Terra-Dynamics Consulting Inc.
432 Niagara Street, Unit 2 St. Catharines, ON L2M 4W3

May 18, 2022

Mr. Jeffrey Swartz
Vice-President, Land Development
EC (Erin) GP Inc.
125 Villarboit Crescent
Vaughan, ON L4K 4K2

Re: Hydrogeological Assessment, Water Balance Assessment and Source Water Protection Analysis, Erin Fairways Subdivision, 5525 Eighth Line, Town of Erin, ON

Dear Mr. Swartz,

EXECUTIVE SUMMARY

The Erin Fairways Subdivision is proposed for development at the Erin Heights Golf Course. A water level monitoring network using groundwater monitoring wells, as well as downgradient monitors of wetlands, surface water and shallow groundwater have been in operation since mid-2021 to document pre-development conditions. Site design can accommodate water balance maintenance for the downgradient provincially significant wetlands and protection of the nearby municipal supply well.

1.0 Introduction and Background Information

Terra-Dynamics Consulting Inc. (Terra-Dynamics) respectfully submits this study of the proposed Erin Fairways Subdivision (the Site, Figure 1). This study includes (i) a Hydrogeological Assessment, (ii) a Water Balance Assessment and (iii) a Source Protection Analysis. The Site is part of a golf course and is approximately 13.9 hectares in size. The Erin Fairways Subdivision will be a municipally serviced residential development (Armstrong, 2021).

2.0 Scope of Work

A background review of available information was completed that included, but was not limited to:

1. West Credit Subwatershed Study, Characterization Report (CVC, 1998);

2. Integrated Water Budget Report – Tier 2, Credit Valley Source Protection Area (AquaResource Inc., 2009);

3. WHPA Delineation and Vulnerability Assessment (Blackport Hydrogeology Inc. and Golder Associates Ltd., 2010);

4. Highly Vulnerable Aquifer Delineation, Groundwater Quality Vulnerability Analysis (CTC Source Protection Region, 2010);

5. Existing Conditions Report, Phase 1 – Environmental Component, Erin Servicing and Settlement Master Plan (CVC et al, 2011);

6. Ontario Geological Survey (OGS) surficial geology (OGS, 2003) and OGS 3-D modelling of surficial deposits (Burt and Dodge, 2016); and

7. Stormwater Management Criteria, Credit Valley Conservation (2012).

In addition, on-site investigations have been reviewed including geotechnical (DS Consultants Inc., 2021) geomorphic (GEO Morphix, 2020) and ecological (WSP, 2022).

2.1 Hydrogeological Assessment

A hydrogeological assessment was completed following the Conservation Authority Guidelines for Hydrogeological Assessments (Conservation Ontario, 2013) as required by the CVC (Vandermeulen, 2021).

The hydrogeological assessment includes (i) a description of existing conditions, (ii) an impact assessment and (iii) recommended mitigation measures. A private well survey and groundwater quality analyses can be completed after review of our initial report by the Town of Erin and Credit Valley Conservation (CVC) for comment on the scope of these items.

Downgradient features discussed in detail include:

(i) Two Provincially significant swamp wetland areas (MNRF, 1995); and

(ii) Two watercourses associated with Subwatershed 15 of the Erin Branch of the West Credit River (AquaResource Inc., 2009) with the main tributary classified as a cold-water fishery (CVC et al, 2011).

As requested by CVC (Salsberg, 2021), Subwatershed 15 West Credit River study recommendations (1998) were also considered.

2.2 Water Balance Assessment

A water balance assessment was completed as required for development of the Site (Salsburg, 2021).

Credit Valley Conservation (CVC) have specified that a "*Site-specific and features-based water balance will be required… Low Impact Development (LID) features be incorporated in the design to achieve a neutral water balance given the site is located within …* (a) *Significant Groundwater Recharge Area* (SGRA)". Also, given the Site is almost entirely mapped as an SGRA, a "*Site specific water balance* (is) *required to identify pre-development groundwater recharge rates and distribution as well as hydrologic and ecologic functions*" (CVC, 2012).

Our water balance assessment used existing long-term modelling results of the Site completed for CVC (AquaResource Inc., 2009) with some adjustments reflecting soil conditions documented during the geotechnical investigation (DS Consultants, 2021), i.e. providing a "*more detailed hydrogeological characterization*" (CVC, 2012).

A Wetland Risk Evaluation (TRCA, 2017) was also completed.

2.3 Source Water Protection Analysis – Municipal Groundwater Supply

Development of the Site includes consideration of source water protection policies given the Town of Erin's Municipal Well E8 is located northwest of the Site, and the associated municipal wellhead protection areas (WHPAs) extend into the Site. The source water protection policies concern water quality, not water quantity (Salsburg, 2021). WHPA water quality considerations include:

A. A Section 59 Notice evaluation, i.e. the Site being in a municipal WHPA requires review by the source water protection risk management officer/investigator;

B. Significant threat management discussion, specifically meeting the Town of Erin/Source Water Protection requirements for:
    i. Higher construction and operational standards for sanitary sewers and related pipes near the municipal supply well; and
    ii. Stormwater management facilities and outlets located in such a way as to prevent negative impacts to the municipal supply well;

C. Consideration of road salt and snow storage management; and

D. Reporting on existing transport pathways and any transport pathways to be created.

3.0 Physical Setting Summary

The Site is located within the Guelph Drumlin Field within a glacial outwash plain spillway area, immediately north of an area that is mapped as till plain (Chapman and Putnam, 1984, and CVC, 1998).

The Site is located within Subwatershed 15 of the West Credit River watershed (AquaResource Inc., 2009). Site topography generally slopes to the north from an elevation of 424 metres above sea level (m ASL) to 397 m ASL, with the downgradient Erin Branch of the West Credit River tributary at/below 394 mASL (Figure 2).

3.1 Surface Water

No surface watercourses are mapped at the Site.

The Erin Branch of the West Credit River is located downgradient and about 50 m northwest of the Site. It has perennial flow and is classified as cold water (Credit Valley et al, 2011). It is noted that downstream of the golf course, the thermal regime is historically reported as cool water (Credit Valley at el, 2011). The river bed material in the area of the Site is reported as sand, and in some riffles, sand and gravel, with watercress noted as evidence of groundwater inputs. The reach is also noted as having a low gradient and an average bankfull depth of 1 m (GEO Morphix Ltd., 2020). Surface water levels were monitored at staff gauge station SW-2, which was responsive to precipitation events (Appendix A).

A tributary of the West Credit River is also located along the east side of the Site, paralleling the Site boundary at a distance of close to, but slightly greater than 30 m. This tributary may have been created between 1954 and 1980, and has a bankfull depth of 0.45 m (GEO Morphix Ltd., 2020). Surface water levels were being monitored at staff gauge station SW-1, however, the monitoring location was destroyed during the fall of 2021 as part of a washout of the tributary and the station was re-installed in spring of 2022. It is currently presumed that this tributary intersects the shallow groundwater table adjacent to the Site. The portion of the Site calculated to be draining to this tributary is shown on Figure 5. Site golf course operations have an irrigation pond that receives discharge from this tributary (Figure 2). This irrigation pond is subject to a Ministry of the Environment, Conservation and Parks (MECP) Permit To Take Water (7370-A8YL4P) which allows for a maximum daily taking of 909,000 Litres/day from the pond. During the August 25, 2021 site visit it was observed that the pond water level was lower than the outlet pipe to the Erin Branch of the West Credit River.

3.1.1 Baseflow

Baseflow analysis was completed for the Erin Branch of the West Credit River at the upgradient Water Survey of Canada (WSC) stream gauge station 02HB020 (Figure 1) as part of the Tier 2 Water Budget (AquaResource Inc., 2009). An average baseflow of 0.33 m^3/s was calculated, including a mean flow of 0.47 m^3/s and a high baseflow component of 71%. It was also noted that low flow issues are sometimes a problem later in summer:

> "*Monthly variations in streamflow are not very large, and summer baseflow remains sustained…the 90th percentile exceedance flow does tend to decrease over the summer months into September which suggests that low flow issues are sometimes a problem later in the summer.*" (AquaResource Inc., 2009)

Historic baseflow measurements of the West Credit River immediately downgradient of the Site indicate this reach can be both an area of groundwater discharge (1.68 L/sec/km^2, August 1992) as well as an area of groundwater recharge (-9.1 L/sec/km^2, November 1995) (CVC 2011 et al):

> "*The gaining and losing portions of the West Credit River through the Erin Village area is variable and recharge/discharge conditions are more complex than previously interpreted.*" (CVC et al, 2011)

Earlier CVC reports (1998) have also indicated "*Much of the baseflow lost in the lower reaches of the northern tributaries of the West Credit appears to be related to the change in surficial geology from till to sands and gravel".* We note that Municipal Well E8 began operation in 1993, between these two sets of baseflow measurements referenced above, and that the water level at Municipal Well E8 changes on average from flowing/above ground surface (0.7 m) to approximately 4.6 m below ground surface during operation (OCWA, 2021). However, it is acknowledged that reporting on the 1993 municipal well testing stated "*there was no direct connection or impact of groundwater discharge to the West Credit River or adjacent wetlands*" (Blackport et al, 2010).

Manual surface water flow measurements have been completed on (i) August 25, 2021, (ii) November 10, 2021 and (iii) April 5, 2022. The monitoring results are described below:

1. No measurable precipitation occurred for 8 days prior to the August measurements (Environment Canada Station 6142400, Shand Dam) meeting the 7-day criteria for baseflow measurements (MacViro, 2009). The approximate baseflow at the tributary (station SW-1) was approximately 0.75 L/s and a temperature measured of 17.6°C (maximum day temperature of 28°C at Shand Dam). The measured baseflow in the Erin Branch of the West Credit River increased from 214 to 225 L/s between stations SW-2 and SW-3, respectively.

2. Precipitation of 5.4 mm occurred the day before the November 10 measurements, with no measurable precipitation for the 8 days prior. The flow at the tributary (station SW-1) was approximately 1.2 L/s. The measured flow in the Erin Branch of the West Credit River increased from 278 to 433 L/s between stations SW-2 and SW-3, respectively.

3. Precipitation of 7.2 mm (partly snow) occurred during the week prior to the April 5, 2022 measurements. The flow at the tributary (station SW-1) was approximately 14 L/s. The measured flow in the Erin Branch of the West Credit River decreased from 729 to 562 L/s between stations SW-2 and SW-3, respectively.

3.2 Soils

The Site soils are mapped as Hillsburgh Fine Sandy Loam (OMAFRA, 2021). These permeable soils were developed on fine to medium outwash sands (Hoffman, Matthews and Wicklund, 1963). Infiltration rates were calculated as per CVC's methodology (2012, CVC Figure B11) from the shallowest grain-size analysis (DS Consultants Ltd., 2021) based upon hydraulic conductivity calculations (Appendix C, Devlin, 2015) at each borehole.

All calculated potential infiltration rates were greater than 7.6 mm/hour as expected for hydrologic soil group A (USDA, 1986), and none were less than 15 mm/hour, i.e. all suitable for recharge measures, with the highest rates in the central portion of the Site at boreholes BH21-3, BH21-6, BH21-7 and BH21-8 (Table 1, Figure 2) which consists of silty sand fill, sand or sand and gravel at surface.

Table 1 - Calculated Infiltration Rates

Calculated Infiltration Rates	Borehole Locations
>50 mm/hour	BH21-3, BH21-6, BH21-7 and BH21-8
15 to 50 mm/hour	MW21-1, MW21-2, BH21-4, BH21-5, BH21-9 and MW21-10

3.3 Surficial Geology

The surficial geology for the Site is regionally mapped as "*gravel and gravelly sand, frequently overlain by several feet of sand or silt*" (OGS, 2003). The 2021 geotechnical investigation (DS Consultants Ltd., 2021), confirmed this classification in the central portion of the Site at boreholes 6, 7 and 8 (Figure 2), however lower permeability silty sand and silt were identified at-surface in most remaining boreholes (Appendix B, Section 3.4.1). Overall, the thickness of the surficial permeable soils, above the underlying silty sand till, had average and median thicknesses of 3.6 m and 2.8 m, respectively.

A local hydrogeologic cross-section summarizes the Site setting, with the overburden thickness above bedrock decreasing from 40 m to less than 10 m towards the northwest and the West Credit River

(Figure 3). This cross-section for the Site matches the general conceptual model in the area of (i) sand and gravel, underlain by (ii) sandy silt (*to silty sand*) till, underlain by (iii) the bedrock aquifer as shown below in Figure 4 (Credit Valley et al, 2011).

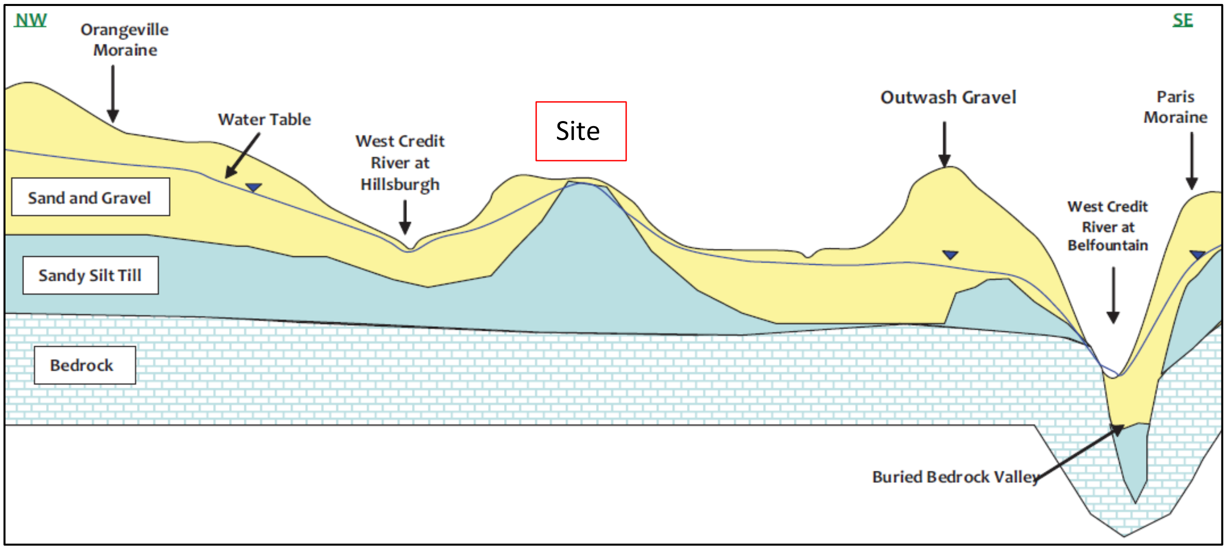


Figure 4 – Hillsburgh and Erin Schematic Cross-Section (Credit Valley et al, 2011)

3.4 Overburden Groundwater

3.4.1 Hydraulic Conductivities

Hydraulic conductivities were calculated from grain-size analyses (DS Consultants Ltd., 2021) according to the methodology of Devlin (2015). Shallow (0.3 to 1.1 mBGS) soil sample results, from highest hydraulic conductivity to lowest, are listed below grouped by material (Appendix C):

1. Sand and gravel (boreholes BH21-6, BH21-7): 10^{-4} m/s
2. Gravelly sand (borehole BH21-8): 10^{-5} m/s
3. Silty Sand Fill (borehole MW21-3): $7x10^{-6}$ m/s
4. Silty Sand and Silty Sand Fill (boreholes MW21-2, BH21-4 and BH21-5): 10^{-6} m/s
5. Silt and Sand (borehole MW21-1): $5x10^{-7}$ m/s
6. Silty Sand Fill (boreholes BH21-9 and MW21-10): $1x10^{-7}$ to $6x10^{-8}$ m/s

While the calculated hydraulic conductivity results appear low for some of the reported borehole log geology (MECP, 2006), the amount of 'fines' lowered the calculated hydraulic conductivities (Appendix C) for the at-surface samples at boreholes MW21-1, MW21-2, MW21-3, BH21-5, BH21-9 and MW21-10. For example, the grain-size classification of the 0.3 m sample from borehole BH21-9 is "poorly sorted sandy silt with fines". Lower hydraulic conductivities that are below the range used for the CVC Model uppermost glaciofluvial outwash layer of $5x10^{-4}$ to $5x10^{-6}$ m/s were identified for approximately 28% of the Site (AquaResource Inc., 2009), e.g. $1x10^{-7}$ m/s at BH21-9 is the same as reported by the MECP for sandy/silty diamicton (2006).

The calculated hydraulic conductivity for the sandy silt till at borehole BH21-1 was $5x10^{-7}$ m/s. This value is reasonable given previous reporting of a moderately low infiltration rate (Credit Valley et al, 2011) and reporting from MECP (2006).

3.4.2 Shallow Overburden Groundwater Flow

In April 2021, four monitoring wells were constructed (DS Consultants, 2021). Three monitoring wells were screened in the surficial silty sand and upper silty sand till (MW21-2, MW21-3 and MW21-10), from 4.6 to 7.6 m BGS, 4.6 to 7.6 m BGS and 1.3 to 4.3 m BGS, respectively (Appendix B). A fourth deeper monitoring well (MW21-1) was also constructed in only the silty sand till from 7.6 to 10.6 m BGS. DS Consultants have completed manual and datalogger monitoring at these locations in 2021 and are continuing measurements in 2022 (Appendix A).

Shallow overburden groundwater flow mimics the topography (Figure 5) with flow generally towards the north-northwest (Figure 5), as previously identified by CVC, *"…gravelly soils….allow water to percolate…and make its way slowly to the river…..*" (CVC, 1998). Overburden water levels are within the silty sand till in the higher portions of the Site and become shallower to the north, sometimes being within the overlying silty sand. The depth to the shallow groundwater table during the spring (April 2021) was generally greater than 1 metre.

With respect to shallow groundwater flow it has been previously reported that:

> "…*an extensive low permeability till unit underlying the sand and gravel … much of the groundwater will not move to depth and likely discharge as baseflow to a local surface water feature*…" (CVC et al 2011).

This is reasonable for the Site given the top of the silty sand till parallels that of the ground surface dipping to the northwest, north and northeast.

As shown in Appendix A, relatively similar water level trends were noted at the shallow monitors (2, 3 and 10) from April to August 2021, with the deeper silty sand till showing some water level recovery during the summer. An upwards vertical gradient was noted between the groundwater levels in the deeper silty sand till (MW21-1) and those in the adjacent shallow silty sand (MW21-10). The only shallow monitor to show a fluctuating water level was MW21-2, which is only 65 metres away from Municipal Well E8, and may reflect the pumping cycle of the municipal well.

An existing shallow monitoring well (2.5 m BGS) was identified between the Site and the Erin Branch of the West Credit River (MW-6-00, Figure 2), and has been incorporated into the monitoring program since November 2021. Groundwater levels were responsive to precipitation (Appendix A).

In August 2021, shallow drive-point piezometers were installed to monitor (a) shallow groundwater at the two wetland polygons (GW-1 and GW-2), (b) surface watercourses (SW-1 and SW-2), (c) at ground surface at the wetlands (WET-1 and WET-2) and (d) shallow groundwater adjacent surface watercourses (GW-3 and GW-4) (Figure 2). The shallow groundwater monitors (GW-1, GW-2, GW-3 and GW-4) were installed approximately 1 m deep, the wetland and surface water monitors (SW-1, SW-2, WET-1, and

WET-2) were installed between 0.2 and 0.4 m deep, and datalogging pressure transducers were installed in each. The hydrographs for these are shown in Appendix A and described below:

1. Water levels in the poplar swamp (WET-1/GW-1) were (a) generally below ground surface, (b) groundwater levels showed some seasonal recovery after the summer period, (c) were responsive to precipitation events, and (d) the vertical gradient was generally downwards.

2. Water levels in the cedar swamp (WET-2/GW-2) were (a) below ground surface, (b) fairly consistent over time, (c) groundwater levels showed some seasonal recovery after the summer period, (d) there was limited responsiveness to precipitation events and (e) the vertical gradient was generally downwards.

3. Shallow groundwater levels adjacent the west tributary (GW-3) were fairly consistent during the monitoring period.

4. Shallow groundwater levels adjacent to the Erin Branch of the West Credit River (GW-4) were (a) responsive to precipitation events, and (b) had a fairly consistent upwards vertical gradient.

3.5 Bedrock Aquifer

The bedrock aquifer underlying the Site is the Amabel Formation, "…*a highly transmissive bedrock aquifer*" (AquaResource Inc., 2009). As shown on the Site cross-section (Figure 3), the confined aquifer bedrock groundwater levels (Section 3.4.1) are above ground surface under static conditions at the Erin Branch of the West Credit River. Regional groundwater flow in the bedrock aquifer is towards the east in the area of the Site (CVC et al, 2011).

3.5.1 Municipal Well E8

Municipal Well E8 is located at 5555 Eighth Line, northwest of the Site (Figure 2). Further details regarding the bedrock supply well include:

> *"Municipal well E8, was constructed to a depth of 46 metres in 1991, and has been in production since 1993. Bedrock was encountered at 6.6 metres below ground surface (m BGS) but the upper bedrock zones were sealed to 16.8 m BGS by pressure-grouting to minimize potential connection to surface water. The well is artesian with a static level about 6.4 m above ground surface.*
> (Credit Valley et al, 2011)

Water levels provided by the Ontario Clean Water Agency (2021) indicated that daily maximum water levels at Municipal Well E8 continue to be generally above ground surface.

3.5.2 Well Head Protection Area (WHPA) Mapping

Well Head Protection Areas (WHPAs) were mapped for Municipal Well E8 as part the 2006 County of Wellington Groundwater Protection Study (Golder Associates Ltd., 2006). Bedrock aquifer vulnerability scoring of the modelled WHPAs was completed in 2010 (Blackport Hydrogeology Inc. and Golder Associated Ltd.). Underlying the Site, the intrinsic susceptibility index (ISI) of the bedrock aquifer vulnerability was modelled as ‘medium’ closer to Municipal Well E8 and ‘low’ further upgradient (Appendix D).

The WHPAs at the Site include (Appendix D):

a) Well Head Protection Area (WHPA)-A: a 100-metre circle around the Municipal Well E8, with a vulnerability score of 10, and covers 0.64 hectares or 5% of the Site.
b) WHPA-B: the 2-year time of travel to Municipal Well E8, with vulnerability scores of 8 and 6 (because of lower natural vulnerability mapped to the southeast), and covers 4.15 hectares or 29% of the Site.
c) WHPA-C: the 5-year time of travel to municipal well E8, with a vulnerability score of 4, and covers 1.3 hectares or 9% of the Site.

Due to the age of the WHPAs, they may be remodelled in the future, which may change their size and location. However, it is our understanding that funding for WHPA updates has not been confirmed, and it would likely take on the order of 3 years to complete the modelling and update the source protection assessment report and plan policies.

3.6 Highly Vulnerable Aquifer Mapping

The delineation of Highly Vulnerable Aquifers (HVAs) was completed as part of a modelling effort (CTC Source Protection Region, 2010) separate from the earlier WHPA modeling (Section 3.5.2). During the HVA modelling project, Municipal Well E8 was still classified as being in a ‘medium’ vulnerability physical setting whereby the bedrock aquifer is “*overlain by aquitard material*”.

However, most of the Site (10.9 hectares or 78%) was regionally classified as an HVA (Appendix D) because of (i) surficial geology mapping of sand and gravel and (ii) off-site water well records suggesting that the on-site sand and gravel thickness is greater than 2 metres on-site. The HVA in this case is the at-surface surficial sediments, not the underlying municipal bedrock aquifer. Based upon the CTC Source Protection Region (2010) criteria using the on-site investigations, the entire Site could be mapped as an HVA; however, this unit is not a potable water supply aquifer on-site, nor immediately downgradient. HVAs are assigned a vulnerable score of 6 based upon source water protection technical rules.

3.7 Wetlands

Downgradient of the Site are three swamp polygons of Provincially Significant Wetland (PSW) associated with the West Credit River Wetland Complex (Figure 2, MNRF, 1995, Appendix D). Ecological Land Classifications (ELC) of these swamps are (WSP, 2022): (i) cedar hardwood organic mixed swamp SWM4-1 or (ii) poplar conifer mineral mixed swamp SWM3-2 (Figure 2). These wetlands occur at ground elevations that are approximately below or lower than the 400 m ASL contour line, similar to the Tributary that is mapped east of the Site (Figure 2).

Soil hand-augering completed for installation of wetland water level monitoring stations noted (i) 0.65 metres of clay and silt at the cedar swamp over sand (WET-2, SWM4-1, polygon 4a), and (ii) 0.75 m clay and silt over silty sand at the poplar swamp (WET-1, SWM3-2, polygon 5a). This is not unexpected as

OMAFRA has mapped "muck", or hydrologic soil group D, for much of the poplar swamp (Appendix D) and the OGS has mapped a portion of the poplar swamp as bog deposits. These lower permeability soils correlate with the expected higher soil water holding capacity at swamps than is expected at the Site, i.e. 350 mm versus 50-100 mm (AquaResource Inc. and NPCA, 2009).

Topographic contours through the wetlands indicate gentle slopes of between 3% (cedar swamp) and 4% (poplar swamp) towards the West Credit River. However, most of the poplar swamp is within the West Credit River floodplain while the cedar swamp is upgradient of the floodplain (Figure 5).

These wetlands are classified as groundwater slope wetlands, defined by Mitsch and Gosselink (2007) as follows (Figure 6):

> "*Wetlands often develop on slopes or hillsides where groundwater discharges to the surface as springs and seeps. Groundwater flow into these wetlands can be continuous or seasonal, depending on the local geohydrology and on the evapotranspiration rates of the wetland and adjacent uplands*."

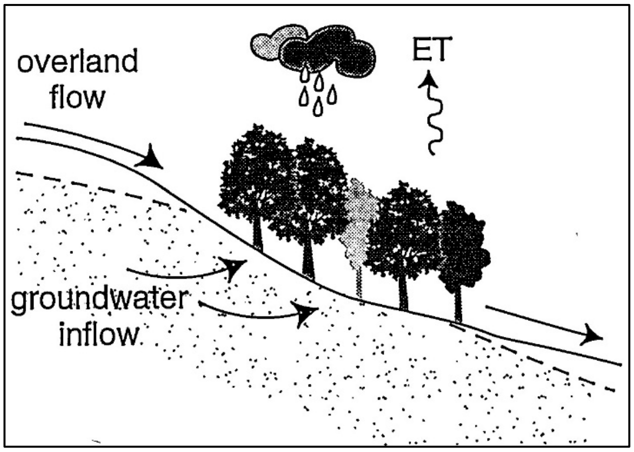


Figure 6 – Groundwater slope wetland (Mitsch and Gosselink, 2007)

The upgradient catchment areas for each wetland were calculated using topographic contours as 2.16 and 7.56 hectares for the cedar (SWM4-1, 4a wetland polygon) and poplar (SWM3-2, 5a wetland polygon) wetlands, respectively (Figure 5). The wetlands are 1.2 and 1.0 hectares approximately, respectively. The upgradient drainage area of each wetland catchment within the Site is 1.38 and 6.05, hectares, respectively (Figure 5). However, it should be noted that 0.78 and 1.51 hectares, respectively can remain unchanged between the Site and the wetlands to both (i) receive direct precipitation recharge and (ii) transmit subsurface recharge.

It is worth noting that previous reporting by CVC (1998) appears to comment on this reach of the West Credit River in the area of the Site, with respect to the effect of wetlands on upgradient infiltrated groundwater, "*…because of the wetland vegetation, most this cool groundwater is used up and transpired by the vegetation before reaching the stream or warms up as it passes through the wetland soils…*" which is reflected in the change from cold to cool of the West Credit River (Section 3.1).

It is also noted that there is an existing irrigation pond adjacent/downgradient of the cedar hardwood organic mixed swamp SWM4-1 (Figure 2). This pond is unlikely to be in operation following residential development of the Site. Consequently, this should benefit wetland hydrology, as the irrigation pond would not be drawn down for irrigation during the growing season.

As introduced in Section 3.4.2, continuous hydrologic monitoring is on-going at the two wetlands since late August 2021 and includes a measure of the vertical gradient. Based upon the water level monitoring completed up to March 2022 (Appendix A):

a) the cedar swamp (WET-2/GW-2) was generally under recharge conditions with groundwater levels during the fall and winter within 0.5 m of surface; and
b) the poplar swamp (WET-1/GW-1) showed more seasonal water level variability with water levels during the fall and winter close to surface.

Overall, precipitation conditions during this fall 2021 and winter 2022 monitoring period were generally at or above historic average conditions at the Shand Dam (Environment Canada Station 6142400).

There is also small polygon (5d, Figure 2) of poplar swamp located north of the Site (WSP, 2022). This has not been investigated for impacts as there is already substantial municipal infrastructure for Municipal Well E8 between the Site and this wetland.

4.0 Water Balances and Groundwater Recharge

4.1 West Credit Subwatershed Study (CVC, 1998)

It has been noted by CVC for Subwatershed 15 of the West Credit River that:

> “*Not all the recharge to the subwatershed discharges to the West Credit River. The average annual precipitation within the subwatershed is 850 mm per year, and average infiltration within the subwatershed is estimated to be 338 mm per year. The average infiltration contributing to baseflow is estimated to be 294 mm per year* (35% of precipitation)*. The difference is approximately 13%, meaning that this water would discharge outside the West Credit Subwatershed to the main Credit River, within Subwatershed 18.”*

4.2 Tier 2 Source Water Protection Water Budget (AquaResource Inc., 2009)

Water Survey of Canada (WSC) surface water flow gauge 02HB020 (Figure 1), is located on the Erin Branch of the West Credit River upstream of 8th Line and the Site. Surface water balance analyses of the 1961-2004 dataset provided the following water balance results in mm: (i) Precipitation 894, (ii) Evapotranspiration 437 (49%), (iii) Runoff 139 (16%) and (iv) Recharge 319 (36%). Of the precipitation noted at the Shand Dam weather station (Environment Canada Station 6142400), 15% of precipitation is snowfall, or 125 mm, and this station is considered representative of climatic conditions west of the Niagara Escarpment.

AquaResource Inc. modelling of groundwater recharge was completed for average conditions for 1960-2005. The results for the Site in mm per hectare were: (i) Precipitation 897, (ii) Evapotranspiration 402-

408, (iii) Runoff 114-122 and (iv) Recharge 368-381. An average area-weighted value for the Site of 340 mm/year recharge (38% of precipitation) was calculated after (a) incorporating values for the lower permeability soils identified for 28% of the Site (Section 3.4.1) which were assigned a recharge rate of 302 mm/year pro-rated from AquaResource Inc. modelling for similar soils west of the Site, and (b) including a limited existing impervious area of 4%. This equates to an annual recharge volume of 47,368 m^3. However, it should be noted that these modelled results remain significantly in excess of typical MECP groundwater recharge rates (Table 2).

Table 2 - Typical Groundwater Recharge Rates (MECP, 1995)

Soil Texture	Groundwater Recharge Rate (mm/year)
Coarse sand and gravel	>250
Fine to medium sand	200-250
Silty sand to sandy silt	150-200
Silt	125-150
Clayey silt	100-125
Clay	<100

4.3 Significant Groundwater Recharge Areas

The CTC Source Protection Committee/Region choose to delineate Significant Groundwater Recharge Areas (SGRAs) as those areas modelled as having 115% greater than the overall average watershed recharge rate of 230 mm/year, for a criterion of 265 mm/year. This value of 265 mm/year is within the expected range for coarse sand and gravel (Table 2, MECP, 1995). Consequently, given a CVC modelled recharge rate of 374 mm/year for the Site (Section 3.6.2) it is mapped almost entirely as an SGRA (95%).

4.4 Maintenance of the Site Water Balance

A daily precipitation analysis was completed for Environment Canada Shand Dam Station 6142400 for the period 2013-2021 and summarized in Table 3. The analysis was completed to determine a precipitation infiltration threshold to maintain pre-development levels of groundwater recharge. This threshold can then be a criterion for design of future stormwater management low impact development (LID) infiltration facilities.

The analysis indicated that annual daily 10 mm or less precipitation events ranged between 386 to 488 mm/year (Table 3). These values exceed the modelled Site pre-development recharge rate of 340 mm/year, with a median '10 mm or greater precipitation' value of 422 mm/year exceeding the modelled recharge by over 24%. However, a larger amount of precipitation abstraction is required. This is because driveway and road runoff cannot be included because of potential water quality concerns (e.g. road salt) to features such as wetlands (CVC, 2012).

The pre-development Site recharge rate will be maintained to 80% or greater, if (a) 15 mm, or less, precipitation events are infiltrated from "clean" impervious surface roof runoff and (b) fill is of loam quality or higher infiltration rate (Table 4). If a higher recharge rate is required more permeable soils than loam could be specified for fill areas. Table 4 is further explained below:

(a) Infiltration of 'clean' runoff from 4.91 hectares of impervious areas (i.e. multiplied by 605 mm/year) via a 3rd pipe system to infiltration areas at the stormwater management facilities resulting in an estimated annual recharge volume of 29,706 m^3; and

(b) 5.21 hectares of continuing recharge for the permeable areas of lots, the park and the stormwater management areas.

  a. 4.81 hectares multiplied by 138 mm/year (representing an average rate for loam soils to be placed at the Site) for an annual recharge volume of 6,633 m^3.
  b. 0.40 hectares multiplied by 302 mm/year (representing areas where native soils will be at-surface not fill) for an annual recharge volume of 1,218 m^3.

The eastern infiltration area will provide groundwater recharge to, and discharge to, the eastern tributary.

It is also noted that the annual precipitation amounts are generally above the 1980-2010 climate normal of 946 mm/year. This analysis was of precipitation (both snow and rainfall), and it is noted that climate change modelling by the Grand River Conservation Authority has indicated future winters are expected to have less snow and greater precipitation (Shifflett, 2014).

Table 3 - Daily Precipitation Summary*

Year	Annual Precipitation (mm/% of average)	Days with 1-10 mm	Depth Sum of 1-10 mm Days (mm)	Days with 1-15 mm	Depth Sum of 1-15 mm Days (mm)	Days with 1-20 mm	Depth Sum of 1-20 mm Days (mm)
2013	1199 (127%)	152 (42%)	395	175 (48%)	686	184 (50%)	840
2014	1102 (116%)	152 (42%)	407	174 (48%)	677	177 (48%)	731
2015	866 (92%)	138 (38%)	386	149 (41%)	523	156 (43%)	643
2016 (Leap)	1032 (109%)	138 (38%)	420	151 (41%)	588	160 (44%)	740
2017	1110 (117%)	160 (44%)	488	175 (48%)	678	185 (51%)	853
2018	953 (101%)	146 (40%)	456	155 (42%)	564	166 (45%)	753
2019	Shand Dam and nearby meteorological stations had too many data gaps						
2020 (Leap)	1017 (108%)	123 (34%)	423	139 (38%)	622	147 (40%)	765
2021	878 (93%)	144 (39%)	428	150 (41%)	498	151 (41%)	516
Average	1,020 (108%)	144 (40%)	425	159 (43%)	605	166 (45%)	730
Median	1,025 (109%)	145 (40%)	422	153 (42%)	605	163 (45%)	747

Note: * - Shand Dam (Station 6142400) 1981-2010 Average Precipitation of 946 mm/year, 20 km away

Table 4 – Annual Estimated Recharge Rates

	Area (hectares)	Recharge (mm/year)	Volume (m^3)
Pre-development	13.86	340	**47,081**
Post-development	4.91 (clean impervious roof areas via 3rd pipe to infiltration systems)	605	29,706
	4.81 (pervious areas fill)	138	6,633
	0.40 (pervious areas native)	302	1,218
		SUM	**37,557**

4.5 Wetland Water Balance Analysis

Credit Valley Conservation (CVC) (AquaResource Inc., 2009), through the source water protection water budgeting exercise, have calculated average water balance results per CVC climatic zone, soil type and land use type. The wetlands downgradient of the Site are in climatic zone 1, with a #3 slope category (i.e. slope 3.01 degrees or greater), and hydrologic soil group "organic" based upon the site investigations (Section 3.7). The CVC reported annual results in mm were: (i) Precipitation 897, (ii) Evapotranspiration 578, (iii) Recharge 152 and (iv) Runoff 167. These results reflect the lower permeability of the uppermost soils of the wetlands as observed during installation of wetland monitoring locations.

A monthly water balance for the swamps was completed using the U.S. Geological Survey (USGS) Monthly Water Balance Model (McCabe and Markstrom, 2007), which considers direct precipitation only, not runoff to the wetland. For temperature and precipitation climate normal inputs, Environment Canada weather station, Shand Dam Station, ID 6142400 (Environment Canada, 2022) was used. The calculated annual surplus (Precipitation minus Evapotranspiration) of 401 mm was higher than that modelled by CVC, and may be a result of the more detailed CVC 1-hour model time steps. The monthly modelling wetland results (Table 5) are summarized below.

1. Potential evapotranspiration exceeded precipitation for June and July, i.e. soil water utilization occurred;
2. Swamp soil water holding capacities were less than saturated for the summer months, i.e. June through September; and
3. Soil water recharge occurred in September.

Table 5 – Monthly Wetland Water Balance (mm)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation (mm)	68	56	60	74	87	84	89	97	93	77	93	69
Potential (mm) Evapotranspiration	8	10	18	36	67	98	113	91	54	29	15	9
Soil Moisture (mm)	350	350	350	350	350	**332**	**305**	**306**	**340**	350	350	350
Soil Water Depletion (mm)						18	45	44	10			

4.6 Maintenance of the Wetland Water Balance

The water balances for the wetlands can be maintained post-development (Table 6). The Table 6 details are explained below:

1. Direct precipitation will continue to the wetlands.

2. Pre-development groundwater recharge rates will be maintained immediately upgradient of the wetlands because development is set-back from the wetlands, i.e. 0.78 ha for Wetland 4a (SWM4-1) and 1.51 ha for Wetland 5a (SWM3-2).

3. Discontinued use of the irrigation pond downgradient of Wetland 4a, as it is possible the pond lowered groundwater levels below the wetland during summer months.

4. Stormwater management infiltration of clean roof runoff will occur at the two proposed infiltration facilities upgradient of the wetlands providing infiltration of events up to 15 mm.

5. Lot-level infiltration will occur in pervious areas upgradient on-site.

Table 6 – Annual Estimated Upgradient Wetland Recharge

Wetland 4a Catchment	**Area – on and off-site (hectares)**	**Recharge (mm/year)**	**Volume (m^3)**
Pre-development	2.16	374	**8,078**
Post-development	0.96 (clean roof runoff infiltrated at SWM LID)	605	5,808
	0.78 (preserved off-site upgradient buffer area)	374	2,917
	0.39 (pervious drainage upgradient on-site)	138	538
		SUM	**9,263**
Wetland 5a Catchment	**Area – on and off-site (hectares)**	**Recharge (mm/year)**	**Volume (m^3)**
Pre-development	7.56	359	**27,140**
Post-development	3.95 (clean roof runoff infiltrated at SWM LID)	605	23,898
	1.51 (preserved off-site upgradient buffer area)	374	5,647
	1.86 (pervious drainage upgradient on-site)	138	2,567
		SUM	**32,112**

4.7 Wetland Risk Evaluation

4.7.1 Magnitude of Hydrological Change

TRCA's wetland risk evaluation decision tree (Figure 6) includes four key hydrological change criteria (2017):

1. Change in catchment size;
2. Impact to recharge areas;
3. Impervious cover in catchment; and

4. Dewatering.

"*The highest magnitude category with one or more criteria satisfied determines the potential magnitude of change*" (TRCA, 2017).

(1)(2) The upgradient groundwater catchments for the downgradient PSW wetlands will be reduced, as well as their associated recharge areas as there will be "*replacement of existing soils with significantly less permeable materials*". The Wetland 4a catchment will be reduced from 2.16 ha to 0.78 ha (64% reduction) and the Wetland 5a catchment will be reduced from 7.56 ha to 1.51 ha (80% reduction). These changes meet the criteria for high magnitude of hydrological change as they are greater than 25%. However, this is without consideration of SWM LID mitigation measures, or consideration of on-site recharge (Section 4.6).

(3) Impervious cover in the upgradient catchments on-site are 72 and 69%, which equate to 46 and 55% of the total wetland catchments for Wetland 4a and Wetland 5a, respectively. These changes meet the criteria for high magnitude of hydrological change as they are greater than 25%. However, this is without consideration of SWM LID mitigation measures.

(4) Dewatering activities may occur during installation of on-site services and construction of basements. However, dewatering needs are expected to be limited to the south and some southwest portions of the Site, given most of the site is planned to receive fill for development (Urbantech, 2022). Given these details remain to be further refined, and the hydrologic risk evaluation is already classified as high based upon the factors (1)(2) and (3) it is suggested this portion of the risk analysis can be completed in future and utilize the existing monitoring network if impacts are a potential concern.

4.7.2 Sensitivity of the Wetlands

The risk assignment (Figure 6) is also to consider the type of wetland and their hydrological sensitivity (TRCA, 2017), downgradient of the Site:

(i) Wetland 4a is mapped as cedar hardwood organic mixed swamp (SWM4-1) which has a High Hydrological Sensitivity; and
(ii) Wetland 5a is mapped as poplar conifer mineral mixed swamp (SWM3-2) which has a Medium Hydrological Sensitivity.

4.7.3 Risk Assignment

The cedar hardwood organic mixed swamp (SWM4-1) receives a High-Risk assignment, having a high hydrological sensitivity and a high magnitude of hydrological change (Figure 6). However, the poplar conifer mineral mixed swamp SWM3-2 receives a Medium Risk assignment because of having a medium hydrological sensitivity although having a high magnitude of hydrological change (Figure 6).

The recommended study, modelling and mitigation requirements are similar for high and medium risks, i.e. similar levels of effort for considering Wetlands 4a and 5a:

(i) Pre-development monitoring is required as outlined in the Wetland Water Balance Monitoring Protocol (TRCA, 2016).

- This monitoring of both wetlands began in August 2021 and is continuing.

(ii) Continuous hydrological modelling is required at daily aggregated to weekly resolution.

- Existing annual HSP-F modelling (completed at 1-hour time steps) completed for CVC was utilized for this report (AquaResource Inc., 2009). This existing work could be re-visited to extract the weekly results, however it is unclear the direct benefit of doing so at this time.

(iii) Design of a mitigation plan to maintain the wetland water balance, in some cases an interim mitigation plan may also be required.

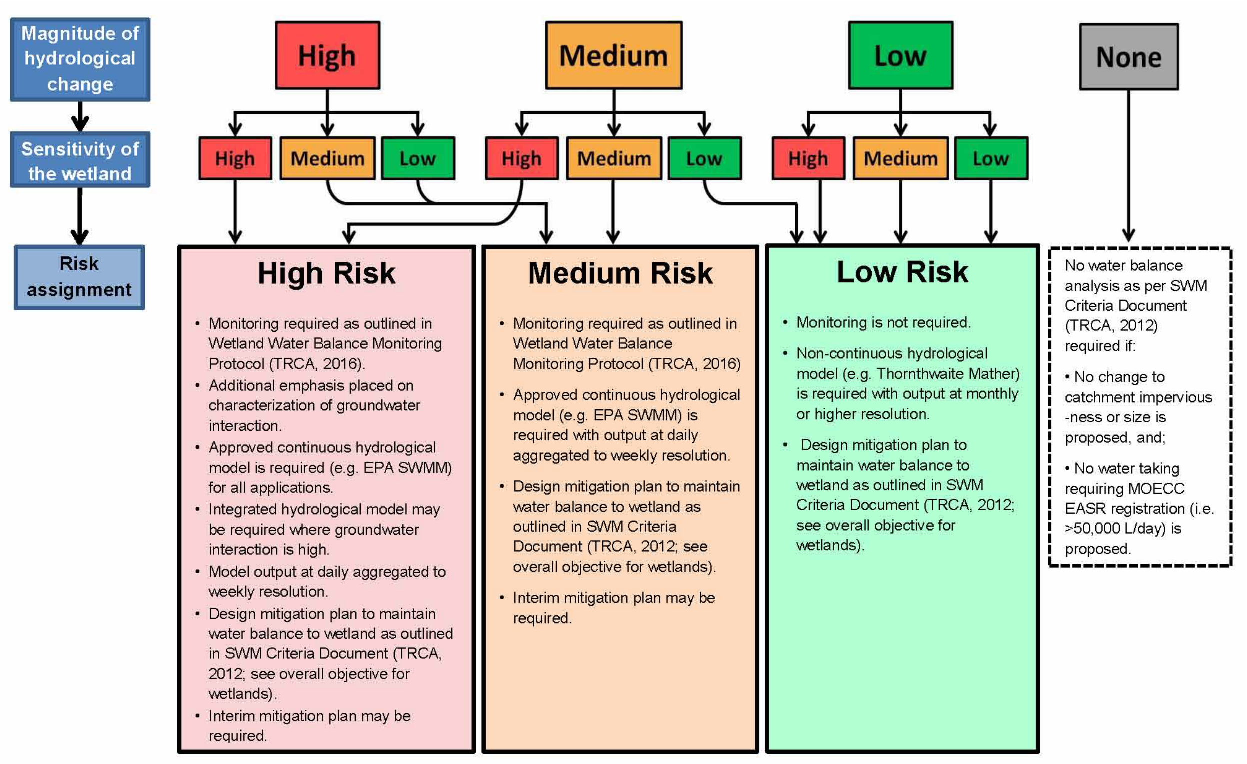
- This has already been prepared as briefly outlined herein and presented in detail in Urbantech (2022).

(iv) Additional emphasis placed on characterization of groundwater interaction [High Risk only, i.e. Wetland 4a]

- Monitoring is on-going with respect to this concern.

(v) Integrated hydrological model may be required where groundwater interaction is high [High Risk only, i.e. Wetland 4a]

- The existing CVC FEFlow model (AquaResource Inc., 2009) can be used if required, however it is unclear of the direct benefit of doing so at this time given the conceptual model appears well understood.



High Risk

- Monitoring required as outlined in Wetland Water Balance Monitoring Protocol (TRCA, 2016).
- Additional emphasis placed on characterization of groundwater interaction.
- Approved continuous hydrological model is required (e.g. EPA SWMM) for all applications.
- Integrated hydrological model may be required where groundwater interaction is high.
- Model output at daily aggregated to weekly resolution.
- Design mitigation plan to maintain water balance to wetland as outlined in SWM Criteria Document (TRCA, 2012; see overall objective for wetlands).
- Interim mitigation plan may be required.

Medium Risk

- Monitoring required as outlined in Wetland Water Balance Monitoring Protocol (TRCA, 2016)
- Approved continuous hydrological model (e.g. EPA SWMM) is required with output at daily aggregated to weekly resolution.
- Design mitigation plan to maintain water balance to wetland as outlined in SWM Criteria Document (TRCA, 2012; see overall objective for wetlands).
- Interim mitigation plan may be required.

Low Risk

- Monitoring is not required.
- Non-continuous hydrological model (e.g. Thornthwaite Mather) is required with output at monthly or higher resolution.
- Design mitigation plan to maintain water balance to wetland as outlined in SWM Criteria Document (TRCA, 2012; see overall objective for wetlands).

No water balance analysis as per SWM Criteria Document (TRCA, 2012) required if:

- No change to catchment impervious -ness or size is proposed, and;
- No water taking requiring MOECC EASR registration (i.e. >50,000 L/day) is proposed.

Figure 6 - Wetland Risk Evaluation Decision Tree

5.0 Source Water Protection Policy Implementation

5.1 Section 59 Notice Evaluation

Site development will include a Section 59 notice evaluation by Wellington County source water protection risk management staff. The '*Section 59 process*' is a review process to ensure that the Site design complies with the required source water protection policies. The policies requiring compliance concern the prevention of significant water quality threats to Municipal Well E8 serving the Town of Erin.

5.2 Significant Threat Management

<u>Source water protection policies SWG-13/SWG-14</u>: If sanitary sewer pipes are proposed within the WHPA-A they will require higher than normal construction and operational standards in order to not be a significant municipal drinking water threat. However, the specifics of these higher standards are not yet available from the municipal staff involved. Source water protection policies SWG-13 and SWG-14 do not require these standards outside the WHPA-A, however such standards may be requested outside the WHPA-A. Parklands are currently proposed for the portion of WHPA-A within the Site. However, it is expected that the sanitary main will be located along 8th Line right-of-way and therefore pass through the WHPA-A and require additional standards for implementation.

<u>Source water protection policies SWG-11(1)/SWG-12(1):</u> Stormwater management facilities, including outlets and infiltration are prohibited within the WHPA-A. One of the water quality concerns for the municipal well is road salt contamination of the municipal water supply. Source water protection policies SWG-11(1) and SWG-12(1) do not require these standards outside the WHPA-A. It is noted CVC (2012) has stated that "*infiltration from "clean" water sources such as roof runoff….will be encouraged in these areas*".

5.3 Road Salt and Snow Storage Management

Road salting, road salt storage, and snow storage are drinking water threats that are associated with urban/developed areas. However, the water quality threat level classification (significant, moderate or low) of these activities is based upon the vulnerability zone (and associated vulnerability score) and activity details as will be explained below.

Road salting and road salt storage are calculated as low water quality threats for the Site, given the area of the WHPA-A is planned to be a park (Armstrong, 2021) without roadways or road salt storage. Snow storage would also be a low threat within WHPA-B for snow storage areas between 0.01 and 0.5 hectares in size; however, snow would not be expected to be stored at the park as it would have to be moved across the stormwater management facility.

<u>Source water protection policy SAL-10:</u> this policy concerns application of road salt and is a '*have-regard-to*" policy not an enforcement policy. This policy advocates development of a salt management plan for the development of the Site including "*directing stormwater discharge outside of vulnerable areas where possible*". Wellington Source Water Protection have recommended the stormwater management facility "*have an impervious liner to avoid recharge of water containing contaminants,*

particularly sodium and chloride, back to the aquifer" (2021) which could be considered unnecessary as downgradient surface water discharge would be expected to infiltrate into the shallow sand unit.

Section 5.4 Existing transport pathways and creation of transport pathways

Transport pathways are created features that could promote 'transport' of contaminants to a water supply aquifer, e.g. unused water supply or monitoring wells.

There is an existing water supply well at the Site, MECP water well record 6700766 (Figure 2) which is listed on the PTTW as the Club House Well. This well will be decommissioned by an Ontario-licensed water well driller once no longer required for golf course operations.

There are monitoring wells located on the Site which will be decommissioned by an Ontario-licensed water well driller once they are no longer required for monitoring purposes.

Section 5.5 Water Quantity

As stated by Wellington County source water protection risk management staff (Vandermeulen, 2021), "*There are currently no Clean Water Act requirements related to the management of the water quantity*…". However, recharge at the Site will be maintained to at least 80%, and maintained to pre-development rates to the downgradient wetlands.

6.0 Conclusions and Recommendations

The following conclusions are provided:

1. There are no watercourses at the Site.

2. Downgradient of the Site is the Erin Branch of the West Credit River, which has perennial flow and a cold-water regime. Analyses of West Credit River flows, upstream of the Site and municipal well E8, indicated a baseflow/groundwater discharge component of 71%. However, baseflow measurements downgradient of the Site have indicated both groundwater discharge and groundwater recharge conditions.

3. Calculated on-site soil infiltration rates were greater than 15 mm/hour, including areas of >50 mm/hour.

4. Surficial geology ranged from gravel and gravelly sand, to silty sand and silt, with a thickness of approximately 3 metres above the underlying silty sand to sandy silt till aquitard.

5. Shallow groundwater flow follows the site topography with flow to the north-northwest. The April 2021 spring water table was generally 1 m below ground surface where mapped.

6. Bedrock groundwater levels at the Erin Branch of the West Credit River are above ground surface when municipal well E8 is not operating.

7. The natural vulnerability of the bedrock aquifer supplying municipal well E8 is medium to low beneath the Site because of overlying aquitard material.

8. Municipal well E8 wellhead protection areas (WHPAs) extend beneath the Site. Policies requiring compliance at the Site concern the WHPA-A, which covers 0.64 hectares of the northwest corner of the Site. This area is proposed to be a park in order to protect the water quality of the municipal well.

9. Highly Vulnerable Aquifer mapping of the Site is related to the overlying sand and gravel, which is not a potable water supply on-site, nor immediately downgradient.

10. CVC annual water balance modelling results for the Site were precipitation (897 mm), evapotranspiration (402-408 mm/year), runoff (114-122 mm/year) and recharge (368-381 mm/year). Considering soil conditions at the Site and existing impervious areas, the pre-development recharge rate for the Site is 340 mm/year.

11. Annual precipitation on average totals (i) 422 mm/year for precipitation events of 10 mm or less, (ii) 605 mm/year for precipitation events of 15 mm or less and (iii) 747 mm/year for events of 20 mm or less.

12. The pre-development recharge rate can be maintained to 80% with a combination of (a) infiltration of 'clean' runoff from precipitation events of 15 mm or less, and (b) permeable area recharge.

13. Provincially significant wetlands, located downgradient of the Site, are identified as mixed swamp cedar hardwood organic (4a SWM4-1), and poplar conifer mineral (5a SWM3-2). These are classified as groundwater slope wetlands with high and medium hydrological sensitivity, respectively.

14. Monitoring of water levels at the wetlands since August 2021 have showed the:

    a. Cedar swamp as generally under recharge conditions with groundwater levels within 0.5 m of surface in fall and winter after some recovery from the summer period; and
    b. Poplar swamp showing seasonal water level variability with water levels during the fall and winter close to surface.

15. CVC wetland annual water balance modelling rates for the types of wetlands identified at the Site were precipitation (897 mm/year), evapotranspiration (578 mm/year), runoff (167 mm/year) and recharge (152 mm/year).

16. A monthly water balance for the wetlands indicated that soil water holding capacities are expected to be less than saturated during the summer months of June to September.

17. Groundwater recharge rates upgradient of the wetlands can be maintained from infiltration of (a) clean roof runoff at LID facilities, (b) preserved buffer areas and (c) pervious areas.

18. The developed wetland risk assignment is high for Wetland 4a, and medium for Wetland 5a. According to the Wetland Risk Evaluation this requires: (i) pre-development monitoring, which is already occurring, (ii) continuous hydrological modelling, which already exists and has been used in this report, and (iii) design of a mitigation plan which has been completed. For the Wetland 4a, given the high-risk assignment, (i) additional groundwater characterization is required which is on-going and (ii) potential use of an integrated hydrology model, which is available as already prepared for CVC, the FEflow model.

19. If sanitary infrastructure is required within the municipal well E8 WHPA-A, higher than standard construction/monitoring requirements must be implemented. These requirements have not been specified as yet by municipal staff. However, it is expected that the sanitary main will be located along 8th Line right-of-way, not on-site, and therefore pass through the WHPA-A and require the additional standards for implementation.

20. Stormwater management facilities are prohibited within the municipal well E8 WHPA-A; however, CVC's stormwater management criteria (2012) state that *"infiltration from "clean" water sources such as roof runoff…will be encouraged in these areas"*.

The following recommendations are provided:

1. Continue the surface water and groundwater monitoring program to further define background conditions as recommended as part of the outcome of the Wetland Risk Evaluation;

2. Submit our report to CVC and the Town of Erin and receive clarification regarding (a) if a private water well survey is required and (b) groundwater quality parameters required for analyses;

3. Fill texture to be classified as loam or a material with a higher infiltration rate than silt.

We trust this information is sufficient for your present needs. Please do not hesitate to contact us if you have any questions.

Yours truly,

TERRA-DYNAMICS CONSULTING INC.

Jayme D. Campbell

Annie Michaud

Jayme D. Campbell, P. Eng.
Senior Water Resources Engineer

Annie Michaud, M.Eng., P. Eng.
Senior Water Resources Engineer

LICENSED PROFESSIONAL ENGINEER
May 18, 2022
J. D. CAMPBELL
J.D.Campbell
PROVINCE OF ONTARIO

cc.
Carleigh Oude-Reimerink, Senior Planning, Project Manager, Armstrong Planning & Project Management
Dragan Zec and Kate Rothwell, Urbantech Consulting
Steven Leslie, WSP

Attachments
Figure 1 – Location of Subject Lands
Figure 2 – Site Details
Figure 3 – Geological Cross-Section A-A’
Figure 5 – Surface water/Groundwater Flow
Appendix A - Hydrographs
Appendix B – Borehole logs
Appendix C – Grain-size Hydraulic Conductivity Analyses
Appendix D – Provincial Maps

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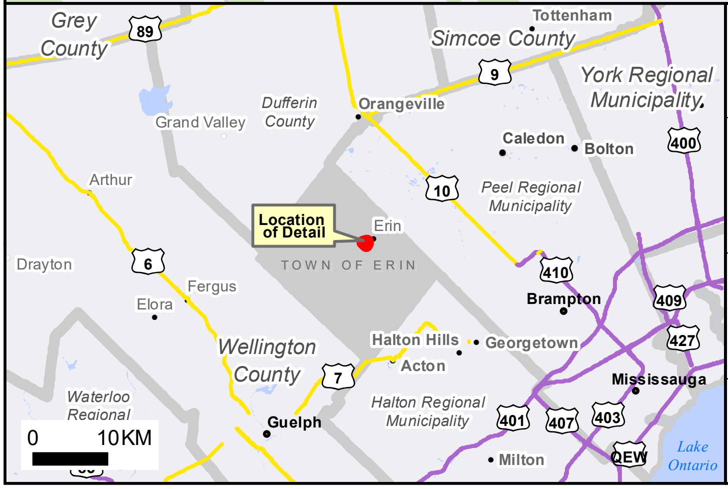


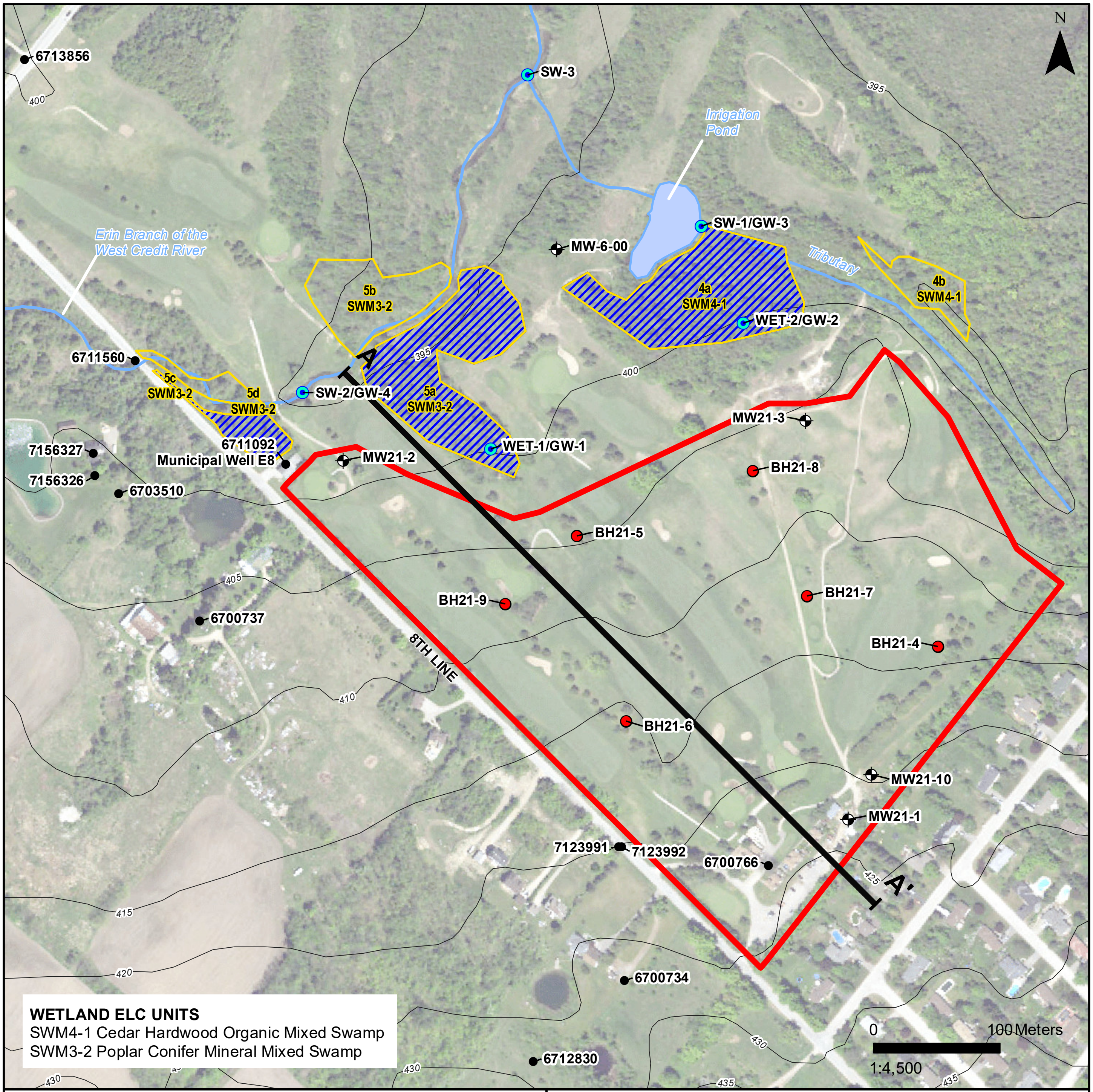
Site Location

Erin Fairways Subdivision
5525 8th Line, Town of Erin, ON
EC (Erin) GP Inc.

Terra-Dynamics Consulting Inc.

Figure 1

Path: H:\TERRA_DYNAMICS\9511 - TD Empire Erin\gis\mxd\Figure 1 Location of Subject Lands.mxd Revised: January 21, 2022



WETLAND ELC UNITS

SWM4-1 Cedar Hardwood Organic Mixed Swamp

SWM3-2 Poplar Conifer Mineral Mixed Swamp

- ▭ Subject Lands
- ▨ Wetlands
- 🟦 Irrigation Pond
- ▭ Ecological Land Classification
- ⊢⊣ Geologic Cross-section Location
- — Ground Surface Contour (5m)
- — Watercourse
- ● Geotechnical Borehole
- ⌖ Monitoring Well
- • Water Well Record (MECP)
- ◉ Drive-point Piezometers and Staff Gauges

Site Details

Erin Fairways Subdivision
5525 8th Line, Town of Erin, ON
EC (Erin) GP Inc.

TDC Terra-Dynamics Consulting Inc.

Figure 2

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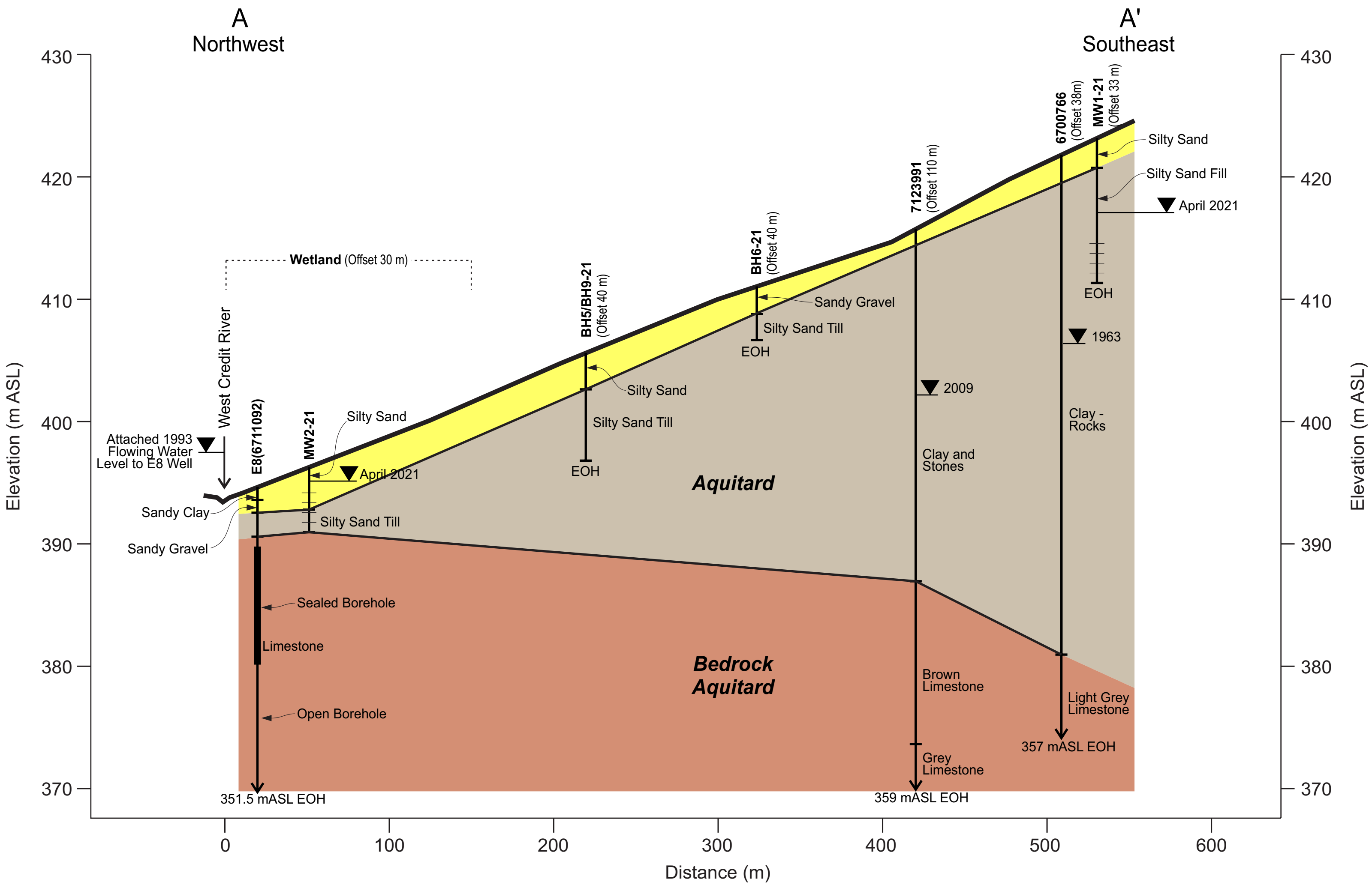

Borehole

Well Screen

EOH End of Hole

▼ Waterlevel

🟨 Sand/Gravel

▨ Silty Sand Till

🟫 Bedrock

Geologic Cross-section A-A’

Erin Fairways Subdivision
5525 8th Line, Town of Erin, ON
EC (Erin) GP Inc.

TDC Terra-Dynamics Consulting Inc.

Figure 3

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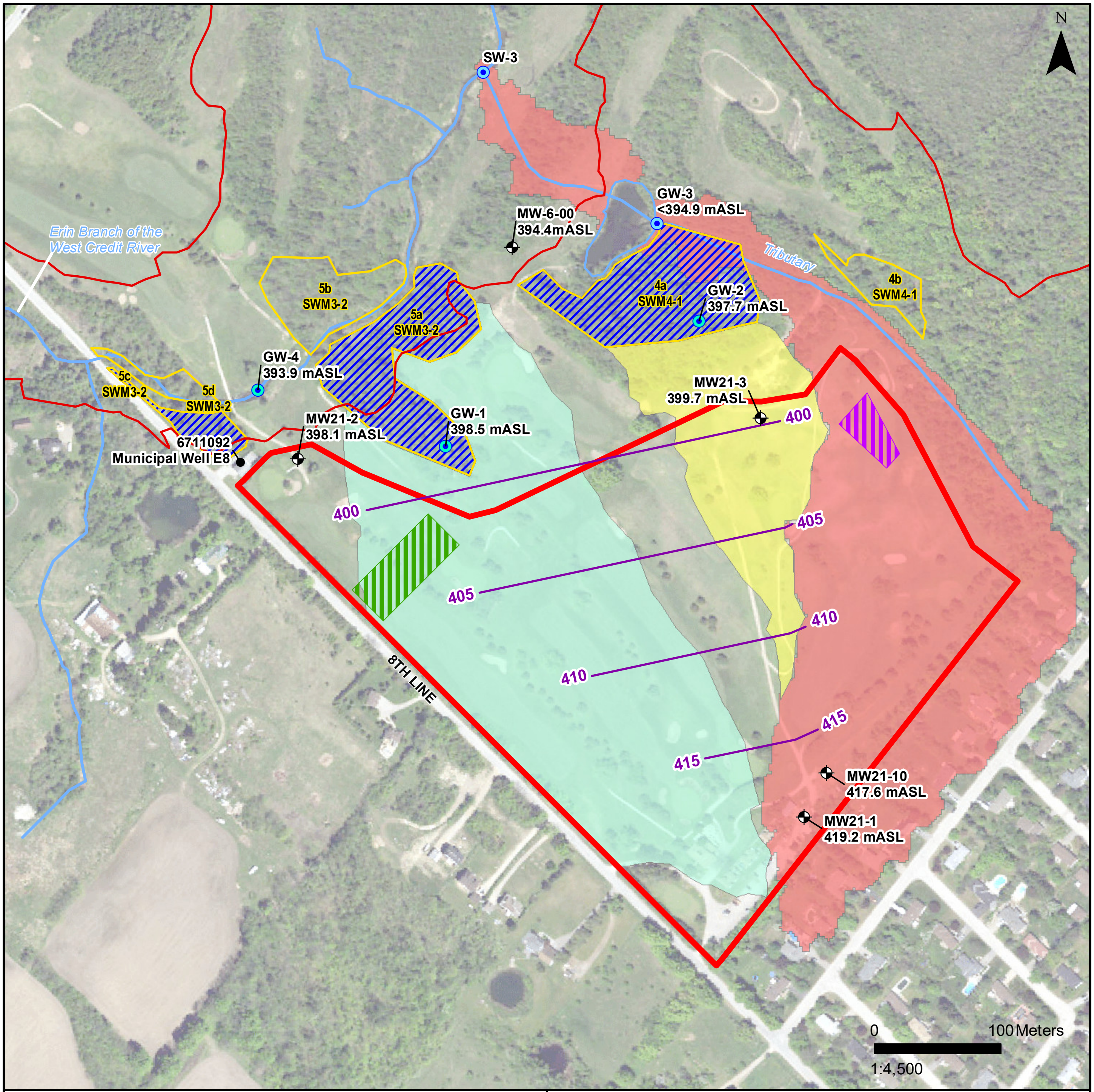


- 🟥 Subject Lands
- ▨ Wetlands
- ☐ Ecological Land Classification
- 🟩 Area for Infiltration of Clean Water
- ▥ Surface Infiltration Gallery
- — Watercourse
- ⊕ Monitoring Well
- ● Water Well Record (MECP)
- ◉ Drive-point piezometers – groundwater levels November 10, 2021
- — Shallow Groundwater Flow Contour (December 14, 2021)
- — Floodplain (Credit Valley Conservation 2008)

Catchment Areas

🟨 Wetland 4a 🟦 Wetland 5a 🟥 Tributary

Surface water / Groundwater Flow

Erin Fairways Subdivision
5525 8th Line, Town of Erin, ON
EC (Erin) GP Inc.

TDC Terra-Dynamics Consulting Inc.

Figure 5

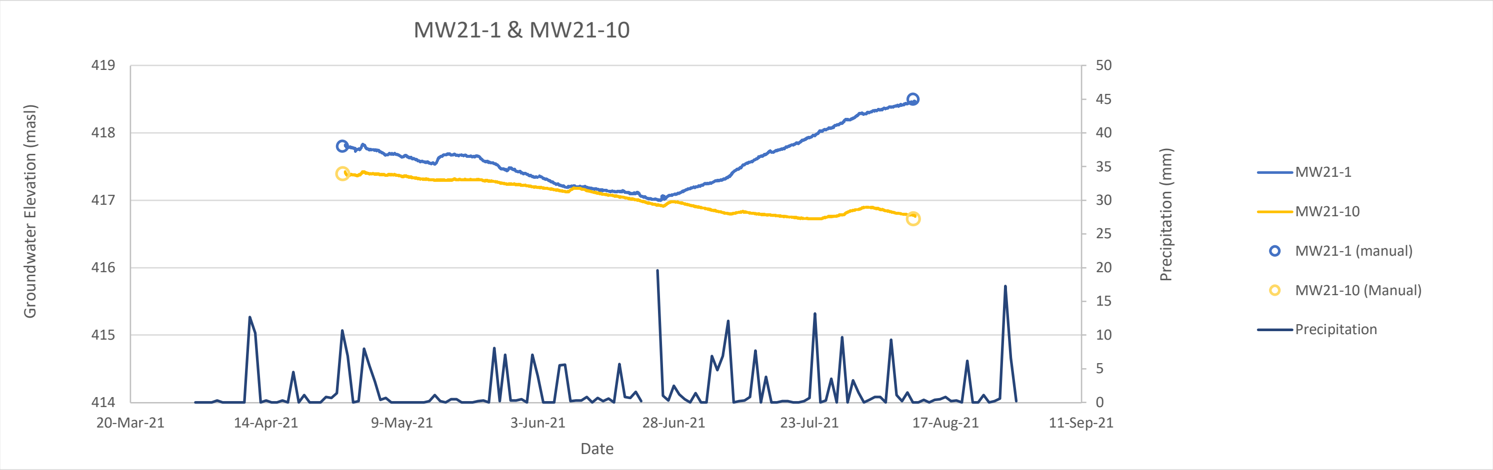
Path: H:\TERRA_DYNAMICS\9511 - TD Empire Erin\gis\mxd\Figure 5 Surfacewater Groundwater flow.mxd Revised: April 8, 2022

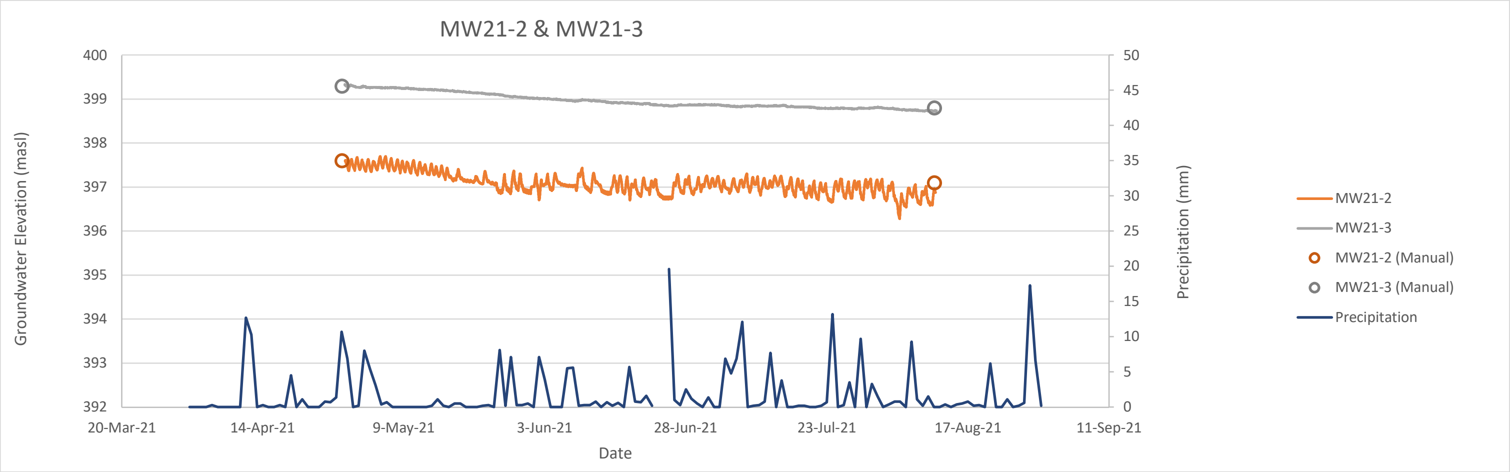
Appendix A

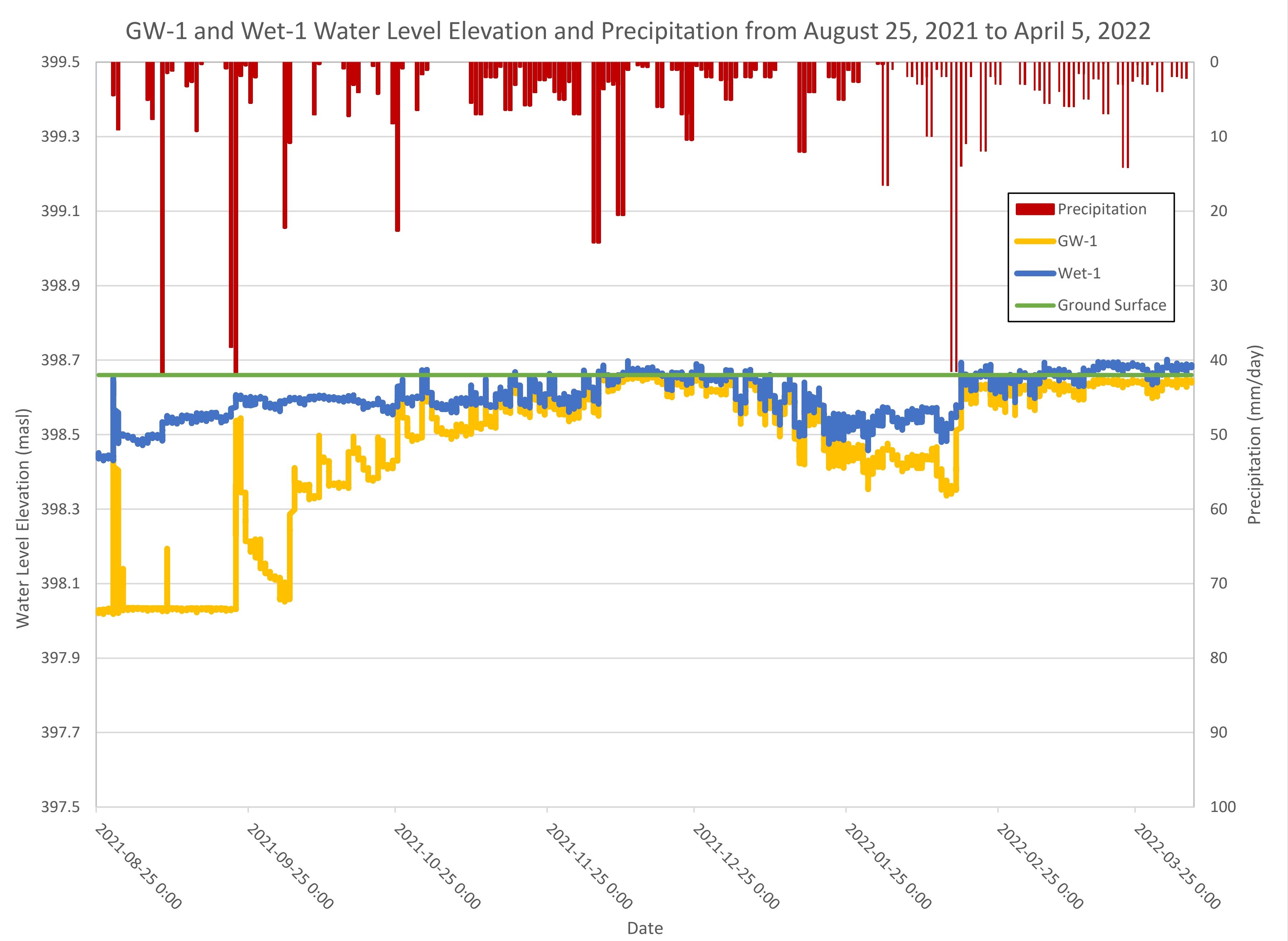
Hydrographs

Erin Heights Golf Course Hydrographs

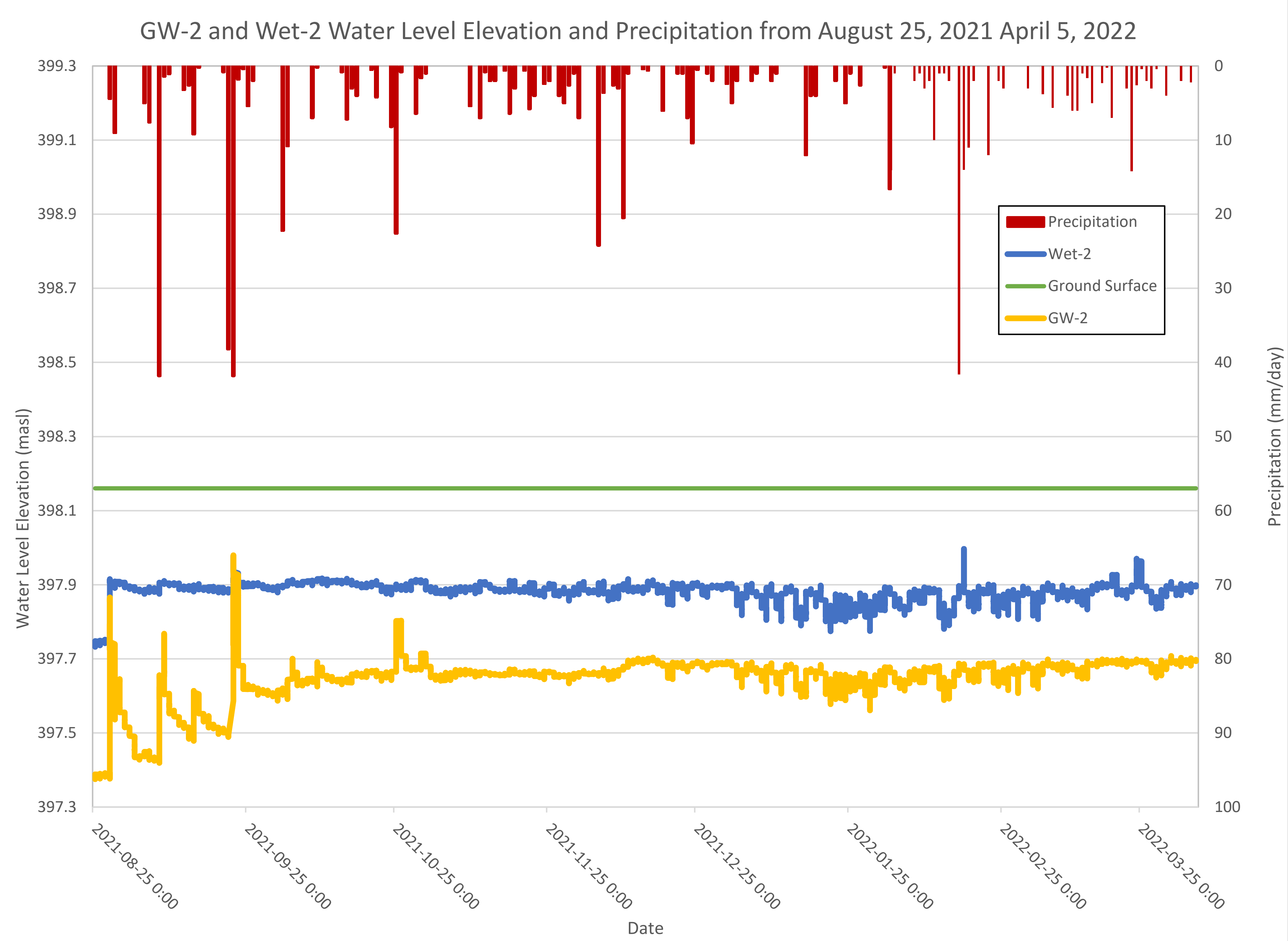
	Ground Surface (masl)	28-Apr-21		11-Aug-21	
		WL (mbgs)	WL (masl)	WL (mbgs)	WL (masl)
BH21-1	422.8	5.0	417.8	3.3	419.5
BH21-2	398.8	1.2	397.6	1.7	397.1
BH21-3	405.7	6.3	399.3	6.9	398.8
BH21-10	419.1	1.7	417.4	2.4	416.7

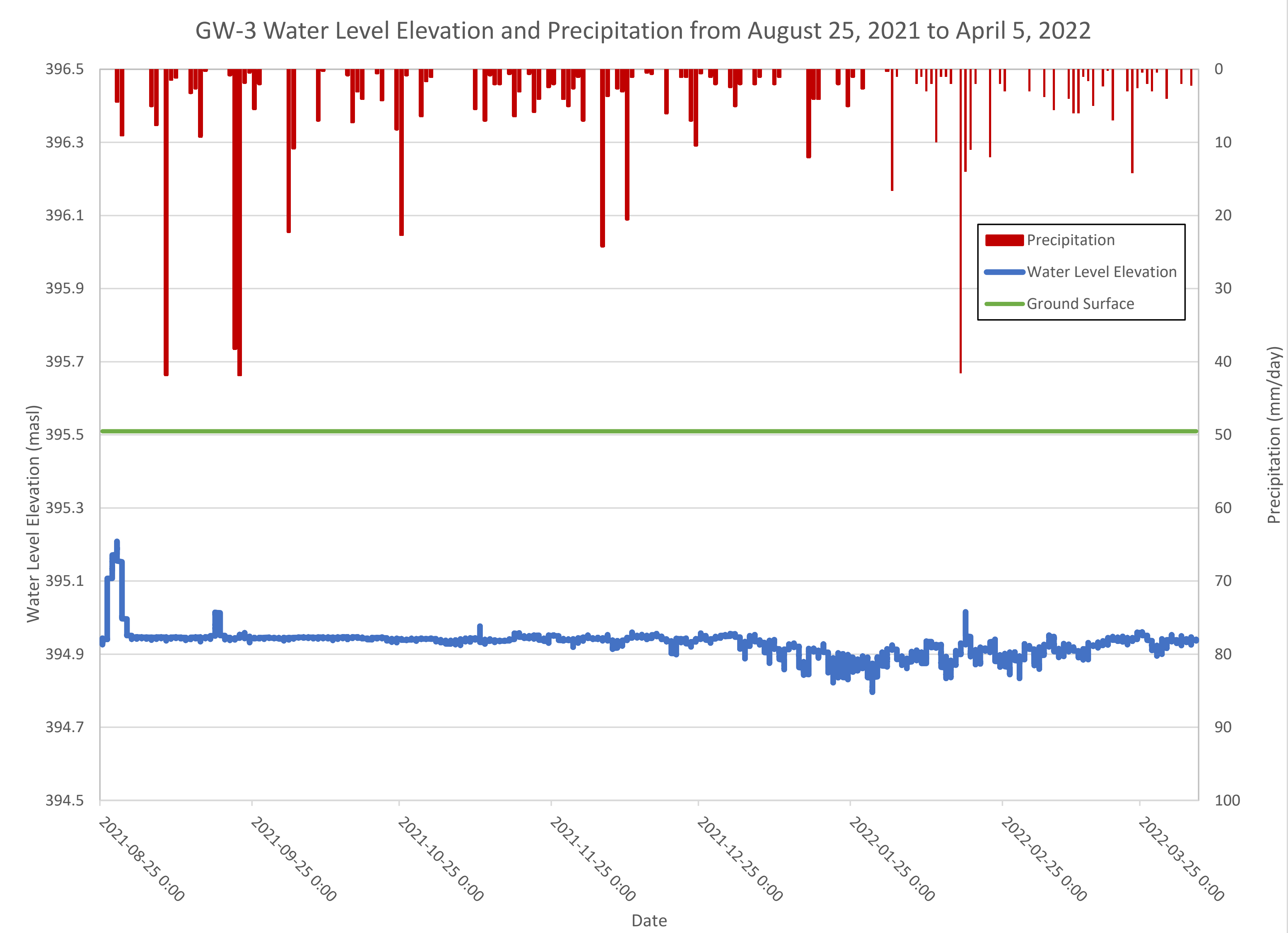


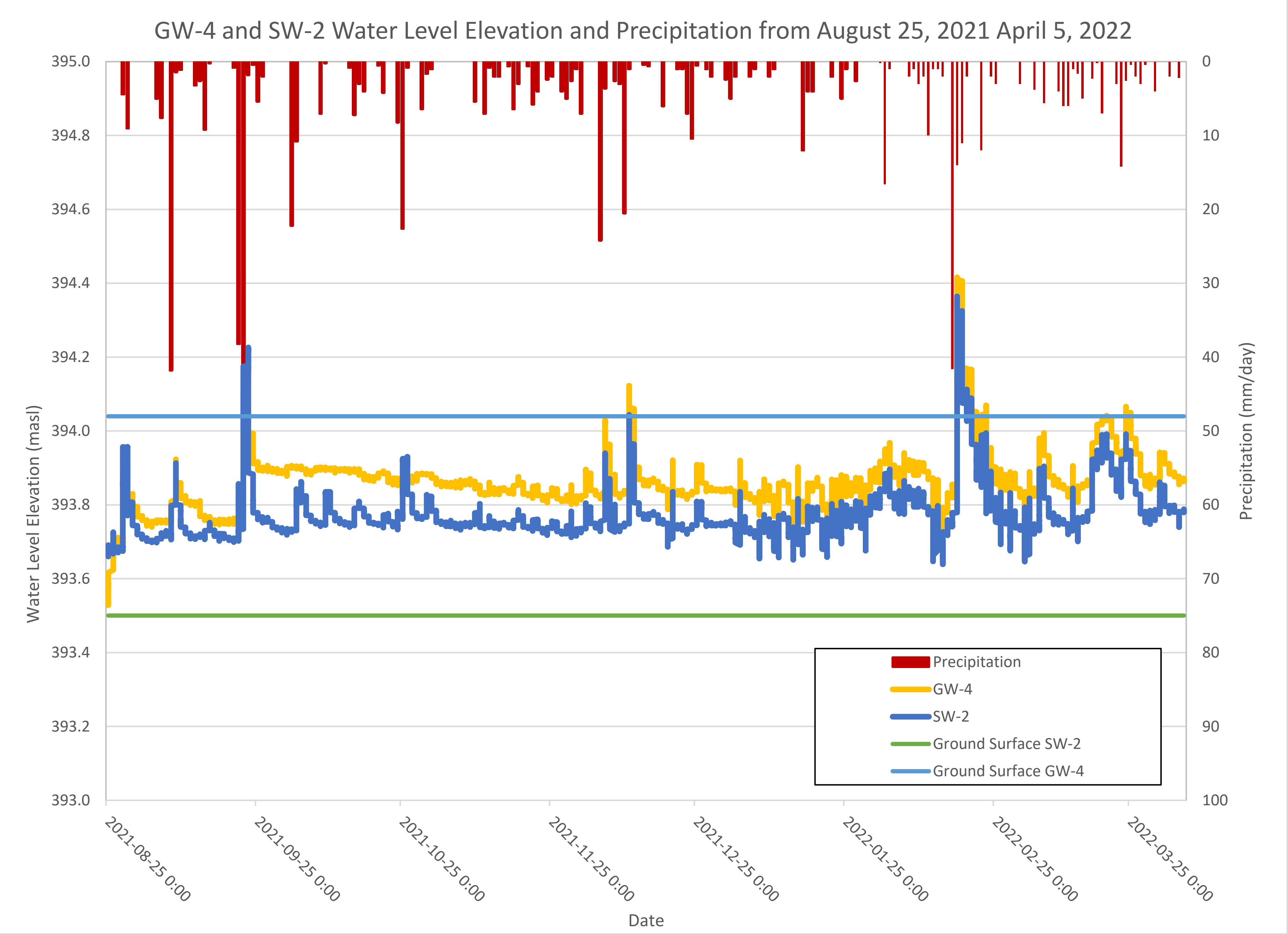


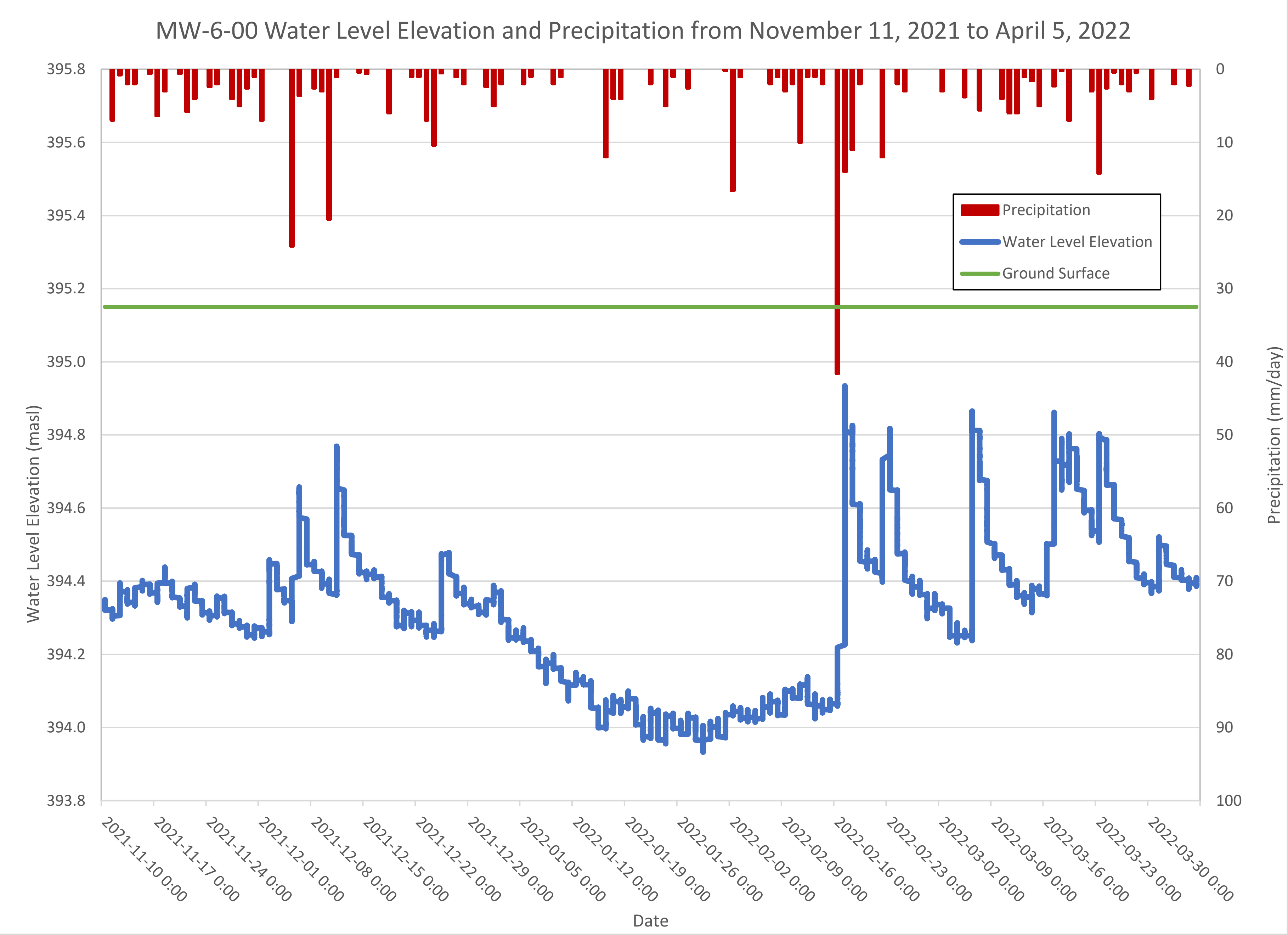


GW-1 and Wet-1 Water Level Elevation and Precipitation from August 25, 2021 to April 5, 2022
Water Level Elevation (masl)
399.5
399.3
399.1
398.9
398.7
398.5
398.3
398.1
397.9
397.7
397.5
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
GW-1
Wet-1
Ground Surface
2021-08-25 0:00
2021-09-25 0:00
2021-10-25 0:00
2021-11-25 0:00
2021-12-25 0:00
2022-01-25 0:00
2022-02-25 0:00
2022-03-25 0:00
Date


GW-2 and Wet-2 Water Level Elevation and Precipitation from August 25, 2021 April 5, 2022
Water Level Elevation (masl)
399.3
399.1
398.9
398.7
398.5
398.3
398.1
397.9
397.7
397.5
397.3
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Wet-2
Ground Surface
GW-2
2021-08-25 0:00
2021-09-25 0:00
2021-10-25 0:00
2021-11-25 0:00
2021-12-25 0:00
2022-01-25 0:00
2022-02-25 0:00
2022-03-25 0:00
Date


GW-3 Water Level Elevation and Precipitation from August 25, 2021 to April 5, 2022
Water Level Elevation (masl)
396.5
396.3
396.1
395.9
395.7
395.5
395.3
395.1
394.9
394.7
394.5
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Water Level Elevation
Ground Surface
2021-08-25 0:00
2021-09-25 0:00
2021-10-25 0:00
2021-11-25 0:00
2021-12-25 0:00
2022-01-25 0:00
2022-02-25 0:00
2022-03-25 0:00
Date


GW-4 and SW-2 Water Level Elevation and Precipitation from August 25, 2021 April 5, 2022
Water Level Elevation (masl)
395.0
394.8
394.6
394.4
394.2
394.0
393.8
393.6
393.4
393.2
393.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
2021-08-25 0:00
2021-09-25 0:00
2021-10-25 0:00
2021-11-25 0:00
2021-12-25 0:00
2022-01-25 0:00
2022-02-25 0:00
2022-03-25 0:00
Date
Precipitation
GW-4
SW-2
Ground Surface SW-2
Ground Surface GW-4


MW-6-00 Water Level Elevation and Precipitation from November 11, 2021 to April 5, 2022
Water Level Elevation (masl)
395.8
395.6
395.4
395.2
395.0
394.8
394.6
394.4
394.2
394.0
393.8
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Water Level Elevation
Ground Surface
2021-11-10 0:00
2021-11-17 0:00
2021-11-24 0:00
2021-12-01 0:00
2021-12-08 0:00
2021-12-15 0:00
2021-12-22 0:00
2021-12-29 0:00
2022-01-05 0:00
2022-01-12 0:00
2022-01-19 0:00
2022-01-26 0:00
2022-02-02 0:00
2022-02-09 0:00
2022-02-16 0:00
2022-02-23 0:00
2022-03-02 0:00
2022-03-09 0:00
2022-03-16 0:00
2022-03-23 0:00
2022-03-30 0:00
Date

Appendix B

Borehole Logs

DS CONSULTANTS LTD.
Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE MW21-1

1 OF 1

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846537.081 E 573786.33

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-15-2021

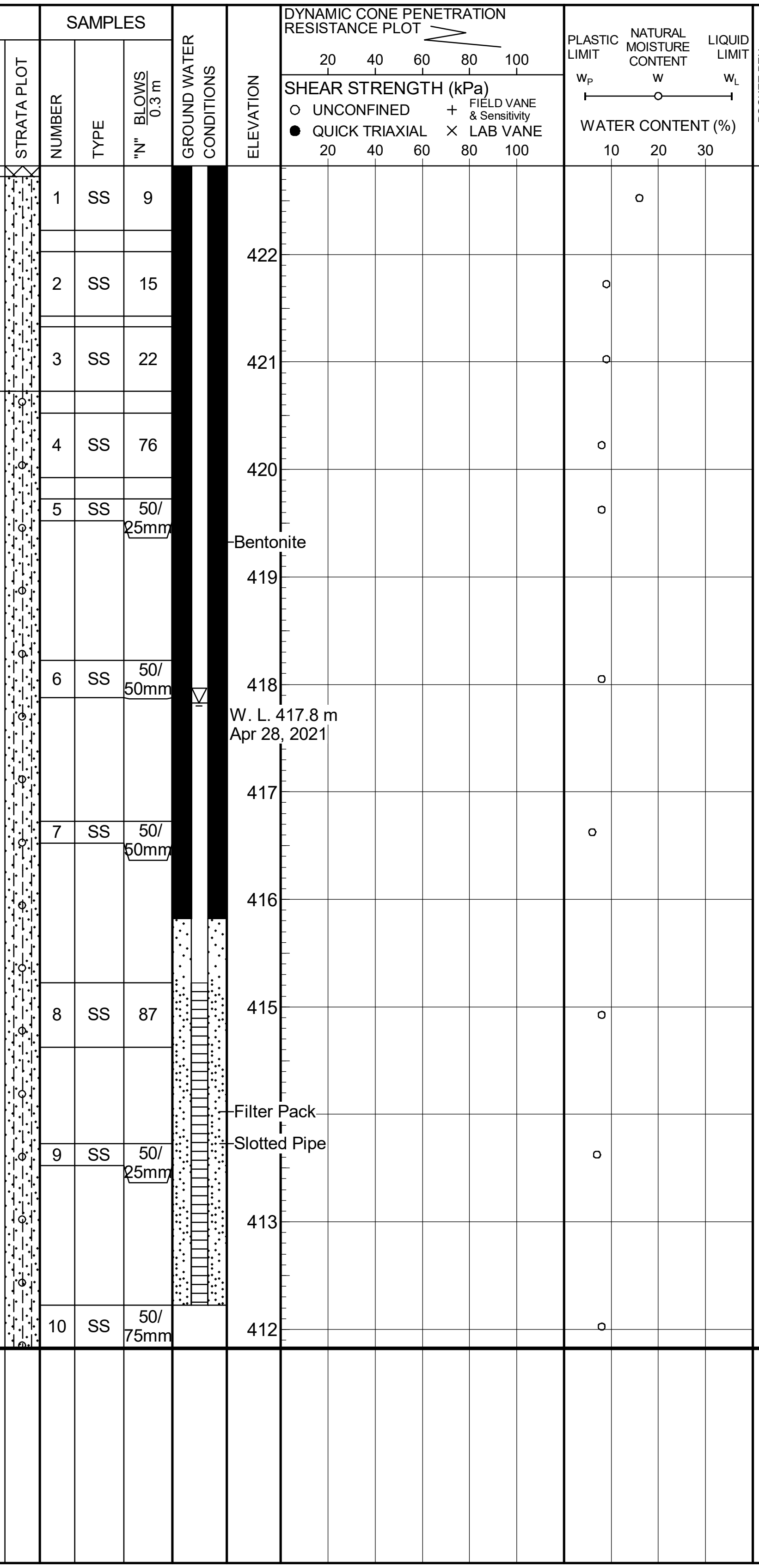
REF. NO.: 21-129-300
ENCL NO.: 2

ELEV (m) / DEPTH	DESCRIPTION
422.8	
422.7 0.1	**GRANULAR FILL:** 50mm
	SILT AND SAND: trace gravel, trace clay, brown, moist, loose to compact
420.7 2.1	**SILTY SAND TILL:** some gravel, some clay, cobble/boulder sizes, brown, moist, very dense wet below 7.6m
411.8 11.0	**END OF BOREHOLE:**

Notes:
1) 50mm dia. monitoring well installed upon completion.
2) Water level Reading:

Date: Water Level (mbgl):
April 28, 2021 5.0

SAMPLES NUMBER	TYPE	"N" BLOWS / 0.3 m	GR	SA	SI	CL
1	SS	9	9	46	37	8
2	SS	15				
3	SS	22				
4	SS	76				
5	SS	50/ 25mm				
6	SS	50/ 50mm				
7	SS	50/ 50mm				
8	SS	87	11	45	31	13
9	SS	50/ 25mm				
10	SS	50/ 75mm				



GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity ○ ^{8}=3% Strain at Failure

LOG OF BOREHOLE MW21-2

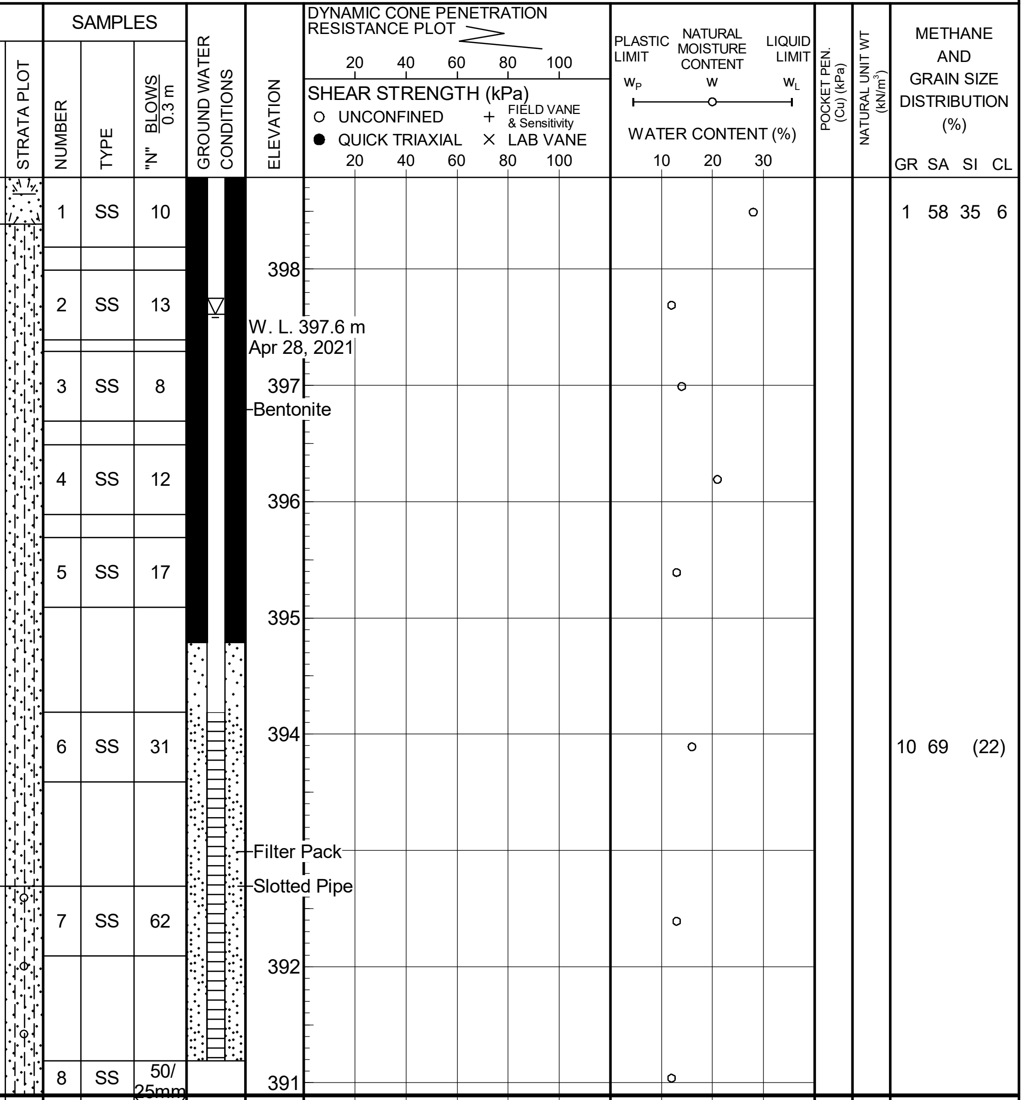
1 OF 1

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846813.344 E 573411.482

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-19-2021

REF. NO.: 21-129-300
ENCL NO.: 3

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	GR	SA	SI	CL
398.8								
0.0	**TOPSOIL:** 350mm	1	SS	10	1	58	35	6
398.4 0.4	**SILTY SAND:** trace to some gravel, trace clay, brown, moist, loose to compact	2	SS	13				
	wet below 1.5m	3	SS	8				
		4	SS	12				
		5	SS	17				
		6	SS	31	10	69	(22)	
392.7 6.1	**SILTY SAND TILL:** some clay, cobble/boulder sizes, brown, moist, very dense	7	SS	62				
390.9		8	SS	50/ 25mm				
7.9	**END OF BOREHOLE:** Notes: 1) 50mm dia. monitoring well installed upon completion. 2) Water level Reading: Date: Water Level (mbgl): April 28, 2021 1.18							



GRAPH NOTES: + 3, × 3: Numbers refer to Sensitivity ○ 8=3% Strain at Failure

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

LOG OF BOREHOLE MW21-3

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846862.76 E 573771.456

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-16-2021

REF. NO.: 21-129-300
ENCL NO.: 4

(m) ELEV DEPTH	DESCRIPTION
405.7	
0.0	**TOPSOIL:** 250mm
405.4 0.3	**FILL**: sand, some silt to silty, some gravel, trace clay, trace organics, brown, moist, loose to compact
402.7 3.0	**SILTY SAND:** trace gravel, trace clay, brown, moist to wet, compact to dense wet below 4.6m
399.6 6.1	**SILTY SAND TILL:** gravelly, brown, wet, compact layer of sand, medium to coarse
397.5 8.2	**END OF BOREHOLE:** Notes: 1) 50mm dia. monitoring well installed upon completion. 2) Water level Reading: Date: Water Level (mbgl): April 28, 2021 6.33

SAMPLES NUMBER	TYPE	"N" BLOWS / 0.3 m	GR	SA	SI	CL
1	SS	4				
2	SS	6	14	67	15	4
3	SS	8				
4	SS	22				
5	SS	15				
6	SS	31	4	59	32	5
7	SS	12				
8	SS	12				

GROUND WATER CONDITIONS:
Bentonite
Filter Pack
Slotted Pipe
W. L. 399.3 m
Apr 28, 2021

ELEVATION: 405, 404, 403, 402, 401, 400, 399, 398

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE: 20 40 60 80 100
PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%): 10 20 30
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m^3)
METHANE AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity ○ ^{8}=3% Strain at Failure

LOG OF BOREHOLE BH21-4

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846678.156 E 573864.767

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-15-2021

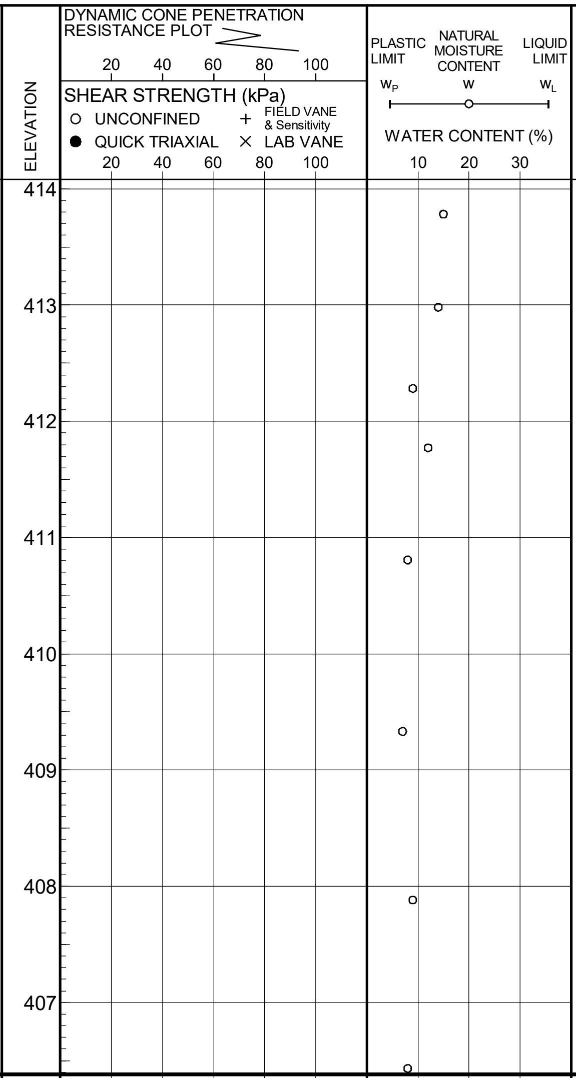
REF. NO.: 21-129-300
ENCL NO.: 5

SOIL PROFILE (m) ELEV DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
414.1 0.0	**TOPSOIL:** 250mm					
413.8 0.3	**FILL**: silty sand, some gravel, trace clay, brown, moist, loose	1	SS	2		
		2	SS	6		16 44 32 8
		3	SS	9		
411.8 2.3	**SILTY SAND TILL:** cobble/boulder sizes, brown, moist to wet, very dense	4	SS	50/ 25mm		
		5	SS	50/ 50mm		
	wet below 4.6m	6	SS	50		
		7	SS	50/ 75mm		
406.4 7.7	**END OF BOREHOLE:**	8	SS	50/ 50mm		

Notes:

1) Water level in open borehole:

Date: Water Level (mbgl):
on completion 4.6



POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m^3)

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ^{8}=3% Strain at Failure

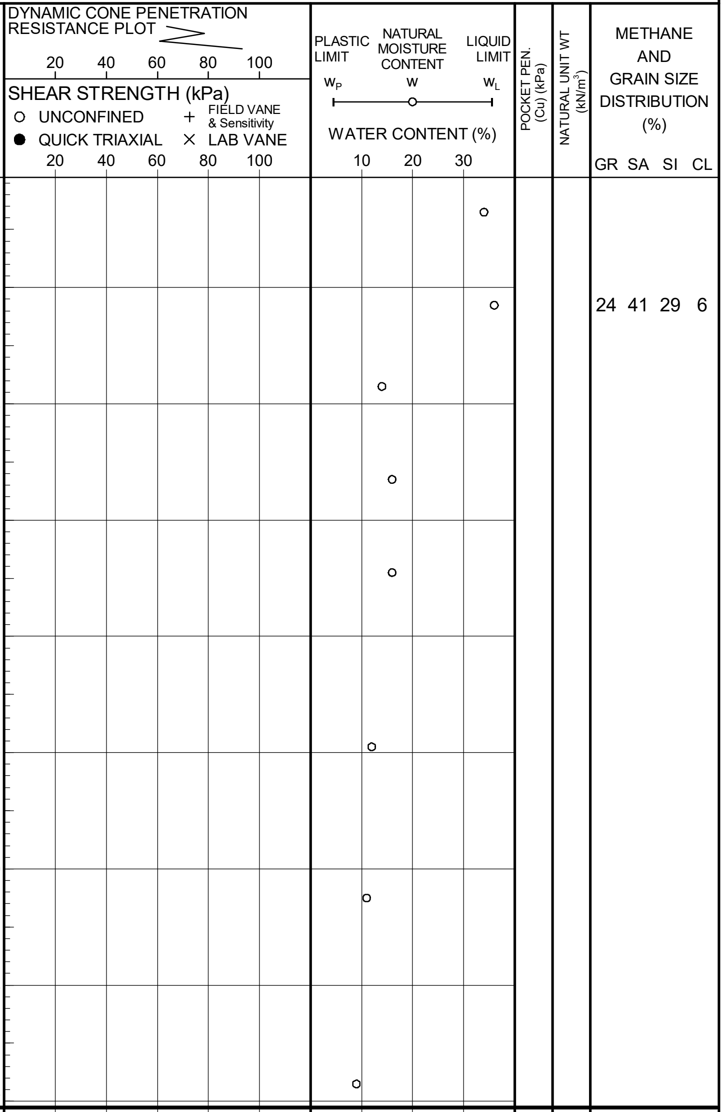
LOG OF BOREHOLE BH21-5

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846760.737 E 573587.463

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-16-2021

REF. NO.: 21-129-300
ENCL NO.: 6

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	ELEVATION	GR	SA	SI	CL
404.9 0.0	**TOPSOIL:** 200mm								
404.7 0.2	**FILL**: silty sand, gravelly, trace clay, brown, wet, loose	1	SS	4					
		2	SS	4	404	24	41	29	6
403.4 1.5	**SILTY SAND**: trace gravel, brown, moist to wet, compact	3	SS	11	403				
	wet below 2.3m	4	SS	15	402				
		5	SS	25	401				
400.3 4.6	**SILTY SAND TILL:** cobble/boulder sizes, brown to grey, moist, very dense	6	SS	50	400				
		7	SS	50/ 50mm	399 398				
396.9		8	SS	50/ 100mm	397				
8.0	**END OF BOREHOLE:**								



Notes:

1) Water level in open borehole:

Date: Water Level (mbgl):
on completion 2.3

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

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Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

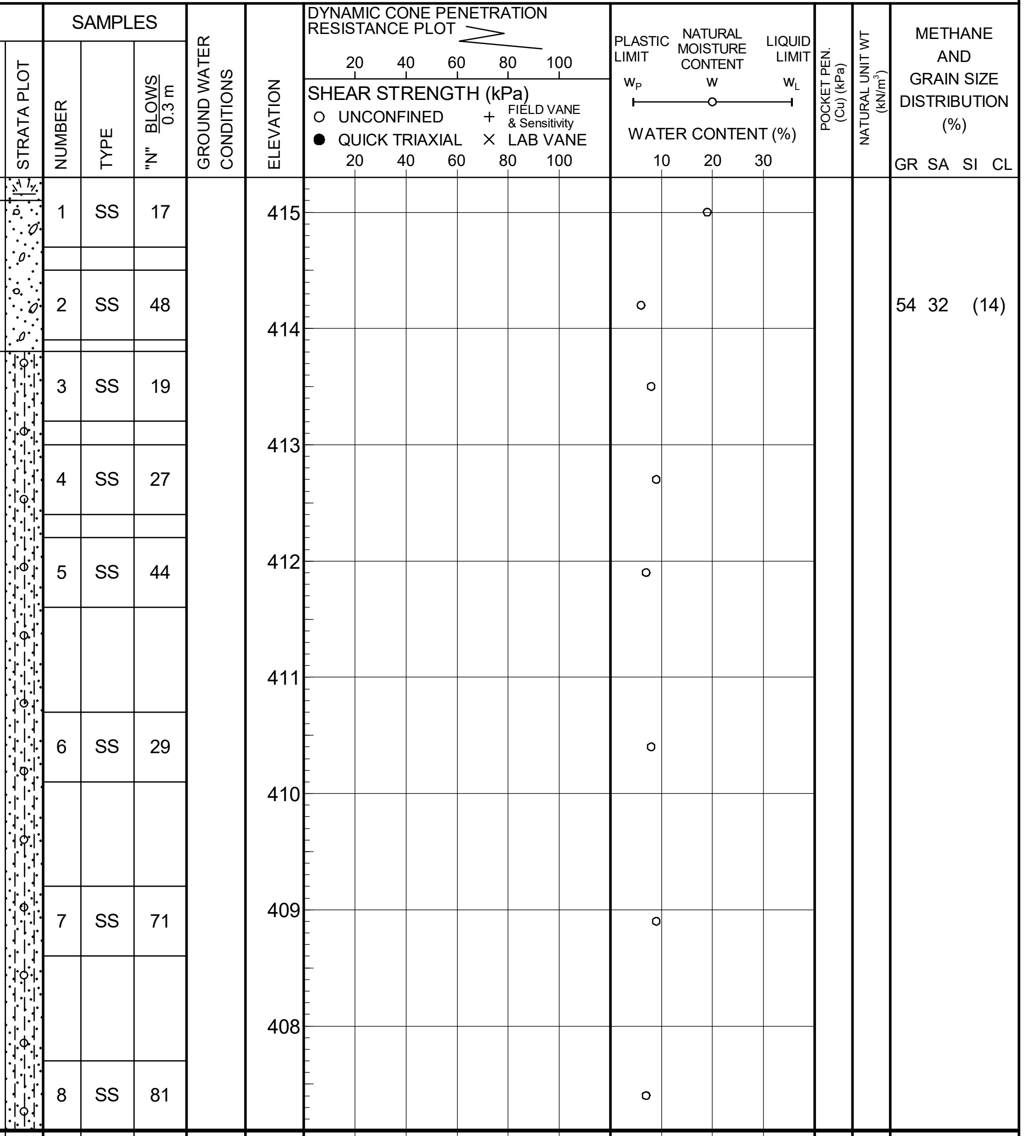
LOG OF BOREHOLE BH21-6

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846610.242 E 573617.42

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-16-2021

REF. NO.: 21-129-300
ENCL NO.: 7

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
415.3 0.0	**TOPSOIL:** 200mm					
415.1 0.2	**SANDY GRAVEL**: some silt, brown, moist, compact to dense	1	SS	17		
		2	SS	48		54 32 (14)
413.8 1.5	**SILTY SAND TILL:** cobble/boulder sizes, brown to grey, moist, compact to very dense	3	SS	19		
		4	SS	27		
		5	SS	44		
		6	SS	29		
		7	SS	71		
		8	SS	81		
407.1 8.2	**END OF BOREHOLE:** Notes: 1) Borehole open and dry upon completion.					



GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES +³, ×³: Numbers refer to Sensitivity ○ ³=3% Strain at Failure

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LOG OF BOREHOLE BH21-7

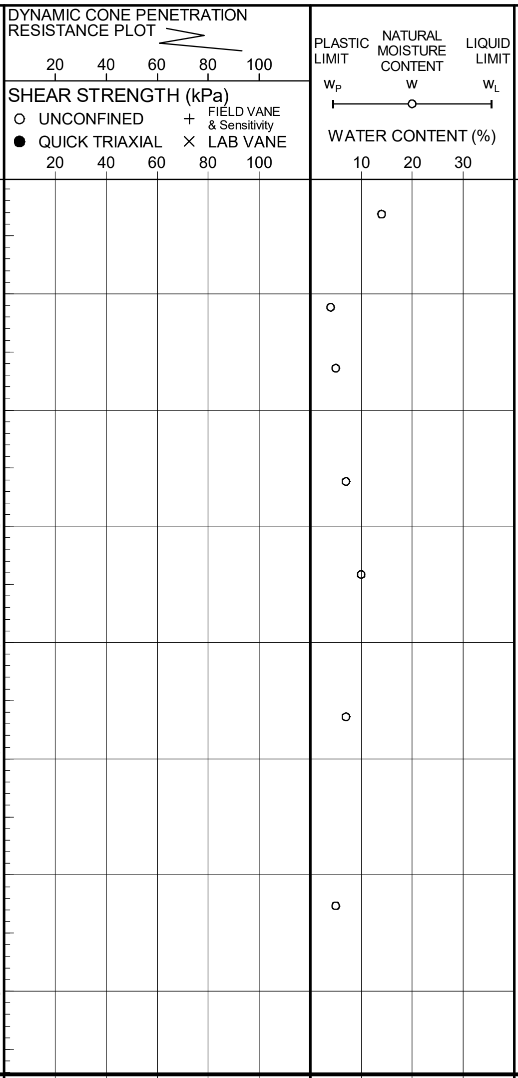
1 OF 1

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846717.062 E 573766.909

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-15-2021

REF. NO.: 21-129-300
ENCL NO.: 8

(m) ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
412.0							
411.9 0.1	**TOPSOIL:** 100mm						
	SAND AND GRAVEL: some silt, brown, moist, loose to very dense	1	SS	4			
		2	SS	65		411	36 47 (17)
		3	SS	50/100mm		410	
409.7 2.3	**SILTY SAND TILL:** cobble/boulder sizes, brown to grey, moist to wet, compact to very dense wet below 3m depth	4	SS	28		409	
		5	SS	18		408	
		6	SS	50/25mm		407	
		7	SS	50/25mm		406 405	
404.3		8	SS	50/25mm			
7.7	**END OF BOREHOLE:** Notes: 1) Water level in open borehole: Date: Water Level (mbgl): on completion 3.0						



POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

DS SOIL LOG 21-129-300 ERIN HEIGHTS BOREHOLE LOGS.GPJ DS.GDT 21-5-5

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE BH21-8

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846819.483 E 573729.609

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-16-2021

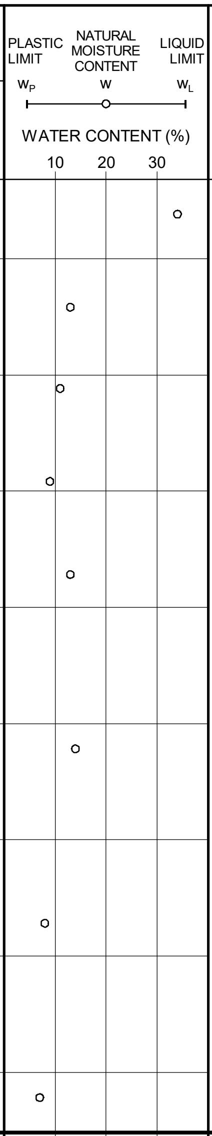
REF. NO.: 21-129-300
ENCL NO.: 9

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
407.7							
407.5 0.0	**TOPSOIL:** 150mm						
0.2	**GRAVELLY SAND**: some silt, brown, moist, loose to compact	1	SS	3			
						407	
		2	SS	19			34 53 (13)
						406	
		3	SS	30			
		4	SS	24		405	
		5	SS	23			
						404	
403.1 4.6	**SILTY SAND**: some gravel, brown, moist to wet, dense to loose					403	
		6	SS	35			
						402	
	wet at 6.1m depth disturbed at 6.1m	7	DIST	(disturbed)			
						401	
400.1 7.6	**SILTY SAND TILL:** brown, moist, dense					400	
		8	SS	39			
399.5 8.2	**END OF BOREHOLE:**						

Notes:

1) Water level in open borehole:

Date: Water Level (mbgl):
on completion 6.1



GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ 8=3% Strain at Failure

LOG OF BOREHOLE BH21-9

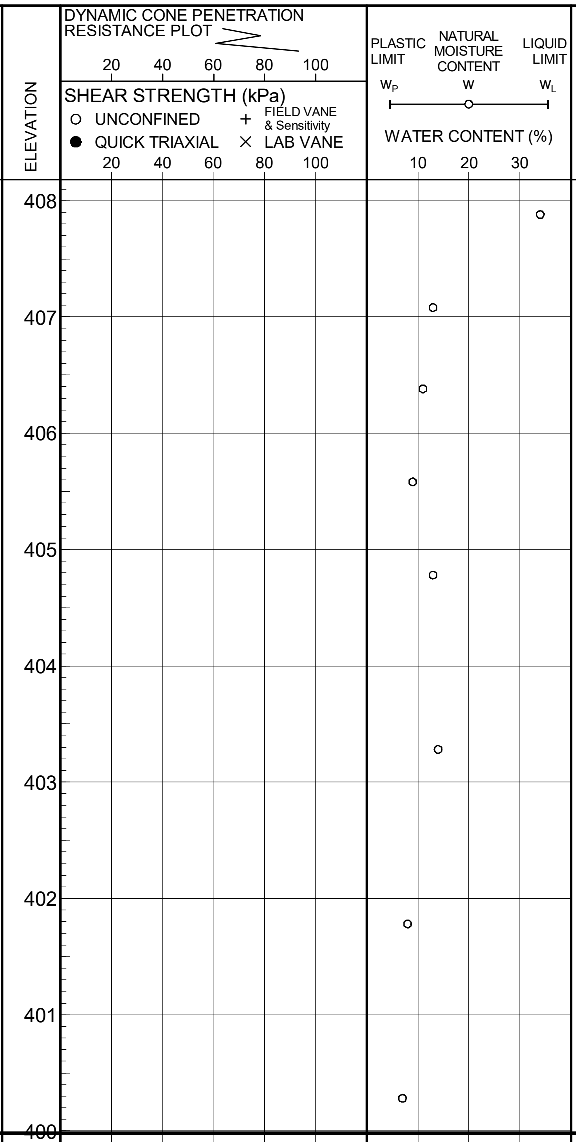
1 OF 1

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846702.204 E 573529.376

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-19-2021

REF. NO.: 21-129-300
ENCL NO.: 10

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
408.2 0.0	**TOPSOIL:** 100mm							
408.1 0.1	**FILL**: sand and silt, trace clay, mixed with organics/topsoil, very loose to compact	1	SS	3				41 51 8
		2	SS	2				
		3	SS	10				
405.9 2.3	**SILTY SAND TILL:** brown, moist to wet, compact to very dense	4	SS	31				
	wet at 3m depth	5	SS	13				
	layer of medium to coarse sand	6	SS	33				
		7	SS	54				
400.0 8.2		8	SS	47				



END OF BOREHOLE:
Notes:

1) Water level in open borehole:

Date: Water Level (mbgl):
on completion 3.0

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+³, ×³: Numbers refer to Sensitivity
○ ³=3% Strain at Failure

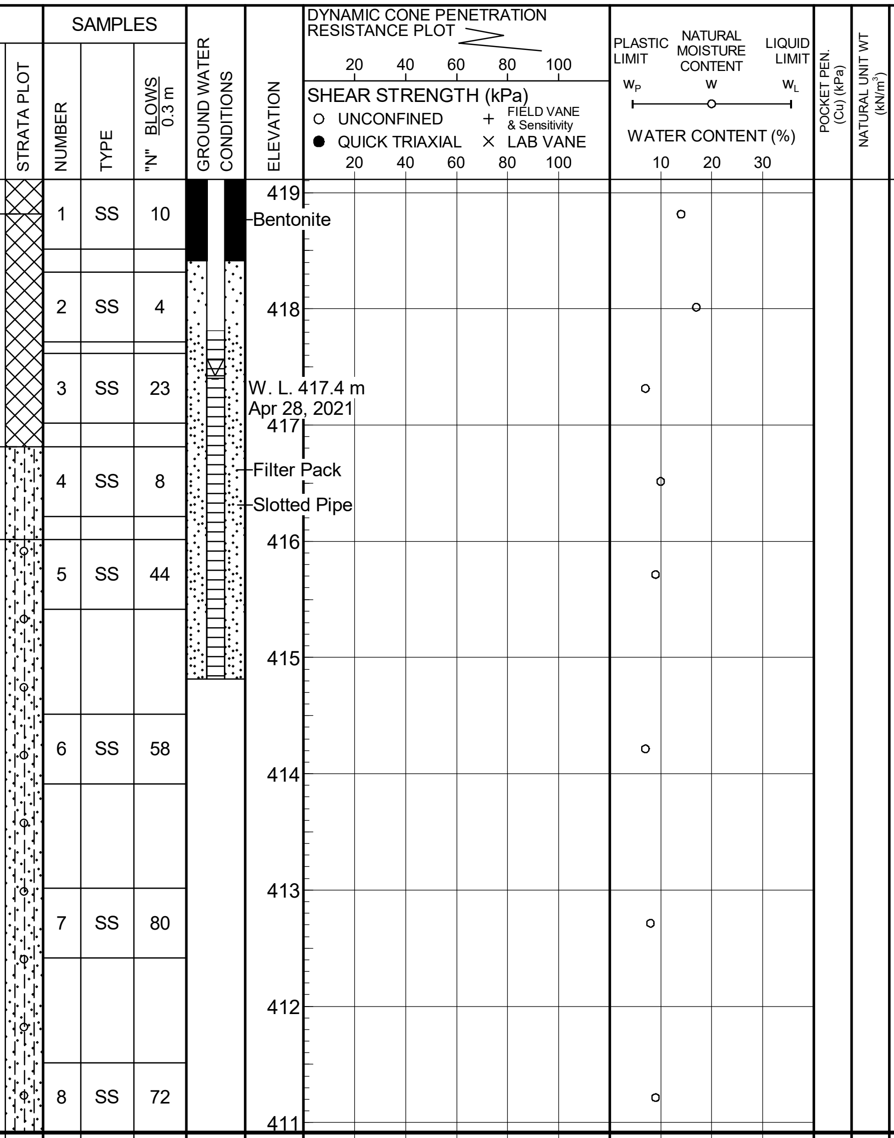
LOG OF BOREHOLE MW21-10

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846573.281 E 573806.122

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-19-2021

REF. NO.: 21-129-300
ENCL NO.: 11

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	GR	SA	SI	CL
419.1 0.0	**GRANULAR FILL:** 250mm	1	SS	10				
418.8 0.3	**FILL**: silty sand, some gravel, trace clay, brown, moist, loose to compact	2	SS	4	11	54	26	9
		3	SS	23				
416.8 2.3	**SILTY SAND:** trace gravel, trace clay, brown, wet, loose	4	SS	8	8	57	26	9
416.0 3.1	**SILTY SAND TILL:** gravelly, brown to grey, moist, dense to very dense	5	SS	44				
		6	SS	58				
		7	SS	80				
		8	SS	72				
410.9 8.2	**END OF BOREHOLE:** Notes: 1) 50mm dia. monitoring well installed upon completion. 2) Water level Reading: Date: Water Level (mbgl): April 28, 2021 1.69							



GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
○ 3=3% Strain at Failure

Appendix C

Grain Size Analyses

K from Grain Size Analysis Report

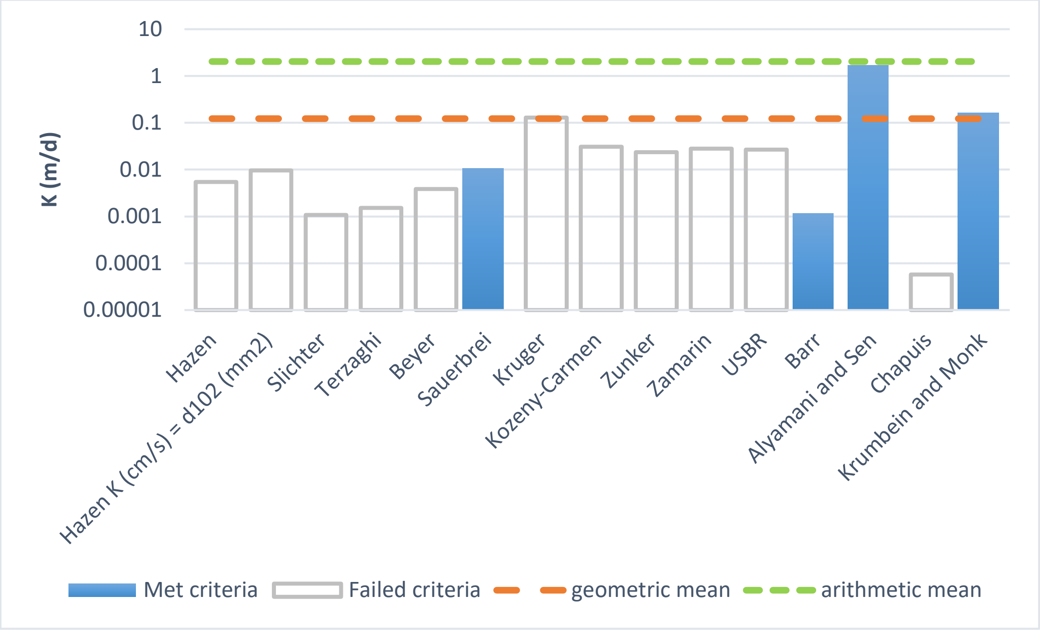
Date: 20-May-21

Sample Name: MW21-1, SS1, 0.3 mBGS, Silt and Sand

Mass Sample (g): 100

T (oC) 20

Poorly sorted gravelly sand with fines



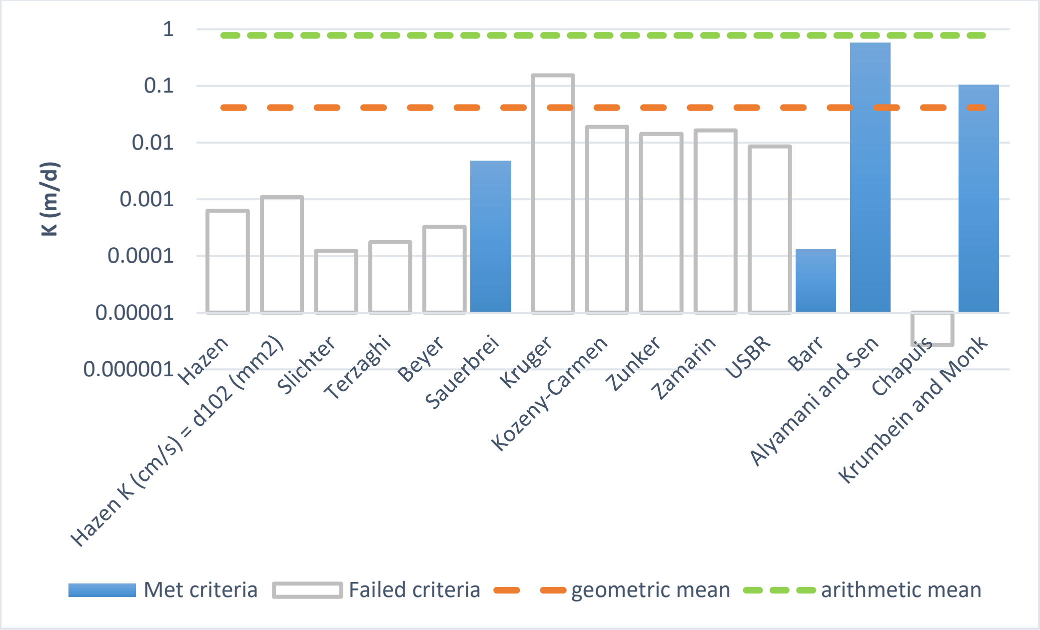
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.631E-05	.631E-07	0.01	
Hazen K (cm/s) = d_{10} (mm)	.111E-04	.111E-06	0.01	
Slichter	.124E-05	.124E-07	0.00	
Terzaghi	.177E-05	.177E-07	0.00	
Beyer	.444E-05	.444E-07	0.00	
Sauerbrei	.123E-04	.123E-06	0.01	
Kruger	.150E-03	.150E-05	0.13	
Kozeny-Carmen	.356E-04	.356E-06	0.03	
Zunker	.273E-04	.273E-06	0.02	
Zamarin	.324E-04	.324E-06	0.03	
USBR	.311E-04	.311E-06	0.03	
Barr	.133E-05	.133E-07	0.00	
Alyamani and Sen	.196E-02	.196E-04	1.70	
Chapuis	.661E-07	.661E-09	0.00	
Krumbein and Monk	.187E-03	.187E-05	0.16	
Shepherd	.965E-02	.965E-04	8.33	
geometric mean meeting criteria	5.E-05	5.E-07	4.E-02	
arithmetic mean meeting criteria	5.E-04	5.E-06	5.E-01	

K from Grain Size Analysis Report Date: 20-May-21

Sample Name: MW21-1, SS8, 7.9 mBGS, Silty Sand Till

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines



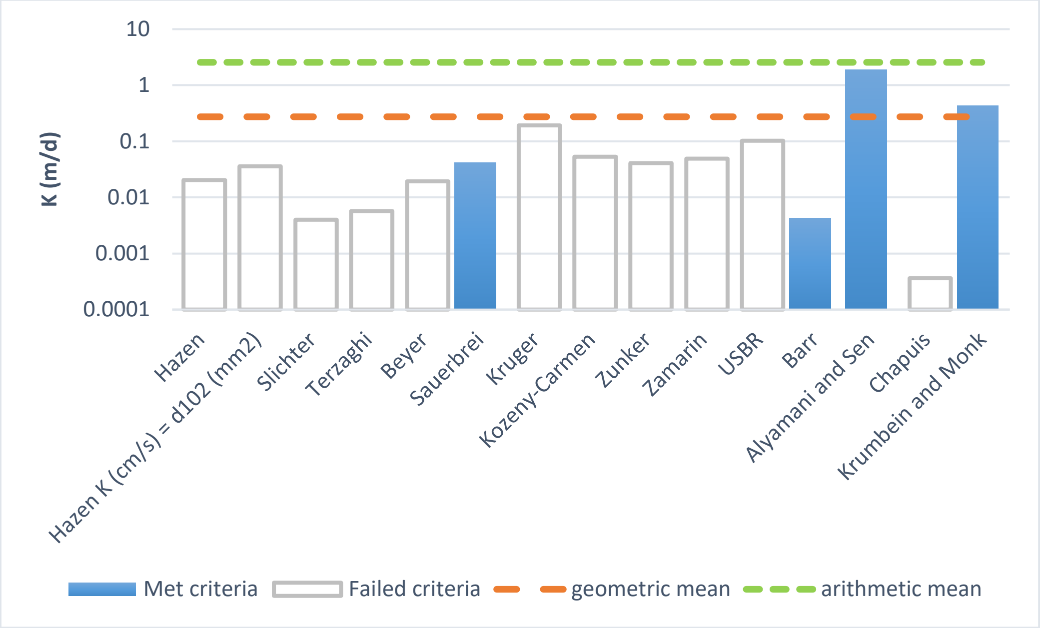
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.723E-06	.723E-08	0.00	
Hazen K (cm/s) = d_{10} (mm)	.128E-05	.128E-07	0.00	
Slichter	.142E-06	.142E-08	0.00	
Terzaghi	.203E-06	.203E-08	0.00	
Beyer	.378E-06	.378E-08	0.00	
Sauerbrei	.551E-05	.551E-07	0.00	
Kruger	.179E-03	.179E-05	0.15	
Kozeny-Carmen	.218E-04	.218E-06	0.02	
Zunker	.164E-04	.164E-06	0.01	
Zamarin	.191E-04	.191E-06	0.02	
USBR	.995E-05	.995E-07	0.01	
Barr	.152E-06	.152E-08	0.00	
Alyamani and Sen	.670E-03	.670E-05	0.58	
Chapuis	.313E-08	.313E-10	0.00	
Krumbein and Monk	.122E-03	.122E-05	0.11	
Shepherd	.370E-02	.370E-04	3.19	
geometric mean meeting criteria	2.E-05	2.E-07	1.E-02	
arithmetic mean meeting criteria	2.E-04	2.E-06	2.E-01	

K from Grain Size Analysis Report Date: 20-May-21

Sample Name: MW21-2, SS1, 0.4 mBGS, Silty Sand

Mass Sample (g): 100 T (oC) 20

Poorly sorted sand with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.234E-04	.234E-06	0.02	
Hazen K (cm/s) = d_{10} (mm)	.414E-04	.414E-06	0.04	
Slichter	.461E-05	.461E-07	0.00	
Terzaghi	.657E-05	.657E-07	0.01	
Beyer	.225E-04	.225E-06	0.02	
Sauerbrei	.484E-04	.484E-06	0.04	
Kruger	.221E-03	.221E-05	0.19	
Kozeny-Carmen	.616E-04	.616E-06	0.05	
Zunker	.474E-04	.474E-06	0.04	
Zamarin	.566E-04	.566E-06	0.05	
USBR	.118E-03	.118E-05	0.10	
Barr	.494E-05	.494E-07	0.00	
Alyamani and Sen	.220E-02	.220E-04	1.90	
Chapuis	.420E-06	.420E-08	0.00	
Krumbein and Monk	.505E-03	.505E-05	0.44	
Shepherd	.121E-01	.121E-03	10.43	
geometric mean meeting criteria	1.E-04	1.E-06	1.E-01	
arithmetic mean meeting criteria	7.E-04	7.E-06	6.E-01	

K from Grain Size Analysis Report

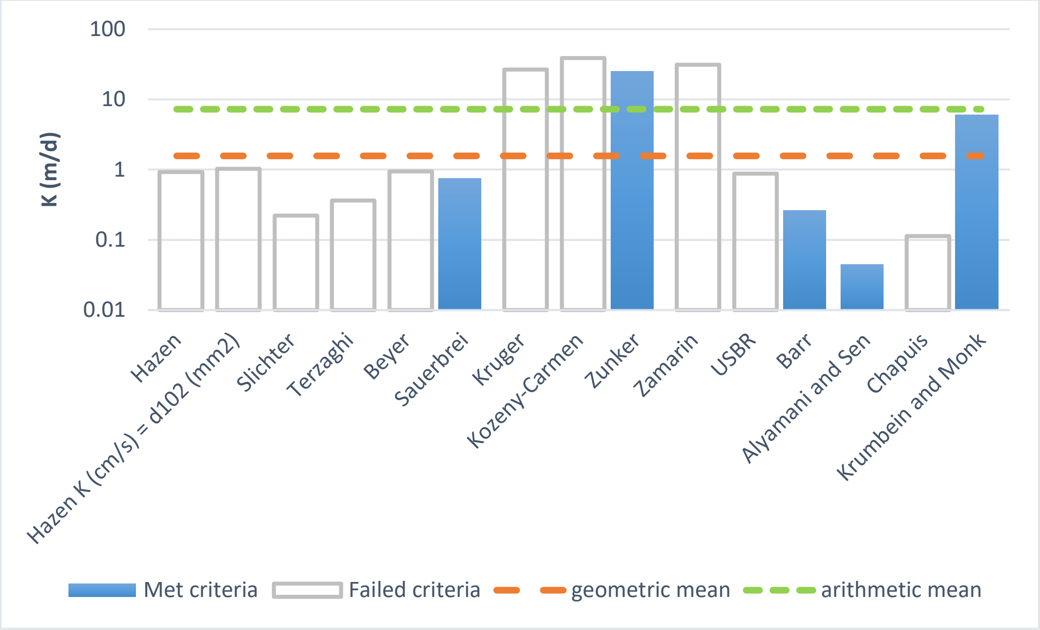
Date: 20-May-21

Sample Name: MW21-2, SS6, 4.9 mBGS, Silty Sand

Mass Sample (g): 100

T (oC) 20

Poorly sorted gravelly sand low in fines



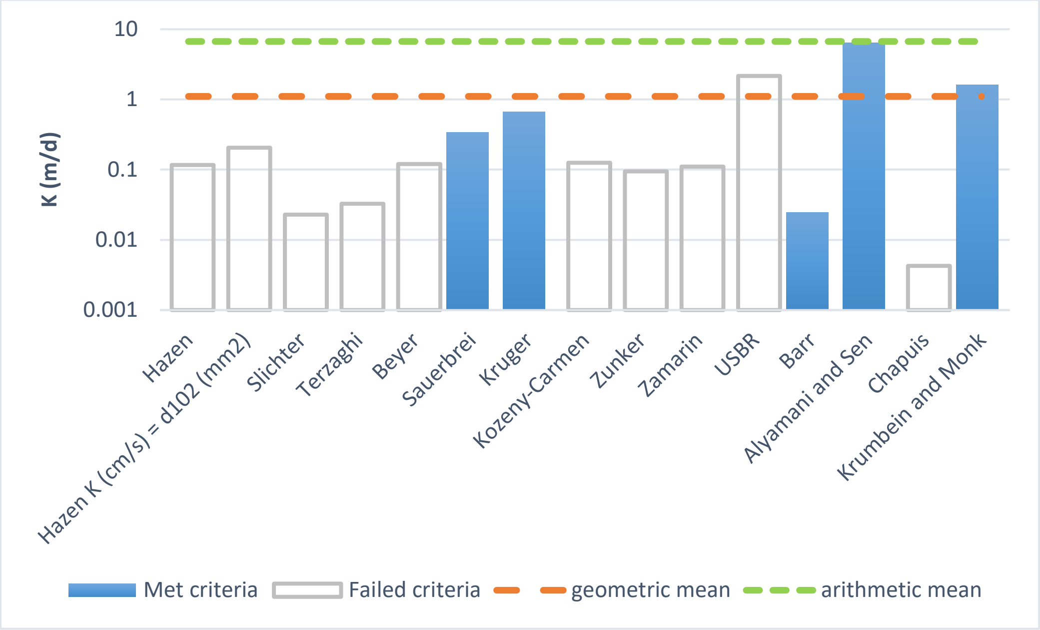
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.107E-02	.107E-04	0.93	
Hazen K (cm/s) = d_{10} (mm)	.118E-02	.118E-04	1.02	
Slichter	.256E-03	.256E-05	0.22	
Terzaghi	.420E-03	.420E-05	0.36	
Beyer	.110E-02	.110E-04	0.95	
Sauerbrei	.862E-03	.862E-05	0.75	
Kruger	.308E-01	.308E-03	26.58	
Kozeny-Carmen	.452E-01	.452E-03	39.06	
Zunker	.292E-01	.292E-03	25.26	
Zamarin	.359E-01	.359E-03	31.01	
USBR	.101E-02	.101E-04	0.87	
Barr	.304E-03	.304E-05	0.26	
Alyamani and Sen	.518E-04	.518E-06	0.04	
Chapuis	.131E-03	.131E-05	0.11	
Krumbein and Monk	.701E-02	.701E-04	6.06	
Shepherd	.129E-01	.129E-03	11.17	
geometric mean meeting criteria	1.E-03	1.E-05	1.E+00	
arithmetic mean meeting criteria	7.E-03	7.E-05	6.E+00	

K from Grain Size Analysis Report Date: 19-May-21

Sample Name: MW21-3, SS2, 1.1 mBGS, Fill

Mass Sample (g): 100 T (oC) 20

Poorly sorted gravelly sand low in fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.135E-03	.135E-05	0.12	
Hazen K (cm/s) = d_{10} (mm)	.237E-03	.237E-05	0.20	
Slichter	.265E-04	.265E-06	0.02	
Terzaghi	.378E-04	.378E-06	0.03	
Beyer	.139E-03	.139E-05	0.12	
Sauerbrei	.394E-03	.394E-05	0.34	
Kruger	.775E-03	.775E-05	0.67	
Kozeny-Carmen	.145E-03	.145E-05	0.13	
Zunker	.109E-03	.109E-05	0.09	
Zamarin	.128E-03	.128E-05	0.11	
USBR	.251E-02	.251E-04	2.17	
Barr	.284E-04	.284E-06	0.02	
Alyamani and Sen	.745E-02	.745E-04	6.43	
Chapuis	.494E-05	.494E-07	0.00	
Krumbein and Monk	.187E-02	.187E-04	1.62	
Shepherd	.359E-01	.359E-03	31.03	
geometric mean meeting criteria	7.E-04	7.E-06	6.E-01	
arithmetic mean meeting criteria	2.E-03	2.E-05	2.E+00	

K from Grain Size Analysis Report

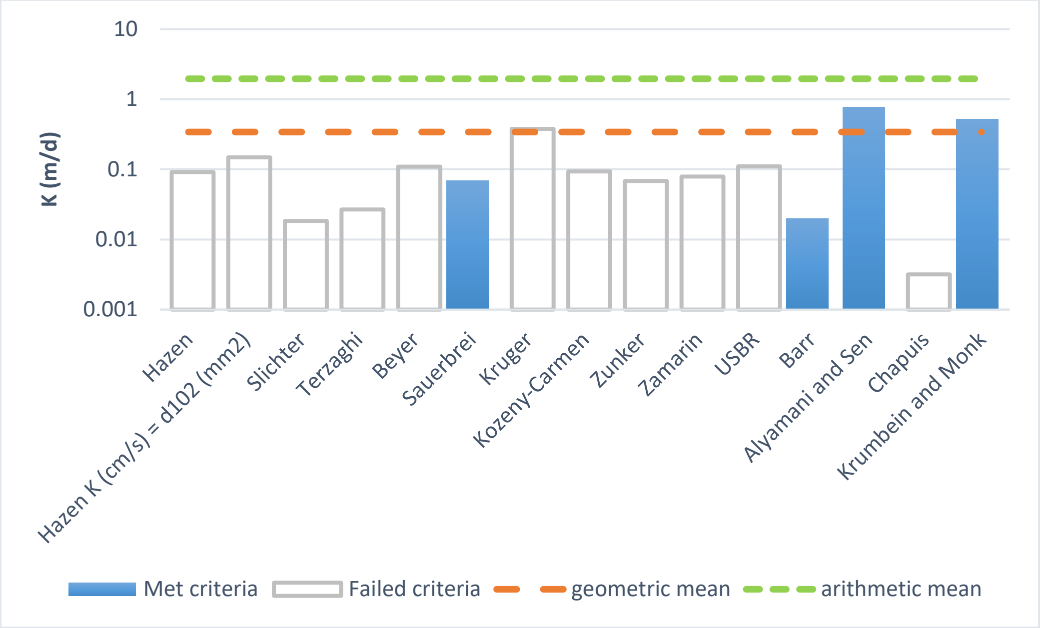
Date: 20-May-21

Sample Name: MW21-3, SS6, 4.9 mBGS, Silty Sand Till

Mass Sample (g): 100

T (oC) 20

Poorly sorted sand low in fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.105E-03	.105E-05	0.09	
Hazen K (cm/s) = d_{10} (mm)	.171E-03	.171E-05	0.15	
Slichter	.212E-04	.212E-06	0.02	
Terzaghi	.311E-04	.311E-06	0.03	
Beyer	.127E-03	.127E-05	0.11	
Sauerbrei	.795E-04	.795E-06	0.07	
Kruger	.439E-03	.439E-05	0.38	
Kozeny-Carmen	.108E-03	.108E-05	0.09	
Zunker	.786E-04	.786E-06	0.07	
Zamarin	.915E-04	.915E-06	0.08	
USBR	.128E-03	.128E-05	0.11	
Barr	.230E-04	.230E-06	0.02	
Alyamani and Sen	.897E-03	.897E-05	0.78	
Chapuis	.368E-05	.368E-07	0.00	
Krumbein and Monk	.599E-03	.599E-05	0.52	
Shepherd	.974E-02	.974E-04	8.42	
geometric mean meeting criteria	2.E-04	2.E-06	2.E-01	
arithmetic mean meeting criteria	4.E-04	4.E-06	3.E-01	

K from Grain Size Analysis Report

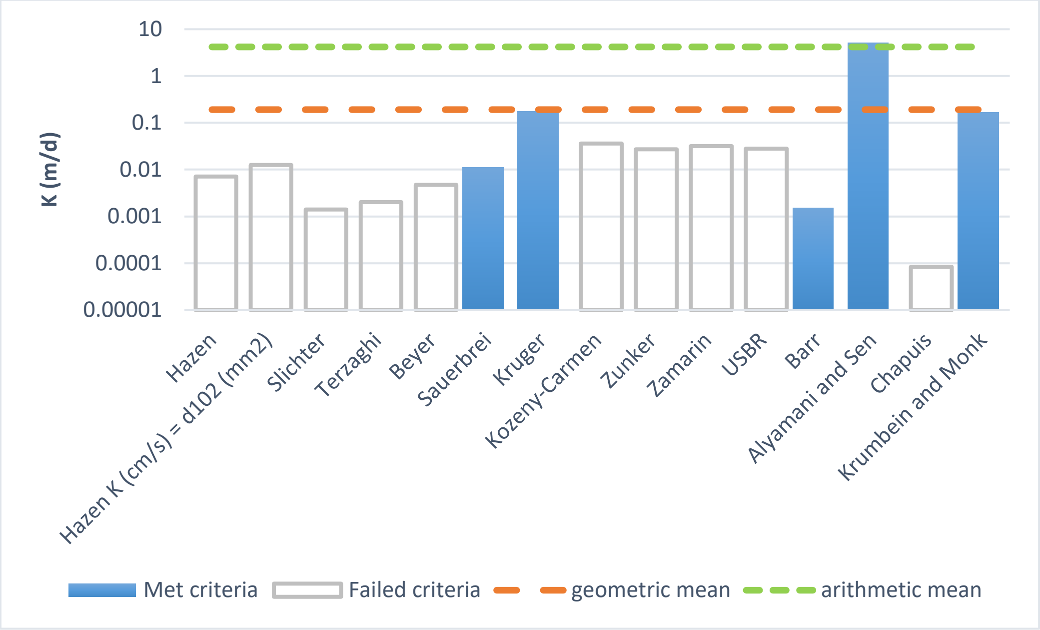
Date: 19-May-21

Sample Name: MW21-4, SS2, 1.1 mBGS, Fill

Mass Sample (g): 100

T (oC) 20

Poorly sorted gravelly sand with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.829E-05	.829E-07	0.01	
Hazen K (cm/s) = d_{10} (mm)	.146E-04	.146E-06	0.01	
Slichter	.163E-05	.163E-07	0.00	
Terzaghi	.232E-05	.232E-07	0.00	
Beyer	.543E-05	.543E-07	0.00	
Sauerbrei	.128E-04	.128E-06	0.01	
Kruger	.203E-03	.203E-05	0.18	
Kozeny-Carmen	.415E-04	.415E-06	0.04	
Zunker	.315E-04	.315E-06	0.03	
Zamarin	.369E-04	.369E-06	0.03	
USBR	.325E-04	.325E-06	0.03	
Barr	.175E-05	.175E-07	0.00	
Alyamani and Sen	.595E-02	.595E-04	5.14	
Chapuis	.972E-07	.972E-09	0.00	
Krumbein and Monk	.192E-03	.192E-05	0.17	
Shepherd	.227E-01	.227E-03	19.62	
geometric mean meeting criteria	9.E-05	9.E-07	8.E-02	
arithmetic mean meeting criteria	1.E-03	1.E-05	1.E+00	

K from Grain Size Analysis Report

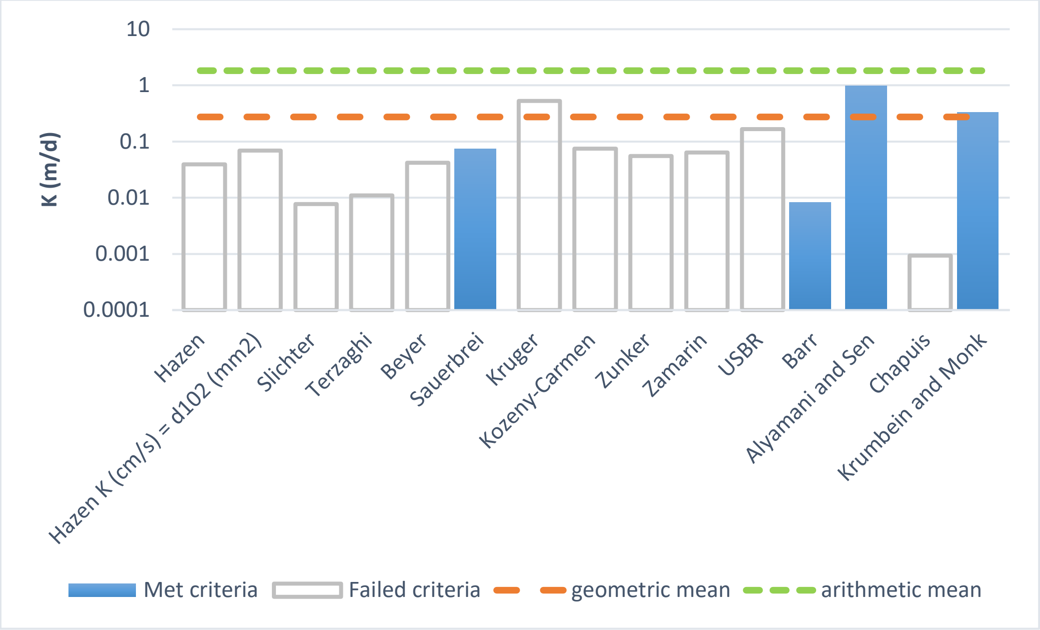
Date: 19-May-21

Sample Name: MW21-5, AS2, 1.1 mBGS, Fill

Mass Sample (g): 100

T (oC) 20

Poorly sorted gravelly sand low in fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.454E-04	.454E-06	0.04	
Hazen K (cm/s) = d_{10} (mm)	.798E-04	.798E-06	0.07	
Slichter	.894E-05	.894E-07	0.01	
Terzaghi	.128E-04	.128E-06	0.01	
Beyer	.483E-04	.483E-06	0.04	
Sauerbrei	.855E-04	.855E-06	0.07	
Kruger	.614E-03	.614E-05	0.53	
Kozeny-Carmen	.865E-04	.865E-06	0.07	
Zunker	.643E-04	.643E-06	0.06	
Zamarin	.742E-04	.742E-06	0.06	
USBR	.193E-03	.193E-05	0.17	
Barr	.959E-05	.959E-07	0.01	
Alyamani and Sen	.114E-02	.114E-04	0.98	
Chapuis	.107E-05	.107E-07	0.00	
Krumbein and Monk	.386E-03	.386E-05	0.33	
Shepherd	.895E-02	.895E-04	7.73	
geometric mean meeting criteria	1.E-04	1.E-06	1.E-01	
arithmetic mean meeting criteria	4.E-04	4.E-06	3.E-01	

K from Grain Size Analysis Report

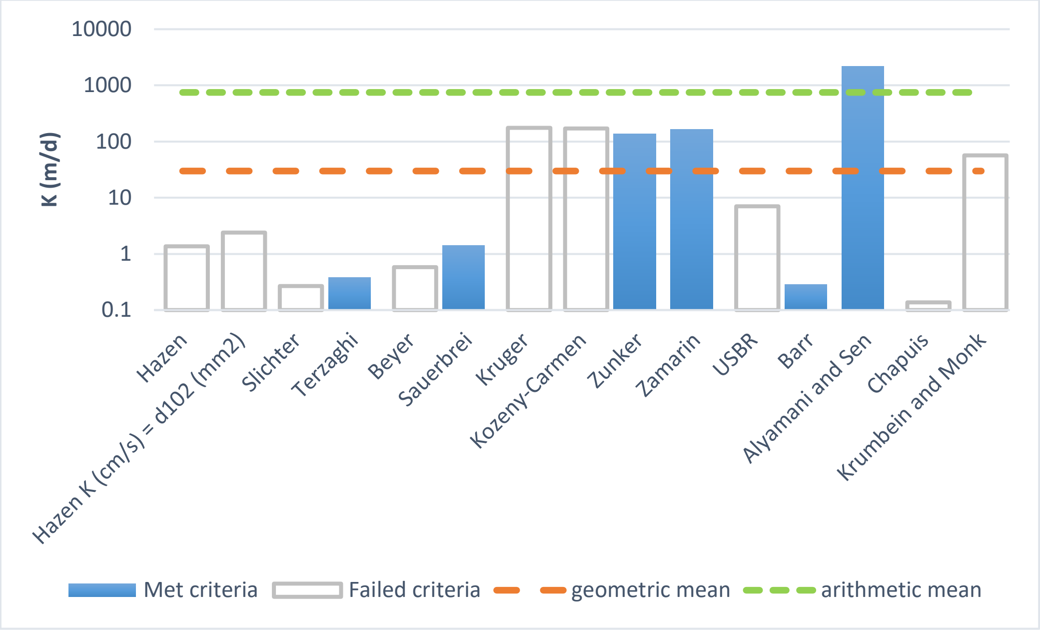
Date: 20-May-21

Sample Name: BH21-6, SS2, 1.1 mBGS, Sandy Gravel

Mass Sample (g): 100

T (oC) 20

Poorly sorted sandy gravel low in fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.158E-02	.158E-04	1.36	
Hazen K (cm/s) = d_{10} (mm)	.279E-02	.279E-04	2.41	
Slichter	.310E-03	.310E-05	0.27	
Terzaghi	.443E-03	.443E-05	0.38	
Beyer	.668E-03	.668E-05	0.58	
Sauerbrei	.165E-02	.165E-04	1.43	
Kruger	.202E+00	.202E-02	174.39	
Kozeny-Carmen	.199E+00	.199E-02	171.65	
Zunker	.157E+00	.157E-02	135.72	
Zamarin	.193E+00	.193E-02	166.38	
USBR	.819E-02	.819E-04	7.08	
Barr	.333E-03	.333E-05	0.29	
Alyamani and Sen	.251E+01	.251E-01	2169.34	
Chapuis	.158E-03	.158E-05	0.14	
Krumbein and Monk	.652E-01	.652E-03	56.36	
Shepherd	.320E+01	.320E-01	2767.67	
geometric mean meeting criteria	2.E-02	2.E-04	1.E+01	
arithmetic mean meeting criteria	5.E-01	5.E-03	4.E+02	

K from Grain Size Analysis Report

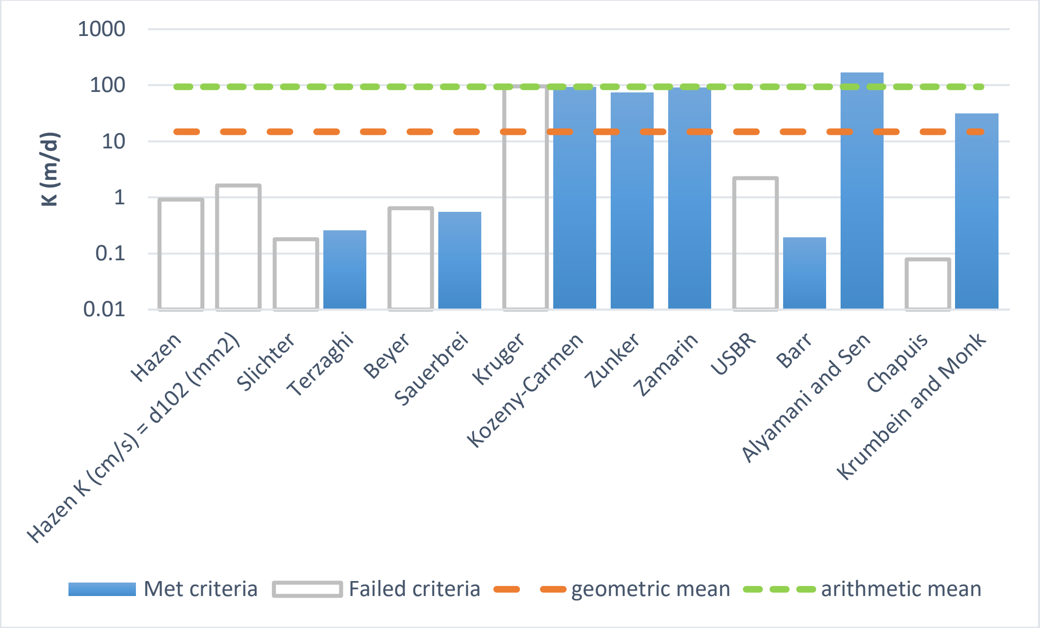
Date: 20-May-21

Sample Name: BH21-7, SS2, 1.1 mBGS, Sand and Gravel

Mass Sample (g): 100

T (oC) 20

Poorly sorted gravelly sand low in fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.106E-02	.106E-04	0.92	
Hazen K (cm/s) = d_{10} (mm)	.188E-02	.188E-04	1.62	
Slichter	.209E-03	.209E-05	0.18	
Terzaghi	.298E-03	.298E-05	0.26	
Beyer	.741E-03	.741E-05	0.64	
Sauerbrei	.636E-03	.636E-05	0.55	
Kruger	.110E+00	.110E-02	94.88	
Kozeny-Carmen	.108E+00	.108E-02	93.23	
Zunker	.854E-01	.854E-03	73.75	
Zamarin	.105E+00	.105E-02	90.47	
USBR	.254E-02	.254E-04	2.20	
Barr	.224E-03	.224E-05	0.19	
Alyamani and Sen	.194E+00	.194E-02	167.43	
Chapuis	.908E-04	.908E-06	0.08	
Krumbein and Monk	.357E-01	.357E-03	30.82	
Shepherd	.448E+00	.448E-02	387.42	
geometric mean meeting criteria	1.E-02	1.E-04	1.E+01	
arithmetic mean meeting criteria	7.E-02	7.E-04	6.E+01	

K from Grain Size Analysis Report

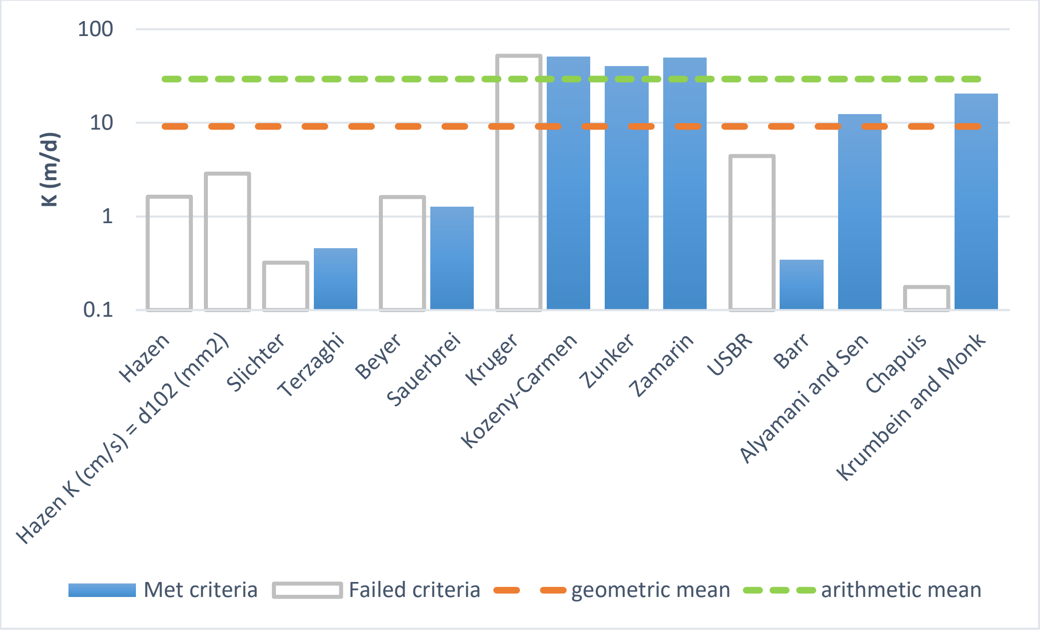
Date: 20-May-21

Sample Name: BH21-8, SS2, 1.1 mBGS, Gravelly Sand

Mass Sample (g): 100

T (oC) 20

Poorly sorted gravelly sand low in fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.189E-02	.189E-04	1.63	
Hazen K (cm/s) = d_{10} (mm)	.333E-02	.333E-04	2.88	
Slichter	.371E-03	.371E-05	0.32	
Terzaghi	.529E-03	.529E-05	0.46	
Beyer	.187E-02	.187E-04	1.61	
Sauerbrei	.146E-02	.146E-04	1.26	
Kruger	.601E-01	.601E-03	51.90	
Kozeny-Carmen	.590E-01	.590E-03	51.01	
Zunker	.467E-01	.467E-03	40.34	
Zamarin	.573E-01	.573E-03	49.50	
USBR	.510E-02	.510E-04	4.40	
Barr	.398E-03	.398E-05	0.34	
Alyamani and Sen	.143E-01	.143E-03	12.35	
Chapuis	.204E-03	.204E-05	0.18	
Krumbein and Monk	.237E-01	.237E-03	20.44	
Shepherd	.102E+00	.102E-02	88.31	
geometric mean meeting criteria	8.E-03	8.E-05	7.E+00	
arithmetic mean meeting criteria	3.E-02	3.E-04	2.E+01	

K from Grain Size Analysis Report

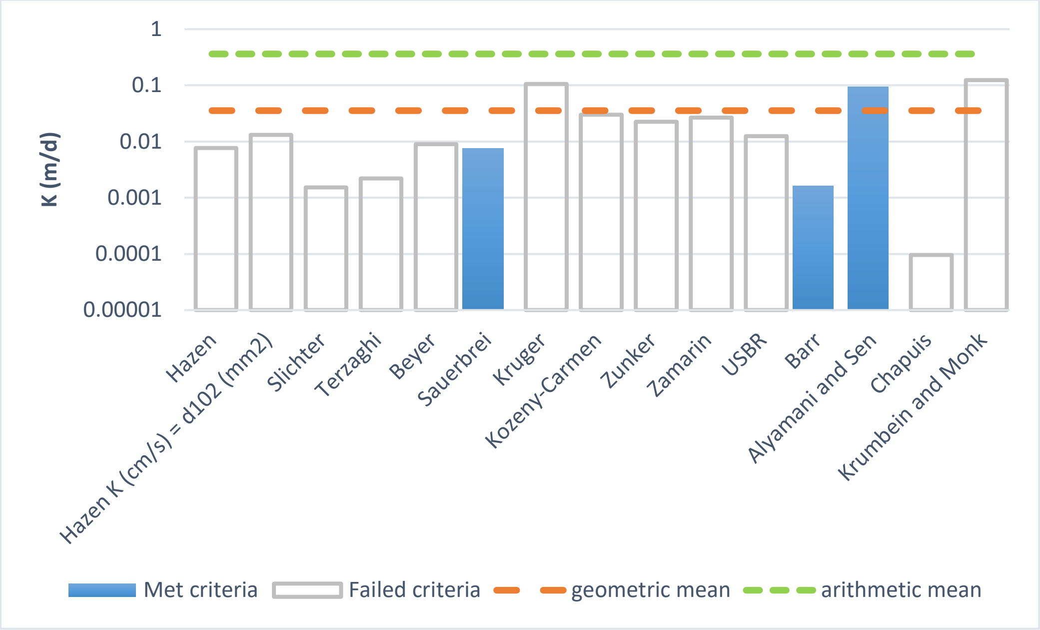
Date: 19-May-21

Sample Name: MW21-9, SS1, 0.3 mBGS, Fill

Mass Sample (g): 100

T (oC) 20

Poorly sorted sandy silt with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.889E-05	.889E-07	0.01	
Hazen K (cm/s) = d_{10} (mm)	.152E-04	.152E-06	0.01	
Slichter	.176E-05	.176E-07	0.00	
Terzaghi	.254E-05	.254E-07	0.00	
Beyer	.104E-04	.104E-06	0.01	
Sauerbrei	.880E-05	.880E-07	0.01	
Kruger	.122E-03	.122E-05	0.11	
Kozeny-Carmen	.348E-04	.348E-06	0.03	
Zunker	.261E-04	.261E-06	0.02	
Zamarin	.308E-04	.308E-06	0.03	
USBR	.145E-04	.145E-06	0.01	
Barr	.190E-05	.190E-07	0.00	
Alyamani and Sen	.110E-03	.110E-05	0.09	
Chapuis	.111E-06	.111E-08	0.00	
Krumbein and Monk	.143E-03	.143E-05	0.12	
Shepherd	.156E-02	.156E-04	1.35	
geometric mean meeting criteria	1.E-05	1.E-07	1.E-02	
arithmetic mean meeting criteria	4.E-05	4.E-07	3.E-02	

K from Grain Size Analysis Report

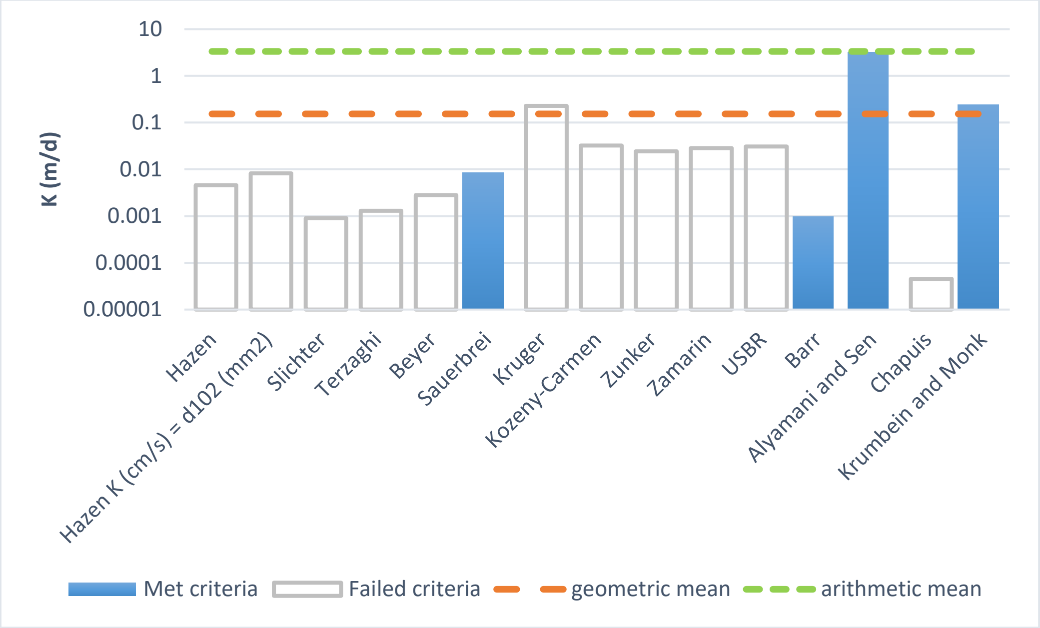
Date: 19-May-21

Sample Name: MW21-10, SS2, 1.1 mBGS, Fill

Mass Sample (g): 100

T (oC) 20

Poorly sorted gravelly sand with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.534E-05	.534E-07	0.00	
Hazen K (cm/s) = d_{10} (mm)	.944E-05	.944E-07	0.01	
Slichter	.105E-05	.105E-07	0.00	
Terzaghi	.150E-05	.150E-07	0.00	
Beyer	.327E-05	.327E-07	0.00	
Sauerbrei	.996E-05	.996E-07	0.01	
Kruger	.266E-03	.266E-05	0.23	
Kozeny-Carmen	.376E-04	.376E-06	0.03	
Zunker	.283E-04	.283E-06	0.02	
Zamarin	.330E-04	.330E-06	0.03	
USBR	.355E-04	.355E-06	0.03	
Barr	.113E-05	.113E-07	0.00	
Alyamani and Sen	.368E-02	.368E-04	3.18	
Chapuis	.524E-07	.524E-09	0.00	
Krumbein and Monk	.278E-03	.278E-05	0.24	
Shepherd	.153E-01	.153E-03	13.25	
geometric mean meeting criteria	6.E-05	6.E-07	5.E-02	
arithmetic mean meeting criteria	1.E-03	1.E-05	9.E-01	

K from Grain Size Analysis Report

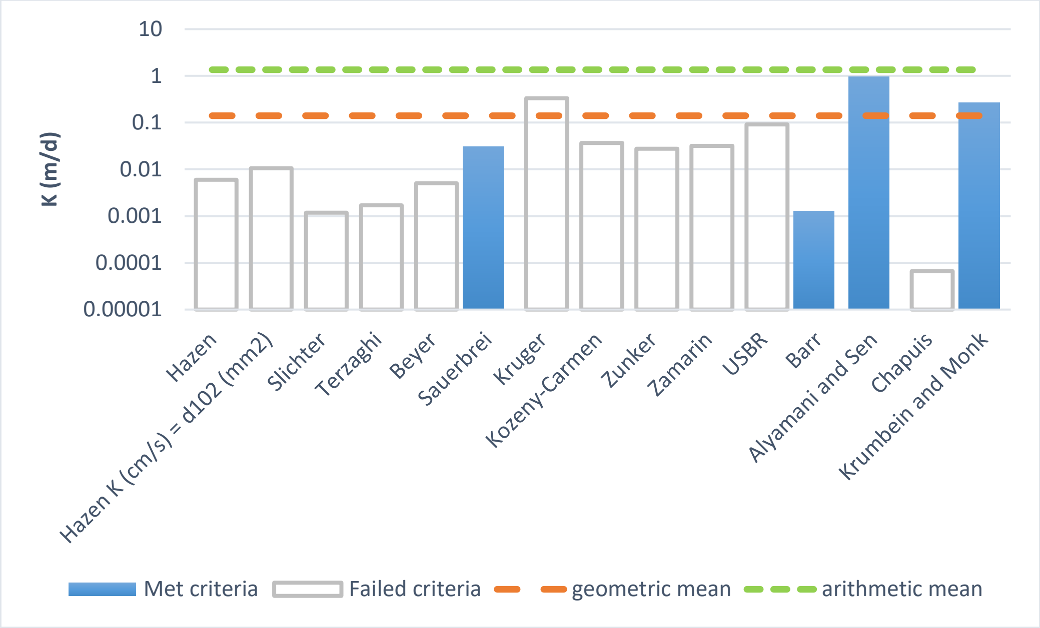
Date: 20-May-21

Sample Name: MW21-10, SS4, 2.6 mBGS, Silty Sand (above the till)

Mass Sample (g): 100

T (oC) 20

Poorly sorted gravelly sand low in fines

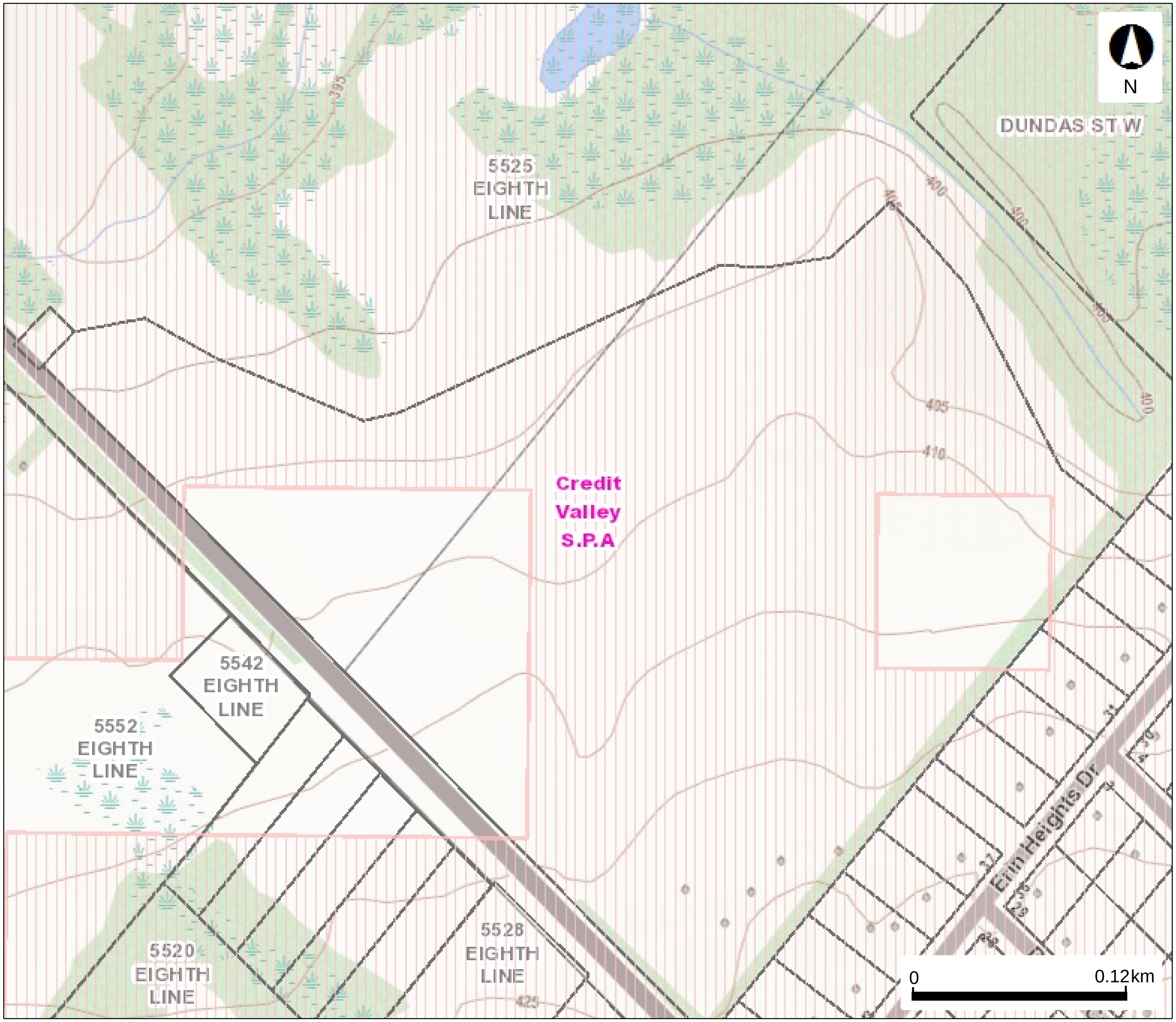


Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	.697E-05	.697E-07	0.01	
Hazen K (cm/s) = d_{10} (mm)	.123E-04	.123E-06	0.01	
Slichter	.137E-05	.137E-07	0.00	
Terzaghi	.195E-05	.195E-07	0.00	
Beyer	.579E-05	.579E-07	0.00	
Sauerbrei	.359E-04	.359E-06	0.03	
Kruger	.385E-03	.385E-05	0.33	
Kozeny-Carmen	.423E-04	.423E-06	0.04	
Zunker	.317E-04	.317E-06	0.03	
Zamarin	.368E-04	.368E-06	0.03	
USBR	.106E-03	.106E-05	0.09	
Barr	.147E-05	.147E-07	0.00	
Alyamani and Sen	.110E-02	.110E-04	0.95	
Chapuis	.762E-07	.762E-09	0.00	
Krumbein and Monk	.306E-03	.306E-05	0.26	
Shepherd	.640E-02	.640E-04	5.53	
geometric mean meeting criteria	6.E-05	6.E-07	6.E-02	
arithmetic mean meeting criteria	4.E-04	4.E-06	3.E-01	

Appendix D

Provincial Maps

Highly Vulnerable Aquifer



Legend

☐ Source Protection Areas

▥ Highly Vulnerable Aquifers

☐ Assessment Parcel with Addre

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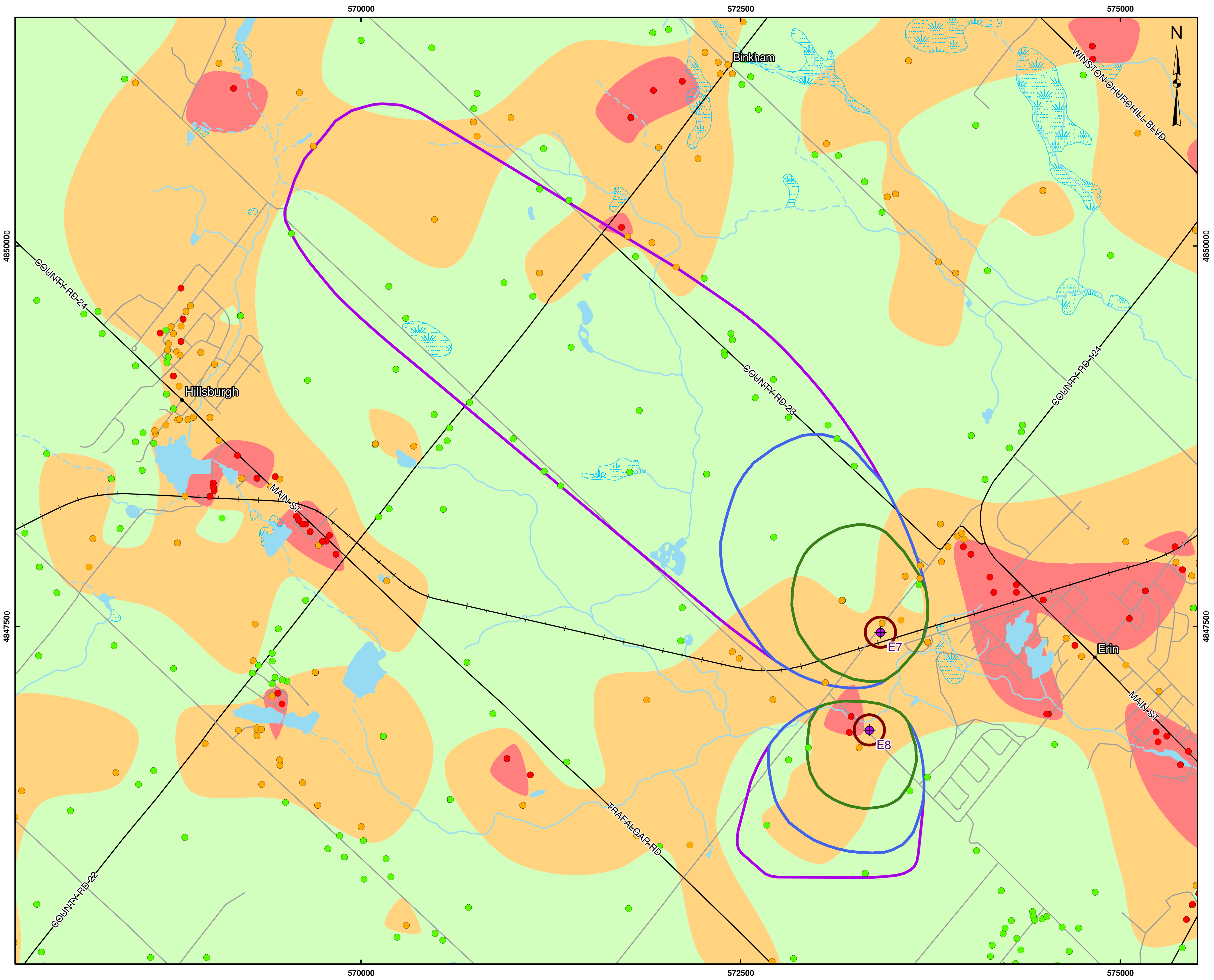
Ontario

Map Created: 1/18/2022
Map Center: 43.76998 N, -80.08494 W



LEGEND

⊕ Production Well

Wells Used in ISI Analysis

- ● Low Vulnerability
- ● Medium Vulnerability
- ● High Vulnerability
- Highway
- Major Road
- Local Road
- Railways
- Watercourse, Permanent
- Watercourse, Intermittent
- Waterbody
- Wetland

Wellhead Protection Area

- ☐ WHPA A (100 m)
- ☐ WHPA B (2 year)
- ☐ WHPA C (5 year)
- ☐ WHPA D (25 year)

ISI Vulnerability

- 🟩 Low (>80)
- 🟧 Medium (30 - 80)
- 🟥 High (<30)

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

0.5 0.25 0 0.5 1 1.5

SCALE 1:25,000 KILOMETERS

PROJECT

SOURCE WATER PROTECTION - TOWN OF ERIN

TITLE

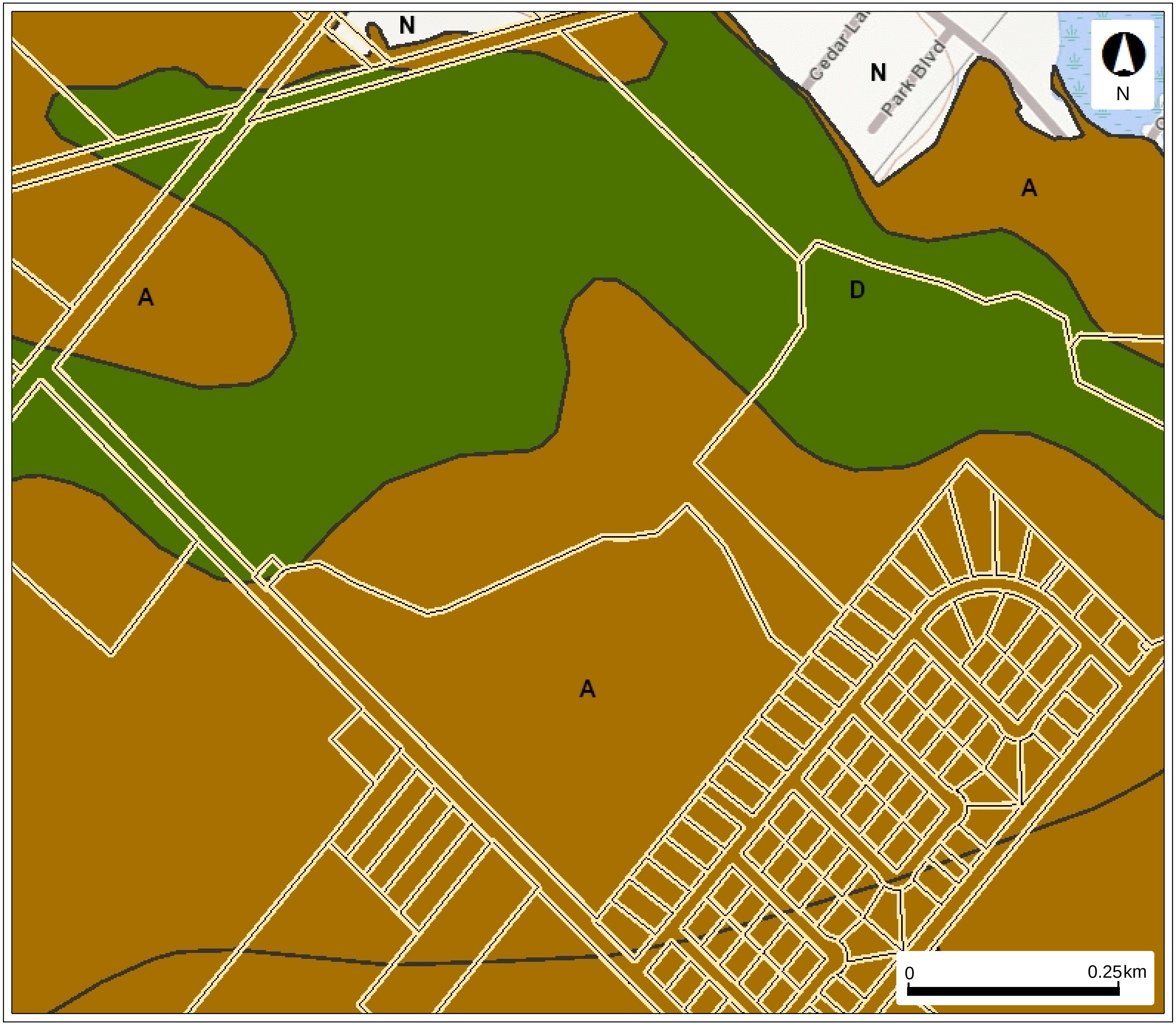
ISI VULNERABILITY MAPPING - BEDROCK, ERIN MUNICIPAL WELLS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6139			SCALE AS SHOWN	REV. 0.0
DESIGN	PRM	1 Apr. 2010	FIGURE: 5	
GIS	PRM	1 Apr. 2010		
CHECK	GP	1 Apr. 2010		
REVIEW	JP	1 Apr. 2010		

G:\Projects\2009\09-1112-6139_Bel_Erin\GIS\MXDs\Draft\Blackport_Hydrogeology\ISI_Vulnerability_Erin_Bedrock.mxd

OMAFRA Hydrologic Soil Group



Legend

☐ Assessment Parcel

Hydrologic Soil Group

- 🟫 A - High
- 🟨 B - Moderate
- 🟦 C - Slow
- 🟩 D - Very Slow

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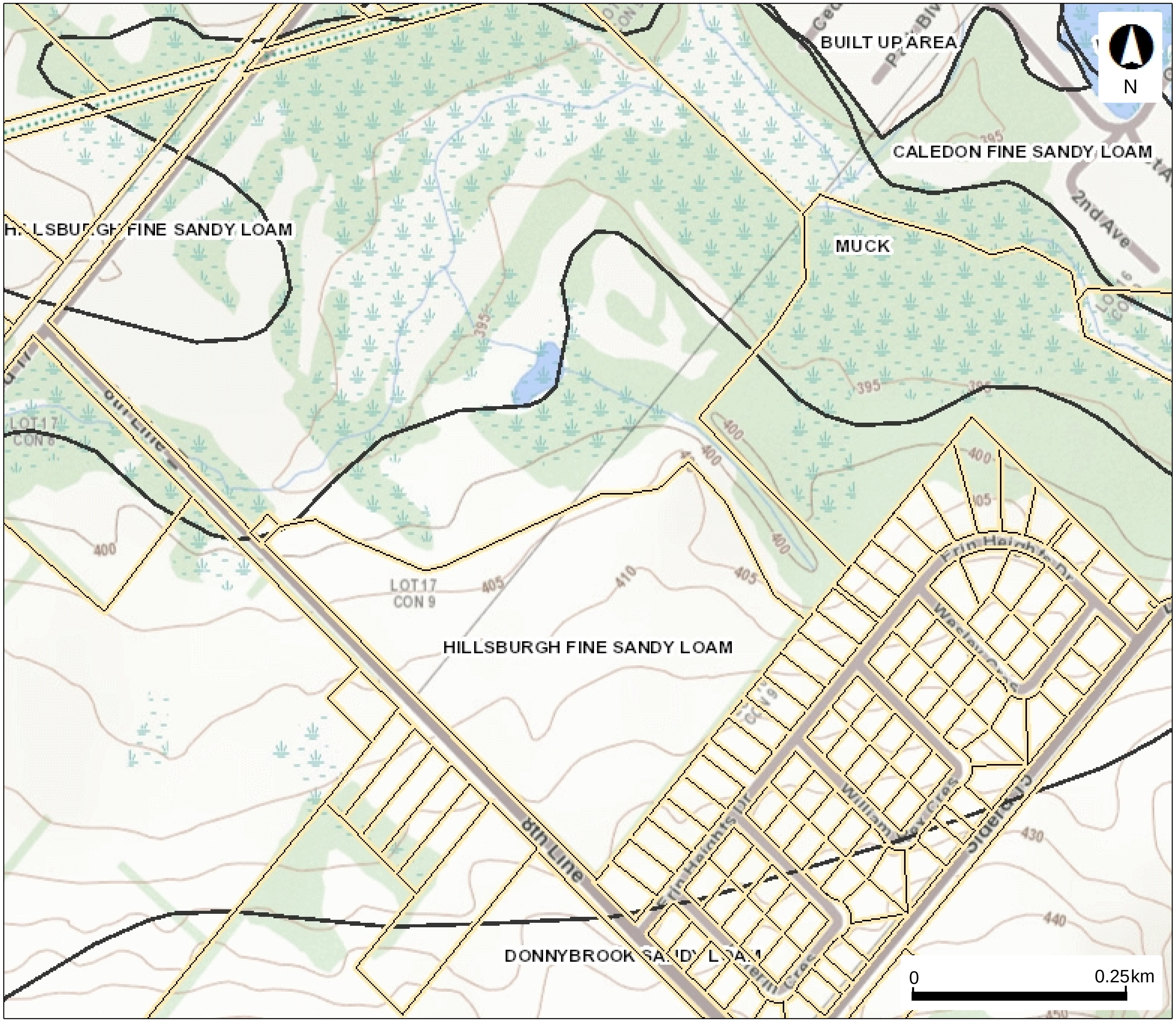
Ontario

Map Created: 1/24/2022
Map Center: 43.77151 N, -80.08421 W

OMAFRA Soil Type



Legend

☐ Assessment Parcel

☐ Soil Name Label

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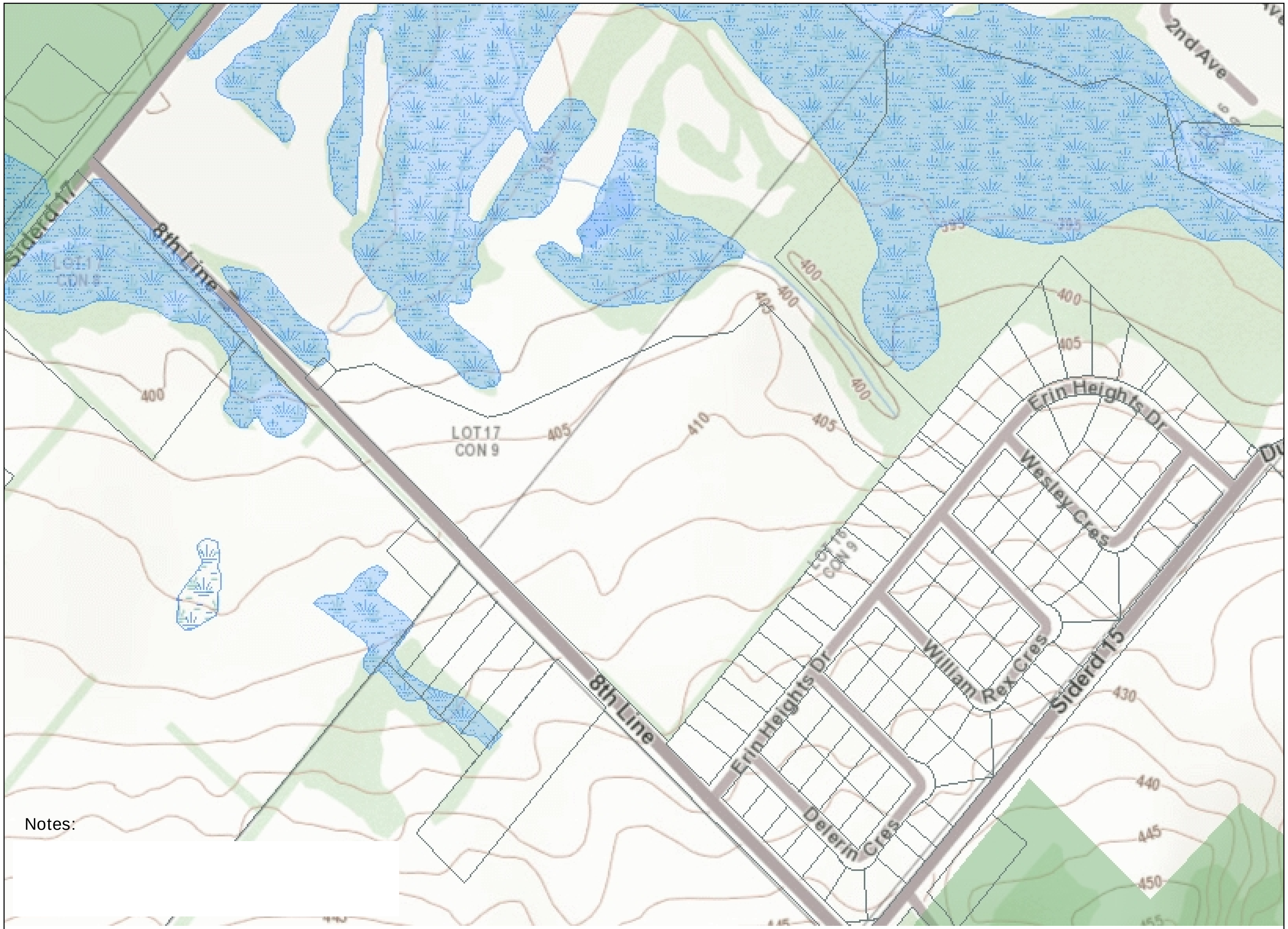
Ontario

Map Created: 1/24/2022
Map Center: 43.77106 N, -80.08421 W

Ontario Ministry of Natural Resources and Forestry
Make-a-Map: Natural Heritage Areas

West Credit River Wetland Complex

Map created:1/18/2022



Notes:

Legend

☐ Assessment Parcel

ANSI

▣ Earth Science Provincially Significant/sciences de la terre d'importance provinciale

▣ Earth Science Regionally Significant/sciences de la terre d'importance régionale

▣ Life Science Provincially Significant/sciences de la vie d'importance provinciale

▣ Life Science Regionally Significant/sciences de la vie d'importance régionale

Evaluated Wetland

▦ Provincially Significant/considérée d'importance provinciale

▦ Non-Provincially Significant/non considérée d'importance provinciale

☐ Unevaluated Wetland

🟩 Conservation Reserve

▨ Provincial Park

🟩 Natural Heritage System

0.3 0 0.17 0.3 Kilometres

Absence of a feature in the map does not mean they do not exist in this area.

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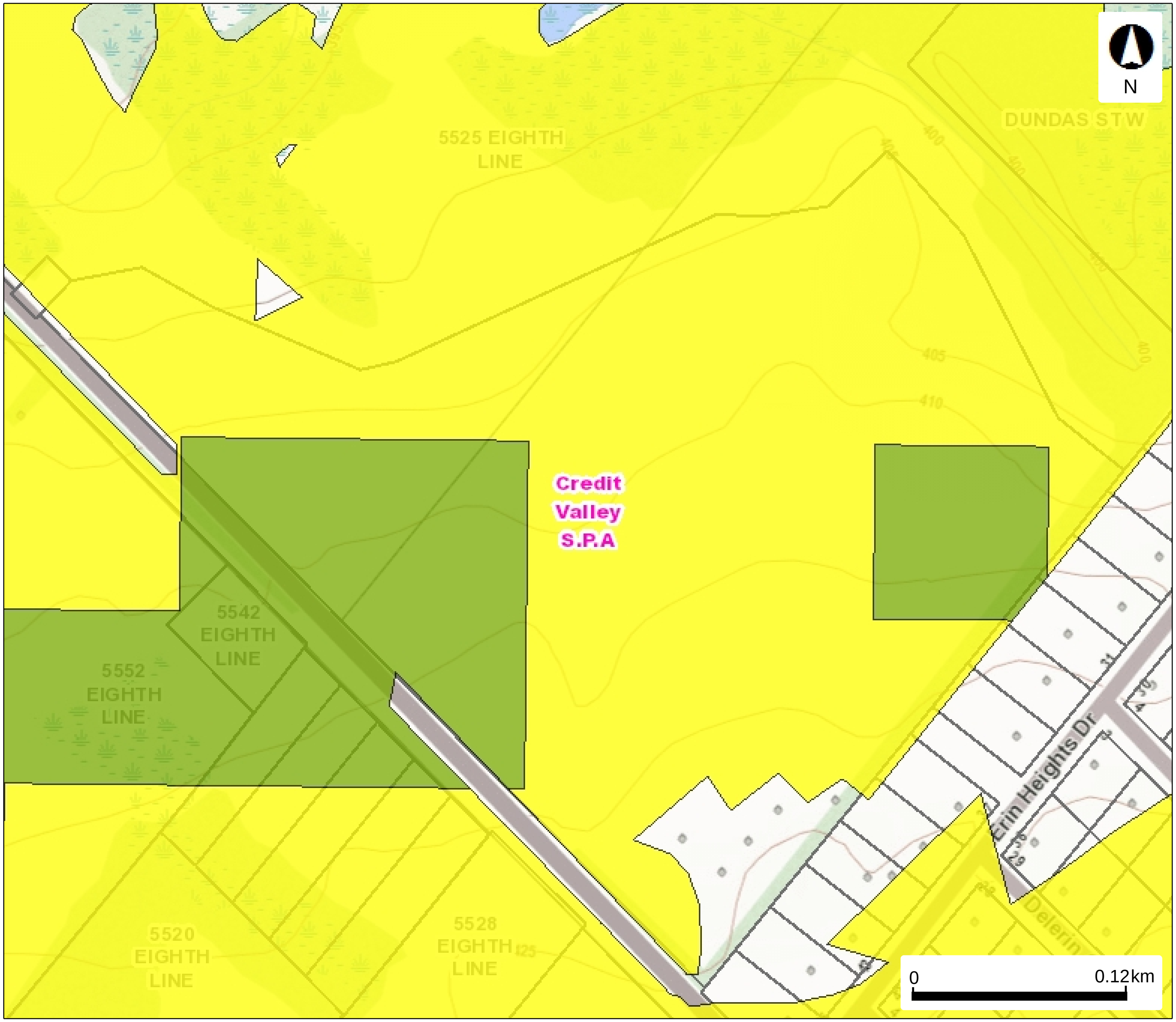
Significant Groundwater Recharge Areas



Legend

☐ Source Protection Areas

Significant Groundwater Recharge Area

🟩 0

🟩 2

🟩 4

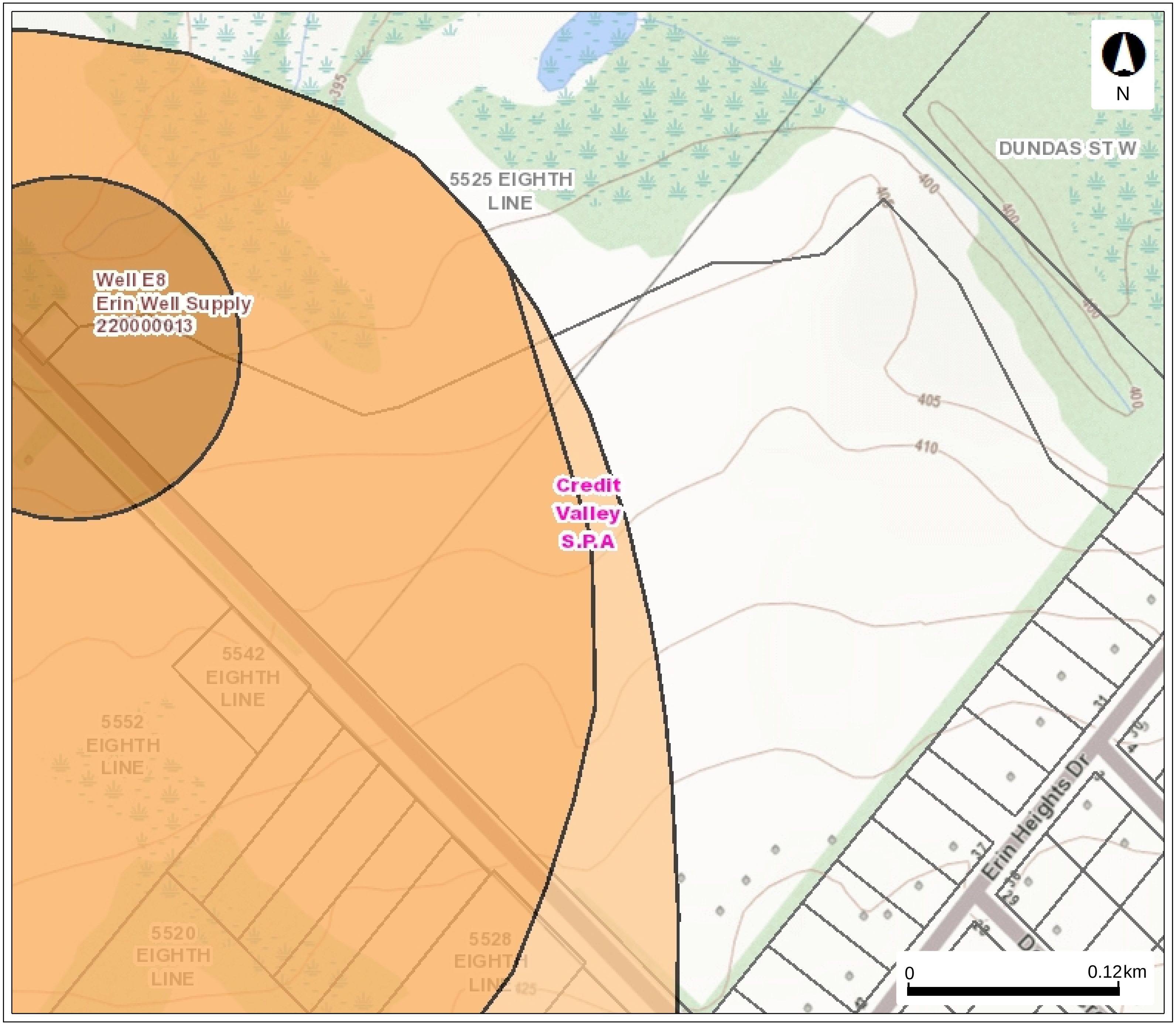
🟨 6

☐ Assessment Parcel with Addre

Ontario

Map Created: 1/18/2022
Map Center: 43.76972 N, -80.08491 W

Wellhead Protection Areas



Legend

☐ Source Protection Areas

Wellhead Protection Area

- 🟫 A
- 🟧 B
- 🟧 C
- 🟫 C1
- 🟨 D
- 🟦 F

☐ Assessment Parcel with Addre

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Ontario

Map Created: 1/18/2022
Map Center: 43.76994 N, -80.08491 W