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GEOTECHNICAL INVESTIGATION

1000 MCGARRY TERRACE

OTTAWA, ONTARIO

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Markham, ON
L3R 3K2

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Project No. FE-P 18-8637Geo-Update
October 5, 2018

Issued to: Dymon Group of Companies

Contact: Bliss Edwards
2-1830 Walkley Road, Ottawa, ON K1H 8K3

Project Name: Geotechnical Investigation

Project Address: Proposed Redevelopment at 1000 McGarry Terrace, Ottawa, Ontario

Project Number: FE-P 18-8637Geo-Update

Issued on: October 5, 2018

Project Manager:
(Primary Contact)

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1.0 INTRODUCTION

Fisher Environmental Limited (Fisher) was commissioned by the Dymon Group of Companies to conduct a Geotechnical Investigation for the proposed redevelopment of the property located at 1000 McGarry Terrace, Ottawa, hereinafter referred to as the 'Site'.

The purpose of this investigation was to assess the subsurface soil and groundwater conditions at the Site and to outline geotechnical parameters and make recommendations for the design of the proposed redevelopment.

Discussion of the findings and results of the geotechnical investigation is in accordance with the general terms of reference. This report was prepared specifically and solely for the purpose of assessing geotechnical conditions as they relate to the development of the site with respect to the proposed structures as detailed to Fisher at the time of the investigation.

A completed preliminary geotechnical investigation report, under Fisher project NO. 18-8637Geo., was submitted to the client dated February 12, 2018. As the detailed design plans and Finished Floor Elevation (FFE) were unverified at that time, the findings and recommendations presented in the report were considered preliminary.

The proposed development Site Plan and finished floor elevations (FFE), prepared by Nicholas Caragianis Architect, dated November 2017 and October 4, 2018, were provided to Fisher for this revised investigation. The Preliminary Geotechnical Investigation is therefore updated to reflect the new site plans and the results of Seismic Shear Wave Velocity surveys provided to Fisher.

2.0 SITE AND PROJECT DESCRIPTIONS

The Site is located on the southeastern corner of the intersection of McGarry Terrace and Strandherd Drive and has an approximate area of 6027m^2. The Site is bounded by residential development to the north and east, commercial development to the west and vacant land with two sheds and construction debris (from a former residential dwelling) to the south.

At the time of the investigation, the Site was vacant and covered by snow and occasional trees. Some mounds of construction debris were noticed in the north portions of the site.

The Site topography is generally flat with a slight slope from west to east with corresponding elevation changes, referencing the chosen temporary benchmark, from 99.75m (BH2) to 98.20m

(BH5). The land was noticeably lower in the northeast corner of the Site with an estimated elevation of approximately 97.0m.

Base on the proposed site development plans provided to Fisher, a single 5-storey building with a footprint of 2461m^2, comprising reception & retails, self-storage, Lobby & Ancillary Services along with internal loading and parking areas will be constructed on the site. The approximately square shaped building is expected to cover most of the property and will have a Finished Floor Elevation (FFE) of 101.30m.

3.0 FIELD AND LABORATARY WORK

Site drilling work for the geotechnical investigation was carried out on February 6, 2018 and consisted of five (5) boreholes (BH1 to BH5). The boreholes were drilled at approximate locations as detailed on the attached Site Plan - Appendix A. Boreholes drilled at this time were advanced to depths of 1.50m (5.0') to 4.05m (13.5'), unless refusal of the drill auger was encountered, with corresponding elevations ranging from 96.70m to 95.45m referencing the TBM.

A Bombardier CME-55 Truck mounted drilling rig equipped with hollow stems was used for drilling work. Soil samples were taken at regular intervals using a split–spoon sampler advanced by means of the Standard Penetration Test (SPT) conducted in general accordance with ASTM specification D1586. Upon completion of drilling, the boreholes were backfilled with Bentonite.

All recovered soil samples were placed in clear, sealed plastic bags in the field and were transported to Fisher laboratory for further examination, characterization and laboratory analyses.

Fisher personnel surveyed the ground surface elevations using 'the top of hydrant' located on the east side of McGarry Terrace as a temporary benchmark (TBM). The TBM was assigned an arbitrary elevation of 100m. All elevations noted in this report, unless stated otherwise, are with reference to the TBM.

The soil samples recovered during the investigation will be stored in the Fisher Environmental laboratory for a period of 30 days after submitting this report and will be discarded thereafter unless otherwise instructed by the client.

4.0 SUBSOIL CONDITIONS

Examination of the soil conditions encountered in the boreholes show that the soil profile generally consists of fill/ topsoil on the surface underlain by silty sand till with occasional silty sand deposit on the upper section to termination of all boreholes at auger refusal. Subsoil encountered at borehole locations are shown on the Borehole Log Sheets, which are attached in Appendix B, and can be summarized as follows:

- **FILL / TOPSOIL** – Fill was encountered at the surface in all boreholes. The fill generally consisted of silt with some to trace organics, traces of gravel, sand, clay pockets, rootlets and brick pieces (BH4). The fill in BH3 contained sand and gravel with some asphalt pieces. Black organic topsoil was detected below the fill in BH1 and extended to a depth of approximately 0.9m. The dark brown to black fill layer was moist and in a very loose to compact condition. The surface of the fill generally appeared in frost. Fill depths at borehole locations are presented in Table 1.

  It should be noted that the fill conditions at the site could vary significantly between and beyond the borehole locations. Further investigations via test pits should be conducted to determine the extent, depth and type of the fill prior to commencing construction.

Table 1: Summary of Depth and Elevation of Fill

Borehole No.	BH1	BH2	BH3	BH4	BH5
BH Ground Elevation (m)	99.50	99.75	99.30	98.50	98.25
Depth of Borehole (m)	4.05	3.60	2.00	2.60	1.50
Elev. at Bottom of BH (m)	95.45	96.15	97.30	95.90	96.75
Depth of Fill / Topsoil (m)	0.90	1.05	0.75	0.75	0.90
Elev. at Bottom of Fill (m)	98.60	98.70	98.55	97.75	97.35

- **SILTY SAND TILL** – A layer of silty sand till with trace of gravel was encountered in all boreholes and extended to termination of each borehole at auger refusal. In BH1 and BH3, reddish brown, loose silty sand with trace rootlets was found at the top of the till around 0.3m in thickness. The light brown to brown silty sand till was moist and in a compact to very dense condition but was generally dense.

- **REFUSAL** – Drilling of all boreholes terminated at auger refusal. SPT 'N' values at auger refusal were generally high with blow counts of greater than 50 blows per 1" penetration. No spoon samples were able to be retrieved. It is expected that the soil at the point of the refusal consist of a very dense till interspersed with cobbles and/or boulders.

5.0 GROUNDWATER CONDITIONS

Groundwater measurements were conducted in all boreholes upon completion. All boreholes remained open and no groundwater was observed within the explored depths.

It should be noted, however, that the groundwater levels at the Site are subject to seasonal fluctuations and to major weather events. Consequently, definitive information on the long-term groundwater levels were not ascertained during the investigation.

6.0 FOUNDATION CONSIDERATIONS

Based on the Site Plan provided to Fisher, it is understood that the development will consist of the construction of a five (5) storey building with no basement. The building is expected to cover most of the property and will have Finished Floor Elevation (FFE) at 101.30m.

The Site was vacant at the time of the investigation. A layer of fill/topsoil was encountered in all boreholes and extended to depths ranging from 0.75m to 1.05m bsg with the bottom of fill elevations extended from 97.35m to 98.70m referencing the TBM. Dense to very dense silty sand till were encountered generally from 1.5m below grade and extended to the depths of auger refusal which occurred in suspected very dense till at elevations ranging from 95.45m to 97.30m.

Given the encountered soil conditions in the boreholes and the proposed building structure with five (5) storey having no basement, the following type of footing and soil bearing capacities may be considered:

6.1 Spread/ Strip Footing Found on Native Soils

Recommended approximate founding depths / elevations and corresponding bearing resistances for limit states (SLS and ULS) are presented in the Table 2.

Table 2: Foundation Design for Conventional Footings

Building/Borehole			Relative Elev. of BH Ground (m)	Approx. Depth of Footings at or below (m)	Approx. Elevation of Footings at or below (m)	Bearing Resistance at SLS (KPa)	Bearing Resistance at ULS (KPa)
Proposed Commercial Structures	**BH1**	**No Basement**	99.50	1.50	98.00	350	525
	BH2		99.75	1.50	98.25	350	525
	BH3		99.30	1.50	97.80	350	525
	BH4		98.50	1.50	97.00	350	525
	BH5		98.25	1.50	96.75	350	525

Footings designed to the above specified bearing pressure values are expected to settle less than 25 mm total and 19mm differential.

It should be noted that the above given footing depths are measured based on site grade observed during the site investigation and that the calculated elevations are based on the relative elevation of a temporary bench mark (the top of the hydrant which is located on the east side of McGarry Terrace with an assumed elevation of 100m). These relative elevations should be converted to geodetic before using them for the footing design.

6.2 General Comments about Footing Construction

- For protection against frost action, all perimeter footings and interior footings placed on soil or fill located within 1m from the exterior walls will require a minimum frost protection equivalent to a soil cover of 1.5m. Footings in unheated areas or exterior footings must have a minimum frost protection equivalent to a soil cover of at least 1.8m.
- Adjacent footings founded at different elevations should be stepped at 10 horizontals to 7 verticals.
- It should be noted that the as-built vertical/horizontal alignment and conditions of the existing underground services/footings should be established prior to the design/construction stage, especially in the areas covered by BH1.
- In the area of the existing structure footings/service trenches, the depths of the proposed footings should be established below the existing footings and inverts of the services in

native undisturbed soils, or alternatively could potentially be bridged over the trench backfill (subject to review by a structural engineer).

- The recommended bearing resistance and foundation elevations have been calculated from limited borehole information and are intended for design purposes only.
- More specific information with respect to soil conditions between and beyond the boreholes will be available when the proposed construction is underway. Therefore, the encountered soil/foundation conditions must be verified in the field, and all footings must be inspected and approved by our office prior to placement of concrete.

7.0 EARTHQUAKE CONDITIONS

Seismic Shear Wave Velocity surveys on the site were conducted by GEOPHYSICS GPR INTERNATIONAL INC. on March 27th, 2018 and the summary report attached in Appendix D. Based on the report, the calculated average V_{s30} value for the subject Site is 868.5 m/s, corresponding to the Site Class “B”. It should be noted however, that classification of Site Class A and B are not to be used if there is more than 3 meters of unconsolidated materials between the rock surface and the bottom of the spread footings or mat foundation. Based on the test results, and as the local bedrock is situated at depths of 16-19m, for the shallow foundation design, it is recommended that the Site Class “C” to be used for the proposed site structure design.

8.0 EXCAVATION AND BACKFILL

No major problems should be encountered for the anticipated depths of excavation for the footings / underground utilities. The excavations for footings or underground services must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA). Specifically, if the excavation is deeper than 1.2m, the excavation sides should be sloped in accordance with the requirements of OHSA. If this condition cannot be met, a temporary shoring system/ trench box should be utilized.

In accordance with O. Reg. 213/91, S.226 (1), the Site subsoils within the anticipated excavation depths mainly consist of dense to very dense silty sand till. After removal of the topsoil / fill, the site soils can be designated as Type 1 to 2. Therefore, for open excavation, the bank slopes should be maintained at a 3/4 :1 to 1:1 incline from a depth of 1.2m above excavation bottom.

No groundwater is expected to be encountered during the footing and underground utilities excavations within the designed depths. Occasional water seepage, if any, into the excavations from the more permeable seams/lenses or surface run-off can be handled by conventional pumping methods

The material to be used for backfill in service trenches should be suitable for compaction, i.e. free of organics and with moisture content within ±3 percent of the optimum moisture value. The backfill material should be compacted in lifts of no more than 200mm in thickness and to at least 98 percent of the Standard Proctor Maximum Dry Density (SPMDD) in the upper 1.0m from road subgrade or in settlement sensitive areas. Beyond these zones, a 95% SPMDD compaction criterion is considered acceptable.

Additionally, on site excavated native soils and selected fill materials can be used as backfill in service trenches, provided that the excavated materials are free of organic soils (topsoil / construction) debris and are of suitable moisture content.

It is recommended that Granular Class ‘B’ aggregates be used for backfill against the subsurface walls and footings. Granular materials excavated on-site may be acceptable subject to further site inspection.

9.0 SLAB ON GRADE AND PERMANENT DRAINAGE

For construction of the proposed building with no basement / underground parking, the finished floor slab can be constructed as slab on grade supported by competent native undisturbed silty sand/ silty sand till or an engineered fill pad (subject to design grade).

If engineered fill is required to raise subgrade for slab construction, the engineered fill must be placed on a thoroughly proof-rolled exposed base. Organic soil / topsoil/ fill / construction debris /underside utilities must be removed and the base approved, by engineering staff from our office, prior to placing the engineered fill. Any soft spots observed during proof rolling must be sub- excavated and back filled with suitable granular materials compacted to 98% SPMDD.

Onsite excavated native soils and selected fill materials can be used as engineered fill provided they contain suitable moisture content. The use of granular Class ‘B’ aggregates is however preferred for subgrade construction for slab on grade, especially during the winter time or wet season.

Similarly, it is recommended that granular Class 'B' aggregates be used for backfill against subsurface walls. However, subject to further site inspection, suitable onsite granular materials may be used.

Upon completion of foundation work, the floor slab should rest on a well compacted bed of size 19 mm clear stone of at least 200 mm thick. The stone bed would act as a barrier and prevent capillary rise of moisture from the subgrade to the floor slab.

If the proposed building slab is 200mm higher than the exterior grade, a permanent perimeter drainage may not be required. Otherwise, a permanent perimeter drainage system for open excavation / foundation walls should be provided as shown in the drainage design recommendation at Appendix C. The drains should be connected to a frost-free outlet.

10.0 UNDERGROUND UTILITIES

Pipe bedding and backfill materials specifications and compaction criteria for water and sewer services should be in accordance with the pipe designer's recommendations and/or local municipal requirements.

If the excavation is deeper than 1.2m, the excavation sides should be sloped in accordance with requirements of OHSA. If this condition cannot be met, a temporary shoring system or trench box should be introduced.

For the subject site, it is expected that the underground services will be founded above the water table and situated in a dense to very dense silty sand till. Granular Class 'B' aggregate is considered well suited to be used as bedding material. However, it should be noted, that the recommended type of bedding is to be placed on undisturbed subgrade. If the construction methods will disturb the subgrade i.e. piping, existing footing, boulder removal etc. or existence of excess hydrostatic pressure, then higher-class bedding combined with a geotextile may have to be used.

Onsite excavated fill materials / native soils are considered suitable for re-use in trench backfilling, provided that organics (topsoil) / construction debris are removed and that materials are not allowed to be wet and the moisture content is within ±3% of the optimum moisture content.

In normal sewer construction practice, the problem of road / pavement settlement largely occurs adjacent to manholes, catch basins and service crossings. In these areas, granular materials are generally required for backfill and compaction.

The underground services should be located below the depth of frost penetration of 1.8m and in accordance with City of Ottawa specifications. The City of Ottawa specifies watermains require a soil cover of at least 2.4m. Where the available soil cover is less than the required 2.4m, an equivalent thermal rigid insulation should be applied for frost protection.

11.0 PAVEMENT

It is expected that the associated pavement for driveways and parking areas will be developed on the site. Pavement structures can be constructed on the native soils or engineered fill, subject to design grade and further onsite inspection.

Prior to asphalt pavement construction, topsoil/organic soil/ construction debris should be removed. The exposed subgrade should be proof rolled and supervised / approved by our office. Any soft / spongy spots detected during proof-rolling should be sub-excavated and replaced with suitable materials and compact to 98% of SPMDD. Engineered fill construction, if any, should be supervised and inspected by engineering staff from our office.

The finished subgrade must be contoured / graded and finally proof-rolled and approved by our office before placing upper granular materials.

Granular materials will be used in construction of asphalt pavement bases. Compaction for granular bases should reach 100 % of Standard Proctor Maximum Dry Density.

Perforated drains connected to sewer MHs/ CBs should be provided under the entire length of curb and constructed in accordance with required local regulations.

Typical flexible pavement designs are shown in Table 3.

Table 3: Typical flexible pavement design

	Heavy Duty	**Medium Duty**	**Light Duty**
Asphaltic Concrete	40 mm HL3	40 mm HL3	50 mm HL3
	65 mm HL8	50 mm HL8	
19 mm Crushed Limestone	150 mm	150 mm	200 mm
Granular B Sub-base	300 mm	200 mm	

The pavement thickness should also meet the minimum local region Pavement Design Standards.

The asphalt material should meet the requirements of OPSS 310 for specified grade and be compacted to at least 92.0% of their Maximum Relative Density (MRD).

12.0 GENERAL COMMENTS

This report is limited in scope to those items specifically referenced in the text. The discussions and recommendations presented herein are intended only as guidance for the client named and design engineers. The information on which these recommendations are based is subject to confirmation by engineering personnel at the time of construction.

It should also be noted that localized variations in subsoil conditions may be present between and beyond the boreholes investigated and should be verified during construction. As more specific subsurface information becomes available during excavations on the Site, this report should be updated.

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 soil and the potential reuse of these soils on/off site. The contractors must draw their own conclusions as to how the near surface and subsurface conditions may affect them.

APPENDIX A – SITE PLAN

Fisher Environmental Ltd.

400 Esna Park Dr., #15
Markham, Ontario
L3R 3K2

Tel: 905 475-7755
Fax: 905 475-7718

KEY PLAN

N

LEGEND

⊕ BOREHOLE

PROJECT NAME AND ADDRESS

GEOTECHNICAL INVESTIGATION

1000 McGARRY TERRACE
NEPEAN, ON

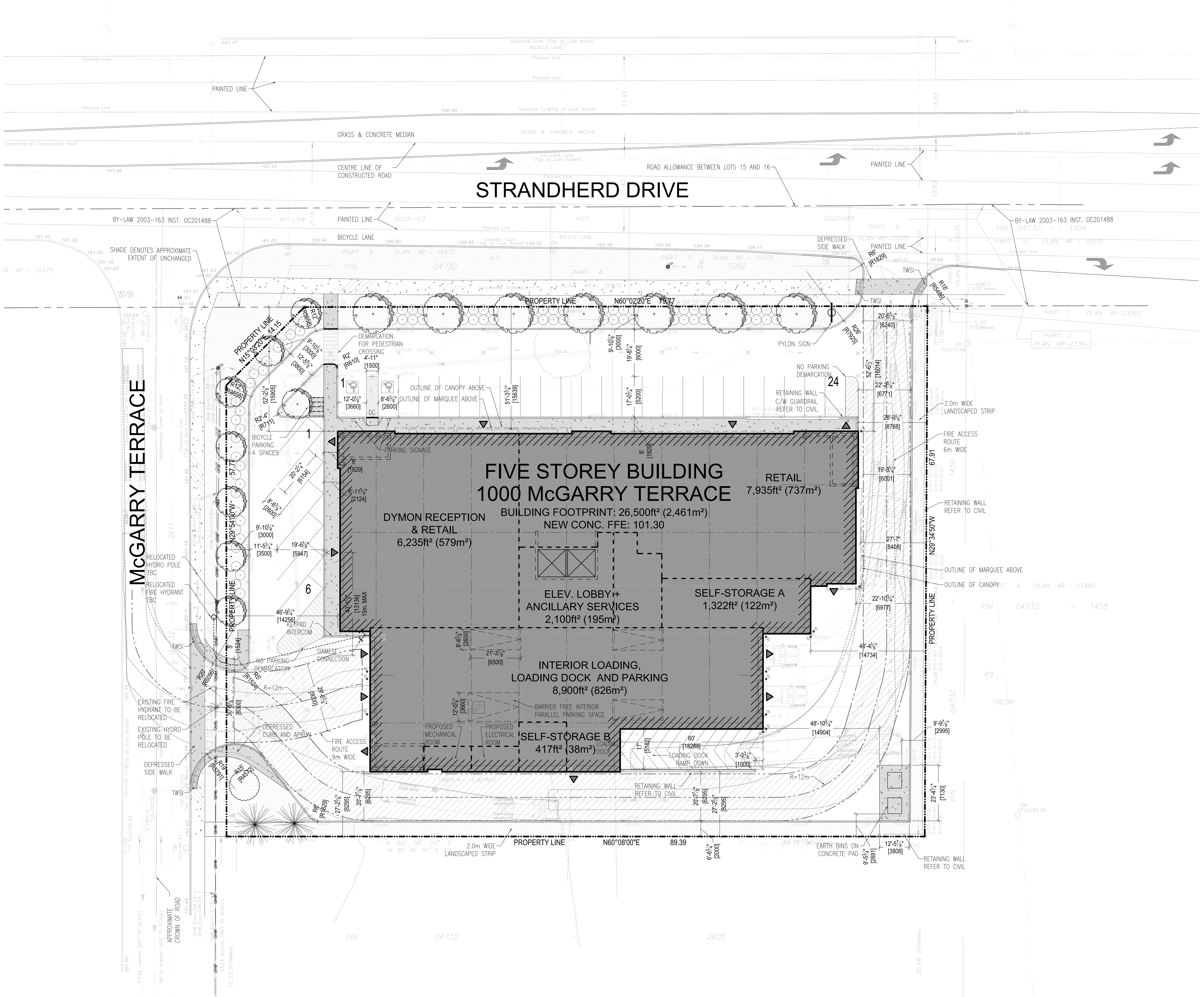
PROJECT NO.
FE-P 18-8637 GEO

DATE
05 OCTOBER 2018

SCALE
AS SHOWN

FIGURE 1:
Site Location Map with Borehole Locations

SHEET NO.
1



1 **SITE PLAN**
A-100 SCALE: 1:250

LEGEND

▨	PROPOSED BUILDING LOCATION
▨	EXISTING NEIGHBORING BUILDINGS
▨	LANDSCAPED AREA
▨	EXISTING PAVERS
▨	CONCRETE/ SIDEWALK
▨	EXISTING CONCRETE/SIDEWALK
▨	BARRIER FREE PARKING CLEARANCE
═	CURB
TWSI	TACTILE WALKING SURFACE INDICATOR
━	DEPRESSED CURB
○	NEW TREE/ VEGETATION (REFER TO LANDSCAPE PLAN FOR TYPE, SIZE AND LOCATION)
○	EXISTING TREE (VEGETATION IS FOR REFERENCE ONLY, REFER TO LANDSCAPE PLAN)
♿	BARRIER FREE PARKING
▭	INTERIOR PARKING
◫	CATCH BASIN
⊤	SIAMESE CONNECTION
▶	ENTRANCE/ EXIT LOCATION
◀✱	PRINCIPAL ENTRANCE
▲	TRANSFORMER
-□-	FENCE & GATE
○	MAN HOLE COVER
● UP	UTILITY POLE
⊕	FIRE HYDRANT
•■	NLS (NEW LIGHT STANDARD, REFER TO ELECTRICAL)
• B	BOLLARD

SITE STATISTICS

LEGAL DESCRIPTION OF PROPERTY:

BLOCK 1
REGISTERED PLAN 4M–1303
CITY OF OTTAWA
SURVEYED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD.
ONTARIO LAND SURVEYORS

ZONING MECHANISM	REQUIRED	PROPOSED
Minimum Lot Area	No minimum	6,027m2
Minimum Lot Width	No minimum	57.7m
Minimum Front Yard Setback	3m	14.27m
Minimum Corner Yard Setback	3m	15.9m
Minimum Interior Side Yard Setback	No minimum	8.29m
Minimum Rear Yard Setback	No minimum	8.7m
Maximum Building Height	20m	23.15m Ave. grading to high point of roof
Minimum Width of Landscaped Area:	3m in a lot abutting a street 1.5m in alot not abutting a street	3m abutting Strandherd Dr. 3m abutting McGarry Terrace
Location of storage:	Must be completely enclosed within a building	Storage enclosed entirely within building
Minimum Parking Space Rates: Section 101	130 spaces	30 3/100m2 of GFA Retail 1+2 6 Interior Loading / Parking
Bicycle Parking Space Rates: Section 111	12	4
Loading Spaces:	2	1
Accessible Parking Space		3 1 Interior Parking/Loading
Landscaped strip abutting South side	–	2.0m
Landscaped strip abutting East side	–	2.0m

LOT AREA	6,027 m2 (100%)	
PAVED AREA	2,587 m2 (42.9%)	
LANDSCAPED AREA	976 m2 (16.3%)	INCLUDES CONC. SIDEWALKS + RAMPS
BUILDING FOOTPRINT	2,461 m2 (40.8%)	

GROSS FLOOR AREA (GFA)

BUILDING FOOTPRINT (INCLUDING INTERIOR LOADING, RETAIL & GROUND FLOOR SELF–STORAGE)	2,461 m² (26,500 ft²)	20 %	
SELF STORAGE GROUND FLOOR	162 m² (1,739 ft²)	1 %	
ELEVATORS LOBBY	195 m² (2,100 ft²)	2 %	20%
TOTAL INT. LOADING & PARKING * AND LOADING DOCK	827 m² (8,900 ft²)	7 %	
TOTAL RECEPTION + DYMON RETAIL *	579 m² (6,235 ft²)	5 %	
TOTAL THIRD PARTY RETAIL	737 m² (7,935 ft²)	6 %	
TOTAL SELF STORAGE **	10,076 m² (108,459 ft²)	80 %	
TOTAL GFA (5–STOREY BLDG.)	12,415 m² (133,629 ft²)	100%	
TOTAL GFA	11,587 m² (124,729 ft²)	WITHOUT INTERIOR LOADING LOADING DOCK & PARKING	

* GROUND FLOOR
** SELF STORAGE INCLUDES GROUND TO FIFTH FLOOR
SECOND TO FIFTH FLOOR: 26,680ft² (2,478m²) PER FLOOR

1. Contractor must verify all job dimensions, all drawings, details, specifications and report any discrepancies to owners before proceeding with work.

2. All drawings and specifications are instruments of service and the property of the architects which must be returned at the completion of the work, and may not be reproduced without their written permission.

ref	description	date
17	FOR SITE PLAN CONTROL	2018 10 03
16	FOR COORDINATION	2018 09 25
15	FOR COORDINATION	2018 07 24
14	FOR CLIENT SIGN OFF	2018 07 19
13	FOR CLIENT SIGN OFF	2018 07 04
12	FOR DISCUSSION	2018 06 27
11	FOR DISCUSSION	2018 06 26
10	FOR COORDINATION	2018 05 31
9	FOR DISCUSSION	2018 05 30
8	FOR DISCUSSION	2018 05 29
7	FOR SITE PLAN CONTROL	2018 02 16
6	FOR COORDINATION	2018 01 22
5	FOR COORDINATION	2017 12 07
4	FOR COORDINATION	2017 11 17
3	FOR DISCUSSION	2017 11 16
2	FOR DISCUSSION	2017 11 13
1	FOR DISCUSSION	2017 11 06

revisions

ONTARIO ASSOCIATION OF ARCHITECTS
NICHOLAS CARAGIANIS
LICENCE
5057

FOR SITE PLAN CONTROL
2018 10 03

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tel: 613-247-0888 fax: 613-247-7730

TRUE NORTH

PROJECT NORTH

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f: 613 237 8289
e: info@ncarchitect.ca
www.ncarchitect.ca

project & location

DYMON SELF-STORAGE
1000 McGARRY TERRACE
OTTAWA, ONT.

CITY FILE NUMBER

title of drawing

SITE PLAN

SCALE 1 : 250
10 0 10 20 30 metres

BOUNDARY INFORMATION FROM SURVEY BY: ANNIS, O'SULLIVAN, VOLLEBEKK LTD.
ONTARIO LAND SURVEYORS
COMPLETED ON SEPTEMBER 27, 2017

scale 1:250
date NOV 2017
drawn by SG / KL
drawing A-100

APPENDIX B – LOG OF BOREHOLES

FISHER ENVIRONMENTAL LTD.

LOG OF BOREHOLE NO. 1 SHEET. 1 of 5

PROJECT NO.: FE-P 18-8637

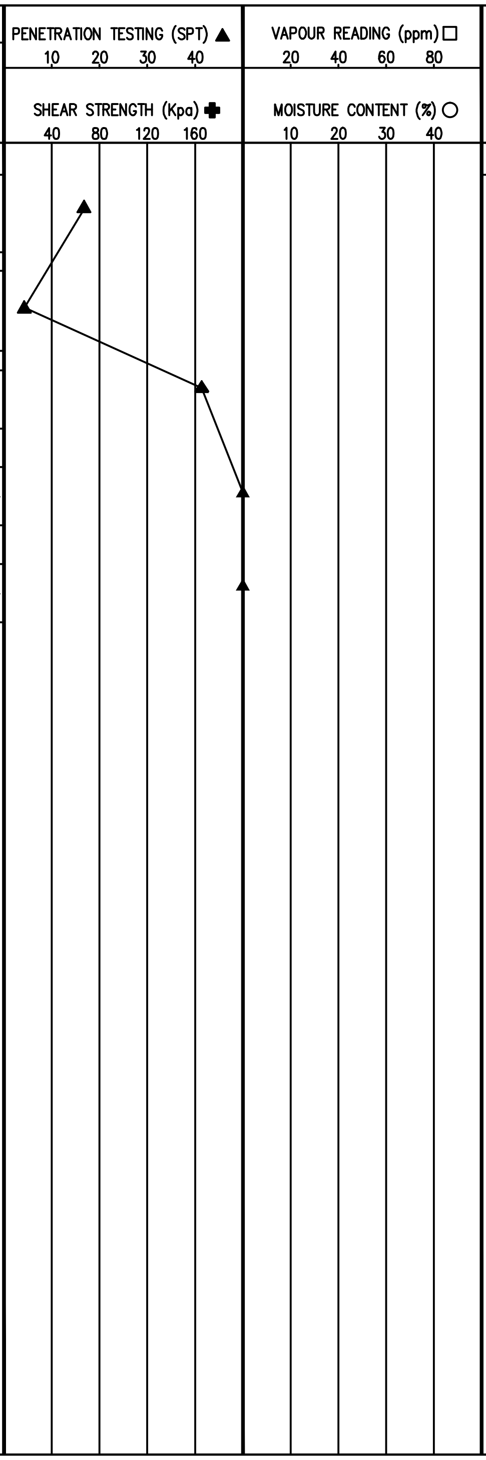
PROJECT NAME: 1000 McGarry Terrace, Nepean, ON

LOCATION: 1000 McGarry Terrace, Nepean, ON

DRILLING METHOD: Hollow Stem

DRILLING DATE: 6 February 2018

SOIL PROFILE			SAMPLES			PIEZOMETER OR WELL CONSTRUCTION
DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	"N" VALUE	
GROUND SURFACE (m asl)		99.50m				
FILL: Silt, some Sand, trace Gravel, organics, rootlets, straw pieces, dark brown, moist, compact some organics @ 2.5' black 98.59m	▨		1	SS	17	
SILTY SAND TILL: Trace Gravel, brown, moist, dense to very dense Dark Brown, silty sand at upper 1' slightly wet	▒	98.59m	2	SS	4	
			3	SS	42	
			4	SS	100+	
			5	SS	100+	
Auger Refusal at 13.5'						
End of Borehole 4.11m		95.39m				



Groundwater Depth (m): On Completion: Dry.

LOGGED: ZV

CHECKED: FF

FISHER ENVIRONMENTAL LTD.

LOG OF BOREHOLE NO. 2 SHEET. 2 of 5

PROJECT NO.: FE–P 18–8637

PROJECT NAME:1000 McGarry Terrace, Nepean, ON

LOCATION: 1000 McGarry Terrace, Nepean, ON

DRILLING METHOD: Hollow Stem

DRILLING DATE: 6 February 2018

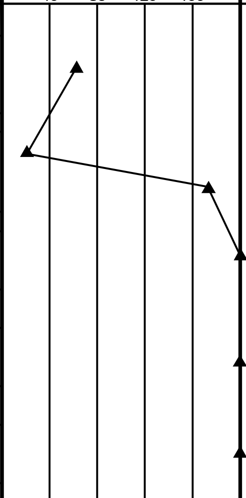
SOIL PROFILE			SAMPLES		
DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	"N" VALUE
GROUND SURFACE (m asl)		99.75m			
FILL: Silt, some organics, trace Sand pockets, rootlets, dark brown, moist, loose to compact	▩		1	SS	16
		98.68m	2	SS	5 43
SILTY SAND TILL: Trace Gravel, brown, moist, dense to very dense.	▒		3	SS	90
			4	SS	100+
		96.09m	5	SS	100+
End of Borehole 3.66m					

DEPTH (feet)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32

DEPTH (metres)	0	1	2	3	4	5	6	7	8	9	10

PENETRATION TESTING (SPT) ▲ 10 20 30 40

SHEAR STRENGTH (Kpa) ✚ 40 80 120 160



VAPOUR READING (ppm) ☐ 20 40 60 80

MOISTURE CONTENT (%) ○ 10 20 30 40

PIEZOMETER OR WELL CONSTRUCTION

Groundwater Depth (m): On Completion: Dry.

LOGGED: ZV

CHECKED: FF

LOG OF BOREHOLE

NO. 3 SHEET. 3 of 5

PROJECT NO.: FE-P 18-8637

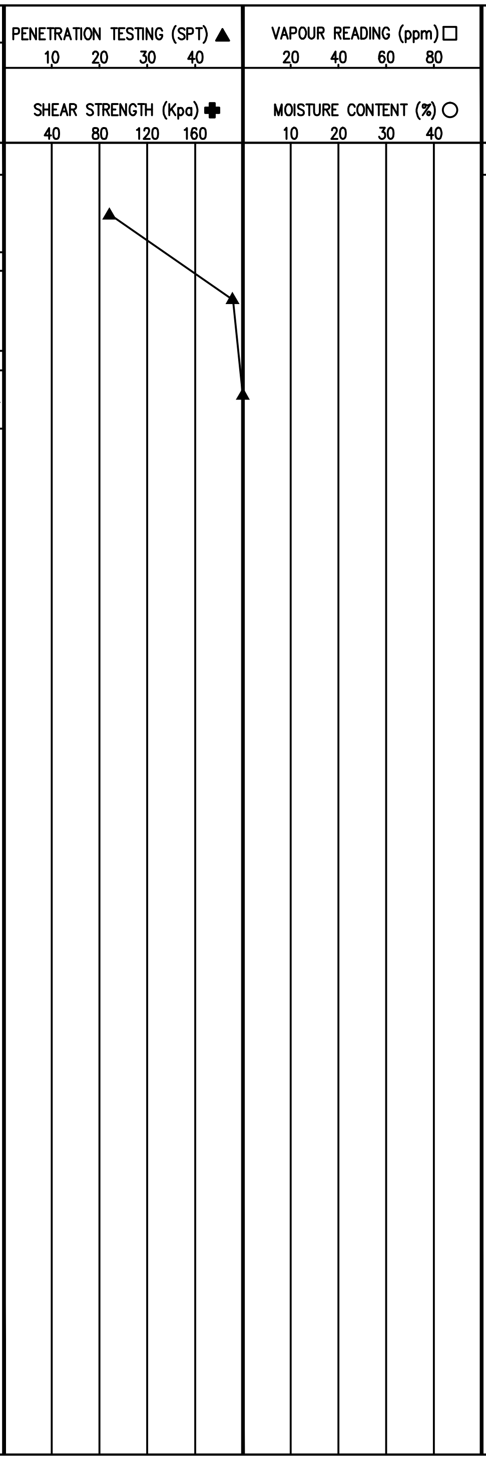
PROJECT NAME: 1000 McGarry Terrace, Nepean, ON

LOCATION: 1000 McGarry Terrace, Nepean, ON

DRILLING METHOD: Hollow Stem

DRILLING DATE: 6 February 2018

DEPTH (feet)	DEPTH (metres)	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	"N" VALUE	PIEZOMETER OR WELL CONSTRUCTION
		GROUND SURFACE (m asl)		99.30m				
0	0	FILL: Sand and Gravel, some Asphalt, trace Clay pockets, dark Brown, moist, compact		98.54m	1	SS	22	
2–6	1–2	SILTY SAND TILL: Reddish Brown at the upper 1' Trace Gravel, brown, moist, dense to very dense.		97.32m	2	SS	47	
					3	SS	100+	
		Auger Refusal at 6.5' End of Borehole 1.98m						



Groundwater Depth (m): On Completion: Dry.

LOGGED: ZV

CHECKED: FF

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LOG OF BOREHOLE NO. 4 SHEET. 4 of 5

PROJECT NO.: FE-P 18-8637

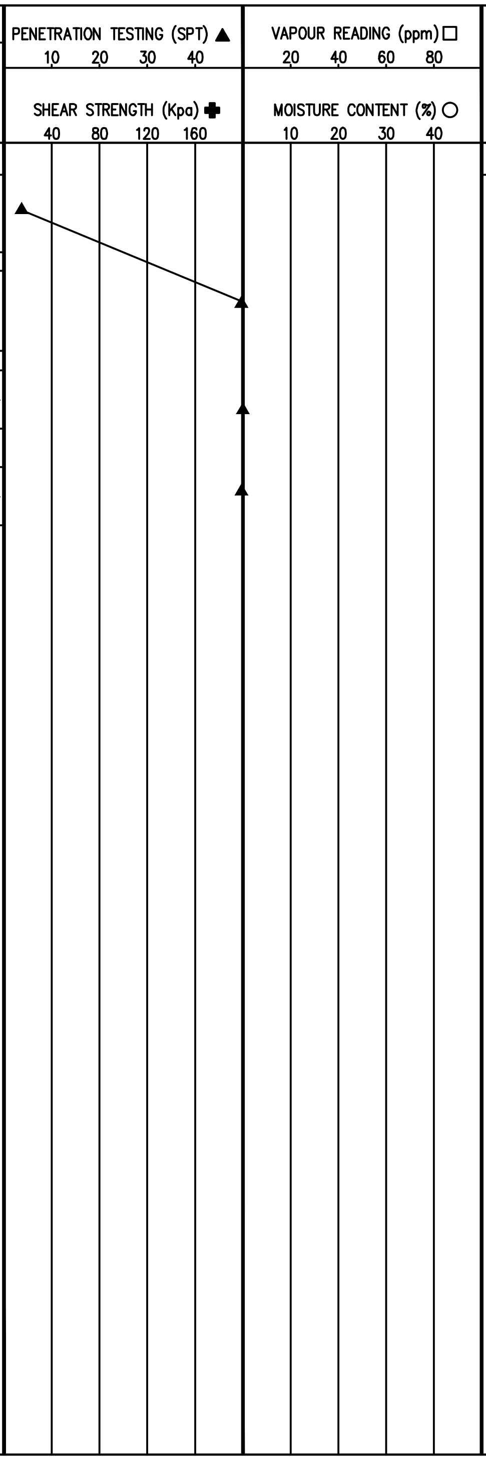
PROJECT NAME:1000 McGarry Terrace, Nepean, ON

LOCATION: 1000 McGarry Terrace, Nepean, ON

DRILLING METHOD: Hollow Stem

DRILLING DATE: 6 February 2018

DEPTH (feet)	DEPTH (metres)	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	"N" VALUE
		GROUND SURFACE (m asl)		98.50m			
0	0	FILL: Silt, some organics, trace Sand, brick, rootlets, dark brown, moist, loose		97.74m	1	SS	4
	1	SILTY SAND TILL: Trace Gravel, brown, moist, very dense.			2	SS	60
	2				3	SS	100+
8		Auger Refusal at 8.5'		95.91m	4	SS	100+
		End of Borehole 2.59m					



PIEZOMETER OR WELL CONSTRUCTION

Groundwater Depth (m): On Completion: Dry.

LOGGED: ZV

CHECKED: FF

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LOG OF BOREHOLE NO. 5 SHEET. 5 of 5

PROJECT NO.: FE-P 18-8637

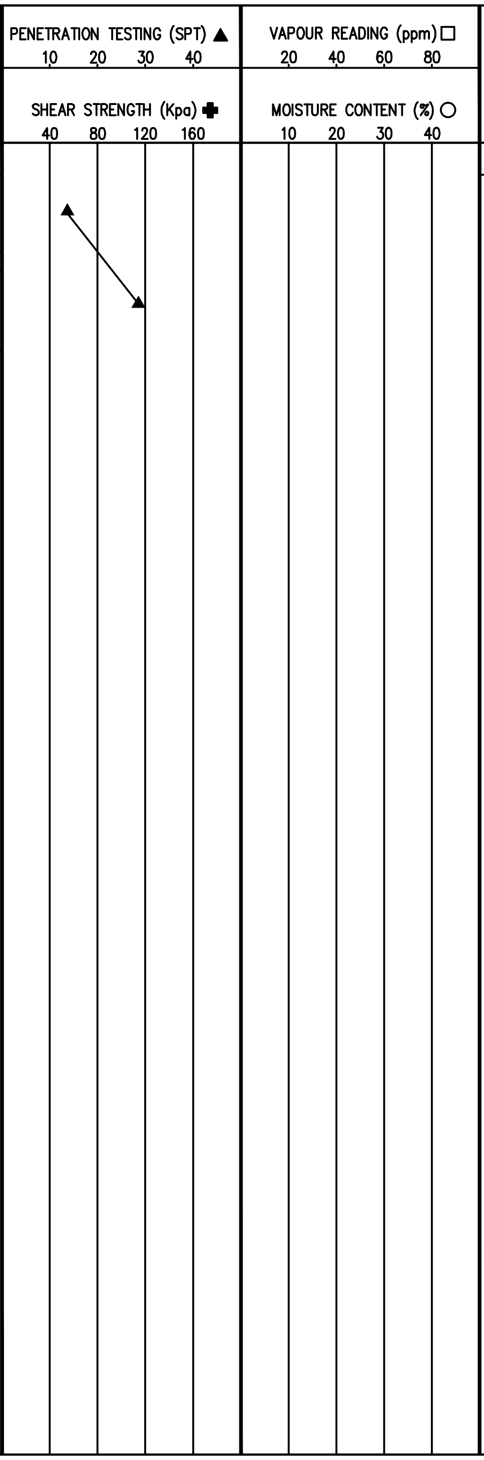
PROJECT NAME: 1000 McGarry Terrace, Nepean, ON

LOCATION: 1000 McGarry Terrace, Nepean, ON

DRILLING METHOD: Hollow Stem

DRILLING DATE: 6 February 2018

DEPTH (feet)	DEPTH (metres)	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUE	PIEZOMETER OR WELL CONSTRUCTION
		GROUND SURFACE (m asl)		98.25m				
0	0	FILL: Silt, some Sand, trace Gravel, organics, rootlets, dark Brown, moist	▩		1	SS	12	
	1	SILTY SAND TILL: Trace Gravel, brown, moist, compact. Auger Refusal at 5'	▥	97.34m	2	SS	28	
				96.73m				
		End of Borehole 1.52m						

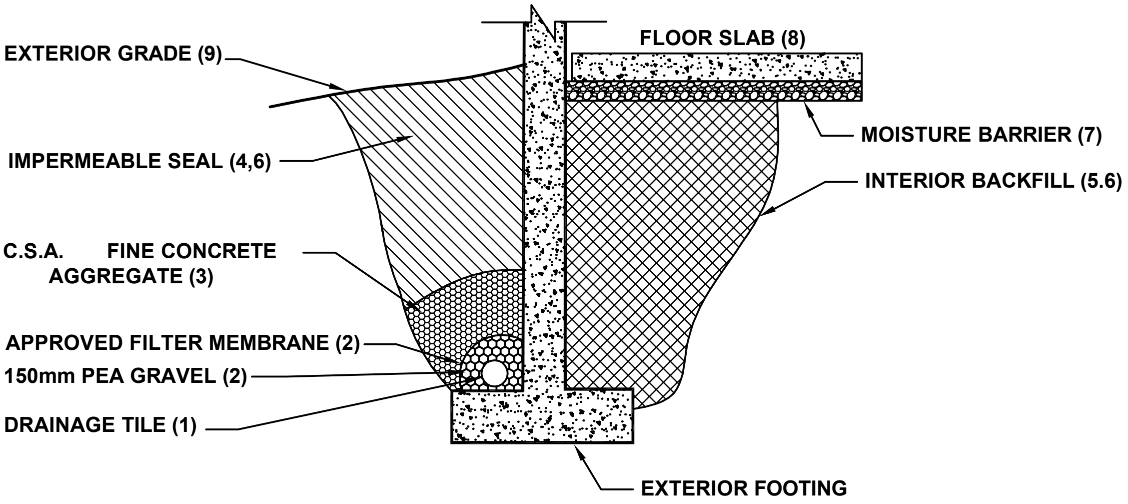


Groundwater Depth (m): On Completion: Dry.

LOGGED: ZV

CHECKED: FF

APPENDIX C– DRAINAGE AND BACKFILL RECOMMENDATIONS



NOTES:

(1) DRAINAGE TILE TO CONSIST OF 100mm (4") DIAMETER WEEPING TILE OR EQUIVALENT PERFORATED PIPE LEADING TO A POSITIVE SUMP OR OUTLET. INVERT TO BE A MINIMUM OF 150MM (6") BELOW UNDERSIDE OF FLOOR SLAB.

(2) PEA GRAVEL-150mm (6") TOP AND SIDE OF DRAIN. IF DRAIN IS NOT ON FOOTING, PLACE 100mm (4") OF PEA GRAVEL BELOW DRAIN. 20mm (3/4") CLEAR STONE IS AN ALTERNATIVE PROVIDED IT IS SURROUNDED BY AN APPROVED FILTER FABRIC (TERRAFIX 270R OR EQUIVALENT).

(3) C.S.A. FINE CONCRETE AGGREGATE TO ACT AS FILTER MATERIAL. MINIMUM 300mm (12") TOP AND SIDE OF TILE DRAIN. THIS MAY BE REPLACED BY AN APPROVED FILTER FABRIC AS INDICATED IN (2).

(4) IMPERMEABLE BACKFILL SEAL - COMPACTED CLAY, CLAYEY SILT OR EQUIVALENT. IF ORIGINAL SOIL IS FREE-DRAINING, SEAL MAY BE OMITTED.

(5) THE ENTIRE FILL MAY BE ANY CLEAN NON-ORGANIC SOIL WHICH CAN BE COMPACTED TO THE SPECIFIED IN THIS CONFINED SPACE.

(6) DO NOT USE HEAVY COMPACTION EQUIPMENT WITHIN 450mm (18") OF THE WALL. DO NOT FILL OR COMPACT WITHIN 1.8m(6') OF THE WALL UNLESS FILL IS PLACED ON BOTH SIDES SIMULTANEOUSLY.

(7) MOISTURE BARRIER TO BE AT LEAST 200mm (8") OF COMPACTED CLEAR 20mm (3/4") STONE.

(8) SLAB ON GRADE SHOULD NOT BE STRUCTURALLY CONNECTED TO THE WALL OR FOOTING.

(9) EXTERIOR GRADE TO SLOPE AWAY FROM BUILDING.

(10) THIS SYSTEM IS NOT NORMALLY REQUIRED IF THE FLOOR SLAB IS AT LEAST 300mm (1') ABOVE THE EXTERIOR GRADE.

DRAINAGE AND BACKFILL RECOMMENDATIONS

FOR SLAB ON GRADE CONSTRUCTION
(NOT TO SCALE)

APPPENDIX D-SEISMIC SHEAR WAVE VELOCITY SURVEYS

GEOPHYSICS GPR INTERNATIONAL INC.

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April 6th, 2018

Transmitted by email: Sean@fisherenvironmental.com
Our Ref.: GPR-18-00488

Mr. Sean Fisher, M.Sc.
Project Manager
Fisher Environmental Ltd.
400 Esna Park Dr #15
Markham (ON) L3R 3K2

Subject: **Shear Wave Velocity Sounding for the Site Class Determination**
1000, McGarry Terrace, Nepean, Ottawa (ON)

Dear Sir,

Geophysics GPR International Inc. has been requested by Fisher Environmental Ltd. to carry out seismic shear wave surveys on a vacant field located at 1000, McGarry Terrace, in Ottawa (ON). The geophysical investigations used the Multi-channel Analysis of Surface Waves (MASW), the Extended SPatial AutoCorrelation (ESPAC), and the seismic refraction methods. From the subsequent results, the $\overline{V}_{S30}$ value was calculated to identify the Site Class.

The surveys were carried out, on March 27th, by Mr. Alexis Marchand and Mr. André Beaudoin, Sr.Tech. Figure 1 shows the regional location of the site and Figure 2 illustrates the location of the seismic spreads. Both figures are presented in the Appendix.

The following paragraphs briefly describe the survey design, the principles of the test methods, and the results in graphic and table format.

METHODS PRINCIPLES

MASW Survey

The *Multi-channel Analysis of Surface Waves* (MASW) and the *Extended SPatial AutoCorrelation* (ESPAC or MAM for *Microtremors Array Method*) are seismic methods used to evaluate the shear wave velocities of subsurface materials through the analysis of the dispersion properties of the Rayleigh surface waves ("ground roll"). The MASW is considered an "active" method, as the seismic signal is induced at known location and time in the geophones spread axis. Conversely, the ESPAC is considered a "passive" method, using the low frequency "noises" produced far away. The method can also be used with "active" seismic source records. The dispersion properties are expressed as a change of phase velocities with frequencies. Surface wave energy will decay exponentially with depth. Lower frequency surface waves will travel deeper and thus be more influenced by deeper velocity layering than the shallow higher frequency waves. The inversion of the Rayleigh wave dispersion curve yields a shear wave (V_S) velocity depth profile (sounding). Figure 3 schematically outlines the basic operating procedure for the MASW method.

Figure 4 illustrates an example of one of the MASW/ESPAC records, the corresponding spectrogram analysis and resulting 1D V_S model. The ESPAC method allows deeper Vs soundings, but generally with a lower resolution for the surface portion. Its dispersion curve can then be merged with the higher frequency one from the MASW to calculate a more complete inversion.

Seismic Refraction Survey

The method consists in measuring the propagation delays of the direct and refracted seismic waves (P and/or S) produced by an artificial source in the axis of a seismic linear spread. The seismic velocities of the materials can be directly calculated, then the refractors depths.

INTERPRETATION METHODS

MASW Surveys

The main processing sequence involved data inspection and edition when required; spectral analysis ("phase shift" for MASW, and "cross-correlation" for ESPAC); picking the fundamental mode; and 1D inversion of the MASW and ESPAC shot records using the SeisImagerSW™ software. The data modelling and inversions used a nonlinear least squares algorithm.

In theory, all the shot records for a given seismic spread should produce a similar shear-wave velocity profile. In practice, however, differences can arise due to energy dissipation, local surface seismic velocities variations, and/or dipping of overburden layers or rock. In general, the precision of the calculated seismic shear wave velocities (V_S) is of the order of 15% or better.

Seismic Refraction surveys

The considered seismic wave's arrival times were identified for each geophone. The General Reciprocal Method was used, with signal sources at both ends of the seismic spreads, to consider seismic wave propagation for two opposite directions. The measurements were produced to calculate the rock depth, and its seismic velocity (using P waves). The rock seismic velocities (V_S) were calculated using two methods: the reduced travel-times (the Hobson and Overton method) and the opposite apparent velocities. Conversely to the MASW method, the seismic rock velocity calculated by seismic refraction is only representative of its superior part, due to the evanescent nature of the refracted wave.

More detailed descriptions of these methods are presented in *Shear Wave Velocity Measurement Guidelines for Canadian Seismic Site Characterization in Soil and Rock*, Hunter, J.A., Crow, H.L., et al., Geological Surveys of Canada, General Information Product 110, 2015

SURVEY DESIGN

The seismic acquisition spreads were located on a vacant field, perpendicular to Strandherd Road, along McGarry Terrace (cf. figure 2). The geophone spacing for the main spread was of 3 metres, using 24 geophones. A shorter seismic spread, with geophone spacing of 1 metre, was dedicated to the near surface materials.

The seismic records counted 4096 data, sampled at 1000 µs for the MASW surveys, and 4096 data, sampled at 50 µs for the seismic refraction. The records included a pre-trig portion of 10 ms. A stacking procedure was also used to improve the Signal / Noise ratio for the seismic records.

Unlike the refraction method, which allows producing a result point beneath each geophone, the shear wave depth sounding can be considered as the average of the bulk area within the geophone spread, especially for its central half-length. The seismic records were made with a seismograph Terraloc MK6 (from ABEM Instrument), and the geophones were 4.5 Hz. A 10 kg sledgehammer was used as the energy source with impacts being recorded off both ends of the seismic spreads.

RESULTS

From seismic refraction surveys, the rock was calculated between 16 and 19 metres deep (± 10%), and it could be overlain with a (very) dense unconsolidated material. The rock shear wave seismic velocity (V_S) was calculated between 1980 and 2640 m/s for the upper portion, with an average velocity of 2310 m/s. These results were used as initial parameters for the basic geophysical model, prior to the MASW dispersion curves inversions.

The MASW calculated V_S results are illustrated at figure 5, and they are also presented at Table 1.

The $\overline{V}_{S30}$ value results from the harmonic mean of the shear wave velocities, from the surface to 30 metres deep. It is calculated by dividing the total depth of interest (30 metres) by the sum of the time spent in each velocity layer from the surface up to 30 metres. This value represents an equivalent homogeneous single layer response.

The calculated $\overline{V}_{S30}$ value for the actual site is 868.5 m/s, corresponding to the Site Class “B”. However, the Site Classes A and B are not to be used if there is more than 3 metres of unconsolidated materials between the rock surface and the bottom of the spread footing or the mat foundation.

CONCLUSION

Geophysical surveys were carried out on a vacant field, located south-east of the intersection of Strandherd Drive and McGarry Terrace, Nepean, in Ottawa (ON). The seismic surveys used the MASW, ESPAC analysis methods, as well as the complementary seismic refraction method, to calculate the $\overline{V}_{S30}$ value for the Site Class determination. The $\overline{V}_{S30}$ calculation is presented in Table 1.

The $\overline{V}_{S30}$ value of the actual site is 869 m/s. Considering this value (determined through the MASW, the ESPAC and the seismic refraction methods), Table 4.1.8.4.A of the CNBC, and the Building Code, O. Reg. 332/12, the investigated site presents a site class “B” ($760 < \overline{V}_{S30} \leq 1500$ m/s). Nevertheless, seismic refraction results suggested rock depth between 16 and 19 metres deep (± 10%). According to the Building Code, the Site Classes A and B are not to be used if there is more than 3 metres of unconsolidated materials between the rock surface and the bottom of the spread footing or the mat foundation.

It must be noted that other geotechnical information gleaned on site; including the presence of liquefiable soils, soft clays, high moisture content etc. can supersede the Site Classification provided in this report based on the $\overline{V}_{S30}$ value.

The V_S values calculated are representative of the in-situ materials and are not corrected for the total and effective stresses.

Jean-Luc Arsenault, M.A.Sc., P.Eng.
Project Manager

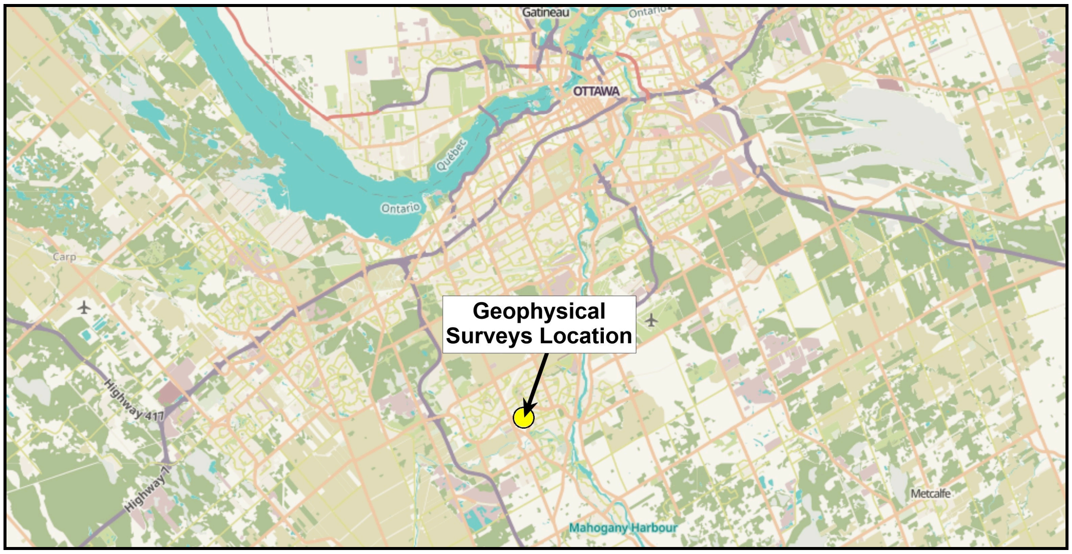


Figure 1: Regional location of the Site
(source: *OpenStreetMap©*)

Figure 2: Location of the seismic spreads
(source: *Google Earth*™)

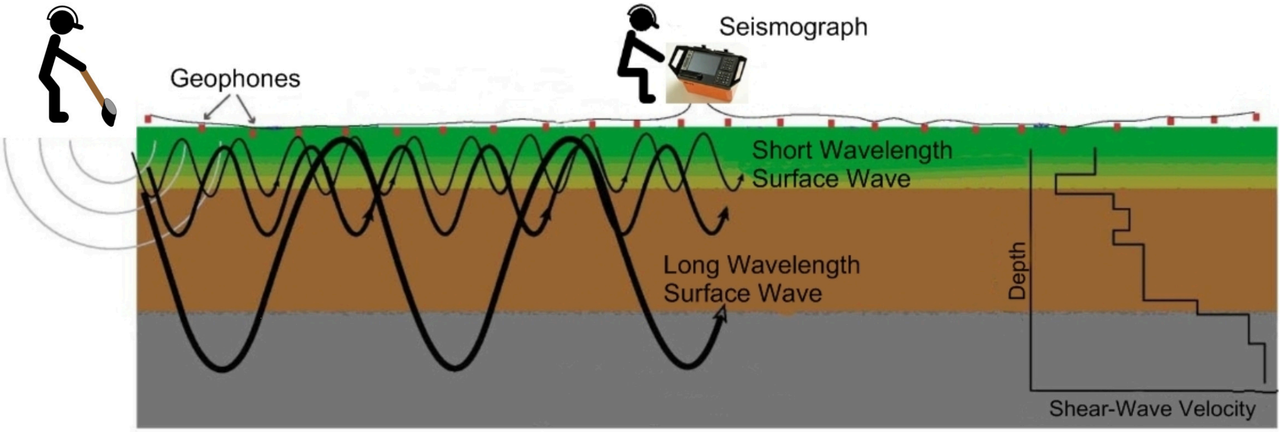
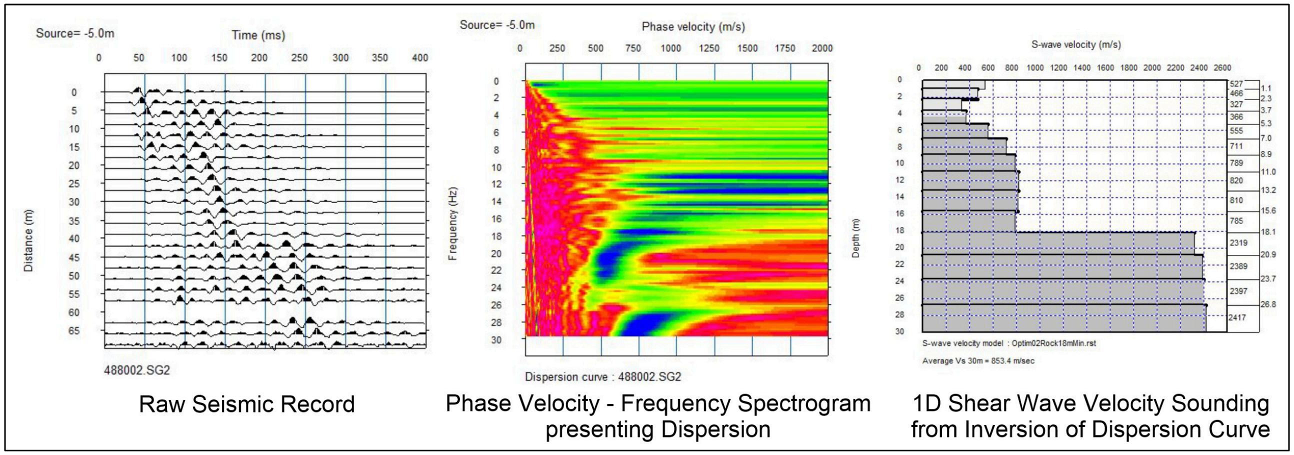


Figure 3: MASW Operating Principle



Raw Seismic Record

Phase Velocity - Frequency Spectrogram presenting Dispersion

1D Shear Wave Velocity Sounding from Inversion of Dispersion Curve

Figure 4: Example of a MASW/ESPAC record, Phase Velocity - Frequency curve and resulting 1D Shear Wave Velocity Model

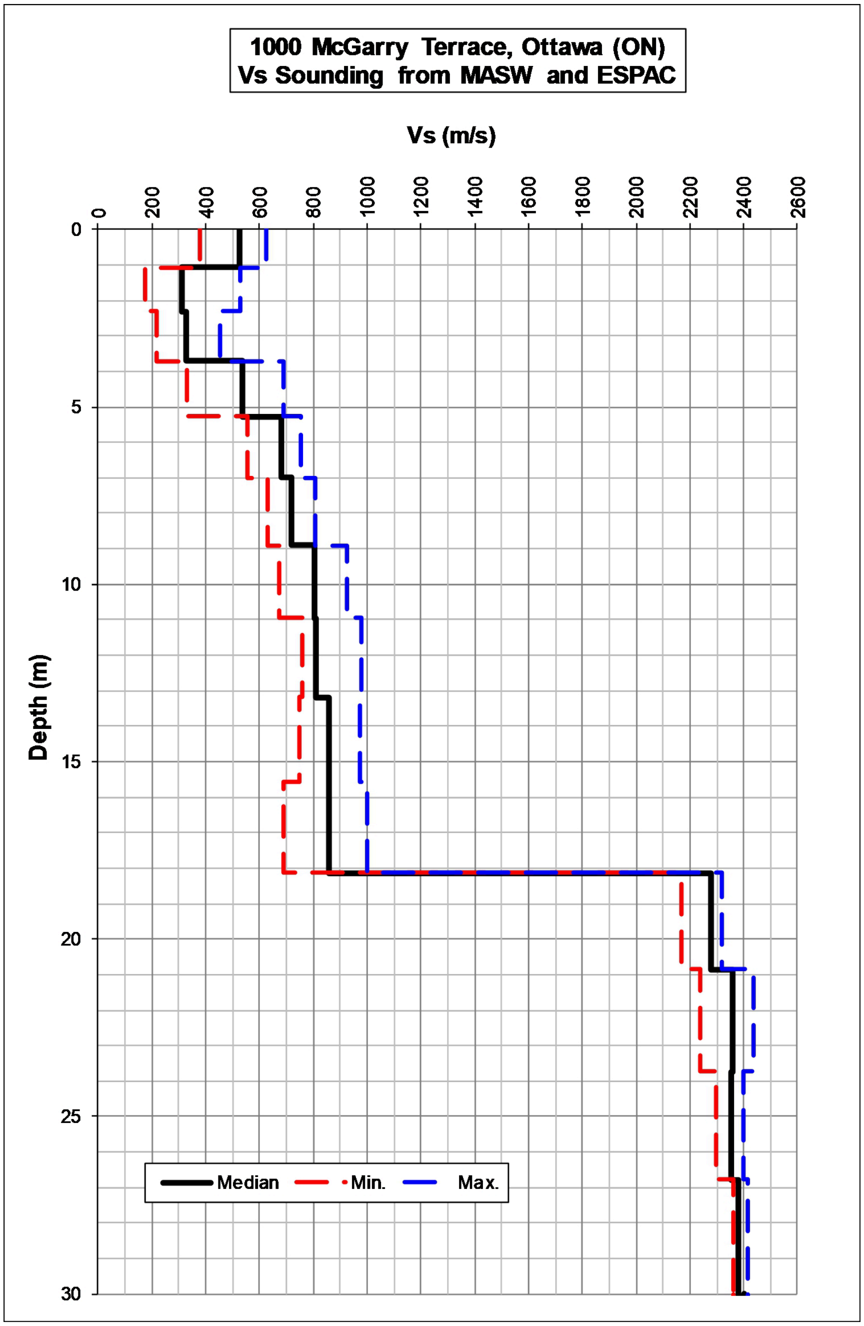


Figure 5: MASW Shear-Wave Velocities Sounding

TABLE 1

V_{S30} Calculation for the Site Class

Depth	Vs			Thickness	Cumulative Thickness	Delay for Med. Vs	Cumulative Delay	Vs at given Depth
	Min.	Median	Max.					
(m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(s)	(s)	(m/s)
0	376.6	527.8	622.7					
1.07	176.2	311.3	527.4	1.07	1.07	0.002030	0.002030	527.8
2.31	219.2	325.0	450.7	1.24	2.31	0.003971	0.006002	384.5
3.71	330.9	537.8	689.5	1.40	3.71	0.004312	0.010313	359.6
5.27	555.3	683.1	755.6	1.57	5.27	0.002912	0.013225	398.8
7.01	631.8	716.5	804.5	1.73	7.01	0.002534	0.015759	444.6
8.90	670.8	802.8	922.5	1.90	8.90	0.002646	0.018404	483.6
10.96	756.2	811.1	980.4	2.06	10.96	0.002567	0.020971	522.7
13.19	746.9	857.0	975.5	2.23	13.19	0.002744	0.023715	556.1
15.58	690.7	858.4	998.3	2.39	15.58	0.002789	0.026504	587.7
18.13	2167.2	2281.0	2319.0	2.55	18.13	0.002977	0.029480	615.1
20.85	2239.4	2356.6	2436.2	2.72	20.85	0.001192	0.030672	679.8
23.74	2295.4	2353.0	2397.4	2.88	23.74	0.001224	0.031897	744.2
26.79	2361.3	2380.7	2417.3	3.05	26.79	0.001296	0.033193	807.0
30	2361.3	2380.7	2417.3	3.21	30.00	0.001350	0.034543	868.5

V_{S30} (m/s)	**868.5**
Class	**B** (1)

(1): The Site Classes A and B are not to be used if there is more than 3 metres of unconsolidated materials between the rock surface and the lower portion of the foundations. The seismic refraction results suggested the rock to be at least 16 metres deep (± 10%).