DRAFT

Geotechnical Investigation

185 Mill Street, Gananoque, Ontario

Client

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Attn: Mr. Brett Vukets

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KIN-00026260-A0

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1. Introduction

Exp Services Inc. (**exp**) was retained by Brennan Custom Homes Inc. to complete a Phase I Environmental Site Assessment (ESA) and Geotechnical Investigation at 185 Mill Street, Gananoque, Ontario, hereinafter referred to as the 'Site'. The following report will discuss the information pertaining to the Geotechnical Investigation. The Phase I ESA was reported under a separate cover. At the time of the investigation, the Site was owned by Mill Street Property Ltd.

1.1 Objective

The purpose of this investigation was to assess the current soil and groundwater (if present) conditions at 19 borehole locations throughout the property. All of the relevant data has been summarized in this report, which presents the findings, and geotechnical comments and recommendations for the proposed development.

1.2 Scope of Work

The scope of work for this Geotechnical Investigation included the following:

- Request local utility locating companies (e.g., telephone, gas, hydro) to mark any underground utilities present at the Site;
- Retain a private utility locating company to mark any underground utilities present in the vicinity of the borehole locations and to clear the individual borehole locations;
- Advance a total of 19 boreholes at the Site to a maximum depth of approximately 9.60 metres below grade;
- Construct a total of nine overburden test pits (TP-1 through TP-6, TP-4B, TP-9 and TP-10) around the exterior of the buildings for geotechnical purposes and two overburden test pits in each building interior (TP-7, TP-8, TP-11 and TP-12);
- Instrument five of the boreholes as monitoring wells, screened within the overburden (MW13-1 through MW13-5) and seven of the boreholes as monitoring wells, screened within the shallow bedrock (BW13-1 through BW13-7);
- Complete an elevation survey of all newly installed and existing monitoring wells to assist in determination of the groundwater flow direction in the shallow groundwater beneath the Site; and,
- Analyze the data and prepare a report of the findings.

2. Site Description and Geology

2.1 General Site Description

The Site, located at 185 Mill Street is situated on the north-east side of Mill Street and south-west shore of the Gananoque River (Figure 1). The Site is approximately rectangular in shape and measured approximately 0.57 hectares. Two buildings are situated on the property (Figure 2). The northern building ("stone building") was constructed circa 1869 and the southern building ("brick building") was constructed circa 1897. The buildings are presently vacant and unoccupied with the doors and windows boarded up. There are remnants of a third building located at the southeast end of the property. The majority of the exterior grounds are graded with gravel. A boat launch and dock are situated along the shore of the Gananoque River at the north-east end of the Site. The Site slopes north-easterly from Mill Street toward the Gananoque River.

The approximate Universal Transverse Mercator (UTM) coordinates for the Site centroid was NAD83 18-407431 E 4908756 N. The UTM coordinates were based on measurements obtained from Google Earth. The accuracy of the centroid was estimated to range from 10 to 15 m.

The Site is legally described as "Lot 1020, part of lots 1021, 1017, 1018, 1019, W Gananoque River, Plan 86 as in G7817, Part of the Bed of the Gananoque River in Leeds County, plan 86, Part of the Canal Reserve, W Gananoque River, Plan 86, Gananoque". The property identification number (PIN) for the Site is 44249-0189(LT). At the time of the investigation, the Site was owned by Mill Street Property Ltd.

2.2 Current and Proposed Property Uses

At the time of this investigation, two buildings that were formerly used for industrial purposes, a parking area, and a boat launch were situated at the Site. Accordingly, the current use of the Site is considered industrial. Reportedly, the Site is to be redeveloped as a residential condominium development.

2.3 Geology

The following information sources were reviewed, to determine the nature of the subsurface materials of the Site:

1. "Geological Highway Map" Map 2441, Ontario Geological Survey, 1979.
2. "Physiography of the Eastern Portion of Southern Ontario" Map 2227, Ont. Dept. of Mines and Northern Affairs, 1972.

Physiography mapping indicates that the subject site is situated within a physiographic formation known as shallow till and rock ridges.

The geological map indicates that the area is located near the division of two (2) geological formations of the late to middle Precambrian age and Cambrian age, including: Felsic intrusive rocks including granite, granophyre, granodiorite, quartz diorite, quartz monzonite, syenite, trondhjemite, and derived gneisses; and Potsdam or Nepean formation, including sandstone.

3. Methodology

3.1 General Overview

The Site investigative activities consisted of the drilling of boreholes to facilitate the collection of soil samples for geologic characterization and chemical analysis and the installation of monitoring wells for hydrogeologic property characterization and the collection of groundwater samples for chemical analysis.

Soil samples were collected at continuous intervals using split spoon sampling devices advanced ahead of the hollow stem augers, where applicable. Monitoring wells were constructed in the boreholes by a MOE licensed well contractor using manufactured well components (i.e., PVC riser pipes and screens) and materials (i.e., sand pack and grout) from documented sources.

3.2 Drilling Program

Prior to the commencement of drilling activities, the locations of underground utilities including telephone, natural gas, electrical lines were marked out by public locating companies. In addition, a private utility locating service was also retained to mark private services.

The fieldwork for this investigation was carried out on May 27th through May 31st and June 3rd, 2013. A total of 19 boreholes (BH-1 through BH-12 and BW13-1 through BW13-7) were advanced at the Site by Canadian Environmental Drilling Ltd. of Inverary, Ontario, a MOE-licensed well contractor, under the full-time supervision of **exp** field staff. The borehole locations are shown in Figure 3.

The boreholes were advanced on level land to completion depths ranging from 0.53 to 9.60 m below grade, using a truck mounted drilling machine equipped with hollow stem augers, split spoons and diamond bit core barrels. During borehole advancement, continuous split spoon sampling and/or auger grab sampling was conducted in order to define the subsurface stratigraphy, record SPT 'N' values, and to collect soil samples.

At the base of boreholes BH-11 and BH-13-1 through BH-13-7, a minimum of two (2) metre long bedrock cores were obtained using HQ sized diamond core barrels to prove bedrock. Piezometers were installed in boreholes BH-4 through BH-7, BH-12 and BH-13-1 through BH-13-7 to collect environmental samples and observe groundwater levels during the field investigation.

3.3 Test Pitting

Prior to the commencement of test pitting activities, the locations of underground utilities including telephone, natural gas, electrical lines were marked out by public locating companies. In addition, a private utility locating service was also retained to mark private services.

The fieldwork for the test pitting investigation was undertaken on June 4, 2013. The exterior test pitting was conducted for geotechnical purposes only while the interior test pitting was conducted for both geotechnical and for the collection of soil samples.

A total of 13 test pits (TP-1 through TP-12 and TP-4B) were constructed at the Site by Canadian Environmental Drilling Ltd. of Inverary, Ontario, using a Kubota mini excavator, under the full-time supervision of **exp** field staff. Nine of the test pits (TP-1 through TP-6, TP-9, TP-10 and TP-4B) were constructed around exteriors of the buildings for geotechnical purposes while four test pits (TP-7, TP-8, TP-11 and TP-12) were constructed inside the building interiors. The test pit locations are shown in Figure 3.

3.4 Elevation Survey

Vertical control of the newly installed boreholes/monitoring wells was obtained by conducting an elevation survey using a Nikon AX-1 Automatic Level in relation to a local benchmark. The benchmark was the top nut of a fire hydrant situated at the northwest corner of the intersection of Mill and Clarence Streets, with an assumed elevation of 100.00 m above mean sea level (AMSL).

4. Subgrade and Subsurface Conditions

4.1 General Overview

Details of the soils encountered during the drilling program are summarized on the attached borehole logs (Appendix B). The borehole logs include textural descriptions of the subsoil in accordance with the Unified Soil Classification System (USCS) and indicate the soil boundaries inferred from non-continuous sampling and observations during the borehole advancement. These boundaries reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. When reading this report and the attached borehole logs, the explanatory notes and definitions provided in Appendix B should be referenced.

4.2 Stratigraphy

The general stratigraphy at the Site, as revealed in the boreholes, consists of silty clay, sand, gravel and/or cobble fill underlain with dolostone over calcite bedrock. Varying occurrences of sand, gravel and rocks were encountered in the overburden material. Coal was observed at five locations and wood fill was observed at three locations. Dolostone bedrock at the Site ranged from ground surface to 4.57 metres below grade. Calcite bedrock at the Site ranged from 2.81 to 6.50 metres. The surficial and subsurface materials encountered at the borehole locations are summarized as follows:

- BH-1: Silty clay fill with some gravel to 0.76 metres. Inferred bedrock at 0.76 metres;
- BH-2: Sand and gravel fill to 0.53 metres. Inferred bedrock at 0.53 metres;
- BH-3: Sand and gravel to 0.53 metres. Inferred bedrock at 0.53 metres;
- BH-4: Sand to 0.85 metres, underlain with sand, gravel and cobbles to 3.52. Layer of wood fill from 3.52 to 3.96 metres. Inferred bedrock at 3.96 metres;
- BH-5: Sand and gravel fill to 1.67 metres underlain with cobbles to 2.06 metres. Inferred bedrock at 2.06 metres;
- BH-6: Sand and gravel to 0.61 metres underlain with sand to 2.81 metres. Calcite at bottom of 2.81 metres. Inferred bedrock at 2.81 metres;
- BH-7: Rock fill to 0.31 metres, sand and gravel to 0.91 metres, clayey silt with some coal fragments to 1.52 metres underlain with sand and gravel to 1.91 metres. Inferred bedrock at 1.91 metres;
- BH-8: Sand and gravel to 0.74 metres underlain with clayey silt to 1.55 metres. Inferred bedrock at 1.55 metres;
- BH-9: Sand and gravel fill to 2.74 metres with layers of clayey silt, brick and wood fragments from 0.87 to 1.83 metres. Inferred bedrock at 2.74 metres;
- BH-10: Sand and gravel to 2.44 metres underlain with black to light brown sand to 2.87 metres. Coal layer from 0.97 to 1.1 metres. Inferred bedrock refusal at 2.87 metres.
- BH-11: Sand and gravel to 0.31 underlain with sand with some gravel to 2.87. Fractured dolostone bedrock from 2.87 metres to 5.87 metres;

- BH-12: Sand and gravel to 0.29 metres with thin black layer of coal at bottom, underlain with silt with gravel to 1.49 m. Inferred bedrock refusal at 1.73 metres;
- BH13-1: Sandy clay and gravel to 0.61 metres, silty clay to 0.71 metres, hard brittle grey fill material to 1.83 metres, sand, gravel and clay mixture to 4.57 metres underlain with grey dolostone to 7.72 metres;
- BH13-2: Sand, gravel and clay fill to 2.44 metres, sand gravel and wood fill to 5.79 metres, rock fill to 6.50 metres underlain with calcite to 9.60 metres;
- BH13-3: Sand, gravel and coal fill to 0.41 metres, concrete with rebar to granite rubble fill to 1.42 metres underlain with dolostone to 3.48 metres;
- BH13-4: Fill containing sand, gravel, large metal objects and brick to 1.42 metres underlain with dolostone to 5.23 metres;
- BH13-5: Sand and gravel to 0.45 metres, silt to 0.58 metres underlain with dolostone to 5.36 metres;
- BH13-6: Sand and gravel to 0.61 metres, sand to 0.78 metres, silty clay to 1.22 metres, gravel to 1.44 metres, clay to 1.67 metres underlain with dolostone to 5.38 metres and calcite to 5.69 metres; and
- BH13-7: Sand and gravel to 0.29 metres with a thin layer of coal at 0.29 metres, silt layer to 1.73 metres underlain with dolostone to 4.98 metres and calcite to 5.66 metres.

The general stratigraphy at the Site, as revealed in the test pits, consists mainly of sand and gravel fill with clay material encountered in some of the fill material. For more descriptive test pit logs, including both the building foundations and subsurface observations, see Appendix B.

4.3 Bedrock and Suspected Bedrock

A summary of the borehole refusal depths on suspected bedrock is presented in Table 1A below:

TABLE 1A – SUMMARY OF BOREHOLE REFUSAL DEPTHS ON SUSPECTED BEDROCK

Borehole No.	Surface Elevation (m)	Approx. Depth to Suspected Bedrock (m)	Approx. Elev. of Suspected Bedrock (m)	Core Obtained to Prove Bedrock
BH-1	95.19	0.8	94.4	No
BH-2	95.53	0.5	95.0	No
BH-3	94.78	0.5	94.3	No
BH-4	93.87	4.0	89.9	No
BH-5	94.82	2.1	92.8	No
BH-6	97.91	2.8	95.1	No
BH-7	94.29	1.9	92.4	No
BH-8	98.38	1.6	96.8	No
BH-9	98.22	2.7	95.5	No

Borehole No.	Surface Elevation (m)	Approx. Depth to Suspected Bedrock (m)	Approx. Elev. of Suspected Bedrock (m)	Core Obtained to Prove Bedrock
BH-10	98.31	2.9	95.4	No
BH-11	98.15	2.9	95.2	Yes (3.0m)
BH-12	97.49	1.7	95.8	No
BH-13-1	93.80	4.6	89.2	Yes (3.2m)
BH-13-2	93.49	6.5	87.0	Yes (3.1m)
BH-13-3	94.85	1.4	93.4	Yes (2.1m)
BH-13-4	96.79	1.4	95.4	Yes (3.8m)
BH-13-5	97.91	0.6	97.3	Yes (4.8m)
BH-13-6	97.97	1.7	96.3	Yes (4.0m)
BH-13-7	97.42	1.7	95.7	Yes (3.9m)

The bedrock recovered from the rock cores was observed as being dolostone in all the cored boreholes, with the exception of BH-13-2, where calcite was encountered. Calcite was also observed at the very bottom of boreholes BH-11, BH-13-6 and BH-13-7 (i.e., beneath the dolostone).

The Rock Quality Designation (RQD) for each core run retrieved from boreholes BH-11 and BH-13-1 through BH-13-7 was calculated. The RQD ranged from 0 percent in runs 1 and 2 of Borehole BH-3 to 73 percent in run 1 of Borehole BH-13-7, indicating very poor to fair quality bedrock. The majority of the RQD's were generally below 50 percent, indicating very poor to poor quality bedrock. The bedrock core data is summarized on the borehole logs in Appendix B.

A summary of the test pit refusal depths on suspected bedrock is presented in Table 1B below:

TABLE 1B – SUMMARY OF TEST PIT REFUSAL DEPTHS ON SUSPECTED BEDROCK

Test Pit No.	Approx. Depth to Suspected Bedrock (m)	Test Pit No.	Approx. Depth to Suspected Bedrock (m)
TP-1	1.07	TP-7	0.76
TP-2	0.74	TP-8	0.58
TP-3	1.24	TP-9	0.43
TP-4	N/A	TP-10	2.13
TP-4B	1.78	TP-11	0.41
TP-5	0.28	TP-12	0.53
TP-6	0.33		

The depths shown in Table 1B are where test pits were terminated at inferred bedrock. Coring of these suspected bedrock surfaces was not conducted to confirm the material. Concrete was encountered just below grade at test pit TP-4 and could not be penetrated. Test Pit TP-4B was advanced at a nearby location. All test pit locations are shown on Figure 3.

4.4 Groundwater

The Site monitoring well network consists of two existing and five newly installed wells into the overburden as well as one

Groundwater levels were measured in the monitoring well network on June 19, 2013. Water levels were recorded using a Solinst oil-water interface meter, and groundwater elevations were calculated based on top of pipe elevation measurements recorded during the Site elevation survey. Groundwater levels and corresponding elevations are summarized in Table 4, respectively; groundwater levels are also presented in the borehole logs provided in Appendix D.

At the time of water level measurements, the wells were checked with the Solinst oil-water interface meter for the presence of free product. Free product was not detected in the monitoring well network on June 19, 2013.

The inferred direction of overburden horizontal groundwater flow based on groundwater level measurements is predominately northerly to northeasterly. The inferred direction of shallow bedrock horizontal groundwater flow based on groundwater level measurements is predominantly northerly to northeasterly. Additionally, the overburden and bedrock appear to be discharging into the Gananoque River.

The groundwater depths recorded in the overburden monitoring wells on June 19 and August 7, 2013 are as follows:

Well Location	Water Level (mbgs) June 19, 2013	Water Level (mbgs) August 19, 2013
MW07-1	0.66	0.69
MW07-2	0.38	0.44
MW13-1	0.85	0.89
MW13-2	1.79	1.85
MW13-3	2.69	2.72
MW13-4	1.24	1.32
MW13-5	1.49	Dry

where mbgs = metres below ground surface

The groundwater depths recorded in the shallow bedrock monitoring wells on June 19 and August 7, 2013 are as follows:

Well Location	Water Level (mbgs) June 19, 2013	Water Level (mbgs) August 19, 2013
BW07-5	2.50	2.53
BW13-1	0.82	0.89
BW13-2	0.54	0.50
BW13-3	1.94	1.83
BW13-4	3.24	3.34
BW13-5	2.65	3.11
BW13-6	3.58	3.65
BW13-7	2.30	2.75

where mbgs = metres below ground surface

5. Geotechnical Comments and Recommendations

5.1 General Construction Recommendations

The stratigraphy at the Site consisted of fine and coarse grained materials overlying shallow bedrock. As such, **exp** recommends founding the proposed building on shallow strip or spread footings bearing on bedrock or shallow strip or spread footings bearing on engineered fill overlying bedrock.

Any foundations that will be subjected to dynamic loading should be founded completely on bedrock. Strip or spread footing widths must comply with the Ontario Building Code minimum requirements.

5.2 Footings on Bedrock – Ultimate Limit States

For strip or spread footings placed directly on sound bedrock, a geotechnical resistance of 1 MPa at Ultimate Limit State (ULS) may be used. The factored geotechnical resistance at ULS is 1 MPa using a geotechnical resistance factor of 0.5. To place strip or spread footings directly on bedrock, all overburden material along with any loose debris and rock shatter must be removed using air hose or water jetting procedures, exposing sound bedrock.

The footings should preferably be established on a relatively level rock surface, i.e., generally sloping at an angle of less than 10° from the horizontal. In some instances, footings can be placed on bedrock sloping up to 25° to 30° from the horizontal, provided rock anchors are incorporated to resist shear. The rock anchors would need to be designed by a structural engineer. Where rock slopes are at steeper angles than 25° to 30° from the horizontal, the rock surface must be leveled to provide a step-like footing base. As an alternative to leveling the bedrock surface where the bedrock is irregular with erratic changes in profile, it may be more practical to provide level benching over these areas with additional concrete (min. 20 MPa) prior to constructing the footings. Typically, this decision is made on-site, since each situation will depend on site specific bedrock conditions.

All bedrock surfaces must be reviewed by a geotechnical engineer prior to pouring foundation concrete. This is necessary to verify the assumed foundation bearing conditions and review the foundation construction procedures, bedrock slope, integrity, etc.

5.2.1 Rock Anchors – Allowable Bond Stress

If anchors are required, the structural engineer normally designs the length and diameter of the steel dowels for footings, based on the type of bedrock and its strength parameters.

Failure typically occurs between the dowel and the grout, or between the grout and the rock, and not from a quasi-conical rock mass failure, provided sufficient dowel bond lengths have been designed. The bond length or grouted portion of the dowel for this rock mass should be a minimum of three (3) metres. Empirical methods of analysis, such as pull out tests have shown that the bond developed between the grout and the dowel are typically twice that of the bond developed between the grout and the bedrock. Therefore, the design analysis should be based on failure occurring between the grout and the bedrock interface. For straight-shafted dowels, the

anchor force, which can be developed, is dependent on the ultimate bond stress of the bedrock or the grout material.

The ultimate bond stress is typically taken as 10 percent of the unconfined compressive strength of the bedrock or the compressive strength of the grout material whichever is less, but not more than 3.1 MPa. An unconfined compressive strength of 90 MPa may be used for the encountered bedrock. The allowable bond stress, "τ_b" taken between the rock and the grout is normally 50 percent or less of the ultimate bond stress, (i.e. Safety Factor of 2.0).

The required bond length (L) for the anchor is a function of the core hole diameter (d), and can be calculated as follows:

$$L \text{ (metres)} = P/(\pi \times d \times \tau_b)$$

Where: P = working capacity of anchor (kg)

τ_b = working bond stress (kg/m^2)

d = core hole diameter (m)

The upper 1 metre of the bedrock is not normally considered part of the bond length, since this area is usually weathered/fractured, and as a result does not usually develop the ultimate bond stress assumed in the above calculations.

During construction, pullout tests equal to the design loads should be performed to confirm the strength of the anchors. This work can be performed on a representative number of anchors by **exp**.

5.3 Footings on Bedrock – Serviceability Limit States

Serviceability Limit State Design does not apply for footings bearing directly on bedrock since failure of the concrete would occur before unacceptable settlement of the foundation. For footings bearing directly on bedrock, settlements will be negligible and should not exceed the elastic compression of the foundation concrete.

5.4 Footings on Engineered Fill Overlying Bedrock – Ultimate Limit States

The foundation recommendations included in this section assume any structures are lightly loaded and do not account for loadings from heavy machinery or vibrations.

For shallow strip or spread footings bearing on engineered fill overlying bedrock, a geotechnical resistance of 500 kPa at ULS may be used. The factored geotechnical resistance at ULS is 250 kPa using a geotechnical resistance factor of 0.5.

To place strip or spread footings on engineered fill overlying bedrock, all overburden material along with any loose debris and rock shatter must be removed using air hose or water jetting procedures, exposing sound bedrock.

All required up-fill material should consist of a Granular "B" Type I Ontario Provincial Standards and Specifications 1010 (OPSS 1010) material (higher bearing capacities are available if Granular "B" Type II material is used instead of Type I). A final 150 mm thick layer of Granular "A" (OPSS 1010) should be placed directly below the underside of the footings. All fill material should be placed in maximum 150 mm thick lifts and be compacted to 100 percent of the Standard Proctor Maximum Dry Density (SPMDD) within 2 percent of the optimum moisture content. The engineered fill material should extend a minimum of 1.0 m beyond the edge of the footings and slope down at 1H:1V.

5.5 Footings on Engineered Fill Overlying Bedrock – Serviceability Limit States

For a strip or spread footings bearing on engineered fill overlying bedrock, a serviceability limit pressure (i.e. geotechnical resistances at SLS) of 125 kPa may be used. This pressure assumes the structure can tolerate settlements up to 13 mm.

5.6 Floor Slab-On-Grade Construction

Floor slab-on-grade construction will be possible at the site provided that all overburden material along with any loose debris and rock shatter is removed using air hose or water jetting procedures, exposing sound bedrock. Once the bedrock surface is prepared, all required up-fill material is to consist of Granular "A" or Granular "B" Type I or Type II (OPSS 1010). A final 300 mm thick layer Granular "A" should be placed directly below the floor slab combined with an appropriate moisture barrier such as a polyethylene membrane. The engineered fill should be placed in maximum 150 mm thick lifts and be compacted to 100% of the SPMDD within 2.0% of the optimum moisture content. A Modulus of Sub-Grade Reaction of 70 MPa/m can be used for the design of the slab-on-grade.

5.7 Excavations

The in-situ native soils may be classified as a Type 3 in conformance with the Ontario Occupational Health and Safety Act (OHSA). Excavation side slopes in Type 3 soils should remain stable at a slope of 1H: 1V.

5.8 Dewatering

The soils encountered at this site generally consist of sand and gravel sized fill and silt to clay sized materials. The estimated hydraulic conductivity (K) of this material ranges from $1x10^{-1}$ to $1x10^{-5}$ cm/s based on empirical data.

Provided the excavation depths do not extend below the groundwater level, any potential perched groundwater should be possible to remove using conventional drainage techniques, such as filtered construction pumps. Excavations below the groundwater level are not anticipated, however could be encountered depending on site conditions and the time of year the construction is performed.

Dewatering requirements will be governed by the time of the year the construction is performed. It is the responsibility of the Contractor to propose a suitable dewatering system based on the

time of construction and groundwater levels. The method used should not undermine any adjacent structures. The dewatering method is the responsibility of the Contractor and the Contractor should submit his proposal to the Prime Consultant for review and approval prior to construction.

5.9 Pavement Design

The recommended pavement structures provided in Table 2 below are based upon an estimate of the sub-grade soil properties determined from visual examination and textural classification of the soil samples. The sub-grade conditions for the new pavement areas are expected to be comprised of silty clay, silty sand or engineered fill. A functional design life of 10 to 15 years has been used to establish the pavement recommendations. This represents the number of years to the first rehabilitation (routing and sealing, etc.), assuming regular maintenance is carried out.

Table 2 – Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Requirements	Thickness	
		Light Duty Parking	Truck Access Route
Asphaltic Concrete (OPSS 310)	As per OPSS 310 a target of 92 to 96.5% MRD	50 mm HL4	40 mm HL4 over 50 mm HL8
Granular "A" Base (OPSS 1010)	100% SPMDD*	150 mm	150 mm
Granular "B" Subbase (OPSS 1010)	100% SPMDD*	450 mm**	450 mm**
GBE TOTAL		**550 mm**	**630 mm**

* Denotes Standard Proctor Maximum Dry Density, ASTM-D698

** May be reduced to 300mm over Granular Engineer Fill

The foregoing design assumes that construction is carried out during dry periods and that the sub-grade is stable under the load of construction equipment. If construction is carried out during wet weather, and heaving or rolling of the sub-grade is experienced, additional thickness of granular material may be required.

The long-term performance of the pavement structure is highly dependent upon the sub-grade support conditions. Stringent construction control procedures should be maintained to ensure that uniform sub-grade moisture and density conditions are achieved. In addition, the need for adequate drainage cannot be over emphasized. The finished pavement surface and underlying sub-grade should be free of depressions and should be sloped to provide effective surface drainage toward catch-basins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas.

Additional comments on the construction of roadways are as follows:

1. As part of the sub-grade preparation, proposed roadways should be stripped of topsoil and other obviously unsuitable material. Fill required to raise the grades to design elevations should be organic-free and at a moisture content that will permit compaction to the densities indicated. The sub-grade should be properly shaped, crowned, and then proof-rolled in the full-time presence of a representative of this office. Soft or spongy sub-grade areas should be sub-excavated and properly replaced with suitable approved backfill compacted to 98 percent SPMDD.

2. The location and extent of sub-drainage required within the paved areas should be reviewed by this office in conjunction with the proposed site grading. In view of the silty/clay nature of the sub-grade soils, we recommend sub-drains be provided through-out the parking lot area. This will ensure no water collects in the granular course which could result in pavement failure during the spring thaw.

3. To minimize the problems of differential movement between the pavement and catch-basins/manhole due to frost action, the backfill around the structures should consist of free-draining granular. In addition, the catch-basin should be perforated just above the drain and the holes screened with filter cloth.

4. The most severe loading conditions on light-duty pavement areas and the sub-grade may occur during construction. Consequently, special provisions such as restricted lanes, half-loads during paving, etc., may be required, especially if construction is carried out during unfavourable weather.

It is recommended that **exp** be retained to review the final pavement structure design and drainage plans prior to construction to ensure that they are consistent with the recommendations of this report.

5.10 Frost Considerations

The freezing index in the Kingston area is approximately 678 C degree-days. There is potential for up to 1.2 metres (4.0 ft) of frost penetration to occur over the winter months in unprotected areas, such as roadways and parking lots, and approximately 0.9 metres (3.0 ft) for heated structures.

The in-situ fill material at this site is classified as having a low frost susceptibility (i.e., the tendency to grow ice lenses and heave during freezing), with a Frost Group rating of F1 based upon the U.S. Corps of Engineers Frost Design Soil Classification.

Provided the above recommendations are followed for shallow foundations on bedrock or on free draining engineered fill overlying bedrock, frost protection is not a concern for both heated and unheated structures.

5.11 Foundation Wall Backfill

All backfill material used for foundation walls should consist of Granular "A", Granular "B" Type I or Granular "B" Type II (OPSS 1010) material, with a maximum aggregate size not exceeding 115 mm, on both sides of the foundation walls. The Granular "B" material used against the foundation walls must be placed in equal lifts, not exceeding 200 mm on each side of the foundation wall during backfilling operations and must be compacted to 98 percent SPMDD. Smaller lifts and lighter compaction equipment should be used adjacent to the foundation walls to prevent over-stressing.

5.12 Re-Use of Excavated Material

The in-situ subsurface materials can potentially be re-used as backfill. Representative samples of the material will need to be obtained during excavation and tested for gradation, density, and moisture content in order to verify whether the material is suitable. The in-situ materials cannot be used as foundation wall backfill or as structural backfill below the foundations.

In addition, the in-situ material may be used for general landscaping purposes, provided it is environmentally safe to do so.

5.13 Lateral Earth Pressure

Any foundation or retaining walls should be designed to resist lateral earth pressure. The expression for calculating lateral earth pressure "p" at any depth "h" is given by the following:

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

where p = Lateral earth pressure (kg/m^2).

K = Coefficient of earth pressure.

γ = Unit weight of backfill (kg/m^3).

h = Depth to point of interest (m).

q = Surcharge load acting adjacent to the wall at the ground surface (kg/m^2).

The above expression does not take into account hydrostatic pressure, which need not be included provided a perimeter weeping tile drain is installed.

Table 3 below lists various earth pressure properties for given materials.

Table 3 - Material Types and Earth Pressure Properties

Material	Friction Angle Ø' (unfactored)	Coefficient Of Active Earth Pressure (k_a)	Coefficient Of Passive Earth Pressure (k_p)	Coefficient Of Earth Pressure at Rest (k_o)	Unit Weight γ (kg/m³)
Granular A	38°	0.24	4.2	0.38	2 225
Granular B Type I	35°	0.27	3.7	0.42	2 150
Granular B Type II	38°	0.24	4.2	0.38	2 300

Note: Values given for horizontal earth pressures are for horizontal backfill. For sloping backfill, the design requirements outlined in the C.H.B.D.C. should be used.

The mobilization of full active or passive resistance requires a measurable and perhaps significant wall movement or rotation. Therefore, unless the structural element can tolerate these deflections, the at-rest earth pressure should be used in design.

The effects of compaction surcharge should be taken into account in the calculations of active and at rest earth pressures. The lateral pressure due to compaction should be taken as at least 12 kPa at the surface, and its magnitude should be assumed to diminish linearly with depth to zero at the depth where the active (or at rest) pressure is equal to 12 kPa. This pressure distribution should be added to the calculated active (or at rest) pressure. Notwithstanding, lighter compaction equipment and smaller lifts should be used adjacent to walls to prevent overstressing.

5.14 Site Classification for Seismic Response

The subsoil and groundwater information at this site have been examined in relation to Section 4.1.8.4 of the Ontario Building Code 2006 edition (OBC, 2006). The subsoil generally consisted of, a sand and gravel fill and some rock fill. Finer materials including silty clay and clayey silt fill were also encountered. It is likely that the proposed development (residential condominium) will be founded on sound bedrock. The reported N-values for the soil at the site ranged from 2 to 55.

There have been no shear wave velocity measurements carried out at this site and therefore, un-drained shear strength and N-values will have to be used to determine the site classification.

The Average Standard Penetration Resistance shown in Table 4.1.8.4.A. Site Classification for Seismic Site Response in OBC 2006 refers to N_{60} which is defined as "Average Standard Penetration Resistance for the top 30m, corrected to a rod energy efficiency of 60% of the theoretical maximum". It should be noted that the drillers in the Kingston area do not have their

rod energy efficiencies measured and therefore, computed N_{60} values are not available for this site.

For the CME automatic hammer used by the driller for the boreholes at this site, the energy transfer compiled by Utah State and reported by GRL in Cleveland, Ohio, indicated that the range would be 67-83% and 59-91% for one and two standard deviations respectively. In our opinion, the reported N-value would therefore be approximately equivalent to the normalized N_{60} values as noted in the OBC 2006 for the purpose of establishing the site classification.

Table 4.1.8.4.A. Site Classification for Seismic Site Response in OBC 2006 indicated that to determine the site classification, the average properties in the top 30 metres are to be used.

Based on the above assumptions and interpretations and the known soil conditions, the Site Class for this site is "C" as per Table 4.1.8.4.A Site Classification for Seismic Site Response, OBC, 2006. The 2006 Ontario Building Code (OBC) has adopted the National Building Code of Canada (NBC) requirements for seismic design considerations.

5.15 Construction Constraints Under Cold Weather Conditions

For all construction activities at this site, the following applies:

- During excavations, all subgrade soils must be maintained at a minimum temperature of 5° C.
- No Granular "A" or Granular "B" Type I material may be placed under frozen conditions, with all fill material maintained at a minimum temperature of 5° C prior to and during installation. If granular fill is to be placed in freezing conditions, the granular fill must be restricted to Granular "B" Type II material. Since Granular "B" Type II has a larger aggregate size, care should be taken to prevent point loading on the underside of the concrete.
- Soils and granular fill material that is in direct contact with fresh concrete must be at a minimum temperature of 5° C prior to pouring the concrete, and must be free of snow and ice fragments.
- All granular fill, prior to placement of concrete, must be reviewed by **exp** to ensure it is free of frost, buried ice and snow.
- All reinforcing steel in the concrete forms must be free of ice and snow, and must be maintained at a minimum temperature of 5° C.
- During the placement of concrete in cold weather conditions, a field cured cylinder should be placed beside the heated form for a period of 6 days. The field cured cylinder should be returned to a designated laboratory on the sixth day for 7 day compressive strength testing.

- All heated and tarped areas should be monitored for temperature using a max/min thermometer.

- All concrete is to have a minimum of 6 to 8 percent air entrainment to prevent spalling and shall be maintained at a minimum temperature of 10° C for a period of 4 to 7 days.

The 6 to 8 percent air entrained concrete during cold weather placement is to prevent significant strength loss of concrete as a result of freezing and thawing. The air entrainment will provide the capacity to absorb stresses during freeze/thaw action.

5.16 Construction Monitoring

An adequate level of construction monitoring is required during construction activities to ensure all recommendations in this report are met.

5.17 Design Review

The recommendations made in this report are in accordance with our present understanding of the project and are provided solely for the design team responsible for the project. We request that we be retained to review our recommendations as the design nears completion to ensure that the final design is in general agreement with the assumptions on which our recommendations are based.

6. Limitations

The information, conclusions and recommendations in this report are specifically for this project (Geotechnical Investigation – 185 Mill Street, Gananoque, Ontario).

Virtually no scope of work, no matter how exhaustive, can identify all constraints and issues. For example, conditions elsewhere within the study area may differ from those encountered, and conditions may change with time. Therefore, no warranty is provided that all site conditions are represented by those identified at specific locations.

It is possible that unexpected conditions may be encountered on the site which has not been explored within the scope of the study. Should such an event occur, **exp** should be notified in order that we may determine if modifications to our conclusions are necessary.

Achieving the objectives stated in this report has required us to arrive at conclusions based upon the best information presently known to us. No investigative method can completely eliminate the possibility of obtaining partially imprecise or incomplete information; it can only reduce the possibility to an acceptable level. Professional judgement was exercised in gathering and analysing the information obtained and in the formulation of the conclusions. Like all professional persons rendering advice, we do not act as absolute insurers of the conclusions we reach, but we commit ourselves to care and competence in reaching those conclusions.

It should also be noted that current applicable guidelines and regulations are subject to change, and such changes, when put into effect, could alter the conclusions and recommendations noted throughout this report.

The conclusions and recommendations noted throughout this report reflect existing site conditions with respect to the current conditions of the subject site at the time of this evaluation, at the specific borehole locations tested. Conditions between borehole locations may vary.

This report has been prepared by **exp** Services Inc. for the exclusive use of Brennan Custom Homes Inc., in accordance with accepted environmental study and/or engineering practices. No other warranties, either expressed or implied, are made as to the professional services provided under the terms of this Report. Any use which a third party makes of this report, or any part hereof, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. **Exp** accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We trust this report is satisfactory for your purposes. If you have any questions regarding our submission, please do not hesitate to contact this office.

Respectfully submitted,

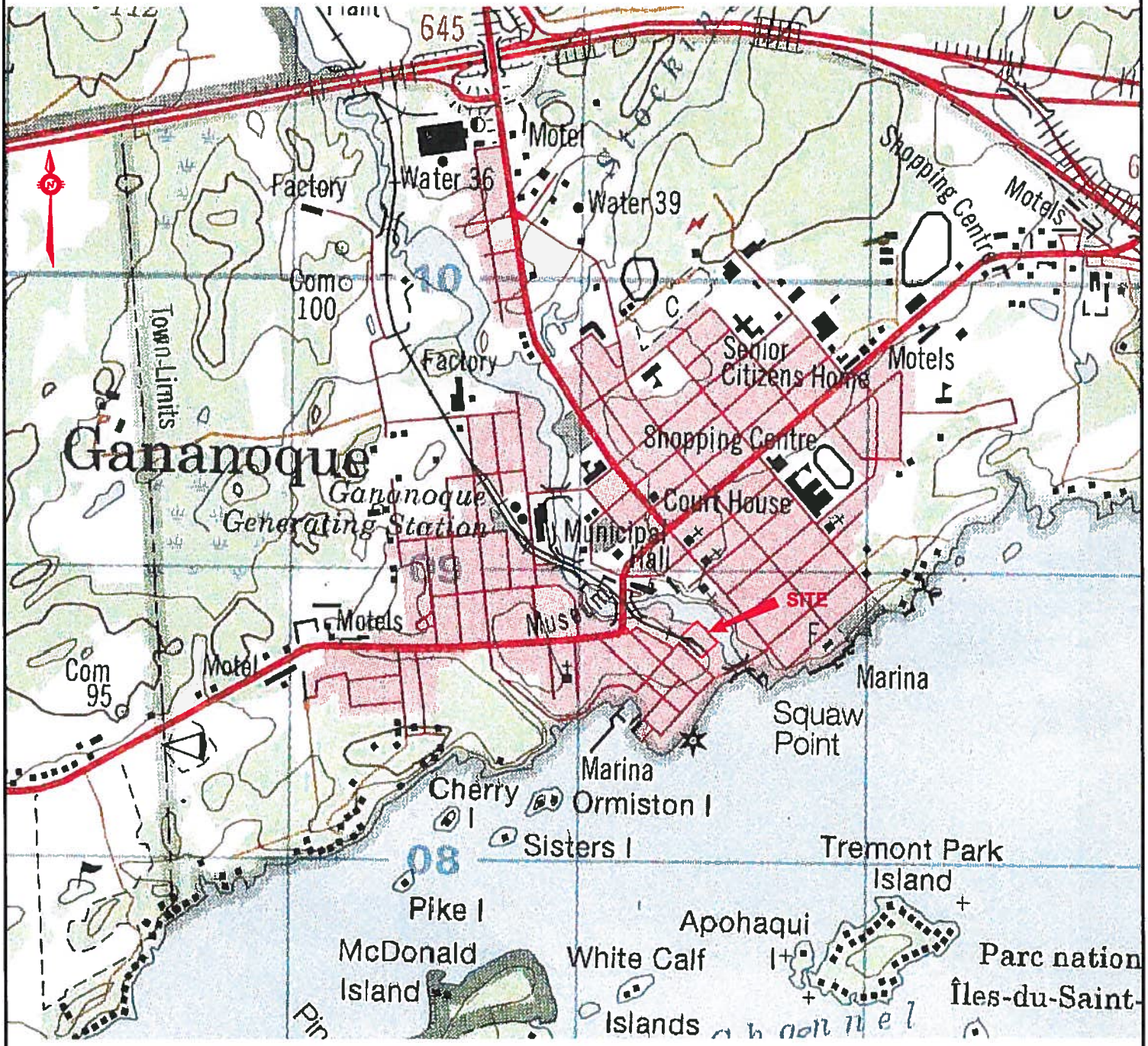
exp Services Inc.

Troy Virtue
Field Technician

Leigh Knegt, P.Eng.
Sr. Geotechnical Engineer

Paula A. Formanek, M.Sc. (Eng.), P.Geo., Q.P.
Sr. Hydrogeologist
Branch Manager

Figures



LEGEND:

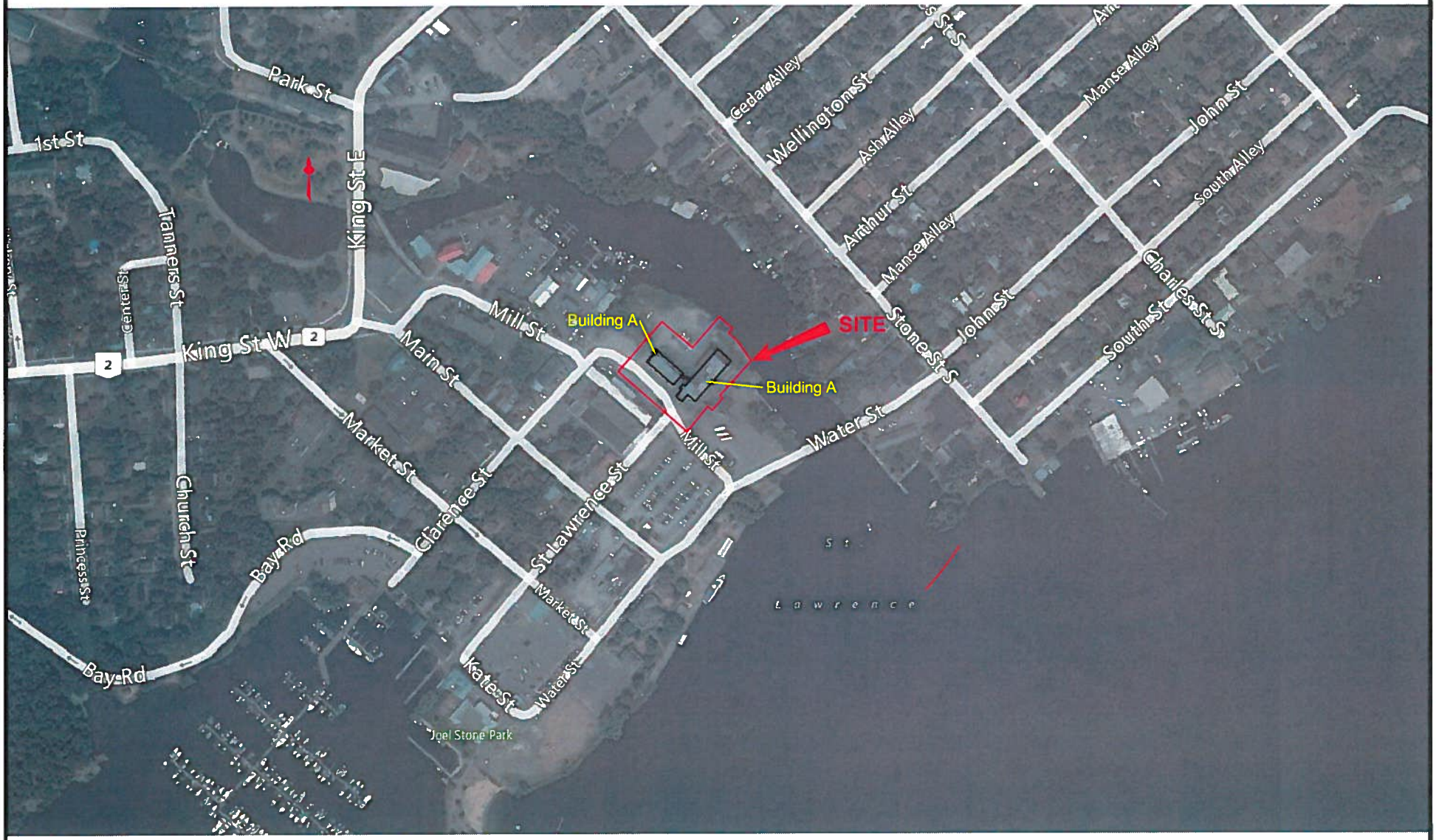
APPROXIMATE PROPERTY BOUNDARY

Source: Natural Resources Canada, NTS Map Sheet 31 C/8 "Gananoque" (2000)

exp Services Inc.

315-4 CATARAQUI STREET, KINGSTON, ONTARIO K7K 1Z7

DATE: SEP. 2013	CLIENT: BRENNAN CUSTOM HOMES INC.	DRAWING NO: KIN-26260-A0
SCALE: 1:20 000	TITLE: SITE LOCATION PLAN GEOTECHNICAL INVESTIGATION 185 MILL STREET, GANANOQUE, ONTARIO	FIG. 1



Source: LiveATC.net (http://LiveATC.Net), 2006

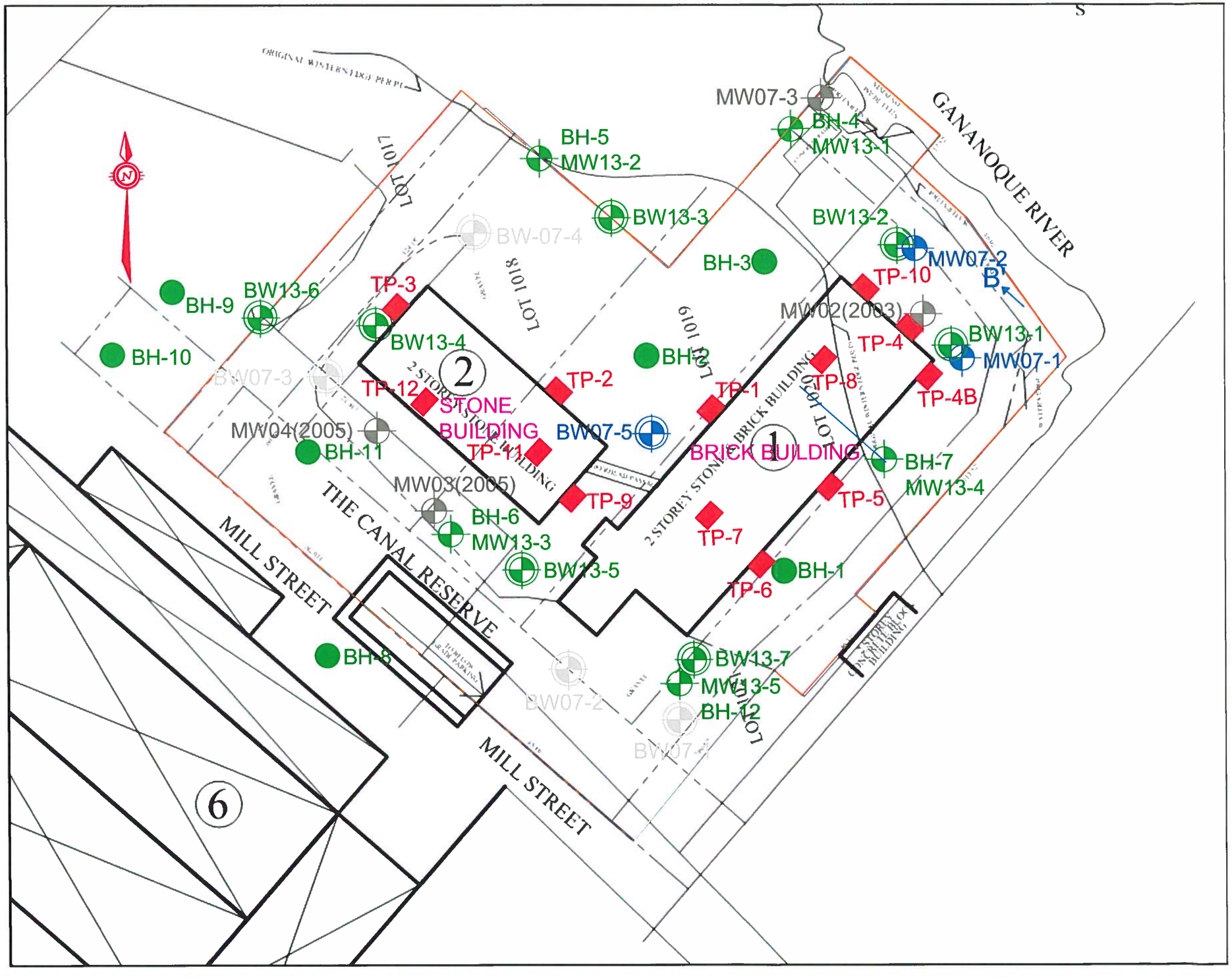
exp Services Inc.

315-4 CATARAQUI STREET, KINGSTON, ONTARIO K7K 1Z7

DATE: SEP. 2013	CLIENT: BRENNAN CUSTOM HOMES INC.	DRAWING NO: FIG. 2
SCALE: 1:5000	TITLE: SITE PLAN GEOTECHNICAL INVESTIGATION, 185 MILL STREET, GANANOQUE, ONTARIO	PROJECT NO: KIN-26260-A0

LEGEND:

APPROXIMATE PROPERTY BOUNDARY



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- MW01(1999) EXISTING OVERBURDEN MONITORING WELL LOCATION AND ID (YEAR CONSTRUCTED)
- MW07-1 EXISTING 2007 OVERBURDEN MONITORING WELL LOCATION AND ID
- BW07-1 EXISTING 2007 BEDROCK MONITORING WELL LOCATION AND ID
- MW07-1 EXISTING 2007 OVERBURDEN MONITORING WELL LOCATION AND ID (COULD NOT BE LOCATED)
- BW07-1 EXISTING 2007 BEDROCK MONITORING WELL LOCATION AND ID (COULD NOT BE LOCATED)
- MW13-1 OVERBURDEN MONITORING WELL LOCATION AND ID
- BW13-1 BEDROCK MONITORING WELL LOCATION AND ID
- BH-1 BOREHOLE LOCATION AND ID
- TP-1 APPROXIMATE TEST PIT LOCATION

NOTE: ALL LOCATIONS APPROXIMATE

No.	DESCRIPTION	DATE	BY	APP'D

REVISIONS

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• BUILDINGS • ENERGY • EARTH & ENVIRONMENT
• INFRASTRUCTURE • SUSTAINABILITY •

CLIENT

BRENNAN CUSTOM HOMES INC.

PROJECT

GEOTECHNICAL INVESTIGATION
185 MILL STREET, GANANOQUE, ONTARIO

TITLE

BOREHOLE, MONITORING WELL AND TEST PIT LOCATION PLAN

design by		project no. KIN-26260-A0
drawn by	M. WHITNEY	drawing no. FIG. 3
checked by	P. FORMANEK	
date	2013/09/23	
scale	1:500	

Appendix A

Borehole, Monitoring Well and Test Pit Logs, Soil & Rock Symbols and Terms

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BH-1

Monitoring Well:

Project No.: KIN-26260
Project: 185 Mill Street
Client: Brennan Custom Homes Inc.
Location: Gananoque, ON
Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	95.19						
1		***Silty Clay Fill:*** Some gravel. No staining or odour.		18	SS-1	0	57%		Sample BH-1 SS-1 submitted for laboratory analysis of PHC, VOC and metals.
2			94.43	-	Aug	-	-		
3 / 1		End of Borehole							Inferred bedrock refusal at 0.76m below grade. Borehole Terminated. No well installed.
4									
5									
6 / 2									
7									
8									
9									
10 / 3									
11									
12									
13 / 4									
14									
15									
16									

Drilled By: Canadian Environmental Drilling
Drill Method: Truck Mounted Drill Rig
Drill Date: May 27, 2013

Hole Size: 200 mm
Datum: Local (95.19 m)
Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Project No.: KIN-26260
Project: 185 Mill Street
Client: Brennan Custom Homes Inc.
Location: Gananoque, ON
Logged by: M. Whitney

Log Of Borehole: BH-2
Monitoring Well:

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	95.53						
0 – 1 / 0		***Sand and Gravel Fill:*** Grey to brown. Some slight dark colorations. No odour.	95.00	31	SS-1 A-1	0	61%		Sample BH-2 SS-2 and A-1 (Duplicate) submitted for laboratory analysis of PHC, VOC, PAHs and metals.
1 – 2 / 0 – 1		End of Borehole							Inferred bedrock refusal at 0.53 m below grade. Borehole Terminated. No well installed.
2 – 3 / 1									
3 – 4 / 1									
4 – 5 / 1									
5 – 6 / 1 – 2									
6 – 7 / 2									
7 – 8 / 2									
8 – 9 / 2									
9 – 10 / 2 – 3									
10 – 11 / 3									
11 – 12 / 3									
12 – 13 / 3 – 4									
13 – 14 / 4									
14 – 15 / 4									
15 – 16 / 4									

Drilled By: Canadian Environmental Drilling
Drill Method: Truck Mounted Drill Rig
Drill Date: May 29, 2013

Hole Size: 200 mm
Datum: Local (95.53 m)
Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BH-3

Monitoring Well:

Project No.: KIN-26260

Project: 185 Mill Street

Client: Brennan Custom Homes Inc.

Location: Gananoque, ON

Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	94.78						
0 – 1		***Sand Fill:*** With plant roots. Dry.		58	SS-1	0	48%		Sample BH-3 SS-1 submitted for laboratory analysis of PHC, VOC, PAHs and metals.
1 – 2		***Sand and Gravel Fill:*** Brown to black. No odour	94.25						
2 – 3 / 1		End of Borehole							Inferred bedrock refusal at 0.53 m below grade. Borehole Terminated. No well installed.
4 – 5									
6 – 7 / 2									
8 – 9									
10 – 11 / 3									
12 – 13									
14 – 15 / 4									
16									

Drilled By: Canadian Environmental Drilling

Drill Method: Truck Mounted Drill Rig

Drill Date: May 29, 2013

Hole Size: 200 mm

Datum: Local (94.78 m)

Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BH-4

Monitoring Well: MW-13-1

Project No.: KIN-26260-A0

Project: 185 Mill Street

Client: Brennan Custom Homes Inc.

Location: Gananoque, Ontario

Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	93.87					Flushmount cover	Flushmount cover TOC=93.68 m
1		***Sand Fill:*** Brown. Dry. No odour.		29	SS-1	0.1	50%	Bentonite	Bentonite
2		***Sand Fill:*** With coal. Black. Dry. No odour.	93.02					51 mm PVC casing	51 mm PVC casing
3 / 1		***Cobbles***		18	SS-2	0.2	75%	SWL=0.85m (June 19, 2013)	SWL=0.85m (June 19, 2013)
4		***Sand and Gravel Fill:*** Rusty brown. Moist. No staining. No odour.	92.65						Sample BH-4 SS-2 submitted for analysis of PHC, BTEX, metals.
5		***Cobbles:*** Augered through layer of cobbles.	92.35	Aug	-	-	-		
6 / 2		***Sand and Gravel Fill:*** Brown. Some cobbles. No staining. No odour. Saturated.		7	SS-3	-	33%		
7									
8				18	SS-4	-	16%	Silica sand	Silica sand
9									
10 / 3				55	SS-5	-	58%	51 mm PVC screen	51 mm PVC screen
11			90.52						
12		***Sand and Gravel Fill:*** Brown. Saturated. No odour or staining.	90.35	5	SS-6	-	58%		
13 / 4		***Wood Fill***	89.91						Borehole terminated at 3.96m below grade. Bedrock not encountered.
14		End of Borehole							
15									
16									

Drilled By: Canadian Environmental Drilling

Drill Method: Truck Mounted Drill Rig

Drill Date: May 29, 2013

Hole Size: 200 mm

Datum: Local (93.87 m)

Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BH-5

Monitoring Well: MW-13-2

Project No.: KIN-26260-A0

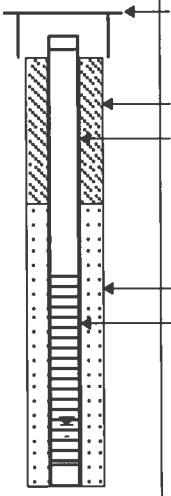
Project: 185 Mill Street

Client: Brennan Custom Homes Inc.

Location: Gananoque, Ontario

Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	94.82						
0 – 3 / 0 – 1		***Sand and Gravel Fill:*** Some brick fragments. Darker coloured layer from approximately 0.82 to 0.86 m below grade. Dry. No odour.		19/24/15/9	SS-1	0.0	63%		
				11/4/8/12	SS-2	0.0	50%		Sample BH-5 SS-2 submitted for analysis of PHC, BTEX, metals and PAHs.
3 – 5 / 1 – 2		***Sand and Gravel Fill:*** Some cobbles. Split-spoon refusal at 1.67 m below grade.	93.60						
			93.15	7/7/50	SS-3	0.0	67%		
5 – 6 / 2		***Cobbles (Fill):*** Augered through cobbles or poor quality rock. Auger refusal at 2.06 m below grade.	92.76	Auger	-	-	-		
		End of Borehole							



SWL=1.79m (June 19, 2013)

Inferred bedrock at 2.06 m below grade. Borehole terminated.

Drilled By: Canadian Environmental Drilling

Drill Method: Truck Mounted Drill Rig

Drill Date: May 29, 2013

Hole Size: 200 mm

Datum: Local (94.82 m)

Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BH-6

Monitoring Well: MW-13-3

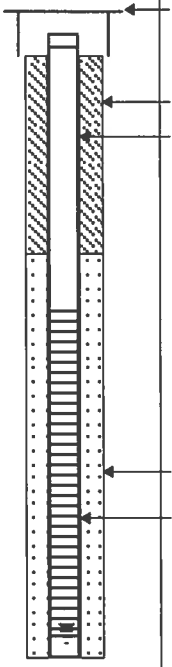
Project No.: KIN-26260-A0

Project: 185 Mill Street

Client: Brennan Custom Homes Inc.

Location: Gananoque, Ontario

Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	97.91						Flushmount cover TOC=97.80 m
1		***Sand and Gravel Fill:*** Light brown underlain with brown sand. Dry. No odour. No staining.	97.30	23	SS-1	0.0	58%		Bentonite
2									51 mm PVC casing
3 / 1		***Sand Fill:*** Some gravel at bottom of spoon. No odour. No staining.	96.69	10	SS-2	0.0	33%		
4		***Sand Fill:*** Fine grained with trace clay. Brown. Moist to Wet. No odour. No staining.		3	SS-3	0.0	54%		Sample BH-6 SS-2 submitted for analysis of PHC, BTEX, PCBs and metals.
5									
6 / 2									Silica sand
7			95.47	2	SS-4	-	38%		51 mm PVC screen
8		***Sand Fill:*** Light brown. Calcite at bottom of spoon.	95.10	50/150mm	SS-5	-	50%		SWL=2.69m (June 19, 2013)
9		End of Borehole							Inferred bedrock at 2.81 m below grade. Borehole terminated.
10 / 3									
11									
12									
13 / 4									
14									
15									
16									

Drilled By: Canadian Environmental Drilling

Hole Size: 200 mm

Drill Method: Truck Mounted Drill Rig

Datum: Local (97.91 m)

Drill Date: May 31, 2013

Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BH-7

Monitoring Well: MW-13-4

Project No.: KIN-26260

Project: 185 Mill Street

Client: Brennan Custom Homes Inc.

Location: Gananoque, ON

Logged by: M. Whitney

Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	94.29					0.85 m stick-up TOC=95.14 m	
		Rock Fill	93.98	-	Aug	-	-		Sample BH-7 SS-2 submitted for analysis of PHC, BTEX, PAHs, PCBs and metals.
2		***Sand and Gravel Fill:*** Dry. No staining. No odour.	93.38	14	SS-1	0.0	46%	32 mm PVC casing; Bentonite	
3 / 1		***Clayey Silt Fill:*** Soft. Very Moist. Some black coal fragments. No odour.	92.77	11	SS-2	0.0	46%	Silica sand	SWL=1.24m (June 19, 2013)
5		Soil Penetration Resistance = 0.25 kg/cm²	92.38	50/150mm	SS-3	-	33%	32 mm PVC screen	
7 / 2		***Sand and Gravel Fill:*** Saturated. No odour. No staining.							Inferred bedrock refusal at 1.91 m below grade. Borehole terminated.
		End of Borehole							
10 / 3									

Drilled By: Canadian Environmental Drilling

Drill Method: Truck Mounted Drill Rig

Drill Date: May 31, 2013

Hole Size: 75 mm

Datum: Local (94.29 m)

Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BH-8

Monitoring Well:

Project No.: KIN-26260

Project: 185 Mill Street

Client: Brennan Custom Homes Inc.

Location: Gananoque, ON

Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	98.38						
0 – 2 / 0		***Sand and Gravel Fill:*** Brown to dark brown. Dry to moist. No odour. No staining.	97.64	13	SS-1	0.0	100%		Sample BH-8 SS-2 submitted for laboratory analysis of PAHs, PCBs and metals. BH-8 SS-3 submitted for analysis of PHC and VOCs.
2 – 5 / 1		***Clayey Silt Fill:*** Brown with some black staining. Moist to wet. No odour.	96.83	8	SS-2	0.0	75%		
				53	SS-3	0.0	100%		
5 / 1		End of Borehole							Inferred bedrock refusal at 1.55 m below grade. Borehole Terminated. No well installed.
6 – 16 / 2 – 4									

Drilled By: Canadian Environmental Drilling

Drill Method: Truck Mounted Drill Rig

Drill Date: June 3, 2013

Hole Size: 200 mm

Datum: Local (98.38 m)

Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BH-9

Monitoring Well:

Project No.: KIN-26260
Project: 185 Mill Street
Client: Brennan Custom Homes Inc.
Location: Gananoque, ON
Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	98.22						
0–2 / 0–1		***Sand and Gravel Fill:*** Dark Brown. Dry to Moist. No staining. No odour.	97.48	52	SS-1	0.0	58%		
2–3 / 1		***Clayey Silt Fill:*** Brown with some black staining. Moist. No odour.	97.35	4	SS-2	0.0	58%		Sample BH-9 SS-2 submitted for laboratory analysis of PHC, VOC, PAHs and metals.
3–4 / 1		***Brick (Fill)***							
4–7 / 1–2		***Sand and Gravel Fill:*** Black to Dark Grey. Dry to Saturated. Wood fragments at 97.0 and 95.45 m. No odour. Split spoon refusal at 2.59 m. Augered to refusal at 2.74 m.		4	SS-3	0.0	42%		
				2	SS-4	-	33%		
8–9 / 2–3			95.48	50/150mm	SS-5	-	66%		
9–16 / 3–4		End of Borehole							Inferred bedrock refusal at 2.74 m below grade. Borehole Terminated. No well installed.

Drilled By: Canadian Environmental Drilling
Drill Method: Truck Mounted Drill Rig
Drill Date: June 3, 2013

Hole Size: 200 mm
Datum: Local (98.22 m)
Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Project No.: KIN-26260
Project: 185 Mill Street
Client: Brennan Custom Homes Inc.
Location: Gananoque, ON
Logged by: M. Whitney

Log Of Borehole: BH-10

Monitoring Well:

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	98.31						
0–7 / 0–2		***Sand and Gravel Fill:*** Brown with 0.13 m thick layer of coal at 97.4m. Dry to Saturated. No staining. No odour.		23	SS-1	0.0	71%		
				6	SS-2	0.0	54%		Sample BH-10 SS-2 submitted for laboratory analysis of PHC, VOC, PAHs, PCBs, and metals.
				2	SS-3	0.0	21%		
				2	SS-4	-	21%		
7–9 / 2–3		***Sand Fill:*** Black sand underlain with light brown sand. Calcite at bottom of spoon. No odour.	95.87 / 95.44	5/150mm	SS-5	-	35%		Inferred bedrock refusal at 2.87 m below grade. Borehole Terminated. No well installed.
10 / 3		End of Borehole							

Drilled By: Canadian Environmental Drilling
Drill Method: Truck Mounted Drill Rig
Drill Date: June 3, 2013

Hole Size: 200 mm
Datum: Local (98.31 m)
Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BH-11

Monitoring Well:

Project No.: KIN-26260
Project: 185 Mill Street
Client: Brennan Custom Homes Inc.
Location: Gananoque, ON
Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	98.15						
0 – 1		***Sand and Gravel Fill:*** Brown. Dry. No staining. No odour.	97.84	25	SS-1	0.0	75%		Sample BH-11 SS-2 submitted for laboratory analysis of PHC, VOC and metals.
1 – 5 / 0 – 1		***Sand Fill:*** Brown. Medium grained. Dry to Wet. No odour. No staining.		4	SS-2	0.0	67%		
			96.32	2	SS-3	0.0	67%		
6 – 9 / 2		***Sand and Gravel Fill:*** Medium to dark brown. Coarse grained sand with some gravel. Saturated. No odour.		2	SS-4	-	100%		
			95.28	50/150mm	SS-5	-	13%		Auger refusal at 2.87 m below grade.
10 – 14 / 3 – 4		***Dolostone:*** Fractured. Horizontal to 15°. Some brown staining in fractures. RQD = 67% (Fair Quality)	93.81	Core	RC-1				
15 – 19 / 5		***Dolostone:*** Grey. Fractured with some brown staining. Vertical brown seam from 3.99 to 4.32 m. Calcite at bottom. RQD = 70% (Fair Quality)	92.28	Core	RC-2				
19 / 6		End of Borehole							Borehole Terminated at 5.87m. No well installed.

Drilled By: Canadian Environmental Drilling
Drill Method: Truck Mounted Drill Rig
Drill Date: June 3, 2013

Hole Size: 200 mm
Datum: Local (98.15 m)
Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BH-12

Monitoring Well: MW13-5

Project No.: KIN-26260

Project: 185 Mill Street

Client: Brennan Custom Homes Inc.

Location: Gananoque, ON

Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	97.49					0.87 m stick-up TOC=98.37m	
0 / 0		***Sand and Gravel Fill:*** Dry. No staining. No odour.	97.20	Auger	-	-	-	Bentonite 32 mm PVC casing	
1 / 0		***Coal:*** Black.							
2 / 1		***Silt Fill:*** Brown with gravel. No odour. No staining. Dry. (Soil Penetration Resistance = 1.25 kg/m ²)	96.88	Auger	-	-	-		
3 / 1		***Silt Fill:*** Stiff. Brown. No odour. No staining. Dry to Wet. (Soil Penetration Resistance = 2.25 to 1.00 kg/cm ²)		Auger	-	-	-	Silica sand 32 mm PVC screen	
5			95.76	Auger	-	-	-	SWL=1.49m (June 19, 2013)	
6		End of Borehole							Borehole Terminated 1.73 m below grade.

Drilled By: Canadian Environmental Drilling

Drill Method: Truck Mounted Drill Rig

Drill Date: May 31, 2013

Hole Size: 200 mm

Datum: Local (97.49 m)

Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BW13-1

Monitoring Well: BW13-1

Project No.: KIN-26260

Project: 185 Mill Street

Client: Brennan Custom Homes Inc.

Location: Gananoque, ON

Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
		Ground Surface	93.80					0.93 m stick-up TOC=94.73 m	
0 / 0		***Sandy Clay and Gravel Fill:*** Brown. No odour. No staining.	93.19	3	SS-1	0.0	25%	Bentonite; 32 mm PVC casing	
2 / 1		***Silty Clay Fill:*** Brown. No odour. No staining.		47	SS-2	0.0	100%	SWL=0.82m (June 19, 2013)	Sample BW13-1 SS-2 submitted for analysis of PHC, VOC and metals.
4 / 1		***Fill:*** Grey cementitious material. Hard and brittle. Dry.	91.97	3	SS-3	-	17%		
6 / 2		***Fill:*** Wet clay mixed with grey cementitous material. Rubber tubing in bottom of spoon.	91.36	6	SS-4	-	13%		
8 / 2		***Stone Fill:*** With wood fragments and trace clay. No odour. No staining. Saturated.	90.75	6	SS-5	-	50%		
10 / 3		***Sand, Gravel and Clay Fill:*** Saturated. No odour. No staining.	90.14	10	SS-6	-	50%		
12									

Drilled By: Canadian Environmental Drilling

Drill Method: Truck Mounted Drill Rig

Drill Date: May 27, 2013

Hole Size: 75 mm

Datum: Local (93.80 m)

Sheet: 1 of 2

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BW13-1

Monitoring Well: BW13-1

Project No.: KIN-26260

Project: 185 Mill Street

Client: Brennan Custom Homes Inc.

Location: Gananoque, ON

Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
12		***Gravel and Silty Clay Fill:*** Saturated. No odour. No staining.							
13				2	SS-7	-	17%		
14			89.53						
		Sand, Gravel and Clay Fill: Saturated. No odour. No staining.	89.23	58	SS-8	-	50%		
15	5								Inferred bedrock refusal at 4.57 m below grade.
16		***Dolostone:*** Grey. Broken layer with brown staining at 4.95m. Calcite seams at bottom 5.53 to 6.15m.							
17				Core	RC-1	-	85%		
18	6	RQD = 47% (Poor Quality).							
19									
20			87.65						Silica sand
21		***Dolostone:*** Grey with calcite seams.							32 mm PVC screen
22	7	RQD = 47% (Poor Quality).							
23				Core	RC-2	-	90%		
24									
25	8		86.08						Borehole terminated at 7.72m below grade.
		End of Borehole							
26									
27									

Drilled By: Canadian Environmental Drilling

Drill Method: Truck Mounted Drill Rig

Drill Date: May 27, 2013

Hole Size: 75 mm

Datum: Local (93.80 m)

Sheet: 2 of 2

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BW13-2

Project No.: KIN-26260
Monitoring Well: BW13-2
Project: 185 Mill Street
Client: Brennan Custom Homes Inc.
Location: Gananoque, ON
Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
		Ground Surface	93.49					0.88 m stick-up TOC=0.88 m	
0 / 0		***Sand and Gravel Fill:*** Dry. Brown. No odour. Rock fill at bottom. Split spoon refusal at 0.84m.		20	SS-1	0.0	71%		Sample BW13-2 SS-1 submitted for analysis of PHC, VOC, and metals.
2			92.65	50/150mm	SS-2	0.0	33%		SWL=0.54m (June 19, 2013)
3 / 1		***Rock Fill:*** Augered through rock fill.		Auger	-	-	-		
5			91.97					Bentonite	
6 / 2		***Sand, Gravel and Clay Fill:*** Some wood fragments. Saturated. No odour. No staining.	91.36	22	SS-3	-	25%	32 mm PVC casing	
8		***Sand and Gravel Fill:*** Saturated. Rusty metal nail in split-spoon.	91.05	8	SS-4	-	50%		
9 / 3		***Wood Fill:*** Saturated.		3	-	-	17%		
10			90.14						
11 / 4		***Sand, Gravel, Wood Fill:*** No staining. No odour. Saturated. Granite at bottom		4	SS-5	-	58%		
13				13	SS-6	-	33%		
15									

Drilled By: Canadian Environmental Drilling
Drill Method: Truck Mounted Drill Rig
Drill Date: May 27/28, 2013

Hole Size: 75 mm
Datum: Local (93.49 m)
Sheet: 1 of 2

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BW13-2

Monitoring Well: BW13-2

Project No.: KIN-26260

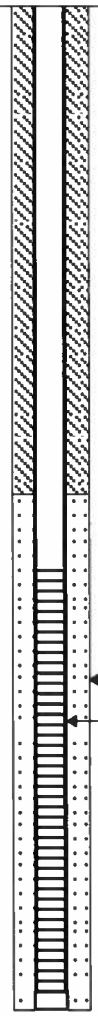
Project: 185 Mill Street

Client: Brennan Custom Homes Inc.

Location: Gananoque, ON

Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
16				10	SS-7	-	33%		
17									
18				3	SS-8	-	33%		
19 – 6			87.70						
20		***Augered:*** Augered through rock fill		Auger	-	-	-		
21			86.99						
22 – 7		***Calcite:*** Fractured. RQD = 75% (Good Quality).		Core	RC-1	-	75%		Inferred bedrock refusal at 6.50 m below grade.
23									
24									
25 – 8									
26			85.41						
27		***Calcite:*** Fractured. Vertical fracture 8.30 to 8.36m. RQD = 67% (Fair Quality).		Core	RC-2	-	93%		
28									
29 – 9									
30									
31			83.89						
32 – 10		End of Borehole							Borehole terminated at 9.60m below grade
33									
34									



Drilled By: Canadian Environmental Drilling

Drill Method: Truck Mounted Drill Rig

Drill Date: May 27/28, 2013

Hole Size: 75 mm

Datum: Local (93.49 m)

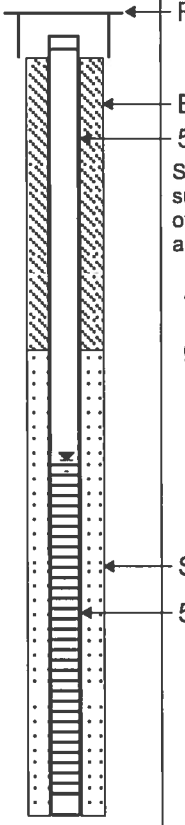
Sheet: 2 of 2

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BW13-3

Project No.: KIN-26260-A0
Monitoring Well: BW13-3
Project: 185 Mill Street
Client: Brennan Custom Homes Inc.
Location: Gananoque, Ontario
Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	94.85						
0 – 1		***Sand, Gravel and Coal Fill:*** Black. Dry. No odour.	94.44	57	SS-1	0.0	75%		
1 – 4 / 1		***Rubble Fill:*** Concrete with rebar to granite rubble.	93.43	Core	RC-1	-	30%		
4 – 9 / 2		***Dolostone:*** Very poor quality. Some calcite. RQD = 0% (Very Poor)	91.90	Core	RC-2	-	20%		
9 – 11 / 3		***Dolostone:*** Very poor quality grey and brown. RQD = 0% (Very Poor)	91.37	Core	RC-3	-	57%		
11 / 4		End of Borehole							



Sample BW13-3 SS-1 submitted for analysis of PHC, VOC, PAHs and, metals.

Auger refusal at 1.42 m below grade. Borehole terminated.

SWL=1.94m (June 19, 2013)

Borehole termintated at 3.48m below grade.

Drilled By: Canadian Environmental Drilling
Drill Method: Truck Mounted Drill Rig
Drill Date: May 28/29, 2013

Hole Size: 75 mm
Datum: Local (94.85 m)
Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BW13-4

Monitoring Well: BW13-4

Project No.: KIN-26260

Project: 185 Mill Street

Client: Brennan Custom Homes Inc.

Location: Gananoque, ON

Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	96.79					0.85 m stick-up TOC=97.63 m	
0 – 1 / 0		***Sand and Gravel Fill:*** Brown. Organic layer top 0.10 metres. Various large metal objects in borehole. Dry. No staining. No odour.	96.18	5	SS-1	0.1	50%		Sample BW13-4 SS-1 submitted for analysis of PHC, VOC, PAHs and metals.
1 – 2 / 1		***Sand Fill:*** Sand, gravel and red brick. Dry. No staining. No odour.	95.58	9	SS-2	0.1	38%	Bentonite	
4 / 1			95.37	50/150mm	SS-3	0.0	75%	32 mm PVC casing	
4 – 5 / 1 – 2		***Sand and Gravel Fill:*** Brown. Moist. No staining. No odour.							Auger refusal at 1.42 m below grade.
5 – 11 / 2 – 3		***Dolostone:*** Highly fractured. Grey. Horizontal to 25° fractures. RQD = 26% (Poor Quality)	93.34	Core	RC-1	-	78%		
11 – 16 / 3 – 5		***Dolostone:*** Highly fractured. Grey with brown seams. Mixed with some calcite. Very broken up, cobbly layer from 3.45-4.24 metres. RQD=17% (Very Poor Quality)	91.56	Core	RC-2	-	81%		SWL=3.24m (June 19, 2013)
16 / 5		End of Borehole						Silica sand 32 mm PVC screen	Borehole terminated at 5.23 m below grade.

Drilled By: Canadian Environmental Drilling

Drill Method: Truck Mounted Drill Rig

Drill Date: May 27/28, 2013

Hole Size: 75 mm

Datum: Local (96.79 m)

Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BW13-5

Monitoring Well: BW13-5

Project No.: KIN-26260-A0

Project: 185 Mill Street

Client: Brennan Custom Homes Inc.

Location: Gananoque, Ontario

Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	97.91					Flushmount cover TOC=97.87m	
1		***Sand and Gravel Fill:*** Brown. Dry. No odour. No staining.	97.46	24	SS-1	0.0	87%	Bentonite 51 mm PVC casing	
2 / 1		***Silt Fill:*** Brown. Wet. No odour. No staining.							Sample BW13-5 SS-1 submitted for analysis of PHC, BTEX, PAHs, PCBs and metals.
3 / 1		***Dolostone:*** Fractured. Grey with brown staining. Horizontal to 15° fractures. RQD = 25% (Poor Quality)	95.74	Core	RC-1	-	86%		
7 / 2		***Dolostone:*** Fractured. Grey. Horizontal to 20° fractures. Vertical fracture from 2.9-3.03 metres. RQD = 26% (Poor Quality)	94.20	Core	RC-2	-	100%		SWL=2.61m (June 19, 2013)
12 / 3								Silica sand 51 mm PVC screen	
13 / 4		***Dolostone:*** Fractured. Grey with brown seams. Horizontal to 45° fractures. RQD = 18% (Very Poor Quality)	92.55	Core	RC-3	-	77%		
17 / 5		End of Borehole							Borehole terminated at 5.36m below grade.
18 / 6									
23									

Drilled By: Canadian Environmental Drilling

Drill Method: Truck Mounted Drill Rig

Drill Date: May 30, 2013

Hole Size: 75 mm

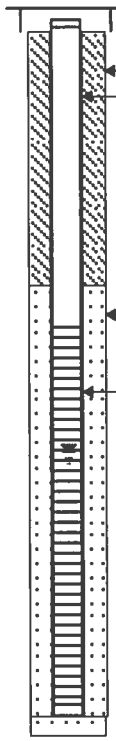
Datum: Local (97.91m)

Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BW13-6

Project No.: KIN-26260-A0
Monitoring Well: BW13-6
Project: 185 Mill Street
Client: Brennan Custom Homes Inc.
Location: Gananoque, Ontario
Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	97.97						Flushmount cover TOC=97.86 m
1		***Sand and Gravel Fill***	97.36	9	SS-1	0.0	63%		Bentonite
2									51 mm PVC casing
3 / 1		***Sand Fill:*** Light brown. Dry. No staining. No odour.	96.75	5	SS-2	0.2	54%		Sample BW13-6 SS-2 submitted for analysis of PHC, BTEX, PAHs, PCBs and metals.
4			96.53						
5		***Silty Clay Fill:*** Stiff. Dark grey/brown. Moist. No odour.	96.30	55	SS-3	0.1	67%		
6									
7 / 2		***Gravel Fill:*** Grey. Moist. No staining. No odour.		Core	RC-1	-	92%		Silica sand
8									
9									
10 / 3		***Clay Fill:*** Dark brown. Damp. No odour. No staining.	94.72						51 mm PVC screen
11									
12		***Dolostone:*** Fractured. Grey. Horizontal to 45° fractures. Coal Slag on top of bedrock surface.							SWL=3.47m (June 19, 2013)
13 / 4				Core	RC-2	-	100%		
14									
15		RQD = 53% (Fair Quality)	93.19						
16									
17 / 5		***Dolostone:*** Highly fractured. Grey with brown seams.	92.59	Core	RC-3	-	100%		
18			92.28						
19		RQD = 28% (Poor Quality)							
20 / 6		***Dolostone:*** Very highly factured. Grey with brown seams.							Borehole terminated at 5.69m below grade.
21									
22									
23 / 7		***Calcite:*** Highly fractured.							
24									
25		RQD = 13% (Very Poor Quality)							
26 / 8		End of Borehole							
27									
28									
29									

Drilled By: Canadian Environmental Drilling
Hole Size: 75 mm
Drill Method: Truck Mounted Drill Rig
Datum: Local (97.97m)
Drill Date: May 30, 2013
Sheet: 1 of 1

exp Services Inc.
315 The Woolen Mill
4 Cataraqui Street
Kingston, ON K7K 1Z7

Log Of Borehole: BW13-7

Monitoring Well: BW13-7

Project No.: KIN-26260

Project: 185 Mill Street

Client: Brennan Custom Homes Inc.

Location: Gananoque, ON

Logged by: M. Whitney

SUBSURFACE PROFILE			SAMPLE						
Depth (ft / m)	Symbol	Description	Depth/Elev.	'N' Value	Sample I.D.	Vapour ppm	Recovery	Well Completion Details	Comments
0 / 0		Ground Surface	97.42					0.87 m stick-up TOC=98.29m	
0 / 0		***Sand and Gravel Fill:*** Dry. No staining. No odour.	97.13	7	SS-1	0.0	75%		Sample BW13-7 SS-1 submitted for analysis of PAHs and metals. BW13-7 submitted for PHC and VOC.
1 / 0		***Coal Fill:*** Black.		6	SS-2	0.0	46%		
1 / 0 – 2 / 1		***Silt Fill:*** Brown with gravel. No odour. No staining. Dry to Wet. (1.00 to 2.25 kg/m3)	95.69	53	SS-3	0.0	75%	Bentonite; 32 mm PVC casing	
2 / 1 – 10 / 3		***Dolostone:*** Fractured. Grey with brown seams. Calcite seam from 2.58 to 2.60 metres. RQD = 73% (Fair Quality)	93.97	Core	RC-1	-	93%	SWL=2.30m (June 19, 2013); 32 mm PVC screen; Silica sand	
10 / 3 – 16 / 5		***Dolostone:*** Grey with brown seams. RQD = 72% (Fair Quality)	92.44	Core	RC-2	-	98%		
16 / 5 – 18 / 5		***Calcite:*** Fractured. Broken up layer from 5.21 to 5.36 m. Thin dolostone layer at top of core. RQD = 41% (Poor Quality)	91.76	Core	RC-3	-	88%		
18 / 5 – 20 / 6		End of Borehole							Borehole Terminated 5.66 m below grade.

Drilled By: Canadian Environmental Drilling

Drill Method: Truck Mounted Drill Rig

Drill Date: May 31, 2013

Hole Size: 75 mm

Datum: Local (97.42 m)

Sheet: 1 of 1

TEST PIT LOGS

TP-1 (Brick Building Exterior):

Foundation Observations:

Depth (m)	Comments:
0-0.76	Stone foundation
0.76-1.07	Concrete footing
1.07	Inferred bedrock

Subsurface Observations:

Depth (m)	Comments:
0-0.48	Dark coloured sand fill
0.48-1.07	Brown sand fill with clay drainage tile
1.07	Inferred bedrock

TP-2 (Stone Building Exterior):

Foundation Observations:

Depth (m)	Comments:
0-0.74	Stone foundation
0.74	Inferred Bedrock

Subsurface Observations:

Depth (m)	Comments:
0-0.30	Brown gravelly topsoil
0.30-0.74	Rusty brown sandy clay fill
0.74	Inferred bedrock

TP-3 (Stone Building Exterior):

Foundation Observations:

Depth (m)	Comments:
0-1.24	Stone foundation
1.24	Inferred bedrock

Subsurface Observations:

Depth (m)	Comments:
0-1.24	Rubble fill
1.24	Inferred bedrock

TP-4 (Brick Building Exterior):

Foundation Observations:

Depth (m)	Comments:
-	Concrete encountered just below grade
-	Could not advance test pit

Subsurface Observations:

Depth (m)	Comments:
-	Sand and gravel fill at surface
-	Concrete encountered, could not advance

TP-4B (Brick Building Exterior):

Foundation Observations:

Depth (m)	Comments:
0-0.91	Concrete
0.91-1.78	Rock
1.78	Inferred bedrock

Subsurface Observations:

Depth (m)	Comments:
0-1.78	Sand, gravel, clay and rock fill
1.78	Inferred bedrock

TP-5 (Brick Building Exterior):

Foundation Observations:

Depth (m)	Comments:
0-0.28	Rock foundation
0.28	Inferred bedrock

Subsurface Observations:

Depth (m)	Comments:
0-0.28	Sand, clay and gravel fill
0.28	Inferred bedrock

TP-6 (Brick Building Exterior):

Foundation Observations:

Depth (m)	Comments:
0-0.33	View of footing obstructed by concrete water drain
0.33	Inferred bedrock

Subsurface Observations:

Depth (m)	Comments:
0-0.33	Sand, clay and gravel fill
0.33	Inferred bedrock

TP-7 (Brick Building Interior):

Foundation Observations:

Depth (m)	Comments:
0-0.20	Interior post
0.20-0.76	Layered/stacked stone blocks
0.76	Inferred bedrock

Subsurface Observations:

Depth (m)	Comments:
0-0.76	Sand and gravel fill
0.76	Inferred bedrock

TEST PIT LOGS (continued)

TP-8 (Brick Building Interior):

Foundation Observations:

Depth (m)	Comments:
Grade	Pillar set on concrete
0-0.58	Stone blocks
0.58	Inferred bedrock

Subsurface Observations:

Depth (m)	Comments:
0-0.58	Sand, gravel and rubble fill
0.58	Inferred bedrock

TP-9 (Stone Building Exterior):

Foundation Observations:

Depth (m)	Comments:
0-0.43	Stone blocks
0.43	Inferred bedrock

Subsurface Observations:

Depth (m)	Comments:
0-0.43	Sand and gravel fill
0.43	Inferred bedrock

TP-10 (Brick Building Exterior):

Foundation Observations:

Depth (m)	Comments:
0-1.52	Concrete foundation
1.5	Concrete or bedrock ledge extends 0.6m to east and then drops off

Subsurface Observations:

Depth (m)	Comments:
0-1.52	Sand and gravel fill
1.52-2.13	Sand and gravel fill
2.13	Inferred bedrock

TP-11 (Stone Building Interior):

Foundation Observations:

Depth (m)	Comments:
0-0.06	9"x9" wooden post
0.06-0.37	30"x30" concrete pad
0.37-0.41	Inferred bedrock

Subsurface Observations:

Depth (m)	Comments:
0-0.09	Concrete
0.09-0.41	Sand and gravel fill
0.41	Inferred bedrock

TP-12 (Stone Building Interior):

Foundation Observations:

Depth (m)	Comments:
Grade	Pillar set on 11"x11" concrete pad
0-0.53	Rock foundation wall
0.53	Inferred bedrock

Subsurface Observations:

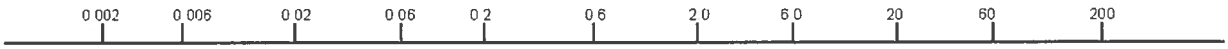
Depth (m)	Comments:
0-0.13	Concrete
0.13-0.53	Sand and gravel fill
0.53	Inferred bedrock

Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Societv for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by **exp** Services Inc. also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Notes On Sample Descriptions (cont'd):

Relative Density of Cohesionless Soils	Standard Penetration Index 'N' Value (Blows/ft or 300mm)
Very Loose	0 - 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very Dense	> 50

Cohesive Soils Consistancy	Standard Penetration Index 'N' Value (Blows/ft or 300mm)	Undrained Shear Strength (kPa)
Very Soft	< 2	< 12
Soft	2 - 4	12 - 25
Firm	4 - 8	25 - 50
Stiff	8 - 15	50 - 100
Very Stiff	15 - 30	100 - 200
Hard	> 30	> 200

Terms	
Trace	1 - 10%
Some	10 - 20%
Description (i.e., silty, sandy)	20 - 35%
And	35 - 50%

Rock Quality Designation (RQD)	
RQD Value (%)	Designation
< 25	Very Poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

Stratigraphy

Other Terminology:

Sample Types:

- SS - Split Spoon
- AS - Auger Sample
- GS - Grab Sample
- ST - Shelby Tube
- RC - Rock Core Sample

Definitions:

Recovery: Recoveries are shown as a percentage of the length of the recovered sample to the length the sampling apparatus was advanced into the subsurface.

Rock Quality Designation (RQD): RQD values are shown as a percentage of the total length of all core segments 10cm or greater in length to the total length of the core run.