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UPDATED GEOTECHNICAL INVESTIGATION REPORT

PROPOSED NEW DEVELOPMENT, 3455 HAWTHORNE ROAD, OTTAWA, ONTARIO

Prepared for:

Dymon Group of Companies

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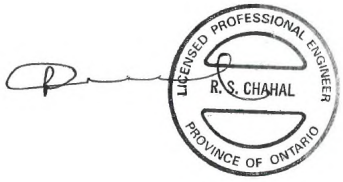
Project No. FE-P 19-9555Geo.

July 9, 2019; Updated July 22, 2022

Issued to:	Dymon Group of Companies
Contact:	Stephen Creighton
Project Name:	Proposed New Development
Project Address:	3455 Hawthorne Road, Ottawa, Ontario
Project Number:	FE-P 19-9555Geo
Issued on:	July 22, 2021



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1. INTRODUCTION

Fisher Environmental Limited was retained by Dymon Group of Companies to carry out a geotechnical subsurface investigation for the proposed new development at 3455 Hawthorne Road in Ottawa, Ontario.

The purpose of the geotechnical investigation was to determine the general subsurface conditions at the site and to provide geotechnical recommendations for the design/construction of the proposed building by means of six (6) boreholes.

This report presents the results of the tests performed in accordance with the general terms of reference outlined above.

The report has been prepared specifically and solely for the due diligence in regards to geotechnical aspects of design & construction of the proposed development at the site.

2. SITE AND PROJECT DESCRIPTION

The subject property is located on the east side of Hawthorne Road, to the immediate north of the existing gas station at the north-east corner of intersection with Hunt Club Road in the City of Ottawa.

Industrial buildings were observed toward north and east sides. Residential dwellings exist on the west side of Hawthorne Road.

The subject property was currently being used for outdoor storage with granular materials coverage across the site.

Site grades were dropping gently in northerly/north-easterly direction.

We understand that a self-storage facility is proposed for the site investigated herein. Details of the proposed building such as location, type/size, finished floor/grade elevation etc. were not available at the time of our investigation. We understand that the building will now contain a full basement. This report has been updated to reflect the subject change.

3. SCOPE OF GEOTECHNICAL WORK

The geotechnical scope of work includes the following:

- Investigation of the subsurface conditions at the site by advancing boreholes, soil sampling and visual evaluation.

- Prepare a geotechnical report with comments and recommendations regarding:
  - Appropriate foundation depth, type and bearing capacity, and seismic classification.
  - Slab-on-grade design and construction.
  - Parking area and driveway pavement structure.
  - Excavation etc.

4. METHOD OF INVESTIGATION

The field work for this investigation was carried out on June 18 2019, in which a total of six (6) boreholes (BH1 – BH6), were drilled to approximate depths ranging between 2.13m & 4.88m below prevailing grades. The approximate locations of the boreholes and elevations are shown on the attached Borehole Location Plan in Appendix A.

The ground surface elevation at each borehole was surveyed by Fisher representative using a temporary benchmark (TBM) "TOP OF MANHOLE ON HAWTHORNE ROAD NORTH OF PROPERTY ENTRANCE" as datum having an assumed elevation of 100.00m.

All boreholes were advanced using solid stem auguring. The subsurface strata were sampled at regular intervals of depth using a split-spoon sampler following the procedure as detailed in the ASTM Standard specification D1586 for the Standard Penetration Test. Field tests to determine the engineering parameters of the soil were carried out during drilling, which included Standard Penetration Tests (SPT).

Water level observations were made in each borehole upon its completion. In addition, monitoring wells were installed in boreholes 1 to 3 for groundwater observations/sampling. Boreholes 4 to 6 were backfilled with bentonite/soil cuttings upon completion.

All soil samples were taken to our accredited laboratory for final visual assessment, classification and selected moisture content testing. The samples were tested and classified in general accordance with the Unified Soil Classification System, ASTM D 2487, and Standard Practice for Classification of Soil for Engineering Purposes.

Soil Description and test results are given in the borehole Records attached to this report.

The soil samples recovered during the investigation will be stored in our laboratory for a period of 30 days after which they will be discarded unless further instructions are received.

5. SUBSURFACE CONDITIONS

The subsurface conditions encountered in the boreholes are shown on the Borehole Log Sheets provided in Appendix B.

The boreholes logs include soil stratification at the borehole locations along with detailed soil descriptions. Variations in the soil stratification may occur and should be expected between borehole locations and elsewhere on the site.

FILL

Fill soils were found at the surface of all boreholes.

Fill extended to the following approximate depths below the prevailing grades.

BH No.	1	2	3	4	5	6
Depth of Fill, m	0.91	0.76	0.76	1.52	1.52	1.37

The fill generally consisted of dark brown to brown silty sand to sandy silt with some to trace of topsoil/roots/gravel and occasional cobbles.

BROWN SILTY SAND

A thin layer of compact brown silty sand was encountered below the fill of borehole 3.

GREYISH BROWN SILT/SANDY SILT

Native soils of greyish brown silt to sandy silt with seams/layers/pieces of shale were found underlying the fill soils of boreholes 1, 2, 4 & 5 and brown silty sand of borehole 3. Relative density of this silt/sandy silt was found to be compact to very dense and it extend3ed to the depths of 2.13m to 2.59m.

GREY SHALE

Grey weathered shale was found underlying the above greyish brown silt/sandy silt with pieces of shale. The shale appears to be weathered in upper portion as it was auger able. Refusal to auguring was encountered at depths varying from 2.13m (no. 6) to 4.88m (nos. 1 & 3). We

consider the refusal depth of 4.88m possibly corresponds to the sound bedrock and shallow refusal depth of 2.13m in borehole 6 may be due to cemented shale/limestone pieces/chunks/seams/layers.

It should be noted that bedrock in Carlsbad Formation is known to contain pyrite and considered as “Expansive Shale”. It can produce sulphuric acid when exposed to oxygen/water and calcite seams/layers can be converted to gypsum which increases its volume resulting in expansion. These conditions are detrimental to lightly loaded structures/slabs-on-grade.

Fisher’s letter addressing City of Ottawa’s comments regarding “Expansive Shale” is attached in Appendix C.

6. GROUNDWATER CONDITIONS

The boreholes were advanced using dry auguring and boreholes were found to be dry on completion of the respective soil borings. Monitoring wells were installed in boreholes 1 to 3 and ground water developed to the depth of 2.1m in borehole 3 by June 19.

Based on the above information and visual examination of the soil samples, we conclude that water bearing aquifer was not encountered within the depths penetrated by boreholes. However, perched water will likely be encountered from the wet seams/pockets/layers trapped inside the fill and/or native soils overlying the bedrock.

7. GEOTECHNICAL DISCUSSIONS AND RECOMMENDATIONS

7.1 General Discussion

- The proposed development will comprise the construction of industrial/warehouse building with associated parking areas and driveways.

- At the time of preparing this report, details such as building type/location; finished floor levels/grades etc. were not available.

The following sections provide general geotechnical recommendations for design and construction.

7.2 Foundation Considerations

Boreholes indicate that natural soils can be used for foundation support using conventional strip and/or spread footing foundations.

For footings placed over undisturbed native soils at/below the approximate minimum depths/elevations presented in the following table, factored geotechnical resistance at ULS of 750kPa and geotechnical reaction at SLS of 500kPa can be used for the foundation design purposes.

Existing Grade and Approximate Minimum Footing Founding Depths/Elevations

B.H. No.	EXISTING GRADE/ ELEVATION, m	APPROX. FOOTING FOUNDING	
		DEPTH, m	ELEV., m
1	99.99	1.11	98.88
2	99.49	0.96	98.53
3	100.61	1.30	99.31
4	100.66	1.72	98.94
5	100.31	2.13	98.18
6	100.20	1.57	98.63

For footings placed over grey weathered shale encountered around the depth of 2.13m, increased soil bearing pressures of 1000kPa (SLS) and 1500kPa (ULS) can be used.

For footings founded at different levels in the vicinity of each other or located adjacent to excavated and backfilled areas, such as sewer trenches/other excavations etc., the slope of the imaginary line joining the bottom of two footings or the bottom of footing and excavation should not be steeper than 10H:7V.

The subsoil conditions at the footing founding levels should be inspected by soils engineer from our office prior to pouring concrete, to ensure that the design soil bearing pressures are being attained.

Footings subjected to seasonal winter weather, such as exterior wall and column footings, should be founded at least 1.5m below the adjacent finished grades to prevent any damage due to frost penetration.

For footing excavations extending into bedrock, we recommend that that the excavations be filled up with concrete to the top of bedrock or footings should be poured within 24 hours of excavation. Alternatively exposed rock surfaces should be covered with skim/mud coat or shotcreted. Preferably the footings should be poured against excavated rock banks.

7.3 Earthquake Consideration

The 2012 OBC Subsection 4.1.8 stipulates that a building should be designed to meet the requirements of the Earthquake Load and Effects. The Site Classification for Seismic Site Response (Table 4.1.8.4.A) is determined from the average Standard Penetration Resistance (N_{60}) and/or the undrained shear strength (Su) of the soils within upper 30 m.

Based on the results of standard penetration tests i.e., “N” values from the geotechnical investigation, the site designation for seismic analysis applicable for the proposed building is **"Class C"**.

Shear-wave velocity sounding was carried out by Geophysics GPR International Inc. The sounding/survey was performed on April 26, 2021.

Shear wave velocity measurements were recommended in order to determine if Site Class ‘B’ can be used for the building design at the subject site.

Average Vs values determined through MASW method varied from 265m/s in upper 2m to 520m/s in 2m to 5m depth range with an overall average Vs30 of 1043m/s. The above Sounding confirms that sound bedrock is located at the approximate depth of 5m below grade which roughly corresponds the refusal depths encountered in the boreholes.

It should be noted that Site Class ‘B’ [Table 4.1.8.4.A., National Building Code of Canada 2015] can only be used if the underside of footings/foundations are located over or within 3m of the confirmed bedrock.

Based on the above and introduction of full basement, we consider Site Class ‘B’ can be used for the building design purposes as the footings will be founded over the bedrock i.e., at depths of more than 4m below grades.

The seismic parameters and analysis requirements are detailed in Subsection 4.1.8 of the 2012 OBC.

7.4 Basement Construction

The basement structure should be equipped with efficient drainage system, which includes the perimeter outside & inside weeping tiles around the bottom of the basement/column wall footings and the interior weeping tiles below the basement floor slab. The weepers should be surrounded by clear stone or pea gravel encased in a granular filter or filter cloth. Exterior and interior weepers should drain positively and connected to independent frost-free sump pits from where the water is constantly removed.

Underfloor weeping tile drainage system should be provided under the floor slab to release any potential uplift pressure on the slab-on-grade and keep the subgrade in dry state. The drains should be encased in 150 mm of clear stone/pea gravel wrapped in geotextile filter & placed below the granular bedding and connected positively to sump pit. The geotextile filter should have equipment opening size of less than 60 µm.

The entire drainage system should be designed by competent professionals, to ensure its capacity and effectiveness concerning the efficient transmittal of volume of water generated without any migration of fines from the surrounding soils.

In the event of power or mechanical failure, a backup system should be designed for pumping/dewatering operations

The basement floor slab can be constructed as slab-on-grade. After excavating to the desired level, any loose or wet soil should be sub-excavated and replaced with granular material compacted to 98% of the Standard Proctor Maximum Dry Density. A 19 mm clear stone granular bedding of at least 200 mm in thickness should be provided. We also recommended that bedrock subgrade, if encountered, should be further evaluated at the time of construction. Exposed basement floor subgrade will likely consist of bedrock and may need to be covered with skim coat to reduce its exposure to oxygen/water. Furthermore, use of sulphate resistant cement may be required for concrete in touch with rock.

The basement walls under free drainage conditions, can be designed for a lateral earth pressure P, given by the following expression:

$$P = K (\gamma h + q)$$

where K = Coefficient of earth pressure

γ = Unit weight of soil

q = Surcharge load, if any

Design parameters K, γ' are suggested in section 7.5 of this report.

If the perimeter/underfloor drainage systems are not permitted/feasible and water tight structure design is adopted then parking garage walls & floor slabs must be designed to resist hydrostatic/uplift pressures. Highest groundwater level should be used for determining the water pressures. Basement walls should be waterproofed to at least 1m above the highest water level.

For a waterproofed basement without drainage, the lateral earth pressures acting on basement walls may be calculated from the following expression:

$$p = K (\gamma h_1 + \gamma' h_2 + q) + \gamma_w h_2$$

where
- p = lateral earth pressure in kPa acting at depth h
- K = earth pressure coefficient, assumed to be 0.4 for vertical walls and horizontal backfill
- γ' = submerged unit weight of backfill of 12kN/m^3 may be assumed
- γ_w = Unit weight of water, a value of 10kN/m^3 can be used
- h_1 = depth to the highest groundwater table in metre
- h_2 = depth below water table in metres
- q = surcharge on the ground surface in kPa

7.5 Slab-On-Grade Construction

We recommend that the existing fill should be further evaluated at the time of construction. All the compressible organic/topsoil mixed fill soils (if any) should be removed from the areas to be slabbed.

Exposed subgrade should be proof rolled in the presence of our soils personnel to detect any compressible, spongy or unstable areas. If any isolated pockets of such materials are detected, they should be sub-excavated to competent subsoils and backfilled with approved inorganic materials compacted to at least 95% of their Standard Proctor Maximum Dry Density (S.P.M.D.D.) in thin layers.

Any new fill should consist of approved compactable inorganic soils, placed in thin layers (not exceeding 300mm), and each layer should be compacted to at least 95% of its S.P.M.D.D. under dry and frost-free conditions. Weathered shale should not be used for backfilling or raise subgrade purposes.

For normal light duty slab-on-grade construction, a 200mm thick bedding layer consisting of granular 'A' or 20mm crusher run material should be specified under the slab-on-grade to serve as a moisture barrier. The bedding layer should be compacted to a minimum of 98% of its S.P.M.D.D.

7.6 Pavement Design

The functional life of a pavement depends directly on the subgrade conditions and the load carrying capacity of the pavement structure. The following minimum flexible pavement structure thicknesses are recommended.

Minimum Flexible Pavement Structure Thicknesses

PAVEMENT LAYER	COMPACTED THICKNESSES	
	LIGHT DUTY PARKING	DRIVEWAYS & HEAVY DUTY PARKING
Asphalt top course, HL-3	40mm	40mm
Asphalt base course, HL-8	40mm	60mm
Granular 'A' or 20mm crusher run limestone base	150mm	150mm
Granular 'B' or 50mm crusher run limestone sub-base	200mm	350mm

The pavement structure should also meet the minimum municipal design requirements, if any, for the proposed development.

The above thicknesses are applicable for dry and stable subgrade conditions during summer season construction only. If the construction is carried out during winter and for unstable subgrade conditions, the thicknesses of granular materials may have to be increased.

The granular base materials should conform to O.P.S.S. Form 1010 specifications and be compacted to at least 98% of their SPMDD's. Similarly, asphaltic concretes should meet the O.P.S.S. Form 1150 requirements for specified grades and be compacted to at least 97% of their Marshall Densities.

The subgrade should be prepared as described previously in subsection 7.4. Prior to placement of granular bases, the finished sub-grade should be contoured to eliminate depressions and sloped at a minimum of 2% towards the catch basins or perimeter ditches to facilitate drainage of subgrade and base materials.

Water should not be allowed to accumulate at/near the pavement edges. The importance of sub-grade drainage and regular maintenance and repairs cannot be over-emphasized.

7.7 Excavation

The excavation of the soil material is expected to be achieved easily using a backhoe. Temporary excavations for footings or underground services must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA).

According to OHSA, if the excavation is deeper than 1.2 m, the excavation sides should be sloped. The slope of the sides depends on the type of the excavated materials.

Loose to compact fill soils encountered below the ground surface up to the depth of 2.0m± may be classified as **Type 3 Soil** in moist condition. In accordance with the OHSA, the excavation side slope for this type of soil is 1H:1V from the bottom of the trench or flatter. Very dense greyish brown silt/sandy silt/weathered shale can be considered as **Type 2 Soil**.

Presence of wet seams/layers/pockets may require flattening of the slopes.

Excavations into bedrock should be carried out with minimum disturbance to the surrounding bedrock. Further assessment of the rock should be undertaken to determine if special precautions such as use of sulphate resistant concrete and skim coat or shotcrete applications for exposed rock surfaces are required

8. GENERAL CONSIDERATIONS

This report is limited in scope to those items specifically referenced in the text. No other testing and design calculations have been performed except as specifically reported.

The discussions and recommendations presented in this report are intended for the sole guidance of the client named and the design consultants. It should not be relied upon for any other purpose.

The information on which these recommendations are based is subject to confirmation by engineering personnel at the time of construction.

The fact that localised variations in the subsurface conditions may be present between and beyond the boreholes and that those conditions may be significantly different from the general description provided for design purposes should be understood.

Contractors bidding on or undertaking the work should decide on their own investigations, as well as their own interpretations of the factual borehole results. This concern specifically applies to the

classification of the subsurface soils and the potential reuse of these soils on/off Site. Contractors must draw their own conclusions as to how the near surface and subsurface conditions may affect them.

It is strongly urged that Fisher be contacted to provide assistance in the interpretation of the borehole records by anyone undertaking work on/or below the ground surface at this site prior to this work being carried out.

The client expressly agrees that it has entered into this agreement with Fisher, both on its own behalf and as agent on behalf of its employees and principals.

The client expressly agrees that Fisher's employees and principals shall have no personal liability to the client in respect of a claim, whether in contract, tort and/or any other cause of action in law. Accordingly, the client expressly agrees that it will bring no proceedings and take no action in any court of law against any of Fisher's employees or principals in their personal capacity.

9. CLOSING

We trust that the foregoing information is sufficient for your present needs and will be pleased to review the contents of this report in greater detail should you so require. Should you require our services further in this regard, please do not hesitate to contact our office.

APPENDIX A – SITE PLAN

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NORTH

LEGEND

- MONITORING WELL
- BOREHOLE
- SITE BOUNDARY
- BENCHMARK

PROJECT NAME AND ADDRESS

GEOTECHNICAL INVESTIGATION AND PHASE II ESA

3455 HAWTHORNE ROAD, OTTAWA, ONTARIO

FIGURE 1:

SITE PLAN WITH BOREHOLE AND MONITORING WELL LOCATIONS

PROJECT NO.	SHEET NO.
FE-P 19-9555	1
DATE: JUNE 2019	
SCALE: AS SHOWN	

APPENDIX B – LOG OF BOREHOLES

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LOG OF BOREHOLE NO. BH1(MW) SHEET. 1 of 1

PROJECT NO.: FE-P 19-9555

PROJECT NAME: Geotechnical Investigation

LOCATION: 3455 Hawthorne Road, Ottawa, ON

DRILLING METHOD: Diedrich D-50

DRILLING DATE: 18 June 2019

DEPTH (feet)	DEPTH (metres)	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES P.I.D. Reading	SAMPLES "N" VALUE
		GROUND SURFACE (m asl)		99.99			
0	0	FILL: dark brown to greyish brown silty sand, trace to some gravel, some to trace of topsoil/roots, moist.			1	SS	9
2							
		0.91m		99.08	2	SS	>100
4	1	GREYISH BROWN SILT: some clay, seam/layer/pieces of shale, moist, very dense.					
6					3	SS	>100
	2	2.13m		97.86			
8		GREY SHALE: weathered in upper portion, dry, hard.			4	SS	>100
10	3						
					5	SS	>100
12							
	4						
14							
16		4.88m		95.11			
	5	End of Borehole					
18							
		Refusal to augering at 4.88m,					
20	6	Monitoring well installed at 4.88m.					
22							
	7	Dry on June 19, 2019.					
24							
26	8						
28							
	9						
30							
32	10						

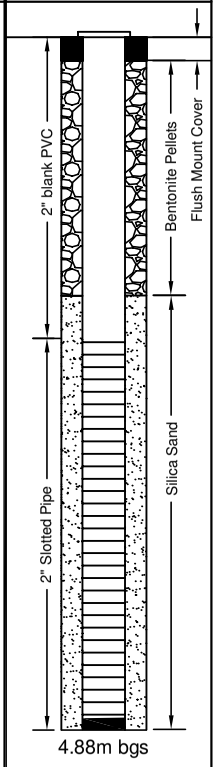
PENETRATION TESTING (SPT) ▲ 20 40 60 80

SHEAR STRENGTH (Kpa) ✤ 40 80 120 160

VAPOUR READING (ppm) □ 20 40 60 80

MOISTURE CONTENT (%) ○ 10 20 30 40

PIEZOMETER OR WELL CONSTRUCTION



FISHER ENVIRONMENTAL LTD.

LOG OF BOREHOLE NO. BH2(MW) SHEET. 1 of 1

PROJECT NO.: FE-P 19-9555

PROJECT NAME: Geotechnical Investigation

LOCATION: 3455 Hawthorne Road, Ottawa, ON

DRILLING METHOD: Diedrich D-50

DRILLING DATE: 18 June 2019

DEPTH (feet)	DEPTH (metres)	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES P.I.D. Reading	SAMPLES "N" VALUE
		GROUND SURFACE (m asl)		99.49			
0	0	FILL: dark brown to greyish brown silty sand, trace to some gravel, some to trace of topsoil/roots, moist.			1	SS	11
2		0.76m		98.73			
4	1	GREYISH BROWN SILT: some clay, seam/layer/pieces of shale, moist, very dense.			2	SS	>100
6					3	SS	>100
	2	2.13m		97.36			
8		GREY SHALE: weathered in upper portion, dry, hard.			4	SS	>100
10	3				5	SS	>100
12							
14	4	4.57m		94.92			
16	5	End of Borehole					
18		BH dry on completion.					
20	6	Monitoring well installed at 4.57m.					
22		Dry on June 19, 2019.					
24	7						
26	8						
28							
30	9						
32	10						

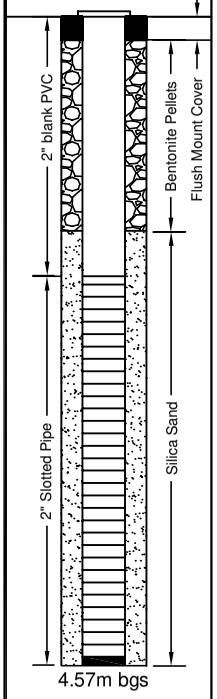
PENETRATION TESTING (SPT) ▲ 20 40 60 80

SHEAR STRENGTH (Kpa) ✚ 40 80 120 160

VAPOUR READING (ppm) □ 20 40 60 80

MOISTURE CONTENT (%) ○ 10 20 30 40

PIEZOMETER OR WELL CONSTRUCTION



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LOG OF BOREHOLE NO. BH3(MW) SHEET. 1 of 1

PROJECT NO.: FE-P 19-9555

PROJECT NAME: Geotechnical Investigation

LOCATION: 3455 Hawthorne Road, Ottawa, ON

DRILLING METHOD: Diedrich D-50

DRILLING DATE: 18 June 2019

DEPTH (feet)	DEPTH (metres)	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES P.I.D. Reading	SAMPLES "N" VALUE
		GROUND SURFACE (m asl)		100.61			
0	0	FILL: dark brown to greyish brown silty sand, trace to some gravel, some to trace of topsoil/roots, moist.			1	SS	17
		0.76m		99.85			
2		BROWN TO GREYISH BROWN SILTY SAND: trace of gravel, moist, compact.			2	SS	12
4	1	1.22m		99.39			
		GREYISH BROWN SILT: some clay. seam/layer/pieces of shale, moist, very dense.			3	SS	65
6	2	2.13m		98.48			
8		GREY SHALE: weathered in upper portion, dry, hard.			4	SS	>100
10	3				5	SS	>100
12							
14	4						
16		4.88m		95.73			
	5	End of Borehole					
18							
20	6	Monitoring well installed at 4.88m.					
		WL at 2.1m on June 19, 2019.					
22	7						
24							
26	8						
28							
30	9						
32							
	10						

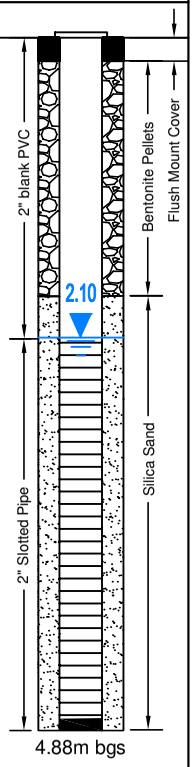
PENETRATION TESTING (SPT) ▲ 20 40 60 80

SHEAR STRENGTH (Kpa) ✚ 40 80 120 160

VAPOUR READING (ppm) □ 20 40 60 80

MOISTURE CONTENT (%) ○ 10 20 30 40

PIEZOMETER OR WELL CONSTRUCTION



FISHER ENVIRONMENTAL LTD.

LOG OF BOREHOLE NO. BH4 SHEET. 1 of 1

PROJECT NO.: FE-P 19-9555

PROJECT NAME: Geotechnical Investigation

LOCATION: 3455 Hawthorne Road, Ottawa, ON

DRILLING METHOD: Diedrich D-50

DRILLING DATE: 18 June 2019

DEPTH (feet)	DEPTH (metres)	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES P.I.D. Reading	SAMPLES "N" VALUE
		GROUND SURFACE (m asl)		100.66			
0	0	FILL: dark brown silty sand, some gravel, occasional cobbles, some to trace of topsoil, roots, moist.			1	SS	26
		0.76m		99.90			
4	1	FILL: greyish brown silt to sandy silt, trace topsoil/roots, pieces of shale, moist.			2	SS	16
		1.52m		99.14			
6	2	GREYISH BROWN TO BROWN GREY SILT TO SANDY SILT: some clay, pieces of shale, moist, compact to dense.			3	SS	45
8		2.59m		98.07	4	SS	70
10	3	GREY SHALE: seam of limestone, weathered in upper portion, dry, hard.			5	SS	>100
		3.35m		97.31			
12	4	End of Borehole					
14		Refusal to augering at 3.35m.					
16	5	BH dry on completion.					
18							
20	6						
22							
24	7						
26	8						
28							
30	9						
32							
	10						

PENETRATION TESTING (SPT) ▲ 20 40 60 80

SHEAR STRENGTH (Kpa) ✚ 40 80 120 160

VAPOUR READING (ppm) □ 20 40 60 80

MOISTURE CONTENT (%) ○ 10 20 30 40

PIEZOMETER OR WELL CONSTRUCTION

FISHER ENVIRONMENTAL LTD.

LOG OF BOREHOLE NO. BH5 SHEET. 1 of 1

PROJECT NO.: FE-P 19-9555

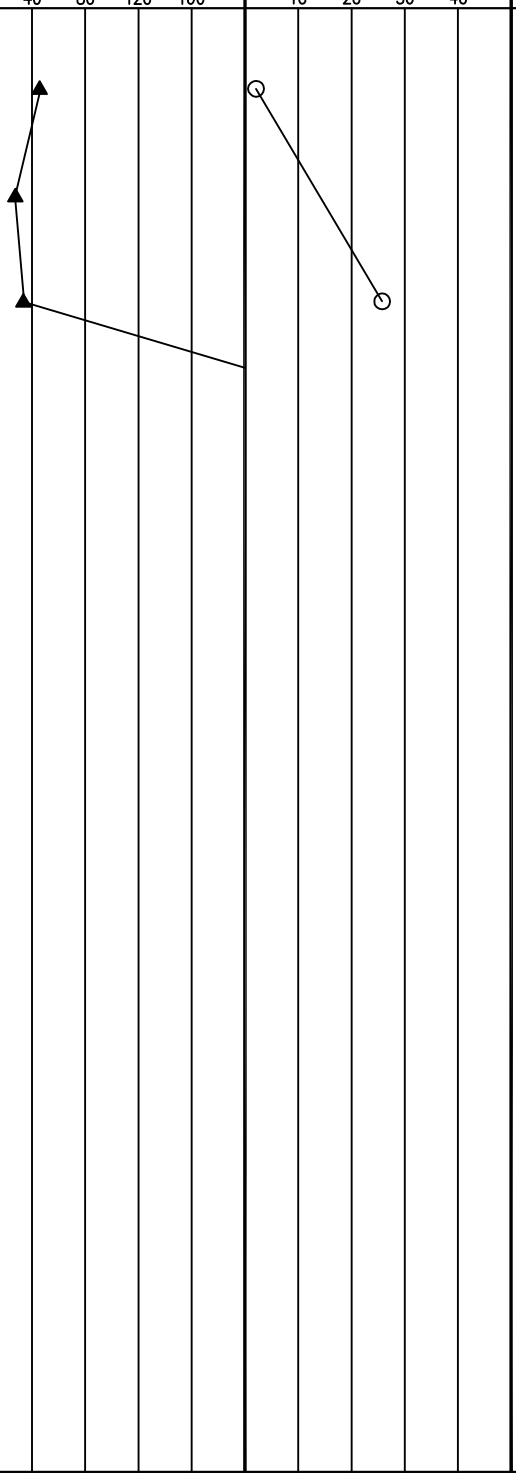
PROJECT NAME: Geotechnical Investigation

LOCATION: 3455 Hawthorne Road, Ottawa, ON

DRILLING METHOD: Diedrich D-50

DRILLING DATE: 18 June 2019

DEPTH (feet)	DEPTH (metres)	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES P.I.D. Reading	SAMPLES "N" VALUE
		GROUND SURFACE (m asl)		100.31			
0	0	FILL: greyish brown sand, some silt & gravel, moist.			1	SS	23
0.61m				99.70			
2	1	FILL: greyish brown silt to sandy silt, trace topsoil/roots, pieces of shale, moist.			2	SS	13
1.52m				98.79			
4	2	GREYISH BROWN TO BROWN GREY SILT TO SANDY SILT: some clay, pieces of shale, moist, compact.			3	SS	16
2.13m				98.18			
2.44m		GREY SHALE: dry, hard.		97.87	4	SS	>100
8		End of Borehole					
10	3	Refusal to augering at 2.44m.					
12		BH dry on completion.					
14	4						
16	5						
18							
20	6						
22	7						
24							
26	8						
28							
30	9						
32	10						



PIEZOMETER OR WELL CONSTRUCTION

FISHER ENVIRONMENTAL LTD.

LOG OF BOREHOLE NO. BH6 SHEET. 1 of 1

PROJECT NO.: FE-P 19-9555

PROJECT NAME: Geotechnical Investigation

LOCATION: 3455 Hawthorne Road, Ottawa, ON

DRILLING METHOD: Diedrich D-50

DRILLING DATE: 18 June 2019

DEPTH (feet)	DEPTH (metres)	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES P.I.D. Reading	SAMPLES "N" VALUE	PENETRATION TESTING (SPT) ▲ / SHEAR STRENGTH (Kpa) ✚	VAPOUR READING (ppm) □ / MOISTURE CONTENT (%) ○	PIEZOMETER OR WELL CONSTRUCTION
		GROUND SURFACE (m asl)		100.20						
0	0	FILL: dark brown silty sand, some gravel, occasional cobbles, some to trace of topsoil, roots, occasional cobbles, moist.			1	SS	18			
2										
4	1				2	SS	57			
		1.37m		98.83						
6	2	GREYISH BROWN SILT TO WEATHERED SHALE: some clay, moist, hard.			3	SS	>100		○	
		2.13m		98.07						
8		End of Borehole								
10	3	Refusal to augering at 2.13m.								
12		BH dry on completion.								
14	4									
16	5									
18										
20	6									
22	7									
24										
26	8									
28										
30	9									
32	10									

PENETRATION TESTING (SPT) ▲ / SHEAR STRENGTH (Kpa) ✚: 20 40 60 80 / 40 80 120 160

VAPOUR READING (ppm) □ / MOISTURE CONTENT (%) ○: 20 40 60 80 / 10 20 30 40

APPENDIX C – COMMENTS REGARDING EXPANSIVE SHALE

April 6, 2022

Dymon Group of Companies
2-1830 Walkley Rd.
Ottawa, ON
K1H 8K3

Attn: James Byck
Tel: 416 317-7328
Email: jbyck@dymon.ca

Re: Expansive Shale, Proposed development 3455 Hawthorne Rd., Ottawa, Ontario.

Dear Mr. Byck,

In response to the following question forwarded by the City of Ottawa, Fisher offers the following response;

Q. Please confirm if the shale is of the expansive Carlsbad or Billings Formation variety. If so, what measures are required to protect from heaving.

R. The geotechnical investigation performed by Fisher at 3455 Hawthorne Rd., Ottawa, Ontario, refer to Fisher Report FE P-19-9555 included the advancement of boreholes to refusal depths on suspected shale bedrock. The works did not include the recovery of bedrock core samples and direct evaluation / testing of the underlying shale for confirmation of type and characterization was not possible. Further investigation would be required for purposes of definite identification of the bedrock shale formation and evaluation of the expansion potential.

Based on geological mapping, and a review of other geotechnical reports in the immediate area it is expected that the underlying shale at the Site is of the Carlsbad formation, which is a pyritic shale.

Pyritic shale is an expansive shale which when oxidized can cause a number of construction related issues. The bacterial oxidation of pyrite, contained within the shale, produces ferrous sulphate and ferric sulphate both of which attack concrete. Further, in the presence of oxygen and water sulphuric acid may be formed which is corrosive to both steel and concrete. When calcite seams are present within the shale, the acid, can convert the calcite to a gypsum which swells in volume resulting in pressures on subsurface structures. These impacts are typically most evident on lightly loaded structures such as basement floor slabs, and are often magnified in the presence of warm environments.

For purposes of minimizing the harmful impacts of the potential expansive pyritic shale on the structure the following measures are recommended;

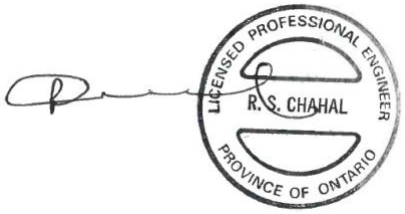
- Excavations should be advanced with the least possible disturbance to the shale below the grade of the basement.

- Exposed shale surfaces, including service trenches, that will not be covered within 24 hours should be protected with the application of a mud-mat, grout, shotcrete, etc.
- The use of sulphate resistant concrete / grouts should be considered in heave sensitive areas.
- Footing trenches should be completely filled with concrete on same day.
- Insulation should be utilized below basement slabs in areas of warm mechanical equipment, steam pipes, etc., to reduce transfer of temperature to underlying shale.
- Avoid drained shafts or pits that could lower the water table beneath the building. If elevator pits, or similar features, are required, the design should include water-tight constructions.
- Excavated shale should not be used for backfilling purposes.

Should you have any additional questions, please do not hesitate to contact us.

Regards,

Regards,
Fisher Engineering



Sean Fisher, M.Sc. Eng.
Project Manager

Rajinder Chahal, P. Eng.
Senior Geotechnical Engineer