Strathroy Turf Farm Ltd.

Supplementary Geotechnical Investigation

DRAFT

Project Name
Kettle Creek Golf and Country Club Development

Project Location
320 Carlow Road, Port Stanley, Ontario

Project Number
LON-0013222-GE

Prepared By:
exp Services Inc.
15701 Robin's Hill Road
London, ON N5V 0A5
Canada

Date Submitted
April 9, 2015

Strathroy Turf Farm Ltd.

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Date Submitted:
April 9, 2015

Legal Notification

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1. Introduction

As requested, **exp** Services Inc. (**exp**) has conducted a supplementary geotechnical investigation in conjunction with a proposed residential development to be located within the Kettle Creek Golf and Country Club property in Port Stanley, Ontario. It is understood that the development will have full municipal servicing and will be accessed by local roadways. This report summarizes the results of the current and previous investigations, and provides supplementary geotechnical engineering guidelines to assist with the design and construction of the proposed development.

1.1 Previous Studies

The following preliminary geotechnical investigations were carried by Exp. and Trow (currently exp) at the site:

- Preliminary Geotechnical Investigation "Proposed Residential Development dated October 2007"; and
- Preliminary Geotechnical Investigation "Kettle Creek Golf and Country Club Development dated September 2014".

The boreholes and test pits carried out within the above two studies are attached in **Appendix B**.

1.2 Terms of Reference

This supplementary geotechnical investigation was generally done in accordance with email correspondence between the client and **exp**.

The purpose of this supplementary investigation was to delineate areas of the site, which could support conventional strip/spread footings and/or stiffened slab foundations for residential dwelling units (with or without basement) without excessive site preparation costs. In addition, the purpose of the current study was to provide feasible/practical deep foundation options for weak zones. In addition, to verify the subsoil and groundwater conditions encountered at the site in previous studies by advancing a series of sampled boreholes and installing piezometers at the locations shown on the attached Boreholes and Test Pit Location Plan (Drawing 1).

Based on an interpretation of the factual test hole data, and a review of soil and groundwater information from test holes advanced at the site, **exp** Services Inc. has provided supplementary engineering guidelines to assist with the geotechnical design and construction of the proposed residential subdivision. More specifically, this report provides comments on foundation and site service options.

This report is provided on the basis of the Terms of Reference presented above and on the assumption that the design will be in accordance with applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning geotechnical aspects of the codes and standards, this office should be contacted to review the design.

2. Methodology

The fieldwork was conducted on March 13 and 19, 2015 and consisted of drilling twelve (12) boreholes at the approximate locations shown on Drawing 1. Two piezometers were installed in BH1 and BH9.

The boreholes were advanced by a specialist drilling subcontractor under the full time supervision of exp geotechnical staff. The boreholes were advanced utilizing track mounted drill rig using 150 mm diameter continuous flight solid stem augers.

During the investigation program, soil samples were taken at 0.76 m to 1.5 m intervals (as appropriate) utilizing a 50 mm diameter split-barrel sampler, advanced by dropping a 63.5 kg hammer approximately 760 mm, in accordance with the standard penetration test (SPT) method (ASTM 1586). The SPT results are reported as (penetration index) "N" values on the borehole logs.

During the drilling activities, the stratigraphy in the boreholes was examined and logged in the field by exp geotechnical personnel.

Short and long-term groundwater level observations within the open boreholes and installed piezometers, and observations pertaining to groundwater conditions at the borehole locations are recorded in the borehole logs found in **Appendix A**.

Soil samples obtained from the boreholes were inspected and classified in the field, immediately upon retrieval for type, texture, colour and moisture. The samples were transferred to exp's London laboratory for tactile examination, detailed descriptions and laboratory testing.

The laboratory work program consisted of moisture content determination on all recovered soil samples and grain size analysis. The test results are presented on the borehole logs.

The information in this report in no way reflects on the environmental aspects of the soil. Should specific information in this regard be needed, additional testing may be required

3. Subsurface Conditions

3.1 Soil Stratigraphy

The subsoil conditions during this study consistent with previous investigation findings. The detailed stratigraphy encountered in each borehole and the results of routine laboratory tests carried out on representative samples of the subsoils are presented on the attached borehole logs. It must be noted that boundaries of soil indicated on the logs are inferred from non-continuous sampling and observations during excavating. These boundaries are intended to reflect transition zones for the purposes of geotechnical design and should not be interpreted as exact planes of geological change.

The subsurface soil conditions encountered in the boreholes of current study are detailed on the boreholes Logs provided in **Appendix A** while the borehole and test pit logs of previous studies are provided in **Appendix B**.

The subsurface conditions at the site consist of topsoil over compact sandy soils or loose to very loose sands, silts and sandy silt interlayered with strata of clayey silt overlying clayey silt/clayey silt till. Random layers of peat were encountered throughout the alluvial soils in few locations. Based on the results of current and previous investigations at the site, the thickness of the loose/soft layers varies across the site and ranging from 0.8 m to up to 6.5 m below ground surface (bgs). Based on the thickness of loose/soft layers, competent soil findings and groundwater levels, the site is divided into four (4) groups designated as Group 1 through Group 4. Each group is then divided into areas. The competent soils were found at depths ranged from 0.8 to 2.3 m bgs in group 1, at about 3.0 m bgs in group 2, ranged from 4.5 to 5.5 m bgs in group 3, and ranged from 6.0 to 6.5 m bgs in group 4. The competent soil depths are provided on Drawing 1.

Subsurface conditions are also summarized in Table 1 attached with this report.

Refer to previous geotechnical investigations or attached boreholes and test pits for further details of the subsurface conditions.

3.2 Groundwater Conditions

During the current investigation, observations of groundwater/seepage conditions and measured depths of the groundwater are provided on the Borehole Logs and Drawing 1 and summarized in Table1, attached.

The groundwater conditions observed within this study is consistent with previous studies. However, groundwater/seepage was observed/measured at depths ranged from 0.6 to 2.5 m in group 1, 2 and 3. In group 4 the groundwater was measured at depths ranged from 3.2 to 3.7 m bgs.

Refer to previous geotechnical investigations or attached boreholes and test pits for further details of the groundwater/seepage conditions.

It is noted that the depth to the groundwater table may vary in response to climatic or seasonal conditions, and, as such, may differ at the time of construction, with higher levels in wet seasons. Capillary rise effects should also be anticipated within fine grained soil deposits.

4. Discussion and Recommendations

There are no set development plans at this time. It is understood, however, that the proposed development will include residential units, full municipal servicing and paved roadways. The following sections of this report provide supplementary geotechnical recommendations regarding foundations and site servicing. **For geotechnical comments and recommendations regarding site preparation, excavations and dewatering, basement design, preloading, and pavement design requirements refer to exp's preliminary geotechnical investigation dated September 2014.**

Based on the results of the investigation, the soils encountered within the site vary widely from very loose/soft to compact and wet to saturated deposits of silt, sand, alluvium, peat and clay which overlie glacial till at depth. The very loose/soft and wet deposits will generally not support conventional strip and spread foundations and stiffened slab foundations without risk of excessive settlements. In addition, conventional construction of site services through very loose/soft deposits may also result in undesirable vertical movement of the service piping unless precaution measurements are taken.

Based on the findings of current and previous studies, the site is divided into four (4) groups Group1 through 4, and then each group subdivided into areas based on their locations and founding depths of the competent soils. Each area was bordered with an imaginary line. The groups and areas are shown on Drawing 1.

The purpose of the current investigation was to delineate areas of the site, which could support conventional strip/spread footings and/or stiffened slab foundations for residential dwelling units (with or without basement) without excessive site preparation costs. In addition, the purpose of the current study was to provide feasible/practical deep foundation options for weak areas.

It is noted that the extent of the groups/areas indicated have been inferred from the results of widely spaced test holes, and that verification of these extents would be required at the time of site grading.

The subsoil and groundwater conditions from current and previous studies and feasible/practical foundation recommendations are summarized in Table 1 (Attached) and detailed below.

4.1 Residential Foundations

4.1.1 Group 1 (Areas A1 & A2)

Group 1 consists of Areas A1 and A2. Findings in these areas are outlined below:

- Groundwater/seepage were observed within about 0.6 to 2.3 m bgs;
- Competent soils were encountered within about 0.8 to 2.3 m bgs.

- Peat was encountered between 1.5 m to 3.2 m bgs at TP2 of 2007, and between 2.5 m to 3.4 m at TP11 of 2014

4.1.1.1 Buildings without Basements

These areas are generally **can support** single family residences without basements founded on conventional strip and spread footings or stiffened slab foundation option. The following comments/remarks will be associated with this option:

- Minor groundwater might be anticipated during excavation and water pumping using a sump pump techniques would be required for only spread/strip footings;
- No Permit To Take Water (PTTW) is required during construction;
- No drainage system is required;
- Minor restoration is required at few localized loose/soft areas for spread/strip footing option but up to 1.5 m thick restoration/engineered fill is required for the stiffened slab foundation; and
- Not feasible option at areas where peat is encountered unless it is removed.

For design of the footings founded on native soils, an allowable Serviceability Limit States (SLS) bearing pressure of 100 kPa Factored Ultimate Limit State (ULS) Geotechnical of 150 KPa can be used for footings set at shallower depths. All footings exposed to seasonal freezing conditions should be protected from frost action by at least 1.2 m (4 ft) of soil cover or equivalent insulation.

4.1.1.2 Buildings with Basements

These areas are generally **can support** single family residences with basements founded on conventional strip and spread footings founded at approximate depth of 2.5 m bgs (founded below topsoil, fill or unsuitable soils on the natural competent subgrade soils). The following comments/remarks will be associated with this option:

- Moderate to severe groundwater is anticipated during excavation and water pumping using a sump pump techniques would be required;
- Permit To Take Water (PTTW) might be required during construction;
- Drainage system is required for foundation walls and floor slab of the basement;

- Permanent PTTW might be required;
- No localized restoration or engineered fill is required; and
- It is a feasible option as well at areas where peat is encountered at depth of up to 2.5 m but the peat encountered below 2.5 m should be removed or ventilation system be installed.

For design of the footings founded on native soils, an allowable Serviceability Limit States (SLS) bearing pressure of 100 kPa Factored Ultimate Limit State (ULS) Geotechnical of 150 KPa can be used for footings set at about 2.5 m or deeper.

4.1.2 Group 2 (Area B)

Group 2 consists of Area B. Findings in this area are outlined below:

- Groundwater/seepage were observed within about 1.3 to 1.5 m bgs;
- Competent soils were encountered at about 3.0 m bgs; and
- No peat was encountered.

4.1.2.1 Buildings without Basements

This area **cannot support** single family residences (without basements) founded on conventional strip and spread footings or stiffened slab foundations due to deep competent soil founded at about 3.0 m bgs. **The conventional strip and spread footings or stiffened slab foundations founded on an engineered fill will be a feasible option**. The following comments/remarks will be associated with this option:

- Moderate to severe groundwater might be anticipated during excavation and water pumping using a sump pump techniques would be required;
- Permit To Take Water (PTTW) might be required during construction;
- No drainage system is required for foundation wall or floor slab/stiffened slab foundation; and
- About 1.8 – 2.3 m engineered fill is required.

For design of the footings and/or stiffened slab foundations founded on an engineered fill, an allowable Serviceability Limit States (SLS) bearing pressure of 100 kPa Factored Ultimate Limit State (ULS) Geotechnical of 150 KPa can be used for footings set at

shallower depths. All footings exposed to seasonal freezing conditions should be protected from frost action by at least 1.2 m (4 ft) of soil cover or equivalent insulation.

4.1.2.2 Buildings with Basements

These areas are generally **can support** single family residences (with basements) founded on conventional strip and spread footings founded at approximate depth of 2.5 m bgs (founded below topsoil, fill or unsuitable soils on the natural competent subgrade soils). The following comments/remarks will be associated with this option:

- Moderate to severe groundwater is anticipated during excavation and water pumping using a sump pump techniques would be required;
- Permit To Take Water (PTTW) might be required during construction;
- Drainage system is required for foundation wall and floor slab of the basement;
- Permanent PTTW might be required; and
- Extending footings and walls of the basement to competent depth of 3.0 m, placing up to 0.5 m of engineered fill or compacting an exposed subgrade prior to footing placement is required.

For design of the footings founded on native soils and/or engineered fill, an allowable Serviceability Limit States (SLS) bearing pressure of 100 kPa Factored Ultimate Limit State (ULS) Geotechnical of 150 KPa can be used for footings set at about 2.5 m or deeper.

4.1.3 Group 3 (Areas C1, C2 & C3)

Group 1 consists of Areas C1, C2 and C3. Findings in these areas are outlined below:

- Groundwater/seepage were observed within about 1.5 to 2.0 m bgs;
- Competent soils were encountered at depths ranged from 4.5 to 5.5 m bgs;
- Thick loose/soft soils were encountered above the competent soils; and
- Peat was encountered between 0.5 m to 0.9 m bgs and between 2.3 m to 3.2 m bgs at BH1 of 2015, between 1.6 m to 3.2 m at BH2 of 2015, and between 0.2 m to 1.0 m at BH7 of 2015.

4.1.3.1 Buildings without Basements

Single family residences (without basements) supporting on conventional strip and spread footings or stiffened slab foundations founded on native soils is **NOT** feasible at these areas due to about 4.0 to 5.0 m thick loose/soft soils encountered at shallower depths above competent soils which was found at depths of 4.5 m to 5.5 m. It is also not feasible to restore the areas to underside of conventional footings, which requires about 4.0 to 5.0 m thick of engineered fill and construction dewatering.

Supporting building on existing loose/soft soils could be considered as an option if the building is structurally designed to tolerate anticipated total and/or differential settlements due to consolidation of the very loose/soft soils below footings. However, building maintenance might be required in the future.

For design of the footings and/or stiffened slab foundations founded on native soils, an allowable Serviceability Limit States (SLS) bearing pressure of 50 kPa Factored Ultimate Limit State (ULS) Geotechnical of 75 KPa can be used for footings set at shallower depths. All footings exposed to seasonal freezing conditions should be protected from frost action by at least 1.2 m (4 ft) of soil cover or equivalent insulation.

4.1.3.2 Buildings with Basements

Single family residences (with basements) supporting on conventional strip and spread footings founded on native soils is **NOT** feasible at these areas. This is due to about 4.0 to 5.0 m thick loose/soft soils encountered at shallower depths above competent soils which was encountered at depths of 4.5 m to 5.5 m. Single family residences (with basements) supporting on conventional strip and spread footings founded on engineered fill is **Not** a **feasible** option due to approximately 2.0 to 3.0 m thick engineered fill requirement to restore the areas to underside of conventional footings and construction dewatering needed.

Supporting building on existing very loose/soft soils could be considered an option if the building is structurally designed to tolerate anticipated total and/or differential settlements due to consolidation of the loose/soft soils and peat layers below footings. However, building maintenance might be required in the future.

For design of the footings founded on native loose/soft soils, an allowable Serviceability Limit States (SLS) bearing pressure of 50 kPa Factored Ultimate Limit State (ULS) Geotechnical of 75 KPa can be used for footings.

4.1.4 Group 4 (Areas D1, D2, D3 & D4)

Group 4 consists of Areas D1, D2, D3 and D4. Findings in these areas are outlined below:

- Groundwater/seepage were observed within about 3.2 to 3.7 m bgs;
- Competent soils were encountered at depths ranged from 6.0 to 6.5 m bgs.
- Thick loose/soft soils were encountered above the competent soils; and
- Peat was encountered between 2.4 m to 4.9 m bgs at BH11 of 2007.

4.1.4.1 Buildings without Basements

Single family residences (without basements) supporting on conventional strip and spread footings or stiffened slab foundations founded on native soils is **NOT** feasible at these areas due to deep competent soils found at depths of 6.0 m to 6.5 m. It is also **NOT** feasible to restore the areas to underside of conventional footings, which requires about 5.0 to 5.5 m thick of engineered fill and construction dewatering.

Supporting building on existing loose/soft soils could be considered an option if the building is structurally designed to tolerate anticipated total and/or differential settlements due to consolidation of the loose/soft soils and peat layers below footings. However, building maintenance might be required in future.

For design of the footings and/or stiffened slab foundations founded on native loose/soft soils, an allowable Serviceability Limit States (SLS) bearing pressure of 50 kPa Factored Ultimate Limit State (ULS) Geotechnical of 75 KPa can be used for footings set at shallower depths. All footings exposed to seasonal freezing conditions should be protected from frost action by at least 1.2 m (4 ft) of soil cover or equivalent insulation.

4.1.4.2 Buildings with Basements

Single family residences (with basements) supporting on conventional strip and spread footings founded on native soils is **NOT** feasible at these areas. This is due to deep competent soils found at depths of 4.5 m to 5.5 m. Single family residences (with basements) supporting on conventional strip and spread footings founded on engineered fill is also **NOT** feasible to restore the areas to underside of conventional footings, which requires about 3.5 to 4.0 m thick of engineered fill and construction dewatering.

Supporting building on existing loose/soft soils could be considered an option if the building is structurally designed to tolerate anticipated total and/or differential

settlements due to consolidation of the loose/soft soils and peat layers below footings. However, building maintenance might be required in future.

For design of the footings founded on native very loose/soft soils at depth of about 2.5 m bgs, an allowable Serviceability Limit States (SLS) bearing pressure of 50 KPa Factored Ultimate Limit State (ULS) Geotechnical of 75 KPa can be used.

General Recommendations

The footing subgrade must be inspected by a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that the condition of the subgrade is compatible with the foundation design requirements.

Where construction is undertaken during the winter, the footing subgrade should be protected from freezing and the foundation walls should be protected against heave due to cold weather conditions.

It should be noted that the recommended bearing capacities have been calculated by **Exp** from the borehole and test pit information for the design stage only. The investigation and comments are necessarily on-going as new information of underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes, when foundation construction is underway. The interpretation between the boreholes/test pits and the recommendations of this report must therefore be checked through field inspections provided by Exp to validate the information for use during the construction stage.

4.1.5 Stiffened Slab Foundations

In general, a stiffened slab foundation consists of a reinforced concrete slab-on-grade, with thickened sections beneath exterior and load-bearing walls, in lieu of footings. Provided the following preliminary recommendations are adhered to, a service limit state (SLS) of 50 KPa and Ultimate Limit State (ULS) of 75 KPa can be used beneath the thickened slab sections, constructed on a minimum of 450 mm of granular fill as discussed below.

Prior to placement of foundations, all topsoil, organics and obvious deleterious soils must be removed from the footprint of the proposed structure. In addition, the subexcavation must extend to a minimum depth of 450 mm below the design underside of the foundation to facilitate the placement of a minimum of 450 mm of structural (i.e., granular) fill. Verification of the soil subgrade should be carried out by a geotechnical engineer prior to the placement of the structural fill.

The structural fill should consist of OPSS Granular ‘B’, and should be compacted to a minimum of 100 percent Standard Proctor Maximum Dry Density (SPMDD). The structural fill should also extend laterally beyond the edges of the proposed building footprint for a distance equal to the depth of structural fill beneath the footing.

In the event groundwater conditions preclude the compaction of the structural fill to the required density, a well-graded clear stone (such as HL4 stone), or recycled concrete could be used in lieu of OPSS Granular 'B'.

Construction of this nature with foundation depths of less than about 1.2 m will require additional protection against frost protection. For a stiffened slab-on-grade with an edge thickness of about 450 mm, a minimum of 50 mm of rigid board extruded polystyrene insulation, such as DOW SM, should be provided, and should have a minimum lateral extension of 1.2 m. A minimum soil cover of 300 mm should be provided over the insulation. The insulation should be sloped in a manner that promotes groundwater drainage away from the foundation.

Perimeter subdrains may be required due to site grading and groundwater conditions. Further evaluation and ongoing liaison in this regard will be required from the office.

4.1.6 Deep Foundation

In order to provide adequate support for any structure at areas where spread/strip footings and stiffened slab foundations or engineered fill placement are not feasible/practical, the deep foundation is alternate option. A treated timber pile foundations, driven steel tube foundation, or helical pile can be considered for each residential unit.

4.1.7 Basement

Ideally, a minimum of 1 metre separation between the groundwater table and the basement floor slab should be maintained. In the event that less than 1 m is provided (at least 0.5 m above the water table), then the basement design and foundation construction should include water-proofing measures such as installation of a water-stop between the footings and foundation walls, and foundation wall backfill using low-permeability soils, perimeter weeping tiles and underfloor drains, dedicated pumps and sumps to a positive outlet. If less than 0.5 m of separation distance is available, full water-proofing on the slab and foundations would be required.

The basement floors can be cast slab-on-grade provided the subgrade is stripped of all topsoil and other obviously objectionable material. The subgrade should then be thoroughly proof-rolled. Any soft spots detected during the proof-rolling should be dug out and replaced with clean compactable excavated material, placed in accordance with the requirements outlined in the previous Section 4.2.1.

A minimum 200 mm (8 inch) thick compacted layer of 19 mm (¾ inch) clear stone should be placed between the prepared subgrade and the floor slab to serve as a moisture barrier.

All basement walls should be damp-proofed and must be designed to resist a horizontal earth pressure 'p' at any depth 'h' below the surface as given by the following expression:

$$p = K(\gamma h + q)$$

where: p = lateral earth pressure in kPa (psf) acting at a depth h:
K = earth pressure coefficient, assumed to be 0.45;
γ = unit weight of backfill, a value of 20.4 kN/m^3 (130 pcf) may be assumed;
h = depth to point of interest in m (ft) and,
q = equivalent value of any surcharge on the ground surface.

Where basements are constructed, installation of perimeter drains is required. The above expression assumes that the perimeter drainage system prevents the build-up of any hydrostatic pressure behind the wall. Suggestions for permanent perimeter drainage are given on Drawing 3.

4.2 Site Servicing

It is anticipated that municipal sewers and water services will be tied into existing infrastructure along Carlow Street.

Water and sewer lines should be provided with a minimum 1.2 m (4 ft) of soil cover for frost protection.

The subgrade soils beneath the water and sewer pipes which service the site are generally expected to comprise of natural competent silt, sand and clayey soils. For services constructed on the natural soils or engineered fill, the bedding should conform to OPS Standards. Localized base improvements may be required for services bedded in wet silty/sandy soils, particularly in wet weather seasons. Some areas of crushed stone bedding enclosed with a geotextile may be required. This is best determined onsite during construction by a geotechnical engineer and/or once site servicing design elevations become available. Bedding aggregate should also be placed around the pipe to at least 300 mm (12 inch) above the pipe, and be compacted to a minimum 95 percent SPMDD.

Where site servicing extends on the natural loose/soft soils on site that do not provide a stable base for bedding, a site specific improvement program can be implemented to restore the competency of the subgrade. If the unsuitable soils are found to be not localized, one of the following two options could be implemented:

Option 1

The site servicing should be constructed within an easement located beyond the zone of influence of any roadways or structures in order to minimize the potential for differential movements because of additional soil loading. In addition, grade raises along the easements should be minimized to avoid surcharging soils in these areas.

Option 2

A styrofoam board/foam or equivalent could be used as a bedding material beneath the sewer and water pipes to restore the competency of the subgrade. Standard backfill materials (Granular 'B') would be too heavy and cause consolidation and settlement of the natural soils below bedding; therefore, a lightweight fill such as styrofoam or equivalent should be a proper alternative backfill. Styrofoam density ranges approximately between 30 – 50 kg/m^3 and its compressive strength ranges approximately between 200 – 300 KPa. The installation of the styrofoam should follow the manufacturing instructions/guidance.

General Comments

The natural material would be too wet to achieve adequate compaction if used around the pipes and within the trenches.

The trenches above the specified pipe bedding should be backfilled with inorganic soils placed in maximum 300 mm thick lifts and uniformly compacted to at least 95% SPMDD. A program of *in situ* density testing should be set up to ensure that satisfactory levels of compaction are achieved. If the depth of services is significantly lower than the groundwater table, the backfill load will need to be reduced. Typical trench backfill details, inspection, and testing schedules are provided in Appendix B.

Based on the results of this investigation, some of the excavated natural soils may be used for construction backfill provided reasonable care is exercised in handling, and construction is carried out in favorable weather. In this regard, the material should be within 3 percent of the optimum moisture as determined in the standard Proctor density test, and stockpiling of material for prolonged periods should be avoided. This is particularly important if construction is carried out in wet or otherwise adverse weather.

Soils excavated from below the stabilized groundwater table may be too wet for reuse as backfill unless adequate time is allowed for drying, or if the material is blended with approved dry fill; otherwise, it may be stockpiled onsite for reuse as landscape fill.

As noted previously, disposal of excavated materials off site should conform to current Ministry of Environment guidelines.

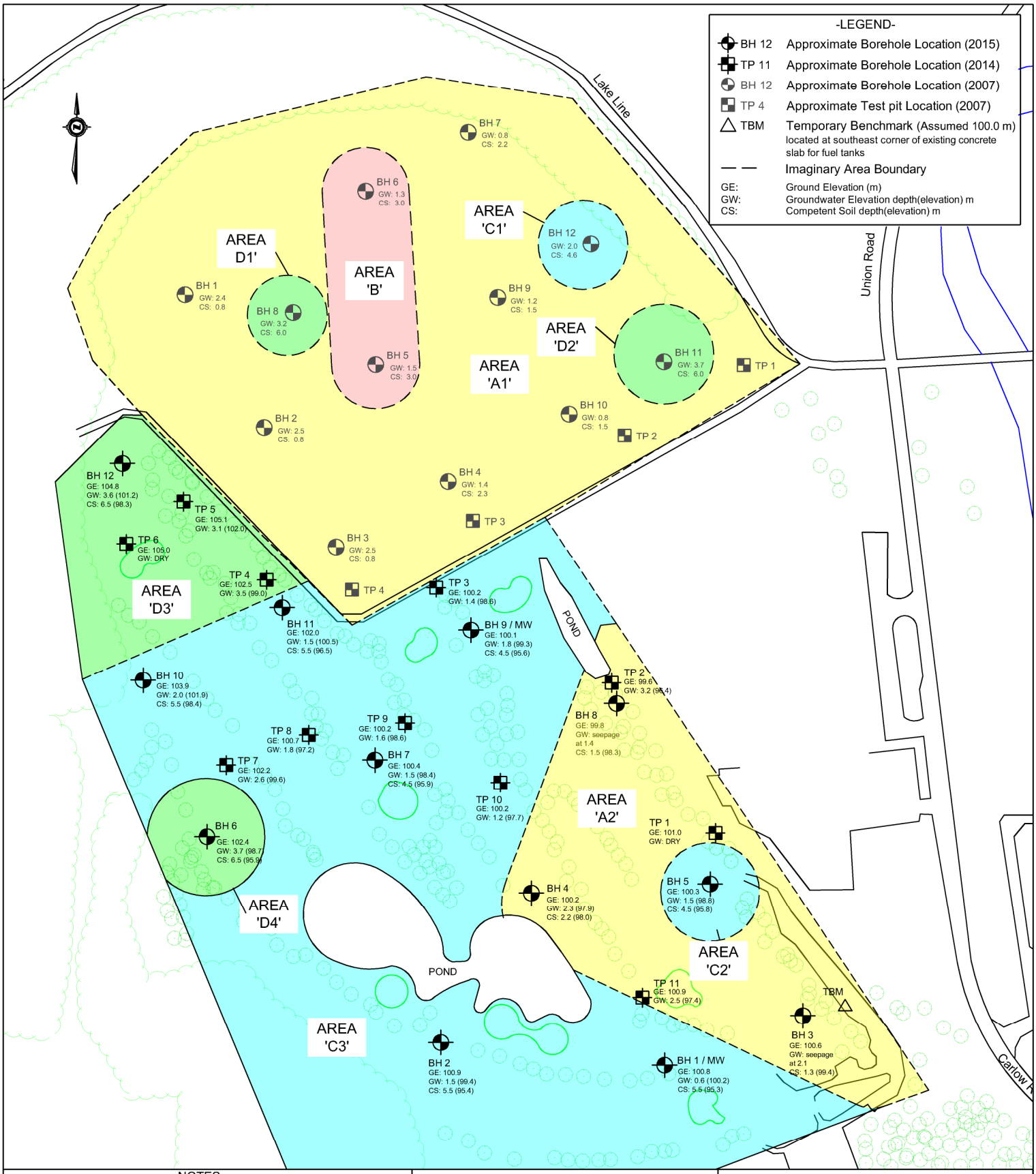
Within the anticipated depths of excavations for site services, the excavations are anticipated to extend below groundwater levels at most areas, therefore a water pumping will required and PTTW might be required.

5. General Comments

The comments given in this report are intended only for the guidance of design engineers. The number of test holes required to determine the localized underground conditions between test holes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

Exp Services Inc. should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not afforded the privilege of making this review, **Exp** Services Inc. will assume no responsibility for interpretation of the recommendations in this report.

We trust that this report is satisfactory to your present requirements and we look forward to assisting you in the completion of this project. Should you have any questions, please contact the undersigned at your convenience.



-NOTES-

1. The boundaries and soil types have been established only at borehole locations. Between boreholes they are assumed and may be subject to considerable error.
2. Soil samples will be retained in storage for 3 months and then destroyed unless client advises that an extended time period is required.
3. Topsoil quantities should not be established from the information provided at the test hole locations.
4. The site plan has been reproduced from "Google Maps 2015" and should be read in conjunction with exp Geotechnical Report LON00013222-GE

Supplementary Geotechnical Investigation

Kettle Creek Golf Course

320 Carlow Road
Port Stanley, Ontario

CLIENT	Strathroy Turf Farm Limited.
TITLE	Borehole and Test Pit Location Plan
DRAWN BY: NH	REVIEWED BY: IS

exp Services Inc.
15701 Robin's Hill Road
London, ON, N5V 0A5

DATE	SCALE	PROJECT NO.	DWG.
APRIL 2015	NTS	LON-00013222-GE	1

BOREHOLE LOG

BH1/MW

CLIENT **Strathroy Turf Farm Ltd.** PROJECT NO. **LON00013222GE**

PROJECT **Kettle Creek Golf and Country Club** DATUM

LOCATION **320 Carlow Road, Port Stanley** DATES: Boring **Mar 19, 2015** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (%)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	100.8								
	100.3	**TOPSOIL** - 450 mm							
	99.9	**SAPRIC PEAT** - black, sapric, loose, wet							
1		**SILTY CLAY** - brown/grey, soft, very moist			SS	S1	350	4	34
					SS	S2	450	3	34
2	98.5								
		FIBRIC PEAT - black/brown, loose, wet			SS	S3	450	4	209
3	97.6								
		ALLUVIAL SILT - grey, trace shells, trace sand, very loose, wet			SS	S4	450	0	109
4					SS	S5	450	2	42
	96.2								
		SAND - grey, trace silt to silty, trace gravel, loose to compact, wet			SS	S6	450	9	20
5	95.1				SS	S7	450	12	17
		CLAYEY SILT TILL - grey, trace gravel, stiff, moist							
6	94.2				SS	S8	350	15	20
		End of Borehole at 6.6 m bgs							
7									
8									
9									
10									

SHEAR STRENGTH

✚ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane

100 200 kPa

Atterberg Limits and Moisture

W_P W W_L

● SPT N Value × Dynamic Cone

10 20 30 40

209

109

NOTES

1)Borehole Logs interpretation requires the assistance by exp before use by others.
Borehole Logs must be read in conjunction with exp Report LON00013222GE.
For definition of terms used on logs, see sheets prior to logs.
2)Borehole open to 6.55 m bgs and groundwater encountered near 5.8 m bgs.
3) bgs denotes below ground surface.
4) Groundwater Measured

Depth (m)	Date
5.8	Mar 19, 2015
0.6	Mar 24, 2015

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH10

CLIENT **Strathroy Turf Farm Ltd.** PROJECT NO. **LON00013222GE**

PROJECT **Kettle Creek Golf and Country Club** DATUM

LOCATION **320 Carlow Road, Port Stanley** DATES: Boring **Mar 13, 2015** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (%)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	103.9								
	103.4	**TOPSOIL** - 460 mm							
1		**CLAYEY SILT** - brown/grey, some sand, trace gravel, soft, moist			SS	S1	450	2	24
	102.2								
2		**SANDY SILT** - brown, trace gravel, dilatent, loose to compact, very moist to wet with depth		▼	SS	S2	350	5	32
					SS	S3	350	6	24
3					SS	S4	350	8	22
4									
5					SS	S5	400	6	15
6		- becoming grey near 6.1 m bgs			SS	S6	450	16	17
7									
	95.9				SS	S7	450	14	22
8		**End of Borehole at 8.0 m bgs**							
9									
10									

SHEAR STRENGTH
✤ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
100 200 kPa

Atterberg Limits and Moisture
W_P W W_L
● SPT N Value × Dynamic Cone
10 20 30 40

NOTES

1)Borehole Logs interpretation requires the assistance by exp before use by others.
Borehole Logs must be read in conjunction with exp Report LON00013222GE.
For definition of terms used on logs, see sheets prior to logs.
2)Borehole open to 2.1 m bgs upon completion and groundwater measured near 2.0 m bgs.
3) bgs denotes below ground surface.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
▥ Rock Core (eg. BQ, NQ, etc.) ▣ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH11

CLIENT **Strathroy Turf Farm Ltd.** PROJECT NO. **LON00013222GE**

PROJECT **Kettle Creek Golf and Country Club** DATUM

LOCATION **320 Carlow Road, Port Stanley** DATES: Boring **Mar 13, 2015** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (%)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	102.0								
	101.7	**TOPSOIL** - 250 mm							
		CLAYEY SILT - brown/grey, some sand, trace gravel, firm, moist							
1	101.0	**SANDY SILT** - brown, loose to very loose, very moist to wet			SS	S1	450	7	25
2				▼	SS	S2	450	6	24
					SS	S3	450	2	23
3		- sand layer			SS	S4	450	4	24
4	97.7				SS	S5	300	0	23
		SAND - grey, trace silt, trace fine gravel, fine to coarse grain, very loose to compact, wet			SS	S6	300	1	19
5									
6					SS	S7	450	17	13
7	94.4								
	94.0	**CLAYEY SILT TILL** - grey, trace sand, trace gravel, very stiff, moist			SS	S8	450	26	19
8		**End of Borehole at 8.0 m bgs**							
9									
10									

SHEAR STRENGTH

✤ S Field Vane Test (#=Sensitivity)

▲ Penetrometer ■ Torvane

100 200 kPa

Atterberg Limits and Moisture

W_P W W_L

● SPT N Value × Dynamic Cone

10 20 30 40

NOTES

1)Borehole Logs interpretation requires the assistance by exp before use by others.
Borehole Logs must be read in conjunction with exp Report LON00013222GE.
For definition of terms used on logs, see sheets prior to logs.
2)Borehole open to 2.1 m bgs upon completion and groundwater measured near 2.0 m bgs.
3) bgs denotes below ground surface.

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube

▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH12

CLIENT **Strathroy Turf Farm Ltd.** PROJECT NO. **LON00013222GE**

PROJECT **Kettle Creek Golf and Country Club** DATUM

LOCATION **320 Carlow Road, Port Stanley** DATES: Boring **Mar 13, 2015** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (%)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	104.8								
	104.6	**TOPSOIL** - 200 mm							
		SANDY SILT - brown, trace fine gravel, loose, moist to wet							
1					SS	S1	450	6	20
2					SS	S2	400	9	23
					SS	S3	450	6	18
3				▼	SS	S4	400	9	16
4					SS	S5	400	8	21
5					SS	S6	400	6	18
6		- compact, very moist			SS	S7	400	12	18
7	97.2								
	96.8	**SILT AND SAND LAYERING** - grey, trace fine gravel, compact, very moist			SS	S8	450	14	17
8		**End of Borehole at 8.0 m bgs**							
9									
10									

SHEAR STRENGTH

✤ S Field Vane Test (#=Sensitivity)

▲ Penetrometer ■ Torvane

100 200 kPa

Atterberg Limits and Moisture

W_P W W_L

● SPT N Value × Dynamic Cone

10 20 30 40

NOTES

1)Borehole Logs interpretation requires the assistance by exp before use by others.
Borehole Logs must be read in conjunction with exp Report LON00013222GE.
For definition of terms used on logs, see sheets prior to logs.
2)Borehole open to 3.0 m bgs upon completion and groundwater measured near 3.6 m bgs
3) bgs denotes below ground surface.

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube

▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH2

CLIENT **Strathroy Turf Farm Ltd.** PROJECT NO. **LON00013222GE**

PROJECT **Kettle Creek Golf and Country Club** DATUM

LOCATION **320 Carlow Road, Port Stanley** DATES: Boring **Mar 19, 2015** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (%)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	100.9						
	100.8	**TOPSOIL** - 175 mm					
	100.1	**SILTY CLAY** - brown/grey, trace sand, trace gravel, stiff, very moist					
1		**SILTY SAND** -brown, trace fine gravel, loose, wet	SS	S1	400	8	26
	99.3						
	99.0	**HEMIC PEAT AND ALLUVIAL SILT** - 75 mm layering; brown/black and grey, trace shells, trace gravel, very loose, wet	SS	S2	450	0	27
2		**FIBRIC PEAT** - black/brown, very loose, wet	SS	S3	450	1	192
3	97.7						
		ALLUVIAL SILT - grey, trace sand, trace shells, very loose, wet	SS	S4	450	0	103
4			SS	S5	450	0	42
	96.3						
		CLAYEY SILT - grey, trace sand, trace gravel, soft, very moist	SS	S6	450	3	16
5	95.6						
		CLAYEY SILT TILL - grey, trace sand, trace gravel, stiff, moist	SS	S7	450	14	18
6			SS	S8	450	16	18
	94.3						
		End of Borehole at 6.6 m bgs					
7							
8							
9							
10							

SHEAR STRENGTH
✤ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
100 200 kPa

Atterberg Limits and Moisture
W_P W W_L
● SPT N Value × Dynamic Cone
10 20 30 40

192
103

NOTES

1)Borehole Logs interpretation requires the assistance by exp before use by others.
Borehole Logs must be read in conjunction with exp Report LON00013222GE.
For definition of terms used on logs, see sheets prior to logs.
2)Borehole open to 1.8 m bgs upon completion and groundwater measured near 1.5 m bgs.
3) bgs denotes below ground surface.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
▥ Rock Core (eg. BQ, NQ, etc.) ▣ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH3

CLIENT **Strathroy Turf Farm Ltd.** PROJECT NO. **LON00013222GE**

PROJECT **Kettle Creek Golf and Country Club** DATUM

LOCATION **320 Carlow Road, Port Stanley** DATES: Boring **Mar 13, 2015** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (%)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	100.6								
	100.4	**TOPSOIL** - 200 mm							
		SILTY SAND - brown, trace gravel, slightly dilatent, loose, very moist							
1					SS	S1	400	4	22
					SS	S2	425	34	20
2		- seepage at 2.1 m bgs							
					SS	S3	450	28	18
3	97.5								
		CLAYEY SILT TILL - grey, trace sand, trace gravel, stiff, moist			SS	S4	450	14	16
4									
	95.6				SS	S5	450	12	18
5		**End of Borehole at 5.0 m bgs**							
6									
7									
8									
9									
10									

SHEAR STRENGTH

✤ S Field Vane Test (#=Sensitivity)

▲ Penetrometer ■ Torvane

100 200 kPa

Atterberg Limits and Moisture

W_P W W_L

● SPT N Value × Dynamic Cone

10 20 30 40

NOTES

1)Borehole Logs interpretation requires the assistance by exp before use by others.
Borehole Logs must be read in conjunction with exp Report LON00013222GE.
For definition of terms used on logs, see sheets prior to logs.
2)Borehole open to 5.0 m bgs upon completion and dry upon completion.
3) bgs denotes below ground surface.

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube

▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH4

CLIENT **Strathroy Turf Farm Ltd.** PROJECT NO. **LON00013222GE**

PROJECT **Kettle Creek Golf and Country Club** DATUM

LOCATION **320 Carlow Road, Port Stanley** DATES: Boring **Mar 19, 2015** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (%)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)	SHEAR STRENGTH / Atterberg Limits and Moisture
0	100.2									✤ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane; 100 200 kPa; W_P W W_L; ● SPT N Value × Dynamic Cone; 10 20 30 40
	100.0	**TOPSOIL** - 200 mm								
1		**CLAYEY SILT** - brown, trace sand, trace gravel, trace shells, soft, moist			SS	S1	250	2	31	
2					SS	S2	350	3	33	
	97.9									
3		**SAND** - grey, coarse grained, trace gravel, some silt, compact, wet			SS	S3	450	12	19	
	96.7				SS	S4	450	18	9	
4		**End of Borehole at 3.5 mbgs**								
5										
6										
7										
8										
9										
10										

NOTES

1)Borehole Logs interpretation requires the assistance by exp before use by others.
Borehole Logs must be read in conjunction with exp Report LON00013222GE.
For definition of terms used on logs, see sheets prior to logs.
2)Borehole open to 2.7 m bgs upon completion and groundwater measured near 2.3 m bgs.
3) bgs denotes below ground surface.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH5

CLIENT **Strathroy Turf Farm Ltd.** PROJECT NO. **LON00013222GE**

PROJECT **Kettle Creek Golf and Country Club** DATUM

LOCATION **320 Carlow Road, Port Stanley** DATES: Boring **Mar 19, 2015** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (%)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	100.3								
	100.0	**TOPSOIL** - 300 mm							
		SANDY SILT - grey/brown, trace fine gravel, loose, very moist							
1	99.3				SS	S1	450	7	25
	99.0	**CLAYEY SILT** - brown/grey, trace sand, trace gravel, soft, wet		▼					
		SILT - grey, trace to some clay, trace sand to sandy, very loose, wet, dilatent			SS	S2	450	3	30
2									
					SS	S3	450	0	26
3	97.2								
		SAND - grey, coarse grained, trace silt, very loose, wet			SS	S4	450	1	29
4					SS	S5	450	5	23
	95.4								
5	95.3	**CLAYEY SILT TILL** - grey, trace sand, trace gravel, stiff, moist			SS	S6	450	18	17
		End of Borehole at 5.0 m bgs							
6									
7									
8									
9									
10									

SHEAR STRENGTH

✤ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane

100 200 kPa

Atterberg Limits and Moisture

W_P W W_L

● SPT N Value × Dynamic Cone

10 20 30 40

NOTES

1)Borehole Logs interpretation requires the assistance by exp before use by others.
Borehole Logs must be read in conjunction with exp Report LON00013222GE.
For definition of terms used on logs, see sheets prior to logs.
2)Borehole open to 2.4 m bgs upon completion and groundwater measured near 1.5 m bgs.
3) bgs denotes below ground surface.

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH6

CLIENT **Strathroy Turf Farm Ltd.** PROJECT NO. **LON00013222GE**

PROJECT **Kettle Creek Golf and Country Club** DATUM

LOCATION **320 Carlow Road, Port Stanley** DATES: Boring **Mar 19, 2015** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (%)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	102.4								
	102.2	**TOPSOIL** - 200 mm							
		SANDY SILT - brown/grey, some clay, trace gravel, very loose, wet			SS	S1	450	3	24
1					SS	S2	450	2	27
	100.5								
2		**CLAYEY SILT** - grey, trace sand, trace gravel, very stiff, very moist			SS	S3	450	2	29
	99.5								
3		**SILT** - grey, some dilatant trace sand, very loose, wet		▼	SS	S4	450	3	25
4					SS	S5	450	1	31
					SS	S6	450	1	31
5					SS	S7	450	3	30
6					SS	S8	450	3	18
	95.5								
7		**CLAYEY SILT TILL** - grey, trace sand, trace gravel, very stiff, moist			SS	S9	450	14	18
	94.4				SS	S10	450	19	18
8		**End of Borehole at 8.0 m bgs**							
9									
10									

SHEAR STRENGTH

✤ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane

100 200 kPa

Atterberg Limits and Moisture

W_P W W_L

● SPT N Value × Dynamic Cone

10 20 30 40

NOTES

1)Borehole Logs interpretation requires the assistance by exp before use by others.
Borehole Logs must be read in conjunction with exp Report LON00013222GE.
For definition of terms used on logs, see sheets prior to logs.
2)Borehole open to 5.5 m bgs upon completion and groundwater measured near 3.7 m bgs.
3) bgs denotes below ground surface.

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH7

CLIENT **Strathroy Turf Farm Ltd.** PROJECT NO. **LON00013222GE**

PROJECT **Kettle Creek Golf and Country Club** DATUM

LOCATION **320 Carlow Road, Port Stanley** DATES: Boring **Mar 19, 2015** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (%)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	100.4								
	100.2	**TOPSOIL** - 200 mm							
		SAPRIC PEAT AND ALLUVIAL SILT LAYERING							
1	99.4	**CLAYEY SILT** - grey, trace gravel, soft, moist		▼	SS	S1	450	3	
					SS	S2	450	4	27
2	98.4	**SANDY SILT** - grey, trace gravel, very loose, wet							
	97.7				SS	S3	450	0	21
		SAND - grey, coarse grained, trace gravel. trace silt, compact, very moist							
3					SS	S4	450	6	19
4					SS	S5	450	4	14
	95.8								
	95.4	**CLAYEY SILT TILL** - grey, reace sand, trace gravel, stiff, moist			SS	S6	450	14	18
5		**End of Borehole at 5.0 m bgs**							
6									
7									
8									
9									
10									

SHEAR STRENGTH

✚ S Field Vane Test (#=Sensitivity)

▲ Penetrometer ■ Torvane

100 200 kPa

Atterberg Limits and Moisture

W_P W W_L

● SPT N Value × Dynamic Cone

10 20 30 40

NOTES

1)Borehole Logs interpretation requires the assistance by exp before use by others.
Borehole Logs must be read in conjunction with exp Report LON00013222GE.
For definition of terms used on logs, see sheets prior to logs.
2)Borehole open to 2.4 m bgs upon completion and groundwater measured near 1.5 m bgs.
3) bgs denotes below ground surface.

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube

▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH8

CLIENT **Strathroy Turf Farm Ltd.** PROJECT NO. **LON00013222GE**

PROJECT **Kettle Creek Golf and Country Club** DATUM

LOCATION **320 Carlow Road, Port Stanley** DATES: Boring **Mar 13, 2015** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (%)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	99.8								
	99.7	**TOPSOIL** - 150 mm							
		FILL SILTY SAND - brown, trace fine gravel, trace clayey silt chunks, very loose, very moist			SS	S1	400	2	24
1	98.3	- seepage near 1.4 m							
	97.8	**CLAYEY SILT** - brown/grey, trace sand, trace gravel, 25 mm silt lamination, stiff, moist			SS	S2	400	10	20
2		**SILTY SAND** - grey, trace fine gravel, compact, moist			SS	S3	350	23	20
	96.8								
3		**CLAYEY SILT TILL** - grey, trace sand, trace gravel, sitff, wet			SS	S4	350	13	16
4									
	94.8				SS	S5	450	18	16
5									
6									
7									
8									
9									
10									

SHEAR STRENGTH

✤ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane

100 200 kPa

Atterberg Limits and Moisture

W_P W W_L

● SPT N Value × Dynamic Cone

10 20 30 40

NOTES

1)Borehole Logs interpretation requires the assistance by exp before use by others.
Borehole Logs must be read in conjunction with exp Report LON00013222GE.
For definition of terms used on logs, see sheets prior to logs.
2)Borehole open to 5.0 m bgs upon completion and dry upon completion.
3) bgs denotes below ground surface.

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH9/MW

CLIENT **Strathroy Turf Farm Ltd.** PROJECT NO. **LON00013222GE**

PROJECT **Kettle Creek Golf and Country Club** DATUM

LOCATION **320 Carlow Road, Port Stanley** DATES: Boring **Mar 13, 2015** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (%)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	100.1								
	100.0	**TOPSOIL** - 150 mm							
1		**SILTY SAND** - brown, trace fine gravel, thin clay laminations, vey loose, very moist to wet			SS	S1	300	2	23
2					SS	S2	150	0	23
	97.9								
		SAND - grey, coarse grained, trace silt, trace fine gravel, loose to very loose, wet Gr Sa Si 0% 95% 5%			SS	S3	400	6	14
3					SS	S4	450	1	17
4	96.0				SS	S5	350	9	14
		CLAYEY SILT TILL - grey, trace sand, trace gravel, very stiff, moist							
5					SS	S6	350	17	19
6									
	93.5				SS	S7	50	19	22
		End of Borehole at 6.6 m bgs							
7									
8									
9									
10									

SHEAR STRENGTH
S Field Vane Test (#=Sensitivity)
Penetrometer Torvane
100 200 kPa

Atterberg Limits and Moisture
W_P W W_L
SPT N Value × Dynamic Cone
10 20 30 40

NOTES

1)Borehole Logs interpretation requires the assistance by exp before use by others.
Borehole Logs must be read in conjunction with exp Report LON00013222GE.
For definition of terms used on logs, see sheets prior to logs.
2)Borehole open to 6.6 m bgs upon completion and groundwater measured near 1.8 m bgs.
3) bgs denotes below ground surface.
4) Ground Water Measured

Depth (m)	Date
1.8	Mar 13, 2015
0.8	Mar 24, 2015

SAMPLE LEGEND
AS Auger Sample SS Split Spoon ST Shelby Tube
Rock Core (eg. BQ, NQ, etc.) VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
Apparent Measured Artesian (see Notes)