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PROJECT NO.: SM 220223-G

June 1, 2022
Revised June 15, 2022

DAC INVESTMENTS NIAGARA INC.
1 Germain Street – Suite 1500
St. John, New Brunswick
E2L 4V1

Attention: David Chemla

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
6378 MOUNTAIN ROAD
NIAGARA FALLS, ONTARIO

Dear Mr. Chemla,

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 P220223, dated March 31, 2022. Our comments and recommendations, based on our findings at the eighteen borehole locations, are presented herein.

1. INTRODUCTION

We understand that the project will involve the construction of an 8 storey residential building with one underground parking level at the property located at 6378 Mountain Road in Niagara Falls, Ontario. The purpose of this geotechnical investigation work was to assess the subsurface soil 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.

It is noted that SOIL-MAT ENGINEERS has previously undertaken assessments of the subject site and surrounding lands. The subject site is noted to have formerly been utilised as a quarry/gravel pit, where significant depths of fill material comprised of silt, sand, debris, and excavated Queenston shale have been deposited. Additionally, SOIL-MAT ENGINEERS has been provided previous geotechnical investigation reports for the subject site prepared by Shehan & Peaker Limited [SPL].

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 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, such as additional storeys or basement levels, this office must be consulted to review the new design with respect to the results of this investigation. It is noted that this report is not intended address the environmental aspects of the site, which have been reported under a separate cover.

2. PROCEDURE

A total of eighteen [18] sampled boreholes were advanced at the locations illustrated in the attached Drawing No. 1, Borehole Location Plan. The boreholes were advanced using continuous flight power auger equipment, under the direction of a representative of SOIL-MAT ENGINEERS. The boreholes were advanced to depths of approximately 3.7 to 16.8 metres below the existing grade between May 2 and 9, 2022. Upon completion of drilling, Borehole No. 11 was outfitted with a groundwater monitoring well. The well installed consisted of 50-millimetre diameter PVC pipe, screened in the lower 3 metres. The monitoring well was backfilled with 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 'stickup' casing. The remaining boreholes were backfilled in general accordance with Ontario Regulation 406/19, and the ground surface reinstated even with the existing 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 the 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 performed on all soil samples recovered from the borings.

The boreholes were located on site by a representative of SOIL-MAT ENGINEERS & CONSULTANTS LTD., based on accessibility over the site and clearance of underground services. The ground surface elevation at the borehole locations was referenced to a site specific geodetic benchmark, based on the topographic survey of the site prepared by The Larocque Group, File No. NS2014-001, dated March 30, 2014, revised February 5, 2015, provided 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 Borehole Nos. 1 to 18, 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 during 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.

3. SITE DESCRIPTION AND SUBSURFACE CONDITIONS

The subject site consists of an undeveloped field located at 6378 Mountain Road in Niagara Falls, Ontario. The site is bounded by Mountain Road to the north, St. Paul Avenue to the east, residential properties to the west, and Ontario Hydro lands to the south. The site gradually slopes to the east towards St. Paul Avenue.

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

Topsoil

A surficial veneer of topsoil approximately 100 to 150 millimetres in thickness was encountered at all borehole locations. It is noted that the depth of topsoil may vary across the site and the depths encountered at all borehole locations, and a conservative approach should be taken in estimating topsoil quantities across the site. It is also noted that the term “topsoil” has been used as a geotechnical point of view, and does not necessarily reflect its nutrient content or ability to support plant life.

Silty Sand/Sandy Silt Fill

Fill material consisting of silty sand/sandy silt was encountered below the topsoil and existing ground surface in all borehole locations. The fill material was brown in colour, contained traces of, to some, clay and gravel/rock fragments and occasional to significant shale inclusions. The presence of shale inclusions was generally noted due to auger performance and limited sampling spoon recovery, however the concentration of shale inclusions was noted to vary across the site. Some more densely concentrated inclusions of shale, including boulder sized fragments, have historically been encountered on the site and should be expected. The fill material encountered was generally in a loose condition, proven to depths of up to 15.2 metres at the borehole locations, however greater depths of fill may be present across the site.

Based on the depths of fill encountered, there is a relatively evident 'drop' in the elevation of the underlying native soils, ranging from about 2 to 5 metres on the western side of this 'drop', and to much greater depths on the eastern portion. This 'drop' appears to be east of the north-south line of Borehole Nos. 3, 6, 11, and 15, where fill was noted to depths of approximately 1.5, 3.7, 1.6, and 4.5 metres, respectively. Fill depths in Borehole Nos. 7, 8, 12, 16, 17, and 18 located east of this line were on the order of 5.3, 11.6, 9.1, 7.0, 13.7, and 15.2 metres, respectively. The depth of fill evidently increases moving west to east across the site. The depths and elevations of the base of fill deposit encountered at the borehole locations has been summarised as follows:

TABLE A – DEPTHS OF FILL ENCOUNTERED

Borehole No.	Ground Surface Elevation (m)	Depth of Fill (m)	Elevation of Native Soil (m)
1	198.47	1.6	196.9
2	198.24	1.4	196.8
3	198.08	1.6	196.5
4	198.87	1.4	197.5
5	198.33	1.3	197.0
6	198.11	3.7	194.4
7	197.68	5.4	192.3
8	197.27	11.7	185.6
9	198.78	1.5	197.3
10	198.51	1.4	197.1
11	198.24	1.6	196.6
12	197.57	9.2	188.4
13	198.93	2.2	196.7
14	198.67	2.4	196.3
15	198.35	4.6	193.8
16	197.85	7.1	190.8
17	197.21	13.7	183.5
18	196.80	15.2	181.6

The 'drop' in depths of fill encountered at the borehole locations has been approximated, as noted above, and illustrated on the attached Borehole Location Plan. Additionally, this transition line as previously estimated by SPL in their geotechnical reports has also been illustrated on the Borehole Location Plan. It is noted that these transition lines are approximate, and may be refined pending additional investigations.

It is recommended that the extents and condition of the fill deposit be further evaluated via the advancement of test excavations. It may be preferable to conduct this assessment once the development details such as building location, depth, etc., have been finalised. Shear wave velocity testing may also allow for a more accurate estimate of fill depths across the site.

Sandy Silt/Clayey Silt

Native sandy silt/clayey silt soil was encountered below the topsoil and fill deposit at all borehole locations. The fine grained granular to slightly cohesive soil was brown in colour, contained traces of, to some, gravel and was generally found in a compact to very dense state. The sandy silt/clay silt soil was proven to termination in all boreholes, with the exception of Borehole No. 7, where auger refusal on bedrock was encountered at a depth of approximately 24.1 metres.

Dolostone/Limestone Bedrock

Bedrock was encountered at depth of between approximately 24.1 metres below the existing grade at Borehole 7, at an elevation of approximately 173.6 metres. Approximately 3.6 metres of the bedrock was cored at this borehole location. The bedrock cores were noted to yield recoveries of approximately 60 to 99 per cent, with a Rock Quality Designation [RQD] of 50 to 77 per cent. Unconfined compressive strength testing on selected portions of the recovered core samples yielded compressive strengths of approximately 86.7 to 123.0 MPa, with an average of 108.8 MPa. The results of this testing can be found appended to the end of this report, and have been summarised as follows:

TABLE B – SUMMARY OF BEDROCK CORING

Borehole No. 7					
Depth of Core (m)	Elevation of Core (m)	Recovery (%)	Rock Quality Designation (RQD, %)	Depth, Elevation of Tested Core Sample (m)	Unconfined Compressive Strength (MPa)
23.8 to 24.7	173.6 to 172.7	60	77	24.0, 173.7	123.0
24.7 to 26.2	172.7 to 171.2	99	50	25.1, 172.6	86.7
26.2 to 27.2	171.2 to 170.0	75	67	26.9, 170.8	116.6

Based on the review of the recovered core samples, as well as available published literature and past experience in the area, the bedrock consists of limestone/dolostone of the Lockport formation. The limestone bedrock is grey, generally fractured and weathered in the upper levels, with occasional vugs and solution cavities. The bedrock is considered very competent in terms of the foundation/excavation requirements for the proposed project, although occasional fissures and/or solution cavities have historically been encountered, as noted above.

Groundwater Observations

The majority of boreholes were noted to be 'dry' upon completion of drilling. As noted above, a monitoring well was installed at Borehole No. 11 to allow for measurements of potential groundwater within the anticipated depths of construction. Observations between May 9 and 27, 2022 indicated the monitoring well to be 'dry'. As such, based on our observations during drilling, within the monitoring well, and our experience in the area, the static groundwater level is estimated at depths of greater than 8 metres. A review of available well records suggest a groundwater level on the order of 12 to 15 metres or more. Regardless, shallower 'perched' deposits of groundwater within more permeable seams, above clayey deposits, etc., should be anticipated.

4. PRELIMINARY FOUNDATION CONSIDERATIONS

Excavations for the proposed foundations and underground parking level are expected to extend to depths of up to 3 to 5 metres below existing grade. It is understood that the structure will situated closer to the western portion of the site, where the depths of fill are generally less, within about 3 to 5 metres below the surface, however portions of the building may encroach onto the eastern portion, where much greater depths of fill were encountered. For the six-storey building proposed, it is anticipated that the majority if not all of the new building could be supported on the competent native soils, below the fill deposit or otherwise unsuitable soils. However, in the event that portions of the building extend to where significant depths of fill are encountered, it may be necessary to support this portion of the structure on a deep foundation scheme extending through the fill deposits to the competent native soils, or underlying bedrock.

4.1 SHALLOW FOUNDATIONS

As noted above, it is understood that the majority of the building will be supported on the western portion of the site. With an underground parking level of 196.65 metres (as per the project Architectural Drawings provided to our office), the founding level is estimated at elevations of roughly 195 to 196 metres, approximately 3 to 4 metres below the

existing ground surface. The depths of fill on the western portion of the site were generally within about 1 to 5 metres. As such, the majority of the proposed basement level and foundations would generally extend through the fill and into the native soils, however some areas may require sub-excavation of unsuitable fill deposits beneath founding elevations or floor slabs, with the majority if not all of the building supported on spread footings or a raft slab on the competent native soils.

Spread footings founded at depths of approximately 3 to 4 metres, on the competent native soils may be designed considering bearing capacities of 300 kPa [~6,000 psf] SLS and 450 kPa [~9,000 psf] ULS. Depending on the final location of the building, this is anticipated to require some sub-excavations of the fill materials encountered on the eastern portion of the building footprint.

Load distribution from the shallow foundations must be taken into account where the building is supported on spread footings or a raft slab. The load distribution should be assumed to extend outwards and down at a rate of 10 horizontal to 7 vertical from the outer edge of the footing. For the purpose of this assessment, it should be assumed that the depth of fill increases vertically immediately east of Borehole Nos. 3, 6, 11, and 15 (depths of 1.5, 3.8, 1.6, and 4.5 metres, respectively) to the depths encountered at Borehole Nos. 7, 12, 16, and 17 (depths of 5.6, 9.1, 7.5, and 13.7 metres, respectively). Conservatively, the depth of fill should be assumed to be a much as about 13 metres depth, or up to 10 metres greater than the founding elevation of the proposed structure. As such, spread footings for the proposed building should be located no less than 15 metres west of the line of Borehole Nos. 3, 6, 11, and 15. Spread footings to the east of this location may not have sufficient bearing capacity without steeping down to significant depths. It is noted that these limits may be further refined with more focused supplemental investigations such as additional boreholes and/or test pits.

4.2 DEEP FOUNDATIONS

Where portions of the building extend into areas where the depths of fill render shallow foundations unfeasible, a deep foundation scheme extending to the competent native soils or underlying bedrock would be required.

4.2.1 CAISSONS

Caisson foundations extending to the dolostone/limestone bedrock may be considered to support portions of the structure though significant fill deposits. Based on the compressive strength testing conducted on the recovered concrete cores, caissons founded on the competent layers of the dolostone/limestone bedrock below any

weathered or fractures layers, may be designed considering a bearing capacity of 7,500 kPa [~150,000 psf] SLS and ULS.

All caissons must be provided with a temporary steel liner to maintain the integrity of the open hole and prevent the infiltration of water. Recent experience in the area indicates that significant groundwater infiltration into caissons may occur if the caisson liner is not properly sealed or if a sufficiently watertight 'set' into the bedrock is not made. A contingency should be in place in the event that significant groundwater infiltration into open caissons is experienced.

In the event that it is not possible to fully dewater the open caissons, the contractor should be prepared to place concrete by means of a 'tremie' pipe method. The contractor should maintain a positive head of concrete in the liner while it is being removed to avoid the intrusion of loose materials [known as 'necking'] into the caisson. The base of the caissons should be thoroughly cleaned to remove all loose or disturbed material immediately prior to the placement of concrete. The installation of caissons should be monitored by a representative of SOIL-MAT ENGINEERS & CONSULTANTS LTD.

MICROPILES

The proposed structure may also be supported using grouted micropiles. The micropiles, typically 125 to 300 millimetres in diameter, would be drilled and grouted into the competent bedrock. The micropiles are provided with a steel casing over the 'free length' to the founding depth, and a steel bar is placed down the middle to aid in load transfer down the grout column to the bedrock, as well as from the micropile to the pile cap. The capacity of micropiles is a function of the bond strength between the grout column and bedrock. For preliminary design purposes a grout to bedrock bond strength of 500 kPa [~10,000 psf] may be considered in the competent bedrock, beginning 0.5 metres into the bedrock. As micropiles tend to be proprietary in nature a specialty contractor should be consulted in the design process. Given the depth of fill encountered, potential for large piece of debris or rock fragments, micropiles may be preferred where deep foundations are required.

GENERAL FOUNDATION COMMENTS

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 the soil type and the

tolerable deflections for serviceability, respectively. Evidently, the bearing capacity values would be lower for very settlement sensitive structures and larger for more flexible buildings. It is also noted that the SLS and ULS bearing capacities are equivalent for the dolostone/limestone bedrock, as in order for serviceability limits to be realised, ultimate failure of the bedrock would have to occur.

Based on the depth of fill encountered across the site, consideration should be given to relocating the proposed building to situate the building entirely on the western portion of the site, where fill is shallowest. This may allow for the building to be founded entirely on spread footings or a raft slab on the competent native soils, and eliminate the need for deep foundation extending to bedrock, structural slabs, etc.

All footings, caisson caps, grade beams, etc., exposed to the environment must be provided with a minimum of 1.2 metres of earth cover or equivalent insulation to protect against frost damage. This frost protection would also be required if construction were undertaken during the winter months. All footings and foundations should be designed and constructed in accordance with the current Ontario Building Code.

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

It is noted that the performance of deep foundation schemes is greatly dependent on the method, equipment, and workmanship utilized during construction. It is therefore essential that installation procedures for the deep foundations be monitored/evaluated by SOIL-MAT ENGINEERS.

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

It is recommended that our office be consulted during the detailed design stage of the foundations for various structures and given an opportunity to review the foundation design scheme to ensure it is consistent with the recommendations of this report.

5. LATERAL EARTH PRESSURE

The lateral earth pressures on basement walls can be estimated on the basis of a retained soil unit weight, [γ_{wet}], of 20 kN/m^3 [~127 pcf]. The coefficient of lateral earth pressure may be taken as, K_o = 0.5 in fill against rigid walls [at rest condition]. Any additional pressures due to surcharge loading, such as adjacent structures, roadways, parked vehicles, floor slab loading, etc. must be included in the design.

6. SEISMIC DESIGN CONSIDERATIONS

The structure shall be designed according to Section 4.1.8 of the Ontario Building Code, Ontario Regulation 332/12 (as amended). Based on the subsurface soil conditions encountered in this investigation the applicable Site Classification for the seismic design is Site Class D – Stiff Soils, based on the average soil characteristics for the site. It is noted that a seismic site class of C may be available, however would need to be confirmed via site specific shear wave velocity testing. Such shear wave velocity testing may also be utilised to further assess the depths of fill across the site, specifically to refine the area where spread footings would be feasible to support the structure.

The seismic data, from Supplementary Standard SB-1 of the Ontario Building Code, for Niagara Falls are as follows.

S_a[0.2]	S_a[0.5]	S_a[1.0]	S_a[2.0]	S_a[5.0]	S_a[10.0]	PGA	PGV
0.0321	0.157	0.072	0.0320	0.0076	0.0030	0.207	0.121

7. EXCAVATIONS AND EXCAVATION SUPPORT CONSIDERATIONS

Excavations for the construction of the proposed 6-storey building will extend to depths of about 3 to 4 metres. Excavations through the fill deposits would be expected to remain stable at inclinations of up to 45 degrees to the horizontal. Where excavations extend into the competent native soils the excavations would be expected to remain stable at inclinations of up to 45 to 60 degrees to the horizontal. Where wet seams are encountered, during periods of extended precipitation, the excavations through the on-site soils may have a tendency to 'slough in' to as flat as 3 horizontal to 1 vertical, or flatter. Notwithstanding the above, all excavations must comply with the current Occupational Health and Safety Act and Regulations for Construction Projects. It is noted that with respect to this act, the fill materials would be considered Type 3 soil, while the native soils would be considered a Type 2 soil. 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. Based on the proposed building location and nature of the subject site, it is anticipated that the proposed excavations will be advanced as open cuts, and use of excavation shoring or support systems will not be required.

As noted above, the groundwater level is estimated at depths greater than 8 metres below the existing ground surface, and is likely at depths on the order of 12 to 15 metres or more. Regardless, some infiltration of perched water and from surface runoff should be anticipated. The rate of infiltration should be sufficiently low such that is should be possible to control via conventional construction dewatering techniques, such as pumping from sumps in the base of the excavation. More control should be anticipated when connections are made to existing services. Surface water should be directed away from the excavations.

8. FLOOR SLAB AND PERIMETER DRAINAGE CONSIDERATIONS

Where a raft slab is not utilised, the building floor slabs may be constructed using conventional slab-on-grade techniques on a prepared subgrade, following the removal of any unsuitable fill materials, including all shale inclusions, from within the building footprint. As noted above, given the depths of fill encountered relative to the proposed basement depths, some sub-excavations of unsuitable fill should be anticipated, especially on the eastern portion of the proposed building footprint where fill depths may extend below the proposed underground level. The exposed subgrade surface should be well compacted in the presence of a representative of SOIL-MAT ENGINEERS. Any soft 'spots' delineated during this work must be sub-excavated and replaced with quality backfill material compacted to 100 per cent of its standard Proctor maximum dry density. The subgrade level can then be raised to the design level with granular soils compacted to 100 per cent of its standard Proctor maximum dry density. Granular fill, such as an imported Ontario Provincial Standard Specification [OPSS] Granular 'B', Type II (crushed limestone bedrock) product, is preferred within the building footprint due to its relative insensitivity to weather conditions, ease in achieving the required degree of compaction, and its quick response to applied stresses. It may be possible to make use of select portions of the fill material on site, however this would be best assessed at the time of construction, and/or via the advancement of test pits to further evaluate the fill.

As the fill deposits contain significant inclusions of Queenston shale, concrete slabs-on-grade would be susceptible to ongoing long-term settlements. Where the building extends east where significant depths of fill were encountered and deep foundations are required, the use of a structural floor slabs should be expected to be required.

As with all concrete floor slabs, there is a tendency for the floor slabs to crack. The slab thickness, concrete mix design, the amount of steel and/or fibre reinforcement and/or wire mesh placed into the concrete slab, if any, will therefore be a function of the owner's tolerance for cracks in, and movements of, the slabs-on-grade, etc. The 'saw-cuts' in the concrete floors, for crack control, should extend to a minimum depth of 1/3 of the thickness of the slab.

A moisture barrier will be required under the floor slabs such as the placement of at least 200 millimetres of compacted 20-millimetre clear crushed stone. At a minimum the moisture barrier material should contain no more than 10 per cent passing the No. 4 sieve. Where 'non-damp' floor slabs are required, as for instance under sheet vinyl floor coverings, etc., extra efforts will be required to damp proof the floor slab, as with the additional provision of a heavy 'poly' sheet, damp proofing sprays/membranes, drainage board products, etc. Where 'poly' sheets are used care should be taken to prevent puncturing and tearing and a sufficiently heavy gauge material be provided.

Curing of the slab-on-grade must be carefully specified to ensure that slab curl is minimised. This is especially critical during the hot summer months of the year when the surface of the slab tends to dry out quickly while high moisture conditions in the moisture barrier or water trapped on top of any 'poly' sheet at the saw cut joints and cracks, and at the edges of the slabs, maintains the underside of the slab in a moist condition.

It is important that the concrete mix design provide a limiting water/cement ratio and total cement content, which will mitigate moisture related problems with low permeance floor coverings, such as debonding of vinyl and ceramic tile. It is equally important that excess free water not be added to the concrete during its placement as this could increase the potential for shrinkage cracking and curling of the slab.

All basement foundation walls should be suitably damp proofed, including the provision of a 'dimple type' drainage board to promote rapid drainage to a perimeter drainage system. This may require the use of foundation wall systems intended for 'blind side' or 'single face' application, depending on the feasibility of open cuts and need for excavation shoring. The perimeter drainage system should consist of 100-millimetre diameter perforated pipe, encased in a geofabric sock and covered with a minimum of 200 millimetres of a 20-millimetre clear crushed stone product, and the clear crushed stone in turn encased by a heavy filter geotextile product. The suppliers of the filter geotextile should be consulted as to the type best suited for this project. This office should examine the installation of the drains. Even a small break in the filtering materials could result in loss of fines into the drains with attendant performance difficulties, including settlements of the ground surface. The perimeter drains should

outlet to a sump pit or retention tank a minimum of 150 millimetres below the underside of finished floor. The exterior grade around the structure should be sloped away from the structure to prevent the ponding of water against the foundation walls. The enclosed Drawing No. 2 shows schematics of the typical requirements for foundation construction with a basement level.

9. BACKFILL CONSIDERATIONS

The excavations are anticipated to consist of primarily the on-site fill, and the native sandy silt/clayey silt. The native soils and select portions of the fill materials may be considered suitable for use as engineered fill, backfill in service trenches, etc. provided it is free of organics or any other deleterious material. Some sorting of the excavated fill materials to remove shale inclusions, as well as any organics, large cobbles/boulders, rock fragments, or otherwise deleterious materials, should be expected.

The on site soils are not considered to be free draining and therefore should not be used where this characteristic is necessary. The use of free draining, well-graded granular material, such as an Ontario Provincial Standard Specification [OPSS] Granular B, Type II (crushed limestone bedrock) is preferred for backfill against foundation walls and to raise the grade within the building footprint. This material is more readily compacted in restricted access areas, and generally presents a more positive support condition for exterior concrete sidewalks, pavement, etc. The use of alternative materials, including recycled concrete aggregates, clear stone materials, etc., may be considered, however should be reviewed and approved by our office prior to use. Any imported fill required in service trenches or to raise the subgrade elevation should have its moisture content within 3 per cent of its optimum moisture content and meet the necessary environmental guidelines.

Backfill materials used in service trenches or to raise the subgrade elevation under the building or exterior pavement areas should have its moisture content within 3 per cent of its optimum moisture content. Backfill material should be compacted to a minimum of 98 per cent of its standard Proctor maximum dry density [SPMDD]. Lift thickness would depend on the material type and moisture content of the backfill material and size of the compaction equipment used by the contractor, however should be limited to an uncompacted thickness of no more than 300 millimetres. A representative of SOIL-MAT should be retained to monitor the backfilling and compaction operations to confirm uniform compaction of the backfill material to project specification requirements.

10. PAVEMENT STRUCTURE DESIGN CONSIDERATIONS

All areas to be paved must be cleared of all organic and otherwise unsuitable materials, and the exposed subgrade proof rolled with 3 to 4 passes of a fully-loaded tandem-axle 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 should be sub-excavated and replaced with suitable backfill material. Where the subgrade condition is poorer it may be necessary to implement more aggressive stabilisation methods, such as the use of coarse aggregate [50mm clear stone, 'rip rap' stone, etc.] 'punched' into the soft areas. It may also be prudent to consider the provision of a heavy geofabric over the subgrade to act as a separator between the subgrade and granular base materials.

Given the presence and condition of fill materials encountered, some sub-excavation of shale or otherwise unsuitable materials beneath pavements should be expected. On a preliminary basis, it is recommended that a minimum of 1 metre of fill material be removed and replaced with a well graded granular material beneath the proposed pavement areas. Depending on assessment of the fill material during construction, greater depths of sub-excavation may be warranted. We note that shale fill materials are prone to ongoing long-term settlements, and any pavements and associated infrastructure (such as catch basins, storm sewers, light standards, curbs, etc.) may need to be periodically repaired or reconstructed due to localized settlements. As such great care should be taken to remove as much of the shale fill as possible.

The need for sub-excavations of softened subgrade materials will be reduced if construction is undertaken during dry periods of the year and careful attention is paid to the compaction operations. The on-site soils are sensitive to disturbance and moisture and may present difficulty for roadway construction during 'wet' periods of the year. Should pavement construction be undertaken during 'wet' periods of the year it should be anticipated that greater stabilisation efforts will be required and/or additional depth of OPSS Granular 'B', Type II (crushed limestone bedrock) sub-base course material may be required.

Good drainage provisions will optimise 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 to prevent 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. SOIL-MAT should be given the opportunity to review the final pavement structure design and subdrain scheme prior to construction to ensure that they are consistent with the recommendations of this report.

The suggested pavement structures outlined in Table C 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 ten-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 – RECOMMENDED PAVEMENT STRUCTURES

LAYER DESCRIPTION	COMPACTION REQUIREMENTS	LIGHT DUTY SECTIONS	HEAVY DUTY [TRUCK ROUTE]
Asphaltic Concrete Wearing course OPSS HL 3 or HL 3A	92 per cent Marshall MRD	40 millimetres	40 millimetres
Binder Course OPSS HL 8	92 per cent Marshall MRD	50 millimetres	80 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.

Where asphalt pavement is to be constructed above the roof deck of the below grade parking level, the granular base layers recommended for the light duty pavement structure recommended above may be considered for both light duty and heavy duty areas. It is noted that in such cases the roof deck slab should be sufficiently sloped

and/or provided with suitable subdrains, in order to promote rapid drainage of water from beneath the pavement. As well the roof slab should be provided with a suitable water proofing system.

To minimise 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 coarse particles during compaction operations. Of course, the above assumes that the asphalt mix is sufficiently hot to allow the 'back-casting' to be performed.

11. SOIL EXPORT CONSIDERATIONS

As the proposed development will incorporate an underground parking level, it is anticipated that construction will require the off-site disposal of surplus soils generated during construction. Ontario Regulation 406/19 has recently come into effect, which regulates the management of such excess soils from construction projects. The support off-site disposal of surplus soils, sufficient assessment, analytical testing, and reporting must be completed in accordance with the Regulation. Such testing can be conducted once development details have been finalised, and an estimate of surplus soils to be generated can be provided.

In the event that site grading, etc., requires the import of soils to the site, such import operations must also be conducted in accordance with the Regulation. This would include review of potential source sites, preparation of a Fill Management Plan [FMP], soil import tracking and record keeping, and confirmatory testing where warranted based on available data. Regardless of the requirement for soil import or export, SOIL-MAT ENGINEERS may be retained to conduct the necessary assessments in accordance with Regulation 406/19.

12. 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.

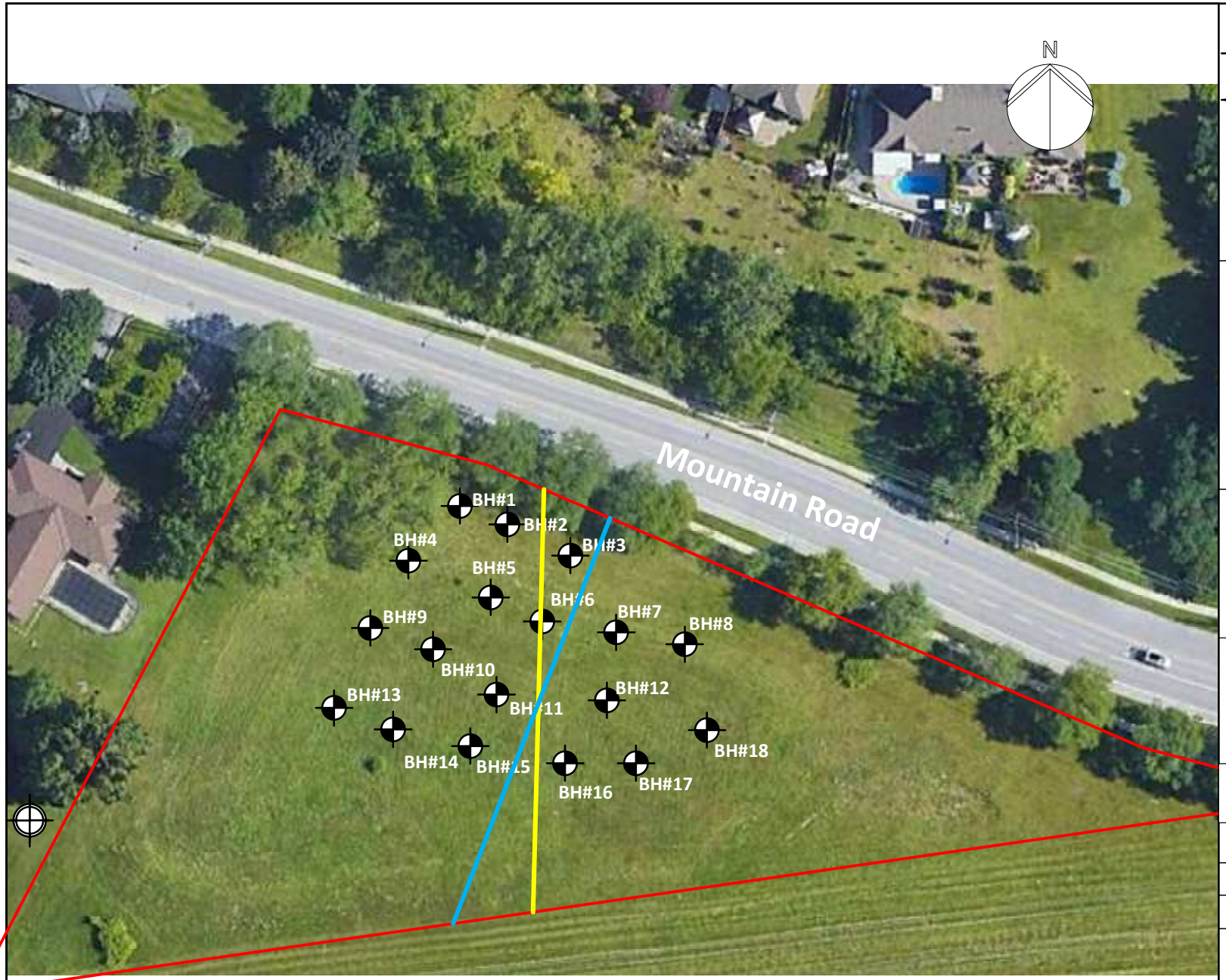
Yours very truly,
SOIL-MAT ENGINEERS & CONSULTANTS LTD.

Kyle Richardson, P. Eng.
Project Engineer

Stephen R. Sears, B.Eng. Mgmt., P.Eng.
Senior Engineer

Enclosures: Drawing No. 1, Borehole Location Plan
Log of Borehole Nos. 1 to 18, inclusive
Drawing No. 2 – Typical Drainage Requirements for Basement Construction

Distribution: Upper Canada Planning and Engineering [pdf]
DAC Investments Inc. [pdf]



LEGEND

- BH# — Borehole Location
- BM — Benchmark
  Southeast edge of shed.
  Elevation of 200.15 metres
- Approximate Property Limits
- Approximate Transition to Deep Fill (SPL)
- Approximate Transition to Deep Fill (Soil-Mat)

NOTES:

1. This drawing should be read in conjunction with Soil-Mat Engineers & Consultants Ltd. Report No. SM 220223-G.

2. Borehole locations are approximate.

SOIL-MAT

ENGINEERS & CONSULTANTS LTD.

Proposed Residential Development
6387 Mountain Road
Niagara Falls, Ontario

Borehole Location Plan

Project No. SM 220223-G

Date: May 2022

Drawn: NS | Checked: KR

SM 220223-G
Borehole Location Plan

Drawing No. 1

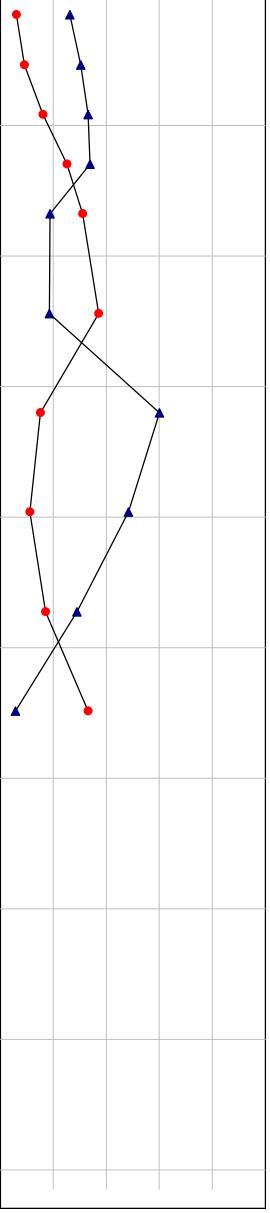
Log of Borehole No. 1

Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777718
E: 654318

Depth (ft / m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	198.47	Ground Surface							
0 – 1 / 0 – 1		**Topsoil** Approximately 150 millimetres of topsoil.	SS	1	2,3,3,4	6			
1 / 1	196.90		SS	2	2,4,5,6	9			
1 – 2 / 1 – 2		**Silty Sand/Sandy Silt Fill** Brown, trace to some clay and rock fragments/gravel, with shale inclusions, loose.	SS	3	3,7,9,13	16			
2 – 3 / 2 – 3			SS	4	9,13,12,11	25			
3 – 4 / 3 – 4		**Sandy Silt/Clayey Silt** Brown, trace to some gravel, stiff to hard.	SS	5	7,14,17,19	31			
4 – 5 / 4 – 5			SS	6	12,18,19,24	37			
5 – 6 / 5 – 6			SS	7	6,9,6,12	15			
6 – 7 / 6 – 7			SS	8	4,5,6,8	11			
7 – 8 / 7 – 8			SS	9	3,6,11,18	17			
8 – 9 / 8 – 9			SS	10	11,16,17,24	33			
9 – 10 / 9 – 10	187.10	End of Borehole							
10 – 11 / 10 – 11		NOTES: 1. Borehole was advanced using solid stem auger equipment on May 2, 2022 to termination at a depth of 11.3 metres. 2. Borehole was recorded as '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.							
11 – 12 / 11 – 12									
12 – 13 / 12 – 13									
13 – 14 / 13 – 14									
14 – 15 / 14 – 15									
15 – 16 / 15 – 16									
16 – 17 / 16 – 17									
17 – 18 / 17 – 18									
18 – 19 / 18 – 19									
19 – 20 / 19 – 20									

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



Drill Method: Hollow Stem Augers
Drill Date: May 2, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

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E: info@soil-mat.ca

Datum: Geodetic
Field Logged by: NS
Checked by: KR
Sheet: 1 of 1

Log of Borehole No. 2

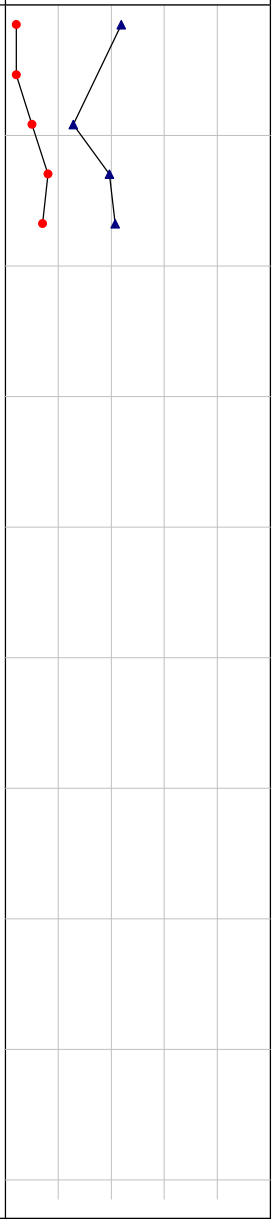
Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777715
E: 654324

Depth (ft)	Depth (m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
		198.24	Ground Surface							
0	0	198.24	**Topsoil** Approximately 150 millimetres of topsoil.	SS	1	1,2,2,3	4			
3	1	196.80	**Silty Sand/Sandy Silt Fill** Brown, trace to some clay and gravel/rock fragments, with shale inclusions, loose.	SS	2	2,2,2,3	4			
6	2			AS	3	3,5,5,7	10			
9	3			SS	4	5,7,9,11	16			
11	3	194.50	**Sandy Silt/Clayey Silt** Brown, trace to some gravel, stiff to very stiff.	SS	5	3,7,7,10	14			
12	4		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 May 9, 2022 to termination at a depth of 3.7 metres.

2. Borehole was recorded as '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: Hollow Stem Augers
Drill Date: May 9, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Davis Drilling

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Sheet: 1 of 1

Log of Borehole No. 3

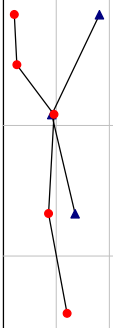
Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777713
E: 654331

Depth (ft / m)	Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	SAMPLE Number	SAMPLE Blow Counts	SAMPLE Blows/300mm	SAMPLE Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	198.08		Ground Surface								
0–3 / 0–1			**Topsoil** Approximately 150 millimetres of topsoil.		SS	1	2,2,2,3	4			
3–5 / 1–1.5	196.50				SS	2	3,3,2,3	5			
5–10 / 1.5–3			**Silty Sand/Sandy Silt Fill** Brown, trace to some clay and gravel/rock fragments, with shale inclusions, loose.		SS	3	5,9,10,8	19			
10–15 / 3–4.5			**Sandy Silt/Clayey Silt** Brown, trace to some gravel, very stiff.		SS	4	3,8,9,9	17			
15–16 / 4.5–5	192.90				SS	5	7,12,12,12	24			
16–60 / 5–18			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 May 9, 2022 to termination at a depth of 5.2 metres.

2. Borehole was recorded as '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: Hollow Stem Augers
Drill Date: May 9, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Davis Drilling

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Sheet: 1 of 1

Log of Borehole No. 4

Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777711
E: 654308

Depth (ft / m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	198.87	Ground Surface							
1–3 / 0–1		**Topsoil** Approximately 100 millimetres of topsoil.	SS	1	2,2,3,3	5			
3–4 / 1	197.50		SS	2	1,2,1,6	3			
4–10 / 1–3		**Silty Sand/Sandy Silt Fill** Brown, trace to some clay and gravel/rock fragments, with shale inclusions, loose to very loose.	SS	3	4,10,14,16	24			
			SS	4	5,12,11,16	23			
		Sandy Silt/Clayey Silt Brown, trace to some gravel, very stiff to hard.	SS	5	8,12,15,16	27			
16–21 / 5–6			SS	6	6,9,12,13	21			
21–26 / 6–8			SS	7	11,16,19,24	35			
			SS	8	11,12,15,14	27			
29–31 / 9	189.10		SS	9	8,9,11,13	20			
32 / 10		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 May 2, 2022 to termination at a depth of 9.8 metres.
2. Borehole was recorded as '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: Hollow Stem Augers
Drill Date: May 2, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

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Sheet: 1 of 1

Log of Borehole No. 5

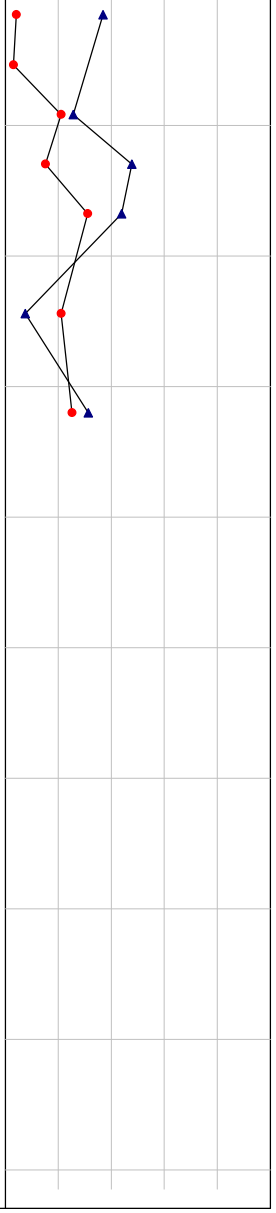
Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777700
E: 654326

Depth (ft / m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	198.33	Ground Surface							
0 / 0		**Topsoil** Approximately 150 millimetres of topsoil.	SS	1	2,2,2,5	4			
3 / 1	197.00		SS	2	2,2,1,5	3			
		Silty Sand/Sandy Silt Fill Brown, trace to some clay and gravel/rock fragments, with shale inclusions, loose to very loose.	SS	3	5,8,13,15	21			
			SS	4	7,7,8,12	15			
10 / 3		**Sandy Silt/Clayey Silt** Brown, trace to some gravel, stiff to hard.	SS	5	7,14,17,17	31			
			SS	6	6,10,11,15	21			
20 / 6									
21 / 6	191.70		SS	7	17,13,12,20	25			
22 / 7		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 May 3, 2022 to termination at a depth of 9.8 metres.

2. Borehole was recorded as '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: Hollow Stem Augers
Drill Date: May 3, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

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Datum: Geodetic
Field Logged by: NS
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Sheet: 1 of 1

Log of Borehole No. 6

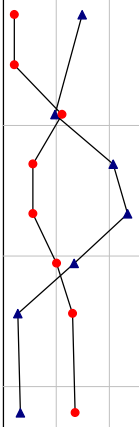
Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777704
E: 654328

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	198.11	Ground Surface								
0–3 / 0–1		**Topsoil** Approximately 150 millimetres of topsoil.		SS	1	2,1,3,4	4			
				SS	2	2,2,2,2	4			
3–11 / 1–3		**Silty Sand/Sandy Silt Fill** Brown, trace to some clay and gravel/rock fragments, with shale inclusions, very loose to compact.		SS	3	19,14,8,8	22			
				SS	4	3,5,6,8	11			
11 / 3	194.40			SS	5	3,4,7,10	11			
12–21 / 4–6		**Sandy Silt/Clayey Silt** Brown, trace to some gravel, very stiff.		SS	6	6,9,11,13	20			
				SS	7	9,12,14,17	26			
21 / 6	191.40			SS	8	11,13,14,20	27			
22 / 7		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 May 3, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as '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: Hollow Stem Augers
Drill Date: May 3, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

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Log of Borehole No. 7

Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777705
E: 654337

Depth (ft)	Depth (m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
		197.68	Ground Surface							
0	0		**Topsoil** Approximately 150 millimetres of topsoil.	SS	1	1,2,2,3	4			
1				SS	2	3,2,1,3	3			
2	1		**Silty Sand/Sandy Silt Fill** Brown, trace to some clay and gravel/rock fragments, with shale inclusions, very loose to dense.	SS	3	5,21,12,20	33			
3				SS	4	4,4,5,3	9			
4	2			SS	5	4,4,5,6	9			
5				SS	6	7,9,7,12	16			
6	3			SS	7	14,8,4,3	12			
7		192.30	**Sandy Silt/Clayey Silt** Brown, trace to some gravel, stiff to hard.	SS	8	2,7,14,15	21			
8	4			SS	9	5,5,9,12	14			
9				SS	10	3,4,6,8	10			
10	5			SS	11	6,12,14,15	26			
11				SS	12	6,10,12,16	22			
12	6			SS	13	5,9,11,11	20			
13										
14	7			SS	14	8,19,21,28	40			
15										
16	8			SS	15	13,21,26,29	47			
17										
18	9									
19										
20	10			SS	16	5,9,11,12	20			
21										
22	11									
23										
24	12									
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26	13									
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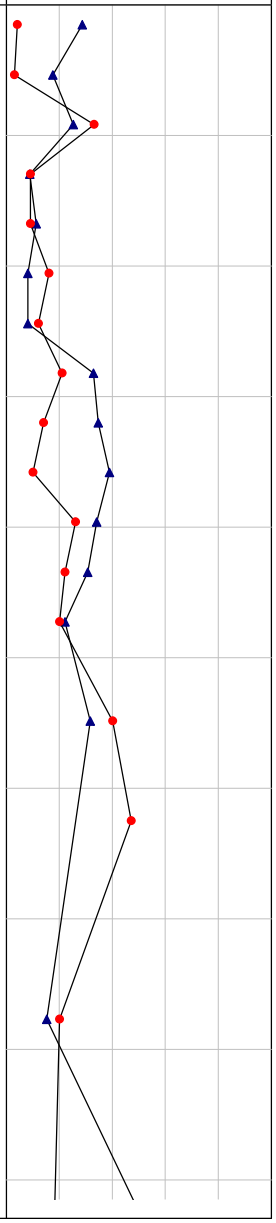
Moisture Content w% (10 20 30 40)

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



NOTES:

1. Borehole was advanced using hollow stem auger equipment on May 4, 2022 to termination at a depth of 24.4 metres.

2. Borehole was backfilled as per Ontario Regulation 903.

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

Drill Method: Hollow Stem Augers
Drill Date: May 4, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

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Log of Borehole No. 7

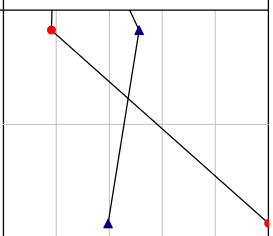
Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777705
E: 654337

Depth	Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0					SS	17	7,6,12,13	18			
1											
2											
3											
4											
5											
6											
7					SS	18	50/2"	100			
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24	173.60										
25			**Limestone** Grey, fractured and weathered in upper levels.		NQ	19	RQD=77%				
26					NQ	20	RQD=50%				
27					NQ	21	RQD=67%				
28	170.00		End of Borehole								
29											
30											
31											
32											
33											
34											
35											
36											

Moisture Content w%
10 20 30 40

Standard Penetration Test blows/300mm
20 40 60 80



Drill Method: Hollow Stem Augers
Drill Date: May 4, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

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Datum: Geodetic
Field Logged by: NS
Checked by: KR
Sheet: 2 of 2

Log of Borehole No. 8

Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777703
E: 654353

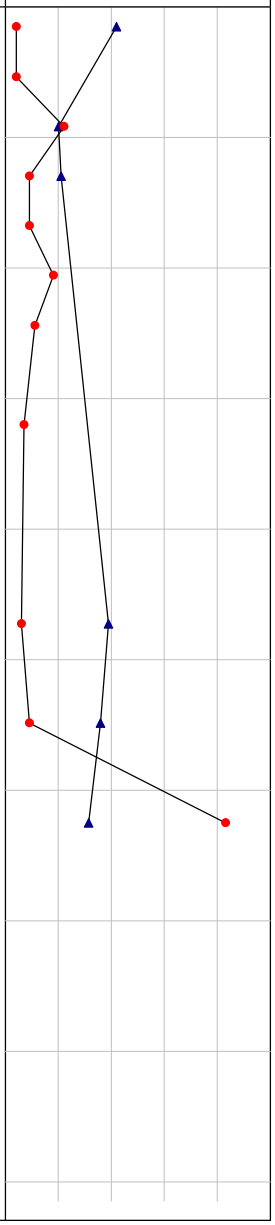
Depth (ft / m)	Elevation (m)	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	197.24	Ground Surface								
0 / 0		**Topsoil** Approximately 150 millimetres of topsoil.		SS	1	1,2,2,2	4			
		Silty Sand/Sandy Silt Fill Brown, trace to some clay and gravel/rock fragments, with significant shale inclusions, very loose to compact.		SS	2	2,2,2,2	4			
2 / 1				SS	3	2,4,18,20	22			
				SS	4	7,6,3,5	9			
3 / 1				SS	5	3,4,5,5	9			
				SS	6	3,4,14,10	18			
4 / 1				SS	7	6,6,5,5	11			
5 / 2				SS	8	4,3,4,13	7			
6 / 2				SS	9	3,2,4,5	6			
7 / 2				SS	10	3,3,6,9	9			
8 / 3	185.60	**Sandy Silt/Clayey Silt** Brown, trace to some gravel, hard.		SS	11	18,45,38,36	83			
9 / 3	184.40	End of Borehole								

NOTES:

1. Borehole was advanced using hollow stem auger equipment on May 5, 2022 to termination at a depth of 12.8 metres.

2. Borehole was recorded as '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: Hollow Stem Augers
Drill Date: May 5, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

Soil-Mat Engineers & Consultants Ltd.
130 Lancing Drive, Hamilton, ON L8W 3A1
T: 905.318.7440 F: 905.318.7455
E: info@soil-mat.ca

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Log of Borehole No. 9

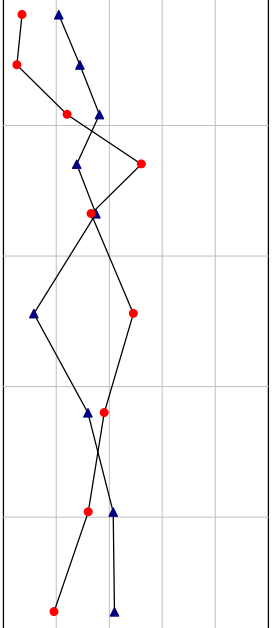
Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777688
E: 654311

Depth (ft / m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	198.78	Ground Surface							
0–4 / 0–1		**Topsoil** Approximately 100 millimetres of topsoil.	SS	1	2,3,4,5	7			
4 / 1	197.30	**Silty Sand/Sandy Silt Fill** Brown, trace to some clay and gravel/rock fragments, with occasional shale inclusions, loose.	SS	2	2,2,3,5	5			
5–10 / 1–3			SS	3	5,9,15,18	24			
10 / 3			SS	4	14,27,25,29	52			
10–13 / 3–4		**Sandy Silt/Clayey Silt** Brown, trace to some gravel, hard to very stiff.	SS	5	12,11,22,25	33			
15–16 / 4–5			SS	6	9,22,27,32	49			
20 / 6			SS	7	16,18,20,26	38			
26 / 8			SS	8	13,14,18,36	32			
30–31 / 9	189.00		SS	9	10,10,9,14	19			
32 / 10		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 May 2, 2022 to termination at a depth of 9.8 metres.

2. Borehole was recorded as '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: Hollow Stem Augers
Drill Date: May 2, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

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130 Lancing Drive, Hamilton, ON L8W 3A1
T: 905.318.7440 F: 905.318.7455
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Datum: Geodetic
Field Logged by: NS
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Sheet: 1 of 1

Log of Borehole No. 10

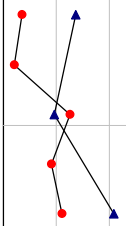
Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777686
E: 654322

Depth (ft)	Depth (m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
		198.51	Ground Surface							
0	0	198.51	**Topsoil** Approximately 150 millimetres of topsoil.	SS	1	1,3,4,7	7			
3	1	197.10	**Silty Sand/Sandy Silt Fill** Brown, trace to some clay and gravel/rock fragments, with shale inclusions, loose to very loose.	SS	2	2,2,2,2	4			
6	2			SS	3	5,11,14,15	25			
9	3			SS	4	4,8,10,12	18			
11	3.4	194.80	**Sandy Silt/Clayey Silt** Brown, trace to some gravel, very stiff.	SS	5	4,10,12,11	22			
12	3.7		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 May 9, 2022 to termination at a depth of 3.7 metres.

2. Borehole was recorded as '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: Hollow Stem Augers
Drill Date: May 9, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Davis Drilling

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130 Lancing Drive, Hamilton, ON L8W 3A1
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Datum: Geodetic
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Log of Borehole No. 11

Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777690
E: 654333

Depth (ft / m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	198.24	Ground Surface							
0–5 / 0–1.5	196.60	**Topsoil** Approximately 150 millimetres of topsoil.	SS	1	1,2,4,6	6			
		Silty Sand/Sandy Silt Fill Brown, trace to some clay and gravel/rock fragments, with occasional shale inclusions, loose.	SS	2	3,3,3,2	6			
5–10 / 1.5–3			SS	3	5,17,16,10	33			
			SS	4	5,10,12,15	22			
10–13 / 3–4		**Sandy Silt/Clayey silt** Brown, trace to some gravel, hard to very stiff.	SS	5	5,8,10,10	18			
15–20 / 4.5–6			SS	6	5,6,13,10	19			
20–25 / 6–7.5			SS	7	12,19,10,15	29			
25–26 / 7.5–8	190.00		SS	8	9,13,16,28	29			
26 / 8		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 May 9, 2022 to termination at a depth of 7.9 metres.

2. Borehole was recorded as '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:

May 27, 2022 - Dry

Drill Method: Hollow Stem Augers
Drill Date: May 9, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Davis Drilling

Soil-Mat Engineers & Consultants Ltd.
130 Lancing Drive, Hamilton, ON L8W 3A1
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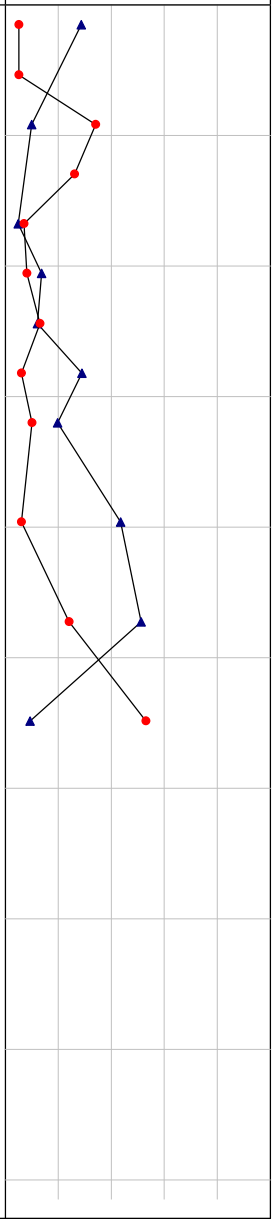
Log of Borehole No. 12

Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777693
E: 654398

Depth (ft / m)	Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
ft 0 / m 0	197.57		Ground Surface								
0–3 / 0–1			**Topsoil** Approximately 150 millimetres of topsoil.		SS	1	1,2,3,4	5			
					SS	2	3,3,2,3	5			
3–6 / 1–2			**Silty Sand/Sandy Silt Fill** Brown, trace to some clay and gravel/rock fragments, with significant shale inclusions, loose to dense.		SS	3	6,17,17,18	34			
					SS	4	29,17,9,7	26			
9–12 / 3–4					SS	5	7,4,3,4	7			
					SS	6	3,4,4,4	8			
15–18 / 5–6					SS	7	10,7,6,6	13			
					SS	8	5,4,2,2	6			
18–21 / 6–7					SS	9	2,4,6,8	10			
24–27 / 8					SS	10	2,3,3,5	6			
29 / 9	188.40		**Sandy Silt/Clayey Silt** Brown, trace to some gravel, very stiff to hard.		SS	11	6,9,15,12	24			
33–36 / 10–11	186.20				SS	12	18,24,29,32	53			
36 / 11			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 May 5, 2022 to termination at a depth of 11.3 metres.

2. Borehole was recorded '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: Hollow Stem Augers
Drill Date: May 5, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

Soil-Mat Engineers & Consultants Ltd.
130 Lancing Drive, Hamilton, ON L8W 3A1
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Datum: Geodetic
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Sheet: 1 of 1

Log of Borehole No. 13

Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777672
E: 654315

Depth (ft)	Depth (m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
		198.93	Ground Surface							
0	0		**Topsoil** Approximately 100 millimetres of topsoil.	SS	1	1,2,2,8	4			
1				SS	2	1,2,2,8	4			
2	1			SS	3	7,6,5,7	11			
3			**Silty Sand/Sandy Silt Fill** Brown, trace to some clay and gravel/rock fragments, with occasional shale inclusions, loose to compact.	SS	4	8,17,21,29	38			
4			**Sandy Silt/Clayey Silt** Brown, trace to some gravel, hard.	SS	5	25,36,45,50	81			
5				SS	6	17,13,18,23	31			
6		196.70								
7		192.20		SS	7	16,20,26,35	46			
			End of Borehole							

NOTES:

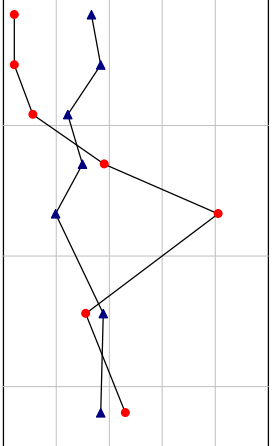
1. Borehole was advanced using hollow stem auger equipment on May 2, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as '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.

Moisture Content w% (10 20 30 40)

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



Drill Method: Hollow Stem Augers
Drill Date: May 2, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

Soil-Mat Engineers & Consultants Ltd.
130 Lancing Drive, Hamilton, ON L8W 3A1
T: 905.318.7440 F: 905.318.7455
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Datum: Geodetic
Field Logged by: NS
Checked by: KR
Sheet: 1 of 1

Log of Borehole No. 14

Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777673
E: 654319

Depth (ft / m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	198.67	Ground Surface							
0 – 2 / 0 – 0.6		**Topsoil** Approximately 150 millimetres of topsoil.	SS	1	1,1,2,1	3			
			SS	2	2,1,3,3	4			
2 – 7 / 0.6 – 2.1	196.30	**Silty Sand/Sandy Silt Fill** Brown, trace to some clay and gravel/rock fragments, with occasional shale inclusions, very loose to loose.	SS	3	2,3,2,2	5			
			SS	4	8,11,17,22	28			
7 – 21 / 2.1 – 6.4		**Sandy Silt/Clayey Silt** Brown, trace to some gravel, very stiff to hard.	SS	5	12,24,27,26	51			
			SS	6	12,19,25,36	44			
21 / 6.4	191.90		SS	7	15,11,18,12	29			
21 / 6.4		End of Borehole							

NOTES:

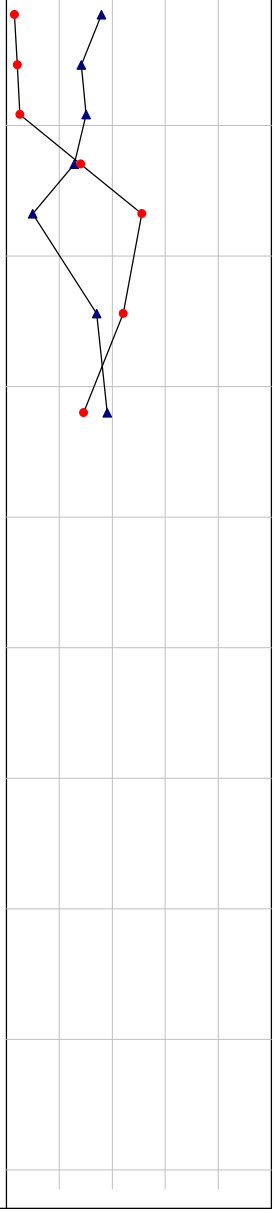
1. Borehole was advanced using hollow stem auger equipment on May 6, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as '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.

Moisture Content w% (10 20 30 40)

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



Drill Method: Hollow Stem Augers
Drill Date: May 6, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

Soil-Mat Engineers & Consultants Ltd.
130 Lancing Drive, Hamilton, ON L8W 3A1
T: 905.318.7440 F: 905.318.7455
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Datum: Geodetic
Field Logged by: NS
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Sheet: 1 of 1

Log of Borehole No. 15

Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777668
E: 654320

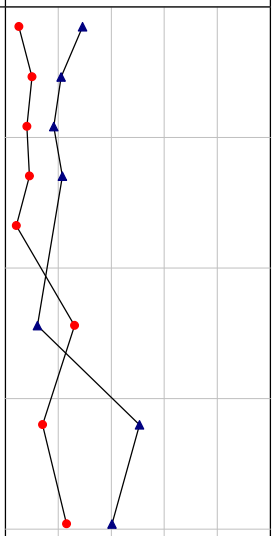
Depth (ft / m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	198.35	Ground Surface							
0 – 4 / 0 – 1.2		**Topsoil** Approximately 150 millimetres of topsoil.							
		Silty Sand/Sandy Silt Fill Brown, trace to some clay and gravel/rock fragments, with shale inclusions, very loose to compact.	SS	1	2,2,3,3	5			
			AS	2	2,5,5,10	10			
			SS	3	4,4,4,9	8			
			SS	4	5,5,4,3	9			
			SS	5	3,2,2,2	4			
14 / 4	193.80								
		Sandy Silt/Clayey Silt Brown, trace to some gravel, stiff to very stiff.	SS	6	2,10,16,23	26			
			SS	7	4,6,8,14	14			
			SS	8	9,9,14,15	23			
26 / 8	190.10	End of Borehole							

NOTES:

1. Borehole was advanced using hollow stem auger equipment on May 6, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as '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: Hollow Stem Augers
Drill Date: May 6, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

Soil-Mat Engineers & Consultants Ltd.
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Datum: Geodetic
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Log of Borehole No. 16

Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777670
E: 654338

Depth (ft / m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	197.85	Ground Surface							
		Topsoil Approximately 150 millimetres of topsoil.	SS	1	2,1,3,5	4			
		Silty Sand/Sandy Silt Fill Brown, trace to some clay and gravel/rock fragments, with significant shale inclusions, very loose to dense.	SS	2	3,3,2,3	5			
			SS	3	2,1,3,7	4			
			SS	4	16,16,25,29	41			
			SS	5	6,6,6,5	12			
			SS	6	34,25,19,5	44			
23 / 7	190.80	**Sandy Silt/Clayey Silt** Brown, trace to some gravel, very stiff to hard.	SS	7	7,13,9,7	22			
			SS	8	3,17,30,40	47			
32 / 10	188.00	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 May 6, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as '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: Hollow Stem Augers
Drill Date: May 6, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

Soil-Mat Engineers & Consultants Ltd.
130 Lancing Drive, Hamilton, ON L8W 3A1
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Datum: Geodetic
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Log of Borehole No. 17

Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777682
E: 654346

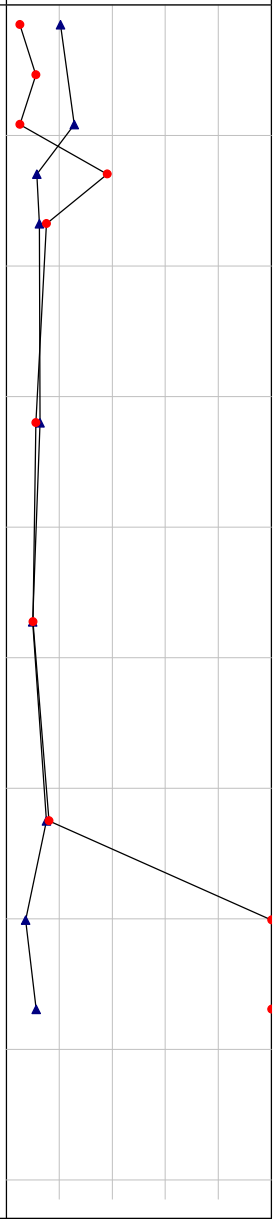
Depth (ft / m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	197.21	Ground Surface							
0 / 0		**Topsoil** Approximately 150 millimetres of topsoil.	SS	1	1,2,3,4	5			
3 / 1			SS	2	4,6,5,4	11			
		Silty Sand/Sandy Silt Fill Brown, trace to some clay and gravel/rock fragments, with significant shale inclusions, loose to dense.	SS	3	1,2,3,19	5			
7 / 2			SS	4	8,12,26,24	38			
10 / 3			SS	5	11,8,7,8	15			
13 / 4									
16 / 5									
19 / 6		NOTES: 1. Borehole was advanced using hollow stem auger equipment on May 6, 2022 to termination at a depth of 15.4 metres. 2. Borehole was recorded as '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.	SS	6	10,6,5,4	11			
23 / 7									
26 / 8									
29 / 9			SS	7	5,5,5,4	10			
33 / 10									
36 / 11									
39 / 12									
43 / 13			SS	8	15,8,8,50/2	16			
44 / 13	183.50								
46 / 14		**Sandy Silt/Clayey Silt** Brown, trace to some gravel, hard.	SS	9	34,50/2"	100			
49 / 15									
50 / 15	181.60			10	50/3"	100			
52 / 16		End of Borehole							
56 / 17									
59 / 18									
60									

Well Data

SAMPLE

Moisture Content w% (10 20 30 40)

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



Drill Method: Hollow Stem Augers
Drill Date: May 6, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

Soil-Mat Engineers & Consultants Ltd.
130 Lancing Drive, Hamilton, ON L8W 3A1
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Datum: Geodetic
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Log of Borehole No. 18

Project No: SM 220223-G
Project: Proposed Residential Development
Location: 6378 Mountain Road, Niagara Falls
Client: DAC Investments Niagara Inc.

Project Manager: Kyle Richardson, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4777682
E: 654361

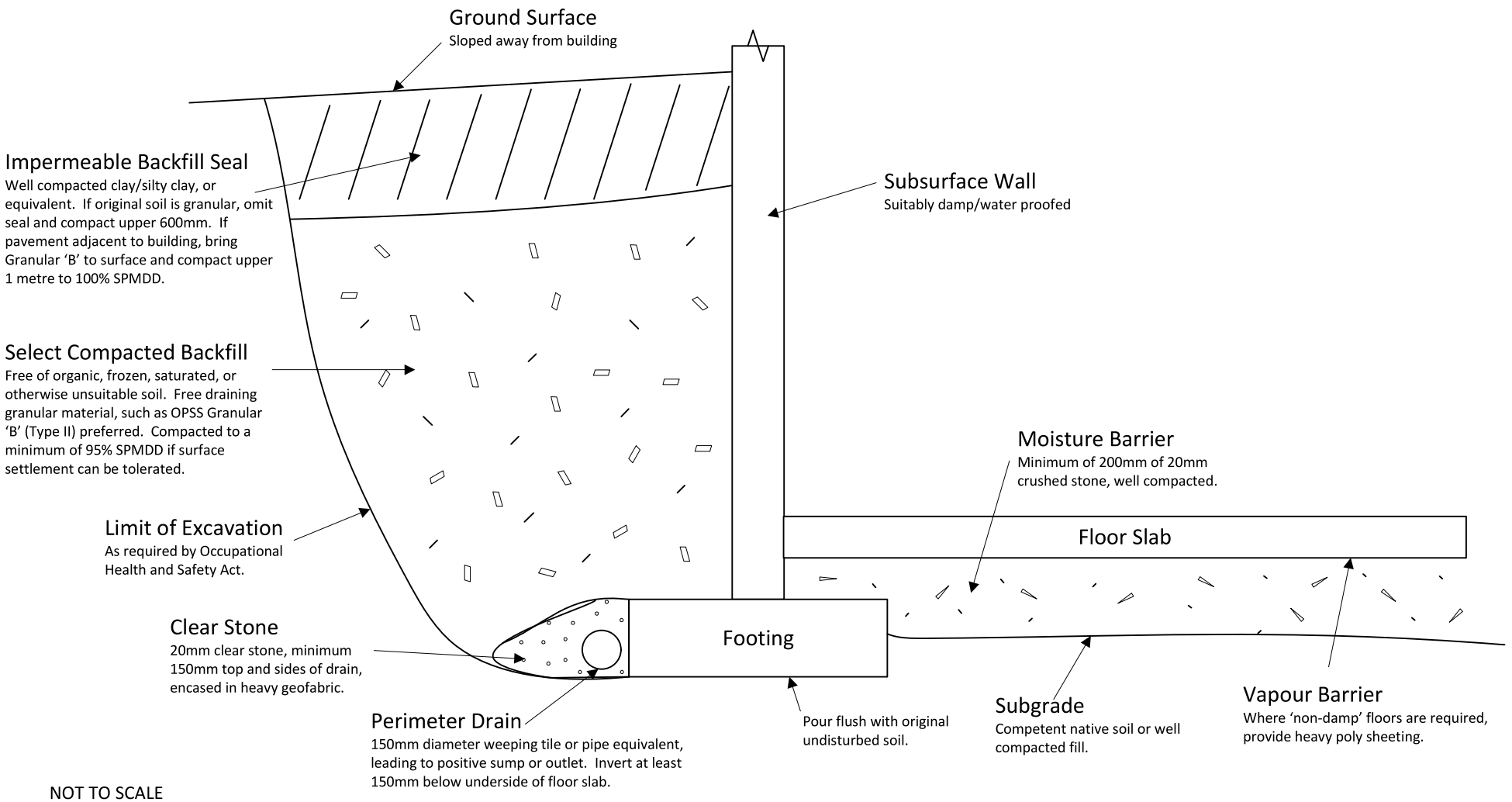
Depth (ft / m)	Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	196.80	Ground Surface							
0 / 0		**Topsoil** Approximately 150 millimetres of topsoil.	SS	1	2,2,4,6	6			
3 / 1			SS	2	5,7,6,8	13			
		Silty Sand/Sandy Silt Fill Brown, trace to some clay and gravel/rock fragments, with shale inclusions, loose to compact.							
6 / 2			SS	3	2,3,2,5	5			
16 / 5			SS	4	5,3,3,3	6			
20 / 6		NOTES: 1. Borehole was advanced using hollow stem auger equipment on May 5, 2022 to termination at a depth of 17.4 metres. 2. Borehole was recorded as '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.							
30 / 9			SS	5	3,5,4,8	9			
36 / 11			SS	6	5,4,6,10	10			
49 / 15	181.60		SS	7	10,8,6,7	14			
50 / 15		**Sandy Silt/Clayey Silt** Brown, trace to some gravel, firm to hard	SS	8	3,3,4,5	7			
56 / 17	179.50		SS	9	16,32,28,26	60			
59 / 18		End of Borehole							

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

Drill Method: Hollow Stem Augers
Drill Date: May 5, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Davis Drilling

Soil-Mat Engineers & Consultants Ltd.
130 Lancing Drive, Hamilton, ON L8W 3A1
T: 905.318.7440 F: 905.318.7455
E: info@soil-mat.ca

Datum: Geodetic
Field Logged by: NS
Checked by: KR
Sheet: 1 of 1



NOT TO SCALE

Soil-Mat

Soil-Mat Engineers & Consultants Ltd.

Project No.:	SM 220223-G
Date:	May 2022

Typical Design Requirements
Drainage and Backfill for Basement Walls

Drawing No. 2