# Report on Geotechnical Investigation and Slope Stability Analysis
# Charleston Homes Residential Subdivision Development
# High Street and Poplar Sideroad, Collingwood, Ontario.

**Prepared For:**
**Charleston Homes c/o C.C Tatham & Associates Ltd.**

**SPL Project No.: 10001514 (Revision 2)**
**Report Date: December 2015**

# Table of Contents

**Drawings**

## 1. INTRODUCTION

SPL Consultants Limited (SPL) was retained by Charleston Homes c/o C.C. Tatham & Associates Ltd. to undertake a geotechnical investigation and slope stability study for the proposed Charleston Homes residential development on a property located at the northwest corner of the intersection of High Street and Poplar Sideroad in Collingwood, Ontario.

The subject property (site) is situated on the tableland of the valley slope associated with Black Ash Creek. The site is irregular in shape, and comprises of agricultural and undeveloped lands and is bounded by High Street to the east, Poplar Sideroad to the south, and is wooded on the north side. Black Ash Creek meanders along the west side of the site in the wooded area.

The proposed Draft Plan of the subdivision was provided to SPL and is enclosed in Appendix A. Based on the Draft Plan, we understand that the proposed development will entail the construction of single detached dwellings and townhouses, and will include internal roads, and associated municipal sewers and water supply. We also understand that two stormwater management ponds (SWMP) will be part of the development, one of them will be constructed in the northwest portion and the second will be constructed in the southwest portion of the development.

The purpose of this geotechnical investigation was to obtain information about the subsurface conditions by means of 18 boreholes and from the findings in the boreholes to make recommendations pertaining to the geotechnical design of site grading, underground utilities, subdivision roads, and to comment on the foundation conditions for general house construction.

This report also includes the results of the slope stability study which was conducted to assess the long-term stability and erosion risks of the valley slope. The study includes a detailed site specific slope stability analysis based on borehole investigation, and provides geotechnical engineering recommendations for the long-term stable slope crest location.

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 the applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. The format and contents are guided by client specific needs and economics and do not conform to generalized standards for services. Laboratory testing follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report has been prepared for Charleston Homes c/o C.C Tatham & Associates Ltd. and their designers. Third party use of this report without SPL Consultants Limited consent is prohibited.

## 2. FIELD AND LABORATORY WORK

The field investigation consisted of drilling eighteen (18) boreholes (BH15-01 through BH15-09, BH15-12, BH15-13, and BH15-15 through BH15-21) at the site between March 10 and 13, 2015. The boreholes were drilled to depths ranging from 4.7 m to 8.2 m below existing ground surface with solid stem continuous flight auger equipment, supplied and operated by a drilling sub-contractor under the direction and supervision of SPL Consultants Limited personnel. Samples were retrieved at regular intervals with a 50 mm O.D. split-barrel sampler driven with a hammer weighing 624 N and dropping 760 mm in accordance with the Standard Penetration Test (ASTM D 1586) method. This sampling method recovers samples from the soil strata, and the number of blows required to drive the sampler 0.3 m depth into the undisturbed soil (SPT 'N'-values) gives an indication of the compactness condition or consistency of the sampled soil material. The SPT 'N' values are indicated on the Borehole Logs (Enclosures B2 to B19, Appendix B).

Soil samples were visually classified in the field and later re-evaluated by a senior engineer in our laboratory. All soil samples were tested for moisture contents. Laboratory Grain Size Analyses were carried out on eight samples, and the results are enclosed in Appendix C.

Water level observations were made during drilling and in the open boreholes at the completion of the drilling operations. Groundwater level was measured in the monitoring wells installed at BH15-01, BH15-04, BH15-09, BH15-15 and BH15-18 on as part of a monthly groundwater level monitoring program from March to November 2015. The annual monitoring program will continue until March 2016.

Selected soil samples were subjected to chemical analysis to assess the environmental quality of the soils to assist in determining off-site disposal options. Chemical Testing Results are presented in Appendix F.

The ground surface elevations of the boreholes were estimated from the topographic survey drawing provided by C.C. Tatham & Associates Ltd.

## 3. SUBSURFACE CONDITIONS

The borehole locations are shown on Drawing 1. Notes on soil sample descriptions are presented on Enclosure B1 in Appendix B. The subsurface conditions at the boreholes (BH15-01 through BH15-09, BH15-12, BH15-13, and BH15-15 through BH15-21) are presented on the individual borehole logs (Enclosures B2 to B19) enclosed in Appendix B, and are summarized in the following paragraphs.

### 3.1 Soil Conditions

**Topsoil:** A layer of surficial topsoil ranging from 125 to 350 mm in thickness was encountered at each of the borehole locations. It should be noted that topsoil quantities should not be calculated from the borehole information, as large variations in depth may exist between boreholes.

**Disturbed Soils:** A layer of disturbed soils was encountered at each borehole location (BH15-01 to BH15-21) below topsoil, and extended to approximately 0.8 m below existing ground surface. The disturbed soils consisted of silty sand to sandy silt materials, with inclusions of rootlets. The reworked soil was typically in a loose state.

**Native Soils:** Underlying the topsoil, the predominant native soils are glaciolacustrine soils of nearshore and beach deposits such as silt, sandy silt to silty sand, sand, and sand and gravel. Clayey silt/silty clay layers of 0.9 m to 1.5 m in thickness were encountered in BH15-05 and BH15-06. In boreholes BH15-01, BH15-06 and BH15-13, the clayey silt/silty clay deposit was encountered at depths ranging between 2.3 m and 4.6 m and extended beyond the explored depths.

The grinding of augers during drilling in various boreholes (such as BH14-04, BH15-17, BH15-18 etc.) indicated that cobbles and boulders exists within the cohesionless deposits.

Two (2) tested samples of the silt and sand (BH15-09/SS7 and BH15-18/SS7) contain 1 to 3% gravel, 32 to 40% sand, 50 to 62% silt and 5 to 7% clay size particles. The grain size distribution curves for the samples are presented on Drawing C1 in Appendix C.

Two (2) tested samples of the silt (BH15-15/SS5 and BH15-16/SS4) contain 0% gravel, 1 to 9% sand, 83 to 86% silt and 8 to 13% clay size particles. The grain size distribution curves for the samples are presented on Drawing C2 in Appendix C.

One (1) tested sample of the sand and gravel (BH15-04/SS7) contains 47% gravel, 39% sand, 11% silt and 3% clay size particles. The grain size distribution curves for the samples are presented on Drawing C3 in Appendix C.

One (1) tested sample of the sand (BH15-20/SS2) contains 1% gravel, 78% sand, 17% silt and 4% clay size particles. The grain size distribution curves for the samples are presented on Drawing C4 in Appendix C.

Two (2) tested samples of the silty clay (BH15-01/SS4 and BH15-05/SS5) contain 0% gravel, 1 to 3 % sand, 72% silt and 25 to 27% clay size particles. The grain size distribution curves for the samples are presented on Drawing C5 in Appendix C.

The cohesionless soils were in a moist to very moist state, and in a loose to very dense relative density. The soils were in general in a compact to very dense state below 1.5 m depth.

The cohesive soils were in a firm to hard consistency.

### 3.2 Groundwater Conditions

During drilling and at the completion of drilling, wet conditions were observed in boreholes BH14-01 to BH14-08, BH15-10 to BH15-17 and BH15-19 to BH15-21 to depths ranging from 1.0 m to 7.1 m below existing grade, and boreholes BH15-09 and BH15-18 were found dry.

The water levels observed in the monitoring wells installed at borehole locations BH 15-01, BH 15-04, BH 15-09, BH 15-15 and BH 15-18 as part of a monthly groundwater level monitoring program from March to November 2015. The annual monitoring program will continue until March 2016. The water level monitoring indicates that the water levels ranged between 0.3 m to 5.3 m below existing grades and ranged in elevation from 206.0 to 196.1 m, with the seasonal high levels observed in March and April, as well as November 2015. The water level measurements are summarized in Table 1 below.

**Table 1: Groundwater Levels Observed in Boreholes**

| BH No. | Date of Drilling | Date of Water Measurement | Depth of Groundwater below existing ground (m) | Elevation of Groundwater (m) |
|---|---|---|---|---|
| BH 15-01 | March 12, 2015 | March 17, 2015 | 0.26 | 199.44 |
| | | April 16, 2015 | 0.78 | 198.62 |
| | | May 22, 2015 | 0.94 | 198.76 |
| | | June 30, 2015 | 0.51 | 199.19 |
| | | July 31, 2015 | 2.43 | 197.27 |
| | | August 27, 2015 | 2.87 | 196.83 |
| | | October 1, 2015 | 3.56 | 196.14 |
| | | October 30, 2015 | 3.50 | 196.20 |
| | | November 30, 2015 | 0.78 | 198.92 |
| BH 15-04 | March 12, 2015 | March 17, 2015 | 3.36 | 198.34 |
| | | April 16, 2015 | 3.55 | 198.15 |
| | | May 22, 2015 | 3.77 | 197.93 |
| | | June 30, 2015 | 3.56 | 198.14 |
| | | July 31, 2015 | 4.01 | 197.69 |
| | | August 27, 2015 | 4.19 | 197.51 |
| | | October 1, 2015 | 4.43 | 197.27 |
| | | October 30, 2015 | 4.30 | 197.40 |
| | | November 30, 2015 | 3.79 | 197.91 |
| BH 15-09 | March 12, 2015 | March 17, 2015 | 4.30 | 201.70 |
| | | April 16, 2015 | 4.04 | 201.96 |

| BH No. | Date of Drilling | Date of Water Measurement | Depth of Groundwater below existing ground (m) | Elevation of Groundwater (m) |
|---|---|---|---|---|
| | | May 22, 2015 | 4.46 | 201.54 |
| | | June 30, 2015 | 4.51 | 201.49 |
| | | July 31, 2015 | 4.83 | 201.17 |
| | | August 27, 2015 | 5.11 | 200.89 |
| | | October 1, 2015 | 5.31 | 200.69 |
| | | October 30, 2015 | 5.38 | 200.62 |
| | | November 30, 2015 | 5.04 | 200.96 |
| BH 15-15 | March 11, 2015 | March 17, 2015 | 0.44 | 205.96 |
| | | April 16, 2015 | 0.67 | 205.73 |
| | | May 22, 2015 | 0.83 | 205.57 |
| | | June 30, 2015 | 0.65 | 205.75 |
| | | July 31, 2015 | 1.00 | 205.40 |
| | | August 27, 2015 | 1.38 | 205.02 |
| | | October 1, 2015 | 1.44 | 204.96 |
| | | October 30, 2015 | 1.13 | 205.27 |
| | | November 30, 2015 | 0.76 | 205.64 |
| BH 15-18 | March 11, 2015 | March 17, 2015 | 2.52 | 205.98 |
| | | April 16, 2015 | 2.87 | 205.63 |
| | | May 22, 2015 | 3.08 | 205.42 |
| | | June 30, 2015 | 2.85 | 205.65 |
| | | July 31, 2015 | 3.61 | 204.89 |
| | | August 27, 2015 | 3.66 | 204.84 |
| | | October 1, 2015 | 3.78 | 204.72 |
| | | October 30, 2015 | 3.39 | 205.11 |
| | | November 30, 2015 | 3.74 | 204.76 |

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to major weather events.

## 4. DISCUSSION AND RECOMMENDATIONS

### 4.1 The Site and General Discussion

The subject site is situated on a relatively flat to gently sloping tableland, and abuts Poplar Sideroad on the south side and High Street on the east side. A densely vegetated/forested slope is located along the west boundary, and Black Ash creek meanders through it. The property currently is undeveloped and vacant, and is used for agricultural purposes.

Cohesionless deposits of silt, sandy silt/silty sand, sand, and sand and gravel are predominant on the site and encountered in all boreholes. Most of the site is characterized to have high groundwater levels, ranging between 0.3 m and 5.3 m below existing ground surface.

### 4.2 The Project

Based on the Draft Plan of the subdivision (Appendix A) provided to us and our discussions with the client, we understand that the proposed development would include the following:

1. Single detached dwellings and townhouse buildings at locations shown on the Draft Plan enclosed in Appendix A;

2. The development will include two stormwater management ponds, one of them will be constructed in the northwest portion and the second will be constructed southwest portion of the site; and

3. The subdivision will include internal roads. It is understood that the residential subdivision will be serviced by municipal sewers and water supply.

### 4.3 Roads

The investigation has shown that the predominant subgrade soil after stripping any topsoil and loose surface material, or any organic or otherwise unsuitable soils will be sandy silt to silty sand soils.

Based on the above and assuming that traffic usage will be residential minor local or local, the following minimum pavement thickness is recommended:

50 mm HL3 Asphaltic Concrete
50 mm HL8 Asphaltic Concrete
150 mm Granular ‘A’
300 mm Granular ‘B’

For bus routes and collector roads, the following minimum pavement thickness is recommended:

50 mm HL3 Asphaltic Concrete
90 mm HL8 Asphaltic Concrete
150 mm Granular 'A'
400 mm Granular 'B'

These values may need to be adjusted according to Town of Collingwood Standards. The site subgrade and weather conditions (i.e. if wet) at the time of construction may necessitate the placement of geogrid/filter fabric and/or thicker granular sub-base layer in order to facilitate the construction. Furthermore, heavy construction equipment may have to be kept off the newly constructed roads before the placement of asphalt and/or immediately thereafter, to avoid damaging the weak subgrade by heavy truck traffic.

### 4.3.1 Stripping, Subexcavation and Grading

The site should be stripped of all topsoil, disturbed soils and fill (if any) and any organic or otherwise unsuitable soils to the full depth of the roads, both in cut and fill areas.

Following stripping, the site should be graded to the subgrade level and approved. The subgrade should then be proof-rolled, in the presence of the Geotechnical Engineer, by at least several passes of a heavy compactor having a rated capacity of at least 8 tonnes. Any soft spots thus exposed should be removed and replaced by select fill material, similar to the existing subgrade soil and approved by the Geotechnical Engineer. The subgrade should then be recompacted from the surface to at least 98% of its Standard Proctor Maximum Dry Density (SPMDD). The final subgrade should be cambered or otherwise shaped properly to facilitate rapid drainage and to prevent the formation of local depressions in which water could accumulate. Proper cambering and allowing the water to escape towards the sides (where it can be removed by means of subdrains) is considered to be beneficial for this project. Otherwise, any water collected in the granular sub-base could be trapped thus causing problems due to softened subgrade, differential frost heave, etc. For the same reason, damaging the subgrade during and after the placement of the granular materials by heavy construction traffic should be avoided.

Any fill required for re-grading the site or backfill should be select, clean material, free of topsoil, organic or other foreign and unsuitable matter. It should be noted that some of the excavated native materials will be wet and must be aerated and left to dry out before they can be used for backfill. The fill should be placed in thin layers and compacted to at least 95% of its SPMDD. The degree of compaction should be increased to 98% within the top 1.0 m of the subgrade, or as per Town Standards. The compaction of the new fill should be checked by frequent field density tests.

### 4.3.2 Construction

Once the subgrade has been inspected and approved, the granular base and sub-base course materials should be placed in layers not exceeding 200 mm (uncompacted thickness) and should be compacted to

at least 100% of their respective SPMDD. The grading of the material should conform to current OPS Specifications.

The placing, spreading and rolling of the asphalt should be in accordance with OPS Specifications or, as required by the local authorities.

Frequent field density tests should be carried out on both the asphalt and granular base and sub-base materials to ensure that the required degree of compaction is achieved.

#### 4.3.3 Drainage

Installation of full-length subdrains is required on all roads. The subdrains should be properly filtered to prevent the loss of (and clogging by) soil fines.

All paved surfaces should be sloped to provide satisfactory drainage towards catchbasins. As discussed in Section 4.3.1, by means of good planning any water trapped in the granular sub-base materials should be drained rapidly towards subdrains or other interceptors.

### 4.4 Sewers

As a part of the site development, a network of new storm and sanitary sewers is to be constructed in the subdivision area.

#### 4.4.1 Trenching, Excavation, Trench Support, and Dewatering

We understand that trenches will probably be 2.5 m to 4.0 m below the existing ground levels.

As indicated in the boreholes, the trenches will be dug generally through cohesionless soils (silt, sandy silt to silty sand, sand, and sand and gravel) which includes cohesive layers at some locations. As noted above, at the time of investigation, the groundwater levels were encountered at between 0.3 m (elevation 199.4 m) and 4.0 m (elevation 201.9 m) below the existing grades, across much of the site. Dewatering will be required for any excavation in the sandy silt to silty sand, or sand and gravelly below the water table. Where the anticipated trench base is below the groundwater level, positive dewatering such as well points/eductors will be required to lower the water table to at least 1.0 m below the excavation base. Otherwise, it will result in an unstable base and flowing sides. A hydrogeological investigation would assess potential dewatering rates and determine the need for a Permit to Take Water from the MOE, and should be considered for this site.

Excavation of the soils can be carried out with heavy hydraulic backhoes. Provisions must be made in the excavation contract for the removal of possible boulders in native soils.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, the cohesionless soils (sand, sandy silt, silt, sand and gravel etc.) and the firm to stiff silty clay to clayey silt can be classified as Type 3 soil above groundwater table and

Type 4 below groundwater table. Very stiff silty clay to clayey silt can be classified as Type 2 soil above groundwater table and Type 3 below groundwater table.

In the planning of the trenches' shoring and excavation, the presence of any adjacent existing buried service pipes should be considered. In addition to the stability of these existing adjacent pipes, which must be maintained without detrimental settlements, the backfill in these trenches and especially the granular bedding surrounding the existing service pipes, manholes, etc. may be a source of water, which, if encountered, must be dealt with.

In the silt and sandy silt deposits where the soil exhibits dilatancy during construction, the soils may have to be stabilized. Any form of soil stabilization and/or dewatering to facilitate construction (e.g. well points, etc.) must be designed and performed being cognizant of the fact that dewatering may induce settlements of existing structures in the vicinity, including existing service pipes. Although unlikely, basal instability could possibly occur if a relatively coarser stratum (such as silty sand) under excess hydrostatic pressure occurs below the base of the excavation comprised of relatively impervious soils (e.g. siltyclay/clayey silt). Should this occur, these layers must be depressurized. For this reason the bases of the excavated trenches should be monitored for evidence of basal heave.

For all these reasons, it would be prudent to open the trenches in relatively short sections and carry out the laying of the pipe and backfilling expeditiously in order to reduce the length of time the trench would be open.

The earth pressure acting on the sheeting and bracing can be evaluated by the following formula:

Above groundwater table: $p = K(\gamma z + q)$

Below groundwater table: $p = K\{\gamma h_1 + \gamma_1(z - h_1) + q\} + p_w$

where $p$ = Lateral earth and water pressure in kPa acting at depth z;

$z$ = Depth below ground surface, in metres;

$K$ = Earth pressure coefficient, K=0.33;

$\gamma$ = Unit weight of soil above groundwater table, assuming 20 kN/m$^3$;

$\gamma_1$ = Submerged unit weight of soil below water table, assuming 10 kN/m$^3$;

$h_1$ = Thickness of soil above groundwater table, in metres;

$q$ = Value of surcharge in kPa;

$p_w$ = Hydrostatic water pressure.

All excavated spoil should be placed at least the depth of the trench away from the edge of the trench for safety reasons.

It is recommended that the excavations for service trenches below the groundwater table be carried out in short sections using a suitable 'geofabric' below the bedding (fine migration prevention) and backfilling the trench section immediately after service placement.

### 4.4.2 Bedding

The soils above the groundwater level, or properly dewatered if encountered below the groundwater level, will provide adequate support for the sewer pipes and allow the use of normal Class B type bedding. The recommended minimum thickness of granular bedding below the invert of the pipes is 150 mm. The thickness of the bedding may, however, have to be increased depending on the pipe diameter or in accordance with local standards or if wet or weak subgrade conditions are encountered, especially when the soil at the trench base level consists of wet, dilatant silt. The bedding material should consist of well graded granular material such as Granular 'A' or equivalent. After installing the pipe on the bedding, a granular surround of approved bedding material, which extends at least 300 mm above the obvert of the pipe, or as set out by the local Authority, should be placed.

To avoid the loss of soil fines from the subgrade, uniformly graded clear stone should not be used unless, below the granular bedding material, a suitable, approved filter fabric (geotextile) is placed. The geotextile should extend along the sides of the trench and should be wrapped all around the poorly graded bedding material.

Localized, wet and unstable soils encountered within generally stable soil zones can be stabilized by 'punching' a 50 mm clear crushed limestone or 50 mm well graded crusher run limestone pad into the soft subgrade prior to bedding placement. The thickness of the 'pad' will depend on field conditions.

In areas where the soils become wet, unstable and dilatant (easily disturbed) such as saturated silts, careful construction techniques and dewatering should be followed, as discussed earlier. If the pipes are laid on disturbed, dilatant soil, significant post-construction settlements could occur after the trenches are backfilled. In such cases, the bottom of the trenches will have to be stabilized by dewatering.

Sewer pipe bedding recommended for wet, unstable soils is a Class 'A' bedding. The rigid concrete bedding (lean mix) should be laid from manhole to manhole and this concrete 'pad' may sit directly on disturbed native subgrade. In isolated situations, where exposed subgrade tends to be wet and unstable, the concrete 'pad' should be poured on a HL-6 stone layer. It is recommended that the HL-6 bed be encircled with an approved filter fabric to prevent the migration of fines.

Where the sewer pipe is placed in water bearing soils below the water table, the joints connecting the sewer sections should be very well sealed to prevent piping of fines into the sewer pipe and manhole catch basin risers.

### 4.4.3 Backfilling of Trenches

The excavated soils can be used as construction backfill provided their moisture content at the time of placement is within 2% of the optimum moisture content. Some moisture conditioning may be required is excess pore air and pore water pressures are generated during compaction process. If bulking is noted, delaying the placement of subsequent lifts may be necessary, to allow for the dissipation of such induced excess pressures.

For the granular soils, smooth drum type vibratory rollers are recommended. The cohesive soils can be best compacted with sheepsfoot type vibratory compactors. Loose lifts of soil, which are to be compacted, should not exceed 300mm.

It is preferable that the native soils be re-used from approximately the position at which they are excavated so that frost response characteristics of the soils after construction remain essentially similar. Consideration may also be given to backfilling trenches with a well graded, compacted granular soil such as Granular 'B' material. The use of such material, if thoroughly compacted, would reduce the post construction settlements to a negligible amount and may also expedite the compaction process. In this instance, however, frost response characteristics of non-frost susceptible granular fill and the frost susceptible indigenous soils would be different giving rise to differential frost heave. In this case, it would be prudent to use as backfill the on-site excavated naturally occurring soils to match the existing conditions within the frost zone (i.e. within about 1.5 m below the road surface elevation) as well as to provide a frost taper zone (i.e. to provide a zone of taper to prevent a sudden change in frost heave characteristics to reduce the effects of frost heave).

It should be noted that the excavated soils are subject to moisture content increase during wet weather which would make these materials too wet for adequate compaction. Stockpiles should therefore be compacted at the surface or be covered with tarpaulins to help minimize moisture uptake.

The degree of compaction of the trench backfill under the roads or other areas where future settlements would be of concern should be at least 98% Standard Proctor Maximum Dry Density (SPMDD) within 2 m of the road surface. The granular pavement sub-base and base materials should be compacted to at least 100% of their respective SPMDD.

## 4.5 Engineered Fill

In the areas where earth fill is required for site grading purposes, an engineered fill may be constructed below house foundations, roads, boulevards, etc.

General guidelines for the placement and preparation of engineered fill are presented on Appendix D. A geotechnical reaction of 150 kPa at the serviceability limit states (SLS), and a factored geotechnical resistance of 225 kPa at the ultimate limit states (ULS) can be used on engineered fill, provided that all requirements on Appendix D are adhered to. To reduce the risk of improperly placed engineered compacted fill, full-time supervision of the contractor is essential. Despite full time supervision, it has

been found that contractors frequently bulldoze loose fill into areas and compact only the surface. The owner and his representatives must accept the risk involved in the use of engineered fill and offset this risk with the monetary savings of avoiding deep foundations. This potential problem must be recognized and discussed at a pre-construction meeting. Procedures can then be instigated to reduce the risk of settlement resulting from un-compacted fill.

The following is a recommended procedure for an engineered fill:

1. Prior to site work involving engineered fill, a site meeting to discuss all aspects must be convened. The surveyor, contractor, design engineer and geotechnical engineer must attend the meeting. At this meeting, the limits of the engineered fill will be defined. The contractor must make known where all fill material will be obtained and samples must be provided to the geotechnical engineer for review, and approval before filling begins.

2. Detailed drawings indicating the lower boundaries as well as the upper boundaries of the engineered fill must be available at the site meeting and be approved by the geotechnical engineer.

3. The building footprint and base of the pad, including basements, garages, etc. must be defined by offset stakes that remain in place until the footings and service connections are all constructed. Confirmation that the footings are within the pad, service lines are in place, and that the grade conforms to drawings, must be obtained by the owner in writing from the surveyor and SPL Consultants Limited. Without this confirmation no responsibility for the performance of the structure can be accepted by SPL Consultants Limited. Survey drawing of the pre and post fill location and elevations will also be required.

4. The area must be stripped of all topsoil, disturbed soils, loose fill (if any) and any organic or otherwise unsuitable soils. Subgrade must be proof-rolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by a SPL Consultants Limited engineer prior to placement of fill.

5. The approved engineered fill must be compacted to 100% Standard Proctor Maximum Dry Density throughout. Granular Fill preferred. Engineered fill should not be placed (where it will support footings) during the winter months. Engineered fill compacted to 100% SPMDD will settle under its own weight approximately 0.5% of the fill height and the structural engineer must be aware of this settlement. In addition to the settlement of the fill, additional settlement due to consolidation of the underlying soils from the structural and fill loads will occur.

6. Full-time geotechnical inspection by SPL Consultants Limited during placement of engineered fill is required. Work cannot commence or continue without the presence of the SPL representative.

7. The fill must be placed such that the specified geometry is achieved. Refer to sketches for minimum requirements. Take careful note that the projection of the compacted pad beyond the footing at footing level is a minimum of 2 m. The base of the compacted pad extends 2 m plus the depth of excavation beyond the edge of the footing.

8. A geotechnical reaction of 150 kPa at the serviceability limit states (SLS), and a factored geotechnical resistance of 225 kPa at the ultimate limit states (ULS) can be used on engineered fill, provided that all requirements on Appendix D are adhered to. A minimum footing width of 500 mm (20 inches) is suggested and footings should be provided with nominal steel reinforcement.

9. All excavations must be done in accordance with the Occupational Health and Safety Regulations of Ontario.

10. After completion of the pad a second contractor may be selected to install footings. All excavations must be backfilled under full time supervision by SPL Consultants to the same degree as the engineered fill pad. Surface water cannot be allowed to pond in excavations or to be trapped in clear stone backfill. Clear stone backfill can only be used with the approval of SPL Consultants.

11. After completion of compaction, the surface of the pad must be protected from disturbance from traffic, rain and frost.

12. If there is a delay in construction, the engineered fill pad must be inspected and accepted by the geotechnical engineer. The location of the structure must be reconfirmed that it remains within the pad.

The inorganic sandy silt to silty sand, and silts encountered on the site are considered suitable for use as engineered fill, provided that their moisture contents at the time of construction are at or near optimum. Soils excavated from below the groundwater level will have higher than optimum in-situ moisture content, and will have to be aerated prior to use as engineered fill. It is therefore imperative that the earth works are carried out in summer months, at favorable conditions, so there is an opportunity to aerate the soils prior to their re-use.

### 4.6 Foundation Conditions

As noted above in Section 4.2, single detached dwellings and townhouses with one level of basement are proposed to be constructed.

Based on the borehole information, the proposed building can be supported by conventional spread and strip footings founded on either on native soils or on engineered fill.

### 4.6.1 Footings on Native Soils

The boreholes in the subdivision area show that below the disturbed soil layer, the native soils in their undisturbed state are suitable to support the proposed single family dwellings and townhouses, and a geotechnical reaction of 150 kPa at the serviceability limit states (SLS), and a factored geotechnical resistance of 225 kPa at the ultimate limit states (ULS) at depths from about 0.8 to 1.5 m below existing ground can be utilized. In BH15-01, relatively weak (firm) silty clay was encountered below a depth of 4.6 m. Prior to raising grades (if any) in vicinity of BH15-01, SPL should be consulted to comment on the bearing capacity and settlement.

### 4.6.2 Foundations on Engineered Fill

For the construction of single family dwellings or townhouses, where the grades needs to be raised, proposed structures supported by spread and strip footings founded on engineered fill can be designed for a geotechnical reaction of 150 kPa at SLS, and a factored geotechnical resistance of 225 kPa at ULS, provided the requirements in preceding section 4.5 and Appendix D are adhered to. As noted in Section 4.6.1, prior to raising grades (if any) in vicinity of BH15-01, SPL should be consulted.

Prior to the placement of the engineered fill, all of the existing fill and surficially softened/loosened native soils must be removed and the exposed subgrade proof-rolled. Any soft spots revealed during proof-rolling must be sub-excavated and re-engineered. To reduce the risk of improperly placed engineered compacted fill, full-time supervision of the contractor is essential.

Where engineered fill is used to support the foundations, the floor slab can also be supported by engineered fill.

### 4.6.3 Floor Slab Construction and Drainage

The basement floor slabs can be placed on undisturbed native soils or on engineered fill. For bedding and moisture barrier purposes, a 200 mm thick layer of 19 mm clear crushed stone must be provided under the concrete basement floor slab. Where wet and/or fine grained soil conditions exist, the subdrains and moisture barrier should be separated from the subgrade by a geotextile fabric to avoid loss of soil/fines and settlement problems.

Underfloor and perimeter drainage will be required in the basements. A hydrogeological study must be carried out to investigate the feasibility of perimeter and underfloor drainage for basement floors below the groundwater table.

### 4.6.4 Other Comments on Foundations

Dewatering will be required for any excavation in the sandy silt to silty sand, or gravelly sand below the water table. Otherwise, it will result in an unstable excavation base and flowing sides. The groundwater table must be lowered one meter below the lowest excavation level. Test pit should be carried out in

the area prior to the excavation to further explore the groundwater and seepage conditions. A specialized dewatering contractor should install the dewatering system.

It is recommended to keep footings as high as possible to avoid or minimize penetration below groundwater levels.

Variations in the soil conditions are expected in between the borehole locations, and during construction, the soil bearing pressures should be confirmed by the Geotechnical Engineer.

Foundations designed to the specified bearing values are expected to settle less than 25 mm total and 20 mm differential.

All footings exposed to seasonal freezing conditions should be provided with at least 1.5 m of earth cover or equivalent thermal insulation against frost.

Where it is necessary to place footings at different levels, the upper footing must be founded below an imaginary 10 horizontal to 7 vertical line drawn up from the base of the lower footing. The lower footing must be installed first to help minimize the risk of undermining the upper foundations.

Note, the silty/sandy soils at the base of footings can be easily disturbed by construction machinery and foot traffic or lose their strength in contact with surface water. We recommend that an allowance to be made for placing a 50 mm thick skim coat of concrete on the founding subgrade immediately after its approval, to prevent its disturbance by construction activities and from ground or surface water, where necessary.

During winter construction, foundations and slab on grades must not be poured on frozen soil. Foundations must be adequately protected at all times from cold weather and freezing conditions.

In the vicinity of the existing buried utilities, all footings must be lowered to undisturbed native soils, or alternatively the services must be structurally bridged.

Standard geotechnical site investigations will not determine dewatering requirements for situation where there is planned excavation or construction below the groundwater table. To quantify conditions for dewatering purposes and to apply for required permits, both for construction and long term drainage, hydrogeologic study and carefully controlled pumping tests are necessary to adequately engineer a construction dewatering system and/or permanent groundwater control. SPL Consultants Limited advises that the geotechnical conditions at this site require such hydrogeologic study and analysis. The company is qualified and prepared to undertake this analysis upon proper authorization. Otherwise SPL accepts no responsibility for the design and construction of the dewatering details.

It should be noted that a permit to take water, issued by the Ontario Ministry of the Environment, will be required if the dewatering system/sumps result in a water taking of more than 50 $m^3$/day. In addition, a permit to discharge the collected water to the sewer system/water body will be required from the applicable agency.

It is essential that imported free-draining OPSS Granular 'B' type fill be used as backfill against foundation walls and used as 'under-floor' (structural fill). Backfilling of the footing wall excavations (and under-floor) is recommended to be placed in 200 mm thick lifts, compacted to 100% SPMDD to proposed sub-grade elevations (see Drawing 2).

It should be noted that the recommended bearing capacities have been calculated by SPL from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of the 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 boreholes and the recommendations of this report must therefore be checked through field inspections provided by SPL to validate the information for use during the construction stage.

### 4.7 Storm Water Management Pond (SWMP)

We understand that two stormwater management ponds (SWMP) will be part of the development, one of them will be constructed in the northwest portion and the second will be constructed in the southwest portion of the development.

Boreholes BH15-04 and BH15-18 were drilled at the locations of SWMP to be constructed in the northwest portion and southwest portion of the proposed development, respectively. These boreholes, beneath the topsoil encountered disturbed soils to about 0.8 m, followed by compact to very dense cohesionless soils consisting of sandy silt, sand and silt, silty sand, sand, and sand and gravel.

The highest groundwater table measured in monitoring wells installed at BH15-04 was 3.3 m (Elev. 198.3 m), and at BH15-18 was 2.5 m (Elev. 206 m). It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to major weather events.

The depth of the ponds is not known at the time of writing this report. Based on borehole information, the sides and bottom of SWMP will consist of cohesionless soils. We recommend that the side slopes be no steeper than 3H : 1 V above water level and 5H:1V below water level, and the bottom and sides of the stormwater pond be provided with an impermeable liner.

The liner may consist of a natural soil material (such as clay or clayey silt) or a synthetic membrane liner (such as a High Density Polyethylene, Geo-synthetic Clay Liner, or PVC). A natural soil liner may be preferable based on the following considerations:

- Low permeability clayey silt materials may be available locally for the construction of the liner.
- A clay liner is readily constructed using locally available construction equipment and manpower.
- A synthetic liner requires more elaborate design and construction considerations with respect to fabrication and protection of the completed liner.

However, a synthetic liner would perform satisfactorily and could be considered if a suitable and sufficient clay source were not available.

The clay liner must cover the bottom and sides of the pond, and should be compacted to at least 98 percent SPMDD.

It is recommended that the minimum liner thickness for clay soils be 0.6 m, and that the liner be inspected on an annual basis, to deal with these considerations. The clay liner should not be left to dry out, as shrinkage will occur and the liner will crack thus inducing excessive seepage. The liner must be covered with a minimum of 300 mm of sand and gravel or other suitable material.

The liner must be constructed of low permeability materials (clayey silt or clay) in order to perform adequately and to provide a liner bulk permeability on the order of $1x10^{-7}$ cm/s. The liner material should consist of inorganic soil. The grain size distribution of the liner material must conform to the following:

- no particle greater than 100 mm dimension
- not greater than 15 percent of the material larger than 4.8 mm (No. 4 sieve)
- minimum 20 percent finer than 0.002 mm (clay size)
- plasticity index of minimum 6.0

A strict control and monitoring of the liner material must be maintained to collect samples to verify its composition based on laboratory test results and to identify any variation in the material. The liner material must be placed at water contents 2 to 4 percent wet of the optimum moisture content. This is required to ensure that the material is compacted to a homogenous mass, and does not remain as distinct "clods" or "clumps". The liner should be constructed in thin lifts (not exceeding 150 mm thick) and be heavily compacted to a minimum of 95 percent SPMDD. Liner materials should not contain any frozen soil should the construction proceeds under winter conditions.

The liner construction must be conducted under the full time supervision of a qualified geotechnical engineer.

Alternatively, as noted before, a synthetic liner (such as HDPE, Geosynthetic Clay Liner or PVC) may be used. Manufacturer’s specifications and recommendations must be referred for the design and construction of a synthetic liner.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, the cohesionless soils (sand, sandy silt, silt, sand and gravel etc.) and the firm to stiff silty clay to clayey silt can be classified as Type 3 soil above groundwater table and Type 4 below groundwater table. Very stiff silty clay to clayey silt can be classified as Type 2 soil above groundwater table and Type 3 below groundwater table.

The design of SWMP must be reviewed by SPL. Also, a detailed pond slope stability analysis should be carried out once the design details of the SWMP are finalized.

### 4.8 Slope Stability Investigation

A detailed site specific slope stability study was carried out based on seven boreholes (BH15-04, BH15-05, BH15-09, BH15-13, BH15-17, BH15-18, and BH15-21). These boreholes were advanced on the tableland, in the proximity of the valley slope crest to assess the long-term stability of the subject slope. This study included a visual inspection of the slope within the study area to assess existing slope conditions with respect to any obvious signs of instability concerns, and a detailed slope stability analysis of selected slope cross-section using computer software.

#### 4.8.1 Slope Inspection and Mapping

A visual inspection of the subject slope was conducted on April 4, 2015. General information pertaining to existing slope features such as slope profile, slope drainage, watercourse features, vegetation cover, structures in the vicinity of the slope, as well as erosion and slope slide features was obtained during the inspection. A brief summary of the results of the visual inspection is presented below.

A topographic survey of the property including the tableland and the valley slope was provided by C.C. Tatham & Associates Limited. Thirteen (13) slope cross-sections (Section A-A to Section M-M) inferred from the available topographic information supplemented by our field observations were used to prepare a slope model for the long-term slope stability analysis. The cross-sections were selected on the basis of the slope height and inclination to represent a critical slope condition present within the study area. The sections included a portion of the tableland and extending across the slope down to the creek. The location of the selected slope cross-sections are presented on Drawing 3, and the details of the slope profile are presented on Drawing 4 through Drawing 16.

The subject property is situated on a relatively flat to gently sloping tableland. The tableland is currently used for agricultural purposes. The west property boundary is associated with densely vegetated/forested valley slope, and Black Ash Creek meanders through it, and at few locations, comes in contact with the toe of the slope. Bank undercutting of slope toe was noted at various locations within the study area (refer photographs 5 to 9, 12 and 14, Appendix E).

Table 3 summarizes the slope height and inclination for the plotted sections (Drawings 4 to 16):

**TABLE 3: Approximate Height and Inclination of Slope at specified Locations**

| Section | Slope Height (m) | Slope Inclination |
|---|---|---|
| A-A | ± 5 m | 5.1 H : 1 V |
| B-B | ± 1 m | Gently Sloping |
| C-C | ± 3.7 m | 2.5 H : 1 V |
| H-H | ± 6.3 m | ± 2.5 H : 1 V |
| E-E | ± 3.5 m | 3.3 H : 1 V |
| F-F | ± 6 m | 3.1 to 7.4 H : 1 V |
| G-G | ± 6 m | Nearly horz. to 4.2 H : 1V |
| H-H | ± 4.5 m | ± 1.9 H : 1 V |
| I-I | ± 2 m | 8.4 H : 1 V |
| J-J | -- | Gently Sloping |
| K-K | ± 1.5 m | 2.5 H : 1 V |
| L-L | -- | Gently Sloping |
| M-M | ± 5 m | ± 4.7 H : 1 V |

The slope is generally well vegetated with numerous young and mature trees and bush growth. Except for a couple of fallen and leaning trees, the tree trunk growth was noted to be generally straight and upright.

### 4.8.2 Soil Parameters and Groundwater

Based on the borehole information, soil parameters used in the slope stability analyses are given on Table 4.

**Table 4: Soil Parameters for Slope Stability Analyses**

| Soil Type | Soil Density ($kN/m^3$) | Long-term Strength | |
|---|---|---|---|
| | | c' (kPa) | ϕ' (degree) |
| Sandy Silt (Loose to Compact) | 18 | 0 | 29 |
| Sandy Silt/Silty Sand (very Dense) | 21 | 0 | 34 |
| Clayey Silt (hard) | 20.5 | 5 | 32 |

The above soil strength parameters are based on the effective stress analysis for long-term slope stability.

The stabilized groundwater table observed in the monitoring well installed in BH15-09 was at 4.0 m below existing ground surface, corresponding to elevation 202.0 m as of April 17, 2015. A groundwater table of 203.5 m was used in the computer model to simulate normal groundwater table.

### 4.8.3 Toe Erosion Allowance

The regression of the slope toe due to erosion over the design life of the structure (typically 100 years for long-term) is compensated by the introduction of an erosion allowance (setback) which is measured as a horizontal distance from the existing creek bank. The erosion allowance is based on the type of the slope toe material and the stream characteristics including the distance between the stream edge and the slope toe, bankfull width as well as the current toe erosion condition. An erosion allowance is recommended in areas where the watercourse position is within 15 m of the slope toe.

At this site, Black Ash creek meanders within the wooded area, and comes in contact with the toe of the slope at few locations. Bank cutting/erosion conditions were evident. Based on borehole information, the toe of slope comprise of dense to very dense cohesionless soils or stiff to hard cohesive soils.

The MNR Policy Guidelines recommends a toe erosion allowance of 5 to 8 m for stiff/hard cohesive soils, and 8 to 15 m for fine granular (sand, silt), for active toe erosion conditions.

At this site, the slope surface is well vegetated with grass, weed, bushes, young to mature trees, and the slope inclination on average is gentle. In consideration of the prevailing soil and site conditions, it is recommended that a 10 m erosion set-back allowance be used for toe erosion.

### 4.8.4 Stability of Existing Slope

As stated in section 4.8.1, SPL inferred thirteen slope profiles (Sections A-A to M-M), of which Section H-H was the critical. A detailed engineering analysis of slope stability was carried out for the selected slope cross-section (Section H-H) utilizing computer software (SLIDE by Rocscience). For purposes of this study, the Morgenstern-Price limit equilibrium method of analysis was conducted. This method of analysis permits the calculation of Factors of Safety for generated or assumed failure surfaces.

The analysis was carried out by preparing a model of the slope/site geometry and subsurface conditions, and analyzing numerous failure surfaces in search of the minimum or critical Factor of Safety in order to assess the stability of the slope. The pertinent data obtained from the topographic and borehole information (Sections 4.8.1 and 4.8.2 above) was input in the slope stability analysis. Many calculations were carried out to examine the Factors of Safety for varying depths for potential failure surfaces. The minimum factor of safety for the existing slope at Section H-H is summarized in Table 5 below:

**Table 5: Computed Factors of Safety for Existing Slope Section**

| Section | Average Inclination | Type of Slope Slide | Minimum Factor of Safety for Potential Slope Slides (Based on Borehole information) |
|---|---|---|---|
| Section H-H | 1.9 H : 1.0 V | Circular Slope Slide | 1.40 (see Drawing No. 18) |

For land development and planning, the MNR Policy Guidelines allow a minimum Factor of Safety of 1.3 to 1.5 for slope stability. The computed minimum factor of safety for Section H-H for the existing slope was 1.4. This factor of safety is lower than the minimum required factor of safety of 1.5, and suggests that the existing slope, in its current condition, is not stable in the long-term.

Therefore, additional slope stability analyses were carried out to determine the stable slope inclination for the subject slope. In order to establish the stable slope inclination, the section was subjected to a number of representative trial profiles of the slope with flatter inclinations but similar slope height and subsurface conditions and was analyzed to obtain a minimum factor of safety of 1.5, in conformance to the policy guidelines.

The results of the slope stability analysis conducted for hypothetical slope profile with a flatter inclination of 2.25 horizontal to 1.0 vertical for the soil with similar sub-surface conditions as that of Section H-H is summarized in Table 6:

**Table 6: Computed Factors of Safety for Assumed Slope Section**

| Section | Average Inclination | Type of Slope Slide | Minimum Factor of Safety for Potential Slope Slides (Based on Borehole information) |
|---|---|---|---|
| Section H-H | 2.25 H : 1.0 V | Circular Slope Slide | 1.55 (see Drawing No. 19) |

For long-term stability of slope, minimum factors of safety of 1.5 is recommended for planning and development. For Section H-H, the above minimum computed factors of safety (for slope profile with an inclination of 2.25 horz. to 1.0 vert.) of 1.55 is considered satisfactory and adequate.

### 4.8.5 Long Term Stable Slope

The Long-term Stable Slope Top of Slope (LTSTOS) location was calculated based on the applicable erosion and stability setbacks. The slope stability analysis completed in section 4.8.5 concludes that a slope inclination of 2.25 horizontal : 1 vertical or flatter is required for the long-term stability of the slope at this site. Drawings 4 to 16 in sections, and Drawing 17 in plan present the estimated location of the Long-term Stable Top of Slope Line in sections and plan (S1-S2-S3-S4-S5-S6-S7-S7-S8-S9-S10-S11-S12-S13-S14-S15-S16-S17-S18-S19-S20-21-S22-S23-S24-S25-S26-S27-S28). Where the existing slope

inclination is gentler than the computed stable slope inclination of 2.25 horizontal : 1 vertical, the existing top of slope is the Long-term Stable Top of Slope Line. The Drawings 4 to 16 delineate the location of the Long-term Stable Top of Slope Line where it is located either behind (inland, towards the tableland) or along the Physical Top of Bank for the subject slope.

#### 4.8.6 Development Setback

In addition to the stability and erosion setbacks an access allowance/development setback is typically required from the identified slope hazard area (long-term Stable Top of Slope Line location) to take into account possible external conditions which could have an adverse effect on the existing natural condition of the slope, and to provide access to the slope in emergencies. This setback generally varies depending upon the policies of individual authorities. The determination of the setback value depends on a number of factors including but not limited to, the watershed classification, type of development, site specific conditions and available access to the slope. The structures may be allowed to be located closer to the long-term Stable Top of Slope Line but only if approved by the concerned conservation authority.

#### 4.8.7 Other Comments on Slope Stability

Additional comments related to any future construction at this property, and in terms of slope stability at the site are as follows:

1. Limit the direct run-off in an uncontrolled fashion over the crest of the slope.

2. A sediment control fence must be erected and maintained during construction to isolate work area from the adjoining slope and valley system.

3. The existing slope vegetation should be maintained. Any slope areas disturbed by construction should be restored with suitable native vegetation.

### 4.9 Chemical Characterization of Soils

Twelve selected soil samples and two duplicate samples were subjected to chemical analysis to assess the environmental quality of the soils to assist in determining off-site disposal options. The chemical testing report and results are enclose in Appendix F.

## 5. GENERAL COMMENTS

SPL Consultants Limited 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 accorded the privilege of making this review, SPL Consultants Limited will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes and test pits required to determine the localized underground conditions between boreholes and test pits 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 and test pit results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

## 6. LIMITATIONS OF REPORT

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to SPL Consultants Limited at the time of preparation. Unless otherwise agreed in writing by SPL Consultants Limited, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. SPL Consultants Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

**SPL CONSULTANTS LIMITED**

Kulbir Singh, M.Eng., P.Eng.

LICENSED PROFESSIONAL ENGINEER
K. SINGH
100052179
PROVINCE OF ONTARIO

Fanyu Zhu, Ph.D., P.Eng.

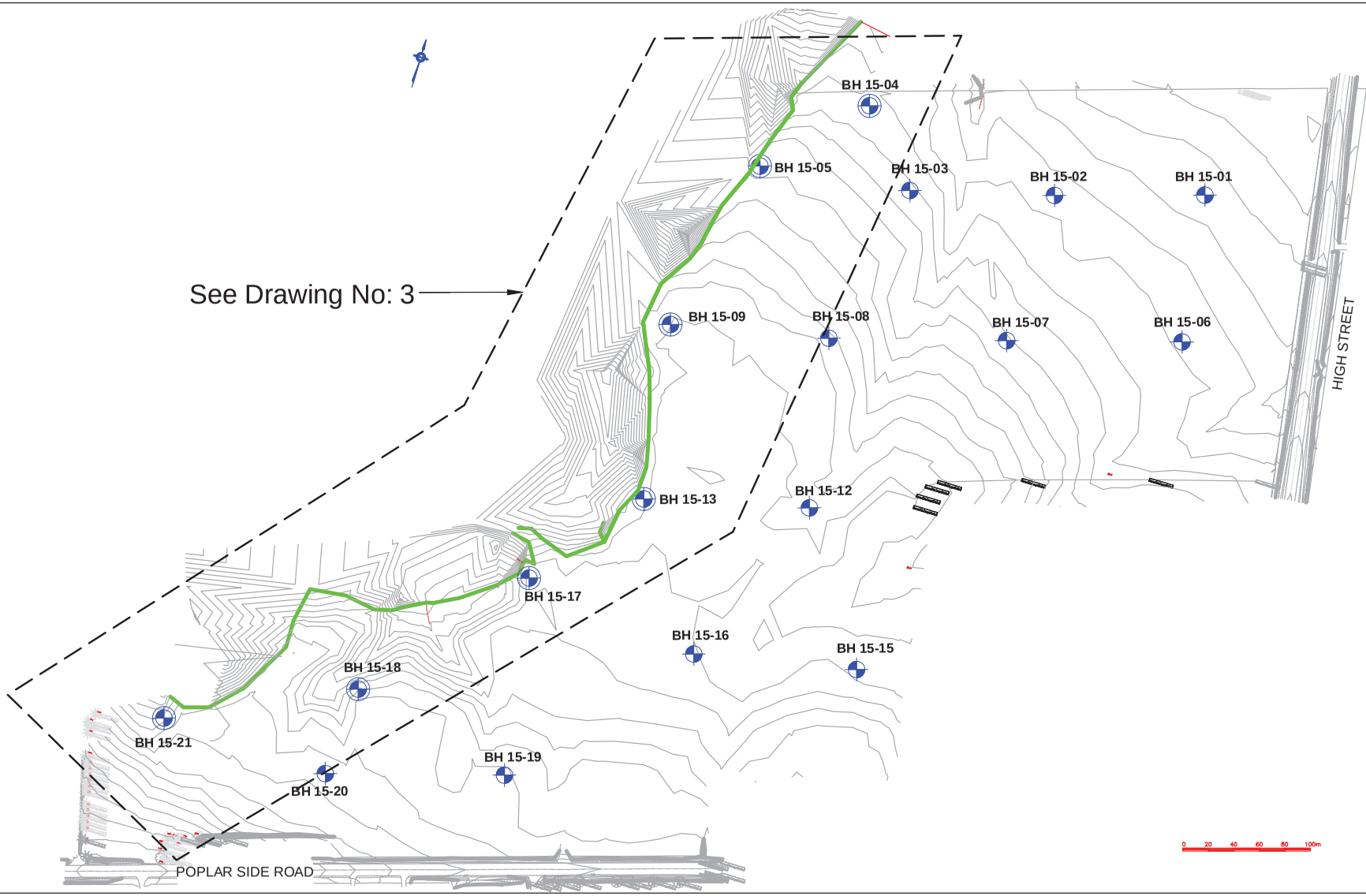
LICENSED PROFESSIONAL ENGINEER
F. ZHU
PROVINCE OF ONTARIO

Shabbir Bandukwala, M.Eng., P.Eng.

LICENSED PROFESSIONAL ENGINEER
S.S. BANDUKWALA
2218113
PROVINCE OF ONTARIO

# DRAWING

- **Borehole Location Plan (Drg. 1)**
- **Drainage and Backfill Recommendations (Drg. 2)**
- **Slope Location and Photograph Location Plan (Drg. 3)**
- **Existing Soil Profiles & Long-Term Stable Top of Slope (LTSTOS) (Drgs. 4 – 16)**
- **Long-Term Stable Top of Slope Line (LTSTOS) (Drg. 17)**
- **Slope Stability Analysis Results (Drgs. 18 & 19)**

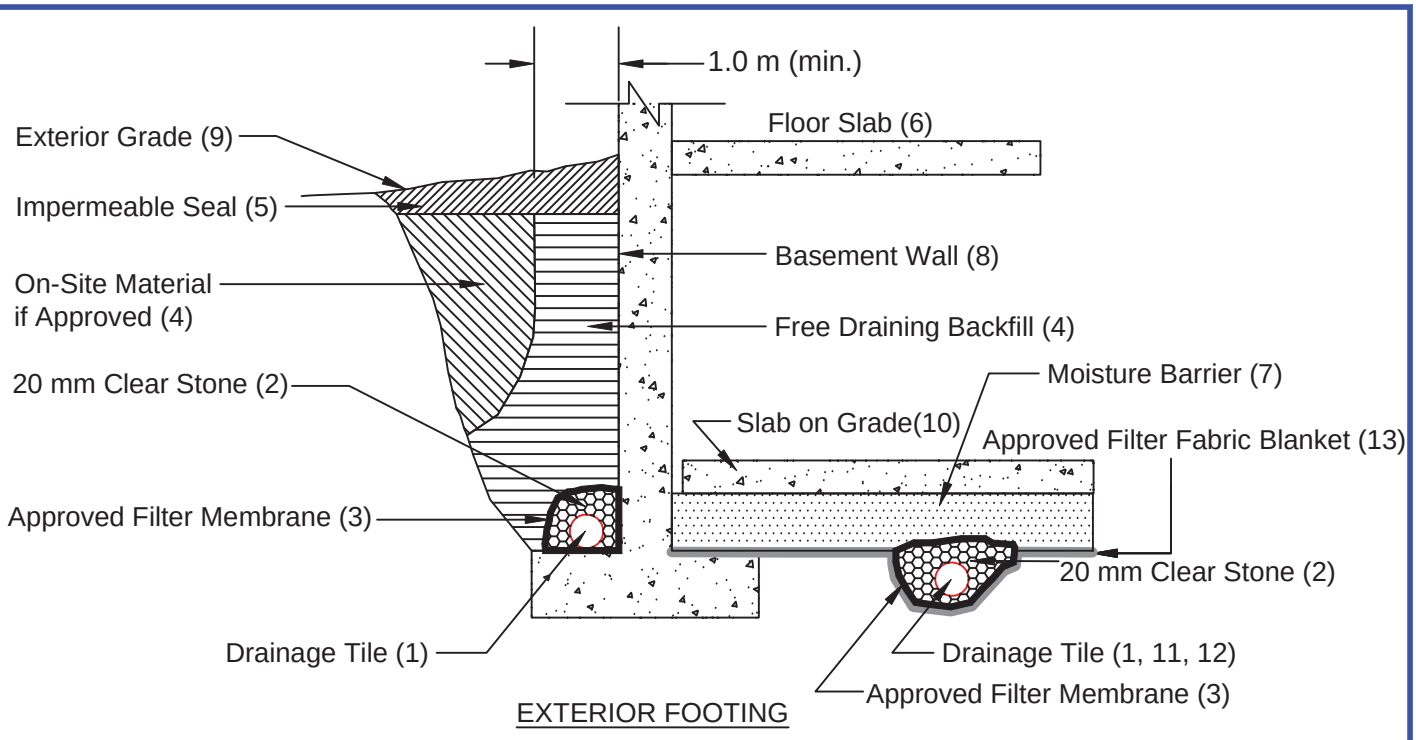



T:\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-Dec05-2015.dwg

**LEGEND**

- Borehole
- Borehole with Monitoring Well

| | | | | | |
|---|---|---|---|---|---|
| Client: | 1671745 Ontario Limited c/o C.C Tatham & Associates Ltd. | | | Project No.: 10001514 | Drawing No.: 1 |
| Drawn: | ZMO | Approved: | KS | Title: | Borehole Location Plan |
| Date: | Dec 04, 2015 | Scale: | As Shown | Project: | Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario |
| Original Size: | Tabloid | Rev: | 01 | | SPL Consultants Limited Geotechnical • Environmental • Materials • Hydrogeology |



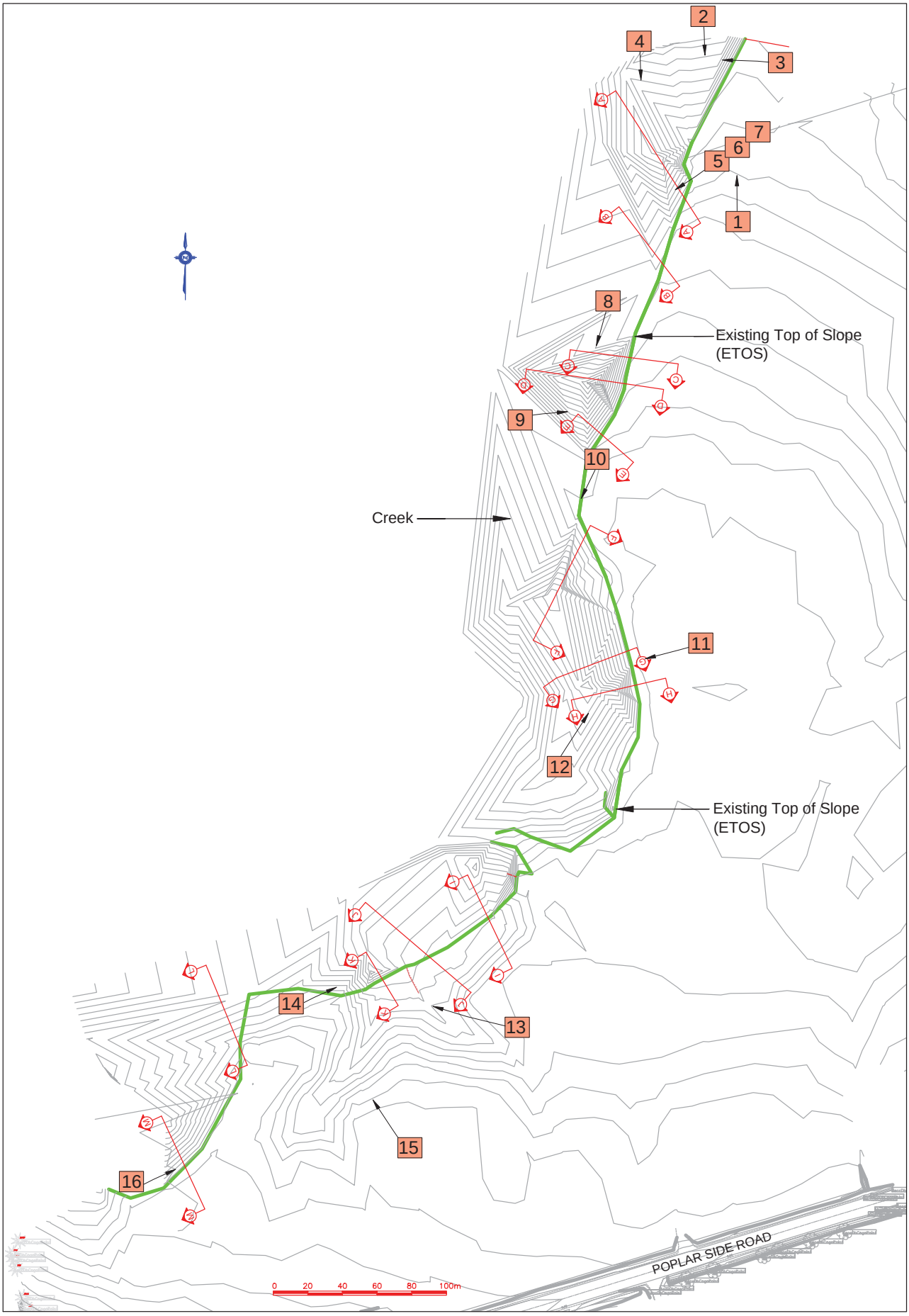

EXTERIOR FOOTING

**Notes**

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. Free Draining backfill - OPSS Granular B or equivalent compacted to the specified density. Do not use heavy compaction equipment within 450 mm (18") of the wall. Use hand controlled light compaction equipment within 1.8 m (6') of wall. The minimum width of the Granular 'B' backfill must be 1.0 m.
5. Impermeable backfill seal - compacted clay, clayey silt or equivalent. If original soil is free-draining, seal may be omitted. Maximum thickness of seal to be 0.5 m.
6. Do not backfill until wall is supported by basement and floor slabs or adequate bracing.
7. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
8. Basement wall to be damp proofed /water proofed.
9. Exterior grade to slope away from building.
10. Slab on grade should not be structurally connected to the wall or footing.
11. Underfloor drain invert to be at least 300 mm (12") below underside of floor slab.
12. Drainage tile placed in parallel rows 6 to 8 m (20 to 25') centers one way. Place drain on 100 mm (4") clear stone with 150 mm (6") of clear stone on top and sides. Enclose stone with filter fabric as noted in (3).
13. The entire subgrade to be sealed with approved filter fabric (Terrafix 270R or equivalent) if non-cohesive (sandy) soils below ground water table encountered.
14. Do not connect the underfloor drains to perimeter drains.
15. Review the geotechnical report for specific details.

## DRAINAGE AND BACKFILL RECOMMENDATIONS
## Basement with Underfloor Drainage

(not to scale)



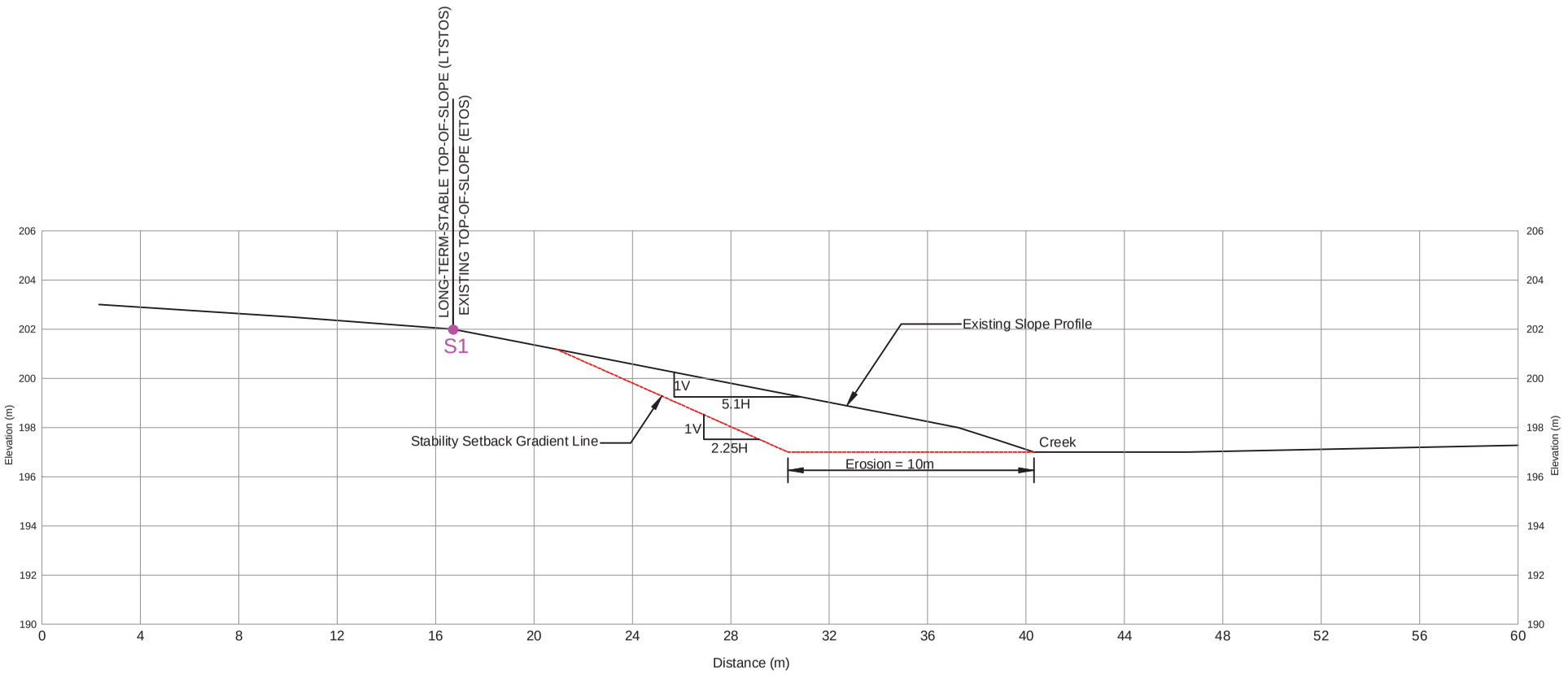

**LEGEND**

Slope Location

1 Photo Location

| | | | | | |
|---|---|---|---|---|---|
| Client: | 1671745 Ontario Limited<br>c/o C.C Tatham & Associates Ltd. | | | Project No.: 10001514 | Drawing No.: 3 |
| Drawn: | ZMO | Approved: | KS | Title: | Slope Location and Photo Location Plan |
| Date: | April 21, 2015 | Scale: | As Shown | Project: | Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario |
| Original Size: | Tabloid | Rev: | N/A | | |

SPL Consultants Limited
Geotechnical • Environmental • Materials • Hydrogeology

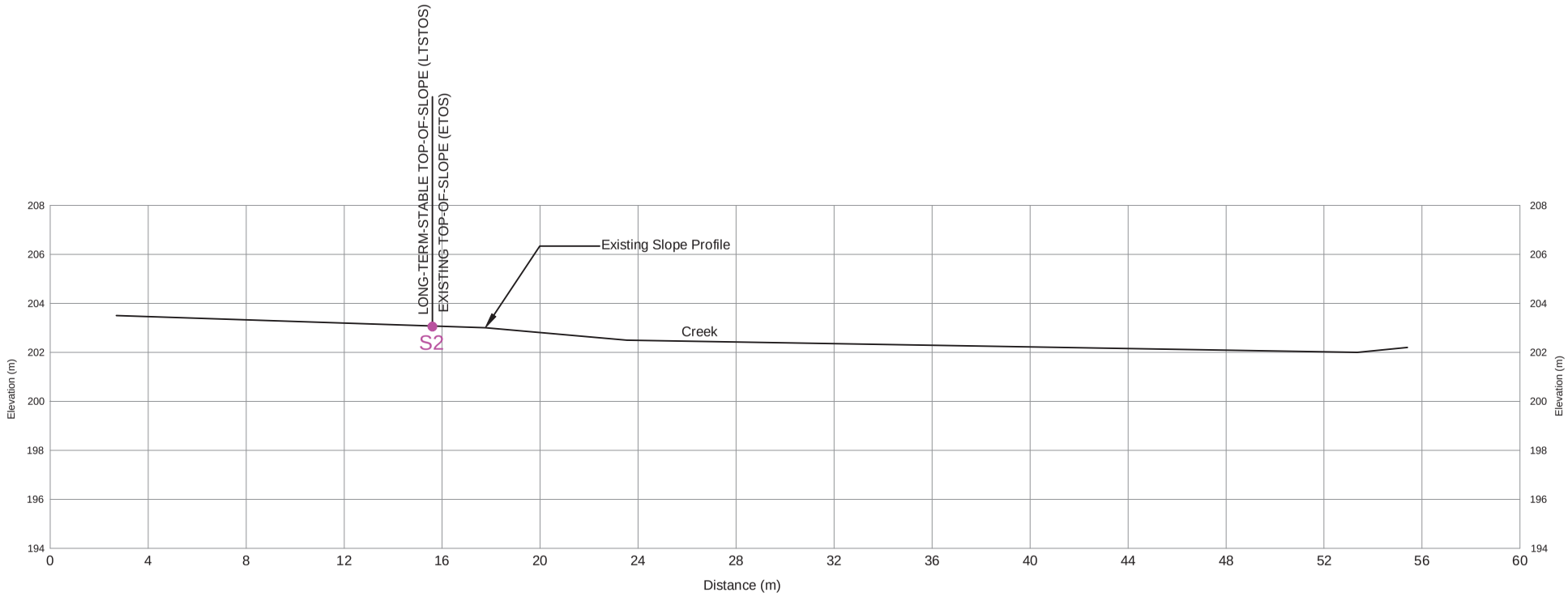



SECTION A-A

| | | | | | |
|---|---|---|---|---|---|
| Client: | **1671745 Ontario Limited c/o C.C Tatham & Associates Ltd.** | | | Project No.: **10001514** | Drawing No.: **4** |
| Drawn: | **ZMO** | Approved: | **KS** | Title: | **Section A-A** |
| Date: | **April 21, 2015** | Scale: | **As Shown** | Project: | **Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario** |
| Original Size: | **Letter** | Rev: | **N/A** | | |

SPL Consultants Limited
Geotechnical * Environmental * Materials * Hydrogeology

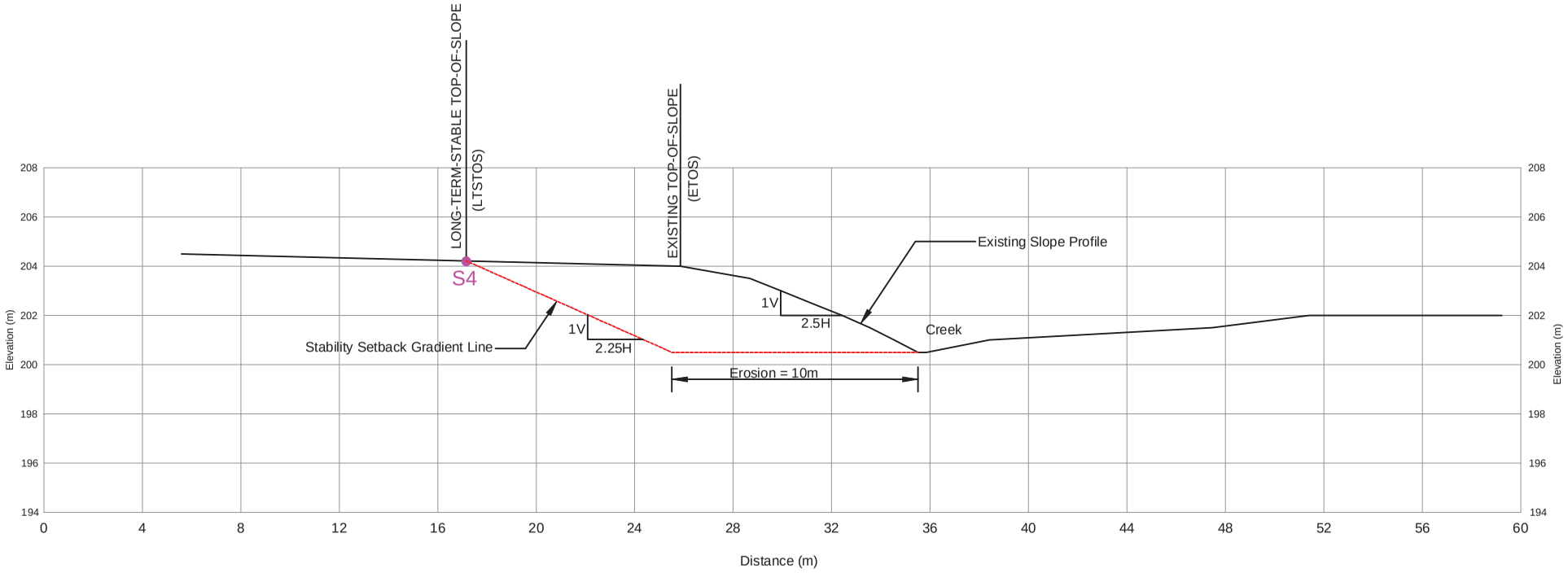
SERVER\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-April21-2015.dwg




SECTION B-B

| | | | | | |
|---|---|---|---|---|---|
| Client: | 1671745 Ontario Limited<br>c/o C.C Tatham & Associates Ltd. | | | Project No.: 10001514 | Drawing No.: 5 |
| Drawn: | ZMO | Approved: | KS | Title: | Section B-B |
| Date: | April 21, 2015 | Scale: | As Shown | Project: | Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario |
| Original Size: | Letter | Rev: | N/A | SPL Consultants Limited<br>Geotechnical * Environmental * Materials * Hydrogeology | |

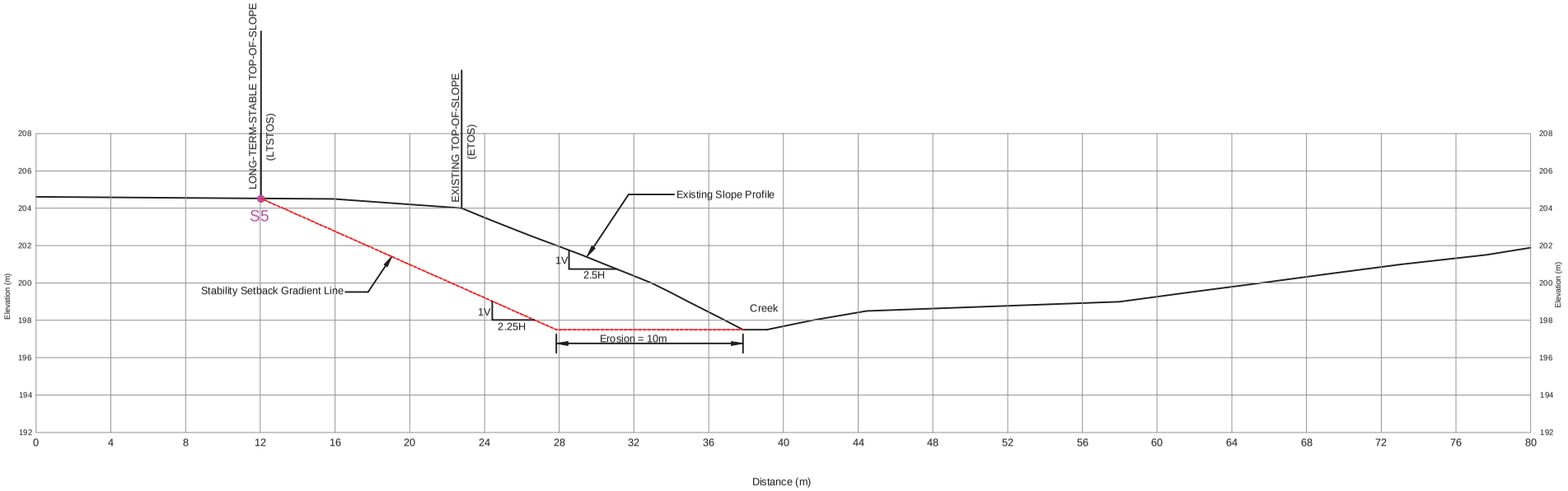
SERVER\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-April21-2015.dwg




# SECTION C-C

| | | | | | |
|---|---|---|---|---|---|
| Client: | **1671745 Ontario Limited c/o C.C Tatham & Associates Ltd.** | | | Project No.: **10001514** | Drawing No.: **6** |
| Drawn: | **ZMO** | Approved: | **KS** | Title: | **Section C-C** |
| Date: | **April 21, 2015** | Scale: | **N.T.S.** | Project: | **Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario** |
| Original Size: | **Letter** | Rev: | **N/A** | SPL Consultants Limited<br>Geotechnical * Environmental * Materials * Hydrogeology | |

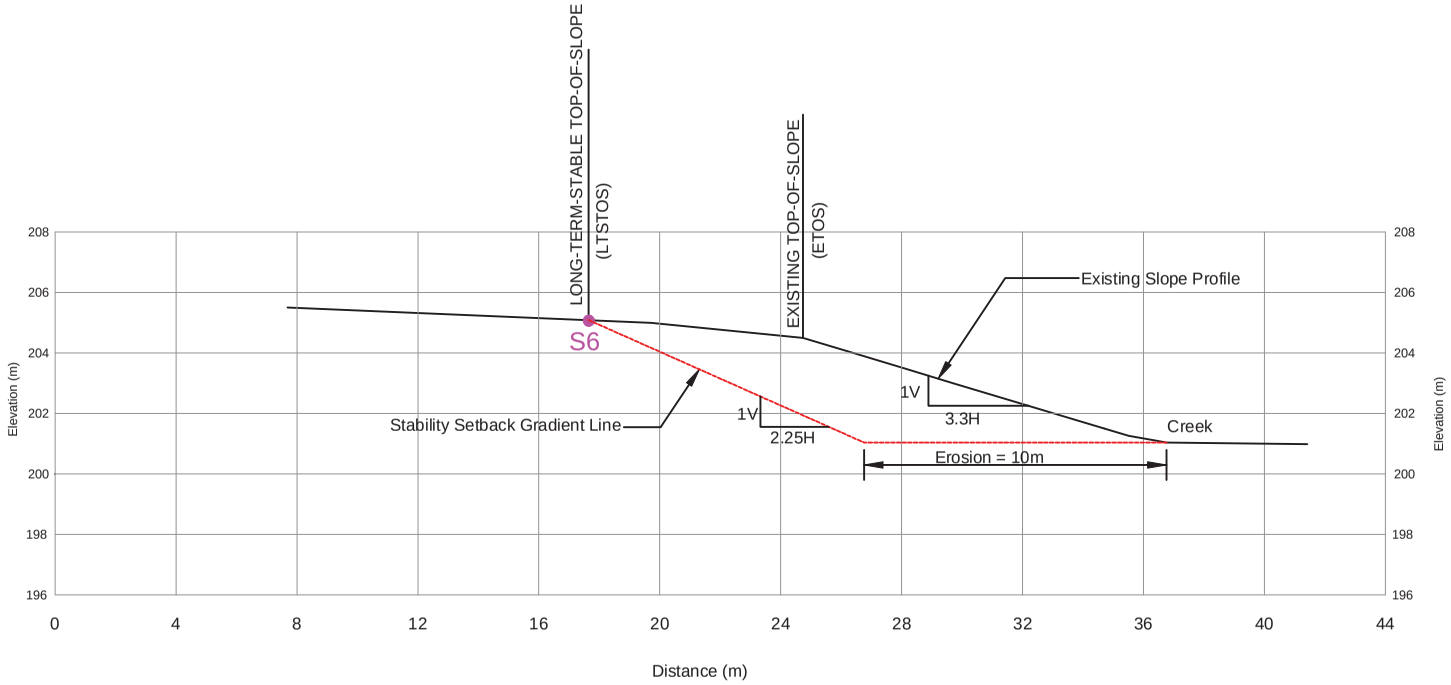
SERVER\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-April21-2015.dwg




SECTION D-D

| | | | | | |
|---|---|---|---|---|---|
| Client: | 1671745 Ontario Limited<br>c/o C.C Tatham & Associates Ltd. | | | Project No.: 10001514 | Drawing No.: 7 |
| Drawn: | ZMO | Approved: | KS | Title: | Section D-D |
| Date: | April 21, 2015 | Scale: | N.T.S. | Project: | Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario |
| Original Size: | Letter | Rev: | N/A | SPL Consultants Limited<br>Geotechnical * Environmental * Materials * Hydrogeology | |

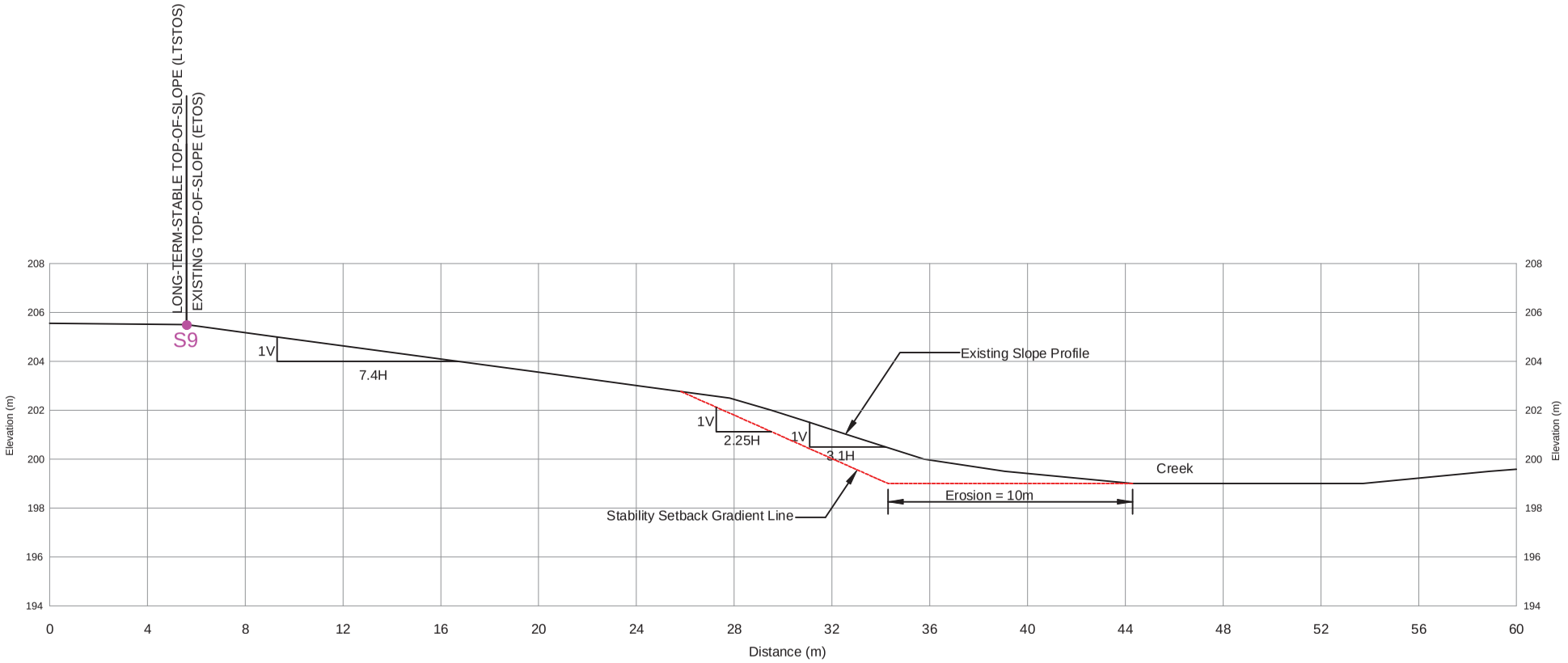
SERVER\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-April21-2015.dwg




# SECTION E-E

| | | | | | |
|---|---|---|---|---|---|
| Client: | **1671745 Ontario Limited c/o C.C Tatham & Associates Ltd.** | | | Project No.: **10001514** | Drawing No.: **8** |
| Drawn: | **ZMO** | Approved: | **KS** | Title: | **Section E-E** |
| Date: | **April 21, 2015** | Scale: | **N.T.S.** | Project: | **Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario** |
| Original Size: | **Letter** | Rev: | **N/A** | SPL Consultants Limited<br>Geotechnical * Environmental * Materials * Hydrogeology | |

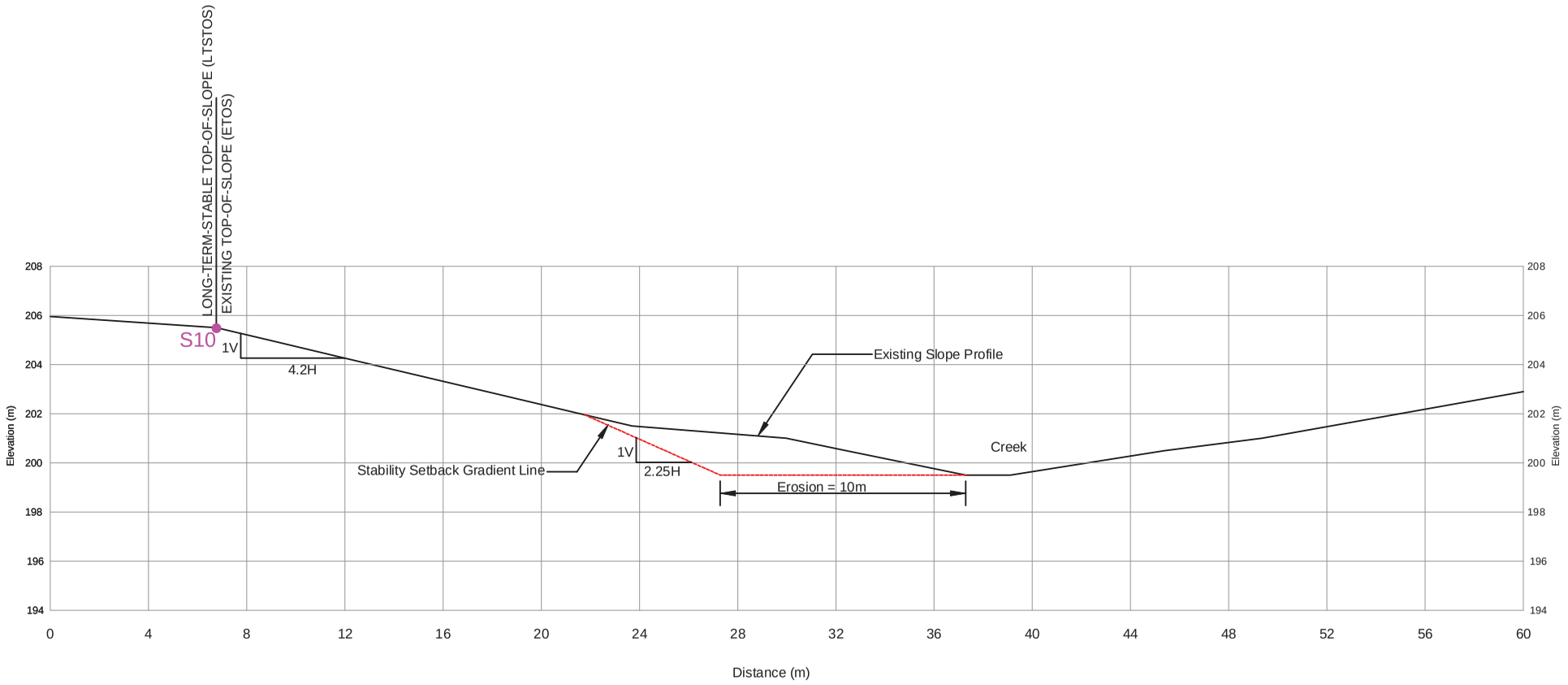
SERVER\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-April21-2015.dwg




SECTION F-F

| | | | | | |
|---|---|---|---|---|---|
| Client: | 1671745 Ontario Limited<br>c/o C.C Tatham & Associates Ltd. | | | Project No.: 10001514 | Drawing No.: 9 |
| Drawn: | ZMO | Approved: | KS | Title: | Section F-F |
| Date: | April 21, 2015 | Scale: | N.T.S. | Project: | Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario |
| Original Size: | Letter | Rev: | N/A | SPL Consultants Limited<br>Geotechnical * Environmental * Materials * Hydrogeology | |

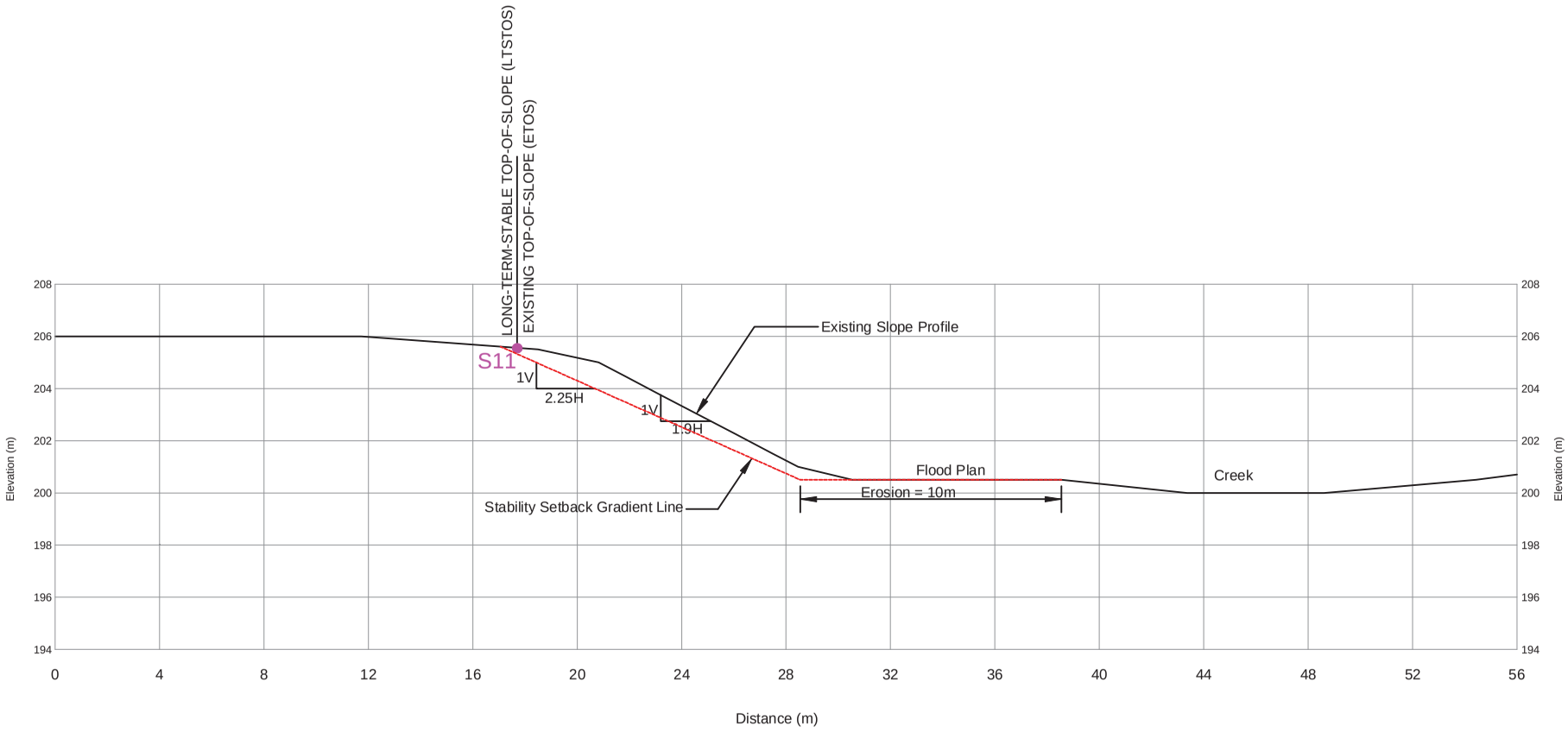
SERVER\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-April21-2015.dwg




# SECTION G-G

| | | | | | |
|---|---|---|---|---|---|
| Client: | 1671745 Ontario Limited<br>c/o C.C Tatham & Associates Ltd. | | | Project No.: 10001514 | Drawing No.: 10 |
| Drawn: | ZMO | Approved: | KS | Title: | Section G-G |
| Date: | April 21, 2015 | Scale: | N.T.S. | Project: | Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario |
| Original Size: | Letter | Rev: | N/A | SPL Consultants Limited<br>Geotechnical * Environmental * Materials * Hydrogeology | |

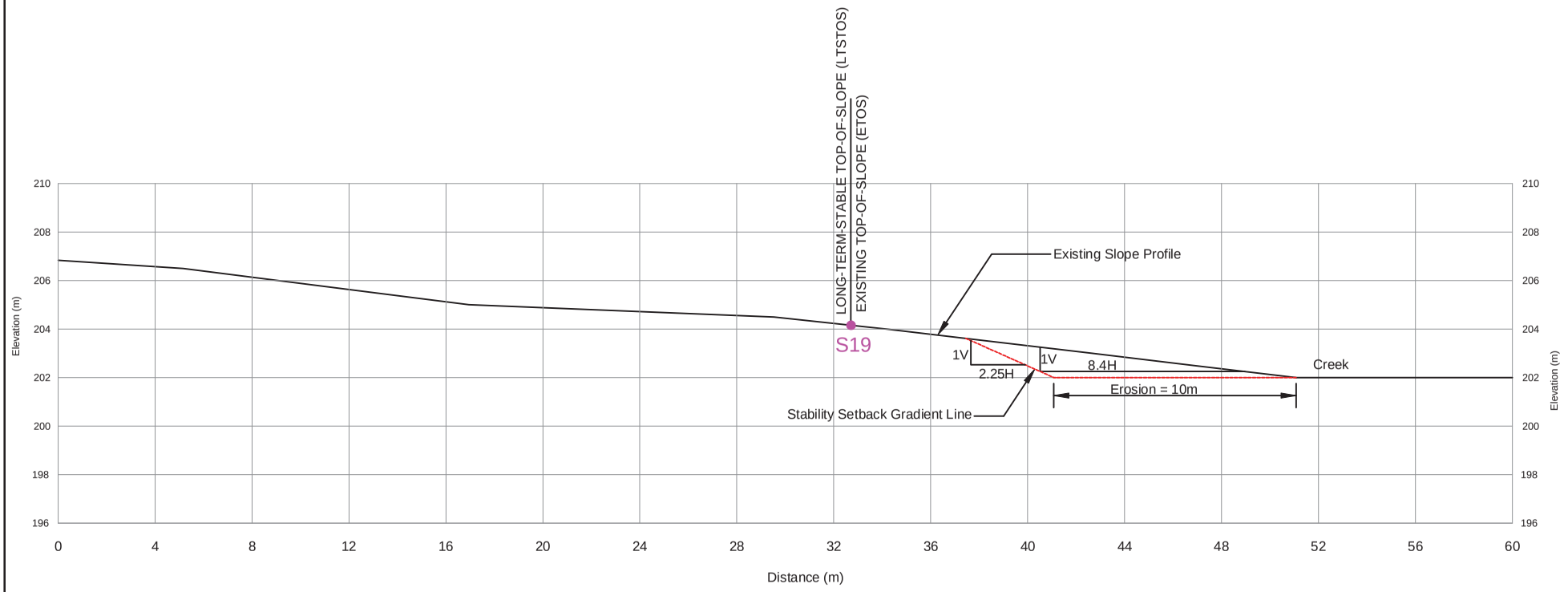
SERVER\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-April21-2015.dwg




# SECTION H-H

| | | | | | |
|---|---|---|---|---|---|
| Client: | **1671745 Ontario Limited c/o C.C Tatham & Associates Ltd.** | | | Project No.: **10001514** | Drawing No.: **11** |
| Drawn: | **ZMO** | Approved: | **KS** | Title: | **Section H-H** |
| Date: | **April 21, 2015** | Scale: | **N.T.S.** | Project: | **Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario** |
| Original Size: | **Letter** | Rev: | **N/A** | SPL Consultants Limited<br>Geotechnical * Environmental * Materials * Hydrogeology | |

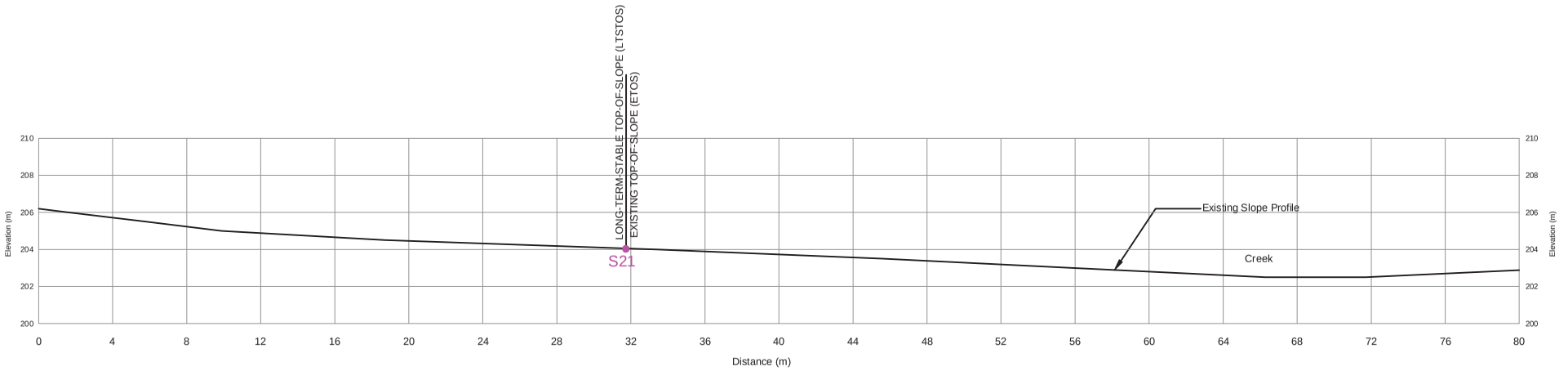
SERVER\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-April21-2015.dwg




SECTION I-I

| | | | | | |
|---|---|---|---|---|---|
| Client: | **1671745 Ontario Limited c/o C.C Tatham & Associates Ltd.** | | | Project No.: **10001514** | Drawing No.: **12** |
| Drawn: | **ZMO** | Approved: | **KS** | Title: | **Section I-I** |
| Date: | **April 21, 2015** | Scale: | **N.T.S.** | Project: | **Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario** |
| Original Size: | **Letter** | Rev: | **N/A** | SPL Consultants Limited<br>Geotechnical * Environmental * Materials * Hydrogeology | |

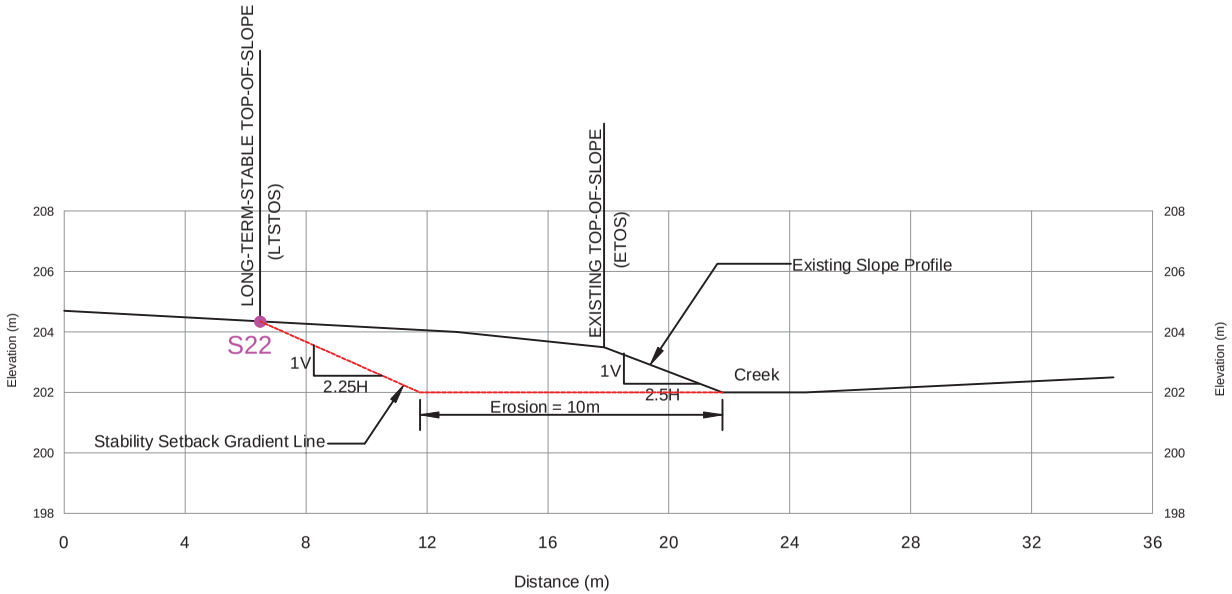
SERVER\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-April21-2015.dwg




SECTION J-J

| | | | | | |
|---|---|---|---|---|---|
| Client: | **1671745 Ontario Limited c/o C.C Tatham & Associates Ltd.** | | | Project No.: **10001514** | Drawing No.: **13** |
| Drawn: | **ZMO** | Approved: | **KS** | Title: | **Section J-J** |
| Date: | **April 20, 2015** | Scale: | **N.T.S.** | Project: | **Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario** |
| Original Size: | **Letter** | Rev: | **N/A** | SPL Consultants Limited<br>Geotechnical * Environmental * Materials * Hydrogeology | |

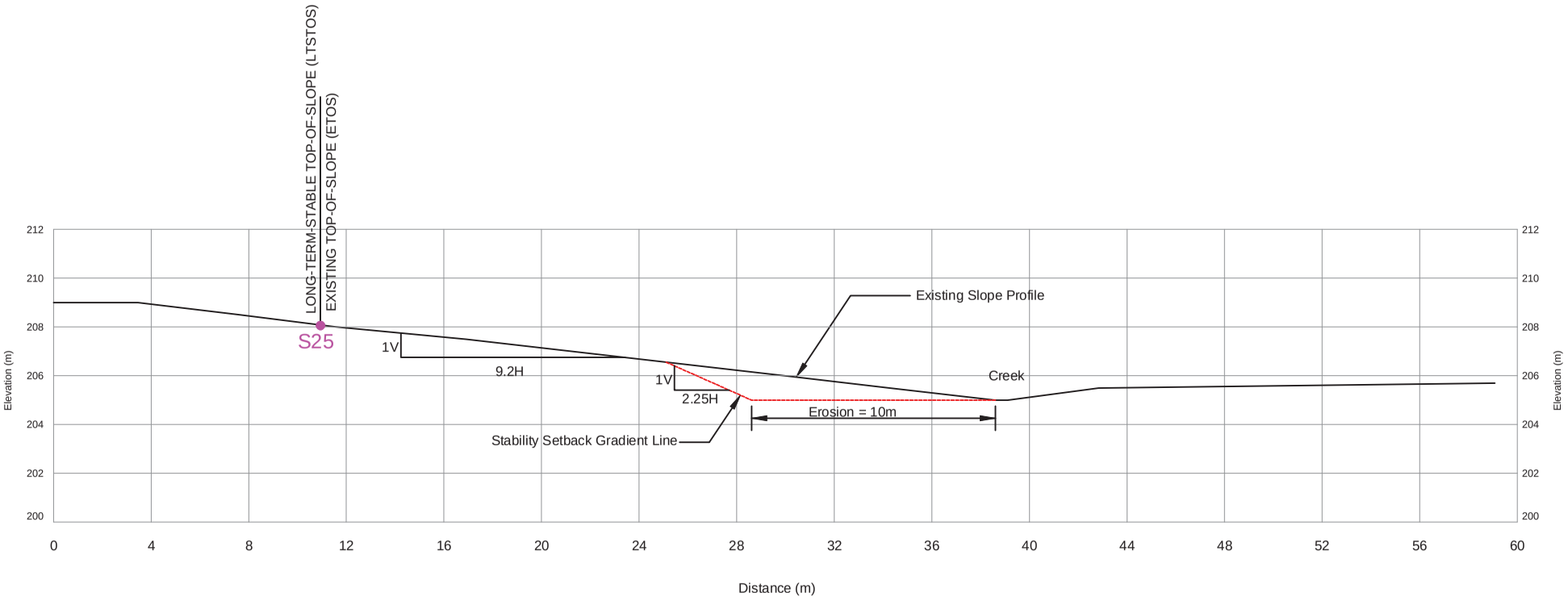
SERVER\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-April21-2015.dwg




# SECTION K-K

| | | | | | |
|---|---|---|---|---|---|
| Client: | **1671745 Ontario Limited c/o C.C Tatham & Associates Ltd.** | | | Project No.: **10001514** | Drawing No.: **14** |
| Drawn: | **ZMO** | Approved: | **KS** | Title: | **Section K-K** |
| Date: | **April 21, 2015** | Scale: | **N.T.S.** | Project: | **Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario** |
| Original Size: | **Letter** | Rev: | **N/A** | SPL Consultants Limited<br>Geotechnical * Environmental * Materials * Hydrogeology | |

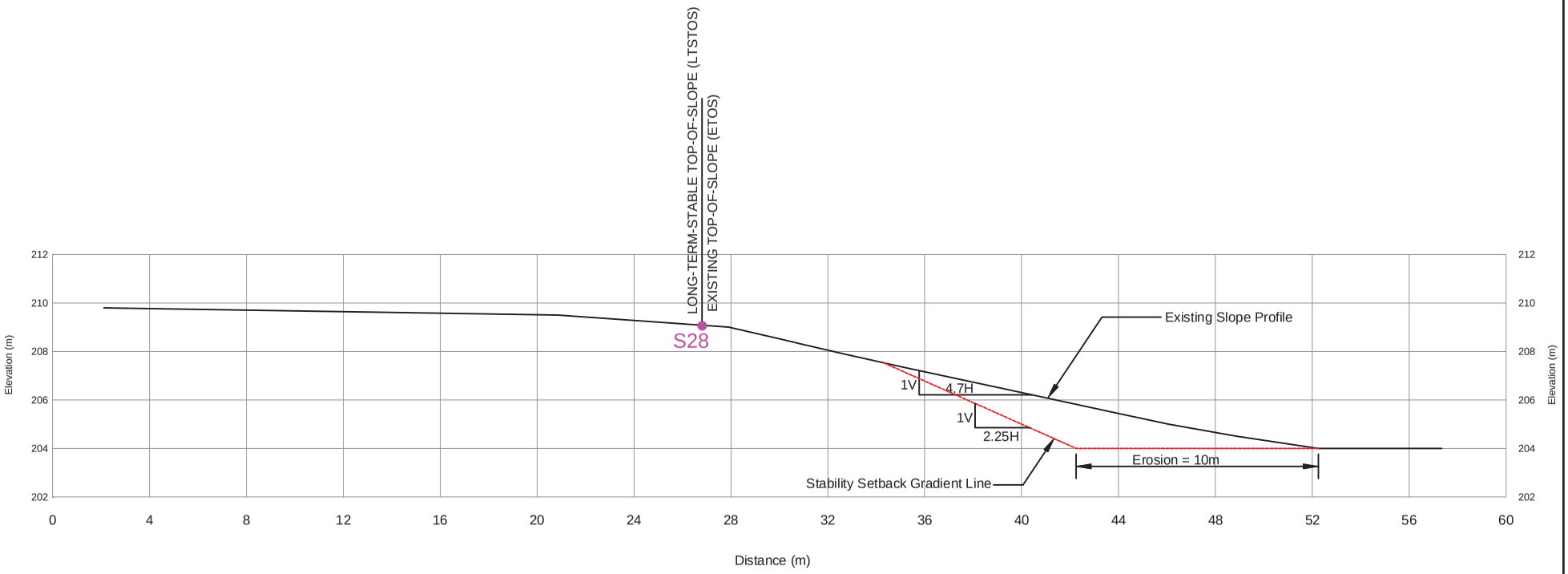
SERVER\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-April21-2015.dwg




# SECTION L-L

| | | | | | |
|---|---|---|---|---|---|
| Client: | **1671745 Ontario Limited c/o C.C Tatham & Associates Ltd.** | | | Project No.: **10001514** | Drawing No.: **15** |
| Drawn: | **ZMO** | Approved: | **KS** | Title: | **Section L-L** |
| Date: | **April 21, 2015** | Scale: | **N.T.S.** | Project: | **Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario** |
| Original Size: | **Letter** | Rev: | **N/A** | | SPL Consultants Limited<br>Geotechnical * Environmental * Materials * Hydrogeology |

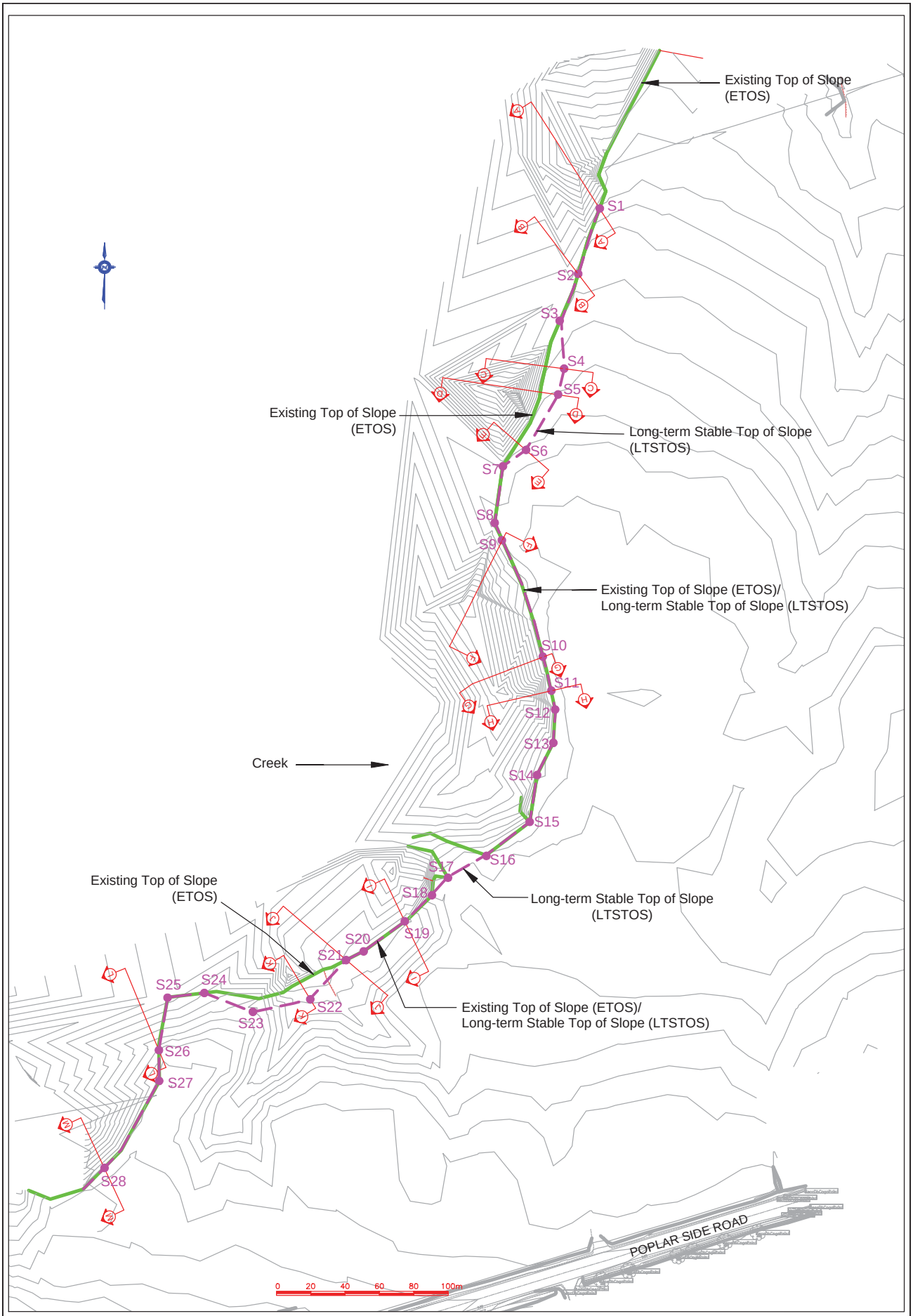
SERVER\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-April21-2015.dwg




# SECTION M-M

| | | | | | |
|---|---|---|---|---|---|
| Client: | **1671745 Ontario Limited c/o C.C Tatham & Associates Ltd.** | | | Project No.: **10001514** | Drawing No.: **16** |
| Drawn: | **ZMO** | Approved: | **KS** | Title: | **Section M-M** |
| Date: | **April 21, 2015** | Scale: | **N.T.S.** | Project: | **Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario** |
| Original Size: | **Letter** | Rev: | **N/A** | SPL Consultants Limited<br>Geotechnical * Environmental * Materials * Hydrogeology | |

SERVER\Geotech\Collingwood Projects\10001514 - Poplar & High Street, Collingwood\Drawings\10001514-Slope-April21-2015.dwg



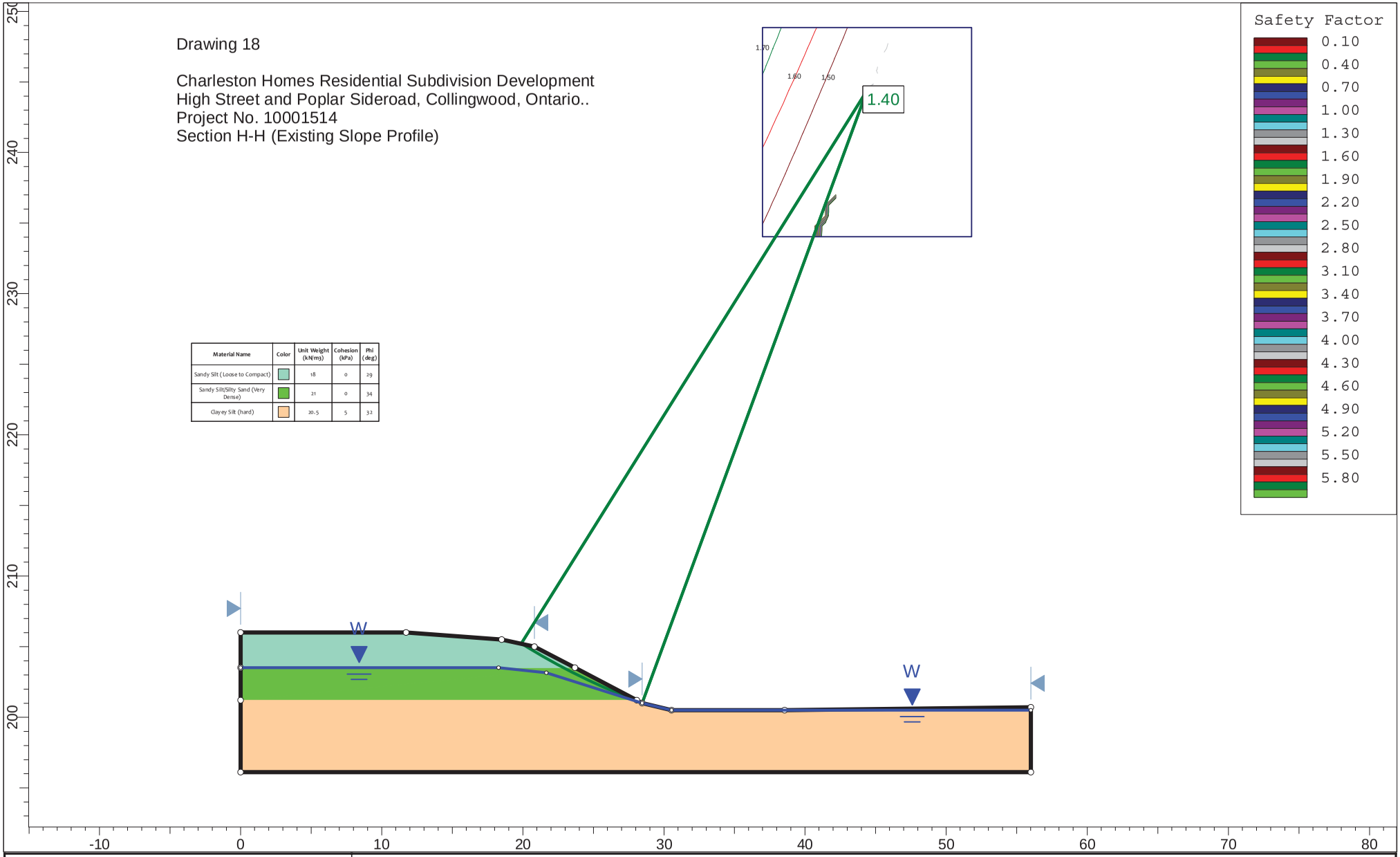

**LEGEND**

- Long-term Stable Top of Slope (LTSTOS): Line S1-S2-S3-S4-S5-S6-S7-S8-S9-S10-S11-S12-S13-S14-S15-S16-S17-S18-S19-S20-S21-S22-S23-S24-S25-S26-S27-S28
- Existing Top of Slope (ETOS)

| | | | | | |
|---|---|---|---|---|---|
| Client: | 1671745 Ontario Limited c/o C.C Tatham & Associates Ltd. | | | Project No.: 10001514 | Drawing No.: 17 |
| Drawn: | ZMO | Approved: | KS | Title: | Long-term Stable Top of Slope (LTSTOS) |
| Date: | April 21, 2015 | Scale: | As Shown | Project: | Geotechnical Investigation - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario |
| Original Size: | Tabloid | Rev: | N/A | | SPL Consultants Limited Geotechnical • Environmental • Materials • Hydrogeology |

Drawing 18

Charleston Homes Residential Subdivision Development
High Street and Poplar Sideroad, Collingwood, Ontario..
Project No. 10001514
Section H-H (Existing Slope Profile)



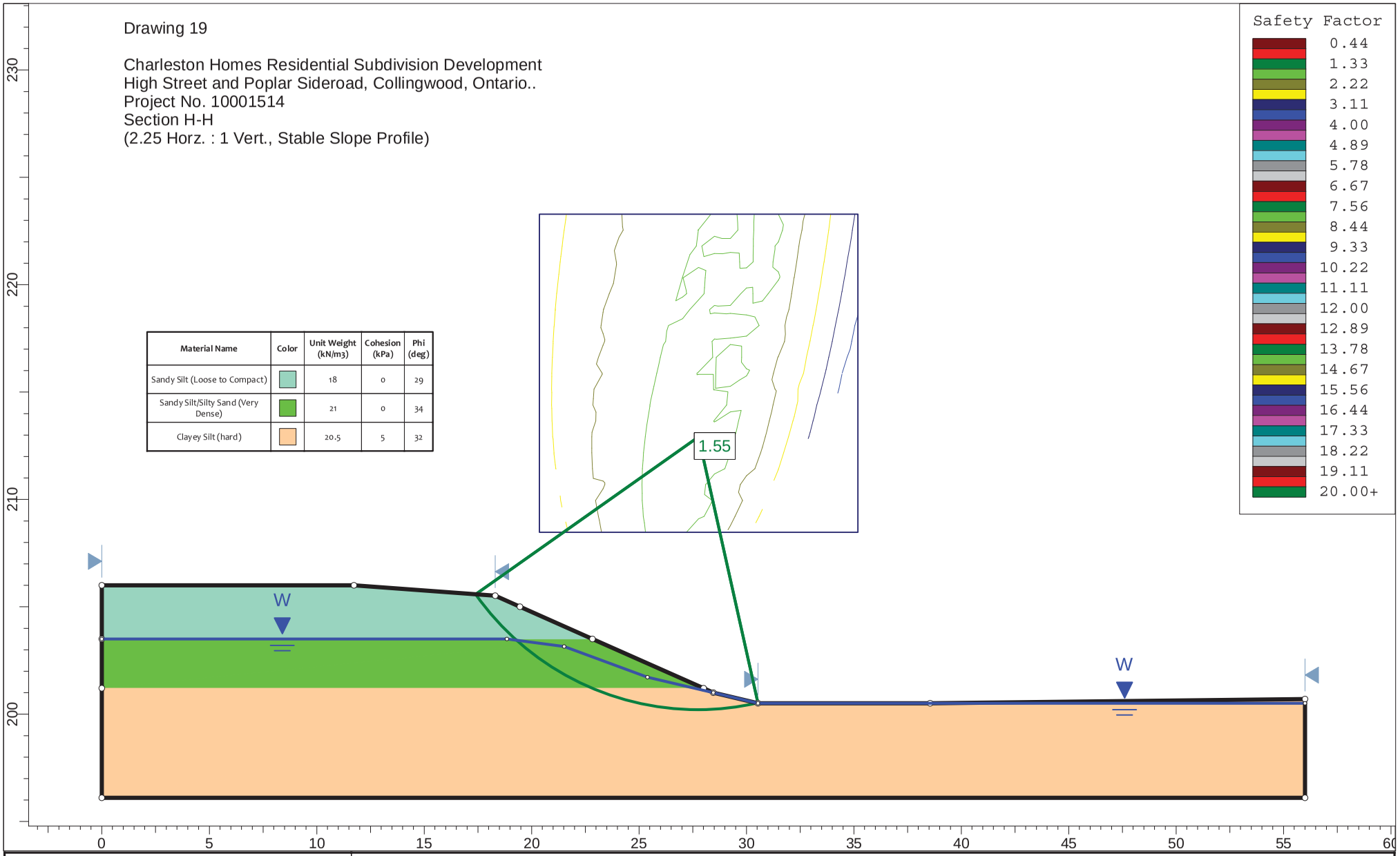

| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Sandy Silt (Loose to Compact) | | 18 | 0 | 29 |
| Sandy Silt/Silty Sand (Very Dense) | | 21 | 0 | 34 |
| Clayey Silt (hard) | | 20.5 | 5 | 32 |

| | | | |
|---|---|---|---|
| Project | Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario. | | |
| Analysis Description | | | |
| Drawn By | | Scale 1:370 | Company SPL Consultants Ltd. |
| Date | April 17, 2015 | | File Name Section H-H Existing Slope Profile.slim |

SLIDEINTERPRET 6.034

Drawing 19

Charleston Homes Residential Subdivision Development
High Street and Poplar Sideroad, Collingwood, Ontario..
Project No. 10001514
Section H-H
(2.25 Horz. : 1 Vert., Stable Slope Profile)




| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Sandy Silt (Loose to Compact) | | 18 | 0 | 29 |
| Sandy Silt/Silty Sand (Very Dense) | | 21 | 0 | 34 |
| Clayey Silt (hard) | | 20.5 | 5 | 32 |

| | | | |
|---|---|---|---|
| Project | Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario. | | |
| Analysis Description | | | |
| Drawn By | | Scale 1:243 | Company SPL Consultants Ltd. |
| Date | April 17, 2015 | | File Name Section H-H Stable Slope Profile.slim |

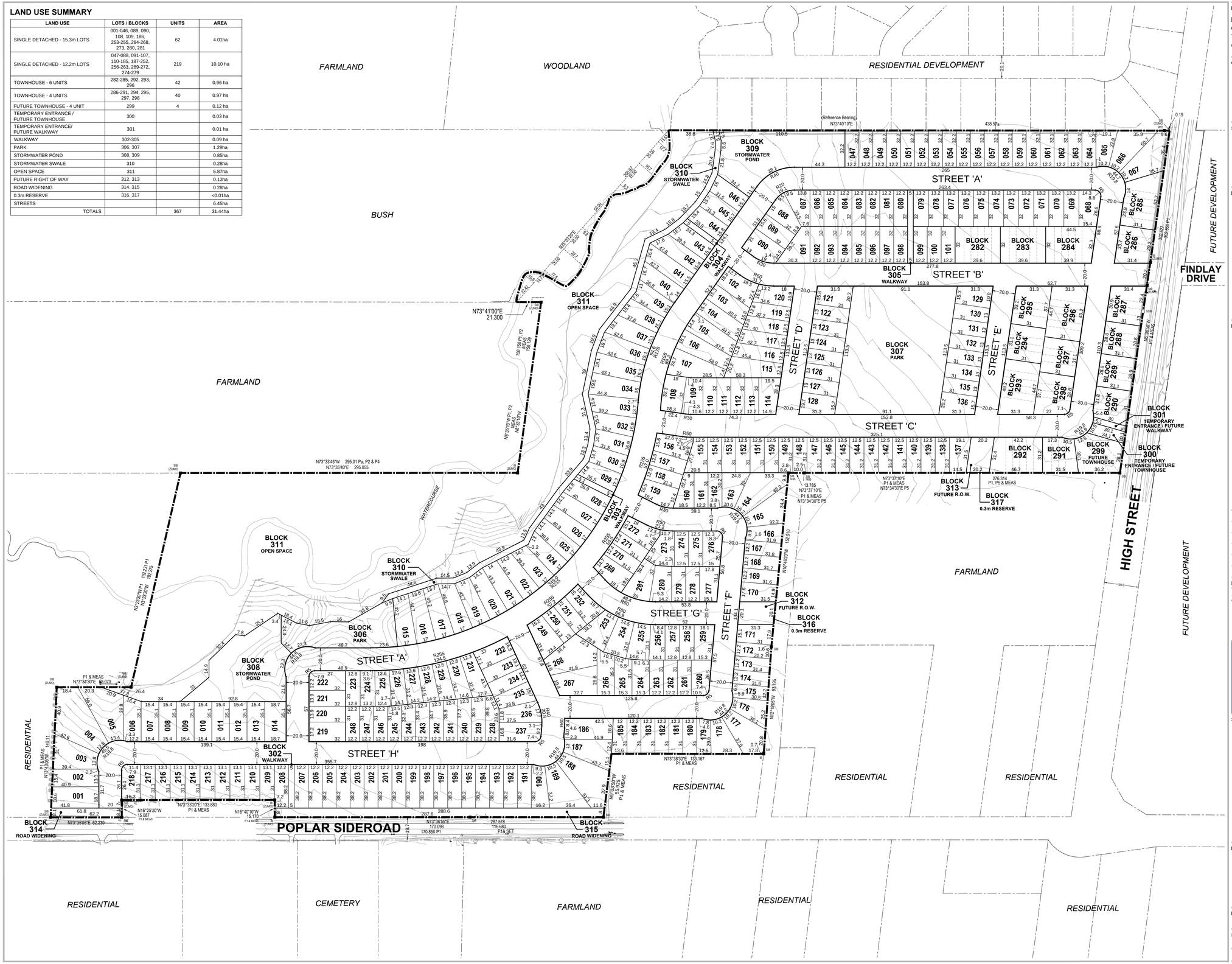
SLIDEINTERPRET 6.034

# APPENDIX A

- **Draft Plan of Proposed Charleston Homes Residential Development**

## LAND USE SUMMARY

| LAND USE | LOTS / BLOCKS | UNITS | AREA |
|---|---|---|---|
| SINGLE DETACHED - 15.3m LOTS | 001-046, 089, 090, 108, 109, 186, 253-255, 264-268, 273, 280, 281 | 62 | 4.01ha |
| SINGLE DETACHED - 12.2m LOTS | 047-088, 091-107, 110-185, 187-252, 256-263, 269-272, 274-279 | 219 | 10.10 ha |
| TOWNHOUSE - 6 UNITS | 282-285, 292, 293, 296 | 42 | 0.96 ha |
| TOWNHOUSE - 4 UNITS | 286-291, 294, 295, 297, 298 | 40 | 0.97 ha |
| FUTURE TOWNHOUSE - 4 UNIT | 299 | 4 | 0.12 ha |
| TEMPORARY ENTRANCE / FUTURE TOWNHOUSE | 300 | | 0.03 ha |
| TEMPORARY ENTRANCE/ FUTURE WALKWAY | 301 | | 0.01 ha |
| WALKWAY | 302-305 | | 0.09 ha |
| PARK | 306, 307 | | 1.29ha |
| STORMWATER POND | 308, 309 | | 0.85ha |
| STORMWATER SWALE | 310 | | 0.28ha |
| OPEN SPACE | 311 | | 5.87ha |
| FUTURE RIGHT OF WAY | 312, 313 | | 0.13ha |
| ROAD WIDENING | 314, 315 | | 0.28ha |
| 0.3m RESERVE | 316, 317 | | <0.01ha |
| STREETS | | | 6.45ha |
| TOTALS | | 367 | 31.44ha |




### LEGAL DESCRIPTION

PART OF LOT 40, CONCESSION 10
GEOGRAPHIC TOWNSHIP OF NOTTAWASAGA
TOWN OF COLLINGWOOD
COUNTY OF SIMCOE

### OWNER'S CERTIFICATE

I HEREBY AUTHORIZE MACNAUGHTON HERMSEN BRITTON CLARKSON PLANNING LIMITED TO SUBMIT THIS PLAN FOR APPROVAL.

DATE: NOVEMBER 30, 2015

CHARLIE KUIKEN - PRESIDENT
CHARLESTON HOMES

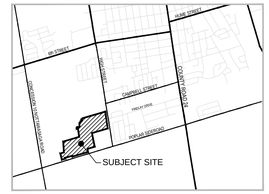
### SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE SUBDIVIDED ON THIS PLAN AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN.

DATE: NOVEMBER 30, 2015

JAMES M. LAWS - O.L.S.
VAN HARTEN SURVEYING INC.

### KEY PLAN




### LEGEND

- BOUNDARY LINE
- RIGHT OF WAY LINE
- BLOCK LINE
- LOT LINE
- UNIT LINE
- PARCEL FABRIC

| REVISION No. | DATE | ISSUED / REVISION | BY |
|---|---|---|---|

**ADDITIONAL INFORMATION REQUIRED UNDER SECTION 51(17) OF THE PLANNING ACT R.S.O. 1990 C.P.13 AS AMENDED**

- **A.** AS SHOWN
- **B.** AS SHOWN
- **C.** AS SHOWN
- **D.** RESIDENTIAL
- **E.** AS SHOWN
- **F.** AS SHOWN
- **G.** AS SHOWN
- **H.** MUNICIPAL WATER SUPPLY
- **I.** SANDY SILT
- **J.** AS SHOWN
- **K.** ALL SERVICES AS REQUIRED
- **L.** NONE


113 COLLIER STREET
BARRIE, ON, L4M 1H2
P: 705 728 0045 F: 705 728 2010
WWW.MHBCPLAN.COM

PLANNING
URBAN DESIGN
& LANDSCAPE
ARCHITECTURE
**MHBC PLANNING**


**STAMP**

| | |
|---|---|
| DATE | NOV. 30, 2015 |
| FILE No. | Y219B |
| SCALE | 1:1,500 (ARCH D) |
| DRAWN BY | M.M. |
| CHECKED BY | K.M. |
| OTHER | |

**PROJECT**

**CHARLESTON SUBDIVISION**
CHARLESTON HOMES
143 DENNIS STREET
P.O. BOX 760
ROCKWOOD, ON N0B 2K0

NORTH

**FILE NAME**
**DRAFT PLAN OF SUBDIVISION**

**DWG No.**
**1 of 1**

**SCALE BAR**
30 20 10 0 25 50 100m

N:\Collingwood\Charleston Homes – Poplar Sideroad at High Street – Y219B\Drawings\Draft Plan\CAD\Y2198_DraftPlan_2015-12-09.dwg

# APPENDIX B

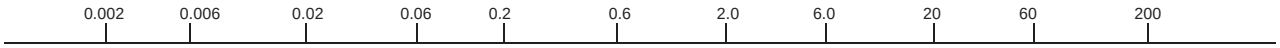
- **Explanation of Terms Used in the Log of Borehole (Encl. 1)**
- **Borehole LOGs (Encls. B2 to B19)**

# Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by SPL also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

| CLAY | SILT | | | SAND | | | GRAVEL | | | COBBLES | BOULDERS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | FINE | MEDIUM | COARSE | FINE | MEDIUM | COARSE | FINE | MEDIUM | COARSE | | |




EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

| CLAY (PLASTIC) TO | FINE | MEDIUM | CRS. | FINE | COARSE |
|---|---|---|---|---|---|
| SILT (NONPLASTIC) | SAND | | | GRAVEL | |

UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional preliminary geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

# LOG OF BOREHOLE BH 15-01

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/12/2015

REF. NO.: 10001514

ENCL NO.: B2

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION |
|---|---|---|---|---|---|---|---|
| 199.7 | | | | | | | |
| 0.0 / 199.5 | **TOPSOIL:** 230mm | | | | | | |
| 0.2 / 198.9 | **SANDY SILT:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | | 1 | SS | 5 | | |
| 0.8 / 198.2 | **SANDY SILT:** trace clay, some oxidization stains, brown, moist, dense | | 2 | SS | 31 | | |
| 1.5 / 197.4 | grey | | 3 | SS | 37 | | |
| 2.3 / 196.7 | **SILTY CLAY:** trace sand, stratified, grey, moist, very stiff | | 4 | SS | 20 | | |
| 3.1 / 195.1 | trace sand, stiff | | 5 | SS | 11 | | |
| 4.6 / 194.5 | firm | | 6 | SS | 6 | | |
| 5.2 | **END OF BOREHOLE** | | | | | | |

W. L. 199.4 m
Mar 17, 2015

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED
● QUICK TRIAXIAL
+ FIELD VANE & Sensitivity
× LAB VANE
20 40 60 80 100

PLASTIC LIMIT $W_P$ | NATURAL MOISTURE CONTENT $W$ | LIQUID LIMIT $W_L$
WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

| GR | SA | SI | CL |
|---|---|---|---|
| 0 | 1 | 72 | 27 |

Notes:
1. Water level was 4.21m below ground upon completion
2. 50 mm dia. monitoring well was installed upon completion , screened from 2.1m to 4.5m.
3. Water Level Measurements in Monitoring Well

| Date | W.L. Depth (m) | W.L. Elev. (m) |
|---|---|---|
| March 17, 2015 | 0.26 | 199.44 |
| April 16, 2015 | 0.78 | 198.92 |
| May 22, 2015 | 0.94 | 198.76 |
| June 30, 2015 | 0.51 | 199.19 |
| July 31, 2015 | 2.43 | 197.27 |
| Aug. 27, 2015 | 2.87 | 196.83 |
| Oct. 1, 2015 | 3.56 | 196.14 |
| Oct. 31, 2015 | 3.50 | 196.20 |
| Nov. 30, 2015 | 0.78 | 198.92 |

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# LOG OF BOREHOLE BH 15-02

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/12/2015

REF. NO.: 10001514

ENCL NO.: B3

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS / 0.3 m | GROUND WATER CONDITIONS | ELEVATION |
|---|---|---|---|---|---|---|---|
| 200.7 | | | | | | | |
| 0.0 / 200.4 | **TOPSOIL:** 310mm | | 1 | SS | 5 | | |
| 0.3 / 199.9 | **SANDY SILT:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | | 2 | SS | 15 | | 200 |
| 0.8 / 198.4 | **SANDY SILT:** trace clay, brown, wet, compact | | 3 | SS | 17 | | 199 |
| 2.3 / 196.1 | **SILT:** some clay, some sand, sand seams, stratified, grey, moist, compact | | 4 | SS | 27 | | 198 |
| | | | 5 | SS | 23 | | 197 |
| 4.6 / 195.5 | trace sand | | 6 | SS | 19 | | 196 |
| 5.2 | **END OF BOREHOLE** | | | | | | |

Notes:
1. Borehole caved to 1.2m and was wet at 1.2m upon completion

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH (kPa) (20 40 60 80 100)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT $W_P$ — NATURAL MOISTURE CONTENT $W$ — LIQUID LIMIT $W_L$

WATER CONTENT (%) (10 20 30)

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

# LOG OF BOREHOLE BH 15-03

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/12/2015

REF. NO.: 10001514

ENCL NO.: B4

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION |
|---|---|---|---|---|---|---|---|
| 202.2 / 0.0 | **TOPSOIL:** 130mm | | | | | | |
| 202.1 / 0.1 | **SILTY SAND:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose to compact | | 1 | SS | 10 | | 202 |
| 201.4 / 0.8 | light brown, wet, loose | | 2 | SS | 8 | | 201 |
| 200.7 / 1.5 | **SANDY SILT:** trace clay, some oxidization stains, brown, moist, compact | | 3 | SS | 11 | | 200 |
| 199.9 / 2.3 | **SILT:** some clay, some sand, stratified, greyish brown, moist, very dense | | 4 | SS | 55 | | 199 |
| 199.2 / 3.1 | trace clay, grey, dense | | 5 | SS | 36 | | 198 |
| 197.6 / 4.6 | **SAND AND GRAVEL:** trace clay, trace silt, clayey silt pockets, grey, wet, very dense | | 6 | SS | 94 for 280mm | | |
| 197.4 / 4.9 | **END OF BOREHOLE** | | | | | | |

Notes:
1. BH caved to 3.7m and was wet at 3.7m upon completion

DYNAMIC CONE PENETRATION RESISTANCE PLOT — 20 40 60 80 100

SHEAR STRENGTH (kPa) — ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE — 20 40 60 80 100

PLASTIC LIMIT $W_P$ — NATURAL MOISTURE CONTENT $W$ — LIQUID LIMIT $W_L$

WATER CONTENT (%) — 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# LOG OF BOREHOLE BH 15-04

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/12/2015

REF. NO.: 10001514

ENCL NO.: B5

| (m) ELEV / DEPTH | DESCRIPTION | NUMBER | TYPE | "N" BLOWS 0.3 m | ELEVATION |
|---|---|---|---|---|---|
| 201.7 / 0.0 | **TOPSOIL:** 230mm | | | | |
| 201.5 / 0.2 | **SANDY SILT:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | 1 | SS | 4 | |
| 200.9 / 0.8 | **SANDY SILT:** trace clay, some oxidization stains, light brown, very moist, compact | 2 | SS | 14 | 201 |
| 200.2 / 1.5 | stratified, greyish brown, moist | 3 | SS | 28 | 200 |
| 199.4 / 2.3 | grey, dense | 4 | SS | 34 | 199 |
| 198.7 / 3.1 | **SILT:** some clay, some sand, trace gravel, stratified, grey, moist, dense | 5 | SS | 38 | |
| 197.1 / 4.6 | some gravel, trace clay, very dense | 6 | SS | 50 | 197 |
| 196.7 / 5.0 | **SILTY SAND:** trace clay, trace gravel, grey, very moist, very dense | | | | 196 |
| 195.6 / 6.1 | **SAND AND GRAVEL:** some silt, trace clay, very dense, grey, wet | 7 | SS | 62 | 195 |
| 193.7 / 8.1 | **END OF BOREHOLE** | 8 | SS | 79 for 280 | 194 |

W. L. 198.3 m
Mar 17, 2015

auger grinding
47 39 11 3

Notes:
1. Water level was 5.9m below ground upon completion
2. 50 mm dia. monitoring well was installed upon completion , screened from 5.5m to 7.0m.
3. Water Level Measurements in Monitoring Well

| Date | W.L. Depth (m) | W.L. Elev. (m) |
|---|---|---|
| March 17, 2015 | 3.36 | 198.34 |
| April 16, 2015 | 3.55 | 198.15 |
| May 22, 2015 | 3.77 | 197.93 |
| June 30, 2015 | 3.56 | 198.14 |
| July 31, 2015 | 4.01 | 197.69 |
| Aug. 27, 2015 | 4.19 | 197.51 |
| Oct. 1, 2015 | 4.43 | 197.27 |
| Oct. 31, 2015 | 4.30 | 197.40 |
| Nov. 30, 2015 | 3.79 | 197.91 |

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# LOG OF BOREHOLE BH 15-05

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/12/2015

REF. NO.: 10001514

ENCL NO.: B6

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|
| 203.2 | | | | | | | | |
| 0.0 / 203.0 | **TOPSOIL:** 180mm | | | | | | | |
| 0.2 | **SILTY SAND:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | | 1 | SS | 4 | | 203 | |
| 202.4 | | | | | | | | |
| 0.8 / 1 | **SILTY SAND:** trace clay and gravel, brown, very moist, loose | | 2 | SS | 6 | | 202 | |
| 201.7 | | | | | | | | |
| 1.5 / 2 | **SANDY SILT:** some clay, clay pockets, light brown, very moist, compact | | 3 | SS | 29 | | 201 | |
| 200.9 | | | | | | | | |
| 2.3 / 3 | **SILT:** some clay, trace sand, stratified, grey, moist, very dense | | 4 | SS | 64 for 290mm | | 200 | |
| 200.2 | | | | | | | | |
| 3.1 | **SILTY CLAY:** trace sand, stratified, grey, moist, hard | | 5 | SS | 47 | | 199 | 0 3 72 25 |
| 4 | | | | | | | | |
| 198.6 | | | | | | | | |
| 4.6 | **SILT:** some gravel and clay, trace sand, stratified, grey, moist, very dense | | 6 | SS | 62 | | 198 | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 196.8 | | | 7 | SS | 64 for 290mm | | 197 | |
| 6.4 | **END OF BOREHOLE** | | | | | | | |

Notes:
1. Borehole caved to 6.0m and was wet at 6.0m upon completion

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH (kPa) (20 40 60 80 100)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT $W_P$ — NATURAL MOISTURE CONTENT $W$ — LIQUID LIMIT $W_L$

WATER CONTENT (%) (10 20 30)

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ $\varepsilon$=3% Strain at Failure

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# LOG OF BOREHOLE BH 15-06

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/13/2015

REF. NO.: 10001514

ENCL NO.: B7

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION |
|---|---|---|---|---|---|---|---|
| 200.9 | | | | | | | |
| 0.0 / 200.7 | **TOPSOIL:** 210mm | | | | | | |
| 0.2 / 200.4 | **SILTY SAND:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | | 1 | SS | 4 | | |
| 0.5 | **SILTY SAND:** trace clay, brown, very moist, loose to compact | | | | | | |
| 1 / 199.8 | | | 2 | SS | 14 | | 200 |
| 1.1 | **CLAYEY SILT:** some sand, some oxidized stains, light brown, very moist, stiff to very stiff | | | | | | |
| 2 / 198.6 | | | 3 | SS | 18 | | 199 |
| 2.3 | **SILT:** some clay, trace sand, dilatant, greyish brown, wet, compact | | 4 | SS | 15 | | |
| 3 / 197.9 | | | | | | | 198 |
| 3.1 | **SILTY CLAY:** some gravel, trace sand, stratified, grey, moist, stiff | | 5 | SS | 10 | | |
| 4 | | | | | | | 197 |
| 5 / 195.7 | | | 6 | SS | 12 | | 196 |
| 5.2 | **END OF BOREHOLE** | | | | | | |

Notes:
1. Borehole caved to 1.1m and was wet at 1.1m upon completion

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH (kPa) (20 40 60 80 100)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT $W_P$ | NATURAL MOISTURE CONTENT $W$ | LIQUID LIMIT $W_L$

WATER CONTENT (%) (10 20 30)

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ $\varepsilon$=3% Strain at Failure

# LOG OF BOREHOLE BH 15-07

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/13/2015

REF. NO.: 10001514

ENCL NO.: B8

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION |
|---|---|---|---|---|---|---|---|
| 202.6 | | | | | | | |
| 0.0 / 202.3 | **TOPSOIL:** 310mm | | 1 | SS | 6 | | |
| 0.3 / 201.8 | **SILTY SAND:** some clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | | | | | | 202 |
| 0.8 / 201.1 | **SILTY SAND:** trace clay, light brown, wet, compact | | 2 | SS | 14 | | |
| 1.5 / 200.3 | loose | | 3 | SS | 9 | | 201 |
| 2.3 / 199.6 | **SANDY SILT:** some clay, some oxidization stains, grey, moist, compact | | 4 | SS | 18 | | 200 |
| 3.1 / 198.0 | **SILT:** some clay, some sand, sand seams, stratified, grey, moist, dense | | 5 | SS | 42 | | 199 |
| 4.6 / 197.4 | very dense | | 6 | SS | 55 | | 198 |
| 5.2 | **END OF BOREHOLE** | | | | | | |

Notes:
1. Borehole caved to 1.1m and was wet at 1.1m upon completion

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED
● QUICK TRIAXIAL
+ FIELD VANE & Sensitivity
× LAB VANE
20 40 60 80 100

PLASTIC LIMIT $W_P$ | NATURAL MOISTURE CONTENT $W$ | LIQUID LIMIT $W_L$

WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

# LOG OF BOREHOLE BH 15-08

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/11/2015

REF. NO.: 10001514

ENCL NO.: B9

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION |
|---|---|---|---|---|---|---|---|
| 205.2 | | | | | | | |
| 0.0 / 205.0 | **TOPSOIL:** 200mm | | | | | | |
| 0.2 | **SILTY SAND:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | | 1 | SS | 5 | | |
| 204.4 | | | | | | | |
| 0.8 | **SILTY SAND:** trace clay, trace gravel, light brown, wet, loose | | 2 | SS | 7 | | |
| 1 | | | | | | | |
| 203.7 | | | | | | | |
| 1.5 | stratified, compact | | 3 | SS | 20 | | |
| 2 | | | | | | | |
| 202.9 | | | | | | | |
| 2.3 | **SANDY SILT:** trace clay, some oxidization stains, grey, moist, very dense | | 4 | SS | 51 | | |
| 3 | | | | | | | |
| 202.2 | | | | | | | |
| 3.1 | **SILT:** some clay, some sand, sand seams, grey, moist, very dense | | 5 | SS | 69 for 280mm | | |
| 4 | | | | | | | |
| 200.6 | | | | | | | |
| 4.6 | trace gravel | | 6 | SS | 77 for 280mm | | |
| 200.3 | | | | | | | |
| 4.9 | **END OF BOREHOLE** | | | | | | |

Notes:
1. Borehole caved to 1.09m and was wet at 1.09m upon completion

DYNAMIC CONE PENETRATION RESISTANCE PLOT — 20 40 60 80 100

SHEAR STRENGTH (kPa) — ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE — 20 40 60 80 100

PLASTIC LIMIT $W_P$ — NATURAL MOISTURE CONTENT $W$ — LIQUID LIMIT $W_L$

WATER CONTENT (%) — 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%) — GR SA SI CL

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ $\varepsilon$=3% Strain at Failure

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# LOG OF BOREHOLE BH 15-09



PROJECT: Geotechnical Investigation
CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.
PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.
DATUM: Geodetic
BH LOCATION:

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 150mm
Date: Mar/12/2015

REF. NO.: 10001514
ENCL NO.: B10

| (m) ELEV / DEPTH | DESCRIPTION | NUMBER | TYPE | "N" BLOWS 0.3 m |
|---|---|---|---|---|
| 206.0 | | | | |
| 206.0 / 0.0 | **TOPSOIL:** 150mm | | | |
| 205.8 / 0.2 | **SILTY SAND:** trace gravel and clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | 1 | SS | 7 |
| 205.2 / 0.8 | **SILTY SAND:** trace clay, brown, very moist, loose | 2 | SS | 9 |
| 204.5 / 1.5 | wet, compact | 3 | SS | 11 |
| 203.7 / 2.3 | **SANDY SILT:** some clay, some oxidization stains, light brown, very moist, compact | 4 | SS | 21 |
| 203.0 / 3.1 | trace clay, stratified, greyish brown, moist, dense | 5 | SS | 44 |
| 201.4 / 4.6 | **SILT:** some sand to sandy, some clay, trace gravel, grey, moist, very dense | 6 | SS | 80 |
| 199.9 / 6.1 | **SANDY SILT TO SILT AND SAND:** trace clay, trace gravel, grey, very moist, very dense | 7 | SS | 62 |
| 199.4 / 6.6 | 50mm coarse sand layer, wet | | | |
| 198.4 / 7.6 | some clay | 8 | SS | 55 |
| 197.8 / 8.2 | **END OF BOREHOLE** | | | |

GROUND WATER CONDITIONS: W. L. 201.7 m, Mar 17, 2015

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH (kPa) (20 40 60 80 100)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT $W_P$ | NATURAL MOISTURE CONTENT $W$ | LIQUID LIMIT $W_L$
WATER CONTENT (%) (10 20 30)

POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

| GR | SA | SI | CL |
|---|---|---|---|
| 1 | 32 | 62 | 5 |

Notes:
1. Borehole dry upon completion
2. 50 mm dia. monitoring well was installed upon completion , screened from 5.7m to 7.3m.
3. Water Level Measurements in Monitoring Well

| Date | W.L.Depth (m) | W.L.Elev. (m) |
|---|---|---|
| March 17, 2015 | 4.30 | 201.70 |
| April 16, 2015 | 4.04 | 201.96 |
| May 22, 2015 | 4.46 | 201.54 |
| June 30, 2015 | 4.51 | 201.49 |
| July 31, 2015 | 4.83 | 201.17 |
| Aug. 27, 2015 | 5.11 | 200.89 |
| Oct. 1, 2015 | 5.31 | 200.69 |
| Oct. 31, 2015 | 5.38 | 200.62 |
| Nov. 30, 2015 | 5.04 | 200.96 |

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ $\varepsilon$=3% Strain at Failure

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# LOG OF BOREHOLE BH 15-12

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/11/2015

REF. NO.: 10001514

ENCL NO.: B11

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION |
|---|---|---|---|---|---|---|---|
| 205.8 | | | | | | | |
| 0.0 / 205.6 | **TOPSOIL:** 250mm | | | | | | |
| 0.3 / 205.0 | **SILTY SAND TO SANDY SILT:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose to compact | | 1 | SS | 12 | | |
| 0.8 / 204.3 | **SILTY SAND TO SANDY SILT:** trace clay, light brown, very moist, loose | | 2 | SS | 7 | | 205 |
| 1.5 / 203.5 | compact | | 3 | SS | 16 | | 204 |
| 2.3 / 202.8 | some clay, stratified, grey, moist, very dense | | 4 | SS | 77 | | 203 |
| 3.1 / 201.2 | **SILT:** some clay, some sand, grey, moist, very dense | | 5 | SS | 76 | | 202 |
| 4.6 / 201.0 | some gravel | | 6 | SS | 70 for 230mm | | 201 |
| 4.8 | **END OF BOREHOLE** | | | | | | |

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE
20 40 60 80 100

PLASTIC LIMIT $W_P$ | NATURAL MOISTURE CONTENT $W$ | LIQUID LIMIT $W_L$

WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Notes:
1. Borehole caved to 1.6m and was wet at 1.6m upon completion

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# LOG OF BOREHOLE BH 15-13

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/11/2015

REF. NO.: 10001514

ENCL NO.: B12

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION |
|---|---|---|---|---|---|---|---|
| 205.8 | | | | | | | |
| 0.0 / 205.6 | **TOPSOIL:** 200mm | | | | | | |
| 0.2 / 205.0 | **SANDY SILT:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | | 1 | SS | 8 | | |
| 0.8 / 204.3 | **SANDY SILT:** some clay, trace gravel, light brown, very moist, compact | | 2 | SS | 25 | | 205 |
| 1.5 | grey | | 3 | SS | 29 | | 204 |
| 203.5 | | | | | | | |
| 2.3 / 202.4 | very dense | | 4 | SS | 99 | | 203 |
| | | | 5 | SS | 90 for 280 | | |
| 3.4 / 201.2 | **SILTY SAND:** some gravel, trace clay, grey, wet, very dense | | | | | | 202 |
| 4.6 / 199.7 | **CLAYEY SILT:** some sand, stratified, grey, moist, hard | | 6 | SS | 37 | | 201 |
| 6.1 | **END OF BOREHOLE** | | 7 | SS | 50 for 25 | | 200 |

Notes:
1. Auger refusal at 6.1m below grade. Sampler bouncing
2. Borehole caved to 5.3m and was dry upon completion

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT $W_P$ | NATURAL MOISTURE CONTENT $W$ | LIQUID LIMIT $W_L$

WATER CONTENT (%): 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ $\varepsilon$=3% Strain at Failure

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# LOG OF BOREHOLE BH 15-15

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/11/2015

REF. NO.: 10001514

ENCL NO.: B13

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION |
|---|---|---|---|---|---|---|---|
| 206.4 | | | | | | | |
| 0.0 / 206.2 | **TOPSOIL:** 250mm | | | | | | |
| 0.3 / 205.6 | **SILTY SAND:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | | 1 | SS | 4 | | |
| 0.8 / 203.9 | **SILTY SAND:** trace clay, light brown, wet, compact | | 2 | SS | 14 | | |
| | | | 3 | SS | 14 | | |
| 2.5 / 203.4 | **SILT:** some sand to sandy, trace clay, grey, very moist, compact | | 4 | SS | 13 | | |
| 3.1 / 201.8 | trace sand, grey, very dense | | 5 | SS | 53 | | |
| | | | 6 | SS | 50 for 80mm | | |
| 4.7 | **END OF BOREHOLE** | | | | | | |

W. L. 206.0 m
Mar 17, 2015

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED
● QUICK TRIAXIAL
+ FIELD VANE & Sensitivity
× LAB VANE
20 40 60 80 100

PLASTIC LIMIT $W_P$ | NATURAL MOISTURE CONTENT $W$ | LIQUID LIMIT $W_L$

WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

| | GR | SA | SI | CL |
|---|---|---|---|---|
| 5 | 0 | 9 | 83 | 8 |

Notes:
1. Water level in well at 1.6m below ground upon completion
2. 50 mm dia. monitoring well was installed upon completion , screened from 2.7m to 4.3m.
3. Water Level Measurements in Monitoring Well

| Date | W.L. Depth (m) | W.L. Elev. (m) |
|---|---|---|
| March 17, 2015 | 0.44 | 205.96 |
| April 16, 2015 | 0.67 | 205.73 |
| May 22, 2015 | 0.83 | 205.57 |
| June 30, 2015 | 0.65 | 205.75 |
| July 31, 2015 | 1.00 | 205.40 |
| Aug. 27, 2015 | 1.38 | 205.02 |
| Oct. 1, 2015 | 1.44 | 204.96 |
| Oct. 31, 2015 | 1.13 | 205.27 |
| Nov. 30, 2015 | 0.76 | 205.64 |

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+ 3, × 3. Numbers refer to Sensitivity
○ ε=3% Strain at Failure

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# LOG OF BOREHOLE BH 15-16

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/10/2015

REF. NO.: 10001514

ENCL NO.: B14

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS / 0.3 m | GROUND WATER CONDITIONS | ELEVATION | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|
| 206.0 | | | | | | | | |
| 0.0 / 205.7 | **TOPSOIL:** 330mm | | 1 | SS | 8 | | | |
| 0.3 / 205.2 | **SANDY SILT:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | | | | | | | |
| 0.8 / 204.5 | **SANDY SILT:** trace clay, light brown, very moist, compact | | 2 | SS | 19 | | 205 | |
| 1.5 / 204.0 | some clay, grey, moist, dense | | 3 | SS | 46 | | | |
| 2.0 | **SILT:** some clay, trace sand, grey, very moist, dense to very dense | | 4 | SS | 68 | | 204 | 0 1 86 13 |
| | | | 5 | SS | 44 | | 203 | |
| | | | | | | | 202 | |
| 4.6 / 201.4 | trace gravel, very moist, compact | | 6 | SS | 22 | | 201 | |
| 5.2 / 200.8 | **END OF BOREHOLE** | | | | | | | |

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT $W_P$ — NATURAL MOISTURE CONTENT $W$ — LIQUID LIMIT $W_L$

WATER CONTENT (%): 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

Notes:
1. Borehole caved to 1.1m and was wet at 1.1m upon completion

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ $^{\varepsilon}$=3% Strain at Failure

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# LOG OF BOREHOLE BH 15-17

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/11/2015

REF. NO.: 10001514

ENCL NO.: B15

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|
| 206.5 | | | | | | | | |
| 0.0 / 206.3 | **TOPSOIL:** 200mm | | | | | | | |
| 0.2 / 205.7 | **SANDY SILT:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | | 1 | SS | 8 | | 206 | |
| 0.8 / 205.0 | some oxidization stains, very moist, compact | | 2 | SS | 28 | | 205 | |
| 1.5 / 204.2 | trace clay, dense | | 3 | SS | 49 | | 205 | |
| 2.3 / 203.5 | **SILT:** some sand, trace clay, trace gravel, grey, moist, very dense | | 4 | SS | 100 for 150mm | | 204 | |
| 3.1 / 201.9 | some gravel, dense | | 5 | SS | 46 | | 203 | |
| 4.6 / 200.4 | very dense | | 6 | SS | 87 for 280mm | | 202 | |
| 6.1 / 198.8 | **SAND AND GRAVEL:** some silt, trace clay, grey, wet, very dense | | 7 | SS | 95 for 255mm | | 201 | auger grinding |
| | | | 8 | SS | 50 for 130 | | 200 | |
| 7.8 | **END OF BOREHOLE** | | | | | | 199 | |

Notes:
1. Borehole caved to 7.0m and was wet at 7.0m upon completion

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT $W_P$ — NATURAL MOISTURE CONTENT $W$ — LIQUID LIMIT $W_L$

WATER CONTENT (%): 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ $\varepsilon$=3% Strain at Failure

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# LOG OF BOREHOLE BH 15-18



PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/11/2015

REF. NO.: 10001514

ENCL NO.: B16

| (m) ELEV / DEPTH | DESCRIPTION | NUMBER | TYPE | BLOWS 0.3 m "N" | GROUND WATER CONDITIONS |
|---|---|---|---|---|---|
| 208.5 | | | | | |
| 208.4 0.1 | **TOPSOIL:** 125mm | | | | |
| | **SANDY SILT:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | 1 | SS | 4 | |
| 207.7 0.8 | | | | | |
| 1 | **SAND TO SANDY SILT:** some clay, trace sand, some oxidation stains, light brown, very moist, compact | 2 | SS | 25 | |
| 207.0 1.5 | very moist, dense | 3 | SS | 49 | |
| 2 206.2 | | | | | |
| 2.3 | **SILT:** some clay, some sand, grey, moist, very dense | 4 | SS | 80 | |
| 3 | | 5 | SS | 70 | |
| 4 | | | | | |
| 203.9 4.6 | trace sand, dense | 6 | SS | 43 | |
| 5 | | | | | |
| 6 202.4 | | | | | |
| 6.1 | **SAND AND SILT:** trace gravel, trace clay, grey, very moist, dense | 7 | SS | 38 | |
| 7 | | | | | |
| 200.8 | | 8 | SS | 50 for 80mm | |
| 7.8 | **END OF BOREHOLE** | | | | |

Notes
1. 50 mm dia. monitoring well was installed upon completion , screened from 6.1m to 7.6m.
2. Water Level Measurements in Monitoring Well

| Date | W.L. Depth (m) | W.L. Elev. (m) |
|---|---|---|
| March 17, 2015 | 2.52 | 205.98 |
| April 16, 2015 | 2.87 | 205.63 |
| May 22, 2015 | 3.08 | 205.42 |
| June 30, 2015 | 2.85 | 205.65 |
| July 31, 2015 | 3.61 | 204.89 |
| Aug. 27, 2015 | 3.66 | 204.84 |
| Oct. 1, 2015 | 3.78 | 204.72 |
| Oct. 31, 2015 | 3.39 | 205.11 |
| Nov. 30, 2015 | 3.74 | 204.76 |

W. L. 206.0 m
Mar 17, 2015

auger grinding
3 40 50 7

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# LOG OF BOREHOLE BH 15-19



PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/10/2015

REF. NO.: 10001514

ENCL NO.: B17

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS / 0.3 m | GROUND WATER CONDITIONS | ELEVATION |
|---|---|---|---|---|---|---|---|
| 209.1<br>0.0<br>208.9 | **TOPSOIL:** 200mm | | | | | | 209 |
| 0.2<br>208.3 | **SILTY SAND:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | | 1 | SS | 6 | | |
| 0.8<br>1<br>207.6 | **SILTY SAND:** trace clay, light brown, very moist, compact | | 2 | SS | 15 | | 208 |
| 1.5<br>2<br>206.8 | **SANDY SILT:** some clay, grey, very moist, dense | | 3 | SS | 44 | | 207 |
| 2.3<br>3<br>206.1 | very dense | | 4 | SS | 59 | | |
| 3.1<br>4<br>204.5 | **SILT:** some clay, some sand, grey, moist, very dense | | 5 | SS | 65 | | 206<br>205 |
| 4.6<br>5<br>203.9 | trace clay, dense | | 6 | SS | 42 | | 204 |
| 5.2 | **END OF BOREHOLE**<br><br>Notes:<br>1. Borehole caved to 3.9m and was wet at 3.9m upon completion | | | | | | |

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH (kPa) (20 40 60 80 100)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT $W_P$ | NATURAL MOISTURE CONTENT $W$ | LIQUID LIMIT $W_L$

WATER CONTENT (%) (10 20 30)

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+3, ×3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

# LOG OF BOREHOLE BH 15-20

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/10/2015

REF. NO.: 10001514

ENCL NO.: B18

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|
| 209.8 | | | | | | | | |
| 0.0 / 209.5 | **TOPSOIL:** 350mm | | 1 | SS | 7 | | | |
| 0.4 / 209.0 | **SILTY SAND:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | | | | | | | |
| 0.8 / 208.2 | **SILTY SAND:** trace clay, light brown, very moist, compact | | 2 | SS | 19 | | 209 | 1 78 17 4 |
| 1.6 / 207.5 | **SANDY SILT:** trace clay, grey, very moist, compact | | 3 | SS | 19 | | 208 | |
| 2.3 / 206.8 | trace to some clay, dense | | 4 | SS | 33 | | 207 | |
| 3.1 / 205.0 | **SILT:** some clay, some sand, trace gravel, grey, very moist, dense to very dense | | 5 | SS | 44 | | 206 | |
| | | | 6 | SS | 75 for 250mm | | 205 | |
| 4.8 | **END OF BOREHOLE** | | | | | | | |

Notes:
1. Borehole caved to 1.3m and was wet at 1.3m upon completion

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH (kPa) (20 40 60 80 100)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT $W_P$ — NATURAL MOISTURE CONTENT $W$ — LIQUID LIMIT $W_L$

WATER CONTENT (%) (10 20 30)

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ $\varepsilon$=3% Strain at Failure

SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# LOG OF BOREHOLE BH 15-21

PROJECT: Geotechnical Investigation

CLIENT: 1671745 Ontario Limited c/o C.C. Tatham & Associates Ltd.

PROJECT LOCATION: Charleston Homes Residential Subdivision, Collingwood.

DATUM: Geodetic

BH LOCATION:

**DRILLING DATA**

Method: Solid Stem Auger

Diameter: 150mm

Date: Mar/10/2015

REF. NO.: 10001514

ENCL NO.: B19

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | BLOWS 0.3 m "N" | GROUND WATER CONDITIONS | ELEVATION | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100) | PLASTIC LIMIT $W_P$ / NATURAL MOISTURE CONTENT $W$ / LIQUID LIMIT $W_L$ — WATER CONTENT (%) (10 20 30) | POCKET PEN. (Cu) (kPa) | NATURAL UNIT WT (kN/m³) | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 208.8 | | | | | | | | | | | | |
| 0.0 / 208.6 | **TOPSOIL:** 225mm | | | | | | | | | | | |
| 0.2 / 208.0 | **SILTY SAND:** trace clay, trace organics, brown to dark brown, disturbed and inclusive of rootlets, loose | | 1 | SS | 5 | | | | | | | |
| 0.8 / 207.3 | **SILTY SAND:** trace clay, light brown, very moist, compact | | 2 | SS | 21 | | 208 | | | | | |
| 1.5 / 206.5 | **SANDY SILT:** trace clay, trace gravel, grey, very moist, dense | | 3 | SS | 46 | | 207 | | | | | |
| 2.3 / 204.2 | **SILT:** some clay, some sand, grey, moist, very dense | | 4 | SS | 91 for 280mm | | 206 | | | | | |
| | | | 5 | SS | 85 for 280mm | | 205 | | | | | |
| 4.6 / 202.7 | some clay, dense | | 6 | SS | 44 | | 204 | | | | | |
| 6.1 / 200.6 | clay pockets | | 7 | SS | 40 | | 203 | | | | | |
| | | | 8 | SS | 39 | | 202 | | | | | |
| | | | | | | | 201 | | | | | |
| 8.2 | **END OF BOREHOLE** | | | | | | | | | | | |

Notes:
1. Borehole caved to 7.1m and was wet at 7.1m upon completion

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

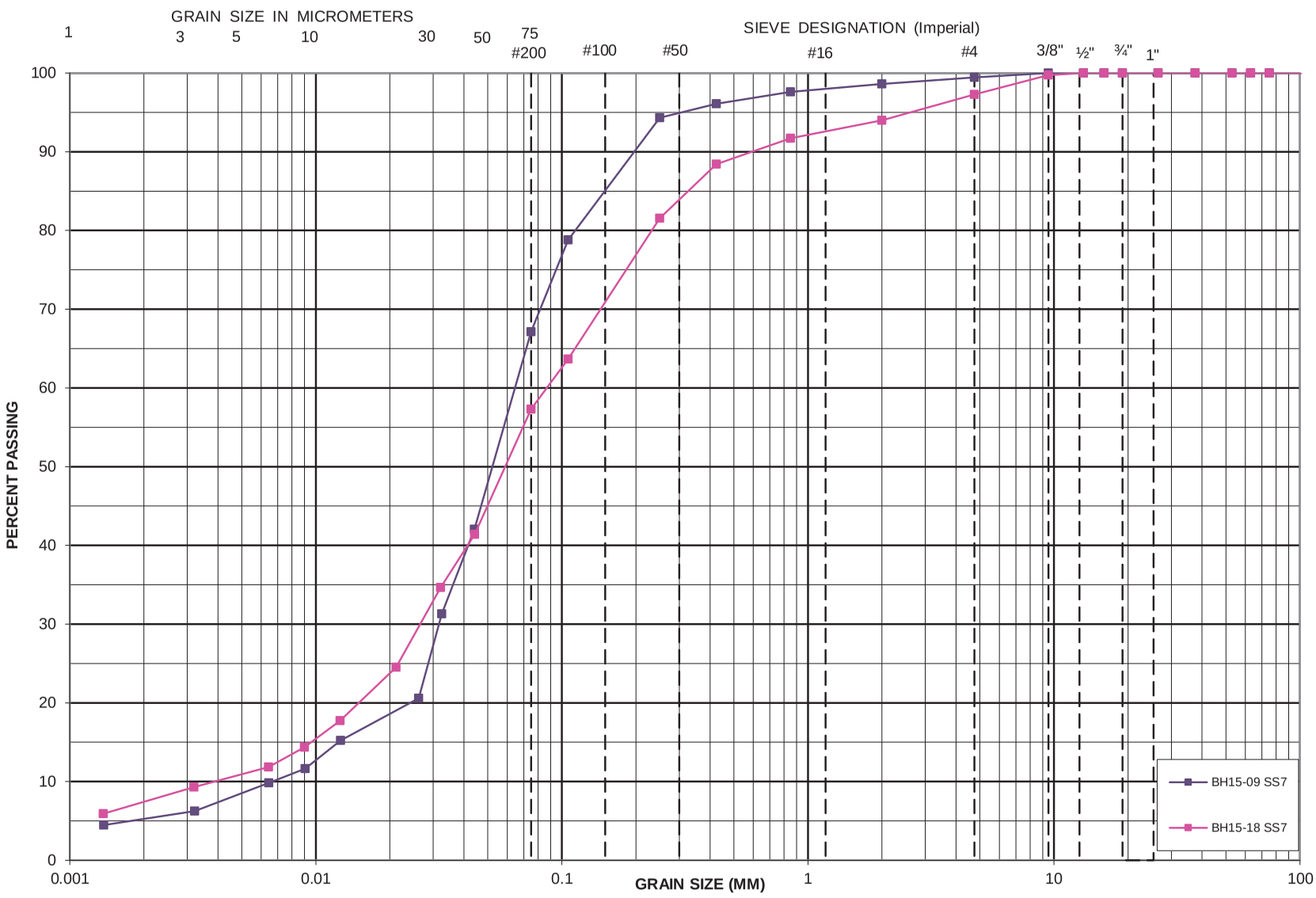
SPL SOIL LOG 10001514 BH LOGS.GPJ SPL.GDT 12/3/15

# APPENDIX C

- **Grain Size Analyses (Encl. C1 to C5)**

UNIFIED SOIL CLASSIFICATION SYSTEM

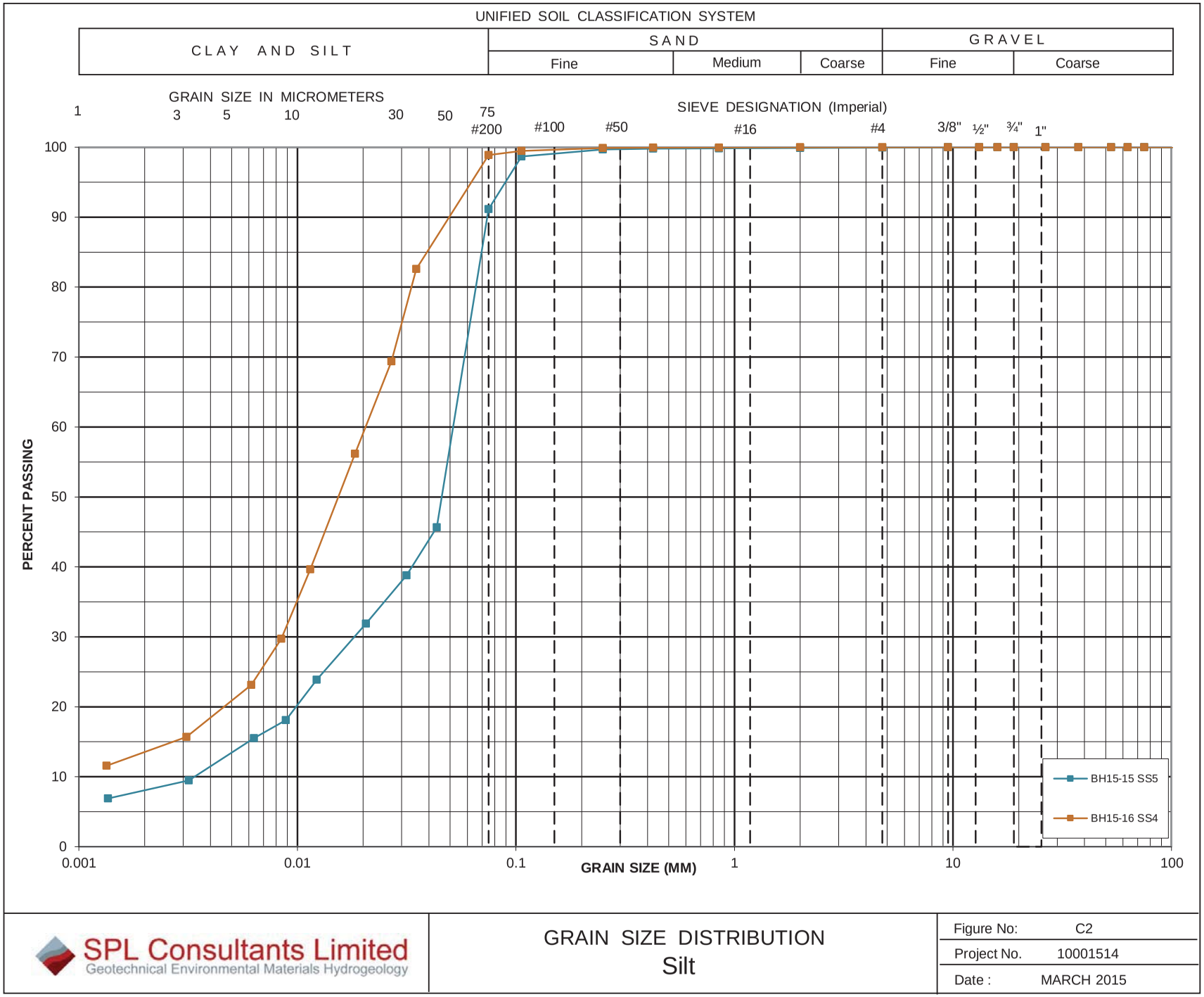
| CLAY AND SILT | SAND | | | GRAVEL | |
|---|---|---|---|---|---|
| | Fine | Medium | Coarse | Fine | Coarse |




SPL Consultants Limited
Geotechnical Environmental Materials Hydrogeology

GRAIN SIZE DISTRIBUTION
Silt and Sand

| | |
|---|---|
| Figure No: | C1 |
| Project No. | 10001514 |
| Date : | MARCH 2015 |



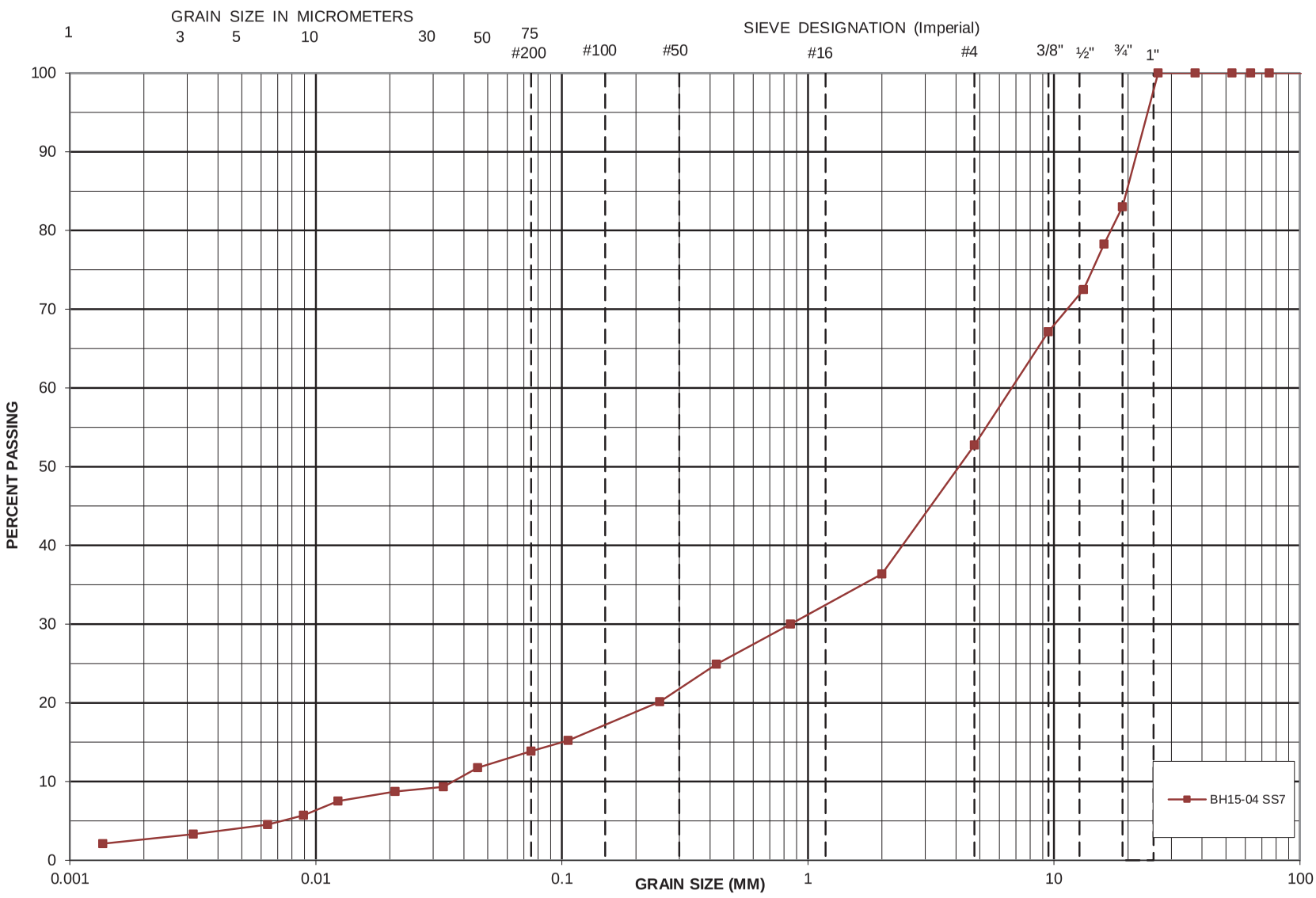

SPL Consultants Limited
Geotechnical Environmental Materials Hydrogeology

# GRAIN SIZE DISTRIBUTION
## Silt

| | |
|---|---|
| Figure No: | C2 |
| Project No. | 10001514 |
| Date : | MARCH 2015 |

UNIFIED SOIL CLASSIFICATION SYSTEM

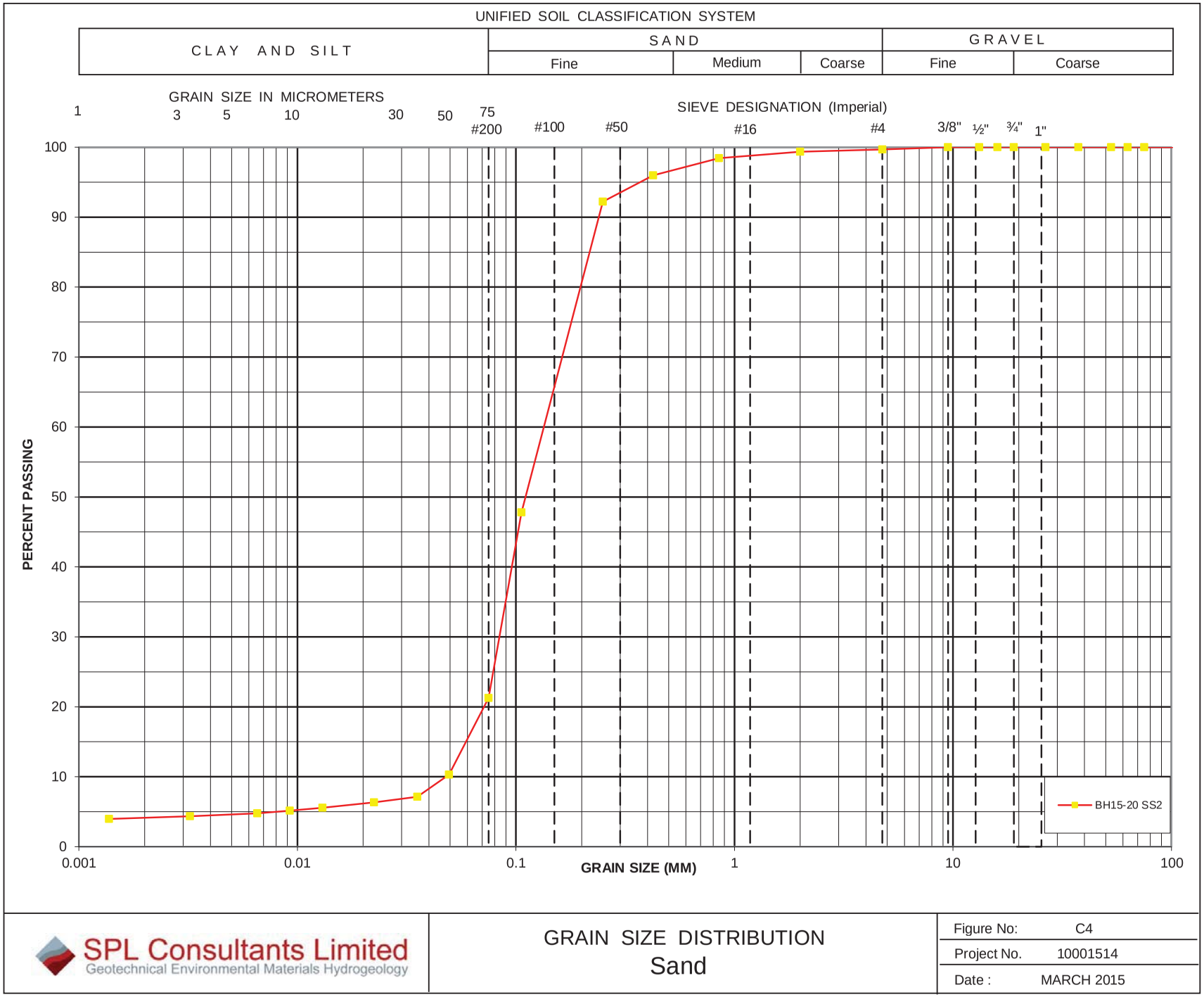
| CLAY AND SILT | SAND | | | GRAVEL | |
|---|---|---|---|---|---|
| | Fine | Medium | Coarse | Fine | Coarse |




SPL Consultants Limited
Geotechnical Environmental Materials Hydrogeology

GRAIN SIZE DISTRIBUTION
Sand and Gravel

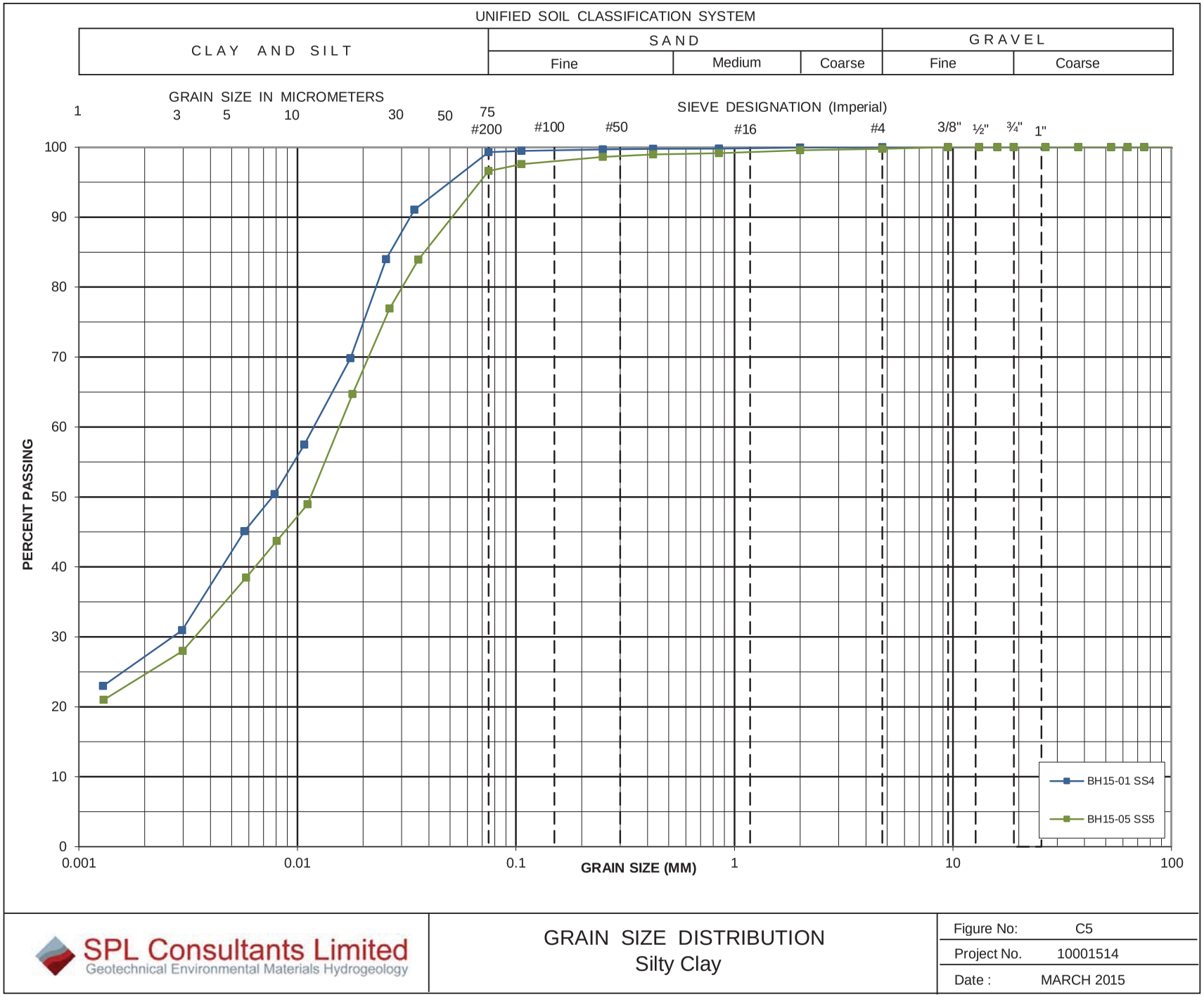
| | |
|---|---|
| Figure No: | C3 |
| Project No. | 10001514 |
| Date : | MARCH 2015 |




SPL Consultants Limited
Geotechnical Environmental Materials Hydrogeology

# GRAIN SIZE DISTRIBUTION
## Sand

| | |
|---|---|
| Figure No: | C4 |
| Project No. | 10001514 |
| Date : | MARCH 2015 |




SPL Consultants Limited
Geotechnical Environmental Materials Hydrogeology

# GRAIN SIZE DISTRIBUTION
Silty Clay

| | |
|---|---|
| Figure No: | C5 |
| Project No. | 10001514 |
| Date : | MARCH 2015 |

# APPENDIX D

- **General Requirements for Engineered Fill**

## GENERAL REQUIREMENTS FOR ENGINEERED FILL

Compacted imported soil that meets specific engineering requirements and is free of organics and debris and that has been continually monitored on a full-time basis by a qualified geotechnical representative is classified as engineered fill. Engineered fill that meets these requirements and is bearing on suitable native subsoil can be used for the support of foundations.

Imported soil used as engineered fill can be removed from other portions of a site or can be brought in from other sites. In general, most of Ontario soils are too wet to achieve the 100% Standard Proctor Maximum Dry Density (SPMDD) and will require drying and careful site management if they are to be considered for engineered fill. Imported non-cohesive granular soil is preferred for all engineered fill. For engineered fill, we recommend use of OPSS Granular 'B' sand and gravel fill material.

Adverse weather conditions such as rain make the placement of engineered fill to the required degree of density difficult or impossible; engineered fill cannot be placed during freezing conditions, i.e. normally not between December 15 and April 1 of each year.

The location of the foundations on the engineered fill pad is critical and certification by a qualified surveyor that the foundations are within the stipulated boundaries is mandatory. Since layout stakes are often damaged or removed during fill placement, offset stakes must be installed and maintained by the surveyors during the course of fill placement so that the contractor and engineering staff are continually aware of where the engineered fill limits lie. Excavations within the engineered fill pad must be backfilled with the same conditions and quality control as the original pad.

To perform satisfactorily, engineered fill requires the cooperation of the designers, engineers, contractors and all parties must be aware of the requirements. The minimum requirements are as follows, however, the geotechnical report must be reviewed for specific information and requirements.

1. Prior to site work involving engineered fill, a site meeting to discuss all aspects must be convened. The surveyor, contractor, design engineer and geotechnical engineer must attend the meeting. At this meeting, the limits of the engineered fill will be defined. The contractor must make known where all fill material will be obtained from and samples must be provided to the geotechnical engineer for review, and approval before filling begins.

2. Detailed drawings indicating the lower boundaries as well as the upper boundaries of the engineered fill must be available at the site meeting and be approved by the geotechnical engineer.

3. The building footprint and base of the pad, including basements, garages, etc. must be defined by offset stakes that remain in place until the footings and service connections are all constructed. Confirmation that the footings are within the pad, service lines are in place, and that the grade conforms to drawings, must be obtained by the owner in writing from the surveyor and SPL Consultants Limited. Without this confirmation no responsibility for the performance of the structure can be accepted by SPL Consultants Limited. Survey drawing of the pre and post fill location and elevations will also be required.

4. The area must be stripped of all topsoil and fill materials. Subgrade must be proof-rolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by a SPL Consultants Limited engineer prior to placement of fill.

5. The approved engineered fill material must be compacted to 100% Standard Proctor Maximum Dry Density throughout. Engineered fill should not be placed during the winter months. Engineered fill compacted to 100% SPMDD will settle under its own weight approximately 0.5% of the fill height and the structural engineer must be aware of this settlement. In addition to the settlement of the fill, additional settlement due to consolidation of the underlying soils from the structural and fill loads will occur and should be evaluated prior to placing the fill.

6. Full-time geotechnical inspection by SPL Consultants Limited during placement of engineered fill is required. Work cannot commence or continue without the presence of the SPL Consultants Limited representative.

7. The fill must be placed such that the specified geometry is achieved. Refer to the attached sketches for minimum requirements. Take careful note that the projection of the compacted pad beyond the footing at footing level is a minimum of 2 m. The base of the compacted pad extends 2 m plus the depth of excavation beyond the edge of the footing.

8. A bearing capacity of 150 kPa at SLS (225 kPa at ULS) can be used provided that all conditions outlined above are adhered to. A minimum footing width of 500 mm (20 inches) is suggested and footings must be provided with nominal steel reinforcement.

9. All excavations must be done in accordance with the Occupational Health and Safety Regulations of Ontario.

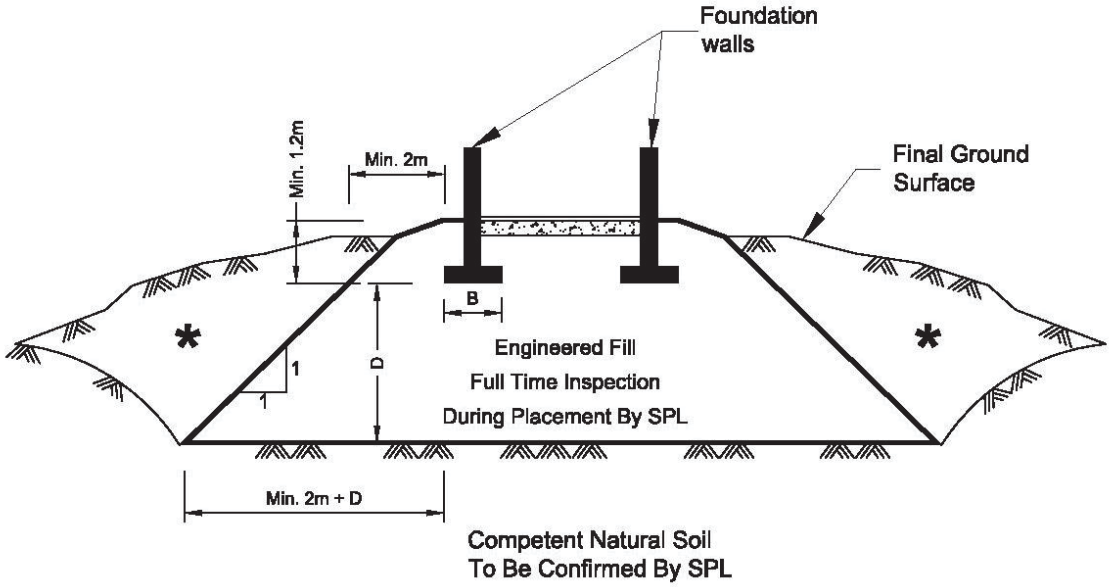
10. After completion of the engineered fill pad a second contractor may be selected to install footings. The prepared footing bases must be evaluated by engineering staff from SPL Consultants Limited prior to footing concrete placements. All excavations must be backfilled under full time supervision by SPL Consultants Limited to the same degree as the engineered fill pad. Surface water cannot be allowed to pond in excavations or to be trapped in clear stone backfill. Clear stone backfill can only be used with the approval of SPL Consultants Limited.

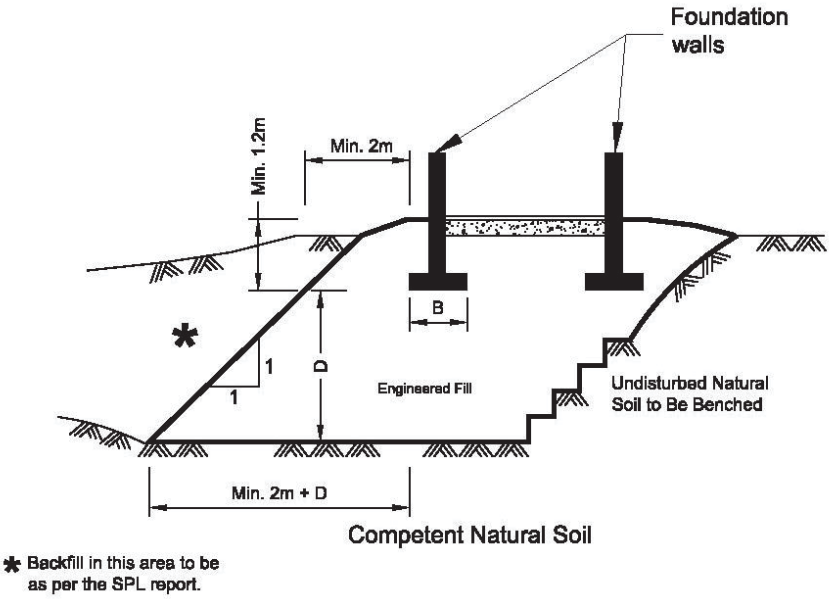
11. After completion of compaction, the surface of the engineered fill pad must be protected from disturbance from traffic, rain and frost. During the course of fill placement, the engineered fill must be smooth-graded, proof-rolled and sloped/crowned at the end of each day, prior to weekends and any stoppage in work in order to promote rapid runoff of rainwater and to avoid any ponding surface water. Any stockpiles of fill intended for use as engineered fill must also be smooth-bladed to promote runoff and/or protected from excessive moisture take up.

12. If there is a delay in construction, the engineered fill pad must be inspected and accepted by the geotechnical engineer. The location of the structure must be reconfirmed that it remains within the pad.

13. The geometry of the engineered fill as illustrated in these General Requirements is general in nature. Each project will have its own unique requirements. For example, if perimeter sidewalks are to be constructed around the building, then the projection of the engineered fill beyond the foundation wall may need to be greater.

14. These guidelines are to be read in conjunction with SPL Consultants Limited report attached.



# APPENDIX E

- **Photographs**


**Aerial Photo 1: An aerial view of the site. The tableland is relatively flat to gently sloping, and is currently used for agricultural purposes. Black Ash Creek meanders along the west side of the site in the wooded area.**

**Photo 1: A view of slope crest, looking north. The slope crest is vegetated with bushes and few trees.**

**Photo 2: A view of slope surface, looking south, the trunk growth of trees is upright straight.**

**Photo 3: Another view of slope surface, looking west. Creek is visible.**

**Photo 4: Looking south, a view of the slope surface.**

**Photo 5: Looking southwest along the creek. Bank cutting is visible.**

**Photo 6: A close-up look od Photograph 5. Toe erosion and exposed root mass visible.**

**Photo 7: Another close-up view of Photograph 5.**

**Photo 8: Looking south at the eroded creek bank.**

**Photo 9: Looking east, at the eroded bank of the creek.**

**Photo 10: Looking southwest, along a gully on slope surface. Gully was dry at the time of inspection.**

**Photo 11: Looking down, south at the slope surface. The slope surface is overgrown with grass, weed, bushes, and young to mature tree growth. Creek is visible in the background.**

**Photo 12: Looking northeast, stream is cutting the bank of the creek.**

**Photo 13: looking northwest, a view of the tableland and slope crest.**

**Photo 14: A view of the bank undercutting, looking northeast.**

**Photo 15: A view of the tableland, looking northwest.**

**Photo 16: A view of slope surface, looking northeast.**

# APPENDIX F

- **Chemical Characterization of Soils**

**Project: 10001514-290** **April 20, 2015**

**C.C. Tatham & Associates Ltd.**
**115 Sandford Fleming Drive**
**Collingwood, Ontario**
**L9Y 5A6**

**Attention: Mr. Jeff Akitt, P.Eng.**

**Re: Soil Characterization Letter**
**Charleston Homes Residential Subdivision-Poplar Sideroad & High Street, Collingwood, Ontario**

SPL Consultants (SPL) was retained by C.C. Tatham & Associates Ltd. to provide chemical characterization of soils at the above noted site in Collingwood, Ontario.

In order to assess options for potential offsite soil disposal of soils at the above captioned site, a total of twelve (12) soil samples and two (2) duplicate samples (DUP 1 & DUP2) were collected from the geotechnical boreholes advanced on the property in March 2015. Samples were collected by SPL and submitted for analysis of metals and inorganics, and OC pesticides, as set out in O.Reg. 153/04 as amended, Section XV.1 of the Environmental Protection Act (EPA). The **Certificates of Analysis** are attached. Sample locations are provided in the following table.

| Sample ID | Sample Date | Location | Depth (mbg) |
|---|---|---|---|
| BH1 TS | March 12, 2015 | North East corner of the site | 0-0.6<br>Top soil overlying sandy silt soil with trace organics |
| BH1 SS2 | March 12, 2015 | North East corner of the site | 0.8-1.4<br>Sandy silt, trace clay. |
| BH21 TS | March 10, 2015 | South west corner of the site | 0-0.6<br>Top soil overlying sandy silt soil with trace organics |
| BH21 SS2 | March 10, 2015 | South west corner of the site | 0.8-1.4<br>Silty sand to sandy silt |
| BH3 TS | March 12, 2015 | North central portion of the site | 0-0.6<br>Top soil overlying silty sand with trace organics |
| BH3 SS2 | March 12, 2015 | North central portion of the site | 0.8-1.4<br>Silty sand |

| | | | |
|---|---|---|---|
| BH9 TS | March 12, 2015 | North west portion of the site | 0-0.6<br>Top soil, silty sand trace organics |
| BH9 SS2<br>(DUP 1) | March 12, 2015 | North west portion of the site | 0.8-1.4<br>Silty sand |
| BH11 TS | March 13, 2015 | Central portion of the site | 0-0.6<br>Top soil, silty sand trace organics |
| BH11 SS2<br>(DUP 2) | March 13, 2015 | Central portion of the site | 0.8-1.4<br>Silty sand |
| BH16 TS | March 10, 2015 | South east portion of the site | 0-0.6<br>Top soil, sandy silt, trace organics |
| BH16 SS2 | March 10, 2015 | South east portion of the site | 0.8-1.4<br>Sandy silt |

Sample locations are presented under **Drawing 1**.

Soil samples were collected and handled in accordance with generally accepted procedures used by the environmental consulting industry. Prior to each sampling event, new disposable gloves were used to transfer samples in plastic bags and glass jars supplied by the laboratory. All soil samples were kept under refrigerated conditions during field storage and transportation to the environmental analytical laboratory.

No visual or olfactory evidence of environmental impact (debris or staining) was noted in any of the soil samples collected.

The chemical analysis was conducted by ALS Environmental (ALS) located in Mississauga, Ontario. ALS is a member of the Canadian Association for Laboratory Accreditation (CALA) and meets the requirements of Section 47 of O.Reg. 153/04 certifying that the analytical laboratory be accredited in accordance with the International Standard ISO/IEC 17025 and with standards developed by the Standards Council of Canada.

For the purposes of soil disposal, the results of chemical analyses were compared to the Background Site Condition Standards for All Property Uses other than Agricultural as contained in Table 1 of the “Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act,” published by the Ministry of Environment (MOE) on April 15, 2011. Additionally the results were also compared to Residential/Parkland/Institutional (RPI) and Industrial/Commercial/Community (ICC) Property Use Standards for Potable Ground Water Condition and Non-Potable Ground Water Condition as contained in Tables 2 and 3, respectively of the aforementioned document.

Based on the results of the chemical analysis, SPL provides the following conclusions/recommendations:

- When compared to MOE Table 1 property use standards all samples meet with the exception of cyanide from sample BH9 SS2; Dichlorodiphenyldichloroethane (DDD) and/or Dichlorodiphenyldichloroethylene (DDE) in sample BH3 TS, BH9 TS and BH21 TS.

- When compared to MOE Table 2 and 3 RPI property uses, all samples meet with the exception of cyanide that exceeded in sample BH9 SS2; and DDE in sample BH21 TS, BH3 TS and BH9 TS

- When compared to MOE Table 2 and 3 ICC property uses, all samples meet with the exception of cyanide that exceeded in sample BH9 SS2; and DDE in sample BH21 TS, BH3 TS and BH9 TS

- The vertical and lateral extents of the exceedances are unknown.

- Separation and re-testing may be an option to reduce disposal cost.

- The results of this testing evaluates the environmental quality of the soil and does not pertain to the geotechnical suitability of the material.

- Acceptance of any excavated soil will be at the discretion of the receiving site.

The purpose of this testing was to chemically characterize the soils analyzed and does not constitute a Phase Two Environmental Site Assessment as defined in O.Reg.153/04, as amended.

It should be noted that if any aesthetically impacted soils are identified during excavation it is recommended that SPL be notified in order to conduct further assessment and/or testing of the material in question.

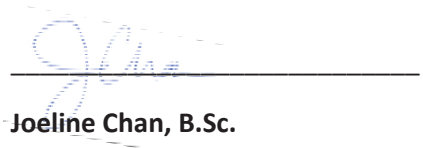
This report was prepared for the account of C.C. Tatham & Associates Ltd. The material in this report reflects SPL's judgment in light of the information available to it at the time of preparation. Any use, which a Third Party not noted above makes of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Parties. SPL Consultants Limited accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

Thank you for the opportunity to be of service on this project. Should you have any questions or wish to review the contents of this letter in more detail, please do not hesitate to contact the undersigned.

Yours Very Truly,

**SPL Consultants Limited**

Prepared By:

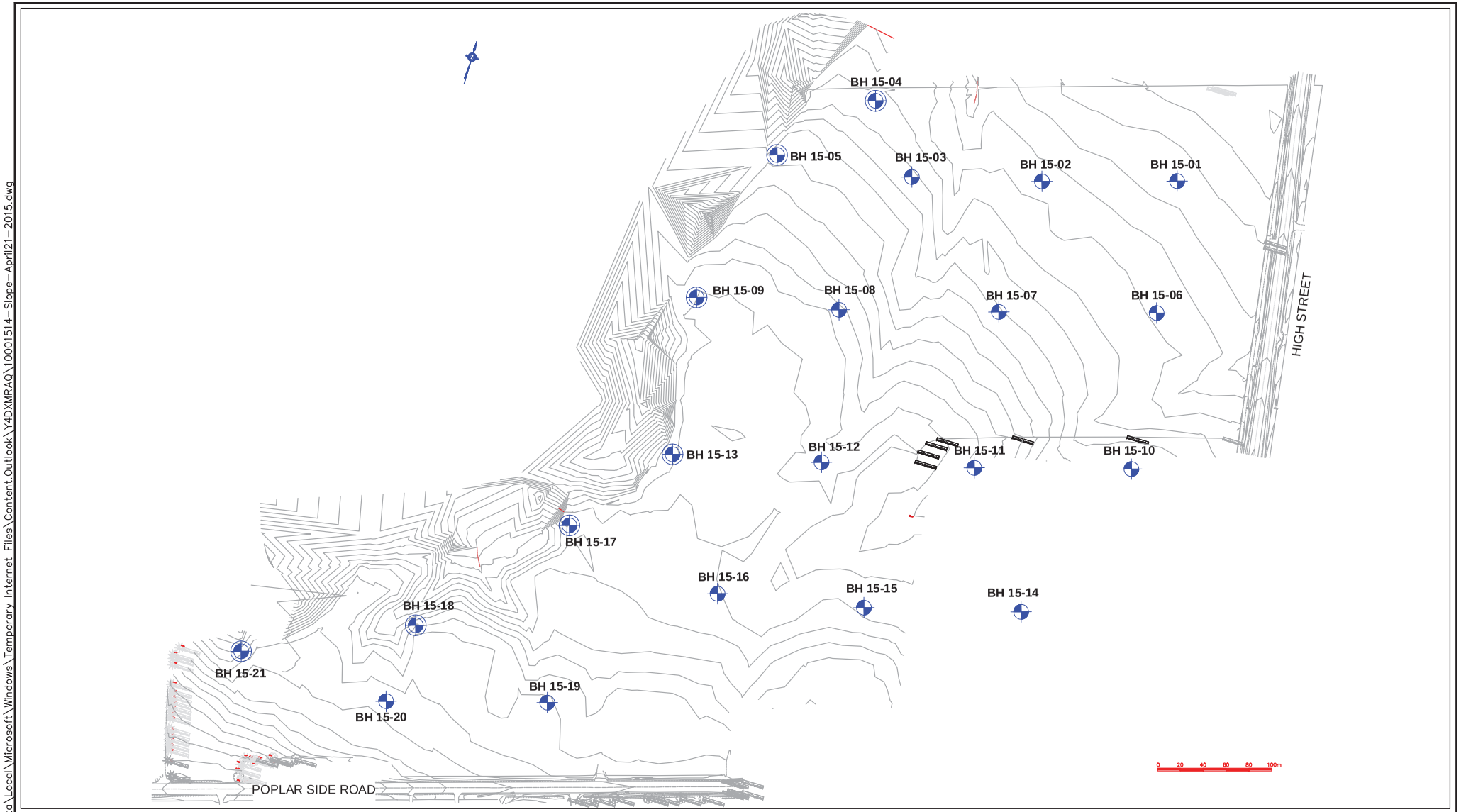


**Joeline Chan, B.Sc.**
**Project Manager – Environmental Services**

Attachments

Drawing 1

Laboratory Certificates of Analysis




**LEGEND**

- Borehole
- Borehole with Monitoring Well

| | | | | | |
|---|---|---|---|---|---|
| Client: | 1671745 Ontario Limited c/o C.C Tatham & Associates Ltd. | | | Project No.: 10001514 | Drawing No.: F-1 |
| Drawn: | ZMO | Approved: | KS | Title: | Borehole Location Plan |
| Date: | April 21, 2015 | Scale: | As Shown | Project: | Soil Quality Assessment - Charleston Homes Residential Subdivision Development, High Street and Poplar Sideroad, Collingwood, Ontario |
| Original Size: | Tabloid | Rev: | N/A | SPL Consultants Limited Geotechnical • Environmental • Materials • Hydrogeology | |

C:\Users\wsp\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Outlook\Y4DXMRAQ\10001514-Slope-April21-2015.dwg

SPL CONSULTANTS LIMITED
ATTN: Marco Visentin
14 Ronell Cresent
Collingwood Ontario L9Y 4J7

Date Received: 17-MAR-15
Report Date: 24-MAR-15 15:00 (MT)
Version: FINAL

Client Phone: 705-445-0064

# Certificate of Analysis

**Lab Work Order #: L1588231**

Project P.O. #: NOT SUBMITTED
Job Reference: 10001514
C of C Numbers: 14-413128, 14-413129
Legal Site Desc:

Emerson Perez
Account Manager

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| Grouping | Analyte | L1588231-1 SOIL 12-MAR-15 DUP 1 | L1588231-2 SOIL 13-MAR-15 DUP 2 | L1588231-3 SOIL 12-MAR-15 BH1 TS | L1588231-4 SOIL 12-MAR-15 BH1 SS2 | L1588231-5 SOIL 10-MAR-15 12:00 BH21 TS |
|---|---|---|---|---|---|---|
| **Sample ID / Description / Sampled Date / Sampled Time / Client ID** | | | | | | |
| **SOIL** | | | | | | |
| **Physical Tests** | Conductivity (mS/cm) | 0.101 | 0.0921 | 0.128 | 0.125 | 0.179 |
| | % Moisture (%) | 17.6 | 16.8 | 13.9 | 14.3 | 18.6 |
| | pH (pH units) | 7.67 | 7.54 | 7.36 | 7.77 | 6.81 |
| **Cyanides** | Cyanide, Weak Acid Diss (ug/g) | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| **Saturated Paste Extractables** | SAR (SAR) | <0.10 | <0.10 | <0.10 | 0.17 | <0.10 |
| | Calcium (Ca) (mg/L) | 8.37 | 15.6 | 23.8 | 15.6 | 24.4 |
| | Magnesium (Mg) (mg/L) | 0.48 | 0.53 | 0.71 | 4.02 | 3.02 |
| | Sodium (Na) (mg/L) | 0.98 | 0.88 | 0.56 | 2.92 | 0.73 |
| **Metals** | Antimony (Sb) (ug/g) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| | Arsenic (As) (ug/g) | 2.1 | 2.8 | 2.8 | 2.9 | 6.3 |
| | Barium (Ba) (ug/g) | 17.5 | 21.7 | 25.1 | 36.0 | 28.6 |
| | Beryllium (Be) (ug/g) | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| | Boron (B) (ug/g) | 6.5 | 6.2 | 6.6 | 9.5 | <5.0 |
| | Boron (B), Hot Water Ext. (ug/g) | <0.10 | <0.10 | 0.14 | 0.11 | 0.16 |
| | Cadmium (Cd) (ug/g) | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| | Chromium (Cr) (ug/g) | 10.0 | 12.0 | 11.3 | 14.1 | 13.7 |
| | Cobalt (Co) (ug/g) | 3.9 | 5.2 | 3.9 | 6.6 | 4.3 |
| | Copper (Cu) (ug/g) | 10.9 | 11.4 | 10.3 | 12.6 | 6.3 |
| | Lead (Pb) (ug/g) | 3.1 | 3.2 | 4.5 | 4.5 | 11.0 |
| | Mercury (Hg) (ug/g) | <0.010 | <0.010 | 0.131 | <0.010 | 0.031 |
| | Molybdenum (Mo) (ug/g) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| | Nickel (Ni) (ug/g) | 7.9 | 11.4 | 9.4 | 13.2 | 9.0 |
| | Selenium (Se) (ug/g) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| | Silver (Ag) (ug/g) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| | Thallium (Tl) (ug/g) | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| | Uranium (U) (ug/g) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| | Vanadium (V) (ug/g) | 18.0 | 20.0 | 18.2 | 24.0 | 24.5 |
| | Zinc (Zn) (ug/g) | 20.4 | 20.1 | 19.5 | 26.0 | 27.9 |
| **Speciated Metals** | Chromium, Hexavalent (ug/g) | <0.20 | <0.20 | 0.39 | <0.20 | 0.62 |
| **Organochlorine Pesticides** | Aldrin (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | gamma-hexachlorocyclohexane (ug/g) | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| | a-chlordane (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Chlordane (Total) (ug/g) | <0.028 | <0.028 | <0.028 | <0.028 | <0.028 |
| | g-chlordane (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | op-DDD (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | pp-DDD (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | 0.048 |

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| Sample ID | L1588231-6 | L1588231-7 | L1588231-8 | L1588231-9 | L1588231-10 |
|---|---|---|---|---|---|
| Description | SOIL | SOIL | SOIL | SOIL | SOIL |
| Sampled Date | 10-MAR-15 | 12-MAR-15 | 12-MAR-15 | 12-MAR-15 | 12-MAR-15 |
| Sampled Time | 12:00 | | | 12:00 | 12:00 |
| Client ID | BH21 SS2 | BH3 TS | BH3 SS2 | BH9 TS | BH9 SS2 |
| **Grouping** / **Analyte** | | | | | |
| **SOIL** | | | | | |
| **Physical Tests** Conductivity (mS/cm) | 0.0880 | 0.128 | 0.101 | 0.131 | 0.0967 |
| % Moisture (%) | 18.8 | 20.7 | 19.4 | 9.83 | 17.1 |
| pH (pH units) | 7.80 | 6.71 | 7.44 | 6.94 | 7.75 |
| **Cyanides** Cyanide, Weak Acid Diss (ug/g) | <0.050 | <0.050 | <0.050 | <0.050 | 0.060 |
| **Saturated Paste Extractables** SAR (SAR) | <0.10 | <0.10 | <0.10 | <0.10 SAR:Q | <0.10 |
| Calcium (Ca) (mg/L) | 15.4 | 20.4 | 18.3 | 19.4 | 14.7 |
| Magnesium (Mg) (mg/L) | 0.80 | 1.05 | 0.66 | 1.32 | 0.66 |
| Sodium (Na) (mg/L) | 0.72 | 0.50 | 0.76 | <0.50 | 0.79 |
| **Metals** Antimony (Sb) (ug/g) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Arsenic (As) (ug/g) | 1.2 | 2.2 | 1.7 | 3.2 | 1.7 |
| Barium (Ba) (ug/g) | 10.2 | 14.6 | 13.9 | 14.6 | 10.7 |
| Beryllium (Be) (ug/g) | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Boron (B) (ug/g) | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| Boron (B), Hot Water Ext. (ug/g) | <0.10 | <0.10 | <0.10 | 0.12 | <0.10 |
| Cadmium (Cd) (ug/g) | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Chromium (Cr) (ug/g) | 6.6 | 7.1 | 6.1 | 11.6 | 6.0 |
| Cobalt (Co) (ug/g) | 2.3 | 2.3 | 2.3 | 2.8 | 2.4 |
| Copper (Cu) (ug/g) | 5.5 | 4.4 | 6.1 | 4.4 | 9.7 |
| Lead (Pb) (ug/g) | 1.9 | 3.6 | 2.5 | 7.5 | 2.0 |
| Mercury (Hg) (ug/g) | <0.010 | 0.026 | <0.010 | 0.014 | <0.010 |
| Molybdenum (Mo) (ug/g) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Nickel (Ni) (ug/g) | 4.5 | 4.9 | 5.7 | 5.1 | 5.0 |
| Selenium (Se) (ug/g) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Silver (Ag) (ug/g) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| Thallium (Tl) (ug/g) | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Uranium (U) (ug/g) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Vanadium (V) (ug/g) | 14.9 | 15.0 | 11.7 | 26.6 | 12.3 |
| Zinc (Zn) (ug/g) | 8.9 | 8.9 | 8.9 | 12.6 | 11.3 |
| **Speciated Metals** Chromium, Hexavalent (ug/g) | <0.20 | 0.52 | 0.26 | <0.20 | <0.20 |
| **Organochlorine Pesticides** Aldrin (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| gamma-hexachlorocyclohexane (ug/g) | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| a-chlordane (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| Chlordane (Total) (ug/g) | <0.028 | <0.028 | <0.028 | <0.028 | <0.028 |
| g-chlordane (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| op-DDD (ug/g) | <0.020 | <0.020 | <0.020 | 0.030 | <0.020 |
| pp-DDD (ug/g) | <0.020 | 0.073 | <0.020 | 0.073 | <0.020 |

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| Grouping | Analyte | L1588231-11 SOIL 13-MAR-15 BH11 TS | L1588231-12 SOIL 13-MAR-15 BH11 SS2 | L1588231-13 SOIL 10-MAR-15 12:00 BH16 TS | L1588231-14 SOIL 10-MAR-15 12:00 BH16 SS2 | |
|---|---|---|---|---|---|---|
| **Sample ID** | | | | | | |
| **Description** | | | | | | |
| **Sampled Date** | | | | | | |
| **Sampled Time** | | | | | | |
| **Client ID** | | | | | | |
| **SOIL** | | | | | | |
| **Physical Tests** | Conductivity (mS/cm) | 0.0935 | 0.164 | 0.160 | 0.141 | |
| | % Moisture (%) | 21.4 | 16.0 | 24.2 | 14.2 | |
| | pH (pH units) | 5.96 | 7.22 | 7.08 | 7.80 | |
| **Cyanides** | Cyanide, Weak Acid Diss (ug/g) | <0.050 | <0.050 | <0.050 | <0.050 | |
| **Saturated Paste Extractables** | SAR (SAR) | <0.10 | <0.10 | <0.10 | 0.12 | |
| | Calcium (Ca) (mg/L) | 12.1 | 28.9 | 22.0 | 18.4 | |
| | Magnesium (Mg) (mg/L) | 0.96 | 0.83 | 1.43 | 2.87 | |
| | Sodium (Na) (mg/L) | 0.58 | 1.97 | 0.95 | 2.12 | |
| **Metals** | Antimony (Sb) (ug/g) | <1.0 | <1.0 | <1.0 | <1.0 | |
| | Arsenic (As) (ug/g) | 4.6 | 1.4 | 4.7 | 1.6 | |
| | Barium (Ba) (ug/g) | 20.5 | 10.3 | 22.1 | 18.5 | |
| | Beryllium (Be) (ug/g) | <0.50 | <0.50 | <0.50 | <0.50 | |
| | Boron (B) (ug/g) | <5.0 | <5.0 | <5.0 | 6.0 | |
| | Boron (B), Hot Water Ext. (ug/g) | 0.19 | <0.10 | 0.48 | 0.18 | |
| | Cadmium (Cd) (ug/g) | <0.50 | <0.50 | <0.50 | <0.50 | |
| | Chromium (Cr) (ug/g) | 10.8 | 6.0 | 10.5 | 8.9 | |
| | Cobalt (Co) (ug/g) | 2.5 | 1.9 | 2.7 | 3.4 | |
| | Copper (Cu) (ug/g) | 6.1 | 4.3 | 12.3 | 8.0 | |
| | Lead (Pb) (ug/g) | 12.4 | 2.1 | 7.3 | 2.6 | |
| | Mercury (Hg) (ug/g) | 0.018 | <0.010 | 0.023 | <0.010 | |
| | Molybdenum (Mo) (ug/g) | <1.0 | <1.0 | <1.0 | <1.0 | |
| | Nickel (Ni) (ug/g) | 5.9 | 4.3 | 5.6 | 6.9 | |
| | Selenium (Se) (ug/g) | <1.0 | <1.0 | <1.0 | <1.0 | |
| | Silver (Ag) (ug/g) | <0.20 | <0.20 | <0.20 | <0.20 | |
| | Thallium (Tl) (ug/g) | <0.50 | <0.50 | <0.50 | <0.50 | |
| | Uranium (U) (ug/g) | <1.0 | <1.0 | <1.0 | <1.0 | |
| | Vanadium (V) (ug/g) | 25.0 | 12.0 | 20.5 | 16.8 | |
| | Zinc (Zn) (ug/g) | 21.3 | 9.1 | 25.7 | 14.4 | |
| **Speciated Metals** | Chromium, Hexavalent (ug/g) | <0.20 | <0.20 | <0.20 | <0.20 | |
| **Organochlorine Pesticides** | Aldrin (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |
| | gamma-hexachlorocyclohexane (ug/g) | <0.010 | <0.010 | <0.010 | <0.010 | |
| | a-chlordane (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |
| | Chlordane (Total) (ug/g) | <0.028 | <0.028 | <0.028 | <0.028 | |
| | g-chlordane (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |
| | op-DDD (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |
| | pp-DDD (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| Grouping | Analyte | L1588231-1 SOIL 12-MAR-15 DUP 1 | L1588231-2 SOIL 13-MAR-15 DUP 2 | L1588231-3 SOIL 12-MAR-15 BH1 TS | L1588231-4 SOIL 12-MAR-15 BH1 SS2 | L1588231-5 SOIL 10-MAR-15 12:00 BH21 TS |
|---|---|---|---|---|---|---|
| **Sample ID** | | L1588231-1 | L1588231-2 | L1588231-3 | L1588231-4 | L1588231-5 |
| **Description** | | SOIL | SOIL | SOIL | SOIL | SOIL |
| **Sampled Date** | | 12-MAR-15 | 13-MAR-15 | 12-MAR-15 | 12-MAR-15 | 10-MAR-15 |
| **Sampled Time** | | | | | | 12:00 |
| **Client ID** | | DUP 1 | DUP 2 | BH1 TS | BH1 SS2 | BH21 TS |
| **SOIL** | | | | | | |
| **Organochlorine Pesticides** | Total DDD (ug/g) | <0.028 | <0.028 | <0.028 | <0.028 | 0.048 |
| | o,p-DDE (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | pp-DDE (ug/g) | <0.020 | <0.020 | 0.027 | <0.020 | 0.862 |
| | Total DDE (ug/g) | <0.028 | <0.028 | <0.036 | <0.028 | 0.862 |
| | op-DDT (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | 0.028 |
| | pp-DDT (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | 0.206 |
| | Total DDT (ug/g) | <0.028 | <0.028 | <0.028 | <0.028 | 0.234 |
| | Dieldrin (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Endosulfan I (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Endosulfan II (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Endosulfan (Total) (ug/g) | <0.028 | <0.028 | <0.028 | <0.028 | <0.028 |
| | Endrin (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Heptachlor (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Heptachlor Epoxide (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Hexachlorobenzene (ug/g) | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| | Hexachlorobutadiene (ug/g) | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| | Hexachloroethane (ug/g) | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| | Methoxychlor (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Surrogate: 2-Fluorobiphenyl (%) | 96.7 | 99.4 | 96.5 | 97.5 | 124.7 |
| | Surrogate: d14-Terphenyl (%) | 99.3 | 97.2 | 96.0 | 91.1 | 110.9 |

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| Grouping | Analyte | L1588231-6 SOIL 10-MAR-15 12:00 BH21 SS2 | L1588231-7 SOIL 12-MAR-15 BH3 TS | L1588231-8 SOIL 12-MAR-15 BH3 SS2 | L1588231-9 SOIL 12-MAR-15 12:00 BH9 TS | L1588231-10 SOIL 12-MAR-15 12:00 BH9 SS2 |
|---|---|---|---|---|---|---|
| **Sample ID** | | L1588231-6 | L1588231-7 | L1588231-8 | L1588231-9 | L1588231-10 |
| **Description** | | SOIL | SOIL | SOIL | SOIL | SOIL |
| **Sampled Date** | | 10-MAR-15 | 12-MAR-15 | 12-MAR-15 | 12-MAR-15 | 12-MAR-15 |
| **Sampled Time** | | 12:00 | | | 12:00 | 12:00 |
| **Client ID** | | BH21 SS2 | BH3 TS | BH3 SS2 | BH9 TS | BH9 SS2 |
| **SOIL** | | | | | | |
| **Organochlorine Pesticides** | Total DDD (ug/g) | <0.028 | 0.073 | <0.028 | 0.103 | <0.028 |
| | o,p-DDE (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | pp-DDE (ug/g) | <0.020 | 0.608 | 0.020 | 0.640 | <0.020 |
| | Total DDE (ug/g) | <0.028 | 0.608 | <0.028 | 0.640 | <0.028 |
| | op-DDT (ug/g) | <0.020 | 0.065 | <0.020 | 0.136 | <0.020 |
| | pp-DDT (ug/g) | <0.020 | 0.441 | <0.020 | 0.409 | <0.020 |
| | Total DDT (ug/g) | <0.028 | 0.506 | <0.028 | 0.545 | <0.028 |
| | Dieldrin (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Endosulfan I (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Endosulfan II (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Endosulfan (Total) (ug/g) | <0.028 | <0.028 | <0.028 | <0.028 | <0.028 |
| | Endrin (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Heptachlor (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Heptachlor Epoxide (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Hexachlorobenzene (ug/g) | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| | Hexachlorobutadiene (ug/g) | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| | Hexachloroethane (ug/g) | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| | Methoxychlor (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| | Surrogate: 2-Fluorobiphenyl (%) | 98.4 | 99.6 | 96.7 | 98.2 | 95.4 |
| | Surrogate: d14-Terphenyl (%) | 90.5 | 93.6 | 88.5 | 92.8 | 99.1 |

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| Grouping | Analyte | L1588231-11 SOIL 13-MAR-15 BH11 TS | L1588231-12 SOIL 13-MAR-15 BH11 SS2 | L1588231-13 SOIL 10-MAR-15 12:00 BH16 TS | L1588231-14 SOIL 10-MAR-15 12:00 BH16 SS2 | |
|---|---|---|---|---|---|---|
| **Sample ID** | | L1588231-11 | L1588231-12 | L1588231-13 | L1588231-14 | |
| **Description** | | SOIL | SOIL | SOIL | SOIL | |
| **Sampled Date** | | 13-MAR-15 | 13-MAR-15 | 10-MAR-15 | 10-MAR-15 | |
| **Sampled Time** | | | | 12:00 | 12:00 | |
| **Client ID** | | BH11 TS | BH11 SS2 | BH16 TS | BH16 SS2 | |
| **SOIL** | | | | | | |
| **Organochlorine Pesticides** | Total DDD (ug/g) | <0.028 | <0.028 | <0.028 | <0.028 | |
| | o,p-DDE (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |
| | pp-DDE (ug/g) | 0.082 | <0.020 | 0.185 | <0.020 | |
| | Total DDE (ug/g) | 0.082 | <0.028 | 0.185 | <0.028 | |
| | op-DDT (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |
| | pp-DDT (ug/g) | 0.038 | <0.020 | 0.031 | <0.020 | |
| | Total DDT (ug/g) | 0.038 | <0.028 | 0.031 | <0.028 | |
| | Dieldrin (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |
| | Endosulfan I (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |
| | Endosulfan II (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |
| | Endosulfan (Total) (ug/g) | <0.028 | <0.028 | <0.028 | <0.028 | |
| | Endrin (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |
| | Heptachlor (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |
| | Heptachlor Epoxide (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |
| | Hexachlorobenzene (ug/g) | <0.010 | <0.010 | <0.010 | <0.010 | |
| | Hexachlorobutadiene (ug/g) | <0.010 | <0.010 | <0.010 | <0.010 | |
| | Hexachloroethane (ug/g) | <0.010 | <0.010 | <0.010 | <0.010 | |
| | Methoxychlor (ug/g) | <0.020 | <0.020 | <0.020 | <0.020 | |
| | Surrogate: 2-Fluorobiphenyl (%) | 97.3 | 96.5 | 100.3 | 124.1 | |
| | Surrogate: d14-Terphenyl (%) | 87.2 | 86.6 | 82.8 | 100.9 | |

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# Reference Information

**Qualifiers for Individual Parameters Listed:**

| Qualifier | Description |
|---|---|
| SAR:Q | Qualified SAR value: actual SAR is lower but is incalculable due to Na, Ca or Mg below detection limit. |

**Test Method References:**

| ALS Test Code | Matrix | Test Description | Method Reference** |
|---|---|---|---|
| **B-HWS-R511-WT** | Soil | Boron-HWE-O.Reg 153/04 (July 2011) | HW EXTR, EPA 6010B |

A dried solid sample is extracted with calcium chloride, the sample undergoes a heating process. After cooling the sample is filtered and analyzed by ICP/OES.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

| | | | |
|---|---|---|---|
| **CHLORDANE-T-CALC-WT** | Soil | Chlordane Total sums | CALCULATION |

Aqueous sample is extracted by liquid/liquid extraction with a solvent mix. After extraction, a number of clean up techniques may be applied, depending on the sample matrix and analyzed by GC/MS.

| | | | |
|---|---|---|---|
| **CN-WAD-R511-WT** | Soil | Cyanide (WAD)-O.Reg 153/04 (July 2011) | MOE 3015/APHA 4500CN I-WAD |

The sample is extracted with a strong base for 16 hours, and then filtered. The filtrate is then distilled where the cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

| | | | |
|---|---|---|---|
| **CR-CR6-IC-R511-WT** | Soil | Hex Chrom-O.Reg 153/04 (July 2011) | SW846 3060A/7199 R511 |

Soil sample undergoes a alkaline digestion process where the sample is acidified and derivatized with 1,5-diphenylcarbazide (DPC) using ion chromatography.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

| | | | |
|---|---|---|---|
| **DDD-DDE-DDT-CALC-WT** | Soil | DDD, DDE, DDT sums | CALCULATION |

Aqueous sample is extracted by liquid/liquid extraction with a solvent mix. After extraction, a number of clean up techniques may be applied, depending on the sample matrix and analyzed by GC/MS.

| | | | |
|---|---|---|---|
| **EC-R511-WT** | Soil | Conductivity-O.Reg 153/04 (July 2011) | MOEE E3138 |

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

| | | | |
|---|---|---|---|
| **ENDOSULFAN-T-CALC-WT** | Soil | Endosulfan Total sums | CALCULATION |

Aqueous sample is extracted by liquid/liquid extraction with a solvent mix. After extraction, a number of clean up techniques may be applied, depending on the sample matrix and analyzed by GC/MS.

| | | | |
|---|---|---|---|
| **HG-R511-WT** | Soil | Mercury-O.Reg 153/04 (July 2011) | SW846 3050B/7471 |

Solid sample is digested with a heated, strong, mixed acid solution to convert all forms of mercury to divalent mercury. The divalent mercury is then reduced to elemental mercury, sparged from solution and analyzed by CVAAS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

| | | | |
|---|---|---|---|
| **MET-200.2-CCMS-WT** | Soil | Metals in Soil by CRC ICPMS | EPA 200.2/6020A |

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CRC ICPMS.

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. This method does not dissolve all silicate materials and may result in a partial extraction. depending on the sample matrix, for some metals, including, but not limited to Al, Ba, Be, Cr, Sr, Ti, Tl, and V.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

| | | | |
|---|---|---|---|
| **MET-200.2-CCMS-WT** | Soil | Metals in Soil by CRC ICPMS | EPA 200.2/6020A (mod) |

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CRC ICPMS.

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may

# Reference Information

be environmentally available. This method does not dissolve all silicate materials and may result in a partial extraction. depending on the sample matrix, for some metals, including, but not limited to Al, Ba, Be, Cr, Sr, Ti, Tl, and V.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

| | | | |
|---|---|---|---|
| **MOISTURE-WT** | Soil | % Moisture | Gravimetric: Oven Dried |
| **PEST-OC-511-WT** | Soil | OC Pesticides-O.Reg 153/04 (July 2011) | SW846 8270 (511) |

Soil sample is extracted in a solvent, after extraction a number of clean up techniques may be applied, depending on the sample matrix and analyzed by GC/MS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

| | | | |
|---|---|---|---|
| **PH-R511-WT** | Soil | pH-O.Reg 153/04 (July 2011) | MOEE E3137A |

A minimum 10g portion of the sample is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

| | | | |
|---|---|---|---|
| **SAR-R511-WT** | Soil | SAR-O.Reg 153/04 (July 2011) | SW846 6010C |

A dried, disaggregated solid sample is extracted with deionized water, the aqueous extract is separated from the solid, acidified and then analyzed using a ICP/OES.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

| Laboratory Definition Code | Laboratory Location |
|---|---|
| WT | ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA |

**Chain of Custody Numbers:**

14-413128 14-413129

**GLOSSARY OF REPORT TERMS**

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*
*mg/kg - milligrams per kilogram based on dry weight of sample.*
*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*
*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*
*mg/L - milligrams per litre.*
*< - Less than.*
*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*
*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*
*UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.*
*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*

# Quality Control Report

Workorder: L1588231 Report Date: 24-MAR-15 

Client: SPL CONSULTANTS LIMITED
14 Ronell Cresent
Collingwood Ontario L9Y 4J7

Contact: Marco Visentin

| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **B-HWS-R511-WT** | **Soil** | | | | | | | |
| **Batch R3161777** | | | | | | | | |
| **WG2056497-3 DUP** | | **L1588862-1** | | | | | | |
| Boron (B), Hot Water Ext. | | <0.10 | <0.10 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| **WG2056497-2 IRM** | | **SALINITY_SOIL4** | | | | | | |
| Boron (B), Hot Water Ext. | | | 87.9 | | % | | 70-130 | 19-MAR-15 |
| **WG2056497-1 MB** | | | | | | | | |
| Boron (B), Hot Water Ext. | | | <0.10 | | ug/g | | 0.1 | 19-MAR-15 |
| **WG2056497-4 MS** | | **L1588862-1** | | | | | | |
| Boron (B), Hot Water Ext. | | | 124.3 | | % | | 60-140 | 19-MAR-15 |
| **CN-WAD-R511-WT** | **Soil** | | | | | | | |
| **Batch R3163700** | | | | | | | | |
| **WG2055956-3 DUP** | | **L1588231-1** | | | | | | |
| Cyanide, Weak Acid Diss | | <0.050 | <0.050 | RPD-NA | ug/g | N/A | 35 | 20-MAR-15 |
| **WG2055956-2 LCS** | | | | | | | | |
| Cyanide, Weak Acid Diss | | | 113.6 | | % | | 80-120 | 20-MAR-15 |
| **WG2055956-1 MB** | | | | | | | | |
| Cyanide, Weak Acid Diss | | | <0.050 | | ug/g | | 0.05 | 20-MAR-15 |
| **WG2055956-4 MS** | | **L1588231-1** | | | | | | |
| Cyanide, Weak Acid Diss | | | 103.0 | | % | | 70-130 | 20-MAR-15 |
| **CR-CR6-IC-R511-WT** | **Soil** | | | | | | | |
| **Batch R3162260** | | | | | | | | |
| **WG2055955-3 CRM** | | **WT-SQC012** | | | | | | |
| Chromium, Hexavalent | | | 96.2 | | % | | 70-130 | 19-MAR-15 |
| **WG2055955-4 DUP** | | **L1588231-1** | | | | | | |
| Chromium, Hexavalent | | <0.20 | <0.20 | RPD-NA | ug/g | N/A | 35 | 19-MAR-15 |
| **WG2055955-2 LCS** | | | | | | | | |
| Chromium, Hexavalent | | | 96.4 | | % | | 80-120 | 19-MAR-15 |
| **WG2055955-1 MB** | | | | | | | | |
| Chromium, Hexavalent | | | <0.20 | | ug/g | | 0.2 | 19-MAR-15 |
| **EC-R511-WT** | **Soil** | | | | | | | |
| **Batch R3161600** | | | | | | | | |
| **WG2056499-4 DUP** | | **WG2056499-3** | | | | | | |
| Conductivity | | 0.927 | 0.978 | | mS/cm | 5.4 | 20 | 19-MAR-15 |
| **WG2056700-1 LCS** | | | | | | | | |
| Conductivity | | | 99.9 | | % | | 90-110 | 19-MAR-15 |
| **WG2056499-1 MB** | | | | | | | | |
| Conductivity | | | <0.0040 | | mS/cm | | 0.004 | 19-MAR-15 |
| **HG-R511-WT** | **Soil** | | | | | | | |

# Quality Control Report



Client: SPL CONSULTANTS LIMITED
14 Ronell Cresent
Collingwood Ontario L9Y 4J7
Contact: Marco Visentin

| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **HG-R511-WT** | **Soil** | | | | | | | |
| **Batch R3162366** | | | | | | | | |
| **WG2056501-2 CRM** | | **WT-SS-1** | | | | | | |
| Mercury (Hg) | | | 127.9 | | % | | 70-130 | 20-MAR-15 |
| **WG2056501-6 DUP** | | **L1588231-1** | | | | | | |
| Mercury (Hg) | | <0.010 | <0.010 | RPD-NA | ug/g | N/A | 30 | 20-MAR-15 |
| **WG2056501-4 LCS** | | | | | | | | |
| Mercury (Hg) | | | 109.5 | | % | | 80-120 | 20-MAR-15 |
| **WG2056501-1 MB** | | | | | | | | |
| Mercury (Hg) | | | <0.010 | | ug/g | | 0.01 | 20-MAR-15 |
| **MET-200.2-CCMS-WT** | **Soil** | | | | | | | |
| **Batch R3162278** | | | | | | | | |
| **WG2056501-6 DUP** | | **L1588231-1** | | | | | | |
| Antimony (Sb) | | <1.0 | <0.10 | RPD-NA | ug/g | N/A | 30 | 19-MAR-15 |
| Arsenic (As) | | 2.1 | 2.03 | | ug/g | 4.7 | 30 | 19-MAR-15 |
| Barium (Ba) | | 17.5 | 15.2 | | ug/g | 14 | 40 | 19-MAR-15 |
| Beryllium (Be) | | <0.50 | 0.19 | | ug/g | 9.7 | 30 | 19-MAR-15 |
| Boron (B) | | 6.5 | 5.3 | | ug/g | 20 | 30 | 19-MAR-15 |
| Cadmium (Cd) | | <0.50 | 0.028 | | ug/g | 12 | 30 | 19-MAR-15 |
| Chromium (Cr) | | 10.0 | 8.37 | | ug/g | 17 | 30 | 19-MAR-15 |
| Cobalt (Co) | | 3.9 | 3.54 | | ug/g | 9.7 | 30 | 19-MAR-15 |
| Copper (Cu) | | 10.9 | 10.0 | | ug/g | 8.0 | 30 | 19-MAR-15 |
| Lead (Pb) | | 3.1 | 2.81 | | ug/g | 11 | 40 | 19-MAR-15 |
| Molybdenum (Mo) | | <1.0 | 0.13 | | ug/g | 17 | 40 | 19-MAR-15 |
| Nickel (Ni) | | 7.9 | 7.17 | | ug/g | 9.9 | 30 | 19-MAR-15 |
| Selenium (Se) | | <1.0 | <0.20 | RPD-NA | ug/g | N/A | 30 | 19-MAR-15 |
| Silver (Ag) | | <0.20 | <0.10 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| Thallium (Tl) | | <0.50 | <0.050 | RPD-NA | ug/g | N/A | 30 | 19-MAR-15 |
| Uranium (U) | | <1.0 | 0.334 | | ug/g | 16 | 30 | 19-MAR-15 |
| Vanadium (V) | | 18.0 | 16.1 | | ug/g | 11 | 30 | 19-MAR-15 |
| Zinc (Zn) | | 20.4 | 16.9 | | ug/g | 19 | 30 | 19-MAR-15 |
| **WG2056501-3 LCS** | | | | | | | | |
| Antimony (Sb) | | | 103.2 | | % | | 80-120 | 19-MAR-15 |
| Arsenic (As) | | | 103.9 | | % | | 80-120 | 19-MAR-15 |
| Barium (Ba) | | | 99.4 | | % | | 80-120 | 19-MAR-15 |
| Beryllium (Be) | | | 86.3 | | % | | 80-120 | 19-MAR-15 |
| Boron (B) | | | 88.3 | | % | | 80-120 | 19-MAR-15 |

# Quality Control Report



Client: SPL CONSULTANTS LIMITED
14 Ronell Cresent
Collingwood Ontario L9Y 4J7
Contact: Marco Visentin

| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **MET-200.2-CCMS-WT** | **Soil** | | | | | | | |
| **Batch R3162278** | | | | | | | | |
| **WG2056501-3 LCS** | | | | | | | | |
| Cadmium (Cd) | | | 99.4 | | % | | 80-120 | 19-MAR-15 |
| Chromium (Cr) | | | 100.3 | | % | | 80-120 | 19-MAR-15 |
| Cobalt (Co) | | | 99.1 | | % | | 80-120 | 19-MAR-15 |
| Copper (Cu) | | | 97.8 | | % | | 80-120 | 19-MAR-15 |
| Lead (Pb) | | | 97.7 | | % | | 80-120 | 19-MAR-15 |
| Molybdenum (Mo) | | | 97.4 | | % | | 80-120 | 19-MAR-15 |
| Nickel (Ni) | | | 99.4 | | % | | 80-120 | 19-MAR-15 |
| Selenium (Se) | | | 103.9 | | % | | 80-120 | 19-MAR-15 |
| Silver (Ag) | | | 98.8 | | % | | 80-120 | 19-MAR-15 |
| Thallium (Tl) | | | 97.4 | | % | | 80-120 | 19-MAR-15 |
| Uranium (U) | | | 92.0 | | % | | 80-120 | 19-MAR-15 |
| Vanadium (V) | | | 101.9 | | % | | 80-120 | 19-MAR-15 |
| Zinc (Zn) | | | 94.9 | | % | | 80-120 | 19-MAR-15 |
| **WG2056501-1 MB** | | | | | | | | |
| Antimony (Sb) | | | <0.10 | | mg/kg | | 0.1 | 19-MAR-15 |
| Arsenic (As) | | | <0.10 | | mg/kg | | 0.1 | 19-MAR-15 |
| Barium (Ba) | | | <0.50 | | mg/kg | | 0.5 | 19-MAR-15 |
| Beryllium (Be) | | | <0.10 | | mg/kg | | 0.1 | 19-MAR-15 |
| Boron (B) | | | <5.0 | | mg/kg | | 5 | 19-MAR-15 |
| Cadmium (Cd) | | | <0.020 | | mg/kg | | 0.02 | 19-MAR-15 |
| Chromium (Cr) | | | <0.50 | | mg/kg | | 0.5 | 19-MAR-15 |
| Cobalt (Co) | | | <0.10 | | mg/kg | | 0.1 | 19-MAR-15 |
| Copper (Cu) | | | <0.50 | | mg/kg | | 0.5 | 19-MAR-15 |
| Lead (Pb) | | | <0.50 | | mg/kg | | 0.5 | 19-MAR-15 |
| Molybdenum (Mo) | | | <0.10 | | mg/kg | | 0.1 | 19-MAR-15 |
| Nickel (Ni) | | | <0.50 | | mg/kg | | 0.5 | 19-MAR-15 |
| Selenium (Se) | | | <0.20 | | mg/kg | | 0.2 | 19-MAR-15 |
| Silver (Ag) | | | <0.10 | | mg/kg | | 0.1 | 19-MAR-15 |
| Thallium (Tl) | | | <0.050 | | mg/kg | | 0.05 | 19-MAR-15 |
| Uranium (U) | | | <0.050 | | mg/kg | | 0.05 | 19-MAR-15 |
| Vanadium (V) | | | <0.20 | | mg/kg | | 0.2 | 19-MAR-15 |
| Zinc (Zn) | | | <2.0 | | mg/kg | | 2 | 19-MAR-15 |
| **MOISTURE-WT** | **Soil** | | | | | | | |

# Quality Control Report



Client: SPL CONSULTANTS LIMITED
14 Ronell Cresent
Collingwood Ontario L9Y 4J7
Contact: Marco Visentin

| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **MOISTURE-WT** | **Soil** | | | | | | | |
| **Batch R3161474** | | | | | | | | |
| **WG2055971-3 DUP** | | **L1588231-14** | | | | | | |
| % Moisture | | 14.2 | 15.4 | | % | 8.1 | 30 | 19-MAR-15 |
| **WG2055971-2 LCS** | | | | | | | | |
| % Moisture | | | 97.6 | | % | | 70-130 | 19-MAR-15 |
| **WG2055971-1 MB** | | | | | | | | |
| % Moisture | | | <0.10 | | % | | 0.1 | 19-MAR-15 |
| **PEST-OC-511-WT** | **Soil** | | | | | | | |
| **Batch R3161517** | | | | | | | | |
| **WG2056617-1 CVS** | | | | | | | | |
| Aldrin | | | 128.6 | | % | | 50-140 | 19-MAR-15 |
| a-chlordane | | | 127.2 | | % | | 50-140 | 19-MAR-15 |
| g-chlordane | | | 134.9 | | % | | 50-140 | 19-MAR-15 |
| op-DDD | | | 110.5 | | % | | 50-140 | 19-MAR-15 |
| pp-DDD | | | 99.0 | | % | | 50-140 | 19-MAR-15 |
| o,p-DDE | | | 119.3 | | % | | 50-140 | 19-MAR-15 |
| pp-DDE | | | 119.2 | | % | | 50-140 | 19-MAR-15 |
| op-DDT | | | 95.5 | | % | | 50-140 | 19-MAR-15 |
| pp-DDT | | | 93.0 | | % | | 50-140 | 19-MAR-15 |
| Dieldrin | | | 101.3 | | % | | 50-140 | 19-MAR-15 |
| Endosulfan I | | | 128.1 | | % | | 50-140 | 19-MAR-15 |
| Endosulfan II | | | 102.0 | | % | | 50-140 | 19-MAR-15 |
| Endrin | | | 115.4 | | % | | 50-140 | 19-MAR-15 |
| gamma-hexachlorocyclohexane | | | 98.6 | | % | | 50-140 | 19-MAR-15 |
| Heptachlor | | | 92.5 | | % | | 50-140 | 19-MAR-15 |
| Heptachlor Epoxide | | | 127.7 | | % | | 50-140 | 19-MAR-15 |
| Hexachlorobenzene | | | 97.0 | | % | | 70-130 | 19-MAR-15 |
| Hexachlorobutadiene | | | 96.0 | | % | | 70-130 | 19-MAR-15 |
| Hexachloroethane | | | 100.8 | | % | | 50-140 | 19-MAR-15 |
| Methoxychlor | | | 93.9 | | % | | 50-140 | 19-MAR-15 |
| **WG2055978-4 DUP** | | **L1588231-1** | | | | | | |
| Aldrin | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| a-chlordane | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| g-chlordane | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| op-DDD | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| pp-DDD | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |

# Quality Control Report



Client: SPL CONSULTANTS LIMITED
14 Ronell Cresent
Collingwood Ontario L9Y 4J7
Contact: Marco Visentin

| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **PEST-OC-511-WT** | **Soil** | | | | | | | |
| **Batch R3161517** | | | | | | | | |
| **WG2055978-4 DUP** | | **L1588231-1** | | | | | | |
| o,p-DDE | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| pp-DDE | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| op-DDT | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| pp-DDT | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| Dieldrin | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| Endosulfan I | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| Endosulfan II | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| Endrin | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| gamma-hexachlorocyclohexane | | <0.010 | <0.010 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| Heptachlor | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| Heptachlor Epoxide | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| Hexachlorobenzene | | <0.010 | <0.010 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| Hexachlorobutadiene | | <0.010 | <0.010 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| Hexachloroethane | | <0.010 | <0.010 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| Methoxychlor | | <0.020 | <0.020 | RPD-NA | ug/g | N/A | 40 | 19-MAR-15 |
| **WG2055978-2 LCS** | | | | | | | | |
| Aldrin | | | 116.9 | | % | | 50-140 | 19-MAR-15 |
| a-chlordane | | | 107.7 | | % | | 50-140 | 19-MAR-15 |
| g-chlordane | | | 110.2 | | % | | 50-140 | 19-MAR-15 |
| op-DDD | | | 106.5 | | % | | 50-140 | 19-MAR-15 |
| pp-DDD | | | 97.0 | | % | | 50-140 | 19-MAR-15 |
| o,p-DDE | | | 96.8 | | % | | 50-140 | 19-MAR-15 |
| pp-DDE | | | 102.1 | | % | | 50-140 | 19-MAR-15 |
| op-DDT | | | 93.1 | | % | | 50-140 | 19-MAR-15 |
| pp-DDT | | | 87.2 | | % | | 50-140 | 19-MAR-15 |
| Dieldrin | | | 96.6 | | % | | 50-140 | 19-MAR-15 |
| Endosulfan I | | | 96.1 | | % | | 50-140 | 19-MAR-15 |
| Endosulfan II | | | 99.1 | | % | | 50-140 | 19-MAR-15 |
| Endrin | | | 109.8 | | % | | 50-140 | 19-MAR-15 |
| gamma-hexachlorocyclohexane | | | 99.0 | | % | | 50-140 | 19-MAR-15 |
| Heptachlor | | | 93.1 | | % | | 50-140 | 19-MAR-15 |
| Heptachlor Epoxide | | | 102.9 | | % | | 50-140 | 19-MAR-15 |
| Hexachlorobenzene | | | 93.1 | | % | | 50-140 | 19-MAR-15 |

# Quality Control Report



Client: SPL CONSULTANTS LIMITED
14 Ronell Cresent
Collingwood Ontario L9Y 4J7
Contact: Marco Visentin

| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **PEST-OC-511-WT** | **Soil** | | | | | | | |
| **Batch R3161517** | | | | | | | | |
| **WG2055978-2 LCS** | | | | | | | | |
| Hexachlorobutadiene | | | 91.4 | | % | | 50-140 | 19-MAR-15 |
| Hexachloroethane | | | 97.8 | | % | | 50-140 | 19-MAR-15 |
| Methoxychlor | | | 88.6 | | % | | 50-140 | 19-MAR-15 |
| **WG2055978-1 MB** | | | | | | | | |
| Aldrin | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| a-chlordane | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| g-chlordane | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| op-DDD | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| pp-DDD | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| o,p-DDE | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| pp-DDE | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| op-DDT | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| pp-DDT | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| Dieldrin | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| Endosulfan I | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| Endosulfan II | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| Endrin | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| gamma-hexachlorocyclohexane | | | <0.010 | | ug/g | | 0.01 | 19-MAR-15 |
| Heptachlor | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| Heptachlor Epoxide | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| Hexachlorobenzene | | | <0.010 | | ug/g | | 0.01 | 19-MAR-15 |
| Hexachlorobutadiene | | | <0.010 | | ug/g | | 0.01 | 19-MAR-15 |
| Hexachloroethane | | | <0.010 | | ug/g | | 0.01 | 19-MAR-15 |
| Methoxychlor | | | <0.020 | | ug/g | | 0.02 | 19-MAR-15 |
| Surrogate: 2-Fluorobiphenyl | | | 100.5 | | % | | 50-140 | 19-MAR-15 |
| Surrogate: d14-Terphenyl | | | 91.1 | | % | | 50-140 | 19-MAR-15 |
| **WG2055978-5 MS** | | **L1588231-1** | | | | | | |
| Aldrin | | | 116.0 | | % | | 50-140 | 19-MAR-15 |
| a-chlordane | | | 100.1 | | % | | 50-140 | 19-MAR-15 |
| g-chlordane | | | 106.5 | | % | | 50-140 | 19-MAR-15 |
| op-DDD | | | 102.7 | | % | | 50-140 | 19-MAR-15 |
| pp-DDD | | | 99.5 | | % | | 50-140 | 19-MAR-15 |
| o,p-DDE | | | 94.6 | | % | | 50-140 | 19-MAR-15 |
| pp-DDE | | | 99.5 | | % | | 50-140 | 19-MAR-15 |

# Quality Control Report



Client: SPL CONSULTANTS LIMITED
14 Ronell Cresent
Collingwood Ontario L9Y 4J7
Contact: Marco Visentin

| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **PEST-OC-511-WT** | **Soil** | | | | | | | |
| **Batch R3161517** | | | | | | | | |
| **WG2055978-5 MS** | | **L1588231-1** | | | | | | |
| op-DDT | | | 94.9 | | % | | 50-140 | 19-MAR-15 |
| pp-DDT | | | 91.9 | | % | | 50-140 | 19-MAR-15 |
| Dieldrin | | | 94.9 | | % | | 50-140 | 19-MAR-15 |
| Endosulfan I | | | 96.8 | | % | | 50-140 | 19-MAR-15 |
| Endosulfan II | | | 101.9 | | % | | 50-140 | 19-MAR-15 |
| Endrin | | | 111.6 | | % | | 50-150 | 19-MAR-15 |
| gamma-hexachlorocyclohexane | | | 97.9 | | % | | 50-140 | 19-MAR-15 |
| Heptachlor | | | 93.0 | | % | | 50-140 | 19-MAR-15 |
| Heptachlor Epoxide | | | 104.3 | | % | | 50-140 | 19-MAR-15 |
| Hexachlorobenzene | | | 94.1 | | % | | 50-140 | 19-MAR-15 |
| Hexachlorobutadiene | | | 81.9 | | % | | 50-140 | 19-MAR-15 |
| Hexachloroethane | | | 88.1 | | % | | 50-140 | 19-MAR-15 |
| Methoxychlor | | | 94.2 | | % | | 50-140 | 19-MAR-15 |
| **PH-R511-WT** | **Soil** | | | | | | | |
| **Batch R3161105** | | | | | | | | |
| **WG2055954-1 DUP** | | **L1588231-1** | | | | | | |
| pH | | 7.67 | 7.70 | J | pH units | 0.03 | 0.3 | 18-MAR-15 |
| **WG2056135-1 LCS** | | | | | | | | |
| pH | | | 7.00 | | pH units | | 6.7-7.3 | 18-MAR-15 |
| **SAR-R511-WT** | **Soil** | | | | | | | |
| **Batch R3161780** | | | | | | | | |
| **WG2056499-4 DUP** | | **WG2056499-3** | | | | | | |
| Calcium (Ca) | | 16.4 | 17.0 | | mg/L | 3.4 | 40 | 19-MAR-15 |
| Sodium (Na) | | 177 | 167 | | mg/L | 5.6 | 40 | 19-MAR-15 |
| Magnesium (Mg) | | 1.39 | 1.30 | | mg/L | 6.5 | 40 | 19-MAR-15 |
| **WG2056499-2 IRM** | | **WT SAR1** | | | | | | |
| Calcium (Ca) | | | 84.2 | | % | | 70-130 | 19-MAR-15 |
| Sodium (Na) | | | 87.3 | | % | | 70-130 | 19-MAR-15 |
| Magnesium (Mg) | | | 82.8 | | % | | 70-130 | 19-MAR-15 |
| **WG2056499-1 MB** | | | | | | | | |
| Calcium (Ca) | | | <0.10 | | mg/L | | 0.1 | 19-MAR-15 |
| Sodium (Na) | | | <0.50 | | mg/L | | 0.5 | 19-MAR-15 |
| Magnesium (Mg) | | | <0.10 | | mg/L | | 0.1 | 19-MAR-15 |

# Quality Control Report

Workorder: L1588231 Report Date: 24-MAR-15

Client: SPL CONSULTANTS LIMITED
14 Ronell Cresent
Collingwood Ontario L9Y 4J7
Contact: Marco Visentin



**Legend:**

| | |
|---|---|
| Limit | ALS Control Limit (Data Quality Objectives) |
| DUP | Duplicate |
| RPD | Relative Percent Difference |
| N/A | Not Available |
| LCS | Laboratory Control Sample |
| SRM | Standard Reference Material |
| MS | Matrix Spike |
| MSD | Matrix Spike Duplicate |
| ADE | Average Desorption Efficiency |
| MB | Method Blank |
| IRM | Internal Reference Material |
| CRM | Certified Reference Material |
| CCV | Continuing Calibration Verification |
| CVS | Calibration Verification Standard |
| LCSD | Laboratory Control Sample Duplicate |

**Sample Parameter Qualifier Definitions:**

| Qualifier | Description |
|---|---|
| J | Duplicate results and limits are expressed in terms of absolute difference. |
| RPD-NA | Relative Percent Difference Not Available due to result(s) being less than detection limit. |

**Hold Time Exceedances:**

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

# Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here
(lab use only)

COC Number: 14 - 413128

Page 1 of 2

| Report To | | Report Format / Distribution | | Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests) | |
|---|---|---|---|---|---|
| Company: SPL Consultants Limited | | Select Report Format: ☒ PDF ☒ EXCEL ☐ EDD (DIGITAL) | | R ☒ | Regular (Standard TAT if received by 3pm) |
| Contact: Marco Visentin | | Quality Control (QC) Report with Report ☐ Yes ☐ No | | P ☐ | Priority (2-4 business days if received by 3pm) |
| Address: 14 Bonell Crescent Unit 1 Collingwood ON | | ☐ Criteria on Report - provide details below if box checked | | E ☐ | Emergency (1-2 business days if received by 3pm) |
| | | Select Distribution: ☒ EMAIL ☐ MAIL ☐ FAX | | E2 ☐ | Same day or weekend emergency if received by 10am – contact ALS for surcharge. |
| Phone: (705) 445-0064 | | Email 1 or Fax mvisentin@splconsultants.ca | | Specify Date Required for E2,E or P: | |
| | | Email 2 gjarvis@splconsultants.ca | | Analysis Request | |
| Invoice To Same as Report To ☐ Yes ☐ No | | Invoice Distribution | | Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below | |
| Copy of Invoice with Report ☐ Yes ☐ No | | Select Invoice Distribution: ☒ EMAIL ☐ MAIL ☐ FAX | | | |
| Company: | | Email 1 or Fax | | | |
| Contact: | | Email 2 accounts@splconsultants.ca | | | |
| Project Information | | Oil and Gas Required Fields (client use) | | | |
| ALS Quote #: | | Approver ID: | Cost Center: | | |
| Job #: 10001514 | | GL Account: | Routing Code: | | |
| PO / AFE: | | Activity Code: | | | |
| LSD: | | Location: | | | |
| ALS Lab Work Order # (lab use only): L1588231 NC 17-Mar-15 | | ALS Contact: | Sampler: | | |

| ALS Sample # (lab use only) | Sample Identification and/or Coordinates (This description will appear on the report) | Date (dd-mmm-yy) | Time (hh:mm) | Sample Type | Metals & Inorganics | OC Pesticides | Number of Containers |
|---|---|---|---|---|---|---|---|
| -1 | Dup 1 | 03/12/15 | AM | Soil | X | X | |
| -2 | Dup 2 | 03/13/15 | AM | | X | X | |
| -3 | BH1 TS | 03/12/15 | AM | | X | X | |
| -4 | BH1 SS2 | 03/12/15 | AM | | X | X | |
| -5 | BH21 TS | 03/10/15 | PM | | X | X | |
| -6 | BH21 SS2 | 03/10/15 | PM | | X | X | |
| -7 | BH3 TS | 03/12/15 | AM | | X | X | |
| -8 | BH3 SS2 | 03/12/15 | AM | | X | X | |
| -9 | BH9 TS | 03/12/15 | PM | | X | X | |
| -10 | BH9 SS2 | 03/12/15 | PM | | X | X | |
| -11 | BH11 TS | 03/13/15 | AM | | X | X | |
| -12 | BH11 SS2 | 03/13/15 | AM | | X | X | |

| Drinking Water (DW) Samples[1] (client use) | Special Instructions / Specify Criteria to add on report (client Use) |
|---|---|
| Are samples taken from a Regulated DW System? ☐ Yes ☒ No | |
| Are samples for human drinking water use? ☐ Yes ☒ No | |

SAMPLE CONDITION AS RECEIVED (lab use only)

| | | | | | |
|---|---|---|---|---|---|
| Frozen | ☐ | SIF Observations | Yes ☐ | No | ☒ |
| Ice packs | Yes ☒ | No ☐ | Custody seal intact | Yes ☐ | No ☐ |
| Cooling Initiated | ☐ | | | | |

| INITIAL COOLER TEMPERATURES °C | | | FINAL COOLER TEMPERATURES °C | | |
|---|---|---|---|---|---|
| 3.6 | | | | | |

| SHIPMENT RELEASE (client use) | | | INITIAL SHIPMENT RECEPTION (lab use only) | | | FINAL SHIPMENT RECEPTION (lab use only) | | |
|---|---|---|---|---|---|---|---|---|
| Released by: Nicole Collin | Date: Mar 16/15 | Time: 4:00pm | Received by: | Date: 17-Mar-15 | Time: 12:00 | Received by: | Date: | Time: |

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

ALS Environmental
www.alsglobal.com

# Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here (lab use only)

COC Number: 14 - 413129

Page 2 of 2

| Report To | | Report Format / Distribution | Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests) |
|---|---|---|---|
| Company: | SPL Consultants Limited | Select Report Format: ☐ PDF ☐ EXCEL ☐ EDD (DIGITAL) | R ☐ Regular (Standard TAT if received by 3pm) |
| Contact: | Marco Visentin | Quality Control (QC) Report with Report ☐ Yes ☐ No | P ☐ Priority (2-4 business days if received by 3pm) |
| Address: | 14 Ronell Crescent, Unit 1 Collingwood, ON | ☐ Criteria on Report - provide details below if box checked | E ☐ Emergency (1-2 business days if received by 3pm) |
| | | Select Distribution: ☐ EMAIL ☐ MAIL ☐ FAX | E2 ☐ Same day or weekend emergency if received by 10am – contact ALS for surcharge. |
| Phone: | (705) 445-0064 | Email 1 or Fax | Specify Date Required for E2,E or P: |
| | | Email 2 | |

| Invoice To | Same as Report To ☐ Yes ☐ No | Invoice Distribution | Analysis Request |
|---|---|---|---|
| | Copy of Invoice with Report ☐ Yes ☐ No | Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX | Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below |
| Company: | | Email 1 or Fax | |
| Contact: | | Email 2 | |

| Project Information | | Oil and Gas Required Fields (client use) | |
|---|---|---|---|
| ALS Quote #: | | Approver ID: | Cost Center: |
| Job #: | 10001514 | GL Account: | Routing Code: |
| PO / AFE: | | Activity Code: | |
| LSD: | | Location: | |
| ALS Lab Work Order # (lab use only) | L1588231 NC 17-Mar-15 | ALS Contact: | Sampler: |

| ALS Sample # (lab use only) | Sample Identification and/or Coordinates (This description will appear on the report) | Date (dd-mmm-yy) | Time (hh:mm) | Sample Type | Metals & Inorganics | OC Pesticides | Number of Containers |
|---|---|---|---|---|---|---|---|
| -13 | BH16 TS | 03/10/15 | PM | Soil | X | X | |
| -14 | BH16 SS2 | 03/10/15 | PM | " | X | X | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| Drinking Water (DW) Samples[1] (client use) | Special Instructions / Specify Criteria to add on report (client Use) |
|---|---|
| Are samples taken from a Regulated DW System? ☐ Yes ☒ No | |
| Are samples for human drinking water use? ☐ Yes ☒ No | |

SAMPLE CONDITION AS RECEIVED (lab use only)

| Frozen | ☐ | SIF Observations | Yes ☐ | No ☒ |
|---|---|---|---|---|
| Ice packs | Yes ☒ | No ☐ | Custody seal intact | Yes ☐ | No ☐ |
| Cooling Initiated | ☐ | | | |

| INITIAL COOLER TEMPERATURES °C | | | FINAL COOLER TEMPERATURES °C | | |
|---|---|---|---|---|---|
| 3.6 | | | | | |

| SHIPMENT RELEASE (client use) | | | INITIAL SHIPMENT RECEPTION (lab use only) | | | FINAL SHIPMENT RECEPTION (lab use only) | | |
|---|---|---|---|---|---|---|---|---|
| Released by: | Date: | Time: | Received by: | Date: | Time: | Received by: | Date: | Time: |
| Nicole Collins | Mar 16/15 | 4:00pm | M. Lang | 17-Mar-15 | 12:00 | | | |

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

ALS FM-0326v.08 Form03 October 2013

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.