRATA – NORTHERN HALF

### 4.3.1 Cohesionless Soils – Upper Strata

Sandy gravel soils were encountered below the topsoils in two of the four boreholes drilling in the northern half of the development. This gravel is observable mostly in the upper northern hill, and does not appear to continue past the pond. The gravel has a high silt content, and contains trace amount of clay and cobble. The material was relatively compact, dry, and light brown in colour. The sandy gravel was noted to be 2.5 to 3.0 metres thick.

The next 6.0 metres of material (borehole No. 1 and 2), as well as within the upper 6.0 metres of the lower area (borehole No. 3 and 4), generally consisted of silt and sand soils. Alternating layers of lacustrine clay was encountered within the strata, with thicknesses ranging between 200 and 600 mm. A high plastic layer was encountered within this material, further discussed in section 4.3.2. Generally, the material contained trace amounts of gavel, and was compact and dry.

### 4.3.2 High Plastic Clay

A layer of high plastic lacustrine soil, approximately 300 to 400 mm thick, was encountered within borehole No. 1 and 2. This layer was encountered approximately 5.0 metres below current site grades. The material was stiff, and medium brown in colour. Laboratory testing of this material is being completed to confirm the plasticity.

#### 4.3.3 Silty Clay and Till Soils

Below the cohesionless soils at a depth of approximately 6.0 to 9.0 metres below current site grades, silty clay soils were encountered. The silty clay contained variable amounts of sand and gravel, generally becoming more sandy and gravelly with depth. The material was noted to be very stiff to hard in consistency, and medium in plasticity. Thin layers of silt and sand were encountered throughout the material. The silty clay soils extended to dense glacial till, at a depth of approximately 10.0 to 11.0 metres below site grades.

The dense glacial till encountered was variable in structure, consisting of silty clay, silt and gravels. The material was dry, low in plasticity, and medium brown in colour. The dense glacial till extended to bedrock at a depth of approximately 15.5 and 16 metres below current site grades in borehole No. 1 and 2. Bedrock was not encountered elsewhere.

#### 4.3.4 Bedrock

Siltstone and sandstone bedrock was encountered in borehole No. 1 and 2 at a depth of approximately 15.5 and 16.0 metres below current site grades. The bedrock was weak to moderately strong in strength, and was augerable to the target depth of 18.2 metres in both boreholes. The material was light brown in colour.

### 4.4 SOIL STRATA: SOUTHERN HALF

A layer of topsoil ranging from 150 to 300 mm was encountered on the surface of all four boreholes drilled within the southern half of the property. Generally alternating layers of silty clay and cohesionless silts and sands were encountered. Thicknesses of the material was also variable, ranging from 300 mm to 4.0 metres. Generally, the cohesionless material consisted of silts and sands, and were noted to be compact. Finite layers of wet silt and sand were encountered throughout, particularly within the silty clay soils, typically at depths below 5.0 metres. The silty clay soils were low to medium in plasticity, and contained trace amounts of sand and gravel. The silty clay was very stiff, and medium brown in colour. The materials extended to the end of investigation of 6.0 and 9.1 metres below current site grades in all four boreholes.

### 4.5 GROUNDWATER

During the drilling process, pockets of thin layers of wet silt and sand was noted throughout, and select boreholes were noted to be wet upon completion of drilling. Groundwater readings were recorded throughout the development on May 12, 2020. At this time, groundwater was not encountered within the two deep boreholes at No.1 and 2. Groundwater was encountered in four of the six remaining boreholes, at depths ranging from 3.58 and 5.1 metres below current site grades.

## 4.6 GENERAL RECOMMENDATIONS

The site consists of suitable bearing soil provided the following recommendations within this report are followed. The following is a list of a few of the highlighted geotechnical aspects of the site. This summary should be read in conjunction with the entire report:

- The soils at the site, with the exception of the topsoil and other organic soils, are suitable for use as general engineered fill. Final site grades are not known at this time, but upon availability of grading and cut/fill plans, M•L should conduct a detailed deep fill grading analysis.
- The native site soils are capable of supporting residential structures, as outlines in section 4.3. Approved engineered fill soils are also suitable to provide support, subject to a deep fills assessment.
- The above statement does not preclude the construction of multi-family residential or commercial structures. The footing design parameters of these structures should be determined by a site- and project-specific geotechnical evaluation once further development plans are known.
- High plastic soils were rarely encountered within the near-surface soils on site. A high plastic layer of silty clay was noted within the silty clay soils in borehole No. 1 and 2 at a depth of approximately 5.0 metres below current site grades. M•L is conducting laboratory testing to determine the Atterberg limits of several soil samples in this layer, and within any silty clay soils were high plastic layering is noted. Careful monitoring should be exercised during final grading to avoid potentially high plastic clays at or near footing elevations, near the surface adjacent to slopes, under slabs or pavement or in other sensitive locations. All residential foundations should be inspected by a qualified geotechnical engineer prior to footing placement to ensure the footing areas are free of high plastic clays.
- Some perched water pockets, typically in sandier layers, were encountered within the silty clay encountered, particularly in the southern half of the development. Water was also encountered near the bedrock interface. These water pockets may be encountered within excavations for deep utilities, or basement excavations, however, it is expected that the seepage from these layers can be accommodated using a system of trenches, sumps, and pumps. These soils may also be encountered during the rough grading program, depending on proposed cut depths, and may hamper traction for rubber-tired vehicles. Deeper excavations may also encounter saturated non-cohesive soils below the water table.
- For the majority of the site, construction excavations can be completed using conventional excavators. Where silty clay tills or bedrock are present it may be possible for excavations to be made with up to 1.5 metres vertical cut and a 1 Horizontal to 1 Vertical side-slope above that. Elsewhere, in non-cohesive soils such as the encountered sand and silt soils, a

minimum side-slope of 1H:1V is required. Bedrock is not anticipated to be encountered during any site development.

- The site soils are suitable to support deep and shallow utilities. Compacted clay or lean mix concrete plugs should be installed at regular intervals to prevent the flow of water through the bedding gravel and reduce migration of fine grained soils into the bedding gravel. Any utilities extending down the slope will require particular attention to clay plug design.

## 4.7 CONSTRUCTION EXCAVATION AND TEMPORARY DEWATERING

The composition and consistencies of the soils encountered at the site are such that conventional hydraulic excavators should be able to remove these materials.

Some perched water pockets, typically in sandier layers, were encountered within the silty clay till and silt till soils encountered in select areas in the southern half of the development. These water pockets may be encountered within excavations for deep utilities, basements, or ponds, however, it is expected that the seepage from these layers can be accommodated using a system of trenches, sumps, and pumps. These soils may also be encountered during the rough grading program, depending on proposed cut depths, and may hamper traction for rubber-tired vehicles. Deeper excavations may also encounter saturated non-cohesive soils below the water table.

Where cohesive silty clay soils or bedrock is encountered, it may be possible that excavations could be made with up to a 1.5 metre vertical cut and a 1 Horizontal to 1 Vertical (1H:1V) side slope above that. Excavations in non-cohesive soil, such as the encountered silt till soils, will require at least 1H:1V side sloping from the base of the excavation. Additional (i.e. shallower) side sloping in the soils will likely be necessary if water seepage is encountered, or if sloughing is occurring. Excavations must be carried out in accordance with Alberta Occupational Health and Safety (OH & S) Regulations. A qualified geotechnical engineering firm should be notified to inspect excavations to verify the excavation is a safe working slope.

Should space constraints not allow adequate side sloping for the excavation to ensure a safe temporary excavation, shoring or trench boxes will be necessary.

Any seepage that occurs should be dewatered using a system of ditches, sumps and pumps. Significant water seepage from wet layers should be periodically expected. Well point dewatering is not expected to be necessary.

## 4.8 SITE GRADING

Some cuts and fills may be required within the proposed development. All organic topsoil, deleterious soils and vegetation should be removed from areas to be filled. The backfill should be placed in uniform lifts compacted to a minimum of 98 percent of Standard Proctor Density at a moisture content in the range of optimum to 3 percent above optimum. The maximum lift thickness is generally 300 mm but also subject to soil conditions and compaction equipment being used, and should be verified by M•L on site.

Deep fills, of thickness greater than two metres, should be reviewed in a Deep Fills Report.

Grading all slopes will require a 5H:1V backsloping in building areas prior to placing fill. Upon determination of a site grading plan, M•L should be consulted to review the stripping requirements for the site. M•L should be notified to inspect all soil surfaces prior to placement of fill soils to verify the organic and deleterious soils have been removed. The site soils are suitable for use as engineered fill. However, any high plastic soils encountered should be placed outside of building envelopes.

It is recommended that final site grading be provided to direct water to areas remote from all proposed structures. Minimum landscape gradients of 2 percent are recommended to reduce the risk of run-off ponding in localized areas. Furthermore, downspouts should be positively directed away from the buildings.

### 4.9 PIPE SUPPORT & BACKFILL PROCEDURES

Fine-grained silt, sand and clay soils are present. To prevent erosion of the bedding soils by water flowing through the bedding gravel, compacted clay or lean-mix concrete plugs should be constructed at regular intervals along utility lines, as per the City of Calgary detail (Drawing 59 in the Standard Specifications for Sewer Construction 2019), on the down-stream side of manholes. Drains should be installed on the upstream side of the manholes to drain groundwater into the storm system. The locations of clay plugs and drains should be determined during detailed design in consultation with M•L. Geotextile placed on-top of the bedding gravel will be necessary where fine-grained soil is used as fill directly on-top of the bedding gravel. The geotextile will prevent migration of fine-grained soil into the gravel which would result in future settlement. The requirements for geotextile should be assessed during construction by a qualified geotechnical engineering firm. A detail drawing of typical clay plug configurations is included in the appendices and numbered 02001385.000.D01.

Shallow utility trenches including catch basin barrels and duct trenches also need to consider proper backfill procedures to prevent surface settlements. Appropriate compaction meeting engineered fill standards is necessary to prevent settlement. In addition, whenever a washed gravel fill is used, particularly in a trap low, such as around a catch basin barrel, a geotextile wrap around all drainage gravel is necessary to prevent migration of fine-grained soils which results in settlements. Clay plugs in these shallow utility trenches will also limit the water flow and potential settlement concerns.

M•L should be notified to inspect the geotextile placement on site. All shallow utility trenches should be backfilled and compacted to avoid detrimental settlements.

### 4.10 SHALLOW FOUNDATIONS

Based on the results of the geotechnical investigation, conventional strip and spread footings may be used for the residential structures within this development. Due to the proximity to steep slopes in excess of 3H:1V, as well as potential of grade change with site development, all proposed foundations within the northern half of the development with site grades exceeding 15% must be reviewed by a qualified geotechnical engineer prior to construction.

A conventional shallow strip and spread footing foundation system placed on approved native soils and engineered fill soils is a feasible foundation option for residential development. Some overexcavation of softened silty clay materials or saturated non-cohesive silt and/or sand deposits may be required, if encountered at footing elevation. The capacity of all bearing surfaces must be verified by handheld Dynamic Cone Penetration Testing (DCPT) and visual bearing inspection by M•L. This inspection is to verify bearing capacity as well as potential presence of high-plastic clays, particularly in the northern portion of the site. Removal and replacement with a soil of lower plasticity may be required if encountered.

The footings should be designed for an Ultimate Limit State (ULS) unfactored bearing resistance of 260 kPa in the competent native silty clay till or silt till soils on site, or engineered fill soils that meet the requirements set out in Section 4.17. A geotechnical resistance factor of 0.5 may be used in conjunction with this ULS value.

To undertake the shallow foundation design using the Working Stress Method, a net allowable bearing pressure of 100 kPa (excluding overburden soil pressure) may be used within the competent native silt till or silty clay till soils or lacustrine silty clay soils on site, or engineered fill soils that meet the requirements set out in Section 4.17.

All prepared bearing surfaces should be inspected by a qualified geotechnical engineering company prior to concrete or gravel placement.

The footing sizes and depths have been estimated to provide the above design values. Should unconventional footing sizes be utilized, a review of the footing sizes and bearing resistances should be undertaken. Footings should be placed on homogenous soils to avoid differential settlements that could occur if footings span non-uniform soil types (e.g. fill to native).

The allowable bearing capacities for residential structures bearing on more than 2.0 metres of fill should be assessed as part of the phase-specific Deep Fills Report.

All foundation excavation should be protected from meteorological elements such as rain, snow, freezing and excessive drying. Foundations should be placed soon after excavation.

## 4.11 FROST PROTECTION

The on-site silty and clayey soils encountered throughout the site should be considered very frost susceptible which will result in frost heave displacement in the soil when frozen.

### 4.11.1 Structures

For protection against frost action, perimeter footings or grade beams in heated structures should be extended to such depths as to provide a minimum soil cover of 1.4 metres. Exterior footings or grade beams in unheated structures should have a minimum soil cover of 2.1 metres, unless provided with equivalent insulation. Grade beams that do not have adequate soil cover for frost protection should have a minimum 100 mm void space on the underside of the grade beam to reduce the risk of interaction with the underlying soil.

### 4.11.2 Surface Concrete

The surficial site soils are predominantly composed of frost susceptible soils. Therefore, some precautions should be followed for the design and construction of concrete flatworks at the site.

In all unheated areas, the site soils will likely experience some degree of heave due to frost formation during the winter months. Generally speaking, if proper consideration is given to the recommendations contained in Section 5.7 below, proper drainage will prevent the subgrade from becoming saturated and will help reduce the severity of frost heave. Nevertheless, concrete flatwork should be designed with anticipation of some frost heave occurring. Concrete sidewalks should be dowelled into footings or grade beams in threshold areas where heave of the concrete panels would obstruct the proper opening of the door and present a tripping hazard. As the outside edge of these panels will still heave, the panel should either be properly jointed to control crack locations, or reinforced by the placement of reinforcing steel 10 mm bars at a 300 mm spacing. The depth of the reinforcement should be controlled so that the reinforcement is properly located within the concrete panels.

Alternatively, rigid insulation can be placed below flatwork to prevent frost formation in the underlying subgrade. M•L can provide recommendations for such insulation if required.

## 4.12 WEEPING TILE

Groundwater readings were recorded throughout the development on May 12, 2020. At this time, groundwater was not encountered within the two deep boreholes at No.1 and 2. Groundwater was encountered in four of the six remaining boreholes, at depths ranging from 3.58 and 5.1 metres below current site grades.

Due to the significant site grades anticipated within the development, surface runoff should be considered for development. A weeping tile subsurface drainage at footing elevation is required for residential buildings in the northern portion of the site due to the sloping terrain anticipated within the proposed lots. Weeping tile is also required for any below grade residential buildings in the southern portion of the site. A perforated weeping tile system at footing elevation will reduce water pooling near the footings after a heavy rainfall event. In addition, a weeping tile in the walkout frost footing is recommended, where applicable. A sump to pump this water up to the storm sewer would be required.

Weeping tile drains should consist of a minimum of 100 mm diameter perforated pipe around the perimeter of below grade structures at the bottom of footing elevation. The pipe should be backfilled with free draining washed gravel and positively drained to a storm sewer, possibly through a sump and pump. A non-woven geotextile filter fabric should cover the top of the drainage gravel to prevent siltation of the gravel.

All backfill around the foundation walls of residential structures should be compacted.

## 4.13 LATERAL WALL PRESSURES

Permanent and temporary walls should be designed to resist all lateral pressures including those due to soil/bedrock or backfill, surcharges, water and adjacent footings using the following expressions defined in terms of total and effective stresses:

$P_{\text{lateral pressure}} = P'_{\text{earth+surcharge}} + P_{\text{net water}} + P'_{\text{adj ft}}$

where $P_{\text{lateral pressure}}$ = total lateral pressure at a given depth (kN/m$^2$)

$P'_{\text{earth+surcharge}}$ = lateral earth pressure due to soil/bedrock or fill and surcharges at a given depth (kN/m$^2$)

$= K(\ h + q)$ above water table or phreatic surface

$= K(\ 'h + q)$ below water table or phreatic surface

$P_{\text{net water}}$ = net water pressure on wall at a given depth (kN/m$^2$), calculated by hand drawn flow net or computer solution based on drainage conditions

$P'_{adj\ fr}$ = lateral earth pressure due to adjacent footings at given depth (kN/m$^2$)

K = coefficient of lateral earth pressure, $K_a$, $K_o$, $K_p$ or combination of as noted below

$K_a$ = coefficient of active earth pressure

$K_o$ = coefficient of at-rest earth pressure

$K_p$ = coefficient of passive earth pressure

' = submerged unit weight of backfill or natural soil or bedrock (kN/m$^3$)

' = − $_w$

= bulk unit weight of backfill or natural soil or bedrock (kN/m$^3$)

$_w$ = unit weight of water 9.81 kN/m$^3$

h = excavation depth (m)

q = surcharge load (kN/m$^2$)

Table 1 below presents coefficients of lateral earth pressure and unit weights.

*Table 1: Coefficients of Lateral Earth Pressure and Unit Weights*

| | $K_a$ | $K_o$ | $K_p$ | (kN/m$^3$) |
|---|---|---|---|---|
| Engineered Fill | 0.39 | 0.58 | 2.56 | 21.5 |
| Native Silt and Silty Clay Till Soils | 0.36 | 0.53 | 2.77 | 20.0 |
| Sandy Gravel Deposits | 0.31 | 0.47 | 3.25 | 23.0 |
| Silt and Sand Deposits | 0.35 | 0.52 | 2.88 | 21.0 |

## 4.14 PERMANENT LATERAL WALL PRESSURES

The distribution of soil pressure against a permanent wall may be assumed using the general equation given above under the Section 4.13 with $K = K_o$.

Permanent walls should be designed to resist the maximum possible water pressure subject to drainage conditions determined by design.

Recommendations for permanent anchors are not included in this report. Lateral forces against permanent walls may be resisted by the wall section and top and bottom slab support.

## 4.15 TEMPORARY LATERAL WALL PRESSURES

The distribution of soil pressure against a temporary wall may be assumed using the general equation given above and values of K according to deformation restrictions as follows:

- If moderate wall movements can be permitted,

  $K=K_a$.

- If foundations of buildings or services exist at a shallow depth, at a distance less than H (height of the wall) behind the top of the wall and not closer than 0.5H,

  $K= 0.5 (K_a + K_o)$.

- If foundations or services exist at a shallow depth, at a distance less than 0.5H,

  $K=K_o$.

## 4.16 TEMPORARY PASSIVE WALL RESISTANCE

Passive resistance at the base of a temporary wall may be calculated as follows:

$P'_p$ = $K_p$ ( 'd/1.5)

where $P'_p$ = passive resistance at depth below excavation (kN/m$^2$)

$K_p$ = coefficient of passive earth pressure

' = submerged unit weight (kN/m$^3$)

d = depth below excavation level (m)

The passive resistance should be taken to act on an area twice the pile diameter below grade.

### 4.17 BACKFILL MATERIALS AND COMPACTION

Portions of existing on-site materials may be suitable for use as general engineered fill subject to material evaluation and removal of deleterious materials. Imported fill should be approved for use as structural or general engineered fills. Areas where fill soils have been identified will require further inspection by a qualified geotechnical engineering firm before additional backfilling activities begin.

Recommended compaction specifications and materials are as follows:

- Structural fill - 100 percent Standard Proctor Maximum Dry Density (SPMDD), maximum compacted lift thickness 250 mm, maximum grain size 200 mm. Structural fill materials should comprise clean, well-graded inorganic granular soils.
- General engineered fill - 98 percent SPMDD, 0 to +3 percent of optimum moisture content, maximum compacted lift thickness 300 mm. General engineered fill materials should comprise clean, well-graded granular soils, or inorganic medium to low plastic cohesive soils.

Where washing of fines is possible, fill material placed should be separated from coarser or finer material by a suitable geotextile.

Backfill comprising cohesive soils should be considered frost susceptible and should not be used in areas where it may become frozen and where frost heaving would be unacceptable.

## 5.0 PRE-GRADING SLOPE STABILITY

The following sections pertain to the pre-grading slope stability analysis conducted for the development. A pre grading slope stability setback line is provided for the north property line. Restrictive covenants are also outlined for any development immediately adjacent to the slope stability setback.

M•L has reviewed the most current concept plan, provided by Pasquini & Associates, sent on March 31, 2020. Should the concept change in layout or extent, M•L must be given the opportunity to review the design. Due to the proximity to steep slopes in excess of 3H:1V, as well as potential of grade change with site development, all proposed foundations within the northern half of the development with site grades exceeding 15% must be reviewed by a qualified geotechnical engineer prior to construction. The final lot grading and building envelope needs to be reviewed for global slope stability. Any proposed multifamily or commercial development proposed must have a site specific slope stability assessment completed once a design has been finalized to confirm the slope stability setback requirements given the chosen foundation type and depth of foundation systems.

## 5.1 MAIN DEVELOPMENT

The stability of the north escarpment slope has been analyzed to determine the existing Factors of Safety (F.O.S.) against slope instability and to establish a development setback, where required. The proposed northern legal boundary line of the development is generally situated within the slope face, near the base of the slope face, and near the edge of the existing storm pond. Thepre grading slope stability setback line provided considers residential construction within any portion of the legal property.

A minimum F.O.S. of 1.5 against slope instability is required for any development to take place on a slope. If this F.O.S. is not met, a development setback from the North Property Line will be required in order to achieve the F.O.S. of 1.5.

A pre grading slope stability setback line has been provided. The setback line (outlined in GREEN) represents the slope stability setback of the existing condition, for any residential foundation as described in Section 4.10. This setback line can be seen in Figure 20-1385.000.G01.

Seven (7) cross-section locations were chosen to be representative of the escarpment slopes, in their current condition. Drawing 20-1385.000.G01 includes a contour survey in the slope areas as well as the location of the slope stability cross-sections.

M•L has analyzed the cross sections presented in Drawings 20-1385.S01 though to S07 using the Morgenstern Price limit equilibrium method modeled by the computer software program SLOPE/W. M•L has used conservatively estimated shear strength soil parameters based upon our on-site observations, subsurface borehole investigation, and experience with these soils.

## 5.2 ANALYSIS

### 5.2.1 Groundwater Conditions

An elevated groundwater elevation (piezometric line) was modeled based on groundwater levels measured in the boreholes and was typically elevated by 1.5 metres over seasonally high levels. Groundwater was not recorded within the four monitoring wells surrounding the north slopes. However, it is understood that the spillway of the storm pond has historically filled the bottom of the valley in a heavy rainfall event. A piezometric line was added to illustrate this event, as well as to represent any potential water trapped at the bedrock interface.

An Ru coefficient of 0.2 was used to model future potential saturation within the high plastic soils encountered in borehole No. 1 and 2. An Ru coefficient of 0.1 was used to model the encountered water pockets within the medium clay soils below the high plastic layer. After two weeks of drilling, the monitoring wells within this area were noted to be dry to a depth of 30.5 metres. This represents an isolated, pocketed water condition within a soil strata that is otherwise free of a permanent groundwater condition. Multiple layers of wet silt and sand were drilled through and noted within the borehole logs and the groundwater data reflects an isolated water condition.

The slope sections analyzed represent the worst case sections and typical sections of the escarpment slopes to allow the F.O.S. to be calculated at each section and interpolated between sections to develop complete setback requirements, measured from the North Property Line.

### 5.2.2 Assumed Soil Parameters

The following table presents the shear strength properties of the soil used for the slope stability analysis. The analysis was completed using these soil parameters in conjunction with the slope geometry and elevated groundwater conditions:

*Table 2: Assumed Soil Parameters for Slope Stability Analysis*

| Soil Type | Unit Weight - γ (kN/m3) | Cohesion – c (kPa) | Effective Friction Angle - Φ (degrees) |
|---|---|---|---|
| Sandy Gravel | 19.5 | 0.0 | 32.0 |
| Upper Sandy Silt | 21.0 | 0.0 | 28.0 |
| High Plastic Clay | 21.0 | 3.0 | 27.0 |
| Medium Silt | 21.0 | 0 | 29.0 |
| Medium Clay | 21.0 | 5.0 | 30.0 |
| Dense Till | 21.5 | 0.0 | 33.0 |
| Bedrock | 23.0 | 15.0 | 40.0 |

Surcharge building load of 100 kPa was applied at the 'Top of Slope' to simulate a future building. This surcharge load is dependent on the building requirements, and must be confirmed on each future development lot adjacent to the north cul-de-sac.

All future development within the subject site must have their own global stability assessment once a design has been finalized.

## 5.3 ANALYSIS CONCLUSIONS

Upon completion of the slope stability modelling, M•L has calculated a pre grading slope stability setback distance from the North Property Line to meet a Factor of Safety of 1.5 against slope instability. The analysis conclusions are summarized in the following table. Slope stability setbacks from the Property line are required for the most northern properties on site. Representative results and their associated F.O.S. determining the setback are shown on each cross-section in Drawings 20-1385.S01 through to S07. This development setback line affects four proposed residential lots, as outlined in the current concept plan.

Setback lines have been outlined based on a minimum F.O.S. of 1.5 against slope instability. The setback line pertaining to the development is illustrated in Drawing 20-1385.000.G01.

*Table 3: Summary of Slope Stability Analysis Results*

| Section No. | Minimum Factor of Safety Identified | Required Setback (m) From Property Line to Obtain a F.O.S. of 1.5 | Shown On Drawing |
|---|---|---|---|
| A | 1.50 | 6.3m | S01 |
| B | 1.50 | 27.6 m | S02 |
| C | 1.50 | - | S03 |
| D | 2.27 | - | S04 |
| E | 1.50 | 38.3 m | S05 |
| F | 1.77 | - | S06 |
| G | 1.84 | - | S07 |

The slope stability evaluation is based on the current site contours, discrete subsurface soil and groundwater information, and on our understanding of the development lands. The existing grades of the site slope need to be maintained to maintain a F.O.S. of 1.5. All vegetation should remain intact. Should a slope disturbance occur, the slope should be repaired and revegetated immediately. The development setbacks may change with cutting or filling at the top of the slope in addition to the already proposed removal of the uncontrolled fill soils. In addition, the setbacks will change if areas near the toe of slope are further cut from original native ground. Should any fills more than 0.5 metres in thickness be proposed at the top of the slope, this slope stability analysis should be reviewed by M•L to ensure a F.O.S. of 1.5 is maintained. M•L would recommend that a slope stability review be completed once the design grades have been established and prior to construction.

## 6.0 SLOPE STABILITY REQUIREMENTS

A restrictive covenant for all proposed lots that back on the development setback line should be implemented and should include the following.

- Channelized flows over the top of slope should be avoided.
- There should be no surcharge loading at the top of slope such as retaining walls, fills in excess of 0.5 metres or other permanent structures, without a full slope/global stability review by a qualified geotechnical engineer.

- Building drainage must be controlled such that there is no ponding or infiltration into the site slopes. M•L must be given the opportunity to review the stormwater management plan to ensure there is little impact to the stability of the site slopes.
- A slope stability assessment for each lot along the north property line adjacent to the site slope.

Should additional fills or cuts at the respective top or toe of the slope be proposed, or if conditions other than those assumed in the analysis are noted in subsequent phases of development, M•L should be given the opportunity to review the slope stability assessment.

## 6.1 GENERAL CONDITIONS

M•L has prepared this report for use in subdivision planning and establishing suitable building sites from a slope stability perspective. The slope stability analysis has been prepared based upon M•L's interpretation of the sites soils from surrounding areas and groundwater condition and design data available at the time of this report. Upon site development it is the responsibility of the civil engineer consulting firm engaged by the developer, or their representative to notify M•L to review the sites soils and groundwater conditions to verify they are consistent with M•L's interpretation.

M•L should be notified to review any site developments on or adjacent to the sloping lands to make our own assessment of potential impacts to the slope the development may have. The report has been prepared assuming there will be no significant cuts on adjacent lands that may impact slope stability. Any alterations to the development and resulting impacts to the slope stability will be the responsibility of the party making the alterations.

## 7.0 CLOSURE

We trust information presented herein meets with your present requirements. If you have questions or require additional geotechnical services please contact our office.

Respectfully submitted,

**McIntosh•Lalani Engineering Ltd.**

TYLER WINDSOR

July 17, 2020

Tyler Windsor, P.Eng.
Project Engineer

MARTIN D. WARD

July 17, 2020

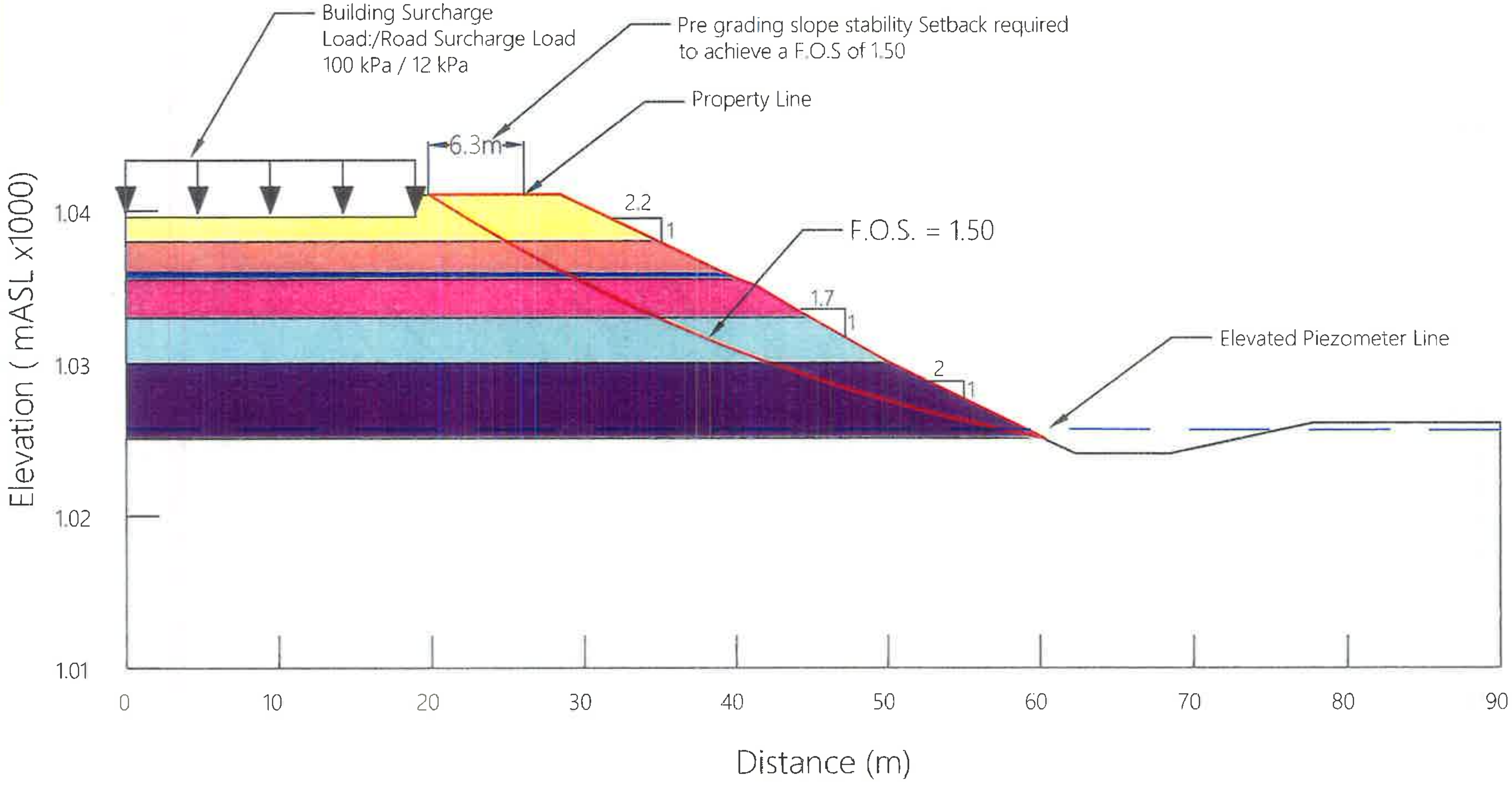
Marty D. Ward, P.Eng.
Senior Project Engineer
APEGA Permit #P6482

# Drawings & Figures

| | | | | |
|---|---|---|---|---|
| Client: Carolina Oxtoby & Doug Howland | McINTOSH • LALANI ENGINEERING LTD. | | | |
| Project: Oxtoby / Howland Lands | | | | |
| Title: Borehole & Cross Section Locations | Job Number: 02001385.000 | Drawing Number: 20-1385.000.G01 | Scale: N.T.S. | Date: July 17, 2020 |

## Soil Parameters

| Soil Colour | Material Type | Unit Weight (kN/m³) | Cohesion (kPa) | Friction Angle (°) | Ru |
|---|---|---|---|---|---|
| 🟨 | Sandy Gravel | 19.5 | 0.0 | 32.0 | 0.0 |
| 🟧 | Upper Sandy Silt | 21.0 | 0.0 | 28.0 | 0.0 |
| 🟦 | High Plastic Clay | 21.0 | 3.0 | 27.0 | 0.2 |
| 🟥 | Medium Silt | 21.0 | 0.0 | 29.0 | 0.1 |
| 🟦 | Medium Clay | 21.0 | 5.0 | 30.0 | 0.0 |
| 🟪 | Dense Till | 21.5 | 0.0 | 33.0 | 0.0 |
| ⬜ | Bedrock | 23.0 | 15.0 | 40.0 | 0.0 |



Client: Carolina Oxtoby & Doug Howland

Project: Oxtoby / Howland Lands

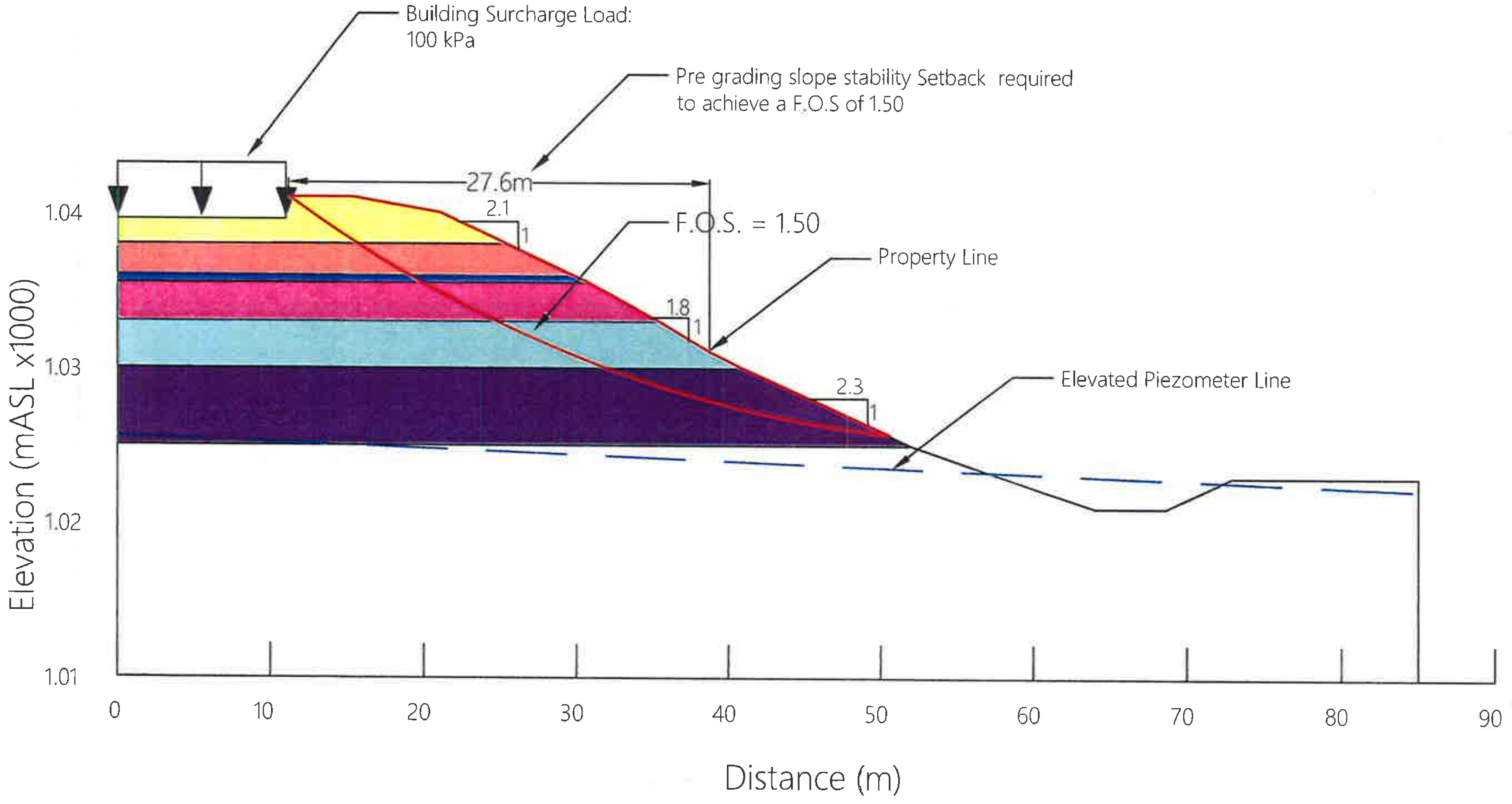
Title: Cross Section A

**McINTOSH • LALANI ENGINEERING LTD.**

| Job Number: | Drawing Number: | Scale: | Date: |
|---|---|---|---|
| 02001385.000 | 20-1385.000.S01 | N.T.S. | July 17, 2020 |

## Soil Parameters

| Soil Colour | Material Type | Unit Weight (kN/m³) | Cohesion (kPa) | Friction Angle (°) | Ru |
|---|---|---|---|---|---|
| 🟨 | Sandy Gravel | 19.5 | 0.0 | 32.0 | 0.0 |
| 🟧 | Upper Sandy Silt | 21.0 | 0.0 | 28.0 | 0.0 |
| 🟦 | High Plastic Clay | 21.0 | 3.0 | 27.0 | 0.2 |
| 🟥 | Medium Silt | 21.0 | 0.0 | 29.0 | 0.1 |
| 🟦 | Medium Clay | 21.0 | 5.0 | 30.0 | 0.0 |
| 🟪 | Dense Till | 21.5 | 0.0 | 33.0 | 0.0 |
| ⬜ | Bedrock | 23.0 | 15.0 | 40.0 | 0.0 |



Client: Carolina Oxtoby & Doug Howland

Project: Oxtoby / Howland Lands

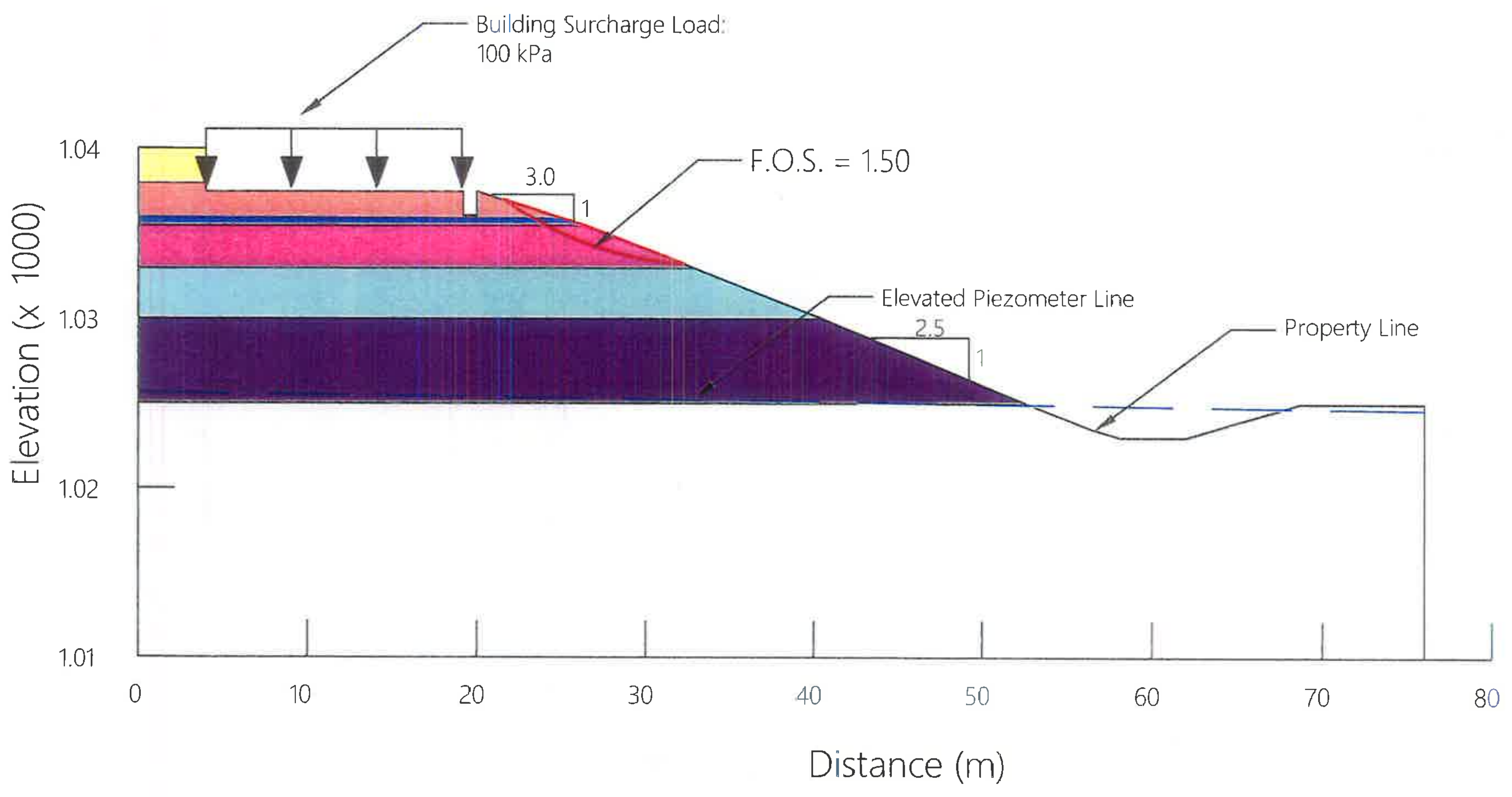
Title: Cross Section B

**McINTOSH • LALANI ENGINEERING LTD.**

| Job Number: | Drawing Number: | Scale: | Date: |
|---|---|---|---|
| 02001385.000 | 20-1385.000.S02 | N.T.S. | July 17, 2020 |

## Soil Parameters

| Soil Colour | Material Type | Unit Weight (kN/m³) | Cohesion (kPa) | Friction Angle (°) | Ru |
|---|---|---|---|---|---|
| 🟨 | Sandy Gravel | 19.5 | 0.0 | 32.0 | 0.0 |
| 🟧 | Upper Sandy Silt | 21.0 | 0.0 | 28.0 | 0.0 |
| 🟦 | High Plastic Clay | 21.0 | 3.0 | 27.0 | 0.2 |
| 🟥 | Medium Silt | 21.0 | 0.0 | 29.0 | 0.1 |
| 🟦 | Medium Clay | 21.0 | 5.0 | 30.0 | 0.0 |
| 🟪 | Dense Till | 21.5 | 0.0 | 33.0 | 0.0 |
| ⬜ | Bedrock | 23.0 | 15.0 | 40.0 | 0.0 |



Client: Carolina Oxtoby & Doug Howland

Project: Oxtoby / Howland Lands

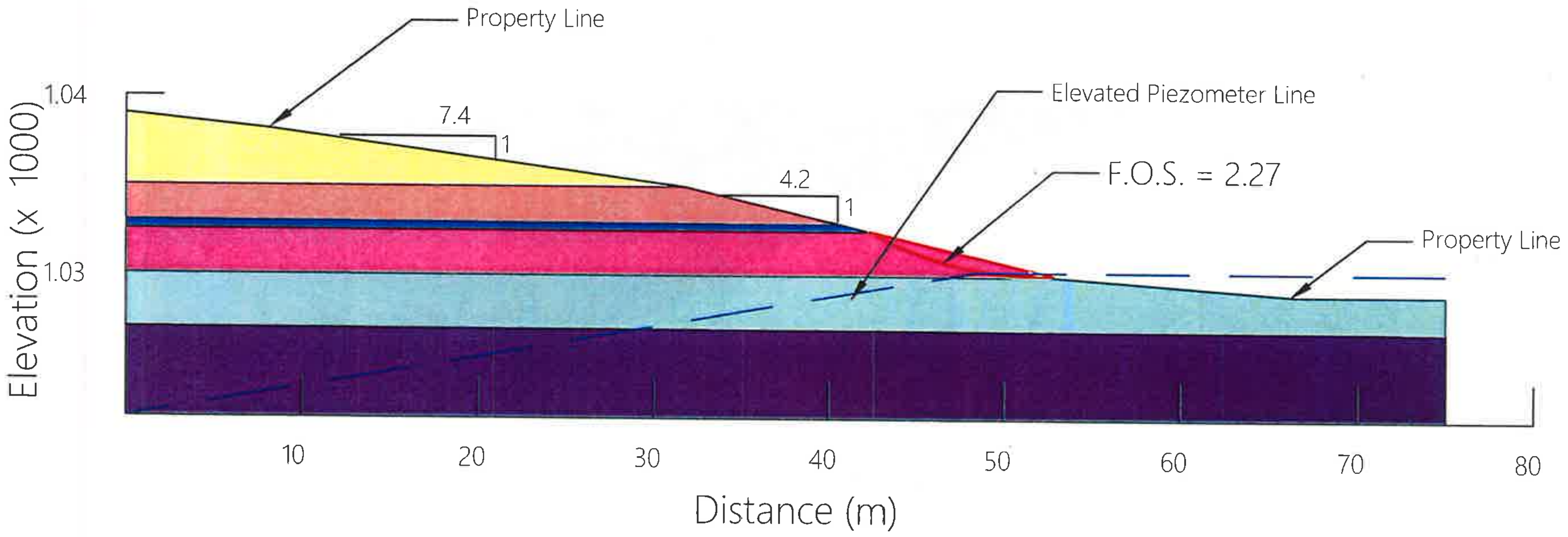
Title: Cross Section C

**McINTOSH • LALANI ENGINEERING LTD.**

| Job Number: | Drawing Number: | Scale: | Date: |
|---|---|---|---|
| 02001385.000 | 20-1385.000.S03 | N.T.S. | July 17, 2020 |

## Soil Parameters

| Soil Colour | Material Type | Unit Weight (kN/m³) | Cohesion (kPa) | Friction Angle (°) | Ru |
|---|---|---|---|---|---|
| 🟨 | Sandy Gravel | 19.5 | 0.0 | 32.0 | 0.0 |
| 🟧 | Upper Sandy Silt | 21.0 | 0.0 | 28.0 | 0.0 |
| 🟦 | High Plastic Clay | 21.0 | 3.0 | 27.0 | 0.2 |
| 🟥 | Medium Silt | 21.0 | 0.0 | 29.0 | 0.1 |
| 🟦 | Medium Clay | 21.0 | 5.0 | 30.0 | 0.0 |
| 🟪 | Dense Till | 21.5 | 0.0 | 33.0 | 0.0 |
| ⬜ | Bedrock | 23.0 | 15.0 | 40.0 | 0.0 |



Client: Carolina Oxtoby & Doug Howland

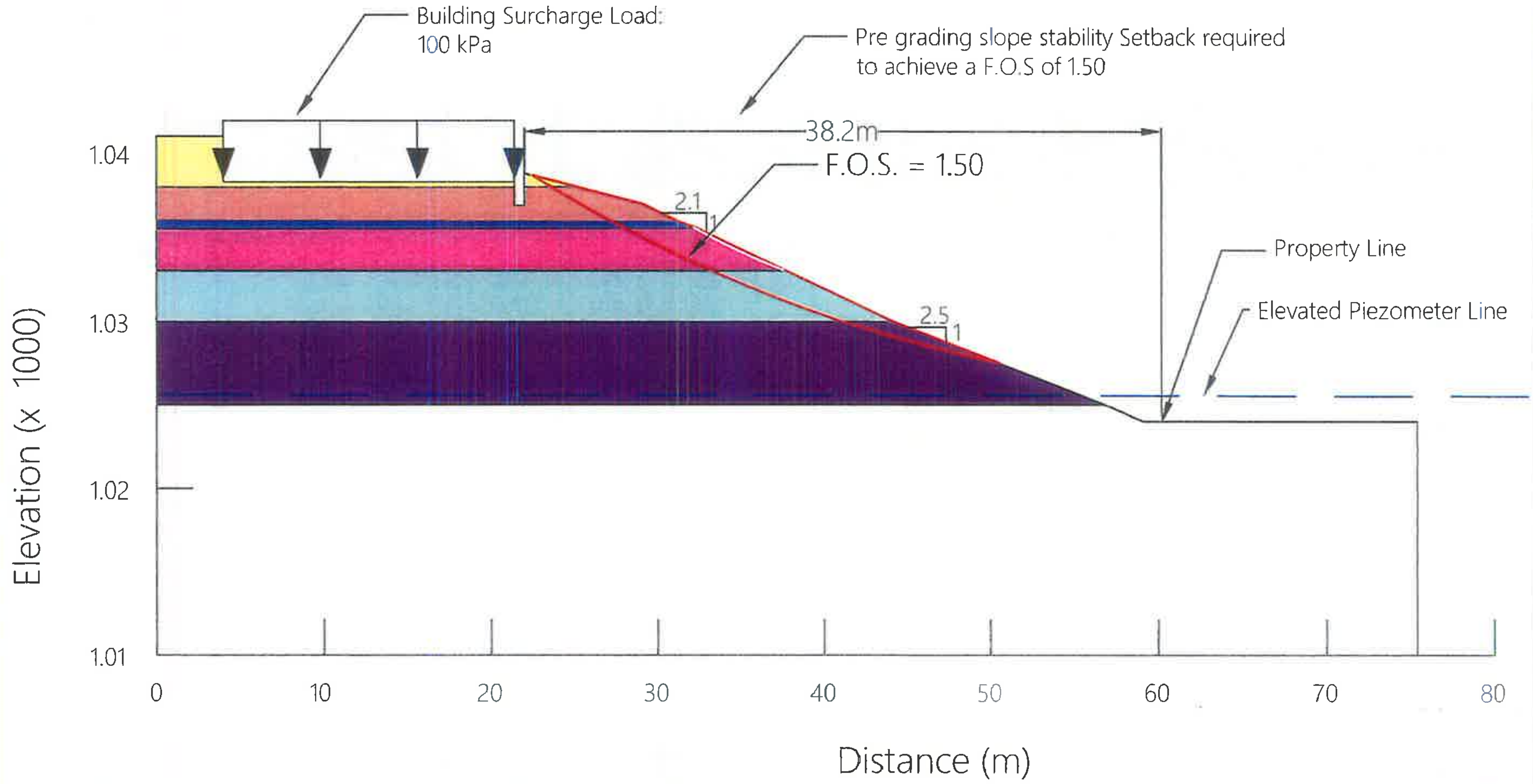
Project: Oxtoby / Howland Lands

Title: Cross Section D

**McINTOSH • LALANI ENGINEERING LTD.**

| Job Number: | Drawing Number: | Scale: | Date: |
|---|---|---|---|
| 02001385.000 | 20-1385.000.S04 | N.T.S. | July 17, 2020 |

| Soil Parameters | | | | | |
|---|---|---|---|---|---|
| Soil Colour | Material Type | Unit Weight (kN/m³) | Cohesion (kPa) | Friction Angle (°) | Ru |
| 🟨 | Sandy Gravel | 19.5 | 0.0 | 32.0 | 0.0 |
| 🟥 | Upper Sandy Silt | 21.0 | 0.0 | 28.0 | 0.0 |
| 🟦 | High Plastic Clay | 21.0 | 3.0 | 27.0 | 0.2 |
| 🟥 | Medium Silt | 21.0 | 0.0 | 29.0 | 0.1 |
| 🟦 | Medium Clay | 21.0 | 5.0 | 30.0 | 0.0 |
| 🟪 | Dense Till | 21.5 | 0.0 | 33.0 | 0.0 |
| ⬜ | Bedrock | 23.0 | 15.0 | 40.0 | 0.0 |



Client: Carolina Oxtoby & Doug Howland

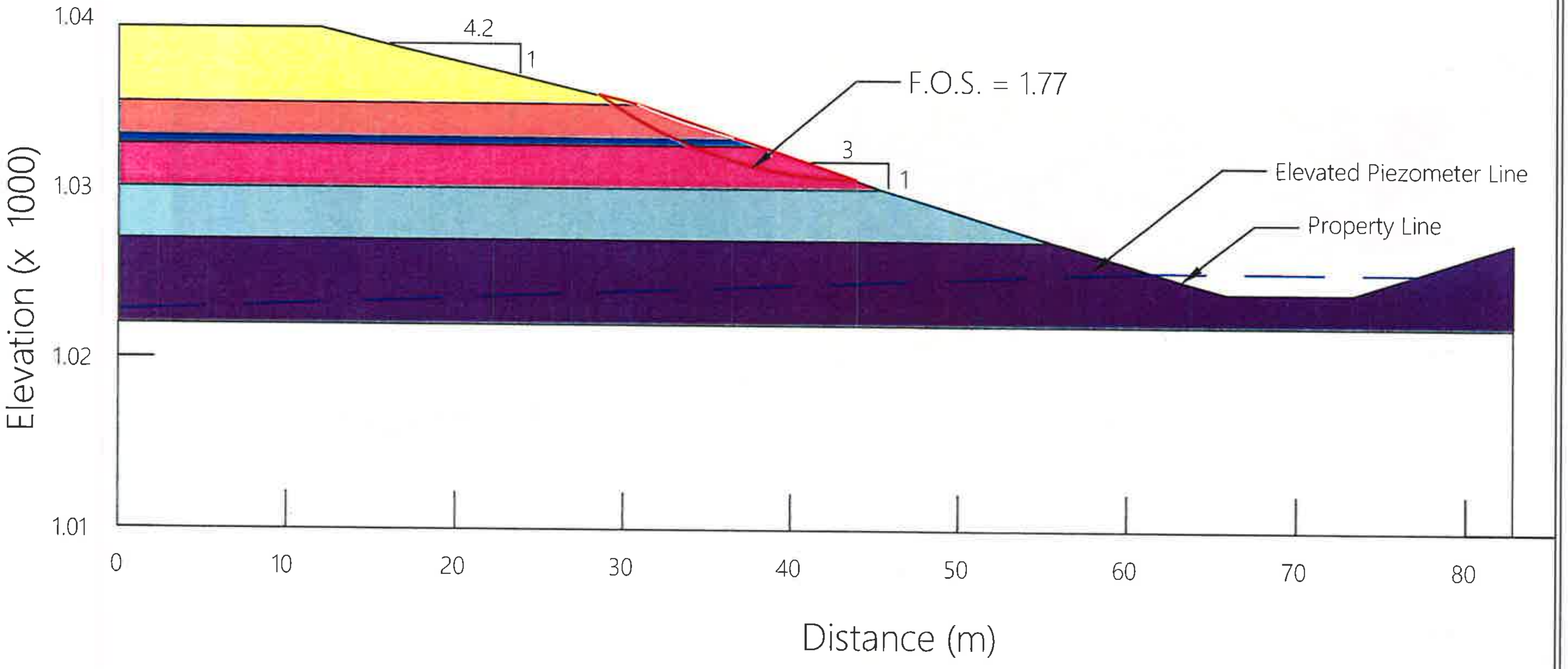
Project: Oxtoby / Howland Lands

Title: Cross Section E

**McINTOSH • LALANI ENGINEERING LTD.**

| Job Number: | Drawing Number: | Scale: | Date: |
|---|---|---|---|
| 02001385.000 | 20-1385.000.S05 | N.T.S. | July 17, 2020 |

| Soil Parameters | | | | | |
|---|---|---|---|---|---|
| Soil Colour | Material Type | Unit Weight (kN/m³) | Cohesion (kPa) | Friction Angle (°) | Ru |
| 🟨 | Sandy Gravel | 19.5 | 0.0 | 32.0 | 0.0 |
| 🟥 | Upper Sandy Silt | 21.0 | 0.0 | 28.0 | 0.0 |
| 🟦 | High Plastic Clay | 21.0 | 3.0 | 27.0 | 0.2 |
| 🟥 | Medium Silt | 21.0 | 0.0 | 29.0 | 0.1 |
| 🟦 | Medium Clay | 21.0 | 5.0 | 30.0 | 0.0 |
| 🟪 | Dense Till | 21.5 | 0.0 | 33.0 | 0.0 |
| ⬛ | Bedrock | 23.0 | 15.0 | 40.0 | 0.0 |



Client: Carolina Oxtoby & Doug Howland

Project: Oxtoby / Howland Lands

Title: Cross Section F

**McINTOSH•LALANI ENGINEERING LTD.**

Job Number: 02001385.000

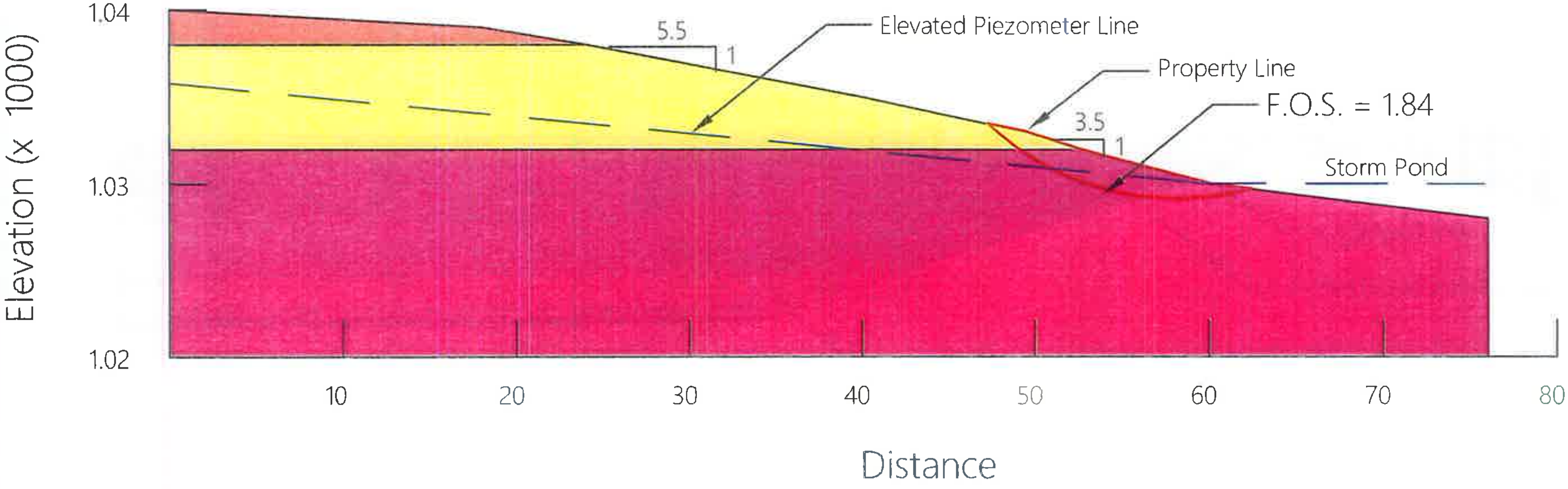
Drawing Number: 20-1385.000.S06

Scale: N.T.S.

Date: July 17, 2020

Soil Parameters

| Soil Colour | Material Type | Unit Weight (kN/m³) | Cohesion (kPa) | Friction Angle (°) | Ru |
|---|---|---|---|---|---|
| 🟨 | Sandy Gravel | 19.5 | 0.0 | 32.0 | 0.0 |
| 🟥 | Upper Sandy Silt | 21.0 | 0.0 | 28.0 | 0.0 |
| 🟥 | Medium Silt | 21.0 | 0.0 | 29.0 | 0.0 |



Client: Carolina Oxtoby & Doug Howland

Project: Oxtoby / Howland Lands

Title: Cross Section G

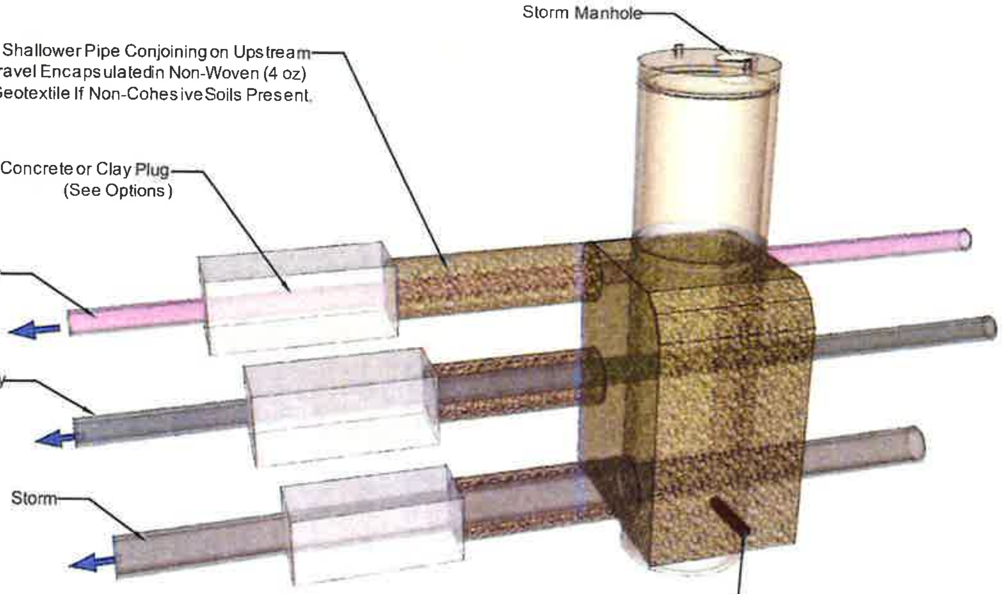
McINTOSH • LALANI ENGINEERING LTD.

Job Number: 02001385.000

Drawing Number: 20-1385.000.S07

Scale: N.T.S.

Date: July 17, 2020



**Option 1: Clay Plug**

- Compacted to minimum 98% SPD OMC to +3
-Minimum 3.0 m long plug along the pipe. Clay to be approved by ML

**Option 2: Concrete Plug (To be Approved By City of Calgary)**

-Lean mix concrete, compressive strength 3-5 MPa.
-Minimum 3.0 m long along the pipe.
-Minimum 100 mm below haunch on top of pipe.
-Place 3 evenly spaced adhesive strips of water stop around entire pipe to be embedded in concrete.

**NOTE:**

Review of actual pipe configuration and site soils is required and may result in altered recommendations during construction.

At minimum, plugs should extend through the entire bedding gravel zone. For pipes installed in separate trenches the bedding gravel should be hydraulically connected to the storm pipe bedding.

Client: Carolina Oxtobay & Doug Howland
Project: Oxtoby / Howland Lands
Title: Standard Clay Plug Detail

McINTOSH • LALANI ENGINEERING LTD.

| Job Number: | Drawing Number: | Scale: | Date: |
|---|---|---|---|
| 02001385.000 | 02001385.000.D01 | N.T.S. | July 17, 2020 |

## Appendix A

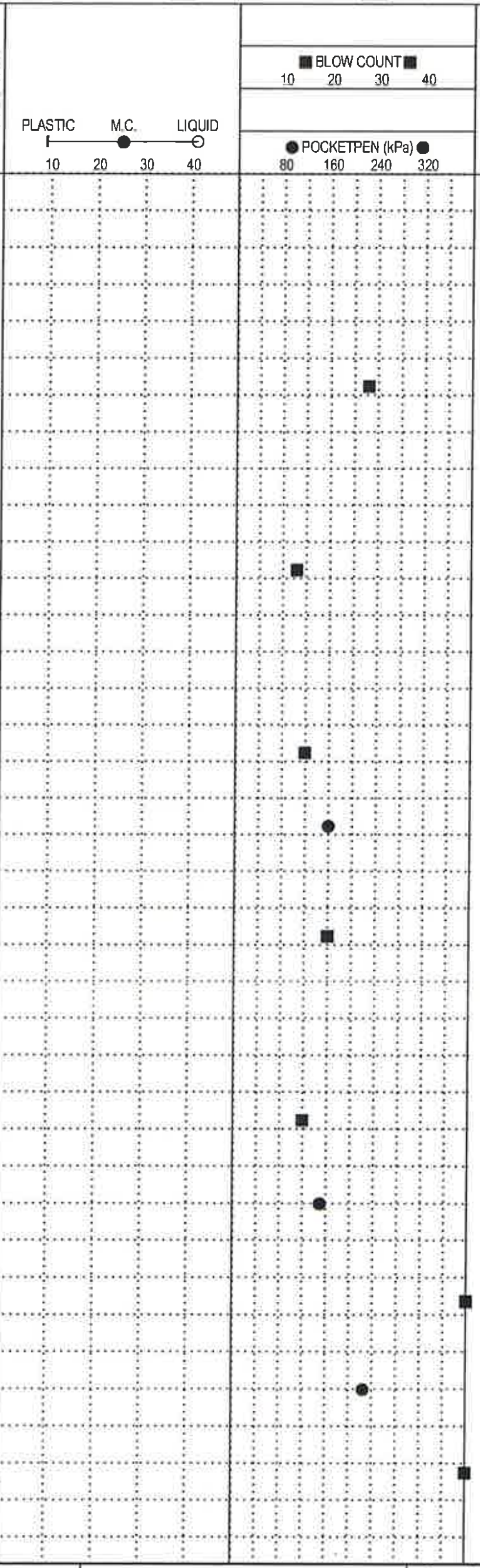
# Borehole Logs

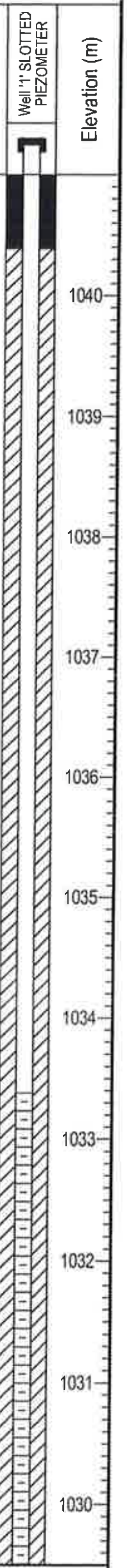
| | | |
|---|---|---|
| Project: Oxtoby/Howland Acreage | Drilling Information: | Borehole No.:1 |
| Client: Carolina Oxtoby & Doug Howland | All Service Drilling Ltd | Project No.:02001385.000 |
| c/o Pasquini | CME 55 track SS-Auger | Elevation:1041 |

SAMPLE TYPE ■ SHELBY TUBE ▯ CORE SAMPLE ☒ SPT SAMPLE GRAB SAMPLE ▮ AUGER SAMPLE ▯ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ⁝ PEA GRAVEL ▥ SLOUGH GROUT ▨ DRILL CUTTINGS ⁙ SAND

| Depth (m) | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | USCS | BLOWS /150 mm |
|---|---|---|---|---|---|
| 0 | TOPSOIL -black organics, approx. 150 mm thick. | | | TPSL | |
| | Gravelly SAND - some silt, compact, damp, light brown. | ▮ | 1-1 | | |
| 1 | | ▮ | 1-2 | | |
| | | ☒ | 1-3 | SPG | 13-13-15 |
| 2 | | ▮ | 1-4 | | |
| 3 | SILT - trace sand and gravel, compact, damp, light brown. | ▯ | n/a | | 11-8-5 |
| | | ▮ | 1-5 | | |
| 4 | - damp to moist. | ▮ | 1-6 | ML | |
| | | ▯ | n/a | | 6-5-10 |
| 5 | | ▮ | 1-7 | | |
| | Silty CLAY -stiff, damp, medium-high plastic, medium-light brown. | ▮ | 1-8 | CI | |
| | SILT - compact, moist, trace clay nodules, light brown. | | | | |
| 6 | | ▯ | n/a | | 8-8-12 |
| | | ▮ | 1-9 | ML | |
| 7 | | ▮ | 1-10 | | |
| | - moist to wet. | ☒ | 1-11 | | 5-7-8 |
| 8 | - high plastic clay lens approx. 20 mm thick. | | | | |
| | Silty CLAY (Till) - stiff, damp, medium plastic, medium-light brown. | ▮ | 1-12 | | |
| 9 | - trace to some gravel, very stiff, trace grey. | ☒ | 1-13 | CI | 21-18-50 |
| 10 | | ▮ | 1-14 | | |
| | Sandy GRAVEL - dense, damp-dry, light brown. | ☒ | 1-15 | | 50/125mm |
| 11 | | | | | |





2017 ML AUGER 02001385.000 OXTOBY.HOWLAND ACREAGE.GPJ M-L STANDARD.GDT 20-6-5

McIntosh Lalani Engineering
Calgary, AB
(403) 291-2345

| | |
|---|---|
| Logged By: Genevieve Kenny | Completion Depth: 60 ft |
| Reviewed By: Tyler Windsor | Drilled on: 2020-04-27 |
| Groundwater Depth: m | Page 1 of 2 |

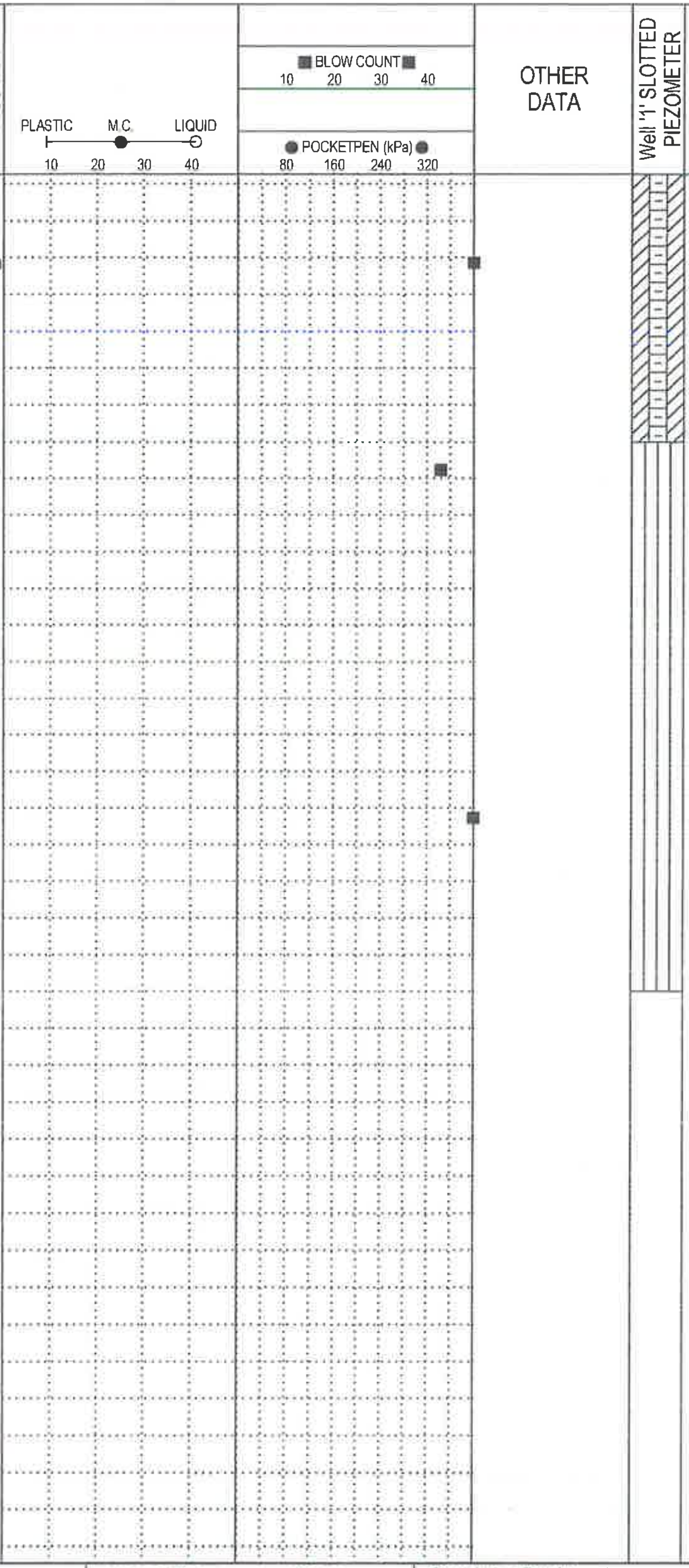
| | | |
|---|---|---|
| Project: Oxtoby/Howland Acreage | Drilling Information: | Borehole No.:1 |
| Client: Carolina Oxtoby & Doug Howland | All Service Drilling Ltd | Project No.:02001385.000 |
| c/o Pasquini | CME 55 track SS-Auger | Elevation:1041 |

SAMPLE TYPE ■ SHELBY TUBE ▯ CORE SAMPLE ☒ SPT SAMPLE GRAB SAMPLE AUGER SAMPLE NO RECOVERY

BACKFILL TYPE ■ BENTONITE PEA GRAVEL SLOUGH GROUT DRILL CUTTINGS SAND

| SOIL DESCRIPTION | SAMPLE NO | USCS | BLOWS /150 mm |
|---|---|---|---|
| | 1-16 | | |
| | n/a | GPS | 50/75mm |
| | 1-17 | | |
| SILT (Till) - trace gravel, dense, damp-dry, light brown. | n/a | | 21-19-24 |
| | 1-18 | ML | |
| Siltstone BEDROCK - completely to highly weathered, very weak, dry, very light brown. | 1-19 | | |
| | n/a | | 50 |
| | | BE | |
| | 1-20 | | |
| END OF HOLE at a depth of 18.3 m. Slough to 13.7 m. 25 mm PVC standpipe installed to a depth of 13.7 m, with 6.1 m slotted. Wet upon completion.<br>Water Level:<br>May 12, 2020 - dry. | | | |

| Depth (m) | Elevation (m) |
|---|---|
| 11.5 | |
| 12 | 1029 |
| 13 | 1028 |
| 14 | 1027 |
| 15 | 1026 |
| 16 | 1025 |
| 17 | 1024 |
| 18 | 1023 |
| 19 | 1022 |
| 20 | 1021 |
| 21 | 1020 |
| 22 | 1019 |



McIntosh Lalani Engineering
Calgary, AB
(403) 291-2345

| | |
|---|---|
| Logged By: Genevieve Kenny | Completion Depth: 60 ft |
| Reviewed By: Tyler Windsor | Drilled on: 2020-04-27 |
| Groundwater Depth: m | Page 2 of 2 |

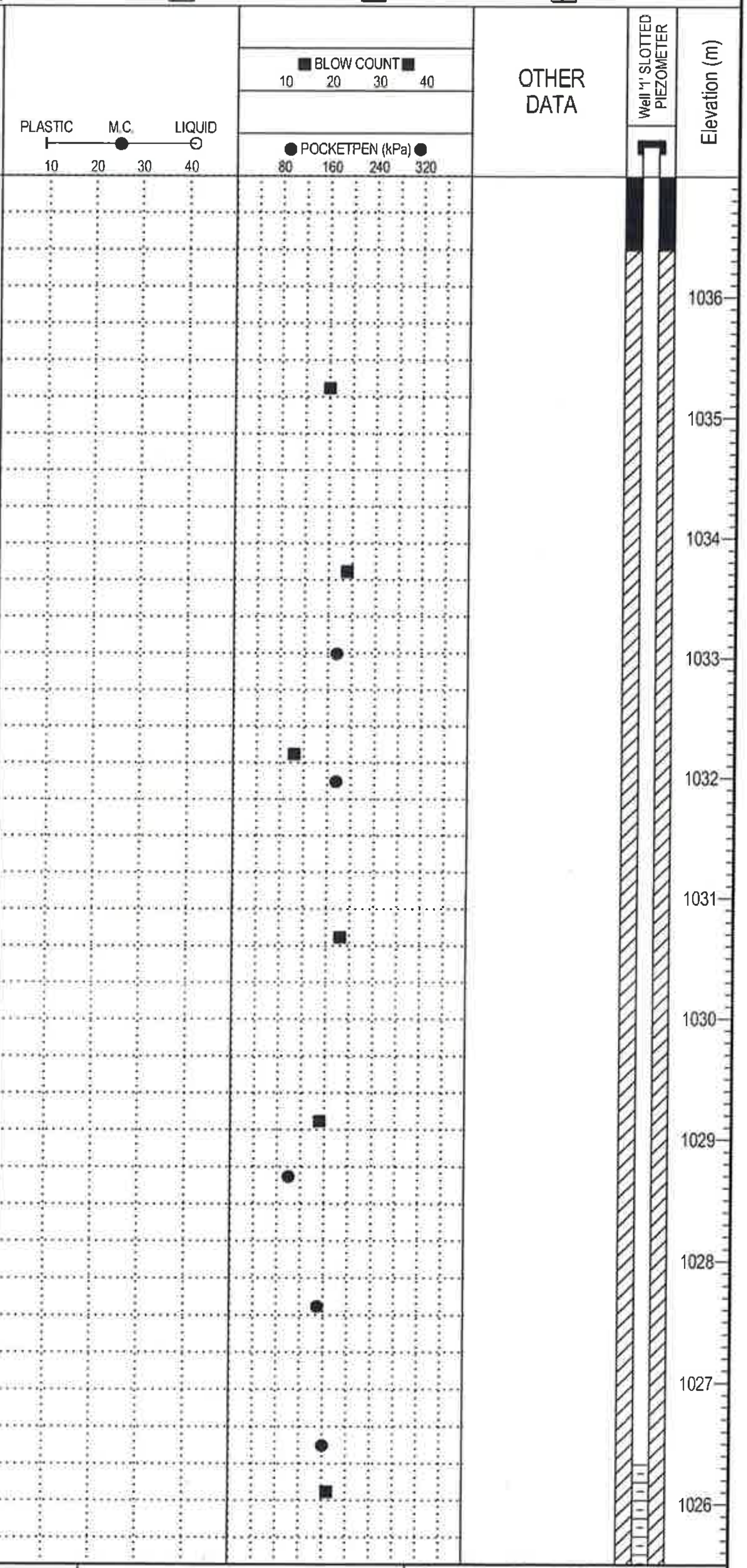
2017 ML AUGER 02001385.000 OXTOBY HOWLAND ACREAGE.GPJ M-L STANDARD.GDT 20-6-5

| | | |
|---|---|---|
| Project: Oxtoby/Howland Acreage | Drilling Information: | Borehole No.:2 |
| Client: Carolina Oxtoby & Doug Howland | All Service Drilling Ltd | Project No.:02001385.000 |
| c/o Pasquini | CME 55 track SS-Auger | Elevation:1037 |

SAMPLE TYPE ■ SHELBY TUBE ▯ CORE SAMPLE ☒ SPT SAMPLE ▨ GRAB SAMPLE ▮ AUGER SAMPLE ▥ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ⁚ PEA GRAVEL ▥ SLOUGH ⁙ GROUT ▨ DRILL CUTTINGS ⁙ SAND

| SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | USCS | BLOWS /150 mm |
|---|---|---|---|---|
| TOPSOIL - black organics, approx. 125 mm thick. | | | TPSL | |
| Gravelly SAND - compact, damp to moist, medium-light brown. | ▮ | 2-1 | | |
| | ▮ | 2-2 | SPG | |
| | ☒ | 2-3 | | .8-9-11 |
| SILT - compact, moist, medium-light brown.<br>- medium to high plastic layers approx 100 mm thick throughout. | ▮ | 2-4 | | |
| | ☒ | n/a | ML | 12-12-12 |
| | ▮ | 2-5 | | |
| Silty CLAY - stiff, moist, medium-high plastic, medium-light brown. | ▥ | n/a | CI | 10-6-7 |
| | ▮ | 2-6 | | |
| SILT - trace sand, rare gravel, compact, damp, light brown. | ▮ | 2-7 | | |
| | ▥ | n/a | ML | 11-10-13 |
| - moist to wet, trace medium-high plastic clay nodules. | ▮ | 2-8 | | |
| | ☒ | 2-9 | | 8-10-9 |
| Silty CLAY - stiff, moist, medium-high plastic, medium grey-brown. | ▮ | 2-10 | CI | |
| - low plastic to clayey silt, damp. | | | CL-ML | |
| - medium-high plastic. | ■ | 2-11 | | |
| | ▮ | 2-12 | | |
| - wet silt lens approx. 30 mm thick. | | | CI | |
| | ▮ | 2-13 | | |
| | ☒ | 2-14 | | 6-9-12 |
| Gravelly CLAY (Till) - trace sand and silt, very stiff, damp, low plastic, | | | | |



Depth (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

| | | |
|---|---|---|
| McIntosh Lalani Engineering<br>Calgary, AB<br>(403) 291-2345 | Logged By: Genevieve Kenny | Completion Depth: 60 ft |
| | Reviewed By: Tyler Windsor | Drilled on: 2020-04-27 |
| | Groundwater Depth: m | Page 1 of 2 |

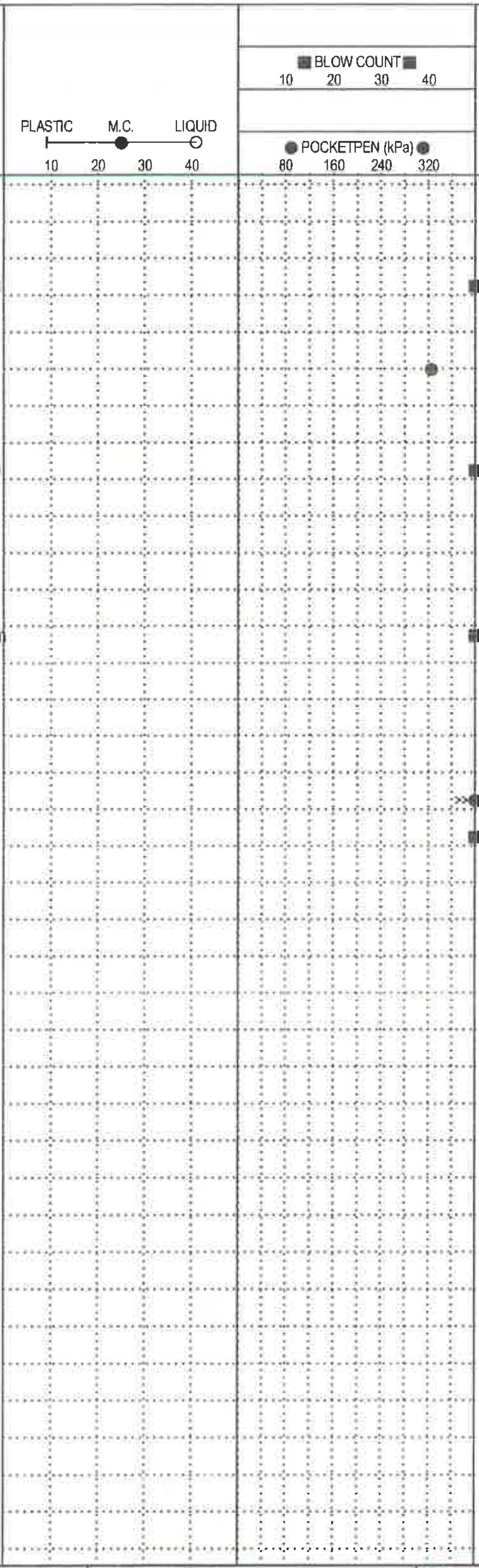
2017 ML AUGER 02001385.000 OXTOBY HOWLAND ACREAGE.GPJ M-L STANDARD.GDT 20-6-5

| | | |
|---|---|---|
| Project: Oxtoby/Howland Acreage | Drilling Information: | Borehole No.:2 |
| Client: Carolina Oxtoby & Doug Howland | All Service Drilling Ltd | Project No.:02001385.000 |
| c/o Pasquini | CME 55 track SS-Auger | Elevation:1037 |

SAMPLE TYPE: ■ SHELBY TUBE ▮ CORE SAMPLE ☒ SPT SAMPLE ✋ GRAB SAMPLE ▮ AUGER SAMPLE ▥ NO RECOVERY

BACKFILL TYPE: ■ BENTONITE ⁚ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ⁘ SAND

| Depth (m) | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | USCS | BLOWS /150 mm | OTHER DATA | Elevation (m) |
|---|---|---|---|---|---|---|---|
| 11.5 | medium-light brown. | ▮ | 2-15 | CLG | | | |
| 12 | | | | | | | 1025 |
| | Silty CLAY (Till) - trace sand and gravel, hard, damp, low plastic, medium brown. | ☒ | 2-16 | | 26-28-28 | - rock in SPT sample. | |
| 13 | | ▮ | 2-17 | CL-ML | | | 1024 |
| | - very hard. | ☒ | 2-18 | | 17-21-30 | | |
| 14 | | | | | | | 1023 |
| | Sandy SILT (Till) - some gravel, compact to dense, damp, medium-light brown. | ▮ | 2-19 | MLS | | | |
| 15 | | | | | | | 1022 |
| | | ☒ | 2-20 | | 50/125mm | | |
| | Sandstone BEDROCK - weak, damp, light brown. | | | | | | |
| 16 | | | | | | | 1021 |
| | | ▮ | 2-21 | | | | |
| | | ▮ | 2-22 | BE | | | |
| 17 | | ▥ | n/a | | 11-19-36 | | 1020 |
| 18 | | ▮ | 2-23 | | | | 1019 |
| | END OF HOLE at a depth of 18.3 m. Slough to 16.8 m.25 mm PVC standpipe installed to a depth of 16.8 m, with 6.1 m slotted. Wet upon completion.<br>Water Level:<br>May 12, 2020 - dry. | | | | | | |
| 19 | | | | | | | 1018 |
| 20 | | | | | | | 1017 |
| 21 | | | | | | | 1016 |
| 22 | | | | | | | 1015 |



Well '1' SLOTTED PIEZOMETER

2017 ML AUGER 02001385.000 OXTOBY.HOWLAND.ACREAGE.GPJ M-L STANDARD.GDT 20-6-5

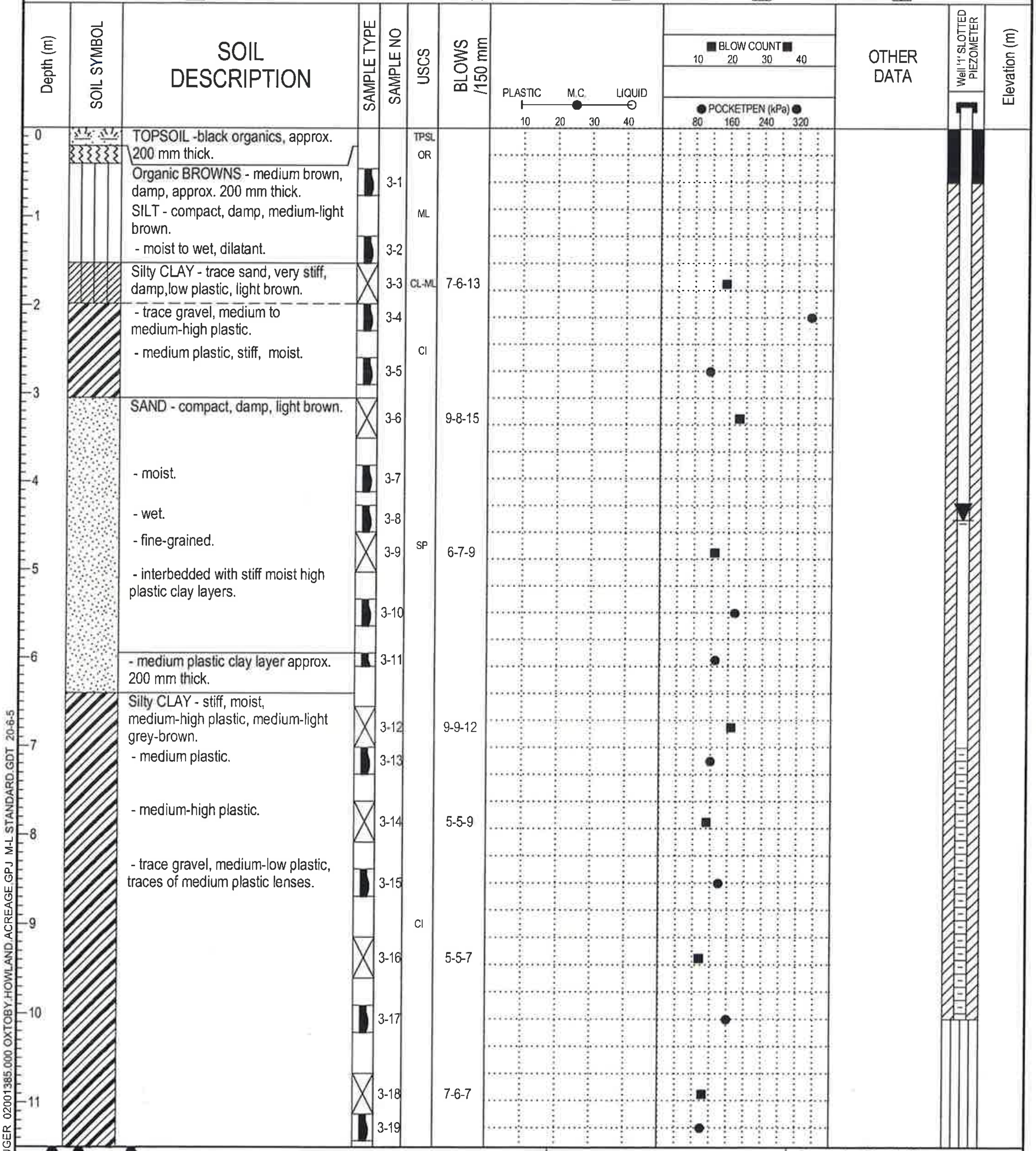
McIntosh Lalani Engineering
Calgary, AB
(403) 291-2345

| | |
|---|---|
| Logged By: Genevieve Kenny | Completion Depth: 60 ft |
| Reviewed By: Tyler Windsor | Drilled on: 2020-04-27 |
| Groundwater Depth: m | Page 2 of 2 |

|  |  |  |
|---|---|---|
| Project: Oxtoby/Howland Acreage | Drilling Information: | Borehole No.:3 |
| Client: Carolina Oxtoby & Doug Howland | All Service Drilling Ltd | Project No.:02001385.000 |
| c/o Pasquini | CME 55 track SS-Auger | Elevation: |

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| SAMPLE TYPE | ■ SHELBY TUBE | ▯ CORE SAMPLE | ☒ SPT SAMPLE | GRAB SAMPLE | ▮ AUGER SAMPLE | ▥ NO RECOVERY |
| BACKFILL TYPE | ■ BENTONITE | ⁙ PEA GRAVEL | ▥ SLOUGH | ⁙ GROUT | ▨ DRILL CUTTINGS | ⁙ SAND |

| SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | USCS | BLOWS /150 mm |
|---|---|---|---|---|
| TOPSOIL -black organics, approx. 200 mm thick. |  |  | TPSL |  |
| Organic BROWNS - medium brown, damp, approx. 200 mm thick. | ▮ | 3-1 | OR |  |
| SILT - compact, damp, medium-light brown. |  |  | ML |  |
| - moist to wet, dilatant. | ▮ | 3-2 |  |  |
| Silty CLAY - trace sand, very stiff, damp,low plastic, light brown. | ☒ | 3-3 | CL-ML | 7-6-13 |
| - trace gravel, medium to medium-high plastic. | ▮ | 3-4 |  |  |
| - medium plastic, stiff, moist. |  |  | CI |  |
|  | ▮ | 3-5 |  |  |
| SAND - compact, damp, light brown. | ☒ | 3-6 |  | 9-8-15 |
| - moist. | ▮ | 3-7 |  |  |
| - wet. | ▮ | 3-8 |  |  |
| - fine-grained. | ☒ | 3-9 | SP | 6-7-9 |
| - interbedded with stiff moist high plastic clay layers. |  |  |  |  |
|  | ▮ | 3-10 |  |  |
| - medium plastic clay layer approx. 200 mm thick. | ▮ | 3-11 |  |  |
| Silty CLAY - stiff, moist, medium-high plastic, medium-light grey-brown. | ☒ | 3-12 |  | 9-9-12 |
| - medium plastic. | ▮ | 3-13 |  |  |
| - medium-high plastic. | ☒ | 3-14 |  | 5-5-9 |
| - trace gravel, medium-low plastic, traces of medium plastic lenses. | ▮ | 3-15 |  |  |
|  |  |  | CI |  |
|  | ☒ | 3-16 |  | 5-5-7 |
|  | ▮ | 3-17 |  |  |
|  | ☒ | 3-18 |  | 7-6-7 |
|  | ▮ | 3-19 |  |  |



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|  |  |
|---|---|
| Logged By: Genevieve Kenny | Completion Depth: 45 ft |
| Reviewed By: Tyler Windsor | Drilled on: 2020-04-28 |
| Groundwater Depth: m | Page 1 of 2 |

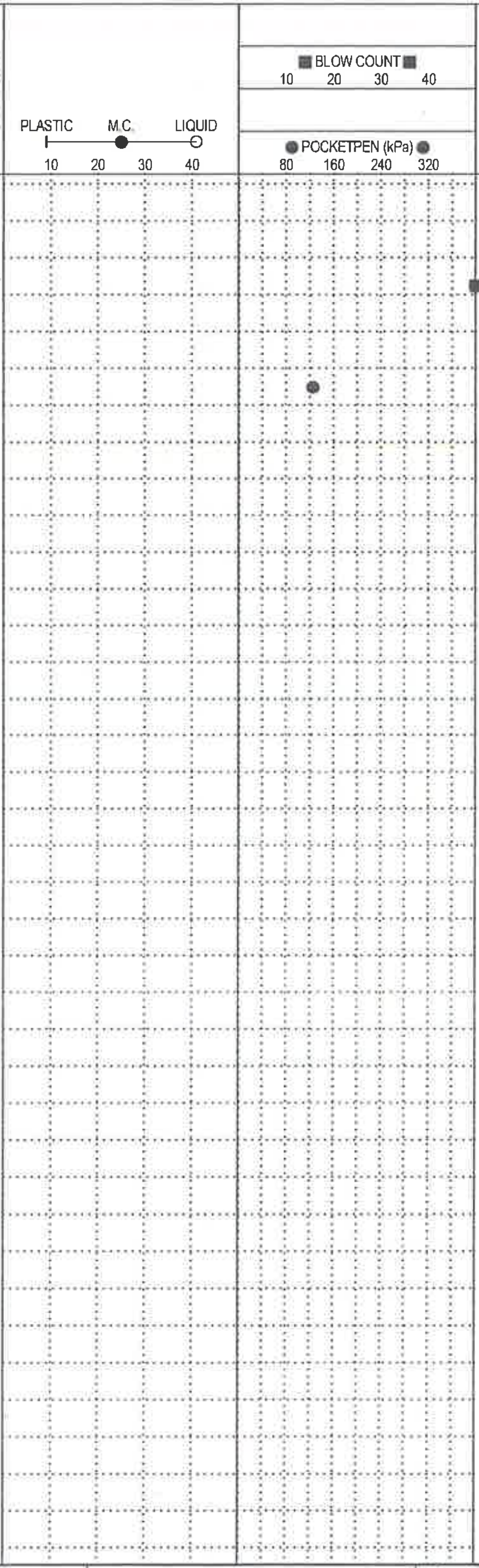
2017 ML AUGER 02001385.000 OXTOBY-HOWLAND ACREAGE.GPJ M-L STANDARD.GDT 20-6-5

| | | |
|---|---|---|
| Project: Oxtoby/Howland Acreage | Drilling Information: | Borehole No.:3 |
| Client: Carolina Oxtoby & Doug Howland | All Service Drilling Ltd | Project No.:02001385.000 |
| c/o Pasquini | CME 55 track SS-Auger | Elevation: |

| | | | | | | |
|---|---|---|---|---|---|---|
| SAMPLE TYPE | ■ SHELBY TUBE | ◫ CORE SAMPLE | ☒ SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | ▯ NO RECOVERY |
| BACKFILL TYPE | ■ BENTONITE | PEA GRAVEL | ▥ SLOUGH | GROUT | ▨ DRILL CUTTINGS | SAND |

| Depth (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | USCS | BLOWS /150 mm | OTHER DATA | Well '1' SLOTTED PIEZOMETER | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 11.5 | | SILT - compact, moist to wet, dilatant, medium-light grey-brown. | | 3-20<br>n/a | ML | 19-25-27 | | | |
| 13 | | Silty CLAY -stiff, moist, medium-high plastic, medium-light grey-brown. | | 3-21 | CI | | | | |
| | | END OF HOLE at a depth of 13.7 m. Slough to 15.6 m. 25 mm PVC standpipe installed to a depth of 15.6 m, with 3.1 m slotted. Wet slough upon completion.<br><br>Water Level:<br>May 12, 2020 - 4.43 m. | | | | | | | |

Depth scale: 11.5, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22



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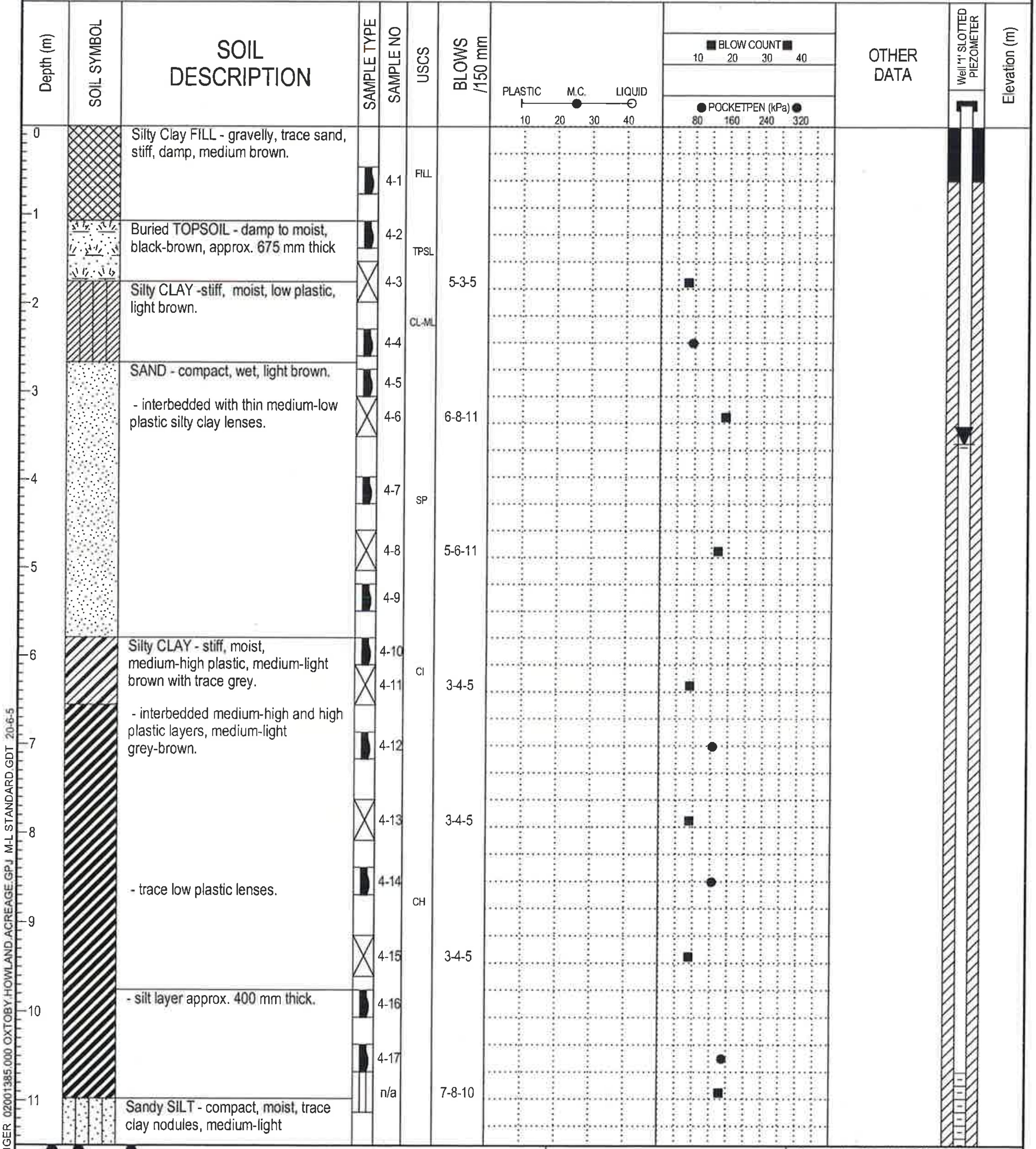
| | |
|---|---|
| Logged By: Genevieve Kenny | Completion Depth: 45 ft |
| Reviewed By: Tyler Windsor | Drilled on: 2020-04-28 |
| Groundwater Depth: m | Page 2 of 2 |

| | | |
|---|---|---|
| Project: Oxtoby/Howland Acreage | Drilling Information: | Borehole No.:4 |
| Client: Carolina Oxtoby & Doug Howland | All Service Drilling Ltd | Project No.:02001385.000 |
| c/o Pasquini | CME 55 track SS-Auger | Elevation: |

SAMPLE TYPE: ■ SHELBY TUBE; CORE SAMPLE; ☒ SPT SAMPLE; GRAB SAMPLE; AUGER SAMPLE; NO RECOVERY

BACKFILL TYPE: ■ BENTONITE; PEA GRAVEL; SLOUGH; GROUT; ▨ DRILL CUTTINGS; SAND



## SOIL DESCRIPTION

Silty Clay FILL - gravelly, trace sand, stiff, damp, medium brown.

Buried TOPSOIL - damp to moist, black-brown, approx. 675 mm thick

Silty CLAY -stiff, moist, low plastic, light brown.

SAND - compact, wet, light brown.

- interbedded with thin medium-low plastic silty clay lenses.

Silty CLAY - stiff, moist, medium-high plastic, medium-light brown with trace grey.

- interbedded medium-high and high plastic layers, medium-light grey-brown.

- trace low plastic lenses.

- silt layer approx. 400 mm thick.

Sandy SILT - compact, moist, trace clay nodules, medium-light

| SAMPLE NO | USCS | BLOWS /150 mm |
|---|---|---|
| 4-1 | FILL | |
| 4-2 | TPSL | |
| 4-3 | | 5-3-5 |
| 4-4 | CL-ML | |
| 4-5 | | |
| 4-6 | | 6-8-11 |
| 4-7 | SP | |
| 4-8 | | 5-6-11 |
| 4-9 | | |
| 4-10 | | |
| 4-11 | CI | 3-4-5 |
| 4-12 | | |
| 4-13 | | 3-4-5 |
| 4-14 | CH | |
| 4-15 | | 3-4-5 |
| 4-16 | | |
| 4-17 | | |
| n/a | | 7-8-10 |

2017 ML AUGER 02001385.000 OXTOBY-HOWLAND ACREAGE.GPJ M-L STANDARD.GDT 20-6-5

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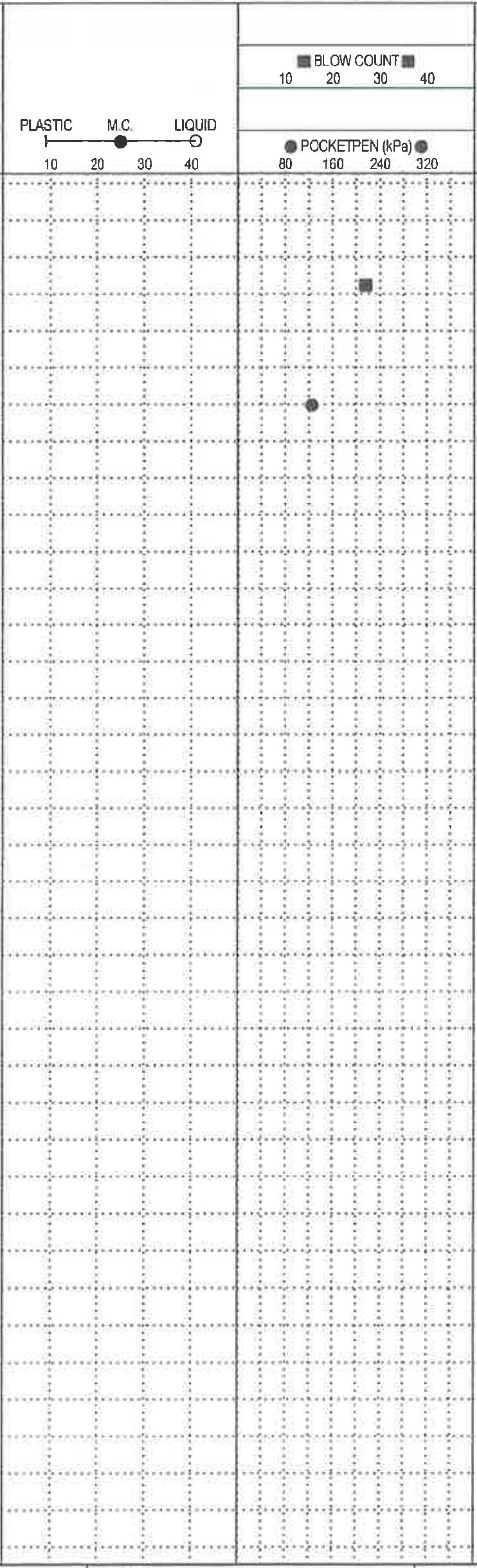
| | |
|---|---|
| Logged By: Genevieve Kenny | Completion Depth: 45 ft |
| Reviewed By: Tyler Windsor | Drilled on: 2020-04-28 |
| Groundwater Depth: m | Page 1 of 2 |

| | | |
|---|---|---|
| Project: Oxtoby/Howland Acreage | Drilling Information: | Borehole No.:4 |
| Client: Carolina Oxtoby & Doug Howland | All Service Drilling Ltd | Project No.:02001385.000 |
| c/o Pasquini | CME 55 track SS-Auger | Elevation: |

| | | | | | | |
|---|---|---|---|---|---|---|
| SAMPLE TYPE | ■ SHELBY TUBE | ▯ CORE SAMPLE | ☒ SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | ▥ NO RECOVERY |
| BACKFILL TYPE | ■ BENTONITE | ⬚ PEA GRAVEL | ▥ SLOUGH | GROUT | ▨ DRILL CUTTINGS | ⁘ SAND |

| Depth (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | USCS | BLOWS /150 mm | OTHER DATA | Well '1' SLOTTED PIEZOMETER | Elevation (m) |
|---|---|---|---|---|---|---|---|---|---|
| 11.5 | | grey-brown. | | 4-18 | | | | | |
| 12 | | | | n/a | MLS | 5-12-15 | | | |
| 13 | | - trace clay lenses, medium-light grey. | | | | | | | |
| | | Silty CLAY - stiff, moist, high plastic, trace silt lenses, medium-light grey. | | 4-19 | CH | | | | |
| 14 | | END OF HOLE at a depth of 13.7 m.<br>25 mm PVC standpipe installed to a depth of 13.7 m, with 3.1 m slotted.<br>Wet upon completion.<br>Water Level:<br>May 12, 2020 - 3.58 m. | | | | | | | |
| 15 | | | | | | | | | |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 | | | | | | | | | |
| 19 | | | | | | | | | |
| 20 | | | | | | | | | |
| 21 | | | | | | | | | |
| 22 | | | | | | | | | |



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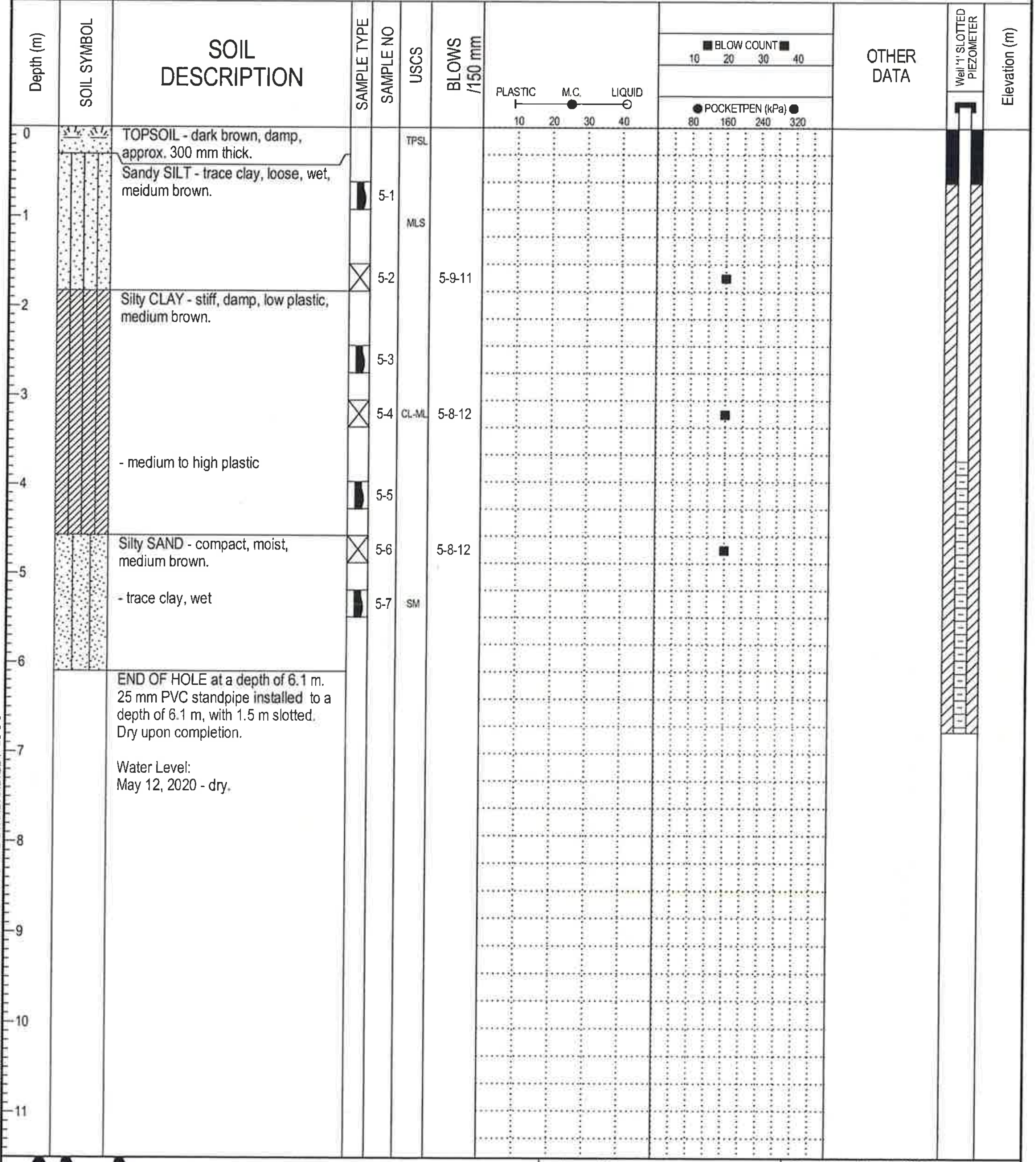
| | |
|---|---|
| Logged By: Genevieve Kenny | Completion Depth: 45 ft |
| Reviewed By: Tyler Windsor | Drilled on: 2020-04-28 |
| Groundwater Depth: m | Page 2 of 2 |

| | | |
|---|---|---|
| Project: Oxtoby/Howland Acreage | Drilling Information: | Borehole No.:5 |
| Client: Carolina Oxtoby & Doug Howland | All Service Drilling Ltd | Project No.:02001385.000 |
| c/o Pasquini | CME 55 track SS-Auger | Elevation: |

SAMPLE TYPE: ■ SHELBY TUBE ▯ CORE SAMPLE ☒ SPT SAMPLE GRAB SAMPLE AUGER SAMPLE NO RECOVERY

BACKFILL TYPE: ■ BENTONITE PEA GRAVEL SLOUGH GROUT ▨ DRILL CUTTINGS SAND



| Depth (m) | SOIL DESCRIPTION | SAMPLE NO | USCS | BLOWS /150 mm |
|---|---|---|---|---|
| 0 | TOPSOIL - dark brown, damp, approx. 300 mm thick. | | TPSL | |
| | Sandy SILT - trace clay, loose, wet, meidum brown. | 5-1 | MLS | |
| | | 5-2 | | 5-9-11 |
| 2 | Silty CLAY - stiff, damp, low plastic, medium brown. | 5-3 | | |
| | | 5-4 | CL-ML | 5-8-12 |
| | - medium to high plastic | 5-5 | | |
| | Silty SAND - compact, moist, medium brown. | 5-6 | | 5-8-12 |
| | - trace clay, wet | 5-7 | SM | |
| 6 | END OF HOLE at a depth of 6.1 m.<br>25 mm PVC standpipe installed to a depth of 6.1 m, with 1.5 m slotted.<br>Dry upon completion.<br>Water Level:<br>May 12, 2020 - dry. | | | |

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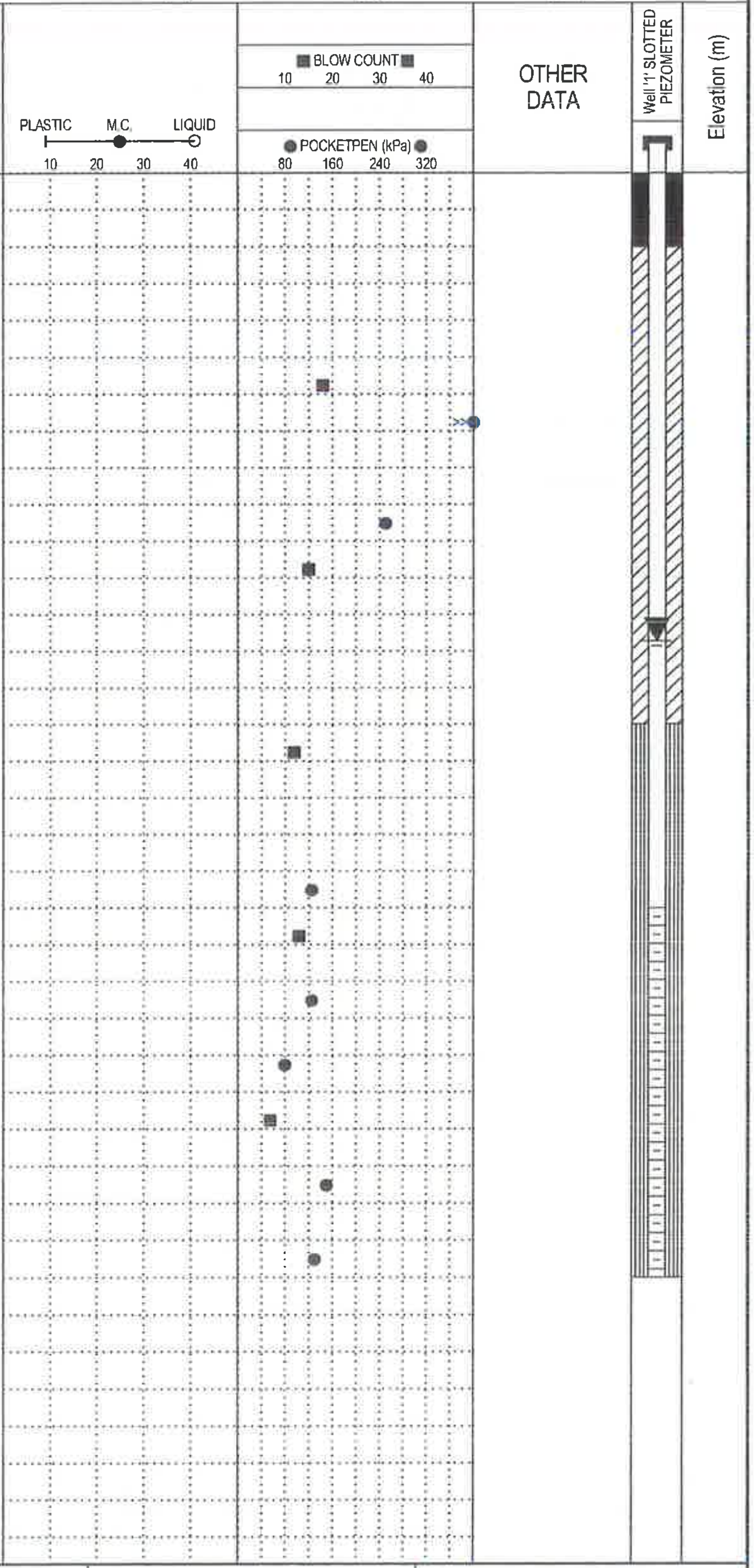
| | |
|---|---|
| Logged By: Sc | Completion Depth: 30 ft |
| Reviewed By: Tyler Windsor | Drilled on: 2020-04-28 |
| Groundwater Depth: m | Page 1 of 1 |

|  |  |  |
|---|---|---|
| Project: Oxtoby/Howland Acreage | Drilling Information: | Borehole No.:6 |
| Client: Carolina Oxtoby & Doug Howland | All Service Drilling Ltd | Project No.:02001385.000 |
| c/o Pasquini | CME 55 track SS-Auger | Elevation: |

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| SAMPLE TYPE | ■ SHELBY TUBE | ▯ CORE SAMPLE | ☒ SPT SAMPLE | GRAB SAMPLE | ▮ AUGER SAMPLE | ▥ NO RECOVERY |
| BACKFILL TYPE | ■ BENTONITE | ⁘ PEA GRAVEL | ▥ SLOUGH | ⁘ GROUT | ▨ DRILL CUTTINGS | ⁘ SAND |

| Depth (m) | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | USCS | BLOWS /150 mm |
|---|---|---|---|---|---|
| 0 | TOPSOIL - black organics,, approx. 150 mm thick. |  |  | TPSL |  |
| 1 | SILT - trace clay, compact, damp, light brown. | ▮<br>▮ | 6-1<br>6-2 |  |  |
|  | - very thin (1 mm) layered deposit. | ☒ | 6-3 | ML | 7-8-10 |
| 2 | - clay layer approx. 100 mm thick. | ▮<br>▮ | 6-4<br>6-5 |  |  |
| 3 | - clay layers approx. 300 mm thick throughout | ▮<br>☒ | 6-6<br>6-7 |  | 6-6-9 |
| 4<br>5 | SAND - trace silt, damp to moist, light brown.<br>- wet. | ▮<br>☒<br>▮ | 6-8<br>6-9<br>6-10 | SP | 5-6-6 |
| 6<br>7 | Silty CLAY - stiff, damp, medium to medium-high plastic, with intebedded wet silty sand lenses, light brown.<br>- firm, medium-light grey-brown. | ▮<br>☒<br>▮<br>▮ | 6-11<br>6-12<br>6-13<br>6-14 | CI | 3-4-9 |
| 8 | SILT - trace clay lenses, compact, wet, light brown. | ☒ | 6-15 | ML | 3-3-4 |
| 9 | Silty CLAY - stiff, moist, medium-high plastic, trace wet sandy silt lenses, medium-light grey. | ▮<br>▮ | 6-16<br>6-17 | CI |  |
| 10<br>11 | END OF HOLE at a depth of 9.1 m. Slough to 4.6 m. 25 mm PVC standpipe installed to a depth of 9.1 m, with 3.1 m slotted. Wet slough upon completion.<br><br>Water Level:<br>May 12, 2020 - 3.88 m. |  |  |  |  |



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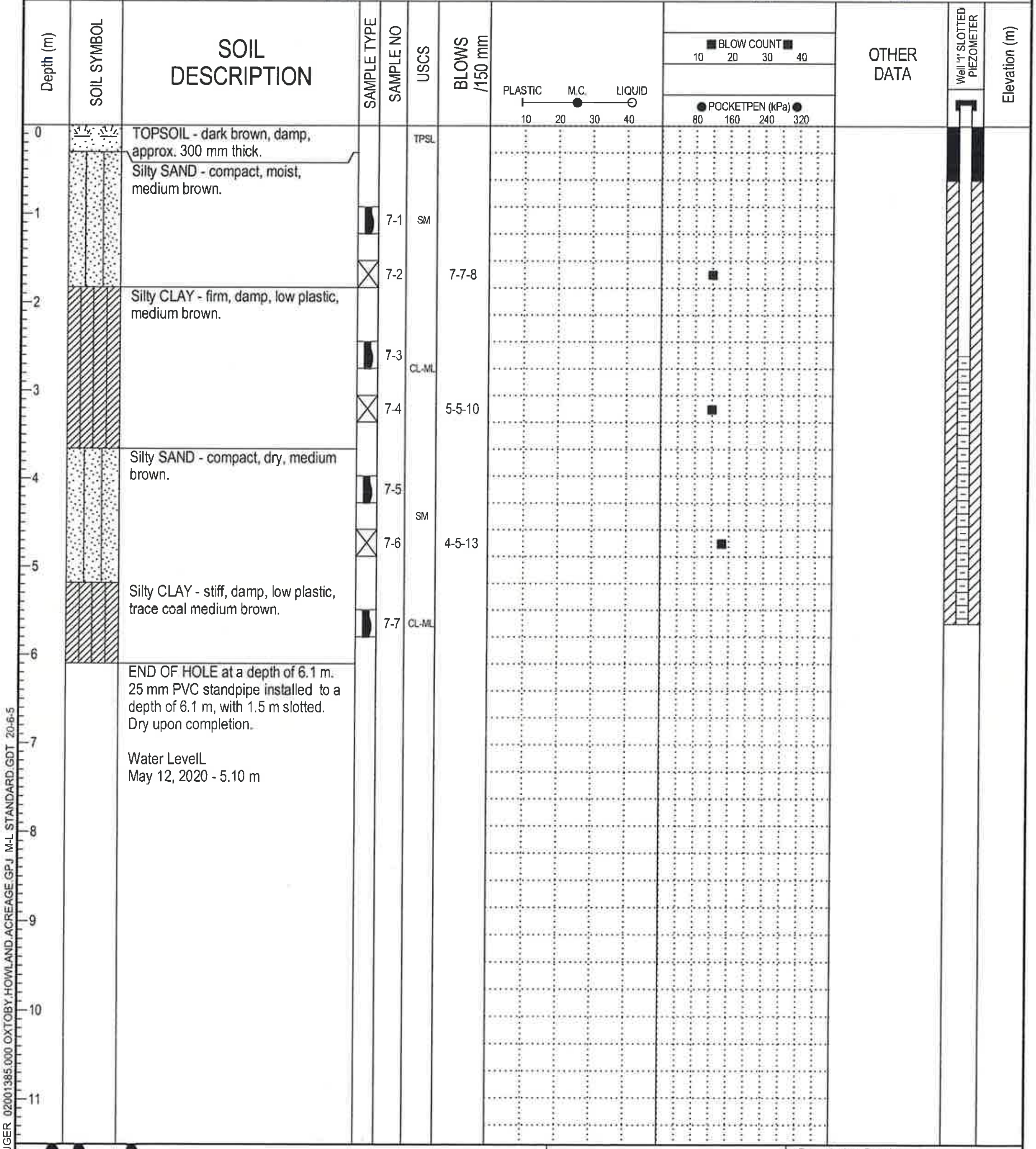
|  |  |
|---|---|
| Logged By: Genevieve Kenny | Completion Depth: 30 ft |
| Reviewed By: Tyler Windsor | Drilled on: 2020-04-28 |
| Groundwater Depth: m | Page 1 of 1 |

| | | |
|---|---|---|
| Project: Oxtoby/Howland Acreage | Drilling Information: | Borehole No.:7 |
| Client: Carolina Oxtoby & Doug Howland | All Service Drilling Ltd | Project No.:02001385.000 |
| c/o Pasquini | CME 55 track SS-Auger | Elevation: |

| | | | | | | |
|---|---|---|---|---|---|---|
| SAMPLE TYPE | ■ SHELBY TUBE | ▯ CORE SAMPLE | ☒ SPT SAMPLE | GRAB SAMPLE | ▮ AUGER SAMPLE | ▥ NO RECOVERY |
| BACKFILL TYPE | ■ BENTONITE | ⛶ PEA GRAVEL | ▥ SLOUGH | GROUT | ▨ DRILL CUTTINGS | ⛶ SAND |



| SOIL DESCRIPTION | USCS |
|---|---|
| TOPSOIL - dark brown, damp, approx. 300 mm thick. | TPSL |
| Silty SAND - compact, moist, medium brown. | SM |
| Silty CLAY - firm, damp, low plastic, medium brown. | CL-ML |
| Silty SAND - compact, dry, medium brown. | SM |
| Silty CLAY - stiff, damp, low plastic, trace coal medium brown. | CL-ML |

| SAMPLE TYPE | SAMPLE NO | BLOWS /150 mm |
|---|---|---|
| ▮ | 7-1 | |
| ☒ | 7-2 | 7-7-8 |
| ▮ | 7-3 | |
| ☒ | 7-4 | 5-5-10 |
| ▮ | 7-5 | |
| ☒ | 7-6 | 4-5-13 |
| ▮ | 7-7 | |

END OF HOLE at a depth of 6.1 m.
25 mm PVC standpipe installed to a depth of 6.1 m, with 1.5 m slotted.
Dry upon completion.

Water LevelL
May 12, 2020 - 5.10 m

2017 ML AUGER 02001385.000 OXTOBY HOWLAND ACREAGE.GPJ M-L STANDARD.GDT 20-6-5

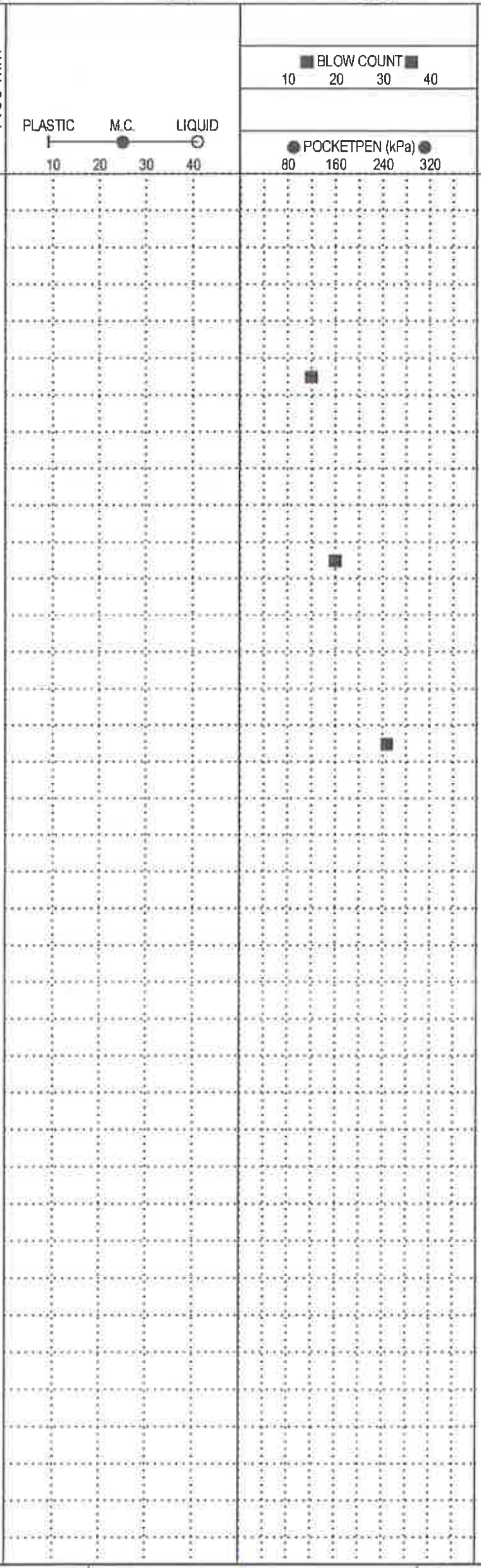
| | | |
|---|---|---|
| McIntosh Lalani Engineering<br>Calgary, AB<br>(403) 291-2345 | Logged By: Sc | Completion Depth: 18.5 ft |
| | Reviewed By: Tyler Windsor | Drilled on: 2020-04-28 |
| | Groundwater Depth: m | Page 1 of 1 |

| | | |
|---|---|---|
| Project: Oxtoby/Howland Acreage | Drilling Information: | Borehole No.:8 |
| Client: Carolina Oxtoby & Doug Howland | All Service Drilling Ltd | Project No.:02001385.000 |
| c/o Pasquini | CME 55 track SS-Auger | Elevation: |

SAMPLE TYPE ■ SHELBY TUBE ▯ CORE SAMPLE ☒ SPT SAMPLE GRAB SAMPLE ▮ AUGER SAMPLE ▯ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▢ PEA GRAVEL ▥ SLOUGH ▨ GROUT ▨ DRILL CUTTINGS ▨ SAND

| Depth (m) | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | USCS | BLOWS /150 mm |
|---|---|---|---|---|---|
| 0 | TOPSOIL - dark brown, damp, approx. 150 mm thick. | | | TPSL | |
| | Silty CLAY - firm, moist, low plastic, medium brown. | ▮ | 8-1 | CL-ML | |
| 1 | | | | | |
| | SILT - compact, damp, medium brown. | ☒ | 8-2 | | 4-7-8 |
| 2 | - some clay | | | ML | |
| | Silty SAND - coarse grain, compact, damp, medium brown. | ▮ | 8-3 | | |
| 3 | | ☒ | 8-4 | | 6-7-13 |
| 4 | | ▮ | 8-5 | SM | |
| | | ☒ | 8-6 | | 6-9-22 |
| 5 | - wet | ▮ | 8-7 | | |
| 6 | END OF HOLE at a depth of 6.1 m.<br>25 mm PVC standpipe installed to a depth of 6.1 m, with 1.5 m slotted.<br>Wet upon completion.<br>Water LevelL<br>May 12, 2020 - 5.10 m | | | | |
| 7 | | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | | | | | |
| 11 | | | | | |



OTHER DATA

Elevation (m)

2017 ML AUGER 02001385.000 OXTOBY HOWLAND ACREAGE.GPJ M-L STANDARD.GDT 20-6-5

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| | |
|---|---|
| Logged By: Sc | Completion Depth: 30 ft |
| Reviewed By: Tyler Windsor | Drilled on: 2020-04-28 |
| Groundwater Depth: m | Page 1 of 1 |

Corix Utilities

#2, 8515 – 48th Street S.E
Calgary, AB T2C 2P8
Tel: (403) 273-8676
Fax: (403) 273-7382
www.corix.com

October 30, 2020

Carol Oxtoby
#8 Heaver Gate, Heritage Point
Alberta, T1S 4K1

**RE: Water Treatment Plant and Wastewater Treatment Plant Capacity**

Dear Carol,

Please accept this letter as our commitment, as the owners and operators of both the Foothills Water Treatment Plant and the Wastewater Treatment Plant, in the rural subdivision of Heritage Pointe, to work with you in developing your 24.39 acre land parcel (Plan 9912130, Block 5).

We understand you have a desire to connect your potential 87 homes to both our Water Treatment Plant and our Wastewater Treatment Plant. In an initial assessment I can confirm we have capacity to accept these connections as outlined in your August, 2020 Amendment Structure Plan.

We look forward to continuing to work with you on this exciting plan.

Please feel free to reach out any time.

Sincerely,

X

Ryan Moray
General Manager, Corix Utilities Western Canada