Terra-Dynamics Consulting Inc.
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April 30, 2024

Elevate Fourth Development Ltd.
c/o Spencer Brown, P. Eng.
13 Carleton St. South
Thorold, Ontario L2V 1Z5

Re: Hydrogeology and Water Balance Study, Barrick Road Subdivision, Port Colborne, ON

Dear Mr. Brown,

**1.0 Introduction and Background Information**

Terra-Dynamics Consulting Inc. respectfully submits this Hydrogeology and Water Balance Study (the Study) of the Proposed 8.34 hectare Barrick Road Subdivision in Port Colborne, Ontario (the Site, Figure 1).

Guidance previously provided by the City of Port Colborne (2022) for this study includes:

A. Investigation of groundwater and surface water resources for "*the protection and integration of natural heritage resources*";

B. Identification of "*constraints and opportunities for enhancement and site specific design and mitigation that will result in the sustainable development*"; and

C. Completion of a water balance "*supported by hydrogeological investigations*" and "*groundwater monitoring*" completed by a "*qualified hydrogeologist*".

This Study also identified "*opportunities and constraints to stormwater drainage and servicing*".

**2.0 Methodology**

The work plan was designed to comply with the Conservation Authority Guidelines for Hydrogeological Assessments (Cuddy, Soo Chan and Post, 2013) and includes the following primary tasks as described below:

Submission of a Hydrogeology and Water Balance Terms of Reference (Appendix A) to Niagara Region for review and comment. Niagara Region indicated they had no objection to the work plan proposed (Niagara Region, 2023).

Description of the Physical Setting: The physiography, topography, surface water catchments, watercourses, soils, surficial geology, bedrock geology, and hydrogeological environment (i.e. aquitard, and aquifer) have been described and visualized via a review of existing information and field investigations.

A. Existing regional reporting included, but not limited to:

a. Niagara Peninsula Conservation Authority: Central Welland River Watershed Plan, Natural Areas Inventory, and Contemporary Watercourse mapping;
b. Ministry of the Environment Conservation and Parks (MECP) water well records;
c. Ontario Geological Survey (OGS) reports and maps (e.g. surficial geology, Paleozoic geology, aggregate resource inventory and karst investigations);
d. Ministry of Natural Resources and Forestry (MNRF) (e.g. Ontario Wetland Evaluation reporting and Oil, Gas and Salt Resources Library);
e. Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) (e.g. soils); and
f. Ministry of Transportation (MTO) geotechnical database.

B. Review of available Site information such as the geotechnical study from Elevate Living Niagara (Niagara Testing and Inspection, 2022), and topographic survey.

C. Communications with staff from government agencies, e.g.:

a. OGS Quaternary Geoscientist Abigail Burt studying Niagara Pensinsula Overburden;
b. OGS Paleozoic Geoscientist Frank Brunton regarding the Onondaga Escarpment; and
c. City of Port Colborne Drainage Superintendent Alana Vanderveen regarding the Beiderman Drain.

D. Field investigations:

a. At the Site: (a) over a year of groundwater level monitoring at the five existing monitoring wells (Niagara Testing and Inspection, 2022) including water level dataloggers recording at 15-minute intervals, (b) hydraulic conductivity testing of the five monitoring wells, and (c) laboratory analyses of baseline groundwater quality.

b. With permission from the City of Port Colborne (2023), hand-augering was completed along the unopened road allowance of the northern extension of Minor Road to determine the inferred depth to bedrock, and the soil composition. Drive-point piezometers were installed in each of these three locations (PZ-1, PZ-2 and PZ-3) to about 3 metres below ground surface to monitor shallow groundwater levels for a year (Figure 2) and were equipped with water level dataloggers recording at 15-minute intervals for a year.

c. Surface water monitoring, as available at the nearby unopened road allowance (Figure 2): (a) Northeast flowing open constructed ephemeral watercourse/drain (SG-1), (b) Western extent of the Provincially Significant Wetland (SG-2), and (c), the Beiderman Drain (SG-3). Staff gauges with water level dataloggers were installed at each location to continuously measure surface water levels for a year at 15-minute intervals. Three sets of surface water quality samples were collected: a spring freshet event, a wet weather event and a dry weather event.

d. Water well survey of nearby properties not municipally serviced on the northern side of Barrick Road, west of Minor Road.

Water Balance Analyses: A pre-development water balance was calculated for the Site using modelling completed by the Niagara Peninsula Source Protection Authority as part of their Tier 1 water budget (NPCA and AquaResource Inc., 2010) for the Central Welland River Watershed Planning Area (AquaResource Inc. and NPCA, 2009). The results were compared to the physical setting for suitability for application. A monthly wetland water balance was also completed using Environment Canada weather data (both climate normals and for the 2023-2024 monitoring period) and compared to the staff gauge water levels at the wetland along the unopened road allowance (SG-2).

Future development: Recommended requirements for Site development have been provided, including an assessment of potential impacts to groundwater and surface water resources and recommendations for future works (e.g. decommissioning of unused wells). Soil and water level information were reviewed for the suitability of low impact development measures.

**3.0 Physical Setting**

The Site is vacant agricultural/undeveloped land with no structures on-site, and is comprised of open former farmland with sparse tree coverage and no infrastructure has been documented (NSS Ltd, 2022). According to historical aerial photos, the Site has been used for agriculture since at least 1934 (Niagara Navigator, 2023).

The Site is fairly flat-lying with ground surface at approximately 187 metres above sea level (m ASL) at the northeast corner sloping to the southwest at 185 m ASL, (Figure 2), with less than 1% slope on average.

The Site is regionally located on 'limestone plain' (Chapman and Putnam, 1984) with the Onondaga Escarpment located approximately 115 m to the northwest (Figure 2), rising approximately 10 m above the clay plain/Wainfleet Bog to the northwest (Figure 3). The physical setting of the Site is similar to the physical setting of the Law Quarry, in the Township of Wainfleet, as visualized by Environment and Climate Change Canada below (Figure 4), with Bois Blanc Formation bedrock forming the cap of the Onondaga Escarpment.

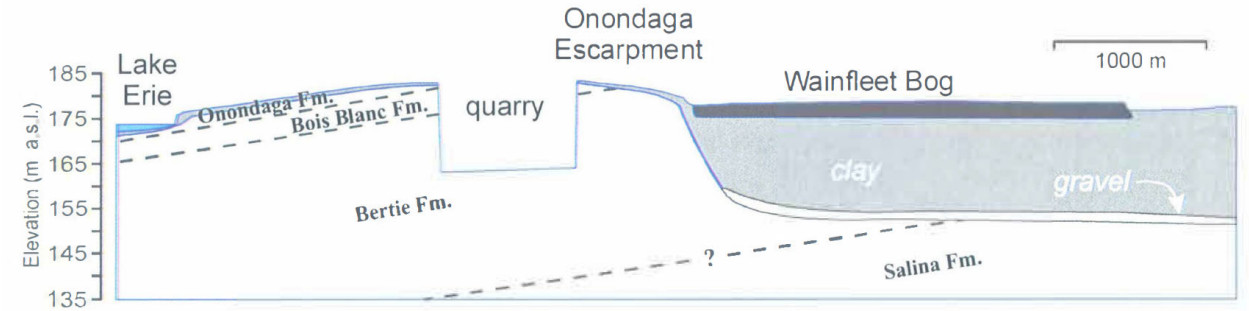



Figure 4–South-north geological cross section from Lake Erie, through the Law Quarry/the Wainfleet Bog (Crowe, et al, 2000)

The Ministry of Natural Resources and Forestry (MNRF) have mapped an area of Provincially Significant Wetland Swamp (PSW) 45 metres to the north of the Site (MNRF, 2009).

### 3.1 Surface Water

The Site almost entirely drains to the southeast (99%), with a drainage divide mapped in the northwest corner of the Site (Figure 2) and a small portion of the Site (1%) draining to the west. No watercourses have been mapped at the Site.

#### 3.1.1 Off-site Surface Water Level Monitoring

Three surface water staff gauges (SG-1, SG-2 and SG-3, Figure 2) were installed in March 20, 2023 and equipped with water level dataloggers and are underlain by clay (Figure 3). The staff gauges were constructed with well-points that allowed measurement of both surface water levels and shallow groundwater levels to 0.1 m below ground surface.

Staff gauge SG-1 was installed in a ditch which outlets to the Beiderman Drain (Appendix B - Photos). NPCA (2007) have historically classified this ditch as ephemeral, open, and constructed. The water level hydrograph indicated: (i) a responsiveness to precipitation events during the summer and fall, (ii) spring freshet/high water levels the 1st week of April, 2023 and the 1st week of February 2024 and (iii) intermittent dry conditions in summer 2023 (Appendix C).

Staff gauge SG-2 was installed in part of the palustrine swamp PSW (MNRF, 2009), located within the road allowance (Appendix B - Photos). The water level hydrograph indicated: (i) water levels can be, but were not often, responsive to precipitation, (ii) a spring season freshet/high water level the 1st week of April, 2023 and the 1st week of February 2024, (iii) became dry by late May, 2023 until fall 2023 (inferred) (Appendix C). May, 2023 precipitation was only 41% of average precipitation (Table 1). Environment Canada Station Welland-Pelham was used because of regular gaps in the precipitation record at their Port Colborne Station.

Staff gauge SG-3 was installed in the constructed municipal Beiderman Drain (Appendix B - Photos). OMAFRA (2023) has classified the Beiderman Drain as Type C, "*Permanent Flow, No sensitive fish species present*' (Kavanagh, Wren and Hoggarth, 2017). The water level hydrograph indicated: (i) a responsiveness to precipitation events, (ii) a spring season freshet/high water level occurred the 1st week of April, 2023 and mid-January 2024, (iii) a minimum water level depth of 5 cm at the staff gauge was recorded on July 25, 2023, i.e. dry conditions were not recorded by the water level datalogging pressure transducer (Appendix C).

#### 3.1.2 Off-site Surface Water Quality Monitoring

Three sets of surface water quality samples were collected at the three staff gauge locations: SG-1 ditch, SG-2 wetland and SG-3 Biederman Drain (Figure 2):

(i) Spring season freshet sample event - March 20, 2023;
(ii) Dry sample event - May 10 2023. This was following three days of no rain (May 8, 9 and 10) and less than 4.2 mm on the four days prior (May 4, 5, 6 and 7); and
(iii) Wet sample event - June 13, 2023. This was following rain on June 11 (9.6 mm), June 12, (20.5 mm) and June 13 (5.4 mm).

Surface water samples were obtained in each case, except at SG-2 on June 13, 2023 as the wetland was dry.

The surface water quality samples were submitted for laboratory analyses (Appendix G) and compared to the Provincial Water Quality Objectives (PWQO) as shown on Table 2. PWQO exceedances were observed at all three locations during all three sampling events. In summary the PWQO exceedances included:

1) Phosphorus at each location and each sample event;
2) Iron at each location and each sample event except at SG-2 during the spring freshet;
3) Hydrogen sulphide (dry/wet sample events) and pH (dry sample event) at SG-3;
4) Cobalt at SG-1 (wet/dry sample events), SG-2 (spring freshet sample event), SG-3 all sample events;
5) Copper at SG-1 (dry sample event) and SG-3 (wet sample event); and
6) Zinc at SG-1 (spring sample event), SG-2 (spring and dry sample events), SG-3 (wet sample event).

**3.2 Soils**

The Site soils are regionally mapped as well-drained Farmington (10 to 20 cm variable textures over bedrock, having a very short saturation period) to Farmington very shallow phase (20 to 50 cm variable textures over bedrock) soils both with '*rapid drainage*' (Figure 5, Kingston and Presant, 1989). Responses to precipitation events in the bedrock groundwater system may have been noted at MW-2 and MW-5, having overburden/soil thicknesses of 1.1 and 0.6 metres, respectively.

"*Farmington textures can vary from sandy loam to silty clay…*"; grain-size analyses of soils from the Site indicate a general soil composition of silty clay to clay (Table 3, Appendix D) as recorded during the borehole investigation (Appendix E, Niagara Testing & Inspection, 2022). The soils are generally greater in thickness than suggested by soils regional mapping ranging from 0.5 to 1.1 metres (Appendix D).

**Table 3 – Soil Grain-size Analyses Summary**

| Soil Name/Location (deepest available presented) | Gravel% | Sand% | Silt% | Clay% | Texture[1] | HSG |
|---|---|---|---|---|---|---|
| Farmington Very Shallow Phase (Bm horizon)[2] | 10 | 46 | 49 | 19 | Silty Sand | B[2] |
| Farmington (Ap Horizon)[2] | 19 | 4 | 52 | 44 | Silty Clay | B[2] |
| Franktown Very Shallow Phase (mbgj horizon)[2] | 9 | 44 | 45 | 22 | Silty Sand | 70%B/ 30%C[2] |
| Welland Loamy Phase (C Horizon)[2] | 0 | 6 | 32 | 63 | Clay | D[2] |
| MW-1 SS-2 | 0 | 6.2 | 37.6 | 56.1 | Clay | D[3] |
| MW-3 SS-2 | 2.3 | 9.9 | 36.9 | 50.9 | Clay | D[3] |
| MW-4 SS-1 | 2.9 | 24.5 | 42.4 | 30.2 | Silty Clay | C[3] |

Notes: [1] - Texture as per Fetter (1994), [2] - Kingston and Presant, 1989,
HSG – Hydrologic Soil Group, [3] – USDA (2009)

The infiltration rates of the on-site soils are calculated as less than 15 mm/hour according to the relationship between soil hydraulic conductivity (Appendix D) and infiltration rate as provided by Credit Valley Conservation (2012). Consequently, the native soils are be considered unsuitable for infiltration trenches, soakaway pits and pervious pipes (MECP, 2003).

The soils along the City of Port Colborne Road Allowance (Appendix D) were regionally mapped as primarily Welland soils (poorly or very poorly drained soil developed on silty clay) (Table 3) with soils closer to Barrick Road along the Road Allowance mapped as Franktown Very Shallow (20 to 50 cm variable textures over bedrock) or Farmington soils (Appendix D). The Horizon C soils encountered during hand-augering was clay to depths between 1.6 m (PZ2/PZ3) and 2 m (PZ1) below ground surface (BGS) (Figure 3).

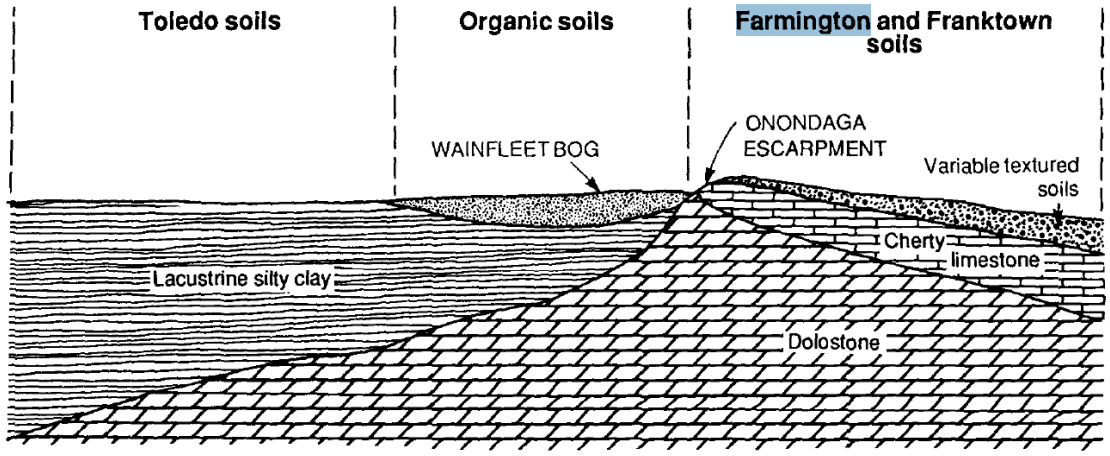



Figure 5 – Schematic landscape cross-section showing the relationship of soils to bedrock in the vicinity of the Wainfleet Bog (Kingston and Presant, 1989)

**3.3 Surficial Geology**

The Ontario Geological Survey (OGS) have mapped the Site's surficial geology as '*bedrock at surface*', which is to represent expecting less than 1 m of soil cover (Feenstra, 1984). The geotechnical investigation for the Site generally confirmed this regional characterization via seven boreholes (NTIL, 2022, Appendix E, Figure 2) as bedrock was encountered between 0.5 and 1.1 metres below ground surface (m BGS) proceeding from west to east across the Site, respectively, beneath the silty clay.

**3.4 Bedrock**

The Site is underlain by the Bois Blanc Formation (limestone over sandstone) which is underlain by Bertie Formation Dolostone (Amstrong, 2017). This is visualized in geologic cross-section on Figure 3. The top of bedrock beneath the Site dips towards the south/southeast from about 186.8 to 185.6 m ASL, which follows the local surface water/catchment divide (Figure 2). The bedrock at the Site was described as "*generally very hard, with the inclusions of chert, however the upper levels tend to be more weathered/fractured*" (NTIL, 2022). The Ontario Geological Survey describes the Bois Blanc Formation as weathering rubbly at the nearby Highway 58 north road cut (approximately 400 m north of the Site) because of its argillaceous nature and high chert content (Armstrong, 2017). The Bois Blanc Formation is not mapped as known/inferred or potential karst, however the underlying Bertie Formation has been regionally mapped as inferred karst (Brunton and Dodge, 2008).

### 3.5 Hydrogeologic Setting

#### 3.5.1 Hydraulic Conductivity

The geometric mean hydraulic conductivity of the silty clay was calculated as $1x10^{-9}$ m/s using the laboratory grain-size analyses and HydrogeoSieveXL (Devlin, 2015, Table 4 below, Appendix D), which is within the published range for clay (Fetter, 1994). A low annual infiltration rate of 100 mm/year was previously modelled by NPCA (NPCA and AquaResource Inc., 2009) also correlating with clay soils (MECP, 1995).

The geometric mean hydraulic conductivity of the bedrock was calculated as $5x10^{-7}$ m/s (Table 4 below, Appendix F) from hydraulic conductivity testing of monitoring wells MW1, MW2, MW3, MW4 and MW5, within previous estimates of between $10^{-6}$ to $10^{-7}$ m/s (Gartner Lee Limited, 1982). This geometric mean hydraulic conductivity is slightly higher than the $10^{-7}$ m/s threshold where "*dewatering not feasible and may not be necessary*" (Preene, 2020).

**Table 4 – Hydraulic Conductivity Analyses**

| Geologic Unit(s) | Location | Hydraulic Conductivity (m/s) | Depth (m BGS) | Analysis Method |
|---|---|---|---|---|
| Poorly sorted clay with fines | MW1 | $3x10^{-10}$ | 1 | Devlin (2015) |
| | MW3 | $7x10^{-10}$ | 1 | |
| | MW4 | $1x10^{-8}$ | 1 | |
| Geometric Mean | | $1x10^{-9}$ | | |
| Bedrock | MW1 | $2x10^{-6}$ | 4.5-7.5 | Bouwer and Rice (1989) |
| | MW2 | $1x10^{-6}$ | 2.6-5.6 | |
| | MW3 | $4x10^{-7}$ | 2.9-6.0 | |
| | MW4 | $7x10^{-8}$ | 4.1-7.2 | |
| | MW5 | $1x10^{-6}$ | 2.7-5.8 | |
| Geometric Mean | | $5x10^{-7}$ | | |

Note: BGS - Below ground surface

#### 3.5.1 Drive-point Piezometer Groundwater Levels

Three drive-point piezometers were hand-installed within the City of Port Colborne Road Allowance (PZ-1, PZ-2 and PZ-3, Figure 2) to measure shallow groundwater levels. These monitoring locations were installed to between 2.7 and 3.0 m BGS with 30 cm length screens. The monitors were installed at the base of the clay soils at bedrock, as inferred by refusal. The three drive-point piezometers were equipped with water level datalogger pressure transducers on March 20, 2023, recording water levels at 15-minute intervals. Groundwater level observations showed no responses to precipitation and included:

1. PZ-1 groundwater levels were relatively stable from May to October, 2023 at close to 174.3 m ASL, or 1.7 m BGS. The relative stability of the water levels during the summer period may suggest supply by upgradient flow from the Onondaga Escarpment slope. However, a downwards vertical groundwater gradient is observed comparing this location to surface water Staff Gauge SG-1.

2. PZ-2 groundwater levels declined from about 173-172.7 m ASL (2.9-3.2 m BGS) in the spring season of 2023 to dry by June, 2023. Despite the water level datalogger being affected by freezing, manual water level measurements did not suggest a recovery of groundwater levels. A downwards vertical water gradient is observed comparing this location to Staff Gauge SG-2; and

3. PZ-3 groundwater levels increased through the monitoring period to be at and above ground surface by surface (175.6 m ASL) by September, 2023. These groundwater levels may reflect shallow bedrock groundwater levels, as they are higher than the Biederman Drive surface water levels. An upwards vertical water gradient is observed comparing this location to Staff Gauge SG-3.

### 3.5.2 Bedrock Groundwater Levels

On-site manual groundwater level measurements began in July, 2022 and included five bedrock monitoring wells (Table 5). The five monitoring wells were also equipped with water level datalogger pressure transducers on January 26, 2023, recording water levels at 15-minute intervals. The monitoring wells were constructed (i.e. screened) to measure shallow bedrock groundwater levels (Appendix E) with the 3.05 m screened interval ranging from 2.4-5.5 m BGS (MW2) to 4.9-7.9 m BGS (MW1), with all monitoring wells including the interval of 3-5.5 m BGS (Table 5). It is believed monitoring wells MW1, MW2, MW3 and MW5 are screened in the Bois Blanc Formation, and MW4 is screened across the Bois Blanc and Bertie Formations (Figure 3). Groundwater levels were (i) above the screened intervals of monitoring wells MW1, MW2 and MW3 and (ii) within the screened intervals at MW4 and MW5.

The shallow groundwater system seasonal trends, as monitored by MW1, MW2 and MW3, were: (a) spring/later winter groundwater level highs, (b) fall groundwater lows and (c) a variation between the highs and lows of generally 1.4 to 1.6 m (Appendix C). The groundwater levels at MW4, interpreted to monitor an intermediate groundwater system, were fairly stable, and any seasonal trend was subtle. However, groundwater levels at MW5 are interpreted to represent two sets of fracture zones as the groundwater levels were ‘stepped’ with (a) highs between December and April, and (b) lows between May and November.

Groundwater levels were shallowest in the central eastern portions of the Site, with the shallowest levels noted in spring or winter (Table 6, Appendix C). Groundwater levels at MW1, MW2 and MW3 were generally less than 2 metres below ground surface (Appendix C).

**Table 6 – Seasonal Shallow Groundwater Levels**

| Location | MW1 | MW2 | MW3 | MW4 | MW5 |
|---|---|---|---|---|---|
| **Spring 2023** | | | | | |
| **Depth (mBGS)** | 0.9 | 1.3 | 0.8 | 4.3 | 2.6 |
| **Winter 2024** | | | | | |
| **Depth (mBGS)** | 0.9 | 0.6 | 0.9 | 4.0 | 2.3 |

### 3.5.3 Groundwater Flow

Following a review of the bedrock groundwater levels at the five on-site monitoring wells, it is surmised that monitoring wells MW1, MW2 and MW3 monitor a water table groundwater system that is shallower than that monitored at MW4 and MW5, as can occur in a fractured bedrock aquifer. In

addition, groundwater levels may be lower at MW4 and MW5 with a closer proximity to the Onondaga Escarpment and an inferred fracture zone in the bedrock. The shallow groundwater flow regime at MW1/MW2/MW3 was observed to sloped towards the south/southwest (Figure 2) with a low horizontal gradient of approximately 0.004 m/m (May, 2023) to 0.005 (October, 2023).

The regional potentiometric surface in the bedrock was previously modelled as between 175 and 174 m ASL below the site with flow northerly towards the Onondaga Escarpment (Waterloo Hydrogeologic Inc., 2005). This is visualized as a downwards vertical groundwater gradient from the shallow system of the monitoring wells, compared to the deeper bedrock system supplying water supply wells, as shown on the hydrogeologic cross-section (Figure 3). The groundwater levels monitored at PZ-1 and PZ-3 are similar in elevation to those reported by NPCA (WHI, 2005) for the potentiometric surface being between 174 and 176 m ASL.

### 3.5.4 Bedrock Groundwater Chemistry

Groundwater quality samples were collected from three monitoring wells (MW1, MW3 and MW4) on May 2023 for laboratory analyses of a general suite of parameters (Appendix G).

The water quality results were compared to the Ontario Drinking Water Standards, Objectives and Guidelines (MECP, 2003) for comparison purposes (Table 7). Fluoride was noted as naturally exceeding the lower Maximum Acceptable Concentration (MAC) threshold of 1.5 mg/L at all three locations but below the upper 2.4 mg/L MAC threshold. Elevated fluoride concentrations in these bedrock units is not unexpected as Devonian Formation bedrock "*have the highest fluoride concentrations*" (Colgrove and Hamilton, 2018). The groundwater was also "hard", with total dissolved solids above the aesthetic objective at MW1 and MW3 and elevated turbidity at MW4.

The general water quality of MW1 and MW3 were very similar although classified as Magnesium-Sulphate and Magnesium-Bicarbonate waters, respectively, with MW4 somewhat fresher and Calcium-Bicarbonate type water (Fetter, 1995). The conductivity and temperature of the groundwaters at each monitoring well was also recorded during the May 3, 2023 hydraulic conductivity testing and is listed below (Table 8):

**Table 8 - Groundwater Field Chemistry Observations**

| Location | MW1 | MW2 | MW3 | MW4 | MW5 |
|---|---|---|---|---|---|
| Conductivity (µs/cm) | 1,059 | 1,292 | 1,296 | 599 | 765 |
| Temperature (°C) | 8.8 | 8.7 | 8.3 | 9.1 | 8.3 |

### 3.5.5 Ministry of the Environment, Conservation and Parks Water Well Records

There are no Ministry of the Environment, Conservation and Parks (MECP) water supply wells mapped at the Site. A number of water supply well records are mapped along Barrick Road south of the Site (Figure 6), however it is our understanding that municipal water supply is provided to residences/properties immediately south of the Site along the Barrick Road. The historic water well records south of Barrick Road date from 1949 to 1979 and were constructed for domestic supply from the underlying bedrock aquifer (Table 9). Bedrock was encountered on average 1 metre below ground surface (m BGS), and the static groundwater level was on average 8.5 m BGS with the wells completed on average 15.2 m BGS (Table 9). This is a deeper groundwater system than is monitored on-site.

### 3.5.6 Water Well Survey

A water well survey was distributed in April, 2023 to nearby properties not on municipal water services on the northern side of Barrick Road, West of Minor Road (Appendix H). No responses were received.

### 3.6 Ministry of Natural Resources and Forestry (MNRF) Oil, Gas and Salt Resources Library

No petroleum records are mapped at the Site by the Ministry of Natural Resources and Forestry Ontario Oil, Gas and Salt Resources Library. The closest record identified is over 300 metres to the north of the Site.

### 3.7 Wetlands

There are no wetlands located at the Site. However, there is swamp, as mapped by the MNRF, about 45 m north of the Site, complexed as part of the Wainfleet Bog Wetland Complex (Figure 2). This 'swamp' is part of a 517 hectare polygon mapped around the outside of the Wainfleet Bog which MNRF reports trembling aspen as the dominant species (MNRF, 2009). It was previously mapped as predominantly moist/dry forest (Regional Municipality of Niagara, 2003). The swamp wetland polygon is mapped both above, as well as below, the Onondaga Escarpment including at SG-2 and PZ-2 along the Port Colborne Road Allowance (Figure 2). The wetland has been mapped as palustrine, defined as having intermittent or no inflow, and either permanent or intermittent outflow and may rely on rainfall and some overland flow (MNRF, 2014).

The NPCA Natural Areas inventory (NPCA, 2009) may have also indicated: (a) Red Maple Swamp or Grey Dogwood Thicket at the base of the Onondaga Escarpment along the Road Allowance and (b) successional woodland on the tableland of the escarpment consisting of White Ash, Basswood and Bitternut Hickory, or Black Maple/Sugar Maple/Hop Hornbeam/Red Oak Forest.

### 3.6.1 Wetland Water Level/Hydroperiod Monitoring

A hydroperiod is defined as "*the seasonal pattern of the water level of a wetland…It characterizes each type of wetland, and the constancy of its pattern from year to year ensures a reasonable stability for that wetland. It defines the rise and fall of a wetland's surface and subsurface water by integrating all of the inflows and outflows"* (Mitsch and Gosselink, 2007).

A wetland water level staff gauge (SG-2) was installed by Terra-Dynamics in March, 2023 to monitor the wetland hydroperiod, as access was not available to the portion of the mapped wetland immediately north of the Site. During installation of PZ-2, adjacent Staff Gauge SG-2, the underlying soils were recorded (Table 10) from the hand-augering process with organic soils noted for the upper 35 cm (re-word). MNRF (2009) have historically reported humic/mesic soils at the wetland.

**Table 10 - Hand-auger Soil Information at PZ-2**

| **Depth (cm)** | 0-35 | 35-95 | 95-100 | 100-105 | 105-164 |
|---|---|---|---|---|---|
| **Soil Type** | Dark brown, Organic, soft | Brown, Silt with sand, wet | Coarse sand in silt | Brown Clay | Grey Clay, DTPL |

Notes: DTPL – Drier than the plastic limit

As mentioned in Section 3.1.1, surface water level monitoring at wetland staff gauge SG-2 began March 2023 for a year and is presented in Appendix C. Following the 2023 spring freshet, and the seasonal high-water level the 1st week of April, dry conditions were observed to begin in May 2023, coincident with below average precipitation (Table 1). Dry conditions persisted through the summer with ponded conditions only noted following some rainfall events (e.g. on August 25 following 34 mm of daily rainfall). Groundwater levels at adjacent PZ-2 were greater than 3 m below ground surface during this monitoring period indicating a downward vertical gradient.

Mitsch and Gosselink (2007) report that the "*hydroperiods of many bottomland hardwood forests and swamps have distinct periods of surface flooding in the winter and early spring due to snow and ice conditions followed by spring floods but otherwise have a water table that can be a meter or more below the surface*" (Figure 7). The SG-2 hydrograph is similar to the published hydroperiod fora Canadian swamp (Figure 7).

**3.6.2 Wetland Characterization**

The monitored wetland at SG-2, and the wetland 45 m north of the Site, are proposed classified as a *surface water depression wetlands* (Figure 8) (Mitsch and Gosselink, 2007).

A surface water depression wetland is summarized as a: "*wetland…dominated by surface runoff and precipitation, with little groundwater outflow due to a layer or low-permeability soils*…". Low permeability silty clay soils have been noted beneath the wetland on the Road Allowance and on-site and it is inferred these also exist at the wetland immediately north of the Site.

**3.6.3 Soil Water Holding Capacity**

The wetland along the City of Port Colborne Road Allowance is underlain by Hydrologic Soil Group (HSG) D soils (Section 3.2) and was assigned a soil water holding capacity (SWHC) of 350 mm. The wetland immediately north of the Site is believed underlain by HSG C based upon the grain-size analyses at MW4 SS1 (Section 3.2), and is assigned a SWHC of 400 mm. These SWHC values are based upon previous values used by NPCA in their water budgeting study (AquaResource Inc. and NPCA, 2009).

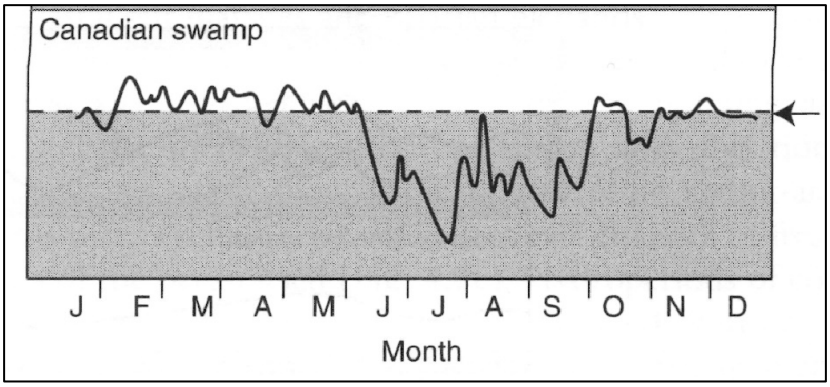



Figure 7 – Published Hydroperiod (Mitsch and Gosselink, 2007)
Note: arrow indicates wetland ground surface

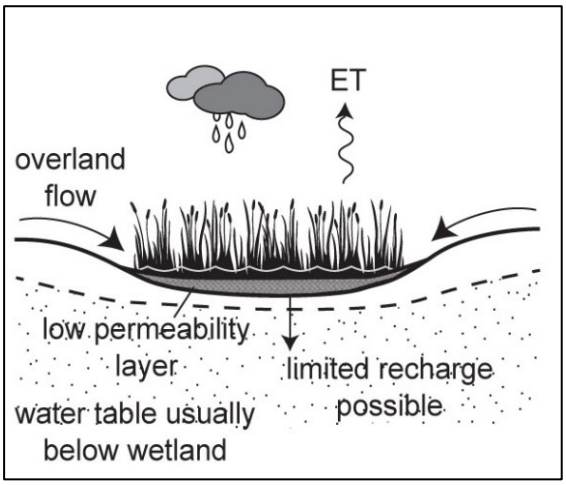



Figure 8 - Surface water depression wetland (modified after Mitsch and Gosselink, 2007)

### 3.6.4 Wetland Surface Water Catchments

As described in Section 3.1, and as shown on Figure 2, most of the Site (99%) drains towards Barrick Road. The overland flow direction for the 1% of the Site draining towards the Onondaga Escarpment was modelled and is shown on Figure 9. The overland flow catchment of about 3.1 ha suggests very little of the mapped wetland above the escarpment may be downgradient of the Site, estimated as between 0.01 and 0.02 ha, and a possible area of 0.51 ha of wetland below the escarpment.

### 3.7 Pre-development Subwatershed Water Balance Modelling

NPCA previously completed pre-development water balance modelling for 1991-2005, as part of provincial water budgeting for the source water protection program (AquaResource Inc. and NPCA, 2009). This modelling was completed at 1-hour time steps with a filled-in meteorological dataset including solar radiation and a crop coefficient for improved calculation of evapotranspiration. The modelling used lumped parameter catchments incorporating data such as soils, land cover and slope.

The Site is primarily located within NPCA modelled catchment Central Welland River Biederman Drain W100 (CWR_BND_W100) and the Port Colborne Road Allowance within catchment W200 (CWR_BDN_W200) (Figure 1). Modelled annual and monthly water balance results were obtained for these catchments and presented on Tables 11, 12 and 13, with decimals shown where modelled values were less than 1 mm (AquaResource Inc. and NPCA, 2009). The annual surplus as shown is precipitation minus evapotranspiration, i.e. the water available for runoff and recharge.

**Table 11 - Water Balance 15-year (1991-2005) Averages**

| Catchment | Precipitation | Actual Evapotranspiration | Annual Surplus | Infiltration* | Recharge | Runoff |
|---|---|---|---|---|---|---|
| | (mm/year) | | | | | |
| CWR_BND_W100 | 968 | 597 | 371 | 73 | 36 | 298 |
| CWR_BND_W200 | 968 | 676 | 292 | 68 | 34 | 223 |

Notes: * - Infiltration is interflow plus recharge

**Table 12 - Monthly Runoff and Infiltration (Catchment CWR_BND_W100)**

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Runoff (mm)** | 40 | 34 | 61 | 46 | 25 | 9 | 4 | 4 | 5 | 9 | 30 | 34 |
| **Infiltration (mm)** | 14 | 12 | 19 | 10 | 3 | 0.6 | 0.1 | 0 | 0 | 0.4 | 4 | 12 |

**Table 13 - Monthly Runoff and Infiltration (Catchment CWR_BND_W200)**

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Runoff (mm)** | 33 | 26 | 53 | 43 | 27 | 7 | 1 | 1 | 1 | 2 | 9 | 20 |
| **Infiltration (mm)** | 12 | 11 | 19 | 11 | 4 | 1 | 0.1 | 0 | 0 | 0.2 | 2 | 8 |

## 4.0 Wetland Water Balance Assessment

A monthly wetland water balance assessment was completed for the wetland located along the Road Allowance and north of the Site, as informed by the Conservation Authority Guidelines for Development Applications (Cuddy, Soo Chan and Post, 2013) and TRCA's guidance for water balances (2012).

It is noted that the MECP (2003) water balance approach is typically concerned with the evaluation of post-development to prevent (i) increased runoff, and/or (ii) reduction in groundwater recharge. However, given the current wetland characterization, any on-site water surplus contribution, with respect to the wetlands, is via additional surface water flow, not groundwater discharge. Consequently, the purpose of the wetland water balance assessment modelling is to evaluate if runoff maintains monthly saturated conditions at the wetlands.

### 4.1 Monthly Water Balance Example

An example of water balance modelling from the University of Waterloo is shown below (Figure 10). Annual soil water recharge begins in the fall following '*soil water utilization*' and '*deficit*' in the summer. Soil water utilization corresponds with evapotranspiration exceeding the precipitation supply. Annual groundwater recharge occurs during the same time period that groundwater levels rise. However, in this example it is noted that the soil water holding capacity (SWHC) modelled was only 100 mm compared to the higher SWHC 350 to 400 mm for the wetlands under consideration (Section 3.6.3), i.e. with a SWHC of 100 mm a water deficit could happen more quickly in a summer period.

### 4.2 Wetland Monthly Water Balance

A monthly water balance for the wetlands was completed using the U.S. Geological Survey (USGS) Monthly Water Balance Model (McCabe and Markstrom, 2007), which only considers direct precipitation to the wetland as a water supply. For temperature and precipitation, two scenarios were modelled (a) climate normal inputs (1981-2010) from Port Colborne Station ID 6139445 were used (Environment Canada, 2024a) and (b) 2023 from Environment Canada Welland-Pelham Station ID 6139449, for the two soil water holding capacities identified (Section 3.6.3). Although only the 2023 results are presented, the model inputs included years prior to 'prime' the model. The Port Colborne station was not used for 2023 due to a number of reporting gaps.

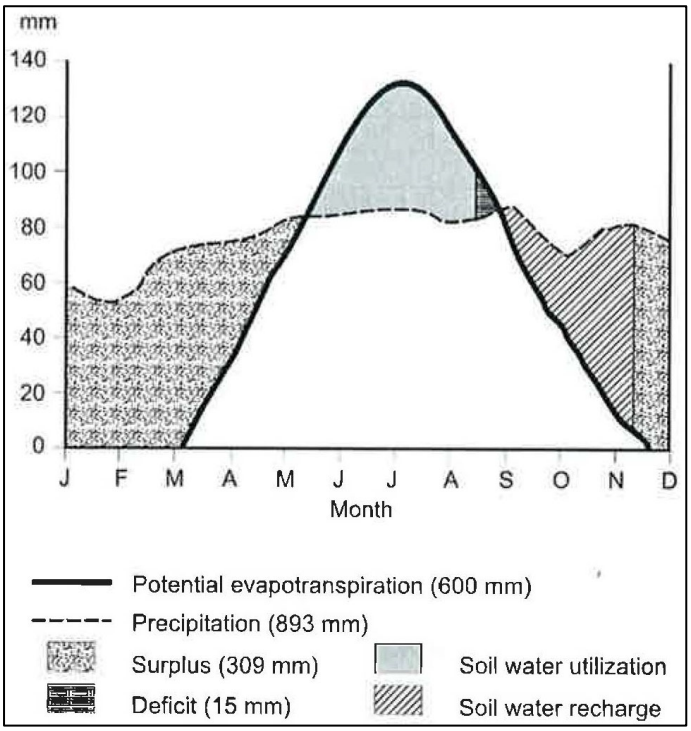



Figure 10 – Brantford Average Water Balance (Sanderson, 2004)

The monthly wetland water balance modelling results are presented on a series of tables: (a) the climate normal/averages (Tables 14a, and 14b) and (b) 2023 (Tables 15a, and 15b). The average results (1981-2010) are summarized below for both modelled soils:

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

With respect to 2023, the modelled results for both soils are described below:

1. Potential evapotranspiration exceeded precipitation for May, June and September, both earlier and later than average (1981-2010) conditions.
2. Soil water holding capacities were less than saturated for the months of May, June, July, September and October, beginning earlier than average conditions; and
3. Soil water recharge occurred in both July and October; usually July is not a recharge month while September usually is.

The results varied from the average conditions primarily because 2023 had: (a) a very dry May and September (41% and 31% of average precipitation, respectively) and (b) a very wet July and August (190% and 168% of average precipitation, respectively) (Table 1).

The modelled results for (Tables 15a/b), reasonably match the monitored water levels at SG-2, supporting wetland primary water supply by precipitation.

The monthly average wetland water balance modelling results are summarized below (Table 16, without decimal places) for the wetland above the escarpment near the Site:

**Table 16 – Average Monthly Wetland Water Balance – Above Onondaga Escarpment (mm)**

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Precipitation (mm)** | 73 | 57 | 67 | 76 | 90 | 79 | 82 | 83 | 98 | 90 | 101 | 89 |
| **Evapotranspiration (mm)** | 13 | 13 | 22 | 43 | 63 | 98 | 121 | 91 | 63 | 37 | 17 | 15 |
| **Soil Moisture (mm)** | 400 | 400 | 400 | 400 | 400 | **371** | **327** | **307** | **337** | **388** | 400 | 400 |
| **Soil Water [1] Depletion (mm)** | | | | | | **29** | **73** | **93** | **63** | **12** | | |

Notes: [1] Difference between the SWHC (400 mm) and the modelled soil moisture

### 4.3 Wetland Water Balance Assessment

As introduced in Section 4.0, "*the purpose of the wetland water balance assessment modelling is to evalute if runoff maintains monthly saturated conditions at the wetlands*". Assessment of this condition is a concern only, on average, for the months of June through October, when the monthly wetland water balance indicated less than saturated conditions may be expected based upon direct precipitation alone to maintain average saturated conditions (Table 16).

The pre-development wetland water balance assessment was a calculation of the June to October monthly runoff area required for wetland downgradient of the northwest corner of the Site to have saturated conditions (Figure 9, Table 17). As the upgradient catchment is 3.1 ha (Section 3.6.4, Figure 9), it appears saturated conditions may only be supported by upgradient runoff in June or October. However, this may occur with, or without, the 0.12 ha northwest corner of the Site's runoff.

**Table 17 – Modelled Runoff to Swamp (above the Onondaga Escarpment)**

| Month | Jun | Jul | Aug | Sep | Oct |
|---|---|---|---|---|---|
| **Soil Water [1] Depletion (mm) [see Table 16]** | 29 | 73 | 93 | 63 | 12 |
| **Wetland Soil Water Depletion Volume[2] ($m^3$)** | 148 | 372 | 474 | 321 | 61 |
| **Modelled Runoff (mm) [see Table 13]** | 7 | 1 | 1 | 1 | 2 |
| **Upgradient area [3] required to produce saturated wetland – Drainage Area (ha)** | **2** | 37 | 47 | 32 | **3** |

Notes: [1] Difference between the SWHC (400 mm) and the modelled soil moisture

[2] Depletion depth multiplied by the area of PSW Swamp potentially receiving runoff (0.51 ha, Section 3.6.4)

[3] Volume of soil water depletion ($m^3$) divided by monthly modelled runoff (mm) converted to hectares – bolded values indicate upgradient drainage area sufficient for saturated conditions

## 4.4 Wetland Risk Evaluation

### 4.4.1 Magnitude of Hydrological Change

TRCA's wetland risk evaluation (2017) decision tree (Figure 11) includes four key hydrological change criteria:

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

(1) Impervious cover in catchment: It is our understanding that the northwest corner of the Site may be developed. If the 0.12 ha of the northwest corner is developed, and made 100% impervious, this would be estimated to increase the overland runoff catchment imperviousness less than 5%.

(2) Change in catchment size: It is our understanding that the northwest corner of the Site may be developed. If the 0.12 ha of the northwest corner is removed from draining to the west/northwest, this is estimated to reduce the overland runoff catchment for the downgradient wetland above the escarpment less than 5%.

(3) Dewatering: Any construction dewatering is not expected to affect wetlands due to the depth of water table (greater than 4 m BGS in the bedrock) in the northwest portion of the Site and the low bedrock hydraulic conductivity as measured at monitoring well MW4 ($7x10^{-8}$ m/s).

(4) Impact to recharge areas: No impacts to wetland recharge areas are predicted as TRCA (2017) defines this as "*replacement of existing soils with significantly less permeable materials*" and the on-site soils are already of low permeability. In addition, there are no locally significant recharge areas to be impacted as these are defined by TRCA (2017) as "*highly porous sedimentary deposits or otherwise having high hydraulic conductivity*".

"*The highest magnitude category with one or more criteria satisfied determines the potential magnitude of change*" with the magnitude thresholds of less than 10% change as low, 10-25% medium and greater than 25% high (TRCA, 2017). A hydrologic risk is assigned based upon the potential magnitude of impervious cover and the potential change in upgradient catchment area. With respect to the downgradient wetland, the amount of impervious area and change in catchment would be less than 5%, classified as a low potential magnitude of change.

### 4.4.2 Sensitivity of the Wetlands

The risk assignment (Figure 11) is to consider the type of wetlands, and their hydrological sensitivity (TRCA, 2017). Although trembling aspen is reported as the dominant species by the MNRF (2009) it is not listed in TRCA's listing of wetland species for their jurisdiction (2017). MNRF (2014) does indicate "*some tree species that can dominate or co-dominate in swamps (e.g. the eastern white cedar, white elm, eastern hemlock, red maples, trembling aspen and balsom poplar) occur in both wetland and upland habitats*".

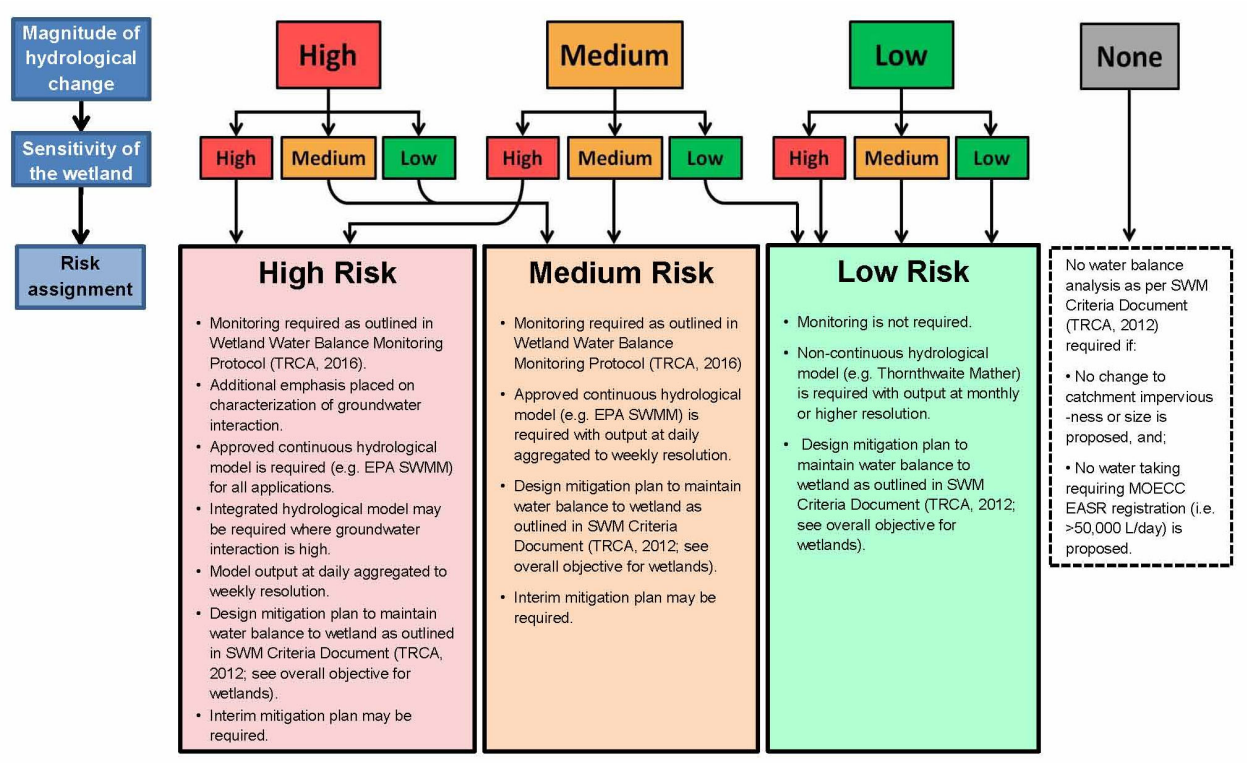



**Figure 11 - Wetland Risk Evaluation Decision Tree (TRCA, 2017)**

Most of the species listed in NPCA's Natural Areas Inventory (NAI) (2009) for successional woodland on the tableland of the Onondaga Escarpment consisted of "*White Ash, Basswood and Bitternut Hickory, or Black Maple/Sugar Maple/Hop Hornbeam/Red Oak Forest*". White Ash (SWD2-A) was listed as medium hydrologic sensitivity to change (TRCA, 2017). Below the Onondaga Escarpment NPCA's NAI (2009) listed Red Maple Swamp or Grey Dogwood Thicket at the base of the Onondaga Escarpment, and these are listed as high hydrologic sensitivity to change for Red Maple Organic Deciduous Swamp (SW6-1) and Silky Dogwood Organic Thicket Swamp (SWT3-B) (TRCA, 2017).

### 4.4.3 Risk Assignment

As per Figure 11, a low risk is assigned based upon (i) the possible magnitude of hydrological change <5%, and (ii) a high/medium wetland sensitivity. The TRCA recommended study, modelling and mitigation requirements based upon a low risk are as follows:

(i) Monitoring is not required (TRCA, 2016).
- However, pre-development monitoring has occurred to inform the conceptual model and impact assessment for the Site.

(ii) Non-continuous hydrological model required with output at a monthly or higher resolution.
- Existing modelling (completed at 1-hour time steps) completed by NPCA was utilized for this report (AquaResource Inc. and NPCA, 2009) as part of the monthly wetland water balance analyses completed for the Site.

(iii) Design of a mitigation plan to maintain the wetland water balance.

- Based upon the Wetland Water Balance Assessment (Section 4.3) development of the northwest corner of the Site will have negligible impact to the downgradient wetlands and therefore no mitigation plan is required.

## 5.0 Conclusions and Recommendations

### 5.1 Conclusions

The following conclusions are provided:

1. The Site is 8.34 hectares in area and fairly flat. It is regionally located on a 'limestone plain' of bedrock of the Onondaga Escarpment with between 0.5 and 1.1 metres of clay overlying bedrock.

2. Native clayey soils are calculated to have low permeability, i.e. less than 15 mm/hour and infiltration of 100 mm/year, and consequently the clayey soils would not naturally support low impact development infiltration measures.

3. No watercourses are located on-site. The Site almost entirely drains to the southeast (99%) and roadside ditch drainage along Barrick and West Side Roads.

4. No wetlands are mapped on-site, as the Site is vacant agricultural/undeveloped land. However, the Ministry of Natural Resources & Forestry have mapped Provincial Significant Swamp Wetland associated with the Wainfleet Bog Wetland Complex approximately 45 metres north of the Site in a separate surface water catchment than 99% of the Site. Based upon available information this is a surface water depression wetland.

5. The underlying Bois Blanc Formation bedrock is not regionally mapped as karstic and as a result, should not be hazardous from a karst perspective.

6. Shallow groundwater flow is within the bedrock and is generally from north to south across the Site. The high water table in the spring/late winter season was as shallow as 0.6-0.9 metres below ground surface in the central and eastern portions of the Site.

7. The average hydraulic conductivity of the underlying bedrock is sufficiently low as to be close to the threshold that "*dewatering* (is) *not feasible and may not be necessary*" (Preene, 2020) if excavations below the water table are required.

8. Wetland water levels monitored from the spring to fall seasons of 2023 resemble published hydroperiods for Canadian swamp and the monitoring data reasonably matches modelled monthly water balance results for being sustained by precipitation alone.

9. A monthly water balance for the wetlands identified, on average, potential evapotranspiration as exceeding precipitation for June, July and August, with soil water holding capacities less than saturated also in September and October. However, saturated conditions downgradient of the Site may only be maintained by runoff in June and October.

10. Pre-development monthly water balance modelling reasonably matches wetland water level monitoring supporting the conceptual model of palustrine wetlands (e.g. intermittent or no inflow) which are supported primarily by precipitation.

11. The Toronto Region Conservation Authority wetland risk screening tool assigned a low risk to the hydrological and ecological integrity of the wetlands.

12. Residential development of the Site should not negatively impact the hydrology of the wetlands.

**5.2 Recommendations**

The following recommendations are provided:

1. During future construction, if surficial depressions or voids in the bedrock are noted in the vicinity of homes during introduction of fill or bedrock excavations, the on-site geotechnical firm should contact a geoscientist with expertise in karst topography;

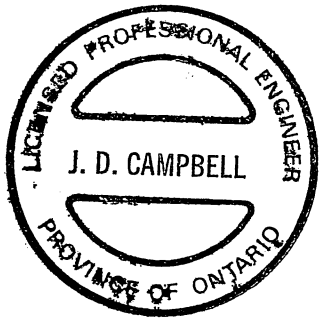
2. If municipal servicing is planned below the high water table, consideration be given to construction with clay-cutoff collars every 45 metres (150 feet) for sanitary sewers and stormsewers; and

3. Once Site Plan approval is received, decommission the on-site monitoring wells using an Ontario-licensed water well contractor as per Regulation 903 of the Ontario Water Resources Act.

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, P. Eng.
Senior Water Resources Engineer

cc. William Heikoop, Upper Canada Planning & Engineering Ltd.
Anne McDonald, Ecological and Environmental Solutions

Attachments
Figure 1 – Location of Subject Lands
Figure 2 – Site Details
Figure 3 – Geologic Cross-Sections A-A'/B-B'
Figure 6 – MECP Water Well Records
Figure 9 – Wetland Catchments

**6.0 References**

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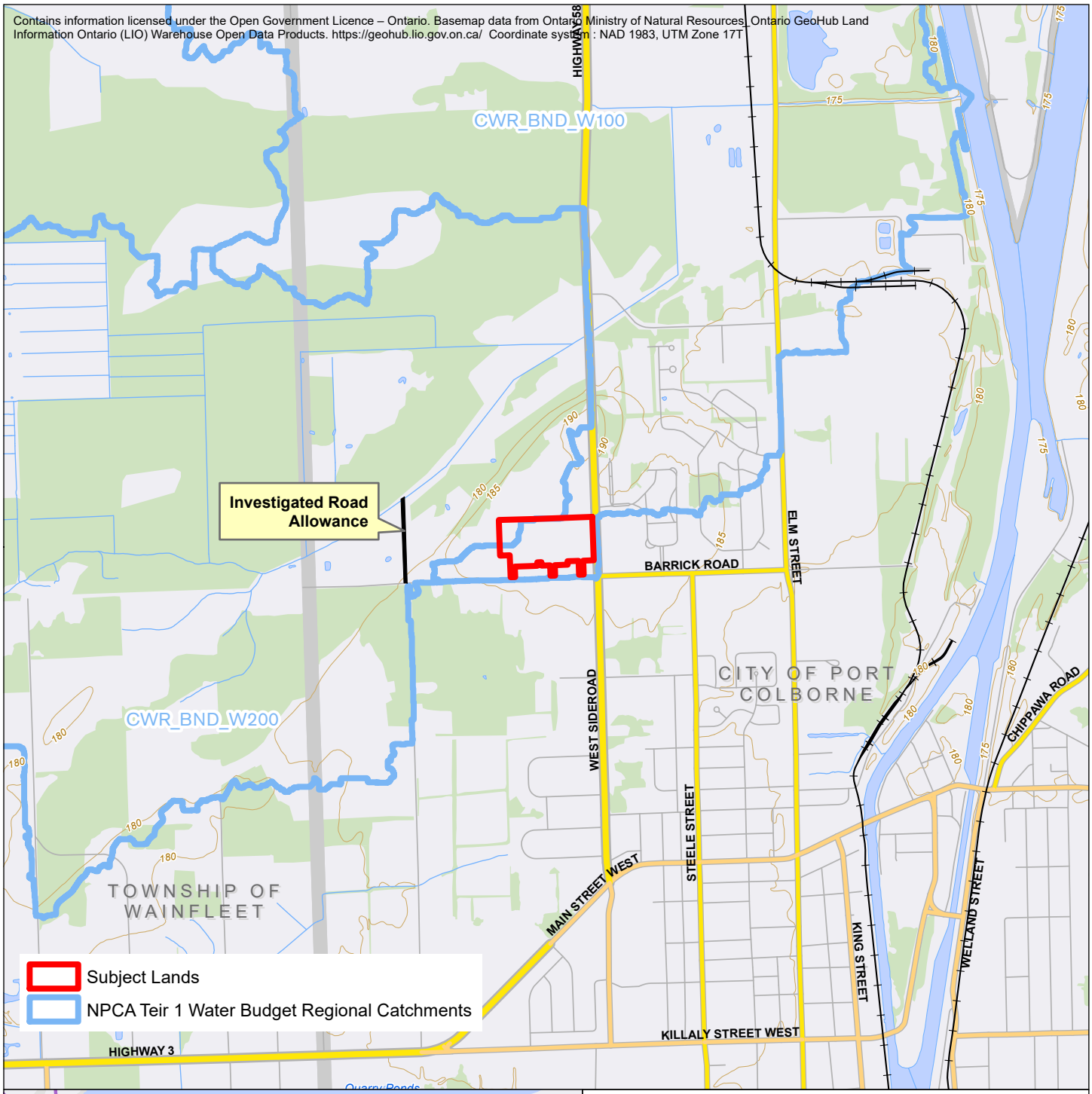



# Location of Subject Lands

Barrick Road Subdivision Study
Elevate Living Niagara
Barrick Road and West Side Road, Port Colborne

Terra-Dynamics Consulting Inc.

0 500 Meters
1:25,000

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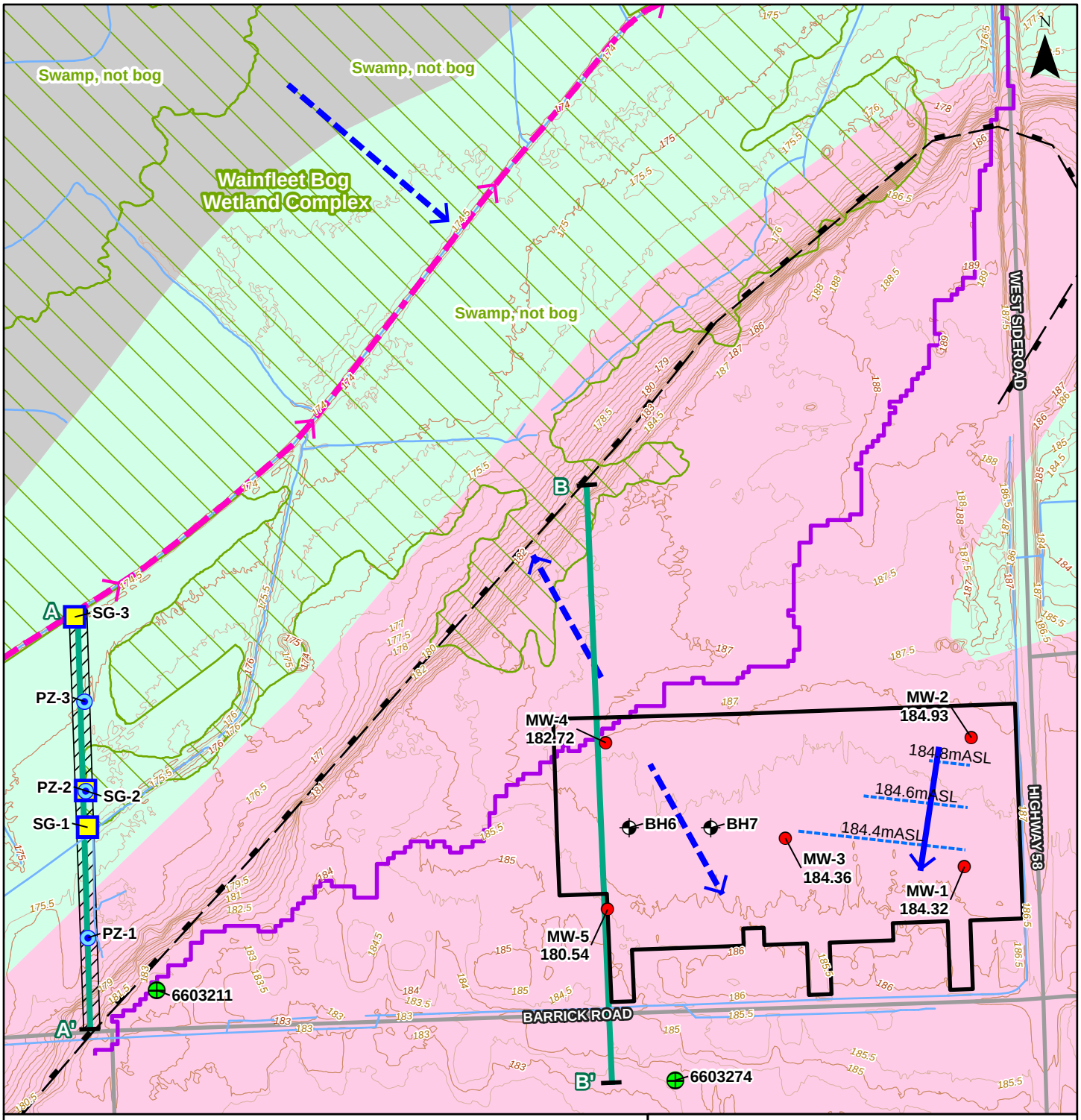
**Figure 1**

Path: H:\TERRA_DYNAMICS\9620 - TD Barrick Topo Delineation\gis\mxd\Figure 1 Location of Subject Lands.mxd Revised: April 30, 2024




Study Area
Biederman Drain
Overland Flow Direction
Goundwater Flow Direction
Watercourse
Subwatershed Divide
Road Allowance (City of Port Colborne)
Provincially Significant Wetland (MNRF)
Surface Contours
Borehole
Section Location

Drive-point Piezometer
Surface Water Staff Gauge
Water Well (MECP WWIS)
Groundwater Contours (Oct 2023)
Groundwater Monitoring Well
Water Level Oct 2023

**Surface Geology (OGS)**

Onondaga Escarpment
Paleozoic Bedrock
Silty Clay
Wainfleet Bog

# Site Map

Barrick Road Subdivision Study
Elevate Living Niagara
Barrick Road and West Side Road, Port Colborne

TDC Terra-Dynamics Consulting Inc.

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**Figure 2**

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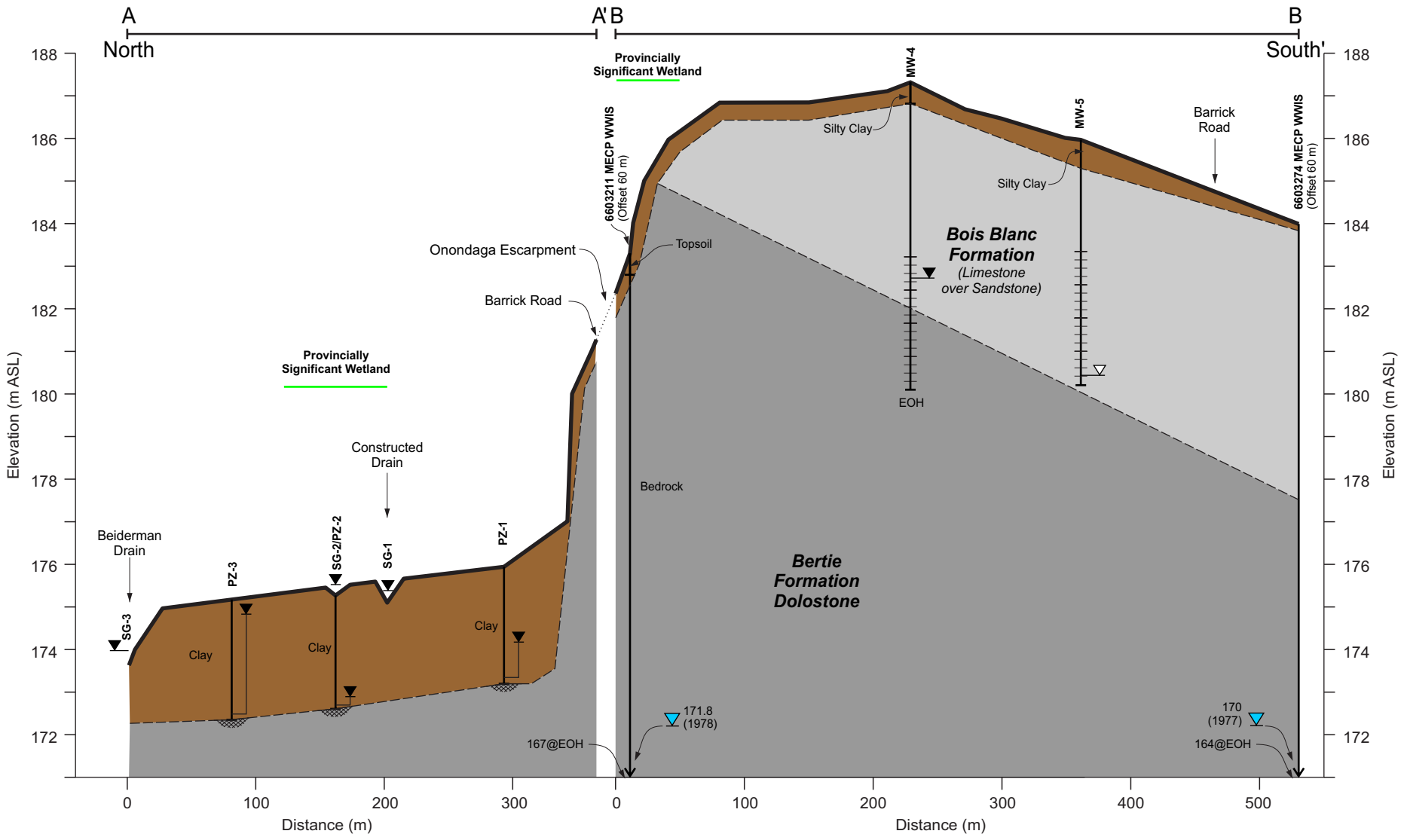


Borehole
Well Screen
EOH End of Hole
Inferred Bedrock

Water Level May 3, 2023
Water Level June 13, 2023
Water Level MECP (date)

Clay
Limestone over Sandstone
Dolostone

# Geologic Cross-sections A-A' & B-B'

Barrick Road Subdivision Study, Elevate Living Niagara
Barrick Road and West Side Road, Port Colborne

TDC Terra-Dynamics Consulting Inc.

**Figure 3**

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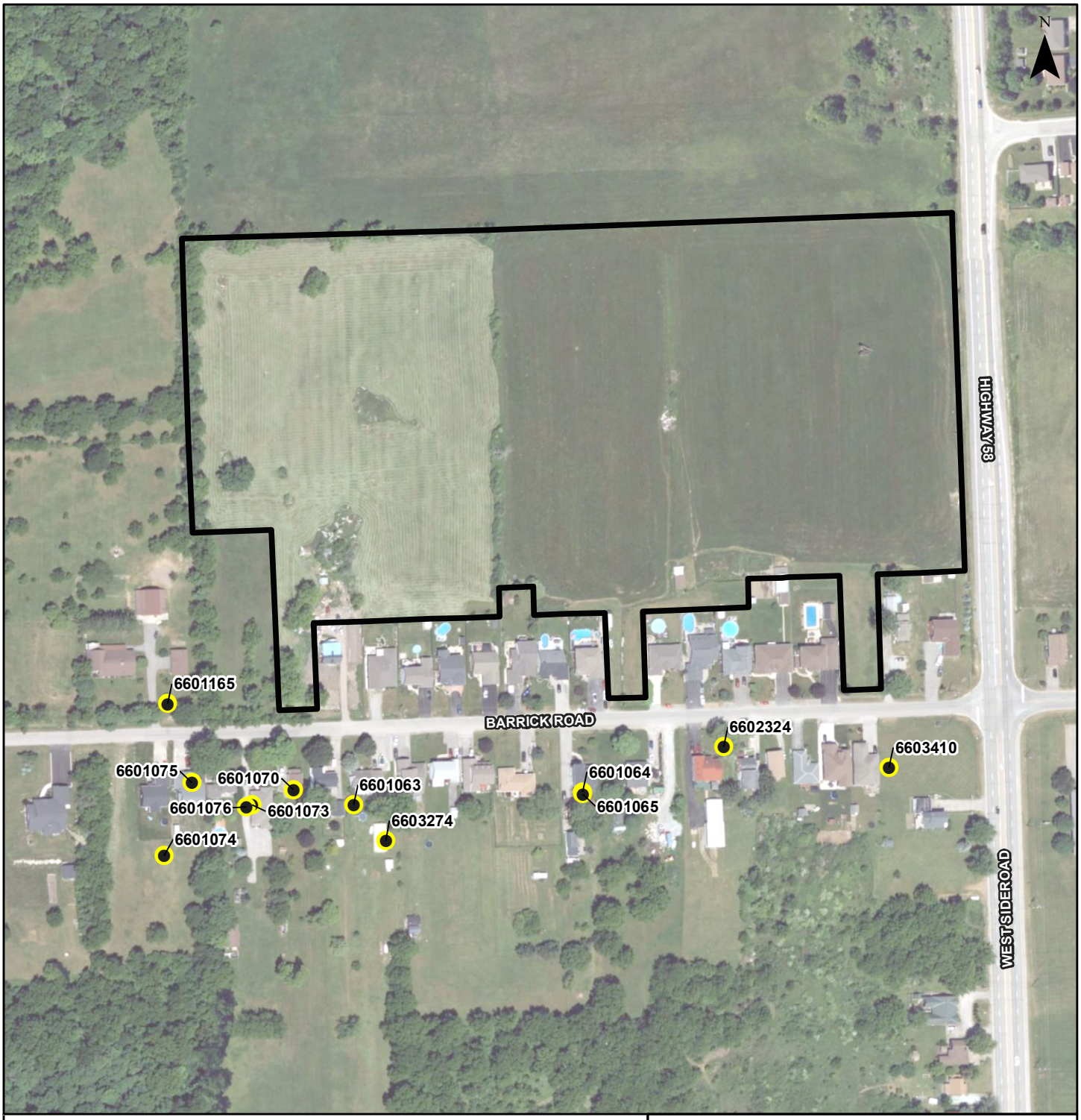


Study Area

MECP Water Well

# MECP Water Well Records

Barrick Road Subdivision Study
Elevate Living Niagara
Barrick Road and West Side Road, Port Colborne

TDC Terra-Dynamics Consulting Inc.

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**Figure 6**

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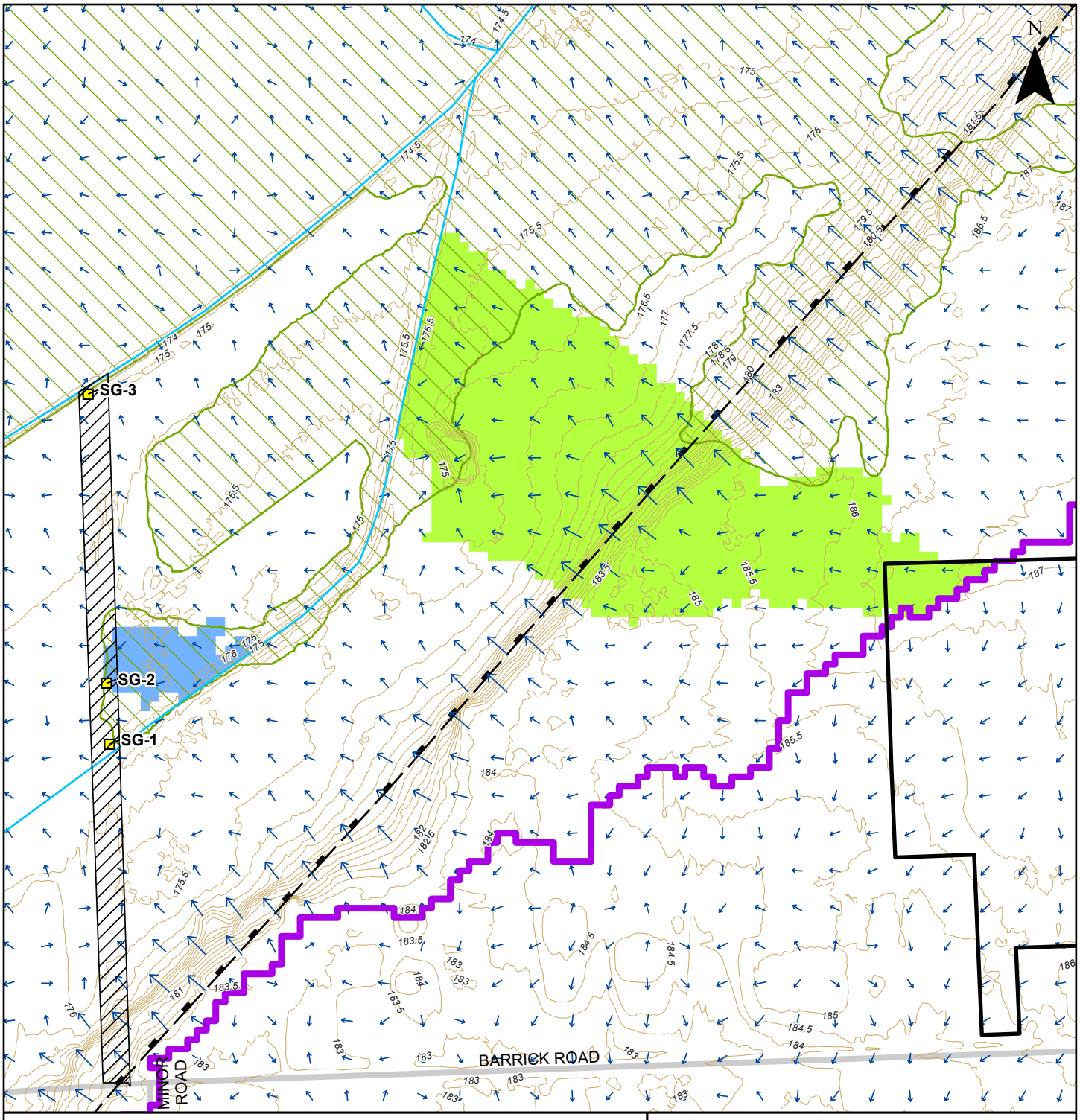


Study Area

Road Allowance (City of Port Colborne)

Surface Water Staff Gauge

Watercourse

Watershed Divide

Surface Water Flow Direction

Surface Contours

Onondaga Escarpment

Wetland

Runoff from NW Corner of Subject Lands (3.1 ha)

Catchment Area for SG-2 (0.2

# Wetland Catchments

Barrick Road Subdivision Study
Elevate Living Niagara
Barrick Road and West Side Road, Port Colborne

Terra-Dynamics Consulting Inc.

0 100 M

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**Figure 9**

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**Table 1**
**Welland-Pelham Precipitation Analyses**

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Average* Precipitation (mm)** | 78.2 | 61.3 | 69.7 | 75.4 | 85.2 | 82.9 | 85.9 | 82.4 | 96.8 | 89.3 | 98.5 | 92.0 | 998 |
| **2022 Welland-Pelham** | 62.1 | 99.7 | 59.2 | 53.4 | 63.7 | 72.6 | 72.5 | 51.2 | 86 | 107.5 | 104.9 | 64.4 | 897 |
| **1-month Average +/-** | 79% | 163% | 85% | 71% | 75% | 88% | 84% | 62% | 89% | 120% | 106% | 70% | 90% |
| **3-Month Average +/-** | | | 106% | 103% | 77% | 78% | 82% | 78% | 79% | 91% | 105% | 99% | |
| **2023 Welland-Pelham** | 86.8 | 68.6 | 109.8 | 98.1 | 34.6 | 74.4 | 163 | 138.7 | 30.1 | 62.9 | 53.6 | 110.3 | 1031 |
| **1-month Average +/-** | 111% | 112% | 158% | 130% | 41% | 90% | 190% | 168% | 31% | 70% | 54% | 120% | 114% |
| **3-Month Average +/-** | 99% | 98% | 127% | 134% | 105% | 85% | 107% | 150% | 125% | 86% | 52% | 81% | |

Note: * - Welland Station

Grey shading - monthly value between 95-105%, Blue shading >105%, Orange < 95%

## Table 2a, SG-1 - Surface Water Quality Results

| Analysis | Units | PWQO | 20-Mar-23 | 10-May-23 | 13-Jun-23 |
|---|---|---|---|---|---|
| Field Temperature | °C | | 5.1 | 15.6 | 15.0 |
| Dissolved Oxygen | mg/L | | 7.09 | 2.07 | 2.25 |
| Field Conductivity | µS/cm | | 174 | 308 | 593 |
| Alkalinity | mg/L as CaCO3 | | 70 | 157 | 91 |
| Bicarbonate | mg/L as CaCO3 | | 70 | 157 | 91 |
| Carbonate | mg/L as CaCO3 | | < 2 | < 2 | < 2 |
| pH | No unit | 6.5-8.5 | 7.29 | 8.00 | 7.83 |
| Total Suspended Solids | mg/L | | 19 | 4 | 46 |
| Phosphorus (total) | mg/L | 0.03 | **0.08** | **0.18** | **0.08** |
| Ammonia+Ammonium | as N mg/L | | < 0.1 | < 0.1 | 0.4 |
| Unionized Ammonia | as N mg/L | 0.02 | ND | ND | 0.0073 |
| Chloride† | mg/L | 120/640 | 6 | 3 | 1 |
| Sulphate | mg/L | | < 2 | < 2 | 190 |
| Nitrite | as N mg/L | | < 0.03 | < 0.03 | < 0.03 |
| Nitrate | as N mg/L | 2.9 | < 0.06 | < 0.06 | 0.41 |
| Nitrate + Nitrite | as N mg/L | | < 0.06 | < 0.06 | 0.41 |
| Lab Conductivity | uS/cm | | 155 | 248 | 544 |
| Fluoride | mg/L | | 0.15 | 0.24 | 0.14 |
| Colour | TCU | | 98 | 162 | 60 |
| Total Dissolved Solids | mg/L | | 160 | 226 | 366 |
| Turbidity | NTU | | 22.0 | 4.1 | 5.1 |
| Dissolved Organic Carbon | mg/L | | 20.3 | 28.7 | 20.0 |
| Hydrogen Sulphide | mg/L | 0.002 | < 0.02 | < 0.02 | < 0.02 |
| Sulphide | mg/L | | < 0.02 | < 0.02 | < 0.02 |
| Mercury (total) | µg/L | 0.0002 | < 0.01000 | < 0.00001 | < 0.00001 |
| Hardness | mg/L as CaCO3 | | 82 | 127 | 272 |
| Silver (total) | mg/L | 0.0001 | < 0.00005 | < 0.00005 | < 0.00005 |
| Aluminum (total) | mg/L | | 1.120 | 0.089 | 0.375 |
| Arsenic (total) | mg/L | 0.1 | 0.0009 | 0.0013 | 0.0014 |
| Barium (total) | mg/L | | 0.0216 | 0.0157 | 0.0624 |
| Beryllium (total) | mg/L | 0.011/1.1 | 0.000056 | 0.000022 | 0.000032 |
| Boron (total) | mg/L | 0.2 | 0.017 | 0.054 | 0.109 |
| Cadmium (total) | mg/L | 0.0002 | 0.000062 | 0.00003 | 0.000079 |
| Cobalt (total) | mg/L | 0.0009 | 0.000782 | **0.00094** | **0.0013** |
| Chromium (total) | mg/L | | 0.00150 | 0.00047 | 0.00076 |
| Copper (total) | mg/L | 0.005 | 0.0033 | 0.0012 | **0.006** |
| Iron (total) | mg/L | 0.3 | **1.45** | **2.37** | **0.72** |
| Manganese (total) | mg/L | | 0.041 | 0.134 | 0.327 |
| Molybdenum (total) | mg/L | 0.04 | 0.00059 | 0.00075 | 0.00277 |
| Nickel (total) | mg/L | 0.025 | 0.0083 | 0.0062 | 0.0063 |
| Lead (total) | mg/L | 0.005 | 0.00155 | 0.00009 | 0.00062 |
| Antimony (total) | mg/L | 0.02 | < 0.0009 | < 0.0009 | < 0.0009 |
| Selenium (total) | mg/L | 0.1 | 0.00032 | 0.00024 | 0.0003 |
| Tin (total) | mg/L | | 0.00007 | 0.00017 | < 0.00006 |
| Strontium (total) | mg/L | | 0.189 | 0.290 | 0.662 |
| Titanium (total) | mg/L | | 0.0192 | 0.00192 | 0.00888 |
| Uranium (total) | mg/L | 0.005 | 0.000218 | 0.000344 | 0.000436 |
| Zinc (total) | mg/L | 0.02 | **0.034** | 0.004 | 0.016 |
| Calcium (total) | mg/L | | 23.9 | 37.6 | 85.0 |
| Magnesium (total) | mg/L | | 5.45 | 7.99 | 14.50 |
| Potassium (total) | mg/L | | 2.87 | 2.63 | 4.53 |
| Sodium (total) | mg/L | | 3.35 | 3.55 | 3.89 |

Notes: PWQO = Provincial Water Quality Objectives for surface water;

**Bolded and shaded concentrations = above PWQO**; blank or --- = Not Sampled; < = less than laboratory detection limit

µg= microgram; mg = milligram; L = Litre; mL = milliLitre; ND = Not Detected; NA = Not Available

Objectives for Chloride and Nitrate obtained from the Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2014)

† Chloride guidelines for freshwater are as follows: 120 mg/L for long-term exposure; 640 mg/L for short-term exposure

Water levels recorded as negative reflect a depth below a benchmark, not water levels below ground surface

Beryllium guidelines are as follows: 0.011 mg/L for <75 hardness as CaCO3; 1.1 mg/L for >75 hardness as CaCO3

## Table 2b, SG-2 - Surface Water Quality Results

| Analysis | Units | PWQO | 20-Mar-23 | 10-May-23 | 13-Jun-23 |
|---|---|---|---|---|---|
| Field Temperature | °C | | 6.1 | 18.5 | Dry |
| Dissolved Oxygen | mg/L | | 7.30 | 4.39 | Dry |
| Field Conductivity | µS/cm | | 240 | 340 | Dry |
| Alkalinity | mg/L as CaCO3 | | 92 | 189 | Dry |
| Bicarbonate | mg/L as CaCO3 | | 92 | 189 | Dry |
| Carbonate | mg/L as CaCO3 | | < 2 | < 2 | Dry |
| pH | No unit | 6.5-8.5 | 7.37 | 7.82 | Dry |
| Total Suspended Solids | mg/L | | 5 | 20 | Dry |
| Phosphorus (total) | mg/L | 0.03 | **0.11** | **0.22** | Dry |
| Ammonia+Ammonium | as N mg/L | | < 0.1 | < 0.1 | Dry |
| Unionized Ammonia | as N mg/L | 0.02 | ND | ND | Dry |
| Chloride† | mg/L | 120/640 | < 1 | < 1 | Dry |
| Sulphate | mg/L | | 15 | < 2 | Dry |
| Nitrite | as N mg/L | | < 0.03 | < 0.03 | Dry |
| Nitrate | as N mg/L | 2.9 | < 0.06 | < 0.06 | Dry |
| Nitrate + Nitrite | as N mg/L | | < 0.06 | < 0.06 | Dry |
| Lab Conductivity | uS/cm | | 175 | 287 | Dry |
| Fluoride | mg/L | | 0.13 | 0.23 | Dry |
| Colour | TCU | | 57 | 94 | Dry |
| Total Dissolved Solids | mg/L | | 163 | 246 | Dry |
| Turbidity | NTU | | 8.8 | 5.0 | Dry |
| Dissolved Organic Carbon | mg/L | | 11.7 | 24.4 | Dry |
| Hydrogen Sulphide | mg/L | 0.002 | < 0.02 | < 0.02 | Dry |
| Sulphide | mg/L | | < 0.02 | 0.02 | Dry |
| Mercury (total) | µg/L | 0.0002 | < 0.01000 | < 0.00001 | Dry |
| Hardness | mg/L as CaCO3 | | 102 | 159 | Dry |
| Silver (total) | mg/L | 0.0001 | < 0.00005 | < 0.00005 | Dry |
| Aluminum (total) | mg/L | | 0.42 | 0.06 | Dry |
| Arsenic (total) | mg/L | 0.1 | 0.0006 | 0.0011 | Dry |
| Barium (total) | mg/L | | 0.0194 | 0.0276 | Dry |
| Beryllium (total) | mg/L | 0.011/1.1 | 0.00002 | 0.000022 | Dry |
| Boron (total) | mg/L | 0.2 | 0.016 | 0.039 | Dry |
| Cadmium (total) | mg/L | 0.0002 | 0.000033 | 0.000030 | Dry |
| Cobalt (total) | mg/L | 0.0009 | **0.00298** | 0.00076 | Dry |
| Chromium (total) | mg/L | | 0.00079 | 0.00035 | Dry |
| Copper (total) | mg/L | 0.005 | 0.0017 | 0.0009 | Dry |
| Iron (total) | mg/L | 0.3 | **1.11** | **2.51** | Dry |
| Manganese (total) | mg/L | | 0.12 | 0.18 | Dry |
| Molybdenum (total) | mg/L | 0.04 | 0.00024 | 0.00045 | Dry |
| Nickel (total) | mg/L | 0.025 | 0.0037 | 0.0043 | Dry |
| Lead (total) | mg/L | 0.005 | 0.00059 | < 0.00009 | Dry |
| Antimony (total) | mg/L | 0.02 | < 0.0009 | < 0.0009 | Dry |
| Selenium (total) | mg/L | 0.1 | 0.00024 | 0.00036 | Dry |
| Tin (total) | mg/L | | < 0.00006 | 0.00015 | Dry |
| Strontium (total) | mg/L | | 0.282 | 0.445 | Dry |
| Titanium (total) | mg/L | | 0.00789 | 0.00131 | Dry |
| Uranium (total) | mg/L | 0.005 | 0.000079 | 0.000178 | Dry |
| Zinc (total) | mg/L | 0.02 | **0.046** | **0.316** | Dry |
| Calcium (total) | mg/L | | 30.6 | 47.8 | Dry |
| Magnesium (total) | mg/L | | 6.25 | 9.67 | Dry |
| Potassium (total) | mg/L | | 2.61 | 4.45 | Dry |
| Sodium (total) | mg/L | | 2.07 | 2.51 | Dry |

Notes: PWQO = Provincial Water Quality Objectives for surface water;

**Bolded and shaded concentrations = above PWQO**; blank or --- = Not Sampled; < = less than laboratory detection limit

µg= microgram; mg = milligram; L = Litre; mL = milliLitre; ND = Not Detected; NA = Not Available

Objectives for Chloride and Nitrate obtained from the Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2014)

† Chloride guidelines for freshwater are as follows: 120 mg/L for long-term exposure; 640 mg/L for short-term exposure

Water levels recorded as negative reflect a depth below a benchmark, not water levels below ground surface

Beryllium guidelines are as follows: 0.011 mg/L for <75 hardness as CaCO3; 1.1 mg/L for >75 hardness as CaCO3

## Table 2c, SG-3 - Surface Water Quality Results

| Analysis | Units | PWQO | 20-Mar-23 | 10-May-23 | 13-Jun-23 |
|---|---|---|---|---|---|
| Field Temperature | °C | | 5.8 | 17.5 | 14.8 |
| Dissolved Oxygen | mg/L | | 10.66 | 4.00 | 3.75 |
| Field Conductivity | µS/cm | | 104 | 91 | 98 |
| Alkalinity | mg/L as CaCO3 | | 28 | 23 | 27 |
| Bicarbonate | mg/L as CaCO3 | | 28 | 23 | 27 |
| Carbonate | mg/L as CaCO3 | | < 2 | < 2 | < 2 |
| pH | No unit | 6.5-8.5 | 6.66 | **6.48** | 6.57 |
| Total Suspended Solids | mg/L | | 11 | 12 | 27 |
| Phosphorus (total) | mg/L | 0.03 | **0.04** | **0.08** | **0.12** |
| Ammonia+Ammonium | as N mg/L | | < 0.1 | < 0.1 | 0.4 |
| Unionized Ammonia | as N mg/L | 0.02 | ND | ND | 0.0004 |
| Chloride† | mg/L | 120/640 | 12 | 16 | 15 |
| Sulphate | mg/L | | 10 | 30 | 27 |
| Nitrite | as N mg/L | | < 0.03 | < 0.30 | < 0.03 |
| Nitrate | as N mg/L | 2.9 | 0.20 | < 0.60 | 0.08 |
| Nitrate + Nitrite | as N mg/L | | 0.2 | < 0.6 | 0.08 |
| Lab Conductivity | uS/cm | | 84 | 65 | 89 |
| Fluoride | mg/L | | 0.10 | 0.12 | 0.09 |
| Colour | TCU | | 870 | 1440 | 35400 |
| Total Dissolved Solids | mg/L | | 214 | 260 | 285 |
| Turbidity | NTU | | 17 | 11 | 29 |
| Dissolved Organic Carbon | mg/L | | 78 | 206 | 115 |
| Hydrogen Sulphide | mg/L | 0.002 | < 0.02 | **0.02** | **0.04** |
| Sulphide | mg/L | | 0.020 | 0.030 | 0.054 |
| Mercury (total) | µg/L | 0.0002 | < 0.01000 | 0.00002 | 0.00002 |
| Hardness | mg/L as CaCO3 | | 61.2 | 50.8 | 78.5 |
| Silver (total) | mg/L | 0.0001 | < 0.00005 | < 0.00005 | < 0.00005 |
| Aluminum (total) | mg/L | | 1.40 | 0.87 | 2.26 |
| Arsenic (total) | mg/L | 0.1 | 0.0017 | 0.0022 | 0.0033 |
| Barium (total) | mg/L | | 0.0167 | 0.0136 | 0.029 |
| Beryllium (total) | mg/L | 0.011/1.1 | 0.000086 | 0.000078 | 0.000153 |
| Boron (total) | mg/L | 0.2 | 0.015 | 0.025 | 0.014 |
| Cadmium (total) | mg/L | 0.0002 | 0.000088 | 0.00008 | 0.000105 |
| Cobalt (total) | mg/L | 0.0009 | **0.00103** | **0.00126** | **0.00222** |
| Chromium (total) | mg/L | | 0.00187 | 0.00143 | 0.00282 |
| Copper (total) | mg/L | 0.005 | 0.003 | 0.0026 | **0.0054** |
| Iron (total) | mg/L | 0.3 | **1.93** | **2.50** | **4.58** |
| Manganese (total) | mg/L | | 0.0532 | 0.0721 | 0.138 |
| Molybdenum (total) | mg/L | 0.04 | 0.00032 | 0.00043 | 0.00134 |
| Nickel (total) | mg/L | 0.025 | 0.0072 | 0.0069 | 0.0114 |
| Lead (total) | mg/L | 0.005 | 0.00118 | 0.001 | 0.0022 |
| Antimony (total) | mg/L | 0.02 | < 0.0009 | < 0.0009 | < 0.0009 |
| Selenium (total) | mg/L | 0.1 | 0.00042 | 0.00023 | 0.00056 |
| Tin (total) | mg/L | | < 0.00006 | 0.00025 | 0.0001 |
| Strontium (total) | mg/L | | 0.134 | 0.109 | 0.203 |
| Titanium (total) | mg/L | | 0.0193 | 0.0146 | 0.035 |
| Uranium (total) | mg/L | 0.005 | 0.000135 | 0.000122 | 0.000212 |
| Zinc (total) | mg/L | 0.02 | 0.014 | 0.011 | **0.040** |
| Calcium (total) | mg/L | | 16.8 | 14.0 | 22.8 |
| Magnesium (total) | mg/L | | 4.65 | 3.88 | 5.23 |
| Potassium (total) | mg/L | | 1.02 | 0.79 | 1.12 |
| Sodium (total) | mg/L | | 2.54 | 1.63 | 1.40 |

Notes: PWQO = Provincial Water Quality Objectives for surface water;

**Bolded and shaded concentrations = above PWQO**; blank or --- = Not Sampled; < = less than laboratory detection limit

µg= microgram; mg = milligram; L = Litre; mL = milliLitre; ND = Not Detected; NA = Not Available

Objectives for Chloride and Nitrate obtained from the Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2014)

† Chloride guidelines for freshwater are as follows: 120 mg/L for long-term exposure; 640 mg/L for short-term exposure

Water levels recorded as negative reflect a depth below a benchmark, not water levels below ground surface

Beryllium guidelines are as follows: 0.011 mg/L for <75 hardness as CaCO3; 1.1 mg/L for >75 hardness as CaCO3

**Table 5**
**Monitoring Location Details and Manual Water Levels**

| Well I.D. | Ground Elevation (m ASL) | Stick-Up (m) | TOC Elevation (m ASL) | Well Depth Below TOC (m) | Well Depth below ground (m) | Date | Water level (m below TOC) | Water Level below ground (m) | Depth of water at Drive point (m) | Water Level Elevation (m ASL) |
|---|---|---|---|---|---|---|---|---|---|---|
| MW-1 | 186.59 | 1.02 | 187.61 | 8.54 | 7.52 | 30-Jul-22 | 3.27 | 2.25 | --- | 185.36 |
| | | | | | | 22-Aug-22 | 3.24 | 2.22 | --- | 184.37 |
| | | | | | | 26-Jan-23 | 2.23 | 1.21 | --- | 185.38 |
| | | | | | | 3-May-23 | 2.37 | 1.35 | --- | 185.24 |
| | | | | | | 13-Jun-23 | 2.90 | 1.88 | --- | 184.72 |
| | | | | | | 4-Jul-23 | 2.93 | 1.91 | --- | 184.68 |
| | | | | | | 3-Oct-23 | 3.30 | 2.28 | --- | 184.32 |
| | | | | | | 5-Mar-24 | 2.23 | 1.21 | --- | 185.39 |
| MW-2 | 187.10 | 0.95 | 188.14 | 6.55 | 5.60 | 30-Jul-22 | 3.25 | 2.30 | --- | 184.89 |
| | | | | | | 22-Aug-22 | 3.53 | 2.58 | --- | 184.61 |
| | | | | | | 26-Jan-23 | 2.36 | 1.42 | --- | 185.77 |
| | | | | | | 3-May-23 | 2.47 | 1.52 | --- | 185.67 |
| | | | | | | 13-Jun-23 | 2.90 | 1.95 | --- | 185.24 |
| | | | | | | 4-Jul-23 | 3.08 | 2.13 | --- | 185.06 |
| | | | | | | 3-Oct-23 | 3.21 | 2.26 | --- | 184.93 |
| | | | | | | 5-Mar-24 | 2.15 | 1.20 | --- | 185.99 |
| MW-3 | 186.48 | 1.27 | 187.59 | 7.26 | 5.99 | 30-Jul-22 | 3.46 | 2.19 | --- | 184.13 |
| | | | | | | 22-Aug-22 | 3.61 | 2.34 | --- | 183.98 |
| | | | | | | 26-Jan-23 | 2.20 | 0.93 | --- | 185.39 |
| | | | | | | 3-May-23 | 2.34 | 1.07 | --- | 185.25 |
| | | | | | | 13-Jun-23 | 2.85 | 1.58 | --- | 184.74 |
| | | | | | | 4-Jul-23 | 3.05 | 1.78 | --- | 184.54 |
| | | | | | | 3-Oct-23 | 3.23 | 1.96 | --- | 184.36 |
| | | | | | | 5-Mar-24 | 2.07 | 0.80 | --- | 185.52 |
| MW-4 | 187.31 | 0.98 | 188.31 | 8.15 | 7.16 | 30-Jul-22 | 5.54 | 4.56 | --- | 182.76 |
| | | | | | | 22-Aug-22 | 5.50 | 4.52 | --- | 182.81 |
| | | | | | | 26-Jan-23 | 6.54 | 5.56 | --- | 181.76 |
| | | | | | | 3-May-23 | 5.60 | 4.62 | --- | 182.71 |
| | | | | | | 13-Jun-23 | 5.65 | 4.66 | --- | 182.66 |
| | | | | | | 4-Jul-23 | 5.71 | 4.72 | --- | 182.60 |
| | | | | | | 3-Oct-23 | 5.59 | 4.60 | --- | 182.72 |
| | | | | | | 5-Mar-24 | 5.60 | 4.62 | --- | 182.71 |
| MW-5 | 185.94 | 1.01 | 186.98 | 6.65 | 5.64 | 30-Jul-22 | 6.69 | 5.69 | --- | 180.29 |
| | | | | | | 22-Aug-22 | 5.71 | 4.71 | --- | 181.27 |
| | | | | | | 26-Jan-23 | 4.21 | 3.21 | --- | 182.77 |
| | | | | | | 3-May-23 | 4.00 | 2.99 | --- | 182.99 |
| | | | | | | 13-Jun-23 | 6.52 | 5.51 | --- | 180.47 |
| | | | | | | 4-Jul-23 | 6.54 | 5.54 | --- | 180.44 |
| | | | | | | 3-Oct-23 | 6.45 | 5.44 | --- | 180.54 |
| | | | | | | 5-Mar-24 | 4.87 | 3.87 | --- | 182.11 |

**Table 5**
**Monitoring Location Details and Manual Water Levels**

| Well I.D. | Ground Elevation (m ASL) | Stick-Up (m) | TOC Elevation (m ASL) | Well Depth Below TOC (m) | Well Depth below ground (m) | Date | Water level (m below TOC) | Water Level below ground (m) | Depth of water at Drive point (m) | Water Level Elevation (m ASL) |
|---|---|---|---|---|---|---|---|---|---|---|
| SG-1 | 175.14 | 0.55 | 175.73 | 0.79 | 0.24 | 20-Mar-23 | 0.32 | -0.23 | 0.23 | 175.41 |
| | | | | | | 3-May-23 | 0.32 | -0.23 | 0.28 | 175.41 |
| | | | | | | 10-May-23 | 0.35 | -0.21 | 0.24 | 175.38 |
| | | | | | | 9-Jun-23 | Dry | Dry | Dry | Dry |
| | | | | | | 13-Jun-23 | 0.52 | -0.04 | 0.01 | 175.21 |
| | | | | | | 4-Jul-23 | Dry | Dry | Dry | Dry |
| | | | | | | 3-Oct-23 | Dry | Dry | Dry | Dry |
| | | | | | | 16-Oct-23 | Dry | Dry | Dry | Dry |
| | | | | | | 5-Mar-24 | 0.33 | -0.23 | 0.21 | 175.40 |
| SG-2 | 175.32 | 0.59 | 175.89 | 0.79 | 0.20 | 20-Mar-23 | 0.40 | -0.19 | 0.19 | 175.49 |
| | | | | | | 3-May-23 | 0.37 | -0.22 | 0.20 | 175.52 |
| | | | | | | 10-May-23 | 0.43 | -0.16 | 0.15 | 175.46 |
| | | | | | | 9-Jun-23 | Dry | Dry | Dry | Dry |
| | | | | | | 13-Jun-23 | Dry | Dry | Dry | Dry |
| | | | | | | 4-Jul-23 | Dry | Dry | Dry | Dry |
| | | | | | | 3-Oct-23 | Dry | Dry | Dry | Dry |
| | | | | | | 16-Oct-23 | Dry | Dry | Dry | Dry |
| | | | | | | 5-Mar-24 | 0.40 | -0.19 | 0.15 | 175.49 |
| SG-3 | 173.70 | 0.65 | 174.43 | 0.95 | 0.30 | 20-Mar-23 | 0.32 | -0.33 | 0.33 | 174.11 |
| | | | | | | 3-May-23 | 0.27 | -0.38 | 0.37 | 174.16 |
| | | | | | | 10-May-23 | 0.31 | -0.34 | 0.30 | 174.12 |
| | | | | | | 9-Jun-23 | 0.57 | -0.08 | 0.16 | 173.86 |
| | | | | | | 13-Jun-23 | 0.50 | -0.15 | 0.13 | 173.93 |
| | | | | | | 4-Jul-23 | 0.38 | -0.27 | 0.22 | 174.05 |
| | | | | | | 3-Oct-23 | 0.46 | -0.19 | 0.13 | 173.97 |
| | | | | | | 16-Oct-23 | 0.40 | -0.24 | 0.10 | 174.02 |
| | | | | | | 5-Mar-24 | 0.32 | -0.33 | 0.40 | 174.11 |
| PZ-1 | 176.00 | 1.06 | 177.08 | 3.79 | 2.73 | 20-Mar-23 | Dry | Dry | --- | Dry |
| | | | | | | 3-May-23 | 2.82 | 1.76 | --- | 174.26 |
| | | | | | | 13-Jun-23 | 2.81 | 1.75 | --- | 174.27 |
| | | | | | | 4-Jul-23 | 2.79 | 1.73 | --- | 174.29 |
| | | | | | | 3-Oct-23 | 2.82 | 1.76 | --- | 174.26 |
| | | | | | | 16-Oct-23 | 2.88 | 1.83 | --- | 174.19 |
| | | | | | | 5-Mar-24 | 2.61 | 1.55 | --- | 174.47 |
| PZ-2 | 175.66 | 0.66 | 176.33 | 3.68 | 3.02 | 20-Mar-23 | 3.15 | 2.49 | --- | 173.18 |
| | | | | | | 3-May-23 | 3.40 | 2.74 | --- | 172.94 |
| | | | | | | 13-Jun-23 | 3.55 | 2.89 | --- | 172.78 |
| | | | | | | 4-Jul-23 | Dry | Dry | --- | Dry |
| | | | | | | 3-Oct-23 | Dry | Dry | --- | Dry |
| | | | | | | 16-Oct-23 | Dry | Dry | --- | Dry |
| | | | | | | 5-Mar-24 | Dry | Dry | --- | Dry |
| PZ-3 | 175.45 | 0.67 | 176.16 | 3.71 | 3.04 | 20-Mar-23 | 1.66 | 1.00 | --- | 174.49 |
| | | | | | | 3-May-23 | 1.34 | 0.68 | --- | 174.82 |
| | | | | | | 13-Jun-23 | 1.08 | 0.42 | --- | 175.08 |
| | | | | | | 4-Jul-23 | 1.00 | 0.34 | --- | 175.16 |
| | | | | | | 3-Oct-23 | 0.65 | -0.01 | --- | 175.50 |
| | | | | | | 16-Oct-23 | 0.68 | 0.02 | --- | 175.48 |
| | | | | | | 5-Mar-24 | 0.38 | -0.29 | --- | 175.78 |

Note: March 20, 2022 Staff Gauges and Piezometers were installed

Note: MW=Monitoring well; TOC= Top of Casing; m ASL=metres above sea level;

Note: Elevations from Upper Canada Planning & Engineering Ltd. on June 9, 2023

## Table 7 - Ground Water Quality Results

| **Sample ID** | | | | MW-1 | MW-3 | MW-4 |
|---|---|---|---|---|---|---|
| **Sample Date** | | ODWS | | 10-May-23 | 10-May-23 | 10-May-23 |
| **Analysis** | **Units** | | | | | |
| Field Temperature | Celsius | NA | | 11.1 | 11.6 | 10.9 |
| Field Conductivity | uS/cm | NA | | 1208 | 830 | 624 |
| Dissolved Oxygen | mg/L | | | 4.60 | 6.46 | 8.74 |
| Alkalinity | mg/L as CaCO3 | 30-500 | OG | 365 | 369 | 277 |
| Bicarbonate | mg/L as CaCO3 | NA | | 365 | 369 | 277 |
| Carbonate | mg/L as CaCO3 | NA | | < 2 | < 2 | < 2 |
| pH | No unit | 6.5-8.5 | OG | 8.04 | 8.02 | 8.12 |
| Total Suspended Solids | mg/L | NA | | 17 | 13 | 234 |
| Total Dissolved Solids | mg/L | 500 | AO | **746** | **771** | 374 |
| Fluoride | mg/L | 1.5 | | **2.31** | **2.32** | **1.66** |
| Turbidity | NTU | 5 | AO | 4 | 4 | **240** |
| Conductivity | uS/cm | NA | | 1060 | 1010 | 571 |
| Colour | TCU | 5 | AO | < 3 | < 3 | 3 |
| Phosphorus (total) | mg/L | NA | | < 0.03 | < 0.03 | 0.05 |
| Ammonia+Ammonium | as N mg/L | NA | | < 0.1 | < 0.1 | < 0.1 |
| Total Kjeldahl Nitrogen | as N mg/L | NA | | < 0.5 | < 0.5 | < 0.5 |
| Hydrogen Sulphide | mg/L | 0.05 | AO | < 0.02 | < 0.02 | < 0.02 |
| Sulphide | mg/L | 0.05 | AO | < 0.02 | < 0.02 | < 0.02 |
| Dissolved Organic Carbon | mg/L | 5 | AO | 2.4 | 1.6 | 1.8 |
| Total Reactive Phosphorous | mg/L | NA | | < 0.03 | < 0.03 | < 0.03 |
| Chloride | mg/L | 250 | AO | 2 | 4 | 4 |
| Sulphate | mg/L | 500 | AO | 310 | 270 | 65 |
| Bromide | mg/L | NA | | < 0.3 | < 0.3 | < 0.3 |
| Nitrite | as N mg/L | 1 | MAC | < 0.03 | < 0.03 | < 0.03 |
| Nitrate | as N mg/L | 10 | MAC | 0.43 | < 0.06 | < 0.06 |
| Nitrate + Nitrite | as N mg/L | NA | | 0.43 | < 0.06 | < 0.06 |
| Hardness | mg/L as CaCO3 | 80-100 | OG | **566** | **548** | **305** |
| Mercury (dissolved) | mg/L | 0.001 | MAC | < 0.00001 | < 0.00001 | < 0.00001 |
| Aluminum (dissolved) | mg/L | 0.1 | OG | 0.006 | 0.003 | 0.010 |
| Arsenic (dissolved) | mg/L | 0.025 | MAC | 0.0002 | < 0.0002 | 0.0004 |
| Barium (dissolved) | mg/L | 1.0 | MAC | 0.0198 | 0.00374 | 0.0288 |
| Beryllium (dissolved) | mg/L | NA | | 0.000008 | 0.000014 | < 0.000007 |
| Boron (dissolved) | mg/L | 5.0 | MAC | 0.013 | 0.013 | 0.056 |
| Bismuth (dissolved) | mg/L | NA | | < 0.00001 | < 0.00001 | < 0.00001 |
| Calcium (dissolved) | mg/L | NA | | 94.9 | 94.6 | 72.6 |
| Cadmium (dissolved) | mg/L | 0.005 | MAC | 0.000006 | 0.000005 | 0.000003 |
| Cobalt (dissolved) | mg/L | NA | | 0.00013 | 0.00002 | 0.000259 |
| Chromium (dissolved) | mg/L | 0.05 | MAC | < 0.00008 | 0.0002 | < 0.00008 |
| Copper (dissolved) | mg/L | 1 | AO | 0.00210 | 0.00060 | 0.0016 |
| Iron (dissolved) | mg/L | 0.3 | AO | 0.078 | 0.010 | < 0.007 |
| Potassium (dissolved) | mg/L | NA | | 1.43 | 2.45 | 1.42 |
| Magnesium (dissolved) | mg/L | NA | | 80.0 | 75.9 | 30.1 |

| **Sample ID** | | | | MW-1 | MW-3 | MW-4 |
|---|---|---|---|---|---|---|
| **Sample Date** | | ODWS | | 10-May-23 | 10-May-23 | 10-May-23 |
| **Analysis** | **Units** | | | | | |
| Manganese (dissolved) | mg/L | 0.05 | AO | 0.00505 | 0.01050 | 0.0459 |
| Molybdenum (dissolved) | mg/L | NA | | 0.00079 | 0.00039 | 0.00144 |
| Sodium (dissolved) | mg/L | 20 or 200 | AO | 19.6 | 12.6 | 4.3 |
| Nickel (dissolved) | mg/L | NA | | 0.0012 | 0.0003 | 0.0021 |
| Phosphorus (dissolved) | mg/L | NA | | 0.0060 | 0.0050 | 0.007 |
| Lead (dissolved) | mg/L | 0.01 | MAC | < 0.00009 | < 0.00009 | < 0.00009 |
| Antimony (dissolved) | mg/L | NA | | < 0.0009 | < 0.0009 | < 0.0009 |
| Selenium (dissolved) | mg/L | 0.01 | MAC | 0.0002 | < 0.00004 | < 0.00004 |
| Tin (dissolved) | mg/L | NA | | 0.0045 | 0.00342 | 0.00507 |
| Strontium (dissolved) | mg/L | NA | | 0.299 | 0.513 | 0.668 |
| Titanium (dissolved) | mg/L | NA | | 0.00030 | 0.00018 | 0.00033 |
| Uranium (dissolved) | mg/L | 0.02 | MAC | 0.00761 | 0.00276 | 0.000576 |
| Vanadium (dissolved) | mg/L | NA | | 0.00014 | 0.00003 | 0.00027 |
| Zinc (dissolved) | mg/L | 5.0 | AO | < 0.002 | 0.003 | < 0.002 |

Notes: ODWS = Ontario Drinking Water Standards; MAC = Maximum Acceptable Concentration (health related);
OG = Operational Guideline (non-health related); AO = Aesthetic Objective (non-health related);
**Bolded** and shaded concentrations = above ODWS MAC, Guideline or Objective; ND = Not Detected
NA = Not Available; NS or --- = Not Sampled; < = less than the laboratory detection limit; TCU = True Colour Unit
* = 20 mg/L for sodium restricted diets, 200 mg/L for regular diets; NTU = Nephelometric Turbidity Unit
cfu = colony forming units; IMAC = Interim Maximum Acceptable Concentration (health related)

**Table 9 - Water Well Record Summary**

| WWIS | Year Constructed | Bedrock Depth (mBGS) | Static Water Level (mBGS) | Finished Well Depth (mBGS) | Depth into Bedrock (m) | Water Quality | Casing Length (m) | Purpose | Material summary |
|---|---|---|---|---|---|---|---|---|---|
| 6601063 | 1949 | 0.9 | 9.1 | 14.0 | 13.1 | Hard | 1.5 | Domestic | 0m-0.9m (top-soil), 0.9m-14.0m (grey limestone) |
| 6601064 | 1949 | 0.9 | 9.8 | 15.5 | 14.7 | Hard | 2.1 | Domestic | 0m-0.9m (top-soil), 0.9m-15.6m (grey limestone) |
| 6601065 | 1949 | 0.9 | 7.6 | 15.2 | 14.3 | Hard | 1.5 | Domestic | 0m-0.9m (clay), 0.9m-15.2m (grey limestone) |
| 6601070 | 1953 | 1.8 | 4.9 | 15.5 | 13.7 | Hard | 1.8 | Domestic | 0m-1.8m (sand and pebbles), 1.8m-15.5 (soft shale) |
| 6601073 | 1952 | 1.5 | 11.9 | 15.5 | 14.0 | Hard | 1.5 | Domestic | 0m-1.5m (clay and pebbles), 1.5m-15.5 (soft shale) |
| 6601074 | 1955 | 0.9 | 2.4 | 6.7 | 5.8 | Clear | 1.2 | Domestic | 0m-0.9m (clay), 0.9m-6.7m (flint) |
| 6601075 | 1955 | 0.6 | 3.7 | 9.8 | 9.1 | Sulphur | 1.2 | Domestic | 0m-0.6m (black loam), 0.6m-3.6m(shale), 3.6m-9.7m (grey limestone) |
| 6601076 | 1955 | 0.6 | 3.7 | 20.1 | 19.5 | Sulphur | 1.2 | Domestic | 0m-0.6m (black loam), 0.6m-3.6m(shale), 3.6m-20.1m (grey limestone) |
| 6601165 | 1952 | 1.2 | 11 | 14.6 | 13.4 | Sulphur | 1.2 | Domestic | 0m-1.2m (clay and pebbles), 1.2m-14.6m (shale) |
| 6602324 | 1968 | 0.9 | 9.1 | 18.9 | 18.0 | Fresh | 2.1 | Domestic | 0m-0.9m (clay loam), 0.9m-18.9m (grey limestone) |
| 6603274 | 1978 | 0.6 | 13.7 | 19.8 | 19.2 | Fresh | 6.4 | Domestic | 0m-0.6m (clay and gravel), 0.6m-19.8m (grey limestone) |
| 6603410 | 1979 | 0.6 | 14.6 | 27.6 | 27.0 | Fresh | NA | Domestic | 0m-0.6m (top-soil), 0.6m-27.1m (grey limestone), 27.1m-27.6m (blue limestone) |
| | | | | | | | | | |
| **MEDIAN** | | 0.9 | 9.1 | | 14.2 | | | | |
| **Average** | | 1.0 | 8.5 | | 15.2 | | | | |

**TABLE 14a**

**USGS 400 mm SHWC Wetland Monthly Water Balance (1981-2010)**

| Date | P | PET | P-PET | Soil Moisture | AET | PET-AET | Snow Storage | Surplus | ROtotal | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| January | 73.1 | 10.3 | 44.1 | 400 | 10.3 | 0 | 23.9 | 44.1 | 48.8 | Surplus |
| February | 57 | 12.1 | 43.7 | 400 | 12.1 | 0 | 23.5 | 43.7 | 46.9 | Surplus |
| March | 66.8 | 21.5 | 59.4 | 400 | 21.5 | 0 | 6.8 | 59.4 | 55.1 | Surplus |
| April | 76.1 | 38.6 | 40.5 | 400 | 38.6 | 0 | 0 | 40.5 | 50.2 | Surplus |
| May | 89.7 | 69.9 | 15.4 | 400 | 69.9 | 0 | 0 | 15.4 | 35.4 | Surplus |
| June | 78.9 | 103.6 | -28.6 | 371.4 | 103.6 | 0 | 0 | 0 | 19.4 | Soil Water Utilization |
| July | 82.2 | 125.4 | -47.3 | 327.4 | 122 | 3.4 | 0 | 0 | 11.8 | Soil Water Utilization |
| August | 82.5 | 103.8 | -25.4 | 306.6 | 99.2 | 4.6 | 0 | 0 | 8 | Soil Water Utilization |
| September | 98 | 63.2 | 29.9 | 336.5 | 63.2 | 0 | 0 | 0 | 6.8 | Soil Water Recharge |
| October | 90.4 | 34.3 | 51.5 | 388.1 | 34.3 | 0 | 0 | 0 | 5.5 | Soil Water Recharge |
| November | 100.9 | 18.5 | 77.3 | 400 | 18.5 | 0 | 0 | 65.4 | 38.2 | Surplus |
| December | 88.8 | 11.7 | 67 | 400 | 11.7 | 0 | 6.9 | 67 | 53.3 | Surplus |
| Sum | 984.4 | | | | 604.9 | | | | 379.4 | |

**TABLE 14b**

**USGS 350 mm SHWC Wetland Monthly Water Balance (1981-2010)**

| Date | P | PET | P-PET | Soil Moisture | AET | PET-AET | Snow Storage | Surplus | ROtotal | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| January | 73.1 | 10.3 | 44.1 | 350 | 10.3 | 0 | 23.9 | 44.1 | 49 | Surplus |
| February | 57 | 12.1 | 43.7 | 350 | 12.1 | 0 | 23.5 | 43.7 | 47 | Surplus |
| March | 66.8 | 21.5 | 59.4 | 350 | 21.5 | 0 | 6.8 | 59.4 | 55.1 | Surplus |
| April | 76.1 | 38.6 | 40.5 | 350 | 38.6 | 0 | 0 | 40.5 | 50.2 | Surplus |
| May | 89.7 | 69.9 | 15.4 | 350 | 69.9 | 0 | 0 | 15.4 | 35.4 | Surplus |
| June | 78.9 | 103.6 | -28.6 | 321.4 | 103.6 | 0 | 0 | 0 | 19.4 | Soil Water Utilization |
| July | 82.2 | 125.4 | -47.3 | 277.9 | 121.5 | 3.9 | 0 | 0 | 11.8 | Soil Water Utilization |
| August | 82.5 | 103.8 | -25.4 | 257.7 | 98.5 | 5.2 | 0 | 0 | 8 | Soil Water Utilization |
| September | 98 | 63.2 | 29.9 | 287.6 | 63.2 | 0 | 0 | 0 | 6.8 | Soil Water Recharge |
| October | 90.4 | 34.3 | 51.5 | 339.2 | 34.3 | 0 | 0 | 0 | 5.5 | Soil Water Recharge |
| November | 100.9 | 18.5 | 77.3 | 350 | 18.5 | 0 | 0 | 66.5 | 38.8 | Surplus |
| December | 88.8 | 11.7 | 67 | 350 | 11.7 | 0 | 6.9 | 67 | 53.6 | Surplus |
| Sum | 984.4 | | | | 603.7 | | | | 380.6 | |

**TABLE 15a**

**2023 400 mm SWHC USGS Wetland Monthly Water Balance**

| Date | P | PET | P-PET | Soil Moisture | AET | PET-AET | Snow Storage | Surplus | ROtotal | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| January | 86.8 | 12.7 | 67 | 400 | 12.7 | 0 | 7.2 | 67 | 52.7 | Surplus |
| February | 68.6 | 13.4 | 49.8 | 400 | 13.4 | 0 | 10.3 | 49.8 | 52 | Surplus |
| March | 109.8 | 22.1 | 89.3 | 400 | 22.1 | 0 | 4 | 89.3 | 74.1 | Surplus |
| April | 98.1 | 42.6 | 54.6 | 400 | 42.6 | 0 | 0 | 54.6 | 66.9 | Surplus |
| May | 34.6 | 63.3 | -30.4 | 369.6 | 63.3 | 0 | 0 | 0 | 32.7 | Soil Water Utilization |
| June | 74.4 | 101.1 | -30.4 | 341.5 | 98.8 | 2.3 | 0 | 0 | 19.2 | Soil Water Utilization |
| July | 163 | 120.8 | 34 | 375.6 | 120.8 | 0 | 0 | 0 | 15.9 | Soil Water Recharge |
| August | 138.7 | 91.1 | 40.7 | 400 | 91.1 | 0 | 0 | 16.2 | 18.9 | Surplus |
| September | 30.1 | 63.2 | -34.6 | 365.4 | 63.2 | 0 | 0 | 0 | 7.5 | Soil Water Utilization |
| October | 62.9 | 36.8 | 23 | 388.4 | 36.8 | 0 | 0 | 0 | 6.1 | Soil Water Recharge |
| November | 53.6 | 16.8 | 34.1 | 400 | 16.8 | 0 | 0 | 22.5 | 15.4 | Surplus |
| December | 110.3 | 14.8 | 90 | 400 | 14.8 | 0 | 0 | 90 | 56.9 | Surplus |
| Sum | 1030.9 | | | | 596.4 | | | | 418.3 | |

**TABLE 15b**

**2023 350 mm SWHC USGS Wetland Monthly Water Balance**

| Date | P | PET | P-PET | Soil Moisture | AET | PET-AET | Snow Storage | Surplus | ROtotal | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| January | 86.8 | 12.7 | 67 | 350 | 12.7 | 0 | 7.2 | 67 | 53.1 | Surplus |
| February | 68.6 | 13.4 | 49.8 | 350 | 13.4 | 0 | 10.3 | 49.8 | 52.1 | Surplus |
| March | 109.8 | 22.1 | 89.3 | 350 | 22.1 | 0 | 4 | 89.3 | 74.2 | Surplus |
| April | 98.1 | 42.6 | 54.6 | 350 | 42.6 | 0 | 0 | 54.6 | 67 | Surplus |
| May | 34.6 | 63.3 | -30.4 | 319.6 | 63.3 | 0 | 0 | 0 | 32.8 | Soil Water Utilization |
| June | 74.4 | 101.1 | -30.4 | 291.9 | 98.4 | 2.6 | 0 | 0 | 19.2 | Soil Water Utilization |
| July | 163 | 120.8 | 34 | 325.9 | 120.8 | 0 | 0 | 0 | 15.9 | Soil Water Recharge |
| August | 138.7 | 91.1 | 40.7 | 350 | 91.1 | 0 | 0 | 16.6 | 19.1 | Surplus |
| September | 30.1 | 63.2 | -34.6 | 315.4 | 63.2 | 0 | 0 | 0 | 7.6 | Soil Water Utilization |
| October | 62.9 | 36.8 | 23 | 338.4 | 36.8 | 0 | 0 | 0 | 6.2 | Soil Water Recharge |
| November | 53.6 | 16.8 | 34.1 | 350 | 16.8 | 0 | 0 | 22.5 | 15.5 | Surplus |
| December | 110.3 | 14.8 | 90 | 350 | 14.8 | 0 | 0 | 90 | 56.9 | Surplus |
| Sum | 1030.9 | | | | 596 | | | | 419.6 | |

# Appendix A

# Terms of Reference

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

November 28, 2023

Elevate Fourth Development Ltd.
c/o Spencer Brown, P. Eng.
13 Carleton St. South
Thorold, Ontario  L2V 1Z5

Re: Terms of Reference, Hydrogeology and Water Balance Study, Barrick Road Subdivision, Port Colborne, ON

## 1.0 Introduction and Background

Terra-Dynamics Consulting Inc. (Terra-Dynamics) respectfully submits this Terms of Reference (TofR) for a Hydrogeology and Water Balance Study, for the 8.34 hectares of the Proposed Barrick Road Subdivision (the Site, Figure 1) in Port Colborne, Ontario.

Guidance previously provided by the City of Port Colborne (2022) for this study includes:

A. Investigating groundwater and surface water resources for "*the protection and integration of natural heritage resources*";

B. Identification of "*constraints and opportunities for enhancement and site specific design and mitigation that will result in the sustainable development*"; and

C. A water balance "*supported by hydrogeological investigations*" and "*groundwater monitoring*" completed by a "*qualified hydrogeologist*".

This work program is also to "*identify opportunities and constraints to stormwater drainage and servicing*".

## 2.0 Work Plan

The work plan was designed to comply with the Conservation Authority Guidelines for Hydrogeological Assessments (Cuddy, Soo Chan and Post, 2013) and includes the following tasks as described below.

Description of the Physical Setting: The physiography, topography, surface water catchments, watercourses, soils, surficial geology, bedrock geology, and hydrogeological environment (i.e. aquitard, and aquifer) will be described in text and visualized in maps and hydrogeologic cross-section(s). This description will be completed via a review of existing information and field investigations described below.

A. A review of existing regional reporting will be completed, including but not limited to:
    i. Niagara Peninsula Conservation Authority: Central Welland River Subwatershed Study, Natural Areas Inventory, and Contemporary Watercourse mapping;
    ii. Ministry of the Environment Conservation and Parks (MECP) water well records;
    iii. Ontario Geological Survey (OGS) reports and maps (e.g. surficial geology, paleozoic geology, aggregate resource inventory and karst investigations);

iv. Ministry of Natural Resources and Forestry (MNRF) (e.g. Ontario Wetland Evaluation reporting and Oil, Gas and Salt Resources Library);
v. Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) (e.g. soils); and
vi. Ministry of Transportation (MTO) geotechnical database.

B. Review of available Site information such as the geotechnical study from Elevate Living Niagara (Niagara Testing and Inspection, 2022), and topographic survey.

C. Communications with government staff, e.g.:

i. OGS Quaternary Geoscientist Abigail Burt who is completing a study of the Overburden sediments of the Niagara Peninsula;
ii. OGS Paleozoic Geoscientist Frank Brunton regarding the Onondaga Escarpment; and
iii. City of Port Colborne Drainage Superintendent Alana Vanderveen regarding the Beiderman Drain.

D. Field investigations:

i. At the Site: (a) a year of groundwater level monitoring at the five existing monitoring wells (Niagara Testing and Inspection, 2022) including water level dataloggers recording at 15-minute intervals, (b) hydraulic conductivity testing of the five monitoring wells, and (c) laboratory analyses of baseline groundwater quality samples.

ii. With permission from the City of Port Colborne, hand-augering was completed along the unopened road allowance of the northern extension of Minor Road to determine the inferred depth to bedrock, and the soil composition. Drive-point piezometers were installed in each of these three locations (PZ-1, PZ-2 and PZ-3) to about 3 metres below ground surface to monitor shallow groundwater levels for a year (Figure 1) and were equipped with water level dataloggers recording at 15-minute intervals.

iii. Surface water monitoring, as available at the nearby unopened road allowance (Figure 1): (a) Northeast flowing open constructed ephemeral watercourse/drain (SG-1), (b) Western extent of the Provincially Significant Wetland (SG-2), and (c), the Beiderman Drain (SG-3). Staff gauges with water level dataloggers were installed at each location to continuously measure surface water levels for a year-long duration at 15-minute intervals. Three sets of surface water quality samples were collected: a spring freshet event, a wet weather event and a dry weather event.

iv. Water well survey of nearby properties not municipally serviced on the northern side of Barrick Road, west of Minor Road.

Water Balance Analyses: A pre-development water balance will be calculated for the Site using modelling completed by the Niagara Peninsula Source Protection Authority as part of their Tier 1 water budget (NPCA and AquaResource Inc., 2010) for the Central Welland River Watershed Planning Area (AquaResource Inc. and NPCA, 2009). These results will be compared to the physical setting for suitability for application and modification made where appropriate to suit site conditions, e.g.

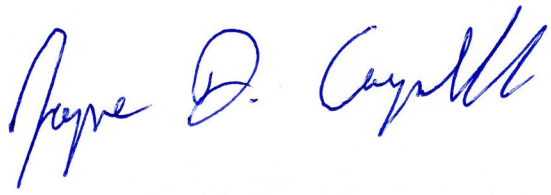
comparison of modelled groundwater recharge rates to those observed at the Barrick Road Site monitoring wells. A monthly wetland water balance will also be completed using Environment Canada weather data (both climate normals and for the 2023-2024 monitoring period) and compared to the staff gauge water levels at the wetland along the unopened road allowance (SG-2).

Future development: Recommended requirements for development of the Site will be provided, including an assessment of potential impacts to groundwater and surface water resources and recommendations for future works (e.g. decommissioning of unused wells). Soil and water level information will be reviewed for the suitability of low impact development measures.

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, P. Eng.
Senior Water Resources Engineer

c.c. Drew Toth, Elevate Fourth Development Ltd.
William Heikoop, Upper Canada Consultants
Anne McDonald, Ecological & Environmental Solutions

**3.0 References**

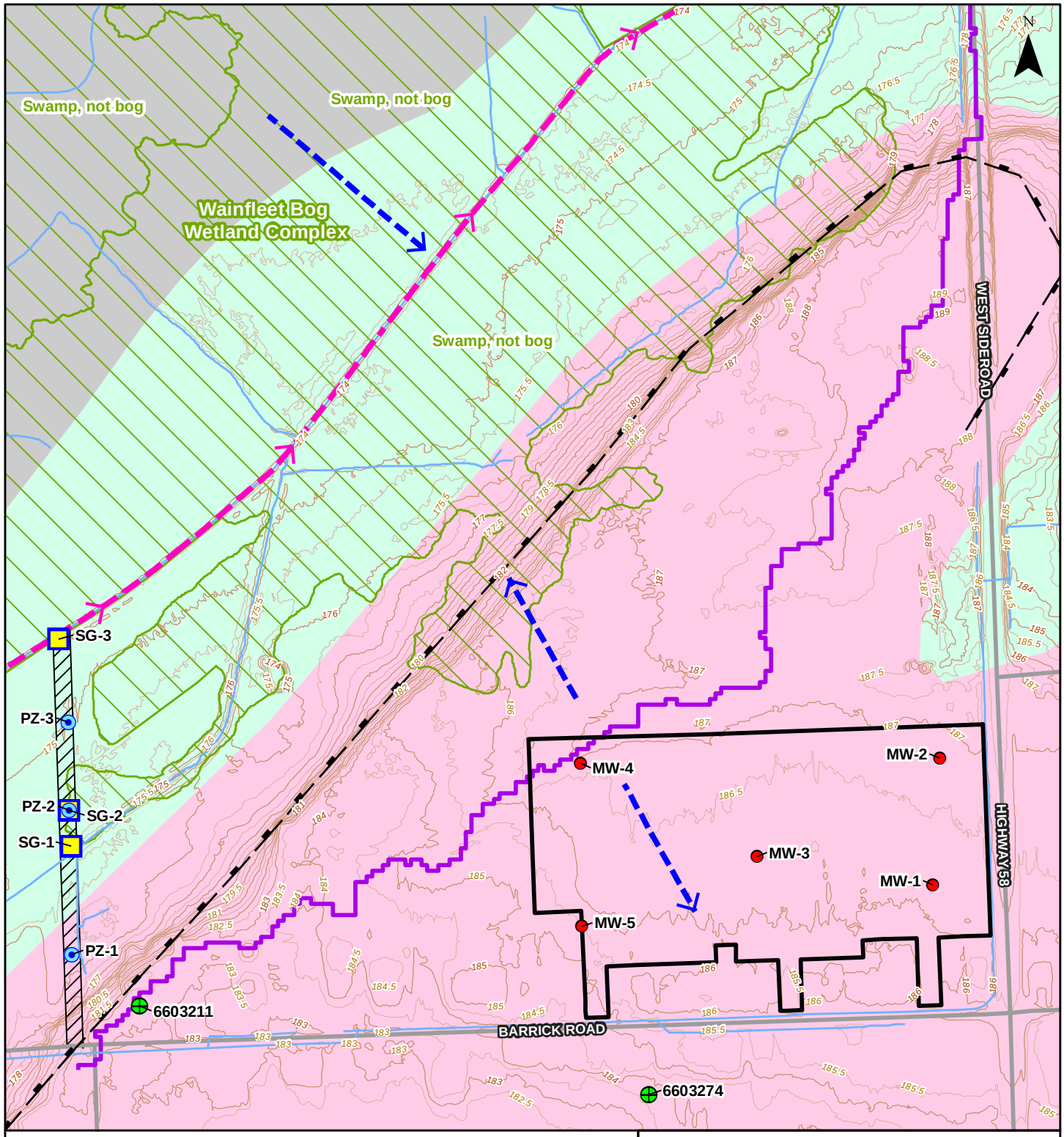
AquaResource Inc and NPCA, 2009. Water Availability Study for the Central Welland River, Big Forks Creek, and Beaverdams Shriners Creeks, Watershed Plan Areas, Niagara Peninsula Source Protection Area.

City of Port Colborne, 2022. DRAFT Barrick Road Secondary Plan Structure.

Cuddy, S., Soo Chan, G. and Post, R., 2013. Hydrogeological Assessment Submissions – Conservation Authority Guidelines for Development Applications.

NPCA and AquaResource Inc., 2010. Niagara Peninsula Tier 1 Water Budget and Water Quantity Stress Assessment, Final Report, Niagara Peninsula Source Protection Area.

Niagara Testing and Inspection, 2022. Preliminary Geotechnical Comments, Proposed Residential Subdivision, Barrick Road, Port Colborne, Ontario.




Study Area
Biederman Drain
Watercourse
Overland Flow Direction
Subwatershed Divide
Road Allowance (City of Port Colbourne)
Provincially Significant Wetland (MNRF)
Surface Contours

Drive-point Piezometers
Surface Water Staff Gauge
Groundwater Monitoring Well
Water Well (MECP WWIS)

**Surface Geology (OGS)**

Onondaga Escarpment
Paleozoic Bedrock
Silty Clay
Wainfleet Bog

# Site Map

Barrick Road Subdivision Study Area
Elevate Living Niagara
Barrick Road and West Side Road, Port Colborne

TDC Terra-Dynamics Consulting Inc.

0 100 M
1:5,000

**Figure 1**

Path: H:\TERRA_DYNAMICS\9620 - TD Barrick Topo Delineation\gis\mxd\Figure 1 Site Map.mxd Revised: November 28, 2023

# Appendix B

# Photographs

# Barrick Road Photo Log

**SG-1**

March 20, 2023

May 3, 2023

June 13, 2023

October 3, 2023

October 16, 2023

October 16, 2023

**SG-2**

March 20, 2023

May 3, 2023

May 10, 2023

June 13, 2023

October 3, 2023

October 16, 2023

**SG-3**

March 20, 2023

May 3, 2023

June 13, 2023

October 3, 2023

October 16, 2023

**PZ-1**

March 20, 2023

May 3, 2023

May 10, 2023

October 3, 2023

October 16, 2023

**PZ-2**

March 20, 2023

May 3, 2023

October 3, 2023

**PZ-3**

March 20, 2023

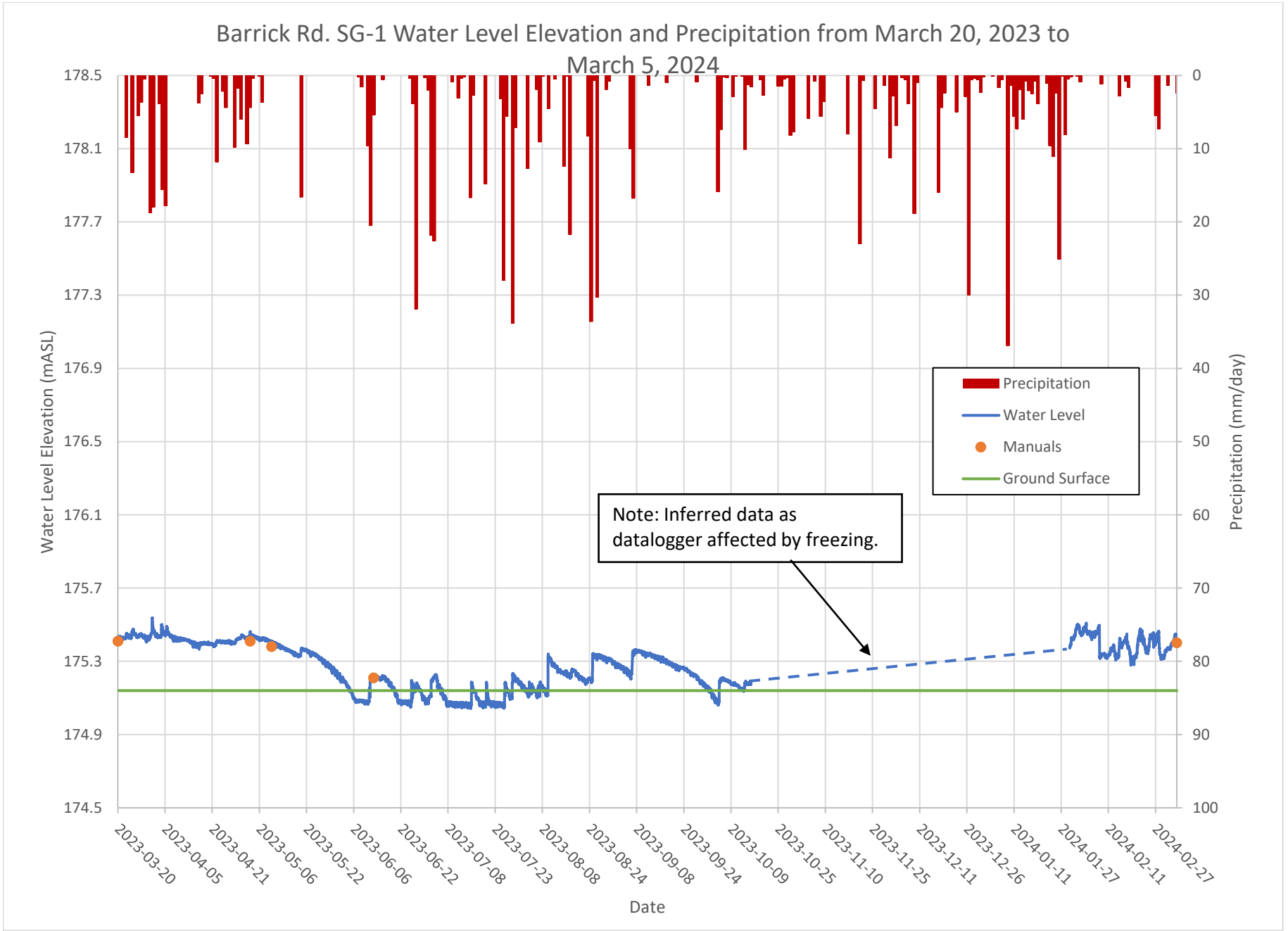
May 3, 2023

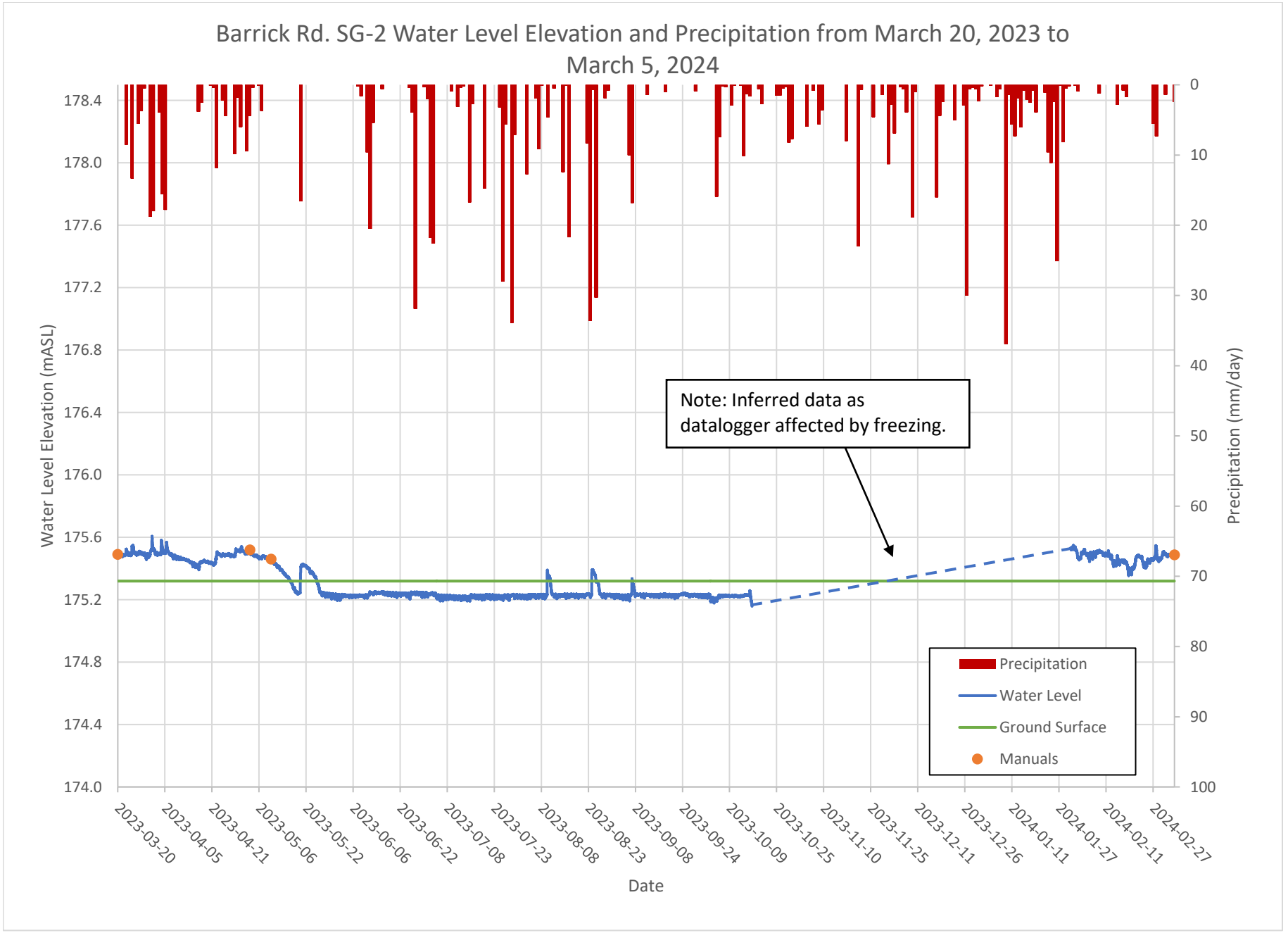
October 3, 2023

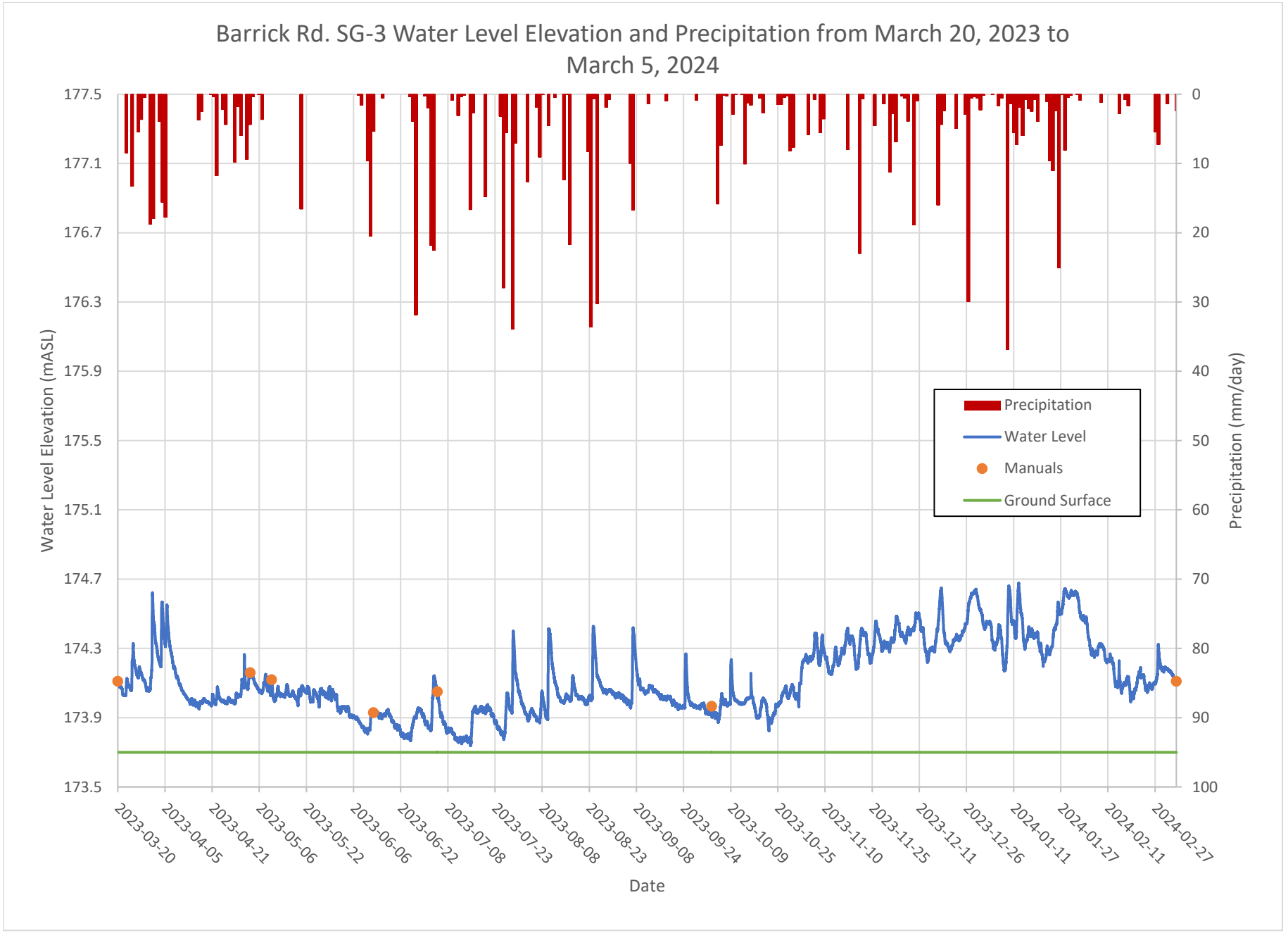
October 16, 2023

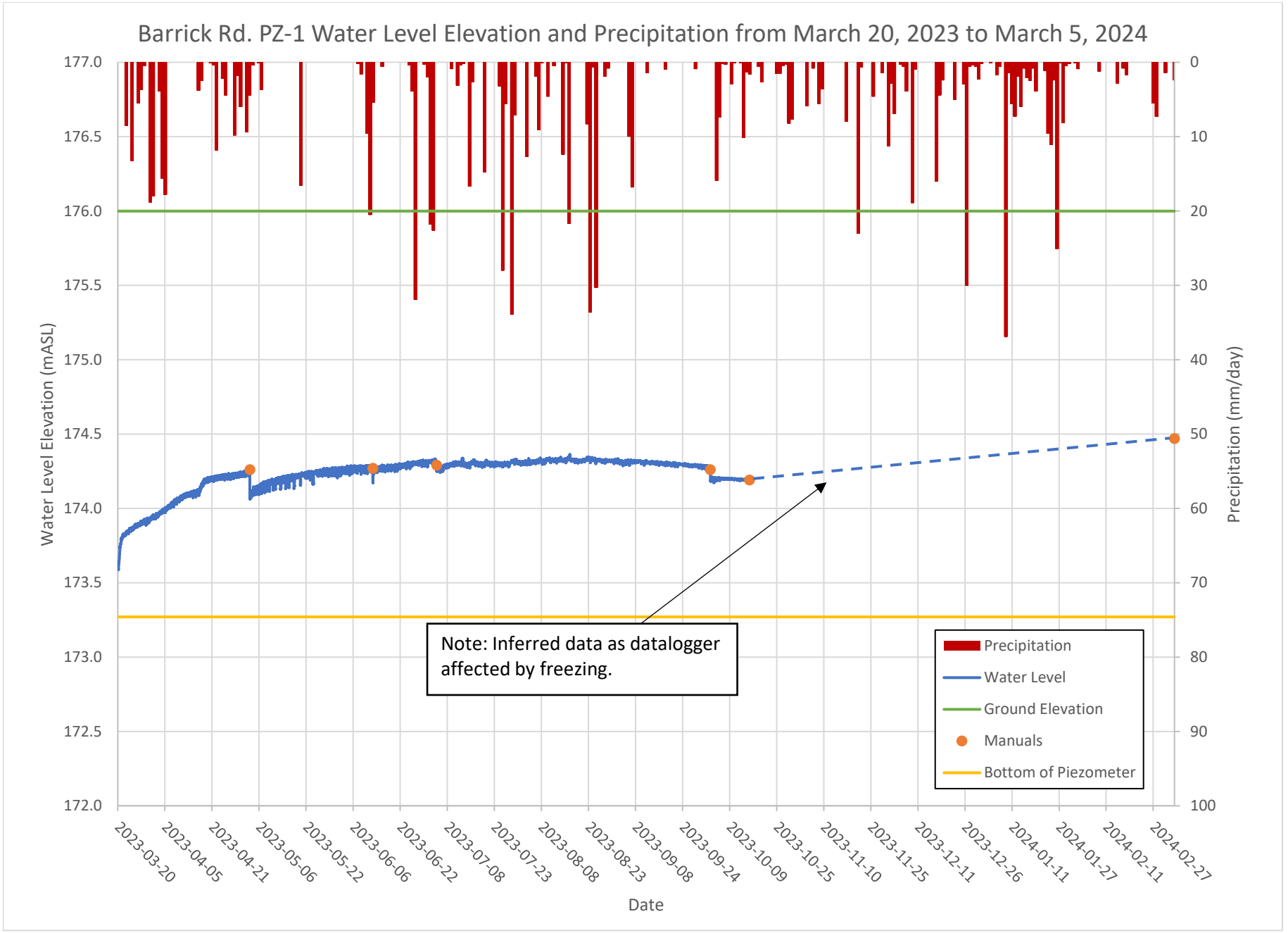
# Appendix C

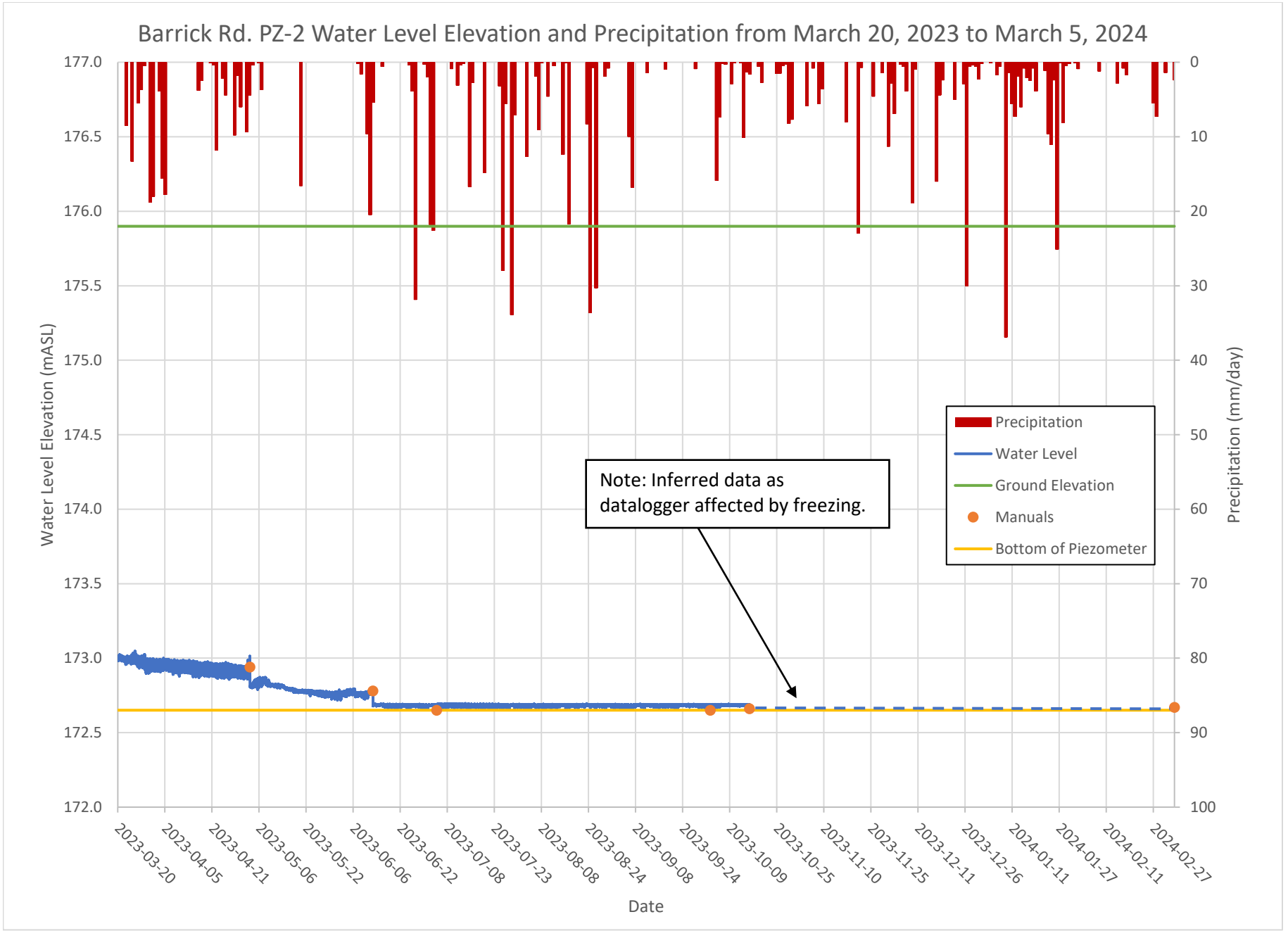
# Water Level Monitoring

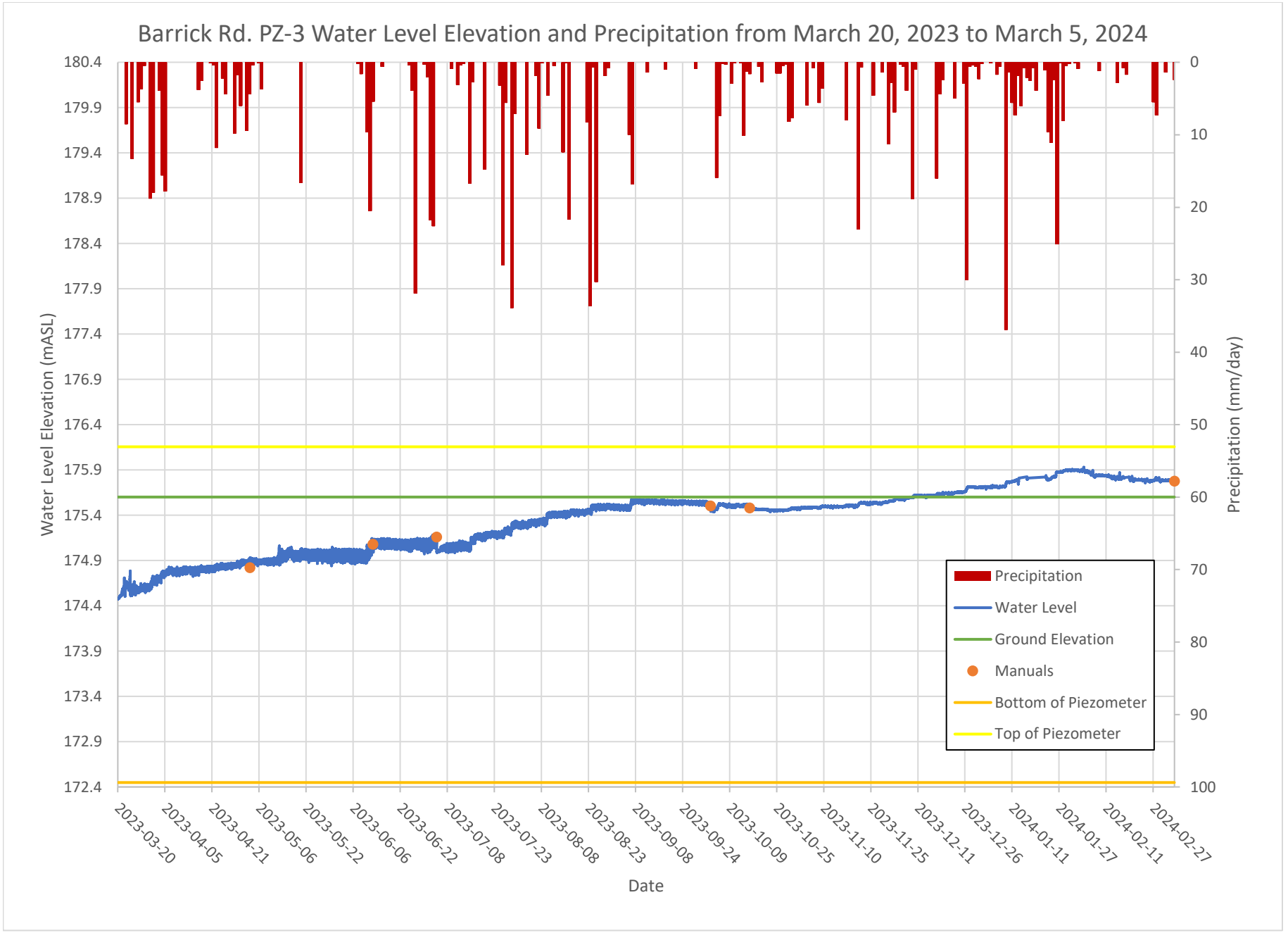

Barrick Rd. SG-1 Water Level Elevation and Precipitation from March 20, 2023 to March 5, 2024
Water Level Elevation (mASL)
Precipitation (mm/day)
Date
Precipitation
Water Level
Manuals
Ground Surface
Note: Inferred data as datalogger affected by freezing.
178.5
178.1
177.7
177.3
176.9
176.5
176.1
175.7
175.3
174.9
174.5
0
10
20
30
40
50
60
70
80
90
100
2023-03-20
2023-04-05
2023-04-21
2023-05-06
2023-05-22
2023-06-06
2023-06-22
2023-07-08
2023-07-23
2023-08-08
2023-08-24
2023-09-08
2023-09-24
2023-10-09
2023-10-25
2023-11-10
2023-11-25
2023-12-11
2023-12-26
2024-01-11
2024-01-27
2024-02-11
2024-02-27

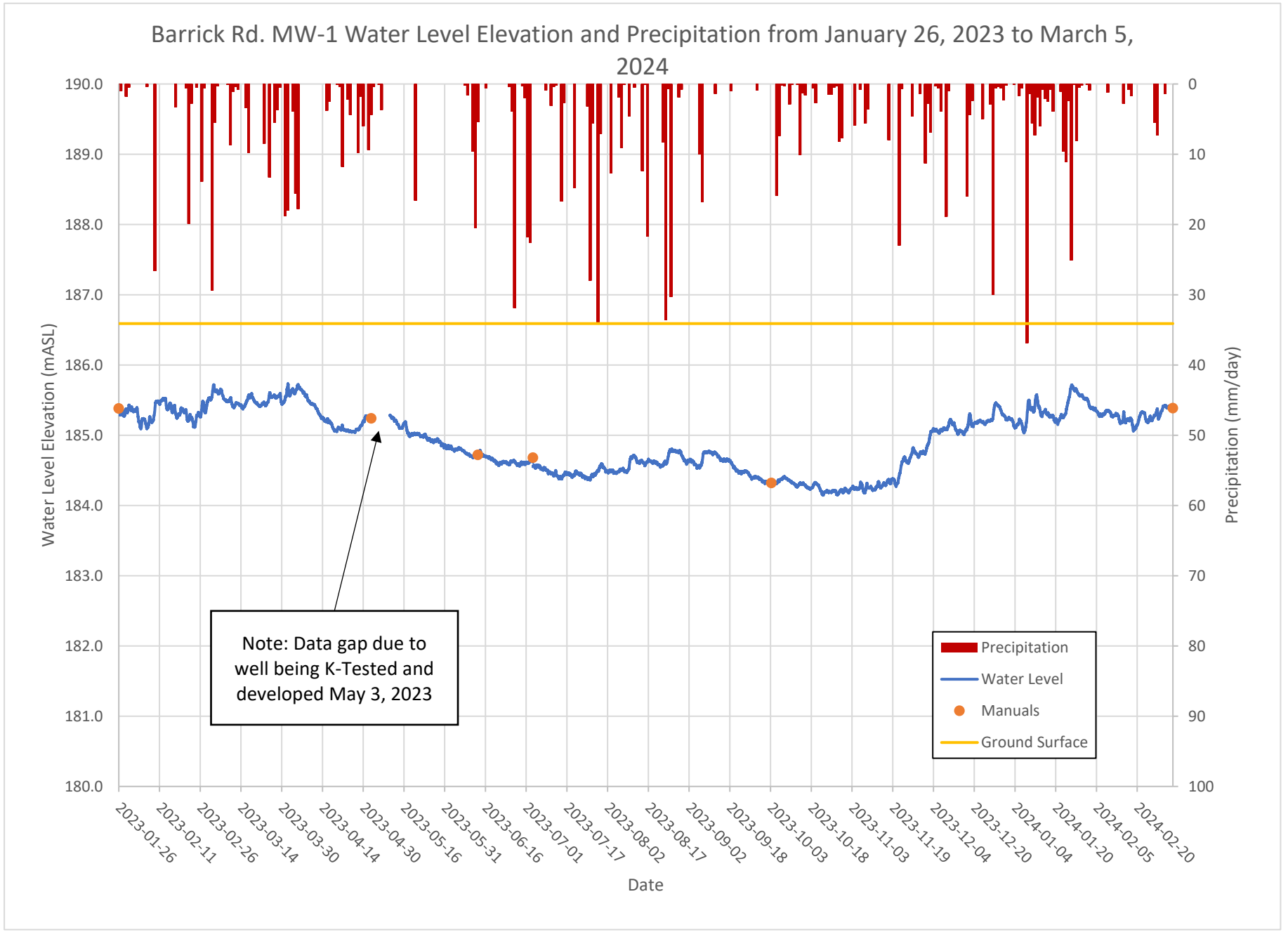

Barrick Rd. SG-2 Water Level Elevation and Precipitation from March 20, 2023 to March 5, 2024
Water Level Elevation (mASL)
Precipitation (mm/day)
Date
Note: Inferred data as datalogger affected by freezing.
Precipitation
Water Level
Ground Surface
Manuals
178.4
178.0
177.6
177.2
176.8
176.4
176.0
175.6
175.2
174.8
174.4
174.0
0
10
20
30
40
50
60
70
80
90
100
2023-03-20
2023-04-05
2023-04-21
2023-05-06
2023-05-22
2023-06-06
2023-06-22
2023-07-08
2023-07-23
2023-08-08
2023-08-23
2023-09-08
2023-09-24
2023-10-09
2023-10-25
2023-11-10
2023-11-25
2023-12-11
2023-12-26
2024-01-11
2024-01-27
2024-02-11
2024-02-27

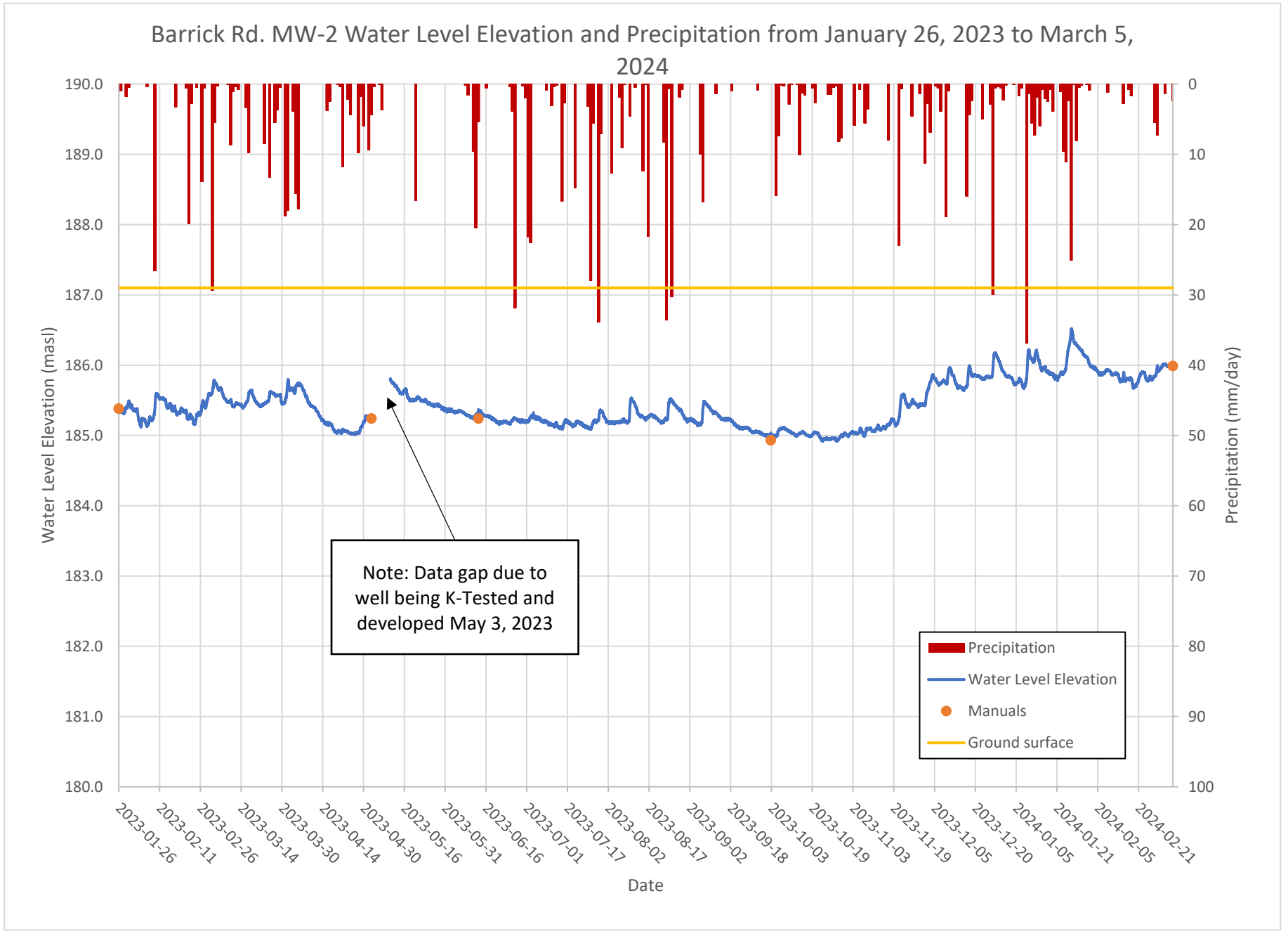

Barrick Rd. SG-3 Water Level Elevation and Precipitation from March 20, 2023 to March 5, 2024
Water Level Elevation (mASL)
177.5
177.1
176.7
176.3
175.9
175.5
175.1
174.7
174.3
173.9
173.5
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Water Level
Manuals
Ground Surface
2023-03-20
2023-04-05
2023-04-21
2023-05-06
2023-05-22
2023-06-06
2023-06-22
2023-07-08
2023-07-23
2023-08-08
2023-08-23
2023-09-08
2023-09-24
2023-10-09
2023-10-25
2023-11-10
2023-11-25
2023-12-11
2023-12-26
2024-01-11
2024-01-27
2024-02-11
2024-02-27
Date

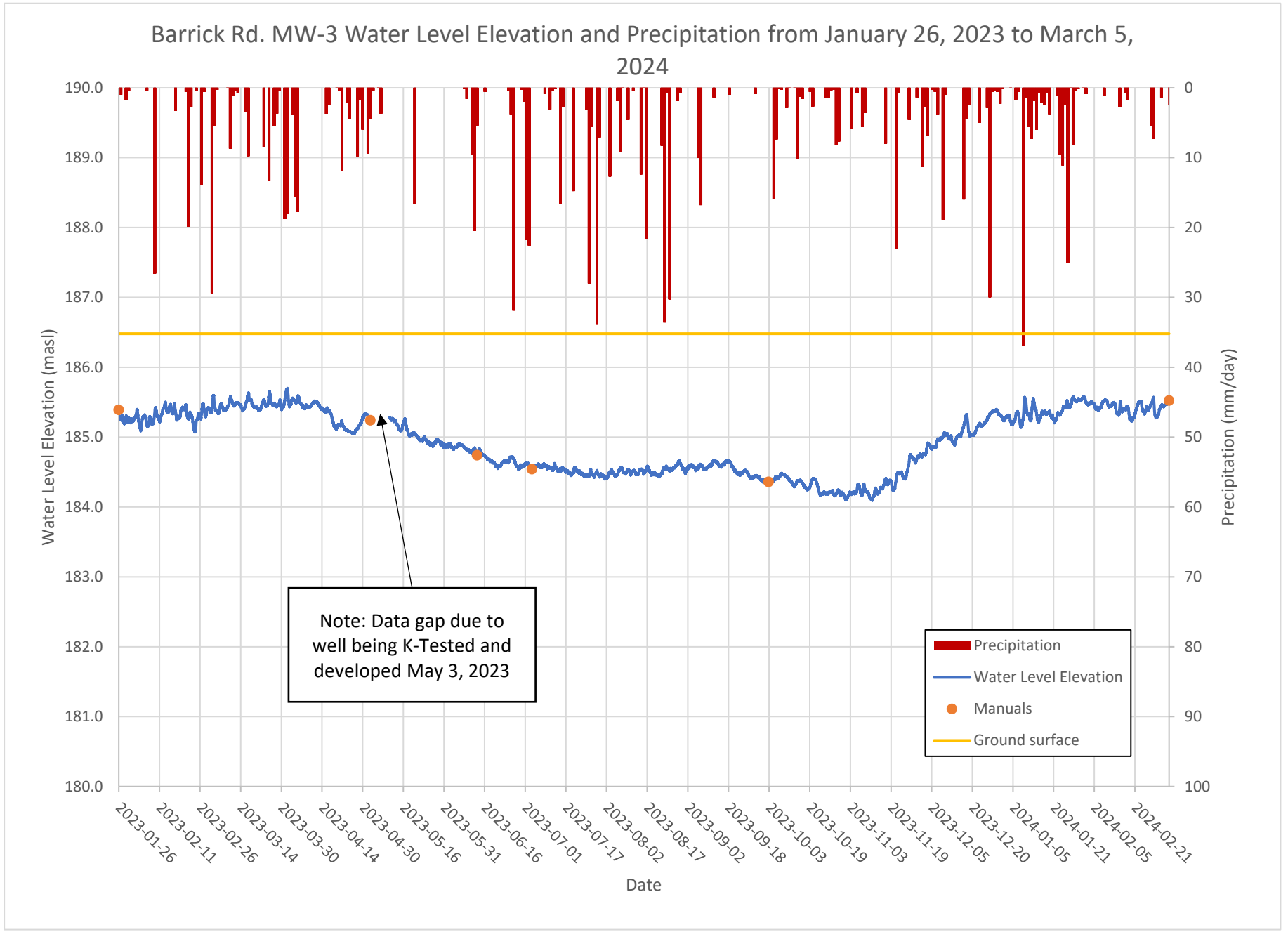

Barrick Rd. PZ-1 Water Level Elevation and Precipitation from March 20, 2023 to March 5, 2024
Water Level Elevation (mASL)
Precipitation (mm/day)
Date
177.0
176.5
176.0
175.5
175.0
174.5
174.0
173.5
173.0
172.5
172.0
0
10
20
30
40
50
60
70
80
90
100
2023-03-20
2023-04-05
2023-04-21
2023-05-06
2023-05-22
2023-06-06
2023-06-22
2023-07-08
2023-07-23
2023-08-08
2023-08-23
2023-09-08
2023-09-24
2023-10-09
2023-10-25
2023-11-10
2023-11-25
2023-12-11
2023-12-26
2024-01-11
2024-01-27
2024-02-11
2024-02-27
Note: Inferred data as datalogger affected by freezing.
Precipitation
Water Level
Ground Elevation
Manuals
Bottom of Piezometer

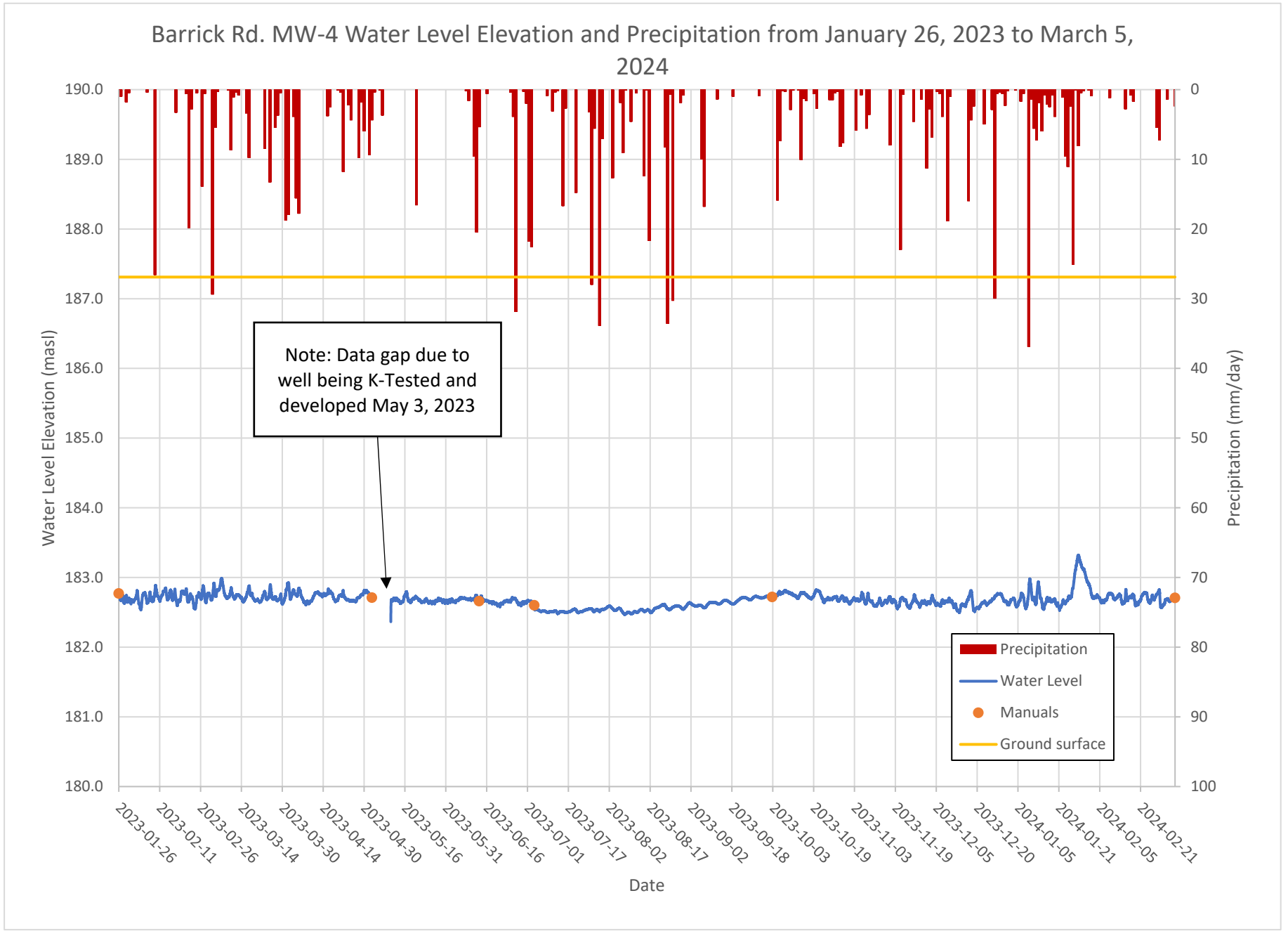

Barrick Rd. PZ-2 Water Level Elevation and Precipitation from March 20, 2023 to March 5, 2024
Water Level Elevation (mASL)
Precipitation (mm/day)
Date
177.0
176.5
176.0
175.5
175.0
174.5
174.0
173.5
173.0
172.5
172.0
0
10
20
30
40
50
60
70
80
90
100
2023-03-20
2023-04-05
2023-04-21
2023-05-06
2023-05-22
2023-06-06
2023-06-22
2023-07-08
2023-07-23
2023-08-08
2023-08-24
2023-09-08
2023-09-24
2023-10-09
2023-10-25
2023-11-10
2023-11-25
2023-12-11
2023-12-26
2024-01-11
2024-01-27
2024-02-11
2024-02-27
Precipitation
Water Level
Ground Elevation
Manuals
Bottom of Piezometer
Note: Inferred data as datalogger affected by freezing.

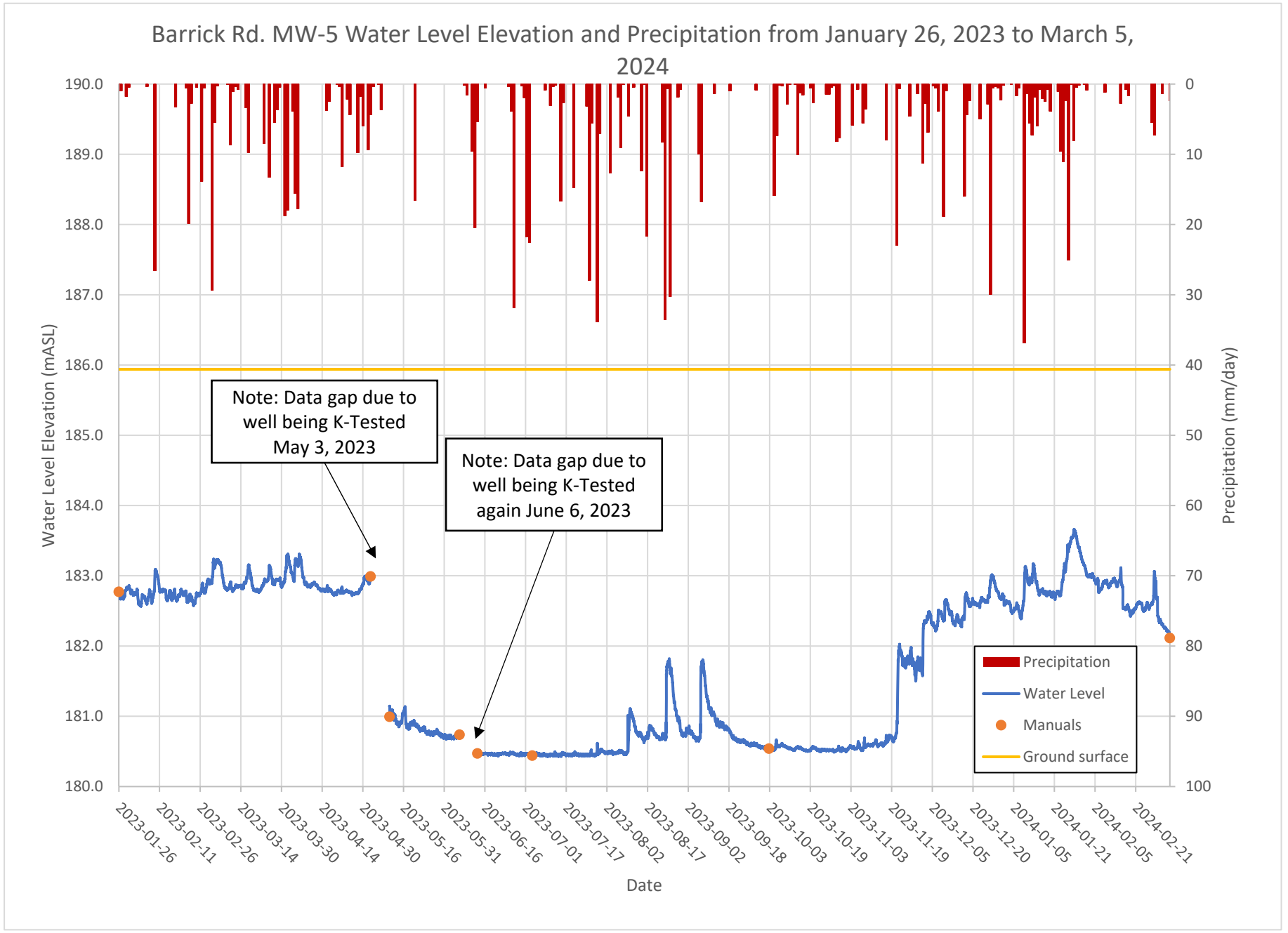

Barrick Rd. PZ-3 Water Level Elevation and Precipitation from March 20, 2023 to March 5, 2024
Water Level Elevation (mASL)
Precipitation (mm/day)
Date
180.4
179.9
179.4
178.9
178.4
177.9
177.4
176.9
176.4
175.9
175.4
174.9
174.4
173.9
173.4
172.9
172.4
0
10
20
30
40
50
60
70
80
90
100
2023-03-20
2023-04-05
2023-04-21
2023-05-06
2023-05-22
2023-06-06
2023-06-22
2023-07-08
2023-07-23
2023-08-08
2023-08-23
2023-09-08
2023-09-24
2023-10-09
2023-10-25
2023-11-10
2023-11-25
2023-12-11
2023-12-26
2024-01-11
2024-01-27
2024-02-11
2024-02-27
Precipitation
Water Level
Ground Elevation
Manuals
Bottom of Piezometer
Top of Piezometer


Barrick Rd. MW-1 Water Level Elevation and Precipitation from January 26, 2023 to March 5, 2024
Water Level Elevation (mASL)
Precipitation (mm/day)
Date
190.0
189.0
188.0
187.0
186.0
185.0
184.0
183.0
182.0
181.0
180.0
0
10
20
30
40
50
60
70
80
90
100
2023-01-26
2023-02-11
2023-02-26
2023-03-14
2023-03-30
2023-04-14
2023-04-30
2023-05-16
2023-05-31
2023-06-16
2023-07-01
2023-07-17
2023-08-02
2023-08-17
2023-09-02
2023-09-18
2023-10-03
2023-10-18
2023-11-03
2023-11-19
2023-12-04
2023-12-20
2024-01-04
2024-01-20
2024-02-05
2024-02-20
Note: Data gap due to well being K-Tested and developed May 3, 2023
Precipitation
Water Level
Manuals
Ground Surface


Barrick Rd. MW-2 Water Level Elevation and Precipitation from January 26, 2023 to March 5, 2024
Water Level Elevation (masl)
Precipitation (mm/day)
Date
190.0
189.0
188.0
187.0
186.0
185.0
184.0
183.0
182.0
181.0
180.0
0
10
20
30
40
50
60
70
80
90
100
2023-01-26
2023-02-11
2023-02-26
2023-03-14
2023-03-30
2023-04-14
2023-04-30
2023-05-16
2023-05-31
2023-06-16
2023-07-01
2023-07-17
2023-08-02
2023-08-17
2023-09-02
2023-09-18
2023-10-03
2023-10-19
2023-11-03
2023-11-19
2023-12-05
2023-12-20
2024-01-05
2024-01-21
2024-02-05
2024-02-21
Note: Data gap due to well being K-Tested and developed May 3, 2023
Precipitation
Water Level Elevation
Manuals
Ground surface


Barrick Rd. MW-3 Water Level Elevation and Precipitation from January 26, 2023 to March 5, 2024
Water Level Elevation (masl)
Precipitation (mm/day)
Date
190.0
189.0
188.0
187.0
186.0
185.0
184.0
183.0
182.0
181.0
180.0
0
10
20
30
40
50
60
70
80
90
100
2023-01-26
2023-02-11
2023-02-26
2023-03-14
2023-03-30
2023-04-14
2023-04-30
2023-05-16
2023-05-31
2023-06-16
2023-07-01
2023-07-17
2023-08-02
2023-08-17
2023-09-02
2023-09-18
2023-10-03
2023-10-19
2023-11-03
2023-11-19
2023-12-05
2023-12-20
2024-01-05
2024-01-21
2024-02-05
2024-02-21
Note: Data gap due to well being K-Tested and developed May 3, 2023
Precipitation
Water Level Elevation
Manuals
Ground surface

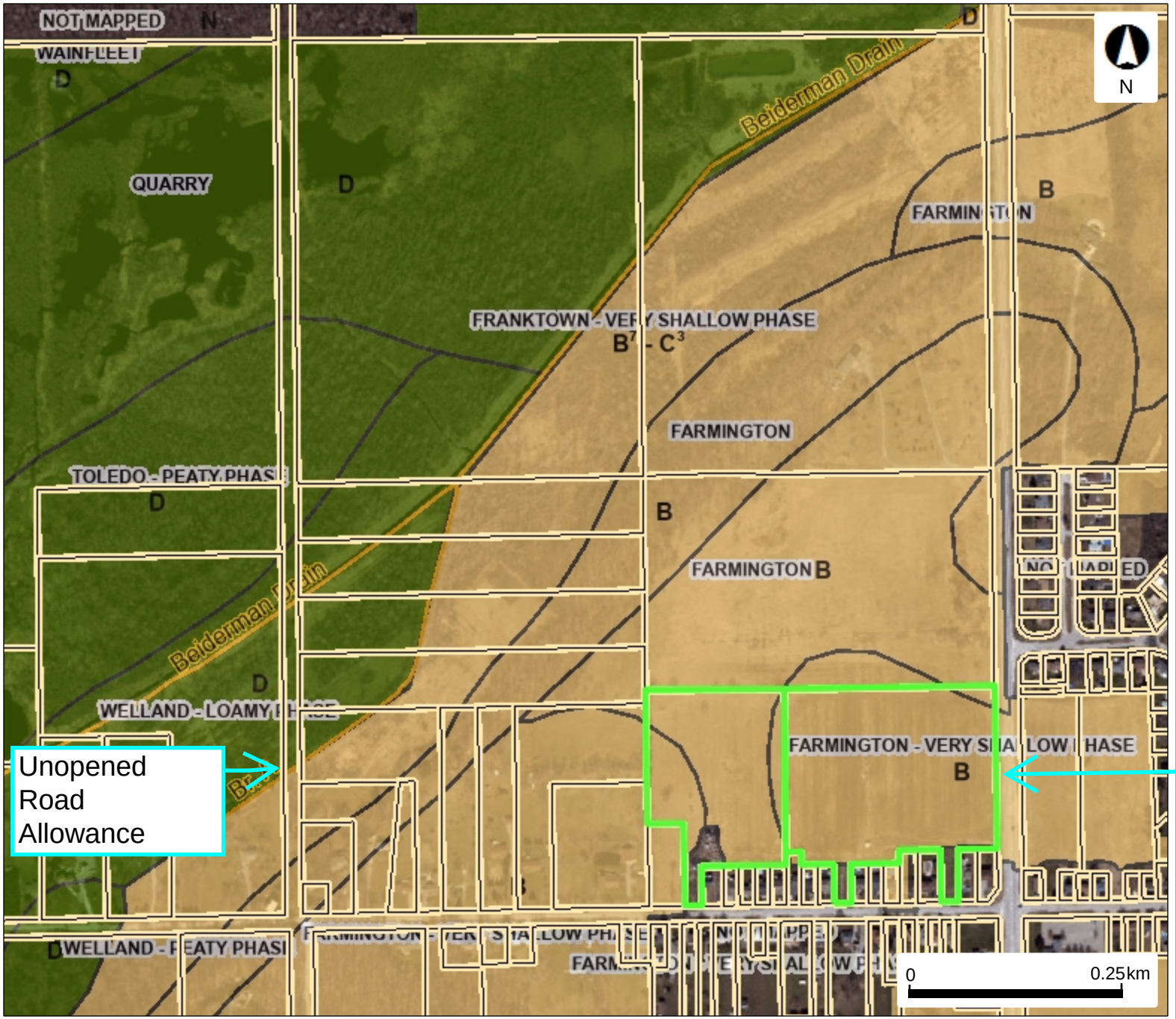

Barrick Rd. MW-4 Water Level Elevation and Precipitation from January 26, 2023 to March 5, 2024
Water Level Elevation (masl)
Precipitation (mm/day)
Date
Note: Data gap due to well being K-Tested and developed May 3, 2023
Precipitation
Water Level
Manuals
Ground surface
190.0
189.0
188.0
187.0
186.0
185.0
184.0
183.0
182.0
181.0
180.0
0
10
20
30
40
50
60
70
80
90
100
2023-01-26
2023-02-11
2023-02-26
2023-03-14
2023-03-30
2023-04-14
2023-04-30
2023-05-16
2023-05-31
2023-06-16
2023-07-01
2023-07-17
2023-08-02
2023-08-17
2023-09-02
2023-09-18
2023-10-03
2023-10-19
2023-11-03
2023-11-19
2023-12-05
2023-12-20
2024-01-05
2024-01-21
2024-02-05
2024-02-21


Barrick Rd. MW-5 Water Level Elevation and Precipitation from January 26, 2023 to March 5, 2024
Water Level Elevation (mASL)
Precipitation (mm/day)
Date
Note: Data gap due to well being K-Tested May 3, 2023
Note: Data gap due to well being K-Tested again June 6, 2023
Precipitation
Water Level
Manuals
Ground surface

# Appendix D

# Soil Information and Analyses

# OMAFRA Soils



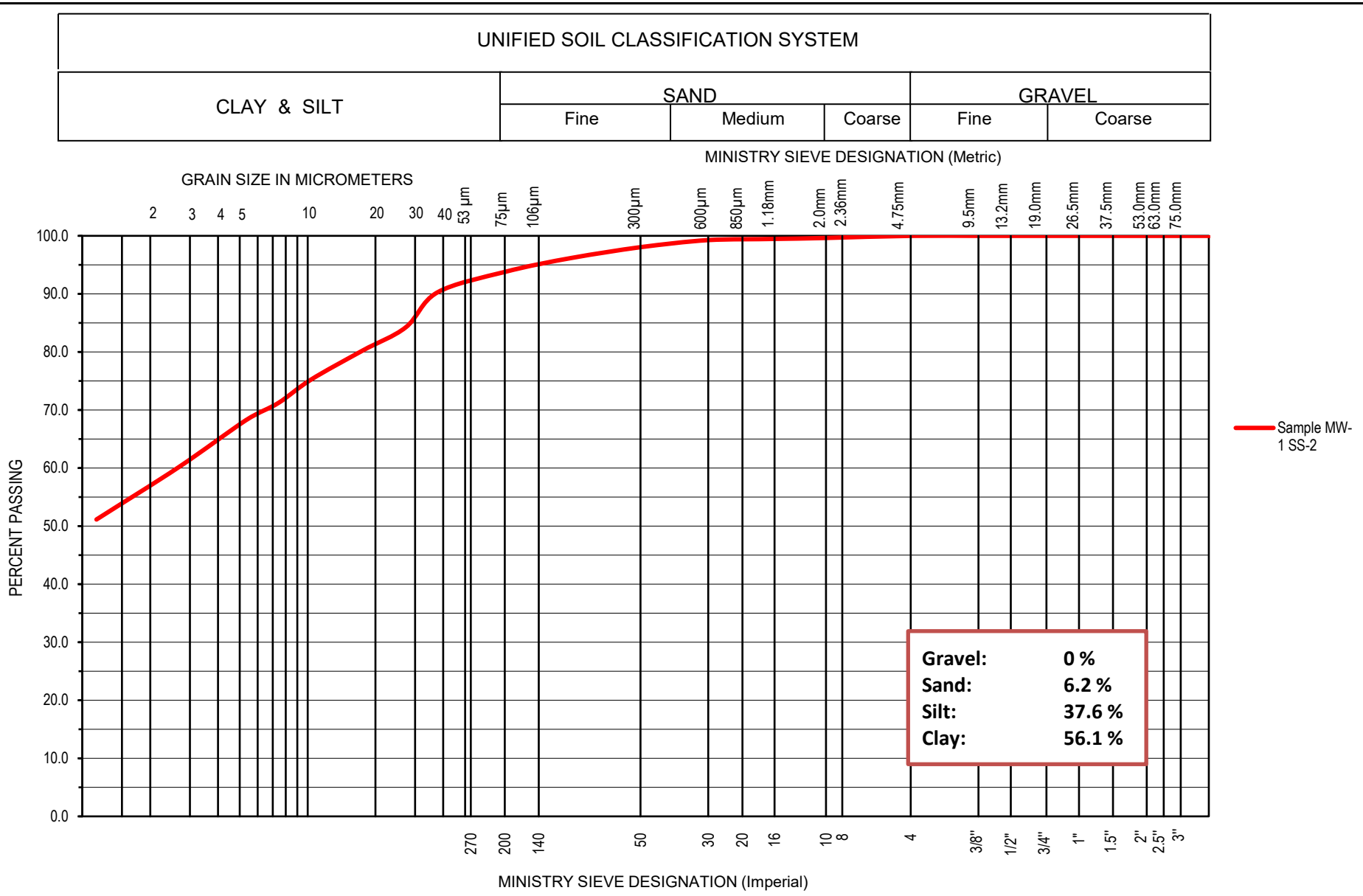

## Legend

- Assessment Parcel
- Constructed Drains
  - Open or Unknown
  - Closed/Tiled
- Soil Name Label
- Hydrologic Soil Group
  - A - High
  - B - Moderate
  - C - Slow
  - D - Very Slow

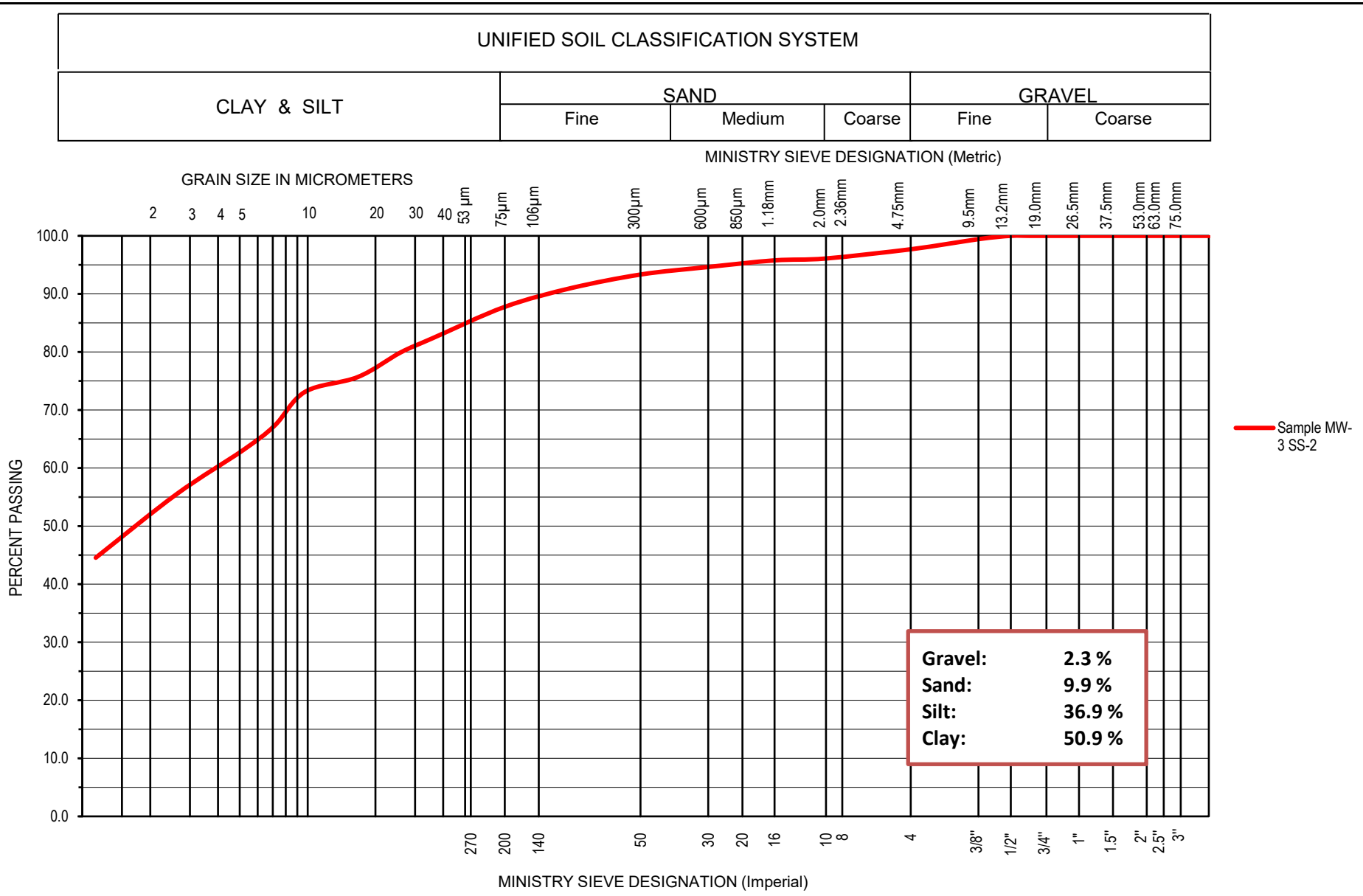
This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) shall not be liable in any way for the use or any information on this map. of, or reliance upon, this map.



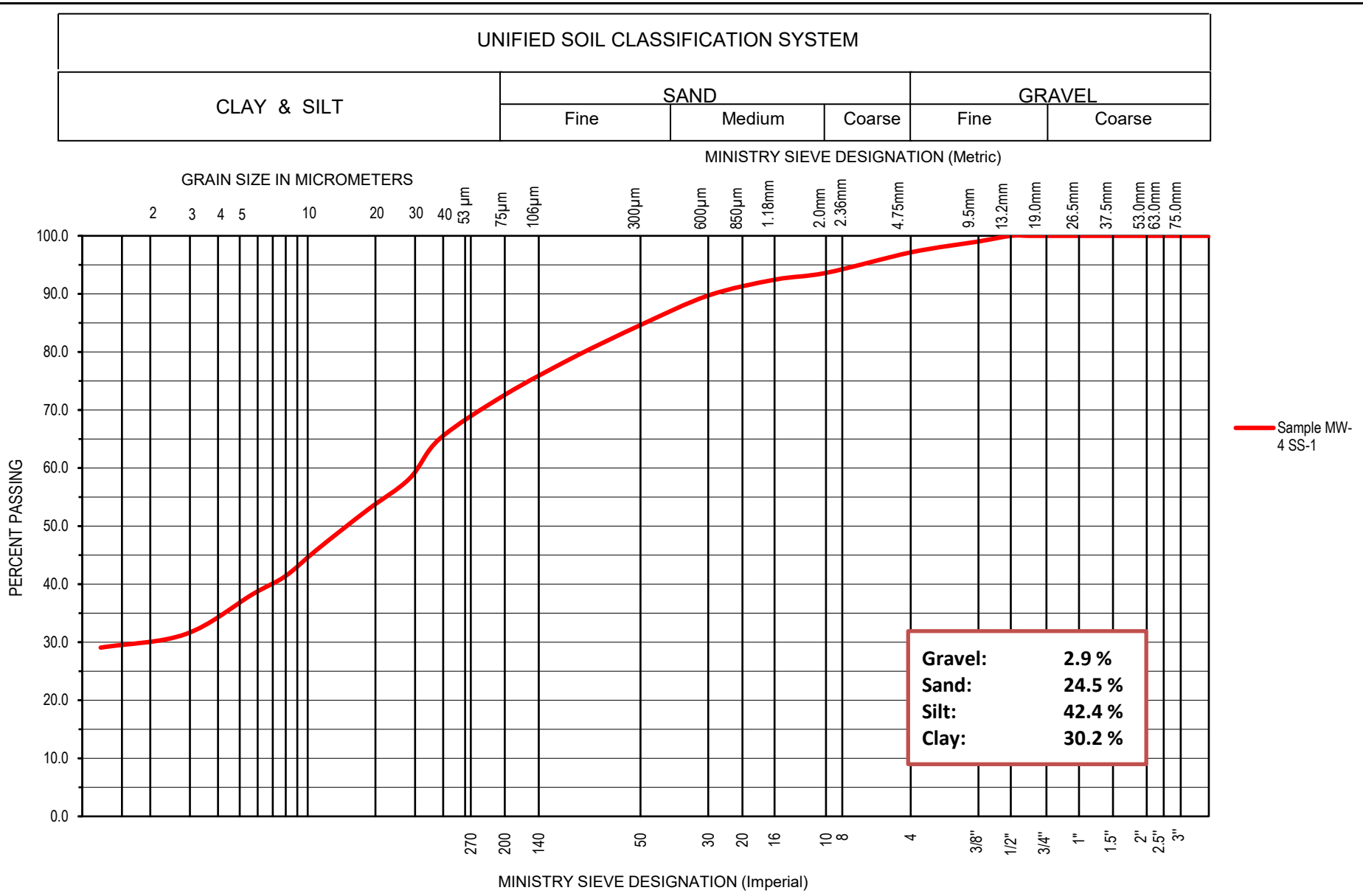
Map Created: 2/28/2024
Map Center: 42.91435 N, -79.2714 W




| | | | |
|---|---|---|---|
| CLIENT: **Toth Group** | PREPARED BY: DN | PROJECT: Sieve / Hydrometer Analysis<br>607 Barrick Road, Port Colborne, Ontario | DATE: July 14, 2022 |
| | | | PROJECT NO: NT22157 |
| Niagara Testing & Inspection Ltd.<br>3300 Merrittville Highway, Unit #5<br>Thorold, Ontario | CHECKED BY: JM | TITLE: Grain Size Distribution | FIGURE NO: 1 |




| | | | |
|---|---|---|---|
| CLIENT: **Toth Group** | PREPARED BY: DN | PROJECT: Sieve / Hydrometer Analysis<br>607 Barrick Road, Port Colborne, Ontario | DATE: July 14, 2022 |
| | | | PROJECT NO: NT22157 |
| Niagara Testing & Inspection Ltd.<br>3300 Merrittville Highway, Unit #5<br>Thorold, Ontario | CHECKED BY: JM | TITLE: Grain Size Distribution | FIGURE NO: 2 |



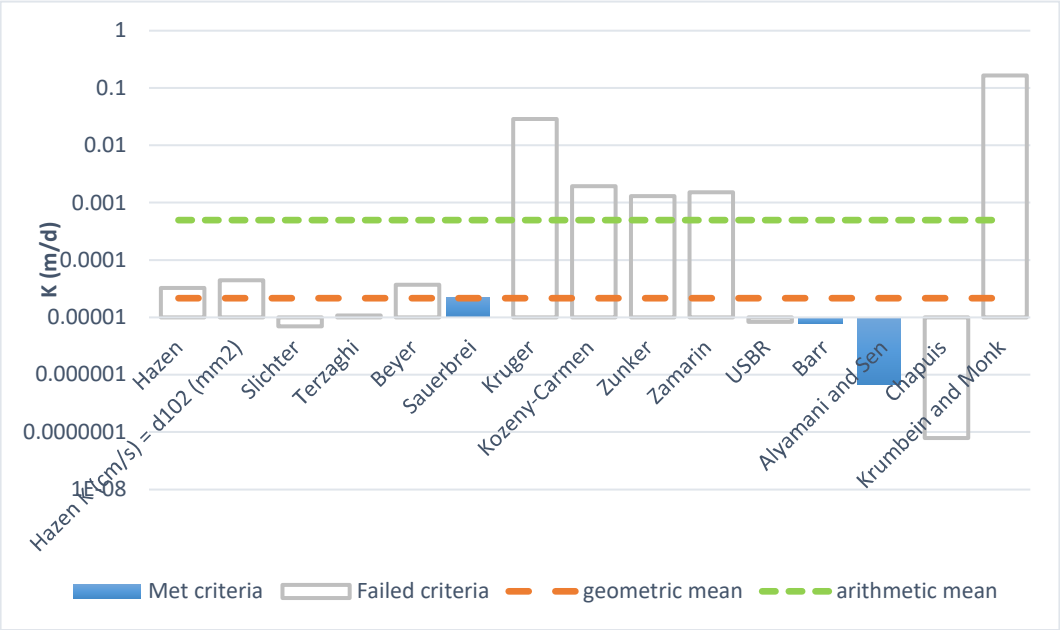

| | | | |
|---|---|---|---|
| CLIENT: **Toth Group** | PREPARED BY: DN | PROJECT: Sieve / Hydrometer Analysis<br>607 Barrick Road, Port Colborne, Ontario | DATE: July 14, 2022 |
| | | | PROJECT NO: NT22157 |
| Niagara Testing & Inspection Ltd.<br>3300 Merrittville Highway, Unit #5<br>Thorold, Ontario | CHECKED BY: JM | TITLE: Grain Size Distribution | FIGURE NO: 3 |

*K* from Grain Size Analysis Report  Date: 27-Apr-23

Sample Name: MW1 SS2 Barrick Road, Port Colborne

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

## Poorly sorted clay with fines



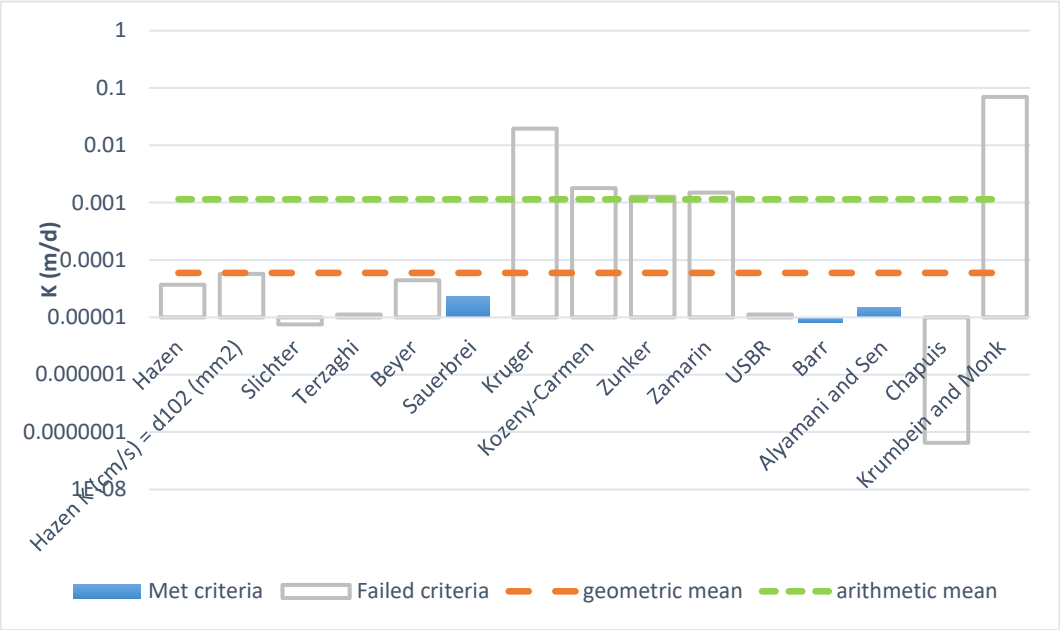

| Estimation of Hydraulic Conductivity | cm/s | m/s | m/d | de |
|---|---|---|---|---|
| Hazen | 4.E-08 | 4.E-10 | 0.00 | |
| Hazen K (cm/s) = $d_{10}$ (mm) | 5.E-08 | 5.E-10 | 0.00 | |
| Slichter | 8.E-09 | 8.E-11 | 0.00 | |
| Terzaghi | 1.E-08 | 1.E-10 | 0.00 | |
| Beyer | 4.E-08 | 4.E-10 | 0.00 | |
| Sauerbrei | 3.E-08 | 3.E-10 | 0.00 | |
| Kruger | 3.E-05 | 3.E-07 | 0.03 | |
| Kozeny-Carmen | 2.E-06 | 2.E-08 | 0.00 | |
| Zunker | 2.E-06 | 2.E-08 | 0.00 | |
| Zamarin | 2.E-06 | 2.E-08 | 0.00 | |
| USBR | 1.E-08 | 1.E-10 | 0.00 | |
| Barr | 9.E-09 | 9.E-11 | 0.00 | |
| Alyamani and Sen | 8.E-10 | 8.E-12 | 0.00 | |
| Chapuis | 9.E-11 | 9.E-13 | 0.00 | |
| Krumbein and Monk | 2.E-04 | 2.E-06 | 0.16 | |
| Shepherd | 2.E-06 | 2.E-08 | 0.00 | |
| geometric mean | 3.E-08 | 3.E-10 | 0.00 | |
| arithmetic mean | 6.E-07 | 6.E-09 | 0.00 | |

*K* from Grain Size Analysis Report  Date: 27-Apr-23

Sample Name: MW3 SS2 Barrick Road, Port Colborne

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

## Poorly sorted clay with fines



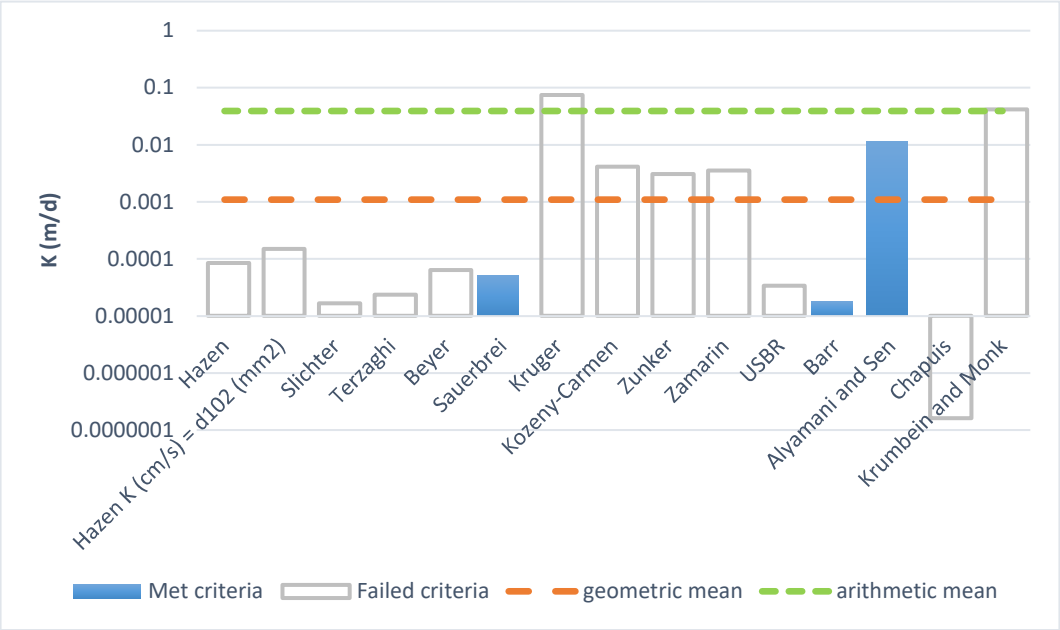

| Estimation of Hydraulic Conductivity | cm/s | m/s | m/d | de |
|---|---|---|---|---|
| Hazen | 4.E-08 | 4.E-10 | 0.00 | |
| Hazen K (cm/s) = $d_{10}$ (mm) | 7.E-08 | 7.E-10 | 0.00 | |
| Slichter | 9.E-09 | 9.E-11 | 0.00 | |
| Terzaghi | 1.E-08 | 1.E-10 | 0.00 | |
| Beyer | 5.E-08 | 5.E-10 | 0.00 | |
| Sauerbrei | 3.E-08 | 3.E-10 | 0.00 | |
| Kruger | 2.E-05 | 2.E-07 | 0.02 | |
| Kozeny-Carmen | 2.E-06 | 2.E-08 | 0.00 | |
| Zunker | 1.E-06 | 1.E-08 | 0.00 | |
| Zamarin | 2.E-06 | 2.E-08 | 0.00 | |
| USBR | 1.E-08 | 1.E-10 | 0.00 | |
| Barr | 9.E-09 | 9.E-11 | 0.00 | |
| Alyamani and Sen | 2.E-08 | 2.E-10 | 0.00 | |
| Chapuis | 7.E-11 | 7.E-13 | 0.00 | |
| Krumbein and Monk | 8.E-05 | 8.E-07 | 0.07 | |
| Shepherd | 5.E-06 | 5.E-08 | 0.00 | |
| geometric mean | 7.E-08 | 7.E-10 | 0.00 | |
| arithmetic mean | 1.E-06 | 1.E-08 | 0.00 | |

*K* from Grain Size Analysis Report  Date: 27-Apr-23

Sample Name: MW4 SS1 Barrick Road, Port Colborne

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

## Poorly sorted clay low in fines




| Estimation of Hydraulic Conductivity | cm/s | m/s | m/d | de |
|---|---|---|---|---|
| Hazen | 1.E-07 | 1.E-09 | 0.00 | |
| Hazen K (cm/s) = $d_{10}$ (mm) | 2.E-07 | 2.E-09 | 0.00 | |
| Slichter | 2.E-08 | 2.E-10 | 0.00 | |
| Terzaghi | 3.E-08 | 3.E-10 | 0.00 | |
| Beyer | 7.E-08 | 7.E-10 | 0.00 | |
| Sauerbrei | 6.E-08 | 6.E-10 | 0.00 | |
| Kruger | 9.E-05 | 9.E-07 | 0.07 | |
| Kozeny-Carmen | 5.E-06 | 5.E-08 | 0.00 | |
| Zunker | 4.E-06 | 4.E-08 | 0.00 | |
| Zamarin | 4.E-06 | 4.E-08 | 0.00 | |
| USBR | 4.E-08 | 4.E-10 | 0.00 | |
| Barr | 2.E-08 | 2.E-10 | 0.00 | |
| Alyamani and Sen | 1.E-05 | 1.E-07 | 0.01 | |
| Chapuis | 2.E-10 | 2.E-12 | 0.00 | |
| Krumbein and Monk | 5.E-05 | 5.E-07 | 0.04 | |
| Shepherd | 2.E-04 | 2.E-06 | 0.15 | |
| geometric mean | 1.E-06 | 1.E-08 | 0.00 | |
| arithmetic mean | 5.E-05 | 5.E-07 | 0.04 | |

# Appendix E

# Geotechnical Logs

# RECORD OF BOREHOLE: MW1

**PROJECT NO.:** NT22157
**PROJECT:** Residential Development
**LOCATION:** Barrick Road, Port Colborne
**CLIENT:** Toth Group Development

**DRILLING COMPANY:** Elements Drilling
**DRILLING METHOD:** Track Mount - Rock Coring
**DRILL RIG:** Diedrich D50
**BOREHOLE COORDINATE (UTM):** 641529 E, 4752394 N

**SHEET** 1 of 1
**DATE STARTED:** June 28, 2022
**DATE COMPLETED:** June 28, 2022
**DATUM:** TBM

| SOIL PROFILE | | | SAMPLES | | | | | FIELD TESTING | | LAB TESTING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LITHOLOGY PLOT | ELEVATION (m / mbgs) | DESCRIPTION | TYPE | NUMBER | SPT 'N' VALUE | RECOVERY (%) | DEPTH SCALE ft / m | SPT (N) 25 50 75 100 / HAND PENETROMETER (kPa) 100 200 300 400 | COV (ppm / %LEL) | MOISTURE CONTENT (%) 10 20 30 40 | WELL INSTALLATION | COMMENTS and ADDITIONAL LAB TESTING |
| | 187.09 | Ground Surface | | | | | ft m | | | | | |
| | 0.0 | **Topsoil** 125 mm **TOPSOIL** | | | | | 0.0 0.0 | | | | | |
| | | **Silty Clay** Brown **NATIVE** trace sand, some organics, Stiff | SS | 1 | 3, 3, 2, 3 | | 1.0 | 5 | 0 | | | |
| | -1.1 | | SS | 2 | 4, 50 for 1" | | 2.0 3.0 1.0 | >54 | 0 | | | |
| | 1.1 | **Bedrock** Limestone **BEDROCK** | | | | | 4.0 5.0 6.0 7.0 8.0 9.0 10.0 2.0 | | | | | |
| | | | | | | | 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 3.0 4.0 5.0 6.0 7.0 8.0 | | | | | |
| | -7.9 7.9 | End of Borehole | | | | | | | | | | |

WELL INSTALLATION: Concrete; 1" Steel Casing; Bentonite; #3 Silica Sand; 2" Slot 10 Screen

Groundwater Level Upon Completion:
Secondary Groundwater Level:

**INITIAL WATER LEVEL:** 2.30 mbgs
**SECONDARY WATER LEVEL:** 2.58 mbgs
**BOREHOLE CAVE UPON COMPLETION:** N/A

**INITIAL WATER LEVEL DATE:** July 30, 2022
**SECONDARY WATER LEVEL DATE:** August 22, 2022

**LOGGED:** DN
**COMPILED:** JM
**CHECKED:** JM

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# RECORD OF BOREHOLE: MW2

**PROJECT NO.:** NT22157
**PROJECT:** Residential Development
**LOCATION:** Barrick Road, Port Colborne
**CLIENT:** Toth Group Development

**DRILLING COMPANY:** Elements Drilling
**DRILLING METHOD:** Track Mount - Rock Coring
**DRILL RIG:** Diedrich D50
**BOREHOLE COORDINATE (UTM):** 641534 E, 4752530 N

**SHEET** 1 of 1
**DATE STARTED:** June 28, 2022
**DATE COMPLETED:** June 28, 2022
**DATUM:** TBM

| SOIL PROFILE | | | SAMPLES | | | | | FIELD TESTING | | LAB TESTING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LITHOLOGY PLOT | ELEVATION (m / mbgs) | DESCRIPTION | TYPE | NUMBER | SPT 'N' VALUE | RECOVERY (%) | DEPTH SCALE ft / m | SPT (N) 25 50 75 100 / HAND PENETROMETER (kPa) 100 200 300 400 | COV (ppm / %LEL) | MOISTURE CONTENT (%) 10 20 30 40 | WELL INSTALLATION | COMMENTS and ADDITIONAL LAB TESTING |
| | 187.62 | Ground Surface | | | | | ft m | | | | | |
| | 0.0 | **Topsoil** 75 mm **TOPSOIL** | | | | | 0.0 0.0 | | | | | |
| | | **Silty Clay** Brown **NATIVE** trace sand and gravel, some organics, Stiff | SS | 1 | 6. 5. 3. 5 | | 1.0 | 8 | 0 | | | |
| | -1.1 | | SS | 2 | 8. 50 for 3" | | 2.0 | >58 | 0 | | | |
| | 1.1 | **Bedrock** Limestone **BEDROCK** | | | | | 3.0 1.0 | | | | | |
| | | | | | | | 4.0 | | | | | |
| | | | | | | | 5.0 | | | | | |
| | | | | | | | 6.0 2.0 | | | | | |
| | | | | | | | 7.0 | | | | | |
| | | | | | | | 8.0 | | | | | |
| | | | | | | | 9.0 | | | | | |
| | | | | | | | 10.0 3.0 | | | | | |
| | | | | | | | 11.0 | | | | | |
| | | | | | | | 12.0 | | | | | |
| | | | | | | | 13.0 4.0 | | | | | |
| | | | | | | | 14.0 | | | | | |
| | | | | | | | 15.0 | | | | | |
| | | | | | | | 16.0 5.0 | | | | | |
| | | | | | | | 17.0 | | | | | |
| | | | | | | | 18.0 | | | | | |
| | | | | | | | 19.0 | | | | | |
| | | | | | | | 20.0 6.0 | | | | | |
| | | | | | | | 21.0 | | | | | |
| | | | | | | | 22.0 | | | | | |
| | | | | | | | 23.0 7.0 | | | | | |
| | | | | | | | 24.0 | | | | | |
| | | | | | | | 25.0 | | | | | |
| | | | | | | | 26.0 8.0 | | | | | |
| | | | | | | | 27.0 | | | | | |
| | -5.5 | | | | | | 28.0 | | | | | |
| | 5.5 | End of Borehole | | | | | | | | | | |

Concrete
1" Steel Casing
#3 Silica Sand
Bentonite
2" Slot 10 Screen

Groundwater Level Upon Completion:
Secondary Groundwater Level:

**INITIAL WATER LEVEL:** 2.25 mbgs
**SECONDARY WATER LEVEL:** 2.22 mbgs
**BOREHOLE CAVE UPON COMPLETION:** N/A

**INITIAL WATER LEVEL DATE:** July 30, 2022
**SECONDARY WATER LEVEL DATE:** August 22, 2022

**LOGGED:** DN
**COMPILED:** JM
**CHECKED:** JM

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# RECORD OF BOREHOLE: MW3

**PROJECT NO.:** NT22157
**PROJECT:** Residential Development
**LOCATION:** Barrick Road, Port Colborne
**CLIENT:** Toth Group Development

**DRILLING COMPANY:** Elements Drilling
**DRILLING METHOD:** Track Mount - Rock Coring
**DRILL RIG:** Diedrich D50
**BOREHOLE COORDINATE (UTM):** 641360 E, 4752437 N

**SHEET** 1 of 1
**DATE STARTED:** June 29, 2022
**DATE COMPLETED:** June 29, 2022
**DATUM:** TBM

| SOIL PROFILE | | | SAMPLES | | | | DEPTH SCALE ft / m | FIELD TESTING | | LAB TESTING | WELL INSTALLATION | COMMENTS and ADDITIONAL LAB TESTING |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LITHOLOGY PLOT | ELEVATION (m / mbgs) | DESCRIPTION | TYPE | NUMBER | SPT 'N' VALUE | RECOVERY (%) | | SPT (N) 25 50 75 100 / HAND PENETROMETER (kPa) 100 200 300 400 | COV (ppm / %LEL) | MOISTURE CONTENT (%) 10 20 30 40 | | |
| | 187.08 | Ground Surface | | | | | ft m | | | | | |
| | 0.0 | **Topsoil** 75 mm **TOPSOIL** | | | | | 0.0 0.0 | | | | | |
| | | **Silty Clay** Brown **NATIVE** trace sand and gravel, some organics, Stiff | SS | 1 | 3, 3, 4, 4 | | 1.0 2.0 | 7 | 0 | | | |
| | | | | | | | 3.0 1.0 | >56 | 0 | | | |
| | -1.1 1.1 | **Bedrock** Limestone **BEDROCK** | SS | 2 | 6, 50 for 2" | | 4.0 5.0 6.0 2.0 7.0 8.0 9.0 10.0 3.0 11.0 12.0 13.0 4.0 14.0 15.0 16.0 5.0 17.0 18.0 19.0 | | | | Concrete, 1" Steel Casing, Bentonite, #3 Silica Sand, 2" Slot 10 Screen | |
| | -6.1 6.1 | End of Borehole | | | | | 20.0 6.0 21.0 22.0 23.0 7.0 | | | | | |

Groundwater Level Upon Completion:
Secondary Groundwater Level:

**INITIAL WATER LEVEL:** 2.19 mbgs
**SECONDARY WATER LEVEL:** 2.34 mbgs
**BOREHOLE CAVE UPON COMPLETION:** N/A

**INITIAL WATER LEVEL DATE:** July 30, 2022
**SECONDARY WATER LEVEL DATE:** August 22, 2022

**LOGGED:** DN
**COMPILED:** JM
**CHECKED:** JM

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Thorold, Ontario, L2V 4Y6

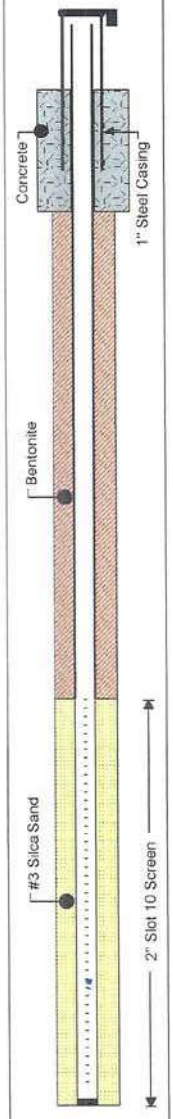
# RECORD OF BOREHOLE: MW4

**PROJECT NO.:** NT22157
**PROJECT:** Residential Development
**LOCATION:** Barrick Road, Port Colborne
**CLIENT:** Toth Group Development

**DRILLING COMPANY:** Elements Drilling
**DRILLING METHOD:** Track Mount - Rock Coring
**DRILL RIG:** Diedrich D50
**BOREHOLE COORDINATE (UTM):** 641205 E, 4752515 N

**SHEET** 1 of 1
**DATE STARTED:** June 29, 2022
**DATE COMPLETED:** June 29, 2022
**DATUM:** TBM

| SOIL PROFILE | | | SAMPLES | | | | | FIELD TESTING | | LAB TESTING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LITHOLOGY PLOT | ELEVATION (m / mbgs) | DESCRIPTION | TYPE | NUMBER | SPT 'N' VALUE | RECOVERY (%) | DEPTH SCALE ft / m | SPT (N) 25 50 75 100 / HAND PENETROMETER (kPa) 100 200 300 400 | COV (ppm / %LEL) | MOISTURE CONTENT (%) 10 20 30 40 | WELL INSTALLATION | COMMENTS and ADDITIONAL LAB TESTING |
| | 187.49 | Ground Surface | | | | | ft m | | | | | |
| | 0.0 | **Topsoil** 100 mm **TOPSOIL** | SS | 1 | 4, 6, 50 for 6" | | 0.0 0.0 | >56 | 0 | | | |
| | -0.5 | **Silty Clay** | | | | | 1.0 | | | | | |
| | 0.5 | Brown **NATIVE** some sand and trace gravel, some organics, Stiff | | | | | 2.0 | | | | | |
| | | **Bedrock** Limestone **BEDROCK** | | | | | 3.0 1.0 | | | | | |
| | | | | | | | 4.0 | | | | | |
| | | | | | | | 5.0 | | | | | |
| | | | | | | | 6.0 2.0 | | | | | |
| | | | | | | | 7.0 | | | | | |
| | | | | | | | 8.0 | | | | | |
| | | | | | | | 9.0 | | | | | |
| | | | | | | | 10.0 3.0 | | | | | |
| | | | | | | | 11.0 | | | | | |
| | | | | | | | 12.0 | | | | | |
| | | | | | | | 13.0 4.0 | | | | | |
| | | | | | | | 14.0 | | | | | |
| | | | | | | | 15.0 | | | | | |
| | | | | | | | 16.0 5.0 | | | | | |
| | | | | | | | 17.0 | | | | | |
| | | | | | | | 18.0 | | | | | |
| | | | | | | | 19.0 | | | | | |
| | | | | | | | 20.0 6.0 | | | | | |
| | | | | | | | 21.0 | | | | | |
| | | | | | | | 22.0 | | | | | |
| | | | | | | | 23.0 7.0 | | | | | |
| | | | | | | | 24.0 | | | | | |
| | | | | | | | 25.0 | | | | | |
| | -7.6 | | | | | | 26.0 | | | | | |
| | 7.6 | End of Borehole | | | | | | | | | | |




Groundwater Level Upon Completion:
Secondary Groundwater Level:

**INITIAL WATER LEVEL:** 4.56 mbgs
**SECONDARY WATER LEVEL:** 4.52 mbgs
**BOREHOLE CAVE UPON COMPLETION:** N/A

**INITIAL WATER LEVEL DATE:** July 30, 2022
**SECONDARY WATER LEVEL DATE:** August 22, 2022

**LOGGED:** DN
**COMPILED:** JM
**CHECKED:** JM

**Niagara Testing & Inspection Ltd.**
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

**Note:** This borehole log has been prepared for Geotechnical purposes and does not necessarily contain information suitable for an Environmentall assessment of the subsurface conditions. Borehole details as presented, do not constitute a through understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer.

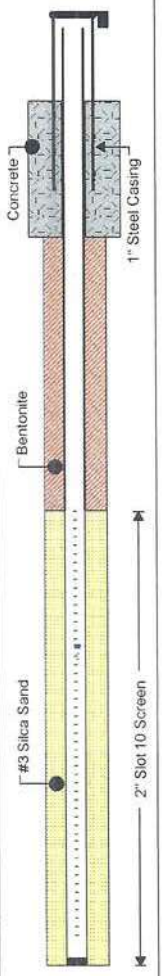
# RECORD OF BOREHOLE: MW5

**PROJECT NO.:** NT22157
**PROJECT:** Residential Development
**LOCATION:** Barrick Road, Port Colborne
**CLIENT:** Toth Group Development

**DRILLING COMPANY:** Elements Drilling
**DRILLING METHOD:** Track Mount - Rock Coring
**DRILL RIG:** Diedrich D50
**BOREHOLE COORDINATE (UTM):** 641219 E, 4752371 N

**SHEET** 1 of 1
**DATE STARTED:** June 29, 2022
**DATE COMPLETED:** June 29, 2022
**DATUM:** TBM

| SOIL PROFILE | | | SAMPLES | | | | | FIELD TESTING | | LAB TESTING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LITHOLOGY PLOT | ELEVATION (m / mbgs) | DESCRIPTION | TYPE | NUMBER | SPT 'N' VALUE | RECOVERY (%) | DEPTH SCALE ft / m | SPT (N) 25 50 75 100 / HAND PENETROMETER (kPa) 100 200 300 400 | COV (ppm / %LEL) | MOISTURE CONTENT (%) 10 20 30 40 | WELL INSTALLATION | COMMENTS and ADDITIONAL LAB TESTING |
| | 186.15 | Ground Surface | | | | | ft m | | | | | |
| | 0.0 | **Topsoil** 100 mm **TOPSOIL** | | | | | 0.0 0.0 | | | | | |
| | | **Silty Clay** Brown **NATIVE** trace sand and gravel, some organics, Stiff | SS | 1 | 4, 5, 10, 10 | | 1.0 | 15 | 0 | | | |
| | -0.6 | | | | | | 2.0 | | | | | |
| | 0.6 | **Bedrock** Limestone **BEDROCK** | | | | | 3.0 1.0 | | | | | |
| | | | | | | | 4.0 | | | | | |
| | | | | | | | 5.0 | | | | | |
| | | | | | | | 6.0 2.0 | | | | | |
| | | | | | | | 7.0 | | | | | |
| | | | | | | | 8.0 | | | | | |
| | | | | | | | 9.0 | | | | | |
| | | | | | | | 10.0 3.0 | | | | | |
| | | | | | | | 11.0 | | | | | |
| | | | | | | | 12.0 | | | | | |
| | | | | | | | 13.0 4.0 | | | | | |
| | | | | | | | 14.0 | | | | | |
| | | | | | | | 15.0 | | | | | |
| | | | | | | | 16.0 5.0 | | | | | |
| | | | | | | | 17.0 | | | | | |
| | | | | | | | 18.0 | | | | | |
| | -5.8 | | | | | | 19.0 6.0 | | | | | |
| | 5.8 | End of Borehole | | | | | 20.0 | | | | | |
| | | | | | | | 21.0 | | | | | |
| | | | | | | | 22.0 | | | | | |
| | | | | | | | 23.0 7.0 | | | | | |




Groundwater Level Upon Completion:
Secondary Groundwater Level:

**INITIAL WATER LEVEL:** 5.68 mbgs
**SECONDARY WATER LEVEL:** 4.70 mbgs
**BOREHOLE CAVE UPON COMPLETION:** N/A

**INITIAL WATER LEVEL DATE:** July 30, 2022
**SECONDARY WATER LEVEL DATE:** August 22, 2022

**LOGGED:** DN
**COMPILED:** JM
**CHECKED:** JM

**Niagara Testing & Inspection Ltd.**
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Thorold, Ontario, L2V 4Y6

# RECORD OF BOREHOLE: BH6

**PROJECT NO.:** NT22157
**PROJECT:** Residential Development
**LOCATION:** Barrick Road, Port Colborne
**CLIENT:** Toth Group Development

**DRILLING COMPANY:** Elements Drilling
**DRILLING METHOD:** Track Mount - Rock Coring
**DRILL RIG:** Diedrich D50
**BOREHOLE COORDINATE (UTM):** 641231 E, 4752443 N

**SHEET** 1 of 1
**DATE STARTED:** June 29, 2022
**DATE COMPLETED:** June 29, 2022
**DATUM:** TBM

| SOIL PROFILE | | | SAMPLES | | | | | FIELD TESTING | | LAB TESTING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LITHOLOGY PLOT | ELEVATION (m / mbgs) | DESCRIPTION | TYPE | NUMBER | SPT 'N' VALUE | RECOVERY (%) | DEPTH SCALE ft / m | SPT (N) 25 50 75 100 / HAND PENETROMETER (kPa) 100 200 300 400 | COV (ppm / %LEL) | MOISTURE CONTENT (%) 10 20 30 40 | WELL INSTALLATION | COMMENTS and ADDITIONAL LAB TESTING |
| | 185.5 | Ground Surface | | | | | ft m 0.0 0.0 | | | | | |
| | 0.0 / -0.1 | **Topsoil** 100 mm **TOPSOIL** | | | | | | | | | | |
| | 0.1 / -0.5 | **Silty Clay** Brown **NATIVE** trace sand and gravel, some organics, stiff | SS | 1 | 4, 5, 6, 50 for 5" | | 1.0 | 11 | 0 | | | |
| | 0.5 / -1.5 | **Bedrock** Limestone **BEDROCK** | | | | | 2.0 | | | | | |
| | 1.5 | End of Borehole | | | | | 3.0 1.0 4.0 5.0 6.0 2.0 7.0 8.0 9.0 3.0 10.0 | | | | | |

Groundwater Level Upon Completion:
Secondary Groundwater Level:

**INITIAL WATER LEVEL:** N/A
**SECONDARY WATER LEVEL:** N/A
**BOREHOLE CAVE UPON COMPLETION:** N/A

**INITIAL WATER LEVEL DATE:** N/A
**SECONDARY WATER LEVEL DATE:** N/A

**LOGGED:** DN
**COMPILED:** JM
**CHECKED:** JM

**Niagara Testing & Inspection Ltd.**
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# RECORD OF BOREHOLE: BH7

**PROJECT NO.:** NT22157
**PROJECT:** Residential Development
**LOCATION:** Barrick Road, Port Colborne
**CLIENT:** Toth Group Development

**DRILLING COMPANY:** Elements Drilling
**DRILLING METHOD:** Track Mount - Rock Coring
**DRILL RIG:** Diedrich D50
**BOREHOLE COORDINATE (UTM):** 641304 E, 4752443 N

**SHEET** 1 of 1
**DATE STARTED:** June 29, 2022
**DATE COMPLETED:** June 29, 2022
**DATUM:** TBM

| SOIL PROFILE | | | SAMPLES | | | | | FIELD TESTING | | LAB TESTING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LITHOLOGY PLOT | ELEVATION (m / mbgs) | DESCRIPTION | TYPE | NUMBER | SPT 'N' VALUE | RECOVERY (%) | DEPTH SCALE ft / m | SPT (N) 25 50 75 100 / HAND PENETROMETER (kPa) 100 200 300 400 | COV (ppm / %LEL) | MOISTURE CONTENT (%) 10 20 30 40 | WELL INSTALLATION | COMMENTS and ADDITIONAL LAB TESTING |
| | 185.97 | Ground Surface | | | | | ft m 0.0 0.0 | | | | | |
| | 0.0 | **Topsoil** | | | | | | | | | | |
| | -0.1 | 100 mm **TOPSOIL** | | | | | | | | | | |
| | 0.1 | **Silty Clay** Brown **NATIVE** trace sand and gavel, some organics, stiff | SS | 1 | 4, 5, 5, 8 | | 1.0 | 10 | 0 | | | |
| | | | SS | 2 | 10, 50 for 5" | | 2.0 | >60 | 0 | | | |
| | -0.9 | | | | | | 3.0 1.0 | | | | | |
| | 0.9 | **Bedrock** Limestone **BEDROCK** | | | | | 4.0 | | | | | |
| | -1.5 | | | | | | 5.0 | | | | | |
| | 1.5 | End of Borehole | | | | | 6.0 2.0 | | | | | |
| | | | | | | | 7.0 | | | | | |
| | | | | | | | 8.0 | | | | | |
| | | | | | | | 9.0 | | | | | |
| | | | | | | | 10.0 3.0 | | | | | |

Groundwater Level Upon Completion:
Secondary Groundwater Level:

**INITIAL WATER LEVEL:** N/A
**SECONDARY WATER LEVEL:** N/A
**BOREHOLE CAVE UPON COMPLETION:** N/A

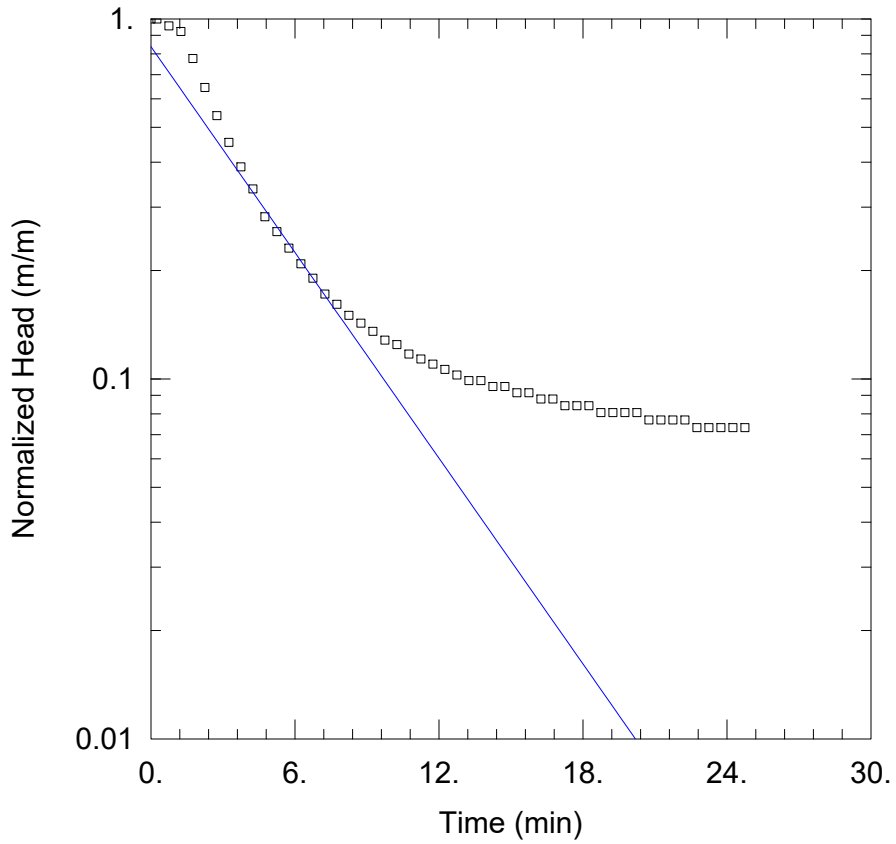
**INITIAL WATER LEVEL DATE:** N/A
**SECONDARY WATER LEVEL DATE:** N/A

**LOGGED:** DN
**COMPILED:** JM
**CHECKED:** JM

**Niagara Testing & Inspection Ltd.**
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

# Appendix F

# Monitoring Well Hydraulic Conductivity Analyses




## BAIL-DOWN RECOVERY

Data Set: C:\...\MW1.aqt
Date: 07/13/23 Time: 16:19:09

## PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Elevate Fourth Developments
Location: Barrick Road, Port Colborne
Test Well: MW1
Test Date: May 3, 2023

## SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.533E-6 m/sec
y0 = 2.285 m

## AQUIFER DATA

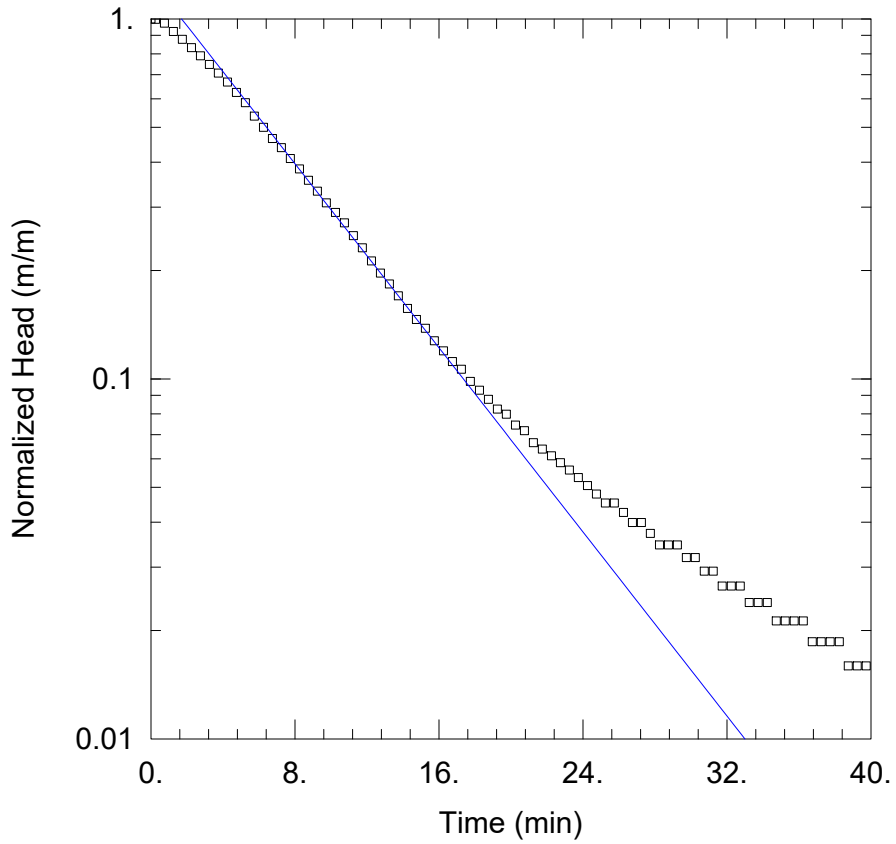
Saturated Thickness: 6.16 m

Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (MW1)

Initial Displacement: 2.73 m
Total Well Penetration Depth: 6.16 m
Casing Radius: 0.0254 m

Static Water Column Height: 6.16 m
Screen Length: 3.05 m
Well Radius: 0.0315 m




## BAIL-DOWN RECOVERY

Data Set: C:\...\MW2.aqt
Date: 07/13/23 Time: 16:16:03

## PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Elevate Fourth Developments
Location: Barrick Road, Port Colborne
Test Well: MW2
Test Date: May 3, 2023

## SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

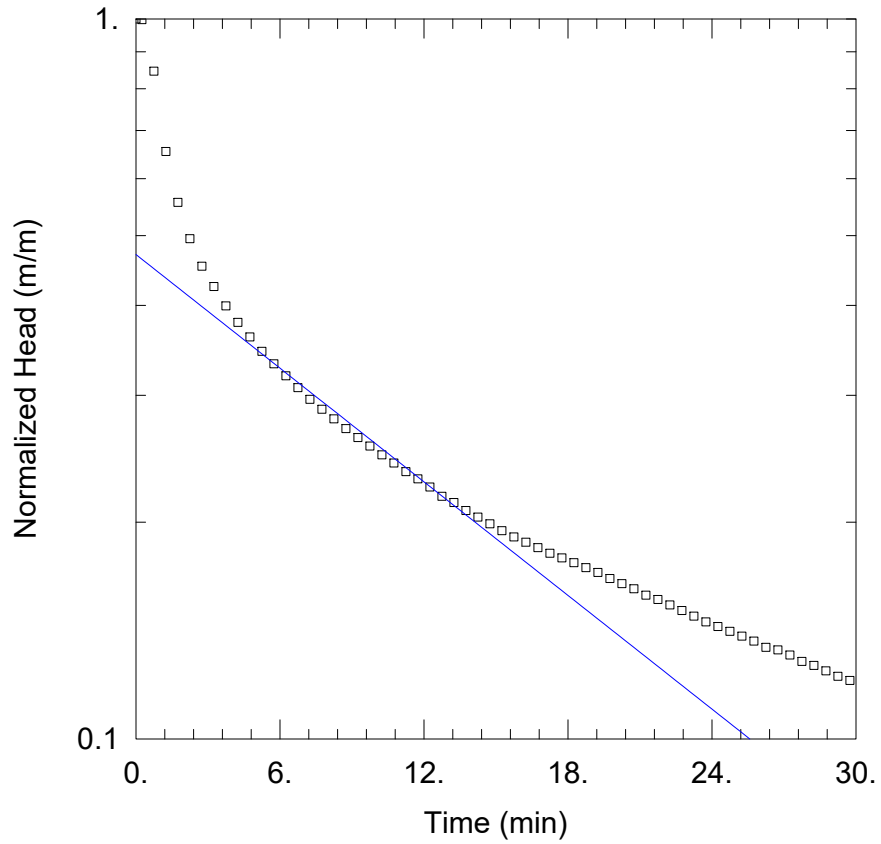
K = 9.62E-7 m/sec
y0 = 4.832 m

## AQUIFER DATA

Saturated Thickness: 4.1 m
Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (MW2)

Initial Displacement: 3.76 m
Total Well Penetration Depth: 4.1 m
Casing Radius: 0.0254 m
Static Water Column Height: 4.1 m
Screen Length: 3.05 m
Well Radius: 0.0315 m




## BAIL-DOWN RECOVERY

Data Set: C:\...\MW3.aqt
Date: 05/19/23 Time: 12:08:17

## PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Elevate Fourth Developments
Location: Barrick Road, Port Colborne
Test Well: MW3
Test Date: May 3, 2023

## SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

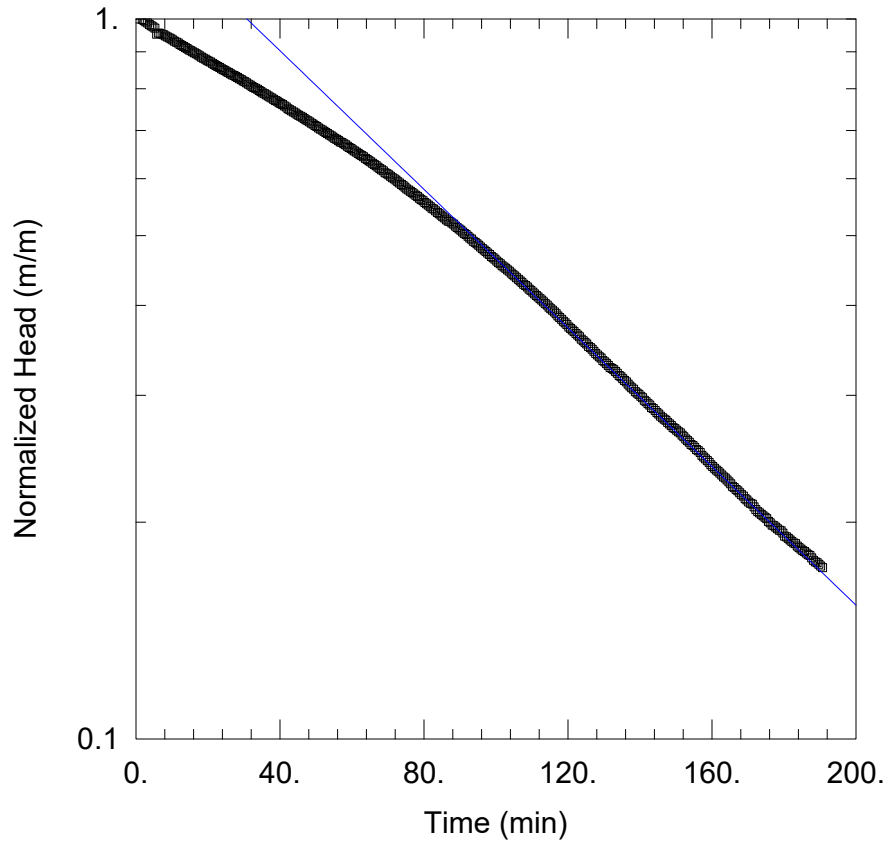
K = 4.1E-7 m/sec
y0 = 0.8708 m

## AQUIFER DATA

Saturated Thickness: 5.04 m
Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (MW3)

Initial Displacement: 1.85 m
Total Well Penetration Depth: 5.04 m
Casing Radius: 0.0254 m
Static Water Column Height: 5.04 m
Screen Length: 3.05 m
Well Radius: 0.0315 m




## BAIL-DOWN RECOVERY

Data Set: C:\...\MW4.aqt
Date: 05/19/23 Time: 12:16:21

## PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Elevate Fourth Developments
Location: Barrick Road, Port Colborne
Test Well: MW4
Test Date: May 3, 2023

## SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

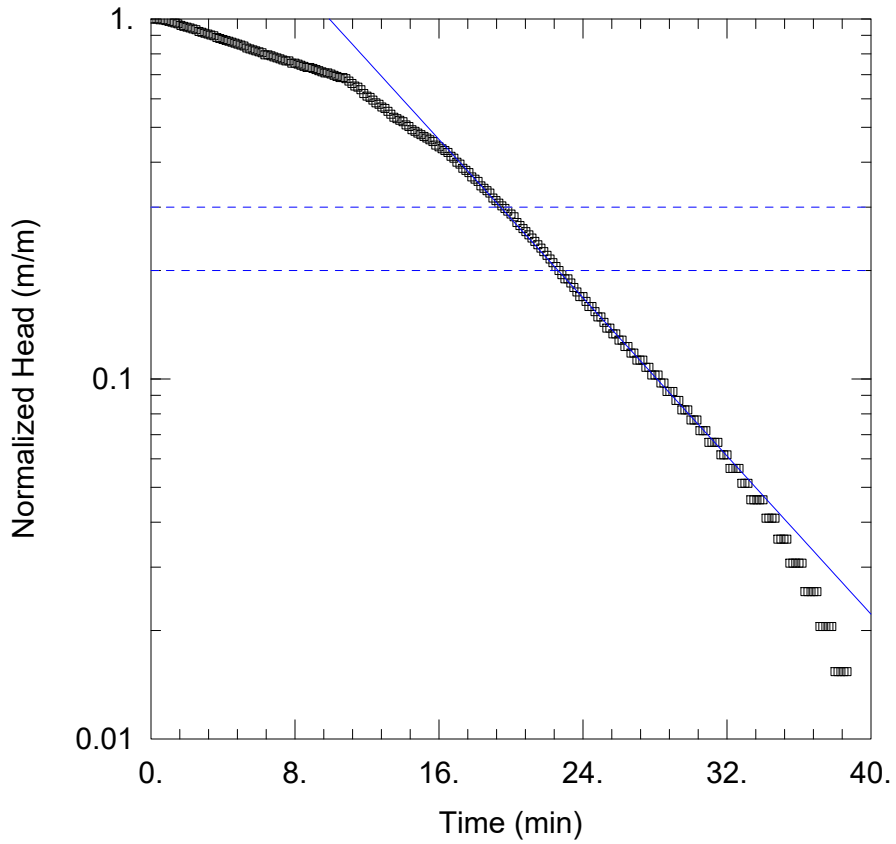
K = 7.028E-8 m/sec
y0 = 3.067 m

## AQUIFER DATA

Saturated Thickness: 2.98 m
Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (MW4)

Initial Displacement: 2.18 m
Total Well Penetration Depth: 3.05 m
Casing Radius: 0.0254 m
Static Water Column Height: 2.98 m
Screen Length: 3.05 m
Well Radius: 0.0315 m




## FALLING HEAD TEST

Data Set: C:\...\MW5.aqt
Date: 02/21/24 Time: 13:16:37

## PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Elevate Fourth Developments
Location: Barrick Road, Port Colborne
Test Well: MW5
Test Date: June 6, 2023

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.041E-6 m/sec
y0 = 6.825 m

## AQUIFER DATA

Saturated Thickness: 2.27 m

Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (MW4)

Initial Displacement: 1.95 m
Total Well Penetration Depth: 3.05 m
Casing Radius: 0.0254 m

Static Water Column Height: 2.27 m
Screen Length: 3.05 m
Well Radius: 0.0315 m

# Appendix G

# Laboratory Water Quality Reports

**SGS Canada Inc.**
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

03-April-2023

**Terra-Dynamics Consulting Inc.**
Attn : David Slaine

**Date Rec. :** 22 March 2023
**LR Report:** **CA15331-MAR23**
**Reference:** Brick Road

**Copy:** #1

432 Niagara Street, Unit 2
St. Catharines, ON
L2M 4W3, Canada

Phone: 905-646-7931
Fax:

# CERTIFICATE OF ANALYSIS
## Final Report

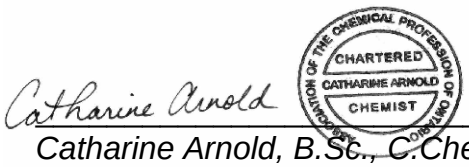
| Analysis | 3: Analysis Completed Date | 4: Analysis Completed Time | 6: SG-3 | 7: SG-2 | 8: SG-1 |
|---|---|---|---|---|---|
| Sample Date & Time | | | 20-Mar-23 17:45 | 20-Mar-23 18:00 | 20-Mar-23 18:15 |
| Temp Upon Receipt [°C] | --- | --- | 11.0 | 11.0 | 11.0 |
| Alkalinity [mg/L as CaCO3] | 24-Mar-23 | 10:43 | 28 | 92 | 70 |
| HCO3 [mg/L as CaCO3] | 24-Mar-23 | 10:43 | 28 | 92 | 70 |
| CO3 [mg/L as CaCO3] | 24-Mar-23 | 10:43 | < 2 | < 2 | < 2 |
| pH [No unit] | 24-Mar-23 | 10:43 | 6.66 | 7.37 | 7.29 |
| TSS [mg/L] | 30-Mar-23 | 13:21 | 11 | 5 | 19 |
| Total P [mg/L] | 24-Mar-23 | 12:37 | 0.04 | 0.11 | 0.08 |
| NH3+NH4 [as N mg/L] | 27-Mar-23 | 10:58 | < 0.1 | < 0.1 | < 0.1 |
| Cl [mg/L] | 28-Mar-23 | 15:21 | 12 | < 1 | 6 |
| SO4 [mg/L] | 28-Mar-23 | 15:21 | 10 | 15 | < 2 |
| NO2 [as N mg/L] | 27-Mar-23 | 13:43 | < 0.03 | < 0.03 | < 0.03 |
| NO3 [as N mg/L] | 27-Mar-23 | 13:43 | 0.20 | < 0.06 | < 0.06 |
| NO2+NO3 [as N mg/L] | 27-Mar-23 | 13:43 | 0.20 | < 0.06 | < 0.06 |
| Temperature @ pH [°C] | 24-Mar-23 | 10:44 | 19.6 | 18.9 | 19.8 |
| Conductivity [uS/cm] | 24-Mar-23 | 10:44 | 84 | 175 | 155 |
| F [mg/L] | 23-Mar-23 | 15:15 | 0.10 | 0.13 | 0.15 |
| Colour [TCU] | 24-Mar-23 | 13:48 | 870 | 57 | 98 |
| TDS [mg/L] | 23-Mar-23 | 16:08 | 214 | 163 | 160 |
| Turbidity [NTU] | 23-Mar-23 | 08:57 | 17 | 8.8 | 22 |
| DOC [mg/L] | 30-Mar-23 | 10:47 | 78.3 | 11.7 | 20.3 |
| H2S [mg/L] | 28-Mar-23 | 11:25 | < 0.02 | < 0.02 | < 0.02 |
| Sulphide [mg/L] | 24-Mar-23 | 14:57 | 0.02 | < 0.02 | < 0.02 |
| Hg (tot) [µg/L] | 27-Mar-23 | 11:32 | < 0.01 | < 0.01 | < 0.01 |
| Hardness [mg/L as CaCO3] | 29-Mar-23 | 11:52 | 61.2 | 102 | 82.1 |
| Ag (tot) [mg/L] | 29-Mar-23 | 11:52 | < 0.00005 | < 0.00005 | < 0.00005 |
| Al (tot) [mg/L] | 29-Mar-23 | 11:52 | 1.40 | 0.420 | 1.12 |
| As (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.0017 | 0.0006 | 0.0009 |
| Ba (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.0167 | 0.0194 | 0.0216 |
| Be (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.000086 | 0.000020 | 0.000056 |

**SGS Canada Inc.**
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

**LR Report :** **CA15331-MAR23**

| Analysis | 3: Analysis Completed Date | 4: Analysis Completed Time | 6: SG-3 | 7: SG-2 | 8: SG-1 |
|---|---|---|---|---|---|
| B (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.015 | 0.016 | 0.017 |
| Cd (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.000088 | 0.000033 | 0.000062 |
| Co (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.00103 | 0.00298 | 0.000782 |
| Cr (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.00187 | 0.00079 | 0.00150 |
| Cu (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.0030 | 0.0017 | 0.0033 |
| Fe (tot) [mg/L] | 29-Mar-23 | 11:52 | 1.93 | 1.11 | 1.45 |
| Mn (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.0532 | 0.120 | 0.0406 |
| Mo (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.00032 | 0.00024 | 0.00059 |
| Ni (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.0072 | 0.0037 | 0.0083 |
| Pb (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.00118 | 0.00059 | 0.00155 |
| Sb (tot) [mg/L] | 29-Mar-23 | 11:52 | < 0.0009 | < 0.0009 | < 0.0009 |
| Se (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.00042 | 0.00024 | 0.00032 |
| Sn (tot) [mg/L] | 29-Mar-23 | 11:52 | < 0.00006 | < 0.00006 | 0.00007 |
| Sr (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.134 | 0.282 | 0.189 |
| Ti (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.0193 | 0.00789 | 0.0192 |
| U (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.000135 | 0.000079 | 0.000218 |
| Zn (tot) [mg/L] | 29-Mar-23 | 11:52 | 0.014 | 0.046 | 0.034 |
| Ca (tot) [mg/L] | 29-Mar-23 | 11:52 | 16.8 | 30.6 | 23.9 |
| Mg (tot) [mg/L] | 29-Mar-23 | 11:52 | 4.65 | 6.25 | 5.45 |
| K (tot) [mg/L] | 29-Mar-23 | 11:52 | 1.02 | 2.61 | 2.87 |
| Na (tot) [mg/L] | 29-Mar-23 | 11:52 | 2.54 | 2.07 | 3.35 |

RL - SGS Reporting Limit




*Catharine Arnold, B.Sc., C.Chem*
*Project Specialist,*
*Environment, Health & Safety*

OnLine LIMS

0003287953

**SGS Canada Inc.**
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

29-May-2023

**Terra-Dynamics Consulting Inc.**
Attn : David Slaine

432 Niagara Street, Unit 2
St. Catharines, ON
L2M 4W3, Canada

Phone: 905-646-7931
Fax:

**Date Rec. :** 11 May 2023
**LR Report:** **CA12591-MAY23**
**Reference:** Barrick Rd SW

**Copy:** #1

# CERTIFICATE OF ANALYSIS
## Final Report

| Analysis | 3: Analysis Completed Date | 4: Analysis Completed Time | 6: SG-1 | 7: SG-2 | 8: SG-3 |
|---|---|---|---|---|---|
| Sample Date & Time | | | 10-May-23 16:10 | 10-May-23 16:20 | 10-May-23 16:30 |
| Temp Upon Receipt [°C] | --- | --- | 14.0 | 14.0 | 14.0 |
| Alkalinity [mg/L as CaCO3] | 15-May-23 | 13:09 | 157 | 189 | 23 |
| HCO3 [mg/L as CaCO3] | 15-May-23 | 13:09 | 157 | 189 | 23 |
| CO3 [mg/L as CaCO3] | 15-May-23 | 13:09 | < 2 | < 2 | < 2 |
| pH [No unit] | 15-May-23 | 13:09 | 8.00 | 7.82 | 6.48 |
| Temperature @ pH [°C] | 15-May-23 | 13:09 | 19.1 | 18.2 | 18.2 |
| TSS [mg/L] | 17-May-23 | 13:57 | 4 | 20 | 12 |
| Conductivity [uS/cm] | 16-May-23 | 09:20 | 248 | 287 | 65 |
| F [mg/L] | 16-May-23 | 09:20 | 0.24 | 0.23 | 0.12 |
| Colour [TCU] | 12-May-23 | 13:29 | 162 | 94 | 1440 |
| TDS [mg/L] | 17-May-23 | 10:20 | 226 | 246 | 260 |
| Turbidity [NTU] | 12-May-23 | 10:27 | 4.1 | 5.0 | 11 |
| Total P [mg/L] | 16-May-23 | 12:44 | 0.18 | 0.22 | 0.08 |
| NH3+NH4 [as N mg/L] | 16-May-23 | 11:18 | < 0.1 | < 0.1 | < 0.1 |
| DOC [mg/L] | 26-May-23 | 11:31 | 28.7 | 24.4 | 206 |

OnLine LIMS

0003346961

**SGS Canada Inc.**
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

**LR Report :** **CA12591-MAY23**

| Analysis | 3: Analysis Completed Date | 4: Analysis Completed Time | 6: SG-1 | 7: SG-2 | 8: SG-3 |
|---|---|---|---|---|---|
| H2S [mg/L] | 18-May-23 | 16:28 | < 0.02 | < 0.02 | 0.02 |
| Sulphide [mg/L] | 15-May-23 | 14:56 | < 0.02 | 0.02 | 0.03 |
| Cl [mg/L] | 18-May-23 | 13:34 | 3 | < 1 | 16 |
| SO4 [mg/L] | 18-May-23 | 13:14 | < 2 | < 2 | 30 |
| NO2 [as N mg/L] | 21-May-23 | 08:12 | < 0.03 | < 0.03 | < 0.3 |
| NO3 [as N mg/L] | 21-May-23 | 08:12 | < 0.06 | < 0.06 | < 0.6 |
| NO2+NO3 [as N mg/L] | 21-May-23 | 08:12 | < 0.06 | < 0.06 | < 0.6 |
| Hg (tot) [mg/L] | 16-May-23 | 15:37 | < 0.00001 | < 0.00001 | 0.00002 |
| Hardness [mg/L as CaCO3] | 17-May-23 | 15:14 | 127 | 159 | 50.8 |
| Ag (tot) [mg/L] | 17-May-23 | 15:14 | < 0.00005 | < 0.00005 | < 0.00005 |
| Al (tot) [mg/L] | 17-May-23 | 15:14 | 0.089 | 0.063 | 0.871 |
| As (tot) [mg/L] | 17-May-23 | 15:14 | 0.0013 | 0.0011 | 0.0022 |
| Ba (tot) [mg/L] | 17-May-23 | 15:14 | 0.0157 | 0.0276 | 0.0136 |
| Be (tot) [mg/L] | 17-May-23 | 15:14 | 0.000022 | 0.000022 | 0.000078 |
| B (tot) [mg/L] | 17-May-23 | 15:14 | 0.054 | 0.039 | 0.025 |
| Bi (tot) [mg/L] | 17-May-23 | 15:14 | 0.00002 | 0.00002 | 0.00003 |
| Cd (tot) [mg/L] | 17-May-23 | 15:14 | 0.000030 | 0.000030 | 0.000080 |
| Co (tot) [mg/L] | 17-May-23 | 15:14 | 0.000940 | 0.000760 | 0.00126 |
| Cr (tot) [mg/L] | 17-May-23 | 15:14 | 0.00047 | 0.00035 | 0.00143 |
| Cu (tot) [mg/L] | 17-May-23 | 15:14 | 0.0012 | 0.0009 | 0.0026 |
| Fe (tot) [mg/L] | 17-May-23 | 15:14 | 2.37 | 2.51 | 2.50 |
| Mn (tot) [mg/L] | 17-May-23 | 15:14 | 0.134 | 0.179 | 0.0721 |
| Mo (tot) [mg/L] | 17-May-23 | 15:14 | 0.00075 | 0.00045 | 0.00043 |
| Ni (tot) [mg/L] | 17-May-23 | 15:14 | 0.0062 | 0.0043 | 0.0069 |
| Pb (tot) [mg/L] | 17-May-23 | 15:14 | 0.00009 | < 0.00009 | 0.00100 |
| Sb (tot) [mg/L] | 17-May-23 | 15:14 | < 0.0009 | < 0.0009 | < 0.0009 |
| Se (tot) [mg/L] | 17-May-23 | 15:14 | 0.00024 | 0.00036 | 0.00023 |
| Sn (tot) [mg/L] | 17-May-23 | 15:14 | 0.00017 | 0.00015 | 0.00025 |
| Sr (tot) [mg/L] | 17-May-23 | 15:14 | 0.290 | 0.445 | 0.109 |

**SGS Canada Inc.**
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

**LR Report :** **CA12591-MAY23**

| Analysis | 3: Analysis Completed Date | 4: Analysis Completed Time | 6: SG-1 | 7: SG-2 | 8: SG-3 |
|---|---|---|---|---|---|
| Ti (tot) [mg/L] | 17-May-23 | 15:14 | 0.00192 | 0.00131 | 0.0146 |
| U (tot) [mg/L] | 17-May-23 | 15:14 | 0.000344 | 0.000178 | 0.000122 |
| Zn (tot) [mg/L] | 17-May-23 | 15:14 | 0.004 | 0.316 | 0.011 |
| Ca (tot) [mg/L] | 17-May-23 | 15:14 | 37.6 | 47.8 | 14.0 |
| Mg (tot) [mg/L] | 17-May-23 | 15:14 | 7.99 | 9.67 | 3.88 |
| K (tot) [mg/L] | 17-May-23 | 15:14 | 2.63 | 4.45 | 0.790 |
| Na (tot) [mg/L] | 17-May-23 | 15:14 | 3.55 | 2.51 | 1.63 |

RL - SGS Reporting Limit

*Alisha Kelly, B.Sc.,*
*Project Specialist,*
*Environment, Health & Safety*

OnLine LIMS

00033469961

**SGS Canada Inc.**
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

26-February-2024

**Terra-Dynamics Consulting Inc.**
Attn : David Slaine

432 Niagara Street, Unit 2
St. Catharines, ON
L2M 4W3, Canada

Phone: 905-646-7931
Fax:

**Date Rec. :** 11 May 2023
**LR Report:** **CA12592-MAY23**
**Reference:** Barrick Rd GW

**Copy:** #2

# CERTIFICATE OF ANALYSIS

## Final Report - Reissue

| Analysis | 3: Analysis Completed Date | 4: Analysis Completed Time | 6: MW-1 | 7: MW-3 | 8: MW-4 |
|---|---|---|---|---|---|
| Sample Date & Time | | | 10-May-23 14:30 | 10-May-23 15:05 | 10-May-23 15:25 |
| Temp Upon Receipt [°C] | --- | --- | 14.0 | 14.0 | 14.0 |
| Alkalinity [mg/L as CaCO3] | 15-May-23 | 13:09 | 365 | 369 | 277 |
| HCO3 [mg/L as CaCO3] | 15-May-23 | 13:09 | 365 | 369 | 277 |
| CO3 [mg/L as CaCO3] | 15-May-23 | 13:09 | < 2 | < 2 | < 2 |
| pH [No unit] | 15-May-23 | 13:09 | 8.04 | 8.02 | 8.12 |
| Temperature @ pH [°C] | 15-May-23 | 13:09 | 19.2 | 19.0 | 18.9 |
| TSS [mg/L] | 17-May-23 | 13:57 | 17 | 13 | 234 |
| TDS [mg/L] | 17-May-23 | 10:21 | 746 | 771 | 374 |
| F [mg/L] | 16-May-23 | 09:20 | 2.31 | 2.32 | 1.66 |
| Turbidity [NTU] | 12-May-23 | 10:27 | 4.0 | 3.7 | 240 |
| Conductivity [uS/cm] | 15-May-23 | 13:09 | 1060 | 1010 | 571 |
| Colour [TCU] | 12-May-23 | 13:30 | < 3 | < 3 | 3 |
| Total P [mg/L] | 15-May-23 | 11:18 | < 0.03 | < 0.03 | 0.05 |
| NH3+NH4 [as N mg/L] | 15-May-23 | 10:49 | < 0.1 | < 0.1 | < 0.1 |
| TKN [as N mg/L] | 15-May-23 | 14:17 | < 0.5 | < 0.5 | < 0.5 |
| H2S [mg/L] | 15-May-23 | 14:57 | < 0.02 | < 0.02 | < 0.02 |
| Sulphide [mg/L] | 15-May-23 | 14:57 | < 0.02 | < 0.02 | < 0.02 |
| DOC [mg/L] | 23-May-23 | 14:18 | 2.4 | 1.6 | 1.8 |
| Tot.Reactive P [mg/L] | 16-May-23 | 08:33 | < 0.03 | < 0.03 | < 0.03 |
| Cl [mg/L] | 18-May-23 | 13:35 | 2 | 4 | 4 |
| SO4 [mg/L] | 18-May-23 | 13:15 | 310 | 270 | 65 |
| Br [mg/L] | 18-May-23 | 13:26 | < 0.3 | < 0.3 | < 0.3 |
| NO2 [as N mg/L] | 18-May-23 | 13:26 | < 0.03 | < 0.03 | < 0.03 |
| NO3 [as N mg/L] | 18-May-23 | 13:26 | 0.43 | < 0.06 | < 0.06 |
| NO2+NO3 [as N mg/L] | 18-May-23 | 13:26 | 0.43 | < 0.06 | < 0.06 |
| Hardness [mg/L as CaCO3] | 18-May-23 | 11:41 | 566 | 548 | 305 |
| Hg (diss) [mg/L] | 16-May-23 | 15:37 | < 0.00001 | < 0.00001 | < 0.00001 |
| Al (diss) [mg/L] | 18-May-23 | 11:42 | 0.006 | 0.003 | 0.010 |
| As (diss) [mg/L] | 18-May-23 | 11:42 | 0.0002 | < 0.0002 | 0.0004 |

**SGS Canada Inc.**
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

**LR Report :** **CA12592-MAY23**

| Analysis | 3: Analysis Completed Date | 4: Analysis Completed Time | 6: MW-1 | 7: MW-3 | 8: MW-4 |
|---|---|---|---|---|---|
| Ba (diss) [mg/L] | 18-May-23 | 11:42 | 0.0198 | 0.00374 | 0.0288 |
| Be (diss) [mg/L] | 18-May-23 | 11:42 | 0.000008 | 0.000014 | < 0.000007 |
| B (diss) [mg/L] | 18-May-23 | 11:42 | 0.013 | 0.013 | 0.056 |
| Bi (diss) [mg/L] | 18-May-23 | 11:42 | < 0.00001 | < 0.00001 | < 0.00001 |
| Ca (diss) [mg/L] | 18-May-23 | 11:42 | 94.9 | 94.6 | 72.6 |
| Cd (diss) [mg/L] | 18-May-23 | 11:42 | 0.000006 | 0.000005 | 0.000003 |
| Co (diss) [mg/L] | 18-May-23 | 11:42 | 0.000130 | 0.000020 | 0.000259 |
| Cr (diss) [mg/L] | 18-May-23 | 11:42 | < 0.00008 | 0.00020 | < 0.00008 |
| Cu (diss) [mg/L] | 18-May-23 | 11:42 | 0.0021 | 0.0006 | 0.0016 |
| Fe (diss) [mg/L] | 18-May-23 | 11:42 | 0.078 | 0.010 | < 0.007 |
| K (diss) [mg/L] | 18-May-23 | 11:42 | 1.43 | 2.45 | 1.42 |
| Mg (diss) [mg/L] | 18-May-23 | 11:42 | 80.0 | 75.9 | 30.1 |
| Mn (diss) [mg/L] | 18-May-23 | 11:42 | 0.00505 | 0.0105 | 0.0459 |
| Mo (diss) [mg/L] | 18-May-23 | 11:42 | 0.00079 | 0.00039 | 0.00144 |
| Na (diss) [mg/L] | 18-May-23 | 11:42 | 19.6 | 12.6 | 4.27 |
| Ni (diss) [mg/L] | 18-May-23 | 11:42 | 0.0012 | 0.0003 | 0.0021 |
| P (diss) [mg/L] | 18-May-23 | 11:42 | 0.006 | 0.005 | 0.007 |
| Pb (diss) [mg/L] | 18-May-23 | 11:42 | < 0.00009 | < 0.00009 | < 0.00009 |
| Sb (diss) [mg/L] | 18-May-23 | 11:42 | < 0.0009 | < 0.0009 | < 0.0009 |
| Se (diss) [mg/L] | 18-May-23 | 11:42 | 0.00018 | < 0.00004 | < 0.00004 |
| Sn (diss) [mg/L] | 18-May-23 | 11:42 | 0.00450 | 0.00342 | 0.00507 |
| Sr (diss) [mg/L] | 18-May-23 | 11:42 | 0.299 | 0.513 | 0.668 |
| Ti (diss) [mg/L] | 18-May-23 | 11:42 | 0.00030 | 0.00018 | 0.00033 |
| U (diss) [mg/L] | 18-May-23 | 11:42 | 0.00761 | 0.00276 | 0.000576 |
| V (diss) [mg/L] | 18-May-23 | 11:42 | 0.00014 | 0.00003 | 0.00027 |
| Zn (diss) [mg/L] | 18-May-23 | 11:42 | < 0.002 | 0.003 | < 0.002 |

Reissued report with corrected sample ID from MW-2 to MW-1

RL - SGS Reporting Limit

*Alisha Kelly, B.Sc.,*
*Project Specialist,*
*Environment, Health & Safety*

OnLine LIMS

0003630092

**SGS Canada Inc.**
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

26-June-2023

**Terra-Dynamics Consulting Inc.**
Attn : David Slaine

432 Niagara Street, Unit 2
St. Catharines, ON
L2M 4W3, Canada

Phone: 905-646-7931
Fax:

**Date Rec. :** 14 June 2023
**LR Report:** **CA13428-JUN23**
**Reference:** Barrick Rd. SW

**Copy:** #1

# CERTIFICATE OF ANALYSIS
## Final Report

| Analysis | 3: Analysis Completed Date | 4: Analysis Completed Time | 6: SW-1 | 7: SW-3 |
|---|---|---|---|---|
| Sample Date & Time | | | 13-Jun-23 10:15 | 13-Jun-23 10:45 |
| Temp Upon Receipt [°C] | --- | --- | 14.0 | 14.0 |
| Alkalinity [mg/L as CaCO3] | 16-Jun-23 | 15:17 | 91 | 27 |
| HCO3 [mg/L as CaCO3] | 16-Jun-23 | 15:17 | 91 | 27 |
| CO3 [mg/L as CaCO3] | 16-Jun-23 | 15:17 | < 2 | < 2 |
| pH [No unit] | 16-Jun-23 | 15:17 | 7.83 | 6.57 |
| Temperature @ pH [°C] | 16-Jun-23 | 15:17 | 20.2 | 22.0 |
| TSS [mg/L] | 19-Jun-23 | 14:48 | 46 | 27 |
| Conductivity [uS/cm] | 16-Jun-23 | 15:17 | 544 | 89 |
| F [mg/L] | 15-Jun-23 | 11:05 | 0.14 | 0.09 |
| Colour [TCU] | 16-Jun-23 | 13:25 | 60 | 35400 |
| TDS [mg/L] | 21-Jun-23 | 14:29 | 366 | 285 |
| Turbidity [NTU] | 15-Jun-23 | 10:30 | 5.1 | 29 |
| NH3+NH4 [as N mg/L] | 16-Jun-23 | 13:51 | 0.4 | 0.4 |
| Cl [mg/L] | 23-Jun-23 | 18:12 | 1 | 15 |
| SO4 [mg/L] | 23-Jun-23 | 18:12 | 190 | 27 |
| NO2 [as N mg/L] | 19-Jun-23 | 15:16 | < 0.03 | < 0.03 |
| NO3 [as N mg/L] | 19-Jun-23 | 15:16 | 0.41 | 0.08 |
| NO2+NO3 [as N mg/L] | 19-Jun-23 | 15:16 | 0.41 | 0.08 |
| Br [mg/L] | 23-Jun-23 | 16:12 | 0.008 | 0.019 |
| Sulphide [mg/L] | 20-Jun-23 | 09:44 | < 0.02 | 0.054 |
| H2S [mg/L] | 20-Jun-23 | 09:44 | < 0.02 | 0.04 |
| DOC [mg/L] | 19-Jun-23 | 08:31 | 20 | 115 |
| Hg (tot) [mg/L] | 20-Jun-23 | 15:18 | < 0.00001 | 0.00002 |
| Hardness [mg/L as CaCO3] | 20-Jun-23 | 15:18 | 272 | 78.5 |
| Ag (tot) [mg/L] | 20-Jun-23 | 15:18 | < 0.00005 | < 0.00005 |
| Al (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.375 | 2.26 |
| As (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.0014 | 0.0033 |
| Ba (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.0624 | 0.0290 |
| Be (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.000032 | 0.000153 |
| B (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.109 | 0.014 |
| Bi (tot) [mg/L] | 20-Jun-23 | 15:18 | < 0.00001 | 0.00003 |
| Cd (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.000079 | 0.000105 |
| Co (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.00130 | 0.00222 |

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**LR Report :** **CA13428-JUN23**

| Analysis | 3: Analysis Completed Date | 4: Analysis Completed Time | 6: SW-1 | 7: SW-3 |
|---|---|---|---|---|
| Cr (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.00076 | 0.00282 |
| Cu (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.0060 | 0.0054 |
| Fe (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.724 | 4.58 |
| Mn (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.327 | 0.138 |
| Mo (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.00277 | 0.00134 |
| Ni (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.0063 | 0.0114 |
| Pb (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.00062 | 0.00220 |
| P (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.083 | 0.124 |
| Sb (tot) [mg/L] | 20-Jun-23 | 15:18 | < 0.0009 | < 0.0009 |
| Se (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.00030 | 0.00056 |
| Sn (tot) [mg/L] | 20-Jun-23 | 15:18 | < 0.00006 | 0.00010 |
| Sr (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.662 | 0.203 |
| Ti (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.00888 | 0.0350 |
| U (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.000436 | 0.000212 |
| Zn (tot) [mg/L] | 20-Jun-23 | 15:18 | 0.016 | 0.040 |
| Ca (tot) [mg/L] | 20-Jun-23 | 15:18 | 85.0 | 22.8 |
| Mg (tot) [mg/L] | 20-Jun-23 | 15:18 | 14.5 | 5.23 |
| K (tot) [mg/L] | 20-Jun-23 | 15:18 | 4.53 | 1.12 |
| Na (tot) [mg/L] | 20-Jun-23 | 15:18 | 3.89 | 1.40 |

RL - SGS Reporting Limit

*Alisha Kelly, B.Sc.,*
*Project Specialist,*
*Environment, Health & Safety*

OnLine LIMS

0003379415

# Appendix H

# Water Well Survey

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

April, 2023

Dear Resident:

On behalf of Elevate Living Inc., Terra-Dynamics Consulting Inc. is completing a water well survey. This is a survey of Barrick Road properties east of the intersection with Minor Road as shown on the attached map. Elevate Living Inc. is seeking to map nearby private wells as part of a subwatershed study of the Barrick Road area. This well and septic system survey is a common recommended component of hydrogeologic, or groundwater, studies which informs an understanding of the physical setting and groundwater uses. This is a standard questionnaire for properties on private services.

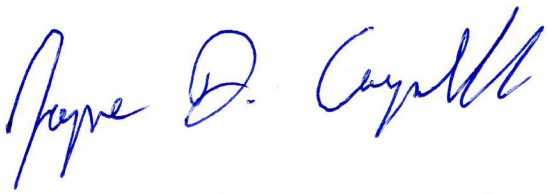
The purpose of this survey is to collect information on private or residential water wells, cisterns and septic systems along Barrick Road (as shown by the outlined addresses on the attached map). **Participation is voluntary.** Participation involves completing the attached questionnaire on municipal, well and/or cistern use, groundwater quantity, quality and your septic system. Please complete it as best as you can. Please fill out the questionnaire and mail it back to Terra-Dynamics Consulting Inc. in the self-addressed and stamped envelope. The information you provide will be summarized in our report and personal information (e.g. name, address, etc.) will be kept confidential and will not be included in our report.

If you have any questions about the questionnaire, please contact Jayme Campbell at 289-407-0915 or via email at jcampbell@terra-dynamics.com.

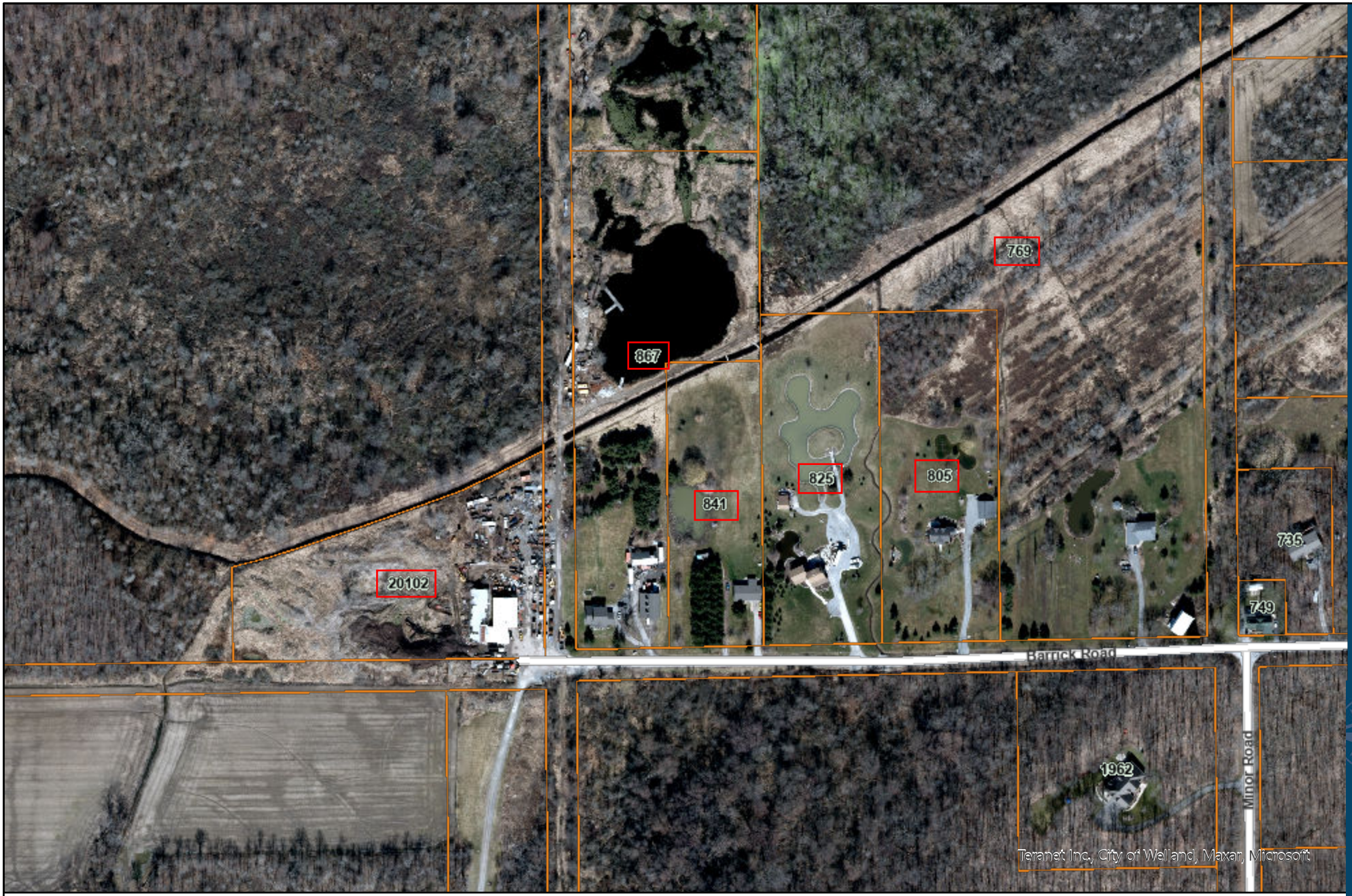
Thank you in advance for your assistance.

Yours truly,

TERRA-DYNAMICS CONSULTING INC.



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




Legend

Address Points

0 0.04 0.07 0.15 0.22 0.3 km

Date: 2023-04-05 Time: 2:57 PM



Niagara Navigator

NAVIGATOR

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

# WATER WELL SURVEY FORM

Date:_____

Contact Person:_____

Property Address:_____

Telephone: _____

Email (if further information requested): _____

## 1.0 GENERAL QUESTIONS

Do you know your drinking water source? Please circle one or more of the following three options:

1.Well (20+ feet casing) 2.Shallow Well (less than 20 feet of casing)
3.Cistern 4. Municipal

Further comments:

_____

_____

Use page 3 or a separate sheet of paper for additional comments.

If your water supply is from a cistern, the rest of the questions do not apply. If you have both a cistern and a well, please complete the well questionnaire (Section 2.0 or 3.0). Please let us know where your place is located either on the supplied map or the area for a sketch on the second last page of this form. Please mail the completed form back to Terra-Dynamics in the provided envelope. Thank you for your assistance.

- If you have a drilled deep well (20+ feet of casing) please complete Sections 2 & 4
- If you have a shallow well (less than 20 feet of casing), please complete Sections 3&4

## 2.0 DRILLED WELL (greater than 20 feet of casing)

How deep is your well?_____

Is your well drilled into rock?_____What is the well casing diameter?_____

Do you know when your well was drilled?_____

Do you know the name of the well driller?_____



905-646-7931 Fax: 905-935-0397 www.terra-dynamics.com

Do you have a well log? (i.e. a description of the geology encountered when drilling your well and if yes, can you supply a copy or write down the information in the Comments Section).

_____

What is the use of your well water? (i.e. drinking water for house, garden irrigation, etc.)
_____

Has your well ever run dry? _____

Do you experience problems with taste, colour or odour? (if yes, please explain).

_____

Do you have any water purification systems for your well water? (i.e. water softeners, UV Light for bacteria, Sulphur/Iron Filter for odour or staining, etc.).

_____

Do you perform regular maintenance on your well? (i.e. pump service, silt removal, etc.)

_____

**3.0 SHALLOW WELL (less than 20 feet of casing)**

What is the well casing material and diameter? _____

What is the expected age of the well? _____

How deep is the well? _____

Does you utilize a jet pump or a submersible pump?_____

Is there problems with water quality (colour, odour, etc.)? Yes_____ No_____

If yes, please explain_____

Do you have any water purification systems for your dug well water? (i.e. water softeners, UV Light for bacteria, Sulphur/Iron Filter for odour or staining, etc.).

_____

Have you ever experienced freeze-up during the winter?_____

What is the use of your shallow dug well water? (i.e. drinking water for house, irrigation, etc.)
_____

Has your dug well ever run dry?

_____

Do you perform regular maintenance on your pump? (i.e. pump service, silt removal)

_____

Additional comments:_____

_____

**4.0 LOCATION MAP**

Can you please draw a sketch map of the location of your well(s), septic tank and sewage bed on your property (please show the location relative to buildings and roads).

_____

**SKETCH MAP OF WELL(S) and SEWAGE SYSTEM LOCATIONS**

Other Comments: (Use a separate sheet, if required)

Please mail the completed form back to Terra-Dynamics in the provided envelope.
Thank you for your help.

Jayme D. Campbell, P. Eng., Senior Water Resource Engineer
432 Niagara Street, Unit 2, St. Catharines, ON L2M 4W3
905-906-2311