Geotechnical Investigation – Proposed Mixed Use Facility – PIDs 41454133 and 41454125 Upper Tantallon, Nova Scotia

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Project Name:
Proposed Residential and Commercial Use Building, 5249 St. Margarets Bay Road, Upper Tantallon, Nova Scotia

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Roach Engineering Inc

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1 Introduction

Roach Engineering Inc. was retained by 44852054 Nova Scotia Ltd. to carry out a geotechnical investigation for the proposed new mixed-use facility on PIDs 41454133 and 41454125 Upper Tantallon, Nova Scotia. We understand the proposed development will consist of a wood and concrete structure utilizing a concrete slab on grade.

The investigation was carried out to determine the sub-surface conditions at the site and to provide geotechnical information and preliminary design parameters for the proposed building. Geotechnical recommendations are provided based on available information and our current understanding of the proposed development.

2 Site Description

The subject site is located at 5249 St. Margarets Bay Road, Upper Tantallon, Nova Scotia. The footprint of the proposed warehouse building will be approximately 18000 square feet and consists of a three-storey facility with commercial on the lower level followed by residential on the upper two levels.

The exterior area will be a mix of landscaping plus light and heavy-duty pavement areas for light duty and commercial truck traffic.

3 Fieldwork

The fieldwork for the geotechnical investigation consisted of advancing seven (9) Test Pits (TP-1 to TP9), with depths extending from 1.5 to 2.1 meters below existing ground surface (BGS). The investigation was carried out using a Sany 14-ton Excavator, supplied by the owner. The investigation for the proposed structure took place on July 24, 2024.

The test pit investigation was conducted in the presence of Roach Engineering staff, who logged the sub-surface stratigraphy and collected representative soil samples.

3.1 Investigation Methodology

The current property owner was responsible for service clearances to confirm that underground utilities were not present at the test pit locations. Third parties should make their own inquiries with local authorities to confirm the presence or absence of utilities on the site.

The proposed locations of the test pits were determined by Roach Engineering in conjunction with site staff members to optimize the best potential location for the new structure.

The locations and elevation of the ground surface at the test pit locations was determined by a Hi-Target GPS survey instrument.

The test pits were advanced until competent natural material was encountered, or the test pit became too unstable to continue. Representative soil samples were obtained from the spoil pile during advancement of each test pit. A preliminary assessment of particle size, density, moisture and colour was visually assessed and recorded for each soil sample in the field.

The general site arrangement and location of the test pits are shown in Figure 10, attached. The location of the proposed structure is also shown in Figure 10.

3.2 Sample Storage and Lab Testing

Soil samples were reviewed in the laboratory by a Roach engineering staff member to confirm soil boundaries and descriptions. Representative samples were selected for laboratory analysis. The following tests were carried out:

- Moisture Content tests were conducted on 5 soil samples.
- Sieve analysis tests were conducted on 5 soil samples to classify the soil strata.

The results of all geotechnical laboratory tests are summarized in Table 1 below.

				Atterberg Limits			Sieve Analysis		
Soil Deposit	Borehole/Sample	Depth (m)	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Gravel (%)	Sand (%)	Fines (%)
Till	TP 1 Sa 1	0.9	7.2				49	39	12
Till	TP 2 Sa 1	1.4	7.8				53	34	13
Till	TP 5 Sa 1	1.9	8.2				39	47	14
Fill	TP 6 Sa 1	1.1	9.5				39	46	15
Fill	TP 7 Sa 1	1	12.6				56	33	11

Table 1 - Summary of Laboratory Test Results

4 Surface and Sub-Surface Conditions

4.1 Summary of Conditions

The general stratigraphy encountered on the site included the following:

- Fill
- Glacial Till

In general, the site is underlain by fill overlying glacial till. Native glacial till was encountered in all test pits below the surficial fill. The fill in all the test pits consisted of a thin layer of root mat and topsoil followed by light grey silty sand and gravel with cobbles and boulders. The natural light reddish brown silty sand and gravel with cobbles and boulder till immediately followed the fill zone.

A summary of the thickness of the various strata encountered during the investigations is provided below in Table 2. Summary descriptions of the various strata are given below in subsequent paragraphs.

It should also be noted that the soil stratigraphy detailed in the descriptions of sub-surface conditions is only valid at the location where the boreholes were conducted. Soil and bedrock stratigraphy can be expected to vary between test pit locations.

Item	Thickness of Rootmat and Topsoil (m)	Thickness of Loose Fills (m)	Depth to Glacial Till (m)	Total Depth of Test Pit (m)
TP 1	0.3	0.5	0.8	1.4
TP 2	0.2	1	1.2	1.5
TP 3	0.2	0.7	0.9	1.5
TP 4	0.2	1.5	1.7	1.8
TP 5	0.3	1.6	1.9	2.1
TP 6	0.2	1.2	1.4	1.8
TP 7	0.2	0.9	1.1	1.8
TP 8	0.3	0.8	1.1	1.5
TP 9	0.2	1.5	1.7	1.8

Table 2 - Summary of Sub-Surface Stratigraphy

4.2 Fill

Fill was encountered in all nine test pits excavated. The depth of the fill zones ranged from 0.8 to 1.9 meters. Under the Unified Soil Classification System (USCS), the fill would be classified as a silty sand and gravel with cobbles and boulders and was in a loose state in all test pits. The moisture contents from samples of the fill were 9.5 and 12.6 percent.

4.3 Glacial Till

Native glacial till was encountered at all test pits locations. Under the Unified Soil Classification System (USCS), the glacial till was classified as Sand and Gravel with silt. Some cobbles and boulders, ranging from 0.2 m to 0.5 m diameter, were encountered in the glacial till. The glacial till was generally light brown to brown in colour. Moisture contents from samples of glacial till varied from approximately 7.2 to 8.2%.

4.4 Groundwater

Groundwater seepage was not encountered in any of the test pits. It should be noted that groundwater conditions vary seasonally and in response to recent precipitation events. The test pits conducted during this investigation represent a limited sampling of the site.

5 Discussion and Recommendations

The following are geotechnical recommendations for the design and construction of the proposed multiuse facility. It is understood that the new building will consist of a wooden and concrete structure with standard frost wall with slab on grade. At this point the finished grade of the new structure is unknown. The following are general recommendations for earthworks construction.

5.1 General Recommendations

5.1.1 Site Preparation

Where encountered, all vegetation, and existing fill should be stripped and removed from within the footprint of the building area and a distance out from the proposed footing an equal distance of depth of bottom of the footing to natural Till plus 600 mm. I.E. if 1.0 meters of structural fill is required under the exterior footing the distance out from the footing for structural fill should be 1.6 meters. After excavation to design subgrade elevations, the exposed surface should be compacted and proof rolled prior to the placement of any backfill or piping. This work should be done in the presence of a qualified geotechnical inspector.

Any local soft or wet areas that exhibit excessive displacement during proof-rolling will require over-excavation and replacement with approved fill to achieve a competent base structural fill. The excavations should be advanced to the depths directed by the geotechnical inspector and backfilled in compacted lifts with approved fill to the satisfaction of the geotechnical inspector.

Although groundwater was not encountered, the use of coarse rock fill or Clear Stone with a separator fabric may be required in any areas if large quantities of groundwater are encountered to effectively replace the over-excavated areas. This type of fill would be helpful in providing a competent base for subsequent backfilling and compaction, where fills may be placed below water and large lift thicknesses are required before compaction can be done above groundwater levels.

5.1.2 Excavation Considerations

Trenches and excavations should be excavated in accordance with the requirements of the Nova Scotia Occupational Health and Safety Division. Excavations in soils extending to a depth greater than 1.2 m should be sloped at a maximum grade of 1 H:1 V. Deep excavations, or those that encounter sandy soils or groundwater, will require flatter slopes for stability, or the use of trench boxes or an engineered shoring system.

5.1.3 Re-Use of Existing Soils

The majority of the existing fill appeared to be reuseable for structural fill placement to bring elevations up to grade to the underside of proposed footings. This information is provided as general information only and it should be noted that these results are based on limited sample sizes attained in the current geotechnical investigation and are only representative of the materials sampled at the specified test pit locations. Third parties must make their own assessment of the potential re-use of existing site materials for new construction. If saturated or organic materials are encountered these materials would not be considered suitable for structural fill. All structural fill placement should be supervised under the guidance of qualified geotechnical personnel. Fill thickness placement should be based on the compaction equipment chosen by the contractor to achieve a minimum of 100 percent of standard Proctor density.

5.1.4 Erosion Prevention and Protection of Work

The soils that will be exposed during construction on this site may be erodible. Temporary erosion prevention measures and sedimentation control features should be included in construction, in accordance with NSDEL's "Erosion and Sedimentation Control Handbook For Construction Sites". Hydro-seeding, the installation of sod or other erosion control measures, should also be constructed on permanent excavated slopes and stripped non-traffic areas to combat soil erosion.

Constructed works should be sealed and sloped to prevent the infiltration of surface water. The grade of the completed ground surface on the site should be sloped such that surface water is diverted to surface water control features.

5.1.5 Groundwater Control

Typical dewatering methods including gravity drainage from interceptor/diversion trenches or pumping from sumps should be effective in typical shallow excavations. More aggressive dewatering systems may be needed for deep excavations, if required. Groundwater control plans should be developed prior to construction and should include measures to continuously control groundwater during construction. Dewatering plans should be submitted to the

Engineer as part of the submittal process prior to construction and reviewed to confirm their adequacy.

The ground surface around excavations should be sloped to divert surface water from flowing into excavations. Any soil softened from exposure to water or freezing should be over-excavated before the placement of any additional backfill or concrete.

Finished surface grades adjacent to foundations should be sloped away from the foundations at a 2% grade for a minimum length of 3 m. These areas should be capped with an impervious material, such as asphaltic concrete or impermeable soil.

It is important to note that groundwater levels vary seasonally, with location across a site and in response to recent precipitation events and other factors. Further, the requirements for groundwater control will be a function of the approach selected for construction.

5.2 Geotechnical Parameters for Design

We anticipate that the foundations will consist of slabs-on-grade, strip footings, column pads and spread footings. The following recommendations are provided on this basis. If different foundations are considered during design, we request the opportunity to review the alternative design and verify that any design assumptions we made are still valid.

5.2.1 Bearing Capacity and Foundation Design

Footings founded on structural fill built-up from the native glacial till or bedrock may be designed using a net geotechnical bearing reaction at Serviceability Limit States (SLS) of 150 kPa. Total and differential settlements of the structure are expected to be less than 25mm and 20mm respectively, at this level of applied bearing pressure. A factored net geotechnical bearing resistance at Ultimate Limit States (ULS) of 350 kPa may be used.

Excavation of existing fill shall extend beyond the edge of the footings at a minimum distance of 600 mm before sloping down at 1 H:1 V to suitable bearing soils (i.e. approved glacial till).

Perimeter footings should be founded at least 1.2 m below finished exterior grades for frost protection. Interior spread footings, if required, in heated structures should be founded at least 600 mm below slabs for confinement. Alternatively, foundation depths may be reduced if an insulation detail is incorporated in the design.

Should foundations extend below the anticipated groundwater elevation, foundation walls should be waterproofed, and a permanent drainage system should be considered in the foundation design. A permanent positive sub-drain system, or properly installed perimeter footing drain tiles along the exterior foundation walls, should be designed to maintain groundwater levels at least 300 mm below the underside of slabs.

5.2.2 Concrete Slab-on-Grade

Concrete slab-on-grade areas should be excavated down to the undisturbed glacial till or bedrock. If glacial till remains after excavation to design subgrade levels, maintaining the integrity of the existing glacial till subgrade soil throughout construction should be considered throughout the design and construction. Good surface drainage and minimal equipment traffic at load bearing elevations are required to prevent disturbance of these soils.

It is recommended that a minimum of 300 mm crushed rock be placed below concrete slabs. It is recommended that the crushed rock have a maximum particle size of 25 mm and meet NSTIR Type 1 Gravel specifications. The newly placed aggregate within the building footprint shall be compacted to 98% of the proctor value determined following ASTM D-698.

The slab-on-grade structure should be considered by the Structural Engineer to ensure that the slab performance will meet expectations, especially in settlement sensitive areas, if any and due to the use of forklift activity. This would include (but not limited to) slab thickness, thickness of aggregates, air or vapour barriers, and reinforcement types. The manufacturer of the proposed refrigeration unit should be consulted to give recommendations of vertical and horizontal distance of insulation under slab at and near the area of the freezer. The supplier should also recommend the thickness and type of this insulation.

5.2.3 Site Class for Seismic Response

We recommend that designers use a site class of C (very dense soil and soft rock) for seismic considerations, in accordance with Table 4.1.8.4.A (Site Classification for Seismic Site Response) in the 2015 National Building Code of Canada. Note that the site class is based on the investigation methods and assumed average conditions of the ground profile in the upper 30 m of the site.

5.2.4 Flexible Pavement Design

Asphalt paved parking and access areas are proposed for the development. It is expected that a mix of vehicle traffic ranging from light passenger to large trucks may be expected. Flexible pavement designs recommended for the site are as follows:

Item	Light Duty Pavement	Medium Duty Pavement
Asphalt Top Course - C Mix[1]	75mm	40mm
Asphalt Base Course - B Mix[1]	--	50mm
NSTIR Type 1 Gravel[2]	150mm	150mm
NSTIR Type 2 Gravel[2]	200mm	300mm

Table 3 – Flexible Pavement Design

[1] Minimum compaction (asphalt pavement) – 92% Theoretical Maximum Density (ASTM D2041)

[2] Minimum compaction (granular(s)) – 100% Standard Proctor Maximum Dry Density

The above design assumes a prepared subgrade levelled and compacted to 98 percent standard Proctor Maximum Dry Density. Grading of parking and access areas should ensure positive drainage away from active site areas. At or near the proposed structure, a minimum of 2 percent positive grade should be maintained.

5.3 General Recommendations

5.3.1 Structural Fill

Where required for development, structural fill should consist of well graded, sand and gravel with less than 12% fines (% passing the 0.080 mm sieve size). The particles comprising the fill should be durable and it should be free of organics, flat or elongated particles and all other deleterious materials. Examples of suitable structural fill for pavement and hardscape areas would be a ‘Type 1' or ‘Type 2' Gravel meeting NSTIR Standard Specifications. Structural fill for under footings and slab-on-grade should consist of a 150mm to 100 mm minus well graded, quarried material.

In wet areas or areas of locally perched groundwater, surge rock or clear stone could be considered for use as structural fill. This can be reviewed during construction.

5.3.2 Backfill Considerations

All backfill should be placed in lifts, not to exceed 300 mm in thickness, and compacted to the following percentage of the optimum dry density, determined by Standard Proctor test (ASTM D698).

Subgrade fill - 95%

Structural fill beneath hardscape elements (sidewalks, curb, asphalt etc.) – 98%

Structural fill beneath footings and slab-on-grade – proof roll coarse rock fill, gravel to 100%

Where possible, each lift of fill should be tested to confirm compaction prior to placing the next lift of fill. Thicker lifts may be used where it can be shown that adequate compactive effort is being achieved.

5.3.3 Winter Construction Considerations

Placing frozen fill or engineered fill on frozen subgrade is not recommended. If work is to be undertaken during freezing conditions, care should be taken to heat and/or insulate the fill prior to and after placement to keep it from freezing. Some typical measures include heated box trucks, insulated tarps, or bales of hay. Frozen subgrade soil and/or previously placed fill must be thawed or removed prior to placement of any engineered fill.

Where the footing elevation is within approved finer-grained materials, we recommend over-excavation by at least 150 mm and placement of clear stone or other clean gravel. This will reduce disturbance of the bearing surface. Foundations should be backfilled with a free-draining granular material and drainage provided to prevent adfreeze of foundations, particularly during construction. At temperatures below -5 degrees Celsius, clear stone gravel or clear rockfill is recommended.

Any service trenches should be opened for as short a time as practical and the excavations should be carried out only in lengths which allow the construction operations, including backfilling, to be fully completed in one working day.

Cast-in-place concrete should be protected during colder weather conditions as per CSA A23.1.

6 Closure

This report has been prepared to assist in the design and construction of the proposed multi use building at

5249 St. Margarets Bay Road, Upper Tantallon, Nova Scotia. If any uncommon details are included in the final design of the proposed structures, the geotechnical engineer should be consulted. Similarly, if conditions are different from those detailed on this report are noted during construction, the engineer should be notified to allow reassessment of any design assumptions, if necessary.

APPENDIX A – Supplemental Photos and Drawings

Figure 1 - Test Pit 1

Figure 2 - Test Pit 2

Figure 3 - Test Pit 3

Figure 4 - Test Pit 4

Figure 5 - Test Pit 5

Figure 6 - Test Pit 6

Figure 7 - Test Pit 7

Figure 8 - Test Pit 8

Figure 9 - Test Pit 9

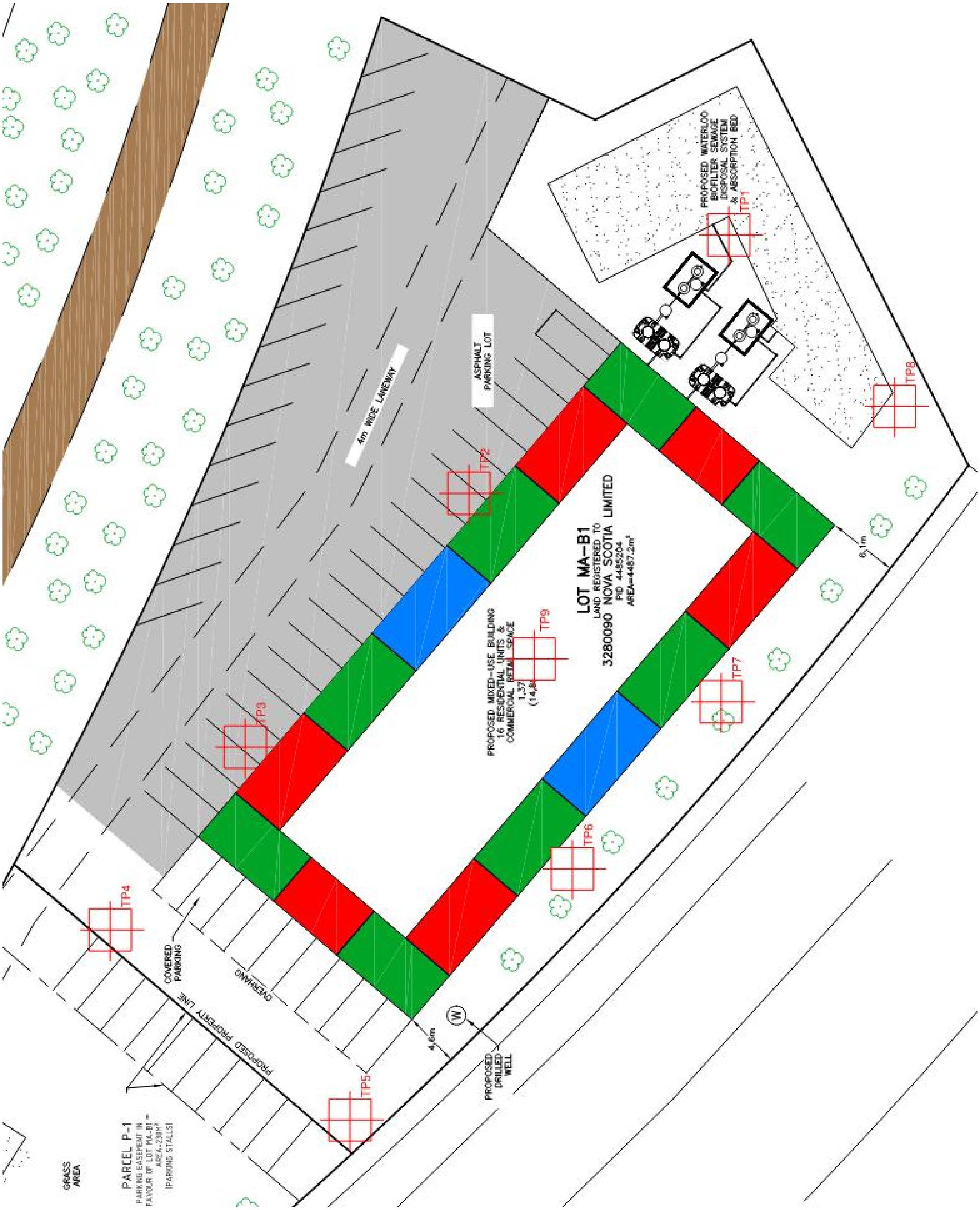

Figure 10 - Test Pit Layout

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