# Preliminary Geotechnical Investigation
# Proposed Residential – Commercial Development
# Former PPG Industrial Site
# 545, Industriel Boulevard
# Town of Hawkesbury
# United Counties of Prescott and Russell, Ontario

Prepared for:

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LRL File No.: 120858

December 2014

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# 1 INTRODUCTION

LRL Associates Ltd. (LRL) was retained by the 8362505 Canada Inc. to conduct a preliminary geotechnical Investigation for a proposed residential and commercial development to be located at 545, Industriel Boulevard in Town of Hawkesbury, Ontario.

The purpose of this investigation was to identify and characterise the subsurface conditions at the site by means of a limited number of test pits and provide preliminary geotechnical recommendations with regard to the design of foundations for the proposed buildings. In addition, this report will also provide construction considerations and establish potential geotechnical constraints to be investigated in more detail using a borehole drilling program.

This report has been prepared in consideration of the terms and conditions noted above. Should there be any changes in the design features, which may relate to the geotechnical recommendations provided in the report, LRL Associates Ltd. should be advised in order to review the report recommendations.

# 2 SITE DESCRIPTION

The proposed multi-use subdivision will be located on the lands formerly occupied by PPG Canada Inc. that are civically known as 545, Industriel Boulevard in the Town of Hawkesbury, Ontario.

The property is currently vacant as all industrial buildings associated with the former PPG Canada Inc have been demolished. It would appear that the concrete from the foundations and floor slab of this former building have been crushed into small stockpiles across the site. Other than the area of the former buildings, which is disturbed and denuded of vegetation, the remaining of the site is primarily forested or covered with wild grasses and shrubs with the exception of a small access trail which travels along the southern and eastern portions of the property. Additionally, the eastern area of the property contains a swamp area (close to TP-7) which contains standing water.

The property has an irregular shape but would be approximately 785m wide (east-west) by 300m deep (north-south) for an approximate surface area of 23.8ha (58.8 acres). The site topography would range from approx. Elev. 70m in the east portion and sloped towards the west, where ground surface elevation would be near Elev. 60m.

## 3 PROJECT DESCRIPTION

It is our understanding that the site development plans will consist of multi-use subdivision to be constructed at this former industrial site. Although, the development plans are still very preliminary, the subdivision would include a mix of low, medium and high density residential buildings (single, semi, townhouses and apartment/condominium complexes) as well as commercial and retail uses.

At present time, it would appear that the commercial retail building would be fronting County Road 17, while the high density residential buildings would be located in the northwest corner of the site. The remainder of the site would consist of low to medium density housing (single, semi-detached, townhouses). However, there is currently very limited information is known about the development (number of storeys, underground parking, footprint, etc.) with regard to the proposed buildings at this time. As a result, this report has been written to provide general guidelines for development and feasibility which will require further investigation to fine-tune the design.

The site will be serviced with municipal services and will be connected to existing streets such as Industriel Boulevard (northwest corner), County Road 17 (south), Alexander Siversky (east) and Duplate Street (north). A stormwater management pond would be located within western limits of the site as well as a pumping station (approx. depth of 10m below ground surface).

A sketch plan (Provided by Atrel Engineering) showing the proposed multi use subdivision is presented in **Appendix A**.

## 4 PROCEDURES

The fieldwork for this preliminary investigation was carried out on November 26 and 27, 2014. The locations of the test pits had been pre-established and were located in the field by Atrel Engineering Ltd. (Atrel). Prior to the fieldwork, the site was cleared for the presence of any underground services and utilities as confirmed by the client. A total of fifteen (15) test pits, labelled TP1 to TP15, were dug across the property. The locations of the test pits on the property and the ground surface elevation were provided by Atrel and are shown on the preliminary sketch plan included in **Appendix A**.

The test pits were dug using an excavator retained by the client and operated by the Ravcon Excavation of Hawkesbury, Ontario. The depth of test pits ranged from 1.5m to 3.9m below ground surface (bgs). The depth of the test pit was dictated by either bedrock refusal or the cave-in of the sidewalls of the test pit due to groundwater. Sampling of the overburden materials encountered in the test pits was carried out by means of grab samples collected at various intervals.

The fieldwork was supervised throughout by a member of our engineering staff who oversaw the digging of the test pits, in-situ testing, cared for the samples obtained and logged the subsurface conditions encountered within each of the test pits. All soil samples collected from the test pits were placed and sealed in plastic bags to prevent moisture loss. 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. 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 at which time, they will be disposed of, unless a written or verbal notice is received, requesting otherwise.

Standpipes, consisting of 19mm diameter PVC piping, were slotted and placed in test pits prior to backfilling them. The standpipes were strictly to establish the static water level of the overburden water table.

# 5 SUBSURFACE SOIL AND GROUNDWATER CONDITIONS

## 5.1 General

A review of local surficial geology maps provided by the Department of Energy, Mines and Resources Canada suggest that the surficial geology for this area consist of glacial deposits in the forms of till plains. It is noted that organic and alluvial deposits are indicated to be present to the east of the property with bedrock outcrop to the west of the property. The bedrock formation is indicated to consist of the Rockcliffe formation, of Middle Ordovician age, which consists of interbedded quarts sandstone and shale.

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 and laboratory testing. The soil descriptions presented in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves judgement and LRL 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 B**. A greater explanation of the information presented in the test pit logs can be found in **Appendix D** of this report. These logs indicate the subsurface conditions encountered at a specific test location only. Boundaries between zones on the logs are often not distinct, but are rather transitional and have been interpreted as such.

## 5.2 Topsoil

All test pit dug within undisturbed areas of the site encountered a layer of topsoil at the surface. The topsoil layer is generally thin and ranges from about 150mm to 300mm. It is described as a dark brown sandy loam.

The soil described as topsoil was based on visual and textural observations made in the field. Consequently, the use of this material described as topsoil cannot be relied upon in regard to vegetation growth for landscaping.

## 5.3 Peat

Peat was encountered within TP-7 only which was conducted at the edge of the swamp found in the east part of the property. The peat is black and is highly organic. The thickness of the peat in the test pit was found to be 0.3m however experience suggests that the peat deposit is likely thicker within the centre of the swamp. It is suggested that a borehole or test pit be completed within the centre of the swamp to delineate the peat thickness in the middle.

## 5.4 Fill

Fill was encountered in TP2, TP3, TP4, TP8 and TP11, directly at the surface. The fill is generally described a mixed of sand, crushed stone with some stones, cobbles, boulders (0.6m diameter) and organic in areas. The fill is generally brown to greyish brown in colour and in a loose state of packing. The fill was found in the areas of the former buildings. The fill extends from the surface and down to 0.6m to 2.1m bgs and was found resting directly over bedrock in TP4, over glacial till in TP8 and over sand in TP2, TP3 and TP11.

## 5.5 Silty Sand to Sand-Silt

A silty sand to sand-silt deposit was encountered in several test pits across the site. The deposit is described as uniform, fine grained to silty to a sand-silt, with very little cohesion, brown in colour to greyish brown with depth, in a compact stated (estimated) but is very sensitive below the water table.

The thickness of this deposit varies across the site ranging from 0.6m to over 3.5m bgs. The full depth of the deposit could not be established in several test pits due to the cave-in as result of the groundwater. The sand layer was confirmed to be resting over glacial till in several of the test pits.

Two (2) samples representative of the soil type were submitted for laboratory testing to the Stantec Laboratories, an accredited material testing laboratory, in order to perform gradation analysis with washing on the 75 µm sieves. The following **Table 1** presents a summary of the analysis results, while the laboratory reports are presented in **Appendix C.**

**Table 1: Laboratory Analysis Summary**

| Test Pit | No. | Depth (m) | Percent for each soil gradation | | | K (cm/s) |
|---|---|---|---|---|---|---|
| | | | Gravel (%) | Sand (%) | Silt and Clay (%) | |
| TP-1 | 1 | 1.5 | 0.1 | 47.6 | 52.3 | $6.12 \times 10^{-4}$ |
| TP-9 | 1 | 2.4 | 1 | 74.9 | 25.1 | $8.76 \times 10^{-4}$ |

The gradation analyses revealed that the deposit to contain 0.1 to 1 percent of gravel, 47.6 to 74.9 percent of sand and 25.1 to 52.3 percent of silt and clay. According to the Unified Soil Classification System, this soil deposit can be classified as SM (Silty sand – sand-silt mixture).

The estimated hydraulic conductivity (K) was established based on the relationship with the mean grain size; $D_{50}$ and $D_{10}$ (Alymani and Şen, 1993). Accordingly, the estimated hydraulic conductivity of this soil unit ranges from $6.12 \times 10^{-4}$ to $8.76 \times 10^{-4}$ cm/s (0.53 to 0.76m/day).

## 5.6 Glacial Till

Glacial till was encountered in all test pits, except TP1, TP2, TP4, TP9, TP11 and TP12. In general, the glacial was found underlying the sand deposit and where glacial till was not encountered, the noted test pit where terminated within the sand deposit. The till is described as silty sand with gravel, some cobbles and pieces of shale rock near the bedrock interface. It is noted that in some test pits, very large boulders or rock slabs (greater than 3m in size) were encountered. The till is generally grey in colour and in a compact state (estimated). The thickness of till layer varies across the site and ranges approximately between 0.45m to over 3.3m thick. Only TP3 and TP15 were terminated within the till without reaching the bedrock formation due to cave-in.

A representative sample of the glacial till was submitted for laboratory testing to the Stantec Laboratories, an accredited material testing laboratory, in order to perform gradation analysis with washing on the 75 µm sieves. The laboratory report is presented in **Appendix C.**

The gradation analyses revealed that the matrix of the till to be well graded; composed of 47.4 percent of gravel, 35.8 percent of sand and 16.8 percent silt and clay. The estimated hydraulic conductivity (K) was established based on the relationship with the mean grain size; D50 and D10 (Alymani and Şen, 1993). Accordingly, the estimated hydraulic conductivity of the till would be approximately 1.20 x 10-2 cm/s (10.3m/day).

## 5.7 Refusal/Bedrock

Refusal over bedrock was encountered in all test pit carried across the site, except for TP1, TP2, TP3, TP9, TP11 and TP15, which were all terminated prior to reaching any refusal due to cave-in. These test pits were all dug in the middle portion of the site, except for TP15, which is dug in the southeast corner of the site. In these areas, the bedrock would be located at depths greater than 3.0m bgs.

In the western portion of the site as well as in the middle-eastern portion of the site, the bedrock is found within 1.5m bgs or shallower. The bedrock appears to be weathered on the surface and mostly composed of shale.

## 5.8 Groundwater

It is noted that during the excavation of the test pit, water seepage and infiltration were noted in numerous test pits and mostly within the silty sand layer but also from the glacial till bedrock interface.

The presence of groundwater was established by installing standpipes in TP-2, TP3, TP6, TP8, TP11, TP12 and TP15 prior to backfilling them. The static water levels were measured using a water meter on December 9, 2014 and are shown on the test pit logs presented in **Appendix B**.

Based on the static water level measurements, there is a shallow overburden water table present at this site and located close to the surface, as it is generally found within the first 1.0m bgs. Based on the established static groundwater elevations, the flow direction of the shallow water table is towards the west to southwest and follows the general topography of the terrain. It is noted however that shallow overburden water table can be also locally affected by the presence of existing ditches and underground services trenches as well as the presence of pervious fill material, which acts as local storage area during wet conditions. It is noted however that the site lacks surficial drainage, especially in its eastern portion, where wetland like conditions were observed that also supports a high water condition.

Due to the time constraints imposed by the project, the seasonal trend of the groundwater could not be established. It is noted however that the fall was relatively wet and consequently, the measurements obtained are expected to represent a high water condition. It should be noted that groundwater levels could fluctuate with seasonal weather conditions (i.e.: rainfall, droughts and spring thawing).

## 6 GEOTECHNICAL RECOMMENDATIONS

As outlined in **Section 3**, it is our understanding that the site development plans will consist of multi-use subdivision to be constructed at this former industrial site. Although, the development plans are still very preliminary, the subdivision would include a mix of low, medium and high density residential buildings (single, semi, townhouses and apartment/condominium complexes) as well as commercial and retail uses.

At present time, it would appear that the commercial retail building would be fronting County Road 17, while the high density residential buildings would be located in the northwest corner of the site. The remaining of the site would consist of low to medium density housing (single, semi-detached and townhouses). However, the very limited information is currently known (number of storeys, underground parking, footprint, etc.) with regard to the proposed buildings at the time of this report.

The site will be serviced with municipal services and will be connected to existing streets such as Industriel Boulevard (northwest corner), County Road 17 (south), Alexander Siversky (east) and Duplate Street (north). A stormwater management pond would be located within western limits of the site as well as a pumping station (approx. depth of 10m below ground surface).

It is understood that the recommendations provided herein are preliminary in nature and will require additional fieldwork to confirm some of the assumptions and parameters used in providing these recommendations as well as more details with regard to the development of this site.

## 6.1 Foundation Design

Based on the subsurface soil conditions encountered across this large site, there is the possibility of founding the various building structure on several founding stratum, which will be discussed hereafter.

### Silty Sand to Silt-Sand Deposit

Conventional strip and column footings set over the native undisturbed sand deposit or properly prepared and approved structural fill may be designed using a maximum allowable bearing pressure of **75kPa** for serviceability limit state (**SLS**) and **110kPa** for ultimate limit state (**ULS**) factored bearing resistance. The allowable bearing capacity is based on a minimum footing width of 0.5m for strip footings and/or 1.0m for pad footings on any sides. The bearing capacity is also contingent on founding the footing 0.3m above the water table. There are no grade raise restrictions when founding over the sand deposit.

The above recommendations are provided on assuming that the sand deposit is in a compact stated over its entire depth and consequently not prone to liquefaction. This will need to be established/confirmed by conducting a borehole drilling program.

### Glacial Till Deposit

In the areas, where glacial till was encountered near the surface, conventional strip and column footings set over the native undisturbed glacial till deposit or properly prepared and approved structural fill may be designed using a maximum allowable bearing pressure of **150kPa** for serviceability limit state (**SLS**) and **250kPa** for ultimate limit state (**ULS**) factored bearing resistance. The allowable bearing capacity is based on a minimum footing width of 0.5m for strip footings and/or 1.0m for pad footings on any sides. The bearing capacity is also contingent on founding the footing 0.3m above the water table. There is no allowable grade raise restriction for founding over the sand deposit

In the event that the glacial till contain numerous stones and cobbles at the founding depth, a uniform founding layer in the form of 150mm of OPSS Granular A bedding will be required in order to limit any punctual loading. The placing and compaction of this bedding layer, if required, will be in accordance with **Section 6.2**. Furthermore, the footing for a specific building must rest entirely over glacial till and not rest over two different founding strata (sand and till) in order to limit differential settlements.

### Shallow Bedrock Foundations

In the areas, where bedrock was encountered near the surface, conventional strip and column footings set over the relatively sound bedrock and below any highly weathered bedrock will be acceptable. The footings set over relative sound bedrock may be designed using a maximum allowable bearing pressure of **300kPa** for serviceability limit state (**SLS**) and **300kPa** for ultimate limit state (**ULS**) factored bearing resistance. The allowable bearing capacity is based on a minimum footing width of 0.4m for strip footings and/or 0.75m for pad footings on any sides.

It is recommended that the underside of the footing be set at 0.3m above the established groundwater table. There is no allowable grade raise restriction for founding over the bedrock formation. Furthermore, the footing for a specific building must rest entirely over bedrock and not two different founding strata (bedrock and till) in order to limit differential settlements

Based on other projects conducted in this area, the bedrock could contain shale, which may become fissiled upon drying or exposed for prolong periods, it is therefore recommended that a minimum 50mm mud slab be placed as soon as possible (within 24-hours following initial exposure) over any exposed bedrock surface. In areas that may have structures founded over bedrock, it is recommended that a borehole be completed within the footprint of the building in order to characterize the quality of the bedrock as well to allow for rock anchor design should they be required.

### Deep Bedrock Foundations

Consideration could also be given on supporting the proposed larger buildings on shallow caissons set below any highly weathered bedrock overlying relatively sound bedrock. These types of foundations could be considered, where the sand deposit was found to be thick (greater than 3.0m). The caisson would need to be set into the relative sound bedrock at a minimum depth of 1.5m.

Caissons founded on relatively sound bedrock can be designed using a tip bearing resistance of 1.0MPa for serviceability limit state (SLS) and 1.5MPa for ultimate limit state (ULS) factored bearing resistance.

The above recommendations are provided based on other project in the area and on assuming that the bedrock is of suitable quality. This will need to be established by conducting a borehole drilling program at the locations where caisson would be considered.

## 6.2 Structural Fill

Any excavations below the underside of footing for the proposed buildings to be founded on relatively sound bedrock should be backfilled using lean concrete only, having a minimum compressive strength of 10 MPa at 28 days.

For foundations set over soil and where excavation below the underside of the footing is performed in order to reach a suitable founding stratum, considerations should be given to support the footings on structural fill. The structural fill should be placed over undisturbed native soils in layers not exceeding 200mm and compacted to 98% of its Standard Proctor Maximum Dry Density (SPMDD). In order to allow the spread of load beneath the footings and to prevent under mining during construction, the structural fill should extend 1m beyond the outside edges of the footings and then outward and downward at 1 horizontal to 1 vertical profile (or flatter) over a distance equal to the depth of the structural fill below the footing. The material used as structural fill to support the footings should consist of imported granular material meeting Ontario Provincial Standards Specifications (OPSS) requirements for a Granular B Type II, or an approved equivalent material.

Prior to placing any structural fill or pouring the footings, any disturbed soils along the base within the footings' area should be removed and that the subgrade soils should be inspected and approved by the geotechnical engineer. The structural fill should be tested to ensure that the specified compaction level is achieved.

## 6.3 Settlement

Provided that any loose and/or disturbed soil is removed from the bearing surfaces prior to pouring concrete or placing of structural fill, foundations set over native overburden deposits, or structural fill designed using the recommended serviceability limit state capacity value, the total settlement will be less than 25mm. The differential settlement between adjacent column footings is anticipated to be 15mm or less.

Provided that the footings are founded below any highly weathered portion of the bedrock and on relatively sound bedrock, the estimated total settlement of the foundations founded over bedrock designed using the recommended serviceability limit state capacity value is less than 15mm. The differential settlement between adjacent column footings is anticipated to be 0.75 of the maximum settlement value given or less.

In the event that not all buildings are constructed at the same time and are to be joined together, a full construction joint should be provided between all existing building structures and all proposed future additions.

## 6.4 Seismic

Based on the results of this limited geotechnical investigation, the site can be classified for all structure founded over native overburden would be a Class "D" as per the Site Classification for Seismic Site Response in accordance with the latest version of the

Ontario Building Code. For buildings founded directly over the bedrock, the site class would be a Class “C”.

It is noted that a greater seismic site response class may be obtained by carrying out deep boreholes or conducting a seismic velocity testing using a multichannel analysis of surface waves (MASW).

The above recommendations are provided based on other projects and assumptions. This will need to be established/confirmed by conducting a borehole drilling program.

### 6.5 Potential for Soil Liquefaction

For buildings founded over the glacial till or the bedrock, the potential of soil liquefaction is not considered to be a concern. However, with regard to the silty sand to silt-sand, the potential for soil liquefaction can only be determined from conducting a borehole drilling program.

### 6.6 Frost Protection

Frost protection is not required for footings founded directly over relatively sound bedrock. For exterior footings and any footings located in unheated portions of the building founded over soil or weathered bedrock should be protected against frost heaving by providing a minimum of 1.5m of earth cover under snow covered surface or 1.7m under exposed surfaces (i.e. sidewalks, paved areas, etc.), or its equivalent in insulation protection. LRL should review the detailed design of frost protection with the use of equivalent insulation prior to construction if this option is chosen.

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 temperatures 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.

## 6.7 Foundation Backfill

To prevent possible foundation frost jacking and lateral loading, the backfill material against any foundation walls, grade beams, isolated walls, or piers, should consist of free draining, non-frost susceptible material such as sand or sand and gravel meeting OPSS Granular B Type I grading requirements.

The foundation wall backfill should be compacted to 90% of its SPMDD using light compaction equipment, where no loads will be set over top. The compaction shall be increased to 95% under walkways, slabs or paved areas close to the foundation or retaining walls. Where foundation wall are required to be backfilled on both sides, the backfilling operations should be carried out progressively on both sides of the walls.

Where foundation walls are located adjacent to an exposed rock face, the exterior face of the wall should be entirely covered with a deformable material (i.e. 50mm extruded polystyrene) to limit lateral pressure on the wall created by the backfill material during placement and compaction. Increased earth pressures due to compaction equipment should be considered in the structural design of the walls, as recommended in Figure 24.9, of the Canadian Foundation Engineering Manual, 2006.

## 6.8 Foundation Drainage

Permanent perimeter drainage is only required for buildings where basements or whenever any open spaces located below the finish ground are being considered. The drainage pipe (100mm minimum) should 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.

Regardless of whether perimeter drainage is required, roof water should be controlled by a roof drainage system that directs water away from the building to prevent ponding of water adjacent to the foundation wall. The exterior grade should be sloped away from the building to promote water drainage away from the foundation walls.

## 6.9 Slab-on-Grade Construction

For predictable performance, the concrete slab-on-grade construction will only be acceptable over the native sand, glacial till or bedrock. Therefore, all organic, fill material, deleterious or otherwise objectionable materials encountered shall be removed from the buildings' footprint. The exposed native subgrade surface should then be inspected and approved by geotechnical personnel.

Any underfloor fill needed to raise the general floor grade to the underside of concrete slab shall consist of Granular B Type I material, or an approved equivalent, compacted to 95% of its SPMDD. The final lift shall be compacted to 98% of its SPMDD. Where bedrock will constitute the subgrade and in order to prevent any loss of fines, the underfloor fill will consist of Granular B Type I material, or an approved equivalent, placed and compacted as previously described. A 200 mm layer of Granular A material shall be placed under the slab and compacted to at least 98% of the SPMDD. Any exposed bedrock should be covered with a mud slab as explained previously.

The modulus of subgrade reaction (ks) for the design of the slabs over native sand, glacial, structural fill or bedrock soil is 18 MPa/m.

In order to minimize and control cracking, the floor slab should be provided with wire mesh reinforcement and construction or control joints. The construction or control joints should be spaced equal distance in both directions and should not exceed 4.5 m. The wire mesh reinforcement shall be carried through the joints.

## 6.10 Retaining Walls and Shoring

The following **Table 2** 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 ($K_o$) should be used.

**Table 2: Material Properties for Shoring and Permanent Wall Design (Static)**

| Type of Material | Bulk Density ($kg/m^3$) | Pressure Coefficient | |
|---|---|---|---|
| | | Active (Ka) | At Rest (Ko) |
| Clay | 18 | 0.45 | 0.80 |
| Sand | 19 | 0.33 | 0.50 |
| Till | 22 | 0.27 | 0.50 |
| Granular B Type I | 20 | 0.33 | 0.50 |
| Granular B Type II | 23.1 | 0.31 | 0.47 |
| Granular A | 23.5 | 0.27 | 0.43 |

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 structure provided it is founded over sand, glacial till, properly prepared and approved structural fill, or relatively sound bedrock.

Retaining walls should also be designed to resist the earth pressures produces under seismic conditions. The Canadian building code recommends the used 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;

$P_{AE} = ½\ K_{AE}\ γ\ H^2\ (1-k_V)$
$P_{PE} = ½\ K_{PE}\ γ\ H^2\ (1-k_V)$
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
γ = bulk density ($kg/m^3$)

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 = Zonal acceleration ratio = 0.2

$K_h$ = Horizontal acceleration coefficient = 0.1

$K_V$ = Horizontal acceleration coefficient = 0.067

The above value of $K_h$ corresponds to ½ 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 $0^o$ to provide a conservative estimate.

The following **Table 3** provides the parameters for seismic design of retaining structures.

**Table 3: Material Properties for Shoring and Permanent Wall Design (Seismic)**

| Parameter | OPSS Granular B Type I | OPSS Granular A and Granular B Type II |
|---|---|---|
| Bulk Unit Weight, γ (kN/m$^3$) | 20 | 23.3 |
| Effective Friction Angle (degrees) | 30 | 32 |
| Angle of Internal Friction Between wall and Backfill (degrees) | 0 | 0 |
| **Yielding Wall** | | |
| Active Seismic Earth Pressure Coefficient ($K_{AE}$) | 0.37 | 0.33 |
| Height of the Application of $P_{AE}$ from the base of the wall as a ration of its height (H) | 0.36 | 0.37 |
| Passive Seismic Earth Pressure Coefficient ($K_{PE}$) | 3.06 | 3.48 |
| Height of the Application of $P_{PE}$ from the base of the wall as a ration of its height (H) | 0.30 | 0.30 |

# 7 POTENTIAL OF CORROSIVE ENVIRONMENT

## 7.1 Sulphate Attack on Buried Concrete

No chemical analysis were conducted at this time but should be confirmed as part of the borehole drilling program. However based on other projects conducted in this area, buried concrete for footings and foundations walls generally do not require any special additive to resist sulphate attack and the use of normal Portland cement is acceptable.

### 7.2 Corrosivity Analysis for Buried Steel

No chemical analysis were conducted at this time but should be confirmed as part of the borehole drilling program. However based on other projects conducted in this area, corrosion protection for buried steel should not require any special or specific corrosion protection measures with respect to cast iron pipes.

## 8 EXCAVATION AND BACKFILLING REQUIREMENTS

### 8.1 Excavation Requirements

Most of the shallow overburden excavation at this site will be through topsoil, various thickness of loose fill, silt-sand and glacial till deposits. Considering the high water table found at this site, most of these soils are located below the water table.

According to the Ontario's Occupational Health and Safety Act (OHSA), O. Reg. 213/91 and its amendments, the surficial overburden soil expected 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. If excavation occurs into saturated soil or if the water table is not lowered below the depth of the excavation, the soil should be classified as Type 4 and as such would require to slope the excavation to 3 horizontal to 1 vertical or shallower from the base of the excavation.

Any excavated material stockpiled near an excavation or trench should be stored at a distance equal to or greater than the depth of the excavation/trench and construction equipment traffic should be limited near any open excavation.

It 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 2 and 3** in **Section 6.10** for use in the design of any shoring structures.

Rock excavation will likely be required for the installation of some underground services and could be possible for some building structures, especially in the eastern and western portions of the site, where the bedrock was found to be relatively shallow. It is also our understanding that a 10m deep pumping station may be required for this subdivision. At this time, the depth and extent of the rock excavation is not known.

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. As encountered within the test holes performed at this site, it is possible that very large boulders (greater than 3m 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.

Once the extent and depth of the potential rock excavation are established, it is recommended that a borehole drilling program be conducted to establish the rock quality, especially for the deep structures.

## 8.2 Groundwater Control

Groundwater seepage and infiltration entering shallow and temporary excavations (less than 3.0m) performed within the overburden 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 should be noted that large volume pumps may be required in the more pervious till deposit (K: $10^{-2}$ cm/s) found on the site, should deep excavations extend within this deposit. This would also apply for deep excavation within the bedrock formation, where shallow bedrock aquifer could be encountered.

Once the extent and depth of the potential rock excavation are established, it is recommended that a borehole drilling program be conducted to establish the potential of groundwater control, especially for the deep structures.

It is anticipated that the invert of the watermain and sewers will be founded below the water table over most of the project. Although the sand and glacial till are anticipated to be compact, they are nevertheless very 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.

Should deeper excavations within the overburden or the bedrock be anticipated as part of this development, it is recommended that a more detail investigation be carried out on these locations with regard to potential groundwater constraints, pumping and permit requirements.

## 8.3 Pipe Bedding Requirements

It is anticipated that the underground services required as part of this project will be founded over native sand, glacial till or bedrock. Alternately, underground services may be founded over properly prepared and approved structural fill, where excavation below the invert is required. Consequently all organic and fill material should be removed down to a suitable bearing layer. Any sub-excavation of disturbed soil should be removed and replaced with a Granular B Type II laid in loose lifts of no more than 200mm thick and compacted to 95% of SPMDD.

Bedding, thickness of cover material and compaction requirements for watermains and sewers 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 Town of Hawkesbury.

It is anticipated that the watermain and sewers will be founded below the groundwater table. Where sand or glacial till will constitute the founding soil and is located below the groundwater, it 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 150mm below the base of the excavation at all time during the installation of the watermain.

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% of the standard Proctor maximum dry density (SPMDD) using suitable vibratory compaction equipment.

## 8.4 Trench Backfill

All service trenches should be backfilled using acceptable and compactable material, free of organics, debris and large cobbles or boulders. Acceptable native materials should be used as backfill between the roadway subgrade level and the depth of seasonal frost penetrations (i.e. 1.8 metres below finished grade) in order to reduce the potential for differential frost heaving. Where native backfill is used, it should match the native materials exposed on the trench walls. Any boulders larger than 300 millimetres in size should not be used as trench backfill. Backfill below the zone of seasonal frost penetration could consist of either acceptable native material or imported granular material conforming at minimum 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 backfill material should be compacted in maximum 300mm thick lifts to at least 95% 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.

For trench carried out in already paved areas (connecting to existing streets), transitions should be constructed to ensure that proper compaction is achieved between any new pavement structure and the existing pavement structure to minimise potential future differential settlement between the existing and new pavement structure. The transition should start at the subgrade level and extend to the underside of the asphaltic concrete level (if any) at a 1 horizontal to 1 vertical slope. This is especially important where trench boxes are used and where no side slopes is provided to the excavation. Where asphaltic concrete is present, it should be cut back to a minimum of 150mm from the edge of the excavation to allow for proper compaction between the new and existing pavement structures.

## 8.5 Suitability of On-site Soils

The existing overburden consists mostly of silty sand to silt-sand and glacial till. These soils are considered to be frost susceptible and should not be used as backfill material directly against foundation walls or underneath concrete slabs. Any waste material encountered in the excavation should be sorted from the fill and be transported to the local landfill.

The existing overburden soil could be reused as general backfill material (service trenches, general landscaping/backfilling), if the material can be compacted according to the specifications outlined herein at the time of construction.

Based on our knowledge of the area, 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 depend on its water content at the time of its use and on the weather conditions prevailing prior and during that time. Therefore, all excavated materials to be reused should be stockpiled in a manner that will minimise any significant changes in its moisture content, especially during wet conditions. Any excavated materials proposed for reuse as part of this project should be stockpiled in order to allow the material to be properly inspected and approved prior to reuse by a geotechnical engineer.

# 9 PAVEMENT DESIGN

It is anticipated that the subgrade soils for the new parking, access road and streets will consist mostly of silty sand and glacial till and potential bedrock in localised areas. The construction of access road and parking areas will be acceptable over these subgrade soils once that all debris, organic material, objectionable fill or otherwise deleterious material are removed from the subgrade. It is noted that for the existing fill area, the fill will need to be compacted and proof roll to be considered acceptable prior to placing the pavement structure. For areas where the subgrade will consist of silt-sand, a non-woven geotextile as per OPSS 1860 - Type I will be placed over the entire subgrade prior to placing any granular pavement structure. For areas where the subgrade will consists of native glacial till, the presence of cobbles and boulders will be treated as per OPSD 204.010.

The following are the recommended pavement structures for light and heavy duty access roads, and parking areas proposed as part of this project.

For light vehicle parking areas and access lanes, the pavement should consist of:

50 millimetres of hot mix asphaltic concrete (HL3) over
150 millimetres of OPSS Granular A base over
300 millimetres of OPSS Granular B Type II subbase

For heavy duty access roads, the pavement should consist of:

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

The base and sub base 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.

Asphaltic concrete should conform to OPSS Form 1150 and be placed and compacted to at least 97% of the Marshall Density. The mix and its constituents should be reviewed, tested and approved by a geotechnical engineer prior to delivery to the site.

### 9.1 Paved Areas and Subgrade Preparation

The proposed access lanes and parking areas should be stripped of vegetation, 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% of its SPMDD using suitable compaction equipment.

The preparation of subgrade should be scheduled and carried out in manner so that a protective cover of overlying granular material is placed as quickly as possible. Frost protection of the surface should be implemented if works are carried out during the winter months.

The recommended pavement structures will be adequate over an acceptable and stable subgrade. 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 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 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 the curb/edge of pavement line but be extended beyond the curb.

Transitions should be constructed between new and existing pavement structures where new parking/access lanes will meet with existing paved areas. In areas where the new pavement will abut existing pavement, 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

Where the existing asphaltic concrete surface of a parking/roadway is affected by the excavating process, the damaged zones should be saw cut and any damaged or loose pieces of asphaltic concrete should be removed down to the binder course or its entire depth, where only one layer exist. The existing base should be scarified and proof-rolled with any soft areas excavated and replaced to the proper level with OPSS Granular A. Where two layers of asphalt exist on an access lane, the surface course should be grinded over a width of 150mm to allow the new surface course to overlap the binder layer and not create one straight vertical joint. On existing streets, the overlap should be increased to 300mm.

Where applicable, frost tapers should be completed in accordance with the specifications given in OPSS 1010.

## 10 INSPECTION SERVICES

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 for the proposed addition should be inspected by LRL 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 and slab-on-grade should be inspected to ensure that the materials used conform to the grading and compaction specifications.

The subgrade for the pavement areas, watermain and sewers should be inspected and approved by geotechnical personnel. In-situ density testing should be carried out on the pavement granular materials and pipe bedding and backfill to ensure the materials meet the specifications from a compaction point of view.

## 11 RECOMMENDED BOREHOLE DRILLING PROGRAM

As discussed herein, the geotechnical report is preliminary in nature and provides general and preliminary recommendations for the developer and his design team to make informed decision on the layout and design of this multi-use subdivision. As noted, some parameters and recommendations provided herein were made from assumptions and based on other project conducted in the area and will need to be confirmed from field testing. Consequently, we are recommendation a borehole drilling program that would address the following;

1. Established the full depth and state of packing of the silty sand to silt-sand deposit in the areas of the site, where it was found to extend below 3.0m bgs in order to confirm if this soil layer would be prone to liquefaction.
2. Should caisson type foundation be considered, the depth and the quality of the bedrock will need to be characterise in those areas.
3. Should deep excavation be required in the bedrock or remain open for a prolonged period, the quality of the bedrock will need to be established as well as the need for groundwater control. This would also involve testing the hydraulic conductivity of the bedrock.
4. The hydraulic conductivity of the overburden (silty sand and glacial till deposits) should also be confirmed from in-situ testing via monitoring wells
5. The Site Classification for Seismic Site Response for foundation resting over native overburden will need to be confirmed.

## 12 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 or its use by a third party other than the client specifically listed in the report is neither intended nor authorized by LRL 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 surface and/or deep 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. Boundaries between zones presented on the logs are often not distinct but transitional and were interpreted. 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 LRL Associates Ltd. to ensure compatibility with the recommendations contained in this project.

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 the undersigned.

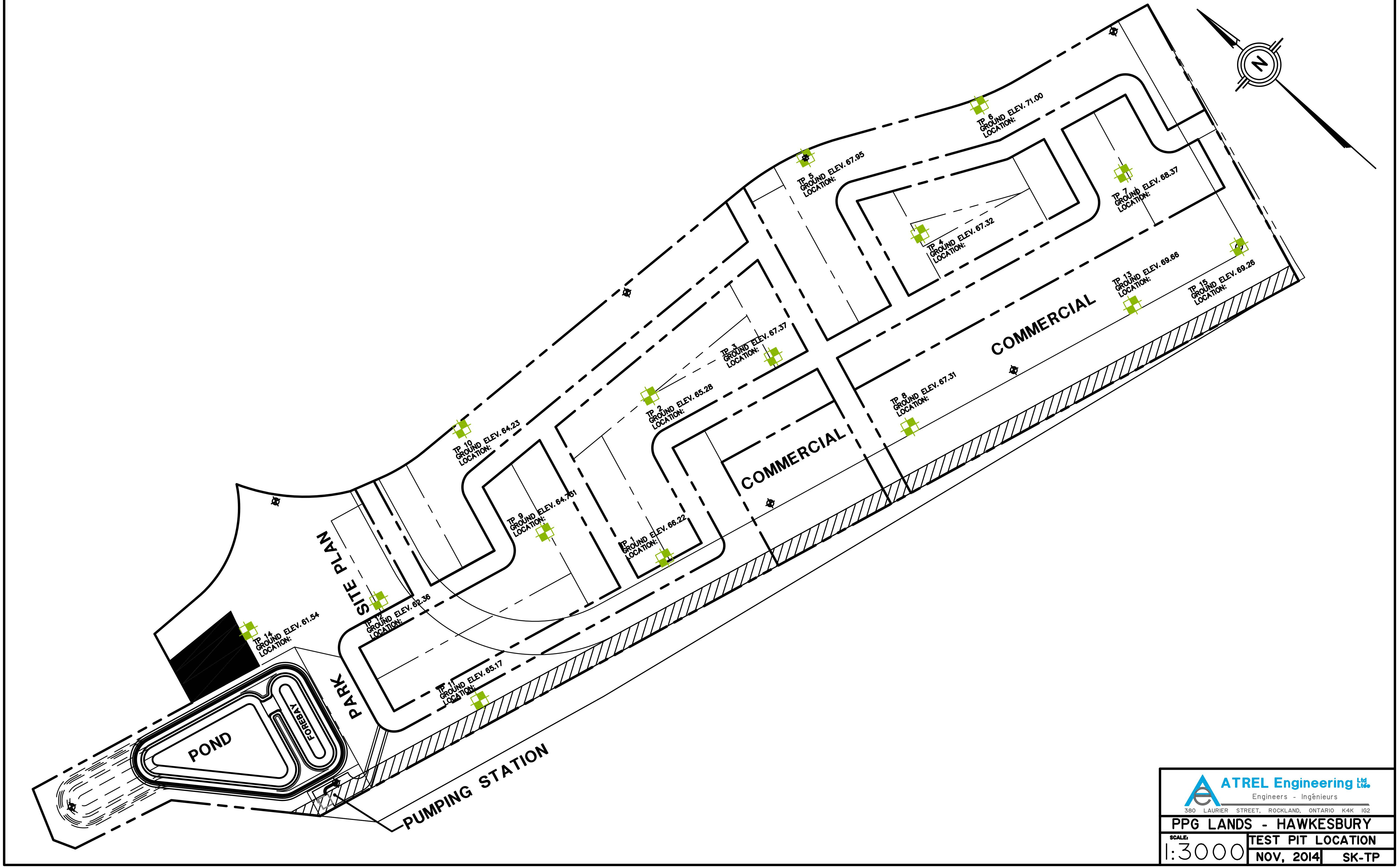
**Yours truly,**
**LRL Associates Ltd.**

Mario Elie, Senior Technologist
Project Manager

Will Ball, P. Eng.
Project Geotechnical Engineer

# APPENDIX A

# TEST PIT LOCATION PLAN



ATREL Engineering Ltd Ltée
Engineers - Ingénieurs
380 LAURIER STREET, ROCKLAND, ONTARIO K4K IG2

PPG LANDS - HAWKESBURY

SCALE:
1:3000

TEST PIT LOCATION

NOV, 2014

SK-TP

# APPENDIX B

# TEST PIT LOGS

# Test Pit Log: TP1

**Project No.:** 120858

**Project:** Hawkesbury PPG Lands Development

**Client:** Asco Construction Ltd.

**Location:** Hawkesbury, Ontario

**Date:** November 26, 2014

**Field Personnel:** W.B.

**Excavation Method:** Hydraulic Shovel

**Excavation Contractor:** Ravcon Excavation

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|
| **Depth** | **Soil Description** | **Elev./Depth (m)** | **Sample Number** | **Shear Strength** (kPa) 50 150 | **Water Content** (%) ▽ 25 50 75 ▽<br>**Liquid Limit** (%) □ 25 50 75 □ | **Water Level (Standpipe or Open Excavation)** |
| ft m 0 0 | Ground Surface | 66.22<br>0.00 | | | | |
| | **TOPSOIL**<br>150mm, Dark brown sandy loam | | | | | |
| | **SAND**<br>Fine grained to silty to sand-silt, brown in colour becoming greyhish brown with depth, moist becoming wet with depth, compact. | | | | | |
| | Test pit terminated due to cave-in. | | | | | |
| | End of Test Pit | 62.92<br>3.30 | | | | |

ft: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

m: 0 1 2 3 4 5

**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 66.22

**Top of Riser Elev.:** 66.22

**Excavation Width:**

**Excavation Length:**

**NOTES**:

# Test Pit Log: TP2

**Project No.:** 120858

**Project:** Hawkesbury PPG Lands Development

**Client:** Asco Construction Ltd.

**Location:** Hawkesbury, Ontario

**Date:** November 26, 2014

**Field Personnel:** W.B.

**Excavation Method:** Hydraulic Shovel

**Excavation Contractor:** Ravcon Excavation

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|
| **Depth** | **Soil Description** | **Elev./Depth (m)** | **Sample Number** | **Shear Strength** (kPa) 50 150 | **Water Content** (%) 25 50 75<br>**Liquid Limit** (%) 25 50 75 | **Water Level (Standpipe or Open Excavation)** |
| | Ground Surface | 65.28<br>0.00 | | | | |
| | **FILL**<br>Crushed stone with some cobbles. | | | | | 0.61m (09-12-14) ▼ |
| | **SAND**<br>Fine grained to silty to sand-silt, brown in colour becoming greyish brown with depth, moist becoming wet with depth, compact<br><br>Test pit terminated due to cave-in at glacial till interface. | 64.68<br>0.60 | | | | |
| | End of Test Pit | 62.28<br>3.00 | | | | |

**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 65.28

**Top of Riser Elev.:** 65.28

**Excavation Width:**

**Excavation Length:**

**NOTES**:

# Test Pit Log: TP3

**Project No.:** 120858

**Project:** Hawkesbury PPG Lands Development

**Client:** Asco Construction Ltd.

**Location:** Hawkesbury, Ontario

**Date:** November 26, 2014

**Field Personnel:** W.B.

**Excavation Method:** Hydraulic Shovel

**Excavation Contractor:** Ravcon Excavation

## SUBSURFACE PROFILE

## SAMPLE DATA

| Soil Description | Elev./Depth (m) | Sample Number |
|---|---|---|
| Ground Surface | 67.37<br>0.00 | |
| **FILL**<br>crushed stone with some cobbles. | 66.77<br>0.60 | |
| **FILL**<br>Fine to medium grained sand, brown in colour, with some cobbles, loose. | 66.17<br>1.20 | |
| **SAND**<br>Fine grained to silty to sand-silt, brown in colour becoming greyish brown with depth, wet, compact | 64.97<br>2.40 | 1 |
| **GLACIAL TILL**<br>Silty sand with gravel, cobbles and boulders, grey in colour, wet, compact<br>Test pit terminated due to cave-in. | 64.07<br>3.30 | |
| End of Test Pit | | |

Depth: ft, m

**Shear Strength** (kPa) 50 150

**Water Content** ▽ (%) ▽ 25 50 75

**Liquid Limit** □ (%) □ 25 50 75

**Water Level (Standpipe or Open Excavation)**

0.45m (09-12-14)

**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 67.37

**Top of Riser Elev.:** 67.37

**Excavation Width:**

**Excavation Length:**

**NOTES**:

## Test Pit Log: TP4

**Project No.:** 120858

**Project:** Hawkesbury PPG Lands Development

**Client:** Asco Construction Ltd.

**Location:** Hawkesbury, Ontario

**Date:** November 26, 2014

**Field Personnel:** W.B.

**Excavation Method:** Hydraulic Shovel

**Excavation Contractor:** Ravcon Excavation

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|
| Depth | Soil Description | Elev./Depth (m) | Sample Number | Shear Strength (kPa)<br>50 150 | Water Content ▽ (%) ▽<br>25 50 75<br>Liquid Limit □ (%) □<br>25 50 75 | Water Level (Standpipe or Open Excavation) |
| ft 0 / m 0 | Ground Surface | 67.32<br>0.00 | | | | |
| | **FILL**<br>Crushed stone at the surface followed by sand mixed with gravel and cobbles.<br>Test pit terminated over bedrock. | | | | | |
| | End of Test Pit | 65.82<br>1.50 | | | | |

ft: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

m: 0 1 2 3 4 5

**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 67.32

**Top of Riser Elev.:** 67.32

**Excavation Width:**

**Excavation Length:**

**NOTES**:

# Test Pit Log: TP5

**Project No.:** 120858

**Project:** Hawkesbury PPG Lands Development

**Client:** Asco Construction Ltd.

**Location:** Hawkesbury, Ontario

**Date:** November 26, 2014

**Field Personnel:** W.B.

**Excavation Method:** Hydraulic Shovel

**Excavation Contractor:** Ravcon Excavation

## SUBSURFACE PROFILE / SAMPLE DATA

| Soil Description | Elev./Depth (m) | Sample Number | Shear Strength (kPa) 50 150 | Water Content (%) 25 50 75 / Liquid Limit (%) 25 50 75 | Water Level (Standpipe or Open Excavation) |
|---|---|---|---|---|---|
| Ground Surface | | | | | |
| **TOPSOIL**<br>Dark brown sandy loam. | 67.95<br>0.00 | | | | |
| **SAND**<br>Fine grained to silty, brown in colour becoming greyish brown with depth, moist becoming wet with depth, compact | 67.65<br>0.30 | | | | |
| **GLACIAL TILL**<br>Silty sand and gravel with some cobbles and boulders (0.6m diameter max.), grey in colour, wet, compact<br>Test pit terminated over bedrock. | 64.95<br>3.00 | | | | |
| End of Test Pit | 64.50<br>3.45 | | | | |

**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 67.95

**Top of Riser Elev.:** 67.95

**Excavation Width:**

**Excavation Length:**

**NOTES**:

# Test Pit Log: TP6

**Project No.:** 120858

**Project:** Hawkesbury PPG Lands Development

**Client:** Asco Construction Ltd.

**Location:** Hawkesbury, Ontario

**Date:** November 26, 2014

**Field Personnel:** W.B.

**Excavation Method:** Hydraulic Shovel

**Excavation Contractor:** Ravcon Excavation

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|
| **Depth** | **Soil Description** | **Elev./Depth (m)** | **Sample Number** | **Shear Strength** (kPa) 50 150 | **Water Content** (%) 25 50 75<br>**Liquid Limit** (%) 25 50 75 | **Water Level (Standpipe or Open Excavation)** |
| ft 0 / m 0 | Ground Surface | 71.00<br>0.00 | | | | |
| | **TOPSOIL**<br>150mm; Dark brown sandy loam. | | | | | 1.00m (09-12-14) |
| | **GLACIAL TILL**<br>Silty sand and gravel with some cobbles and boulders (3.0m diameter max.), brown to brownish grey with depth in colour, moist becoming wet with depth, compact<br><br>Test pit terminated over bedrock. | | 1 | | | |
| | End of Test Pit | 67.55<br>3.45 | | | | |

**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 71

**Top of Riser Elev.:** 71

**Excavation Width:**

**Excavation Length:**

**NOTES**:

## Test Pit Log: TP7

**Project No.:** 120858

**Project:** Hawkesbury PPG Lands Development

**Client:** Asco Construction Ltd.

**Location:** Hawkesbury, Ontario

**Date:** November 26, 2014

**Field Personnel:** W.B.

**Excavation Method:** Hydraulic Shovel

**Excavation Contractor:** Ravcon Excavation

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|
| **Depth** | **Soil Description** | **Elev./Depth (m)** | **Sample Number** | **Shear Strength** (kPa) 50 150 | **Water Content** ▽ (%) ▽ 25 50 75<br>**Liquid Limit** □ (%) □ 25 50 75 | **Water Level (Standpipe or Open Excavation)** |
| ft m | Ground Surface | 68.37<br>0.00 | | | | |
| | **PEAT**<br>Black, high organic content. | 68.07<br>0.30 | | | | |
| | **SAND**<br>Fine grained to silty to sand-silt, greyish brown in colour, wet, compact | 67.47<br>0.90 | | | | |
| | **GLACIAL TILL**<br>Silty sand with gravel, some cobbles, grey in colour, wet, compact<br>Test pit terminated over bedrock. | 66.57<br>1.80 | | | | |
| | End of Test Pit | | | | | |

ft: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

m: 0 1 2 3 4 5

**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 68.37

**Top of Riser Elev.:** 68.37

**Excavation Width:**

**Excavation Length:**

**NOTES**:

## Test Pit Log: TP8

**Project No.:** 120858
**Project:** Hawkesbury PPG Lands Development
**Client:** Asco Construction Ltd.
**Location:** Hawkesbury, Ontario
**Date:** November 26, 2014
**Field Personnel:** W.B.
**Excavation Method:** Hydraulic Shovel
**Excavation Contractor:** Ravcon Excavation

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|
| Depth | Soil Description | Elev./Depth (m) | Sample Number | Shear Strength (kPa)<br>50 150 | Water Content (%) ▽ 25 50 75 ▽<br>Liquid Limit (%) □ 25 50 75 □ | Water Level (Standpipe or Open Excavation) |
| ft m<br>0 0 | Ground Surface | 67.31<br>0.00 | | | | |
| | **FILL**<br>100mm of crushed stone. | | | | | |
| 1<br>2<br>3 1<br>4<br>5 | **FILL**<br>Fine to medium grained sand and gravel, brown in colour, with some cobbles and boulders (0.5 to 0.6m in diameter), moist becoming wet with depth, loose | | | | | 0.75m (09-12-14) |
| 6<br>2<br>7 | **GLACIAL TILL**<br>Silty sand with gravel, grey in colour, wet, compact<br>Test pit terminated over bedrock. | 65.51<br>1.80 | | | | |
| 8<br>9<br>10 3<br>11<br>12<br>13 4<br>14<br>15<br>16 5<br>17<br>18<br>19 | End of Test Pit | 64.95<br>2.36 | | | | |

**Easting:** 0
**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 67.31
**Top of Riser Elev.:** 67.31

**Excavation Width:**
**Excavation Length:**

**NOTES**:

# Test Pit Log: TP9

**Project No.:** 120858

**Project:** Hawkesbury PPG Lands Development

**Client:** Asco Construction Ltd.

**Location:** Hawkesbury, Ontario

**Date:** November 27, 2014

**Field Personnel:** W.B.

**Excavation Method:** Hydraulic Shovel

**Excavation Contractor:** Ravcon Excavation

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|
| Depth | Soil Description | Elev./Depth (m) | Sample Number | Shear Strength (kPa) 50 150 | Water Content ▽ (%) ▽ 25 50 75<br>Liquid Limit □ (%) □ 25 50 75 | Water Level (Standpipe or Open Excavation) |
| ft 0, m 0 | Ground Surface | 64.76<br>0.00 | | | | |
| | **TOPSOIL**<br>Dark brown sandy loam | 64.46<br>0.30 | | | | |
| | **SAND**<br>Fine grained to silty to sand-silt, brown in colour becoming greyhish brown with depth, moist becoming wet with depth, compact<br>Test pit terminated over bedrock. | | 1 | | | |
| | End of Test Pit | 60.96<br>3.80 | | | | |

Depth scale: ft 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19; m 0 1 2 3 4 5

**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 64.76

**Top of Riser Elev.:** 64.76

**Excavation Width:**

**Excavation Length:**

**NOTES**:

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# Test Pit Log: TP10

**Project No.:** 120858
**Project:** Hawkesbury PPG Lands Development
**Client:** Asco Construction Ltd.
**Location:** Hawkesbury, Ontario
**Date:** November 26, 2014
**Field Personnel:** W.B.
**Excavation Method:** Hydraulic Shovel
**Excavation Contractor:** Ravcon Excavation

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|
| **Depth**<br>ft 0 1 2 3 4 5 6 7 8 9 10 11 12 13<br>m 0 1 2 3 | **Soil Description** | **Elev./Depth (m)** | **Sample Number** | **Shear Strength** (kPa)<br>50 150 | **Water Content** ▽ (%) ▽<br>25 50 75<br>**Liquid Limit** □ (%) □<br>25 50 75 | **Water Level (Standpipe or Open Excavation)** |
| | Ground Surface | | | | | |
| | **TOPSOIL**<br>Dark brown sandy loam | 64.23<br>0.00 | | | | |
| | **SAND**<br>Fine grained to silty to sand-silt, brown in colour becoming greyish brown with depth, moist becoming wet with depth, compact | 63.93<br>0.30 | | | | |
| | **GLACIAL TILL**<br>Silty sand with gravel, grey in colour, wet, compact | 61.63<br>2.60 | | | | |
| | Test pit terminated over bedrock. | 61.43<br>2.80 | | | | |
| | End of Test Pit | | | | | |

**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 64.23

**Top of Riser Elev.:** 64.23

**Excavation Width:**

**Excavation Length:**

**NOTES**:

# Test Pit Log: TP11

**Project No.:** 120858

**Project:** Hawkesbury PPG Lands Development

**Client:** Asco Construction Ltd.

**Location:** Hawkesbury, Ontario

**Date:** November 26, 2014

**Field Personnel:** W.B.

**Excavation Method:** Hydraulic Shovel

**Excavation Contractor:** Ravcon Excavation

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|
| Depth (ft / m) | Soil Description | Elev./Depth (m) | Sample Number | Shear Strength (kPa) 50 150 | Water Content (%) 25 50 75<br>Liquid Limit (%) 25 50 75 | Water Level (Standpipe or Open Excavation) |
| 0 / 0 | Ground Surface | 65.17<br>0.00 | | | | |
| 0 – 7 ft / 0 – 2.10 m | **FILL**<br>Greyish brown silty sand with presence of organic (trees branches, peat), moist to wet with depth | | | | | 1.45m (09-12-14) ▼ |
| 7 ft / 2.10 m | **SAND**<br>Fine grained to silty to sand-silt, brown in colour becoming greyish brown with depth, compact.<br>Test pit terminated due to cave-in. | 63.07<br>2.10 | | | | |
| 13 ft / 3.90 m | End of Test Pit | 61.27<br>3.90 | | | | |

**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 65.17

**Top of Riser Elev.:** 65.17

**Excavation Width:**

**Excavation Length:**

**NOTES**:

# Test Pit Log: TP12

**Project No.:** 120858

**Project:** Hawkesbury PPG Lands Development

**Client:** Asco Construction Ltd.

**Location:** Hawkesbury, Ontario

**Date:** November 27, 2014

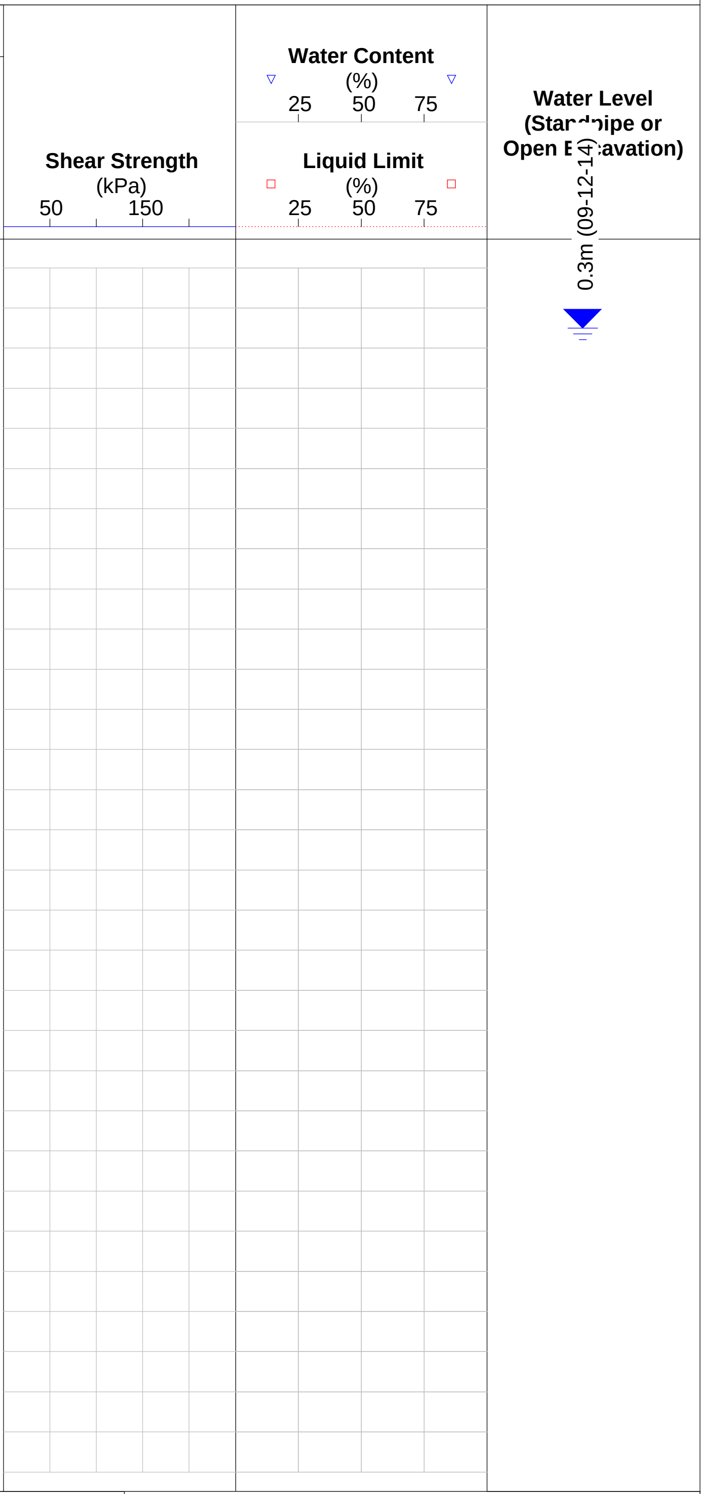
**Field Personnel:** W.B.

**Excavation Method:** Hydraulic Shovel

**Excavation Contractor:** Ravcon Excavation

## SUBSURFACE PROFILE / SAMPLE DATA

| Depth (ft / m) | Soil Description | Elev./Depth (m) | Sample Number |
|---|---|---|---|
| 0 / 0 | Ground Surface | 62.36<br>0.00 | |
| | **TOPSOIL**<br>Dark brown sandy loam. | 62.06<br>0.30 | |
| | **SAND**<br>Fine grained to silty to sand-silt, brown in colour becoming greyish brown with depth, wet, compact<br>Test pit terminated over bedrock. | 60.56<br>1.80 | |
| | End of Test Pit | | |



**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 62.36

**Top of Riser Elev.:** 62.36

**Excavation Width:**

**Excavation Length:**

**NOTES**:

# Test Pit Log: TP13

**Project No.:** 120858

**Project:** Hawkesbury PPG Lands Development

**Client:** Asco Construction Ltd.

**Location:** Hawkesbury, Ontario

**Date:** November 26, 2014

**Field Personnel:** W.B.

**Excavation Method:** Hydraulic Shovel

**Excavation Contractor:** Ravcon Excavation

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|
| **Depth** | **Soil Description** | **Elev./Depth (m)** | **Sample Number** | **Shear Strength** (kPa) 50 150 | **Water Content** ▽ (%) ▽ 25 50 75<br>**Liquid Limit** □ (%) □ 25 50 75 | **Water Level (Standpipe or Open Excavation)** |
| ft m 0 | Ground Surface | 69.66<br>0.00 | | | | |
| | **TOPSOIL**<br>150mm Dark brown sandy loam | | | | | |
| | **SAND**<br>Fine grained to silty to sand-silt, brown in colour becoming greyish brown with depth, moist, compact. | | | | | |
| | **GLACIAL TILL**<br>Silty sand with gravel, some cobbles, grey in colour, wet, compact<br>Test pit terminated over bedrock | 67.86<br>1.80 | | | | |
| | End of Test Pit | 67.11<br>2.55 | | | | |

ft: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

m: 0 1 2 3 4 5

**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 69.66

**Top of Riser Elev.:** 69.66

**Excavation Width:**

**Excavation Length:**

**NOTES**:

# Test Pit Log: TP14

**Project No.:** 120858

**Project:** Hawkesbury PPG Lands Development

**Client:** Asco Construction Ltd.

**Location:** Hawkesbury, Ontario

**Date:** November 27, 2014

**Field Personnel:** W.B.

**Excavation Method:** Hydraulic Shovel

**Excavation Contractor:** Ravcon Excavation

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|
| Depth | Soil Description | Elev./Depth (m) | Sample Number | Shear Strength (kPa)<br>50 150 | Water Content ▽ (%) ▽<br>25 50 75<br>Liquid Limit □ (%) □<br>25 50 75 | Water Level (Standpipe or Open Excavation) |
| ft m | Ground Surface | 61.54<br>0.00 | | | | |
| | **TOPSOIL**<br>Dark brown sandy loam. | 61.24<br>0.30 | | | | |
| | **GLACIAL TILL**<br>Silty sand with gravel, with some cobbles and boulders (0.7m max. in diameter) grey in colour, moist, compact<br><br>Test pit terminated over bedrock. | 60.04<br>1.50 | | | | |
| | End of Test Pit | | | | | |

**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 61.54

**Top of Riser Elev.:** 61.54

**Excavation Width:**

**Excavation Length:**

**NOTES**:

# Test Pit Log: TP15

**Project No.:** 120858

**Project:** Hawkesbury PPG Lands Development

**Client:** Asco Construction Ltd.

**Location:** Hawkesbury, Ontario

**Date:** November 26, 2014

**Field Personnel:** W.B.

**Excavation Method:** Hydraulic Shovel

**Excavation Contractor:** Ravcon Excavation

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|
| Depth (ft / m) | Soil Description | Elev./Depth (m) | Sample Number | Shear Strength (kPa) 50 150 | Water Content (%) ▽ 25 50 75 ▽<br>Liquid Limit (%) □ 25 50 75 □ | Water Level (Standpipe or Open Excavation) |
| 0 ft / 0 m | Ground Surface | 69.26<br>0.00 | | | | 0.5m (09-12-14) ▼ |
| | **TOPSOIL**<br>150mm, Dark brown sandy loam | | | | | |
| | **SAND**<br>Fine grained to silty to sand-silt, brown in colour becoming greyish brown with depth, wet, compact | | | | | |
| | **GLACIAL TILL**<br>Silty sand with gravel, grey in colour, wet, compact<br>Test pit terminated due to cave-in. | 66.86<br>2.40 | | | | |
| | End of Test Pit | 65.96<br>3.30 | | | | |

**Easting:** 0

**Northing:** 0

**Site Datum:** Geodetic

**Groundsurface Elevation:** 69.26

**Top of Riser Elev.:** 69.26

**Excavation Width:**

**Excavation Length:**

**NOTES**:

# APPENDIX C

# LABORATORY TEST REPORTS

**Stantec** 2781 Lancaster Road, Suite 101
Ottawa ON, K1B 1A7

# Sieve Analysis
**LS 602**
**ASTM C136**

Client: **LRL Associates Ltd.**
Project: **Housing Development, Hawkesbury**
Material Type: **Soils / Aggregates:**
Proposed Use: **Fill/Granulars**
Source: **TP-3**
Sample Number: **N/A**
Sampled Depth: **5'**
Sampled By: **LRL Associates Ltd.**
Date Sampled: **November 26, 2014**

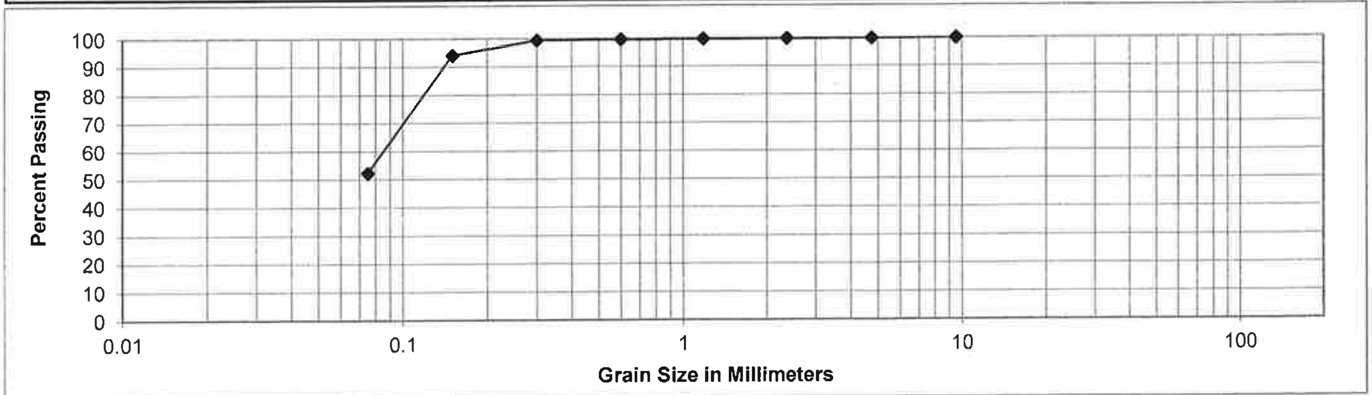
Project Number: **122410526**
Tested By: **Denis Rodriguez**
Date Tested: **December 3, 2014**

| Sieve Test Data | | Wash Test Data | | |
|---|---|---|---|---|
| Sample Weight Before Sieve, (g): | **576.3** | Sample Weight Before Wash, (g): | **262.3** | **Corrected** |
| Sample Weight After Sieve, (g): | **576.4** | Sample Weight After Wash, (g): | **172.2** | |
| Percent Loss In Sieve, (%): | **-0.02** | Percent Passing No. 200, (%): | **34.3** | **34.3** |

## Sieve Analysis

| Sieve No. | Size of Opening | | Weight Retained | Cumulative Weight Retained | Percent Passing | No Envelope | |
|---|---|---|---|---|---|---|---|
| | Inches | mm | g | g | % | Minimum | Maximum |
| | 6 | 150 | | | | | |
| | 4 | 106 | | | | | |
| | 3 | 76.2 | | | | | |
| | 2 | 53.0 | | | | | |
| | 1.5 | 37.5 | | | | | |
| | 1 | 26.5 | | | | | |
| | 3/4 | 19.0 | | | | | |
| | 5/8 | 16.0 | | | | | |
| | 1/2 | 13.2 | | | | | |
| | 3/8 | 9.5 | 0.0 | 0.0 | 100.0 | | |
| +4 | 0.187 | 4.75 | 0.7 | 0.7 | 99.9 | | |
| | | - 4.75 | 575.7 | 576.4 | | | |
| 8 | 0.0937 | 2.36 | | 0.1 | 99.8 | | |
| 16 | 0.0469 | 1.18 | | 0.4 | 99.7 | | |
| 30 | 0.234 | 0.600 | | 0.7 | 99.6 | | |
| 50 | 0.0117 | 0.300 | | 1.2 | 99.4 | | |
| 100 | 0.0059 | 0.150 | | 15.2 | 94.1 | | |
| 200 | 0.0029 | 0.075 | | 124.9 | 52.3 | | |
| | | Pan | | 171.0 | | | |

**Classification of Sample:** % Gravel: **0.1** % Sand: **47.6** % Silt & Clay: **52.3**



**Remarks:**

**Reviewed By:** Brian Prevost

**Date:** December 9/2014

**Stantec** 2781 Lancaster Road, Suite 101
Ottawa ON, K1B 1A7

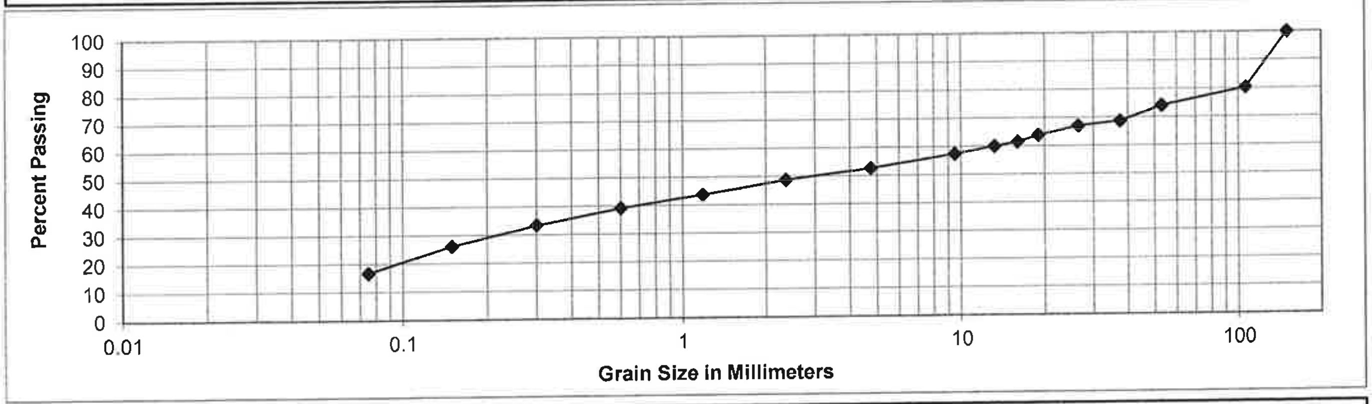
# Sieve Analysis
LS 602
ASTM C136

| | | | |
|---|---|---|---|
| Client: | **LRL Associates Ltd.** | Project Number: | **122410526** |
| Project: | **Housing Development, Hawkesbury** | | |
| Material Type: | **Soils / Aggregates:** | | |
| Proposed Use: | **Fill/Granulars** | | |
| Source: | **TP-6** | | |
| Sample Number: | **N/A** | | |
| Sampled Depth: | **5'** | | |
| Sampled By: | **LRL Associates Ltd.** | Tested By: | **Denis Rodriguez** |
| Date Sampled: | **November 26, 2014** | Date Tested: | **December 3, 2014** |

| Sieve Test Data | | Wash Test Data | | |
|---|---|---|---|---|
| Sample Weight Before Sieve, (g): | **10706.0** | Sample Weight Before Wash, (g): | **279.3** | **Corrected** |
| Sample Weight After Sieve, (g): | **10618.0** | Sample Weight After Wash, (g): | **197.4** | |
| Percent Loss In Sieve, (%): | **0.82** | Percent Passing No. 200, (%): | **29.3** | **15.4** |

## Sieve Analysis

| Sieve No. | Size of Opening | | Weight Retained | Cumulative Weight Retained | Percent Passing | No Envelope | |
|---|---|---|---|---|---|---|---|
| | Inches | mm | g | g | % | Minimum | Maximum |
| | 6 | 150 | 0 | 0.0 | 100.0 | | |
| | 4 | 106 | 2120.2 | 2120.2 | 80.2 | | |
| | 3 | 76.2 | 0.0 | 2120.2 | 80.2 | | |
| | 2 | 53.0 | 660.0 | 2780.2 | 74.0 | | |
| | 1.5 | 37.5 | 585.2 | 3365.4 | 68.6 | | |
| | 1 | 26.5 | 168.3 | 3533.7 | 67.0 | | |
| | 3/4 | 19.0 | 337.8 | 3871.5 | 63.8 | | |
| | 5/8 | 16.0 | 255.2 | 4126.7 | 61.5 | | |
| | 1/2 | 13.2 | 163.2 | 4289.9 | 59.9 | | |
| | 3/8 | 9.5 | 271.2 | 4561.1 | 57.4 | | |
| +4 | 0.187 | 4.75 | 517.7 | 5078.8 | 52.6 | | |
| | | - 4.75 | 5539.2 | 10618.0 | | | |
| 8 | 0.0937 | 2.36 | | 20.3 | 48.7 | | |
| 16 | 0.0469 | 1.18 | | 46.9 | 43.7 | | |
| 30 | 0.234 | 0.600 | | 71.3 | 39.1 | | |
| 50 | 0.0117 | 0.300 | | 102.3 | 33.3 | | |
| 100 | 0.0059 | 0.150 | | 140.2 | 26.2 | | |
| 200 | 0.0029 | 0.075 | | 190.0 | 16.8 | | |
| | | Pan | | 196.7 | | | |
| **Classification of Sample:** | | % Gravel: | 47.4 | % Sand: | 35.8 | % Silt & Clay: | 16.8 |



**Remarks:**

**Reviewed By:** Brian Prevost

**Date:** December 9/2014

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**Stantec** 2781 Lancaster Road, Suite 101
Ottawa ON, K1B 1A7

# Sieve Analysis
**LS 602**
**ASTM C136**

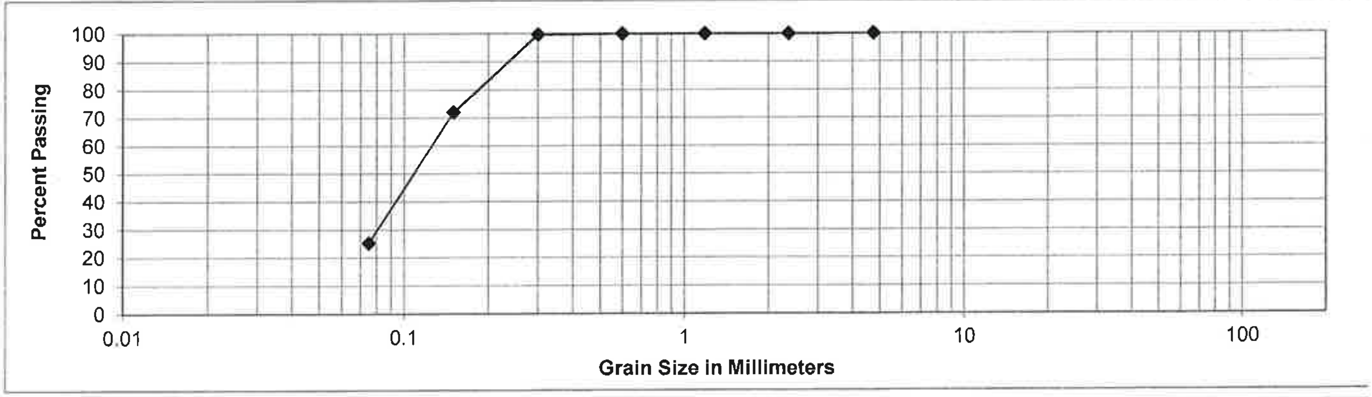
| | | | |
|---|---|---|---|
| Client: | **LRL Associates Ltd.** | Project Number: | **122410526** |
| Project: | **Housing Development, Hawkesbury** | | |
| Material Type: | **Soils / Aggregates:** | | |
| Proposed Use: | **Fill/Granulars** | | |
| Source: | **TP-9** | | |
| Sample Number: | **N/A** | | |
| Sampled Depth: | **8'** | | |
| Sampled By: | **LRL Associates Ltd.** | Tested By: | **Denis Rodriguez** |
| Date Sampled : | **November 26, 2014** | Date Tested: | **December 3, 2014** |

| Sieve Test Data | | Wash Test Data | | |
|---|---|---|---|---|
| Sample Weight Before Sieve, (g): | **588.3** | Sample Weight Before Wash, (g): | **262.1** | **Corrected** |
| Sample Weight After Sieve, (g): | **588.2** | Sample Weight After Wash, (g): | **216.5** | |
| Percent Loss In Sieve, (%): | **0.02** | Percent Passing No. 200, (%): | **17.4** | **17.4** |

## Sieve Analysis

| Sieve No. | Size of Opening | | Weight Retained | Cumulative Weight Retained | Percent Passing | No Envelope | |
|---|---|---|---|---|---|---|---|
| | Inches | mm | g | g | % | Minimum | Maximum |
| | 6 | 150 | | | | | |
| | 4 | 106 | | | | | |
| | 3 | 76.2 | | | | | |
| | 2 | 53.0 | | | | | |
| | 1.5 | 37.5 | | | | | |
| | 1 | 26.5 | | | | | |
| | 3/4 | 19.0 | | | | | |
| | 5/8 | 16.0 | | | | | |
| | 1/2 | 13.2 | | | | | |
| | 3/8 | 9.5 | | | | | |
| +4 | 0.187 | 4.75 | 0.0 | 0.0 | 100.0 | | |
| | | - 4.75 | 588.2 | 588.2 | | | |
| 8 | 0.0937 | 2.36 | | 0.2 | 99.9 | | |
| 16 | 0.0469 | 1.18 | | 0.3 | 99.9 | | |
| 30 | 0.234 | 0.600 | | 0.3 | 99.9 | | |
| 50 | 0.0117 | 0.300 | | 1.1 | 99.6 | | |
| 100 | 0.0059 | 0.150 | | 73.4 | 72.0 | | |
| 200 | 0.0029 | 0.075 | | 196.2 | 25.1 | | |
| | | Pan | | 216.2 | | | |

**Classification of Sample:** % Gravel: **0.0** % Sand: **74.9** % Silt & Clay: **25.1**



**Remarks:**

**Reviewed By:** Brian Prevost

**Date:** December 9/2014

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# APPENDIX D

# SYMBOLS AND TERMS USED IN BOREHOLE/TEST PIT LOGS

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# Symbols and Terms Used on Borehole and Test Pit Logs

The following explains the data presented in the borehole and test pit logs.

## 1. Soil Description

The soil descriptions presented in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves some judgement and LRL Associates Ltd. does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice. Boundaries between zones on the logs are often not distinct but transitional and were interpreted.

### a. Proportion

The proportion of each constituent part, as defined by the grain size distribution, is denoted by the following terms:

| Term | Proportions |
|---|---|
| “trace” | 1% to 10% |
| “some” | 10% to 20% |
| prefix (i.e. “sandy” silt) | 20% to 35% |
| “and” (i.e. sand “and” gravel) | 35% to 50% |

### b. Compactness and Consistency

The state of compactness of granular soils is defined on the basis of the Standard Penetration Test. See Section 2c for more details. The consistency of clayey or cohesive soils is based on the shear strength of the soil, as determined by field vane tests and by a visual and tactile assessment of the soil strength.

The state of compactness of granular soils is defined by the following terms:

| State of Compactness Granular Soils | Standard Penetration Number “N” |
|---|---|
| Very loose | 0 – 4 |
| Loose | 4 – 10 |
| Compact or medium | 10 - 30 |
| Dense | 30 - 50 |
| Very dense | over - 50 |

The consistency of cohesive soils is defined by the following terms:

| Consistency Cohesive Soils | Undrained Shear Strength (Cu) (kPa) |
|---|---|
| Very soft | under 10 |
| Soft | 10 - 25 |
| Medium or firm | 25 - 50 |
| Stiff | 50 - 100 |
| Very stiff | 100 - 200 |
| Hard | over - 200 |

## 2. Sample Data

### a. Elevation depth

This is a reference to the geodesic elevation of the soil or to a benchmark of an arbitrary elevation at the location of the borehole or test pit. The depth of geological boundaries is measured from ground surface.

### b. Type

| Symbol | Type | Letter Code |
|---|---|---|
| ⌇ | Auger | AU |
| ⧗ | Split spoon | SS |
| ‖ | Shelby tube | ST |
| ▥ | Rock Core | RC |

### c. Sample Number

Each sample taken from the borehole is numbered in the field as shown in this column.

LETTER CODE (as above) – Sample Number

### d. Blows (N) or RQD

This column indicates the Standard Penetration Number (N) as per ASTM D-1586. This is used to determine the state of compactness of the soil sampled. It corresponds to the number of blows required to drive 300 mm of the split spoon sampler using a 622 kg*m/s$^2$ hammer falling freely from a height of 760 mm. For a 600 mm long split spoon, the blow counts are recorded for every 150 mm. The “N” index is obtained by adding the number of blows from the 2nd and 3rd count. Technical refusal indicates a number of blows greater than 50.

In the case of rock, this column presents the Rock Quality Designation (RQD). The RQD is calculated as the cumulative length of rock pieces recovered having lengths of 10 cm or more divided by the length of coring. The qualitative description of the bedrock based on RQD is given below.

| Rock Quality Designation (RQD) (%) | Description of Rock Quality |
|---|---|
| 0 –25 | very poor |
| 25 – 50 | poor |
| 50 – 75 | fair |
| 75 – 90 | good |
| 90 – 100 | excellent |

### e. Recovery (%)

For soil samples this is the percentage of the recovered sample obtained versus the length sampled. In the case of rock, the percentage is the length of rock core recovered compared to the length of the drill run.

## 3. General Monitoring Well Data