SOIL-MAT ENGINEERS & CONSULTANTS LTD.

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PROJECT NO.: SM 301961-G October 22, 2024

JEC PROPERTIES
5341 John Lucas Drive
Burlington, Ontario
L7L 6A8

Attention: Mohammad Abdullah

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
2105 HEADON ROAD
BURLINGTON, ONTARIO

Dear Mr. Abdullah,

Further to your authorisation, SOIL-MAT ENGINEERS & CONSULTANTS LTD. has completed the fieldwork, laboratory testing, and report preparation in connection with the above noted project. The scope of work was completed in general accordance with our proposal P301961, dated July 9, 2021 and revised on April 20, 2023. Our comments and recommendations based on our findings at the four [4] borehole locations are presented in the following paragraphs.

1. INTRODUCTION

We understand that the project will involve the construction a nine-unit townhouse block, along with installation of associated underground municipal services along an asphalt paved roadway, upon demolition of the existing structures located at 2105 Headon Road in Burlington, Ontario. The purpose of this geotechnical investigation work was to assess the subsurface soil and groundwater conditions, and to provide our comments and recommendations with respect to the design and construction of the proposed development, from a geotechnical point of view.

This report is based on the above summarised project description, and on the assumption that the design and construction will be performed in accordance with the applicable codes and standards. Any significant deviations from the proposed project design may void the recommendations given in this report. If significant changes are made to the proposed design, this office must be consulted to review the new design with respect to the results of this investigation. It is noted that SOIL-MAT ENGINEERS has completed a Phase One ESA for the subject site, which has been reported under a separate cover.

2. PROCEDURE

A total of four [4] sampled boreholes were advanced at the locations illustrated in the attached Drawing No. 1, Borehole and Slope Profile Location Plan. The boreholes were advanced using continuous flight power auger equipment on August 23, 2024 under the direction and supervision of a staff member of SOIL-MAT ENGINEERS & CONSULTANTS LTD., to termination at depths of approximately between 4.8 to 6.3 metres below the existing ground surface.

Upon completion of drilling, monitoring wells were installed in Borehole Nos. 1 and 4 to allow for the future monitoring of the groundwater level. The monitoring wells consisted of 50-millimetre PVC pipe, screened in the lower 3.0 meters. The monitoring wells were encased in well filter sand up to approximately 0.3 metres above the screened portion, then with bentonite 'hole plug' to the surface and fitted with a protective steel 'stick up' casing. The remaining boreholes were backfilled in general accordance with Ontario Regulation 903, and the ground surface was reinstated even with the surrounding grade.

Representative samples of the subsoils were recovered from the borings at selected depth intervals using split barrel sampling equipment driven in accordance with the requirements of ASTM test specification D1586, Standard Penetration Resistance Testing. After undergoing a general field examination, the soil samples were preserved and transported to the SOIL-MAT laboratory for visual, tactile, and olfactory classifications. Routine moisture content tests were preformed on all soil samples recovered from the borings, with hand penetrometer testing conducted on all cohesive samples. Additionally, two [2] selected soil samples were subject to laboratory grain size

The boreholes were located in the field by representatives of SOIL-MAT ENGINEERS, based on accessibility over the site and clearance of underground utilities. The ground surface elevation at the borehole locations has been referenced to a site specific geodetic benchmark, noted as the south corner of an existing dwelling, as illustrated in the Drawing No. 1, Borehole Location Plan. The benchmark is noted to have an elevation of 143.62 metres as per MMP survey drawing, Project No. 20-152, dated September 22, 2020, forwarded to our office.

Details of the conditions encountered in the boreholes, together with the results of the field and laboratory tests, are presented in Log of Boreholes Nos. 1 to 4 inclusive, following the text of this report. It is noted that the boundaries of soil types indicated on the borehole logs are inferred from non-continuous soil sampling and observations made while drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and therefore should not be construed at the exact depths of geological change.

Additionally, a representative slope profile was measured, based on accessibility in the area of slope on the south side of the property, from the existing fence line, down to relatively flat area on the south side. The location of this slope profile is illustrated on the attached Drawing No. 2, Slope Profile Location Plan, while the slope profile itself is illustrated on the attached Drawing No. 3, Slope Profile A-A. It is noted that due to limited access over the slopes from fallen trees over the slope, this was the only accessible area to measure a profile, and based on our visual assessment of the slope, is considered representative of the slope section nearest the development.

A Slope Stability Rating Chart as per the Ontario Ministry of Natural Resources publication "Geotechnical Principles for Stable Slopes" [Geotechnical Principles publication] was completed for the slope at the worst-case scenario at Slope Profile A-A, and indicated a Rating Value of 32. This corresponds to a slight potential for slope instability. A copy of the Slope Stability Rating Charts have been appended to the end of this report.

3. SITE DESCRIPTION AND SUBSURFACE CONDITIONS

The subject site is consists of an existing residential dwelling with associated granular driveway and parking area, located at 2105 Headon Road in Burlington, Ontario. The subject site is surrounded by residential properties with CH Norton Public School located on north side of the site. The project area is relatively flat around the existing house structure, with gently sloping down to Headon Road on south side, and down to the valley lands of Tuck Creek on south and east side of the property with an elevation difference of approximately 4 metres.

The subsurface conditions encountered at the borehole locations are summarised as follows:

Topsoil

A surficial veneer of topsoil approximately 200 millimetres in thickness was encountered at Borehole Nos. 3 and 4. It is noted that the depth of topsoil may vary across the site and from the depths encountered at the borehole locations, and would be expected to be thicker in areas of heavy vegetation. As such, a conservative approach should be taken in estimating topsoil quantities across the site. It is also noted that the term 'topsoil' has been used from a geotechnical point of view, and does not necessarily reflect the materials nutrient content or ability to support plant life.

Pavement Structure

Borehole Nos. 1 and 2 were advanced through the existing granular surfaced driveway, which was found to consist of approximately 200 millimetres of compact granular material.

Silty Clay/Clayey Silt

Native silty clay/clayey silt was encountered beneath the topsoil or pavement structure in all the borehole locations. The native cohesive soils were reddish brown in colour, contained trace to some sand, trace gravel, occasional cobbles, and were generally very stiff to hard in consistency. The native soils were proven to termination at depths of between approximately 5.2 to 6.3 metres below existing ground surface. It is noted that the upper levels of the native soils generally had a weathered or reworked appearance in upper levels, likely due to weathering and having been subjected to freeze/thaw cycles. It is also noted that while not explicitly identified during our investigation, some fill deposits associated with grading, construction of existing structures, etc., may be present across the site.

Grain size analyses were conducted on two [2] selected samples of the native soils encountered. The results of this testing can be found appended to the end of this report, and are summarized as follows:

TABLE A – GRAIN SIZE ANALYSES

Sample ID	Depth	% Clay	% Silt	% Sand	% Gravel	Hydraulic Conductivity, k [cm/s]
BH1 SS4	2.6 m	34	46	16	4	10^{-7}
BH4 SS3	1.8 m	39	47	12	2	10^{-7}

The field and laboratory testing demonstrate the native soils to predominantly consist of Silt and Clay with some Sand and trave Gravel. According to the Unified Soil Classification System (USCS), the soils are classified as M.L. – clayey silts with slight plasticity to inorganic silts. The silty clay/clayey silt soils encountered have a low hydraulic conductivity, on the order of 10^{-7}cm/sec, and would be considered effectively impermeable.

A review of available published information [Quaternary Geology of Ontario, Southern Sheet Map 2556] indicate the subsurface soils to consist of clay to silt-textured till, consistent with our experience in the area, the above analyses, and our observations during drilling.

Groundwater Observations

All the boreholes were recorded as open and 'dry' upon completion of drilling. It is noted that insufficient time would have passed for the static groundwater level to stabilise in the open boreholes.

As noted above, monitoring wells were installed in Borehole Nos. 1 and 4 to allow for future measurements of the groundwater level. The details of the monitoring well installation, as well as the groundwater measurements taken, have been summarized as follows.

TABLE B: SUMMARY OF GROUNDWATER MEASUREMENTS

BH/MW#	Ground Surface Elevation (m)	MW Depth (m)	Screened Interval (m)	September 9, 2024		October 3, 2024	
				Water Depth (m)	Water Elevation (m)	Water Depth (m)	Water Elevation (m)
1	142.78	6.1	3.1 – 6.1	2.3	140.5	2.8	140.0
4	142.86	6.1	3.1 – 6.1	5.3	137.6	4.7	138.1

Note: It is noted that, the above elevations are referenced to a site specific temporary benchmark with an assigned elevation of 100 meters for convenience.

Based on the conditions encountered at the borehole locations it is anticipated that the relatively shallow groundwater levels observed in Borehole No. 1 may be artificially shallow, influenced by permeable seams. The available groundwater data to date indicates a groundwater level on the order of perhaps 4 to 5 metres below the existing ground surface, at elevations of approximately between 137.5 to 138.5 metres, varying with the physical topography, and would be expected to fluctuate seasonally. These groundwater depths are below the anticipated depths of construction. Regardless, shallower 'perched' deposits within permeable seams, etc., should be expected, especially during the 'wet' times of the year.

4. SLOPE CONDITIONS AND STABILITY ASSESSMENT

As noted above, a representative profiles of the subject slope, identified as Slope Profile A-A, was measured in the area of slope on the south side of the property, from the existing fence line, down to the valley lands on the south side. The subject slope on the south side of the property was measured to be approximately 4.5 metres in height, flat near the existing fence line sloping down to the south with an overall inclination of about 1.8 horizontal to 1 vertical. The ground surface was noted to be predominately vegetated with young to mature trees with exposed roots, and some patches of grass

and scrub vegetation. No evidence of significant surficial movements, failure scars, tension cracks, or other signs of global slope instability were observed at the time of our site visit.

As with all slopes, there is a reduction in shearing resistance attributed to the effects of freezing and thawing, wetting and drying, burrowing animals, etc. With time, the surface of the slope will degenerate and tend to reach equilibrium within its stress and ambient environment, including vegetative cover. However, this degeneration of the slope angle is a very slow process as is evident by the present condition of the existing slope.

A stability analysis of the subject slope was performed with a computerized modelling program [SLOPE/W 2021] utilising multiple methods of analysis [Ordinary, Bishop and Janbu, Morgenstern-Price, etc.] and considering different slip planes and centres of rotation, as well as normal and elevated groundwater conditions, to determine the minimum factors of safety for the slope.

Soil properties for the subsurface soils have been conservatively attributed based on the soil strata encountered in the boreholes advanced. In this case the subsurface soils have been modelled as native silty clay/clayey silt, and have been conservatively assigned a unit weight of γ = 19.5 kN/m^3, an angle of internal friction of ϕ = 32 degrees, and cohesion of c = 5 kPa.

Based on our analyses using the conservative soil parameters noted above, the subject slope was found to have minimum factors of safety, with respect to the top of stable slope location (delineated through the Ministry of Natural Resources method noted below) on the order of 1.88 or greater for normal groundwater conditions, and on the order of 1.72 or greater under elevated groundwater conditions. Sample results of these analyses are attached to the end of this report.

The Ministry of Natural Resources “Geotechnical Principles for Stable Slopes” publication, Table 7.2 lists a minimum Factor of Safety of 1.3 to 1.5 for Active Land Use properties [habitable or occupied structures near the slope]. As the calculated factors of safety were found to be within or exceed this range, the subject slope would be considered stable in the short and long term, with respect to the long-term top of stable slope.

4.1 TOP OF STABLE SLOPE

The top of stable slope location (based on the Ministry of Natural Resources method) is determined by the application of an erosion allowance at the toe and a stable slope inclination through the slope. In this case, considering the condition of the toe of the slope, and the absence of any watercourse within 15 metres of the toe of the slope, an erosion allowance of 0 metres would be considered appropriate. Table 4.3 of the Ministry of Natural Resources publication "Geotechnical Principles for Stable Slopes" indicates stable slope inclinations through glaciolacustrine clays and silts in the range of 2.0 to 4.0 horizontal to 1.0 vertical. Based on the conditions encountered at the borehole location, a stable slope inclination of 2.0 horizontal to 1 vertical has been applied for the very stiff to hard silty clay/clayey silt soils. Applying this stable slope inclination and erosion allowance results in a long-term top of stable slope location approximately 0.6 metres "uphill" of the physical crest, as illustrated on Drawing No. 1, Borehole and Slope Profile Location Plan.

4.2 CONSTRUCTION CONSIDERATIONS

It is our opinion that the existing slope is considered to be stable in the long-term, and that the construction of the proposed townhouse and associated laneway uphill of the established long-term top of stable slope location, would have no negative impact on the stability of the subject slope, from a geotechnical point of view.

The following recommendations should be considered in the proposed construction:

- Excavated soil and/or heavy construction equipment should not be placed or travel near the top of stable slope location. In this regard it is recommended that a silt fence be placed along, or slightly 'uphill' from, the top of stable slope for the duration of construction. This will act as a barrier for construction activity and also prevent sediment runoff during construction.
- Any drainage towards the slope should be in a controlled fashion, such as sheet flow through well-established grass or vegetation, so as to not alter the natural drainage over the slope or create concentrated flows onto the slope.
- Vegetation on the slope should be protected during construction and all existing trees on the slope maintained. Uphill of the crest of the slope the vegetation should be repaired/improved with the establishment of new deep-rooted vegetation post construction, where required, in accordance with the site landscape plan.

5. EXCAVATIONS

Excavations for the installation of foundations and underground services are anticipated to extend to depths of up to approximately 2 to 3 metres below the existing grade. Excavations through the native silty clay/clayey silt soils should be relatively straightforward, with the sides remaining stable for the short construction period at slopes of up to 60 degrees to the horizontal. Where wet seams are encountered, during periods of extended precipitation, or where excavations extend below the static groundwater level, the sides of excavations should be expected to 'slough in' to as flat as 3 horizontal to 1 vertical, or flatter. Notwithstanding the foregoing, however, all excavations must comply with the current Occupational Health and Safety Act and Regulations for Construction Projects. Excavation slopes steeper than those required in the Safety Act must be supported and a senior geotechnical engineer from this office should monitor the work. With respect to the Safety Act, the competent native silty clay/clayey silt soils would be considered as Type 2 soil.

As noted above the static groundwater level is conservatively anticipated at depths of approximately 4 to 5 metres below the existing ground surface, below the anticipated depths of construction. Regardless, some infiltration of water from permeable seams, as well as from surface runoff, should still be anticipated, especially during the 'wet' times of the year. The rate of infiltration should be sufficiently low, such that it should be possible to control via conventional construction dewatering techniques for excavations extending near to slightly below the static groundwater level. More water should be expected when connections are made to existing services. Surface water should be directed away from the excavations.

Any utility poles, light poles, etc. located within 3 metres of the top of an excavation slope should be braced to ensure their stability. Likewise, temporary support might be required for other existing above and below ground structures, including existing underground services, depending on their proximity to the trench excavations.

6. BACKFILL CONSIDERATIONS

The excavated materials will primarily consist of the native silty clay/clayey silt soils encountered in the boreholes, as described above, as well as fill materials associated with existing structures. The native soils are generally considered suitable for use as engineered fill, trench backfill, etc., provided they are free of organics, debris, or other deleterious material, and that their moisture contents can be controlled to within 3 percent of their standard Proctor optimum moisture content. Some selective sorting to remove organics, debris, etc. from fill deposits associated with existing structures, should be expected to be required.

It is noted that the cohesive soils encountered are not considered to be free draining, and should not be used where this characteristic is required. It is also noted that these soils present difficulties in achieving effective compaction where access with compaction equipment is restricted. The silty clay/clayey silt soils are generally considered to be near to slightly 'dry' of their standard Proctor Optimum moisture content. Some moisture conditioning may be required depending upon the weather conditions at the time of construction. It is noted that these soils will become nearly impossible to compact when wet of its optimum moisture content. Any material that becomes wet to saturated should be spread out to allow to dry, or removed and discarded, or utilised in non-settlement sensitive areas.

We note that where the backfill material is placed near or slightly above its optimum moisture content, the potential for long term settlements due to the ingress of groundwater and collapse of the fill structure is reduced. Correspondingly, the shear strength of the 'wet' backfill material is also lowered, thereby reducing its ability to support construction traffic and therefor impacting construction. If the soil is well dry of its optimum value, it will appear to be very strong when compacted, but will tend to settle with time as the moisture content in the fill increases to equilibrium condition. The cohesive soils may require high compaction energy to achieve acceptable densities if the moisture content is not close to its standard Proctor optimum value. It is therefore very important that the placement moisture content of the backfill soils be within 3 percent of their standard Proctor optimum moisture content during placement and compaction to minimise long term subsidence [settlement] of the fill mass. Any imported fill required in service trenches or to raise the subgrade elevation should have its moisture content within 3 percent of its optimum moisture content and meet the necessary environmental guidelines.

A representative of SOIL-MAT should be present on-site during the backfilling and compaction operations to confirm the uniform compaction of the backfill material to project specification requirements. Close supervision is prudent in areas that are not readily accessible to compaction equipment, for instance near the end of compaction 'runs', and around the foundation walls. Any structural fill required, backfill within service trenches, areas to be paved, etc., should be placed in loose lifts of 300 millimetres maximum thickness, and compacted with the heaviest available appropriate equipment, i.e. pad-toe roller for cohesive soils, smooth drum roller for granular materials, to a minimum of 98 per cent standard Proctor maximum dry density [SPMDD], with monitoring and testing be a representative of SOIL-MAT ENGINEERS on a full time basis. A method should be developed to assess compaction efficiency employing the on-site compaction equipment and backfill materials during construction.

7. MANHOLES, CATCH BASINS AND THRUST BLOCKS

Properly prepared bearing surfaces for manholes, valve chambers, etc. in the native competent soils, stabilised where required, will be practically non-yielding under the anticipated loads. Proper preparation of the founding soils will tend to accentuate the protrusion of these structures above the pavement surface if compaction of the fill around these structures is not adequate, causing settlement of the surrounding paved surfaces. Conversely, the pavement surfaces may rise above the valve chambers and around manholes under frost action. To alleviate the potential for these types of differential movements, free-draining, non-frost susceptible material should be employed as backfill around the structures located within the paved roadway limits, and compacted to a minimum of 98 per cent of its SPMDD.

The thrust blocks in the native soils may be conservatively sized as recommended by the applicable Ontario Provincial Standard Specification conservatively using a horizontal allowable bearing pressure of up to 150 kPa [~3,000 psf]. Any backfill required behind the blocks should be a well-graded granular product and should be compacted to a minimum of 98 per cent of its SPMDD.

8. TOWNHOUSE CONSTRUCTION

It is anticipated that the proposed structure will have a founding level on the order of approximately 2 to 3 metres below the existing ground surface. The native soils encountered at these depths are considered capable of supporting bearing capacities of 200 kPa [~4,000 psf] SLS and 300 kPa [~6,000 psf] ULS or more, however such higher bearing capacities are not expected to be required. Depending on the depths of any fill deposits encountered, some sub-excavation of unsuitable materials below founding elevations may be required. Where such fill deposits are encountered, the founding level may be raised from the competent native soils up to the design founding elevation via the placement of lean-mic [~5 MPa] concrete, or other methods. This would be best assessed at the time of construction, if required. The founding surfaces must be hand cleaned of any loose or disturbed material, along with any ponded water, immediately prior to placement of foundation concrete.

It is noted that the SLS value represents the Serviceability Limit State, which is governed by the tolerable deflection [settlement] based on the proposed building type, using unfactored load combinations. The ULS value represents the Ultimate Limit State and is intended to reflect an upper limit of the available bearing capacity of the founding soils in terms of geotechnical design, using factored load combinations. There is no direct relationship between ULS and SLS; rather they are a function of soil type and the tolerable deflections for serviceability, respectively. Evidently, the bearing capacity would be lower for very settlement sensitive structure and larger for more flexible buildings.

The support conditions afforded by the native soils and/or engineered fill are generally not uniform across the building footprint, nor are the loads on the various foundation elements. As such, the provision of nominal steel reinforcement should be considered in the concrete foundations. Such reinforcement will act to reduce the potential for cracking in the foundation walls due to minor settlements, heaving, shrinkage, etc. and will assist in resisting the earth pressures generated against the foundation walls by the backfill. This nominal reinforcement is an economical approach to the reduction or prevention of costly foundation repairs after completion and later in the life of the buildings. Such nominal reinforcement would typically consist of two continuous 15M steel bars placed in the footings [directly below the foundation wall] and a similar two continuous 15M steel bars placed approximately 300 millimetres from the top of the foundation walls. The reinforcing bars should be bent to reinforce all corners and under basement windows, and be provided with sufficient overlap at staggered splice locations. At 'steps' in the foundations and at window locations, the reinforcing steel should be bent to follow the step diagonally, rather than at 90 degrees, to maintain the continuous tensile capacity of the reinforcement.

All footings exposed to the environment must be provided with a minimum of 1.2 metres of earth cover or equivalent insulation to protect against frost penetration. This frost protection, or equivalent, would also be required if construction were undertaken during the winter months. All footings must be proportioned to satisfy the requirements of the Ontario Building Code.

In areas where it will be necessary to provide adjacent footings at different founding elevations, the lower footing should be constructed before the higher footing is constructed, if possible, and the higher footing should be set below and imaginary line drawn up from the lower footing at 10 horizontal to 7 vertical. This practice will limit stress transfer from the higher footings to lower footings.

With foundations designed as outlined above and as required by the Ontario Building Code, and with careful attention paid to construction detail, total and differential settlements should be well within normally tolerated limits of 25 and 20 millimetres respectively, for the type of building and occupancy expected.

It is imperative that a soils engineer be retained from this office to provide geotechnical engineering services during the excavation and foundation construction phases of the project. This is to observe compliance with the design concepts and recommendations of this geotechnical investigation report, and to allow changes to be made in the event that subsurface conditions differ from the conditions identified at the borehole locations.

9. PAVEMENT DESIGN CONSIDERATIONS

All areas to be paved should be stripped of all organic or otherwise unsuitable materials. The exposed subgrade should be proof rolled with 3 to 4 passes of a loaded tandem truck in the presence of a representative of SOIL-MAT ENGINEERS & CONSULTANTS LTD., immediately prior to the placement of the sub-base material. Any areas of distress revealed by this or other means must be sub-excavated and replaced with suitable backfill material. Alternatively, the soft areas may be stabilized by placing coarse crushed stone and 'punching' it into the soft areas. Where the subgrade condition is poorer it may be necessary to implement more aggressive stabilisation methods, such as the use of coarse aggregate [50-millimetre clear stone, 'rip rap', etc.] 'punched' into the soft areas, or the use of stabilizing geogrid and a geofabric separator. The need for the treatment of softened subgrade will be reduced if construction is undertaken during the dry summer months and careful attention is paid to the compaction operations. The fill over shallow utilities cut into or across paved areas such as telephone, hydro, gas, etc. must also be compacted to 98 per cent of its SPMDD.

Good drainage provisions will optimize the long-term performance of the pavement structure. The subgrade must be properly crowned and shaped to promote drainage to the subdrain system. Subdrains should be installed to intercept excess subsurface water and mitigate softening of the subgrade material. Surface water should not be allowed to pond adjacent to the outer limits of the paved areas.

The most severe loading conditions on the subgrade typically occur during the course of construction, therefore precautionary measures may have to be taken to ensure that the subgrade is not unduly disturbed by construction traffic. This may include restricting certain areas from construction traffic, or 'bulking' up the access roadways with additional granular sub-base layers during import of granular materials, spreading out/reusing the additional granular material once import is complete.

If construction is conducted under adverse weather conditions, additional subgrade preparation may be required. During wet weather conditions such as during the Fall, Winter and Spring months, it should be anticipated that additional subgrade preparation will be required, such as additional depth of OPSS Granular 'B', Type II (crushed limestone bedrock) sub-base material. It is also important that the sub-base and base granular layers of the pavement structure be placed as soon as possible after exposure, preparation, and approval of the exposed subgrade.

Where roads are to be assumed by the City of Burlington the pavement structure should confirm to the appropriate municipal standard. The suggested pavement structures outlined in Table C below may also be considered. These are based on subgrade parameters estimated on the basis of visual and tactile examinations of the on-site soils and past experience. The outlined pavement structure may be expected to have an approximate fifteen to twenty year life, assuming that regular maintenance is performed. Should a more detailed pavement structure design be required, site specific traffic information would be needed, together with detailed laboratory testing of the subgrade soils.

TABLE C – TYPICAL SUGGESTED PAVEMENT STRUCTURES

LAYER DESCRIPTION	COMPACTION REQUIREMENTS	LIGHT DUTY SECTIONS	HEAVY DUTY [TRUCK ROUTE]
Asphaltic Concrete Wearing course OPSS HL 3 or HL 3A	Min. 92 % Marshall MRD	40 millimetres	40 millimetres
Binder Course OPSS HL 8	Min. 92 % Marshall MRD	50 millimetres	65 millimetres
Base Course OPSS Granular 'A'	100% SPMDD	150 millimetres	150 millimetres
Sub-base Course OPSS Granular 'B', Type II	100% SPMDD	300 millimetres	450 millimetres

* Marshall MRD denotes Maximum Relative Density.
* SPMDD denotes Standard Proctor Maximum Dry Density, ASTM-D698.

Depending on the anticipated traffic, a reduced light duty asphalt structure consisting of 65 millimetres of HL3 surface course may also perform sufficiently. This would be reasonable in areas subjected only to light vehicles such as cars for parking. Such a structure may have a reduced lifespan if subjected to heavier vehicles, and would also not allow for 'mill and pave' type operations for future rehabilitation.

To minimize segregation of the finished asphalt mat, the asphalt temperature must be maintained uniform throughout the mat during placement and compaction. All too often, significant temperature gradients exist in the delivered and placed asphalt with the cooler portions of the mat resisting compaction and presenting a honeycomb surface. As the spreader moves forward, a responsible member of the paving crew should monitor the pavement surface, to ensure a smooth uniform surface. The contractor can mitigate the surface segregation by 'back-casting' or scattering shovels of the full mix material over the segregated areas and raking out the course particles during compaction operations. Of course, the above assumes that the asphalt mix is sufficiently hot to allow the 'back-casting' to be performed.

10. GENERAL COMMENTS

The comments provided in this document are intended only for the guidance of the design team. The material in it reflects SOIL-MAT ENGINEERS' best judgement in light of the information available at the time of preparation. The subsurface descriptions and borehole information are intended to describe conditions at the borehole locations only. It is the contractors' responsibility to determine how these conditions will affect the scheduling and methods of construction for the project. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. SOIL-MAT ENGINEERS accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We trust that this geotechnical report is sufficient for your present requirements. Should you require any additional information or clarification as to the contents of this document, please do not hesitate to contact the undersigned.

Yours very truly,
SOIL-MAT ENGINEERS & CONSULTANTS LTD.

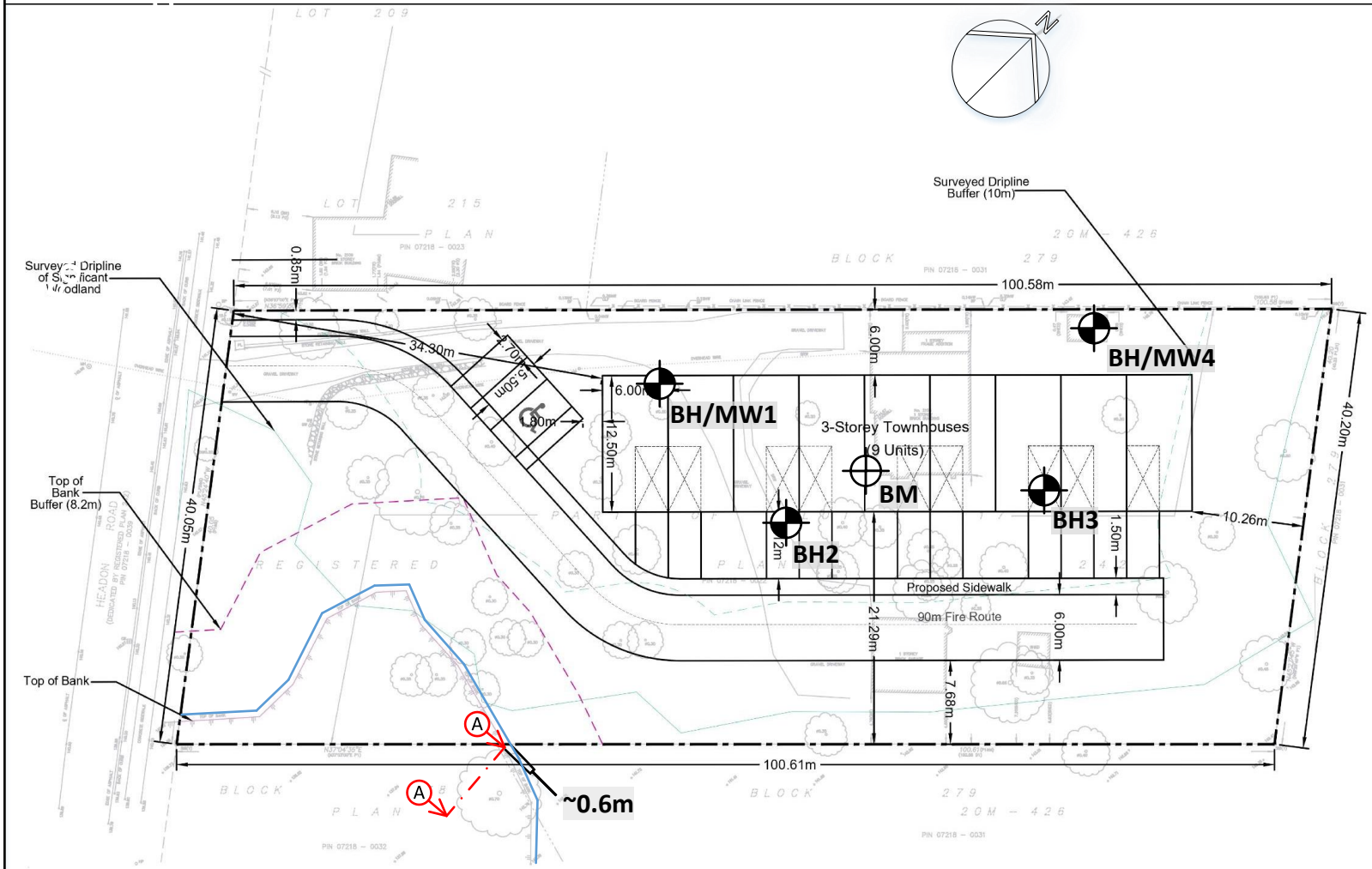
Ishan Chauhan, B.Eng., EIT.
Junior Engineer



Kyle Richardson, P. Eng.
Review Engineer

Enclosures: Drawing No. 1, Borehole and Slope Profile Location Plan
Log of Borehole Nos. 1 to 4, inclusive
Drawing No. 2, Slope Profile A-A
Slope Stability Rating Chart
Slope Stability Analysis
Grain Size Analysis

Distribution: JEC Properties [pdf]



LEGEND

- BH# — Borehole Location
- BM — Geodetic Benchmark
  Southwest corner of an existing house
  Geodetic elevation of 143.62 m.
- Slope Profile Location
- Long Term Top of Stable Slope Location

NOTES

1. This drawing should be read in conjunction with Soil-Mat Engineers & Consultants Ltd. Report No. SM 301961-G.
2. Borehole, Slope profile and Top of Stable Slope locations are approximate.

SOIL-MAT
ENGINEERS & CONSULTANTS LTD.

Geotechnical Investigation
2105 Headon Road
Burlington, Ontario

Borehole and Slope Profile Location Plan

Project No. SM 301961-G

Date: October, 2024

Drawn: IC | Checked: KR

SM 301961-G Borehole and Slope Profile Location Plan

Drawing No. 2

Log of Borehole No. 1

Project No: SM-301961-G
Project: Proposed Townhouses
Location: 2105 Headon Road, Burlington
Client: JEC Properties

Project Manager: Kyle Richardson, P. Eng
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4803444
E: 596073

Depth (ft / m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	142.78	Ground Surface							
0 / 0		**Pavement Structure** Approximately 200 millimetres of compact granular material.							
0 / 0		**Silty Clay/Clayey Silt** Reddish brown, some gravel, occasional to frequent cobbles, stiff to hard.	SS	1	16,8,7,6	15			
3 / 1			SS	2	5,5,7,13	12		>4.5	
6 / 2			SS	3	9,17,23,20	40		>4.5	
9 / 3			SS	4	6,12,18,24	30		>4.5	
12 / 4			SS	5	9,15,20,23	35		>4.5	
16 / 5			SS	6	27,50/4"	100		>4.5	
20 / 6	136.50		SS	7	50/1"	100			
20 / 6		End of Borehole							

NOTES:

1. Borehole was advanced using hollow stem auger equipment on August 23, 2024 to termination at a depth of 6.3 metres.

2. Borehole was recorded as open and 'dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

4. A monitoring well was installed. The following free groundwater level readings have been measured:

September 9, 2024 - 2.28 metres

Moisture Content w% (10 20 30 40)

Standard Penetration Test blows/300mm (20 40 60 80)

Drill Method: Hollow Stem Auger
Drill Date: August 23, 2024
Hole Size: 200 Millimetres
Drilling Contractor: Elements

Soil-Mat Engineers & Consultants Ltd.
401 Grays Road, Hamilton, Ontario, L8E 2Z3
T: 905.318.7440, TF: 800.243.1922, F: 905.318.7455
www.soil-mat.ca E: info@soil-mat.ca

Datum: Geodetics
Field Logged by: AS
Checked by: KR
Sheet: 1 of 1

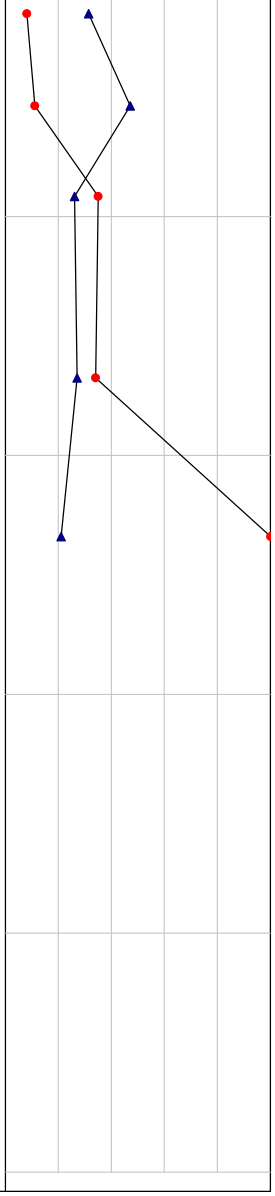
Log of Borehole No. 2

Project No: SM-301961-G
Project: Proposed Townhouses
Location: 2105 Headon Road, Burlington
Client: JEC Properties

Project Manager: Kyle Richardson, P. Eng
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4803436
E: 596088

Depth (ft / m)	Elevation (m)	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	142.87	Ground Surface								
0–3 / 0–1		**Pavement Structure** Approximately 200 millimetres of compact granular material.		SS	1	9,5,3,2	8			
3–15 / 1–4		**Silty Clay/Clayey Silt** Reddish brown, some gravel, stiff to hard.		SS	2	3,5,6,8	11		>4.5	
				SS	3	7,15,29,23	35		>4.5	
				SS	5	10,14,20,20	34		>4.5	
15 / 4.8	138.07	End of Borehole		SS	6	50/6"	100		>4.5	

Moisture Content w% (10 20 30 40)
Standard Penetration Test blows/300mm (20 40 60 80)



NOTES:

1. Borehole was advanced using solid stem auger equipment on August 23, 2024 to termination at a depth of 4.8 metres.

2. Borehole was recorded as open and 'dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Auger
Drill Date: August 23, 2024
Hole Size: 200 Millimetres
Drilling Contractor: Elements

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Datum: Geodetics
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Sheet: 1 of 1

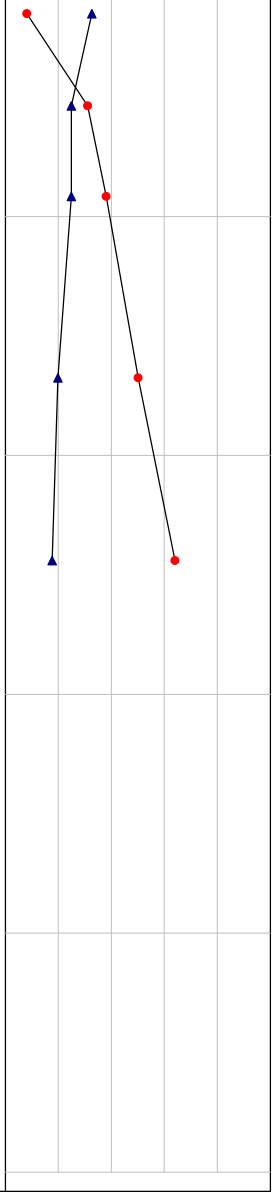
Log of Borehole No. 3

Project No: SM-301961-G
Project: Proposed Townhouses
Location: 2105 Headon Road, Burlington
Client: JEC Properties

Project Manager: Kyle Richardson, P. Eng
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4803458
E: 596095

Depth (ft / m)	Elevation (m)	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	143.09	Ground Surface								
0 / 0		**Topsoil** Approximately 200 millimetres of topsoil.		SS	1	3,4,4,4	8			
3 / 1		**Silty Clay/Clayey Silt** Reddish brown, some gravel, occasional cobbles, very stiff to hard.		SS	2	5,13,18,24	31		>4.5	
6 / 2				SS	3	5,18,20,23	38		>4.5	
10 / 3				SS	5	8,20,30,30	50		>4.5	
16 / 5	137.90			SS	6	6,31,33,50	64		>4.5	
17 / 5		End of Borehole NOTES: 1. Borehole was advanced using solid stem auger equipment on August 23, 2024 to termination at a depth of 5.2 metres. 2. Borehole was recorded as open and 'dry' upon completion and backfilled as per Ontario Regulation 903. 3. Soil samples will be discarded after 3 months unless otherwise directed by our client.								
33 / 9										

Moisture Content w% (10 20 30 40)
Standard Penetration Test blows/300mm (20 40 60 80)



Drill Method: Solid Stem Auger
Drill Date: August 23, 2024
Hole Size: 200 Millimetres
Drilling Contractor: Elements

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Datum: Geodetics
Field Logged by: AS
Checked by: KR
Sheet: 1 of 1

Log of Borehole No. 4

Project No: SM-301961-G
Project: Proposed Townhouses
Location: 2105 Headon Road, Burlington
Client: JEC Properties

Project Manager: Kyle Richardson, P. Eng
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4803461
E: 596108

Depth (ft / m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	142.86	Ground Surface							
0 / 0	142.60	**Topsoil** Approximatley 200 millimetres of topsoil.							
2 / 1		**Silty Clay/Clayey Silt** Reddish brown, some gravel, occasional cobbles, stiff to hard.	SS	1	3,7,6,6,	13			
4 / 1			SS	2	8,17,23,24	40		>4.5	
6 / 2			SS	3	8,15,18,18	33		>4.5	
10 / 3			SS	5	10,15,21,19	36		>4.5	
15 / 4			SS	6	50/6"	100		>4.5	
20 / 6	136.50		SS	7	50/1"	100			
20 / 6		End of Borehole							

Moisture Content w% (10 20 30 40)

Standard Penetration Test blows/300mm (20 40 60 80)

NOTES:

1. Borehole was advanced using hollow stem auger equipment on August 23, 2024 to termination at a depth of 6.3 metres.

2. Borehole was recorded as open and 'dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

4. A monitoring well was installed. The following free groundwater level readings have been measured:

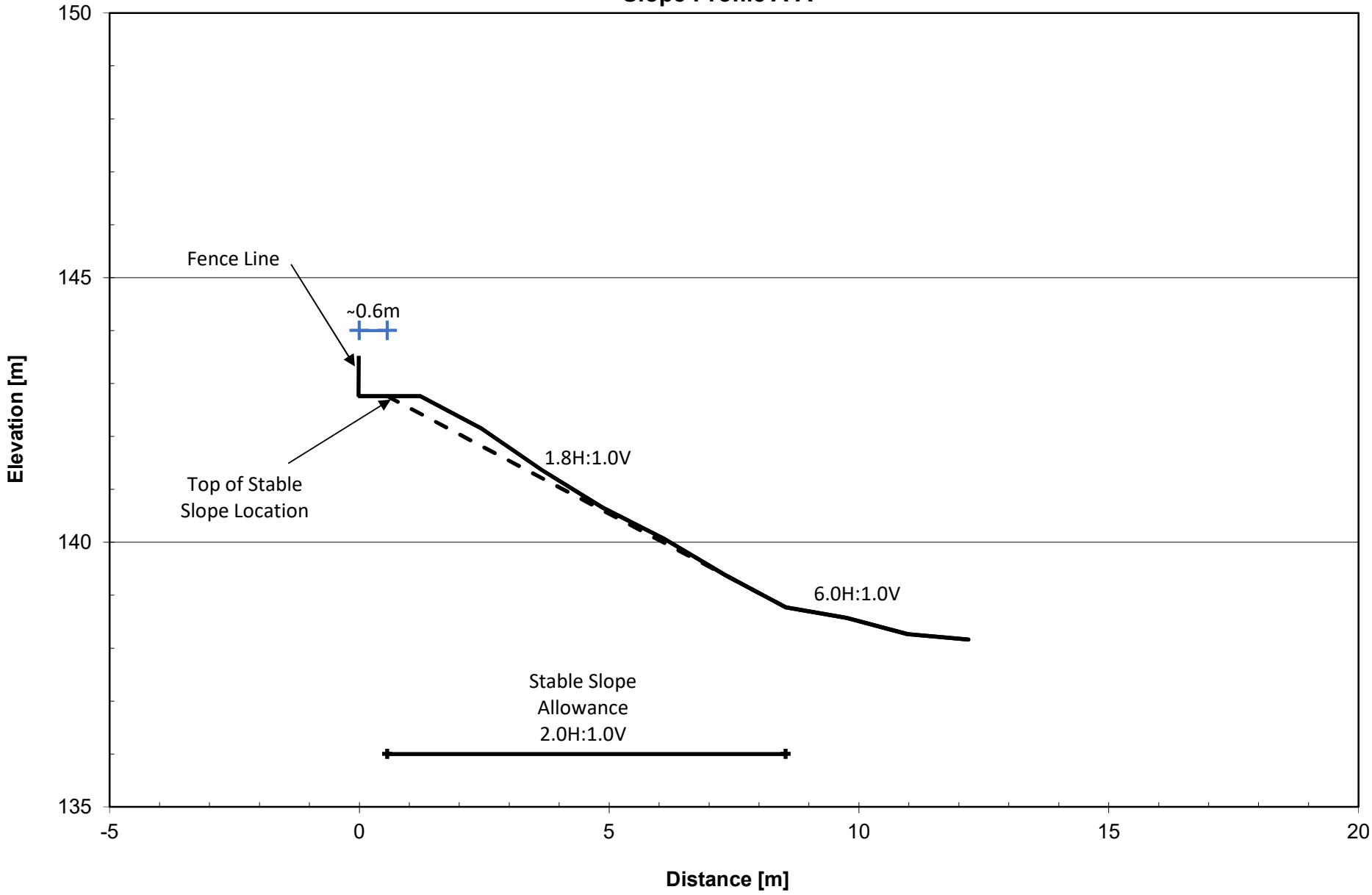
September 9, 2024 - 5.3 metres

Drill Method: Hollow Stem Auger
Drill Date: August 23, 2024
Hole Size: 200 Millimetres
Drilling Contractor: Elements

Soil-Mat Engineers & Consultants Ltd.
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Sheet: 1 of 1

Slope Profile Section
2105 Headon Road
Burlington, Ontario
Slope Profile A-A



Project No.: SM 301961-G

DRAWING No. 2

TABLE 8.1 - SLOPE STABILITY RATING CHART

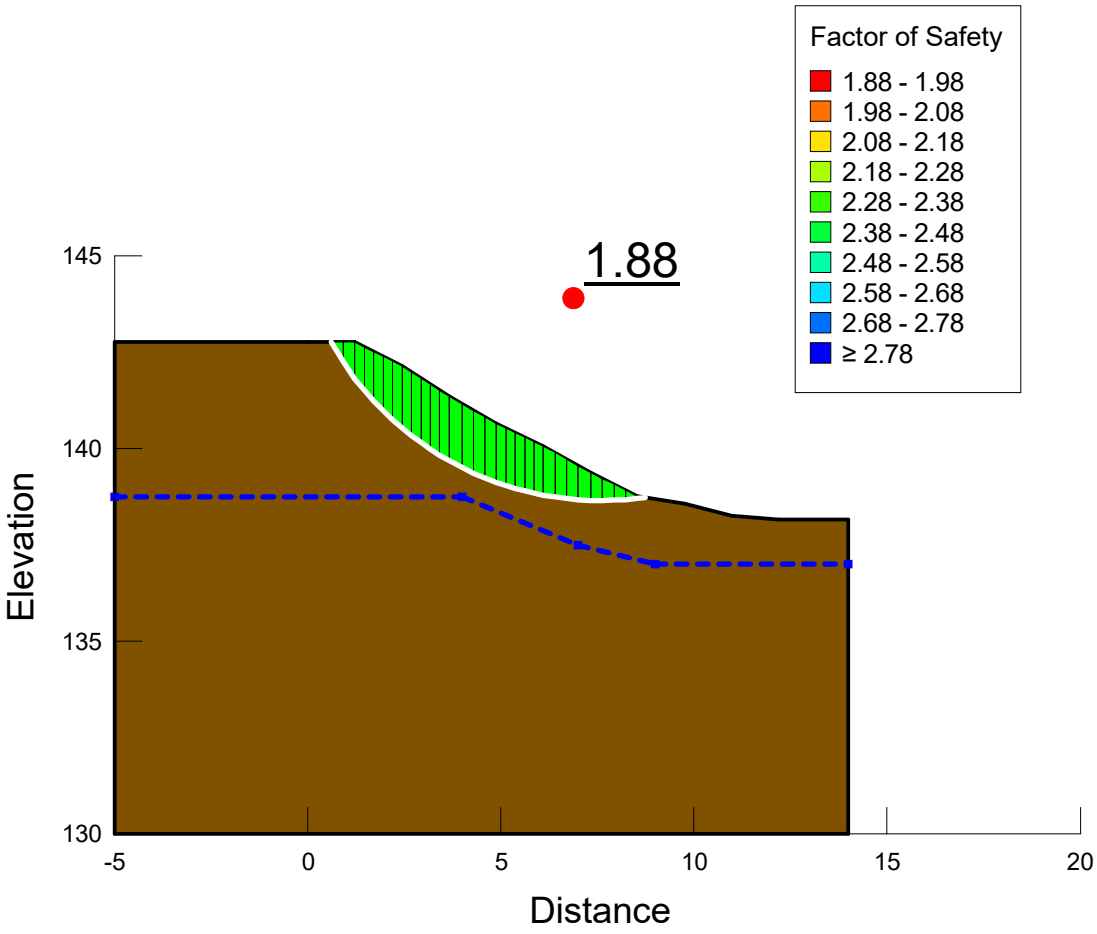
Site Location: 2105 Headon Road, Burlington
Property Owner:
Inspected By: I.C.

File No. SM 301961-G
Inspection Date: October 17, 2024
Weather:

				Rating Value	
1.	**SLOPE INCLINATION**				
		degrees	**horiz. : vert.**		
	a)	18 or less	3 : 1 or flatter	0	
	b)	18 - 26	2 : 1 to more than 3 : 1	6	16
	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	12
	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	0
	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	2
	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	0
	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	2
	c)	Drainage over slope, active erosion, gullies		4	
7.	**PROXIMITY OF WATERCOURSE TO SLOPE TOE**				
	a)	15 metres or more from slope toe		0	0
	b)	Less than 15 metres from slope toe		6	
8.	**PREVIOUS LANDSLIDE ACTIVITY**				
	a)	No		0	0
	b)	Yes		6	
	SLOPE INSTABILITY RATING		**RATING VALUES TOTAL**	**INVESTIGATION REQUIREMENTS**	**TOTAL** 32
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 from each category; compare total rating value with above requirements.
b) If there is a water body (stream, creek, river, pond, bay, lake) at the slope toe; the potential for toe erosion and undercutting should be evaluated in detail and, protection provided if required.

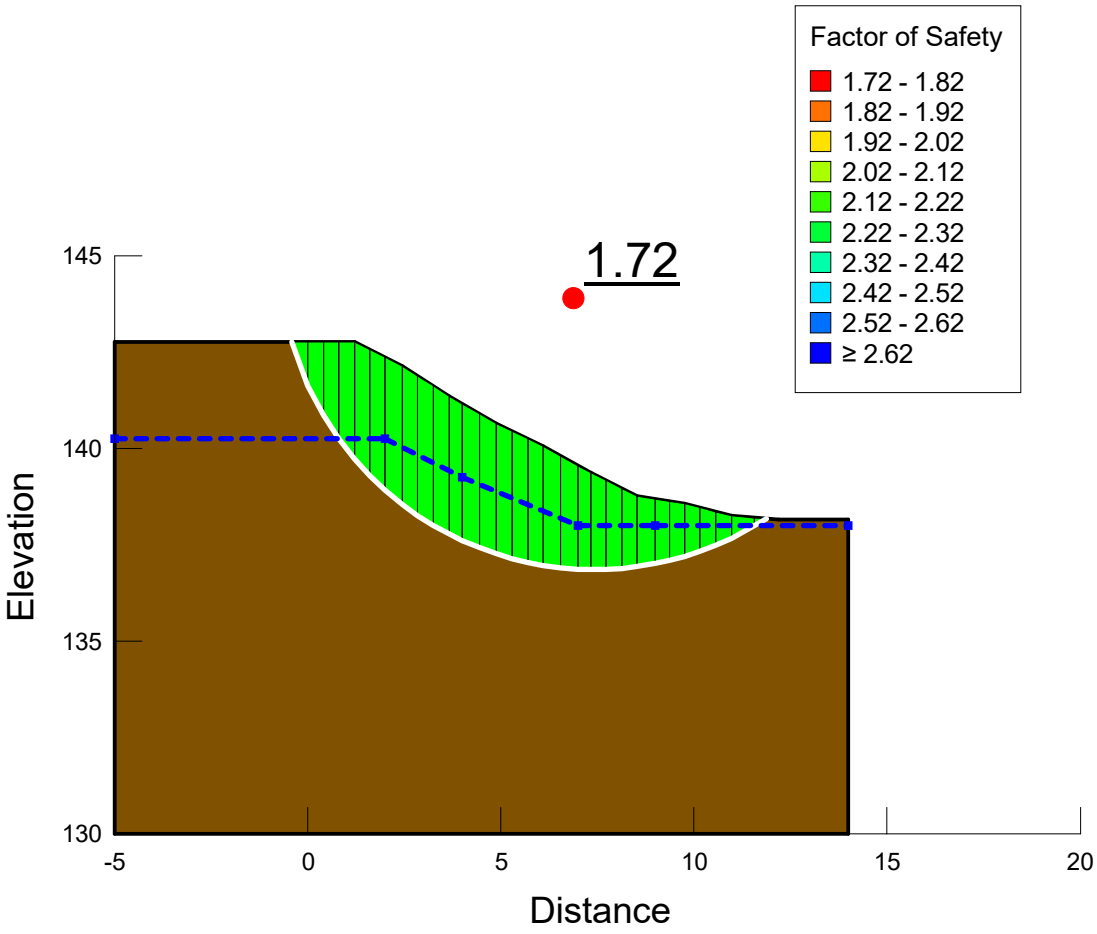
Elevated Groundwater Condition
Slope Profile A-A
2105 Headon Road
Burlington, Ontario



Name: Silty Clay/Clayey Silt
Unit Weight: 19.5 kN/m³
Effective Cohesion: 5 kPa
Effective Friction Angle: 32 °

Slope Stability Analysis - 2105 Headon Road, Burlington
Slope Profile A-A (Normal Groundwater)
October 2024

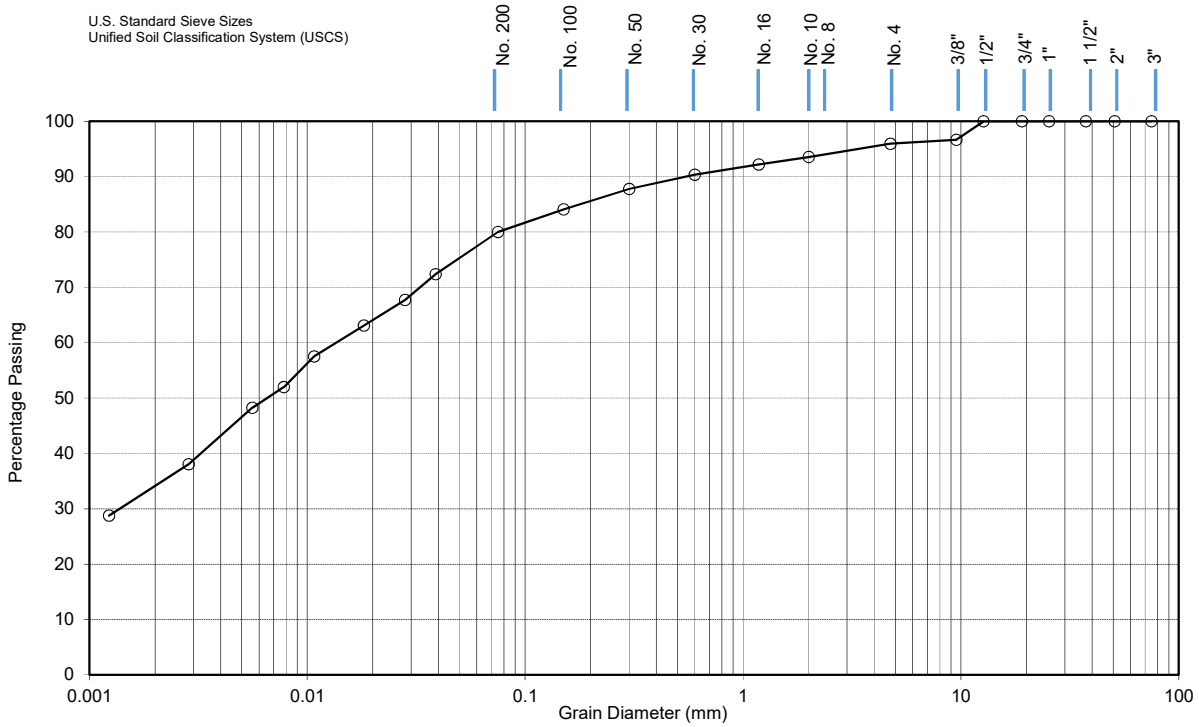
Elevated Groundwater Condition
Slope Profile A-A
2105 Headon Road
Burlington, Ontario



Name: Silty Clay/Clayey Silt
Unit Weight: 19.5 kN/m³
Effective Cohesion: 5 kPa
Effective Friction Angle: 32 °

Slope Stability Analysis - 2105 Headon Road, Burlington
Slope Profile A-A (Elevated Groundwater)
October 2024

Mechanical & Hydrometer Analyses



CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE
		SAND			GRAVEL	

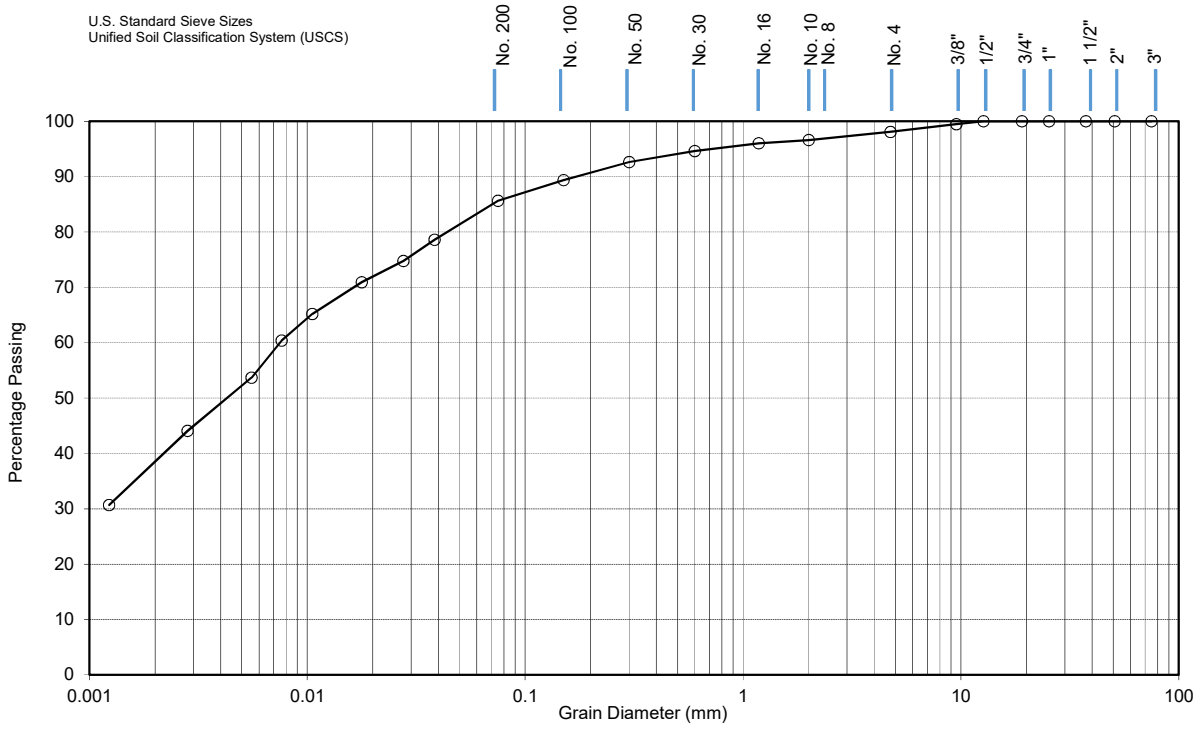
Lab No.:	**24-325**	Notes: Depth : 7.5'			
Borehole No.:	**1**				
Sample No.:	**4**				
CLAY [%]:	**34**	Soil Description: **Brown Clayey Silt w/ some Sand and a trace of Gravel**			
SILT [%]:	**46**	**M.L. - Clayey silts with slight plasticity, inorganic silts and very fine sands, clayey fine sands**			
SAND [%]:	**16**				
GRAVEL [%]:	**4**	Estimated Infiltration Rate [mm/hr] :	**< 10**	Estimated Permeability, k [cm/s]:	**10^{-7}**
D_{10} (Effective Diam. in mm):	**0.0003**	Coefficient of Uniformity C_U:	**46.7**	Coefficient of Curvature C_C:	**0.5**

SOIL-MAT ENGINEERS & CONSULTANTS LTD.

2105 Headon Road, Burlington ON

September 2024	**Grain Size Analysis No. 1**	**Project No.: SM 301961-T**

Mechanical & Hydrometer Analyses



CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE
		SAND			GRAVEL	

Lab No.:	**24-326**	Notes: Depth : 5'			
Borehole No.:	**4**				
Sample No.:	**3**				
CLAY [%]:	**39**	Soil Description:	**Brown Silt and Clay w/ some Sand and a trace of Gravel**		
SILT [%]:	**47**		**M.L. - Inorganic silts and very fine sands to C.L. - Inorganic clays of low to medium plasticity**		
SAND [%]:	**12**				
GRAVEL [%]:	**2**	Estimated Infiltration Rate [mm/hr] :	**< 10**	Estimated Permeability, k [cm/s]:	**10^{-7}**
D_{10} (Effective Diam. in mm):	**0.0004**	Coefficient of Uniformity C_U:	**19.0**	Coefficient of Curvature C_C:	**0.6**

SOIL-MAT ENGINEERS & CONSULTANTS LTD.

2105 Headon Road, Burlington ON

September 2024	**Grain Size Analysis No. 2**	**Project No.: SM 301961-T**