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Project No.: SM 301708-G

July 23, 2021

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RUDANCO HOSPITALITY CORPORATION
4728 DORCHESTER ROAD – UNIT 11B, 2ND FLOOR
Niagara Falls, Ontario
L2E 7H9

Attention: Jeremia Rudan

**PRELIMINARY GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
13030 LUNDY'S LANE
ALLANBURG, ONTARIO**

Dear Mr. Rudan,

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 P301708, dated May 27, 2021. Our comments and recommendations based on our findings at the ten [10] borehole locations are presented in the following paragraphs.

1. INTRODUCTION

We understand that the project will involve the construction of a residential development consisting of single-family dwellings and townhouse blocks, a stormwater management pond, commercial and mixed blocks, and occasional mid to high rise residential buildings up to 18 storeys in height, along with the installation of associated underground municipal service along asphalt paved roadways and parking areas located at 13030 Lundy's Lane in Allanburg, Ontario. At this time it is understood that the mid to high rise buildings will have one to two underground parking levels. The purpose of this preliminary 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 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 the information contained in this report does not reflect upon the environmental aspects of the site.

2. PROCEDURE

A total of ten [10] sampled boreholes were advanced at the locations illustrated in the attached Drawing No. 1, Borehole Location Plan. It is noted that due to the presence of crops within the agricultural field, the boreholes were situated to the perimeter of the field to limit disturbance. The boreholes were advanced using continuous flight power auger equipment on May 28, 2021 under the direction and supervision of a staff member of SOIL-MAT ENGINEERS & CONSULTANTS LTD., to termination at depths of between approximately 5.2 and 12.2 metres below the existing ground surface.

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 performed on all soil samples recovered from the borings. Selected samples were also subjected to laboratory grain size analyses and Atterberg Limits testing.

Upon completion of drilling, a monitoring well was installed at Borehole Nos. 1, 5, 6, and 9 to allow for the future measurements of the groundwater level. The monitoring wells consisted of 50-millimetre PVC pipe, screened in the lower 3.0 metres. 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.

The boreholes were located in the field by representatives of SOIL-MAT ENGINEERS, based accessibility over the site and clearance of underground utilities. The ground surface elevation at the borehole locations have been referenced to a site-specific geodetic benchmark, described as the top of the manhole lid located just east of the

entranceway to 13030 Lundy's Lane as illustrated in the attached Drawing No. 1. This benchmark was noted to have a geodetic elevation of 185.05 metres as per the Suda & Maleszyk Surveying Inc site plan (File No. 19-151, Job No. 5920-1) that was 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 10, 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 is currently occupied by a motel and associated parking areas at the southern portion of the site as well as an active agricultural plot of land over the remainder of the site to the north. A large hydro corridor bisects the northern part of the agricultural land with a northeast/southwest orientation. The site is bound to the north and west by existing agricultural land, to the east by Thorold Townline Road, and to the south by Lundy's Lane. The site has an overall topographic relief of up to approximately 4 to 5 metres from east to west.

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

Topsoil

A surficial veneer of topsoil approximately 200 to 250 millimetres in thickness was encountered at all borehole locations. It is noted that the depth of topsoil may vary across the site and from the depths encountered at the borehole locations. As the land is known to have been historically used as agricultural land resulting in disturbance in the upper levels, a conservative approach should be taken in estimating topsoil quantities, and organics may extend to depths greater than those encountered at the borehole locations. It is also noted that the term 'topsoil' has been used from a geotechnical point of view, and does not necessarily reflect its nutrient content or ability to support plant life.

Clayey Silt

Native clayey silt was encountered beneath the surficial topsoil at all borehole locations. The native cohesive soils were brown to reddish brown in colour, generally transitioning to grey below a depth of approximately 3 to 4 metres. The clayey silt soils encountered contained trace to some gravel, and were generally stiff to hard in the upper levels, becoming soft with depth. Sampling spoon refusal was occasionally encountered, likely due to the presence of large gravel or cobbles. The clay content of the soils generally decreased with depth as the soils became less cohesive. Occasional more permeable sandier seams were also encountered. The native clayey silt was proven to termination or auger refusal on assumed bedrock at all borehole locations.

A review of available published information [Quaternary Geology of Ontario, Southern Sheet Map 2556] indicate the subsurface soils to fine-textured glaciolacustrine deposits of silt and clay, with minor sand and gravel. These conditions are consistent with our experience in the area and observations during drilling.

Limestone/Dolostone Bedrock

Bedrock was inferred from spoon refusal, at depths of approximately 12.2 and 10.9 metres at Borehole Nos. 7 and 8, respectively. The depth and elevation of the inferred bedrock surface has been summarised in the following table:

TABLE A
ASSUMED BEDROCK DEPTHS AND ELEVATIONS

Borehole No.	Surface Elevation [m]	Assumed Bedrock Depth [m]	Assumed Bedrock Elevation [m]
1	185.55	>6.7	<178.90
2	186.32	>6.7	<179.60
3	185.33	>6.4	<178.90
4	185.78	>6.7	<179.10
5	187.33	>6.7	<180.60
6	182.68	>6.7	<176.00
7	182.87	12.2	170.70
8	182.35	10.9	171.50
9	184.28	>6.7	<177.60
10	184.27	>5.2	<179.10

Based on the bedrock elevations noted above, the bedrock was encountered at elevations of approximately 170.70 to 171.50 metres along the eastern limit of the site. From a review of available published information and past experience in the area, the bedrock consists of Limestone and Dolostone of the Bois Blanc formation. The bedrock is considered very competent in terms of excavation and foundation requirements for the project, however the upper levels of the bedrock are often weathered and fractured, and are noted to be susceptible to 'vugs' and solution cavities. The bedrock was not cored as part of this investigation.

Grain Size Analyses and Atterberg Limits

Grain size analyses and Atterberg limits testing were conducted on selected samples of the native soils recovered from the boreholes. The results of this grain size and Atterberg limits testing can be found appended to the end of this report, and are summarized as follows:

TABLE B
GRAIN SIZE ANALYSES

Sample ID	Depth	% Clay	% Silt	% Sand	% Gravel	Hydraulic Conductivity, k [cm/s]	Estimated Infiltration Rate, [mm/hr]
BH1 SS3	1.5 m	44	49	6	1	10^{-8}	<10
BH5 SS5	3.0 m	60	38	2	0	10^{-8}	<10
BH5 SS7	6.1 m	18	69	10	3	10^{-7}	<10
BH6 SS5	3.0 m	54	45	1	0	10^{-8}	<10
BH7 SS4	2.3 m	29	70	1	0	10^{-7}	<10
BH7 SS8	10.7 m	16	67	15	2	10^{-7}	<10
BH9 SS5	3.0 m	54	44	2	0	10^{-8}	<10
BH10 SS3	1.5 m	47	51	2	0	10^{-8}	<10

TABLE C
ATTERBERG LIMITS

Sample ID	Depth	Plastic Limit	Liquid Limit	Plasticity Index
BH1 SS3	1.5 m	18.5	38.8	20.3
BH5 SS7	3.0 m	15.7	21.9	6.20
BH5 SS5	6.1 m	18.6	45.1	26.5
BH6 SS5	3.0 m	17.7	42.6	24.9
BH7 SS4	2.3 m	17.5	31.1	13.5
BH7 SS8	10.7 m	14.7	19.2	4.50
BH 9 SS5	3.0 m	20.1	38.2	18.1
BH10 SS3	1.5 m	18.0	35.8	17.8

Note 1: Infiltration rate estimated using Ontario Ministry of Municipal Affairs and Housing (OMMAH). 1997. Supplementary Guidelines to the Ontario Building Code 1997. SG-6 Percolation Time and Soil Descriptions. Toronto, Ontario.

The field and laboratory testing demonstrate the native soils to consist of clay and silt mixtures with trace sand and gravel. Clay content was generally noted to decrease with depth, with soils consisting predominately of silt with some clay. According to the Unified Soil Classification System (USCS), the soils are generally classified as C.L. – Inorganic clays of low plasticity to C.H. – Inorganic clays of medium to high plasticity, with occasional more sandy seams. These soils would generally behave as a low permeability to an effectively impermeable cohesive material, and would be well suited to provide an impermeable liner in the event that a stormwater management pond is proposed. Such soils are not considered suitable for low impact development (LID) stormwater management systems.

Groundwater Observations

Borehole Nos. 1 and 5 were noted to be open and 'wet' at depths of approximately 6.4 metres upon completion of drilling, while Borehole Nos. 7 and 8 had caved to a depth of approximately 8.2 metres and were 'wet' at depths of approximately 4.6 and 3.9 metres, respectively. The remainder of the boreholes were noted as being 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, a monitoring well was installed at Borehole Nos. 1, 5, 6, and 9, to allow for future measurements of the static groundwater level. The monitoring wells were equipped with data loggers to capture interval readings over a sustained period of time, notably between May 31 to July 1, 2021. The groundwater level readings taken to date conservatively indicate a groundwater level on the order of 2 to 3 metres below the existing grade, at an elevation

of roughly 183 to 186 metres, however indicating a trend towards greater depths, and would be expected to fluctuate seasonally. Further monitoring of the groundwater level may allow for a more accurate estimate of the groundwater level.

4. FOUNDATION CONSIDERATIONS – COMMERCIAL BLOCK, MID TO HIGH-RISE BUILDINGS

As noted above, at this time it is understood that the proposed development will include commercial blocks and mid to high rise residential buildings. It is recommended that more detailed specific investigations be conducted for the mid to high rise structures once design details have been finalised.

4.1 SHALLOW FOUNDATIONS

The soil conditions encountered at the borehole locations are generally considered suitable to support the proposed commercial development, single family dwellings, and potential low to mid rise structures on conventional spread footings founded in the undisturbed native soils, below any fill or otherwise unsuitable material, as noted above. Footings founded within the competent, undisturbed native soils may be designed considering a factored Ultimate Limit State [ULS] bearing capacity of 225 kPa [\sim 4,500 psf], and a Serviceability Limit State [SLS] bearing capacity of 150 kPa [\sim 3,000 psf], based on total and differential settlements not exceeding 25 and 20 millimetres, respectively. The exposed footing beds must be hand cleared of any loose or disturbed material, or ponded water, immediately prior to the placement of the concrete.

The clayey silt soils encountered are susceptible to disturbance from moisture conditions and construction traffic. Consideration should be given to the placement of a thin, lean-mix [\sim 5 MPa] concrete 'mud slab' upon completion of excavation and evaluation of founding soils. This would serve to protect the founding soils from disturbance, and provide a clean working surface for the construction of footing formwork and placement of reinforcing steel. Regardless, 'mud slab' or footing concrete should be placed as soon as possible after excavation to prevent disturbance to the founding soils from weather or construction traffic.

RAFT SLAB

In the event that the proposed loading results in a spread footing coverage of 50 per cent of the building foot print or more, a raft slab may be considered to support the mid-rise structures. It is recommended that a raft slab be designed considering a 100 kPa [\sim 2,000 psf] SLS and 150 kPa [\sim 3,000 psf] ULS bearing capacity. If a flexible design approach is used, a conservatively value of subgrade modulus of $k = 25 \text{ MN/m}^3$ [\sim 90 pci]

may be considered on the competent native soils. Depending on the depth of the raft slab foundation relatively to the groundwater level, the raft slab may also need to be designed to resist hydrostatic uplift pressures where founded below the static groundwater level.

4.2 CAISSONS

Depending on the loads of the proposed mid to high-rise buildings, it may be necessary to found the proposed structures on deep foundations extending to the limestone bedrock, to support the mid-rise residential structures. Caissons extending to the competent limestone/dolostone bedrock encountered at depths of approximately 10.9 to 12.2 metres below the existing ground or 170.7 to 171.5 metres in elevation, below any significantly fractured or weathered surface layers, may be designed considering a SLS and ULS bearing capacity of 1,000 kPa [\sim 90 ksf] on a preliminary basis. Higher capacity is likely available within the more competent bedrock, however additional investigations would be necessary, including coring and unconfined compressive strength testing of the limestone bedrock.

Caissons excavations through the cohesive clayey silt/silty clay soils encountered and more specifically through the more permeable and sensitive silt layers may remain open for the short construction period, however it may be necessary to utilise a steel liner to maintain the integrity of the open hole and prevent the infiltration of water, especially where more permeable sandy seams are encountered. The contractor should be prepared to provide such a steel liner in the event that instability of the excavation or significant groundwater infiltration is noted.

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 'tremmie' 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.

4.2 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 structure and larger for more flexible buildings. It is also noted that the SLS and ULS bearing capacities are equivalent within the competent limestone bedrock, as in order for serviceability limits to be realized, ultimate failure of the bedrock would have to occur.

The support conditions afforded by the founding soils are usually not uniform across the site, neither are the loads on the various foundation elements. It is therefore recommended that the footings and foundation walls be provided with continuous structural reinforcement to account for potential variable support and loading conditions.

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 an imaginary line drawn up from the edge of the lower footing at 10 horizontal to 7 vertical. This practice will limit stress transfer from the higher footings to lower footings.

All footings, pile 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 well within normally tolerated limits of 25 and 20 millimetres, respectively, for the type of building and occupancy expected. As is typical in most new construction, 'cosmetic' cracking of plasterboard, foundation walls, etc. should be anticipated within the first year of construction as a result of shrinkage, minor settlement, etc. Subsequent to repair, additional cracking should be minimal.

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 report and to allow changes to be made in the event that subsurface conditions differ from the conditions identified at the borehole locations.

5. SEISMIC DESIGN CONSIDERATIONS

The structure shall be designed according to Section 4.1.8 of the Ontario Building Code, Ontario Regulation 332/12. Based on the subsurface soil conditions encountered in this investigation the applicable Site Classification for the seismic design is Site Class D, 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.

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

$S_a(0.2)$	$S_a(0.5)$	$S_a(1.0)$	$S_a(2.0)$	$S_a(5.0)$	$S_a(10.0)$	PGV	PGA
0.321	0.157	0.072	0.0320	0.0076	0.0030	0.207	0.121

6. FLOOR SLABS AND PERMANENT DRAINAGE

The floor slabs of the proposed commercial and mid-rise residential buildings may be constructed using conventional slab-on-grade techniques on a prepared subgrade. 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 bedrock) 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.

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 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 provisions 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.

Where the finished floor level is less than 300 millimetres above the finished exterior grade consideration should be given to the provision of a perimeter weeping tile system to prevent the buildup of water against foundations. Where provided, 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 stone product, and the clear 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 gravity sewer connection, a nearby catch basin, or a sump pit 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 and 3 shows schematics of the typical perimeter drainage requirements for slab-on-grade foundation construction, with and without a basement, respectively.

As noted above, the measured groundwater level was noted at depths of approximately 1 to 2 metres, based on the available data to date. Depending on the proposed depth of potential basement levels, further measurement of the groundwater level may be warranted, and depending on these results, a more detailed hydrogeological assessment may be required. Such an assessment would serve to estimate daily dewatering rates during construction, as well as post construction discharge rates for permanent dewatering systems.



7. EXCAVATIONS

Excavations for the installation of foundations and underground services are anticipated to extend to depths of up to approximately 3 to 4 metres below the existing grade. Excavations above the static groundwater level through the cohesive clayey silt soils would be expected to remain stable at inclinations of up to 45 to 60 degrees to the horizontal. Where wet/more permeable silty or sandy 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. The native soils anticipated would be considered a Type 2 and 3 soil, as outlined in the Ontario Health and Safety Act III – Excavation. 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.

As noted above the static groundwater level is estimated at depths of approximately 3 to 3 metres, perhaps deeper pending a more detailed assessment of the groundwater level, however potentially approaching the proposed depths of construction, such as for deeper sewer trenches and basements. Infiltration of water through the more permeable, as well as runoff into the open excavations, should be anticipated. However, given the low permeability of the clayey silt soils encountered, the rate of infiltration is anticipated to be relatively low, such that it should be possible to adequately control groundwater infiltration for short construction periods using conventional construction dewatering methods, such as pumping from sumps in the base of the excavation. More groundwater should be anticipated when connections are made to existing services, or where relatively deep excavations are required. Surface water should be directed away from the excavations.

Where deeper excavations are required, extending significantly below the groundwater level and into the silt soils, or where excavations are required to be open for a longer period of time, some difficulty may be encountered with base and side slope stability, groundwater control, etc. The sides of the excavations in these granular soils may tend to slump in to flatter stable inclinations. The base of the excavations may have a tendency to become unstable, requiring the placement of coarse ballast to control groundwater infiltration, or the use of more sophisticated groundwater control methods may be required. In this regard it would be prudent to advance a series of test excavations where deep services or basements are proposed. This will give contractors an opportunity to observe first hand how any potential shallow groundwater conditions or permeable seams may affect the excavations during construction.

The base of the excavations in the native clayey silt encountered in the boreholes should generally remain firm and stable, however may require stabilisation where exposed to moisture conditions and construction traffic. Standard pipe bedding, as typically specified by the Ontario Provincial Standard Specification should be satisfactory, compacted to 95 per cent of its standard Proctor maximum dry density [SPMDD], should suffice.

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, roadways, existing dwellings, etc. depending on their proximity to the trench excavations.

8. BACKFILL CONSIDERATIONS

The excavated material will consist primarily of the clayey silt soils encountered in the boreholes as described above. These soils are generally considered suitable for use as engineered fill, trench backfill, etc., provided that they are free of organics, construction debris, or other deleterious material, and that its moisture content can be controlled to within 3 per cent of its standard Proctor optimum moisture content.

It is noted that the on-site soils encountered are not considered to be free draining and should not be used where this characteristic is necessary. It is also noted that these fine grained to cohesive soils will present difficulties in achieving effective compaction where access with compaction equipment is restricted. The on-site soils encountered are generally considered to be slightly 'wet' of their standard Proctor optimum moisture content. Some moisture conditioning will 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 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 therefore impacting roadway 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 encountered 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 moisture content of the backfill soils be within 3 per cent of its 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 per cent 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'. Backfill within service trenches, areas to be paved, etc., should be placed in loose lifts not exceeding 300 millimetres in thickness and compacted to a minimum of 98 per cent of its standard Proctor maximum dry density [SPMDD]. All structural fill should be compacted to 100 per cent of its SPMDD. The appropriate compaction equipment should be employed based on soil type, i.e. pad-toe for cohesive soils and smooth drum/vibratory plate for granular soils. A method should be developed to assess compaction efficiency employing the on-site compaction equipment and backfill materials during construction.

9. 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 100 per cent of its standard Proctor maximum dry density.

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 100 per cent of its standard Proctor maximum dry density.

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 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 subexcavated 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 [50-millimetre clear stone, 'rip rap', 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 where the subgrade is wet to saturated.

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.

If construction is conducted under adverse weather conditions, additional subgrade preparation may be required. During wet weather conditions, such as during the fall and spring months, it should be anticipated that additional subgrade preparation will be required, such as additional depth of Ontario Provincial Standard Specification [OPSS] Granular 'B', Type II (crushed 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 subgrade level.

The suggested pavement structures outlined in Table D below are based on subgrade parameters estimated on the basis of visual and tactile examinations of the on-site soils and past experience, and may be considered for parking lots, etc. around the commercial block. The outlined pavement structure may be expected to have an approximate ten to fifteen-year life, assuming that regular maintenance is performed.

TABLE D – SUGGESTED PAVEMENT STRUCTURE

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

The proposed roadways through the residential subdivision would be required to adequately support cars, trucks and intermittent delivery and garbage trucks. For this project, a recommended pavement minimum structure would consist of 300 millimetres of OPSS Granular 'B', Type II (crushed bedrock) sub-base course, 150 millimetres of OPSS Granular 'A' base course, 65 millimetres of HL8 binder course asphaltic concrete, and 40 millimetres of HL3 surface course asphaltic concrete. Notwithstanding, the pavement structure should conform to the relevant Niagara Region requirements where they are to be assumed by the Region. It is our opinion that this design is suitable for use on a residential roadway section, provided that the subgrade has been prepared as specified and is good and firm before the sub-base course material is placed. If the subgrade is soft, remedial measures as discussed above may have to be implemented and/or the sub-base thickness may have to be increased. The granular sub-base and base courses and asphaltic concrete layers should be compacted to OPSS or Niagara Region requirements. A program of in-place density testing must be carried out to monitor that compaction requirements are being met. We note that this pavement structure is not to be considered as a construction roadway design.

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.

Asphalt paving of driveways should be consistent with the general recommendations provided above. Proper preparation of the subgrade soils is essential to good long-term performance of the pavement. Likewise, sufficient depth and compaction of granular base materials and adequate drainage will be important in achieving good long-term performance, i.e. preventing/limiting premature cracking, subgrade failure, rutting, etc. A recommended light duty pavement structure for residential driveways would consist of a minimum of 200 millimetres of OPSS Granular 'A' base course, compacted to 100 percent standard Proctor maximum dry density, followed by a minimum of 50 millimetres of HL3 or HL3F asphaltic concrete, compacted to a minimum of 92 per cent of their Marshall maximum relative density [MRD].

11. HOUSE AND TOWNHOUSE CONSTRUCTION

Based on the observed groundwater conditions, it is recommended that the design founding level for residential dwellings and townhouse blocks be limited to depths of no greater than 1.5 to 2 metres below the existing grade, based on the available groundwater data. The native soils encountered at the borehole locations are considered capable of supporting the loads associated with typical residential dwelling and townhouse structures on conventional spread footings, below any fill, organic, or otherwise unsuitable materials. This typically considers a nominal design bearing pressure of 75 kPa [\sim 1,500 psf], however bearing pressures of up to 150 kPa [\sim 3,000 psf] SLS and 225 kPa [\sim 3,000 psf] ULS may be considered in the competent native soils, potentially higher, although it is not anticipated such higher bearing capacities are required for the proposed residential structures. 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.

In the event that site grading works result in engineered fill below founding elevations, the general recommendations presented in the Backfill Considerations above should be strictly adhered to, with compaction to 100 percent standard Proctor maximum dry density, verified by monitoring and testing by a representative of SOIL-MAT ENGINEERS present on a full time basis. If there is a short fall in the volume of fill required, then the source of imported fill should be reviewed for gradation, Proctor value, compatibility with

existing fill, environmental characteristics and be approved by this office prior to use. The design bearing capacity for footings within the engineered fill should be limited to 100 kPa [\sim 2,000 psf] SLS and 150 kPa [\sim 3,000 psf] ULS.

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 it is recommended that consideration be given to the provision of nominal reinforcement in the footings and foundation walls to account for variable support and loading conditions. The use of nominal reinforcement is considered good construction practice as it 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 pressures generated against the foundation walls by the backfill. Such nominal reinforcement is an economical approach to the reduction and prevention of costly foundation repairs after completion and later in the life of the buildings. This reinforcement would typically consist of two continuous 15M steel bars placed in the footings [directly below the foundation wall], and similarly two steel bars placed approximately 300 millimeters from the top of the foundation walls at a minimum, depending on ground conditions exposed during construction. These reinforcement bars would 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 transition diagonally, rather than at 90 degrees, to maintain the continuous tensile capacity of the reinforcement. Where footings are founded on, or partially on, engineered fill the above provision for nominal reinforcement would be required.

All basement foundation walls should be suitably damp proofed, including the provision of a 'dimple board' type drainage product, and provided with a perimeter drainage tile system outlet to a gravity sewer connection or positive sump pit a minimum of 150 millimetres below the basement floor slab. The clear stone material surrounding the weeping tile should be encased with a geotextile material to prevent the migration of fines from the foundation wall backfill into the clear stone product. In the event that sump pit systems are required we would recommend that the sump pump system should be constructed with an 'oversized' reservoir and a 'back-flow' prevention valve so that the sump pump will not cycle repeatedly within short time periods.

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

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 outlined in this report, and to allow changes to be made in the event that subsurface conditions differ from the conditions identified at the borehole locations.

12. HYDROGEOLOGICAL CONSIDERATIONS

As noted above, it is understood that the proposed development will consist predominately of residential dwellings and townhouses, with a commercial block in the southern portion of the site, and potential mid-rise structures with a single underground basement level on the east side of the site. Groundwater levels measurements to date indicate a groundwater level on the order of 1.5 to 2 metres, potentially deeper, based on our observations and experience in the area. The soils encountered consisted predominately of silt and clay, and are considered low permeability to effectively impermeable, based on the grain size analyses summarised above. Given the proposed depths of construction, the rate of infiltration of groundwater into open excavations is expected to be relatively low, readily handled with conventional construction dewatering techniques, even for excavations extending a metre or so below the groundwater level. Such infiltration would be expected to be less than 50,000 L/day, and certainly less than 400,000 L/day, such that an EASR or PTTW would not be required. It is noted that depending on the design basement depth of the proposed mid-rise structures relative to the groundwater level, additional testing may be warranted, as detailed above. Based on our observations of the groundwater level, experience in the area, and nature of the proposed development, it is our opinion that the proposed development will have negligible impact on the groundwater condition in the area, and no further hydrogeological assessment is required at this time.

As noted above, depending on the final design details of the mid to high rise residential structures such as depth of underground levels, additional more detailed investigations may be warranted.



13. 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.

Scott Wylie, B.Eng., EIT.

Kyle Richardson, P. Eng.
Project Engineer





Enclosures: Drawing No. 1, Borehole Location Plan
 Log of Borehole Nos. 1 to 10, inclusive
 Grain Size Analyses
 Atterberg Limits – Plasticity Chart
 Drawing No. 2, Recommended Design Requirements for Slab-on-Grade
 Construction
 Drawing No. 3, Recommended Design Requirements for Basement Perimeter
 Drainage

Distribution: Rudanco Hospitality Corporation [1, plus pdf]



LEGEND

-  Borehole Location
BH#
-  Temporary Benchmark
Top of manhole lid.
TBM Geodetic elevation of 185.05 metres

NOTES

1. This drawing should be read in conjunction with Soil-Mat Engineers & Consultants Ltd. Geotechnical Report SM 301708-G.
2. Borehole locations are approximate.

SOIL-MAT

ENGINEERS & CONSULTANTS LTD.

Geotechnical Investigation
Proposed Residential
Development
13030 Lundy's Lane
Niagara Falls, Ontario

Borehole Location Plan

Project No. SM 301708-G

Date: June 2021

Drawn: SW | Checked: KR

SM 301708-G Borehole Location Plan

Drawing No. 1

Log of Borehole No. 1

Project No: SM 301708-G

Project Manager: Kyle Richardson, P.Eng

Project: Proposed Residential Development

Borehole Location: See Drawing No.1

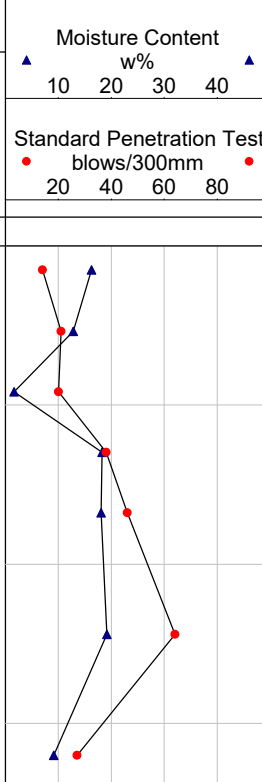
Location: 13030 Lundy's Lane, Allanburg

UTM Coordinates - N: 4771535

Client: Rudanco Hospitality Corporation

E: 648208

Depth	Elevation (m)	Symbol	Description	Well Data	SAMPLE					Moisture Content w%		
					Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm ²)	U.Wt. (kN/m ³)	▲
0	185.55		Ground Surface									
0-1			Topsoil Approximately 200 millimeters of topsoil.	SS	1	4,5,9,11	14					
1-2			Clayey Silt Brown, trace to some gravel, trace sand, decreasing content with depth, occasional cobbles and sandy seams, very stiff to hard.	SS	2	2,16,5	21					
2-3				SS	3	5,10,10,16	20		>4.5			
3-4				SS	4	10,16,22,24	38		>4.5			
4-5				SS	5	16,20,26,29	46		>4.5			
5-6				Transition to grey								
6-7	181.50			SS	6	19,34,30,20 moist	64		>4.5			
7-8	178.90		End of Borehole	SS	7	13,14,13,9	27					
8-9			NOTES:									
9-10			1. Borehole was advanced using solid stem auger equipment on May 27, 2021 to termination at a depth of 6.7 metres.									
10-11			2. Borehole was recorded as 'wet' at a depth of 6.4 metres upon completion and backfilled as per Ontario Regulation 903.									
11-12			3. Soil samples will be discarded after 3 months unless otherwise directed by our client.									
12-13			4. A monitoring well was installed. The following free groundwater level readings have been measured:									
13-14			July 1, 2021 - 1.09 metres below the existing ground surface									



Drill Method: Solid Stem Augers

Drill Date: May 27, 2021

Hole Size: 150 Millimeters

Drilling Contractor: Ponthill

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: PT

Checked by: KR

Sheet: 1 of 1

Log of Borehole No. 2

Project No: SM 301708-G

Project Manager: Kyle Richardson, P.Eng

Project: Proposed Residential Development

Borehole Location: See Drawing No.1

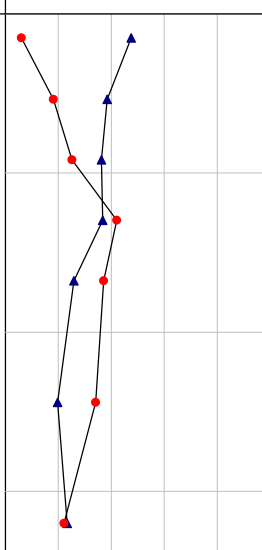
Location: 13030 Lundy's Lane, Allanburg

UTM Coordinates - N: 4771719

Client: Rudanco Hospitality Corporation

E: 648134

Depth	Elevation (m)	Symbol	Description	Well Data	SAMPLE						Moisture Content w%		
					Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm ²)	U.Wt.(kN/m ³)	▲	▲
0	186.32		Ground Surface										
0			Topsoil Approximately 200 millimeters of topsoil.		SS	1	2,3,3,3	6					
1			Clayey Silt Brown to reddish brown, trace to some gravel, trace sand, decreasing content with depth, occasional cobbles and sandy seams, very stiff.		SS	2	5,8,10,12	18		>4.5			
2				SS	3	9,10,15,16	25						
3				SS	4	7,16,26,26	42		4.5				
4				SS	5	14,17,20,25	37						
5	181.70			Transition to grey		SS	6	14,16,18,21	34				
6			End of Borehole		SS	7	13,10,12,25	22					
7	179.60												
8			NOTES: 1. Borehole was advanced using solid stem auger equipment on May 27, 2021 to termination at a depth of 6.7 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 Augers

Drill Date: May 27, 2021

Hole Size: 150 Millimeters

Drilling Contractor: Ponthill

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Datum: Geodetic

Field Logged by: PT

Checked by: KR

Sheet: 1 of 1

Log of Borehole No. 3

Project No: SM 301708-G

Project Manager: Kyle Richardson, P.Eng

Project: Proposed Residential Development

Borehole Location: See Drawing No.1

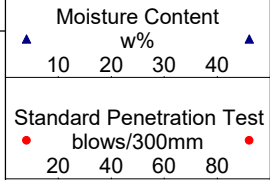
Location: 13030 Lundy's Lane, Allanburg

UTM Coordinates - N: 4771577

Client: Rudanco Hospitality Corporation

E: 648350

Depth	Elevation (m)	Symbol	Description	Well Data	SAMPLE						Moisture Content w%		
					Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)	▲	▲
0	185.33		Ground Surface										
0-1			Topsoil Approximately 250 millimeters of topsoil.		SS 1	2,3,3,4	6			3.0			
1-2			Clayey Silt Brown, trace to some gravel, trace sand, decreasing content with depth, occasional cobbles and sandy seams, very stiff to hard.		SS 2	6,8,12,12	20			>4.5			
2-3				SS 3	10,18,26,21	44							
3-4				SS 4	10,16,23,28	39							
4-5				SS 5	17,20,27,24	47							
5-6				SS 6	24,25,22,30	47							
6-7													
7-8													
8-9	179.70		Transition to grey										
9-10			End of Borehole NOTES: 1. Borehole was advanced using solid stem auger equipment on May 27, 2021 to termination at a depth of 6.4 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.		SS 7	49,50/5"	100						
10-11	178.90												
11-12													
12-13													
13-14													
14-15													
15-16													
16-17													
17-18													
18-19													



Drill Method: Solid Stem Augers

Drill Date: May 27, 2021

Hole Size: 150 Millimeters

Drilling Contractor: Ponthill

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: PT

Checked by: KR

Sheet: 1 of 1

Log of Borehole No. 4

Project No: SM 301708-G

Project Manager: Kyle Richardson, P.Eng

Project: Proposed Residential Development

Borehole Location: See Drawing No.1

Location: 13030 Lundy's Lane, Allanburg

UTM Coordinates - N: 4771970

Client: Rudanco Hospitality Corporation

E: 648319

Depth	Elevation (m)	Symbol	Description	Well Data	SAMPLE					Moisture Content w%		
					Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm ²)	U.Wt.(kN/m ³)	▲
0	185.78		Ground Surface									
0-1			Topsoil Approximately 200 millimeters of topsoil.		SS 1	2,4,4,3	8					
1-2			Clayey Silt Brown to reddish brown, trace to some gravel, trace sand, decreasing content with depth, occasional cobbles and sandy seams, very stiff to hard.		SS 2	5,9,12,14	21		4.5			
2-3				SS 3	10,14,16,18	30						
3-4				SS 4	8,18,35,40	53						
4-5				SS 5	17,50/4"	100						
5-6				SS 6	29,40,43,50/5"	83						
6-7				SS 7	21,49,50/5"	100						
7	179.10			End of Borehole								
7-8			NOTES: 1. Borehole was advanced using solid stem auger equipment on May 31, 2021 to termination at a depth of 6.7 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 Augers

Drill Date: May 31, 2021

Hole Size: 150 Millimeters

Drilling Contractor: Ponthill

Soil-Mat Engineers & Consultants Ltd.

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Datum: Geodetic

Field Logged by: PT

Checked by: KR

Sheet: 1 of 1

Log of Borehole No. 5

Project No: SM 301708-G

Project Manager: Kyle Richardson, P.Eng

Project: Proposed Residential Development

Borehole Location: See Drawing No.1

Location: 13030 Lundy's Lane, Allanburg

UTM Coordinates - N: 4771893

Client: Rudanco Hospitality Corporation

E: 648124

Depth ft m	Elevation (m)	Symbol	Description	Well Data	SAMPLE					Moisture Content w%		
					Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm ²)	U.Wt.(kN/m ³)	▲
0	187.33		Ground Surface									
1			Topsoil Approximately 250 millimeters of topsoil.		SS 1	2,3,4,5	7		4.25			
2			Clayey Silt Brown to reddish brown, trace to some gravel, trace sand, decreasing content with depth, occasional cobbles and sandy seams, very stiff to hard.		SS 2	4,9,12,13	21					
3				SS 3	13,19,32,35	51						
4				SS 4	40,44,50/5"	100						
5				SS 5	40,44,49,50/5	93						
6				SS 6	9,46,50/5" moist	100						
7	180.60		End of Borehole		SS 7	41,50/5"	100					
8			NOTES: 1. Borehole was advanced using solid stem auger equipment on May 27, 2021 to termination at a depth of 6.7 metres. 2. Borehole was recorded as open and 'wet' at a depth of 6.4 metres 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: July 1, 2021 - 1.85 metres below the existing ground surface									

Drill Method: Solid Stem Augers

Drill Date: May 27, 2021

Hole Size: 150 Millimeters

Drilling Contractor: Pontil 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: PT

Checked by: KR

Sheet: 1 of 1

Log of Borehole No. 6

Project No: SM 301708-G

Project Manager: Kyle Richardson, P.Eng

Project: Proposed Residential Development

Borehole Location: See Drawing No.1

Location: 13030 Lundy's Lane, Allanburg

UTM Coordinates - N: 4771990

Client: Rudanco Hospitality Corporation

E: 648505

Depth ft m	Elevation (m)	Symbol	Description	Well Data	SAMPLE					Moisture Content w%		
					Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm ²)	U.Wt. (kN/m ³)	▲
0	182.68		Ground Surface									
1			Topsoil Approximately 200 millimeters of topsoil.	SS	1	2,2,3,3	5		3.5			
2			Clayey Silt Brown, trace to some gravel, trace sand, occasional cobbles and sandy seams, very stiff to stiff.	SS	2	4,5,7,10	12		>4.5			
3				SS	3	5,5,8,10	13		>4.5			
4				SS	4	4,7,8,11	15		4.5			
5				SS	5	3,5,6,7	11		2.5			
6	178.60		Transition to reddish brown to grey, increased clay content									
7				SS	6	1,2,3,3	5		<1.0			
8												
9												
10												
11												
12												
13												
14	176.00											
15												
16												
17												
18												
19												
20												
21												
22												
23			End of Borehole									
24			NOTES:									
25			1. Borehole was advanced using solid stem auger equipment on May 27, 2021 to termination at a depth of 6.7 metres.									
26			2. Borehole was recorded as 'dry' at a depth of 6.7 metres upon completion and backfilled as per Ontario Regulation 903.									
27			3. Soil samples will be discarded after 3 months unless otherwise directed by our client.									
28			4. A monitoring well was installed. The following free groundwater level readings have been measured:									
29			July 1, 2021 - 2.33 metres below the existing ground surface									
30												
31												
32												
33												
34												
35												
36												
37												
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39												
40												
41												
42												
43												
44												
45												
46												
47												
48												
49												

Drill Method: Solid Stem Augers

Drill Date: May 31, 2021

Hole Size: 150 Millimeters

Drilling Contractor: Pontil 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: PT

Checked by: KR

Sheet: 1 of 1

Log of Borehole No. 7

Project No: SM 301708-G

Project: Proposed Residential Development

Location: 13030 Lundy's Lane, Allanburg

Client: Rudanco Hospitality Corporation

Project Manager: Kyle Richardson, P.Eng

Borehole Location: See Drawing No.1

UTM Coordinates - N: 4771799

E: 648516

Depth ft m	Elevation (m)	Symbol	Description	Well Data	SAMPLE					Moisture Content w%		
					Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm ²)	U.Wt. (kN/m ³)	▲
0	182.87		Ground Surface									
1			Topsoil Approximately 200 millimeters of topsoil.	SS	1	5,3,5,6	8		3.5			
2			Clayey Silt Brown to reddish brown, trace to some gravel, trace sand, occasional cobbles and sandy seams, stiff to hard.	SS	2	5,7,9,10	16		>4.5			
3				SS	3	4,7,11,14	18		>4.5			
4				SS	4	4,7,7,8	14		4.5			
5				SS	5	2,2,2,3	4		2.5			
6												
7	176.80		Transition to reddish brown, increased clay content	SS	7	2,4,5,6	9		2.0			
8			Predominantly silt layer	SS	8	1,2,3,5	5		1.5			
9												
10				SS	9	2,2,2,3	4		<1.0			
11	172.30			SS	10	28,40,50/3"	100					
12	170.70		End of Borehole Spoon refusal on assumed bedrock	SS	11	50/2"	100					

NOTES:

- Borehole was advanced using solid stem auger equipment on May 27, 2021 to spoon refusal at a depth of 12.2 metres.
- Borehole was recorded as open until a depth of 8.2 metres and 'we't at a depth of 4.6 metres upon completion and backfilled as per Ontario Regulation 903.
- Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers

Drill Date: May 28, 2021

Hole Size: 150 Millimeters

Drilling Contractor: Pontil 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: PT

Checked by: KR

Sheet: 1 of 1

Log of Borehole No. 8

Project No: SM 301708-G

Project Manager: Kyle Richardson, P.Eng

Project: Proposed Residential Development

Borehole Location: See Drawing No.1

Location: 13030 Lundy's Lane, Allanburg

UTM Coordinates - N: 4771709

Client: Rudanco Hospitality Corporation

E: 648518

Depth	Elevation (m)	Symbol	Description	Well Data	SAMPLE					Moisture Content w%		
					Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm ²)	U.Wt.(kN/m ³)	▲
0	182.35		Ground Surface									
1			Topsoil Approximately 200 millimeters of topsoil.	SS	1	2,4,3,4	7		3.0			
2			Clayey Silt Brown, trace to some gravel, trace sand, occasional cobbles and sandy seams, very stiff.	SS	2	4,5,7,11	12		4.5			
3				SS	3	5,5,6,8	11		>4.5			
4				SS	4	2,2,3,5	5		2.5			
5				SS	5	2,2,4,3	6		2.5			
6	178.70			Transition to grey, increased clay content								
7				SS	6	0,1,1,2	2		<1.0			
8				SS	7	2,2,3,5	5		<1.0			
9				SS	8	0,10,3,5	13		<1.0			
10	172.90		Predominantly silt layer	SS	9	5,8,19,35	27		<1.0			
11			End of Borehole Spoon refusal on assumed bedrock	SS	10	45,50/3"	100					
12	171.50											
13			NOTES:									
14			1. Borehole was advanced using solid stem auger equipment on May 27, 2021 to spoon refusal at a depth of 10.9 metres.									
			2. Borehole was recorded as open until a depth of 8.2 metres and 'wet' at a depth of 3.9 metres 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 Augers

Drill Date: May 28, 2021

Hole Size: 150 Millimeters

Drilling Contractor: Pontil 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: PT

Checked by: KR

Sheet: 1 of 1

Log of Borehole No. 9

Project No: SM 301708-G

Project Manager: Kyle Richardson, P.Eng

Project: Proposed Residential Development

Borehole Location: See Drawing No.1

Location: 13030 Lundy's Lane, Allanburg

UTM Coordinates - N: 4771554

Client: Rudanco Hospitality Corporation

E: 648464

Depth ft m	Elevation (m)	Symbol	Description	Well Data	SAMPLE					Moisture Content w%		
					Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt. (kN/m3)	▲
0	184.28		Ground Surface									
1			Topsoil Approximately 200 millimeters of topsoil.	SS	1	2,2,2,2	4					
2			Clayey Silt Brown to reddish brown, trace to some gravel, trace sand, occasional cobbles and sandy seams, stiff to soft.	SS	2	3,6,7,9	13		4.5			
3				SS	3	4,5,6,5	11		4.5			
4				SS	4	2,2,4,3	6		4.0			
5				SS	5	2,2,3,4	5		1.0			
6	180.90		Transition to grey, increased clay content									
7			End of Borehole	SS	6	2,5,5,6	10					
8				SS	7	4,4,4,6	8					
9	177.60		NOTES: 1. Borehole was advanced using solid stem auger equipment on May 27, 2021 to termination at a depth of 6.7 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 levels have been measured: July 1, 2021 - 1.09 metres below the existing ground surface									

Drill Method: Solid Stem Augers

Drill Date: May 28, 2021

Hole Size: 150 Millimeters

Drilling Contractor: Pontil 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: PT

Checked by: KR

Sheet: 1 of 1

Log of Borehole No. 10

Project No: SM 301708-G

Project Manager: Kyle Richardson, P.Eng

Project: Proposed Residential Development

Borehole Location: See Drawing No.1

Location: 13030 Lundy's Lane, Allanburg

UTM Coordinates - N: 4771430

Client: Rudanco Hospitality Corporation

E: 648478

Depth ft m	Elevation (m)	Symbol	Description	Well Data	SAMPLE					Moisture Content w%			
					Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm ²)	U.Wt.(kN/m ³)	▲ 10 20 30 40 ▲	
0	184.27		Ground Surface										
1			Topsoil Approximately 250 millimeters of topsoil.	SS	1	2,2,2,3	4						
2			Clayey Silt Brown to reddish brown, trace to some gravel, trace sand, occasional cobbles and sandy seams, stiff to soft.	SS	2	2,2,6,6	8		4.0				
3				SS	3	3,4,7,9	11		4.5				
4				SS	4	3,6,8,10	14		4.0				
5				SS	5	5,7,13,10	20		4.0				
6				SS	6	2,2,3,4 moist	5						
7	180.90		Transition to reddish brown, increased clay content										
8			End of Borehole NOTES: 1. Borehole was advanced using solid stem auger equipment on May 27, 2021 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.										
9	179.10												
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Drill Method: Solid Stem Augers

Drill Date: May 28, 2021

Hole Size: 150 Millimeters

Drilling Contractor: Pontil 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

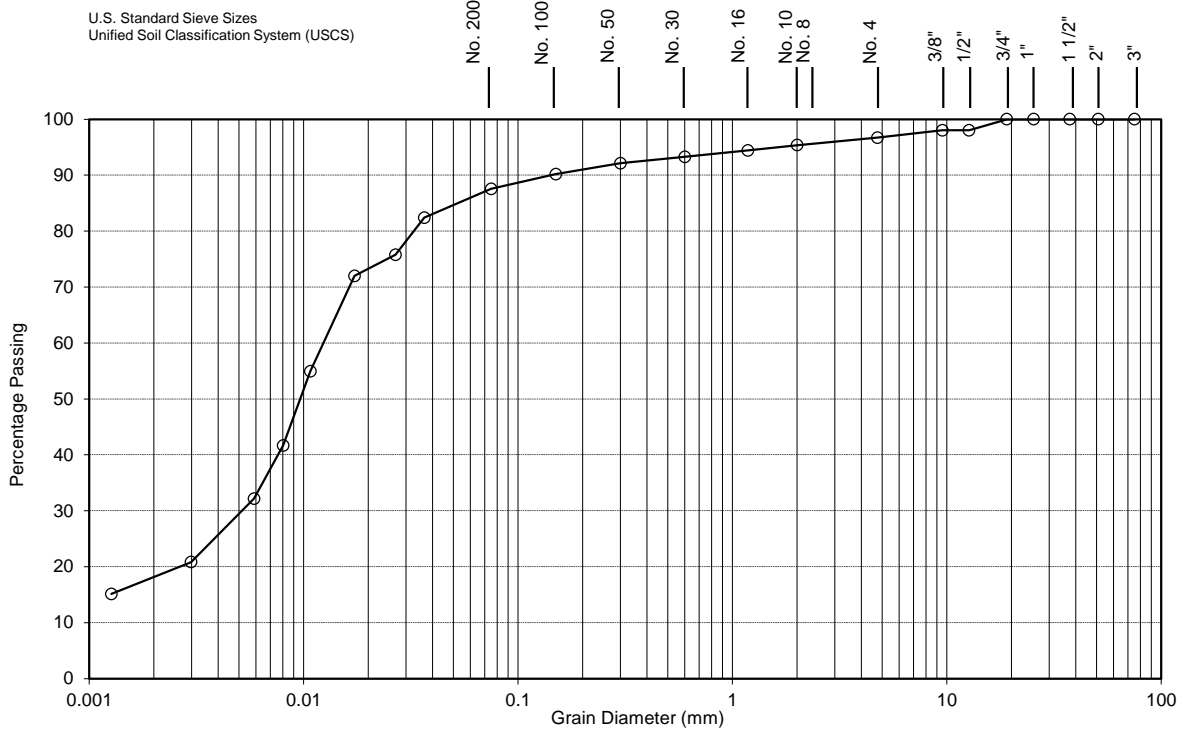
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Field Logged by: PT

Checked by: KR

Sheet: 1 of 1

Mechanical & Hydrometer Analyses



CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE
		SAND			GRAVEL	

Lab No.:	21-284	Notes: Depth 20'	
Sample No.:	7		
Borehole No.:	5		
CLAY [%]:	18	Soil Description: Brown Silt w/ some Clay and Sand w/ a trace of Gravel M.H. - Inorganic silts to M.L. - Inorganic silts and very fine sands	
SILT [%]:	69		
SAND [%]:	10		
GRAVEL [%]:	3		
D ₁₀ (Effective Diam. in mm): 0.0006		Estimated Infiltration Rate [mm/hr]: < 10	Estimated Permeability, k [cm/s]: 10⁻⁷
		Coefficient of Uniformity C _u : 21.7	Coefficient of Curvature C _c : 3.5

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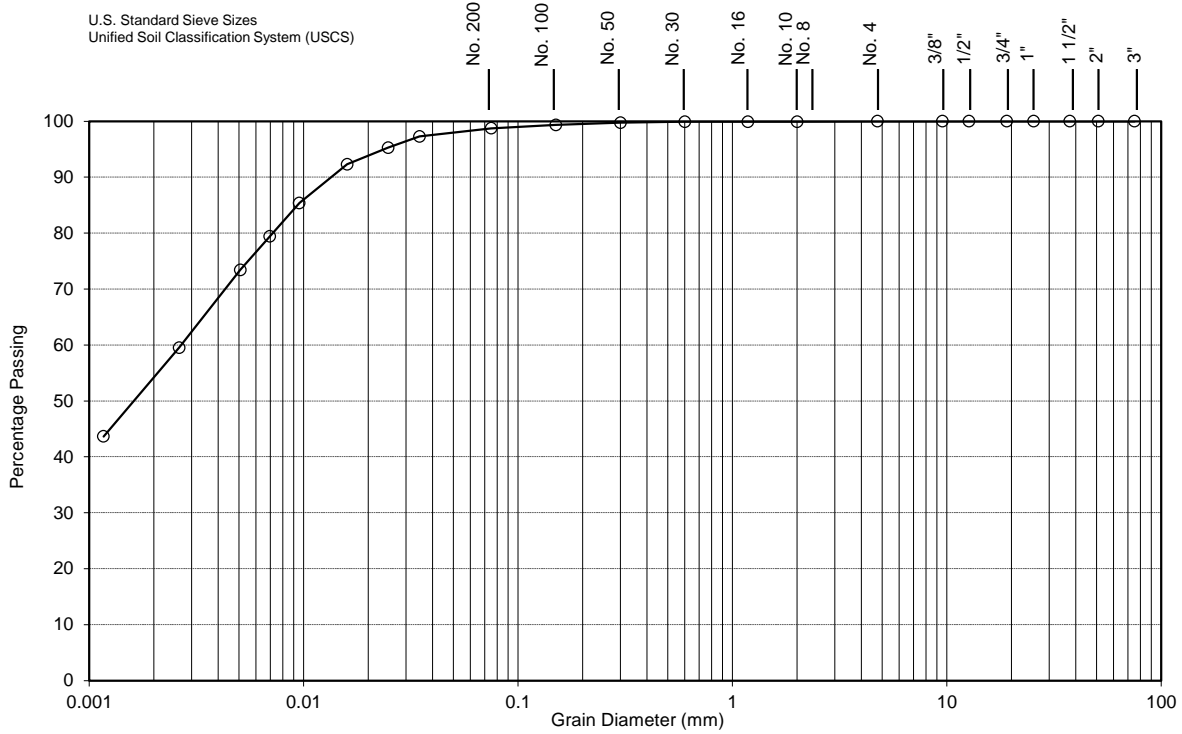


July 2021

Grain Size Analysis No. 3

Project No.: SM 301708-T

Mechanical & Hydrometer Analyses



CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE
		SAND			GRAVEL	

Lab No.:	21-287	Notes: Depth 10'			
Sample No.:	5	Soil Description: Brown Clay and Silt w/ a trace of Sand C.H. - Inorganic clays of medium to high plasticity to M.H. - Inorganic silts			
Borehole No.:	6				
CLAY [%]:	54				
SILT [%]:	45	Estimated Infiltration Rate [mm/hr]:	< 10	Estimated Permeability, k [cm/s]	10⁻⁸
SAND [%]:	1	Coefficient of Uniformity C _u :	9.0	Coefficient of Curvature C _c :	0.4
GRAVEL [%]:	0	D ₁₀ (Effective Diam. in mm):	0.0003		

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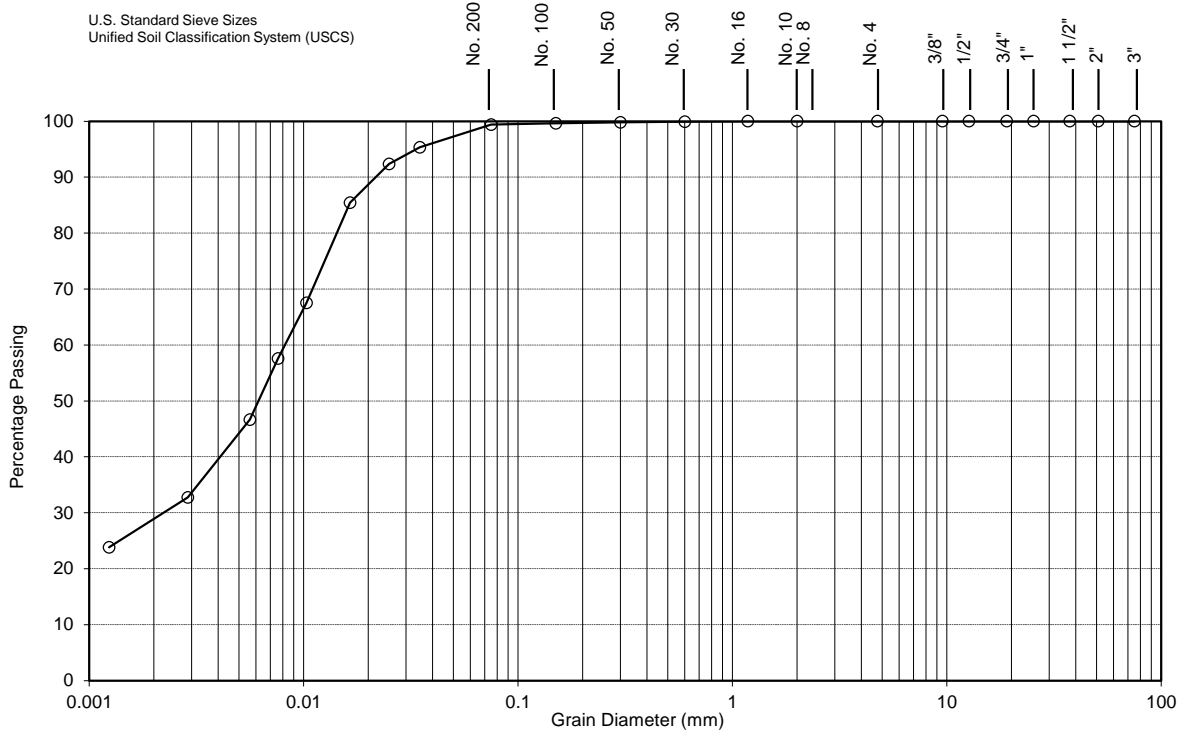


July 2021

Grain Size Analysis No. 4

Project No.: SM 301708-T

Mechanical & Hydrometer Analyses



CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE
		SAND			GRAVEL	

Lab No.:	21-275	Notes: Depth 7.5'			
Sample No.:	4	Soil Description: Brown Clayey Silt w/ a trace of Sand M.L. - Clayey Silts with slight plasticity to M.H. - Inorganic silts			
Borehole No.:	7				
CLAY [%]:	29				
SILT [%]:	70	Estimated Infiltration Rate [mm/hr]:	< 10	Estimated Permeability, k [cm/s]	10⁻⁷
SAND [%]:	1	Coefficient of Uniformity C _u :	16.2	Coefficient of Curvature C _c :	1.2
GRAVEL [%]:	0	D ₁₀ (Effective Diam. in mm):	0.0005		

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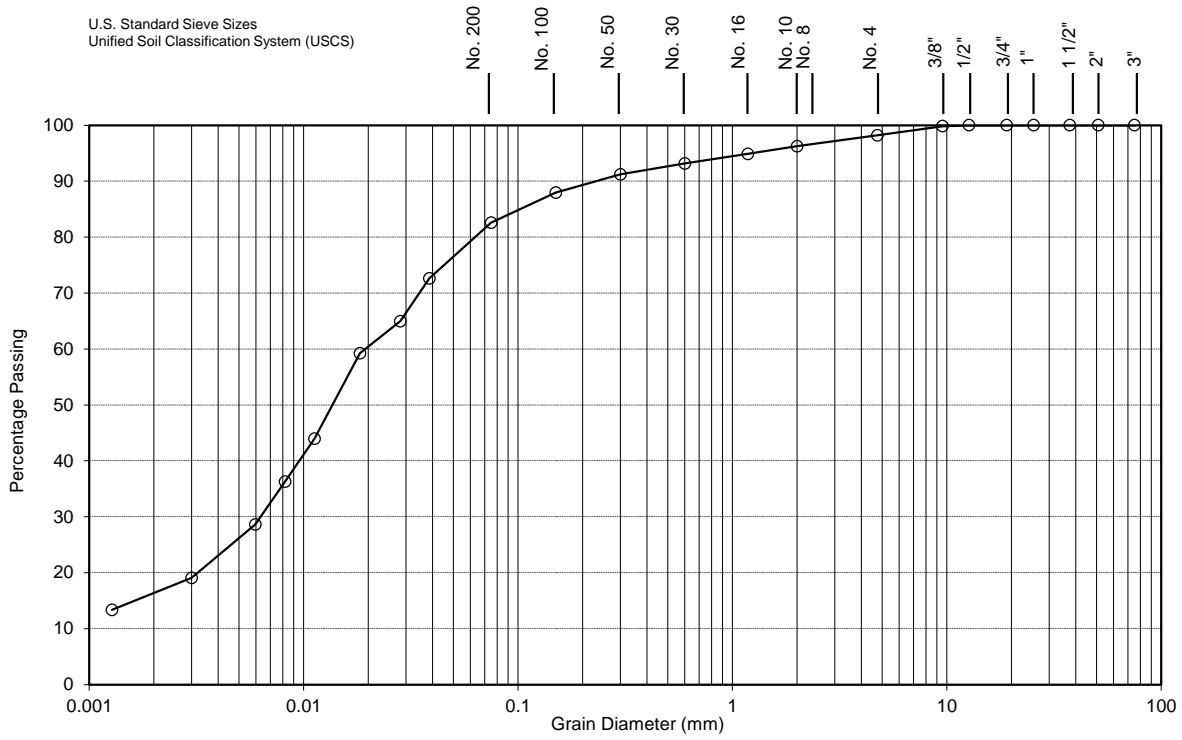


July 2021

Grain Size Analysis No. 5

Project No.: SM 301708-T

Mechanical & Hydrometer Analyses



CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE
		SAND			GRAVEL	

Lab No.:	21-285	Notes: Depth 35'			
Sample No.:	8	Soil Description: Brown Silt w/ some Clay and Sand w/ a trace of Gravel M.H. - Inorganic silts to M.L. - Inorganic silts and very fine sands			
Borehole No.:	7				
CLAY [%]:	16				
SILT [%]:	67				
SAND [%]:	15	Estimated Infiltration Rate [mm/hr]:	< 10	Estimated Permeability, k [cm/s]	10⁻⁷
GRAVEL [%]:	2	Coefficient of Uniformity C _u :	23.8	Coefficient of Curvature C _c :	2.5
D ₁₀ (Effective Diam. in mm):	0.0008				

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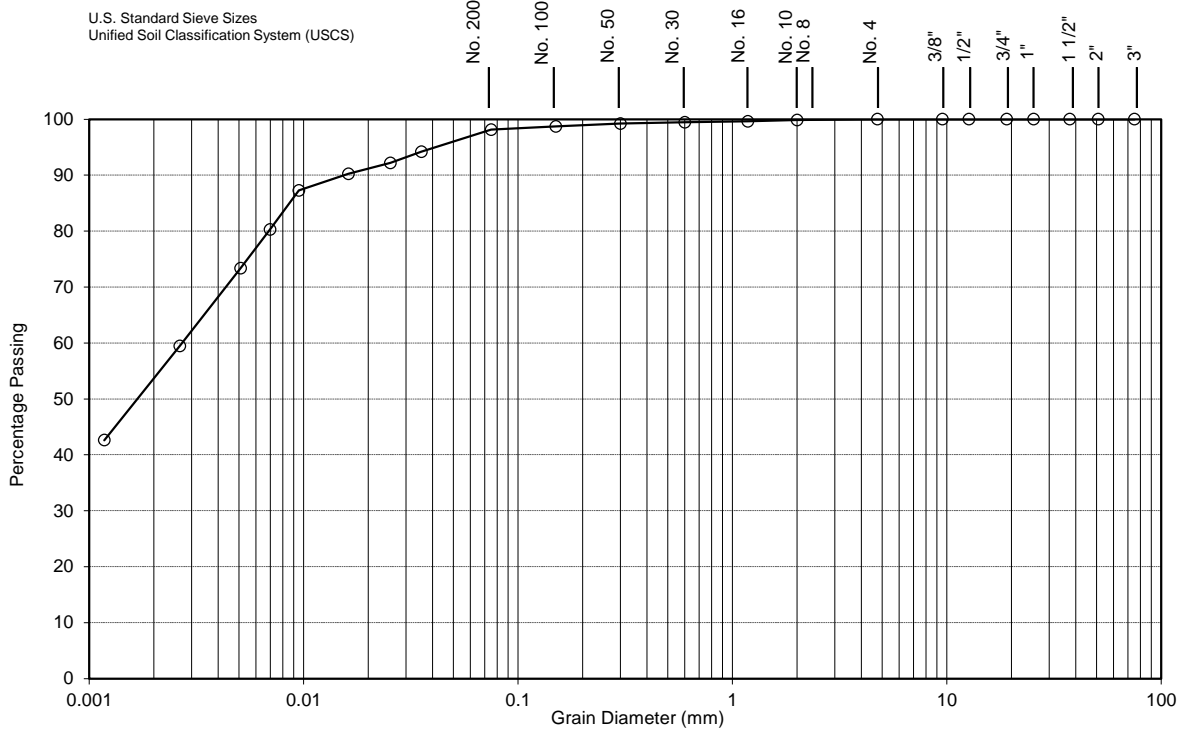


July 2021

Grain Size Analysis No. 6

Project No.: SM 301708-T

Mechanical & Hydrometer Analyses



CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE
		SAND			GRAVEL	

Lab No.:	21-273	Notes: Depth 10'			
Sample No.:	5	Soil Description: Brown Clay and Silt w/ a trace of Sand C.H. - Inorganic clays of medium to high plasticity			
Borehole No.:	9				
CLAY [%]:	54				
SILT [%]:	44	Estimated Infiltration Rate [mm/hr]:	< 10	Estimated Permeability, k [cm/s]	10⁻⁷
SAND [%]:	2	Coefficient of Uniformity C _u :	6.8	Coefficient of Curvature C _c :	0.5
GRAVEL [%]:	0	D ₁₀ (Effective Diam. in mm):	0.0004		

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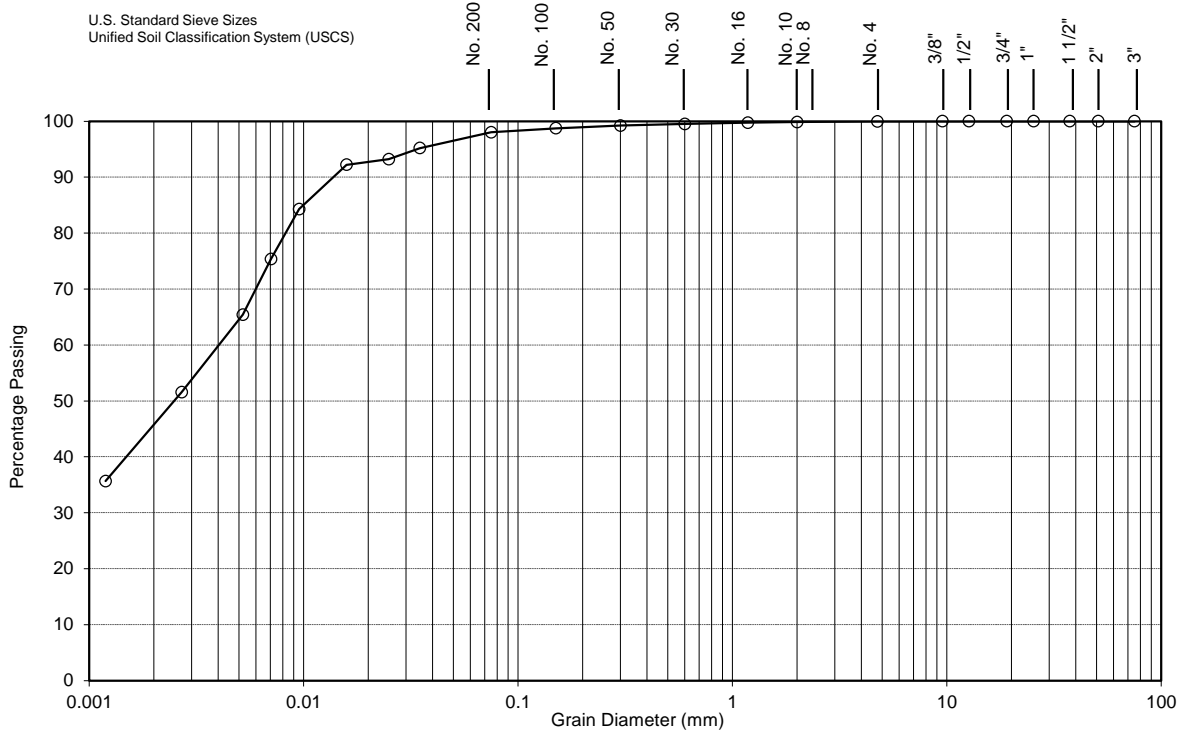


July 2021

Grain Size Analysis No. 7

Project No.: SM 301708-T

Mechanical & Hydrometer Analyses



CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE
		SAND			GRAVEL	

Lab No.:	21-274	Notes: Depth 5'			
Sample No.:	3	Soil Description: Brown Silt and Clay w/ a trace of Sand C.H. - Inorganic clays of medium to high plasticity			
Borehole No.:	10				
CLAY [%]:	47				
SILT [%]:	51	Estimated Infiltration Rate [mm/hr]:	< 10	Estimated Permeability, k [cm/s]	10⁻⁷
SAND [%]:	2	Coefficient of Uniformity C _u :	10.0	Coefficient of Curvature C _c :	0.4
GRAVEL [%]:	0	D ₁₀ (Effective Diam. in mm): 0.0004			

SOIL-MAT ENGINEERS & CONSULTANTS LTD.

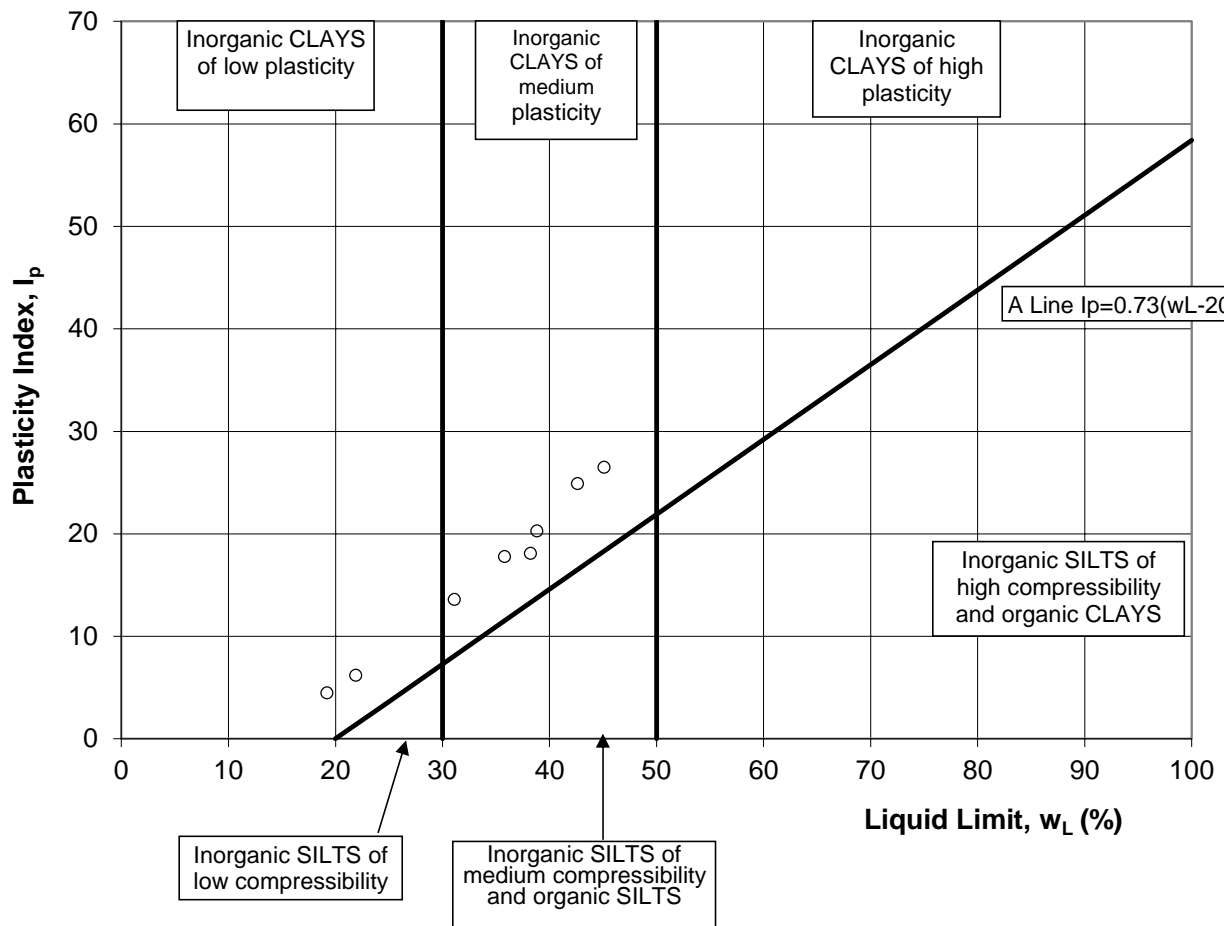
13030 Lundy's Lane - Rolling Meadows



July 2021

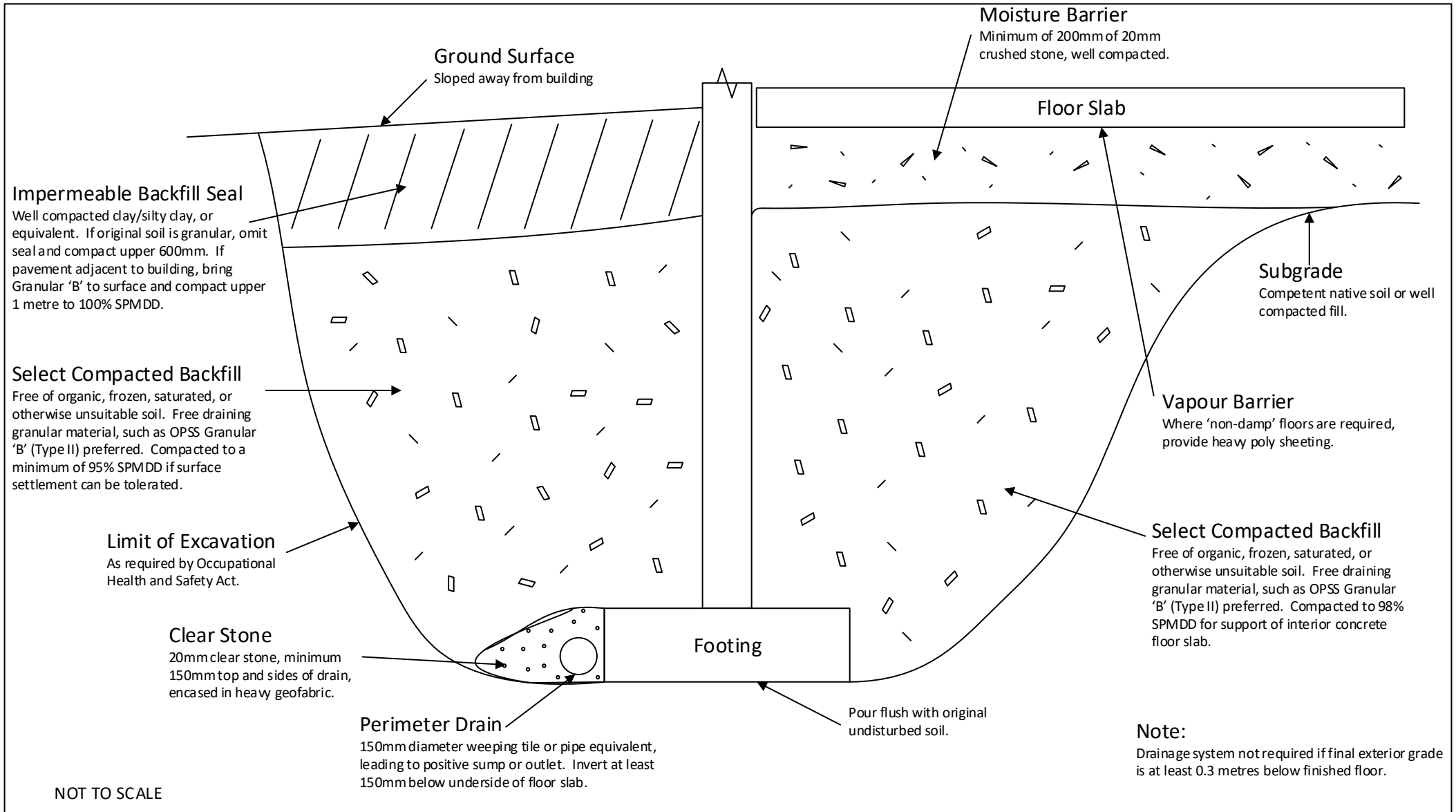
Grain Size Analysis No. 8

Project No.: SM 301708-T

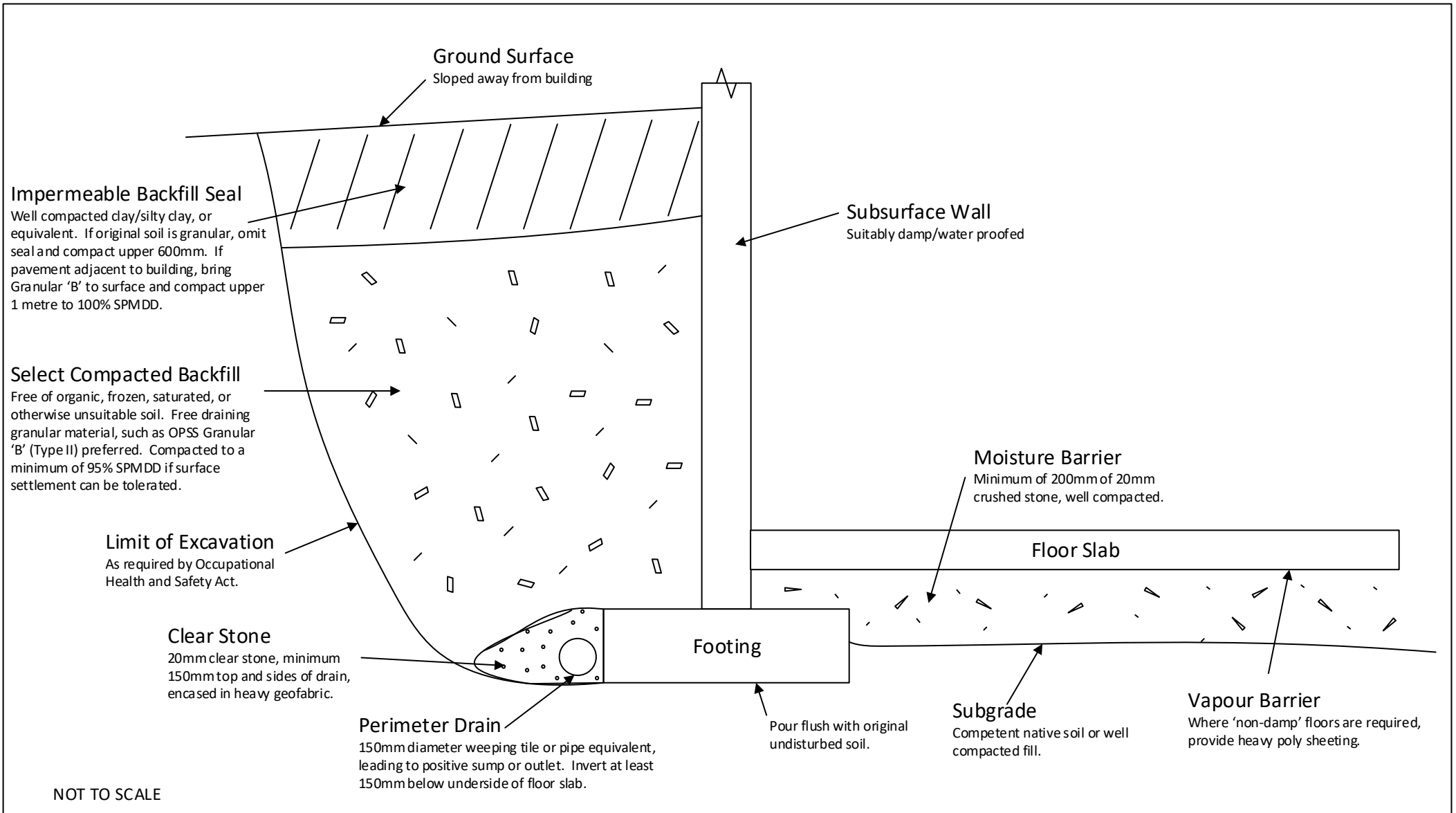


Atterberg Limits				
Sample No.	Sample Location	Liquid Limit wL	Plastic Limit wp	Plasticity Index Ip
BH10 SS5	10'	38.2	20.1	18.1
BH 6 SS7	20'	21.9	15.7	6.2
BH 8 SS8	25'	19.2	14.7	4.5
BH 6 SS5	10'	45.1	18.6	26.5
BH 8 SS4	7.5'	31.1	17.5	13.6
BH 7 SS5	10'	42.6	17.7	24.9
BH 11 SS3	5'	35.8	18.0	17.8
BH 2 SS3	5'	38.8	18.5	20.3

SOIL-MAT ENGINEERS & CONSULTANTS LTD.		
13030 Lundy's Lane - Rolling Meadows		
Atterberg Limits		
Client:	Rudanco Hospitality Corporation	
Project No.:	SM 301708-G	July 2021
		Plasticity Chart



	<h1>Soil-Mat Engineers & Consultants Ltd.</h1>		Project No.:	SM 301708-G
			Date:	July 2021
<h2>Typical Design Requirements Slab-on-Grade with Perimeter Drainage</h2>			<h3>Drawing No. 2</h3>	



	<h1>Soil-Mat Engineers & Consultants Ltd.</h1>		Project No.:	SM 301708-G
			Date:	July 2021
<h2>Typical Design Requirements Drainage and Backfill for Basement Walls</h2>			<h3>Drawing No. 3</h3>	