PRELIMINARY GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL SUBDIVISION DEVELOPMENT
PART OF FARM LOT 10, REGISTERED PLAN NO. 15
FORMERLY IN THE VILLAGE OF L’ORIGNAL
NOW IN THE TOWNSHIP OF CHAMPLAIN
UNITED COUNTIES OF PRESCOTT-RUSSELL

Prepared for
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1 INTRODUCTION

9167-5637 Quebec Inc. retained the services of Lascelles Engineering & Associates Ltd. (Lascelles) to conduct a preliminary geotechnical investigation for a proposed residential subdivision development located in the Village of L’Orignal, Ontario.

The purpose of the investigation was to identify the subsurface soil conditions within the project by means of a limited number of test pits, and based on the factual information obtained, provide preliminary guidelines on the geotechnical engineering aspects of the design of the proposed dwellings’ foundations and roadways, including construction considerations which may influence the design of the subdivision development in effort of obtaining “Draft Plan” approval.

Should there be any changes in the design features, which may relate to the guidelines provided in the report, Lascelles Engineering & Associates Ltd. should be advised in order to review the report recommendations.

2 PROJECT AND SITE

The proposed subdivision is located to the south of the Village of L’Orignal, Ontario. It is located to east of Victoria and Pilon Street; refer to Figure 1 for location. It is our understanding that the project will consist in the development of approximately 70 residential lots that will house single and semi-detached family dwellings. The subdivision will be serviced with municipal water and sewers, which will connect with those on Victoria Street. A stormwater facility in the form of a pond will be located to the southeast of the subdivision. A draft plan of the subdivision prepared by Schultz Barrette Surveying is presented in Appendix A.

The site has an irregular rectangular shape being approximately 175m wide (east-west) and approximately 430m deep (north-south) for an approximate total surface area of 7.33 ha (18.11 acres). The developer also owns the lands to the west up to John Street and south up to the railway. Most of the northern portion of the site was formerly forested for which it was recently cleared. The southern portion of the site was former agricultural fields that were left unattended for numerous years and became overgrown with wild grasses and shrubs as well as edge rows,
especially along the perimeter. Recently however, the owner has cleared the property and has returned to cropping most of the site.

The site is gently sloped to toward the south and up to the railway that is located approximately 320m from the southern boundary of the site. The ground surface elevations in the northern portion of the site are around Elev. 54.5m and gradually slopes to the south, where elevations are around 53.0m.

![Site Location](image)

3 PROCEDURE

The fieldwork for this investigation was carried out on September 03, 2015 and consisted of digging six (6) test pits across the proposed subdivision. Prior to any fieldwork, the test pit locations were cleared for the presence of any underground services and utilities. The locations of the test pits were overlaid over the draft subdivision plan prepared by Schultz Barrette Surveying, which is attached in Appendix B.
The test pits were completed using an excavator supplied and operated by Laviolette Excavation. The test pits were taken down to depths ranging from 1.6m to 4.0m below ground surface (bgs). Sampling of the overburden materials encountered in the test pits was carried out by means of grab samples taken either directly from the excavation or from the bucket of the excavator. The recovered soil samples collected from the test pits were classified based on visual and tactile examination of the materials recovered and the results of the in-situ testing (field vanes and dynamic cone penetrometer). Upon completion, the test pits were backfilled with the excavated overburden materials and lightly compacted.

Standpipes were installed in three (3) of the test pits prior to backfilling them to measure the static groundwater level in the area. The standpipes consisted of 25mm diameter PVC piping that were slotted and placed within the overburden prior to backfilling them. The standpipes were used strictly to establish the static water level of the overburden water table.

The fieldwork was supervised throughout by a member of our engineering staff who supervised the digging of the test pits, coordinated the testing of the materials, cared for the samples collected and logged the subsurface conditions encountered at each location.

All soil samples collected from test pits were placed and sealed in plastic bags to prevent loss of moisture. All soil samples were transported to our office for further examination by our geotechnical engineer. All samples collected during this project will be kept in storage for a period of six (6) months following the issuing of this report, where at which time, they will be disposed of, unless a written or verbal notice is received, requesting otherwise.

Finally, all test pits were surveyed and located using a GPS (Global Positioning System) receiver using NAD 83 datum (North American Datum). The topographic survey was conducted using a laser level. The test pit elevations were referenced to a temporary site benchmark given to the northwest corner of the top of concrete base of transformer located near the intersection of Julien and Pilon Street; Elev. 54.96m (considered geodetic).
4 SUBSURFACE SOIL AND GROUNDWATER CONDITIONS

4.1 General

A review of the surficial geology maps for this area suggests that most of the site would be underlain by glacial deposits in the form of till as well as shallow bedrock formation. The soil deposits would transition into Champlain Sea deposits towards the south, which are generally composed of silt and clay. The drift thickness would vary between less than 2m and up to 5m deep increasing towards the south of the site. The bedrock would belong to the Rockcliffe formation, which is generally described as interbedded quartz sandstone and shale, to shaly limestone.

The subsurface conditions encountered in the test pits were classified based on visual and tactile examination of the materials recovered from the test holes and the results of the in-situ testing and field observations. The soil descriptions presented in this report are based on commonly accepted methods of classification and identification of soil employed in geotechnical practice. Classification and identification of soil involves judgement and Lascelles does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The subsurface soil conditions encountered at each test pit location are given in the Test Pit Logs presented in Appendix C. These logs indicate the subsurface conditions encountered at specific test locations only. Boundaries between zones on the logs are often not distinct, but are rather transitional and have been interpreted.

4.2 Topsoil

A thin (100mm to 500mm) layer of topsoil was encountered at the surface in every test pits completed at this site. The topsoil is described as being a dark brown clayey loam.

The material was classified as topsoil based on colour and the presence of organic materials and is intended as identification for geotechnical purposed only. This does not constitute a statement as to the suitability of this layer for cultivation and sustaining plant growth.
4.3 Silty Clay

A silty clay layer (1.5m) deposit was encountered underlying the topsoil in TP-6 only, which is located to the south of the subdivision where the proposed stormwater facility will be located. The clay is described as being silty, grey in colour, very stiff in consistency (Cu greater than 100 kPa). The clay was found mantling glacial till.

4.4 Glacial Till

Glacial till deposits was encountered in all test pits performed as part of this investigation. The till is described as a well graded mixed of silt, sand and gravel with some clay and with some cobbles. It is grey in colour and generally compact becoming dense with depth. It is further noted that the presence of some sub-rounded to sub-angular cobbles, boulders and rock slabs can be found within the local till deposits as seen at the surface. Consequently, large boulders or rock slabs can be expected to be found occasionally within the glacial till at this site. TP-6 was terminated within the glacial till deposit, while all other test pits were terminated over bedrock.

4.5 Refusal/Bedrock

Refusal over bedrock was encountered in TP-1 to TP-5 between 1.6m to 3.2m bgs. The bedrock would be sloped to towards the south of the site. The bedrock was not characterised as part of this investigation but local geological mapping would suggest that it would belong to the Rockcliffe Formation.

4.6 Groundwater Conditions

The static water level was measured within the standpipes installed within TP-1, TP-3 and TP-4 using a water meter on September 10, 2015. The depth of the groundwater was found to range from 0.36m to 1.1m bgs.

It should be noted that this groundwater table can easily fluctuate with seasonal weather conditions (i.e.: rainfall, droughts and spring thawing). In addition, it can be locally affected by the presence of existing ditches and underground services trenches at or in the vicinity of the site.
5  GEOTECHNICAL CONSIDERATIONS

5.1  General

This section of the report provides general engineering guidelines on the geotechnical design aspects of the project based on our interpretation and review of the information obtained from the test pits and the project requirements. It is our understanding that the project will consist in the development of approximately 70 residential lots that will house single and semi-detached family dwellings. The subdivision will be serviced with municipal water and sewers, which will connect with those on Victoria Street. A stormwater facility in the form of a pond will be located to the southeast of the subdivision. A draft plan of the subdivision prepared by Schultz Barrette Surveying is presented in Appendix A.

5.2  Foundations

Based on the preliminary characterisation of the subsurface soil conditions established at this site, it is recommended that the foundation for the proposed residential buildings can be founded over the native undisturbed clay, glacial till or relatively sound bedrock. Therefore, any organics and fill material found within the building footprint will need to be removed.

Conventional strip and pad footings set over the above mention founding soil type or properly prepared and approved engineered fill may be designed using a maximum allowable bearing pressure of $75\text{ kPa}$ for serviceability limit state (SLS) and $100\text{ kPa}$ for ultimate limit state (ULS) factored bearing resistance. This bearing capacity contingent to a minimum footing width of 0.4m for strip footings and 0.9m for pad footings. There are no grade restrictions to be respected for the bearing capacity provided.

It is recommended that the footings for any given residential dwelling be founded over the same subgrade soils to limit differential settlement between two (2) different founding stratum. Depending on the conditions encountered at the time of construction, specifics recommendations will be provided (i.e. bedding layer, sub-excavation, reinforcement in wall, etc.). It is therefore recommended that a founding soil inspection be carried at the time of construction once the entire subgrade for the footings has been exposed so appropriate recommendations can be provided, if required.
Should a greater bearing capacity be required, a more detailed and building-specific investigation should be carried out.

5.3 Settlement

Provided that any loose and/or disturbed soil is removed from the bearing surfaces prior to pouring concrete, the estimated total settlement of the foundations, designed using the recommended serviceability limit state capacity value given herein as well as other recommendations provided herein will be less than 25mm. The differential settlement between adjacent footings is anticipated to be 20mm or less.

5.4 Structural Fill

Where excavation below the underside of the footing is performed, consideration shall be given to support the footings on structural fill. The structural fill must extend 0.6m beyond the outside edge of the footings and extend outward and down at a 1 Horizontal to 1 Vertical profile out from the edge equal to the depth of the structural fill set below the footing. The recommended material to be used as structural fill to support the footings shall consist of Granular B Type II crushed stone, or an approved equivalent material.

The structural fill shall be placed over undisturbed native soils in layers not exceeding 300mm and compacted to 98 percent of its Standard Proctor Maximum Dry Density (SPMDD) as per ASTM D-698. Prior to placing any structural fill or to pouring the footings, it is required that any disturbed soils along the base of the footing be removed and that the subgrade soils be inspected and approved by the geotechnical engineer. Furthermore, the structural fill must be tested to ensure that the specified compaction level was achieved.

5.5 Seismic Design

Based on the results of the geotechnical investigation, the deposit at this site can be classified as a Class “C” as per the Site Classification for Seismic Site Response in accordance with the latest version of the Ontario Building Code. It is noted that a greater seismic site response class may be obtained by carrying out seismic velocity testing using a multichannel analysis of surface waves (MASW).
5.6 Potential for Soil Liquefaction

Based on the preliminary characterisation of the subsurface soil conditions established at this site, the potential of soil liquefaction is not considered to be a concern.

5.7 Slab-on-Grade Construction

For predictable performance of the proposed concrete basement slab-on-grade, it shall rest over native soil, bedrock or structural fill only. Therefore, all organic, deleterious or otherwise objectionable fill material encountered shall be removed from the building’s footprint.

The exposed native subgrade surface should then be inspected and approved by geotechnical personnel. Any soft areas evident should be sub-excavated and replaced with suitable engineered fill however disturbances should be minimized as much as possible.

Any underfloor fill needed to raise the general floor grade shall consist of OPSS Granular B Type I material or an approved equivalent, compacted to 95 percent of its SPMDD. The final lift shall be compacted to 98 percent of its SPMDD. A 200mm layer of OPSS Granular A material shall be placed under the slab and compacted to at least 98 percent of the SPMDD.

In order to minimize and control cracking, the floor slab should be provided with wire or fibre mesh reinforcement and crack control joints. The crack control joints should be spaced equal distance in both directions and where possible not exceeding a spacing of 4.5 metres. The mesh reinforcement should be carried through the joints.

5.8 Frost Protection

All exterior footings and those located in any unheated portion of the proposed building should be provided with at least 1.5m of earth cover for frost protection purposes. Exterior footings constructed in areas that are to be cleared of snow during the winter period should be provided with at least 1.7m of earth cover for frost protection purposes. Alternatively, the required frost protection could be provided using a combination of earth cover and extruded polystyrene insulation. Lascelles Engineering should review the detailed design of frost protection with the use of equivalent insulation prior to construction.
In the event that foundations are to be constructed during winter months, foundation soils are required to be protected from freezing temperatures using suitable construction techniques. Therefore, the base of all excavations should be insulated from freezing temperature immediately upon exposure, until the time that heat can be supplied to the building interior and footings have sufficient soil cover to prevent freezing of the subgrade soils.

5.9 Foundation Drainage

It is anticipated that the dwellings will have basements and will therefore, require permanent perimeter drainage. The drainage pipe shall be embedded in a 300mm layer of 20mm diameter clear crushed stone wrapped in a geotextile and set adjacent to the perimeter footings. The drainage pipe should be connected positively to a suitable outlet such as a sump pit or storm sewer. In order to reduce the potential for ponding of water adjacent to the foundation walls, roof water should be controlled by a roof drainage system that directs water away from the building and the exterior grade should be sloped to promote water away from the foundation walls.

5.10 Foundation Wall Backfill

To prevent possible foundation frost jacking, the backfill against foundation walls should consist of free draining, non-frost susceptible material meeting OPSS Granular B Type I gradation requirements.

The foundation fill should be compacted to 90 percent of its SPMDD using light compaction equipment, where no loads will be set over top. The compaction shall be increased to 95 percent under walkways, slabs or paved areas close to the foundation or retaining walls. Backfilling against foundation walls should be carried out on both sides of the wall at the same time.

5.11 Retaining Walls and Shoring

The following Table 1 below provides the suggested soil parameters for the design of retaining wall and/or shoring systems. For excavations near existing services and structures, the coefficient of earth pressure at rest (K₀) should be used.
Table 1: Material Properties for Shoring and Permanent Wall Design (Static)

<table>
<thead>
<tr>
<th>Type of Material</th>
<th>Bulk Density (kg/m³)</th>
<th>Pressure Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Active (Ka)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>At Rest (Ko)</td>
</tr>
<tr>
<td>Clay</td>
<td>18</td>
<td>0.45</td>
</tr>
<tr>
<td>Sand</td>
<td>19</td>
<td>0.33</td>
</tr>
<tr>
<td>Till</td>
<td>22</td>
<td>0.27</td>
</tr>
<tr>
<td>Granular B Type I</td>
<td>20</td>
<td>0.33</td>
</tr>
<tr>
<td>Granular B Type II</td>
<td>23.1</td>
<td>0.31</td>
</tr>
<tr>
<td>Granular A</td>
<td>23.5</td>
<td>0.27</td>
</tr>
</tbody>
</table>

The above values are for a flat surface behind the wall, a straight wall and a wall friction angle of 0 degree. The designer should consider any difference between these coefficients, and make appropriate corrections for a sloped surface behind the wall, angled wall or wall friction as required. The bearing capacity for the design of a retaining wall are the same as provided for the building structures provided it is founded over native soil or properly prepared and approved structural fill.

Retaining walls should also be designed to resist the earth pressures produces under seismic conditions. Lascelles recommends the use of combined coefficients of static and seismic earth pressure, referred to as $K_{AE}$ for active conditions and $K_{PE}$ for passive conditions for routine design purposes.

The total active and passive loads under seismic conditions can be calculated using the following two equations;

$$P_{AE} = \frac{1}{2} K_{AE} \gamma H^2 (1-K_v)$$
$$P_{PE} = \frac{1}{2} K_{PE} \gamma H^2 (1-K_v)$$

Where;

$K_{AE}$ = Combined Static and Seismic Active Earth Pressure Coefficient
$K_{PE}$ = Combined static and seismic passive earth pressure coefficient
$H$ = Total Height of the Wall (m)
$K_h$ = horizontal acceleration coefficient
$K_v$ = vertical acceleration coefficient
$\gamma$ = bulk density (kg/m³)
These equations are based on a horizontal slope behind the wall and a vertical back of the retaining wall and zero wall friction. For this site, the following design parameters were used to develop the recommended $K_{AE}$ and $K_{PE}$ values.

\[ A = \text{Zonal acceleration ratio} = 0.2 \]
\[ K_h = \text{Horizontal acceleration coefficient} = 0.1 \]
\[ K_V = \text{Horizontal acceleration coefficient} = 0.067 \]

The above value of $K_h$ corresponds to $\frac{1}{2}$ of the A value and the value $K_V$ of corresponds to 0.67 of the $K_h$ value. The angle of friction between the soil and the wall has been set at $0^\circ$ to provide a conservative estimate. The following Table 2 provides the parameters for seismic design of retaining structures.

### Table 2: Material Properties for Shoring and Permanent Wall Design (Seismic)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OPSS Granular B Type I</th>
<th>OPSS Granular A and Granular B Type II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk Unit Weight, $\gamma$ (kN/m$^3$)</td>
<td>20</td>
<td>23.3</td>
</tr>
<tr>
<td>Effective Friction Angle (degrees)</td>
<td>30</td>
<td>32</td>
</tr>
<tr>
<td>Angle of Internal Friction Between wall and Backfill (degrees)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Yielding Wall**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OPSS Granular B Type I</th>
<th>OPSS Granular A and Granular B Type II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Seismic Earth Pressure Coefficient ($K_{AE}$)</td>
<td>0.37</td>
<td>0.33</td>
</tr>
<tr>
<td>Height of the Application of $P_{AE}$ from the base of the wall as a ration of its height ($H$)</td>
<td>0.36</td>
<td>0.37</td>
</tr>
<tr>
<td>Passive Seismic Earth Pressure Coefficient ($K_{PE}$)</td>
<td>3.06</td>
<td>3.48</td>
</tr>
<tr>
<td>Height of the Application of $P_{PE}$ from the base of the wall as a ration of its height ($H$)</td>
<td>0.30</td>
<td>0.30</td>
</tr>
</tbody>
</table>

### 6 EXCAVATION AND GROUNDWATER CONTROL

It is anticipated that shallow excavation in overburden soils would not exceed 3.6m bgs for the proposed dwellings and municipal services. Most of the shallow excavation will be through clay and glacial till deposits. According to the Ontario’s Occupational Health and Safety Act (OHSA), O. Reg. 213/91 and its amendments, the surficial overburden soil anticipated to be excavated into at this site can be classified as Type 3 for fully drained excavations. Therefore, shallow temporary excavation in the overburden soil classified as Type 3 can be cut at 1 horizontal to 1 vertical for a fully drained excavation starting at the base of the excavation and as per requirements of the OHSA regulations.
The listed slopes are for fully drained excavations. Gentler slopes could be required under undrained excavations or below the water table, where localised water infiltrations can occur and where the excavations are exposed for a prolonged period of time.

Any excavated material stockpiled near a trench or open excavation should be stored at a distance equal to or greater than the depth of the excavated soil within the trench or open excavation and equipment circulation should be restricted away from the top of the slope excavation.

If the event that the aforementioned slopes are not possible to achieve due to space restrictions, the excavation should be shored according to OHSA O. Reg. 213/91 and its amendments. A geotechnical engineer should design and approve the shoring and establish the shoring depth under the excavation profile. Refer to the parameters provided in Tables 3 and 4 in Section 5.11 for use in the design of any shoring structures. The excavation for the underground services could be carried out within tightly fitting, braced steel trench boxes, approved by a professional engineer.

It is anticipated that rock excavation will be required for the installation of some underground services, where shallow bedrock was encountered. It is anticipated that any weathered portion of the bedrock may be excavated using a large excavator and that the remaining bedrock will require the use of hoe-rams. Although not encountered within the test holes performed at this site, it is possible that large boulders (greater than 1m in size) may be encountered as part of the glacial till, and may need to be broken to excavate.

The slopes of the rock excavation may be vertical with a 1m wide bench at the soil-rock interface on all sides of the excavation. Any loose pieces of rock from the sidewalls of the excavation should be removed and the bottom of the excavation should be sufficiently flattened and exempt of rock ledges.
A condition survey of any nearby structures and services should be undertaken prior to commencing any construction. In view of the potential for vibration during excavating and removal of the bedrock, it is recommended that the excavation activities be monitored throughout the project by a vibration specialist engineer or consultant and that the vibration limits be established based on the local conditions and nearby structures to ensure that ground vibration are not exceeded.

6.1 Groundwater Control

Groundwater seepage and infiltration entering shallow and temporary excavations performed within the overburden consisting of clay and glacial till should be mitigated by pumping from sumps installed in the excavation. Surface water runoff into the excavation should be avoided and diverted away from the excavation.

It is anticipated that the invert of the municipal services will be founded below the water table. Although the glacial till is compact to dense, it is nevertheless sensitive below the water table and may also be susceptible to piping and scouring from water pressure at the base of the excavation. Special consideration should be given to water control such as pre-pumping using wells or sand points. The base of the excavation should not be exposed for prolonged periods of time and should be backfilled as soon as possible.

6.2 Pipe Bedding Requirements

Bedding, thickness of cover material and compaction requirements for the underground municipal services should conform to the manufacturers design requirements and to the requirements and detailed installations outlined in the Ontario Provincial Standard Specifications (OPSS) and any applicable standards or requirements from the Township of Champlain.

Where the invert of an underground service will be founded below the groundwater table and within glacial till, the glacial till may be sensitive to disturbances and may also be susceptible to piping and scouring from water pressure at the base of the excavation. Therefore, special precautions should be taken in these areas to stabilize and confine the base of the excavation such as using recompression (thicker bedding) and/or dewatering methods (pre-pumping). In order to properly compact the bedding, the water table should be kept at least 0.30m below the base of the excavation at all time during the installation of the underground services.
As an alternative to Granular A bedding and only where wet conditions are encountered, the use of “clear stone” bedding, such as 19mm clear stone, OPSS 1004, may be considered only in conjunction with a suitable geotextile filter. Without proper filtering, there may be entry of fines from native soils and trench backfill into the bedding, which could result in loss of support to the pipes and possible surface settlements.

The sub-bedding, bedding and cover materials should be compacted in maximum 200mm thick lifts to at least 95 percent of the standard Proctor maximum dry density (SPMDD) using suitable vibratory compaction equipment.

### 6.3 Trench Backfill

Acceptable and compactable native materials should be used as trench backfill between the roadway subgrade level and the depth of seasonal frost penetrations (i.e. 1.8m below finished grade). In order to reduce the potential for differential frost heaving between the new excavated trench and the adjacent section of roadway, the selected trench backfill material should match, as best as possible, the existing soil exposed on the trench walls. Any boulders larger than 300mm in size should not be used as trench backfill. Where there is lack of backfill material and it would need to be imported, it should conform to OPSS Granular B Type I or approved equivalent.

Where two different frost susceptible soil types are used in the trench backfill, frost tapers should be provided. The minimum frost taper should consist of cutting back the side slope of the trench to 3 horizontal to 1 vertical profile starting at 1.2m below the finish grade.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the roadway, the trench should be compacted in maximum 300mm thick lifts to at least 95 percent of the SPMDD. The specified density may be reduced where the trench backfill is not located within or in close proximity to existing roadways or any other structures.

Thrust blocks, where required, should be designed according to OPSD 1103.01 and 1103.020 using the allowable soil bearing capacities given hereafter. It is anticipated that thrust blocks would be located within 2.4m of the finish ground surface. An allowable bearing pressure of 75kPa may be used for the design of thrust blocks located in clay, 150kPa for thrust blocks in till
and 300kPa may be used for the design of thrust blocks located against bedrock. The bearing pressure of the soil should be verified on-site at the time of construction.

7 REUSE OF ON-SITE SOILS

The majority of the native soil found at this site consists of silty clay and glacial till and are considered frost susceptible and are not recommended for engineered fill or backfilling against foundation wall. It is however possible to use these soils for landscaping and general backfilling purposes.

Most of the existing overburden material found above the water table, except the organic deposits, could be reused for service trench backfill, if the material can be compacted according to the guidelines outlined herein at the time of construction. Any boulders larger than 300mm in size should not be used as service trench backfill. The reuse of the glacial till found below the water table or the stiff to firm clay will depend on its water content at the time of construction, its ability to be properly compacted and if it can be dried sufficiently. It should generally be possible to reuse the upper portion of the silty clay deposit (clay crust), if the operations are carried out in dry weather. With depth, the water content of the clay is above the range of which it could properly be compacted. It is anticipated that efforts to reduce the moisture content of the clay to an acceptable level may be time consuming, if even possible. Any imported material should conform to OPSS Granular B- Type I.

The bedrock formation was not characterised nor tested as part of this investigation. The bedrock formation found at this site is not known as a suitable aggregate source due to its relatively high shale content and would likely not meet the aggregate material properties outlined in the OPSS for Granular A or B crushed stone. Consequently, it not recommended that the bedrock be crushed and used as backfill material against foundations walls, base material underneath concrete structures, or as part of the road/parking pavement structure. It could be used as general backfill material outside of any structures, trench backfill or select subgrade material if it is properly crushed to meet the required specifications.
It should be noted that the adequacy of a material for reuse as backfill will primarily depend on the water content of the material at the time of use and on weather conditions at that time. Any excavated materials proposed for reuse should be stockpiled in a manner to promote drying and should be inspected and approved for reuse by a geotechnical engineer.

8 PAVEMENT DESIGN

For predictable performance of the municipal roads, any organic, soft or deleterious materials should be removed from the proposed pavement areas to expose native undisturbed subgrade soil. The exposed subgrade should be inspected and approved by geotechnical personnel and any evidently loose and unstable areas should be sub-excavated and replaced with suitable earth borrow approved by the geotechnical engineer. The subgrade should be shaped and crowned to promote drainage of the roadway. Following approval of the preparation of the subgrade, the granular subbase may be placed.

It is anticipated that the subgrade for the proposed municipal street will mostly consist of glacial till. The recommended pavement structure for the proposed municipal street should consist of:

- 40 millimetres of hot mix asphaltic concrete surface layer (HL3) over
- 50 millimetres of hot mix asphaltic concrete binder layer (HL8) over
- 150 millimetres of OPSS Granular A base over
- 350 millimetres of OPSS Granular B, Type II subbase

The base and subbase granular materials should conform to OPSS Form 1010 material specifications. Prior to importing any granular material onto the site, it should be tested and approved by a geotechnical engineer prior to delivery to the site and should be compacted to 100% SPMDD. Compaction of the granular pavement materials should be carried out in maximum 200 mm thick loose lifts to 100% of its SPMDD using suitable vibratory compaction equipment.

The Job Mix Formula (JMF) of the asphaltic concrete should be in accordance with OPSS 1150 for Material Specification for Hot Mix Asphalt. The asphaltic concrete should be placed in accordance to OPSS 310 for Construction Specification for Hot Mix Asphalt. The asphaltic concrete should compacted to a minimum of 92% of the Maximum Relative Density. The JMF
and its constituents should be reviewed, tested and approved by a geotechnical engineer prior to delivery to the site.

8.1 Paved Areas and Subgrade Preparation

The footprint of the proposed municipal streets should be stripped of vegetation, topsoil, debris and other obvious objectionable material. Following the backfilling and satisfactory compaction of any underground service trenches up to the subgrade level, the subgrade should be shaped, crowned and proof-rolled using heavy roller with any resulting soft areas sub-excavated down to an adequate bearing layer and replaced with approved backfill. Following approval of the preparation of the subgrade, the pavement structure may be placed.

Any materials used as select subgrade should be approved by the geotechnical engineer before placement within the roadway. These materials should be placed in maximum 300mm thick loose lifts and be compacted to at least 95 percent of its SPMDD using suitable compaction equipment. Any grade raise must respect the recommendations provided in the foundation section.

If the roadway subgrade is disturbed or wetted due to construction operations or precipitation, the granular thicknesses given above may not be adequate and it may be necessary to increase the thickness of the Granular B Type II subbase and/or incorporate a non-woven geotextile separator between the roadway subgrade surface and the granular subbase material.

The preparation of subgrade should be scheduled and carried out in such a manner that a protective cover of overlying granular material is placed as quickly as possible in order to avoid unnecessary circulation by heavy equipment over the subgrade. Frost protection of the surface should be implemented (i.e. insulated tarps, etc.), if works are carried out during the winter months.

Transitions should be constructed between new and existing pavement structures where the new street will meet with the existing street. In areas where the new pavement structure will abut existing pavement structure, the depths of granular materials should be tapered up or down at 5 horizontal to 1 vertical, or flatter, to match the depths of the granular material(s) exposed in the existing pavement.
The performance of the pavement structure is highly dependent on the subsurface groundwater conditions and maintaining the subgrade and pavement structure in a dry condition. To intercept excess subsurface water within the pavement structure granular materials, sub-drains with suitable outlets should be installed below the pavement structure subgrade, if adequate overland flow drainage is not provided (i.e. ditches). The surface of the pavement should be properly graded to direct runoff water towards suitable drainage features. It is recommended that the lateral extent of the subbase and base layers not be terminated vertically immediately behind any proposed the curb/edge of pavement line but be extended beyond the curb.

9 CONSTRUCTION CONSIDERATION

The current report is considered preliminary in nature and was prepared to provide general characterisation of the soil and groundwater condition across the subdivision by means of a limited number of test pits. The purpose of the investigation was to identify any potential constraints and to provide general guidelines on the geotechnical engineering aspects for the design of the subdivision in efforts to obtain “Draft Plan” approval. Considering the size of the subdivision and that it will be developed in several phases over the course of several years, it is recommended that a specific geotechnical investigation be carried out on a per phase basis to supplement and confirm the findings and recommendations provided as part of this preliminary investigation.

The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed development do not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design. All footing areas and any engineered fill areas (if required) for the proposed subdivision should be inspected by Lascelles Engineering and Associates Ltd. to ensure that a suitable subgrade has been reached and properly prepared. The placing and compaction of any granular materials beneath the foundations (if required) should be inspected to ensure that the materials used conform to the gradation and compaction specifications.
The subgrade for the pavement areas, watermains and sewers should be inspected and approved by geotechnical personnel. In-situ density testing should be carried out on the slab on grade granular materials, pavement granular materials, pipe bedding and backfill to ensure the materials meet the specifications from a compaction point of view.

10 REPORT CONDITIONS AND LIMITATIONS

It is stressed that the information presented in this report is provided for the guidance of the designers and is intended for this project only. The use of this report as a construction document is neither intended nor authorized by Lascelles Engineering & Associates Ltd. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data as it affects their construction techniques, schedule, safety and equipment capabilities.

The professional services for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible subsurface contamination resulting from previous uses or activities at this site or adjacent properties, and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this report.

The recommendations provided in this report are based on subsurface data obtained at the specific test locations only. Experience indicates that the subsurface soil and groundwater conditions can vary significantly between and beyond the test locations. For this reason, the recommendations given in this report are subject to a field verification of the subsurface soil conditions at the time of construction.

The report recommendations are applicable only to the project described in the report. Any changes to the project will require a review by Lascelles Engineering & Associates Ltd., to ensure compatibility with the recommendations contained in this project. Any changes to the project will require a review by Lascelles Engineering & Associates Ltd., to insure compatibility with the recommendations contained in this report.
We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report or if we may be of further services to you, please do not hesitate to contact our office.

Yours truly,
Lascelles Engineering & Associates Ltd.

Mario Elie, Senior Technologist
Project Manager

Will Ball, P. Eng.
Geotechnical Engineer
Appendix A

Draft Plan of Subdivision
Appendix B

Test Pit Location Plan
Appendix C

Test Pit Logs
**SOIL PROFILE**

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>DESCRIPTION</th>
<th>ELEV.</th>
<th>SHEAR STRENGTH kPa</th>
<th>SAMPLE N.</th>
<th>Water Level (Standpipe or Open Excavation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
<td>53.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>Topsoil 300mm of dark brown clayey loam</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>Glacial Till Mix of silt, sand and gravel with some cobbles, brown in colour, compact to dense and moist.</td>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>Groundwater infiltration at the bedrock interface.</td>
<td>52.80</td>
<td></td>
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</tr>
<tr>
<td>1.5</td>
<td>Test pit terminated over bedrock.</td>
<td>51.50</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2.0</td>
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</tbody>
</table>

**COMMENTS:**
- **Easting:** 524859
- **Northing:** 5052155
- **Site Datum:** Geodetic
- **Groundsurface Elevation:** 53.1
- **Width of Excavation:** 1m
- **Length of Excavation:** 2m

**PROJECT No.:** Proposed Residential Subdivision

**LOGGED BY:** N.V.

**CONTRACTOR:** Laviolette Excavation

**EXCAVATION METHOD:** Hydraulic Shovel

**DATE:** September 03, 2015
**SOIL PROFILE**

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>DESCRIPTION</th>
<th>ELEV.</th>
<th>SHEAR STRENGTH</th>
<th>Water Level (Standpipe or Open Excavation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
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<td>kPa</td>
<td>L'Orignal, Ontario</td>
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<td>Topsoil 100mm of dark brown clayey loam</td>
<td>0.00</td>
<td></td>
<td>N.V.(9167-5637 Quebec inc.) Mr. Jean-Claude Goyer</td>
</tr>
<tr>
<td>0.5</td>
<td>Glacial Till Mix of silt, sand and gravel with some cobbles, brown in colour, compact to dense and moist.</td>
<td>50.05</td>
<td>20 40 60 80 100</td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>Groundwater infiltration at 3.0m near the bedrock interface.</td>
<td>3.20</td>
<td></td>
<td>Ground Surface</td>
</tr>
<tr>
<td>1.5</td>
<td>Test pit terminated over bedrock.</td>
<td>3.20</td>
<td></td>
<td>Topsoil 100mm of dark brown clayey loam</td>
</tr>
<tr>
<td>2.0</td>
<td>Glacial Till Mix of silt, sand and gravel with some cobbles, brown in colour, compact to dense and moist.</td>
<td>3.20</td>
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</tr>
<tr>
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<td>Glacial Till Mix of silt, sand and gravel with some cobbles, brown in colour, compact to dense and moist.</td>
</tr>
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<td>Glacial Till Mix of silt, sand and gravel with some cobbles, brown in colour, compact to dense and moist.</td>
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<td>Glacial Till Mix of silt, sand and gravel with some cobbles, brown in colour, compact to dense and moist.</td>
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<td>Glacial Till Mix of silt, sand and gravel with some cobbles, brown in colour, compact to dense and moist.</td>
</tr>
<tr>
<td>4.5</td>
<td>Glacial Till Mix of silt, sand and gravel with some cobbles, brown in colour, compact to dense and moist.</td>
<td>3.20</td>
<td></td>
<td>Glacial Till Mix of silt, sand and gravel with some cobbles, brown in colour, compact to dense and moist.</td>
</tr>
<tr>
<td>5.0</td>
<td>Glacial Till Mix of silt, sand and gravel with some cobbles, brown in colour, compact to dense and moist.</td>
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<td></td>
<td>Glacial Till Mix of silt, sand and gravel with some cobbles, brown in colour, compact to dense and moist.</td>
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**Easting:** 524745  
**Northing:** 5052035  
**Site Datum:** Geodetic  
**Groundsurface Elevation:** 53.25  
**Width of Excavation:** 1m  
**Length of Excavation:** 2m  

**COMMENTS:**
### SOIL PROFILE

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>DESCRIPTION</th>
<th>ELEV.</th>
<th>SAMPLE N.</th>
<th>SHEAR STRENGTH (kPa)</th>
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<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
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<td>-</td>
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</tr>
<tr>
<td>0.5</td>
<td>Topsoil 200mm Dark brown clayey loam</td>
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<td>-</td>
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</tr>
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<td>0.5</td>
<td>Glacial Till Mix of silt, sand and gravel with some cobbles, brown in colour, compact to dense and moist.</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1.0</td>
<td>Groundwater infiltration at the bedrock interface.</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1.5</td>
<td>Test pit terminated over bedrock.</td>
<td>52.45</td>
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<tr>
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<tr>
<td>2.5</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>3.0</td>
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<td>-</td>
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<td>-</td>
</tr>
<tr>
<td>3.5</td>
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</tr>
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<td>4.0</td>
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<tr>
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<td>-</td>
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</table>

### Water Level (Standpipe or Open Excavation)

- 0.82m (10-09-15)

### Comments:

- Test pit terminated over bedrock.

### Site Information:

- **Easting:** 524867
- **Northing:** 5052012
- **Site Datum:** Geodetic
- **Groundsurface Elevation:** 54.35
- **Width of Excavation:** 1m
- **Length of Excavation:** 2m

---

**PROJECT No.:** Proposed Residential Subdivision  
**LOGGED BY:** N.V.  
**CONTRACTOR:** Laviolette Excavation  
**EXCAVATION METHOD:** Hydraulic Shovel
### TEST PIT LOG: TP-4

**PROJECT No.:** Proposed Residential Subdivision  
**LOGGED BY:** N.V.  
**CONTRACTOR:** Laviolette Excavation  
**EXCAVATION METHOD:** Hydraulic Shovel

#### SOIL PROFILE

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>DESCRIPTION</th>
<th>ELEV.</th>
<th>SHEAR STRENGTH (kPa)</th>
<th>SAMPLE N.</th>
<th>Water Level (Standpipe or Open Excavation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
<td>53.95</td>
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<tr>
<td>0.5</td>
<td>Topsoil</td>
<td>0.00</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Dark brown clayey loam</td>
<td>53.45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>Glacial Till</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mix of sand and gravel with some silt and cobbles, brown in colour, compact, moist to saturated</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>Groundwater infiltration at 2.6m</td>
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<td>1</td>
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<tr>
<td>2.0</td>
<td>Test pit terminated over inferred bedrock.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2.5</td>
<td>End of Test Pit</td>
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<td>3.0</td>
<td>51.35</td>
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<td>3.5</td>
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<td>4.0</td>
<td>53.45</td>
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</tr>
<tr>
<td>4.5</td>
<td>53.95</td>
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</tr>
<tr>
<td>5.0</td>
<td>End of Test Pit</td>
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</table>

**Eastings:** 524775  
**Nortings:** 5051859  
**Site Datum:** Geodetic  
**Groundsurface Elevation:** 53.95  
**Width of Excavation:** 1m  
**Length of Excavation:** 2m  
**COMMENTS:**
## Soil Profile

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
<td>54.25</td>
</tr>
<tr>
<td>0.5</td>
<td><strong>Topsoil</strong>&lt;br&gt;Dark brown clayey loam</td>
<td>53.75</td>
</tr>
<tr>
<td>1.0</td>
<td><strong>Glacial Till</strong>&lt;br&gt;Mix of silt, sand and gravel with some cobbles, brown in colour near the surface becoming grey with depth, compact to dense and Moist.</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>No groundwater infiltration observed within the depth excavated.</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>Test pit terminated over inferred bedrock.</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>End of Test Pit</td>
<td>51.55</td>
</tr>
<tr>
<td>3.0</td>
<td></td>
<td>2.70</td>
</tr>
</tbody>
</table>

### Shear Strength

<table>
<thead>
<tr>
<th>Sample N.</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
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</thead>
</table>

### Water Level

(Standpipe or Open Excavation)
### Soil Profile

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
<th>Elevation</th>
<th>Shear Strength (kPa)</th>
<th>Sample N.</th>
<th>Water Level (Standpipe or Open Excavation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
<td>51.15</td>
<td>20 40 60 80 100</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>Topsoil 300mm of dark brown clayey loam</td>
<td>50.85</td>
<td>20 40 60 80 100</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td>Clay Silty, grey with reddish bands, very stiff.</td>
<td>49.35</td>
<td>110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.80</td>
<td>Glacial Till Mix of silt, sand and gravel with some cobbles, brown in colour becoming grey with depth, compact to dense, and moist.</td>
<td>47.15</td>
<td>&gt;120</td>
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</table>

No groundwater infiltration observed within the depth excavated.

**Easting:** 524937  **Northing:** 5051671
**Site Datum:** Geodetic  **Groundsurface Elevation:** 51.15
**Width of Excavation:** 1m  **Length of Excavation:** 2m

**Comments:**