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Hydrogeological Assessment - Dorsay Lands

DIV Development (Barrie) Ltd.
Barrie, Ontario

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1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) has been retained by DIV Development (Barrie) Ltd. to complete a hydrogeological assessment for the Dorsay lands located south of Mapleview Drive, north of Lockhart Road and west of Sideroad 20 in the City of Barrie, Ontario (Figure 1). The lands are located within the Barrie Annexed Lands and the OPA 39 Hewitt's Secondary Plan Area (SPA) on the southern boundary of the City of Barrie. In 2016, a Subwatershed Impact Study (SIS) for the Hewitt's SPA was completed for the Hewitt's Creek Landowners Group that included an assessment of regional hydrogeology (Burnside, 2016). The SIS included recommendations for additional studies to be done in support of draft plan approvals for the individual parcels within the Hewitt's SPA.

The current assessment is aimed at updating information contained in the SIS and providing more detailed site-specific information in support of an application for draft plan approval.

1.1 Scope of Work

The scope of work completed for the hydrogeological assessment was developed to build upon the more regional work completed for the Hewitt's SPA (Burnside, 2016) and to address requirements for hydrogeological studies in support of draft plan approval. The scope of work for the hydrogeological assessment included the completion of the following site-specific tasks:

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 was completed to assess the regional and local 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 9. 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. Establish groundwater monitoring network: Groundwater monitoring locations were established to characterize seasonal variations in the water table in both the upper surficial and first encountered aquifers. Monitoring wells previously

constructed by Soil Engineers Ltd. were incorporated into the monitoring network. An additional five monitoring wells were installed by Burnside in 2019 and three piezometer nests were installed along water courses to observe groundwater surface water interactions. The locations of the monitoring wells and piezometers 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 soil hydraulic conductivity. Single well response tests were completed at two groundwater monitoring wells (DS-MW1 and DS-MW12d) in 2020. Hydraulic conductivity testing completed by Soil Engineers Ltd. in 2017 was reviewed and included in the current study. The hydraulic conductivity field testing results are provided in Appendix C.

5. Monitoring of groundwater levels: Monitoring has been completed to measure the depth to the water table and assess the horizontal and vertical groundwater flow conditions. Groundwater level monitoring was completed between June 2019 and March 2024 in monitoring wells and piezometers. Automatic water level recorders (dataloggers) were installed in four monitoring wells (DS-MW1, DS-MW7, DS-MW9 and DS-MW12d) and two piezometers (DS-PZ1d and DS-PZ3d) to document the range of groundwater fluctuations and the response of the groundwater table to precipitation events. Barometric data from a barologger installed in the vicinity of the subject lands was used for calibration of the datalogger results. The groundwater monitoring data and hydrographs are provided in Appendix D.

6. Monitoring of surface water: Surface water monitoring was completed at three monitoring stations located along watercourses that traverse the subject lands (Figure 2). The stations were inspected for water depth and flow on each site visit. The surface water monitoring data are summarized in Appendix E.

7. Water quality testing: Water quality data were collected from selected monitoring locations to typify the groundwater and surface water quality. Samples were collected in 2020 from two monitoring wells: DS-MW12d and DS-MW17 and two surface water locations SW1 and SW3. The water samples were submitted to an accredited 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. An additional water sample was collected in 2023 from DS-MW7 and analyzed for additional parameters based on the City of Barrie guidelines. The laboratory water quality data are provided in Appendix F.

8. Water balance calculations: Pre-development and post-development water balance calculations have been completed to assess the groundwater infiltration

volumes for the subject lands. The local climate data and detailed water balance calculations are provided in Appendix G.

9. Reporting: All the data compiled as part of the assessment was reviewed in order to develop an understanding of site-specific hydrogeological conditions. The data were used to construct maps and figures and geological cross-sections in support of the interpreted geological conditions.

2.0 Topography and Drainage

The subject lands are located within the Innisfil Creek and Hewitt's Creek subwatershed of the larger Lake Simcoe watershed (Figure 3). The topography of the subject lands is generally flat to gently rolling. Elevations range from a high of 260 meters above sea level (masl) in the northwest corner of the subject lands to a low of 248 masl along Sideroad 20 along the tributaries of Sandy Cove Creek.

Tributaries of Sandy Cove Creek traverse the subject lands from west to east and southwest to east and northeast. One tributary is located on the northern portion of the subject lands, flows east and leaves the subject lands at Sideroad 20 near Mapleview Drive. Another tributary originates within the Natural Heritage System located in the middle of the Dorsay lands, two branches flowing east and north merge and then flow east leaving the subject lands at a culvert along Sideroad 20. Wetland features are associated with the tributaries mapped as unevaluated wetlands as per the Ontario Wetland Evaluation System the drainage network is illustrated on Figure 3.

3.0 Geology

The subject lands are located in the physiographic region known as the Peterborough Drumlin Field. The region is characterized as a rolling drumlinized till plain. The drumlins through the region are comprised of highly calcareous till (Chapman & Putnam, 1984). The overburden in the vicinity of the subject lands was deposited as a series of advances and retreats of the Simcoe glacial ice lobe. This has resulted in drumlinized sheets of glacial till (Newmarket till), stratified glaciolacustrine deposits of sand and gravel, littoral-foreshore deposits and massive-well laminated deposits of sand and gravel (OGS, 2003).

A review of the quaternary geology mapping for the area (OGS, 2003) indicates that the overburden sediments of the subject lands consist of silty to sandy glacial till and ice-contact stratified deposits (Figure 4).

The bedrock underlying the subject lands is mapped as the Verulam Formation which consists of grey limestone with alternating shale and claystone (Figure 5). The southwest corner of the subject lands is mapped as the Lindsay Formation of the Simcoe Group, which consists of limestone and shale (OGS, 2007). The overburden has been estimated to be over 145 m thick in the vicinity of the subject lands (ORMGP, 2020).

4.0 Hydrogeology

4.1 Regional Hydrostratigraphy

The regional hydrogeology of an area describes the major aquifers and aquitards and the interactions between these types of hydrogeological units. Local conditions may vary from the regional interpretations, however major groundwater flow systems are assumed to be regional in nature.

The overburden deposits underlying the subject lands have been interpreted by regional studies such as the Tier 3 Water Balance (AquaResource, 2011) and Source Water Protection Assessment Report (LSRCA, 2012) to consist of alternating sequences of coarser-grained permeable layers (aquifers) and finer-grained less permeable layers (aquitards) of varying thicknesses. This sequence of layers was also supported by the SIS (Burnside, 2016). The basic hydrostratigraphic sequence that was interpreted for the area of the subject lands includes four main aquifer layers (A1 to A4) and four main aquitards (C1 to C4) with a confining layer (UC) overlying the uppermost aquifer (A1).

A description of the interpreted regional hydrostratigraphic framework is provided below based on the Source Water Protection Assessment Report (LSRCA, 2012):

- Surficial Geology Layer – This layer represents coarse grained sediments in stream beds and at surface surficial geology areas that overly the UC. The thickness ranges from 5 m to 15 m.
- UC – Upper Confining Layer – Represents smaller areas of less permeable surficial material. The upper confining layer has been mapped as coarse-grained lacustrine deposits which are part of a regionally extensive sand plain (LSRCA, 2012). Regional studies such as the AquaResource (2011) report indicate that the confining layer (UC) is patchy in the Barrie area.
- A1 – Represents the uppermost aquifer – Occasionally exists as a surficial unconfined aquifer and is stratigraphically equivalent to the Oak Ridges Moraine. It is generally associated with coarse grained glacial and interglacial sediments mapped as ice contact stratified drift. The majority of the local domestic wells in the Barrie area are completed within this aquifer.
- C1 – Upper aquitard – Described as varved clay and silt (LRSCA, 2012).
- A2 – Intermediate aquifer which is stratigraphically equivalent to areas within the Northern Till. The aquifer is generally described as being composed of sand with

some clast rich portions (LRSCA, 2012). This area is used for the Innisfil Heights water supply.

- C2 – Intermediate aquitard.
- A3 – This area constitutes the main Barrie municipal aquifer and is the source of the Stroud water supply; it is stratigraphically equivalent to the Thorncliffe deposits in the Upland regions.
- C3 – Lower aquitard.
- A4 – Lower aquifer, thin and sometimes combined with A3 where C3 is thin or absent.
- C4 – Lower aquitard but may also represent weathered bedrock.

4.2 Local Stratigraphy

A total of 17 boreholes were drilled across the subject lands as part of geotechnical investigations by Soil Engineers Ltd. in 2016 and drilling by Burnside in 2019. The locations of the boreholes are shown on Figure 6 and the borehole logs are provided in Appendix B. The boreholes indicated that the overburden is generally composed of layers of sandy silt to silty sand till overlying silty sand and sand. The till deposits also had varying amounts of clay and gravel. Localized units of sandy silt and silty clay were also encountered. The lithology encountered by the boreholes is generally consistent with the lithology shown on the geological maps.

To illustrate the shallow stratigraphy of the subject lands, schematic geologic cross-sections have been prepared (Figures 7 and 8) using 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 (Figures 7 and 8) show that the subject lands are underlain by a sand, silt and silty sand till that is 5 m to 15 m thick. There are occasional clay and silt deposits at surface. The sand and silty sand till is underlain by a confining clay and silt layer 15 m to 25 m thick. A regional sand/gravel aquifer is interpreted below the clay silt layer.

4.3 Soil Hydraulic Conductivity

Hydraulic conductivity is a measure of a soil’s ability to transmit groundwater. 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. Single well response tests such as in situ bail-down or slug-testing methods are used in groundwater monitoring wells to assess in situ hydraulic conductivity of the soils represented across the screened interval of the well. 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.

4.3.1 Grainsize Analysis

During geotechnical investigations on the subject lands, representative soil samples were collected and analyzed for grainsize distribution (Appendix C). To estimate hydraulic conductivity based on grainsize analysis, an empirical formula method known as the Hazen estimation is used. This method is an approximation of 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. Hydraulic conductivity values were derived empirically using the Hazen method when applicable for eight soil samples. The grainsize distribution graphs of the soil samples are provided in Appendix C and are summarized in Table 1.

Table 1: Estimated Hydraulic Conductivity Based on Grainsize Analyses

Sample ID	Depth of Sample (mbgs*)	Soil Classification	% Fines	Hydraulic Conductivity (cm/sec)
BH5-SS8	7.8	Silty Sand Till	47	9.0×10^{-6}
BH6-SS5	3.3	Silty Sand	49	2.3×10^{-4}
BH1-SS14	13.9	Silty Clay	96	n/a
BH1-SS13	12.4	Sandy Silt	58	6.3×10^{-4}
BH2-SS7	6.4		65	2.6×10^{-4}
BH9-SS3	1.8	Silty Clay Till	60	n/a
BH7-SS10	7.9	Sandy Silt Till	55	2.3×10^{-6}
BH1-SS7	4.9	Sand, some silt.	12	2.7×10^{-3}

*metres below ground surface
na – Hazen formulae not applicable

Grainsize analyses results indicate that the sediments within the overburden range in composition from sand some silt (12% fines) to silty clay (96% fines). The greater amounts 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. The grainsize analyses indicate that the sediments encountered on the subject lands are mainly sand and silty sand with occasional layers with a greater percentage of fines. Computed hydraulic conductivities based on these analyses indicate a range of 10^{-3} to 10^{-6} cm/sec which is regarded as moderate to low.

4.3.2 Single Well Response Tests

Single well response tests were completed by Soil Engineers Limited at seven monitoring wells in 2016. The results of the tests are provided in Appendix C and summarized in Table 2 below. To confirm the results of the previous testing bail-down tests and slug test were conducted by Burnside at two monitoring wells. The results from the tests were plotted (Appendix C) 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)
DS-MW1	13.4 – 16.9	Silty Clay, Silty Sand	3.5×10^{-4}
			4.7×10^{-5}
DS-MW3	4.0 – 7.6	Silty Sand and Sandy Silt	4.7×10^{-5}
DS-MW5	4.0 – 7.6	Silty Sand Till	1.5×10^{-4}
DS-MW7	5.3 – 9.0	Sandy Silt Till	4.9×10^{-5}
DS-MW8	2.6 – 6.2	Gravelly Sand and Sandy Silt Till	1.4×10^{-4}
DS-MW9	5.3 – 9.0	Silty Sand Till	4.3×10^{-5}
DS-MW12d	3.7 – 5.8	Silty Sand Till, Silty Sand	5.6×10^{-4}
			8.7×10^{-4}

*metres below ground surface

Single well response tests in wells screened in the silty sand till indicated moderate hydraulic conductivities in the order of 10^{-4} cm/sec to 10^{-5} cm/sec.

4.4 Local Groundwater Use

The City of Barrie obtains its water supply from a combination of groundwater and surface water based sources. Municipal servicing is assumed to be available for lands within the municipal city boundary and areas outside of the city are privately serviced. It is our understanding that municipal servicing is being extended into the area as part of the development of the Hewitt's Secondary Plan Area. Areas that were previously privately serviced are assumed to still have individual private water supply wells as the servicing works are not yet complete.

A review of the MECP water well records indicated that there are approximately 39 water supply well records within 500 m of the subject lands. Of the 39 well records, 22 are identified as private water supply wells. Based on the well records and interpreted hydrostratigraphy, most of these wells are completed in the first encountered (local) aquifer with depths ranging from 9.1 m to 29 m with five of the wells located in the deep aquifer with depths greater than 30 m. The cross-sections completed indicate that the top of the first encountered aquifer zone is located at elevations around 225 masl to 230 masl. The locations of the MECP water well records are shown on Figure 9.

There are no municipal water supply wells located in the vicinity of the subject lands. The closest municipal supply wells are located on the west and northern sides of the city and more than 5 kilometers from the subject lands. The subject lands do not fall within any wellhead protection areas or intake protection zones associated with the City of Barrie water supply systems (LSRCA, 2012). The City of Barrie groundwater supply wells are located in deep aquifers (A3 and A4 in the regional hydrostratigraphy). These aquifers are interpreted to be found at elevations of 150 masl to 195 masl and 115 masl to 160 masl respectively and are therefore significantly below (approximately 100 to 150 m below the surficial layer found on the subject lands) and separated from any potential impact due to the proposed development (AquaResource et al., 2011).

4.5 Water Level Monitoring Results

Groundwater levels were monitored at 8 monitoring wells including one nest across the subject lands in order to gain information on groundwater distribution and fluctuations. Groundwater levels were monitored at the on-site monitoring wells between June 2019 and March 2024. Groundwater level data is provided in tables and hydrographs in Appendix D. Groundwater elevations are plotted with daily precipitation data obtained from a nearby climate station – Barrie-Oro (Climate Station ID# 6117700) which is the closest station with daily precipitation values for 2019 and 2021 to 2024. In 2020 precipitation data is obtained from the Barrie Landfill Climate Station (Climate Station ID#6110556) since the Barrie-Oro climate station data was not available.

In addition to the manual water level measurements recorded at each location, automatic water level recorders were installed in DS-MW1, DS-MW9, DS-MW12d, DS-PZ1d and DS-PZ3d to record continuous water levels. The datalogger data collected are included on the hydrographs provided in Appendix D.

The groundwater monitoring data show the following (refer to Figure 2 for the monitoring locations and the data tables and hydrographs in Appendix D):

- Shallow wells in southern Ontario typically show a pattern of groundwater fluctuations that is related to seasonal variations in precipitation and infiltration. This pattern shows the highest groundwater levels occurring in the spring, levels declining throughout the summer and early fall and then rising again in the late fall/early winter. This pattern is apparent in the wells located on the subject lands (Figures D-1 to D-12, in Appendix D). The seasonal variation in water levels shows a range from 0.7 m to 1.5 m (Figures D-1 to D-12). Seasonal variations at drive-point piezometers (Figures D-13, D-14 and D-15) were generally less than 1 m.

- Continuous water level data obtained from dataloggers at one-hour frequency were plotted against precipitation to determine whether there is a correlation between precipitation events (recharge events) and changes in water level (Figures D-1, D-4, D-6 and D-7). Water level response is observed at DS-MW7 following three days of heavy rain at the end of October 2019 (Figure D-4, Appendix D). At DS-MW12d water levels respond to precipitation events such as a large rain event in January 12, 2020 (0.5 m increase). Water levels also increased 0.6 m after three days of heavy rain at the end of October 2019 (Figure D-7, Appendix D). At DS-MW1, water levels show a response of 0.5 m after a heavy rainfall in July 2020 (Figure D-1, Appendix D).

- Groundwater potentiometric levels at the monitoring wells ranged from above grade to 5.6 meters below ground surface for wells completed in the shallow subsurface.

- Groundwater levels in DS-MW8 and DS-MW9, DS-MW15 appear to be under pressure heads with water level being noted to be seasonally near or above grade (Figures D-5, D-6 and D-10, Appendix D). DS-MW8 and DS-MW9 are screened within a sandy silt till layer. DS-MW15 is screened in shallow sands. These pressures are interpreted to be generated due to the elevation of the recharge areas and the confining influence of less permeable layers in the subsurface. Where lithology allows, the potentiometric heads are observed to locally extend into the surrounding sand and silt till.

4.6 Interpreted Groundwater Flow Pattern

Groundwater flow within the shallow surficial soils (water table) is interpreted to be influenced by the surface topography with groundwater flow from the topographically higher areas towards topographically lower areas and surface water features (Figure 10). Groundwater elevation data (March 2020) obtained from the monitoring wells are shown on Figure 10, along with the interpreted groundwater elevation contours for the area. Arrows perpendicular to the groundwater elevation contours shown on Figure 10 illustrate the interpreted direction of the groundwater movement. On Figure 10, groundwater is interpreted to flow towards the tributaries of Sandy Cove Creek.

4.7 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. Recharge areas are generally located where there is 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 into wetlands and along watercourses.

When evaluating groundwater recharge or discharge conditions, nested wells (two wells screened at different depths at the same location) can be used to determine vertical hydraulic gradients and groundwater recharge or discharge conditions in the subsurface.

At monitoring well nest DS-MW12s/d, the groundwater levels in the deep well are similar to the shallow well or slightly higher indicating a small upward gradient and potential for groundwater movement from the deep to the shallow zones (Figure D-7, Appendix D).

4.7.1 Groundwater Surface Water Interactions

To assess shallow groundwater conditions and gradients near the watercourses and wetlands two drive-point piezometer nests were monitored.

PZ1s/d is located along the north tributary of Sandy Cove Creek near SW1 (Figure 2). The water levels in PZ1d took four months to recover from installation. Once groundwater stabilized in the piezometer an upward gradient (shallow water level lower than deep water level) is observed, showing the potential for groundwater discharge conditions to exist in this area (Figure D-13, Appendix D). The actual volume of discharge will be minimal due to the low hydraulic conductivity of the soils.

DS-PZ2s/d is located in the wetland along the southern tributary of Sandy Cove Creek near SW3 (Figure 2). The water levels in DS-PZ2s/d took three months to recover after installation indicating very tight soils. After stabilization, the water levels were generally above grade showing an upward gradient (Figure D-14) and the potential for groundwater discharge to the wetland.

DS-PZ3s/d is located in a wetland in the south-central portion of the subject lands (Figure 2). A slight downward gradient is observed during the duration of monitoring (Figure D-15). There is a strong seasonal trend in water levels and water levels respond rapidly to precipitation events.

4.7.2 Significant Groundwater Recharge Areas and Ecologically Significant Groundwater Recharge Areas

Significant Groundwater Recharge Areas (SGRAs) can be described as areas that can effectively move water from the surface through the unsaturated soil zone to replenish available groundwater resources (LSRCA, 2012). SGRAs were mapped by the Source Water Protection Assessment Report (LSRCA, 2012) as a requirement of the Clean Water Act, 2006 and based on guidance provided by the MECP. The delineation of these areas was completed using numerical models and analyses that included the evaluations of numerous factors including precipitation, temperature and other climate data along with land use, soil type, topography and vegetation to predict groundwater recharge, runoff and evapotranspiration. SGRAs represent areas where the annual recharge rate is greater than 115% of the average recharge of 164 mm/year across the Lake Simcoe watershed (or greater than the threshold recharge rate of 189 mm/year) (LSRCA, 2012).

Ecologically Significant Groundwater Recharge Areas (ESGRAs) were delineated for the Barrie Creek, Lovers Creek and Hewitt's Creek subwatersheds by Earthfx (2012) using the groundwater model developed by AquaResources for the Source Protection studies. ESGRAs were defined as areas of land that are assumed to support groundwater systems or environmentally sensitive features like lakes, cold water streams and wetlands (Earthfx, 2012). ESGRAs were delineated in the groundwater model by identifying pathways in which recharge, if it occurred, would reach an ecologically significant feature. Ecologically significant features used for the delineation of the ESRGAs included headwater streams, cold water fisheries, wetlands, and brook trout and sculpin capture sites. ESGRAs and SGRAs are not mutually exclusive. ESGRAs are determined based on the linkage between a recharge area and an ecologically sensitive area while SGRAs are located where high volumes of recharge are assumed to occur.

The locations of mapped SGRAs and ESGRAs on the subject lands are shown in Figure 11. SGRAs mapped on the subject lands correspond to surficial geology mapping of glaciofluvial ice-contact stratified sediments (Figure 4).

5.0 Surface Water Monitoring

To characterize the flow conditions of watercourses on the subject lands monitoring locations were established and flow conditions were measured during monitoring events. Surface water flow monitoring was conducted at three monitoring locations, SW1, SW2 and SW3 (Figure 2). Monitoring data over the period of this study is provided in Appendix E and summarized below:

- SW1 is located along the northern tributary of Sandy Cove Creek which flows west to east across the subject lands. The tributary at SW1 is an incised channel that flows through the agricultural lands. Flows observed at SW1 ranged from 2.9 L/s to 39.5 L/s. Standing water (no flow) was generally observed in the summer months (July, August, September) and frozen conditions were observed December 2019, January and March 2020, December 2022 and February and March 2023.

- SW2 is downstream of SW1 along the tributary of Sandy Cove Creek as the tributary leaves the subject lands at Sideroad 20. The tributary between SW1 and SW2 is incised, and tile drain outlets were observed along its southern banks. Flow was found to be present on all monitoring visits except for during the winter months when conditions were reported as frozen. Flows observed at SW2 ranged from <0.5 L/s to 24.2 L/s and show an increase in flow from SW1 (indicating a gaining stream).

- SW3 is located along the southern tributary of Sandy Cove Creek which flows through the Natural Heritage System on the subject lands at the culvert along Sideroad 20. Flows were observed at SW3 ranging from 0.4 L/sec to 16.1 L/sec. In July and August 2019 no flow was observed. Frozen conditions were observed in the winter months (November to March).

6.0 Water Quality

6.1 Groundwater Quality

Water quality data was collected from two monitoring wells to typify the groundwater quality in the vicinity of the subject lands. Groundwater sampling was completed on June 1, 2020 at two groundwater monitoring wells (DS-MW12d and DS-MW17). The water samples were submitted to an accredited 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.

For comparison purposes, the Ontario Drinking Water Quality Standards (ODWQS) and the Provincial Water Quality Objectives (PWQO) are provided with the results on Table F-1, Appendix F. The groundwater will not be used for drinking water however the ODWQS provides an indication of acceptable concentrations for potable water. The PWQO provides an indication of whether the groundwater on the subject lands could be discharged to surface water should pumping associated to construction be required. The groundwater testing results from the analytical laboratory are provided in Table F-1, Appendix F and discussed below:

- All samples exceeded the ODWQS for total hardness (100 mg/L) with values of 193 mg/L (DS-MW17) and 262 mg/L (DS-MW12d). Hardness in groundwater is caused by dissolved calcium and magnesium and is typically related to the geologic material of the aquifer. Elevated values are typical for aquifers in Southern Ontario.

- All samples exceeded the ODWQS for turbidity (5 NTU) with values ranging from 601 NTU (DS-MW12d) and 13500 NTU (DS-MW17). The high turbidity is likely a result of high silt content in the samples. It is noted that the monitoring wells were originally constructed as geotechnical boreholes and are not likely to have been developed as part of construction. The high silt content is likely related to the lack of well development and is not considered to be a water quality issue in this area.

- Nitrate was detected in both of the samples with values of 0.22 mg/L (DS-MW17) and 9.6 mg/L (DS-MW12d). Elevated nitrate at DS-MW12d (9.6 mg/L) is likely a result of agricultural activities in the area of the subject lands. The concentration is close to the ODWQS for nitrate which is 10 mg/L.

- Total phosphorus was reported in the samples at 0.29 mg/L and 1.92 mg/L which exceeds the PWQO of 0.03 mg/L. Total phosphorus is a measure of all forms of phosphorus (dissolved or particulate) that are found in the water sample. There was very little dissolved phosphorus (ortho-phosphate) reported in the groundwater samples suggesting the reported concentrations are particulate in the groundwater sample.

Additional groundwater sampling was completed on December 18, 2023. Monitoring well DS-MW7 was sampled using low-flow sampling methods and samples collected were sent to AGAT Laboratories for analysis of parameters listed in Appendix B – Hydrogeological Sample Analysis Parameters (City of Barrie). The sample results (see Table F-1a) were compared to the limits provided in Appendix B as well as to Table 8 SCS from O.Reg. (Table 8: Generic Site Condition Standards for Use within 30 m of Water Body in a Potable Groundwater Condition). There were no exceedances of Appendix B or Table 8 SCS limits.

6.2 Surface Water Quality

Surface water quality data was collected at SW1, SW2 and SW3 to typify the surface water quality in the vicinity of the subject lands. Sampling was conducted in June 2020 and submitted to an accredited laboratory for analyses of general water quality indicators (e.g., pH, hardness, and conductivity), basic ions (including chloride and nitrate) and selected metals. The surface water quality testing results from the analytical laboratory are provided in Table F-2, Appendix F and have been compared to the Provincial Water Quality Objectives (PWQO):

- The results showed that the water generally met the Provincial Water Quality Objectives (PWQO).

- Total phosphorus at SW3 was reported at a concentration of 0.05 mg/L which exceeds the PWQO of 0.03 mg/L. Total phosphorus is a measure of all forms of phosphorus (dissolved or particulate) that are found in the water sample. There was no dissolved phosphorus (ortho-phosphate) reported in the sample suggesting the reported concentrations are particulate.

- At SW1, uranium was reported at a concentration of 0.006 mg/L which exceeds the PWQO of 0.005 mg/L. Uranium can be found in phosphate fertilizers and may have been associated with the agricultural land use that occurred on the subject lands. There was no uranium detected in the surface water sample from SW3 and no uranium detected in the groundwater samples. It is anticipated that the cessation of agricultural use will remove the source of uranium.

As part of the field surface water monitoring, when flow was present surface water chemistry field parameters were collected. The results of the monitoring are provided in Table F-3, Appendix F. Parameters collected included temperature, conductivity, total dissolved solids and total suspended solids. Temperatures at the surface water monitoring locations ranged from 1.6 deg Celsius to 19.5 deg Celsius. Total suspended solids ranged from 0 mg/L to 58 mg/L.

7.0 Water Balance

In order to assess potential land development impacts on the local groundwater conditions, a detailed water balance analysis has been completed 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 are provided in Appendix G.

The water balance computed as part of the current study was completed using a similar approach as that completed for the SIS (Burnside, 2016). It was noted at the SIS level that subsequent studies should complete individual water balance assessments at a site-specific level in order to determine the potential impacts of development on local features and to evaluate the need for Low Impact Development (LID) measures.

7.1 Water Balance Components

A water balance is a planning tool that provides an accounting of the water resources within a given area. The water balance uses regional and site-specific information to estimate the resulting parameters. It is important to understand that the water balance is a diagnostic tool that provides an order of magnitude understanding of water resources. Based on the assumptions and simplification required to undertake these assessments, it should be noted that predictions from a water balance provide more of an understanding of the nature of an impact rather than a precise measure of the impact.

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 an area. The information collected as part of the current study including 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. These input parameters have been estimated for the subject lands and are discussed below:

Precipitation (P)

Precipitation represents the main input to the water balance calculation. Precipitation for the subject lands was estimated based on the climate normal (the long-term average annual precipitation for the 30-year period 1981 to 2010). The normal precipitation for the area of the subject lands was determined to be 933 mm based on data from the Environment Canada Barrie WPCC (Station 6110557, 44°22'33.012" N, 79°41'23.010" W, elevation 221.0 masl). The climate station is located 5 km northeast of the subject lands. The normal monthly records of precipitation and temperature from this station have been used for the water balance calculations in this study (Appendix G). It is noted that the actual precipitation of the subject lands may vary from the documented normal.

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 for the purposes of the water balance calculation. This does not impact the evaluation as the water balance is considered at the annual scale where annual losses and annual gains are expected to balance out.

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 assessment, the PET has been calculated using a climate variable approach and corrections for latitude and heat index. The AET is 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.

7.2 Water Balance Approach and Methodology

The analytical approach to calculate the water balance involves monthly soil-moisture balance calculations to determine the pre-development (based on existing land use) infiltration volumes. A soil-moisture balance approach assumes that soils do not release water as potential recharge while a soil moisture deficit exists. During wetter periods, any excess of precipitation over evapotranspiration first goes to restore soil moisture. 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).

A soil moisture storage capacity of 150 mm was selected as a representative value for the existing vegetation and soil conditions which consists of predominantly short to moderate-rooted vegetation in the fields and agricultural areas (Table G-1, Appendix G). A soil moisture storage capacity of 300 mm was used to represent the woodland located in the Natural Heritage System (Table G-2, Appendix G). A soil moisture storage capacity of 75 mm was used to represent the post-development vegetation which will be dominantly urban lawn (Table G-3, Appendix G). Tables G-1 to G-3 in Appendix G details 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. The calculated water balance components from this table are then used to assess the pre-development and post development volumes for runoff and infiltration as presented on Table G-4 in Appendix G.

7.3 Water Balance Component Values

The detailed monthly calculations of the water balance components are provided in Tables G-1 to G-3 in Appendix G. The infiltration and runoff components have been calculated using the infiltration factor methodology from Table 3.1 of MECP SWM Planning and Design Manual (2003). The methodology accounts for topography, soil type and land cover assigning a factor between 0.1 and 0.3 to each component. The calculations show that a water surplus is generally available from November to May and the period of surplus is illustrated in Figure G-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 G-1 to G-3, Appendix G). A summary of these values is provided in Table 3.

Table 3: Water Balance Component Values

Water Balance Component	Agricultural	Woodland	Urban Lawn
Average Precipitation	933 mm/year	933 mm/year	933 mm/year
Actual Evapotranspiration	593 mm/year	593 mm/year	555 mm/year
Water Surplus	340 mm/year	340 mm/year	378 mm/year
Infiltration	170 mm/year	204 mm/year	189 mm/year
Runoff	170 mm/year	136 mm/year	189 mm/year

7.4 Pre-Development Water Balance (Existing Conditions)

The pre-development water balance calculations are presented in Table G-4 in Appendix G for the subject lands. The water balance component values from Tables G-1 to G-3 were used to calculate the average annual volume of infiltration for the area under consideration. The infiltration factors used in the calculations reflect the site-specific information that has become available from work conducted by Burnside and others and deviates from the factors used during the SIS. Soil factors and land cover were selected based on site specific data versus the regional data used for the SIS. Slope was computed based on available topographic data for the subject lands in both pre and post-development scenarios. Based on these component values, the pre-development infiltration volume for the subject lands is calculated to be about 144,800 m^3/year (Table G-4, Appendix G).

It is acknowledged that infiltration rates are directly dependent upon the hydraulic conductivity of soils that may naturally vary over several orders of magnitude. Recognizing the wide margins of error associated with this type of analysis, the calculated infiltration volume is considered simply as a reasonable estimate that can serve as a target for post development infiltration.

7.5 Potential Urban Development Impacts to Water Balance

Development of an area affects the natural water balance and results in differences between pre-development and post development water balance due to the changes to various parameters caused by the development process. The most significant change in conditions is due to 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 64% of precipitation in the study area). 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.

A water balance calculation of the potential water surplus for impervious areas is shown at the bottom of Table G-1 in Appendix G. For the purposes of the calculations in this study, the evaporation has been estimated to be 15% of precipitation. The remaining 85% of the precipitation that falls on impervious surfaces is 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 793 mm/year.

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.

7.6 Post-Development Water Balance with No Mitigation

To assess potential development impacts on infiltration, the post-development infiltration volumes have been calculated for the subject lands on Table G-4 in Appendix G. The total areas for the proposed land uses and the associated percentage imperviousness were provided by Schaeffers Consulting Engineers (the design engineers).

The infiltration and runoff components for the post-development land uses have been calculated using the MECP SWM Planning and Design Manual (2003) methodology based on topography, soil type and land cover as shown on Table G-3 in Appendix G. The calculated post-development infiltration volume (without mitigation) is calculated to be about 81,900 m^3/year (Table G-4, Appendix G).

Comparing the pre- and post-development infiltration volumes, shows that development has the potential to reduce the average infiltration on the subject lands from 144,800 m^3/year to 81,900 m^3/year, i.e., a reduction of about 63,000 m^3/year or 43%.

These calculations assume no low impact development (LID) measures for stormwater management are in place.

7.7 Water Balance Mitigation Strategies

It is recommended to minimize the potential development impacts to infiltration through the use of ‘low impact development’ (LID) measures for stormwater management to ensure the post-development groundwater infiltration volume is maintained as close to the predevelopment infiltration volume as possible.

The proposed LID measures for the subject lands as described in the Functional Servicing and Stormwater Management Report completed by Schaeffers Consulting Engineers (May 2024) include the following:

- Directing roof leaders to rain gardens at front yards of all single detached;
- Infiltration swales within NHS buffer; and
- Bio-retention swales along municipal boulevards.

The proposed LID measures were chosen based on the suitability of the soils and groundwater levels.

Grainsize analysis of the soils on the subject lands indicate soils are generally sand and silty sand and can be considered to be classified as Hydrologic Soil Group A & B (sandy, sandy loam, silt loam). Information provided by Schaeffers indicates that the base of the bioswales and infiltration swales has been designed to have a minimum of 1.0 m separation from seasonal groundwater high elevations.

Water balance calculations based on post-development with the use of LIDs are included in the FSR/SWM Report provided by Schaeffers (May 2024).

8.0 Development Considerations

8.1 Construction Below the Water Table

Based on groundwater level data collected as part of this study, water table on the subject lands ranges from 0 m to 5 m below ground surface. Groundwater has been interpreted to exist within the local supply aquifer with seasonal variations, discharge gradients and local semi-confining conditions resulting in shallow groundwater conditions on a temporal and spatial basis.

Should excavations, completed, during construction of servicing extend below the water table the local soils may need to be dewatered. The volume of water required for dewatering is dependent on the hydrogeological properties of the sediments and the depth of the excavation. Hydraulic conductivity testing of the soils estimated the hydraulic conductivity to range between 10^{-5} to 10^{-8} m/sec. Significant groundwater flows may be encountered in the higher permeability sand layers while groundwater flows are expected to be minimal in the shallower low permeability till sediments. An evaluation of volumes should be completed once servicing depths are available.

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 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.

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.

8.2 Local Groundwater Supply Wells

The area surrounding the subject lands is not currently serviced and residences are supplied by private wells. A water well survey study was completed on behalf of the Hewitt’s SPA Landowner’s Group for residences within 300 m of the Hewitt’s SPA lands to assess the potential for impacts to private supply wells (Burnside, 2019). The report, which included the subject lands identified potentially vulnerable wells in the vicinity of the subject lands and outlined a monitoring and mitigation plan. This report was submitted to the Town of Barrie and a domestic well monitoring program was initiated in 2019. Excerpts from the well survey report are provided in Appendix H.

The wells shown on Figure 9, Appendix H are regarded as those that are at risk of potential impacts due to development of the subject lands. To ensure that construction does not adversely affect local groundwater supplies of private water supply wells, a monitoring and mitigation protocol will be implemented during earthworks and servicing construction activities.

Monitoring on behalf of the Hewitt's Creek Landowner Group has been ongoing since 2019. It is recommended that wells identified as vulnerable within 300 m of the Dorsay lands be contacted and that suitable wells be added to the monitoring program if homeowner permission is obtained for access.

8.2.1 Water Supply Mitigation

Should a resident report an impact to Burnside, an investigation will be initiated within 24 hours of the report and recommendations will be made to the relevant landowner for temporary water supply to be provided. The MECP, City of Barrie or the Town of Innisfil will also be notified of the impact and the initiation of the investigation and the provision of a temporary replacement water supply. The investigation into the cause of the water supply well issues will include:

- Review of the symptoms as noted by the resident.
- Download and review of water level data from nearby monitoring wells.
- Review of relevant climatic data.
- Obtain water quality sample from well and review against baseline water quality data (if required).
- Make recommendations on whether issues are short-term or permanent in nature.

Should a causative relationship be established between work on the development site and a nearby well, Burnside will recommend that replacement water be provided. As part of the mitigation response, Burnside will provide an update to the City or Town of Innisfil outlining the conclusions of the investigations and any actions taken. Burnside will also advise of the date of the return to service of the private water supply well (if required). It should be noted that if no impact is determined after the investigation or if the well is too far away from an active or previously active construction area, a notice of no impact will be provided. If permanent harm is caused to a well due to development activities Burnside will review water supply options and make recommendations for new permanent water supply to be established on the subject property.

8.3 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.

9.0 References

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Soil Eng., 2017b. A Report to DIV Development (Barrie) Ltd., Proposed Residential Subdivision, Southwest Corner of Mapleview Drive East and 20th Sideroad, City of Barrie. Soil Engineers Ltd., April 2017.

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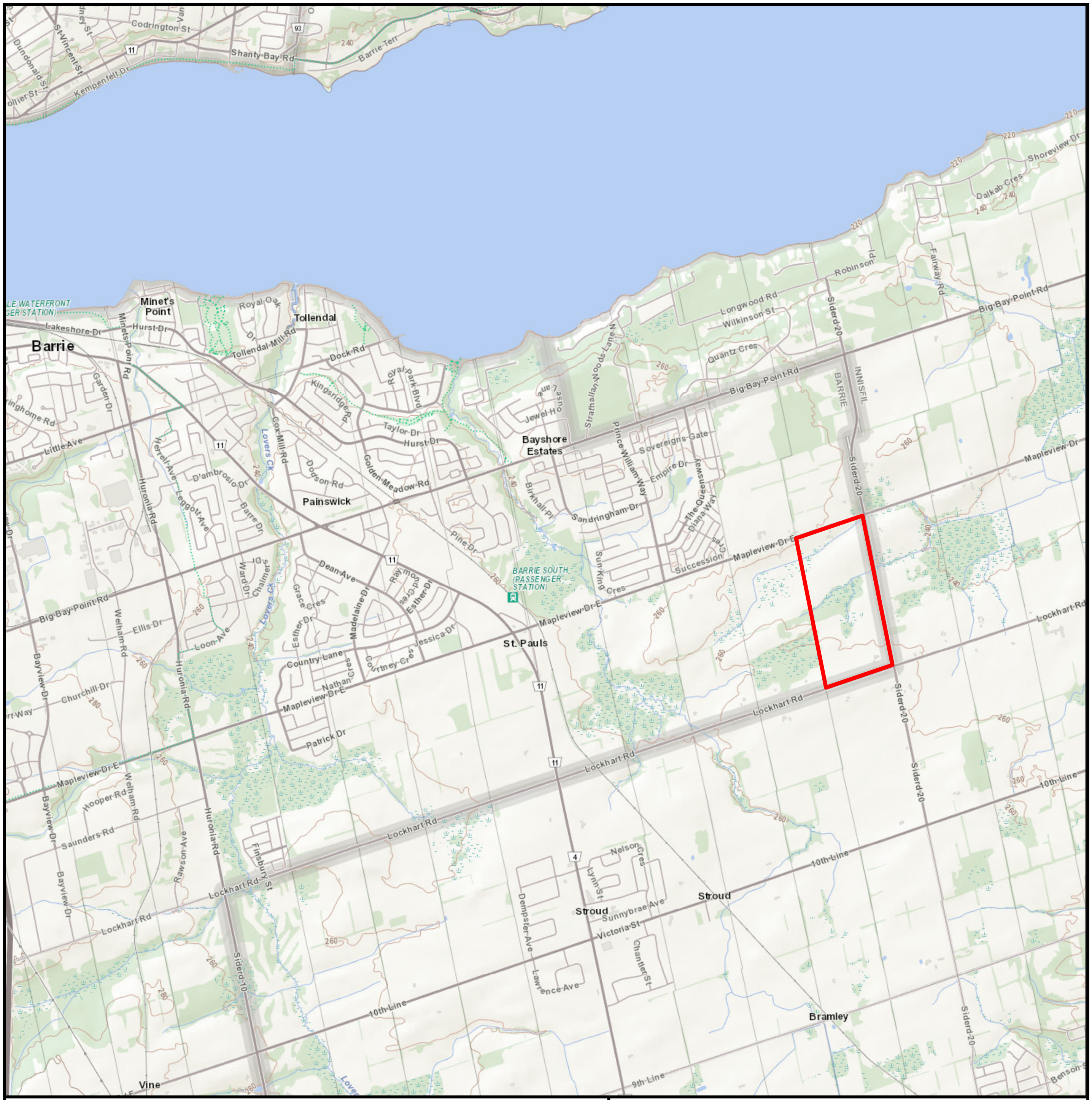
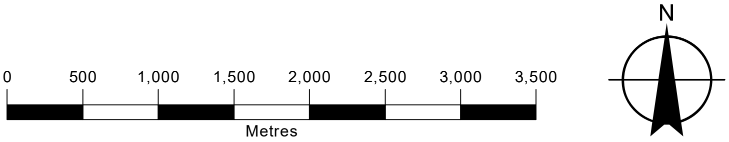
[THE DIFFERENCE IS OUR PEOPLE]

Figures



LEGEND

🟥 SUBJECT LANDS



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INNISFIL, ONTARIO

HYDROGEOLOGICAL ASSESSMENT

Figure Title:

SITE LOCATION

Drawn	Checked	Date	Figure No.
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Scale		Project No.	
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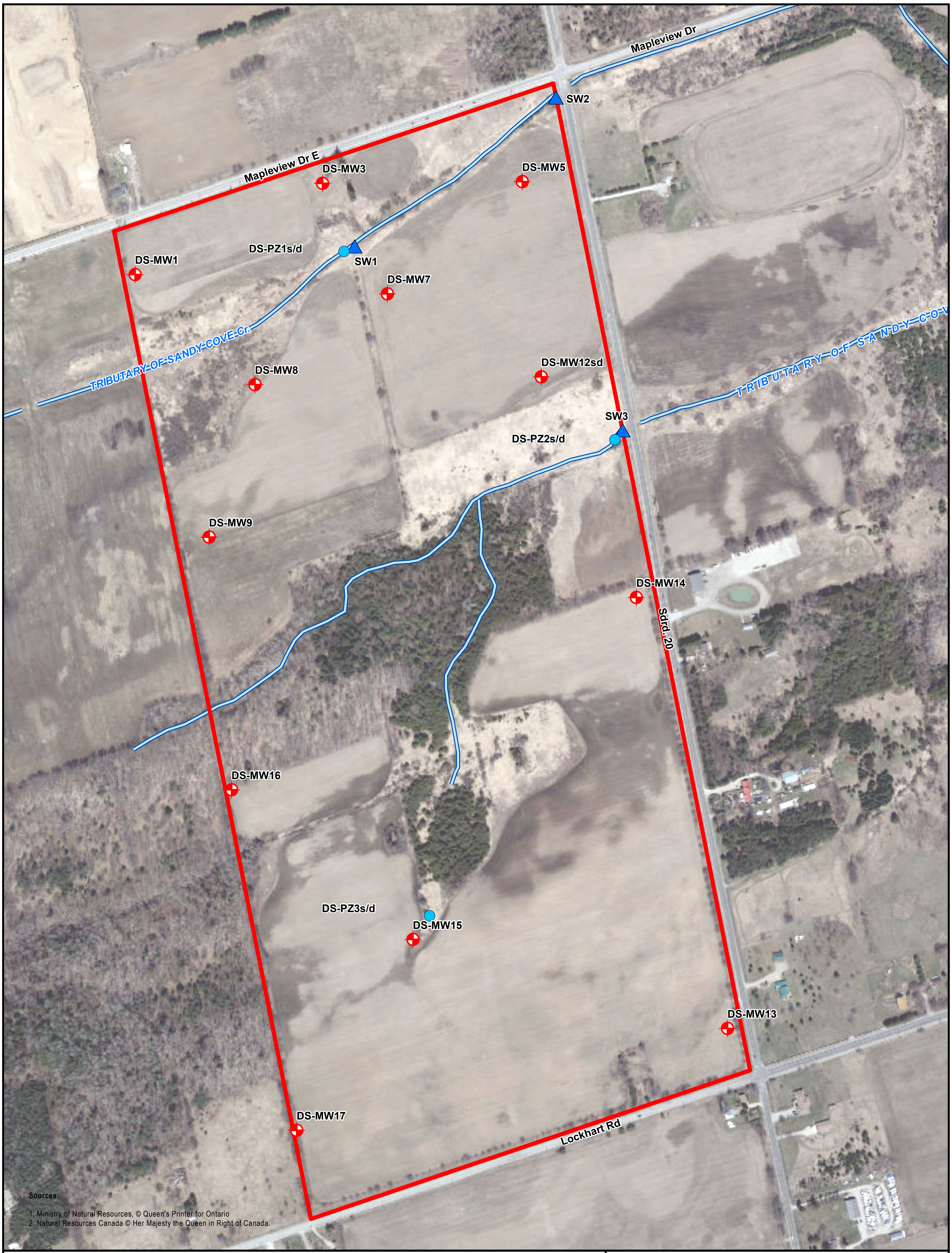

Sources:

1. Ministry of Natural Resources, © Queen's Printer for Ontario
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LEGEND

🟥 SUBJECT LANDS

═ WATERCOURSE

⊕ MONITORING WELL (SOIL ENG., 2016)

● DRIVE POINT PIEZOMETER

▲ SURFACE WATER MONITORING LOCATION

0 100 200 300 400 500
Metres

N

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Figure Title

MONITORING LOCATIONS

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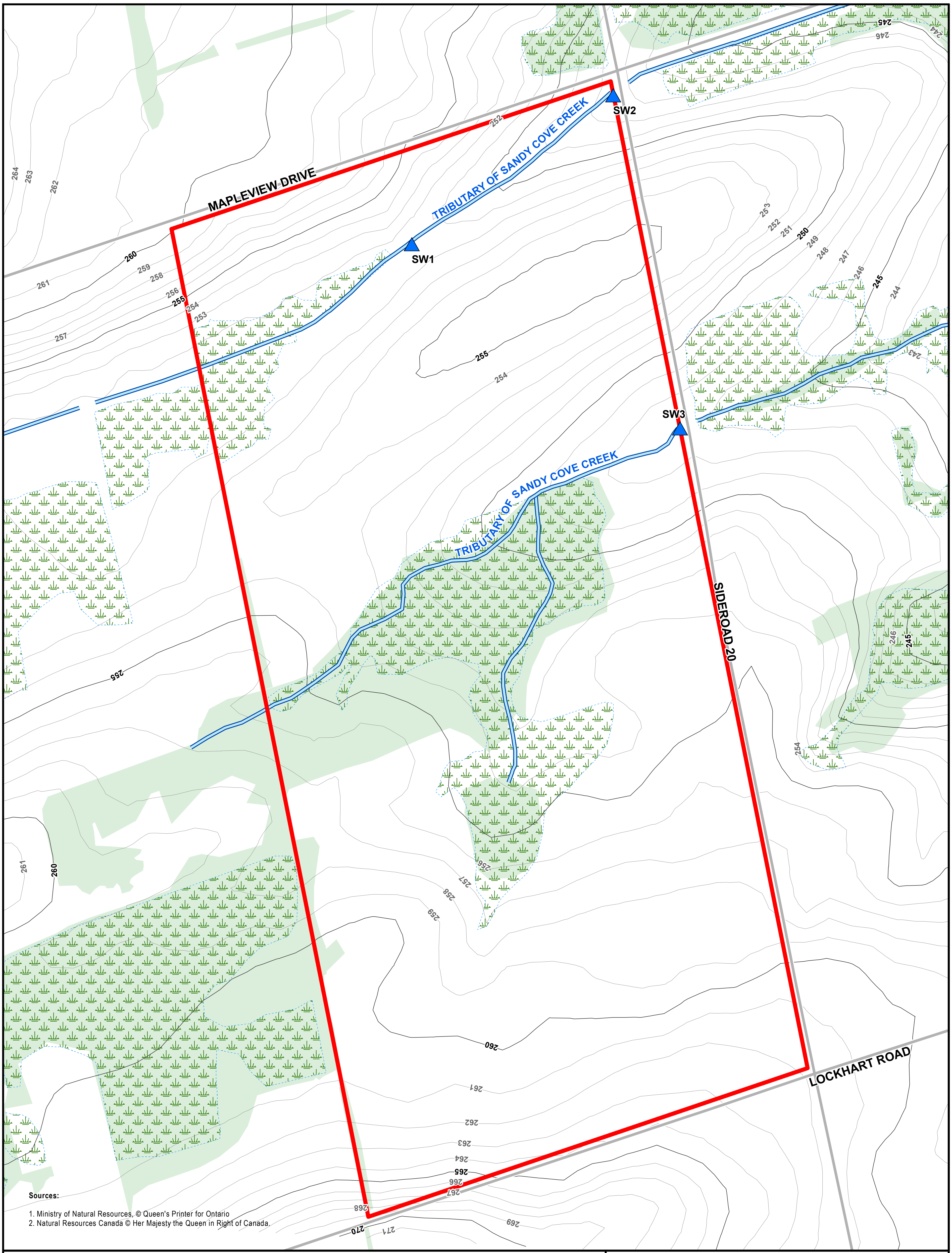

Sources:

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LEGEND

- 🟥 SUBJECT LANDS
- ═ WATERCOURSE
- ━ ROADWAY
- ─ CONTOUR (5m intervals - masl)
- ─ CONTOUR (1m intervals - masl)
- ▨ WETLAND
- 🟩 WOODED AREA
- ▲ SURFACE WATER MONITORING LOCATION

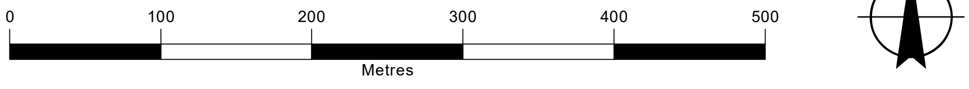

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Figure Title

TOPOGRAPHY AND DRAINAGE

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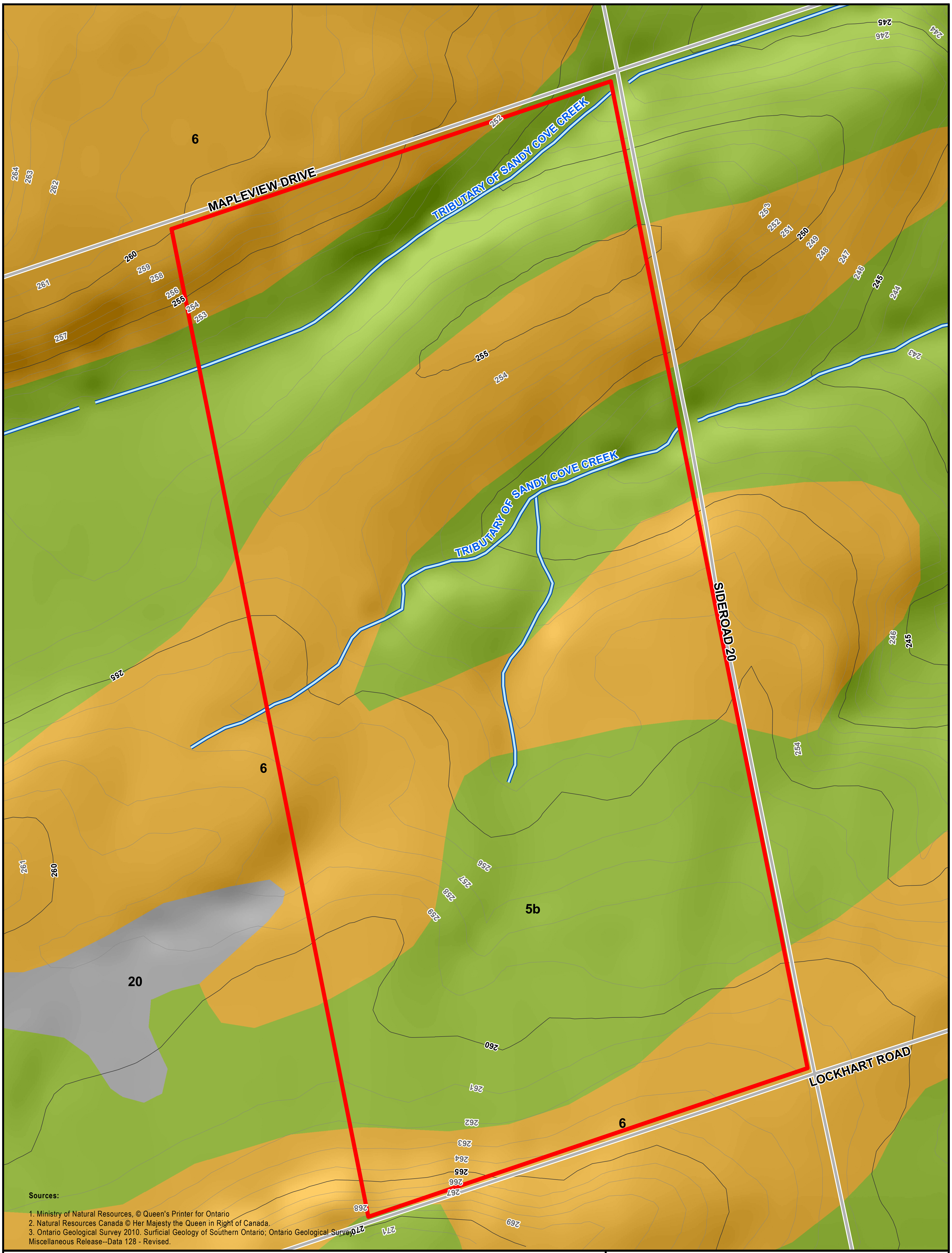

Sources:

1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Ontario Geological Survey 2010. Surficial Geology of Southern Ontario; Ontario Geological Survey Miscellaneous Release--Data 128 - Revised.

LEGEND

- 🟥 SUBJECT LANDS
- ═ WATERCOURSE
- ━ ROADWAY
- ─ CONTOUR (5m intervals - masl)
- ─ CONTOUR (1m intervals - masl)
- 🟩 5b: Till: Stone-poor, carbonate-derived silty to sandy till
- 🟨 6: Ice-contact stratified deposits: sand, gravel, sandy gravel
- ⬜ 20: Organic deposits

0 100 200 300 400 500
Metres

N

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Figure Title

SURFICIAL GEOLOGY

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Scale		Project No.	
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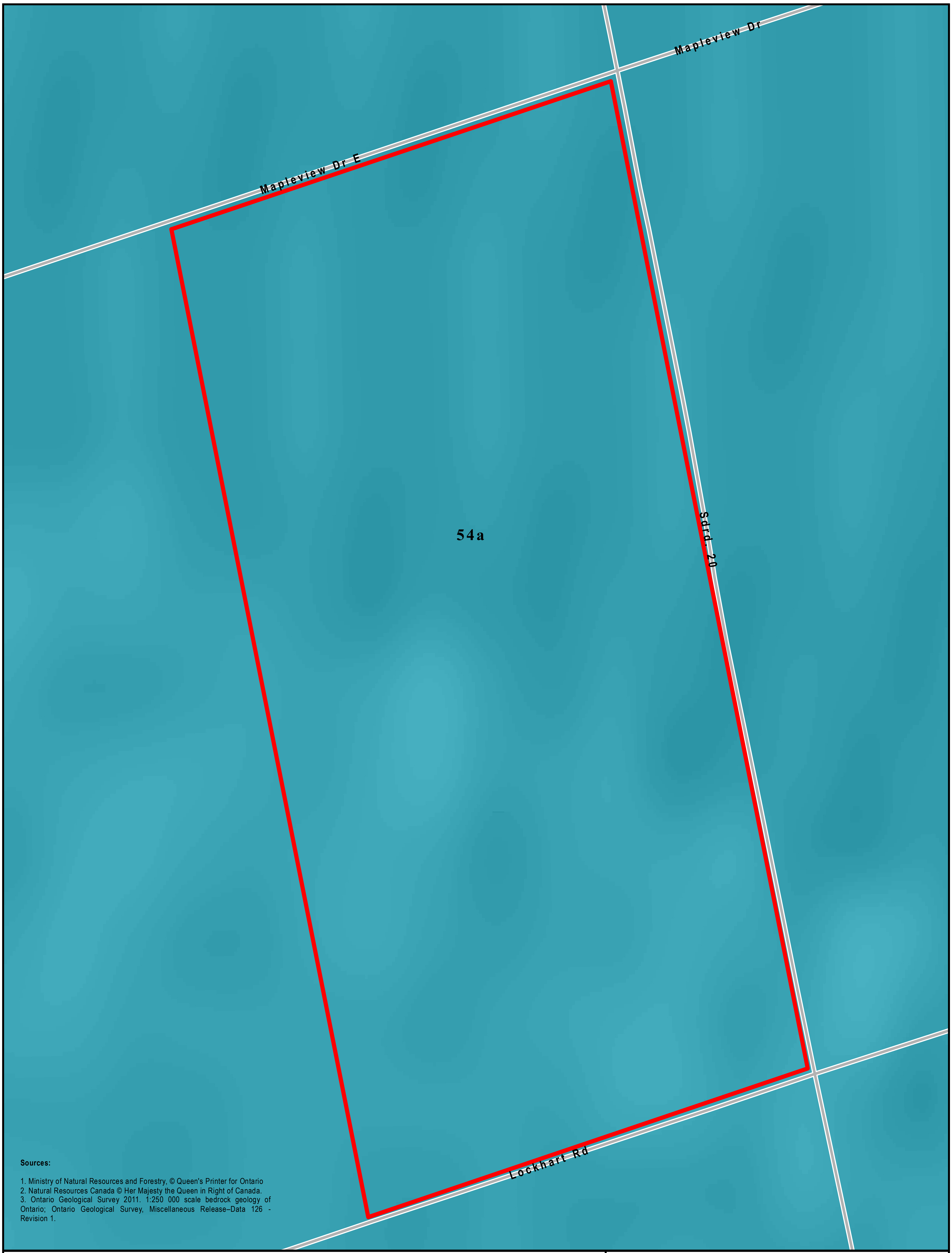

Sources:

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

LEGEND

🟥 SUBJECT LANDS

— ROADWAY

MIDDLE ORDOVICIAN - 54 Limestone, dolostone, shale, arkose, sandstone

🟦 54a Ottawa Gp.; Simcoe Gp.; Shadow Lake Fm.

0 100 200 300 400 500

Metres

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Figure Title

BEDROCK GEOLOGY

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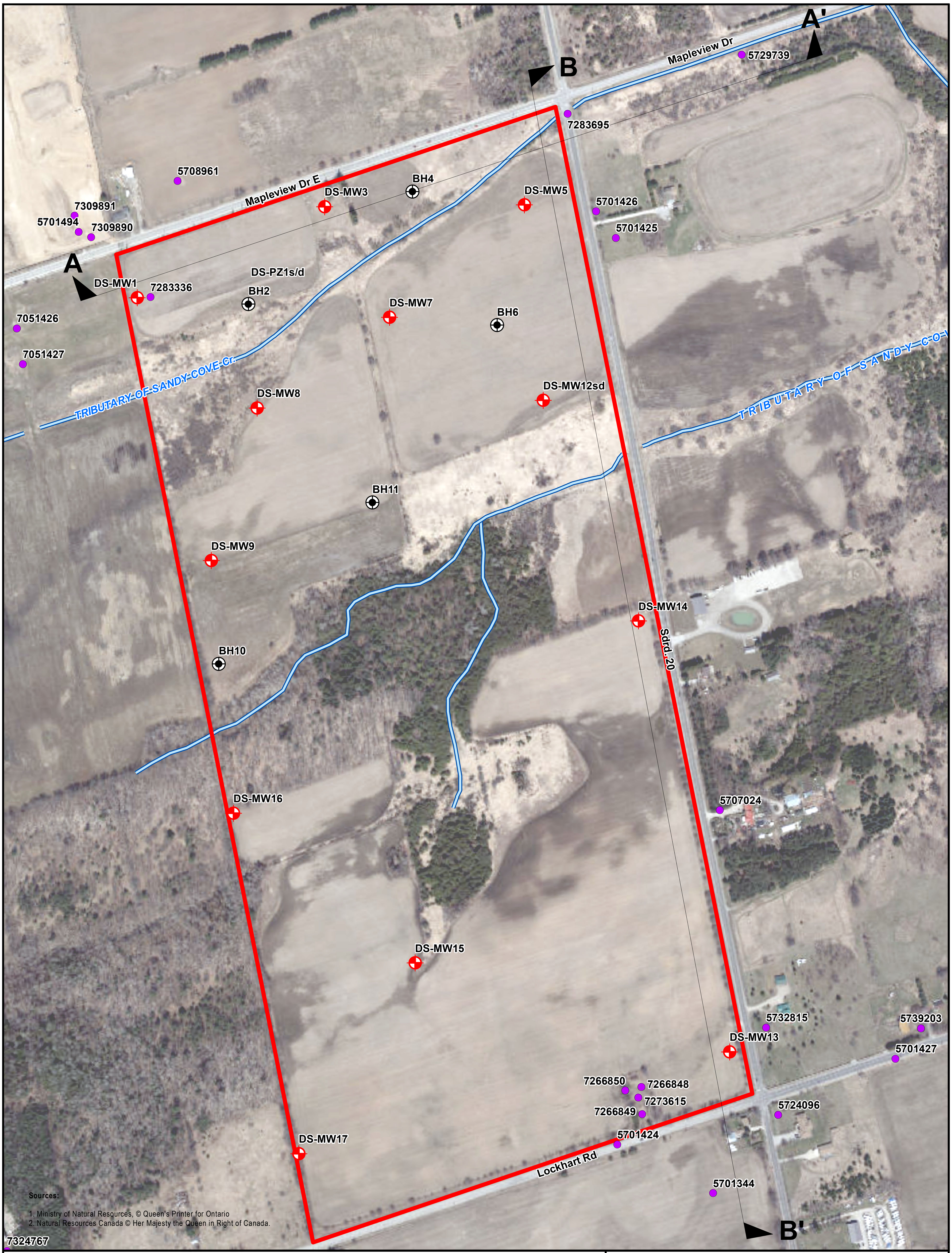

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🟥 SUBJECT LANDS

═ WATERCOURSE

⊕ MONITORING WELL (SOIL ENG., 2016)

⊕ BOREHOLE (SOIL ENG. 2016)

● MECP WELL RECORD LOCATION

CROSS-SECTION LOCATION KEY

0 100 200 300 400 500

Metres

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HYDROGEOLOGICAL ASSESSMENT

Figure Title

BOREHOLE, WELL AND CROSS-SECTION LOCATIONS

Drawn	Checked	Date	Figure No.
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Scale		Project No.	
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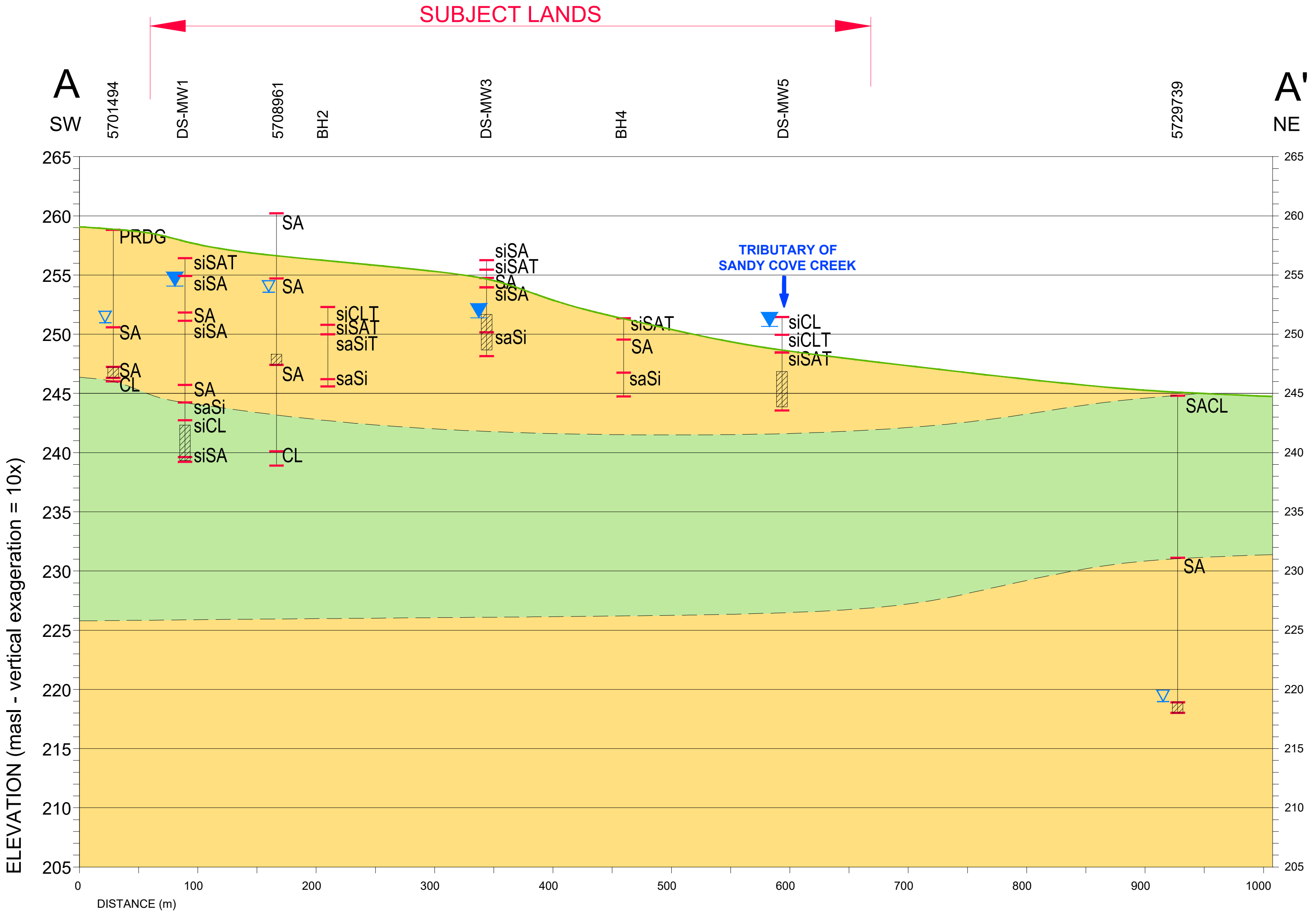

LEGEND

BH1 WELL NUMBER / ID

EXISTING GROUND PROFILE

GEOLOGICAL CONTACT

▽ STATIC WATER LEVEL
(MECP WELL RECORD)

▼ MEASURED WATER LEVEL
(MARCH 2, 2020)

▨ WELL SCREEN

si	SILTY
sa	SANDY
cl	CLAYEY
PRDG	PRE-DUG
GR	GRAVEL
SA	SAND
Si	SILT
CL	CLAY
T	TILL

— — — INTERPRETED STRATIGRAPHY

🟨 SAND / SILT / GRAVEL

🟩 SILT CLAY TILL

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HYDROGEOLOGICAL ASSESSMENT

Figure Title

INTERPRETED GEOLOGICAL CROSS-SECTION A-A'

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Scale		Project No.	
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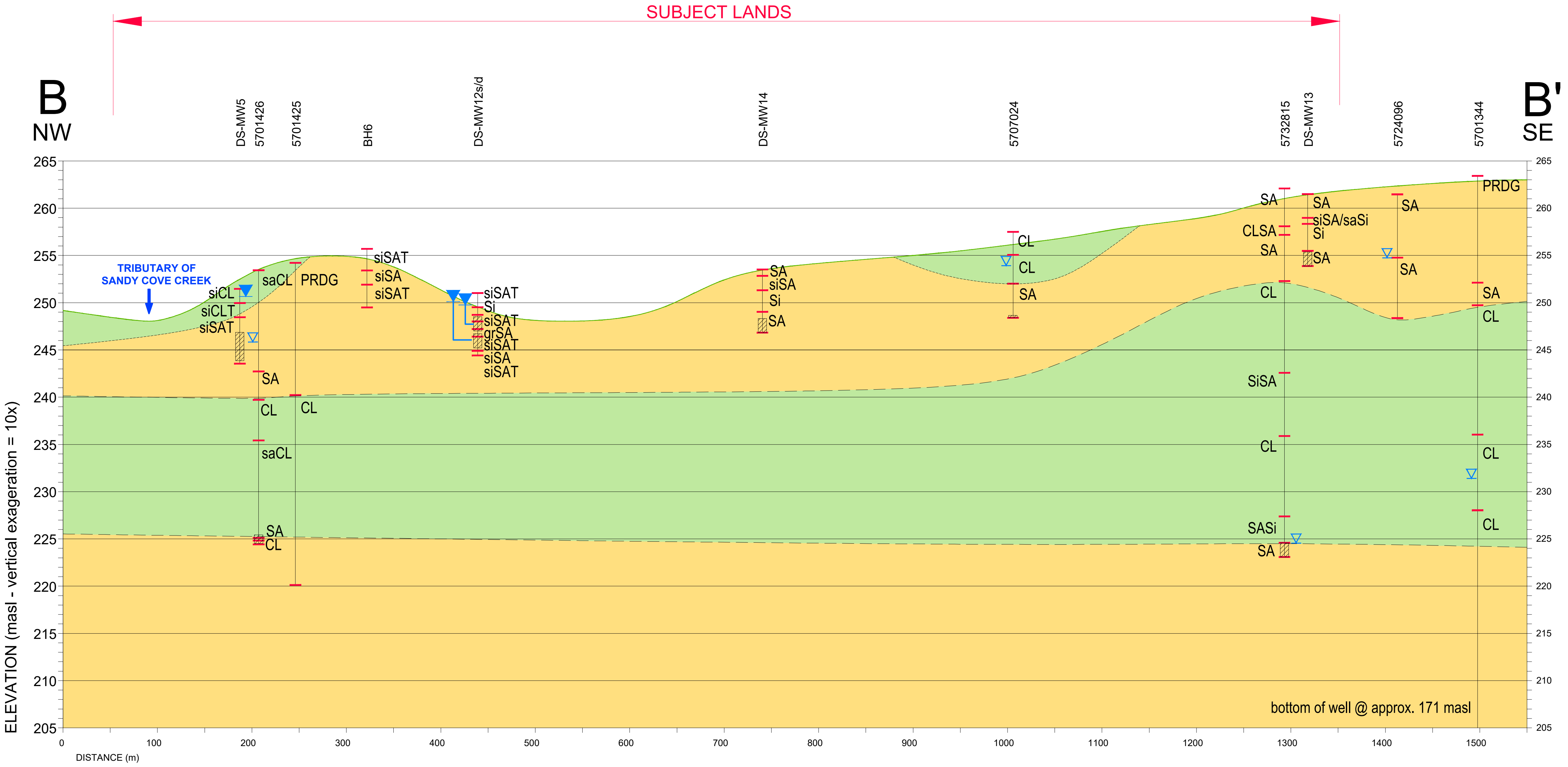

LEGEND

BH1 WELL NUMBER / ID

EXISTING GROUND PROFILE

GEOLOGICAL CONTACT

▽ STATIC WATER LEVEL (MECP WELL RECORD)

▼ MEASURED WATER LEVEL (MARCH 2, 2020)

▨ WELL SCREEN

si	SILTY
sa	SANDY
cl	CLAYEY
PRDG	PRE-DUG
GR	GRAVEL
SA	SAND
Si	SILT
CL	CLAY
T	TILL

— — — INTERPRETED STRATIGRAPHY

🟨 SAND / SILT / GRAVEL

🟩 SILT CLAY TILL

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HYDROGEOLOGICAL ASSESSMENT

Figure Title

INTERPRETED GEOLOGICAL CROSS-SECTION B-B'

Drawn	Checked	Date	Figure No.
SK	SC	May 2024	8
Scale		Project No.	
1:5,000		300043693	

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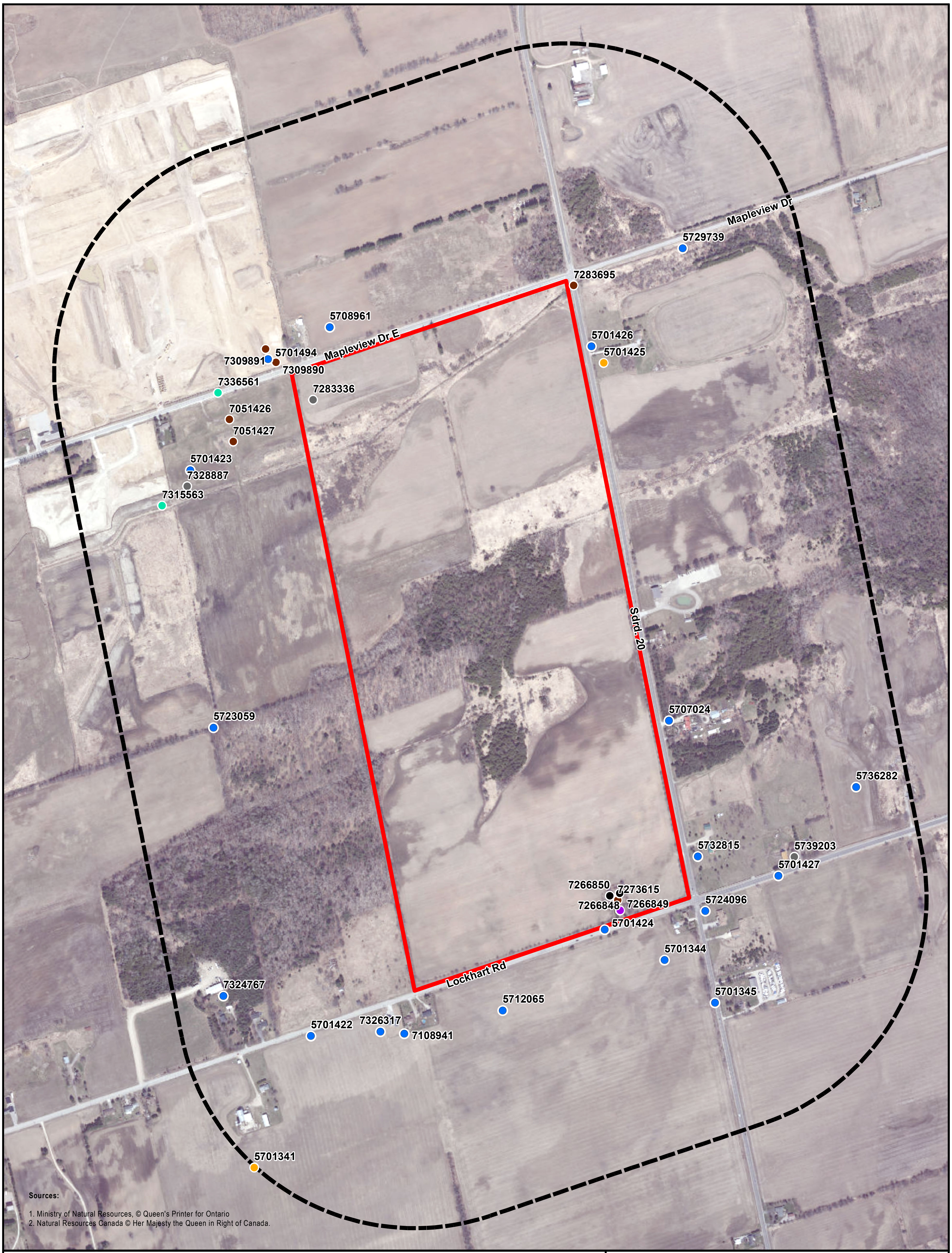

Sources:

1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.

LEGEND

▭ SUBJECT LANDS

▭ BUFFER (500m)

WELL STATUS:

- ● WATER SUPPLY
- ● OBSERVATION
- ● MONITORING AND TEST HOLE
- ● TEST HOLE
- ● ABANDONED - OTHER
- ● ABANDONED - SUPPLY
- ● UNKNOWN

0 100 200 300 400 500 600 700 800 900

Metres

N

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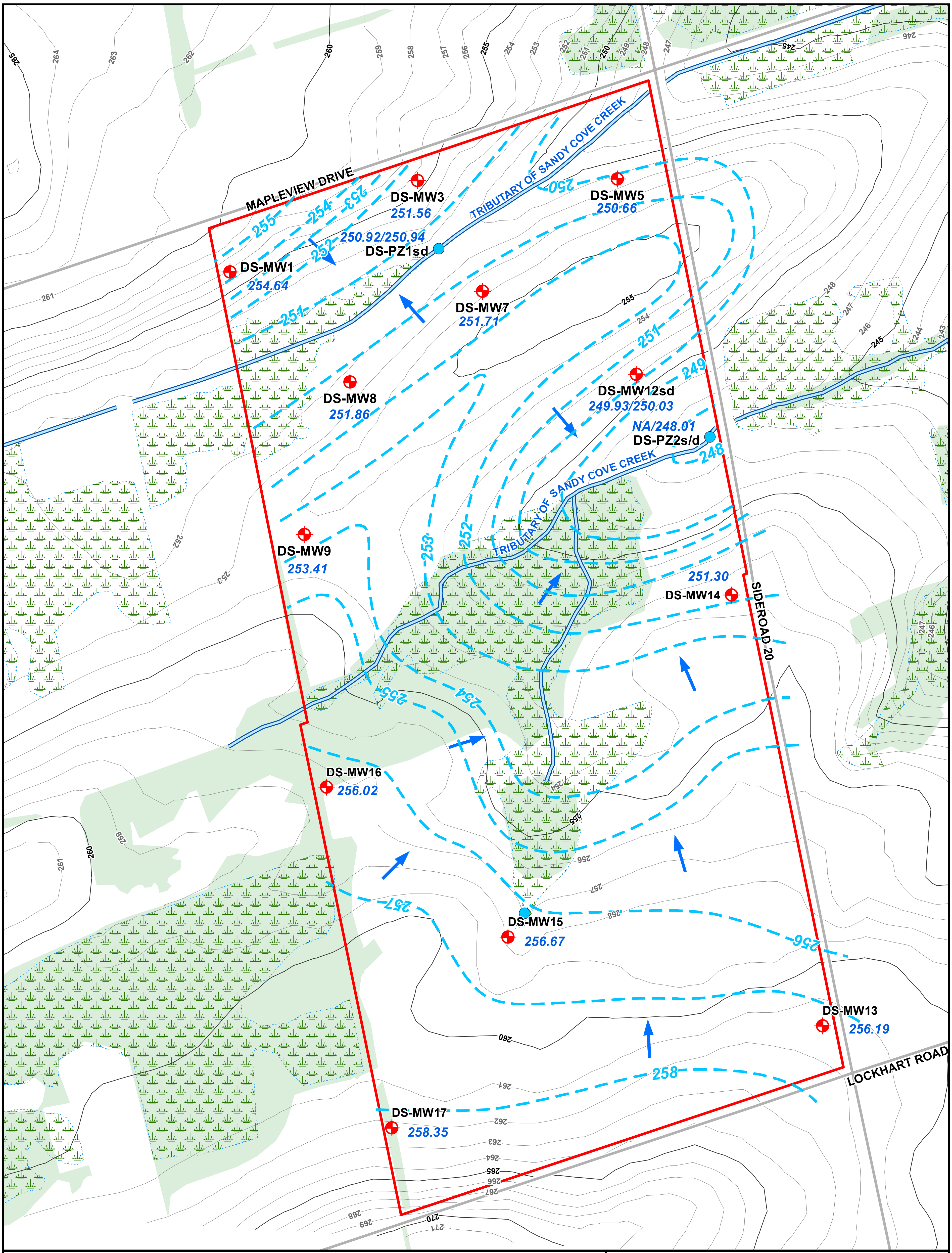
Figure Title

MECP WELL RECORD LOCATIONS

Drawn	Checked	Date	Figure No.
SK	SC	May 2024	9
Scale		Project No.	
1:8,000		300043693	

File Path: Nigel/Shared Work Areas/A:\043693 Dorsay\06_GIS\Hydrogeological Assessment\043693 MECP Well Locations.mxd Print Date: 2023/02/15 Time: 11:34 AM



LEGEND

═ WATERCOURSE

▭ SUBJECT LANDS

▬ ROADWAY

— CONTOUR (5m intervals - masl)

— CONTOUR (1m intervals - masl)

▨ WETLAND

🟩 WOODED AREA

⊕ MONITORING WELL (SOIL ENG., 2016)

● DRIVEPOINT PIEZOMETER

– – INTERPRETED GROUNDWATER CONTOUR (masl)

→ INTERPRETED GROUNDWATER FLOW DIRECTION

177.95 MEASURED WATER LEVEL
(MARCH 2, 2020)

Sources:

1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.

N

0 100 200 300 400
Metres

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HYDROGEOLOGICAL ASSESSMENT

Figure Title

INTERPRETED GROUNDWATER FLOW

Drawn	Checked	Date	Figure No.
SK	SC	May 2024	10
Scale		Project No.	
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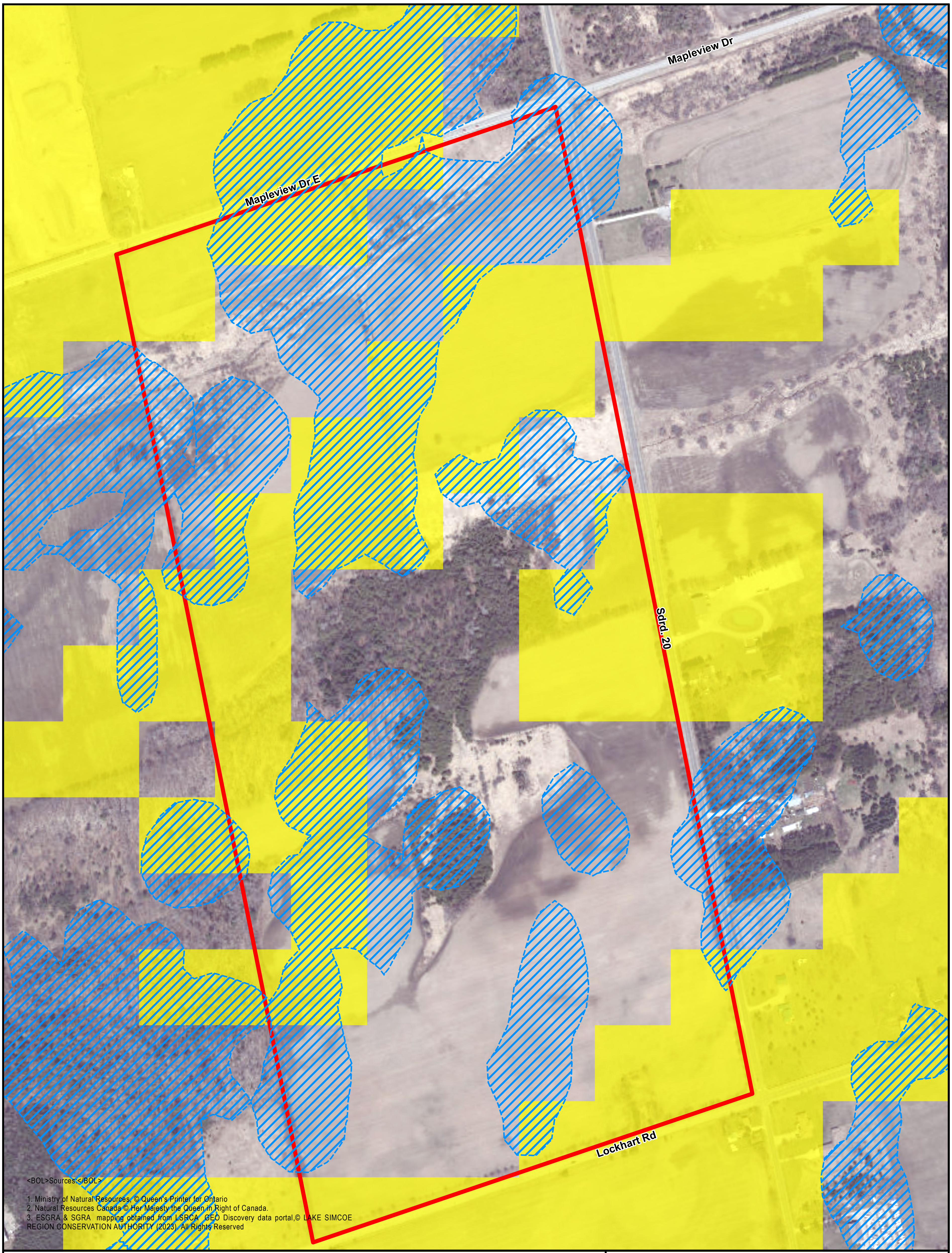
File Path: NigelA:\043693 Dorsay\06_GIS\Hydrogeological Assessment\043693 Groundwater Flow.mxd Print Date: 2024/05/14 Time: 03:22 PM



<BOL>Sources:</BOL>

1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. ESGRA & SGRA mapping obtained from LSRCA GEO Discovery data portal,© LAKE SIMCOE REGION CONSERVATION AUTHORITY (2023). All Rights Reserved

LEGEND

🟥 SUBJECT LANDS

🟨 SIGNIFICANT GROUNDWATER RECHARGE AREAS (SGRA, LSRCA)

▨ ECOLOGICALLY SIGNIFICANT GROUNDWATER RECHARGE AREAS (ESGRA)

0 100 200 300 400 500
Metres

N

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INNISFIL, ONTARIO
HYDROGEOLOGICAL ASSESSMENT

Figure Title

RECHARGE AREAS

Drawn	Checked	Date	Figure No.
SK	SC	May 2024	11
Scale		Project No.	
1:5,000		300043693	

File Path: Nigel/Shared Work Areas/A:\043693 Dorsay\06_GIS\Hydrogeological Assessment\043693 Recharge Areas.mxd Print Date: 2023/02/15 Time: 11:04 AM

Appendix A

MECP Water Well Records

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
INNISFIL TOWNSHIP	17 611597 4912035 W	2018/05 7201	2			MO	0035 5	7315563 (Z287580) A248578	BRWN SAND GRVL CLAY 0040
INNISFIL TOWNSHIP	17 611327 4912344 W	2004/04 7178	6.42	FR 0180	51///:	DO	0178 8	5738770 (Z06336) A006238	BLCK LOAM 0001 BRWN SAND 0050 GREY CLAY 0056 GREY CLAY SILT 0061 BRWN SAND 0066 GREY CLAY HARD 0178 BRWN SAND 0190
INNISFIL TOWNSHIP	17 611915 4912258 W	2016/11 7230						7283336 (C36619) A217111 P	
INNISFIL TOWNSHIP	17 612464 4912499 W	2016/12 7201	2			MO		7283695 (Z234166) A	
INNISFIL TOWNSHIP	17 612561 4911219 W	2016/04 7383	2	0020		TH	0015 10	7266848 (Z231717) A203573	SAND
INNISFIL TOWNSHIP	17 612562 4911183 W	2016/04 7383	2	0020		TH	0015 10	7266849 (Z231716) A203571	SAND
INNISFIL TOWNSHIP	17 612540 4911214 W	2016/04 7383	2	0020		TH	0015 10	7266850 (Z231718) A203572	SAND
INNISFIL TOWNSHIP	17 611342 4912150 W	2019/06 7360	2	UT 0008	///:	MO	0013 12	7336560 (Z312362) A266742	BRWN GRVL 0004 BRWN SAND FILL 0011 BRWN FSND 0020 BRWN SAND ---- 0025
INNISFIL TOWNSHIP	17 611715 4912273 W	2019/06 7360	2	UT 0020	///:	MO	0020 10	7336561 (Z312363) A268803	BLCK ---- 0005 BRWN STNS 0010 BRWN FSND 0015 FSND ---- 0020 0030
INNISFIL TOWNSHIP CON 021	17 613059 4911443 W	2001/05 4645	6 5	UK 0060	7/50/4/1:0	DO	0050 10	5736282 (225488)	BLCK LOAM SOFT 0002 BRWN SAND SOFT 0004 BRWN SAND BLDR HARD 0005 BRWN SAND SILT SOFT 0013 BRWN SAND GRVL LOOS 0020 GREY SILT FSND DRTY 0030 GREY CLAY SILT SOFT 0050 GREY FSND LOOS 0060
INNISFIL TOWNSHIP CON 10 019	17 612057 4910928 W	2018/12 5528	6.09 5.51	UT 0072	45/66/4/1:0	DO	0075 4	7326317 (Z287351) A210692	BRWN CLAY 0007 GREY CLAY 0035 BRWN SAND 0079 GREY CLAY TILL 0080
INNISFIL TOWNSHIP CON 10 019	17 611640 4910741 W	1963/12 2514	6 5	FR 0061	44/67/3/2:0	ST DO	0061 3 0064 3	5701342 ()	LOAM 0001 GRVL 0015 MSND GRVL 0045 CSND 0055 YLLW FSND 0067 BLUE CLAY FSND 0084
INNISFIL TOWNSHIP CON 10 020	17 612655 4911079 W	1964/11 2514	6	FR 0301	105/140/20/1:30	DO	0301 3	5701344 ()	PRDG 0037 MSND 0045 BLUE CLAY 0090 BLUE CLAY FSND 0116 BLUE CLAY 0245 CLAY FSND 0280 CLAY 0299 MSND 0304
INNISFIL TOWNSHIP CON 10 020	17 612314 4910973 W	1974/11 2514	6	FR 0081	47/83/3/1:30	DO	0081 6	5712065 ()	LOAM 0001 BRWN GRVL BLDR 0007 GREY CLAY BLDR GRVL 0024 BRWN MSND CSND 0055 GREY SAND SILT 0081 BRWN FSND 0087

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
INNISFIL TOWNSHIP CON 10 021	17 612761 4910989 W	1965/06 2514	6	FR 0058	33/58/3/2:0	ST DO	0058 3	5701345 ()	PRDG 0035 MSND CLAY 0055 FSND 0061 BLUE CLAY 0064
INNISFIL TOWNSHIP CON 10 021	17 612741 4911182 W	1988/10 3030	36	FR	22///:	DO		5724096 (36952)	BRWN LOAM 0001 BRWN SAND DRY 0022 BRWN SAND WBRG 0043
INNISFIL TOWNSHIP CON 11 019	17 611910 4910919 W	1964/10 4608	30	FR 0031	6//1/:	ST DO		5701422 ()	RED CLAY 0009 MSND 0038
INNISFIL TOWNSHIP CON 11 019	17 611656 4912110 W	1965/09 1510	4	FR 0030	15/17/10/2:0	ST DO	0040 4	5701423 ()	BRWN CLAY 0003 BRWN CLAY STNS 0030 FSND 0036 CSND 0044
INNISFIL TOWNSHIP CON 11 019	17 611705 4911568 L	1987/11 3203	5	FR 0044	21/32/5/:	DO	0040 4	5723059 (NA)	LOAM 0001 BRWN CLAY SAND 0027 BRWN SAND WBRG 0044 BRWN SAND CLAY 0051
INNISFIL TOWNSHIP CON 11 019	17 611739 4912217 W	2007/07 7219			///:	NU		7051426 (Z67263) A060735 A	
INNISFIL TOWNSHIP CON 11 019	17 611726 4911003 W	2018/12 4645	6.25	FR 0105	23/55/8/1:	DO	0101 4	7324767 (Z298450) A257711	BLCK LOAM SOFT 0001 BRWN SAND LOOS 0013 BRWN CLAY SILT SOFT 0026 BRWN SILT DRTY 0030 GREY CLAY HARD 0082 GREY SAND DRTY 0088 GREY CLAY HARD 0092 GREY SAND CLN 0105
INNISFIL TOWNSHIP CON 11 019	17 612107 4910924 W	2008/05 3413	6		35/70/6/3:	DO		7108941 (Z69316) A062275	BRWN CLAY 0025 BRWN SAND 0060 GREY SAND 0080
INNISFIL TOWNSHIP CON 11 019	17 611650 4912076 W	2018/10 7626						7328887 (C43391) A255624 P	
INNISFIL TOWNSHIP CON 11 019	17 611747 4912170 W	2007/09 7219	4		///:	NU		7051427 (Z67264) A060738 A	
INNISFIL TOWNSHIP CON 11 020	17 612693 4912577 W	1992/11 2514	6	FR 0085	40/80/5/2:30	DO	0085 3	5729739 (108670)	PRDG 0045 BRWN SAND CLAY 0085 GREY SAND 0088
INNISFIL TOWNSHIP CON 11 020	17 612529 4911143 W	1964/11 2514	6	FR 0036	27/38/11/1:30	ST DO	0036 3 0039 3	5701424 ()	PRDG 0008 BRWN CLAY FSND 0034 YLLW MSND 0042
INNISFIL TOWNSHIP CON 11 020	17 612557 4911205 W	2016/09 4645	6.25					7273615 (Z235594) A	
INNISFIL TOWNSHIP CON 11 021	17 612527 4912336 W	1965/04 2514	6					5701425 () A	PRDG 0046 BLUE CLAY 0112
INNISFIL TOWNSHIP CON 11 021	17 612501 4912371 W	1965/04 2514	6	FR 0093	25/91/4/2:0	ST DO	0092 3	5701426 ()	LOAM 0001 BRWN CLAY MSND BLDR 0035 YLLW FSND 0045 BLUE CLAY 0059 CLAY MSND 0093 GREY FSND 0094 CLAY 0095
INNISFIL TOWNSHIP CON 11 021	17 612895 4911256 W	1965/09 2514	6	FR 0053	35/58/3/4:0	ST DO	0053 3 0056 3	5701427 ()	PRDG 0036 FSND 0053 MSND 0059 MSND CLAY 0061
INNISFIL TOWNSHIP CON 11 021	17 612664 4911583 W	1969/07 5420	34	FR 0018	12///:	DO		5707024 ()	LOAM 0001 BRWN CLAY 0008 BLUE CLAY STNS 0018 GREY CSND 0030

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
INNISFIL TOWNSHIP CON 11 021	17 612725 4911297 W	1997/04 2513	6	FR 0123	35/120/16/1:0	DO	0123 5	5732815 (173398)	YLLW SAND 0013 YLLW CLAY SAND 0016 YLLW SAND 0032 BRWN CLAY LYRD 0064 YLLW SILT FSND HARD 0086 GREY CLAY 0114 GREY SILT FSND 0123 GREY FSND 0128
INNISFIL TOWNSHIP CON 11 021	17 612929 4911296 W	2004/10 7144						5739203 (Z00378) A	
INNISFIL TOWNSHIP CON 11 022	17 613246 4911413 W	1994/12 6870	6 5	FR 0113	1/70/6/2:0	DO	0129 4	5731349 (123238)	FILL 0004 BRWN SAND GRVL 0016 BLUE CLAY 0030 GREY FSND VERY 0064 BLUE CLAY 0113 GREY FSND 0140
INNISFIL TOWNSHIP CON 12 019	17 611837 4912337 W	2018/03 4645	6.25				0181 6	7309890 (Z271032) A	
INNISFIL TOWNSHIP CON 12 019	17 611815 4912365 W	2018/03 4645	6.23				0022 4	7309891 (Z271033) A	
INNISFIL TOWNSHIP CON 12 020	17 611820 4912344 W	1964/11 2514	6	FR 0038	26/39/2/1:0	DO	0038 3	5701494 ()	PRDG 0027 MSND 0038 YLLW MSND 0041 BRWN CLAY 0042
INNISFIL TOWNSHIP CON 12 020	17 611950 4912411 W	1972/06 3203	5	FR 0042	22/36/6/1:0	DO	0039 3	5708961 ()	BLCK LOAM 0001 YLLW FSND 0018 YLLW MSND 0042 YLLW SAND CLAY 0066 GREY CLAY 0070

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

JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH/MW 1

FIGURE NO.: 1

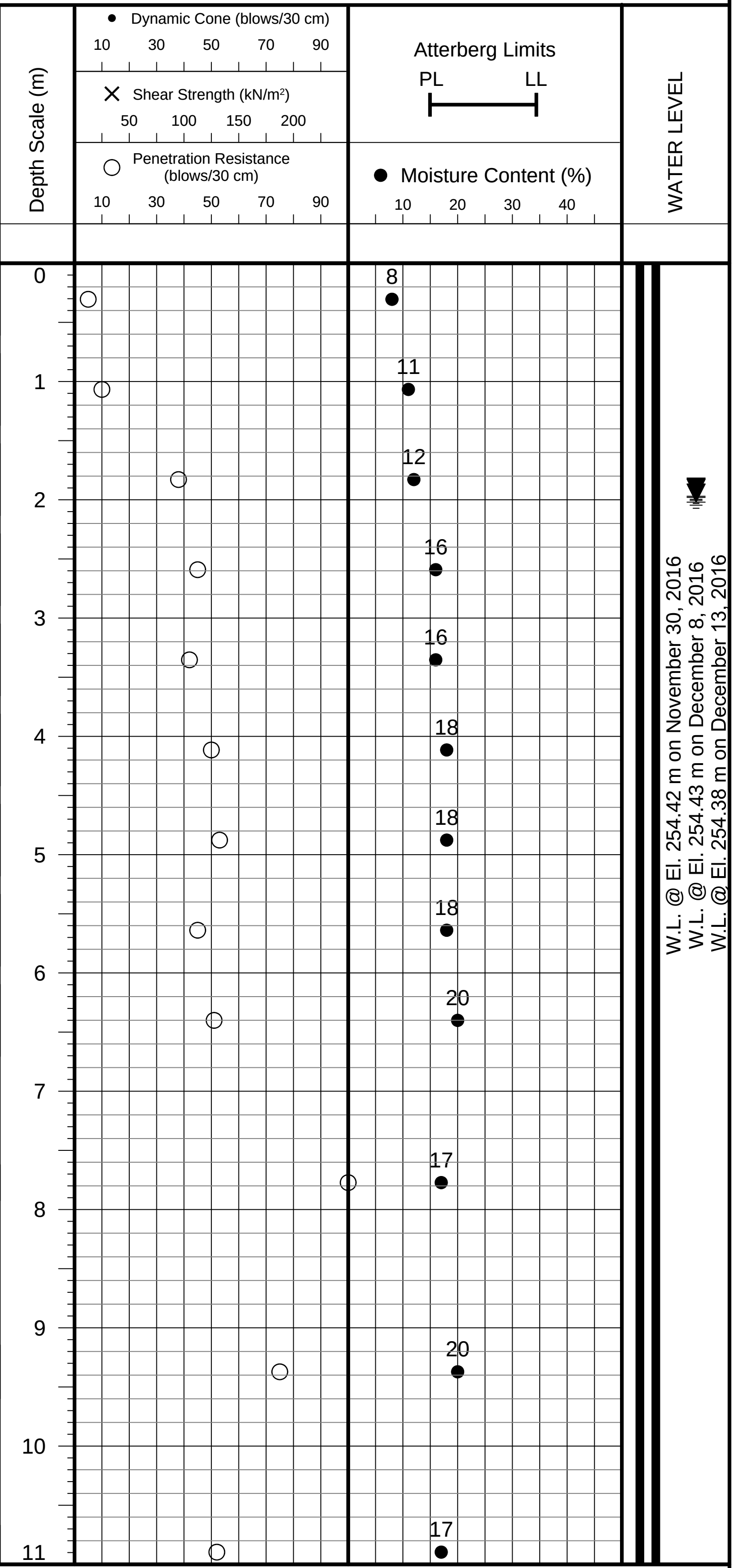
PROJECT DESCRIPTION: Proposed Residential Subdivision

METHOD OF BORING: Flight-Auger (Hollow Stem)

PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 14, 2016

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
256.4	Ground Surface			
0.0	**25 cm TOPSOIL**			
0.3	Brown, loose, weathered **SILTY SAND TILL** a trace to some clay a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	1	DO	5
		2	DO	10
254.9 1.5	Brown, dense **SILTY FINE SAND** a trace of clay	3	DO	38
		4	DO	45
		5	DO	42
		6	DO	50
251.8 4.6	Brown, very dense **SAND** fine to medium grained a trace to some silt	7	DO	53
251.1 5.3	Brown, dense to very dense **SILTY FINE SAND** clay layers a trace of clay	8	DO	45
		9	DO	51
		10	DO	50/15
		11	DO	75
245.7 10.7 245.4		12	DO	52



W.L. @ El. 254.42 m on November 30, 2016
W.L. @ El. 254.43 m on December 8, 2016
W.L. @ El. 254.38 m on December 13, 2016

Soil Engineers Ltd.

JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH/MW 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Residential Subdivision

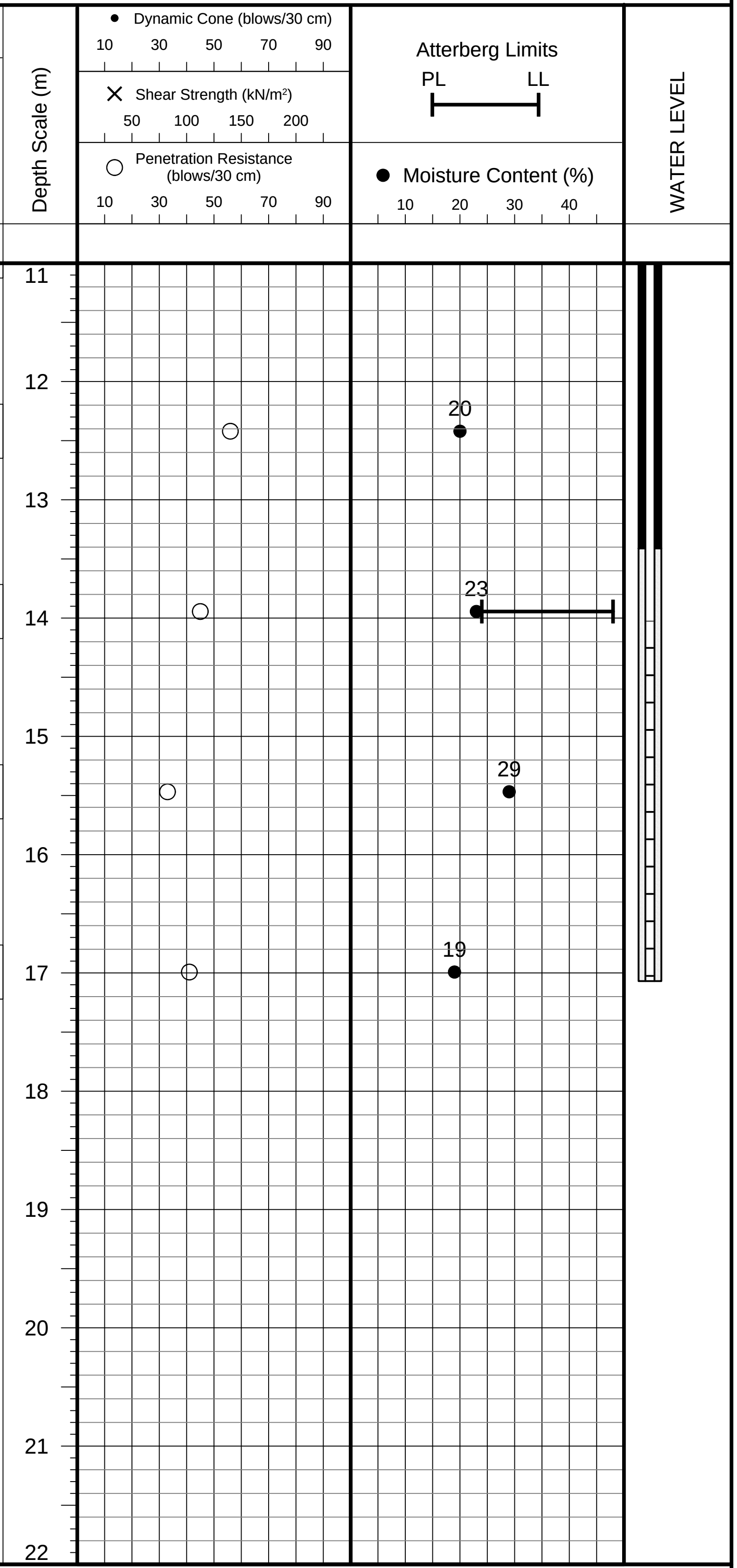
METHOD OF BORING: Flight-Auger (Hollow Stem)

PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 14, 2016

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
11.0	Brown, very dense **SAND** fine to medium grained a trace to some silt			
244.2 12.2	Grey, very dense **SANDY SILT** a trace of clay	13	DO	56
242.7 13.7	Grey, hard **SILTY CLAY** a trace of fine sand occ. wet sand and silt seams and layers	14	DO	45
		15	DO	33
239.6 16.8	Grey, dense **SILTY FINE SAND** a trace of clay	16	DO	41
239.2 17.2	**END OF BOREHOLE**			

Installed 50 mm Ø PVC monitoring well to 17.1 m (3.0 m screen)
Sand backfill from 13.4 to 17.1 m
Bentonite holeplug from 0.0 to 13.4 m
Provided with a 4x4 steel monument casing with top and bottom caps, and lock



Soil Engineers Ltd.

JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH 2

FIGURE NO.: 2

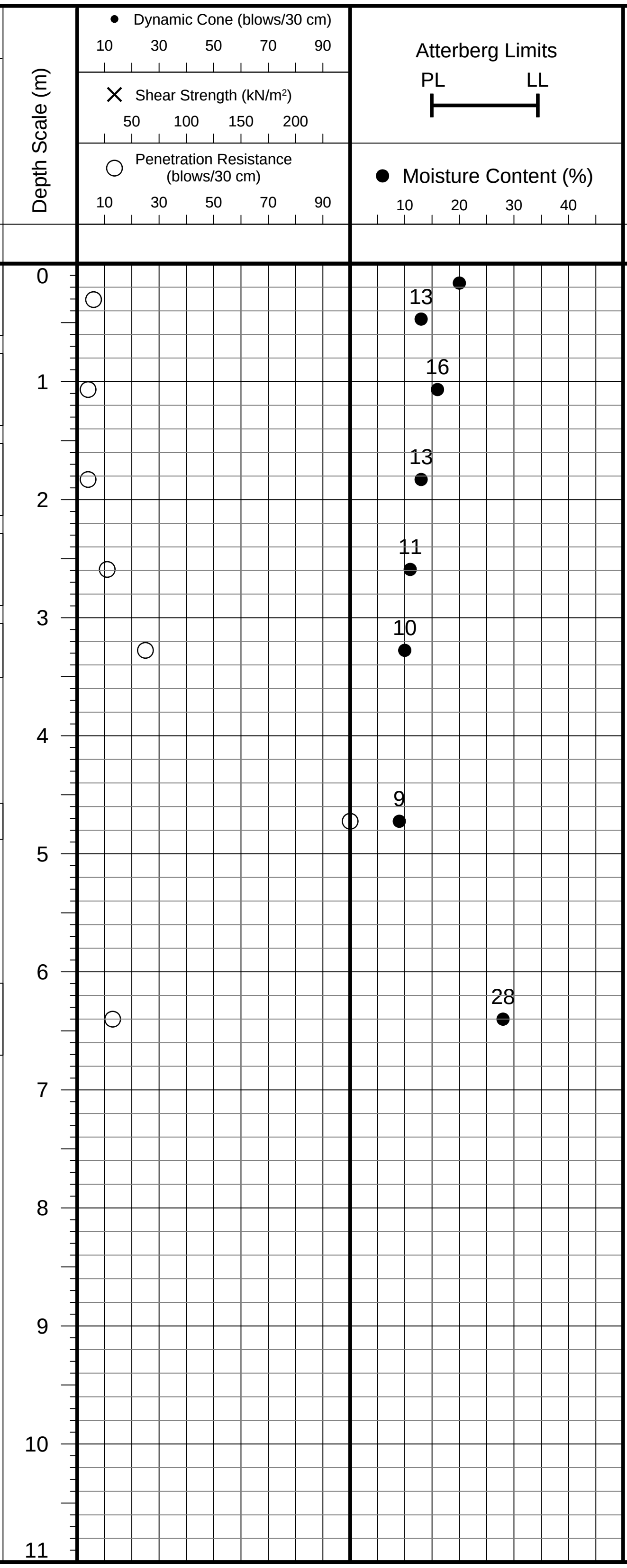
PROJECT DESCRIPTION: Proposed Residential Subdivision

METHOD OF BORING: Flight-Auger (Solid Stem)

PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 15, 2016

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
252.2	Ground Surface			
0.0	**33 cm TOPSOIL**	1A	DO	6
0.3	Brown, soft to firm, weathered **SILTY CLAY TILL** sandy, a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders — sand layer	1B		
		2	DO	4
250.7 1.5	Brown, very loose, weathered **SILTY SAND TILL** some clay, a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders — clay layer	3	DO	4
249.9 2.3	Brown, compact to very dense	4	DO	11
	SANDY SILT TILL	5	DO	25
	a trace to some clay a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	6	DO	50/15
246.1 6.1	Brown, compact **SANDY SILT** a trace of clay	7	DO	13
245.5 6.7	**END OF BOREHOLE**			



WATER LEVEL

▼ Cave-in @ El. 251.0 m on completion

Soil Engineers Ltd.

JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH/MW 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Residential Subdivision

METHOD OF BORING: Flight-Auger (Hollow Stem)

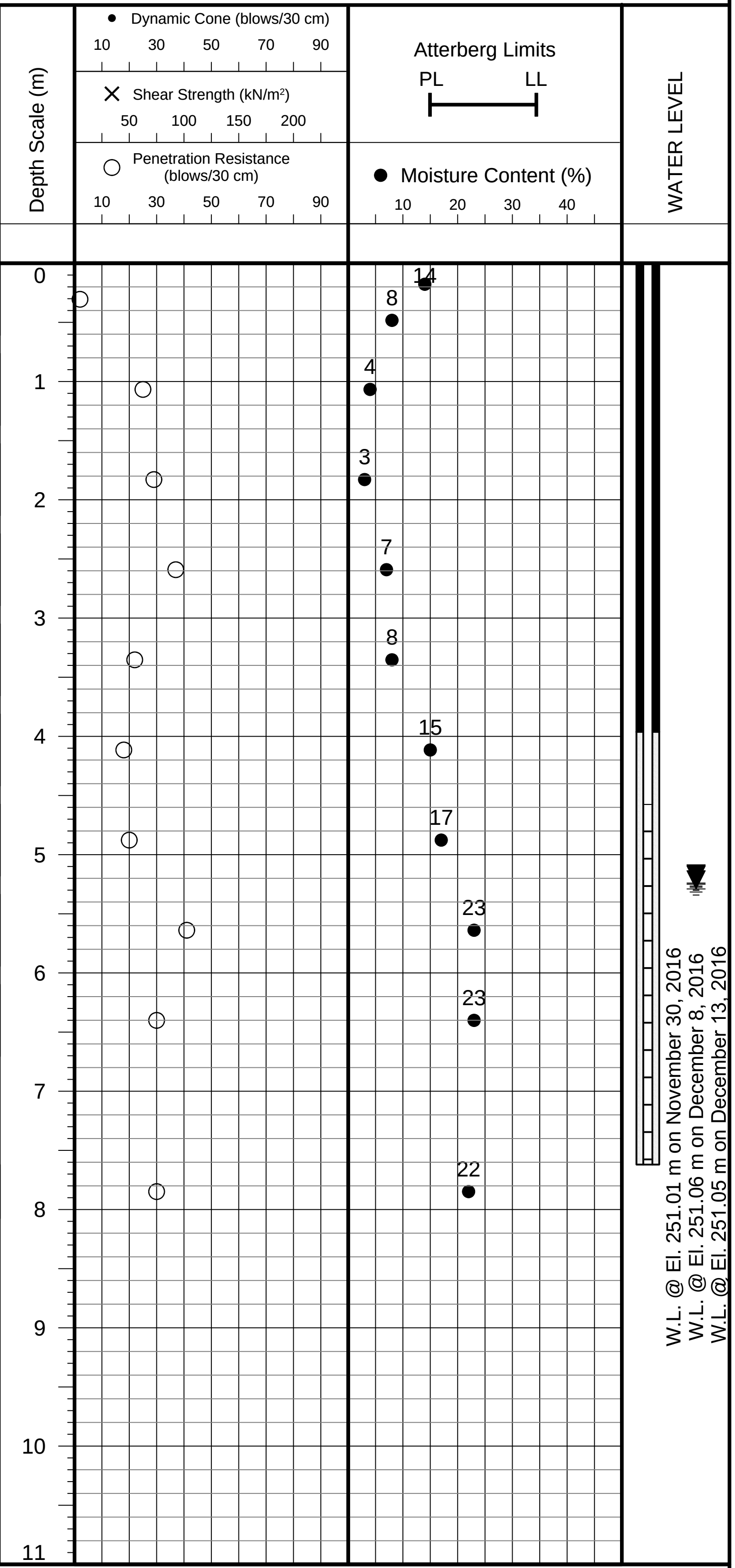
PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 11, 2016

El. (m) Depth (m)	SOIL DESCRIPTION
256.3	Ground Surface
0.0	**36 cm TOPSOIL**
0.4	Brown, very loose, weathered **SILTY FINE SAND** a trace of clay with organic inclusions
255.5 0.8	Brown, compact **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders
254.8 1.5	Brown, compact **SAND** fine grained a trace to some silt a trace of gravel clay layer
254.0 2.3	Brown, compact to dense **SILTY FINE SAND** a trace of clay
250.2 6.1	Brown, compact **SANDY SILT** a trace of clay
248.2 8.1	**END OF BOREHOLE**

Installed 50 mm Ø PVC monitoring well to 7.6 m (3.0 m screen)
Sand backfill from 4.0 to 7.6 m
Bentonite holeplug from 0.0 to 4.0 m
Provided with a 4x4 steel monument casing with top and bottom caps, and lock

SAMPLES		
Number	Type	N-Value
1A	DO	2
1B		
2	DO	25
3	DO	29
4	DO	37
5	DO	22
6	DO	18
7	DO	20
8	DO	41
9	DO	30
10	DO	30



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Page: 1 of 1

JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH 4

FIGURE NO.: 4

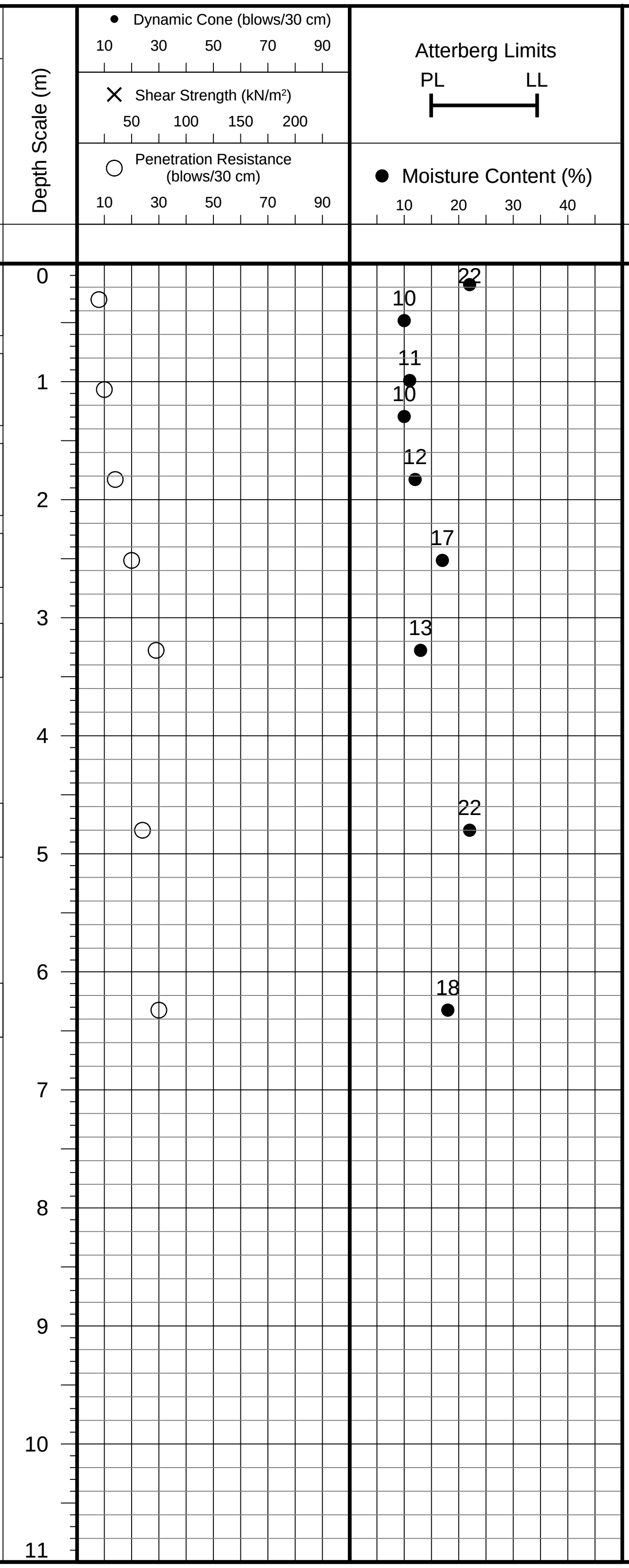
PROJECT DESCRIPTION: Proposed Residential Subdivision

METHOD OF BORING: Flight-Auger
(Solid Stem)

PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 15, 2016

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
251.4	Ground Surface			
0.0	**36 cm TOPSOIL**	1A	DO	8
0.4	Brown, loose, weathered **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders clay layer	1B		
		2A	DO	10
		2B		
249.6 1.8	Brown, compact **SAND** fine to medium grained a trace to some silt	3	DO	14
		4	DO	20
		5	DO	29
246.8 4.6	Brown, compact **SANDY SILT** a trace of clay	6	DO	24
		7	DO	30
244.8 6.6	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 250.0 m on completion
Cave-in @ El. 249.9 m on completion

Soil Engineers Ltd.

JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH/MW 5

FIGURE NO.: 5

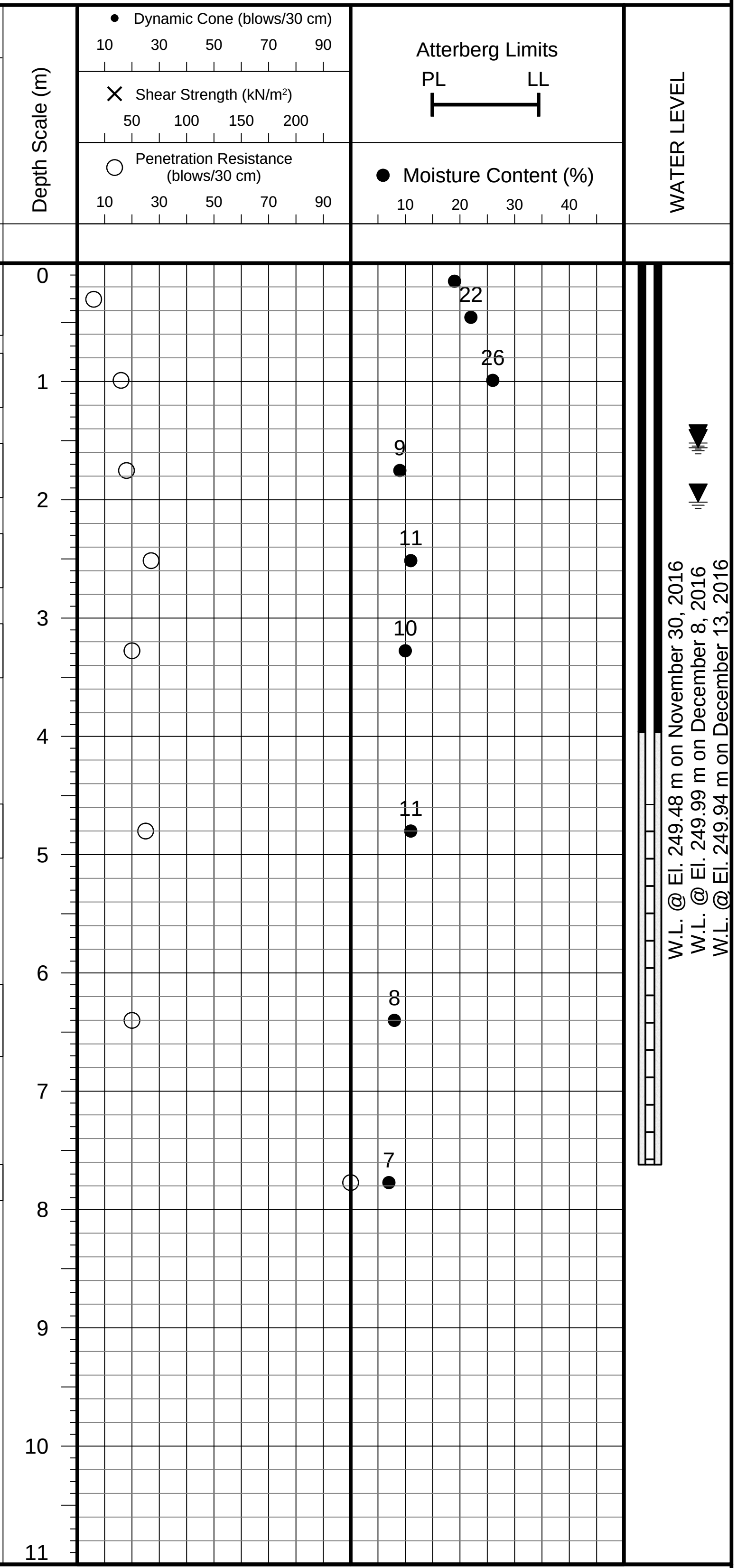
PROJECT DESCRIPTION: Proposed Residential Subdivision

METHOD OF BORING: Flight-Auger
(Hollow Stem)

PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 15, 2016

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
251.5	Ground Surface			
0.0	**30 cm TOPSOIL**	1A	DO	6
0.3	Brown, firm to stiff **SILTY CLAY** a trace of sand occ. wet sand and silt seams and layers weathered	1B		
		2	DO	16
250.0 1.5	Brown, very stiff **SILTY CLAY TILL** sandy, a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders sand layers/ rock fragments	3	DO	18
		4	DO	27
248.5 3.0	Compact to very dense **SILTY SAND TILL** a trace to some gravel a trace of clay occ. wet sand and silt seams and layers, cobbles and boulders	5	DO	20
		6	DO	25
	brown grey	7	DO	20
		8	DO	50/15
243.6 7.9	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 7.6 m (3.0 m screen) Sand backfill from 4.0 to 7.6 m Bentonite holeplug from 0.0 to 4.0 m Provided with a 4x4 steel monument casing with top and bottom caps, and lock			



W.L. @ El. 249.48 m on November 30, 2016
W.L. @ El. 249.99 m on December 8, 2016
W.L. @ El. 249.94 m on December 13, 2016

Soil Engineers Ltd.

JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH 6

FIGURE NO.: 6

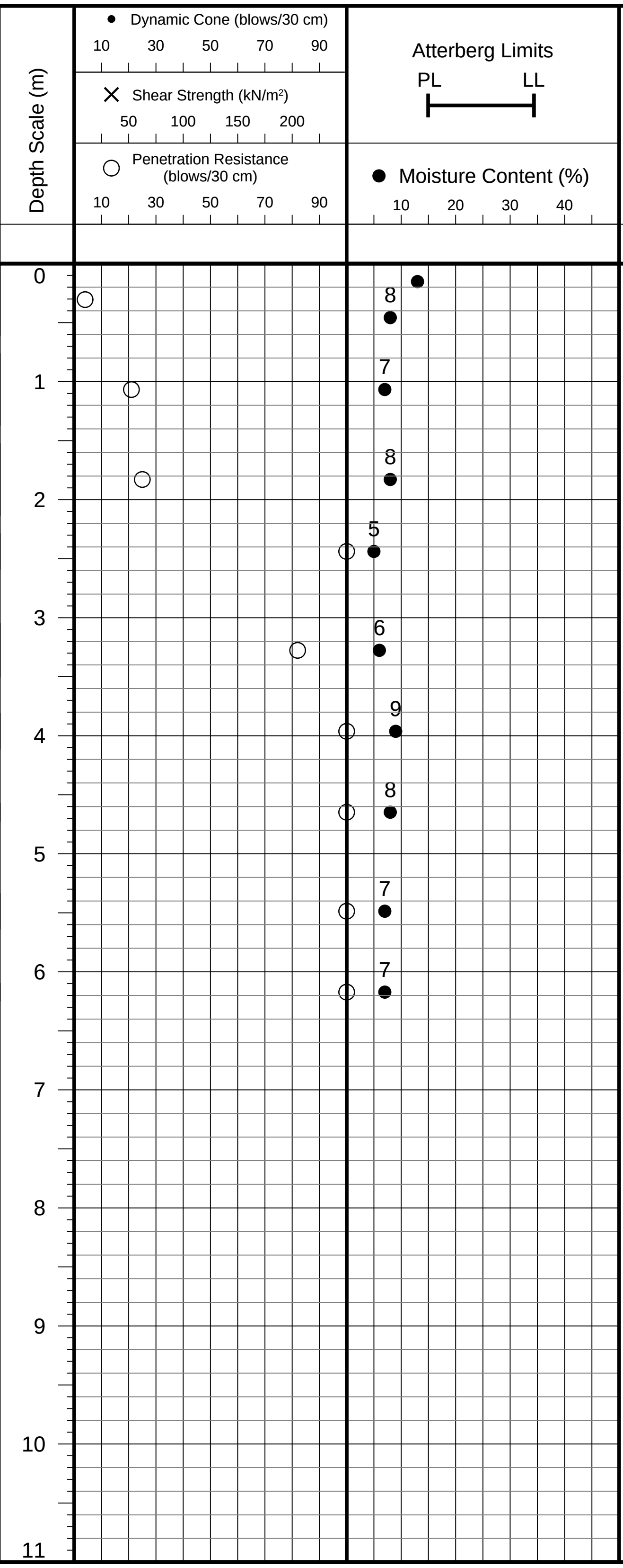
PROJECT DESCRIPTION: Proposed Residential Subdivision

METHOD OF BORING: Flight-Auger
(Solid Stem)

PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 16, 2016

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	WATER LEVEL
255.7	Ground Surface				
0.0	**30 cm TOPSOIL**	1A	DO	4	
0.3	Brown, very loose to compact weathered **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	1B			
		2	DO	21	
		3	DO	25	
253.4 2.3	Brown, very dense **SILTY FINE SAND** a trace of clay	4	DO	60/15	
		5	DO	82	
251.9 3.8	Brown, very dense **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	6	DO	50/15	Dry on completion
		7	DO	50/15	
		8	DO	50/15	
		9	DO	50/15	
249.5 6.2	**END OF BOREHOLE**				



Soil Engineers Ltd.

JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH/MW 7

FIGURE NO.: 7

PROJECT DESCRIPTION: Proposed Residential Subdivision

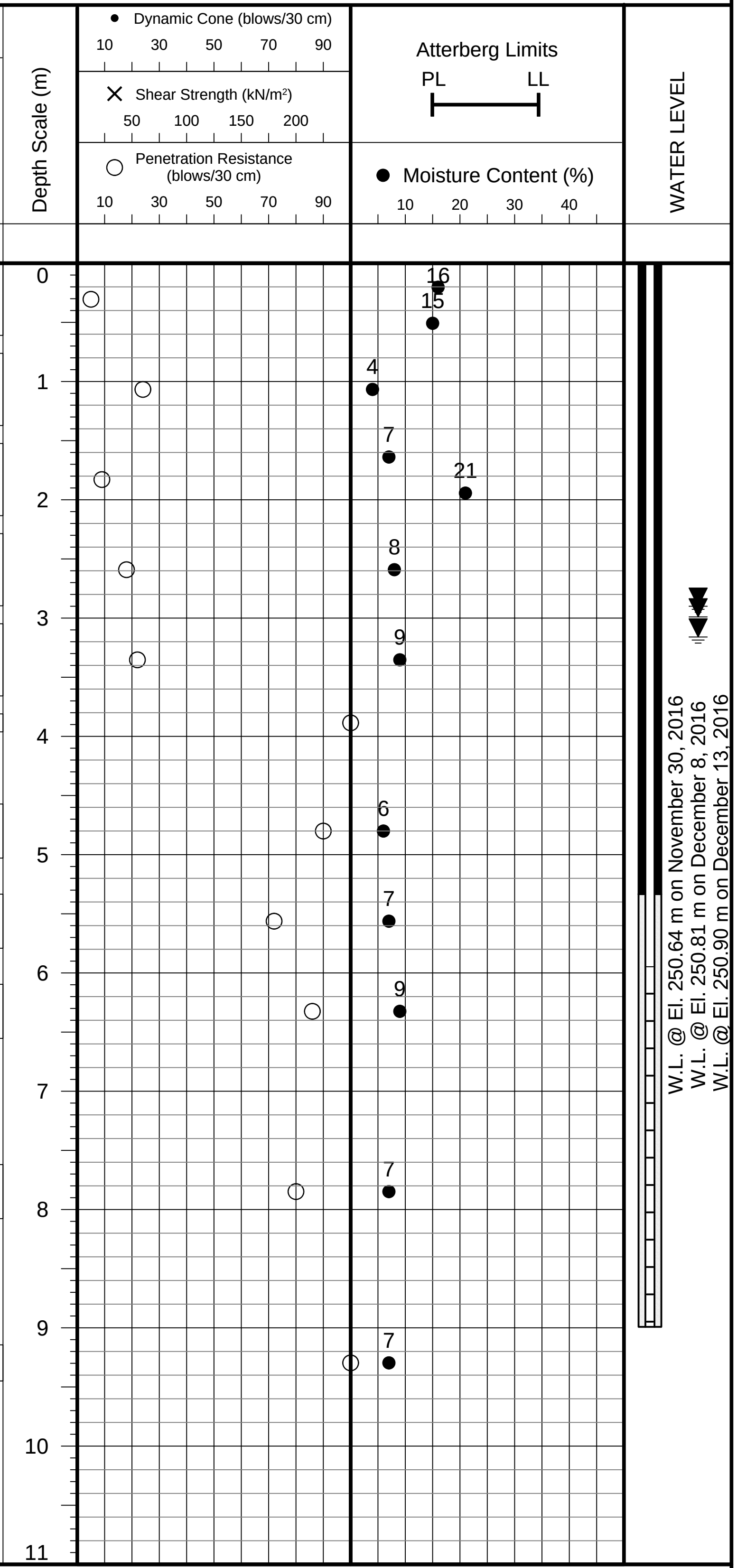
METHOD OF BORING: Flight-Auger (Hollow Stem)

PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 17, 2016

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
253.8	Ground Surface			
0.0	**41 cm TOPSOIL**	1A	DO	5
0.4	Brown, loose to compact **SAND** fine to medium grained a trace to some silt a trace of gravel weathered/fine grained — fine to medium grained	1B		
		2	DO	24
252.0 1.8	Brown, stiff **SILTY CLAY TILL** sandy, a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	3A	DO	9
		3B		
251.5 2.3	Compact to very dense **SANDY SILT TILL** a trace to some clay a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders brown — grey	4	DO	18
		5	DO	22
		6	DO	90/15
		7	DO	90
		8	DO	72
		9	DO	86
		10	DO	80
		11	DO	60/15
244.4 9.4	**END OF BOREHOLE**			

Installed 50 mm Ø PVC monitoring well to 9.0 m (3.0 m screen)
Sand backfill from 5.3 to 9.0 m
Bentonite holeplug from 0.0 to 5.3 m
Provided with a 4x4 steel monument casing with top and bottom caps, and lock



JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH/MW 8

FIGURE NO.: 8

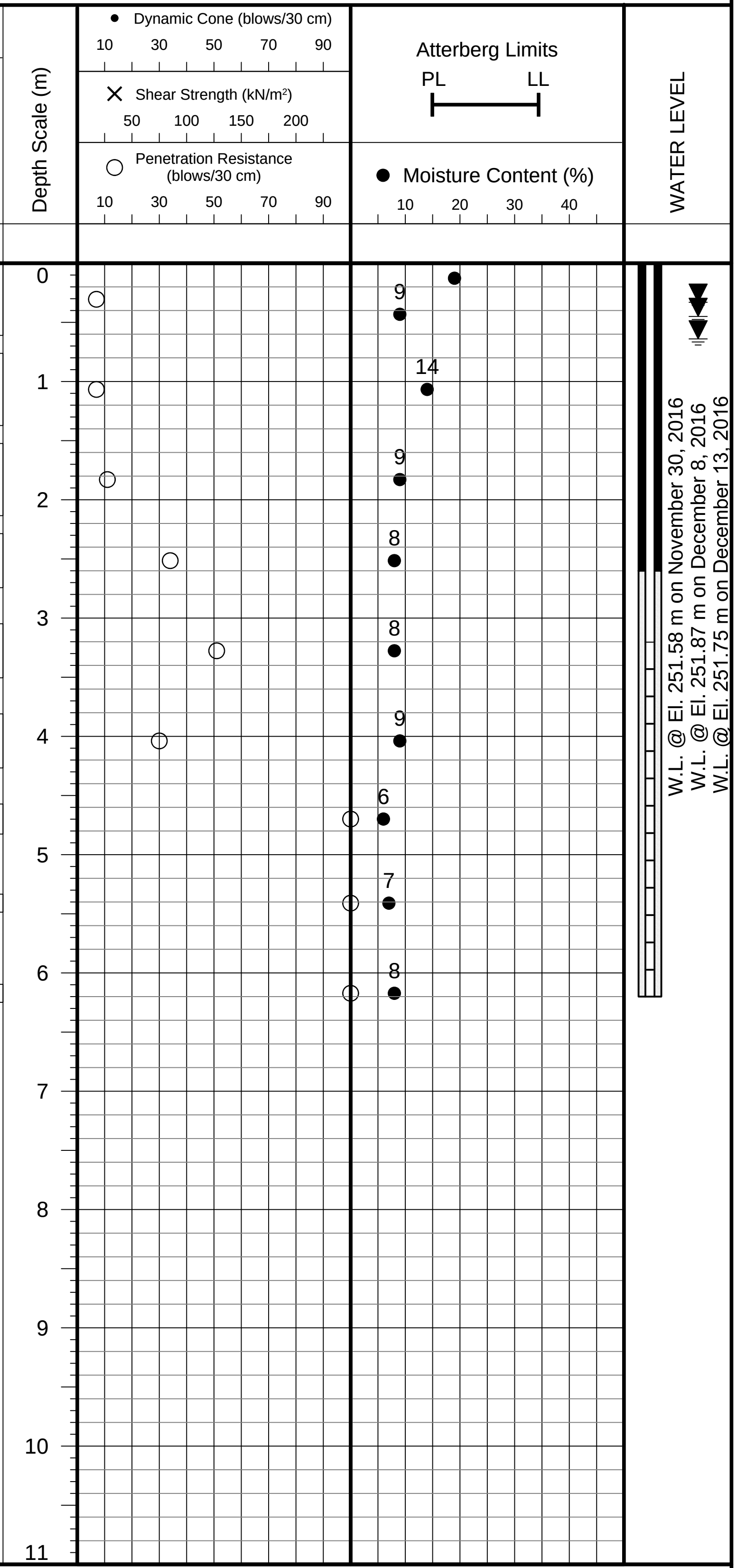
PROJECT DESCRIPTION: Proposed Residential Subdivision

METHOD OF BORING: Flight-Auger (Hollow Stem)

PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 17, 2016

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
252.2	Ground Surface			
0.0	**25 cm TOPSOIL**	1A	DO	7
0.3	Brown, firm, weathered **SILTY CLAY TILL** sandy, a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	1B		
		2	DO	7
250.7 1.5	Grey, compact to dense **SILTY SAND TILL** a trace to some clay a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	3	DO	11
		4	DO	34
249.2 3.0	Grey, very dense **GRAVELLY SAND** a trace of silt	5	DO	51
248.4 3.8	Grey, compact to very dense **SANDY SILT TILL** a trace to some clay a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	6	DO	30
		7	DO	50/10
		8	DO	50/15
		9	DO	70/15
246.0 6.2	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 6.2 m (3.0 m screen) Sand backfill from 2.6 to 6.2 m Bentonite holeplug from 0.0 to 2.6 m Provided with a 4x4 steel monument casing with top and bottom caps, and lock			



JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH/MW 9

FIGURE NO.: 9

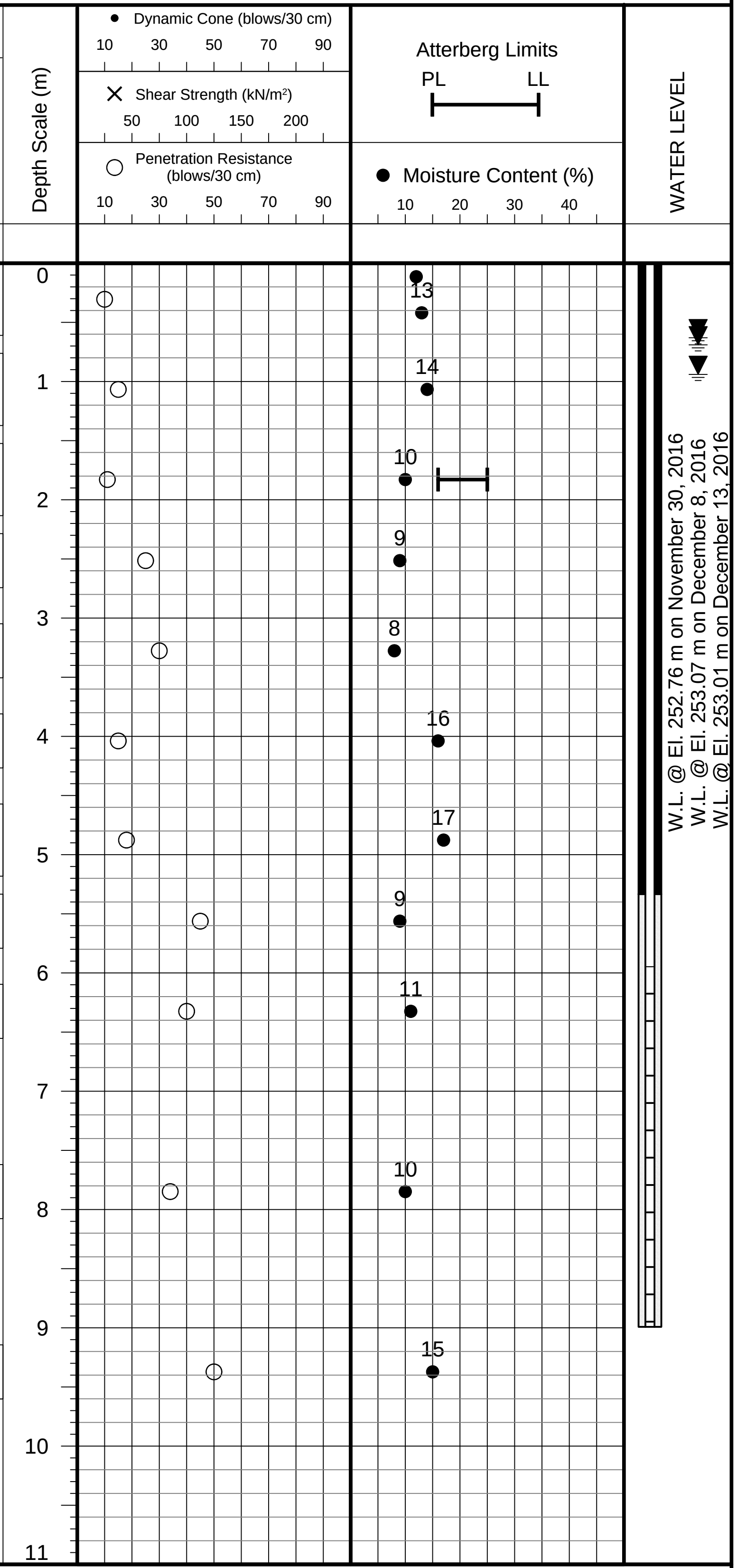
PROJECT DESCRIPTION: Proposed Residential Subdivision

METHOD OF BORING: Flight-Auger (Hollow Stem)

PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 16 and 17, 2016

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
253.7	Ground Surface			
0.0	**23 cm TOPSOIL**	1A	DO	10
0.2	Brown, stiff **SILTY CLAY TILL** weathered some sand to sandy a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	1B		
		2	DO	15
		3	DO	11
251.4 2.3	Brown, compact **SANDY SILT TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	4	DO	25
		5	DO	30
249.9 3.8	Grey, compact **SILTY FINE SAND** a trace of clay	6	DO	15
249.1 4.6	Grey, compact **SAND** fine grained a trace to some silt occ. cobbles	7	DO	18
248.4 5.3	Grey, dense **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	8	DO	45
		9	DO	40
		10	DO	34
244.6 9.1	Grey, dense **SILT** some clay, a trace of sand	11	DO	50
244.1 9.6	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 9.0 m (3.0 m screen). Sand backfill from 5.3 to 9.0 m. Bentonite holeplug from 0.0 to 5.3 m. Provided with a 4x4 steel monument casing with top and bottom caps, and lock			



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Page: 1 of 1

JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH 10

FIGURE NO.: 10

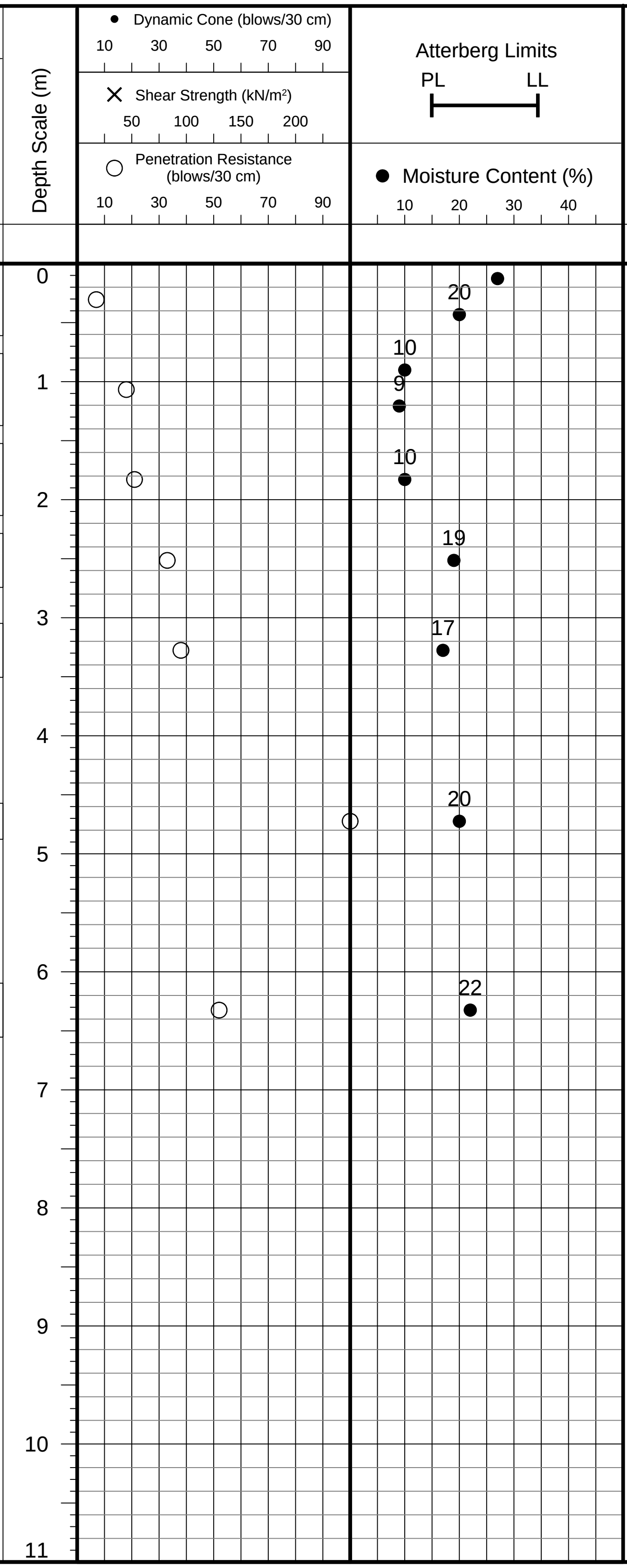
PROJECT DESCRIPTION: Proposed Residential Subdivision

METHOD OF BORING: Flight-Auger (Solid Stem)

PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 17, 2016

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
255.4	Ground Surface			
0.0	**25 cm TOPSOIL**	1A	DO	7
0.3	Brown, firm, weathered **SILTY CLAY TILL** some sand to sandy a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	1B		
254.4 1.0		2A	DO	18
		2B		
253.9 1.5	Brown, compact **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	3	DO	21
	Compact to dense	4	DO	33
	SILTY FINE SAND — — sandy silt layer	5	DO	38
	a trace of clay	6	DO	50/15
	— — brown grey	7	DO	52
248.8 6.6	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 253.3 m on completion

Cave-in @ El. 253.3 m on completion

Soil Engineers Ltd.

JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH 11

FIGURE NO.: 11

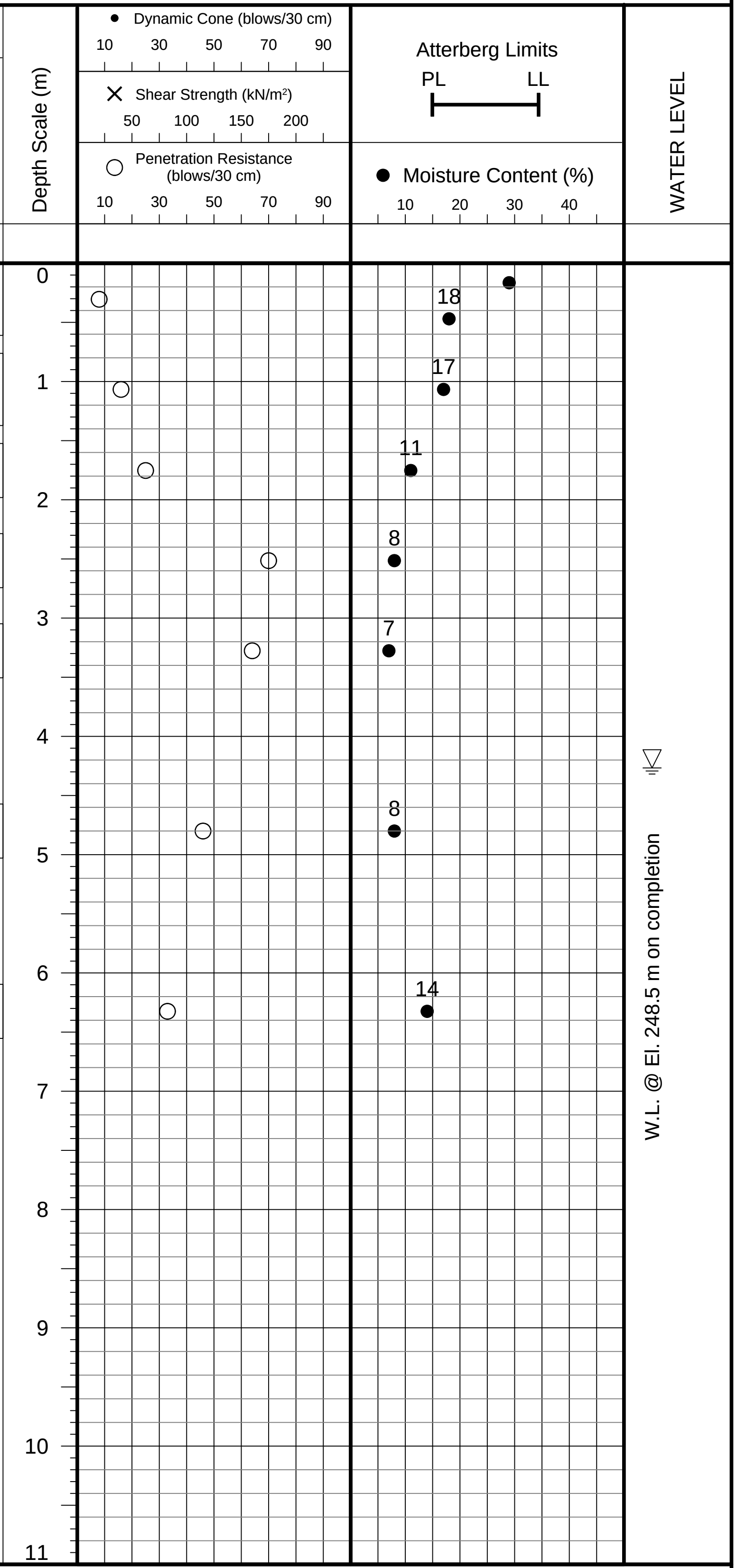
PROJECT DESCRIPTION: Proposed Residential Subdivision

METHOD OF BORING: Flight-Auger
(Solid Stem)

PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 18, 2016

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
252.8	Ground Surface			
0.0	**33 cm TOPSOIL**	1A	DO	8
0.3	Brown, firm to stiff **SILTY CLAY TILL** some sand to sandy a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders organic inclusions/ weathered	1B		
		2	DO	16
251.3 1.5	Brown, compact to very dense **SANDY SILT TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	3	DO	25
		4	DO	70
249.8 3.0	Grey, dense to very dense **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	5	DO	64
		6	DO	46
	rock fragments	7	DO	33
246.2 6.6	**END OF BOREHOLE**			



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Page: 1 of 1

JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH/MW 12D

FIGURE NO.: 12A

PROJECT DESCRIPTION: Proposed Residential Subdivision

METHOD OF BORING: Flight-Auger (Hollow Stem)

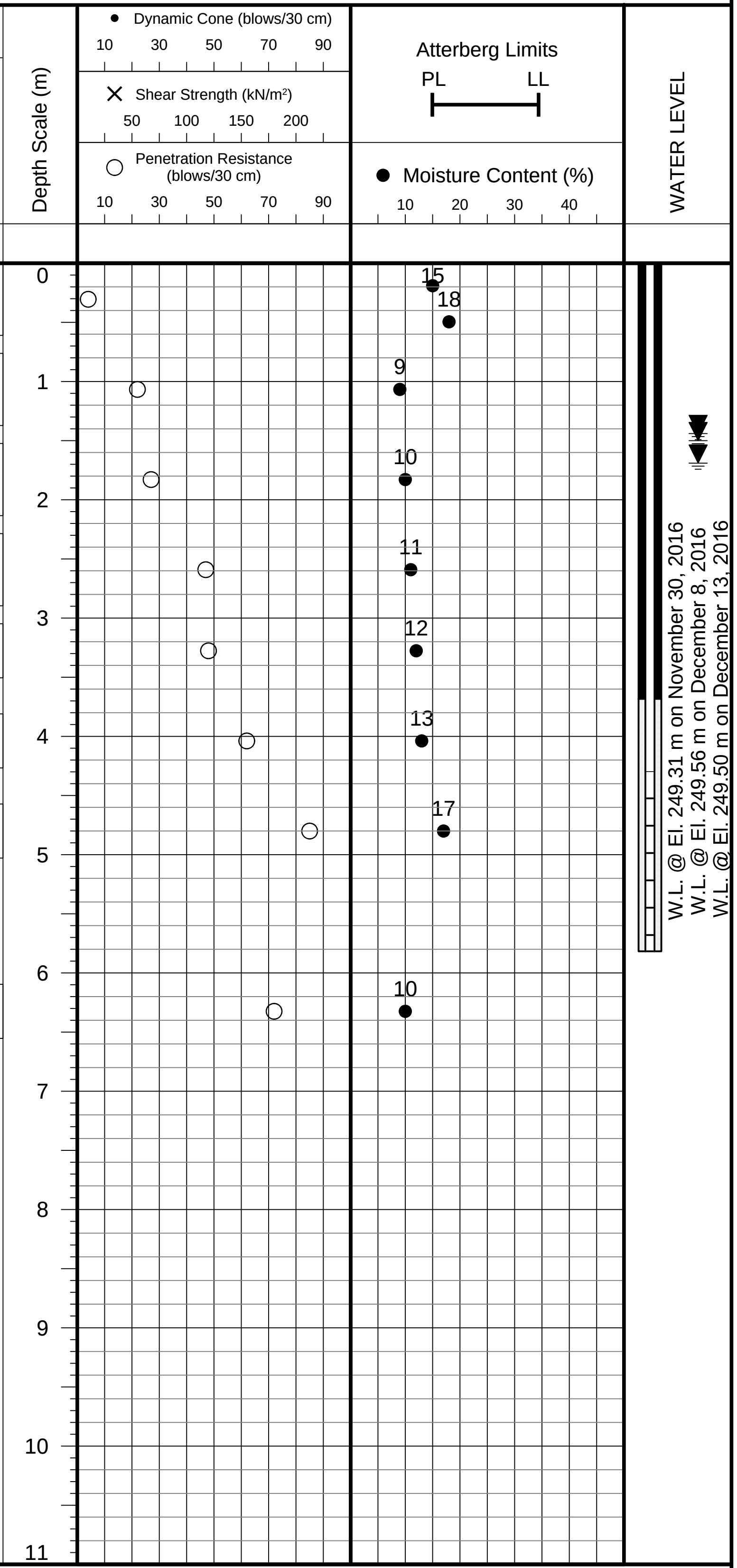
PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 16, 2016

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
251.0	Ground Surface			
0.0	**38 cm TOPSOIL**	1A	DO	4
0.4	Brown, very loose to compact **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders organic inclusions/ weathered	1B		
		2	DO	22
249.5 1.5	Brown, compact **SILT** traces of clay and sand	3	DO	27
248.7 2.3	Brown, dense **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders silt layer	4	DO	47
248.0 3.0	Brown, dense **GRAVELLY SAND** a trace of silt with rock fragments	5	DO	48
247.2 3.8	Brown, very dense **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders and rock fragments	6	DO	62
246.4 4.6	Brown, very dense **SILTY FINE SAND** a trace of clay	7	DO	85
244.9 6.1	Brown, very dense **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	8	DO	72
244.4 6.6				

END OF BOREHOLE

Installed 50 mm Ø PVC monitoring well to 5.8 m (1.5 m screen)
Sand backfill from 3.7 to 5.8 m
Bentonite holeplug from 0.0 to 3.7 m
Provided with a 4x4 steel monument casing with top and bottom caps, and lock



JOB NO.: 1610-W116

LOG OF BOREHOLE NO.: BH/MW 12S

FIGURE NO.: 12B

PROJECT DESCRIPTION: Proposed Residential Subdivision

METHOD OF BORING: Flight-Auger
(Hollow Stem)

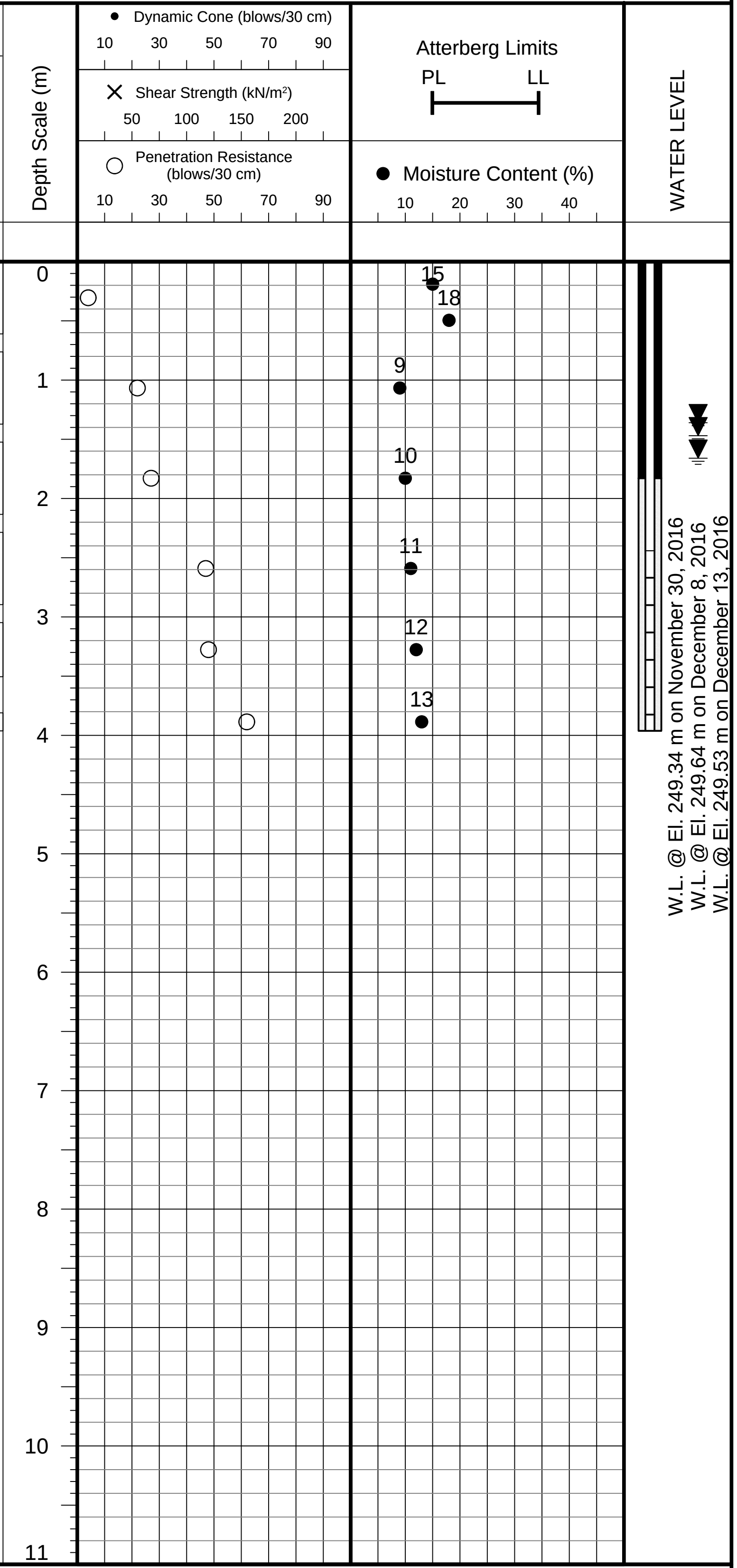
PROJECT LOCATION: Southwest Corner of Mapleview Drive East
and 20th Sideroad
City of Barrie

DRILLING DATE: November 16, 2016

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
251.0	Ground Surface			
0.0		1A	DO	4
0.4	Brown, very loose to compact **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	1B		
		2	DO	22
249.5 1.5	Brown, compact **SILT** traces of clay and sand	3	DO	27
248.7 2.3	Brown, dense **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	4	DO	47
248.0 3.0	Brown, dense **GRAVELLY SAND** a trace of silt with rock fragments	5	DO	48
247.2 246.4		6	DO	62
4.0	Brown, very dense **SILTY SAND TILL** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders and rock fragments			

END OF BOREHOLE

Installed 50 mm Ø PVC monitoring well to
4.0 m (1.5 m screen)
Sand backfill from 1.8 to 4.0 m
Bentonite holeplug from 0.0 to 1.8 m
Provided with a 4x4 steel monument casing
with top and bottom caps, and lock



BURNSIDE
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LOG OF DRILLING OPERATIONS

DS-MW13

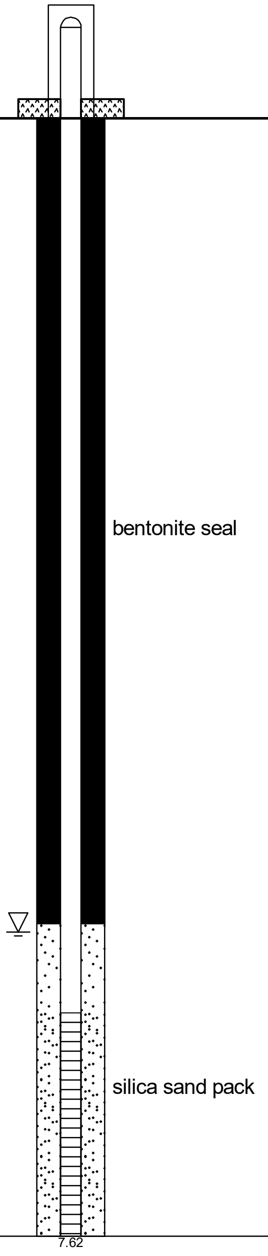
Page 1 of 1

Client: **DIV Development (Barrie) Ltd.**	Project Name: **Dorsay**	Logged by: **B.Ward**
Project No.: **300043693**	Location: **Barrie, ON**	Ground (masl): **261.18**
Drilling Co.: **Lantech Drilling Services Inc.**	Date Started: **11/19/2019**	Static Water Level (masl): **255.63**
Drilling Method: **Hollow Stem Auger**	Date Completed: **11/19/2019**	Sand Pack Depth (m): **6.10-7.62**

Surface Elevation (m): **261.18**

Stratigraphic Description	Elev. / Depth (m)
TOPSOIL sand uniform, dark brown, damp, friable, soft	260.98 0.20
SAND uniform, fine grained, light brown, dry to damp, friable, soft to medium hardness	258.66 2.52
SILTY SAND/ SANDY SILT uniform, light brown, dry to damp, stiff -with depth silt content increases	258.03 3.15
SILT uniform, light brown, dry to damp, very stiff -3.81m - 4.01m sand seam -at 4.01m silt becomes wet with increasing sand content -with depth becomes saturated -5.33m - 5.67m sand seam	255.16 6.02
SAND uniform, light brown, saturated, friable, very stiff to hard	253.56 7.62

Depth Scale (ft)	Depth Scale (m)
	1.0
5.0	
	2.0
	3.0
10.0	
	4.0
15.0	
	5.0
	6.0
20.0	
	7.0
25.0	



SAMPLE

Num.	Type	Int.	N.Val.
1	SS	☒	9
2	SS	☒	5
3	SS	☒	7
4	SS	☒	7
5	SS	☒	22
6	SS	☒	33
7	SS	☒	33
8	SS	☒	44
9	SS	☒	47
10	SS	☒	62

Prepared By: **B.Ward** Checked By: **D. Smikle** Date Prepared: **2/10/2020**

This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.

LEGEND
▼ Water found @ time of drilling
▽ Static Water Level - 12/16/2019

MONITORING WELL DATA
Pipe: **51 mm dia. PVC**
Screen: **51 mm dia. PVC #10 slot**

SAMPLE TYPE

AC	◧	Auger Cutting	SS	☒	Split Spoon
CS	▯	Continuous	AR	▯	Air Rotary
RC	▨	Rock Core	WC	▭	Wash Cuttings

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LOG OF DRILLING OPERATIONS

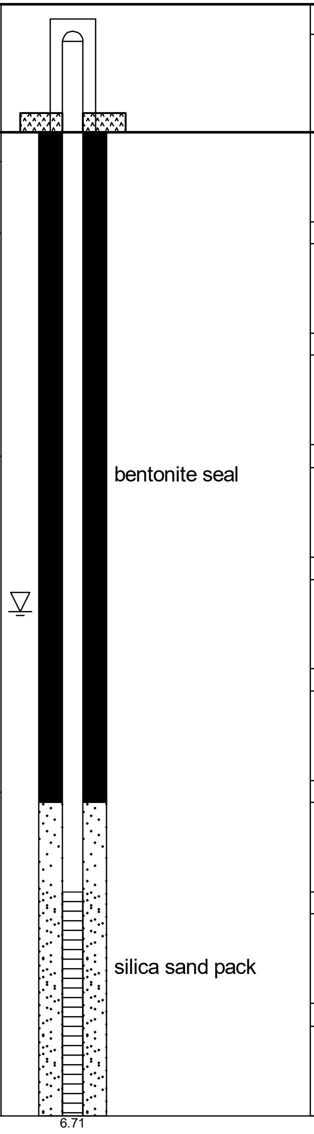
DS-MW14

Page 1 of 1

Client: **DIV Development (Barrie) Ltd.**	Project Name: **Dorsay**	Logged by: **B.Ward**
Project No.: **300043693**	Location: **Barrie, ON**	Ground (masl): **253.62**
Drilling Co.: **Lantech Drilling Services Inc.**	Date Started: **11/19/2019**	Static Water Level (masl): **250.35**
Drilling Method: **Hollow Stem Auger**	Date Completed: **11/20/2019**	Sand Pack Depth (m): **4.57-6.71**

Surface Elevation (m): **253.62**

Stratigraphic Description	Elev. / Depth (m)
TOPSOIL, sandy silt/silty sand dark brown, damp, friable, soft, organic fragments throughout soil	253.42 0.20
SAND trace silt, uniform, damp, soft	252.93 0.69
SILTY SAND well graded, light brown, dry, medium density, some gravel -at 1.52m trace clay, increases with depth, occasional gravel <1cm rounded -at 1.69m sand and gravel seam	251.41 2.21
SILT light brown, damp, medium density, trace sand, occasional gravel -at 2.47m silt becomes uniform, wet -with depth sample becomes dense	249.12 4.50
SAND light brown, saturated, hard, trace silt, occasional gravel <1cm diameter -at 5.33m sand is uniform	246.91 6.71



Num.	Type	Int.	N.Val.
1	SS	☒	6
2	SS	☒	21
3	SS	☒	38
4	SS	☒	28
5	SS	☒	36
6	SS	☒	44
7	SS	☒	79
8	SS	☒	43
9	SS	☒	92

Prepared By: **B.Ward** Checked By: **D. Smikle** Date Prepared: **2/10/2020**

This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.

LEGEND
- ▼ Water found @ time of drilling
- ▽ Static Water Level - 12/16/2019

MONITORING WELL DATA
- Pipe: **51 mm dia. PVC**
- Screen: **51 mm dia. PVC #10 slot**

SAMPLE TYPE

AC	◧	Auger Cutting	SS	☒	Split Spoon
CS	▯	Continuous	AR	▯	Air Rotary
RC	▨	Rock Core	WC	▭	Wash Cuttings

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LOG OF DRILLING OPERATIONS

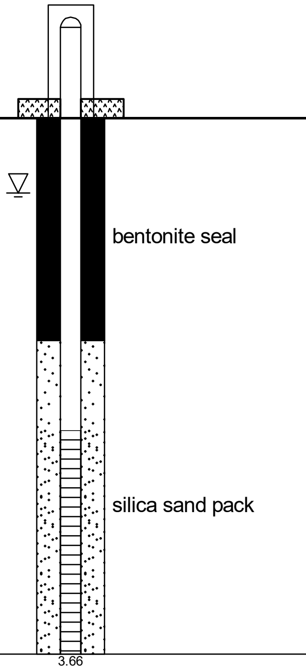
DS-MW15

Page 1 of 1

Client: **DIV Development (Barrie) Ltd.**	Project Name: **Dorsay**	Logged by: **B.Ward**
Project No.: **300043693**	Location: **Barrie, ON**	Ground (masl): **256.66**
Drilling Co.: **Lantech Drilling Services Inc.**	Date Started: **11/20/2019**	Static Water Level (masl): **256.15**
Drilling Method: **Hollow Stem Auger**	Date Completed: **11/20/2019**	Sand Pack Depth (m): **1.52-3.66**

Surface Elevation (m): **256.66**

Depth Scale (ft)	Depth Scale (m)	Stratigraphic Description	Elev. Depth (m)
		TOPSOIL dark brown, wet, very soft, sandy silt, occasional rootlets	256.51 0.15
	1.0	CLAYEY SILT uniform, light brown, wet, very soft to soft, iron staining, trace sand	255.97 0.69
5.0	2.0	SAND uniform, light brown, saturated, fine grained, very stiff -0.93m - 1.1m sand and gravel seam -1.05m - 1.57m silt seam -at 2.44 m silt seam 1cm in depth	
10.0	3.0		253.00 3.66



SAMPLE Num.	Type	Int.	N.Val.
1	SS	☒	3
2	SS	☒	28
3	SS	☒	31
4	SS	☒	32
5	SS	☒	40

Prepared By: **B.Ward** Checked By: **D. Smikle** Date Prepared: **2/10/2020**

This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.

LEGEND
- ▼ Water found @ time of drilling
- ▽ Static Water Level - 12/16/2019

MONITORING WELL DATA
- Pipe: **51 mm dia. PVC**
- Screen: **51 mm dia. PVC #10 slot**

SAMPLE TYPE

AC	◨	Auger Cutting	SS	☒	Split Spoon
CS	▯	Continuous	AR	▯	Air Rotary
RC	▨	Rock Core	WC	▭	Wash Cuttings

BURNSIDE
R.J. Burnside & Associates Limited
15 Townline, Orangeville, Ontario L9W 3R4
telephone (519) 941-5331 fax (519) 941-8120

LOG OF DRILLING OPERATIONS

DS-MW16

Page 1 of 1

Client: **DIV Development (Barrie) Ltd.**	Project Name: **Dorsay**	Logged by: **B.Ward**
Project No.: **300043693**	Location: **Barrie, ON**	Ground (masl): **257.73**
Drilling Co.: **Lantech Drilling Services Inc.**	Date Started: **11/20/2019**	Static Water Level (masl): **254.82**
Drilling Method: **Hollow Stem Auger**	Date Completed: **11/20/2019**	Sand Pack Depth (m): **2.43-4.49**

Depth Scale (ft) (m): 1.0, 5.0, 2.0, 3.0, 10.0, 4.0

Stratigraphic Description — Surface Elevation (m): **257.73**

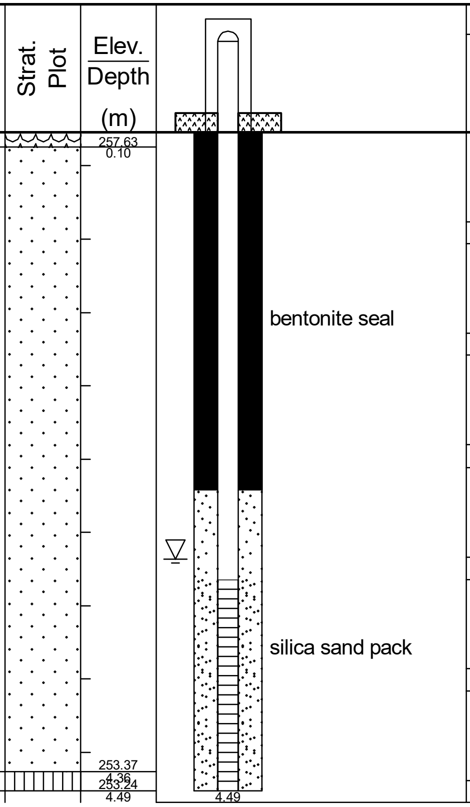
TOPSOIL
dark brown, damp, friable, soft, occasional rootlets

SAND
uniform, light brown, damp, medium to stiff

-0.10m - 0.25m sand is reddish brown with trace silt, with depth becomes light brown

-at 2.29m sand becomes wet, with depth becomes saturated

SILT
uniform, light brown, saturated, stiff



SAMPLE Num.	Type	Int.	N.Val.
1	SS	☒	4
2	SS	☒	14
3	SS	☒	14
4	SS	☒	18
5	SS	☒	21
6	SS	☒	19

Prepared By: **B.Ward** Checked By: **D. Smikle** Date Prepared: **2/10/2020**

This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.

LEGEND	MONITORING WELL DATA	SAMPLE TYPE
▼ Water found @ time of drilling	Pipe: **51 mm dia. PVC**	AC Auger Cutting; SS ☒ Split Spoon
▽ Static Water Level - 12/16/2019	Screen: **51 mm dia. PVC #10 slot**	CS Continuous; AR Air Rotary
		RC Rock Core; WC Wash Cuttings

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LOG OF DRILLING OPERATIONS

DS-MW17

Page 1 of 1

Client: **DIV Development (Barrie) Ltd.**	Project Name: **Dorsay**	Logged by: **B.Ward**
Project No.: **300043693**	Location: **Barrie, ON**	Ground (masl): **261.44**
Drilling Co.: **Lantech Drilling Services Inc.**	Date Started: **11/21/2019**	Static Water Level (masl): **257.45**
Drilling Method: **Hollow Stem Auger**	Date Completed: **11/21/2019**	Sand Pack Depth (m): **4.27-6.10**

Depth Scale (ft) (m)

Stratigraphic Description

Surface Elevation (m): **261.44**

TOPSOIL
dark brown, damp, soft, sandy silt, occasional rootlets

SAND
uniform, light brown, damp, friable, soft to medium

-0.24m - 0.69m sand is reddish brown, with depth becomes light brown

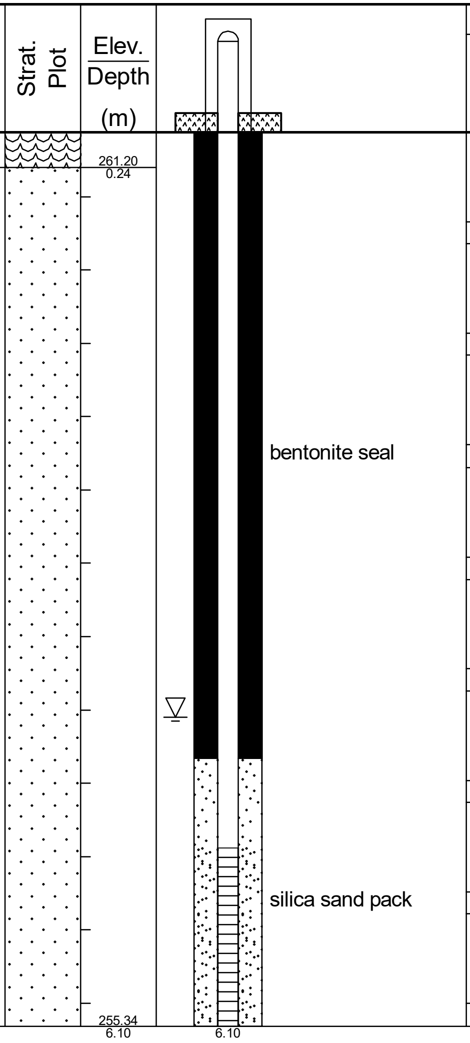
-1.52m - 2.29m occasional gravel

-3.05m - 3.81m sand becomes wet with trace silt

-at 3.81, sand becomes saturated

-at 4.11m silt seam 2cm in depth

-4.57m - 4.70m silt seam



SAMPLE			
Num.	Type	Int.	N.Val.
1	SS	☒	9
2	SS	☒	8
3	SS	☒	43
4	SS	☒	43
5	SS	☒	78
6	SS	☒	78
7	SS	☒	87
8	SS	☒	100

Depth Scale (ft) (m): 5.0, 10.0, 15.0, 20.0 (ft); 1.0, 2.0, 3.0, 4.0, 5.0, 6.0 (m)

Prepared By: **B.Ward** Checked By: **D. Smikle** Date Prepared: **2/10/2020**

This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.

LEGEND	MONITORING WELL DATA	SAMPLE TYPE				
▼ Water found @ time of drilling	Pipe: **51 mm dia. PVC**	AC	Auger Cutting	SS	☒	Split Spoon
▽ Static Water Level - 12/16/2019	Screen: **51 mm dia. PVC #10 slot**	CS	Continuous	AR		Air Rotary
		RC	Rock Core	WC		Wash Cuttings

BURNSIDE
[THE DIFFERENCE IS OUR PEOPLE]

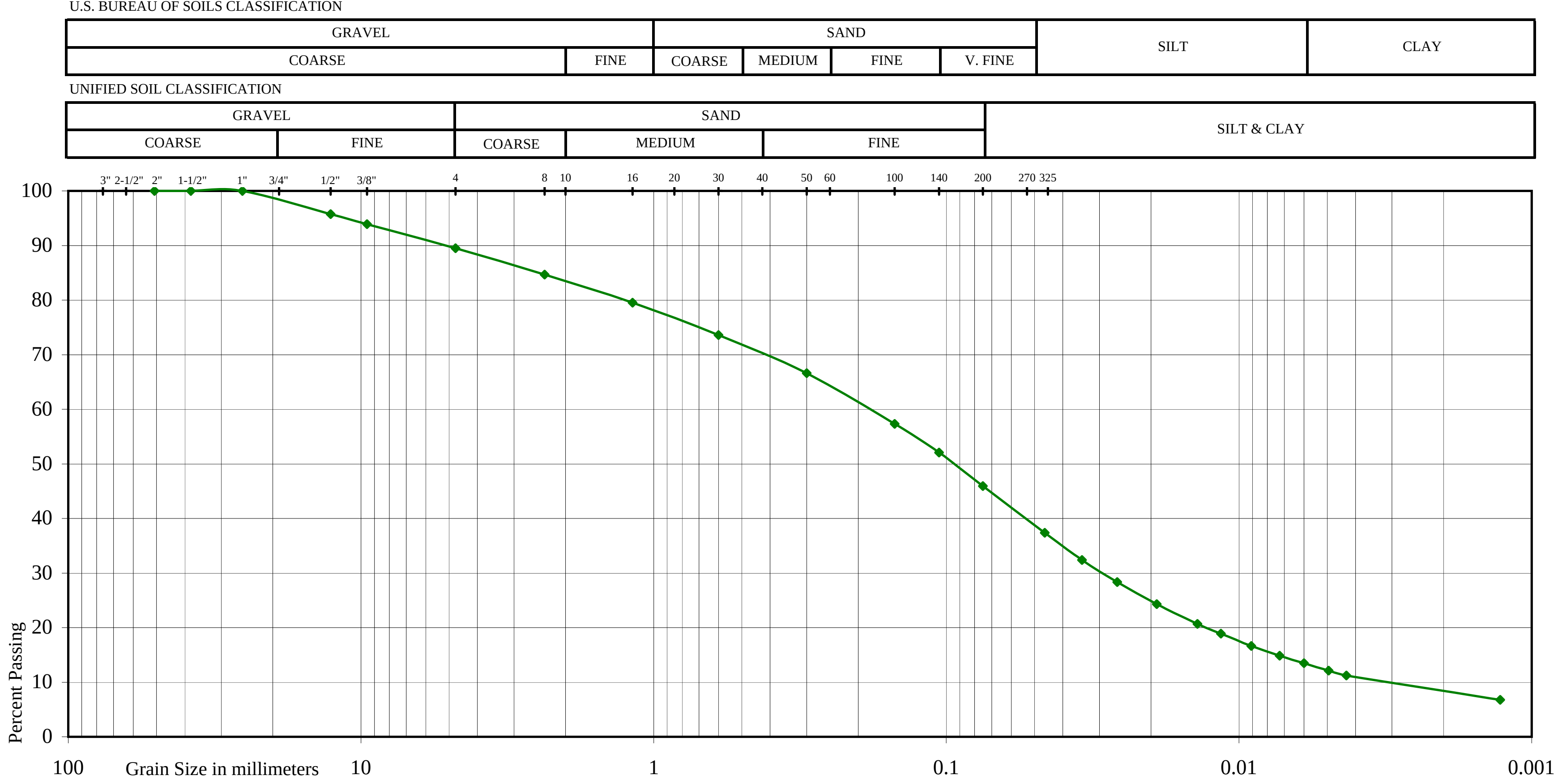
Appendix C

Grain Size and Hydraulic Conductivity Data

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1610-W116



Project: Proposed Residential Development

Location: Southwest Corner of Mapleview Drive East and 20th Sideroad, City of Barrie

Borehole No: 5

Sample No: 8

Depth (m): 7.8

Elevation (m): 243.7

Estimated Permeability (cm./sec.) = 10^{-6}

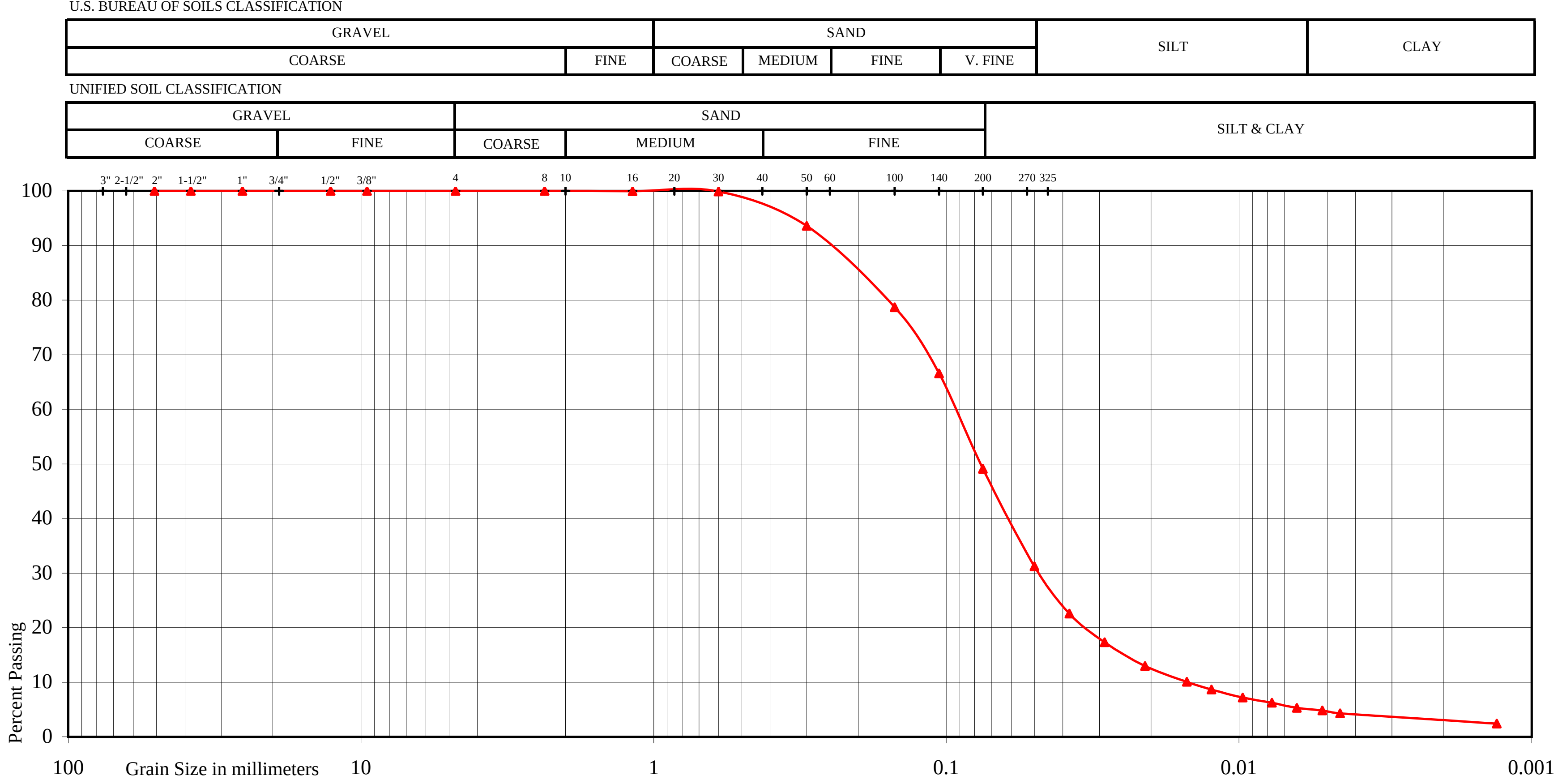
Classification of Sample [& Group Symbol]: SILTY SAND TILL, some gravel, a trace of clay

Figure: 13

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 11610-W116



Project: Proposed Residential Development

Location: Southwest Corner of Mapleview Drive East and 20th Sideroad, City of Barrie

Borehole No: 6

Sample No: 5

Depth (m): 3.3

Elevation (m): 252.4

Estimated Permeability (cm./sec.) = 10^{-4}

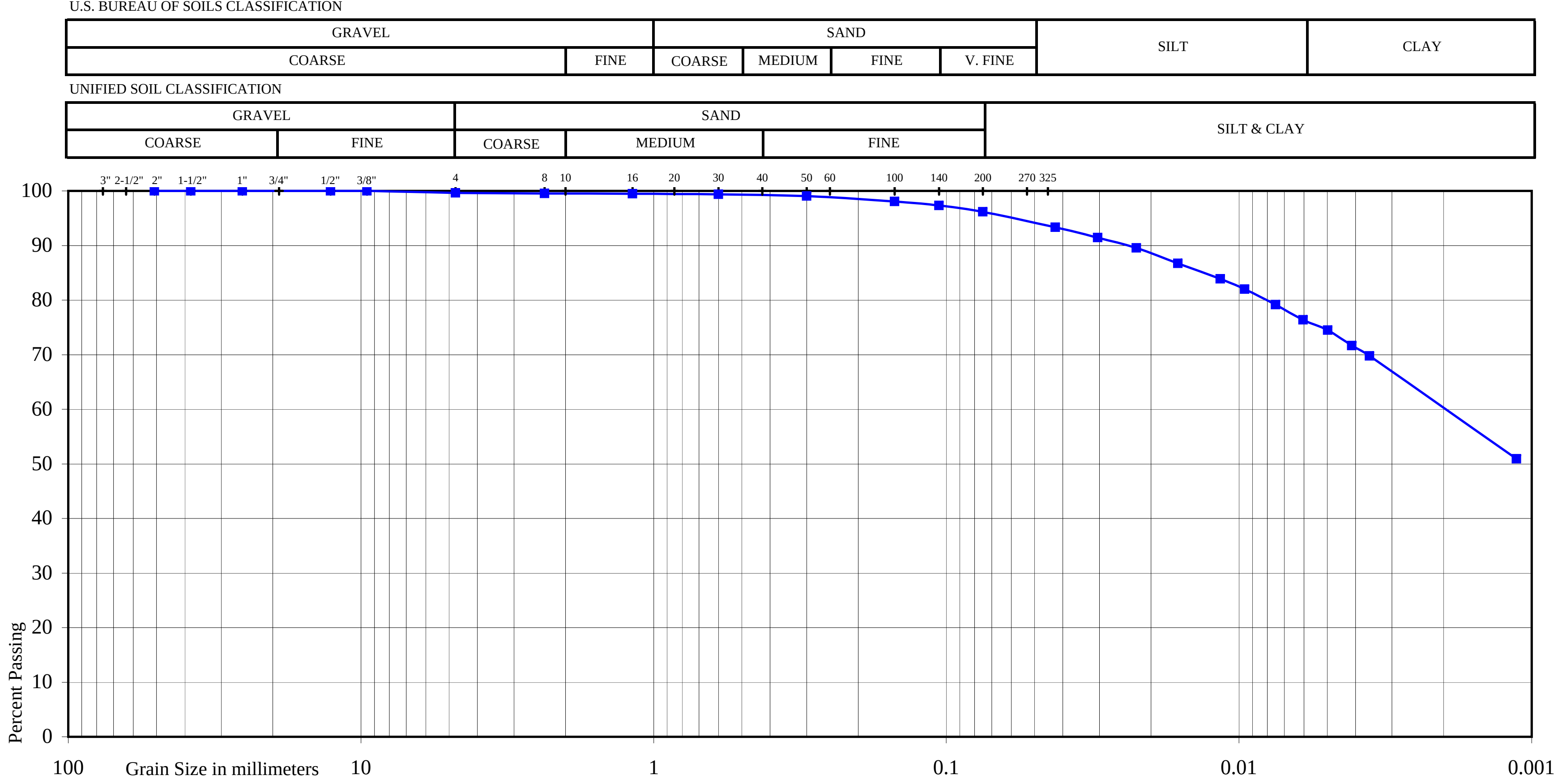
Classification of Sample [& Group Symbol]: SILTY FINE SAND, a trace of clay

Figure: 14

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1610-W116



Project: Proposed Residential Development

Location: Southwest Corner of Mapleview Drive East and 20th Sideroad, City of Barrie

Borehole No: 1

Sample No: 14

Depth (m): 13.9

Elevation (m): 242.5

Estimated Permeability (cm./sec.) = 10^{-7}

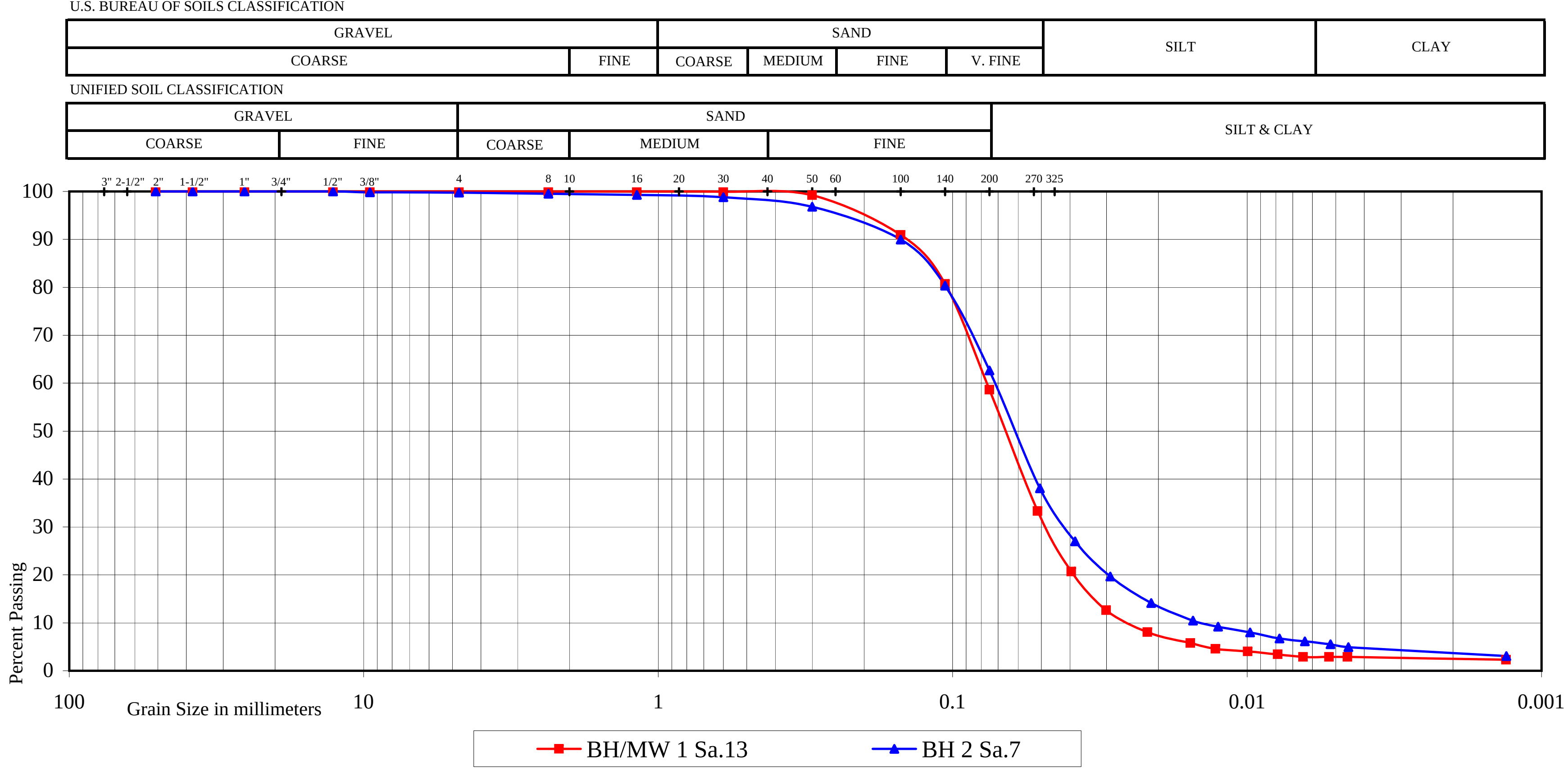
Classification of Sample [& Group Symbol]: SILTY CLAY, a trace of fine sand

Figure: 15

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1610-W116



Project: Proposed Residential Development

Location: Southwest Corner of Mapleview Drive East and 20th Sideroad, City of Barrie

Borehole No:	1	2
Sample No:	13	7
Depth (m):	12.4	6.4
Elevation (m):	244	245.8

BH 1 Sa. 13 Estimated Permeability (cm./sec.) = 10^{-4}

BH 2 Sa. 7 Estimated Permeability (cm./sec.) = 10^{-4}

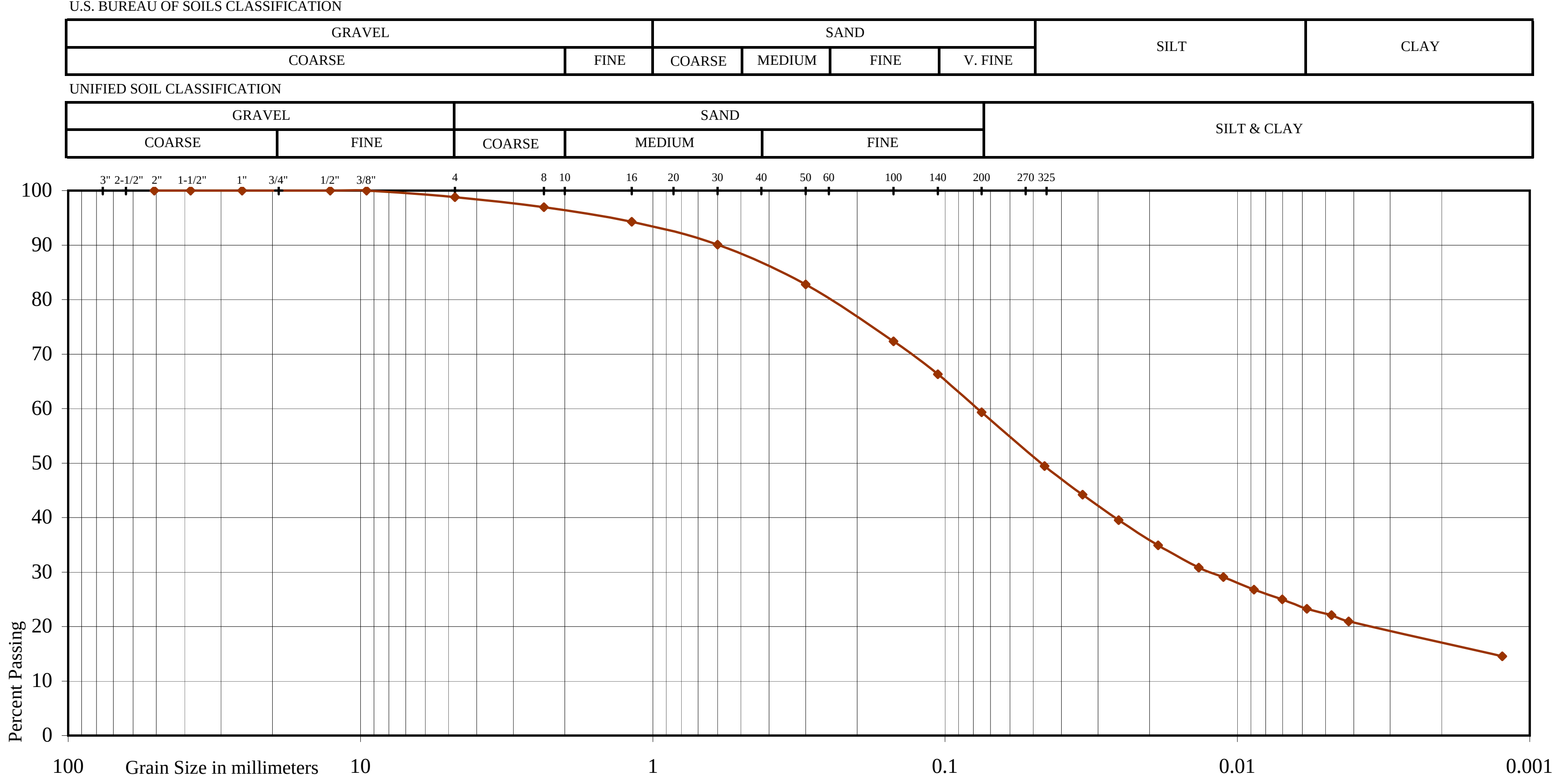
Classification of Sample [& Group Symbol]: SANDY SILT, a trace of clay

Figure: 16

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1610-W116



Project: Proposed Residential Development

Location: Southwest Corner of Mapleview Drive East and 20th Sideroad, City of Barrie

Borehole No: 9

Sample No: 3

Depth (m): 1.8

Elevation (m): 251.9

Estimated Permeability (cm./sec.) = 10^{-7}

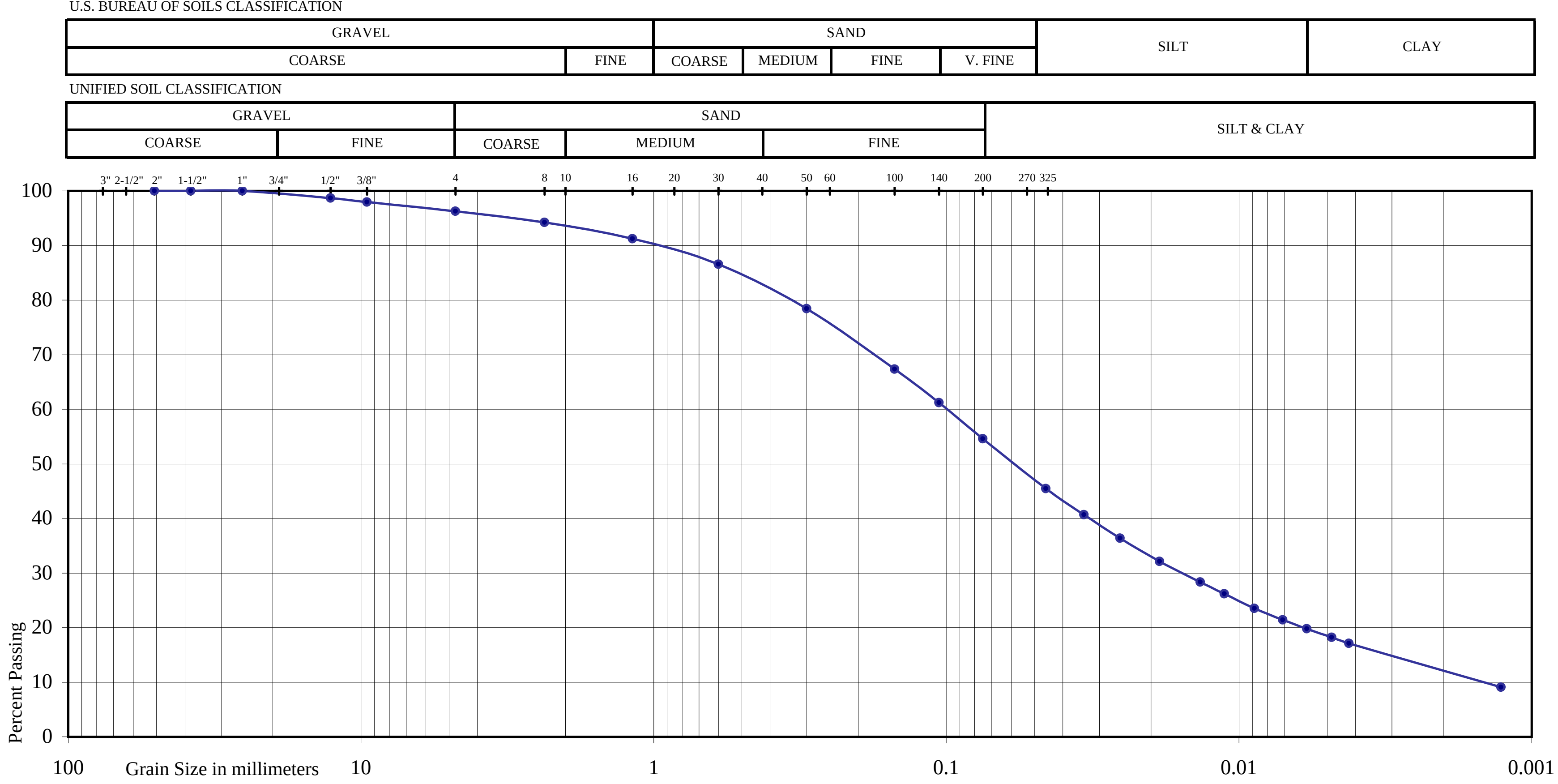
Classification of Sample [& Group Symbol]: SILTY CLAY TILL, sandy, a trace of gravel

Figure: 17

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1610-W116



Project: Proposed Residential Development

Location: Southwest Corner of Mapleview Drive East and 20th Sideroad, City of Barrie

Borehole No: 7

Sample No: 10

Depth (m): 7.9

Elevation (m): 245.9

Estimated Permeability (cm./sec.) = 10^{-6}

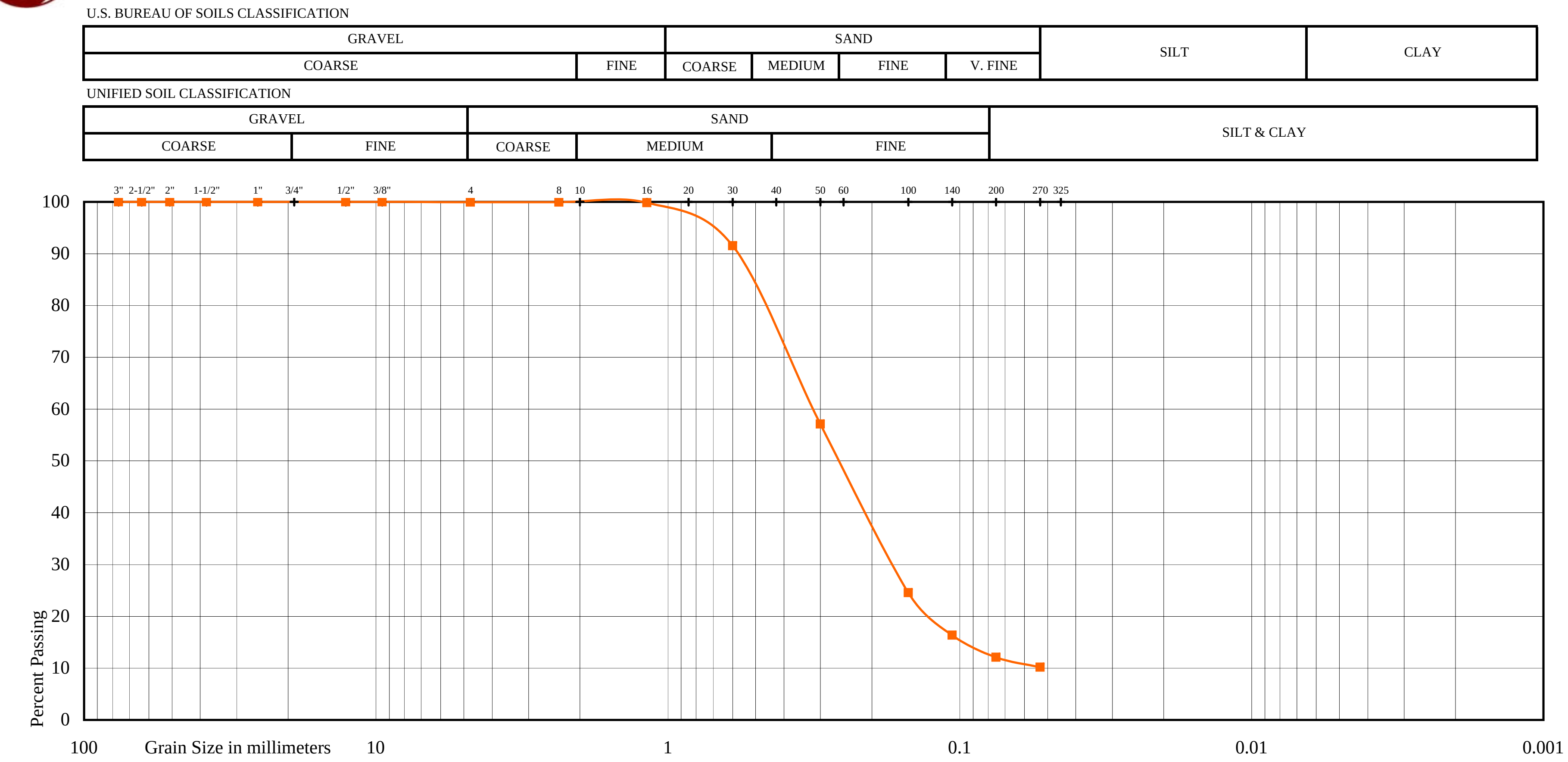
Classification of Sample [& Group Symbol]: SANDY SILT TILL, some clay, a trace of gravel

Figure: 18

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1610-S116



Project: Proposed Residential Development

Location: Southwest Corner of Mapleview Drive East and 20th Sideroad, City of Barrie

Borehole No: 1

Sample No: 7

Depth (m): 4.9

Elevation (m): 251.5

Estimated Permeability(cm./sec.) = 10^{-3}

Classification of Sample [& Group Symbol]: FINE TO MEDIUM SAND, some silt

Figure 19

Falling Head Test (Slug Test)

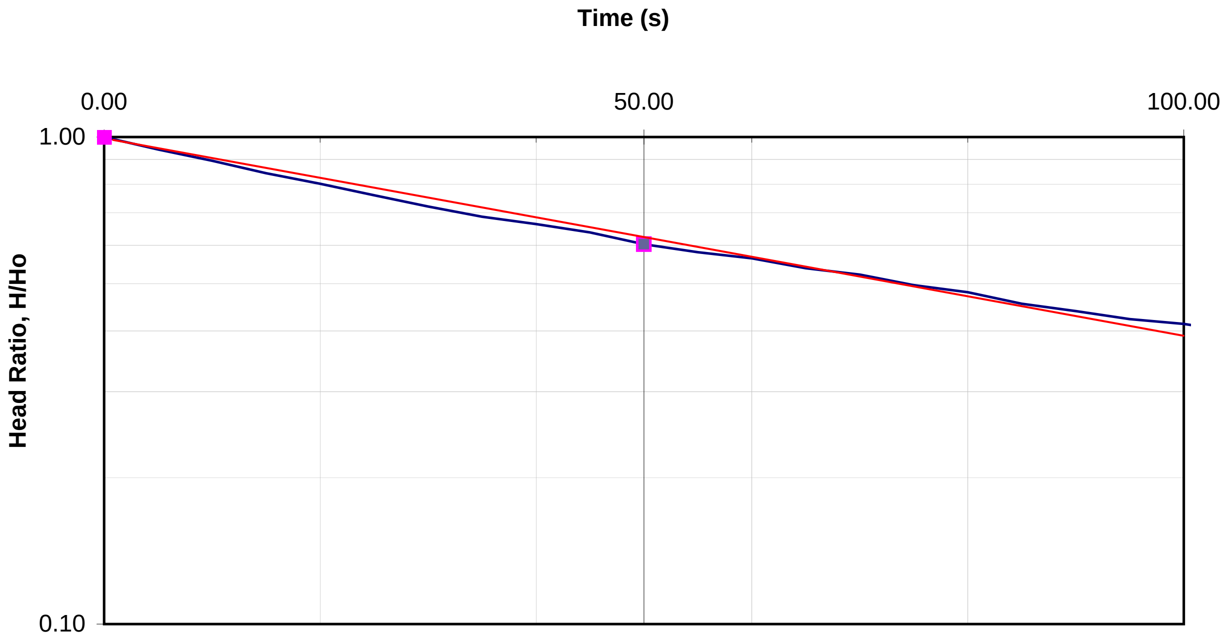
Test Date:		8-Dec-16	
Piezometer/Well No.:		BH/MW 1	
Ground level:		256.40	m
Screen top level:		242.30	m
Screen bottom level:		239.30	BH/MW
Test El. (at midpoint of screen):		240.80	m
Test depth (at midpoint of screen):		15.6	m
Screen length	L=	3.0	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.433	m
Initial water depth		1.97	m
Aquifer material:		**Silty Clay and Silty Fine Sand**	

Shape factor $F = \dfrac{2 \times 3.14 \times L}{\ln(L/R)} = 5.701815$ m

Permeability $K = \dfrac{3.14 \times r2}{F \times (t2 - t1)} \times \ln(H1/H2)$ (Bouwer and Rice Method)

$$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.010124346$$

K= **3.5E-04** cm/s
3.5E-06 m/s



Falling Head Test (Slug Test)

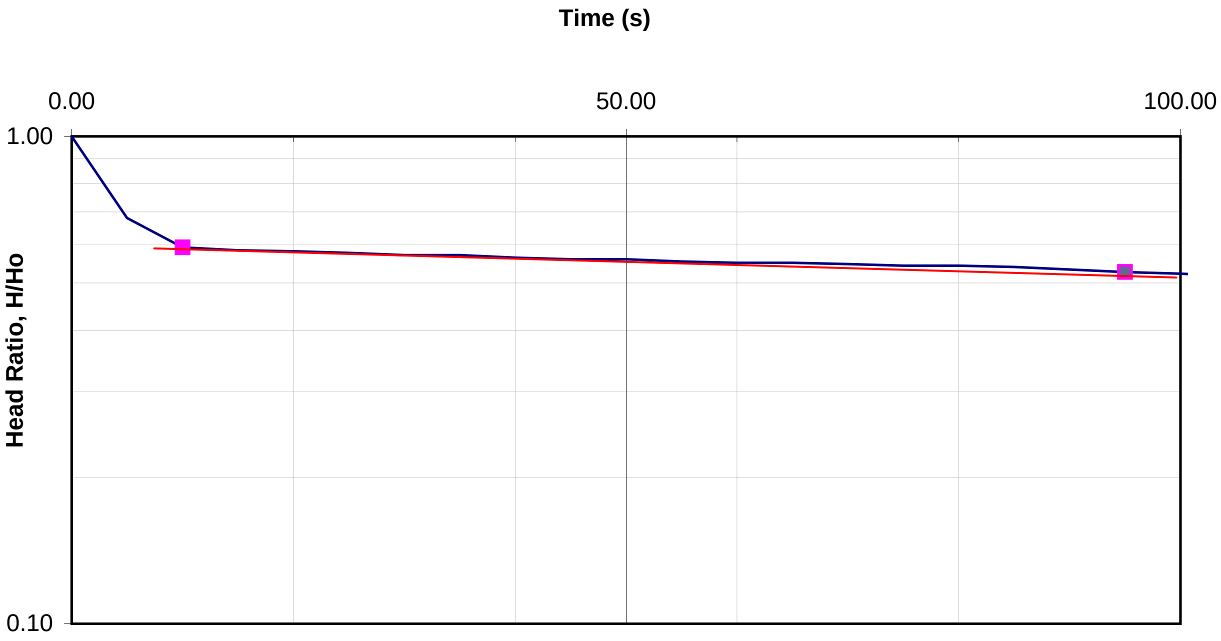
Test Date:		8-Dec-16		
Piezometer/Well No.:		BH/MW 3		
Ground level:		256.30	m	
Screen top level:		251.70	m	
Screen bottom level:		248.70	BH/MW	
Test El. (at midpoint of screen):		250.20	m	
Test depth (at midpoint of screen):		6.1	m	
Screen length	L=	3.0	m	
Diameter of undisturbed portion c	2R=	0.22	m	
Standpipe diameter	2r=	0.05	m	
Initial unbalanced head	Ho=	-1.05	m	
Initial water depth		5.24	m	
Aquifer material:		**Silty Fine Sand and Sandy Silt**		

Shape factor F= 2 x 3.14 x L / ln(L/R) = 5.701815 m

Permeability K= 3.14 x r2 / F x (t2 - t1) x ln (H1/H2) (Bouwer and Rice Method)

ln (H1/H2) / (t2 - t1) = 0.001364389

K= **4.7E-05** cm/s
4.7E-07 m/s



Falling Head Test (Slug Test)

Test Date:		8-Dec-16	
Piezometer/Well No.:		BH/MW 5	
Ground level:		251.50	m
Screen top level:		246.90	m
Screen bottom level:		243.90	m
Test El. (at midpoint of screen):		245.40	m
Test depth (at midpoint of screen):		6.1	m
Screen length	L=	3.0	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.609	m
Initial water depth		1.51	m
Aquifer material:		**Silty Sand Till**	

Shape factor

$$F= \frac{2 \times 3.14 \times L}{\ln(L/R)} = 5.701815 \text{ m}$$

Permeability

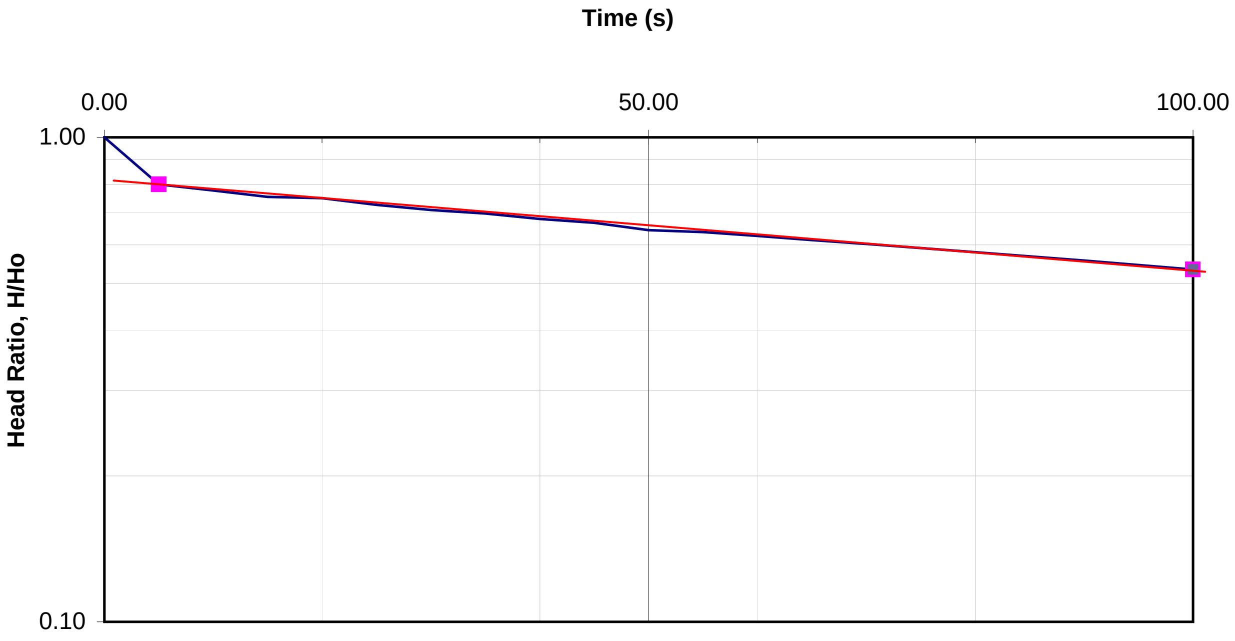
$$K= \frac{3.14 \times r2}{F \times (t2 - t1)} \times \ln (H1/H2)$$

(Bouwer and Rice Method)

$$\frac{\ln (H1/H2)}{(t2 - t1)} = 0.004257252$$

K= **1.5E-04** cm/s

1.5E-06 m/s



Falling Head Test (Slug Test)

Test Date:		8-Dec-16	
Piezometer/Well No.:		BH/MW 7	
Ground level:		253.80	m
Screen top level:		247.80	m
Screen bottom level:		244.80	m
Test El. (at midpoint of screen):		246.3	m
Test depth (at midpoint of screen):		7.5	m
Screen length	L=	3.0	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.698	m
Initial water depth		2.99	m
Aquifer material:		**Sandy Silt Till**	

Shape factor F= 2 x 3.14 x L / ln(L/R) = 5.701815 m

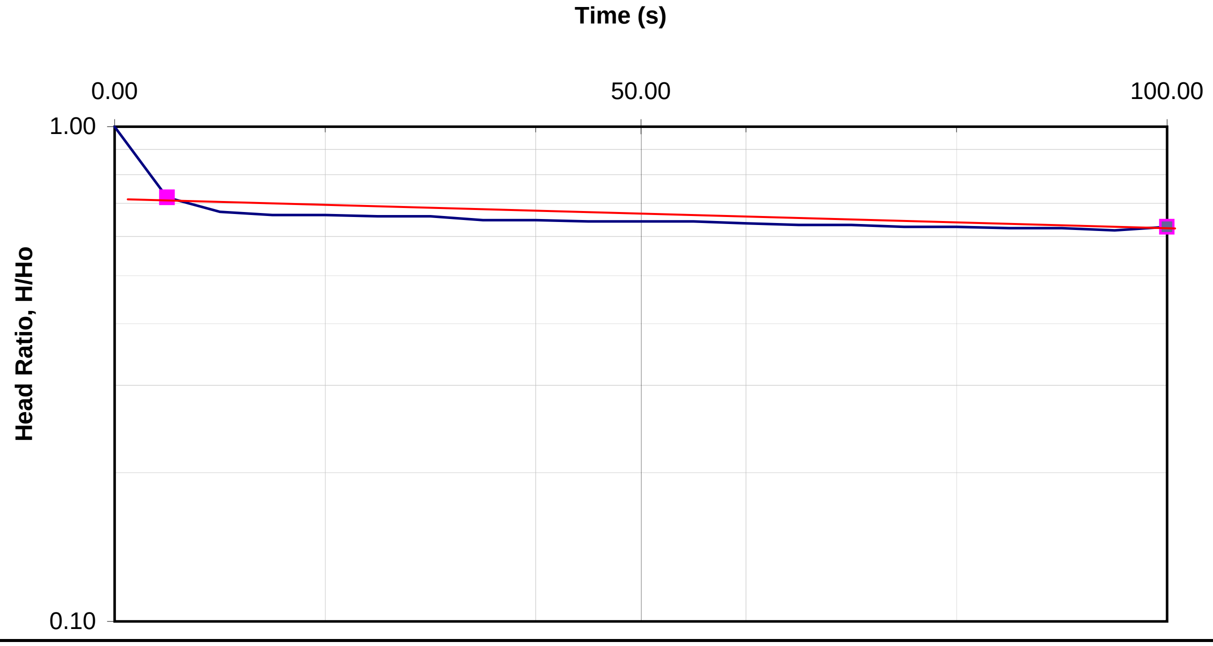
```
                    2 x 3.14 x L
Shape factor   F=   ---------------        =        5.701815 m
                      ln(L/R)

                    3.14 x r2
Permeability   K=   -------------    x ln (H1/H2)    (Bouwer and Rice Method)
                    F x ( t2 - t1 )

          ln (H1/H2)
          ------------        =        0.001435592
          ( t2 - t1 )
```

K= **4.9E-05** cm/s

4.9E-07 m/s



Falling Head Test (Slug Test)

Test Date:		8-Dec-16	
Piezometer/Well No.:		BH/MW 8	
Ground level:		252.20	m
Screen top level:		249.00	m
Screen bottom level:		246.00	m
Test El. (at midpoint of screen):		247.5	m
Test depth (at midpoint of screen):		4.7	m
Screen length	L=	3.0	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.324	m
Initial water depth		0.33	m
Aquifer material:		**Gravelly Sand and Sandy Silt Till**	

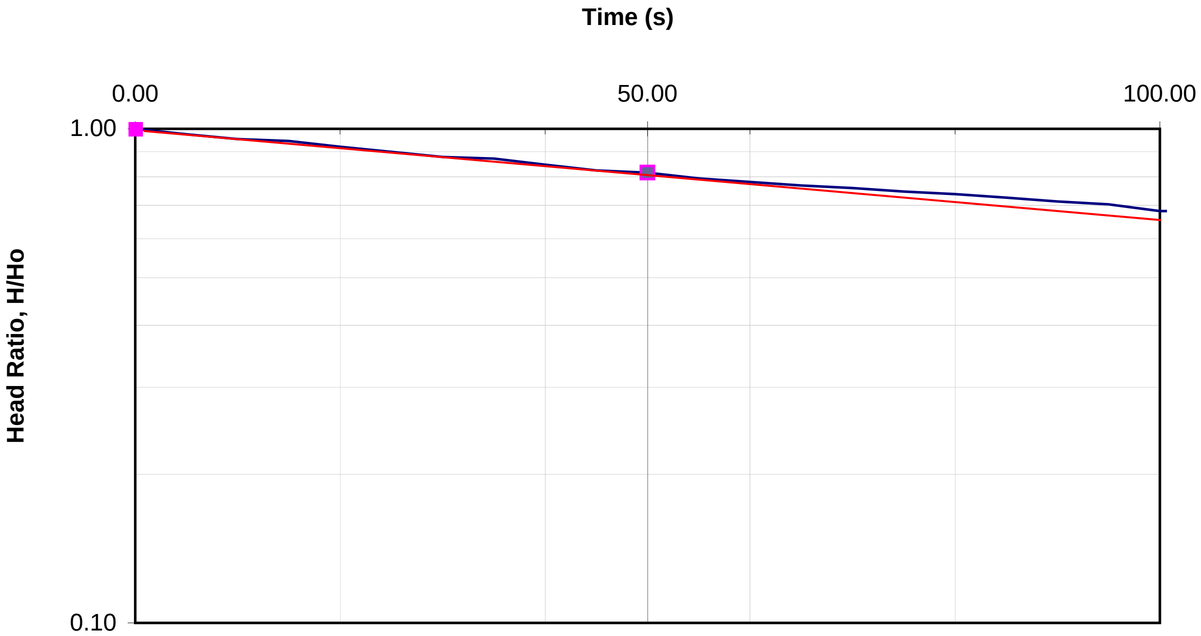
Shape factor $F = \frac{2 \text{ x } 3.14 \text{ x } L}{\ln(L/R)} = 5.701815$ m

Permeability $K = \frac{3.14 \text{ x } r2}{F \text{ x } (t2 - t1)} \text{ x } \ln(H1/H2)$ (Bouwer and Rice Method)

$$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.004095888$$

K= **1.4E-04** cm/s

1.4E-06 m/s



Falling Head Test (Slug Test)

Test Date: 8-Dec-16
Piezometer/Well No.: BH/MW 9
Ground level: 253.70 m
Screen top level: 247.70 m
Screen bottom level: 244.70 m
Test El. (at midpoint of screen): 246.2 m
Test depth (at midpoint of screen): 7.5 m
Screen length L= 3.0 m

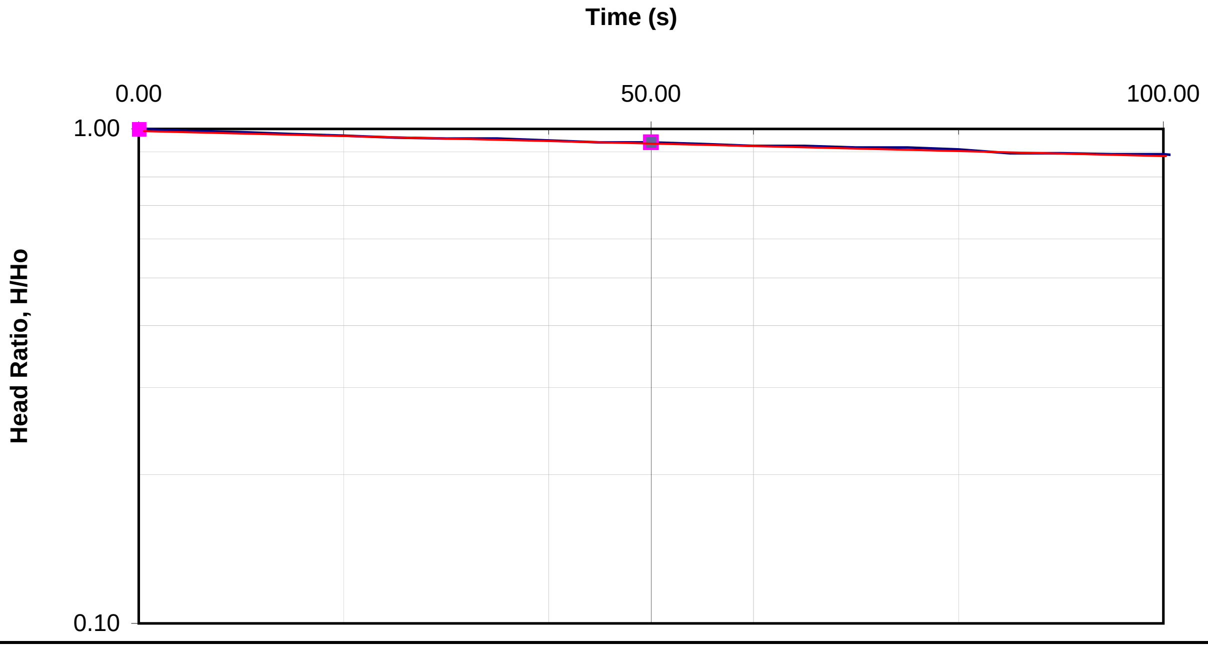
Diameter of undisturbed portion c 2R= 0.22 m
Standpipe diameter 2r= 0.05 m
Initial unbalanced head Ho= -0.458 m
Initial water depth 0.63 m
Aquifer material: **Silty Sand Till**

2 x 3.14 x L
Shape factor F= --------------- = 5.701815 m
ln(L/R)

3.14 x r2
Permeability K= ------------- x ln (H1/H2) (Bouwer and Rice Method)
F x (t2 - t1)

ln (H1/H2)
------------ = 0.00126168
(t2 - t1)

K= **4.3E-05** cm/s
4.3E-07 m/s



Falling Head Test (Slug Test)

Test Date:		8-Dec-16	
Piezometer/Well No.:		BH/MW 12D	
Ground level:		251.00	m
Screen top level:		246.70	m
Screen bottom level:		245.20	m
Test El. (at midpoint of screen):		245.95	m
Test depth (at midpoint of screen):		5.05	m
Screen length	L=	1.5	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.715	m
Initial water depth		1.44	m
Aquifer material:		**Silty Fine Sand**	

Shape factor

$$F= \frac{2 \times 3.14 \times L}{\ln(L/R)} = 3.607239 \text{ m}$$

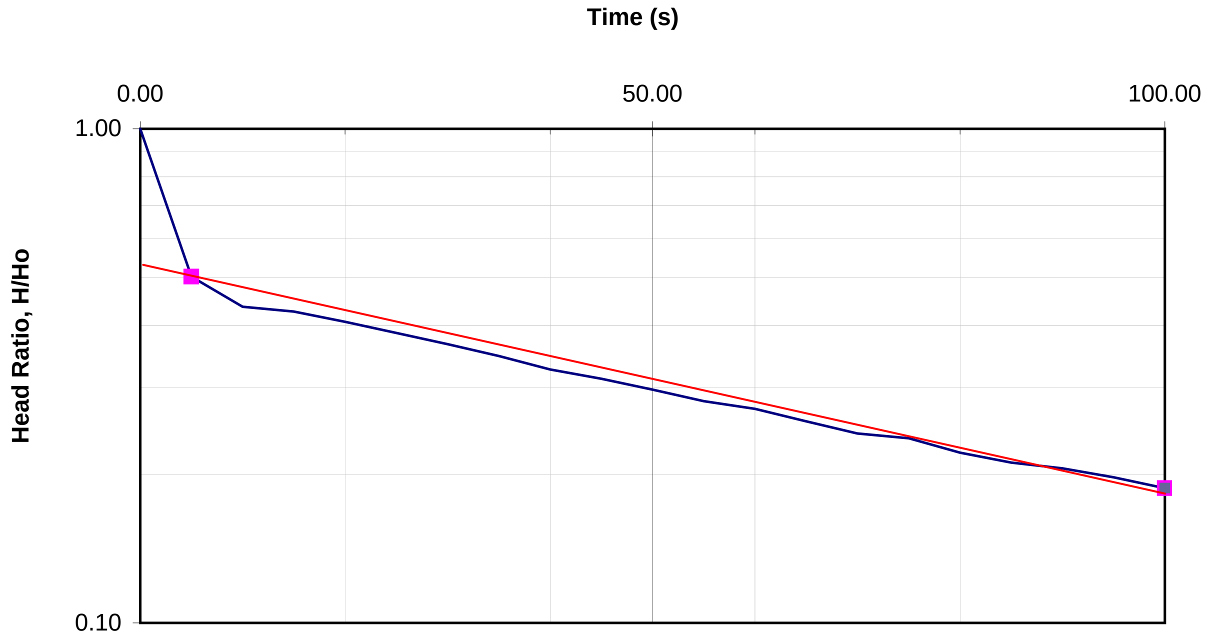
Permeability

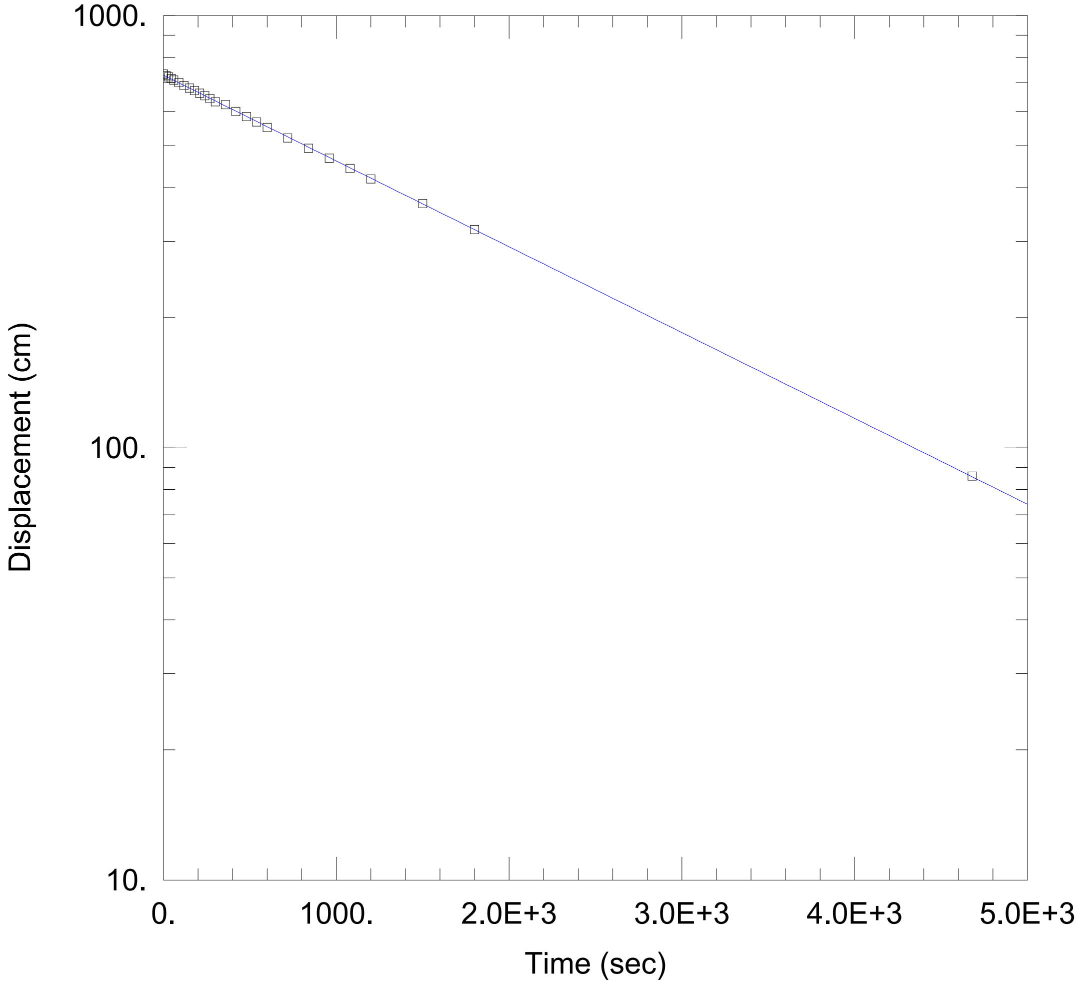
$$K= \frac{3.14 \times r2}{F \times (t2 - t1)} \times \ln (H1/H2)$$

(Bouwer and Rice Method)

$$\frac{\ln (H1/H2)}{(t2 - t1)} = 0.010373501$$

K= **5.6E-04** cm/s
5.6E-06 m/s





HYDRAULIC CONDUCTIVITY TEST AT MW1

PROJECT INFORMATION

Company: R.J Burnside & Associates Limi
Project: 300043693
Location: Barrie
Test Well: MW1
Test Date: June 1, 2020

AQUIFER DATA

Saturated Thickness: 1546. cm
Anisotropy Ratio (Kz/Kr): 0.1

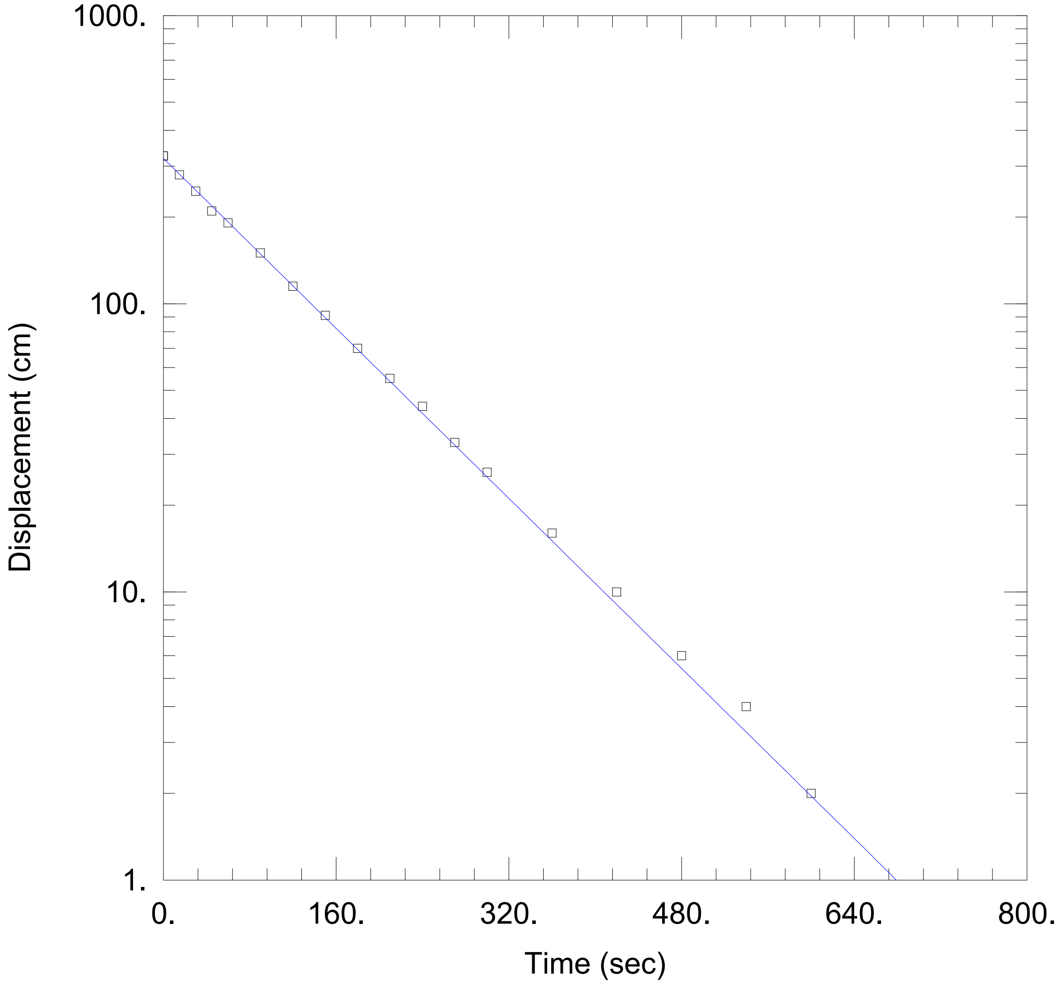
WELL DATA (MW1)

Initial Displacement: 733. cm
Total Well Penetration Depth: 1546. cm
Casing Radius: 2.54 cm
Static Water Column Height: 1546. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 4.693E-5 cm/sec
y0 = 727.8 cm



HYDRAULIC CONDUCTIVITY TEST AT MW12D

PROJECT INFORMATION

Company: R.J Burnside & Associates Limi
Project: 300043693
Location: Barrie
Test Well: MW12d
Test Date: June 1, 2020

AQUIFER DATA

Saturated Thickness: 494. cm
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW12d)

Initial Displacement: 326. cm
Total Well Penetration Depth: 494. cm
Casing Radius: 2.54 cm
Static Water Column Height: 494. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 0.0008719 cm/sec
y0 = 319.5 cm

Appendix D

Groundwater Elevation Data

Table D-1
Groundwater Elevations

	Well Depth (mbgl)	Ground Surface Elevation (masl)	11-Apr-2019		25-Jun-2019		31-Jul-2019		26-Aug-2019		26-Sep-2019	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
DS-MW1	**16.94**	**256.40**	1.85	254.55	1.80	254.60	1.80	254.60	1.89	254.51	2.02	254.38
DS-MW3	**6.92**	**256.30**	4.86	251.44	4.64	251.66	4.91	251.39	5.11	251.19	5.26	251.04
DS-MW5	**7.45**	**251.50**	0.91	250.59	0.66	250.84	1.31	250.19	1.76	249.74	2.13	249.37
DS-MW7	**8.96**	**253.80**	0.29	253.51	1.86	251.94	2.50	251.30	2.85	250.95	3.20	250.60
DS-MW8	**6.19**	**252.20**	0.22	251.98	0.07	252.13	0.73	251.47	1.05	251.15	1.18	251.03
DS-MW9	**8.70**	**253.70**	0.07	253.63	0.22	253.48	0.96	252.74	1.25	252.45	1.41	252.29
DS-MW12s	**4.00**	**251.00**	0.99	250.01	0.89	250.11	1.43	249.57	1.71	249.29	1.88	249.12
DS-MW12d	**5.83**	**251.00**	1.01	249.99	0.86	250.14	1.42	249.58	1.67	249.33	1.84	249.16
DS-MW13	**7.43**	**261.18**	-	-	-	-	-	-	-	-	-	-
DS-MW14	**6.53**	**253.62**	-	-	-	-	-	-	-	-	-	-
DS-MW15	**3.92**	**256.66**	-	-	-	-	-	-	-	-	-	-
DS-MW16	**4.49**	**257.73**	-	-	-	-	-	-	-	-	-	-
DS-MW17	**5.93**	**261.44**	-	-	-	-	-	-	-	-	-	-
DS-PZ1s	**0.53**	**249.26**	-	-	0.17	249.09	0.35	248.91	0.40	248.86	0.20	249.06
DS-PZ1d	**0.97**	**249.26**	-	-	0.57	248.69	0.30	248.96	0.22	249.04	0.16	249.10
DS-PZ2s	**1.24**	**246.64**	-	-	0.54	246.10	0.19	246.45	0.06	246.58	-0.01	246.65
DS-PZ2d	**1.81**	**246.64**	-	-	1.02	245.62	0.47	246.17	0.25	246.39	0.04	246.60
DS-PZ3s	**0.89**	**256.18**	-	-	0.30	255.88	0.61	255.57	0.80	255.38	0.83	255.35
DS-PZ3d	**1.38**	**256.18**	-	-	0.33	255.85	0.69	255.49	0.84	255.34	0.87	255.31

Notes:

"-" Denotes data unavailable

mbgl - Metres below ground level

masl - Metres above sea level

Table D-1
Groundwater Elevations

	Well Depth (mbgl)	Ground Surface Elevation (masl)	8-Nov-2019		21-Nov-2019		16-Dec-2019		23-Jan-2020		2-Mar-2020	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
DS-MW1	**16.94**	**256.40**	2.07	254.33	2.08	254.32	2.12	254.28	1.78	254.62	1.76	254.64
DS-MW3	**6.92**	**256.30**	5.19	251.11	5.15	251.15	5.01	251.29	4.58	251.72	4.74	251.56
DS-MW5	**7.45**	**251.50**	1.32	250.18	1.44	250.06	1.00	250.50	0.48	251.02	0.84	250.66
DS-MW7	**8.96**	**253.80**	2.90	250.90	2.83	250.97	2.25	251.55	Frozen	Frozen	2.09	251.71
DS-MW8	**6.19**	**252.20**	0.52	251.68	0.33	251.87	0.31	251.89	Frozen	Frozen	0.34	251.86
DS-MW9	**8.70**	**253.70**	0.50	253.20	0.35	253.35	0.25	253.45	0.21	253.49	0.29	253.41
DS-MW12s	**4.00**	**251.00**	1.46	249.54	1.40	249.60	1.24	249.76	0.80	250.20	1.07	249.93
DS-MW12d	**5.83**	**251.00**	1.47	249.53	1.42	249.58	1.22	249.78	0.72	250.28	0.97	250.03
DS-MW13	**7.43**	**261.18**	-	-	5.59	255.59	5.55	255.63	5.24	255.94	5.25	255.93
DS-MW14	**6.53**	**253.62**	-	-	3.15	250.47	3.27	250.35	2.63	250.99	2.98	250.64
DS-MW15	**3.92**	**256.66**	-	-	0.69	255.97	0.51	256.15	Frozen	Frozen	0.48	256.18
DS-MW16	**4.49**	**257.73**	-	-	3.12	254.61	2.91	254.82	2.29	255.44	2.27	255.46
DS-MW17	**5.93**	**261.44**	-	-	4.12	257.32	3.99	257.45	3.49	257.95	3.59	257.85
DS-PZ1s	**0.53**	**249.26**	0.08	249.18	0.05	249.21	0.06	249.20	Frozen	Frozen	0.08	249.18
DS-PZ1d	**0.97**	**249.26**	0.09	249.17	0.06	249.20	0.04	249.22	Frozen	Frozen	0.06	249.20
DS-PZ2s	**1.24**	**246.64**	-0.13	246.77	-0.13	246.77	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen
DS-PZ2d	**1.81**	**246.64**	-0.06	246.70	-0.06	246.70	Frozen	Frozen	Frozen	Frozen	-0.01	246.65
DS-PZ3s	**0.89**	**256.18**	0.78	255.40	0.53	255.65	0.43	255.75	0.31	255.87	0.40	255.78
DS-PZ3d	**1.38**	**256.18**	0.82	255.36	0.56	255.62	0.46	255.72	0.34	255.84	0.45	255.73

Notes:

"-" Denotes data unavailable

mbgl - Metres below ground level

masl - Metres above sea level

Table D-1
Groundwater Elevations

	Well Depth (mbgl)	Ground Surface Elevation (masl)	26-Mar-2020		21-Apr-2020		1-Jun-2020		27-Oct-2020		27-Nov-2020	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
DS-MW1	**16.94**	**256.40**	1.44	254.96	1.49	254.91	1.49	254.91	1.56	254.84	1.40	255.00
DS-MW3	**6.92**	**256.30**	4.37	251.93	4.44	251.86	4.57	251.73	4.85	251.45	4.84	251.46
DS-MW5	**7.45**	**251.50**	0.35	251.15	0.65	250.85	0.66	250.84	1.05	250.45	0.82	250.68
DS-MW7	**8.96**	**253.80**	1.41	252.39	1.74	252.06	1.93	251.87	2.54	251.26	2.40	251.40
DS-MW8	**6.19**	**252.20**	-0.02	252.22	0.18	252.02	0.12	252.08	0.26	251.94	0.06	252.14
DS-MW9	**8.70**	**253.70**	-0.05	253.75	0.15	253.55	0.14	253.56	0.28	253.42	0.14	253.56
DS-MW12s	**4.00**	**251.00**	0.69	250.31	0.93	250.07	0.98	250.02	1.25	249.75	1.00	250.00
DS-MW12d	**5.83**	**251.00**	0.60	250.40	0.81	250.19	0.90	250.10	1.26	249.74	1.11	249.89
DS-MW13	**7.43**	**261.18**	4.99	256.19	4.92	256.26	5.00	256.18	5.23	255.95	5.28	255.90
DS-MW14	**6.53**	**253.62**	2.32	251.30	2.54	251.08	2.68	250.94	3.29	250.33	3.20	250.42
DS-MW15	**3.92**	**256.66**	-0.01	256.67	0.22	256.44	0.29	256.37	0.42	256.24	0.34	256.32
DS-MW16	**4.49**	**257.73**	1.71	256.02	1.68	256.05	1.68	256.05	2.57	255.16	2.49	255.24
DS-MW17	**5.93**	**261.44**	3.09	258.35	3.07	258.37	3.27	258.17	3.63	257.81	3.70	257.74
DS-PZ1s	**0.53**	**249.26**	0.07	249.19	0.09	249.17	0.02	249.24	0.07	249.19	0.08	249.18
DS-PZ1d	**0.97**	**249.26**	0.05	249.21	-0.04	249.30	-0.02	249.28	-0.02	249.28	0.11	249.15
DS-PZ2s	**1.24**	**246.64**	-0.08	246.72	-0.04	246.68	-0.06	246.70	-0.05	246.69	-0.05	246.69
DS-PZ2d	**1.81**	**246.64**	-0.06	246.70	-0.09	246.73	-0.25	246.89	-0.41	247.05	-0.01	246.65
DS-PZ3s	**0.89**	**256.18**	0.20	255.98	0.34	255.84	0.31	255.87	0.37	255.81	0.33	255.85
DS-PZ3d	**1.38**	**256.18**	0.22	255.96	0.29	255.89	0.35	255.83	0.40	255.78	0.39	255.79

Notes:

"-" Denotes data unavailable

mbgl - Metres below ground level

masl - Metres above sea level

Table D-1
Groundwater Elevations

	Well Depth (mbgl)	Ground Surface Elevation (masl)	17-Dec-2020		1-Apr-2021		24-Aug-2021		8-Dec-2021		22-Mar-2022	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
DS-MW1	**16.94**	**256.40**	1.44	254.96	1.53	254.87	0.93	255.47	1.06	255.34	1.19	255.21
DS-MW3	**6.92**	**256.30**	4.65	251.65	4.57	251.73	4.51	251.79	4.45	251.85	4.30	252.00
DS-MW5	**7.45**	**251.50**	0.67	250.83	0.64	250.86	1.11	250.39	0.60	250.90	1.04	250.46
DS-MW7	**8.96**	**253.80**	1.73	252.07	1.72	252.08	2.21	251.59	1.70	252.10	2.08	251.72
DS-MW8	**6.19**	**252.20**	0.05	252.15	0.11	252.09	0.48	251.72	-0.02	252.22	0.21	251.99
DS-MW9	**8.70**	**253.70**	0.18	253.52	0.19	253.51	0.80	252.90	0.15	253.55	0.12	253.58
DS-MW12s	**4.00**	**251.00**	0.97	250.03	0.94	250.06	1.31	249.69	0.90	250.10	1.00	250.00
DS-MW12d	**5.83**	**251.00**	0.91	250.09	0.86	250.14	1.19	249.81	0.81	250.19	0.91	250.09
DS-MW13	**7.43**	**261.18**	5.18	256.00	5.02	256.16	-	-	-	-	-	-
DS-MW14	**6.53**	**253.62**	2.86	250.76	2.77	250.85	-	-	-	-	-	-
DS-MW15	**3.92**	**256.66**	0.20	256.46	0.23	256.43	-	-	-	-	-	-
DS-MW16	**4.49**	**257.73**	2.17	255.56	1.86	255.87	-	-	-	-	-	-
DS-MW17	**5.93**	**261.44**	3.49	257.95	3.29	258.15	-	-	-	-	-	-
DS-PZ1s	**0.53**	**249.26**	Frozen	Frozen	-0.34	249.60	0.20	249.06	Frozen	Frozen	0.05	249.21
DS-PZ1d	**0.97**	**249.26**	Frozen	Frozen	0.51	248.75	0.04	249.22	0.47	248.79	0.15	249.11
DS-PZ2s	**1.24**	**246.64**	Frozen	Frozen	-0.07	246.71	0.00	246.64	Frozen	Frozen	-0.07	246.71
DS-PZ2d	**1.81**	**246.64**	Frozen	Frozen	-0.11	246.75	-0.36	247.00	-0.44	247.08	Frozen	Frozen
DS-PZ3s	**0.89**	**256.18**	0.29	255.89	0.28	255.90	-	-	-	-	-	-
DS-PZ3d	**1.38**	**256.18**	0.39	255.79	0.38	255.80	-	-	-	-	-	-

Notes:

"-" Denotes data unavailable

mbgl - Metres below ground level

masl - Metres above sea level

Table D-1
Groundwater Elevations

	Well Depth (mbgl)	Ground Surface Elevation (masl)	8-Jun-2022		15-Sep-2022		20-Dec-2022		6-Feb-2023	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
DS-MW1	**16.94**	**256.40**	1.48	254.92	1.68	254.72	1.32	255.08	0.95	255.45
DS-MW3	**6.92**	**256.30**	4.63	251.67	5.10	251.20	5.07	251.23	4.76	251.54
DS-MW5	**7.45**	**251.50**	1.08	250.42	2.26	249.24	1.86	249.64	1.29	250.21
DS-MW7	**8.96**	**253.80**	2.35	251.45	3.25	250.55	2.96	250.84	2.36	251.44
DS-MW8	**6.19**	**252.20**	0.12	252.08	1.16	251.04	0.60	251.60	0.40	251.80
DS-MW9	**8.70**	**253.70**	0.35	253.35	1.46	252.24	0.68	253.02	0.54	253.16
DS-MW12s	**4.00**	**251.00**	1.09	249.91	2.01	248.99	1.72	249.28	1.39	249.61
DS-MW12d	**5.83**	**251.00**	1.03	249.97	1.88	249.12	1.61	249.39	1.26	249.74
DS-MW13	**7.43**	**261.18**	-	-	-	-	-	-	5.79	255.39
DS-MW14	**6.53**	**253.62**	-	-	-	-	-	-	3.24	250.38
DS-MW15	**3.92**	**256.66**	-	-	-	-	-	-	0.65	256.01
DS-MW16	**4.49**	**257.73**	-	-	-	-	-	-	2.83	254.90
DS-MW17	**5.93**	**261.44**	-	-	-	-	-	-	4.08	257.36
DS-PZ1s	**0.53**	**249.26**	0.20	249.06	0.25	249.01	0.10	249.16	0.09	249.17
DS-PZ1d	**0.97**	**249.26**	0.14	249.12	0.27	248.99	0.15	249.11	0.15	249.11
DS-PZ2s	**1.24**	**246.64**	-0.03	246.67	-0.03	246.67	-0.08	246.72	Frozen	Frozen
DS-PZ2d	**1.81**	**246.64**	-0.34	246.98	-0.34	246.98	Frozen	Frozen	Frozen	Frozen
DS-PZ3s	**0.89**	**256.18**	-	-	-	-	-	-	0.54	255.64
DS-PZ3d	**1.38**	**256.18**	-	-	-	-	-	-	0.51	255.67

Notes:

"-" Denotes data unavailable

mbgl - Metres below ground level

masl - Metres above sea level

Table D-1
Groundwater Elevations

	Well Depth (mbgl)	Ground Surface Elevation (masl)	14-Mar-2023		13-Jun-2023		14-Sep-2023		24-Nov-2023	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
DS-MW1	**16.94**	**256.40**	0.72	255.68	0.50	255.90	0.98	255.42	1.28	255.12
DS-MW3	**6.92**	**256.30**	4.54	251.76	4.27	252.03	4.41	251.89	4.55	251.75
DS-MW5	**7.45**	**251.50**	0.93	250.57	0.30	251.20	1.30	250.20	1.34	250.16
DS-MW7	**8.96**	**253.80**	2.12	251.68	1.61	252.19	2.42	251.38	2.57	251.23
DS-MW8	**6.19**	**252.20**	Frozen	Frozen	-0.19	252.39	0.59	251.61	0.30	251.90
DS-MW9	**8.70**	**253.70**	0.41	253.29	0.14	253.56	0.93	252.77	0.43	253.27
DS-MW12s	**4.00**	**251.00**	1.19	249.81	0.72	250.28	1.44	249.56	1.32	249.68
DS-MW12d	**5.83**	**251.00**	1.05	249.95	0.62	250.38	1.29	249.71	1.31	249.69
DS-MW13	**7.43**	**261.18**	5.48	255.70	5.08	256.10	5.03	256.15	5.30	255.88
DS-MW14	**6.53**	**253.62**	3.02	250.60	2.92	250.70	3.32	250.30	3.30	250.32
DS-MW15	**3.92**	**256.66**	0.58	256.08	0.46	256.20	0.51	256.15	0.47	256.19
DS-MW16	**4.49**	**257.73**	2.57	255.16	2.13	255.60	2.57	255.16	2.80	254.93
DS-MW17	**5.93**	**261.44**	3.94	257.50	3.51	257.93	3.58	257.86	3.82	257.62
DS-PZ1s	**0.53**	**249.26**	Frozen	Frozen	0.08	249.18	0.06	249.20	0.02	249.24
DS-PZ1d	**0.97**	**249.26**	Frozen	Frozen	-0.02	249.28	0.10	249.16	0.14	249.12
DS-PZ2s	**1.24**	**246.64**	Frozen	Frozen	-0.06	246.70	-0.02	246.66	-0.12	246.76
DS-PZ2d	**1.81**	**246.64**	Frozen	Frozen	-0.42	247.06	-0.37	247.01	Frozen	Frozen
DS-PZ3s	**0.89**	**256.18**	0.47	255.71	0.37	255.81	0.49	255.69	0.40	255.78
DS-PZ3d	**1.38**	**256.18**	0.51	255.67	0.40	255.78	0.36	255.82	0.36	255.82

Notes:

"-" Denotes data unavailable

mbgl - Metres below ground level

masl - Metres above sea level

Table D-1
Groundwater Elevations

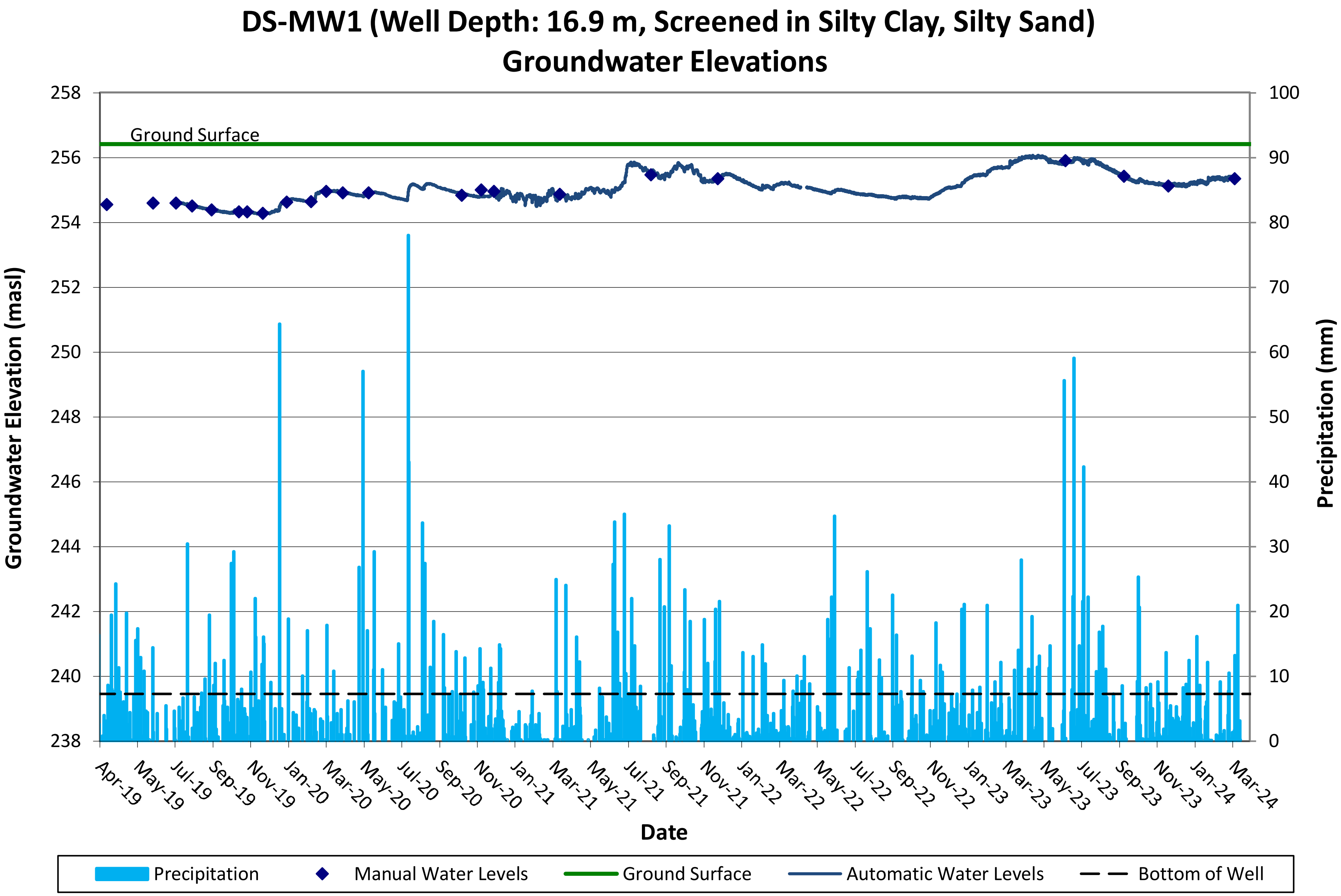
	Well Depth (mbgl)	Ground Surface Elevation (masl)	8-Mar-2024	
			Water Level (mbgs)	Water Elevation (masl)
DS-MW1	**16.94**	**256.40**	1.06	255.34
DS-MW3	**6.92**	**256.30**	4.29	252.01
DS-MW5	**7.45**	**251.50**	0.73	250.77
DS-MW7	**8.96**	**253.80**	1.74	252.06
DS-MW8	**6.19**	**252.20**	0.07	252.13
DS-MW9	**8.70**	**253.70**	0.22	253.48
DS-MW12s	**4.00**	**251.00**	0.98	250.02
DS-MW12d	**5.83**	**251.00**	0.81	250.19
DS-MW13	**7.43**	**261.18**	5.04	256.14
DS-MW14	**6.53**	**253.62**	2.68	250.94
DS-MW15	**3.92**	**256.66**	0.21	256.45
DS-MW16	**4.49**	**257.73**	2.07	255.66
DS-MW17	**5.93**	**261.44**	3.38	258.06
DS-PZ1s	**0.53**	**249.26**	-0.02	249.28
DS-PZ1d	**0.97**	**249.26**	0.11	249.15
DS-PZ2s	**1.24**	**246.64**	-0.11	246.75
DS-PZ2d	**1.81**	**246.64**	-0.37	247.01
DS-PZ3s	**0.89**	**256.18**	0.29	255.89
DS-PZ3d	**1.38**	**256.18**	0.33	255.85

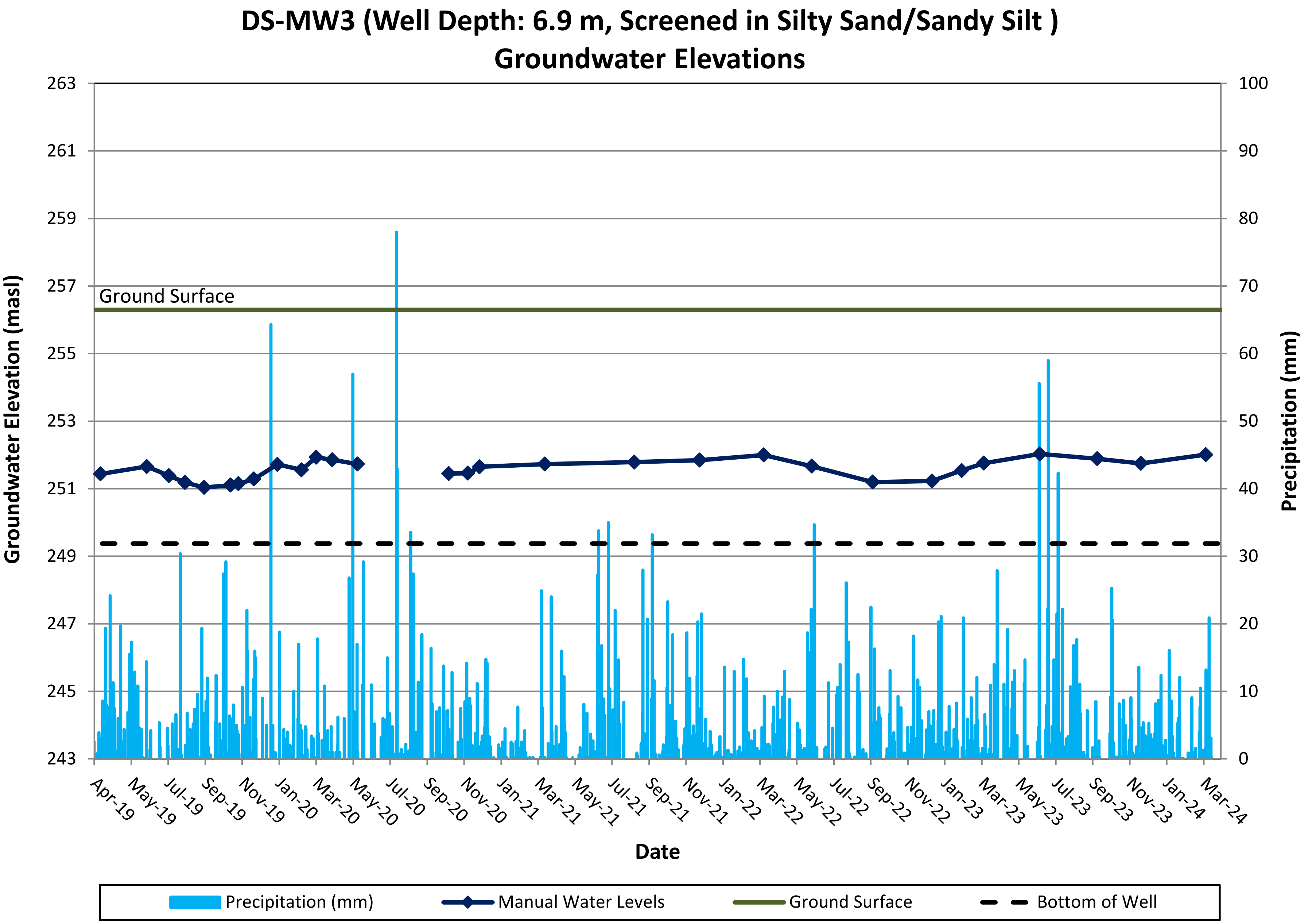
Notes:

"-" Denotes data unavailable

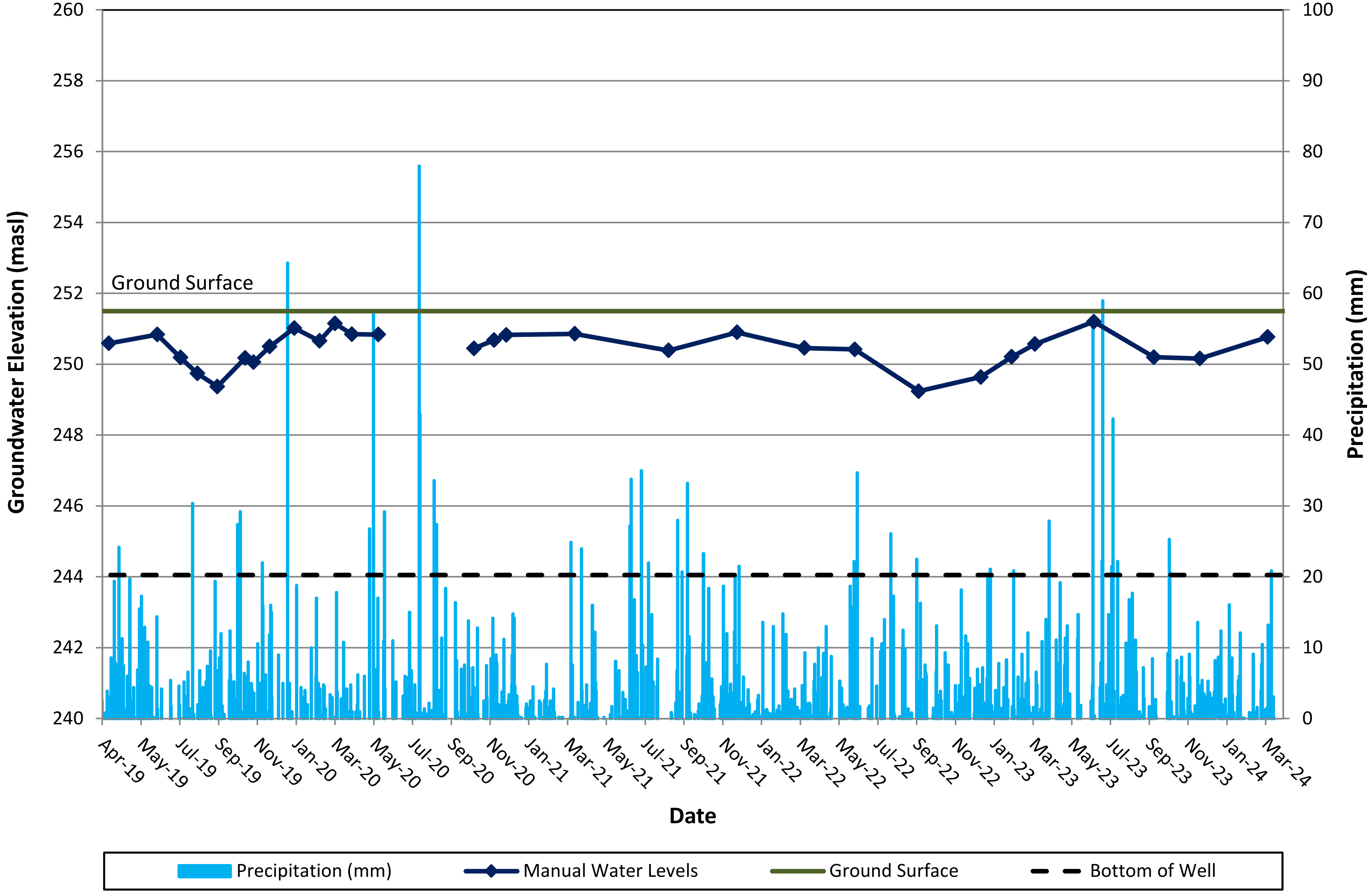
mbgl - Metres below ground level

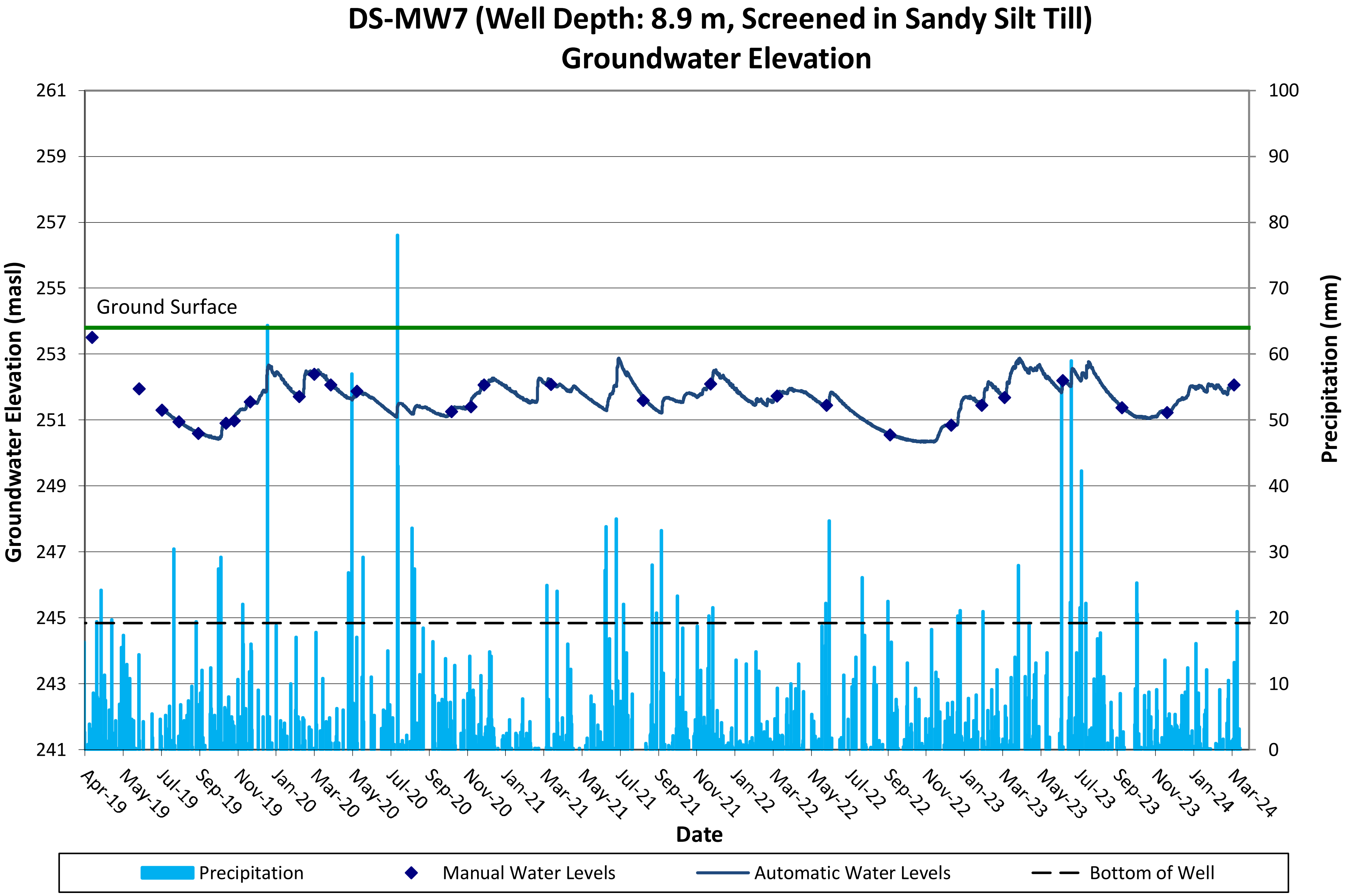
masl - Metres above sea level


DS-MW1 (Well Depth: 16.9 m, Screened in Silty Clay, Silty Sand)
Groundwater Elevations
Ground Surface
Groundwater Elevation (masl)
Precipitation (mm)
258
256
254
252
250
248
246
244
242
240
238
100
90
80
70
60
50
40
30
20
10
0
Apr-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
Mar-24
Date
Precipitation
Manual Water Levels
Ground Surface
Automatic Water Levels
Bottom of Well

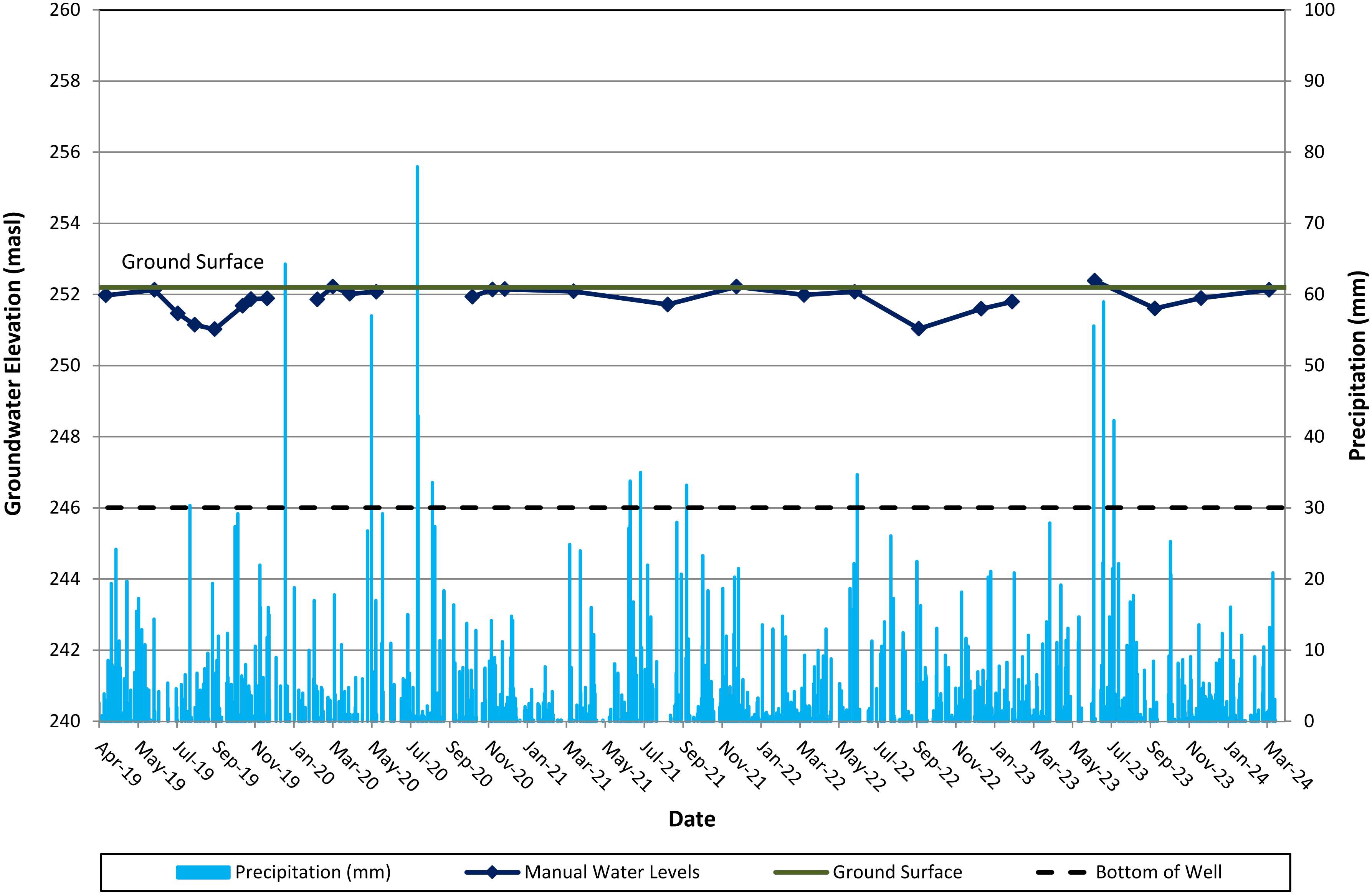

DS-MW3 (Well Depth: 6.9 m, Screened in Silty Sand/Sandy Silt)
Groundwater Elevations
Groundwater Elevation (masl)
263
261
259
257
255
253
251
249
247
245
243
Precipitation (mm)
100
90
80
70
60
50
40
30
20
10
0
Ground Surface
Apr-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
Mar-24
Date
Precipitation (mm)
Manual Water Levels
Ground Surface
Bottom of Well

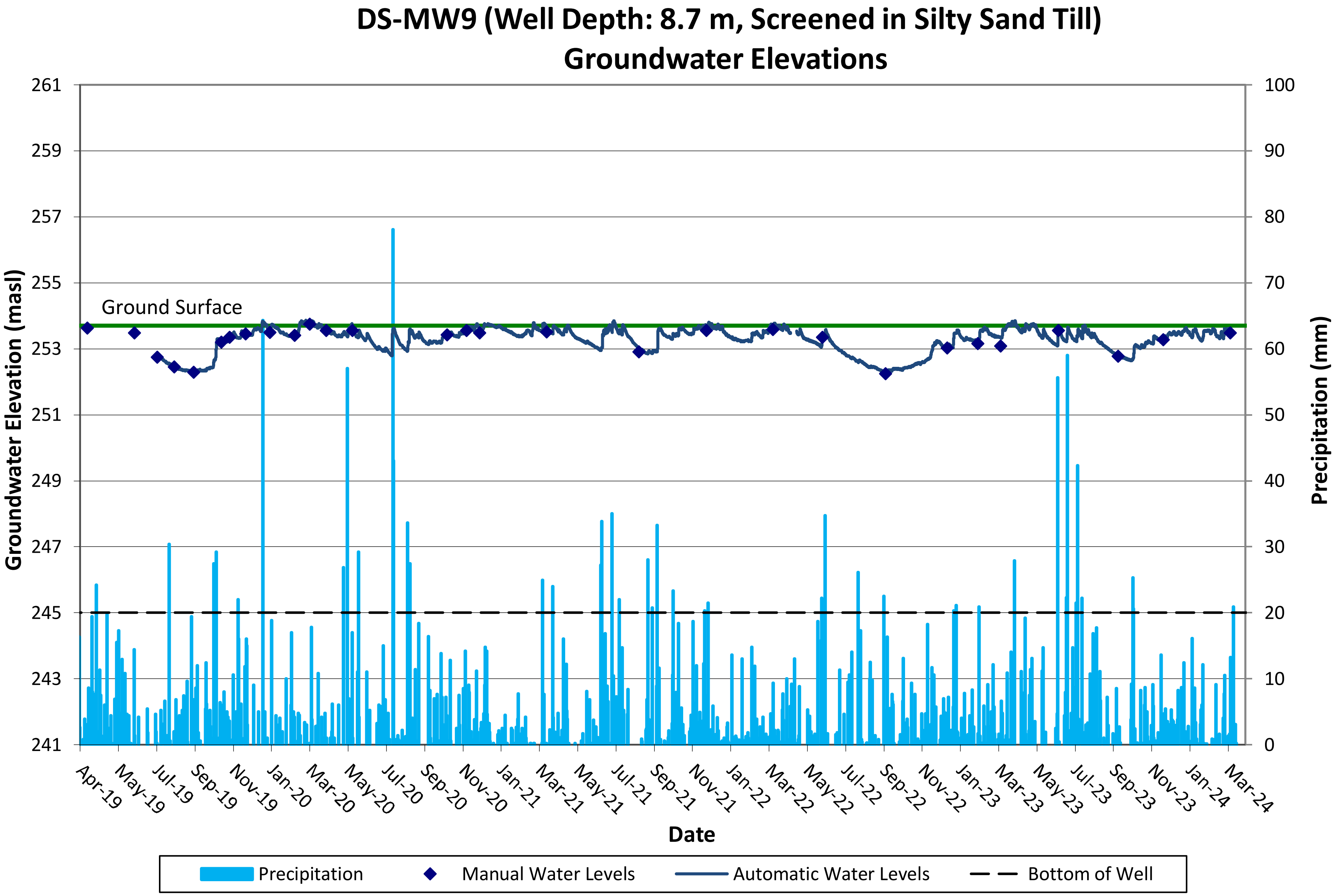
DS-MW5 (Well Depth: 7.5 m, Screened in Silty Sand)
Groundwater Elevations



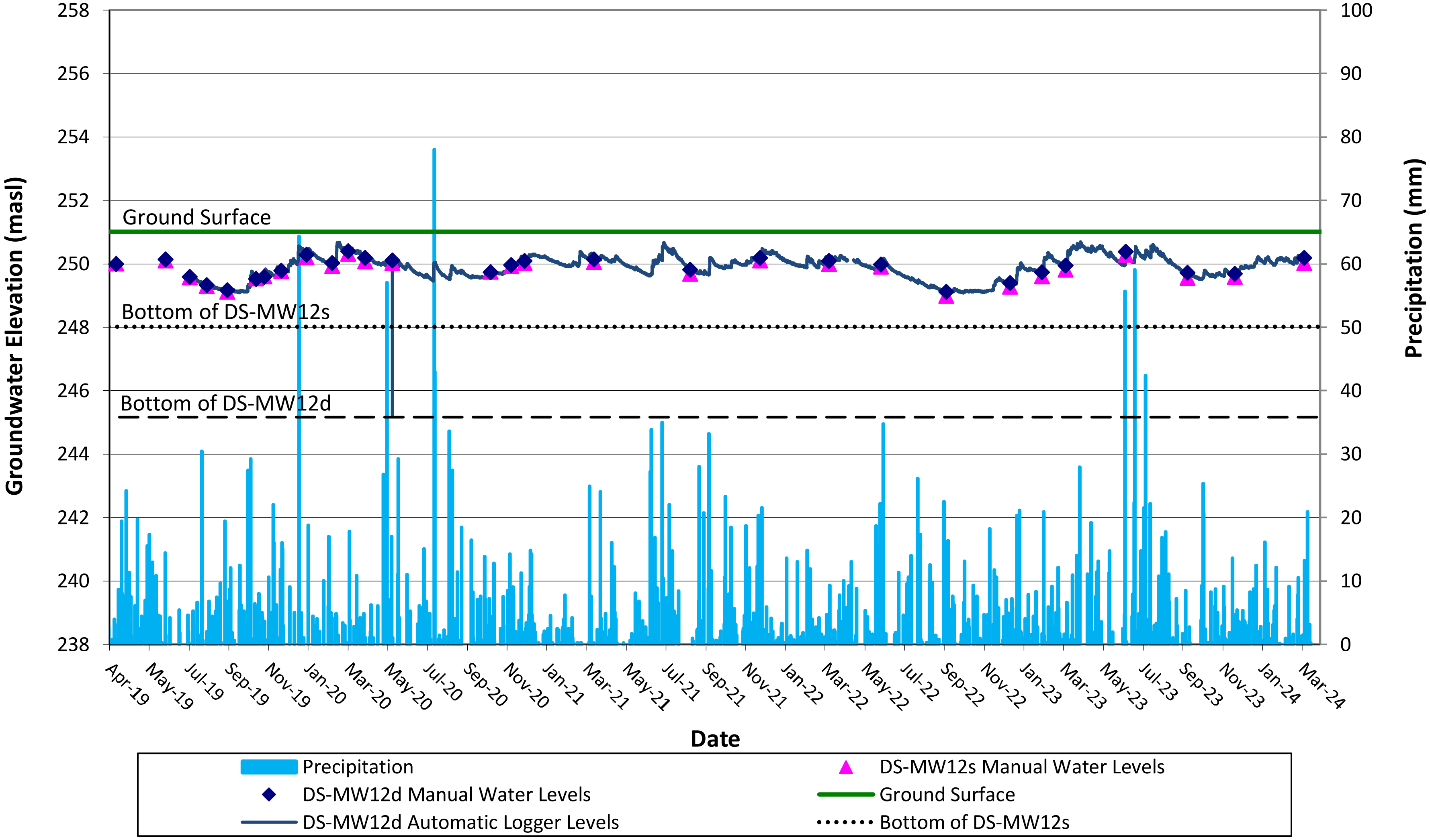

DS-MW7 (Well Depth: 8.9 m, Screened in Sandy Silt Till)
Groundwater Elevation
Groundwater Elevation (masl)
261
259
257
255
253
251
249
247
245
243
241
Precipitation (mm)
100
90
80
70
60
50
40
30
20
10
0
Ground Surface
Apr-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
Mar-24
Date
Precipitation
Manual Water Levels
Automatic Water Levels
Bottom of Well

DS-MW8 (Well Depth: 6.2 m, Screened in Gravelly Sand, Sandy Silt Till) Groundwater Elevations

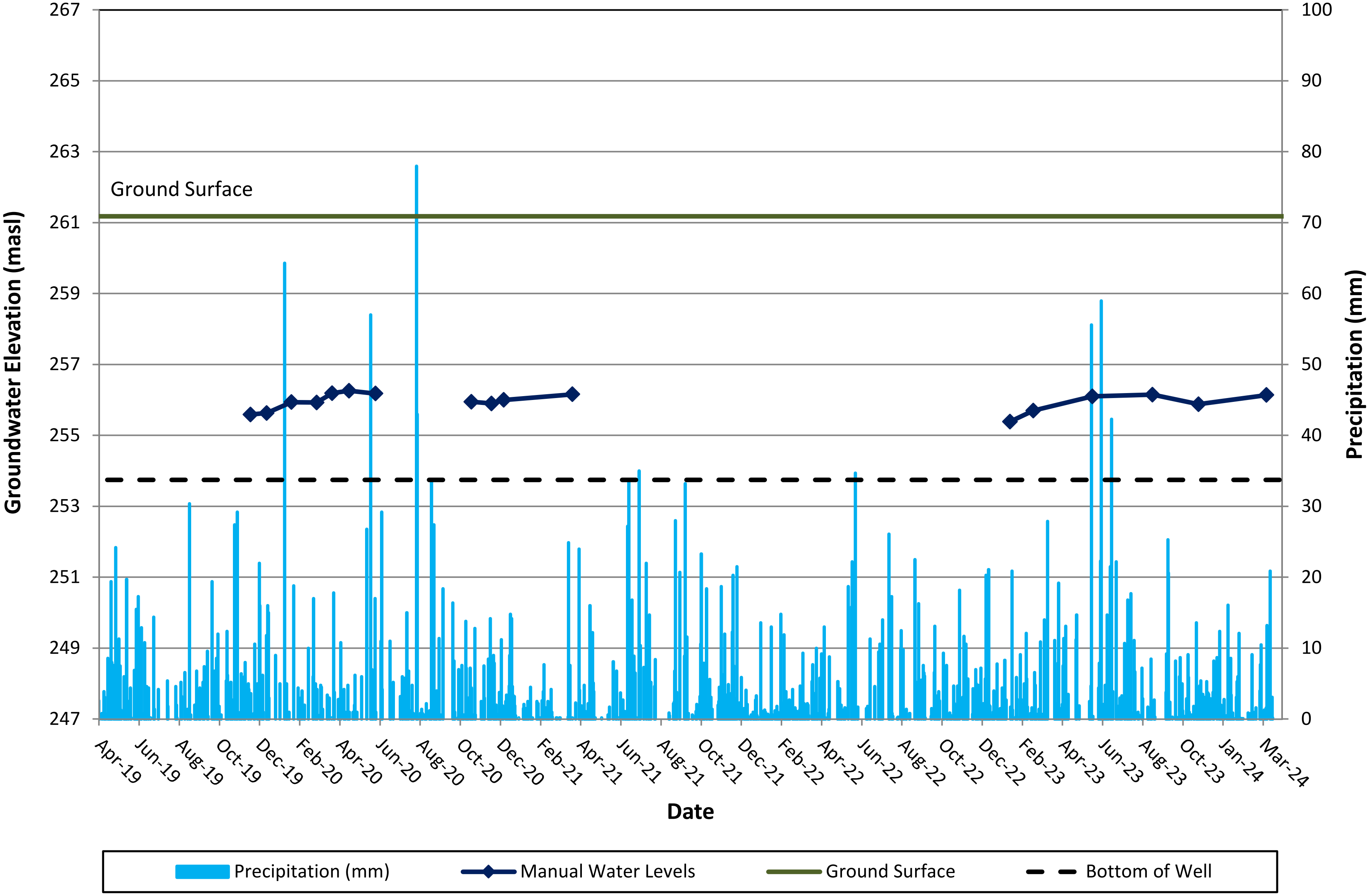


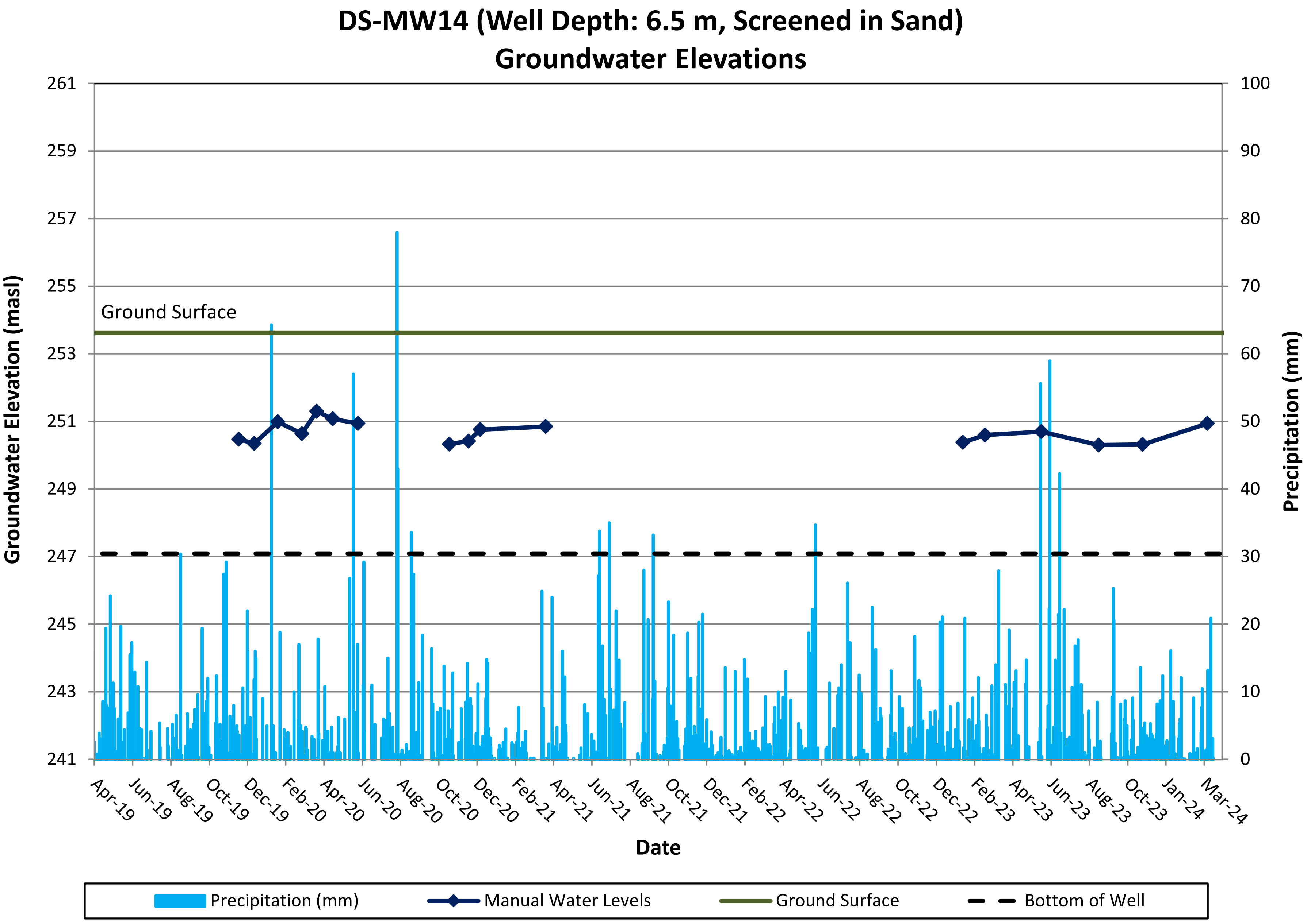

DS-MW9 (Well Depth: 8.7 m, Screened in Silty Sand Till)
Groundwater Elevations
Groundwater Elevation (masl)
261
259
257
255
253
251
249
247
245
243
241
Precipitation (mm)
100
90
80
70
60
50
40
30
20
10
0
Ground Surface
Apr-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
Mar-24
Date
Precipitation
Manual Water Levels
Automatic Water Levels
Bottom of Well

DS-MW12s (Well Depth: 4 m, Screened in Silt, Silty Sand Till, Gravelly Sand)
DS-MW12d (Well Depth: 5.8 m, Screened in Silty Sand Till, Silty Sand)
Groundwater Elevations



DS-MW13 (Well Depth: 7.4 m, Screened in Sand)
Groundwater Elevations





DS-MW14 (Well Depth: 6.5 m, Screened in Sand)
Groundwater Elevations
Groundwater Elevation (masl)
261
259
257
255
253
251
249
247
245
243
241
Precipitation (mm)
100
90
80
70
60
50
40
30
20
10
0
Ground Surface
Apr-19
Jun-19
Aug-19
Oct-19
Dec-19
Feb-20
Apr-20
Jun-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
Aug-21
Oct-21
Dec-21
Feb-22
Apr-22
Jun-22
Aug-22
Oct-22
Dec-22
Feb-23
Apr-23
Jun-23
Aug-23
Oct-23
Jan-24
Mar-24
Date
Precipitation (mm)
Manual Water Levels
Ground Surface
Bottom of Well

DS-MW15 (Well Depth: 3.9 m, Screened in Sand)
Groundwater Elevations

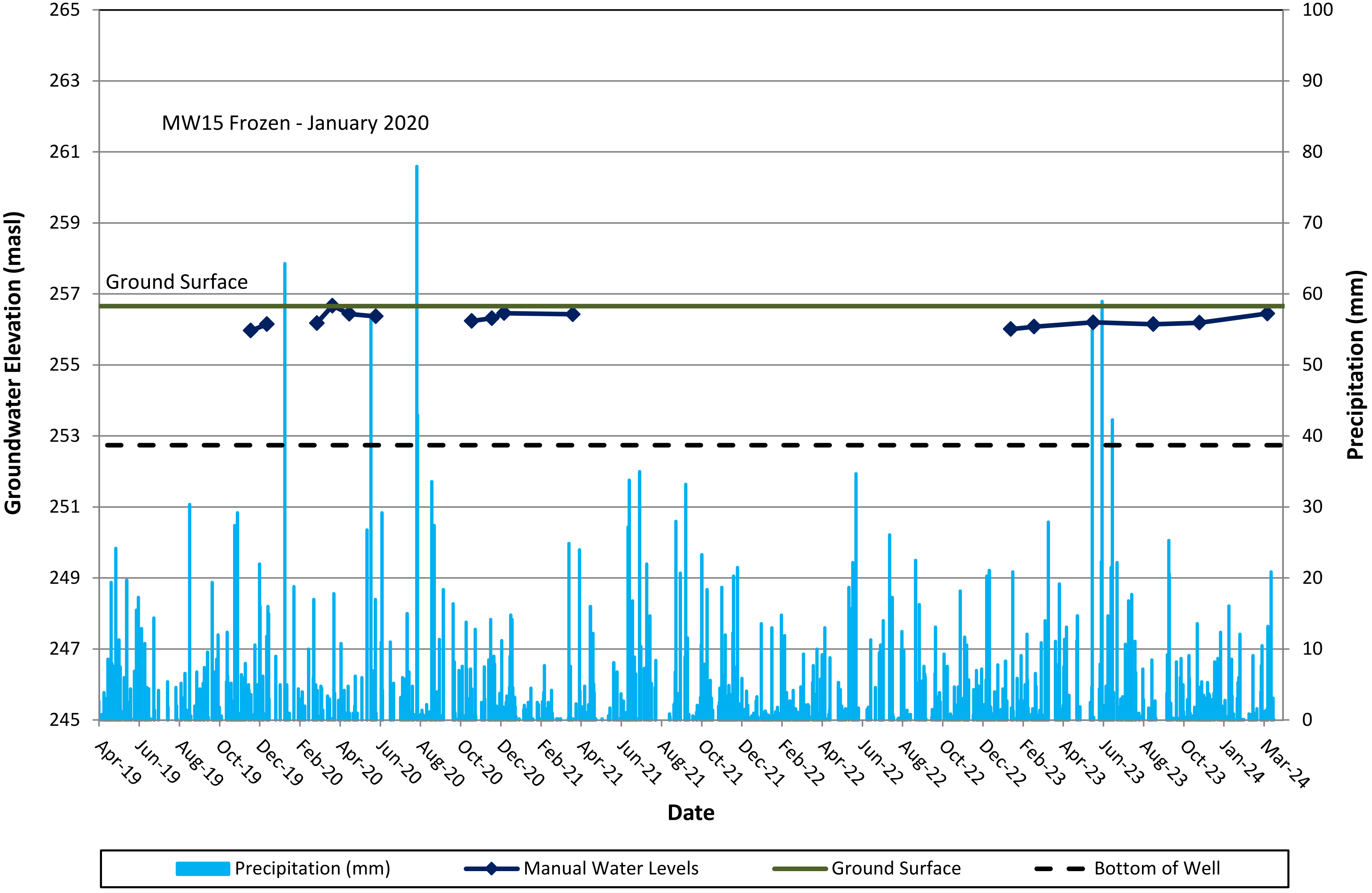


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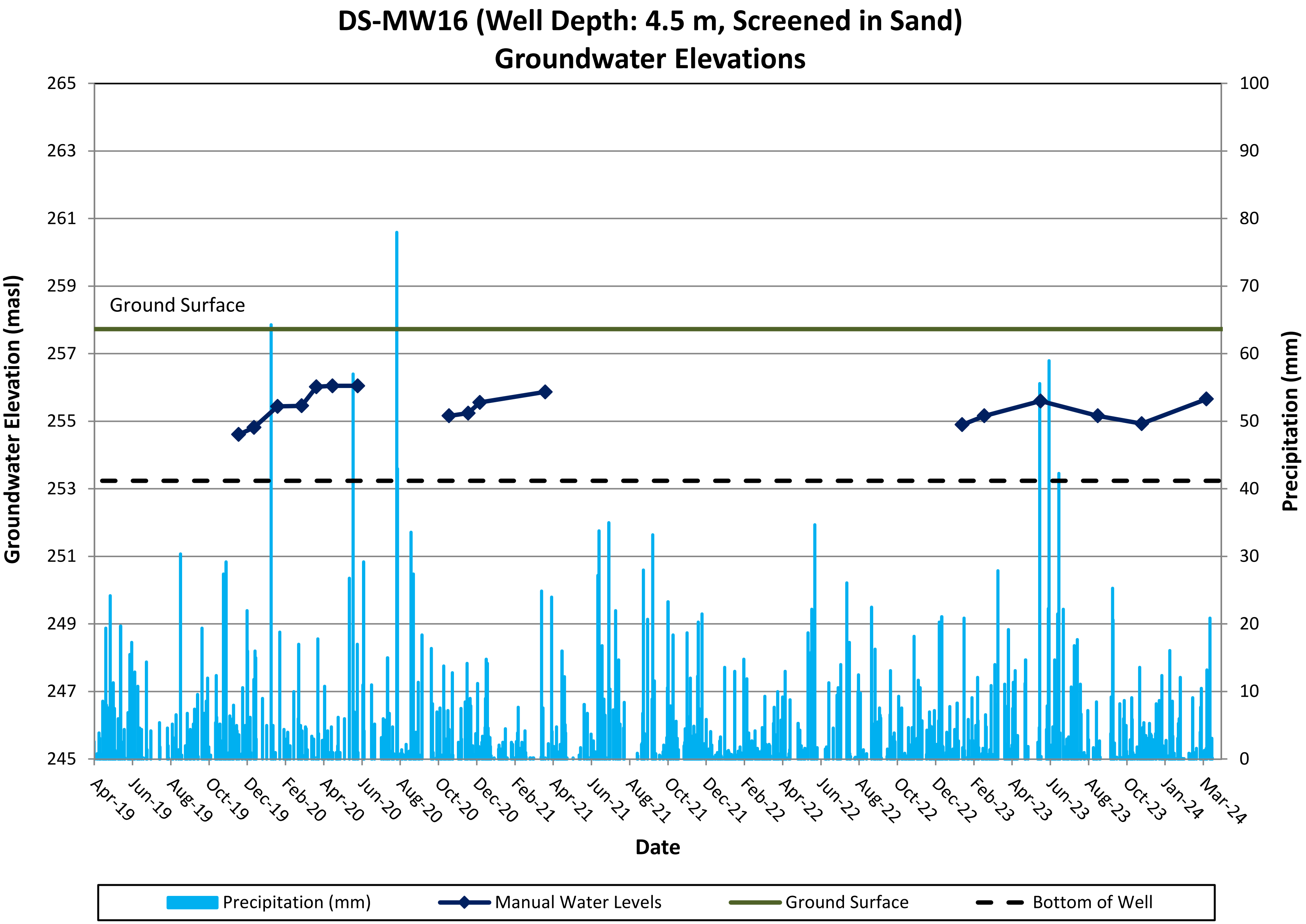
Figure D-10


DS-MW16 (Well Depth: 4.5 m, Screened in Sand)
Groundwater Elevations
Groundwater Elevation (masl)
265
263
261
259
257
255
253
251
249
247
245
Precipitation (mm)
100
90
80
70
60
50
40
30
20
10
0
Ground Surface
Apr-19
Jun-19
Aug-19
Oct-19
Dec-19
Feb-20
Apr-20
Jun-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
Aug-21
Oct-21
Dec-21
Feb-22
Apr-22
Jun-22
Aug-22
Oct-22
Dec-22
Feb-23
Apr-23
Jun-23
Aug-23
Oct-23
Jan-24
Mar-24
Date
Precipitation (mm)
Manual Water Levels
Ground Surface
Bottom of Well

DS-MW17 (Well Depth: 5.9 m, Screened in Sand)
Groundwater Elevations

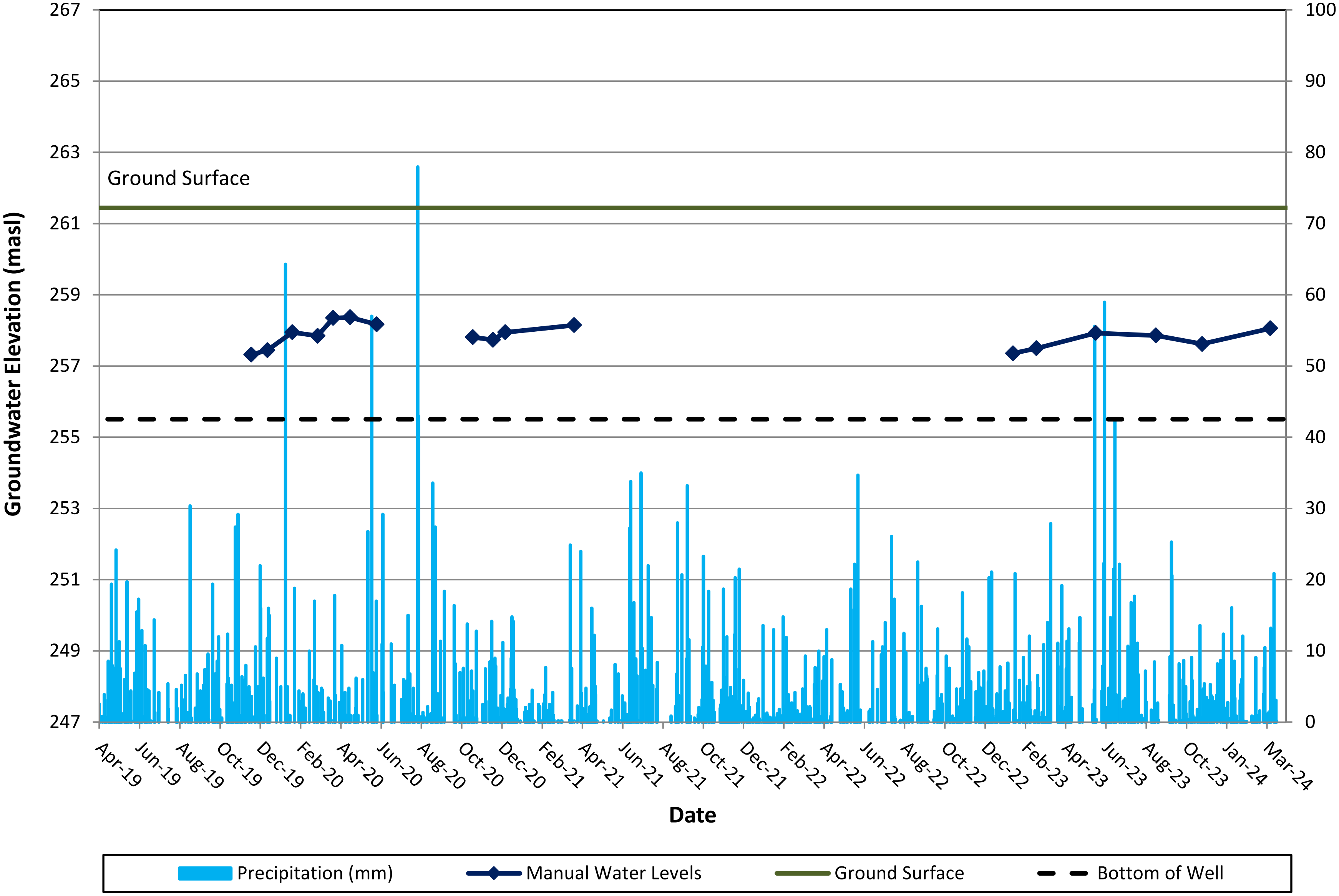
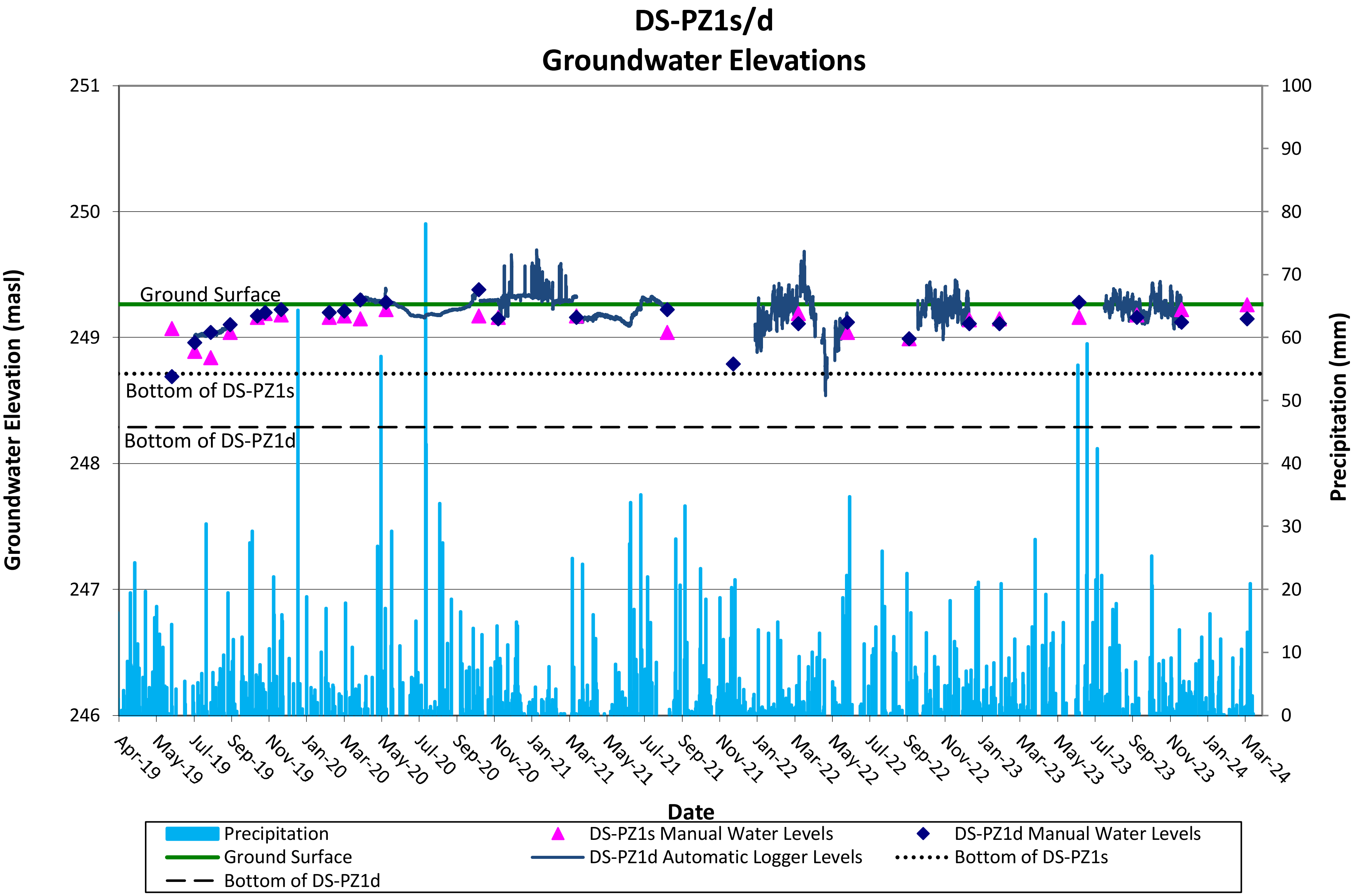
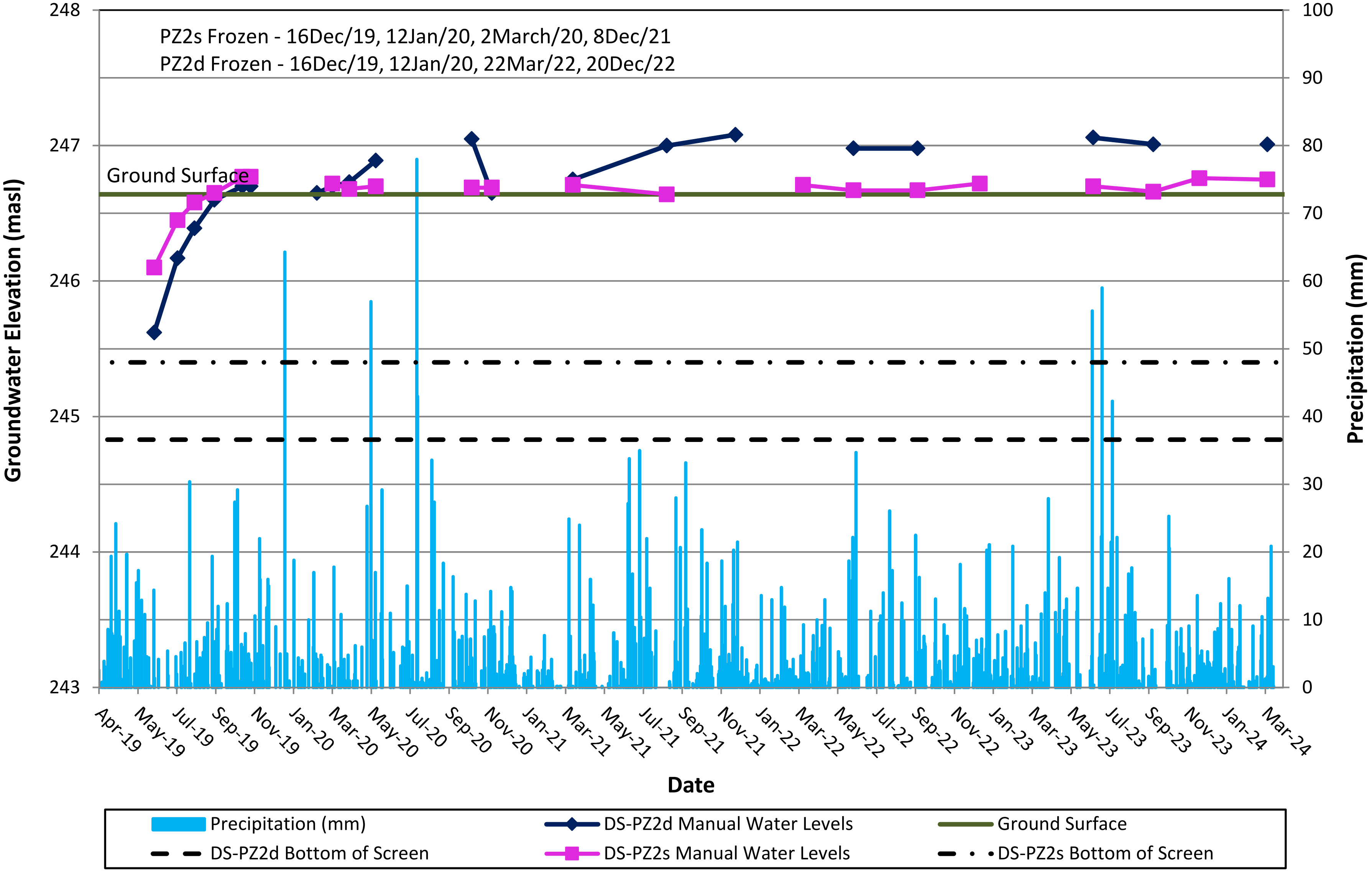


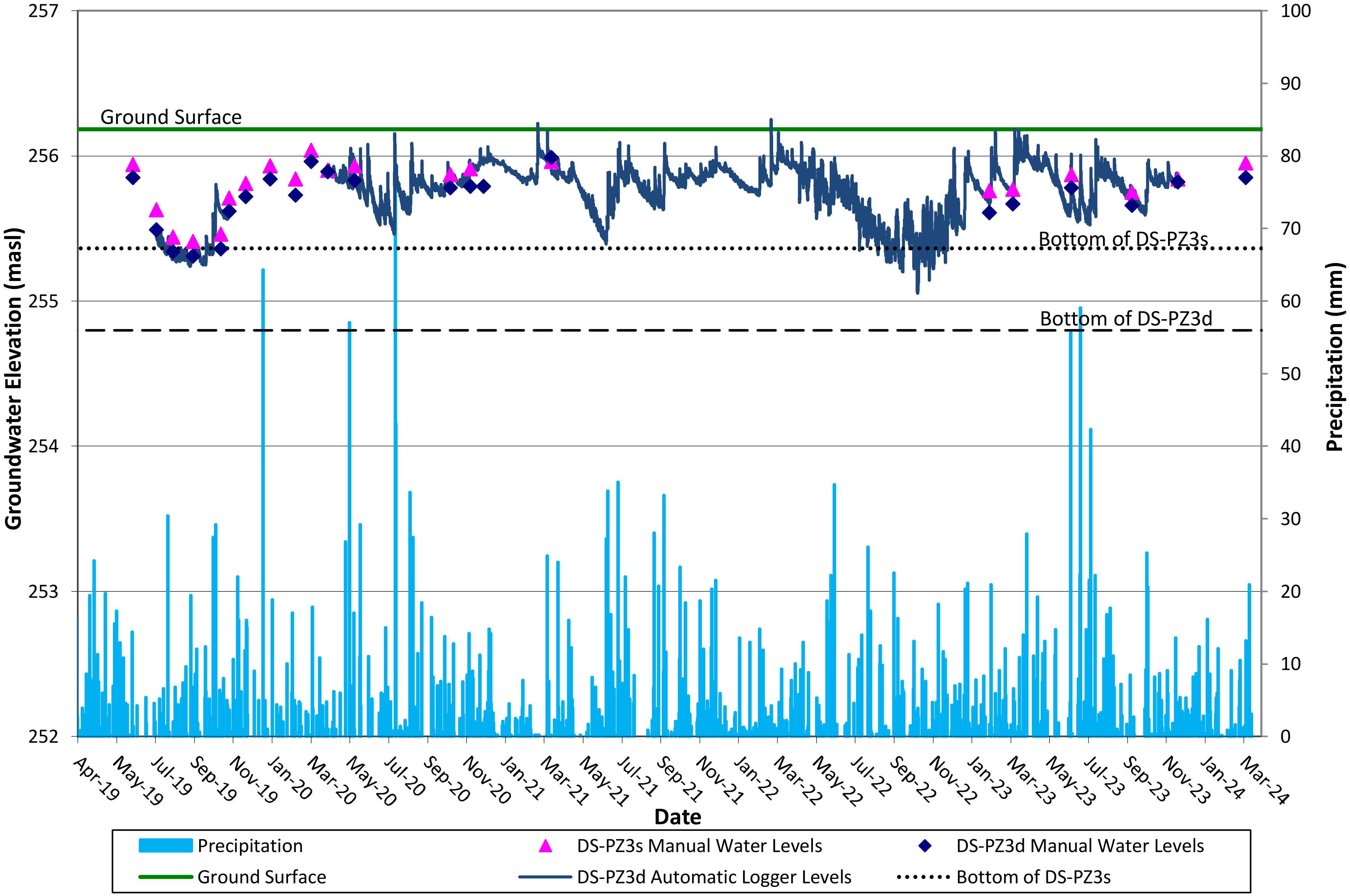
Figure D-12


DS-PZ1s/d
Groundwater Elevations
Groundwater Elevation (masl)
251
250
249
248
247
246
Precipitation (mm)
100
90
80
70
60
50
40
30
20
10
0
Ground Surface
Bottom of DS-PZ1s
Bottom of DS-PZ1d
Apr-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
Mar-24
Date
Precipitation
DS-PZ1s Manual Water Levels
DS-PZ1d Manual Water Levels
Ground Surface
DS-PZ1d Automatic Logger Levels
Bottom of DS-PZ1s
Bottom of DS-PZ1d

DS-PZ2s/d
Groundwater Elevations



DS-PZ3s/d
Groundwater Elevations



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Appendix E

Surface Water Monitoring

Table E-1
Surface Water Flow

Date	**Days since rain:**	**Flow (L/sec)**		
		SW1	**SW2**	**SW3**
25-Jun-19	0	5.3	5.6	8
31-Jul-19	1	Standing Water	<0.5	Standing Water
26-Aug-19	0	Standing Water	<0.5	Standing Water
26-Sep-19	0	Standing Water	1.8	0.4
8-Nov-19	0	2.9	2.9	Partially Frozen
21-Nov-19	0	14.4	22.1	13.8
16-Dec-19	1	Partially Frozen	Partially Frozen	Partially Frozen
23-Jan-20	4	Frozen	Frozen	Frozen
2-Mar-20	0	Frozen	Frozen	Frozen
26-Mar-20	0	9.8	21.4	16.1
21-Apr-20	0	5.8	7	6.8
1-Jun-20	0	7.9	8.5	7.6
27-Oct-20	0	2.4	8.4	5.3
27-Nov-20	1	18.9	24.2	5
24-Aug-21	17	Standing Water	1.9	1
8-Dec-21	0	4.3	7.3	Partially Frozen
22-Mar-22	0	6	7.5	Partially Frozen
8-Jun-22	0	4.5	7.9	1.32
15-Sep-22	3	Standing Water	1	<0.5
20-Dec-22	0	Frozen	2.9	Frozen
6-Feb-23	6	Frozen	Frozen	Frozen
14-Mar-23	1	Frozen	Frozen	Frozen
13-Jun-23	1	20.1	38.0	13.8
14-Sep-23	1	<0.5	10.8	<0.5
24-Nov-23	1	12.0	21.0	17.1
8-Mar-24	0	5.1	8.5	Partially Frozen

"<0.5" minimal flow not measureable with equipment (estimated)

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Appendix F

Water Quality

Table F-1
Groundwater Quality

Monitoring Well					**DS-MW12d**	**DS-MW17**
Date Sampled					**1-Jun-20**	**1-Jun-20**
Parameter	**Unit**	**RDL**	**ODWQS**	**PWQO**		
Electrical Conductivity	µS/cm	2			521	409
pH	pH Units	NA	(6.5-8.5)	(6.5-8.5)	7.7	7.68
Saturation pH					7.03	7.21
Langelier Index					0.67	0.469
Total Hardness (as CaCO3)	mg/L	0.5	(80-100)		**262**	**193**
Total Dissolved Solids	mg/L	20	500		294	202
Alkalinity (as CaCO3)	mg/L	5	(30-500)		241	215
Bicarbonate (as CaCO3)	mg/L	5			241	215
Carbonate (as CaCO3)	mg/L	5			<5	<5
Hydroxide (as CaCO3)	mg/L	5			<5	<5
Fluoride	mg/L	0.05	1.5		<0.05	<0.05
Chloride	mg/L	0.10	250		3.89	4.27
Nitrate as N	mg/L	0.05	10.0		9.6	0.22
Nitrite as N	mg/L	0.05	1.0		<0.05	<0.05
Bromide	mg/L	0.05			<0.05	<0.05
Sulphate	mg/L	0.10	500		9.09	6.43
Ortho Phosphate as P	mg/L	0.10			<0.10	<0.10
Reactive Silica	mg/L	0.05			12.4	8.13
Ammonia as N	mg/L	0.02			<0.02	<0.02
Total Phosphorus	mg/L	0.02		0.03	0.29	1.92
Total Organic Carbon	mg/L	0.5			1.8	4.8
Colour	TCU	5	5		<5	<5
Turbidity	NTU	0.5	5		**601**	**13500**
Dissolved Calcium	mg/L	0.05			91.1	72.6
Dissolved Magnesium	mg/L	0.05			8.41	2.95
Dissolved Sodium	mg/L	0.05	20 (200)		3.15	2.66
Dissolved Potassium	mg/L	0.05			0.97	0.97
Dissolved Aluminum	mg/L	0.004	0.1	0.075	0.018	0.019
Dissolved Antimony	mg/L	0.001	0.006		<0.001	<0.001
Dissolved Arsenic	mg/L	0.001	0.025	1	<0.001	0.001
Dissolved Barium	mg/L	0.002	1		0.036	0.009
Dissolved Beryllium	mg/L	0.0005			<0.0005	<0.0005
Dissolved Boron	mg/L	0.010	5	2	<0.010	0.01
Dissolved Cadmium	mg/L	0.0001	0.005	0.0002	<0.0001	<0.0001
Dissolved Chromium	mg/L	0.002	0.05	0.009	<0.002	<0.002
Dissolved Cobalt	mg/L	0.0005			<0.0005	<0.0005
Dissolved Copper	mg/L	0.001	1	0.005	<0.001	<0.001
Dissolved Iron	mg/L	0.010	0.3	0.3	0.032	<0.010
Dissolved Lead	mg/L	0.0005	0.01	0.001	<0.0005	<0.0005
Dissolved Manganese	mg/L	0.002	0.05		0.004	<0.002
Dissolved Mercury	mg/L	0.0001	0.001	0.0002	<0.0001	<0.0001
Dissolved Molybdenum	mg/L	0.002		0.04	<0.002	<0.002
Dissolved Nickel	mg/L	0.003		0.025	<0.003	<0.003
Dissolved Selenium	mg/L	0.001	0.01	0.01	<0.001	<0.001
Dissolved Silver	mg/L	0.0001		<0.002	<0.0001	<0.0001
Dissolved Strontium	mg/L	0.005			0.153	0.134
Dissolved Thallium	mg/L	0.0003		0.0003	<0.0003	<0.0003
Dissolved Tin	mg/L	0.002			<0.002	<0.002
Dissolved Titanium	mg/L	0.002			<0.002	<0.002
Dissolved Tungsten	mg/L	0.010			<0.010	<0.010
Dissolved Uranium	mg/L	0.0005	0.02	0.005	<0.0005	<0.0005
Dissolved Vanadium	mg/L	0.002	3		<0.002	<0.002
Dissolved Zinc	mg/L	0.005	5	0.03	<0.005	<0.005
Dissolved Zirconium	mg/L	0.004			<0.004	<0.004

ODWQS - Ontario Drinking Water Quality Standards

RDL - Reported Detection Limit

PWQS - Provincial Water Quality Standards

Bold indicates an exceedence of the ODWQS

Table F-1a
Groundwater Quality

Monitoring Well					DS-MW7
			Guideline		18-Dec-23
Parameter	**Unit**	**RDL**	**Appendix B**	**Table 8 SCS**	
pH	pH Units	NA	6.5-8.5		7.92
Total Suspended Solids	mg/L	10	15		<10
Total Phosphorus	mg/L	0.02	0.03		<0.02
Total Kjeldahl Nitrogen	mg/L	0.1	100		<0.10
Ammonia as N	mg/L	0.02			<0.02
Fluoride	mg/L	0.05	10		<0.05
Chloride	mg/L	0.1	1500	790	11.4
Sulphate	mg/L	0.1	1500		48.7
Sulphide	mg/L	0.01	1		<0.01
Phenols	mg/L	0.002	0.01		<0.002
Cyanide, SAD	mg/L	0.002	0.05		<0.002
Total Aluminum	mg/L	0.01	0.075		0.038
Total Antimony	mg/L	0.003	0.02		<0.003
Total Arsenic	mg/L	0.003	0.005		<0.003
Total Barium	mg/L	0.002	5		0.138
Total Bismuth	mg/L	0.002	0.01		<0.002
Total Cadmium	mg/L	0.0001	0.001		<0.0001
Total Chromium	mg/L	0.003	0.001		<0.003
Total Cobalt	mg/L	0.0005	0.0009		<0.0005
Total Copper	mg/L	0.002	0.01		<0.002
Total Gold	mg/L	0.00001	5		<0.00001
Total Iron	mg/L	0.05	0.3		0.099
Total Lead	mg/L	0.0005	0.05		<0.0005
Total Manganese	mg/L	0.002	5		0.034
Total Mercury	mg/L	0.0002	0.0002		<0.0002
Total Molybdenum	mg/L	0.002	0.04		0.002
Total Nickel	mg/L	0.003	0.25		<0.003
Total Platinum	mg/L	0.0001	5		<0.0001
Total Rhodium	mg/L	0.00001	5		<0.00001
Total Selenium	mg/L	0.002	0.1		0.004
Total Silver	mg/L	0.0001	0.0001		<0.0001
Total Tin	mg/L	0.002	5		<0.002
Total Vanadium	mg/L	0.002	0.006		<0.002
Total Zinc	mg/L	0.02	0.02		<0.020
Biochemical Oxygen Demand, Total	mg/L	6	15		<6
Benzene	µg/L	0.2	0	5	<0.20
Toluene	µg/L	0.2	0	22	<0.20
Ethylbenzene	µg/L	0.1	0	2.4	<0.10
m & p-Xylene	µg/L	0.2			<0.20
o-Xylene	µg/L	0.1			<0.10
Xylenes (Total)	µg/L	0.2	0	300	<0.20
F1 (C6 to C10)	µg/L	25			<25
F1 (C6 to C10) minus BTEX	µg/L	25		420	<25
F2 (C10 to C16)	µg/L	100		150	<100
F3 (C16 to C34)	µg/L	100		500	<100
F4 (C34 to C50)	µg/L	100		500	<100

Table F-1a
Groundwater Quality

Monitoring Well					**DS-MW7**
			Guideline		**18-Dec-23**
Parameter	**Unit**	**RDL**	**Appendix B**	**Table 8 SCS**	
Total Suspended Solids (Lab filtered)	mg/L	10	15		<10
Dissolved Aluminum	mg/L	0.004			0.005
Dissolved Antimony	mg/L	0.001		0.006	<0.001
Dissolved Arsenic	mg/L	0.001		0.025	<0.001
Dissolved Barium	mg/L	0.002		1	0.131
Dissolved Bismuth	mg/L	0.002			<0.002
Dissolved Cadmium	mg/L	0.0001		0.0021	<0.0001
Dissolved Chromium	mg/L	0.002		0.05	<0.002
Dissolved Cobalt	mg/L	0.0005		0.0038	0.0009
Dissolved Copper	mg/L	0.001		0.069	<0.001
Dissolved Iron	mg/L	0.01			0.012
Dissolved Lead	mg/L	0.0005		0.01	<0.0005
Dissolved Manganese	mg/L	0.002			0.015
Dissolved Molybdenum	mg/L	0.002		0.07	0.002
Dissolved Nickel	mg/L	0.001		0.1	<0.001
Dissolved Selenium	mg/L	0.001		0.01	<0.001
Dissolved Silver	mg/L	0.0001		0.0012	<0.0001
Dissolved Tin	mg/L	0.002			<0.002
Dissolved Vanadium	mg/L	0.002		0.0062	<0.002
Dissolved Zinc	mg/L	0.005		0.89	0.009
Oil and Grease (animal/vegetable) in water	mg/L	0.5	0		<0.5
Oil and Grease (mineral) in water	mg/L	0.5	0		<0.5
Dichloromethane	mg/L	0.0003		0.05	<0.0003
Benzene	mg/L	0.0002	0		<0.0002
Trichloroethylene (TCE)	mg/L	0.0002	0		<0.0002
Toluene	mg/L	0.0002	0		<0.0002
Tetrachloroethene	mg/L	0.0002	0		<0.0002
Ethylbenzene	mg/L	0.0001	0		<0.0001
1,1,2,2-Tetrachloroethane	mg/L	0.0001	0		<0.0001
1,4-Dichlorobenzene	mg/L	0.0001	0		<0.0001
1,2-Dichlorobenzene	mg/L	0.0001	0		<0.0001
Xylenes (Total)	mg/L	0.0002	0		<0.0002
Acenaphthylene	mg/L	0.00011		0.001	<0.00011
Acenaphthene	mg/L	0.0001		0.0041	<0.00010
Fluorene	mg/L	0.0002			<0.0002
Phenanthrene	mg/L	0.00011		0.001	<0.00011
Anthracene	mg/L	0.00007		0.001	<0.00007
Fluoranthene	mg/L	0.00012		0.00041	<0.00012
Pyrene	mg/L	0.00012		0.0041	<0.00012
Benzo(a)anthracene	mg/L	0.00008		0.001	<0.00008
Chrysene	mg/L	0.00005		0.0001	<0.00005
Benzo(b)fluoranthene	mg/L	0.00003		0.1	<0.00003
Benzo(k)fluoranthene	mg/L	0.00006		0.0001	<0.00006
Indeno(1,2,3-cd)pyrene	mg/L	0.00003		0.0002	<0.00003
Dibenzo(a,h)anthracene	mg/L	0.00009		0.0002	<0.00009
Benzo(ghi)perylene	mg/L	0.00006		0.0002	<0.00006
Total PAHs	mg/L	0.0003	0.005		<0.0003

Table F-1a
Groundwater Quality

Monitoring Well					**DS-MW7**
			Guideline		**18-Dec-23**
Parameter	**Unit**	**RDL**	**Appendix B**	**Table 8 SCS**	
Vinyl Chloride	mg/L	0.002	0		<0.0002
1,3,5-Trimethylbenzene	mg/L	0.0001	0		<0.0001
Trichlorofluoromethane	mg/L	0.0003	0		<0.0003
1,1,2-Trichloroethane	mg/L	0.0002	0		<0.0002
1,1,1-Trichloroethane	mg/L	0.0003	0		<0.0003
1,2,4-Trichlorobenzene	mg/L	0.0001	0		<0.0001
Tetrachloroethylene	mg/L	0.0001	0	0.06	<0.0001
1,1,1,2-Tetrachloroethane	mg/L	0.0001	0	0.0011	<0.0001
Styrene	mg/L	0.0001	0	0.0054	<0.0001
Methyl tert-butyl ether	mg/L	0.0002	0	0.015	<0.0002
1,2-Dichloropropane	mg/L	0.0002	0		<0.0002
1,3-Dichlorobenzene	mg/L	0.0001	0		<0.0001
1,2-Dichloroethane	mg/L	0.0002	0		<0.0002
1,1-Dichloroethane	mg/L	0.0002	0		<0.0002
1,2-Dichloroethylene	mg/L	0.0002	0		<0.0002
Chloromethane	mg/L	0.0001	0		<0.0001
Bromomethane	mg/L	0.0002	0		<0.0002
Bromoform	mg/L	0.0001	0		<0.0001
Bromodichloromethane	mg/L	0.0002	0		<0.0002

RDL - Reported Detection Limit

Bold indicates an exceedence of Appendix B: Hydrogeological Sample Analysis Parameters and Limits (City of Barrie).

Underlined indicates an exceedence of Table 8: Generic (SCS) Site Condition Standards for Use within 30 m of a Water Body in a Potable Ground Water Condition - Groundwater - All Types of Property Uses

Table F-2
Surface Water Quality

Sample Location				**SW1**	**SW3**
Date Sampled				**1-Jun-20**	**1-Jun-20**
Parameter	**Unit**	**RDL**	**PWQO**		
Electrical Conductivity	µS/cm	2		663	446
pH	pH Units	NA	(6.5-8.5)	7.74	7.63
Saturation pH				6.8	7.1
Langelier Index				0.942	0.532
Total Hardness (as CaCO3)	mg/L	0.5		366	233
Total Dissolved Solids	mg/L	20		416	244
Alkalinity (as CaCO3)	mg/L	5		315	231
Bicarbonate (as CaCO3)	mg/L	5		315	231
Carbonate (as CaCO3)	mg/L	5		<5	<5
Hydroxide (as CaCO3)	mg/L	5		<5	<5
Fluoride	mg/L	0.05		<0.05	<0.05
Chloride	mg/L	0.20		15.8	6.46
Nitrate as N	mg/L	0.10		0.22	<0.05
Nitrite as N	mg/L	0.10		<0.10	<0.05
Bromide	mg/L	0.10		<0.10	<0.05
Sulphate	mg/L	0.20		24.6	4.68
Ortho Phosphate as P	mg/L	0.20		<0.20	<0.10
Reactive Silica	mg/L	0.05		7.54	9.16
Ammonia as N	mg/L	0.02		<0.02	<0.02
Total Phosphorus	mg/L	0.02	0.03	<0.02	**0.05**
Total Organic Carbon	mg/L	0.5		18.6	9.5
Colour	TCU	5		89	37
Turbidity	NTU	0.5		4.9	0.7
Calcium	mg/L	0.05		124	82.4
Magnesium	mg/L	0.05		13.8	6.69
Sodium	mg/L	0.05		7.07	4.79
Potassium	mg/L	0.05		1.31	0.46
Aluminum (dissolved)	mg/L	0.004	0.075	0.005	<0.004
Antimony	mg/L	0.001		<0.001	<0.001
Arsenic	mg/L	0.003	1	<0.003	<0.003
Barium	mg/L	0.002		0.064	0.036
Beryllium	mg/L	0.0005		<0.0005	<0.0005
Boron	mg/L	0.010	2	0.024	0.017
Cadmium	mg/L	0.0001	0.0002	<0.0001	<0.0001
Chromium	mg/L	0.003	0.009	<0.003	<0.003
Cobalt	mg/L	0.0005		<0.0005	<0.0005
Copper	mg/L	0.001	0.005	0.002	<0.001
Iron	mg/L	0.010	0.3	0.152	0.065
Lead	mg/L	0.001	0.001	<0.001	<0.001
Manganese	mg/L	0.002		0.041	0.044
Dissolved Mercury	mg/L	0.0001	0.0002	<0.0001	<0.0001
Molybdenum	mg/L	0.002	0.04	<0.002	<0.002
Nickel	mg/L	0.003	0.025	<0.003	<0.003
Selenium	mg/L	0.004	0.01	<0.004	<0.004
Silver	mg/L	0.0001		<0.0001	<0.0001
Strontium	mg/L	0.005		0.307	0.18
Thallium	mg/L	0.0003	0.0003	<0.0003	<0.0003
Tin	mg/L	0.002		<0.002	<0.002
Titanium	mg/L	0.002		<0.002	<0.002
Tungsten	mg/L	0.010		<0.010	<0.010
Uranium	mg/L	0.002	0.005	**0.006**	<0.002
Vanadium	mg/L	0.002		<0.002	<0.002
Zinc	mg/L	0.005	0.03	<0.005	0.006
Zirconium	mg/L	0.004		<0.004	<0.004
Total Suspended Solids	mg/L	10		<10	<10

PWQS - Provincial Water Quality Objectives

RDL - Reported Detection Limit

Bold indicates an exceedence of the PWQO

Table F-3
Surface Water Field Chemistry

Surface Water Station	Temperature (°C)	pH	Conductivity (mS/cm)	TDS (g/L)	TSS (mg/L)	Salinity (ppt)	Dissolved Oxygen (mg/L)
SW1							
26-Jun-19	19.5	-	985	0.702	13	0.36	-
8-Nov-19	1.6	9.52	1276	0.905	7	0.43	9.50
21-Nov-19	3.0	9.27	1156	0.820	5	0.39	8.20
26-Mar-20	4.8	9.32	879	0.629	-	0.30	-
21-Apr-20	4.5	9.70	936	0.662	13	0.32	-
1-Jun-20	11.7	9.01	987	0.700	12	0.35	-
27-Oct-20	7.3	9.19	1249	0.883	24	0.44	-
8-Dec-21	2.1	8.11	814	0.580	14	0.40	-
22-Mar-22	1.5	8.21	743	0.527	4	0.37	9.79
8-Jun-22	18.1	8.20	686	0.487	25	0.38	2.38
13-Jun-23	16.7	8.87	732	0.493	21	0.37	-
SW2							
26-Jun-19	17.6	9.03	1081	0.705	11	0.41	13.60
26-Sep-19	12.8	8.64	1310	0.930	6	0.48	5.50
8-Nov-19	3.1	8.90	1352	0.958	2	0.46	8.60
21-Nov-19	3.6	8.51	1213	0.858	3	0.41	7.40
26-Mar-20	5.4	8.96	992	0.707	-	0.34	-
21-Apr-20	5.0	8.86	1086	0.770	7	0.38	-
1-Jun-20	12.4	9.17	1116	0.793	5	0.40	-
24-Aug-21							-
8-Dec-21	3.4	8.23	836	0.591	9	0.42	-
22-Mar-22	3.0	8.35	669	0.471	3	0.33	10.95
8-Jun-22	18.2	8.46	756	0.537	22	0.41	2.57
15-Sep-22	14.3	8.6	895	0.64	4	0.5	-
20-Dec-22	4.1	8.2	877	0.71	9	0.5	-
13-Jun-23	15.5	8.5	872	0.50	8	0.4	-
SW3							
26-Jun-19	16.5	-	722	0.507	58	0.26	11.60
26-Sep-19	15.0	8.04	1006	0.715	20	0.37	5.60
21-Nov-19	1.9	8.54	682	0.484	0	0.23	6.90
26-Mar-20	3.4	8.59	543	0.383	-	0.18	-
21-Apr-20	2.6	8.90	597	0.425	5	0.20	-
8-Jun-22	18.6	8.00	464	0.329	29	0.25	2.21
13-Jun-23	15.1	8.37	663	0.455	25	0.30	-

Notes:

Water quality data only collected when sufficient flowing water present and not collected when dry,

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Appendix G

Water Balance Calculations

Appendix G

WATER BALANCE CALCULATIONS
DIV Development (Barrie) Ltd.
Dorsay Lands
Innisfil, ON
PROJECT No.300043693

TABLE G-1

Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 150 mm (moderately-rooted vegetation in sandy loam soils)

Precipitation data from Barrie WPCC Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	**6.9**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.19	3.91	6.90	8.66	7.97	5.44	2.31	0.39	0.00	**36.8**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	25.18	58.76	88.02	103.48	97.59	74.33	40.47	11.47	0.00	**499**
Adjusting Factor for U (Latitude 44° 20' N)	0.81	0.82	1.02	1.13	1.27	1.29	1.3	1.2	1.04	0.95	0.8	0.76	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
WATER BALANCE COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	83	62	58	62	82	85	77	90	94	78	89	74	**933**
Potential Evapotranspiration (PET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
P - PET	83	62	58	34	8	-29	-57	-27	17	39	80	74	**340**
Change in Soil Moisture Storage	0	0	0	0	0	-29	-57	-27	17	39	58	0	**0**
Soil Moisture Storage max 150 mm	150	150	150	150	150	121	64	37	53	92	150	150	
Actual Evapotranspiration (AET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
Soil Moisture Deficit max 150 mm	0	0	0	0	0	29	86	113	97	58	0	0	
Water Surplus - available for infiltration or runoff	83	62	58	34	8	0	0	0	0	0	22	74	**340**
Potential Infiltration (based on MOE methodology*; independent of temperature)	41	31	29	17	4	0	0	0	0	0	11	37	**170**
Potential Direct Surface Water Runoff (independent of temperature)	41	31	29	17	4	0	0	0	0	0	11	37	**170**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	933	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	140	mm/year											
P-PE (surplus available for runoff from impervious areas)	793	mm/year											

Assume January storage is 100% of Soil Moisture Storage		
Soil Moisture Storage	150 mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003
*MOE SWM infiltration calculations		
topography - hilly (avg slope 4%)	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - sandy loam and sandy till	0.3	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - predominantly cultivated land	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.5**	
Latitude of site (or climate station)	44 °N.	

WATER BALANCE CALCULATIONS
DIV Development (Barrie) Ltd.
Dorsay Lands
Barrie, ON
PROJECT No.300043693

BURNSIDE

TABLE G-2

Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 300 mm (wooded areas in sandy loam soils)

Precipitation data from Barrie WPCC Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	**6.9**
Heat index: i = $(t/5)^{1.514}$	0.00	0.00	0.00	1.19	3.91	6.90	8.66	7.97	5.44	2.31	0.39	0.00	**36.8**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	25.18	58.76	88.02	103.48	97.59	74.33	40.47	11.47	0.00	**499**
Adjusting Factor for U (Latitude 44^{o} 20' N)	0.81	0.82	1.02	1.13	1.27	1.29	1.3	1.2	1.04	0.95	0.8	0.76	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
WATER BALANCE COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	83	62	58	62	82	85	77	90	94	78	89	74	**933**
Potential Evapotranspiration (PET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
P - PET	83	62	58	34	8	-29	-57	-27	17	39	80	74	**340**
Change in Soil Moisture Storage	0	0	0	0	0	-29	-57	-27	17	39	58	0	**0**
Soil Moisture Storage max 300 mm	300	300	300	300	300	271	214	187	203	242	300	300	
Actual Evapotranspiration (AET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
Soil Moisture Deficit max 300 mm	0	0	0	0	0	29	86	113	97	58	0	0	
Water Surplus - available for infiltration or runoff	83	62	58	34	8	0	0	0	0	0	22	74	**340**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	50	37	35	20	5	0	0	0	0	0	13	44	**204**
Potential Direct Surface Water Runoff (independent of temperature)	33	25	23	13	3	0	0	0	0	0	9	29	**136**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	933	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	140	mm/year											
P-PE (surplus available for runoff from impervious areas)	793	mm/year											

Assume January storage is 100% of Soil Moisture Storage
Soil Moisture Storage 300 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 - sandy loam and sandy till	0.3	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - woodlands	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.6**	

Latitude of site (or climate station) 44 ^{O} N.

WATER BALANCE CALCULATIONS
DIV Development (Barrie) Ltd.
Dorsay Lands
Barrie, ON
PROJECT No.300043693

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TABLE G-3

Post-Development Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 75 mm (urban lawn in sandy loam soils)

Precipitation data from Barrie WPCC Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	**6.9**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.19	3.91	6.90	8.66	7.97	5.44	2.31	0.39	0.00	**36.8**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	25.18	58.76	88.02	103.48	97.59	74.33	40.47	11.47	0.00	**499**
Adjusting Factor for U (Latitude 44° 20' N)	0.81	0.82	1.02	1.13	1.27	1.29	1.3	1.2	1.04	0.95	0.8	0.76	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
WATER BALANCE COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	83	62	58	62	82	85	77	90	94	78	89	74	**933**
Potential Evapotranspiration (PET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
P - PET	83	62	58	34	8	-29	-57	-27	17	39	80	74	**340**
Change in Soil Moisture Storage	0	0	0	0	0	-29	-46	0	17	39	19	0	**0**
Soil Moisture Storage max 75 mm	75	75	75	75	75	46	0	0	17	56	75	75	
Actual Evapotranspiration (AET)	0	0	0	28	75	114	123	90	77	38	9	0	**555**
Soil Moisture Deficit max 75 mm	0	0	0	0	0	29	75	75	58	19	0	0	
Water Surplus - available for infiltration or runoff	83	62	58	34	8	0	0	0	0	0	60	74	**378**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	41	31	29	17	4	0	0	0	0	0	30	37	**189**
Potential Direct Surface Water Runoff (independent of temperature)	41	31	29	17	4	0	0	0	0	0	30	37	**189**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	933	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	140	mm/year											
P-PE (surplus available for runoff from impervious areas)	793	mm/year											

Assume January storage is 100% of Soil Moisture Storage		
Soil Moisture Storage	75 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 - sandy loam and sandy till	0.3	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - urban lawn	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.5**	
Latitude of site (or climate station)	44 ^{O} N.	

WATER BALANCE CALCULATIONS
DIV Development (Barrie) Ltd.
Dorsay Lands
Barrie, ON
PROJECT No.300043693

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TABLE G-4

Water Balance for Pre- and Post-Development Land Use Conditions (with no SWM/LID measures in place)

Land Use Description	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)
Pre-Development Land Use												
Woodland/Wetland	256,600	0.00	0	0.793	0	256,600	0.136	34,868	0.204	52,303	34,868	52,303
Open Space /Agricultural	540,100	0.00	0	0.793	0	540,100	0.170	91,740	0.170	91,740	91,740	91,740
Rural Residential	5,600	0.25	1,400	0.793	1,110	4,200	0.189	794	0.189	794	1,904	794
TOTAL PRE-DEVELOPMENT	**802,300**		**1,400**		**1,110**	**800,900**		**127,402**		**144,837**	**128,513**	**144,837**
Post-Development Land Use (with no LID measures in place)												
Single Detached/Semi-Detached	212,600	0.67	142,442	0.793	112,952	70,158	0.189	13,260	0.189	13,260	126,211	13,260
Townhomes (Medium Density)	67,600	0.79	53,404	0.793	42,348	14,196	0.189	2,683	0.189	2,683	45,031	2,683
Elementary School	22,900	0.79	18,091	0.793	14,346	4,809	0.189	909	0.189	909	15,254	909
Parks	29,300	0.21	6,153	0.793	4,879	23,147	0.189	4,375	0.189	4,375	9,254	4,375
Stormwater Management Blocks	55,500	0.50	27,750	0.793	22,005	27,750	0.189	5,245	0.189	5,245	27,249	5,245
Pumping Station	1,700	1.00	1,700	0.793	1,348	0	0.189	0	0.189	0	1,348	0
Natural Heritage System	258,700	0.00	0	0.793	0	258,700	0.136	35,154	0.189	48,894	35,154	48,894
Environmental Lands	2,100	0.00	0	0.793	0	2,100	0.136	285	0.204	428	285	428
Road Widening and Walkways	20,300	1.00	20,300	0.793	16,097	0	0.189	0	0.189	0	16,097	0
Right of Way	113,200	0.75	84,900	0.793	67,323	28,300	0.189	5,349	0.189	5,349	72,671	5,349
Future Development	18,400	0.79	14,536	0.793	11,527	3,864	0.189	730	0.189	730	12,257	730
TOTAL POST-DEVELOPMENT	**802,300**		**369,276**		**292,823**	**433,024**		**67,989**		**81,872**	**360,812**	**81,872**
% Change from Pre to Post											281	43
Effect of development (with no mitigation)											2.8 times increase in runoff	43% reduction of infiltration

* data provided by Schaeffers, May 2024

** figures from Tables G-1, G-2 and G-3.

To balance pre- to post-,
the infiltration target (m^3/a)= **62,965**

Figure G-1
Pre-Development Monthly Site Water Balance

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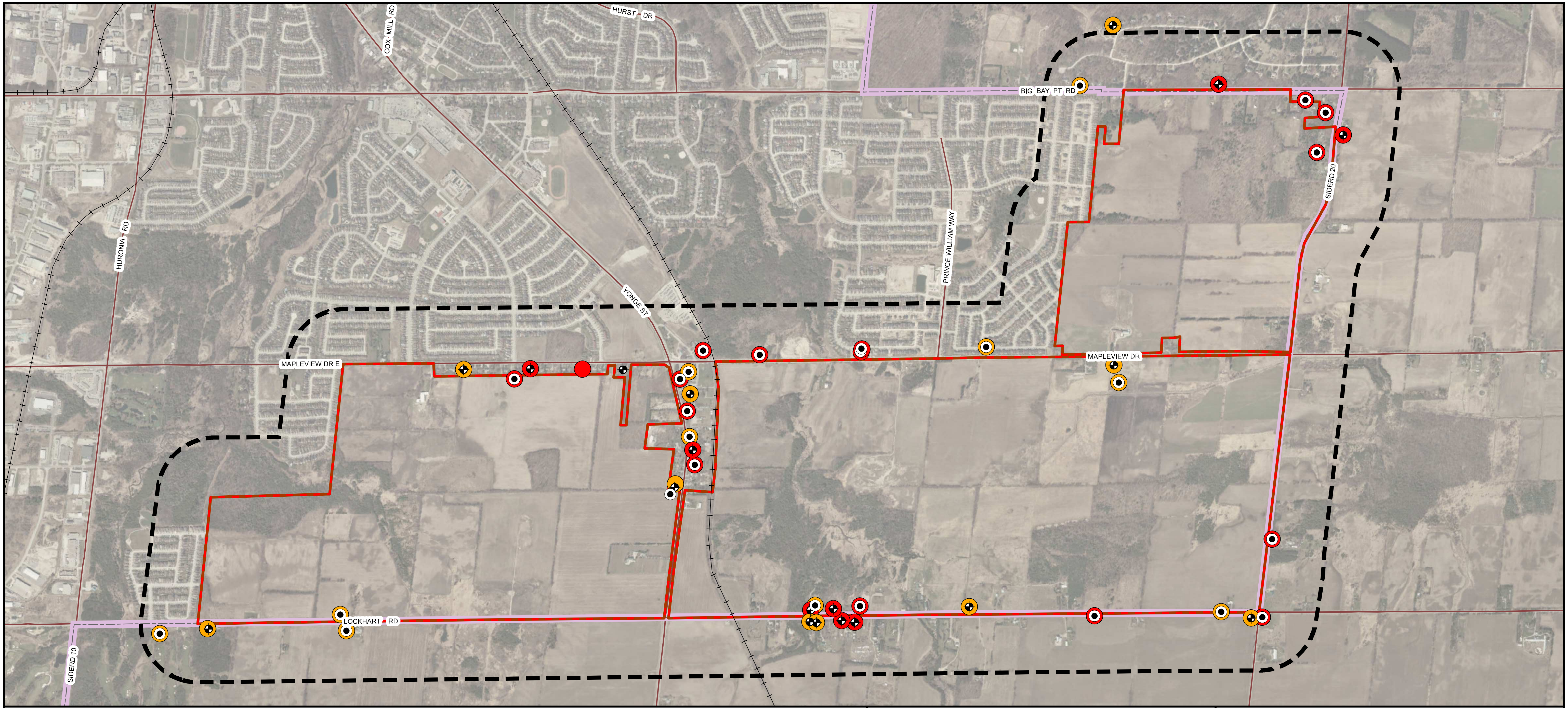
Appendix H

Water Well Survey

Appendix H



Legend

▭ HEWITT'S SECONDARY PLAN AREA (STUDY AREA)

⬚ STUDY AREA BUFFER (300m)

- - MUNICIPAL BOUNDARY

— ROADWAY

+—+ RAILWAY

⊕ WELL LOCATION CONFIRMEND THROUGH WELL SURVEY

⊙ WELL LOCATION FROM MECP WELL RECORDS

WELL VULNERABILITY

🔴 HIGH

🟠 MODERATE

Sources:

1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. County of Simcoe WebServices
4. Satellite Image: Simcoe County online maps, Public/Ortho_2012
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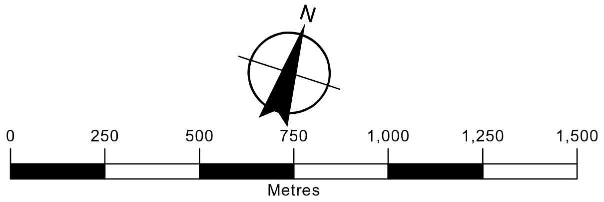

BURNSIDE

Client / Report

HEWITT'S CREEK LANDOWNERS GROUP
BARRIE, ONTARIO

HEWITT'S SPA WELL SURVEY REPORT

Figure Title

WATER SUPPLY WELL VULNERABILITY

Drawn	Checked	Date	Figure No.
SK	SC	October 2018	9
Scale		Project No.	
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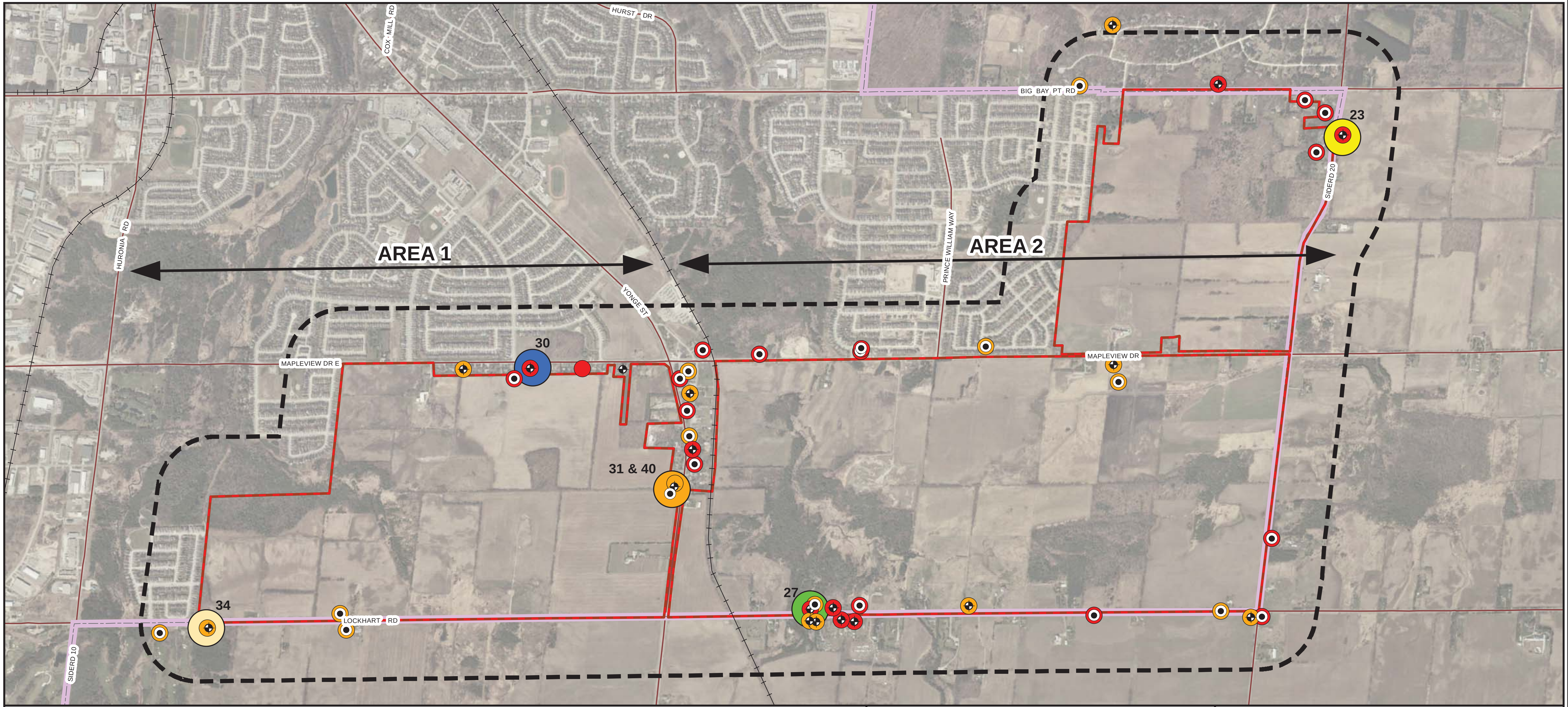
Table B-1: Summary of Water Well Survey Results

Address	Type	Year Drilled	Approx. Depth (m)	Adequate Supply	Adequate Quality	MECP Well ID Number
3553 20th Sideroad	Dug	-	-	Yes	Yes	
1646 Big Bay Point Road	Dug	-	-	Yes	Yes	
1987 Lockhart Road	Dug	-	9	Yes	Yes	
2005 Lockhart Road	Dug	-	5	Yes	Yes	
786 Lockhart Road	Dug	-	9	Yes	Yes	
802 Lockhart Road	Dug	-	9	Yes	Yes	
585 Mapleview Drive	Dug	1960	8	Yes	Yes	
647 Mapleview Drive	Dug	-	10	Yes	Yes	
925 Yonge Street	Drilled	2006	-	No	Yes	
3569 20th Sideroad	Drilled	1995	20	Yes	Yes	
3277 20th Sideroad	Drilled	1965	29	Yes	Yes	5701426
1656 Big Bay Point Road	Drilled	-	59	Yes	Yes	
1667 Lockhart Road	Drilled	1974	26	Yes	Yes	5712065
1675 Lockhart Road	Drilled	2008	24	Yes	Yes	7108941
1881 Lockhart Road	Drilled	-	51	Yes	Yes	
2569 Lockhart Road	Drilled	2007	17	Yes	Yes	7048322
798 Lockhart Road	Drilled	-	18	Yes	Yes	
523 Mapleview Drive	Drilled	1969	17	Yes	Yes	
553 Mapleview Drive	Drilled	1978	20	Yes	Yes	5716049
569 Mapleview Drive	Drilled	1970	23	Yes	Yes	
593 Mapleview Drive	Drilled	-	19	-	-	
619 Mapleview Drive	Drilled	1971	21	-	Yes	
628 Mapleview Drive	Drilled	-	20	Yes	Yes	
637 Mapleview Drive	Drilled	1972	20	-	-	
68 St. Pauls Street	Drilled	2010	18	-	-	
105 St. Pauls Street	Drilled	-	16	-	Yes	
2087 Wilkinson Street	Drilled	1998	43	Yes	Yes	
7315 Yonge Street	Drilled	-	23	Yes	Yes	
933 Yonge Street	Drilled	-	18	Yes	Yes	
965 Yonge Street	Drilled	1983	21	Yes	Yes	
971 Yonge Street	Drilled	1983	23	No	Yes	
2994 20th Sideroad	Drilled	-	-	Yes	Yes	
1001 Lockhart Road	Drilled	-	9	Yes	Yes	
2033 Lockhart Road	Drilled	-	-	Yes	Yes	
2041 Lockhart Road	Drilled	-	8	Yes	Yes	
2751 Lockhart Road	Drilled	1973	14	No	Yes	
894 Lockhart Road	Drilled	-	-	Yes	Yes	
541 Mapleview Road	-	-	-	Yes	Yes	
969 Mapleview Drive	Drilled	-	13	Yes	Yes	
1856 Quantz Crescent	Drilled	1983	-	Yes	Yes	
76 St. Pauls Street	Drilled	-	-	-	Yes	
8342 Yonge Street	Drilled	-	12	Yes	Yes	
958 Yonge Street	Drilled	1999	12	No	-	

"-" indicates information is unknown or not provided

Table E-1 Monitoring and Mitigation Plan Hewitt's SPA Landowner's Group

Item	Frequency/ Duration	Notes	Mitigation
Groundwater level monitoring at five private water supply wells	Start up in spring 2019 Five year duration in Area 1 Ten year duration in Area 2	See Figure Mon 1 for locations	Replacement domestic wells to be selected from vulnerable well list if wells are unavailable or unsuitable for monitoring
Water sampling at five selected private water supply wells	Baseline survey in spring 2019	See Figure Mon 1 for locations	Replacement domestic wells to be selected from vulnerable well list if wells are unavailable or unsuitable for sampling.
Data downloads from installed data loggers	Quarterly downlaods at private water supply wells. Five year duration in Area 1 Ten year duration in Area 2	See Figure Mon 1 for locations	Data loggers to be repaired or replaced as required
Notification of residents within 300 m of planned construction	As required	Residences within 300 m of construction to be advised at least 2 weeks ahead of construction of planned activities and provided with contact information in case of impact	
Water quantity complaints	As required		Investigation to be initiated and temporary water to be supplied for duration of impact
Water quality complaints	As required		Investigation to be initiated and temporary water to be supplied for duration of impact



Legend

- 🟥 HEWITT'S SECONDARY PLAN AREA (STUDY AREA)
- ⬚ STUDY AREA BUFFER (300m)
- MUNICIPAL BOUNDARY
- ROADWAY
- RAILWAY
- ⊕ WELL LOCATION CONFIRMEND THROUGH WELL SURVEY
- ⊙ WELL LOCATION FROM MECP WELL RECORDS

WELL VULNERABILITY

- ● HIGH
- ● MODERATE

34 MAP WELL ID (from Table E-2)

- ● SELECTED MONITORING AREA - 1
- ● SELECTED MONITORING AREA - 2
- ● SELECTED MONITORING AREA - 3
- ● SELECTED MONITORING AREA - 4
- ● SELECTED MONITORING AREA - 5

Note: Alternative monitoring locations may be selected based on resident response.

Sources:

1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. County of Simcoe WebServices
4. Satellite Image: Simcoe County online maps, Public/Ortho_2012
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Client / Report

HEWITT'S CREEK LANDOWNERS GROUP
BARRIE, ONTARIO

HEWITT'S SPA WELL SURVEY REPORT

Figure Title

MONITORING LOCATIONS FOR PRIVATE WATER SUPPLY

Drawn	Checked	Date	Figure No.
SK	DS	April 2019	Mon 1
Scale		Project No.	
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R.J. Burnside & Associates Limited