Hydrogeological Assessment

1242, 1250 and 1260 Gordon Street
and 9 Valley Road
City of Guelph, ON

FINAL REPORT
Version 2

August 13, 2021

Prepared for:

Tricar Developments Inc.
3800 Colonel Talbot Road
London, ON N6P 1H5

Prepared by:

Stantec Consulting Ltd.
100-300 Hagey Blvd.
Waterloo, ON N2L 0A4

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Sign-off Sheet

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G. Whitehead

Digitally signed by Grant
Whitehead
Date: 2021.08.13
12:18:56 -04'00'

Prepared by ______________________________________
(signature)

Grant Whitehead, MES, P.Geo. (Limited)
Senior Hydrogeologist

Digitally signed by Roger
Freymond
Date: 2021.08.13
12:24:56 -04'00'

Reviewed by ______________________________________
(signature)

Roger Freymond, P.Eng.
Senior Hydrogeologist

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Abbreviations

AMSL	above mean sea level
ASTM	American Society for Testing and Materials
BGS	below ground surface
City	City of Guelph
EASR	Environmental Activity Sector Registry
GRCA	Grand River Conservation Area
GRIN	Grand River Information Network
GUDI	Groundwater Under the Direct Influence of Surface Water
DNAPL	dense non-aqueous phase liquid
GUDI	Groundwater Under the Direct Influence
HDPE	high-density polyethylene
HVA	Highly Vulnerable Aquifer
ID	inside diameter
IPZ	Intake Protection Zone
LID	Low Impact Development
Maxxam	Maxxam Analytics Inc.
MECP	Ontario Ministry of the Environment, Conservation and Parks
ODWQS	Ontario Drinking Water Quality Standards
ORP	oxidation reduction potential
PTTW	Permit to Take Water
PVC	polyvinyl chloride

Site	1242, 1250 & 1260 Gordon Street, within the City of Guelph, Ontario
SGRA	Significant Groundwater Recharge Area
Stantec	Stantec Consulting Ltd.
Tricar	Tricar Developments Inc.
WHPA	Well Head Protection Area

1.0 INTRODUCTION

Tricar Developments Inc. (Tricar) retained Stantec Consulting Limited (Stantec) to complete a hydrogeological investigation of the property located at 1242, 1250 & 1260 Gordon Street, within the City of Guelph, Ontario (Site) (Figure 1). The Site is approximately 3.1 hectares (ha) in size and is bounded to the northwest by existing residential subdivision, to the northeast by protected woodlot affiliated with the Torrance Creek Swamp, to the southeast by existing high-density development (i.e., Liberty Square apartment complex), and to the southwest by Gordon Street.

The purpose of the hydrogeological investigation is to support Zoning By-law and Official Plan Amendments and the Site Plan Application to permit the construction of the proposed residential development, which will consist of two 12 story apartment buildings having nine townhouse units and 368 apartment units. The development will have a combination of surface parking and two levels of underground parking. The proposed underground parking footprint will cover an area of approximately 11,450 m^2, with the anticipated base of the underground parking garage being located at an elevation of 335.7 m AMSL.

As per input initially provided by the City of Guelph (City) (2018) (Appendix J) and comments provided by the City (2020) following the first submission of this report (Appendix J), this hydrogeological assessment consists of meeting the following objectives:

- Characterize current geological and hydrogeological conditions at the Site, including a discussion of overburden and bedrock stratigraphy, hydrostratigraphic units, seasonal fluctuations in groundwater levels and hydraulic gradients, flow direction across the Site, soil infiltration potential, and groundwater quality conditions.
- Evaluate the hydraulic relationship between the groundwater system present beneath the Site and the adjacent Torrance Creek Swamp and assess whether the future development of the Site could potentially disrupt the hydrogeological form and/or function of this wetland.
- Evaluate pre-development infiltration volumes at the Site and assess the impact that proposed land use changes could potentially have on these volumes under the post-development condition, including an evaluation of potential measures that could be employed throughout the Site under the post-development condition to mitigate these impacts.
- Perform infiltration testing and groundwater mounding analysis to support stormwater infiltration strategies proposed for the Site under the post-development condition.
- Assess whether proposed buildings, site servicing and associated construction activities will intercept the groundwater table and if construction dewatering may be required and assess whether any measures are required to mitigate these potential disturbances to pre-development groundwater levels, flow patterns, and groundwater-surface water interactions.

- Evaluate whether proposed land use activities conform to Source Water Protection requirements as stipulated in the Clean Water Act, S.O. 2006, Chapter 22.

This report is arranged into ten sections, including this introduction (Section 1). Section 2 presents the physical setting of the Site at a regional scale. Section 3 outlines the methods utilized to evaluate the Site hydrogeological conditions. Section 4 presents the results of the Site investigation, with Section 5 presenting the water balance assessment. Section 6 presents the groundwater mounding assessment in support of the post-development stormwater infiltration strategy. Section 7 presents the groundwater dewatering assessment and Section 8 discusses the potential hydrogeological impacts of the project and recommended mitigation measures. Report conclusions and references are listed in Sections 9 and 10, respectively. All figures and tables referenced in this report are presented in Appendices A and B, respectively. Appendices C to J include Regional Groundwater Flow Mapping, Regional Groundwater Recharge Mapping, Borehole Logs, Laboratory Certificates of Analysis, Hydraulic Conductivity Analytical Solutions, Dewatering Calculations, Source Protection Plan - Threat Policy Applicability Mapping, and City of Guelph Correspondence, respectively.

2.0 PHYSICAL SETTING

2.1 PHYSIOGRAPHY AND TOPOGRAPHY

The Site is situated within the physiographic region referred to by Chapman and Putnam (1984) as the Guelph Drumlin Field. The Guelph Drumlin Field consists of a series of broad oval type hills with axes trending in a northwest to southeast direction (i.e., drumlins). As shown in Figure 2, most of the Site is situated upon a drumlin, which is further supported by the regional topographic setting (Figure 3). The drumlins and associated till plain of the physiographic region consist of stony, calcareous till derived from dolostone of the Goat Island and Gasport Formations (formerly referred to as the Amabel Formation) and consists of sand (50%; average content based on grain-size analysis completed on till samples), silt (35%) and clay (15%) (Chapman and Putnam, 1984). The drumlin groupings occur in swampy valleys that are flanked by terraced spillway channels of sand and gravel, which contain tributaries of the Grand River (e.g., Torrance Creek Swamp located northeast of the Site; Figure 2). Gravel ridges or eskers are also known to cut through the till plain in the same general direction as the drumlins.

Most of the Site lies within the Torrance Creek Subwatershed (Totten Sims Hubicki Associates *et al.*, 1998), with the southwestern portions of the property being located within the Upper Hanlon Creek Subwatershed (Golder, 2011; Gamsby & Mannerow, 1993). Both subwatersheds occur within the Grand River Watershed and are under the jurisdiction of the Grand River Conservation Authority (GRCA). The Torrance Creek Subwatershed is characterized by hummocky terrain associated with the drumlins and by the network of broad, relatively flat spillway channels that cut through the drumlin fields. As shown on Figure 3, topographic high points occur along the northwestern and southeastern boundaries within the central portion of the Site, with the topography generally sloping to the northeast towards Torrance Creek Swamp and the southwest towards Gordon Street. As shown on Figure 1, topographic contours throughout the Site range from highs of 344.5 m AMSL near Valley Road (northwest boundary) and 342.5 m AMSL near Borehole 4 (southeast boundary), to lows of 337 m AMSL near Gordon Street and 335 m AMSL along the northeast boundary of the Site near Torrance Creek Swamp.

As shown on Figure 15 and discussed in the Stantec (2021) *Functional Servicing Report*, the direction of surface water runoff occurring within the Site under existing conditions is split between two catchments. Catchment 101 directs surface water runoff westward to an existing storm sewer on Gordon Street, whereas surface water runoff occurring within Catchment 102 flows overland to the east and eventually discharges to Torrance Creek Swamp.

2.2 REGIONAL GEOLOGY AND HYDROSTRATIGRAPHY

Geological conditions within the region have been mapped and described by Matrix Solutions Inc. (2017), the Lake Erie Region Source Protection Committee (LERSPC, 2015a), Golder Associates Limited (2011), Totten Sims Hubicki Associates *et al.* (1998), Gamsby & Mannerow (1993), and Jagger Hims Limited (1998). Based on these previous studies, overburden and bedrock geology near the Site is summarized as follows, listed from ground surface downward:

Organic Deposits: Accumulations of peat and/or muck associated with wetland areas (Figure 4, Unit 20).

Glaciofluvial Deposits: Glaciofluvial outwash and glaciolacustrine deposits of sand and gravel with minor silt and clay associated with the spillway channels (Figure 4, Units 7a and 7b).

Ice-Contact Deposits: Predominantly sand and gravel containing lenses of silt and clay left behind by the melting of enclosed ice blocks (i.e., eskers, kames) (Figure 4, Unit 6).

Port Stanley Till: An occasionally stony, silty sand to sandy silt till, forming the till plain and drumlins that characterize the region (Figure 4, Unit 5b). Some of the drumlins, however, can consist of an older clayey silt till core that is subsequently covered by a veneer of Port Stanley Till (Karrow, 1968). In the areas south of the Speed River, the till plain is often covered by a layer of glaciofluvial and glaciolacustrine sediments (i.e., fine to silty sand, sandy silt, sand and gravel) deposited from melting glacier ice, with the till extending to the bedrock surface.

Bedrock: The Eramosa Formation (Reformatory Quarry Member), representing the uppermost bedrock unit beneath the Site is described as a light brown to cream coloured, pseudonodular, thickly bedded and coarsely crystalline dolostone, which may act as an aquitard (Brunton, 2008). As per Golder (2011), the bedrock surface near the Site appears to be located at an elevation of 320 m AMSL and will not be encountered with the proposed development.

2.3 REGIONAL HYDROGEOLOGY

Based on previous groundwater modeling work completed by Matrix Solutions Inc. (2017), the following aquifer and aquitard systems are identified as occurring throughout the region in which the Site resides:

Upper Sand and Gravel Aquifer: an unconfined aquifer system consisting predominantly of outwash sand and gravel deposits. This unit is reported to have a horizontal hydraulic conductivity ranging from 7.0 x 10^{-4} m/s to 6.0 x 10^{-6} m/s, with the vertical hydraulic conductivity being one tenth (0.1) to an order (1.0) of magnitude lower than the horizontal hydraulic conductivity (Golder, 2011). Soil permeability testing using a Guelph Permeameter indicates that the sandy soils of this unit have vertical hydraulic conductivities in the range of 10^{-5} m/s (Totten Sims Hubicki Associates *et al.*, 1998).

Lower Till Aquitard: dense sandy to silty glacial till (i.e., Port Stanley Till) that is occasionally interbedded with discontinuous lenses of coarse sand and gravel. This unit is reported to have a horizontal hydraulic conductivity ranging from 1.0 x 10^{-4} m/s to 2.0 x 10^{-9} m/s, with the vertical hydraulic conductivity being one half (0.5) to an order (1.0) of magnitude lower than the horizontal hydraulic conductivity (Golder, 2011).

Contact Zone Aquifer: coarse, unconsolidated granular deposits directly overlying, and hydraulically connected to, upper weathered/fractured bedrock. This unit typically forms a thin aquifer having an assumed thickness of four meters (two meters above and below bedrock surface) (Golder, 2011). This aquifer is reported to have a horizontal hydraulic conductivity ranging from 1.0 x 10^{-4} m/s to 1.0 x 10^{-5} m/s, with the vertical hydraulic conductivity being one half (0.5) to an order (1.0) of magnitude lower than the horizontal hydraulic conductivity (Golder, 2011).

Bedrock Aquifer: consisting of medium to thick bedded fossiliferous dolostone of the Guelph Formation. This unit is reported to have a horizontal hydraulic conductivity ranging from 8.0 x 10^{-3} m/s to 7.0 x 10^{-9} m/s, with the vertical hydraulic conductivity being one tenth (0.1) to an order (1.0) of magnitude lower than the horizontal hydraulic conductivity (Golder, 2011).

As presented in Figure 4.3 of Matrix Solutions Inc. (2017) (Appendix C), simulated groundwater table surface elevations produced via a calibrated steady-state groundwater flow model suggests that regional groundwater movement is to the northwest through the overburden aquifer located beneath the Site, eventually discharging to the Speed River. However, groundwater flow interpretations presented in Totten Sims Hubicki Associates *et al.* (1998) (Figure 4.4.7, Appendix C) suggest that at a local scale, groundwater movement through the shallow overburden near the Site is to the northeast and east, with these flows potentially being influenced by pumping from the Burke and/or Carter Municipal Production Wells.

Regionally, the lands containing the Site are characterized by groundwater recharge conditions. Mapping created using the Grand River Information Network (GRIN) (GRCA, 2019) indicates that downward vertical hydraulic gradients are present beneath the Site, with annual recharge rates across the property ranging from 100 to 200 mm/year (Appendix D).

2.4 SOURCE WATER PROTECTION

As established under the Ontario Clean Water Act, 2006, S.O., 2006, c. 22, source protection areas and associated land use restrictions exist for all municipal drinking water sources located throughout the Grand River Source Protection Area (i.e., defined by the boundaries of the Grand River Watershed). Within the Source Protection Area (SPA), the Ministry of the Environment, Conservation and Parks (MECP) has designated four types of vulnerable areas that apply to drinking water sources:

Wellhead Protection Areas (WHPA): an area delineated on the ground surface that represents the capture zone for the underlying aquifer in which a given municipal well draws its water. The zone represents the total amount of time it would take for groundwater to flow through the aquifer system and reach the intake of a given municipal well. The zones are defined as follows:

- WHPA-A: 100 m radius around the municipal well.
- WHPA-B: Horizontal time of travel to the municipal well is two years or less.

- WHPA-C: Horizontal time of travel to the municipal well is equal to or less than five years and greater than two years.
- WHPA-D: Horizontal time of travel to the municipal well is equal to or less than 25 years and greater than five years.
- WHPA-E: Area where groundwater is under the direct influence of surface water (GUDI), where horizontal time of travel to the municipal well is two hours or less from the surface water body to the well.

As shown on Figure 5, the Site is located within the WHPA for the Burke Municipal Production Well (Burke Well), with this production well located approximately 165 m to the southwest of the Site. Specifically, the Site is intercepted by Burke Well WHPA-B and -C, noting that the footprint for the proposed development is confined to the WHPA-C (i.e., representing an area where it takes greater than two years but less than five years for precipitation that has recharged the aquifer to flow through this aquifer to the production well intake). The WHPA-C has an assigned vulnerability score ranging from four (4) to six (6) (Figure 6). Development on municipal services in areas where vulnerability scores are in the 4 to 6 range represent a low threat to drinking water supplies.

The northeastern portion of the Site also lies within the WHPA-E (vulnerability score of 7.2, MECP, 2020; Figure 7) of the Burke Well, with this well being classified as Groundwater Under the Direct Influence (GUDI) of surface water (i.e., a surface water source has a direct connection to the groundwater system and is drawn into the production well during pumping). The extents of the WHPA-E are equivalent to the area of an Intake Protection Zone (IPZ); that is, a capture zone delineated for those drinking-water systems that obtain their potable water from surface water bodies. The WHPA-E is equivalent to an IPZ-3, which represents surface water bodies and adjacent lands (i.e., GRCA Regulation Limit or 120 m, whichever is greater) that may be impacted by extreme events such as storms (e.g., 100-year rainfall event) and subsequently, potentially contribute surface water to the municipal well. For the Burke Well, the IPZ-3 encompasses the nearby Torrance Creek Swamp.

Significant Groundwater Recharge Areas (SGRA): This is an area where it is desirable to regulate drinking water threats that may affect recharge of an aquifer. Recharge areas are classified as “significant” when they supply more water to an aquifer used as a drinking water source than the surrounding area. As shown in Figure 8, the SGRA represents an area where the rate of annual recharge to the underlying aquifer system is greater than the average annual rate of recharge within the Grand River SPA by a factor of 1.15 or more (i.e., at least 15% greater than the average recharge rate). Based on the modeling results presented in AquaResource (2009), the average annual rate of recharge within the Grand River SPA is calculated to be 176 mm/year; consequently, a SGRA threshold is defined as an area within the watershed where the annual recharge rate equals or is greater than 202 mm/year. A similar SGRA threshold of 200 mm/year was calculated for those lands located within the City of Guelph and Township of Guelph/Eramosa as described in Matrix Solutions Inc. (2017). For the Site, the SGRA is assigned a vulnerability score of four (4), indicating that activities occurring in this area of the property that limit recharge to the underlying aquifer pose a moderate threat to groundwater quantities in the aquifer, which is or may be used as a source of drinking water.

Highly Vulnerable Aquifers (HVA): Defined as subsurface, geologic formations that are sources of drinking water, which could be easily affected by the release of pollutants on the ground surface. The HVA is identified using variables that include depth to the aquifer, physical properties of the overlying soil and/or rock, and the aquifer composition. In general, an HVA will consist of granular aquifer materials (i.e., sands and gravels) that are exposed near the ground surface and where a relatively shallow groundwater table is present. As per the mapping provided by the MECP (2020), the Site does not occur in an area defined as HVA.

Intake Protection Zones (IPZ): A zone established around a drinking / surface water intake within which a spill or leak may get to the intake too quickly for the operators of the municipal water treatment plant to shut the intake down until the pollutant passes by. These zones also include land adjacent to streams and storm sewers where surface water runoff can quickly reach the intake. As discussed above, the northeastern portion of the Site is intercepted by an IPZ-3.

3.0 METHODOLOGY

The hydrogeological site investigation included the:

- drilling of boreholes
- installation of monitoring wells
- installation of drive-point piezometers
- monitoring of groundwater levels
- collection of groundwater samples for quality testing
- performing hydraulic response (hydraulic conductivity) testing
- completion of infiltration (soil permeability) testing.

The methodology for these tasks is described in Section 3.1 to 3.6 below.

3.1 BOREHOLE DRILLING AND MONITORING WELL INSTALLATIONS

Between July 9 and 30, 2018 boreholes were advanced at seven locations across the Site (Figure 1). Five of the locations involved the drilling of a borehole, which was then equipped with a single monitoring well (i.e., MW1-18 to MW3-18, MW6-18, MW7-18). The remaining two locations involved the installation of a multi-level monitoring well (i.e., MW4-18(S/D) and MW5-18(S/D)) where two boreholes (one shallow and one deep) were drilled within meters of each other, with each of these boreholes then being equipped with a single monitoring well. Overall, the boreholes were strategically positioned throughout the Site to obtain a spatially representative understanding of soil conditions, groundwater depths and fluctuations, and to evaluate local patterns of groundwater flow.

Stantec on behalf of Tricar retained Aardvark Drilling Inc. to complete the borehole drilling and monitoring well installations. The boreholes were drilled using a CME track-mounted drilling rig equipped with a hollow stem auger drilling system (i.e., to permit the installation of monitoring wells). Soil samples were collected using split-spoon sampling techniques. Soil sampling occurred using a 0.6 m long stainless-steel split spoon sampler at 0.75 m (2.5 feet) intervals for the first 6.0 m (20 feet) of drilling depth, followed by sample collection occurring at approximately every 1.5 m (5 feet) to the termination depth of the borehole. The completed depths of the boreholes ranged from 12.8 m to 15.8 m below ground surface (BGS). Stantec personnel directed the drilling and soil sampling operations and logged the borehole stratigraphy using the American Society for Testing and Materials (ASTM) guideline for the description and identification of soils (ASTM, 2009). The borehole logs contain descriptions (where relevant and possible) of soil type, texture, colour, structure, consistency, plasticity, moisture content, and other visual and olfactory observations. Copies of the borehole logs are provided in Appendix E.

The drilling contractor installed the monitoring wells adhering to the construction requirements as outlined under Ontario Regulation 903 (O.Reg. 903) (MOE, 1990). Installation details for each of the monitoring wells are summarized in Table 1. Each monitoring well is constructed of 50 mm inside diameter, Schedule 40 polyvinyl chloride (PVC) pipe, having a No. 10 slot screen (0.01-inch slot) measuring 3.0 m in length. Backfilling of the screened interval consisted of silica sand to a height of approximately 0.3 m above the top of screen, followed by granular bentonite to ground surface prevent a hydraulic connection from occurring between the screened formation and overlying soils. The completion of each monitoring well involved encasing the pipe stick-up within a lockable steel casing. Stantec Geomatics surveyed the ground surface and top-of-pipe elevations at each monitoring well location to a geodetic benchmark using the Can-Net GPS Survey system, having a spatial accuracy of +/- 0.03 m and +/- 0.02 m in the vertical and horizontal plane, respectively.

Following installation, Stantec personnel purged each monitoring well using dedicated 16 mm (2/3 inch) inside diameter high density polyethylene (HDPE) tubing connected to a D-25 Waterra™ foot valve. Using the dedicated tubing, Stantec personnel purged 10 standing column volumes from each well (where possible) to clear out any fine-grained sediments and, subsequently, establish a proper hydraulic connection with the native aquifer material.

3.2 DRIVE-POINT PIEZOMETER INSTALLATIONS

On April 10, 2019 Stantec personnel installed one multi-level drive-point piezometer, consisting of a shallow and a deep piezometer (i.e., DP1-19(S) and DP1-19(D)), within a section of the Torrance Creek Swamp located approximately 75 m to the northeast of the Site (Figure 1). The multi-level piezometer was installed to evaluate whether this wetland functions as a groundwater recharge feature (i.e., contributes water to subsurface), discharge feature (receives water from the subsurface), or a combination of both.

Each drive-point piezometer is constructed of a 0.42 m long steel screen (19 mm diameter) that is connected to 25 mm diameter steel riser pipes. Stantec personnel drove the drive-point piezometers into the substrate using a fence post driver, with shallow and deep pipes being constructed within one meter of each other and their screens being separated by a vertical distance of approximately 1.7 m. Construction details for the drive-point piezometers are summarized in Table 1.

3.3 GROUNDWATER LEVEL MONITORING

Groundwater levels were recorded at the monitoring well and piezometer locations from July 2018 to June 2020 using a combination of automated and manual measurement methods. Solinst® Edge Leveloggers® (Leveloggers) were installed at all monitoring well and piezometer locations to allow automatic measurement of water levels. The Leveloggers were suspended into the water column at each monitoring well and drive-point piezometer and set to record water levels at 60-minute intervals. Leveloggers are not vented to the atmosphere and therefore record total pressure (where total pressure is the sum of the atmospheric pressure and the height of water column). To obtain an accurate measurement of the groundwater level at each well, the water level data obtained from the Leveloggers were corrected for atmospheric pressure using data obtained from a Solinst® Edge Barologger® (Barologger), which was suspended in the air column at monitoring well MW5-18(S).

Groundwater levels were manually measured several times from the onsite monitoring wells (nine events) and the multi-level drive-point piezometer (six events) between July 2018 and June 2020. The groundwater level measurements were recorded in metres to the nearest 0.01 m using a battery-operated water level indicator. Manual groundwater level measurements were used to verify data recorded by the Leveloggers. Manual water levels collected from the monitoring wells and drive-point piezometer are presented in Tables 2 and 3, respectively. Hydrographs presenting both the automatic and manually measured groundwater level data are provided in Figures 9 and 10.

3.4 GROUNDWATER SAMPLING AND TESTING

Groundwater quality samples were collected from MW2-18, MW4-18(S), MW6-18, and MW7-18 on September 11, 2018. The samples were collected to help evaluate pre-development groundwater quality conditions at the Site. Specifically, all samples were analyzed for general inorganic parameters and dissolved metals and compared against their corresponding Ontario Drinking Water Quality Standard (ODWQS) (MOE, 2006) concentrations, with MW2-18 results being compared against those parameters listed under the City of Guelph Sanitary and Storm Sewer By-law (1996)-15202.

Stantec personnel collected groundwater samples from the onsite monitoring wells using dedicated HDPE tubing connected to a foot valve. Prior to collecting the samples, wells were purged and field parameters including pH, temperature, electrical conductivity, oxidation reduction potential (ORP), and dissolved oxygen (DO) were monitored periodically during the purging process using a multi-parameter water quality meter and flow through cell. The meter was calibrated prior to use according to the manufacturer’s specifications with the appropriate calibration standards. Groundwater sampling occurred after these field parameter concentrations had stabilized, indicating that water being pumped from the monitoring wells was representative of groundwater flowing into the well from surrounding geological formations.

The groundwater sample collected from each monitoring well consisted of pouring water directly from the HDPE tubing into lab supplied sample bottles. Groundwater samples collected for metals analysis were field-filtered using disposable in-line 0.45 µm (micron) filters attached to the HDPE tubing. The groundwater samples were carefully packed into coolers with ice, which was added to maintain sample temperatures below 10ºC during transport to the analytical laboratory. Samples were delivered to Maxxam Analytics Inc. (Maxxam) for analysis. Chain of custody forms were completed and included with the samples.

The results of the groundwater quality testing are summarized in Tables 4 (Sewer By-law) and 5 (ODWQS) and illustrated in a piper diagram on Figure 11. A copy of the Laboratory Certificate of Analysis is presented in Appendix F.

3.5 HYDRAULIC RESPONSE TESTING

Stantec performed in-situ hydraulic response testing at each monitoring well between July 26 and 27, 2018 to estimate the horizontal hydraulic conductivity of the deposits beneath the Site. The testing consisted of creating an instantaneous change in the well water level by removing a known volume of water followed by recording the time taken for the water level to return to static conditions (i.e., a rising head or bail test). Data were analyzed using the Bouwer and Rice (1976) solution for a bail test in an unconfined aquifer as provided in the software package AQTESOLV™ Pro Version 4.5 (Duffield, 2014). Testing provided an estimate of the horizontal hydraulic conductivity of the sediments within the screened interval for each monitoring well. Table 1 provides a summary of the calculated horizontal hydraulic conductivities, with the analytical solutions for the data being presented in Appendix G.

Since hydraulic conductivity in the horizontal direction is generally an order (potentially two orders for clay-based deposits) of magnitude higher than hydraulic conductivity in the vertical direction (Todd 1980; Freeze and Cherry 1979), the vertical hydraulic conductivities for overburden deposits surrounding the well screens were assumed to be one order of magnitude lower than in-situ measured horizontal hydraulic conductivities calculated at MW2-18 to MW7-18. Infiltration rates were calculated based on an established relationship between vertical hydraulic conductivity and infiltration rate presented in the Credit Valley Conservation and Toronto and Region Conservation Authority (CVC-TRCA, 2010) Low Impact Stormwater Management Planning and Design Guideline - Version 1.0. Table 6 provides a summary of estimated infiltration rates based on the results of the horizontal hydraulic conductivity testing.

3.6 INFILTRATION TESTING

As discussed in the Stantec (2021) *Functional Servicing Report*, the revised stormwater management strategy for the Site will include the construction of the East Infiltration Trench (i.e., rock trench) immediately to the northeast of Building 2 (Figure 12). The South Infiltration Trench (i.e., Permavoid) will be constructed along the southwestern limits of the Site immediately to the south of Building 2 (Figure 12).

On June 10 and 11, 2021 D&J Lockhart Excavators Ltd. (Lockhart) excavated a series of test pits within locations of the Site where the previously mentioned post-development stormwater infiltration facilities are planned. The excavation of three test pits (TP1 to TP3) occurred near the southeastern limits of the Site where the South Infiltration Trench is proposed for construction, and two test pits (TP4 and TP5) within the central portion of the property at the future location of the East Infiltration Trench (Figure 12). Stantec notes that the locations of TP4 and TP5 occurred in the original footprint of the East Infiltration Trench (as presented in the Stantec (2020) *Hydrogeological Assessment* report); however, the extents of this facility have since been revised resulting in the test pits now being located from five to 22 m outside of the new footprint. However, given that the subsurface deposits characterizing the Site are relatively ubiquitous (i.e., silty to sandy glacial till), the testing results obtained from these test pits are still considered to be representative of infiltration conditions within the new East Infiltration Trench footprint.

Under the supervision of Stantec personnel, the test pit excavations extended to the projected base elevation of each infiltration trench for the performing of soil infiltration testing. Once completing the soil infiltration testing at the proposed base elevation of each trench, the test pits were then excavated further to depths of at least 1.5 m below these base elevations, with the soils at these depths also being subjected to infiltration testing as per the protocols outlined in the Credit Valley Conservation (CVC) and Toronto and Region Conservation (TRCA) (2010) *Low Impact Stormwater Management Planning and Design Guideline*. Stantec personnel classified the soils targeted for infiltration testing using the ASTM guideline for visual-manual description and identification of soils (ASTM D2488-00) and once the test pit was no longer required, Lockhart backfilled the excavations to the existing grade.

Assessment of the infiltration potential for the on-Site soils involved the use of a Guelph Permeameter (a constant head permeameter designed to measure in-situ vertical hydraulic conductivities of a given substrate). At the various excavated depths of the test pits, Stantec personnel used a hand auger to drill an approximately 0.5 m deep, 50 mm diameter cylindrical hole into the native soil to be tested. The Guelph Permeameter was then filled with water, inserted into the hole while making a concerted effort to avoid knocking debris into the excavation, and then stabilized against the substrate. Stantec personnel then proceeded to record the eventual steady-state rate of water recharge into the soil. The infiltration rate for each soil tested was converted from the measured vertical hydraulic conductivity using the established relationship between vertical hydraulic conductivity and infiltration rate presented by the CVC/TRCA (2010). Table 7 presents the results of this soil infiltration testing.

Using the infiltration testing results, Stantec proceeded to calculate the Design Infiltration Rate for each infiltration facility as per the approach outlined by the CVC/TRCA (2010). The calculated infiltration rate used in the design of the East and South Infiltration Trenches is 32 mm/hour and 23 mm/hour, respectively (Table 8).

4.0 LOCAL GEOLOGY AND HYDROGEOLOGY

4.1 GEOLOGY

Figure 4 presents the surficial geology throughout the Site as mapped by the OGS (2010), with this mapping indicating that the entire Site is covered by stone-poor, silty to sandy glacial till (i.e., the Port Stanley Till). Figure 1 shows the locations of Cross-Section A-A' (Figure 13) and B-B' (Figure 14), which were constructed using geological information obtained from the onsite drilling completed at the Site by CMT Engineering (2018) and Stantec (Appendix E). Although onsite drilling results confirm that silty sand to sandy silt till (Port Stanley Till) predominantly forms a horizontally and vertically contiguous unit beneath the Site, this unit is overlain by a 2.3 to 4.8 m thick diamicton deposit consisting of very loose to dense sand and silt, with some gravel and trace clay (CMT, 2018). A 2.4 m thick, discontinuous layer of sand was encountered in the Port Stanley Till at a depth of 11.3 m BGS (331.7 m AMSL) at MW2-18. The Port Stanley Till occurs at elevations ranging from 341.6 to 334.7 m AMSL beneath the Site, with this unit extending to the termination depth of the onsite boreholes (333.4 to 324.6 m AMSL). Locally, the bedrock surface is reported to occur at an elevation of approximately 320 m AMSL (Golder, 2011).

4.2 HYDROGEOLOGY

4.2.1 Groundwater Levels and Flow

Figures 9 and 10 and Table 2 present the continuous and manual water levels recorded within the monitoring wells between July 2018 and June 2020. Groundwater elevations across the Site ranged from 0.9 m BGS (at MW5-18) to 9.2 m BGS (at MW1-18) over the monitoring period, equating to elevations ranging from 332.6 m to 340.7 m AMSL.

As shown in the hydrographs (Figures 9 and 10), the groundwater table demonstrated a similar pattern in fluctuations across the Site, with high groundwater conditions predominantly occurring in the spring (i.e., early March to early June) due to lower evapotranspiration losses and a melting snowpack, which in turn provided a greater volume of water available to infiltrate and recharge the groundwater system. Starting in mid-June, the groundwater table across the entire Site begins to experience a steady decline, reaching its lowest elevation in late October to early November as a response to more water being drawn from the subsurface over this period to meet evapotranspiration demands. Overall, the groundwater table decline that occurred from the early summer to late fall at the monitoring well locations ranged from 1.4 m (MW7-18) to 5.6 m (MW2-18).

Throughout the Site, groundwater levels showed no marked response to notable precipitation events (i.e., immediate spike/rise in the groundwater table), suggesting that there is no direct hydraulic connection between the ground surface and the groundwater system (i.e., via vertical fissures/fractures in the overburden). The subdued response to precipitation events is not surprising, given that dense to very densely packed native deposits of silty sand to sandy silt till are present beneath the Site, with these deposits being characterized by horizontal hydraulic conductivities in the range of 10^{-7} to 10^{-9} m/s

(Table 1; Appendix G). However, Stantec notes that infiltration testing completed in the shallower native deposits of silty sand to sandy silt till (i.e., 0.5 to 3.5 m BGS) suggest that horizontal hydraulic conductivities are higher within certain areas of the Site (e.g., near proposed locations of the proposed infiltration trenches) where estimated values range from 10^{-5} to 10^{-7} m/s (Table 7).

Figure 12 presents groundwater elevation contours and the interpreted direction of horizontal flow through the groundwater system beneath the Site using level measurements collected from the on-site monitoring wells in May 2019. In general, groundwater contours mimic the prevailing topography of the Site, with a localized groundwater divide running along the northeast-southwest axis of the drumlin upon which the property is situated (Figure 3). From the divide, groundwater is shown to flow to the northeast across the Site towards Torrance Creek Swamp at a calculated horizontal hydraulic gradient of 0.04 m/m, which is in general agreement with regional flow patterns presented in Totten Sims Hubicki Associates *et al.* (1998) (Figure 4.4.7, Appendix C). However, groundwater is also shown to flow to the southwest from the divide towards Gordon Street at a calculated horizontal hydraulic gradient of 0.09 m/m and onward towards Hanlon Creek Swamp. These groundwater flow patterns also mimic existing surface water runoff / drainage patterns occurring at the Site as discussed in Stantec (2021).

Horizontal hydraulic conductivity estimates calculated from onsite hydraulic response testing completed at the onsite monitoring wells, which are all screened within sandy silt till, ranged from 5.4×10^{-7} m/s to 1.6×10^{-9} m/s (Table 1; Appendix G). These calculated values are consistent with the literature values of hydraulic conductivity provided for these deposits (Fetter, 1994) and with values provided for the Lower Till Aquitard (Port Stanley Till) as reported in Golder (2011). Overall, the estimated bulk (i.e., geometric mean) horizontal hydraulic conductivity calculated for the overburden deposits is 3.7×10^{-8} m/s (Table 1).

The velocity at which groundwater horizontally flows through the subsurface is calculated through the application of Darcy's law, where:

$$v = \frac{K \nabla}{\theta}$$

where: v = velocity (m/yr)
K = hydraulic conductivity
∇ = hydraulic gradient
θ = effective porosity

Assuming a soil porosity of 0.2 for glacial till (Fetter, 1994), an average horizontal hydraulic gradient of 0.04 m/m for groundwater moving towards the northeast, and geometric mean hydraulic conductivity of 3.7×10^{-8} m/s, the estimated velocity of groundwater flowing through the overburden beneath the Site towards Torrance Creek Swamp is calculated to be approximately 0.23 m/year (i.e., one meter every 4.3 years). Using the same input parameters as above, except for an average horizontal hydraulic gradient of 0.09 m/m, the estimated velocity of groundwater flowing through the overburden beneath the Site towards Gordon Street is calculated to be approximately 0.52 m/year (i.e., one meter every 1.9 years).

The Site is also characterized by downward vertical hydraulic gradients as recorded at MW4-18(S/D) (Figure 9) and MW5-18(S/D) (Figure 10). Vertical hydraulic gradients ranged from -0.5 to -1.0 over the monitoring period, confirming that the Site is a groundwater recharge area.

4.2.2 Groundwater-Surface Water Interaction

Data available on the Grand River Information Network (GRIN) (GRCA, 2019) indicates that downward vertical hydraulic gradients are present beneath the Site and in the surrounding area, with annual recharge rates within the boundaries of the Site ranging from 100 to 200 mm/year (Appendix D). As shown in Figure 10, over the monitoring period (i.e., April 2019 to June 2020) groundwater levels recorded in the multi-level drive-point piezometer (i.e., DP1-19(S/D)) installed within Torrance Creek Swamp approximately 75 m to the northeast of the Site show that the groundwater table occurred at or above ground surface during the spring, declining to depths up to 1.1 m BGS by the late summer to early fall (Table 3; Figure 10). Neutral to upward vertical hydraulic gradients consistently occur beneath this area of the Torrance Creek Swamp, although the vertical gradient did switch to downward over the monitoring period. Overall, vertical hydraulic gradients at DP1-19(S/D) have ranged from -0.06 to 0.17, indicating that this area of the wetland functions as both a groundwater recharge and discharge feature. However, the potential volume of groundwater discharging to the Torrance Creek Swamp during those periods where discharge conditions are present is expected to be minimal, given that groundwater moves at a very slow rate through the overburden deposits (i.e., one meter every 4.3 years).

4.2.3 Infiltration Potential

Estimated infiltration rates for the overburden deposits are provided in Tables 6 and 7. Infiltration rates were calculated based on an established relationship between vertical hydraulic conductivity and infiltration rate presented in CVC-TRCA (2010), with vertical hydraulic conductivities being estimated based on both the results of in-situ hydraulic response testing completed at each monitoring well (Section 3.5) and Guelph Permeameter testing completed within the footprints of the proposed infiltration trenches (Section 3.6). Vertical hydraulic conductivities for the deeper deposits of sandy silt till (i.e., 5.0 m to 15.1 m BGS) are assumed to be one order of magnitude lower than in-situ measured horizontal hydraulic conductivities, resulting in values ranging from 5.6×10^{-8} to 1.6×10^{-10} m/s for these till deposits (Table 6). However, results of infiltration testing completed in the areas of the Site where the East and South Infiltration Trenches will be constructed had vertical hydraulic conductivities ranging from 3.9×10^{-5} m/s to 1.8×10^{-7} m/s (i.e., from depths of 0.5 to 3.6 m BGS) (Table 7). Based on these values, the calculated infiltration rates for the previously mentioned deposits can range from as low as 5 mm/hour to an upper value of 123 mm/hour (Tables 6 and 7).

4.2.4 Groundwater Quality

Groundwater quality results from the sample collected from MW2-18 on September 11, 2018 was assessed against City of Guelph Sanitary and Storm Sewer By-law (1996)-15202 guidelines (i.e., for quality of water potentially discharged to storm or sanitary sewage works during dewatering) (Table 4). Groundwater samples collected from MW4-18(S), MW6-18, and MW7-18, together with the previously mentioned sample results, were also compared against the ODWQS (Table 5). A summary of the results is discussed in the sections below.

4.2.4.1 City of Guelph Sanitary and Sewer By-Law

Results of groundwater quality analysis for the sample collected from MW2-18 (Table 4), which was not field-filtered (i.e., representing the quality of groundwater that would be pumped from an open excavation and discharged to the sewer system without treatment), indicate that this groundwater does not meet the City of Guelph Storm Sewer By-law guidelines due to the following parameter concentrations being exceeded:

- Fecal Coliform (200 MPN/100mL): exceeded the storm sewer limit with a count of 350 MPN/100mL.
- Total Cadmium (0.001 mg/L): exceeded the storm sewer limit with a concentration of 0.0019 mg/L.
- Total Copper (0.01 mg/L): exceeded the storm sewer limit with a concentration of 0.03 mg/L.
- Total Lead (0.05 mg/L): exceeded the storm sewer limit with a concentration of 0.13 mg/L.
- Total Suspended Solids (15 mg/L): exceeded the storm sewer limit with a count of 2,500 mg/L.
- Total Zinc (0.05 mg/L): exceeded the storm sewer limit with a concentration of 0.64 mg/L.

The groundwater also does not meet the City of Guelph Sanitary Sewer By-law guidelines due to the following parameter concentrations being exceeded:

- Total Suspended Solids (350 mg/L): exceeded the sanitary sewer limit with a count of 2,500 mg/L.

Stantec notes that results for the set of groundwater samples that were field-filtered and collected from MW4-18(S), MW6-18, and MW7-18 indicate that if groundwater pumped as part of construction dewatering (if required) is treated for TSS prior to leaving the Site that the removal of the associated sediment-bound metals from the groundwater would result in the remaining dissolved concentrations of cadmium (<0.0001 mg/L), copper (<0.001 mg/L), lead (<0.00056 mg/L), and zinc (<0.005 mg/L) (Table 5) not exceeding the corresponding City of Guelph Storm Sewer By-law concentrations for these parameters.

4.2.4.2 Ontario Drinking Water Quality Standards

Results of the quality testing indicates that the groundwater beneath the Site is classified as calcium-bicarbonate type groundwater (Figure 11), which is typical of shallow fresh groundwater systems in Ontario. The parameters tested in the groundwater samples (i.e., MW4-18(S), MW6-18, and MW7-18) did not exceed any corresponding ODWQS health-related criteria; however, the following tested parameters did exceed their corresponding ODWQS Aesthetic Objectives (non-health related):

- Hardness (100 mg/L): exceeded with concentrations ranging from 320 mg/L to 520 mg/L.
- Total Dissolved Solids (500 mg/L): exceeded at MW4-18(S) (540 mg/L) and MW7-18 (530 mg/L).

In addition, the Medical Officer of Health Reporting Limit (Ontario) of 20 mg/L for sodium was exceeded at MW7-18 (34 mg/L).

5.0 WATER BALANCE

Water balance calculations were completed to quantify infiltration volumes at the Site and confirm the recharge function. A comparison of water balance data under existing (i.e., pre-development) and proposed (i.e., post-development) conditions was completed to determine the potential impacts of development on the Site's recharge function. The methodology for the water balance calculations is provided in Section 5.1. Results of the pre- and post-development water balance analysis are presented in Sections 5.2 and 5.3, respectively.

5.1 METHODOLOGY

Within the hydrologic cycle, the flow of water into and out of system can be described through a simplified water balance equation as follows:

$$P = ET + S + R + I \qquad \textbf{Equation 1}$$

Where:

P = precipitation
ET = evapotranspiration
S = change in groundwater storage
R = runoff
I = infiltration (groundwater recharge)

Equation 1 may be further simplified by ignoring the change in groundwater storage (S), which trends over time to zero. The various components of the hydrologic cycle may be estimated through calculations or based on measurements made in the field. Precipitation (P) is typically a measured value. Evapotranspiration (ET) is calculated based on measured air temperatures. Infiltration (I) and Runoff (R) are calculated based on P and ET, where the difference between P and ET is the water surplus (WS) available for Infiltration (I) and Recharge (R) as follows:

$$WS = P - ET \qquad \textbf{Equation 2}$$

Where WS is used to calculate I after applying an infiltration factor (IF),

$$I = WS \times IF \qquad \textbf{Equation 3}$$

And R is estimated by subtracting I from WS,

$$R = WS - I \qquad \textbf{Equation 4}$$

For this assessment, ET was calculated using the soil moisture balance model by Thornthwaite and Mather (1955). In the Thornthwaite and Mather model monthly potential evapotranspiration (PET) is calculated based on the measured average monthly daily temperature (T_a) and a heat index (H_i) value assuming 12 hours of daylight in a day and 30 days in a month, as follows:

$$PET = 16 \times \left(\frac{10T_a}{H_i}\right)^{\alpha}$$ **Equation 5**

Where T_a is taken as 0 degrees Celsius for months with negative temperatures, and $H_{i,}$ the heat index is estimated as,

$$H_i = \sum_{i=1}^{12} \left(\frac{10T_a}{5}\right)^{1.514}$$ **Equation 6**

For α

$$\alpha = 0.49 + (0.0179 \times H_i) - \left(0.0000771 \times H_i{}^2\right) + \left(0.000000675 \times H_i{}^3\right)$$ **Equation 7**

PET values are then multiplied by an adjustment factor, after Thornthwaite and Mather (1957), which represents the average number of daylight hours per month at the latitude of the subject property to give the Adjusted Potential Evapotranspiration (PET_{adj}).

Actual Evapotranspiration (AET) is derived as,

$$AET = PET_{adj} - \Delta S$$ **Equation 8**

Where ΔS is the change in storage for the month, calculated as,

$$\Delta S = S_{mc} \times e^{\left(\frac{APWL}{S_{mc}}\right)}$$ **Equation 9**

Where:

S_{mc} = soil moisture capacity

APWL = accumulated potential water loss, calculated for ΔP < 0 as $APWL = -\sum_{i=0}^{12} PET_i$, and for ΔP > 0 by rearranging equation 8; with ΔP= net precipitation = P - PET_{adj}

WS is derived by subtracting AET from the monthly precipitation,

$$WS = P - AET$$ **Equation 10**

And the infiltration and runoff calculated per Equations 3 and 4 above.

The infiltration factor shown in Equation 3 is estimated based on the topography, soil type and land cover after MOE (2003) and the Ministry of the Environment and Energy (MOEE) (1995). To define appropriate infiltration factors, the Site is divided into four Sub-Areas based on similarities in soil type, topography and vegetation cover as follows:

Sub-Area A	Fine sandy to silt loam, rolling topography, woodland cover
Sub-Area B	Fine sandy to silt loam, rolling topography, pasture and shrubs land cover
Sub-Area C	Fine sandy to silt loam, rolling topography, urban lawn
Sub-Area D	Fine sandy to silt loam, rolling topography, urban lawn, 95% impervious cover

The delineated Sub-Areas are shown on Figure 15 and the infiltration factors assigned for each Sub-Area under existing conditions (i.e., pre-development) within Catchment 101 (i.e., drainage directed westward towards Upper Hanlon Creek Watershed) and Catchment 102 (i.e., drainage directed eastward towards Torrance Creek subwatershed) is presented in Tables 9 and 10, respectively. As shown in Figure 15, the lands fronting Valley Road within the northeastern portion of the Site are not included in the pre- and post-development water balance calculations, given that these lands are to come under the ownership of the City and, subsequently, will no longer be the responsibility of Tricar.

Soil moisture capacity was set between 75 mm to 300 mm among the Sub-Areas depending on the soil type and land cover as specified under MOE (2003). In Sub-Area A, where the fine sandy to silt loam and woodland cover is present, soil moisture was set at 75 mm. For Sub-Area B, soil moisture content was set at 150 mm corresponding to a fine sandy to silt loam covered with pasture and shrub vegetation. For Sub-Areas C and D, soil moisture content was set at 300 mm corresponding to fine sandy to silt loam having urban lawn type cover associated with the existing onsite residential and commercial properties.

For this water balance assessment, climate normals (1981 to 2010) as recorded at the Waterloo Wellington A Climate Station were used to obtain monthly values of precipitation and temperature. The climate data were obtained from Environment Canada (2020) and are summarized in Table 11. The Waterloo Wellington A Climate Station is located approximately 15 km to the southwest of the Site. Although the Guelph Arboretum Climate Station is located approximately 1.5 km to the northwest of the Site, climate normals from 1971 to 2000 are only available from this station.

5.2 PRE-DEVELOPMENT WATER BALANCE

5.2.1 Catchments Contributing to Upper Hanlon Creek Subwatershed

The average annual precipitation at the Site is estimated at 916 mm based on data obtained from the Waterloo Wellington A Climate Station (Environment Canada, 2020). In comparison, Matrix Solutions Inc. (2017) reported average annual precipitation in the Upper Speed Assessment Area is 923 mm/year as measured at the Guelph Arboretum Climate Station. In Sub-Areas A, B, and C/D, annual actual evapotranspiration from pervious areas is estimated as 563 mm, 554 mm, and 541 mm, respectively. This means that 353 mm of surplus water is available for runoff and infiltration across Sub-Area A on an annual basis, with annual surpluses of 362 mm and 375 mm being available across Sub-Areas B and C/D, respectively. Applying the estimated infiltration factors of 0.65 for Sub-Area A, 0.60 for Sub-Area B and 0.50 for Sub-Area C/D, the calculated annual infiltration for these sub-areas is 230 mm, 217 mm, and 188 mm, respectively.

Based on the previously mentioned water balance components, the average annual volume of infiltration occurring within Catchment 101 (Figure 15) under the pre-development condition is estimated at 2,553 m^3, equating to a rate of 192 mm/year (Table 9). This infiltration rate falls within the 100 mm/year to 200 mm/year groundwater recharge rate range modeled for the Site as per GRIN mapping (Appendix D).

The average annual volume of surface water runoff occurring within Catchment 101 (Figure 15) under the pre-development condition is 2,952 m^3 (222 mm/year) (Table 9).

5.2.2 Catchments Contributing to Torrance Creek Subwatershed

The average annual precipitation at the Site is estimated at 916 mm based on data obtained from the Waterloo Wellington A Climate Station (Environment Canada, 2020). In Sub-Areas A, B, and C, annual actual evapotranspiration from pervious areas is estimated as 563 mm, 554 mm, and 541 mm, respectively. This means that 353 mm of surplus water is available for runoff and infiltration across Sub-Area A on an annual basis, with annual surpluses of 362 mm and 375 mm being available across Sub-Areas B and C/D, respectively. Applying the estimated infiltration factors of 0.65 for Sub-Area A, 0.60 for Sub-Area B and 0.50 for Sub-Area C, the calculated annual infiltration for these sub-areas is 230 mm, 217 mm, and 188 mm, respectively.

Based on the previously mentioned water balance components, the average annual volume of infiltration occurring within Catchment 102 (Figure 15) under the pre-development condition is estimated at 3,828 m^3, equating to a rate of 222 mm/year (Table 10). This infiltration rate slightly exceeds the 200 mm/year groundwater recharge rate range modeled for the Site as per GRIN mapping (Appendix D).

The average annual volume of surface water runoff occurring within Catchment 101 (Figure 15) under the pre-development condition is 2,443 m^3 (222 mm/year) (Table 10).

5.3 POST-DEVELOPMENT WATER BALANCE

5.3.1 Catchments Contributing to Upper Hanlon Creek Subwatershed

Under the post-development condition in the former area of Catchment 101, Stantec has assumed for the water balance calculations that the topography and physical characteristics of the surficial soil deposits (i.e., fine sandy to silt loam) in each of the Sub-Areas will remain relatively unchanged; however, land cover was adjusted to reflect the projected imperviousness cover percentages of the new catchment areas that will occur under proposed conditions (i.e., Catchments 201 to 204 and 207 to 209) (Figure 16). Stantec also assumes that the remaining pervious areas within the new catchment areas will consist of urban lawns and other vegetation associated with urban landscaping. Overall, approximately 80% (1.16 ha) of the Site area covered by the previously mentioned catchments will be converted to impervious surfaces. Under this scenario, the annual volume of infiltration occurring across these lands will decline from 2,553 m^3 to 553 m^3, resulting in an annual infiltration deficit of 2,000 m^3 (Table 12). Annual volumes of surface water runoff from these lands will concurrently increase from 2,952 m^3 to 11,177 m^3, for a runoff increase of 8,225 m^3 (Table 10).

5.3.2 Catchments Contributing to Torrance Creek Subwatershed

In the former Catchment 102, which will be replaced largely by Catchments 205 and 206, the topography, soil deposits (i.e., fine sandy to silt loam), and vegetation cover of these lands will remain mostly unchanged between pre- and post-development conditions. Overall, approximately 1% (0.02 ha) of the Site area covered by the previously mentioned catchments will be converted to impervious surfaces. Under this scenario, the annual volume of infiltration occurring across these lands will decline from 3,828 m^3 to 3,550 m^3, resulting in an annual infiltration deficit of 279 m^3 (Table 13). Annual volumes of surface water runoff from these lands will concurrently decrease from 2,443 m^3 to 2,245 m^3, for a runoff decrease of 198 m^3 (Table 13).

6.0 GROUNDWATER MOUNDING ASSESSMENT

As requested by the City, Stantec completed an assessment of the magnitude of groundwater mounding that could potentially occur directly beneath the East Infiltration Trench and South Infiltration Trench following a 25 mm storm event. Stantec calculated the projected height of groundwater mounding up to 36 m away from each infiltration gallery using a spreadsheet developed by the United States Geological Survey (USGS) applying the Hantush equation (Carelton, 2010). The equation consists of the following input parameters:

R = recharge (Infiltration) rate (feet/day)
Sy = specific yield (unitless)
K = horizontal hydraulic conductivity (feet/day)
x = 1/2 length of infiltration gallery
y = 1/2 width of infiltration gallery
t = duration of infiltration (drawdown) period (days)
hi(0) = initial thickness of saturated zone receiving recharge (feet)

The specific values entered in the equation and the subsequent results for each infiltration gallery assessment are discussed below.

The projected high groundwater condition occurring in both areas where the East and South Infiltration Trenches will be constructed is based on groundwater elevation monitoring completed at the Site and the groundwater elevation contours constructed from these data as documented in this report. The groundwater elevation contour mapping presented on Figure 12 (based on data collected in May 2019) represents the period of the monitoring program where groundwater elevations recorded across the Site were at their highest elevation. As shown in Figure 12, groundwater elevations underlying the East Infiltration Trench slope to the northeast from an elevation of 339.2 m AMSL to 338.6 m AMSL and, as such, Stantec used a groundwater elevation of 339.2 m AMSL for the mounding assessment beneath this facility. For the South Infiltration Trench, groundwater elevations underlying this facility are estimated to range from 339.0 m AMSL to 338 m AMSL, with the elevation of 339.0 m AMSL being used in the mounding analysis for this trench. Stantec notes that monitoring wells are proposed for installation within and near the footprints of both infiltration trenches (i.e., MW101-21 to MW104-21), with these wells being equipped with continuous data logging equipment to confirm the high groundwater elevation assumptions utilized in each mounding assessment.

The specific values entered in the USGS spreadsheet and the subsequent results for each infiltration trench groundwater mounding assessment are discussed below.

6.1 EAST INFILTRATION TRENCH

The proposed construction location for the East Infiltration Trench will be in the central portion of the Site (Catchment 206) immediately to the northeast of Building 2 (Figure 16), with this facility being situated within the Torrance Creek Subwatershed. The East Infiltration Trench will receive stormwater runoff from the rooftop of Building 2 (Catchment 203). The invert (base) of this rock trench will be constructed at an elevation of 340.0 m AMSL, placing the base elevation of the gallery approximately 0.8 m above the projected seasonally high groundwater table in this area of the Site (i.e., 339.2 m AMSL) (Figure 12).

The projected elevation and extents of the groundwater mound are based on the following equation inputs:

- **R** - Design Infiltration Rate of 32 mm/hour (Table 8).
- **Sy** - A specific yield of 0.23 based on the average of specific yields for silt, fine sand, medium sand, coarse sand, and gravelly sand as reported by Johnson (1967).
- **K** - A geometric vertical hydraulic conductivity of 2.0 x10^{-6} m/s is calculated for the subsurface deposits situated from five to 22 m from the trench footprint based on in-situ Guelph Permeameter testing completed on various soil horizons located at elevations ranging from 340.4 m AMSL to 337.4 m AMSL (Table 7). Since hydraulic conductivity in the horizontal direction is generally an order of magnitude higher than hydraulic conductivity in the vertical direction (Todd 1980; Freeze and Cherry 1979), the horizontal hydraulic conductivity of the shallow groundwater system is assumed to be 2.0 x 10^{-5} m/s (5.62 feet/day). This estimated horizontal hydraulic conductivity falls within the range of conductivities reported for the silty sand and gravel to sandy gravelly silt deposits that characterize the subsurface of the Upper Hanlon Creek Watershed (i.e., 10^{-3} m/s to 10^{-6} m/s; Gamsby and Mannerow Ltd. 1993).
- **x, y** - The dimensions of the infiltration trench are 11 m (36.1 feet) long by 10 m (32.8 feet) wide.
- **t** - The time taken for the infiltration gallery to drain following a 25 mm storm event is 18 hours (0.75 days).
- **hi(0)** – A saturated zone thickness of 19.2 m (62.9 feet) (i.e., high groundwater elevation of 339.2 m AMSL minus bedrock surface elevation of 320.0 m AMSL that underlies the Site).

Table 14 presents the results of the groundwater mounding analysis for the East Infiltration Trench. Based on the above input parameters, the maximum groundwater mounding predicted to occur beneath the center of the East Infiltration Trench after a 25 mm event is 0.6 m, equating to an elevation of 339.8 m AMSL based on the seasonally high groundwater elevation (i.e., 339.2 m AMSL + 0.6 m = 339.8 m AMSL). As shown on Table 14 and Figure 17, the rise in the groundwater table does not exceed 0.1 m beyond 18 m from the trench center point after a 25 mm storm event.

Although storm event induced mounding will temporarily raise groundwater elevations beneath the foundation of Building 2, the magnitude of this mounding not expected to exceed more than 0.1 m (Figure 17). Stantec notes that this building foundation (as with all onsite building foundations) will be constructed as a watertight structure (sealed with a water impermeable membrane), with the floor slab designed to structurally resist the hydrostatic pressure exerted by the groundwater. Consequently, no permanent drainage system / dewatering will be required for Building 2. The groundwater mound is also not expected to extend below the residential homes fronting Valley Road to the northwest of the Site.

Stantec notes that East Infiltration Trench overflows potentially occurring following a greater than 25 mm storm event will be directed overland to the northeast where this runoff will eventually discharge to the Torrance Creek Swamp (refer to Stantec (2021) *Stormwater Management Brief* for additional details).

6.2 SOUTH INFILTRATION TRENCH

The proposed construction location for the South Infiltration Trench is near the southwest limits of the Site, with this facility being situated within the Upper Hanlon Creek Subwatershed (Figure 16). The South Infiltration Trench will receive stormwater runoff from the rooftop of Building 1 (Catchment 202) and associated parking areas (Catchments 204 and 208). The invert (base) of this Permavoid infiltration trench will be constructed at an elevation of 340.4 m AMSL, placing the base elevation of the gallery approximately 1.4 m above the projected seasonally high groundwater table in this area of the Site (i.e., 339.0 m AMSL) (Figure 12).

The projected elevation and extents of the groundwater mound are based on the following equation inputs:

- **R** - Design Infiltration Rate of 23 mm/hour (Table 8).
- **Sy** - A specific yield of 0.23 based on the average of specific yields for silt, fine sand, medium sand, coarse sand, and gravelly sand as reported by Johnson (1967).
- **K** - A geometric vertical hydraulic conductivity of 1.8 x10^{-6} m/s is calculated for the subsurface deposits situated within the trench footprint based on in-situ Guelph Permeameter testing completed on various soil horizons located at elevations ranging from 341.6 m AMSL to 339.1 m AMSL (Table 7). Since hydraulic conductivity in the horizontal direction is generally an order of magnitude higher than hydraulic conductivity in the vertical direction (Todd 1980; Freeze and Cherry 1979), the horizontal hydraulic conductivity of the shallow groundwater system is assumed to be 1.8 x10^{-5} m/s (5.02 feet/day). This estimated horizontal hydraulic conductivity falls within the range of conductivities reported for the silty sand and gravel to sandy gravelly silt deposits that characterize the subsurface of the Upper Hanlon Creek Watershed (i.e., 10^{-3} m/s to 10^{-6} m/s; Gamsby and Mannerow Ltd. 1993).
- **x, y** - The dimensions of the infiltration trench are 33.3 m (109.2 feet) long by 12.7 m (41.8 feet) wide.
- **t** - The time taken for the infiltration gallery to drain following a 25 mm storm event is 24 hours (one day).
- **hi(0)** – A saturated zone thickness of 19.0 m (62.3 feet) (i.e., high groundwater elevation of 339.0 m AMSL minus bedrock surface elevation of 320.0 m AMSL that underlies the Site).

Table 14 presents the results of the groundwater mounding analysis for the South Infiltration Trench. Based on the above input parameters, the maximum groundwater mounding predicted to occur beneath the center of the South Infiltration Trench after a 25 mm event is 1.1 m, equating to an elevation of 340.1 m AMSL based on the seasonally high groundwater elevation (i.e., 339.0 m AMSL + 1.1 m = 340.1 m AMSL). As shown on Table 14 and Figure 17, the rise in the groundwater table does not exceed 0.1 m beyond 30 m from the trench center point after a 25 mm storm event.

As shown in Figure 17, storm event induced mounding will temporarily raise groundwater elevations beneath the underground parking area of the development by 0.7 m along southern limits of this structure, with the mound disappearing once reaching the underside of Building 2. As previously mentioned, the building and underground parking foundations will be constructed as watertight structures (sealed with a water impermeable membrane) to resist the hydrostatic pressure exerted by the groundwater. As such, no permanent drainage system / dewatering will be required for these structures. The predicted groundwater mound is also not expected to intercept the residential buildings located on the adjacent property immediately to the southeast of the Site.

Stantec notes that any overflows from the South Infiltration Trench following a greater than 25 mm storm event will be directed to an underground Permavoid storage tank and ultimately outlet to the Gordon Street storm sewer (refer to Stantec (2021) *Stormwater Management Brief* for additional details).

6.3 IMPACT TO NATURAL HERITAGE FEATURES

As shown in Figure 17, groundwater mounding predicted to occur beneath the East Infiltration Trench under the previously mentioned storm event scenario will not intercept the Torrance Creek Swamp, which is located approximately 75 m to the northeast from where the groundwater mounding effects cease. As such, there is no opportunity for the groundwater mounding to potentially reverse vertical hydraulic gradients observed to occur beneath this wetland (i.e., reversing from a groundwater discharge to recharge function).

Eventually, when storm water exiting the East Infiltration Trench and infiltrating to the groundwater table equals the rate at which the receiving groundwater system can transport this water away, the mounding will subside. This recharge water will flow through the groundwater system to the northeast and discharge to the Torrance Creek Swamp. Stantec's opinion is that this increased recharge will not only help to maintain, but likely enhance, groundwater inputs to the wetland.

7.0 GROUNDWATER DEWATERING ASSESSMENT

The following section evaluates the potential onsite needs for construction dewatering and/or the installation of a permanent drainage system, and what mitigation measures could be employed at the Site to minimize any potential disturbances these activities may cause to the form and function of the groundwater system. If dewatering is anticipated, the section will also provide an indication of the quantity and quality of groundwater that will be discharged to the City sewer system. The evaluation is based on information collected from the Site as part of the field investigation together with a review of available background hydrogeological information.

7.1 GROUNDWATER DEWATERING – QUANTITY

7.1.1 Construction Dewatering Volumes

The proposed residential development is to consist of two 12 story apartment buildings having nine townhouse units and 368 apartment units. The development will have a combination of surface parking and two levels of underground parking. The proposed footprint of the underground parking area will cover approximately 11,450 m^2, with the anticipated base of the second level of underground parking being located at an elevation of 335.7 m AMSL. Since seasonally high groundwater depths measured within the proposed underground parking area range from 1.0 m to 4.8 m BGS (334.0 m to 340.3 m AMSL), Stantec anticipates that the excavation for this sturcture will intercept the groundwater table.

Stantec utilized the Dupuit-Forchheimer equation (Powers et al., 2007) to calculate what volume of dewatering could be required to lower the groundwater elevation in the excavation of the underground parking area:

$$Q = \frac{\pi K(H^2 - {h_w}^2)}{\ln R_o/r_w}$$

where Q = steady state pumping rate (m^3/s)
K = representative hydraulic conductivity (m/s)
H = height of static water level above assigned datum (m)
h_w = depth of dewatering relative to assigned datum (m)
r_w = equivalent radius of dewatering area (m)
R_o = dewatering radius of influence (m)

The input parameters required for this equation were taken from the findings of this hydrogeological investigation, regional geological studies (Golder, 2011), and the layout for the proposed underground parking area (Figure 1), such as information pertaining to the projected area of the excavation, horizontal hydraulic conductivity of the subsurface material, the base elevation of the aquifer being pumped, and the targeted groundwater dewatering elevation.

For the excavation, the groundwater dewatering volume potentially required during construction is calculated based on the following assumptions:

- The groundwater table resides within the native diamicton deposits of sand and silt to silty sand / sandy silt till (Port Stanley Till) that underly the Site, which is characterized by horizontal conductivities ranging from 5.4 x 10^{-7} m/s to 1.6 x 10^{-9} m/s. The calculated bulk horizontal hydraulic conductivity for the overburden is 3.7 x 10^{-8} m/s, representing the geometric mean of the above field-tested hydraulic conductivities. For the purposes of the dewatering calculations, Stantec used the bulk horizontal hydraulic conductivity of 3.7 x 10^{-8} m/s (Table 1).
- The highest groundwater levels measured in the overburden monitoring wells constructed within the proposed footprint of the underground parking area over the monitoring period (i.e., July 2018 to June 2020) ranged from 1.0 m to 4.8 m BGS, corresponding to elevations of 334.0 m to 340.3 m AMSL. A high groundwater elevation of 340.3 m AMSL was assumed to occur over the full area of the proposed underground parking, with this assumption contributing to the overall conservative nature of the analysis.
- The depth of dewatering is set to 1.0 m below the elevation of the second parking level, which will be constructed at an elevation of 335.7 m AMSL (i.e., 335.7 m – 1.0 m = 334.7 m AMSL).
- The base of the groundwater flow system is set to the elevation of the bedrock surface, which is estimated to occur at an elevation of 320 m AMSL.
- The area of the proposed underground parking structure is estimated to be 11,450 m^2.

Based on the above assumptions, the predicted maximum daily volume of groundwater that will be pumped from the subsurface within the footprint of the underground parking area is approximately 37,700 L (Table H1, Appendix H). Stantec notes that this predicted groundwater volume will likely only be realized during the initial stages of dewatering, with the bulk of this volume representing groundwater that is stored in the overburden deposits. Once this overburden storage is drained and removed from the subsurface, Stantec anticipates that the pumping volumes will lower to reflect a reduced rate of groundwater flowing into the excavation (i.e., normalize to a steady state discharge rate). To account for the initial removal of overburden storage volumes and potential basal groundwater seepage into the excavation, a 3.0 factor of safety is applied to the previously mentioned calculated steady state inflow rate, resulting in a projected dewatering volume of **113,100 L/day**. Stantec notes that these dewatering calculations are estimates and will be subject to adjustments if any changes are made to the input parameters discussed above.

Stantec notes that the predicted dewatering volume does not account for any runoff that may enter the open excavation during construction following a rainfall and/or snowmelt event. Assumming that the excavation required to construct the underground parking garage area is fully open (i.e., 11,450 m^2) during a 25 mm precipitation event, the resulting volume of stormwater accumulating in the excavation together with groundwater inflow volumes could be in the range of **399,350 L.**

Under O. Reg. 64/16 and O. Reg. 63/16, a MECP Permit to Take Water (PTTW) is required when construction dewatering rates are anticipated to exceed 400,000 L/day, whereas an Environmental Activity and Sector Registry (EASR) is required when dewatering volumes are expected to range between 50,000 L/day and 400,000 L/day. Consequently, Stantec's opinion is that Site will require an EASR to complete construction dewatering for the proposed underground parking garage.

The MECP has made recent amendments to EASR requirements for construction dewatering that came into effect July 1, 2021. The following provides a brief summary of the changes:

- The ability to register multiple dewatering pits for a single project under the same EASR.
- Allowing construction dewatering of up to 400,000 L/day for each dewatering pit as long as the dewatering area of influence do not overlap.
- Stormwater will no longer be counted in the 400,000 L/day water taking limit, however, registrants will at a minimum be required to keep a record of precipitation events, or if determined by a Qualified Person, detailed monitoring/documentation.
- EASRs will apply to linear projects including transit and pipelines.
- Registrants will be required to notify the local municipalities and conservation authorities if the water taking is intended to continue for more than 365 days.

Based on the predicted volumes to be pumped from the native diamicton deposits of sand and silt to silty sand / sandy silt till (Port Stanley Till), groundwater dewatering is expected to be handled using conventional pumping methods (i.e., standard sump pumps).

7.1.2 Dewatering Radius of Influence

One of the key issues of concern with the performing of dewatering activities for construction purposes is the potential impact that pumping water from the groundwater system could have on the hydrogeological form and function of nearby natural heritage features, such as the Torrance Creek Swamp.

Based on the above calculations, temporary construction dewatering will likely be required for the short-term cut and cover works associated with the building construction. The effects of local dewatering in general cannot be mitigated, since dewatering deliberately seeks to create an effect (i.e., temporary lowering of groundwater levels); however, the amount of drawdown to occur due to construction activities is expected to remain within a relatively small distance around the excavations due to the low permeability of the surrounding deposits. The lateral extent of groundwater level drawdown from the excavation areas is calculated using the Sichart and Kryieleis method (Powers et al., 2007):

$$R_o = r_w + 3000(H - h_w)\sqrt{K}$$

where R_o = dewatering radius of influence (m)
K = representative hydraulic conductivity (m/s)
H = height of static water level above assigned datum (m)
h_w = depth of dewatering relative to assigned datum (m)
r_w = equivalent radius of dewatering area from center of the excavation (m)

According to the calculation, the predicted dewatering radius of influence from the proposed development is approximately 64 m from the edge of the excavation area (Table H1, Appendix H). Overall, the radius of influence from short-term construction dewatering is not expected to extend into nearby natural heritage features (Figure 18).

7.1.3 Long-term Drainage

The proposed foundation of the underground parking area will be constructed with a waterproof base and, as such, no permanent drainage system / dewatering is planned for this structure.

7.2 GROUNDWATER DEWATERING – QUALITY

7.2.1 Discharging to Storm Sewer

As discussed in Section 4.2.4, groundwater quality results for the sample collected from MW2-18 (Table 4) indicate that any potential dewatering volumes cannot be discharged to the City storm sewer system as the following parameters exceed the City of Guelph Sanitary and Storm Sewer By-law (1996)-15202 limits due to concentrations exceeding the following parameters:

- Fecal Coliform (200 MPN/100mL): exceeded the storm sewer limit with a count of 350 MPN/100mL.
- Total Cadmium (0.001 mg/L): exceeded the storm sewer limit with a concentration of 0.0019 mg/L.
- Total Copper (0.01 mg/L): exceeded the storm sewer limit with a concentration of 0.03 mg/L.
- Total Lead (0.05 mg/L): exceeded the storm sewer limit with a concentration of 0.13 mg/L.
- Total Suspended Solids (15 mg/L): exceeded the storm sewer limit with a count of 2,500 mg/L.
- Total Zinc (0.05 mg/L): exceeded the storm sewer limit with a concentration of 0.64 mg/L.

7.2.2 Discharging to Sanitary Sewer

Groundwater at the Site does largely satisfy the bylaw limits to permit discharging to the City sanitary sewer system, except for TSS:

- Total Suspended Solids (350 mg/L): exceeded the sanitary sewer limit with a count of 2,500 mg/L.

However, if groundwater is treated for TSS (e.g., filtration or sedimentation measures) prior to leaving the Site, the concentration for this parameter can be reduced to levels that would allow for this groundwater to be discharged to the sanitary sewer system.

Prior to discharging groundwater pumped from the excavation (during construction dewatering) to the sanitary sewer, the Contractor retained to complete the dewatering will be expected to implement measures to reduce TSS in the discharge water to below the corresponding concentrations mentioned above.

The Contractor should consult with the City to confirm whether there are preferred methods and/or policies for reducing TSS concentrations in discharge water (including monitoring requirements). In Stantec’s experience, common mitigation measures utilized to reduce TSS concentrations in discharge water can include:

- wrapping of the inlet pump head (i.e., sump/trash pumps) with filter fabric and surrounding the inlet with clear stone, or equivalent
- passing discharge water through geotextile filter bags or straw bale/filter fabric device
- directing discharge through a tank, allowing time for the suspended solids to settle out prior to being released to the sewer.

In addition, the Contractor’s responsibilities will often include:

- obtaining a sewer use permit prior to discharging to the sanitary sewer
- ensuring that the quality of the pumped groundwater meets required By-law limits
- complete any additional groundwater quality testing as required by the City of Guelph.

8.0 IMPACT ASSESSMENT AND MITIGATION MEASURES

8.1 GROUNDWATER RECHARGE

As per the proposed Site Plan (Figure 1), development is to include the construction of two 12 story apartment buildings having nine townhouse units, internal roadways, surface parking, and two levels of underground parking. In the areas of the Site where this development is to occur, there will also be the introduction of impervious surfaces (e.g., rooftops, concrete/asphalt roadways, and walkways) and, subsequently, a corresponding reduction in the volume of water infiltrating to the subsurface. The potential impacts associated with the introduction of impervious surfaces on the recharge function of the Site are discussed below.

Under the post-development condition, impervious surfaces in the former Catchment 101 (lands draining to the Upper Hanlon Creek Subwatershed) are expected to cover approximately 80% of the post-development catchment areas (1.16 ha of 1.46 ha), resulting in a projected infiltration volume deficit of 2,000 m^3/year (i.e., from 2,553 m^3/year to 553 m^3/year) (Tables 9 and 12). For the former Catchment 102 (lands draining to the Torrance Creek Subwatershed), impervious surfaces will cover approximately 1% of the post-development catchment areas (0.02 ha of 1.60 ha), resulting in a projected infiltration volume deficit of 279 m^3/year (i.e., from 3,828 m^3/year to 3,550 m^3/year) (Tables 10 and 13). Overall, the total volume of infiltration at the Site will be reduced from 6,381 m^3/year to 4,103 m^3/year (infiltration deficit of 2,278 m^3/year) from the pre- to post-development condition.

Low impact development (LID) is a stormwater management strategy that seeks to mitigate the impacts of increased stormwater runoff by managing this runoff as close to source as possible, with the implementation of such strategies also providing the residual benefit of offsetting potential infiltration losses associated with the increase in impervious surfaces associated with a given development. Infiltration augmentation options (as described in CVC-TRCA *Low Impact Development Stormwater Management Planning and Design Guide*, 2010) that could potentially be available for use across the Site to assist in maximizing infiltration under the post-development condition include:

- roof downspout disconnection
- soakaways / infiltration trenches
- bioretention cells
- vegetated filter strips
- grass swales or enhanced grassed swales

As discussed in the Stormwater Management Brief, which is provided in the *Functional Servicing Report* (Stantec, 2021), the post-development LID infiltration strategy proposed for the Site will involve the construction of two infiltration facilities referred to as the East Infiltration Trench and South Infiltration Trench (Figure 12).

The East Infiltration Trench is designed return infiltration volumes lost from the pre- to post-development condition within the portion of the Site located within the Torrance Creek Subwatershed. This trench is sized to infiltrate a 25 mm storm event captured by the 2,300 m^2 of building rooftop in Catchment 203, resulting in an infiltration volume of 57.5 m^3 for each such storm event. As per historical climate records (Table 11), on average there are approximately five days a year where storm events total 25 mm, equating to a total volume of 287 m^3 that will be directed to the infiltration gallery and, subsequently, mitigate roughly 40% of the projected annual infiltration deficit. Given that there are on average a total of 29 days where precipitation totals will range from 10 to 25 mm (assume each daily event is 10 mm: 0.01 m * 2,300 m^2 * 29 days = 667 m^3) and 55 days where precipitation totals will range from five to 10 mm, it is reasonable to conclude that the proposed East Infiltration Trench will more than mitigate the remaining annual infiltration deficit for this portion of the Site.

The South Infiltration Trench is designed return infiltration volumes lost from the pre- to post-development condition within the portion of the Site located within the Upper Hanlon Creek Subwatershed. This trench is sized to infiltrate stormwater captured by 9,300 m^2 of impervious surfaces associated with the Building 1 rooftop (Catchment 202) and parking areas within Catchments 204 and 208 during a 25 mm storm event, resulting in an infiltration volume of 232.5 m^3 for each such storm event. As per historical climate records (Table 11), on average there are approximately five days a year where storm events total 25 mm, equating to a total volume of 1,185 m^3 that will be directed to the South Infiltration Trench and will mitigate roughly 57% of the projected annual infiltration deficit. Given that there are on average a total of 29 days where precipitation totals will range from 10 to 25 mm (assume each daily event is 10 mm: 0.01 m * 9,300 m^2 * 29 days = 2,967 m^3) and 55 days where precipitation totals will range from five to 10 mm, it is reasonable to conclude that the proposed South Infiltration Trench will be capable at mitigating the remaining annual infiltration deficit for this portion of the Site.

8.2 GROUNDWATER DEWATERING

One of the key issues of concern with the performing of dewatering activities for construction purposes is the potential impact that pumping water from the groundwater system could have on nearby natural heritage features.

The effects of local dewatering in general cannot be mitigated, since dewatering deliberately seeks to create an effect (i.e., temporary lowering of groundwater levels); however, the amount of drawdown expected to occur due to construction activities is expected to remain within a small distance around the development excavation. According to the dewatering calculations, the predicted maximum horizontal distance that the pumping zone of influence will extend outward from the active zone of dewatering is estimated at 64 m. As shown in Figure 17, this predicted dewatering radius of influence will not intercept the Torrance Creek Swamp to the northeast or Hanlon Creek Swamp to the southwest of the Site.

Stantec notes that the residual effects of short-term construction dewatering are reversible seeing that once pumping ceases, groundwater levels will recover and re-equilibrate to the local groundwater table.

Since the proposed underground parking area will be constructed with a waterproof base, no permanent drainage system / dewatering is planned for this structure. As such, there will be no long-term effects of permanent dewatering associated with this development.

8.3 SOURCE WATER PROTECTION

A drinking-water threat is an activity or condition that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as a source of drinking water. The following activities are prescribed by the province of Ontario under O. Reg. 287/07 to be drinking water threats (i.e., Significant Drinking Water Threat Policy Categories):

1. The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*.
2. The establishment, operation or maintenance of a system that collects, stores, transmits, treats, or disposes of sewage.
3. The application of agricultural source material to land.
4. The storage of agricultural source material.
5. The management of agricultural source material.
6. The application of non-agricultural source material to land.
7. The handling and storage of non-agricultural source material.
8. The application of commercial fertilizer to land.
9. The handling and storage of commercial fertilizer.
10. The application of pesticide to land.
11. The handling and storage of pesticide.
12. The application of road salt.
13. The handling and storage of road salt.
14. The storage of snow.
15. The handling and storage of fuel.
16. The handling and storage of a dense non-aqueous phase liquid (DNAPL).

17. The handling and storage of an organic solvent.

18. The management of runoff that contains chemicals used in the de-icing of aircraft.

19. An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body.

20. An activity that reduces the recharge of an aquifer.

21. The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.

The Site is intercepted by the Burke Well WHPA-B and -C, noting that the footprint for the proposed development is confined to the WHPA-C. The WHPA-C has an assigned vulnerability score ranging from four (4) to six (6) (Figure 6), indicating that the threat of an activity or condition occurring at ground surface within this area, and subsequently adversely affecting the quality and/or quantity of the aquifer system in which the Burke Well draws its groundwater supply, is low to medium, respectively.

As per the Source Protection Plan (SPP) (LERSPC, 2015b), the Site is only subject to the protection policies specified under Significant Drinking Water Threat Policy Category 16 (DNAPLs). Since the planned use for the Site does not involve the onsite handling and storage of a DNAPL, the policies under Category 16 does not apply.

No protection policies are specified in the SPP (LERSPC, 2015b) that apply to the Site's designation as a SGRA or WHPA-E (intercepts the northeast portion of the property).

8.4 SPILL CONTAINMENT AND RESPONSE

The potential exists for spills during any construction activity, with the most probable type of spill occurring being attributable to the refuelling of construction equipment that cannot readily leave the Site (e.g., earth movers). The potential impacts of a spill could be the contamination of soils, groundwater and/or surface water. By implementing proper protocols for the handling of fuels and lubricants during construction, the risk of a spill occurring will be greatly reduced. The procedures to be implemented to prevent onsite spills are as follows:

- all trucks or other road vehicles would be refuelled and maintained offsite, where practicable
- refuelling and lubrication of other construction equipment would not be allowed within 30 m of a drainage system or dewatering excavation
- regular inspections of hydraulic and fuel systems on machinery, with leaks being repaired immediately upon detection or the equipment being removed from Site
- spill kits containing absorbent materials would be kept on hand
- implement best management practices and develop an emergency spill response plan

Given that anticipated construction activities at the Site are not expected to involve the storage or use of bulk chemicals or fuels, any potential spill that does occur would be localized and involve a small volume of material. Standard containment facilities and emergency response materials are to be maintained onsite as required, with refuelling, equipment maintenance, and other potentially contaminating activities being confined to designated areas. As appropriate, spills are to be reported immediately to the MECP Spills Action Centre.

9.0 CONCLUSIONS

Based on the hydrogeological assessment, using the existing data collected at the Site and information obtained from a background review of regional data, the following conclusions are provided:

1. Subsurface conditions across the Site consist of silty sand to sandy silt till (Port Stanley Till), which predominantly forms a horizontally and vertically contiguous unit beneath the Site, with this unit being overlain by a 2.3 to 4.8 m thick diamicton deposit consisting of very loose to dense sand and silt, with some gravel and trace clay. The Port Stanley Till occurs at elevations ranging from 341.6 to 334.7 m AMSL beneath the Site, with this unit extending to the termination depth of the onsite boreholes (333.4 to 324.6 m AMSL). Locally, the bedrock surface is reported to occur at an elevation of approximately 320 m AMSL and does not factor into the construction of the proposed development.

2. Groundwater depths across the Site range from 1.0 m to 9.2 m BGS over the monitoring period (July 2018 to June 2020), fluctuating between elevations of 332.6 m to 340.7 m AMSL. Overall, the highest groundwater table occurred in the spring, declining by up to 5.6 m to its lowest elevation by late fall.

3. Groundwater contours mimic the prevailing topography of the Site, with a localized groundwater divide running along the northeast-southwest axis of the drumlin upon which the property is situated (Figure 12). Groundwater flows from the divide to the northeast and southwest towards Torrance Creek Swamp and Gordon Street, respectively.

4. The estimated velocity of groundwater flowing through the overburden beneath the Site towards Torrance Creek Swamp is calculated to be approximately 0.23 m/year (i.e., one meter every 4.3 years). Groundwater flow towards Gordon Street is estimated to move at a velocity of approximately 0.52 m/year (i.e., one meter every 1.9 years).

5. Neutral to upward vertical hydraulic gradients consistently occur beneath the area of the Torrance Creek Swamp that is located approximately 75 m to the northeast of the Site, although noting that the vertical hydraulic gradient is observed to switch downward over the year. Overall, vertical hydraulic gradients beneath this wetland ranged from -0.06 to 0.17, indicating that the wetland functions as both a groundwater recharge and discharge feature. However, the potential volume of groundwater discharging to the Torrance Creek Swamp during those periods where discharge conditions are present is expected to be minimal, given that groundwater moves at a very slow rate through the overburden deposits (i.e., one meter every 4.3 years).

6. Vertical hydraulic conductivities for the sandy silt till range from 5.6×10^{-8} to 1.6×10^{-10} m/s at depths ranging from 5.0 m to 15.1 m BGS throughout the Site. However, results of infiltration testing completed in the areas of the Site where the East and South Infiltration Trenches will be constructed had vertical hydraulic conductivities ranging from 3.9×10^{-5} m/s to 1.8×10^{-7} m/s (i.e., from depths of 0.5 to 3.6 m BGS). Based on these values, the calculated infiltration rates for the previously mentioned deposits can range from as low as 5 mm/hour to an upper value of 123 mm/hour at the Site.

7. Groundwater beneath the Site is classified as calcium-bicarbonate type water. No tested parameters having health-related ODWQS were detected above their applicable standards. The ODWQS for hardness was exceeded in samples collected at all wells. The presence of elevated hardness concentrations is typical of groundwater in southern Ontario.

8. The proposed development footprint for the Site is located within the WHPA-C for the Burke Municipal Well. Subsequently, as per the Source Protection Plan, the Site is only subject to the protection policies specified under Significant Drinking Water Threat Policy Category 16 (DNAPLs). Since the planned use for the Site does not involve the onsite handling and storage of a DNAPL, the policies under Category 16 do not apply to the development.

9. Tricar is proposing to construct an infiltration facility (i.e., East Infiltration Trench) within the portion of the Site that lies within the Torrance Creek Subwatershed. Water balance calculations indicate that the proposed development of the Site will reduce infiltration volumes to the Torrance Creek Subwatershed by 279 m^3/year. However, calculations indicate that the East Infiltration Trench as currently designed will maintain to enhance pre-development infiltration volumes to this subwatershed under the post-development condition.

10. The maximum groundwater mounding predicted to occur beneath the center of the East Infiltration Trench after a 25 mm event is 0.6 m, equating to an elevation of 339.8 m AMSL based on the seasonally high groundwater elevation. Although storm event induced mounding will temporarily raise groundwater elevations beneath the foundation of Building 2, the magnitude of this mounding is not expected to exceed more than 0.1 m. Stantec notes that this building foundation (as with all onsite building foundations) will be constructed as a watertight structure (sealed with a water impermeable membrane), with the floor slab designed to structurally resist the hydrostatic pressure exerted by the groundwater.

11. Tricar is proposing to construct an infiltration facility (i.e., South Infiltration Trench) within the portion of the Site that lies within the Upper Hanlon Creek Subwatershed. Water balance calculations indicate that the proposed development of the Site will reduce infiltration volumes to the Upper Hanlon Creek Subwatershed by 2,000 m^3/year. However, calculations indicate that the South Infiltration Trench as currently designed will maintain to enhance pre-development infiltration volumes to the subwatershed under the post-development condition.

12. The maximum groundwater mounding predicted to occur beneath the center of the South Infiltration Trench after a 25 mm event is 1.1 m, equating to an elevation of 340.1 m AMSL based on the seasonally high groundwater elevation. The rise in the groundwater table does not exceed 0.1 m beyond 30 m from the trench center point after a 25 mm storm event. This groundwater storm event induced mounding will temporarily raise groundwater elevations beneath the underground parking area of the development by 0.7 m along southern limits of this structure, with the mound disappearing once reaching the underside of Building 2.

13. The predicted groundwater mounds for the East and South Infiltration Trenches are not expected to intercept the residential buildings located on surrounding properties.

14. Groundwater mounding predicted to occur beneath the East Infiltration Trench will not intercept the Torrance Creek Swamp, which is located approximately 75 m to the northeast from where the groundwater mounding effects cease. As such, there is no opportunity for the groundwater mounding to potentially reverse vertical hydraulic gradients beneath this wetland (i.e., reversing from a groundwater discharge to recharge function).

15. The steady-state groundwater pumping rate for construction dewatering activities is predicted to be 37,700 L/day. Higher dewatering rates could be realized at the start of construction and during storm / snowmelt events. A design dewatering rate of 399,350 L/day reflects a factor of safety to provide an adequate dewatering volume to account for wet weather events and potential basal groundwater seepage into the excavation. Consequently, an MECP EASR will be required to complete construction dewatering activities, given that pumped volumes will exceed 50,000 L/day and remain below 400,000 L/day. Based on the volumes predicted and the type of material (dense till), groundwater dewatering is expected to be handled using conventional pumping methods (i.e., standard sump pumps).

16. The proposed underground parking area associated with the development will be constructed with a waterproof base and, as such, no permanent drainage system / dewatering is planned for this structure.

17. According to the dewatering calculations, the predicted maximum horizontal distance that the pumping zone of influence will extend is 64 m outward from the active zone of dewatering (Figure 18). This predicted dewatering radius of influence will not intercept the Torrance Creek Swamp to the northeast or Hanlon Creek Swamp to the southwest of the Site and, consequently, not interfere with the hydrogeological function of these wetlands.

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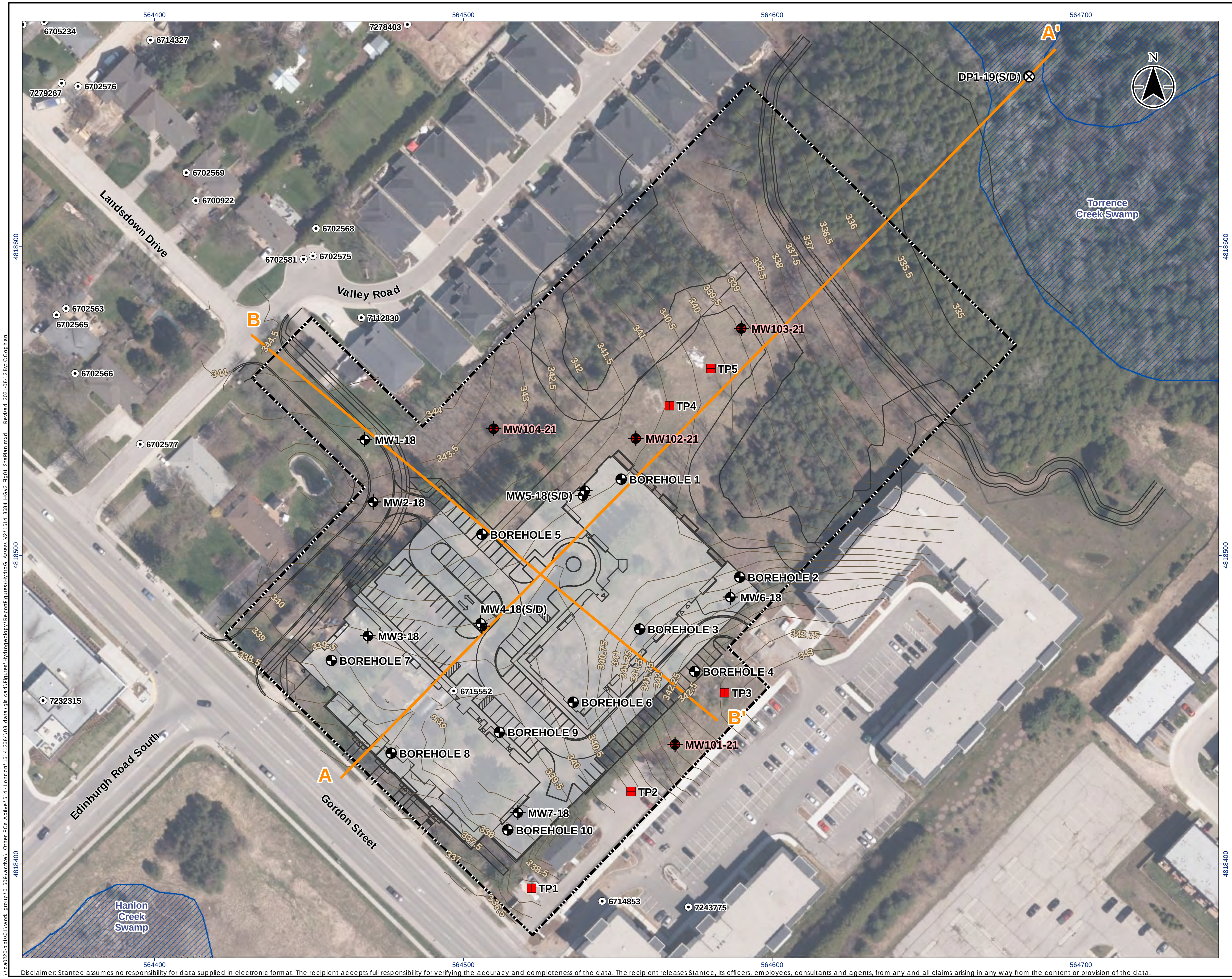
APPENDIX A:
FIGURES



Stantec

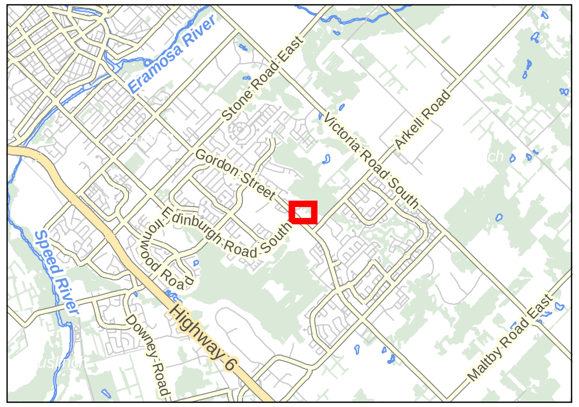
Legend

- ⬚ Site Boundary
- ⌖ Monitoring Well (Stantec, 2018)
- ⊗ Drive-Point Piezometer (Stantec, 2019)
- ◐ Borehole (CMT Engineering, 2018)
- 🟥 Test Pit (Stantec, 2021)
- ⌖ Proposed Monitoring Well (Stantec, 2021)
- ⊙ MECP Water Well
- — Cross-Section Location
- — Proposed Development Plan
- — Topographic Contour (m AMSL)
- ▭ Proposed Extent of Underground Parking
- ▨ Wetland - Evaluated (Provincial)

0 25 50
Metres

1:1,250 (At original document size of 11x17)

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, 2020.
3. Orthoimagery © First Base Solutions, 2018. Imagery flown in 2019.
4. MECP water wells have been positioned based on published UTM coordinates and should be considered approximate.



Project Location
City of Guelph

161413684
Prepared by CMC on 2021-08-12

Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
1

Title
Site Location

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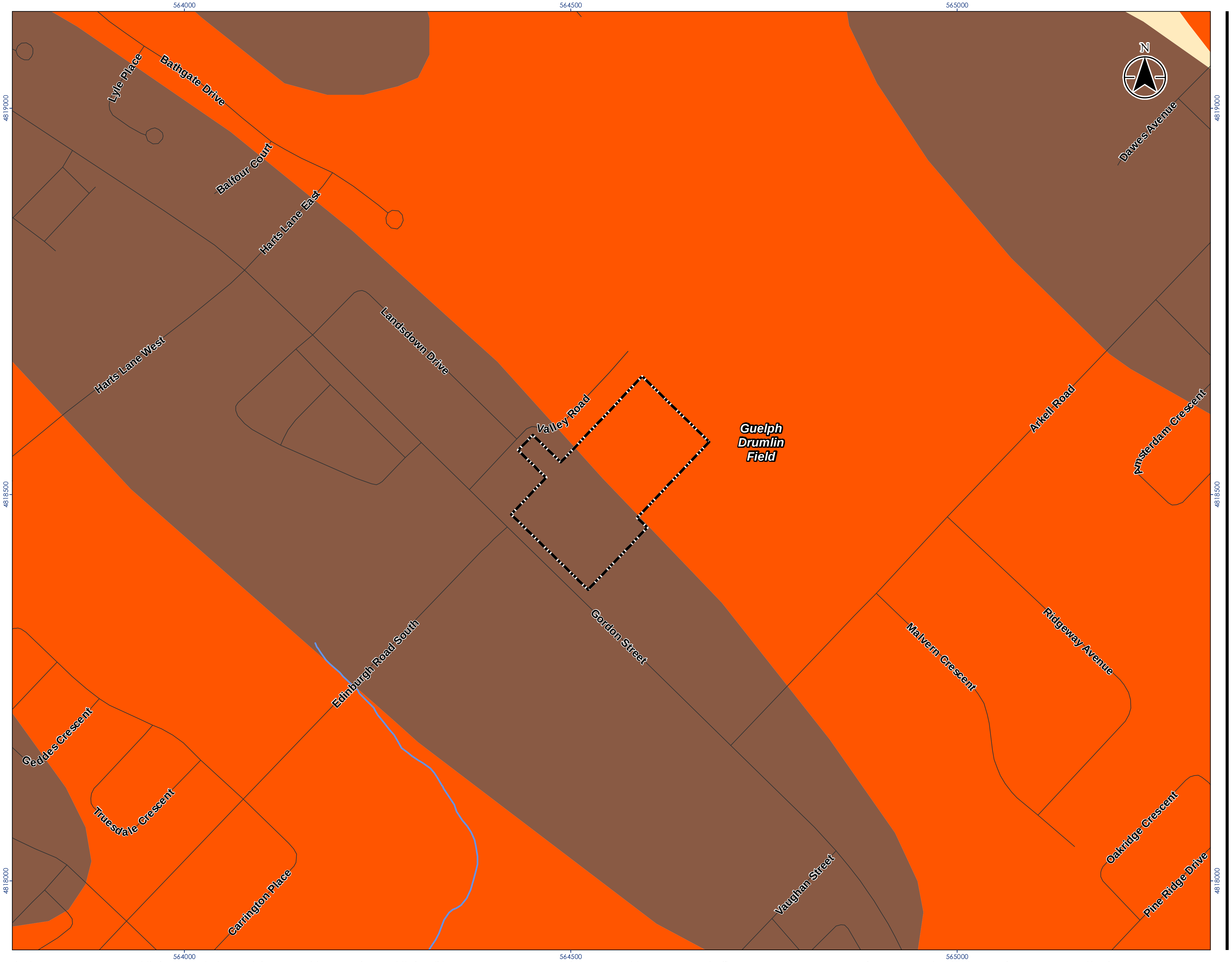


Stantec

Legend

- ⬚ Site Boundary
- Watercourse (Permanent)
- ⬚ Physiographic Region Boundary

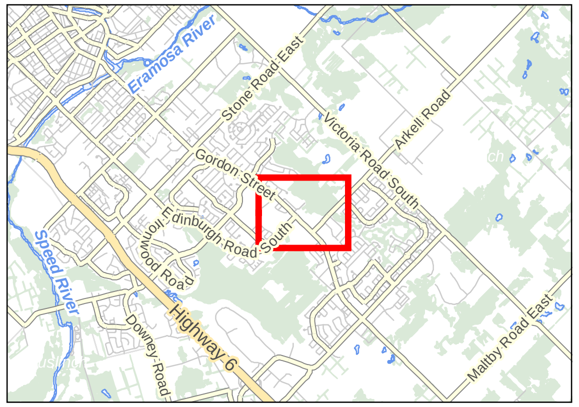
Physiography

- ■ 7: Drumlins
- ■ 6: Till Plains (Drumlinized)
- ■ 3: Spillways

0 125 250 Metres

1:5,000 (At original document size of 11x17)

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, 2018.
3. Chapman, L.J. and Putnam, D.F. 2007. Physiography of southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 228.



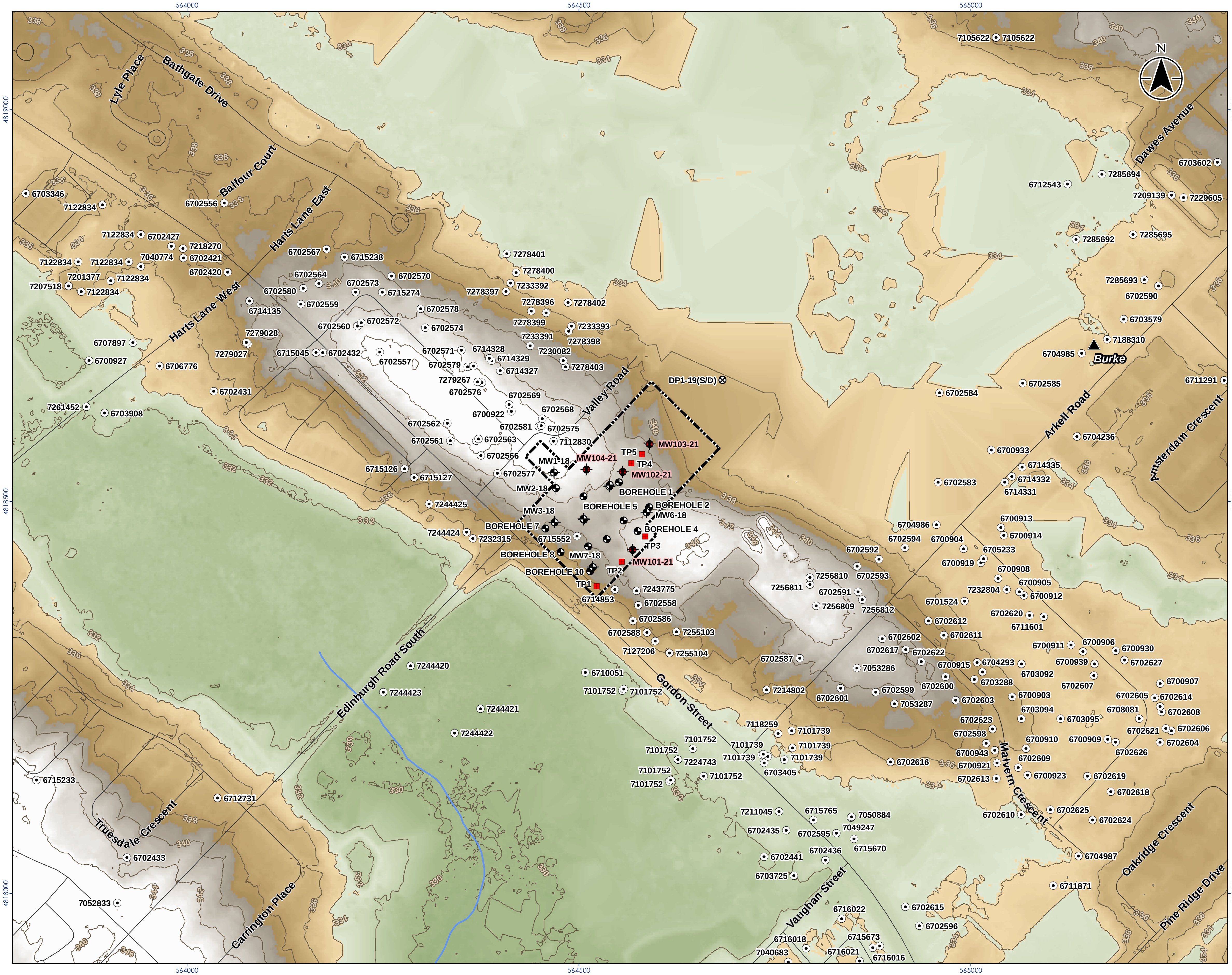
Project Location 161413684
City of Guelph Prepared by CMC on 2021-08-12

Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
2

Title
Physiography

\\ca0220-ppfss01\work_group\01609\active_Other_PCs_Active\614 - London\161413684\03_data\gis_cad\Figures\Hydrogeology\ReportFigures\HydroG_Assess_V2\161413684_HGv2_Fig02_Physiography.mxd Revised: 2021-08-12 By: CCoghlan



Stantec

Legend

- ⬚ Site Boundary
- ⌖ Monitoring Well (Stantec, 2018)
- ⊗ Drive-Point Piezometer (Stantec, 2019)
- ◐ Borehole (CMT Engineering, 2018)
- ■ Test Pit (Stantec, 2021)
- ⌖ Proposed Monitoring Well (Stantec, 2021)
- ▲ Production Well
- ⊙ MECP Water Well
- — Watercourse (Permanent)
- — Topographic Contour (m AMSL)

Ground Surface Elevation (m AMSL)

High : 348.52

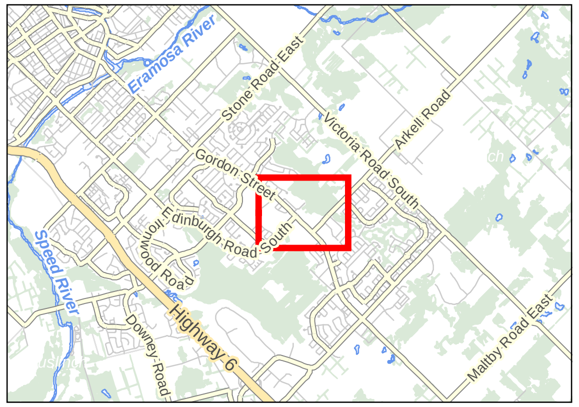
Low : 328.91

0 125 250 Metres

1:5,000 (At original document size of 11x17)

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, 2019.
3. Topography derived from the Southwestern Ontario Orthophotography Project (2015) © Queen's Printer for Ontario, 2019.

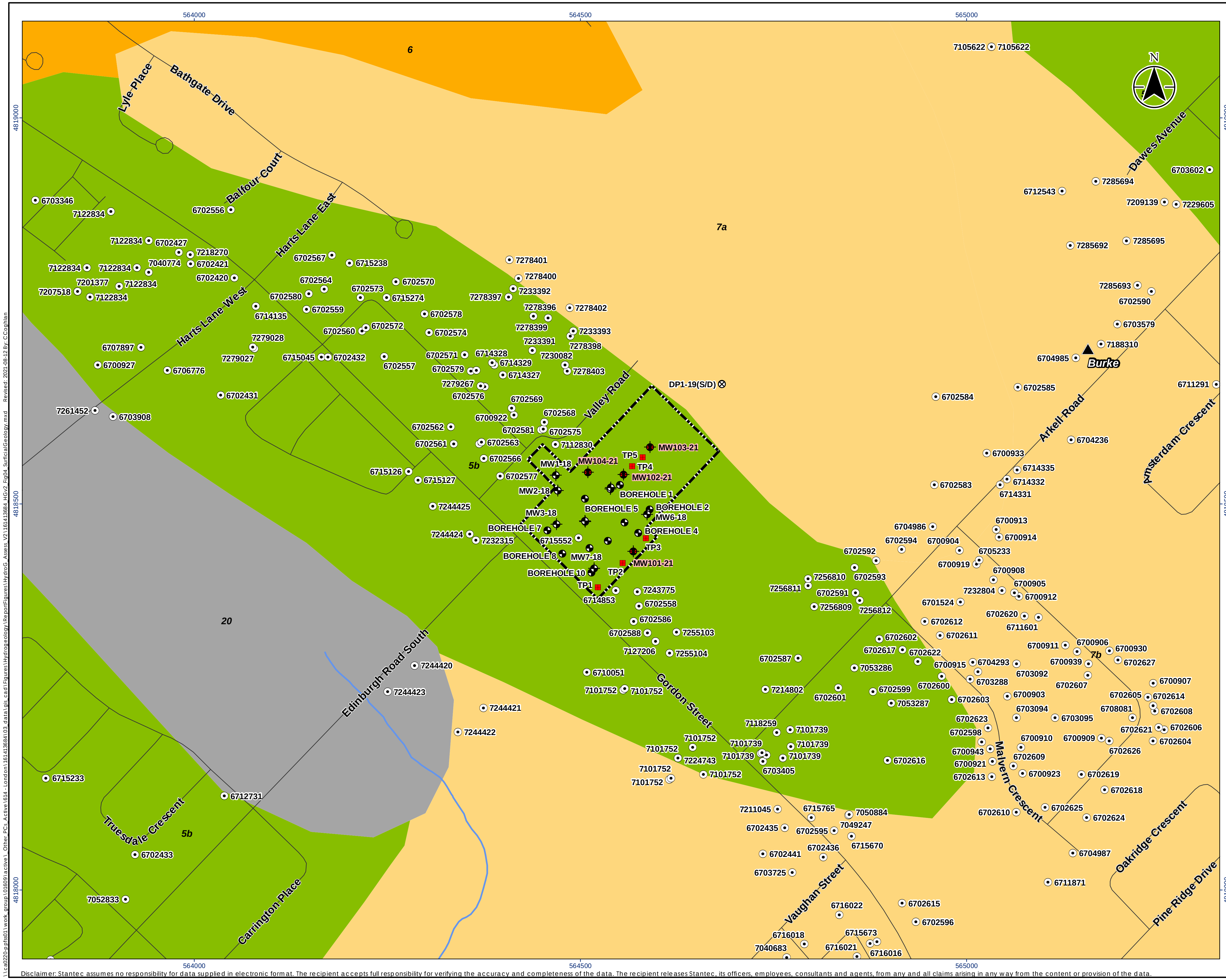


Project Location 161413684
City of Guelph Prepared by CMC on 2021-08-12

Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
3

Title
Topography



Stantec

Legend

- ⬚ Site Boundary
- ⌖ Monitoring Well (Stantec, 2018)
- ⊗ Drive-Point Piezometer (Stantec, 2019)
- ● Borehole (CMT Engineering, 2018)
- 🟥 Test Pit (Stantec, 2021)
- ⌖ Proposed Monitoring Well (Stantec, 2021)
- ▲ Production Well
- ⊙ MECP Water Well
- — Watercourse (Permanent)

Surficial Geology

- ▨ 20: Organic deposits
- ▨ 7a: Glaciofluvial deposits (Sandy deposits)
- ▨ 7b: Glaciofluvial deposits (Gravelly deposits)
- 🟧 6: Ice-contact stratified deposits
- 🟩 5b: Stone-poor, carbonate-derived silty to sandy till

0 125 250
Metres

1:5,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
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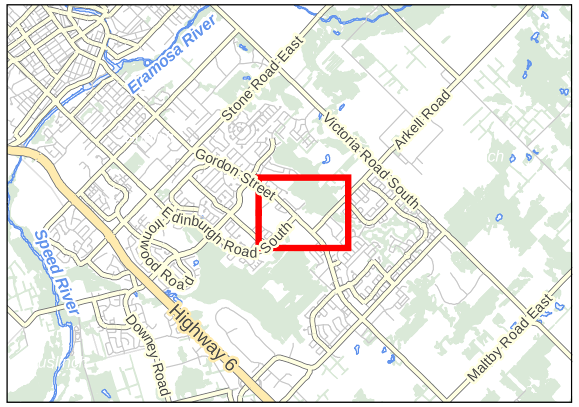
3. Ontario Geological Survey 2010. Surficial geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128-REV ISBN 978-1-4435-2483-4



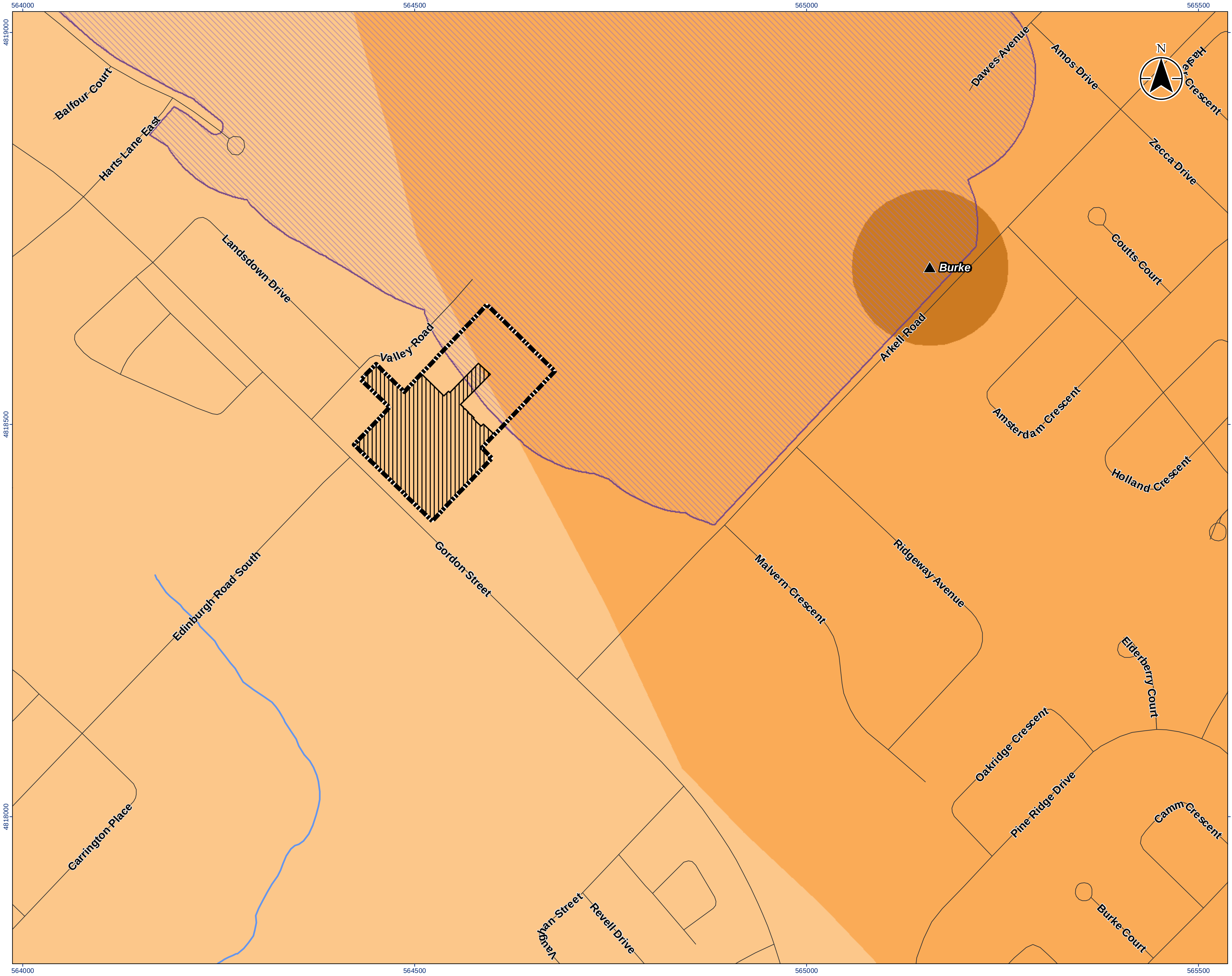
Project Location
City of Guelph

161413684
Prepared by CMC on 2021-08-12

Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
4

Title
Surficial Geology



Stantec

Legend
▭ Site Boundary
▥ Proposed Development Footprint
— Watercourse (Permanent)

Wellhead Protection Areas
■ WHPA-A
■ WHPA-B
■ WHPA-C
▨ WHPA-E

0 125 250 Metres
1:5,000 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
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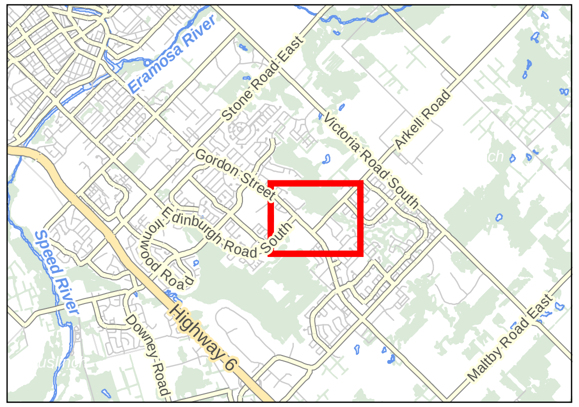
3. Wellhead protection areas © Grand River Conservation, 2018.



Project Location
City of Guelph
161413684
Prepared by CMC on 2021-08-12

Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
5

Title
Wellhead Protection Areas

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Stantec

Legend

- ▦ Site Boundary
- ▥ Proposed Development Footprint
- — Watercourse (Permanent)

Wellhead Protection Areas

- ☐ WHPA-A
- ☐ WHPA-B
- ☐ WHPA-C

Vulnerability Scoring

- 🟩 4
- 🟨 6
- 🟧 8
- 🟥 10

0 125 250 Metres

1:5,000 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
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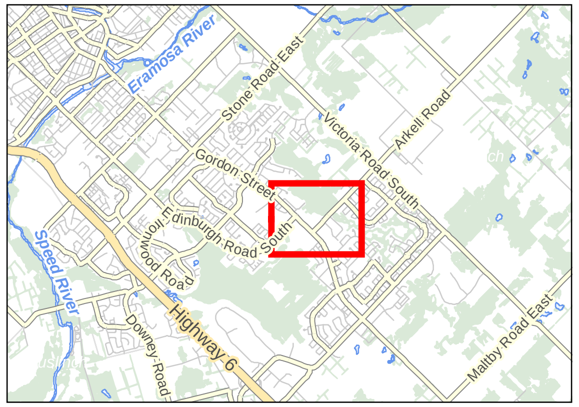
3. Wellhead protection areas © Grand River Conservation, 2018.

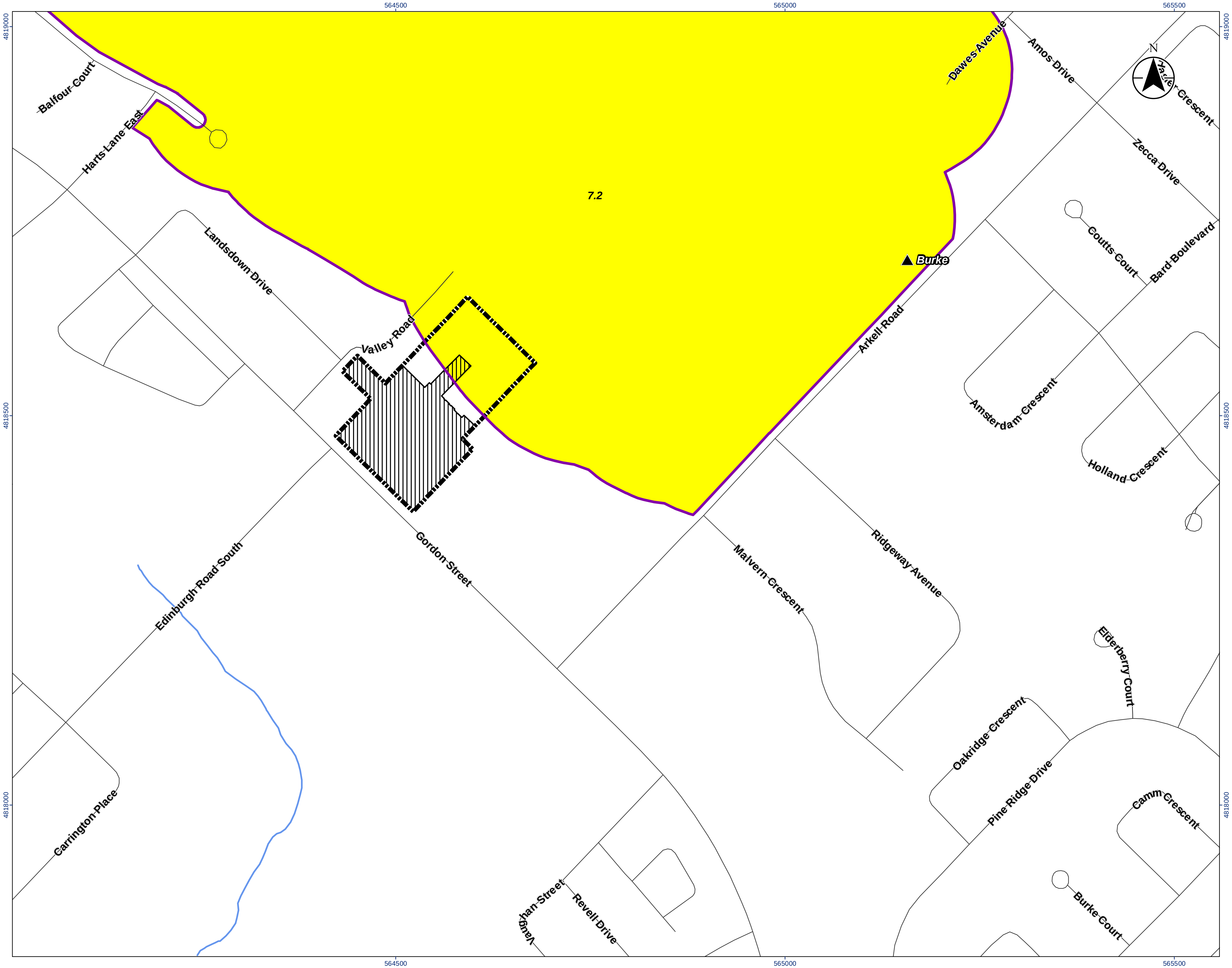


Project Location City of Guelph	161413684 Prepared by CMC on 2021-08-12

Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
6

Title
WHPA Vulnerability Scores



Stantec

Legend

▨ Site Boundary

▥ Proposed Development Footprint

— Watercourse (Permanent)

Wellhead Protection Areas

☐ WHPA-E (GUDI)

Vulnerability Scoring

🟨 7.2

0 125 250 Metres

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Notes

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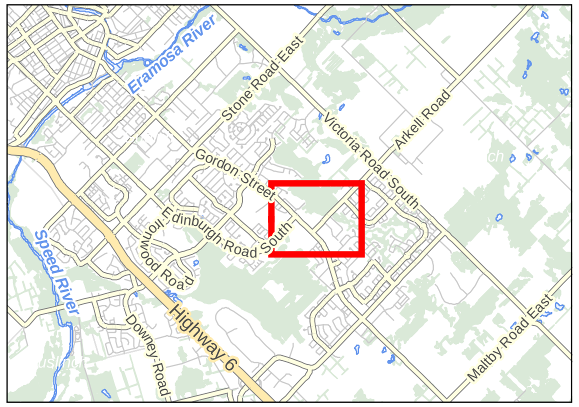

Project Location
City of Guelph

161413684
Prepared by CMC on 2021-08-12

Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
7

Title
WHPA-E Vulnerability Scores

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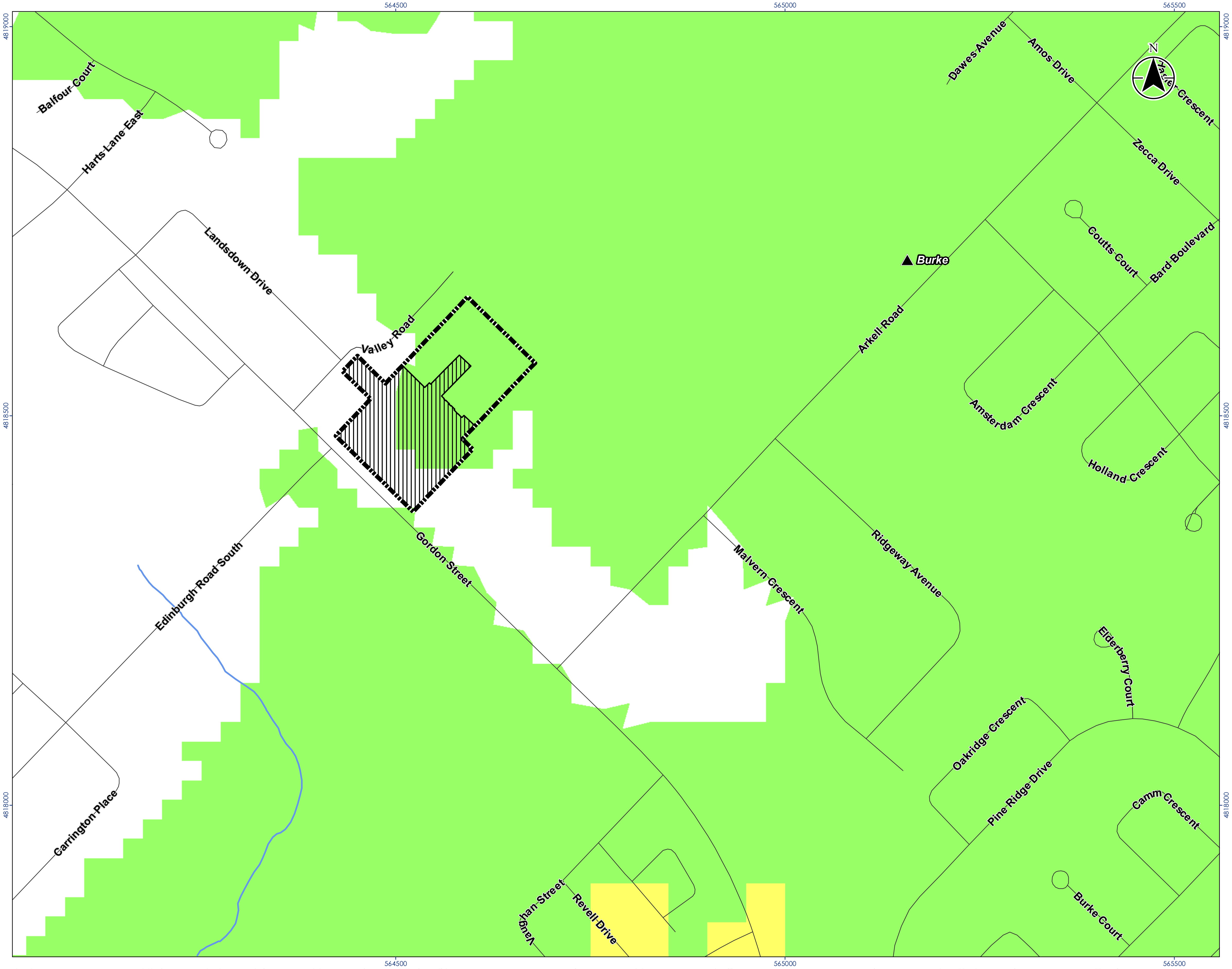

Stantec

Legend

▭ Site Boundary

▥ Proposed Development Footprint

— Watercourse (Permanent)

Significant Groundwater Recharge Area

🟨 Vulnerability 6

🟩 Vulnerability 4

0 125 250 Metres

1:5,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
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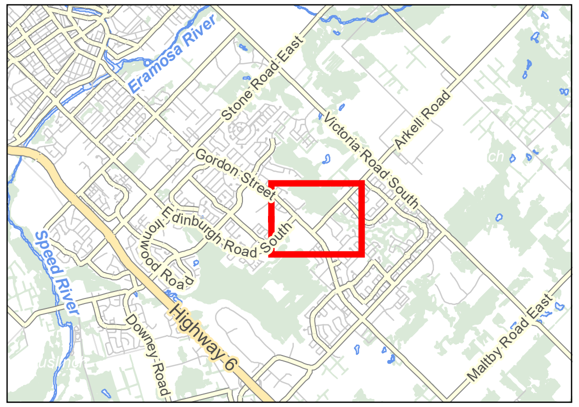


Project Location
City of Guelph

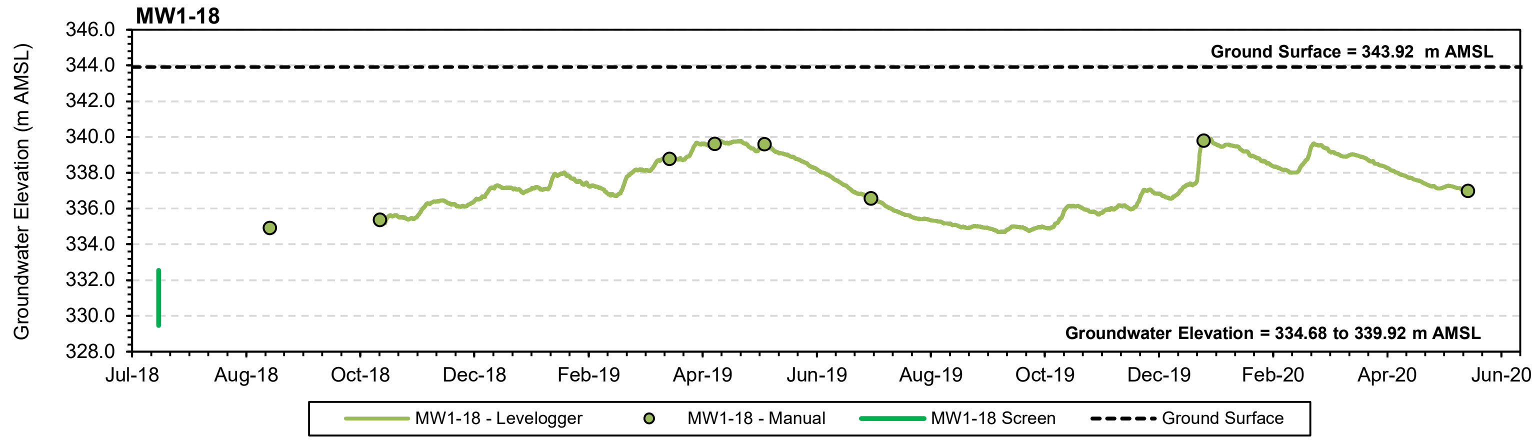
161413684
Prepared by CMC on 2021-08-12

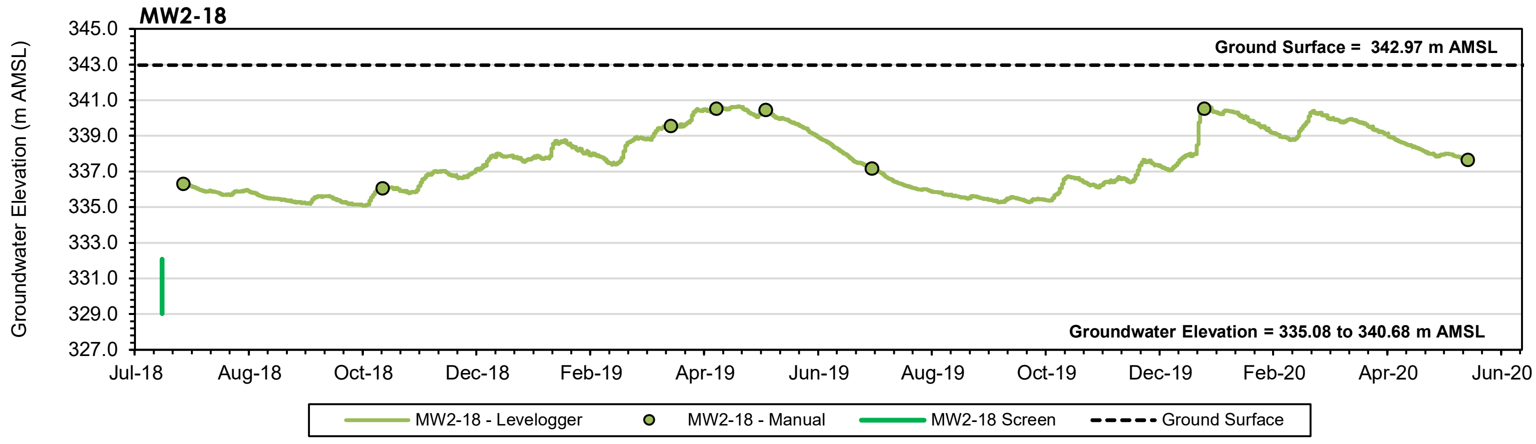
Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

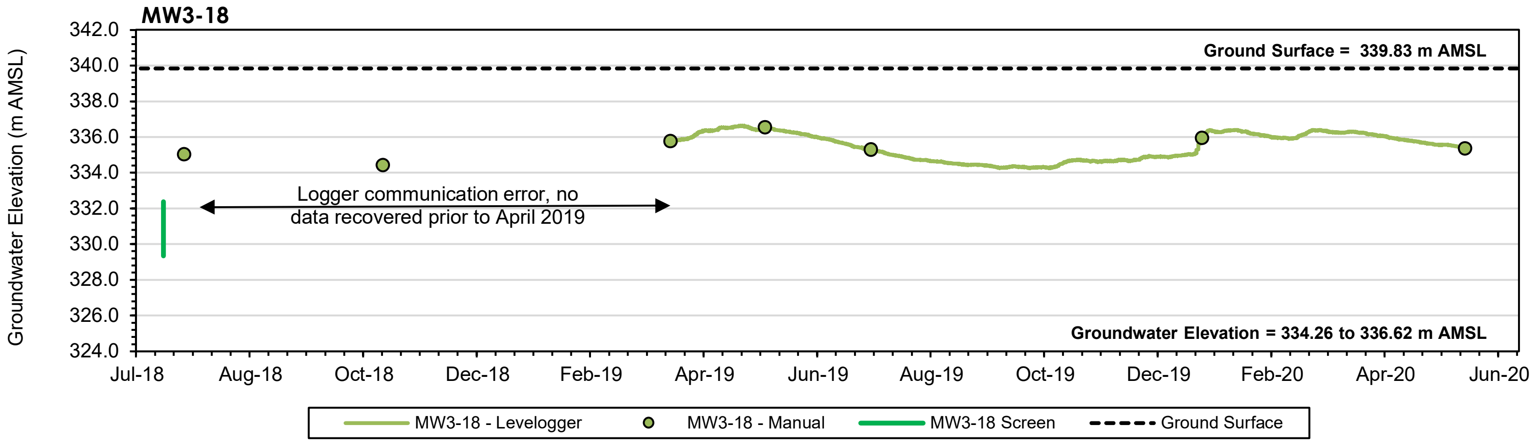
Figure No.
8

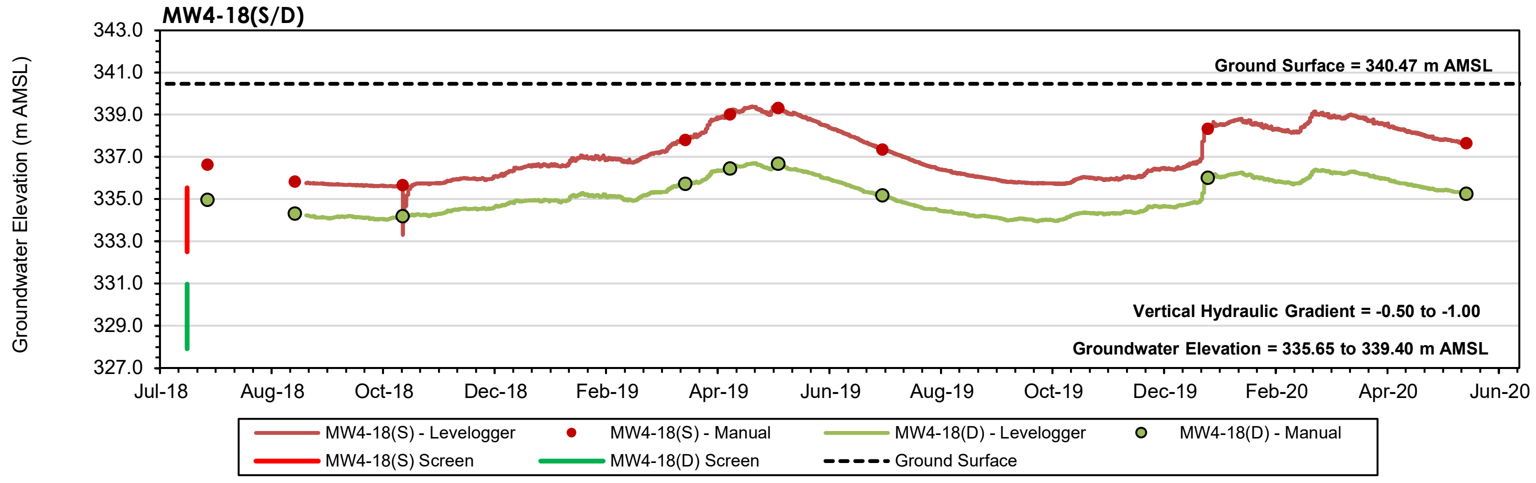
Title
Significant Groundwater Recharge Area

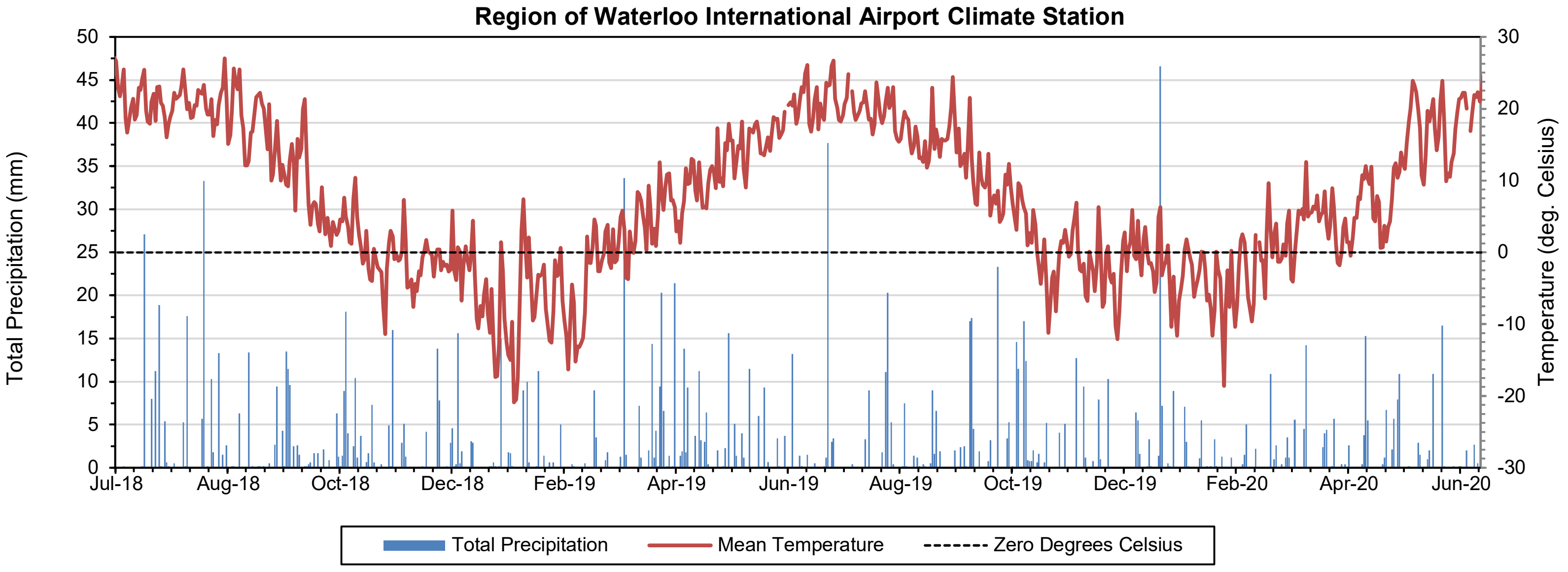
\\ca0220-ppfss01\work_group\01609\active_Other_PCs_Active\614 - London\161413684\03_data\gis_cad\Figures\Hydrogeology\ReportFigures\HydroG_Assess_V2\161413684_HGv2_Fig08_SGRA.mxd Revised: 2021-08-12 By: CCoghlan











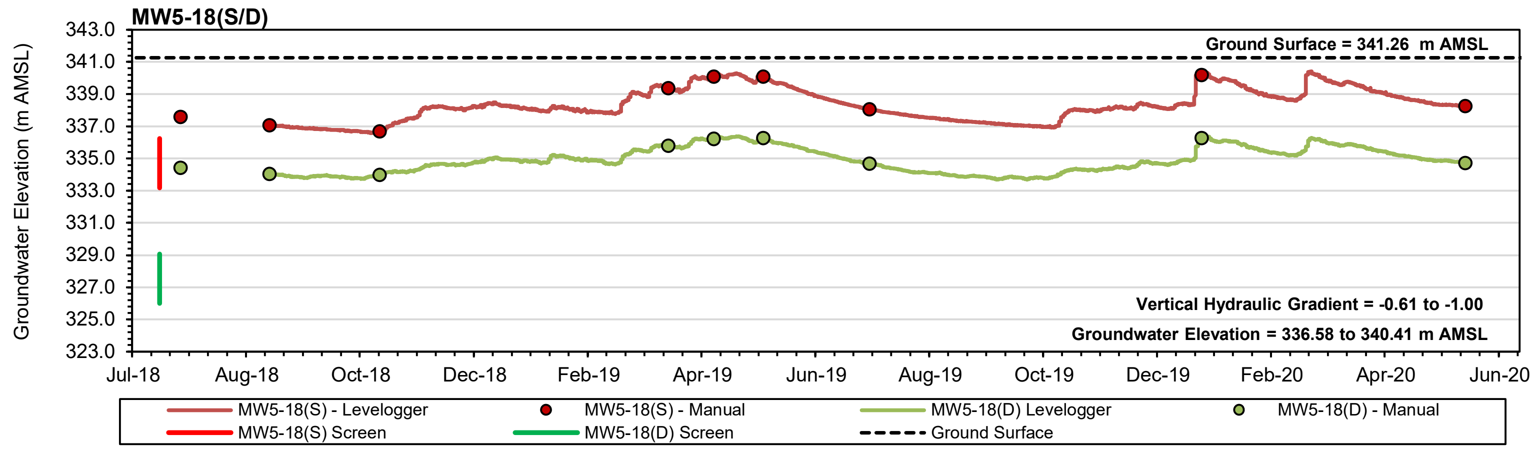
Precipitation and temperature data obtained from Environment Canada for the Region of Waterloo International Airport Climate Station (ID 6144239), accessed June 2020.

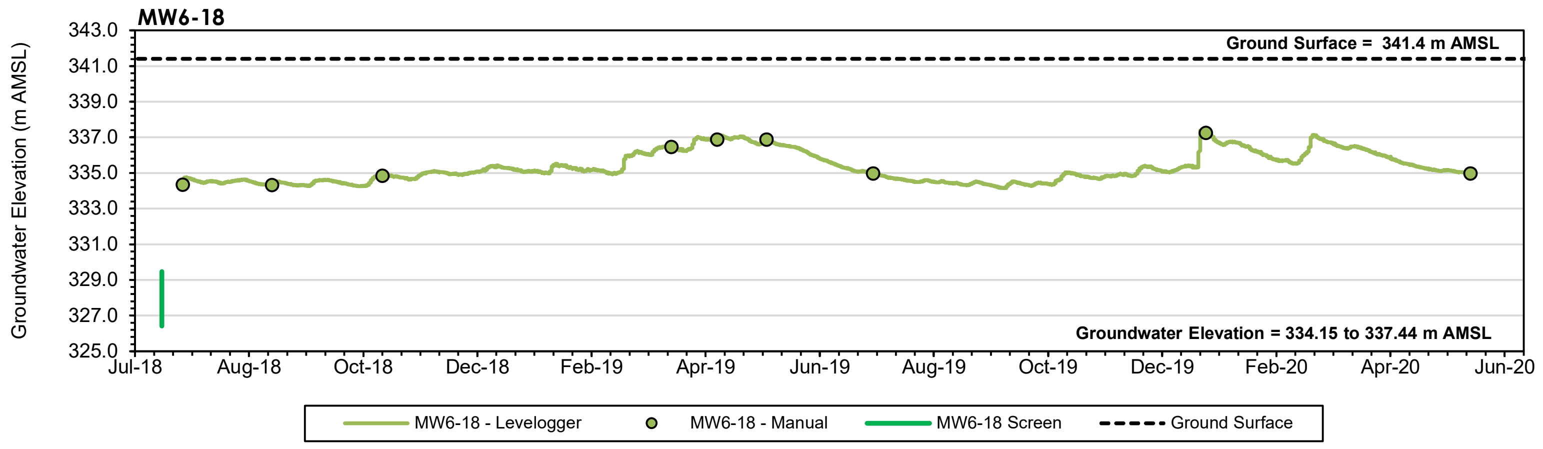
Stantec

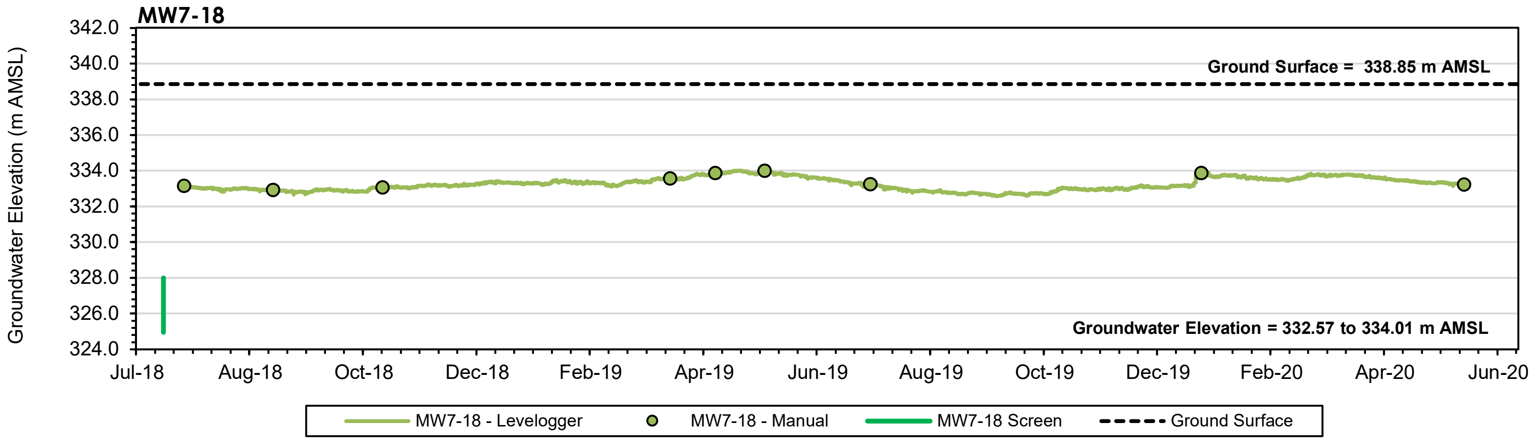
Client/Project
Tricar Developments Inc.
1242, 1250, 1260 Gordon Street and 9 Valley Road, Guelph
Hydrogeological Assessment

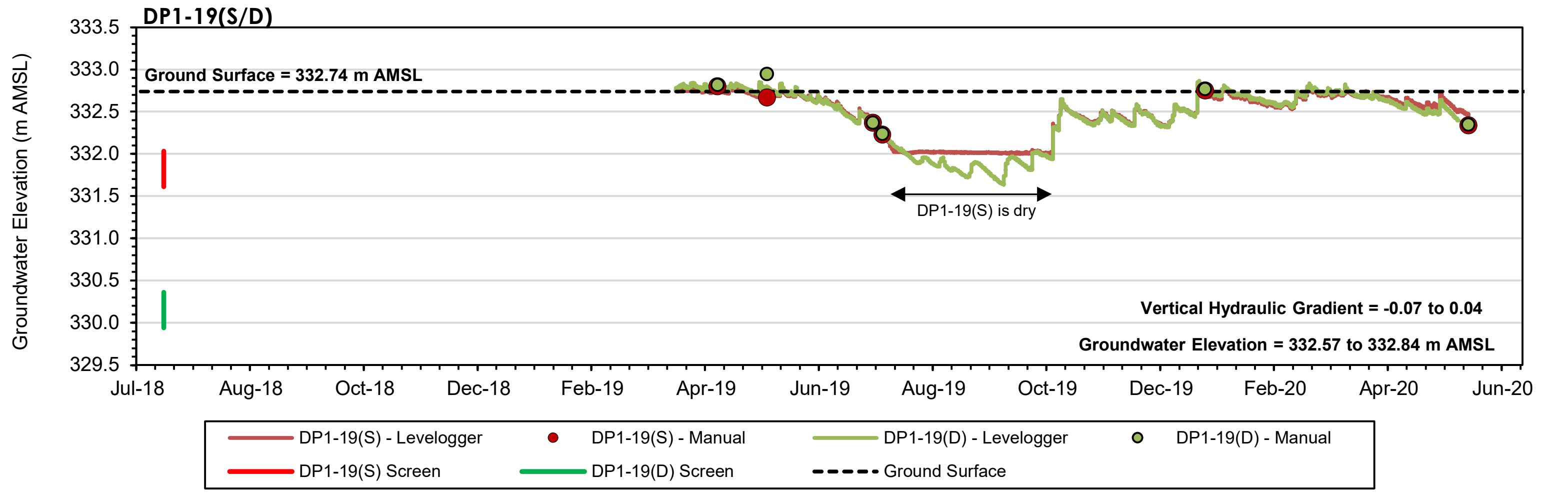
Figure No.
9

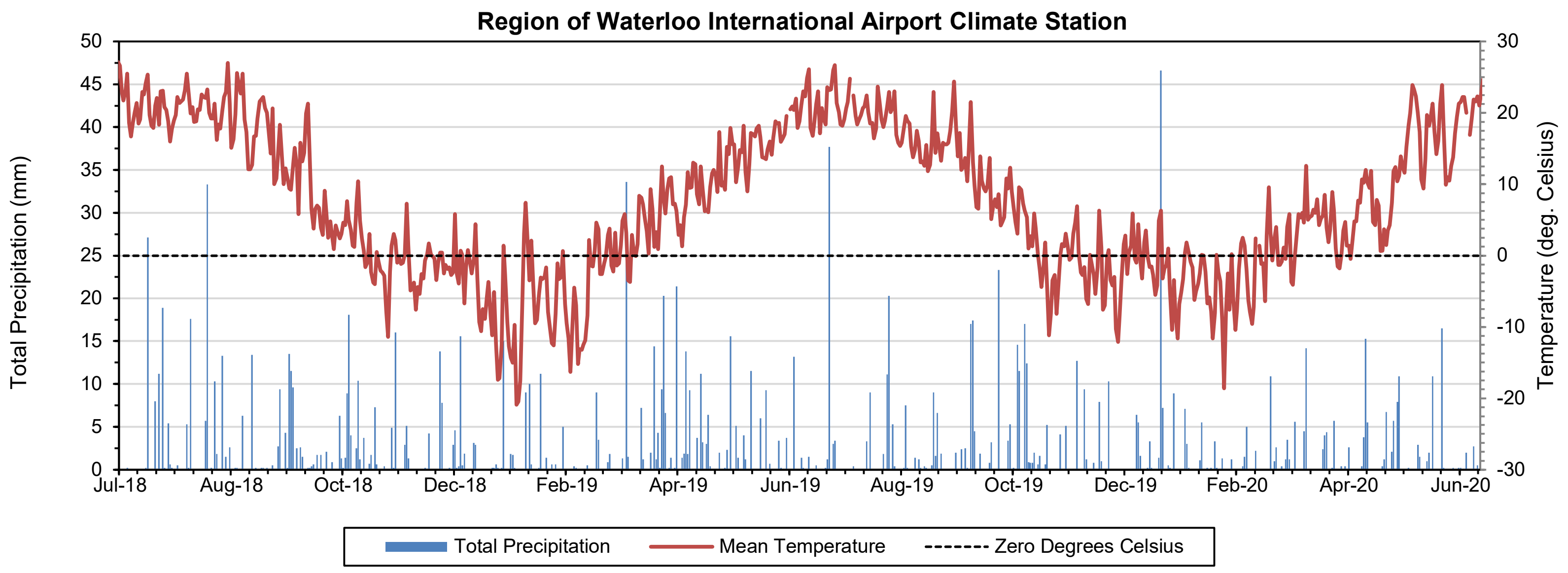
Title
HYDROGRAPHS
MW1-18 to MW4-18









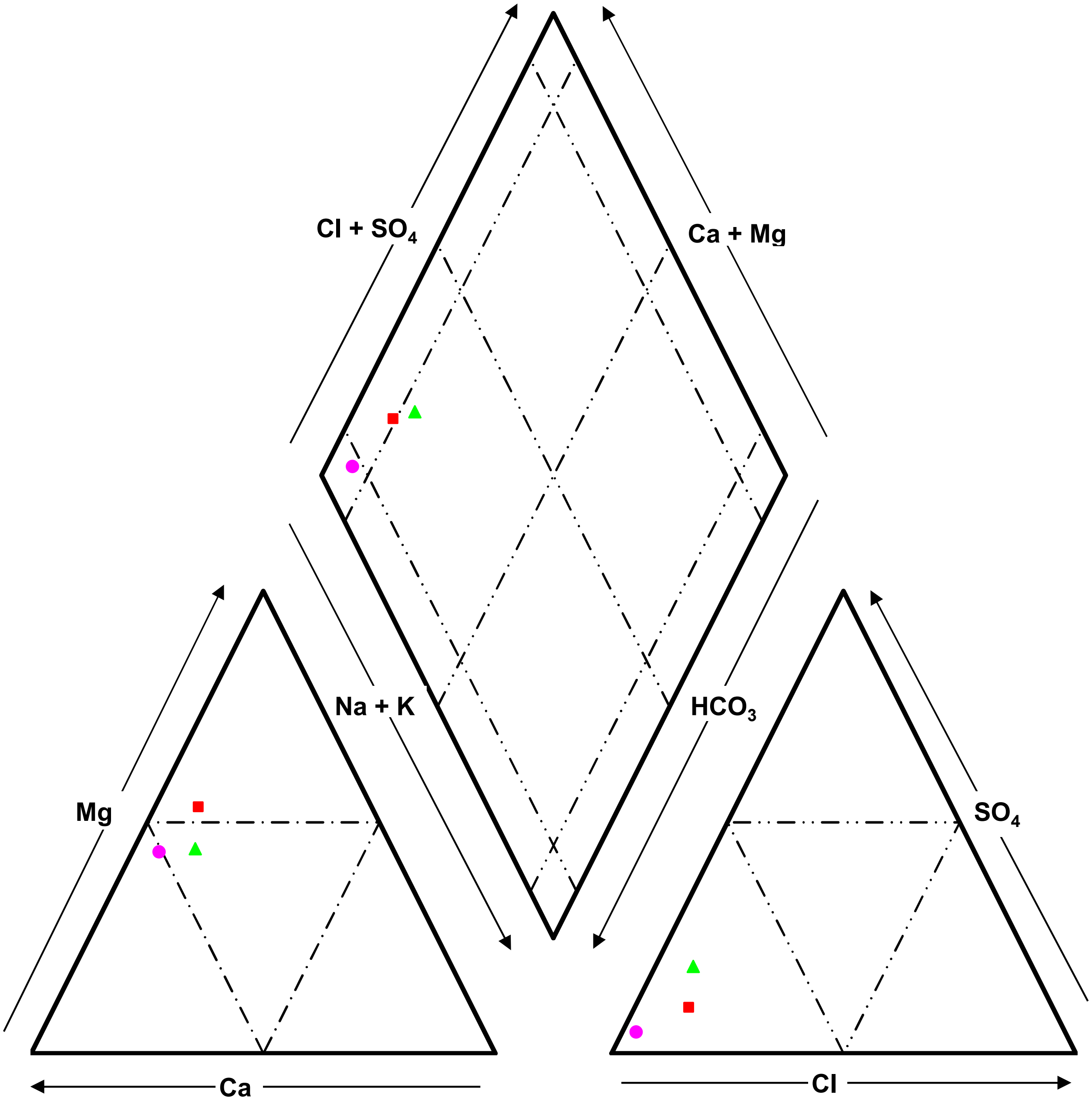


Precipitation and temperature data obtained from Environment Canada for the Region of Waterloo International Airport Climate Station (ID 6144239), accessed June 2020.

Client/Project
Tricar Developments Inc.
1242, 1250, 1260 Gordon Street and 9 Valley Road, Guelph
Hydrogeological Assessment

Figure No.
10

Title
HYDROGRAPHS
MW5-18 to MW7-18 and DP1-19(S/D)



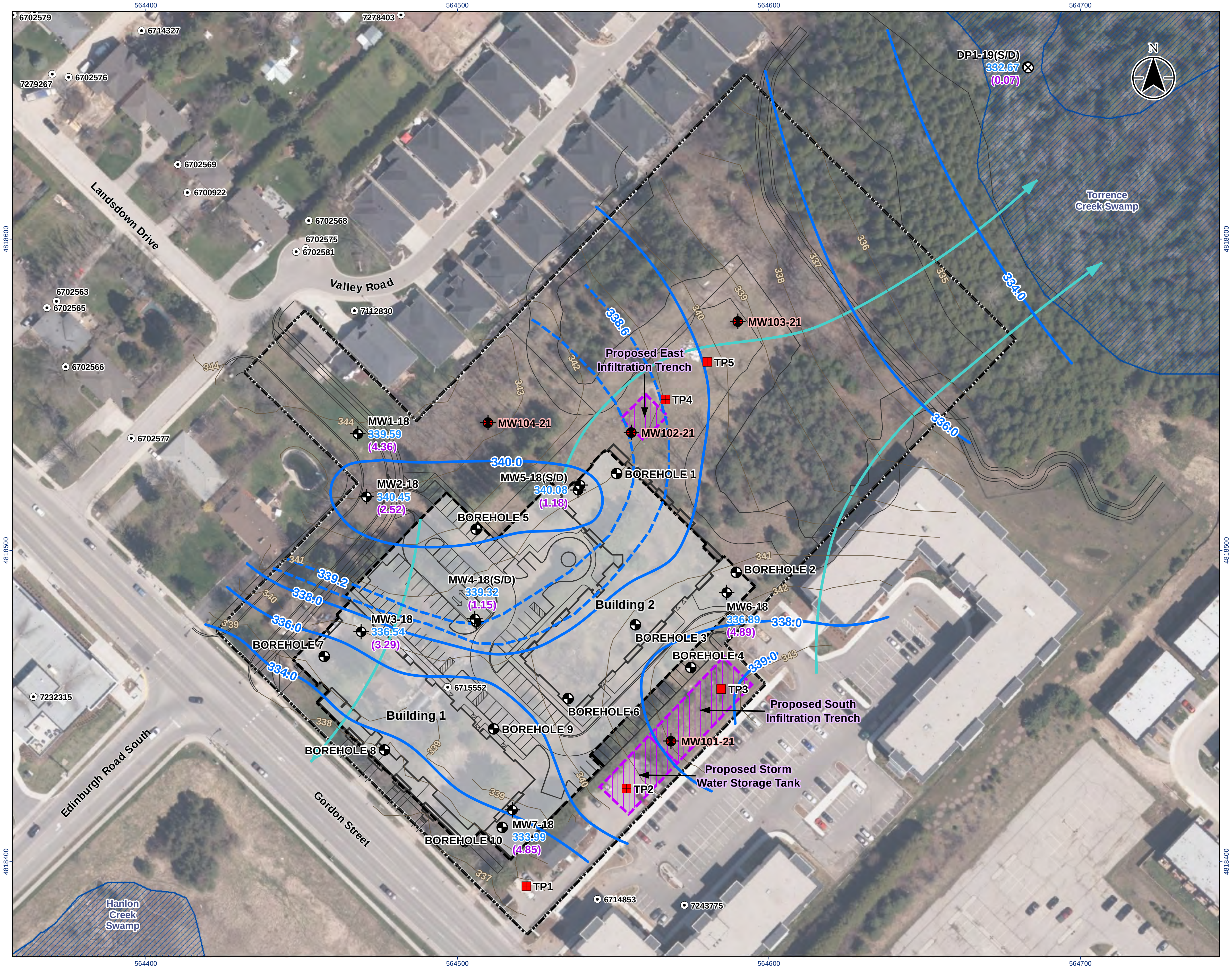
🟥 MW4-18(S)   ● MW6-18   ▲ MW7-18

Stantec

1242, 1250, 1260 GORDON ST. AND 9 VALLEY DR.
HYDROGEOLOGICAL ASSESSMENT

PIPER DIAGRAM

DATE:	SCALE:	PROJECT No.	FIGURE No.
August 2021		161413684	**11**



Stantec

Legend

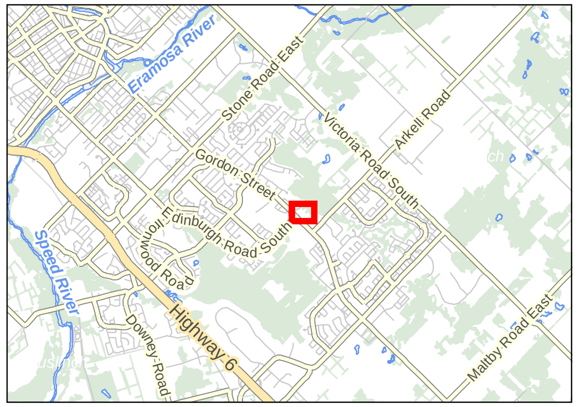
- ⬚ Site Boundary
- ⌖ Monitoring Well (Stantec, 2018)
- ⊗ Drive-Point Piezometer (Stantec, 2019)
- ◑ Borehole (CMT Engineering, 2018)
- 🟥 Test Pit (Stantec, 2021)
- ⌖ Proposed Monitoring Well (Stantec, 2021)
- ⊙ MECP Water Well
- 337.54 Groundwater Elevation (m AMSL) - May 2019
- (4.35) Groundwater Depth (m BGS)
- ― Groundwater Contour (m AMSL)
- → Interpreted Direction of Groundwater Flow
- ― Proposed Building
- - - Proposed Building (Underground)
- ― Proposed Development Plan
- ― Topographic Contour (m AMSL)
- ▭ Proposed Extent of Underground Parking
- ▨ Proposed Stormwater Management Facility
- ▨ Wetland - Evaluated (Provincial)

0 25 50 Metres

1:1,250 (At original document size of 11x17)

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, 2018.
3. Orthoimagery © First Base Solutions, 2018. Imagery flown in 2017.
4. MECP water wells have been positioned based on published UTM coordinates and should be considered approximate.



Project Location
City of Guelph

161413684
Prepared by CMC on 2021-08-12

Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
12

Title
Groundwater Flow

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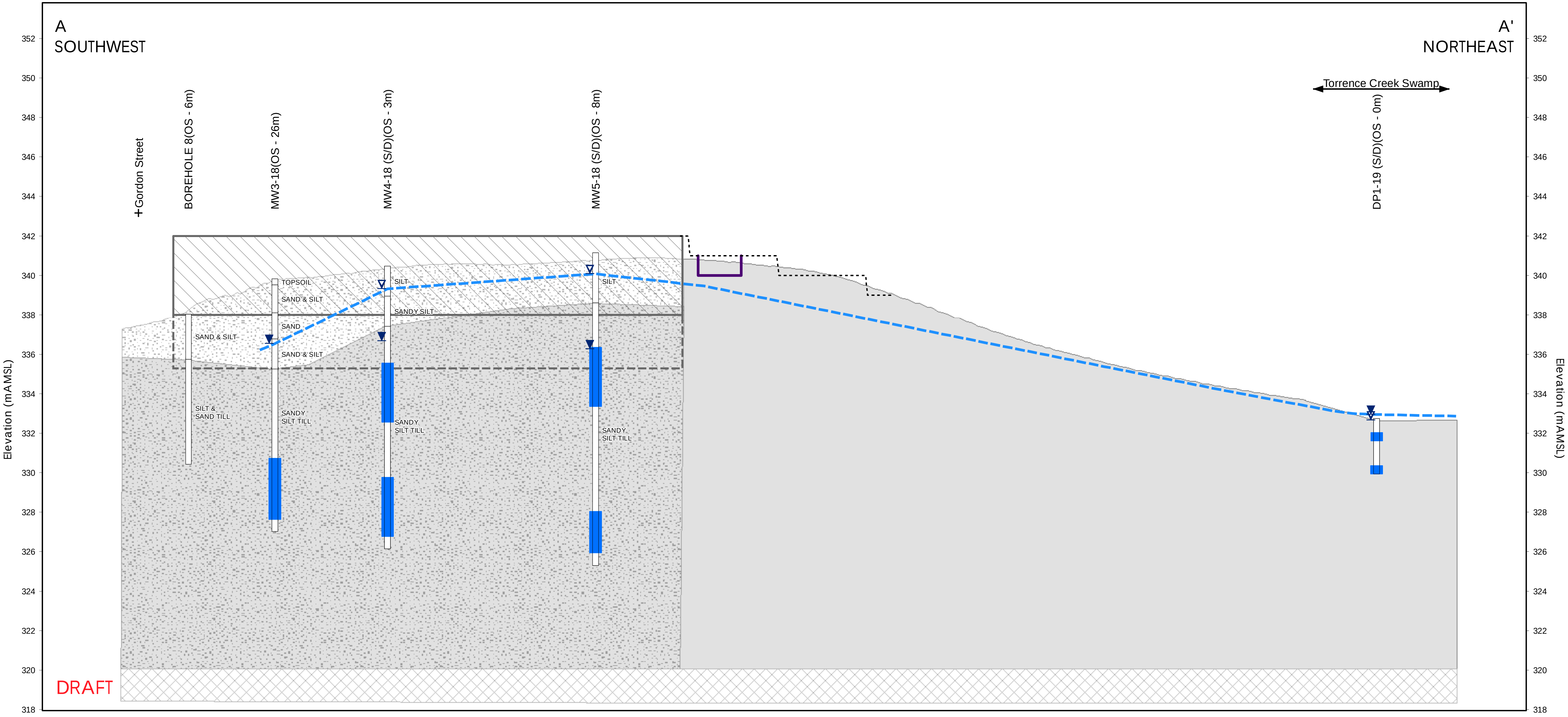

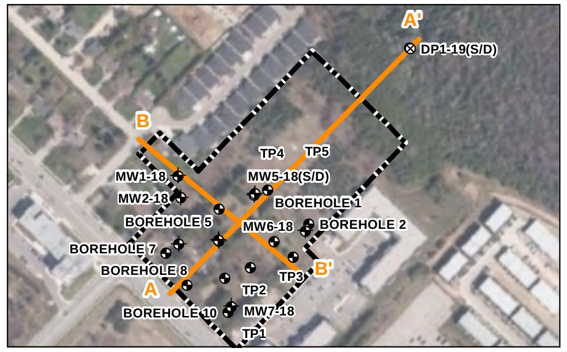

Notes
1. Groundwater levels measured on May 29, 2019.
2. Orthoimagery © First Base Solutions, 2018. Imagery flown in 2019.

MW1-15 (OS m) **Well ID (Offset)**
Sand Stratigraphy
▽ Water Level (Shallow Pipe)
▼ Water Level (Deep Pipe)
■ Well Screen

- - - Interpreted Water Table (May 29, 2019)
······ Proposed Post Development Grade
— Proposed East Infiltration Trench (Base Elevation of 340 m AMSL)
▨ Proposed Condo Building/Parking Level 1
⬚ Proposed Underground Parking Level 2 (Approximate)
▢ Overburden (No Borehole Data Available)
▢ Diamicton (Silt, Sand, Gravel)
▢ Port Stanley Till (Silty Sand to Sandy Silt Till)
▨ Bedrock

5x Vertical Exaggeration
0 20 40 metres
1:1,000 (At original document size of 11x17)

Project Location
City of Guelph

161413684 REVA
Prepared by CCoghlan on 2021-08-12
Technical Review by xxx on xxxx-xx-xx

Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
13
DRAFT

Title
Cross-Section A-A'

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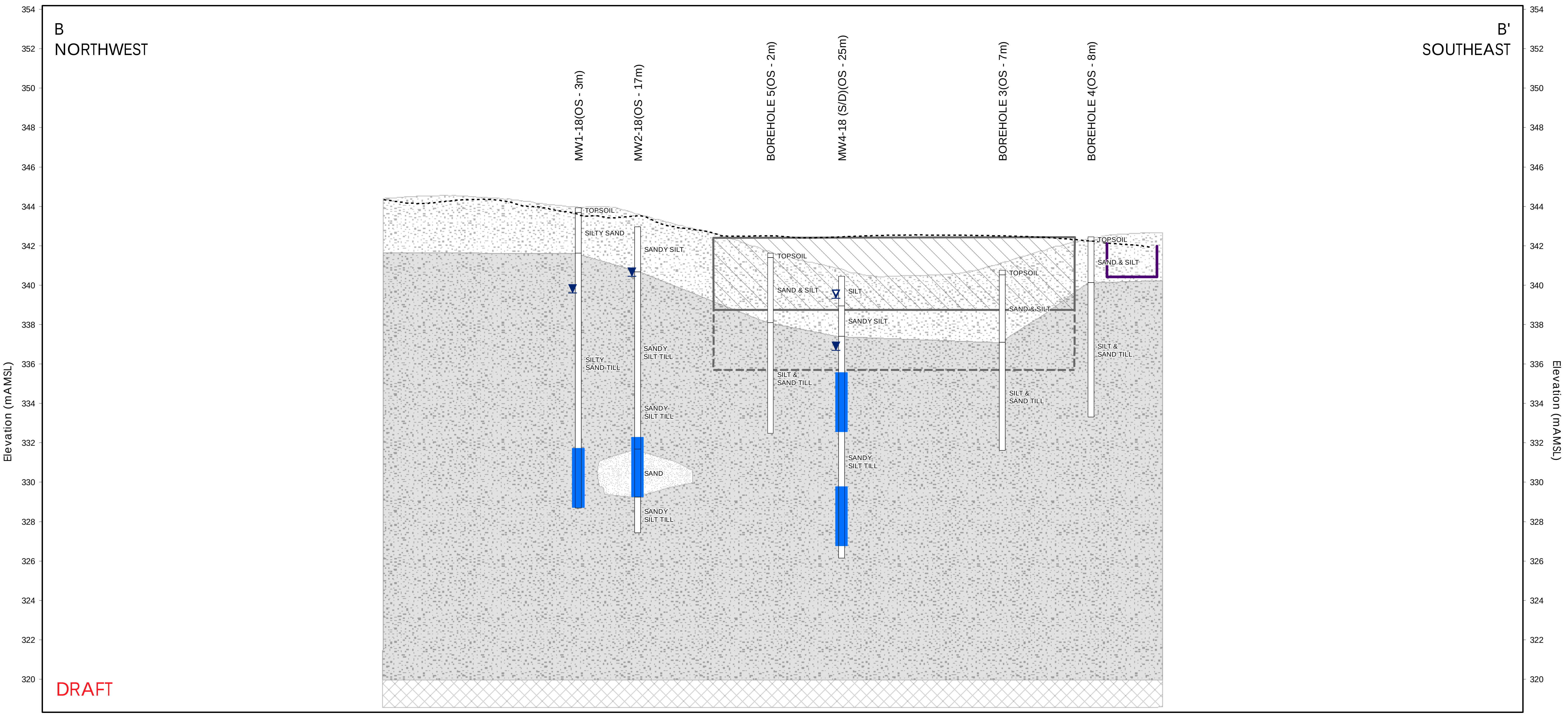

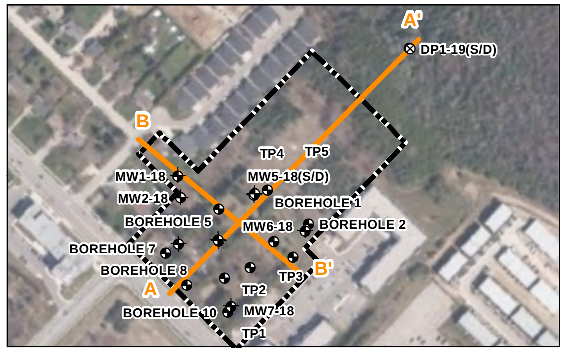

MW1-15 (OS m)

Well ID (Offset)

Sand Stratigraphy

▽ Water Level (Shallow Pipe)

▼ Water Level (Deep Pipe)

■ Well Screen

—	Proposed South Infiltration Trench (Base Elevation of 340.43 m AMSL)
┈	Proposed Post Development Grade
▧	Proposed Condo Building/Parking Level 1
⬚	Proposed Underground Parking Level 2
▢	Overburden (No Borehole Data Available)
▢	Diamicton (Silt, Sand, Gravel)
▢	Sand
▢	Port Stanley Till (Silty Sand to Sandy Silt Till)
▨	Bedrock

5x Vertical Exaggeration

0 20 40 metres

1:1,000 (At original document size of 11x17)

Stantec

Project Location
City of Guelph

161413684 REVA
Prepared by CCoghlan on 2021-08-12
Technical Review by xxx on xxxx-xx-xx

Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
14

DRAFT

Title
Cross-Section B-B'

Notes
1. Groundwater levels measured on May 29, 2019.
2. Orthoimagery © First Base Solutions, 2018. Imagery flown in 2017.

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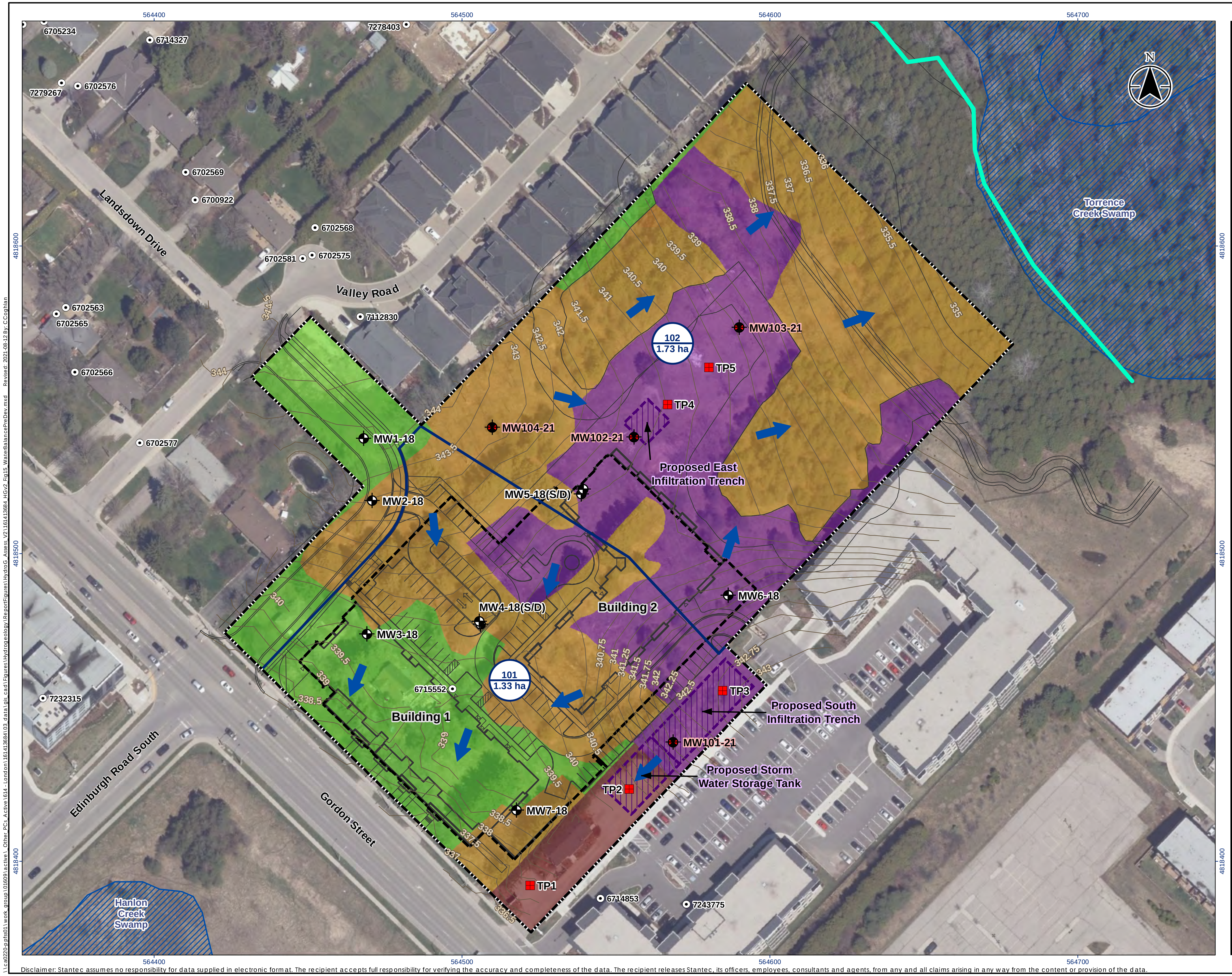

Stantec

Legend
⬚ Site Boundary
⊕ Monitoring Well (Stantec, 2018)
🟥 Test Pit (Stantec, 2021)
⊕ Proposed Monitoring Well (Stantec, 2021)
⊙ MECP Water Well
— Proposed Building
--- Proposed Building (Underground)
— Proposed Development Plan
— Approximate GRCA Wetland Boundary (2014)
➡ Major Overland Flood Route
— Topographic Contour (m AMSL)
▨ Proposed Stormwater Management Facility
☐ Stormwater Catchment (Existing Conditions)
▨ Wetland - Evaluated (Provincial)

Water Balance Sub Areas

🟨 Sub-Area A - Rolling, Fine Sandy Loam, Mature Forest
🟪 Sub-Area B - Rolling, Fine Sandy Loam, Pasture and Shrubs
🟩 Sub-Area C - Rolling, Fine Sandy Loam, Urban Lawn
🟫 Sub-Area D - Rolling, Fine Sandy Loam, Urban Lawn, 95% Impervious Cover

0 25 50 Metres

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Notes
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4. MECP water wells have been positioned based on published UTM coordinates and should be considered approximate.

Project Location
City of Guelph

161413684
Prepared by CMC on 2021-08-12

Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
15

Title
Water Balance - Pre-Development Condition

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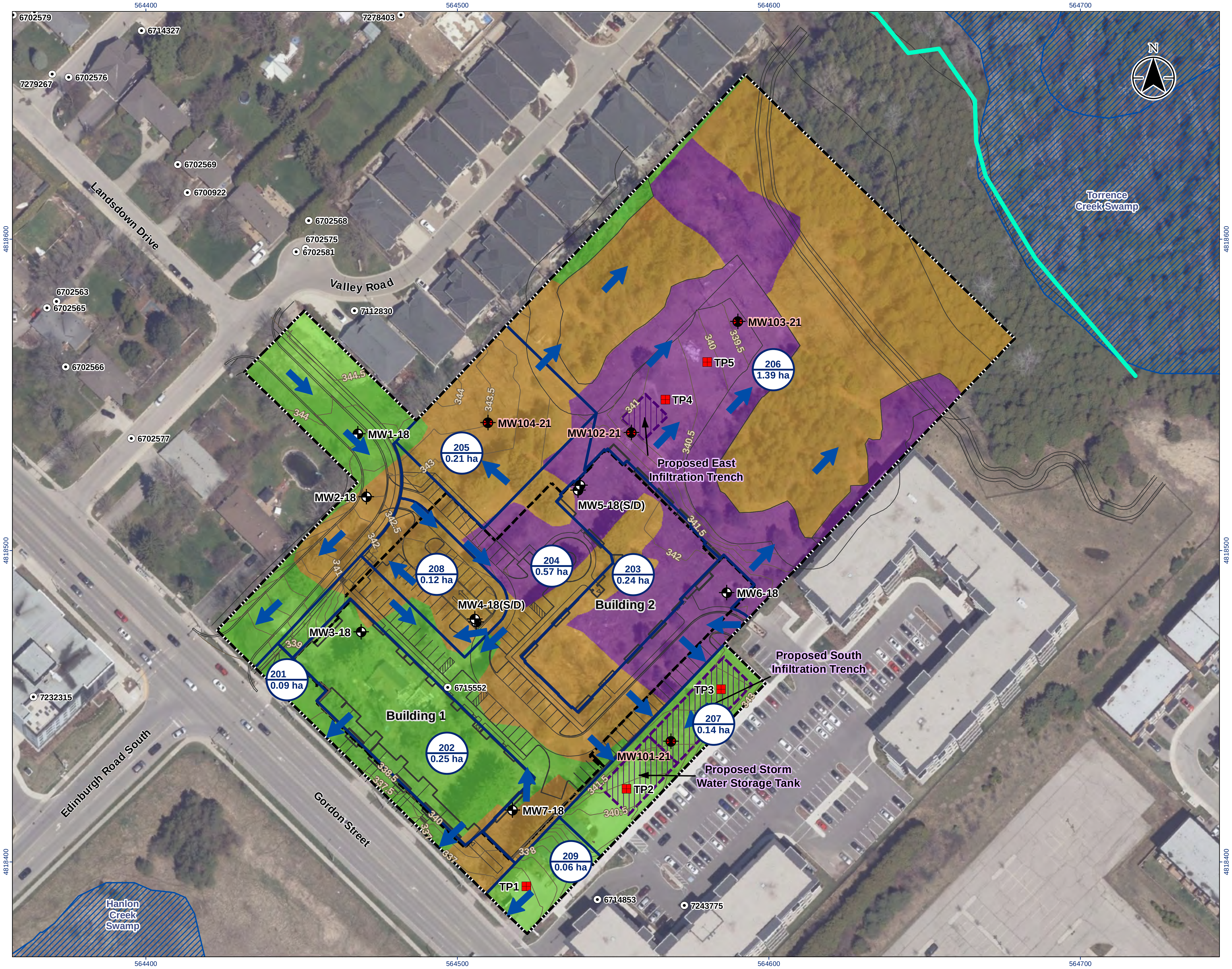

Stantec

Legend
- ⬚ Site Boundary
- ⌖ Monitoring Well (Stantec, 2018)
- 🟥 Test Pit (Stantec, 2021)
- ⌖ Proposed Monitoring Well (Stantec, 2021)
- ⊙ MECP Water Well
- — Proposed Building
- - - Proposed Building (Underground)
- — Proposed Development Plan
- — Approximate GRCA Wetland Boundary (2014)
- ➡ Major Overland Flood Route
- — Proposed Topographic Contour (m AMSL)
- ▥ Proposed Stormwater Management Facility
- ☐ Stormwater Catchment (Proposed Conditions)
- ▨ Wetland - Evaluated (Provincial)

Water Balance Sub Areas
- 🟧 Sub-Area A - Rolling, Fine Sandy Loam, Mature Forest
- 🟪 Sub-Area B - Rolling, Fine Sandy Loam, Pasture and Shrubs
- 🟩 Sub-Area C - Rolling, Fine Sandy Loam, Urban Lawn

0 25 50 Metres

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Notes
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Project Location
City of Guelph

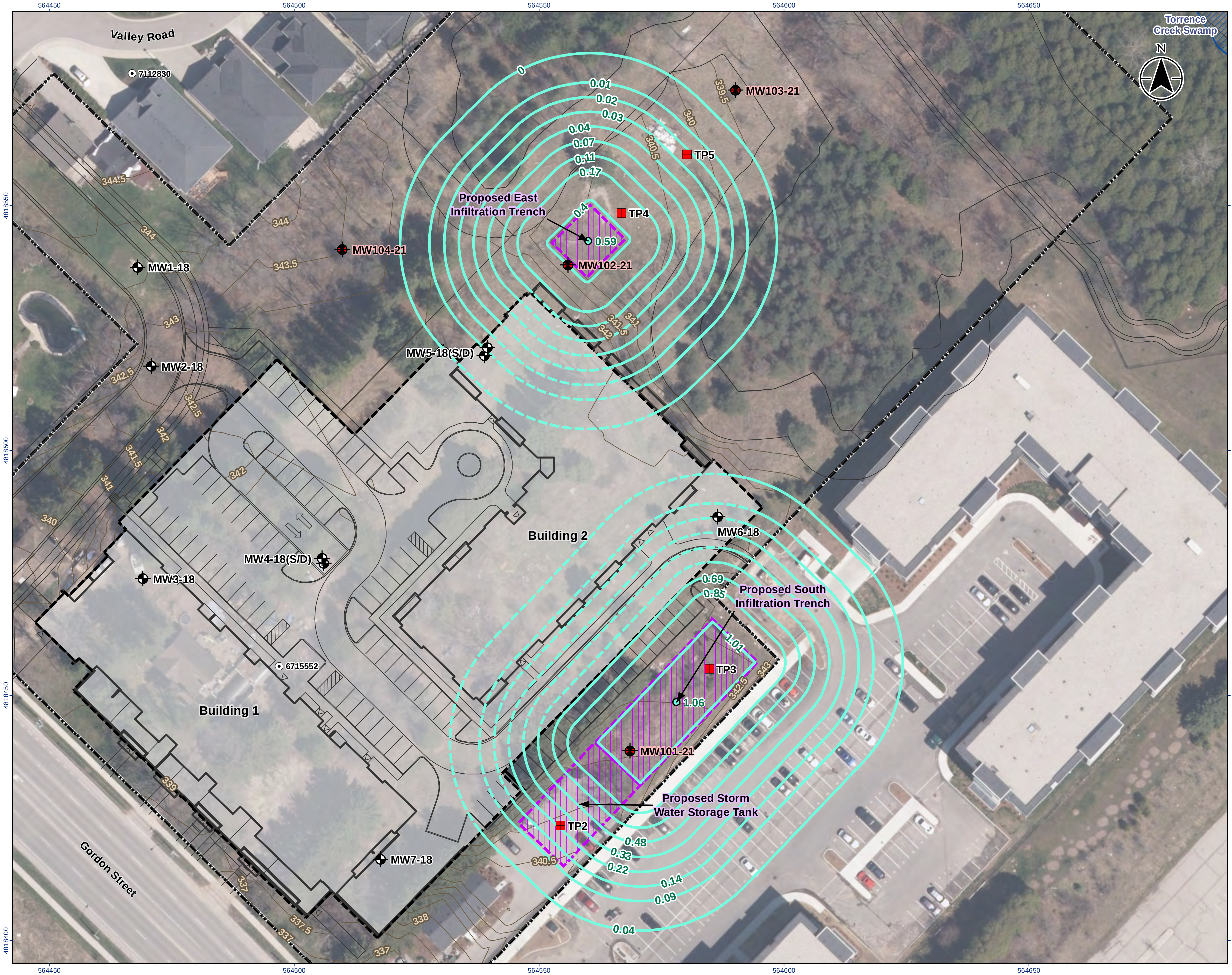
161413684
Prepared by CMC on 2021-08-12

Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
16

Title
Water Balance - Post-Development Conditions

\\ca0220-ppfss01\work_group\01609\active_Other_PCs_Active\614 - London\161413684\03_data\gis_cad\Figures\Hydrogeology\ReportFigures\HydroG_Assess_V2\161413684_HGv2_Fig16_WaterBalancePostDev.mxd Revised: 2021-08-12 By: CCoghlan



Stantec

Legend

- Site Boundary
- Monitoring Well (Stantec, 2018)
- Test Pit (Stantec, 2021)
- Proposed Monitoring Well (Stantec, 2021)
- MECP Water Well
- Proposed Building
- Proposed Building (Underground)
- Proposed Development Plan
- Proposed Topographic Contour (m
- 337.54 Predicted Groundwater Mounding Height (m)
- Predicted Groundwater Mounding Contour (mAMSL)
- Proposed Extent of Underground Parking
- Proposed Stormwater Management Facility
- Wetland - Evaluated (Provincial)

0 12.5 25 Metres

1:800 (At original document size of 11x17)

Notes

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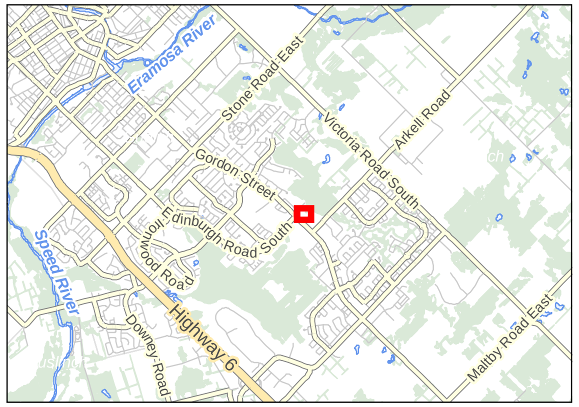
4. MECP water wells have been positioned based on published UTM coordinates and should be considered approximate.



Project Location
City of Guelph

161413684
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Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
17

Title
Groundwater Mounding -
25mm Storm Event

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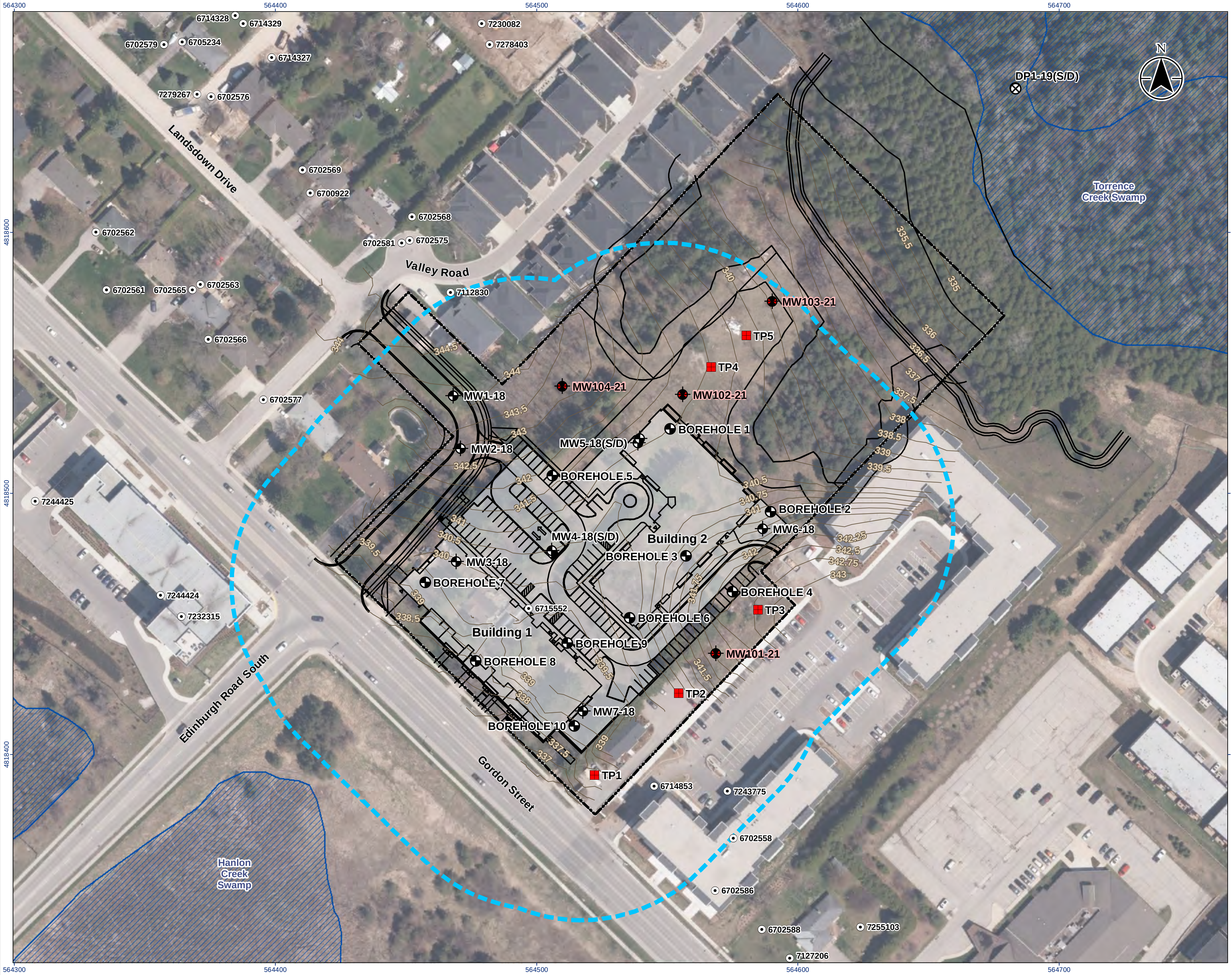

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Stantec

Legend

- ⬚ Site Boundary
- ⊕ Monitoring Well (Stantec, 2018)
- ⊗ Drive-Point Piezometer (Stantec, 2019)
- ◐ Borehole (CMT Engineering, 2018)
- 🟥 Test Pit (Stantec, 2021)
- ⊕ Proposed Monitoring Well (Stantec, 2021)
- ⊙ MECP Water Well
- — Proposed Development Plan
- — Topographic Contour (m AMSL)
- ⬚ Dewatering Radius of Influence
- ▭ Proposed Extent of Underground Parking
- ▨ Wetland - Evaluated (Provincial)

0 25 50 Metres

1:1,500 (At original document size of 11x17)

Notes

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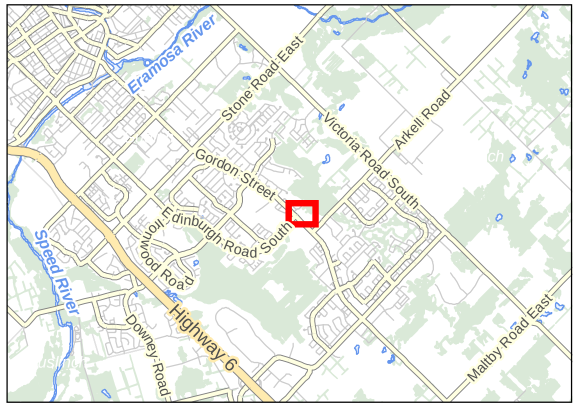
4. MECP water wells have been positioned based on published UTM coordinates and should be considered approximate.



Project Location
City of Guelph

161413684
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Client/Project
TRICAR DEVELOPMENTS INC.
1242, 1250, 1260 GORDON ST AND 9 VALLEY RD
HYDROGEOLOGICAL ASSESSMENT

Figure No.
18

Title
Dewatering Radius of Influence

APPENDIX B:
TABLES

TABLE 1
WELL CONSTRUCTION DETAILS

Well ID	UTM Coordinates		Elevations		Well Stick-up	Well Depth	Well Depth	Well Base Elevation	Screened Interval				Screened Material Description (a)	Hydraulic Conductivity (b)
	Northing	Easting	Top of Casing (m AMSL)	Ground Surface (m AMSL)	(m)	(m BTOC)	(m BGS)	(m AMSL)	Top Elevation (m BGS)	Top Elevation (m AMSL)	Bottom Elevation (m BGS)	Bottom Elevation (m AMSL)		(m/s)
Stantec Monitoring Wells														
MW1-18	4818537	564468	344.72	343.92	0.77	15.99	15.22	328.70	12.17	331.75	15.22	328.70	Sandy SILT TILL	-
MW2-18	4818517	564471	343.77	342.97	0.80	14.74	13.94	329.03	10.89	332.08	13.94	329.03	Sandy SILT TILL (19%) / SAND (81%)	4.7E-07
MW3-18	4818474	564469	340.91	339.83	1.08	13.30	12.22	327.61	9.17	330.66	12.22	327.61	Sandy SILT TILL	1.6E-09
MW4-18(S)	4818478	564506	341.32	340.47	0.85	8.82	7.97	332.50	4.92	335.55	7.97	332.50	Sandy SILT TILL	1.8E-07
MW4-18(D)	4818478	564506	341.28	340.47	0.81	14.51	13.70	326.77	10.65	329.82	13.70	326.77	Sandy SILT TILL	3.4E-09
MW5-18(S)	4818521	564540	342.02	341.26	0.76	8.84	8.08	333.18	5.03	336.23	8.08	333.18	Sandy SILT TILL	1.2E-08
MW5-18(D)	4818519	564539	342.02	341.14	0.88	16.01	15.13	326.01	13.61	327.53	15.13	326.01	Sandy SILT TILL	2.0E-08
MW6-18	4818487	564586	342.55	341.40	1.15	16.14	14.99	326.41	13.47	327.93	14.99	326.41	Sandy SILT TILL	5.4E-07
MW7-18	4818416	564518	339.64	338.85	0.79	14.69	13.90	324.95	12.38	326.47	13.90	324.95	Sandy SILT TILL	5.8E-08
													GEOMEAN =	**3.7E-08**
Stantec Drive-Point Piezometers														
DP1-19(S)	4818655	564683	333.74	332.74	1.00	2.13	1.13	331.61	0.71	332.03	1.13	331.61	-	-
DP1-19(D)	4818655	564683	333.89	332.74	1.15	3.95	2.80	329.94	2.38	330.36	2.80	329.94	-	-

Notes:

(a) Refer to **Appendix E** for borehole and well construction logs
(b) Refer to **Appendix G** hydraulic conductivity analytical solutions

m AMSL = meters above mean sea level
m BGS = meters below ground surface
m BTOC = meters below top of well casing
\- = data not available

TABLE 2
GROUNDWATER LEVEL DATA - MONITORING WELLS

Well ID	UTM Coordinates		Date	Time	Well Depth			Screen Length	Screen Separation (1)	Top of Casing Elevation (m AMSL)	Ground Surface Elevation (m AMSL)	Pipe Stick-up (m)	Groundwater Level			Vertical Hydraulic Gradient (3)
	Northing	Easting			(m BTOC)	(m BGS)	(m AMSL)	(m)	(m)				(m BGS) (2)	(m BTOC)	(m AMSL)	(+) = Upward (-) = Downward
MW1-18	4818537	564468	26-Jul-18	10:15 AM	15.99	15.22	329.50	3.05		344.72	343.92	0.77	-	-	-	
			11-Sep-18	9:17 AM									9.03	9.80	334.89	
			8-Nov-18	9:10 AM									8.57	9.34	335.35	
			9-Apr-19	2:14 PM									5.16	5.93	338.76	
			3-May-19	8:41 AM									4.34	5.11	339.58	
			29-May-19	11:07 AM									4.36	5.13	339.56	
			24-Jul-19	11:30 AM									7.38	8.15	336.54	
			15-Jan-20	10:55 AM									4.15	4.92	339.77	
			2-Jun-20	12:06 PM									6.97	7.74	336.95	
MW2-18	4818517	564471	26-Jul-18	3:58 PM	14.74	13.94	329.83	3.05		343.77	342.97	0.80	6.65	7.45	336.32	
			11-Sep-18	-									-	-	-	
			8-Nov-18	9:33 AM									6.90	7.70	336.07	
			9-Apr-19	2:14 PM									3.42	4.22	339.55	
			3-May-19	8:52 AM									2.44	3.24	340.53	
			29-May-19	11:15 AM									2.52	3.32	340.45	
			24-Jul-19	11:41 AM									5.80	6.60	337.17	
			15-Jan-20	11:04 AM									2.45	3.25	340.52	
			2-Jun-20	11:56 AM									5.31	6.11	337.66	
MW3-18	4818474	564469	26-Jul-18	2:56 PM	13.30	12.22	328.69	3.05		340.91	339.83	1.08	4.81	5.89	335.02	
			11-Sep-18	-									-	-	-	
			8-Nov-18	9:45 AM									5.41	6.49	334.42	
			9-Apr-19	3:29 PM									4.07	5.15	335.76	
			3-May-19	10:55 AM									-	-	-	
			29-May-19	11:22 AM									3.29	4.37	336.54	
			24-Jul-19	11:41 AM									4.54	5.62	335.29	
			15-Jan-20	11:11 AM									3.89	4.97	335.94	
			2-Jun-20	11:52 AM									4.47	5.55	335.36	
MW4-18(S)	4818478	564506	26-Jul-18	10:15 AM	8.82	7.97	333.35	3.05		341.32	340.47	0.85	3.83	4.68	336.64	
			11-Sep-18	1:18 PM									4.63	5.48	335.84	
			8-Nov-18	10:54 AM									4.81	5.66	335.66	
			9-Apr-19	3:26 PM									2.66	3.51	337.81	
			3-May-19	10:34 AM									1.45	2.30	339.02	
			29-May-19	12:20 PM									1.15	2.00	339.32	
			24-Jul-19	11:56 AM									3.11	3.96	337.36	
			15-Jan-20	12:06 PM									2.12	2.97	338.35	
			2-Jun-20	11:22 AM									2.82	3.67	337.65	
MW4-18(D)	4818478	564506	26-Jul-18	10:16 AM	14.51	13.70	327.58	3.05	2.68	341.28	340.47	0.81	5.49	6.30	334.98	-0.62
			11-Sep-18	1:20 PM									6.15	6.96	334.32	-0.57
			8-Nov-18	10:54 AM									6.27	7.08	334.20	-0.54
			9-Apr-19	3:23 PM									4.73	5.54	335.74	-0.77
			3-May-19	10:35 AM									4.01	4.82	336.46	-0.96
			29-May-19	12:18 PM									3.79	4.60	336.68	-0.99
			24-Jul-19	11:59 AM									5.28	6.09	335.19	-0.81
			15-Jan-20	12:08 PM									4.46	5.27	336.01	-0.87
			2-Jun-20	11:20 AM									5.21	6.02	335.26	-0.89

TABLE 2
GROUNDWATER LEVEL DATA - MONITORING WELLS

Well ID	UTM Coordinates		Date	Time	Well Depth			Screen Length	Screen Separation $^{(1)}$	Top of Casing Elevation (m AMSL)	Ground Surface Elevation (m AMSL)	Pipe Stick-up (m)	Groundwater Level			Vertical Hydraulic Gradient $^{(3)}$
	Northing	Easting			(m BTOC)	(m BGS)	(m AMSL)	(m)	(m)				(m BGS) $^{(2)}$	(m BTOC)	(m AMSL)	(+) = Upward (-) = Downward
MW5-18(S)	4818521	564540	26-Jul-18	11:27 AM	8.84	8.08	333.94	3.05		342.02	341.26	0.76	3.67	4.43	337.59	
			11-Sep-18	10:17 AM									4.20	4.96	337.06	
			8-Nov-18	10:28 AM									4.57	5.33	336.69	
			9-Apr-19	3:11 PM									1.89	2.65	339.37	
			3-May-19	10:13 AM									1.17	1.93	340.09	
			29-May-19	11:57 AM									1.18	1.94	340.08	
			24-Jul-19	12:29 PM									3.21	3.97	338.05	
			15-Jan-20	11:20 AM									1.06	1.82	340.20	
			2-Jun-20	11:30 AM									3.01	3.77	338.25	
MW5-18(D)	4818519	564539	26-Jul-18	11:24 AM	14.69	13.81	328.21	1.52	4.21	342.02	341.14	0.88	6.72	7.60	334.42	-0.75
			11-Sep-18	10:18 AM									7.11	7.99	334.03	-0.72
			8-Nov-18	10:23 AM									7.15	8.03	333.99	-0.64
			9-Apr-19	3:09 PM									5.35	6.23	335.79	-0.85
			3-May-19	10:14 AM									4.92	5.80	336.22	-0.92
			29-May-19	11:51 AM									4.87	5.75	336.27	-0.90
			24-Jul-19	12:31 PM									6.46	7.34	334.68	-0.80
			15-Jan-20	11:22 AM									4.87	5.75	336.27	-0.93
			2-Jun-20	11:29 AM									6.41	7.29	334.73	-0.84
MW6-18	4818487	564586	26-Jul-18	1:05 PM	16.14	14.99	329.73	3.05		342.55	341.40	1.15	7.43	8.20	334.35	
			11-Sep-18	11:20 AM									7.45	8.22	334.33	
			8-Nov-18	10:14 AM									6.93	7.70	334.85	
			9-Apr-19	2:52 PM									5.31	6.08	336.47	
			3-May-19	10:03 AM									4.89	5.66	336.89	
			29-May-19	11:43 AM									4.89	5.66	336.89	
			24-Jul-19	12:18 PM									6.80	7.57	334.98	
			15-Jan-20	11:45 AM									4.53	5.30	337.25	
			2-Jun-20	11:44 AM									6.79	7.56	334.99	
MW7-18	4818416	564518	26-Jul-18	2:04 PM	14.69	13.90	329.87	1.52		339.64	338.85	0.79	5.70	6.50	333.14	
			11-Sep-18	12:00 PM									5.92	6.72	332.92	
			8-Nov-18	10:03 AM									5.79	6.59	333.05	
			9-Apr-19	2:42 PM									5.28	6.08	333.56	
			3-May-19	9:51 AM									4.99	5.79	333.85	
			29-May-19	11:34 AM									4.85	5.65	333.99	
			24-Jul-19	12:07 PM									5.60	6.40	333.24	
			15-Jan-20	11:55 AM									4.98	5.78	333.86	
			2-Jun-20	11:48 AM									5.61	6.41	333.23	

Notes:

(1) Distance between the top of the screen in the deep well and the bottom of screen in the shallow well.
(2) A negative value indicates that the water level measured within the pipe is located above ground surface
(3) Negative and positive values indicate downward and upward gradients, respectively.

m BGS = meters below ground surface
m BTOC = meters below top of casing
DRY = no groundwater or surface water was observed in the piezometer or watercourse, respectively

TABLE 3
GROUNDWATER LEVEL DATA - DRIVE-POINT PIEZOMETERS

Piezometer ID	UTM Coordinates		Total Depth		Screen Length	Screen Separation (1)	Pipe Stick-up	Ground Surface Elevation	Top of Casing Elevation	Date	Time	Groundwater Level			Surface Water Level		Vertical Hydraulic Gradient(4) (+) = Upward (-) = Downward
	Northing	Easting	(m BTOC)	(m BGS)	(m)	(m)	(m)	(m AMSL)	(m AMSL)			(m BGS) (2)	(m BTOC)	(m AMSL)	(m BTOC) (3)	(m AMSL)	
DP1-19(S)	4818655	564683	2.13	1.13	0.30		1.00	332.74	333.74	3-May-19	9:10 AM	-0.06	0.94	332.80	0.90	332.84	
										29-May-19	10:48 AM	0.07	1.07	332.67	DRY	-	
										24-Jul-19	11:02 AM	0.37	1.37	332.37	DRY	-	
										29-Jul-19	3:08 PM	0.51	1.51	332.23	DRY	-	
										15-Jan-20	10:34 AM	-0.01	0.99	332.75	DRY	-	
										2-Jun-20	11:35 AM	0.40	1.40	332.34	DRY	-	
DP1-19(D)	4818655	564683	3.95	2.80	0.30	1.67	1.15	332.74	333.89	3-May-19	9:15 AM	-0.08	1.07	332.82	1.03	332.86	0.01
										29-May-19	10:48 AM	-0.21	0.94	332.95	DRY	-	0.17
										24-Jul-19	11:02 AM	0.37	1.52	332.37	DRY	-	0.00
										29-Jul-19	3:08 PM	0.50	1.65	332.24	DRY	-	0.01
										15-Jan-20	10:37 AM	-0.03	1.12	332.77	DRY	-	0.01
										2-Jun-20	11:34 AM	0.39	1.54	332.35	DRY	-	0.01

Notes:

(1) Distance between the mid-point of the screened intervals of the shallow and deep piezometer.
(2) A negative value indicates that the water level measured within the pipe is located above ground surface.
(3) A negative value indicates that the surface water level is above the top of the piezometer.
(4) Vertical hydraulic gradient between the surface water feature substrate and the piezometer screened interval.

m BGS = meters below ground surface
m BTOC = meters below top of casing
DRY = no groundwater or surface water was observed in the piezometer or surface water feature, respectively
n/a = measurement not available

TABLE 4 - GROUNDWATER QUALITY RESULTS
CITY OF GUELPH SANITARY AND SEWER BY-LAW (1996)-15202

Sample Location			**MW2-18**	
Sample Date			**11-Sep-18**	**11-Sep-18**
Sample ID			**WG-161413684-20180911-DS-04**	**WG-161413684-20180911-DS-04 Lab-Dup**
Sampling Company			**STANTEC**	**STANTEC**
Laboratory			**MAXX**	**MAXX**
Laboratory Work Order			**B8N6455**	**B8N6455**
Laboratory Sample ID			**HSJ715**	**HSJ715**
Sample Type	**Units**	**City of Guelph**		**Lab Replicate**
General Chemistry				
Chloride	mg/L	1,500[A]	46	-
Cyanide	mg/L	2[A]	<0.0050	-
Fluoride	mg/L	10[A]	0.13	-
pH, lab	S.U.	5.5-9.5[A] 6.0-9.0[B]	7.90	-
Phenols-4AAP	mg/L	n/v	<0.0010	-
Sulfate	mg/L	1,500[A]	40	-
Total Suspended Solids	mg/L	350[A] 15[B]	**2,500[AB]**	-
Carbonaceous BOD - 5 Day	mg/L	n/v	<2	<2
Total Kjeldahl Nitrogen	mg/L	100[A]	1.7	-
Petroleum Hydrocarbons				
Animal/Veg Oil & Grease	mg/L	100[A]	<0.50	-
Mineral Oil and Grease	mg/L	n/v	<0.50	-
Oil and Grease, Total	mg/L	n/v	<0.50	-
Metals, Total				
Aluminum	mg/L	50[A]	15	-
Antimony	mg/L	5[A]	<0.00050	-
Arsenic	mg/L	1[A]	0.0062	-
Bismuth	mg/L	5[A]	<0.0010	-
Cadmium	mg/L	1[A] 0.001[B]	**0.0019[B]**	-
Chromium	mg/L	5[A] 0.2[B]	0.040	-
Cobalt	mg/L	5[A]	0.0096	-
Copper	mg/L	3[A] 0.01[B]	**0.030[B]**	-
Iron	mg/L	50[A]	23	-
Lead	mg/L	5[A] 0.05[B]	**0.13[B]**	-
Manganese	mg/L	5[A]	1.3	-
Mercury	mg/L	0.1[A] 0.001[B]	<0.0001	-
Molybdenum	mg/L	5[A]	0.0032	-
Nickel	mg/L	3[A] 0.05[B]	0.021	-
Phosphorus	mg/L	10[A]	1.1	-
Selenium	mg/L	5[A]	<0.0020	-
Silver	mg/L	5[A]	<0.00010	-
Tin	mg/L	5[A]	0.0011	-
Titanium	mg/L	5[A]	0.49	-
Vanadium	mg/L	5[A]	0.031	-
Zinc	mg/L	3[A] 0.05[B]	**0.64[B]**	-
Microbiological				
Fecal Coliform	5TMPN/100ML	200 (MPN/100mL)[B]	**350[B]**	-

Notes:

Guelph	City of Guelph
A	City of Guelph Sanitary Sewer-Use By-Law No. (1996)-15202
B	City of Guelph Storm Sewer-Use By-Law
6.5[A]	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
<0.50	Laboratory reporting limit was greater than the applicable standard.
<0.03	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
-	Parameter not analyzed / not available.

TABLE 5 - GROUNDWATER QUALITY RESULTS
ONTARIO DRINKING WATER QUALITY STANDARDS

Sample Location			**MW2-18**	**MW4-18(S)**	**MW6-18**	**MW7-18**
Sample Date			**11-Sep-18**	**11-Sep-18**	**11-Sep-18**	**11-Sep-18**
Sample ID			**WG-161413684-20180911-DS-04**	**WG-161413684-20180911-DS-03**	**WG-161413684-20180911-DS-01**	**WG-161413684-20180911-DS-02**
Sampling Company			**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**
Laboratory			**MAXX**	**MAXX**	**MAXX**	**MAXX**
Laboratory Work Order			**B8N6455**	**B8N6455**	**B8N6455**	**B8N6455**
Laboratory Sample ID	**Units**	**ODWS**	**HSJ715**	**HSJ714**	**HSJ712**	**HSJ713**
General Chemistry						
Alkalinity, Carbonate (as CaCO3)	mg/L	n/v	-	5.3	3.7	4.7
Alkalinity, Total (as CaCO3)	mg/L	$30\text{-}500^{E}$	-	410	310	340
Ammonia (as N)	mg/L	n/v	-	0.071	<0.050	<0.050
Anion Sum	me/L	n/v	-	10.7	6.67	9.3
Bicarbonate(as CaCO3, Calculated)	mg/L	n/v	-	410	300	330
Cation Sum	me/L	n/v	-	10.9	6.66	11.8
Chloride	mg/L	250^{C}	46	43	7	27
Dissolved Organic Carbon (DOC)	mg/L	5^{C}	-	1.4	0.83	1
Electrical Conductivity, Lab	µmhos/cm	n/v	-	950	580	830
Hardness (as CaCO3)	mg/L	$80\text{-}100^{E}$	-	**490^{E}**	**320^{E}**	**520^{E}**
Ion Balance	%	n/v	-	1.08	0.05	12.1
Langelier Index (at 20 C)	none	n/v	-	1.2	1.01	1.25
Langelier Index (at 4 C)	none	n/v	-	0.947	0.762	0.997
Nitrate (as N)	mg/L	10.0_{d}^{B}	-	1.93	0.25	0.12
Nitrate + Nitrite (as N)	mg/L	10.0_{d}^{B}	-	1.96	0.25	0.12
Nitrite (as N)	mg/L	1.0_{d}^{B}	-	0.026	<0.010	<0.010
Orthophosphate(as P)	mg/L	n/v	-	0.012	<0.010	<0.010
pH, lab	S.U.	$6.5\text{-}8.5^{E}$	7.90	8.14	8.11	8.18
Saturation pH (at 20 C)	none	n/v	-	6.95	7.1	6.93
Saturation pH (at 4 C)	none	n/v	-	7.2	7.35	7.18
Sulfate	mg/L	500_{h}^{C}	40	50	15	84
Total Dissolved Solids (Calculated)	mg/L	500^{C}	-	**540^{C}**	330	**530^{C}**
Total Suspended Solids	mg/L	n/v	-	100	1,800	1,200
Metals, Dissolved						
Aluminum	mg/L	0.1^{E}	-	0.0064	<0.0050	0.063
Antimony	mg/L	0.006^{B}	-	<0.00050	<0.00050	<0.00050
Arsenic	mg/L	0.01^{B}	-	<0.0010	<0.0010	0.0015
Barium	mg/L	1^{B}	-	0.13	0.032	0.076
Beryllium	mg/L	n/v	-	<0.00050	<0.00050	<0.00050
Boron	mg/L	5^{B}	-	0.11	0.014	0.013
Cadmium	mg/L	0.005^{B}	-	<0.00010	<0.00010	<0.00010
Calcium	mg/L	n/v	-	82	69	100
Chromium	mg/L	0.05^{B}	-	<0.0050	<0.0050	<0.0050
Cobalt	mg/L	n/v	-	<0.00050	<0.00050	<0.00050
Copper	mg/L	1^{C}	-	<0.0010	<0.0010	<0.0010
Iron	mg/L	0.3^{C}	-	<0.10	<0.10	0.19
Lead	mg/L	0.01^{B}	-	<0.00050	<0.00050	0.00056
Magnesium	mg/L	n/v	-	71	36	63
Manganese	mg/L	0.05^{C}	-	0.02	0.011	0.046
Molybdenum	mg/L	n/v	-	0.0042	0.00079	0.003
Nickel	mg/L	n/v	-	<0.0010	<0.0010	<0.0010
Phosphorus	mg/L	n/v	-	0.11	<0.10	<0.10
Potassium	mg/L	n/v	-	5.9	1.1	2.6
Selenium	mg/L	0.05^{B}	-	0.0022	<0.0020	<0.0020
Silicon	mg/L	n/v	-	5.2	6.3	7.9
Silver	mg/L	n/v	-	<0.00010	<0.00010	<0.00010
Sodium	mg/L	200_{g}^{C} 20_{g}^{D}	-	20	5.4	**34^{D}**
Strontium	mg/L	n/v	-	0.23	0.13	0.2
Thallium	mg/L	n/v	-	<0.000050	<0.000050	<0.000050
Titanium	mg/L	n/v	-	<0.0050	<0.0050	0.0051
Uranium	mg/L	0.02^{B}	-	0.003	0.00063	0.0022
Vanadium	mg/L	n/v	-	0.0012	<0.00050	0.0014
Zinc	mg/L	5^{C}	-	<0.0050	<0.0050	<0.0050

Notes:

ODWS	O.Reg 169/03 - Ontario Drinking Water Quality Standards (January 1, 2018); Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines (MOE, 2006), in support of O.Reg 169/03 (January 1, 2018)
^{A}	Schedule 1 - Microbiological Standards (expressed as a maximum)
^{B}	Schedule 2 - Chemical Standards (expressed as a maximum acceptable concentration)
^{C}	ODWS Table 4 - Chemical/Physical Objectives and Guidelines, Aesthetic Objectives
^{D}	ODWS Table 4 - Medical Officer of Health Reporting Limit
^{E}	ODWS Table 4 - Chemical/Physical Objectives and Guidelines, Operational Guidelines
6.5^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
<0.50	Laboratory reporting limit was greater than the applicable standard.
<0.03	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
-	Parameter not analyzed / not available.
$_{d}$	Where both nitrate and nitrite are present, the total of the two should not exceed 10 mg/L (as nitrogen).
$_{g}$	The aesthetic objective for sodium in drinking water is 200 mg/L. The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets.
$_{h}$	When sulfate levels exceed 500 mg/L, water may have a laxative effect on some people.

TABLE 6 - INFILTRATION RATES ESTIMATED FROM HORIZONTAL HYDRAULIC CONDUCTIVITY TESTING RESULTS

Testing Location ID	Horizontal Hydraulic Conductivity (m/s)	Vertical Hydraulic Conductivity (cm/s)	Vertical Hydraulic Conductivity (m/s)	Infiltration Rate (mm/hr)	Pit Depth (m BGS)	Screened Interval (m BGS)	Soil Substrate Tested	Surficial Deposit or Hydrostratigraphic Unit
In-situ Hydraulic Response Testing (Monitoring Wells)								
MW2-18	4.7E-07	-	4.7E-08	20	-	10.9 - 13.9	Sandy SILT TILL (19%) / SAND (81%)	Lower Till Aquitard (Sand Layer)
MW3-18	1.6E-09	-	1.6E-10	5	-	7.5 - 10.5	Sandy SILT TILL	Lower Till Aquitard
MW4-18(S)	1.8E-07	-	1.8E-08	15	-	5.0 - 8.0	Sandy SILT TILL	Lower Till Aquitard
MW4-18(D)	3.4E-09	-	3.4E-10	5	-	9.5 - 12.5	Sandy SILT TILL	Lower Till Aquitard
MW5-18(S)	1.2E-08	-	1.2E-09	8	-	5.0 - 8.0	Sandy SILT TILL	Lower Till Aquitard
MW5-18(D)	2.0E-08	-	2.0E-09	9	-	12.1 - 15.1	Sandy SILT TILL	Lower Till Aquitard
MW6-18	5.4E-07	-	5.4E-08	21	-	12.0 - 15.0	Sandy SILT TILL	Lower Till Aquitard
MW7-18	5.8E-08	-	5.8E-09	12	-	10.9 - 13.9	Sandy SILT TILL	Lower Till Aquitard

Notes:

(1) Infiltration rate calculated based on established relationship between vertical hydraulic conductivity and infiltration rate presented in *Credit Valley Conservation and Toronto and Region Conservation (2010) Low Impact Stormwater Management Planning and Design Guideline - Version 1.0.*

(2) Vertical hydraulic conductivities for deeper overburden deposits assumed to be one order of magnitude lower than in-situ measured horizontal hydraulic conductivities

TABLE 7 - INFILTRATION RATE TESTING RESULTS (2021)

Testing Location ID	**Ground Surface Elevation**	**Vertical Hydraulic Conductivity**		**Infiltration Rate (1)**	**Horizontal Hydraulic Conductivity (2)**	**Testing Depth**		**Soil Substrate Tested**
	(m AMSL)	**(cm/s)**	**(m/s)**	**(mm/hr)**	**(m/s)**	**(m BGS)**	**(m AMSL)**	
East Infiltration Trench - designed base elevation: 340.00 m AMSL								
TP4-21	340.9	3.9E-03	3.9E-05	123	3.9E-04	0.6	340.4	Clayey SAND TILL, fine to medium grained sand
TP5-21	340.3	1.8E-03	1.8E-05	100	1.8E-04	0.6	339.7	Clayey SAND TILL, fine to medium grained sand
TP4-21	340.9	1.1E-04	1.1E-06	48	1.1E-05	2.0	339.0	Clayey SAND TILL, fine to medium grained sand
TP5-21	340.3	2.0E-06	2.0E-08	16	2.0E-07	2.9	337.4	Clayey SAND TILL, fine to medium grained sand
MW5-18(S)	341.3	-	-	8	1.2E-08	5.0 - 8.0	336.2 - 333.2	Sandy SILT TILL
MW5-18(D)	341.1	-	-	9	2.0E-08	13.6 - 15.1	327.5 - 326.0	Sandy SILT TILL
South Infiltration Trench - designed base elevation: 340.43 m AMSL								
TP1-21 (Test 1)	337.9	8.7E-06	8.7E-08	24	8.7E-07	0.5	337.4	Silty Clay FILL, trace fine grained sand and cobbles
TP1-21 (Test 2)	337.9	2.9E-05	2.9E-07	33	2.9E-06	0.5	337.4	Silty Clay FILL, trace fine grained sand and cobbles
TP1-21	337.9	3.5E-03	3.5E-05	120	3.5E-04	1.4	336.5	Silty Clay FILL, trace fine grained sand and cobbles
TP2-21	340.5	1.2E-03	1.2E-05	89	1.2E-04	0.6	340.0	Sandy SILT TILL, fine to medium grained sand
TP2-21	340.5	1.8E-05	1.8E-07	29	1.8E-06	1.5	339.1	Sandy SILT TILL, fine to medium grained sand
TP3-21 (Test 1)	342.8	2.7E-04	2.7E-06	60	2.7E-05	1.2	341.6	Sandy SILT TILL, fine to medium grained sand
TP3-21 (Test 2)	342.8	2.2E-04	2.2E-06	57	2.2E-05	1.2	341.6	Sandy SILT TILL, fine to medium grained sand
TP3-21 (Test 1)	342.8	1.4E-04	1.4E-06	51	1.4E-05	2.6	340.2	Sandy SILT TILL, fine to medium grained sand
TP3-21 (Test 2)	342.8	5.1E-04	5.1E-06	71	5.1E-05	2.6	340.2	Sandy SILT TILL, fine to medium grained sand
TP3-21 (Test 1)	342.8	4.6E-04	4.6E-06	70	4.6E-05	3.5	339.3	Sandy SILT TILL, fine to medium grained sand
TP3-21 (Test 2)	342.8	2.3E-05	2.3E-07	31	2.3E-06	3.6	339.3	Sandy SILT TILL, fine to medium grained sand
MW6-18	342.5	-	-	21	5.4E-07	13.5 - 15.0	327.9 - 326.4	Sandy SILT TILL
MW7-18	339.6	-	-	12	5.8E-08	12.4 - 13.9	326.5 - 324.9	Sandy SILT TILL

Notes:

(1) Infiltration rate calculated based on established relationship between vertical hydraulic conductivity and infiltration rate presented in *Credit Valley Conservation and Toronto and Region Conservation (2010) Low Impact Stormwater Management Planning and Design Guideline - Version 1.0.*

(2) Horizontal hydraulic conductivity assumed to be one order of magnitude greater than Guelph Permeameter tested / calculated vertical hydraulic conductivity as per Freeze and Cherry (1979) and Todd (1980). Note that horizontal hydraulic conductivities for provided MW5-18(S/D), MW6-18 and MW7-18 calculated from in-situ hydraulic response testing completed on each monitoring well.

TABLE 8 - DESIGN INFILTRATION RATE CALCULATIONS

East Infiltration Trench

	Calculated Vertical Hydraulic Conductivities (m/s)			Geomean	Infiltration Rate (mm/hr)
Base (340.00 m AMSL)	3.9E-05	1.8E-05		2.6E-05	111
~1.5 m below Base (338.5 m AMSL)	1.1E-06			1.1E-06	48
Ratio (Base / 1.5 m)					*2.3*
Safety Factor					3.5
Design Infiltration Rate					***32***

South Infiltration Trench

	Calculated Vertical Hydraulic Conductivities (m/s)			Geomean	Infiltration Rate (mm/hr)
Base (340.43 m AMSL)	2.7E-06	2.2E-06		2.4E-06	58
~1.5 m below Base (338.93 m AMSL)	1.4E-06	5.1E-06	1.2E-05	4.4E-06	69
Ratio (Base / 1.5 m)					*0.8*
Safety Factor					2.5
Design Infiltration Rate					***23***

TABLE 9 - PRE-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENT 101 (LANDS DRAINING TO THE UPPER HANLON CREEK SUBWATERSHED)

Pre-Development
Model Type: Thornthwaite and Mather (1955)
Client: Tricar Developments Inc.
Location Catchment 101 (Lands Draining to Upper Hanlon Creek Subwatershed)
Total Site Area (ha) 1.33

Land Description Factors (Sub-area descriptions provided below)	**Sub-Area A**	**Sub-Area B**	**Sub-Area C**	**Sub-Area D**									**Total**
Topography	0.20	0.20	0.20	0.20									
Soils	0.25	0.25	0.25	0.25									
Cover	0.20	0.15	0.05	0.05									
Sum (Infiltration Factor)[†]	0.65	0.60	0.50	0.50									
Soil Moisture Capacity (mm)	300	150	75	75									
Site area (ha)	0.52	0.26	0.43	0.12									1.33
Imperviousness Coefficient	0.00	0.00	0.00	1.00									
Impervious Area (ha)	0.00	0.00	0.00	0.12									0.12
Percentage of Total Site Area	0.0%	0.0%	0.0%	9.3%									9%
Remaining Pervious Area (ha)	0.52	0.26	0.43	0.00									1.20
Total Pervious Site Area (ha)	0.52	0.26	0.43	0.00									1.20
Percentage of Total Site Area	38.8%	19.4%	32.4%	0.0%									91%

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Climate Data (Waterloo Wellington A Climate Normals, 1981 - 2010)[‡]													
Average Daily Temperature (°C)	-6.5	-5.5	-1	6.2	12.5	17.6	20	18.9	14.5	8.2	2.5	-3.3	**7.0**
Precipitation (mm)	65.2	54.9	61	74.5	82.3	82.4	98.6	83.9	87.8	67.4	87.1	71.2	**916**

Potential Evapotranspiration Analysis for Site	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Heat Index	0.0	0.0	0.0	1.4	4.0	6.7	8.2	7.5	5.0	2.1	0.4	0.0	**35**
Unadjusted Potential Evapotranspiration (mm)	0.0	0.0	0.0	29.0	60.8	87.2	99.8	94.0	71.1	39.0	11.1	0.0	**492**
Potential Evapotranspiration Adjusting Factor for Latitude*	0.77	0.87	0.99	1.12	1.23	1.29	1.26	1.16	1.04	0.92	0.81	0.75	
Adjusted Potential Evapotranspiration (PET)(mm)	0	0	0	32	75	112	126	110	74	36	9	0	**573**
Precipitation - PET (mm)	65	55	61	42	8	-30	-27	-26	14	32	78	71	**343**

Evapotranspiration Analysis													
Sub-Area A	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-65	-28	0	0	
Storage (S)	300	300	300	300	300	272	248	228	242	273	300	300	
Change in Storage	0	0	0	0	0	-28	-23	-20	14	32	27	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	111	122	104	74	36	9	0	**563**
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	51	71	**353**
Potential Infiltration (I)	42	36	40	27	5	0	0	0	0	0	33	46	230
Potential Direct Surface Water Runoff (R)	23	19	21	15	3	0	0	0	0	0	18	25	124
Potential Infiltration (mm)	0	0	0	191	5	0	0	0	0	0	33	0	230
Pervious Evapotranspiration (m^3)	0	0	0	167	385	571	629	537	382	185	46	0	2,902
Pervious Runoff (m^3)	118	99	110	76	14	0	0	0	0	0	93	128	**637**
Pervious Infiltration (m^3)	0	0	0	986	25	0	0	0	0	0	172	0	**1,184**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	65	55	61	75	82	82	99	84	88	67	87	71	916
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

TABLE 9 - PRE-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENT 101 (LANDS DRAINING TO THE UPPER HANLON CREEK SUBWATERSHED)

Evapotranspiration Analysis													
Sub-Area B	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-60	-19	0	0	
Storage (S)	150	150	150	150	150	123	103	87	100	132	150	150	
Change in Storage	0	0	0	0	0	-27	-20	-16	14	32	18	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	109	119	100	74	36	9	0	**554**
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	60	71	**362**
Potential Infiltration (I)	39	33	37	25	5	0	0	0	0	0	36	43	217
Potential Direct Surface Water Runoff (R)	26	22	24	17	3	0	0	0	0	0	24	28	145
Potential Infiltration (mm)	0	0	0	177	5	0	0	0	0	0	36	0	217
Pervious Evapotranspiration (m^3)	0	0	0	84	193	282	307	258	191	92	23	0	1,431
Pervious Runoff (m^3)	67	57	63	43	8	0	0	0	0	0	62	74	**374**
Pervious Infiltration (m^3)	0	0	0	456	12	0	0	0	0	0	93	0	**560**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	65	55	61	75	82	82	99	84	88	67	87	71	916
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

Evapotranspiration Analysis													
Sub-Area C	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-50	-5	0	0	
Storage (S)	75	75	75	75	75	50	35	25	39	70	75	75	
Change in Storage	0	0	0	0	0	-25	-15	-10	14	32	5	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	107	114	94	74	36	9	0	**541**
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	73	71	**375**
Potential Infiltration (I)	33	27	31	21	4	0	0	0	0	0	37	36	188
Potential Direct Surface Water Runoff (R)	33	27	31	21	4	0	0	0	0	0	37	36	188
Potential Infiltration (mm)	0	0	0	147	4	0	0	0	0	0	37	0	188
Pervious Evapotranspiration (m^3)	0	0	0	140	322	461	491	406	320	154	39	0	2,333
Pervious Runoff (m^3)	141	118	132	91	16	0	0	0	0	0	158	154	**809**
Pervious Infiltration (m^3)	0	0	0	635	16	0	0	0	0	0	158	0	**809**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	65	55	61	75	82	82	99	84	88	67	87	71	916
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

Evapotranspiration Analysis													
Sub-Area D	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-50	-5	0	0	
Storage (S)	75	75	75	75	75	50	35	25	39	70	75	75	
Change in Storage	0	0	0	0	0	-25	-15	-10	14	32	5	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	107	114	94	74	36	9	0	**541**
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	73	71	**375**
Potential Infiltration (I)	33	27	31	21	4	0	0	0	0	0	37	36	188
Potential Direct Surface Water Runoff (R)	33	27	31	21	4	0	0	0	0	0	37	36	188
Potential Infiltration (mm)	0	0	0	147	4	0	0	0	0	0	37	0	188
Pervious Evapotranspiration (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0
Pervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Pervious Infiltration (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	65	55	61	75	82	82	99	84	88	67	87	71	916
Impervious Runoff (m^3)	81	68	75	92	102	102	122	104	108	83	108	88	**1,132**

TABLE 9 - PRE-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENT 101 (LANDS DRAINING TO THE UPPER HANLON CREEK SUBWATERSHED)

Pre-Development Infiltration (INF)	2,553	m^3/yr	192	mm/yr	0.1	L/s
Pre-Development Runoff (R)	2,952	m^3/yr	222	mm/yr	0.1	L/s
Pre-Development Evapotranspiration (ET)	6,666	m^3/yr	501	mm/yr	0.2	L/s
Total = INF + R + ET	12,171	m^3/yr	915	mm/yr	0.4	L/s
Precipitation	12,171	m^3/yr	916	mm/yr	0.4	L/s

Sub-Area Descriptions (topography, soils, cover)	
Sub-Area A	Rolling, Fine Sandy to Silt Loam, Mature Forest
Sub-Area B	Rolling, Fine Sandy to Silt Loam, Pasture and Shrubs
Sub-Area C	Rolling, Fine Sandy to Silt Loam, Urban Lawn
Sub-Area D	Rolling, Fine Sandy to Silt Loam, Urban Lawn, 95% Impervious Cover

Notes:

† Infiltration factors after Ontario Ministry of the Environment, 2003. Stormwater Management Planning and Design Manual. March 2003.; and Ontario Ministry of Environment and Energy (MOEE). 1995. MOEE Hydrogeological Technical Information Requirements for Land Development Applications. April 1995.

* PET adjustment factors after Thornthwaite, C.W., and J.R. Mather, 1957. Instructions and Tables for Computing Potential Evapotranspiration and the water balance. Drexel Institute of Technology, Laboratory of Climatology, Publications in Climatology, Volume X, No. 3. Centerton, New Jersey.

‡ Climate Data after Environment Canada, 2020. Canadian Climate Normals 1981-2010, Waterloo Wellington A Station, Climate ID 6149387. [Online] http://climate.weather.gc.ca/climate_normals/index_e.html Accessed June 30, 2020.

Assumptions:
[1] The monthly average precipitation collected at the Waterloo Wellington A climate station is reflective of the precipitation trends that have historically occurred at the Site.
[2] Surplus water is not available for runoff and recharge during months where water losses from actual evapotranspiration exceed precipitation inputs.
[3] Runoff, infiltration and evapotranspiration do not occur in months where the average daily temperature is below 0°C, which is the case for the months of December through March at the Site.
[4] Precipitation during freezing months (i.e., December to March) is assumed to accumulate as snow and result in additional precipitation in the first month thereafter where the average temperature is greater than 0°C (i.e., April).
[5] Soil moisture capacity is at a maximum in April.

TABLE 10 - PRE-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENT 102 (LANDS DRAINING TO TORRANCE CREEK SUBWATERSHED)

Pre-Development
Model Type: Thornthwaite and Mather (1955)
Client: Tricar Developments Inc.
Location **Catchment 102 (Lands Draining to Torrance Creek Subwatershed)**
Total Site Area (ha) 1.73

Land Description Factors **(Sub-area descriptions provided below)**	**Sub-Area A**	**Sub-Area B**	**Sub-Area C**									**Total**
Topography	0.20	0.20	0.20									
Soils	0.25	0.25	0.25									
Cover	0.20	0.15	0.05									
Sum (Infiltration Factor)†	0.65	0.60	0.50									
Soil Moisture Capacity (mm)	300	150	75									
Site area (ha)	0.98	0.72	0.03									1.73
Imperviousness Coefficient	0.01	0.01	0.01									
Impervious Area (ha)	0.01	0.01	0.00									0.02
Percentage of Total Site Area	0.6%	0.4%	0.0%									1%
Remaining Pervious Area (ha)	0.97	0.71	0.03									1.71
Total Pervious Site Area (ha)	0.97	0.71	0.03									1.71
Percentage of Total Site Area	56.1%	41.2%	1.6%									99%

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Climate Data (Waterloo Wellington A Climate Normals, 1981 - 2010)‡													
Average Daily Temperature (°C)	-6.5	-5.5	-1	6.2	12.5	17.6	20	18.9	14.5	8.2	2.5	-3.3	**7.0**
Precipitation (mm)	65.2	54.9	61	74.5	82.3	82.4	98.6	83.9	87.8	67.4	87.1	71.2	**916**

Potential Evapotranspiration Analysis for Site	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Heat Index	0.0	0.0	0.0	1.4	4.0	6.7	8.2	7.5	5.0	2.1	0.4	0.0	**35**
Unadjusted Potential Evapotranspiration (mm)	0.0	0.0	0.0	29.0	60.8	87.2	99.8	94.0	71.1	39.0	11.1	0.0	**492**
Potential Evapotranspiration Adjusting Factor for Latitude*	0.77	0.87	0.99	1.12	1.23	1.29	1.26	1.16	1.04	0.92	0.81	0.75	
Adjusted Potential Evapotranspiration (PET)(mm)	0	0	0	32	75	112	126	110	74	36	9	0	**573**
Precipitation - PET (mm)	65.2	54.9	61.0	42.0	7.6	-29.7	-27.0	-25.6	13.7	31.6	78.1	71.2	**343**
	0	0	0	100	100	100	100	100	100	100	100	0	

Evapotranspiration Analysis													
Sub-Area A	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Precipitation (m^3)	639	538	598	730	807	807	966	822	860	660	854	698	**8,979**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-65	-28	0	0	
Storage (S)	300	300	300	300	300	272	248	228	242	273	300	300	
Change in Storage	0	0	0	0	0	-28	-23	-20	14	32	27	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	111	122	104	74	36	9	0	**563**
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	51	71	**353**
Potential Infiltration (I)	42	36	40	27	5	0	0	0	0	0	33	46	230
Potential Direct Surface Water Runoff (R)	23	19	21	15	3	0	0	0	0	0	18	25	124
Potential Infiltration (mm)	0	0	0	191	5	0	0	0	0	0	33	0	230
Pervious Evapotranspiration (m^3)	0	0	0	315	725	1074	1184	1011	719	347	87	0	5,462
Pervious Runoff (m^3)	221	186	207	143	26	0	0	0	0	0	174	242	**1,200**
Pervious Infiltration (m^3)	0	0	0	1856	48	0	0	0	0	0	324	0	**2,228**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	65	55	61	75	82	82	99	84	88	67	87	71	916
Impervious Runoff (m^3)	6	5	6	7	8	8	10	8	9	7	9	7	**90**

TABLE 10 - PRE-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENT 102 (LANDS DRAINING TO TORRANCE CREEK SUBWATERSHED)

Evapotranspiration Analysis													
Sub-Area B	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Precipitation (m^3)	469	395	439	536	593	593	710	604	632	485	627	513	**6,598**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-60	-19	0	0	
Storage (S)	150	150	150	150	150	123	103	87	100	132	150	150	
Change in Storage	0	0	0	0	0	-27	-20	-16	14	32	18	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	109	119	100	74	36	9	0	**554**
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	60	71	**362**
Potential Infiltration (I)	39	33	37	25	5	0	0	0	0	0	36	43	217
Potential Direct Surface Water Runoff (R)	26	22	24	17	3	0	0	0	0	0	24	28	145
Potential Infiltration (mm)	0	0	0	177	5	0	0	0	0	0	36	0	217
Pervious Evapotranspiration (m^3)	0	0	0	232	533	780	847	713	528	255	64	0	3,952
Pervious Runoff (m^3)	186	157	174	120	22	0	0	0	0	0	171	203	**1,032**
Pervious Infiltration (m^3)	0	0	0	1259	32	0	0	0	0	0	257	0	**1,548**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	65	55	61	75	82	82	99	84	88	67	87	71	916
Impervious Runoff (m^3)	5	4	4	5	6	6	7	6	6	5	6	5	**66**

Evapotranspiration Analysis													
Sub-Area C	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Precipitation (m^3)	18	16	17	21	23	23	28	24	25	19	25	20	**260**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-50	-5	0	0	
Storage (S)	75	75	75	75	75	50	35	25	39	70	75	75	
Change in Storage	0	0	0	0	0	-25	-15	-10	14	32	5	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	107	114	94	74	36	9	0	**541**
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	73	71	**375**
Potential Infiltration (I)	33	27	31	21	4	0	0	0	0	0	37	36	188
Potential Direct Surface Water Runoff (R)	33	27	31	21	4	0	0	0	0	0	37	36	188
Potential Infiltration (mm)	0	0	0	147	4	0	0	0	0	0	37	0	188
Pervious Evapotranspiration (m^3)	0	0	0	9	21	30	32	26	21	10	3	0	152
Pervious Runoff (m^3)	9	8	9	6	1	0	0	0	0	0	10	10	**53**
Pervious Infiltration (m^3)	0	0	0	41	1	0	0	0	0	0	10	0	**53**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	65	55	61	75	82	82	99	84	88	67	87	71	916
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**3**

Catchment 102						
Pre-Development Infiltration (INF)	3,828	m^3/yr	222	mm/yr	0.1	L/s
Pre-Development Runoff (R)	2,443	m^3/yr	141	mm/yr	0.1	L/s
Pre-Development Evapotranspiration (ET)	9,566	m^3/yr	553	mm/yr	0.3	L/s
Total = INF + R + ET	15,837	m^3/yr	916	mm/yr	0.5	L/s
Precipitation	15,837	m^3/yr	916	mm/yr	0.5	L/s
Error	0.000	m^3/yr	0.000	mm/yr	0.000	L/s

Sub-Area Descriptions (topography, soils, cover)	
Sub-Area A	Rolling, Fine Sandy to Silt Loam, Mature Forest
Sub-Area B	Rolling, Fine Sandy to Silt Loam, Pasture and Shrubs
Sub-Area C	Rolling, Fine Sandy to Silt Loam, Urban Lawn

Notes:

† Infiltration factors after Ontario Ministry of the Environment, 2003. Stormwater Management Planning and Design Manual. March 2003.; and Ontario Ministry of Environment and Energy (MOEE). 1995. MOEE Hydrogeological Technical Information Requirements for Land Development Applications. April 1995.

* PET adjustment factors after Thornthwaite, C.W., and J.R. Mather, 1957. Instructions and Tables for Computing Potential Evapotranspiration and the water balance. Drexel Institute of Technology, Laboratory of Climatology, Publications in Climatology, Volume X, No. 3. Centerton, New Jersey.

‡ Climate Data after Environment Canada, 2020. Canadian Climate Normals 1981-2010, Waterloo Wellington A Station, Climate ID 6149387. [Online] http://climate.weather.gc.ca/climate_normals/index_e.html Accessed June 30, 2020.

Assumptions:
[1] The monthly average precipitation collected at the Waterloo Wellington A climate station is reflective of the precipitation trends that have historically occurred at the Site.
[2] Surplus water is not available for runoff and recharge during months where water losses from actual evapotranspiration exceed precipitation inputs.
[3] Runoff, infiltration and evapotranspiration do not occur in months where the average daily temperature is below 0°C, which is the case for the months of December through March at the Site.
[4] Precipitation during freezing months (i.e., December to March) is assumed to accumulate as snow and result in additional precipitation in the first month thereafter where the average temperature is greater than 0°C (i.e., April).
[5] Soil moisture capacity is at a maximum in April.

TABLE 11
1981 TO 2010 CANADIAN CLIMATE NORMALS (WATERLOO WELLINGTON A)

Climate Normals 1981-2010 Station Data
Metadata including Station Name, Province, Latitude, Longitude, Elevation, Climate ID, WMO ID, TC ID

STATION_NAME	PROVINCE	LATITUDE	LONGITUDE	ELEVATION	CLIMATE_ID	WMO_ID	TC_ID
WATERLOO WELLINGTON A	ON	43°27'00.000" N	80°23'00.000" W	317.0 m	6149387		

Legend
A = WMO "3 and 5 rule" (i.e. no more than 3 consecutive and no more than 5 total missing for either temperature or precipitation)
B = At least 25 years
C = At least 20 years
D = At least 15 years

1981 to 2010 Canadian Climate Normals Station Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Temperature														
Daily Average (°C)	-6.5	-5.5	-1	6.2	12.5	17.6	20	18.9	14.5	8.2	2.5	-3.3	7	C
Standard Deviation	2.9	2.5	2	1.4	2.1	1.3	1.3	1.3	1.2	1.4	1.5	2.9	0.9	C
Daily Maximum (°C)	-2.6	-1.2	3.6	11.5	18.5	23.6	26	24.8	20.4	13.5	6.3	0.2	12	C
Daily Minimum (°C)	-10.3	-9.7	-5.6	0.8	6.4	11.5	14	12.9	8.6	2.9	-1.4	-6.8	2	C
Extreme Maximum (°C)	14.2	13.7	24.4	29.2	32	36.1	36	36.5	33.3	29.4	21.7	18.7		
Date (yyyy/dd)	1995/14	2000/26	2000/08	1990/25	1987/28	1988/25	1988/07	2001/08	1973/03	1971/02	1974/01	1982/03		
Extreme Minimum (°C)	-31.9	-29.2	-25.4	-16.1	-3.9	-0.6	5	1.1	-3.7	-8.3	-15.4	-27.2		
Date (yyyy/dd)	1984/16	1979/18	1980/02	1972/08	1970/07	1972/11	1971/03	1982/29	1989/27	1976/27	2000/23	1980/25		
Precipitation														
Rainfall (mm)	28.7	29.7	36.8	68	81.8	82.4	98.6	83.9	87.8	66.1	75	38	776.8	C
Snowfall (cm)	43.7	30.3	26.5	7.3	0.4	0	0	0	0	1.4	13	37.2	159.7	C
Precipitation (mm)	65.2	54.9	61	74.5	82.3	82.4	98.6	83.9	87.8	67.4	87.1	71.2	916.5	C
Average Snow Depth (cm)	11	11	6	0	0	0	0	0	0	0	1	5	3	C
Median Snow Depth (cm)	11	11	4	0	0	0	0	0	0	0	0	3	3	C
Snow Depth at Month-end (cm)	12	9	1	0	0	0	0	0	0	0	1	9	3	C
Extreme Daily Rainfall (mm)	43	47	36.8	53.4	51.8	54.2	89.8	73.7	74.4	39.2	56	36.8		
Date (yyyy/dd)	1995/15	2001/09	1991/27	1992/16	1996/20	1984/17	1985/15	1975/24	1986/10	1977/08	1992/12	1990/29		
Extreme Daily Snowfall (cm)	16.8	17.8	21.2	22.9	6	0	0	0	0	6	16.6	22.4		
Date (yyyy/dd)	1992/14	1985/12	1980/08	2002/02	1984/13	1970/01	1970/01	1970/01	1970/01	1997/26	1986/20	1971/30		
Extreme Daily Precipitation (mm)	43	47	53.8	53.4	51.8	54.2	89.8	73.7	74.4	39.2	56	36.8		
Date (yyyy/dd)	1995/15	2001/09	1976/02	1992/16	1996/20	1984/17	1985/15	1975/24	1986/10	1977/08	1992/12	1990/29		
Extreme Snow Depth (cm)	58	74	77	18	0	0	0	0	0	2	19	50		
Date (yyyy/dd)	1976/24	1982/14	1982/10	1975/04	1970/01	1970/01	1970/01	1970/01	1970/01	1989/21	1986/21	2000/31		
Days with Maximum Temperature														
<= 0 °C	20.7	15.7	9.2	0.64	0	0	0	0	0	0	3.2	14	63.5	C
> 0 °C	10.3	12.5	21.8	29.4	31	30	31	31	30	31	26.8	17	301.7	C
> 10 °C	0.45	0.5	4.9	17.3	29.3	29.9	31	31	29.6	22.5	7.4	1.6	205.4	C
> 20 °C	0	0	0.29	2.9	11.6	23.5	29.7	28.1	15.9	3.6	0.15	0	115.7	C
> 30 °C	0	0	0	0	0.32	2.1	3.6	1.9	0.45	0	0	0	8.4	C
> 35 °C	0	0	0	0	0	0.05	0.23	0.05	0	0	0	0	0.33	C
Days with Minimum Temperature														
> 0 °C	1.5	1.9	4	15.5	28.9	30	31	31	29.2	21.7	10.4	2.5	207.6	C
<= 2 °C	30.5	27.9	29.2	19.6	6.1	0.23	0	0.09	2.6	14.6	24.2	29.8	184.7	C
<= 0 °C	29.5	26.4	27	14.5	2.1	0	0	0	0.77	9.3	19.7	28.5	157.6	C
< -2 °C	27.2	23.6	21.9	8.3	0.18	0	0	0	0.18	3.8	13.1	23.1	121.3	C
< -10 °C	15.1	13.4	6.7	0.18	0	0	0	0	0	0	0.85	9.1	45.4	C
< -20 °C	2.9	2	0.41	0	0	0	0	0	0	0	0	0.67	6	C
< - 30 °C	0.05	0	0	0	0	0	0	0	0	0	0	0	0.05	C
Days with Rainfall														
>= 0.2 mm	5.6	5	6.9	11.5	12.4	12	10.6	10.7	12.2	13.7	11.6	6.9	118.7	C
>= 5 mm	1.8	1.8	2.5	4.1	5.1	5.2	5.1	4.4	5	4.4	4.7	2.8	46.9	C
>= 10 mm	0.95	1	1.4	2.1	2.9	3.1	3.4	2.8	2.8	2.4	2.4	1.2	26.4	C
>= 25 mm	0.09	0.14	0.09	0.32	0.45	0.36	0.95	0.77	0.68	0.14	0.48	0.14	4.6	C
Days With Snowfall														
>= 0.2 cm	16.1	11.9	9	3.3	0.18	0	0	0	0	0.91	6.5	14.4	62.2	C
>= 5 cm	2.5	1.8	1.9	0.36	0.05	0	0	0	0	0.05	0.67	2.3	9.6	C
>= 10 cm	0.64	0.5	0.64	0.09	0	0	0	0	0	0	0.05	0.57	2.5	C
>= 25 cm	0	0	0	0	0	0	0	0	0	0	0	0	0	C
Days with Precipitation														
>= 0.2 mm	18.2	14.2	13.8	13.7	12.4	12	10.6	10.7	12.2	13.9	16.4	18.1	166	C
>= 5 mm	4.3	3.2	4	4.5	5.2	5.2	5.1	4.4	5	4.5	5.3	4.5	55.1	C
>= 10 mm	1.5	1.6	1.8	2.3	2.9	3.1	3.4	2.8	2.8	2.4	2.5	2.1	29.2	C
>= 25 mm	0.09	0.18	0.27	0.32	0.45	0.36	0.95	0.77	0.68	0.14	0.48	0.38	5.1	C
Days with Snow Depth														
>= 1 cm	26.9	24.3	17.2	1.7	0	0	0	0	0	0.18	5.6	19.4	95.3	C
>= 5 cm	20.6	17.5	9.7	0.41	0	0	0	0	0	0	1.1	10.5	59.8	C
>= 10 cm	13.7	11.2	6.5	0.05	0	0	0	0	0	0	0.33	4.5	36.2	C
>= 20 cm	6.8	5.1	1.5	0	0	0	0	0	0	0	0	1.4	14.7	C
Wind														
Speed (km/h)	15.2	14.3	14.9	14.6	12.3	10.4	9.6	8.5	9.8	11.7	14.5	14.8	12.6	C
Most Frequent Direction	W	W	W	NW	NW	NW	NW	NW	NW	W	W	SW	W	C
Maximum Hourly Speed (km/h)	70	67	74	72	71	52	52	45	53	63	66	61	74	
Date (yyyy/dd)	1982/04	2002/01	2002/09	1984/30	1976/05	1998/02	2001/01	1966/09	1967/26	2001/26	1975/10	1972/13	2002/09	
Direction of Maximum Hourly Speed	SW	W	W	S	SW	W	NW	W	S	SW	SW	SW	W	
Maximum Gust Speed (km/h)	113	113	120	98	106	89	111	98	89	96	100	96	120	
Date (yyyy/dd)	1978/26	2002/01	1981/30	1984/30	1976/05	1998/02	1997/14	1990/27	1997/29	2001/25	1998/11	1982/28	1981/30	

TABLE 11
1981 TO 2010 CANADIAN CLIMATE NORMALS (WATERLOO WELLINGTON A)

Direction of Maximum Gust	S	W	SW	SW	SW	W	W	N	W	SW	SW	SW	SW	
Days with Winds >= 52 km/h														
Days with Winds >= 63 km/h														
Degree Days														
Above 24 °C	0	0	0	0	0.1	1.6	5.2	2.5	0.3	0	0	0	9.8	C
Above 18 °C	0	0	0	1	10.2	40.9	77.2	54.7	16.6	0.7	0	0	201.4	C
Above 15 °C	0	0	0.1	3.7	30.2	94.1	157.3	125	46.3	4.5	0	0	461.2	C
Above 10 °C	0	0	2.3	20.3	103.6	227.6	310.8	275.6	145.8	33	3.8	0.6	1123.2	C
Above 5 °C	1.2	0.9	13.4	75.1	234.7	376.8	465.8	430.5	286.4	115.6	28.1	5	2033.3	C
Above 0 °C	11	13.9	55.4	190.6	388.6	526.8	620.8	585.5	436.2	255.6	100.1	26.1	3210.6	C
Below 0 °C	211.7	168	89.7	6.1	0	0	0	0	0	0.2	23.6	129.4	628.8	C
Below 5 °C	356.8	296.1	202.7	40.7	1.1	0	0	0	0.1	15.2	101.7	263.3	1277.6	C
Below 10 °C	510.7	436.4	346.7	135.8	25	0.8	0	0.2	9.6	87.5	227.3	413.8	2193.7	C
Below 15 °C	665.7	577.5	499.4	269.3	106.6	17.2	1.5	4.6	60.1	214.1	373.6	568.3	3357.8	C
Below 18 °C	758.7	662.2	592.4	356.6	179.7	54	14.4	27.2	120.4	303.3	463.6	661.3	4193.6	C
Humidex														
Extreme Humidex	13.4	13	28	33.7	39.6	43.2	47.7	48.3	41.2	34.5	24.4	22.1		
Date (yyyy/dd)	1995/14	1997/21	1998/30	2002/16	1987/30	1988/25	1995/14	1988/02	1983/10	1971/02	1987/03	1982/03		
Wind Chill														
Extreme Wind Chill	-40.5	-37.1	-30.2	-20.6	-8.1	0	0	0	-4.1	-11.9	-22.2	-31.2		
Date (yyyy/dd)	1982/17	1979/17	1989/07	1982/04	1978/01	1966/13	1966/01	1966/01	1989/27	1969/23	1976/29	1983/26		
Humidity														
Average Relative Humidity - 0600LST (%)	86.4	83.4	84.8	84.4	84.7	87	90.1	93.6	94.3	90.6	87.6	87.1	87.8	D
Average Relative Humidity - 1500LST (%)	78.2	75.4							66.5	69.7		81.7		

1981 to 2010 Canadian Climate Normals station data (Frost-Free)

	Frost-Free:	Code					
Average Date of Last Spring Frost	7-May	D					
Average Date of First Fall Frost	2-Oct	D					
Average Length of Frost-Free Period	147 Days	D					
Probability of last temperature in spring of 0 °C or lower or	10%	25%	33%	50%	66%	75%	90%
Date	18-May	15-May	13-May	8-May	4-May	30-Apr	28-Apr
Probability of first temperature in fall of 0 °C or lower on or	10%	25%	33%	50%	66%	75%	90%
Date	19-Sep	24-Sep	25-Sep	30-Sep	3-Oct	8-Oct	16-Oct
Probability of frost-free period equal to or less than indicate	10%	25%	33%	50%	66%	75%	90%
Days	128	135	136	144	152	157	169

Source: Environment Canada, 2020. Canadian Climate Normals 1981-2010. Online [http://climate.weather.gc.ca/climate_normals/index_e.html] Last Accessed February 2018

TABLE 12 - POST-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENTS 201 TO 204 AND 207 TO 209 (LANDS DRAINING TO THE UPPER HANLON CREEK SUBWATERSHED)

	Post-Development
Model Type:	Thornthwaite and Mather (1955)
Client:	Tricar Developments Inc.
Location	**Former Catchment 101 (Lands Draining to Upper Hanlon Creek Subwatershed)** **Post-Development Catchments 201 to 204 and 207 to 209**
Total Site Area (ha)	1.46

Land Description Factors (Sub-area descriptions provided below)	**Sub-Area A**	**Sub-Area B**	**Sub-Area C**										**Total**
Topography	0.20	0.20	0.20										
Soils	0.25	0.25	0.25										
Cover	0.05	0.05	0.05										
Sum (Infiltration Factor)[†]	0.50	0.50	0.50										
Soil Moisture Capacity (mm)	300	150	75										
Site area (ha)	0.51	0.32	0.63										1.46
Imperviousness Coefficient	0.91	0.94	0.63										
Impervious Area (ha)	0.46	0.30	0.40										1.16
Percentage of Total Site Area	31.6%	20.7%	27.2%										79.5%
Remaining Pervious Area (ha)	0.05	0.02	0.23										0.30
Total Pervious Site Area (ha)	0.05	0.02	0.23										0.30
Percentage of Total Site Area	3.2%	1.4%	15.9%										20.5%

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Climate Data (Waterloo Wellington A Climate Normals, 1981 - 2010)[‡]													
Average Daily Temperature (°C)	-6.5	-5.5	-1	6.2	12.5	17.6	20	18.9	14.5	8.2	2.5	-3.3	**7.0**
Precipitation (mm)	65.2	54.9	61	74.5	82.3	82.4	98.6	83.9	87.8	67.4	87.1	71.2	**916**

Potential Evapotranspiration Analysis for Site	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Heat Index	0.0	0.0	0.0	1.4	4.0	6.7	8.2	7.5	5.0	2.1	0.4	0.0	**35**
Unadjusted Potential Evapotranspiration (mm)	0.0	0.0	0.0	29.0	60.8	87.2	99.8	94.0	71.1	39.0	11.1	0.0	**492**
Potential Evapotranspiration Adjusting Factor for Latitude*	0.77	0.87	0.99	1.12	1.23	1.29	1.26	1.16	1.04	0.92	0.81	0.75	
Adjusted Potential Evapotranspiration (PET)(mm)	0	0	0	32	75	112	126	110	74	36	9	0	**573**
Precipitation - PET (mm)	65	55	61	42	8	-30	-27	-26	14	32	78	71	**343**

Evapotranspiration Analysis													
Sub-Area A	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Precipitation (m^3)													**4,647**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-65	-28	0	0	
Storage (S)	300	300	300	300	300	272	248	228	242	273	300	300	
Change in Storage	0	0	0	0	0	-28	-23	-20	14	32	27	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	111	122	104	74	36	9	0	563
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	51	71	**353**
Potential Infiltration (I)	33	27	31	21	4	0	0	0	0	0	26	36	177
Potential Direct Surface Water Runoff (R)	33	27	31	21	4	0	0	0	0	0	26	36	177
Potential Infiltration (mm)	0	0	0	147	4	0	0	0	0	0	26	0	177
Pervious Evapotranspiration (m^3)	0	0	0	15	34	51	56	48	34	16	4	0	259
Pervious Runoff (m^3)	15	13	14	10	2	0	0	0	0	0	12	16	**81**
Pervious Infiltration (m^3)	0	0	0	68	2	0	0	0	0	0	12	0	**81**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	65	55	61	75	82	82	99	84	88	67	87	71	916
Impervious Runoff (m^3)	301	253	281	344	380	380	455	387	405	311	402	328	**4,225**

TABLE 12 - POST-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENTS 201 TO 204 AND 207 TO 209 (LANDS DRAINING TO THE UPPER HANLON CREEK SUBWATERSHED)

Evapotranspiration Analysis													
Sub-Area B	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Precipitation (m^3)													**2,944**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-60	-19	0	0	
Storage (S)	150	150	150	150	150	123	103	87	100	132	150	150	
Change in Storage	0	0	0	0	0	-27	-20	-16	14	32	18	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	109	119	100	74	36	9	0	**554**
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	60	71	**362**
Potential Infiltration (I)	33	27	31	21	4	0	0	0	0	0	30	36	181
Potential Direct Surface Water Runoff (R)	33	27	31	21	4	0	0	0	0	0	30	36	181
Potential Infiltration (mm)	0	0	0	147	4	0	0	0	0	0	30	0	181
Pervious Evapotranspiration (m^3)	0	0	0	6	15	22	24	20	15	7	2	0	110
Pervious Runoff (m^3)	6	5	6	4	1	0	0	0	0	0	6	7	**36**
Pervious Infiltration (m^3)	0	0	0	29	1	0	0	0	0	0	6	0	**36**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	65	55	61	75	82	82	99	84	88	67	87	71	916
Impervious Runoff (m^3)	197	165	184	225	248	248	297	253	265	203	263	215	**2,762**

Evapotranspiration Analysis													
Sub-Area C	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Precipitation (m^3)													**5,766**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-50	-5	0	0	
Storage (S)	75	75	75	75	75	50	35	25	39	70	75	75	
Change in Storage	0	0	0	0	0	-25	-15	-10	14	32	5	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	107	114	94	74	36	9	0	**541**
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	73	71	**375**
Potential Infiltration (I)	33	27	31	21	4	0	0	0	0	0	37	36	188
Potential Direct Surface Water Runoff (R)	33	27	31	21	4	0	0	0	0	0	37	36	188
Potential Infiltration (mm)	0	0	0	147	4	0	0	0	0	0	37	0	188
Pervious Evapotranspiration (m^3)	0	0	0	75	174	248	265	219	172	83	21	0	1,257
Pervious Runoff (m^3)	76	64	71	49	9	0	0	0	0	0	85	83	**436**
Pervious Infiltration (m^3)	0	0	0	342	9	0	0	0	0	0	85	0	**436**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	65	55	61	75	82	82	99	84	88	67	87	71	916
Impervious Runoff (m^3)	259	218	242	296	327	327	391	333	348	268	346	283	**3,637**

Post-Development Catchments 201 to 204 and 207 to 209

Post-Development Infiltration (INF)	553	m^3/yr	38	mm/yr	0.0	L/s
Post-Development Runoff (R)	11,177	m^3/yr	767	mm/yr	0.4	L/s
Post-Development Evapotranspiration (ET)	1,626	m^3/yr	112	mm/yr	0.1	L/s
Total = INF + R + ET	13,356	m^3/yr	916	mm/yr	0.4	L/s
Precipitation	13,356	m^3/yr	916	mm/yr	0.4	L/s

Pre-Development Infiltration	2,553	m^3/yr
Infiltration Deficit	**-2,000**	**m^3/yr**

Sub-Area Descriptions (topography, soils, cover)	
Sub-Area A	Rolling, Fine Sandy to Silt Loam, Mature Forest
Sub-Area B	Rolling, Fine Sandy to Silt Loam, Pasture and Shrubs
Sub-Area C	Rolling, Fine Sandy to Silt Loam, Urban Lawn

Notes:

† Infiltration factors after Ontario Ministry of the Environment, 2003. Stormwater Management Planning and Design Manual. March 2003.; and Ontario Ministry of Environment and Energy (MOEE). 1995. MOEE Hydrogeological Technical Information Requirements for Land Development Applications. April 1995.

* PET adjustment factors after Thornthwaite, C.W., and J.R. Mather, 1957. Instructions and Tables for Computing Potential Evapotranspiration and the water balance. Drexel Institute of Technology, Laboratory of Climatology, Publications in Climatology, Volume X, No. 3. Centerton, New Jersey.

‡ Climate Data after Environment Canada, 2020. Canadian Climate Normals 1981-2010, Waterloo Wellington A Station, Climate ID 6149387. [Online] http://climate.weather.gc.ca/climate_normals/index_e.html Accessed June 30, 2020.

Assumptions:
[1] The monthly average precipitation collected at the Waterloo Wellington A climate station is reflective of the precipitation trends that have historically occurred at the Site.
[2] Surplus water is not available for runoff and recharge during months where water losses from actual evapotranspiration exceed precipitation inputs.
[3] Runoff, infiltration and evapotranspiration do not occur in months where the average daily temperature is below 0°C, which is the case for the months of December through March at the Site.
[4] Precipitation during freezing months (i.e., December to March) is assumed to accumulate as snow and result in additional precipitation in the first month thereafter where the average temperature is greater than 0°C (i.e., April).
[5] Soil moisture capacity is at a maximum in April.

TABLE 13 - POST-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENTS 205 AND 206 (LANDS DRAINING TO TORRANCE CREEK SUBWATERSHED)

Post-Development
Model Type: Thornthwaite and Mather (1955)
Client: Tricar Developments Inc.
Location **Former Catchment 102 (Lands Draining to Torrance Creek Subwatershed)**
Post-Development Catchments 205 and 206
Total Site Area (ha) 1.60

Land Description Factors (Sub-area descriptions provided below)	**Sub-Area A**	**Sub-Area B**	**Sub-Area C**										**Total**
Topography	0.20	0.20	0.20										
Soils	0.25	0.25	0.25										
Cover	0.20	0.15	0.05										
Sum (Infiltration Factor)†	0.65	0.60	0.50										
Soil Moisture Capacity (mm)	300	150	75										
Site area (ha)	0.99	0.58	0.03										1.60
Imperviousness Coefficient	0.01	0.01	0.01										
Impervious Area (ha)	0.01	0.01	0.00										0.02
Percentage of Total Site Area	0.6%	0.4%	0.0%										1.0%
Remaining Pervious Area (ha)	0.98	0.57	0.03										1.58
Total Pervious Site Area (ha)	0.98	0.57	0.03										1.58
Percentage of Total Site Area	61.2%	35.8%	2.1%										99.0%

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Climate Data (Waterloo Wellington A Climate Normals, 1981 - 2010)‡													
Average Daily Temperature (°C)	-6.5	-5.5	-1	6.2	12.5	17.6	20	18.9	14.5	8.2	2.5	-3.3	**7.0**
Precipitation (mm)	65.2	54.9	61	74.5	82.3	82.4	98.6	83.9	87.8	67.4	87.1	71.2	**916**

Potential Evapotranspiration Analysis for Site	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Heat Index	0.0	0.0	0.0	1.4	4.0	6.7	8.2	7.5	5.0	2.1	0.4	0.0	**35**
Unadjusted Potential Evapotranspiration (mm)	0.0	0.0	0.0	29.0	60.8	87.2	99.8	94.0	71.1	39.0	11.1	0.0	**492**
Potential Evapotranspiration Adjusting Factor for Latitude*	0.77	0.87	0.99	1.12	1.23	1.29	1.26	1.16	1.04	0.92	0.81	0.75	
Adjusted Potential Evapotranspiration (PET)(mm)	0	0	0	32	75	112	126	110	74	36	9	0	**573**
Precipitation - PET (mm)	65	55	61	42	8	-30	-27	-26	14	32	78	71	**343**

Evapotranspiration Analysis													
Sub-Area A	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Precipitation (m^3)													**9,053**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-65	-28	0	0	
Storage (S)	300	300	300	300	300	272	248	228	242	273	300	300	
Change in Storage	0	0	0	0	0	-28	-23	-20	14	32	27	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	111	122	104	74	36	9	0	563
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	51	71	**353**
Potential Infiltration (I)	42	36	40	27	5	0	0	0	0	0	33	46	230
Potential Direct Surface Water Runoff (R)	23	19	21	15	3	0	0	0	0	0	18	25	124
Potential Infiltration (mm)	0	0	0	191	5	0	0	0	0	0	33	0	230
Pervious Evapotranspiration (m^3)	0	0	0	318	731	1083	1193	1019	725	350	88	0	5,507
Pervious Runoff (m^3)	223	188	209	144	26	0	0	0	0	0	176	244	**1,209**
Pervious Infiltration (m^3)	0	0	0	1871	48	0	0	0	0	0	327	0	**2,246**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	65	55	61	75	82	82	99	84	88	67	87	71	916
Impervious Runoff (m^3)	6	5	6	7	8	8	10	8	9	7	9	7	**91**

TABLE 13 - POST-DEVELOPMENT MONTHLY WATER BALANCE CALCULATIONS
CATCHMENTS 205 AND 206 (LANDS DRAINING TO TORRANCE CREEK SUBWATERSHED)

Evapotranspiration Analysis													
Sub-Area B	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Precipitation (m^3)													**5,294**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-60	-19	0	0	
Storage (S)	150	150	150	150	150	123	103	87	100	132	150	150	
Change in Storage	0	0	0	0	0	-27	-20	-16	14	32	18	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	109	119	100	74	36	9	0	**554**
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	60	71	**362**
Potential Infiltration (I)	39	33	37	25	5	0	0	0	0	0	36	43	217
Potential Direct Surface Water Runoff (R)	26	22	24	17	3	0	0	0	0	0	24	28	145
Potential Infiltration (mm)	0	0	0	177	5	0	0	0	0	0	36	0	217
Pervious Evapotranspiration (m^3)	0	0	0	186	427	626	680	572	424	205	51	0	3,171
Pervious Runoff (m^3)	149	126	140	96	17	0	0	0	0	0	137	163	**828**
Pervious Infiltration (m^3)	0	0	0	1010	26	0	0	0	0	0	206	0	**1,242**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	65	55	61	75	82	82	99	84	88	67	87	71	916
Impervious Runoff (m^3)	4	3	4	4	5	5	6	5	5	4	5	4	**53**

Evapotranspiration Analysis													
Sub-Area C	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Precipitation (m^3)													**303**
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-50	-5	0	0	
Storage (S)	75	75	75	75	75	50	35	25	39	70	75	75	
Change in Storage	0	0	0	0	0	-25	-15	-10	14	32	5	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	107	114	94	74	36	9	0	**541**
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	73	71	**375**
Potential Infiltration (I)	33	27	31	21	4	0	0	0	0	0	37	36	188
Potential Direct Surface Water Runoff (R)	33	27	31	21	4	0	0	0	0	0	37	36	188
Potential Infiltration (mm)	0	0	0	147	4	0	0	0	0	0	37	0	188
Pervious Evapotranspiration (m^3)	0	0	0	11	24	35	37	31	24	12	3	0	177
Pervious Runoff (m^3)	11	9	10	7	1	0	0	0	0	0	12	12	**62**
Pervious Infiltration (m^3)	0	0	0	48	1	0	0	0	0	0	12	0	**62**
Potential Impervious Evaporation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Potential Impervious Runoff (mm)	65	55	61	75	82	82	99	84	88	67	87	71	916
Impervious Runoff (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**3**

Catchments 205 and 206

Post-Development Infiltration (INF)	3,550	m^3/yr	222	mm/yr	0.1	L/s
Post-Development Runoff (R)	2,245	m^3/yr	140	mm/yr	0.1	L/s
Post-Development Evapotranspiration (ET)	8,855	m^3/yr	554	mm/yr	0.3	L/s
Total = INF + R + ET	14,650	m^3/yr	916	mm/yr	0.5	L/s
Precipitation	14,650	m^3/yr	916	mm/yr	0.5	L/s

Pre-Development Infiltration	3,828	m^3/yr
Infiltration Deficit	**-279**	**m^3/yr**

Sub-Area Descriptions (topography, soils, cover)	
Sub-Area A	Rolling, Fine Sandy to Silt Loam, Mature Forest
Sub-Area B	Rolling, Fine Sandy to Silt Loam, Pasture and Shrubs
Sub-Area C	Rolling, Fine Sandy to Silt Loam, Urban Lawn

Notes:

† Infiltration factors after Ontario Ministry of the Environment, 2003. Stormwater Management Planning and Design Manual. March 2003.; and Ontario Ministry of Environment and Energy (MOEE). 1995. MOEE Hydrogeological Technical Information Requirements for Land Development Applications. April 1995.

* PET adjustment factors after Thornthwaite, C.W., and J.R. Mather, 1957. Instructions and Tables for Computing Potential Evapotranspiration and the water balance. Drexel Institute of Technology, Laboratory of Climatology, Publications in Climatology, Volume X, No. 3. Centerton, New Jersey.

‡ Climate Data after Environment Canada, 2020. Canadian Climate Normals 1981-2010, Waterloo Wellington A Station, Climate ID 6149387. [Online] http://climate.weather.gc.ca/climate_normals/index_e.html Accessed June 30, 2020.

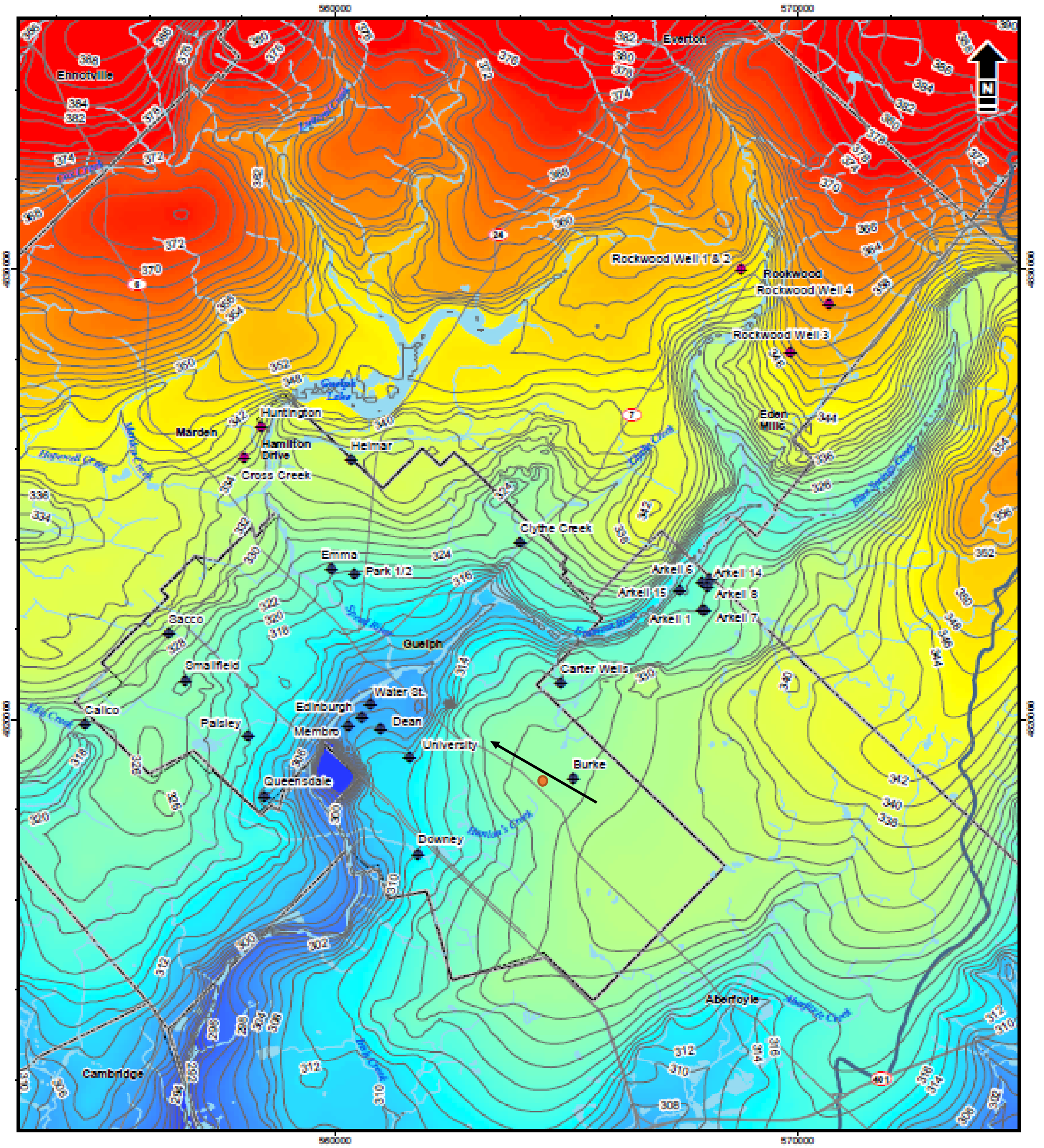
Assumptions:

[1] The monthly average precipitation collected at the Waterloo Wellington A climate station is reflective of the precipitation trends that have historically occurred at the Site.
[2] Surplus water is not available for runoff and recharge during months where water losses from actual evapotranspiration exceed precipitation inputs.
[3] Runoff, infiltration and evapotranspiration do not occur in months where the average daily temperature is below 0°C, which is the case for the months of December through March at the Site.
[4] Precipitation during freezing months (i.e., December to March) is assumed to accumulate as snow and result in additional precipitation in the first month thereafter where the average temperature is greater than 0°C (i.e., April).
[5] Soil moisture capacity is at a maximum in April.

TABLE 14 - GROUNDWATER MOUNDING ANALYSIS

Storm Event	Duration of Infiltration Period (1) (days)	Groundwater Mounding Height Above Seasonal High Water Table at Distance (d) from Center of Infiltration Gallery																			
		d = 0 m		d = 6 m		d = 12 m		d = 15 m		d = 18 m		d = 21 m		d =24 m		d = 27 m		d = 30 m		d = 36 m	
		(m)	(m AMSL)	(m)	(m AMSL)	(m)	(m AMSL)	(m)	(m AMSL)	(m)	(m AMSL)	(m)	(m AMSL)	(m)	(m AMSL)	(m)	(m AMSL)	(m)	(m AMSL)	(m)	(m AMSL)
East Infiltration Trench																					
Obvert (Top) Elevation =		340.40	m AMSL																		
Invert (Base) Elevation =		340.00	m AMSL																		
High Groundwater =		339.20	m AMSL	as estimated from Figure 1																	
25 mm		*0.59*	339.79	*0.40*	339.60	*0.17*	339.37	*0.11*	339.31	*0.07*	339.27	*0.04*	339.24	*0.03*	339.23	*0.02*	339.22	*0.01*	339.21	*0.00*	339.20
South Infiltration Trench																					
Obvert (Top) Elevation =		340.86	m AMSL																		
Invert (Base) Elevation =		340.43	m AMSL																		
High Groundwater =		339.00	m AMSL	as estimated from Figure 1																	
25 mm	1.00	*1.06*	340.06	*1.01*	340.01	*0.85*	339.85	*0.69*	339.69	*0.48*	339.48	*0.33*	339.33	*0.22*	339.22	*0.14*	339.14	*0.09*	339.09	*0.04*	339.04

APPENDIX C:
REGIONAL GROUNDWATER FLOW MAPPING



- 🗺 Grand River Watershed Boundary
- ⬚ Community
- Water Body
- Watercourse
- Major Road
- Water Table Contour (2m)
- ◆ Municipal Well (City of Guelph)
- ◆ Municipal Well (Guelph/Eramosa Township)
- ● Site
- ← Interpreted Flow Direction

Water Table (m asl)

High : 375

Low : 285

1:120,000

1 0 1

Kilometres

NAD 1983 UTM Zone 17N

Reference: Base Data - City of Guelph, 2008; GRCA, 2008; CVC, 2008; Ministry of Natural Resources, 2008. Produced using information provided by the Grand River Conservation Authority. Copyright © Grand River Conservation Authority, 2013. Produced using information provided by the Ministry of Natural Resources, Copyright © Ministry of Natural

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Guelph and Township of Guelph/Eramosa
Tier 3 Water Budget and Local Area Risk Assessment

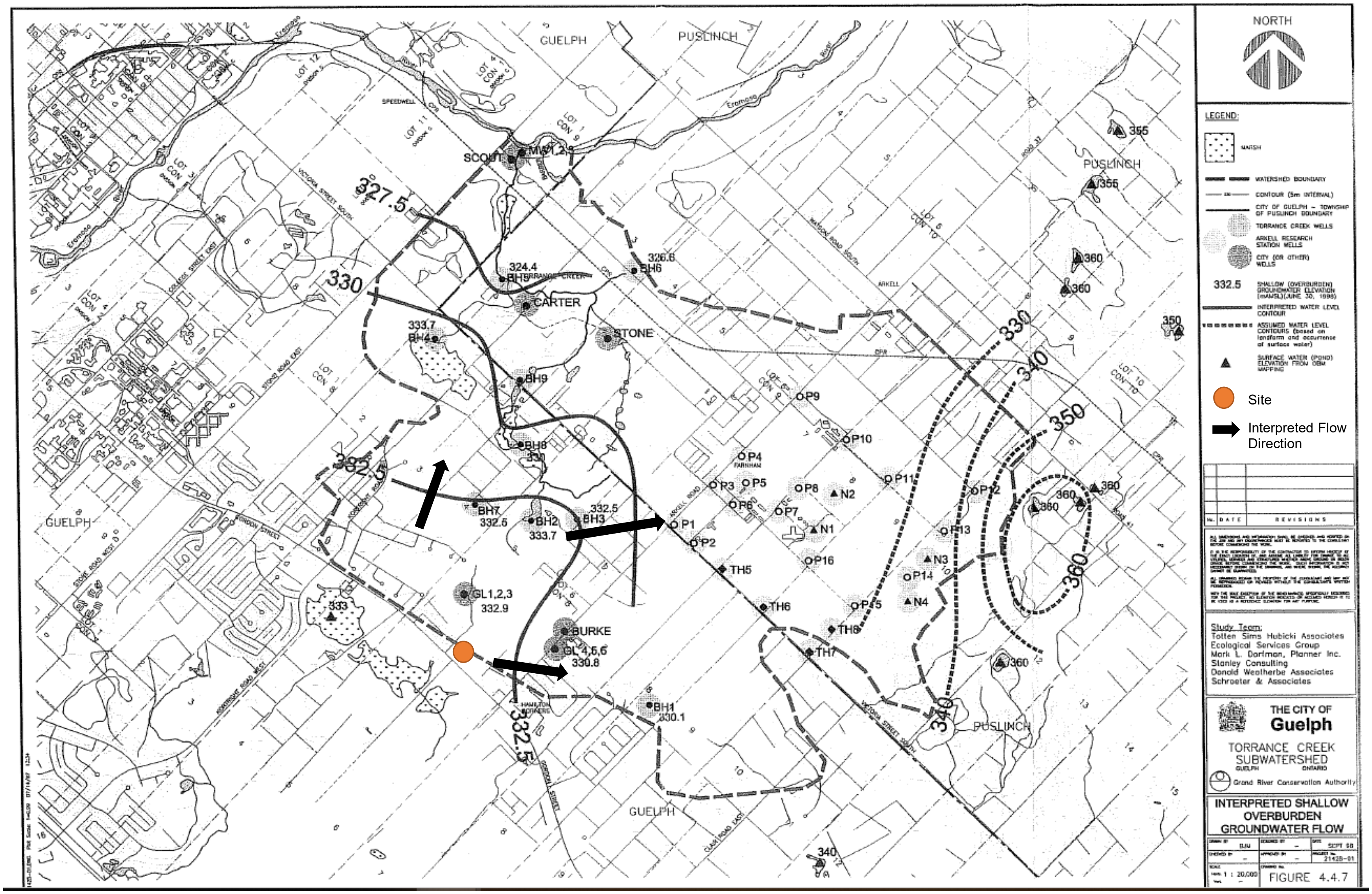
Model Predicted Water Table Elevation (Area of Interest)

Date: 23 Mar 2017	Project: 15072-527	Technical: P. Chin	Reviewer: D. VanVliet	Drawn: M. Urthell

Disclaimer: Prepared solely for the use of City of Guelph as specified in the accompanying report. No representation of any kind is made to other parties with which City of Guelph has not entered into contract.

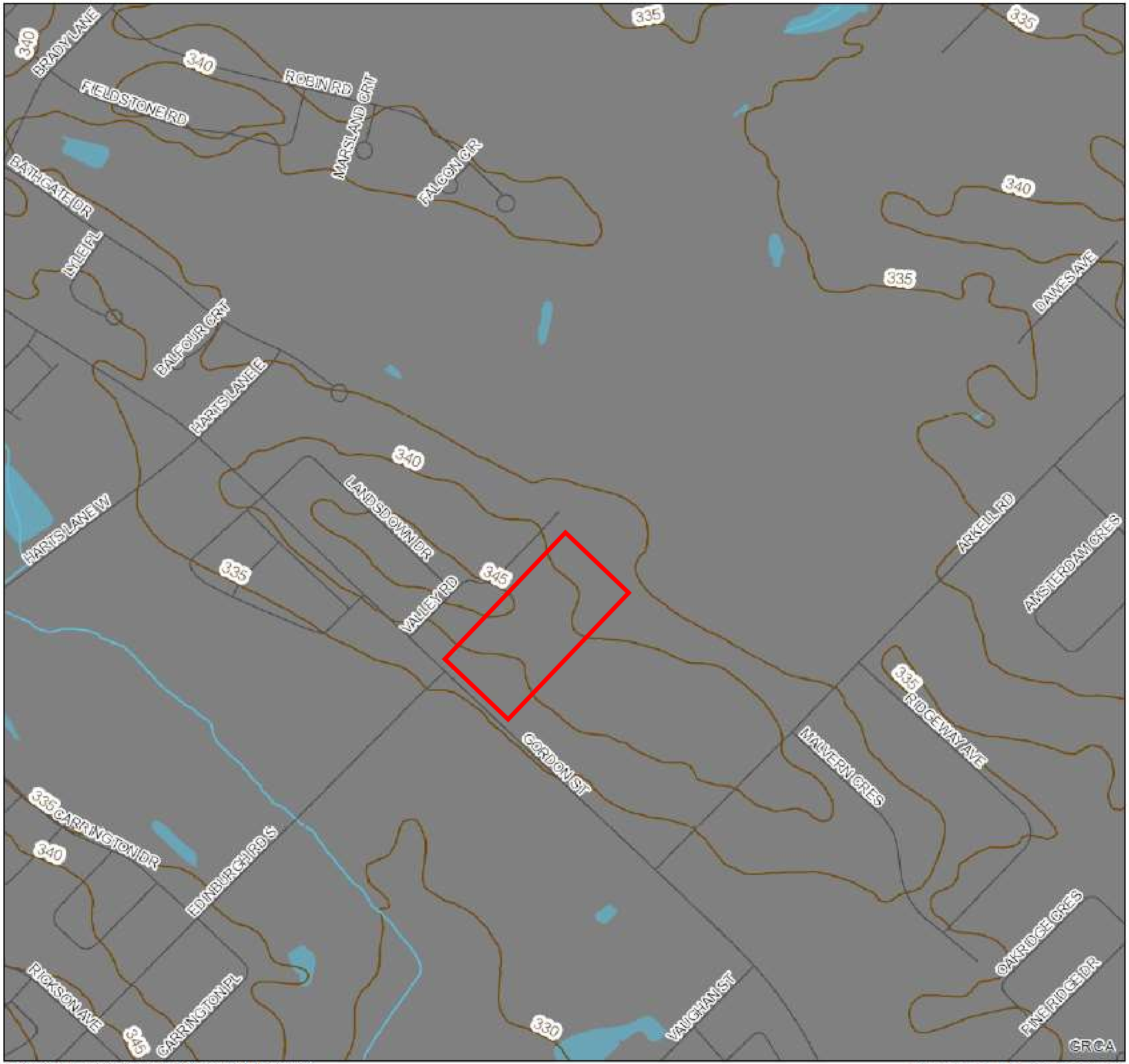
Figure 4-3

Source: Matrix Solutions Inc. 2017. City of Guelph and Township of Guelph/Eramosa Tier Three Water Budget and Local Area Risk Assessment.



Source: Totten Sims Hubicki Associates, Ecological Services Group, Ray Blackport, Mark L. Dorfman Planner Inc., Shroeter & Associates, and Donald G. Weatherbe Associates. 1998. Torrance Creek Subwatershed Study - Management Study. Prepared for City of Guelph and Grand River Conservation Authority, September 1998, September 1998, Revised November 1998.

APPENDIX D:
REGIONAL GROUNDWATER RECHARGE MAPPING



Map Centre (UTM NAD83 z17): 564,582.48 4,818,656.58

This map is not to be used for navigation

Grand River
Conservation Authority
Date: Jul 22, 2019

Hydraulic Gradient

Legend

- ☐ Municipal Boundary (GRCA)
- — Watercourse - Local (GRCA)
- — Contour 5m (ON)
- ☐ Park - Local (GRCA)
- 🟦 Waterbody - Local (GRCA)

Hydraulic Gradient (GRCA)

- 🟦 Upward
- ⬛ Downward

🟥 **Site Boundary (Approximate)**

The source for each data layer is shown in parentheses in the map legend. For a complete listing of sources and citations go to: https://maps.grandriver.ca/Sources-and-Citations.pdf

0 45 90 180 270 Metres

N

NAD 1983 UTM Zone 17N

Scale: 7,762

Grand River
Conservation Authority
Date: Jul 22, 2019

Average Annual Recharge

Map Centre (UTM NAD83 z17): 564,582.48 4,818,656.58

This map is not to be used for navigation

Legend

- ⬜ Municipal Boundary (GRCA)
- — Watercourse - Local (GRCA)
- — Contour 5m (ON)
- ⬜ Park - Local (GRCA)
- 🟦 Waterbody - Local (GRCA)

Average Annual Recharge (GRCA)

- 🟫 less than 50 mm/yr
- 🟫 50 - 100
- 🟩 100 - 200
- ⬛ 200 - 300
- 🟦 300 - 400
- 🟦 > 400
- 🟥 **Site Boundary (Approximate)**

The source for each data layer is shown in parentheses in the map legend. For a complete listing of sources and citations go to: https://maps.grandriver.ca/Sources-and-Citations.pdf

0 45 90 180 270 Metres

N

NAD 1983 UTM Zone 17N

Scale: 7,762

APPENDIX E:
BOREHOLE LOGS

kell Rd. Well #2

6. № 933

PW2/66(COG)

Burke Well

12 inch E

5 R N

5 R 1/1/0/0

The Ontario Water Resources Commission Act

WATER WELL RECORD

12 31 or District Wellington ~~Corp.~~ City of Guelph Township, Village, Town or City

Date completed 16th June 1966 - well
20th Aug 1966 - testing

number 8 Lot number 6

Corporation of the City of Guelph (print in block letters) Address Guelph Ont.

Casing and Screen Record

side diameter of casing 12 inch

length of casing 64 ft 10 in.

ype of screen nil

ength of screen nil

to top of screen nil

Diameter of finished hole 12 inch

Pumping Test

Static level 10 ft. 332

Test-pumping rate 1000 G.P.M.

Pumping level 20 ft 11 inches

Duration of test pumping 24 hours

Water clear or cloudy at end of test clear

Recommended pumping rate 800 G.P.M.

with pump setting of 100 feet below ground surface

Well Log

Overburden and Bedrock Record	From ft.	To ft.
black muck and gravel	0	4
rough gravel	4	24
sandy blue clay	24	34
blue clay	34	55
blue clay & gravel	55	64
light brown rock	64	95
dark brown rock	95	104
dark brown & black rock	104	140
dark grey rock	140	245
dark blue rock	245	253
blue shale	253	259

Water Record

Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
136 ft	fresh

r what purpose(s) is the water to be used? Corporation of the City of Guelph

well on upland, in valley, or on hillside?

illing or Boring Firm Graham Well Drilling

ddress 119 Renfield St.
Guelph Ont.

icence Number 2076

ame of Driller or Borer Arthur Titus

ddress Eramosa Rd. Guelph Ont.

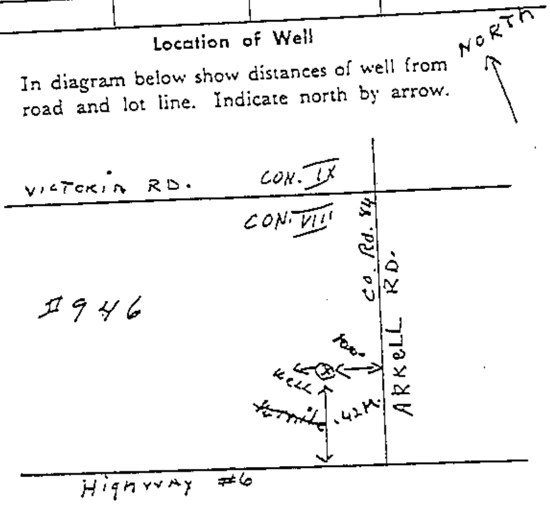
ate Aug 31st 1966

J L Graham - per

(Signature of Licensed Drilling or Boring Contractor)

Location of Well

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



orm 7 15M-60-4138

OWRC COPY

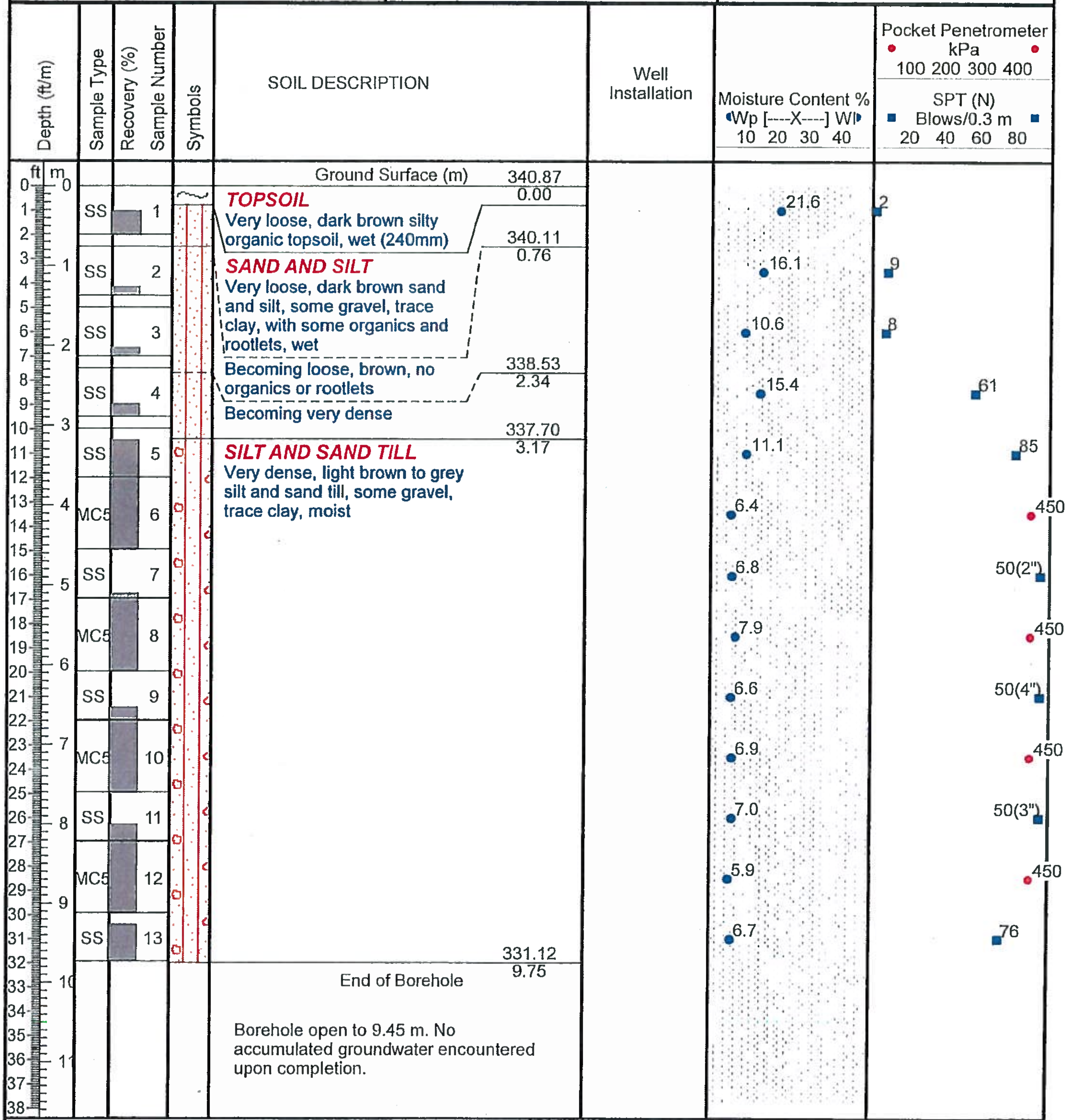
BOREHOLE 1

Page 1 of 1

Date Drilled: April 18, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 340.87 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m	Pocket Penetrometer kPa
SS	1	21.6	2	
SS	2	16.1	9	
SS	3	10.6	8	
SS	4	15.4	61	
SS	5	11.1	85	
MC5	6	6.4		450
SS	7	6.8	50(2")	
MC5	8	7.9		450
SS	9	6.6	50(4")	
MC5	10	6.9		450
SS	11	7.0	50(3")	
MC5	12	5.9		450
SS	13	6.7	76	

Ground Surface (m) 340.87

0.00

TOPSOIL

Very loose, dark brown silty organic topsoil, wet (240mm)

340.11
0.76

SAND AND SILT

Very loose, dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet

338.53
2.34

Becoming loose, brown, no organics or rootlets

Becoming very dense

337.70
3.17

SILT AND SAND TILL

Very dense, light brown to grey silt and sand till, some gravel, trace clay, moist

331.12
9.75

End of Borehole

Borehole open to 9.45 m. No accumulated groundwater encountered upon completion.

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

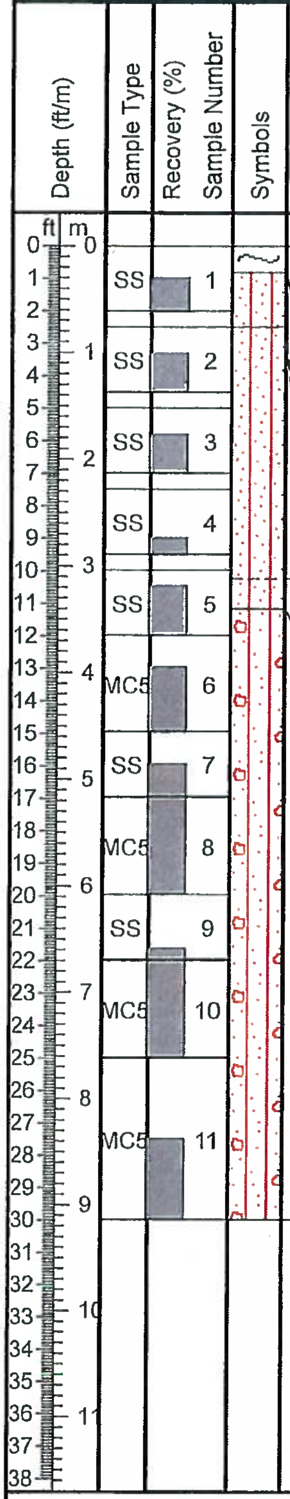
BOREHOLE 2

Page 1 of 1

Date Drilled: April 18, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 341.25 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON

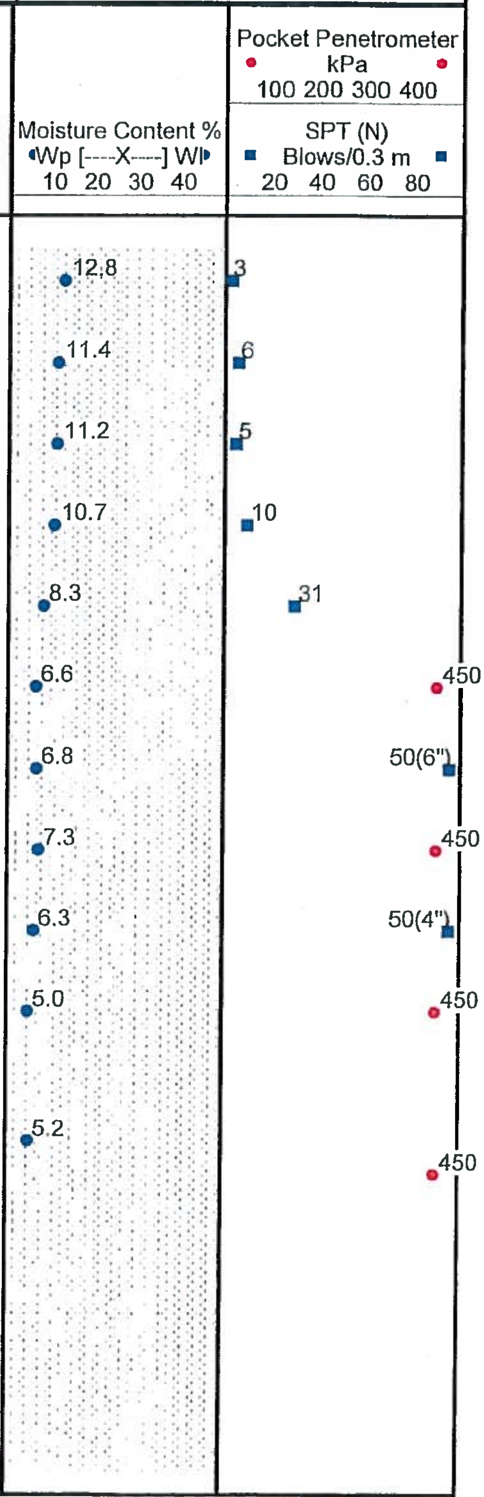


SOIL DESCRIPTION

Well Installation

Ground Surface (m)	341.25 0.00
TOPSOIL Very loose, dark brown silty organic topsoil, wet (250mm)	340.49 0.76
CLAYEY SAND AND GRAVEL Very loose, dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet Becoming loose, light brown, no organics or rootlets	338.13 3.12
Becoming very dense, brown, moist ***SILT AND SAND TILL*** Very dense, light brown to grey silt and sand till, some gravel, trace clay, moist	332.11 9.14
End of Borehole	

Borehole open to 8.76 m. No accumulated groundwater encountered upon completion.



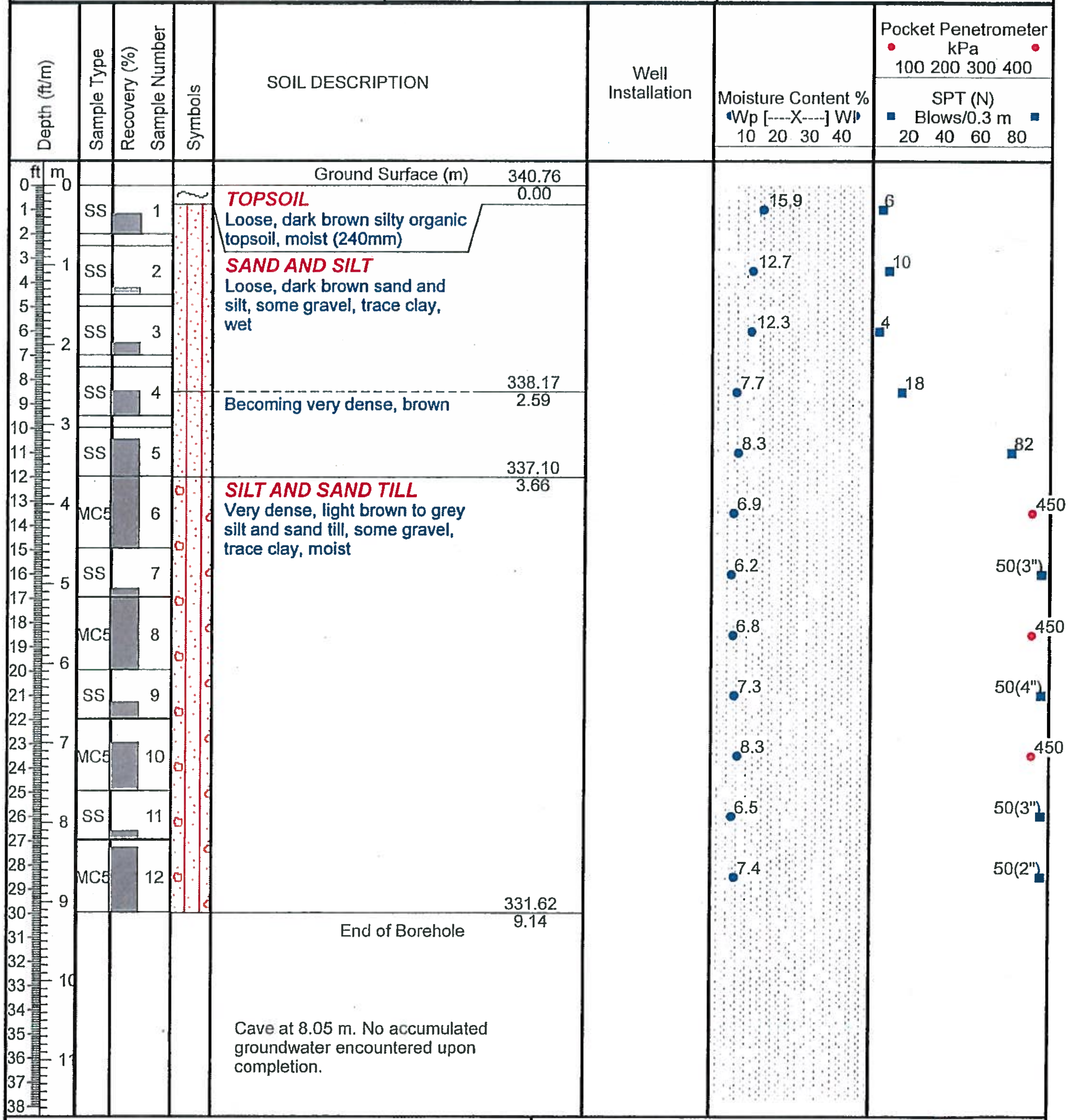
CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

BOREHOLE 3

Date Drilled: April 17, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 340.76 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Ground Surface (m) 340.76

0.00

TOPSOIL
Loose, dark brown silty organic topsoil, moist (240mm)

SAND AND SILT
Loose, dark brown sand and silt, some gravel, trace clay, wet

338.17
2.59

Becoming very dense, brown

337.10
3.66

SILT AND SAND TILL
Very dense, light brown to grey silt and sand till, some gravel, trace clay, moist

331.62
9.14

End of Borehole

Sample Type	Sample Number	Moisture Content %	Pocket Penetrometer kPa	SPT (N) Blows/0.3 m
SS	1	15.9		6
SS	2	12.7		10
SS	3	12.3		4
SS	4	7.7		18
SS	5	8.3		82
MC5	6	6.9	450	
SS	7	6.2		50(3")
MC5	8	6.8	450	
SS	9	7.3		50(4")
MC5	10	8.3	450	
SS	11	6.5		50(3")
MC5	12	7.4		50(2")

Cave at 8.05 m. No accumulated groundwater encountered upon completion.

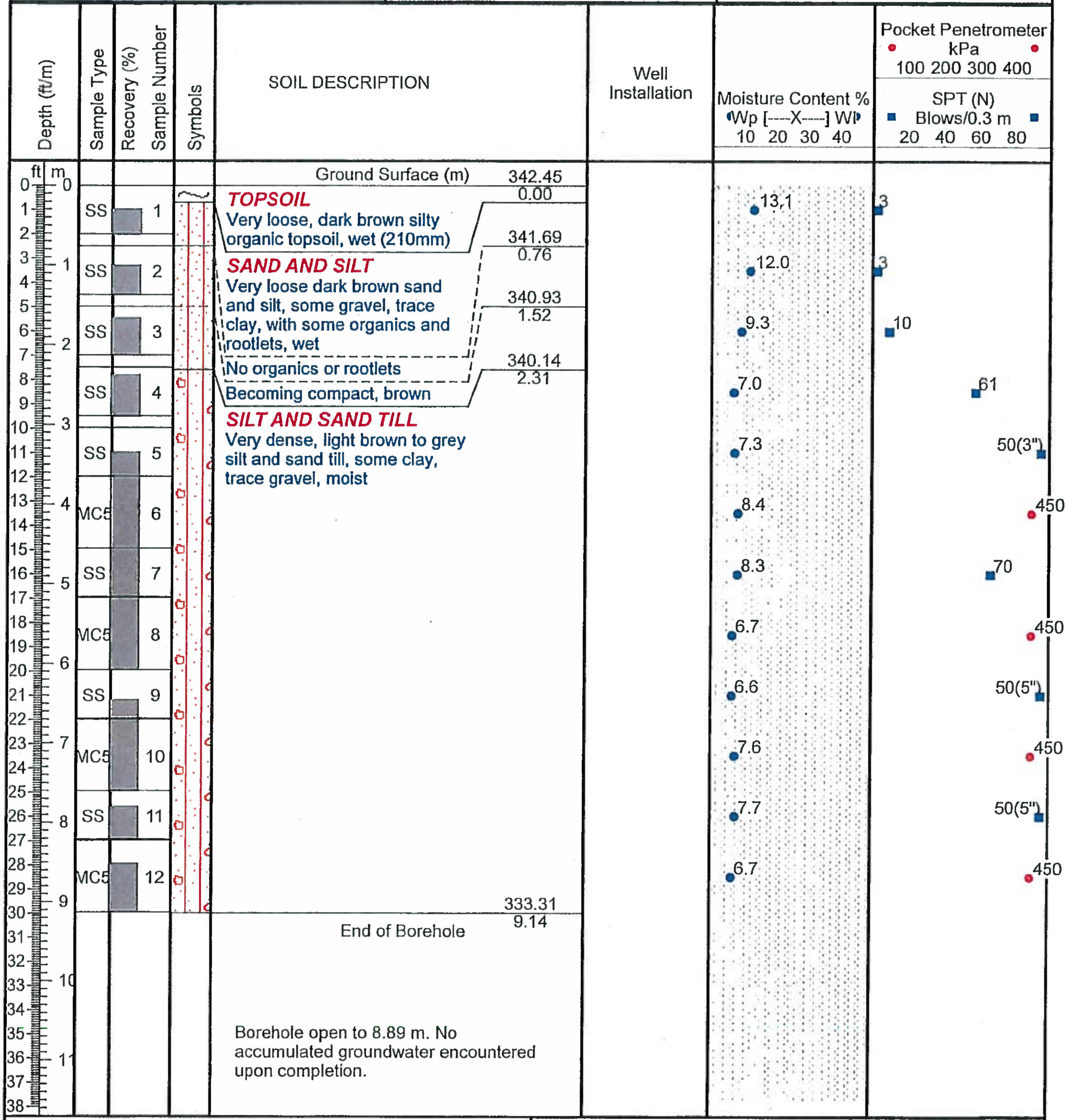
BOREHOLE 4

Page 1 of 1

Date Drilled: April 18, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 342.45 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Ground Surface (m) 342.45

0.00

TOPSOIL
Very loose, dark brown silty organic topsoil, wet (210mm)

341.69
0.76

SAND AND SILT
Very loose dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet

340.93
1.52

No organics or rootlets

340.14
2.31

Becoming compact, brown

SILT AND SAND TILL
Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist

333.31
9.14

End of Borehole

Borehole open to 8.89 m. No accumulated groundwater encountered upon completion.

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m	Pocket Penetrometer kPa
SS	1	13.1	3	
SS	2	12.0	3	
SS	3	9.3	10	
SS	4	7.0	61	
SS	5	7.3	50(3")	
MC5	6	8.4		450
SS	7	8.3	70	
MC5	8	6.7		450
SS	9	6.6	50(5")	
MC5	10	7.6		450
SS	11	7.7	50(5")	
MC5	12	6.7		450

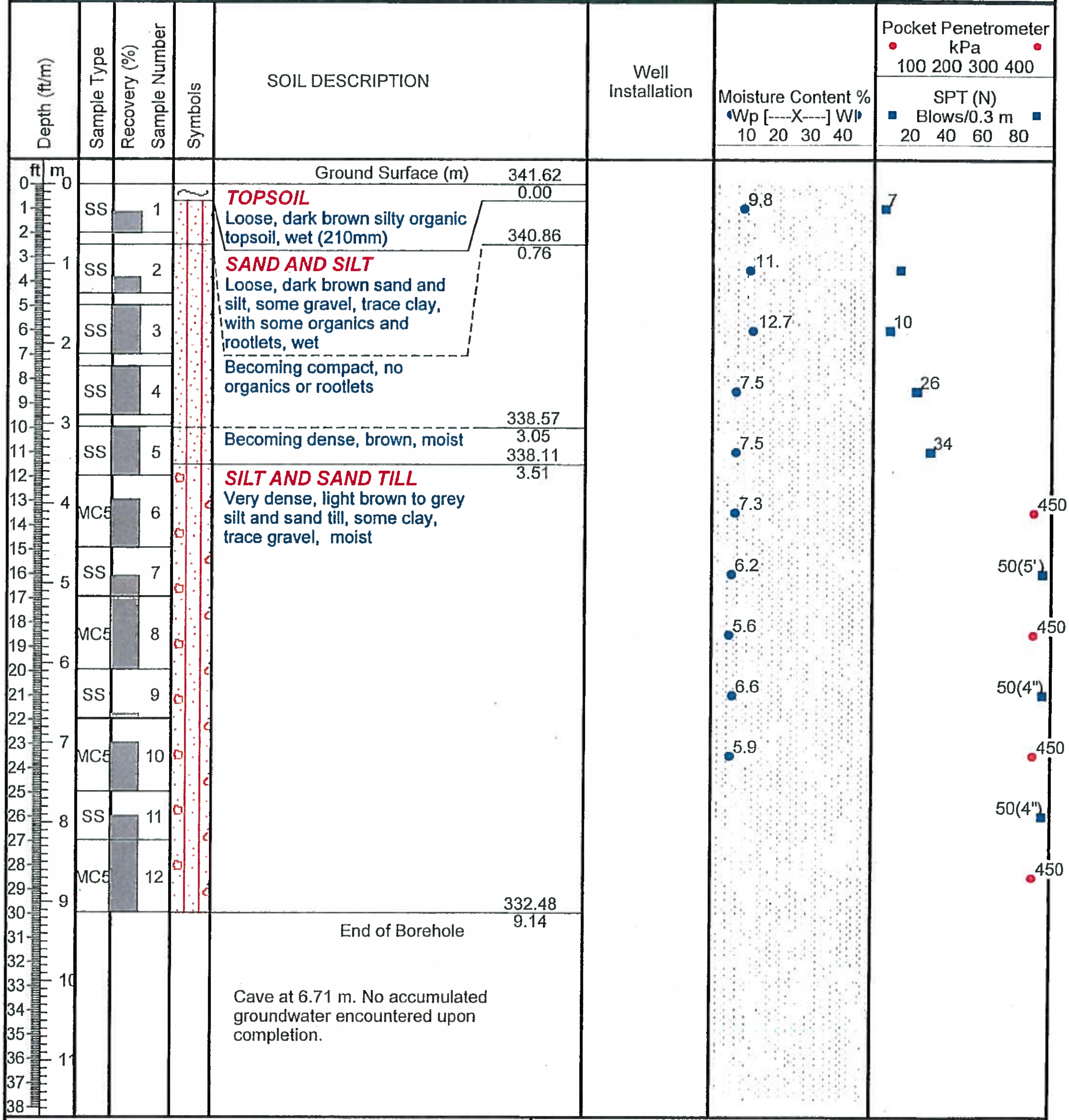
BOREHOLE 5

Page 1 of 1

Date Drilled: April 19, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 341.62 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Description	Elevation (m) / Depth (m)
Ground Surface (m)	341.62 0.00
TOPSOIL Loose, dark brown silty organic topsoil, wet (210mm)	340.86 0.76
SAND AND SILT Loose, dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet	
Becoming compact, no organics or rootlets	338.57 3.05
Becoming dense, brown, moist	338.11 3.51
SILT AND SAND TILL Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist	332.48 9.14
End of Borehole	

Sample Type	Sample Number	Moisture Content %	SPT (N)	Pocket Penetrometer kPa
SS	1	9.8	7	
SS	2	11.		
SS	3	12.7	10	
SS	4	7.5	26	
SS	5	7.5	34	
MC5	6	7.3		450
SS	7	6.2	50(5')	
MC5	8	5.6		450
SS	9	6.6	50(4")	
MC5	10	5.9		450
SS	11		50(4")	
MC5	12			450

Cave at 6.71 m. No accumulated groundwater encountered upon completion.

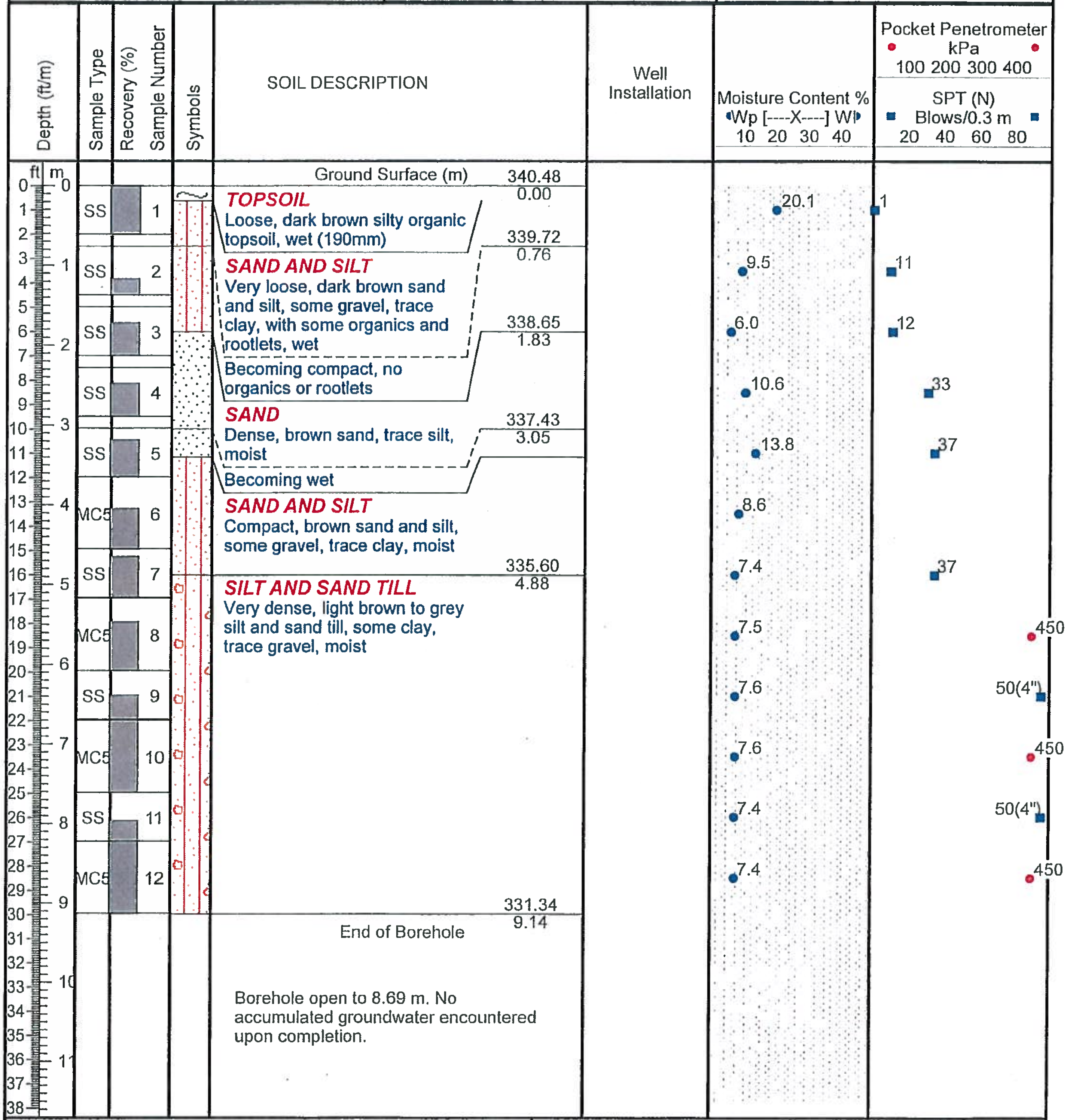
BOREHOLE 6

Page 1 of 1

Date Drilled: April 19, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 340.48 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Ground Surface (m) 340.48

SOIL DESCRIPTION		
	340.48	0.00
TOPSOIL Loose, dark brown silty organic topsoil, wet (190mm)	339.72	0.76
SAND AND SILT Very loose, dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet Becoming compact, no organics or rootlets	338.65	1.83
SAND Dense, brown sand, trace silt, moist Becoming wet	337.43	3.05
SAND AND SILT Compact, brown sand and silt, some gravel, trace clay, moist	335.60	4.88
SILT AND SAND TILL Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist	331.34	9.14

End of Borehole

Borehole open to 8.69 m. No accumulated groundwater encountered upon completion.

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m	Pocket Penetrometer kPa
SS	1	20.1	1	
SS	2	9.5	11	
SS	3	6.0	12	
SS	4	10.6	33	
SS	5	13.8	37	
MC5	6	8.6		
SS	7	7.4	37	
MC5	8	7.5		450
SS	9	7.6	50(4")	
MC5	10	7.6		450
SS	11	7.4	50(4")	
MC5	12	7.4		450

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BOREHOLE 7

Page 1 of 1

Date Drilled: April 19, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 339.88 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON

SOIL DESCRIPTION	Elevation (m) / Depth (m)
Ground Surface (m)	339.88 0.00
TOPSOIL Loose, dark brown silty organic topsoil, wet (210mm)	339.12 0.76
SAND AND SILT Very loose, dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet Becoming compact, no organics or rootlets	338.15 1.73 337.59 2.29
SAND Dense, brown sand, trace gravel, moist Becoming trace silt and clay, wet	336.83 3.05
SAND AND SILT Compact, brown, sand and silt, some gravel, trace clay, moist	335.31 4.57
SILT AND SAND TILL Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist	332.26 7.62
End of Borehole	

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m	Pocket Penetrometer kPa
SS	1	11,2	2	
SS	2	9.8	14	
SS	3	12.3	14	
SS	4	18.4	45	
SS	5	14.0	41	
SS	6	6.9	82	
MC5	7	6.5		450
SS	8	8.5	50(3")	
MC5	9	6.2		450

Borehole open to 6.91 m. No accumulated groundwater encountered upon completion.

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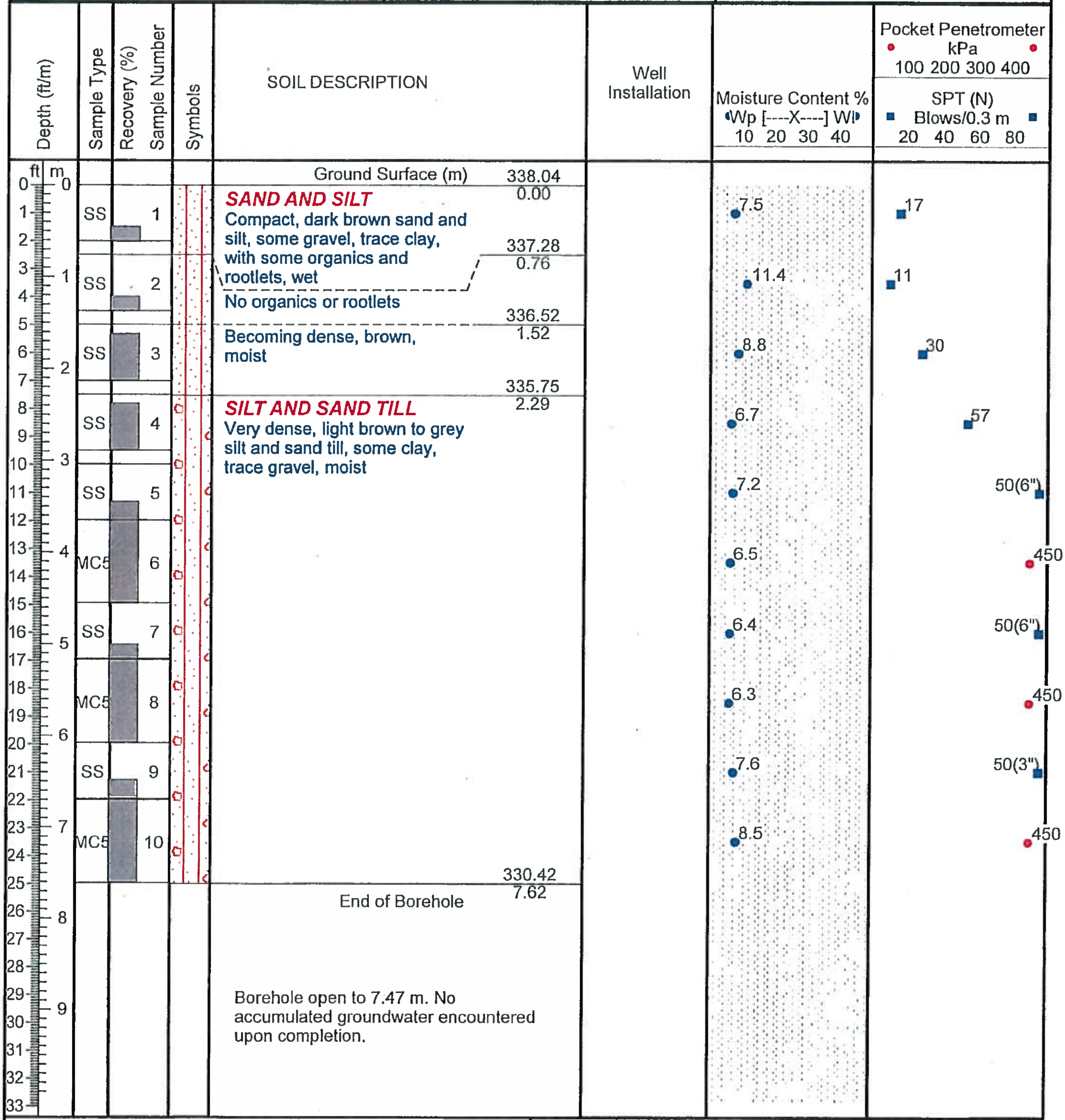
BOREHOLE 8

Page 1 of 1

Date Drilled: April 19, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 338.04 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Sample Type	Sample Number	Moisture Content %	SPT (N) / Pocket Penetrometer
SS	1	7.5	17
SS	2	11.4	11
SS	3	8.8	30
SS	4	6.7	57
SS	5	7.2	50(6")
MC5	6	6.5	450
SS	7	6.4	50(6")
MC5	8	6.3	450
SS	9	7.6	50(3")
MC5	10	8.5	450

Ground Surface (m) 338.04 / 0.00

SAND AND SILT
Compact, dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet

337.28 / 0.76
No organics or rootlets

336.52 / 1.52
Becoming dense, brown, moist

335.75 / 2.29
SILT AND SAND TILL
Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist

330.42 / 7.62
End of Borehole

Borehole open to 7.47 m. No accumulated groundwater encountered upon completion.

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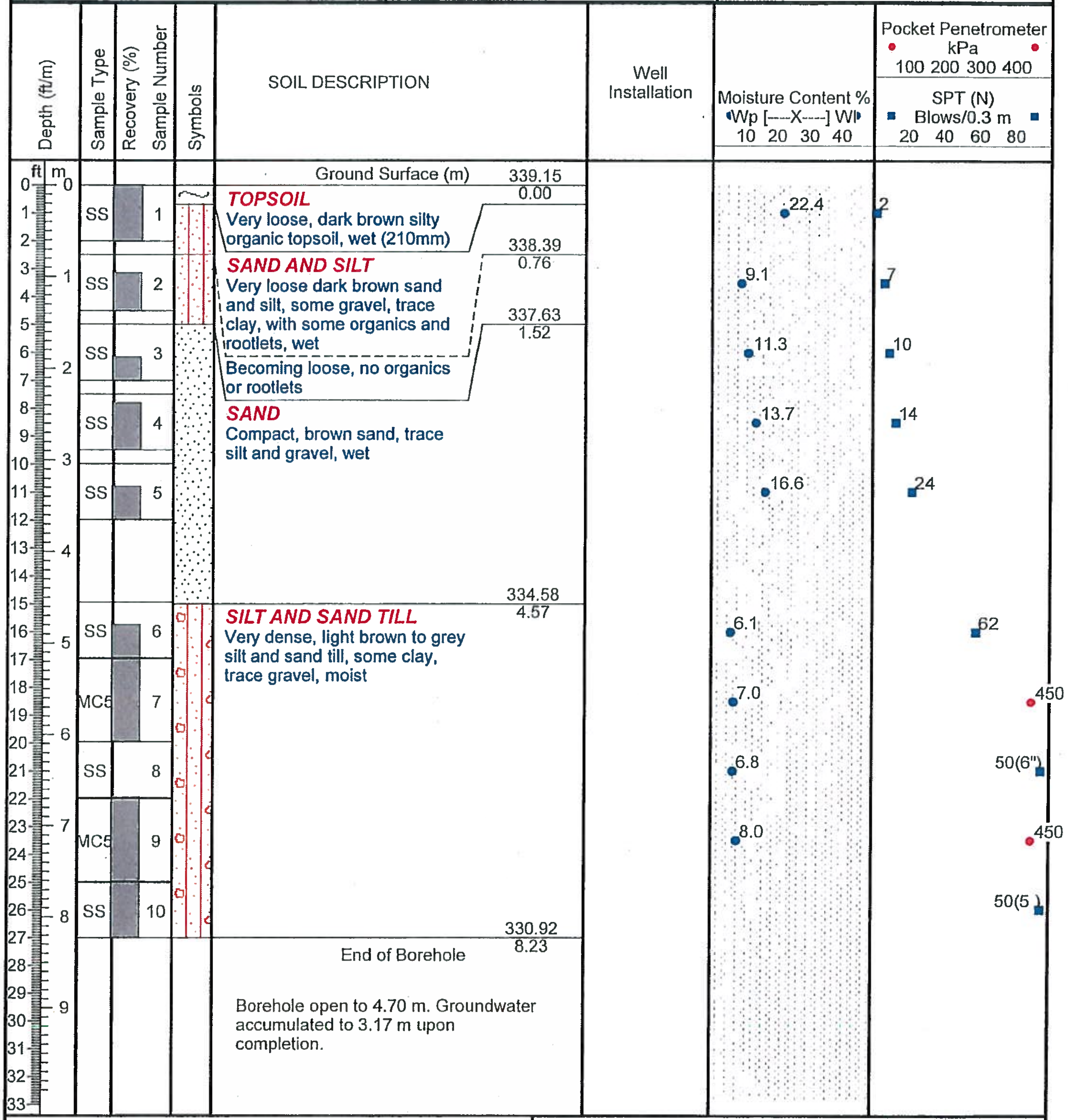
BOREHOLE 9

Page 1 of 1

Date Drilled: April 19, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 339.15 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Ground Surface (m)	339.15	
TOPSOIL Very loose, dark brown silty organic topsoil, wet (210mm)	0.00	
SAND AND SILT Very loose dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet	338.39	0.76
Becoming loose, no organics or rootlets	337.63	1.52
SAND Compact, brown sand, trace silt and gravel, wet		
SILT AND SAND TILL Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist	334.58	4.57
End of Borehole	330.92	8.23

SS	1	22.4	2
SS	2	9.1	7
SS	3	11.3	10
SS	4	13.7	14
SS	5	16.6	24
SS	6	6.1	62
MC5	7	7.0	450
SS	8	6.8	50(6")
MC5	9	8.0	450
SS	10		50(5)

Borehole open to 4.70 m. Groundwater accumulated to 3.17 m upon completion.

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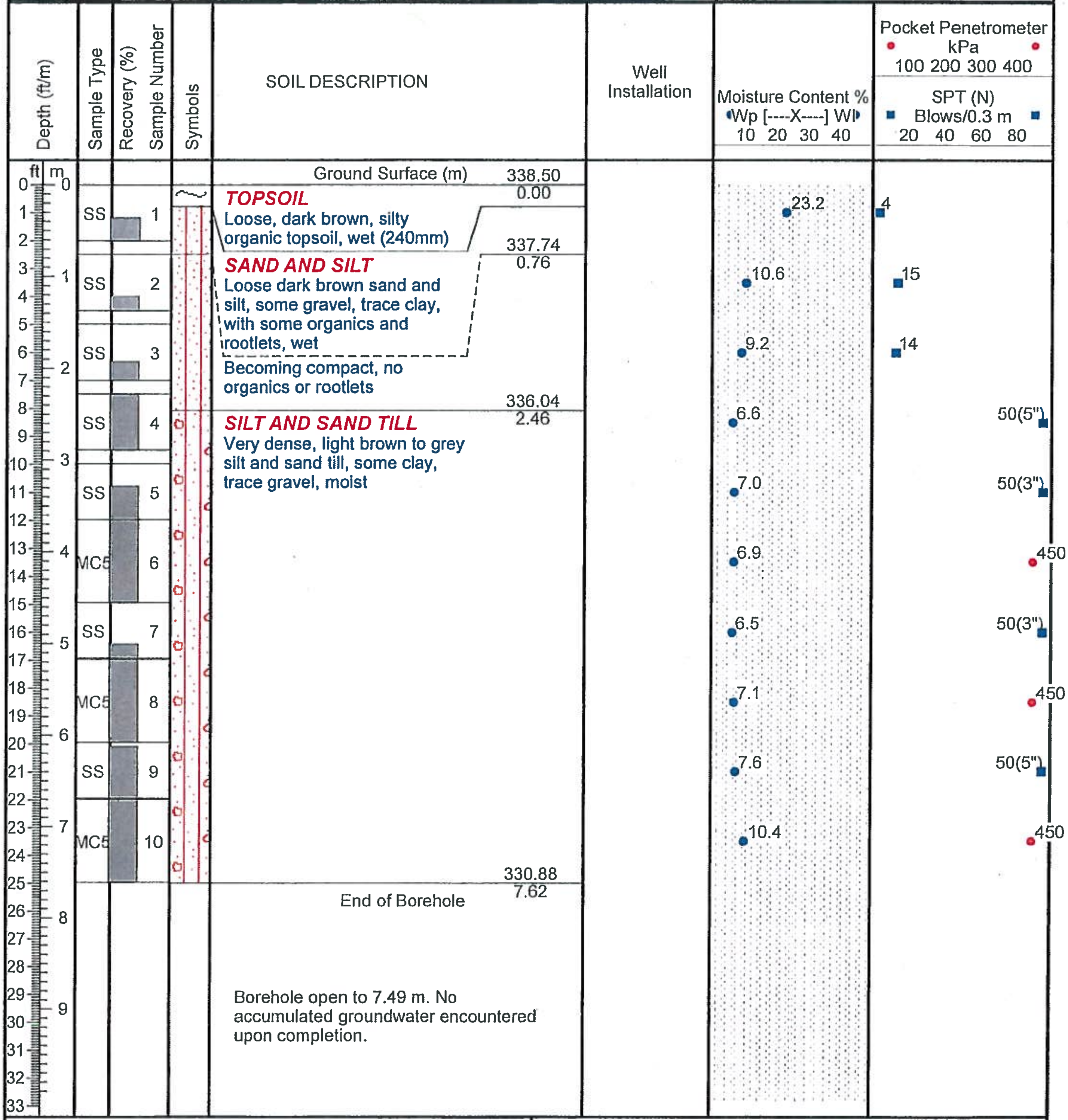
BOREHOLE 10

Page 1 of 1

Date Drilled: April 17, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 338.50 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Ground Surface (m) 338.50 / 0.00

TOPSOIL
Loose, dark brown, silty organic topsoil, wet (240mm)

337.74 / 0.76

SAND AND SILT
Loose dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet

Becoming compact, no organics or rootlets

336.04 / 2.46

SILT AND SAND TILL
Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist

330.88 / 7.62

End of Borehole

Borehole open to 7.49 m. No accumulated groundwater encountered upon completion.

Sample Type	Sample Number	Moisture Content %	SPT (N)	Pocket Penetrometer kPa
SS	1	23.2	4	
SS	2	10.6	15	
SS	3	9.2	14	
SS	4	6.6	50(5")	
SS	5	7.0	50(3")	
MC5	6	6.9		450
SS	7	6.5	50(3")	
MC5	8	7.1		450
SS	9	7.6	50(5")	
MC5	10	10.4		450

Monitoring Well: MW1-18

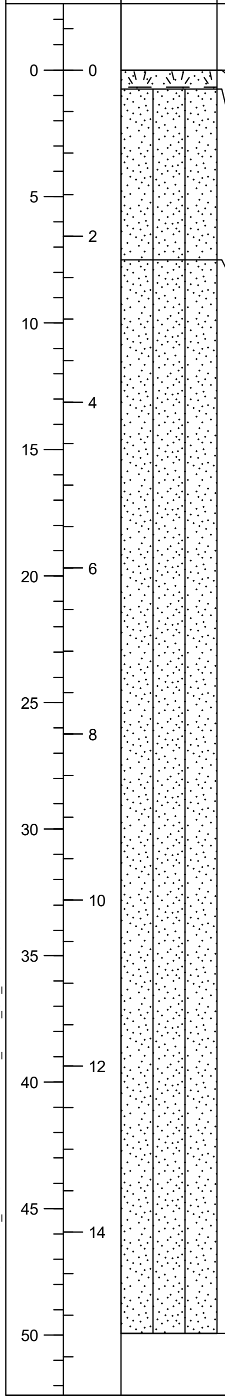
Project: 1242, 1250 and 1260 Gordon Street and 9 Valley Road
Client: Tricar Developments Inc.
Location: Guelph, Ontario
Number: 161413684

Field Investigator: C. Davis
Contractor: Aardvark Drilling, Inc
Drilling method: Hollow Stem Auger
Date started/completed: 30-Jul-2018

Ground surface elevation: 343.92 m AMSL
Top of casing elevation: 344.72 m AMSL
Easting: 564468
Northing: 4818537

SUBSURFACE PROFILE

Depth (ft) (m) — Graphic Log

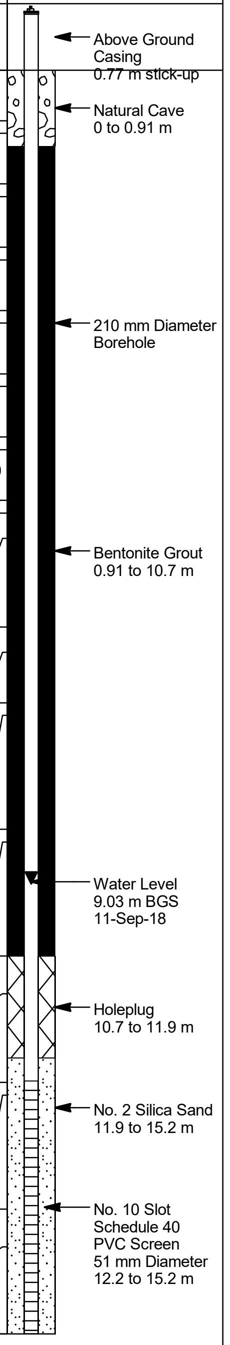


Lithologic Description	Elevation (m AMSL) Depth (m BGS)
	344.72
Ground Surface	343.92
TOPSOIL Loose, very dark brown (7.5 YR 2/3), silty sand, fine to medium grained sand, fine gravel, dry to moist	0.00 343.69
SILTY SAND Compact, yellowish brown (10 YR 5/4), fine to coarse grained sand, trace fine gravel, trace to some clay in dry clumps, dry to moist Becoming moist at 1.1 m BGS Clay and gravel content increases at 1.5 m BGS Colour change to brown (10 YR 5/3) at 1.6 m BGS Becomes moist to wet at 1.9 m BGS Limestone cobble at 2.1 m BGS	0.23 341.63
SILTY SAND TILL Compact, pale brown (10 YR 6/3), fine to coarse grained sand, limestone fragments, trace to some clay in clumps, fine gravel and cobbles (angular), dry to moist Becoming dense at 3.0 m BGS Metamorphic rock fragments at 3.6 m BGS Very dense, increased clay content starting at 3.8 m BGS Cobble/boulders from 5.5 to 6.7 m BGS At 6.8 m BGS, becomes very dense, grey, fine silty sand, trace medium and coarse grained sand, trace gravel, dry Some rounded fine gravel at 7.6 m BGS Becoming less compact, trace limestone fragments, moist at 10.7 m BGS Cobble at 11.2 m BGS Becoming moist at 14.0 m BGS	2.29 328.70
End of Borehole	15.22

SAMPLE DETAILS

Sample Number	Sample Type	Recovery	N Value
1	SS	6" 25%	2-5-6-4 (11)
2	SS	18" 75%	5-8-8-11 (16)
3	SS	21" 88%	4-6-7-10 (13)
4	SS	24" 100%	5-8-10-12 (18)
5	SS	24" 100%	9-20-15-40 (35)
6	SS	24" 100%	29-37-50 (87)
7	SS	24" 100%	29-31-49-50 (80)
8	SS	10.5" 88%	13-50 (50)
9	SS	11" 92%	40-50 (50)
10	SS	n/a	50 (0)
11	SS	5" 83%	50 (0)
12	SS	22" 122%	28-40-50 (90)
13	SS	6" 100%	50 (0)
14	SS	19" 106%	47-35-50 (85)
15	SS	0" 0%	50 (0)

WELL DETAILS



Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
n/a - not available/applicable

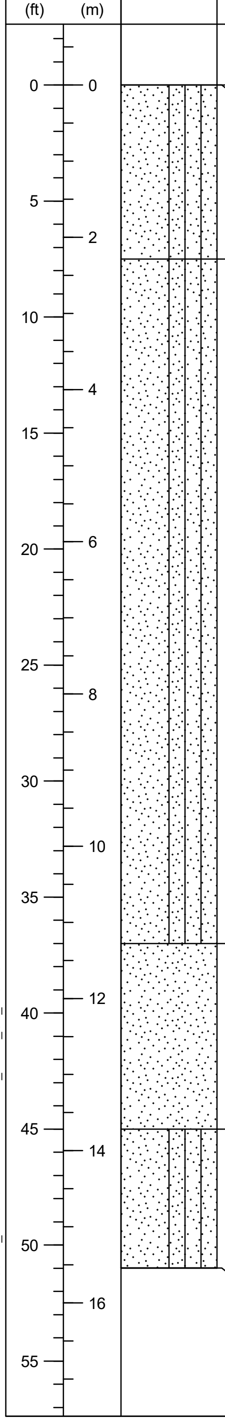
Stantec

Drawn By/Checked By: AH / SR / GW

Monitoring Well: MW2-18

Project:	1242, 1250 and 1260 Gordon Street and 9 Valley Road	**Field Investigator:**	A. Healey	**Ground surface elevation:**	342.97 m AMSL
Client:	Tricar Developments Inc.	**Contractor:**	Aardvark Drilling, Inc	**Top of casing elevation:**	343.77 m AMSL
Location:	Guelph, Ontario	**Drilling method:**	Hollow Stem Auger	**Easting:**	564471
Number:	161413684	**Date started/completed:**	09-Jul-2018 / 10-Jul-2018	**Northing:**	4818517

SUBSURFACE PROFILE

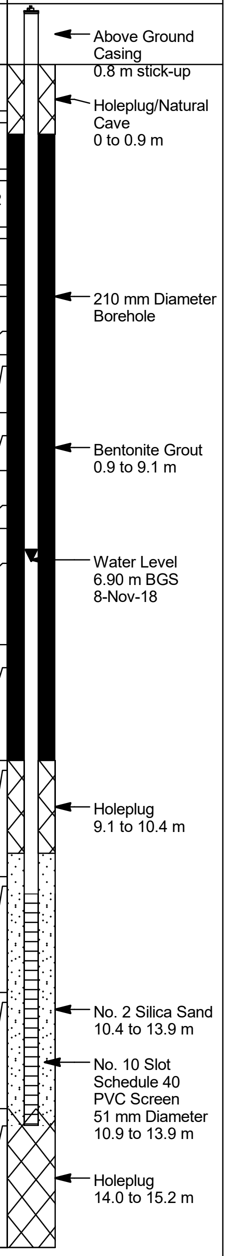


Lithologic Description	Elevation (m AMSL) Depth (m BGS)
	343.77
Ground Surface	342.97
SANDY SILT Loose, 10 YR 4/3 brown, with organics (roots) and some subangular coarse gravel, dry	0.00
Compact, organics no longer visible, increased subangular fine and coarse gravel, change in colour to 10 YR 6/3 pale brown at 0.76 m BGS, crumbles easily	
becoming more silt with some sand, some subangular fine and coarse gravel, moist to dry	340.68
SANDY SILT TILL Compact, 10 YR 5/3 brown, fine sand with some clay and angular fine and coarse gravel, trace coarse sand, moist	2.29
Very dense, trace 10 YR 6/1 gray coarse gravel/cobble	
10 YR 6/1 gray cobble at 5.0 m BGS	
becoming slightly more moist than above	
change in colour to 10 YR 6/2 light brownish gray	331.69
SAND Very dense, medium to coarse sand, some subangular fine gravel, trace coarse gravel, wet	11.28
	329.25
SANDY SILT TILL Very dense, 10 YR 6/2 light brownish gray, some medium sand and fine to coarse gravel, trace clay, moist crushed cobble at 13.8 m BGS increased clay content at 13.9 m BGS	13.72
crushed cobble at 15.3 m BGS	327.43
End of Borehole	15.54

SAMPLE DETAILS

Sample Number	Sample Type	Recovery	N Value
1	SS	17" 71%	3-3-3-10 (6)
2	SS	19" 79%	8-11-14-17 (25)
3	SS	20" 83%	10-11-11-12 (22)
4	SS	24" 100%	4-7-9-18 (16)
5	SS	19" 106%	13-30-50 (80)
6	SS	2" 33%	50 (0)
7	SS	14" 117%	30-50 (50)
8	SS	20" 111%	26-39-50 (89)
9	SS	23" 128%	30-42-50 (92)
10	SS	13" 108%	31-50 (50)
11	SS	6" 119%	50/5.0" (50/5.0")
12	SS	8" 159%	50/5.0" (50/5.0")
13	SS	4" 79%	50/5.0" (50/5.0")
14	SS	15" 167%	47-50/3.0" (50/3.0")
15	SS	18" 150%	41-50 (50)

WELL DETAILS



Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
n/a - not available/applicable

Stantec

Drawn By/Checked By: AH / SR / GW

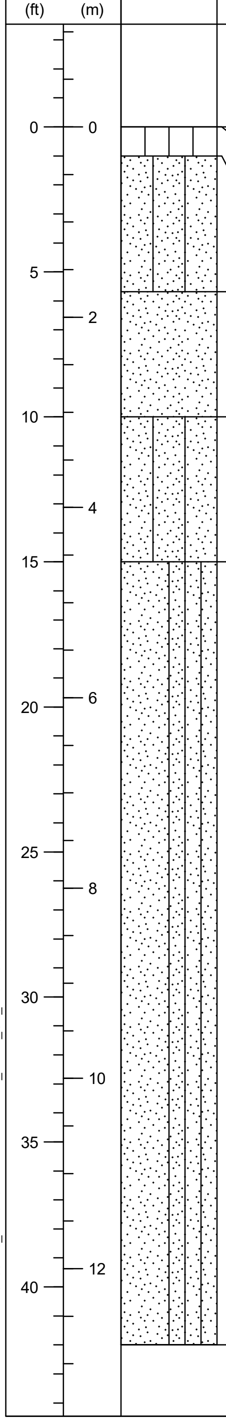
Monitoring Well: MW3-18

Project: 1242, 1250 and 1260 Gordon Street and 9 Valley Road
Client: Tricar Developments Inc.
Location: Guelph, Ontario
Number: 161413684

Field Investigator: A. Healey
Contractor: Aardvark Drilling, Inc
Drilling method: Hollow Stem Auger
Date started/completed: 12-Jul-2018 / 13-Jul-2018

Ground surface elevation: 339.83 m AMSL
Top of casing elevation: 340.91 m AMSL
Easting: 564469
Northing: 4818474

SUBSURFACE PROFILE

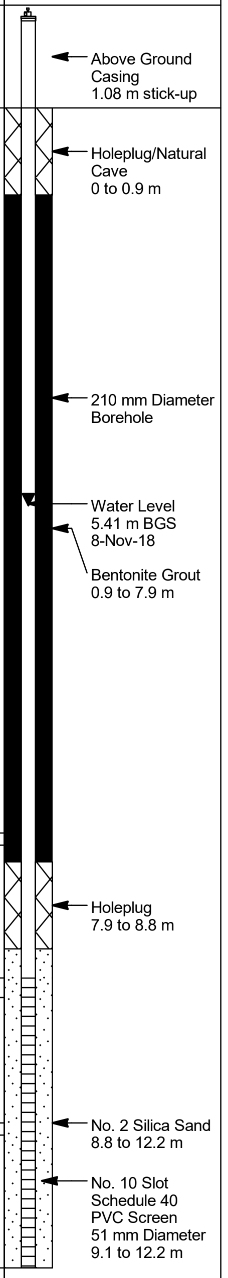


Lithologic Description	Elevation (m AMSL) Depth (m BGS)
	340.91
Ground Surface	339.83
TOPSOIL Loose, dark brown silty organic topsoil, wet	0.00
SAND AND SILT Very loose, dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet becoming compact, no organics or rootlets	339.53 0.30
SAND Dense, brown sand, trace gravel, moist becoming trace silt and clay, wet	338.10 1.73
SAND AND SILT Compact, brown, sand and silt, some gravel, trace clay, moist	336.78 3.05
SANDY SILT TILL Very dense, 10 YR 6/1 gray, fine sand with trace coarse sand and fine gravel, trace clay, moist wet at 9.4 m BGS trace coarse gravel at 10.8 m BGS	335.26 4.57
End of Borehole	327.03 12.80

SAMPLE DETAILS

Sample Number	Sample Type	Recovery	N Value
1	SS	5" 99%	50/5.0" (50/5.0")
2	SS	12" 149%	43-50/2.0" (50/2.0")
3	SS	6" 119%	50/5.0" (50/5.0")
4	SS	12" 109%	49-50/5.0" (50/5.0")

WELL DETAILS



Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
n/a - not available/applicable

Well was straight drilled to 7.6 m due to proximity of well in comparison to recently drilled borehole (BH7, drilled April 19, 2018 by CMT Drilling Inc.). Stratigraphy from 0-7.6 m is inferred from this borehole log.

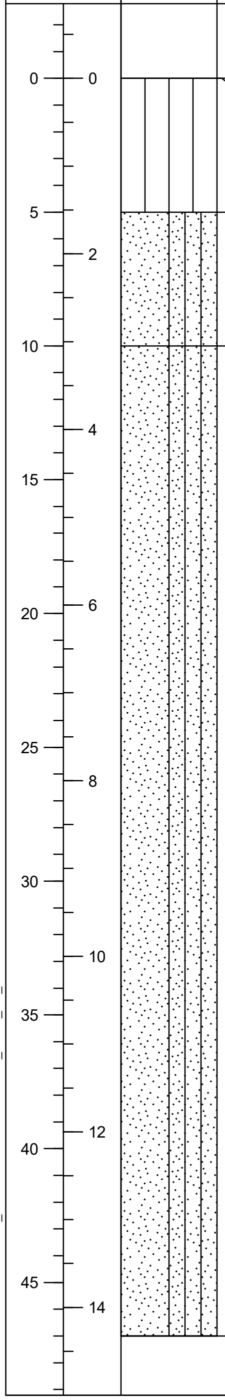
Stantec

Drawn By/Checked By: AH / SR / GW

Monitoring Well: MW4-18 (S/D)

Project:	1242, 1250 and 1260 Gordon Street and 9 Valley Road	**Field Investigator:**	A. Healey
Client:	Tricar Developments Inc.	**Contractor:**	Aardvark Drilling, Inc
Location:	Guelph, Ontario	**Drilling method:**	Hollow Stem Auger
Number:	161413684	**Date started/completed:**	11-Jul-2018 / 12-Jul-2018

SUBSURFACE PROFILE



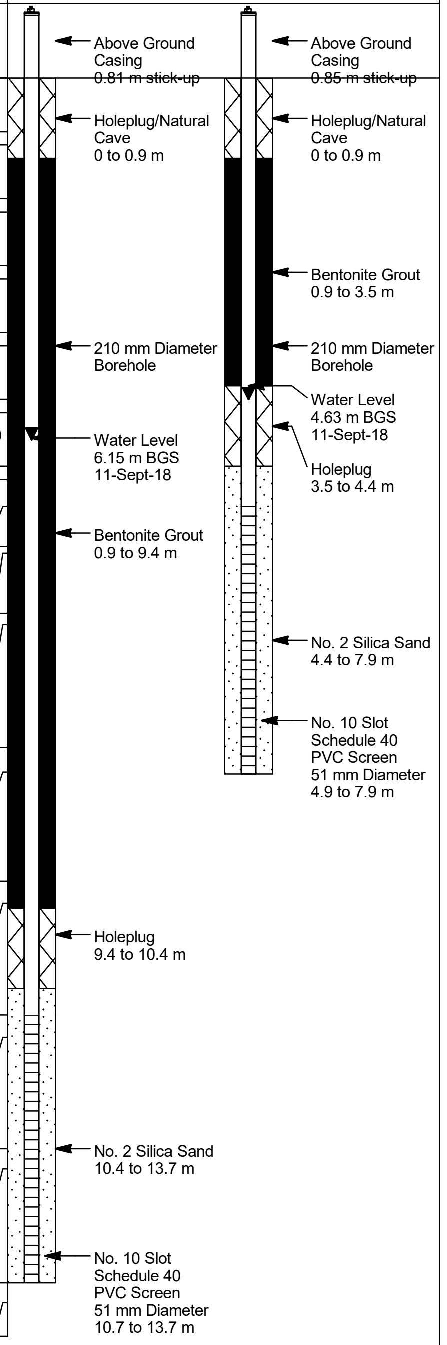
Lithologic Description	Elevation (m AMSL) Depth (m BGS)
	341.32
Ground Surface	340.47 0.00
SILT (TOPSOIL) Loose, 10 YR 5/3 brown to 10 YR 5/4 yellowish brown, trace to some fine sand, some organics and fine and coarse gravel (subangular) in top 2 cm, moist compact, increased sand and fine gravel content starting at 1.0 m BGS crushed coarse gravel/cobble at 1.3 m BGS	338.95 1.52
SANDY SILT Loose, 10 YR 5/4 yellowish brown, fine sand with some medium to coarse sand and fine to coarse subangular gravel, trace clay, moist compact, crushed coarse gravel/cobble at 2.5 m BGS	337.42 3.05
SANDY SILT TILL Compact, 10 YR 5/3 brown, fine sand and some medium to coarse sand, some fine to coarse gravel, trace clay, moist minor reddish brown mottling at 3.4 m BGS dense, increased sand and gravel content from 3.8 to 4.4 m BGS crushed coarse gravel/cobble at 4.6 and 4.8 m BGS crushed coarse gravel/cobble at 5.3 and 6.2 m BGS change in colour to 10 YR 5/1 gray at 6.1 m BGS, wet coarse gravel at 12.3 m BGS becoming slightly softer at 12.5 m BGS	326.14 14.33
End of Borehole	

SAMPLE DETAILS

Sample Number	Sample Type	Recovery	N Value
1	SS	20" 83%	3-3-2-2 (5)
2	SS	14" 58%	3-8-18-23 (26)
3	SS	16" 67%	3-4-5-7 (9)
4	SS	20" 83%	11-10-9-7 (19)
5	SS	24" 100%	4-4-12-15 (16)
6	SS	25" 104%	11-21-20-20 (41)
7	SS	12" 100%	46-50 (50)
8	SS	4" 133%	50/3.0" (50/3.0")
9	SS	9" 179%	50/5.0" (50/5.0")
10	SS	18" 163%	44-50/5.0" (50/5.0")
11	SS	17" 171%	49-50/4.0" (50/4.0")
12	SS	13" 131%	49-50/4.0" (50/4.0")
13	SS	14" 156%	39-50/3.0" (50/3.0")
14	SS	12" 133%	48-50/3.0" (50/3.0")

WELL DETAILS

Name:	MW4-18D	Name:	MW4-18S
GS Elev:	340.47 m AMSL	GS Elev:	340.47 m AMSL
TOC Elev:	341.28 m AMSL	TOC Elev:	341.32 m AMSL
Easting:	564506	Easting:	564506
Northing:	4818478	Northing:	4818478
Stick-up:	0.81 m	Stick-up:	0.85 m



Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
n/a - not available/applicable

Drawn By/Checked By: AH / SR / GW

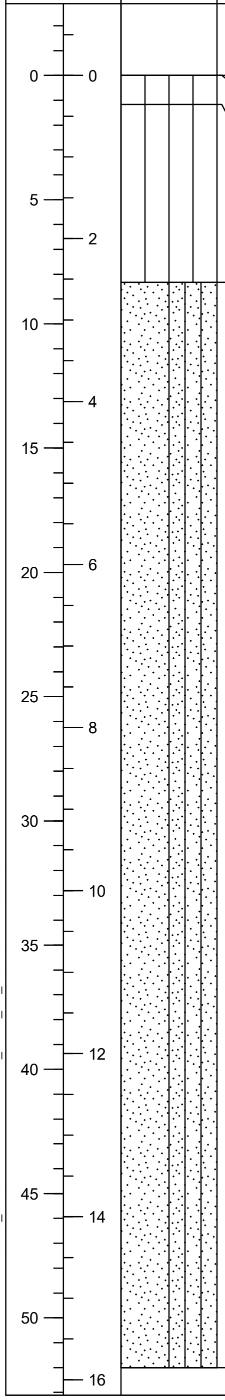
STANTEC BOREHOLE AND WELL - MASTER 17X11 20180723_AH.GPJ DATA TEMPLATE_ENVS_CA_140725.GDT 3/30/20 SRIXON

Monitoring Well: MW5-18 (S/D)

Project: 1242, 1250 and 1260 Gordon Street and 9 Valley Road
Client: Tricar Developments Inc.
Location: Guelph, Ontario
Number: 161413684

Field Investigator: A. Healey
Contractor: Aardvark Drilling, Inc
Drilling method: Hollow Stem Auger
Date started/completed: 10-Jul-2018 / 11-Jul-2018

SUBSURFACE PROFILE



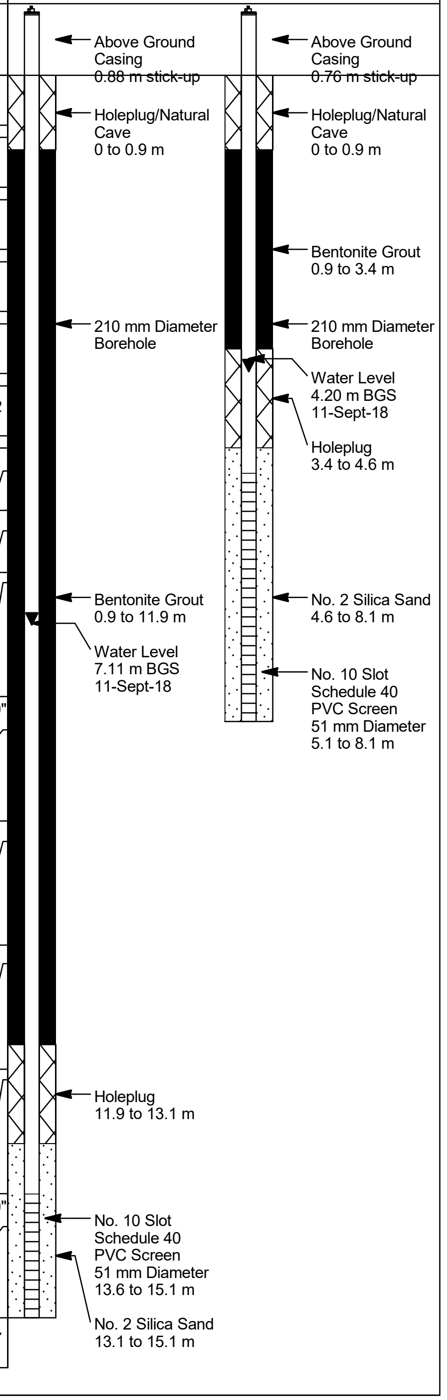
Lithologic Description	Elevation (m AMSL) Depth (m BGS)
	342.02
Ground Surface	341.14
SILT Loose, 10 YR 4/2 dark grayish brown with organics, trace clay and fine to coarse sand, moist	0.00
SILT Compact, 10 YR 4/3 brown, trace clay and fine to coarse sand, moist increased coarse sand content, trace subangular fine gravel crushed 10 YR 6/1 gray coarse gravel, cobbles further increase of coarse sand and fine gravel content, increased moisture content some coarse gravel starting at 2.0 m BGS	340.78 0.36
SANDY SILT TILL Compact, 10 YR 6/3 pale brown, fine sand, some medium to coarse sand and fine to coarse subangular gravel, moist 10 YR 6/1 gray coarse gravel/cobble at 2.8 m BGS becoming less compact from 3.0 to 3.6 m BGS very dense, some coarse gravel starting at 3.7 m BGS minor reddish brown mottling from 4.3 to 7.6 m BGS coarse gravel/cobble at 4.9 m BGS change in colour to 10 YR 6/2 light brownish gray at 6.1 m BGS coarse gravel/cobble at 6.2 m BGS coarse gravel/cobble at 8.1 m BGS medium to coarse sand content increasing starting at 10.8 m BGS becomes less dense and moisture content increases at 13.8 m BGS, reduced sand content	338.60 2.54
End of Borehole	325.29 15.85

SAMPLE DETAILS

Sample Number	Sample Type	Recovery	N Value
1	SS	19" 79%	3-3-3-4 (6)
2	SS	18" 75%	3-4-12-9 (16)
3	SS	15" 63%	2-7-13-12 (20)
4	SS	14" 58%	4-8-9-11 (17)
5	SS	14" 58%	3-4-6-12 (10)
6	SS	30" 125%	15-31-36-32 (67)
7	SS	23" 208%	21-50/5.0" (50/5.0")
8	SS	7" 70%	50 (0)
9	SS	6" 119%	50/5.0" (50/5.0")
10	SS	18" 113%	16-27-50/4.0" (50/4.0")
11	SS	12" 120%	48-50/4.0" (50/4.0")
12	SS	16" 178%	45-50/3.0" (50/3.0")
13	SS	5" 99%	50/5.0" (50/5.0")
14	SS	27" 169%	13-27-50/4.0" (50/4.0")
15	SS	23" 96%	30-40-47-47 (87)

WELL DETAILS

Name:	MW5-18D	Name:	MW5-18S
GS Elev:	341.14 m AMSL	GS Elev:	341.26 m AMSL
TOC Elev:	342.02 m AMSL	TOC Elev:	342.02 m AMSL
Easting:	564540	Easting:	564540
Northing:	4818521	Northing:	4818521
Stick-up:	0.88 m	Stick-up:	0.76 m



Stantec

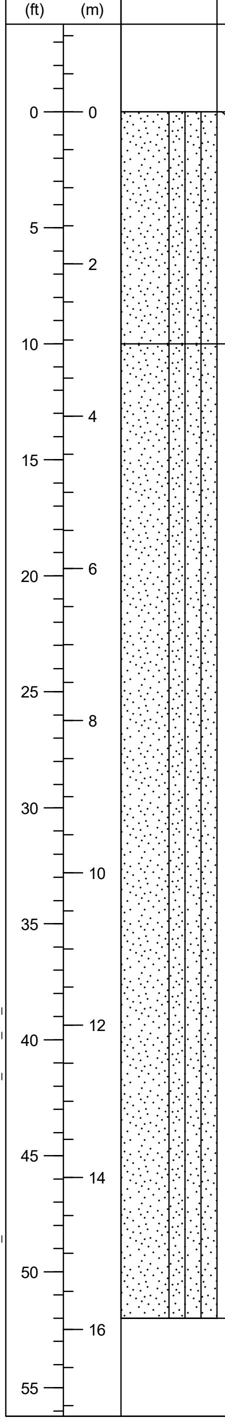
Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
n/a - not available/applicable

Drawn By/Checked By: AH / SR / GW

Monitoring Well: MW6-18

Project:	1242, 1250 and 1260 Gordon Street and 9 Valley Road	**Field Investigator:**	A. Healey	**Ground surface elevation:**	341.40 m AMSL
Client:	Tricar Developments Inc.	**Contractor:**	Aardvark Drilling, Inc	**Top of casing elevation:**	342.55 m AMSL
Location:	Guelph, Ontario	**Drilling method:**	Hollow Stem Auger	**Easting:**	564586
Number:	161413684	**Date started/completed:**	13-Jul-2018 / 16-Jul-2018	**Northing:**	4818487

SUBSURFACE PROFILE

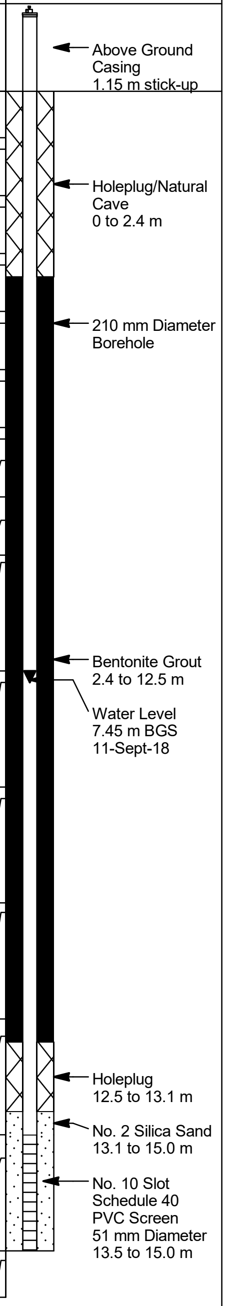


Lithologic Description	Elevation (m AMSL) Depth (m BGS)
	342.55
Ground Surface	341.40
SANDY SILT Loose, 10 YR 4/3 brown, fine sand, some organics, trace fine gravel, moist to dry becoming trace organics starting at 0.3 m BGS becoming moist at 0.43 m BGS some coarse sand and fine gravel starting at 0.89 m BGS minor reddish brown mottling from 1.8 to 2.0 m BGS	0.00
	338.35
SANDY SILT TILL Very dense, 10 YR 6/3 pale brown, fine sand, some medium to coarse sand and fine to coarse gravel, trace clay, moist, crushed coarse gravel/cobbles throughout change in colour to 7.5 YR 5/1 gray wet at 12.2 m BGS increase in clay content and decrease in sand content	3.05
	325.55
End of Borehole	15.85

SAMPLE DETAILS

Sample Number	Sample Type	Recovery	N Value
1	SS	18" 75%	3-4-5-12 (9)
2	SS	20" 83%	10-9-8-7 (17)
3	SS	13" 54%	5-5-4-7 (9)
4	SS	21" 88%	3-5-13-20 (18)
5	SS	27" 113%	8-21-26-37 (47)
6	SS	25" 104%	44-39-43-37 (82)
7	SS	12" 109%	44-50/5.0" (50/5.0")
8	SS	12" 100%	44-50 (50)
9	SS	6" 152%	50/4.0" (50/4.0")
10	SS	8" 133%	50 (0)
11	SS	6" 100%	50 (0)
12	SS	6" 119%	50/5.0" (50/5.0")
13	SS	11" 122%	40-50/3.0" (50/3.0")
14	SS	14" 117%	45-50 (50)
15	SS	8" 159%	50/5.0" (50/5.0")

WELL DETAILS



Above Ground Casing 1.15 m stick-up

Holeplug/Natural Cave 0 to 2.4 m

210 mm Diameter Borehole

Bentonite Grout 2.4 to 12.5 m

Water Level 7.45 m BGS 11-Sept-18

Holeplug 12.5 to 13.1 m

No. 2 Silica Sand 13.1 to 15.0 m

No. 10 Slot Schedule 40 PVC Screen 51 mm Diameter 13.5 to 15.0 m

Stantec

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
n/a - not available/applicable

Drawn By/Checked By: AH / SR / GW

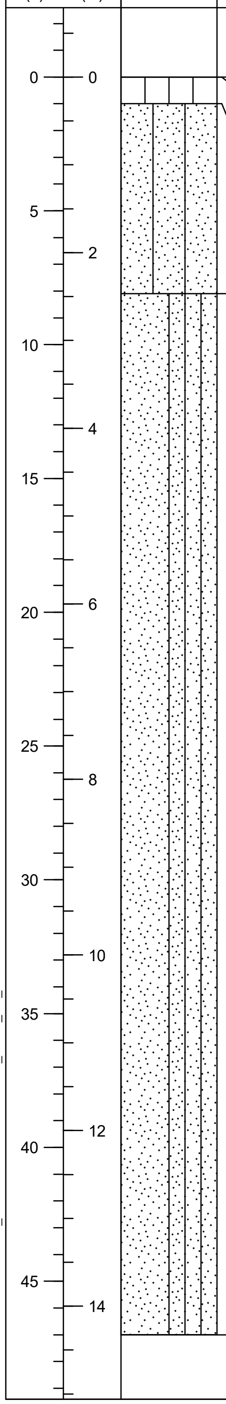
Monitoring Well: MW7-18

Project: 1242, 1250 and 1260 Gordon Street and 9 Valley Road
Client: Tricar Developments Inc.
Location: Guelph, Ontario
Number: 161413684

Field Investigator: A. Healey
Contractor: Aardvark Drilling, Inc
Drilling method: Hollow Stem Auger
Date started/completed: 16-Jul-2018

Ground surface elevation: 338.85 m AMSL
Top of casing elevation: 339.64 m AMSL
Easting: 564518
Northing: 4818416

SUBSURFACE PROFILE

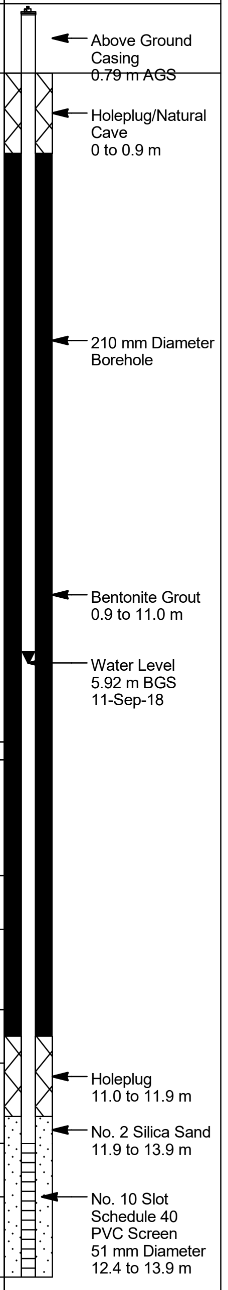


Lithologic Description	Elevation (m AMSL) Depth (m BGS)
	339.64
Ground Surface	338.85
TOPSOIL Loose, dark brown, silty organic topsoil	0.00
SAND AND SILT loose, dark brown, sand and silt, some gravel, trace clay, with some organics and rootlets, wet becoming compact, no organics or rootlets	338.55 0.30
SANDY SILT TILL Compact, 7.5 YR 5/2 brown, fine sand, trace medium to coarse sand, some fine subangular gravel, trace crushed gravel/cobble throughout, moist change in colour to 10 YR 5/1 gray at 9.1 m BGS becoming wet at 9.6 m BGS	336.38 2.47
End of Borehole	324.52 14.33

SAMPLE DETAILS

Sample Number	Sample Type	Recovery	N Value
1	SS	13" 162%	44-50/2.0" (50/2.0")
2	SS	26" 108%	37-31-32-38 (63)
3	SS	26" 108%	13-20-22-30 (42)
4	SS	24" 100%	24-28-34-47 (62)
5	SS	25" 104%	14-13-24-27 (37)

WELL DETAILS



Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
SS - split-spoon sample
n/a - not available/applicable

Well was straight drilled to 7.6 m due to proximity of well in comparison to recently drilled borehole (BH10, drilled April 19, 2018 by CMT Drilling Inc.). Stratigraphy from 0-7.6 m is inferred from this borehole log.

Stantec

Drawn By/Checked By: AH / SR / GW

APPENDIX F:
LABORATORY CERTIFICATES OF ANALYSIS

Your Project #: 161413684
Site Location: GUELPH, ON
Your C.O.C. #: 111362

Attention: Grant Whitehead

Stantec Consulting Ltd
300 Hagey Blvd
Suite 100
Waterloo, ON
CANADA N2L 0A4

Report Date: 2018/09/19
Report #: R5406235
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8N6455
Received: 2018/09/11, 16:40

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Alkalinity	2	N/A	2018/09/14	CAM SOP-00448	SM 23 2320 B m
Alkalinity	1	N/A	2018/09/19	CAM SOP-00448	SM 23 2320 B m
Carbonate, Bicarbonate and Hydroxide	3	N/A	2018/09/14	CAM SOP-00102	APHA 4500-CO2 D
Carbonaceous BOD	1	2018/09/12	2018/09/17	CAM SOP-00427	SM 23 5210B m
Chloride by Automated Colourimetry	1	N/A	2018/09/13	CAM SOP-00463	EPA 325.2 m
Chloride by Automated Colourimetry	2	N/A	2018/09/14	CAM SOP-00463	EPA 325.2 m
Chloride by Automated Colourimetry	1	N/A	2018/09/19	CAM SOP-00463	EPA 325.2 m
Conductivity	3	N/A	2018/09/14	CAM SOP-00414	SM 23 2510 m
Total Cyanide	1	2018/09/13	2018/09/13	CAM SOP-00457	OMOE E3015 5 m
Dissolved Organic Carbon (DOC) (1)	3	N/A	2018/09/14	CAM SOP-00446	SM 23 5310 B m
Fluoride	1	2018/09/12	2018/09/13	CAM SOP-00449	SM 23 4500-F C m
Hardness (calculated as CaCO3)	3	N/A	2018/09/17	CAM SOP 00102/00408/00447	SM 2340 B
Mercury in Water by CVAA	1	2018/09/14	2018/09/14	CAM SOP-00453	EPA 7470A m
Dissolved Metals by ICPMS	1	N/A	2018/09/14	CAM SOP-00447	EPA 6020B m
Dissolved Metals by ICPMS	1	N/A	2018/09/17	CAM SOP-00447	EPA 6020B m
Dissolved Metals by ICPMS	1	N/A	2018/09/19	CAM SOP-00447	EPA 6020B m
Total Metals Analysis by ICPMS	1	N/A	2018/09/13	CAM SOP-00447	EPA 6020B m
Ion Balance (% Difference)	3	N/A	2018/09/17		
Anion and Cation Sum	3	N/A	2018/09/17		
Fecal coliform, (5TMPN/100mL)	1	N/A	2018/09/11	BBY4 SOP-000127	MFHPB-19
Total Ammonia-N	3	N/A	2018/09/18	CAM SOP-00441	EPA GS I-2522-90 m
Nitrate (NO3) and Nitrite (NO2) in Water (2)	3	N/A	2018/09/13	CAM SOP-00440	SM 23 4500-NO3I/NO2B
Animal and Vegetable Oil and Grease	1	N/A	2018/09/14	CAM SOP-00326	EPA1664B m,SM5520B m
Total Oil and Grease	1	2018/09/14	2018/09/14	CAM SOP-00326	EPA1664B m,SM5520A m
pH	1	N/A	2018/09/13	CAM SOP-00413	SM 4500H+ B m
pH	3	N/A	2018/09/14	CAM SOP-00413	SM 4500H+ B m
Phenols (4AAP)	1	N/A	2018/09/14	CAM SOP-00444	OMOE E3179 m
Orthophosphate	3	N/A	2018/09/14	CAM SOP-00461	EPA 365.1 m
Sat. pH and Langelier Index (@ 20C)	3	N/A	2018/09/17		

Your Project #: 161413684
Site Location: GUELPH, ON
Your C.O.C. #: 111362

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300 Hagey Blvd
Suite 100
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CANADA N2L 0A4

Report Date: 2018/09/19
Report #: R5406235
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8N6455
Received: 2018/09/11, 16:40

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Sat. pH and Langelier Index (@ 4C)	3	N/A	2018/09/17		
Sulphate by Automated Colourimetry	1	N/A	2018/09/13	CAM SOP-00464	EPA 375.4 m
Sulphate by Automated Colourimetry	3	N/A	2018/09/14	CAM SOP-00464	EPA 375.4 m
Total Dissolved Solids (TDS calc)	3	N/A	2018/09/17		
Total Kjeldahl Nitrogen in Water	1	2018/09/17	2018/09/17	CAM SOP-00938	OMOE E3516 m
Mineral/Synthetic O & G (TPH Heavy Oil) (3)	1	2018/09/14	2018/09/14	CAM SOP-00326	EPA1664B m,SM5520F m
Total Suspended Solids	4	2018/09/12	2018/09/13	CAM SOP-00428	SM 23 2540D m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) Dissolved Organic Carbon (DOC) present in the sample should be considered as non-purgeable DOC.
(2) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.
(3) Note: TPH (Heavy Oil) is equivalent to Mineral / Synthetic Oil & Grease

Your Project #: 161413684
Site Location: GUELPH, ON
Your C.O.C. #: 111362

Attention: Grant Whitehead

Stantec Consulting Ltd
300 Hagey Blvd
Suite 100
Waterloo, ON
CANADA N2L 0A4

Report Date: 2018/09/19
Report #: R5406235
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8N6455
Received: 2018/09/11, 16:40

Encryption Key

Colby Coutu
Project Manager Assistant
19 Sep 2018 17:12:27

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Augustyna Dobosz, Project Manager
Email: ADobosz@maxxam.ca
Phone# (905)817-5700 Ext:5798

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total Cover Pages : 3

THE CITY OF GUELPH SANITARY SEWER BYLAW (WATER)

Maxxam ID		HSJ715			HSJ715		
Sampling Date		2018/09/11 15:05			2018/09/11 15:05		
COC Number		111362			111362		
	UNITS	**WG-161413684-20180911-DS-04**	**RDL**	**QC Batch**	**WG-161413684-20180911-DS-04 Lab-Dup**	**RDL**	**QC Batch**
Calculated Parameters							
Total Animal/Vegetable Oil and Grease	mg/L	<0.50	0.50	5724443			
Inorganics							
Total Carbonaceous BOD	mg/L	<2	2	5726645	<2	2	5726645
Fluoride (F-)	mg/L	0.13	0.10	5727841			
Total Kjeldahl Nitrogen (TKN)	mg/L	1.7	0.10	5734882			
pH	pH	7.90		5727848			
Phenols-4AAP	mg/L	<0.0010	0.0010	5729249			
Total Suspended Solids	mg/L	2500	33	5727677			
Dissolved Sulphate (SO4)	mg/L	40	1.0	5727421			
Total Cyanide (CN)	mg/L	<0.0050	0.0050	5729123			
Dissolved Chloride (Cl-)	mg/L	46	1.0	5727413			
Petroleum Hydrocarbons							
Total Oil & Grease	mg/L	<0.50	0.50	5731988			
Total Oil & Grease Mineral/Synthetic	mg/L	<0.50	0.50	5732048			
Metals							
Mercury (Hg)	mg/L	<0.0001	0.0001	5731153			

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

THE CITY OF GUELPH STORM SEWER BYLAW (WATER)

Maxxam ID		HSJ715		
Sampling Date		2018/09/11 15:05		
COC Number		111362		
	UNITS	**WG-161413684-20180911-DS-04**	**RDL**	**QC Batch**
Metals				
Total Aluminum (Al)	mg/L	15	0.025	5728921
Total Antimony (Sb)	mg/L	<0.00050	0.00050	5728921
Total Arsenic (As)	mg/L	0.0062	0.0010	5728921
Total Bismuth (Bi)	mg/L	<0.0010	0.0010	5728921
Total Cadmium (Cd)	mg/L	0.0019	0.00010	5728921
Total Chromium (Cr)	mg/L	0.040	0.0050	5728921
Total Cobalt (Co)	mg/L	0.0096	0.00050	5728921
Total Copper (Cu)	mg/L	0.030	0.0010	5729988
Total Iron (Fe)	mg/L	23	0.10	5728921
Total Lead (Pb)	mg/L	0.13	0.00050	5728921
Total Manganese (Mn)	mg/L	1.3	0.0020	5728921
Total Molybdenum (Mo)	mg/L	0.0032	0.00050	5728921
Total Nickel (Ni)	mg/L	0.021	0.0010	5728921
Total Phosphorus (P)	mg/L	1.1	0.10	5728921
Total Selenium (Se)	mg/L	<0.0020	0.0020	5728921
Total Silver (Ag)	mg/L	<0.00010	0.00010	5728921
Total Tin (Sn)	mg/L	0.0011	0.0010	5728921
Total Titanium (Ti)	mg/L	0.49	0.0050	5728921
Total Vanadium (V)	mg/L	0.031	0.00050	5728921
Total Zinc (Zn)	mg/L	0.64	0.0050	5728921
Microbiological				
Fecal coliform	5TMPN/100mL	350	1.8	5726125

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		HSJ712		HSJ713		
Sampling Date		2018/09/11 12:40		2018/09/11 13:10		
COC Number		111362		111362		
	UNITS	**WG-161413684-20180911-DS-01**	**QC Batch**	**WG-161413684-20180911-DS-02**	**RDL**	**QC Batch**
Calculated Parameters						
Anion Sum	me/L	6.67	5724250	9.30	N/A	5724250
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	300	5724251	330	1.0	5724251
Calculated TDS	mg/L	330	5724255	530	1.0	5724255
Carb. Alkalinity (calc. as CaCO3)	mg/L	3.7	5724251	4.7	1.0	5724251
Cation Sum	me/L	6.66	5724250	11.8	N/A	5724250
Hardness (CaCO3)	mg/L	320	5724254	520	1.0	5724254
Ion Balance (% Difference)	%	0.0500	5724249	12.1	N/A	5724249
Langelier Index (@ 20C)	N/A	1.01	5724252	1.25		5724252
Langelier Index (@ 4C)	N/A	0.762	5724253	0.997		5724253
Saturation pH (@ 20C)	N/A	7.10	5724252	6.93		5724252
Saturation pH (@ 4C)	N/A	7.35	5724253	7.18		5724253
Inorganics						
Total Ammonia-N	mg/L	<0.050	5732437	<0.050	0.050	5732437
Conductivity	umho/cm	580	5727479	830	1.0	5727479
Dissolved Organic Carbon	mg/L	0.83	5727802	1.0	0.50	5727802
Orthophosphate (P)	mg/L	<0.010	5727668	<0.010	0.010	5727668
pH	pH	8.11	5727480	8.18		5727480
Dissolved Sulphate (SO4)	mg/L	15	5727661	84	1.0	5727661
Alkalinity (Total as CaCO3)	mg/L	310	5727466	340	1.0	5738172
Dissolved Chloride (Cl-)	mg/L	7.4	5727647	27	1.0	5738161
Nitrite (N)	mg/L	<0.010	5727425	<0.010	0.010	5727425
Nitrate (N)	mg/L	0.25	5727425	0.12	0.10	5727425
Nitrate + Nitrite (N)	mg/L	0.25	5727425	0.12	0.10	5727425
Metals						
Dissolved Aluminum (Al)	mg/L	<0.0050	5728244	0.063	0.0050	5738013
Dissolved Antimony (Sb)	mg/L	<0.00050	5728244	<0.00050	0.00050	5738013
Dissolved Arsenic (As)	mg/L	<0.0010	5728244	0.0015	0.0010	5738013
Dissolved Barium (Ba)	mg/L	0.032	5728244	0.076	0.0020	5738013
Dissolved Beryllium (Be)	mg/L	<0.00050	5728244	<0.00050	0.00050	5738013
Dissolved Boron (B)	mg/L	0.014	5728244	0.013	0.010	5738013

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		HSJ712		HSJ713		
Sampling Date		2018/09/11 12:40		2018/09/11 13:10		
COC Number		111362		111362		
	UNITS	**WG-161413684-20180911-DS-01**	**QC Batch**	**WG-161413684-20180911-DS-02**	**RDL**	**QC Batch**
Dissolved Cadmium (Cd)	mg/L	<0.00010	5728244	<0.00010	0.00010	5738013
Dissolved Calcium (Ca)	mg/L	69	5728244	100	0.20	5738013
Dissolved Chromium (Cr)	mg/L	<0.0050	5728244	<0.0050	0.0050	5738013
Dissolved Cobalt (Co)	mg/L	<0.00050	5728244	<0.00050	0.00050	5738013
Dissolved Copper (Cu)	mg/L	<0.0010	5728244	<0.0010	0.0010	5738013
Dissolved Iron (Fe)	mg/L	<0.10	5728244	0.19	0.10	5738013
Dissolved Lead (Pb)	mg/L	<0.00050	5728244	0.00056	0.00050	5738013
Dissolved Magnesium (Mg)	mg/L	36	5728244	63	0.050	5738013
Dissolved Manganese (Mn)	mg/L	0.011	5728244	0.046	0.0020	5738013
Dissolved Molybdenum (Mo)	mg/L	0.00079	5728244	0.0030	0.00050	5738013
Dissolved Nickel (Ni)	mg/L	<0.0010	5728244	<0.0010	0.0010	5738013
Dissolved Phosphorus (P)	mg/L	<0.10	5728244	<0.10	0.10	5738013
Dissolved Potassium (K)	mg/L	1.1	5728244	2.6	0.20	5738013
Dissolved Selenium (Se)	mg/L	<0.0020	5728244	<0.0020	0.0020	5738013
Dissolved Silicon (Si)	mg/L	6.3	5728244	7.9	0.050	5738013
Dissolved Silver (Ag)	mg/L	<0.00010	5728244	<0.00010	0.00010	5738013
Dissolved Sodium (Na)	mg/L	5.4	5728244	34	0.10	5738013
Dissolved Strontium (Sr)	mg/L	0.13	5728244	0.20	0.0010	5738013
Dissolved Thallium (Tl)	mg/L	<0.000050	5728244	<0.000050	0.000050	5738013
Dissolved Titanium (Ti)	mg/L	<0.0050	5728244	0.0051	0.0050	5738013
Dissolved Uranium (U)	mg/L	0.00063	5728244	0.0022	0.00010	5738013
Dissolved Vanadium (V)	mg/L	<0.00050	5728244	0.0014	0.00050	5738013
Dissolved Zinc (Zn)	mg/L	<0.0050	5728244	<0.0050	0.0050	5738013

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		HSJ714		
Sampling Date		2018/09/11 13:55		
COC Number		111362		
	UNITS	**WG-161413684-20180911-DS-03**	**RDL**	**QC Batch**
Calculated Parameters				
Anion Sum	me/L	10.7	N/A	5724250
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	410	1.0	5724251
Calculated TDS	mg/L	540	1.0	5724255
Carb. Alkalinity (calc. as CaCO3)	mg/L	5.3	1.0	5724251
Cation Sum	me/L	10.9	N/A	5724250
Hardness (CaCO3)	mg/L	490	1.0	5724254
Ion Balance (% Difference)	%	1.08	N/A	5724249
Langelier Index (@ 20C)	N/A	1.20		5724252
Langelier Index (@ 4C)	N/A	0.947		5724253
Saturation pH (@ 20C)	N/A	6.95		5724252
Saturation pH (@ 4C)	N/A	7.20		5724253
Inorganics				
Total Ammonia-N	mg/L	0.071	0.050	5732437
Conductivity	umho/cm	950	1.0	5727479
Dissolved Organic Carbon	mg/L	1.4	0.50	5727802
Orthophosphate (P)	mg/L	0.012	0.010	5727668
pH	pH	8.14		5727480
Dissolved Sulphate (SO4)	mg/L	50	1.0	5727661
Alkalinity (Total as CaCO3)	mg/L	410	1.0	5727466
Dissolved Chloride (Cl-)	mg/L	43	1.0	5727647
Nitrite (N)	mg/L	0.026	0.010	5727425
Nitrate (N)	mg/L	1.93	0.10	5727425
Nitrate + Nitrite (N)	mg/L	1.96	0.10	5727425
Metals				
Dissolved Aluminum (Al)	mg/L	0.0064	0.0050	5728244
Dissolved Antimony (Sb)	mg/L	<0.00050	0.00050	5728244
Dissolved Arsenic (As)	mg/L	<0.0010	0.0010	5728244
Dissolved Barium (Ba)	mg/L	0.13	0.0020	5728244
Dissolved Beryllium (Be)	mg/L	<0.00050	0.00050	5728244
Dissolved Boron (B)	mg/L	0.11	0.010	5728244

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Stantec Consulting Ltd
Client Project #: 161413684
Site Location: GUELPH, ON
Sampler Initials: DS

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		HSJ714		
Sampling Date		2018/09/11 13:55		
COC Number		111362		
	UNITS	**WG-161413684-20180911-DS-03**	**RDL**	**QC Batch**
Dissolved Cadmium (Cd)	mg/L	<0.00010	0.00010	5728244
Dissolved Calcium (Ca)	mg/L	82	0.20	5728244
Dissolved Chromium (Cr)	mg/L	<0.0050	0.0050	5728244
Dissolved Cobalt (Co)	mg/L	<0.00050	0.00050	5728244
Dissolved Copper (Cu)	mg/L	<0.0010	0.0010	5728244
Dissolved Iron (Fe)	mg/L	<0.10	0.10	5728244
Dissolved Lead (Pb)	mg/L	<0.00050	0.00050	5728244
Dissolved Magnesium (Mg)	mg/L	71	0.050	5728244
Dissolved Manganese (Mn)	mg/L	0.020	0.0020	5728244
Dissolved Molybdenum (Mo)	mg/L	0.0042	0.00050	5728244
Dissolved Nickel (Ni)	mg/L	<0.0010	0.0010	5728244
Dissolved Phosphorus (P)	mg/L	0.11	0.10	5728244
Dissolved Potassium (K)	mg/L	5.9	0.20	5728244
Dissolved Selenium (Se)	mg/L	0.0022	0.0020	5728244
Dissolved Silicon (Si)	mg/L	5.2	0.050	5728244
Dissolved Silver (Ag)	mg/L	<0.00010	0.00010	5728244
Dissolved Sodium (Na)	mg/L	20	0.10	5728244
Dissolved Strontium (Sr)	mg/L	0.23	0.0010	5728244
Dissolved Thallium (Tl)	mg/L	<0.000050	0.000050	5728244
Dissolved Titanium (Ti)	mg/L	<0.0050	0.0050	5728244
Dissolved Uranium (U)	mg/L	0.0030	0.00010	5728244
Dissolved Vanadium (V)	mg/L	0.0012	0.00050	5728244
Dissolved Zinc (Zn)	mg/L	<0.0050	0.0050	5728244

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

RESULTS OF ANALYSES OF WATER

Maxxam ID		HSJ712	HSJ713		HSJ714		
Sampling Date		2018/09/11 12:40	2018/09/11 13:10		2018/09/11 13:55		
COC Number		111362	111362		111362		
	UNITS	**WG-161413684-20180911-DS-01**	**WG-161413684-20180911-DS-02**	**RDL**	**WG-161413684-20180911-DS-03**	**RDL**	**QC Batch**
Inorganics							
Total Suspended Solids	mg/L	1800	1200	25	100	1.3	5727677

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

TEST SUMMARY

Maxxam ID: HSJ712
Sample ID: WG-161413684-20180911-DS-01
Matrix: Water

Collected: 2018/09/11
Shipped:
Received: 2018/09/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	5727466	N/A	2018/09/14	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	5724251	N/A	2018/09/14	Automated Statchk
Chloride by Automated Colourimetry	KONE	5727647	N/A	2018/09/14	Deonarine Ramnarine
Conductivity	AT	5727479	N/A	2018/09/14	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	5727802	N/A	2018/09/14	Shivani Shivani
Hardness (calculated as CaCO3)		5724254	N/A	2018/09/17	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	5728244	N/A	2018/09/17	Arefa Dabhad
Ion Balance (% Difference)	CALC	5724249	N/A	2018/09/17	Automated Statchk
Anion and Cation Sum	CALC	5724250	N/A	2018/09/17	Automated Statchk
Total Ammonia-N	LACH/NH4	5732437	N/A	2018/09/18	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	5727425	N/A	2018/09/13	Chandra Nandlal
pH	AT	5727480	N/A	2018/09/14	Surinder Rai
Orthophosphate	KONE	5727668	N/A	2018/09/14	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	5724252	N/A	2018/09/17	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	5724253	N/A	2018/09/17	Automated Statchk
Sulphate by Automated Colourimetry	KONE	5727661	N/A	2018/09/14	Deonarine Ramnarine
Total Dissolved Solids (TDS calc)	CALC	5724255	N/A	2018/09/17	Automated Statchk
Total Suspended Solids	BAL	5727677	2018/09/12	2018/09/13	Jingwei (Alvin) Shi

Maxxam ID: HSJ713
Sample ID: WG-161413684-20180911-DS-02
Matrix: Water

Collected: 2018/09/11
Shipped:
Received: 2018/09/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	5738172	N/A	2018/09/19	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	5724251	N/A	2018/09/14	Automated Statchk
Chloride by Automated Colourimetry	KONE	5738161	N/A	2018/09/19	Deonarine Ramnarine
Conductivity	AT	5727479	N/A	2018/09/14	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	5727802	N/A	2018/09/14	Shivani Shivani
Hardness (calculated as CaCO3)		5724254	N/A	2018/09/17	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	5738013	N/A	2018/09/19	Thao Nguyen
Ion Balance (% Difference)	CALC	5724249	N/A	2018/09/17	Automated Statchk
Anion and Cation Sum	CALC	5724250	N/A	2018/09/17	Automated Statchk
Total Ammonia-N	LACH/NH4	5732437	N/A	2018/09/18	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	5727425	N/A	2018/09/13	Chandra Nandlal
pH	AT	5727480	N/A	2018/09/14	Surinder Rai
Orthophosphate	KONE	5727668	N/A	2018/09/14	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	5724252	N/A	2018/09/17	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	5724253	N/A	2018/09/17	Automated Statchk
Sulphate by Automated Colourimetry	KONE	5727661	N/A	2018/09/14	Deonarine Ramnarine
Total Dissolved Solids (TDS calc)	CALC	5724255	N/A	2018/09/17	Automated Statchk
Total Suspended Solids	BAL	5727677	2018/09/12	2018/09/13	Jingwei (Alvin) Shi

TEST SUMMARY

Maxxam ID: HSJ714
Sample ID: WG-161413684-20180911-DS-03
Matrix: Water

Collected: 2018/09/11
Shipped:
Received: 2018/09/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	5727466	N/A	2018/09/14	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	5724251	N/A	2018/09/14	Automated Statchk
Chloride by Automated Colourimetry	KONE	5727647	N/A	2018/09/14	Deonarine Ramnarine
Conductivity	AT	5727479	N/A	2018/09/14	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	5727802	N/A	2018/09/14	Shivani Shivani
Hardness (calculated as CaCO3)		5724254	N/A	2018/09/17	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	5728244	N/A	2018/09/14	Arefa Dabhad
Ion Balance (% Difference)	CALC	5724249	N/A	2018/09/17	Automated Statchk
Anion and Cation Sum	CALC	5724250	N/A	2018/09/17	Automated Statchk
Total Ammonia-N	LACH/NH4	5732437	N/A	2018/09/18	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	5727425	N/A	2018/09/13	Chandra Nandlal
pH	AT	5727480	N/A	2018/09/14	Surinder Rai
Orthophosphate	KONE	5727668	N/A	2018/09/14	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	5724252	N/A	2018/09/17	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	5724253	N/A	2018/09/17	Automated Statchk
Sulphate by Automated Colourimetry	KONE	5727661	N/A	2018/09/14	Deonarine Ramnarine
Total Dissolved Solids (TDS calc)	CALC	5724255	N/A	2018/09/17	Automated Statchk
Total Suspended Solids	BAL	5727677	2018/09/12	2018/09/13	Jingwei (Alvin) Shi

Maxxam ID: HSJ715
Sample ID: WG-161413684-20180911-DS-04
Matrix: Water

Collected: 2018/09/11
Shipped:
Received: 2018/09/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Carbonaceous BOD	DO	5726645	2018/09/12	2018/09/17	Frank Zhang
Chloride by Automated Colourimetry	KONE	5727413	N/A	2018/09/13	Alina Dobreanu
Total Cyanide	SKAL/CN	5729123	2018/09/13	2018/09/13	Xuanhong Qiu
Fluoride	ISE	5727841	2018/09/12	2018/09/13	Surinder Rai
Mercury in Water by CVAA	CV/AA	5731153	2018/09/14	2018/09/14	Ron Morrison
Total Metals Analysis by ICPMS	ICP/MS	5728921	N/A	2018/09/13	Arefa Dabhad
Fecal coliform, (5TMPN/100mL)	INC	5726125	N/A	2018/09/11	Sirimathie Aluthwala
Animal and Vegetable Oil and Grease	BAL	5724443	N/A	2018/09/14	Automated Statchk
Total Oil and Grease	BAL	5731988	2018/09/14	2018/09/14	Amjad Mir
pH	AT	5727848	N/A	2018/09/13	Surinder Rai
Phenols (4AAP)	TECH/PHEN	5729249	N/A	2018/09/14	Bramdeo Motiram
Sulphate by Automated Colourimetry	KONE	5727421	N/A	2018/09/13	Alina Dobreanu
Total Kjeldahl Nitrogen in Water	SKAL	5734882	2018/09/17	2018/09/17	Rajni Tyagi
Mineral/Synthetic O & G (TPH Heavy Oil)	BAL	5732048	2018/09/14	2018/09/14	Amjad Mir
Total Suspended Solids	BAL	5727677	2018/09/12	2018/09/13	Jingwei (Alvin) Shi

TEST SUMMARY

Maxxam ID: HSJ715 Dup
Sample ID: WG-161413684-20180911-DS-04
Matrix: Water

Collected: 2018/09/11
Shipped:
Received: 2018/09/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Carbonaceous BOD	DO	5726645	2018/09/12	2018/09/17	Frank Zhang

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	6.7°C

Sample HSJ713 [WG-161413684-20180911-DS-02] : Elevated ion balance result was confirmed by re-analysis.

Sample HSJ715, Total Metals Analysis by ICPMS: Test repeated.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5726645	Total Carbonaceous BOD	2018/09/17					<2	mg/L	NC	30	98	85 - 115
5727413	Dissolved Chloride (Cl-)	2018/09/13	NC	80 - 120	104	80 - 120	<1.0	mg/L	0.80	20		
5727421	Dissolved Sulphate (SO4)	2018/09/13	NC	75 - 125	97	80 - 120	<1.0	mg/L	0.58	20		
5727425	Nitrate (N)	2018/09/13	89	80 - 120	102	80 - 120	<0.10	mg/L	NC	20		
5727425	Nitrite (N)	2018/09/13	104	80 - 120	104	80 - 120	<0.010	mg/L	NC	20		
5727466	Alkalinity (Total as CaCO3)	2018/09/14			97	85 - 115	<1.0	mg/L	0.90	20		
5727479	Conductivity	2018/09/14			101	85 - 115	<1.0	umho/cm	0.36	25		
5727480	pH	2018/09/14			101	98 - 103			0.24	N/A		
5727647	Dissolved Chloride (Cl-)	2018/09/14	114	80 - 120	101	80 - 120	<1.0	mg/L	13	20		
5727661	Dissolved Sulphate (SO4)	2018/09/14	104	75 - 125	103	80 - 120	<1.0	mg/L	0.21	20		
5727668	Orthophosphate (P)	2018/09/14	109	75 - 125	99	80 - 120	<0.010	mg/L	NC	25		
5727677	Total Suspended Solids	2018/09/13					<10	mg/L	NC	25	95	85 - 115
5727802	Dissolved Organic Carbon	2018/09/14	95	80 - 120	98	80 - 120	<0.50	mg/L	5.0	20		
5727841	Fluoride (F-)	2018/09/13	97	80 - 120	99	80 - 120	<0.10	mg/L	6.7	20		
5727848	pH	2018/09/13			102	98 - 103			0.24	N/A		
5728244	Dissolved Aluminum (Al)	2018/09/14	102	80 - 120	100	80 - 120	<0.0050	mg/L				
5728244	Dissolved Antimony (Sb)	2018/09/14	105	80 - 120	101	80 - 120	<0.00050	mg/L	NC	20		
5728244	Dissolved Arsenic (As)	2018/09/14	101	80 - 120	100	80 - 120	<0.0010	mg/L	NC	20		
5728244	Dissolved Barium (Ba)	2018/09/14	102	80 - 120	100	80 - 120	<0.0020	mg/L	1.7	20		
5728244	Dissolved Beryllium (Be)	2018/09/14	112	80 - 120	105	80 - 120	<0.00050	mg/L	NC	20		
5728244	Dissolved Boron (B)	2018/09/14	112	80 - 120	104	80 - 120	<0.010	mg/L	NC	20		
5728244	Dissolved Cadmium (Cd)	2018/09/14	103	80 - 120	101	80 - 120	<0.00010	mg/L	NC	20		
5728244	Dissolved Calcium (Ca)	2018/09/14	NC	80 - 120	94	80 - 120	<0.20	mg/L				
5728244	Dissolved Chromium (Cr)	2018/09/14	99	80 - 120	94	80 - 120	<0.0050	mg/L	NC	20		
5728244	Dissolved Cobalt (Co)	2018/09/14	95	80 - 120	96	80 - 120	<0.00050	mg/L	NC	20		
5728244	Dissolved Copper (Cu)	2018/09/14	101	80 - 120	96	80 - 120	<0.0010	mg/L	NC	20		
5728244	Dissolved Iron (Fe)	2018/09/14	103	80 - 120	101	80 - 120	<0.10	mg/L				
5728244	Dissolved Lead (Pb)	2018/09/14	99	80 - 120	100	80 - 120	<0.00050	mg/L	NC	20		
5728244	Dissolved Magnesium (Mg)	2018/09/14	106	80 - 120	102	80 - 120	<0.050	mg/L				
5728244	Dissolved Manganese (Mn)	2018/09/14	100	80 - 120	98	80 - 120	<0.0020	mg/L				

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5728244	Dissolved Molybdenum (Mo)	2018/09/14	105	80 - 120	103	80 - 120	<0.00050	mg/L	8.3	20		
5728244	Dissolved Nickel (Ni)	2018/09/14	96	80 - 120	95	80 - 120	<0.0010	mg/L	3.1	20		
5728244	Dissolved Phosphorus (P)	2018/09/14	115	80 - 120	116	80 - 120	<0.10	mg/L				
5728244	Dissolved Potassium (K)	2018/09/14	106	80 - 120	104	80 - 120	<0.20	mg/L				
5728244	Dissolved Selenium (Se)	2018/09/14	99	80 - 120	99	80 - 120	<0.0020	mg/L	NC	20		
5728244	Dissolved Silicon (Si)	2018/09/14	100	80 - 120	102	80 - 120	<0.050	mg/L				
5728244	Dissolved Silver (Ag)	2018/09/14	98	80 - 120	98	80 - 120	<0.00010	mg/L	NC	20		
5728244	Dissolved Sodium (Na)	2018/09/14	NC	80 - 120	101	80 - 120	<0.10	mg/L	3.9	20		
5728244	Dissolved Strontium (Sr)	2018/09/14	101	80 - 120	98	80 - 120	<0.0010	mg/L				
5728244	Dissolved Thallium (Tl)	2018/09/14	100	80 - 120	97	80 - 120	<0.000050	mg/L	NC	20		
5728244	Dissolved Titanium (Ti)	2018/09/14	105	80 - 120	103	80 - 120	<0.0050	mg/L				
5728244	Dissolved Uranium (U)	2018/09/14	102	80 - 120	101	80 - 120	<0.00010	mg/L	4.9	20		
5728244	Dissolved Vanadium (V)	2018/09/14	97	80 - 120	93	80 - 120	<0.00050	mg/L	NC	20		
5728244	Dissolved Zinc (Zn)	2018/09/14	98	80 - 120	97	80 - 120	<0.0050	mg/L	4.0	20		
5728921	Total Aluminum (Al)	2018/09/13	112	80 - 120	101	80 - 120	0.0062, RDL=0.0050	mg/L	0.18	20		
5728921	Total Antimony (Sb)	2018/09/13	101	80 - 120	99	80 - 120	<0.00050	mg/L	NC	20		
5728921	Total Arsenic (As)	2018/09/13	99	80 - 120	100	80 - 120	<0.0010	mg/L	NC	20		
5728921	Total Bismuth (Bi)	2018/09/13	89	80 - 120	91	80 - 120	<0.0010	mg/L	NC	20		
5728921	Total Cadmium (Cd)	2018/09/13	100	80 - 120	99	80 - 120	<0.00010	mg/L	NC	20		
5728921	Total Chromium (Cr)	2018/09/13	98	80 - 120	95	80 - 120	<0.0050	mg/L	NC	20		
5728921	Total Cobalt (Co)	2018/09/13	99	80 - 120	97	80 - 120	<0.00050	mg/L	NC	20		
5728921	Total Iron (Fe)	2018/09/13	99	80 - 120	98	80 - 120	<0.10	mg/L	1.5	20		
5728921	Total Lead (Pb)	2018/09/13	92	80 - 120	92	80 - 120	<0.00050	mg/L	1.7	20		
5728921	Total Manganese (Mn)	2018/09/13	95	80 - 120	96	80 - 120	<0.0020	mg/L	2.3	20		
5728921	Total Molybdenum (Mo)	2018/09/13	97	80 - 120	100	80 - 120	<0.00050	mg/L	3.9	20		
5728921	Total Nickel (Ni)	2018/09/13	91	80 - 120	92	80 - 120	<0.0010	mg/L	NC	20		
5728921	Total Phosphorus (P)	2018/09/13	NC	80 - 120	111	80 - 120	<0.10	mg/L				
5728921	Total Selenium (Se)	2018/09/13	105	80 - 120	105	80 - 120	<0.0020	mg/L	NC	20		
5728921	Total Silver (Ag)	2018/09/13	95	80 - 120	95	80 - 120	<0.00010	mg/L	NC	20		
5728921	Total Tin (Sn)	2018/09/13	98	80 - 120	97	80 - 120	<0.0010	mg/L	NC	20		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5728921	Total Titanium (Ti)	2018/09/13	96	80 - 120	98	80 - 120	<0.0050	mg/L	6.5	20		
5728921	Total Vanadium (V)	2018/09/13	94	80 - 120	94	80 - 120	<0.00050	mg/L	7.8	20		
5728921	Total Zinc (Zn)	2018/09/13	99	80 - 120	100	80 - 120	<0.0050	mg/L	1.6	20		
5729123	Total Cyanide (CN)	2018/09/13	85	80 - 120	97	80 - 120	<0.0050	mg/L	1.6	20		
5729249	Phenols-4AAP	2018/09/13	93	80 - 120	94	80 - 120	<0.0010	mg/L	NC	20		
5729988	Total Copper (Cu)	2018/09/14	102	80 - 120	103	80 - 120	<0.0010	mg/L	NC	20		
5731153	Mercury (Hg)	2018/09/14	95	75 - 125	92	80 - 120	<0.0001	mg/L	NC	20		
5731988	Total Oil & Grease	2018/09/14	91	75 - 125	96	85 - 115	<0.50	mg/L	1.6	25		
5732048	Total Oil & Grease Mineral/Synthetic	2018/09/14	93	75 - 125	92	85 - 115	<0.50	mg/L	2.7	25		
5732437	Total Ammonia-N	2018/09/18	101	75 - 125	102	80 - 120	<0.050	mg/L	NC	20		
5734882	Total Kjeldahl Nitrogen (TKN)	2018/09/17	98	80 - 120	100	80 - 120	<0.10	mg/L	1.7	20	99	80 - 120
5738013	Dissolved Aluminum (Al)	2018/09/19	105	80 - 120	99	80 - 120	<0.0050	mg/L				
5738013	Dissolved Antimony (Sb)	2018/09/19	110	80 - 120	100	80 - 120	<0.00050	mg/L	NC	20		
5738013	Dissolved Arsenic (As)	2018/09/19	103	80 - 120	100	80 - 120	<0.0010	mg/L	NC	20		
5738013	Dissolved Barium (Ba)	2018/09/19	107	80 - 120	99	80 - 120	<0.0020	mg/L	1.1	20		
5738013	Dissolved Beryllium (Be)	2018/09/19	99	80 - 120	99	80 - 120	<0.00050	mg/L	NC	20		
5738013	Dissolved Boron (B)	2018/09/19	104	80 - 120	100	80 - 120	<0.010	mg/L	0.083	20		
5738013	Dissolved Cadmium (Cd)	2018/09/19	98	80 - 120	98	80 - 120	<0.00010	mg/L	NC	20		
5738013	Dissolved Calcium (Ca)	2018/09/19	NC	80 - 120	99	80 - 120	<0.20	mg/L				
5738013	Dissolved Chromium (Cr)	2018/09/19	100	80 - 120	97	80 - 120	<0.0050	mg/L	NC	20		
5738013	Dissolved Cobalt (Co)	2018/09/19	99	80 - 120	97	80 - 120	<0.00050	mg/L	3.6	20		
5738013	Dissolved Copper (Cu)	2018/09/19	104	80 - 120	98	80 - 120	<0.0010	mg/L	NC	20		
5738013	Dissolved Iron (Fe)	2018/09/19	104	80 - 120	100	80 - 120	<0.10	mg/L				
5738013	Dissolved Lead (Pb)	2018/09/19	90	80 - 120	97	80 - 120	<0.00050	mg/L	NC	20		
5738013	Dissolved Magnesium (Mg)	2018/09/19	NC	80 - 120	99	80 - 120	<0.050	mg/L				
5738013	Dissolved Manganese (Mn)	2018/09/19	101	80 - 120	98	80 - 120	<0.0020	mg/L				
5738013	Dissolved Molybdenum (Mo)	2018/09/19	113	80 - 120	101	80 - 120	<0.00050	mg/L	1.9	20		
5738013	Dissolved Nickel (Ni)	2018/09/19	95	80 - 120	96	80 - 120	<0.0010	mg/L	7.9	20		
5738013	Dissolved Phosphorus (P)	2018/09/19	116	80 - 120	118	80 - 120	<0.10	mg/L				
5738013	Dissolved Potassium (K)	2018/09/19	108	80 - 120	99	80 - 120	<0.20	mg/L				
5738013	Dissolved Selenium (Se)	2018/09/19	99	80 - 120	100	80 - 120	<0.0020	mg/L	NC	20		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5738013	Dissolved Silicon (Si)	2018/09/19	107	80 - 120	101	80 - 120	<0.050	mg/L				
5738013	Dissolved Silver (Ag)	2018/09/19	96	80 - 120	97	80 - 120	<0.00010	mg/L	NC	20		
5738013	Dissolved Sodium (Na)	2018/09/19	NC	80 - 120	97	80 - 120	<0.10	mg/L	1.4	20		
5738013	Dissolved Strontium (Sr)	2018/09/19	NC	80 - 120	97	80 - 120	<0.0010	mg/L				
5738013	Dissolved Thallium (Tl)	2018/09/19	90	80 - 120	96	80 - 120	<0.000050	mg/L	NC	20		
5738013	Dissolved Titanium (Ti)	2018/09/19	110	80 - 120	101	80 - 120	<0.0050	mg/L				
5738013	Dissolved Uranium (U)	2018/09/19	96	80 - 120	100	80 - 120	<0.00010	mg/L	1.8	20		
5738013	Dissolved Vanadium (V)	2018/09/19	106	80 - 120	97	80 - 120	<0.00050	mg/L	NC	20		
5738013	Dissolved Zinc (Zn)	2018/09/19	90	80 - 120	96	80 - 120	<0.0050	mg/L	NC	20		
5738161	Dissolved Chloride (Cl-)	2018/09/19	115	80 - 120	102	80 - 120	<1.0	mg/L	5.6	20		
5738172	Alkalinity (Total as CaCO3)	2018/09/19			96	85 - 115	<1.0	mg/L	1.2	20		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Cristina Carriere

Cristina Carriere, Scientific Service Specialist

Sirimathie Aluthwala, Campobello Micro

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam MICRO
A Bureau Veritas Group Company
[illegible] Campo[illegible] Mississauga, Ontario [illegible]
Phone [illegible] Toll Free [illegible]

CHAIN OF CUSTODY RECORD 111362

Page 1 of 1

Invoice Information		Report Information (if differs from invoice)		Project Information (where applicable)	
Company Name	Stantec	Company Name		Quotation #	Stantec 2015-2018
Contact Name	Grant Whitehead	Contact Name		P.O. # AFE#	
Address		Address		Project #	161413684
				Site Location	Guelph, ON
Phone / Fax		Phone / Fax		Site #	
Email	Grant.whitehead@stantec.com	Email		Sampled By	Drew Smith

Turnaround Time (TAT) Required

☒ Regular TAT (5-7 days) Most analyses

PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS

Rush TAT (Surcharges will be applied)

☐ 1 Day ☐ 2 Days ☐ 3-4 Days

Date Required

Rush Confirmation #:

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153

☐ Table 1 ☐ Res/Park ☐ Med/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other
☐ For
FOR RSC (PLEASE CIRCLE) Y / N

Other Regulations

☐ CCME ☐ Sanitary Sewer Bylaw
☐ MISA ☐ Storm Sewer Bylaw
☒ PWQO Region
☒ Other (Specify) ODWS
☐ REG 558 (MIN. 3 DAY TAT REQUIRED)

Include Criteria on Certificate of Analysis: Y / N

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

Analysis Requested

	SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) [✓ Metals] / Hg / Cr VI	RCAp comprehensive	Guelph Sewer [illegible]	TSS	HOLD - DO NOT ANALYZE
1	WG-161413684-20180911-DS-01	2018/09/11	12 40	GW		X	X		X	
2	WG-161413684-20180911-DS-02	2018/09/11	13:10	GW		X	X		X	
3	WG-161413684-20190911-DS-03	2018/09/11	13:55	GW		X	X		X	
4	WG-161413684-20180911-DS-04	2018/09/11	15:5	GW				X		
5										
6										
7										
8										
9										
10										

LABORATORY USE ONLY

CUSTODY SEAL Y/N		COOLER TEMPERATURES
Present	Intact	

COOLING MEDIA PRESENT Y / N

COMMENTS

REC'D IN WATERLOO

RELINQUISHED BY (Signature/Print)	DATE (YYYY/MM/DD)	TIME (HH:MM)	RECEIVED BY (Signature/Print)	DATE (YYYY/MM/DD)	TIME (HH:MM)
/ Drew Smith	2018/09/11	16 42			
			[illegible]	2018/09/1	18 [illegible]

11-Sep-18 16:40
Augustyna Dobosz
B8N6455
VMK ENV-1263

Your Project #: 161413684
Your C.O.C. #: 686036-01-01

Attention: Grant Whitehead

Stantec Consulting Ltd
300 Hagey Blvd
Suite 100
Waterloo, ON
CANADA . N2L 0A4

Report Date: 2018/11/14
Report #: R5484375
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8T9171
Received: 2018/11/08, 14:50

Sample Matrix: Water
Samples Received: 5

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Alkalinity	4	N/A	2018/11/10	CAM SOP-00448	SM 23 2320 B m
Carbonate, Bicarbonate and Hydroxide	4	N/A	2018/11/12	CAM SOP-00102	APHA 4500-CO2 D
Carbonaceous BOD	1	2018/11/09	2018/11/14	CAM SOP-00427	SM 23 5210B m
Chloride by Automated Colourimetry	5	N/A	2018/11/12	CAM SOP-00463	EPA 325.2 m
Conductivity	4	N/A	2018/11/10	CAM SOP-00414	SM 23 2510 m
Total Cyanide	1	2018/11/12	2018/11/13	CAM SOP-00457	OMOE E3015 5 m
Dissolved Organic Carbon (DOC) (1)	4	N/A	2018/11/12	CAM SOP-00446	SM 23 5310 B m
Fluoride	1	2018/11/10	2018/11/13	CAM SOP-00449	SM 23 4500-F C m
Hardness (calculated as CaCO3)	4	N/A	2018/11/13	CAM SOP 00102/00408/00447	SM 2340 B
Mercury in Water by CVAA	1	2018/11/14	2018/11/14	CAM SOP-00453	EPA 7470A m
Dissolved Metals by ICPMS	5	N/A	2018/11/12	CAM SOP-00447	EPA 6020B m
Total Metals Analysis by ICPMS	1	N/A	2018/11/12	CAM SOP-00447	EPA 6020B m
Ion Balance (% Difference)	4	N/A	2018/11/13		
Anion and Cation Sum	4	N/A	2018/11/13		
Fecal coliform, (5TMPN/100mL)	1	N/A	2018/11/08	BBY4 SOP-000127	MFHPB-19
Total Ammonia-N	3	N/A	2018/11/12	CAM SOP-00441	EPA GS I-2522-90 m
Total Ammonia-N	1	N/A	2018/11/13	CAM SOP-00441	EPA GS I-2522-90 m
Nitrate (NO3) and Nitrite (NO2) in Water (2)	4	N/A	2018/11/13	CAM SOP-00440	SM 23 4500-NO3I/NO2B
Animal and Vegetable Oil and Grease	1	N/A	2018/11/13	CAM SOP-00326	EPA1664B m,SM5520B m
Total Oil and Grease	1	2018/11/13	2018/11/13	CAM SOP-00326	EPA1664B m,SM5520A m
pH	4	N/A	2018/11/10	CAM SOP-00413	SM 4500H+ B m
pH	1	N/A	2018/11/12	CAM SOP-00413	SM 4500H+ B m
Phenols (4AAP)	1	N/A	2018/11/13	CAM SOP-00444	OMOE E3179 m
Orthophosphate	4	N/A	2018/11/12	CAM SOP-00461	EPA 365.1 m
Sat. pH and Langelier Index (@ 20C)	4	N/A	2018/11/13		
Sat. pH and Langelier Index (@ 4C)	4	N/A	2018/11/13		
Sulphate by Automated Colourimetry	5	N/A	2018/11/12	CAM SOP-00464	EPA 375.4 m
Total Dissolved Solids (TDS calc)	4	N/A	2018/11/13		
Total Kjeldahl Nitrogen in Water	1	2018/11/10	2018/11/12	CAM SOP-00938	OMOE E3516 m

Your Project #: 161413684
Your C.O.C. #: 686036-01-01

Attention: Grant Whitehead
Stantec Consulting Ltd
300 Hagey Blvd
Suite 100
Waterloo, ON
CANADA N2L 0A4

Report Date: 2018/11/14
Report #: R5484375
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8T9171
Received: 2018/11/08, 14:50

Sample Matrix: Water
Samples Received: 5

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Mineral/Synthetic O & G (TPH Heavy Oil) (3)	1	2018/11/13	2018/11/13	CAM SOP-00326	EPA1664B m,SM5520F m
Total Suspended Solids	5	2018/11/09	2018/11/12	CAM SOP-00428	SM 23 2540D m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Dissolved Organic Carbon (DOC) present in the sample should be considered as non-purgeable DOC.
(2) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.
(3) Note: TPH (Heavy Oil) is equivalent to Mineral / Synthetic Oil & Grease

Your Project #: 161413684
Your C.O.C. #: 686036-01-01

Attention: Grant Whitehead

Stantec Consulting Ltd
300 Hagey Blvd
Suite 100
Waterloo, ON
CANADA N2L 0A4

Report Date: 2018/11/14
Report #: R5484375
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8T9171
Received: 2018/11/08, 14:50

Encryption Key

Colby Coutu
Project Manager Assistant
14 Nov 2018 17:01:42

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Augustyna Dobosz, Project Manager
Email: ADobosz@maxxam.ca
Phone# (905)817-5700 Ext:5798

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total Cover Pages : 3

THE CITY OF GUELPH SANITARY SEWER BYLAW (WATER)

Maxxam ID		IGE068		
Sampling Date		2018/11/08 11:30		
COC Number		686036-01-01		
	UNITS	**WG-161413684-20181108-DS01**	**RDL**	**QC Batch**
Calculated Parameters				
Total Animal/Vegetable Oil and Grease	mg/L	3.3	0.50	5827390
Inorganics				
Total Carbonaceous BOD	mg/L	<2	2	5829310
Fluoride (F-)	mg/L	0.12	0.10	5831501
Total Kjeldahl Nitrogen (TKN)	mg/L	<0.10	0.10	5831642
pH	pH	7.69		5831504
Phenols-4AAP	mg/L	<0.0010	0.0010	5832393
Total Suspended Solids	mg/L	4800	17	5830227
Dissolved Sulphate (SO4)	mg/L	44	1.0	5831429
Total Cyanide (CN)	mg/L	<0.0050	0.0050	5832812
Dissolved Chloride (Cl-)	mg/L	38	1.0	5831425
Petroleum Hydrocarbons				
Total Oil & Grease	mg/L	3.3	0.50	5833748
Total Oil & Grease Mineral/Synthetic	mg/L	<0.50	0.50	5833755
Metals				
Mercury (Hg)	mg/L	<0.0001	0.0001	5836000

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

THE CITY OF GUELPH STORM SEWER BYLAW (WATER)

Maxxam ID		IGE068		
Sampling Date		2018/11/08 11:30		
COC Number		686036-01-01		
	UNITS	**WG-161413684-20181108-DS01**	**RDL**	**QC Batch**
Metals				
Total Aluminum (Al)	mg/L	7.4	0.0050	5831797
Total Antimony (Sb)	mg/L	<0.00050	0.00050	5831797
Total Arsenic (As)	mg/L	0.0038	0.0010	5831797
Total Bismuth (Bi)	mg/L	<0.0010	0.0010	5831797
Total Cadmium (Cd)	mg/L	0.00024	0.00010	5831797
Total Chromium (Cr)	mg/L	0.019	0.0050	5831797
Total Cobalt (Co)	mg/L	0.0040	0.00050	5831797
Total Copper (Cu)	mg/L	0.011	0.0010	5831797
Total Iron (Fe)	mg/L	10	0.10	5831797
Total Lead (Pb)	mg/L	0.030	0.00050	5831797
Total Manganese (Mn)	mg/L	0.40	0.0020	5831797
Total Molybdenum (Mo)	mg/L	0.0040	0.00050	5831797
Total Nickel (Ni)	mg/L	0.0089	0.0010	5831797
Total Phosphorus (P)	mg/L	0.41	0.10	5831797
Total Selenium (Se)	mg/L	<0.0020	0.0020	5831797
Total Silver (Ag)	mg/L	<0.00010	0.00010	5831797
Total Tin (Sn)	mg/L	0.0015	0.0010	5831797
Total Titanium (Ti)	mg/L	0.22	0.0050	5831797
Total Vanadium (V)	mg/L	0.016	0.00050	5831797
Total Zinc (Zn)	mg/L	0.098	0.0050	5831797
Microbiological				
Fecal coliform	5TMPN/100mL	<1.8	1.8	5828861

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		IGE069	IGE070	IGE071		
Sampling Date		2018/11/08 12:40	2018/11/08 13:15	2018/11/08 13:20		
COC Number		686036-01-01	686036-01-01	686036-01-01		
	UNITS	**WG-161413684-20181108-DS02**	**WG-161413684-20181108-DS03**	**WG-161413684-20181108-DS04**	**RDL**	**QC Batch**
Calculated Parameters						
Anion Sum	me/L	8.98	7.31	6.51	N/A	5827281
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	230	310	240	1.0	5827280
Calculated TDS	mg/L	460	350	330	1.0	5827284
Carb. Alkalinity (calc. as CaCO3)	mg/L	3.2	3.2	4.1	1.0	5827280
Cation Sum	me/L	9.29	7.10	5.93	N/A	5827281
Hardness (CaCO3)	mg/L	380	330	190	1.0	5827179
Ion Balance (% Difference)	%	1.72	1.43	4.65	N/A	5827180
Langelier Index (@ 20C)	N/A	0.601	0.775	0.477		5827282
Langelier Index (@ 4C)	N/A	0.352	0.526	0.228		5827283
Saturation pH (@ 20C)	N/A	7.57	7.27	7.78		5827282
Saturation pH (@ 4C)	N/A	7.82	7.52	8.03		5827283
Inorganics						
Total Ammonia-N	mg/L	0.23	<0.050	<0.050	0.050	5831662
Conductivity	umho/cm	840	630	590	1.0	5830552
Dissolved Organic Carbon	mg/L	1.4	0.98	0.68	0.50	5830640
Orthophosphate (P)	mg/L	<0.010	0.012	0.027	0.010	5830606
pH	pH	8.17	8.04	8.26		5830556
Dissolved Sulphate (SO4)	mg/L	20	20	54	1.0	5830605
Alkalinity (Total as CaCO3)	mg/L	240	310	250	1.0	5830538
Dissolved Chloride (Cl-)	mg/L	140	18	17	1.0	5830597
Nitrite (N)	mg/L	<0.010	0.074	<0.010	0.010	5830573
Nitrate (N)	mg/L	<0.10	1.01	<0.10	0.10	5830573
Nitrate + Nitrite (N)	mg/L	<0.10	1.08	<0.10	0.10	5830573
Metals						
Dissolved Aluminum (Al)	mg/L	0.25	0.0071	0.0071	0.0050	5828185
Dissolved Antimony (Sb)	mg/L	<0.00050	0.00051	<0.00050	0.00050	5828185
Dissolved Arsenic (As)	mg/L	<0.0010	<0.0010	0.0044	0.0010	5828185
Dissolved Barium (Ba)	mg/L	0.046	0.088	0.024	0.0020	5828185
Dissolved Beryllium (Be)	mg/L	<0.00050	<0.00050	<0.00050	0.00050	5828185
Dissolved Boron (B)	mg/L	0.071	0.047	0.036	0.010	5828185
Dissolved Cadmium (Cd)	mg/L	<0.00010	<0.00010	<0.00010	0.00010	5828185

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		IGE069	IGE070	IGE071		
Sampling Date		2018/11/08 12:40	2018/11/08 13:15	2018/11/08 13:20		
COC Number		686036-01-01	686036-01-01	686036-01-01		
	UNITS	**WG-161413684-20181108-DS02**	**WG-161413684-20181108-DS03**	**WG-161413684-20181108-DS04**	**RDL**	**QC Batch**
Dissolved Calcium (Ca)	mg/L	33	47	18	0.20	5828185
Dissolved Chromium (Cr)	mg/L	<0.0050	<0.0050	<0.0050	0.0050	5828185
Dissolved Cobalt (Co)	mg/L	<0.00050	<0.00050	<0.00050	0.00050	5828185
Dissolved Copper (Cu)	mg/L	<0.0010	0.0015	<0.0010	0.0010	5828185
Dissolved Iron (Fe)	mg/L	0.33	<0.10	<0.10	0.10	5828185
Dissolved Lead (Pb)	mg/L	0.0020	<0.00050	<0.00050	0.00050	5828185
Dissolved Magnesium (Mg)	mg/L	73	51	35	0.050	5828185
Dissolved Manganese (Mn)	mg/L	0.030	0.012	<0.0020	0.0020	5828185
Dissolved Molybdenum (Mo)	mg/L	0.027	0.010	0.019	0.00050	5828185
Dissolved Nickel (Ni)	mg/L	0.0021	<0.0010	0.0011	0.0010	5828185
Dissolved Phosphorus (P)	mg/L	<0.10	<0.10	<0.10	0.10	5828185
Dissolved Potassium (K)	mg/L	5.1	7.5	3.0	0.20	5828185
Dissolved Selenium (Se)	mg/L	<0.0020	<0.0020	<0.0020	0.0020	5828185
Dissolved Silicon (Si)	mg/L	5.9	3.9	4.3	0.050	5828185
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	0.00010	5828185
Dissolved Sodium (Na)	mg/L	33	7.7	47	0.10	5828185
Dissolved Strontium (Sr)	mg/L	0.21	0.15	0.27	0.0010	5828185
Dissolved Thallium (Tl)	mg/L	<0.000050	<0.000050	<0.000050	0.000050	5828185
Dissolved Titanium (Ti)	mg/L	0.012	<0.0050	<0.0050	0.0050	5828185
Dissolved Uranium (U)	mg/L	0.00050	0.0017	0.0010	0.00010	5828185
Dissolved Vanadium (V)	mg/L	0.00084	0.0012	0.0014	0.00050	5828185
Dissolved Zinc (Zn)	mg/L	0.0062	<0.0050	<0.0050	0.0050	5828185

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		IGE072		
Sampling Date		2018/11/08 13:45		
COC Number		686036-01-01		
	UNITS	**WG-161413684-20181108-DS05**	**RDL**	**QC Batch**
Calculated Parameters				
Anion Sum	me/L	13.3	N/A	5827281
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	290	1.0	5827280
Calculated TDS	mg/L	700	1.0	5827284
Carb. Alkalinity (calc. as CaCO3)	mg/L	2.4	1.0	5827280
Cation Sum	me/L	13.2	N/A	5827281
Hardness (CaCO3)	mg/L	470	1.0	5827179
Ion Balance (% Difference)	%	0.280	N/A	5827180
Langelier Index (@ 20C)	N/A	0.753		5827282
Langelier Index (@ 4C)	N/A	0.506		5827283
Saturation pH (@ 20C)	N/A	7.18		5827282
Saturation pH (@ 4C)	N/A	7.43		5827283
Inorganics				
Total Ammonia-N	mg/L	0.13	0.050	5831661
Conductivity	umho/cm	1300	1.0	5830552
Dissolved Organic Carbon	mg/L	1.0	0.50	5830640
Orthophosphate (P)	mg/L	0.012	0.010	5830606
pH	pH	7.94		5830556
Dissolved Sulphate (SO4)	mg/L	84	1.0	5830605
Alkalinity (Total as CaCO3)	mg/L	300	1.0	5830538
Dissolved Chloride (Cl-)	mg/L	200	2.0	5830597
Nitrite (N)	mg/L	<0.010	0.010	5830573
Nitrate (N)	mg/L	<0.10	0.10	5830573
Nitrate + Nitrite (N)	mg/L	<0.10	0.10	5830573
Metals				
Dissolved Aluminum (Al)	mg/L	<0.0050	0.0050	5828185
Dissolved Antimony (Sb)	mg/L	<0.00050	0.00050	5828185
Dissolved Arsenic (As)	mg/L	0.0011	0.0010	5828185
Dissolved Barium (Ba)	mg/L	0.089	0.0020	5828185
Dissolved Beryllium (Be)	mg/L	<0.00050	0.00050	5828185
Dissolved Boron (B)	mg/L	0.069	0.010	5828185
Dissolved Cadmium (Cd)	mg/L	<0.00010	0.00010	5828185

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		IGE072		
Sampling Date		2018/11/08 13:45		
COC Number		686036-01-01		
	UNITS	**WG-161413684-20181108-DS05**	**RDL**	**QC Batch**
Dissolved Calcium (Ca)	mg/L	71	0.20	5828185
Dissolved Chromium (Cr)	mg/L	<0.0050	0.0050	5828185
Dissolved Cobalt (Co)	mg/L	<0.00050	0.00050	5828185
Dissolved Copper (Cu)	mg/L	0.0016	0.0010	5828185
Dissolved Iron (Fe)	mg/L	<0.10	0.10	5828185
Dissolved Lead (Pb)	mg/L	<0.00050	0.00050	5828185
Dissolved Magnesium (Mg)	mg/L	71	0.050	5828185
Dissolved Manganese (Mn)	mg/L	0.021	0.0020	5828185
Dissolved Molybdenum (Mo)	mg/L	0.012	0.00050	5828185
Dissolved Nickel (Ni)	mg/L	0.0015	0.0010	5828185
Dissolved Phosphorus (P)	mg/L	<0.10	0.10	5828185
Dissolved Potassium (K)	mg/L	5.6	0.20	5828185
Dissolved Selenium (Se)	mg/L	<0.0020	0.0020	5828185
Dissolved Silicon (Si)	mg/L	5.0	0.050	5828185
Dissolved Silver (Ag)	mg/L	<0.00010	0.00010	5828185
Dissolved Sodium (Na)	mg/L	84	0.10	5828185
Dissolved Strontium (Sr)	mg/L	0.26	0.0010	5828185
Dissolved Thallium (Tl)	mg/L	<0.000050	0.000050	5828185
Dissolved Titanium (Ti)	mg/L	<0.0050	0.0050	5828185
Dissolved Uranium (U)	mg/L	0.0027	0.00010	5828185
Dissolved Vanadium (V)	mg/L	0.0012	0.00050	5828185
Dissolved Zinc (Zn)	mg/L	<0.0050	0.0050	5828185

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

RESULTS OF ANALYSES OF WATER

Maxxam ID		IGE069		IGE070		IGE071		
Sampling Date		2018/11/08 12:40		2018/11/08 13:15		2018/11/08 13:20		
COC Number		686036-01-01		686036-01-01		686036-01-01		
	UNITS	**WG-161413684-20181108-DS02**	**RDL**	**WG-161413684-20181108-DS03**	**RDL**	**WG-161413684-20181108-DS04**	**RDL**	**QC Batch**
Inorganics								
Total Suspended Solids	mg/L	3000	20	630	10	2400	20	5830227

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		IGE072		
Sampling Date		2018/11/08 13:45		
COC Number		686036-01-01		
	UNITS	**WG-161413684-20181108-DS05**	**RDL**	**QC Batch**
Inorganics				
Total Suspended Solids	mg/L	1400	10	5830227

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID		IGE068		
Sampling Date		2018/11/08 11:30		
COC Number		686036-01-01		
	UNITS	**WG-161413684-20181108-DS01**	**RDL**	**QC Batch**
Metals				
Dissolved Aluminum (Al)	mg/L	<0.0050	0.0050	5828185
Dissolved Antimony (Sb)	mg/L	<0.00050	0.00050	5828185
Dissolved Arsenic (As)	mg/L	<0.0010	0.0010	5828185
Dissolved Bismuth (Bi)	mg/L	<0.0010	0.0010	5828185
Dissolved Cadmium (Cd)	mg/L	<0.00010	0.00010	5828185
Dissolved Chromium (Cr)	mg/L	<0.0050	0.0050	5828185
Dissolved Cobalt (Co)	mg/L	<0.00050	0.00050	5828185
Dissolved Copper (Cu)	mg/L	0.0012	0.0010	5828185
Dissolved Iron (Fe)	mg/L	<0.10	0.10	5828185
Dissolved Lead (Pb)	mg/L	<0.00050	0.00050	5828185
Dissolved Manganese (Mn)	mg/L	0.019	0.0020	5828185
Dissolved Molybdenum (Mo)	mg/L	0.0027	0.00050	5828185
Dissolved Nickel (Ni)	mg/L	<0.0010	0.0010	5828185
Dissolved Phosphorus (P)	mg/L	<0.10	0.10	5828185
Dissolved Selenium (Se)	mg/L	<0.0020	0.0020	5828185
Dissolved Silver (Ag)	mg/L	<0.00010	0.00010	5828185
Dissolved Tin (Sn)	mg/L	<0.0010	0.0010	5828185
Dissolved Titanium (Ti)	mg/L	<0.0050	0.0050	5828185
Dissolved Vanadium (V)	mg/L	0.0015	0.00050	5828185
Dissolved Zinc (Zn)	mg/L	<0.0050	0.0050	5828185

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

TEST SUMMARY

Maxxam ID: IGE068
Sample ID: WG-161413684-20181108-DS01
Matrix: Water

Collected: 2018/11/08
Shipped:
Received: 2018/11/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Carbonaceous BOD	DO	5829310	2018/11/09	2018/11/14	Althea Gonzalez
Chloride by Automated Colourimetry	KONE	5831425	N/A	2018/11/12	Deonarine Ramnarine
Total Cyanide	SKAL/CN	5832812	2018/11/12	2018/11/13	Xuanhong Qiu
Fluoride	ISE	5831501	2018/11/10	2018/11/13	Surinder Rai
Mercury in Water by CVAA	CV/AA	5836000	2018/11/14	2018/11/14	Ron Morrison
Dissolved Metals by ICPMS	ICP/MS	5828185	N/A	2018/11/12	Thao Nguyen
Total Metals Analysis by ICPMS	ICP/MS	5831797	N/A	2018/11/12	Arefa Dabhad
Fecal coliform, (5TMPN/100mL)	INC	5828861	N/A	2018/11/08	Sirimathie Aluthwala
Animal and Vegetable Oil and Grease	BAL	5827390	N/A	2018/11/13	Automated Statchk
Total Oil and Grease	BAL	5833748	2018/11/13	2018/11/13	Francis Afonso
pH	AT	5831504	N/A	2018/11/12	Surinder Rai
Phenols (4AAP)	TECH/PHEN	5832393	N/A	2018/11/13	Bramdeo Motiram
Sulphate by Automated Colourimetry	KONE	5831429	N/A	2018/11/12	Deonarine Ramnarine
Total Kjeldahl Nitrogen in Water	SKAL	5831642	2018/11/10	2018/11/12	Rajni Tyagi
Mineral/Synthetic O & G (TPH Heavy Oil)	BAL	5833755	2018/11/13	2018/11/13	Francis Afonso
Total Suspended Solids	BAL	5830227	2018/11/09	2018/11/12	Nilam Borole

Maxxam ID: IGE069
Sample ID: WG-161413684-20181108-DS02
Matrix: Water

Collected: 2018/11/08
Shipped:
Received: 2018/11/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	5830538	N/A	2018/11/10	Neil Dassanayake
Carbonate, Bicarbonate and Hydroxide	CALC	5827280	N/A	2018/11/12	Automated Statchk
Chloride by Automated Colourimetry	KONE	5830597	N/A	2018/11/12	Deonarine Ramnarine
Conductivity	AT	5830552	N/A	2018/11/10	Neil Dassanayake
Dissolved Organic Carbon (DOC)	TOCV/NDIR	5830640	N/A	2018/11/12	Nimarta Singh
Hardness (calculated as CaCO3)		5827179	N/A	2018/11/13	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	5828185	N/A	2018/11/12	Thao Nguyen
Ion Balance (% Difference)	CALC	5827180	N/A	2018/11/13	Automated Statchk
Anion and Cation Sum	CALC	5827281	N/A	2018/11/13	Automated Statchk
Total Ammonia-N	LACH/NH4	5831662	N/A	2018/11/12	Chandra Nandlal
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	5830573	N/A	2018/11/13	Chandra Nandlal
pH	AT	5830556	N/A	2018/11/10	Neil Dassanayake
Orthophosphate	KONE	5830606	N/A	2018/11/12	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	5827282	N/A	2018/11/13	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	5827283	N/A	2018/11/13	Automated Statchk
Sulphate by Automated Colourimetry	KONE	5830605	N/A	2018/11/12	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	5827284	N/A	2018/11/13	Automated Statchk
Total Suspended Solids	BAL	5830227	2018/11/09	2018/11/12	Nilam Borole

TEST SUMMARY

Maxxam ID: IGE070
Sample ID: WG-161413684-20181108-DS03
Matrix: Water

Collected: 2018/11/08
Shipped:
Received: 2018/11/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	5830538	N/A	2018/11/10	Neil Dassanayake
Carbonate, Bicarbonate and Hydroxide	CALC	5827280	N/A	2018/11/12	Automated Statchk
Chloride by Automated Colourimetry	KONE	5830597	N/A	2018/11/12	Deonarine Ramnarine
Conductivity	AT	5830552	N/A	2018/11/10	Neil Dassanayake
Dissolved Organic Carbon (DOC)	TOCV/NDIR	5830640	N/A	2018/11/12	Nimarta Singh
Hardness (calculated as CaCO3)		5827179	N/A	2018/11/13	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	5828185	N/A	2018/11/12	Thao Nguyen
Ion Balance (% Difference)	CALC	5827180	N/A	2018/11/13	Automated Statchk
Anion and Cation Sum	CALC	5827281	N/A	2018/11/13	Automated Statchk
Total Ammonia-N	LACH/NH4	5831662	N/A	2018/11/12	Chandra Nandlal
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	5830573	N/A	2018/11/13	Chandra Nandlal
pH	AT	5830556	N/A	2018/11/10	Neil Dassanayake
Orthophosphate	KONE	5830606	N/A	2018/11/12	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	5827282	N/A	2018/11/13	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	5827283	N/A	2018/11/13	Automated Statchk
Sulphate by Automated Colourimetry	KONE	5830605	N/A	2018/11/12	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	5827284	N/A	2018/11/13	Automated Statchk
Total Suspended Solids	BAL	5830227	2018/11/09	2018/11/12	Nilam Borole

Maxxam ID: IGE071
Sample ID: WG-161413684-20181108-DS04
Matrix: Water

Collected: 2018/11/08
Shipped:
Received: 2018/11/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	5830538	N/A	2018/11/10	Neil Dassanayake
Carbonate, Bicarbonate and Hydroxide	CALC	5827280	N/A	2018/11/12	Automated Statchk
Chloride by Automated Colourimetry	KONE	5830597	N/A	2018/11/12	Deonarine Ramnarine
Conductivity	AT	5830552	N/A	2018/11/10	Neil Dassanayake
Dissolved Organic Carbon (DOC)	TOCV/NDIR	5830640	N/A	2018/11/12	Nimarta Singh
Hardness (calculated as CaCO3)		5827179	N/A	2018/11/13	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	5828185	N/A	2018/11/12	Thao Nguyen
Ion Balance (% Difference)	CALC	5827180	N/A	2018/11/13	Automated Statchk
Anion and Cation Sum	CALC	5827281	N/A	2018/11/13	Automated Statchk
Total Ammonia-N	LACH/NH4	5831662	N/A	2018/11/12	Chandra Nandlal
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	5830573	N/A	2018/11/13	Chandra Nandlal
pH	AT	5830556	N/A	2018/11/10	Neil Dassanayake
Orthophosphate	KONE	5830606	N/A	2018/11/12	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	5827282	N/A	2018/11/13	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	5827283	N/A	2018/11/13	Automated Statchk
Sulphate by Automated Colourimetry	KONE	5830605	N/A	2018/11/12	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	5827284	N/A	2018/11/13	Automated Statchk
Total Suspended Solids	BAL	5830227	2018/11/09	2018/11/12	Nilam Borole

TEST SUMMARY

Maxxam ID: IGE072
Sample ID: WG-161413684-20181108-DS05
Matrix: Water

Collected: 2018/11/08
Shipped:
Received: 2018/11/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	5830538	N/A	2018/11/10	Neil Dassanayake
Carbonate, Bicarbonate and Hydroxide	CALC	5827280	N/A	2018/11/12	Automated Statchk
Chloride by Automated Colourimetry	KONE	5830597	N/A	2018/11/12	Deonarine Ramnarine
Conductivity	AT	5830552	N/A	2018/11/10	Neil Dassanayake
Dissolved Organic Carbon (DOC)	TOCV/NDIR	5830640	N/A	2018/11/12	Nimarta Singh
Hardness (calculated as CaCO3)		5827179	N/A	2018/11/13	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	5828185	N/A	2018/11/12	Thao Nguyen
Ion Balance (% Difference)	CALC	5827180	N/A	2018/11/13	Automated Statchk
Anion and Cation Sum	CALC	5827281	N/A	2018/11/13	Automated Statchk
Total Ammonia-N	LACH/NH4	5831661	N/A	2018/11/13	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	5830573	N/A	2018/11/13	Chandra Nandlal
pH	AT	5830556	N/A	2018/11/10	Neil Dassanayake
Orthophosphate	KONE	5830606	N/A	2018/11/12	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	5827282	N/A	2018/11/13	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	5827283	N/A	2018/11/13	Automated Statchk
Sulphate by Automated Colourimetry	KONE	5830605	N/A	2018/11/12	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	5827284	N/A	2018/11/13	Automated Statchk
Total Suspended Solids	BAL	5830227	2018/11/09	2018/11/12	Nilam Borole

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	0.0°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5828185	Dissolved Aluminum (Al)	2018/11/12	97	80 - 120	98	80 - 120	<0.0050	mg/L				
5828185	Dissolved Antimony (Sb)	2018/11/12	110	80 - 120	101	80 - 120	<0.00050	mg/L	2.4	20		
5828185	Dissolved Arsenic (As)	2018/11/12	103	80 - 120	100	80 - 120	<0.0010	mg/L	NC	20		
5828185	Dissolved Barium (Ba)	2018/11/12	100	80 - 120	99	80 - 120	<0.0020	mg/L	1.3	20		
5828185	Dissolved Beryllium (Be)	2018/11/12	103	80 - 120	100	80 - 120	<0.00050	mg/L	NC	20		
5828185	Dissolved Bismuth (Bi)	2018/11/12	92	80 - 120	92	80 - 120	<0.0010	mg/L				
5828185	Dissolved Boron (B)	2018/11/12	99	80 - 120	100	80 - 120	<0.010	mg/L	2.5	20		
5828185	Dissolved Cadmium (Cd)	2018/11/12	103	80 - 120	99	80 - 120	<0.00010	mg/L	NC	20		
5828185	Dissolved Calcium (Ca)	2018/11/12	NC	80 - 120	98	80 - 120	<0.20	mg/L				
5828185	Dissolved Chromium (Cr)	2018/11/12	100	80 - 120	98	80 - 120	<0.0050	mg/L	NC	20		
5828185	Dissolved Cobalt (Co)	2018/11/12	100	80 - 120	99	80 - 120	<0.00050	mg/L	NC	20		
5828185	Dissolved Copper (Cu)	2018/11/12	103	80 - 120	99	80 - 120	<0.0010	mg/L	NC	20		
5828185	Dissolved Iron (Fe)	2018/11/12	103	80 - 120	101	80 - 120	<0.10	mg/L				
5828185	Dissolved Lead (Pb)	2018/11/12	94	80 - 120	94	80 - 120	<0.00050	mg/L	NC	20		
5828185	Dissolved Magnesium (Mg)	2018/11/12	NC	80 - 120	98	80 - 120	<0.050	mg/L				
5828185	Dissolved Manganese (Mn)	2018/11/12	101	80 - 120	98	80 - 120	<0.0020	mg/L				
5828185	Dissolved Molybdenum (Mo)	2018/11/12	106	80 - 120	101	80 - 120	<0.00050	mg/L	4.7	20		
5828185	Dissolved Nickel (Ni)	2018/11/12	101	80 - 120	100	80 - 120	<0.0010	mg/L	NC	20		
5828185	Dissolved Phosphorus (P)	2018/11/12	109	80 - 120	109	80 - 120	<0.10	mg/L				
5828185	Dissolved Potassium (K)	2018/11/12	102	80 - 120	99	80 - 120	<0.20	mg/L				
5828185	Dissolved Selenium (Se)	2018/11/12	103	80 - 120	105	80 - 120	<0.0020	mg/L	NC	20		
5828185	Dissolved Silicon (Si)	2018/11/12	96	80 - 120	97	80 - 120	<0.050	mg/L				
5828185	Dissolved Silver (Ag)	2018/11/12	98	80 - 120	99	80 - 120	<0.00010	mg/L	NC	20		
5828185	Dissolved Sodium (Na)	2018/11/12	NC	80 - 120	97	80 - 120	<0.10	mg/L	0.78	20		
5828185	Dissolved Strontium (Sr)	2018/11/12	NC	80 - 120	99	80 - 120	<0.0010	mg/L				
5828185	Dissolved Thallium (Tl)	2018/11/12	93	80 - 120	93	80 - 120	<0.000050	mg/L	NC	20		
5828185	Dissolved Tin (Sn)	2018/11/12	103	80 - 120	99	80 - 120	<0.0010	mg/L				
5828185	Dissolved Titanium (Ti)	2018/11/12	98	80 - 120	101	80 - 120	<0.0050	mg/L				
5828185	Dissolved Uranium (U)	2018/11/12	105	80 - 120	102	80 - 120	<0.00010	mg/L	1.2	20		
5828185	Dissolved Vanadium (V)	2018/11/12	102	80 - 120	98	80 - 120	<0.00050	mg/L	9.2	20		
5828185	Dissolved Zinc (Zn)	2018/11/12	99	80 - 120	99	80 - 120	<0.0050	mg/L	NC	20		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5829310	Total Carbonaceous BOD	2018/11/14					<2	mg/L	9.6	30	96	85 - 115
5830227	Total Suspended Solids	2018/11/12					<10	mg/L	NC	25	96	85 - 115
5830538	Alkalinity (Total as CaCO3)	2018/11/09			94	85 - 115	<1.0	mg/L	1.2	20		
5830552	Conductivity	2018/11/09			100	85 - 115	<1.0	umho/cm	0.43	25		
5830556	pH	2018/11/09			101	98 - 103			1.5	N/A		
5830573	Nitrate (N)	2018/11/13	90	80 - 120	98	80 - 120	<0.10	mg/L	0.38	20		
5830573	Nitrite (N)	2018/11/13	103	80 - 120	103	80 - 120	<0.010	mg/L	NC	20		
5830597	Dissolved Chloride (Cl-)	2018/11/12	115	80 - 120	104	80 - 120	<1.0	mg/L	1.3	20		
5830605	Dissolved Sulphate (SO4)	2018/11/12	NC	75 - 125	105	80 - 120	<1.0	mg/L	0.99	20		
5830606	Orthophosphate (P)	2018/11/12	113	75 - 125	100	80 - 120	<0.010	mg/L	NC	25		
5830640	Dissolved Organic Carbon	2018/11/12	95	80 - 120	98	80 - 120	<0.50	mg/L	0.55	20		
5831425	Dissolved Chloride (Cl-)	2018/11/12	110	80 - 120	103	80 - 120	<1.0	mg/L	0.67	20		
5831429	Dissolved Sulphate (SO4)	2018/11/12	NC	75 - 125	106	80 - 120	<1.0	mg/L	0.10	20		
5831501	Fluoride (F-)	2018/11/12	95	80 - 120	107	80 - 120	<0.10	mg/L	0	20		
5831504	pH	2018/11/12			102	98 - 103			2.1	N/A		
5831642	Total Kjeldahl Nitrogen (TKN)	2018/11/12	NC	80 - 120	102	80 - 120	<0.10	mg/L	0.78	20	99	N/A
5831661	Total Ammonia-N	2018/11/13	103	75 - 125	101	80 - 120	<0.050	mg/L	3.8	20		
5831662	Total Ammonia-N	2018/11/12	97	75 - 125	100	80 - 120	<0.050	mg/L	NC	20		
5831797	Total Aluminum (Al)	2018/11/12	101	80 - 120	101	80 - 120	<0.0050	mg/L	1.1	20		
5831797	Total Antimony (Sb)	2018/11/12	104	80 - 120	101	80 - 120	<0.00050	mg/L				
5831797	Total Arsenic (As)	2018/11/12	102	80 - 120	101	80 - 120	<0.0010	mg/L				
5831797	Total Bismuth (Bi)	2018/11/12	102	80 - 120	101	80 - 120	<0.0010	mg/L				
5831797	Total Cadmium (Cd)	2018/11/12	104	80 - 120	101	80 - 120	<0.00010	mg/L	NC	20		
5831797	Total Chromium (Cr)	2018/11/12	95	80 - 120	94	80 - 120	<0.0050	mg/L	NC	20		
5831797	Total Cobalt (Co)	2018/11/12	102	80 - 120	99	80 - 120	<0.00050	mg/L	NC	20		
5831797	Total Copper (Cu)	2018/11/12	103	80 - 120	102	80 - 120	<0.0010	mg/L	10	20		
5831797	Total Iron (Fe)	2018/11/12	99	80 - 120	99	80 - 120	<0.10	mg/L	0.34	20		
5831797	Total Lead (Pb)	2018/11/12	101	80 - 120	100	80 - 120	<0.00050	mg/L	NC	20		
5831797	Total Manganese (Mn)	2018/11/12	96	80 - 120	97	80 - 120	<0.0020	mg/L	2.3	20		
5831797	Total Molybdenum (Mo)	2018/11/12	103	80 - 120	97	80 - 120	<0.00050	mg/L	1.3	20		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5831797	Total Nickel (Ni)	2018/11/12	99	80 - 120	99	80 - 120	<0.0010	mg/L	0.39	20		
5831797	Total Phosphorus (P)	2018/11/12	102	80 - 120	106	80 - 120	<0.10	mg/L				
5831797	Total Selenium (Se)	2018/11/12	109	80 - 120	109	80 - 120	<0.0020	mg/L				
5831797	Total Silver (Ag)	2018/11/12	100	80 - 120	97	80 - 120	<0.00010	mg/L	NC	20		
5831797	Total Tin (Sn)	2018/11/12	104	80 - 120	101	80 - 120	<0.0010	mg/L	NC	20		
5831797	Total Titanium (Ti)	2018/11/12	99	80 - 120	101	80 - 120	<0.0050	mg/L	NC	20		
5831797	Total Vanadium (V)	2018/11/12	97	80 - 120	96	80 - 120	<0.00050	mg/L	13	20		
5831797	Total Zinc (Zn)	2018/11/12	100	80 - 120	101	80 - 120	<0.0050	mg/L	3.2	20		
5832393	Phenols-4AAP	2018/11/13	101	80 - 120	102	80 - 120	<0.0010	mg/L	NC	20		
5832812	Total Cyanide (CN)	2018/11/13	103	80 - 120	100	80 - 120	<0.0050	mg/L	NC	20		
5833748	Total Oil & Grease	2018/11/13			99	85 - 115	<0.50	mg/L	3.9	25		
5833755	Total Oil & Grease Mineral/Synthetic	2018/11/13			96	85 - 115	<0.50	mg/L	2.7	25		
5836000	Mercury (Hg)	2018/11/14	99	75 - 125	105	80 - 120	<0.0001	mg/L	NC	20		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Anastassia Hamanov, Scientific Specialist

Sirimathie Aluthwala, Campobello Micro

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

MICRO

Maxxam Analytics International Corporation o/a Maxxam Analytics
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel (905) 817-5700 Toll-free 800-563-6266 Fax (905) 817 5777 www.maxxam.ca

CHAIN OF CUSTODY RECORD

Page 1 of 1

INVOICE TO:
Company Name: #9197 Stantec Consulting Ltd
Attention: Accounts Payable
Address: 300 Hagey Blvd Suite 100
Waterloo ON N2L 0A4
Tel: (519) 579-4410 Fax: (519) 579-6733
Email: SAPinvoices@Stantec.com

REPORT TO:
Company Name:
Attention: Grant Whitehead
Address:
Tel: (519) 585-7400 Fax: (519) 579-4239
Email: grant.whitehead@stantec.com

PROJECT INFORMATION:
Quotation #: B77373
P.O. #: 400
Project: 161413684
Project Name:
Site #:
Sampled By: Drew Smith

Laboratory Use Only:
Maxxam Job #:
Bottle Order #: 586036
COC #: C#586036-01-01
Project Manager: Augustyna Dobosz

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011):
☐ Table 1 ☐ Res/Park ☐ Medium/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ For RSC
☐ Table ___

Other Regulations:
☐ CCME ☐ Sanitary Sewer Bylaw
☐ Reg 558 ☐ Storm Sewer Bylaw
☐ MISA Municipality ________
☒ PWQO
☒ Other ODWS

Special Instructions:

Include Criteria on Certificate of Analysis (Y/N)? ______

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle) [✓ Metals] / Hg / Cr VI	RCAp - Comprehensive	Total Suspended Solids	The City of Guelph Sanitary and Storm Sewer Bylaw	Total metals (not filtered)	# of Bottles	Comments
1		WG-161413684-20181108-DS01	2018/11/08	11:30	GW	X			X	X	11	Total metals and dissolved metals
2		WG-161413684-20181108-DS02	2018/11/08	12:40	GW	X	X	X			5	
3		WG-161413684-20181108-DS03		13:15	GW	X	X	X			5	
4		WG-161413684-20181108-DS04		13:20	GW	X	X	X			5	
5		WG-161413684-20181108-DS05		13:45	GW	X	X	X			5	
6												
7												
8												
9												
10												

Turnaround Time (TAT) Required
Please provide advance notice for rush projects

Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details

Job Specific Rush TAT (if applies to entire submission)
Date Required ________ Time Required ________ ☐
Rush Confirmation Number ________ (call lab for #)

08-Nov-18 14:50
Augustyna Dobosz
B8T9171
CA2 ENV-961

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
/ Drew Smith	18/11/08	15:00		2018/11/08	16:50	
				2018/11/08	17:59	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
	0 0 0	Present		✓
		Intact		

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

White: Maxxam Yellow: Client

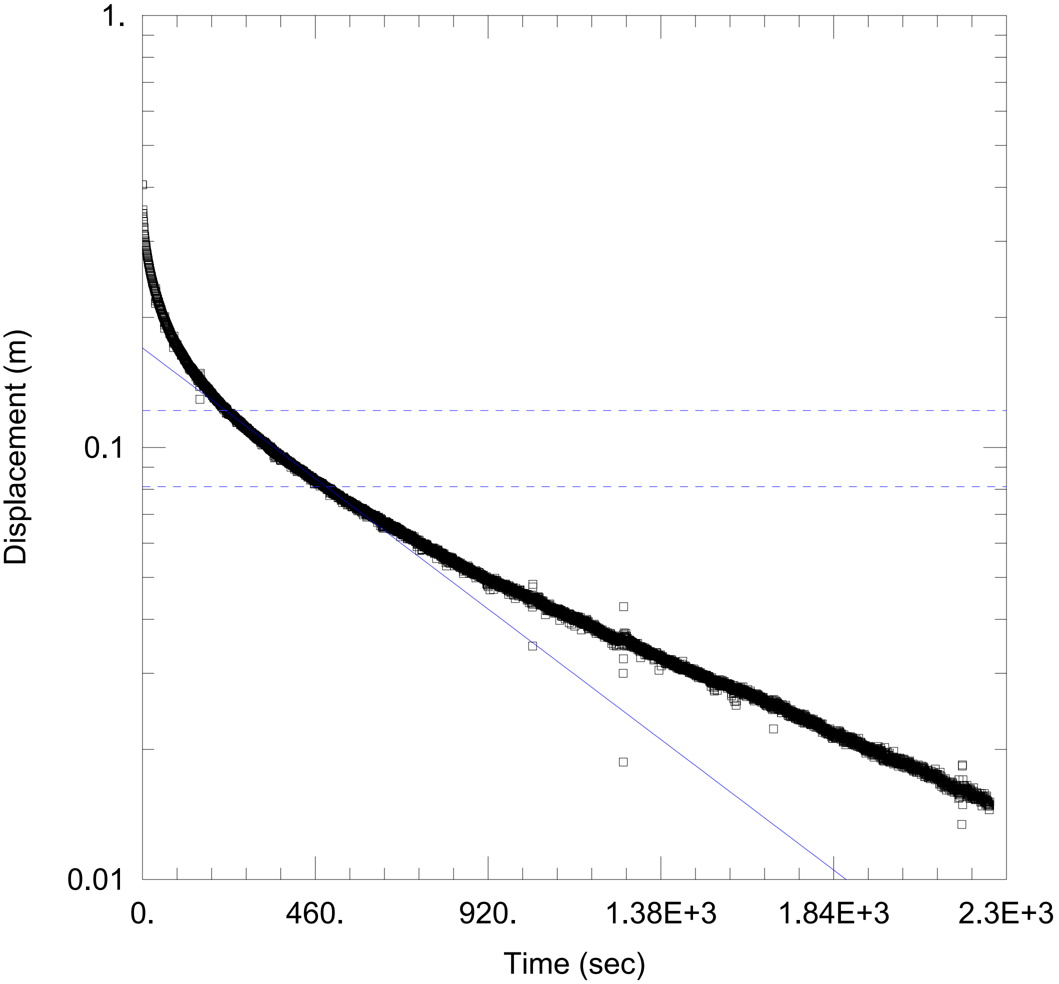
37021

6/3/4 ice

1 c

Maxxam Analytics International Corporation o/a Maxxam Analytics

APPENDIX G:
HYDRAULIC CONDUCTIVITY ANALYTICAL SOLUTIONS



MW2-18

Data Set: \...\161413684_MW2-18_20180803_DS_JK.aqt
Date: 11/21/18
Time: 15:25:14

PROJECT INFORMATION

Company: Stantec
Project: 161413684
Location: Guelph, Ontario
Test Well: MW2-18
Test Date: 2018/07/27

AQUIFER DATA

Saturated Thickness: 2.44 m
Anisotropy Ratio (Kz/Kr): 0.5

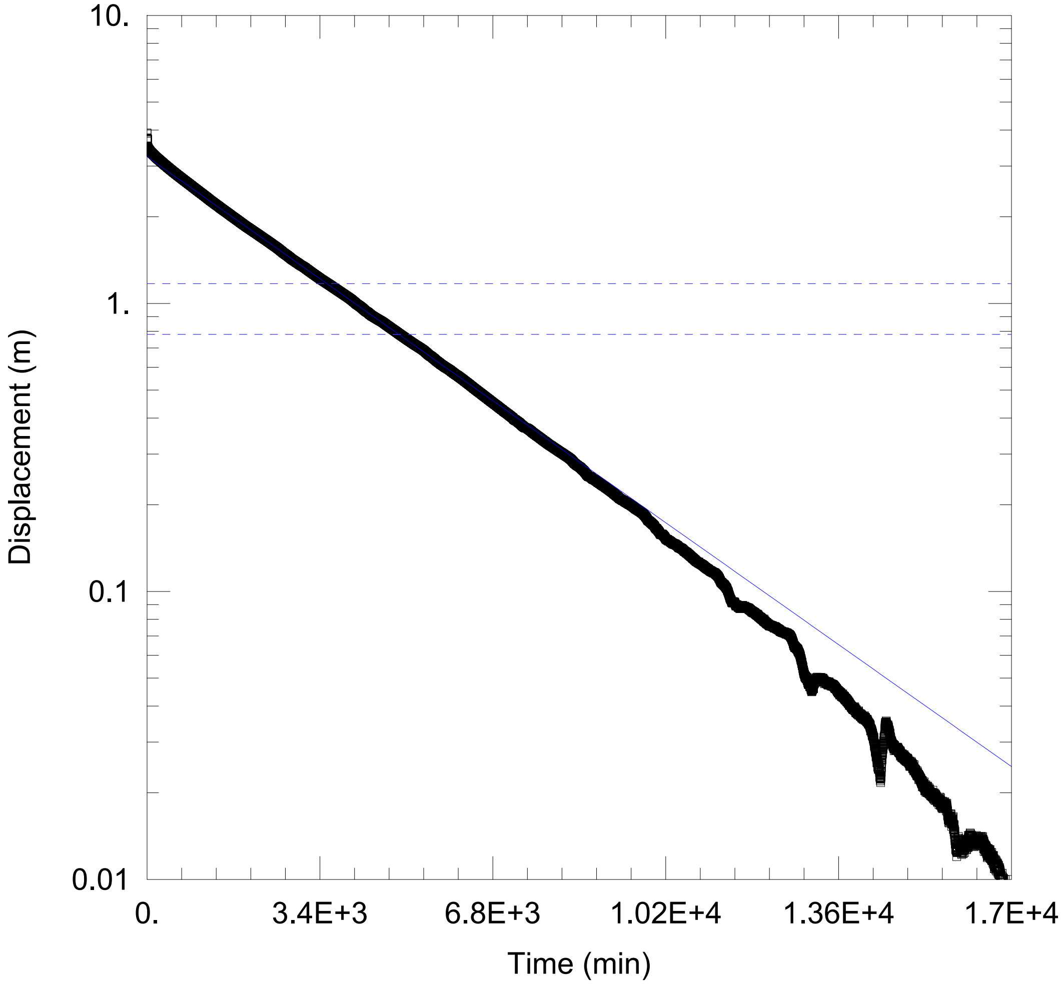
WELL DATA (MW2-18)

Initial Displacement: 0.4056 m
Static Water Column Height: 7.29 m
Total Well Penetration Depth: 2.44 m
Screen Length: 2.44 m
Casing Radius: 0.0254 m
Well Radius: 0.105 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 4.7E-7 m/sec
y0 = 0.1699 m



MW3-18

Data Set: \...\161413684_MW3-18_DS_JK.aqt
Date: 11/21/18 Time: 16:06:39

PROJECT INFORMATION

Company: Stantec
Project: 161413684
Location: Kitchener, ON
Test Well: MW3-18
Test Date: 2018/07/27

AQUIFER DATA

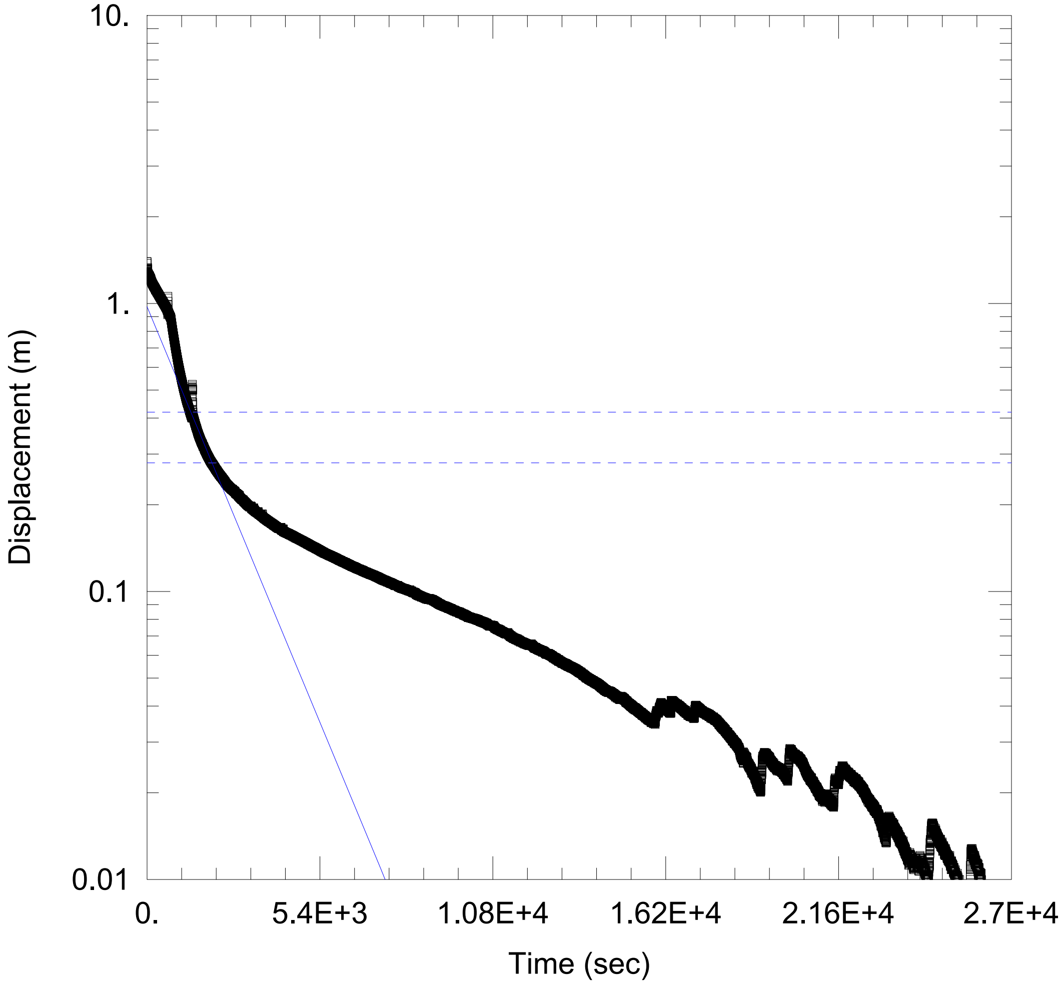
Saturated Thickness: 6.91 m
Anisotropy Ratio (Kz/Kr): 0.3

WELL DATA (MW3-18)

Initial Displacement: 3.902 m
Static Water Column Height: 6.375 m
Total Well Penetration Depth: 6.325 m
Screen Length: 3.05 m
Casing Radius: 0.0254 m
Well Radius: 0.105 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.6E-9 m/sec
y0 = 3.231 m



MW4-18S

Data Set: \...\161413684_MW4-18S_DS_JK.aqt
Date: 11/22/18 Time: 10:00:42

PROJECT INFORMATION

Company: Stantec
Project: 161413684
Location: Kitchener, ON
Test Well: MW4-18S
Test Date: 2018/07/27

AQUIFER DATA

Saturated Thickness: 10.41 m
Anisotropy Ratio (Kz/Kr): 0.3

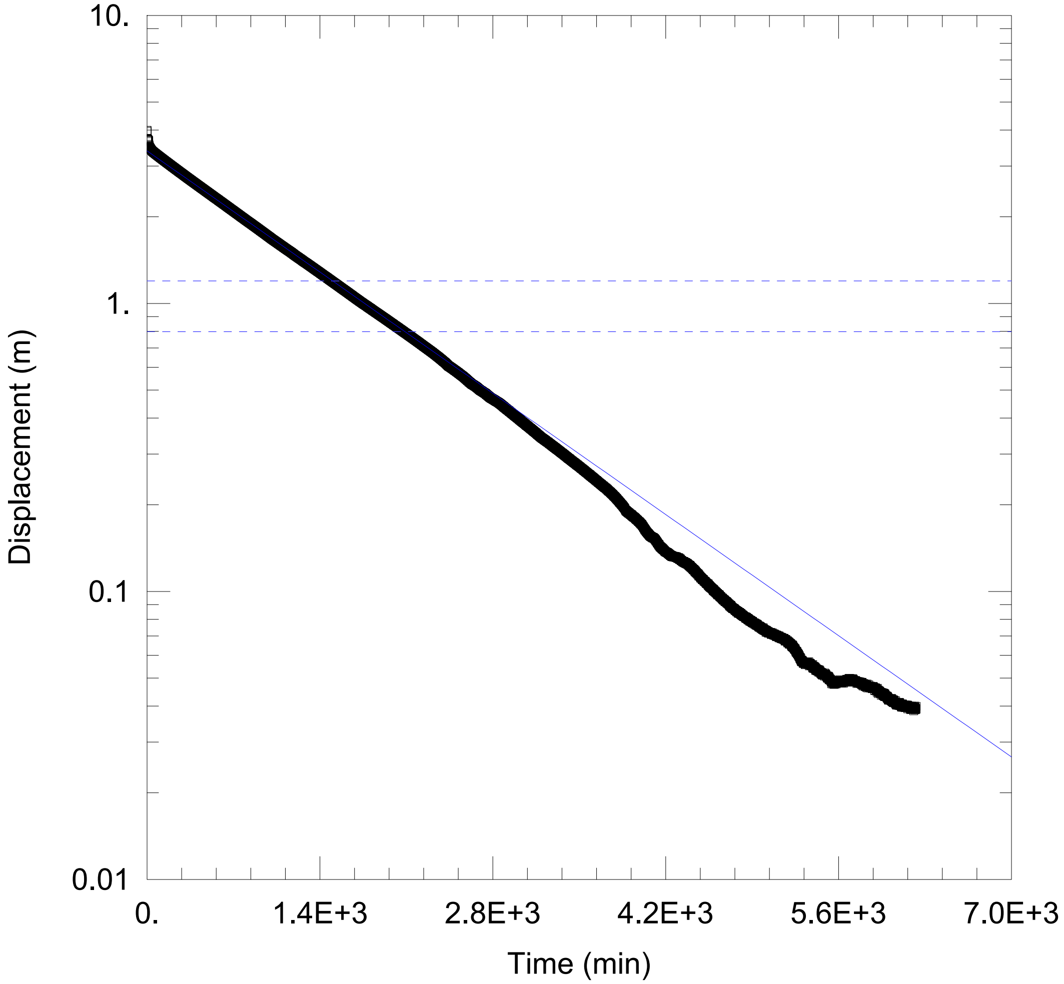
WELL DATA (MW4-18S)

Initial Displacement: 1.398 m
Static Water Column Height: 4.105 m
Total Well Penetration Depth: 4.155 m
Screen Length: 3.05 m
Casing Radius: 0.0254 m
Well Radius: 0.105 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.8E-7 m/sec
y0 = 0.9741 m



MW4-18D

Data Set: \...\161413684_MW4-18D_confined_DS_JK.aqt
Date: 11/22/18 Time: 09:54:50

PROJECT INFORMATION

Company: Stantec
Project: 161413684
Location: Kitchener, ON
Test Well: MW4-18D
Test Date: 2018/07/27

AQUIFER DATA

Saturated Thickness: 3.63 m
Anisotropy Ratio (Kz/Kr): 0.3

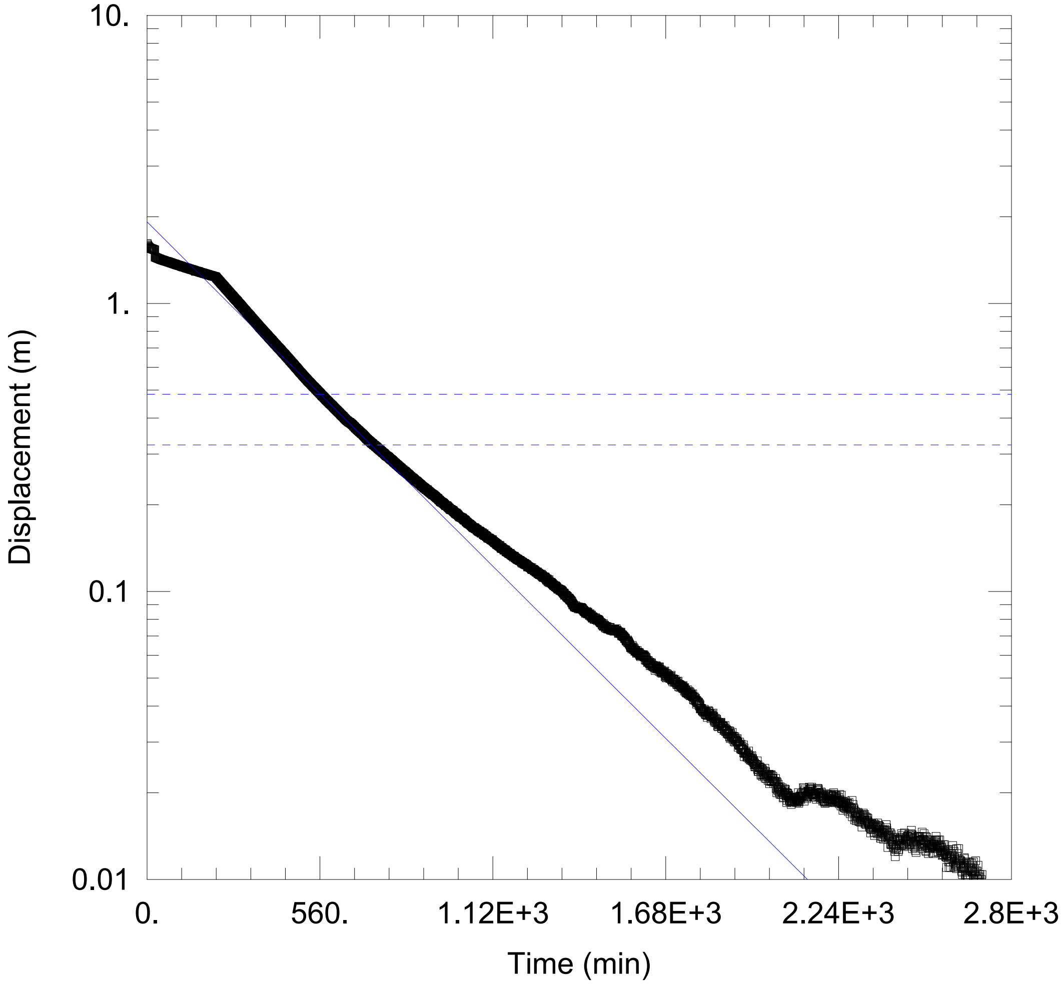
WELL DATA (MW4-18D)

Initial Displacement: 3.99 m
Static Water Column Height: 8.185 m
Total Well Penetration Depth: 3.05 m
Screen Length: 3.05 m
Casing Radius: 0.0254 m
Well Radius: 0.105 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 3.4E-9 m/sec
y0 = 3.387 m



MW5-18S

Data Set: \...\161413684_MW5-18S_DS_JK.aqt
Date: 11/21/18 Time: 16:35:11

PROJECT INFORMATION

Company: Stantec
Project: 161413684
Location: Guelph, ON
Test Well: MW5-18S
Test Date: 2018/07/27

AQUIFER DATA

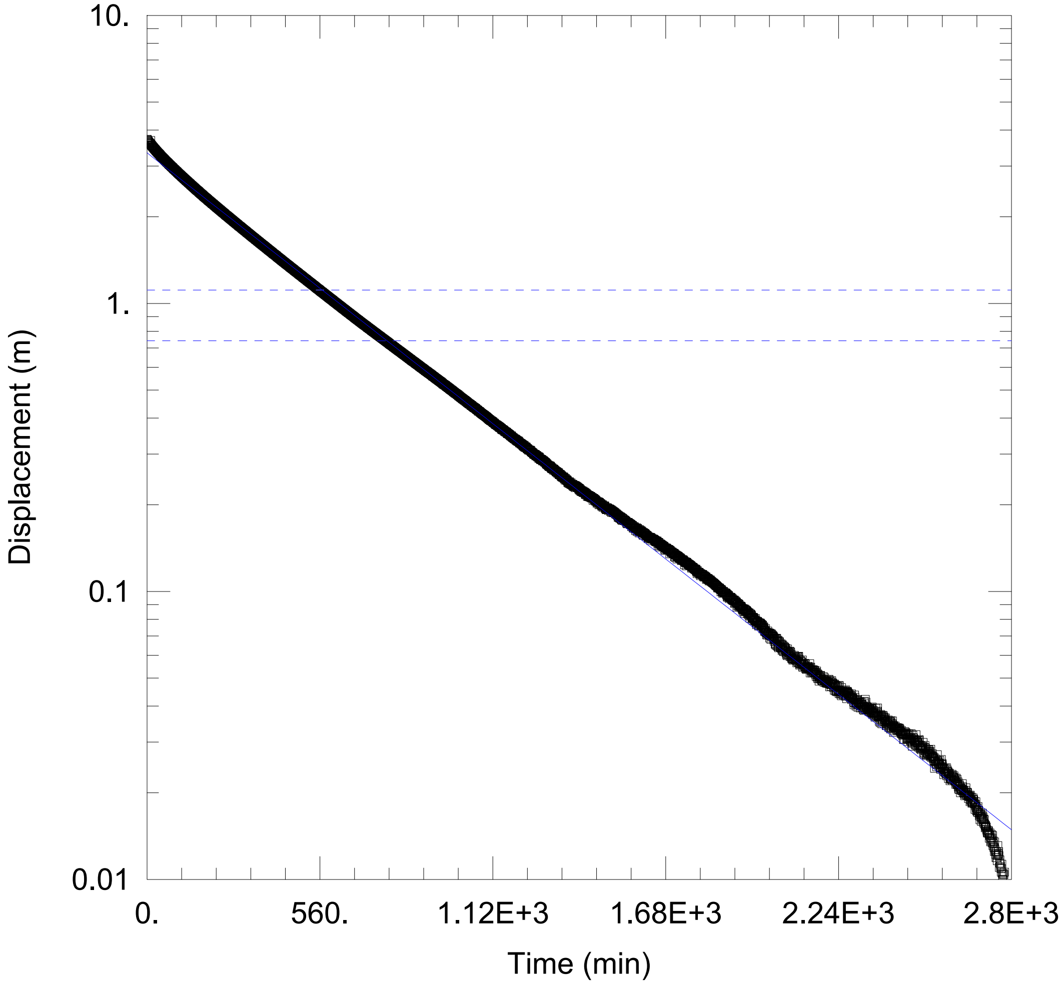
Saturated Thickness: 12.16 m
Anisotropy Ratio (Kz/Kr): 0.3

WELL DATA (MW5-18S)

Initial Displacement: 1.613 m
Static Water Column Height: 4.35 m
Total Well Penetration Depth: 4.35 m
Screen Length: 3.05 m
Casing Radius: 0.0254 m
Well Radius: 0.105 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.2E-8 m/sec
y0 = 1.92 m



MW5-18D

Data Set: \...\161413684_MW5-18D_DS_JK.aqt
Date: 11/21/18 Time: 16:34:37

PROJECT INFORMATION

Company: Stantec
Project: 161413684
Location: Kitchener, ON
Test Well: MW5-18D
Test Date: 2018/07/27

AQUIFER DATA

Saturated Thickness: 9.015 m
Anisotropy Ratio (Kz/Kr): 0.3

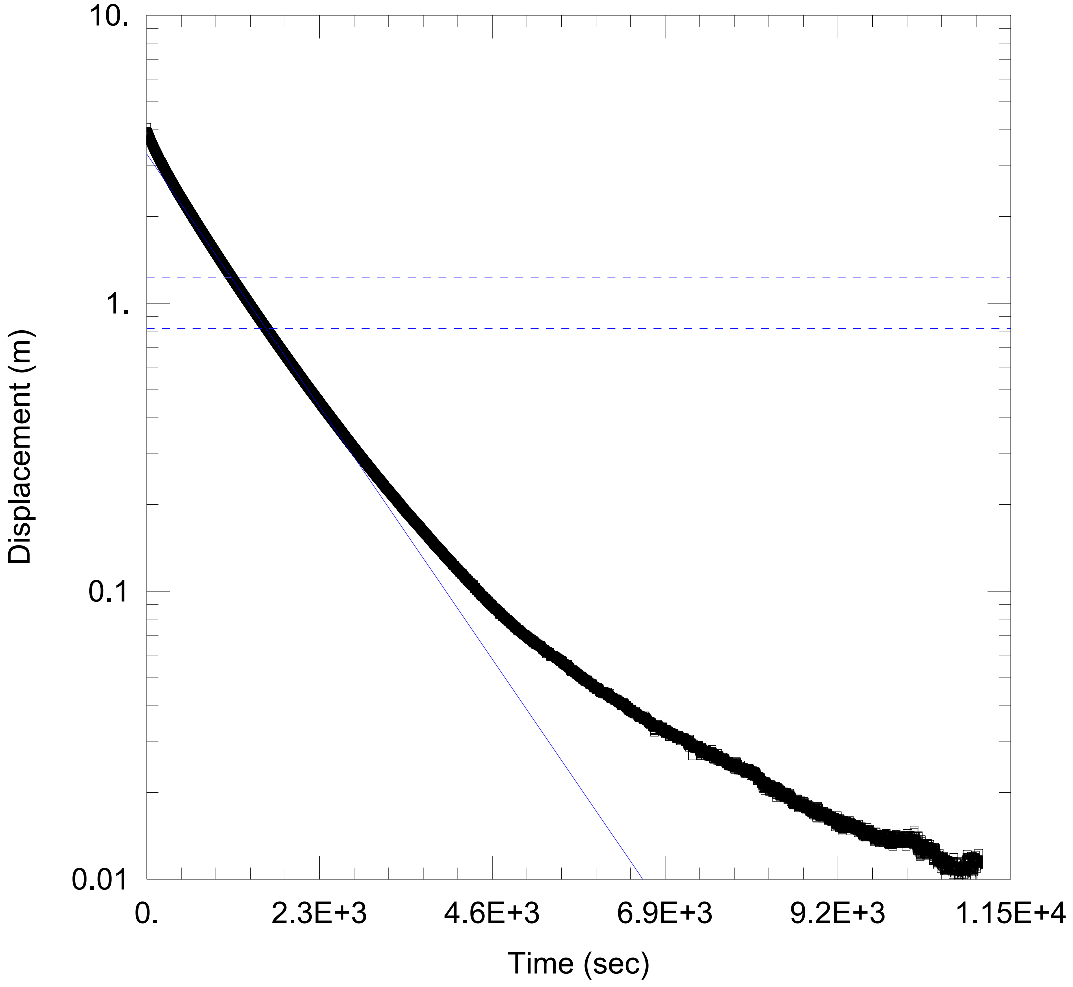
WELL DATA (MW5-18D)

Initial Displacement: 3.711 m
Static Water Column Height: 8.455 m
Total Well Penetration Depth: 8.459 m
Screen Length: 1.524 m
Casing Radius: 0.0254 m
Well Radius: 0.105 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.0E-8 m/sec
y0 = 3.333 m



MW6-18

Data Set: \...\161413684_MW6-18_20180807_DS_JK.aqt
Date: 11/21/18
Time: 16:37:22

PROJECT INFORMATION

Company: Stantec
Project: 161413684
Location: Guelph, Ontario
Test Well: MW6-18
Test Date: 2018/07/26

AQUIFER DATA

Saturated Thickness: 8.545 m
Anisotropy Ratio (Kz/Kr): 0.3

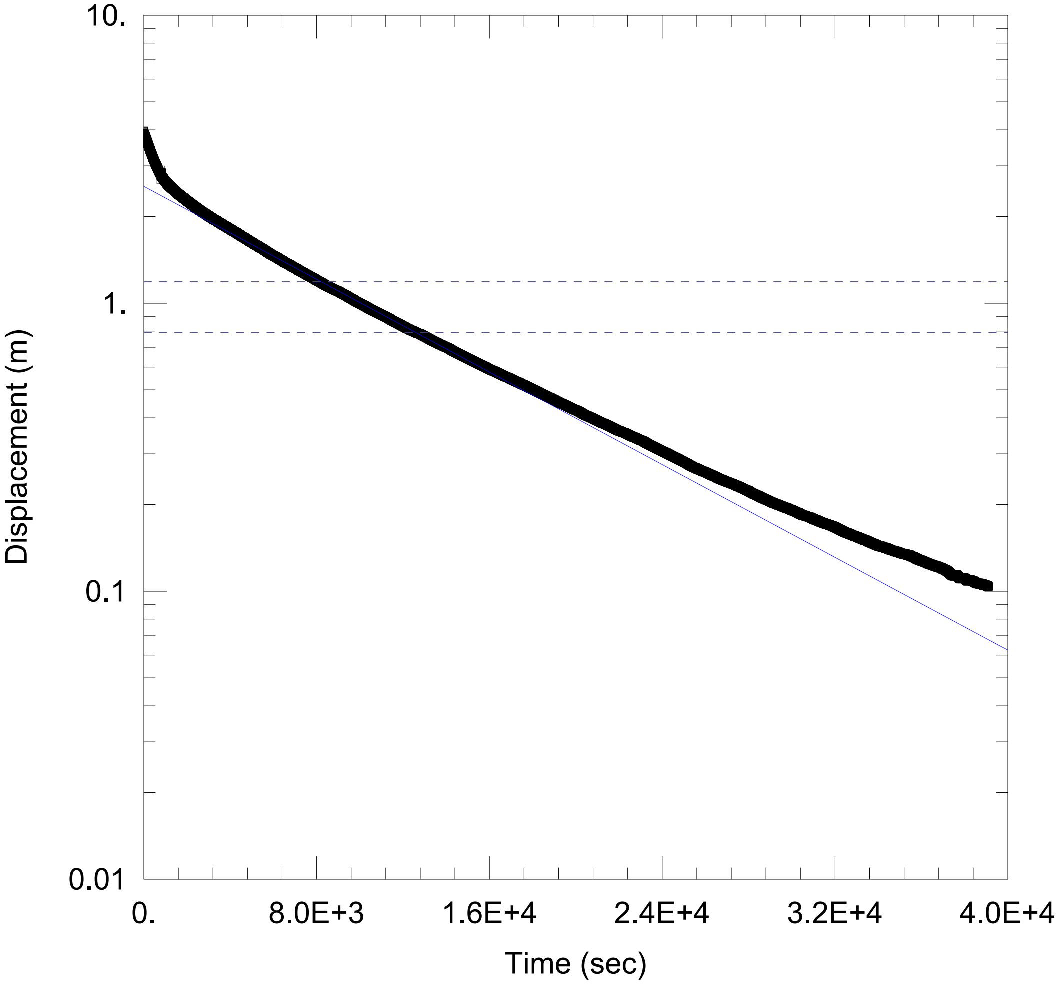
WELL DATA (MW6-18)

Initial Displacement: 4.08 m
Static Water Column Height: 7.94 m
Total Well Penetration Depth: 7.964 m
Screen Length: 1.524 m
Casing Radius: 0.0254 m
Well Radius: 0.105 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 5.4E-7 m/sec
y0 = 3.297 m



MW7-18

Data Set: \...\161413684_MW7-18_20180803_DS_JK.aqt
Date: 11/21/18 Time: 16:42:06

PROJECT INFORMATION

Company: Stantec
Project: 161413684
Location: Guelph, Ontario
Test Well: MW7-18
Test Date: 2018/07/26

AQUIFER DATA

Saturated Thickness: 8.64 m
Anisotropy Ratio (Kz/Kr): 0.3

WELL DATA (MW7-18)

Initial Displacement: 3.961 m
Total Well Penetration Depth: 8.219 m
Casing Radius: 0.0254 m
Static Water Column Height: 8.195 m
Screen Length: 1.524 m
Well Radius: 0.105 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 5.8E-8 m/sec
y0 = 2.545 m

APPENDIX H:
DEWATERING CALCULATIONS

Table H1 - Groundwater Dewatering Calculations

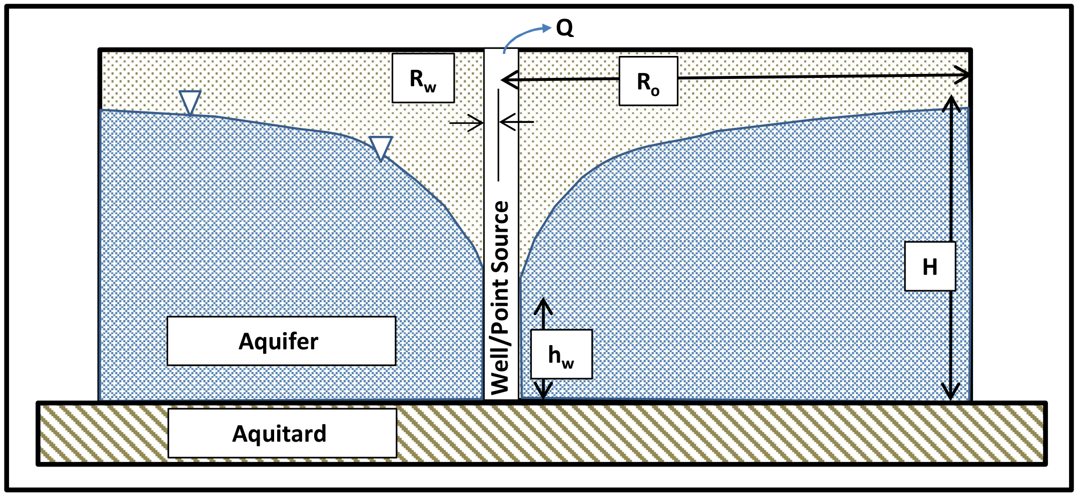
Dupuit Forcheimer Equation for Radial Flow to a Well or Point Source Excavation in an Unconfined Aquifer:

$$Q = \frac{\pi K\left(H^2 - {h_w}^2\right)}{ln\,\frac{R_o}{r_w}}$$

Where:

Q = pumping rate (m^3/s)
K = hydraulic conductivity (m/s)
H = hydraulic head of the original water table (m)
h_w = hydraulic head at maximum dewatering (m)
R_o = radius of influence from centre of the excavation caused by pumping (m)
r_w = equivalent radius of dewatering area / theoretical radius of pumping well (m)

Conceptual Drawdown



The equivalent radius of influence (R_o) is approximated using the Sichart and Kryieleis method:

$$R_o = r_w + 3000(H - h_w)\sqrt{K}$$

The term r_w is calculated as follows:

$$r_w = \sqrt{\frac{area}{\pi}}$$

Where: area = area of excavation (m^2)

Calculations:

K = 3.7E-08 m/s
H = 20.3 m
h_w = 14.7 m
R_o = 63.6 m
r_w = 60.4 m

Q= 0.00043649 m^3/s
37,713 L/day

Saftey Factor = 3.0

Safety Factor Adjusted Volume
113,138 L/day

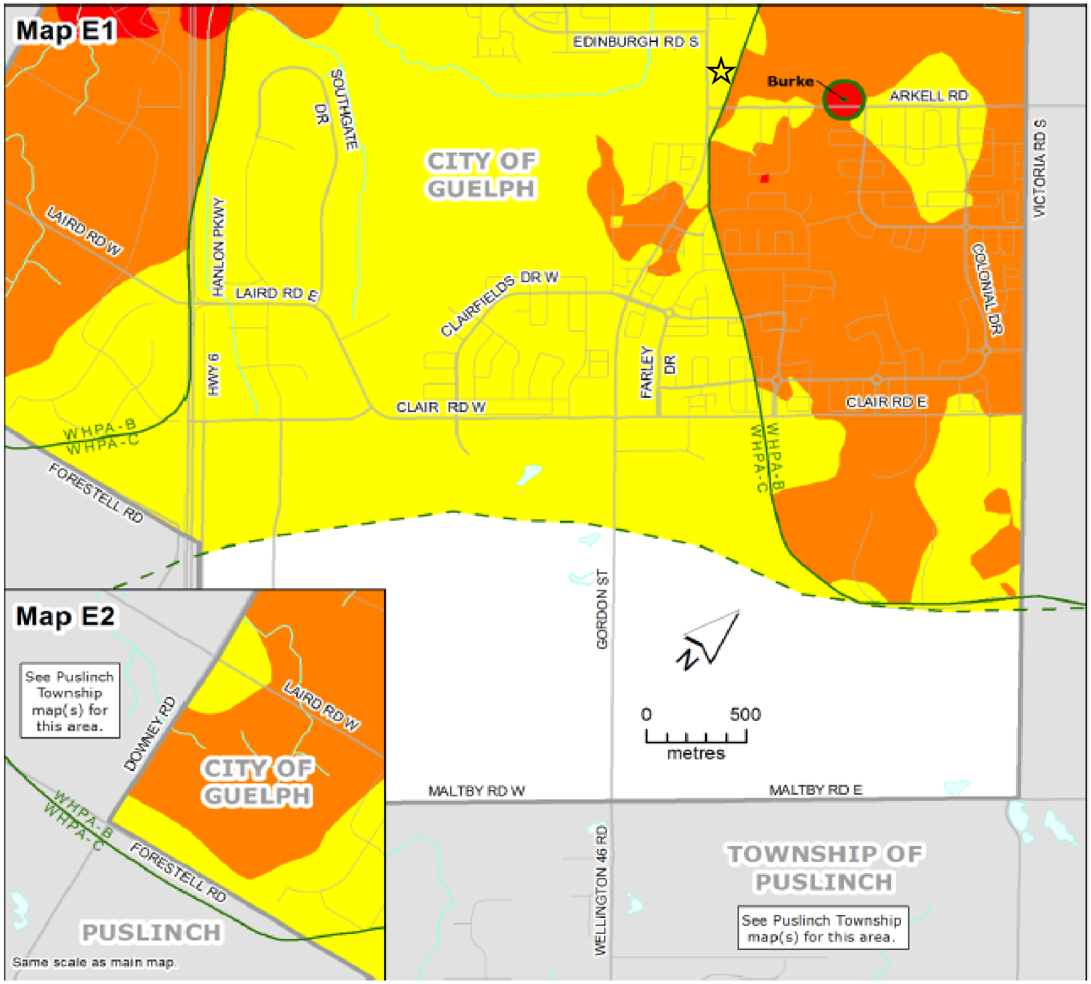
Dewatering radius of influence beyond edge of dewatering area = 3.2 m

Base of Aquifer	320 m AMSL		approximate elevation at which bedrock is encountered beneath the Site
Static Water Level	340.3 m AMSL		highest groundwater elevation measured in onsite monitoring wells
Elevation requiring dewatering	334.7 m AMSL	5.6	meters of groundwater height to be lowered (base elevation of Parking Level 2)

Equations obtained from Powers, J.P., A.B. Corwin, P.C. Schmall, and W.E. Kaeck, 2007. Construction Dewatering and Groundwater Control, New Methods and Applications. John Wiley & Sons, Inc., 3rd Edition.

APPENDIX I:
SOURCE PROTECTION PLAN - THREAT POLICY APPLICABILITY MAPPING

8.12 Schedule F: City of Guelph: Guelph Waterworks Well Supply, Map E



Significant Drinking Water Threat Policy Applicability

Significant Drinking Water Threat Policy Categories		Vulnerability Scores on Map		
		10	8	2,4,6
1.	Waste Disposal	🟥	🟧	
2.	Sewage Systems	🟥	🟧	
3, 4.	Agricultural Source Material	🟥		
6, 7.	Non-Agricultural Source Material*	🟥		
8, 9.	Commercial Fertilizer*	🟥		
10, 11.	Pesticide	🟥		
12, 13.	Road Salt*	🟥		
14.	Storage of Snow	🟥		
15.	Fuel	🟥		
16.	DNAPLs	🟥	🟧	🟨
17.	Organic Solvents	🟥		
18.	Aircraft De-icing	🟥		
21.	Livestock Area	🟥		
Local Threat	Oil Pipelines	🟥		

Note: This table provides a summary of the activities listed in the Clean Water Act (2006) that apply as Prescribed Drinking Water Threats (PDWT) within the Non-GUDI Wellhead Protection Zones shown on this map. For details refer to the text of the Source Protection Plan and the Ministry of the Environment Drinking Water Threats Tables.

*Application of Commercial Fertilizer, Non-Agricultural Source Material, and Road Salt may not be a significant drinking water threat in some areas due to the % managed land, livestock density, and/or % impervious surface calculations for these areas. See the text of the plan for further details.

● Well
Road
Minor River
Lake / Main River
City of Guelph Boundary

Wellhead Protection Zones:
WHPA-A
WHPA-B
WHPA-C
☆ **Site**

1. Updated November 18, 2014
2. Larger scale mapping of some map layers, including roads and vulnerability scores, is available at www.sourcewater.ca.
3. This map is for illustrative purposes only. Information contained hereon is not a substitute for professional review or a site survey and is subject to change without notice. The Grand River Conservation Authority takes no responsibility for, nor guarantees, the accuracy of the information contained on this map. Any interpretations or conclusions drawn from this map are the sole responsibility of the user.

Source: Lake Erie Region Source Protection Committee. 2015b. Grand River Source Protection Area, Approved Source Protection Plan – Volume II. November 26, 2015.

APPENDIX J:
CORRESPONDENCE WITH CITY OF GUELPH

17 October 2018

Sent via email

Melissa Straus, MSc.
Terrestrial Ecologist
Stantec
1-70 Southgate Drive
Guelph ON
N1G 4P5

Dear Melissa,

RE: 1242, 1250 and 1260 Gordon Street and 9 Valley Road EIS TOR

City of Guelph Environmental Planning and Park Planning staff reviewed the proposed Environmental Impact Study (EIS) Terms of Reference (TOR) prepared by Stantec, dated July 19, 2018. Park Planning staff provided comments to Environmental Planning Staff on September 7, 2018. The Grand River Conservation Authority (GRCA) also provided comments on the EIS TOR on October 17, 2018 via email. All comments received to date are integrated below and appended to this letter.

On September 12, 2018 the EIS TOR was brought forward to the Environmental Advisory Committee (EAC) and the TOR was accepted with conditions.

Subwatershed Context:

1. The EIS TOR should indicate that the lands fall partially within the Hanlon Creek Subwatershed and partially within the Torrance Creek Subwatershed. As part of the background review, the Torrance Creek Subwatershed Study and Hanlon Creek Subwatershed Study should be referred to. These subwatershed studies include targets and recommendations that should also be considered in the EIS.
2. The hydrology of the adjacent Provincially Significant Wetland (PSW) should be characterized and an associated water balance for the natural feature should be prepared as part of a Hydrogeological Report to support the EIS, in addition to the water budget that forms part of the Stormwater Management Report. This should include consideration for any groundwater impacts from underground parking, where proposed. Incorporation of Low Impact Development (LID) as part of the stormwater management (SWM) approach is also encouraged to assist with achieving a water balance for the site, and maintaining infiltration and recharge functions.

Hydrological / Hydrogeological Study to support EIS

3. It is not clear where or what type of instrumentation will be used to characterize existing conditions and assess the wetland water balance. In terms of data collection, staff would like to see continuous data loggers installed in piezometers. Also, ensure wetland catchments are delineated and depicted to set the context and that the analysis is provided on a

monthly as well as annual basis. Please interpret the data in terms of the pre-to-post wetland water balance.

4. The Hydrogeological Study should identify groundwater levels to inform the required separation distance for the development from the groundwater table.
5. Consideration should also be given to the protection of groundwater functions, including recharge. Also review and consider any other recommendations or requirements from the Torrance Creek Subwatershed Study within the EIS.
6. Results from the Hydrological Study should be integrated into the EIS to assess the potential for hydrologic impacts to the adjacent wetland.

Preliminary Screening Assessment for Significant Wildlife Habitat:

7. April 2017 guidance from the Ministry of Natural Resources and Forestry (MNRF) Guelph District on survey protocols for identifying suitable maternity roost trees indicate that surveys should be completed during leaf-on condition for Tri-colored Bat (*Perimyotis subflavus*) which roost in dead/dying leaves along a dead branch, and during leaf-off condition for Little Brown Myotis/Northern Myotis (*Myotis lucifugus*/*M. septentrionalis*) which roost in tree hollows and cracks. Field surveys are proposed in May to assess Bat Roost Habitat, and should also be proposed during leaf-off condition. Note that surveys in May should be completed in late May to ensure that leaves have in fact developed.
8. Note that where surveys for SWH are not proposed, staff expect a conservative approach to be taken in the EIS which acknowledges candidate SWH and identifies constraints based on the precautionary principle.
9. The EIS TOR indicates that candidate SWH is present for Reptile Hibernaculum. Clarification is needed as to what field surveys for wildlife habitat assessment entail. It is unclear whether or not snake exit surveys and/or snake surveys are proposed.
10. Candidate SWH is also identified for Woodland Raptor Nesting Habitat. Clarification is needed as to whether or woodland raptor nesting surveys are proposed as part of surveys for wildlife habitat.
11. Note that deer movement occurs along the edge of the PSW (as observed through other EISs) as well as across Gordon Street (as indicated in the Natural Heritage Strategy). Table 1 should be updated to reflect this information.

EIS Field Surveys:

12. Location of field surveys, such as breeding bird point count locations and amphibian monitoring stations should be provided on a study area map.
13. MNRF has identified the Torrance Creek PSW as a deer winter congregation area. The habitat should be characterized and impacts assessed through the EIS. In addition, staff request that movement of deer be studied on the subject lands using wildlife cameras to assess movement in the east-west and north-south direction.
14. Clarification on the timing (e.g. spring emergence, first/second breeding bird window), conditions and search effort proposed for wildlife surveys, species of special concern and rare species searches is necessary.
15. Vegetation community mapping should also indicate woodland staking with City staff as a requirement.

16. Spring botanical inventories should ideally be completed in early May. Waiting until June will miss early spring ephemerals, which will have senesced by June.
17. Vegetation community descriptions should include description of soils, per the Ecological Land Classification (ELC) protocol.
18. Table 1 indicates that incidental observations of terrestrial crayfish will be recorded. Clarify where searches for terrestrial crayfish will be performed (i.e. target habitats).
19. Regarding Species of Conservation Concern/Locally Rare Species, it should be noted that City records show that American Bullfrog (*Lithobates catesbeianus*) and Meadow Horsetail (*Equisetum pretense*) have been recently documented in the Torrance Creek Subwatershed.
20. Section 4.2.1.2 Vascular Plants should be revised to indicate that a three-season botanical inventory will be completed.
21. Note that formal wetland boundary and woodland boundary delineation with agencies is required.
22. With respect to area sensitive breeding bird habitat, based on results from multiple EISs completed in this area of the City, it has been confirmed that the Torrance Creek PSW is SWH for area-sensitive breeding bird habitat. The proposed studies should assess the use of habitat edges and areas in relation to the site in order to assess potential impacts.

Tree Inventory and Preservation Plan:

23. The subject lands are regulated under the City's Private Tree By-law and any tree removals will require authorization from the City. The EIS should inform the development application and should look for opportunities to retain trees and integrate them into the development proposal, where feasible. A Tree Inventory and Preservation Plan (TIPP), undertaken by a qualified arborist, is required and should be integrated into the EIS. The TIPP should include the following:
    - Tree inventory information for all trees 10cm Diameter at Breast Height (DBH) or greater proposed to be removed/retained including: Tree # corresponding to plan/drawing, species name, DBH, crown diameter, condition (vigour), remarks, recommended action and rationale.
    - Identify shared, public and private trees with crowns that are within 6m of property lines.
    - Identify opportunities for protection, enhancement and restoration of trees within the Urban Forest.
    - Tree Protection Fencing locations and/or other tree protection/mitigation measures.
24. The TIPP should also note that where preservation is not possible, as agreed to by the City, compensation is required. Note that the City seeks compensation at a 3:1 replacement ratio. Where replacement plantings are not achievable cash-in-lieu may be accepted at a rate of $500 for each damaged or destroyed tree.

EIS Data Analysis

25. The EIS TOR should indicate that where candidate or confirmed SWH exists, staff would like to see it mapped in the EIS.

26. The City of Guelph Local Species List should be consulted when doing the impact analysis and the species lists should include a column to indicate any locally significant species.
27. Deer movement patterns that occur on the subject lands should be mapped in the EIS, and all data collected from wildlife cameras and field studies should be provided.

Impact Analysis:

28. A buffer analysis should be included within the impacts assessment/avoidance discussion. While the City's OP does include policies for minimum buffers, the establishment of larger buffers warrants consideration in the EIS and is also reflected in the City's OP policies.
29. The proposed development concept needs to consider the trail connection across the site. The EIS should explore alternatives for a trail alignment and assess impacts associated with each alignment. Staff should be consulted for further direction on this item.
30. The setbacks and buffers assigned to the development should factor in the community trail that will be built, even though the trail will ultimately be completed by the City.
31. Opportunities for protection, enhancement and restoration of trees within the Urban Forest should also be identified.
32. The impact analysis should mention potential impacts and/or mitigation measures to address salt application.
33. It is acknowledged that the EIS will include a more defined concept of the proposed development plan in order to assess potential impacts resulting from grading, roads, SWM, etc.

Recommended Mitigation Measures:

34. The EIS should also recommend mitigation measures including environmental education and outreach opportunities, demarcation and any recommendations for monitoring plans.
35. The monitoring plan should include post-construction monitoring of SWM design, LID measures and mitigation.
36. An Environmental Implementation Report (EIR) will be required for this development. Environmental Planning staff have found it helpful to document considerations for the EIR in the EIS.

Park Planning Comments (see attached Memo):

37. Provide a revised development concept plan indicating all the proposed elements including public park, east-west and north-south public trail, Active Transportation Network (ATN) and open space in consultation with City staff.
38. Park planning staff would like to walk the site along with the environmental consultant and environmental planning staff to identify and approve a preliminary trail alignment. The approved trail alignment will be flagged on site. Identify the final trail alignment west of Torrance Creek PSW, through EIS and flag the trail route on site for City's review.
39. Trail design including surfacing, clear width and height, grading and drainage, trail signage, etc. should be provided in consultation with Park Planning staff. The design and development of the trail system should be completed in accordance with the city's Facility Accessibility Design

Manual, the city’s current trail design and development practice and standards, and ATN standards.

40. Assess the environmental impact of the proposed trail development in the EIS.
41. Recommend measures to mitigate the environmental impact due to the proposed trail development in the EIS.
42. Recommend management of the woodland along the trail route including removal of invasive species and hazard trees in the EIS.
43. Recommend preparation of an EIR, Trail and Landscape Drawings through EIS to detail design an appropriate trail system and associated mitigation measures in accordance with the city’s design and development standards.
44. Provide preliminary grading and drainage plans to demonstrate that the design of the park block, trail connection and open space meets city standards.
45. The owner will be responsible for implementation of city approved landscape plans in accordance with the EIR including, but not limited to restoration, compensation and enhancement planting within the open space.
46. Describe the recommended approach to demarcate existing and proposed public park and open spaces, if any, within and adjacent to the subject property.
47. Recommend provision of public education through educational/interpretive signage at the entry points to the trail and open space system. Public education should address the environmental sensitivity of natural heritage features and procedures residents can follow to protect and/or enhance these areas.
48. City will review and approve the design and locations of interpretive and educational signage, to be included on landscape plans.

Environmental Advisory Committee:
On September 12, 2018 the EIS TOR was brought forward to EAC and resulted in the following draft motion. Note that motions remain draft until such time that EAC formally adopts the minutes.

Staff recommends that the Environmental Advisory Committee accept the Terms of Reference for an Environmental Impact Study prepared by Stantec (July 19, 2018) with the following condition:
THAT a revised EIS TOR is provided which addresses staff comments and at a minimum includes:

- A study area map showing survey locations;
- A Tree Inventory and Preservation Plan;
- Clarification on surveys proposed for assessing significant wildlife habitat;
- Deer movement surveys using wildlife cameras;
- Commitment to utilize continuous data loggers to collect data to support a wetland water balance and a monthly analysis;
- Recommended mitigation measures for salt management; and
- Considerations for a future Environmental Implementation Report.
- A hydrogeological report that includes the following:
  - Infiltration testing using a Guelph Permeameter (or equivalent method) to support SWM planning;

- Hydrographs that include high water table data including the spring freshet and other storm and melt events. Groundwater data should be collected for a minimum of 1 year, with comparison to local precipitation data;
- It is also recommended that groundwater data be collected from the wetland area (pending access).

Do not hesitate to contact me further should you have any questions.

Regards,

leah lefler

Leah Lefler, MES
Environmental Planner

Planning, Urban Design and Building Services
Infrastructure, Development and Enterprise
City of Guelph: 1 Carden Street, Guelph

T 519-822-1260 x2362
F 519-822-4632
E leah.lefler@guelph.ca

cc Chris DeVriendt – Manager, Development Planning
Melissa Aldundate – Manager, Planning Policy and Urban Design
Mary Angelo – Supervisor, Development Engineering
Jyoti Pathak – Park Planner

INTERNAL MEMO

DATE	September 7, 2018
TO	**Leah Lefler**
FROM	Jyoti Pathak
DIVISION	Parks and Recreation
DEPARTMENT	Public Services
SUBJECT	**1242, 1250 and 1260 Gordon Street and 9 Valley Road – Proposed Terms of Reference for Environmental Impact Study –(File # TBD)**

Parks Planning and Development has reviewed the draft Terms of Reference (TOR) prepared by Stantec dated July 19, 2018 for an Environmental Impact Study (EIS) to be compiled in support of a draft plan of subdivision and Zoning By-Law and Official Plan Amendments for the proposed high density residential subdivision development on the subject property.

Location: The subject property is located on the east side of Gordon Street immediately south of Valley Road.

Development Proposal: The future development proposal will include a public street, public park, public trail/ ATN route, natural open space, residential apartments and townhouses. A pre-consultation meeting between the applicant and City staff was scheduled on Wednesday June 13, 2018 and a concept plan has been developed by the applicant. The site area is 3.67 hectares inclusive of natural heritage features and a developable area.

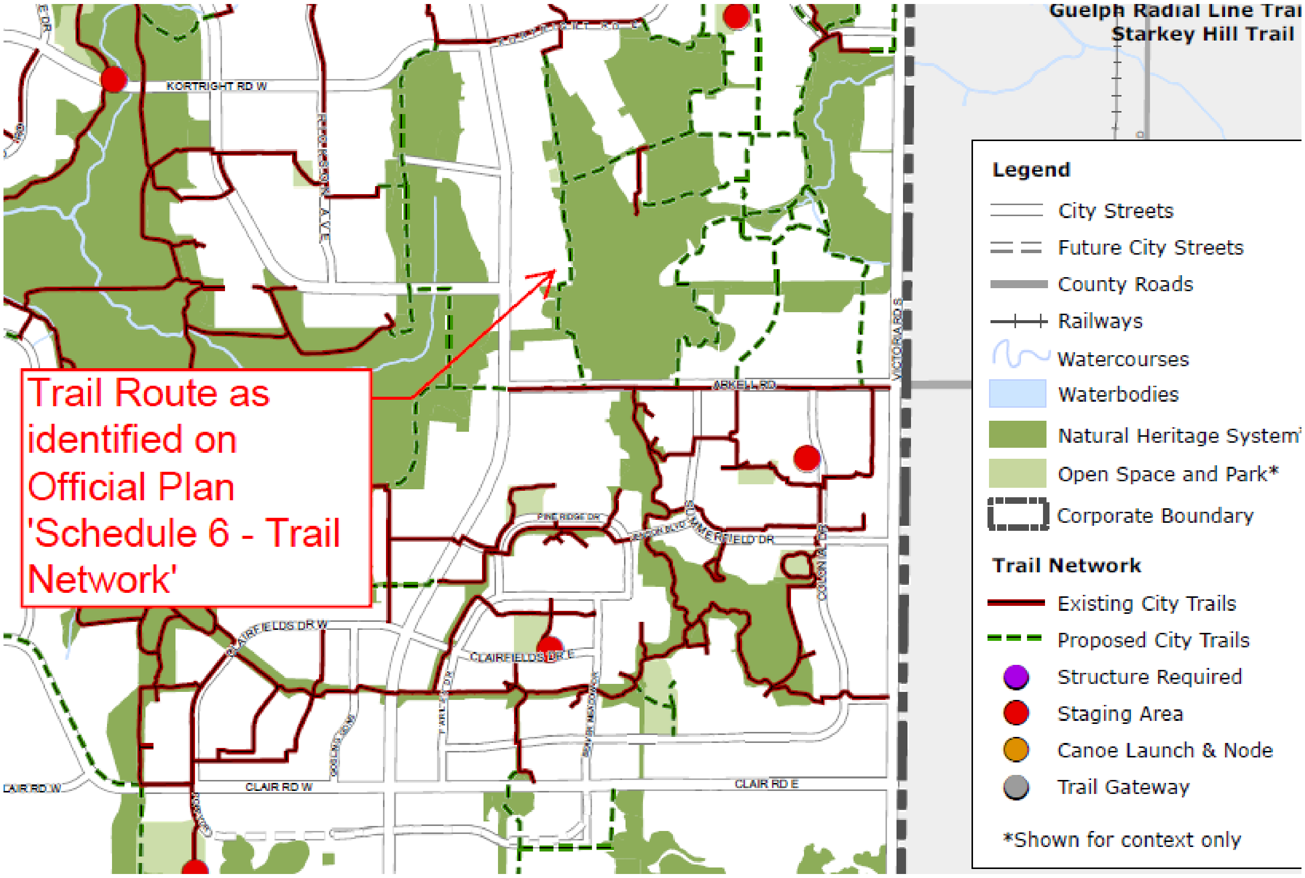
Background:

Parkland Dedication:
In accordance with the City's Official Plan Policy 7.3.5.1 (ii) parkland dedication is required for the proposed residential subdivision development. Park block frontage, size and configuration of the park will be determined in accordance with the neighbourhood park design criteria outlined in City's official Plan and Zoning By-Law. Park block would be located within developable area of the site and outside of the existing natural heritage system.

Guelph Trail Network:
Official Plan 'Schedule 6 - Trail Network' identifies a proposed north-south multi-use trail route from Brady Lane (south of Kortright Road East) to Arkell Road along the west side of Torrance Creek PSW Complex. The proposed multi-use trail would be used for walking, cycling, personal mobility devices etc.

Multi-Use Trail System/ Active Transportation Route (AT Route) (north-south) from Arkell Road to Brady Lane west of the Torrance Creek provincially significant wetlands (PSW):
The trail system from Arkell Road to Brady Lane aligns with the active transportation route and serves both recreational and transportation purposes. This route is being detailed designed in segments through review of the past and current development applications. The trail route immediately north of the subject property was identified through site plan approval process of the existing Valley Road extension condominium and the trail property immediately south of the subject property has been secured through development approval process on 1280 and 1284 Gordon Street.

Multi-Use Trail/AT Route (east-west) from Gordon Street to the proposed Trail west of Torrance Creek PSW: Provide a direct, accessible, multi-use active transportation route from the Gordon Street to the proposed Multi Use Trail system.



Trail Route as identified on Official Plan 'Schedule 6 - Trail Network'

Active Transportation Route in yellow highlight

Parks Planning and Development offer the following comments:

1. **Development concept plan:**
   - Provide a revised development concept plan indicating all the proposed elements including public park, east-west and north-south public trail/ ATN route from Gordon Street to the and open space in consultation with City staff.

2. **Trail route alignment:**
   - Park planning staff would like to walk the site along with the environmental consultant and environmental planning staff to identify and approve preliminary trail alignment. The approved trail alignment will be flagged on site. Identify the final trail alignment west of Torrance Creek PSW, through EIS and flag the trail route on site for City's review.

3. **Trail design and development standards:**
   - Trail design including surfacing, clear width and height, grading and drainage, trail signage etc. would be finalized in consultation with Park Planning staff. The design and development of the trail system would be completed in accordance with City's Facility Accessibility Design Manual, City's current trail design and development practice and standards and Active Transpiration standards.

4. **Environmental impacts and mitigation:**
    - Assess the environmental impact of the proposed trail development through EIS.
    - Recommend measures to mitigate the environmental impact due to the proposed trail development through the EIS.
    - Recommend management of the woodlot along the trail route including removal of invasive species and hazard trees through the EIS.
    - Recommend preparation of an Environmental Implementation Report (EIR), Trail and Landscape Drawings through EIS to detail design an appropriate trail system and associated mitigation measures in accordance with the City's design and development standards.
5. **Grading and drainage:**
    - Provide preliminary grading and drainage plans to demonstrate that the design of the park block, trail connection and open space meets City's standards.
6. **Open space restoration and enhancement:**
    - The owner will be responsible for implementation of City approved landscape plans in accordance with the EIR including, but not limited to, restoration, compensation and enhancement planting within the open space.
7. **Demarcation of public open space:**
    - Describe the recommended approach to demarcate existing and proposed public park and open spaces, if any, within and adjacent to the subject property.
8. **Public education:**
    - Recommend provision of public education through educational/ interpretive signage at the entry points to the trail and open space system. Public education should address the environmental sensitivity of natural Heritage features and procedures residents can follow to protect and/or enhance these areas.
    - City will review and approve the design and locations of interpretive and educational signage, to be included on landscape plans.

Summary:
Revise the Terms of Reference for scoped EIS, to address Parks comments above, for our further review.

Please contact me if you have any questions.

Sincerely,

Jyoti Pathak,
Parks Planner

Parks and Recreation
Public Services
Location: City Hall
T 519-822-1260 x 2431
E Jyoti.pathak@guelph.ca

From:	Fred Natolochny <fnatolochny@grandriver.ca>
Sent:	Wednesday, October 17, 2018 10:11 AM
To:	Leah Lefler
Subject:	FW: 1242, 1250, 1260 Gordon St. 9 Valley Rd. Guelph

From our ecologist. Can you also send me the original message again – I appear to have mis-filed it. Sorry

---

From: Robert Messier
Sent: October 16, 2018 9:06 AM
To: Fred Natolochny
Subject: 1242, 1250, 1260 Gordon St. 9 Valley Rd. Guelph

I have reviewed the ToR EIS for the redevelopment of 1242, 1250, 1260 Gordon St. and 9 Valley Rd. in Guelph. As part of the background review they should also look at the Torrence Creek Subwatershed study and the Hanlon Creek subwatershed study. For the monitoring plan they should include a post construction monitoring of SWM design and mitigation. The setbacks and buffers assigned to the development should factor in the community trail that will be built even though the trail will ultimately be completed by the City. If you have any questions please let me know

Robert Messier
Ecologist
Grand River Conservation Authority
400 Clyde Road
Cambridge, Ontario N1R 5W6
(519) 621-2763 x2310
www.grandriver.ca

INTERNAL MEMO

DATE October 2, 2020 File No. 16.152.369

TO **Lindsay Sulatycki**

FROM Mohsin Talpur
DIVISION Engineering Services
DEPARTMENT Infrastructure, Development and Enterprise Services

SUBJECT **1242-1260 Gordon Street and 9 Valley Road – Draft Plan of Subdivision, Official Plan Amendment and Zoning By-law Amendment.**

We have reviewed the following plans and reports that were submitted in support of the 1242-1260 Gordon Street and 9 Valley Road Draft Plan of Subdivision, Official Plan Amendment and Zoning By-law Amendment:

a) *Report, Re, Functional Servicing Report for Gordon Street, Guelph ON; dated April 13, 2020; prepared by Stantec;*
b) *b) Report, Re, Geotechnical Investigation, Two 12-story Apartment Buildings 1242, 1250, 1260 Gordon Street, Guelph Ontario; dated April 25, 2018; prepared by CMT Engineering Inc.;*
c) *Report, Re, Hydrogeological Assessment, 1242, 1250, 1260 Gordon Street, City of Guelph ON; dated May 4, 2020; prepared by Stantec;*
d) *Report, Re, Noise Impact Study, 1250 Gordon Street, Guelph ON; dated February 20, 2020; prepared by J.E. Coulter Associates Limited;*
e) *Engineering Plans; dated April 15, 2020; prepared by Stantec;*
f) *Report, Re, 1242, 1250, 1260 Gordon Street and 9 Valley Road, Traffic Impact Study; dated May 21, 2020; prepared by Stantec.; and*
g) *Report, Re, 1242, 1250, 1260 Gordon Street and 9 Valley Road, Guelph, ON-Environmental Impact Sturdy; dated May 22, 2020; prepared by Stantec.*

And offer the following comments:

Functional Servicing Report

1. The disclaimer statement does not include City of Guelph to rely on the report. Please include City in the disclaimer statement or remove it.

2. Please provide a copy of Phase One ESA and/or Phase Two ESA reports for our review prior to zone change.

3. Sufficient and adequate capacity is available of the City's existing water supply and distribution system to accommodate the proposed development

and there are no water capacity constraints expected for most demand scenarios. However, there is potential for marginal water supply pressures in proposed development under certain conditions such as peak hour demand scenario at locations with elevation greater than 346 m height above mean sea level (AMSL) and average day demand scenario at locations with elevation greater than 339 m height AMSL in the existing water system.

4. In Section 3, email correspondence from City regarding sanitary servicing capacity was discussed, but there are no email attachments found in the report as mentioned. Please include the correspondence is the FSR.

5. No capacity is available in the City's Gordon St. existing downstream sanitary sewer to accommodate discharge of sanitary flows from the proposed development. However, City is in process of studying the upgradation of the sanitary service capacity within Gordon Street. Therefore, a 'H' (holding) symbol will be placed on the property until such time a new sewer is installed.

6. The gradient of Street A, an extension of Landsdown Drive and Edinburgh appears to be over 6% that is not desirable in the approach of an intersection. Please refer TAC section 9.7.3 and lower the gradient.

7. The typical cross-section and label for centreline radius (minimum 18m) are missing. Please provide the details for review.

8. The pavement width should be 8.4 m as per Development Engineering manual. Provide sidewalks on both sides of proposed Street A.

9. Provide traffic geometrics plan showing large moving trucks to/from the site.

10. The proposed Street A ROW appears to be excluded from the pre-development and post-development stormwater management plan. The drainage area (i.e. 0.29 ha) of the Street A is discharging stormwater to Gordon Street uncontrolled without any quality control measures. Please include the area of Street A and demonstrate the quality and quantity control requirements are met and provide details for review.

11. Based on the topographic plan, there are external areas draining to the proposed development site from adjacent lots on Valley Road and the backyards of Gordon Street lots. Please delineate the external drainage areas discharging to the proposed development and update the drainage plans by accounting for external drainage under pre- and post-development stormwater management plan.

12. In section 5, the stormwater management strategy is discussed. The first document referred is Hanlon Creek Watershed Plan (HCWSP) that states all

stormwater generated from the area including 100-year storm must either infiltrate into the ground or evaporate (i.e. zero runoff). Another document referred is Torrance Creek Subwatershed Study (TCSS) that states that for the zone 2, detain the post-development flow to pre-development rates for the 2-year to 100-year storm events and to infiltrate minimum 150 mm/year. The Report indicates that the TCSS criteria is decided to be applicable for the site. However, it appears that, except for the woodlot area (draining uncontrolled east to the TCSS), the proposed stormwater is diverted to the Gordon street (Hanlon Creek Subwatershed area), which is contradicting the selection criteria. Please demonstrate the equitable share of surface water contribution to TCSS is maintained under post development conditions.

13. Based on information provided in figure 1, the existing stormwater is divided between two Subwatershed areas, major portion of the area (1.73 ha) discharges to TCSS and remaining area (1.13 ha) discharge to Gordon Street (HCWSP). The groundwater flow follows a similar divide to the surface water flow, with a portion flowing east as part of the Torrance Creek Subwatershed another portion flowing west as part of the Hanlon Creek Subwatershed. However, under proposed conditions, the infiltration gallery is proposed at TCSS portion and we have concerns that that may reduce recharge targets for Hanlon Creek Subwatershed area. Please demonstrate equitable share of recharge is maintained for each Subwatershed under post development adopting distributed infiltration approach.

14. It is mentioned that the development will also increase the impervious area and will produce increase in stormwater flows to the downstream Gordon Street storm sewer. The Gordon storm sewer (525 mm diameter storm sewer) is discharging to the existing downstream SWM facility (at 1291 Gordon Street), which is already at capacity. The additional flow from the development including uncontrolled flow from Street A could cause surcharging in the existing storm sewers and negative impacts downstream such as, erosion etc. Therefore, it is suggested to explore the option of discharging additional stormwater to the TCSS area.

15. Rooftop controls (i.e. 16 cm of ponding) are proposed for both buildings for the attenuation of stormwater discharging to the infiltration trench through downspout system with 75mm diameter orifice. The overflow arrangements of infiltration trench are directing water to the underground storage tank for out-letting to Gordon Street. The rooftop water is considered as clean; therefore, it is recommended to direct the overflow towards Provincially Significant Wetland (PSW) part of Torrance Creek Subwatershed.

16. It appears that an underground storage tank (located in the underground parking structure) is proposed to attenuate runoff generated form parking area and laneway; in addition, the underground storage is proposed for

attenuation of active storage required for rooftop runoff at 100-year event. The underground storage tank is not a desirable option for the City. Please explore surface water storage for the water quantity control.

17. The proposed infiltration gallery invert is set at 339.00 m and the invert of perforated pipe at inlet appears to be at 339.96 m. Based on the nearest monitoring well (MW5-18 (S)) data provided in the hydrological assessment report shows that the seasonal high groundwater level is approximately 340.7 m. Thus, all rooftop runoff could bypass the gallery and discharge to proposed underground storage via proposed overflow arrangements. Please revise the infiltration gallery design and ensure bottom of infiltration gallery is set minimum 1m higher than the seasonal high groundwater elevation and size appropriately to meet recharge targets.

18. It appears that the propose cover for the infiltration gallery is less than 0.5 m that does not meet frost protection requirement of minimum 1.2 m. Please ensure the minimum 1.2 m cover for the frost protection. Please refer Section 5.7.8 of DEM for further details

19. There is no discussion of on-site permeameter testing conducted at the location of proposed infiltration gallery. Please conduct in-situ permeameter testing using Guelph Permeameter or double ring infiltration testing method as per our Development Engineering Manual and CVC LID manual– Appendix C and size the infiltration gallery accordingly.

20. For water quality control an Oil-grit Separator (i.e. Stormceptor EF 4) is proposed and claimed 90% TSS removal. Based on Environmental Testing Verification (ETV) Canada, Oil-grit separators are 60% efficient when used as stand alone. Therefore, please justify enhanced quality control through the proposed OGS unit.

21. The IDF values used for hydrologic modeling are based on our Development Engineering Manual (DEM); however, the runoff coefficient (C) values do not match DEM. Please be consistent in using hydrologic parameters for the analysis based on DEM.

Hydrogeological Report

22. It seems that the proposed foundation of the underground parking area will be constructed with a water proof base and, as such, no permanent drainage system/dewatering is expected for these structures. However, a large footprint of infiltration is proposed in the close proximity of proposed building. Assuming it functions as designed, the concentrated flow from infiltration gallery and presence of dense glacial till encountered in the lower zone may have the potential to create perched water condition. There are chances of groundwater mounding impacts on the building’s underground

parking lot and adjacent properties. Please conduct a groundwater mounding analysis including influence zone and submit for review.

23. Approach to analysis of slug testing results. Most of Stantec's graphs display a double straight-line effect that may be exaggerating the geometric mean conductivity values in the formation itself. They have matched most of the curves to the early drawdown, which typically is assumed to be the response of the gravel pack and not the formation itself.

24. The in-situ hydraulic response testing conducted at each monitoring well to estimate horizontal hydraulic conductivity of the deposit. All MW screens are located within sandy silt till layer that are deeper than the bottom of proposed infiltration gallery. Thus, the hydraulic conductivity estimated using slug tests would not be representative (k) values for designing infiltration galleries. The field saturated hydraulic conductivity should be determine using Constant heads Guelph Permeameter method or Constant head double-ring infiltrometer method. As stated in City's Development Engineering Manual (DEM), a minimum of one on-site infiltration test shall be conducted at the proposed bottom elevation of infiltration gallery; in addition, one on-site infiltration test shall be conducted at every other soil horizon encountered with 1.5 meters below the proposed bottom elevation. Please arrange onsite testing at the proposed locations and design infiltration gallery as per details provided in Section 5.7.7 & 5.7.8 of DEM.

Water Balance Analysis

25. Evapotranspiration estimations for pre-development conditions is based on annual precipitation (i.e. 916 mm) from Waterloo Wellington A. However, under post-development water balance evapotranspiration estimations are based on annual precipitation (i.e. 921 mm) seems from another climate station. Despite climatic data taken from two different stations, the adjusting factor for latitude remains unchanged. Please justify.

26. The climate data of 1981 to 2010 (22 years) selected from Waterloo Wellington Station A for water balance calculations. However, the climate data is available for more than 36 years period. Please provide the rationale for using only 22 years data.

27. It appears that the topographic factor (0.1) used for the sub-area A to Sub-area C considering the areas as hilly. However, these sub-areas can be categorized as rolling lands with factor 0.2. Please update the factors in water balance calculations.

Source Water Protection:

28. The property is located in a WHPA B and C with a vulnerability score of 4-8. As such, all construction related activities are subject to the City of Guelph's

SOP for construction projects within 500 m of a municipal well (attached). The property is not located in an Issue Contributing Area.

29. In accordance with Grand River Source Protection Policy CG-CW-29, please provide 5 digital copies of a Salt Management Plan.

30. Ensure that any private water supply or monitoring wells that are no longer in use are abandoned in accordance with O. Reg. 903.

31. In accordance with Grand River Source Protection Policy CG-CW-37, the applicant will need to indicate what DNAPL (if any) or other potentially significant drinking water threats will be stored and/or handled on the property. A Risk Management Plan may need to be developed.

Noise Impact Study

32. The title of the report is Noise Impact Study. The report appears to be a combination of both feasibility study and detailed study features as per the Guelph Noise Control Guidelines (GNCG) study requirements. Please clarify and change the tile appropriately to avoid any confusion.

33. The Noise Impact Study (NIS) submitted in support of "Zone change and Draft Plan amendment for the property 1242 – 1260 Gordon Street. However, the address mentioned as 1250 Gordon Street that is not consistent with the submission. Please correct the address.

34. In Section 2 of the NIS report, it is mentioned that the west facades of the Buildings A and B are setback approximately 24 m and 77m, respectively from the centerline of Gordon Street. However, other drawings included in the submission show that parts of the building facade with amenity areas are approximately 12.4m from the centreline of Gordon Street, and approximately 8.3m from the centreline of Street A (an extension of Edinburgh Road South). Please clarify, updating the report as necessary.

35. Table 1 includes "Outside bedroom window" and "Outside living room window" as part of the listed "Sound Level Limits…". The other values in this table correspond to MECP NPC-300 stated criteria sound level limits, whereas these two categories correspond to values used to determine ventilation and building component requirements; distinction between these should be made (we suggest separating them into two separate tables, for clarity).

36. The statement in the footnote of Table 1 is incorrect and should be removed or reworded. Excess above the stated criteria for OLAs may be permitted, with engineering judgment and justification, at the discretion of the Municipality, and are not automatically allowed.

37. In Section 3.2, not sure why the word “excesses” is used; the unit ventilation requirements are stated, and no “excess” to these are permitted. In addition, there are no discussions about building component design requirements.

38. In Section 3.3, technically, the stationary noise criteria is based on the worst-case scenario for the affected site; while is this often at the point of time of lowest ambient roadway traffic, that isn't always the case, and is not the way NPC-300 defines it. Please correct.

39. In Section 3.3, it is mentioned that the proposed development is located in a Class 1 Urban Area. However, this is Class 2 Area. Please update the report and analysis accordingly.

40. Table 2, there are several datasets included in the appendix. How was AADT values mentioned determined? If additional calculations were done, please include them in the report. In addition, future heavy truck percentage on Edinburgh Road is assumed as zero. Even if existing heavy truck % is zero, why is projected heavy truck % zero? It would only be valid if the road has a heavy truck prohibition (if it does, verify it is planned to remain in place to the horizon year). Please also update the roadway descriptions to include the class of road (arterial, collector, etc.) and whether or not it is a divided roadway

41. The note for the Table 2 mentioned that the traffic growth on all roads has been assumed to be 1.5% per annum. There is no rationale provided for the assumption of only 1.5% per year. The standard is 2.5% traffic growth rate. Please justify or correct it accordingly.

42. The first paragraph in Section 5 refers to Appendix A, Figure 2 for calculation locations. However, Appendix A Figure 2 does not appear to specify or otherwise indicate the calculation locations. Please update the figure accordingly.

43. The building identifications mentioned in Table 3 is not consistent with other submitted plans/reports. Please standardize building identifications.

44. The outdoor amenity is mentioned in the Table 3, without referring to amenity location. The concept plan submitted with the complete application (revision 3 dated 2020.05.21) shows two separate outdoor common amenity areas, plus a proposed park, and an “Amenity Roof”. Please verify that all appropriate OLAs are being analyzed. In addition, the outdoor amenity daytime sound level at exterior façade mentioned as << 55 dB L_{eq}. Please clarify if this value is calculated/predicted or assumed: only calculated/predicted values should be indicated in the table.

45. The Table 3 note 2 does not match the definition of an OLA as per the Guelph Noise Control Guidelines. Please correct it. In addition, the second sentence of note 2 should be separated as note 3. Again, actual calculated/predicted values should always be reported in the table, even if upon analysis they are determined to be “insignificant”. That said, it may be relevant to not include noise from Edinburgh Road South for some of the calculated receiver locations: this should be outlined in the report complete with justification.

46. In Section 6, air conditioning and warning clauses are listed as noise control measures. These are not noise control measures and should not be listed as such. In addition, it appears that the building component calculations are missing in the report. Please include in the report and reference in the section.

47. There are patio/balconies identified on the submitted plans that are more than 4m deep. However, there are also ground-based OLAs and indoor amenity spaces that have not been identified or analyzed. Please clarify, updating the report as necessary.

48. When including stationary noise calculations in a noise report, many more details are required. Please see the Guelph Noise Control Guidelines for information on what level of detail is required.

49. The point of reception for stationary off-site noise sources are identified in Section 7, but it is not clear how were these locations selected? Are there other locations (including other floors) that would experience a larger impact from these sources? Please provide details.

50. Section 7 does not include analysis of proposed outdoor points of reception. Please include these in the analysis.

51. In Section 8, the surrounding buildings (1280 Gordon Street & 1284 Gordon Street) are identified as 5 story buildings but that is not consistent with earlier in the report where they are identified as 6 story apartment buildings. Please clarify.

52. Please include, in an appendix of this report, the HVAC design drawings for each building. Verify that there are no planned sources of noise at any location on/at/around these proposed buildings other than the roof-top (above the 12th storey): other elements that may be missing from this analysis include (but not limited to) blowers/exhaust from the underground parking, emergency generators, HVAC equipment on lower roof levels, etc. If the HVAC has not yet been designed, this needs to be documented in this report, along with sources for equipment/noise levels used in the analysis, assumptions on location, assumptions on other equipment, etc.

53. The analysis of the impact of proposed development on the surrounding areas appears to be based on a "best-case scenario" for HAVC design for buildings of this type, and provides little assistance to identify possible noise impacts to external sensitive receivers. Please provide justification within the report concerning the type, number, placement and selection of HVAC equipment for these proposed buildings.

54. Please clarify what methodology was used for the evaluation in Section 10. Additional details are required, as are the calculations completed (can be included in an appendix). Based on most methods, review of actual architectural drawings would be required: was this done? If this is a Feasibility Noise Study, the level of detail expected is much lower, but detailed evaluation would be required as part of the subsequent Detailed Noise Study (typically at Site Plan or similar stage of the land development). It should be noted in this section that a review of the building components is a requirement under NPC-300 due to the sound levels predicted.

55. The summary of on-site noise impacts on adjacent noise sensitive land uses is missing. Please include it.

56. In Section 12 recommendation 2 identifies reference to recommended warning clauses. Please note that, if this is a Detailed Noise Study, the warning clauses need to be specified in detail within the report, as per the GNCG Appendix A, and not simply referenced by clause "letter". If this is a Feasibility Noise Study, warning clauses need not be recommended (see the GNCG for details of report requirements).

57. In Section 12, it is mentioned in recommendation 4 that the analysis will be conducted prior to building permit. This analysis will be required prior to Site Plan Approval, as per the Guelph Noise Control Guidelines.

58. The Figure 1 does not include standard required map orientation items. Please include standard-required map orientation items, such as a north arrow, etc. This figure should also outline the extents of the site under investigation.

59. Please include the locations of the on-site points of reception used in the evaluation of transportation noise in Figure 2.

60. Please include standard required map orientation items, such as a north arrow in Figure 3 & Figure 4.

61. Please clarify that the building description is based on magnetic north or project/site north in the STAMPSON output, and/or coordinate and standardize the location descriptions to cardinal points based on included drawings.

62. The location of the points of reception mentioned in the model are unknown, beyond the general description (as they are not shown on an included drawing/figure). Once they are known, we will review the STAMSON predictions in more detail. Until that time, please see some general comments below.

63. It appears that absorptive ground surface is used in the model. Based on the included drawings, the intervening ground surface to all receptors on site would not be considered absorptive. Therefore, reflective ground should be used for all predictions.

64. The receiver height mentioned in STAMPSON is 36.00 m. However, based on the submitted elevation drawings, this value does not appear correct. Please clarify how the receiver height was determined?

65. It appears that a barrier is included in some predictions. Why was a barrier introduced? If a barrier exists, complete the three elevation values. Note that barriers should not be included in the analysis for receivers in the bright zone of the barrier.

<u>Water Servicing, including Metering</u>

66. The plans are missing a property line valve. For new servicing we are looking for a tapping valve (or valve on the 'T') and a property line valve in all cases.

67. All water, including that to supply fire suppression and hydrants, must be bulk metered.

68. The water meter shall be located within a meter chamber at property line. The chamber position would be at the PL of building 1 or be bulk metered inside Building 1 for the entire property

<u>Traffic Impact Study</u>

69. "Section 7.1 Zoning By-law Requirements" noted that a review was completed to determine the reduced drive aisle width of 6.7m meters. Please provide the details of the review.

70. The proponent will be responsible for design and construction of Street A, and reconstruction of the intersection at Gordon Street and Edinburgh Road including any modifications to geometry and traffic signalization.

<u>TDM</u>

71. Per section 8.2 of the TIS, please strengthen active transportation connections between Buildings #1, #2 and Gordon Street, on the south side of the site. A 3.0 m wide shared pathway for pedestrians and cyclists

eliminates the need for these users to travel out of their way via the proposed municipal ROW, when travelling southbound on Gordon Street.

72. Per section 8.1 of the TIS, staff recommend provision of high quality, secure, indoor bicycle storage. This means at least half of the bike racks provided should be horizontal and lift-assist, rather than all racks being vertical wall mounted. Providing high quality amenities ensures a range of users can access these spaces, and promotes active transportation as an appealing alternative to single-occupancy vehicle use.

73. Several ground mounted racks for oversized bicycles such as cargo bikes, recumbent hand cycles and bicycles with trailers attached should be provided.

74. Section 2.0, on page 2.1 indicates there will be 442 bicycle parking spaces underground, while table 13 indicates 415 spaces. Please clarify.

75. Note, per the Site Plan procedures and guidelines the long term bike parking should be provided at a rate of one space per unit, while the 2 spaces per 20 units are for visitor bike parking. These visitor bike parking spaces should be situated above ground, directly next to the main building entrances.

76. Please consider unbundled parking provisions so residents can opt-out of parking spaces they may not need.

77. Staff recommend the implementation of EV-charging stations for residents in the underground parking.

Please do not hesitate to contact me if you have any questions regarding my comments.
Thanks,

Mohsin Ali Talpur, M.Eng., P.Eng.
Development - Environmental Engineer

Internal Memo

Date	December 8, 2020
To	**Lindsay Sulatycki, Senior Development Planner**
From	Leah Lefler, Environmental Planner
Service Area	Infrastructure, Development and Enterprise Services
Department	Planning and Building Services
Subject	**1242-1260 Gordon Street and 9 Valley Road** **Draft Plan of Subdivision, Official Plan Amendment and Zoning By-law Amendment** **Environmental Planning Comments on First Submission**

Environmental Planning reviewed the following documents that pertain to the proposed Draft Plan of Subdivision, Official Plan Amendment and Zoning By-law Amendment at 1242-1260 Gordon Street and 9 Valley Road:

Environmental Impact Study, Stantec, May 2020
Functional Servicing Report, Stantec, April 2020
Geotechnical Report, CMT Engineering Inc., April 2018
Hydrogeological Assessment, Stantec, May 2020
Landscape Concept, Stantec, March 2020
Planning Justification Report – May 2020
Tree Inventory and Preservation Plan – March 2020

Based on the review of the materials listed above, Environmental Planning staff offer the following comments at this time:

Environmental Impact Study

1. In the Introduction, please note that the planning approval sought by the applicant is a Draft Plan of Subdivision, Official Plan Amendment and Zoning By-law Amendment. Following approval, the development will proceed to detailed design and subdivision registration. Text in the third paragraph should be updated accordingly.
2. Under 1.1 Agency Consultation, reference is made to a Hydrology Report. Please revise this to Hydrogeological Assessment.
3. Under 2.2.1 Official Plan, it is stated that “Natural Areas where development may be permitted provided an EIS can demonstrate that there will be no negative impacts to the natural heritage features or their ecological function”. This statement is incorrect. General Permitted uses and feature specific policies apply to Significant Natural Areas and Natural Areas alike. Permitted uses may be more permissive in Natural Areas in comparison to Significant Natural Areas,

but not necessarily. If a feature does not meet criteria for protection, development may be permitted. Conversely, if a feature meets criteria for protection, the general permitted use policies and feature-specific policies apply. Please clarify this.

4. The last sentence on page 2.2 states that "The Natural Heritage System also incorporates hazard lands including steep slopes, erosion hazard lands and unstable soils that are under the jurisdiction of the GRCA". This statement is incorrect. Criteria for designating Significant Valleylands (a Significant Natural Area included in the NHS) includes undeveloped portions of the regulatory floodplain. Hazard lands are not outright included in the NHS. Please correct this.
5. Under 2.2.3 Tree By-law, it is stated that the "Tree By-law was created to prevent damage or destruction to trees". This statement is incorrect. The Tree By-law 'regulates' the destruction or injuring of trees and enables the City of Guelph to require a tree permit prior to the injury/destruction of a regulated tree, and compensation. The Tree By-law helps protect and enhance the tree canopy cover in the City. Please revise accordingly.
6. Under 3.2 Field Investigations on page 3.8, please include bat acoustic surveys as well as bat exit surveys in the list of targeted field surveys.
7. Under 3.2.8.2 Bat Exit Surveys on page 3.14, please include the type of device used for acoustic monitoring. For example, was a hand-held unit used, a song meter or both?
8. Under 3.2.9.1 Diurnal Surveys on page 3.15, it is stated that "fieldwork was conducted at, or within, half an hour of sunrise". This statement does not match dates and times listed in Table 3.7. Best results are achieved within half an hour of sunrise, especially in noisy urban environments, and especially in forested ecosystems. The first breeding bird survey was completed on June 12, 2018, which is very late for a first visit. Based on timing of field surveys, data should be interpreted accordingly (i.e. lack of record does not indicate absence). Please update the text, as appropriate.
9. Under 3.2.9.2 Crepuscular Surveys on page 3.16, mention of moon phase is not made. Were conditions appropriate for surveying crepuscular birds during site visits completed for bats? Refer to MNRF's 'Eastern Whip-poor-will and Common Nighthawk Survey Protocol' for guidance.
10. Under 4.4.6 Amphibian Survey and Habitat Assessment on page 4.6, it is stated that suitable habitat for amphibian breeding was not present. This seems odd, given that the Torrance Creek PSW is located within the Study Area, which is known to provide woodland amphibian breeding habitat. Snow melt and a high groundwater table result in seasonal ponding within this wetland complex. Please clarify.
11. Under 4.4.14 Incidental Wildlife Observations, the DeKay's Brownsnake observation from May 16, 2019 should be added to the list of incidental wildlife. This species was observed, along with several Eastern Gartersnake and a Red-bellied Snake during the feature staking exercise, with City staff. Further, please assess the significance of the snake records recorded with respect to

significant wildlife habitat and the potential for snake hibernacula to occur in the vicinity of the subject property.

12. Section 5.0 Significant Natural Heritage Features should be based on the natural heritage and water resources policies of the City of Guelph Official Plan (March 2018 Consolidation), in addition to the policies of the Provincial Policy Statement. Please update this section to address Official Plan policy.
13. Section 5.2 Significant Woodlands includes the following statement: “notwithstanding the criteria denoted in the OP excluding plantations”. This statement is incorrect. *Plantations* is a defined term in the Official Plan. Cultural Plantation, per ELC, is not the same thing as *plantation* in the Official Plan. A cultural plantation unit must meet the Official Plan’s definition of *plantation* to be excluded from the assessment of significant woodland. Please clarify this.
14. Section 5.2.1 Other Woodlands refers to a deciduous woodland and claims that it was excluded from Significant Woodland due to composition, origin and size. Please provide the analysis to support this. Do the Cultural Woodlands criteria of the Official Plan to this deciduous woodland? This assessment should also be included in a revised EIS.
15. What does the bolded text indicate in Table 5.1? For clarity, please uses bolded text consistently within each Table, and among Tables 5.1 through 5.4. Also, please update Tables 5.1 through 5.4 to accurately assess field data collected against MNRF’s Ecoregion 6E Criteria to determine whether or not Candidate or Confirmed SWH is present within the Study Area and/or Subject Property.
16. Section 5.3.5 Locally Significant Species should be updated to include the names of the two locally significant plant species. Also, the list of locally significant bird species should be updated to include Northern Flicker. A total of six locally significant bird species were documented, based on field records.
17. Section 5.4.1 Butternut should be updated to indicate that an ‘authorization’ under the *Endangered Species Act* is sought. The EIS should be updated with information from the MECP and Natural Resource Solutions Inc. to reflect the current status of Butternut, ESA requirements and compensation plantings. Correspondence and supporting documentation should be included as an Appendix.
18. Section 5.4.3 Bat SAR, please provide a map showing the extent of bat species at risk habitat (roosting habitat, foraging habitat). Please also provide correspondence with MECP confirming support of the proposed approach.
19. Section 5.5 Significant Natural Heritage Features Summary, on page 5.8, please update the bullet list to include bat species at risk, and to note that honey locust is a planted specimen. Also, the statement “unable to confirm presence/absence” is incorrect. The field surveys were designed to enable an assessment of SWH. For example, breeding bird survey results in fact confirm the woodland as Woodland Area Sensitive Breeding Bird Habitat. Based on results of field surveys, it may or may not be possible to confirm SWH. Unconfirmed SWH would remain Candidate SWH in areas meeting the criteria of the schedules for 6E. Please clarify this in the text.
20. Section 5.5 Significant Natural Heritage Features Summary, on page 5.9, includes other woodlands (WODM4-4). Based on the ELC figure, the WODM4-4

vegetation community appears to be contiguous with an FOCM5 vegetation community. As per comment 14 above, please assess this woodland against the Official Plan’s criteria for Cultural Woodland and update the text on page 5.9 accordingly.

21. Section 6.1 Stormwater Management should reference stormwater targets prescribed in the Torrance Creek Subwatershed Study for infiltration rates. A portion of the site is located in Catchment 102, where the following targets apply:

    - infiltrate to enhance baseflow in Torrance Creek: 150mm/yr to 200mm/year or match pre- to post-
    - pre- to post- peak flow control for all design events (2 to 100-year events)
    - 24-hour extended detention for 25mm rainfall event
    - minimum 80% TSS removal

    Similarly, the Stormwater targets prescribed in the Hanlon Creek Subwatershed Study should be referenced in this section, as a portion of the site is located within the Hanlon Creek Subwatershed. The proposed stormwater outlet drains to Tributary D, where the following targets apply:

    - match pre- to post- peak flows for all storm events
    - implement infiltration best practice to the great extent feasible

22. The Functional Servicing Report (FSR)and Engineering Plans indicate that parking lot water as well as rooftop water will be directed to the infiltration trench. Further, stormwater management does not appear to be provided for a portion of the site, including drainage from the extension of Edinburgh Road. Lastly, sufficient capacity to accommodate flows from the proposed development is not available in the receiving stormwater management pond. Section 6.1 should be updated to provide an accurate and detailed description of the proposed stormwater management system so that all potential impacts can be identified in Section 7.0.

23. The first paragraph on page 6.2 states that “the total flow to Gordon Street (inclusive of rooftop-controlled flow) meets the predevelopment target rates”. Please provide supporting documentation or provide reference to specific values and/or sections of the FSR.

24. On page 6.2, a description of the infiltration trench is provided. Based on this description, it is unclear how groundwater levels factored into the design of the facility. For example, has 1m separation distance from the high-water level mark been factored in?

25. Section 6.1.2 Trail, references the Guelph Trail Master Plan and a proposed connection through the subject property. A recommendation is provided that the trail be completed as part of a broader trail design approach, to be completed by the City at a future date. This recommendation conflicts with the requirements set out in the Terms of Reference, which included an assessment of the trail route, recommendation for trail alignment consistent with Official Plan policy (i.e., consistent with permitted uses within the natural heritage system, demonstration of no negative impact, etc.) and identification of best management practices to provide the basis for basic trail design, which is to be

completed as part of the Environmental Implementation Report (refer to pages 18 and 20 of the approved TOR). The Active Transportation Network Study maps the portion of trail through the subject property as a desired Active Transportation route (i.e. for cycling). The feasibility of accommodating an Active Transportation route through the subject project is to be assessed based on Official Plan policy in the EIS. Lastly, a trail connection from the Park Block to the trail network is desired and should be assessed and evaluated through the EIS to inform the design.

26. Section 7.0 Potential Impacts of Development and Mitigation Recommendations, reference is made to “net environmental impact assessment”. This is not appropriate as the policy test is “no negative impact”. Please revise this statement and confirm that the analysis provided is based on the “no negative impact” test.
27. Section 7.1 Impacts on Significant Natural Features, given that two 12 storey buildings are proposed, the EIS should evaluate the potential for bird strike impacts, and inform the design, as appropriate. Lighting impacts may also result from the proposal; the EIS should make recommendations for lighting adjacent to the natural heritage system based on best management practices. Lastly, grading impacts should be assessed in the EIS. An analysis of the grading plan should be provided in the context of permitted uses within the natural heritage system. Please update section 7.1 accordingly.
28. In Section 7.1.1 Significant Wetlands, it is stated that “incidental runoff impacts associated with sediments, dust, as well as nutrient loads will be reduced by the natural polishing function of the vegetative zone between the feature ad development”. It is unclear what this statement means. The Stormwater system is designed to infiltrate the 25mm storm event via an infiltration trench. Surplus runoff will fill a storage tank and then outlet to the storm sewer on Gordon Street, which outlets to a stormwater pond, which discharges to the Hanlon Creek PSW. Further, the last sentence of the first paragraph in this section states that “all surface runoff from the proposed development is directed to the existing storm sewer on Gordon Street”. This statement is not consistent with section 6.1 of the EIS or the FSR. Please clarify.
29. Also in Section 7.1.1 Significant Wetlands, please demonstrate that infiltration rates and volumes have been matched, pre- to post- in the Torrance Creek and Hanlon Creek Subwatersheds. This section notes that infiltration will “match and likely notably exceed pre-development infiltration volumes” in the catchment that directs flows to Torrance Creek. Torrance PSW has both a recharge and discharge function, depending on the time of year. During periods of an elevated water table and an upward hydraulic gradient, are impacts associated with the infiltration trench anticipated? For example, if infiltration cannot occur due to a high-water table, surplus will fill the storage tank and discharge to Hanlon PSW, likely resulting in a negative impact to both PSWs. Please include an in-depth analysis of stormwater impacts on the natural heritage system’s features and functions.
30. On page 7.2, discussion is provided on the predicted impacts associated with reduced infiltration to the Hanlon Creek Subwatershed, with a conclusion of no negative impact drawn. Please provide the supporting analysis to support this

claim. For example, what is the difference in pre- to post- infiltration volumes and rates? If infiltration is reduced, is the potential for baseflow impacts in Hanlon Creek? If infiltration is reduced, will more runoff be directed to Hanlon PSW? In addition, the FSR indicates that this runoff would be directed to the storm sewer on Gordon. The EIS fails to address Stormwater impacts associated with unattenuated/untreated runoff from the catchment containing the extension of Valley Road/Edinburgh.

31. The Torrance Creek PSW has a recharge and discharge function. What impact does the proposed stormwater management system have on the recharge/discharge function of the wetland? Please update the EIS to include a comparison of pre- to post- monthly differences in vertical hydraulic gradients, infiltration, runoff, etc. Note that this is required to demonstrate no negative impact the PSW.

32. Section 7.1.5 Significant Habitat of Endangered and Threatened Species, please provide documentation of correspondence with MECP confirming the proposed mitigation measures for bat species at risk are acceptable. Please also update the Butternut paragraph to include details from NRSI, as requested above.

33. Section 7.1.6 Locally Significant Species, please clarify where the Yellow-billed Cuckoo was heard. The text appears to indicate that the Yellow-billed Cuckoo was heard singing from the development area of the site. Please provide an assessment based on the Official Plan’s policy on Habitat for Significant Species to establish whether or not this Natura Area designation applies.

34. In section 7.3.1.3 Wildlife Friendly Building Design, please note that the EIR should include more detailed guidance on bird-friendly building design to inform detailed design.

35. Environmental planning staff are supportive of the timing recommendations made for the removal of debris and woodchip piles to protect snakes. Consider including a recommendation to incorporate snake hibernacula and/or gestation site habitat structures in the buffer portion of the natural heritage system. The Environmental Implementation Report would then provide further information on location, design, etc. to assist with detailed design and implementation.

36. In section 7.3.4 on page 7.8, please update the paragraph on Butternut to reflect the outcome of the Butternut Health Assessment and authorization. NRSI should be contacted for this information.

37. The details included in the post-construction monitoring program are acceptable for the EIS; however, please note that a requirement of the forthcoming EIR will be to provide a detailed post-construction monitoring plan. Similarly, additional detail on vegetation plantings will also need to be provided in the EIR. Please update the EIS to include a summary section on EIR requirements and a proposed outline for the future report. Please note that this was included within the approved Terms of Reference.

38. The following major topics were omitted from the EIS and should be assessed in detail in a revised EIS as part of the next submission:

    - assessment of bat species at risk habitat and supporting documentation from MECP;
    - Butternut assessment details and supporting documentation from MECP;

  - assessment of Habitat for Significant Species;
  - assessment of Cultural Woodland;
  - assessment of the need for Established Buffers;
  - assessment of grading impacts;
  - assessment of wetland water balance, based on assessment of monthly differences, pre- to post-development, for lands draining to the Torrance PSW and Hanlon PSW, to determine whether or not ecological and/or hydrologic impacts resulting from the proposed development are anticipated; and
  - recommended scope for EIR.

39. Section 9.0 Policy Compliance should focus on the consistency of the proposal with the “no negative impact test”. As written, the focus appears to be on establishing feature-based constraints to development. This is not consistent with the PPS, and the natural heritage system’s approach to protecting, enhancing and restoring natural heritage in Ontario.

40. Section 10.1 Report Summary, please update the bullet on SWH to indicate Candidate vs Confirmed. Further, the bullet on the proposed stormwater management plan indicates that parking lot runoff will be infiltrated. This detail was not included in the description of the stormwater management system presented earlier in the EIS. Please ensure that all statements are consistent and coordinated with the engineering plans prepared for the proposed development. Please note that infiltration of parking lot water is not supported by the City. Lastly, the report summary should include changes to wetland hydrology and ecology, and removal of accessory habitat to list of potential impacts associated with the proposed development.

41. Please update section 10.2 Recommendations to include the erection of Tree Protection Fencing prior to the commencement of site alteration/construction.

42. Please update mapping provided in Appendix A to include the following:

  - established wetland buffer;
  - Ecological Land Classification vegetation community information for polygon adjacent to FOD5-6;
  - extent and type of Significant Wildlife Habitat features;
  - limit of the Natural Heritage System; and
  - Cultural Woodland and/or Habitat for Significant Species, as appropriate, based on the criteria-based assessment requested above.

Hydrogeological Assessment

43. In section 4.2.4.1, pre-treatment for TSS is suggested to eliminate a number of sediment-bound metals in the discharge effluent. City staff agree that the proposed pre-treatment approach would likely reduce these concentrations; however, please note that samples would still be required to be collected to confirm this assumption, prior to the discharge being authorized to City sewers.

44. Please update section 4.2.4.1 to clarify whether or not VOCs were sampled to confirm presence/absence. The City’s Sewer Use By-law prohibits discharge of VOC-impacted. Please note that VOC sampling may be required under a future discharge agreement with the City’s Wastewater Division.

45. The post-development water balance provided in section 5.3 does not appear to account for the lands fronting on Valley Road (0.27ha catchment shown on Figure 15). Please explain why this area was excluded from water balance calculations, or update the water balance to include this catchment. Further, the size of the catchment draining to Torrance provided in the water balance assessment is 1.73ha, which does not match the catchment area of 1.44 ha in the hydrologic model. Please update the calculations ensuring that consistent catchment areas are applied.

46. The EIS should refer to Section 6.0 Groundwater Dewatering Assessment and include recommendations for monitoring and best practice. This could be included as an item for the future EIR.

47. Section 6.1 – It appears that a safety factor was not considered in the calculations of dewatering volume estimation, nor was any basal seepage considered. Although the site typically has observed downward gradients, the hydrological assessment indicates that upward gradients are present. Please add a factor of safety to the calculations and account for basal seepage, or provide text to explain why these elements were not considered in the calculations.

48. An infiltration (rock) trench is proposed to address the infiltration deficit. The infiltration (rock) trench is located within the Torrance Creek Subwatershed. Please include an analysis of the post-development water balance per watershed. For example, with LID measures in place, the water balance should demonstrate that the infiltration rate/volume should roughly match pre- to post-rates/volumes within each Subwatershed (i.e. Torrance and Hanlon). A stormwater management design and supporting analysis demonstrate no negative impact to the receiving natural heritage system is required. This is typically achieved by demonstrating that the proposed development and stormwater management system matches pre- to post- monthly infiltration rates/volumes and monthly runoff rates/volumes. Hydrographs depicting monthly differences in runoff volumes and infiltration volumes are helpful in demonstrating consistency with the natural heritage system “no negative impact” policy test.

49. In Section 7.2 construction proximity to the nearby municipal well is accounted for; however, there is no discussion provided as to private residential wells in the area. During the filing of an application for PTTW or registration under the EASR, it is recommended that the proponent assess potential impacts to private residential wells.

Tree Preservation Plan

50. Please update the Tree Preservation Plan to include recommendations for the EIR and detailed design.

51. Environmental planning is generally supportive of using a polygon approach in certain situations; however, based on data provided in Appendix 1 Tree Inventory Data, it is unclear how the stem count column relates to the Polygon. For example, 1 stem is reported from each of Polygons A, B, C, E and F. Given the brief description provided on page 4 of the plan: “If trees were present in monoculture hedgerow features, a polygon method was used”. Based on this description, >1 stem per polygon would be expected. Please clarify.

52. Please update Map 2 of the Tree Inventory and Preservation Plan to show Tree Protection Fencing around the perimeter of the natural heritage system.

Functional Servicing Report

53. Please update section 5.1.2 Torrance Creek Subwatershed Study to accurately reflect recommended infiltration rates, which in the case of the proposed development is between 150mm/yr to 200 mm/yr.

54. The FSR indicates that the area outletting to Gordon Street (Hanlon Creek Subwatershed) will increase, post-development. The infiltration trench is proposed in the Torrance Creek Subwatershed, which means the majority of stormwater originating from the Hanlon Creek catching will be generated as runoff. Please clarify that the receiving stormwater pond has capacity to control the runoff volumes generated by the proposed development. Please note that surcharge of this facility is directed to the Hanlon PSW. Runoff volumes should match pre- to post- per the Hanlon Creek Subwatershed recommendations.

55. The description of Catchment 202 provided at the bottom of 5.6 indicates that roof-top water will be directed the storm sewer on Gordon Street, with the 25mm event being directed to the infiltration trench. Please clarify that up to and including the 25mm is intended to be directed to the infiltration trench. Events in excess of 25mm or when back to back events occur prior to draw-down would be directed to the storage tank, eventually draining to the storm sewer when capacity is reached. Environmental planning strongly encourages infiltration of ‘clean’ water to maintain infiltration and baseflow in Hanlon Creek to the greatest extent feasible. Please consider this comment when updating the FSR.

56. The EIS should include an analysis of the findings presented on page 5.8 which relate to pre- to post- differences in runoff and infiltration being directed to the Torrance and Hanlon Subwatersheds under the post-development scenario. Based on the analysis provided in the FSR, the EIS should provide an assessment as to whether or not impacts to the ecology or hydrology of the wetlands are anticipated.

57. How would the infiltration trench function in the event of back-to-back storms? Please clarify whether or not a safety factor was incorporated into the sizing and design of the infiltration trench.

58. In section 5.6 On-site Infiltration, on page 5.9, it is stated that “The infiltration gallery should only be intercepted by groundwater in spring-time”. How was this detail factored into the water balance? The EIS should provide an analysis of potential impacts arising from the proposed stormwater design. For example, if groundwater intercepts the infiltration trench during the spring, infiltration will not occur which would result in more runoff being directed to Hanlon Subwatershed. This is unacceptable and should be addressed in the next submission.

59. Please note that in situ permeameter testing is required to demonstrate that the proposed infiltration trench will function as anticipated. Please provide this information in the next submission.

60. Drawing SSP-2 Storm Drainage Area Plan – It is unclear how the Area IDs relate to the Catchments described in the FSR and Hydrological Investigation report's water balance calculations. Please ensure that this is clarified and coordinated among studies and drawings in the next submission.
61. Drawing GP-1 Grading Plan indicates that extensive grading is required adjacent to the natural heritage system. Please provide additional detail on grading requirements (e.g. spot elevations) to enable a proper assessment of consistency with Official Plan policy. Please note that a cross-section can be helpful in demonstrating how the required grading relates to the protection of the natural heritage system. At a minimum, please update GP-1 to show differences in grade adjacent to the natural heritage system, and slope, particularly at the southeast end of the site.
62. It is unclear how the proposed erosion and sediment control plan has been coordinated with the proposed grading plan. For example, tree protection fencing and silt fencing is proposed in an area identified for extensive grading on GP-1. Please clarify.

Landscape Concept

63. The Landscape Concept proposes the planting of coniferous and deciduous trees on top of the infiltration facility. Guelph's Engineering Development Manual specifies a minimum 1m offset of plant material from infiltration galleries. Please relocate the proposed trees outside of the infiltration gallery area.

Summary

A revised EIS is required to address the comments provided above. Revisions to the supporting studies, including the Tree Preservation Plan, Hydrological Assessment, Functional Servicing Report and Landscape Plan are required. Environmental planning encourages the applicant to meet with City staff to discuss the comments provided, prior to providing a second submission. Substantial work remains outstanding to adequately demonstrate no negative impact to the natural heritage system's ecological and hydrologic features and functions.

Please note that comments provided by Scott Cousins, City of Guelph Hydrologist, are incorporated into the comments provided under the Hydrogeological Assessment heading above.

Leah Lefler, Environmental Planner
Planning and Building Services, **Infrastructure, Development and Enterprise**
Location: City Hall
519-822-1260 extension 2362
leah.lefler@guelph.ca

Copy: Mohsin Talpur, Jyoti Pathak, Scott Cousins