PROJECT NO.: 2019-94-G

November 21, 2019

Lally Homes Ltd.
4025 Dorchester Road
Niagara Falls, Ontario
L2E 7K8

Attention: Mr. John Lally

GEOTECHNICAL INVESTIGATION
PROPOSED HIGH RISE BUILDING
858 – 862 NIAGARA STREET, WELLAND, ONTARIO

Dear Mr. Lally,

We have completed the laboratory testing and report preparation in connection with the above noted project. Our comments and recommendations, based on our findings at the six borehole locations are presented in the following paragraphs.

1. INTRODUCTION

We understand that the proposed project will consist the construction of a six storey basementless building located at 858 – 862 Niagara Street, Welland, Ontario. The building will include ground level commercial space and five storeys of residential usage, together with surrounding landscaped spaces and concrete walkway and asphaltic concrete paved areas. The purpose of this geotechnical investigation work was to determine subsurface soils information at the six borehole locations and to provide comments and recommendations with respect to the design and construction of foundations, installation of underground municipal services and related earthworks for the proposed building, from a geotechnical point of view.

This report is based on the above summarised project, 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. The information contained in this report does not reflect upon the environmental aspects of the site and therefore have not been addressed in this document.

2. PROCEDURE

A total of six [6] sampled boreholes were advanced at the locations shown in the attached Drawing No. 1, Borehole Location Plan. The borings were put down using hollow stem auger equipment on October 9, 2019 under the direct supervision of a staff member of Hallex

Environmental Ltd. The boreholes were advanced to termination at depths between about 3.5 to 9.6 metres below the existing grade. Dynamic Cone testing was conducted in Borehole Nos. 1 and 4 from a depth of about 9.75 metres to a depth of about 13.4 metres. In addition, a groundwater monitoring well was installed in Borehole No. 2 to allow for long term monitoring of the groundwater level.

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 soils laboratory for visual, tactile, and olfactory classifications. Routine moisture content tests were performed on the geotechnical soil samples recovered from the borings.

The boreholes were located on site by a representative of Hallex Environmental Ltd. The elevation of the existing ground surface at the borehole locations was referenced to a temporary site benchmark, described as the top of the survey marker within the proposed parking area, by a representative of Hallex Environmental Ltd. For convenience the elevation of this benchmark was set at 100.00 metres.

Details of the conditions encountered in the boreholes, together with the results of the field and laboratory tests, are presented on the attached Borehole Logs Nos. 1 through 6, 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 located at 858 – 862 Niagara Street in Welland, Ontario. The subject property is bordered to the north by a hotel building property, to the west by Niagara Street, to the south by a Tim Horton's Store property and to the east by a mature treed area. The subject site is primarily grass covered with a number of mature trees. There are noted to be two driveway approaches off Niagara Street into the subject property. There are remnants of an asphaltic concrete driveway to a previous residential building in the southwest quadrant. A review of a 2010 aerial photograph from Google Earth appears to show a single family dwelling located immediately north of the existing Tim Horton's store. This building has been demolished at the time of the fieldwork. The site is relatively 'flat' with surface drainage directed to the eastern limit of the property.

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

Topsoil/Silty Sand

A surficial veneer of topsoil, approximately 20 to 150 millimetres, in thickness was encountered at the borehole locations. It should be noted that the depth of topsoil must be expected to vary across this area and from the depths encountered at the borehole locations. It should also be noted that the term 'topsoil' has been used from a geotechnical point of view and does not necessary reflect its nutrient content or ability to support plant growth. A thin layer of silty sand and silty sand and gravel fill was found to underlie the topsoil material.

Silty Clay Fill

A silty clay fill material was found to underlie the topsoil/silty sand veneer in Borehole Nos. 2 and 3. The fill material was found to contain some topsoil, rootlets, sand and building debris and some black staining. The fill material was generally found to be in a loose state. The depth of fill material may vary across the project site. The fill material encountered may be associated with previous site structures.

Silty Clay

A native silty clay was found to underlie the topsoil/silty sand veneer in Borehole Nos. 1, 4, 5 and 6 and the silty clay fill in Borehole Nos. 2 and 3. The silty clay was noted to have a weathered/reworked appearance in the upper level. The silty clay was found to be layered and to contain occasional grey/red mottling, occasional thin red vertical seams and clayey silt seams. Hand penetrometer testing conducted on select recovered cohesive soil samples measured unconfined compressive strengths generally greater than 4.5 kilograms per square centimetre [4.5 tons per square foot]. The silty clay was generally found to be very stiff to firm in consistency. Borehole Nos. 5 and 6 were terminated in the silty clay at depths of about 3.5 metres below grade.

Clayey Silt

A native clayey silt was found to underlie the silty clay in Borehole Nos. 1 to 4, inclusive. The clayey silt was noted to contain occasional thin grey vertical seams, occasional thin fine/sand and silty clay seams and to firm to soft in consistency. We note that the Standard Penetration test results indicated that the 'N' values obtained during split-spoon sampling, in the lower levels of the soil in these borings may have been influenced by soil disturbance ['suction' during removal of the auger flights]. The test results from the dynamic cone penetration tests, conducted in Borehole Nos. 1 and 4 from a depth of about 9.75 metres to a depth of about 13.4 metres, indicate that this soil disturbance may have occurred in the upper levels of the clayey silt. The sampled clayey silt was encountered to termination of Borehole Nos. 1 to 4, inclusive at a depth of about 9.60 metres.

Groundwater Observations

A groundwater monitoring well was installed in Borehole No. 2. The groundwater level was recorded at depths of about 3.88 and 3.83 metres on October 21 and 23, 2019, respectively. There was insufficient time to allow for the groundwater levels to stabilize in the open boreholes during the course of the fieldwork prior to backfilling. It is noted that the static groundwater level fluctuates based on seasonal conditions experienced, and may at times be slightly shallower than noted above during the 'wet' periods of the year [i.e. spring melt]. Nevertheless, some minor infiltration of groundwater through more permeable seams within the fill materials and from surface runoff should be anticipated during the excavation operations. Surface water should be directed away from the excavations.

4. FOUNDATION CONSIDERATIONS

The subsoil conditions encountered at the six borehole locations are such that the proposed six storey basementless building may be supported on conventional spread footings founded in the native silty clay immediately beneath any surficial weathered zones and the fill material identified in the borings. The foundations may be designed using a factored Ultimate Limit State [ULS] bearing capacity of 300 kPa [~6,000 psf]. The allowable bearing stress at Serviceability Limit State [SLS] should be limited to 200 kPa [~4,000 psf], based on the total and differential settlements not exceeding 25 and 20 millimetres, respectively.

However, the footings must be sized such that the SLS 'stress' increase at a depth of 4.5 metres below the existing grade is not greater than 100 kPa [~2,000 psf]. The 'stress' at any given depth may be calculated by assuming that the bearing pressure at the footing base level is 'spread' through the soil in the shape of a truncated pyramid, whose 'flat-top' has the dimensions of the footing in question, and the sides of the pyramid are sloped down and out at two vertical to one horizontal. The 'stress' at any given depth is then calculated by dividing the total load on the footing in question by the area of the base of the pyramid at the depth where the 'stress' is to be determined. We recommend that this office review the final foundation drawings and specifications prior to commencement of the tendering procedures.

Construction and foot traffic in and around the footing beds will tend to result in disturbance to the native founding soils and should therefore be kept to a minimum. It would be prudent to place a thin [50 millimetre] concrete 'mud-slab' immediately following foundation excavation, and evaluation, to minimise this type of disturbance to the founding soils. This would also serve to provide a 'clean' working surface for the placement of formwork and reinforcing steel. All footing beds should be hand-cleaned of any loose or disturbed material immediately prior to the placement of the 'mud-slab' or foundation concrete.

Alternatively, the proposed building may be supported on spread footings following a 'ground improvement' operation. The use of rammed aggregate piers will provide a cost-effective method for achieving a significant increase in the available design bearing pressures for conventional spread footings at a standard founding level. The design Serviceability Limit State [SLS] bearing capacity for this project could approach 300 to 400 kPa [~6,000 to 8,000 psf], based on total and differential settlements not exceeding 25 and 20 millimetres, respectively. This is a proprietary system installed by GeoSolv Design/Build Inc., contact Neil Isenegger [905-266-2599] for additional information and costing. In addition, the rammed aggregate piers may be designed to support 'working' uplift loads of 150 kN [~33 kips] or greater.

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. The above dissertation assumes a typical building. Evidently, the bearing capacity values would be lower for very settlement sensitive structures and larger for more flexible buildings.

All footings exposed to the environment must be provided with a minimum of 1.2 metres of earth cover or equivalent insulation to protect against frost 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.

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 –Stiff Soil, based on the average soil characteristics for the site. The conducting of site specific shear wave velocity testing may allow for the property to be classified as a Class C - Very Dense Soil and Soft Rock site.

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

$S_a[0.2]$	$S_a[0.5]$	$S_a[1.0]$	$S_a[2.0]$	PGA
0.340	0.180	0.068	0.022	0.200

6. EXCAVATIONS

Excavations for the installation of new foundations and site services are expected to extend to depths of up to about 4.0 metres below the existing grade into the upper fill and underlying native silty clay. Excavations into the upper fill and native soils should be relatively straightforward. Excavations into the fill materials should remain stable for the short construction period at slopes of up to one horizontal to one vertical. Where wet seams are encountered in the upper fill material, foundations areas of the demolished site structure or during periods of extended precipitation, side slopes of the fill material should be expected to 'slough' in to as flat as 3 horizontal to 1 vertical. Side slopes in the native silty clay are expected to remain stable for the short construction period at 60 degrees to the horizontal or steeper. Notwithstanding the above, all excavations must comply with the current Occupational Health and Safety Act and Regulations for Construction Projects. We note that the rate of excavation may be slowed should remnants of the demolished site building[s] be encountered by the contractor, such as, foundations, floor slabs, services, etc.

Some groundwater must be expected into the excavations from more permeable seams in the fill material and native soils. Nevertheless, it should be possible to adequately control any water that may enter the open excavations using conventional construction 'dewatering' techniques, such as pumping from sumps and ditches. More water infiltration should be anticipated when connections are made to existing services. Surface water should be directed away from the excavations.

With a firm and stable base standard pipe bedding, as typically specified by the Ontario Provincial Standard Specifications [or the Town of Welland] should suffice. Additional pipe bedding or stabilisation with a ballast material may be required should construction be undertaken during 'wet' periods of the year. The bedding material should be uniformly compacted to 95 percent standard Proctor density. Special attention should be paid to compaction under the pipe haunches.

7. GROUND FLOOR SLABS

The ground floor slab may be constructed using conventional slab-on-grade techniques on a prepared subgrade. The surficial veneer of topsoil should be removed and the exposed subgrade surface should then be well compacted in the presence of a representative of Bendigo Consulting Inc. Any soft 'spots' delineated during this work must be sub-excavated and replaced with quality backfill material compacted to 100 percent of its standard Proctor maximum dry density. Some subexcavation should be expected in the area of the demolished site building[s]. Imported granular fill is preferred due to its relative insensitivity to weather conditions, its relative 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, amount of steel and/or fibre reinforcement and/or wire mesh placed into the concrete slab, if any, will there 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 a minimum of 1/3 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 percent passing the No. 4 sieve.

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 also 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.

Areas where the interior floor slab elevation is less than 300 millimetres above the final exterior grade should be provided with a permanent perimeter drainage system to prevent the buildup of water under the slab-on-grade and against the foundation walls. As a minimum it is recommended that the perimeter weeping tile consist of a 100 millimetres diameter perforated pipe with a geofabric 'sock', surrounded with 200 millimetres of 20 millimetre clear stone, with the stone in turn encased by a heavy geotextile filter fabric. The suppliers of the geotextile filter fabric should be consulted as to the type best suited for this project. The perimeter drainage system should outlet to a gravity storm sewer connection, fitted with a suitable back-flow prevention valve.

This office should examine the installation of the perimeter 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 exterior grade around the structure should be sloped away from the structure to prevent the ponding of water against the foundation walls.

9. BACKFILL CONSIDERATIONS

The majority of the excavated soil will consist of the upper fill material and the native cohesive soils, as encountered in the boreholes and described above. Select portions of the fill material may be use for backfilling purposes, however, this is best assessed in the field at the time of construction. Unsuitable excavated material should be used in non-settlement sensitive areas, such as landscaping areas. The native soil is generally considered suitable for use as service trench backfill and engineered fill, provided their moisture conditions are within 3 percent of their standard Proctor optimum moisture contents. The soils encountered in the boreholes are generally considered to be near their optimum moisture content. However, some moisture conditioning may be required depending upon the weather conditions at the time of construction.

The fine grained site soils are sensitive to moisture and will become difficult to compact when they become 'wet'. Any 'wet' soils should be spread out and allowed to air-dry until considered suitable for compaction, or discarded. The on-site soils are considered to be frost susceptible and have the potential to 'heave' as a result of freezing. The on-site soils are not generally considered to be free-draining, and should not be used where this characteristic is required.

It is noted that the use of a free draining granular fill material, such as an Ontario Provincial Standard Specification [OPSS] Granular 'B' product, is generally preferred for use a backfill against foundation walls. Such materials are more readily compacted in restricted access areas, are less sensitive to moisture conditions and generally provide more positive support to interior floor and exterior concrete slabs and pavements.

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. It is therefore very important that the placement moisture content of the backfill soils be within 3 percent of its standard Proctor optimum moisture content during placement and compaction to minimise long term subsidence [settlement] of the fill mass. Any imported fill should have its moisture content within 3 percent of its optimum moisture content and meet the necessary environmental guidelines. We would recommend that all subexcavated areas of the site remediation work be backfilled with a well graded granular product compacted to 100 percent of its standard Proctor density.

The backfilling and compaction operations should be monitored by a representative of Bendigo Consulting Inc. to monitor uniform compaction of the backfill material to project specification requirements. Service trench and foundation wall backfill should be compacted to a minimum of 98 percent of the material's standard Proctor density. The upper one metre should be compacted to 100 percent. The backfill should be placed in loose lifts not exceeding 300 millimetres, and should be compacted with sufficient compaction equipment. Close supervision is prudent in areas that are not readily accessible to compaction equipment, for instance near the end of compaction 'runs'. A method should be developed to assess compaction efficiency employing the on-site compaction equipment and backfill materials during construction.

10. PAVEMENT STRUCTURE DESIGN CONSIDERATIONS

All areas to be paved should be proofrolled with 3 to 4 passes of a loaded tandem truck, following removal of the topsoil, in the presence of a representative of Bendigo Consulting Inc., immediately prior to the placement of the sub-base material. Any areas of distress revealed by this or other means should be sub-excavated and replaced with suitable backfill material. 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.

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.

The suggested pavement structures outlined in Table A [following page] 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 A
SUGGESTED PAVEMENT STRUCTURE

LAYER DESCRIPTION	COMPACTION REQUIREMENTS	LIGHT DUTY SECTIONS	HEAVY DUTY [TRUCK ROUTE]
Asphaltic Concrete Wearing course OPSS HL 3 or HL 3A	97 percent Marshall	65 millimetres	40 millimetres
Binder Course OPSS HL 8	97 percent Marshall		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

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

Depending on the arrangement of light duty and heavy duty pavement sections, the transition between sections may present some difficulty for contractors. In this regard, consideration might be given to a slightly increased light duty pavement structure consisting of 50 millimetres of HL8 binder course and 40 millimetres of HL3 surface course asphaltic concrete. This structure will provide for a continuous depth of surface course asphalt allowing for ease of construction. As well such a structure would have an improved performance over an increased design life. Such an arrangement of asphalt layers would also allow for future rehabilitation with a 'mill and pave' type operation.

11. GENERAL COMMENTS

The comments provided in this document are intended only for the guidance of the design team. The subsoil descriptions and borehole information are only intended to describe conditions at the six borehole locations. Contractors placing bids or undertaking this project should carry out due diligence in order to verify the results of this investigation and to determine how the subsurface conditions will affect their operations.

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

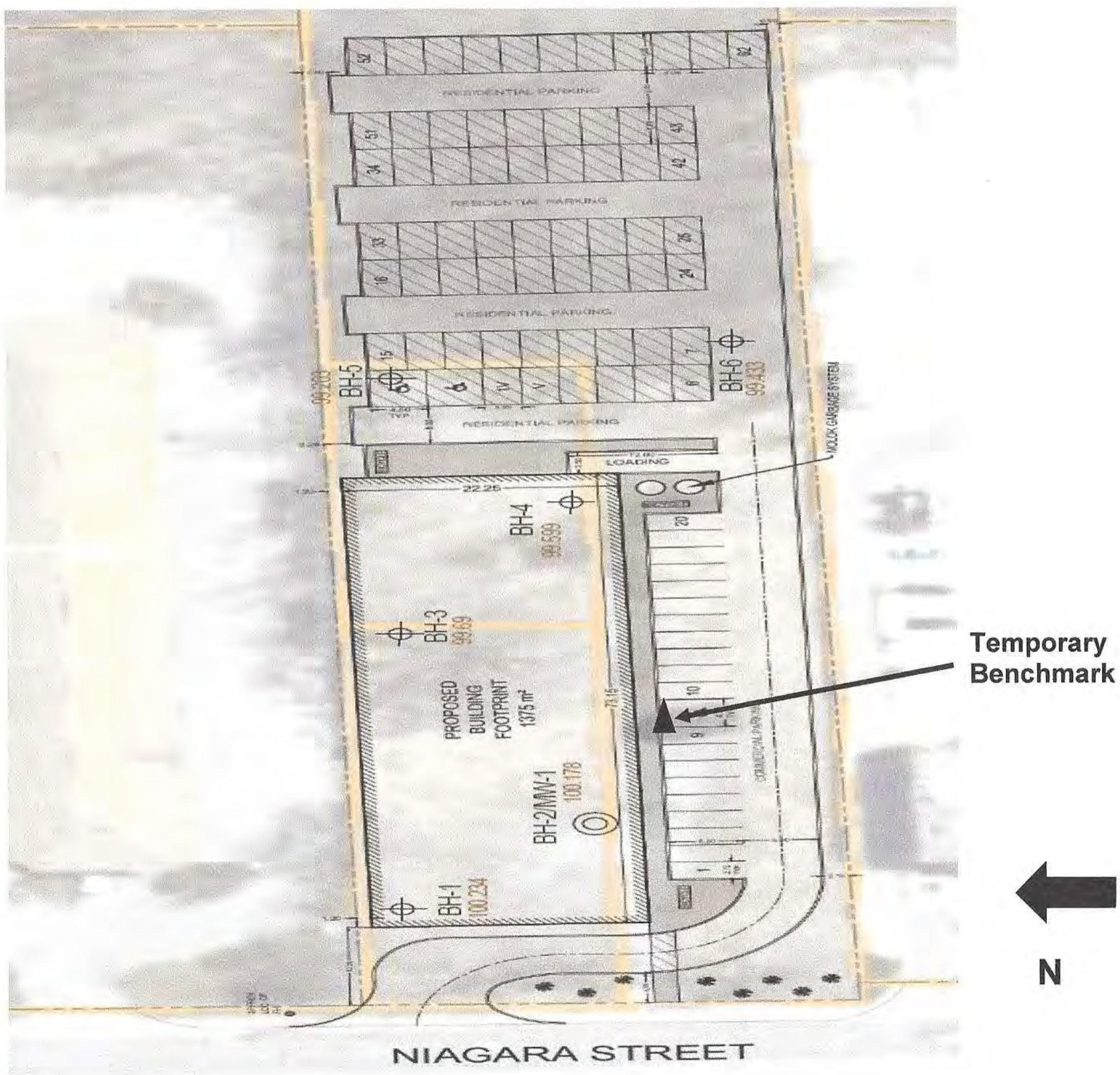
Yours very truly,
BENDIGO CONSULTING INC.

John Monkman, P. Eng.
Project Engineer

LICENSED PROFESSIONAL ENGINEER
Nov 22/19
J. D. MONKMAN
PROVINCE OF ONTARIO

Enclosures: Drawing No.1, Borehole Location Plan
Borehole Log Nos. 1 to 6, inclusive

Distribution: Lally Homes Ltd. [1 bound copy and one pdf copy]
Hallex Environmental Ltd. [one pdf copy]



LEGEND

- Borehole
- Temporary Benchmark

NOTES:

1. This report must be read in conjunction with Bendigo Consulting Inc. Report No.: 2019-94-G.
2. Soil samples will be discarded after three months unless directed otherwise by client.
3. Borehole locations were referenced to temporary benchmark described as the top of survey marker [assigned Elevation 100.0 m].

4. Image obtained from Hallex Environmental Ltd..

Bendigo Consulting Inc.

Client
Lally Homes Ltd.

Project Description
Geotechnical Investigation
Proposed High Rise Building
858 - 862 Niagara Street, Welland, Ontario

Borehole Location Plan

Project No.: 2018-94-G

Scale: NTS

Date: November 2019

Drawing No. 1

Log of Borehole No. 1

Date Drilled: October 9, 2019
Drill Method: Hollow Stem Auger
Drilling Company: Landshark Drilling Inc.
Hole Size: 150mm
Hammer Type: Mechanical

Project: Proposed High Rise Building
Location: 858-862 Niagara Street
City: Welland
Datum: Temporary

Project No.: 2019-94-G
Client: Lally Homes Ltd.

Elev. [m]	Sample Type	Number	Blows/0.15 m	Blows/300 mm	Recovery	Description	Moisture Content %	SPT (N)	Pocket Penetrometer kPa
100.23						Ground Surface			
99.78	SS	1	1,3,3	6	20	Topsoil, about 50 millimetres in thickness overlying compact silty sand.	15.8	6	
	SS	2	6,8,12	18	50	Silty Clay - Greyish brown to reddish brown, grey mottling in upper level, trace of rootlets and fine gravel, layered, occasional thin grey vertical seams, occasional thin fine sand/silt seams in lower level, very stiff to stiff	18.9	18	>450
	SS	3	7,11,13	24	85		20.2	24	>450
	SS	4	6,9,12	21	80		19.6	21	>450
	SS	5	3,4,5	9	88		26.1	9	400
95.73	SS	6	1,1,2	3	12	Clayey Silt - Greyish Brown to grey, occasional grey vertical seams and fine sand/silt and silty clay seams, soft.	21.7	3	
	SS	7	1,0,1	1	100		25.8	1	
	SS	8	2,1,2	3	100		29.5	3	
90.63	SS	9	1,0,1	1	100		23.7	1	
						End of Borehole			

Dynamic Cone driven from about 9.75 to 13.4 metres [blows per 0.3 metres]: 3,3,14,16,15,11,10,10,10,16,19,24 and 30

Notes:
1. Borehole advanced using hollow stem auger equipment on October 9, 2019 to termination at depth of about 9.6 metres. Dynamic cone driven from about 9.75 to 13.4 metres.
2. Borehole backfilled on completion.
3. Soil samples will be discarded after three months unless directed otherwise by client.

Note: This borehole log has been prepared for geotechnical purposes and does not necessarily contain information suitable for an environmental assessment of the subsurface conditions.

Bendigo Consulting Inc.
666 Ardleigh Crescent
Burlington, Ontario
L7L 4K8
www.bendigo.ca

Log of Borehole No. 2

Date Drilled: October 9, 2019
Drill Method: Hollow Stem Auger
Drilling Company: Landshark Drilling Inc.
Hole Size: 150mm
Hammer Type: Mechanical

Project: Proposed High Rise Building

Location: 858-862 Niagara Street
City: Welland
Datum: Temporary

Project No.: 2019-94-G

Client: Lally Homes Ltd.

Depth (m)	Elev. [m]	Sample Type	Number	Blows/0.15 m	Blows/300 mm	Recovery	DESCRIPTION	Moisture Content %	SPT (N)	Pocket Penetrometer kPa
0	100.18						Ground Surface			
	99.58	SS	1	6,7,5	12	66	Topsoil, about 30 millimetres in thickness overlying compact silty sand and gravel fill.	6.9	12	
1	98.58	SS	2	2,3,6	9	33	Silty Clay Fill - Brown, loose.	25.1	9	
2		SS	3	4,5,8	13	66	Silty Clay - Reddish brown, grey/red mottling in upper level, layered, occasional clayey silt seams, occasional thin red vertical seams, trace of rootlets, sand and fine gravel, very stiff to stiff	22.6	13	>450
										>450
		SS	4	5,7,8	15	66		22.7	15	
3		SS	5	4,4,4	8	66		22.6	8	>450
4		SS	6	2,3,6	9	88		25.5	9	
5	95.18									Vane 100
		SS	7	4,3,4	7	100	Clayey Silt - Greyish Brown to grey, occasional grey vertical seams, occasional thin fine sand/silt and silty clay seams, firm to soft.	17.4	7	
6		SS	8	2,2,2	4	100		24.1	4	
8		SS	9	1,0,1	1	100		33.1	1	
9	90.58	SS	10	1,0,2	2	100		26.0	2	
							End of Borehole			

Well Installation: Stickup Casing; Bentonite; #3 Silca Sand; 50 mm Riser; 50 mm Slot 10 Screen

Notes:
1. Borehole advanced using hollow stem auger equipment on October 9, 2019 to termination at depth of about 9.6 metres.
2. Groundwater monitoring well installed on completion. Groundwater level recorded at depth of about 3.88 and 3.83 metres on October 21 and 23, 2019, respectively.
3. Soil samples will be discarded after three months unless directed otherwise by client.

Note: This borehole log has been prepared for geotechnical purposes and does not necessarily contain information suitable for an environmental assessment of the subsurface conditions.

Bendigo Consulting Inc.
666 Ardleigh Crescent
Burlington, Ontario
L7L 4K8
www.bendigo.ca

Log of Borehole No. 3

Date Drilled: October 9, 2019
Drill Method: Hollow Stem Auger
Drilling Company: Landshark Drilling Inc.
Hole Size: 150mm
Hammer Type: Mechanical

Project: Proposed High Rise Building

Location: 858-862 Niagara Street
City: Welland
Datum: Temporary

Project No.: 2019-94-G

Client: Lally Homes Ltd.

Elev. [m]	Sample Type	Number	Blows/0.15 m	Blows/300 mm	Recovery	DESCRIPTION	Moisture Content %	SPT (N)	Pocket Penetrometer kPa	Well Installation
99.69						Ground Surface				
99.24	SS	1	1,2,3	5	78	Topsoil, about 40 millimetres in thickness overlying compact silty sand.	19.2	5		
	AS	2	2,2,2	4	0	Clayey Silt Fill - Black staining, some topsoil, organic inclusions, rootlets, sand and building debris, loose	23.0	4		
	SS	3	1,2,3	5	44		>50.0	5		
97.39	SS	4	1,2,5	7	66	Silty Clay - Greyish brown to reddish brown, grey mottling and weathered in upper level, trace of rootlets, sand and fine gravel, layered, very stiff to stiff	24.5	7	400	
	SS	5	4,5,7	12	75		23.2	12	425	
95.19	SS	6	1,2,2	4	100	Clayey Silt - Greyish Brown to grey, occasional grey vertical seams, occasional thin fine sand/silt and silty clay seams, firm to soft.	31.2	4		
	SS	7	1,1,2	3	100		26.8	3		
	SS	8	1,0,2	2	100		26.1	2		
90.09	SS	9	1,2,2	4	100		24.1	4		
						End of Borehole				

Depth (m): 0 to 11

Notes:
1. Borehole advanced using hollow stem auger equipment on October 9, 2019 to termination at depth of about 9.6 metres.
2. Borehole backfilled on completion.
3. Soil samples will be discarded after three months unless directed otherwise by client.

Note: This borehole log has been prepared for geotechnical purposes and does not necessarily contain information suitable for an environmental assessment of the subsurface conditions.

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Burlington, Ontario
L7L 4K8
www.bendigo.ca

Log of Borehole No. 4

Date Drilled: October 9, 2019
Drill Method: Hollow Stem Auger
Drilling Company: Landshark Drilling Inc.
Hole Size: 150mm
Hammer Type: Mechanical

Project: Proposed High Rise Building
Location: 858-862 Niagara Street
City: Welland
Datum: Temporary

Project No.: 2019-94-G
Client: Lally Homes Ltd.

Elev. [m]	Sample Type	Number	Blows/0.15 m	Blows/300 mm	Recovery	Moisture Content %	SPT (N)	Pocket Penetrometer kPa
99.60								
99.15	SS	1	6,4,3	7	47	7.1	7	
	SS	2	2,3,3	6	58	21.9	6	>450
	SS	3	4,4,6	10	67	20.2	10	>450
								>450
	SS	4	5,6,10	16	90	18.5	16	
	SS	5	3,4,6	10	90	21.3	10	450
95.10								
	SS	6	1,2,3	5	100	25.6	5	
	SS	7	2,1,2	3	100	26.1	3	
	SS	8	1,1,2	3	100	25.1	3	
90.00	SS	9	1,1,1	2	100		2	

DESCRIPTION

Ground Surface

Topsoil, about 150 millimetres in thickness overlying compact silty sand.

Silty Clay - Greyish brown to reddish brown, grey/reddish brown mottling in upper level, layered, trace of rootlets in upper level, sand and fine gravel, layered, occasional thin grey vertical seams, very stiff to stiff

Clayey Silt - Greyish Brown to grey, occasional grey vertical seams, occasional thin fine sand/silt and silty clay seams, firm to soft.

Dynamic Cone driven from about 9.75 to 13.4 metres [blows per 0.3 metres]: 1,6,4,4,5,5,6,10,15,22,32,34 and 42

Notes:
1. Borehole advanced using hollow stem auger equipment on October 9, 2019 to termination at depth of about 9.6 metres. Dynamic cone driven from about 9.75 to 13.4 metres.
2. Borehole backfilled on completion.
3. Soil samples will be discarded after three months unless directed otherwise by client.

End of Borehole

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Log of Borehole No. 5

Date Drilled: October 9, 2019
Drill Method: Hollow Stem Auger
Drilling Company: Landshark Drilling Inc.
Hole Size: 150mm
Hammer Type: Mechanical

Project: Proposed High Rise Building
Location: 858-862 Niagara Street
City: Welland
Datum: Temporary

Project No.: 2019-94-G
Client: Lally Homes Ltd.

Depth (m)	Elev. [m]	Sample Type	Number	Blows/0.15 m	Blows/300 mm	Recovery	Description	Moisture Content %	SPT (N)	Pocket Penetrometer kPa
0	99.20						Ground Surface			
		SS	1	1,3,3	6	61	Sod over Topsoil, about 60 millimetres in thickness	26.4	6	
1		SS	2	6,8,12	20	61	Silty Clay - Greyish brown to reddish brown, weathered in upper level, grey/reddish brown mottling in upper level, layered, trace of rootlets and organic staining in upper level and fine gravel, occasional thin grey vertical seams and clayey silt seams in lower level, stiff to very stiff	20.4	20	>450
		SS	3	7,11,13	24	72		18.2	24	>450
2										425
		SS	4	6,9,12	21	97		27.6	21	
3	95.69	SS	5	2,3,2	5	90			5	
3.5							End of Borehole			

Notes:
1. Borehole advanced using hollow stem auger equipment on October 9, 2019 to termination at depth of about 3.5 metres.
2. Borehole backfilled on completion.
3. Soil samples will be discarded after three months unless directed otherwise by client.

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Log of Borehole No. 6

Date Drilled: October 9, 2019
Drill Method: Hollow Stem Auger
Drilling Company: Landshark Drilling Inc.
Hole Size: 150mm
Hammer Type: Mechanical

Project: Proposed High Rise Building
Location: 858-862 Niagara Street
City: Welland
Datum: Temporary

Project No.: 2019-94-G
Client: Lally Homes Ltd.

Depth (m)	Elev. [m]	Sample Type	Number	Blows/0.15 m	Blows/300 mm	Recovery	DESCRIPTION	Moisture Content %	SPT (N)	Pocket Penetrometer kPa
0	99.43						Ground Surface			
		SS	1	1,2,2	4	44	Topsoil, about 20 millimetres in thickness over 30 millimetres of gravel fill	27.0	4	
1		SS	2	3,6,8	14	69	Silty Clay - Greyish brown to reddish brown, grey/reddish brown mottling in upper level, layered, trace of sand and fine gravel, occasional thin grey vertical seams and clayey silt seams in lower level, stiff to firm	20.9	14	>450
		SS	3	3,7,7	14	72		23.1	14	>450
2										400
		SS	4	3,4,5	9	92		20.8	9	
3	95.92	SS	5	1,2,2	4	100		27.5	4	
							End of Borehole			

Notes:
1. Borehole advanced using hollow stem auger equipment on October 9, 2019 to termination at depth of about 3.5 metres.
2. Borehole backfilled on completion.
3. Soil samples will be discarded after three months unless directed otherwise by client.

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