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Civil • Geotechnical •
Structural • Environmental •
Hydrogeology

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**REPORT ON**

# GEOTECHNICAL INVESTIGATION
# PROPOSED RESIDENTIAL DEVELOPMENT
# 351 CROYDON ROAD
# CITY OF OTTAWA, ONTARIO

Project # 160861

Submitted to:

Urban Structure Properties Ltd.
3926 Leitrim Road
Ottawa, Ontario
K1G 3N4

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January 24, 2017

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January 24, 2017 160861

Urban Structure Properties Ltd.
3926 Leitrim Road
Ottawa, Ontario
K1G 3N4

RE: GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
351 CROYDON ROAD
CITY OF OTTAWA, ONTARIO

Dear Sirs:

This report presents the results of a geotechnical investigation carried out for the above noted proposed residential building. The purpose of the investigation was to identify the subsurface conditions at the site based on a limited number of boreholes. Based on the factual information obtained, Kollaard Associates Inc. was to provide guidelines on the geotechnical engineering aspects of the project design; including construction considerations, which could influence design decisions.

## BACKGROUND INFORMATION AND SITE GEOLOGY

Plans are being prepared to construct an eight unit apartment building at 351 Croydon Road in the City of Ottawa, Ontario (see Key Plan, Figure 1). The site has a total of about 0.04 hectares (0.11 acre) and is currently undeveloped and used by two mobile chip trucks and an outdoor seating area. The property is asphaltic concrete surfaced. The site has about 15 metres of frontage onto Croydon Road.

Preliminary plans indicate that the proposed building will be of wood or steel framed construction with conventional spread footing foundations and a concrete slab on grade floor.

The site is located within an area of mixed commercial and residential development. The site is bordered on the west by Croydon Road followed by mixed commercial and residential development, on the east and north by commercial development and on the south by a parking lot.

Based on a review of the surficial geology map for the site area, it is expected that the site is underlain by older alluvial deposits of clay, silt, sand and gravel followed by bedrock. Bedrock geology maps indicate that the bedrock underlying the site consists of limestone with some shaly partings, of the Ottawa Formation or shale with lenses of sandstone of the Rockliffe Formation.

**PROCEDURE**

The field work for this investigation was carried out on January 9, 2017 at which time three boreholes, numbered BH1, BH2 and BH3 were put down at the site using a truck mounted drill rig equipped with a hollow stem auger owned and operated by OGS. Inc. of Almonte, Ontario.

Sampling of the overburden materials encountered at the borehole location was carried out at regular 0.75 metre depth intervals using a 50 millimetre diameter drive open conventional split spoon sampler in conjunction with standard penetration testing to depths ranging from about 5.5 to 7.0 metres below the existing ground surface (ASTM D-1586 – Penetration Test and Split Barrel Sampling of Soils). In situ vane shear testing (ASTM D-2573 Standard Test Method for Field Shear Test in Cohesive Soil) was not carried out as no cohesive materials were encountered at any of the boreholes.

The subsurface soil conditions at the boreholes were identified based on visual examination of the samples recovered (ASTM D2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), and standard penetration tests (ASTM D-1586) as well as laboratory test results on select samples. Groundwater conditions at the borehole was noted at the time of drilling. The boreholes were loosely backfilled with the auger cuttings upon completion of drilling.

One soil sample (BH3) was submitted to determine the grain size distribution (Hydrometer - ASTM D422). A sample of soil obtained from BH2 was also delivered to a chemical laboratory for testing for any indication of potential soil sulphate attack and soil corrosion on buried concrete and steel.

The field work was supervised throughout by a member of our engineering staff who located the boreholes in the field, logged the boreholes and cared for the samples obtained. A description of the subsurface conditions encountered at the boreholes are given in the attached Record of Borehole Sheets. The results of the laboratory testing of the soil samples are presented in the Laboratory Test Results section and Attachment A following the text in this report. The approximate location of the boreholes are shown on the attached Site Plan, Figure 2.

## SUBSURFACE CONDITIONS

### General

As previously indicated, a description of the subsurface conditions encountered at the boreholes is provided in the attached Record of Borehole Sheets following the text of this report. The borehole logs indicate the subsurface conditions at the specific drill location only. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. Subsurface conditions at locations other than borehole locations may vary from the conditions encountered at the boreholes.

The soil descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification was in general completed by visual-manual procedures in accordance with ASTM 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) with select samples being classified by laboratory testing in accordance with ASTM 2487. Classification and identification of soil involves judgement and Kollaard Associates Inc. does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The groundwater conditions described in this report refer only to those observed at the location and on the date the observations were noted in the report and on the borehole logs. Groundwater conditions may vary seasonally, or may be affected by construction activities on or in the vicinity of the site.

The following is a brief overview of the subsurface conditions encountered at the boreholes.

**Fill**

From the ground surface, fill materials were encountered at all of the borehole locations. The fill materials consisted of about a 50 millimetre thickness of asphaltic concrete followed by a sand and gravel with a trace to some silt and organics. The thickness of the fill materials ranged from about 1.7 to 1.9 metres. The fill materials were fully penetrated at the borehole locations.

**Glacial Till / Bedrock**

Glacial till was encountered beneath the fill materials at all of the borehole locations. The glacial till consisted of gravel, cobbles and boulders, in a matrix of grey brown to grey sand, with a trace of clay. The results of standard penetration testing carried out in the glacial till material, range from 10 to 93 blows per 0.3 metres with an average value of 52 blows per 0.3 metres, indicating a compact to very dense state of packing.

All three of the boreholes encountered refusal to further advancement of the standard penetration split spoon on either large boulders or bedrock at depths of about 7.0, 6.0 and 5.5 metres, respectively, below the existing ground surface for boreholes BH1, BH2 and BH3.

One soil sample (BH3-SS4–3.0 to 3.7m) was submitted to Stantec for particle size analysis. The results of the particle size analysis testing using the Unified Soil Classification System indicated that the sample consists of about 16 percent gravel with 51 percent sand and 33 percent silt and clay size particles. The results are located in Attachment A.

BH1 encountered glacial till at a depth of about 6.7 metres and was continued by dynamic cone penetration testing. The dynamic cone penetration test carried out at BH1 gave values ranging from 27 to 100 blows per 0.3 metres between the depths of 6.7 and 7.0 metres below the existing ground surface. At a depth of some 7.0 metres below the existing ground surface at borehole 1, refusal to cone penetration was encountered. It is considered likely that the refusal to cone penetration indicates either large boulders or bedrock in borehole 1 at about 7.0 metres.

**Glacial Till / Bedrock**

All of the boreholes were terminated with practical with practical refusal to advancement at depths of about 7.0, 6.0 and 5.5 metres, respectively below the existing ground surface. Borehole 1 was further advanced using dynamic cone penetration testing at a depth of about 6.7 metres below the existing ground surface. The dynamic cone penetration test carried out at BH1 gave values ranging from 27 to greater 100 blows per 0.3 metres. At a depth of some 7.0 metres blow the existing ground surface, refusal to cone penetration was also encountered.

Based on bedrock mapping and a review of borehole information provided in the Ecolog Eris report for the Phase I Environmental Site Assessment for the site, it is considered that the refusal to advancement was on the surface of large boulders as bedrock is indicated to be at depths ranging between about 7.5 to 9.0 metres below the existing ground surface.

**Groundwater**

All of the boreholes were observed to be dry at the time of drilling. It should be noted that the groundwater levels may be higher during wet periods of the year such as the early spring.

**Corrosivity on Reinforcement and Sulphate Attack on Portland Cement**

The results of the laboratory testing of a soil sample for submitted for chemistry testing related to corrosivity is summarized in the following table.

| Item | Threshold of Concern | Test Result | Comment |
|---|---|---|---|
| Chlorides (Cl) | Cl > 0.04 % | 0.014 | Negligible |
| pH | 5.0 < pH | 8.3 | Neutral/Slightly Basic<br>Negligible concern |
| Resistivity | R < 20,000 ohm-cm | 2780 | Highly Corrosive |
| Sulphates ($SO_4$) | $SO_4$ > 0.1% | <0.01 | Negligible concern |

The results were compared with Canadian Standards Association (CSA) Standards A23.1 for sulphate attack potential on concrete structures and posses a "negligible" risk for sulphate attack on concrete materials and accordingly, conventional GU or MS Portland cement may be used in the construction of the proposed concrete elements.

The pH value for the soil sample was reported to be at 8.3, indicating a durable condition against corrosion. This value was evaluated using Table 2 of Building Research Establishment (BRE) Digest 362 (July 1991).The pH is greater than 5.5 indicating the concrete will not be exposed to attack from acids.

The chloride content of the sample was also compared with the threshold level and present negligible concrete corrosion potential. Soil resistivity was found to be 2.78 ohm-m for the sample analyzed. Consideration to increasing the specified strength and/or adding air entrainment into any reinforced concrete in contact with the soil should be given. Special protection is required for reinforcement steel within the concrete walls.

## GEOTECHNICAL DESIGN GUIDELINES

### General

This section of the report provides engineering guidelines on the geotechnical design aspects of the project based on our interpretation of the information from the test holes and the project requirements. It is stressed that the information in the following sections is provided for the guidance of the designers and is intended for this project only. 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 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 offsite sources are outside the terms of reference for this report.

### Foundations for Proposed Residential Development

With the exception of the fill materials, the subsurface conditions encountered at the boreholes advanced during the investigation are suitable for the support of the proposed residential building on conventional spread footing foundations. The excavations for the foundations should be taken down through any fill, topsoil or otherwise deleterious material to expose the native, undisturbed glacial till. The subgrade surface should then be inspected and approved by geotechnical personnel. The excavations within the sand/silty sand and gravel fill above the groundwater level should not present any serious constraints.

The allowable bearing pressure for any footings depends on the depth of the footings below original ground surface, the width of the footings, and the height above the original ground surface of any landscape grade raise adjacent to the dwelling foundation.

For the proposed residential development with a partial or full depth basement, a maximum allowable bearing pressure of 150 kilopascals using serviceability limit states design and a factored ultimate bearing resistance of 300 kilopascals using ultimate limit states design, may be used for the design of conventional strip footings, a minimum of 0.5 metres in width, or pad footings founded on glacial till bedrock or on a suitably constructed engineered pad founded on the glacial till. The above allowable bearing pressures are suitable for a grade raise fill thickness adjacent to the structure of up to 3.0 metres and footing widths of up to 2.0 metres.. Total and differential settlement of the footings designed and founded based on the above guidelines should be less than 25 millimetres and 20 millimetres, respectively.

Provided that any loose and/or disturbed soil is removed from the bearing surfaces prior to pouring concrete, the total and differential settlement of the footings should be less than 25 millimetres and 20 millimetres, respectively.

Any fill required to raise the footings for the proposed building to founding level should consist of imported granular material (engineered fill). To allow the spread of load beneath the footings, the engineered fill should extend down and out from the edges of the footing at 1 horizontal to 1 vertical, or flatter. The excavations for the proposed building should be sized to accommodate this fill placement. The engineered fill should consist of granular material meeting Ontario Provincial Standards Specifications (OPSS) requirements for Granular A or Granular B Type II and should be compacted in maximum 300 millimetre thick loose lifts to at least 98 percent of the standard Proctor maximum dry density. It is considered that the engineered fill should be compacted using dynamic compaction with a large diameter vibratory steel drum roller or diesel plate compactor. If a diesel plate compactor is used, the lift thickness may need to be restricted to less than 300 mm to achieve proper compaction. Compaction should be verified by a suitable field compaction test method.

The native glacial till soils at this site will be sensitive to disturbance from construction operations and from rainwater or snowmelt, and frost. In order to minimize disturbance, construction traffic operating directly on the subgrade should be kept to an absolute minimum and the subgrade should be protected from below freezing temperatures.

***Frost Protection Requirements for Spread Footing Foundations***

All exterior foundation elements and those in any unheated parts of the proposed building should be provided with at least 1.5 metres of earth cover for frost protection purposes. Isolated, unheated foundation elements adjacent to surfaces, which are cleared of snow cover during winter months should be provided with a minimum 1.8 metres of earth cover for frost protection purposes.

The depth of frost cover could be reduced for footings bearing on engineered fill over glacial till. In this case, the combined thickness of earth cover and the engineered fill should be at least 1.5 metres for frost protection purposes. Alternatively, the required frost protection could be provided using a combination of earth cover and extruded polystyrene insulation. Detailed guidelines for footing insulation frost protection could be provided upon request.

Where less than the required depth of soil cover can be provided, the foundation elements should be protected from frost by using a combination of earth cover and extruded polystyrene rigid insulation. A typical frost protection insulation detail could be provided upon request, if required.

***Foundation Wall Backfill and Drainage***

To prevent possible foundation frost jacking due to frost adhesion, the backfill against the foundation walls or 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. Alternatively, foundations could be backfilled with native material in conjunction with the use of an approved proprietary drainage layer system such as "System Platon" against the foundation wall. It is pointed out that there is potential for possible frost jacking of the upper portion of some types of these drainage layer systems if frost susceptible material is used as backfill. This could be mitigated by backfilling the upper approximately 0.6 metres with non-frost susceptible granular material.

Where the backfill material will ultimately support a pavement structure or walkway, it is suggested that the foundation wall backfill material be compacted in 250 millimetre thick lifts to 95 percent of the standard Proctor dry density value.

Groundwater inflow from the native soils into the basement excavations during construction, if any should be handled by pumping from sumps within the excavations.

The basement foundation walls should be designed to resist the earth pressure, P, acting against the walls at any depth, h, calculated using the following equation.

$$\mathbf{P = k_0 (\gamma h + q)}$$

| | | | |
|---|---|---|---|
| Where: | P | = | the pressure, at any depth, h, below the finished ground surface |
| | $k_0$ | = | earth pressure at-rest coefficient, 0.5 |
| | $\gamma$ | = | unit weight of soil to be retained, estimated at 22 $kN/m^3$ |
| | q | = | surcharge load (kPa) above backfill material |
| | h | = | the depth, in metres, below the finished ground surface at which the pressure, P, is being computed |

This expression assumes that the water table would be maintained at the founding level by the above mentioned foundation perimeter drainage and backfill requirements.

Where the backfill material will ultimately support a pavement structure or walkway, it is suggested that the foundation wall backfill material be compacted in 250 millimetre thick lifts to 95 percent of the standard Proctor dry density value.

Provided everywhere the proposed finished floor surfaces are above the exterior finished grade and provided the exterior grade is adequately sloped away from the proposed building addition, no perimeter foundation drainage system is required.

***Slab on Grade Support***

For predictable performance of the proposed concrete floor slab all existing fill material, topsoil and any otherwise deleterious material should be removed from below the proposed floor slab area. The exposed native subgrade surface should then be inspected and approved by geotechnical personnel. Any soft areas evident should be subexcavated and replaced with suitable engineered fill. Any fill materials consisting of granular material, removed from the proposed concrete floor slab area, could be stockpiled for possible reuse with approval from the geotechnical engineer.

The fill materials beneath the proposed concrete floor slab on grade should consist of a minimum of 150 millimetre thickness of crushed stone meeting OPSS Granular A immediately beneath the concrete floor slab followed by sand, or sand and gravel meeting the OPSS for Granular B Type I, or crushed stone meeting OPSS grading requirements for Granular B Type II, or other material approved by the Geotechnical Engineer. The fill materials should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density.

The concrete floor slab should be saw cut at regular intervals to minimize random cracking of the slab due to shrinkage of the concrete. The saw cut depth should be about one quarter of the thickness of the slab. The crack control cuts should be placed at a grid spacing not exceeding the lesser of 25 times the slab thickness or 4.5 metres.

If any areas of the proposed building are to remain unheated during the winter period, thermal protection of the slab on grade may be required. Further details on the insulation requirements could be provided, if necessary.

**Seismic Design for the proposed Light Industrial Building**

For seismic design purposes, in accordance with the 2012 OBC Section 4.1.8.4, Table 4.1.8.4.A., the site classification for seismic site response is Site Class D.

Seismic Site Response Site Class Calculation

| Borehole 1 | | | | | |
|---|---|---|---|---|---|
| Layer | Description | Depth (m) | $d_i$ (m) | $N(60)_i$ (blows/0.3m) | $d_i/N_i$ (blows/0.3m) |
| 1 | Fill | | | | |
| 2 | Glacial Till | 1.7 | 5.3 | 29 | 0.183 |
| 3 | Bedrock | 7.0 | 24.7 | 100 | 0.247 |
| $sum(d_i/N(60)_i)$ | | | | | 0.43 |
| $d_c/(sum(d_i/N(60)_i)$ | | | | | 69.8 |
| | | | | | |

Since the N(60)>50 = 69.8, the seismic site response is Site Class C.

**Potential for Soil Liquefaction**

Since the subgrade soils between the proposed underside of footing elevation will consist of either compacted granular material (engineered fill) overlying a thin layer of compact to very dense glacial till followed by bedrock or will consist of a thin layer of glacial till overlying bedrock it is considered that the subgrade soils below the footings are not susceptible to liquefaction during a seismic event.

## SITE SERVICES

***Excavation***

The excavations for the site services will be carried out through fill and possibly glacial till. The sides of the excavations in overburden materials should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Ontario Occupational Health and Safety Act. Where space constraints dictate, the excavation and backfilling operations should be carried out within a tightly fitting, braced steel trench box.

It is expected that boulders of significant size and quantity may be encountered within the excavations for the site services. Any groundwater inflow into the service trenches should be handled by pumping from sumps from within the excavations.

***Pipe Bedding and Cover Materials***

It is suggested that the service pipe bedding material consist of at least 150 millimetres of granular material meeting OPSS requirements for Granular A. A provisional allowance should, however, be made for sub-excavation of any existing fill or disturbed material encountered at subgrade level. Granular material meeting OPSS specifications for Granular B Type II could be used as a sub-bedding material. The use of clear crushed stone as bedding or sub-bedding material should not be permitted.

Cover material, from pipe spring line to at least 300 millimetres above the top of the pipe, should consist of granular material, such as OPSS Granular A or Granular B Type I (with a maximum particle size of 25 millimetres).

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

***Trench Backfill***

The general backfilling procedures should be carried out in a manner that is compatible with the future use of the area above the service trenches.

In areas where the service trench will be located below or in close proximity to existing or future pavement areas, acceptable native materials should be used as backfill between the pavement subgrade level and the depth of seasonal frost penetration (i.e. 1.8 metres below finished grade) in order to reduce the potential for differential frost heaving between the area over the trench and the adjacent section of roadway.

Where native backfill is used, it should match the native materials exposed on the trench walls. Since the native material may contain large cobbles and boulders, it should be sorted or screened to remove the large cobbles and boulders prior to use as backfill. Some of the native materials from the lower part of the trench excavations may be wet of optimum for compaction. Depending on the weather conditions encountered during construction, some drying of materials and/or recompaction may be required. Any wet materials that cannot be compacted to the required density should either be wasted from the site or should be used outside of existing or future roadway areas. Backfill below the zone of seasonal frost penetration could consist of either acceptable native material or imported granular material conforming to OPSS Granular B Type I. If the native material is not suitable for backfill, imported granular material may have to be used. If imported granular materials are used, suitable frost tapers should be used OPSD 802.013.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the parking areas, sidewalks, etc., the trench should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density. The specified density may be reduced to 90 percent where the trench backfill is not located or in close proximity to existing or future roadways, driveways, sidewalks, or any other type of permanent structure.

**ACCESS ROADWAY AND PARKING AREA PAVEMENTS**

In preparation for pavement construction at this site the existing asphalt and underlying fill material should be removed to the elevation of the proposed top of subgrade based on the proposed final grading plan and proposed pavement structure thickness. The exposed sub-grade should be inspected and approved by geotechnical personnel and any soft areas evident should be sub-excavated and replaced with approved engineered fill material. The sub-grade should be shaped and crowned to promote drainage of the roadway area granular. Following approval of the preparation of the sub-grade, the pavement granular may be placed.

For any areas of the site that require the sub-grade to be raised to proposed pavement sub-grade level, the material used should consist of OPSS select sub-grade material or OPSS Granular B Type I or Type II. Recycled crushed concrete meeting the grading specifications for Granular B Type II could also be used. Materials used for raising the sub-grade to proposed roadway area sub-grade level should be placed in maximum 300 millimetre thick loose lifts and be compacted to at least 95 percent of the standard Proctor maximum dry density using suitable compaction equipment.

For pavement areas subject to cars and light trucks the pavement should consist of:

50 millimetres of Superpave 12.5 asphaltic concrete over
150 millimetres of OPSS Granular A base over
300 millimetres of OPSS Granular B, Type II subbase over
(50 or 100 millimetre minus crushed stone)
Non-woven geotextile fabric (4 oz/sy) such as Terrafix 270R or Thrace-Ling 130EX or approved alternative.

Performance grade PG 58-34 asphaltic concrete should be specified. Compaction of the granular pavement materials should be carried out in maximum 300 millimetre thick loose lifts to 100 percent of the standard Proctor maximum dry density value using suitable vibratory compaction equipment.

The above pavement structures will be adequate on an acceptable sub-grade, that is, one where any roadway fill and service trench backfill has been adequately compacted. If the roadway sub-grade 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. The adequacy of the design of the pavement thickness should be assessed by the geotechnical personnel at the time of construction.

**CONSTRUCTION CONSIDERATIONS**

It is suggested that the final design drawings for the project, including the proposed site grading plan, be reviewed by the geotechnical engineer to ensure that the guidelines provided in this report have been interpreted as intended.

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 foundation areas and any engineered fill areas for the proposed building should be inspected by Kollaard Associates Inc. to ensure that a suitable subgrade has been reached and properly prepared. The placing and compaction of any granular materials beneath the foundations should be inspected to ensure that the materials used conform to the grading and compaction specifications.

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

The native sand/silty sand deposits within the glacial till material at this site will be sensitive to disturbance from construction operations, from rainwater or snow melt, and frost. In order to minimize disturbance, construction traffic operating directly on the subgrade should be kept to an absolute minimum and the subgrade should be protected from below freezing temperatures.

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.

Regards,
Kollaard Associates Inc.

LICENSED PROFESSIONAL ENGINEER
Jan 27.2017
S.E. deWit
100079612
PROVINCE OF ONTARIO

Dean Tataryn, B.E.S., EP.

Steve DeWit, P.Eng.

Attachments: Record of Boreholes
Figures 1 and 2
Laboratory Test Results for Chemical Properties
Laboratory Test Results for Physical Properties – Stantec Laboratory Test Results for Soils

# RECORD OF BOREHOLE BH1

**PROJECT:** Proposed Residential Development
**CLIENT:** Urban Structure Properties Ltd.
**LOCATION:** 351 Croydon Road, Ottawa, Ontario
**PENETRATION TEST HAMMER:** 63.5kg, Drop, 0.76mm

**PROJECT NUMBER:** 160861
**DATE OF BORING:** January 9, 2017
**SHEET** 1 of 1
**DATUM:**

| DEPTH SCALE (meters) | SOIL PROFILE: DESCRIPTION | ELEV. DEPTH (M) | SAMPLES: NUMBER | TYPE | BLOWS/0.3m | PIEZOMETER OR STANDPIPE INSTALLATION |
|---|---|---|---|---|---|---|
| | Ground Surface | | | | | |
| 0 | Grey brown sand and gravel, trace silt and organics (FILL) | 0.00 | | | | |
| 1 | | | 1 | SS | 12 | |
| | Grey brown silty sand, some gravel, cobbles and boulders, trace clay (GLACIAL TILL) | 1.72 | 2 | SS | 60 | |
| 2 | | | 3 | SS | 63 | Borehole dry at time of drilling, January 9, 2017. |
| 3 | | | 4 | SS | 20 | |
| 4 | | | 5 | SS | 22 | |
| 5 | | | 6 | SS | 11 | |
| | Grey silty sand, some gravel, cobbles and boulders, trace clay (GLACIAL TILL) | 5.48 | 7 | SS | 17 | |
| 6 | | | 8 | SS | 44 | |
| | Borehole continued as Probe Hole, probably grey silt, then grey silty sand with some gravel, cobbles and boulders (GLACIAL TILL) | 6.70 | | | | |
| 7 | End of Borehole, refusal on large boulder or bedrock | 7.01 | | | | |
| 8 | | | | | | |

UNDIST. SHEAR STRENGTH × Cu, kPa × 20 40 60 80

REM. SHEAR STRENGTH ○ Cu, kPa ○ 20 40 60 80

DYNAMIC CONE PENETRATION TEST blows/300 mm 10 30 50 70 90

STRATA PLOT

ADDITIONAL LAB TESTING

**DEPTH SCALE:** 1 to 50
**BORING METHOD:** Power Auger
**AUGER TYPE:** 200 mm Hollow Stem
**LOGGED:** DT
**CHECKED:** DT

# RECORD OF BOREHOLE BH2

**PROJECT:** Proposed Residential Development
**CLIENT:** Urban Structure Properties Ltd.
**LOCATION:** 351 Croydon Road, Ottawa, Ontario
**PENETRATION TEST HAMMER:** 63.5kg, Drop, 0.76mm

**PROJECT NUMBER:** 160861
**DATE OF BORING:** January 9, 2017
**SHEET** 1 of 1
**DATUM:**

| DEPTH SCALE (meters) | SOIL PROFILE – DESCRIPTION | STRATA PLOT | ELEV. DEPTH (M) | SAMPLES – NUMBER | TYPE | BLOWS/0.3m | UNDIST. SHEAR STRENGTH × Cu, kPa 20 40 60 80 / REM. SHEAR STRENGTH ○ Cu, kPa 20 40 60 80 | DYNAMIC CONE PENETRATION TEST blows/300 mm 10 30 50 70 90 | ADDITIONAL LAB TESTING | PIEZOMETER OR STANDPIPE INSTALLATION |
|---|---|---|---|---|---|---|---|---|---|---|
| | Ground Surface | | | | | | | | | |
| 0 | Grey brown sand and gravel, trace silt and organics (FILL) | | 0.00 | | | | | | | |
| 1 | | | | 1 | SS | 32 | | | | |
| | Grey brown silty sand, some gravel, cobbles and boulders, trace clay (GLACIAL TILL) | | 1.70 | 2 | SS | 50 | | | | Borehole dry at time of drilling, January 9, 2017. |
| 2–3 | | | | 3 | SS | 93 | | | | |
| | | | | 4 | SS | 26 | | | | |
| | Grey silty sand, some gravel, cobbles and boulders, trace clay (GLACIAL TILL) | | 3.40 | | | | | | | |
| 4 | | | | 5 | SS | 8 | | | | |
| 5 | | | | 6 | SS | 10 | | | | |
| | | | | 7 | SS | 51 | | | | |
| 6 | End of Borehole, refusal on large boulder or bedrock | | 5.97 | | | | | | | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |

**DEPTH SCALE:** 1 to 50
**BORING METHOD:** Power Auger
**AUGER TYPE:** 200 mm Hollow Stem
**LOGGED:** DT
**CHECKED:** DT

# RECORD OF BOREHOLE BH3

**PROJECT:** Proposed Residential Development
**CLIENT:** Urban Structure Properties Ltd.
**LOCATION:** 351 Croydon Road, Ottawa, Ontario
**PENETRATION TEST HAMMER:** 63.5kg, Drop, 0.76mm

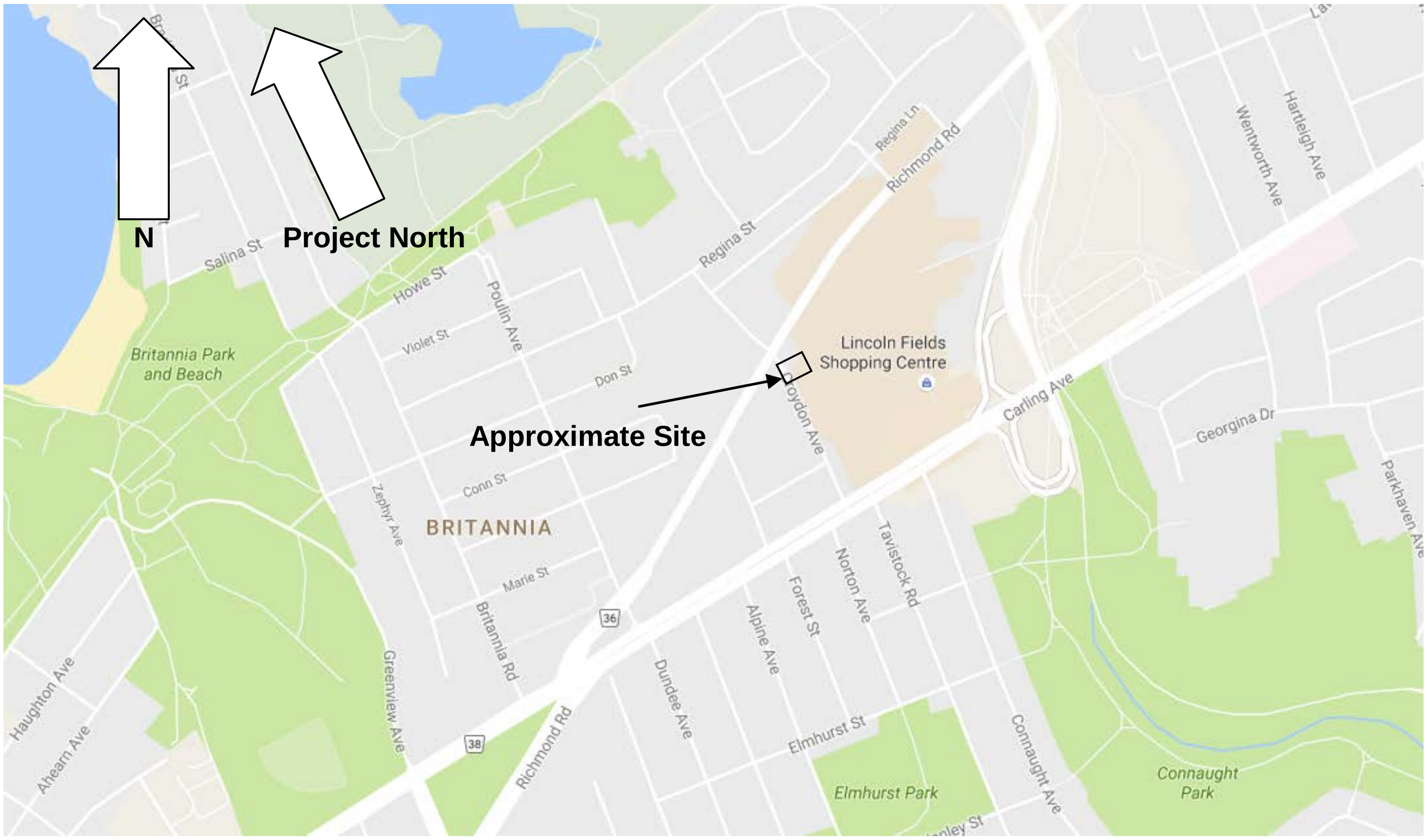
**PROJECT NUMBER:** 160861
**DATE OF BORING:** January 9, 2017
**SHEET** 1 of 1
**DATUM:**

| DEPTH SCALE (meters) | SOIL PROFILE: DESCRIPTION | ELEV. DEPTH (M) | SAMPLES: NUMBER | TYPE | BLOWS/0.3m | UNDIST. SHEAR STRENGTH × Cu, kPa 20 40 60 80 / REM. SHEAR STRENGTH ○ Cu, kPa 20 40 60 80 | DYNAMIC CONE PENETRATION TEST blows/300 mm 10 30 50 70 90 | ADDITIONAL LAB TESTING | PIEZOMETER OR STANDPIPE INSTALLATION |
|---|---|---|---|---|---|---|---|---|---|
| | Ground Surface | | | | | | | | |
| 0 | Grey brown sand and gravel, trace silt and organics (FILL) | 0.00 | | | | | | | |
| 1 | | | 1 | SS | 24 | | | | |
| | | | 2 | SS | 43 | | | | |
| 2 | Grey brown silty sand, some gravel, cobbles and boulders, trace clay (GLACIAL TILL) | 1.87 | | | | | | | Borehole dry at time of drilling, January 9, 2017. |
| | | | 3 | SS | 23 | | | | |
| 3 | | | 4 | SS | 32 | | | | |
| 4 | | | 5 | SS | 29 | | | | |
| | Grey silty sand, some gravel, cobbles and boulders, trace clay (GLACIAL TILL) | 4.32 | | | | | | | |
| 5 | | | 6 | SS | 13 | | | | |
| | | | 7 | SS | 50 | | | | |
| | End of Borehole, refusal on large boulder or bedrock | 5.49 | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |

**DEPTH SCALE:** 1 to 50
**BORING METHOD:** Power Auger
**AUGER TYPE:** 200 mm Hollow Stem
**LOGGED:** DT
**CHECKED:** DT

# KEY PLAN

**FIGURE 1**

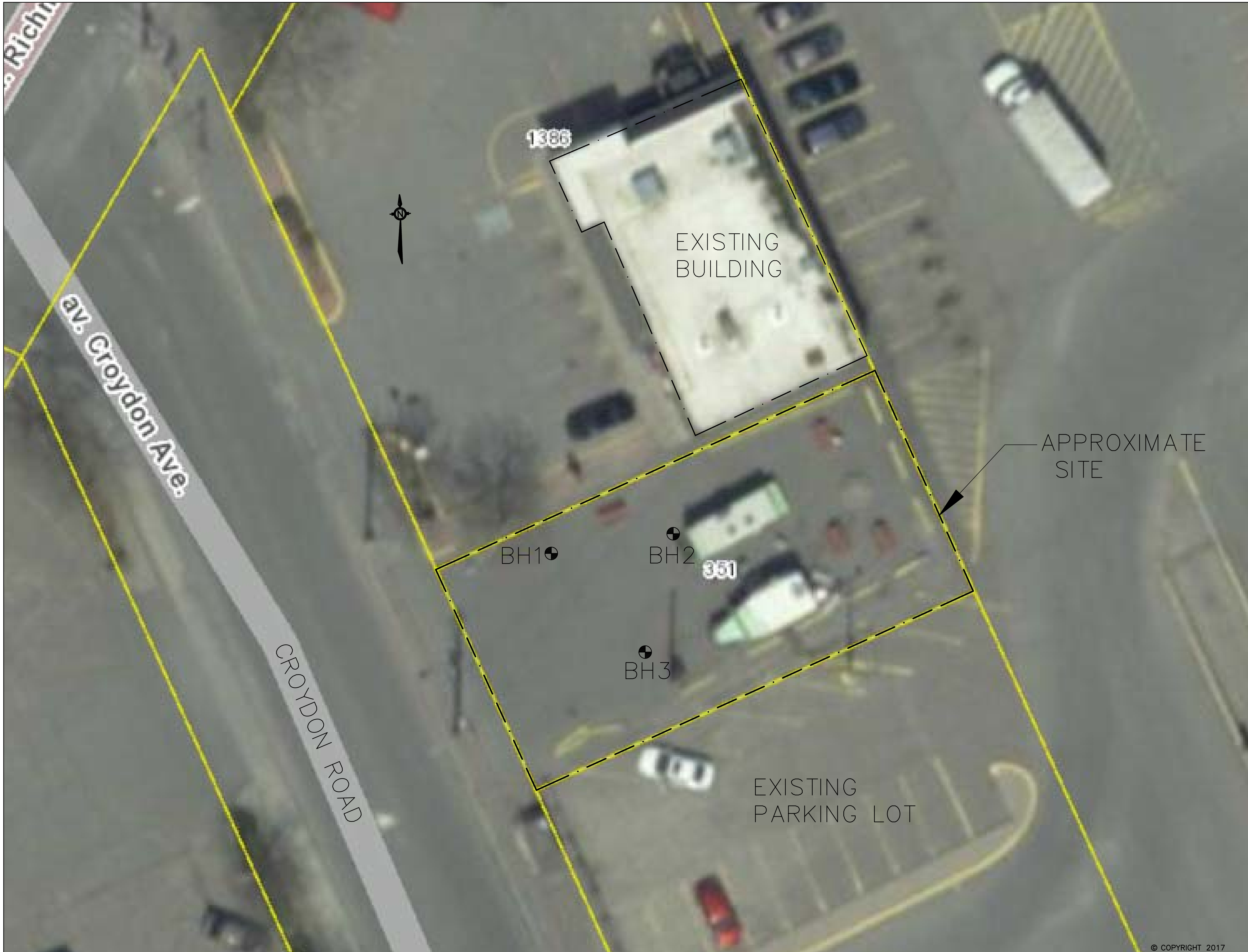



**NOT TO SCALE**

Kollaard Associates Engineers

Project No. 160861

Date January 2017






*DRAWING NUMBER:*
SITE PLAN, FIGURE 2

LEGEND:

BH1 APPROXIMATE BOREHOLE LOCATION

REFERENCE: PLAN SUPPLIED BY CITY OF OTTAWA EMAPS.

SPECIAL NOTE: THIS DRAWING TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

| REV. | NAME | DATE | DESCRIPTION |
|---|---|---|---|
| | | | |

Kollaard Associates
Engineers
PO, BOX 189, 210 PRESCOTT ST
KEMPTVILLE ONTARIO
K0G 1J0 FAX (613) 258-0475
http://www.kollaard.ca
(613) 860-0923
info@kollaard.ca

*CLIENT:*
URBAN STRUCTURE PROPERTIES LTD.

*PROJECT:*
GEOTECHNICAL INVESTIGATION FOR RESIDENTIAL BUILDING

*LOCATION:*
351 CROYDON ROAD
CITY OF OTTAWA, ONTARIO

| *DESIGNED BY:* -- | *DATE:* JAN. 19, 2017 |
|---|---|
| *DRAWN BY:* DT | *SCALE:* N.T.S |

*KOLLAARD FILE NUMBER:*
160861

## Laboratory Test Results for Chemical Properties

# Certificate of Analysis

Environment Testing

| | | | |
|---|---|---|---|
| Client: | Kollaard Associates Inc.<br>210 Prescott St., Box 189<br>Kemptville, ON<br>K0G 1J0 | Report Number: | 1700367 |
| | | Date Submitted: | 2017-01-10 |
| | | Date Reported: | 2017-01-17 |
| | | Project: | 160861 |
| | | COC #: | 185143 |
| Attention: | Mr. Dean Tataryn | | |
| PO#: | | | |
| Invoice to: | Kollaard Associates Inc. | | |



**Dear Dean Tataryn:**

**Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).**

Report Comments:

APPROVAL: ______________________________

Shyla Monette
Team Leader, Inorganics

All analysis is completed in Ottawa, Ontario (unless otherwise indicated).

Eurofins Ottawa is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on our CALA scope of accreditation. It can be found at http://www.cala.ca/scopes/2602.pdf.

Eurofins(Ottawa) is certified and accredited for specific parameters by OMAFRA, Ontario Ministry of Agriculture, Food and Rural Affairs (for farm soils). Licensed by Ontario MOE for specific tests in drinking water.

Eurofins(Mississauga) is accredited for specific parameters by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required.

# Certificate of Analysis

Environment Testing

Client: Kollaard Associates Inc.
210 Prescott St., Box 189
Kemptville, ON
K0G 1J0
Attention: Mr. Dean Tataryn
PO#:
Invoice to: Kollaard Associates Inc.

Report Number: 1700367
Date Submitted: 2017-01-10
Date Reported: 2017-01-17
Project: 160861
COC #: 185143

| Group | Analyte | MRL | Units | Guideline | Lab I.D. 1276810<br>Sample Matrix Soil<br>Sample Type<br>Sampling Date 2017-01-09<br>Sample I.D. BH2 SS2 5-7 |
|---|---|---|---|---|---|
| Agri. - Soil | pH | 2.0 | | | 8.3 |
| General Chemistry | Cl | 0.002 | % | | 0.014 |
| | Electrical Conductivity | 0.05 | mS/cm | | 0.36 |
| | Resistivity | 1 | ohm-cm | | 2780 |
| | SO4 | 0.01 | % | | <0.01 |

**Guideline =** *** = Guideline Exceedence**

All analysis completed in Ottawa, Ontario (unless otherwise indicated by ** which indicates analysis was completed in Mississauga, Ontario).
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

# Certificate of Analysis

Eurofins Environment Testing

| | | | | |
|---|---|---|---|---|
| Client: | Kollaard Associates Inc.<br>210 Prescott St., Box 189<br>Kemptville, ON<br>K0G 1J0 | | Report Number: | 1700367 |
| Attention: | Mr. Dean Tataryn | | Date Submitted: | 2017-01-10 |
| PO#: | | | Date Reported: | 2017-01-17 |
| Invoice to: | Kollaard Associates Inc. | | Project: | 160861 |
| | | | COC #: | 185143 |

## *QC Summary*

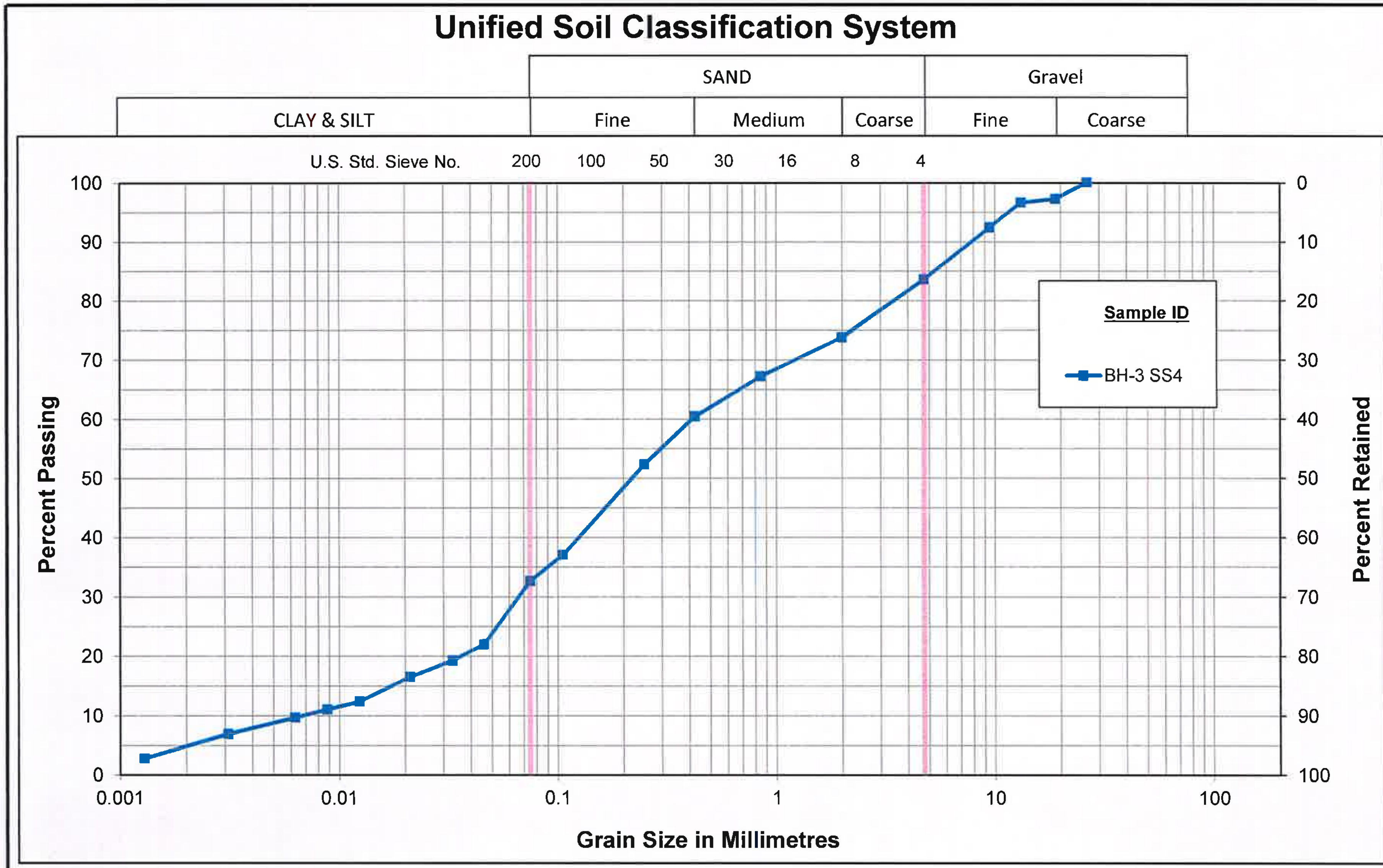
| Analyte | Blank | QC % Rec | QC Limits |
|---|---|---|---|
| **Run No** 320259 **Analysis/Extraction Date** 2017-01-11 **Analyst** AET | | | |
| **Method** Ag Soil | | | |
| pH | | | 90-110 |
| **Method** Cond-Soil | | | |
| Electrical Conductivity | | | 85-115 |
| **Run No** 320448 **Analysis/Extraction Date** 2017-01-12 **Analyst** NP | | | |
| **Method** C SM4500-SO4--D | | | |
| SO4 | <0.01 % | 100 | 70-130 |
| **Run No** 320466 **Analysis/Extraction Date** 2017-01-13 **Analyst** SCM | | | |
| **Method** Resistivity - soil | | | |
| Resistivity | | | |
| **Run No** 320590 **Analysis/Extraction Date** 2017-01-16 **Analyst** NP | | | |
| **Method** C CSA A23.2-4B | | | |
| Chloride | | 99 | 90-110 |

**Guideline =** *** = Guideline Exceedence**

All analysis completed in Ottawa, Ontario (unless otherwise indicated by ** which indicates analysis was completed in Mississauga, Ontario).
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

**Laboratory Test Results for Physical Properties**




| | | |
|---|---|---|
| Stantec | **GRAIN SIZE DISTRIBUTION**<br>Kollaard Associates Engineers, File #160861<br>Residential Development, 351 Croydon Avenue | Figure No.<br>Project No. 122410003 |

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

# Particle-Size Analysis of Soils
**LS702**
**ASSHTO T 88**

## PROJECT DETAILS

| | | | |
|---|---|---|---|
| Client: | Kollaard Associates Engineers, File #160861 | Project No.: | 122410003 |
| Project: | Residential Development, 351 Croydon Avenue | Test Method: | LS702 |
| Material Type: | Soil | Sampled By: | Kollaard Associates Engineers |
| Source: | BH-3 | Date Sampled: | January 9, 2017 |
| Sample No.: | SS4 | Tested By: | Denis Rodriguez |
| Sample Depth: | 10'-12' | Date Tested: | January 13, 2017 |

## WASH TEST DATA

| | |
|---|---|
| Oven Dry Mass In Hydrometer Analysis (g) | 52.53 |
| Sample Weight after Hydrometer and Wash (g) | 29.43 |
| Percent Passing No. 200 Sieve (%) | 44.0 |
| Percent Passing Corrected (%) | 32.45 |

## PERCENT LOSS IN SIEVE

| | |
|---|---|
| Sample Weight Before Sieve (g) | 519.90 |
| Sample Weight After Sieve (g) | 518.80 |
| Percent Loss in Sieve (%) | 0.21 |

## SOIL INFORMATION

| | | |
|---|---|---|
| Liquid Limit (LL) | | |
| Plasticity Index (PI) | | |
| Soil Classification | | |
| Specific Gravity ($G_s$) | 2.750 | |
| Sg. Correction Factor ($\alpha$) | 0.978 | |
| Mass of Dispersing Agent/Litre | 48 | g |

## CALCULATION OF DRY SOIL MASS

| | |
|---|---|
| Oven Dried Mass ($W_o$), (g) | 96.36 |
| Air Dried Mass ($W_a$), (g) | 96.74 |
| Hygroscopic Corr. Factor ($F=W_o/W_a$) | 0.9961 |
| Air Dried Mass in Analysis ($M_a$), (g) | 52.74 |
| Oven Dried Mass in Analysis ($M_o$), (g) | 52.53 |
| Percent Passing 2.0 mm Sieve ($P_{10}$), (%) | 73.78 |
| Sample Represented (W), (g) | 71.20 |

## SIEVE ANALYSIS

| Sieve Size mm | Cum. Wt. Retained | Percent Passing |
|---|---|---|
| 75.0 | | 100.0 |
| 63.0 | | 100.0 |
| 53.0 | | 100.0 |
| 37.5 | | 100.0 |
| 26.5 | 0.0 | 100.0 |
| 19.0 | 14.5 | 97.2 |
| 13.2 | 17.7 | 96.6 |
| 9.5 | 39.6 | 92.4 |
| 4.75 | 85.3 | 83.6 |
| 2.00 | 136.3 | 73.8 |
| Total (C + F)[1] | 518.80 | |
| 0.850 | 4.67 | 67.22 |
| 0.425 | 9.48 | 60.47 |
| 0.250 | 15.25 | 52.36 |
| 0.106 | 26.17 | 37.03 |
| 0.075 | 29.28 | 32.66 |
| PAN | 29.40 | |

Note 1: (C + F) = Coarse + Fine

## HYDROMETER DETAILS

| | |
|---|---|
| Volume of Bulb ($V_B$), ($cm^3$) | 63.0 |
| Length of Bulb ($L_2$), (cm) | 14.47 |
| Length from '0' Reading to Top of Bulb ($L_1$), (cm) | 10.29 |
| Scale Dimension ($h_s$), (cm/Div) | 0.155 |
| Cross-Sectional Area of Cylinder (A), ($cm^2$) | 27.2 |
| Meniscus Correction ($H_m$), (g/L) | 1.0 |

**START TIME** 11:09 AM

## HYDROMETER ANALYSIS

| Date | Time | Elapsed Time T Mins | $H_s$ Divisions g/L | $H_c$ Divisions g/L | Temperature $T_c$ °C | Corrected Reading $R = H_s - H_c$ g/L | Percent Passing P % | L cm | η Poise | K | Diameter D mm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13-Jan-17 | 11:10 AM | 1 | 24.0 | 8.0 | 21.5 | 16.0 | 21.99 | 12.49191 | 9.7308 | 0.0130 | 0.0461 |
| 13-Jan-17 | 11:11 AM | 2 | 22.0 | 8.0 | 21.5 | 14.0 | 19.24 | 12.80191 | 9.7308 | 0.0130 | 0.0330 |
| 13-Jan-17 | 11:14 AM | 5 | 20.0 | 8.0 | 21.5 | 12.0 | 16.49 | 13.11191 | 9.7308 | 0.0130 | 0.0211 |
| 13-Jan-17 | 11:24 AM | 15 | 17.0 | 8.0 | 21.5 | 9.0 | 12.37 | 13.57691 | 9.7308 | 0.0130 | 0.0124 |
| 13-Jan-17 | 11:39 AM | 30 | 16.0 | 8.0 | 21.5 | 8.0 | 10.99 | 13.73191 | 9.7308 | 0.0130 | 0.0088 |
| 13-Jan-17 | 12:09 PM | 60 | 15.0 | 8.0 | 21.5 | 7.0 | 9.62 | 13.88691 | 9.7308 | 0.0130 | 0.0063 |
| 13-Jan-17 | 3:19 PM | 250 | 13.0 | 8.0 | 21.5 | 5.0 | 6.87 | 14.19691 | 9.7308 | 0.0130 | 0.0031 |
| 14-Jan-17 | 11:09 AM | 1440 | 10.0 | 8.0 | 23.0 | 2.0 | 2.75 | 14.66191 | 9.3925 | 0.0128 | 0.0013 |

Remarks:

Reviewed By: Brian Prevost
Date: January 16/2017

V:\01224\active\laboratory_standing_offers\2017 Laboratory Standing Offers\122410003 Kollaard Associates Engineers\January 9, Hydrometer, Kollaard #160861\Hydrometer.xlsx