Consulting
Engineers and
Scientists

Hydrogeological and Geotechnical Investigation

Proposed Outdoor Storage Development

518, 520, 522 and 524 Tiffin Street, Barrie, Ontario

Submitted to:
Pioneer Family Pools
43 Anne Street South
Barrie, Ontario, L4N 2C9

Submitted by:
GEI Consultants Ltd.
647 Welham Road, Unit 14
Barrie, Ontario, L4N 0B7
705-719-7994

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1. Introduction

GEI Consultants (GEI) was retained by Pioneer Family Pools to complete a hydrogeological and geotechnical investigation and report in support of the proposed outdoor storage facility at 518, 520, 522 and 524 Tiffin Street in Barrie, Ontario. A site location plan is enclosed as Figure 1.

The existing 0.5-hectare property is rectangular in shape and is approximately 73 metres long (east to west) and approximately 68 metres wide (north to south). The property is bounded by Tiffin Street to the south, residential properties to the west, and wooded undeveloped properties to the north and west. The western half of the property is vacant with some grass/trees and the eastern half of the property is currently being used for vehicle, boat and equipment storage. A small single slab-on-grade structure is in the northeastern corner of the property. The topography on-site and within the study area is relatively flat, about 1 m of relief, and is near approximate elevation 236 metres above sea level (masl). An aerial image of the site is provided on Figure 2A.

GEI was provided the following documents for review in preparation of this report:

- *"Official Plan/Zoning By-Law Amendment, Pre-Consultation Review, Planning Comments*", File: D28-082-2021, dated September 29, 2021, by the City of Barrie.

- *"Pioneer Family Pools Barrie Inc. Concept Plan"* File: PIO-21060, dated July 30, 2021, by Jones Consulting Group Ltd.

It is understood through email correspondence with The Jones Consulting Group (TJCG) and the above noted documents, that the Owner is proposing to continue utilizing the property for the storage of building materials, trailers, and equipment but intends to enhance the site by creating a more formal structure to the site by incorporating parking, internal driveways and set locations for storage. It is noted that the existing building in the northeastern corner of the property will remain. A concept plan is provided on Figure 2B.

Based on the comments from Ms. C. Papdatos from The City of Barrie, as of September 23, 2021 as part of the pre-consultation application package, the following is required:

> "*A geotechnical/hydrogeological report will be required in support of this rezoning. This report must address groundwater levels and any impact those levels may have on servicing and foundations. Opportunities for LID initiatives should be identified within this report"*

As such GEI has completed a combined geotechnical and hydrogeological report for the project.

1.1 Purpose and Scope of Work

The main objectives of the combined hydrogeological and geotechnical Investigation were to:

- Describe the existing site conditions including:
    - Site location and description of topography, drainage, with desktop review to provide background physiography, geology and overburden soil.
    - Subsurface conditions encountered within the four (4) test pits completed on-site including soil and groundwater observations.
    - In-situ percolation rates, groundwater flow direction and description of surface water features and functions.
- Provide geotechnical recommendations pertaining to:
    - Road and parking lot subgrade preparation, drainage considerations and pavement structure for new pavements.
    - Constructability requirements, such as excavations, soil compaction and temporary groundwater control.
- Provide hydrogeological recommendations including:
    - Commentary on the presence of high vulnerability aquifers, significant groundwater recharge areas and wellhead protection areas in the vicinity of the site.
    - Pre-construction and post-construction water balance calculation to assess changes in run-off and infiltration, and a discussion regarding potential mitigation measures.
    - Results of in-situ infiltration rates and discussion on factored infiltration rates to be used for infiltration based Low Impact Development (LID) features.

It is noted that Guelph Permeameter (GP) testing was proposed; however, relatively shallow saturated conditions inhibited the ability complete the proposed GP testing which is to be completed in unsaturated conditions.

1.2 Regulatory Requirements

1.2.1 Source Water Protection

The site is within the jurisdiction of Lake Simcoe Region Conservation Authority (LSRCA). The following documents should be used in determination of the regulatory requirements when it comes to maintaining hydrogeological function at this site:

- "*Lake Simcoe Protection Plan*", dated July 2009, by MOECC, MNR & LSRCA.
- "*Approved South Georgian Bay Lake Simcoe Source Protection Plan*", dated January 26, 2015, by LSRCA.
- *"Lake Simcoe Protection Plan Water Budget Policy for LSPP 4.8-DP and 6.40-DP,"* dated November 2018, by LSRCA.

It is noted that based on the comments from Mr. L. Munnoch with the LSRCA, dated September 24, 2021, a geotechnical / soils report is required; however, a hydrogeological investigation is not required. Although a hydrogeological investigation was noted to not be required by the LSRCA, the City of Barrie is requesting a hydrogeological investigation. As such, GEI has followed both the City of Barrie and LSRCA typical hydrogeological investigation requirements for the purposes of this investigation.

Based on Source Water Protection online mapping, the following is noted:

- Wellhead Protection Area (WHPA): The site is located within a WHPA-B (Figure 3).
- Intake Protection Zone (IPZ): The site is located within IPZ-3 (Figure 4)
- Highly Vulnerable Aquifer (HVA): The site is not located within an HVA (Figure 5).
- Significant Groundwater Recharge Area (SGRA): The site is not located within an SGRA (Figure 6).
- The site is not located within the Oak Ridges Moraine or Niagara Escarpment.

2. Site Setting

2.1 Physiography, Surficial and Bedrock Geology

The site is located within the physiographic region denoted as the Simcoe Lowlands comprising sand plains (Chapman and Putnam, 1984).

Quaternary geology mapping of the site by the Ontario Geological Survey indicates that the site is within an area mapped as glaciomarine deposits comprising sand, gravelly sand, and gravel. These findings are consistent with the subsurface soil conditions encountered in the test pits advanced on site, as discussed in Section 4.1.

The bedrock in the general area corresponds to the Verulam Formation, consisting of limestone and shale, and is part of the Simcoe Group. Bedrock is anticipated at depths greater than 75 m based on available drift thickness mapping for the Barrie Area (Ontario Division of Mines, Drift Thickness Series, Barrie Area Map P980).

2.2 Topography and Drainage

The existing site has relatively flat topography with relative elevations measured at the test pits ranging from 99.21 to 98.93 m, showing approximately 0.3 m of topographic relief across the site. Surficial runoff on-site is anticipated to follow the gentle topographic relief on-site towards the center of the site, and then to either the wetland to the north of the site and/or existing municipal infrastructure to the south of the site. Regional groundwater flow is anticipated to flow to the west/northwest towards Lake Simcoe.

No water bodies are located on the site; however, Dyment’s Creek is located immediately south of the site within the Tiffin Street Right of Way (ROW). Further an unevaluated wetland is located immediately to the north of the site. The site is located within the Barrie Creeks subwatershed, in the jurisdiction of LSRCA.

2.3 MECP Water Well Records

MECP water well records were obtained within 500 metres of the site area to assess the general nature of the groundwater resource in the vicinity of the site, and historical/current uses of wells in the area. Twenty-five (25) well records were found, the approximate MECP well locations are shown on Figure 7 and a well records summary table is included in Appendix A.

The wells were installed for the following uses:

- Seven (7) of the records indicate domestic use.
- One (1) of the records indicate commercial use.

- Four (4) of the records indicate municipal use/public supply.
- One (1) of the records indicate industrial use.
- Five (5) of the records indicate monitoring/test holes.
- One (1) of the records indicate dewatering use.
- Four (4) of the records indicate not used/abandoned.
- Two (2) of the records did not specify the use and are of unknown use.

The stratigraphic descriptions within the MECP monitoring well records are typically inaccurate due to the methodology in which they are determined (observations of cuttings and no consistency between descriptions of soil between different drillers). Though in this case, an overall sense of the deep stratigraphy can be determined by looking at commonalities between most stratigraphic descriptions and where the wells were terminated in an aquifer. The well records typically indicate sand with variable clay and gravel deposits were encountered. The noted domestic water supply wells were typically installed in a sand unit at depths of approximately 11.3 to 73.2 m below existing grade.

The four (4) identified municipal water supply water well records are located 340 m southwest of the site and correspond to Municipal Water Supply Well W18. It is noted that Municipal Water Supply Well W18 is currently not online. Specifically, WWR #5734829 is installed at a depth of 92 m below existing grade. A pump test was completed where a pump rate of 500 GPM was utilized for a duration of 48-hours, resulting in a total drawdown of 1.5 m at the end of the pump test.

2.4 Visual Inspection of Site

A visual site inspection was carried out on January 12, 2022, by senior GEI staff to assess site drainage, topography and presence of surface water features.

The existing 0.5-hectare property is rectangular in shape and is approximately 73 metres long (east to west) and approximately 68 metres wide (north to south). The property is bounded by Tiffin Street to the south, residential properties to the west, and wooded undeveloped properties to the north and west. The western half of the property is vacant with some grass/trees and the eastern half of the property is currently being used for vehicle, boat and equipment storage. A small single storey slab-on-grade structure is in the northeastern corner of the property.

The topography at the site, within the study area, is relatively flat and has only about 1 m of relief, with the site at approximate elevation 236 masl.

3. Procedures and Methodology

GEI laid out the test pit locations in the field. Prior to the commencement of excavation activities, the locations of underground utilities including natural gas, electrical, telephone, water, etc. were marked out by public and private utility locating companies. The test pits were advanced cognizant of underground utilities.

The fieldwork for the test pit program was carried out on January 12, 2022. Test Pits (TP) 1 to 4 were advanced across the site to 2.0 to 2.1 metres depth below existing grade (local Elev. 99.2 to 93.2 masl) by an excavating subcontractor retained and supervised by GEI. The test pits were advanced using a rubber track excavator. Test Pit locations are shown on Figures 2A/2B, and test pit logs are provided in Appendix B.

Ground surface elevations of the test pits were measured using survey equipment in relation to a temporary benchmark (top of the fire hydrant spindle, located southeast of the site along Tiffin Street), with an assumed local elevation of 100.00 metres. GPS coordinates were measured with a handheld GPS unit and were referenced to the NAD 83 geodetic datum.

Three (3) standpipes were installed (TP1, TP2 and TP4) to facilitate long-term groundwater monitoring. All four test pits were backfilled upon completion with the excavated soil and leveled with the surrounding ground surface.

The GEI field staff examined and classified characteristics of the soils encountered in the test pits, including the presence of fill materials, made groundwater observations during and upon completion of excavation, recorded observations of test pit construction, and processed the recovered samples. Soil sampling was conducted at regular intervals for the full depth of the test pits. All recovered soil samples were logged in the field, carefully packaged and transported to the laboratory for more detailed examination and classification.

In the laboratory, the samples were classified as to their visual and textural characteristics. Three (3) samples were submitted to our laboratory for grain size analysis and the results are provided in Appendix C.

4. Subsurface Conditions

It should be noted that the conditions summarized below are for specific test pit locations only and can vary between and beyond the test pit locations. It should be noted these boundaries are intended to reflect approximate transition zones and should not be interpreted as exact planes of geological change. The passage of time also may result in changes in conditions interpreted to exist at locations where sampling was conducted.

4.1 Stratigraphy

The soil conditions encountered at the test pit locations are summarized below.

Test Pit	Ground Surface Elev. (m)	Northing (m)	Easting (m)	Total Depth (m)	Depth (m) and Stratigraphy	Seepage / Groundwater Comments
TP1	99.13	4913383	601453	2.1	0 to 0.8 – Fill: organic silt and sand, trace gravel with steel wire/metals, brown, moist 0.8 to 1.8 – Peat: black, wet 1.8 to 2.1***** – Sand: trace silt, brown, wet	Seepage below 1.8 m Caving below 1.8 m
TP2	98.93	4913391	601484	2.0	0 to 0.5***** – Fill: sand, trace silt, brown, moist 0.5 to 1.8 – Peat: black, wet 1.8 to 2.0 – Sand: trace silt, grey stain, wet	Seepage below 0.5 m Caving below 1.8 m
TP3	98.96	4913425	601447	2.0	0 to 0.5 – Fill: sand, trace organics, trace gravel, trace silt, brown, moist 0.5 to 1.6 – Peat: black, wet 1.6 to 2.0 – Sand: trace silt, brown, wet	Seepage below 1.0 m Caving below 1.6 m
TP4	99.21	49133430	601491	2.1	0 to 0.5 – Fill: sand, trace organics, trace gravel, trace silt, brown, moist 0.5 to 1.7 – Peat: black, wet 1.7 to 2.1***** – Sand: trace silt, brown, wet	Seepage below 1.4 m Caving below 1.4 m

***** A representative soil sample was submitted for particle size distribution as per the applicable Ontario LS standards in reference to ASTM D6913 and D7928.

All three (3) grain size distribution curves are shown in the graph in Appendix C.

4.2 Groundwater

4.2.1 Groundwater Levels

Unstabilized groundwater level measurements and cave measurements were taken upon completion of each test pit as shown on the table above. These measurements were taken to provide a rough estimate of the possible excavation and temporary groundwater control constructability considerations that may arise. Unstabilized groundwater measurements ranged between 0.5 and 1.8 metres below existing grade. Cave measurements taken ranged between 1.4 to 1.8 metres below existing grade.

Standpipes were installed in three (3) test pits (TP1, TP2 and TP4) to facilitate the measurements of stabilized groundwater levels. A 50 mm diameter PVC pipe with a 1.5-metre-long screen was installed in one (1) test pit and a 19 mm diameter PVC pipe with a 1.5-metre-long screen was installed in the remaining two (2) test pits. Groundwater measurements are shown in the table below.

Monitoring Well	Screen Location		Strata Screened	Depth / Local Elev. (m) of Groundwater Table		
	Depth (m)	Local Elev. (m)		2022-01-12	2022-01-19	2022-02-03
TP1	0.6 to 2.1	98.5 to 97.0	Peat and Sand	0.86 / 98.27	1.16 / 97.97	1.40 / 97.73
TP2	0.5 to 2.0	98.4 to 96.9	Peat and Sand	0.72 / 98.21	0.95 / 97.98	1.36 / 97.57
TP4	0.6 to 2.1	98.6 to 97.1	Peat and Sand	1.18 / 98.03	1.03 / 98.18	1.13 / 98.08

The groundwater levels from the last reading (February 3, 2022) ranged from 1.13 to 1.40 metres below existing grade (local elevation 98.08 to 97.57 masl). Based on the stabilized groundwater levels to-date, on-site near surface groundwater flow is anticipated to move towards the southwestern corner of the site.

The regional groundwater is anticipated to flow towards the west/northwest toward Lake Simcoe.

4.2.2 Hydraulic Conductivity

The hydraulic conductivity of selected soil samples was estimated using the grain size distribution determined by laboratory testing and an established empirical formula by Vukovic and Soro (1992). The grain size distribution curves are provided in Appendix C and the estimated K-values are summarized below:

Test Pit	Sample	Depth (m)	Material Type	Estimated Hydraulic Conductivity (m/s)
1	3	1.8 to 2.1	Fill: Sand, trace silt	2.3×10^{-4}
2	1	0 to 0.5	Sand: some silt, trace gravel	2.5×10^{-5}
4	3	1.7 to 2.1	Sand: trace silt	2.1×10^{-4}

According to Freeze and Cherry (1979), the typical hydraulic conductivity of the strata investigated are:

- Clean Sand: 10^{-2} m/s to 10^{-5} m/s
- Silty Sand: 10-3 m/s to 10^{-7} m/s

4.3 Infiltration

Determination of percolation rates are based on the "*Ministry of Municipal Affairs and Housing (MMAH) Supplementary Guidelines SB-6, Percolation Time and Soil Descriptions, September 14, 2012*". Based on this document, the estimated percolation rate (T-Time) of the earth fill is listed below and is related to an estimated infiltration rate using the relationship provided in *"Low Impact Development Stormwater Management Planning and Design Guide"*, by CVC (Version 1.0, 2010).

The test pits indicate fill compromised of sand encountered near surface overlying peat, overlying native sand with trace to some silt. The Unified Soil Classification System classifications for the predominant soils encountered on-site are summarized below with the interpreted unfactored percolation rates (T-Time) and unfactored infiltration rates:

Unified Soil Classification System Classification	Sample	Unfactored Percolation Rate (T-Time) (mins/cm)	Unfactored Estimated Infiltration Rate (mm/hr)
S.P. Poorly graded sands gravelly sand, little or no fines	TP 1 (Sand) and TP 4 (Sand)	2 to 8	300 to 75
S.M. Silty sands, sand-silt mixtures	TP 2 (Fill)	8 to 20	75 to 30

This infiltration rate is not applicable below the groundwater table and is not applicable to the existing zones of earth fill across the site. Appendix C of the CVC guide suggests safety factors to be applied to infiltration rates. The safety factor applicable to the site is expected to be 2.5 but this must be confirmed once the final location and elevation of LID measures are known. It is also noted that the relationships noted above are not direct conversions and estimates only.

Overall, the site conditions are not favourable for LID facilities. The sand is permeable, but a high groundwater table is present. There does not appear enough space above the groundwater table to accommodate the requirement for a typical 1 m buffer between the base of the LID and the groundwater table.

Some additional general LID considerations are provided below for bioretention and perforated pipe exfiltration systems. Detailed design of LID features will be carried out by others.

- Bioretention infiltration elevations should be kept 1 metre or more above the seasonally high groundwater table to prevent groundwater from intersecting the filter bed and potentially contaminating the groundwater or causing the LID feature to fail.
- Care should be taken during construction to prevent disturbance or siltation of the cohesionless earth fill soils at the proposed infiltration elevations.

- There is a risk of groundwater contamination in urban and industrial areas, especially from higher traffic roadways where de-icing salts are applied. Pre-treatment of stormwater may be required.
- The LIDs should be kept at least 4 metres from any building foundations.
- Settlement of nearby dwellings due to infiltration is not considered to be an issue.
- Vegetation in bioretention facilities should be maintained to help reduce erosion.
- The bioretention facilities within or adjacent to the parking areas and roadway should be designed so that retained water is not allowed to pool within the granular base material of the pavement structure.

5. Discussion and Analysis

It is understood through email correspondence with TJCG that the Owner is proposing to continue utilizing the property for the storage of building materials, trailers, and equipment, but intends to enhance the site by creating a more formal structure to the site by incorporating parking, internal driveways and set locations for storage. It is noted that the existing building in the northeastern corner of the property will remain in its current condition.

5.1 Hydrogeological Assessment

5.1.1 Preliminary Water Balance

5.1.1.1 Water Balance Components

A water balance is an accounting of the water resources within a given area. The water balance equates the precipitation (P) over a given area to the summation of the change in ground water storage (S), evapotranspiration/evaporation (ET), surface water runoff (R) and infiltration (I) using the following equation:

$$\mathrm{P} = S + I + ET + R$$

The components of the water balance vary in space and time and depend on climatic conditions as well as the soil and land cover conditions (i.e., rainfall intensity, land slope, soil hydraulic conductivity and vegetation). For example, runoff occurs at a higher percentage during periods of snowmelt when the ground is frozen or during intense rainfall events.

Precise measurement of the water balance components is difficult, and as such, approximations and simplifications are made to characterize the water balance of a property. Field observations of the drainage conditions, land cover and soil types, groundwater levels and local climatic records are important inputs to the water balance calculations.

- <u>Precipitation (P):</u> For the purposes of approximating the annual precipitation at this site, the monthly rainfall between 1981 and 2010 was used based on Environment Canada historical weather data for the Barrie WPCC weather station (Climate ID 6110557, Latitude 44.38 N, Longitude -79.69 W, Elevation 221 masl), which is located about 3.5 km northeast of the site.
- <u>Storage (S):</u> Although there are groundwater storage gains and losses on a short-term basis, the net change in groundwater storage on a long-term basis is assumed to be zero.
- <u>Evapotranspiration/Evaporation (PET):</u> The evapotranspiration and evaporation components vary based on the characteristics of the land surface cover (i.e., type of vegetation, soil moisture conditions, perviousness of surfaces, etc.). Potential evapotranspiration refers to the water loss from a vegetated surface to the atmosphere

under conditions of an unlimited water supply. Evaporation occurs from a hard surface (such as flat rooftops, asphalt, gravel parking areas, etc.).

- Water Surplus (R + I): The difference between the mean precipitation and evapotranspiration is referred to as the water surplus. The water surplus is divided into two parts: as surface or overland runoff (R) and the infiltration into the surficial soil (I). The infiltration is comprised of two end member components: one component that moves vertically downward to underlying aquifers (referred to as percolation, deep infiltration or net recharge) and a second component that moves laterally through the near surface soil profile or shallow soils as interflow that re-emerges locally to surface (i.e., as runoff) at some short distance and time following precipitation.

5.1.1.2 Approach and Methodology

The analytical approach to calculate the water balance involves monthly soil-moisture balance calculations to determine the pre-development infiltration volumes. The detailed water balance calculation is provided in Appendix D, which is summarized in this and subsequent sections of the report. The following assumptions were used as part of the soil-moisture balance calculations:

- A soil moisture balance approach assumes that soils do not release water as potential recharge while a soil moisture deficit exists.
- During wetter periods, any excess of precipitation over evapotranspiration first goes to restore soil moisture. Considering the nature of the near surface soils (sand, trace silt), a soil moisture storage capacity of 75 mm was used for the site which is vegetated with shrubs, grasses and some trees. It is assumed that post-construction permeable areas will be shallow urban vegetation and the same storage capacity was used post-development for the permeable areas.
- Once the soil moisture deficit is overcome, any further excess water can then pass through the soil as infiltration and either become interflow (indirect runoff) or recharge (deep infiltration).

Monthly potential evapotranspiration calculations accounting for latitude, climate and the actual evapotranspiration and water surplus components of the water balance based on the monthly precipitation and soil moisture conditions was calculated. The *MECP SWM Planning and Design Manual* (2003) methodology for calculating total infiltration based on topography, soil type and land cover was used, and a corresponding infiltration factor was calculated for pre and post-development conditions. The water surplus was multiplied by the infiltration factor to determine both the pre-existing and post-condition annual volumes for run-off and infiltration for the property.

The post-development water balance scenario was estimated based on the assumption that 45% of the 0.5-hectare lands would comprise impermeable components (e.g. office building, laneways, parking, and shed). The water balance must be updated following final site configuration to reflect the final site plans.

It is noted that the infiltration and runoff values presented in Appendix D, are estimates only. Single values are used for the water balance calculations, but it is important to understand that infiltration rates are dependent upon the hydraulic conductivity of the surficial soils which may vary over several orders of magnitude. As such, the margins of error for the calculated infiltration and runoff component values are potentially quite large. These margins of error are recognized, but for the purposes of this assessment, the numbers used in the water balance calculations are considered reasonable estimates based on the site-specific conditions and useful for comparison of pre- to post-development conditions.

5.1.1.3 Pre and Post Development Water Balance

The detailed water balance calculations are included in Appendix D. The pre and post development calculations are summarized in this section are preliminary only and must be updated once site plans are finalized.

The table below summarizes the pre and post construction water balance for the 0.5 hectare site.

Condition	Permeable Areas	Impermeable Areas	Average Annual Runoff Volume (m^3/year)	Average Annual Infiltration Volume (m^3/year)
Pre-Development Land Use	70% (vegetated area)	30% (house, shed, walkway, and driveway)	1,556.2	907.7
Post-Development Land Use (Preliminary Plan)	55% (vegetated area)	45% (warehouse, office, laneways, parking, and shed)	2,056.4	713.2

These calculations suggest that, without mitigation such as Low Impact Development (LID) measures, the proposed outdoor storage development will decrease average infiltration by about 194.5 m^3/year (21% decrease). The proposed outdoor storage development will increase runoff by about 500.2 m^3/year (32% increase). This means about 195 m^3/year of infiltration is required to maintain the water balance. The potential impacts of these changes and recommended mitigation measures are discussed below.

5.1.1.4 Recommended Mitigation Measures

The three broad categories which typically need to be mitigated and accounted for are:

- Reducing the volume and speed in which additional surface water runoff occurs;
- Increasing the amount of infiltration to match pre-development conditions; and
- Ensuring that the quality of existing surface water features and groundwater will not be adversely impacted.

5.1.1.5 Runoff Quantity

Urban development of an area affects the natural water balance. The most significant difference is the addition of impervious surfaces as a type of surface cover (e.g. roads, parking lots, driveways, rooftops). Impervious surfaces prevent infiltration of water into the underlying soils and the removal of the vegetation reduces the evapotranspiration component of the natural water balance. The evaporation component from impervious surfaces is relatively minor (estimated to be 15% of precipitation) compared to the evapotranspiration component that occurs with vegetation in this area (up to two thirds of precipitation). So, the net effect of the urbanization of the site is that most of the precipitation that falls onto impervious surfaces increases the surplus water resulting in more direct runoff from developed areas and reduced natural infiltration.

In conjunction with increased runoff, there is a reduction in infiltration to the shallow groundwater system. A reduction in infiltration can potentially lead to a lowering of the local water table and reduce the potential for this seasonal water table intersection and discharge.

Methods which do not necessarily increase infiltration rate, but decrease the volume and concentration of surface water runoff can be considered at this site include (but are not limited to):

- Increasing the topsoil thickness by about two times the normal thickness (up to 30 cm) to retain more water in storage; and
- Implementation of rainwater harvesting which intercepts/diverts and stores roof runoff or parking lot run-off (i.e. cisterns/tanks) for future use.

5.1.1.6 Mitigation Measures for Maintaining Infiltration

The increases in surface water runoff that will occur with urban development and mitigation of the potential impacts to the local water table due to reduction of infiltration may be minimized by using appropriate stormwater management and using LID measures to promote infiltration. These measures can be implemented on-site.

The basic premise for LID is to try to minimize changes to runoff and infiltration. As outlined in the *MECP SWMP Design Manual* (2003) and *Low Impact Development Stormwater Management Planning and Design Guide* published by the Credit Valley Conservation (CVC) and TRCA (2010), there are a suite of techniques that may be considered to promote infiltration and reduce runoff.

In order to maintain groundwater function at the site the following typical LID measures can be considered as part of typical site developments (can depend on land use):

- Collection of runoff from the building rooftops and redirection to grass areas and overland flow. If feasible, it is recommended that there be a minimum 5 metre flow path over pervious areas to allow this mitigation method to be fully effective;

- Provision of gentle slopes in open areas or along grass swales in order to allow time for water infiltration;
- Construction of engineered infiltration measures such as soakaway pits, infiltration galleries or bioswales. Subsurface infiltration methods can only be considered in areas where there is sufficient soil permeability and depth to water table to accommodate the systems within the unsaturated zone (typically the infiltration elevation must be kept 1 metre or more above the seasonal high groundwater level).
- Construction of grass channels or filter strips which allow infiltration, discharge at a lower rate and direct roof runoff to overland flow.

Implementation of LID measures will not only allow for infiltration of the surface water into the near-surface groundwater regime but will also allow for increase in natural filtration of surficial runoff, prevent sedimentation transport and potential erosion, and help reduce flooding by increasing the transit time for water on the site. These types of LID techniques promote natural infiltration by providing additional water volumes in the permeable areas. This is particularly effective in the summer months when natural infiltration would not generally occur because the additional water overcomes the natural soil moisture deficit.

Details and designs for LID measures will be provided in a stormwater management report for the site (by others). This includes demonstrating through plans and sections (including all dimensions, materials used and including the seasonal high groundwater level) how this infiltration deficit will be mitigated.

As it is typically a requirement of maintaining the same levels of infiltration post construction, no appreciable change in the groundwater table elevation should occur over the long-term condition.

If the water balance cannot be fully maintained due to low soil permeability and higher groundwater levels, minimal impacts are expected for the following reasons:

- The site is not within a SGRA.
- The land surrounding the site is expected to be serviced by City water supply instead of domestic wells.
- Groundwater recharge and baseflow to creeks is anticipated to be low due to the existing City of Barrie stormwater management systems.

5.1.1.7 Groundwater Quality

Depending on land use, runoff from urban developments may contain a variety of dilute contaminants such as suspended solids, chloride from road salt, oil and grease, metals, pesticide residues, phosphorous, bacteria and viruses. For groundwater, generally except for the dissolved constituents such as nitrogen and salt, most contaminants are attenuated by filtration during groundwater flow through the soils.

LID measures or end treatments such as oil/grit separators or wet ponds also help to remove suspended solids and other contaminants in runoff prior to infiltration or conveying the flows off the site, especially when a treatment train approach is taken for stormwater management. The stormwater management facilities (to be designed by others) must be designed such that the water quality is maintained or improved prior to discharging water from the site or infiltrating water into the ground.

Runoff from residential developments (e.g., rooftops, landscaped areas) are typically considered "clean" and can be collected an infiltrated where possible. Further, infiltration-based practices would likely be permitted for impervious areas such paved/parking and driveways.

Since only clean or pre-treated runoff will be infiltrated, the groundwater quality will not be degraded and will not impact nearby domestic wells, the watercourse or other nearby environmental features. The surficial aquitard present across the site also limits the amount of water infiltrating deeper below grade as recharge.

5.2 Geotechnical Engineering

5.2.1 Pavement Design and Construction

5.2.1.1 Subgrade Preparation

Grading plans were not available for review at the time of preparing this report, however some minor grading (assumed to be less than 1 m) may be required to accommodate the proposed driveways and parking areas. It is noted that the peat at the site is compressible and if left in place under pavements or any grade raise, will potentially cause settlement and/or differential performance and ultimately cracking of the asphalt surface will occur relatively soon after placement.

In this regard two option are provided. Sub-excavate the peat in pavement/driveway areas and replaced with select fill, placed in 200 mm thick lifts and compacted to minimum 95% Standard Proctor Maximum Dry Density (SPMDD) to the subgrade level. It is noted that the sand underlying the peat is wet and proofrolling will likely not be possible. Further, the initial lift of fill should comprise a 500 mm thick lift of Granular B Type II. Where settlement can be tolerated, the peat can be left in place and a gravel surface pavement can be adopted, with regular on-going maintenance/grading to be expected.

The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures must be maintained to ensure that uniform subgrade moisture and density conditions are achieved as much as possible when fill is placed, and the natural subgrade is not disturbed or weakened after it is exposed.

5.2.1.2 Drainage

Control of surface water is an important factor in achieving a good pavement life. The need for adequate subgrade drainage cannot be over-emphasized. The subgrade must be free of depressions and sloped (at a minimum grade of 3 percent) to provide effective drainage toward subgrade drains or ditches / swales adjacent to the pavement. Grading adjacent to pavement areas should be designed to ensure that water is not allowed to pond adjacent to the outside edges of the pavement. Typical pavement drainage details are included in Appendix D.

5.2.1.3 Pavement Structure

The industry pavement design methods are based on a design life of 15 to 20 years for typical weather conditions depending on actual traffic volumes. Light duty pavement is recommended for car parking and driving areas. Heavy duty pavement is recommended for fire truck, garbage truck, or heavy equipment. The following pavement designs are provided based on the above noted considerations and subgrade improvement where peat is removed.

Pavement Layer	Compaction Requirements	Minimum Component Thickness	
		Light Duty	Heavy Duty
Surface Course Asphaltic Concrete: HL3 (OPSS 1150) with PG 58-28 Asphalt Cement (OPSS.MUNI 1101)	OPSS 310	40 mm	40 mm
Binder Course Asphaltic Concrete: HL8 (OPSS 1150) with PG 58-28 Asphalt Cement (OPSS.MUNI 1101)		50 mm	70 mm
Base Course: Granular A (OPSS.MUNI 1010)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Subbase Course: Granular B Type I or II (OPSS.MUNI 1010)		300 mm	450 mm

Where a gravel surface will be adopted (peat left in place and settlement is tolerable), the asphalt will not be placed, the Granular A base would be increased to 200 mm and be placed over the light duty or heavy duty Granular B subbase.

The granular materials should be placed in lifts 200 mm thick or less and be compacted to a minimum of 100% SPMDD for both granular base and subbase. Asphalt materials should be rolled and compacted as per OPSS 310.MUNI. The granular and asphalt pavement materials and their placement should conform to OPSS.MUNI 310, 501, 1010 and 1150.

If the pavement construction occurs in wet, winter or inclement weather, it may be necessary to provide additional subgrade support for heavy construction traffic by increasing the thickness of the granular subbase, base or both. Further, traffic areas for construction equipment may experience unstable subgrade conditions. These areas may be stabilized utilizing additional thickness of granular materials or geogrid.

It should be noted that in addition to adherence of the above pavement design recommendations, a close control on the pavement construction process will also be required in order to obtain the desired pavement life. Therefore, it is recommended that regular inspection and testing should be conducted during the pavement construction to confirm material quality, thickness, and to ensure adequate compaction.

The most severe loading conditions on the subgrade may occur during construction. Consequently, special provisions such as end dumping and forward spreading of earth and aggregate fills, restricted construction lanes, and half-loads during paving and other work may be required, especially if construction is carried out during unfavorable weather.

5.2.2 Constructability Considerations

5.2.2.1 Excavations

Excavation where peat removal is carried out, will encounter the fill, the peat and the top of the underlying wet native sand. Where peat is to be left in place excavation will likely only encounter the fill, possibly the underlying peat.

Excavations must be carried out in accordance with the Occupational Health and Safety Act, Ontario Regulation 213/91 (as amended), Construction Projects, Part III - Excavations, Section 222 through 242. Where workers must enter a trench or excavation the soil must be suitably sloped and/or braced in accordance with the OHSA.

These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety. If more than one soil type is encountered in a trench, the soil type with the highest number will govern the trench/excavation sidewall geometry. Subject to adequate ground water control, as required and discussed in the next section, excavations for the pavement where peat is not encountered (peat is left in place) shall be carried out with Type 3 Soil geometry, with sidewalls to be constructed no steeper than 1 horizontal to 1 vertical (1H:1V) from the base of the excavation. Where the peart encountered (peat to be removed) Type 4 soil conditions are applicable. As such excavations that encounter peat will require side slopes to be flattened to 3H:1V from the base of the excavation. Further, depending on the thickness of the peat and moisture content, sidewalls flatter than 3H:1V may be required, subject to geotechnical review during construction.

Minimum support system requirements for steeper excavations are stipulated in Sections 235 through 238 and 241 of the OHSA and include provisions for timbering, shoring and moveable trench boxes. To reduce the potential for instability of the trench excavations, materials excavated from the service trenches and/or other fill materials or heavy equipment should not be placed near the crest of the trench excavations.

It is important to note that soils encountered in the construction excavations may vary significantly across the site. Our preliminary soil classifications are based solely on the materials encountered in the test pits advanced on site. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, we recommend that GEI be contacted immediately to evaluate the conditions encountered.

5.2.2.2 Temporary Construction Groundwater Control

The groundwater levels from the last reading (February 3, 2022) ranged from 1.13 to 1.40 metres below existing grade (local elevation 98.08 to 97.57 masl).

For excavations kept above the prevailing groundwater table (where peat removal is not attempted), any seepage from precipitation or minor perched water zones can be controlled using a conventional sump pump system.

For excavation the extends below the ground water table (where peat removal is carried out) sump pits created with a corrugated steel pipe filled with gravel which allows the water to enter the sumps and continuously pumping the sumps until all the water stored within the cohesionless soils are drained, may be required. Pumping from multiple sumps may be required.

It is recommended to carry out the work during the dry time of the year when the ground water table is lowest, to mitigate groundwater control measures. Also reducing the size of the excavation that is open at any one time will aid in reducing groundwater control requirements.

The exact scenario where these groundwater control techniques will work are estimates only and are directly correlated to how coarse/fine the native soils are in an excavation, and both the lateral and vertical extent of the cohesionless deposits encountered. If the groundwater table is not controlled during construction, the base of the excavations will probably be unstable, leading to difficulties in excavating and placement of pipes.

A preliminary assessment on the amount of dewatering required where peat excavation is carried out is likely less than 400,000 L/day. With reduced excavation size and carrying out work during the dry time of the year, dewatering is likely less than 50,000 L/day. Once design details are established, they should be provided to GEI to further assess dewatering requirements.

5.2.3 Compaction Specifications

Standard Proctor Maximum Dry Density (SPMDD) is the specification to indicate the degree to which soil or aggregate is compacted . To achieve the specified SPMDD as indicated in this report, all soils or aggregates must be placed in lift thicknesses no greater than 200 mm. If this is not the case, only the upper portion of the lift will be adequately compacted, and the lower portion of the lift has a high probability of not meeting compaction specifications. In addition, industry standard equipment used to determine the degree of compaction consists of nuclear densometers. These devices have an inherent limitation in that they cannot test beyond 300 mm in depth, and so the degree of compaction beyond this depth cannot be quantitatively determined.

Along with lift thickness, ensuring that the soil or aggregate is within 2% of its optimum moisture content ensures that the specified compaction can be reached. If the soil or aggregate is too dry/wet, it is either very difficult or impossible to reach the specified compaction. This is especially true for when higher compaction specifications such as 98% and 100% SPMDD are required.

Moisture can be increased by adding water and mixing the soil prior to re-use, or by importing soil to the site that is at optimum and can be readily compacted. Moisture can be reduced by tilling or spreading out the soil to dry or blending it with drier material. In-situ moisture contents can change based on the season and local groundwater levels and can also change for stockpiled material due to precipitation.

In addition to the above compaction specifications, in any areas where compacted fill will be placed over the exposed native soil subgrade, any loose, soft, wet or unstable areas should be sub-excavated, and backfilled with clean earth fill or Granular ‘B’ (OPSS.MUNI 1010) compacted to a minimum of 95% SPMDD. This recommendation applies to site servicing and pavement subgrades. Where structures/buildings require upfilling beneath the structure the fill should be compacted to 100% SPMDD.

5.2.4 Quality Verification Services

On-site quality verification services are an integral part of the geotechnical design function, and for foundations and retaining walls, are required under the Ontario Building Code (OBC). Quality verification services are used to confirm that construction is being conducted in general conformance with the requirements as outlined in the drawings, reports and specifications prepared for the proposed development.

GEI Consultants can provide all the on-site quality verification services outlined below:

- The subgrade for foundations must be field reviewed by the geotechnical engineer as required by the OBC.

- Installation of retaining structures over 1 metre in height and related backfilling operations must be field reviewed on a continuous basis by the geotechnical engineer as required by the OBC.
- Part-time monitoring of the subgrade support capabilities, material quality, lift thickness, moisture content, degree of compaction, etc. is recommended for the following areas to ensure the recommendations within this report are followed and they perform adequately in the long-term:
  a. Slabs-on-grade;
  b. Pavement structure (granular layers and asphalt); and
  c. Bedding/backfilling of site servicing.
- Full-time monitoring of the subgrade support capabilities, material quality, lift thickness, moisture content, degree of compaction, etc. is recommended for engineered fill under structures;
- Testing of the concrete (compressive strength, slump, air content, etc.) and testing of the asphalt (asphalt content and gradation) are recommended to ensure that the quality of the materials being brought to site meet the requirements of the project. This would only apply to poured in place foundations and not pre-cast structures.

6. Limitations and Conclusions

6.1 Limitations

The recommendations and comments provided are necessarily on-going as new information of underground conditions becomes available. More specific information with respect to the conditions between samples, or the lateral and vertical extent of materials may become apparent during excavation operations. The interpretation of the test pit information must, therefore, be validated during excavation operations. Consequently, conditions not observed during this investigation may become apparent. Should this occur, GEI should be contacted to assess the situation and additional testing and reporting may be required.

GEI should be retained for a general review of the final design drawings and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, GEI will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of the design engineers. The number of test pits required to determine the localized underground conditions between test pits affecting construction costs, techniques, sequencing, equipment, scheduling, etc. could be greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual test pit results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

This report was authorized by, and prepared by GEI for, the account of Pioneer Family Pools (as provided in the Standard Professional Services Agreement, signed December 23, 2021). Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. GEI accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.

6.2 Conclusion

It is recognized that municipal/regional governing bodies, in their capacity as the planning and building authority under Provincial statues, will make use of and rely upon this report, cognizant of the limitations thereof, both as are expressed and implied.

GEI trusts this report is complete within our terms of reference, and the information presented is sufficient for your present purposes. If you have any questions, or when we may be of further assistance, please do not hesitate to contact our office.

Yours Truly,

GEI Consultants

Prepared By:

Aiden Belfrage, B.E.S., Senior Environmental Technician

PROFESSIONAL GEOSCIENTISTS
ALICIA KIMBERLEY
PRACTISING MEMBER
2949
Mar 4, 2022
ONTARIO

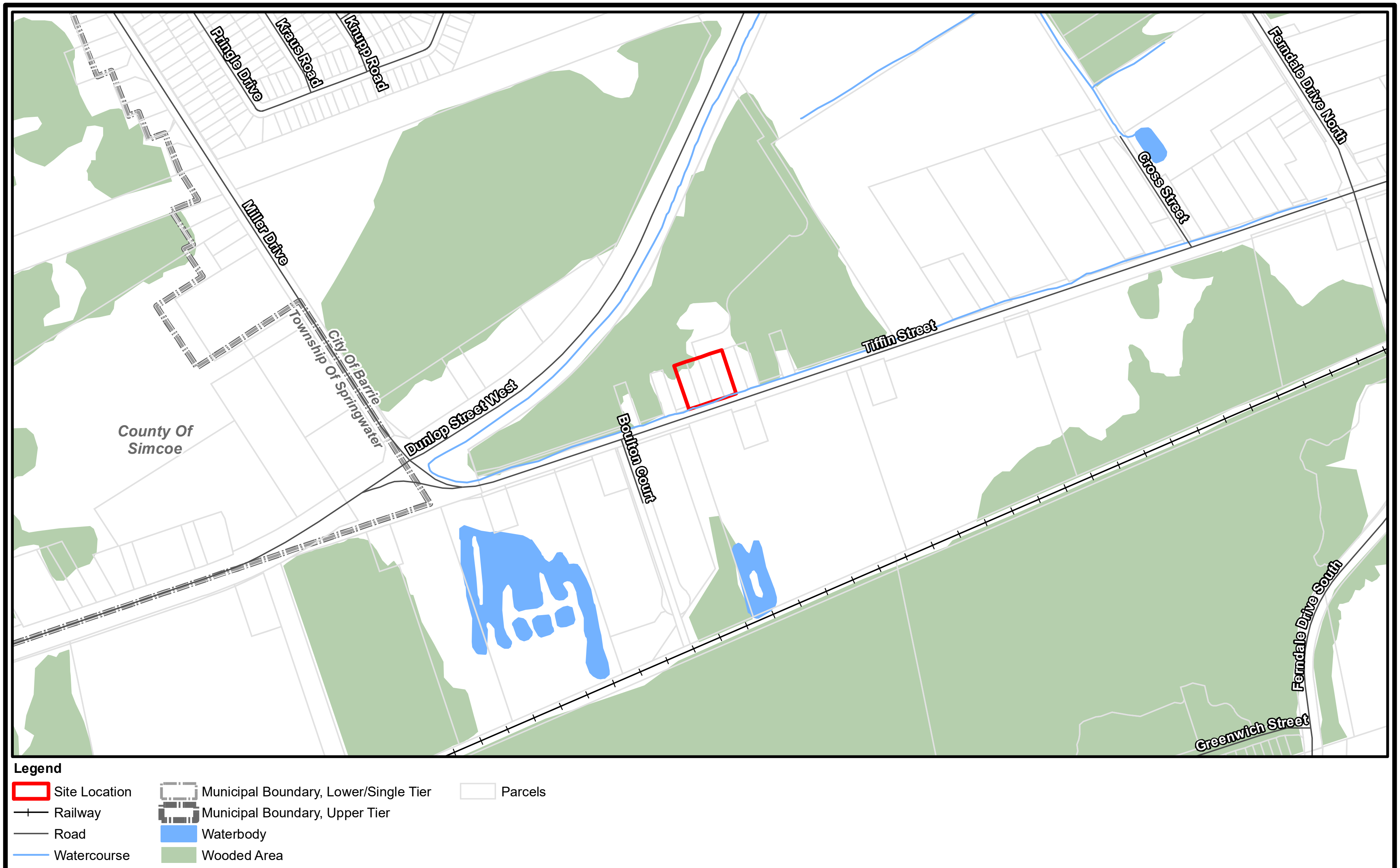
Alicia Kimberley, MSc., P.Geo.
Geoenvironmental and Hydrogeological Practice Lead

Reviewed By:

LICENSED PROFESSIONAL ENGINEER
G. R. WHITE
MAR 4 2022
PROVINCE OF ONTARIO

Geoffrey White, P.Eng
Geotechnical Practice Lead

Figures



NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2022.
3. Parcel boundaries from 'CA ON Simco Parcels', AGOL Web Service. Accessed Jan 2022.

518, 520, 522, 524 Tiffin Street
Barrie, ON

Pioneer Family Pools

GEI Consultants

SITE LOCATION PLAN

Project 2200026

March 2022

Fig. 1

Legend

Site Location

Test Pit Location

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
3. Orthoimagery © First Base Solutions, 2022.
Imagery taken in 2020.

0 8.5 17 m
1:700

N

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Barrie, ON

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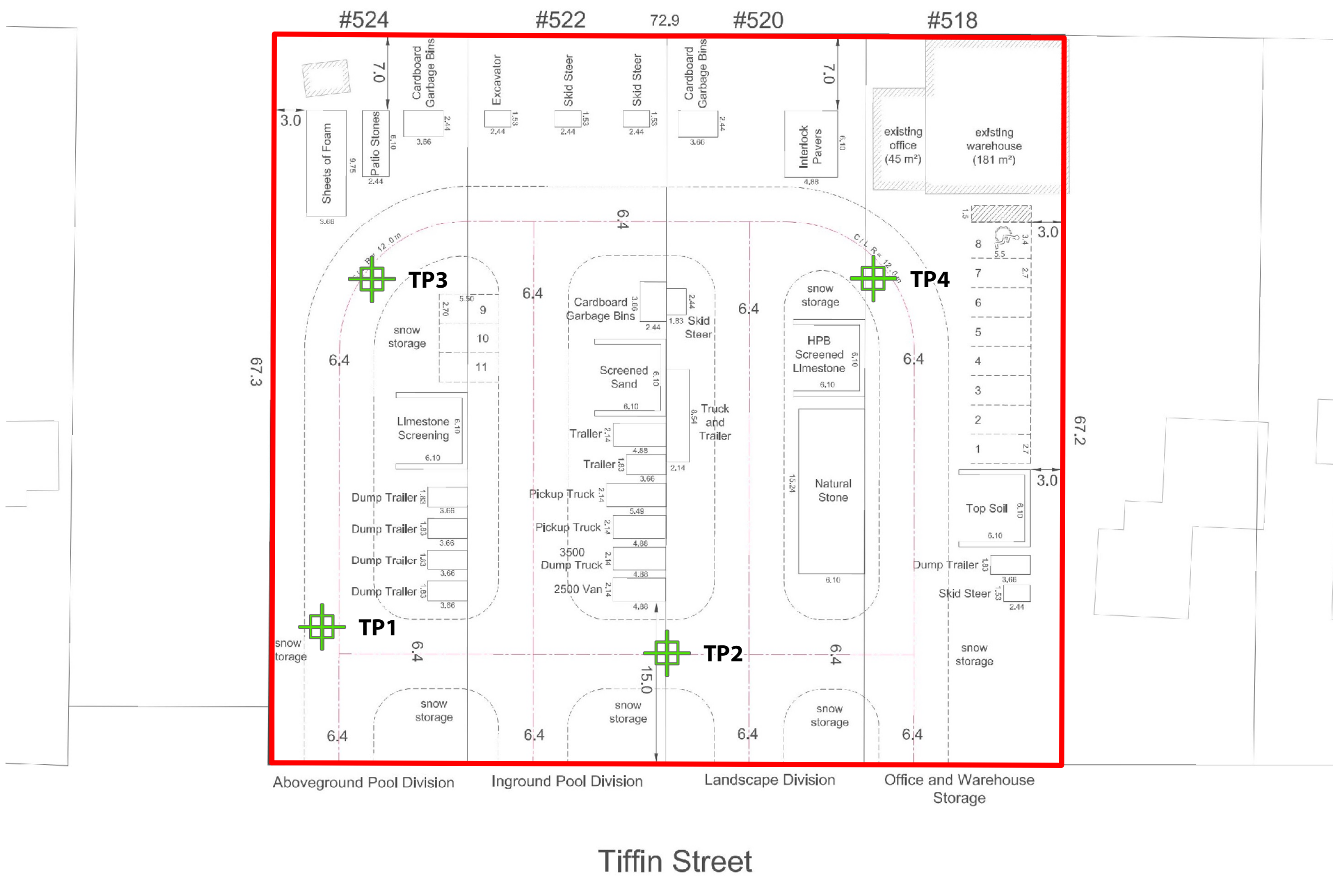
TEST PIT LOCATION PLAN
(AERIAL)

March 2022

Fig. 2A



Legend

Site Location

Test Pit Location

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Site Plan: 'Pioneer Family Pools Barrie Inc. Concept Plan'. File: PIO-21060-CP-1.dwg, Jones Consulting Group LTD., July 30, 2021.

0 8.5 17 m

1:700

N

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Pioneer Family Pools

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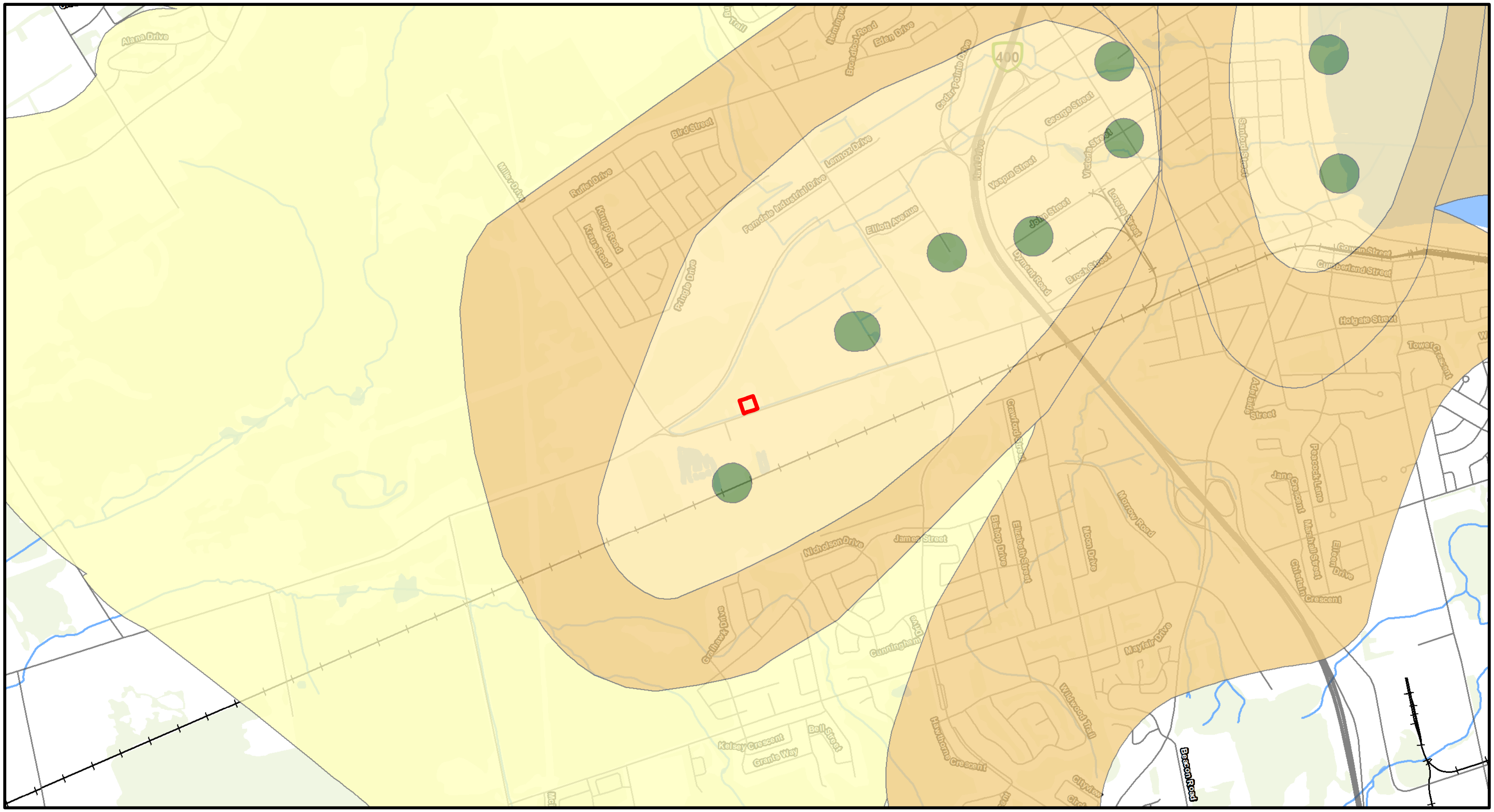
TEST PIT LOCATION PLAN
(SITE PLAN)

Project 2200026

March 2022

Fig. 2B



Legend

Site Location
Railway
Highway
Road
Watercourse
Waterbody
Wooded Area

Wellhead Protection Area (LSRCA 2021)

Zone

A
B
C
D

NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2022.
3. Site is within a Zone B Wellhead Protection Area.

0 380 760 m

1:30,000

N

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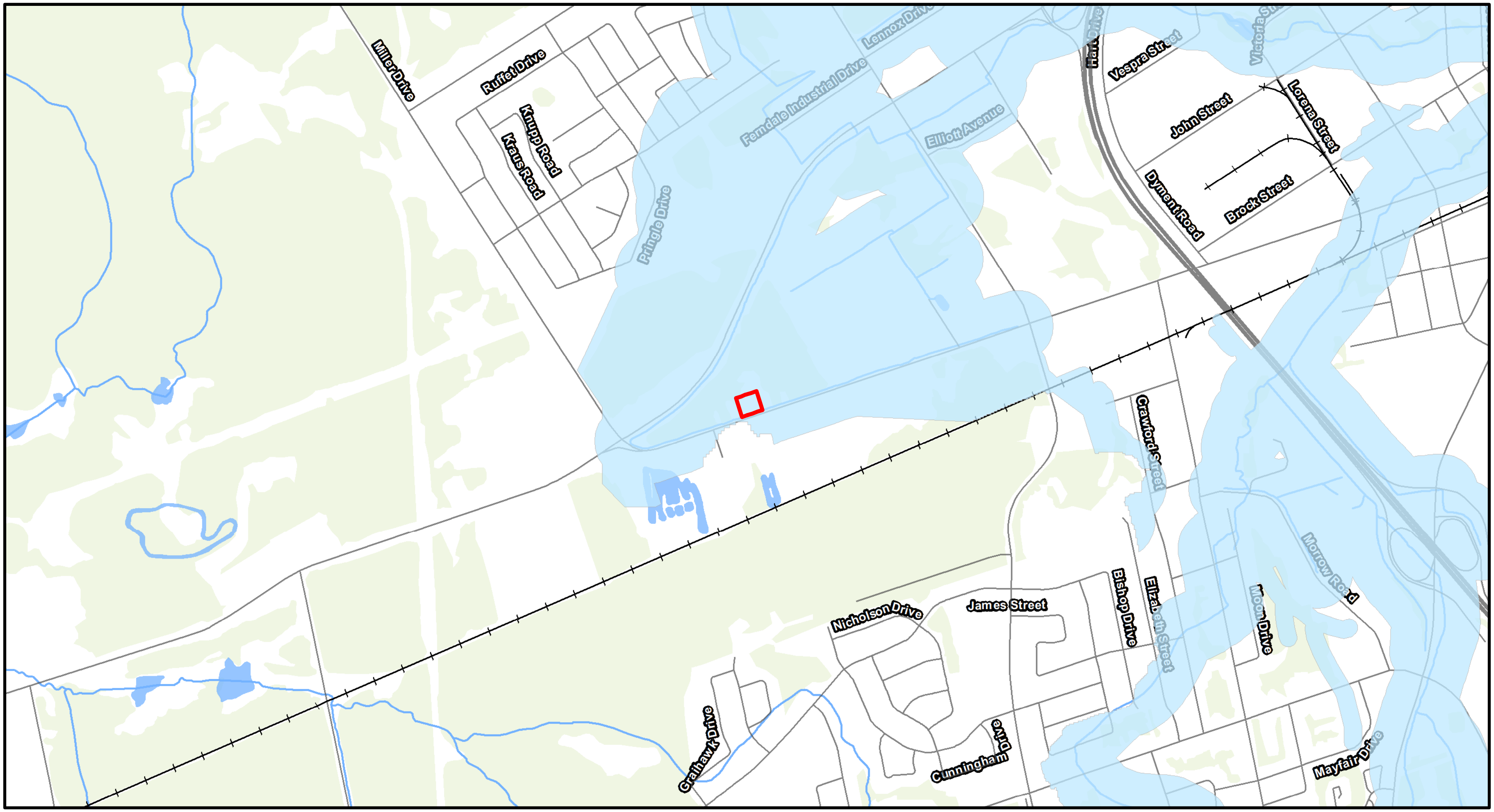
WELLHEAD PROTECTION AREAS

Project 2200026

March 2022

Fig. 3



Legend

Site Location
Railway
Highway
Road
Watercourse
Waterbody
Wooded Area

Intake Protection Zone
3

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2022.
3. Site is within Intake Protection Zone 3.

0 250 500 m
1:20,000

N

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Barrie, ON

Pioneer Family Pools

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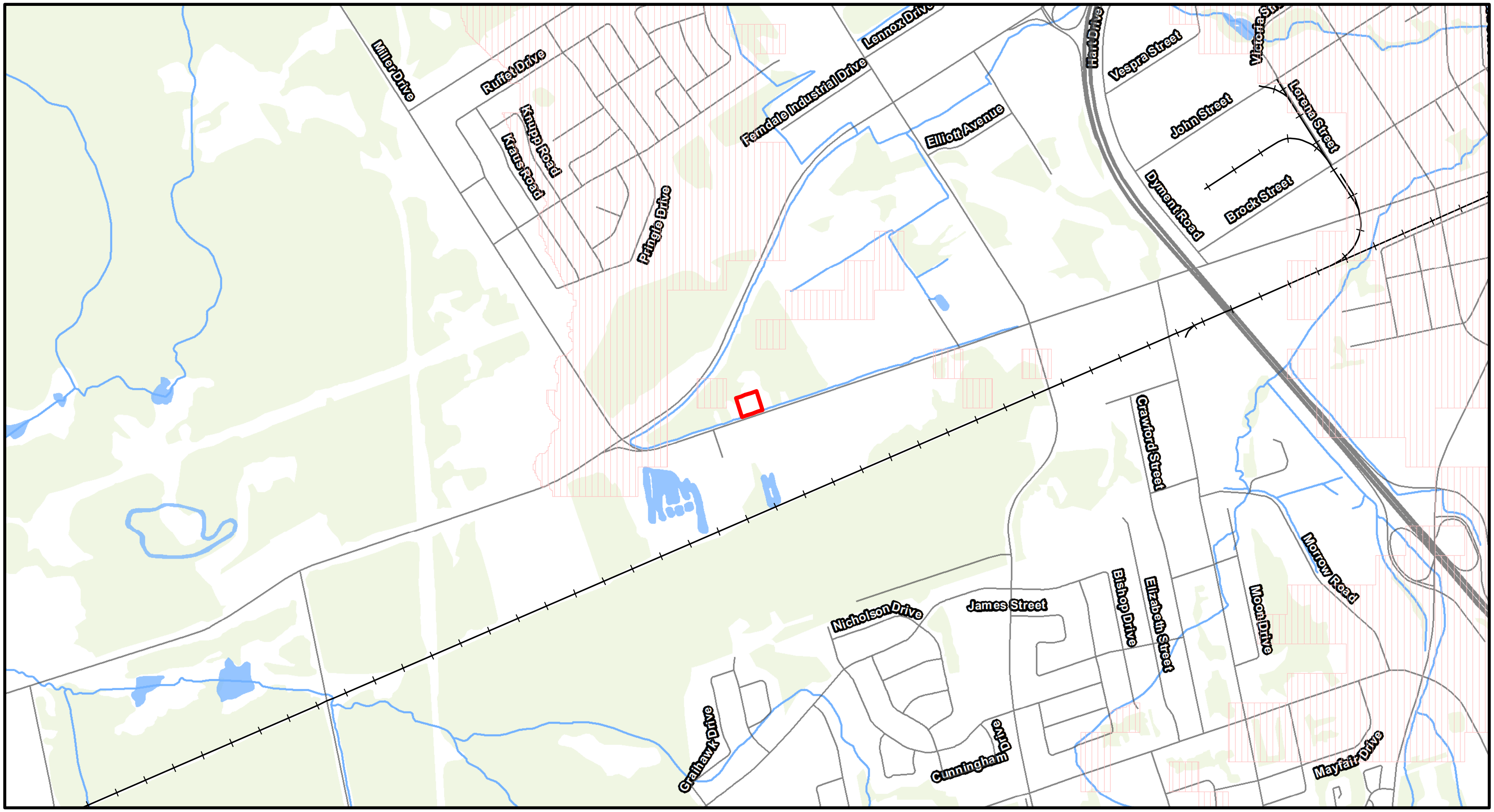
INTAKE PROTECTION ZONES

Project 2200026

March 2022

Fig. 4



Legend

- Site Location
- Railway
- Highway
- Road
- Watercourse
- Waterbody
- Wooded Area
- Highly Vulnerable Aquifer (LSRCA 2021)

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2022.
3. Site is not within a Highly Vulnerable Aquifer.

0 250 500 m

1:20,000

N

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Pioneer Family Pools

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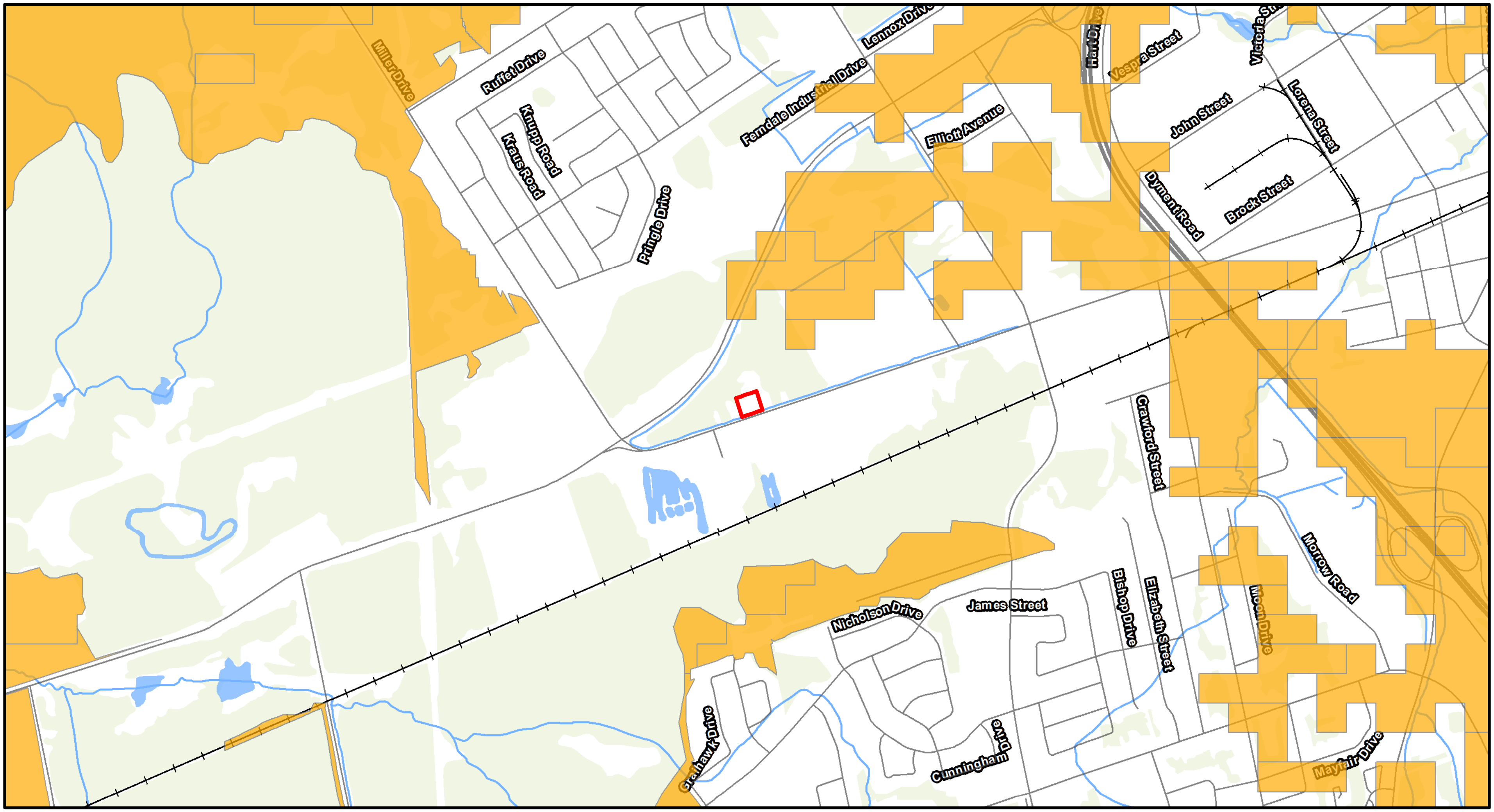
HIGHLY VULNERABLE AQUIFERS

Project 2200026

March 2022

Fig. 5



Legend

- Site Location
- Railway
- Highway
- Road
- Watercourse
- Waterbody
- Wooded Area
- Significant Groundwater Recharge Areas (LSRCA 2021)

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2022.
3. Site is not within a Significant Groundwater Recharge Area.

0 250 500 m

1:20,000

N

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Pioneer Family Pools

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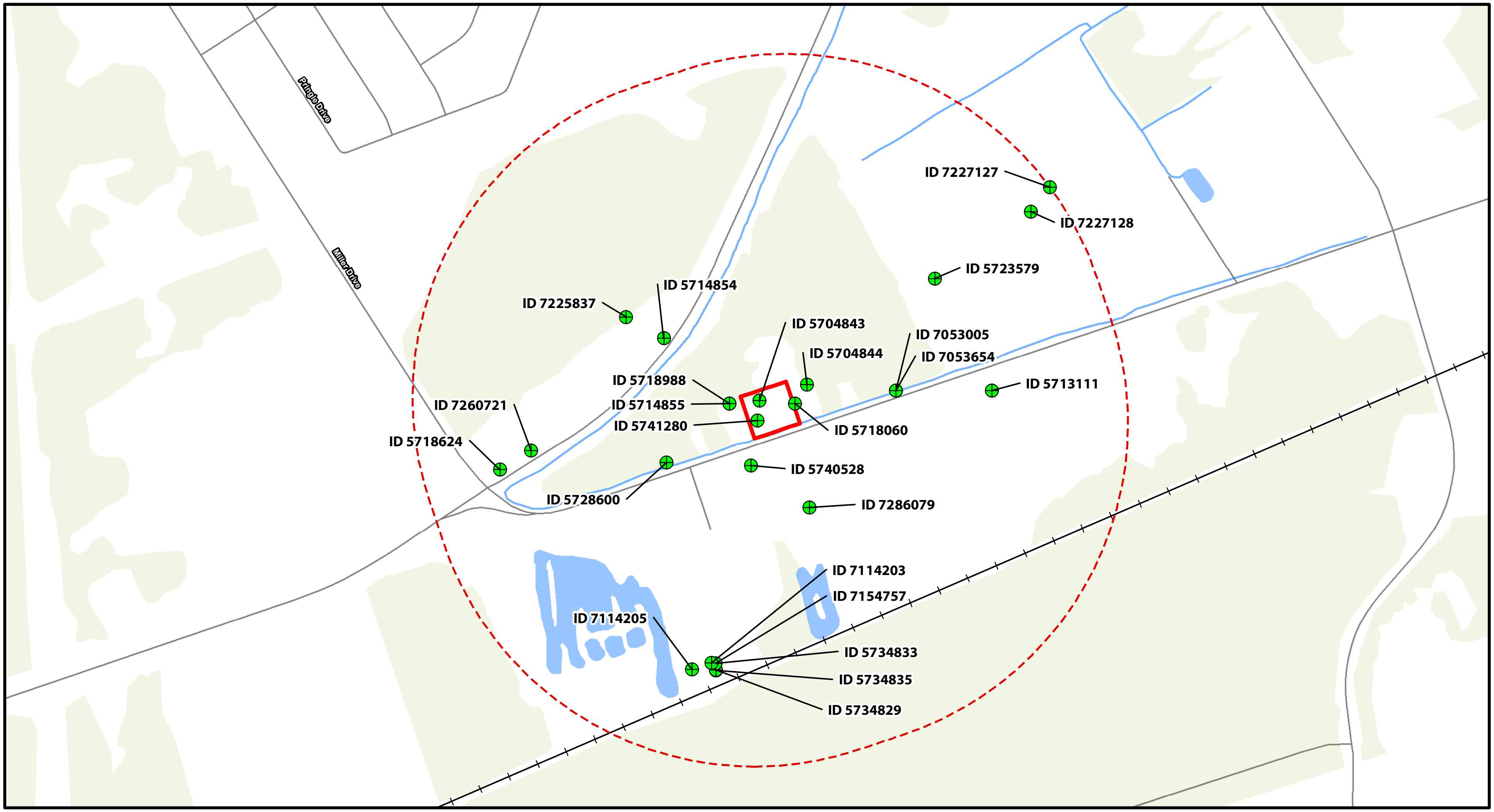
Project 2200026

SIGNIFICANT GROUNDWATER RECHARGE AREAS

March 2022

Fig. 6



Legend

- Site Location
- Site Location +500m
- MESP Well Record within 500m of Site Boundary (WWIS 2021)
- Railway
- Road
- Watercourse
- Waterbody
- Wooded Area

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2022.

0 110 220 m
1:9,000

N

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Barrie, ON

Pioneer Family Pools

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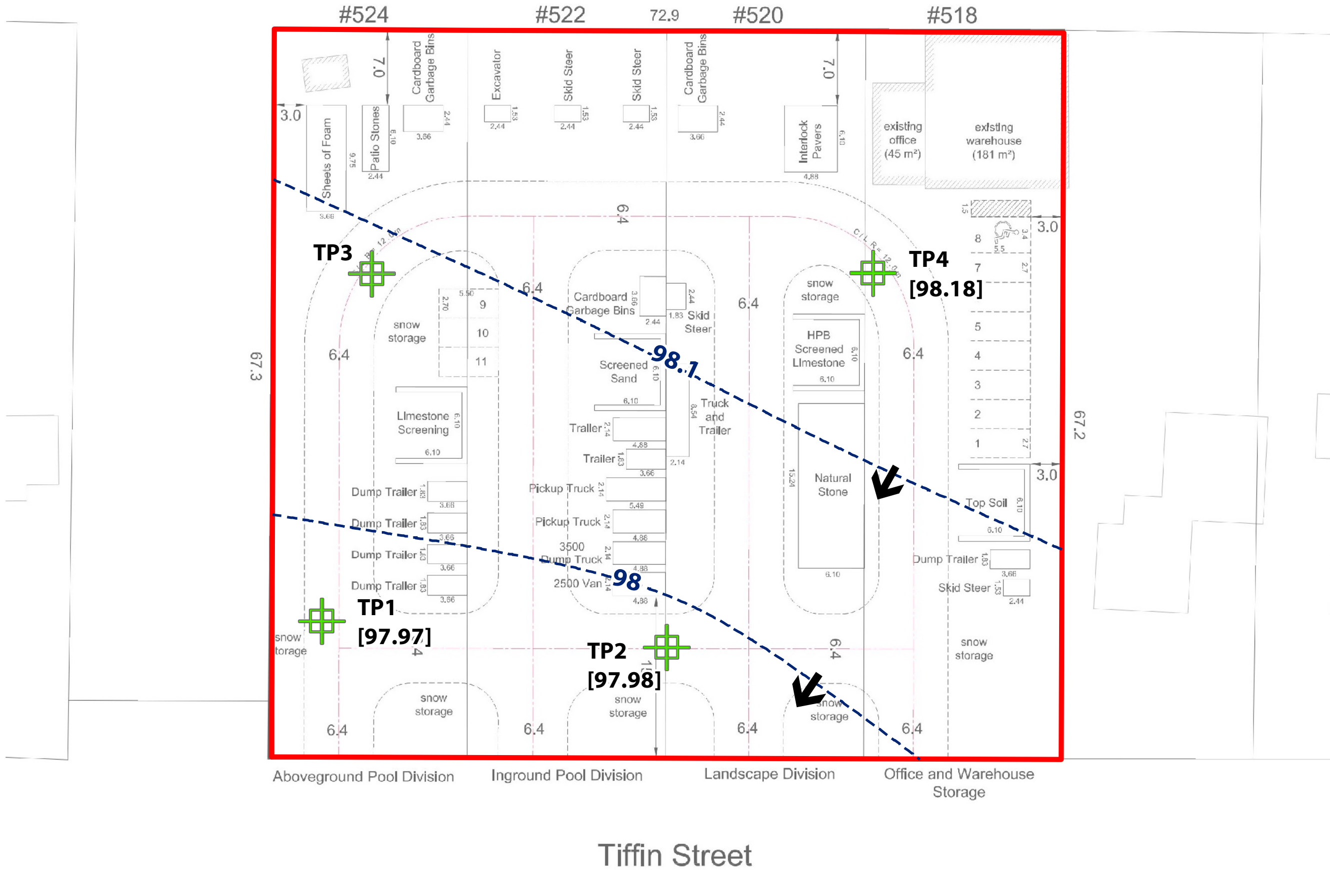
Project 2200026

MECP WELL RECORD LOCATIONS

March 2022

Fig. 7



Legend

Site Location
Groundwater Contours
Interpreted Direction of Groundwater Flow
Test Pit Location
[xx.xx] Groundwater Level (masl) (January 19, 2022)

NOTES:
1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Site Plan: 'Pioneer Family Pools Barrie Inc. Concept Plan'. File: PIO-21060-CP-1.dwg, Jones Consulting Group LTD., July 30, 2021.
3. Water levels (masl) measured on January 19, 2022

0 8.5 17 m
1:700

N

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Barrie, ON

Pioneer Family Pools

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GROUNDWATER CONTOURS

Project 2200026 | January 2022 | Fig. 8

Appendix A

MECP Well Record Summary Table

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
BARRIE CITY	17 601668 4913443 W	2007/11 6926	1.99	FR 0003		DE		7053005 (Z62263) A071567	GREY LOAM 0002 BRWN SAND SLTY CLAY 0015
BARRIE CITY	17 601668 4913443 W	2007/11 6926						7053654 (Z62275) A071567 A	GREY LOAM 0002 BRWN SAND SLTY CLAY 0015
BARRIE CITY (VESPRA)	17 601112 4913352 W	2015/06 7383	2	7		TH	0005 10	7260721 (Z208381) A182324	
BARRIE CITY (VESPRA)	17 601874 4913716 W	2014/08 7190	4 2	UT 0005		MT	0005 10	7227128 (Z186044) A146232	BLCK SAND 0002 BLCK SAND 0010 GREY SAND 0015
BARRIE CITY (VESPRA)	17 601257 4913555 W	2014/08 7201	2			MT	0009 5	7225837 (Z187563) A164187	BRWN SAND GRVL SILT 0004 BRWN SAND SILT CLAY 0010 GREY CLAY SAND 0015
BARRIE CITY (VESPRA) 07 025	17 601727 4913614 W	1988/06 2801	2 1 1	FR 0282	52/53/30/1:20	NU	0297 20	5723579 (31211)	CLAY FILL 0006 BLCK MUCK 0008 BRWN SAND CLAY SLTY 0011 GREY SAND CLAY 0016 GREY CLAY SAND 0086 CLAY SAND SLTY 0092 SAND CLAY SLTY 0120 CLAY SAND SNDY 0155 CLAY SAND SNDY 0228 GREY CLAY GRVL SNDY 0232 GREY CLAY SAND SNDY 270 GREY CLAY GRVL SNDY 0289 GRVL SAND HARD 0292 SAND GRVL PCKD 0307 CLAY GRVL SNDY 0322 CLAY GRVL SNDY 0340 WHIT CLAY SAND GRVL 0349 WHIT CLAY GRVL CMTD 0352
BARRIE CITY (VESPRA) 524	17 601457 4913397 W	2006/09 2514				DO		5741280 (Z34744) A048099 A	
BARRIE CITY (VESPRA) CON 07 025	17 601460 4913428 W	1959/05 1637	4	FR 0060	6/40/7/2:0	DO	0062 5	5704843 ()	GRVL MUCK 0037 HPAN 0060 CSND 0067
BARRIE CITY (VESPRA) CON 07 025	17 601532 4913452 W	1964/10 4715	4	FR 0103 FR 0222	20/26/20/48:0	DO		5704844 ()	FILL 0002 MSND SILT 0010 GREY CLAY 0040 CLAY MSND SILT 0095 GREY CLAY 0103 GRVL MSND 0105 CLAY SILT 0215 GREY CLAY 0222 CLAY SILT MSND 0226 FSND GRVL 0247
INNISFIL TOWNSHIP	17 601536 4913265 W	2017/03 7190	1.25	UT 0012	12///:	MO	0010 5	7286079 (Z255332) A216610	BRWN CLAY SILT DRY 0010 BRWN SILT CLAY SAND 0015
INNISFIL TOWNSHIP CON 14 002	17 601014 4913123 W	1984/11 4816	6	FR 0040	6/30/20/2:0	DO	0034 3	5719487 ()	SAND FILL 0002 BLCK SAND 0006 CLAY SAND 0020 MSND 0040
INNISFIL TOWNSHIP CON 14 003	17 601394 4913017 W	1999/08 2801	14 8		40/55/5004/48:0	MN	0272 30	5734829 (173495)	BLCK LOAM 0005 SILT SAND GRVL 0010 GREY CLAY SOFT VERY 0016 SAND GRVL CLAY 0024 SAND GRVL 0046 CLAY SAND SOFT 0052 GRVL 0063 GREY CLAY 0066 SAND GRVL CLAY 0071 GREY CLAY SAND GRVL 080 GREY CLAY 0148 GREY CLAY STNY 0184 CLAY SAND GRVL 0192 GREY CLAY STNY 0230 GRVL BLDR GRVL 0272 GRVL SAND BLDR 0296 GRVL CMTD 0301 GRVL CMTD 0304 UNKN 0308 GREY CLAY STNY 0316
INNISFIL TOWNSHIP CON 14 003	17 601394 4913016 W	1999/08 2801	2		8///:	PS	0042 5	5734835 (173496)	BLCK LOAM 0005 SILT SLTY SAND 0010 GREY CLAY SOFT VERY 0016 SAND GRVL 0024 SAND GRVL 0045 SAND GRVL CLAY 0049

GEI Consultants

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
INNISFIL TOWNSHIP CON 14 003	17 601447 4913329 W	2006/02 2801	5.90 2.00 1.25		38//28/1:0	NU	0250 30	5740528 (Z33256) A011223	FILL 0002 BLCK LOAM 0004 SAND PCKD 0015 GREY CLAY 0021 FSND MSND 0061 FGVL FSND MGVL 0068 SAND PCKD 0087 GREY CLAY GRVL 0100 GREY CLAY SAND GRVL 0119 GREY SAND CLAY PCKD 0171 GREY SAND GRVL 0192 MSND PCKD FSND 0213 GREY CLAY HARD 0222 GREY CLAY GRVL 0238 GRVL SAND BLDR 0276 GRVL CLAY 0285 CLAY GRVL 0299
INNISFIL TOWNSHIP CON 14 003	17 601393 4913027 W	1999/05 2801	2		45/46/30/3:0	MN	0234 20	5734833 (156613)	BLCK LOAM 0006 SAND GRVL CLAY 0015 SAND GRVL 0025 GRVL CLAY 0044 SAND 0059 GREY CLAY 0068 SAND CLAY 0071 GREY CLAY 0149 GREY CLAY SAND GRVL 0185 CLAY SAND GRVL 0192 GREY CLAY STNY 0206 CLAY SAND GRVL 0214 GREY CLAY STNY 0226 SAND GRVL CLAY 0232 SAND GRVL PCKD 0239 SAND GRVL PCKD 0255 GREY CLAY SNDY 0260 GREY CLAY 0272 GRVL SNDY CLAY 0297 GRVL SNDY CLAY 0302 GRVL CMTD 0304 GREY CLAY STNY 0325
INNISFIL TOWNSHIP CON 14 003	17 601357 4913018 W	2008/02 2801			37///:	TH		7114205 (Z68121) A011239	FILL 0008 SAND GRVL LYRD 0020 SAND GRVL PCKD 0092 GREY CLAY SAND LYRD 0160 SAND PCKD 0187 GREY CLAY HARD 0230 GRVL SAND CMTD 0240 SAND GRVL PCKD 0274 GRVL MRBL CMTD 0289 GRVL BLDR SAND 0311 SAND GRVL PCKD 0314 SAND GRVL 0331
INNISFIL TOWNSHIP CON 14 003	17 601393 4913027 W	2010/10 2801						7154757 (Z115271) A	
INNISFIL TOWNSHIP CON 14 003	17 601387 4913028 W	2007/12 2801	0.15	FR 0039	45///72:23	MN		7114203 (Z68141) A011235	FILL 0008 SAND CLAY LYRD 0020 SAND GRVL PCKD 0046 SAND PCKD 0072 GREY CLAY SAND LYRD 0084 GREY CLAY 0170 GREY CLAY GRVL 0196 GREY CLAY GRVL HARD 0224 GREY SAND CLAY PCKD 0233 GRVL BLDR 0238 GRVL MARL CMTD 0247 GREY CLAY SAND 0255 FGVL MARL CMTD 0262 FSND PCKD 0275 GRVL MARL BLDR 0292 GRVL MARL CMTD 0307 GREY CLAY GRVL 0314
INNISFIL TOWNSHIP CON 14 004	17 601814 4913443 W	1975/06 2514	6	FR 0063	7/64/5/2:0	IN	0064 3	5713111 ()	FILL 0005 MUCK DKCL 0007 GREY CLAY 0019 GREY SILT 0043 GREY SAND SILT 0063 GREY SAND GRVL SILT 0067
VESPRA TOWNSHIP CON 07 025	17 601318 4913333 W	1991/10 2514	6	FR 0237	35/55/35/1:30	DO	0237 3	5728600 (108636)	BLCK LOAM 0002 BLCK MUCK 0004 GREY CLAY SNDY 0197 GREY FSND LYRD CLAY 0236 BRWN SAND GRVL 0240
VESPRA TOWNSHIP CON 07 025	17 601314 4913523 W	1977/11 2801	2		33/38/35/3:0	NU	0330 10	5714854 ()	BLCK MUCK SOFT 0003 BRWN SAND GRVL LOOS 0010 GREY CLAY SOFT 0088 GREY CLAY SAND LYRD 0103 GREY SAND CLAY 0111 GREY CLAY HARD 0136 GREY CLAY FSND LYRD 0151 GREY FSND PCKD 0160 GREY CLAY HARD 0169 GREY FSND CLAY PCKD 0225 GREY CLAY SILT HARD 0253 GREY CLAY SAND LYRD 0265 GREY FSND FGVL PCKD 0275 GREY CLAY GRVL PCKD 0280 SAND GRVL BLDR 0283 GRVL SAND BLDR 0295 GREY SAND FGVL 0307 GRVL SAND PCKD 0338 GREY CLAY HARD 0346 GREY CLAY GRVL HARD 0361
VESPRA TOWNSHIP CON 07 025	17 601514 4913423 W	1982/04 3203	5	FR 0073	73/83/10/1:0	DO	0083 3	5718060 ()	FILL 0002 BRWN CLAY 0017 GREY CLAY 0051 GREY SILT 0073 GREY MSND 0083

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
VESPRA TOWNSHIP CON 07 025	17 601414 4913423 W	1977/11 2801	2 1			NU	0314 22	5714855 ()	BLCK MUCK 0003 BRWN SAND GRVL LOOS 0011 GREY CLAY STKY SOFT 0043 GREY FSND CLAY SOFT 0092 GREY FSND FGVL PCKD 0106 GREY CLAY HARD 0113 GREY FSND PCKD 0115 GREY CLAY FSND LYRD 0119 GREY CLAY HARD 0129 GREY FSND PCKD 0146 GREY CLAY FSND LYRD 0160 GREY FSND CLAY PCKD 0217 GREY CLAY FSND LYRD 0226 GREY FSND CLAY LYRD 0231 GREY CLAY FSND LYRD 0240 GREY CLAY HARD 0255 WHIT SAND GRVL CMTD 0267 GREY SAND GRVL PCKD 0292 GREY SAND FGVL BLDR 0324 GREY CLAY SAND HARD 0327 GRVL SAND BLDR 0339 GREY CLAY GRVL LYRD 0357
VESPRA TOWNSHIP CON 07 025	17 601064 4913323 W	1983/08 1467	5	FR 0019	8/15/30/1:0	CO	0041 3	5718624 ()	BRWN LOAM 0001 BRWN FILL 0003 GREY SAND DRY 0019 GREY MSND 0050
VESPRA TOWNSHIP CON 07 025	17 601414 4913423 W	1984/01 3660	5	MN 0054	13/35/20/24:0	DO	0060 5	5718988 ()	BRWN SAND FILL 0005 BRWN SAND DRTY 0015 GREY CLAY 0054 GREY MSND WBRG 0065

Appendix B

Test Pit Logs

TEST PIT LOG

Project Name:	518 to 524 Tiffin St.	Test Pit #:	1
Project #:	2200026	Date/Time:	Jan. 12, 2022
Project Loc.:	Barrie	Inspector:	BH
Client:	Pioneer Family Pools	Weather:	Overcast 0C
Contractor:	Morris Shelswell	Equipment:	Rubber Track Excavator
Northing:	4913383	Easting:	601453

Depth (m)		Symbol	Stratigraphy	Samples	Notes
Top	Bottom				
0	0.8		FILL : Organic Silt and Sand, Trace Gravel with Steel wire/metals, Brown, Moist	0.5m	
0.8	1.8		Peat, Black, Wet	1.2m	
1.8	2.1		Sand, Trace Silt, Brown, Wet	2.0m	

Additional Notes

Seepage:	**Flowing water condition below 1.8m**
Caving:	**Below peat layer 1.8m**
Other:	**S/P Installed at 2.1m; Elev. 99.13**

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Barrie, Ontario, L4N 0B7
T: (705) 719-7994

TEST PIT LOG

Project Name:	518 to 524 Tiffin St.	Test Pit #:	2
Project #:	2200026	Date/Time:	Jan. 12, 2022
Project Loc.:	Barrie	Inspector:	BH
Client:	Pioneer Family Pools	Weather:	Overcast 0C
Contractor:	Morris Shelswell	Equipment:	Rubber Track Excavator
Northing:	4913391	Easting:	601484

Depth (m)		Symbol	Stratigraphy	Samples	Notes
Top	Bottom				
0	0.5		Fill: Sand, Trace Silt, Brown, Moist	0.3m	
0.5	1.8		Peat, Black, Wet	1.0m	
1.8	2.0		Sand, Trace Silt, Grey Stain, Wet	2.0m	

Additional Notes

Seepage:	**Flowing water condition below 0.5m**
Caving:	**Below peat layer 1.8m**
Other:	**S/P Installed at 2.0m; Elev. 98.93**

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T: (705) 719-7994

TEST PIT LOG

Project Name:	518 to 524 Tiffin St.	Test Pit #:	3
Project #:	2200026	Date/Time:	Jan. 12, 2022
Project Loc.:	Barrie	Inspector:	BH
Client:	Pioneer Family Pools	Weather:	Overcast 0C
Contractor:	Morris Shelswell	Equipment:	Rubber Track Excavator
Northing:	4913425	Easting:	601447

Depth (m)		Symbol	Stratigraphy	Samples	Notes
Top	Bottom				
0	0.5		FILL : Sand, Trace Organics, Trace Gravel, Trace Silt, Brown, Moist		
0.5	1.6		Peat, Black, Wet	0.7m	
1.6	2.0		Sand, Trace Silt, Brown, Wet	1.7m	

Additional Notes

Seepage:	**Flowing water condition below 1.0m**
Caving:	**Below peat layer 1.6m**
Other:	**Elev. 98.96**

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647 Welham Road, Unit 14
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T: (705) 719-7994

TEST PIT LOG

Project Name:	518 to 524 Tiffin St.	Test Pit #:	4
Project #:	2200026	Date/Time:	Jan. 12, 2022
Project Loc.:	Barrie	Inspector:	BH
Client:	Pioneer Family Pools	Weather:	Overcast 0C
Contractor:	Morris Shelswell	Equipment:	Rubber Track Excavator
Northing:	49133430	Easting:	601491

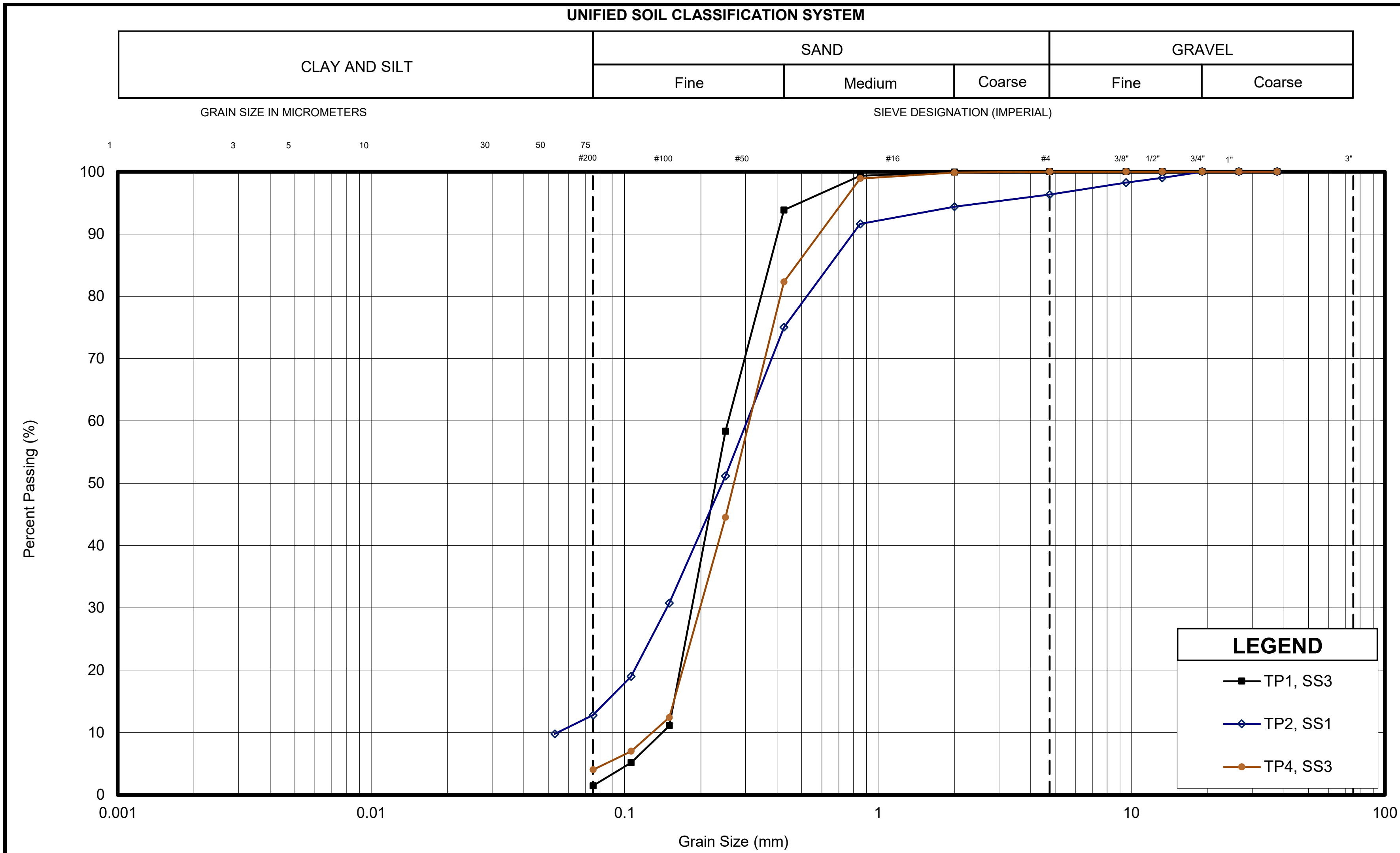
Depth (m)		Symbol	Stratigraphy	Samples	Notes
Top	Bottom				
0	0.5		FILL : Sand, Trace Organics, Trace Gravel, Trace Silt, Brown, Moist	0.3m	
0.5	1.7		Peat, Black, Wet	1.0m	
1.7	2.1		Sand, Trace Silt, Brown, Wet	2.0m	

Additional Notes

Seepage:	**Water Seepage at 1.4m**
Caving:	**Below 1.4m**
Other:	**S/P Installed at 2.1m; Elev. 99.21**

Appendix C

Geotechnical Laboratory Results



Sample	Description	Gr.	Sa.	Si.	Cl.	D_{10}	D_{30}	D_{60}	C_u	C_c
TP1, SS3	SAND, Trace Silt	0	99	1	-	0.141	0.184	0.256	1.8	0.9
TP2, SS1	SAND, Some Silt, Trace Gravel	4	84	12	-	0.055	0.147	0.304	5.5	1.3
TP4, SS3	SAND, Trace Silt	0	96	4	-	0.129	0.198	0.311	2.4	1.0

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GRAIN SIZE DISTRIBUTION - 518 to 524 Tiffin Street

SAND

FIGURE No.	Graph
REF. No.	2200026
DATE	March 2022

Appendix D

Preliminary Water Balance

File No. 2200026

Water Balance - 518 to 524 Tiffin Street, Barrie, Ontario

MONTHLY AND YEARLY WATER BALANCE COMPONENTS														
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Potential Evapotranspiration Calculation	Average Temperature: T (°C)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	6.9
	Heat Index: $i=(T/5)^{1.514}$	0.00	0.00	0.00	1.19	3.91	6.90	8.66	7.97	5.44	2.31	0.39	0.00	36.8
	Unadjusted Daily Potential Evapotranspiration: U (mm)	0.0	0.0	0.0	25.2	59.0	88.5	104.1	98.1	74.7	40.6	11.5	0.0	501.7
	Adjusting Factor for U (Latitude 44°)	0.81	0.81	1.02	1.13	1.27	1.28	1.30	1.20	1.04	0.94	0.80	0.76	-
	Adjusted Potential Evapotranspiration - PET (mm)	0.0	0.0	0.0	28.5	74.9	113.3	135.3	117.8	77.7	38.1	9.2	0.0	594.8
Pervious Components	Precipitation: P (mm)	82.5	61.8	58.1	62.2	82.4	84.8	77.2	89.9	94.0	77.5	88.9	73.6	932.9
	Adjusted Potential Evapotranspiration: PET (mm)	0.0	0.0	0.0	28.5	74.9	113.3	135.3	117.8	77.7	38.1	9.2	0.0	594.8
	P - PET	82.5	61.8	58.1	33.7	7.5	-28.5	-58.1	-27.9	16.3	39.4	79.7	73.6	338.1
	Change in Soil Moisture Storage (mm)	0.0	0.0	0.0	0.0	0.0	-28.5	-58.1	-27.9	16.3	39.4	0.0	0.0	-
	Water Holding Capacity (max. 75 mm)	75.0	75.0	75.0	75.0	75.0	46.5	0.0	0.0	16.3	55.7	75.0	75.0	-
	Water Surplus Available for Infiltration or Runoff	82.5	61.8	58.1	33.7	7.5	0.0	0.0	0.0	0.0	0.0	60.4	73.6	377.6
	Potential Infiltration based on MECP Infiltration Factor (mm)	57.8	43.3	40.7	23.6	5.2	0.0	0.0	0.0	0.0	0.0	42.3	51.5	264.3
	Potential Surface Water Runoff (mm)	24.8	18.5	17.4	10.1	2.2	0.0	0.0	0.0	0.0	0.0	18.1	22.1	113.3
Impervious Components	Precipitation: P (mm)	-												932.9
	Potential Evaporation: PE (mm), Assume 15%	-												139.9
	Potential Surface Water Runoff: P - PE (mm)	-												793.0

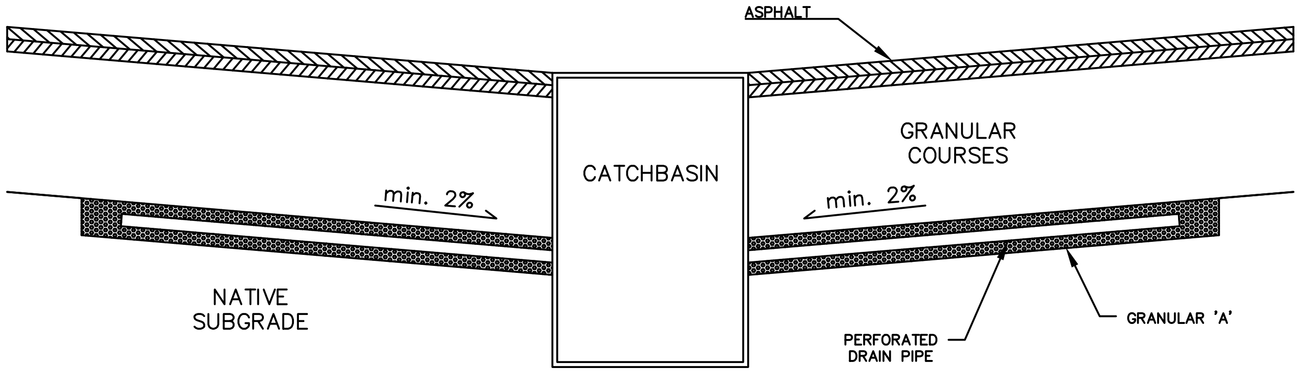
PRE- AND POST-DEVELOPMENT WATER BALANCE (NO LOW IMPACT DEVELOPMENT MEASURES IN PLACE)							
		Total Land Area (m²)	Est. Fraction of Land	Est. Land Area (m²)	Runoff (m³/annum)	Infiltration (m³/annum)	**Runoff Increase Pre to Post**
Existing Land Use (Pre-Development)	Pervious Area	4906.2	70%	3434.3	389.0	907.7	32%
	Impervious Area (house, shed, walkway and driveway)		30%	1471.9	1167.1	0.0	**Infiltration Decrease Pre to Post**
	TOTAL	-	100%	4906.2	1556.2	907.7	-21%
Proposed Land Use (Post-Development)	Pervious Area	4906.2	55%	2698.4	305.7	713.2	**Infiltration Required to Meet Pre-Development Conditions (m³)**
	Impervious Area (warehouse, office, laneways, parking and shed)		45%	2207.8	1750.7	0.0	
	TOTAL	-	100%	4906.2	2056.4	713.2	195

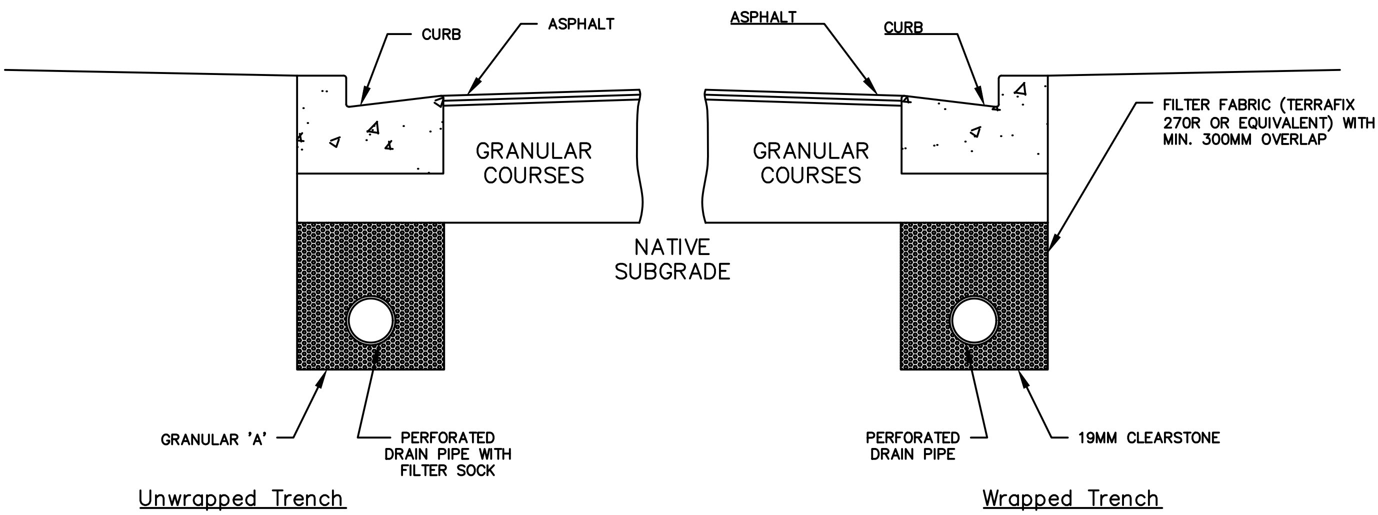
Notes
1. Both potential infiltration and surface water runoff are independent of temperature
2. Assumption is in January maximum soil moisture storage value is present (75mm)
3. Water Holding Capacity & Infiltration Factors taken from Table 3.1 of MOE SWMPDM, 2003
4. Average Temp. and Precip. taken from Environment Canada station "Barrie WPCC" between 1981 and 2010
5. Adjusting Factor for U based on Lorente, 1961

Infiltration Criteria	Site Description	Infiltration Factor
Topography	Rolling Land - Average Slope 2.8 to 3.8 m/km	0.2
Soils	Open Sandy Loam	0.4
Cover	Cultivated Land	0.1
	Sum of Infiltration Factors	**0.7**

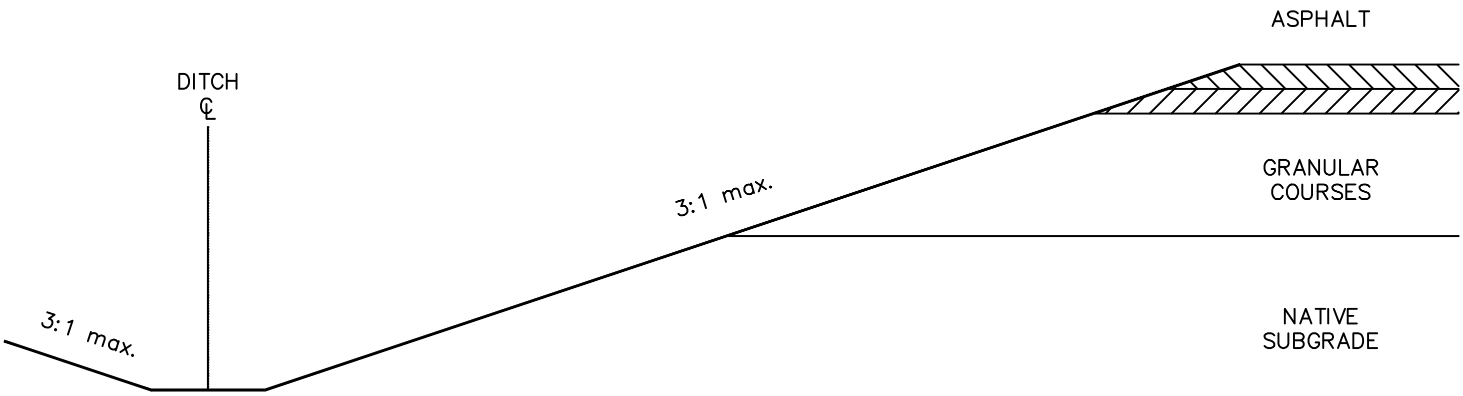
Appendix E

Pavement Drainage Typical Details





Urban Cross Sections



Rural Cross Section

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PAVEMENT DRAINAGE ALTERNATIVES
TYPICAL DETAILS