Geotechnical Investigation

Proposed Lot Severance
2940 Mer Bleue Road
Navan, Ontario
Revision 1

Prepared for:

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1 INTRODUCTION

LRL Associates Ltd. (LRL) was retained by Jihad Zamat to perform a geotechnical investigation for a proposed lot severance application to be located at 2940 Mer Bleue Road, Navan (Ottawa) ON. It is understood that three (3) residential lots will be severed from the above-mentioned civic address, and will support the construction of single family dwellings.

The purpose of the investigation was to identify the subsurface conditions across the site by the completion of a borehole drilling program. Based on the visual and factual information obtained, this report will provide guidelines on the geotechnical engineering aspects of the design of the project, including construction considerations. In addition, the report will also include a section pertaining to the stability of the slope of the banks located at the south and southwest portion of the site.

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

2 SITE AND PROJECT DESCRIPTION

The property is situated at 2940 Mer Bleue Road, Navan, Ontario. It is legally described as Part of Lot 1 Concession 4 within the City of Ottawa. It is located directly west of Mer Bleue Road and 250 m south of Navan Road. The location of the site is shown in **Figure 1.** The site's dimensions are 150.6 m in width by 95.4 m in depth. The site's total surface area is approximately 15,500 m² (1.55 ha). The property is presently developed with an existing single-family residence along with additional outbuildings on the north side of the site. The topography is slightly inclined in the north direction, but can generally be considered relatively flat; with the exception of the slopes located near the property lines at the south and southwest portions of the site.

At the time of generating this report, it is understood the site will be severed into three (3) residential lots. The future dwellings will be serviced with municipal water and private septic systems.

3 PROCEDURE

The fieldwork for this investigation was carried out on June 26 and 27, 2023, in conjunction with the fieldwork for the Terrain Analysis, completed by LRL's Environmental Department. Prior to the fieldwork, the site was cleared for the presence of any underground services and utilities. A total of five (5) boreholes were drilled onsite to get a general representation of the site's underlying soil conditions, and labelled BH23-1 through BH23-5. The approximate locations of the boreholes are shown in Figure 2 included in **Appendix A**.

The boreholes were advanced using a track mounted CME 55 drill rig equipped with 200 mm diameter continuous flight hollow stem auger supplied and operated by George Downing Estate Drilling Ltd. A "two man" crew experienced with geotechnical drilling operated the drill rig and equipment.

Sampling of the overburden materials encountered in the boreholes was carried out at regular depth intervals using a 50.8 mm diameter drive open conventional spoon sampler

in conjunction with standard penetration testing (SPT) “N” values. The SPTs were conducted following the method **ASTM D1586** and the results of SPT, in terms of the number of blows per 0.3 m of split-spoon sampler penetration after first 0.15 m designated as the “N” value.

Boreholes were advanced to depths ranging between 5.94 and 11.9 m below ground surface (bgs). Three (3) of the boreholes were converted into monitoring wells for the purposes of the Terrain Analysis and will be used to measure the groundwater level for this study. These wells were constructed by using slotted 50 mm diameter PVC pipe, backfilled with silica sand, and sealed with bentonite.

In-situ field vane shear testing was carried out in the cohesive layers once the material became very soft; based on the “N” values. This was done by using a 200 x 100 mm tapered vane, and the undrained shear strength values were calculated following the procedure **ASTM D 2573.**

The fieldwork was supervised throughout by a member of our engineering staff who oversaw the drilling activities, cared for the samples obtained and logged the subsurface conditions encountered within each of the boreholes. All soil samples were transported back to our office for further evaluation. The recovered soil samples collected from the boreholes were classified based on visual examination of the materials recovered and the results of the in-situ testing.

Furthermore, all boreholes were located using a Garmin Etrex Legend GPS (Global Positioning System) receiver using NAD 83 datum (North American Datum). LRL’s field personnel determined the existing grade elevations at the borehole locations through a topographic survey carried out using a temporary site bench mark (mailbox directly east of the site across Mer Bleue Road) and having an assumed value of 100.00 m. Ground surface elevations of the boring locations are shown on their respective borehole logs.

4 SUBSURFACE SOIL AND GROUNDWATER CONDITIONS

4.1 General

A review of local surficial geology maps provided by the Department of Energy, Mines and Resources Canada suggest that the surficial geology for this area is made up of Post-Champlain Sea Deposits, consisting of silt and silty clay; commonly including lenses of sand, generally underlain by blue-grey clay.

The subsurface conditions encountered in the boreholes were classified based on visual and tactile examination of the materials recovered from the boreholes. The soil descriptions presented in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil were conducted according to the procedure **ASTM D2487** and judgement, and LRL does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The subsurface soil conditions encountered are given in their respective borehole logs presented in **Appendix B**. A greater explanation of the information presented in the borehole logs can be found in **Appendix C** of this report. These logs indicate the subsurface conditions encountered at a specific test location only. Boundaries between zones on the logs are often not distinct, but are rather transitional and have been interpreted as such.

4.2 Topsoil

At the surface of all boring locations a layer of sandy topsoil was encountered. This was found ranging between 100 and 160 mm thick.

This material was classified as topsoil based on colour and the presence of organic material and is intended as identification for geotechnical purposes only. It does not constitute a statement as to the suitability of this layer for cultivation and sustaining plant growth.

4.3 Sand

Underlying the topsoil in BH22-1, BH22-2, and BH23-5 a layer of sand was encountered, and extended to depths of 2.29 and 3.81 m bgs. This material can generally be described as having some silt, trace clay, brown, and dry becoming moist with increased depths. The SPT "N" values were found ranging between 3 and 41, indicating the material is very loose to dense. The natural moisture contents were found to range between 24 and 60%.

4.4 Sandy Clay

Underlying the topsoil in BH22-3, and BH22-4, a layer of sandy clay was encountered, and extended to depths of 0.60 and 2.29 m bgs respectively. This material can generally be described as having trace silt, grey to brown, and dry. The SPT "N" values were found ranging between 9 and 12, indicating the material is stiff. The natural moisture contents were found to be 23 and 32%.

4.5 Clay to Silty Clay

Underlying the sand in BH22-1, BH22-2, and BH23-5, and the sandy clay in BH22-2, and BH23-4, clay to silty clay was encountered, and extended to depths ranging between 5.94 and 12.20 m bgs (end of exploration depths). The SPT "N" values were found ranging between 14 and Weight of Hammer (WOH), indicating the material is stiff, becoming very soft with increased depths. The natural moisture contents were found to range between 35 and 74%.

4.6 Laboratory Analysis

Three (3) soil samples were collected for laboratory gradation analyses. The gradation analyses comprised of sieve and hydrometer, and were conducted following the procedure **ASTM D422.** Details of laboratory analyses are reflected in **Table 1**.

Table 1: Gradation Analysis Summary

Sample Location	Depth (m)	Percent for Each Soil Gradation							Estimated Hydraulic Conductivity K (m/s)
		Gravel		Sand			Silt (%)	Clay (%)	
		Coarse (%)	Fine (%)	Coarse (%)	Medium (%)	Fine (%)			
BH23-1	1.5-2.1	0.0	12.4	5.3	4.9	62.8	12.3	2.3	2×10^{-5}
BH23-2	1.5-2.1	20.2	17.9	7.5	8.3	23.1	14.9	8.1	2×10^{-5}
BH23-4	5.3-5.9	0.0	0.0	0.0	0.0	0.3	23.5	76.2	1×10^{-7}

Atterberg limits and moisture contents were conducted on a split spoon soil sample. Based on the test result, the values indicate that the subsoils contains inorganic clays of low and high plasticity.

A summary of these values are provided below in **Table 2**.

Table 2: Summary of Atterberg Limits and Water Contents

Sample Location	Parameter					
	Depth (m)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Water Content (%)	USCS Group Symbol
BH23-3	1.5-2.3	75	30	45	41	CH

The laboratory analysis reports can be found in **Appendix D** of this report.

4.7 Groundwater Conditions

The below **Table 3** summarizes the groundwater level measurements. The water level measurements are also shown on the borehole logs presented in **Appendix B.**

Table 3: Groundwater Monitoring Data

Boring Location	Existing Grade Elevation (m)	Date of Observation	Water Level Data	
			Depth Below Existing Grade (m)	Elevation (m)
BH23-1	99.27	June 28, 2023	3.20	96.07
BH23-2	99.67	June 28, 2023	4.20	95.47
BH23-5	100.28	June 28, 2023	1.36	94.48

It should be noted that groundwater levels could fluctuate with seasonal weather conditions, (i.e.: rainfall, droughts, spring thawing) and due to construction activities at or near the vicinity of the site.

5 GEOTECHNICAL CONSIDERATIONS

This section of the report provides general geotechnical recommendations for the design aspect of the proposed residential dwellings based on our interpretation of the information gathered from the borehole data performed at this site and from the project requirements.

5.1 Foundations

Based on the subsurface soil conditions established at this site, it is recommended that the footings for the proposed residential dwellings be founded on the native material, consisting of either sand, clay, and/or sandy clay. Therefore, all topsoil, organic and any other deleterious material shall me stripped from the footprint(s).

5.2 Shallow Foundation

Conventional strip and column footings founded over the undisturbed native material may be designed using a maximum allowable bearing pressure of **75 kPa** for serviceability limit

state **(SLS)** and **110 kPa** for ultimate limit state **(ULS)** factored bearing resistance. The factored ULS value includes the geotechnical resistance factor of 0.5. This bearing capacity limits the allowable grade raise to 2.5 m, and allows for a strip footing maximum width of 1.8 m, and a pad footing maximum width of 3.6 m on any side.

In-situ field testing is required to check the strength and stability of the footing subgrade prior to any placement of concrete on a lot-by-lot basis. Any incompetent subgrade areas as identified from in-situ testing must be sub-excavated and backfilled with approved structural fill consisting of OPSS Granular B Type II. Similarly, any soft areas should also be sub-excavated and backfilled with approved structural fill only. Prior to placing any approved structural fill, the subgrade should be inspected and approved by geotechnical engineer or a qualified geotechnical personnel.

5.3 Structural Fill

For foundations set over undisturbed native soil and where excavation below the underside of the footings is performed in order to reach a suitable founding stratum, consideration should also be given to support the footings on structural fill. The structural fill, consisting of OPSS Granular B Type II, should be placed over undisturbed native soils in layers not exceeding 300 mm and compacted to 98% of its Standard Proctor Maximum Dry Density (SPMDD) within ±2% of its optimum moisture content. In order to allow the spread of load beneath the footings and to prevent undermining during construction, the structural fill should extend minimum 1.2 m beyond the outside edges of the footings and then outward and downward at 1 horizontal to 1 vertical profile (or flatter) over a distance equal to the depth of the structural fill below the footing. Furthermore, the structural fill must be tested to ensure that the specified compaction level is achieved

5.4 Lateral Earth Pressure

The following equation should be used to estimate the intensity of the lateral earth pressure against any earth retaining structure/foundation walls.

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

Where;

P = Earth pressure at depth h;

K = Appropriate coefficient of earth pressure;

γ = Unit weight of compacted backfill, adjacent to the wall;

h = Depth (below adjacent to the highest grade) at which P is calculated;

q = Intensity of any surcharge distributed uniformly over the backfill surface (usually surcharge from traffic, equipment or soil stockpiled and typically considered 10 kPa).

The coefficient of earth pressure at rest (K_0) should be used in the calculation of the earth pressure on the storm water manhole/basement walls, which are expected to be rather rigid and not to deflect.

The above expression assumes that perimeter drainage system prevents the build-up of any hydrostatic pressure behind the foundation wall.

5.5 Settlement

The estimated total settlement of the shallow foundations, designed using the recommended serviceability limit state capacity value, as well as other recommendations given above, will be less than 25 mm. The differential settlement between adjacent column footings is anticipated to be 15 mm or less.

5.6 Seismic

Based on the results of this geotechnical investigation and in accordance with the Ontario Building Code 2012 (table 4.1.8.4.A.) and Canadian Foundation Engineering Manual (4th edition), the site can be classified as Class "E" as per the Site Classification for Seismic Site Response. It should be noted that a greater seismic site response class may be obtained by conducting seismic velocity testing using a multichannel analysis of surface waves (MASW).

The above classifications were recommended based on conventional method exercised for Site Classification for Seismic Site Response and in accordance with the generally accepted geotechnical engineering practice.

5.7 Liquefaction Potential

As recommended in Canadian Foundation Engineering Manual 4th edition (*Bray et al. 2004)*, the following criteria can be used to determine liquefaction susceptibility of fine grained soils.

- $w/w_L \geq 0.85$ and $I_p \leq 12$: Susceptible to liquefaction or cyclic mobility
- $w/w_L \geq 0.8$ and $12 \leq I_p \leq 20$: Moderately susceptible to liquefaction or cyclic mobility
- $w/w_L < 0.8$ and $I_p \leq 20$: No liquefaction or cyclic mobility, but may undergo significant deformations if cyclic shear stress > static undrained shear strength.

Based on the above criteria, liquefaction is not a concern for this site.

5.8 Frost Protection

All exterior footings for any heated structure exposed to frost conditions should have a minimum of 1.5 m of earth cover. Footings for any unheated structures, signage or lighting, and where snow will be cleared, 1.8 m of earth cover is required. Alternatively, the required frost protection could be provided using a combination of earth cover and extruded polystyrene insulation. Detailed guidelines for footing insulation frost protection can be provided upon request.

In the event that foundations are to be constructed during winter months, the foundation soils are required to be protected from freezing temperatures using suitable construction techniques. The base of all excavations should be insulated from freezing temperatures immediately upon exposure, until heat can be supplied to the building interior and the footings have sufficient soil cover to prevent freezing of the subgrade soils.

5.9 Foundation Walls Backfill

To prevent possible lateral loading, the backfill material against any foundation walls, grade beams, isolated walls, or piers should consist of free draining, non-frost susceptible material such as sand or sand and gravel meeting OPSS Granular B Type I, II or Select Subgrade Material (SSM).

The foundation wall backfill should be compacted to minimum 95% of its SPMDD using light compaction equipment, where no loads will be set over top. The compaction shall be increased to 98% of its SPMDD under walkways, slabs or paved areas close to the foundation or retaining walls. Backfilling against foundation walls should be carried out on both sides of the wall at the same time where applicable.

5.10 Basement Construction

Basement floor slabs can rest either on undisturbed native material or approved structural fill. For bedding, a minimum 200 mm thick layer of 19 mm clear stone meeting the **OPSS 1004** gradation requirements should be placed.

A moisture barrier with vapour retarder shall be placed directly underlying the concrete slab, and overlying the clear stone bedding.

5.11 Foundation Drainage

A conventional, perforated corrugated polyethylene drainage pipe (100 mm minimum), pre-wrapped with geotextile knitted sock conforming to **OPSS 1840** should be embedded in a 300 mm layer of 19 mm clear stone and set adjacent to the perimeter footings. The drainage pipe should be connected positively to a suitable outlet, such as a sump pit or storm sewer.

In order to minimize ponding of water adjacent to the foundation walls, roof water should be controlled by a roof drainage system that directs water away from the building to prevent ponding of water adjacent to the foundation wall. The exterior grade should be sloped away from the building to promote water drainage away from the foundation walls.

5.12 Tree Planting Guidelines

It shall be noted that the cohesive soils encountered onsite may be sensitive to water depletion by trees of high water demand during periods of dry weather. When trees draw water the underlying soils may undergo shrinkage which can result in settlement of adjacent structures.

Small (7.5 m mature tree height) to medium (7.5 – 14.0 m mature tree height) size trees are permitted to be planted provided they are set back a minimum of 4.5 m from the foundation if the following conditions are met:

- The USF is 2.1 m or greater below the lowest finished grade.
- A small tree must have a minimum of 25 m^3 of available soil volume, and a medium tree must be provided with a minimum of 30 m^3 of available soil volume as determined by a landscape architect.
- Foundation walls are reinforced, at minimum, with two (2) upper and two (2) lower 15M rebar.
- Grading surrounding the tree must promote draining to the tree root zone.

5.13 Corrosion Potential and Cement Type

A soil sample was submitted to Paracel Laboratories Ltd. for chemical testing. The following **Table 4** below summarizes the results.

Table 4: Results of Chemical Analysis

Sample Location	Depth (m)	pH	Sulphate (µg/g)	Chloride (µg/g)	Resistivity (Ohm.cm)
BH23-3	1.5 – 2.1	7.63	21	<10	9,940

The above results revealed a measured sulphate concentration of 21 µg/g in the sample. Based on the CAN/CSA-A23.1 standards (Concrete Materials and Methods of Concrete Construction), a sulphate concentration of less than 1000 µg/g falls within the negligible category for sulphate attack on buried concrete. The test results from soil samples were below the noted threshold. As such, buried concrete for footings and foundations walls will not require any special additive to resist sulphate attack and the use of normal Portland cement is acceptable.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The soil resistivity was measured to be 9,940 ohm.cm, which falls between the “moderately corrosive” range for soil resistivity.

6 EXCAVATION AND BACKFILLING REQUIREMENTS

6.1 Excavation

It is anticipated that the maximum depth of excavation for this development will be 1.8 m bgs. Excavation must be carried-out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects.

According to the Ontario’s Occupational Health and Safety Act (OHSA), O. Reg. 213/91 and its amendments, the surficial overburden expected to be excavated into at this site can be classified as Type 3 for fully drained excavations. Therefore, shallow temporary excavations in the overburden soil can be cut at 1 horizontal to 1 vertical, for a fully drained excavation starting from the base of the excavation and as per requirements of the OHSA regulations.

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

6.2 Groundwater Control

Based on the subsurface conditions encountered at this site, minor (if any) groundwater seepage or infiltration into the temporary excavations during construction is expected to be encountered. Any water will be able to be controlled by pumping with sump pumps. Surface water runoff into the excavation should be minimized and diverted away from the excavation.

A permit to take water (PTTW) is required from Ministry of Environment and Climate Change (MOECC), Ontario Reg. 387/04, if more than 400,000 litres per day of groundwater will be pumped during a construction period less than 30 days. Registration in the Environmental Activity and Sector Registry (EASR) is required when water takings range between 50,000 and 400,000 litres per day.

The actual amount of groundwater inflow into open excavations will depend on several factors such as the contractor’s schedule, rate of excavation, the size of excavation, depth below the groundwater level, and at the time of year which the excavation is executed. It

is anticipated that pumping rates will be less than 50,000 litres per day. As such, EASR registration is not required for the construction at this site. However, this requirement could be confirmed by undertaking a hydrogeological study to determine the maximum volume of ground water inflow that will required to be pumped.

6.3 Pipe Bedding Requirements

It is anticipated that any underground services required as part of this project will be founded over properly prepared and approved structural fill. Consequently all organic material should be removed down to a suitable bearing layer. Any sub-excavation of disturbed soil should be removed and replaced with a Granular B Type II or I, or an approved equivalent, laid in loose lifts of thickness not exceeding 300 mm and compacted to 95% of its SPMDD. Bedding, thickness of cover material and compaction requirements for watermains, storm and sewer pipes should conform to the manufacturer's design requirements and to the detailed installations outlined in the Ontario Provincial Standard Specifications (OPSS) or any other applicable standards.

6.4 Trench Backfill

All service trenches should be backfilled using compactable material, free of organics, debris and large cobbles or boulders. Acceptable native materials (if encountered and where possible) should be used as backfill between the roadway subgrade level and the depth of seasonal frost penetrations (i.e. 1.8 m below finished grade) in order to reduce the potential for differential frost heaving between the new excavated trench and the adjacent section of roadway. Where native backfill is used, it should match the native materials exposed on the trench walls. Backfill below the zone of seasonal frost penetration could consist of either acceptable native material or imported granular material conforming to OPSS Granular B Type II. Any boulders larger than 150 mm in size should not be used as trench backfill.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the roadway, the trench should be compacted in maximum 300 mm thick lifts to at least 95% of its SPMDD. The specified density may be reduced where the trench backfill is not located within or in close proximity to existing roadways or any other structures.

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

7 SLOPE STABILITY ANALYSIS

7.1 Slope Description

The slope under review is located near the property line at the south and southwest portion of the site. The slope at the south of the site has a total height of about 6 m, and the slope at the southwest has a height of about 4 m. The slope profiles were determined to be about 2H:1V and 3H:1V respectively. The slope profiles were determined using the

Topographic Survey provided to LRL, and confirmed onsite using a measuring tape and hand-eye bubble level.

The slopes onsite were vegetated with some mature trees, shrubs, and wild overgrown grasses.

After a visual inspection of the slopes, no signs of any past slope failures were observed.

7.2 Slope Stability Results

The slope modelling program, Slide 5.0 (Rocscience), was used to implement the Bishop simplified method of slices. Two (2) slope profile named Section A and Section B were selected and modeled to check the conditions of the slope. The location of the profiles selected are shown on the Site Plan generated by EAU Structural and Environmental Services, attached in **Appendix E.** The slope was analyzed under undrained (short term failure), drained (long term failure), and seismic conditions.

The seismic analysis was performed by incorporating the seismic coefficient (k_h) into the modelling. The peak ground acceleration (PGA) for this area is equal to 0.32 for the 2% in 50 year probability of exceedance as per the NBC 2015. The value for k_h was taken as 50% of the PGA, which equates to 0.16. The minimum factor of safety (FoS) with regards to seismic condition is 1.10.

The field measurements in conjunction with known published data of the materials encountered onsite were used for selection of appropriate soil modelling parameters in the slope stability analyses.

The results of the analyses are potentially dependent on the assumption of groundwater condition. During the development of this report, no information on the groundwater level was available throughout the year. However, as a conservative approach the analysis was completed assuming full saturation throughout the slope profile.

The designed load for the dwelling was not provided (design bearing pressure at serviceability limit state) during our field investigation. However, a typical value of 75 kPa for residential construction was assumed and included within the model.

Table 5: Soil Parameters used in Slope Stability Analysis

Soil Type	Effective cohesion (c') - KPa	Angle of internal friction (ϕ') - degrees	Bulk unit weight (γ_B) – KN/m^3
Drained Parameters (Long Term)			
Sand	2	32	17.0
Clay	8	30	19.0
Undrained Parameters (Short Term)			
Sand	2	32	17.0
Clay	75	-	19.0

The below **Table 6** is a summary of the factor of safety (FoS) values were each section that was ran as part of the modelling.

Table 6: FOS Values for Slope Stability Modelling

Section	Drained Condition	Undrained Condition	Seismic
Factor of Safety			
Section A	1.771	2.699	1.624
Section B	3.236	4.028	2.156
Min. Required	**1.50**	**1.50**	**1.10**

These results indicate that the slopes present on site will remain stable in the drained, undrained, and seismic conditions.

The model results are included in **Appendix E.**

7.3 Setback Requirements

As outlined in the Ministry of Natural Resources (MNR) Guidelines, The Limit of Hazard Land consists of three components as follows The Limit of Hazard Land consists of three components as follows:

Limit of Hazard land = Stable Slope Allowance + Toe Erosion Allowance + Erosion Access Allowance.

The Stable Slope Allowance is the area where a factor of safety is less than 1.50 against overall rotational failure. As indicated above, the factor of safety's are greater than 1.50, therefore a stable slope allowance is not required.

Toe Erosion Allowance - based on our field observations, no toe erosion was observed, therefore no toe erosion allowance is required.

An Erosion Access Allowance is intended to provide a corridor of sufficient width that allows equipment to access the site to undertake a repair for any future unforeseen slope failure. A 6 m allowance is recommended for Erosion Access Allowance for all slopes at this site.

In summary, the Limit of Hazard Lands for this site is 6 m from the top of the slope.

7.4 Potential of Retrogressive Failure

A slope has the potential for retrogressive failure when the following three (3) conditions are met:

- Slope height is greater than 8 m;
- Slope angle of inclination is 14% or greater, and;
- Minimum 35 – 40% of the slope height is above the critical failure surface consists of sensitive marine clay.

Based on the above criteria, this slope is not prone to retrogressive failure.

7.5 Proposed Culvert Re-alignment

As part of generating this report; the "Culvert Design Technical Memorandum – 2940 Mer Bleue Road Watercourse Re-alignment" generated by J.L. Richards, dated September 03,

2024 was thoroughly reviewed to ensure to proposed re-alignment of the water course will not negatively affect the stability of the slope found onsite.

After review of the proposed cross-sections of the inlet, outlet, and of the piping/structures, it was concluded that the proposed grades and cross sections will not be significantly altered from existing conditions. Therefore, LRL can confirm the proposed re-alignment will not affect the stability of the slope in the short term, long term, or in the event of any seismic activity.

7.6 Conclusions/Recommendations

The following recommendations should be adhered to during the construction and post construction to ensure the long-term stability of the slopes.

- The existing vegetation cover near and within the existing slope should not be disturbed any more than is absolutely necessary for any proposed construction, as it promotes stability and erosion control to the slope.
- Any site drainage should be diverted away from the slope. Drainage outlets, if any, shall be protected with riprap over approved geotextile to eliminate erosion in the slope.
- No backfill or excavated material shall be placed within the Limit of Hazard Land.
- The slope profiles should not be modified in any way as part of the proposed construction. If modifications to the current slope profile are proposed, LRL should be consulted to ensure that the results of this report are still valid.

8 Reuse of On-Site Soils

The existing surficial overburden materials consists of sands and clays. These materials are considered to be frost susceptible and should not be used as backfill material directly against foundation walls or underneath unheated concrete slabs. However, it could be reused as general backfill material (service trenches, general landscaping/backfilling) if it can be compacted according to the specifications outlined herein at the time of construction and found free from any waste, organics and debris.

It should be noted that the adequacy of any material for reuse as backfill will depend on its water content at the time of its use and on the weather conditions prevailing prior to and during that time. Therefore, all excavated materials to be reused shall be stockpiled in a manner that will prevent any significant changes in their moisture content, especially during wet conditions, and approved for reuse by a geotechnical engineer.

9 Pavement Reinstatement

There are no access roads or municipal streets proposed to be constructed as part of this project. There will only be driveway(s) for the residential dwellings. However, there may be some street reinstatement from connecting to the municipal services.

The reinstatement of any pavement structure within the existing street should be conducted as recommended in **Section 6.4** and the pavement structure should be reinstated to match at minimum what already exists.

Where the existing asphaltic concrete surface of a roadway is affected by the excavating process, the damaged zones should be saw cut and any damaged or loose pieces of asphaltic concrete should be removed down to the binder course or its entire depth, where

only one layer exist. The existing base should be scarified and proof-rolled with any soft areas excavated and replaced to the proper level with OPSS Granular A. Where two layers of asphalt exist on an access lane, the surface course should be grinded over a width of 150 mm to allow the new surface course to overlap the binder layer and not create one straight vertical joint. On existing streets, the overlap should be increased to 300 mm.

10 INSPECTION SERVICES

The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed site do not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design.

All footing areas and any structural fill areas for the proposed buildings should be inspected by LRL to ensure that a suitable subgrade has been reached and properly prepared. The placing and compaction of any granular materials beneath the foundations and slab-on-grade should be inspected to ensure that the materials used conform to the required gradation and compaction specifications.

If the footings are to be constructed during winter season, the footing subgrade should be protected from freezing temperatures using suitable construction techniques.

11 REPORT CONDITIONS AND LIMITATIONS

It is stressed that the information presented in this report is provided for the guidance of the designers and is intended for this project only. The use of this report as a construction document or its use by a third party beyond the client specifically listed in the report is neither intended nor authorized by LRL Associates Ltd. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data as it affects their construction techniques, schedule, safety and equipment capabilities.

The professional services for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible contamination resulting from previous uses or activities at this site or adjacent properties, and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this report.

The recommendations provided in this report are based on subsurface data obtained at the specific test pit locations only. Boundaries between zones presented on the test pit logs are often not distinct but transitional and were interpreted. Experience indicates that the subsurface soil and groundwater conditions can vary significantly between and beyond the test locations. For this reason, the recommendations given in this report are subject to a field verification of the subsurface soil conditions at the time of construction.

The recommendations are applicable only to the project described in this report. Any changes to the project will require a review by LRL Associates Ltd., to ensure compatibility with the recommendations contained in this project.

We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report or if we may be of further services to you, please do not hesitate to contact the undersigned.

Yours truly,
LRL Associates Ltd.

Brad Johnson, P. Eng.
Geotechnical Engineer
W:\FILES 2023\230311\05 Geotechnical\01 Investigation\05 Reports\2024.10.30_Geotechnical Investigation_ Proposed Lot Severence_2940 Mer Bleue_Navan_R1.docx

APPENDIX A

Site and Borehole Location Plan

LRJ
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PROJECT

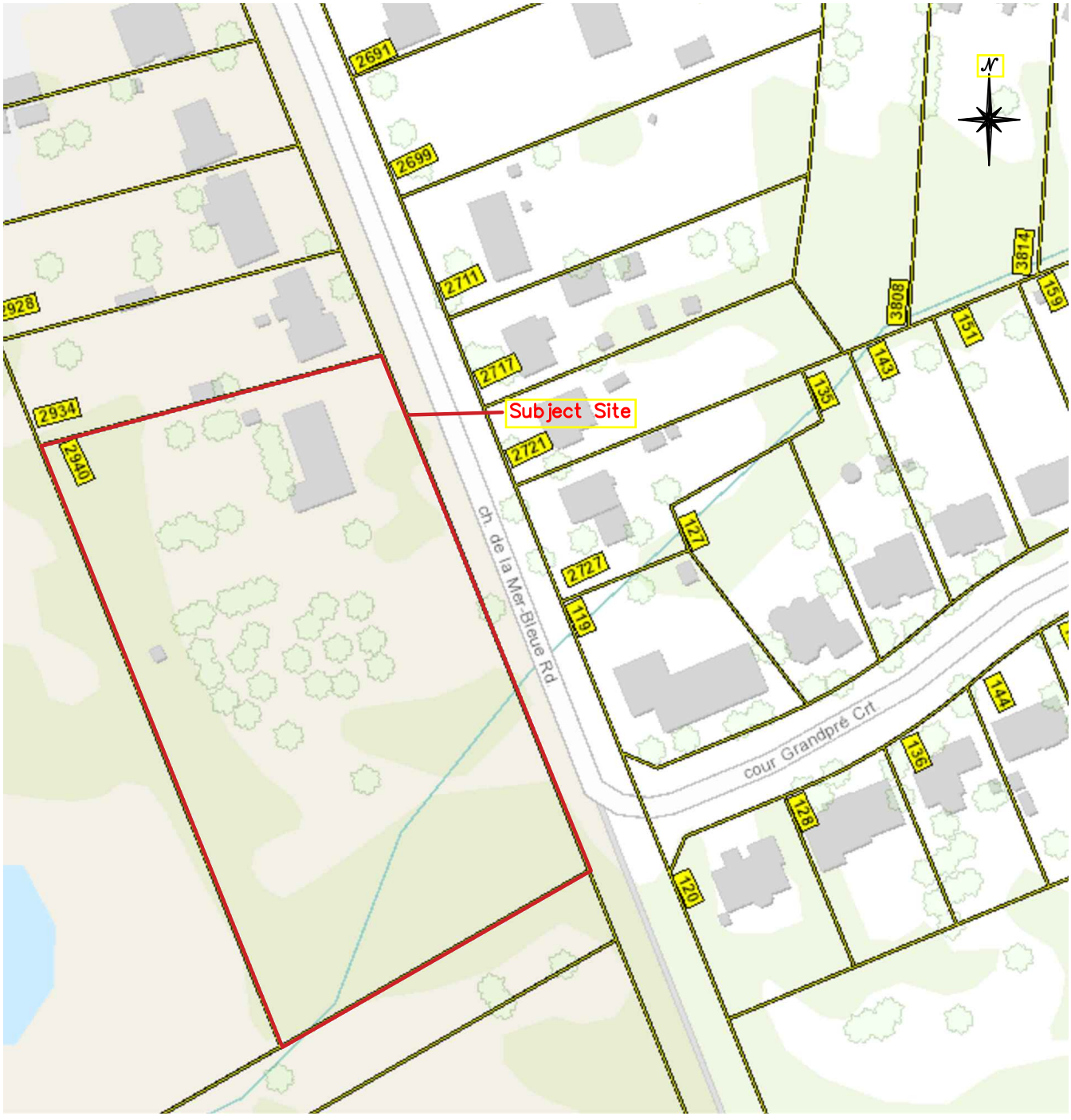
GEOTECHNICAL INVESTIGATION
PROPOSED LOT SEVERANCE
2940 MER-BLEUE ROAD
NAVAN, ONTARIO

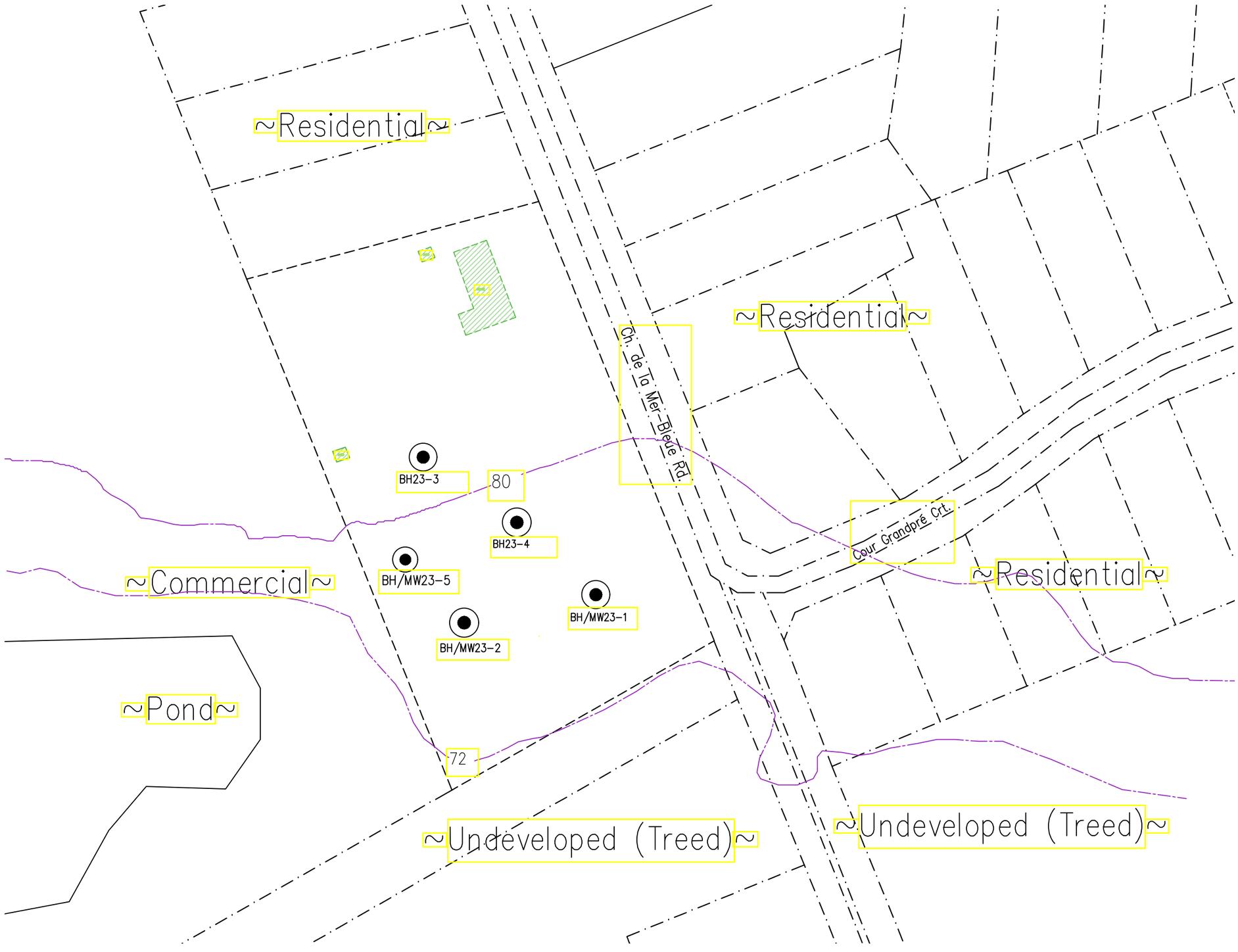
DRAWING TITLE

SITE LOCATION
(NOT TO SCALE)
SOURCE: GEOOTTAWA

CLIENT	DATE	PROJECT
JIHAD ZAMAT	AUGUST 2023	230311

FIGURE 1





LEGEND

- Subject Site Boundary
- Property Line
- Existing Building/Structure
- XX — Approximate Topographic Contour (Source: GeoOttawa)
- BH23-99 — Borehole (June 2023)
- BH/MW23-99 — Groundwater Monitoring Well (June 2023)

15m 0 30 60m

SCALE: 1:1250

No.	REVISIONS	BY	DATE
01	FINAL	B.J.	02/08/2023

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CLIENT

JIHAD ZAMAT

DESIGNED BY:	DRAWN BY:	APPROVED BY:
--	C.C.	B.J.

PROJECT

GEOTECHNICAL INVESTIGATION
PROPOSED LOT SEVERANCE
2940 MER-BLEUE ROAD
NAVAN, ONTARIO

DRAWING TITLE

BOREHOLE LOCATIONS

PROJECT NO.
230311

DATE
AUGUST 2023

FIGURE 2

APPENDIX B
Borehole Logs

BOREHOLE LOG: BH/MW23-1

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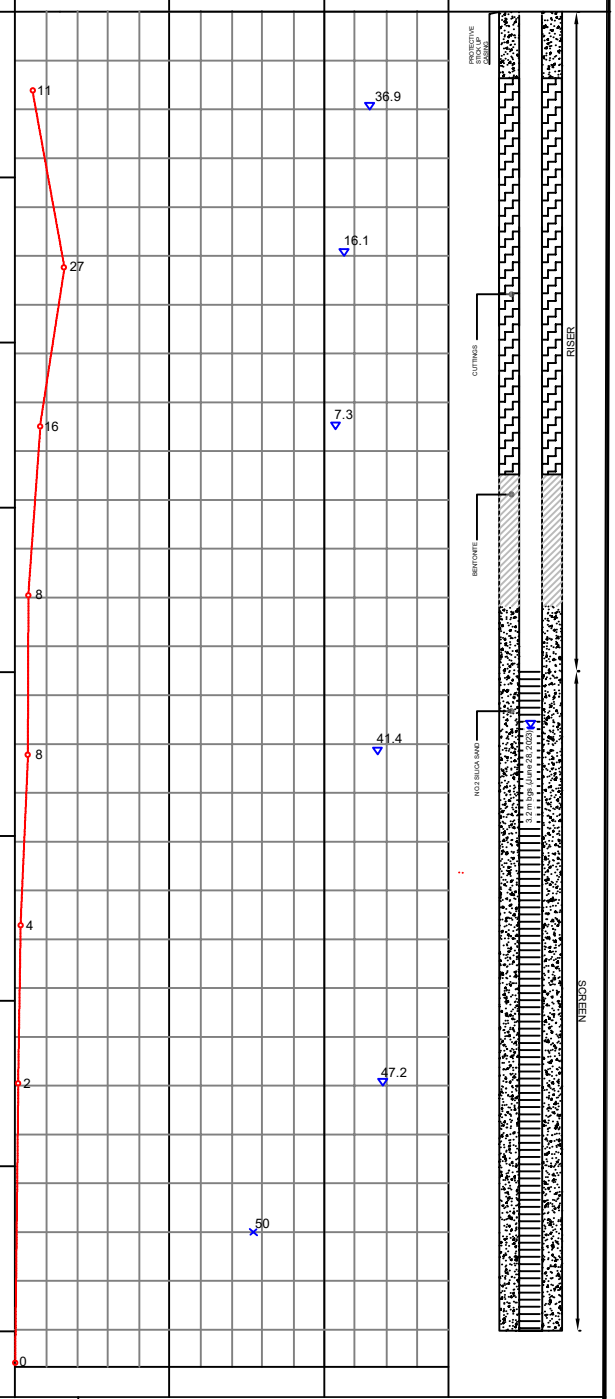
PROJECT NO.: 230311
CLIENT: JIHAD ZIMAT
DATE: JUNE 27, 2023

PROJECT: GEOTECHNICAL INVESTIGATION AND TERRAIN ANALYSIS
LOCATION: 2940 MER-BLEUE ROAD, NAVAN, ONTARIO
FIELD PERSONNEL: JESSICA ARTHURS/ CYNDII CHESTNUT

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED CME-55 **DRILLING METHOD:** Hollow Stem Auger

DEPTH (FT / M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS
0.0 / 0.0	**GRASS SURFACE**							
	TOP SOIL: Sandy, dark brown, dry.	0.00			SS1A			
1.0	**SAND:** Some silt, some gravel, trace clay, brown becoming dark brown at 0.76 m bgs, becoming light brown at 0.92 m bgs, dry, compact.				SS1	11	36	
3.0 / 1.0					SS2	27	43	
5.0					SS3	16	37	
6.0 / 2.0								
7.0		2.29			SS4	8	67	
8.0	**CLAY:** Some silt, brown becoming grey-brown at 4.57m bgs becoming grey at 8.38m bgs, dry becoming moist at 3.81m bgs becoming saturated at 10.7m bgs. Stiff becoming soft at 3.81m bgs becoming very soft at 6.86m bgs, reddish bands to 5.33m bgs, dark grey bands at 9.14m bgs, plasticky at 3.81m bgs, fissured at 3.70m bgs.							
10.0 / 3.0					SS5	8	100	
12.0								
13.0 / 4.0					SS6	4	100	
15.0								
16.0 / 5.0					SS7	2	100	
17.0								
18.0								
19.0								
20.0 / 6.0					SS8	WOH	100	



MONITORING WELL DETAILS

EASTING: 18T 0462017 **NORTHING:** 5029934

SITE DATUM: Mailbox directly east of the Site across Mer-Bleue Road (100.00 m)

GROUNDSURFACE ELEVATION: 99.27
HOLE DIAMETER: 203mm

TOP OF RISER ELEVATION: 100.17
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
N/A: Not applicable
WOH: Weight Of Hammer

BOREHOLE LOG: BH/MW23-1

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www.lrl.ca | (613) 842-3434

PROJECT NO.: 230311
CLIENT: JIHAD ZIMAT
DATE: JUNE 27, 2023

PROJECT: GEOTECHNICAL INVESTIGATION AND TERRAIN ANALYSIS
LOCATION: 2940 MER-BLEUE ROAD, NAVAN, ONTARIO
FIELD PERSONNEL: JESSICA ARTHURS/ CYNDII CHESTNUT

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED CME-55 **DRILLING METHOD:** Hollow Stem Auger

DEPTH (FT / M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	SPT N Values (Blows/0.3 m) 20 40 60 80	Vane Shear Strength (KPa) 20 40 60 80 / Vane Remold Shear Strength (KPa) 20 40 60 80	Water Content % 25 50 75	MONITORING WELL DETAILS
21.0 / 6.4					SS8	1-12"	100		1			
22.0												
23.0 / 7.0					SS9	WOH	100		0		55.1	
24.0												
25.0												
26.0 / 8.0					SS10	WOH	100		0			
27.0												
28.0												
29.0 / 9.0					SS11	WOH	100		0		72.8	
30.0												
31.0					SS12	WOH	100		0			
32.0												
33.0 / 10.0					SS13	WOH	100		0		70.8	
34.0												
35.0												
36.0 / 11.0					SS14	WOH	100		0			
37.0												
38.0					SS15	WOH	100		0		73.5	
39.0 / 12.0	End of Borehole	11.9										
40.0												
41.0												

BACKFILLED WITH CUTTINGS

EASTING: 18T 0462017 **NORTHING:** 5029934

SITE DATUM: Mailbox directly east of the Site across Mer-Bleue Road (100.00 m)

GROUNDSURFACE ELEVATION: 99.27
HOLE DIAMETER: 203mm

TOP OF RISER ELEVATION: 100.17
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
N/A: Not applicable
WOH: Weight of Hammer

BOREHOLE LOG: BH/MW23-2

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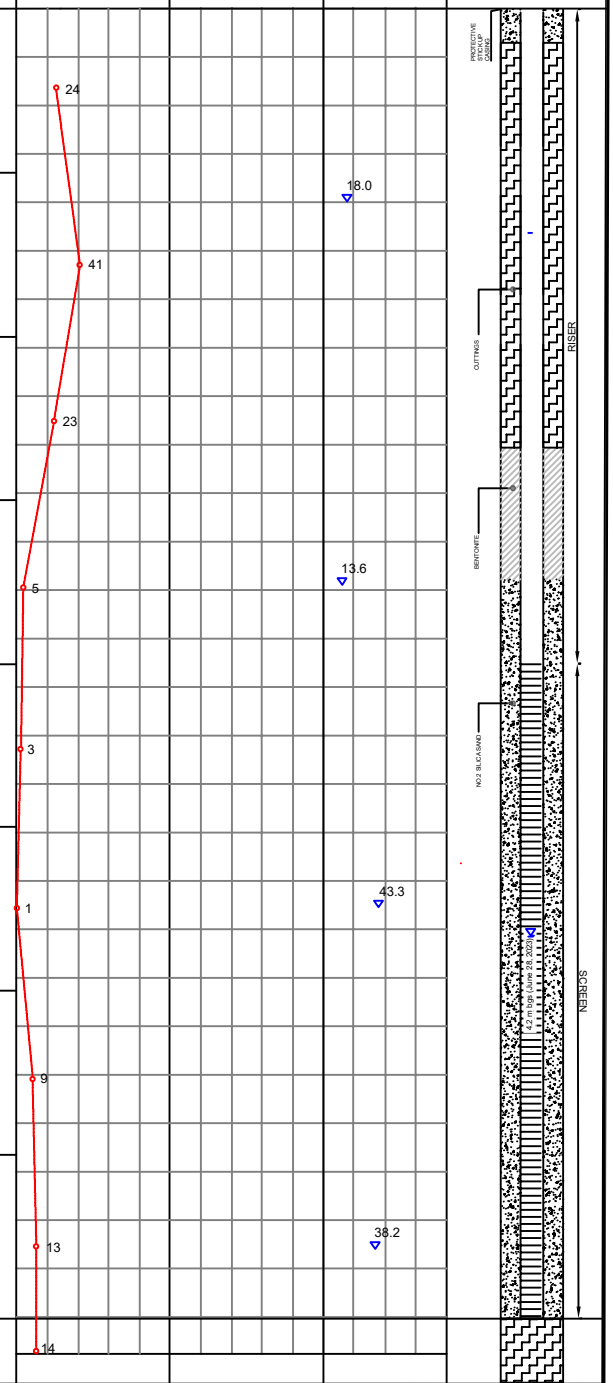
PROJECT NO.: 230311
CLIENT: JIHAD ZIMAT
DATE: JUNE 26, 2023

PROJECT: GEOTECHNICAL INVESTIGATION AND TERRAIN ANALYSIS
LOCATION: 2940 MER-BLEUE ROAD, NAVAN, ONTARIO
FIELD PERSONNEL: JESSICA ARTHURS/ CYNDII CHESTNUT

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED CME-55 **DRILLING METHOD:** Hollow Stem Auger

DEPTH (FT / M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS
0.0 / 0.0	**GRASS SURFACE**							
	TOP SOIL: Sandy clay loam, brown, dry.	0.00 / 99.78			SS1A			
	SAND: Some silt, trace clay, becoming gravelly below about 1.5 m bgs, brown, dry, becoming moist at 3.81 m bgs.	0.16			SS1B	24	44	
3.0 / 1.0					SS2A / SS2B / SS2C	41	53	
					SS3	23	27	
					SS4	5	27	
10.0 / 3.0					SS5	3	0	
	CLAY: Some silt, grey-brown becoming blue at 9.14m bgs, dry becoming moist at 9.14m bgs, becoming saturated at 10.7m bgs, stiff becoming soft at 6.86m bgs becoming very soft at 8.38m bgs, reddish bands at 6.1m bgs, slightly plasticky at 6.86m bgs, traces of organic matter at 5.33m bgs.	3.81			SS6	1	11	
15.0 / 5.0					SS7	9	43	
					SS8	13	72	
20.0 / 6.0					SS9	14	100	

SPT N Values (Blows/0.3 m): 20 40 60 80
Vane Shear Strength (KPa): 20 40 60 80
Vane Remold Shear Strength (KPa): 20 40 60 80
Water Content %: 25 50 75



EASTING: 18T 0461980 **NORTHING:** 5029927
SITE DATUM: Mailbox directly east of the Site across Mer-Bleue Road (100.00 m)

GROUNDSURFACE ELEVATION: 99.67
HOLE DIAMETER: 203mm
TOP OF RISER ELEVATION: 100.64
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
N/A: Not applicable
WOH: Weight of Hammer

BOREHOLE LOG: BH/MW23-2

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PROJECT NO.: 230311
CLIENT: JIHAD ZIMAT
DATE: JUNE 26, 2023

PROJECT: GEOTECHNICAL INVESTIGATION AND TERRAIN ANALYSIS
LOCATION: 2940 MER-BLEUE ROAD, NAVAN, ONTARIO
FIELD PERSONNEL: JESSICA ARTHURS/ CYNDII CHESTNUT

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD.
DRILLING EQUIPMENT: TRACK MOUNTED CME-55
DRILLING METHOD: Hollow Stem Auger

DEPTH (FT / M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS
21.0 / 6.4					SS9	14	100	
23.0 / 7.0					SS10	6	100	
26.0 / 8.0					SS11	7	100	
29.0 / 9.0					SS12	3	100	
31.0					SS13	WOH	100	
33.0 / 10.0					SS14	3	100	
36.0 / 11.0					SS15	WOH	100	
38.0 / 12.0					SS16	WOH	100	
40.0	End of Borehole	12.2						

SPT N Values (Blows/0.3 m): 20 40 60 80
Vane Shear Strength (KPa): 20 40 60 80
Vane Remold Shear Strength (KPa): 20 40 60 80
Water Content %: 25 50 75

SPT N values: SS9 = 14; SS10 = 6; SS11 = 7; SS12 = 3; SS13 = 0; SS14 = 3; SS15 = 0; SS16 = 0
Water content: 45.5; 54.0; 66.5; 73.6

MONITORING WELL DETAILS: BACKFILLED WITH CUTTINGS

EASTING: 18T 0461980
NORTHING: 5029927
SITE DATUM: Mailbox directly east of the Site across Mer-Bleue Road (100.00 m)

GROUNDSURFACE ELEVATION: 99.67
HOLE DIAMETER: 203mm
TOP OF RISER ELEVATION: 100.64
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
N/A: Not applicable
WOH: Weight of Hammer

BOREHOLE LOG: BH/MW23-3

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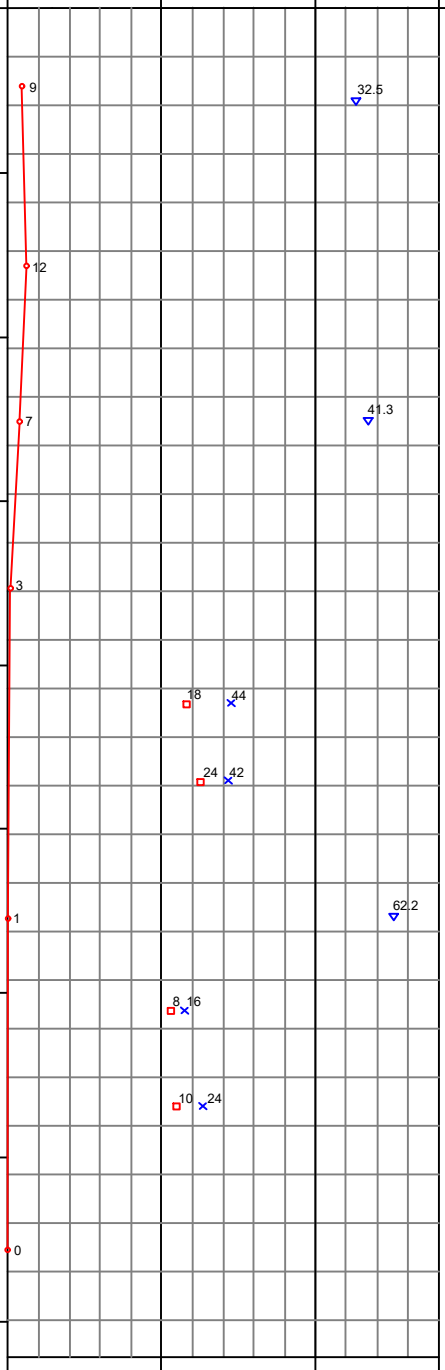
PROJECT NO.: 230311
CLIENT: JIHAD ZIMAT
DATE: JUNE 26, 2023

PROJECT: GEOTECHNICAL INVESTIGATION AND TERRAIN ANALYSIS
LOCATION: 2940 MER-BLEUE ROAD, NAVAN, ONTARIO
FIELD PERSONNEL: JESSICA ARTHURS/ CYNDII CHESTNUT

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED CME-55 **DRILLING METHOD:** Hollow Stem Auger

DEPTH (FT / M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS
0.0 / 0.0	**GRASS SURFACE**					
	TOP SOIL: Sandy loam, dark brown, dry, loose.	0.00	SS1A			
	SANDY CLAY: Low silt, brownish red becoming grey brown at 0.52m bgs, dry, loose.	0.12	SS1B	9	59	
	CLAY: Some silt, grey brown becoming blue at 3.81m bgs, dry becoming moist at 2.30m bgs, compact to very soft at 2.30m bgs, sticky at 3.81m bgs.	0.6	SS2	12	100	
			SS3	7	100	
			SS4	3	100	
			SS5	1	100	
			SS6	WOH	100	
	End of Borehole	6.1				

SPT N Values (Blows/0.3 m) 20 40 60 80
Vane Shear Strength (KPa) 20 40 60 80
Vane Remold Shear Strength (KPa) 20 40 60 80
Water Content % 25 50 75
MONITORING WELL DETAILS



EASTING: 18T 0461967 **NORTHING:** 5029971
SITE DATUM: Mailbox directly east of the Site across Mer-Bleue Road (100.00 m)
GROUNDSURFACE ELEVATION: 101.44 **TOP OF RISER ELEVATION:** N/A
HOLE DIAMETER: 203mm **MONITORING WELL DIAMETER:** N/A

NOTES:
bgs: Below Ground Surface
N/A: Not applicable
WOH: Weight of Hammer

BOREHOLE LOG: BH/MW23-4

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PROJECT NO.: 230311
CLIENT: JIHAD ZIMAT
DATE: JUNE 26, 2023

PROJECT: GEOTECHNICAL INVESTIGATION AND TERRAIN ANALYSIS
LOCATION: 2940 MER-BLEUE ROAD, NAVAN, ONTARIO
FIELD PERSONNEL: JESSICA ARTHURS/ CYNDII CHESTNUT

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED CME-55 **DRILLING METHOD:** Hollow Stem Auger

DEPTH (FT / M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS
0.0 / 0.0	**GRASS SURFACE**							
	TOP SOIL: Sandy, dark brown, dry.	0.00			SS1A			
		0.10						
	SANDY CLAY: Fine sand with traces of clay bands and roots, becoming clayey sandy loam with traces of silt at 1.15m bgs, brown becoming dark brown at 1.15m bgs, dry, loose.				SS1B	9	29	
					SS2A	12	75	
1.0 / 1.0					SS2B			
					SS3	11	31	
2.0 / 2.0								
	SILTY CLAY: Grey brown, moist becoming saturated at 3.81m bgs, soft becoming stiff (hard to break with hands) at 3.81m, fissured and reddish bands at 3.81m bgs.	2.29			SS4	0	32	
3.0 / 3.0								
4.0 / 4.0					SS5	4	71	
5.0 / 5.0								
					SS6	2	100	
6.0 / 6.0	End of Borehole	5.94						

SPT N Values (Blows/0.3 m): 20 40 60 80
Vane Shear Strength (KPa): 20 40 60 80
Vane Remold Shear Strength (KPa): 20 40 60 80
Water Content %: 25 50 75
MONITORING WELL DETAILS

SPT N values: 9, 12, 11, 0, 4, 2
Vane Shear Strength: 8, 18, 50, 50, 50
Water Content: 23.8, 38.0, 62.7

EASTING: 18T 0461995 **NORTHING:** 5029955
SITE DATUM: Mailbox directly east of the Site across Mer-Bleue Road (100.00 m)
GROUNDSURFACE ELEVATION: 99.97
HOLE DIAMETER: 203mm
TOP OF RISER ELEVATION: N/A
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
N/A: Not applicable
WOH: Weight of Hammer

BOREHOLE LOG: BH/MW23-5

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PROJECT NO.: 230311
CLIENT: JIHAD ZIMAT
DATE: JUNE 26, 2023

PROJECT: GEOTECHNICAL INVESTIGATION AND TERRAIN ANALYSIS
LOCATION: 2940 MER-BLEUE ROAD, NAVAN, ONTARIO
FIELD PERSONNEL: JESSICA ARTHURS/ CYNDII CHESTNUT

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD.
DRILLING EQUIPMENT: TRACK MOUNTED CME-55
DRILLING METHOD: Hollow Stem Auger

DEPTH (FT / M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS
0.0 / 0.0	**GRASS SURFACE**							
	TOP SOIL: Sandy, dark brown, dry.	0.00			SS1A			
		0.12						
1.0	**SAND:** Trace of silt, gravel and clay, brown, dry, loose.				SS1B	21	27	
2.0								
3.0 / 1.0					SS2	15	29	
4.0								
5.0					SS3	9	33	
6.0 / 2.0								
7.0								
8.0	**CLAY:** Some silt, brown becoming grey-brown at 3.81m bgs, then becoming blue at 6.86m bgs. Dry becoming moist at 4.57m bgs and saturated at 9.14m bgs, stiff becoming soft at 3.81m bgs becoming very soft at 6.86m bgs, reddish bands at 3.81m bgs, organic fossils at 2.28m bgs.	2.29			SS4	11	68	
9.0								
10.0 / 3.0								
11.0					SS5	9	67	
12.0								
13.0 / 4.0								
14.0					SS6	8	100	
15.0								
16.0					SS7	4	100	
17.0 / 5.0								
18.0								
19.0					SS8	1-12"	100	
20.0 / 6.0								

SPT N Values (Blows/0.3 m): 20 40 60 80
Vane Shear Strength (KPa): 20 40 60 80
Vane Remold Shear Strength (KPa): 20 40 60 80
Water Content %: 25 50 75

SPT N values: 21 (SS1B), 15 (SS2), 9 (SS3), 11 (SS4), 9 (SS5), 8 (SS6), 4 (SS7), 1 (SS8)
Water content: 20.3, 7.6, 42.5, 50.6

MONITORING WELL DETAILS: PROTECTIVE STICK UP CASING; BENTONITE; NO.3 SILICA SAND; RISER; SCREEN

EASTING: 18T 0461957
NORTHING: 5029942
SITE DATUM: Mailbox directly east of the Site across Mer-Bleue Road (100.00 m)
GROUNDSURFACE ELEVATION: 100.28
HOLE DIAMETER: 203mm
TOP OF RISER ELEVATION: 101.17
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
N/A: Not applicable
WOH: Weight of Hammer

BOREHOLE LOG: BH/MW23-5

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PROJECT NO.: 230311
CLIENT: JIHAD ZIMAT
DATE: JUNE 26, 2023

PROJECT: GEOTECHNICAL INVESTIGATION AND TERRAIN ANALYSIS
LOCATION: 2940 MER-BLEUE ROAD, NAVAN, ONTARIO
FIELD PERSONNEL: JESSICA ARTHURS/ CYNDII CHESTNUT

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED CME-55 **DRILLING METHOD:** Hollow Stem Auger

DEPTH (FT / M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	SPT N Values (Blows/0.3 m) 20 40 60 80	Vane Shear Strength (KPa) 20 40 60 80 / Vane Remold Shear Strength (KPa) 20 40 60 80	Water Content % 25 50 75	MONITORING WELL DETAILS
21.0 / 6.4										18 24		
22.0										14 30		
23.0 / 7.0					SS9	1-18"	100		1		70.4	
24.0												
25.0												
26.0 / 8.0					SS10	1-18"	100		1			
27.0												
28.0					SS11	WOH	100		0		72.5	
29.0 / 9.0												
30.0												
31.0					SS12	WOH	100		0			
32.0												
33.0 / 10.0					SS13	WOH	100		0		72.7	
34.0												
35.0												
36.0					SS14	WOH	100		0			
37.0 / 11.0	End of Borehole	11.9										
38.0												
39.0												
40.0 / 12.0												
41.0												

BACKFILLED WITH CUTTINGS

EASTING: 18T 0461957 **NORTHING:** 5029942

SITE DATUM: Mailbox directly east of the Site across Mer-Bleue Road (100.00 m)

GROUNDSURFACE ELEVATION: 100.28
HOLE DIAMETER: 203mm

TOP OF RISER ELEVATION: 101.17
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
N/A: Not applicable
WOH: Weight of Hammer

APPENDIX C
Symbols and Terms used in Borehole Logs

Symbols and Terms Used on Borehole and Test Pit Logs

1. Soil Description

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

a. Proportion

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

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

b. Compactness and Consistency

The state of compactness of granular soils is defined on the basis of the Standard Penetration Number (N) as per ASTM D-1586. It corresponds to the number of blows required to drive 300 mm of the split spoon sampler using a metal drop hammer that has a weight of 62.5 kg and free fall distance of 760 mm. For a 600 mm long split spoon, the blow counts are recorded for every 150 mm. The "N" value is obtained by adding the number of blows from the 2nd and 3rd count. Technical refusal indicates a number of blows greater than 50.

The consistency of clayey or cohesive soils is based on the shear strength of the soil, as determined by field vane tests and by a visual and tactile assessment of the soil strength.

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

State of Compactness Granular Soils	Standard Penetration Number "N"	Relative Density (%)
Very loose	0 – 4	<15
Loose	4 – 10	15 – 35
Compact	10 - 30	35 – 65
Dense	30 - 50	65 - 85
Very dense	> 50	> 85

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

Consistency Cohesive Soils	Undrained Shear Strength (C_u) (kPa)	Standard Penetration Number "N"
Very soft	<12.5	<2
Soft	12.5 - 25	2 - 4
Firm	25 - 50	4 - 8
Stiff	50 - 100	8 - 15
Very stiff	100 - 200	15 - 30
Hard	>200	>30

c. Field Moisture Condition

Description (ASTM D2488)	Criteria
Dry	Absence of moisture, dusty, dry to touch.
Moist	Dump, but not visible water.
Wet	Visible, free water, usually soil is below water table.

2. Sample Data

a. Elevation depth

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

b. Type

Symbol	Type	Letter Code
	Auger	AU
	Split Spoon	SS
	Shelby Tube	ST
	Rock Core	RC

c. Sample Number

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

LETTER CODE (as above) – Sample Number.

d. Recovery (%)

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

3. Rock Description

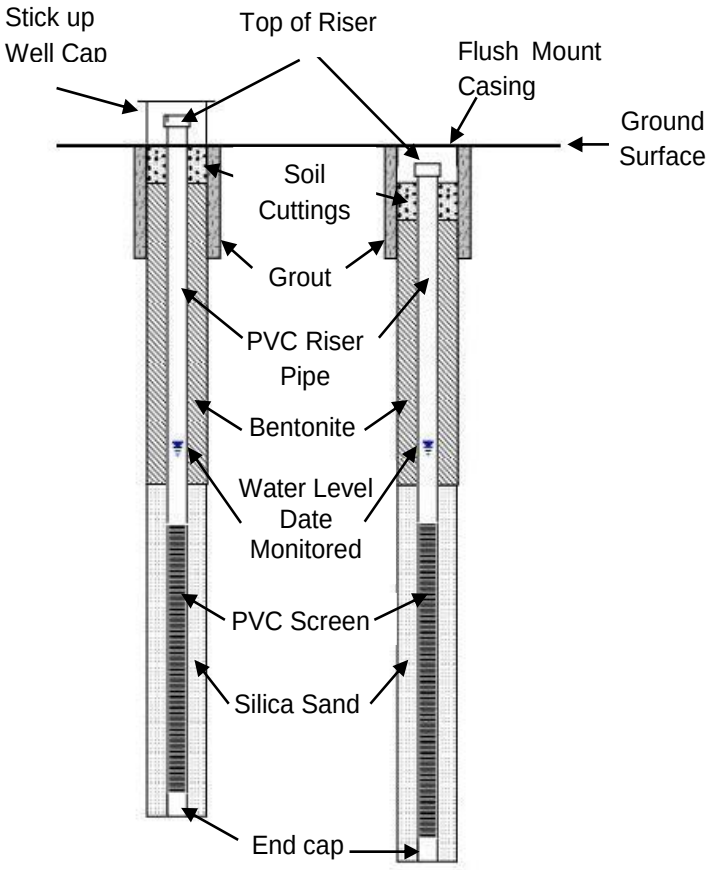
Rock Quality Designation (RQD) is a rough measure of the degree of jointing or fracture in a rock mas. The RQD is calculated as the cumulative length of rock pieces recovered having lengths of 100 mm or more divided by the length of coring. The qualitative description of the bedrock based on RQD is given below.

Rock Quality Designation (RQD) (%)	Description of Rock Quality
0 –25	Very poor
25 – 50	Poor
50 – 75	Fair
75 – 90	Good
90 – 100	Excellent

Strength classification of rock is presented below.

Strength Classification	Range of Unconfined Compressive Strength (MPa)
Extremely weak	< 1
Very weak	1 – 5
Weak	5 – 25
Medium strong	25 – 50
Strong	50 – 100
Very strong	100 – 250
Extremely strong	> 250

4. General Monitoring Well Data



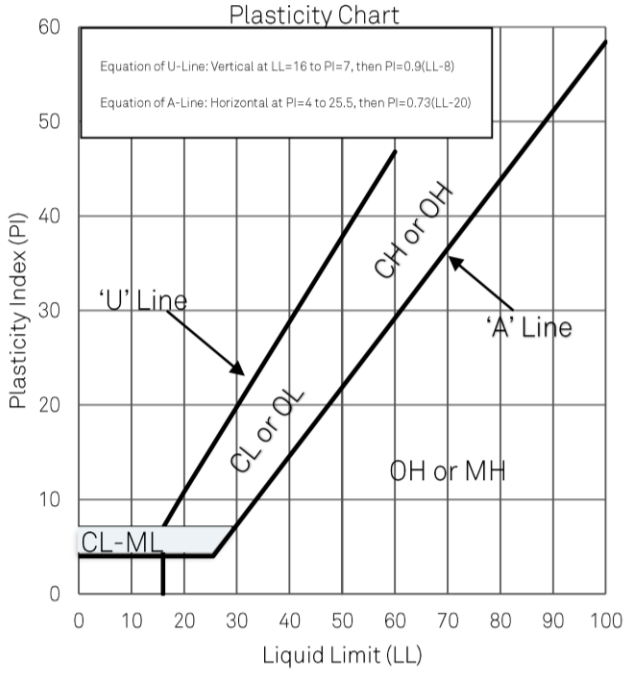
5. Classification of Soils for Engineering Purposes (ASTM D2487)

(United Soil Classification System)

Major divisions			Group Symbol	Typical Names	Classification Criteria
Coarse-grained soils More than 50% retained on No. 200 sieve* (>0.075 mm)	Gravels More than 50% of coarse fraction retained on No. 4 sieve(4.75 mm)	Clean gravels <5% fines	GW	Well-graded gravel	If 15% sand add "with sand" to group name.
			GP	Poorly graded gravel	
		Gravels with >12% fines	GM	Silty gravel	
			GC	Clayey gravel	
	Sands 50% or more of coarse fraction passes No. 4 sieve(<4.75 mm)	Clean sands <5% fines	SW	Well-graded sand	If 15% gravel add "with gravel to group name
			SP	Poorly graded sand	
		Sands with >12% fines	SM	Silty sand	
			SC	Clayey sand	
Fine-grained soils50% or more passes No. 200 sieve* (<0.075 mm)	Silts and Clays Liquid Limit <50%	Inorganic	ML	Silt	If 15 to 29% coarse-grained, add "with sand" or "with gravel" as appropriate. If > 30% coarse-grained, add "sandy" or "gravelly" as appropriate. Class as organic when oven dried liquid limit is < 75% of undried liquid limit.
			CL	Lean Clay -low plasticity	
		Organic	OL	Organic clay or silt (Clay plots above 'A' Line)	
	Silts and Clays Liquid Limit >50%	Inorganic	MH	Elastic silt	
			CH	Fat Clay -high plasticity	
		Organic	OH	Organic clay or silt (Clay plots above 'A' Line)	
	Highly Organic Soils		PT	Peat, muck and other highly organic soils	

Classification on basis of percentage of fines:
Less than 5% pass No. 200 sieve - GW, GP, SW, SP
More than 12% pass No. 200 sieve - GM, GC, SM, SC
5 to 12% pass No. 200 sieve - Borderline classifications, use of dual symbols

$C_u = \frac{D_{60}}{D_{10}} \geq 4$; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3		
Not meeting either Cu or Cc criteria for GW		
Atterberg limits below "A" line or PI less than 4		Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
Atterberg limits on or above "A" line and PI > 7		If fines are organic add "with orgnic fines" to group name
$C_u = \frac{D_{60}}{D_{10}} \geq 6$; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3		
Not meeting either Cu or C ccriteria for SW		
Atterberg limits below "A" line or PI less than 4		Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
Atterberg limits on or above "A" line and PI > 7		If fines are organic add "with orgnic fines" to group name



APPENDIX D
Laboratory Results

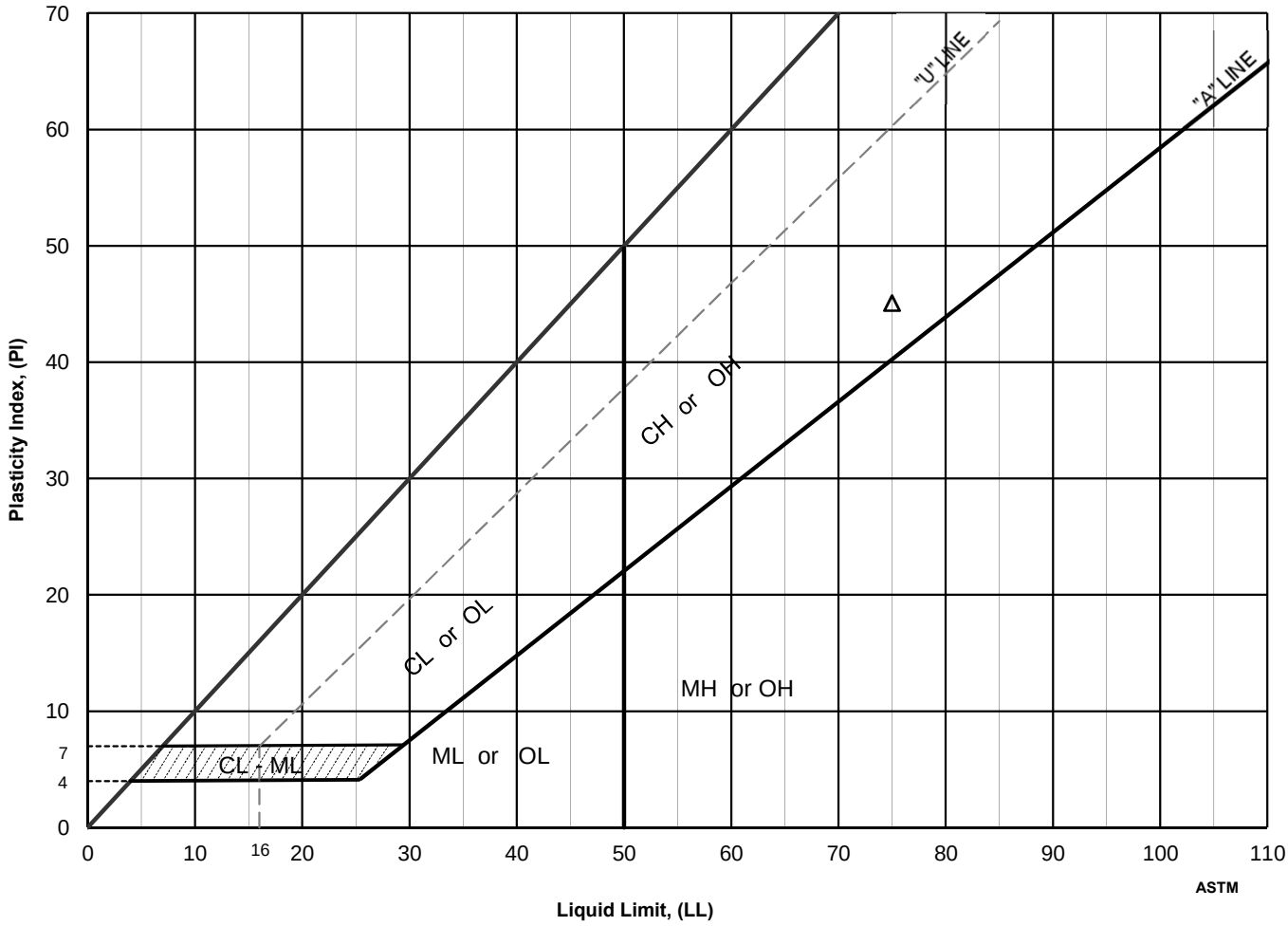
LRL Associates Ltd.

PLASTICITY INDEX

ASTM D 4318 / LS-703/704

Client:	Jihad Zamat	**File No.:**	230311
Project:	Geotechnical Investigation	**Report No.:**	1
Location:	2940 Mer Bleue Road, Navan, ON.	**Date:**	June 26, 2023

Plasticity Chart



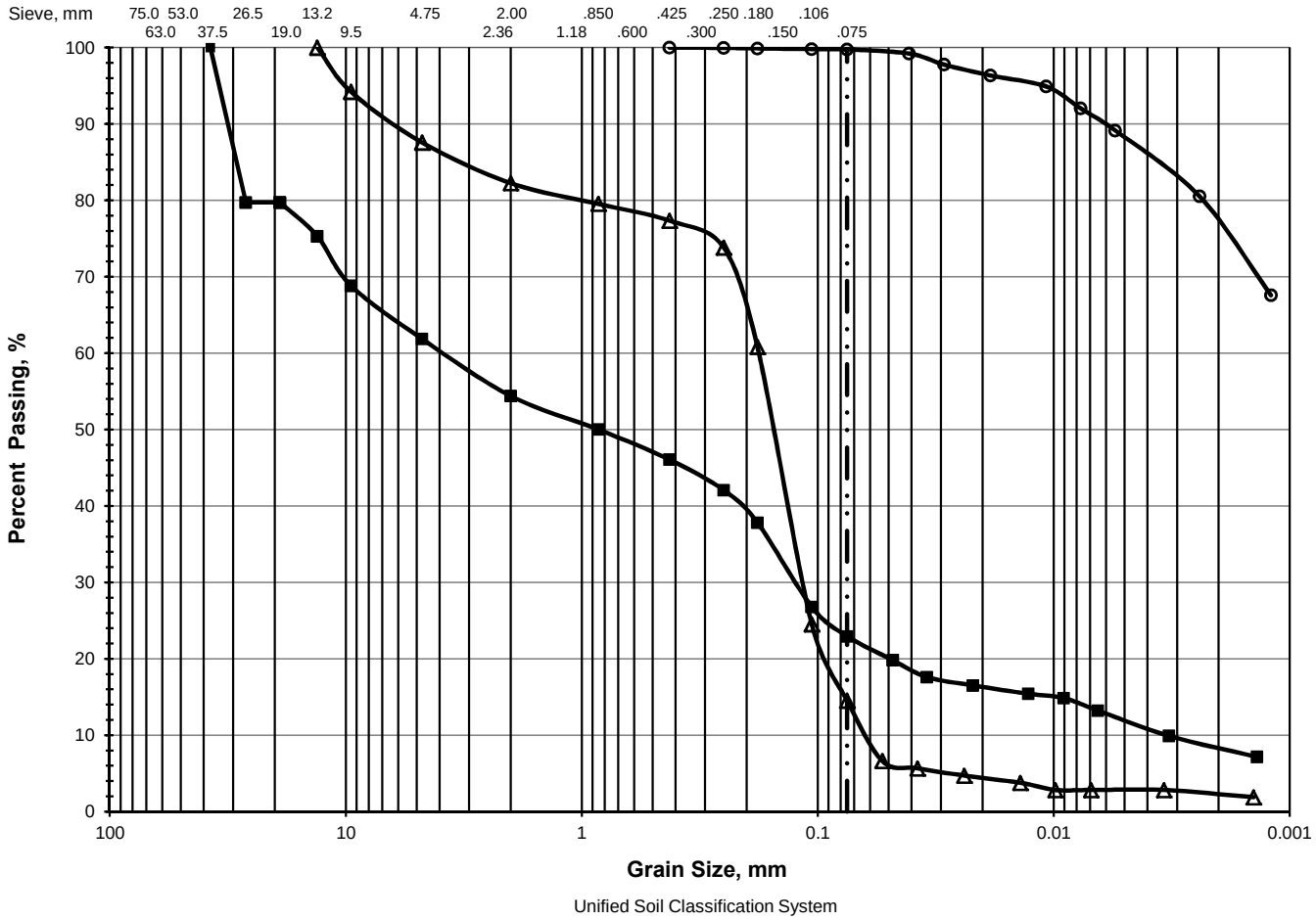
	Location	Sample	Depth, m	Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Activity Number	USCS
△	BH 23-3	SS-3	1.52 - 2.29	41	75	30	45	0.25	n/d	CH

LRL Associates Ltd.

PARTICLE SIZE ANALYSIS

ASTM D 422 / LS-702

Client:	Jihad Zamat	**File No.:**	230311
Project:	Geotechnical Investigation	**Report No.:**	2
Location:	2940 Mer Bleue Road, Navan, ON.	**Date:**	June 26, 2023



Unified Soil Classification System

	> 75 mm	% GRAVEL		% SAND			% FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
△	0.0	0.0	12.4	5.3	4.9	62.8	12.3	2.3
■	0.0	20.2	17.9	7.5	8.3	23.1	14.9	8.1
○	0.0	0.0	0.0	0.0	0.0	0.3	23.5	76.2

	Location	Sample	Depth, m	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
△	BH 23-1	SS-3	1.52 - 2.13	0.1783	0.1579	0.1172	0.0765	0.0625	1.2	2.9
■	BH 23-2	SS-3	1.52 - 2.13	4.0635	0.8493	0.1318	0.0100	0.0033	1.3	1231.4
○	BH 23-4	SS-6	5.33 - 5.94							

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1-800-749-1947
www.paracellabs.com

Certificate of Analysis

LRL Associates Ltd.
5430 Canotek Road
Ottawa, ON K1J 9G2
Attn: Brad Johnson

Client PO:
Project: 230311
Custody: 71564

Report Date: 13-Jul-2023
Order Date: 7-Jul-2023

Order #: 2327350

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2327350-01	BH23-3 SS3 5-7'

Approved By:

Dale Robertson, BSc
Laboratory Director

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	11-Jul-23	12-Jul-23
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	10-Jul-23	10-Jul-23
Resistivity	EPA 120.1 - probe, water extraction	10-Jul-23	11-Jul-23
Solids, %	CWS Tier 1 - Gravimetric	7-Jul-23	10-Jul-23

Certificate of Analysis

Report Date: 13-Jul-2023

Client: **LRL Associates Ltd.**

Order Date: 7-Jul-2023

Client PO:

Project Description: 230311

	Client ID:	BH23-3 SS3 5-7'	-	-	-		
	Sample Date:	26-Jun-23 09:00	-	-	-	-	-
	Sample ID:	2327350-01	-	-	-		
	Matrix:	Soil	-	-	-		
	MDL/Units						
Physical Characteristics							
% Solids	0.1 % by Wt.	72.2	-	-	-	-	-
General Inorganics							
pH	0.05 pH Units	7.63	-	-	-	-	-
Resistivity	0.1 Ohm.m	99.4	-	-	-	-	-
Anions							
Chloride	10 ug/g	<10	-	-	-	-	-
Sulphate	10 ug/g	21	-	-	-	-	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions								
Chloride	ND	10	ug/g					
Sulphate	ND	10	ug/g					
General Inorganics								
Resistivity	ND	0.1	Ohm.m					

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	183	10	ug/g	177			3.0	35	
Sulphate	437	10	ug/g	347			23.0	35	
General Inorganics									
pH	7.88	0.05	pH Units	7.87			0.1	2.3	
Resistivity	49.5	0.1	Ohm.m	50.0			1.0	20	
Physical Characteristics									
% Solids	88.9	0.1	% by Wt.	91.0			2.3	25	

Certificate of Analysis

Report Date: 13-Jul-2023

Client: **LRL Associates Ltd.**

Order Date: 7-Jul-2023

Client PO:

Project Description: 230311

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	275	10	ug/g	177	97.3	82-118			
Sulphate	440	10	ug/g	347	92.9	80-120			

Certificate of Analysis

Report Date: 13-Jul-2023

Client: **LRL Associates Ltd.**

Order Date: 7-Jul-2023

Client PO:

Project Description: 230311

Qualifier Notes:

Sample Data Revisions:

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

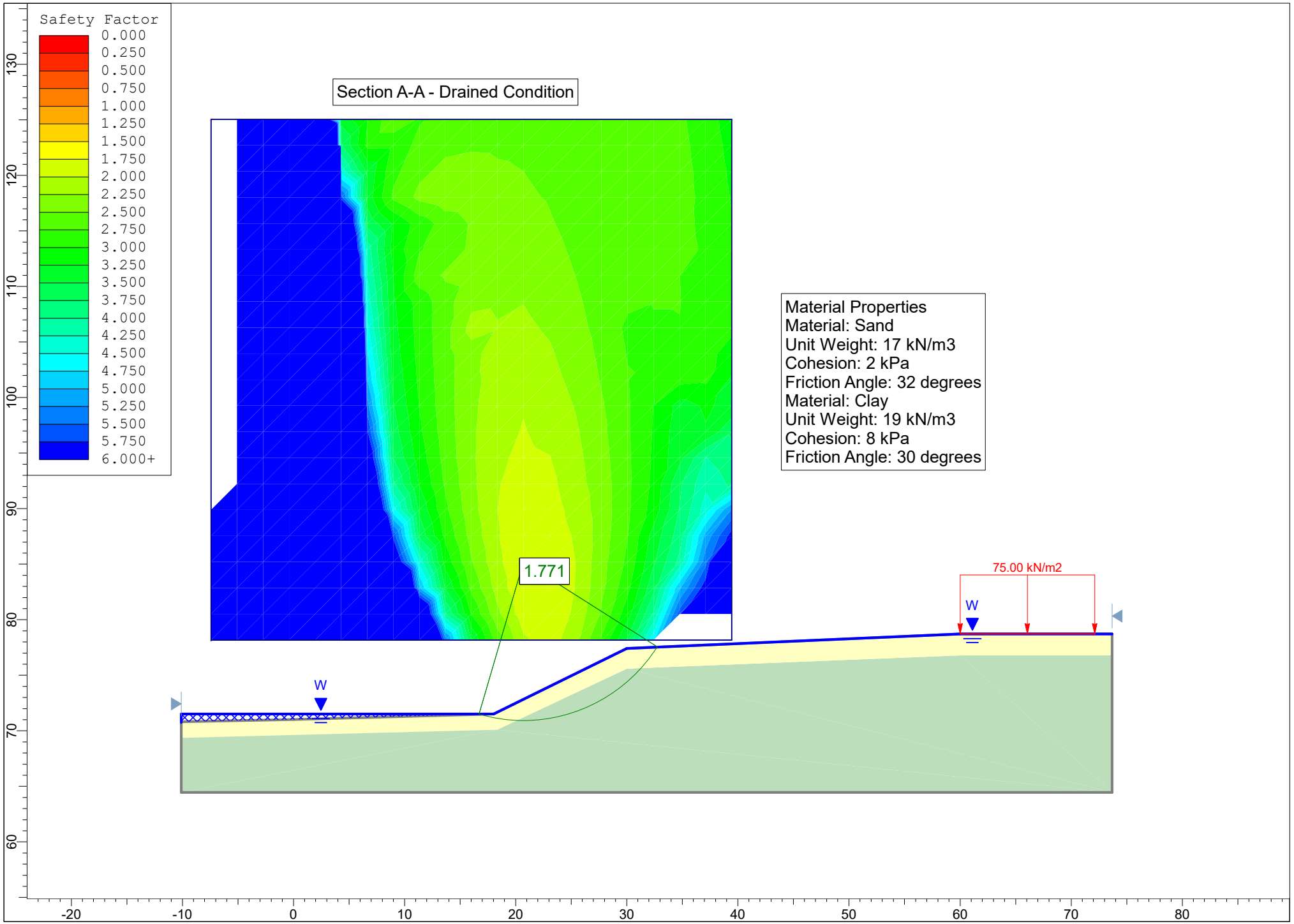
RPD: Relative percent difference.

NC: Not Calculated

Soil results are reported on a dry weight basis unlesss otherwise noted.

Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

APPENDIX E
Slope Stability Modelling Results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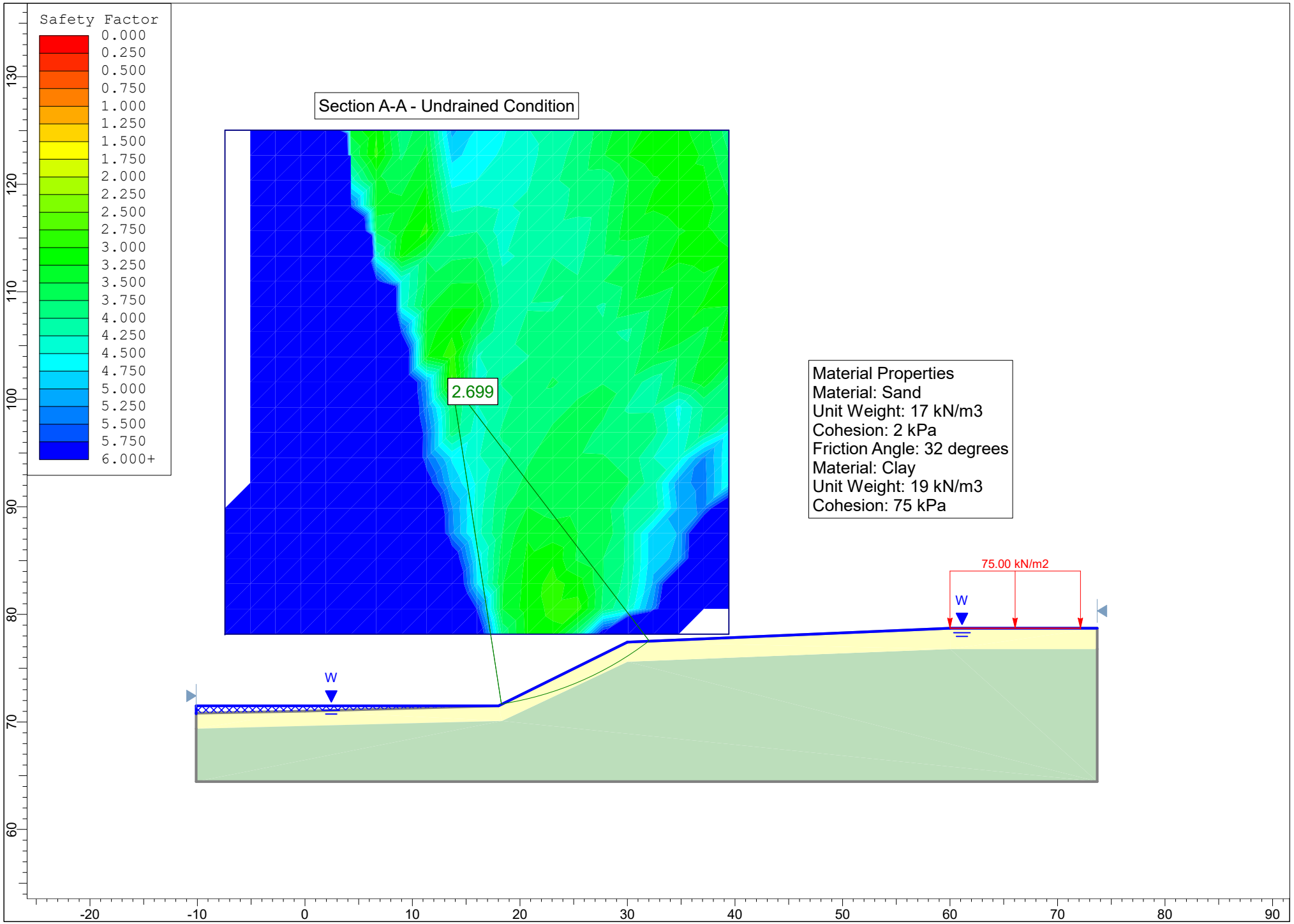
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
Section A-A - Drained Condition
Material Properties
Material: Sand
Unit Weight: 17 kN/m3
Cohesion: 2 kPa
Friction Angle: 32 degrees
Material: Clay
Unit Weight: 19 kN/m3
Cohesion: 8 kPa
Friction Angle: 30 degrees
1.771
75.00 kN/m2
W
W
130
120
110
100
90
80
70
60
-20
-10
0
10
20
30
40
50
60
70
80


Safety Factor
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1.250
1.500
1.750
2.000
2.250
2.500
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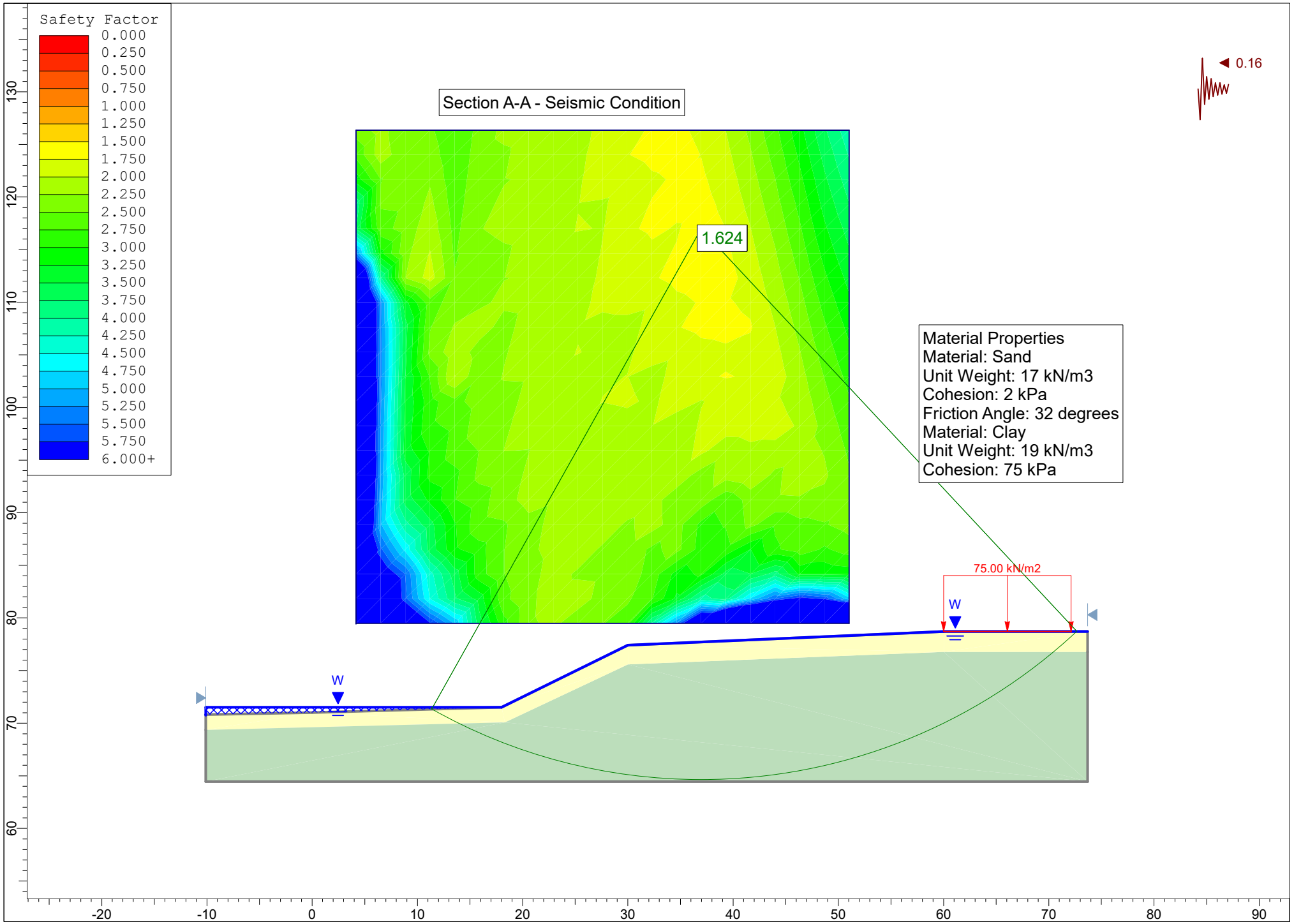
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
Section A-A - Undrained Condition
2.699
Material Properties
Material: Sand
Unit Weight: 17 kN/m3
Cohesion: 2 kPa
Friction Angle: 32 degrees
Material: Clay
Unit Weight: 19 kN/m3
Cohesion: 75 kPa
75.00 kN/m2
W
W
130
120
110
100
90
80
70
60
-20
-10
0
10
20
30
40
50
60
70
80
90


Safety Factor
0.000
0.250
0.500
0.750
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1.250
1.500
1.750
2.000
2.250
2.500
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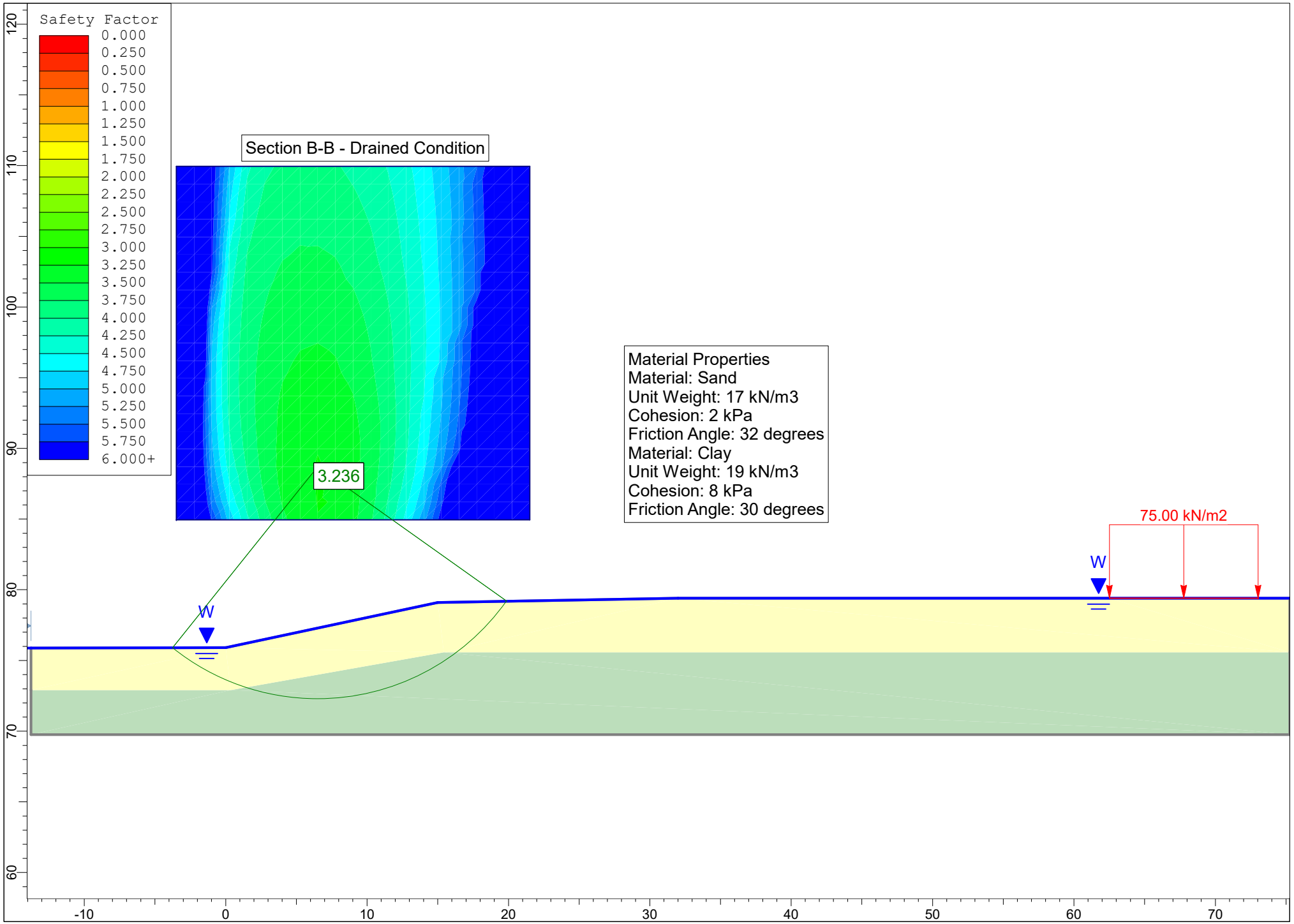
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
Section A-A - Seismic Condition
0.16
1.624
Material Properties
Material: Sand
Unit Weight: 17 kN/m3
Cohesion: 2 kPa
Friction Angle: 32 degrees
Material: Clay
Unit Weight: 19 kN/m3
Cohesion: 75 kPa
75.00 kN/m2
W
W
130
120
110
100
90
80
70
60
-20
-10
0
10
20
30
40
50
60
70
80
90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2.000
2.250
2.500
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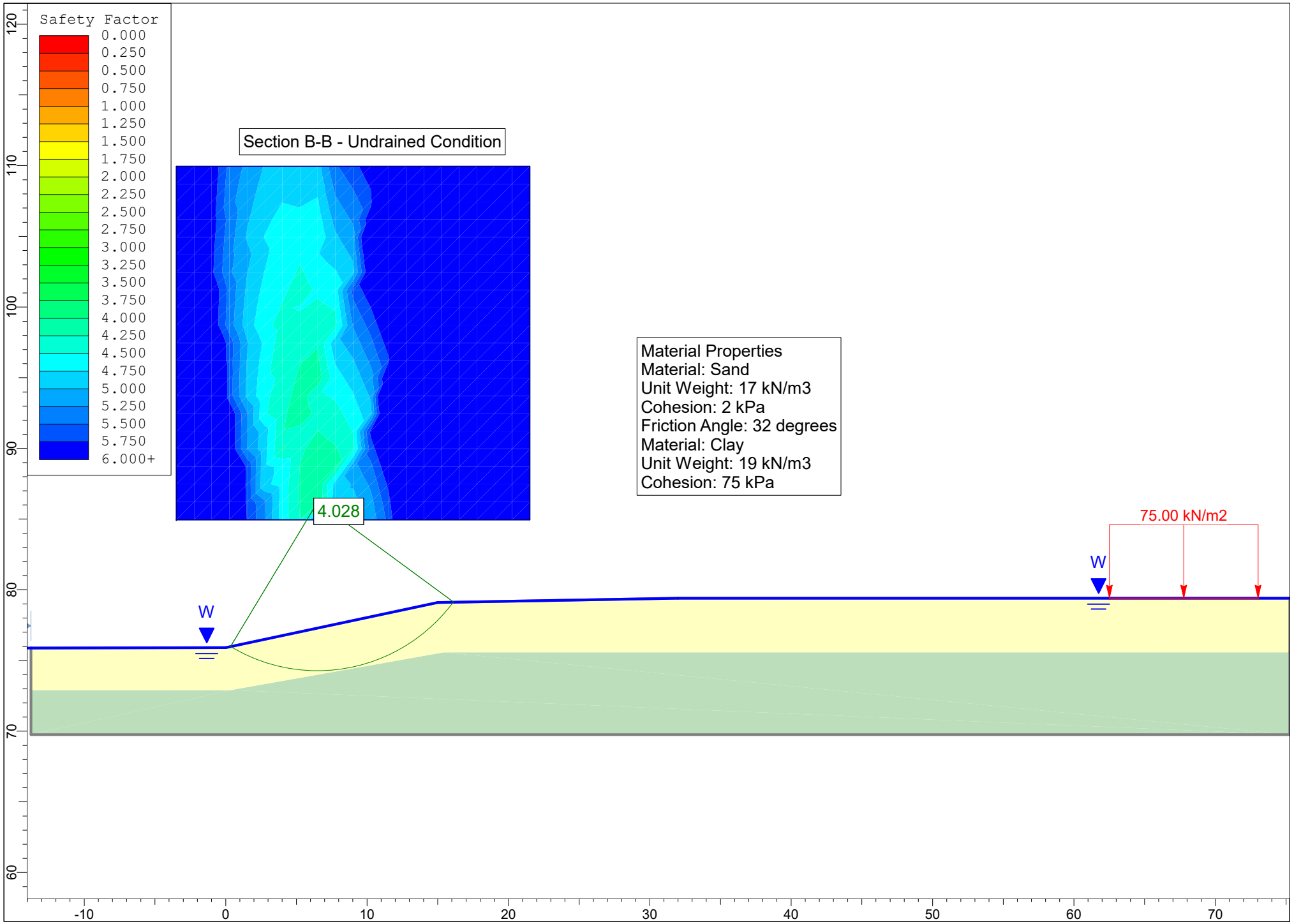
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
Section B-B - Drained Condition
3.236
Material Properties
Material: Sand
Unit Weight: 17 kN/m3
Cohesion: 2 kPa
Friction Angle: 32 degrees
Material: Clay
Unit Weight: 19 kN/m3
Cohesion: 8 kPa
Friction Angle: 30 degrees
75.00 kN/m2
W
W
120
110
100
90
80
70
60
-10
0
10
20
30
40
50
60
70


Safety Factor
0.000
0.250
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0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
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3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
Section B-B - Undrained Condition
4.028
Material Properties
Material: Sand
Unit Weight: 17 kN/m3
Cohesion: 2 kPa
Friction Angle: 32 degrees
Material: Clay
Unit Weight: 19 kN/m3
Cohesion: 75 kPa
75.00 kN/m2
W
W
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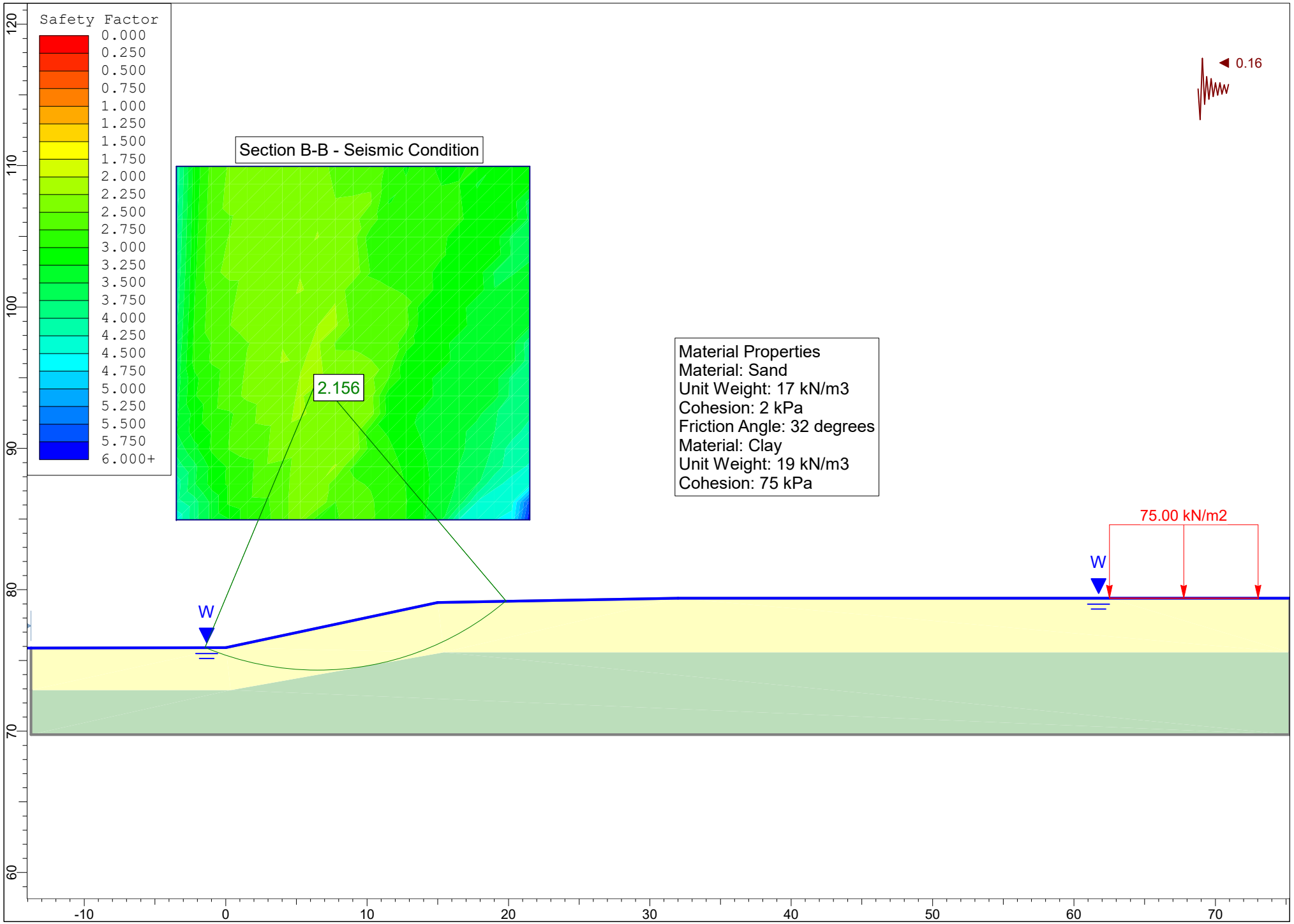
110
100
90
80
70
60
-10
0
10
20
30
40
50
60
70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0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
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3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
Section B-B - Seismic Condition
2.156
0.16
Material Properties
Material: Sand
Unit Weight: 17 kN/m3
Cohesion: 2 kPa
Friction Angle: 32 degrees
Material: Clay
Unit Weight: 19 kN/m3
Cohesion: 75 kPa
75.00 kN/m2
W
W
120
110
100
90
80
70
60
-10
0
10
20
30
40
50
60
70

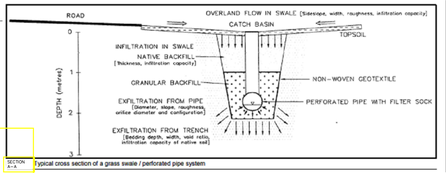
TOPOGRAPHIC PLAN OF SURVEY OF

PART OF LOT 1
CONCESSION 4 (OTTAWA FRONT)
GEOGRAPHIC TOWNSHIP OF GLOUCESTER
CITY OF OTTAWA

FARLEY, SMITH & DENIS SURVEYING LTD. 2021

Notes & Legend

existing level = 89.00
proposed level = 89.00
BM = 82.39m
SLC = spring line connection to water main
LL = lot line
DS = down spout
VB = valve box
water lateral = 19mm dia., type K copper pipe
– – – – – – – = 10m set back requirement for slope stability



Typical cross section of a grass swale / perforated pipe system

A-A

ISSUED FOR			
No	DATE	DESCRIPTION	App.
1	2022.03.21	PRELIMINARIES	P.T.
2	2022.12.06	LOTS DIVISION DRAFT BY CONSENT	P.T.
3	2023.06.23	For Review	D.C.
4			
5			
6			
7			

REVISION			
No	DATE	DESCRIPTION	App.
1	2022.02.25	ACCORDING TO SURVEY & CITY COMMENTS	P.T.
2	2023.06.06	ACCORDING TO CITY COMMENTS	P.T.
3	2023.06.23	For Review	D.C.
4			
5			
6			
7			

Stamps

LICENSED PROFESSIONAL ENGINEER D. R. CLARK 26/6/23 PROVINCE OF ONTARIO

EAU Structural Environmental Services

Derrick Clark PEng
EAU Structural & Environmental Svs
tel., 613 869 0523,
Email: derrick.r.clark@rogers.com

Project: RESIDENTIAL PROJECT
3 SINGLE FAMILY DWELLING
2940 MER-BLEUE, Orléans, ON.

Title: SITE PLAN

Scale: 1:300
Sheet:
Date: 2023/06/06
Drawn /: A. Aldu.
Drawing No. A-100
Revision: 2
Verify /: P.Tabet