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PROJECT NO.: SM 302519-G June 8, 2022

LOSANI HOMES
430 McNeilly Road, Suite 203
Stoney Creek, Ontario
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Attention: Travis Skelton, MCIP, RPP
Senior Project Manager and Planner

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
1284 MAIN STREET
HAMILTON, ONTARIO

Dear Mr. Skelton,

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 P302519, dated January 14, 2022 and revised February 3, 2022. Our comments and recommendations, based on our findings at the eleven [11] borehole locations, are presented in the following paragraphs.

1. INTRODUCTION

We understand that it is proposed to undertake a residential redevelopment of the property at 1284 Main Street East, the former Delta Collegiate Institute. It is noted that portions of the existing building are subject to heritage designation, which will be renovated as part of the redevelopment. The details of the redevelopment plan have not yet been established, however are anticipated to consist of a new mid-rise or multi-storey buildings, with possible underground parking levels on the southern portion of the site. Construction would also include the installation of associate underground municipal services, and paved driveway and parking areas. The purpose of this geotechnical investigation work is to assess the subsurface soil conditions, and to provide our comments and recommendations with respect to the design and construction of the proposed structure, 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, 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.

2. PROCEDURE

A total of eleven [11] 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 from February 7 to 10, 2022, under the direction and supervision of a staff member of SOIL-MAT ENGINEERS & CONSULTANTS LTD., to termination at depths of approximately 6.7 to 25.0 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 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.

Upon completion of drilling monitoring wells were installed in Borehole Nos. 4, 5, 6, 8, 9, and 10. The monitoring wells consisted of 50-millimetre PVC pipe, screened in the lower 3 metres, encased in well sand to approximately 0.3 metres above the screened section, then with a bentonite ‘hole plug’ to the surface. The monitoring wells were fitted with a protective steel ‘stick up’ casing at the surface, and the remaining borehole was backfilled in general accordance with Ontario Regulation 903, and the ground surface reinstated flush with the existing grade.

The boreholes were located on site by a representative of SOIL-MAT ENGINEERS & CONSULTANTS LTD. The ground surface elevation at the borehole locations was referenced to a site-specific temporary benchmark, described as the top of a catchbasin along Graham Avenue South. This benchmark has been assigned an elevation of 100.00 metres for convenience.

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 comprised of the former Delta Collegiate Institute at 1284 Main Street in Hamilton, Ontario. The property is bounded at the north by Main Street East, to the east by Wexford Avenue South, to the south by Maple Avenue and to the west by Graham Avenue South. The surrounding area is comprised of existing residential, primarily single family dwellings, with various commercial properties fronting Main Street East to the north, of the site. The site is relatively flat and even, with a slight downward relief from south to north of approximately 2 metres.

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

Pavement Structure

All borehole locations, with the exception of Borehole Nos. 2, 9, and 10 were advanced through the existing pavement structure. The pavement structure was found to consist of approximately 75 to 200 millimetres of asphaltic concrete overlying approximately 300 millimetres of granular base material. The pavement surface was noted to generally be in a poor condition, with frequent longitudinal, alligator cracking, and patch work repairs. The pavement structure encountered at the borehole locations has been summarized as follows:

Table A – Pavement Structure Catalogue

Borehole No.	1	3	4	4b	5	6	7	8
Asphaltic Concrete (mm)	200	100	75	100	100	100	100	100
Granular Base (mm)	300	300	300	300	300	300	300	300

Topsoil

A surficial veneer of topsoil approximately 100 to 150 millimetres in thickness was encountered at Borehole Nos. 2, 9, and 10. It is noted that the depth of topsoil may vary across the site and from 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.

Sand and Gravel Fill

A sand and gravel fill was encountered beneath the pavement structure in Borehole No. 1. The fill material was brown to grey in colour, comprised of primarily crushed limestone and was generally found to be in a compact state. The sand and gravel fill encountered was proven to depths of approximately 1.8 metres.

Sandy Silt/Clayey Silt Fill

A deposit of sandy silt/clayey silt fill was encountered beneath the topsoil or pavement structure in Borehole Nos. 2, 4, 5, 8, and 9. The fill material was brown in colour, contained trace gravel, with occasional construction debris and was generally found to have a firm consistency. The sandy silt/clayey silt fill encountered was proven to depths of approximately 1.3 to 3.0 metres.

Sand

Native sand was encountered beneath the topsoil at Borehole No. 10. The native medium grained soils were brown in colour, contained trace silt and gravel, and generally in a loose state. The sand was proven to a depth of approximately 1.0 metre. Based on our experience in the area relatively thin, near surface deposits of sand are expected across the site.

Silty Clay/Clayey Silt

Native clayey silt/silty clay was encountered beneath the topsoil, pavement structure and/or fill soils at all borehole locations. The native cohesive soils were brown in colour, transitioning to grey at depths of between approximately 3 to 5 metres, contained trace sand, and generally in a very stiff to firm consistency. The silty clay/clayey silt was proven to depths of approximately 18.3 to 19.7 metres in Borehole Nos. 2, 3 and 7, and to termination at depths of 5.2 to 12.8 metres in the remaining boreholes.

Glacial Till

Native glacial till was encountered beneath the clayey silt/silty clay soils at Borehole Nos. 2, 3, and 7. The native cohesive soils were grey in colour, comprised primarily of clay, silt and sand with trace gravel, with occasional shale fragments, and was generally in a hard consistency. The glacial till was proven to depths of approximately 18.7 to 25.0 metres.

Weathered Queenston Shale

While not explicitly encountered in our investigation, our experience in the area and the condition of the glacial till at depth, indicates close proximity to weathered Queenston Shale. The weathered bedrock would exhibit characteristics of a hard soil in the upper levels, becoming more sound with depth.

Overburden Permeability/Infiltration Characteristics

A review of available published information [Quaternary Geology of Ontario, Southern Sheet Map 2556] indicate the subject site be near a transition between clay to silt textured till and coarse textured glaciolacustrine deposits, consistent with our experience in the area and observations during our fieldwork.

As noted above, selected samples of the native soils were subjected to grain size analyses. The results of these analyses are presented as follows:

Table B - Grain Size Analyses

Sample ID	Depth (m)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Estimated Permeability [k, cm/s]	Estimated Infiltration Rate [mm/hr]
BH1 SS4	3.3	43	41	14	2	10^{-7}	<10
BH8 SS2	1.8	46	40	13	1	10^{-7}	<10

Note 1: Infiltration rate estimated referencing Appendix C of the CVC Low Impact Development Stormwater Management Planning and Design Guide.

The results outlined above indicate silt and clay, with some fine to medium gradation sand and trace gravel. According to the Unified Soil Classification System the soil samples is classified as C.L. - Inorganic clays of low to medium plasticity, silty clay. The D_{10}, of the tested soil is approximately 0.0004 millimetres. Based on these results, the estimated infiltration rate is estimated to be generally on the order of less than 10 millimetres/hour. These results are consistent with our observations of the soils during drilling and our visual assessment of the recovered samples.

Groundwater Observations

The majority of the borehole locations were noted to be 'wet' upon completion of drilling, with freestanding water encountered at depths of 1.5 to 19.8 metres. It is noted that insufficient time would have passed for the static groundwater level to stabilise in the open boreholes. As noted above, monitoring wells were installed in Borehole Nos. 4, 5, 6, 8, 9, and 10 to allow for future measurements of the static groundwater level. Groundwater depths were measured as follows:

Table C - Summary of Monitoring Well Readings

Borehole No.	G/S Elev. [m]	Feb 22, 2022		Feb 24, 2022		May 17, 2022	
		Ground Water Depth (m)	Ground Water Elev. (m)	Ground Water Depth (m)	Ground Water Elev. (m)	Ground Water Depth (m)	Ground Water Elev. (m)
4	100.55	1.17	99.38	1.75	98.80	1.74	98.81
5	100.42	5.32	95.1	5.56	94.86	4.45	95.97
6	100.08	2.46	97.62	4.44	95.64	1.10	98.98
8	100.39	1.07	99.32	2.77	97.62	0.97	99.42
9	100.36	5.32	95.04	5.4	94.96	1.19	99.17
10	99.87	6.18	93.69	7.03	92.84	1.49	98.38

Based on the above data, these groundwater levels may be influenced by surficial infiltration, and may be artificially high. Based on our observations during drilling, the available data, and our experience in the area, the static groundwater level is estimated at depths of approximately 3 to 5 metres, and would be expected to fluctuate seasonally.

It is noted that the elevations noted above are based on reference to a temporary benchmark with an assumed elevation of 100.00 metres. The groundwater elevation should be corrected once the geodetic elevation of the benchmark has been established.

4. FOUNDATION CONSIDERATIONS

While the proposed construction is expected to consist of mid rise to multi-storey buildings with one underground level or more, the exact details of the development are currently unknown. As such the foundation solutions will be largely dependent on the finalized construction details, i.e. height and number of basement levels. Based on the encountered subsurface conditions there would be viable options for shallow spread footings or raft slab foundations, possible ground improvement, or deep foundations extending to the glacial till or Queenston Shale bedrock at depth.

SPREAD FOOTING AND RAFT SLAB CONSTRUCTION

The native silty clay/clayey silt soils have a limited stiff to very stiff weathered ‘crust’ in the upper levels, becoming firm with depth. Spread footings founded on the undisturbed native clayey silt/silty clay at a depth of approximately 3 to 3.5 metres or shallower, may be designed using a Serviceability Limit State [SLS] of 150 kPa [~3,000 psf] and a factored Ultimate Limit State [ULS] of 225 kPa [~4,500 psf], based on total and differential settlements not exceeding 25 and 20 millimetres, respectively. Where the founding level extends below 3.5 metres form the existing grade, spread footings should consider reduced design bearing values of 100 kPa [~2,000 psf] SLS and 150 kPa [~3,000 psf] ULS.

Based on the anticipated loads for mid-rise structures, these would be expected to result in a building footprint coverage by the spread foundations of greater than 50 per cent, and as such the building should be supported on a raft slab foundation. The raft slab may be designed considering bearing values of 100 kPa [~2,000 psf] SLS and 150 kPa [~3,000 psf] ULS. Alternatively, if a flexible design approach is used, a value of subgrade modulus of k = 25 MN/m^3 [~92 pci] may be considered. A raft slab design could be considered as outlined irrespective of the founding depth.

INTERMEDIATE FOUNDATION SOLUTIONS

Ground improvement methods may be considered to facilitate the support of the proposed structure on a raft slab. Rammed Aggregate Piers [RAP] or Controlled Modulus Columns [CMC] would be a feasible option in this case. These methods use a ram of a proprietary design to compact aggregate vertically into an open pier excavation, or as displacement piers. The rammed aggregate piers serve to improve the in-situ conditions to allow for increased available bearing values, and corresponding reduced settlement potential, to make conventional spread footings or raft slabs feasible for many structures. As such ground improvement methods are proprietary systems it is recommended that a specialty design-build contractor be consulted in the design of their system to accommodate the site conditions and structure requirements. Geosolv Design-Build [contact Mr. Mark Tigchelaar, mark@geosolv.ca] or Menard Canada [contact Mr.Neil Isenegger neil.isenegger@menardcanada.ca] may be provided the results of our Geotechnical Investigation to provide design feasibility and cost estimation for the construction of their proprietary foundation systems.

CAISSONS

Caisson foundations extending a minimum of one caisson diameter into the Glacial Till, at depths of approximately 20 to 21 metres or more below the existing grade, may be conservatively designed using bearing values of 500 kPa [~10,000 psf] SLS and 750 kPa [~15,000 psf] ULS.

While not specifically confirmed in the scope of this investigation, as noted above it is estimated that Queenston Shale bedrock is present within a depth of perhaps 25 to 30 metres. However, this should be confirmed through additional investigation. On a preliminary basis, where caissons extend a minimum of one caisson diameter into the Queenston Shale Bedrock anticipated at depth, a factored Ultimate Limit State [ULS] bearing capacity of 1000 kPa [~20,000 psf]. Since it will be necessary for the bedrock to fail in order to realise the serviceability tolerances, the unfactored Serviceability Limit State [SLS] value may also be taken as 1000 kPa [~20,000 psf]. Where caissons extend through the weathered Shale and into sound bedrock [about 1.5 metres or more] it would be feasible to design caissons to also take advantage of skin friction within the rock. A unit skin friction resistance of ULS = SLS = 250 kPa [~5,000 psf] may be considered. It is noted that higher bearing and skin friction values are likely available within the sound bedrock, however would need to be confirmed through more detailed investigation including coring of the bedrock. This would be best conducted once the design plan for the development has been refined.

The installation of caissons would produce limited vibrations in the area of the site, and uplift capacity could be readily achieved with the unit skin friction in the weathered Queenston Shale bedrock.

All caissons must be provided with a temporary steel liner to maintain the integrity of the open hole and allow for the entry of personnel for cleaning of the base and evaluation of the bedrock socket. The depth of clayey silt overburden above the bedrock should allow for the contractor to ‘seal’ the liner for dewatering of the caissons. If the caissons cannot be sufficiently dewatered then entry of personnel to examine the bedrock will not be possible. In such case it is recommended that all caissons have a minimum socket depth of 0.5 metres below the top of sound bedrock elevation. As well it would be necessary for the contractor to place concrete by ‘tremmie’ method.

MICROPILES

The proposed structures may also be supported using grouted micropiles. The micropiles, typically 125 to 300 millimetres in diameter, would be drilled and grouted into the competent Queenston shale 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 250 kPa [~5,000 psf] may be considered in the competent Queenston shale bedrock. As micropiles tend to be proprietary in nature a specialty contractor should be consulted in the design process

GENERAL FOUNDATION COMMENTS

The deep foundations bedrock and soil design parameters are preliminary in nature. Prior to utilizing these values for foundations design, additional investigations to confirm the bedrock condition should be conducted. Coring of the bedrock on site may allow the use of higher capacities and skin friction, which could significantly impact design of foundations for taller buildings.

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 for the Queenston Shale bedrock, as in order for serviceability limits to be realised, ultimate failure of the bedrock would have to occur.

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, 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 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 backfill [free draining granular material] unit weight, [γ], of 19.5 kN/m^3 [~124 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 parked vehicles, floor slab loading, etc. must be included in the design. Where foundations are constructed as a 'waterproofed' section, they must also be designed to support the lateral hydrostatic pressure of a water level at ground surface.

6. 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 – Stiff Soil, based on the average soil characteristics for the site. A Site Class C may be available but this would need to be verified via downhole shear wave testing.

The seismic data from Supplementary Standard SB-1 of the Ontario Building Code for Hamilton 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
0.260	0.128	0.061	0.0280	0.0068	0.0027	0.168	0.101

7. EXCAVATION AND EXCAVATION SUPPORT CONSIDERATIONS

Excavations for the installation of foundations and underground services are anticipated to extend to depths of up to approximately 3 to 5 metres below the existing grade. Excavations through the various fill materials as well as the sand soils encountered in the boreholes should be relatively straightforward, with the sides remaining stable for the short construction period at slopes of up to 45 degrees to the horizontal. Excavations through the native clayey silt/silty clay soils encountered in the boreholes, would be expected to remain stable for the short construction period with slopes of up to 60 degrees to the horizontal. Where excavations extend below the static groundwater level, below about 3.5 metres, or during periods of extended precipitation, excavation faces may locally ‘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. With respect to the Act the native clayey silt/silty clay would be considered as a Type 2 soil, while the fill soils and sand encountered on site would be considered a Type 3 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. Support of the existing underground services and roadway adjacent to the project area must also be considered in assessing the excavation support requirements.

Stabilisation of the excavation bases is likely to be necessary to a varying degree depending on the depth of excavation. It is recommended that the excavation base be provided with a ‘mud slab’, composed of a ‘lean-mix’ [~5 MPa] concrete after excavation has been completed, to avoid disturbance of the clayey silt/silty clay soils encountered in the boreholes. Alternatively, a layer of roughly 300 millimetres of coarse crushed aggregate could be provided. This will act to protect the founding soils from disturbance, and provide a clean and stable working surface.

It is anticipated that the construction may approach the property limits. Depending on the site plan and depth of foundations, open cut excavations as outlined above may be feasible. However, in the event that the proximity of the excavations to adjacent structures, roadways, etc., encroaches on the zone of influence it may be necessary to provide excavation shoring systems to ensure the support conditions adjacent structures are not compromised. It is noted that a preconstruction survey of adjacent above and below grade structures should be conducted to assess the appropriate shoring requirements, as well as establish a baseline condition.

A specialty contractor or shoring consultant should be consulted with respect to the design of such a shoring system, where required. For preliminary design purposes the shoring system should be designed on the basis of a retained soil unit weight of γ_{wet} = 19.5 kN/m^3 [~124 pcf], and a lateral earth pressure coefficient of k_o = 0.5 (at rest case) or k_A = 0.3 (active case). Shoring systems such as soldier piles or caisson walls may be supported on caissons extending into the underlying silty clay till, and may be designed for end bearing using the values provided above, however it is recommended that a 50% reduction of this bearing value be used in the shoring design.

The shoring system should be monitored during construction, and the contractor should have a contingency plan in place to be implemented should deflections of the shoring system exceed the tolerable limits. In addition, it is imperative that a pre-construction condition survey be conducted of the adjacent structures, roadways, etc. in order to document the existing conditions prior to the commencement of construction. This will allow for comparison and assessment in the event that disturbance due to construction activities is claimed.

As noted above the static groundwater level is anticipated to be approximately 3 to 5 metres below the existing ground surface, generally near, to below, the anticipated depths of foundation depths associated with one underground level. Nevertheless, some minor infiltration of groundwater through more permeable seams, as well as surface runoff into open excavations, should be anticipated. It should be possible to adequately control groundwater infiltration for the short construction period using conventional construction dewatering methods, such as pumping from sumps in the base of the excavation. More groundwater control should be anticipated when connections are made to existing services. Surface water should be directed away from the excavations. The rate of temporary construction dewatering for a single basement level would not be anticipated to exceed 50,000 L/day. However, this should be reviewed in more detail as the development plan is established.

Where the depth of the proposed buildings extends more than about 3.5 metres below the existing grade, such as where more than one basement level is considered, excavations would be expected to be below the static groundwater level. The rate of infiltration through the low permeability clayey silt/silty clay soils may be sufficiently low such that it would be possible to control the infiltration of groundwater by pumping from construction sumps, however the need for multiple pumps should be anticipated and resulting dewatering volumes may exceed 50,000 L/day or even 400,000 L/day requiring an EASR filing or Permit to Take Water. It would be necessary to conduct further more detailed hydrogeological assessment of the groundwater conditions, including single well response test(s) in installed monitoring wells, in order to better establish the infiltration rates and an estimate of the volume of water to be controlled during construction. It is noted that the groundwater control requirements will be significantly influenced by the excavation shoring method implemented, being greatest for open cuts into the overburden soils, and much less for a continuous caisson wall. In this regard the use of timber lagging for excavations extending below the groundwater level is cautioned, due to the potential for ongoing groundwater seepage, and well as potential loss of soil washing through the lagging boards. As such the use of a caisson wall or steel sheet piling would be preferred. Such systems would also greatly reduce the construction dewatering requirements for the project.

8. PERIMETER AND UNDERFLOOR DRAINAGE

If the finished floor level of any basement space is designed to be sufficiently above the static groundwater level, ideally with a finished floor slab at no more than 3.0 metres below the existing grade, this would avoid the need for permanent or sustained pumping of groundwater post construction. It is noted that City of Hamilton does not allow for permanent dewatering for basement levels below the groundwater level, and so it would be necessary to construct the foundations as water tight where the basement slab is more than about 3.0 metres below the existing grade.

For a single basement level, the 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. 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 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 shows schematics of the typical requirements for slab-on-grade construction with a basement level.

Depending on the floor slab level versus the static groundwater level, it may be prudent of provide under-floor drainage to address the potential for the build-up of groundwater beneath the basement floor slabs. Under-floor drains may consist of 150-millimetre diameter perforated pipe, with a geofabric sock, placed in the clear stone beneath the floor slabs on nominal 4 to 6 metre centres. It is noted that the under-floor and perimeter drainage systems should have separate piping, i.e. piping from perimeter system does not connect to the under-floor system, in order to prevent surcharging of the under-floor system. They may outlet into a common sump-pit, though separate systems would be preferred. The enclosed Drawing No. 3 shows schematics of requirements for foundation construction with an underfloor drain system.

Where the basement slab elevation extends to or below the groundwater elevation, more than about 3.0 metres below the exiting grade it is recommended to design the foundations and basement slab to be water tight, making use of suitable membrane systems and concrete additives beneath the slab and against the exterior of foundation walls. The system should also incorporate a water-stop component between the footings below the slab and against foundation walls. This approach would avoid the requirement for permanent drainage and dewatering systems. The enclosed Drawing No. 4 shows a schematic of the typical requirements for water tight basement foundation construction. The foundation walls and floor slab will also be required to be designed to resist the hydrostatic pressure.

Elevator pit excavations extending below the general basement floor level should also be designed to be water-tight. It is recommended that this water-tight design for the elevator pit be implemented regardless of the water proofing or drainage design adopted for the general basement level.

9. FLOOR SLAB CONSTRUCTION

The basement floor slabs 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 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.

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 well-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 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.

As noted above, depending on the depth of the basement floor it may be necessary to construct the foundations as water tight. In this case it may be appropriate to provide a water tight membrane system beneath the lower level parking garage slab of the highrise structures. The type of membrane system should be carefully selected and installed in accordance with the manufacturer specifications in order to achieve a permanent water tight condition. The installation of the water proofing system should be closely monitored to ensure it is continuous beneath the slab, with no breaks or gaps, and connects sufficiently to the foundation wall water proofing, to ensure that it will function per the manufacturer requirements.

10. BACKFILL CONSIDERATIONS

The majority of excavated material will consist of the native clayey silt/silty clay and fill materials encountered in the boreholes and to a lesser extent the surficial native sand, as described above. This material is generally considered suitable for use as engineered fill and service trench backfill, provided the moisture content can be controlled to within 3 per cent of the material's standard Proctor optimum value, and the material is free of any organic or otherwise deleterious materials. Depending on the weather conditions at the time of construction, some moisture conditioning of the excavated materials may be required to achieve acceptable compaction densities and minimise long-term settlement. Compaction of the cohesive clayey silt/silty clay will prove to be difficult in areas where access with compaction equipment is restricted.

It is noted that the clayey silt/silty clay soils encountered are not free draining and should not be used where this characteristic is necessary. The use of a free draining, well-graded granular material, such as an Ontario Provincial Standard Specification [OPSS] Granular B, Type II (crushed limestone bedrock), is recommended for backfill against foundation walls or to raise the interior grade to the design subgrade level. This material is more readily compacted in restricted access areas, and generally presents a more positive support condition for concrete floor slabs and exterior sidewalks/pavement.

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 silty clay/clayey silt soils may require high compaction energy to achieve acceptable densities if the moisture content is not close to its standard Proctor optimum value. It is very important that the placement 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 provision of 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'. All structural fill should be compacted to 100 per cent of its standard Proctor maximum dry density [SPMDD]. Backfill within service trenches, areas to be paved, etc., should be compacted to a minimum of 98 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.

11. 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 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 [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.

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. As noted above 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 D 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 D

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	40millimetres	40 millimetres
Binder Course OPSS HL 8	92 per cent Marshall MRD	50 millimetres	65 millimetres
Base Course OPSS Granular A	100% SPMDD	150 millimetres	150 millimetres
Sub-base Course OPSS Granular B Type II	100% SPMDD	200 millimetres	350 millimetres

* Marshall MRD denotes Maximum Relative Density.

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

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

To 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.

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.

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.

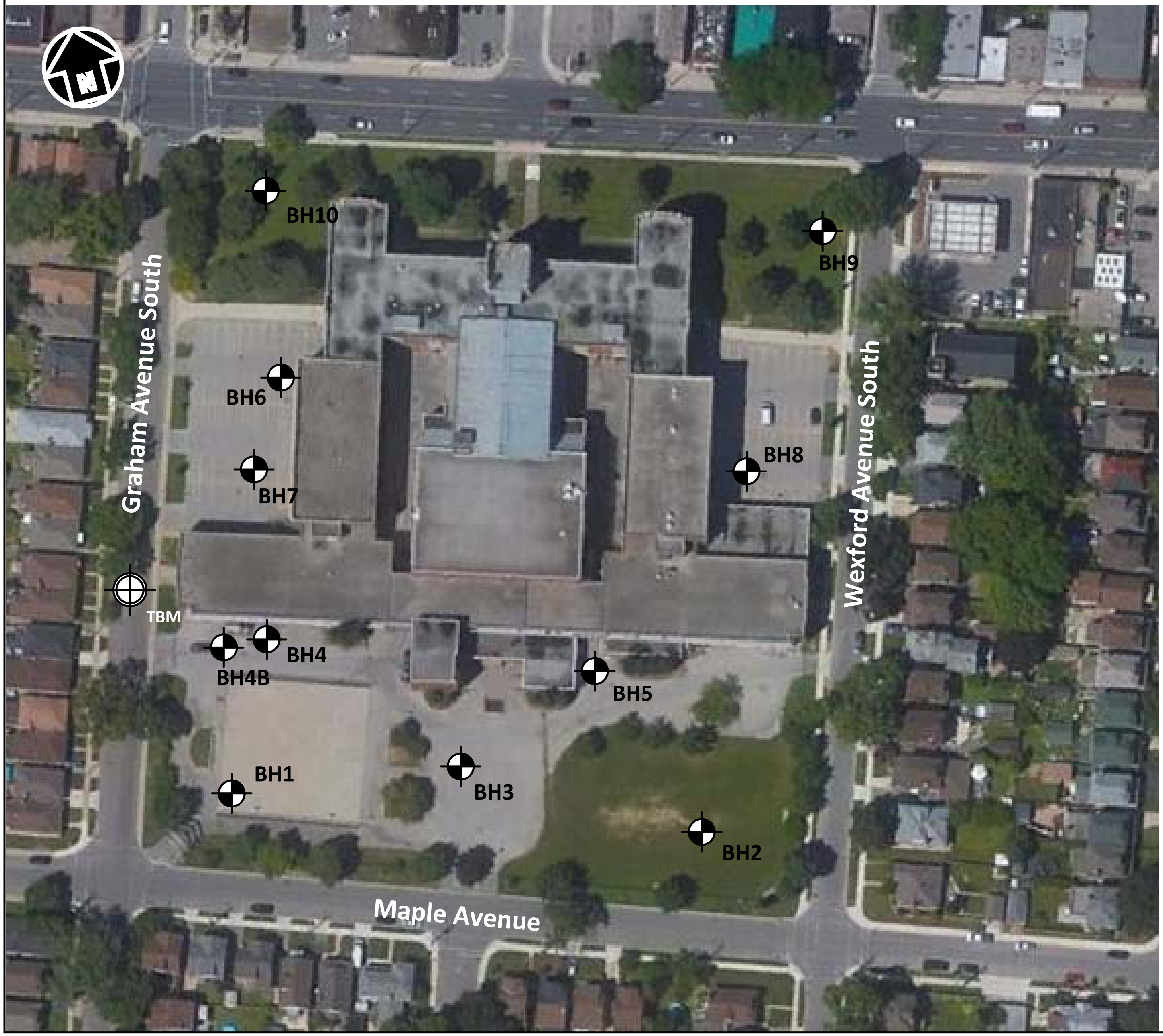
LICENSED PROFESSIONAL ENGINEER
June 8, 2022
Y. MORMIL
100531911
PROVINCE OF ONTARIO

Yaroslav Mormil, P. Eng
Project Engineer

Ian Shaw, P. Eng., QP_{ESA}
Review Engineer

Enclosures:
- Drawing No. 1, Borehole Location Plan
- Log of Borehole Nos. 1 to 10, inclusive
- Drawing No. 2 - Basement Perimeter Drainage
- Drawing No. 3 – Basement Perimeter Drainage with Underfloor Drains
- Drawing No. 4 – Watertight Basement
- Grain Size Analysis

Distribution: LOSANI HOMES [1, plus pdf]



LEGEND

● BH#	Borehole Location
○ TBM	Temporary Benchmark Catch Basin on Graham Ave Temporary Elevation of 100.00 m

NOTES:

1. This map should be read in conjunction with Soil-Mat Engineers and Consultants Ltd. Report No.: SM 302519-G

2. Base map provided by:
© 2022 Google Earth

Soil-Mat
Engineers & Consultants Ltd.

CLIENT

LOSANI HOMES

PROJECT TITLE

Geotechnical Investigation
1284 Main Street East
Hamilton, Ontario

DRAWING TITLE

Borehole Location Plan

PROJECT No.	SM 302519-G
DATE	February 2022
CHECKED	NS
DRAWN	IS
FILE NAME	302519 Site Plan 2.vsd

DRAWING No. 1

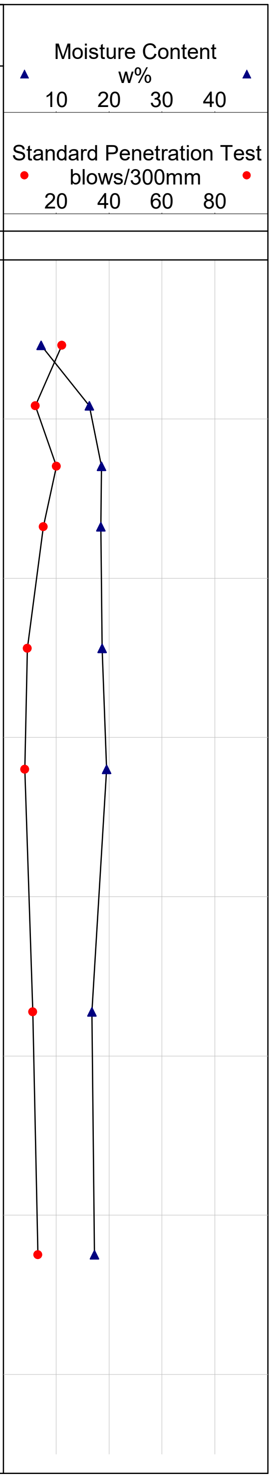
Log of Borehole No. 1

Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes

Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788152
E: 596200

Elevation (m)	Description
100.64	Ground Surface
100.14	**Pavement Structure** Approximately 200 millimetres of asphaltic concrete over 300 millimetres of compact granular base.
98.80	**Sand and Gravel Fill** Brown, compact.
97.60	**Silty Clay/Clayey Silt** Brown, trace sand and gravel, stiff to very stiff. Transition in colour to grey, stiff.
87.80	End of Borehole

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	8,13,9,4	22	▨		
SS	2	5,6,6,6	12	▨		
SS	3	6,9,11,14	20	▨	>4.5	
SS	4	5,6,9,12	15	▨	>4.5	
SS	5	3,3,6,7	9	▨	3.0	
SS	6	2,3,5,5	8	▨	<1.0	
SS	7	3,5,6,8	11	▨	<1.0	
SS	8	4,5,8,9	13	▨	<1.0	



NOTES:

1. Borehole was advanced using solid stem auger equipment on February 7, 2022 to termination at a depth of 12.8 metres.

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

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

Drill Method: Solid Stem Augers
Drill Date: February 7, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

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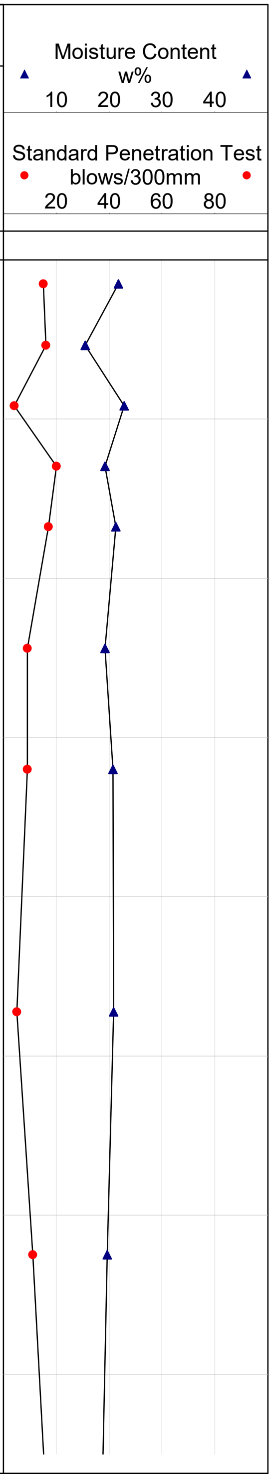
Datum: Temporary Benchmark
Field Logged by: NS
Checked by: IS
Sheet: 1 of 1

Log of Borehole No. 2

Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes

Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788117
E: 596307

Depth	Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
ft m 0 0	101.27		Ground Surface								
			Topsoil Approximately 100 millimetres of topsoil.		SS	1	13,9,6,9	15	▨		
			Sandy Silt/Clayey Silt Fill Brown, some gravel, trace construction debris.		SS	2	9,8,8,5	16	▨		
	99.27				SS	3	3,1,3,5	4	▨	>4.5	
			Silty Clay/Clayey Silt Brown, trace sand and gravel, soft to very stiff.		SS	4	6,8,12,15	20	▨	4.5	
	98.20		Transition in colour to grey, stiff.		SS	5	4,7,10,13	17	▨	4.0	
					SS	6	4,3,6,8	9	▨	3.0	
					SS	7	2,4,5,6	9	▨	<1.0	
					SS	8	2,2,3,5	5	▨	<1.0	
					SS	9	3,4,7,7	11	▨	<1.0	



Drill Method: Solid Stem Augers
Drill Date: February 7, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

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Log of Borehole No. 2

Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes

Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788117
E: 596307

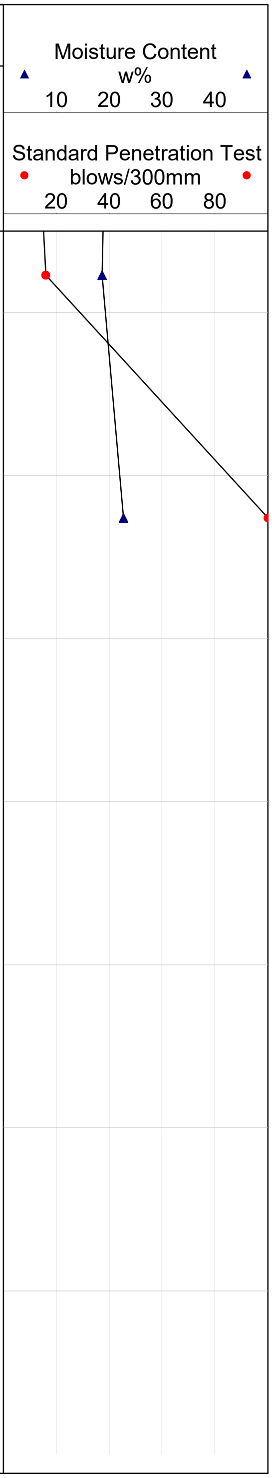
Depth		Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
50 51 52 53 54 55 56 57 58 59	16 17 18	83.00	▨			SS	10	4,6,10,11	16	▇	<1.0	
60 61		82.60	⁘	**Glacial Till** Grey, with sand and gravel, shale inclusions, hard.		SS	11	5,12,50/5"	100	▇		
62 63 64 … 98	19 20 21 22 23 24 25 26 27 28 29			End of Borehole								

NOTES:

1. Borehole was advanced using solid stem auger equipment on February 7, 2022 to termination at a depth of 18.7 metres.

2. Borehole was recorded as open and 'wet' at a depth of 1.5 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: February 7, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

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Sheet: 2 of 2

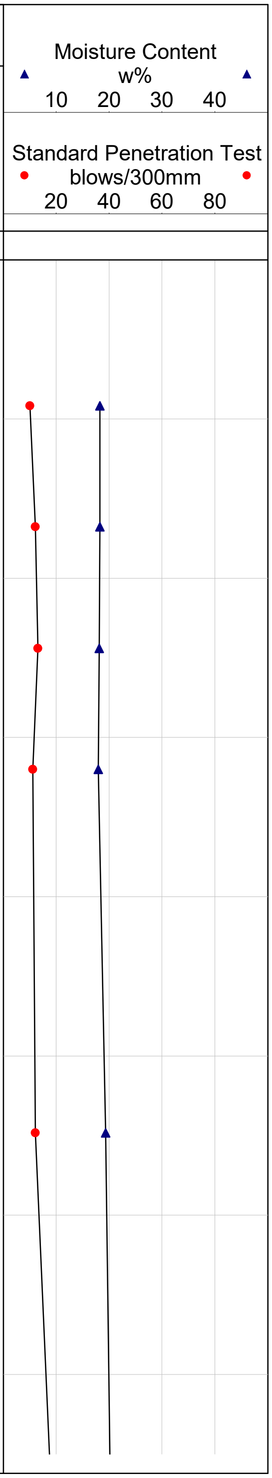
Log of Borehole No. 3

Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes

Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788143
E: 596259

Depth (ft / m)	Elevation (m)	Description
0 / 0	101.00	Ground Surface
	100.60	**Pavement Structure** Approximately 100 millimetres of asphaltic concrete over 300 millimetres of compact granular base.
		Silty Clay/Clayey Silt Brown, reworked in the upper levels, trace sand and gravel, stiff
	98.00	Transition in colour to grey, stiff to very stiff.

Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
	SS	1	3,3,7,7	10	▇		
	SS	2	4,5,7,7	12	▇	3.25	
	SS	3	4,6,7,10	13	▇	2.0	
	SS	4	3,5,6,7	11	▇	1.5	
	SS	5	4,5,7,7	12	▇	1.75	



Drill Method: Solid Stem Augers
Drill Date: February 8, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

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Log of Borehole No. 3

Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes
Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788143
E: 596259

Depth: 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98

16 17 18 19 20 21 22 23 24 25 26 27 28 29

Elevation (m)	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
			SS	6	5,7,11,15	18	▨	3.0	
82.70	**Glacial Till** Brown, with sand and gravel, some shale inclusions, hard.								
			SS	7	9,17,27,31	44	▨		
76.00			SS	8	14,24,40,50/5	64	▨		

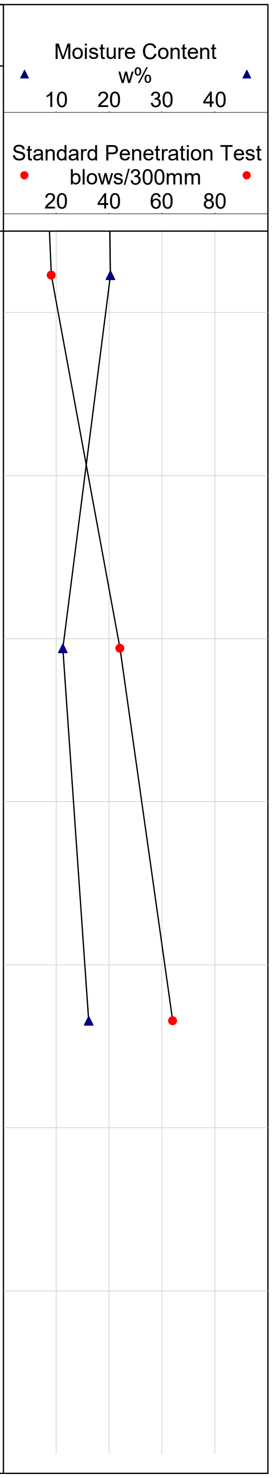
End of Borehole

NOTES:

1. Borehole was advanced using solid stem auger equipment on February 8, 2022 to termination at a depth of 25.0 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: February 8, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

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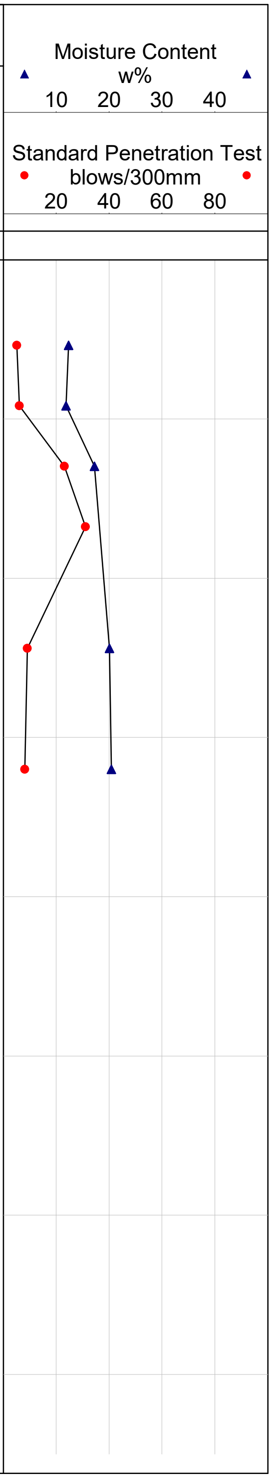
Log of Borehole No. 4

Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes

Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788180
E: 596213

Elevation (m)	Description
100.55	Ground Surface
100.17	**Pavement Structure** Approximately 75 millimetres of asphaltic concrete over 300 millimetres of compact granular base.
98.55	**Sandy Silt/Clayey Silt Fill** Brown, trace gravel, firm.
	Silty Clay/Clayey Silt Grey, trace sand and gravel, hard to stiff.
93.80	End of Borehole

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	3,2,3,6	5	■		
SS	2	4,3,3,5	6	■		
SS	3	7,10,13,17	23	■		
SS	4	7,12,19,22	31	■	4.5	
SS	5	3,4,5,6	9	■	2.0	
SS	6	3,3,5,6	8	■	<1.0	



NOTES:

1. Borehole was advanced using solid stem auger equipment on February 8, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as open and 'wet' at a depth of 4.5 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:

Feb 22, 2022 - 1.17 metres
Feb 24, 2022 - 1.75 metres
May 17, 2022 - 1.74 metres

Drill Method: Solid Stem Augers
Drill Date: February 8 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

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Datum: Temporary Benchmark
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Sheet: 1 of 1

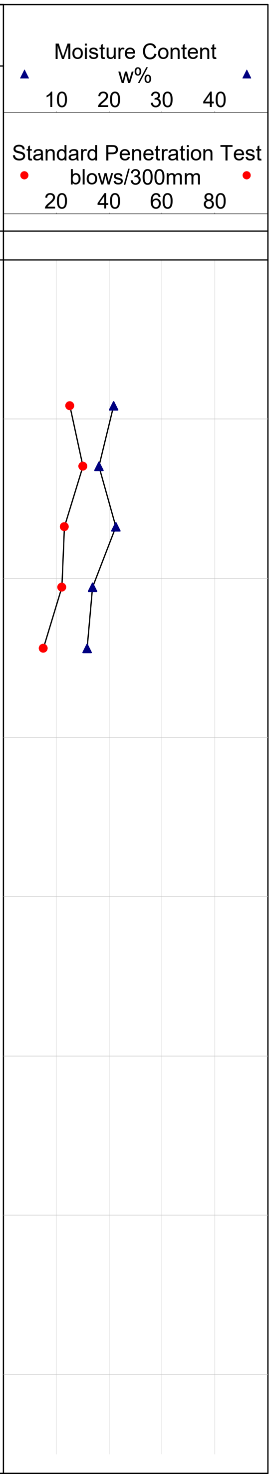
Log of Borehole No. 4B

Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes

Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788189
E: 596202

Depth (ft / m)	Elevation (m)	Symbol	Description	Well Data
0 / 0	100.60		Ground Surface	
	100.20		**Pavement Structure** Approximately 100 millimetres of asphaltic concrete over 300 millimetres of compact granular base.	
			Silty Clay/Clayey Silt Brown to greyish brown, trace sand and gravel, very stiff to hard.	
	96.10		Transition in colour to grey, very stiff.	
	95.40		End of Borehole	

SAMPLE						
Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	8,11,14,13	25	▨		
SS	2	8,13,17,21	30	▨		
SS	3	6,10,13,14	23	▨	>4.5	
SS	4	6,9,13,15	22	▨	>4.5	
SS	5	4,7,8,7	15	▨	3.0	



NOTES:

1. Borehole was advanced using solid stem auger equipment on February 9, 2022 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.

Drill Method: Solid Stem Augers
Drill Date: February 9, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

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Datum: Temporary Benchmark
Field Logged by: NS
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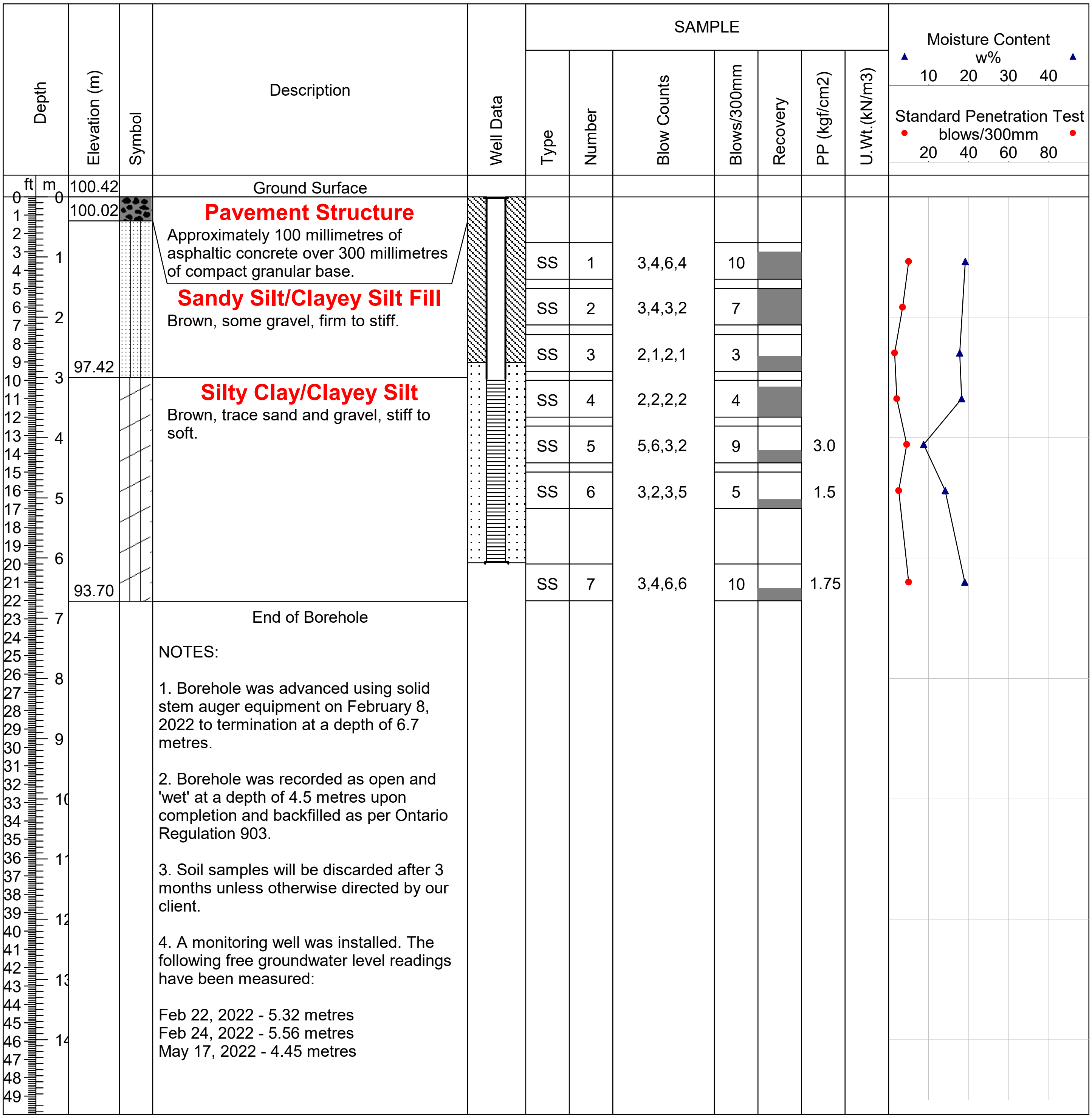
Sheet: 1 of 1

Log of Borehole No. 5

Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes

Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788156
E: 596286



Elevation (m)	Description
100.42	Ground Surface
100.02	**Pavement Structure** Approximately 100 millimetres of asphaltic concrete over 300 millimetres of compact granular base.
	Sandy Silt/Clayey Silt Fill Brown, some gravel, firm to stiff.
97.42	**Silty Clay/Clayey Silt** Brown, trace sand and gravel, stiff to soft.
93.70	End of Borehole

Type	Number	Blow Counts	Blows/300mm	PP (kgf/cm2)
SS	1	3,4,6,4	10	
SS	2	3,4,3,2	7	
SS	3	2,1,2,1	3	
SS	4	2,2,2,2	4	
SS	5	5,6,3,2	9	3.0
SS	6	3,2,3,5	5	1.5
SS	7	3,4,6,6	10	1.75

NOTES:

1. Borehole was advanced using solid stem auger equipment on February 8, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as open and 'wet' at a depth of 4.5 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:

Feb 22, 2022 - 5.32 metres
Feb 24, 2022 - 5.56 metres
May 17, 2022 - 4.45 metres

Drill Method: Solid Stem Augers
Drill Date: February 8 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

Soil-Mat Engineers & Consultants Ltd.
130 Lancing Drive, Hamilton, ON L8W 3A1
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Log of Borehole No. 6

Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes

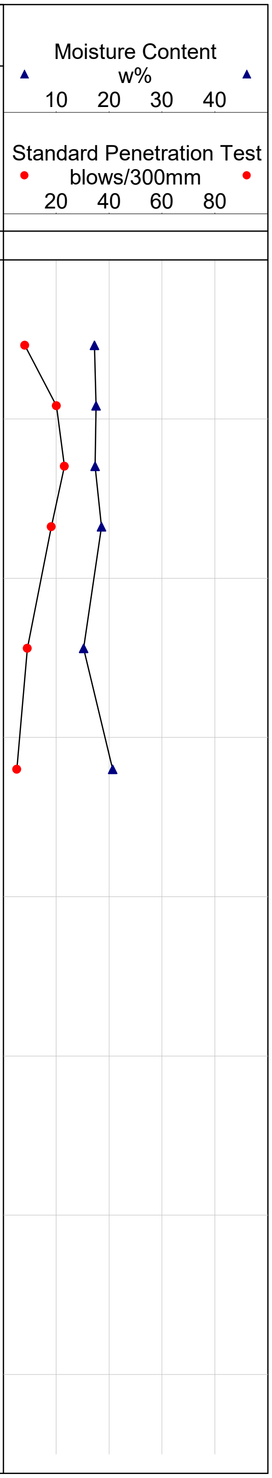
Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788239
E: 596219

Depth ft: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
Depth m: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Elevation (m)	Description
100.08	Ground Surface
99.68	**Pavement Structure** Approximately 100 millimetres of asphaltic concrete over 300 millimetres of compact granular base.
	Silty Clay/Clayey Silt Brown to greyish brown, trace sand and gravel, very stiff to hard.
95.60	Transition in colour to grey, very stiff.
93.40	End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	12,5,3,4	8	▨		
SS	2	5,8,12,12	20	▨		
SS	3	12,11,12,14	23	▨	>4.5	
SS	4	5,6,12,13	18	▨	>4.5	
SS	5	4,4,5,5	9	▨	2.5	
SS	6	2,2,3,5	5	▨	<1.0	



NOTES:

1. Borehole was advanced using solid stem auger equipment on February 10, 2022 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 and the following groundwater level readings have been measured:

Feb 22, 2022 - 2.46 metres
Feb 24, 2022 - 4.44 metres
May 17, 2022 - 1.10 metres

Drill Method: Solid Stem Augers
Drill Date: February 10, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

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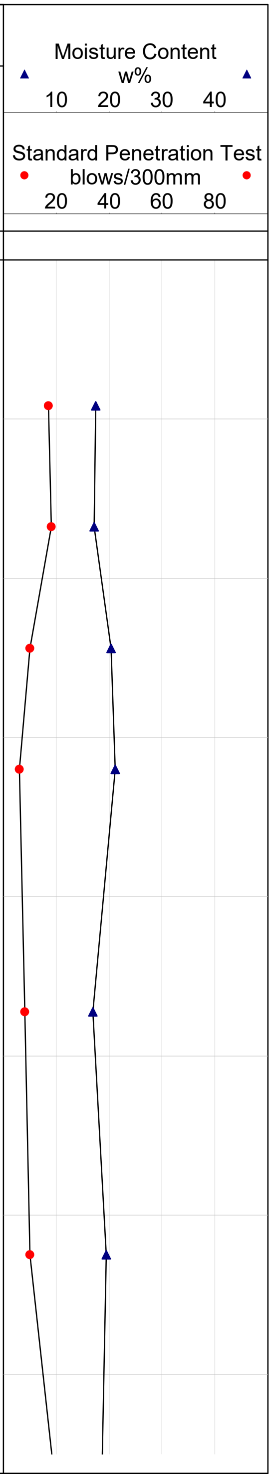
Log of Borehole No. 7

Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes

Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788219
E: 596224

Depth (ft / m)	Elevation (m)	Symbol	Description	Well Data
0 / 0	100.05		Ground Surface	
	99.65		**Pavement Structure** Approximately 100 millimetres of asphaltic concrete over 300 millimetres of compact granular base.	
			Silty Clay/Clayey Silt Brown to greyish brown, trace sand and gravel, stiff to very stiff.	
	95.60		Transition in colour to grey, stiff to hard.	

SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	5,8,9,12	17	▨	>4.5	
SS	2	4,7,11,13	18	▨	4.0	
SS	3	3,4,6,6	10	▨	<1.0	
SS	4	2,3,3,5	6	▨	<1.0	
SS	5	2,4,4,6	8	▨	<1.0	
SS	6	2,4,6,8	10	▨	1.5	



Drill Method: Solid Stem Augers
Drill Date: February 10, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

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Sheet: 1 of 2

Log of Borehole No. 7

Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes

Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788219
E: 596224

Depth	Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
					SS	7	4,8,12,13	20	▇		
					SS	8	10,12,21,27	33	▇		
	80.30										
			Glacial Till Brown, with sand and gravel, shale inclusions, hard.		SS	9	12,17,23,50/5	40	▇		
	78.10		End of Borehole								

Depth: 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98

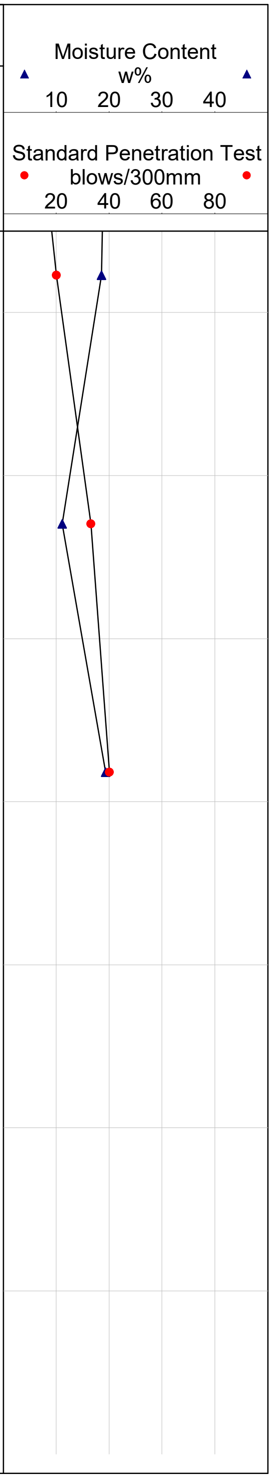
16 17 18 19 20 21 22 23 24 25 26 27 28 29

NOTES:

1. Borehole was advanced using solid stem auger equipment on February 10, 2022 to termination at a depth of 21.9 metres.

2. Borehole was recorded as open and 'wet' at a depth of 19.8 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: February 10, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

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Sheet: 2 of 2

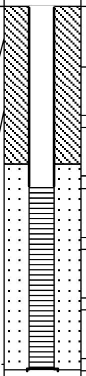
Log of Borehole No. 8

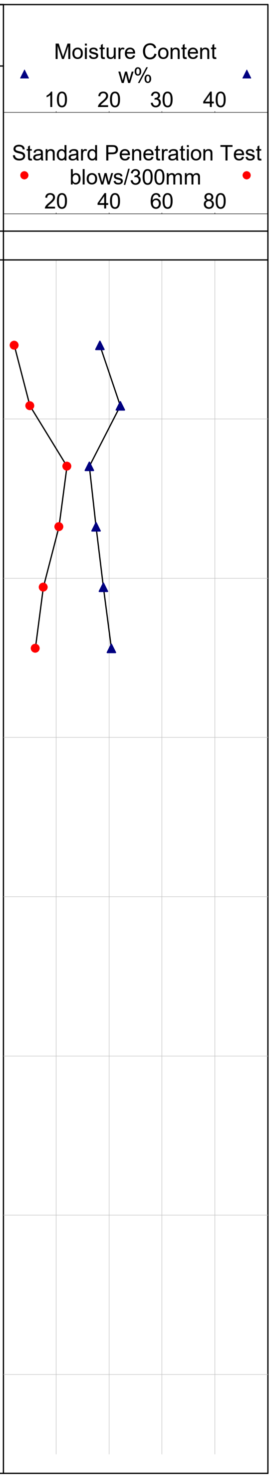
Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes

Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788194
E: 596329

Depth (m)	Elevation (m)	Description
0	100.39	Ground Surface
0 – 0.9	99.99 99.09	**Pavement Structure** Approximately 100 millimetres of asphaltic concrete over 300 millimetres of compact granular base.
0.9 –		**Silty Sand/Clayey Silt Fill** Brown, trace gravel, some organics, loose to compact.
– 4.5	95.90	**Silty Clay/Clayey Silt** Brown to greyish brown, trace sand and gravel, very stiff to stiff.
4.5 – 5.2	95.20	Transition in colour to grey.
5.2		End of Borehole

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	2,2,2,2	4	■		
SS	2	3,4,6,7	10	■		
SS	3	7,12,12,14	24	■	>4.5	
SS	4	6,9,12,15	21	■	4.0	
SS	5	5,7,8,9	15	■	2.0	
SS	6	3,5,7,6	12	■	<1.0	





NOTES:

1. Borehole was advanced using solid stem auger equipment on February 9, 2022 to termination at a depth of 5.2 metres.

2. Borehole was recorded as open and 'wet' at a depth of 3.8 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:

Feb 22, 2022 - 1.07 metres
Feb 24, 2022 - 2.77 metres

Drill Method: Solid Stem Augers
Drill Date: February 9, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

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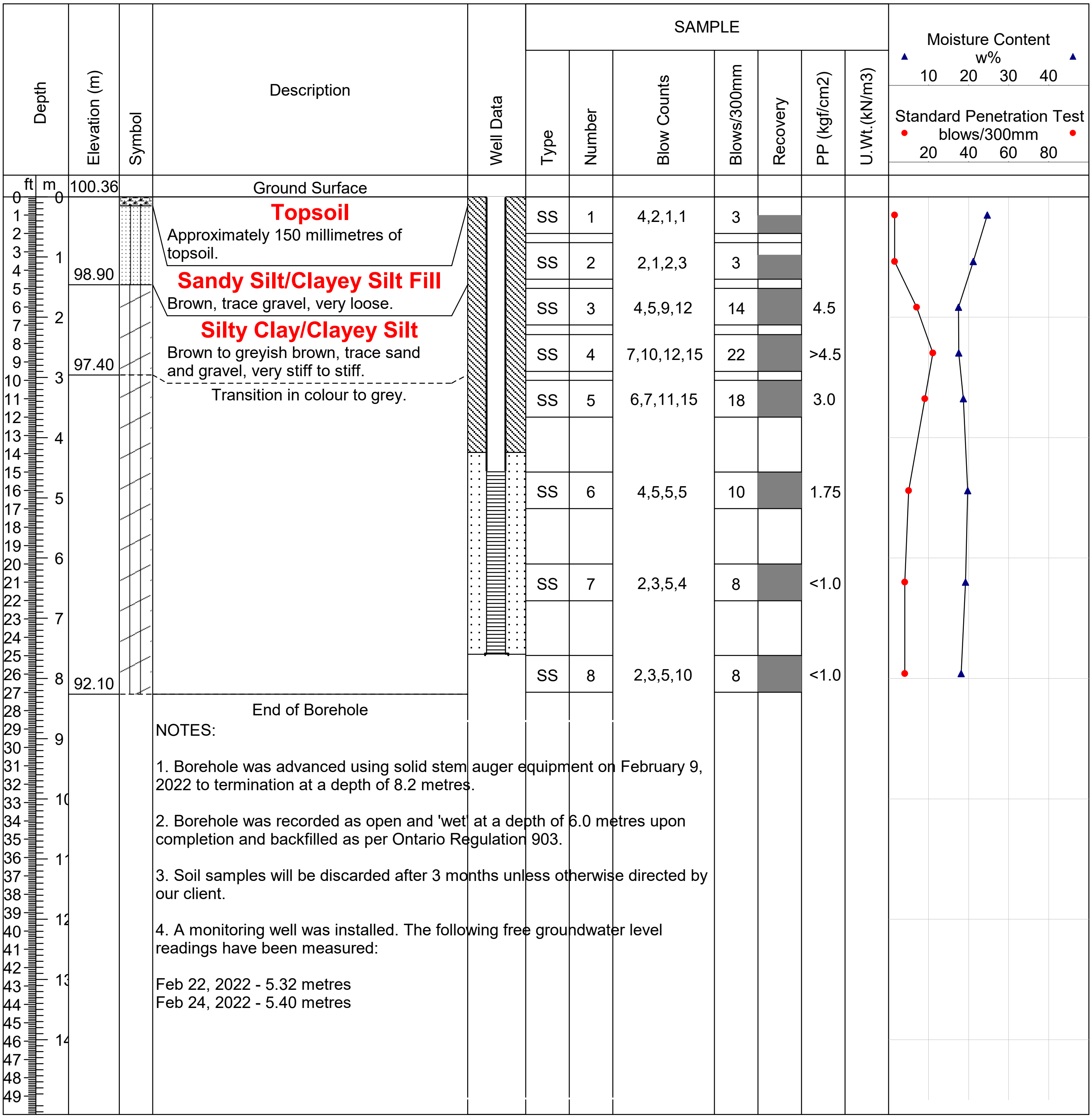
Log of Borehole No. 9

Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes
Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788245
E: 596361



Elevation (m)	Description
100.36	Ground Surface
	Topsoil Approximately 150 millimetres of topsoil.
98.90	**Sandy Silt/Clayey Silt Fill** Brown, trace gravel, very loose.
97.40	**Silty Clay/Clayey Silt** Brown to greyish brown, trace sand and gravel, very stiff to stiff. Transition in colour to grey.
92.10	End of Borehole

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	4,2,1,1	3	▆		
SS	2	2,1,2,3	3	▆		
SS	3	4,5,9,12	14	▆	4.5	
SS	4	7,10,12,15	22	▆	>4.5	
SS	5	6,7,11,15	18	▆	3.0	
SS	6	4,5,5,5	10	▆	1.75	
SS	7	2,3,5,4	8	▆	<1.0	
SS	8	2,3,5,10	8	▆	<1.0	

NOTES:

1. Borehole was advanced using solid stem auger equipment on February 9, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as open and 'wet' at a depth of 6.0 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:

Feb 22, 2022 - 5.32 metres
Feb 24, 2022 - 5.40 metres

Drill Method: Solid Stem Augers
Drill Date: February 9, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

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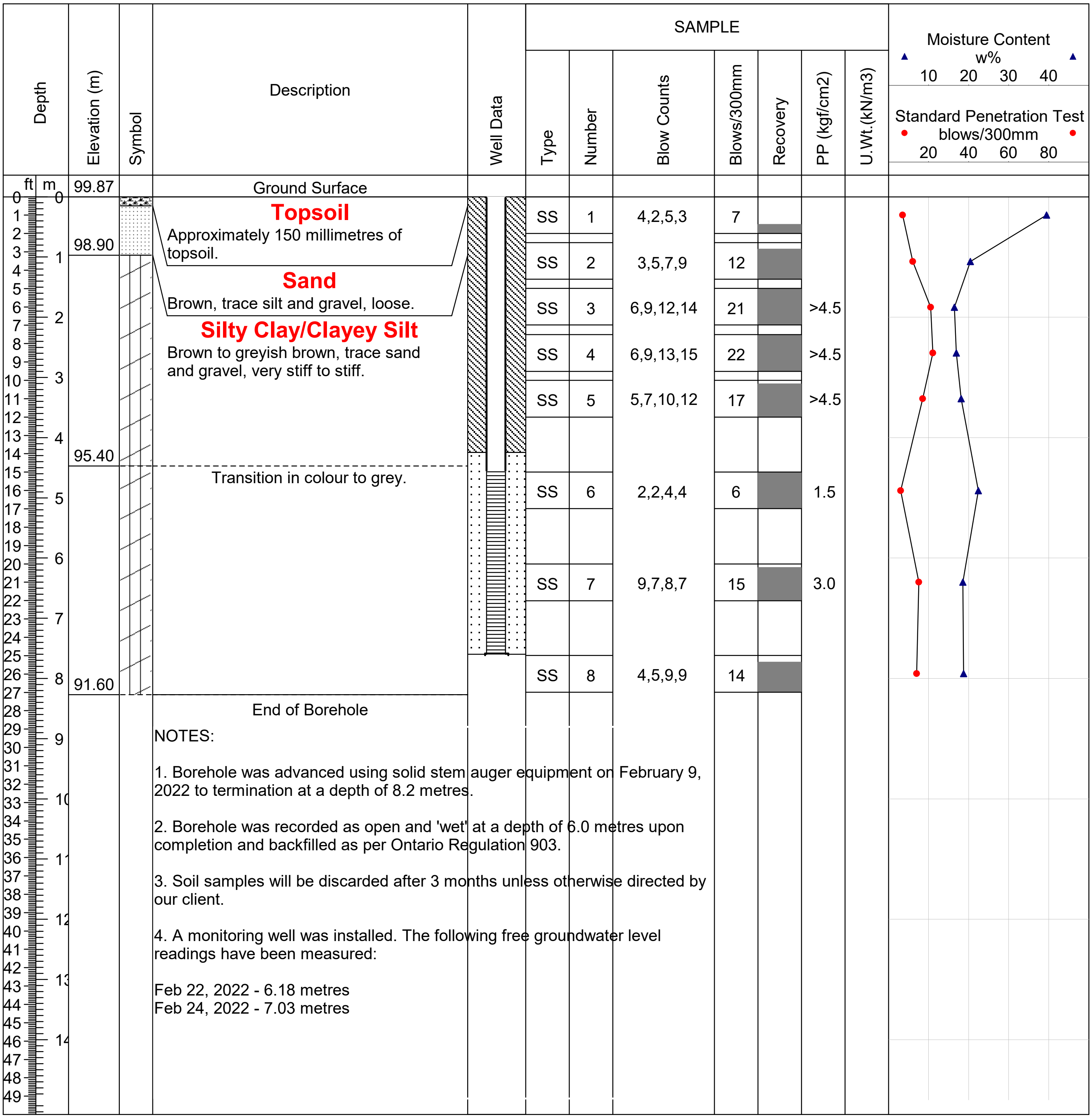
Log of Borehole No. 10

Project No: SM 302519-G-E
Project: Proposed Residential Development
Location: 1284 Main Street East, Hamilton
Client: Losani Homes

Project Manager: Ian Shaw, P.Eng
Borehole Location: See Drawing No.1
UTM Coordinates - N: 4788283
E: 596236



Elevation (m)	Description
99.87	Ground Surface
	Topsoil Approximately 150 millimetres of topsoil.
98.90	**Sand** Brown, trace silt and gravel, loose.
	Silty Clay/Clayey Silt Brown to greyish brown, trace sand and gravel, very stiff to stiff.
95.40	Transition in colour to grey.
91.60	End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	4,2,5,3	7	▨		
SS	2	3,5,7,9	12	▨		
SS	3	6,9,12,14	21	▨	>4.5	
SS	4	6,9,13,15	22	▨	>4.5	
SS	5	5,7,10,12	17	▨	>4.5	
SS	6	2,2,4,4	6	▨	1.5	
SS	7	9,7,8,7	15	▨	3.0	
SS	8	4,5,9,9	14	▨		

NOTES:

1. Borehole was advanced using solid stem auger equipment on February 9, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as open and 'wet' at a depth of 6.0 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:

Feb 22, 2022 - 6.18 metres
Feb 24, 2022 - 7.03 metres

Drill Method: Solid Stem Augers
Drill Date: February 9, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elite Drilling Services

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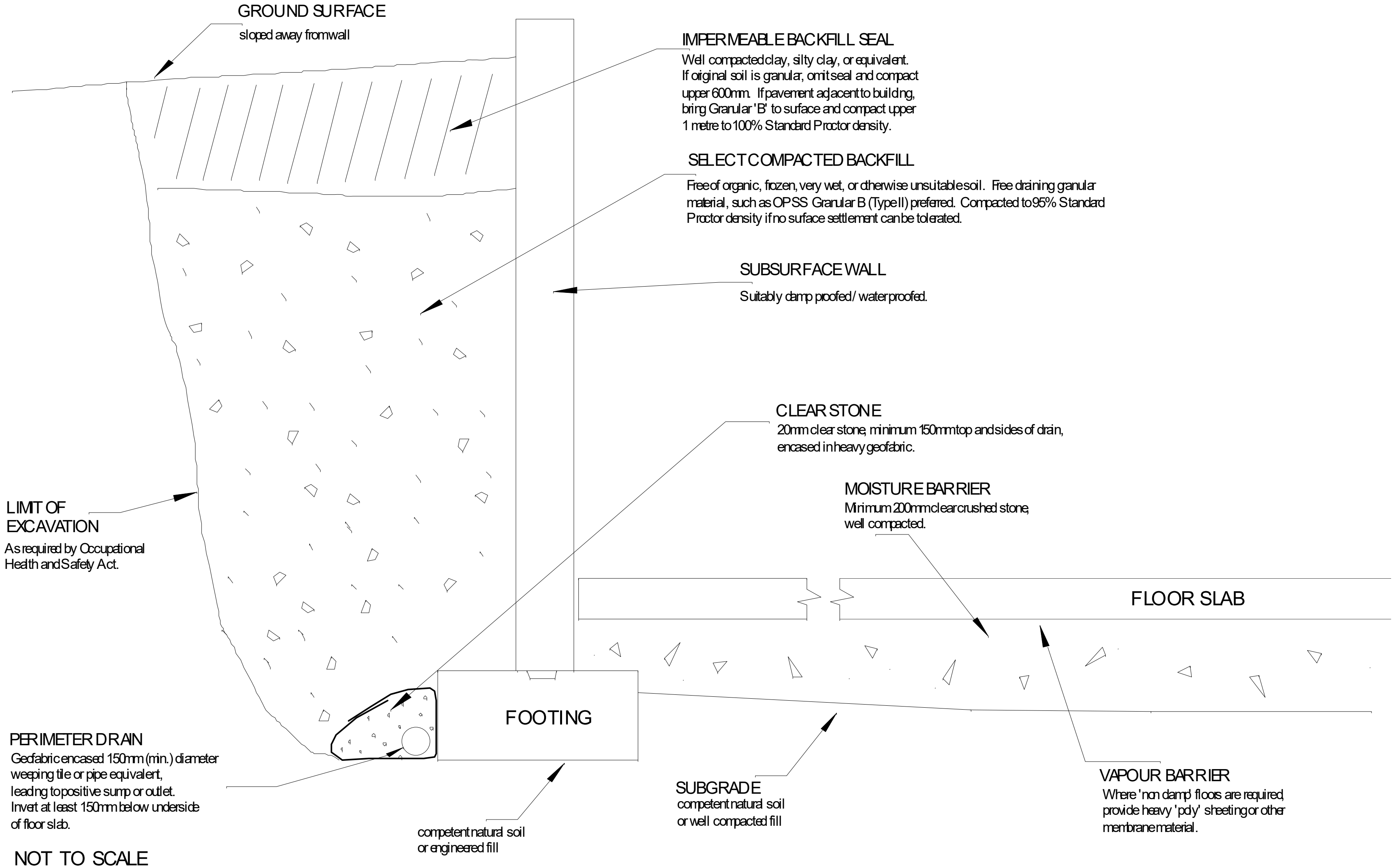


NOT TO SCALE

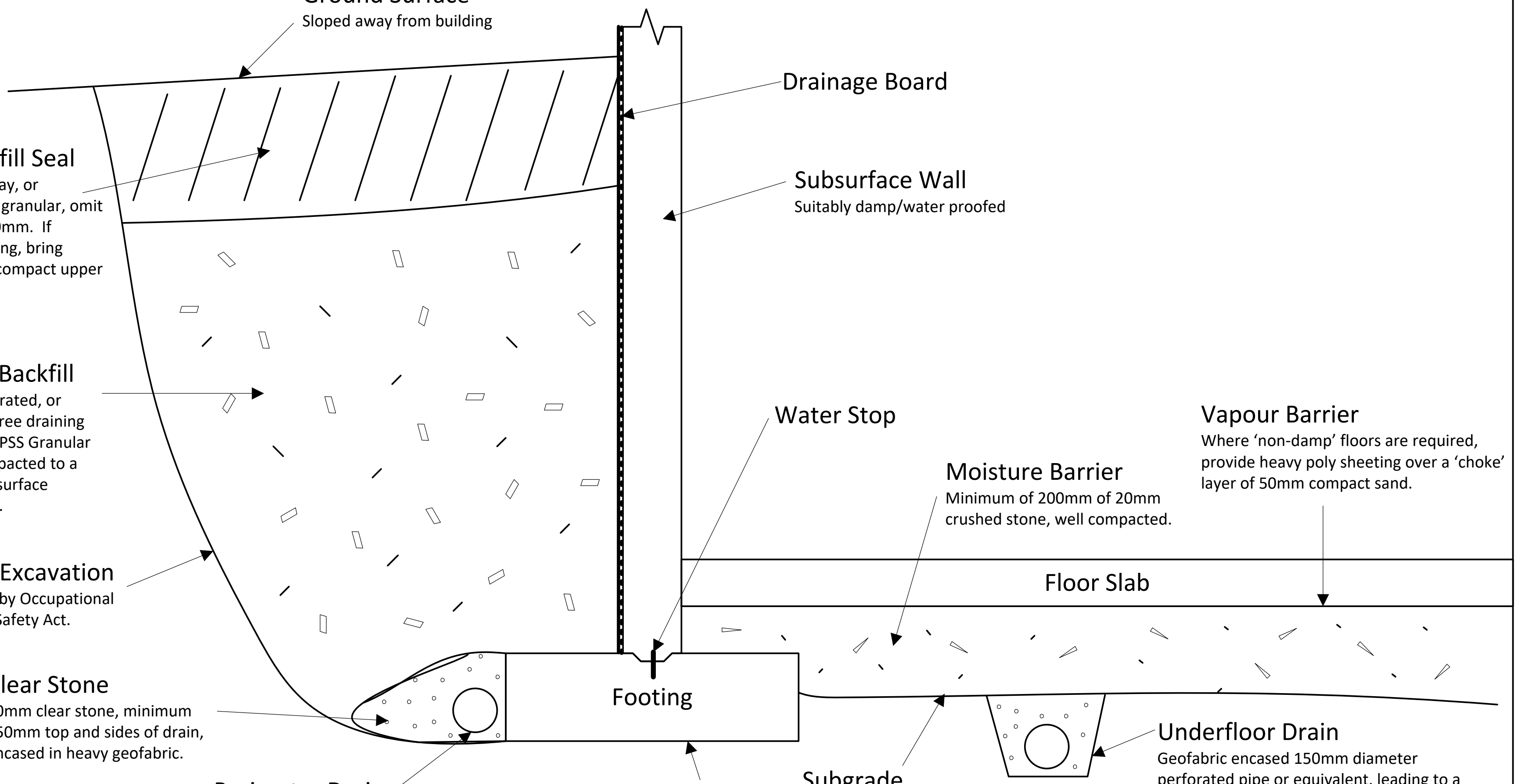
Soil-Mat

Soil-Mat Engineers & Consultants Ltd.

Project No.:	SM 302519-G
Date:	June 2022

Typical Design Requirements
Drainage and Backfill for Basement Walls

Drawing No. 2



Ground Surface
Sloped away from building

Drainage Board

Impermeable Backfill Seal
Well compacted clay/silty clay, or equivalent. If original soil is granular, omit seal and compact upper 600mm. If pavement adjacent to building, bring Granular 'B' to surface and compact upper 1 metre to 100% SPMDD.

Subsurface Wall
Suitably damp/water proofed

Select Compacted Backfill
Free of organic, frozen, saturated, or otherwise unsuitable soil. Free draining granular material, such as OPSS Granular 'B' (Type II) preferred. Compacted to a minimum of 95% SPMDD if surface settlement can be tolerated.

Water Stop

Vapour Barrier
Where 'non-damp' floors are required, provide heavy poly sheeting over a 'choke' layer of 50mm compact sand.

Moisture Barrier
Minimum of 200mm of 20mm crushed stone, well compacted.

Limit of Excavation
As required by Occupational Health and Safety Act.

Clear Stone
20mm clear stone, minimum 150mm top and sides of drain, encased in heavy geofabric.

Underfloor Drain
Geofabric encased 150mm diameter perforated pipe or equivalent, leading to a positive sump or outlet. Invert at least 300mm below underside of floor slab. Pipe placed in parallel rows on nominal 4-6m centres.

Perimeter Drain
150mm diameter weeping tile or pipe equivalent, leading to positive sump or outlet. Invert at least 150mm below underside of floor slab.

Pour flush with original undisturbed soil.

Subgrade
Competent native soil or well compacted fill.

NOT TO SCALE

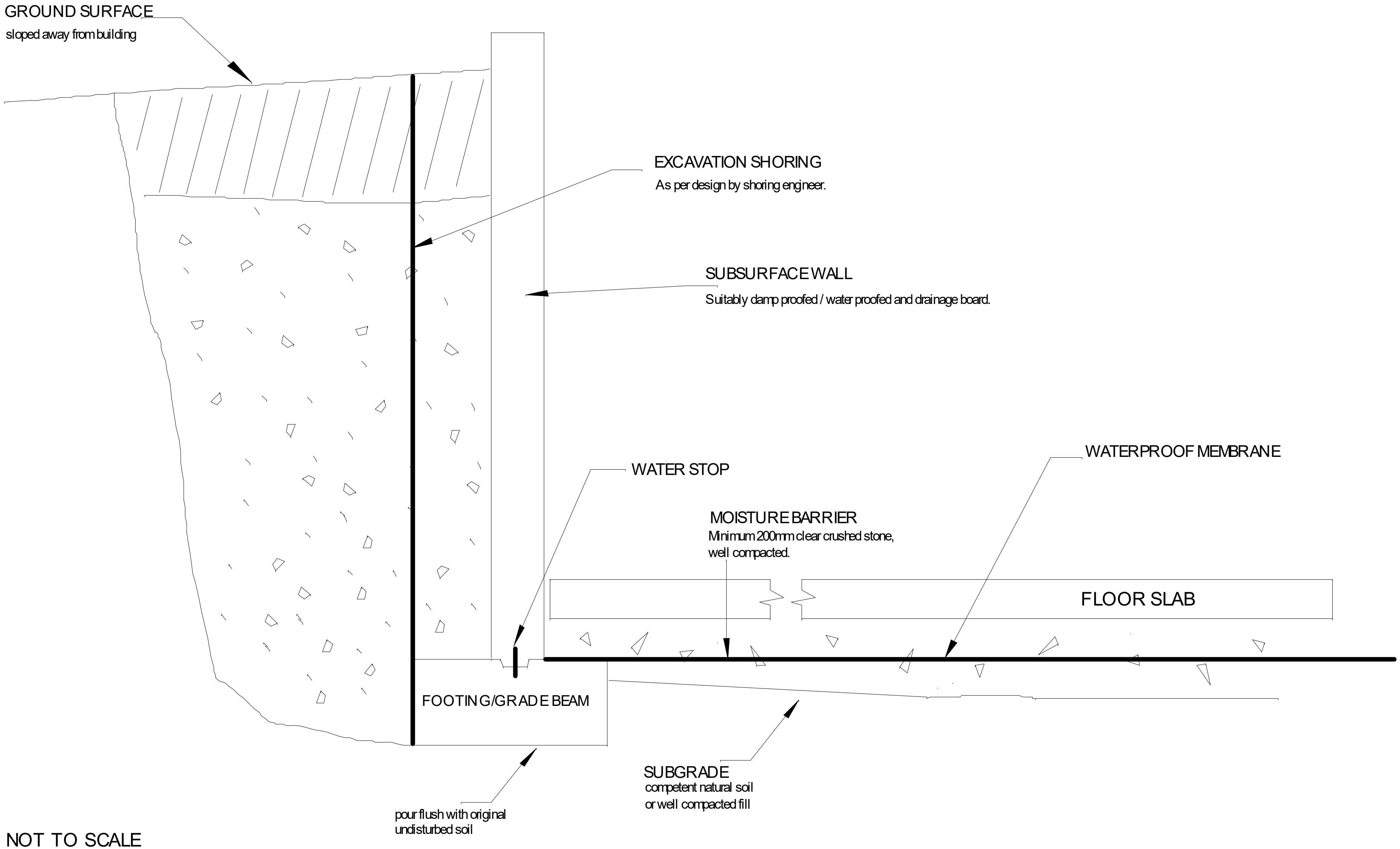
Soil-Mat

Soil-Mat Engineers & Consultants Ltd.

Project No.:	SM 302519-G
Date:	June 2022

Typical Design Requirements
Drainage and Backfill for Basement Walls

Drawing No. 3



NOT TO SCALE

Soil-Mat

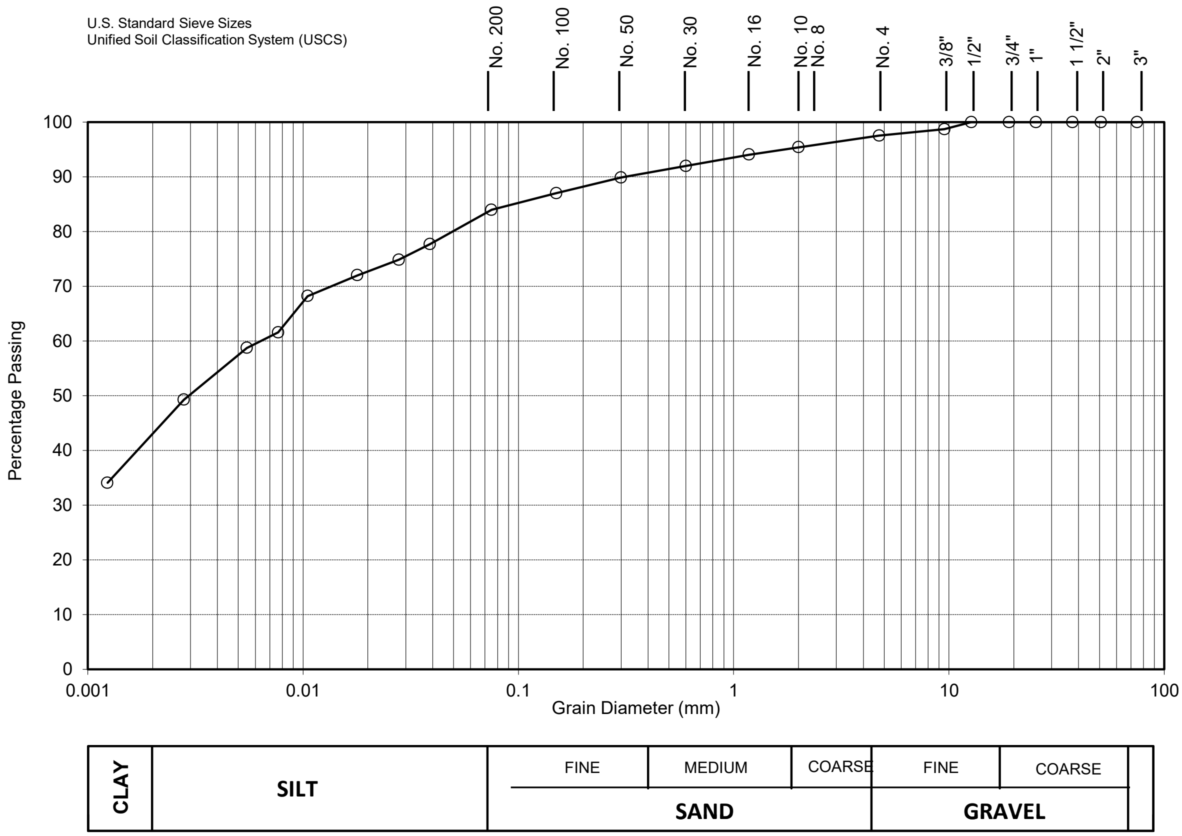
Soil-Mat Engineers & Consultants Ltd.

Project No.:	SM 302519-G
Date:	June 2022

Typical Design Requirements
Water Tight Basement Foundations

Drawing No. 4

Mechanical & Hydrometer Analyses



Lab No.:	**22-196**	Notes: Depth: 10'
Borehole No.:	**1**	
Sample No.:	**4**	

CLAY [%]: **43**
SILT [%]: **41**
SAND [%]: **14**
GRAVEL [%]: **2**
D_{10} (Effective Diam. in mm): **0.0004**

Soil Description: **Brown Clay and Silt w/ some Sand and a trace of Gravel**
M.L. - Inorganic silts and very fine sands to
C.L. - Inorganic clays of low to medium plasticity

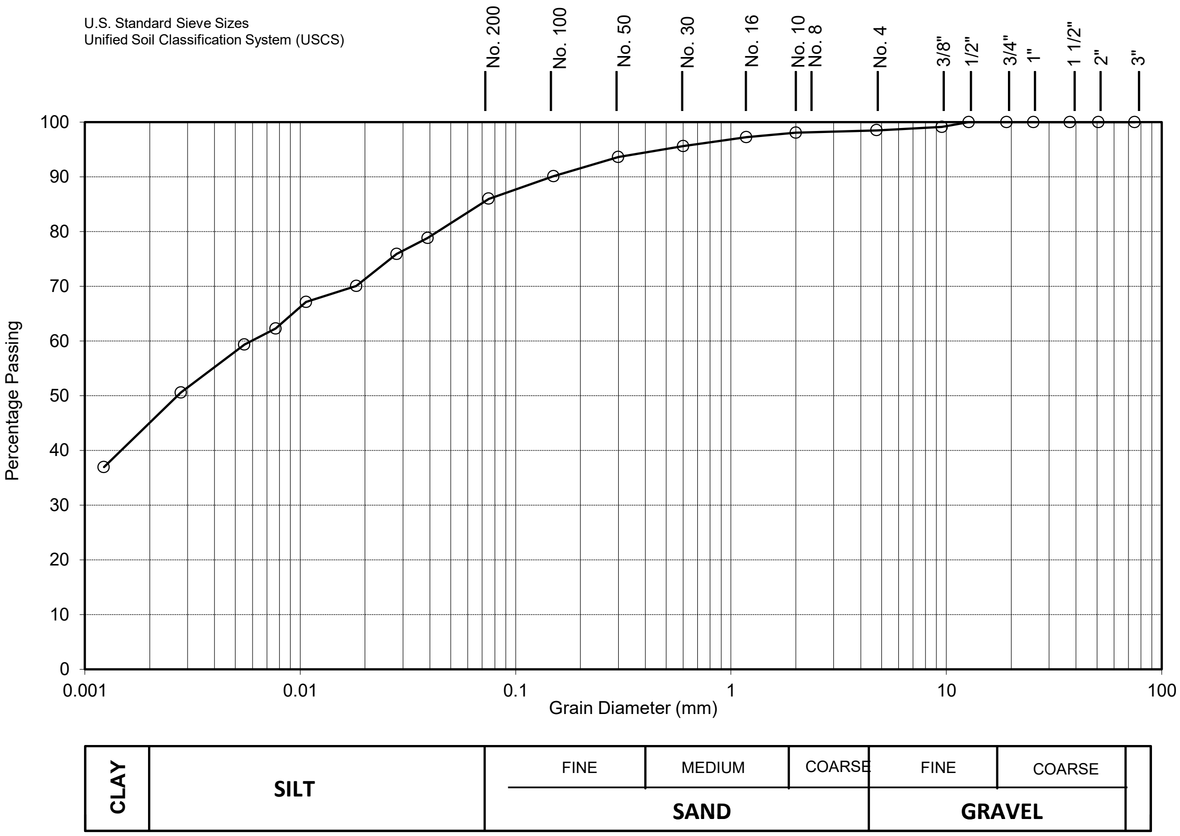
Estimated Infiltration Rate [mm/hr] :	**< 10**	Estimated Permeability, k [cm/s]	**10^{-7}**
Coefficient of Uniformity C_U:	**15.5**	Coefficient of Curvature C_C:	**0.4**

SOIL-MAT ENGINEERS & CONSULTANTS LTD.

1284 Main Street East, Hamilton ON

May 2022	**Grain Size Analysis No. 1**	**Project No.: SM 302519-T**

Mechanical & Hydrometer Analyses



Lab No.:	**22-197**
Borehole No.:	**8**
Sample No.:	**2**
CLAY [%]:	**46**
SILT [%]:	**40**
SAND [%]:	**13**
GRAVEL [%]:	**1**
D_{10} (Effective Diam. in mm):	**0.0004**

Notes: Depth: 5'

Soil Description: **Brown Clay and Silt w/ some Sand and a trace of Gravel**
M.L. - Inorganic silts and very fine sands to
C.L. - Inorganic clays of low to medium plasticity

Estimated Infiltration Rate [mm/hr] :	**< 10**	Estimated Permeability, k [cm/s]	**10^{-7}**
Coefficient of Uniformity C_U:	**14.8**	Coefficient of Curvature C_C:	**0.3**

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1284 Main Street East, Hamilton ON

May 2022 | **Grain Size Analysis No. 2** | **Project No.: SM 302519-T**