

Geotechnical
Engineering

Environmental
Engineering

Hydrogeology

Geological
Engineering

Materials Testing

Building Science

Noise and Vibration
Studies

Geotechnical Investigation

Proposed Industrial Redevelopment
135 Cardevco Road
Carp, Ontario

Prepared For

Premier Bus Lines Inc.

Paterson Group Inc.

Consulting Engineers
154 Colonnade Road South
Ottawa (Nepean), Ontario
Canada K2E 7S8

Tel: (613) 226-7381
Fax: (613) 226-6344
www.patersongroup.ca

November 30, 2021

Report: PG6018-1

Table of Contents

	PAGE
1.0 Introduction	1
2.0 Proposed Development.....	1
3.0 Method of Investigation	2
3.1 Field Investigation.....	2
3.2 Field Survey.....	3
3.3 Laboratory Review	3
3.4 Analytical Testing	3
4.0 Observations	4
4.1 Surface Conditions	4
4.2 Subsurface Profile	4
4.3 Groundwater.....	5
5.0 Discussion	6
5.1 Geotechnical Assessment.....	6
5.2 Site Grading and Preparation.....	6
5.3 Foundation Design.....	7
5.4 Design for Earthquakes.....	8
5.5 Slab on Grade Construction.....	8
5.6 Pavement Design	9
6.0 Design and Construction Precautions.....	10
6.1 Foundation Drainage and Backfill	10
6.2 Protection of Footings Against Frost Action.....	10
6.3 Excavation Side Slopes.....	11
6.4 Pipe Bedding and Backfill	11
6.5 Groundwater Control	12
6.6 Winter Construction.....	12
6.7 Corrosion Potential and Sulphate	13
7.0 Recommendations	14
8.0 Statement of Limitations.....	15

Appendices

- Appendix 1** Soil Profile and Test Data Sheets
 Symbols and Terms
 Analytical Testing Results
- Appendix 2** Figure 1 - Key Plan
 Drawing PG6018-1 - Test Hole Location Plan

1.0 Introduction

Paterson Group (Paterson) was commissioned by Premier Bus Lines Inc. to conduct a preliminary geotechnical investigation for the proposed industrial redevelopment, located at 135 Cardevco Rd. Carp, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the preliminary geotechnical investigation were to:

- Determine the subsoil and groundwater conditions at this site by means of test pits.
- Provide geotechnical recommendations pertaining to the design of the proposed development including construction considerations which may affect the design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as they are understood at the time of writing this report.

2.0 Proposed Development

Based on the available drawings, it is understood that the proposed redevelopment will consist of demolishing the southern portion of the existing slab-on-grade warehouse structure present at the subject site, and constructing a new smaller warehouse addition. It is further understood that the northern portion of the existing warehouse will remain. The rest of the site will remain as an asphalt covered parking.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the geotechnical investigation was conducted on November 12, 2021. At that time, a total of **five (5) test pits** were advanced to a maximum depth of 3.5 m below the existing ground surface. The test hole locations were selected by Paterson and distributed in a manner to provide general coverage of the subject site taking into consideration existing site features and underground utilities. Two test pits were excavated within the vicinity of the proposed southern warehouse addition. The remaining three test holes were excavated adjacent to the exterior footings of the northern portion of the existing warehouse, in order to confirm founding conditions and to allow for scanning foundation rebars. The locations of the boreholes are shown on Drawing PG6018-1 - Test Hole Location Plan included in Appendix 2.

All test pits were excavated using a backhoe. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer. The subsurface conditions observed in the test holes were recorded in detail in the field. The soil profiles are logged on the Soil Profile and Test Data sheets presented in Appendix 1 of this report.

Sampling and In Situ Testing

Grab samples were recovered from the excavated tests pits at the time of the investigation. The samples were classified on site, placed in sealed plastic bags, and transported to our laboratory. The depths at which the grab samples were recovered from the test pits are shown as G, on the Soil Profile and Test Data sheets in Appendix 1.

The subsurface conditions observed in the boreholes were recorded in detail in the field. The soil profiles are logged on the Soil Profile and Test Data sheets in Appendix 1 of this report.

Groundwater

Groundwater infiltration depths were observed in the excavated test pits at the time of the investigation. The groundwater infiltration depth observations are discussed in Section 4.3 and are presented in the Soil Profile and Test Data sheets in Appendix 1.

3.2 Field Survey

The test hole locations were selected by Paterson to provide general coverage of the proposed warehouse addition, taking into consideration the existing site features and underground utilities. The test hole locations and ground surface elevation at each test hole location were surveyed by Paterson personnel using a handheld GPS and referenced to a geodetic datum. The location of the test holes and ground surface elevation at each test hole location are presented on Drawing PG6018-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Review

Soil samples were recovered from the subject site and visually examined in our laboratory to review the results of the field logging. Soil samples will be stored for a period of one month after this report is completed, unless otherwise directed.

3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was submitted to determine the concentration of sulphate and chloride, the resistivity, and the pH of the samples. The results are presented in Appendix 1 and are discussed further in Section 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is currently occupied by an existing warehouse building with an asphalt and granular driveway and parking lot, and landscaped areas occupying the remainder of the site.

The subject site is bordered by commercial and/or industrial properties on all sides, and by Cardevco Road to the Northeast. The existing ground surface across the subject site is relatively flat with an approximate geodetic elevation of 118.5 m.

4.2 Subsurface Profile

Overburden

Generally, the subsurface profile at the test hole locations was observed to consist of asphalt or topsoil overlying a fill layer consisting of crushed stone and brown silty sand with gravel and occasional cobbles and trace asphalt. A 560 mm thickened edge slab, underlain by 100 mm thick rigid insulation layer was observed to extend from ground surface at the locations of TP 1-21, TP 2-21, and TP 3-21. 300 mm of crushed stone were encountered below the rigid insulation layer, within Test Pit TP 2-21. Compact to dense brown silty sand with some gravel and cobbles and occasional boulders was encountered underlying the rigid insulation or fill materials at all borehole locations except TP 5-21 where the crushed stone layer was found to be underlain by very dense glacial till. Refusal to excavation on very dense glacial till was encountered in TP 5-21 at a depth of 2.2 m below ground surface.

The test pits were terminated at depths between 1.6 m and 3.5 m below the existing ground surface. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for the details of the soil profile encountered at each test hole location.

Bedrock

Based on available geological mapping, the subject site is underlain by Paleozoic limestone of the Bobcaygeon Formation with an overburden thickness of 5 to 10 m.

4.3 Groundwater

Groundwater infiltration depths were observed during the current investigation on November 12, 2021 within the walls of the excavated test pits. The observed depth of infiltration are presented in Table 1 below:

Table 1 – Summary of Groundwater Infiltration Depths				
Test Hole Number	Ground Surface Elevation (m)	Observed Groundwater Infiltration Depth		Dated Observed
		Depth (m)	Elevation (m)	
TP 1-21	118.65	Dry	N/A	November 12, 2021
TP 2-21	118.66	Dry	N/A	
TP 3-21	118.55	Dry	N/A	
TP 4-21	118.77	2.00	116.77	
TP 5-21	118.31	1.90	116.41	
Note: The ground surface elevation at each borehole location was surveyed using a handheld GPS using a geodetic datum.				

Based on observation of groundwater infiltration depths, the long-term groundwater table is expected at a depth of 2 to 3m below ground surface. The recorded groundwater infiltration depths are noted on the applicable Soil Profile and Test Data sheet presented in Appendix 1.

However, it should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater levels could vary at the time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered suitable for the proposed warehouse addition. It is anticipated that the finish floor level for the proposed warehouse addition will be the same as the finish floor level for the existing northern warehouse portion to remain. As revealed from the excavated test pits TP 1-21, TP 2-21, and TP 3-21, it was determined that the northern portion of the warehouse to remain is founded on a concrete thickened edge slab.

The proposed warehouse addition can be founded on conventional shallow spread footings placed on undisturbed, compact to dense brown silty sand bearing surface.

Due to demolition of the existing warehouse, concrete removal is anticipated at the subject site.

Where the footing subgrade consists of silty sand which is observed to be in a loose state of compactness, the material should be proof compacted using suitable vibratory equipment making several passes under dry conditions and above freezing temperatures and which is approved by Paterson at the time of construction.

The above and other considerations are further discussed in the following sections.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and deleterious fill, such as those containing significant organic materials, should be stripped from under any buildings, paved areas, pipe bedding, and other settlement sensitive structures.

It should be noted that the existing fill layer, where noted to be free of significant amounts of deleterious and organic materials, can be left in place below parking areas and access lanes provided that a proof-rolling program is witnessed and approved by Paterson personnel at the time of construction. Any poor performing areas should be removed and reinstated with an approved granular fill.

Fill Placement

Fill used for grading beneath the proposed development should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the buildings and paved areas should be compacted to at least 98% of the material's standard Proctor maximum dry density (SPMDD), unless noted otherwise throughout this report.

Non-specified existing fill, along with site-excavated soil, can be used as general landscaping fill where settlement of the ground surface is of minor concern. This material should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If this material is to be used to build up the subgrade level for areas to be paved, it should be compacted in thin lifts to at least 95% of the material's SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless used in conjunction with a geocomposite drainage membrane, such as Miradrain G100N or Delta Drain 6000.

5.3 Foundation Design

Shallow Foundation

Footings placed directly on an undisturbed, compact to dense silty sand bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **125 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **200 kPa**. A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value at ULS.

An undisturbed soil bearing surface consists of a surface from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

Footings placed on a soil bearing surface and designed using the bearing resistance values at SLS given above will be subjected to potential post construction total and differential settlements of 25 and 20 mm, respectively.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a compact to dense silty sand bearing surface above the groundwater table when a plane extending horizontally and vertically from the underside of the footing at a minimum of 1.5H:1V passes only through in situ soil of the same or higher bearing capacity as the bearing medium soil.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class C** for the foundations considered at this site. Soils underlying the subject site are not susceptible to liquefactions. Reference should be made to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

5.5 Slab on Grade Construction

With the removal of all topsoil and deleterious fill within the footprint of the proposed warehouse, the native soil subgrade and or existing crushed stone fill, proof-rolled with a suitably sized vibratory roller making several passes under dry and above freezing conditions, reviewed and approved by Paterson personnel at the time of construction, will be considered an acceptable subgrade upon which to commence backfilling for floor slab construction.

It is recommended that the upper 200 mm of sub-floor fill consists of OPSS Granular A crushed stone. All backfill material within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of the materials SPMDD.

5.6 Pavement Design

Car only parking areas, access lanes and loading areas are anticipated at this site. The proposed pavement structures are shown in Tables 2 and 3.

Table 2 – Recommended Flexible Pavement Structure – Car Only Parking Areas	
Thickness (mm)	Material Description
50	Wear Course – HL-3 or Superpave 12.5 Asphaltic Concrete
150	BASE – OPSS Granular A Crushed Stone
300	SUBBASE – OPSS Granular B Type II
SUBGRADE – Either fill, in-situ soil, or OPSS Granular B Type I or II material placed over in-situ soil or fill.	

Table 3 – Recommended Flexible Pavement Structure – Access Lanes and Heavy Truck Parking and Loading Areas	
Thickness (mm)	Material Description
40	Wear Course – HL-3 or Superpave 12.5 Asphaltic Concrete
50	Wear Course – HL-8 or Superpave 19 Asphaltic Concrete
150	BASE – OPSS Granular A Crushed Stone
400	SUBBASE – OPSS Granular B Type II
SUBGRADE – Either fill, in-situ soil, or OPSS Granular B Type I or II material placed over in-situ soil or fill.	

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project. The pavement granulars (base and subbase) should be placed in maximum 300 mm thick lifts and compacted to a minimum of 100% of the material's SPMDD using suitable compaction equipment.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated to a competent layer and replaced with OPSS Granular B Type II material.

As a preliminary precaution, weak subgrade conditions may be experienced over service trench fill materials. This may require the use of a geotextile, such as Terrafix 200W or equivalent, thicker subbase or other measures that can be recommended at the time of construction as part of the field observation program.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

It is recommended that a perimeter foundation drainage system be provided for the proposed warehouse addition. The system should consist of a 150 mm diameter perforated corrugated plastic pipe wrapped in a geosock, surrounded on all sides by 150 mm of 10 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The clear stone should be wrapped in a non-woven geotextile. The pipe should have a positive outlet, such as a gravity connection to the storm sewer or sump pump pit.

Foundation Backfill

Backfill against the exterior sides of the foundation walls should consist of free-draining, non-frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls, unless used in conjunction with a drainage geocomposite, such as Delta Drain 6000, connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise be used for this purpose.

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effects of frost action. A minimum 1.5 m thick soil cover (or insulation equivalent) should be provided in this regard.

Other exterior unheated footings, such as those for isolated exterior piers and retaining walls, are more prone to deleterious movement associated with frost action. These should be provided with a minimum 2.1 m thick soil cover (or insulation equivalent).

6.3 Excavation Side Slopes

The side slopes of excavations in the overburden materials should be either cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. It is assumed that sufficient room will be available for the greater part of the excavation to be undertaken by open-cut methods (i.e. unsupported excavations). Where space restrictions exist, or to reduce the trench width, the excavation can be carried out within the confines of a fully braced steel trench box.

Unsupported Excavations

The excavations for the proposed warehouse will be mostly through crushed stone, silty sand, or glacial till. The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below groundwater level.

The subsoil at this site is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress. Excavation side slopes should also be protected from erosion by surface water and rainfall events by the use of tarpaulins or other means of erosion protection along their footprint.

It is recommended that a trench box be used at all times to protect personnel working in trenches with steep or vertical sides. It is expected that services will be installed by “cut and cover” methods and excavations will not be left open for extended periods of time.

6.4 Pipe Bedding and Backfill

At least 150 mm of OPSS Granular A should be used for pipe bedding for sewer and water pipes when placed on a soil subgrade. The bedding should extend to the spring line of the pipe.

Cover material, from the spring line to at least 300 mm above the obvert of the pipe, should consist of OPSS Granular A or Granular B Type II with a maximum size of 25 mm. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to 99% of the material's SPMDD.

It should generally be possible to re-use the site-excavated material above the cover material if the excavation and filling operations are carried out in dry weather conditions. Any stones greater than 200 mm in their longest dimension should be removed from these materials prior to placement.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD.

6.5 Groundwater Control

Based on our observations, it is anticipated that groundwater infiltration into the excavations should be moderate and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations. The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

Permit to Take Water

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

For typical ground or surface water volumes being pumped during the construction phase, typically between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project. The subsoil conditions at this site consist of frost susceptible materials. In the presence of water and freezing conditions, ice could form within the soil mass. Heaving and settlement upon thawing could occur.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters and tarpaulins or other suitable means.

In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

Trench excavations should be carried in a manner to avoid the introduction of frozen materials, snow, or ice into the trenches.

6.7 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of a non-aggressive to slightly aggressive corrosive environment.

7.0 Recommendations

It is a requirement for the foundation design data provided herein to be applicable that the following material testing and observation program be performed by the geotechnical consultant:

- Review of the grading plan from a geotechnical perspective.
- Observation of all bearing surfaces prior to the placement of concrete.
- Sampling and testing of the concrete and fill materials.
- Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- Observation of all subgrades prior to backfilling and placement of mud slabs.
- Field density tests to determine the level of compaction achieved.
- Sampling and testing of the bituminous concrete including mix design reviews.

All excess soils, with the exception of engineered crushed stone fill, generated by construction activities that will be transported on-site or off-site should be handled as per *Ontario Regulation 406/19: On-Site and Excess Soil Management*.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued upon the completion of a satisfactory inspection program by the geotechnical consultant.

8.0 Statement of Limitations


The recommendations provided are in accordance with the present understanding of the project. Paterson requests permission to review the recommendations when the drawings and specifications are completed.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, Paterson requests immediate notification to permit reassessment of our recommendations.


The recommendations provided herein should only be used by the design professionals associated with this project. They are not intended for contractors bidding on or undertaking the work. The latter should evaluate the factual information provided in this report and determine the suitability and completeness for their intended construction schedule and methods. Additional testing may be required for their purposes.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Premier Bus Line Inc. or their agents is not authorized without review by Paterson for the applicability of our recommendations to the alternative use of the report.

Paterson Group Inc.


Maha Saleh, P.Eng (Provisional)




David J. Gilbert, P.Eng

Report Distribution:

- Premier Bus Line Inc. (email copy)
- Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

DATUM Geodetic

FILE NO. **PG6018**

REMARKS

HOLE NO. **TP 1-21**

BORINGS BY Backhoe

DATE November 12, 2021

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction	
		TYPE	NUMBER	RECOVERY	N VALUE or RQD			○ Water Content %					
GROUND SURFACE								20	40	60	80		
Asphaltic concrete	0.09					0	118.65						
FILL: Crushed stone	0.10	G	1										
FILL: Brown silty sand with crushed stone, gravel, occasional cobbles		G	2										
Rigid insulation	0.60												
	0.70												
Compact to dense, brown SILTY SAND		G	3			1	117.65						
End of Test Pit	1.80												
Bottom of thickened concrete slab encountered at 0.56m depth.													
Underside of 100mm dia. PVC drainage pipe at 0.56m depth.													
(TP dry upon completion)													

20 40 60 80 100
Shear Strength (kPa)
 ▲ Undisturbed △ Remoulded

DATUM Geodetic



FILE NO. **PG6018**

REMARKS

HOLE NO. **TP 3-21**

BORINGS BY Backhoe

DATE November 12, 2021

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80		
GROUND SURFACE						0	118.55						
TOPSOIL	0.12												
FILL: Brown silty sand with crushed stone, gravel and cobbles, trace asphalt		G	1										
Rigid insulation	0.60 0.70												
Compact to dense, brown SILTY SAND		G	2			1	117.55						
End of Test Pit	1.60												
Bottom of thickened concrete slab encountered at 0.56m depth.													
Underside of 100mm dia. PVC drainage pipe at 0.56m depth.													
(TP dry upon completion)													

20 40 60 80 100
Shear Strength (kPa)
 ▲ Undisturbed △ Remoulded

DATUM Geodetic

FILE NO. **PG6018**

REMARKS

HOLE NO. **TP 4-21**

BORINGS BY Backhoe

DATE November 12, 2021

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80		
GROUND SURFACE						0	118.77						
TOPSOIL	0.05												
FILL: Crushed stone and gravel	0.20	G	1										
FILL: Brown silty sand with gravel	0.40	G	2										
Compact to dense, brown SILTY SAND		G	3			1	117.77						
		G	4			2	116.77						▽
						3	115.77						
End of Test Pit	3.50												
(Groundwater infiltration at 2.0m depth)													

20 40 60 80 100
Shear Strength (kPa)
 ▲ Undisturbed △ Remoulded

DATUM Geodetic

REMARKS

BORINGS BY Backhoe

DATE November 12, 2021

FILE NO. **PG6018**

HOLE NO. **TP 5-21**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction
		TYPE	NUMBER	RECOVERY	N VALUE or RQD			○ Water Content %				
GROUND SURFACE								20	40	60	80	
Asphaltic concrete FILL: Crushed stone	0.05 0.15	G	1			0	118.31					
GLACIAL TILL: Very dense, brown silty sand with gravel, cobbles and boulders		G	2			1	117.31					
						2	116.31					
End of Test Pit	2.20											
Practical refusal to excavation at 2.20m depth (Groundwater infiltration at 1.9m depth)												

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the relative strength of cohesionless soils is the compactness condition, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm. An SPT N value of "P" denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

Compactness Condition	'N' Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

Consistency	Undrained Shear Strength (kPa)	'N' Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity, S_t , is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

Low Sensitivity:	$S_t < 2$
Medium Sensitivity:	$2 < S_t < 4$
Sensitive:	$4 < S_t < 8$
Extra Sensitive:	$8 < S_t < 16$
Quick Clay:	$S_t > 16$

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NQ or larger size core. However, it can be used on smaller core sizes, such as BQ, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube, generally recovered using a piston sampler
G	-	"Grab" sample from test pit or surface materials
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

WC%	-	Natural water content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic Limit, % (water content above which soil behaves plastically)
PI	-	Plasticity Index, % (difference between LL and PL)
D _{xx}	-	Grain size at which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D ₁₀	-	Grain size at which 10% of the soil is finer (effective grain size)
D ₆₀	-	Grain size at which 60% of the soil is finer
C _c	-	Concavity coefficient = $(D_{30})^2 / (D_{10} \times D_{60})$
C _u	-	Uniformity coefficient = D_{60} / D_{10}

C_c and C_u are used to assess the grading of sands and gravels:

Well-graded gravels have: $1 < C_c < 3$ and $C_u > 4$

Well-graded sands have: $1 < C_c < 3$ and $C_u > 6$

Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.

C_c and C_u are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

p' _o	-	Present effective overburden pressure at sample depth
p' _c	-	Preconsolidation pressure of (maximum past pressure on) sample
C _{cr}	-	Recompression index (in effect at pressures below p' _c)
C _c	-	Compression index (in effect at pressures above p' _c)
OC Ratio		Overconsolidation ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
W _o	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

k	-	Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.
---	---	--

SYMBOLS AND TERMS (continued)

STRATA PLOT



Topsoil



Asphalt



Fill



Peat



Sand



Silty Sand



Silt



Sandy Silt



Clay



Silty Clay



Clayey Silty Sand



Glacial Till



Shale



Bedrock

MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Report Date: 18-Nov-2021

Client: Paterson Group Consulting Engineers

Order Date: 12-Nov-2021

Client PO: 33413

Project Description: PG6018

Client ID:	TP2-21 GS3	-	-	-
Sample Date:	12-Nov-21 09:00	-	-	-
Sample ID:	2146568-01	-	-	-
MDL/Units	Soil	-	-	-

Physical Characteristics

% Solids	0.1 % by Wt.	86.8	-	-	-
----------	--------------	------	---	---	---

General Inorganics

pH	0.05 pH Units	7.27	-	-	-
Resistivity	0.10 Ohm.m	147	-	-	-

Anions

Chloride	5 ug/g dry	<5	-	-	-
Sulphate	5 ug/g dry	9	-	-	-

APPENDIX 2

FIGURE 1 – KEY PLAN

DRAWING PG6018-1 – TEST HOLE LOCATION PLAN

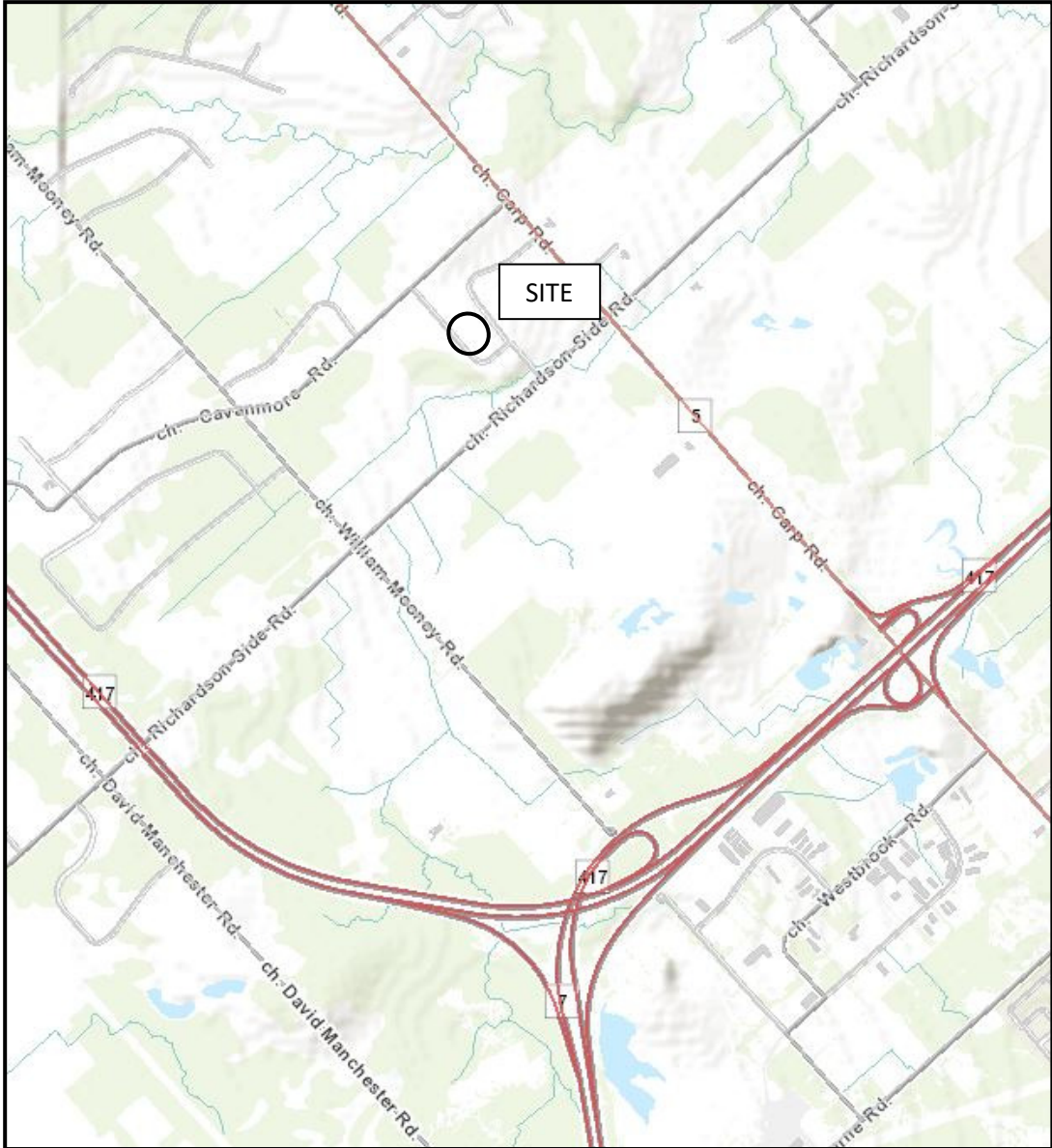
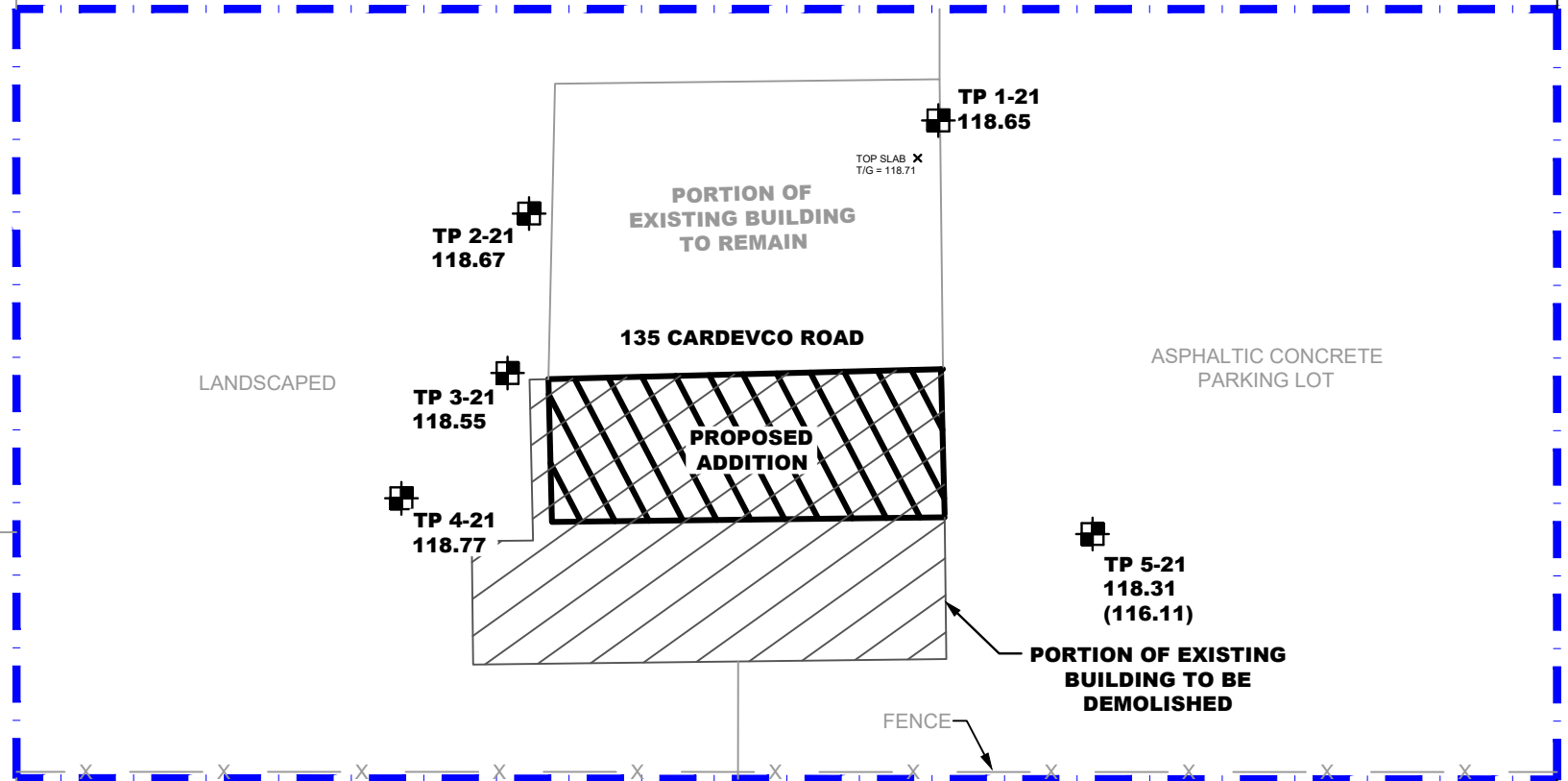
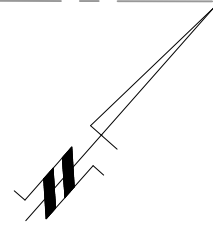



FIGURE 1
KEY PLAN



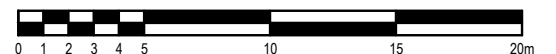
CARDEVCO ROAD

LEGEND:

-  TEST PIT LOCATION
- 118.31 GROUND SURFACE ELEVATION (m)
- (116.11) PRACTICAL REFUSAL TO AUGERING ELEVATION (m)

CONCEPTUAL PLAN PROVIDED BY ARBAUM ARCHITECTS
 GROUND SURFACE ELEVATIONS AT TEST PIT LOCATIONS ARE REFERENCED TO A GEODETIC DATUM.

SCALE: 1:300



patersongroup
 consulting engineers

154 Colonnade Road South
 Ottawa, Ontario K2E 7J5
 Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL

PREMIER BUS LINES INC.
GEOTECHNICAL INVESTIGATION
PROPOSED INDUSTRIAL REDEVELOPMENT
135 CARDEVCO ROAD

OTTAWA (CARP), ONTARIO

TEST HOLE LOCATION PLAN

Scale:	1:300	Date:	11/2021
Drawn by:	JM	Report No.:	PE6018-1
Checked by:	MS	Dwg. No.:	PG6018-1
Approved by:	DJG	Revision No.:	