Geotechnical Investigation & Slope Stability Study - Lot 3 Indacom Drive, Douro-Dummer

2021-10-22

Prepared for:
The Township of Douro-Dummer

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1.0 Introduction

Cambium Inc. (Cambium) was retained by The Township of Douro-Dummer (Client) to complete a geotechnical investigation and slope stability study in support of the proposed severance, and future development, of Lot 3, located immediately southeast of the intersection of Indacom Drive and County Road 4, in the township of Douro-Dummer. It is understood that considerable amounts of fill, sourced from municipal ditching programs, have been placed at the site without any form of compaction or inspection for organics or other deleterious material.

No current development plan is formed, and the purpose of the investigation is to provide foundation design recommendations and erosion hazard setbacks.

This report presents the methodology and findings of the geotechnical investigation at the Site and addresses requirements and constraints for the design and construction of the subdivision.

2.0 Methodology

2.1 Field Investigation

A borehole investigation was conducted on September 24th, 2021, to assess subsurface conditions at the Site. Eight (8) boreholes, designated as BH101-21 through BH108-21 were advanced at the Site. All boreholes were advanced to a minimum of 6 m below existing grade (mbeg), extending a minimum of 1.5 m into compact to dense native soils underlying loose fill material above. All boreholes were advanced adjacent for the purposes of the geotechnical investigation and slope stability study.

The location of the boreholes was measured in the field and the UTM coordinates of each borehole were obtained using an RTK unit. The elevation of the boreholes was surveyed relative to site specific benchmark. The borehole and benchmark locations are shown on Figure 1.

Drilling and sampling was completed using a track-mounted drill rig, under the supervision of a Cambium technician. The boreholes were advanced to the pre-determined depths by means of continuous flight solid stem augers with 50 mm O.D. split spoon samplers. Standard Penetration Test (SPT) N values were recorded for the sampled intervals as the number of blows required to drive a split spoon (SS) sampler 305 mm into the soil using a 63.5 kg drop hammer falling 750 mm, as per ASTM D1586 procedures. The SPT N values are used in this report to assess consistency of cohesive soils and relative density of non-cohesive materials. Soil samples were collected at 0.75 m intervals from 0 mbeg to 3 mbeg and 1.5 m intervals at depths greater than 3.0 mbeg. The encountered soil units were logged in the field using visual and tactile methods, and samples were placed in labelled plastic bags for transport, future reference, possible laboratory testing, and storage. Open boreholes were checked for groundwater and general stability prior to backfilling. All boreholes were backfilled and sealed in accordance with Ontario Regulation (O.Reg.) 903.

Borehole logs are provided in Appendix A. Site soil and groundwater conditions are described, and geotechnical recommendations are discussed in the following sections of this report.

2.2 Physical Laboratory Testing

Physical laboratory testing, including six (6) particle size distribution analyses (LS-702,705), was completed on selected soil samples to confirm textural classification and to assess geotechnical parameters. Moisture content testing (LS-701) was completed on all retrieved soil samples. Results are presented in Appendix B and are discussed in subsequent sections of this report.

3.0 Subsurface Conditions

Subsurface conditions are such that variable fill material is consistently overlying native material throughout the site. The fill material ranges from silt to gravel, varies lithologically both vertically and laterally, and contains organic matter at variable depths in each borehole. The fill material was moist at the time of completion and found to have a very loose to loose relative density. Native gravelly sand and “sand and silt” was encountered at depths ranging from 3 mbeg to 5.5 mbeg in all boreholes. The native material was found to be moist at the time of the investigation and exhibits a dense to very dense relative density. No groundwater or bedrock was encountered within the limits of the investigation.

The individual soil units are described in detail below and shown on the test pit logs provided in Appendix A.

3.1 Fill

Light brown to brown fill ranging in composition from silt to sandy gravel was encountered at surface in all boreholes. Organics in the form of roots, rootlets, and wood chips and chunks were commonly found in the upper 0.7 m in each borehole but were also found at depths of 2.1 mbeg in boreholes BH101-21, BH104-21, and BH105-21, and at depths of 5 mbeg and 3 mbeg in boreholes BH 105-21 and BH106-21 respectively. Unless organics were separated from inorganic soils during the ditching programs, it is likely that some organics are present throughout the fill, but it is difficult to determine the overall amount.

Fill thickness ranged from 3 m in borehole BH107-21 and 4 m in borehole BH106-21 to 5.5m in all other boreholes. All fill encountered was found to be moist, to slightly wet, at the time of the investigation. Based on SPT N values of 3 to 7, the fill was found to have a very loose to loose relative density.

Laboratory particle size distribution analyses were completed on three (3) samples of the fill material taken from the boreholes and depths described in Table 1. The soil samples and analysis results are based on the Unified Soil Classification System (USCS) scale, with full results provided in Appendix B.

Table 1 Particle Size Distribution Analysis

BH	Depth (mbeg)	Material	Description	% Gravel	% Sand	% Silt	% Clay	% Moisture Content
BH101-21 SS4	2.3 – 2.7	Fill	Silty Sand some Gravel some Clay	15	43	30	12	13.9
BH 101-21 SS7	6.1 – 6.6	Native	Sand and Silt some Gravel	14	43	43		6.1
BH 102-21 SS2	0.8 – 1.2	Fill	Gravelly Silty Sand	27	41	25	7	7.1
BH 103-21 GS7	6.1 – 6.6	Native	Gravelly Silty Sand	29	44	27		5.3
BH 104-21 GS3	1.5 - 2	Fill	Sandy Silty Gravel	35	31	26	8	9.2
BH 105-21 GS7	6.1 – 6.6	Native	Sand and Silt	4	44	52		10

3.2 Native Material

Native light brown to brown gravelly sand, and “sand and silt” soil was encountered immediately below the fill, extending to termination depth in each borehole. Sand and silt with trace to some gravel was encountered in boreholes BH101-21, BH102-21, and BH105-21, whereas gravelly silty sand to gravelly sand with some silt was encountered in all other boreholes. The native material encountered within the extents of this investigation was found to be moist at the time of investigation. SPT N values ranging from 24 to much greater than 50, provide evidence of soil with a generally dense to very dense relative density.

Laboratory particle size distribution analyses were completed on three (4) samples of the native material taken from the boreholes and depths described in Table 1. The soil samples and analysis results are based on the Unified Soil Classification System (USCS) scale, with full results provided in Appendix B.

3.3 Bedrock

Bedrock was not encountered within the depths of this investigation.

3.4 Groundwater

Groundwater was not encountered within the depths and limits of this investigation.

It should be noted that groundwater levels at the site may fluctuate seasonally and in response to climatic events.

4.0 Geotechnical Considerations

The following recommendations are based on the test pit information and are intended to assist designers. Recommendations should not be construed as providing instructions to contractors, who should form their own opinions about site conditions. It is possible that subsurface conditions beyond the test pit locations may vary from those observed. If significant variations are found before or during construction, Cambium should be contacted so that we can reassess our findings, if necessary.

4.1 Site Preparation

Any and all surficial vegetation and organic soils, including topsoil, should be removed from beneath the proposed structures, roadways, and utilities. The exposed subgrade should be proof-rolled and inspected by qualified geotechnical engineering personnel prior to the placement of any fill or bedding material. Any loose/soft soils identified at the time of proof-rolling that are unable to be uniformly compacted should be sub-excavated and removed. The excavations created through the removal of these materials should be backfilled with approved engineered fill consistent with the recommendations provided below.

4.2 Frost Penetration

Based on climate data and design charts, the frost penetration depth below the pavement at the site is estimated at 1.2 m.

It is assumed that the pavement structure thickness will be less than 1.2 m, so grading and drainage are important for good pavement performance and life expectancy. Any services/utilities should be located below this depth or be appropriately insulated.

4.3 Excavations and Shoring

All excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA). The generally very loose to loose fill material found in the upper 3 m to 5.5 m of the site may be classified as Type 4 soils in accordance with OHSA and may be excavated with unsupported side slopes no steeper than 3H:1V. Dense native soils

may be considered Type 2 soils and may be excavated with vertical slopes to a depth of 1.2 m, below which unsupported side slopes should be no steeper than 1H:1V. Test excavations should be carried out at the time of construction to assess the soil integrity and water levels to determine any shoring requirements.

Excavation side slopes should be protected from exposure to precipitation and associated ground surface runoff and should be inspected regularly for signs of instability. If localized instability is noted during excavation or if wet conditions are encountered, the side slopes should be flattened as required to maintain safe working conditions or the excavation sidewalls must be fully supported (shored).

4.4 Dewatering

Based on the absence of groundwater through the investigation, significant groundwater seepage is not anticipated within the excavation depths. Any seepage within the excavation depths should be controllable with filtered sumps and pumps and a Permit to Take Water (PTTW) or registry in the Environmental Activity and Sector Registry for the Ministry of the Environment, Conservation, and Parks (MOECP) will not be required.

It should be noted that the groundwater table is influenced by seasonal fluctuations and major precipitation events

4.5 Backfill and Compaction

Excavated topsoil from the Site is not appropriate for use as fill below grading, roadways and parking areas. Excavated fill, and imported fill, not containing organics or any other deleterious material, may be appropriate for use as engineered fill, provided that the actual or adjusted moisture content at the time of construction is within a range that permits compaction to required densities. Some moisture content adjustments may be required depending upon seasonal conditions. Geotechnical inspections and testing of engineered fill are required to confirm acceptable quality.

Any engineered fill below foundations should be placed in lifts appropriate to the type of compaction equipment used on site and be compacted to a minimum of 100% of standard

Proctor maximum dry density (SPMDD), as confirmed by nuclear densometer testing. If native soils from the site are not used as engineered fill, imported material for engineered fill should consist of clean, non-organic soils, free of chemical contamination or deleterious material. The moisture content of the engineered fill will need to be close enough to optimum at the time of placement to allow for adequate compaction.

Foundation wall and any buried utility backfill material should consist of free-draining imported granular material. Most of the native site soils are too fine-grained to provide proper drainage, and as such this should be accomplished using well graded Granular B Type 1 material complying with OPSS 1010. The fill should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95 SPMDD, taking care not to damage any utility pipes during compaction.

The backfill material, if any, in the upper 300 mm below the pavement subgrade elevation should be compacted to 100 percent of SPMDD in all areas.

4.6 Foundation Design

It is understood that there are no current plans for the property and that general recommendations are required for a potential purchaser of the land. As such, Cambium recommends several options for foundation design, none of which are conventional by nature; this is simply because fill was not properly compacted when placed on site and organics are commonly found throughout the fill. Except for the helical pile option, design of the other foundation systems would require additional test pits to be completed at the site to determine the overall percentage of the fill that is organic.

4.6.1 Helical Piles

Founding structures on grade beams, supported by helical piles extending to dense native soils at depth is an effective foundation option. Helical piles can be used to achieve both uplift and compressive resistance. If helical piles are to be considered, the helix portion of the helical pile should be installed within competent native soil. This would require the installation of large capacity helical piles to depth of up to 5 mbeg to 10 mbeg, depending on location within the

property in order to encounter soils competent enough to provide adequate torque during installation. In areas closer to the road where competent native soils are founded at shallower depths, if any, it is suggested that the helix of the piles should be embedded at a minimum depth of 1.5 m, in order to provide sufficient resistance against potential freezing stresses. Grade beams should be placed a minimum of 1.5 mbeg or be properly insulated. Floor slabs may be placed as identified in Section 4.7.

The helical pile systems are typically proprietary, designed and installed by the specialized contractor / supplier. The piles are installed to a specified torque, measured with equipment at the ground surface. In order to verify that the piles are installed in accordance with design assumptions, monitoring of the pile installations by an experienced inspector is recommended. The monitoring should include measuring and recording of the torque used in the pile installation.

4.6.2 Legalett Geo-Slab Frost Protected Shallow Foundation

Another foundation option is the Geo-Slab design by Legalett (or equivalent). This method and design incorporate a shallow engineered structural concrete slab with reinforcing steel and a thick system of high-density rigid polystyrene to provide support and insulation for the structure. The Geo-Slab design distributes the loadings to the extent that the overall building loads on the soils can often be brought down to 35 kPa or less. At these loadings, existing site soils, including fill, below the surficial topsoil would be sufficient to support the building loads.

In this scenario a specialty design firm such as Legalett should be contacted to design the structural slab.

4.6.3 Ground Improvement

Conventional footings may be employed only if the ground is substantially improved at the Site. There are several methods by which the ground may be improved, including but not limited to:

- Removal of existing fill and replacement in compacted lifts, as outlined in Section 4.5
- Rapid Impact Compaction

- Rammed Aggregate Pier Systems
- Rigid Inclusion Systems

For any of these options, care should be taken to ensure the slope is adequately stabilized or equipment is not utilized near the unstabilized slope, as vibrations resulting from several of the ground improvement methods, may trigger failures in the unstabilized slope.

Cambium would be pleased to meet with the Client to further discuss a planned course of action. Design-build companies such as Geosolv would be pleased to provide quotes for use of their proprietary technologies.

4.7 Floor Slabs

Inorganic native soils at the site are considered competent to support floor slab loads, provided local organic contend is negligible. To create a stable working surface and to distribute loadings, shallow floor slabs should be constructed on a minimum of 300 mm of OPSS Granular A, compacted as outlined in section 4.5. Basement floor slabs should be constructed on a 300 mm thick base of OPSS Granular A, compacted as outlined in section 4.5.

4.8 Lateral Earth Pressures

Lateral earth pressure coefficients (K) for foundation and retaining wall design are provided below. It is assumed that potential lateral loads will result from cohesionless, frictional materials, such as well-drained granular backfill.

Ko (at rest)	0.42
Ka (active)	0.27
Kp (passive)	3.7

The following formula may be used to calculate active lateral thrust (Pa) on yielding retaining structures;

$$Pa = (H/2)(Ka)(\gamma H + 2q)$$

where,

H = Height of retaining structure (m)

γ= unit weight of retained soil (kN/m^3)

q = surcharge (kPa)

A unit weight of 22 kN/m^3 should be assumed for compacted granular backfill loadings.

Soil parameters for existing soils are presented in Section 5.5.

4.9 Buried Utilities

All utilities should be places at a minimum depth of 1.5mbeg in order to prevent damage due to frost or be adequately insulated. Where required, trench excavations should generally consider Type 4 soil conditions which allow for excavation side slopes no steeper than 3H:1V.

Bedding and cover material for any services should consist of OPSS 1010-3 Granular A or B Type II, placed in accordance with pertinent Ontario Provincial Standard Drawings (OPSD 802.013). The bedding and cover material shall be placed in maximum 200 mm thick lifts and should be compacted to at least 98 percent of SPMDD. The cover material shall be a minimum of 300 mm over the top of the pipe and compacted to 98 percent SPMDD, taking care not to damage the utility pipes during compaction.

4.10 Design Review and Inspections

Test excavations should be advanced at the site of each home or building, prior to construction, in order to compare findings to those observed in this report. Should soil or groundwater conditions change drastically from this report, a qualified geotechnical engineer should be consulted.

Testing and inspections should be carried out during construction operations to examine and approve subgrade conditions, placement and compaction of fill materials, and dewatering requirements. Concrete used during construction should also be tested for slump, air entrainment and compressive strength.

We should be contacted to review and approve design drawings, prior to tendering or commencing construction, to ensure that all pertinent geotechnical-related factors have been addressed. It is important that onsite geotechnical supervision be provided at this site for

excavation and backfill procedures, deleterious soil removal, subgrade inspections and compaction and concrete testing.

5.0 Slope Stability

As requested, a Cambium representative was on site on September 14th, 2021, to conduct a slope stability assessment. It is understood the work was required to determine the erosion hazard limit for the slopes on the southwest side of the lot, and on the northeast side of Indacom Drive located near borehole BH101-21, based on the Ontario Ministry of Natural Resources and Forestry (MNRF) "Geotechnical Principles For Stable Slopes" (June 1998). It is understood that the Client proposes to sever this portion of the land with the intention to sell for development.

To complete the analysis, a visual assessment of the slope was conducted, along with boreholes, surveying of the slope, and a preliminary engineering study.

5.1 Field Investigation

The field investigation that was completed on September 14th, 2021, included a visual assessment of the site and a survey of the slope in question. The borehole investigation was completed on September 24th, 2021 and is summarized in Section 2, with results presented in Section 3 and Appendix A and Appendix B.

5.2 Slope Inspection Record

The characteristics of the slope were assessed following Table 4.1: Slope Inspection Record, of the Technical Guide, which is provided in Appendix C. The Site is currently vacant and with a locked gate at the entrance to the property from Indacom Drive, near County Road 4. Most of the lot is relatively level, table flat land, with an approximate 2% grade to the top of the slope. The surface of the site ranged from sandy silt to gravel and cobbles in areas. Weeds are common over much of the lot and other organic debris in the form of pieces of roots and branches introduced to the site frequent the surface of the lot as well as the surface of the slope. The lot and slope are void of trees and shrubs, whereas mature trees are situated at the base of the slope.

The slope adjacent to borehole BH101-21, at the bend in Indacom Drive, is characterized by a 6 m to 7 m high slope with inclination steeper than one horizontal to one vertical (1H:1V) in places. The slope along the east side of the lot is approximately 10 m to 11 m in height with an average inclination of 1.5H:1V, with some areas slightly steeper than this. There was no apparent watercourse within 15 m of the base of the slope. A large recent full slope failure exists on the northeast end of the slope and many rills and small cullies are evident within the mainly bare slope face. Many of these features are evident in the cross sections presented in Appendix D and site photographs in Appendix E.

Based on the borehole investigation, Ontario Well Records, physiographic mapping and visual assessments of the Site, the soil stratigraphy consists of a relatively thick, 3m to 6 m, stratum of variable loose fill material overlying native gravelly sands ice-contact stratified deposits and sand and silt glacial till deposits; the site inspection confirmed this. Additionally, frequent organic debris was present throughout the entire column of fill material.

5.3 Slope Stability Rating Chart

The slope at the Site is defined as the inclination that extends from the table land flat above to the base of the fill extending into the mature trees below. The stability of the slope was assessed on-site following Table 4.2: Slope Stability Rating Chart, of the Technical Guide. As per the appended Slope Stability Rating Chart provided in Appendix C, the total ratings value sums to 56 for the slope. This deems that the slope has a moderate potential for instability. Specific items of interest that contribute to this rating are outlined below:

1. Slope Inclination – The surface of the slope was determined to have an inclination greater than 2H:1V, giving a rating of 16.
2. Soil Stratigraphy –The slope consists almost entirely of fill material, giving a rating of 16.
3. Seepage from Slope Face – At the time of the investigation, there was no seepage, or sign of seepage, from the slope face, giving a rating of 0.
4. Slope Height – The slope height for the site was greater than 10 m, resulting in a rating of 8.

5. Vegetation Cover on Slope Face – The slope was relatively bare in general, giving a rating of 8.
6. Table Land Drainage – The table land was relatively flat, with very minor drainage over the slope to the east, giving a rating of 2.
7. Proximity of Watercourse to Slope Toe – No apparent watercourse was present within 15 m of the base of the slope, and therefore the site carries a rating of 0.
8. Previous Landslide Activity – A recent, large, full-slope failure was present on the NE end of the slope, giving a rating of 6.

Many of these properties are easily visible in the site photographs found in Appendix E.

A slope with moderate potential for instability requires an investigation that includes boreholes, a monitoring well, surveying, and engineering analysis to determine the Factor of Safety (FOS) for the Site. Due to the absence of water present within the extent of the boreholes, monitoring wells were not installed. All other report parameters for a slope with moderate potential have been completed, including a slope inspection record, surveying of the slope, boreholes, engineering analysis, site photographs documenting the existing condition, and a discussion of the site investigation in a detailed report.

5.4 Toe Erosion Allowance

Based on the lack of a watercourse near the base of the slope, there is not anticipated to be any toe erosion at this site.

5.5 Stable slope allowance

The stable slope allowance is defined by the Technical Guide as a slope no steeper than 3H:1V or as determined by a study using accepted geotechnical principles.

For the purpose of this study, due to the moderate potential for instability assessed through the slope rating chart, stability analyses were carried out to assess the Factor of Safety (FOS) against slope failure. The slope was assessed in its current state and found to have an insufficient FOS, and therefore an unstable slope. Subsequent stability analyses were

carried out, in order to determine the minimum stable slope allowance and associated FOS for a spread load of 150 kPa placed at a depth of 1.5 m below ground surface and 6 m landward of the top of designed stable slope, to account for the erosion access allowance.

Slope stability analyses were performed using Slope/W, an industry standard two-dimensional limit equilibrium slope modelling program. Inputs required for the Slope/W program include soil stratigraphy and geotechnical design parameters are discussed in the subsequent section.

Based on the results of a desktop review and findings of the geotechnical investigations, the geotechnical parameters used to evaluate the stability of the slope are presented in Table 2. Effective stress strength parameters were based on published laboratory test results and in situ testing correlations.

Table 2 Parameters for Stability Analyses

Lithological Unit	**Unit Weight**	**Peak Effective Strength Parameters**	
	(kN/m^2)	C' (kPa)	(ϕ')
Loose Sandy Silt Fill	17.5	0	27^o
Loose Gravelly Sand Fill	19	0	29
Loose Silty Sand Fill	18	0	28
Dense Native Sand and Silt	21	0	32
Dense Native Gravelly Sand	22	0	34

The modelling cases used in the stability evaluation are presented in Table 3 and illustrations from each case are provided in Appendix D.

In general, where subsurface information was limited, engineering judgement was used to infer subsurface conditions.

Table 3 Stability Loading Cases and Results

Case	FOS
Existing conditions slope A-A'	<1
Existing conditions slope B-B'	<1
Slope A-A' with reshaped 2.7H:1V gradient, 150 kPa loads keyed in to 1.2mbeg, 6m back of slope	1.49
Slope B-B' with reshaped 2.7H:1V gradient, 150 kPa loads keyed in to 1.2mbeg, 6m back of slope	1.51

It should be note that Section C-C' had similar results to Sections A-A' and B-B', and as such only results from A-A' and B-B' are shown.

Based on engineering analysis it was clear that the existing slopes are unstable in their current state, however reshaped 2.7H:1V slopes provide a FOS of 1.5 and are considered stable, even under loads of the proposed structures, provided they are keyed in to at least 1.2 mbeg or founded at greater depths.

As such the designed slopes are considered stable at an inclination of 2.7H:1V. With slope heights of 6.8 m and 11.2 m in Sections A-A' and B-B', this translates to a stable slope allowance of 18.4 m and 30.3 m, respectively, based on results of the engineering study. Cambium recommends that a stable slope allowance equivalent to 2.7 time the height of the slope be applied to the entire slope.

Resultingly, the top of stable slope can be defined as the 2.7 times the height of the slope, measured horizontally from the base of the. This value ranges from approximately 19 m near borehole BH101-21, to 30 m near BH103-21, reducing back to 20 m near BH105-21 and is illustrated in Figure 1.

5.6 Erosion Access Allowance

The erosion access allowance is the last component used to determine the landward limit of the erosion hazards. This allowance is used to provide emergency access to erosion prone areas, construction access, and protection against unforeseen conditions, which could have an adverse effect on the natural condition of the slope. The Technical Guide suggests an erosion access allowance of 6 m. Due to the significant height of the slope and the current instability

of the slope, Cambium agrees with this value and recommends that an erosion access allowance of 6 m be applied to both slopes on this Site.

5.7 Erosion Hazard Limit

The erosion hazard limit is the sum of the horizontal components of each of:

- Toe Erosion Allowance (TEA)
- Stable Slope Allowance (SSA)
- Erosion Access Allowance (ESA)

The erosion hazard limit is often used in conservation policy to establish setbacks from slopes, at which development may occur without being negatively affected by the slope.

The erosion hazard limit is illustrated in Figure 1 as a 6 m setback from the top of stable slope, which ranges from 25 m to 36 m horizontally from the base of the slope.

5.8 Geotechnical Discussion

Based on the compact to dense sandy soils on Site, low ground water, and results of engineering analysis, it is apparent that structures landward of the erosion hazard limit will have no impact on the integrity of the slope and similarly, that the slope will pose no threat to the stability of the structure constructed landward of the erosion hazard limit. Notwithstanding, no major structures should be constructed within the erosion hazard limit.

5.8.1 Slope Stabilization

In order to reduce the setback distance of the erosion hazard, slope stabilization methods may be employed. A simple, yet rather large retaining wall may be constructed to retain and stabilize the fill material. Alternately several proprietary stabilization options are also available including:

- Geosolv’s Geopier SRT system, whereby vertical plates are installed throughout the slope

- A geogrid reinforced slope using TerraSlope 45, a Terrafix product that can stabilize slopes at up to 1H:1V.

Cambium would be pleased to meet with the Client to further discuss a planned course of action. Design-build companies such as Geosolv would be pleased to provide quotes for use of their proprietary technologies.

It should be noted that despite employment of stabilization methods, ORCA may not allow encroachment into the originally defined erosion hazard limit. This matter should be addressed with ORCA prior to proceeding with any stabilization efforts.

5.9 Erosion Control

During construction, care should be taken to retain as much of the vegetation on the slope as possible and erosion control measures should be put in place to maintain the stable slope, including revegetation of the slope if any bushes and trees are removed, or in areas where vegetation is presently sparse. Care should also be taken to ensure that there is no concentration of runoff down the slope from downspouts or regrading of the site.

6.0 Closing

We trust the information in this report is sufficient for your current needs. If you have questions or comments regarding this document, please do not hesitate to contact Mr. Baird or Mr. Peterkin at (705) 742-7900 ext. 332 or 301.

Respectfully submitted,

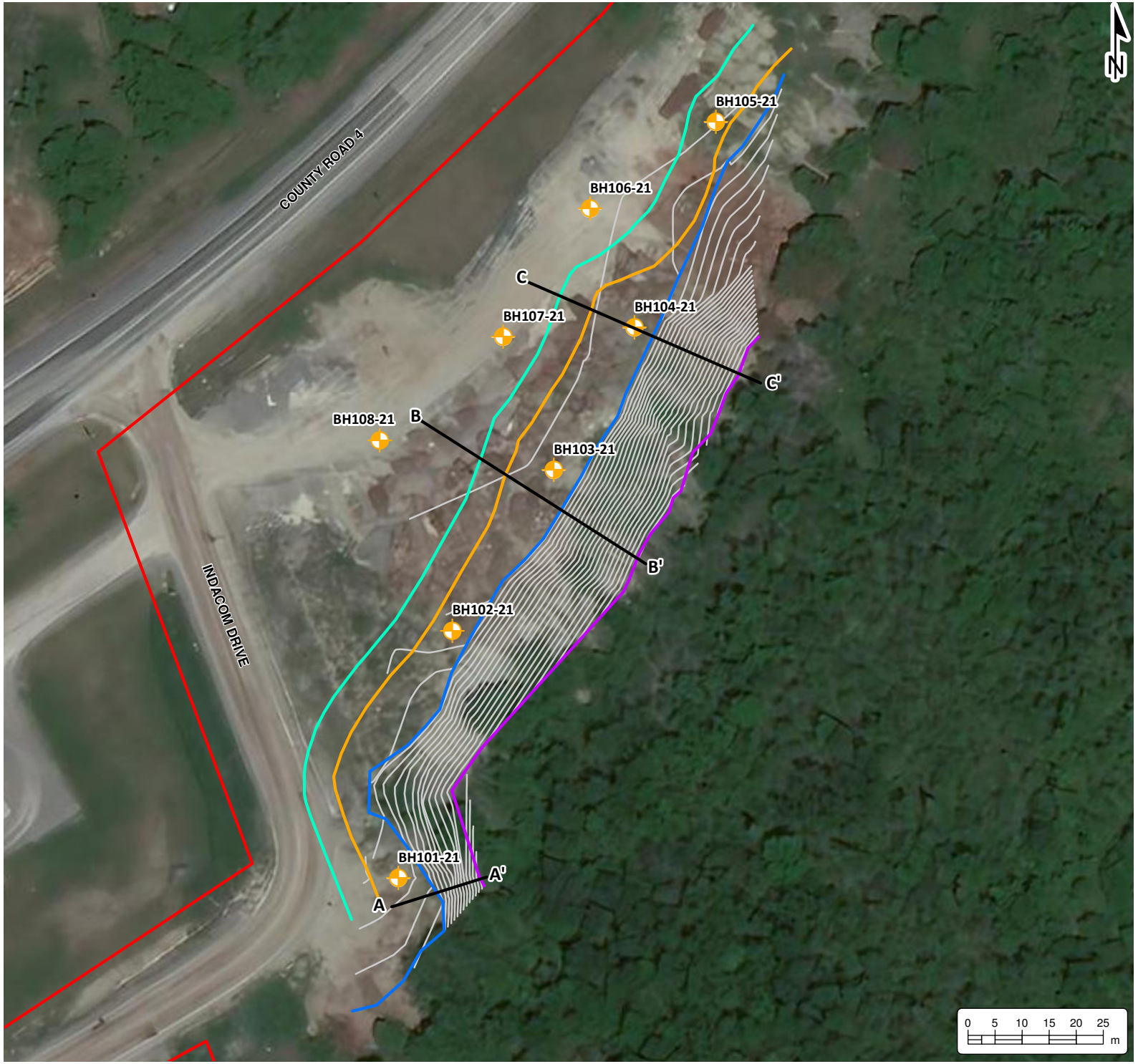
Cambium Inc.

Stuart Baird, M.Eng., P.Eng.
Director – Geotechnical & Construction Monitoring

Brian Peterkin, M.Eng., P.Geo.
Senior Project Manager

SEB/BP
P:\13400 to 13499\13455-001 TWP of Douro-Dummer - GEO - Hwy 28 & CR 4 Severances\Deliverables\2021-10-22 RPT Geotech - Lot 3 Indacom Drive Douro-Dummer .docx

Appended Figures



SLOPE STABILITY STUDY

MUNICIPALITY OF DOURO-DUMMER

Indacom Drive

Douro-Dummer, Ontario

LEGEND

- Borehole
- Topographic Contour
- Erosion Hazard Limit
- Top of Stable Slope
- Top of Existing Slope
- Bottom of Slope
- Cross-Section Location
- Site (approximate)

Notes:

- Base mapping features are © Queen's Printer of Ontario, 2019 (this does not constitute an endorsement by the Ministry of Natural Resources or the Ontario Government).
- Distances on this plan are in metres and can be converted to feet by dividing by 0.3048.
- Cambium Inc. makes every effort to ensure this map is free from errors but cannot be held responsible for any damages due to error or omissions. This map should not be used for navigation or legal purposes. It is intended for general reference use only.

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SITE PLAN

Project No.: 13455-001		Date: September 2021	Rev.:
Scale: 1:1,000		Projection: NAD 1983 UTM Zone 17N	
Created by: TLC	Checked by: BP	Figure: 1	

O:\GIS\MXDs\13400-13499\13455-001 TWP of Douro-Dummer - GEO - Hwy 28 & CR 4 Severances\2021-09-24 FIG 1 - Site Plan.mxd

Appendix A
Borehole Logs

Peterborough
Barrie
Oshawa
Kingston
T: 866-217-7900
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Log of Borehole: BH101-21

Client: TWP of Douro-Dummer
Project Name: Hwy 28 & CR 4 Severances
Project No.: 13455-001
Contractor: Canadian Environmental
Method: Solid Stem Auger
Date Completed: September 24, 2021
Location: Highway 28 and County Road 4, Douro-Dummer, ON
UTM: 17T 721326.047 m E, 4916893.12 m N
Elevation: 105.242 masl

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
105 / 0		SILT: Brown, silt, some sand, some gravel, wet, loose	1A 1B	SS SS	40	9				
		SILTY SAND: Brown, silty sand, some gravel, moist, loose								
104 / 1		GRAVELLY SAND: Brown, gravelly silty sand, trace clay, trace rootlets, moist to wet, very loose	2	SS	60	3				Borehole open and dry upon completion
		SILTY SAND: Brown, silty sand, some gravel, some clay, trace rootlets, moist to wet, very loose	3	SS	60	3				
103 / 2		-no organics	4	SS	70	4				SS4 GSA: 15% gravel 43% sand 30% silt 12% clay
102 / 3		-becomes loose	5	SS	40	5				
101 / 4		SANDY SILT: Brown, sandy silt, some gravel, moist to wet, loose	6	SS	30	7				Cobble present from this point and on
100 / 5		SAND AND SILT: Light brown, sand and silt, some gravel, moist, dense	7	SS	70	36				SS7 GSA: 14% gravel 43% sand 43% silt & clay
99 / 6										
98 / 7										
97 / 8		-becomes very dense	8	SS	50	50/ 400				
		Borehole terminated at 8.08 mbgs in sand and silt								

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Input By: J. Riseling

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Log of Borehole: BH102-21

Client:	TWP of Douro-Dummer	**Project Name:**	Hwy 28 & CR 4 Severances	**Project No.:**	13455-001
Contractor:	Canadian Environmental	**Method:**	Solid Stem Auger	**Date Completed:**	September 24, 2021
Location:	Highway 28 and County Road 4, Douro-Dummer, ON	**UTM:**	17T 721335.991 m E, 4916938.873 m N	**Elevation:**	106.918 masl

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
107 / 0		SILTY SAND: Brown, silty sand, some gravel, some organics, moist, loose	1A	SS	60	7				
			~~1B~~	~~SS~~						
		SANDY SILT: Light brown, sandy silt, trace gravel, moist, loose								
106 / 1		GRAVELLY SAND: Brown, gravelly silty sand, trace clay, moist, compact	2	SS	60	29				SS2 GSA: 27% gravel 41% sand 25% silt 7% clay
		SANDY SILT: Brown, sandy silt, trace gravel, trace clay, moist, very loose	3	SS	30	3				
105 / 2		SAND AND GRAVEL: Brown/grey, sand and gravel, trace silt, moist, loose	4	SS	10	8				
104 / 3		SILTY SAND: Brown, silty sand, some gravel, saturated, very loose	5	SS	10	3				Ground water first encountered at 3.35 mbgs
103 / 4		SAND AND SILT: Light brown, sand and silt, some gravel, wet, very loose	6	SS	50	3				Borehole open and no noticeable water level on completion
102 / 5										
101 / 6		SAND AND SILT: Brown/grey, sand and silt, some gravel, moist to wet, dense	7	SS	50	39				
100 / 7		-becomes very dense	8	SS	50	50/375				
		Borehole terminated at 7.01 mbgs in sand and silt								
99 / 8										

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Log of Borehole: BH103-21

Client: TWP of Douro-Dummer
Project Name: Hwy 28 & CR 4 Severances
Project No.: 13455-001
Contractor: Canadian Environmental
Method: Solid Stem Auger
Date Completed: September 24, 2021
Location: Highway 28 and County Road 4, Douro-Dummer, ON
UTM: 17T 721354.736 m E, 4916968.566 m N
Elevation: 107.426 masl

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
107 / 0		SILT: Dark brown, silt, trace gravel, trace organics (wood chips and rootlets), moist, loose	1	SS	60	7				
106 / 1		GRAVELLY SAND: Brown, gravelly silty sand, trace clay, moist, compact	2	SS	70	22				
		-becomes loose	3	SS	30	7				
105 / 2		SANDY SILT: Light brown, sandy silt, trace gravel, moist, loose	4	SS	50	5				Borehole open and dry upon completion
104 / 3		-some gravel, loose	5	SS	30	5				
103 / 4										
102 / 5			6	SS	30	8				
101 / 6		GRAVELLY SAND: Brown/grey, gravelly silty sand, moist, very dense	7	SS	50	60				SS7 GSA: 29% gravel 44% sand 27% silt & clay
100 / 7			8	SS	50	50/400				
99 / 8		Borehole terminated at 7.01 mbgs in gravelly silty sand								

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Input By: J. Riseling

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Log of Borehole: BH104-21

Client:	TWP of Douro-Dummer	**Project Name:**	Hwy 28 & CR 4 Severances	**Project No.:**	13455-001
Contractor:	Canadian Environmental	**Method:**	Solid Stem Auger	**Date Completed:**	September 24, 2021
Location:	Highway 28 and County Road 4, Douro-Dummer, ON	**UTM:**	17T 721369.619 m E, 4916994.876 m N	**Elevation:**	107.359 masl

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
107 / 0		SILT: Brown, silt, some gravel, trace sand, trace organics (roots and leaves), moist, compact	1	SS	25	24				
106 / 1		GRAVELLY SAND: Light brown, gravelly silty sand, trace clay, moist, loose	2	SS	75	5				
105 / 2		SANDY GRAVEL: Dark brown, sandy silty gravel, trace clay, some organics (pieces of rotted tree), moist, loose	3	SS	50	4				SS3 GSA: 35% gravel 31% sand 26% silt 8% clay
104 / 3		SANDY SILT: Brown, sandy silt, some gravel, moist, loose	4	SS	20	6				
103 / 4		SILT: Light brown, silt, some sand, some gravel, moist to wet, loose	5	SS	50	4				
102 / 5		SANDY SILT: Brown, sandy silt, some gravel, moist to wet, compact	6	SS	40	10				Borehole open and dry upon completion
101 / 6		GRAVELLY SAND: Brown, gravelly silty sand, moist, very dense	7	SS	60	51				
100 / 7		Borehole terminated at 7.01 mbgs in gravelly silty sand	8	SS	50	50/375				
99 / 8										

Logged By: J. Riseling **Input By:** J. Riseling

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Log of Borehole: BH105-21

Client: TWP of Douro-Dummer
Project Name: Hwy 28 & CR 4 Severances
Project No.: 13455-001
Contractor: Canadian Environmental
Method: Solid Stem Auger
Date Completed: September 24, 2021
Location: Highway 28 and County Road 4, Douro-Dummer, ON
UTM: 17T 721384.603 m E, 4917032.866 m N
Elevation: 107.603 masl

Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
107 / 0		SILT: Dark brown, silt, some sand, trace organics (rootlets and leaves), moist to wet, very dense	1	SS	45	54				
107 / 1		SILTY SAND: Light brown, silty sand, some gravel, trace clay, moist, loose	2	SS	25	7				
106 / 2		SILT AND SAND: Light brown, silt and sand, some gravel, trace clay, moist, loose	3	SS	45	6				
105 / 3		SILT: Dark brown, silt, some sand, trace gravel, moist, loose	4	SS	20	4				Borehole open and dry upon completion
104 / 4			5	SS	25	4				
103 / 5		-becomes compact	6A / 6B	SS / SS	40	11				
102 / 6		SILT: Dark brown, silt, trace sand, trace gravel, trace organics (wood chips), moist, compact								
101 / 7		SILT AND SAND: Brown, silt and sand, trace gravel, moist, compact	7	SS	40	24				SS7 GSA: 4% gravel 44% sand 52% silt & clay
100 / 8		-becomes dense	8	SS	45	45				
99		Borehole terminated at 7.01 mbgs in silt and sand								

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Input By: J. Riseling

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Log of Borehole: BH106-21

Client:	TWP of Douro-Dummer	**Project Name:**	Hwy 28 & CR 4 Severances	**Project No.:**	13455-001
Contractor:	Canadian Environmental	**Method:**	Solid Stem Auger	**Date Completed:**	September 24, 2021
Location:	Highway 28 and County Road 4, Douro-Dummer, ON	**UTM:**	17T 721361.414 m E, 4917016.868 m N	**Elevation:**	107.66 masl

SUBSURFACE PROFILE			SAMPLE								
Elevation (m) / Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
107 / 0		SAND AND GRAVEL: Grey/light brown, sand and gravel, trace silt, dry to moist, very dense	1	SS	80	50				
107 / 1		-becomes loose	2	SS	20	7				
106 / 2		SANDY SILT: Grey, sandy silt, some gravel, trace clay, moist, loose	3	SS	50	7				
105 / 3		SANDY SILT: Brown, sandy silt, some gravel, trace clay, trace organic (pieces of tree branch), loose	4	SS	30	5				
104 / 4		GRAVELLY SAND: Grey/brown, gravelly silty sand, moist, compact	5	SS	40	19				Cobble present from this point on
103 / 5		GRAVELLY SAND: Light brown, gravelly silty sand, moist, dense	6	SS	50	34				Borehole open and dry upon completion
102 / 6		-becomes very dense	7	SS	55	57				
101 / 7		Borehole terminated at 6.55 mbgs in gravelly silty sand								
100 / 8										
99										

Logged By: J. Riseling **Input By:** J. Riseling

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Log of Borehole: BH107-21

Client: TWP of Douro-Dummer
Project Name: Hwy 28 & CR 4 Severances
Project No.: 13455-001
Contractor: Canadian Environmental
Method: Solid Stem Auger
Date Completed: September 24, 2021
Location: Highway 28 and County Road 4, Douro-Dummer, ON
UTM: 17T 721345.423 m E, 4916993.177 m N
Elevation: 107.765 masl

Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	Well Installation	Remarks
107.7	0.0		TOPSOIL: 50 mm Topsoil	1	SS	90	43		
107.2	0.5		SILT: Light brown, silt, some sand, some gravel, trace clay, dry to moist, dense						
106.7	1.0		SILTY SAND: Light brown, silty sand, some gravel, trace clay, moist, compact	2	SS	30	12		
106.2	1.5		-becomes loose	3	SS	20	6		
105.7	2.0		SILT: Light brown, silt, some sand, trace gravel, trace clay, moist, compact	4	SS	20	13		Borehole open and dry upon completion
105.2	2.5		GRAVELLY SAND: Brown, gravelly silty sand, moist, dense	5	SS	80	37		
103.7	4.0		-becomes very dense	6	SS	40	52		
101.7	6.0			7	SS	40	50/375		
101.2	6.5		Borehole terminated at 6.55 mbgs in gravelly silty sand						

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Input By: J. Riseling

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Log of Borehole: BH108-21

Client: TWP of Douro-Dummer
Project Name: Hwy 28 & CR 4 Severances
Project No.: 13455-001
Contractor: Canadian Environmental
Method: Solid Stem Auger
Date Completed: September 24, 2021
Location: Highway 28 and County Road 4, Douro-Dummer, ON
UTM: 17T 721322.63 m E, 4916974.067 m N
Elevation: 107.911 masl

Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N) / DCPT	% Moisture (25 50 75)	SPT (N) / DCPT (10 20 30 40)	Well Installation	Remarks
108	0		SANDY GRAVEL: Grey/brown, sandy gravel, trace silt, dry to moist,	1	SS	30	50/375				
107	1		SAND AND SILT: Light brown, sand and silt, some gravel, trace clay, moist, compact	2	SS	85	22				
			SILTY SAND: Brown, silty sand, some gravel, moist, loose	3	SS	20	8				
106	2			4	SS	30	6				Borehole open and dry upon completion
105	3			5	SS	40	6				
104	4										
103	5			6	SS	25	8				
102	6		GRAVELLY SAND: Brown, gravelly silty sand, moist, compact	7	SS	40	16				
101	7			8	SS	40	25				
100	8		Borehole terminated at 7.01 mbgs in gravelly silty sand								

Logged By: J. Riseling
Input By: J. Riseling

Appendix B

Physical Laboratory Data

Grain Size Distribution Chart

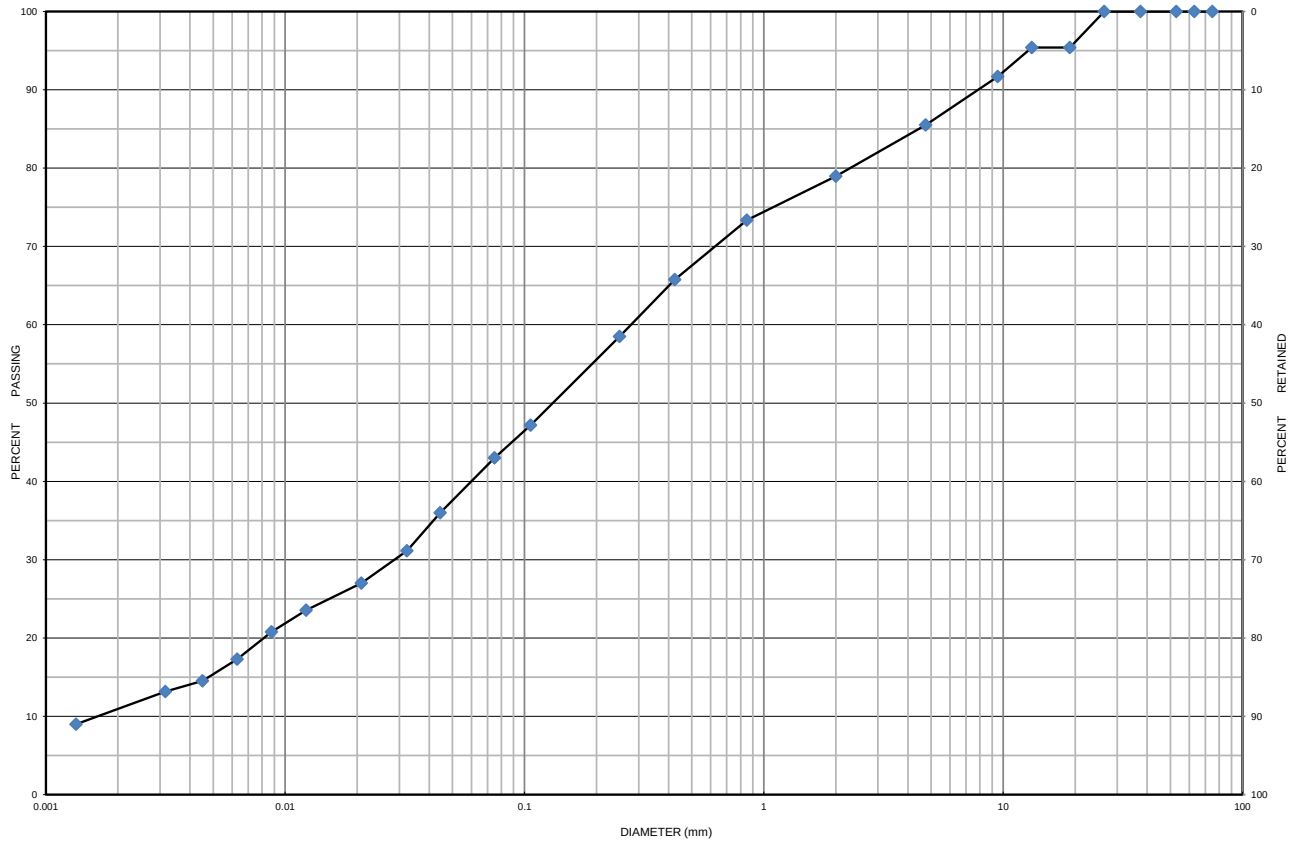
Project Number: *13455-001* **Client:** *Township of Douro-Dummer*

Project Name: *Geotechnical Investigation - HWY 28 & CR 4 Severances*

Sample Date: *September 24, 2021* **Sampled By:** *Josh Riseling - Cambium Inc.*

Location: *BH 101-21 SS 4* **Depth:** *2.3 m to 2.7 m* **Lab Sample No:** *S-21-1246*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-21	SS 4	2.3 m to 2.7 m	15	43	30	12	13.9

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Sand some Gravel some Clay	SM	0.2800	0.0290	0.0017	164.71	1.77

Additional information available upon request

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Grain Size Distribution Chart

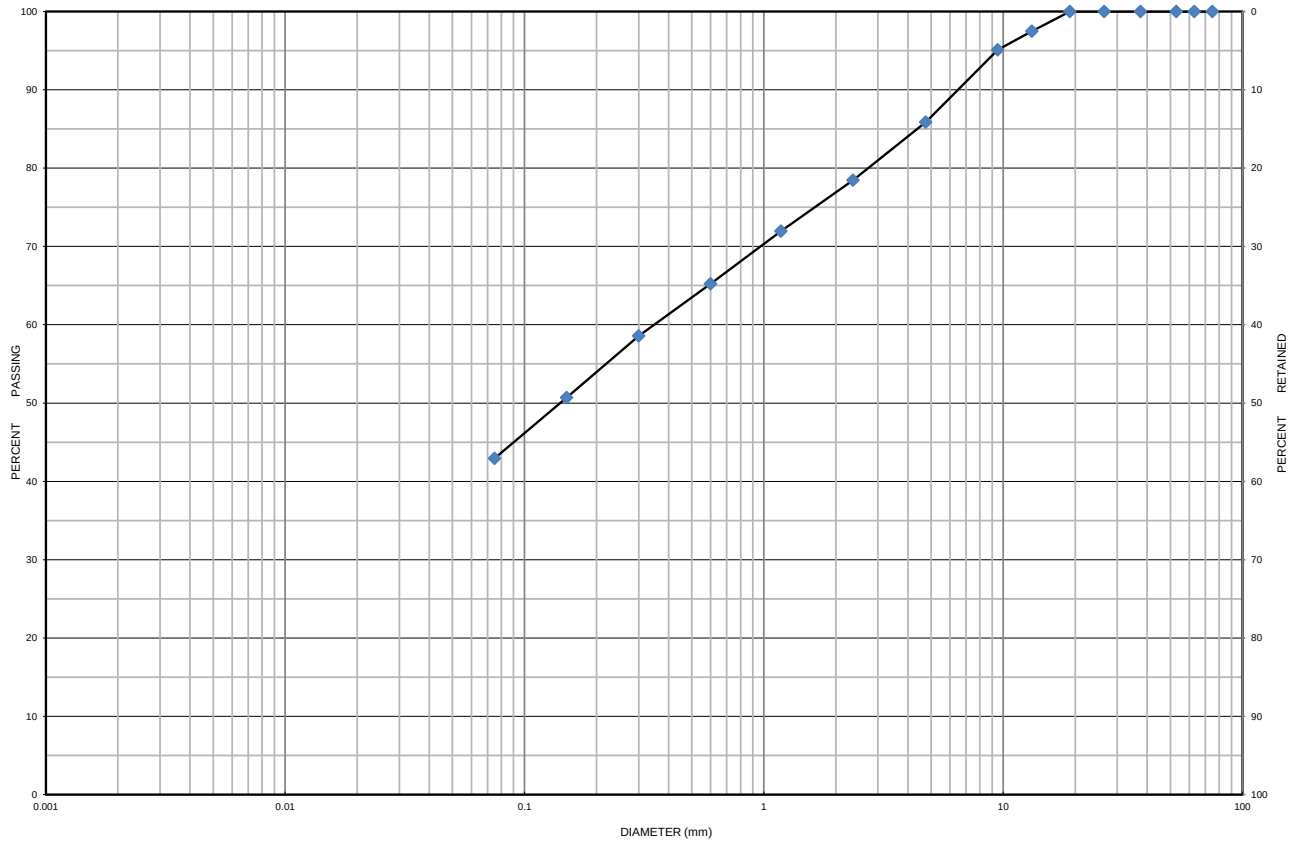
Project Number: *13455-001* **Client:** *Township of Douro-Dummer*

Project Name: *Geotechnical Investigation - HWY 28 & CR 4 Severances*

Sample Date: *September 24, 2021* **Sampled By:** *Josh Riseling - Cambium Inc.*

Location: *BH 101-21 SS 7* **Depth:** *6.1 m to 6.6 m* **Lab Sample No:** *S-21-1241*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-21	SS 7	6.1 m to 6.6 m	14	43	43		6.1

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sand and Silt some Gravel	SM	0.350	-	-	-	-

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Grain Size Distribution Chart

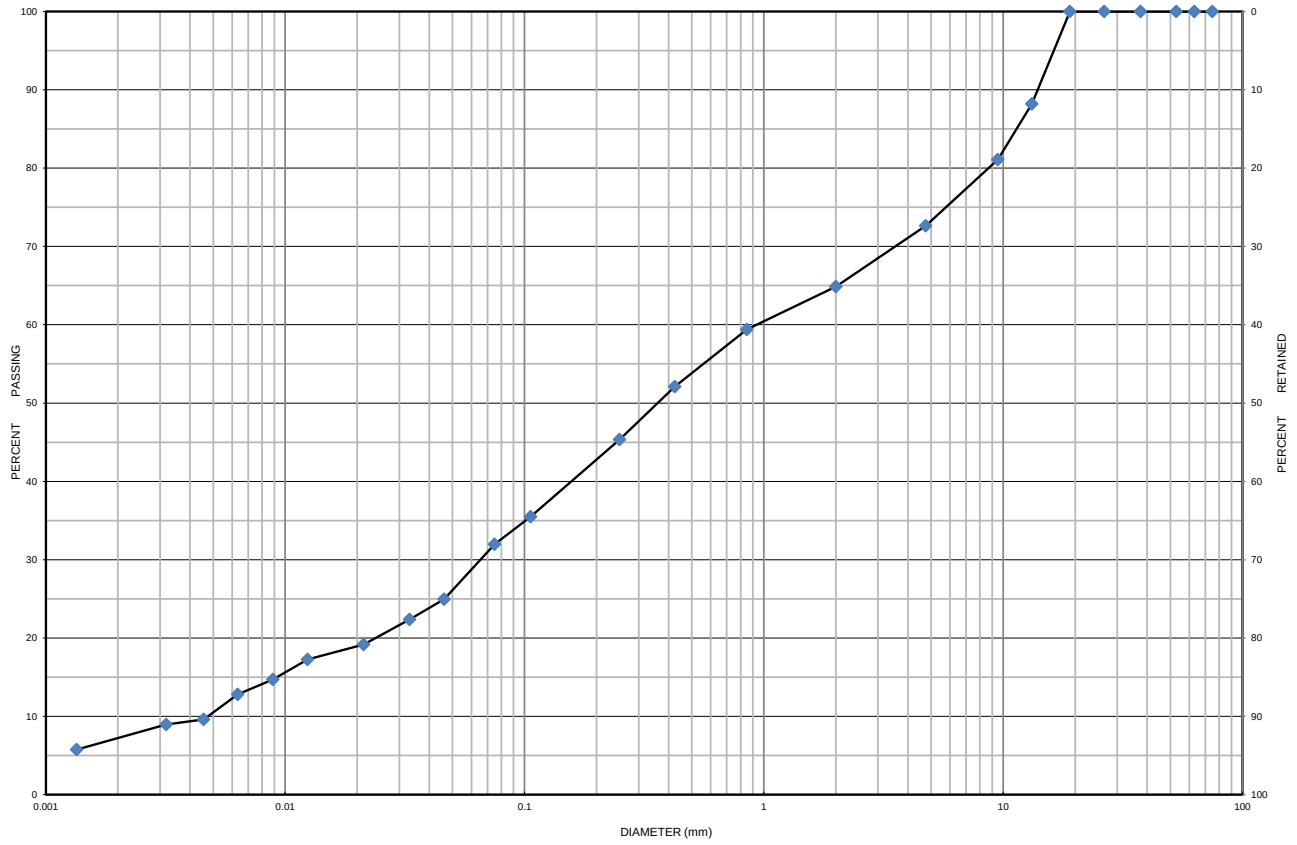
Project Number: *13455-001* **Client:** *Township of Douro-Dummer*

Project Name: *Geotechnical Investigation - HWY 28 & CR 4 Severances*

Sample Date: *September 24, 2021* **Sampled By:** *Josh Riseling - Cambium Inc.*

Location: *BH 102-21 SS 2* **Depth:** *0.8 m to 1.2 m* **Lab Sample No:** *S-21-1245*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 102-21	SS 2	0.8 m to 1.2 m	27	41	25	7	7.1

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Gravelly Silty Sand trace Clay	SM	0.9100	0.0650	0.0048	189.58	0.97

Additional information available upon request

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Grain Size Distribution Chart

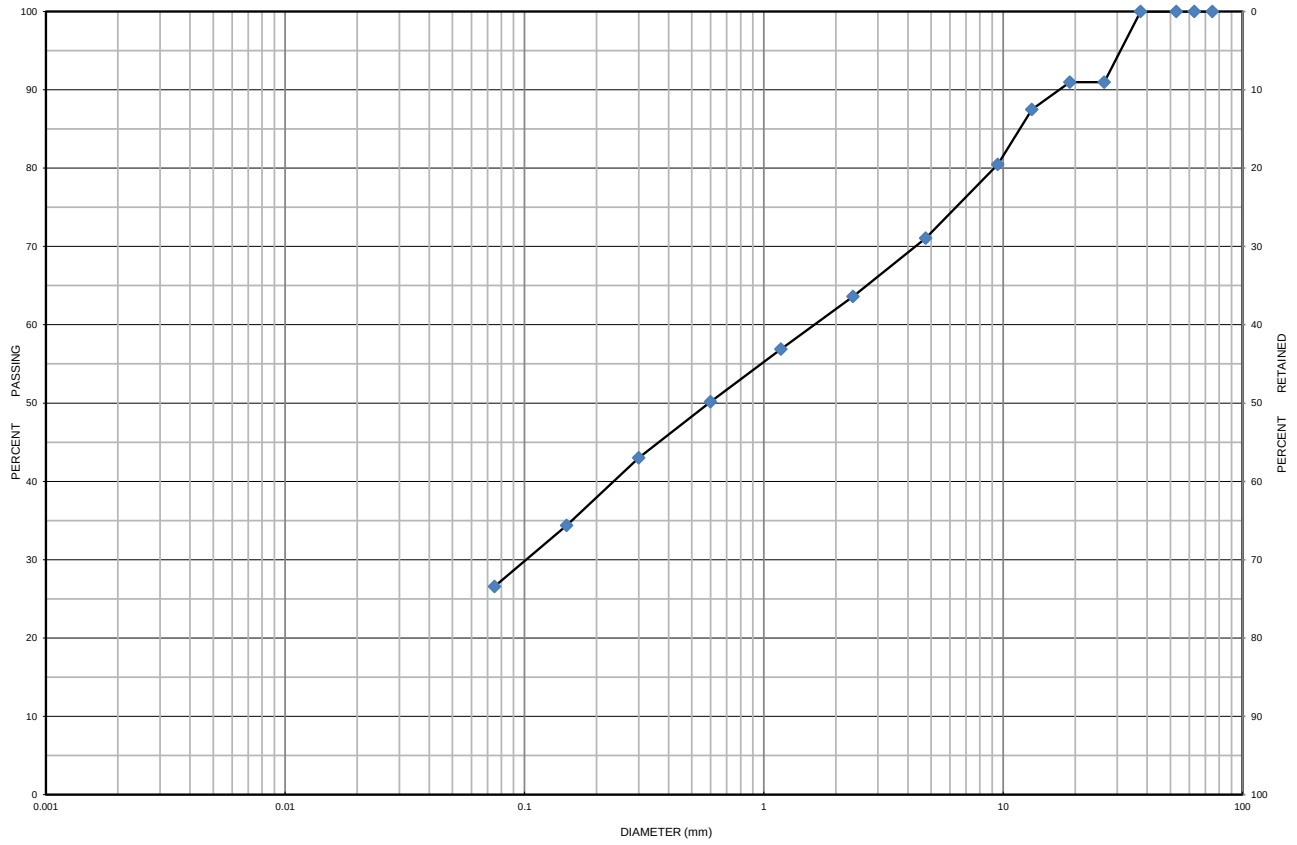
Project Number: *13455-001* **Client:** *Township of Douro-Dummer*

Project Name: *Geotechnical Investigation - HWY 28 & CR 4 Severances*

Sample Date: *September 24, 2021* **Sampled By:** *Josh Riseling - Cambium Inc.*

Location: *BH 103-21 SS 7* **Depth:** *6.1 m to 6.6 m* **Lab Sample No:** *S-21-1242*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 103-21	SS 7	6.1 m to 6.6 m	29	44	27		5.3

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Gravelly Silty Sand	SM	1.650	0.100	-	-	-

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Grain Size Distribution Chart

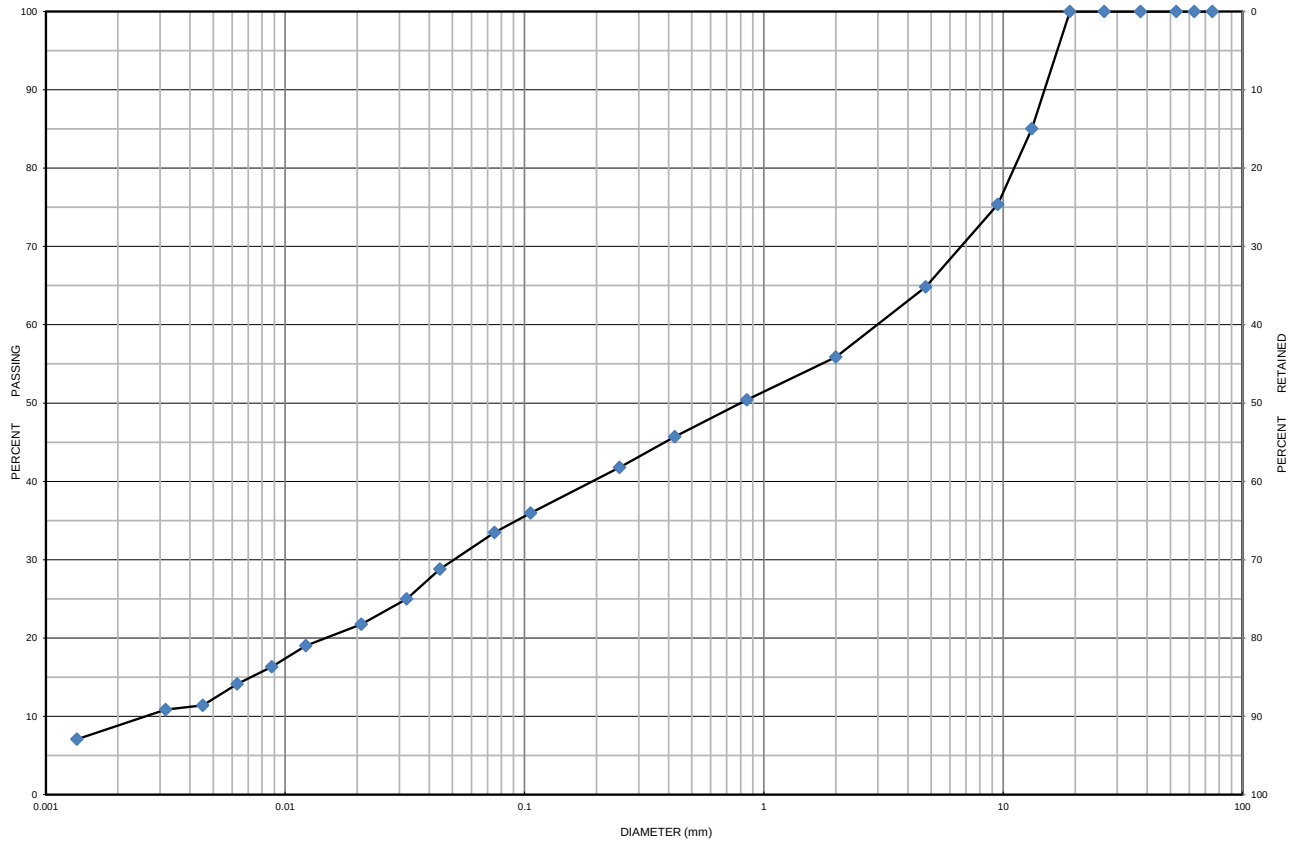
Project Number: *13455-001* **Client:** *Township of Douro-Dummer*

Project Name: *Geotechnical Investigation - HWY 28 & CR 4 Severances*

Sample Date: *September 24, 2021* **Sampled By:** *Josh Riseling - Cambium Inc.*

Location: *BH 104-21 SS 3* **Depth:** *1.5 m to 2 m* **Lab Sample No:** *S-21-1244*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 104-21	SS 3	1.5 m to 2 m	35	31	26	8	9.2

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Sandy Silty Gravel trace Clay	SM	3.0000	0.0500	0.0026	1153.85	0.32

Additional information available upon request

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Grain Size Distribution Chart

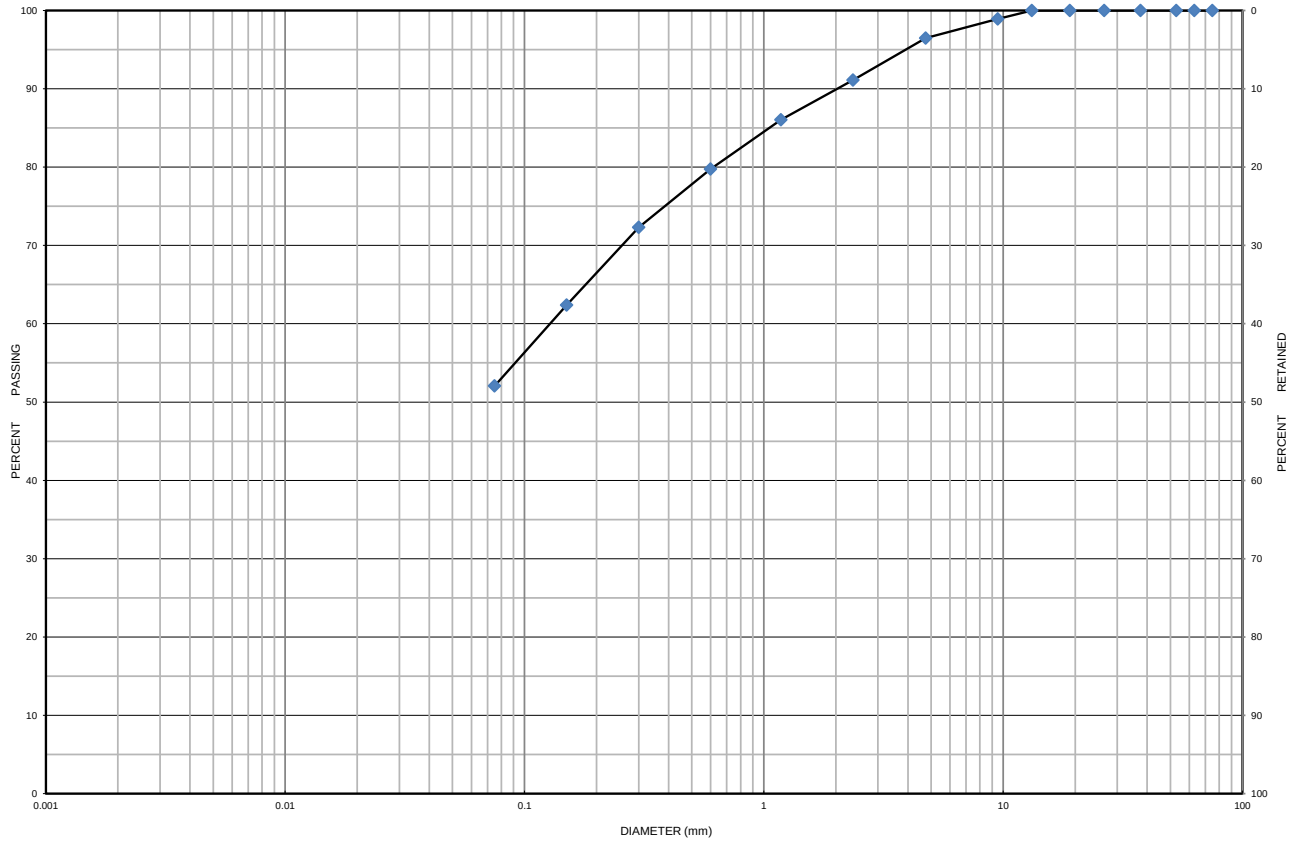
Project Number: *13455-001* **Client:** *Township of Douro-Dummer*

Project Name: *Geotechnical Investigation - HWY 28 & CR 4 Severances*

Sample Date: *September 24, 2021* **Sampled By:** *Josh Riseling - Cambium Inc.*

Location: *BH 105-21 SS 7* **Depth:** *6.1 m to 6.6 m* **Lab Sample No:** *S-21-1243*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 105-21	SS 7	6.1 m to 6.6 m	4	44	52		10.0

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silt and Sand trace Gravel	ML	0.135	-	-	-	-

Additional information available upon request

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Appendix C

Slope Stability Record & Rating Chart

SLOPE INSPECTION RECORD

1. FILE NAME/NO. 13455-001

INSPECTION DATE:September 14, 2021

WEATHER (circle):	sunny	partly cloudy		cloudy
	calm	breeze		windy
	clear	fog	rain	snow
	cold	cool	warm	hot
		estimated air temperature:	13°C	

INSPECTED BY: Juan Monroy

2. SITE LOCATION (describe, main roads, features)

Lot 3, County Road 4, Twp of Douro-Dummer, just east of Wood By Design

3. WATERSHED

4. PROPERTY OWNERSHIP (name, address, phone):

Township of Douro-Dummer, 894 South Street, P.O. Box 92, Warsaw, K0L 3A0

LEGAL DESCRIPTION

Lot	3	off Indacom Drive
Concession		
Township	Douro Dummer	
County	Peterborough	

CURRENT LAND USE (circle and describe)

- vacant: field, bush, woods, forest, wilderness, tundra

Fill has been placed over the field generating an unatural slope at Site

- passive: recreactional parks, golf courses, non-habitable structures, buried utilities, swimming pools

- active: habitable structures, residential, commercial, industrial, warehousing and storage

- infrastructure or public use: stadiums, hospitals, schools, bridges, high voltage power lines, waste management sites

5. SLOPE DATA:

HEIGHT

- 3-6 m	- 6-10 m	- 10-15 m	- 15-20 m
- 20-25 m	- 25-30 m	- >30 m	

estimated height (m): 10.8__

INCLINATION AND SHAPE

4:1 or flatter	up to 3:1	up to 2:1
25% 14°	33% 18°	50% 26°
up to 1:1	up to :1	steeper than :1
100% 45°	200% 63°	>63°

SLOPE INSPECTION RECORD

6. SLOPE DRAINAGE (describe):

TOP north table land flat, with south table land sloping towards forest
no observed drainage throughout the site

FACE

BOTTOM

7. SLOPE SOIL STRATIGRAPHY (describe, positions, thicknesses, types)

TOP Fill placed on top, face and bottom of slope, consisting of loose sand and gravel,
some cobbles, some boulders, some organics including roots, branches, tree trunks,
FACE wood chunks, and construction debris

BOTTOM

8. WATER COURSE FEATURES (circle and describe)

SWALE, CHANNEL

GULLY

STREAM, CREEK, RIVER

N/A

POND, BAY, LAKE:

SPRINGS

MARSHY GROUND

9. VEGETATION COVER (grasses, weeds, shrubs, saplings, trees)

TOP Occasional grasses and weeds, rest is bare with fill

FACE Occasional grasses and weeds, rest is bare with fill

BOTTOM Bare in some areas at bottom, other areas the base of slope is heavily forested with mature
trees, shrubs and saplings

10. STRUCTURES (buildings, walls, fences, sewers, roads, stairs, decks, towers)

TOP N/A

FACE N/A

BOTTOM N/A

11. EROSION FEATURES (scour, undercutting, bare areas, piping, rills, gully)

TOP Bare areas

FACE Rills and gully, bare areas

BOTTOM Bare areas

SLOPE INSPECTION RECORD

12. SLOPE SLIDE FEATURES (tension cracks, scarps, bulges, grabens, ridges, bent trees)

TOP	N/A
FACE	Large, exising recent full slope failure on the NE end of the lot
BOTTOM	N/A

13. PLAN SKETCH OF SLOPE

See additional report appendices

13. PROFILE SKETCH OF SLOPE

See additional report appendices

SLOPE STABILITY RATING CHART

Site Location:	Lot 3, County Road 4, Twp of Douro-Dummer	File No.	13455-001
Property Owner:	Twp of Douro-Dummer	Inspection Date:	2021-09-14
Inspected By:	Juan Monroy	Weather:	13 °C

Inspection Task		Rating Value
1. SLOPE INCLINATION		
Degrees	**Horizontal:Vertical**	
a) 18 or less	3:1 or flatter	0
b) 18 to 26	2:1 to more than 3:1	6
c) more than 26	Steeper than 2:1	16
2. SOIL STRATIGRAPHY		
a) Shale, Limestone, Granite (Bedrock)		0
b) Sand, Gravel		6
c) Glacial Till		9
d) Clay, Silt		12
e) Fill		16
f) Leda Clay		24
3. SEEPAGE FROM SLOPE FACE		
a) None or near bottom only		0
b) Near mid-slope only		6
c) Near crest only or from several levels		12
4. SLOPE HEIGHT		
a) 2 m or less		0
b) 2.1 to 5 m		2
c) 5.1 to 10 m		4
d) more than 10 m		8
5. VEGETATION COVER ON SLOPE FACE		
a) Well vegetated, heavy shrubs or forested with mature trees		0
b) Light Vegetation; Mostly grass, weeds, occasional trees, shrubs		4
c) No vegetation, bare		8
6. TABLE LAND DRAINAGE		
a) Table land flat, no apparent drainage over slope		0
b) Minor drainage over slope, no active erosion		2
c) Drainage over slope, active erosion, gullies		4
7. PROXIMITY OF WATERCOURSE TO SLOPE TOE		
a) 15 m or more from slope toe		0
b) Less than 15 m from slope toe		6
8. PREVIOUS LANDSLIDE ACTIVITY		
a) No		0
b) Yes		6
	RATING VALUES TOTAL	**56**

SLOPE INSTABILITY RATING		INVESTIGATION REQUIREMENTS
1. Low Potential	<24	Site inspection only, confirmation, report letter
2. Slight Potential	25 - 35	Site inspection and surveying, preliminary study, detailed report
3. Moderate Potential	>35	Boreholes, piezometers, lab tests, surveying detailed report

Notes:

a) Choose only one rating value from each category; compare total rating value with above requirements

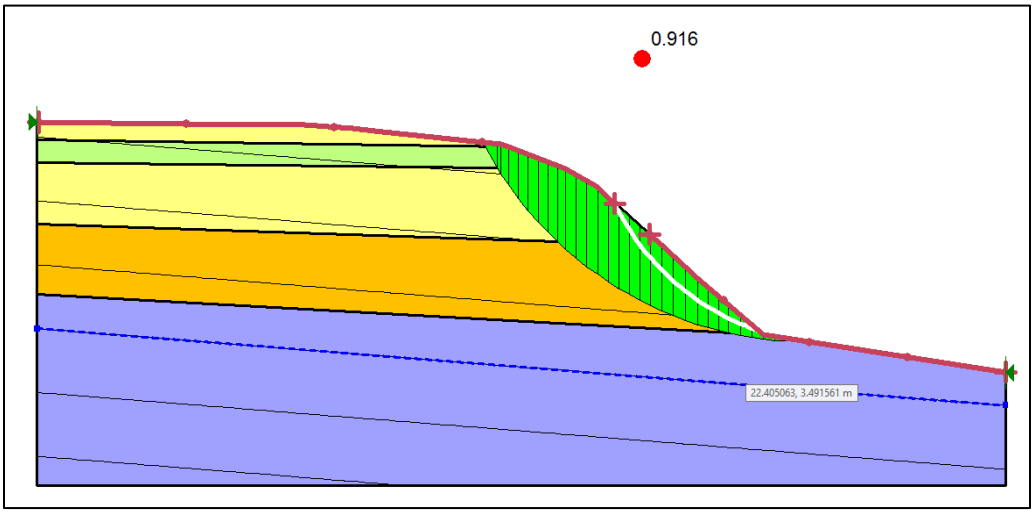
b) If there is a waterbody (stream, creek, river, pond, bay, lake) at the slope toe, the potential for toe ersoion and undercutting should be evaluated in detail and protection provided if required.

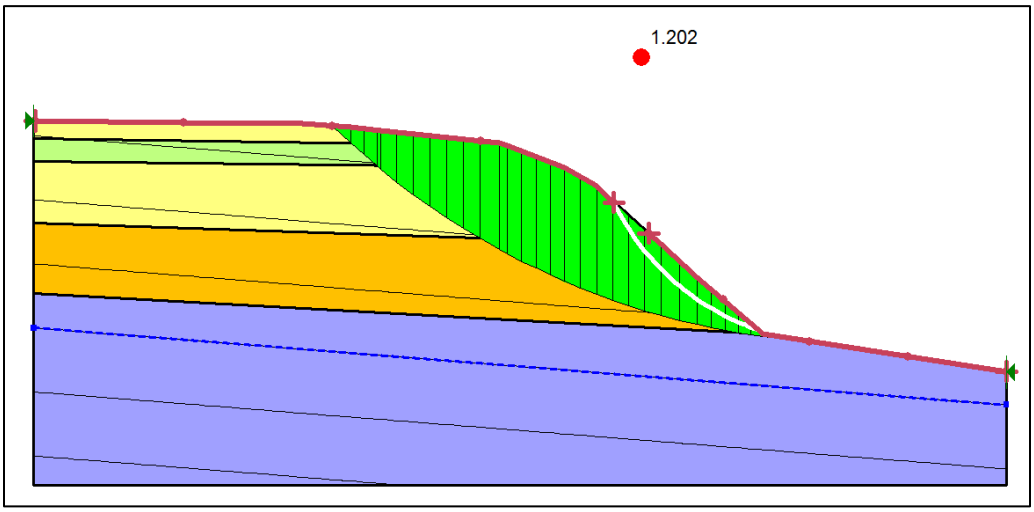
c) For leda clay and rock slopes, additional evaluation must be carried out

Source: Table 8.1 Geotechnical Principles for Stable Slopes (June 1998), Ontario Ministry of Natural Resources

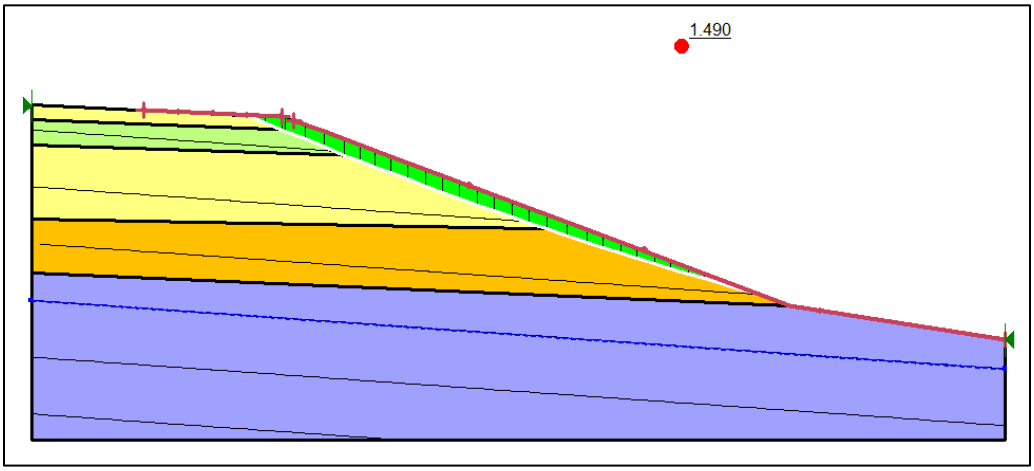
Appendix D
Engineering Analysis

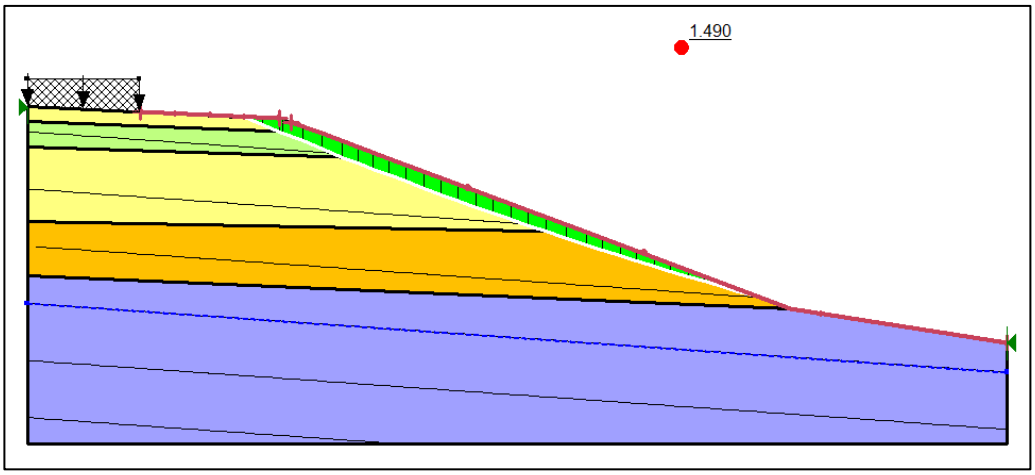
Section A-A’ Existing Conditions (1H:1V)



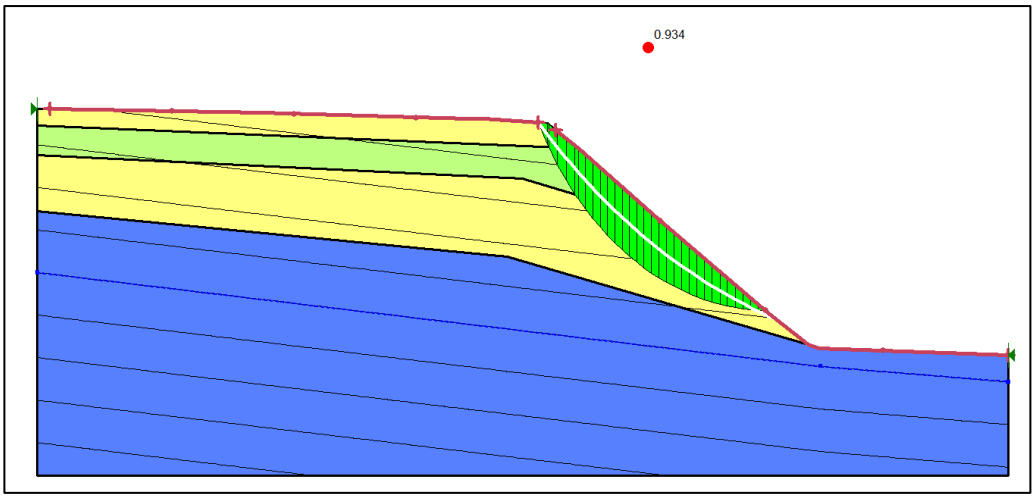


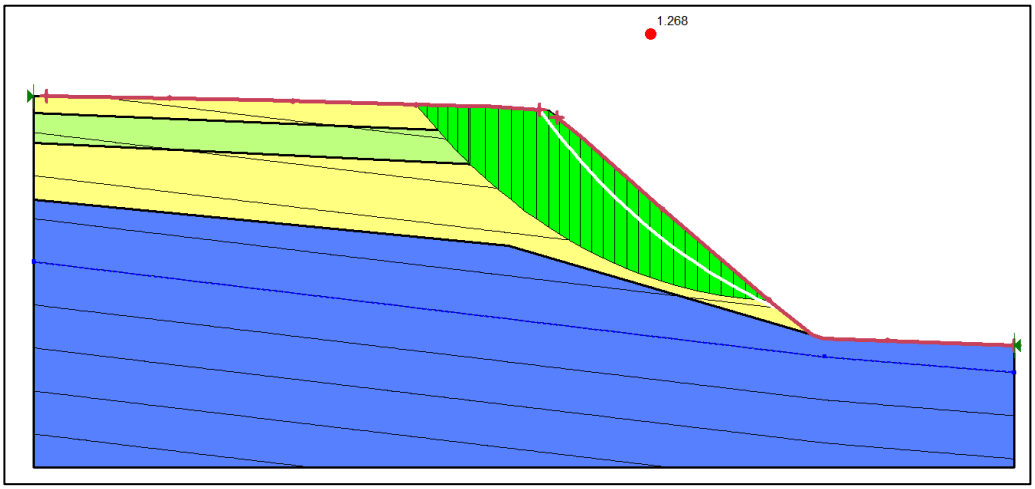
Section A-A’ Reduced Slope (2.5H:1V)



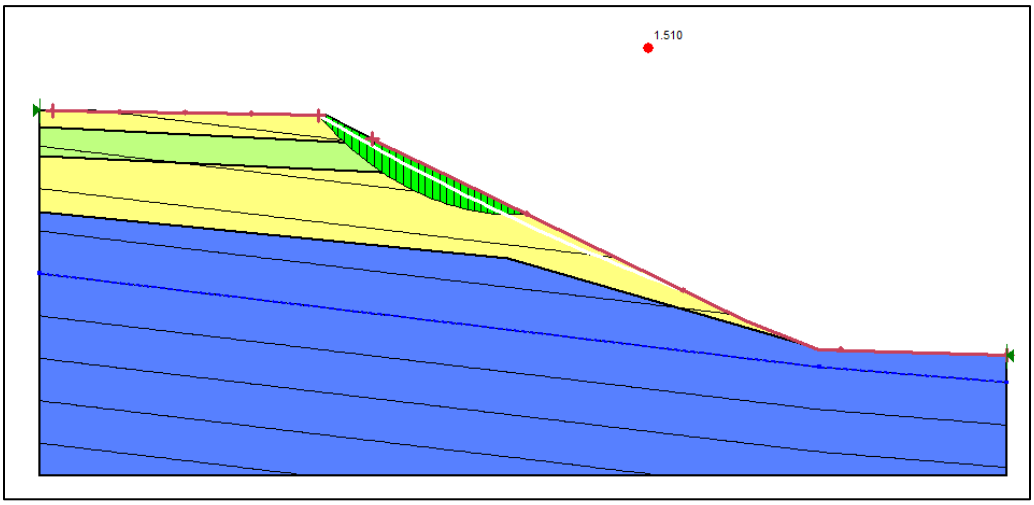


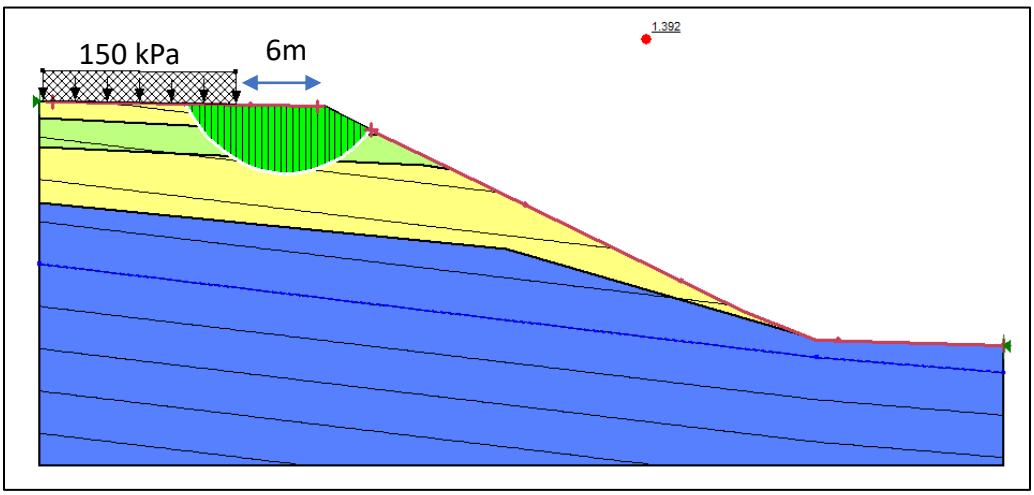
Section B-B’ Existing Conditions (1.5H:1V)

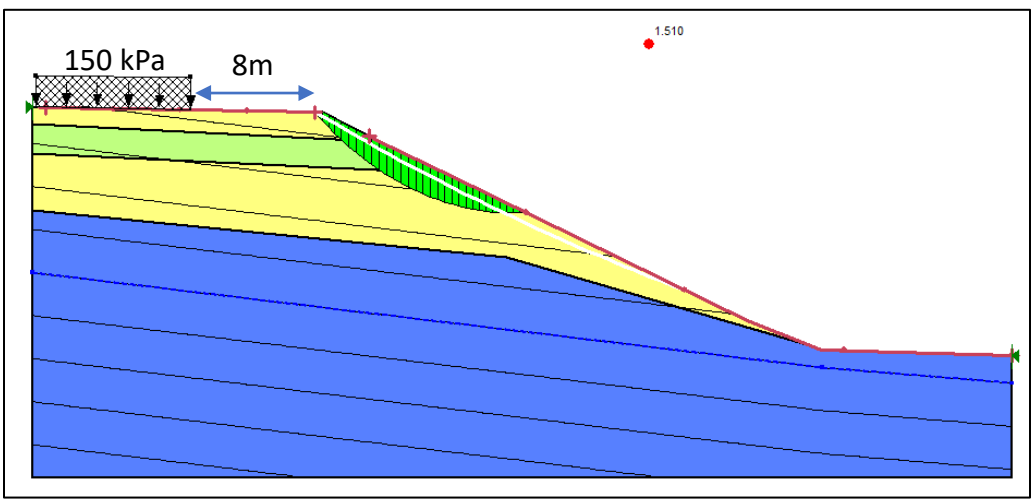




Section B-B’ Reduced Slope (2.8H:1V)







Appendix E
Site Photographs

Site Photographs

Photo 1: View of slope looking northeast from the location of BH101-21 at corner of Indacom Drive.

Photo 2: Location of BH101-21 on flat ground above slope.

Photo 3: View of slope looking northeast from the location of BH101-21 at corner of Indacom Drive.

Photo 4: View down very steep slope adjacent to BH101-21. Large rocks and organics in and on slope.

Photo 5: View of table flat land that makes up the lot atop the slope, looking east from near the entrance from Indacom Drive. Slope is to the right.

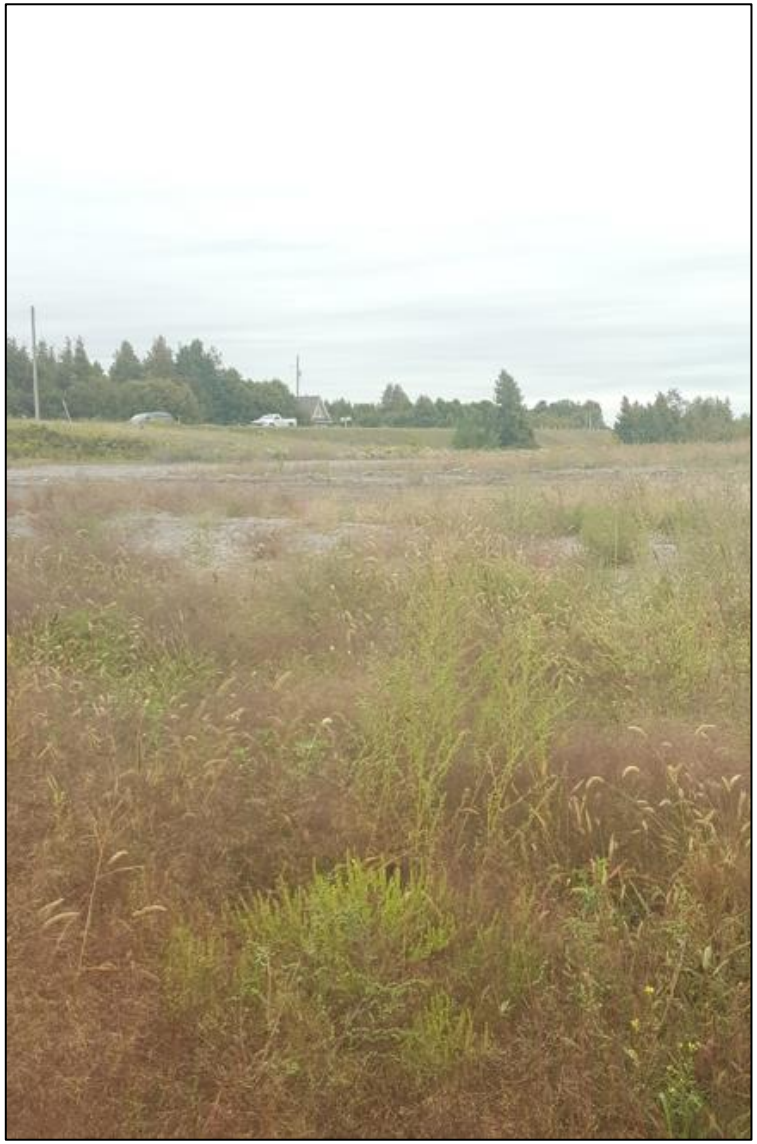


Photo 6: View looking northeast from BH102-21 across table flat land.

Photo 7: BH105-21 overlooking slope to SE. Long grasses at top of slope.

Photo 8: View looking down slope on SE side of lot. Some weeds on slope, some bare areas, large boulders at the base. Densely treed at base of slope.

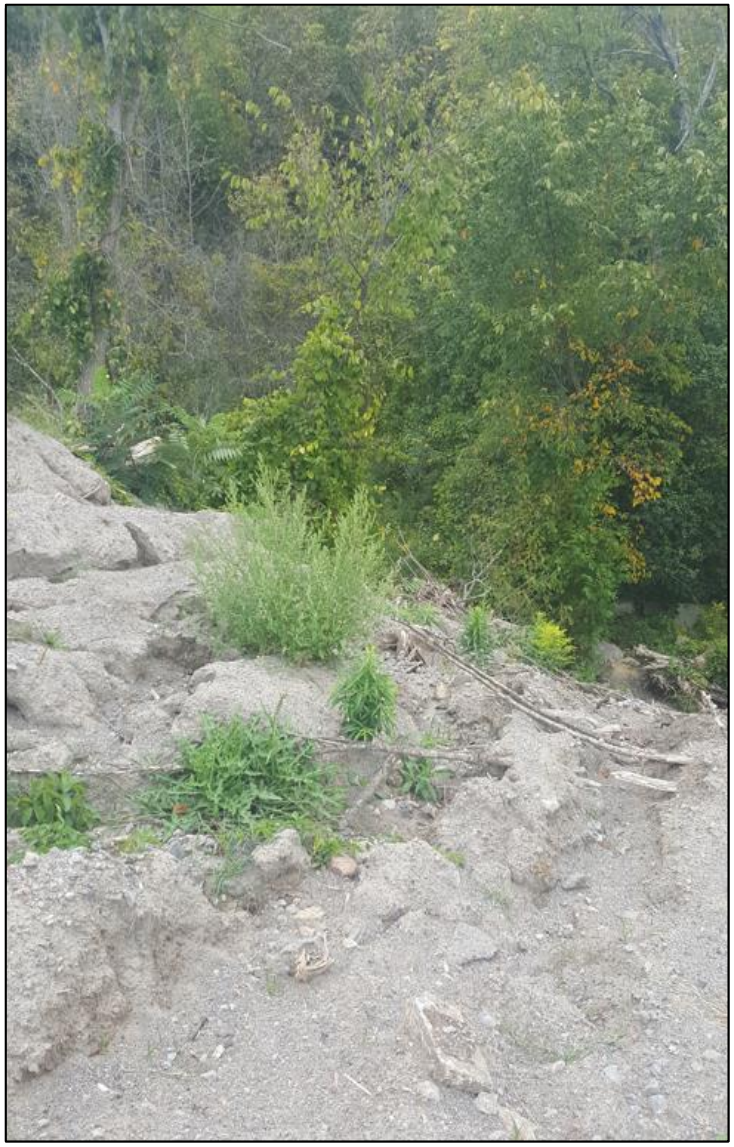


Photo 9: View of slope on SE side of lot from base of slope. Many bare areas, large boulders and large wood debris over slope.

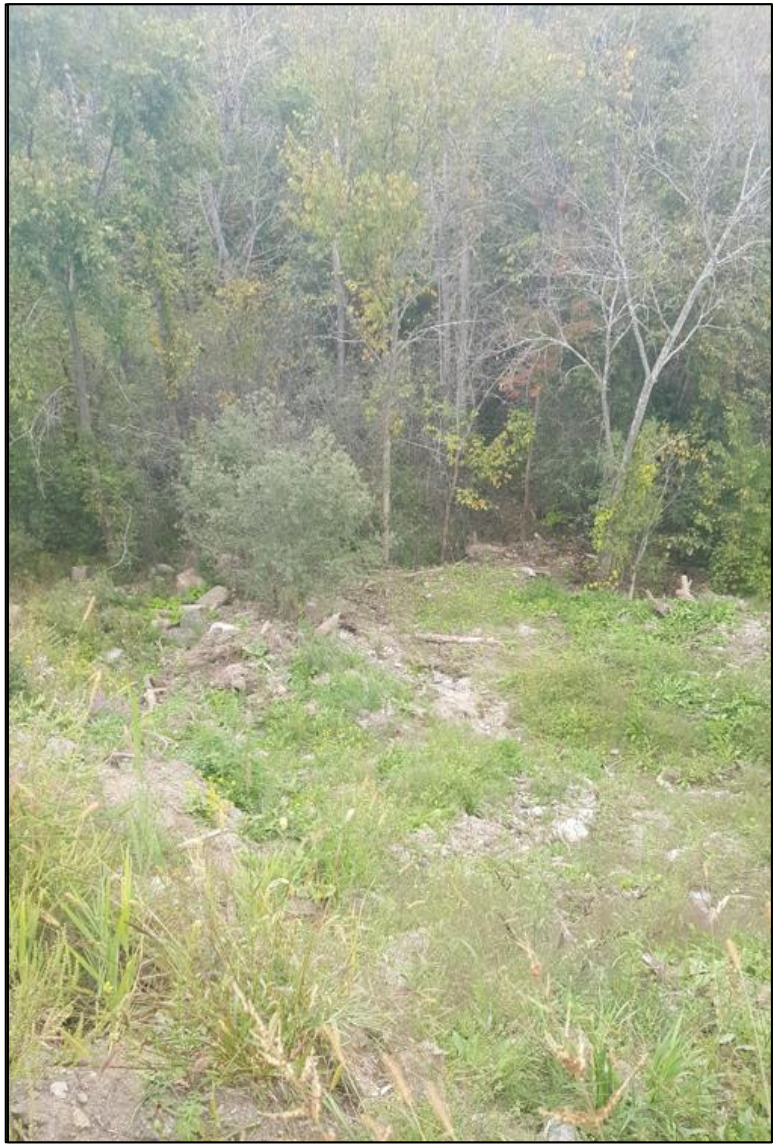


Photo 10: View looking down slope on SE side of lot. Some weeds on slope, some bare areas, large wood debris in slope. Densely treed at base of slope.

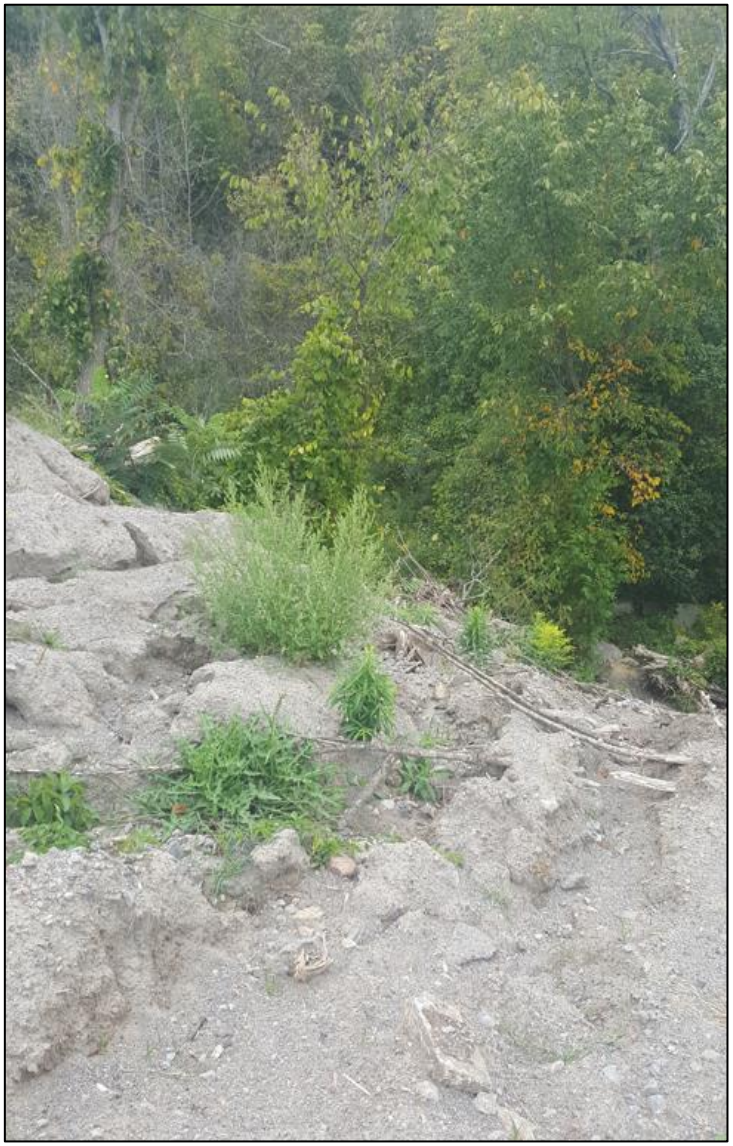


Photo 11: View of bare soil at the top of the slope where rills have formed in the soil as water drains over the slope to the SW, near BH102-21.

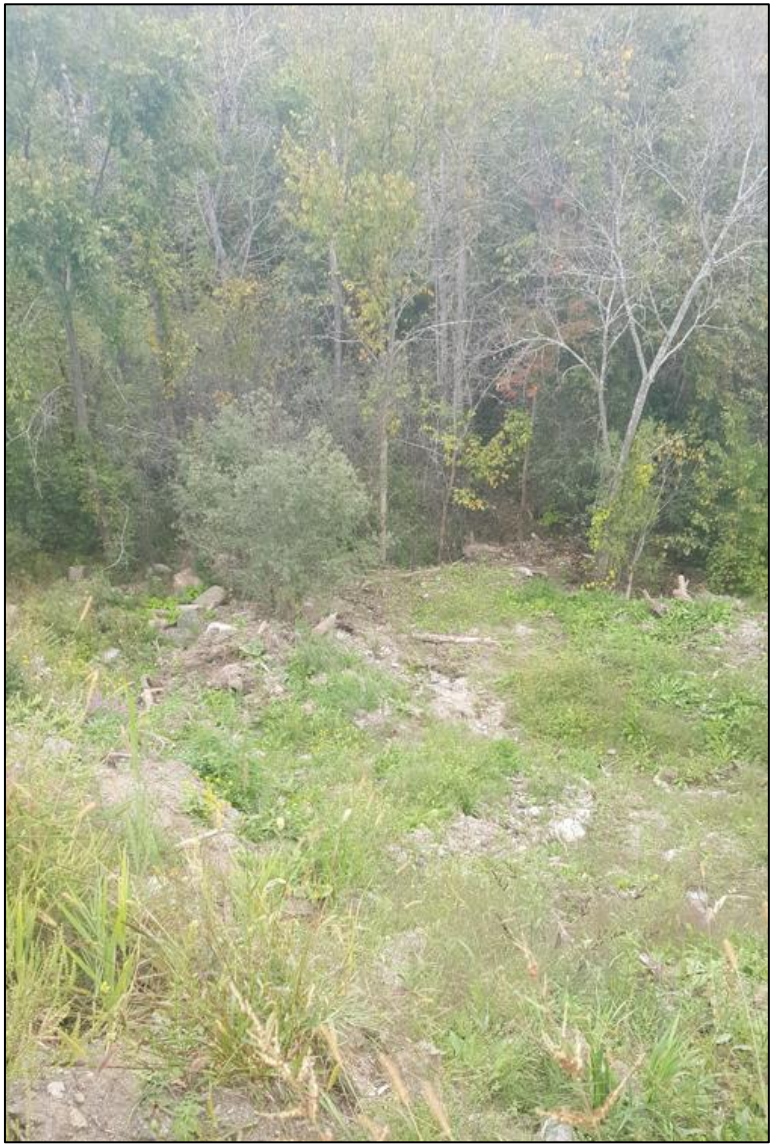


Photo 12: View looking down slope between BH104-21 and BH105-21, where a landslide occurred within the slope. This portion of the slope is now less steep, after failure.

Photo 13: Relatively Flat land at the base of the slope.