Limebank Road and Leitrim Road
Hydrogeological Investigation

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1 Introduction

1.1 Project Description

EXP Services Inc. (EXP) was retained by One Properties Real Estate Inc. to prepare a Hydrogeological Investigation Report associated with the proposed development located at Limebank Road and Leitrim Road, in Ottawa, Ontario (hereinafter referred to as the 'Site').

The Site is located within a rural area and is occupied by agricultural fields. The Site is rectangular in shape and has an area of approximately 15 hectares. Based on a review of historical aerial photographs, maps, previous reports, and other records review, it appears the Site has only been used for agricultural purposes. It is our understanding that the proposed development will consist of four (4) slab-on-grade single storey industrial buildings with no basements and a stormwater management pond. Three different site layouts with differing building sizes are being considered for the Site. The Site location plan is shown on Figure 1.

EXP conducted a Geotechnical Investigation and Environmental Site Assessment at the Site in April 2022. The pertinent information gathered from those investigations is utilized for this report.

1.2 Project Objectives

The main objectives of the Hydrogeological Investigation are as follows:

- Establish the local hydrogeological settings within the Site;
- Assess construction dewatering flow rates and potential impacts;
- Assess long-term foundation sub-drain discharge volumes;
- Assess groundwater quality; and
- Prepare a Hydrogeological Investigation Report.

1.3 Scope of Work

To achieve the investigation objectives, EXP has completed the following scope of work:

- Reviewed available geological and hydrogeological information for the Site;
- Drilled 17 boreholes (BH-1 to BH-16, BH-18) to an approximate depth of 7.9 to 15.8 meters below ground surface (mbgs);
- Installed six (6) 50 mm diameter monitoring wells (BH-1, BH-3, BH-8, BH-11, BH-12, and BH-15) to an approximate depth of 4.6 meters below ground surface (mbgs);
- Installed two (2) 38 mm diameter piezometers (BH-7 and BH-9) to an approximate depth of 7.6 meters below ground surface (mbgs);
- Developed and conducted Single Well Response Tests (SWRT) on three of the monitoring wells to assess hydraulic conductivities of the saturated soils at the Site;
- Completed a percolation test (P-1) in the vicinity of the proposed stormwater management pond;
- Completed one (1) round of groundwater level measurements at all monitoring wells;
- Collected one (1) groundwater sample for analyses of parameters, as listed in the City of Ottawa Sanitary and Storm Sewer Use By-Law;
- Evaluated the information collected during the field investigation program, including borehole geological information, Water Well Records (WWR), SWRT results, groundwater level measurements and groundwater water quality;

- Prepared site plans, cross sections, geological mapping and groundwater contour mapping for the Site;
- Provided preliminary recommendations on the requirements for construction and long-term dewatering;
- Provided recommendations on the Ministry of Environment, Conservation and Parks (MECP) Water Taking Permits and City of Ottawa Sewer Discharge Agreements (SDA) for the construction and post-construction phases; and
- Prepared a Hydrogeological Investigation Report.

The Hydrogeological Investigation was prepared in accordance with the Ontario Water Resources Act, Ontario Regulation 387/04, and City of Ottawa Sewer Use Bylaw. The scope of work outlined above was made to assess dewatering and included a review of Environmental Site Assessments (ESA).

1.4 Review of Previous Reports

The following reports were reviewed as part of this Hydrogeological Investigation:

- EXP Services Inc. (April 21, 2022), Phase One Environmental Site Assessment, Vacant Land, Limebank Road at Leitrim Road, Ottawa, Ontario, prepared for One Properties Real Estate Inc.
- EXP Services Inc. (May 12, 2022), Soil Sampling Letter, Vacant Land, Limebank Road at Leitrim Road, Ottawa, Ontario, prepared for One Properties Real Estate Inc.
- EXP Services Inc. (May 20, 2022), Draft Geotechnical Investigation, Proposed Industrial Development, Limebank Road and Leitrim Road, Ottawa, Ontario prepared for One Properties Real Estate Inc.

There are no surface water bodies onsite other than irrigation ditches. The closest significant body of water is the Rideau River found approximately 1.7 km to the west. Topographically, the Site is relatively flat, with nearby lands sloping down to the west towards the river valley. Based on this local topography, the groundwater flow at the Site is anticipated to be westerly. There are no areas of natural or scientific interest (ANSI) within the study area.

The Phase I Environmental Site Assessment (ESA) prepared for the Site by EXP (April 2022) identified the use of the Site as agricultural land, and the presence of several oil buckets on the south part of the Site as areas of potential environmental concern. Based on this information, shallow soil sampling was recommended to determine the current soil conditions at the Site. Potential contaminants of concern were identified as organochlorinated pesticides (OC pesticides), for the entire Site, and petroleum hydrocarbons (PHCs), in the vicinity of the oil buckets.

On April 28 and 29, 2022, EXP collected ten (10) soil samples from the top 0.1 to 0.5 m of surficial soil at the Site. Subsurface conditions at the Site consist of a 220 mm to 350 mm thick surficial topsoil layer. The topsoil is underlain by a reworked silty clay material to a depth of 0.5 m below ground surface. No odours or staining were observed in the soil samples. Based on the analytical results obtained, the concentrations of all tested parameters were less than the Ministry of the Environment, Conservation and Parks (MECP) Table 1 SCS for background conditions and Table 3 SCS for a non-potable groundwater condition and commercial land use. No further environmental investigation was recommended.

Any past and/or future geotechnical, hydrogeological, environmental and risk assessments, and updated development/ architectural plans should be provided to update this hydrogeological report prior to submission of permits and approvals by the municipalities and agencies.

2 Hydrogeological Setting

2.1 Regional Setting

2.1.1 Regional Physiography

Topographically, the Site is relatively flat, with nearby lands sloping down to the west towards the Rideau River which is approximately 1.8 km away.

The Site is within a physiographic region known as the Ottawa Valley Clay. The physiographic landform is named the Clay Plain. The Ottawa Valley Clay lies to the north of Russell and Prescott Sand Plains (Chapman & Putnam, 2007).

2.1.2 Regional Geology and Hydrogeology

Beneath any fill, the surficial geology of the subject Site is characterized by Champlain Sea offshore deposits of clay, silty clay, and silt overlain by thin sands. The bedrock geology underlying the Site consists of dolomite and limestone of the Oxford Formation. The depth to rock in the area is typically 5 to 10 m below grade.

The surficial geology of the Site and surrounding areas is shown on Figure 2.

Regional groundwater across the area flows north towards the Ottawa River and northwest towards the Rideau River. Local deviations from regional groundwater flow pattern may occur in response to changes in topography and/or soils, as well as the presence of surface water features and/or existing subsurface infrastructure.

2.1.3 Existing Water Well Survey

Water Well Records (WWRs) were compiled from the database maintained by the MECP and reviewed to determine the number of water wells documented within a 500-m radius of the Site boundaries. The MECP WWR database indicates that three (3) records are present within a 500 m radius from the Site boundaries.

The reported static water levels ranged from depths of 3.5 m to 7.3 metres below ground surface (mbgs).

The residence and barn at 3995 Limebank Road were demolished in 2014. Therefore, it is unlikely that the noted water supply wells (well 2 and well 3 on Figure 3) are still active. The well installed in 2005 is likely still active and is shown as Well 1 on Figure 3. These wells all source their water from the bedrock.

The locations of the MECP WWRs within 500 m of the Site are shown on Figure 3. A summary of the WWR is included in Appendix A.

2.2 Site Setting

2.2.1 Site Topography

The Site is located in an agricultural area. The topography is considered relatively flat with a regional gradual slope towards the Rideau River, located approximately 1.8 km northwest.

As indicated on the borehole logs included in Appendix B, the surface elevation of the Site ranges between approximately 91.70 to 92.89 meters above sea level (masl).

2.2.2 Local Surface Water Features

The Site is within the Lower Rideau River watershed, and the Mosquito Creek sub watershed. No surface water features exist onsite, except for irrigation ditches which border the Site. The nearest surface water feature is an unnamed tributary to Mosquito

Creek, approximately located 185 meters southwest of the Site boundary. The Rideau River is approximately 1.8 km from the Site boundary to the northwest. Based on the Rideau Valley Conservation Authority Website, the Site is not within the flood plain area.

2.2.3 Local Geology and Hydrogeology

A summary of subsurface soil stratigraphy is provided in the following paragraphs. The soil descriptions are based on the Geotechnical Investigation report (EXP, 2022). They are summarized for the hydrogeological interpretations. As such, the information provided in this section shall not be used for construction design purposes.

The detailed soil profiles encountered in each borehole and the results of moisture content determinations are presented on the attached borehole logs (Appendix B). The soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones for the Hydrogeological Investigation and shall not be interpreted as exact planes of geological change.

The "Notes on Sample Description" preceding the borehole logs form an integral part of and should be read in conjunction with this report. The following is a brief description of the soil conditions encountered during the investigation.

Based on the results of the geotechnical investigation, the general subsurface soil stratigraphy consists of the following units from top to bottom:

Topsoil

A 220 mm to 350 mm thick surficial topsoil layer was encountered in all seventeen (17) boreholes.

Silty Clay

The topsoil is underlain by silty clay with trace to some sand confirmed by retrieved split spoon samples to 7.6 m to 10.7 m depths (Elevation 82.0 m to Elevation 85.3 m). The silty clay was reworked in the upper levels and has a very stiff to stiff upper crust extending to depths ranging from 1.9 to 2.8 m below ground (Elevation 89.3 to 90.2 m). Based on a review of the results of the grain-size analysis and Atterberg limits, the soil may be classified as a clay of high plasticity (CH) in the upper crust and clay of low plasticity underneath the crust.

Silty Gravelly Sand Till

The silty clay in Borehole Nos. 3, 6, and 8 is underlain by clayey silty sand with gravel glacial till extending to the maximum explored depths of 12.5 m to 15.9 m (elevation 76.3 m to 80.4 m) in these boreholes. The till consists of silty sand with gravel and some cobbles and boulders. A grain-size analyses performed on the till yielded a composition of 43 percent clay and silt, 38 percent sand and 19 percent gravel.

Limestone

Auger refusal on assumed bedrock was encountered at depths of 12.5 m to 14.3 m below the existing ground surface in two of the boreholes, BH-6 and BH-8(Elev. 78.6 m to 80.4 m). No bedrock coring occurred at the Site.

The borehole and monitoring well locations are shown on Figure 4. Geological cross-sections were generated based on the available borehole logs completed as part of the current investigation and is shown on Figure 5A (Cross section A-A'), and 5B (Cross section B-B'). The cross section shows a simplified representation of soil conditions and soil deposits may be interconnected differently than represented. Borehole logs used to generate both cross-sections are provided in Appendix B.

3 Results

3.1 Monitoring Well Details

A total of eight (8) monitoring wells or piezometers were installed across the Site as part of the Preliminary Geotechnical Investigation. The details of monitoring network are as follows:

- The wells were installed to an approximated depth ranging from 5.0 to 7.7 mbgs;
- Each monitoring well consists of a 50-mm (2-inch) diameter PVC pipe with a 1.5 metre long well screen; and,
- Each piezometer consists of a 38-mm (1-1/4 inch) diameter PVC pipe with a 1.5 metre long well screen.

Borehole logs and monitoring well installation details are provided in Appendix B. The monitoring well locations are shown on Figure 4.

3.2 Water Level Monitoring

As part of the Hydrogeological Investigation, static water levels in the monitoring wells were recorded on May 10, 2022. A summary of all static water level data is given in Table 3-1 below.

The groundwater elevations ranged from 91.23 masl (0.68 mbgs at BH-11 to 92.59 masl (0.29 mbgs at BH-3).

Table 3.1: Groundwater Elevations

Monitoring Well ID	Ground Surface Elevation (masl)	Stick Up/Down (+/-) (m)	Approximate Full Well Depth (mbgs)	Depth - May 10, 2022		
				(mbtoc)	(mbgs)	(masl)
BH-1	91.70	+1.05	4.6	1.50	0.45	91.25
BH-3	92.88	+1.06	4.6	1.35	0.29	92.59
BH-7	92.56	+1.00	7.9	1.44	0.44	92.12
BH-8	92.89	+1.02	4.6	1.46	0.44	92.45
BH-9	92.29	+1.03	7.6	1.33	0.30	91.99
BH-11	91.91	+1.03	4.6	1.71	0.68	91.23
BH-12	92.10	+1.04	4.6	1.46	0.42	91.68
BH-15	91.80	+1.01	4.6	1.38	0.37	91.43

Note: Elevations were collected using a high precision GPS unit with a geodetic elevation relative to mean sea level.
mbtoc – metres below top of plastic well casing
mASL – metres above sea level
NA – not applicable

Based on the groundwater level measurements of 2018, the groundwater flow direction in the area is to the west as shown on Figure 6.

Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions. This may also affect the direction and rate of flow. It is recommended to conduct seasonal groundwater level measurements to provide more information on seasonal groundwater level fluctuations.

The underlying bedrock aquifer is confined. WWR 1535501 (Appendix A) suggests a vertical downward hydraulic gradient.

3.3 Hydraulic Conductivity Testing

Single Well Response Tests (SWRT's) were completed on three (3) of the monitoring wells on May 10, 2022. The tests were completed to estimate the saturated hydraulic conductivity (K) of the soils at the well screen depths.

The static water level within each monitoring well was measured prior to the start of testing. In advance of performing SWRTs, each monitoring well underwent development to remove fines introduced into the screens following construction. The development process involved purging of the monitoring wells to induce the flow of fresh formation water through the screen. Each monitoring well was permitted to fully recover prior to performing SWRTs.

Hydraulic conductivity values were calculated from the SWRT and constant rate test data as per Hvorslev's solution included in the Aqtesolv Pro. V.4.5 software package. The semi-log plots for normalized drawdown versus time are included in Appendix C.

A summary of the hydraulic conductivities (K-values) estimated from the SWRTs are provided in Table 3-2.

Table 3.2A: Summary of Hydraulic Conductivity Testing from SWRTs

Monitoring Well	Well Depth (mbgs)	Screen Interval (mbgs)		Screened Lithology*	Estimated Hydraulic Conductivity (m/s)
		from	to		
BH-1	4.6	3.5	4.6	Silty Clay	7.7E-6
BH-11	4.6	3.5	4.6	Silty Clay	1.5E-7
BH-15	4.6	3.5	4.6	Silty Cay	2.4E-7
				Highest Estimated K Value	7.7E-6
				Arithmetic Mean of Estimated K Values	2.7E-6
				Geometric Mean of Estimated K Values	6.5E-7

Note:
mbgs: meter below ground surface
masl: meter above mean sea level
*based on geotechnical borehole logs (EXP, 2022)

SWRTs provide K-estimates of the geological formation surrounding the well screens and may not be representative of bulk formation hydraulic conductivity. As shown in Table 3-2, the highest K-value of the tested water-bearing zone is 7.7×10^{-6} m/s. The arithmetic and the geometric mean of the K-values are 2.7×10^{-6} and 6.5×10^{-7} m/s, respectively.

Six soil samples were also collected from the boreholes for grain size analysis in order to determine hydraulic conductivity.

Table 3.2B: Summary of Hydraulic Conductivity Testing from Particle Size Analyses

Borehole	Sample	Sample Depth (mbgs)	Lithology	Percentage of Fines d > 0.02 mm (%)	Estimated Hydraulic Conductivity (m/s)
BH-1	SS2	0.8 - 1.4	Silty Clay	93%	<1.0E-09
BH-3	SS5	4.6 - 5.2	Silty Clay	55%	2.1E-09
BH-6	SS10	13.7 - 14.3	Glacial Till	26%	4.2E-07
BH-9	SS5	6.1 - 6.7	Silty Clay	65%	<1.0E-09
BH11	SS4	3.0 - 3.7	Silty Clay	93%	<1.0E-09
BH16	SS3	1.5 - 2.1	Silty Clay	93%	<1.0E-09

Cross sections are included in Figure 5. Borehole logs for the monitoring wells installed by EXP are provided in Appendix B.

3.4 Groundwater Quality

To assess the suitability for discharging pumped groundwater into the sewers owned by the City of Ottawa during dewatering activities, one (1) groundwater sample was collected from monitoring well BH-12 on May 10, 2022, using a peristaltic pump. Prior to collecting the noted water sample, approximately three (3) standing well volumes of groundwater were purged from the referred well. The samples were collected unfiltered and placed into pre-cleaned laboratory-supplied vials and/or bottles provided with analytical test group specific preservatives, as required. Dedicated nitrile gloves were used during sample handling. The groundwater samples were submitted for analysis to Caduceon Laboratories, a CALA certified independent laboratory in Ottawa, Ontario. The analytical results are provided in Appendix D.

Table 3-3 summarizes exceedance(s) of the Sanitary (Table 1) and Storm (Table 2) Sewer Use By-Law parameters.

When comparing the chemistry of the collected groundwater samples to the City of Ottawa Sanitary and Combined Sewer Discharge Criteria (Table 1), no parameter exceedances were reported.

When comparing the chemistry of the collected groundwater samples to the City of Ottawa Storm Sewer Discharge Criteria (Table 2) there was an exceedance of manganese. No other parameter exceedances were reported.

Reporting detection limits (RDLs) were below the Sewer Use By-Law parameter criteria of Tables 1 and 2.

Table 3.3: Summary of Analytical Results

Parameter	Units	City of Ottawa Sanitary and Combined Sewer Discharge Limit (Table 1)	City of Ottawa Storm Sewer Discharge Limit (Table 2)	Concentration BH-12 May 10, 2022
Manganese (Mn)	mg/L	5	0.05	**0.272**

Notes: **Bold** – Exceeds City of Ottawa Storm Sewer Discharge Limit (Table 2).

Bold & underlined – Exceeds City of Ottawa Sanitary and Combined Sewer Discharge Limit (Table 1).

For the short-term dewatering system (construction phase), it is anticipated that TSS levels and some other parameters (for example, Total Metals) in the pumped groundwater may become elevated and exceed both, Sanitary and Storm Sewer Use By-Law limits. To control the concentration of TSS and associated metals, it is recommended that a suitable treatment method be implemented (filtration or decantation facilities and/ or any other applicable treatment system) during construction dewatering activities to discharge to the applicable sewer system. The specifications of the treatment system will need to be adjusted to the reported water quality results by the treatment contractor/process engineer.

For the long-term dewatering discharge to the sanitary sewer system (post-development phase) and based on the water quality test results, the water is suitable to be discharged without a treatment system.

For the long-term dewatering discharge to the storm sewer system (post-development phase) and based on the water quality results, it is recommended to implement a suitable pre-treatment, as required.

The water quality results presented in this report may not be representative of the long-term condition of groundwater quality onsite. As such, regular water quality monitoring is recommended for the post-construction phase, as required by the City of Ottawa.

An agreement to discharge into the sewers owned by the City of Ottawa will be required prior to releasing dewatering effluent to the sanitary sewer.

3.5 Infiltration Testing

To assess the native soil's suitability to accommodate storm water flows generated by the redevelopment of the Site, an in-situ percolation tests were performed on May 10, 2022. The location of the test hole is shown on Figure 4 (P-1) and is in the location of the proposed stormwater management pond.

The percolation test was performed by hand-augering a 5 cm diameter hole in the soil. Once constructed the test hole was filled with water and the rate at which the water level in the hole fell was closely monitored using an electronic data logger as well as manual measurements. The result of the percolation test is summarized in Table 3-4 below and the data is presented in Appendix E.

Table 3.4: Summary of Percolation Test Results

Test Location	Total Depth (mbgs)	Saturated Hydraulic conductivity (m/s)	Soil Description
P1	1.03	1.9E-8	Silty Clay

For the proposed storm water management pond in the vicinity of test hole P1, the water table in the overburden was found to be approximately 0.68 mbgs. Water added to this borehole for testing purposes did not fully drain after the test.

Flat topography and a high-water table make it difficult to separate stormwater from groundwater by 1.0 meter, as required in MOE (2003). A common stormwater management approach in a low-relief environment is to construct (wet) ponds or (pocket) wetlands. These are typically excavated below the water table to provide the required pool storage for pollutant removal. A weir above the pool can be used to create additional storage.

Keeping the normal pool elevation above the water table elevation reduces the influence of groundwater on the pond's water budget. As a practical target, groundwater should probably supply no more than a quarter of the stormwater quality pond's total water budget. The pond design should not rely on groundwater dilution alone for stormwater treatment. Depending on local groundwater quality, it is possible for groundwater to augment rather than dilute some pollutants (particularly nitrogen). Therefore, the design should maximize internal features that can provide greater physical and biological treatment of stormwater. Longer flow paths, greater residence times, higher treatment volumes and wetland plantings are essential in physical treatment for stormwater in high groundwater areas.

Infiltration into the underlying confined bedrock aquifer is not recommended.

4 Dewatering Assessment

It is our understanding that the proposed development will consist of four (4) slab-on-grade single storey industrial buildings with no basements and a stormwater management pond. Three different site layouts with differing building sizes are being considered for the Site. Based on the geotechnical report, the proposed structures are anticipated to be supported by either spread and strip footings or pile foundations (EXP, 2022). At the time of writing this report no details were specified for the stormwater management pond. Therefore, it has been excluded from the dewatering assessment for now.

Multiple design options are still under consideration for the Site. Option 2 (east west layout of the buildings) was selected for the dewatering assessment. Table 4-1 presents the assumptions used to calculate the dewatering rate for the Site.

Table 4.1 Building Dimensions for Dewatering Assessment

Input Parameter	Assumption	Units	Notes
Ground Surface Elevation	92.89	masl	Highest ground surface elevation at the Site based on the geotechnical borehole logs (EXP, 2022)
Groundwater elevation	92.89	masl	The highest recorded groundwater elevation measured across the Site (92.59 masl at BH-3 on May 10, 2022), groundwater assumed to saturate to surface to account for seasonal fluctuations.
Lowest Foundation Elevation	92.0	masl	Assumed based on existing average ground surface elevations.
Lowest Top Slab Elevation	93.0	masl	Assumed to be approximately 1.0 m above the lowest footing elevation.
Construction Dewatering Elevation Target	90.0	masl	Assumed to be approximately 3.0 m below the lowest slab elevation.
Long Term Dewatering Elevation Target	92.5	masl	Assumed to be 0.5 m below top of slab elevation.
Bottom Elevation of Water-Bearing Zone	82.0	masl	Assumed to be the bottom of the silty clay unit.
Excavation Area (Length x Width) (Option 2)	A: Two structures: each 21,440 (268 x 80) B: Two structures: each 13,920 (240 x 58)	m^2 (m x m)	Approximate area (length x width) of the proposed development based on the conceptual architectural drawing for Option 2 (Figure 4).
Hydraulic Conductivity (K)	2.7E-6	m/s	Arithmetic mean of K-value for overburden
Specific Yield	0.03	1	Assumed for Silty Clay

Note: All building values provided are for preliminary design purposes only, and subject to change pending final building design.

4.1 Dewatering Flow Rate Estimate and Zone of Influence

The Dupuit-Forcheimer equation for radial flow to both sides of an excavation through an unconfined aquifer resting on a horizontal impervious surface was used to obtain a flow rate estimate. Dewatering flow rate is expressed as follows:

$$Q_w = \frac{\pi K(H^2 - h^2)}{Ln\left[\frac{R_o}{r_e}\right]}$$

$$r_e = \frac{a+b}{\pi} \qquad R_o = R_{cj} + r_e$$

Where:

Qw = Rate of pumping (m^3/s)
X = Length of excavation (m)
K = Hydraulic conductivity (m/s)
H = Hydraulic head beyond the influence of pumping (static groundwater elevation) (m)
h = Hydraulic head above the base of aquifer in an excavation (m)
R_0 = Radius of influence (m)
R_{cj} = Cooper-Jacob's radius of influence (m)
r_e = Equivalent perimeter (m)
a = Length of the excavation area (m)
b = Width of the excavation area (m)

It is expected that the initial dewatering rate will be higher to remove groundwater from within the overburden formation. The dewatering rates are expected to decrease once the target water level is achieved in the excavation footprint as groundwater will have been removed, primarily from storage, resulting in lower seepage rates into the excavation.

4.2 Cooper-Jacob's Radius of Influence

The radius of influence (Rcj) for the construction dewatering was calculated based on Cooper-Jacob's equation. This equation is used to predict the distance at which the drawdown resulting from pumping is negligible.

The estimated radius of influence due to pumping is based on Cooper-Jacob's formula as follows:

$$\mathrm{R}_{cj} = \sqrt{2.25KDt/s}$$

Where:

Ro = Estimated radius of influence (m)
D = Aquifer thickness (original saturated thickness) (m)
K = Hydraulic conductivity (m/s)
S = Storage coefficient
t = Duration of pumping (s)

4.3 Stormwater

Additional pumping capacity may be required to maintain dry conditions within the excavation during and following significant precipitation events. Therefore, the dewatering rates at the Site should also include removing stormwater from the excavation.

A 15 mm precipitation event was utilized for estimating the stormwater volume. The calculation of the stormwater volume is included in Appendix F.

The estimate of the stormwater volume only accounts for direct precipitation into the excavation. The dimensions of the excavation are considered in the dewatering calculations. Runoff which originated outside of the excavation's footprint is excluded and it should be directed away from the excavation.

During precipitation events greater than 15 mm (ex: 100-year storm), measures should be taken by the contractor to retain stormwater onsite in a safe manner to not exceed the allowable water taking and discharge limits, as necessary. A two (2) and a one hundred (100) year storm event over a 24-hour period are 51.8 and 115.6 mm.

4.4 Results of Dewatering Rate Estimates

4.4.1 Construction Dewatering Rate Estimate

For this assessment, it was assumed that the proposed construction plans include four (4) separate excavations with shoring enclosing each proposed building. EXP should be retained to review the assumptions outlined in this section, should the assumed shoring design change.

Short-term (construction) dewatering calculations are presented in Appendix F.

Pits (sump pits etc.) are assumed to have the same excavation depth and dewatering target as the main excavation; deeper pits may require localized dewatering and revised dewatering estimates.

Based on the assumptions provided in this report, the results of the dewatering rate estimate can be summarized as follows:

Table 4-2 Summary of Construction Dewatering Rate

Peak Dewatering Flow Rate Including Rain Collection Volume and Zone of Influence		
Description	For Building Design A (268 m x 80 m) **(L/day)**	For Building Design B **(240 m x 58 m)** **(L/day)**
Single Building Total Volume (L/day) Short Term Discharge of Groundwater (Construction dewatering) with Safety Factor (including precipitation)	453,000	326,000
Single Building Total Volume (L/day) Short Term Discharge of Groundwater (Construction dewatering) with Safety Factor	132,000	117,000

The peak dewatering flow rates do not account for flow from utility beddings and variations in hydrogeological properties beyond those encountered during this investigation.

Local dewatering may be required for pits (sump pits, raft) if these extend deeper than the dewatering target, and for localized areas with permeable, soft, or wet soil conditions. Local dewatering is not considered to be part of this assessment, but the contractor should be ready to install additional system to manage such conditions. Dewatering estimates should be reviewed once the pit dimensions are available.

All grading around the perimeter of the excavation should be graded away from the shoring the systems and ramp/site access to redirect runoff away from excavation.

The dewatering assumptions are based on using shoring system without open cuts and sloped excavations.

All grading around the perimeter of the construction Site should be graded away from the shoring the system.

The contractor is responsible for the design of the dewatering systems (depth of wells, screen length, number of wells, spacing sand pack around screens, prevent soil loss etc.) to ensure that dry conditions are always maintained within the excavation at all costs.

Dewatering should be monitored using dedicated monitoring wells within and around the perimeter of the excavation, and these wells should be monitored using manual measurements and with electronic data loggers; records should be maintained onsite to track dewatering progress. Discharge rates should be monitored using calibrated flow meters and records of dewatering progress, and daily precipitation as per MECP requirements should be maintained.

4.4.2 Post-Construction Dewatering Rate Estimate

It is our understanding that the development plan includes a permanent foundation sub-drain system that will ultimately discharge to the municipal sewer system if conventional footings are installed.

The long-term dewatering was based on the same equations as construction dewatering shown in Section 4.1.

The calculation for the estimated flow to the future sub-drain system (with no cutoff walls) is provided in Appendix F. The dewatering target for the foundation drainage system is taken at 0.5 m below the lowest slab elevation.

The foundation drain analysis provides a flow rate estimate. Once the foundation drain is built, actual flow rate measurements of the sump discharge will be required to confirm the estimated flow rate.

Based on the assumptions provided in this report, the estimated sub-drain discharge volumes are summarized in Appendix F. Seasonal and daily fluctuations are expected. These estimates may be affected by hydrogeological conditions beyond those encountered at this time, fluctuations in groundwater regimes, surrounding Site alterations, and existing and future infrastructures.

For the design of foundations without perimeter and/or foundation drainage system, shallower wells need to be considered to evaluate the shallow groundwater table. The hydrogeologist needs to be consulted during the design process.

Table 4-3: Summary of Long-Term Dewatering Rate Per Block

Long-Term Dewatering Flow Rate	For Building Design A (268 m x 80 m) (L/day)	For Building Design B (240 m x 58 m) (L/day)
Total Volume (L/day) Long-Term Drainage of groundwater (from foundation drainage, weeping tiles, sub slab drainage) with Safety Factor Included	9,330	35,600
Long-Term Dewatering Rate without Safety Factor	6,220	5,650
Total for All Four Proposed Buildings:	35,600	

Intermittent cycling of sump pumps and seasonal fluctuation in groundwater regimes should be considered for pump specifications. A safety factor was applied to the flow rate to account for water level fluctuations due to seasonal changes.

These estimates assume that pits (sump pits) are made as watertight structures (without drainage), if their depths extend below the dewatering target, as previously stated. The dewatering assumptions are based on using shoring system without open cuts. Open cuts can act as preferential groundwater pathways in the long-term and cause foundation drainage volumes to increase.

The sub-drain rate estimate is based on the assumptions outlined in this report. Any variations in hydrogeological conditions beyond those encountered as part of this investigation may significantly influence the sub-drain discharge volumes.

4.5 MECP Water Taking Permits

4.5.1 Short-Term Discharge Rate (Construction Phase)

In accordance with the Ontario Water Resources Act, if the water taking for the construction dewatering is more than 50,000 L/day but less than 400,000 L/day, then an online registration in the Environmental Activity and Sector Registry (EASR) with the MECP will be required. If groundwater dewatering rates onsite exceed 400,000 L/day, a Category 3 Permit to Take Water (PTTW) will be required from the MECP.

As of July 1, 2021, an amendment of O. Reg. 63/16 has come into effect and replaced the former subsection 7 (5) such that the EASR water taking limit of 400,000 L/day would apply to groundwater takings of each dewatered work area only, excluding stormwater.

For each individual building, the dewatering estimate including a safety factor is greater than 50,000 L/day and less than 400,000 L/day as shown in Table 4-2. The MECP construction dewatering rate excludes the precipitation amount and is the rate used for the permit application. Based on the MECP construction dewatering up to three buildings may be constructed at the same time and only an EASR will be required to facilitate the construction dewatering program of the Site. Should all four of the buildings be constructed at the same time, a PTTW will be required as the dewatering estimate would exceed 400,000 L/day.

A Discharge Plan (dewatering sketch, sewer discharge agreement) must be developed and applied for any discharges from the Site. Monitoring of both water quantity and water quality must be carried out for the entire duration of the construction dewatering phase. During this phase, the Discharge Plan and the daily water taking records must be available onsite.

The PTTW/EASR, Discharge Plan, hydrogeological investigation report, and geotechnical assessment of settlements must also be available at the construction Site during the entire construction dewatering. EXP should be notified immediately about any changes to the construction dewatering schedule or design, since the EASR will need to be updated to reflect these modifications. Altogether, the hydrogeological report, EASR, Discharge Plan and geotechnical assessment constitute the Water Taking Plan which needs to be available onsite during the construction dewatering.

4.5.2 Long-Term Discharge Rate (Post Construction Phase)

In accordance with the Ontario Water Resources Act, if the water taking for the construction dewatering is more than 50,000 L/day, then an application for a Category 3 Permit to Take Water (PTTW) will be required from the MECP.

Based on the dewatering estimate shown in Table 4-3 less than 50,000 L/day, a Category 3 Permit to Take Water (PTTW) will not be required to facilitate the post-development phase.

The safety factor for construction (short-term) dewatering is selected larger than for long-term to account for anticipated greater groundwater volumes during initial dewatering. The applied analytical formula is adequate for long-term (steady state) conditions as it omits specific yield and time dependency. When the formula is used for short-term conditions a larger safety factor is recommended to cover a larger initial dewatering rate, which is required to remove stored groundwater. Moreover, a large initial construction dewatering rate is favorable, as it supports reducing the time to reach the dewatering target elevation.

5 Environmental Impact

5.1 Surface Water Features

The topography of area is relatively flat with a gradual slope to the northwest, towards the Rideau River which is 1.8 km away.

Due to the limited extent of zone of influence and the wide distance to the nearest surface water feature, no detrimental impacts on surface water features are expected during construction activities.

5.2 Groundwater Sources

Well Records from the MECP Water Well Record (WWR) Database were reviewed to determine the presence and number of water supply wells within a 500 m radius of the Site boundaries. Given that the dewatering zone of influence is limited, no dewatering related impact is expected on the water supply wells in the area, if present.

5.3 Geotechnical Considerations

As per the MECP technical requirement for PTTW and EASRs, the geotechnical assessment of the stability of the soils due to water taking (ex: settlement, soil loss, subsidence, etc.) is required. The water taking should not have unacceptable interference on soils and underground structures (foundations, utilities, etc.).

A letter related to geotechnical issues as it pertains to the Site is required to be completed under a separate cover.

5.4 Groundwater Quality

It is our understanding that the potential effluent from the dewatering system during the construction will be released to the municipal sewer system. As such, the quality of groundwater discharge is required to conform the City of Ottawa Sewer Use By-Law.

Dewatering (short and long-term) may induce migration of contaminants within the zone of influence and beyond due to changing hydraulic gradients, hydrogeological conditions beyond Site boundaries and preferential pathways in utility beddings etc. The water quality sampling conducted as part of this assessment was performed under static conditions. As a result, monitoring may be required during dewatering activities (short and long-term) to monitor potential migration, and this should be performed more frequently during early dewatering stages.

For the short-term dewatering system (construction phase), it is anticipated that TSS levels and some other parameters (for example, Total Metals) in the pumped groundwater may become elevated and exceed both, Sanitary and Storm Sewer Use By-Law limits. To control the concentration of TSS and associated metals, it is recommended that a suitable treatment method be implemented (filtration or decantation facilities and/ or any other applicable treatment system) during construction dewatering activities to discharge to the applicable sewer system. The specifications of the treatment system will need to be adjusted to the reported water quality results by the treatment contractor/process engineer.

For the long-term dewatering discharge to the sanitary sewer system (post-development phase), and based on the water quality test results, the water is suitable to be released without a treatment system.

For the long-term dewatering discharge to the storm sewer system (post-development phase) and based on the water quality results, it is recommended to implement a suitable pre-treatment, as required.

The water quality results presented in this report may not be representative of the long-term condition of groundwater quality onsite. As such, regular water quality monitoring is recommended for the post-construction phase as required by the City of Ottawa.

An agreement to discharge into the sewers owned by the City of Ottawa will be required prior to releasing dewatering effluent.

The Environmental Site Assessment Report(s) shall be reviewed for more information on the groundwater quality conditions at the Site.

5.5 Well Decommissioning

In conformance with Regulation 903 of the Ontario Water Resources Act, the installation and eventual decommissioning of any dewatering system wells or monitoring wells must be completed by a licensed well contractor. This will be required for all wells that are no longer in use.

6 Conclusions and Recommendations

Based on the findings of the Hydrogeological Investigation, the following conclusions and recommendations are provided:

- When comparing the chemistry of the collected groundwater samples to the City of Ottawa Sanitary and Combined Sewer Discharge Criteria (Table 1), no parameter exceedances were reported.
- When comparing the chemistry of the collected groundwater samples to the City of Ottawa Storm Sewer Discharge Criteria (Table 2) there was an exceedance of manganese. No other parameter exceedances were reported..
- Based on the assumptions outlined in this report, the estimated peak dewatering rate for proposed construction activities for Site Building A is approximately 132,000 L/day per structure, and approximately 117,000 L/day per structure for Site Building B. This is the rate which will be required to be discharged to the municipal sewer system.
- As the dewatering flow rate estimate is between 50,000 L/day and 400,000 L/day, an EASR would be required to facilitate the construction dewatering program for the Site, provided that all four buildings are not constructed at the same time. If all four buildings are constructed at the same time, a PTTW will be required.
- The long-term flow rate of the foundation sub-drain is estimated to be approximately 35,600 L/day. A PTTW will not be required for long-term discharge.
- The construction dewatering and long-term estimate of sub-drain discharge volumes is based on the assumptions outlined in this report. Any variations in hydrogeological conditions beyond those encountered as part of this preliminary investigation may significantly influence the discharge volumes.
- For the short-term dewatering system (construction phase), it is anticipated that TSS levels and some other parameters (for example, Total Metals) in the pumped groundwater may become elevated and exceed both, Sanitary and Storm Sewer Use By-Law limits. To control the concentration of TSS and associated metals, it is recommended that a suitable treatment method be implemented (filtration or decantation facilities and/ or any other applicable treatment system) during construction dewatering activities to discharge to the applicable sewer system. The specifications of the treatment system will need to be adjusted to the reported water quality results by the treatment contractor/process engineer.
- For the long-term dewatering discharge to the sanitary sewer system (post-development phase) and based on the water quality test results, the water is suitable to discharge without a treatment system.
- For the long-term dewatering discharge to the storm sewer system (post-development phase) and based on the water quality results, it is recommended to implement a suitable pre-treatment as required.
- As per the MECP technical requirement for PTTW and EASRs, the geotechnical assessment of the stability of the soils due to water taking (ex: settlement, soil loss, subsidence etc.) is required. The water taking should not have unacceptable interference on soils and underground structures (foundations, utilities etc.). A letter related to geotechnical issues as it pertains to the Site is required to be completed under a separate cover.
- An agreement to discharge into the sewers owned by the City of Ottawa will be required prior to releasing dewatering effluent.
- The EASR registration allows construction dewatering discharge of up to 400,000 L/day. A Discharge Plan (dewatering sketch, sewer discharge agreement) must be developed and applied for any discharges from the Site. The Discharge Plan and monitoring for both water quantity and water quality must be carried at the Site during the entire construction dewatering phase. The daily water taking records must be maintained onsite for the entire construction dewatering phase. The EASR, Discharge Plan, hydrogeological investigation report, and geotechnical assessment of settlements must always also be available at the construction Site for the entire construction dewatering. EXP should be notified immediately about any changes to the construction dewatering schedule or design, since EASR will need to be updated

to reflect these modifications. The hydrogeological report, EASR, Discharge Plan and geotechnical assessment constitutes the Water Taking Plan which needs to be available onsite for the duration of construction dewatering.

- In conformance with Regulation 903 of the Ontario Water Resources Act, the installation and eventual decommissioning of any dewatering system wells or monitoring wells must be completed by a licensed well contractor. This will be required for all wells that are no longer in use.

The conclusions and recommendations provided above should be reviewed in conjunction with the entirety of the report. They assume that the present design concept described throughout the report will proceed to construction. This report is solely intended for the construction and long-term dewatering assessments. Any changes to the design concept may result in a modification to the recommendations provided in this report.

7 Limitations

This report is based on a limited investigation designed to provide information to support an assessment of the current hydrogeological conditions within the study area. The conclusions and recommendations presented within this report reflect Site conditions existing at the time of the assessment. EXP must be contacted immediately, if any unforeseen Site conditions are experienced during construction activities. This will allow EXP to review the new findings and provide appropriate recommendations to allow the construction to proceed in a timely and cost-effective manner.

Our undertaking at EXP, therefore, is to perform our work within limits prescribed by our clients, with the usual thoroughness and competence of the geoscience/engineering profession. No other warranty or representation, either expressed or implied, is included or intended in this report.

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We trust that this information is satisfactory for your purposes. Should you have any questions or comments, please do not hesitate to contact this office.

Sincerely,

EXP Services Inc.

Leah Wells, P. Eng.
Environmental Engineer
Environmental Services

Reinhard Zapata Blosa, Ph.D., P. Geo.
Senior Hydrogeologist
Environmental Services

8 References

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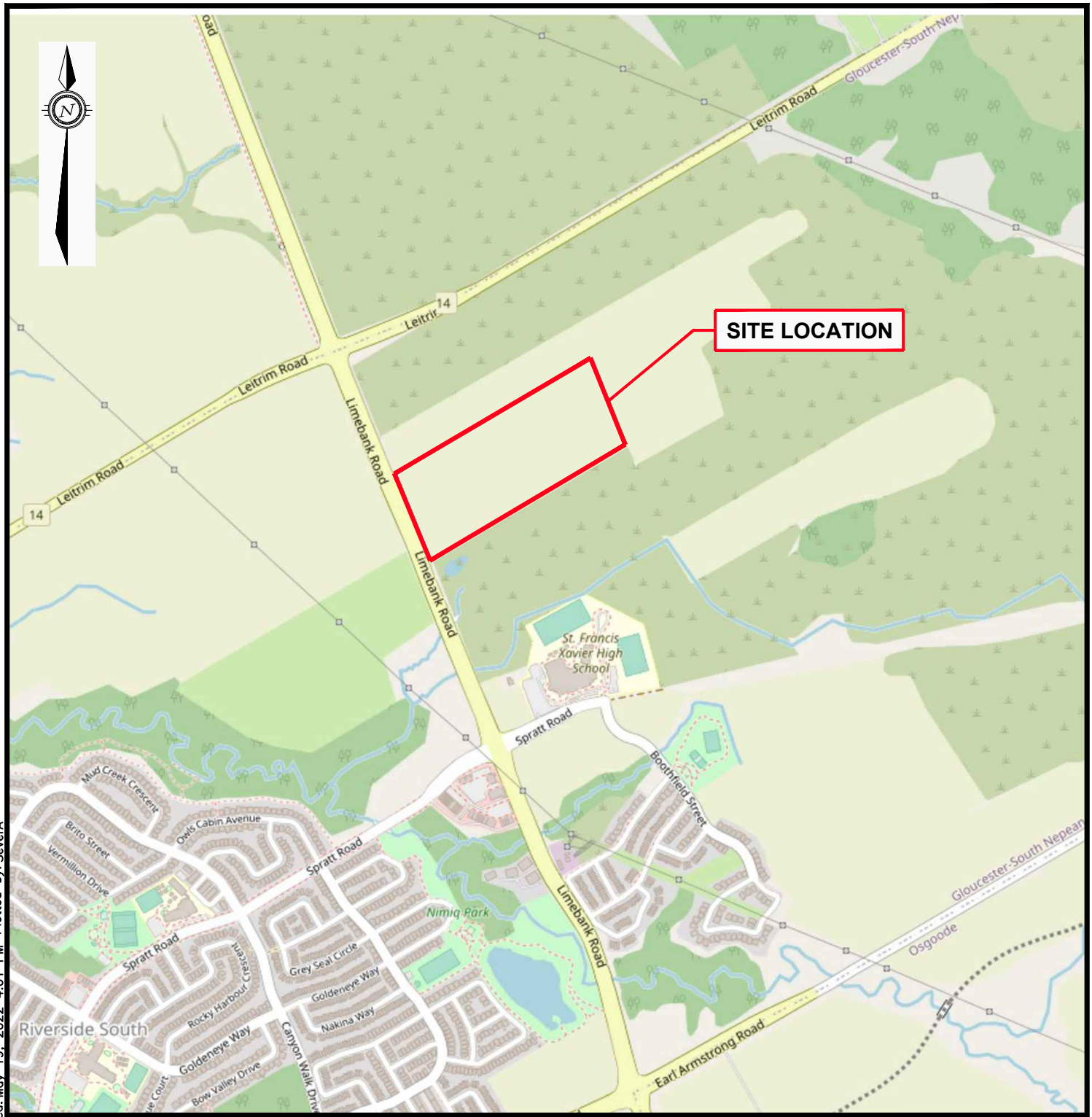
Figures



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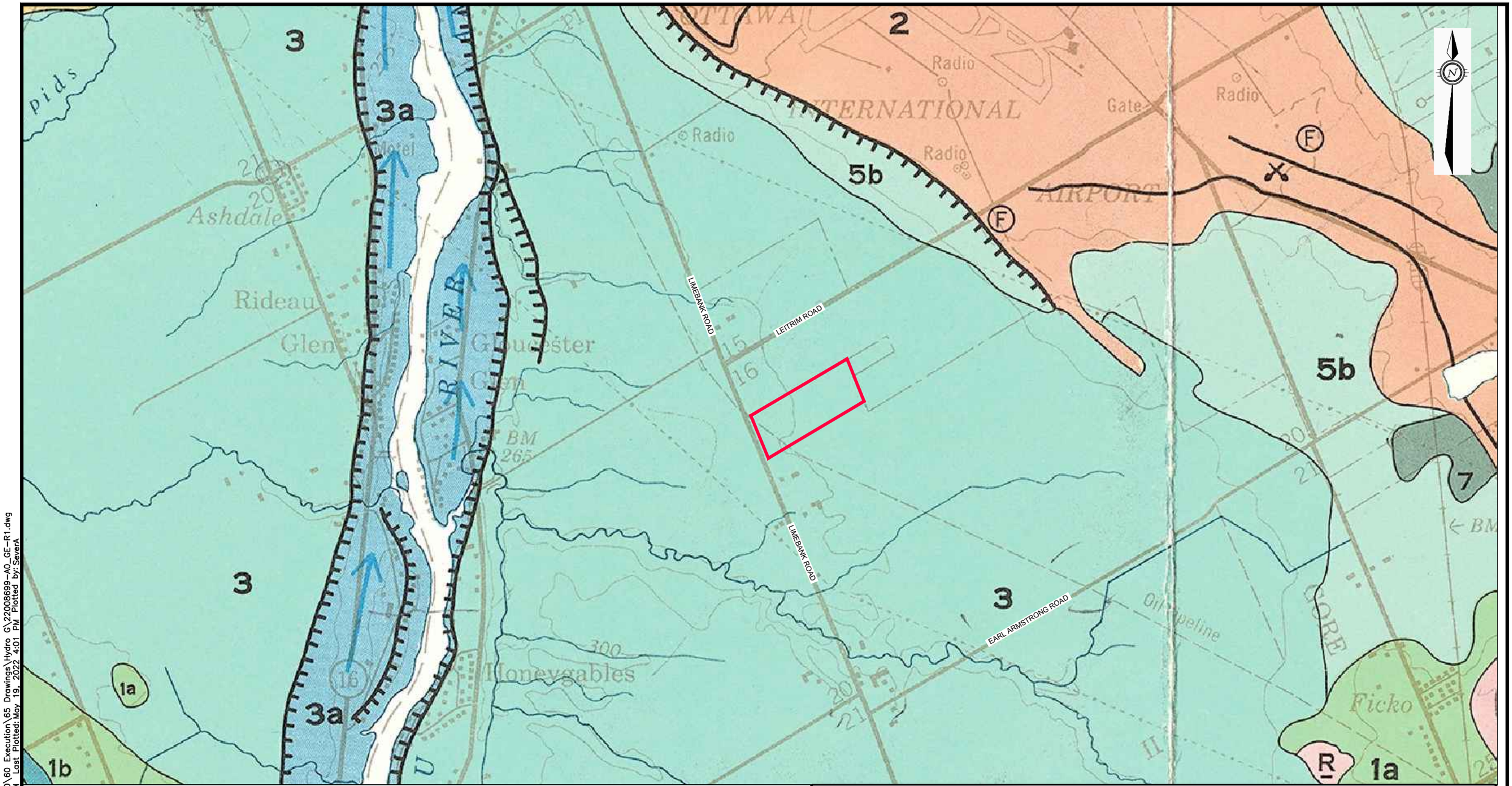

CENOZOIC
QUATERNARY

POST-CHAMPLAIN SEA DEPOSITS

7 — *ORGANIC DEPOSITS: mainly muck and peat in bogs, fens, swamps, and poorly drained areas*

CHAMPLAIN SEA SEDIMENTS

5b — *Fine-to medium- grained sand, calcareous and commonly fossiliferous; nearshore sand generally occurs as a sheet or as bars or spits associated with glaciofluvial materials*

3 — *OFFSHORE MARINE DEPOSITS: clay, silty clay and silt, commonly calcareous and fossiliferous; locally overlain by thin sands. Upper parts are generally mottled or laminated reddish brown and bluish grey and may contain lenses and pockets of sand, but at depth the clay is uniform and blue-grey*

3a — *Clay and silt underlying erosional terraces; upper part of marine deposits removed to variable depths by fluvial erosion so in places clay is uniform blue-grey; unit includes lenses, bars and channel fills of sand and pockets of nonmarine silt that were formed during terrace (or channel) cutting*

GLACIAL DEPOSITS

2 — *ICE-CONTACT STRATIFIED DRIFT: gravel and sand, poorly to well sorted and bedded, mainly coarse- to medium-grained with numerous cobbles, boulders and lenses of till; includes esker fans and outwash deltas deposited below sea level, kames, kame terraces, eskers, and outwash plains. In areas that lie below marine limit (approx. 198 m (650 ft) a.s.l.) it is generally overlain by marine beach deposits*

1a — *Till, plain; local relief <5m (<15 ft)*

1b — *Till, drumlinized*

BEDROCK

PALEOZOIC

R — *Limestone, dolomite, sandstone, and locally shale; relatively flat lying; mainly occurring as bare, tabular outcrops; includes areas thinly veneered by unconsolidated Quaternary sediments up to 1 m (3 ft) thick*

LEGEND

PROPERTY BOUNDARY

0 200m 400m 800m

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TITLE: SURFICIAL GEOLOGY
LIMEBANK ROAD - LEITRIM ROAD, OTTAWA, ONTARIO

project no. OTT-22008699-A0
scale 1:20,000
FIG 2

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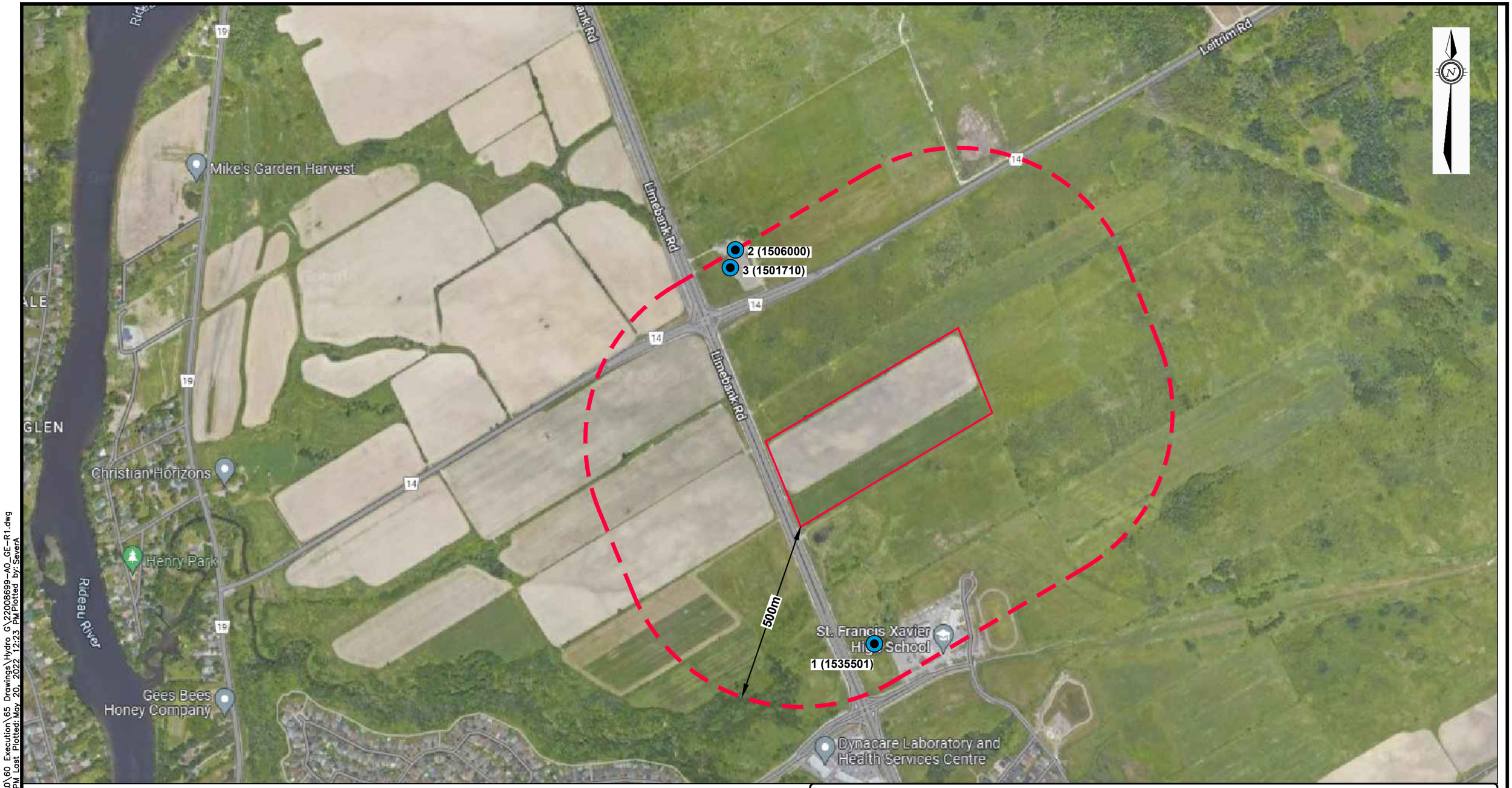

LEGEND

PROPERTY BOUNDARY

1 (1535501) EXISTING RESIDENTIAL WELLS

500m STUDY RADIUS

0 100m 200m 400m

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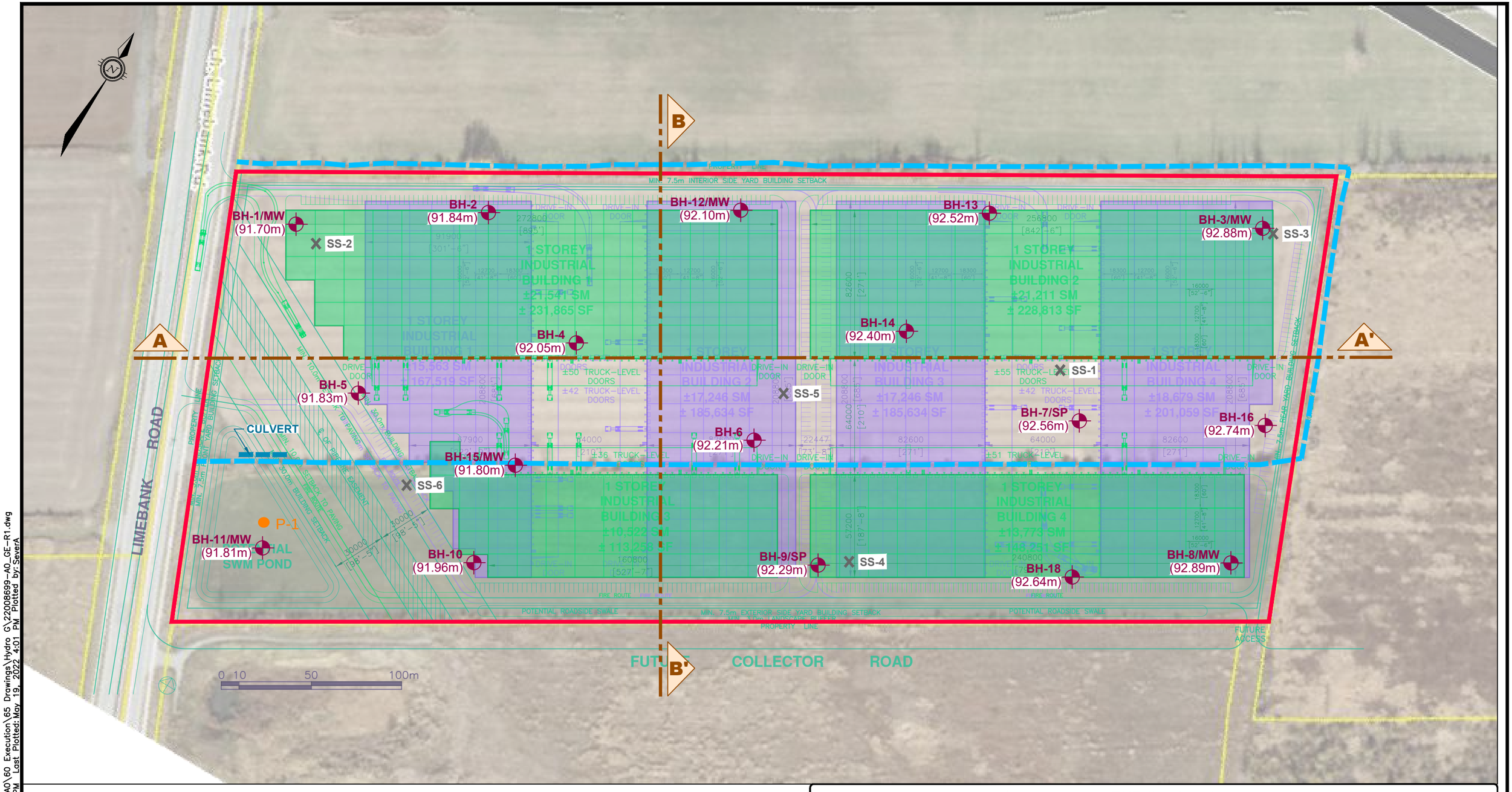

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- BH-1 (91.70m) — BOREHOLE NAME & LOCATION - GEOTECHNICAL (GROUND ELEVATION)
- BH-1/MW — BOREHOLE INDICATED HAS Ø2" MONITORING WELL
- BH-7/SP — BOREHOLE INDICATED HAS Ø1.5" STANDPIPE
- PROPOSED ARCHITECTURE (OPT. 2)
- PROPOSED ARCHITECTURE (OPT. 3)
- SURFACE SOIL SAMPLE NAME & LOCATION - ENVIRONMENTAL
- DRAINAGE DITCH
- SECTION MARK
- PERCOLATION TEST LOCATION

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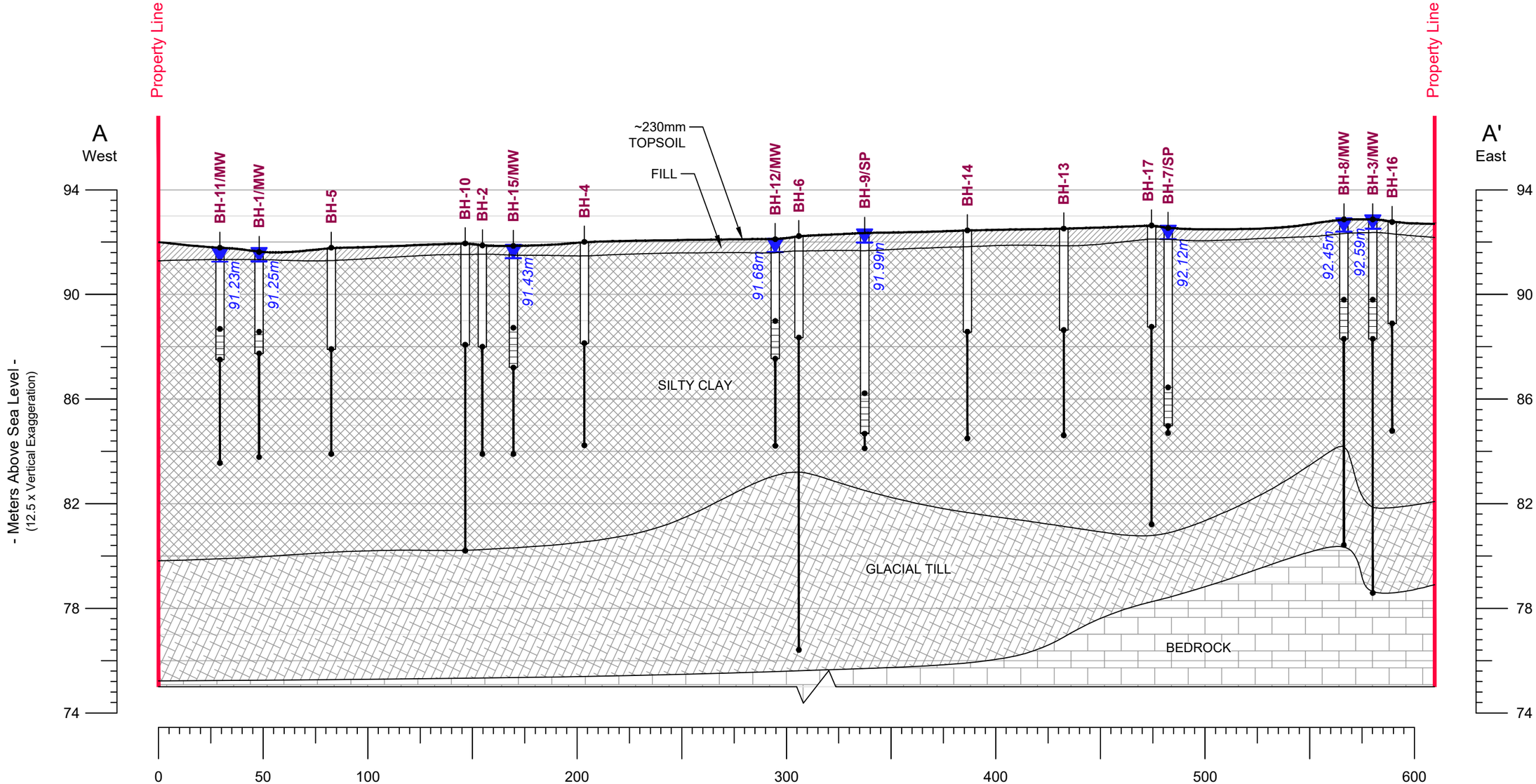

LEGEND

	PROPERTY BOUNDARY
BH-2	BOREHOLE NAME & LOCATION
BH-1/MW	BOREHOLE INDICATED HAS Ø50mm MONITORING WELL
BH-7/SP	BOREHOLE INDICATED HAS Ø38mm STANDPIPE
91.23m	GROUNWATER ELEVATION

0 20m 40m 80m

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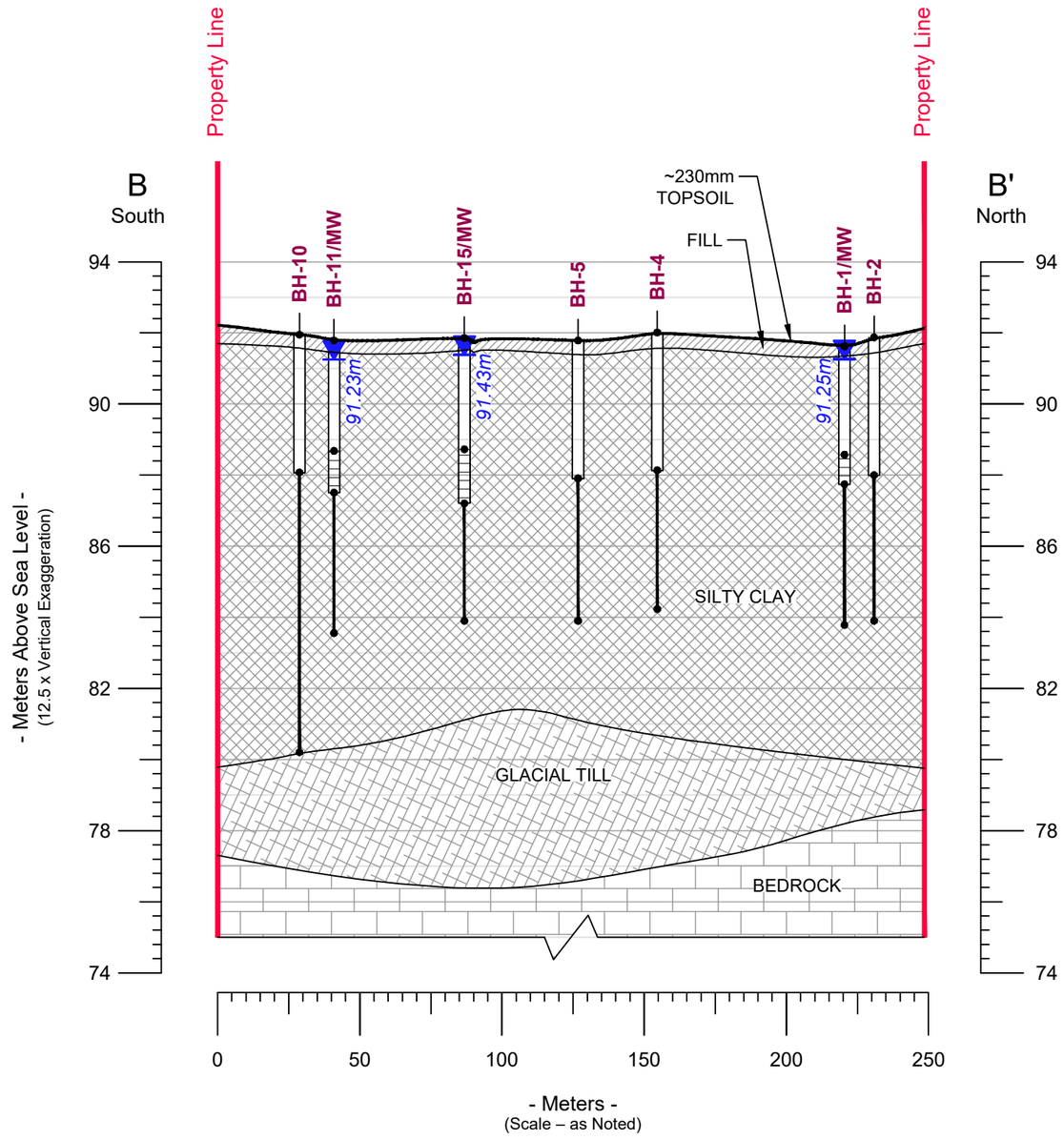

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	PROPERTY BOUNDARY
BH-2	BOREHOLE NAME & LOCATION
BH-1/MW	BOREHOLE INDICATED HAS Ø50mm MONITORING WELL
BH-7/SP	BOREHOLE INDICATED HAS Ø38mm STANDPIPE
91.23m	GROUNWATER ELEVATION

0 20m 40m 80m

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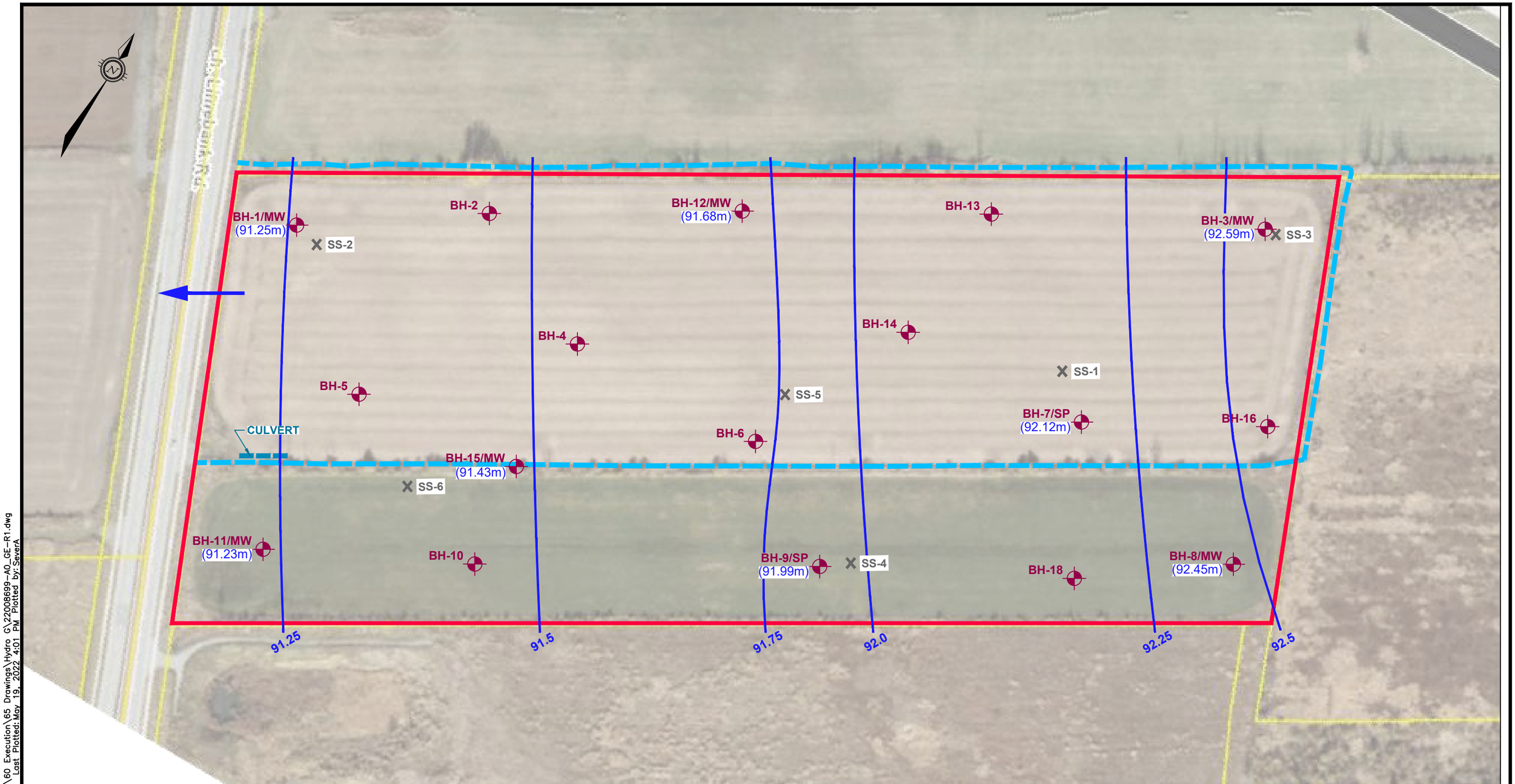

LEGEND

- PROPERTY BOUNDARY
- BH-1 (91.25m) — BOREHOLE NAME & LOCATION - GEOTECHNICAL (GROUNDWATER ELEVATION)
- BH-1/MW — BOREHOLE INDICATED HAS Ø2" MONITORING WELL
- BH-7/SP — BOREHOLE INDICATED HAS Ø1.5" STANDPIPE
- GROUNDWATER FLOW DIRECTION
- 91.25 — GROUNDWATER EQUIPOTENTIAL CONTOURS
- DRAINAGE DITCH

0 20m 40m 80m

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Appendix A – MECP WWR Summary Table

TABLE II: MECP Water Well Summary

Limebank Road and Leitrim Road in Ottawa, Ontario
OTT-22006899-A0

Well No.	MECP Well ID	Depth of Well (m)	Depth to Bedrock (m)	Static Water Level From Ground (m)	Depth to Water Found (m)	Year Installed	Distance to Centroid of Site (m)
1	1535501	58.52	17.07	3.49	55.8	2005	370 m
2	1506000	30.48	28.60	Flowing	30.5	1963	490 m
3	1501710	22.86	16.76	7.31	22.9	1960	490 m

31G/5b.

UTM 18 Z 446880 E

5 R 5016180 N

Elev. 4 R 0298

Basin 25

Rideau Front

Con 11

Lot 15

15 № 1710

GROUND WATER BRANCH
DEC 6 1960
ONTARIO WATER RESOURCES COMMISSION

The Ontario Water Resources Commission Act, 1957

WATER WELL RECORD

County or District CARLETON

Township, Village, Town or City GLOUCESTER

[redacted]

Date completed 29 (day) SEP (month) 60 (year)

[redacted]ress

Casing and Screen Record

Inside diameter of casing 4"

Total length of casing 55

Type of screen —

Length of screen —

Depth to top of screen —

Diameter of finished hole 4"

Pumping Test

Static level 24

Test-pumping rate 5 G.P.M.

Pumping level 24

Duration of test pumping 1 HR

Water clear or cloudy at end of test CLEAR

Recommended pumping rate 5 G.P.M.

with pumping level of 24

Well Log / Water Record

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, sulphur)
PINK CLAY	0	55			
GREY LIMESTONE	55	75	75	51	FRESH

For what purpose(s) is the water to be used?

House

Is well on upland, in valley, or on hillside?

Drilling Firm M MEAGHER

Address OTTAWA

Licence Number

Name of Driller SAME

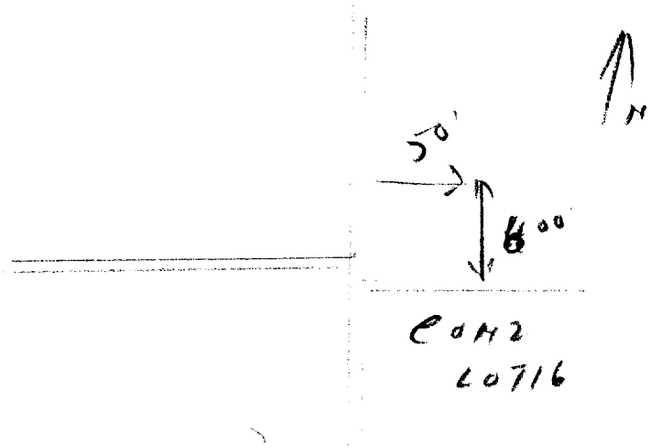
Address

Date NOV 25/60

(Signature of Licensed Drilling Contractor)

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



CSS.58

Form 5
15M-58-4149

31G/5b.

UTM 18 Z 446860 E

Ridge Front 62110 N

Elev. 4 R 02998

Basin Lot 15

15 No. 6000

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District CARLETON Township, Village, Town or City Gloucester

Con. 2 BF Lot 15 Date completed 24 (day) MAY (month) 63 (year)

[redacted]dress RR5 OTTAWA

Casing and Screen Record

Inside diameter of casing 4

Total length of casing 94

Type of screen

Length of screen

Depth to top of screen

Diameter of finished hole 4

Pumping Test

Static level FLOWS

Test-pumping rate 3½ G.P.M.

Pumping level FLOWS

Duration of test pumping 1 HR

Water clear or cloudy at end of test CLEAR

Recommended pumping rate 3½ G.P.M.

with pump setting of 30 feet below ground surface

Well Log

Overburden and Bedrock Record	From ft.	To ft.	Water Record: Depth(s) at which water(s) found	Water Record: Kind of water (fresh, salty, sulphur)
CLAY	0	90		
GRAVEL	90	94		
LIMESTONE	94	100	100	FRESH

For what purpose(s) is the water to be used? NEW HOUSE

Is well on upland, in valley, or on hillside?

Drilling or Boring Firm M MEAGHER

Address OTTAWA

Licence Number 1024

Name of Driller or Borer SAME

Address

Date

M Meagher

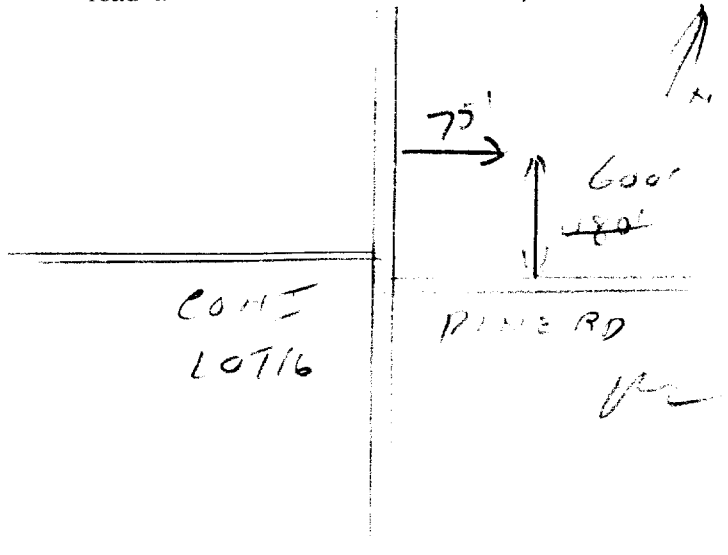
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M-60-4138

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



69

125

Ontario | Ministry of the Environment

Well T A019567 (number below)

A019567

Well Record

Regulation 903 Ontario Water Resources Act

page ___ of ___

Instructions for Completing Form

- For use in the **Province of Ontario** only. This document is a permanent **legal** document. Please retain for future reference.
- All Sections **must** be completed in full to avoid delays in processing. Further instructions and explanations are available on the back of this form.
- Questions regarding completing this application can be directed to the Water Well Management Coordinator at 416-235-6203.
- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only

MUN | CON | LOT

Well Owner's Information and Location of Well Information

[redacted]

Address of Well Location (County/District/Municipality): Ottawa/Carleton | Gloucester | Part of Lot 19 Part of Plan-5R-4171

RR#/Street Number/Name: 4269 Limebank Road | City/Town/Village: Gloucester | Site/Compartment/Block/Tract etc.:

GPS Reading | NAD: 83 | Zone: 18 | Easting: 447345 | Northing: 5015411 | Unit Make/Model: Garmin | Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth From	Depth To
Brown	Clay		Packed	0	8.53
Grey	Clay		Soft	8.53	13.70
Grey	Clay	Gravel	Packed Soft	13.70	17.07
Grey	Limestone		Hard	17.07	49.99
Grey	Sandstone		Hard	49.99	58.52

Hole Diameter

Depth From	Depth To (Metres)	Diameter (Centimetres)
0	18.44	25.08
18.44	58.52	15.55

Water Record

Water found at Metres: 55.46 m ☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas ☐ Other: / ___ m ☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas ☐ Other: / ___ m ☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas ☐ Other:

Kind of Water

After test of well yield, water was ☐ Clear and sediment free ☐ Other, specify

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth From	Depth To (Metres)
Casing				
15.88	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0	18.44
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		18.44	58.52

Test of Well Yield

Pumping test method: Sub mersible

Pump intake set at - (metres): 150

Pumping rate - (litres/min): 45

Duration of pumping: 1 hrs + 0 min

Final water level end of pumping: 3.745 metres

Recommended pump type: ☐ Shallow ☒ Deep

Recommended pump depth: 40 metres

Recommended pump rate: 45 (litres/min)

If flowing give rate - (litres/min)

If pumping discontinued, give reason.

	Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level		3.49		3.745
1	1	3.85	1	3.35
2	2	3.81	2	3.33
3	3	3.77	3	3.31
4	4	3.74	4	3.30
5	5	3.72	5	3.30
10	10	3.69	10	
15	15	3.695	15	
20	20	3.70	20	
25	25	3.705	25	
30	30	3.715	30	
40	40	3.73	40	
50	50	3.735	50	
60	60	3.745	60	3.30

Plugging and Sealing Record ☒ Annular space ☐ Abandonment

Depth set at - From	Depth set at - To (Metres)	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
18.44	0	Bentonite Pressure Grouted	1.139

Method of Construction

☐ Cable Tool ☒ Rotary (air) ☐ Diamond ☐ Digging
☐ Rotary (conventional) ☒ Air percussion ☐ Jetting ☐ Other
☐ Rotary (reverse) ☐ Boring ☐ Driving

Water Use

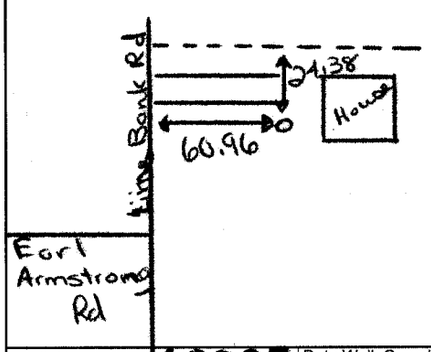
☒ Domestic ☐ Industrial ☐ Public Supply ☐ Other
☐ Stock ☐ Commercial ☐ Not used
☐ Irrigation ☐ Municipal ☐ Cooling & air conditioning

Final Status of Well

☒ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☐ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.



Audit No. Z 19837

Date Well Completed: YYYY 2005 MM 03 DD 15

Was the well owner's information package delivered? ☒ Yes ☐ No

Date Delivered: YYYY 2005 MM 03 DD 22

Well Contractor/Technician Information

Name of Well Contractor: Splash Well Drilling | Well Contractor's Licence No.: 4877

Business Address (street name, number, city etc.): P.O. BOX 1083 Prescott

Name of Well Technician (last name, first name): Ferguson, Todd | Well Technician's Licence No.: T478

Signature of Technician/Contractor: Todd Ferguson | Date Submitted: YYYY 2005 MM 03 DD 30

Ministry Use Only

Data Source | Contractor: 4877

Date Received: YYYY MM DD MAY 26 2005 | Date of Inspection: YYYY MM DD

Remarks | Well Record Number

0506E (09/03) Contractor's Copy ☐ Ministry's Copy ☒ Well Owner's Copy ☐

Cette formule est disponible en français

Appendix B – Borehole Logs

Log of Borehole BH-01

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 3

Page. 1 of 1

Date Drilled: 'April 29, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test (S)
Combustible Vapour Reading
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~230 mm thick	91.7	0	4		SS1	
			91.66					
		FILL	91.5					
		Silty clay, some rootlets, brown, moist, loose	91.1					
		SILTY CLAY (DESICCATED CRUST)		1	6, 220 kPa		SS2	18.2
		Brown, moist, high plasticity (hard)			210 kPa			
			89.6	2	2, 50 kPa		SS3	16.1
		SILTY CLAY						
		Grey, wet (firm)		3	29 kPa			
		with reddish brown bands from 2.3 to 2.9 m		4	43 kPa			
					Hammer Weight		SS4	
				5	38 kPa			
				6	Hammer Weight		SS5	
				7	34 kPa			
			83.8					
		Borehole Terminated at 7.9 m Depth						

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
May 4, 2022	0.0	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-02

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 4

Page. 1 of 1

Date Drilled: 'April 29, 2022

Drill Type: CME-55 LC Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample ⊠ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test —— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits |—○—| | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~220 mm thick	91.84	0				
		FILL	91.6					
		Silty clay, some rootlets, brown, moist (loose)	91.2					
		SILTY CLAY (DESICCATED CRUST) Brown, moist (very stiff)		1	6		SS1	18.6
					5		SS2	17.9
					183 kPa			
			89.7	2				
		SILTY CLAY Grey, wet (soft to stiff)			2		SS3	
				3	72 kPa			
					Hammer Weight		SS4	
					62 kPa			
				5				
					Hammer Weight		SS5	
				6	19 kPa			
					Hammer Weight		SS6	
					29 kPa			
			83.9					
		Borehole Terminated at 7.9 m Depth						

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Upon Completion	7.0	no cave

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-03

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 5

Page. 1 of 2

Date Drilled: 'April 26, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○⊣
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~270 mm thick	92.88	0	5		SS1	19.3
		FILL Silty clay, some rootlets, brown, moist (loose)	92.71 / 92.6 / 92.3					
		SILTY CLAY (DESICCATED CRUST) Brown, moist (very stiff)		1	5; 147 kPa		SS2	18.5
				2	3; 77 kPa		SS3	
		With reddish brown bands from 1.5 to 2.1 m depths						
		SILTY CLAY With sand, grey, wet, low plasticity (firm)	90.2	3			ST4	
				4	53 kPa			
				5	Hammer Weight		SS5	
					29 kPa			
				6			ST6	
				7	24 kPa			
				8	Hammer Weight		SS7	
					34 kPa			
				9	Hammer Weight		SS8	
				10				

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
May 4, 2022	0.2	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-03

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Figure No. 5

Page. 2 of 2

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		SILTY CLAY With sand, grey, wet, low plasticity (firm) *(continued)*	82.88	10	20 40 60 80 Shear Strength kPa **53 kPa** 100 150 200	250 500 750 Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60		
			81.8	11	**3**		SS9	
		GLACIAL TILL Clayey silty sand with gravel, boulders and cobbles, grey, wet, slightly cohesive (compact/stiff)		12	**13**		SS10	
				13				
				14	**25, then 20/ 0 mm sampler bouncing**		SS11	
			78.6					
		Auger Refusal at 14.3 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
May 4, 2022	0.2	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-04

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 6

Page. 1 of 2

Date Drilled: 'April 29, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample ⊠ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test —— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊢○⊣ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		TOPSOIL ~250 mm thick	92.05	0
		FILL	91.8	
		Silty clay, some rootlets, brown, moist (loose)	91.5	
		SILTY CLAY (DESICCATED CRUST) Brown, moist (stiff to very stiff)		1
				2
			89.3	3
		SILTY CLAY Grey, wet (firm to stiff)		
				4
				5
				6
				7
			84.2	8
		Dynamic Cone Penetration Test (DCPT) conducted from 7.9 m to cone refusal at 16.8 m depth		9
				10

Standard Penetration Test N Value: 20 40 60 80

Shear Strength: 50 100 150 200 kPa

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % / Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES	Natural Unit Wt. kN/m³
SS1	
SS2	18.6
SS3	
SS4	
SS5	

5

4 — 122 kPa

80 kPa

86 kPa

Hammer Weight

58 kPa

Hammer Weight

29 kPa

Hammer Weight

38 kPa

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Upon Completion	2.5	no cave

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-04

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Figure No. 6

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		Dynamic Cone Penetration Test (DCPT) conducted from 7.9 m to cone refusal at 16.8 m depth *(continued)*	82.05	10	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
				11				
				12				
				13				
				14				
				15				
				16				
		Cone Refusal at 16.8 m Depth	75.3					

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Upon Completion	2.5	no cave

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-05

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 7

Page. 1 of 1

Date Drilled: 'April 29, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢—⊖
Dynamic Cone Test	—	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value (20, 40, 60, 80) / Shear Strength kPa (50, 100, 150, 200)	Combustible Vapour Reading (ppm) (250, 500, 750) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) (20, 40, 60)	SAMPLES	Natural Unit Wt. kN/m³
			91.83	0				
		TOPSOIL ~250 mm thick	91.6		6	×		SS1
		FILL Silty clay, some rootlets, brown, moist (loose)	91.2					
		SILTY CLAY (DESICCATED CRUST) Brown, moist (hard)		1	6; 220 kPa	×		SS2 17.6
					210 kPa			
			89.7	2				
		SILTY CLAY Grey, wet (firm)			3	×		SS3
				3	43 kPa			
				4	43 kPa			
					Hammer Weight	×		SS4
				5	38 kPa			
				6	Hammer Weight	×		SS5
				7	38 kPa			
			83.9					
		Borehole Terminated at 7.9 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Upon Completion	3.2	no cave

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-06

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 8

Page. 1 of 2

Date Drilled: 'April 25, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample ⊠ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test —— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊢○ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~230 mm thick	92.21	0	5		SS1	
		FILL	92.0					
		Silty clay, some rootlets, brown, moist (loose)	91.6	1	7		SS2	18.0
		SILTY CLAY (DESICCATED CRUST) Brown, moist (very stiff to hard)		2	230 kPa; 180 kPa			
		SILTY CLAY Grey, wet (soft to stiff)	89.4	3	Hammer Weight		SS3	
				4	62 kPa			
				5	Hammer Weight; 34 kPa		SS4	
				6	Hammer Weight		SS5	
				7	24 kPa			
				8	Hammer Weight; 43 kPa		SS6	
		GLACIAL TILL Clayey silty sand with gravel, boulders and cobbles, grey, wet (loose to very dense)	83.3	9	5		SS7	
				10				

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Upon Completion	9.6	no cave

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-06

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Figure No. 8

Page. 2 of 2

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		GLACIAL TILL Clayey silty sand with gravel, boulders and cobbles, grey, wet (loose to very dense) *(continued)*	82.21	10				
				11	6		SS8	
				12	6		SS9	
		Dense below 13.7 m depth		13				
				14	40		SS10	
				15	79		SS11	24.7
			76.4					
		Borehole Terminated at 15.8 m Depth						

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % / Atterberg Limits (% Dry Weight): 20 40 60

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Upon Completion	9.6	no cave

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-07

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 9

Page. 1 of 2

Date Drilled: 'April 25, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample ⊠ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test —— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits |—○—| | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		TOPSOIL ~250 mm thick	92.56	0
		FILL	92.3	
		Silty clay, some rootlets, brown, moist (loose)	92.0	
		SILTY CLAY (DESICCATED CRUST) Brown, moist (hard to very stiff)		1
				2
			89.8	3
		SILTY CLAY Grey, wet (soft to firm)		4
				5
				6
				7
			84.7	8
		Dynamic Cone Penetration Test (DCPT) conducted from 7.9 m to cone refusal at 13.7 m depth		9
				10

Standard Penetration Test N Value: 20 40 60 80

Shear Strength: 50 100 150 200 kPa

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

6 | 8 | >120 kPa | 170 kPa | Hammer Weight | 29 kPa | Hammer Weight | 24 kPa | Hammer Weight | 43 kPa

SAMPLES	Natural Unit Wt. kN/m³
SS1	
SS2	18.8
SS3	
SS4	
SS5	

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 38 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-07

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Figure No. 9

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		Dynamic Cone Penetration Test (DCPT) conducted from 7.9 m to cone refusal at 13.7 m depth *(continued)*	82.56	10	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
				11				
				12				
				13				
		Cone Refusal at 13.7 m Depth	78.9					

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 38 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-08

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 10

Page. 1 of 2

Date Drilled: 'April 28, 2022

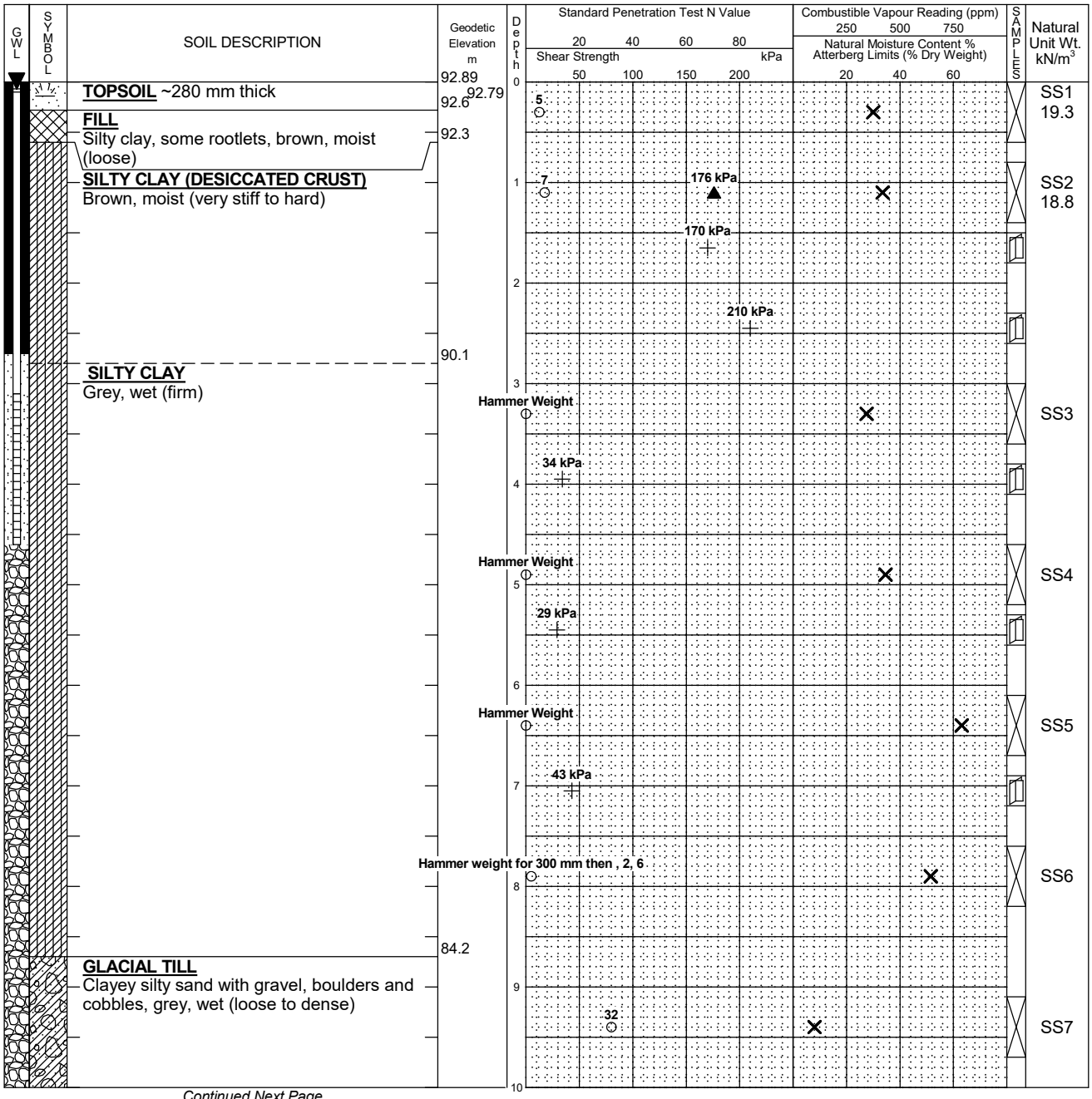
Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○⊣
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲



Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
May 4, 2022	0.1	

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-08

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Figure No. 10

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		GLACIAL TILL Clayey silty sand with gravel, boulders and cobbles, grey, wet (loose to dense) *(continued)*	82.89	10	Shear Strength 20 40 60 80 / 50 100 150 200 kPa	250 500 750 / 20 40 60		
				11	7		SS8	
				12	27 then 50 for 75 mm		SS9	
		Auger Refusal at 12.5 m Depth	80.4					

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
May 4, 2022	0.1	

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-09

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 11

Page. 1 of 1

Date Drilled: 'April 28, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample ⊠ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test —— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits |—○—| | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		TOPSOIL ~260 mm thick	92.29	0
		FILL	92.0	
		Silty clay, some rootlets, brown, moist (loose)	92.1	
			91.7	
		SILTY CLAY (DESICCATED CRUST)		1
		Brown, moist (very stiff)		
			90.4	2
		SILTY CLAY		
		Grey, wet, low plasticity, (firm to stiff)		3
				4
				5
				6
				7
			84.1	8
		Borehole Terminated at 8.2 m Depth		

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES	Natural Unit Wt. kN/m³	Standard Penetration Test N Value	Shear Strength kPa	Combustible Vapour Reading (ppm)	Natural Moisture Content % Atterberg Limits (% Dry Weight)
SS1	18.6	4			
SS2	18.9	6	196 kPa		
			140 kPa		
SS3		2			
			82 kPa		
			38 kPa		
SS4		Hammer Weight			
			34 kPa		
SS5		Hammer Weight			
			48 kPa		
SS6		Hammer Weight			

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 38 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
May 4, 2022	0.2	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-10

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 12

Page. 1 of 2

Date Drilled: 'April 29, 2022

Drill Type: CME-55 LC Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○—|
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		TOPSOIL ~250 mm thick	91.96	0
		Piezocone Penetration Test (CPTu) Conducted from 0.3 m to cone refusal at 11.8 m depth	91.7	

Standard Penetration Test N Value: 20 40 60 80
Shear Strength kPa: 50 100 150 200
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

210 kPa
180 kPa
100 kPa
62 kPa
53 kPa
29 kPa
24 kPa
34 kPa

SAMPLES | Natural Unit Wt. kN/m³

Continued Next Page

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-10

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Figure No. 12

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		Piezocone Penetration Test (CPTu) Conducted from 0.3 m to cone refusal at 11.8 m depth *(continued)*	81.96	10	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
				11				
		CPTu Cone Refusal met at 11.8 m Depth	80.2					

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-11

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 13

Page. 1 of 1

Date Drilled: 'April 27, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test (S)
Combustible Vapour Reading
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~310 mm thick	91.81	0	5		SS1	
			91.55					
		FILL Silty clay, some rootlets, brown, moist (loose)	91.2					
		SILTY CLAY (DESICCATED CRUST) Brown, moist (very stiff to hard)		1	6; 122 kPa		SS2	18.4
				2	220 kPa			
			89.7					
		SILTY CLAY Grey, wet, low plasticity, (firm)		3	225 kPa		SS3	
					1		SS4	
				4	34 kPa			
				5	38 kPa		ST5	
				6	Hammer Weight		SS6	
				7	38 kPa			
				8			ST7	
			83.6					
		Borehole Terminated at 8.2 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
May 4, 2022	0.3	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-12

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 14

Page. 1 of 1

Date Drilled: 'April 29, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample ⊠ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test —— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits |—○—| | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~280 mm thick	92.1	0	5		SS1	
			91.87					
		FILL Silty clay, some rootlets, brown, moist (loose)	91.8					
			91.5	1	7; 167 kPa		SS2	18.2
		SILTY CLAY (DESICCATED CRUST) Brown, moist (very stiff)			140 kPa			
				2	120 kPa			
			89.3					
		SILTY CLAY Grey, wet (soft to firm)		3	Hammer Weight		SS3	
				4	29 kPa			
				5	1; 24 kPa		SS4	
				6	Hammer Weight		SS5	
				7	43 kPa			
			84.2					
		Borehole Terminated at 7.9 m Depth						

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
May 4, 2022	0.2	

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-13

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 15

Page. 1 of 1

Date Drilled: 'April 26, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Legend		Legend	
Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢—○
Dynamic Cone Test	—	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value (20 40 60 80) / Shear Strength kPa (50 100 150 200)	Combustible Vapour Reading (ppm) (250 500 750) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) (20 40 60)	SAMPLES	Natural Unit Wt. kN/m³
			92.52	0				
		TOPSOIL ~250 mm thick	92.3		4	×		SS1
		FILL Silty clay, some rootlets, brown, moist (loose)	91.9					
		SILTY CLAY (DESICCATED CRUST) Brown, moist (very stiff)		1	6; 123 kPa	×		SS2 17.3
					120 kPa			
				2	96 kPa			
			89.5	3				
		SILTY CLAY Grey, wet (soft to firm)			Hammer Weight	×		SS3
				4	31 kPa			
					Hammer Weight	×		SS4
				5	24 kPa			
				6	Hammer Weight	×		SS5
				7	34 kPa			
			84.6					
		Borehole Terminated at 7.9 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Upon Completion	4.8	4.8

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-14

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 16

Page. 1 of 1

Date Drilled: 'April 26, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample ⊠ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test —— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits |—○—| | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		TOPSOIL ~350 mm thick	92.4	0
		FILL	92.1	
		Silty clay, some rootlets, brown, moist (loose)	91.8	
		SILTY CLAY (DESICCATED CRUST) Brown, moist (stiff to very stiff)		1
				2
			89.6	3
		SILTY CLAY Grey, wet (soft to firm)		4
				5
				6
				7
			84.5	
		Borehole Terminated at 7.9 m Depth		

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % / Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES	Natural Unit Wt. kN/m³
SS1	19.0
SS2	18.2
SS3	
SS4	
SS5	

7 | 7 | 115 kPa | 130 kPa | 86 kPa | Hammer Weight | 24 kPa | Hammer Weight | 20 kPa | Hammer Weight | 29 kPa

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Upon Completion	3.0	4.3

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-15

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 17

Page. 1 of 1

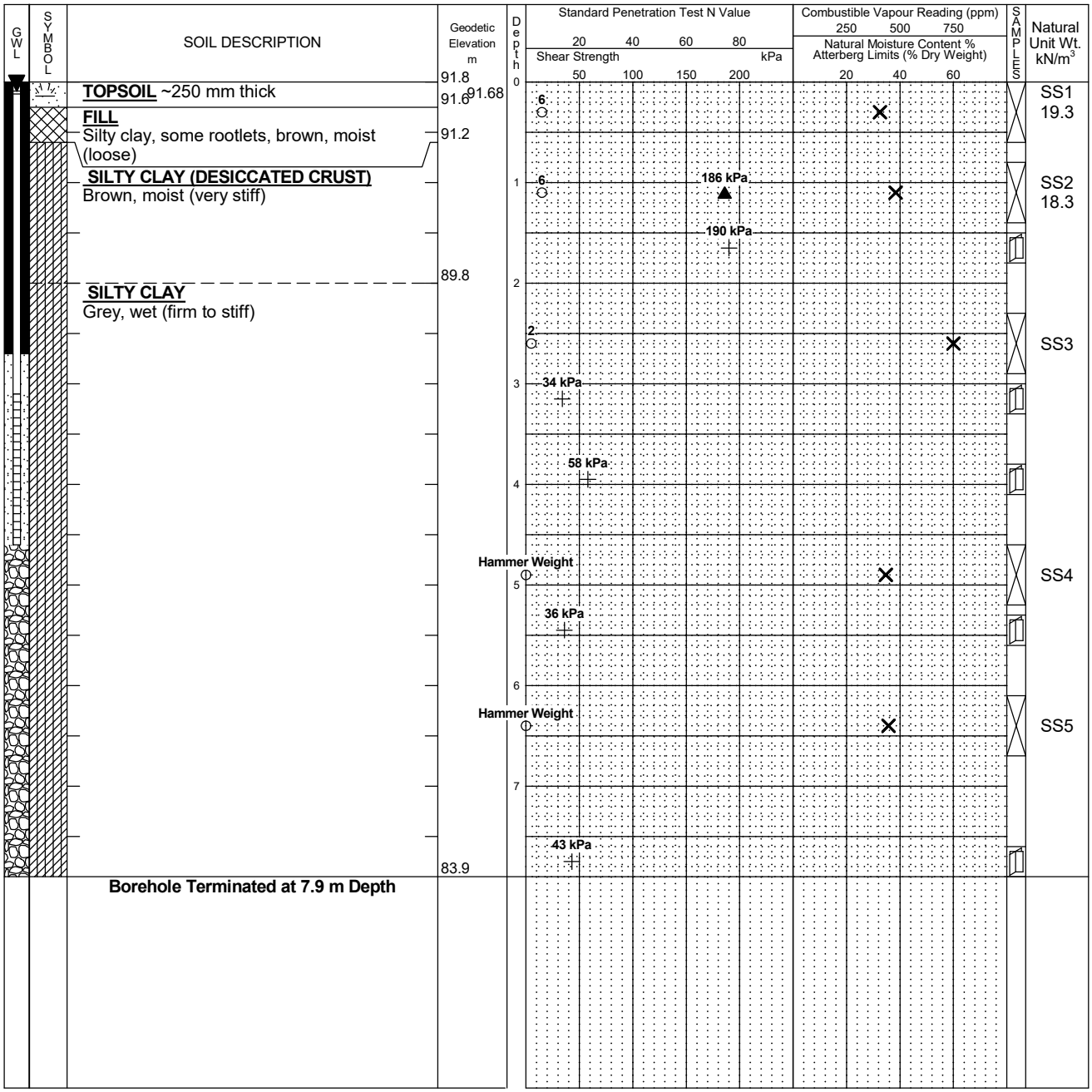
Date Drilled: 'April 28, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test (S)
Combustible Vapour Reading
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test



NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
May 4, 2022	0.1	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-16

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 18

Page. 1 of 1

Date Drilled: 'April 25, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○—|
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		TOPSOIL ~230 mm thick	92.74	0
		FILL	92.5	
		Silty clay, some rootlets, brown, moist (loose)	92.1	
		SILTY CLAY (DESICCATED CRUST) Brown, moist, high plasticity (very stiff)		1
				2
			89.9	3
		SILTY CLAY Grey, wet (firm)		
				4
				5
				6
				7
			84.8	
		Borehole Terminated at 7.9 m Depth		

Standard Penetration Test N Value: 20 40 60 80
Shear Strength: 50 100 150 200 kPa

Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

6
6
4
120 kPa
Hammer Weight
50 kPa
Hammer Weight
33 kPa
Hammer Weight
48 kPa

SAMPLES	Natural Unit Wt. kN/m³
SS1	
SS2	18.8
SS3	17.6
SS4	
SS5	
SS6	

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Upon Completion	5.1	5.6

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-18

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Location: Leitrim and Limebank Roads, Ottawa, ON

Figure No. 19

Page. 1 of 2

Date Drilled: 'April 27, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢○⊣
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		TOPSOIL ~300 mm	92.64	0
		Piezocone Penetration Test (CPTu) conducted from 0.3 m to cone refusal at 11.4 m depth	92.3	

Standard Penetration Test N Value: 20 40 60 80

Shear Strength: 50 100 150 200 kPa

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 5/10/22

Log of Borehole BH-18

Project No: OTT-22008699-A0

Project: Due Diligence Environmental, Geotechnical and Hydrogeological Investigation

Figure No. 19

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		Piezocone Penetration Test (CPTu) conducted from 0.3 m to cone refusal at 11.4 m depth *(continued)*	82.64	10	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
				11				
			81.2					
		CPTu Cone Refusal met at 11.4 m Depth						

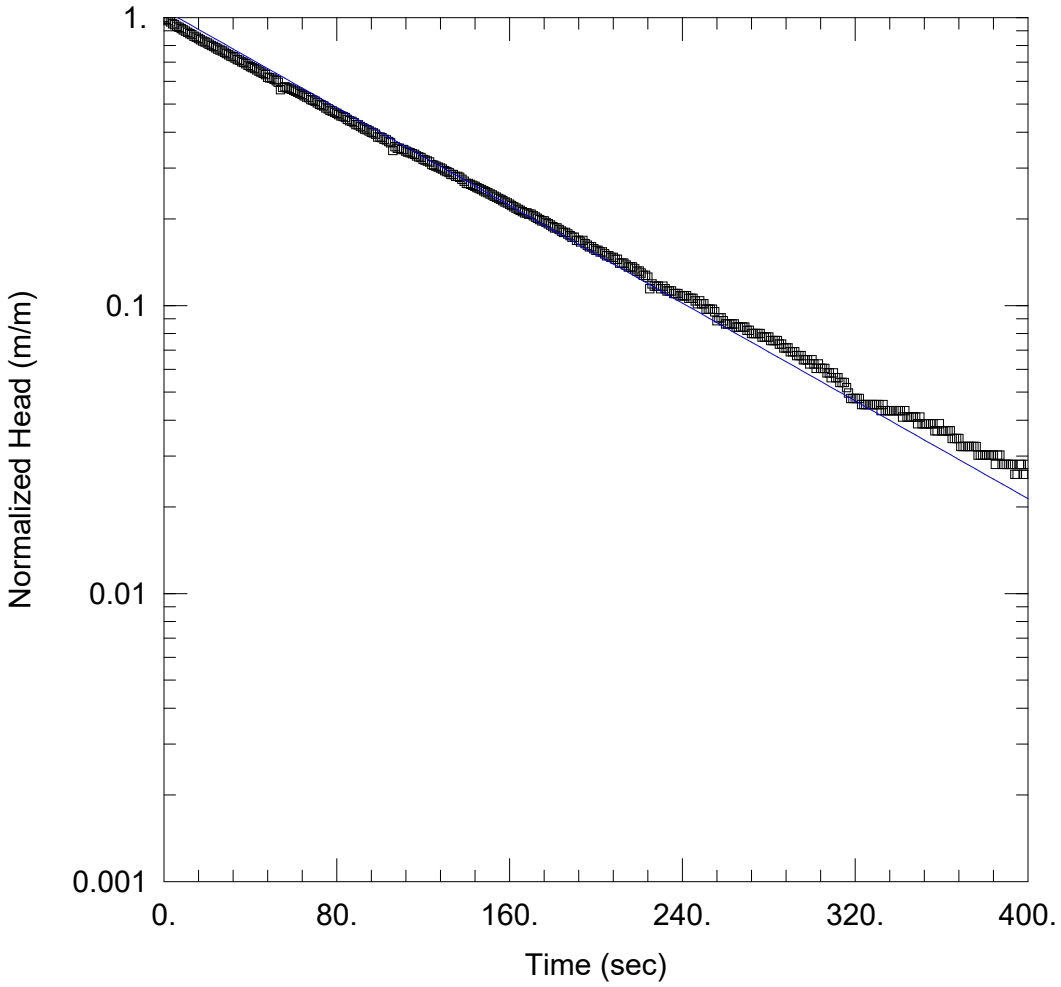
NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-A0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

Appendix C – SWRT Procedures and Results



SWRT OF BH 1

Data Set: \...\BH 1.aqt
Date: 05/18/22 Time: 18:11:03

PROJECT INFORMATION

Company: exp Services Inc.
Client: One Properties
Project: OTT-22008699-A0
Location: Limebank and Leitrim Rd Ottawa
Test Well: BH 1
Test Date: May 10, 2022

AQUIFER DATA

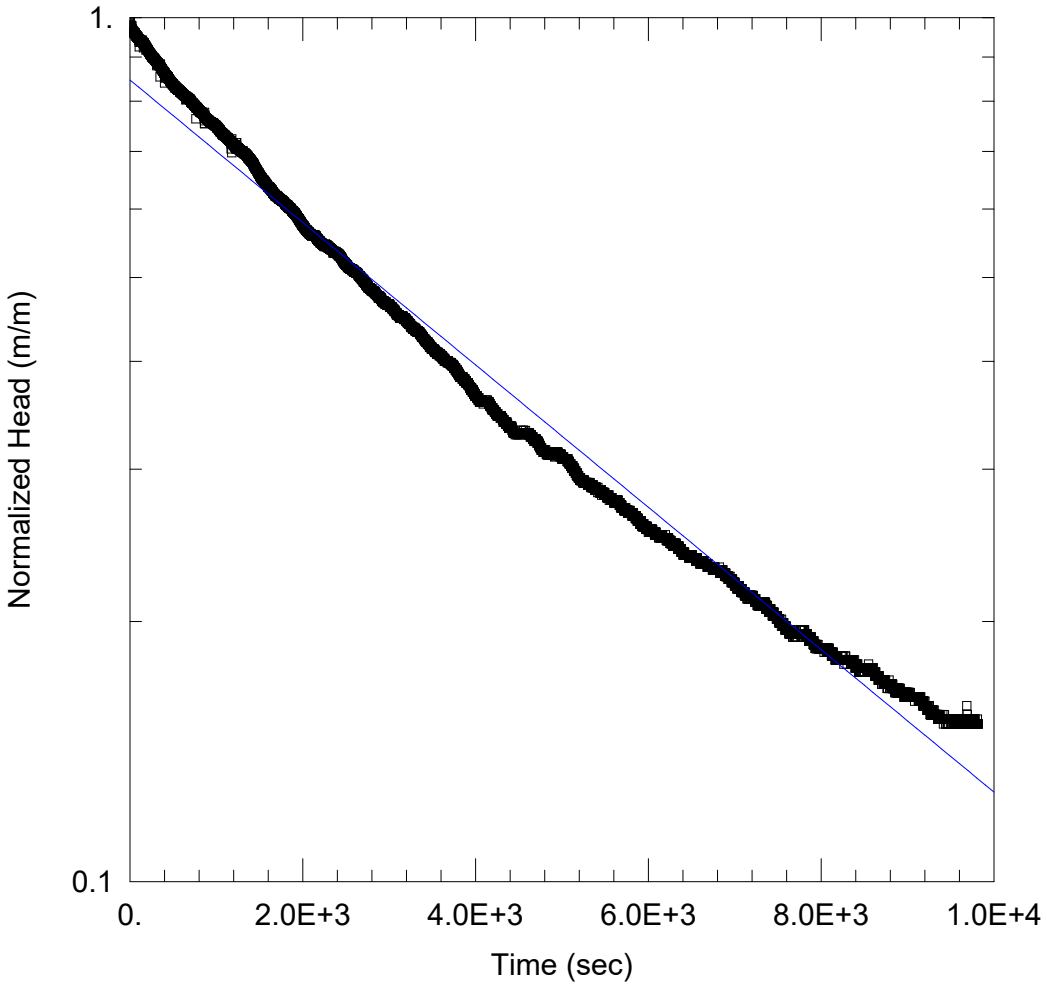
Saturated Thickness: 3.64 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH 1)

Initial Displacement: 0.463 m
Total Well Penetration Depth: 3.64 m
Casing Radius: 0.0254 m
Static Water Column Height: 3.64 m
Screen Length: 1.5 m
Well Radius: 0.0762 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 7.718E-6 m/sec
y0 = 0.4923 m



SWRT OF BH 11

Data Set: \...\BH 11.aqt
Date: 05/18/22 Time: 18:13:39

PROJECT INFORMATION

Company: exp Services Inc.
Client: One Properties
Project: OTT-22008699-A0
Location: Limebank and Leitrim Rd Ottawa
Test Well: BH 11
Test Date: May 10, 2022

AQUIFER DATA

Saturated Thickness: 4.76 m Anisotropy Ratio (Kz/Kr): 1.

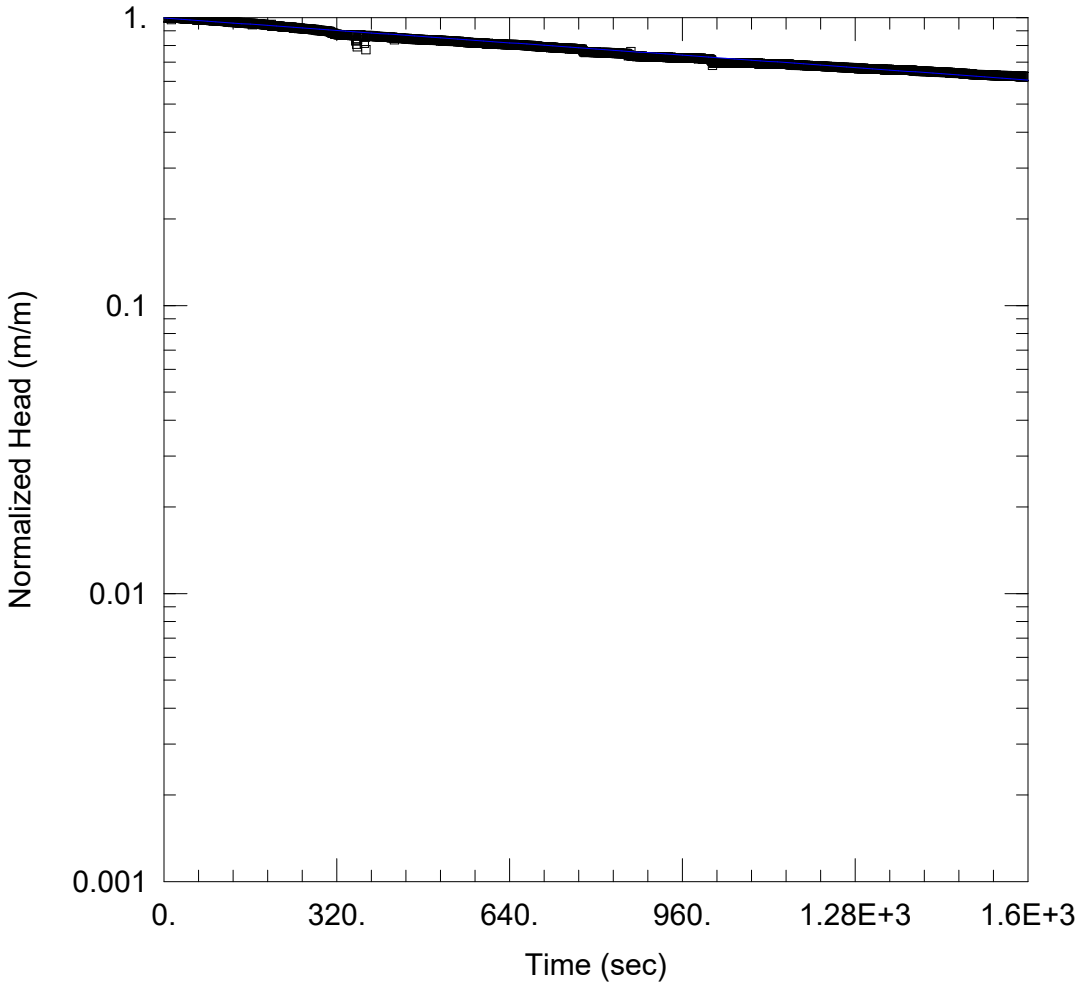
WELL DATA (New Well)

Initial Displacement: 0.532 m
Total Well Penetration Depth: 4.76 m
Casing Radius: 0.0254 m
Static Water Column Height: 4.76 m
Screen Length: 1.5 m
Well Radius: 0.0762 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 1.499E-7 m/sec y0 = 0.4503 m



SWRT OF BH 15

Data Set: \...\BH 15.aqt
Date: 05/18/22 Time: 18:14:29

PROJECT INFORMATION

Company: exp Services Inc.
Client: One Properties
Project: OTT-22008699-A0
Location: Limebank and Leitrim Rd Ottawa
Test Well: BH 15
Test Date: May 10 and 11, 2022

AQUIFER DATA

Saturated Thickness: 3.57 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH 15)

Initial Displacement: 0.369 m
Total Well Penetration Depth: 3.57 m
Casing Radius: 0.0254 m
Static Water Column Height: 3.57 m
Screen Length: 1.5 m
Well Radius: 0.0762 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 2.444E-7 m/sec
y0 = 0.3675 m

Appendix D – Laboratory's Certificates of Analysis

CADUCEON™ ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G110503 **REPORT No. B22-13747**

Report To:

EXP Services Inc
2650 Queensview Drive, Suite 100
Ottawa ON K2B 8H6 Canada
Attention: Chris Kimmerly

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 11-May-22
DATE REPORTED: 18-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: OTT-22008699-AO
P.O. NUMBER:
WATERWORKS NO.

Parameter	Qty	Site Analyzed	Analyst Initials	Date Analyzed	Lab Method	Reference Method
pH	1	Holly Lane	SYL	12-May-22	A-PH-01 (o)	SM 4500H
A - Wet Chem	1	Kingston	ach	12-May-22	A-TPTKN-001 (N)(k)	E3516.2
A - Wet Chem	1	Kingston	ach	12-May-22	A-TPTKN-001 (P)(k)	E3516.2
Total Suspended Solids	1	Kingston	TK	16-May-22	A-TSS-001 (k)	SM2540D
BOD	1	Kingston	JWF	12-May-22	C-BOD-001 (k)	SM 5210B
Oil & Grease	1	Kingston	aso	13-May-22	C-O&G-001 (k)	SM 5520
Mercury	1	Holly Lane	PBK	17-May-22	D-HG-02 (o)	SM 3112 B
Metals - ICP-OES	1	Holly Lane	NHG	11-May-22	D-ICP-01 (o)	SM 3120
Metals - ICP-MS	1	Holly Lane	TPR	16-May-22	D-ICPMS-01 (o)	EPA 200.8
Subcontracted	1	Default Site	JGC	17-May-22	S-Formaldehyde	EPA 556.1

O-Sanitary Combined Sewer - Sanitary Combined Sewer Use By-Law Limits
O-Storm Sewer Guidelines - City of Ottawa Storm Sewer Guidelines
Ottawa Sanitary-Combined - City of Ottawa Sanitary Combined Sewer Use By-Law



Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 11-May-22
DATE REPORTED: 18-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: OTT-22008699-AO
P.O. NUMBER:
WATERWORKS NO.

	Client I.D.		BH-12				-Sanitary Combined Sew	
	Sample I.D.		B22-13747-1				O-Storm Sewer Guidelines	Ottawa Sanitary-Combined
	Date Collected		10-May-22					
Parameter	**Units**	**R.L.**						
pH @25°C	pH Units		8.16					
BOD(5 day)	mg/L	3	< 3				25	
CBOD5	mg/L	3	< 3					300
Oil and Grease-Anim/Veg. (Calculation)	mg/L	1.0	1.1					150
Oil and Grease-Mineral	mg/L	1.0	< 1.0					15
Oil & Grease-Total	mg/L	1.0	1.1					
Total Suspended Solids	mg/L	3	15				15	350
Total Kjeldahl Nitrogen	mg/L	0.1	0.7					100
Phosphorus-Total	mg/L	0.01	0.14				0.4	10
Aluminum	mg/L	0.01	0.17					50
Antimony	mg/L	0.0001	0.0004					5
Arsenic	mg/L	0.0001	0.0021				0.02	1
Bismuth	mg/L	0.02	< 0.02					5
Boron	mg/L	0.005	0.278					25
Cadmium	mg/L	0.005	< 0.005				0.008	0.02
Chromium	mg/L	0.002	< 0.002				0.08	5
Cobalt	mg/L	0.005	< 0.005					5
Copper	mg/L	0.002	< 0.002				0.04	3
Lead	mg/L	0.02	< 0.02				0.12	5
Manganese	mg/L	0.001	**0.272**				0.05	5
Mercury	mg/L	0.00002	< 0.00002				0.0004	0.001
Molybdenum	mg/L	0.01	< 0.01					5
Nickel	mg/L	0.01	< 0.01				0.08	3
Selenium	mg/L	0.001	< 0.001				0.02	5
Silver	mg/L	0.005	< 0.005				0.12	5
Tin	mg/L	0.05	< 0.05					5

O-Sanitary Combined Sewer - Sanitary Combined Sewer Use By-Law Limits
O-Storm Sewer Guidelines - City of Ottawa Storm Sewer Guidelines
Ottawa Sanitary-Combined - City of Ottawa Sanitary Combined Sewer Use By-Law



Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 11-May-22
DATE REPORTED: 18-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: OTT-22008699-AO
P.O. NUMBER:
WATERWORKS NO.

	Client I.D.		BH-12				-Sanitary Combined Sew	
	Sample I.D.		B22-13747-1				O-Storm Sewer Guidelines	Ottawa Sanitary-Combined
	Date Collected		10-May-22					
Parameter	**Units**	**R.L.**						
Titanium	mg/L	0.005	0.014					5
Vanadium	mg/L	0.005	< 0.005					5
Zinc	mg/L	0.005	0.018				0.04	3
Formaldehyde	mg/L	0.008	0.011 [1]					0.3

1 . Subcontracted to Testmark Labs

O-Sanitary Combined Sewer - Sanitary Combined Sewer Use By-Law Limits
O-Storm Sewer Guidelines - City of Ottawa Storm Sewer Guidelines
Ottawa Sanitary-Combined - City of Ottawa Sanitary Combined Sewer Use By-Law

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Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

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Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 11-May-22
DATE REPORTED: 18-May-22
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: OTT-22008699-AO
P.O. NUMBER:
WATERWORKS NO.

Summary of Exceedances

City of Ottawa Storm Sewer Guidelines		
BH-12	Found Value	Limit
Manganese (mg/L)	0.272	0.05

O-Sanitary Combined Sewer - Sanitary Combined Sewer Use By-Law Limits
O-Storm Sewer Guidelines - City of Ottawa Storm Sewer Guidelines
Ottawa Sanitary-Combined - City of Ottawa Sanitary Combined Sewer Use By-Law

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

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Appendix E – Percolation Testing

Limebank Road and Leitrim Road
OTT-22006899-A0
Low Impact Design (LID) Calculations for Infiltration Gallery

Test Location	Hydraulic Conductivity (K_{fs}) (cm/s)	Infiltration Rate (IR) (mm/hr)	Discrete Design Infiltration Rate(DIR) (mm/hr)	Percolation Time (min/cm)
P-1	1.9E-06	16	2	318

Geology Units	Geometric Mean of K_{fs} (cm/s)	Infiltration Rate (I) (mm/hr)*	Ratio of Mean Measured Infiltration Rates	Safety Correction Factor (SCF)
Overlying Geology Unit	1.90E-06	16	1.0	8.5
Underlying Geology Unit (1.5 m below the bottom of trench)	1.90E-06	16		

Design Infiltration Rate(DIR) (mm/hr)	Minimum	2	**Percolation Time (min/cm)**	318
	Maximum	2		318
	Geometric Mean	**2**		**318**

Note:
Analytical Solutions (CVC and TRCA 2010)

$$Infiltration\ Rate\ (IR) = \left(\frac{K_{fs}}{6x10^{-11}}\right)^{\frac{1}{3.7363}}$$

$$Design\ Infiltration\ Rate\ (DIR) = \frac{IR}{SCF}$$

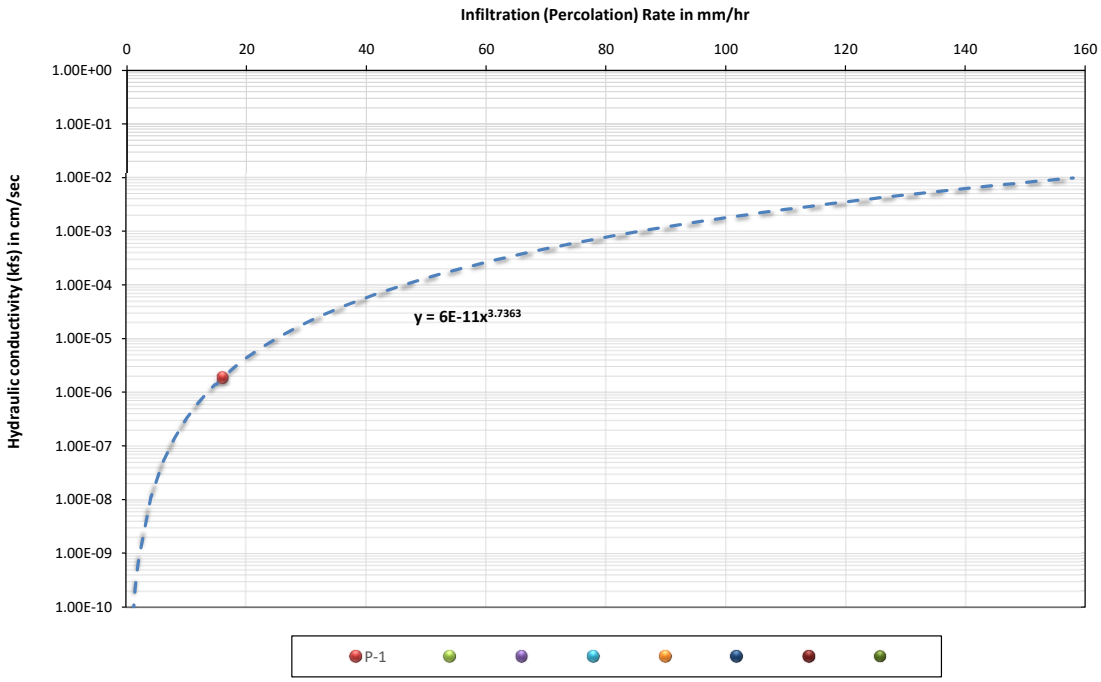
Kfs: hydraulic conductivity (cm/sec)

IR: infiltration rate (mm/hr)

DIR: design infiltration rate (mm/hr)

SCF: Safety Correction Factor (based on the chart recommended by CVC and TRCA, 2010)

Figure : Approximate relationship between infiltration rate and hydraulic conductivity (LID SWM planning and Design Guide, Appendix C1)



Appendix F – Construction and Post-Construction Flow Rate Calculations

APPENDIX F: Dewatering Flow Rates

Limebank Road and Leitrim Road
OTT-22008699-A0

Table F-1: Construction and Post Construction Dewatering Assessments

Parameters	Symbols	Unit	Construction Building A	Construction Building B	Post Construction Building A	Post Construction Building B
Geological Formation	-	-	Marine Deposit	Marine Deposit	Marine Deposit	Marine Deposit
INPUTS						
Ground Elevation	-	mASL	92.89	92.89	92.89	92.89
Highest Groundwater Elevation	-	mASL	92.89	92.89	92.89	92.89
Lowest Top Slab Elevation	-	mASL	93.00	93.00	93.00	93.00
Lowest Foundation Invert Elevation	-	mASL	92.00	92.00	92.00	92.00
Dewatering Target Elevation	-	mASL	90.00	90.00	92.50	92.50
Base of Aquifer / Water Bearing Zone	-	mASL	82.00	82.00	82.00	82.00
Height of Static Water Table Above the Base of the Water-Bearing Zone	**H**	m	10.89	10.89	10.89	10.89
Height of Target Water Level Above the Base of Water-Bearing Zone	**h_w**	m	8.00	8.00	10.50	10.50
Drawdown	**s**	m	2.89	2.89	0.39	0.39
Dupuit Check (> 45%)	**%**	m	73%	73%	96%	96%
Hydraulic Conductivity	**K**	m/s	2.7E-06	2.7E-06	2.7E-06	2.7E-06
Length of Excavation	-	m	268.00	240.00	268.00	240.00
Width of Excavation	-	m	80.00	58.00	80.00	58.00
Equivalent Radius (equivalent perimeter)	**r_e**	m	110.77	94.86	110.77	94.86
Method to Calculate Radius of Influence	-	-	**Cooper-Jacob**	**Cooper-Jacob**	**Cooper-Jacob**	**Cooper-Jacob**
Time (days)	**t**	day	45.00	45.00	180.00	180.00
Time (seconds)	**t**	s	3,888,000	3,888,000	15,552,000	15,552,000
Specific Yield	**Sy**		0.030	0.030	0.030	0.030
OUTPUTS						
Cooper-Jacob's Radius of Influence from Sides of Excavation	**Rcj**	m	92.60	92.60	185.19	185.19
Radius of Influence	**Ro**	m	203.37	187.45	295.96	280.05
Dewatering Flow Rate (unconfined radial flow component)	**Q**	m^3/day	65.85	58.74	6.22	5.65
Factor of Safety	**fs**	-	2.00	2.00	1.50	1.50
Dewatering Flow Rate (multiplied by factor of safety)	**Q.fs**	m^3/day	**132**	**117**	**9**	**8**
Precipitation Event	-	mm/day	15	15	0	0
Volume from Precipitation	-	m^3/day	322	209	0	0
Single Building - Total Volume (L/day) Discharge of Groundwater (Construction dewatering) **without Safety Factor** (including precipitation	-	m^3/day	387	268	6.221	5.647
Single Building - Total Volume (L/day) Discharge of Groundwater (Construction dewatering) **with Safety Factor** (including precipitation)	-	m^3/day	453	326	9.331	8.471
4 Buildings - Total Volume (L/day) Discharge of Groundwater (Construction dewatering) **with Safety Factor** (including precipitation)	-	m^3/day	1,559		35.605	
Precipitation Event 2 year storm	-	mm/day	51.8	51.8		
Volume from Precipitation	-	m^3/event	1,111	721		
Precipitation Event 100 year storm	-	mm/day	115.6	115.6		
Volume from Precipitation	-	m^3/event	**2,478**	**1,609**		

Notes:
mASL - meters above sea level

Analytical Solution for Estimating Radial Flow from an Unconfined Aquifer to a Fully-Penetrating Excavation

$$Q_w = \frac{\pi K(H^2 - h^2)}{Ln\,[\frac{R_o}{r_e}]}$$ (Based on the Dupuit-Forcheimer Equation)

$$r_e = \frac{a+b}{\pi} \qquad R_o = R_{cj} + r_e \qquad R_{cj} = \sqrt{2.25KDt/S}$$

Where:

Q_w = Flow rate per unit length of excavation (m^3/s)
K = Hydraulic conductivity (m/s)
H = Height of static water table above base of water-bearing zone (m)
h_w = Height of target water level above the base of water-bearing zone (m)
Rcj=Cooper Jacob Radius of Influence (m)
R_o=Radius of influence (m)
re=Equivalent perimeter (m)