BURNSIDE

Centre Wellington Operations Centre Hydrogeological Assessment
965 Gartshore Street
Fergus, Ontario

Township of Centre Wellington
Fergus, Ontario

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1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) has been retained by the Township of Centre Wellington (Township) to complete a hydrogeological assessment for the proposed new Operations Centre to be located at 965 Gartshore Street in Fergus (herein referred to as the subject lands). The hydrogeological assessment is being completed as part of background studies to support the design and construction of the new facility. The subject lands are located west of Gartshore Street between the intersections with Sideroad 10 and Glengarry Crescent. The location of the subject lands is illustrated in Figure 1 and Figure 2.

1.1 Scope of Work

The scope of the hydrogeological assessment involved a review of available regional information as well as the completion of site-specific investigations as described below:

1. Review of published geological and hydrogeological information: A review of background material for the area, including topography, surficial geology and bedrock geology mapping and existing geotechnical and hydrogeological reports and source protection mapping was completed to assess the regional hydrogeological setting.

2. Review of the Ministry of the Environment, Conservation and Parks (MECP) water well records: The MECP maintains a database that provides geological records of water supply wells drilled in the province. A list of the available MECP water well records for local wells is provided in Appendix A and the well locations are plotted on Figure 11. It is noted that the well locations listed in the MECP records are approximations only and may not be representative of the precise well locations in the field. These well data were compiled and mapped to characterize the local groundwater resources and assess potential impacts to the local private wells from development of the subject lands.

3. Install groundwater monitoring network: Groundwater monitoring locations were established to characterize seasonal variations in the water table in both the shallow and deep aquifers. A total of nine boreholes were drilled at seven locations and all were completed as monitoring wells (5 cm diameter) to determine the local stratigraphy and site-specific soil and groundwater conditions of the subject lands. Two monitoring well nests (two wells of different depths at the same location) were installed to assess vertical gradients. The locations of the monitoring wells are shown on Figure 2 and monitoring well construction details are provided on the borehole logs in Appendix B.

4. Hydraulic conductivity testing: Burnside conducted single well response tests in order to determine hydraulic conductivity. Single well response tests were conducted at three groundwater monitoring wells (BH2, BH3, and BH7s). The hydraulic conductivity field testing results are provided in Appendix C.

5. Infiltration Testing: Sites for infiltration testing will be determined based on need and discussions with the stormwater management design engineering team. At the time of writing the testing has not been completed yet.

6. Monitoring of groundwater levels: Monitoring was completed in monitoring wells to measure the depth to the water table and assess the horizontal and vertical groundwater flow conditions. Groundwater level monitoring was completed monthly from December 2022 through May 2023. Automatic water level recorders (dataloggers) were installed in two monitoring wells and one nest (total of four wells) to document the range of groundwater fluctuations and the response of aquifers to precipitation events (BH1s/d, BH2, BH5). A barometric pressure logger was also installed on the subject lands to be used for the calibration of the datalogger results. The groundwater monitoring data and hydrographs are provided in Appendix D.

7. Water quality sampling: Water quality data was collected from two monitoring wells (BH2 and BH5) to typify the water quality in the vicinity of the subject lands. The water samples were submitted to a qualified laboratory for analyses of general water quality indicators (e.g., pH, hardness, and conductivity), basic ions (including chloride and nitrate) and selected metals to characterize the background water quality at the property. The laboratory water quality data are provided in Appendix E.

8. Water balance calculations: Pre and post-development water balance calculations have been completed to assess the groundwater infiltration volumes across the study area. The local climate data and detailed water balance calculations are provided in Appendix F.

9. Data compilation, assessment of site conditions and reporting.

2.0 Physical Setting

2.1 Topography and Drainage

The subject lands are located in the physiographic region known as the Guelph Drumlin Field which is characterized by drumlins or groups of drumlins, edged with gravel terraces and swampy valleys (Chapman & Putnam, 1984). The Ontario Geological Survey online database (OGS Earth) indicates that the site features a combination of drumlinized till plains and spillways. The topographic high on the subject lands is approximately 430 metres above sea level (masl) which occurs on the east-southeast corner of the property (Figure 3). The land slopes gently to the northwest and southwest and the lowest elevations on the subject lands are found in the northwest corner at 423 masl. The available mapping does not show any wetlands or watercourses on the subject lands however there is a Provincially Significant Wetland (PSW) located approximately 40 m north of the subject lands.

The northern edge of the subject lands is located within the GRCA regulation limit due to the PSW in this area and the site is in the in the Irvine Creek subwatershed within the jurisdiction of the Grand River Conservation Authority (GRCA). Regionally, drainage is expected to be northward towards Irvine Creek which then flows southwest to join the Grand River in Elora.

2.2 Geology

Surficial geology mapping published by the Ontario Geological Survey (2010) shows that the subject lands are underlain by glaciofluvial (sandy) deposits at the north and south ends with a band of stone-poor, carbonate-derived silty to sandy till across the centre and northern portions (Figure 4). Organic deposits are mapped just north of the subject lands in the region of the PSW. The bedrock underlying the subject lands consists of dolostone from the Guelph Formation (Figure 5).

2.3 Stratigraphy

A total of nine boreholes were drilled at seven locations and completed as monitoring wells in October 2022 to determine the local stratigraphy and site-specific soil and groundwater conditions of the subject lands (logs provided in Appendix B and locations shown on Figure 5). The boreholes indicated that the overburden stratigraphy is generally composed of layers of silty sand with pockets of sandy silt till overlying a more homogenous sandy silt till. The borehole logs generally agree with the published mapping, with the near surface materials consisting sandy sediments as expected in the north and south and sandy silt till in the central portions.

To illustrate the shallow stratigraphy of the subject lands, schematic geologic cross-sections have been prepared (Figures 7 and 8) using the MECP well records (Appendix A) and the soils information collected during drilling of boreholes and monitoring wells (Appendix B). The locations of the cross-sections are illustrated on Figure 6 along with the locations of water wells and boreholes used in the construction of the cross-sections. The cross-sections illustrate that the subject lands are underlain by overburden that is 25 to 30 m thick overlying limestone bedrock (Figures 7 and 8). Bedrock is interpreted to be found at elevations of approximately 397 masl (Figures 7 and 8).

3.0 Hydrogeology

3.1 Hydraulic Conductivity

The ability of soil to transmit groundwater is measured as its hydraulic conductivity. Hydraulic conductivity is low in poorly transmissive sediments (aquitards) and higher in more transmissive sediments (aquifers). The determination of hydraulic conductivity rates assists with the determinations of groundwater flow directions and relationships between various layers in the subsurface. There are various methods that can be used to assess soil hydraulic conductivity depending on the available instrumentation. Grainsize data and soil characteristics collected during a geotechnical investigation can be used to provide a general estimate of hydraulic conductivity. In situ bail-down or slug-testing methods are used in groundwater monitoring wells to assess site-specific hydraulic conductivity. Both methods have been used to estimate the hydraulic conductivity of the soils encountered in the boreholes completed on the subject lands as discussed below.

3.1.1 Grainsize Analysis

Representative soil samples were collected by the geotechnical consultant during drilling of boreholes and four samples were submitted for grainsize analysis.

To estimate hydraulic conductivity based on grainsize analysis, an empirical formula method known as the Hazen estimation is used. This method approximates hydraulic conductivity based on grainsize curves for sandy soils. The approximation does not strictly apply to finer grained materials; however, it is still considered useful to provide a general indication of the range of the hydraulic conductivity values. Grainsize distribution data were available for seven samples obtained from on-site wells and these data were used to obtain hydraulic conductivity values empirically using the Hazen method. The grainsize distribution graphs are provided in Appendix C-1 and the estimated hydraulic conductivity values are provided in Table 1.

Table 1: Estimated Hydraulic Conductivity Based on Grainsize Analyses

Sample ID	Depth of Sample (mbgs*)	Soil Description	% Fines	Estimated Hydraulic Conductivity (cm/s)
BH1-SS6	3.3 – 4.4	Sand, some Silt	15	2.0×10^{-3}
BH1-SS12	12.2 – 12.8	Sandy Silt	62	1.2×10^{-5}
BH7-SS7	4.6 – 5.2	Silty Sand	28	2.3×10^{-4}
BH7-SS15	16.8 –17.4	Silty Sand	28	1.4×10^{-4}

*metres below ground surface

Grainsize analyses results indicate that the sediments within the overburden range in composition from sand with some silt (15% fines) to sandy silt (62% fines). A greater amount of fines within a deposit impacts the ability of the material to transmit water and generally lowers the overall hydraulic conductivity. Groundwater flow is generally limited by fine grained sediments with lower hydraulic conductivity. Grainsize analyses completed indicate that the sediments generally consist of varying amounts of sand, silt and gravel with trace clay. The hydraulic conductivities based on grainsize analyses for the sediments is estimated in the range of 10^{-3} to 10^{-5} cm/sec.

3.1.2 Single Well Response Tests

To assess the in situ hydraulic conductivity of the sediments, single well response tests (bail-down tests and slug tests) were conducted at three monitoring wells. The results from the tests were plotted (Appendix C-2) and analyzed to calculate hydraulic conductivity of the sediments screened. A summary of the calculated hydraulic conductivities is provided below in Table 2.

Table 2: Single Well Response Testing Results

Monitoring Well	Screen Interval (mbgs)*	Formation Screened	Hydraulic Conductivity (cm/sec)
BH2	3.1 – 4.6	Silty Sand	4.0×10^{-3}
BH3	3.2 – 4.7	Silty Sand	3.5×10^{-3}
BH5	3.2 – 4.7	Silty Sand	4.0×10^{-4}
BH7s	3.3 – 4.8	Silty Sand	4.0×10^{-3}

*metres below ground surface

Single well response tests in wells screened in the silty sand indicate moderate hydraulic conductivities in the order of 10^{-3} to 10^{-4} cm/sec.

3.2 Local Groundwater Use

The community of Fergus is supplied with municipal groundwater however there are still some private water supply wells that are used in unserviced areas. A review of the MECP well records for an area of approximately 500 m surrounding the subject lands identified 19 well records. Of the 19, 6 were for water supply (domestic commercial, stock and industrial) wells and 9 records were for monitoring wells. The records for 4 wells did not indicate the purpose or use of the well. All but one of the water supply wells are completed in the bedrock at depths ranging from 35 m to 70 m. Summaries of the MECP well records are provided in Appendix A and the plotted locations have been included on Figure 11.

A municipal supply well (Fergus supply well F6) is located immediately north of the subject lands, within 15 m from the property boundary. The well record reports the estimated capacity as 1,363 L/min (300 gpm). The subject lands are located within the wellhead protection area for well F6 and are therefore subject to various source protection policies which are discussed in Sections 5.1 and 5.2.

3.3 Groundwater Level Monitoring Results

Water levels in nine monitoring wells were recorded monthly from December 2022 through May 2023 using a water level meter. Dataloggers (automatic water level recorders) were installed at BH1s/d, BH2 and BH5 to provide continuous data (hourly readings) of water levels during the monitoring period. A barometric pressure logger was also installed to measure changes in barometric pressure. These data are used to correct the water level data by accounting for changes in atmospheric pressure.

The groundwater monitoring data show the following (refer to Figure 6 for the monitoring locations and the data tables and hydrographs in Appendix D):

- Groundwater elevations across the subject lands ranged from 422.1 masl to 425.2 masl in the shallow overburden sediments over the monitoring period (December 2022 to May 2023). Groundwater elevations in the deep overburden were in the range of 413.5 to 421.8 masl. The depth to water table ranges from ground surface to 4 m below ground in the shallow overburden and was up to 12 m below ground in the deep overburden.

- Typically, shallow wells in southern Ontario show a seasonal pattern in groundwater levels with highest levels occurring in the spring, declining throughout the summer and early fall and then rising again in the late fall/early winter. Over the monitoring period (December 2022 to May 2023), groundwater levels fluctuated by up to about 2 m, with the highest groundwater levels observed during the spring freshet (March to April 2023), which is consistent with typical seasonal patterns in the area.

- Hourly automatic water level readings (datalogger readings) collected at monitoring wells BH1s/d, BH2 and BH5 are plotted against precipitation (data from Fergus Shand Dam climate station) to determine if there is a correlation between changes in water level and the occurrence of precipitation events (Appendix D). The groundwater level data show a response to individual precipitation events at BH1s/d and at BH2, with shallow groundwater levels increasing by up to 1 m following significant precipitation events in January and February 2023. The response at BH5 is considerably muted but a response to precipitation in January has been noted.

- Nested monitoring wells BH1s/d and BH7s/d were installed to determine vertical hydraulic gradients and evaluate the recharge or discharge conditions on the subject lands. There was clear downward (potential for recharge) gradient observed at monitoring well nest BH1s/d with water levels in the deep well staying consistently just over 1 m lower than the levels in the shallow well (Appendix D). Water levels at

BH7s/d also showed a consistent downward (recharge) gradient indicating groundwater movement from the overburden towards the bedrock.

- Monitoring well BH7d is completed close to the overburden/bedrock interface (bottom of well at 400.2 masl; bedrock interface interpreted at approximately 397 masl) and could potentially be impacted by water level changes in the bedrock if both systems are hydraulically connected. Drawdown in the deep overburden could potentially be increased if the municipal well F6 is pumping and causing a response in the overburden. BH1d is completed in the deep overburden (bottom of well 409.3 masl) and this well is fitted with a datalogger. The data reviewed over the monitoring period have not indicated a response in the deep overburden to the pumping of the municipal supply well.

- The water well record for F6 (the municipal well) indicates that water was found at around 39 m below ground and after completion of the well the static water level had risen to a potentiometric level of 17.5 m below ground surface. The static (potentiometric) levels indicated by the bedrock aquifer are not anticipated to be encountered if the productive zone in the bedrock (at 39 m) is not encountered. Additionally, the data gathered over the monitoring period have not indicated a connection between the bedrock and overburden aquifers.

3.4 Interpreted Groundwater Flow

Groundwater elevation data (May 2023) obtained from the monitoring wells are shown on Figure 9, along with the interpreted groundwater elevation contours for the area. The groundwater movement in the shallow overburden on the subject lands is interpreted to follow the elevation contours and flow in a generally north to northwest direction. Arrows perpendicular to the groundwater contours are used to illustrate the groundwater flow directions.

Groundwater flow in the deep overburden and in the bedrock have not been assessed as part of this study as the development is not expected to extend to these aquifers. The data evaluated so far have indicated that there is no response in the overburden to pumping at the municipal well F6.

3.5 Recharge and Discharge Conditions

Areas where water from precipitation infiltrates into the ground and moves downward (i.e., areas of downward hydraulic gradients) are known as recharge areas. These areas are generally in areas of relatively higher topographic elevation. Areas where groundwater moves upward (i.e., areas of upward hydraulic gradients) are discharge areas and these generally occur in areas of relatively lower topographic elevation, such as along watercourses. Recharge and discharge may occur in local, intermediate and more regional flow systems. Infiltrating water at any given location may follow a shallow flow path and discharge a short distance away from the recharge area along the nearest slopes or in small watercourses, swales, agricultural ditches, wetlands, etc. This is referred to as a local groundwater flow system (i.e., flows that closely follow the existing topography with relatively short flow distances, e.g., up to a few hundred metres).

The soils on the subject lands (sandy silt till and silty sand) are expected to provide conditions conducive to groundwater recharge; however, high water table conditions in some areas due to the presence of fine-grained sediments may impede recharge from occurring. Finer grained sediments occurring in the area may restrict groundwater recharge or cause groundwater to perch above the regional aquifer systems and potentially provide support for wetlands in these areas.

Water level measurements obtained from monitoring wells on the subject lands indicate a downward gradient is present between the shallow and deep overburden. These data are interpreted to indicate that after infiltrating at surface groundwater percolates down through the shallow system to the lower overburden and bedrock aquifers (recharge).

4.0 Water Quality

To establish background water quality on the subject lands groundwater samples were collected on December 1, 2022. Water samples were collected from two groundwater wells (BH2 and BH5). The samples were sent to Bureau Veritas Laboratories for analysis of general water quality indicator parameters and basic ions (e.g., pH, alkalinity, hardness, conductivity, chloride, nitrate, etc.) and selected metals.

4.1 Groundwater Quality

The analytical results from the laboratory are provided in Appendix E and are discussed below. The data reviewed showed the following:

- Groundwater exceeded the Ontario Drinking Water Quality Standards (ODWQS) operational guideline for total hardness (80 to 100 mg/L) with values of 330 and 370 mg/L. Hardness in groundwater is caused by dissolved calcium and magnesium and is typically a result of the geologic material of the aquifer. Further analysis of the concentration of calcium and magnesium indicate that these parameters are elevated and indicate a carbonate environment within the groundwater.

- Groundwater exceeded the ODWQS aesthetic objective for manganese (0.05 mg/L) and the Canadian Drinking Water Quality Guideline maximum acceptable concentration (0.12 mg/L) with a concentration of 0.28 mg/L at BH5.

- Groundwater concentrations of 12 and 17 mg/L were reported for sodium and chloride was reported at 36 and 47 mg/L.

- Groundwater results for nitrate are interpreted to represent impacts from fertilizer application with concentrations of 4.8 and 1.1 mg/L at BH2 and BH5, respectively.

- The water on site displayed good water quality indicators with potential for impacts due to anthropogenic activities. It is noted that no domestic or potable use of the shallow groundwater is proposed and hence no potential quality impacts are predicted. It is noted that the site is in a source protection regulated area and hence water quality as related to drinking water threats will be regulated.

5.0 Source Water Protection

The subject lands are located within the Grand River Source Protection Area for which policies in the Grand River Source Protection Plan (SPP) apply. A review of the Source Protection Atlas indicates that the subject lands are located within the Wellhead Protection Area (WHPA) for Fergus municipal supply well F6. The subject lands are located within the 100 m separation zone (WHPA-A) and the 2-year time of travel (WHPA-B). The location of the subject lands in relation to the WHPAs is shown on Figure 10. The subject lands are also known to be located within a local area for water quantity protection WHPA-Q.

5.1 Aquifer Vulnerability

Aquifer vulnerability refers to the susceptibility of the aquifer to potential contamination. Some degree of protection for aquifers is offered by the nature of the soil above the water table. The degree of protection is dependent on the depth to water table or the depth to the aquifer and the type of soil above the water table or aquifer. Generally greater depths provide better protection and finer deposits (clays and silts) provide better protection than sands and gravels. Figure 10 indicates that the subject lands are mapped with an intrinsic vulnerability of 10 within WHPA-A and 8 within WHPA-B. There are no highly vulnerable aquifers (HVA) mapped in the area of the subject lands. Vulnerability scores of 10 and 8 are however the highest scores applicable to vulnerable areas and this rating suggest that the municipal aquifer in the area is vulnerable to contamination.

5.2 Threat Evaluation

Since the subject lands are located within the wellhead protection areas for the community of Fergus (Figure 10) the proposed development will be subject to policies under the Grand River Source Protection Policy if activities include any of the prescribed drinking water threats (Clean Water Act, 2006) that would be a significant drinking water threat. Potential drinking water threats that may occur on the subject lands include:

- The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage;

- The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act;
- The application of road salt;
- The handling and storage of road salt;
- The storage of snow;
- The handling and storage of fuel;
- The handling and storage of a dense non-aqueous phase liquid;
- The handling and storage of an organic solvent;
- An activity that reduces the recharge of an aquifer;
- Establishment and operation of a liquid hydrocarbon pipeline.

Due to the potential for these threats to arise on the subject lands, a Threats Disclosure report may be required.

6.0 Water Balance

A water balance assessment is required in order to assess potential land development impacts on the local groundwater conditions. The water balance will be completed for this study to determine the pre-development recharge volumes (based on existing land use conditions) and the post-development recharge volumes that would be expected based on the proposed land use plan. The detailed water balance calculations will be provided in Appendix F.

6.1 Water Balance Components

A water balance is an accounting of the water resources within a given area. As a concept, the water balance is relatively simple and may be estimated from the following equation:

$$P = S + ET + R + I$$

Where:	P	=	precipitation
	S	=	change in groundwater storage
	ET	=	evapotranspiration/evaporation
	R	=	surface water runoff
	I	=	infiltration

The components of the water balance vary in space and time and depend on climatic conditions as well as the soil and land cover conditions (i.e., rainfall intensity, land slope, soil hydraulic conductivity and vegetation). Runoff, for example, occurs particularly during periods of snowmelt when the ground is frozen, or during intense rainfall events. Precise measurement of the water balance components is difficult and as such, approximations and simplifications are made to characterize the water balance of a property. Field observations of the drainage conditions, land cover and soil types, groundwater levels and local climatic records are important input considerations for the water balance calculations.

The groundwater balance components for the subject lands are discussed below:

Precipitation (P)

The long-term average annual precipitation for the area of the subject lands is 946 mm based on data from the Environment Canada Fergus Shand Dam (Station 6142400, 43°44'05.088" N, 80°19'49.098" W, elevation 417.6 masl) for the period between 1981 and 2010. The climate station is located approximately 4 km east of the subject lands. Average monthly records of precipitation and temperature from this station have been used for the water balance calculations in this study (Appendix F).

Storage (S)

Although there are groundwater storage gains and losses on a short-term basis, the net change in groundwater storage on a long-term basis is assumed to be zero so this term is dropped from the equation and not considered for the calculations.

Evapotranspiration (ET)

Evapotranspiration and evaporation components vary based on the characteristics of the land surface cover (i.e., type of vegetation, soil moisture conditions, perviousness of surfaces, etc.). Potential evapotranspiration (PET) refers to the water loss from a vegetated surface to the atmosphere under conditions of an unlimited water supply. The actual rate of evapotranspiration (AET) is generally less than the PET under dry conditions (i.e., during the summer when there is a soil moisture deficit). In this report, the PET and AET have been calculated using a soil-moisture balance approach.

Water Surplus (R + I)

The difference between the mean annual P and the mean annual ET is referred to as the water surplus. Part of the water surplus travels across the surface of the soil as surface or overland runoff (R) and the remainder infiltrates the surficial soil (I). The infiltration is comprised of two end member components: one component that moves vertically downward to the groundwater table (referred to as recharge) and a second component that moves laterally through the topsoil profile or shallow soils as interflow that re-emerges locally to surface (i.e., as runoff) at some short time following cessation of precipitation. As opposed to the “direct” component of surface runoff that occurs during precipitation or snowmelt events, interflow becomes an “indirect” component of runoff. The interflow component of surface runoff is not accounted for in the water balance equation cited above since it is often difficult to distinguish between interflow and direct (overland) runoff, however both interflow and direct runoff together form the total surface water runoff component.

6.2 Approach and Methodology

The analytical approach to calculate the water balance utilized for this assessment involves monthly soil-moisture balance calculations to determine the pre-development (based on existing land use) infiltration volumes. For the purposes of this study, the water balance calculations were undertaken using a spreadsheet model. The soil-moisture balance approach utilized assumes that soils do not release water as potential recharge while a soil moisture deficit exists. During wetter periods, any excess of precipitation over evapotranspiration first goes to restore soil moisture. Once the soil moisture deficit is overcome, any further excess water can then pass through the soil as infiltration and either become interflow (indirect runoff) or recharge (deep infiltration).

The soil moisture capacity for the soils on the subject lands were estimated based on guidance available in the MECP SWM Planning and Design Manual (2003). A soil moisture storage capacity of 200 mm was used for the areas where the land cover was predominantly short to moderate-rooted vegetation in the fields and agricultural areas (Table F-1, Appendix F). A soil moisture storage capacity of 125 mm was used for areas that will become lawn or manicured areas (Tables F-2 and F-3, Appendix F). Tables F-1 to F-3 in Appendix F detail the monthly potential evapotranspiration calculations accounting for latitude and climate, and then calculate the actual evapotranspiration and water surplus components of the water balance based on the monthly precipitation and soil moisture conditions.

The MECP SWM Planning and Design Manual (2003) methodology for calculating total infiltration based on topography, soil type and land cover was used and a corresponding runoff component was calculated for the soil moisture storage conditions (Tables F-1, F-2 and F-3, Appendix F). The calculated water balance components from this table are used to assess the pre-development and post-development volumes for runoff and infiltration as presented on Table F-4 in Appendix F.

6.3 Water Balance Component Values

The detailed monthly calculations of the water balance components are provided in Tables F-1 to F-3 in Appendix F. For these calculations, it has been assumed that silt loam soils are representative for the subject lands for estimating the soil infiltration factor. The calculations show that a water surplus is generally available from November to May (see Figure F-1). The monthly water balance calculations illustrate how infiltration occurs during periods when there is sufficient water available to overcome the soil moisture storage requirements. The monthly calculations are summed to provide estimates of the annual water balance component values (Tables F-1, F-2 and F-3, Appendix F). A summary of these values is provided in Table 3.

Table 3: Water Balance Component Values

Water Balance Component	Agricultural Lands	Urban Lawns	Grassed Berms
Average Precipitation	946 mm/year	946 mm/year	946 mm/year
Actual Evapotranspiration	579 mm/year	579 mm/year	579 mm/year
Water Surplus	367 mm/year	367 mm/year	367 mm/year
Infiltration	202 mm/year	220 mm/year	147 mm/year
Runoff	165 mm/year	147 mm/year	220 mm/year

6.4 Pre-Development Water Balance (Existing Conditions)

The pre-development water balance calculations for the subject lands are presented in Table F-4 in Appendix F. The total area of the subject lands is about 79,700 m^2. The pre-development land use was predominantly agricultural (moderately rooted crops). The total calculated pre-development infiltration volume is about 15,500 m^3/year (Table F-4, Appendix F). It is acknowledged that infiltration rates depend on the hydraulic conductivity of soils and that hydraulic conductivity may naturally vary over several orders of magnitude, so the margins of error on the calculations are high. As such the calculated volumes are considered as general estimates only.

6.5 Potential Urban Development Impacts to Water Balance

Urban development of an area affects the natural water balance. The most significant difference is the addition of impervious surfaces as a type of surface cover (i.e., roads, parking lots, driveways, and rooftops). Impervious surfaces prevent infiltration of water into the soils and the removal of the vegetation removes the evapotranspiration component of the natural water balance. The evaporation component from impervious surfaces is relatively minor (estimated to be 10% to 20% of precipitation) compared to the evapotranspiration component that occurs with vegetation in this area (about 58% of precipitation in the area of the subject lands). So, the net effect of the construction of impervious surfaces is that most of the precipitation that falls onto impervious surfaces becomes surplus water and direct runoff. The natural infiltration components (interflow and deep recharge) are reduced.

For the purposes of this study the evaporation will be estimated to be 15% of precipitation. The remaining 85% of the precipitation that falls on impervious surfaces will be assumed to become runoff. Therefore, assuming an evaporation/loss from impervious surfaces of 15% of the precipitation, there is a potential water surplus from impervious areas of 804 mm/year.

As noted previously, the subject lands are located in a WHPA-Q for water quantity protection and in these areas, loss/ reduction of recharge is not allowed. Specific action through the implementation of LID measures will be required to maintain recharge to the greatest extent possible.

It is noted that the proposed development will be serviced by municipal water supply and wastewater services. Therefore, there will be no impact on the water balance and local groundwater or surface water quantity and quality conditions related to any on-site groundwater supply pumping or disposal of septic effluent.

6.6 Post-Development Water Balance with No Mitigation

To assess the potential development impact on infiltration, the post-development infiltration volume was calculated for the subject property based on the proposed development plan. These calculations assume no mitigation is in place (i.e., all runoff from impervious surfaces will be directed to the storm sewers), resulting in quantification of an infiltration target for the design of a Low Impact Development (LID) strategy for stormwater management.

The land areas for each proposed land use on the subject property were estimated based on the stormwater management report completed by Burnside in 2023. The infiltration and runoff components for the post-development land uses were calculated using the SWM Planning and Design Manual (2003) methodology based on topography, soil type and land cover as shown on Tables F-2 and F-3, Appendix F. The total calculated post-development infiltration and runoff volumes (without mitigation) are presented in Table F-4, Appendix F. The estimated annual infiltration volume is about 4,900 m^3/year.

Comparing the existing (pre-development) and post-development values in Table F-4, Appendix F, the water balance calculations show that development has the potential to reduce the natural infiltration across the subject property by about 68% (10,600 m^3/year).

LID measures for stormwater management are recommended to try to promote infiltration and make up the difference between these pre- and post-development infiltration conditions to the extent practical. As noted above, with the wide margins of error associated with this type of analysis, the infiltration deficit volume is considered as a reasonable estimate that is suitable as a target or guide for LID strategy design.

6.7 Post-Development with Mitigation (LID)

There are various LID techniques that may be used to increase the post-development infiltration in a newly urbanized area. The proposed LID measures for the subject property were developed in conjunction with Burnside SWM engineers and will include:

- Infiltration of the runoff from the 25 mm storm event from roof areas of Phase 1 and Phase 2 buildings in catchment area 201 via an infiltration trench.

Calculations have been completed to assess the effects of these LID measures as shown on Table F-5, Appendix F. Quantification of these LID techniques is challenging and there are no widely accepted quantification standards. To assess the potential effectiveness of these LID measures for the proposed development, water balance calculations have been completed.

To calculate the annual infiltration volume for roof runoff directed to infiltration trenches, the Toronto Wet Weather Flow Management Guidelines (City of Toronto, 2006) were used to correlate the storm event size the swales are designed to infiltrate to a percentage of the average annual rainfall depth, which was then applied to the impervious area directed to these trenches to calculate an infiltration volume, as shown in Table F-5 (Appendix F). It is reported in these Guidelines, based on the review of rainfall data from 16 rainfall stations across Toronto, the 25 mm storm accounts for approximately 95% of the annual precipitation.

Recalculation of the water balance for the subject property with these LID measures in place demonstrates that 66% of the pre-development volumes can be maintained (Table F-5, Appendix F). This shows the significant benefit of the proposed LID strategy in increasing recharge volumes in the developed area.

7.0 Development Considerations

7.1 Construction Below the Water Table

Based on groundwater level data collected as part of this study the water table on the subject lands ranges from 1 to 4 m below surface across the subject lands. Should excavations during construction or servicing extend below the water table the local soils may need to be dewatered. Due to the potential for encountering the water table during construction, the dewatering of local aquifers may be required in order for services to be installed below the water table. The undertaking of dewatering according to industry standards and in accordance with a MECP processes will ensure that adequate attention is paid to potential adverse impacts to the environment. Currently the MECP allows for construction dewatering of less than 400,000 L/d to proceed under the Environmental Activity Sector Registry (EASR) process. If dewatering is to be above this threshold, then the standard Permit to Take Water (PTTW) process applies. In both cases, a scientific study is required in support of EASR registration or PTTW application. This scientific study must review the potential for environmental impacts and provide mitigation and monitoring measures to the satisfaction of the MECP or other review agency. The requirements for construction dewatering will be confirmed by geotechnical/hydrogeological investigations completed in support of detailed design.

The construction of buried services below the water table has the potential to capture and redirect groundwater flow through more permeable fill materials typically placed in the base of excavations. Groundwater may also infiltrate into joints in storm sewers and maintenance holes (i.e., manholes). Over the long-term, these impacts can lower the groundwater table across the development area. To mitigate this effect, services to be installed below the water table should be constructed to prevent redirection of groundwater flow. This will involve the use of anti-seepage collars or clay plugs surrounding the pipes to provide barriers to flow and prevent groundwater flow along granular bedding material and erosion of the backfill materials.

7.2 Local Groundwater Supply Wells

The community of Fergus is supplied with municipal water and the subject lands will also be serviced by municipal water supply and wastewater. It is noted that some areas of Fergus are not serviced and that rural residences in the surrounding area may also not be serviced by municipal supply. To identify potentially vulnerable wells in the vicinity of the subject lands the serviced area mapping for Fergus along with water well records from the MECP were reviewed and shown in Figure 11. Our review of the MECP water well records within 500 m of the subject lands indicates that all water supply wells are located in the bedrock (Appendix A). Dewatering, if required, is expected to be limited to the shallow overburden and bedrock wells are not expected to be impacted. It is however recommended that the scientific study required for PTTW or EASR should include an assessment of the potential zone of influence for dewatering and within that zone, identify any wells that require monitoring during the dewatering process. A well interference response protocol should also be developed and implemented during dewatering.

7.3 Well Decommissioning

Prior to or during construction, it is necessary to ensure that all inactive wells within the development footprint have been located and properly decommissioned by a licensed water well contractor according to Ontario Regulation 903. This regulation applies to private domestic wells and to the groundwater observation wells installed for this study unless they are maintained throughout the construction for monitoring purposes.

8.0 References

City of Toronto. 2006. Toronto Wet Weather Flow Management Guidelines.

Chapman, L.J. and D.F. Putnam. 1984. The Physiography of Southern Ontario. Ontario Geological Survey, Special Volume 2, 270p. Accompanied by Map P.2715 (coloured), scale 1:600,000.

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Environment Canada, Canadian Climate Normals 1981-2010, Fergus Shand Dam, Ontario.

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Hazen, A. 1892. Some physical properties of sand and gravel, with special reference to their use in filtration. Massachusetts State Board of Health 24th annual report, p.539-556.

Hazen, A. 1911. Discussion of “Dams on sand formations” by A.C. Koenig. Transactions of the American Society of Civil Engineers, 73: 199-203.

Ontario Geological Survey. 2003. Bedrock Geology of Ontario. Ontario Geological Survey, Miscellaneous Release – Data 126, scale 1:250,000.

Ontario Geological Survey. 2010. Surficial Geology of Southern Ontario. Ontario Geological Survey, Miscellaneous Release – Data 128, scale 1:5,000.

Ontario Ministry of Environment, Conservation and Parks (MECP). 2003. Storm Water Management Planning and Design Manual, March 2003.

Ontario Ministry of Environment, Conservation and Parks (MECP). 2023. Source Water Protection Atlas.

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R.J. Burnside & Associates Limited. 2023. Functional Servicing and Stormwater Management Report Centre Wellington Operations Centre. Burnside Project 300055234.0000 dated April 24, 2023.

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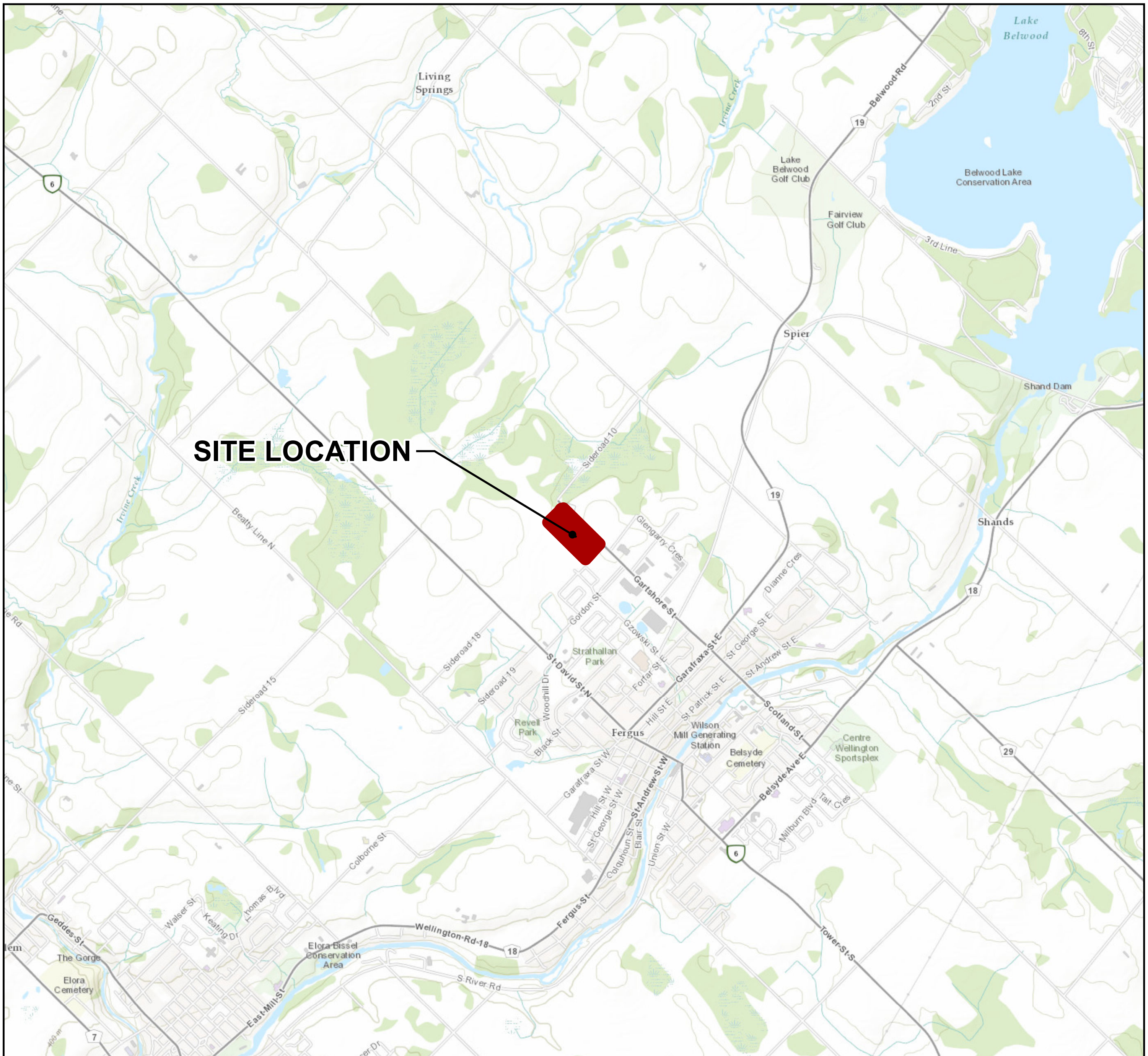
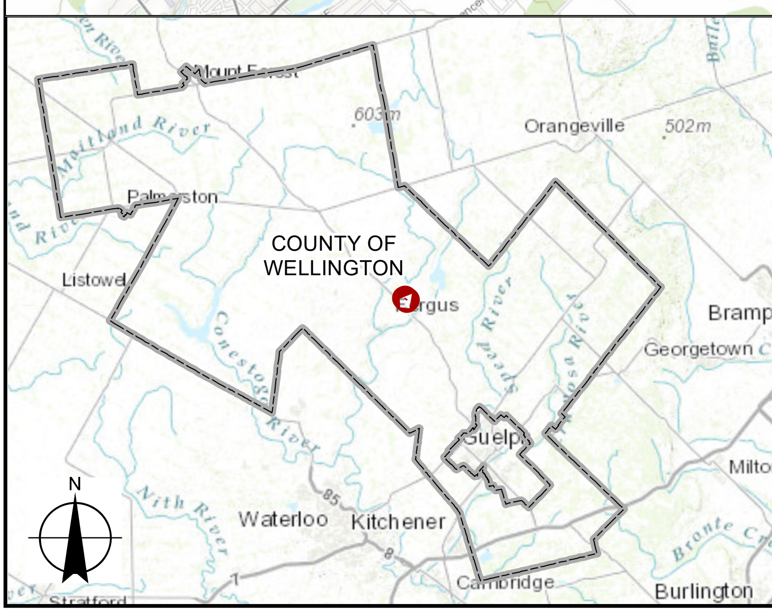
Figures





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Client

TOWNSHIP OF CENTRE WELLINGTON

Map Title

CENTRE WELLINGTON OPERATIONS CENTRE HYDROGEOLOGICAL ASSESSMENT

SITE LOCATION PLAN

Drawn	Checked	Date	Figure No.
CD	AM	May 2023	1
Scale		Project No.	
1:50,000		300055234	

File Path: \\elmo\Shared Work Areas\055234 Centre Wellington Operations Centre\08_GIS\02 Hydrogeology\055234 HG Site Location Plan.mxd Print Date: 2023/05/12 Time: 11:51 AM

LEGEND

SUBJECT LANDS

MONITORING WELL LOCATION
(By JLP, 2022)

MECP OVERBURDEN WELL LOCATION

MECP BEDROCK WELL LOCATION

Air Photo Source:
Background 2020 Air Photo obtained from Township of Centre Wellington Online GIS Server: https://gis.centrewellington.ca/server/rest/services Layer: Airphoto202016cm

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0 40 80 120 160
Metres

BURNSIDE

Client

TOWNSHIP OF CENTRE WELLINGTON

Figure Title

CENTRE WELLINGTON OPERATIONS CENTRE HYDROGEOLOGICAL ASSESSMENT

SITE PLAN AND PROPOSED DEVELOPMENT

Drawn	Checked	Date	Figure No.
CD	AM	May 2023	2
Scale		Project No.	
1:2,000		300055234	

File: \\elmo\Shared Work Areas\055234 Centre Wellington Operations Centre\03_Production\02 Hydrogeology\055234 HG Report Figures.dwg Date Plotted: May 17, 2023 - 9:47 AM

LEGEND

- SUBJECT LANDS
- GROUND ELEVATION (masl)
- WETLAND (MNR)

Air Photo Source:
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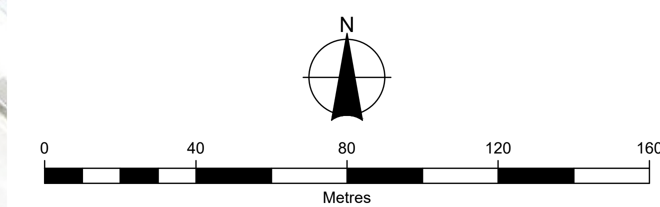

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Client

TOWNSHIP OF CENTRE WELLINGTON

Figure Title

CENTRE WELLINGTON OPERATIONS CENTRE HYDROGEOLOGICAL ASSESSMENT

TOPOGRAPHY AND DRAINAGE

Drawn	Checked	Date	Figure No.
CD	AM	May 2023	3
Scale		Project No.	
1:2,000		300055234	

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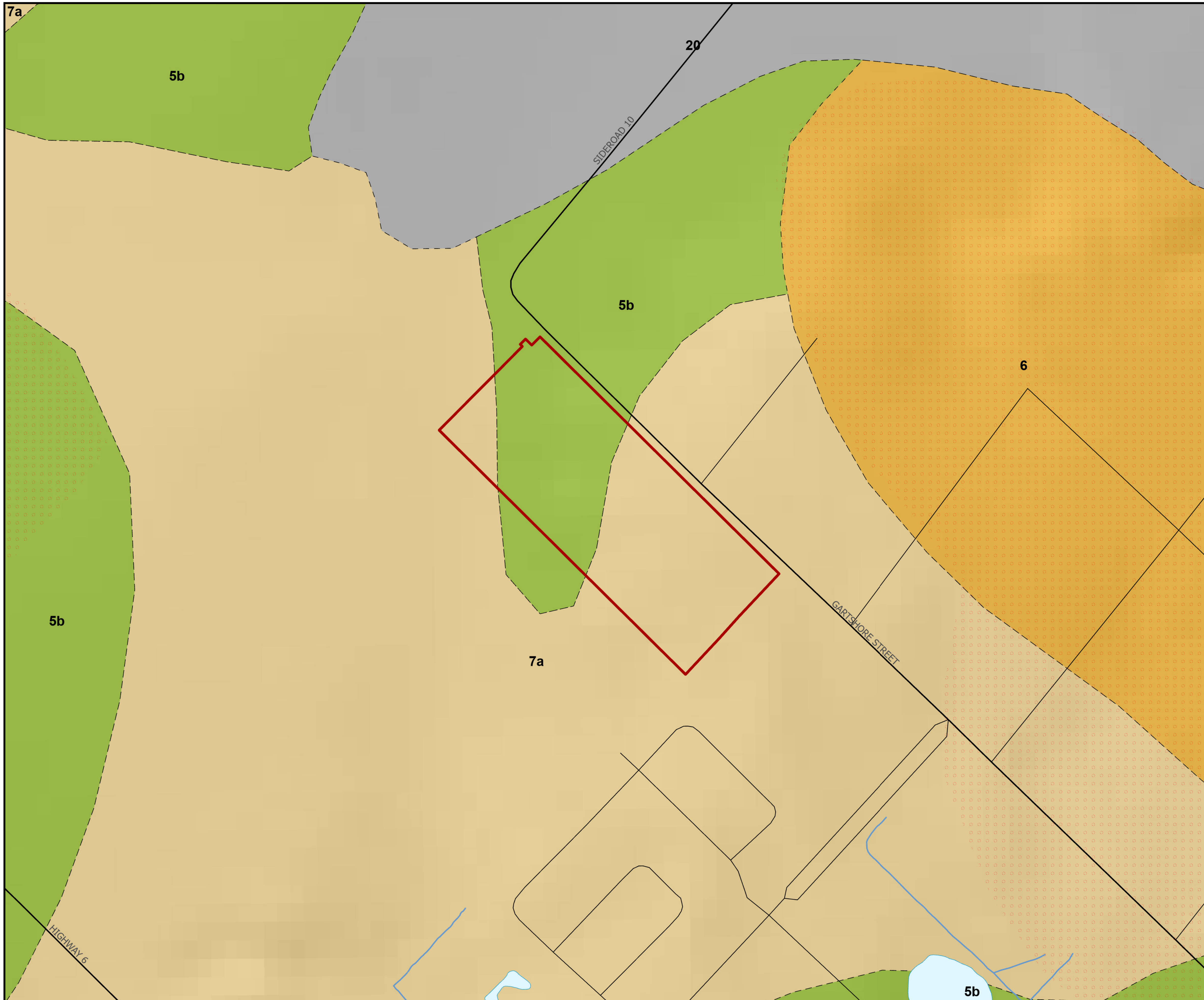

Legend

- Subject Lands
- Local Roads
- Roads
- Waterbody
- Watercourse

Surficial Geology

- 5b: Till: Stone-poor, carbonate-derived silty to sandy till
- 6: Ice-contact stratified deposits
- 7a: Glaciofluvial deposits: Sandy deposits
- 20: Organic deposits
- Hummocky Topography
- Unit Contact Boundary

Sources:

1. Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release–Data 126 - Revision 1.
2. Ministry of Natural Resources, © King's Printer for Ontario
3. Natural Resources Canada © His Majesty the King in Right of Canada

Datum: North American 1983 CSRS

Coord. System: NAD 1983 CSRS UTM Zone 17N

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Metres

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TOWNSHIP OF CENTRE WELLINGTON

Figure Title

CENTRE WELLINGTON OPERATIONS CENTRE HYDROGEOLOGICAL ASSESSMENT

SURFICIAL GEOLOGY

Drawn	Checked	Date	Figure No.
CD	DS	May 2023	4
Scale		Project No.	
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Legend

- Subject Lands
- Local Roads
- Roads
- Watercourse
- Waterbody

LOWER SILURIAN - 56 Sandstone, shale, dolostone, siltstone

- 56a Guelph Fm.

Sources:

1. Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release–Data 126 - Revision 1.
2. Ministry of Natural Resources, © King's Printer for Ontario
3. Natural Resources Canada © His Majesty the King in Right of Canada

Datum: North American 1983 CSRS

Coord. System: NAD 1983 CSRS UTM Zone 18N

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Metres

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TOWNSHIP OF CENTRE WELLINGTON

Figure Title

CENTRE WELLINGTON OPERATIONS CENTRE HYDROGEOLOGICAL ASSESSMENT

BEDROCK GEOLOGY

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Scale		Project No.	
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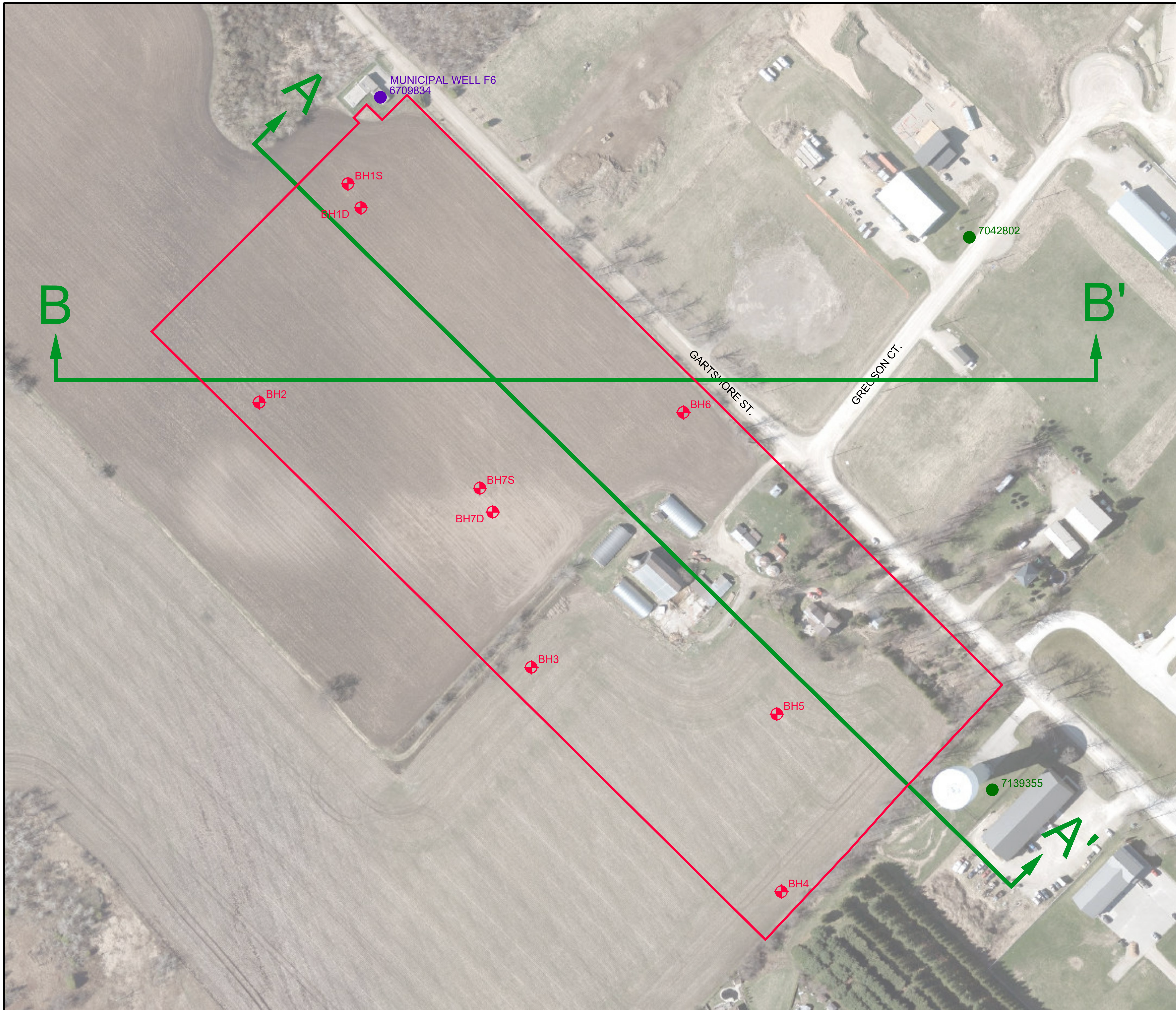

LEGEND

SUBJECT LANDS

MONITORING WELL LOCATION
(By JLP, 2022)

MECP OVERBURDEN WELL LOCATION

MECP BEDROCK WELL LOCATION

Air Photo Source:
Background 2020 Air Photo obtained from Township of Centre Wellington Online GIS
Server: https://gis.centrewellington.ca/server/rest/services Layer: Airphoto202016cm

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Metres

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TOWNSHIP OF CENTRE WELLINGTON

Figure Title
CENTRE WELLINGTON OPERATIONS CENTRE HYDROGEOLOGICAL ASSESSMENT

BOREHOLE, MONITORING WELL AND CROSS SECTION PLAN

Drawn	Checked	Date	Figure No.
CD	AM	May 2023	6
Scale		Project No.	
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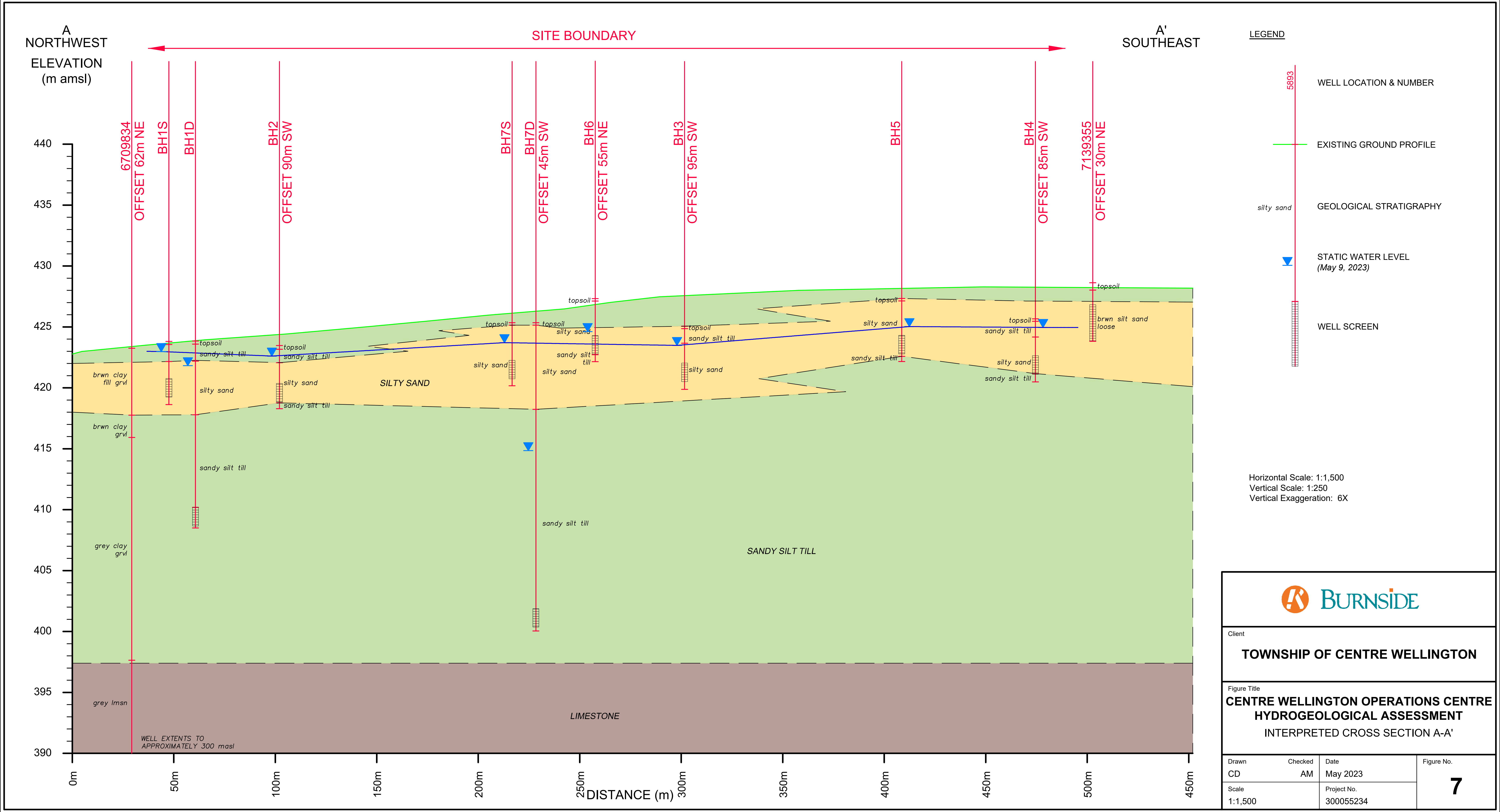

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TOWNSHIP OF CENTRE WELLINGTON

Figure Title

CENTRE WELLINGTON OPERATIONS CENTRE HYDROGEOLOGICAL ASSESSMENT

INTERPRETED CROSS SECTION A-A'

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Scale		Project No.	
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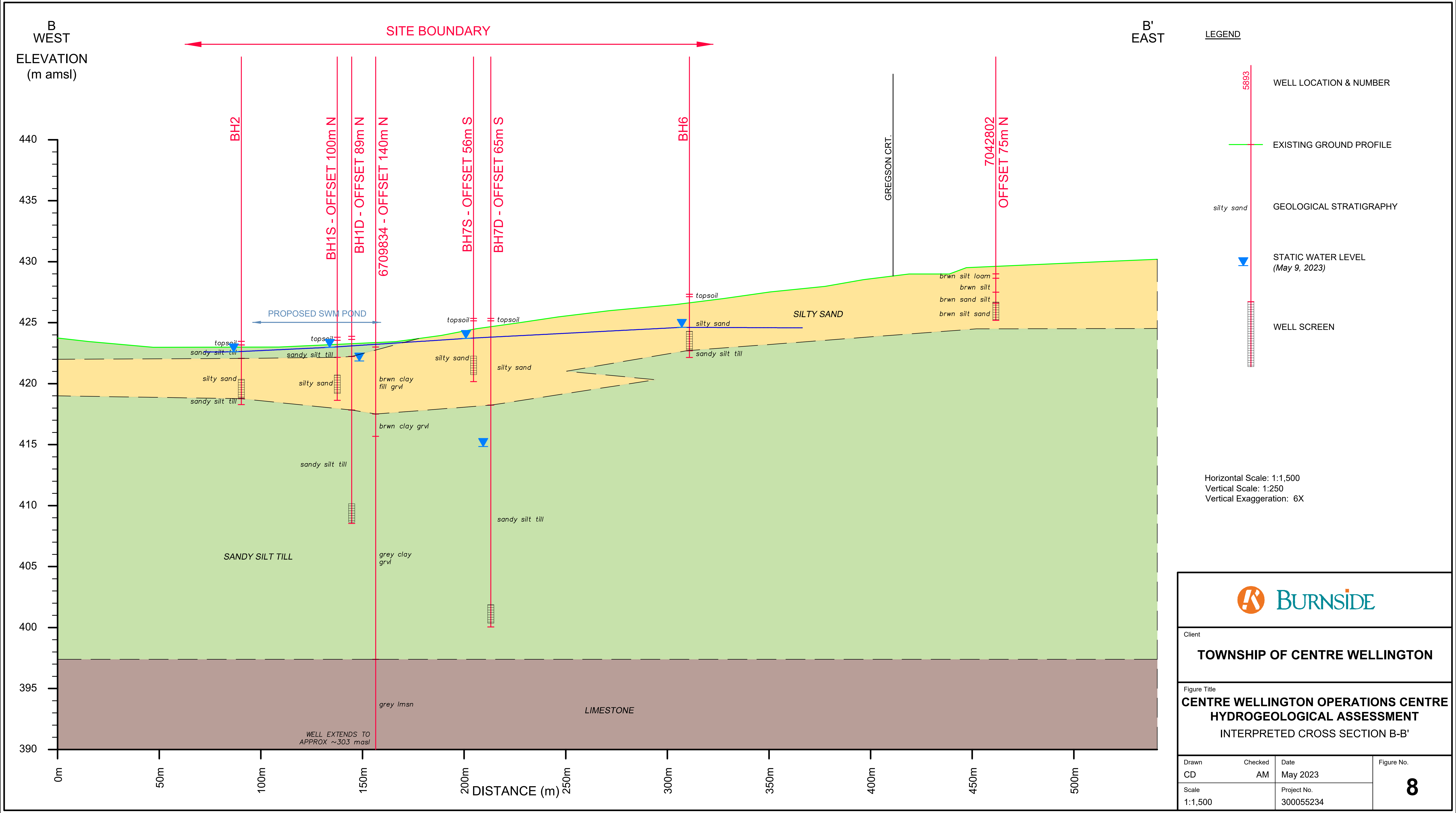

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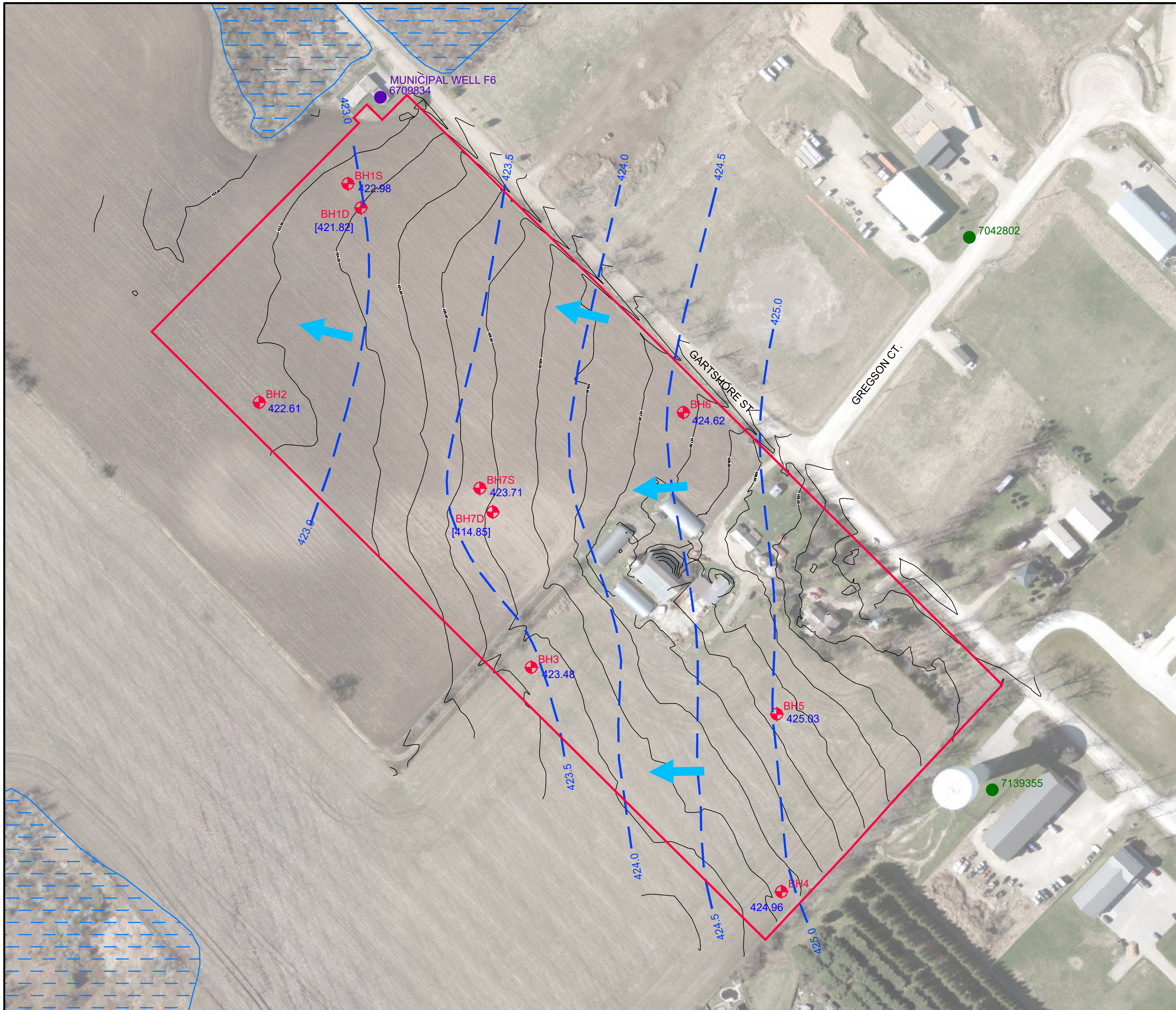

LEGEND

SUBJECT LANDS

MONITORING WELL LOCATION
(By JLP, 2022)

422.45 SHALLOW GROUNDWATER ELEVATION
(May 9, 2023) - masl

[413.50] DEEP GROUNDWATER ELEVATION
(May 9, 2023) - masl

GROUNDWATER CONTOUR - masl

INTERPRETED GROUNDWATER FLOW DIRECTION

WETLAND (MNR)

Air Photo Source:
Background 2020 Air Photo obtained from Township of Centre Wellington Online GIS Server: https://gis.centrewellington.ca/server/rest/services Layer: Airphoto202016cm

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Metres

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TOWNSHIP OF CENTRE WELLINGTON

Figure Title

CENTRE WELLINGTON OPERATIONS CENTRE HYDROGEOLOGICAL ASSESSMENT

SHALLOW GROUNDWATER FLOW - MAY, 2023

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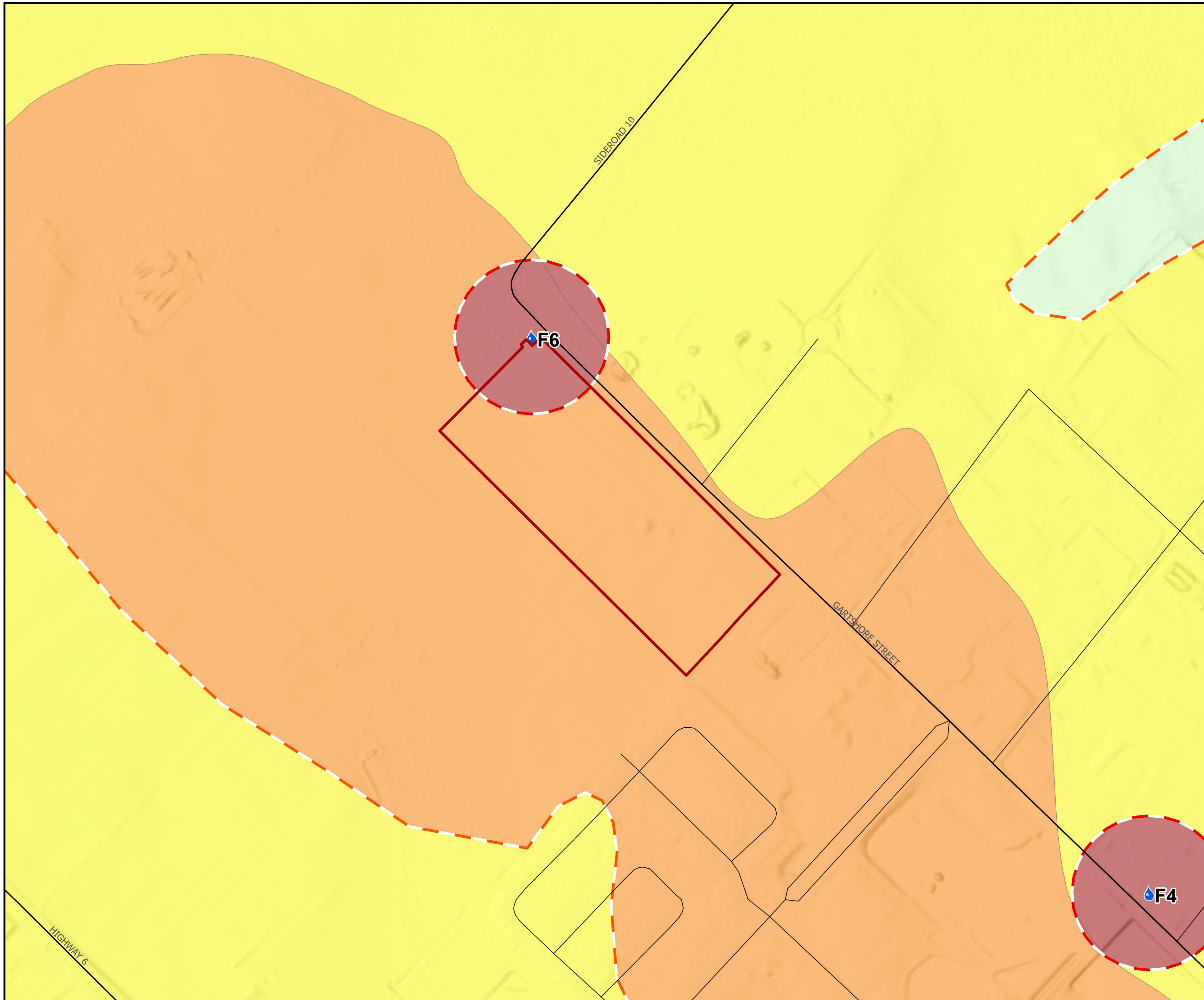

Legend

- Subject Lands
- Local Roads
- Roads

SWP WHPA-Wellhead Protection Area (GRCA)

- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D

SWP WHPA Vulnerability (GRCA)

- 10
- 8
- 6
- 4
- 2
- Well

Sources:

1. Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release–Data 126 - Revision 1.
2. Ministry of Natural Resources, © King's Printer for Ontario
3. Natural Resources Canada © His Majesty the King in Right of Canada

Datum: North American 1983 CSRS

Coord. System: NAD 1983 CSRS UTM Zone 17N

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Metres

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TOWNSHIP OF CENTRE WELLINGTON

Figure Title

CENTRE WELLINGTON OPERATIONS CENTRE HYDROGEOLOGICAL ASSESSMENT

SOURCE WATER PROTECTION

Drawn	Checked	Date	Figure No.
CD	DS	May 2023	10
Scale		Project No.	
1:5,000		300055234	

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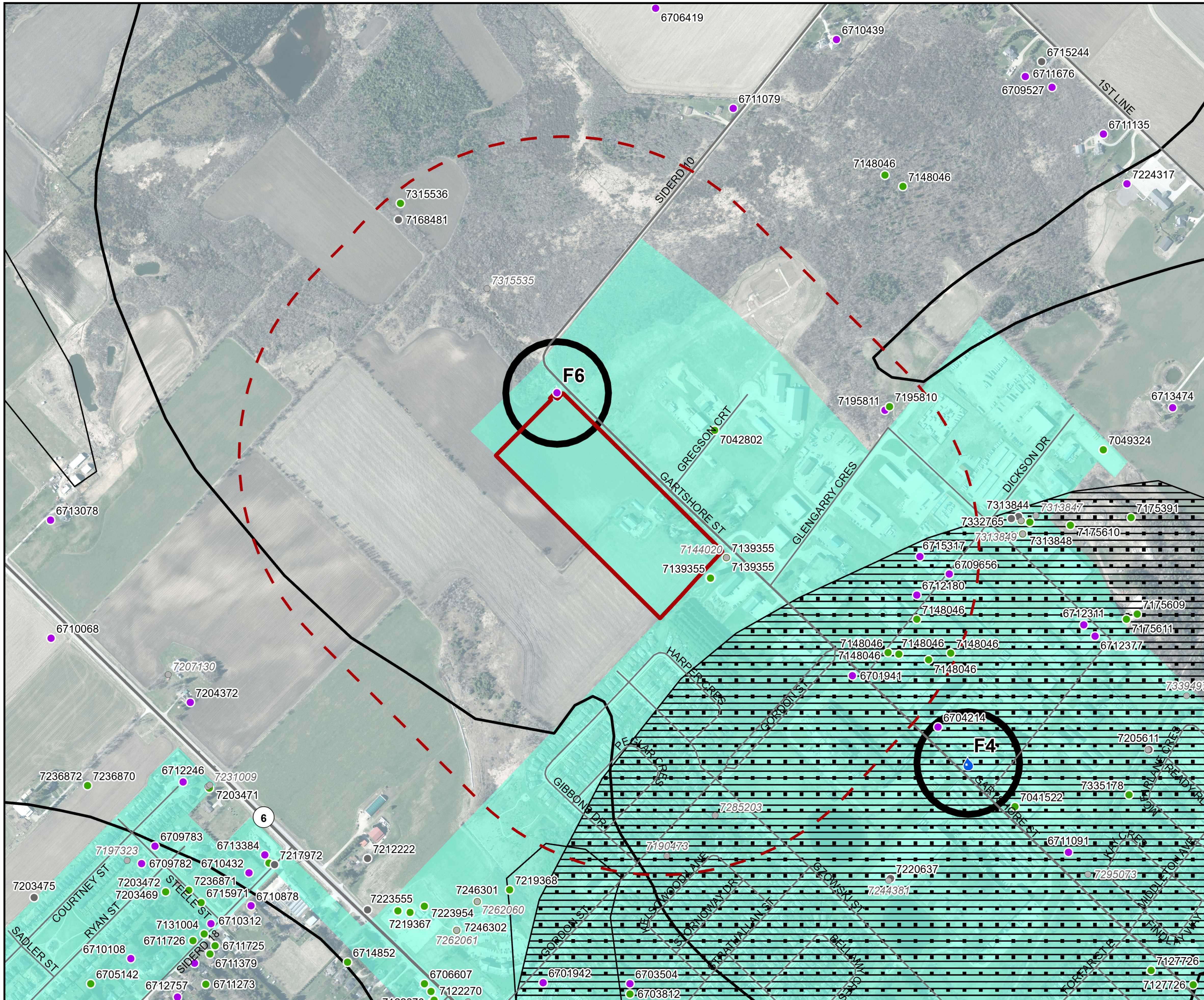

Legend

- Subject Lands
- Subject Lands 500m Buffer
- MECP Bedrock Well Location
- MECP Overburden Well Location
- MECP Well - Unknown Status/Formation
- MECP Abandoned Well Location
- Municipally Serviced Area (Approximate)
- Expressway / Highway
- Arterial / Collector Road
- Local Road

Issue Contributing Area

- Chloride
- TCE & Chloride
- TCE
- TCE

Wellhead Protection Area

- WHPA A
- WHPA B
- WHPA C
- WHPA D
- Well

Sources:

1. Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release–Data 126 - Revision 1.
2. Ministry of Natural Resources, © King's Printer for Ontario
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Datum: North American 1983 CSRS
Coord. System: NAD 1983 CSRS UTM Zone 17N

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Metres

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TOWNSHIP OF CENTRE WELLINGTON

Figure Title
CENTRE WELLINGTON OPERATIONS CENTRE HYDROGEOLOGICAL ASSESSMENT

GROUNDWATER IMPACT EVALUATION

Drawn	Checked	Date	Figure No.
CD	DS	May 2023	11
Scale		Project No.	
1:7,500		300055234	

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Appendix A

MECP Water Well Records

Appendix A

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
FERGUS TOWN	17 549552 4841203 W	2010/03 7366	0 1			MT	0005 100006 10	7144020 (Z105901) A083485 A	
FERGUS TOWN	17 549964 4840873 W	1972/03 2801	12 12 10	FR 0265 FR 0290 FR 0295 FR 0380 FR 0385	63/169/300/24:0	MN		6704214 ()	LOAM 0001 BRWN CLAY SAND GRVL 0044 GREY CLAY SAND GRVL 0160 BRWN SILT SAND 0190 BRWN SAND 0220 BRWN CLAY SAND GRVL 0259 BRWN SNDS 0264 WHIT LMSN 0425
FERGUS TOWN	17 549797 4840973 W	1951/10 2411	4 4	FR 0200	40/40/10/:	ST DO		6701941 ()	MSND GRVL 0110 LMSN 0200
FERGUS TOWN	17 549552 4841203 W	2010/01 7366	1			MO		7139355 (M04742) A083485	BRWN LOAM SILT LOOS 0002 BRWN SILT SAND LOOS 0016
FERGUS TOWN	17 548917 4841893 W	2018/06 7238	2	UT 0030		MO	0054 10	7315536 (Z293105) A237330	BRWN SILT SAND 0003 BLUE SILT STNS BLDR 0025 GREY SILT STNS SAND 0064
FERGUS TOWN	17 549870 4841497 W	2012/09 7221	1.34			MO		7195810 (Z143777) A118997	BRWN CLAY SNDY 0014 GREY CLAY STNY STNS 0072 GREY SAND SLTY STNS 0076
FERGUS TOWN	17 549086 4841727 W	2018/06 7238				MO		7315535 (Z293106) A130084 A	
FERGUS TOWN 01 010	17 549529 4841451 W	2007/02 6607	2.00	0005			0008 5	7042802 (Z70431) A053557	BRWN SILT LOAM 0001 BRWN SILT 0005 BRWN SAND SILT 0008 BRWN SILT SAND 0012
FERGUS TOWN 16 020	17 549929 4841205 W	2005/02 1737	6	FR 0225	140/142//1:	IN		6715317 (Z24376) A011658	BRWN SAND SILT CLAY 0038 GREY CLAY STNS 0100 BRWN LMSN 0230
NICHOL TOWNSHIP	17 549436 4840622 W	2012/10 7221	36 30	UT 0016				7190473 (Z159341) A	
NICHOL TOWNSHIP	17 548913 4841861 W	2011/08 7238						7168481 (Z135834) A114027	SAND GRVL 0030 GREY TILL CLAY STNS 0070 GREY LMSN 0480 GREY SHLE 0490
NICHOL TOWNSHIP	17 549530 4840701 W	2017/04 7221	35.8			DO		7285203 (Z256286) A	
NICHOL TOWNSHIP CON 15 018	17 548653 4840624 W	2000/06 6865	6 6	UK 0170 UK 0185 UK 0195	89/140/6/1:	DO		6713384 (211320)	BRWN SAND 0029 GREY CLAY SAND 0052 GREY CLAY STNS 0084 LMSN 0095 GREY LMSN 0129 BRWN LMSN 0164 BRWN LMSN 0190 GREY LMSN 0196

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
NICHOL TOWNSHIP CON 16 017	17 549222 4841524 W	1989/05 2801	12 11	FR 0128	58/153/350/24:0	MN		6709834 (31325)	BRWN CLAY FILL GRVL 0018 BRWN CLAY GRVL 0024 GREY CLAY GRVL 0084 GREY LMSN 0165 BRWN LMSN 0213 GREY LMSN 0225 BRWN LMSN 0232 GREY LMSN 0315 BRWN LMSN 0378 GREY LMSN 0400 WHIT LMSN 0402
NICHOL TOWNSHIP CON 16 018	17 548853 4840617 W	2013/05 6607						7212222 (C20908) A141577 P	
NICHOL TOWNSHIP CON 16 019	17 549923 4841130 W	1995/09 3518	6 6	FR 0114	57/87/10/2:0	CO		6712180 (165520)	BRWN CLAY SAND HARD 0020 GREY CLAY STNS HARD 0080 BRWN SNDS BLDR HARD 0097 BRWN ROCK HARD 0114
WEST GARAFRAXA TOWNS	17 549861 4841490 W	2012/08 7221	6.26 6.13			MO		7195811 (Z143799) A078888	BRWN SAND CLAY 0018 GREY CLAY STNS 0087 BRWN LMSN 0116 GREY LMSN 0145 BRWN LMSN 0330 BRWN LMSN 0394 GREY LMSN 0470 GREY LMSN 0485 BLUE SHLE 0495
WEST GARAFRAXA TOWNS CON 01 009	17 549986 4841171 W	1988/06 3518	6	FR 0124	40/90/12/2:0	DO		6709656 (26873)	BLCK LOAM SOFT 0002 BRWN SAND SILT CLAY 0020 GREY CLAY STNS 0075 GREY SILT CLAY LOOS 0100 BRWN ROCK 0124
WEST GARAFRAXA TOWNS CON 01 009	17 549867 4841018 W	2010/06 7147	1.97	FR 0003		MO		7148046 (M08690) A092945	BLCK LOAM 0001 BRWN SAND STNS FGRD 0014

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION

Notes:
UTM: UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
DATE CNTR: Date Work Completedand Well Contractor Licence Number
CASING DIA: .Casing diameter in inches
WATER: Unit of Depth in Fee. See Table 4 for Meaning of Code

PUMP TEST: Static Water Level in Feet / Water Level After Pumping in Feet / Pump Test Rate in GPM / Pump Test Duration in Hour : Minutes
WELL USE: See Table 3 for Meaning of Code
SCREEN: Screen Depth and Length in feet
WELL: WEL (AUDIT #) Well Tag . A: Abandonment; P: Partial Data Entry Only
FORMATION: See Table 1 and 2 for Meaning of Code

1. Core Material and Descriptive terms

Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
BLDR	BOULDERS	FCRD	FRACTURED	IRFM	IRON FORMATION	PORS	POROUS	SOFT	SOFT
BSLT	BASALT	FGRD	FINE-GRAINED	LIMY	LIMY	PRDG	PREVIOUSLY DUG	SPST	SOAPSTONE
CGRD	COARSE-GRAINED	FGVL	FINE GRAVEL	LMSN	LIMESTONE	PRDR	PREV. DRILLED	STKY	STICKY
CGVL	COARSE GRAVEL	FILL	FILL	LOAM	TOPSOIL	QRTZ	QUARTZITE	STNS	STONES
CHRT	CHERT	FLDS	FELDSPAR	LOOS	LOOSE	QSND	QUICKSAND	STNY	STONEY
CLAY	CLAY	FLNT	FLINT	LTCL	LIGHT-COLOURED	QTZ	QUARTZ	THIK	THICK
CLN	CLEAN	FOSS	FOSILIFEROUS	LYRD	LAYERED	ROCK	ROCK	THIN	THIN
CLYY	CLAYEY	FSND	FINE SAND	MARL	MARL	SAND	SAND	TILL	TILL
CMTD	CEMENTED	GNIS	GNEISS	MGRD	MEDIUM-GRAINED	SHLE	SHALE	UNKN	UNKNOWN TYPE
CONG	CONGLOMERATE	GRNT	GRANITE	MGVL	MEDIUM GRAVEL	SHLY	SHALY	VERY	VERY
CRYS	CRYSTALLINE	GRSN	GREENSTONE	MRBL	MARBLE	SHRP	SHARP	WBRG	WATER-BEARING
CSND	COARSE SAND	GRVL	GRAVEL	MSND	MEDIUM SAND	SHST	SCHIST	WDFR	WOOD FRAGMENTS
DKCL	DARK-COLOURED	GRWK	GREYWACKE	MUCK	MUCK	SILT	SILT	WTHD	WEATHERED
DLMT	DOLOMITE	GVLY	GRAVELLY	OBDN	OVERBURDEN	SLTE	SLATE		
DNSE	DENSE	GYPS	GYPSUM	PCKD	PACKED	SLTY	SILTY		
DRTY	DIRTY	HARD	HARD	PEAT	PEAT	SNDS	SANDSTONE		
DRY	DRY	HPAN	HARDPAN	PGVL	PEA GRAVEL	SNDY	SANDYOAPSTONE		

2. Core Color

Code	Description
WHIT	WHITE
GREY	GREY
BLUE	BLUE
GREN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED
BLCK	BLACK
BLGY	BLUE-GREY

3. Well Use

Code	Description	Code	Description
DO	Domestic	OT	Other
ST	Livestock	TH	Test Hole
IR	Irrigation	DE	Dewatering
IN	Industrial	MO	Monitoring
CO	Commercial	MT	Monitoring TestHole
MN	Municipal		
PS	Public		
AC	Cooling And A/C		
NU	Not Used		

4. Water Detail

Code	Description	Code	Description
FR	Fresh	GS	Gas
SA	Salty	IR	Iron
SU	Sulphur		
MN	Mineral		
UK	Unknown		

Burnside

[The Difference is our People]

Appendix B

Borehole Logs

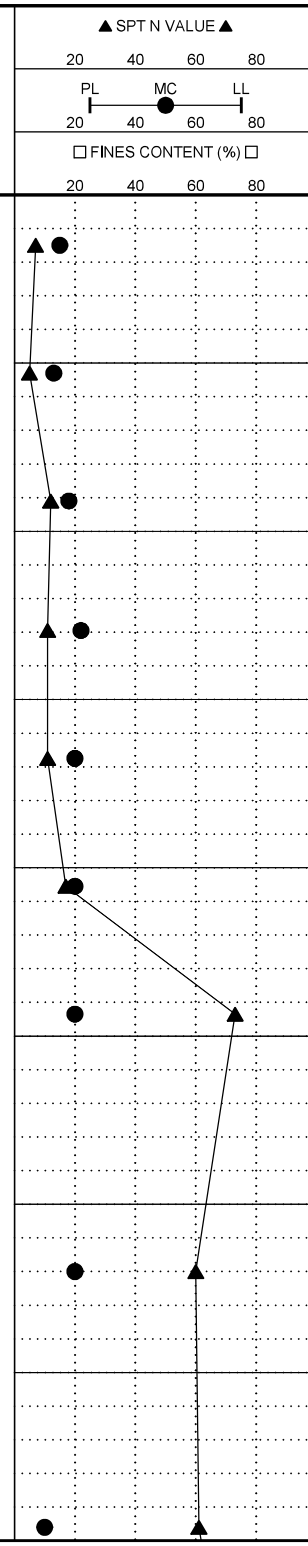
Appendix B

BORING NUMBER BH1D

JLP
Geotechnical & Environmental Consultants

CLIENT	Township of Centre Wellington	**PROJECT NAME**	Operation Centre
PROJECT NUMBER	G4599-22-6	**PROJECT LOCATION**	965 Gartshore Street, Fergus, Ontario
DATE STARTED	26-10-22 **COMPLETED** 26-10-22	**GROUND ELEVATION**	423.881 m Geodetic **HOLE SIZE** 200mm
DRILLING CONTRACTOR	Pontil Drilling	**GROUND WATER LEVELS:**	
DRILLING METHOD	D50. Hollow Stem	**AT TIME OF DRILLING**	---
LOGGED BY	GB **CHECKED BY** AL	**AT END OF DRILLING**	---
NOTES		**AFTER DRILLING**	2.43 m / Elev 421.45 m

ELEV. (m)	DEPTH (m)	MATERIAL DESCRIPTION	DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY %	HEADSPACE VAPOUR	ANALYSIS
		TOPSOIL sandy silt, trace gravel, scattered organic inclusions; black to dark brown, moist no odour, no staining.	0.3	SS 1	1-3-4-6 (7)			
423	1	**SANDY SILT TILL** trace to some gravel, scattered organic inclusions in upper zone; dark brown to brown, moist, loose to compact no odour, no staining.		SS 2	3-2-3-4 (5)			
422	2		1.9	SS 3	2-3-9-9 (12)			
		SILTY SAND fine grained, scattered silt seams; brown, wet to saturated, compact to very dense no odour, no staining.		SS 4	3-6-5-4 (11)			
421	3			SS 5	2-6-5-10 (11)			
420	4			SS 6	4-7-10-17 (17)			
419	5			SS 7	9-23-50 (73)			
418	6		6.3	SS 8	9-12-48-42 (60)			
		SANDY SILT TILL trace gravel inclusions, trace clay; grey, moist, very dense no odour, no staining.						
417	7							
416	8			SS	19-29-32-31			



WELL CONSTRUCTION

(Continued Next Page)

CLIENT Township of Centre Wellington

PROJECT NAME Operation Centre

PROJECT NUMBER G4599-22-6

PROJECT LOCATION 965 Gartshore Street, Fergus, Ontario

ELEV. (m)	DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY %	HEADSPACE VAPOUR	ANALYSIS	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80	WELL CONSTRUCTION
			SANDY SILT TILL trace gravel inclusions, trace clay; grey, moist, very dense no odour, no staining. *(continued)*		9	(61)					
415	9										
					SS 10	23-32-44-50 (76)					
414	10										
					SS 11	40-50					
413	11										
412	12										
					SS 12	24-33-20-47 (53)					
411	13										
					SS 13	50/0.10				>>	
410	14										
409	15										
				15.3	SS 14	50/0.10				>>	

End of Borehole at 15.34 mbgs.

BORING NUMBER BH1S

JLP
Geotechnical & Environmental Consultants

CLIENT Township of Centre Wellington
PROJECT NAME Operation Centre
PROJECT NUMBER G4599-22-6
PROJECT LOCATION 965 Gartshore Street, Fergus, Ontario
DATE STARTED 27-10-22 **COMPLETED** 27-10-22
GROUND ELEVATION 423.881 m Geodetic **HOLE SIZE** 200mm
DRILLING CONTRACTOR Pontil Drilling
GROUND WATER LEVELS:
DRILLING METHOD D50. Hollow Stem Auger
AT TIME OF DRILLING ---
LOGGED BY GB **CHECKED BY** AL
AT END OF DRILLING ---
NOTES
AFTER DRILLING 1.34 m / Elev 422.54 m

ELEV. (m)	DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY %	HEADSPACE VAPOUR	ANALYSIS	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80	WELL CONSTRUCTION
			TOPSOIL sandy silt, trace gravel, scattered organic inclusions; black to dark brown, moist no odour, no staining.	0.3							
423	1		**SANDY SILT TILL** trace to some gravel, scattered organic inclusions in upper zone; dark brown to brown, moist, loose to compact no odour, no staining.	1.9							
422	2		**SILTY SAND** fine grained, scattered silt seams; brown, wet to saturated, compact to very dense no odour, no staining.	5.2							
421	3										
420	4										
419	5										

End of Borehole at 5.18 mbgs.

BORING NUMBER BH2

JLP Geotechnical & Environmental Consultants

CLIENT Township of Centre Wellington | **PROJECT NAME** Operation Centre

PROJECT NUMBER G4599-22-6 | **PROJECT LOCATION** 965 Gartshore Street, Fergus, Ontario

DATE STARTED 27-10-22 **COMPLETED** 27-10-22 | **GROUND ELEVATION** 423.47 m Geodetic **HOLE SIZE** 200mm

DRILLING CONTRACTOR Pontil Drilling | **GROUND WATER LEVELS:**

DRILLING METHOD D50. Hollow Stem | **AT TIME OF DRILLING** ---

LOGGED BY GB **CHECKED BY** AL | **AT END OF DRILLING** ---

NOTES | **AFTER DRILLING** 1.23 m / Elev 422.24 m

DEPTH (m)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY %	HEADSPACE VAPOUR	ANALYSIS
0.3	**TOPSOIL** sandy silt, scattered organic inclusions and rootlets; black to dark brown, moist no odour, no staining.	SS 1	2-4-8-8 (12)			
1.7	**SANDY SILT TILL** trace to some gravel inclusions; dark brown to brown, moist, compact no odour, no staining.	SS 2	3-4-9-7 (13)			
5.0	**SILTY SAND** fine grained, scattered silt seams; brown, wet to saturated, compact no odour, no staining.	SS 3	7-8-11-10 (19)			
		SS 4	6-7-10-11 (17)			
		SS 5	5-7-10-11 (17)			
		SS 6	5-8-13-13 (21)			
5.2	**SANDY SILT TILL** trace gravel inclusions, trace clay; grey, moist, dense no odour, no staining.	SS 7	8-19-19-15 (38)			

End of Borehole at 5.18 mbgs.

ELEV. (m): 423, 422, 421, 420, 419

DEPTH (m): 1, 2, 3, 4, 5

▲ SPT N VALUE ▲ 20 40 60 80

PL MC LL 20 40 60 80

☐ FINES CONTENT (%) ☐ 20 40 60 80

WELL CONSTRUCTION

BORING NUMBER BH3

JLP

Geotechnical & Environmental Consultants

CLIENT Township of Centre Wellington

PROJECT NAME Operation Centre

PROJECT NUMBER G4599-22-6

PROJECT LOCATION 965 Gartshore Street, Fergus, Ontario

DATE STARTED 27-10-22 **COMPLETED** 27-10-22

GROUND ELEVATION 425.06 m Geodetic **HOLE SIZE** 200mm

DRILLING CONTRACTOR Pontil Drilling

GROUND WATER LEVELS:

DRILLING METHOD D50. Hollow Stem

AT TIME OF DRILLING ---

LOGGED BY GB **CHECKED BY** AL

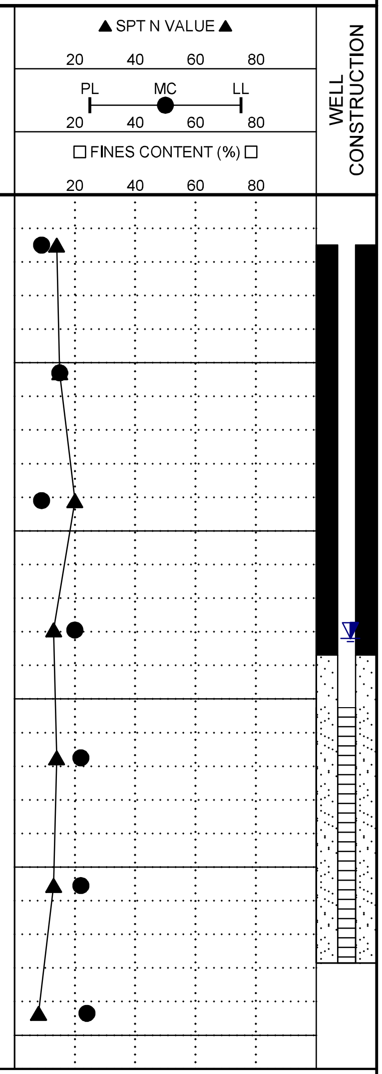
AT END OF DRILLING ---

NOTES

AFTER DRILLING 2.64 m / Elev 422.42 m

ELEV. (m)	DEPTH (m)	MATERIAL DESCRIPTION	DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY %	HEADSPACE VAPOUR	ANALYSIS
425		**TOPSOIL** sandy silt, scattered organic seams and inclusions; black to dark brown, moist no odour, no staining.	0.2	SS 1	2-5-9-12 (14)			
424	1	**SANDY SILT TILL** trace to some gravel inclusions, scattered organic inclusions in upper zone; dark brown to brown, moist, compact no odour, no staining.	1.6	SS 2	9-10-5-6 (15)			
423	2	**SILTY SAND** fine to medium grained; brown, moist to wet, compact to loose no odour, no staining.		SS 3	7-11-9-8 (20)			
422	3			SS 4	4-5-8-5 (13)			
				SS 5	5-6-8-4 (14)			
421	4			SS 6	6-6-7-6 (13)			
420	5	becoming grey at 5.0m	5.2	SS 7	4-3-5-5 (8)			

End of Borehole at 5.18 mbgs.



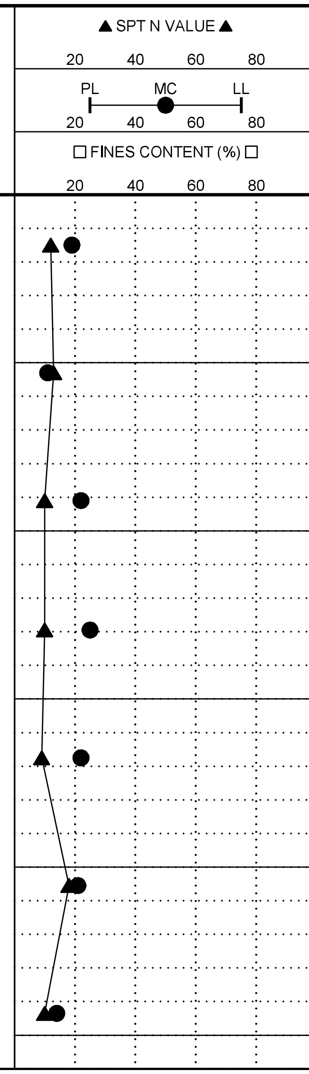
BORING NUMBER BH4

JLP
Geotechnical & Environmental Consultants

CLIENT Township of Centre Wellington
PROJECT NAME Operation Centre
PROJECT NUMBER G4599-22-6
PROJECT LOCATION 965 Gartshore Street, Fergus, Ontario
DATE STARTED 27-10-22 **COMPLETED** 27-10-22
GROUND ELEVATION 425.668 m Geodetic **HOLE SIZE** 200mm
DRILLING CONTRACTOR Pontil Drilling
GROUND WATER LEVELS:
DRILLING METHOD D50. Hollow Stem
AT TIME OF DRILLING ---
LOGGED BY GB **CHECKED BY** AL
AT END OF DRILLING ---
NOTES
AFTER DRILLING 2.21 m / Elev 423.46 m

ELEV. (m)	DEPTH (m)	MATERIAL DESCRIPTION	DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY %	HEADSPACE VAPOUR	ANALYSIS
		TOPSOIL sandy silt, scattered organic inclusions and rootlets; black to dark brown, moist no odour, no staining.	0.2	SS 1	2-5-7-5 (12)			
425	1	**SANDY SILT TILL** trace gravel inclusions, scattered organic inclusions in upper zone; dark brown to brown, moist, compact no odour, no staining.	1.5	SS 2	3-5-8-7 (13)			
424	2	**SILTY SAND** fine to medium grained; brown, wet to saturated, compact to loose no odour, no staining.		SS 3	4-5-5-5 (10)			
423	3			SS 4	4-5-5-7 (10)			
422				SS 5	2-2-7-4 (9)			
	4	becoming grey at about 4.1m	4.5	SS 6	4-10-8-4 (18)			
421	5	**SANDY SILT TILL** trace to some clay,trace gravel inclusions, scattered sand seams; grey, wet, compact no odour, no staining.	5.2	SS 7	3-6-4-5 (10)			

End of Borehole at 5.18 mbgs.



WELL CONSTRUCTION

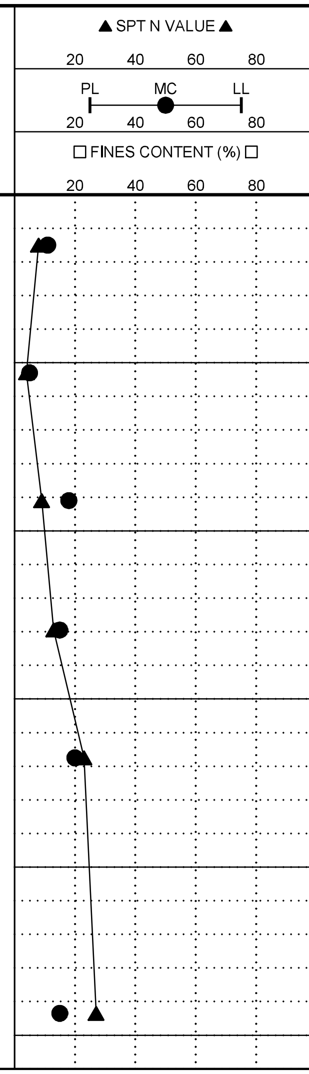
BORING NUMBER BH5

JLP
Geotechnical & Environmental Consultants

CLIENT Township of Centre Wellington
PROJECT NAME Operation Centre
PROJECT NUMBER G4599-22-6
PROJECT LOCATION 965 Gartshore Street, Fergus, Ontario
DATE STARTED 25-10-22 **COMPLETED** 25-10-22
GROUND ELEVATION 427.339 m Geodetic **HOLE SIZE** 200mm
DRILLING CONTRACTOR Pontil Drilling
GROUND WATER LEVELS:
DRILLING METHOD D50. Hollow Stem
AT TIME OF DRILLING ---
LOGGED BY GB **CHECKED BY** AL
AT END OF DRILLING ---
NOTES
AFTER DRILLING 3.82 m / Elev 423.52 m

DEPTH (m)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY %	HEADSPACE VAPOUR	ANALYSIS
0.2	**TOPSOIL** sandy silt, scattered organic seams and inclusions; black to dark brown, moist no odour, no staining.	SS 1	2-3-5-5 (8)			
	SILTY SAND fine to medium grained; brown, moist to wet, loose to compact no odour, no staining.	SS 2	3-2-2-1 (4)			
		SS 3	3-4-5-6 (9)			
		SS 4	4-6-7-8 (13)			
		SS 5	7-12-11-12 (23)			
4.8						
5.2	**SANDY SILT TILL** trace to some gravel inclusions; grey, moist, compact no odour, no staining.	SS 6	8-14-13-18 (27)			
	End of Borehole at 5.18 mbgs.					

ELEV. (m): 427, 426, 425, 424, 423
DEPTH (m): 1, 2, 3, 4, 5



WELL CONSTRUCTION

BORING NUMBER BH6

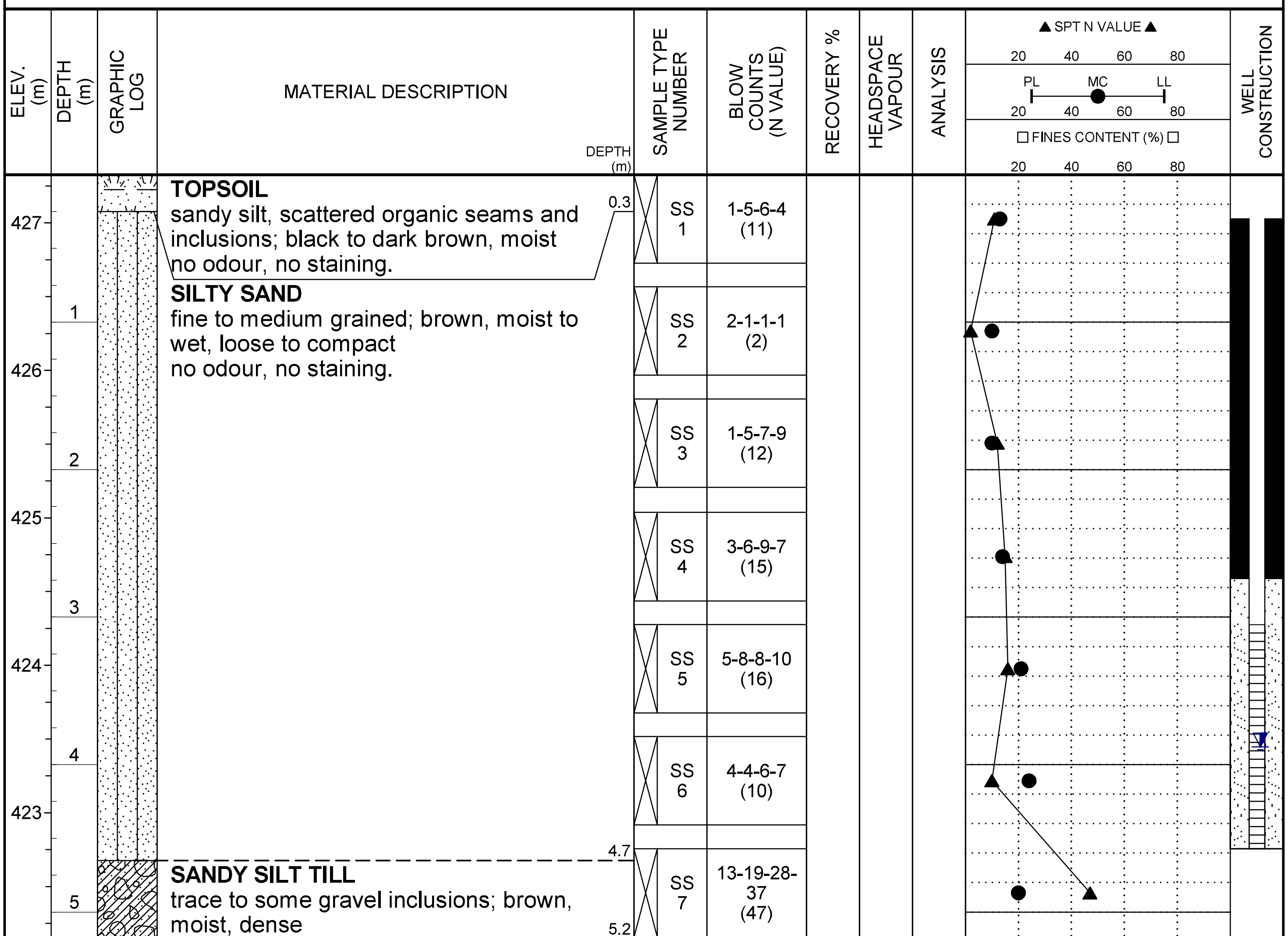
JLP

Geotechnical & Environmental Consultants

CLIENT	Township of Centre Wellington	**PROJECT NAME**	Operation Centre
PROJECT NUMBER	G4599-22-6	**PROJECT LOCATION**	965 Gartshore Street, Fergus, Ontario
DATE STARTED	25-10-22 **COMPLETED** 25-10-22	**GROUND ELEVATION**	427.327 m Geodetic **HOLE SIZE** 200mm
DRILLING CONTRACTOR	Pontil Drilling	**GROUND WATER LEVELS:**	
DRILLING METHOD	D50. Hollow Stem Auger	**AT TIME OF DRILLING**	---
LOGGED BY	GB **CHECKED BY** AL	**AT END OF DRILLING**	---
NOTES		**AFTER DRILLING**	3.88 m / Elev 423.45 m

DEPTH (m)	MATERIAL DESCRIPTION
0.0–0.3	**TOPSOIL** sandy silt, scattered organic seams and inclusions; black to dark brown, moist no odour, no staining.
0.3–4.7	**SILTY SAND** fine to medium grained; brown, moist to wet, loose to compact no odour, no staining.
4.7–5.2	**SANDY SILT TILL** trace to some gravel inclusions; brown, moist, dense no odour, no staining.
	End of Borehole at 5.18 mbgs.

SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY %	HEADSPACE VAPOUR	ANALYSIS
SS 1	1-5-6-4 (11)			
SS 2	2-1-1-1 (2)			
SS 3	1-5-7-9 (12)			
SS 4	3-6-9-7 (15)			
SS 5	5-8-8-10 (16)			
SS 6	4-4-6-7 (10)			
SS 7	13-19-28-37 (47)			



BORING NUMBER BH7D

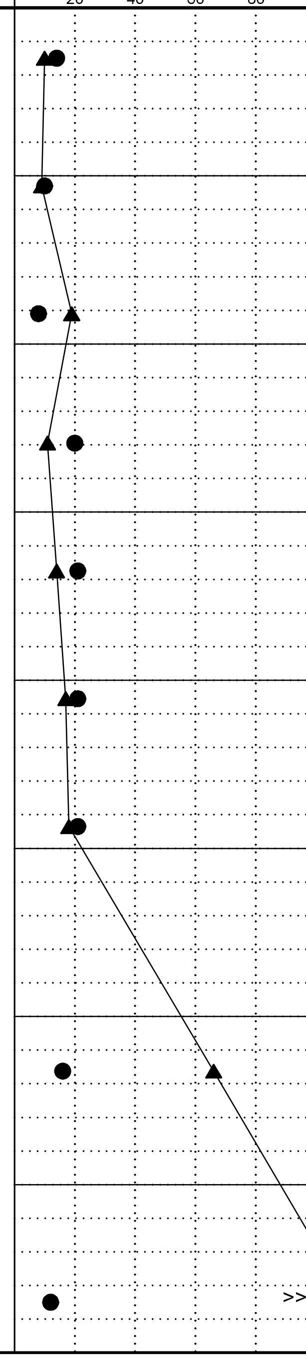
JLP
Geotechnical & Environmental Consultants

CLIENT Township of Centre Wellington
PROJECT NAME Operation Centre
PROJECT NUMBER G4599-22-6
PROJECT LOCATION 965 Gartshore Street, Fergus, Ontario
DATE STARTED 24-10-22 **COMPLETED** 25-10-22
GROUND ELEVATION 425.347 m Geodetic **HOLE SIZE** 200mm
DRILLING CONTRACTOR Pontil Drilling
GROUND WATER LEVELS:
DRILLING METHOD D50. Hollow Stem Auger
AT TIME OF DRILLING ---
LOGGED BY AK **CHECKED BY** AL
AT END OF DRILLING ---
NOTES
AFTER DRILLING 11.78 m / Elev 413.57 m

ELEV. (m)	DEPTH (m)	MATERIAL DESCRIPTION	DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY %	HEADSPACE VAPOUR	ANALYSIS
		TOPSOIL sandy silt, scattered organic seams and inclusions; black to dark brown, moist no odour, no staining.	0.2	SS 1	2-4-6-6 (10)			
		SILTY SAND fine grained, scattered organic inclusions in upper zone; dark brown to brown, moist to wet, compact no odour, no staining.		SS 2	5-4-5-6 (9)			
				SS 3	7-9-10-10 (19)			
				SS 4	3-5-6-6 (11)			
				SS 5	5-6-8-7 (14)			
				SS 6	3-8-9-9 (17)			
				SS 7	8-8-10-8 (18)			
		sand and gravel, some silt, coarse grained, clayey seams; wet		SS 8	18-16-50 (66)			
		SANDY SILT TILL some clay, trace to some gravel; grey, wet, very dense no odour, no staining.	7.3	SS 9	50/0.10			

ELEV. (m): 425, 424, 423, 422, 421, 420, 419, 418
DEPTH (m): 1, 2, 3, 4, 5, 6, 7, 8

▲ SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
☐ FINES CONTENT (%) ☐ 20 40 60 80



WELL CONSTRUCTION

(Continued Next Page)

CLIENT Township of Centre Wellington
PROJECT NAME Operation Centre
PROJECT NUMBER G4599-22-6
PROJECT LOCATION 965 Gartshore Street, Fergus, Ontario

ELEV. (m)	DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY %	HEADSPACE VAPOUR	ANALYSIS	▲ SPT N VALUE ▲ / PL MC LL / ☐ FINES CONTENT (%) ☐	WELL CONSTRUCTION
417			**SANDY SILT TILL** some clay, trace to some gravel; grey, wet, very dense no odour, no staining. *(continued)*							
	9									
416				SS 10	50/0.13				>>	
	10									
415										
	11			SS 11	41-50					
414										
	12									
413				SS 12	50/0.10				>>	
	13									
412										
	14			SS 13	45-45-50 (95)					
411										
	15									
410				SS 14	16-16-50 (66)					
	16									
409										
	17			SS 15	50/0.13				>>	

(Continued Next Page)

BORING NUMBER BH7D

JLP
Geotechnical & Environmental Consultants

CLIENT Township of Centre Wellington
PROJECT NAME Operation Centre
PROJECT NUMBER G4599-22-6
PROJECT LOCATION 965 Gartshore Street, Fergus, Ontario

ELEV. (m)	DEPTH (m)	MATERIAL DESCRIPTION	DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY %	HEADSPACE VAPOUR	ANALYSIS	▲ SPT N VALUE ▲ / PL MC LL / ☐ FINES CONTENT (%) ☐	WELL CONSTRUCTION
408		**SANDY SILT TILL** some clay, trace to some gravel; grey, wet, very dense no odour, no staining. *(continued)*								
	18									
407				SS 16	50/0.13				>>▲	
	19									
406										
	20			SS 17	50/0.13				>>▲	
405										
	21									
404				SS 18	50/0.13				>>▲	
	22									
403										
	23			SS 19	50/0.13				>>▲	
402										
	24									
401				SS 20	50/0.13				>>▲	
	25		25.3	SS 21	40-50					

End of Borehole at 25.3 mbgs.

BORING NUMBER BH7S

JLP
Geotechnical & Environmental Consultants

CLIENT	Township of Centre Wellington	PROJECT NAME	Operation Centre
PROJECT NUMBER	G4599-22-6	PROJECT LOCATION	965 Gartshore Street, Fergus, Ontario
DATE STARTED	25-10-22	COMPLETED	25-10-22
GROUND ELEVATION	425.347 m Geodetic	HOLE SIZE	200mm
DRILLING CONTRACTOR	Pontil Drilling	GROUND WATER LEVELS:	
DRILLING METHOD	D50. Hollow Stem Auger	AT TIME OF DRILLING	---
LOGGED BY	GB	CHECKED BY	AL
		AT END OF DRILLING	---
NOTES		AFTER DRILLING	2.72 m / Elev 422.63 m

ELEV. (m)	DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY %	HEADSPACE VAPOUR	ANALYSIS	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80	WELL CONSTRUCTION
425			**TOPSOIL** sandy silt, scattered organic seams and inclusions; black to dark brown, moist no odour, no staining.	0.2							
424	1		**SILTY SAND** fine grained, scattered organic inclusions in upper zone; dark brown to brown, moist to wet, compact no odour, no staining.								
423	2										
422	3										
421	4										
	5			5.2							

End of Borehole at 5.18 mbgs.

BURNSIDE

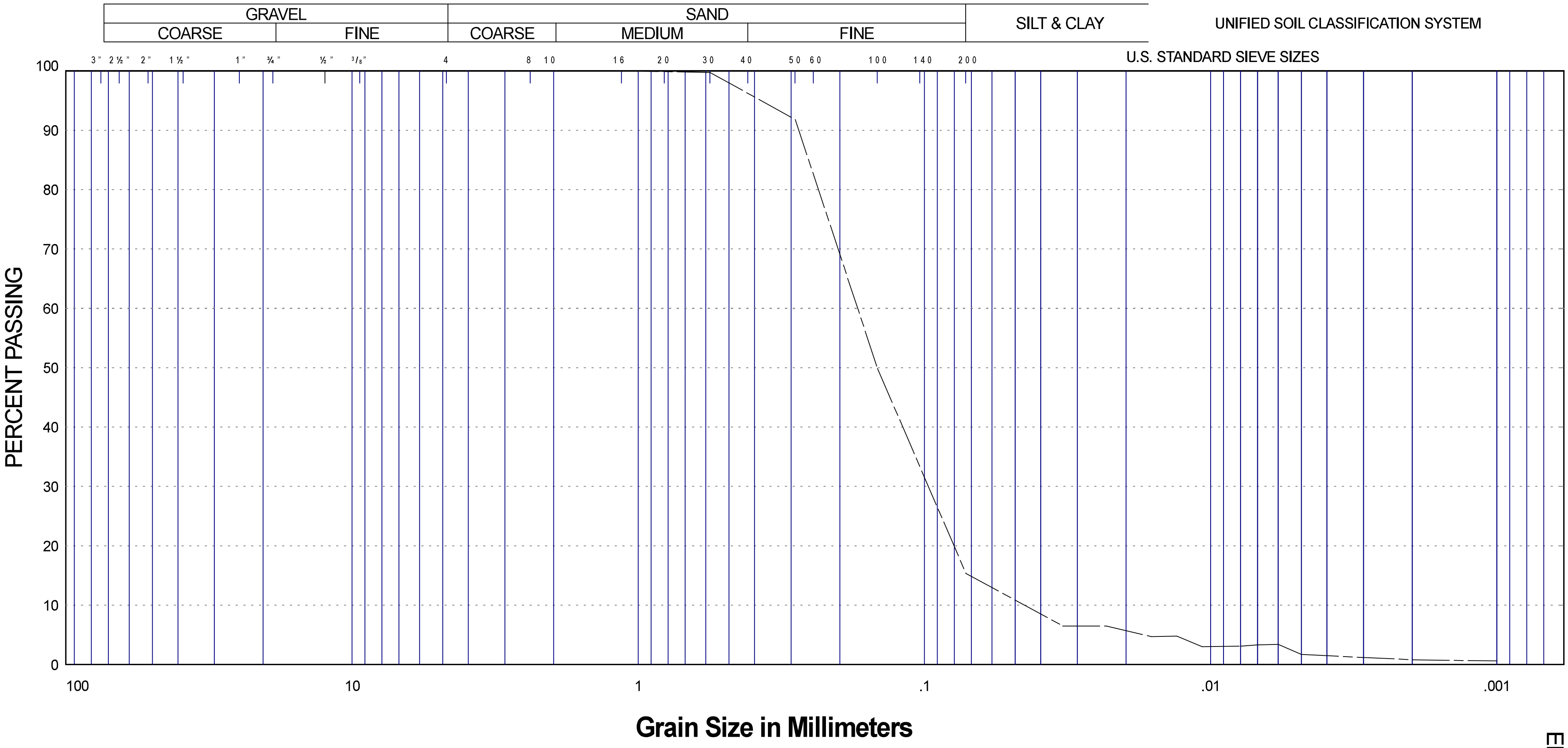
[THE DIFFERENCE IS OUR PEOPLE]

Appendix C

Hydraulic Conductivity

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G4599-22-6



PROJECT: Operations Centre
LOCATION: 965 Gartshore Street, Fergus, ON
BOREHOLE N°: 1
SAMPLE N°: 6
DEPTH: 3.8 - 4.4 m±
ELEVATION: 420.1 - 419.5 m±

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SAND, some silt

PLASTIC PROPERTIES

LIQUID LIMIT	% = -
PLASTIC LIMIT	% = -
PLASTICITY INDEX	% = -
MOISTURE CONTENT	% = 18.6

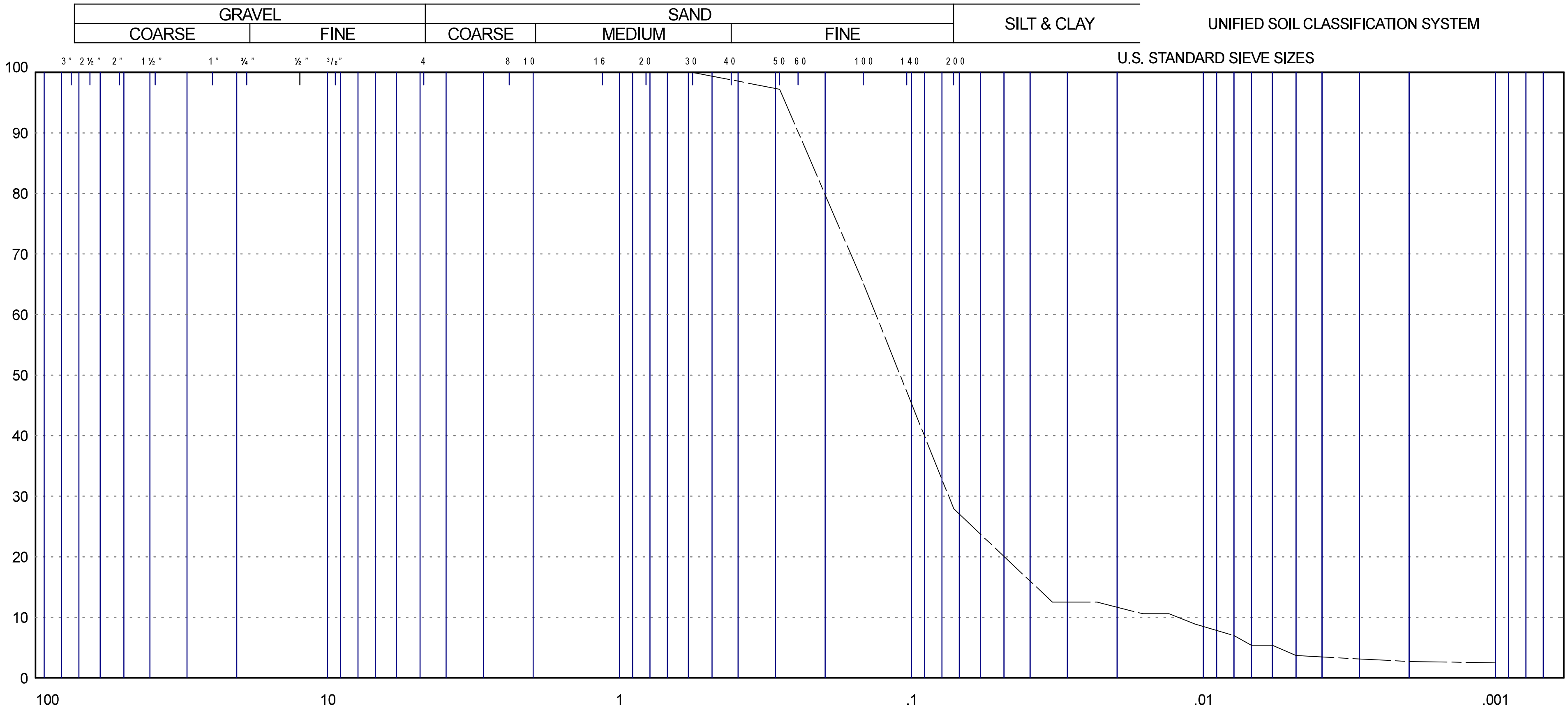
ENCLOSURE N° 11

JLP SERVICES INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G4599-22-6

UNIFIED SOIL CLASSIFICATION SYSTEM



Grain Size in Millimeters

PROJECT: Operations Centre
LOCATION: 965 Gartshore Street, Fergus, ON
BOREHOLE N°: 7
SAMPLE N°: 7
DEPTH: 4.6 - 5.2 m±
ELEVATION: 420.8 - 420.2 m±

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SILTY SAND, trace clay

PLASTIC PROPERTIES

LIQUID LIMIT	% = -
PLASTIC LIMIT	% = -
PLASTICITY INDEX	% = -
MOISTURE CONTENT	% = 20.0

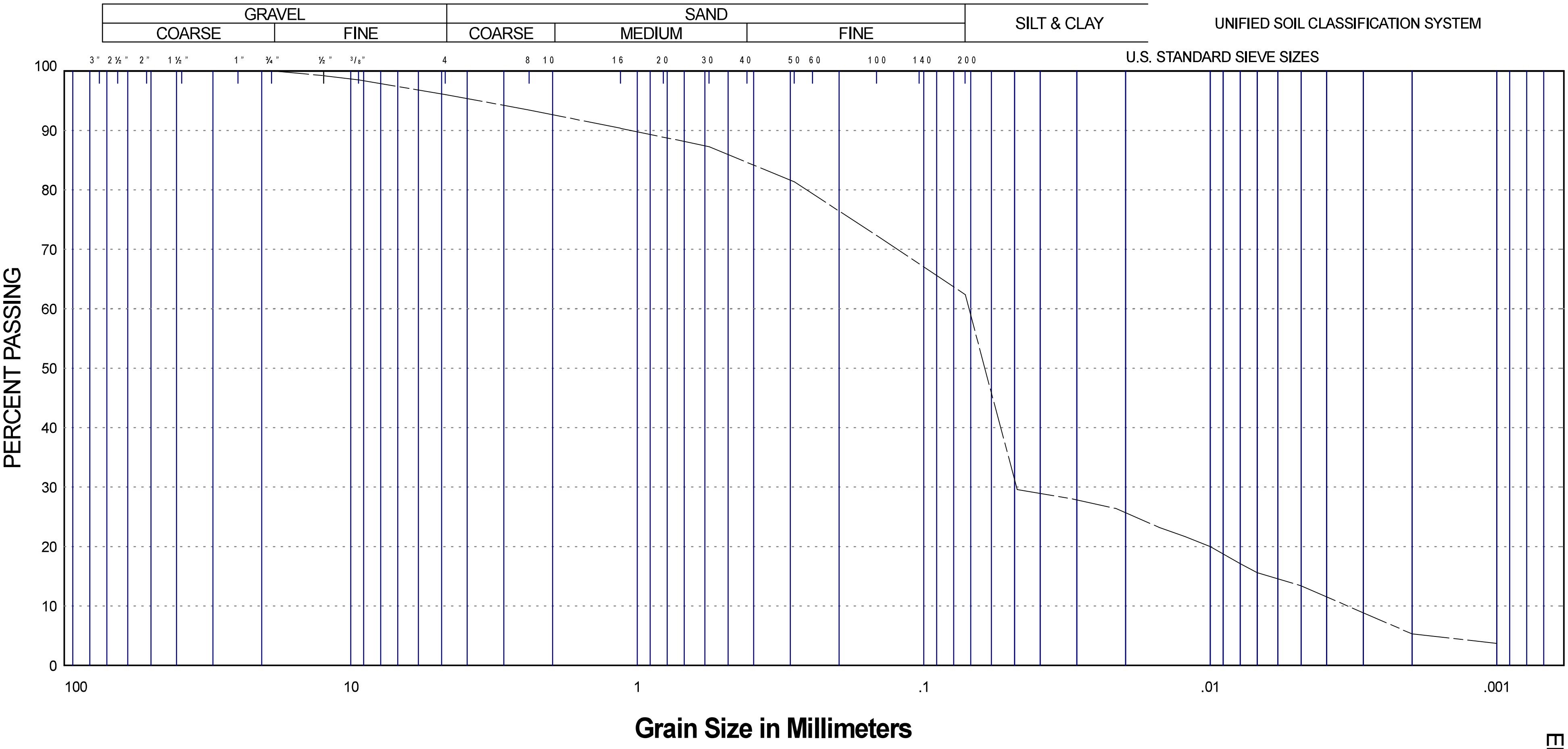
ENCLOSURE N° 12

JLP SERVICES INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G4599-22-6

UNIFIED SOIL CLASSIFICATION SYSTEM



PROJECT: Operations Centre

LOCATION: 965 Gartshore Street, Fergus, ON

BOREHOLE N°: 1

SAMPLE N°: 12

DEPTH: 12.2 - 12.8 m±

ELEVATION: 411.7 - 411.1 m±

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SANDY SILT, trace clay, trace gravel (ML)

PLASTIC PROPERTIES

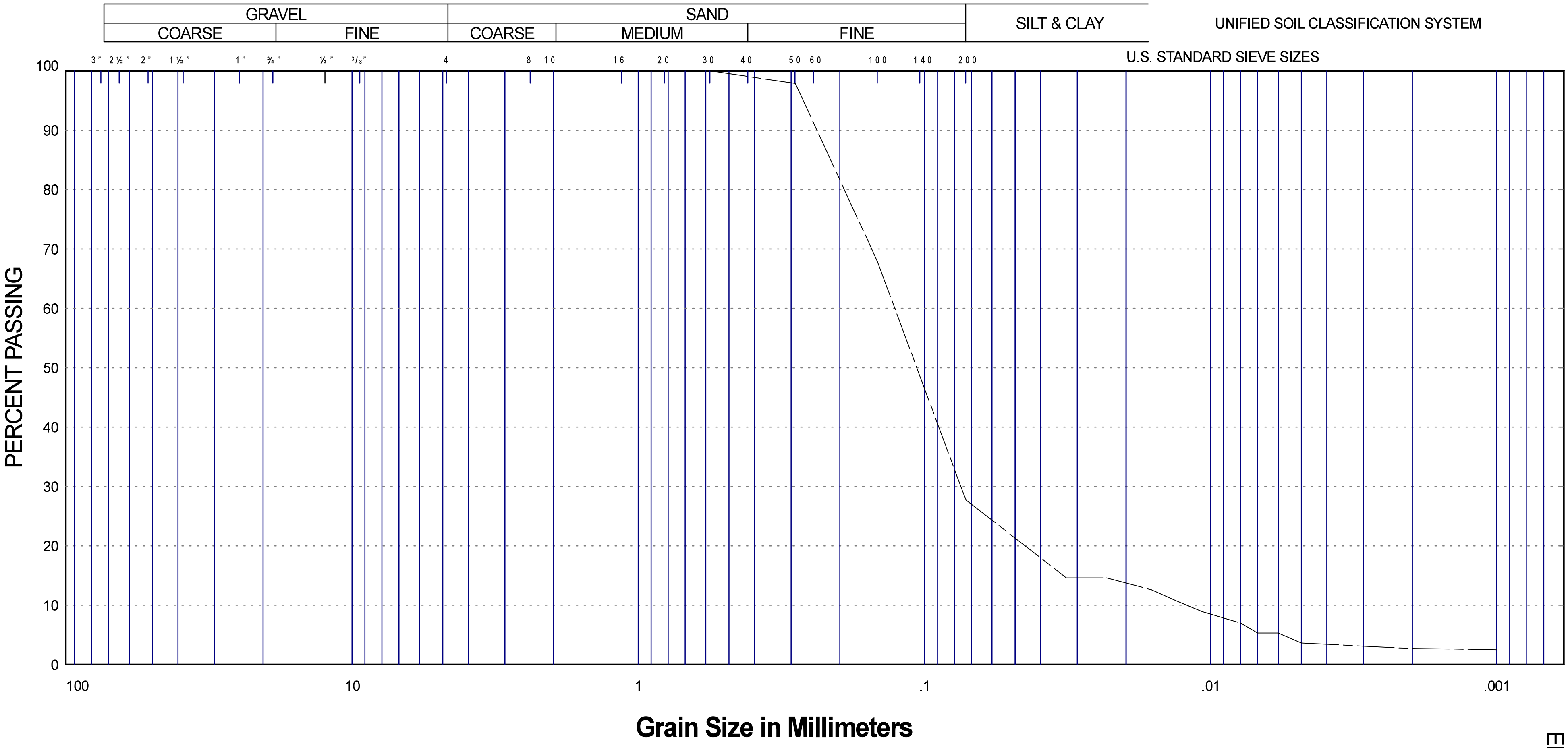
LIQUID LIMIT	% = 10.6
PLASTIC LIMIT	% = 9.2
PLASTICITY INDEX	% = 1.4
MOISTURE CONTENT	% = 10.0

ENCLOSURE N° 13

JLP SERVICES INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G4599-22-6



PROJECT: Operations Centre

LOCATION: 965 Gartshore Street, Fergus, ON

BOREHOLE N°: 7

SAMPLE N°: 15

DEPTH: 16.8 - 17.4 m±

ELEVATION: 408.6 -408.0 m±

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SILTY SAND, trace clay (SM)

PLASTIC PROPERTIES

LIQUID LIMIT % = -

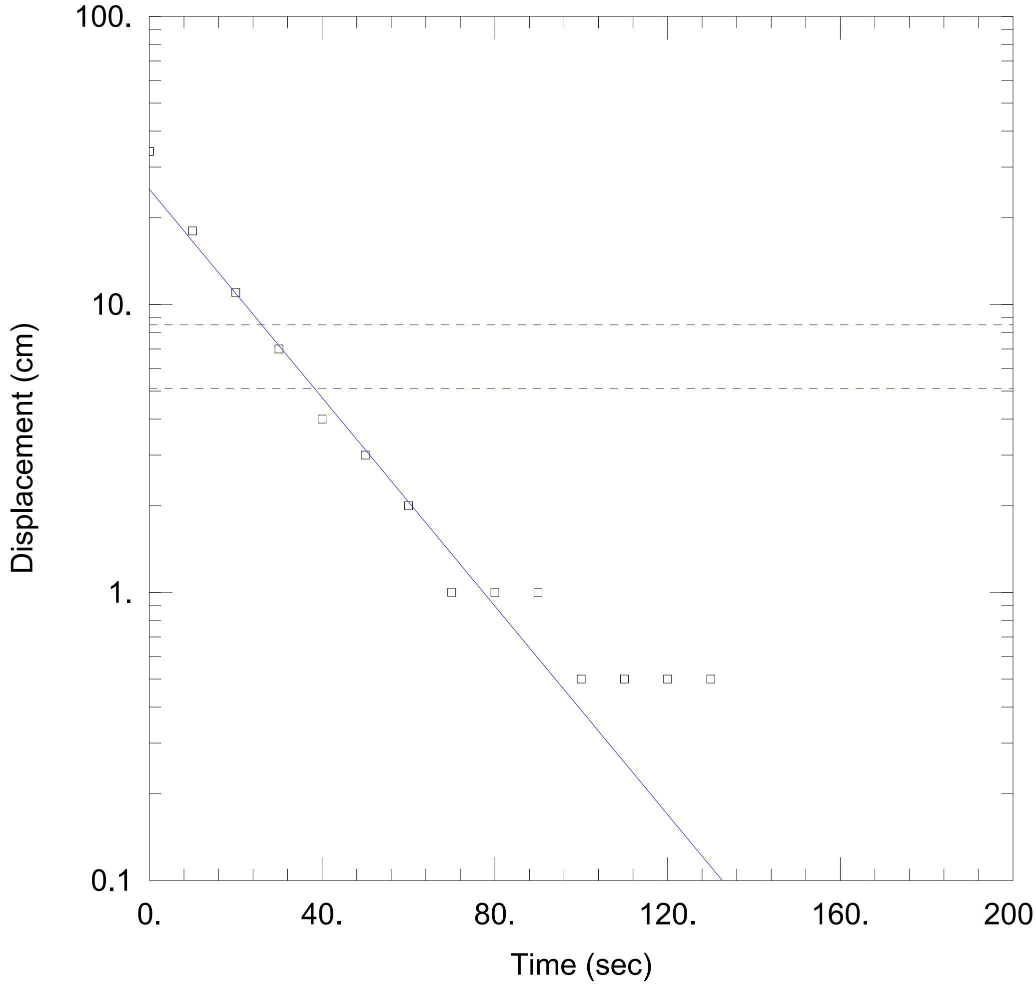
PLASTIC LIMIT % = -

PLASTICITY INDEX % = -

MOISTURE CONTENT % = 21.5

ENCLOSURE N° 14

JLP SERVICES INC.



HYDRAULIC CONDUCTIVITY TEST - BH2 - RISING HEAD SLUG - SCREENED IN SILTY SAND

PROJECT INFORMATION

Company: R.J. Burnside
Client: Centre Wellington
Project: 300055234
Location: Fergus, ON
Test Well: BH2
Test Date: Dec 1 2022

AQUIFER DATA

Saturated Thickness: 334. cm

Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH2)

Initial Displacement: 34. cm
Total Well Penetration Depth: 573. cm
Casing Radius: 2.54 cm

Static Water Column Height: 334. cm
Screen Length: 152. cm
Well Radius: 10. cm

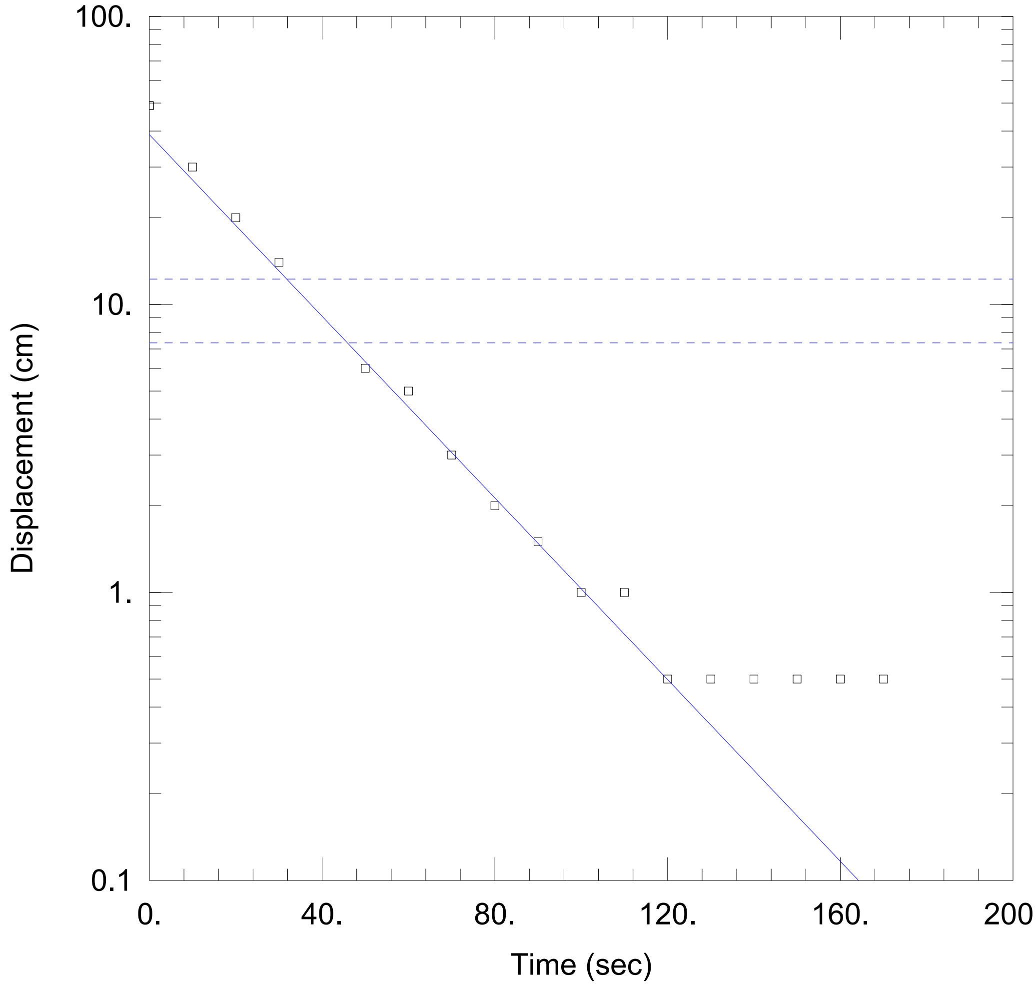
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 0.004037 cm/sec

y0 = 25.11 cm



HYDRAULIC CONDUCTIVITY TEST - BH3 - RISING HEAD SLUG - SCREENED IN SILTY SAND

PROJECT INFORMATION

Company: R.J. Burnside
Client: Centre Wellington
Project: 300055234
Location: Fergus, ON
Test Well: BH3
Test Date: Dec 1 2022

AQUIFER DATA

Saturated Thickness: 202. cm
Anisotropy Ratio (Kz/Kr): 0.1

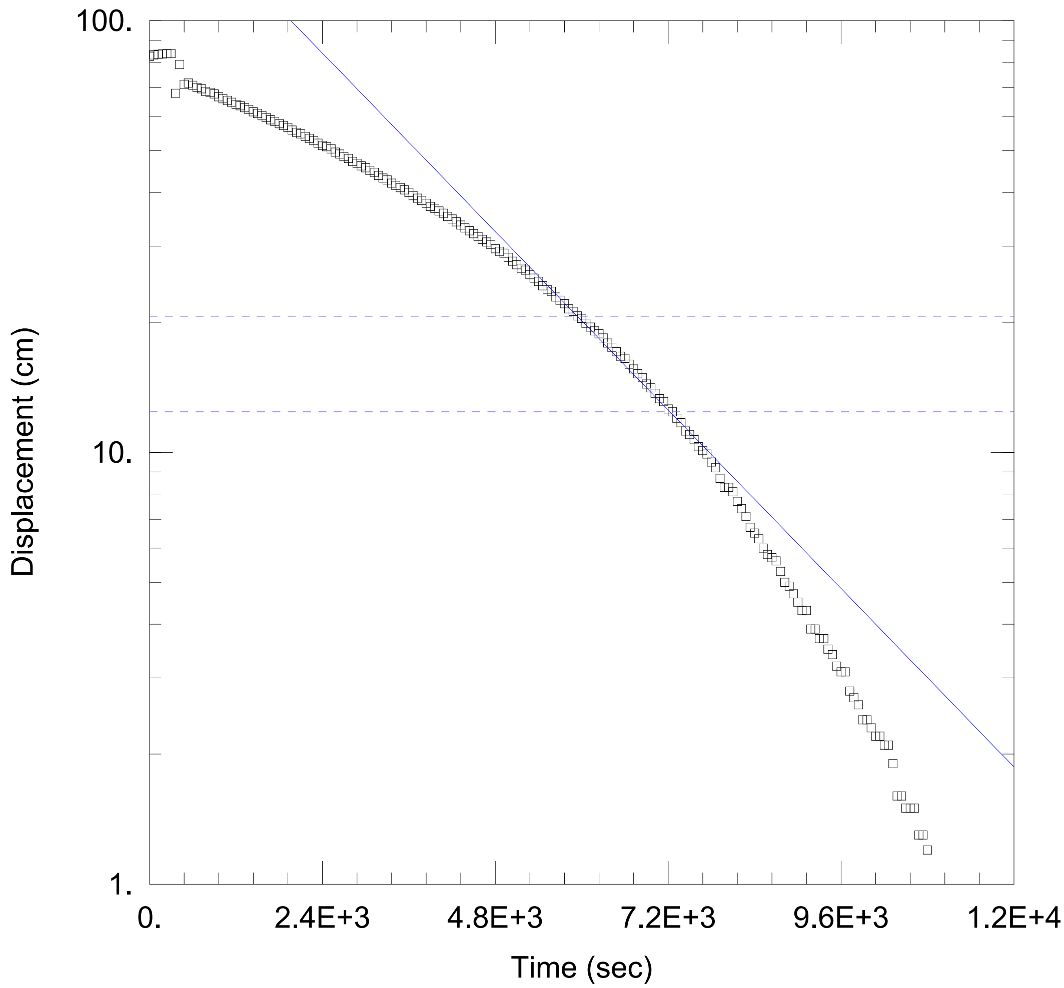
WELL DATA (BH3)

Initial Displacement: 49. cm
Total Well Penetration Depth: 575. cm
Casing Radius: 2.54 cm
Static Water Column Height: 202. cm
Screen Length: 152. cm
Well Radius: 10. cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 0.003518 cm/sec
y0 = 38.85 cm



HYDRAULIC CONDUCTIVITY TEST - BH5 - RISING HEAD SLUG - SCREENED IN SILTY SAND

PROJECT INFORMATION

Company: R.J. Burnside
Client: Centre Wellington
Project: 300055234
Location: Fergus, ON
Test Well: BH3
Test Date: Dec 1 2022

AQUIFER DATA

Saturated Thickness: 90. cm

Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH5)

Initial Displacement: 82.7 cm
Total Well Penetration Depth: 152. cm
Casing Radius: 2.54 cm

Static Water Column Height: 90. cm
Screen Length: 152. cm
Well Radius: 10. cm
Gravel Pack Porosity: 0.3

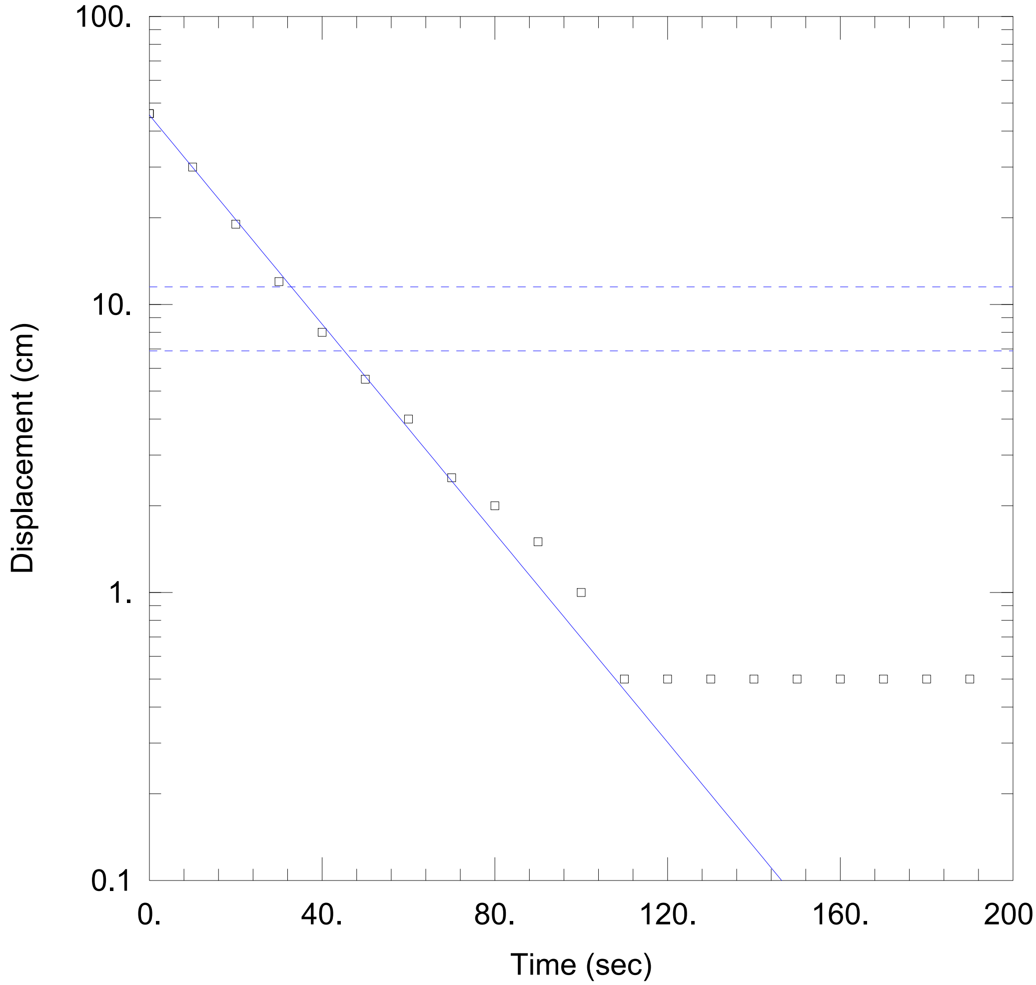
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 0.0004029 cm/sec

y0 = 217.6 cm



HYDRAULIC CONDUCTIVITY TEST - BH7S - RISING HEAD SLUG - SCREENED IN SILTY SAND

PROJECT INFORMATION

Company: R.J. Burnside
Client: Centre Wellington
Project: 300055234
Location: Fergus, ON
Test Well: BH7S
Test Date: Dec 1 2022

AQUIFER DATA

Saturated Thickness: 200. cm
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH7S)

Initial Displacement: 46. cm
Total Well Penetration Depth: 575. cm
Casing Radius: 2.54 cm
Static Water Column Height: 200. cm
Screen Length: 152. cm
Well Radius: 10. cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 0.004049 cm/sec
y0 = 45.42 cm

[THE DIFFERENCE IS OUR PEOPLE]

Appendix D

Groundwater Levels

Appendix D

Centre Wellington Operations Centre

Table D-1 - Groundwater Elevations

Monitoring Well	Stick-up (magl)	Well Depth (mbgl)	Ground Elevation* (masl)	Measuring Point Elevation (masl)	01-Dec-22		05-Dec-22		16-Jan-23		08-Feb-23	
					Water Level (mbgl)	Water Elevation (masl)	Water Level (mbgl)	Water Elevation (masl)	Water Level (mbgl)	Water Elevation (masl)	Water Level (mbgl)	Water Elevation (masl)
BH1s	1.02	**4.36**	**423.81**	424.83	1.34	422.47	1.34	422.47	1.27	422.54	1.34	422.47
BH1d	1.14	**14.54**	**423.88**	425.02	2.47	421.41	2.43	421.45	2.46	421.42	2.57	421.31
BH2	1.16	**4.57**	**423.47**	424.63	1.23	422.24	1.23	422.24	1.22	422.25	1.31	422.16
BH3	1.05	**4.70**	**425.06**	426.11	2.68	422.38	2.64	422.42	2.46	422.60	2.57	422.49
BH4	1.17	**4.24**	**425.67**	426.84	2.25	423.42	2.21	423.46	1.92	423.75	2.05	423.62
BH5	1.12	**4.71**	**427.34**	428.46	3.81	423.53	3.82	423.52	3.70	423.64	3.62	423.72
BH6	1.02	**4.66**	**427.33**	428.35	3.88	423.45	3.88	423.45	3.70	423.63	3.75	423.58
BH7s	0.98	**4.77**	**425.35**	426.33	2.77	422.58	2.72	422.63	2.51	422.84	2.64	422.71
BH7d	1.12	**25.16**	**425.35**	426.47	11.83	413.52	11.78	413.57	11.75	413.60	11.76	413.59

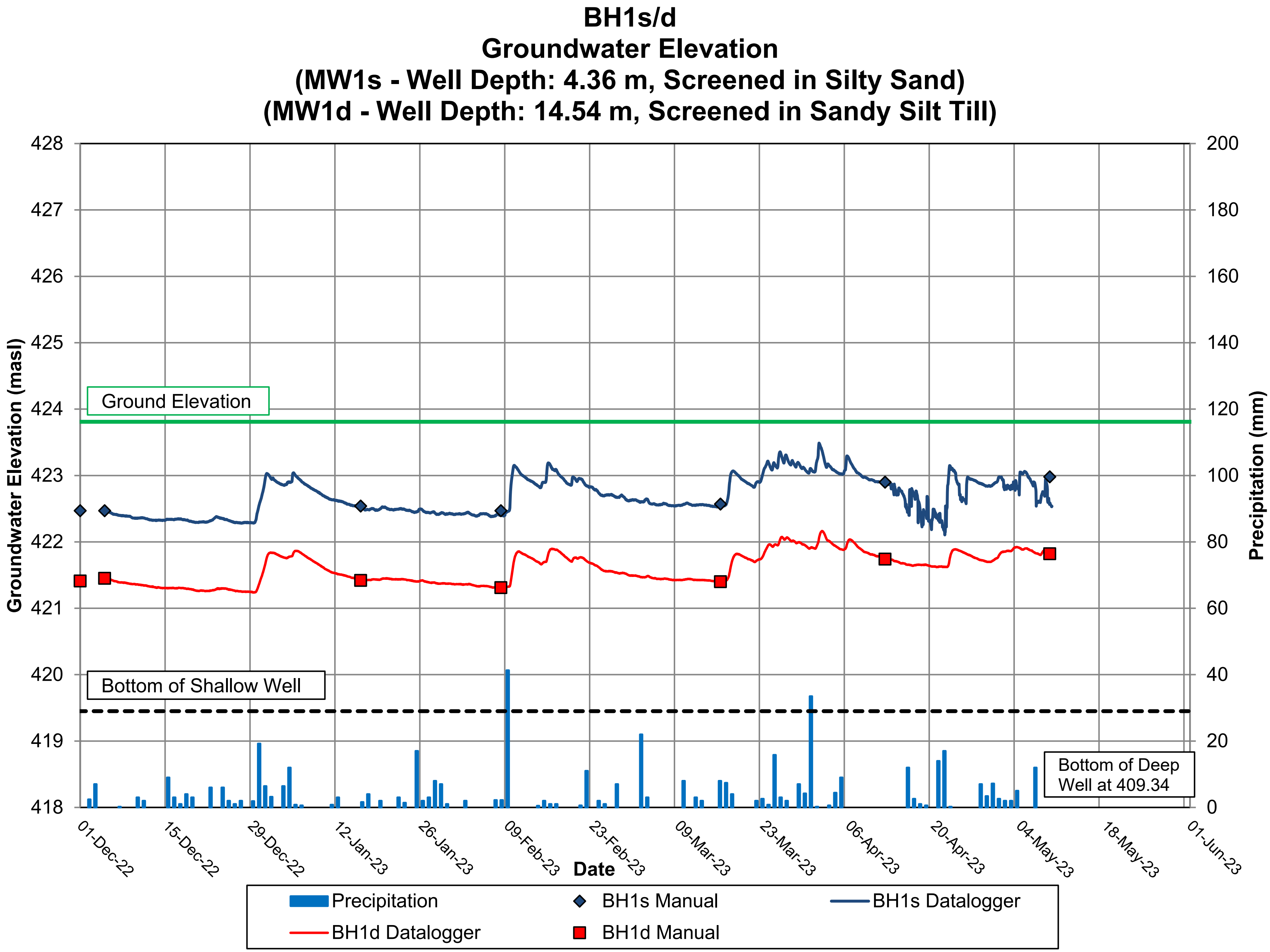
magl - metres above ground level
mbgl - metres below ground level
masl - metres above sea level
* surveyed ground elevations (JLP, 2022)

Centre Wellington Operations Centre

Table D-1 - Groundwater Elevations

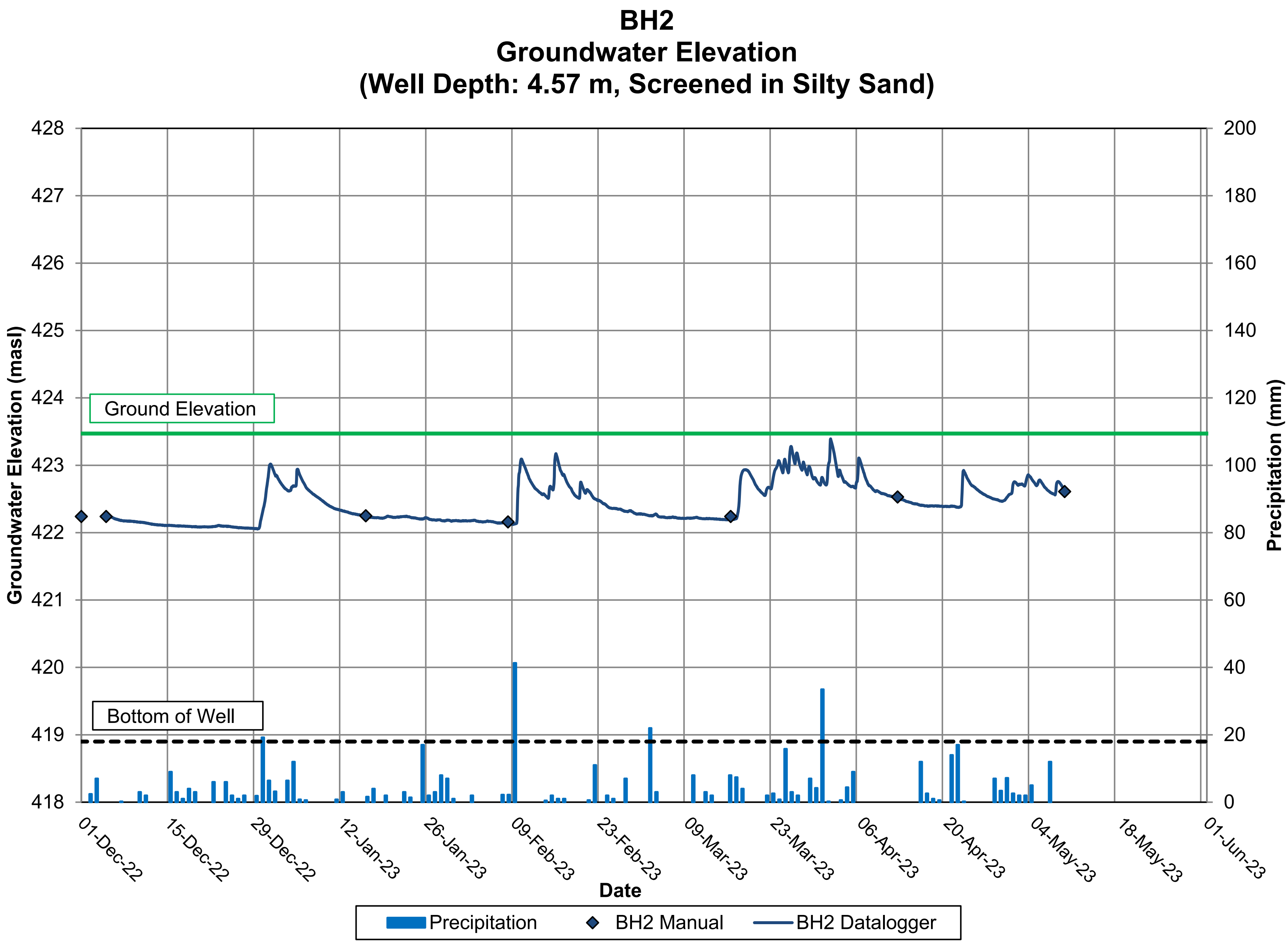
Monitoring Well	Stick-up (magl)	Well Depth (mbgl)	Ground Elevation* (masl)	Measuring Point Elevation (masl)	16-Mar-23		12-Apr-23		09-May-23	
					Water Level (mbgl)	Water Elevation (masl)	Water Level (mbgl)	Water Elevation (masl)	Water Level (mbgl)	Water Elevation (masl)
BH1s	1.02	**4.36**	**423.81**	424.83	1.24	422.57	0.91	422.90	0.83	422.98
BH1d	1.14	**14.54**	**423.88**	425.02	2.48	421.40	2.14	421.74	2.06	421.82
BH2	1.16	**4.57**	**423.47**	424.63	1.23	422.24	0.94	422.53	0.86	422.61
BH3	1.05	**4.70**	**425.06**	426.11	2.36	422.70	1.65	423.41	1.58	423.48
BH4	1.17	**4.24**	**425.67**	426.84	1.83	423.84	0.50	425.17	0.71	424.96
BH5	1.12	**4.71**	**427.34**	428.46	3.30	424.04	2.41	424.93	2.31	425.03
BH6	1.02	**4.66**	**427.33**	428.35	3.47	423.86	2.85	424.48	2.71	424.62
BH7s	0.98	**4.77**	**425.35**	426.33	2.43	422.92	1.74	423.61	1.64	423.71
BH7d	1.12	**25.16**	**425.35**	426.47	11.38	413.97	10.72	414.63	10.50	414.85

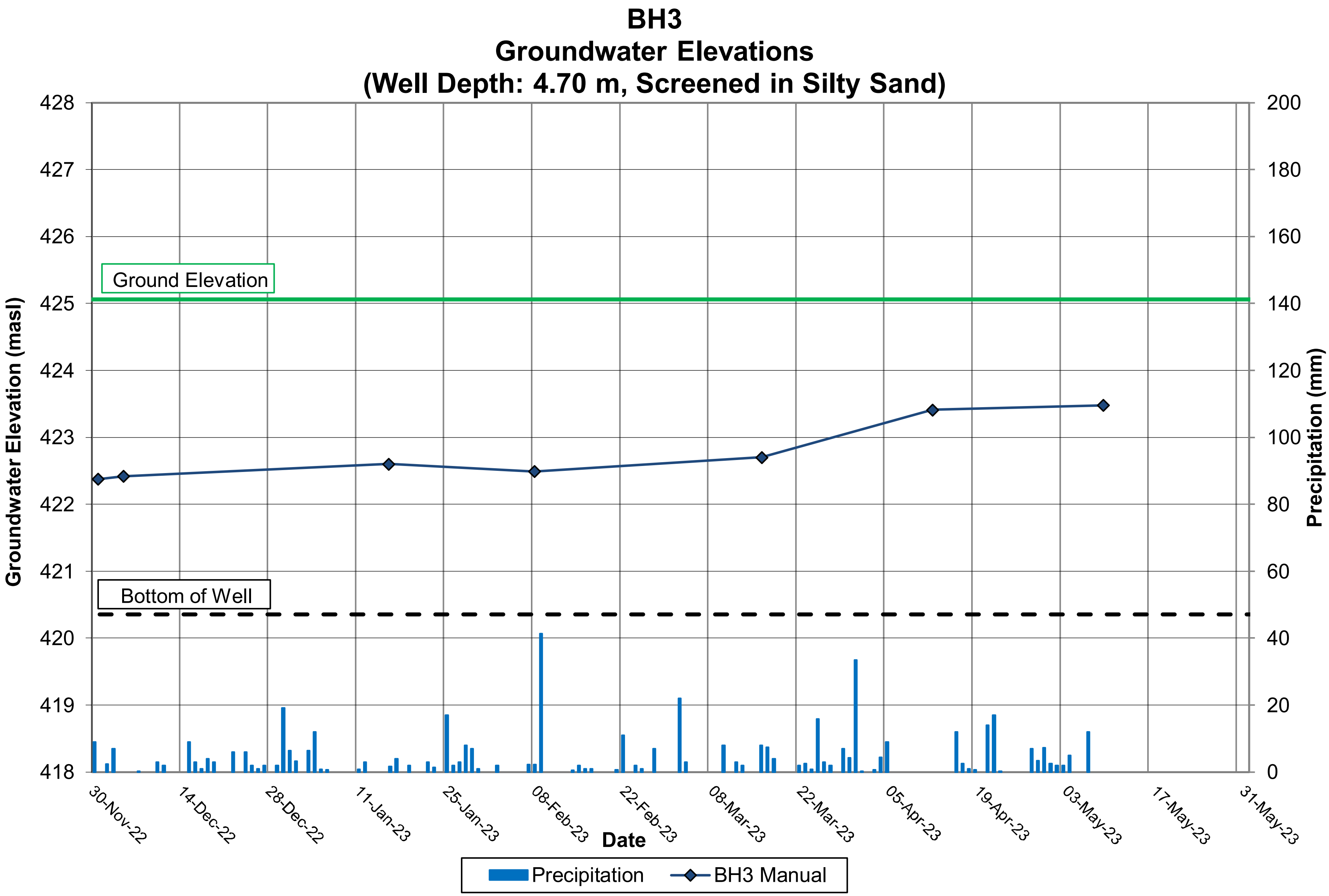
magl - metres above ground level
mbgl - metres below ground level
masl - metres above sea level
* surveyed ground elevations (JLP, 2022)



R.J. Burnside & Associates Limited
300055234

Figure D-1


BH2
Groundwater Elevation
(Well Depth: 4.57 m, Screened in Silty Sand)
Groundwater Elevation (masl)
Precipitation (mm)
Ground Elevation
Bottom of Well
428
427
426
425
424
423
422
421
420
419
418
200
180
160
140
120
100
80
60
40
20
0
01-Dec-22
15-Dec-22
29-Dec-22
12-Jan-23
26-Jan-23
09-Feb-23
23-Feb-23
09-Mar-23
23-Mar-23
06-Apr-23
20-Apr-23
04-May-23
18-May-23
01-Jun-23
Date
Precipitation
BH2 Manual
BH2 Datalogger



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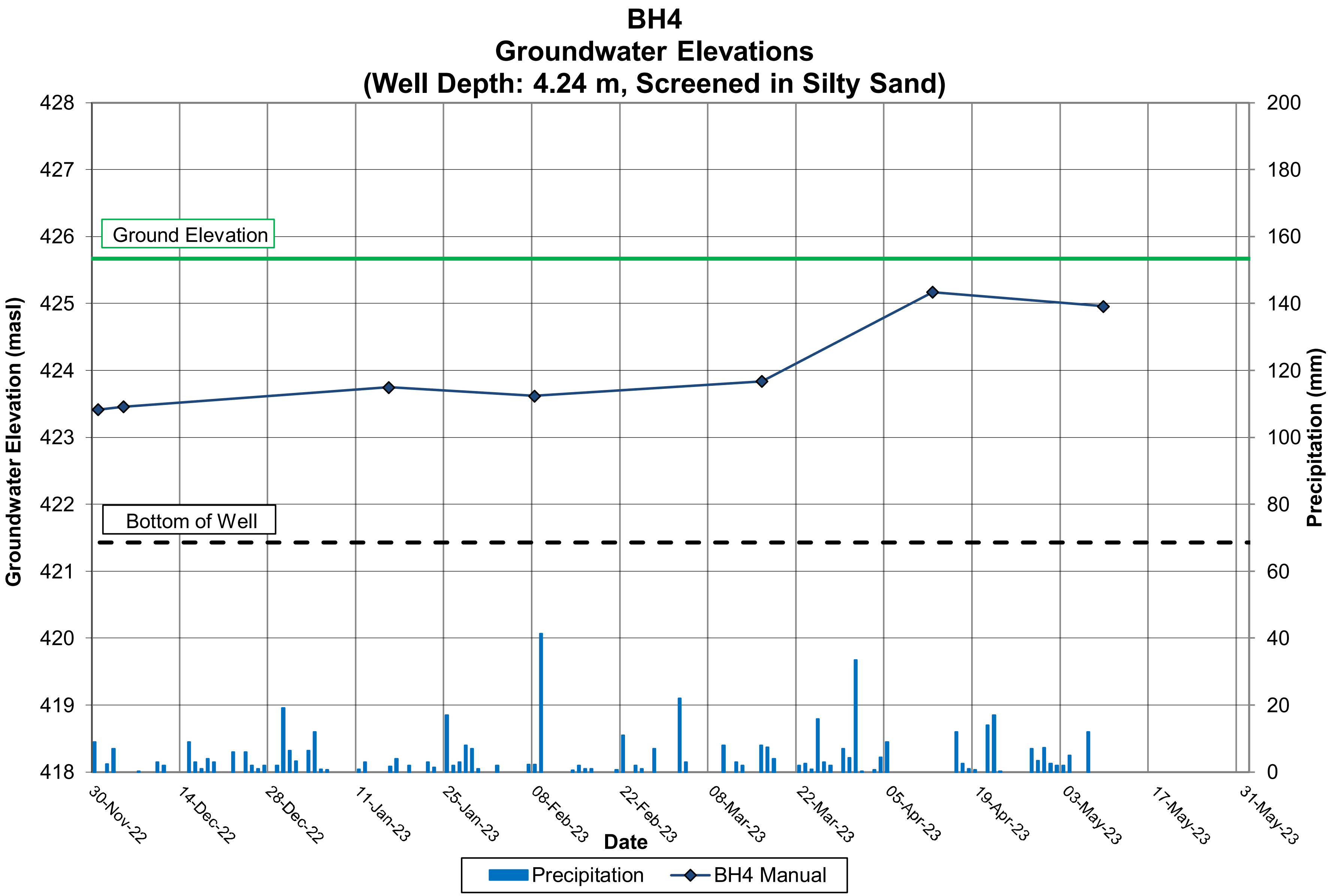
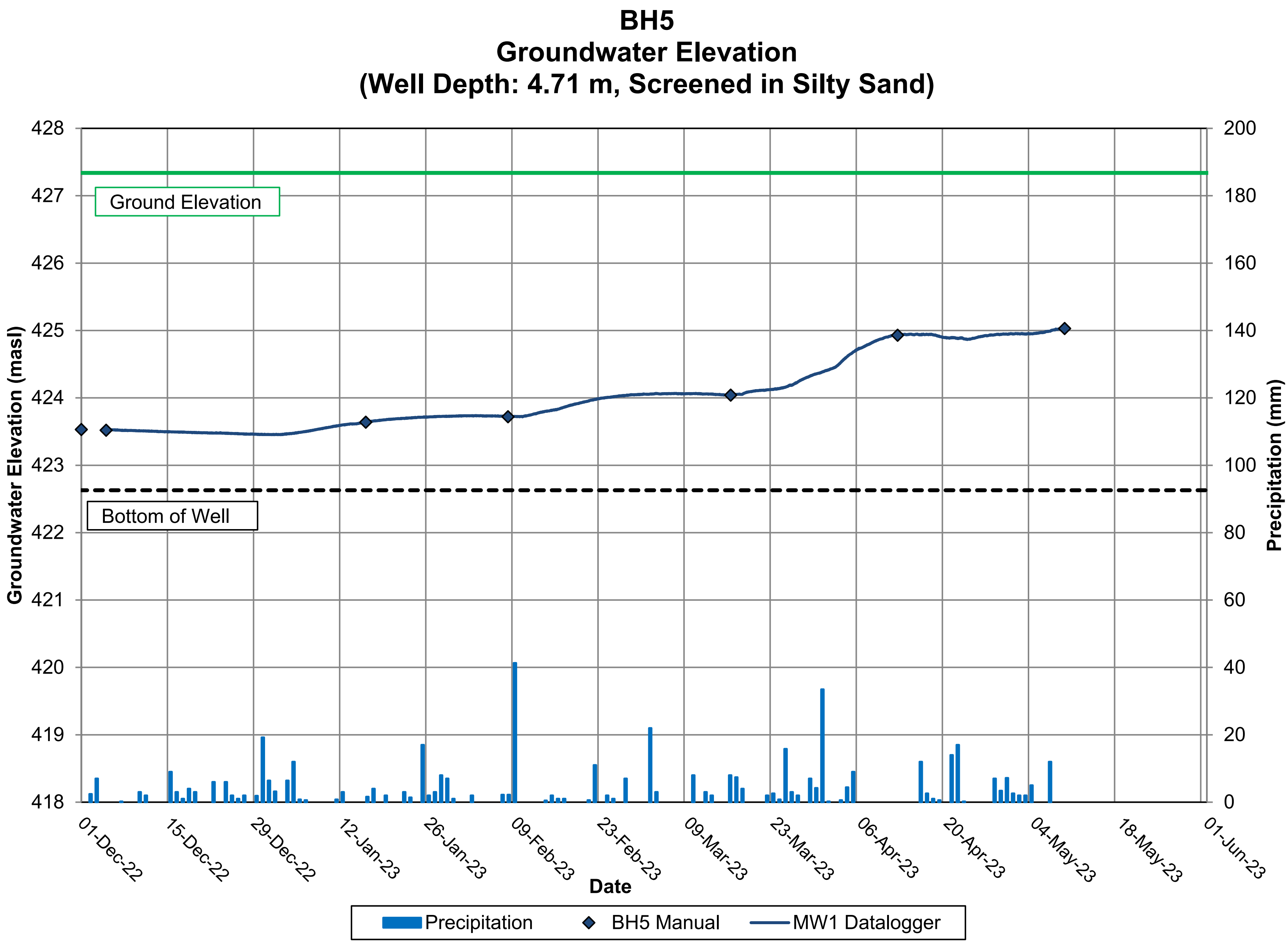
300055234

Figure D-3



BH4
Groundwater Elevations
(Well Depth: 4.24 m, Screened in Silty Sand)
Groundwater Elevation (masl)
Precipitation (mm)
Ground Elevation
Bottom of Well
428
427
426
425
424
423
422
421
420
419
418
200
180
160
140
120
100
80
60
40
20
0
30-Nov-22
14-Dec-22
28-Dec-22
11-Jan-23
25-Jan-23
08-Feb-23
22-Feb-23
08-Mar-23
22-Mar-23
05-Apr-23
19-Apr-23
03-May-23
17-May-23
31-May-23
Date
Precipitation
BH4 Manual

Figure D-4


BH5
Groundwater Elevation
(Well Depth: 4.71 m, Screened in Silty Sand)
Ground Elevation
Bottom of Well
Groundwater Elevation (masl)
Precipitation (mm)
428
427
426
425
424
423
422
421
420
419
418
200
180
160
140
120
100
80
60
40
20
0
01-Dec-22
15-Dec-22
29-Dec-22
12-Jan-23
26-Jan-23
09-Feb-23
23-Feb-23
09-Mar-23
23-Mar-23
06-Apr-23
20-Apr-23
04-May-23
18-May-23
01-Jun-23
Date
Precipitation
BH5 Manual
MW1 Datalogger

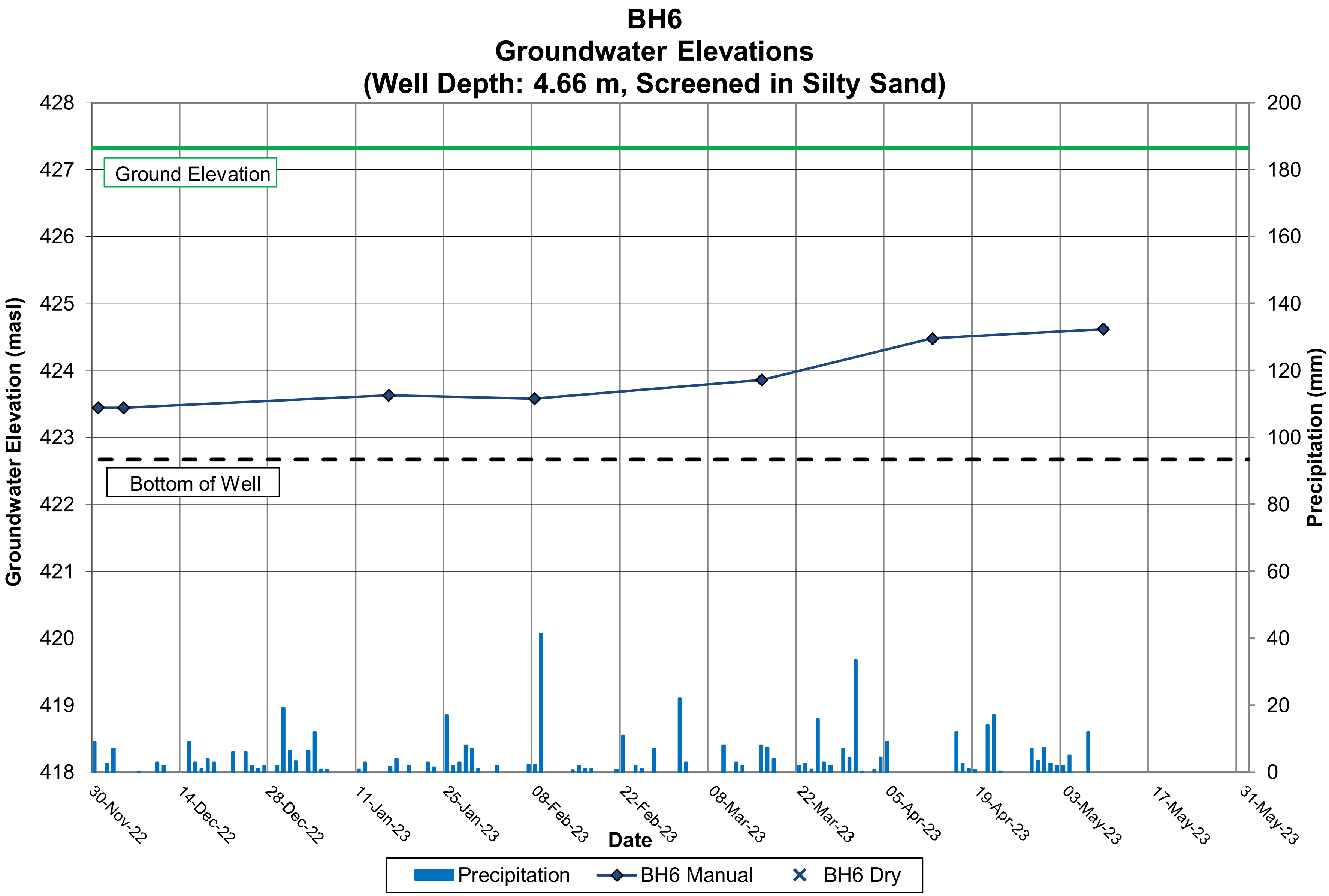


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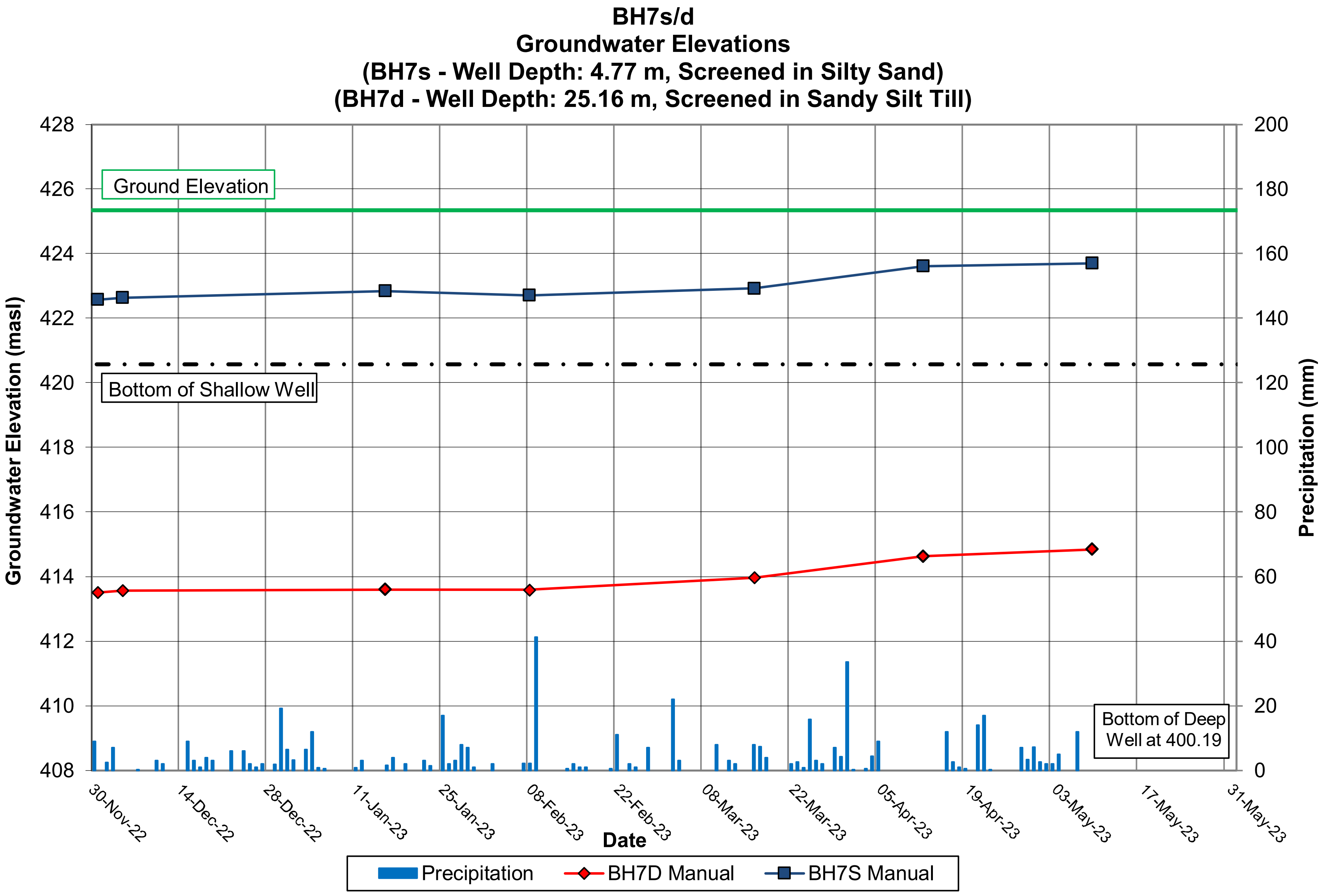
Figure D-6



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300055234

Figure D-7

[The Difference is our People]

Appendix E

Groundwater Quality

BURNSIDE

Centre Wellington Operations Centre
Table E-1
Groundwater Analysis Results

			Location	**BH2**	**BH5**
			Matrix	Groundwater	Groundwater
			Sampling Date	**12/1/2022**	**12/1/2022**
Parameter	***ODWS***	***RDL***	***UNITS***	***Result***	***Result***
Anion Sum	-	N/A	me/L	6.64	7.34
Bicarb. Alkalinity (calc. as CaCO3)	$30\text{-}500_{OG}$	1.0	mg/L	240	250
Calculated TDS	500_{AO}	1.0	mg/L	370	410
Carb. Alkalinity (calc. as CaCO3)	-	1.0	mg/L	2	3
Cation Sum	-	N/A	me/L	7.54	8.02
Hardness (CaCO3)	$80\text{-}100_{OG}$	1.0	mg/L	**330**	**370**
Ion Balance (% Difference)	-	N/A	%	6.35	4.44
Langelier Index (@ 20C)	-	N/A	N/A	1	1
Langelier Index (@ 4C)	-	N/A	N/A	0.693	0.768
Saturation pH (@ 20C)	-	N/A	N/A	7	7
Saturation pH (@ 4C)	-	N/A	N/A	7.31	7.28
Total Ammonia-N	-	0.1	mg/L	ND	0
Conductivity	-	1.0	umho/cm	680	710
Dissolved Organic Carbon	5_{AO}	0.5	mg/L	1	1
Orthophosphate (P)	-	0.010	mg/L	ND	ND
pH	$6.5\text{-}8.5_{OG}$	N/A	pH	8	8
Dissolved Sulphate (SO4)	500_{AO}	1.0	mg/L	4.6	53.0
Alkalinity (Total as CaCO3)	-	1.0	mg/L	240	260
Dissolved Chloride (Cl-)	250_{AO}	1.0	mg/L	47	36
Nitrite (N)	1_{MAC}	0.0	mg/L	ND	0
Nitrate (N)	10_{MAC}	0.10	mg/L	4.80	1.06
Nitrate + Nitrite (N)	10_{MAC}	0.1	mg/L	5	1
Dissolved Aluminum (Al)	0.1_{OG}	0.0050	mg/L	ND	0.0085
Dissolved Antimony (Sb)	0.006_{IMAC}	0.0	mg/L	ND	ND
Dissolved Arsenic (As)	0.01_{IMAC}	0.0010	mg/L	ND	ND
Dissolved Barium (Ba)	1_{MAC}	0.0	mg/L	0.04	0.02
Dissolved Beryllium (Be)	-	0.00050	mg/L	ND	ND
Dissolved Boron (B)	5_{IMAC}	0.0	mg/L	0.015	0.018
Dissolved Cadmium (Cd)	0.005_{MAC}	0.00010	mg/L	ND	ND
Dissolved Calcium (Ca)	-	0.2	mg/L	97	100
Dissolved Chromium (Cr)	0.05_{MAC}	0.0050	mg/L	ND	ND
Dissolved Cobalt (Co)	-	0.0	mg/L	ND	ND
Dissolved Copper (Cu)	1_{AO}	0.0010	mg/L	0.0018	0.0017
Dissolved Iron (Fe)	0.3_{AO}	0.1	mg/L	ND	ND
Dissolved Lead (Pb)	0.01_{MAC}	0.00050	mg/L	ND	ND
Dissolved Magnesium (Mg)	-	0.1	mg/L	21	29
Dissolved Manganese (Mn)	0.05_{AO}	0.0020	mg/L	ND	**0.28**
Dissolved Molybdenum (Mo)	-	0.0	mg/L	ND	0
Dissolved Nickel (Ni)	-	0.0010	mg/L	ND	0.0012
Dissolved Phosphorus (P)	-	0.1	mg/L	ND	ND
Dissolved Potassium (K)	-	0.20	mg/L	10.0	1.7
Dissolved Selenium (Se)	0.01_{MAC}	0.0	mg/L	ND	ND
Dissolved Silicon (Si)	-	0.050	mg/L	4.7	6.2
Dissolved Silver (Ag)	-	0.0	mg/L	ND	ND
Dissolved Sodium (Na)	20_{OG}; 200_{MOH}	0.10	mg/L	17	12
Dissolved Strontium (Sr)	-	0.0	mg/L	0	0
Dissolved Thallium (Tl)	-	0.000050	mg/L	ND	0.0001
Dissolved Titanium (Ti)	-	0.0	mg/L	ND	ND
Dissolved Uranium (U)	0.02_{MAC}	0.00010	mg/L	0.0002	0.0008
Dissolved Vanadium (V)	-	0.0	mg/L	ND	ND
Dissolved Zinc (Zn)	5_{AO}	0.0050	mg/L	ND	0.0058

LEGEND	
Bold & Red	Exceedes criteria
N/A	Not applicable
RDL	Reportable Detection limit
ODWS	Ontario Drinking Water Standards, Objectives and Guidelines (revised June 2006)
MAC	ODWS Maximum Acceptable Concentration
IMAC	ODWS Interim Maximum Acceptable Concentration
AO	ODWS Aesthetic Objective
OG	ODWS Operational Guideline
MOH	Medical Officer of Health reporting limit

Your Project #: 300055234.9000
Site Location: CENTRE WELLINGTON OPS
Your C.O.C. #: 907634-01-01

Attention: Patty Workman

RJ Burnside Associates Ltd
292 Speedvale Ave W
Unit 20
Guelph, ON
CANADA N1H 1C4

Report Date: 2022/12/08
Report #: R7422272
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2Z5173
Received: 2022/12/02, 14:18

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity	2	N/A	2022/12/05	CAM SOP-00448	SM 23 2320 B m
Carbonate, Bicarbonate and Hydroxide	2	N/A	2022/12/06	CAM SOP-00102	APHA 4500-CO2 D
Chloride by Automated Colourimetry	2	N/A	2022/12/08	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	2	N/A	2022/12/05	CAM SOP-00414	SM 23 2510 m
Dissolved Organic Carbon (DOC) (1)	2	N/A	2022/12/05	CAM SOP-00446	SM 23 5310 B m
Hardness (calculated as CaCO3)	2	N/A	2022/12/05	CAM SOP 00102/00408/00447	SM 2340 B
Dissolved Metals by ICPMS	2	N/A	2022/12/05	CAM SOP-00447	EPA 6020B m
Ion Balance (% Difference)	2	N/A	2022/12/08		
Anion and Cation Sum	2	N/A	2022/12/06		
Total Ammonia-N	2	N/A	2022/12/06	CAM SOP-00441	USGS I-2522-90 m
Nitrate & Nitrite as Nitrogen in Water (2)	2	N/A	2022/12/06	CAM SOP-00440	SM 23 4500-NO3I/NO2B
pH	1	2022/12/03	2022/12/05	CAM SOP-00413	SM 4500H+ B m
pH	1	2022/12/05	2022/12/05	CAM SOP-00413	SM 4500H+ B m
Orthophosphate	2	N/A	2022/12/07	CAM SOP-00461	SM 23 4500-P E m
Sat. pH and Langelier Index (@ 20C)	2	N/A	2022/12/08		Auto Calc
Sat. pH and Langelier Index (@ 4C)	2	N/A	2022/12/08		Auto Calc
Sulphate by Automated Colourimetry	2	N/A	2022/12/08	CAM SOP-00464	EPA 375.4 m
Total Dissolved Solids (TDS calc)	2	N/A	2022/12/08		Auto Calc

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

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

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or

Your Project #: 300055234.9000
Site Location: CENTRE WELLINGTON OPS
Your C.O.C. #: 907634-01-01

Attention: Patty Workman

RJ Burnside Associates Ltd
292 Speedvale Ave W
Unit 20
Guelph, ON
CANADA N1H 1C4

Report Date: 2022/12/08
Report #: R7422272
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2Z5173

Received: 2022/12/02, 14:18

implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

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

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:
Ashton Gibson, Project Manager
Email: Ashton.Gibson@bureauveritas.com
Phone# (905)817-5765
==
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Bureau Veritas 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvna.com

Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

Bureau Veritas Job #: C2Z5173
Report Date: 2022/12/08

RJ Burnside Associates Ltd
Client Project #: 300055234.9000
Site Location: CENTRE WELLINGTON OPS
Sampler Initials: DW

RESULTS OF ANALYSES OF WATER

Bureau Veritas ID		UMD884			UMD884			UMD885		
Sampling Date		2022/12/01 10:45			2022/12/01 10:45			2022/12/01 15:00		
COC Number		907634-01-01			907634-01-01			907634-01-01		
	UNITS	**BH2**	**RDL**	**QC Batch**	**BH2 Lab-Dup**	**RDL**	**QC Batch**	**BH5**	**RDL**	**QC Batch**
Calculated Parameters										
Anion Sum	me/L	6.64	N/A	8381453				7.34	N/A	8381453
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	240	1.0	8381454				250	1.0	8381454
Calculated TDS	mg/L	370	1.0	8381457				410	1.0	8381457
Carb. Alkalinity (calc. as CaCO3)	mg/L	2.3	1.0	8381454				2.7	1.0	8381454
Cation Sum	me/L	7.54	N/A	8381453				8.02	N/A	8381453
Hardness (CaCO3)	mg/L	330	1.0	8380977				370	1.0	8380977
Ion Balance (% Difference)	%	6.35	N/A	8381452				4.44	N/A	8381452
Langelier Index (@ 20C)	N/A	0.942		8381455				1.02		8381455
Langelier Index (@ 4C)	N/A	0.693		8381456				0.768		8381456
Saturation pH (@ 20C)	N/A	7.07		8381455				7.03		8381455
Saturation pH (@ 4C)	N/A	7.31		8381456				7.28		8381456
Inorganics										
Total Ammonia-N	mg/L	ND	0.050	8385020				0.28	0.050	8385020
Conductivity	umho/cm	680	1.0	8384233	710	1.0	8384233	710	1.0	8383125
Dissolved Organic Carbon	mg/L	1.0	0.40	8384878				1.0	0.40	8384878
Orthophosphate (P)	mg/L	ND	0.010	8383152				ND	0.010	8383152
pH	pH	8.01		8384227	8.02		8384227	8.05		8383126
Dissolved Sulphate (SO4)	mg/L	4.6	1.0	8383151				53	1.0	8383151
Alkalinity (Total as CaCO3)	mg/L	240	1.0	8384225	260	1.0	8384225	260	1.0	8383123
Dissolved Chloride (Cl-)	mg/L	47	1.0	8383149				36	1.0	8383149
Nitrite (N)	mg/L	ND	0.010	8383127				0.015	0.010	8383127
Nitrate (N)	mg/L	4.80	0.10	8383127				1.06	0.10	8383127
Nitrate + Nitrite (N)	mg/L	4.80	0.10	8383127				1.08	0.10	8383127

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable
ND = Not Detected at a concentration equal or greater than the indicated Detection Limit.

RJ Burnside Associates Ltd
Client Project #: 300055234.9000
Site Location: CENTRE WELLINGTON OPS
Sampler Initials: DW

RESULTS OF ANALYSES OF WATER

Bureau Veritas ID		UMD885		
Sampling Date		2022/12/01 15:00		
COC Number		907634-01-01		
	UNITS	**BH5 Lab-Dup**	**RDL**	**QC Batch**
Inorganics				
Orthophosphate (P)	mg/L	ND	0.010	8383152
Dissolved Sulphate (SO4)	mg/L	53	1.0	8383151
Dissolved Chloride (Cl-)	mg/L	36	1.0	8383149

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
ND = Not Detected at a concentration equal or greater than the indicated Detection Limit.

Bureau Veritas Job #: C2Z5173
Report Date: 2022/12/08

RJ Burnside Associates Ltd
Client Project #: 300055234.9000
Site Location: CENTRE WELLINGTON OPS
Sampler Initials: DW

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Bureau Veritas ID		UMD884	UMD885		
Sampling Date		2022/12/01 10:45	2022/12/01 15:00		
COC Number		907634-01-01	907634-01-01		
	UNITS	**BH2**	**BH5**	**RDL**	**QC Batch**
Metals					
Dissolved Aluminum (Al)	ug/L	ND	8.5	4.9	8383402
Dissolved Antimony (Sb)	ug/L	ND	ND	0.50	8383402
Dissolved Arsenic (As)	ug/L	ND	ND	1.0	8383402
Dissolved Barium (Ba)	ug/L	40	20	2.0	8383402
Dissolved Beryllium (Be)	ug/L	ND	ND	0.40	8383402
Dissolved Boron (B)	ug/L	15	18	10	8383402
Dissolved Cadmium (Cd)	ug/L	ND	ND	0.090	8383402
Dissolved Calcium (Ca)	ug/L	97000	100000	200	8383402
Dissolved Chromium (Cr)	ug/L	ND	ND	5.0	8383402
Dissolved Cobalt (Co)	ug/L	ND	ND	0.50	8383402
Dissolved Copper (Cu)	ug/L	1.8	1.7	0.90	8383402
Dissolved Iron (Fe)	ug/L	ND	ND	100	8383402
Dissolved Lead (Pb)	ug/L	ND	ND	0.50	8383402
Dissolved Magnesium (Mg)	ug/L	21000	29000	50	8383402
Dissolved Manganese (Mn)	ug/L	ND	280	2.0	8383402
Dissolved Molybdenum (Mo)	ug/L	ND	1.6	0.50	8383402
Dissolved Nickel (Ni)	ug/L	ND	1.2	1.0	8383402
Dissolved Phosphorus (P)	ug/L	ND	ND	100	8383402
Dissolved Potassium (K)	ug/L	10000	1700	200	8383402
Dissolved Selenium (Se)	ug/L	ND	ND	2.0	8383402
Dissolved Silicon (Si)	ug/L	4700	6200	50	8383402
Dissolved Silver (Ag)	ug/L	ND	ND	0.090	8383402
Dissolved Sodium (Na)	ug/L	17000	12000	100	8383402
Dissolved Strontium (Sr)	ug/L	130	210	1.0	8383402
Dissolved Thallium (Tl)	ug/L	ND	0.056	0.050	8383402
Dissolved Titanium (Ti)	ug/L	ND	ND	5.0	8383402
Dissolved Uranium (U)	ug/L	0.20	0.76	0.10	8383402
Dissolved Vanadium (V)	ug/L	ND	ND	0.50	8383402
Dissolved Zinc (Zn)	ug/L	ND	5.8	5.0	8383402

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not Detected at a concentration equal or greater than the indicated Detection Limit.

Bureau Veritas Job #: C2Z5173
Report Date: 2022/12/08

RJ Burnside Associates Ltd
Client Project #: 300055234.9000
Site Location: CENTRE WELLINGTON OPS
Sampler Initials: DW

TEST SUMMARY

Bureau Veritas ID: UMD884
Sample ID: BH2
Matrix: Water

Collected: 2022/12/01
Shipped:
Received: 2022/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	8384225	N/A	2022/12/05	Kien Tran
Carbonate, Bicarbonate and Hydroxide	CALC	8381454	N/A	2022/12/06	Automated Statchk
Chloride by Automated Colourimetry	KONE	8383149	N/A	2022/12/08	Alina Dobreanu
Conductivity	AT	8384233	N/A	2022/12/05	Kien Tran
Dissolved Organic Carbon (DOC)	TOCV/NDIR	8384878	N/A	2022/12/05	Gyulshen Idriz
Hardness (calculated as CaCO3)		8380977	N/A	2022/12/05	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	8383402	N/A	2022/12/05	Prempal Bhatti
Ion Balance (% Difference)	CALC	8381452	N/A	2022/12/08	Automated Statchk
Anion and Cation Sum	CALC	8381453	N/A	2022/12/06	Automated Statchk
Total Ammonia-N	LACH/NH4	8385020	N/A	2022/12/06	Shivani Shivani
Nitrate & Nitrite as Nitrogen in Water	LACH	8383127	N/A	2022/12/06	Chandra Nandlal
pH	AT	8384227	2022/12/05	2022/12/05	Kien Tran
Orthophosphate	KONE	8383152	N/A	2022/12/07	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	8381455	N/A	2022/12/08	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	8381456	N/A	2022/12/08	Automated Statchk
Sulphate by Automated Colourimetry	KONE	8383151	N/A	2022/12/08	Samuel Law
Total Dissolved Solids (TDS calc)	CALC	8381457	N/A	2022/12/08	Automated Statchk

Bureau Veritas ID: UMD884 Dup
Sample ID: BH2
Matrix: Water

Collected: 2022/12/01
Shipped:
Received: 2022/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	8384225	N/A	2022/12/05	Kien Tran
Conductivity	AT	8384233	N/A	2022/12/05	Kien Tran
pH	AT	8384227	2022/12/05	2022/12/05	Kien Tran

Bureau Veritas ID: UMD885
Sample ID: BH5
Matrix: Water

Collected: 2022/12/01
Shipped:
Received: 2022/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	8383123	N/A	2022/12/05	Kien Tran
Carbonate, Bicarbonate and Hydroxide	CALC	8381454	N/A	2022/12/06	Automated Statchk
Chloride by Automated Colourimetry	KONE	8383149	N/A	2022/12/08	Alina Dobreanu
Conductivity	AT	8383125	N/A	2022/12/05	Kien Tran
Dissolved Organic Carbon (DOC)	TOCV/NDIR	8384878	N/A	2022/12/05	Gyulshen Idriz
Hardness (calculated as CaCO3)		8380977	N/A	2022/12/05	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	8383402	N/A	2022/12/05	Prempal Bhatti
Ion Balance (% Difference)	CALC	8381452	N/A	2022/12/08	Automated Statchk
Anion and Cation Sum	CALC	8381453	N/A	2022/12/06	Automated Statchk
Total Ammonia-N	LACH/NH4	8385020	N/A	2022/12/06	Shivani Shivani
Nitrate & Nitrite as Nitrogen in Water	LACH	8383127	N/A	2022/12/06	Chandra Nandlal
pH	AT	8383126	2022/12/03	2022/12/05	Kien Tran

BUREAU VERITAS

Bureau Veritas Job #: C2Z5173
Report Date: 2022/12/08

RJ Burnside Associates Ltd
Client Project #: 300055234.9000
Site Location: CENTRE WELLINGTON OPS
Sampler Initials: DW

TEST SUMMARY

Bureau Veritas ID: UMD885
Sample ID: BH5
Matrix: Water

Collected: 2022/12/01
Shipped:
Received: 2022/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Orthophosphate	KONE	8383152	N/A	2022/12/07	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	8381455	N/A	2022/12/08	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	8381456	N/A	2022/12/08	Automated Statchk
Sulphate by Automated Colourimetry	KONE	8383151	N/A	2022/12/08	Samuel Law
Total Dissolved Solids (TDS calc)	CALC	8381457	N/A	2022/12/08	Automated Statchk

Bureau Veritas ID: UMD885 Dup
Sample ID: BH5
Matrix: Water

Collected: 2022/12/01
Shipped:
Received: 2022/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride by Automated Colourimetry	KONE	8383149	N/A	2022/12/08	Alina Dobreanu
Orthophosphate	KONE	8383152	N/A	2022/12/07	Alina Dobreanu
Sulphate by Automated Colourimetry	KONE	8383151	N/A	2022/12/08	Samuel Law

Bureau Veritas 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvna.com

GENERAL COMMENTS

Results relate only to the items tested.

BUREAU VERITAS

Bureau Veritas Job #: C2Z5173
Report Date: 2022/12/08

RJ Burnside Associates Ltd
Client Project #: 300055234.9000
Site Location: CENTRE WELLINGTON OPS
Sampler Initials: DW

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8383123	KIT	Spiked Blank	Alkalinity (Total as CaCO3)	2022/12/05		96	%	85 - 115
8383123	KIT	Method Blank	Alkalinity (Total as CaCO3)	2022/12/05	ND, RDL=1.0		mg/L	
8383123	KIT	RPD	Alkalinity (Total as CaCO3)	2022/12/05	2.1		%	20
8383125	KIT	Spiked Blank	Conductivity	2022/12/05		100	%	85 - 115
8383125	KIT	Method Blank	Conductivity	2022/12/05	ND, RDL=1.0		umho/cm	
8383125	KIT	RPD	Conductivity	2022/12/05	0.18		%	25
8383126	KIT	Spiked Blank	pH	2022/12/05		102	%	98 - 103
8383126	KIT	RPD	pH	2022/12/05	0.46		%	N/A
8383127	C_N	Matrix Spike	Nitrite (N)	2022/12/06		103	%	80 - 120
			Nitrate (N)	2022/12/06		92	%	80 - 120
8383127	C_N	Spiked Blank	Nitrite (N)	2022/12/06		103	%	80 - 120
			Nitrate (N)	2022/12/06		105	%	80 - 120
8383127	C_N	Method Blank	Nitrite (N)	2022/12/06	ND, RDL=0.010		mg/L	
			Nitrate (N)	2022/12/06	ND, RDL=0.10		mg/L	
8383127	C_N	RPD	Nitrite (N)	2022/12/06	NC		%	20
			Nitrate (N)	2022/12/06	NC		%	20
8383149	ADB	Matrix Spike [UMD885-01]	Dissolved Chloride (Cl-)	2022/12/08		NC	%	80 - 120
8383149	ADB	Spiked Blank	Dissolved Chloride (Cl-)	2022/12/08		100	%	80 - 120
8383149	ADB	Method Blank	Dissolved Chloride (Cl-)	2022/12/08	ND, RDL=1.0		mg/L	
8383149	ADB	RPD [UMD885-01]	Dissolved Chloride (Cl-)	2022/12/08	1.2		%	20
8383151	S1L	Matrix Spike [UMD885-01]	Dissolved Sulphate (SO4)	2022/12/08		NC	%	75 - 125
8383151	S1L	Spiked Blank	Dissolved Sulphate (SO4)	2022/12/08		100	%	80 - 120
8383151	S1L	Method Blank	Dissolved Sulphate (SO4)	2022/12/08	ND, RDL=1.0		mg/L	
8383151	S1L	RPD [UMD885-01]	Dissolved Sulphate (SO4)	2022/12/08	0.10		%	20
8383152	ADB	Matrix Spike [UMD885-01]	Orthophosphate (P)	2022/12/07		101	%	75 - 125
8383152	ADB	Spiked Blank	Orthophosphate (P)	2022/12/07		101	%	80 - 120
8383152	ADB	Method Blank	Orthophosphate (P)	2022/12/07	ND, RDL=0.010		mg/L	
8383152	ADB	RPD [UMD885-01]	Orthophosphate (P)	2022/12/07	NC		%	20
8383402	PBA	Matrix Spike	Dissolved Aluminum (Al)	2022/12/05		102	%	80 - 120
			Dissolved Antimony (Sb)	2022/12/05		104	%	80 - 120
			Dissolved Arsenic (As)	2022/12/05		104	%	80 - 120
			Dissolved Barium (Ba)	2022/12/05		101	%	80 - 120
			Dissolved Beryllium (Be)	2022/12/05		103	%	80 - 120
			Dissolved Boron (B)	2022/12/05		101	%	80 - 120
			Dissolved Cadmium (Cd)	2022/12/05		102	%	80 - 120
			Dissolved Calcium (Ca)	2022/12/05		NC	%	80 - 120
			Dissolved Chromium (Cr)	2022/12/05		102	%	80 - 120
			Dissolved Cobalt (Co)	2022/12/05		102	%	80 - 120
			Dissolved Copper (Cu)	2022/12/05		104	%	80 - 120
			Dissolved Iron (Fe)	2022/12/05		105	%	80 - 120
			Dissolved Lead (Pb)	2022/12/05		98	%	80 - 120
			Dissolved Magnesium (Mg)	2022/12/05		NC	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Manganese (Mn)	2022/12/05		103	%	80 - 120
			Dissolved Molybdenum (Mo)	2022/12/05		105	%	80 - 120
			Dissolved Nickel (Ni)	2022/12/05		101	%	80 - 120
			Dissolved Phosphorus (P)	2022/12/05		104	%	80 - 120
			Dissolved Potassium (K)	2022/12/05		108	%	80 - 120
			Dissolved Selenium (Se)	2022/12/05		102	%	80 - 120
			Dissolved Silicon (Si)	2022/12/05		104	%	80 - 120
			Dissolved Silver (Ag)	2022/12/05		88	%	80 - 120
			Dissolved Sodium (Na)	2022/12/05		105	%	80 - 120
			Dissolved Strontium (Sr)	2022/12/05		101	%	80 - 120
			Dissolved Thallium (Tl)	2022/12/05		101	%	80 - 120
			Dissolved Titanium (Ti)	2022/12/05		100	%	80 - 120
			Dissolved Uranium (U)	2022/12/05		99	%	80 - 120
			Dissolved Vanadium (V)	2022/12/05		105	%	80 - 120
			Dissolved Zinc (Zn)	2022/12/05		104	%	80 - 120
8383402	PBA	Spiked Blank	Dissolved Aluminum (Al)	2022/12/05		102	%	80 - 120
			Dissolved Antimony (Sb)	2022/12/05		101	%	80 - 120
			Dissolved Arsenic (As)	2022/12/05		101	%	80 - 120
			Dissolved Barium (Ba)	2022/12/05		100	%	80 - 120
			Dissolved Beryllium (Be)	2022/12/05		97	%	80 - 120
			Dissolved Boron (B)	2022/12/05		96	%	80 - 120
			Dissolved Cadmium (Cd)	2022/12/05		101	%	80 - 120
			Dissolved Calcium (Ca)	2022/12/05		104	%	80 - 120
			Dissolved Chromium (Cr)	2022/12/05		99	%	80 - 120
			Dissolved Cobalt (Co)	2022/12/05		101	%	80 - 120
			Dissolved Copper (Cu)	2022/12/05		104	%	80 - 120
			Dissolved Iron (Fe)	2022/12/05		103	%	80 - 120
			Dissolved Lead (Pb)	2022/12/05		99	%	80 - 120
			Dissolved Magnesium (Mg)	2022/12/05		103	%	80 - 120
			Dissolved Manganese (Mn)	2022/12/05		100	%	80 - 120
			Dissolved Molybdenum (Mo)	2022/12/05		102	%	80 - 120
			Dissolved Nickel (Ni)	2022/12/05		100	%	80 - 120
			Dissolved Phosphorus (P)	2022/12/05		108	%	80 - 120
			Dissolved Potassium (K)	2022/12/05		106	%	80 - 120
			Dissolved Selenium (Se)	2022/12/05		99	%	80 - 120
			Dissolved Silicon (Si)	2022/12/05		104	%	80 - 120
			Dissolved Silver (Ag)	2022/12/05		101	%	80 - 120
			Dissolved Sodium (Na)	2022/12/05		103	%	80 - 120
			Dissolved Strontium (Sr)	2022/12/05		99	%	80 - 120
			Dissolved Thallium (Tl)	2022/12/05		100	%	80 - 120
			Dissolved Titanium (Ti)	2022/12/05		99	%	80 - 120
			Dissolved Uranium (U)	2022/12/05		98	%	80 - 120
			Dissolved Vanadium (V)	2022/12/05		101	%	80 - 120
			Dissolved Zinc (Zn)	2022/12/05		101	%	80 - 120
8383402	PBA	Method Blank	Dissolved Aluminum (Al)	2022/12/05	ND, RDL=4.9		ug/L	
			Dissolved Antimony (Sb)	2022/12/05	ND, RDL=0.50		ug/L	
			Dissolved Arsenic (As)	2022/12/05	ND, RDL=1.0		ug/L	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Barium (Ba)	2022/12/05	ND, RDL=2.0		ug/L	
			Dissolved Beryllium (Be)	2022/12/05	ND, RDL=0.40		ug/L	
			Dissolved Boron (B)	2022/12/05	ND, RDL=10		ug/L	
			Dissolved Cadmium (Cd)	2022/12/05	ND, RDL=0.090		ug/L	
			Dissolved Calcium (Ca)	2022/12/05	ND, RDL=200		ug/L	
			Dissolved Chromium (Cr)	2022/12/05	ND, RDL=5.0		ug/L	
			Dissolved Cobalt (Co)	2022/12/05	ND, RDL=0.50		ug/L	
			Dissolved Copper (Cu)	2022/12/05	ND, RDL=0.90		ug/L	
			Dissolved Iron (Fe)	2022/12/05	ND, RDL=100		ug/L	
			Dissolved Lead (Pb)	2022/12/05	ND, RDL=0.50		ug/L	
			Dissolved Magnesium (Mg)	2022/12/05	ND, RDL=50		ug/L	
			Dissolved Manganese (Mn)	2022/12/05	ND, RDL=2.0		ug/L	
			Dissolved Molybdenum (Mo)	2022/12/05	ND, RDL=0.50		ug/L	
			Dissolved Nickel (Ni)	2022/12/05	ND, RDL=1.0		ug/L	
			Dissolved Phosphorus (P)	2022/12/05	ND, RDL=100		ug/L	
			Dissolved Potassium (K)	2022/12/05	ND, RDL=200		ug/L	
			Dissolved Selenium (Se)	2022/12/05	ND, RDL=2.0		ug/L	
			Dissolved Silicon (Si)	2022/12/05	ND, RDL=50		ug/L	
			Dissolved Silver (Ag)	2022/12/05	ND, RDL=0.090		ug/L	
			Dissolved Sodium (Na)	2022/12/05	ND, RDL=100		ug/L	
			Dissolved Strontium (Sr)	2022/12/05	ND, RDL=1.0		ug/L	
			Dissolved Thallium (Tl)	2022/12/05	ND, RDL=0.050		ug/L	
			Dissolved Titanium (Ti)	2022/12/05	ND, RDL=5.0		ug/L	
			Dissolved Uranium (U)	2022/12/05	ND, RDL=0.10		ug/L	
			Dissolved Vanadium (V)	2022/12/05	ND, RDL=0.50		ug/L	
			Dissolved Zinc (Zn)	2022/12/05	ND, RDL=5.0		ug/L	
8383402	PBA	RPD	Dissolved Aluminum (Al)	2022/12/05	NC		%	20

Bureau Veritas Job #: C2Z5173
Report Date: 2022/12/08

RJ Burnside Associates Ltd
Client Project #: 300055234.9000
Site Location: CENTRE WELLINGTON OPS
Sampler Initials: DW

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Antimony (Sb)	2022/12/05	NC		%	20
			Dissolved Arsenic (As)	2022/12/05	2.8		%	20
			Dissolved Barium (Ba)	2022/12/05	3.4		%	20
			Dissolved Beryllium (Be)	2022/12/05	NC		%	20
			Dissolved Boron (B)	2022/12/05	2.0		%	20
			Dissolved Cadmium (Cd)	2022/12/05	NC		%	20
			Dissolved Calcium (Ca)	2022/12/05	0.61		%	20
			Dissolved Chromium (Cr)	2022/12/05	NC		%	20
			Dissolved Cobalt (Co)	2022/12/05	NC		%	20
			Dissolved Copper (Cu)	2022/12/05	NC		%	20
			Dissolved Iron (Fe)	2022/12/05	3.4		%	20
			Dissolved Lead (Pb)	2022/12/05	NC		%	20
			Dissolved Magnesium (Mg)	2022/12/05	2.9		%	20
			Dissolved Manganese (Mn)	2022/12/05	1.1		%	20
			Dissolved Molybdenum (Mo)	2022/12/05	0.89		%	20
			Dissolved Nickel (Ni)	2022/12/05	NC		%	20
			Dissolved Phosphorus (P)	2022/12/05	NC		%	20
			Dissolved Potassium (K)	2022/12/05	2.9		%	20
			Dissolved Selenium (Se)	2022/12/05	NC		%	20
			Dissolved Silicon (Si)	2022/12/05	0.37		%	20
			Dissolved Silver (Ag)	2022/12/05	NC		%	20
			Dissolved Sodium (Na)	2022/12/05	3.8		%	20
			Dissolved Strontium (Sr)	2022/12/05	3.5		%	20
			Dissolved Thallium (Tl)	2022/12/05	NC		%	20
			Dissolved Titanium (Ti)	2022/12/05	NC		%	20
			Dissolved Uranium (U)	2022/12/05	2.8		%	20
			Dissolved Vanadium (V)	2022/12/05	NC		%	20
			Dissolved Zinc (Zn)	2022/12/05	NC		%	20
8384225	KIT	Spiked Blank	Alkalinity (Total as CaCO3)	2022/12/05		97	%	85 - 115
8384225	KIT	Method Blank	Alkalinity (Total as CaCO3)	2022/12/05	ND, RDL=1.0		mg/L	
8384225	KIT	RPD [UMD884-01]	Alkalinity (Total as CaCO3)	2022/12/05	6.3		%	20
8384227	KIT	Spiked Blank	pH	2022/12/05		101	%	98 - 103
8384227	KIT	RPD [UMD884-01]	pH	2022/12/05	0.15		%	N/A
8384233	KIT	Spiked Blank	Conductivity	2022/12/05		101	%	85 - 115
8384233	KIT	Method Blank	Conductivity	2022/12/05	ND, RDL=1.0		umho/cm	
8384233	KIT	RPD [UMD884-01]	Conductivity	2022/12/05	3.9		%	25
8384878	GID	Matrix Spike	Dissolved Organic Carbon	2022/12/05		95	%	80 - 120
8384878	GID	Spiked Blank	Dissolved Organic Carbon	2022/12/05		96	%	80 - 120
8384878	GID	Method Blank	Dissolved Organic Carbon	2022/12/05	ND, RDL=0.40		mg/L	
8384878	GID	RPD	Dissolved Organic Carbon	2022/12/05	1.3		%	20
8385020	SSV	Matrix Spike	Total Ammonia-N	2022/12/06		96	%	75 - 125
8385020	SSV	Spiked Blank	Total Ammonia-N	2022/12/06		97	%	80 - 120
8385020	SSV	Method Blank	Total Ammonia-N	2022/12/06	ND, RDL=0.050		mg/L	

Bureau Veritas Job #: C2Z5173
Report Date: 2022/12/08

RJ Burnside Associates Ltd
Client Project #: 300055234.9000
Site Location: CENTRE WELLINGTON OPS
Sampler Initials: DW

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8385020	SSV	RPD	Total Ammonia-N	2022/12/06	13		%	20

N/A = Not Applicable

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

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

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

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

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

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

Bureau Veritas 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvna.com

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Cristina Carriere

Cristina Carriere, Senior Scientific Specialist

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Bureau Veritas
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel:(905) 817-5700 Toll-free:800-563-6266 Fax:(905) 817-5777 www.bvna.com

CHAIN

02-Dec-22 14:18
Ashton Gibson
C2Z5173
N4 ENV-1582
COC #: C#907634-01-01

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ler #:

Project Manager: Ashton Gibson

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:	
Company Name:	#685 RJ Burnside Associates Ltd	Company Name:	RJ Burnside + Associates Limited	Quotation #:	B16792
Attention:	Accounts Payable	Attention:	Patty Workman	P.O. #:	
Address:	292 Speedvale Ave W Unit 20	Address:	292 Speedvale Ave W Unit 20	Project:	300055234.9000
	Guelph ON N1H 1C4		Guelph ON N1H 1C4	Project Name:	Centre Wellington Ops
Tel:	(519) 941-5331 Ext: 286 Fax: (519) 941-7721	Tel:	226 314 2135 Fax:	Site #:	
Email:	ap@rjburnside.com	Email:	patty.workman@rjburnside.com	Sampled By:	Patty Workman

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

Regulation 153 (2011)	Other Regulations	Special Instructions
☐ Table 1 ☐ Res/Park ☐ Medium/Fine	☐ CCME ☐ Sanitary Sewer Bylaw	
☐ Table 2 ☐ Ind/Comm ☐ Coarse	☐ Reg 558 ☐ Storm Sewer Bylaw	
☐ Table 3 ☐ Agri/Other ☐ For RSC	☐ MISA Municipality ______	
☐ Table ___	☐ PWQO ☐ Reg 406 Table ______	
	☐ Other ______	

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

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

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

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

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

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	RCAp - Comprehensive									# of Bottles	Comments
1		BH2	Dec 1 2022	10:45	Groundwater	✓	X									4	
2		BH5	Dec 1 2022	15:00	Groundwater	✓	X									4	
3																	
4																	
5																	
6																	REC'D IN WATERLOO
7																	
8																	
9																	NoSEAL/ONICE
10																	

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
Patty Workman	22/12/01	16:44	KINNAL RAJAPATI	2022/12/2	14.18	
			Ronalda / RUPINDER	2022/12/02	18:35	

Laboratory Use Only				
Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
	1/2/1°C	Present		✓
		Intact		✓

White: Bureau Veritas Yellow: Client

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/COC-TERMS-AND-CONDITIONS.

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

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/CHAIN-CUSTODY-FORMS-COCS.

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

[THE DIFFERENCE IS OUR PEOPLE]

Appendix F

Water Balance

TABLE F-1

Pre-Development Monthly Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 200 mm (moderately rooted crops in sandy/silty soils) - C101

Precipitation data from Fergus Shand Dam Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.40	-6.30	-1.90	5.70	12.20	17.50	20.00	19.00	14.90	8.30	2.10	-3.90	**6.7**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.22	3.86	6.66	8.16	7.55	5.22	2.15	0.27	0.00	**35.1**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	26.65	59.36	86.76	99.85	94.61	73.26	39.58	9.32	0.00	**489**
Adjusting Factor for U (Latitude 43^{o} 40' N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	30	75	111	129	114	76	38	8	0	**579**
COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	68	56	60	74	87	84	89	97	93	77	93	69	**946**
Potential Evapotranspiration (PET)	0	0	0	30	75	111	129	114	76	38	8	0	**579**
P - PET	68	56	60	44	12	-27	-40	-17	17	40	85	69	**367**
Change in Soil Moisture Storage	0	0	0	0	0	-27	-40	-17	17	40	27	0	**0**
Soil Moisture Storage max 200 mm	200	200	200	200	200	173	133	116	133	173	200	200	
Actual Evapotranspiration (AET)	0	0	0	30	75	111	129	114	76	38	8	0	**579**
Soil Moisture Deficit max 200 mm	0	0	0	0	0	27	67	84	67	27	0	0	
Water Surplus - available for infiltration or runoff	68	56	60	44	12	0	0	0	0	0	58	69	**367**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	37	31	33	24	7	0	0	0	0	0	32	38	**202**
Potential Direct Surface Water Runoff (independent of temperature)	31	25	27	20	5	0	0	0	0	0	26	31	**165**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	946	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	142	mm/year											
P-PE (surplus available for runoff from impervious areas)	804	mm/year											

Assume January storage is 100% of Soil Moisture Storage

Soil Moisture Storage (moderately rooted crops in sandy / silty soils)	200 mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003
*MOE SWM infiltration calculations		
topography - flat to rolling land	0.25	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - medium combinations of sand and loam	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - cultivated land	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.55**	
Latitude of site (or climate station)	43 ^{O} N	

TABLE F-2

Pre- and Post-Development Monthly Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 125 mm (urban lawns in sandy / silty soils) - C101 & C201

Precipitation data from Fergus Shand Dam Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.40	-6.30	-1.90	5.70	12.20	17.50	20.00	19.00	14.90	8.30	2.10	-3.90	**6.7**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.22	3.86	6.66	8.16	7.55	5.22	2.15	0.27	0.00	**35.1**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	26.65	59.36	86.76	99.85	94.61	73.26	39.58	9.32	0.00	**489**
Adjusting Factor for U (Latitude 43^{o} 40' N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	30	75	111	129	114	76	38	8	0	**579**
COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	68	56	60	74	87	84	89	97	93	77	93	69	**946**
Potential Evapotranspiration (PET)	0	0	0	30	75	111	129	114	76	38	8	0	**579**
P - PET	68	56	60	44	12	-27	-40	-17	17	40	85	69	**367**
Change in Soil Moisture Storage	0	0	0	0	0	-27	-40	-17	17	40	27	0	**0**
Soil Moisture Storage max 125 mm	125	125	125	125	125	98	58	41	58	98	125	125	
Actual Evapotranspiration (AET)	0	0	0	30	75	111	129	114	76	38	8	0	**579**
Soil Moisture Deficit max 125 mm	0	0	0	0	0	27	67	84	67	27	0	0	
Water Surplus - available for infiltration or runoff	68	56	60	44	12	0	0	0	0	0	58	69	**367**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	41	34	36	27	7	0	0	0	0	0	35	41	**220**
Potential Direct Surface Water Runoff (independent of temperature)	27	22	24	18	5	0	0	0	0	0	23	27	**147**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	946	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	142	mm/year											
P-PE (surplus available for runoff from impervious areas)	804	mm/year											

Assume January storage is 100% of Soil Moisture Storage			
Soil Moisture Storage (urban lawns in sandy / silty soils)	125	mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003
*MOE SWM infiltration calculations			
topography - flat to rolling land	0.25		<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - medium combinations of sand and loam	0.2		<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - cultivated land/woodland	0.15		<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.6**		
Latitude of site (or climate station)	43 ^{O} N		

TABLE F-3

Post-Development Monthly Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 125 mm (urban grased berms with sandy / silty soils) - UNC1 & UNC 2

Precipitation data from Fergus Shand Dam Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.40	-6.30	-1.90	5.70	12.20	17.50	20.00	19.00	14.90	8.30	2.10	-3.90	**6.7**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.22	3.86	6.66	8.16	7.55	5.22	2.15	0.27	0.00	**35.1**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	26.65	59.36	86.76	99.85	94.61	73.26	39.58	9.32	0.00	**489**
Adjusting Factor for U (Latitude 43^{o} 40' N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	30	75	111	129	114	76	38	8	0	**579**
COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	68	56	60	74	87	84	89	97	93	77	93	69	**946**
Potential Evapotranspiration (PET)	0	0	0	30	75	111	129	114	76	38	8	0	**579**
P - PET	68	56	60	44	12	-27	-40	-17	17	40	85	69	**367**
Change in Soil Moisture Storage	0	0	0	0	0	-27	-40	-17	17	40	27	0	**0**
Soil Moisture Storage max 125 mm	125	125	125	125	125	98	58	41	58	98	125	125	
Actual Evapotranspiration (AET)	0	0	0	30	75	111	129	114	76	38	8	0	**579**
Soil Moisture Deficit max 125 mm	0	0	0	0	0	27	67	84	67	27	0	0	
Water Surplus - available for infiltration or runoff	68	56	60	44	12	0	0	0	0	0	58	69	**367**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	27	22	24	18	5	0	0	0	0	0	23	27	**147**
Potential Direct Surface Water Runoff (independent of temperature)	41	34	36	27	7	0	0	0	0	0	35	41	**220**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	946	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	142	mm/year											
P-PE (surplus available for runoff from impervious areas)	804	mm/year											

Assume January storage is 100% of Soil Moisture Storage		
Soil Moisture Storage (urban grassed berms in sandy / silty soils)	125 mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003
*MOE SWM infiltration calculations		
topography - hilly land	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - medium combinations of clay and loam	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - cultivated land	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.4**	
Latitude of site (or climate station)	43 ^{O} N	

TABLE F-4

Water Balance - Existing Conditions and Post-Development with No Mitigation

Land Use**	Approx. Land Area (m^2)**	Estimated Impervious Fraction for Land Use**	Estimated Impervious Area (m^2)	Runoff from Impervious Area* (m/a)	Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Runoff from Pervious Area* (m/a)	Runoff Volume from Pervious Area (m^3/a)	Infiltration from Pervious Area* (m/a)	Infiltration Volume from Pervious Area (m^3/a)	Total Runoff Volume (m^3/a)	Total Infiltration Volume (m^3/a)
Existing Land Use												
Hardscape (Roof, Drivewways, Paved areas) (C101)	1,700	1.00	1,700	0.804	1,367	0	0.165	0	0.202	0	1,367	0
Urban Lawn (C101)	9,800	0.00	0	0.804	0	9,800	0.147	1,437	0.220	2,155	1,437	2,155
Gravel (C101)	2,400	0.90	2,160	0.804	1,736	240	0.165	40	0.202	48	1,776	48
Agricultural/ Open Space (C101)	65,800	0.00	0	0.804	0	65,800	0.165	10,853	0.202	13,264	10,853	13,264
TOTAL PRE-DEVELOPMENT	**79,700**	**-**	**3,860**		**3,103**	**75,840**	**-**	**12,329**	**-**	**15,468**	**15,432**	**15,468**
Post-Development Land Use												
Hardscape (Roof, Drivewways, Paved areas) C(C201)	46,200	1.00	46,200	0.804	37,145	0	0.147	0	0.220	0	37,145	0
Urban Lawn (C201)	16,900	0.00	0	0.804	0	16,900	0.147	2,478	0.220	3,716	2,478	3,716
SWM Facility (C201)	6,400	1.00	6,400	0.804	5,146	0	0.147	0	0.220	0	5,146	0
Grass Berm (UNC1/UNC2)	10,200	0.20	2,040	0.804	1,640	8,160	0.220	1,794	0.147	1,196	3,435	1,196
TOTAL POST-DEVELOPMENT	**79,700**	**-**	**54,640**	**-**	**43,931**	**25,060**	**-**	**4,272**	**-**	**4,913**	**48,204**	**4,913**
% Change from Pre to Post											312	68
Effect of development (with no mitigation)											3.1 times increase	68% reduction in infiltration

To balance pre- to post infiltration target (m^3/a)= **10,555**

* figures from Tables F-1, F-2 & F-3

** from Functional Servicing and Stormwater Management Report (Burnside, 2023)

TABLE F-5

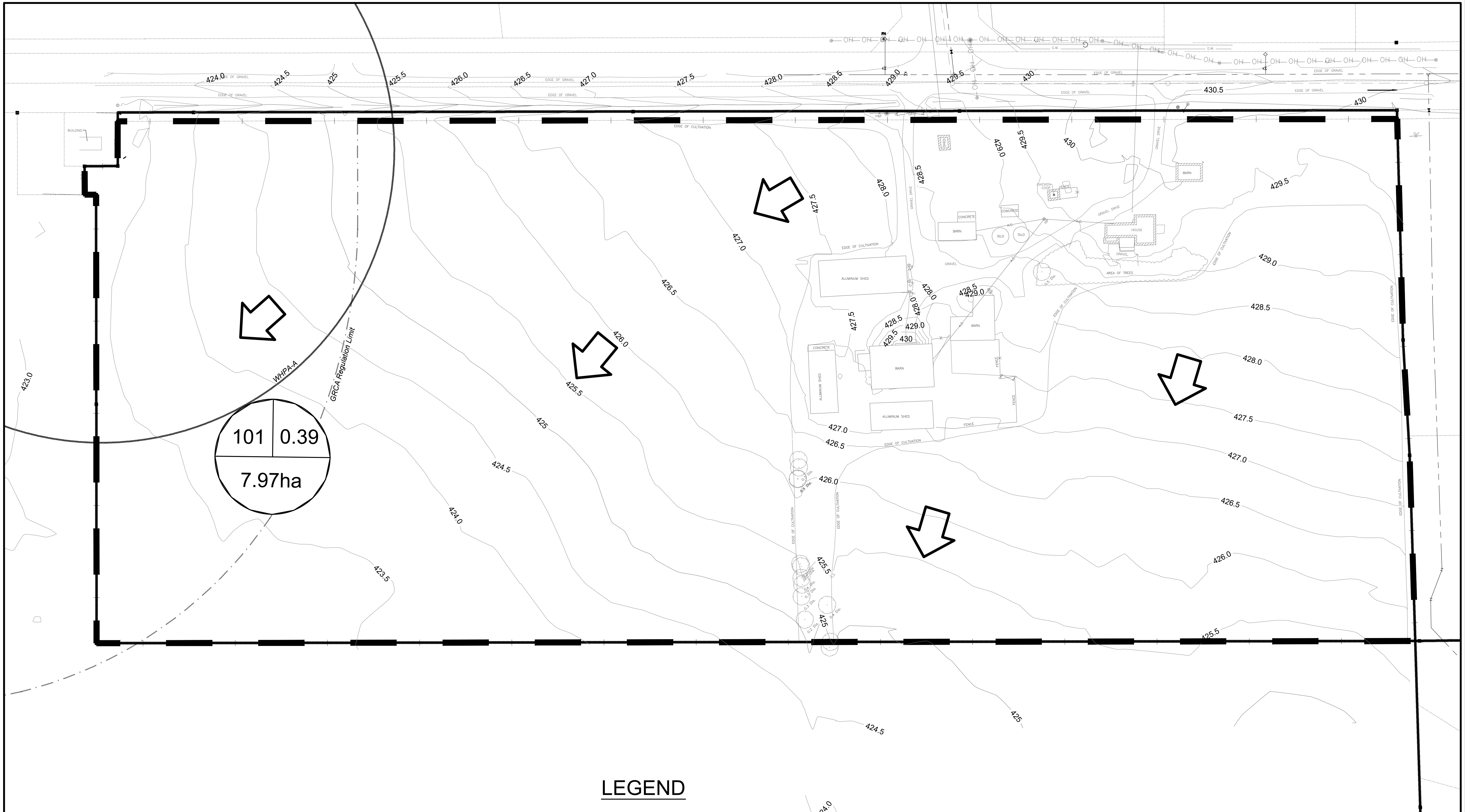
Water Balance - Existing Conditions and Post-Development with Mitigation (with LIDs)

Land Use		Approx. Land Area (m^2)**	Estimated Impervious Fraction for Land Use**	Estimated Impervious Area (m^2)	Runoff from Impervious Area* (m/a)	Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Runoff from Pervious Area* (m/a)	Runoff Volume from Pervious Area (m^3/a)	Infiltration from Pervious Area* (m/a)	Infiltration Volume from Pervious Area (m^3/a)	Total Runoff Volume (m^3/a)	Total Infiltration Volume (m^3/a)
Existing Land Use													
Hardscape (Roof, Driveway, Paved Areas) (C101)		1,700	1.00	1,700	0.804	1,367	0	0.165	0	0.202	0	1,367	0
Urban Lawn (C101)		9,800	0.00	0	0.804	0	9,800	0.147	1,437	0.220	2,155	1,437	2,155
Gravel (C101)		2,400	0.90	2,160	0.804	1,736	240	0.165	40	0.202	48	1,776	48
Agrcultural/ Open Space (C101)		65,800	0.00	0	0.804	0	65,800	0.165	10,853	0.202	13,264	10,853	13,264
TOTAL PRE-DEVELOPMENT		**79,700**	**-**	**3,860**		**3,103**	**75,840**	**-**	**12,329**	**-**	**15,468**	**15,432**	**15,468**
Post-Development Land Use													
Works Yard & SWM Facility (C201)	Urban Lawn	16,900	0.00	0	0.804	0	16,900	0.147	2,478	0.220	3,716	2,478	3,716
	SWM Facility	6,400	1.00	6,400	0.804	5,146	0	0.147	0	0.220	0	5,146	0
	Hardscape (Roof, Drivewways, Paved areas)	41,300	1.00	41,300	0.804	33,206	0	0.147	0	0.220	0	33,206	0
	Roof Areas directed to infiltration trench	4,900	1.00	4,900	0.804	3,940	0	0.147	0	0.220	0	3,940	0
	Infiltration Trench - assume designed to accommodate25 mm storm from proposed buildings; 25 mm storms account for approximately 95% of total precipitation; so assume 95% of runoff from building roof will infiltrate [a]	NA	NA	NA	NA	-3,743	NA	NA	NA	NA	3,743	-3,743	3,743
Grassed berm on north and west side (not draining to SWM Facility) (UNC1, UNC2)	Urban Lawn	10,200	0.20	2,040	0.804	1,640	8,160	0.220	1,794	0.147	1,196	3,435	1,196
TOTAL POST-DEVELOPMENT		**79,700**	**-**	**54,640**	**-**	**40,189**	**25,060**	**-**	**4,272**	**-**	**8,656**	**44,461**	**8,656**
% Change from Pre to Post												288	44
Effect of development (with mitigation)												2.9 times increase	44% reduction in infiltration
To balance pre- to post infiltration target (m^3/a)=													**6,812**

* figures from Tables F-1, F-2 & F-3

** from Functional Servicing and Stormwater Management Report (Burnside, 2023)

[a] based on the Toronto Wet Weather Flow Management Guidelines (City of Toronto, 2006)



LEGEND

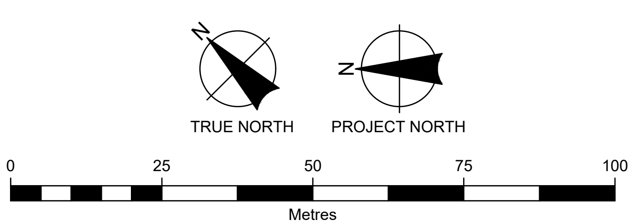
PROPERTY BOUNDARY

DRAINAGE BOUNDARY

OVERLAND FLOW DIRECTION

CATCHMENT No. — 101 | 0.50 — RUNOFF COEFFICIENT

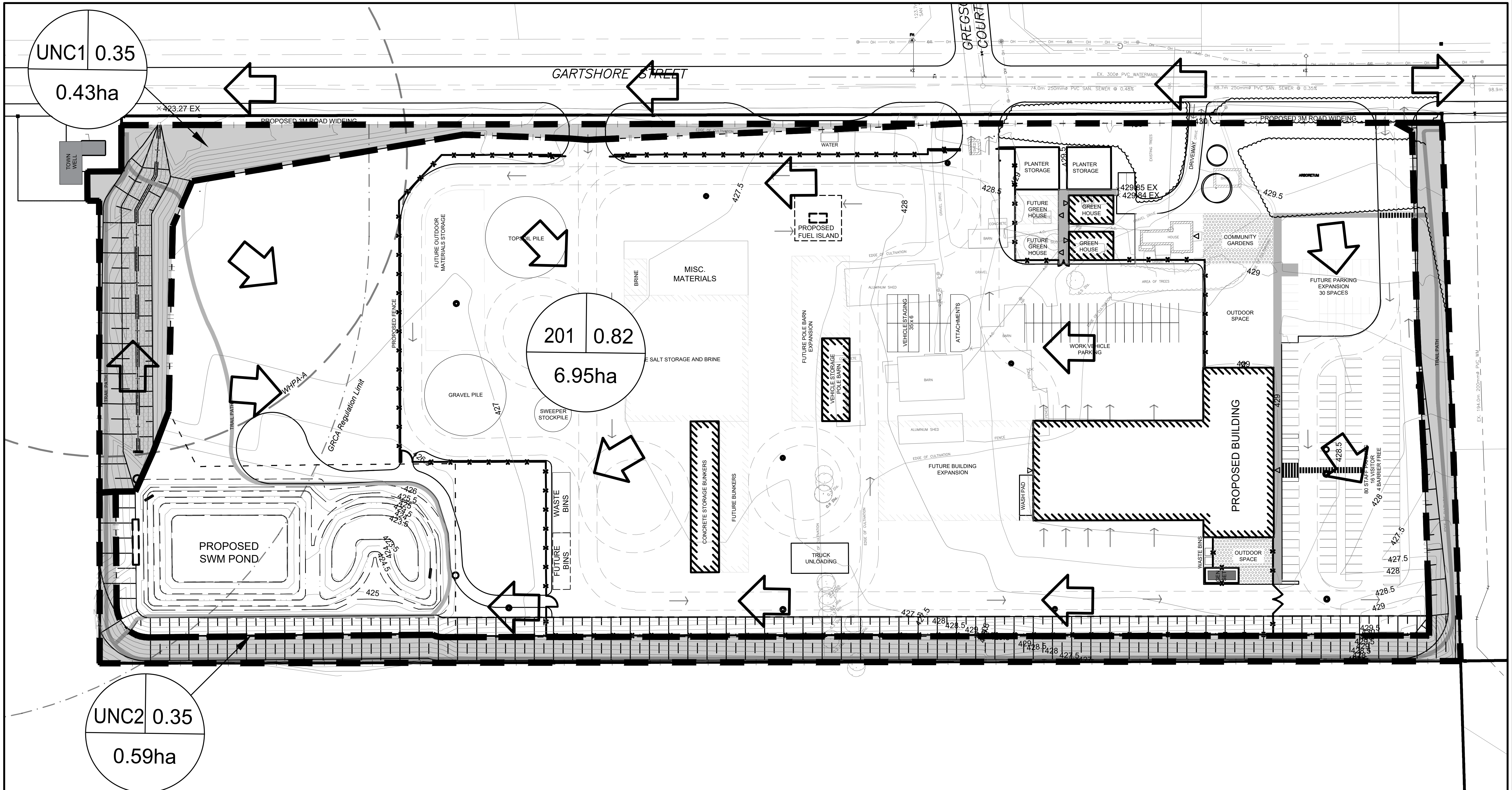
AREA — 10.00ha



BURNSIDE

Figure Title	**CENTRE WELLINGTON OPERATIONS CENTRE** EXISTING SITE DRAINAGE CONDITIONS
Client	**TOWNSHIP OF CENTRE WELLINGTON**
Drawn	JR
Checked	FG
Date	23/02/03
Scale	1:1250
Project No.	300055234.0000
Figure No.	4

File: \\sherlock\shared work areas\055234 centre wellington operations ctr\07_Figures\055234 FIG3 EXISTING SITE CONDITIONS.dwg Date Plotted: April 17, 2023 - 9:29 AM



LEGEND

PROPERTY BOUNDARY

DRAINAGE BOUNDARY

OVERLAND FLOW DIRECTION

CATCHMENT No. — 101 | 0.50 — RUNOFF COEFFICIENT

AREA — 10.00ha

TRUE NORTH

PROJECT NORTH

0 25 50 75 100

Metres

BURNSIDE

Figure Title	**CENTRE WELLINGTON OPERATIONS CENTRE** PROPOSED SITE DRAINAGE CONDITIONS
Client	**TOWNSHIP OF CENTRE WELLINGTON**
Drawn	JR
Checked	FG
Date	23/02/03
Scale	1:1250
Project No.	300055234.0000
Figure No.	**5**

File: \\sherlock\shared work areas\055234 centre wellington operations ctr\07_Figures\055234 FIG4 PROPOSED SITE CONDITIONS.dwg Date Plotted: April 17, 2023 - 9:29 AM

BURNSIDE

CALCULATION SHEET

Project: **Centre Wellington Operations Centre**

C101

Existing/Allowable Flows

Prepared by:	J. Rooke
Checked by:	F.Goulding
Project No:	300055234.0000
Date:	6-Feb-2023

Runoff Equation Q = 2.78CIA (L/s)

where,
C = runoff coefficient
I = rainfall intensity (mm/hr)
A = area (ha)
2.78= conversion factor

Definition	Area		C	
Asphalt/Concrete/Rooftops	0.17	ha	0.90	**From Centre Wellington Design Standards*
Grass Short / Mowed	0.98	ha	0.35	**From Centre Wellington Design Standards*
Gravel	0.24	ha	0.70	**From Centre Wellington Design Standards*
Agricultural	6.58	ha	0.31	**From MTO Design Chart*
Totals	7.97	ha	0.34	

$$I = AT^B$$

I= Rainfall Intensity (mm/hr)
T= Time of concentration (hour)
(use T=10 min or 0.1666667hr)

Return Period	A	B	T		I		C	Q	
2 year	23.3	-0.699	0.167	hr	81.52	mm/hr	0.34	612.74	L/s
5 year	30.7	-0.699	0.167	hr	107.42	mm/hr	0.34	807.35	L/s
10 year	35.6	-0.699	0.167	hr	124.56	mm/hr	0.34	936.21	L/s
25 year	41.8	-0.699	0.167	hr	146.25	mm/hr	0.34	1099.26	L/s
50 year	46.4	-0.699	0.167	hr	162.35	mm/hr	0.34	1220.23	L/s
100 year	50.9	-0.699	0.167	hr	178.09	mm/hr	0.34	1338.57	L/s

Allowable release rate from the site is 1338.57 L/s

IDF Curve Data taken from the MTO IDF Curve Lookup database for the site location

BURNSIDE

CALCULATION SHEET

Project: **Centre Wellington Operations Centre**

C201

Post Development Controlled Flows

Prepared by:	J. Rooke
Checked by:	F.Goulding
Project No:	300055234
Date:	6-Feb-2023

Runoff Equation Q = 2.78CIA (L/s)

where,
C = runoff coefficient
I = rainfall intensity (mm/hr)
A = area (ha)
2.78= conversion factor

Definition	Area	C	
Asphalt/Concrete/Rooftops	4.62 ha	0.90	**From Centre Wellington Design Standards*
Grass Short / Mowed	1.69 ha	0.35	**From Centre Wellington Design Standards*
SWM Facility	0.64 ha	1.00	
Totals	6.95 ha	0.78	

I = AT^B

I= Rainfall Intensity (mm/hr)
T= Time of concentration (hour)
(use T=10 min or 0.1666667hr)

Return Period	A	B	T	I	C	Q
2 year	23.3	-0.699	0.167 hr	81.52 mm/hr	0.78	1219.56 L/s
5 year	30.7	-0.699	0.167 hr	107.42 mm/hr	0.78	1606.88 L/s
10 year	35.6	-0.699	0.167 hr	124.56 mm/hr	0.78	1863.36 L/s
25 year	41.8	-0.699	0.167 hr	146.25 mm/hr	0.85	2406.66 L/s
50 year	46.4	-0.699	0.167 hr	162.35 mm/hr	0.93	2914.37 L/s
100 year	50.9	-0.699	0.167 hr	178.09 mm/hr	1.00	3435.98 L/s

IDF Curve Data taken from the MTO IDF Curve Lookup database for the site location

BURNSIDE

CALCULATION SHEET

Project: **Centre Wellington Operations Centre**

UNC1
Post Development Uncontrolled Flows

Prepared by:	J. Rooke
Checked by:	F.Goulding
Project No:	300055234
Date:	6-Feb-2023

Runoff Equation Q = 2.78CIA (L/s)

where,
C = runoff coefficient
I = rainfall intensity (mm/hr)
A = area (ha)
2.78= conversion factor

Definition	Area		C	
Asphalt/Concrete/Rooftops	0.00	ha	0.90	**From Centre Wellington Design Standards*
Grass Short / Mowed	0.43	ha	0.35	**From Centre Wellington Design Standards*
SWM Facility	0.00	ha	1.00	
Totals	0.43	ha	0.35	

$$I = AT^B$$

I= Rainfall Intensity (mm/hr)
T= Time of concentration (hour)
(use T=10 min or 0.1666667hr)

Return Period	A	B	T		I		C	Q	
2 year	23.3	-0.70	0.167	hr	81.52	mm/hr	0.35	34.08	L/s
5 year	30.7	-0.70	0.167	hr	107.42	mm/hr	0.35	44.91	L/s
10 year	35.6	-0.70	0.167	hr	124.56	mm/hr	0.35	52.08	L/s
25 year	41.8	-0.70	0.167	hr	146.25	mm/hr	0.39	67.26	L/s
50 year	46.4	-0.70	0.167	hr	162.35	mm/hr	0.42	81.45	L/s
100 year	50.9	-0.70	0.167	hr	178.09	mm/hr	0.44	93.07	L/s

IDF Curve Data taken from the MTO IDF Curve Lookup database for the site location

BURNSIDE

CALCULATION SHEET

Project: **Centre Wellington Operations Centre**

UNC2

Post Development Uncontrolled Flows

Prepared by:	J. Rooke
Checked by:	F.Goulding
Project No:	300055234
Date:	6-Feb-2023

Runoff Equation Q = 2.78CIA (L/s)

where,
C = runoff coefficient
I = rainfall intensity (mm/hr)
A = area (ha)
2.78= conversion factor

Definition	Area	C	
Asphalt/Concrete/Rooftops	0.00 ha	0.90	**From Centre Wellington Design Standards*
Grass Short / Mowed	0.59 ha	0.35	**From Centre Wellington Design Standards*
SWM Facility	0.00 ha	1.00	
Totals	0.59 ha	0.35	

$$I = AT^B$$

I= Rainfall Intensity (mm/hr)
T= Time of concentration (hour)
(use T=10 min or 0.1666667hr)

Return Period	A	B	T	I	C	Q
2 year	23.3	-0.70	0.167 hr	81.52 mm/hr	0.35	46.77 L/s
5 year	30.7	-0.70	0.167 hr	107.42 mm/hr	0.35	61.62 L/s
10 year	35.6	-0.70	0.167 hr	124.56 mm/hr	0.35	71.45 L/s
25 year	41.8	-0.70	0.167 hr	146.25 mm/hr	0.39	92.29 L/s
50 year	46.4	-0.70	0.167 hr	162.35 mm/hr	0.42	111.76 L/s
100 year	50.9	-0.70	0.167 hr	178.09 mm/hr	0.44	127.70 L/s

IDF Curve Data taken from the MTO IDF Curve Lookup database for the site location

R.J. Burnside & Associates Limited