Hydrogeological Impact Assessment for 16114 Airport Road, East Caledon, Ontario

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March 2017 - Updated September 2020
300039242.0000

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Record of Revisions

Revision	Date	Description
-	March 17, 2017	First Submission
1	September 10, 2018	Second Submission to Glen Schnarr & Associates
2	August 23, 2019	Third Submission to Glen Schnarr & Associates
3	October 25, 2019	Fourth Submission to Glen Schnarr & Associates
4	September 29, 2020	Fifth Submission to Glen Schnarr & Associates

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1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) was retained by Shacca Caledon Holdings Inc. (Shacca) to complete a hydrogeological assessment for a property located at 16114 Airport Road in Caledon East, Ontario (Figure 1). The legal description of the property is Part Lot 4, Concession 6 (EHS), Part 1 on Plan 43R20293. The property is approximately 4.09 ha and urban development is proposed for the subject lands that will include condominium townhouses and retail commercial. For the purposes of this study, the property is referred to as the subject lands.

The subject lands are bounded by Airport Road to the east, residential lots to the north, Walkers Road to the south and a woodlot/wetland to the west. The land uses on the subject lands currently include residential, open meadow and woodland and wetlands (Figure 2).

2.0 Scope of Work

The scope of the hydrogeological assessment was based on our experience in completing similar studies and our understanding of agency requirements. The study included the following:

1. Review of published geological and hydrogeological information: A review of background material for the area, including surficial geology and bedrock geology mapping, Ministry of Environment, Parks and Conservation (MECP) water well records and existing geotechnical and hydrogeological reports was completed to assess the regional hydrogeological setting. The water well records reviewed are summarized in Appendix A.

2. Review of borehole logs: Borehole logs from geotechnical investigations on the subject lands completed in October 2016 by Terraprobe were reviewed to characterize the surficial sediments and estimate the hydraulic conductivity of the soils encountered. The borehole logs and monitoring well construction details are provided in Appendix B. Grain-size analyses were conducted at specific locations and the results are provided in Appendix C.

3. Monitoring of groundwater levels: Monitoring of monitoring wells and piezometers has been completed to measure the depth to the water table and assess the horizontal and vertical groundwater flow conditions. Groundwater level measurements were completed between October 2016 and March 2020. Automatic water level recorders (dataloggers) were installed in two groundwater wells (BH3s and BH3d) and one piezometer (PZ2d) to record continuous water level fluctuations. A barologger was installed on the subject lands to collect

barometric data that was used for barometric correction of the datalogger results. The groundwater monitoring data and hydrographs are provided in Appendix D.

4. Piezometers including one nest (one shallow and one deep piezometer installed in the same location) were installed to investigate shallow groundwater conditions and the potential for groundwater/surface water interactions along the watercourse that traverses the subject lands.

5. Monitoring of surface water: Three surface water monitoring stations (SS1, SS2 and SS3) were established along the watercourse that traverses the subject lands. During monitoring events, the surface water stations were visually inspected and spot flow measurements were taken when flow was present. The surface water monitoring data are summarized in Appendix E.

6. Single well response tests were completed in two groundwater monitoring wells (BH6 and BH18) to estimate the in-situ hydraulic conductivity of the geological units. The field testing results and calculations are provided in Appendix C.

7. Water quality samples were collected from one groundwater monitoring well (BH18) and from the watercourse that traverses the subject lands at SS1. The laboratory and field water quality data are provided in Tables F-1 and F-2, respectively in Appendix F.

8. Water balance calculations: Pre-development water balance calculations (based on existing land use conditions) and post-development water balance calculations (based on the proposed development concept) were completed to assess the potential impacts of land development on the local groundwater recharge conditions. The local climate data and detailed water balance calculations are provided in Appendix G.

9. Dewatering assessment: An assessment of the potential dewatering requirements for the site was completed. The assessment is provided in Appendix H.

10. Water well survey: A door-to-door water well survey was completed to identify water supply wells within 500 m of the site. The results of the survey are provided in Appendix I.

3.0 Physiography and Topography

The subject lands are located near the boundary of the Niagara Escarpment and the Oak Ridges Moraine physiographic regions (Chapman and Putnam, 1984). The Oak Ridges Moraine is one of the largest moraines in the Ontario extending from the Niagara Escarpment east through the Greater Toronto Area and to Rice Lake. The Moraine has a distinctive hummocky topography and due to its coarse grained sediments very low surface drainage. The Niagara Escarpment Region extends from the Niagara River to the north tip of the Bruce Peninsula. Physiographic mapping indicates that the subject lands are located along a spillway located between a kame moraine to the north and till moraine to the south (Chapman and Putnam, 1984).

The topography of the subject lands is gently rolling with elevations ranging from 291 metres above sea level (masl) in the eastern corner to 297.75 masl along the northwest property boundary (Figure 3). The highest elevations on the subject land are associated with a small hill located on the northwest boundary that rises 5 m above the center of the subject lands and the nearby woodlot/wetland area. The subject lands generally slopes to the east and southeast (Figure 3).

4.0 Drainage

The subject lands are located in the Humber River watershed and are within the jurisdiction of the Toronto and Region Conservation Authority (TRCA). A watercourse traverses the west side of the subject lands that is part of the headwaters of Boyce’s Creek, a tributary of the Humber River. The watercourse consists of two branches, one entering the property from the northwest boundary and one from the western boundary.

Surrounding the watercourse is a woodlot/wetland that is part of the provincially significantly Caledon East Wetland Complex. The Caledon East Wetland Complex consists of six hydrologically linked wetlands on the Oak Ridges Moraine (OMNRF, 2015).

4.1 Surface Water Monitoring

Surface water monitoring was completed at three locations along Boyce’s Creek. The monitoring locations SS1 to SS3 were inspected for surface water levels and flow during monitoring events completed between October 2016 and March 2020. The locations of the surface monitoring stations (SS) are shown on Figure 2 and flow measurements are presented in Table E-1, Appendix E.

SS1 is located on the watercourse as it enters from the northwest property boundary flowing in a southeast direction. The watercourse originates from a pond on a residential property north of the subject lands (Figure 3). SS2 is located near the confluence of the northwest branch with another branch of the tributary (Figure 3) that originates within woodlot/wetland west of the subject lands and enters the subject lands along its western edge. SS3 is downstream of SS2 and is located along the main watercourse as it leaves the subject lands through a culvert under Walker Road West.

Flow measurements at all stations (SS1 to SS3) indicate flow ranging between < 0.5 L/s to 10.4 L/s. Flow was perennial in the watercourse, with the exception of some winter months due to frozen conditions in the watercourse. Flow measurements along the creek suggest that the creek is a losing stream during low water table conditions (Fall 2016, Summer 2017, 2018, September 2019) and a gaining stream during high water table conditions (Spring 2017, 2018, 2019, 2020 and November 2017). The stream flow data is in agreement with the interpreted gradients observed at PZ2s/d (see Figure D-10) with the recharge conditions observed in October, November 2016, August and September 2017 and September 2019 and discharge conditions observed from April to July 2017, November 2017, May 2018 and June 2019.

5.0 Hydrogeology

5.1 Geology

Surficial geology mapping published by the Ontario Geological Survey (OGS, 2003) indicates that the surficial sediments at the subject lands consist of glaciofluvial deposits of sand and gravel (Figure 4). Ice-contact stratified deposits of sand and gravel with minor silt and clay till are located west of the subject lands. The glaciofluvial deposits on the subject lands are identified as being part of the Caledon East Meltwater Channel (White, 1975).

Bedrock in the area of the subject lands is shale, dolostone and limestone of the Queenston Formation (OGS, 1991). MECP water well records in the area indicate that the bedrock is located between 24 m to 36 m below ground surface.

Geotechnical boreholes completed on the subject lands (logs provided in Appendix B and locations shown on Figure 5) indicate that the stratigraphy generally consists of topsoil with thickness of 100 mm to 450 mm, silty sand fill with depths ranging from 0.3 m to 1.2 m, overlying glaciofluvial deposits of sand, silty sand and sandy silt. The boreholes extended to depths of 5 to 6.6 mbgs (Terraprobe, 2016). A lens of clayey silt was observed at BH13 with a thickness of 1.6 m. The clayey silt was not observed at any of the other boreholes.

5.2 Hydrostratigraphy

Two interpreted cross sections through the subject lands have been prepared to illustrate the local stratigraphy of the subject lands. The cross sections use site-specific geological information obtained from the geotechnical boreholes (logs provided in Appendix B) and MECP water well records (Appendix A). Regional modelling completed for the area (Earthfx, 2008) to support the delineation of the Caledon East municipal wells wellhead protection areas (WHPA) was also used to interpret the stratigraphy of the subject lands. The cross section locations are shown on Figure 5 along with the borehole locations and MECP water well records that have been used to prepare the cross sections. The interpreted cross sections are provided as Figures 6 and 7.

Regional modelling indicates that the stratigraphic units in the area of the subject lands consist of the Oak Ridges Aquifer Complex (ORAC), Newmarket Till, Thorncliffe Formation and bedrock (Earthfx, 2008). The cross sections show that the main aquifer underlying the subject lands is the ORAC consisting of glaciofluvial deposits of sand, silty sand and sandy silt with occasional lenses of clay which range from 2 to 10 m thick. Underlying the ORAC are clay sediments interpreted to be Newmarket Till with thicknesses of 10 to 20 m. A few water supply wells in the area of the subject lands are screened in a layer of sand beneath the clay layer and interpreted to be the Thorncliffe Formation (Figure 6). Shale bedrock is interpreted to occur at approximately 270 masl to 245 masl.

5.3 Local Groundwater Use

The MECP maintains a database that provides geological records of water supply wells drilled in the province. A review of this database was completed and a table summarizing water well records within 500 m of the subject lands is provided in Appendix A. The MECP water well record database indicates that there are 31 water well records located within 500 m of the subject lands. The water well record details are provided in Appendix A and the well locations are plotted on Figure 5. 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.

Of the 31 identified water well records, 12 were monitoring wells, five were test boreholes, six abandoned wells, seven supply wells and one unknown. Of the seven water supply wells, one was screened in the shale bedrock and two were screened in deep sand (Thorncliffe Formation) interpreted to be below the zone of interest for the current study. Four water supply wells were overburden wells screened at depths of 6.1 m to 26.5 m and within the zone of interest for the current study.

The proposed development will be municipally serviced and there is no proposed groundwater use for the development. The village of Caledon East is serviced by Region of Peel’s Caledon East water supply system. The subject lands are located within the WHPA-C (5 year time of travel) zone of the combined WHPA for Caledon East Well 2 & 3 (Figure 9). Since the issuing of the Toronto and Region Source Protection Areas Assessment Report (TRCA, 2015) Caledon East Well 2 has been decommissioned (Region of Peel, 2018). The WHPA for Caledon East Well 3 will be updated by the Region of Peel but is not yet available. Caledon East Well 3 is screened in the ORAC at depths of 30.2 m to 47.2 m deep (TRCA, 2015).

5.4 Hydraulic Conductivity

There are various methods that can be used to assess soil hydraulic conductivity, i.e., the ability of the soil to transmit groundwater. Grain-size data and soil characteristics can be used to provide a general estimate of hydraulic conductivity.

In-situ bail-down or slug-testing methods are used in groundwater monitoring wells to assess site-specific hydraulic conductivity. These methods have been used to estimate the hydraulic conductivity of the soils encountered in the study area as discussed below.

5.4.1 Grain-Size Analysis

As part of the geotechnical study completed by Terraprobe, representative soil samples of soil types encountered in the boreholes were collected and submitted for grain-size analysis. A summary of the grain-size analyses is provided in Table 1 and data is provided in Appendix C.

Table 1: Summary of Grain-Size Analyses

Sample ID	Depth of Sample (mbgs)	Soil Classification	% Fines
BH4-SS2	1.0	Sandy Silt, trace clay	69
BH8-SS5	3.3	Sandy Silt, trace clay, trace gravel	67
BH12-SS3	1.8	Sand and Silt, trace clay	53
BH15-SS3	1.8	Silt and Sand, some clay	64
BH19-SS4	2.5	Sand, some silt, trace clay, trace gravel	20

Grain-size analyses results indicate that the sediments within the overburden are variations of sand and silt with some to trace gravel and clay.

To estimate hydraulic conductivity based on grain-size analyses, an empirical method known as the Hazen estimation can be used. This method is an approximation of hydraulic conductivity based on grain-size curves for sandy soils. Terraprobe derived a hydraulic conductivity value of 2.2 x 10-^{5} cm/sec using the Hazen method for the BH19-SS4.

5.4.2 Single Well Response Tests

To assess the in-situ hydraulic conductivity of the sediments, in-situ well testing was conducted on two monitoring wells. Single well response tests (bail-down tests) were conducted at BH6 and BH18. The results from the tests were plotted (Appendix C) and analyzed to estimate hydraulic conductivity of the sediments screened. The single well response test analysis resulted in hydraulic conductivities in the range of 10^{-4} cm/sec. A summary of the formations screened in the tested wells and the calculated hydraulic conductivities is provided below in Table 2.

Table 2: Single Well Response Testing Results

Monitoring Well	Well Depth (mbgs)*	Formation Screened	Hydraulic Conductivity (cm/sec)
BH6	5.34	Sand	4.4×10^{-4}
BH18	4.65	Sandy Silt to Silt and Sand	4.2×10^{-4}

*metres below ground surface

Grain-size analysis results indicate that the sediments sampled range in composition from sand with some silt (20% fines) to sandy silt with trace clay and trace gravel (69%) fines. The greater number of fines within a deposit impacts the ability of the aquifer to transmit water and thus the overall hydraulic conductivity. Groundwater flow is generally limited by sediments with lower hydraulic conductivity. Overall, the hydraulic conductivity found within the overburden on the subject lands is interpreted to be moderate, in the range of 10^{-4} to 10^{-5} cm/sec.

5.5 Groundwater Levels

Monitoring wells were installed in nine boreholes by Terraprobe in October 2016 and four drive-point piezometers were installed along the watercourse that traverses the subject lands to monitor shallow groundwater and surface water interactions (Figure 2). Groundwater levels collected from monitoring wells and piezometers on the subject lands are provided in Table D-1 in Appendix D and hydrographs for each monitoring location are provided in Appendix D. Groundwater elevations are plotted with daily precipitation data obtained from a nearby climate station – Toronto Lester B. Pearson International Airport (Climate Station ID# 6158733) which is the closest station with daily precipitation values for 2016-2018.

In addition to the manual water level measurements recorded at each location, automatic water level recorders were installed at BH3s, BH3d, and PZ2d in October 2016. The datalogger was removed from PZ2d during the winter months to prevent freezing of the logger. The datalogger hydrographs are presented in Appendix D.

5.5.1 Monitoring Wells

The groundwater elevation data indicates that the water table across the subject land's ranges between approximately 289 masl and 293.5 masl. A seasonal variation in the groundwater table of up to 2.35 m is observed at monitoring wells with water levels highest in the spring and decreasing over the summer and early fall months. During high water table conditions groundwater levels within 1 m of ground surface are observed at BH6, BH15 and BH18. Groundwater was also reported as within 1 m of ground surface at BH3s with the potentiometric surface in BH3d being above grade.

Water levels in the nested wells, BH3s/d show an upward gradient with the deep well BH3d (depth of 11.45 mbgs) consistently higher than levels in the shallow well BH3s (depth of 4.11 mbgs) (Figure D-1). This relationship indicates that groundwater from the lower zone is serving to recharge the shallow zone in the area of this nest. The above grade water level noted at BH3d is interpreted to represent a potentiometric surface which is the level to which groundwater would rise if the overlying layers were punctured, they however do not represent the shallow water table conditions on the subject lands as BH3d is 11.45 m deep and is completed below the zone that is expected to be impacted by the proposed development. It is our interpretation that the shallow water table conditions are reflected by conditions at BH3s and the other shallow boreholes on site.

5.5.2 Piezometers

Water level data collected at four piezometers located along Boyce’s Creek are provided in Table D-1 and on Figures D-9 to D-11.

PZ1 is located at the northwest property boundary as the creek flows into the subject lands (Figure 2). Groundwater levels at PZ1 range between 293.6 and 293.75 masl and are consistently less than 1 m below ground level. Based on observed water levels and their relation to local topography, groundwater flow is interpreted to converge towards the watercourse near PZ1 and groundwater discharge to the watercourse is possible in this area.

Piezometer nest PZ2s/d is located south of PZ1 just before the confluence of a channel from the south into the main creek (Figure 3). Water levels at PZ2s/d ranged from 291.2 masl to 292.3 masl (Figure D-10). The continuous water level data collected by a datalogger in PZ2d shows responses to precipitation events of approximately 0.1 m to 0.7 m depending on the event (Figure D-10). From October to December 2016, water levels in the piezometers recover from installation, indicating that the soils have a low hydraulic conductivity. Groundwater levels in the deep piezometer were higher than the shallow piezometer from April to July 2017, November 2017 and May 2018 indicating an upward gradient. It is interpreted that groundwater discharge is possible during high water table conditions at this location. During low water table conditions (August and September 2017, July 2018 and September 2019) the water levels in the piezometers have similar elevations showing no gradient or a downward gradient.

PZ3 is located on the southwest boundary as the creek leaves the subject lands (Figure 2). Water levels at PZ3 ranged from 290.37 masl to 290.78 masl with highest levels occurring in the spring (Figure D-11). Groundwater levels at this piezometer were also consistently within 1 m of grade and groundwater discharge to the creek is also possible at this location.

5.6 Groundwater Flow

Groundwater elevation data (May 2017) obtained from the monitoring wells and piezometers are shown on Figure 8, along with the interpreted groundwater elevation contours for the area. Arrows perpendicular to the groundwater elevation contours shown on Figure 8 illustrate the interpreted direction of the groundwater movement. Groundwater flow across the subject lands is interpreted to be a general south and southeast direction. The groundwater is influenced by the surface topography with groundwater moving from topographic highs towards topographic lows. This is consistent with regional groundwater flow mapping for the ORAC (Earthfx, 2008).

5.6.1 Recharge and Discharge Conditions

Areas where water from precipitation infiltrates into the ground and moves downward (i.e., areas of downward hydraulic gradients) are known as recharge areas. These areas are generally in areas of relatively higher topographic elevation. Areas where groundwater moves upward (i.e., areas of upward hydraulic gradients) are discharge areas and these generally occur in areas of relatively lower topographic elevation.

The monitoring of water levels with nested wells (one shallow, one deep) such as BH3s/d and PZ2s/d was intended to assist with the determination of vertical hydraulic gradients and thereby assist with the evaluation of groundwater recharge or discharge conditions on the subject lands.

An upward gradient at monitoring well nest BH3s/d is observed with water levels in the deep well consistently higher than levels in the shallow well. BH3s/d is located in the eastern corner of the subject lands which is also the lowest section of the subject lands. Groundwater flow is interpreted to flow towards BH3s/d and the upward gradient is a result of the 6 m decrease in topography west to east. Water levels in the piezometer nest PZ2s/d show an upward gradient during high water table conditions and no gradient or a downward gradient during low water table conditions.

Groundwater flowing from the high point along the west portion of the subject lands is interpreted to converge along the watercourse near PZ1 (Figure 8). Moving south the watercourse is interpreted to be a losing stream (recharge conditions) during low water table conditions and a gaining stream during high water table conditions.

6.0 Water Quality

6.1 Groundwater Quality

A groundwater quality sample was collected from BH18 in December 2016. The laboratory groundwater chemistry results are provided in Table F-1 in Appendix F.

The groundwater quality data were compared to the Ontario Drinking Water Quality Standards (ODWQS) and show:

- The groundwater showed elevated levels of hardness (372 mg/L) and manganese (0.153 mg/L). Hardness and manganese are both aesthetic objectives and no health concerns are associated with these parameters. Elevated levels of hardness and manganese are generally a result of the source material in which the groundwater is found.
- Turbidity was also elevated above the ODWQS aesthetic objectives, 31,200 NTU compared to the objective of 5 NTU. High turbidity may result from high levels of sediment in the sample which is interpreted to be due to the non-removal of sediment from the well after drilling (well was not developed).
- Sodium and chloride concentrations in the groundwater were 15.4 mg/L and 36.1 mg/L respectively. These concentrations are not considered elevated due to anthropogenic activities.
- Nitrate and nitrite were not detected in the groundwater samples (<0.25 mg/L). Nitrate in groundwater is typical of areas where agricultural activities are present. Since land uses in the vicinity of the subject lands do not include agricultural activities elevated nitrates are not expected.

6.2 Surface Water Quality

A surface water sample was collected in December 2016 at SS1 and analyzed for general water quality indicator parameters, basic ions such as chloride and nitrate, and selected metals. The laboratory surface water chemistry results are provided in Table F-2 in Appendix F.

The surface water quality data were compared to the Provincial Water Quality Objective (PWQO) and show:

- Sodium and chloride concentrations were 18.8 mg/L and 27 mg/L respectively. These values are similar to values in the groundwater sample supporting the interpretation that there is groundwater contribution to the watercourse at SS1 (Figure 8).
- Nitrate and phosphorus were not detected in the surface water sample (<0.25 mg/L and <0.01 mg/L respectively). Since land uses in the vicinity of the subject lands do not include agricultural activities elevated nitrates and phosphorus are not expected.
- The laboratory results indicate that all metals were below the PWQOs.

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.

7.1 Water Balance Components

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

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

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

The components of the water balance vary in space and time and depend on climatic conditions as well as the soil and land cover conditions (i.e., rainfall intensity, land slope, soil hydraulic conductivity and vegetation). Runoff, for example, occurs particularly during periods of snowmelt when the ground is frozen, or during intense rainfall events.

Precise measurement of the water balance components is difficult and as such, approximations and simplifications are made to characterize the water balance of a study area. Field observations of the drainage conditions, land cover and soil types, groundwater levels and local climatic records are important input considerations for the water balance calculations.

The water balance components are discussed below:

Precipitation (P)

The long-term average annual precipitation for the area is 821 mm based on data from the Environment Canada Albion Field Centre Climate Station (Station 6150103, 43.55°N 79.50°W, Elevation 281.9 masl) for the period between 1981 and 2010. The climate station is located 6.7 km north of the subject lands. Although this station is closest to the subject lands it does not have daily precipitation data for the monitoring period (2016 to 2019) and hence could not be used for the hydrographs presented in Section 5.5.

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.

Evapotranspiration (ET)/Evaporation (E)

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). The mean annual ET has been calculated for this study using a monthly soil-moisture balance approach considering the local climate conditions.

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 (I) the surficial soil.

The infiltration is comprised of two-end member components: one component that moves vertically downward to the groundwater table (typically referred to as recharge) and a second component that moves laterally through the 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 overland during precipitation or snowmelt events, shallow interflow becomes an “indirect” component of runoff. The interflow component of surface water 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, but both interflow and direct runoff contribute to the overall surface water runoff from a property.

7.2 Approach and Methodology

The analytical approach to calculate a water balance for the subject lands involved monthly soil-moisture balance calculations to determine the pre-development (based on the existing land use conditions) infiltration and runoff 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 (deeper infiltration).

A soil moisture storage capacity of 75 mm was used for areas with mowed grass and meadow vegetation on the subject lands. A soil moisture storage capacity of 300 mm was used for forested areas on the subject lands. Table G-1 (for 75 mm retention) and Table G-2 (for 300 mm retention) in Appendix G detail the monthly potential evapotranspiration calculations accounting for latitude and climate, and then calculate the actual evapotranspiration and water surplus components of the water balance based on the monthly precipitation and soil moisture conditions.

The MECP SWMP Design Manual methodology for calculating total infiltration based on topography, soil type and land cover was used and a corresponding runoff component was calculated. These water balance component calculations are shown on Tables G-1 and G-2 in Appendix G. The calculated water balance components from the table are then used to assess the pre-development water balance scenario based on the existing land use characteristics (residential and agricultural/ natural areas).

7.3 Component Values

The detailed monthly calculations of the water balance components are provided on Tables G-1 and G-2 in Appendix G. The calculations show that a water surplus is generally available from December to May (Tables G-1 and G-2, Appendix G). The monthly water balance calculations illustrate how infiltration occurs during periods when there is sufficient water available to overcome the soil moisture storage requirements. In winter climates, frozen conditions affect when the actual runoff and infiltration will occur, however, the monthly balance calculations show the potential volumes available for these water balance components.

The monthly calculations are summed to provide estimates of the annual water balance component values (Tables G-1 and G-2, Appendix G). A summary of these values is provided in Table 3.

Table 3: Water Balance Component Values

Water Balance Component	Lawn/Meadow	Wooded Areas
Average Precipitation	821 mm/year	821 mm/year
Actual Evapotranspiration	579 mm/year	579 mm/year
Water Surplus	286 mm/year	243 mm/year
Infiltration	171 mm/year	218 mm/year
Runoff	114 mm/year	24 mm/year

7.4 Pre-Development Infiltration (Existing Conditions)

Pre-development water balance calculations are presented in Table G-3 in Appendix G. As summarized on Table G-3, the total area of the subject lands is about 4.1 ha. The water balance component values from Table G-1 and Table G-2 were used to calculate the average annual volume of infiltration across the subject lands. Based on these component values, the pre-development infiltration volume for the subject lands is calculated to be about 8,000 m^3/year (Table G-3, Appendix G).

7.5 Potential Development Impacts to Water Balance

Development of an area affects the natural water balance. The most significant difference is the addition of impervious surfaces as a type of surface cover (i.e., roads, parking lots, driveways, and rooftops). Impervious surfaces prevent infiltration of water into the soils and the removal of the vegetation removes the evapotranspiration component of the natural water balance. The evaporation component from impervious surfaces is relatively minor (estimated to be 10% to 20% of precipitation) compared to the evapotranspiration component that occurs with vegetation in this area (about 65 to 70% of precipitation on the subject lands). 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, 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 component is reduced. A calculation of the potential water surplus for impervious areas is shown at the bottom of Table G-1 in Appendix G.

7.6 Post-Development Infiltration

The post-development plans for the subject lands include residential condominiums of approximately 0.84 ha and a commercial area of approximately 0.55 ha. A small portion of the lands will be used for the widening of the right of way for Airport Road (0.07 ha) and a portion will be used for a park. The representative imperviousness values for each of the post-development land uses as provided by Trafalgar Engineering, are provided below in Table 4.

Table 4: Water Balance Land Use Categories

Land Use Category	Land Area (m^2)*	Estimated Imperviousness*
Residential	8,420	68%
Commercial	5,550	68%
Potential Park	1,037	0%
Road Widening	1000	0%
Natural Heritage System and Buffer	24,854	0%

*values provided by Trafalgar Engineering

To assess potential development impacts on infiltration, the post-development infiltration volumes have been calculated for the subject lands on Table G-3 in Appendix G. The calculated post-development infiltration volume would be about 6,600 m^3/year.

Comparing the pre- and post-development infiltration volumes shows that development has the potential to reduce the average infiltration on the subject lands by about 19%.

As noted above, with the wide margins of error associated with this type of analysis, the infiltration deficit volume is considered as a reasonable estimate that can be considered as an infiltration target for the design of stormwater management measures.

7.7 Mitigation

In order to mitigate the potential impacts of development on the water balance the use of ‘low impact development’ (LID) measures for storm water management will be used. Low Impact Development is based on the premise of trying to manage storm water to minimize the runoff of rainfall and increase the potential for infiltration. As outlined in the MECP SWMP Design Manual (2003) and Low Impact Development Stormwater Management Planning and Design Guide published by the CVC and TRCA (2010), there are a wide variety of mitigation techniques that can be used to try to reduce the increases in direct runoff that occur with land development and increase the potential for post-development infiltration.

Techniques to maximize the water availability in pervious areas such as downspout disconnection and designing grades to direct roof runoff towards lawns, side and rear yard swales, and other pervious areas where possible can considerably increase the volume of infiltration in developed areas. This type of surface LID technique promotes natural infiltration simply by providing additional water volumes in the previous areas. This may be particularly effective in the summer months, when natural infiltration would not generally occur because the additional water overcomes the natural soil moisture deficit.

Quantification of the surficial LID techniques is challenging and there are no widely accepted quantification standards however the following calculations are provided to illustrate the positive impact of implantation of downspout disconnection. Downspout disconnection and directing of roof leaders to pervious areas provides additional water to these areas. These pervious areas would receive precipitation as well as extra water from roof runoff, and with such increased water supply, evapotranspiration can occur at the maximum potential rate. Within the proposed development, all residential roofs leaders will be disconnected and directed to rear/side yards. The heritage house to be used for commercial development will also have roof leader disconnection with runoff directed to pervious areas. The TRCA & CVC Stormwater Management Criteria (2010) indicates that the benefit of downspout disconnection is a 50% reduction in runoff (increase in infiltration) due to roof leader disconnection for sandy soils. The impact of the reduction in runoff (increase in infiltration) has been estimated for the area of the development that will be residential development plus the heritage house. Table G-4 in Appendix G summarizes the impact of downspout disconnection and indicates that the above measures will achieve an additional 1,106 m^3/year of infiltration

(Table G-4, Appendix G). The calculation illustrates that using downspout disconnection would increase the post-development recharge volume to approximately 7,660 m^3/year which is approximately 95% of the pre-development recharge. It is generally accepted that post-development infiltration that is within 10% of pre-development is within the margin of error for water balance calculations and can be regarded as acceptable due to the required assumptions and simplifications. The calculations demonstrate that the impact of development can be mitigated by the proposed measures.

8.0 Impact Assessment

8.1 Water Quality

Depending on land use, runoff from urban developments may contain a variety of dilute contaminants such as suspended solids, chloride from road salt, oil and grease, metals, pesticide residues, bacteria and viruses. The proposed development will be serviced by municipal waste water services. Therefore, there will be no impact related to onsite groundwater disposal of septic effluent. For groundwater, generally, with the exception of the dissolved constituents such as nitrogen and salt, most contaminants are attenuated by filtration during groundwater transport through the soils. The potential for effects on groundwater quality from infiltration on the subject lands is therefore expected to be limited. It is recommended that winter maintenance on the property be conducted according to industry best management practices to limit the amount of road salt infiltrating into the aquifer. Only clean roof runoff water will be directed to pervious areas for infiltration and this will support the management of impacts due to winter road maintenance.

8.2 Construction Below the Water Table

It is expected that excavations during construction of servicing may extend below the water table in some areas where localized dewatering may be required. Water takings in excess of 50,000 L/day are regulated by the Ministry of Environment, Conservation and Parks (MECP). For construction dewatering in excess of 50,000 L/d but less than 400,000 L/d the site needs to register via the Environmental Sector Activity Registry (EASR) process. For takings in excess of 400,000 L/d a Permit to Take Water (PTTW) will be required. An assessment of the potential dewatering requirements for the subject lands is provided in Appendix H.

8.3 Private Water Wells

Most of the areas surrounding the subject lands are municipally serviced however it is possible that there may be some properties that still rely on private wells as a water supply. As indicated in Section 5.3, MECP water well records indicate that there are potentially seven private supply wells located within 500 m of the subject lands. A door-to-door water well survey was completed on July 9, 2018 to identify water supply wells within 500 m of the subject lands. If the homeowner was not home a survey and prepaid envelope was left for the homeowner. The results of the survey are summarized in Appendix I.

Based on the interpreted groundwater flow, none of the potential domestic wells are located downgradient of the subject lands (Figure I-1) and the area is municipally serviced. Impacts on private water wells from the proposed development are not anticipated.

8.4 Monitoring and Mitigation

Despite the anticipated limited impact on groundwater and surface water resources due to construction on the subject lands, it is recommended that a monitoring program be put in place as part of site due diligence. The monitoring program is recommended to ensure that unacceptable impacts to the local groundwater and surface water quality and quantity do not occur during the construction activities. The recommended monitoring program includes three stages as follows:

1. **Pre-construction monitoring –** to establish the baseline groundwater and surface water conditions prior to initiation of earthworks.

2. **Monitoring during construction –** to trigger any contingency actions required to prevent or mitigate impacts to the groundwater and surface water.

3. **Post-construction monitoring –** to confirm acceptable groundwater and surface conditions once construction activities are complete.

8.4.1 Pre-Construction

Pre-construction monitoring would be a continuation of the on-going bimonthly groundwater and surface water monitoring on the subject lands. Monitoring that has been occurring since October 2016 should provide an adequate baseline for pre-construction conditions.

8.4.2 During Construction

During construction groundwater monitoring should continue at piezometers within the wetland and groundwater wells outside of the area of construction. Monitoring locations equipped with automatic water level meters should continue to be downloaded to provide a detailed record of groundwater levels during construction activities. Since no private water wells were confirmed within the vicinity of the subject lands and lands downgradient of the subject lands are municipally serviced private water well monitoring is not required.

8.4.3 Post-Construction

Following completion of the construction activities, monitoring of the piezometers and any remaining groundwater observation wells should continue bi-monthly until water levels in the wells have recovered and stabilized or at least for a period of four months.

8.4.4 Contingency

Although impacts are not anticipated should it be determined that construction activities have impacted surrounding receptors (including private water supply wells, wetlands or watercourses) then the following mitigation measures will be taken:

Wetlands/Watercourses: Should groundwater levels in wetland piezometers fall below background levels during dewatering, it will trigger an investigative action by which a review of precipitation data and dewatering pumping rates will be conducted. The review will investigate the cause of the decrease in water levels by looking at precipitation patterns and dewatering records. Should a correlation to dewatering be identified then mitigation measures will be initiated. Impacts may be mitigated by discharging pumped water to the area of the impacted watercourse.

Private Water Supply Wells: If an interference complaint is received from a private water supply well owner, it will be reported to the MECP and an investigation will be initiated. While the complaint is being investigated, the resident will be provided with an adequate potable water supply and this will remain in place until the supply has been reinstated or the investigation completed with a no fault conclusion. As part of the investigation, an automatic water level meter will be installed in the well and a short-term test will be completed. Should it be determined that a water supply has been adversely affected by dewatering, the temporary water supply will remain in place. Should the investigation indicate that other factors not due to dewatering are at play, the resident will be informed and options for obtaining a replacement supply will be provided.

9.0 Development Considerations

9.1 Source Water Protection

The subject lands are located within the Toronto and Region Source Protection Area for which policies in the CTC Source Protection Plan (SPP) apply. Policies in the CTC SPP apply to vulnerable areas defined under the Clean Water Act including wellhead protection areas (WHPA), highly vulnerable aquifers (HVA) and significant groundwater recharge areas (SGRAs).

9.1.1 Wellhead Protection Area

Wellhead protection areas are areas where water travels through the ground to a municipal well. The areas are determined based on the time of travel for groundwater to reach the municipal well and include a WHPA-A (100 meter radius around well), a 2 year time of travel zone (WHPA-B), a 5 year time of travel zone (WHPA-C) and a 25 year time of travel zone (WHPA-D). Wellhead protection areas in the vicinity of the subject lands are mapped in Figure 9. Since the subject lands are located within a WHPA for the Caledon East water supply system (Caledon East Wells 2 and 3) the proposed development will be subject to policies if activities include any of the prescribed drinking water threats (Clean Water Act, 2006) that would be a significant drinking water threat. The prescribed drinking water threats include:

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

17. The handling and storage of an organic solvent.

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

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

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

21. The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.

22. The establishment and operation of a liquid hydrocarbon pipeline.

The Table of Drinking Water Threats (Clean Water Act, 2006) provides the circumstances for which a prescribed threat may be considered a concern for each vulnerable area and ranks the threats as low, moderate or significant based on the vulnerability of the area and the threat rating. The Table of Drinking Water Threats was reviewed to identify potential significant drinking water threats associated with the proposed development. Based on the property being within a WHPA-C with a vulnerability of 8, any activities that would include the storage or handling of Dense Non-aqueous Phase Liquids (DNAPLs) would be significant threats and would therefore be prohibited with the exception of incidental quantities for personal use. This prohibition would likely impact tenants for the proposed commercial development if their activities include the use of DNAPL products. It is recommended that this be further examined during the tenant selection process or as required by the municipality. The prohibition is not expected to impact residential uses.

It is noted that Caledon East Well 2 has been decommissioning since the issuing of the Toronto and Region Source Protection Areas Assessment Report (CTC SPR, 2015) however updates to the WHPAs for Caledon East Well 3 are not completed yet. Until these updates are included in an updated approved assessment report, the policies for the current WHPAs will apply.

9.1.2 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. The delineation of these areas was completed for the Toronto and Region Source Protection Area Assessment Report 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. SGRA mapping from the Assessment Report is shown on Figure 10. Only a small portion of the subject lands is located within a SGRA and it is within the woodlot/wetland outside of the area of development.

9.1.3 Highly Vulnerable Aquifers

Highly vulnerable aquifers (HVAs) are aquifers that are more susceptible to contamination. Aquifer vulnerability refers to the susceptibility of the aquifer to potential contamination. The vulnerability of an aquifer is dependent upon the depth to the water table (for unconfined aquifers) or to the depth of the aquifer (for confined aquifers) and the type of soil above the water table or aquifer. Aquifer vulnerability mapping was completed as part of the Toronto and Region SPA Assessment Report (CTC SPR, 2015). Areas with high vulnerability were identified as Highly Vulnerable Aquifers (HVA) which have policies within the CTC Source Protection Plan. As shown on Figure 10, the entire subject lands are located within an HVA.

There are policies within the CTC SPP that apply future uses within HVAs (i.e. Policies SAL-10, SAL-12, DNAP-3 and OS-3). These policies encourage best management practices related to the application of road salt and the handling and storage of dense non-aqueous phase liquids and organic solvents.

Policy SAL-10 and SAL-12 require salt management plans for developments with new roads and parking lots within HVAs. The salt management plan would include mitigation measures regarding design of parking lots, roadways and sidewalks to minimize the need for repeat application of road salt. A Salt Management Plan for the development will be provided at Site Plan Approval.

Since the subject lands are located in a WHPA-C, the handling and storage of dense non-aqueous phase liquids is prohibited, therefore implementation of DNAP-3 will not be required. Policy OS-3 suggests that best management practices be encouraged for ICI properties for the storage and handling of organic solvents. Best management practices could include proper storage practices for chemicals and spill response plans.

9.2 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 private domestic wells and to the groundwater observation wells installed for this study unless they are maintained throughout the construction for monitoring purposes.

10.0 References

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BURNSIDE

[The Difference is our People]

Figures

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LEGEND

▭ SUBJECT LANDS

N

0 50 100 200 300 400 500 600 700 800

Meters

BURNSIDE

Client/Report

SHACCA CALEDON HOLDINGS INC.
CALEDON EAST, ONTARIO

HYDROGEOLOGICAL IMPACT ASSESSMENT

Map Title

SITE LOCATION

Drawn SK

Checked SC

Date September 2020

Figure No. 1

Scale 1:10,000

Project No. 300039242

File Path: Nigel\Shared Work Areas\039242 Shacca\06_GIS\ 039242 Shacca HG Assessment SL.mxd

LEGEND

□ SUBJECT LANDS
— WATERCOURSE
⊕ MONITORING WELL (TERRAPROBE, 2016)
● PIEZOMETER
▲ SURFACE WATER MONITORING STATION

Sources:

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

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CALEDON EAST, ONTARIO

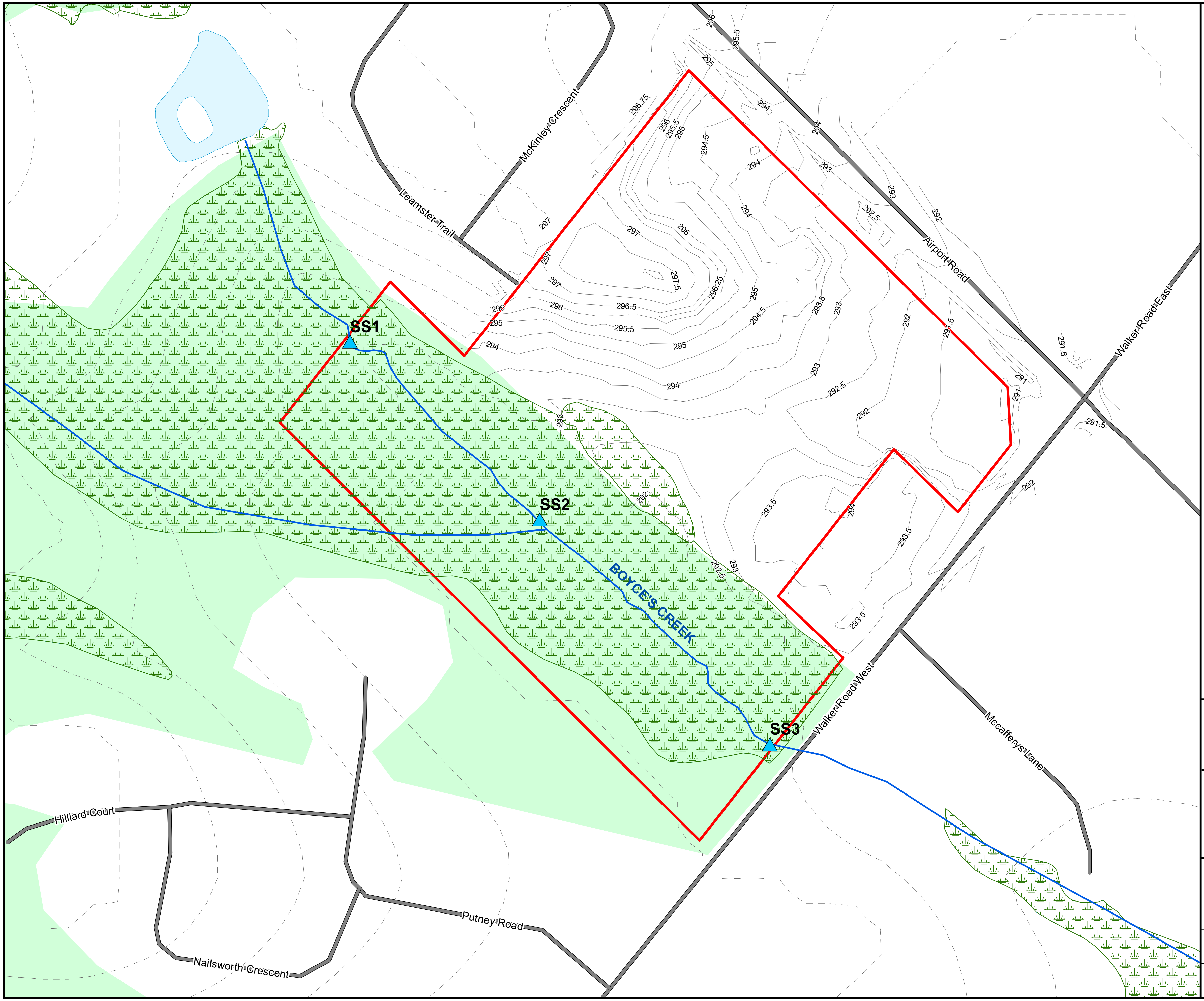
HYDROGEOLOGICAL IMPACT ASSESSMENT

Figure Title

MONITORING LOCATIONS

Drawn	Checked	Date	Figure No.
SK	SC	September 2020	2
Scale		Project No.	
1:1,250		300039242	

File Path: Nigel\Shared Work Areas\039242 Shacca\06_GIS\ 039242 Shacca HG Assessment ML.mxd



LEGEND

- 🟥 SUBJECT LANDS
- ROADWAY
- WATERCOURSE
- CONTOUR (1m intervals - masl)
- CONTOUR (0.5m intervals - masl)
- WETLAND
- OPEN WATER
- WOODS
- ▲ SURFACE WATER MONITORING STATION

Sources:

1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Site contours provided by David B. Searles Surveying Ltd., July 21, 2016.
4. Regional contours created from 2002 Dem file, MNR.

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0 20 40 60 80 100 120

Metres

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CALEDON EAST, ONTARIO

HYDROGEOLOGICAL IMPACT ASSESSMENT

Figure Title

TOPOGRAPHY AND DRAINAGE

Drawn	Checked	Date	Figure No.
SK	SC	September 2020	3
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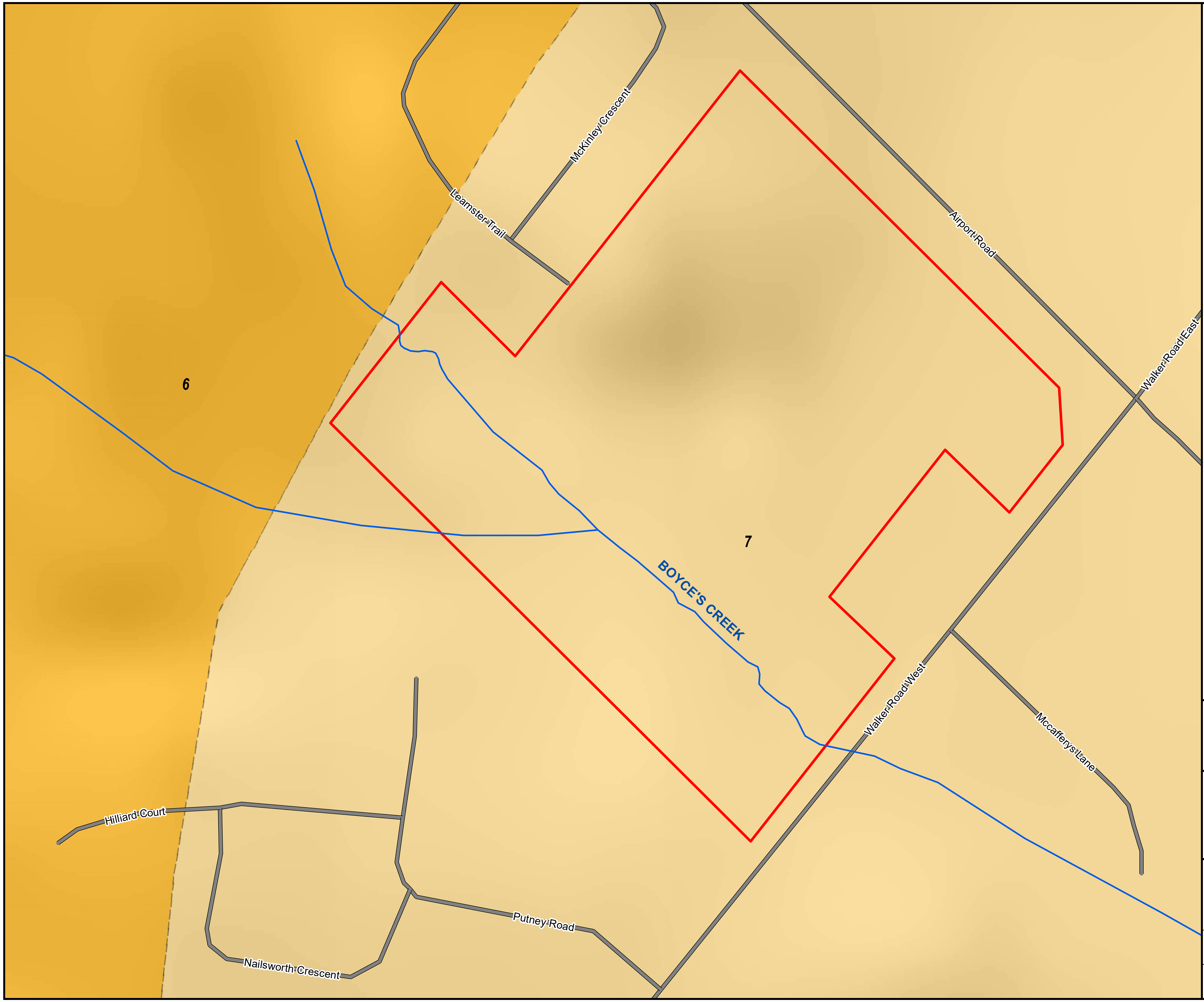

LEGEND

- 🟥 SUBJECT LANDS
- ━ ROADWAY
- ─ WATERCOURSE
- 🟧 6: Ice-contact stratified deposits: sand and gravel, minor silt, clay and till
- 🟨 7: Glaciofluvial deposits: sand and gravel

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 2003. Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128.

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HYDROGEOLOGICAL IMPACT ASSESSMENT

Figure Title

SURFICIAL GEOLOGY

Drawn	Checked	Date	Figure No.
SK	SC	September 2020	4
Scale		Project No.	
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LEGEND

🟥 SUBJECT LANDS
⊕ MUNICIPAL WELL
— WATERCOURSE
● MONITORING WELL (TERRAPROBE, 2016)
● BOREHOLE (TERRAPROBE, 2016)
⊕ MECP WELL RECORD LOCATION
⌴ CROSS SECTION LOCATION KEY

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CALEDON EAST, ONTARIO

HYDROGEOLOGICAL IMPACT ASSESSMENT

Figure Title

WELL LOCATION PLAN

Drawn	Checked	Date	Figure No.
SK	SC	September 2020	5
Scale		Project No.	
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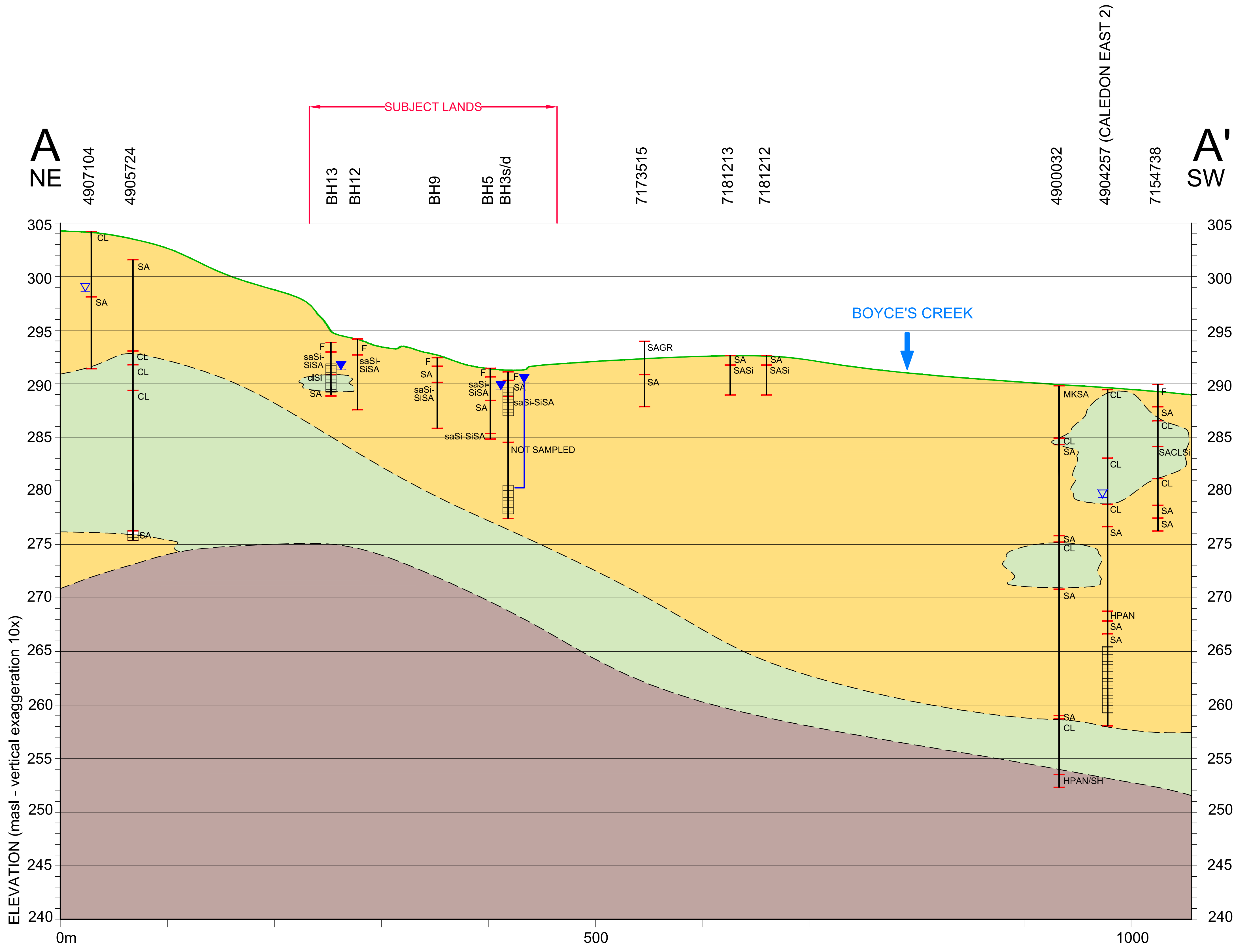

LEGEND

BH1 WELL NUMBER

EXISTING GROUND PROFILE

CLSA GEOLOGICAL STRATIGRAPHY

▼ MEASURED WATER LEVEL (DECEMBER 15, 2016)

WELL SCREEN

🟨 SAND / SILTY SAND

🟩 CLAY / CLAY TILL

🟫 SHALE / BEDROCK

⬇ WATERCOURSE CROSSING

si	SILTY
cl	CLAYEY
sa	SANDY
F	FILL
T	TILL
MK	MUCK
SA	SAND
Si	SILT
GR	GRAVEL
CL	CLAY
PRDG	PREDUG
SH	SHALE
HPAN	HARDPAN

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HYDROGEOLOGICAL IMPACT ASSESSMENT

Figure Title

INTERPRETED GEOLOGICAL CROSS SECTION A-A'

Drawn	Checked	Date	Figure No.
SK	SC	September 2020	6
Scale		Project No.	
1:4,000		300039242	

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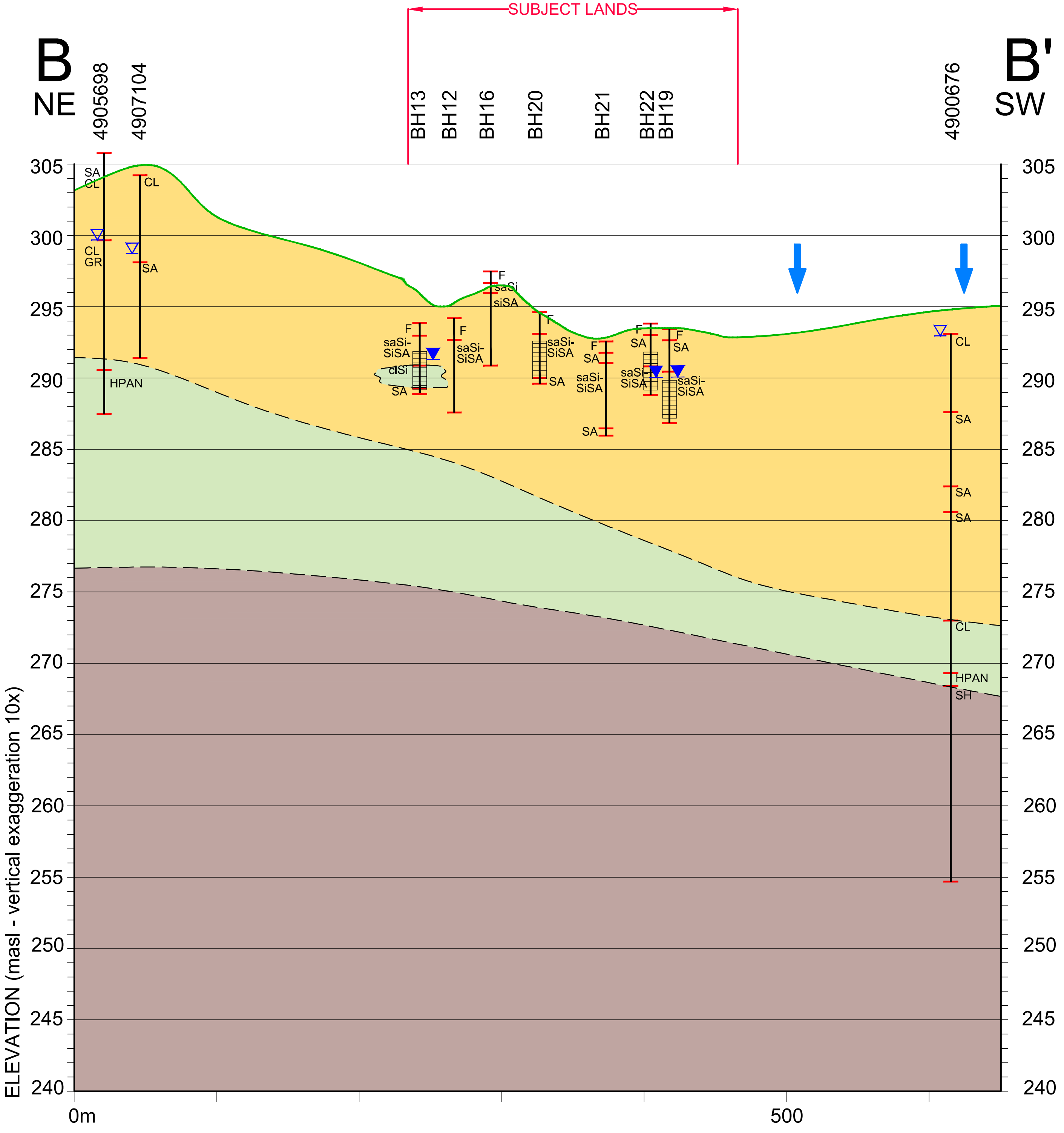

LEGEND

BH1 WELL NUMBER

EXISTING GROUND PROFILE

CLSA GEOLOGICAL STRATIGRAPHY

MEASURED WATER LEVEL
(DECEMBER 15, 2016)

WELL SCREEN

🟨	SAND / SILTY SAND
🟩	CLAY / CLAY TILL
🟫	SHALE / BEDROCK
↓	WATERCOURSE CROSSING

si	SILTY
cl	CLAYEY
sa	SANDY
F	FILL
T	TILL
MK	MUCK
SA	SAND
Si	SILT
GR	GRAVEL
CL	CLAY
PRDG	PREDUG
SH	SHALE
HPAN	HARDPAN

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CALEDON EAST, ONTARIO

HYDROGEOLOGICAL IMPACT ASSESSMENT

Figure Title

**INTERPRETED GEOLOGICAL
CROSS SECTION B-B'**

Drawn	Checked	Date	Figure No.
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Scale		Project No.	
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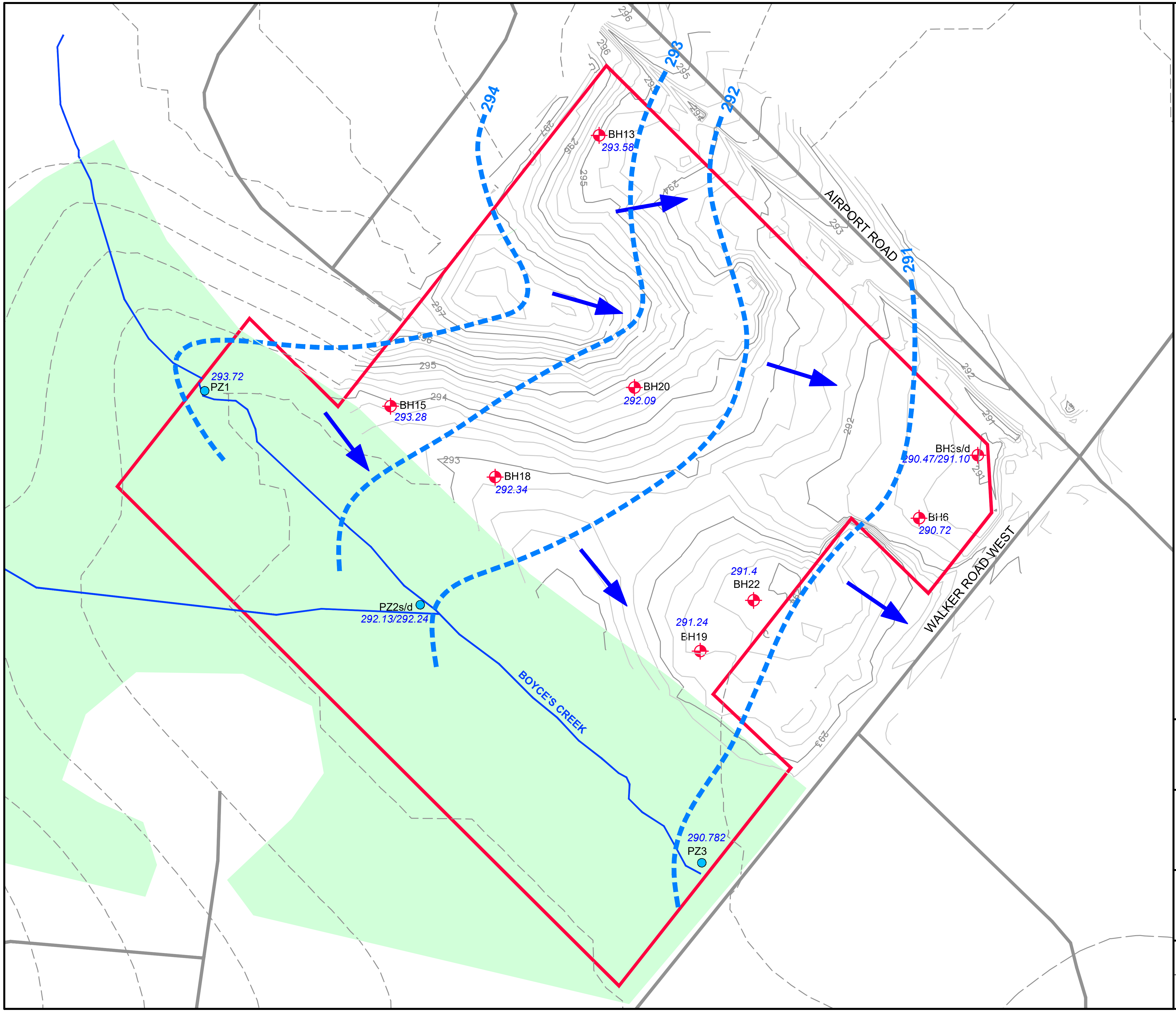

LEGEND

- 🟥 SUBJECT LANDS
- WATERCOURSE
- 🟩 WOODED AREA
- CONTOUR (0.5m intervals - masl)
- CONTOUR (1m intervals)
- ⊕ MONITORING WELL (TERRAPROBE, 2016)
- ● DRIVE POINT PIEZOMETER (RJB, 2016)
- INTERPRETED GROUNDWATER CONTOUR (masl)
- *289.45* MEASURED WATER LEVEL (MAY 11 2017)
- → INTERPRETED GROUNDWATER FLOW DIRECTION

Sources:
1. Ministry of Natural Resources, © Queen's Printer for Ontario
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3. Site contours provided by David B. Searles Surveying Ltd., July 21, 2016.
4. Regional contours created from 2002 Dem file, MNR.

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CALEDON EAST, ONTARIO

HYDROGEOLOGICAL IMPACT ASSESSMENT

Figure Title

INTERPRETED GROUNDWATER FLOW

Drawn	Checked	Date	Figure No.
SK	SC	September 2020	8
Scale		Project No.	
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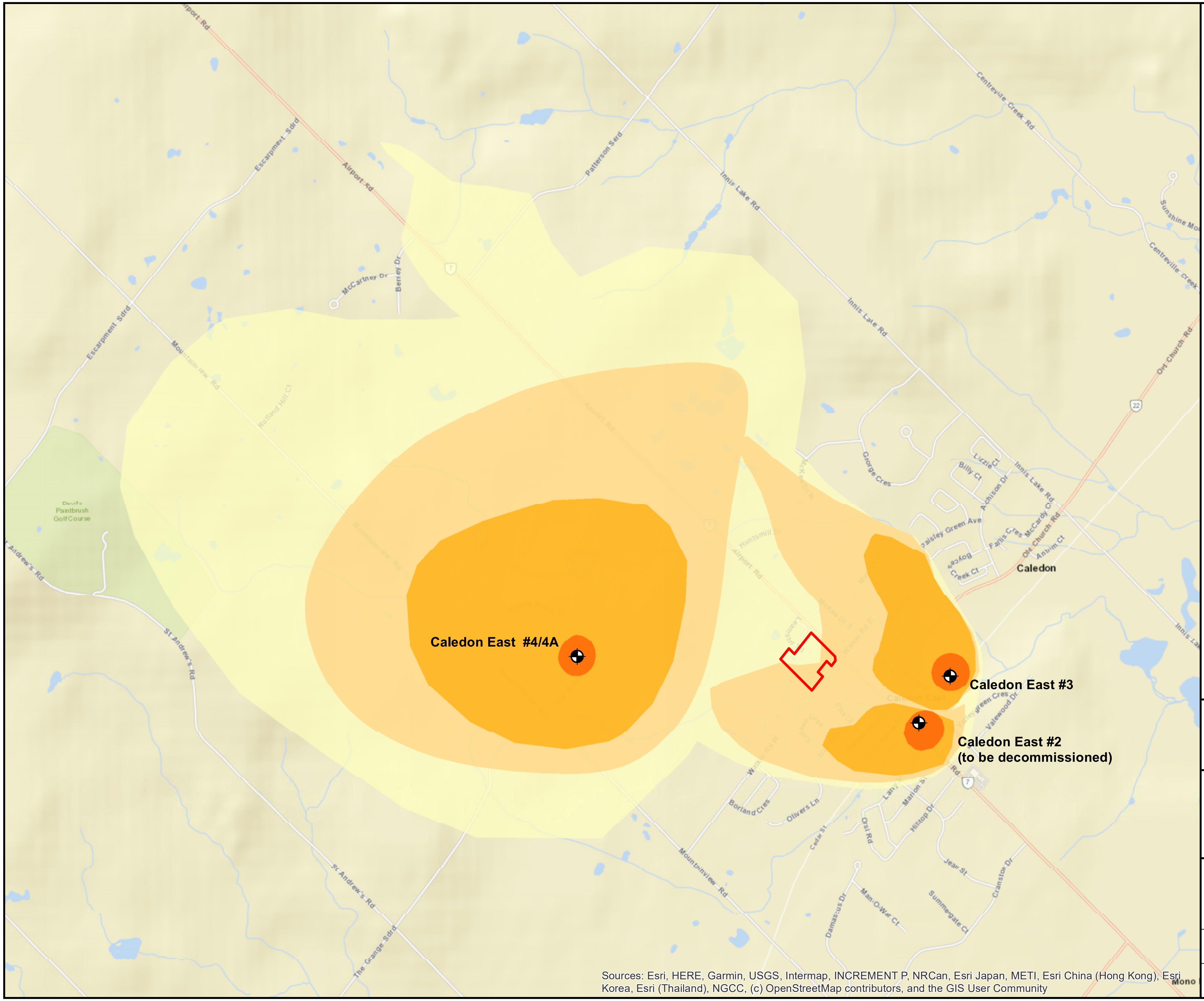

LEGEND

🟥	SUBJECT LANDS
⌖	MUNICIPAL WELL
🟧	WHPA - A
🟨	WHPA - B
▨	WHPA - C
▢	WHPA - D

Sources:

1. Ministry of Natural Resources, © Queen's Printer for Ontario
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3. WHPA Mapping obtained from Region of Peel, 2012, online mapping.

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HYDROGEOLOGICAL IMAPCT ASSESSMENT

Figure Title

WELLHEAD PROTECTION AREAS

Drawn	Checked	Date	Figure No.
SK	SC	September 2020	9
Scale		Project No.	
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LEGEND

- 🟥 SUBJECT LANDS
- 🟨 SIGNIFICANT GROUNDWATER RECHARGE AREAS (SGRA)
- ▨ HIGHLY VULNERABLE AQUIFER AREAS

Sources:
1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. SGRA and HVA mapping derived from Ontario Land Information, Source Protection Information Atlas, Minitry of the Environment, Conservation and Parks - online mapping.

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CALEDON EAST, ONTARIO

HYDROGEOLOGICAL IMPACT ASSESSMENT

Figure Title

VULNERABLE AREAS

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SK	SC	September 2020	**10**
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Appendix A

Water Well Records

Appendix A

TOWNSHIP CONCESSION (LOT)	UTM^1	DATE ^{2} CNTR ^{3}	CASING DIA ^{4}	WATER^{5,6} DETAIL	STAT LVL/PUMP LVL^7 RATE^8/TIME HR:MIN	WATER USE^9	SCREEN INFO^{10}	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND^{5,11}
CALEDON TOWN (ALBION CON 01(019)	17 591794 4857734^W	2006/05 4011	00		055 / / :0			4910197 (Z30265) SAND CLN 0057 0055 SAND FILL CLN 0053 0033 SAND FILL 0032 0005 SAND FILL 0003
CALEDON TOWN (ALBION CON 01(019)	17 591630 4857603^W	1961/05 1308	30	FR 0062	062 / 007 / :0	ST		4900031 () BRWN CLAY 0006 GRVL 0011 BRWN CLAY MSND 0029 BRWN MSND 0070 BRWN CLAY MSND 0073 BRWN MSND 0075
CALEDON TOWN (ALBION CON 01(020)	17 591555 4857643^W	1960/04 2801	10	FR 0075 FR 0004		NU		4900036 () LOAM 0001 FSND BLDR 0004 FSND SILT 0012 FSND BLDR 0014 FSND SILT 0048 GRVL MSND 0051 MSND SILT GRVL 0054 CLAY GRVL 0063 CLAY 0073 MSND SILT 0075 SHLE 0081
CALEDON TOWN (ALBION CON 01(020)	17 592040 4858931^W	2006/07 4011	00		012 / / :0			4910267 (Z49734) PRDG 0035
CALEDON TOWN (ALBION CON 01(020)	17 591239 4857864^W	1994/09 3406	08	UK 0041	006 / 040 200 / 6:0	NU	49 21	4907959 (149263) GRVL FILL STNS 0001 BLCK SILT 0002 GREY CLAY SLTY SAND 0009 GREY SILT CLAY 0024 GREY CLAY 0029 GREY CLAY STNS 0031 GREY CLAY SOFT 0039 GREY CLAY STNS 0040 BRWN CLAY SAND 0041 BRWN FSND MSND 0064 BRWN MSND 0071
CALEDON TOWN (ALBION CON 01(020)	17 591964 4858923^W	1980/05 3612	30 30	UK 0022	022 / 030 004 / 1:30	DO		4905749 () BRWN LOAM 0002 BRWN SAND CLAY 0021 BRWN SAND 0026 BRWN SAND GRVL 0032
CALEDON TOWN (ALBION CON 01(020)	17 591238 4857863^W	1994/08 3406	08	UK 0041	007 / 040 150 / 6:30	NU	41 20	4907960 (149277) GRVL FILL 0001 BLCK LOAM 0002 GREY CLAY SLTY SAND 0008 GREY SILT CLAY 0029 GREY CLAY SLTY SOFT 0038 GREY CLAY STNS HARD 0040 BRWN CLAY SAND 0041 BRWN SAND CLAY LYRD 0063
CALEDON TOWN (ALBION CON 01(020)	17 591172 4857921^W	1959/01 2904	06	FR 0046 FR 0101	004 / / :0	NU		4900032 () BRWN MSND 0002 BLCK MUCK MSND 0016 GREY CLAY 0018 QSND 0046 QSND GRVL 0048 CLAY FSND 0062 QSND 0101 QSND GRVL 0102 CLAY MSND 0119 HPAN SHLE 0123
CALEDON TOWN (ALBION CON 01(020)	17 591238 4857863^W	1994/08 6490	04	FR 0042		NU	42 5	4907901 (151023) GREY GRVL FILL 0002 BLCK LOAM 0003 GREY SILT CLAY SAND 0016 GREY SILT CLAY 0042 BRWN SAND GRVL LYRD 0062
CALEDON TOWN (ALBION CON 01(020)	17 592009 4858898^W	1974/04 3612	30 30	UK 0021	021 / 035 003 / 1:0	DO		4904342 () BRWN LOAM 0002 BRWN SAND 0020 GREY SAND 0022 GREY GRVL 0035 GREY FSND 0037
CALEDON TOWN (ALBION CON 01(020)	17 591417 4858178^W	1979/05 4006						4905642 ()

TOWNSHIP CONCESSION (LOT)	UTM^{1}	DATE ^{2} CNTR ^{3}	CASING DIA ^{4}	WATER^{5,6} DETAIL	STAT LVL/PUMP LVL^{7} RATE^{8}/TIME HR:MIN	WATER USE^{9}	SCREEN INFO^{10}	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND^{5,11}
CALEDON TOWN (ALBION CON 01(020)	17 591485 4857693^{W}	1960/04 2801	10	FR 0014		NU		4900037 () LOAM 0001 FSND BLDR 0014 GRVL 0018 FSND GRVL 0020 GRVL 0022 GRVL FSND CLAY 0025 FSND SILT 0034 FSND 0036 FSND SILT 0041
CALEDON TOWN (ALBION CON 01(020)	17 592452 4858432^{W}	2000/03 7110	06	FR 0208	020 / 175 012 / 2:0	DO	209 7	4908579 (212842) BRWN SAND CLAY 0044 BLUE CLAY 0072 GREY SILT 0208 BRWN SAND 0217 BLUE CLAY 0220
CALEDON TOWN (ALBION CON 01(020)	17 591841 4858992^{W}	1960/03 2801	10	FR 0012 FR 0090		NU		4900035 () LOAM 0001 FSND 0002 MSND GRVL BLDR 0012 FSND GRVL 0021 MSND SILT GRVL 0026 MSND SILT 0032 GRVL 0033 MSND SILT 0038 FSND SILT 0045 MSND SILT 0067 CLAY 0090 MSND SILT 0112 GRVL 0114 FSND GRVL 0115 BLUE CLAY 0116 SHLE 0135
CALEDON TOWN (ALBION CON 01(020)	17 591837 4858771^{W}	1965/10 3612	36	FR 0023	023 / 003 / :0	DO		4900039 () LOAM 0001 MSND STNS 0027 QSND 0030
CALEDON TOWN (ALBION CON 01(020)	17 591364 4858614^{W}	2006/09 7147	01			NU	10 1	4910305 (Z53721) A041545 BLCK LOAM 0001 BRWN SAND 0010
CALEDON TOWN (ALBION CON 01(020)	17 591316 4857985^{W}	2006/08 7147	01			NU	7 1	4910303 (Z53723) A041547 BLCK LOAM 0001 BRWN SAND 0008
CALEDON TOWN (ALBION CON 01(020)	17 591090 4858021^{W}	1960/08 2801	10	FR 0039	003 / 029 155 / 24:0	MN	65 10	4900038 () LOAM 0002 MSND SILT 0020 BLUE CLAY 0039 GRVL MSND CLAY 0046 MSND SILT 0049 FSND 0059 MSND 0067 FSND SILT 0117
CALEDON TOWN (ALBION CON 01(020)	17 592340 4858419^{W}	1967/08 3612	36	FR 0019	019 / 027 002 / 1:0	DO		4900033 () LOAM 0002 BRWN CLAY BLDR 0019 MSND STNS 0028 BLUE CLAY STNS 0030
CALEDON TOWN (ALBION CON 01(020)	17 591238 4857863^{W}	1994/08 6490	02	FR 0040		NU	40 5	4907902 (151024) BLCK LOAM 0001 GREY SILT CLAY SAND 0014 GREY SILT CLAY 0040 BRWN SAND GRVL LYRD 0050
CALEDON TOWN (ALBION CON 01(021)	17 591752 4858806^{W}	2006/07 4011	00		015 / / :0			4910268 (Z49735) PRDG 0024
CALEDON TOWN (ALBION CON 01(021)	17 589093 4861825^{W}	2004/02 7143	06	UK	054 / 076 003 / 4:0	DO	79 7	4909364 (Z04340) A004236 BRWN MSND 0061 BRWN CLAY MSND MGVL 0081 BRWN MSND 0086
CALEDON TOWN (ALBION CON 01(021)	17 591322 4858523^{W}	1959/11 2801	02	SA 0055	008 / 012 016 / 3:0	NU	51 10	4900040 () LOAM 0001 FSND CLAY 0004 MSND GRVL 0015 MSND GRVL BLDR 0031 CSND GRVL 0037 MSND GRVL BLDR 0042 CSND GRVL 0055 MSND CLAY GRVL 0061

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
CALEDON TOWN (ALBION CON 01(021)	17 591393 4858528^{W}	1959/12 2801	02	FR 0051	008 / 014 030 / 4:0	NU	50 11	4900042 () LOAM 0001 FSND BLDR 0008 MSND GRVL BLDR 0030 MSND GRVL 0041 MSND CLAY 0051 FSND CLAY 0061
CALEDON TOWN (ALBION CON 01(021)	17 591770 4858842^{W}	2006/07 4011	00		013 / / :0			4910269 (Z49736) PRDG 0019
CALEDON TOWN (ALBION CON 01(021)	17 591414 4858623^{W}	1959/03 2904	06	FR 0044 FR 0016	009 / 038 080 / 72:0		28 10 38 6	4900034 () LOAM 0002 SAND GRVL CLAY 0016 SAND GRVL 0018 BLDR SAND 0019 SAND GRVL 0024 SAND STNS BLDR 0027 SAND GRVL 0035 CSND GRVL 0040 FSND 0041 GRVL SAND 0044 FSND 0055
CALEDON TOWN (ALBION CON 01(021)	17 591293 4858498^{W}	1959/11 2801	02	FR 0061	008 / 015 030 / 6:0	NU	61 11	4900041 () LOAM 0001 MSND GRVL BLDR 0044 FSND 0061 FSND SILT CLAY 0083
CALEDON TOWN (ALBION CON 01(022)	17 591148 4858924^{W}	1973/08 2801				PS		4904266 () BRWN SAND GRVL BLDR 0005 BRWN CLAY SAND 0051 BRWN CLAY SILT 0062 GREY CLAY 0076 GREY SHLE CLAY 0083 GREY LMSN 0086
CALEDON TOWN (ALBION CON 01(022)	17 591240 4859627^{W}	1973/08 2801				PS		4904264 () BRWN SAND GRVL CLAY 0038 BRWN CLAY 0044 BRWN SAND CLAY 0049 GREY CLAY GRVL 0063 GREY CLAY 0070 SAND GRVL 0071 GREY SAND CLAY GRVL 0083 GREY CLAY 0137 GREY FSND GRVL CLAY 0143 GREY SHLE 0150 GREY SHLE LMSN 0151
CALEDON TOWN (ALBION CON 01(022)	17 591044 4859326^{W}	1973/09 2801				PS		4904265 () LOAM 0003 GREY SILT CLAY 0073 BRWN SAND CLAY GRVL 0105 GREY CLAY GRVL 0110 RED CLAY 0117 GREY CLAY SHLE 0125
CALEDON TOWN (ALBION CON 01(022)	17 591034 4859359^{W}	1973/08 2801				PS		4904263 () LOAM 0001 BRWN FSND 0017 GREY SAND CLAY 0040 GREY CLAY SAND 0047 FSND GRVL CLAY 0058 GREY CLAY 0072 GREY FSND CLAY 0078 GREY CLAY GRVL 0087 GREY FSND CLAY 0103 GREY CLAY GRVL 0110 GREY SHLE LMSN 0122
CALEDON TOWN (ALBION CON 01(022)	17 590564 4858573^{W}	1978/08 3561	07	FR 0060	020 / 020 005 / 24:0	DO		4905698 () LOAM 0002 SAND CLAY 0020 CLAY GRVL SAND 0050 HPAN 0060
CALEDON TOWN (ALBION CON 01(022)	17 591426 4859460^{W}	1973/08 2801				PS		4904260 () BRWN MSND FSND 0015 BRWN CLAY 0041 GREY CLAY 0051 GREY SAND CLAY 0059 GREY SAND CLAY 0068 GREY CLAY 0075 GREY CLAY SAND 0093 GREY FSND CLAY 0097 SAND GRVL SHLE 0099 GREY CLAY GRVL SHLE 0108 RED SHLE 0112

TOWNSHIP CONCESSION (LOT)	UTM^{1}	DATE ^{2} CNTR ^{3}	CASING DIA ^{4}	WATER^{5,6} DETAIL	STAT LVL/PUMP LVL^{7} RATE^{8}/TIME HR:MIN	WATER USE^{9}	SCREEN INFO^{10}	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND^{5,11}
CALEDON TOWN (CALEDO HS E 06(001)	17 591783 4856251^{W}	1990/12 3132	06	FR 0070	017 / 055 007 / 2:30	DO	68 4	4907508 (78137) BRWN CLAY STNS DNSE 0016 BRWN CLAY SAND DNSE 0047 GREY SAND WBRG LOOS 0072
CALEDON TOWN (CALEDO HS E 06(001)	17 592149 4856719^{W}	1973/11 3561	07	FR 0055	050 / 060 001 / 3:0	DO		4904330 () LOAM 0002 BLUE CLAY 0055 GRVL CLAY 0060
CALEDON TOWN (CALEDO HS E 06(001)	17 591674 4856466^{L}	2003/10 7154				NU		4909271 (264258) BRWN CLAY SILT 0013 BRWN CLAY 0036 BRWN MSND 0060 GREY SAND SLTY 0187 GREY CLAY 0209 GREY CLAY STNS SLTY 0318 GREY SILT FSND VERY 0326 GREY SILT STNS 0420
CALEDON TOWN (CALEDO HS E 06(001)	17 592185 4856809^{W}	1962/12 1307	30	FR 0034	034 / 004 / :0	DO		4900669 () BRWN LOAM 0020 GREY CLAY 0025 BRWN CSND 0046
CALEDON TOWN (CALEDO HS E 06(001)	17 591885 4856400^{W}	1973/05 4917	30	UK 0021	021 / 040 / 1:0	DO		4904072 () BRWN LOAM 0001 BRWN SAND 0042
CALEDON TOWN (CALEDO HS E 06(002)	17 590511 4856841^{W}	1975/10 5206	06	FR 0138	048 / 065 / :0	DO	145 5	4905001 () LOAM 0002 BRWN CLAY GRVL 0027 CLAY SAND 0080 HPAN 0120 BLUE CLAY GRVL 0138 GRVL 0150 GRVL 0163
CALEDON TOWN (CALEDO HS E 06(002)	17 591615 4857413^{W}	1977/06 3612	30 30	UK 0049	049 / 063 002 / 1:30	DO		4905179 () BRWN LOAM 0002 BRWN CLAY SAND 0041 GREY SAND 0049 BRWN SAND 0067
CALEDON TOWN (CALEDO HS E 06(002)	17 591290 4857451^{W}	1956/12 1307	36 36	FR 0054	054 / 001 / :0	DO		4900671 () BRWN LOAM 0018 BRWN LOAM MSND 0054 BRWN FSND 0063
CALEDON TOWN (CALEDO HS E 06(002)	17 590801 4856982^{W}	1988/07 4868	30	FR 0032	028 / / :0	MN	8	4906897 (41597) BRWN LOAM LOOS 0001 BRWN CLAY STNS SILT 0016 GREY CLAY SILT 0020 BRWN CLAY SILT 0026 BRWN SAND 0034
CALEDON TOWN (CALEDO HS E 06(002)	17 591527 4857206^{W}	1955/11 1308	24	FR 0049	049 / / :0	DO		4900670 () BRWN MSND 0049 BRWN QSND 0057
CALEDON TOWN (CALEDO HS E 06(002)	17 591250 4857365^{W}	1957/11 1307	36 36	FR 0037	037 / 003 / :0	DO		4900672 () BRWN LOAM 0037 BRWN CSND 0055
CALEDON TOWN (CALEDO HS E 06(003)	17 590802 4857342^{L}	3406				NU		4909380 (Z06220)
CALEDON TOWN (CALEDO HS E 06(003)	17 590164 4957474^{W}	1978/01 2341	05	FR 0015	006 / 008 010 / 4:0	DO	18 3	4905277 () BRWN SAND 0015 GRVL 0023
CALEDON TOWN (CALEDO HS E 06(003)	17 590114 4957374^{W}	1977/12 2341	05	FR 0018	008 / 014 006 / 4:0	DO	18 3	4905276 () BRWN SAND 0018 GRVL 0022
CALEDON TOWN (CALEDO HS E 06(003)	17 590200 4857053^{W}	2001/07 1663	06	FR 0025	007 / / :0	DO	35 3	4908889 (227475) BRWN SAND 0012 BLUE SAND CLAY LYRD 0038 BRWN CLAY SAND 0058 GREY GRVL CLAY 0063 RED SHLE 0066

TOWNSHIP CONCESSION (LOT)	UTM^1	DATE ^{2} CNTR ^{3}	CASING DIA ^{4}	WATER^{5,6} DETAIL	STAT LVL/PUMP LVL^7 RATE^8/TIME HR:MIN	WATER USE^9	SCREEN INFO^{10}	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND^{5,11}
CALEDON TOWN (CALEDO HS E 06(003)	17 592421 4856650^W	1989/02 3561	06	FR 0045	038 / 038 008 / 1:30	DO	42 3	4907027 () LOAM 0001 BRWN CLAY SAND 0025 BLUE CLAY 0045 SAND 0048
CALEDON TOWN (CALEDO HS E 06(003)	17 590064 4957274^W	1978/02 2341	05	FR 0015	007 / 006 / 4:0	DO		4905310 () BRWN SAND 0015 GRVL 0020 BLUE SILT 0024
CALEDON TOWN (CALEDO HS E 06(003)	17 590115 4857173^W	1978/09 3612	24 30	UK 0005	005 / 014 002 / 1:30	DO		4905453 () BLCK LOAM 0002 BRWN CLAY 0005 BRWN SAND CLAY 0012 BRWN FSND 0016
CALEDON TOWN (CALEDO HS E 06(004)	17 590205 4857795^W	1961/09 1307	30	FR 0028	/ 025 / :0	ST DO		4900679 () BRWN LOAM 0015 GRVL 0035
CALEDON TOWN (CALEDO HS E 06(005)	17 589426 4857857^W	1974/07 3612	30	UK 0019 UK 0031	014 / 036 003 / 1:30	DO		4904478 () BLCK LOAM 0002 BRWN CLAY STNS 0020 GREY SAND 0031 BRWN SAND STNS 0038
CALEDON TOWN (CALEDO HS E 06(005)	17 589468 4857949^W	1974/03 1657						4904318 () BRWN CLAY 0001 SAND 0027 FSND 0089 SILT CLAY 0098 CLAY SAND 0140 GREY CLAY 0149 CLAY SAND GRVL 0155 RED SHLE 0220
CALEDON TOWN (CALEDO HS E 06(005)	17 589635 4857743^W	1971/05 1657	05	FR 0160	028 / 120 020 / 5:0	DO		4903598 () BRWN MSND 0004 BLUE CLAY MSND 0092 GREY MSND CLAY SILT 0094 GREY MSND CLAY 0160 GRVL SILT 0165
CALEDON TOWN (CALEDO HS E 06(005)	17 589464 4857923^W	1977/04 4919	30	UK 0012	008 / 022 / 0:30	DO		4905130 () BRWN LOAM HARD 0001 BRWN CLAY HARD 0010 BRWN SAND LOOS 0022 GREY CLAY SOFT 0025
CALEDON TOWN (CALEDO HS E 06(005)	17 590514 4858473^W	1980/05 3317	05 05	FR 0083	012 / 060 006 / 3:0	ST DO	83 3	4905724 () SAND CLAY SLTY 0028 CLAY BLDR 0032 RED CLAY 0040 GREY CLAY STNS 0083 SAND STNS 0086
CALEDON TOWN (CALEDO HS E 06(006)	17 589452 4858283^W	1988/03 3903	06	FR 0187	033 / 070 300 / 24:0	MN	177 10	4906951 () BRWN CLAY SAND LYRD 0025 BRWN CLAY SAND STNY 0075 BRWN SAND CLAY STNY 0090 GREY CLAY STNS HARD 0132 GREY CLAY SOFT DNSE 0147 BRWN CSND GRVL LOOS 0187 RED CLAY STNS HARD 0204 GREY CLAY STNS HARD 0225 GREY SHLE CLAY LYRD 0240
CALEDON TOWN (CALEDO HS E 06(006)	17 580407 4847442^W	1999/09 3132	06 06	FR 0153	037 / 068 012 / :0	DO	149 4	4908531 (194165) BRWN CLAY SAND DNSE 0017 GREY CLAY STNS DNSE 0123 BLUE CLAY SAND DNSE 0137 BLUE CLAY STNS SAND 0160
CALEDON TOWN (CALEDO HS E 06(006)	17 589371 4858209^W	1990/12 3903	20 10	FR 0182	007 / 084 600 / 24:0	MN	156 26	4907507 (104161) BRWN CLAY SAND STNS 0025 BRWN CLAY STNS LYRD 0075 BRWN FSND CLAY STNS 0090 GREY CLAY STNS HARD 0132 GREY CLAY SOFT DNSE 0147 BRWN CSND GRVL LOOS 0186

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
CALEDON TOWN (CALEDO ()	17 590967 4857739^{W}	1949/08 4620		FR 0050	039 / / :0	CO		4900674 () LOAM MSND 0003 CLAY 0006 CLAY MSND 0030 BLUE CLAY 0043 GRVL CLAY MSND 0046 FSND 0055 FSND CLAY 0062 CLAY FSND 0069 HPAN CLAY 0096 MSND CLAY 0103 CLAY HPAN 0107 SHLE 0109
CALEDON TOWN (CALEDO ()		2003/01 1129	02	FR 0021			185 10	4909348 (54287) LOAM 0001 BRWN SAND 0007 BRWN SILT 0029 BRWN SAND GRVL 0039 BRWN SAND SNDY SILT 0065 BRWN SILT SAND 0070 GREY SILT WBRG CLYY 0082 GREY FSND SILT FGVL 0086 BRWN FSND SILT 0090 GREY SILT SAND WBRG 0172 GREY SILT CLYY 0177 GREY FSND SILT WBRG 0195
CALEDON TOWN (CALEDO ()	17 590949 4858010^{W}	2004/05 1129	02				14 10	4909686 (Z17484) A010248 LOAM 0001 BRWN SILT SAND GRVL 0006 BRWN CSND 0009 BRWN PEAT 0010 BRWN SILT 0012 GREY FSND 0016 GREY SILT FSND 0024
CALEDON TOWN (CALEDO ()	17 591128 4858035^{W}	2004/05 1129	02				14 10	4909685 (Z17483) A010247 BRWN LOAM 0001 BRWN SILT CLYY 0005 BRWN SILT FSND 0010 BRWN SILT SAND CLAY 0025
CALEDON TOWN (CALEDO ()		2003/01 1129	02	FR 0025			175 10	4909349 (54281) LOAM 0001 BRWN SAND 0004 BRWN SILT SAND 0014 BRWN FSND 0031 BRWN SILT SAND 0035 BRWN SAND WBRG 0042 GREY SILT WBRG 0054 GREY FSND WBRG 0095 GREY CLAY SAND SILT 0105 GREY SAND SILT WBRG 0110 GREY SILT SAND CLAY 0120 GREY SILT 0128 BRWN CLAY TILL 0140 BRWN SILT 0176 GREY GRVL TILL WDFR 0178 SHLE ROCK 0181
CALEDON TOWN (CALEDO ()	17 591240 4857923^{W}	1972/08 3002	20 10 20	FR 0071 FR 0044	033 / 044 225 / 20:0	MN	79 20	4904257 () BRWN CLAY SILT SAND 0021 GREY CLAY SILT 0035 CLAY SILT 0042 HPAN 0044 SAND CLAY 0068 HPAN 0071 FSND 0075 FSND 0103
CALEDON TOWN (CALEDO ()		2001/05 4011						4908801 (229079)
CALEDON TOWN (CALEDO ()	17 591470 4857512^{W}	1959/10 1307	30	FR 0054	054 / 002 / :0	DO		4900673 () BRWN LOAM 0040 BRWN MSND 0064
CALEDON TOWN (CALEDO ()	17 591081 4857930^{W}	1954/09 3512	04	FR 0152	072 / 121 002 / 1:0	DO		4900675 () YLLW CLAY 0006 YLLW MSND 0023 BLUE CLAY 0080 QSND 0121 BLUE CLAY 0152 FSND 0160
CALEDON TOWN (CALEDO ()	17 590516 4857742^{W}	1967/05 3612	36	FR 0009	009 / 017 002 / :0	DO		4900678 () LOAM 0001 CSND 0009 MSND 0018 QSND 0020

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Appendix B

Borehole Logs

LOG OF BOREHOLE 1

Terraprobe

Project No. : 1-16-0543-01	Client : Shacca Caledon Homes Inc.	Originated by : NB	
Date started : October 5, 2016	Project : 16114 Airport Road	Compiled by : AS	
Sheet No. : 1 of 1	Location : Caledon, Ontario	Checked by : MMT	

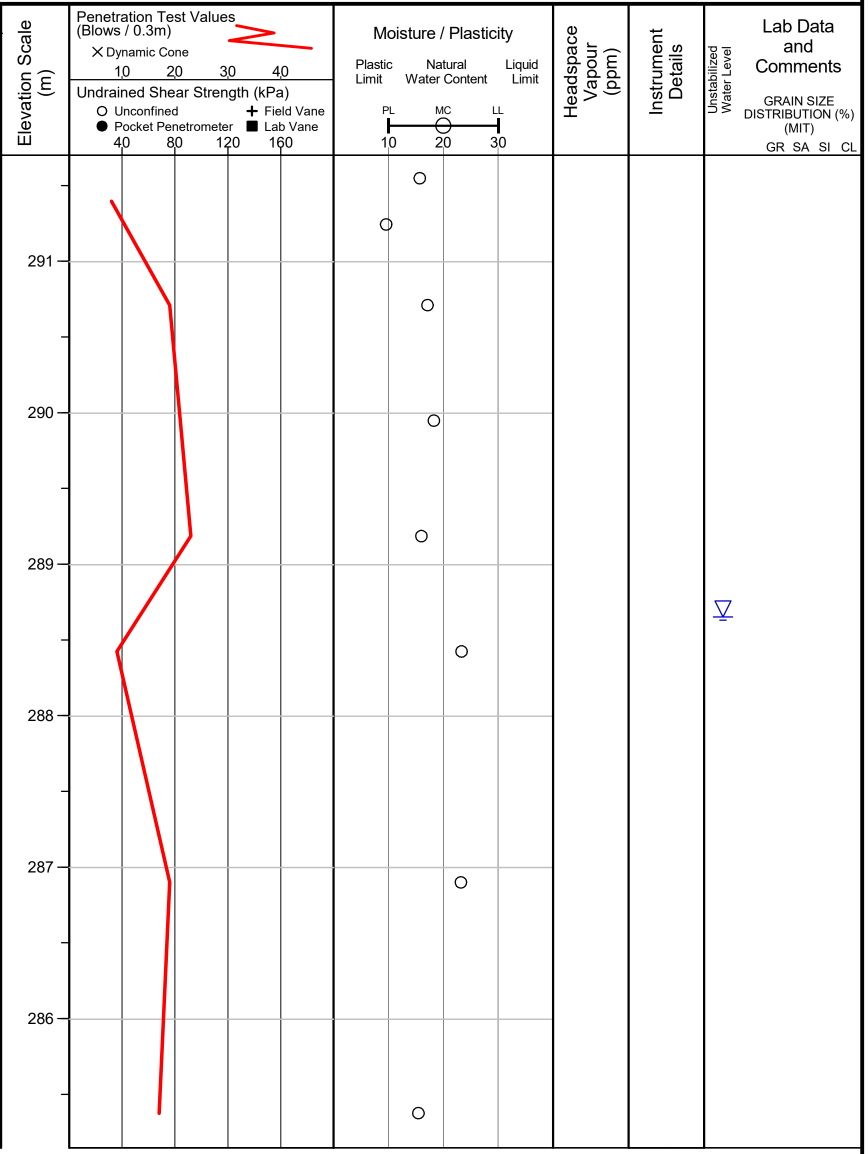
Position : E: 590777, N: 4858285 (UTM 17T)

Elevation Datum : Geodetic

Rig type : CME 55, track-mounted

Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	Samples Number	Type	SPT 'N' Value
291.7	**GROUND SURFACE**			
291.4 0.3	300mm **TOPSOIL**	1A	SS	8
290.9 0.8	**FILL**, silty sand, trace clay, trace gravel, trace rootlets, loose, dark brown, moist	1B		
285.1 6.6	**SANDY SILT to SILT AND SAND**, trace gravel, trace clay, dilatant, loose to compact, brown, wet	2	SS	19
		3	SS	21
		4	SS	23
		5	SS	9
		6	SS	19
		7	SS	17



END OF BOREHOLE

Unstabilized water level measured at 3.0 m below ground surface; borehole caved to 3.4 m below ground surface upon completion of drilling.

file: 1-16-0543-01 bh logs.gpj

Terraprobe

LOG OF BOREHOLE 2

Project No. : 1-16-0543-01
Date started : October 6, 2016
Sheet No. : 1 of 1

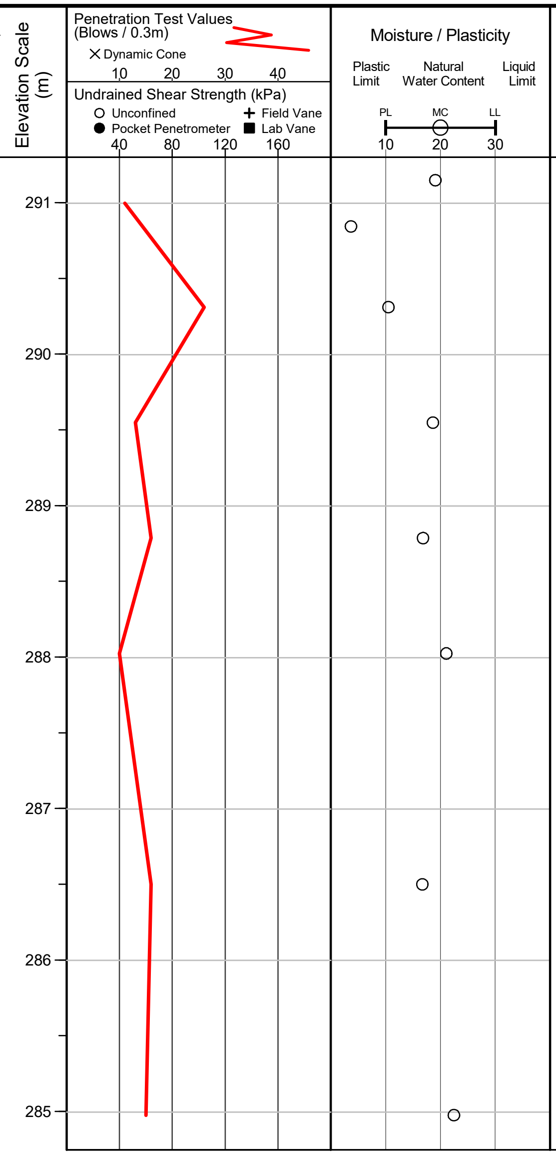
Client : Shacca Caledon Homes Inc.
Project : 16114 Airport Road
Location : Caledon, Ontario

Originated by : NB
Compiled by : AS
Checked by : MMT

Position : E: 590771, N: 4858293 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	SAMPLES Type	SAMPLES SPT 'N' Value	Unstabilized Water Level	Lab Data and Comments
0	**291.3**	**GROUND SURFACE**						
	291.0 0.3	300mm **TOPSOIL**		1A	SS	11		
	290.5 0.8	**FILL**, silty sand, trace clay, trace gravel, trace rootlets, compact, dark brown, moist		1B				
1	289.8 1.5	**SAND**, trace to some silt, trace clay, trace gravel, compact, brown, wet		2	SS	26		
2		**SANDY SILT to SILT AND SAND**, trace gravel, trace clay, dilatant, compact, brown, wet		3	SS	13		spoon wet
				4	SS	16		
3				5	SS	10	∇	
5				6	SS	16		
6	284.7 6.6			7	SS	15		



Headspace Vapour (ppm)

Instrument Details

GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL

END OF BOREHOLE

Unstabilized water level measured at 3.4 m below ground surface; borehole caved to 3.7 m below ground surface upon completion of drilling.

LOG OF BOREHOLE 3D

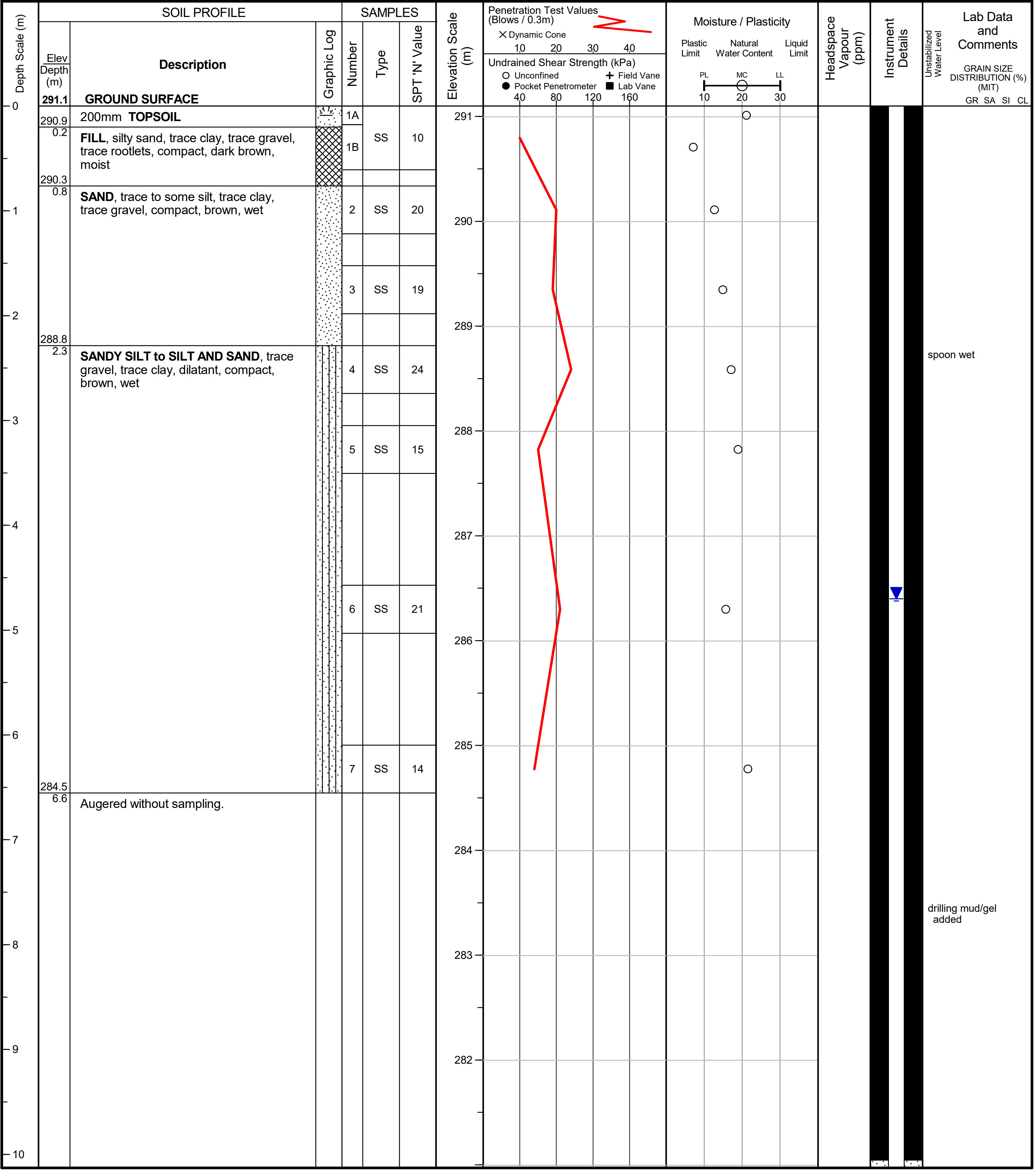
Project No. : 1-16-0543-01
Date started : October 4, 2016
Sheet No. : 1 of 2

Client : Shacca Caledon Homes Inc.
Project : 16114 Airport Road
Location : Caledon, Ontario

Originated by : NB
Compiled by : AS
Checked by : MMT

Position : E: 590796, N: 4858277 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Hollow stem augers

Elev Depth (m)	Description	Number	Type	SPT 'N' Value	Lab Data and Comments
291.1	**GROUND SURFACE**				
290.9 0.2	200mm **TOPSOIL**	1A			
	FILL, silty sand, trace clay, trace gravel, trace rootlets, compact, dark brown, moist	1B	SS	10	
290.3 0.8	**SAND**, trace to some silt, trace clay, trace gravel, compact, brown, wet	2	SS	20	
		3	SS	19	
288.8 2.3	**SANDY SILT to SILT AND SAND**, trace gravel, trace clay, dilatant, compact, brown, wet	4	SS	24	spoon wet
		5	SS	15	
		6	SS	21	
		7	SS	14	
284.5 6.6	Augered without sampling.				drilling mud/gel added



(continued next page)

file: 1-16-0543-01 bh logs.gpj

Terraprobe

LOG OF BOREHOLE 3D

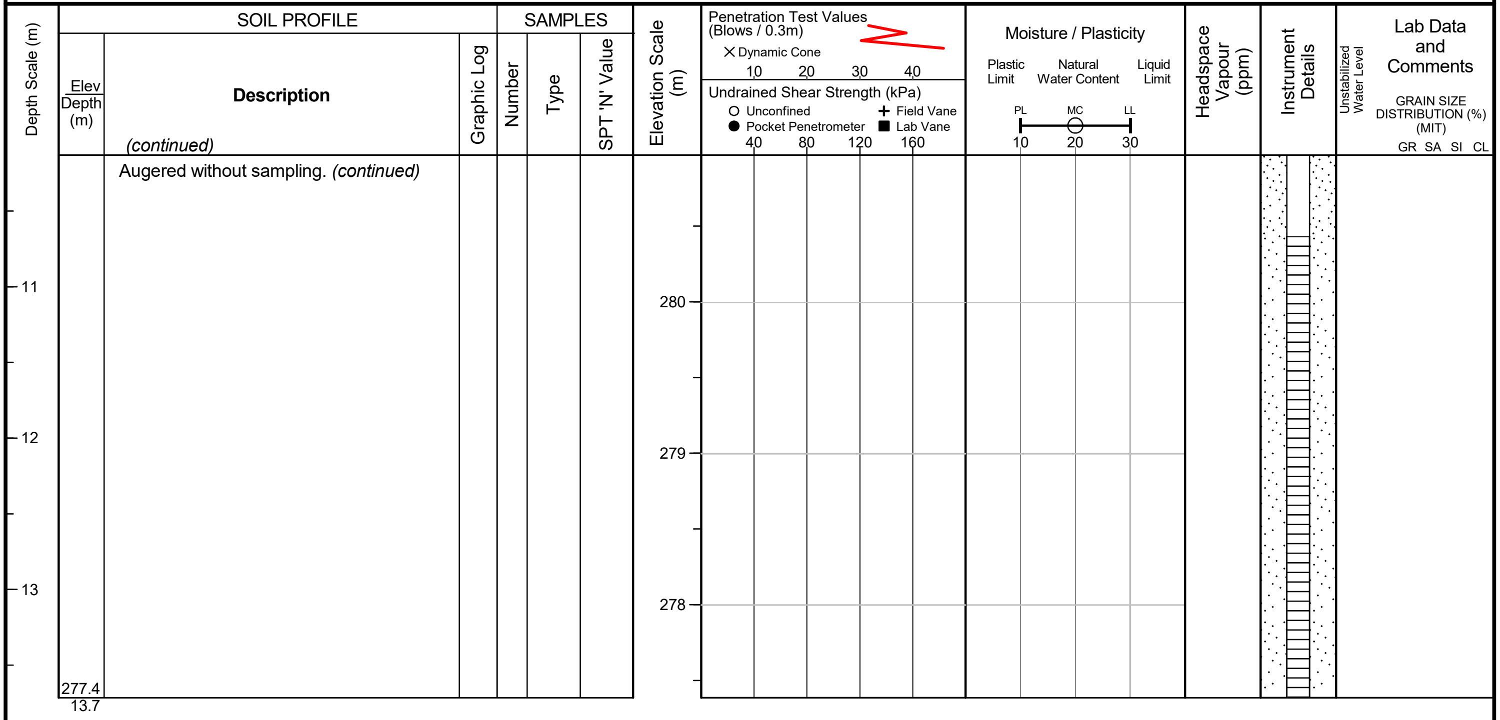
Project No. : 1-16-0543-01
Date started : October 4, 2016
Sheet No. : 2 of 2

Client : Shacca Caledon Homes Inc.
Project : 16114 Airport Road
Location : Caledon, Ontario

Originated by : NB
Compiled by : AS
Checked by : MMT

Position : E: 590796, N: 4858277 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Hollow stem augers



Augered without sampling. *(continued)*

END OF BOREHOLE

Borehole contained drill water upon completion of drilling. Unstabilized water level and cave not measured.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 26, 2016	4.7	286.4

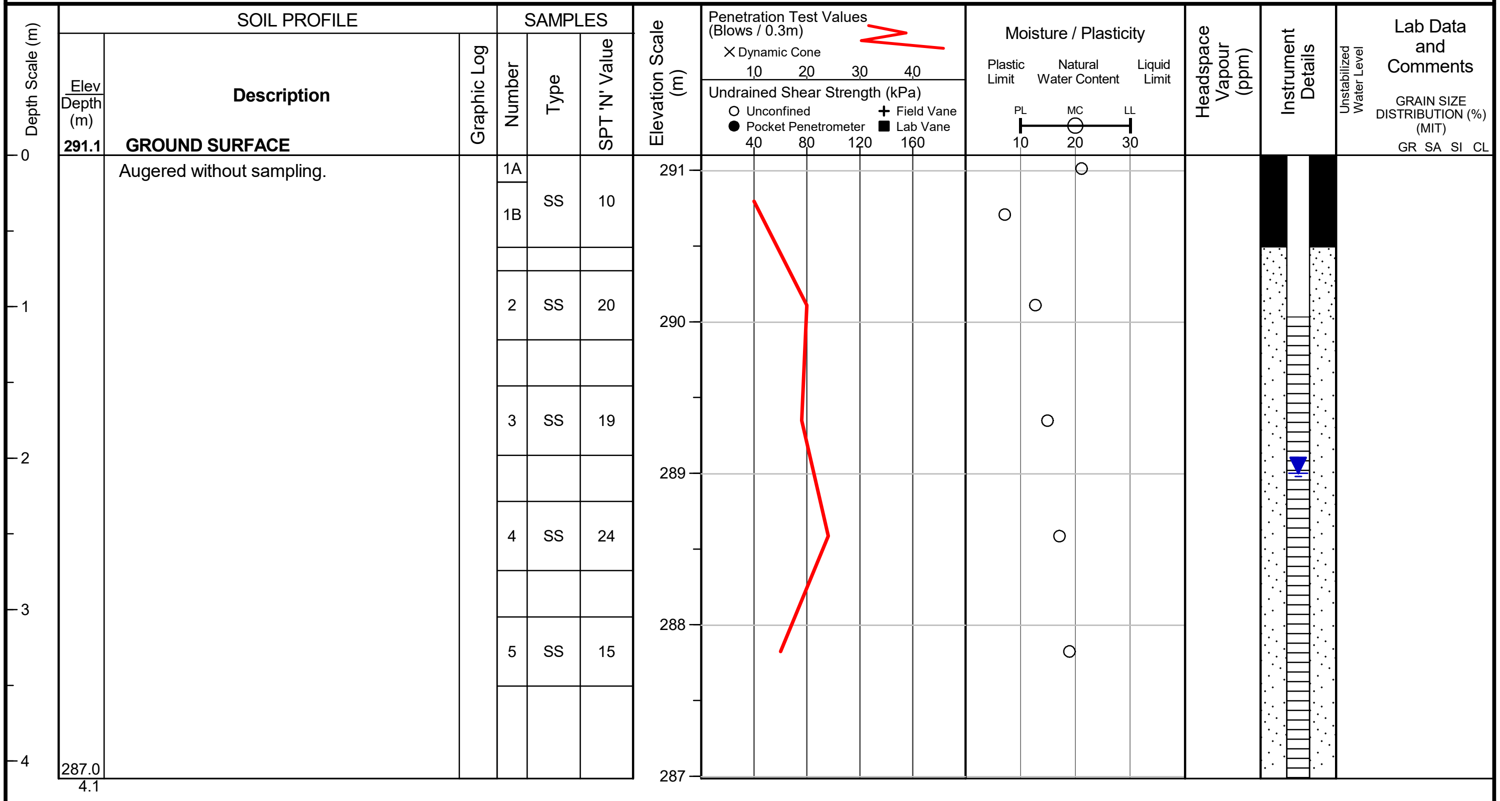
LOG OF BOREHOLE 3S

Project No. : 1-16-0543-01
Date started : October 4, 2016
Sheet No. : 1 of 1

Client : Shacca Caledon Homes Inc.
Project : 16114 Airport Road
Location : Caledon, Ontario

Originated by : NB
Compiled by : AS
Checked by : MMT

Position : E: 590796, N: 4858277 (UTM 17T)
Rig type : CME 55, truck-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers



Number	Type	SPT 'N' Value	
1A			
1B	SS	10	
2	SS	20	
3	SS	19	
4	SS	24	
5	SS	15	

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 26, 2016	2.1	289.0

Terraprobe

LOG OF BOREHOLE 4

Project No. : 1-16-0543-01	Client : Shacca Caledon Homes Inc.	Originated by : NB
Date started : October 5, 2016	Project : 16114 Airport Road	Compiled by : AS
Sheet No. : 1 of 1	Location : Caledon, Ontario	Checked by : MMT

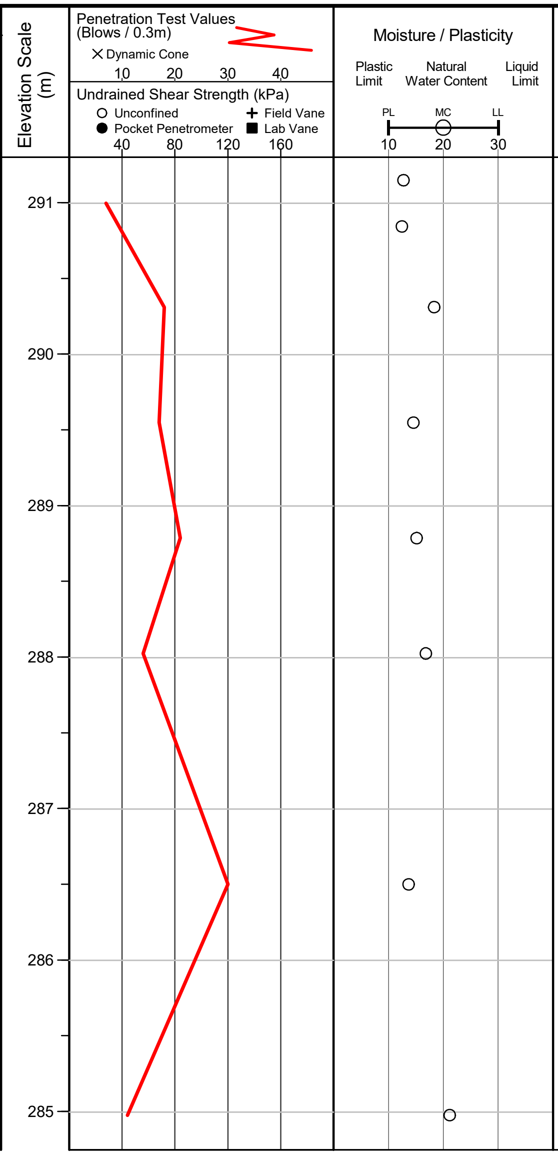
Position : E: 590780, N: 4858262 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
291.3	**GROUND SURFACE**
291.1 0.2	180mm **TOPSOIL**
290.5 0.8	**FILL**, silty sand, trace clay, trace gravel, trace rootlets, loose, dark brown, moist
284.7 6.6	**SANDY SILT to SILT AND SAND**, trace gravel, trace clay, dilatant, compact, brown, wet ...sand, some silt

SAMPLES

Number	Type	SPT 'N' Value	Lab Data and Comments
1A	SS	7	
1B			
2	SS	18	GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL: 0 31 62 7 SS2 Analysis: M&I
3	SS	17	
4	SS	21	spoon wet
5	SS	14	
6	SS	30	
7	SS	11	



Headspace Vapour (ppm) | Instrument Details | Unstabilized Water Level: ∇ at approximately 3.8 m

END OF BOREHOLE

Unstabilized water level measured at 3.8 m below ground surface; borehole caved to 4.0 m below ground surface upon completion of drilling.

LOG OF BOREHOLE 5

Project No. : 1-16-0543-01
Date started : October 6, 2016
Sheet No. : 1 of 1

Client : Shacca Caledon Homes Inc.
Project : 16114 Airport Road
Location : Caledon, Ontario

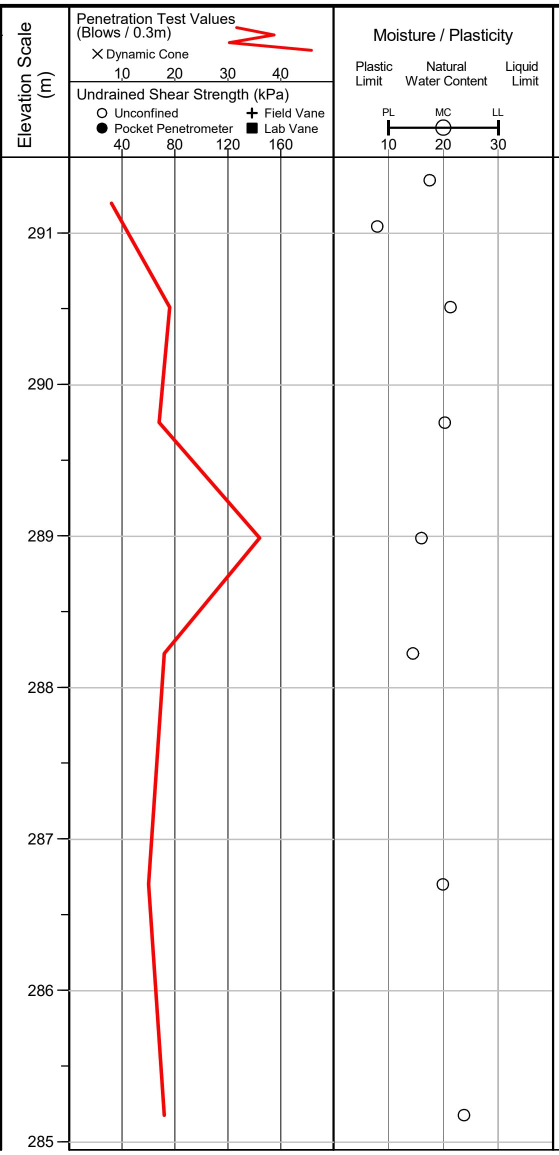
Originated by : NB
Compiled by : AS
Checked by : MMT

Position : E: 590777, N: 4858280 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value	Headspace Vapour (ppm)	Instrument Details	Unstabilized Water Level	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
291.5	**GROUND SURFACE**							
	300mm **TOPSOIL**	1A	SS	8				
291.2 0.3	**FILL**, silty sand, trace clay, trace gravel, trace rootlets, loose, dark brown, moist	1B						
290.7 0.8	**SANDY SILT to SILT AND SAND**, trace clay, dilatant, compact to dense, wet	2	SS	19				
		3	SS	17				spoon wet
		4	SS	36				
288.5 3.0	**SAND**, trace to some silt, trace clay, trace gravel, compact, brown, wet	5	SS	18				
							∇	
		6	SS	15				
285.4 6.1	**SANDY SILT to SILT AND SAND**, trace clay, dilatant, compact to dense, wet	7	SS	18				
284.9 6.6	**END OF BOREHOLE**							

Unstabilized water level measured at 3.7 m below ground surface; borehole caved to 4.0 m below ground surface upon completion of drilling.



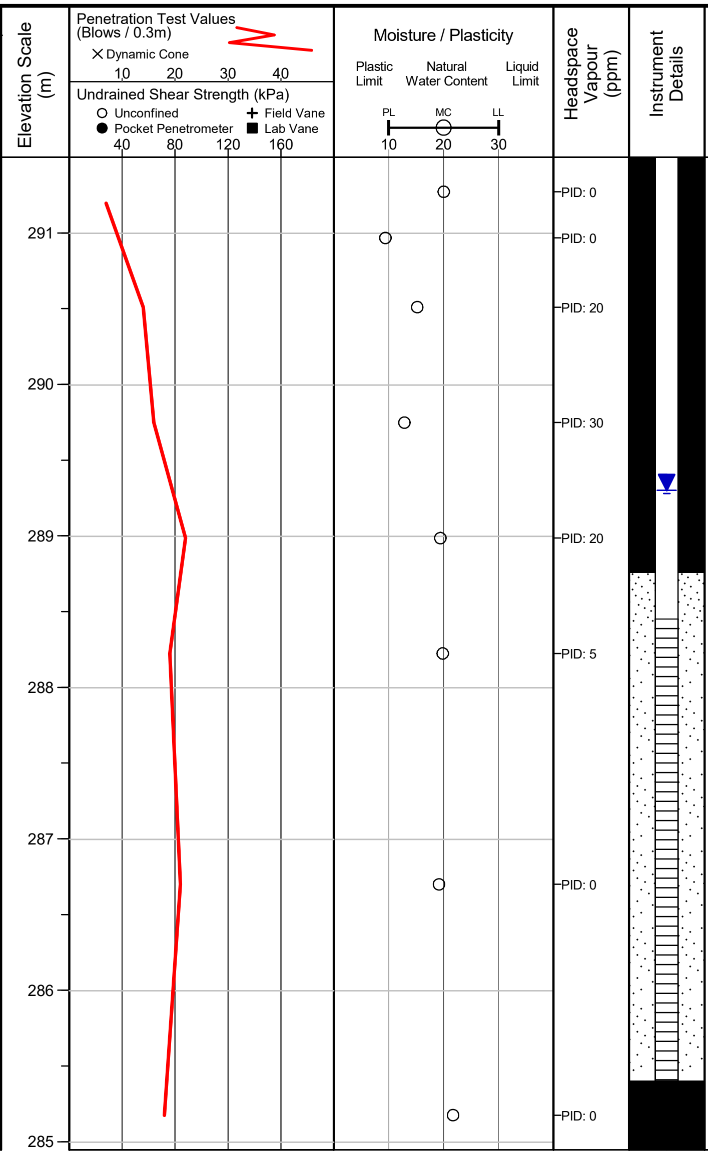
Terraprobe

LOG OF BOREHOLE 6

Project No. : 1-16-0543-01
Client : Shacca Caledon Homes Inc.
Originated by : NB
Date started : October 11, 2016
Project : 16114 Airport Road
Compiled by : AS
Sheet No. : 1 of 1
Location : Caledon, Ontario
Checked by : MMT

Position :
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Hollow stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value	Headspace Vapour (ppm)
291.5	**GROUND SURFACE**				
291.0 0.5	450mm **TOPSOIL**	1A	SS	7	PID: 0
290.7 0.8	**FILL**, silty sand, trace clay, trace gravel, trace organics, loose, moist	1B			PID: 0
290.0 1.5	**SANDY SILT to SILT AND SAND**, trace gravel, trace clay, dilatant, loose to compact, brown, moist ...wet	2	SS	14	PID: 20
285.4 6.1	**SAND**, trace to some silt, trace clay, trace gravel, compact, brown, wet	3	SS	16	PID: 30
		4	SS	22	PID: 20
		5	SS	19	PID: 5
		6	SS	21	PID: 0
284.9 6.6	**SANDY SILT to SILT AND SAND**, trace gravel, trace clay, dilatant, compact, brown, moist	7	SS	18	PID: 0



Lab Data and Comments
GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL

Unstabilized Water Level

SS3 Analysis: PHC

spoon wet

END OF BOREHOLE

Unstabilized water level measured at 1.5 m below ground surface; borehole was open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 26, 2016	2.2	289.3

file: 1-16-0543-01 bh logs.gpj

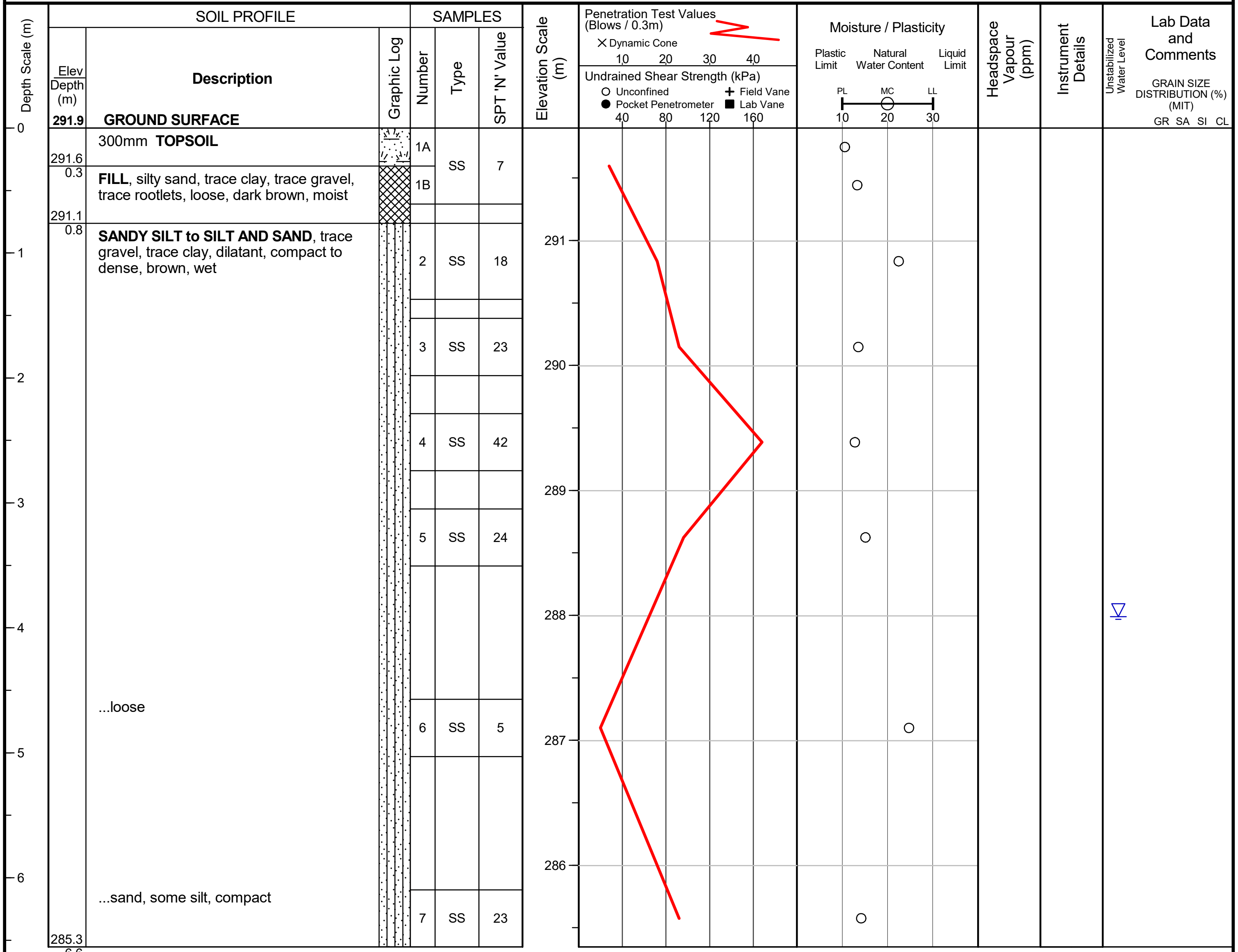
Terraprobe

LOG OF BOREHOLE 7

Project No. : 1-16-0543-01
Client : Shacca Caledon Homes Inc.
Originated by : NB
Date started : October 5, 2016
Project : 16114 Airport Road
Compiled by : AS
Sheet No. : 1 of 1
Location : Caledon, Ontario
Checked by : MMT

Position : E: 590750, N: 4858254 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
291.9	**GROUND SURFACE**			
291.6 0.3	300mm **TOPSOIL**	1A	SS	7
291.1 0.8	**FILL**, silty sand, trace clay, trace gravel, trace rootlets, loose, dark brown, moist	1B		
	SANDY SILT to SILT AND SAND, trace gravel, trace clay, dilatant, compact to dense, brown, wet	2	SS	18
		3	SS	23
		4	SS	42
		5	SS	24
	...loose	6	SS	5
285.3 6.6	...sand, some silt, compact	7	SS	23



END OF BOREHOLE

Unstabilized water level measured at 3.9 m below ground surface; borehole caved to 4.0 m below ground surface upon completion of drilling.

file: 1-16-0543-01 bh logs.gpj

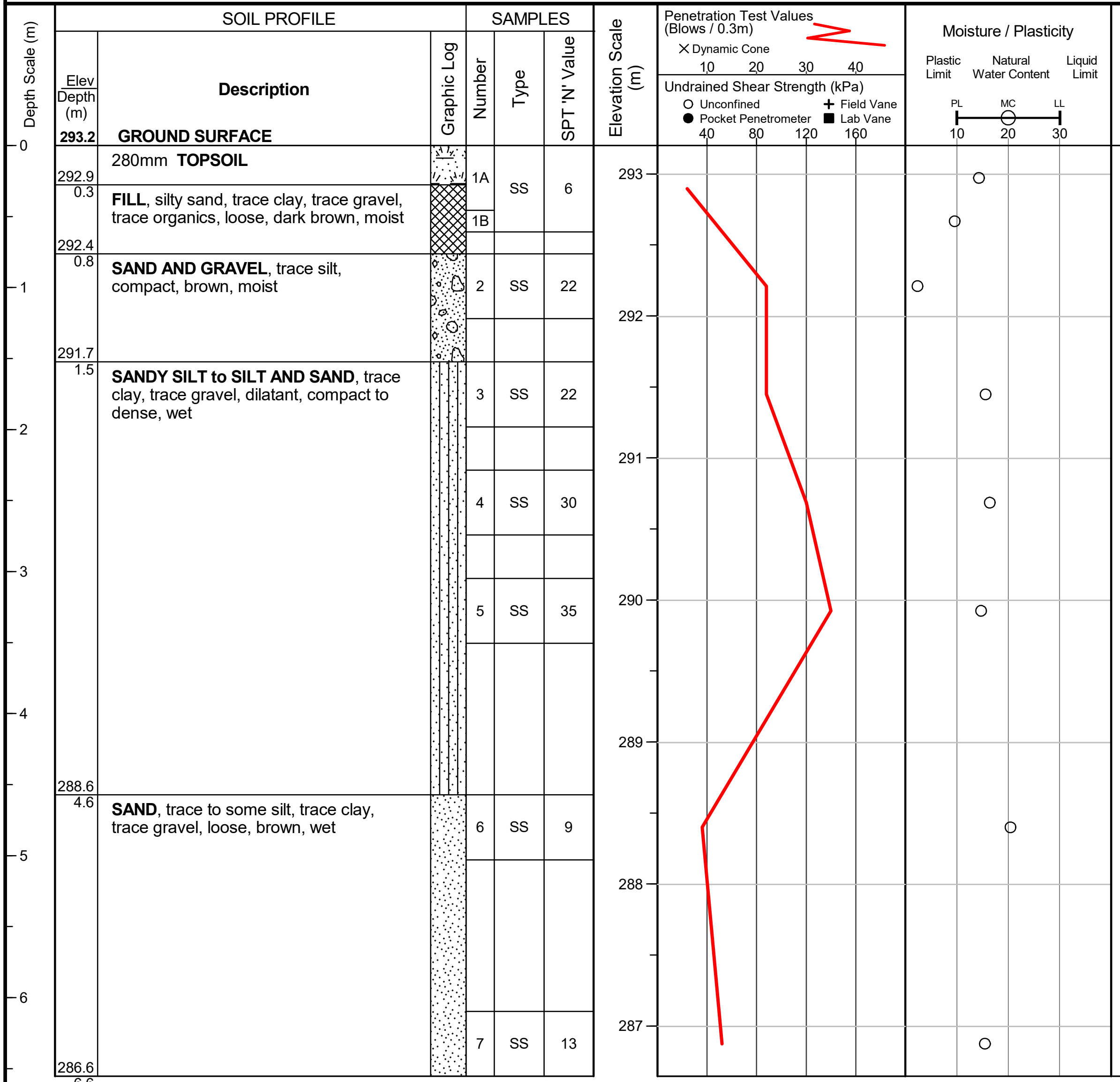
Terraprobe

LOG OF BOREHOLE 8

Project No. : 1-16-0543-01
Client : Shacca Caledon Homes Inc.
Originated by : NB
Date started : October 6, 2016
Project : 16114 Airport Road
Compiled by : AS
Sheet No. : 1 of 1
Location : Caledon, Ontario
Checked by : MMT

Position : E: 590724, N: 4858289 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value	Unstabilized Water Level	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
293.2	**GROUND SURFACE**					
	280mm **TOPSOIL**	1A	SS	6		
292.9 0.3	**FILL**, silty sand, trace clay, trace gravel, trace organics, loose, dark brown, moist	1B				
292.4 0.8	**SAND AND GRAVEL**, trace silt, compact, brown, moist	2	SS	22		
291.7 1.5	**SANDY SILT to SILT AND SAND**, trace clay, trace gravel, dilatant, compact to dense, wet	3	SS	22		
		4	SS	30		
		5	SS	35		2 31 58 9
					▽	
288.6 4.6	**SAND**, trace to some silt, trace clay, trace gravel, loose, brown, wet	6	SS	9		
		7	SS	13		
286.6 6.6						



END OF BOREHOLE

Unstabilized water level measured at 4.0 m below ground surface; borehole caved to 4.3 m below ground surface upon completion of drilling.

file: 1-16-0543-01 bh logs.gpj

LOG OF BOREHOLE 9

Project No. : 1-16-0543-01
Date started : October 6, 2016
Sheet No. : 1 of 1

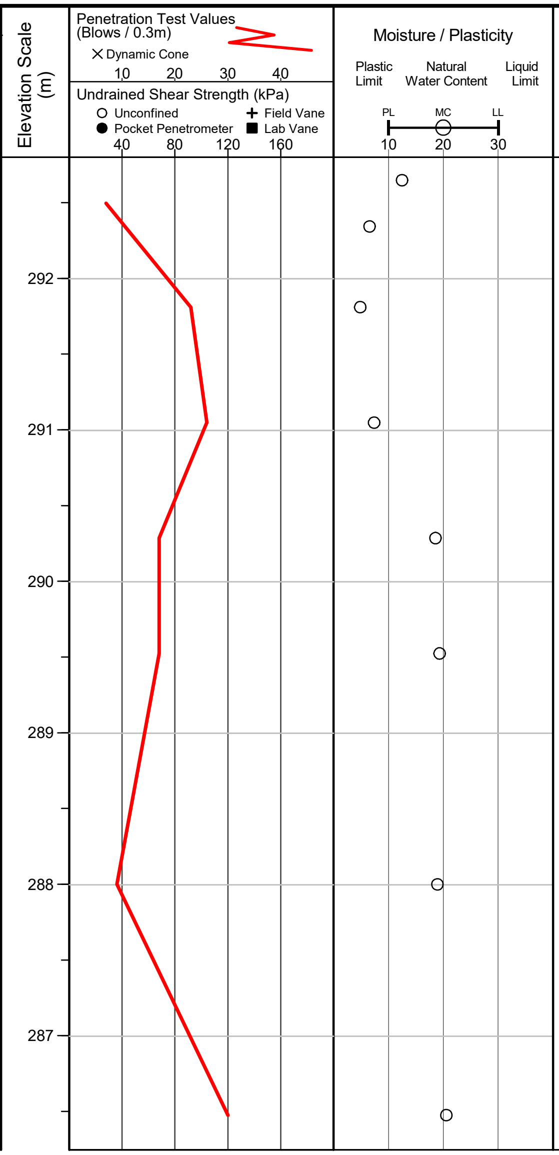
Client : Shacca Caledon Homes Inc.
Project : 16114 Airport Road
Location : Caledon, Ontario

Originated by : NB
Compiled by : AS
Checked by : MMT

Position : E: 590735, N: 4858314 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description
0	292.8	**GROUND SURFACE**
		280mm **TOPSOIL**
	292.5 0.3	**FILL**, silty sand, trace clay, trace gravel, trace rootlets, loose, dark brown, moist
	292.0 0.8	**SAND**, trace to some gravel, trace to some silt, compact, brown, moist
	290.5 2.3	**SANDY SILT to SILT AND SAND**, trace gravel, trace clay, dilatant, loose to compact, brown, wet
	286.2 6.6	**END OF BOREHOLE**

Number	Type	SPT 'N' Value
1A	SS	7
1B		
2	SS	23
3	SS	26
4	SS	17
5	SS	17
6	SS	9
7	SS	30



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level: ∇ (3.0 m)

Lab Data and Comments
GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL

spoon wet (Sample 4)

END OF BOREHOLE

Unstabilized water level measured at 3.0 m below ground surface; borehole caved to 3.4 m below ground surface upon completion of drilling.

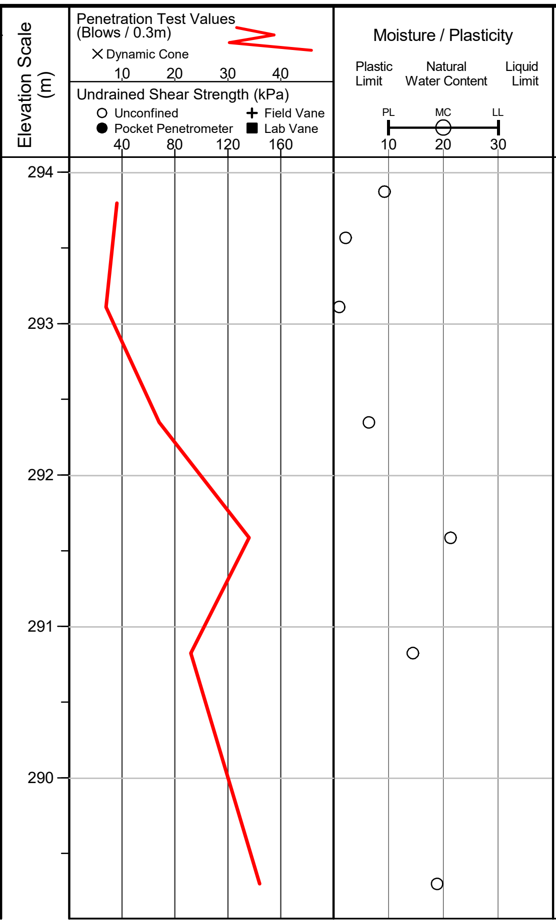
file: 1-16-0543-01 bh logs.gpj

LOG OF BOREHOLE 11

Project No. : 1-16-0543-01
Client : Shacca Caledon Homes Inc.
Originated by : NB
Date started : October 7, 2016
Project : 16114 Airport Road
Compiled by : AS
Sheet No. : 1 of 1
Location : Caledon, Ontario
Checked by : MMT

Position : E: 590705, N: 4858300 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value
0	**294.1**	**GROUND SURFACE**				
	293.9 0.2	230mm **TOPSOIL**		1A	SS	9
		FILL, sandy silt, trace clay, trace gravel, trace rootlets, trace organics, loose, dark brown, moist		1B		
1	292.9 1.2			2	SS	7
	291.8 2.3	**SAND**, trace to some silt, trace gravel, trace clay, compact, brown, moist		3	SS	17
2						
		SANDY SILT to SILT AND SAND, trace gravel, trace clay, dilatant, compact to dense, brown, wet		4	SS	34
3				5	SS	23
4						
5	289.1 5.0			6	SS	36



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR SA SI CL

SS2 Analysis: M&I

spoon wet

∇

END OF BOREHOLE

Unstabilized water level measured at 4.2 m below ground surface; borehole caved to 4.3 m below ground surface upon completion of drilling.

file: 1-16-0543-01 bh logs.gpj

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LOG OF BOREHOLE 12

Project No. : 1-16-0543-01
Client : Shacca Caledon Homes Inc.
Originated by : NB

Date started : October 7, 2016
Project : 16114 Airport Road
Compiled by : AS

Sheet No. : 1 of 1
Location : Caledon, Ontario
Checked by : MMT

Position : E: 590679, N: 4858343 (UTM 17T)
Elevation Datum : Geodetic

Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
294.5	**GROUND SURFACE**
294.2 0.3	300mm **TOPSOIL**
293.0 1.5	**FILL**, sandy silt, trace clay, trace gravel, trace rootlets, trace organics, loose to compact, dark brown, damp to moist
287.9 6.6	**SANDY SILT to SILTY SAND**, trace gravel, trace clay, dilatant, compact to dense, brown, moist ...silt layer ...wet below

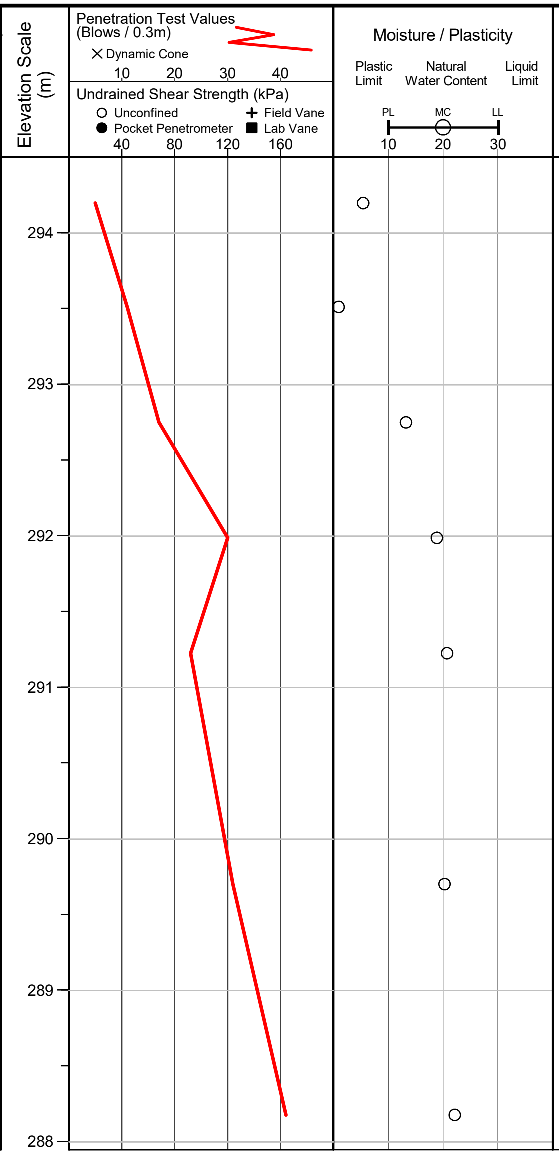
END OF BOREHOLE

Unstabilized water level measured at 4.8 m below ground surface; borehole caved to 4.9 m below ground surface upon completion of drilling.

SAMPLES

Number	Type	SPT 'N' Value	Lab Data and Comments (GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL)
1	SS	5	
2	SS	11	SS2 Analysis: M&I
3	SS	17	0 47 47 6
4	SS	30	
5	SS	23	
6	SS	31	
7	SS	41	

Unstabilized Water Level: ∇ spoon wet



LOG OF BOREHOLE 13

Project No. : 1-16-0543-01
Date started : October 11, 2016
Sheet No. : 1 of 1

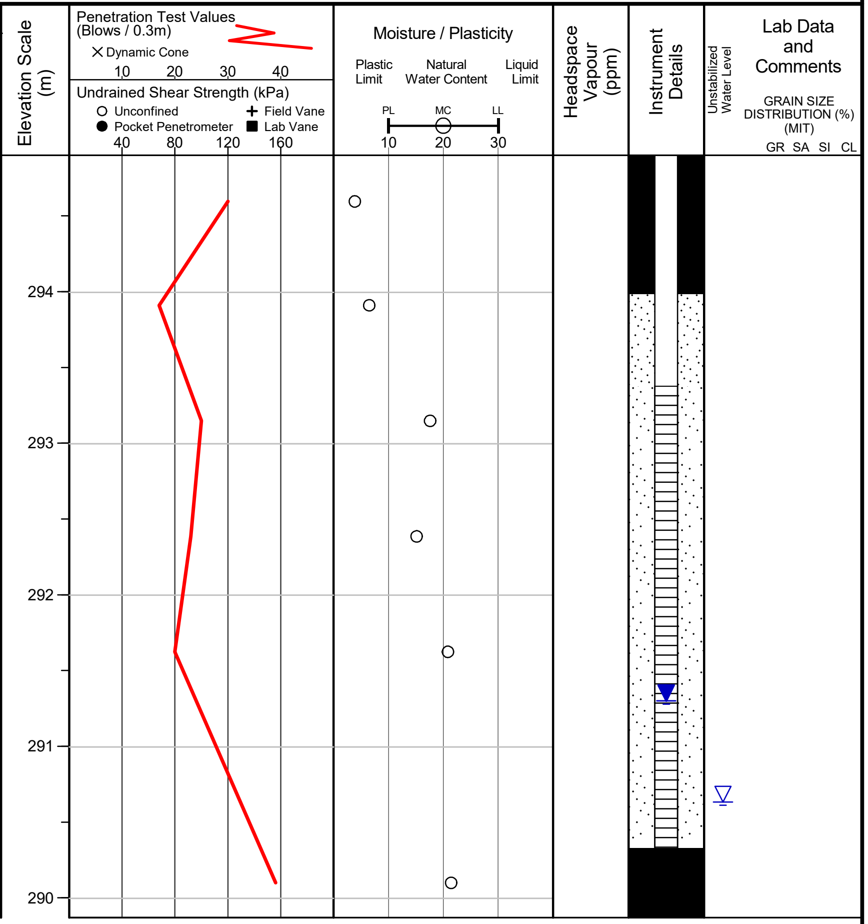
Client : Shacca Caledon Homes Inc.
Project : 16114 Airport Road
Location : Caledon, Ontario

Originated by : NB
Compiled by : AS
Checked by : MMT

Position : E: 590668, N: 4858383 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
0	294.9	**GROUND SURFACE**			
	294.7 0.2	150mm **TOPSOIL**			
		FILL, sandy silt, trace clay, trace gravel, trace rootlets, trace organics, compact, dark brown, moist	1	SS	30
1 2	294.0 0.9	**SANDY SILT to SILT AND SAND**, trace clay, dilatant, compact, wet	2 3 4	SS SS SS	17 25 23
3 4	291.9 3.0	**CLAYEY SILT**, some sand, trace gravel, very stiff, brown, wet	5	SS	20
5	290.3 4.6	**SANDY SILT to SILT AND SAND**, trace clay, dilatant, dense, wet	6	SS	39
	289.9 5.0				



END OF BOREHOLE

Unstabilized water level measured at 4.3 m below ground surface; borehole was open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 26, 2016	3.6	291.3

LOG OF BOREHOLE 15

Project No. : 1-16-0543-01
Date started : October 11, 2016
Sheet No. : 1 of 1

Client : Shacca Caledon Homes Inc.
Project : 16114 Airport Road
Location : Caledon, Ontario

Originated by : NB
Compiled by : AS
Checked by : MMT

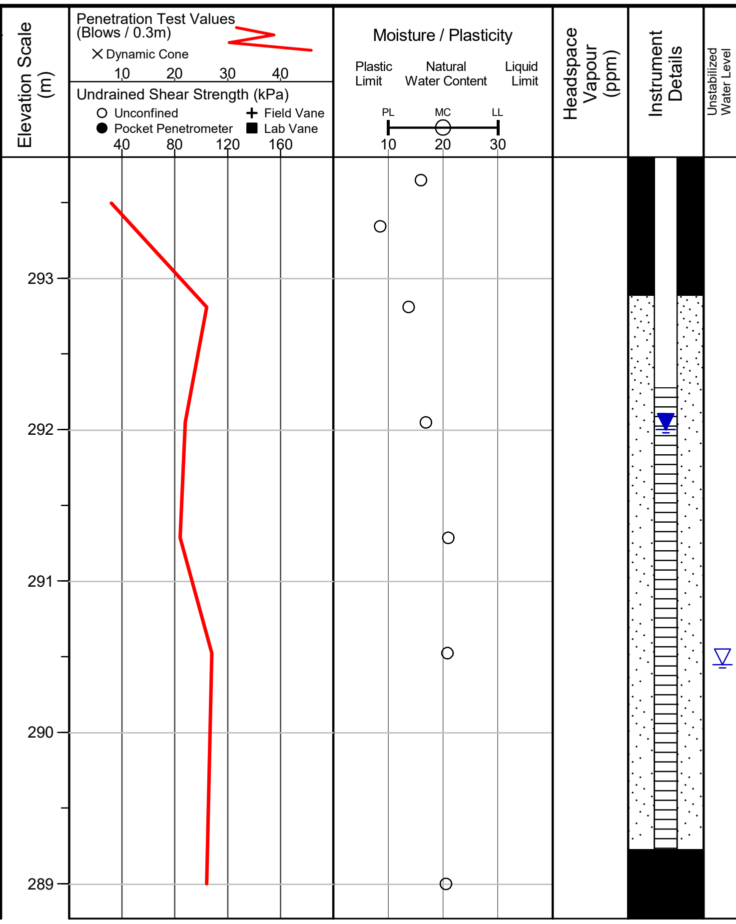
Position : E: 590602, N: 4858281 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
293.8	**GROUND SURFACE**
293.6 0.2	200mm **TOPSOIL**
293.0 0.8	**FILL**, sandy silt, trace clay, trace gravel, trace rootlets, trace organics, dark brown, moist
292.3 1.5	**SAND**, trace to some silt, trace clay, trace gravel, compact, brown, wet
288.8 5.0	**SANDY SILT to SILT AND SAND**, trace to some clay, dilatant, compact, wet

SAMPLES

Number	Type	SPT 'N' Value	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
1A	SS	8	
1B			
2	SS	26	
3	SS	22	0 36 54 10
4	SS	21	
5	SS	27	
6	SS	26	



END OF BOREHOLE

Unstabilized water level measured at 3.4 m below ground surface; borehole caved to 3.7 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 26, 2016	1.8	292.0

file: 1-16-0543-01 bh logs.gpj

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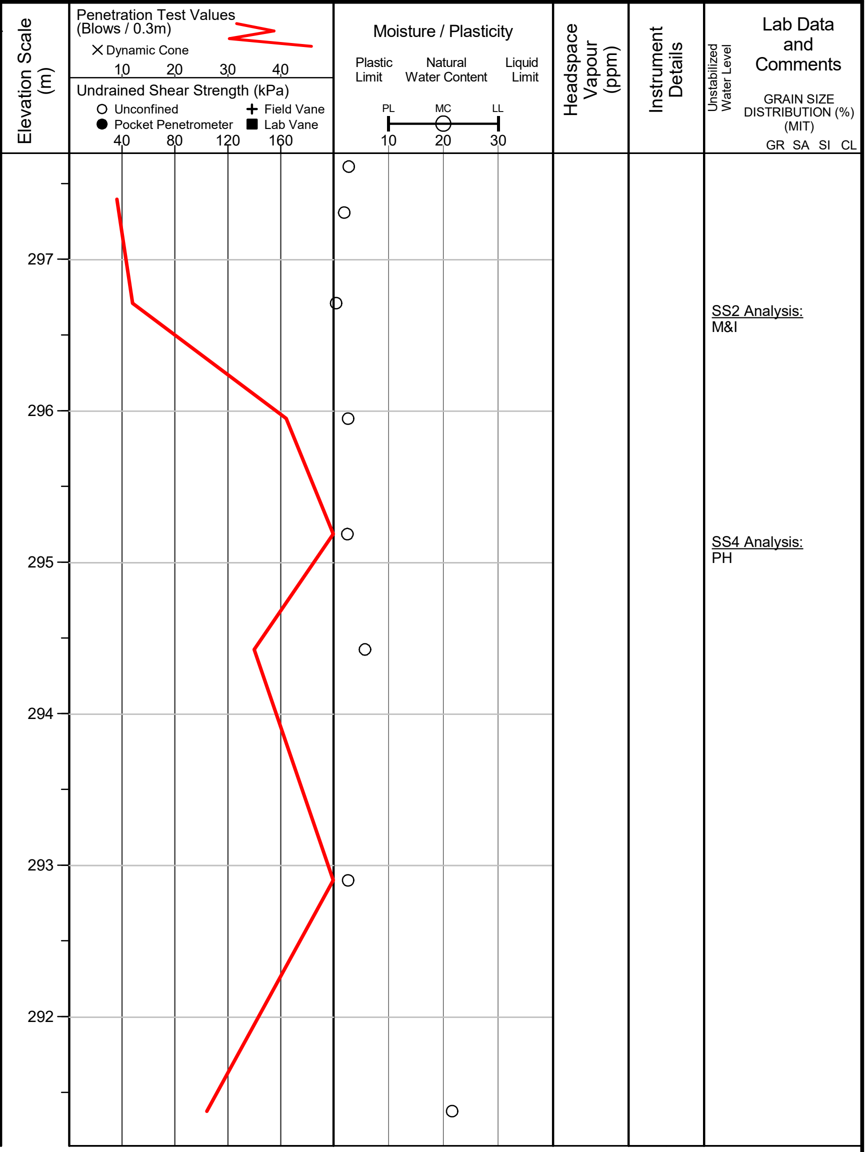
LOG OF BOREHOLE 16

Project No. : 1-16-0543-01
Client : Shacca Caledon Homes Inc.
Originated by : NB
Date started : October 7, 2016
Project : 16114 Airport Road
Compiled by : AS
Sheet No. : 1 of 1
Location : Caledon, Ontario
Checked by : MMT

Position : E: 590646, N: 4858315 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value	Lab Data and Comments
0	**297.7**	**GROUND SURFACE**					
	297.5	180mm **TOPSOIL**		1A			
	0.2	**FILL**, sandy silt, trace gravel, trace clay, trace rootlets, trace organics, loose, dark brown, damp		1B	SS	9	
1	296.9 0.8	**SANDY SILT**, trace gravel, trace clay, trace rootlets, compact, brown, damp		2	SS	12	SS2 Analysis: M&I
	296.2 1.5	**SILTY SAND**, trace to some gravel, trace clay, dense to very dense, brown, moist		3	SS	41	
2							
				4	SS	73	SS4 Analysis: PH
3				5	SS	35	
4							
		...gravelly		6	SS	64	
5							
6		...wet, silt and sand, dilatant, compact		7	SS	26	
	291.1 6.6	**END OF BOREHOLE**					

Borehole was dry and caved to 5.8 m below ground surface upon completion of drilling.



Terraprobe

LOG OF BOREHOLE 17

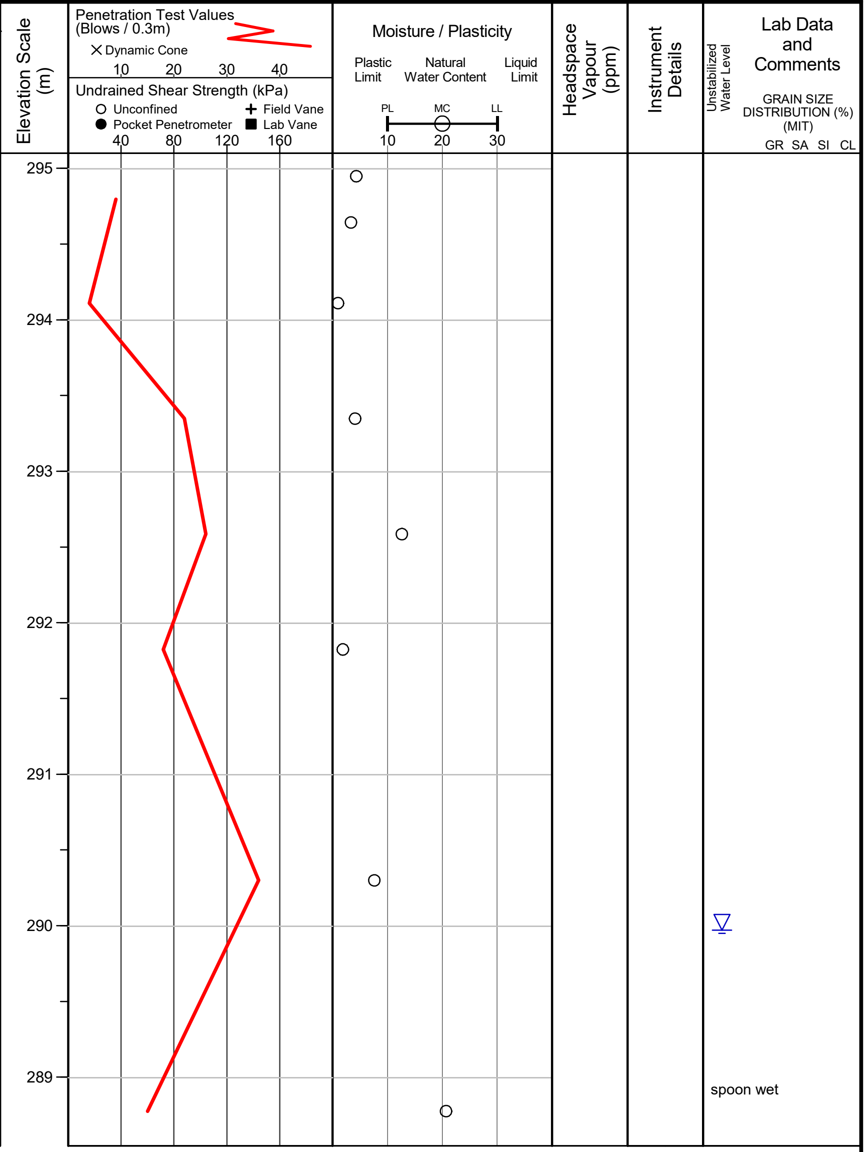
Project No. : 1-16-0543-01
Date started : October 7, 2016
Sheet No. : 1 of 1

Client : Shacca Caledon Homes Inc.
Project : 16114 Airport Road
Location : Caledon, Ontario

Originated by : NB
Compiled by : AS
Checked by : MMT

Position : E: 590695, N: 4858251 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	SAMPLES Type	SAMPLES SPT 'N' Value	Unstabilized Water Level	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
0	**295.1**	**GROUND SURFACE**						
		280mm **TOPSOIL**		1A	SS	9		
	294.8 0.3	**FILL**, sandy silt, trace clay, trace gravel, trace rootlets, trace organics, loose, dark brown, damp to moist	▩	1B				
1				2	SS	4		
	293.6 1.5	**SAND**, some silt to silty, trace clay, trace gravel, compact to dense, brown, moist	░	3	SS	22		
2				4	SS	26		
3				5	SS	18		
4		...some gravel		6	SS	36		
5							∇	
6		...wet, silt layers, grey		7	SS	15		spoon wet
	288.5 6.6							



END OF BOREHOLE

Unstabilized water level measured at 5.1 m below ground surface; borehole caved to 5.2 m below ground surface upon completion of drilling.

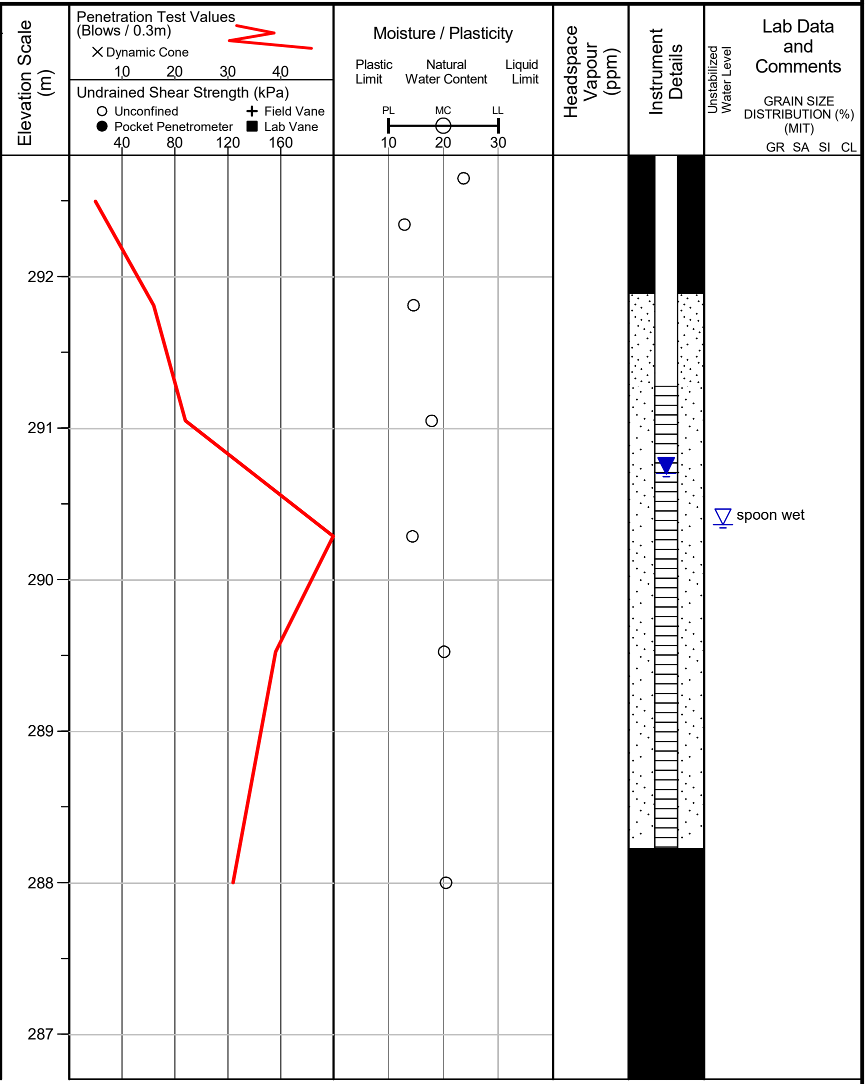
file: 1-16-0543-01 bh logs.gpj

LOG OF BOREHOLE 18

Project No. : 1-16-0543-01
Client : Shacca Caledon Homes Inc.
Originated by : NB
Date started : October 11, 2016
Project : 16114 Airport Road
Compiled by : AS
Sheet No. : 1 of 1
Location : Caledon, Ontario
Checked by : MMT

Position : E: 590633, N: 4858259 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

SOIL PROFILE		SAMPLES		
Elev Depth (m)	Description	Number	Type	SPT 'N' Value
292.8	**GROUND SURFACE**			
	200mm **TOPSOIL**	1A	SS	5
292.6 0.2	**FILL**, silty sand, trace clay, trace gravel, trace rootlets, loose, dark brown, moist	1B		
292.0 0.8	**SANDY SILT to SILT AND SAND**, trace gravel, trace clay, dilatant, compact to very dense, brown, wet	2	SS	16
		3	SS	22
		4	SS	52
		5	SS	39
	...silt, some sand, grey, dilatant	6	SS	31
287.8 5.0	Augered without sampling			
286.7 6.1				



END OF BOREHOLE

Unstabilized water level measured at 2.4 m below ground surface; borehole caved to 2.7 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 26, 2016	2.1	290.7

file: 1-16-0543-01 bh logs.gpj

Terraprobe

LOG OF BOREHOLE 19

Project No. : 1-16-0543-01
Date started : October 11, 2016
Sheet No. : 1 of 1

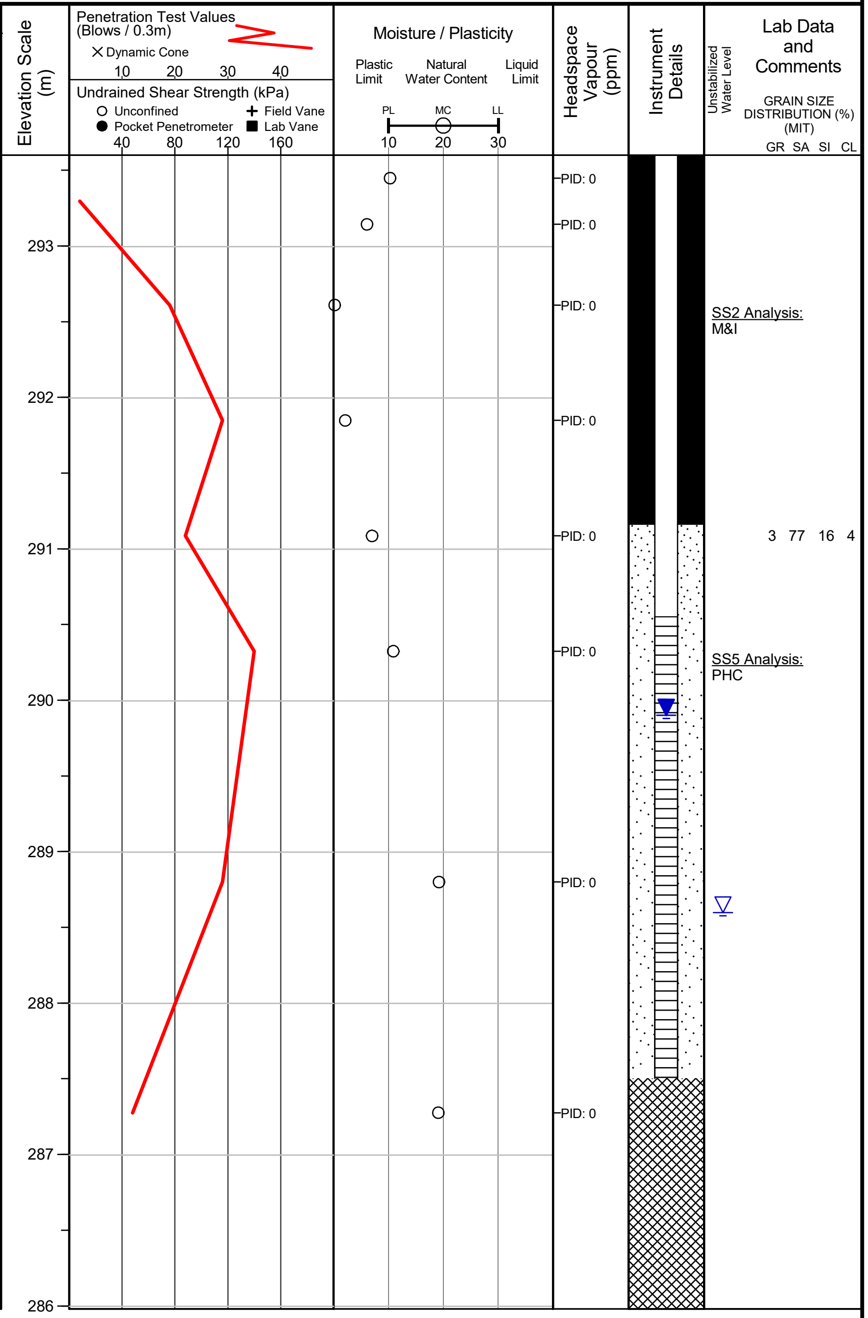
Client : Shacca Caledon Homes Inc.
Project : 16114 Airport Road
Location : Caledon, Ontario

Originated by : NB
Compiled by : AS
Checked by : MMT

Position : E: 590700, N: 4858204 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value	Headspace Vapour (ppm)	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
293.6	**GROUND SURFACE**					
293.4 0.2	180mm **TOPSOIL**	1A	SS	2	PID: 0	
	FILL, silty sand, trace clay, trace gravel, trace rootlets, very loose, dark brown, moist	1B			PID: 0	
292.8 0.8	**SAND**, trace to some silt, trace clay, trace gravel, compact, brown, damp to moist	2	SS	19	PID: 0	SS2 Analysis: M&I
		3	SS	29	PID: 0	
		4	SS	22	PID: 0	3 77 16 4
290.6 3.0	**SANDY SILT to SILT AND SAND**, trace gravel, trace clay, dilatant, compact to dense, brown, wet	5	SS	35	PID: 0	SS5 Analysis: PHC
	...dilatant below	6	SS	29	PID: 0	
		7	SS	12	PID: 0	
287.0 6.6	Augered without sampling.					
286.0 7.6						



END OF BOREHOLE

Unstabilized water level measured at 5.0 m below ground surface; borehole caved to 5.2 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 26, 2016	3.7	289.9

LOG OF BOREHOLE 20

Project No.	: 1-16-0543-01	Client	: Shacca Caledon Homes Inc.	Originated by	: NB
Date started	: October 7, 2016	Project	: 16114 Airport Road	Compiled by	: AS
Sheet No.	: 1 of 1	Location	: Caledon, Ontario	Checked by	: MMT

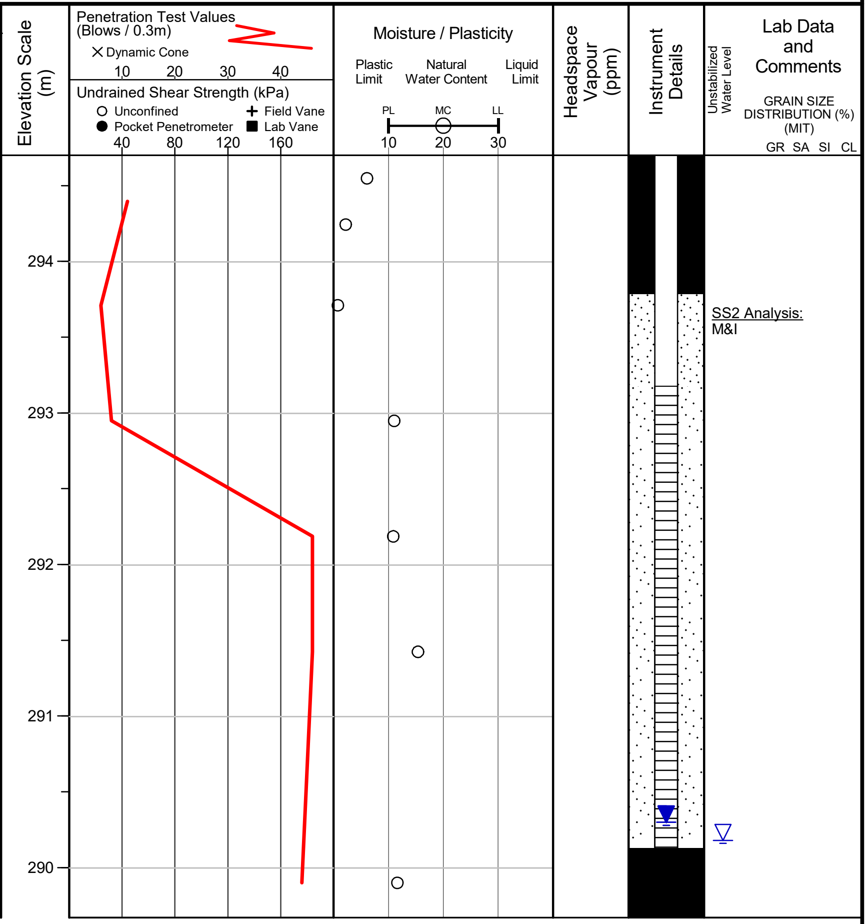
Position : E: 590683, N: 4858293 (UTM 17T)

Elevation Datum : Geodetic

Rig type : CME 55, track-mounted

Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
0	294.7	**GROUND SURFACE**			
		380mm **TOPSOIL**	1A	SS	11
	294.3 0.4	**FILL**, sandy silt, trace clay, trace gravel, trace rootlets, trace organics, loose to compact, dark brown, damp to moist	1B		
1			2	SS	6
	293.2 1.5	**SANDY SILT to SILT AND SAND**, trace gravel, trace clay, dilatant, dense, brown, moist	3	SS	8
2			4	SS	46
3			5	SS	46
4					
	290.1 4.6	**SAND**, trace to some silt, trace clay, trace gravel, dense, brown, wet	6	SS	44
5	289.7 5.0				



END OF BOREHOLE

Unstabilized water level measured at 4.5 m below ground surface; borehole was open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 26, 2016	4.4	290.3

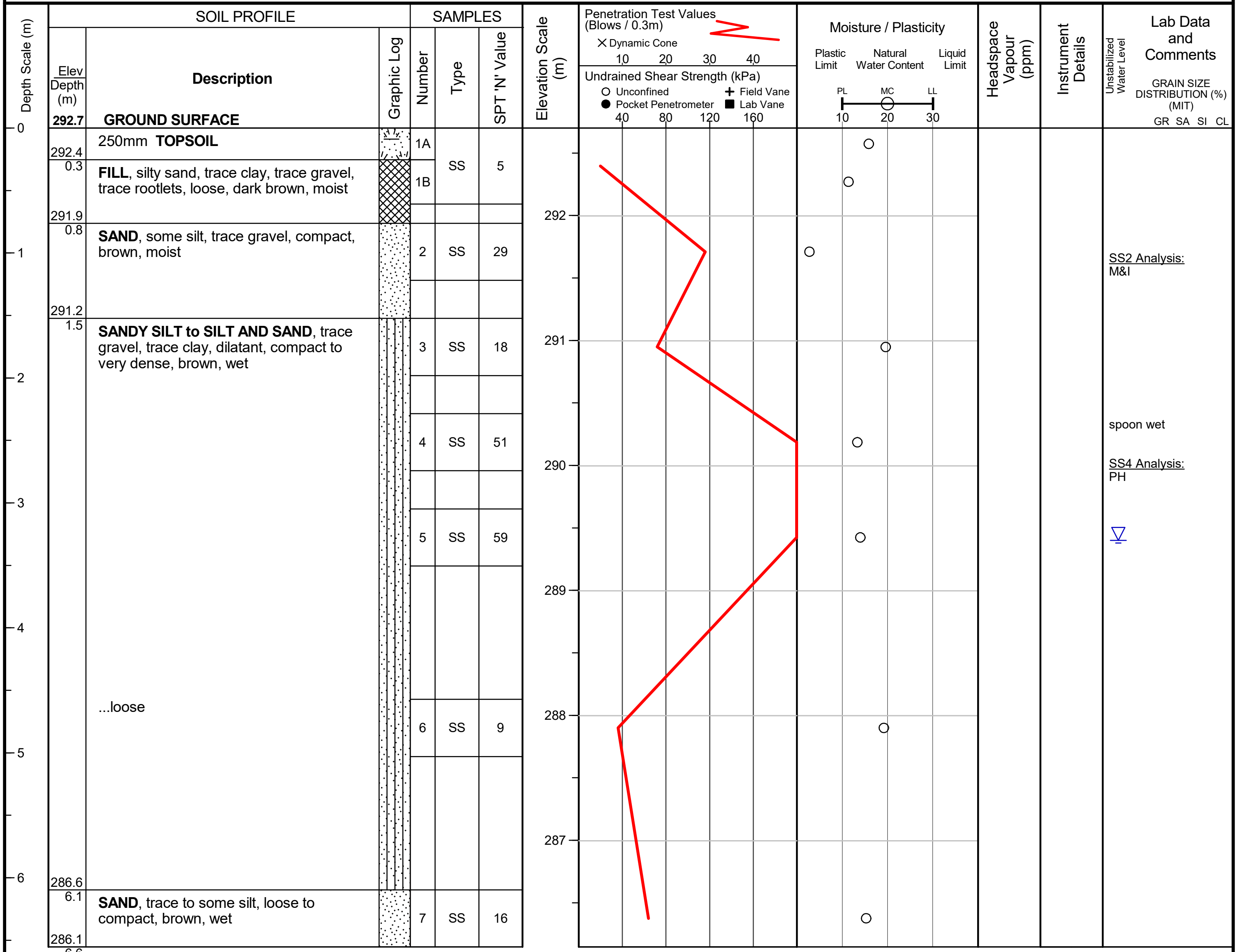
Terraprobe

LOG OF BOREHOLE 21

Project No. : 1-16-0543-01	Client : Shacca Caledon Homes Inc.	Originated by : NB
Date started : October 7, 2016	Project : 16114 Airport Road	Compiled by : AS
Sheet No. : 1 of 1	Location : Caledon, Ontario	Checked by : MMT

Position : E: 590711, N: 4858252 (UTM 17T)
Elevation Datum : Geodetic
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value	Lab Data and Comments
292.7	**GROUND SURFACE**				
	250mm **TOPSOIL**	1A	SS	5	
292.4 0.3	**FILL**, silty sand, trace clay, trace gravel, trace rootlets, loose, dark brown, moist	1B			
291.9 0.8	**SAND**, some silt, trace gravel, compact, brown, moist	2	SS	29	SS2 Analysis: M&I
291.2 1.5	**SANDY SILT to SILT AND SAND**, trace gravel, trace clay, dilatant, compact to very dense, brown, wet	3	SS	18	
		4	SS	51	spoon wet SS4 Analysis: PH
		5	SS	59	∇
	...loose	6	SS	9	
286.6 6.1	**SAND**, trace to some silt, loose to compact, brown, wet	7	SS	16	
286.1 6.6	**END OF BOREHOLE**				



Unstabilized water level measured at 3.3 m below ground surface; borehole caved to 3.4 m below ground surface upon completion of drilling.

LOG OF BOREHOLE 22

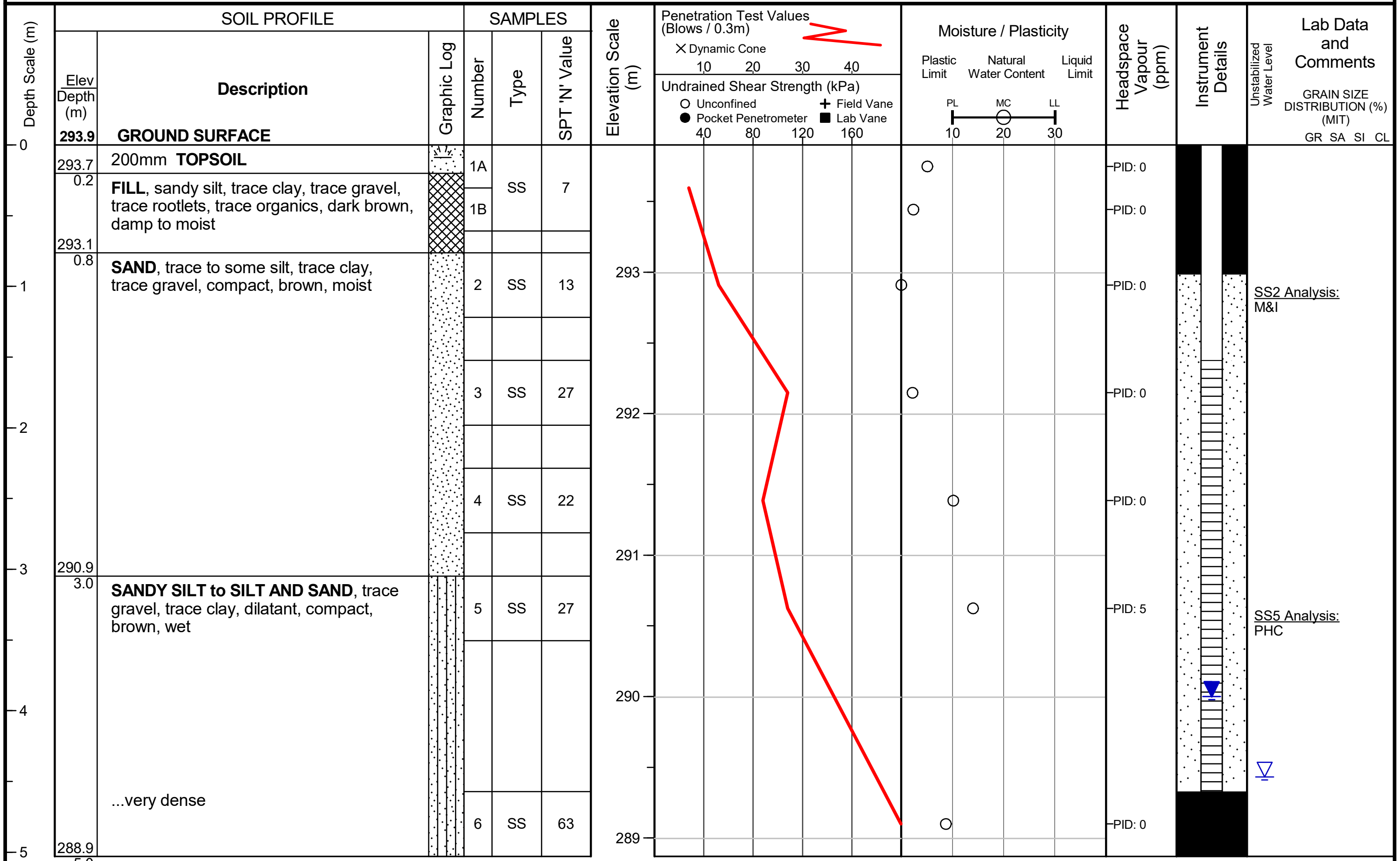
Project No. : 1-16-0543-01
Client : Shacca Caledon Homes Inc.
Originated by : NB

Date started : October 11, 2016
Project : 16114 Airport Road
Compiled by : AS

Sheet No. : 1 of 1
Location : Caledon, Ontario
Checked by : MMT

Position : E: 590719, N: 4858224 (UTM 17T)
Elevation Datum : Geodetic

Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers



Elev / Depth (m)	Description	Number	Type	SPT 'N' Value	Headspace Vapour (ppm)	Lab Data and Comments
293.9	**GROUND SURFACE**					
293.7 0.2	200mm **TOPSOIL**	1A	SS	7	PID: 0	
293.1 0.8	**FILL**, sandy silt, trace clay, trace gravel, trace rootlets, trace organics, dark brown, damp to moist	1B			PID: 0	
290.9 3.0	**SAND**, trace to some silt, trace clay, trace gravel, compact, brown, moist	2	SS	13	PID: 0	SS2 Analysis: M&I
		3	SS	27	PID: 0	
		4	SS	22	PID: 0	
288.9 5.0	**SANDY SILT to SILT AND SAND**, trace gravel, trace clay, dilatant, compact, brown, wet	5	SS	27	PID: 5	SS5 Analysis: PHC
	...very dense	6	SS	63	PID: 0	

END OF BOREHOLE

Unstabilized water level measured at 4.5 m below ground surface; borehole was open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 26, 2016	3.9	290.0

file: 1-16-0543-01 bh logs.gpj

BURNSIDE

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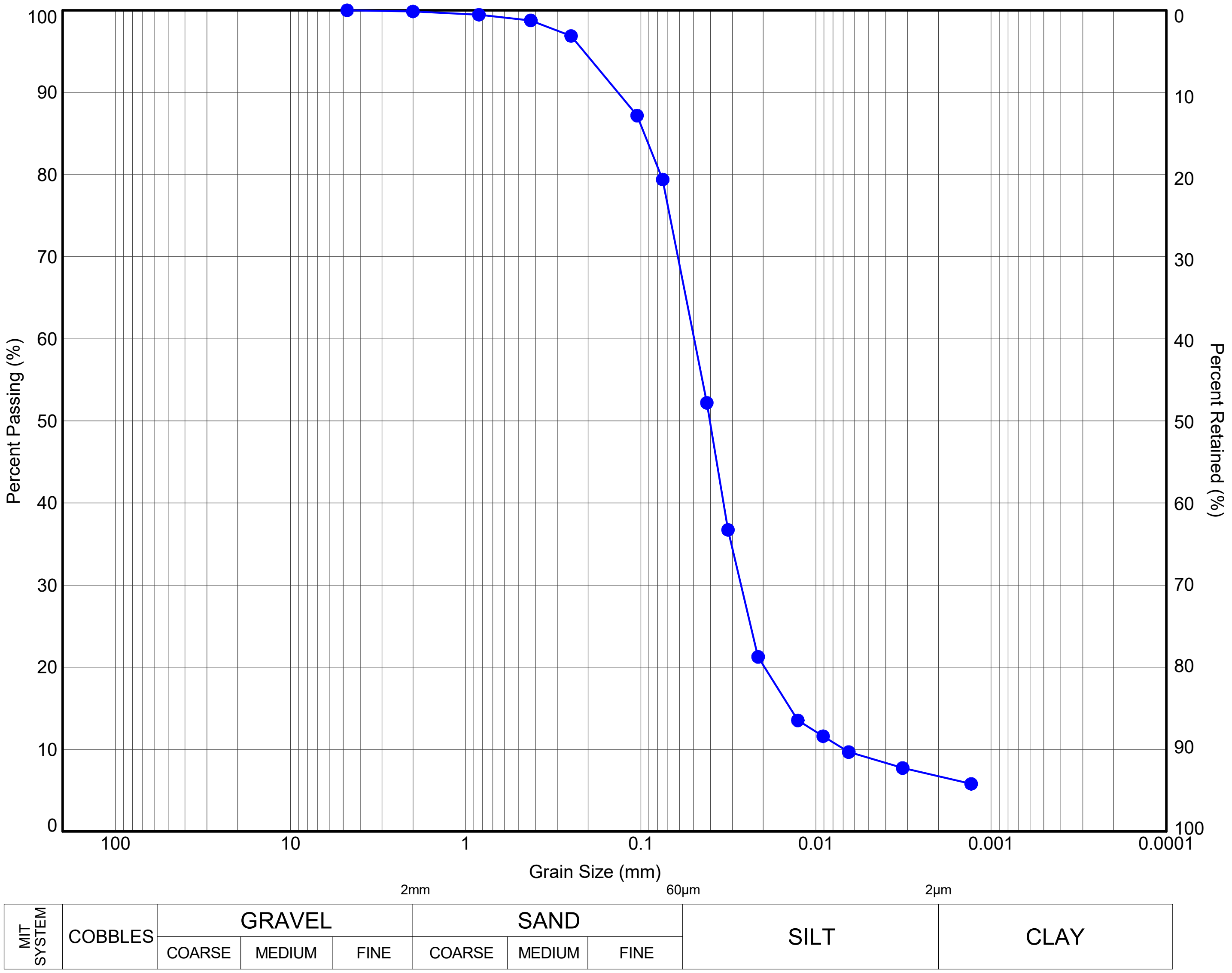
Appendix C

Hydraulic Conductivity

Appendix C



MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**4**	SS2	1.0	290.3	0	31	62	7	

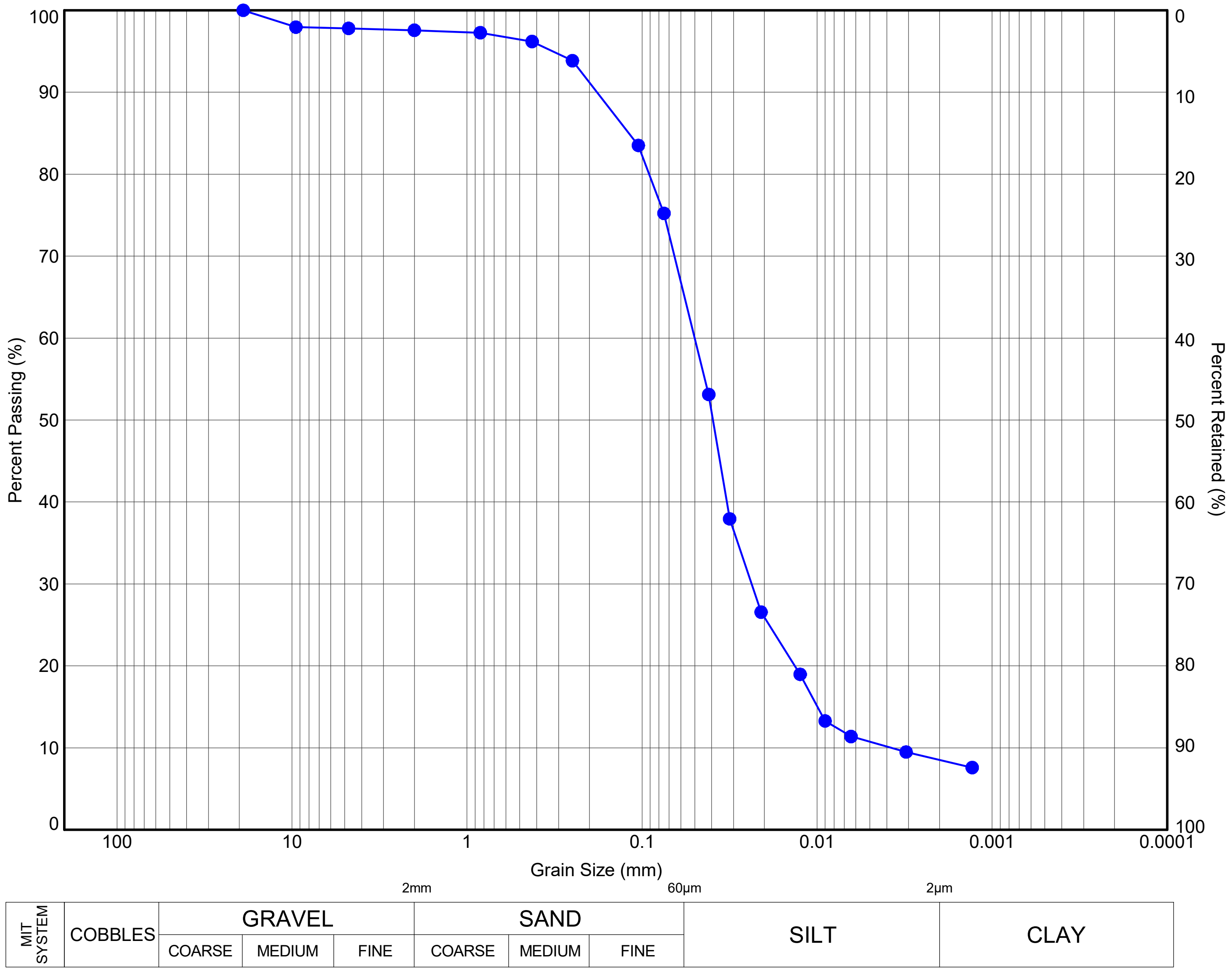
Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SANDY SILT, TRACE CLAY

File No.: **1-16-0543-01**



					MIT SYSTEM				
	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**8**	SS5	3.3	289.9	2	31	58	9	

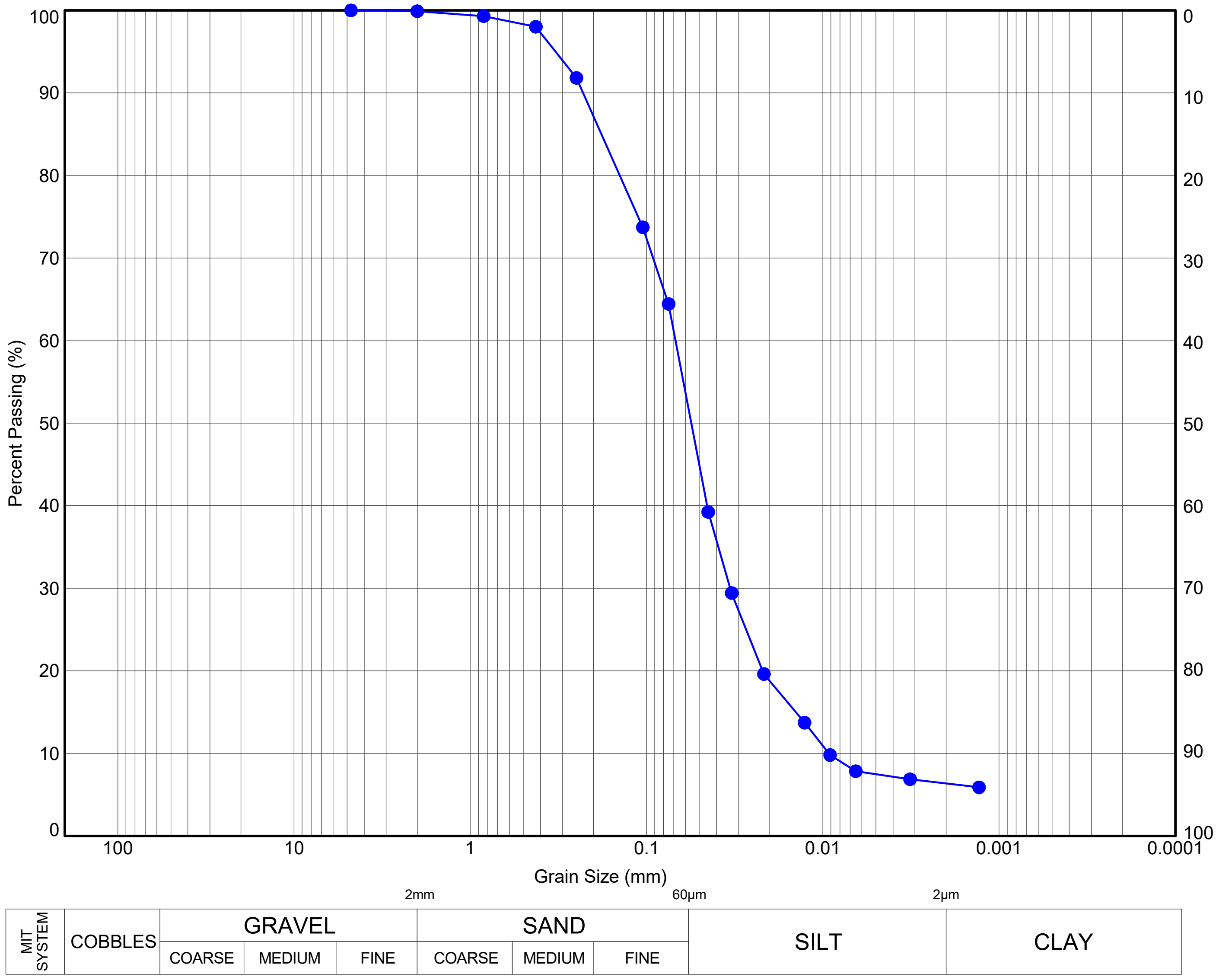
Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SANDY SILT, TRACE CLAY, TRACE GRAVEL

File No.: **1-16-0543-01**



					MIT SYSTEM				
	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**12**	SS3	1.8	292.7	0	47	47	6	

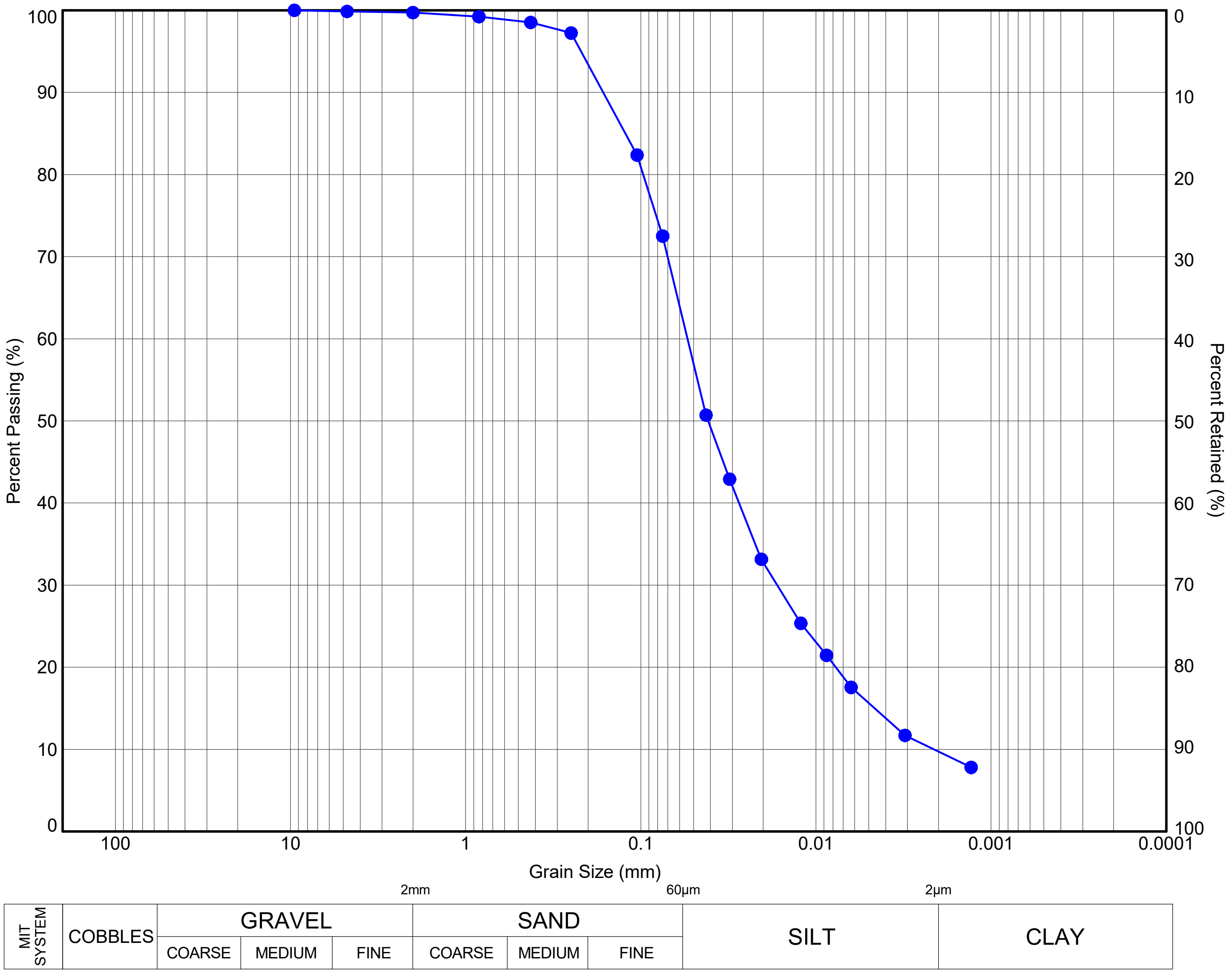
Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SAND AND SILT, TRACE CLAY

File No.: **1-16-0543-01**



					MIT SYSTEM				
	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**15**	SS3	1.8	292.0	0	36	54	10	

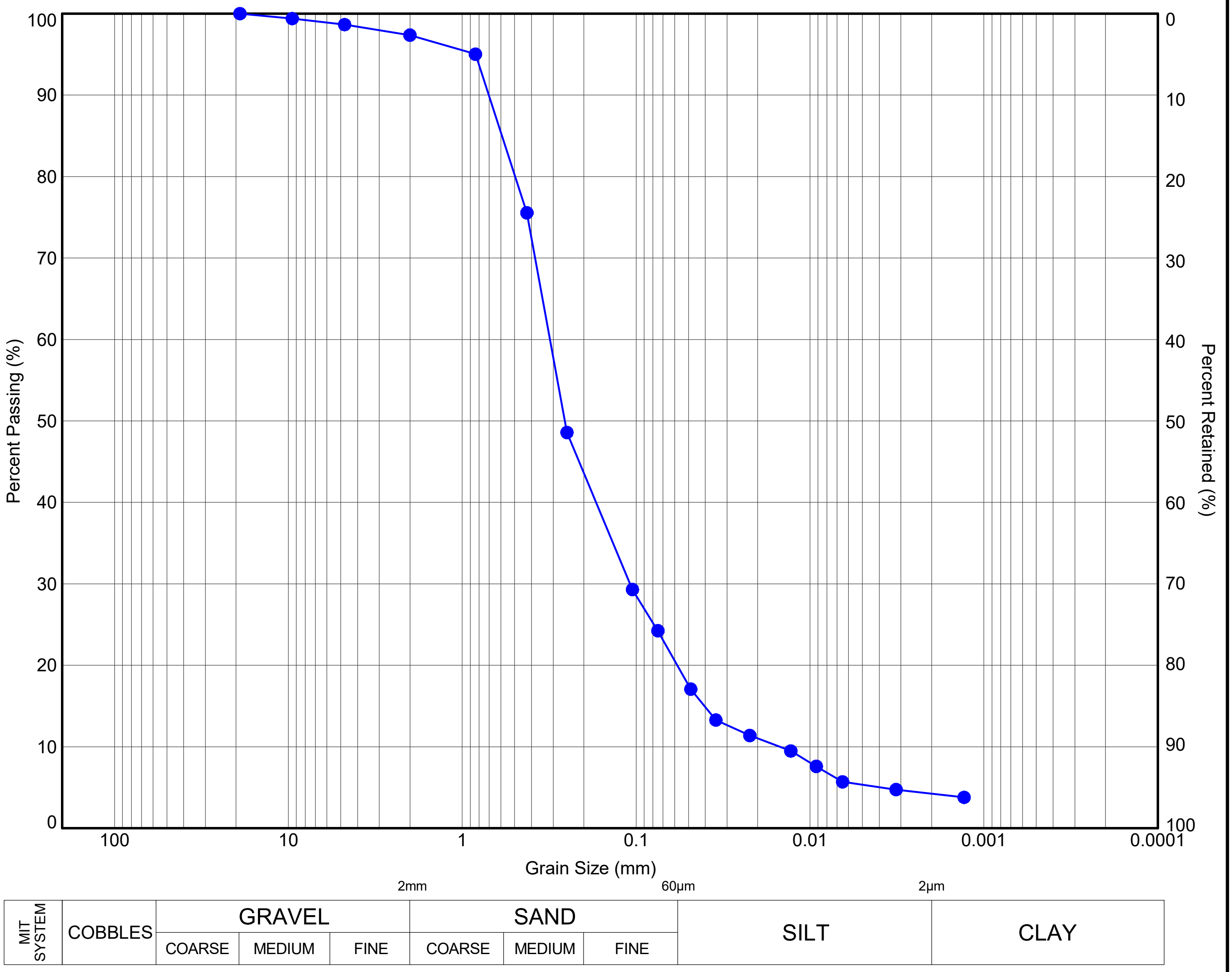
Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SILT AND SAND, SOME CLAY

File No.: **1-16-0543-01**



					MIT SYSTEM				
	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**19**	SS4	2.5	291.1	3	77	16	4	

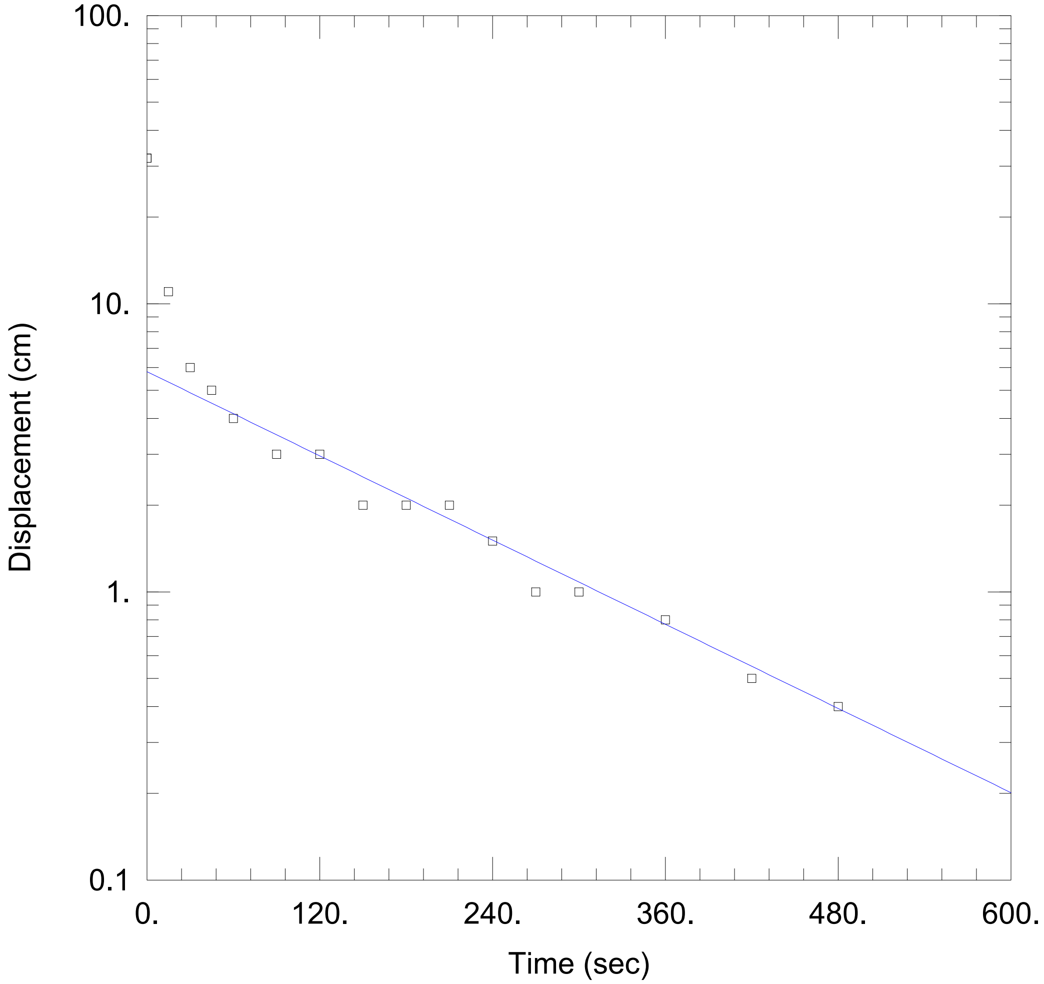
Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SAND, SOME SILT, TRACE CLAY, TRACE GRAVEL

File No.: **1-16-0543-01**



HYDRAULIC CONDUCTIVITY TEST AT BH6

PROJECT INFORMATION

Company: R.J Burnside & Associates
Client: Shacca Caledon Holdings Inc.
Project: 300039242
Location: 16114 Airport Rd, Caledon
Test Well: BH6
Test Date: Dec 15/2016

AQUIFER DATA

Saturated Thickness: 340. cm
Anisotropy Ratio (Kz/Kr): 1.

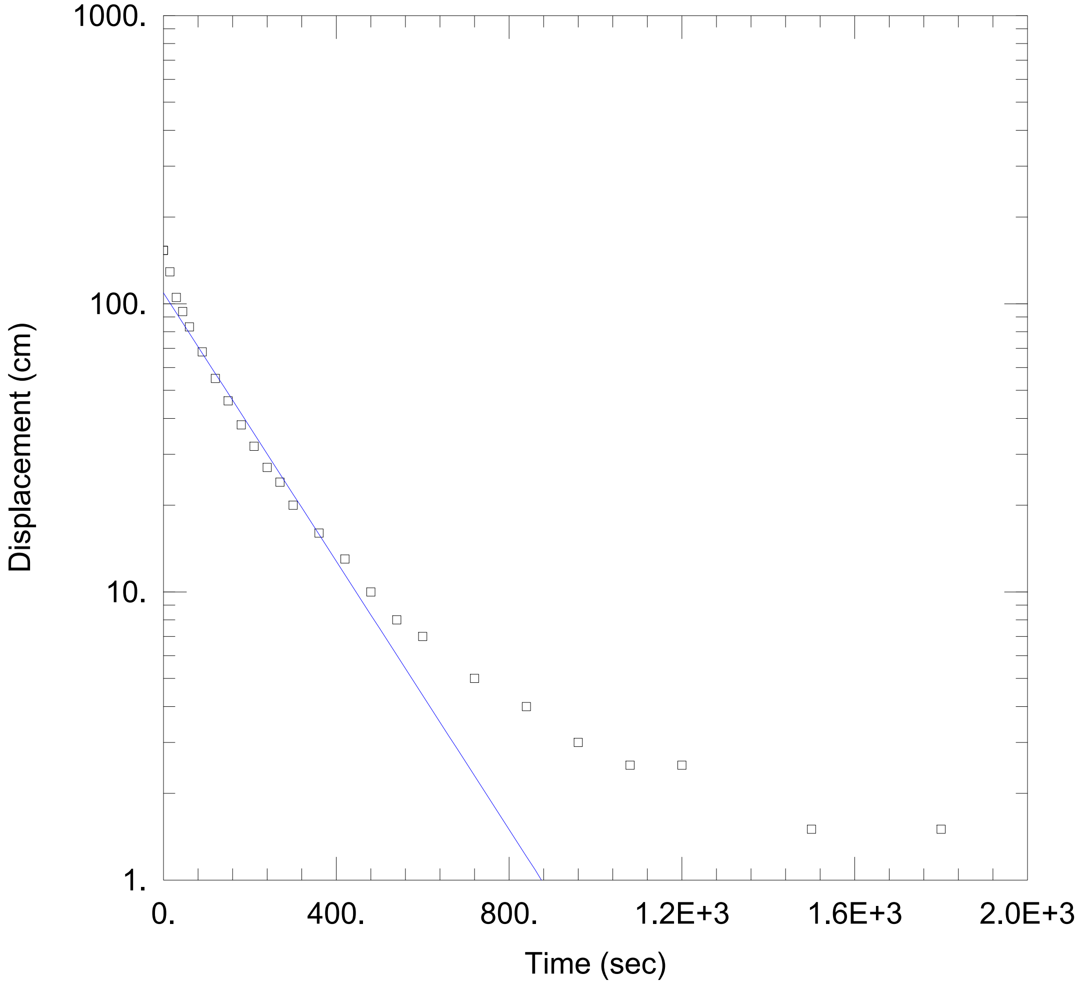
WELL DATA (BH6)

Initial Displacement: 32. cm
Total Well Penetration Depth: 340. cm
Casing Radius: 2.54 cm
Static Water Column Height: 340. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 0.0004387 cm/sec
y0 = 5.808 cm



HYDRAULIC CONDUCTIVITY TEST AT BH18

PROJECT INFORMATION

Company: R.J Burnside & Associates
Client: Shacca Caledon Holdings Inc.
Project: 300039242
Location: 16114 Airport Road, Caledon
Test Well: BH18
Test Date: Dec 15/2016

AQUIFER DATA

Saturated Thickness: 308. cm
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH18)

Initial Displacement: 153. cm
Total Well Penetration Depth: 308. cm
Casing Radius: 2.54 cm
Static Water Column Height: 308. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 0.0004193 cm/sec
y0 = 108.9 cm

BURNSIDE

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Appendix D

Groundwater Monitoring

Table D-1
Groundwater Elevations

	Well Depth (mbgs)	Ground Surface Elevation (masl)	18-Oct-2016		25-Nov-2016		15-Dec-2016		16-Jan-2017		14-Feb-2017	
			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)
BH3s	**4.11**	**291.10**	1.89	289.21	1.74	289.36	1.65	289.45	1.17	289.93	0.95	290.15
BH3d	**11.45**	**291.09**	1.34	289.75	1.16	289.93	1.06	290.03	0.53	290.56	0.28	290.81
BH6	**5.34**	**291.52**	2.15	289.37	1.97	289.55	1.87	289.65	1.37	290.15	1.12	290.40
BH13	**4.67**	**294.84**	3.61	291.23	3.44	291.40	3.32	291.52	2.46	292.38	2.09	292.75
BH15	**4.77**	**293.76**	1.88	291.88	1.59	292.17	1.42	292.34	0.81	292.95	0.78	292.98
BH18	**4.65**	**292.81**	1.96	290.85	1.70	291.11	1.53	291.28	0.92	291.89	0.71	292.10
BH19	**6.24**	**293.61**	3.78	289.83	3.62	289.99	3.47	290.14	2.99	290.62	2.70	290.91
BH20	**4.74**	**294.77**	4.50	290.27	4.30	290.47	4.18	290.59	3.49	291.28	2.93	291.84
BH22	**4.44**	**293.86**	4.01	289.86	3.82	290.04	3.71	290.15	Frozen	Frozen	Frozen	Frozen
PZ1	**1.34**	**293.83**	0.23	293.60	0.12	293.71	0.14	293.69	Frozen	Frozen	0.13	293.70
PZ2s	**1.32**	**292.12**	0.81	291.31	0.54	291.58	0.34	291.78	Frozen	Frozen	0.06	292.06
PZ2d	**1.93**	**292.12**	0.94	291.18	0.65	291.47	0.41	291.71	Frozen	Frozen	Frozen	Frozen
PZ3	**1.34**	**290.83**	0.46	290.37	0.33	290.50	0.31	290.52	0.19	290.64	0.15	290.68

"-" denotes data unavalable

mbgs - meters below ground surface

masl - meters above sea level

Table D-1
Groundwater Elevations

	Well Depth (mbgs)	Ground Surface Elevation (masl)	13-Mar-2017		12-Apr-2017		11-May-2017		21-Jun-2017		21-Jul-2017	
			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)
BH3s	**4.11**	**291.10**	0.76	290.34	0.66	290.44	0.63	290.47	0.90	290.20	0.76	290.35
BH3d	**11.45**	**291.09**	Frozen	Frozen	0.00	291.09	-0.01	291.10	0.23	290.86	0.18	290.91
BH6	**5.34**	**291.52**	0.91	290.61	0.78	290.74	0.80	290.72	1.09	290.43	0.99	290.53
BH13	**4.67**	**294.84**	1.59	293.25	1.28	293.56	1.26	293.58	2.00	292.84	1.70	293.14
BH15	**4.77**	**293.76**	0.61	293.15	0.30	293.46	0.48	293.28	0.67	293.09	0.45	293.31
BH18	**4.65**	**292.81**	0.57	292.24	0.36	292.45	0.47	292.34	0.68	292.13	0.54	292.27
BH19	**6.24**	**293.61**	2.47	291.14	2.31	291.30	2.37	291.24	2.70	290.91	2.66	290.95
BH20	**4.74**	**294.77**	2.57	292.20	2.62	292.15	2.68	292.09	3.17	291.60	3.11	291.66
BH22	**4.44**	**293.86**	Frozen	Frozen	2.43	291.43	2.46	291.40	2.89	290.97	2.85	291.01
PZ1	**1.34**	**293.83**	Frozen	Frozen	0.08	293.75	0.11	293.72	0.12	293.71	0.10	293.73
PZ2s	**1.32**	**292.12**	Frozen	Frozen	-0.01	292.13	-0.01	292.13	0.02	292.10	-0.02	292.14
PZ2d	**1.93**	**292.12**	Frozen	Frozen	-0.14	292.26	-0.12	292.24	-0.04	292.16	-0.10	292.22
PZ3	**1.34**	**290.83**	Frozen	Frozen	0.09	290.74	0.05	290.78	0.12	290.71	0.13	290.70

"-" denotes data unavalable

mbgs - meters below ground surface

masl - meters above sea level

Table D-1
Groundwater Elevations

	Well Depth (mbgs)	Ground Surface Elevation (masl)	16-Aug-2017		11-Sep-2017		24-Nov-2017		8-Mar-2018		11-May-2018		9-Jul-2018	
			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)	Water Level (mbgs)	Water Elevation (masl)
BH3s	**4.11**	**291.10**	1.08	290.02	1.20	289.90	1.05	290.05	1.01	290.09	0.76	290.34	1.30	289.80
BH3d	**11.45**	**291.09**	0.39	290.70	0.51	290.58	0.38	290.71	0.30	290.79	0.05	291.04	0.62	290.47
BH6	**5.34**	**291.52**	1.26	290.26	1.37	290.15	1.12	290.40	Frozen	Frozen	0.86	290.66	1.47	290.05
BH13	**4.67**	**294.84**	2.12	292.72	2.43	292.41	2.31	292.53	2.11	292.73	1.52	293.32	2.58	292.26
BH15	**4.77**	**293.76**	1.02	292.74	1.13	292.63	0.79	292.97	0.72	293.04	0.60	293.16	1.28	292.48
BH18	**4.65**	**292.81**	0.98	291.83	1.10	291.71	0.83	291.98	0.71	292.10	0.53	292.28	1.25	291.56
BH19	**6.24**	**293.61**	2.80	290.81	2.94	290.67	2.78	290.83	Frozen	Frozen	2.45	291.16	3.08	290.53
BH20	**4.74**	**294.77**	3.32	291.45	3.51	291.26	3.38	291.40	3.20	291.57	2.83	291.94	3.67	291.10
BH22	**4.44**	**293.86**	2.98	290.88	3.14	290.72	3.00	290.86	Frozen	Frozen	2.60	291.26	3.27	290.59
PZ1	**1.34**	**293.83**	0.21	293.62	0.23	293.60	0.12	293.71	0.16	293.67	0.15	293.68	0.26	293.57
PZ2s	**1.32**	**292.12**	0.12	292.00	0.16	291.96	0.03	292.09	0.07	292.05	0.03	292.09	0.36	291.76
PZ2d	**1.93**	**292.12**	0.12	292.00	0.17	291.95	-0.02	292.14	Frozen	Frozen	-0.10	292.22	0.36	291.76
PZ3	**1.34**	**290.83**	0.19	290.64	0.24	290.59	0.17	290.66	0.16	290.67	0.09	290.74	0.28	290.55

"-" denotes data unavalable

mbgs - meters below ground surface

masl - meters above sea level

Table D-1
Groundwater Elevations

	Well Depth (mbgs)	Ground Surface Elevation (masl)	13-Sep-2018		13-Nov-2018		21-Jun-2019		19-Sep-2019		11-Dec-2019		18-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)	Water Level (mbgs)	Water Elevation (masl)
BH3s	**4.11**	**291.10**	1.37	289.73	1.09	290.01	1.52	289.58	2.30	288.80	1.79	289.31	0.92	290.18
BH3d	**11.45**	**291.09**	0.66	290.43	0.37	290.72	0.64	290.45	1.53	289.56	0.97	290.12	0.14	290.95
BH6	**5.34**	**291.52**	1.53	289.99	1.21	290.31	1.55	289.97	2.41	289.11	1.87	289.65	1.20	290.32
BH13	**4.67**	**294.84**	2.70	292.14	2.18	292.66	2.20	292.64	3.47	291.37	2.94	291.90	1.64	293.20
BH15	**4.77**	**293.76**	1.21	292.55	0.72	293.04	0.97	292.79	1.77	291.99	1.00	292.76	0.38	293.38
BH18	**4.65**	**292.81**	1.22	291.59	0.77	292.04	0.98	291.83	1.91	290.90	1.20	291.61	0.41	292.40
BH19	**6.24**	**293.61**	3.09	290.52	2.74	290.87	2.94	290.67	3.88	289.73	3.32	290.29	Frozen	Frozen
BH20	**4.74**	**294.77**	3.73	291.04	3.34	291.43	3.45	291.32	4.52	290.25	4.00	290.77	2.87	291.90
BH22	**4.44**	**293.86**	3.31	290.55	2.98	290.88	3.15	290.71	4.15	289.71	3.59	290.27	Frozen	Frozen
PZ1	**1.34**	**293.83**	0.23	293.60	0.10	293.73	0.18	293.65	0.26	293.57	0.12	293.71	0.13	293.70
PZ2s	**1.32**	**292.12**	0.25	291.87	0.05	292.07	0.11	292.01	0.71	291.41	0.14	291.98	0.05	292.07
PZ2d	**1.93**	**292.12**	0.25	291.87	-0.02	292.14	0.05	292.07	0.84	291.28	0.13	291.99	Frozen	Frozen
PZ3	**1.34**	**290.83**	0.27	290.56	0.16	290.67	0.20	290.63	0.39	290.44	0.27	290.56	0.19	290.64

"-" denotes data unavalable

mbgs - meters below ground surface

masl - meters above sea level

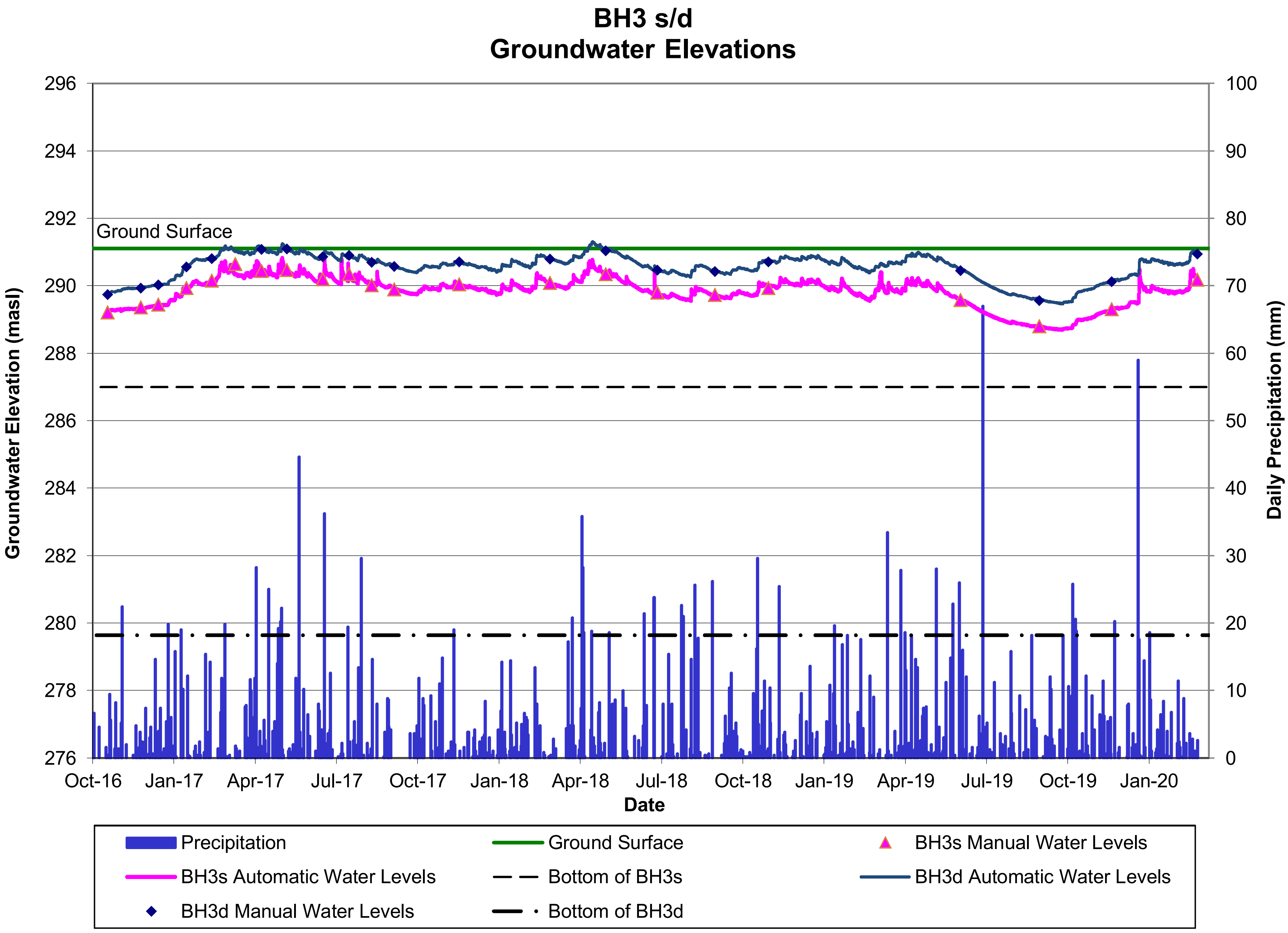
BH3 s/d
Groundwater Elevations
Ground Surface
Groundwater Elevation (masl)
Daily Precipitation (mm)
Date
296
294
292
290
288
286
284
282
280
278
276
100
90
80
70
60
50
40
30
20
10
0
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Apr-18
Jul-18
Oct-18
Jan-19
Apr-19
Jul-19
Oct-19
Jan-20
Precipitation
Ground Surface
BH3s Manual Water Levels
BH3s Automatic Water Levels
Bottom of BH3s
BH3d Automatic Water Levels
BH3d Manual Water Levels
Bottom of BH3d

Figure D-1

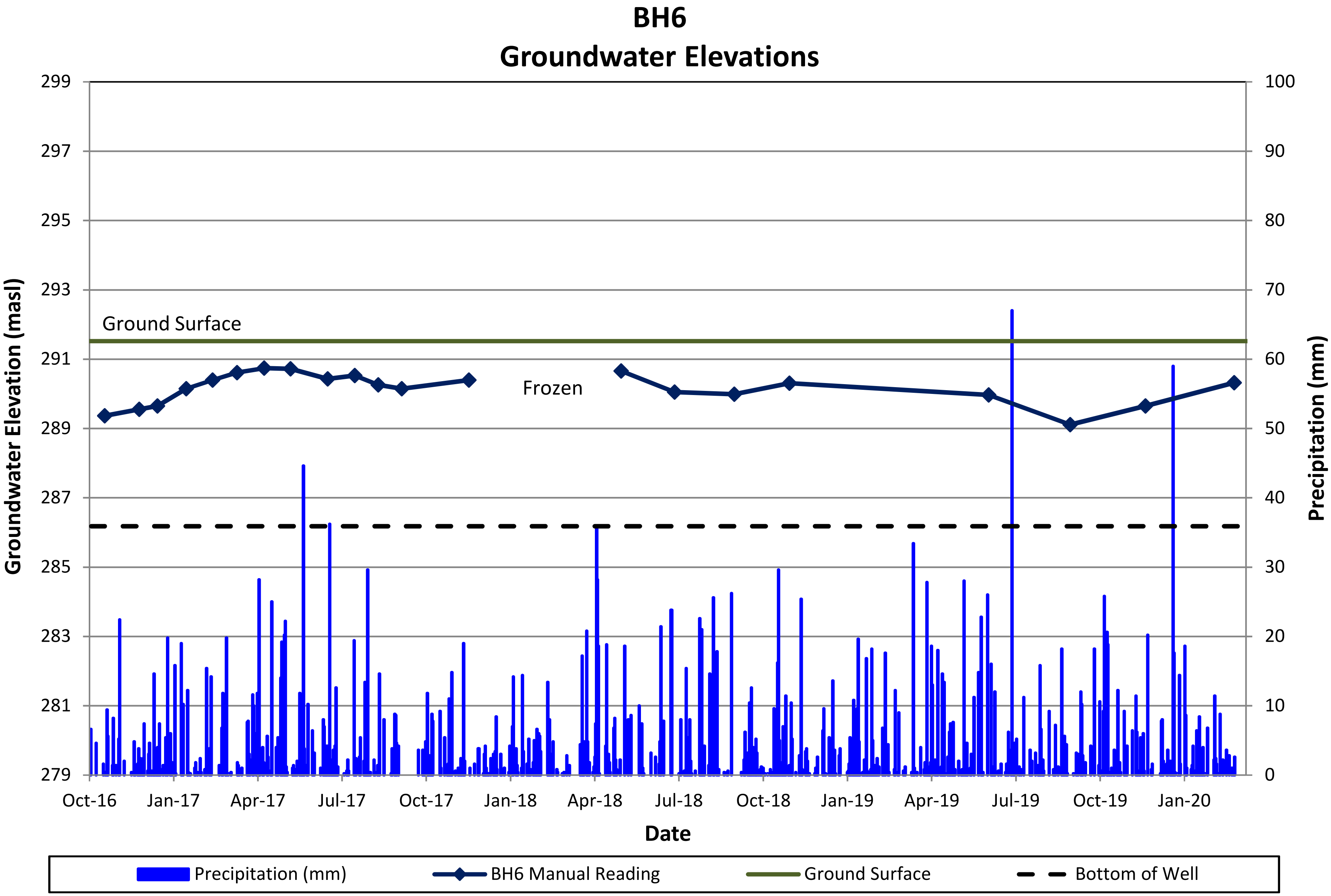
BH6
Groundwater Elevations
Groundwater Elevation (masl)
299
297
295
293
291
289
287
285
283
281
279
Precipitation (mm)
100
90
80
70
60
50
40
30
20
10
0
Ground Surface
Frozen
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Apr-18
Jul-18
Oct-18
Jan-19
Apr-19
Jul-19
Oct-19
Jan-20
Date
Precipitation (mm)
BH6 Manual Reading
Ground Surface
Bottom of Well

Figure D-2

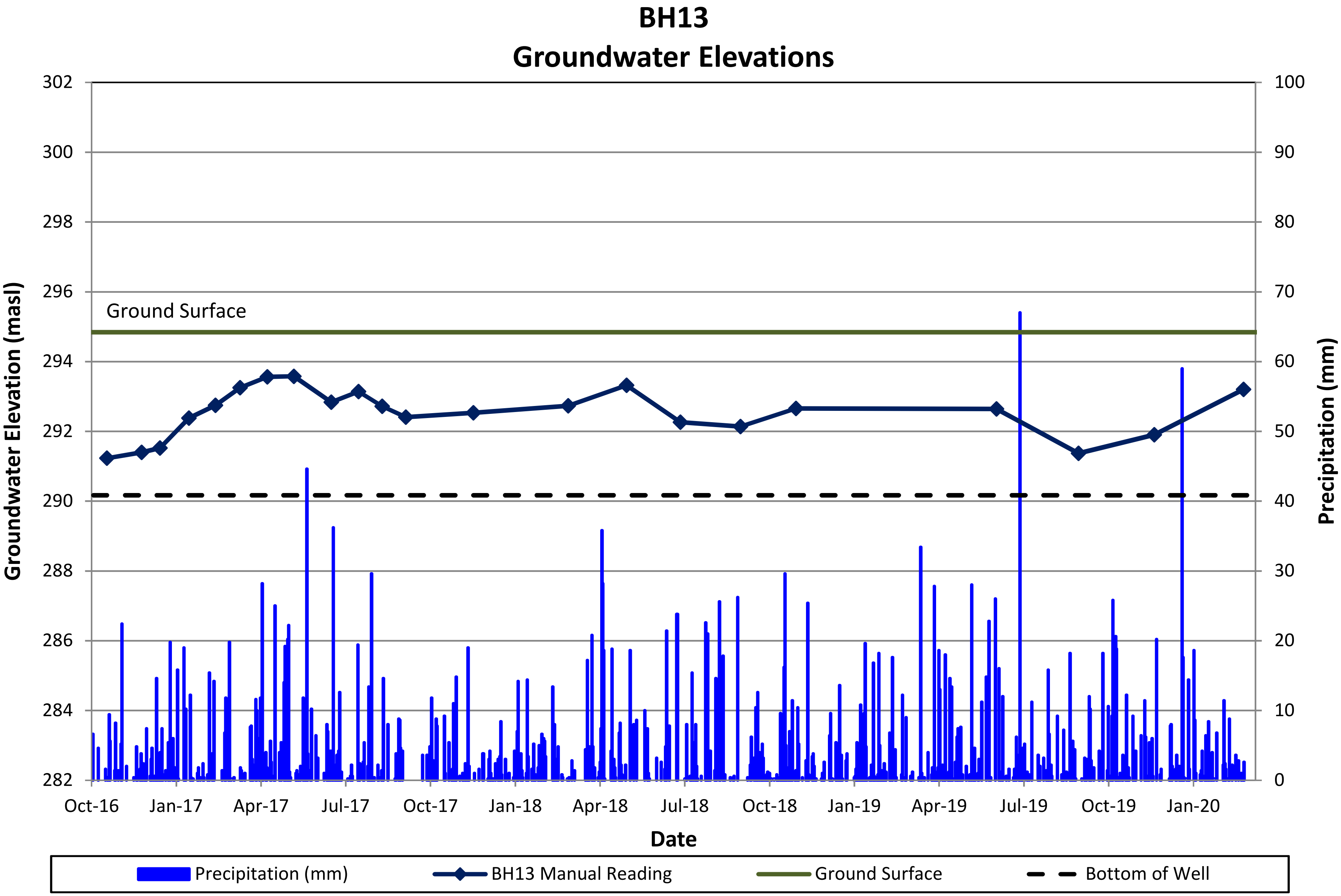

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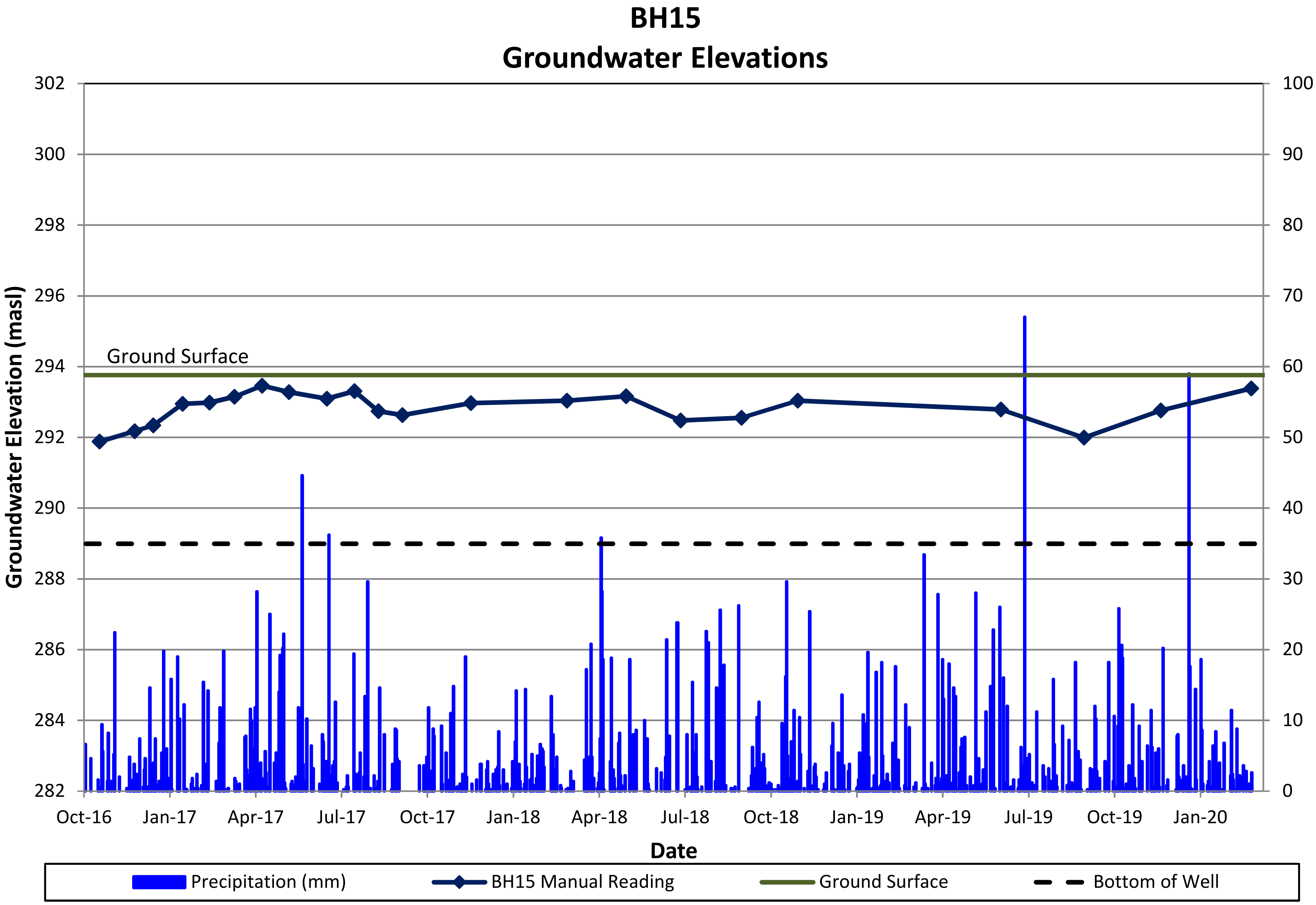
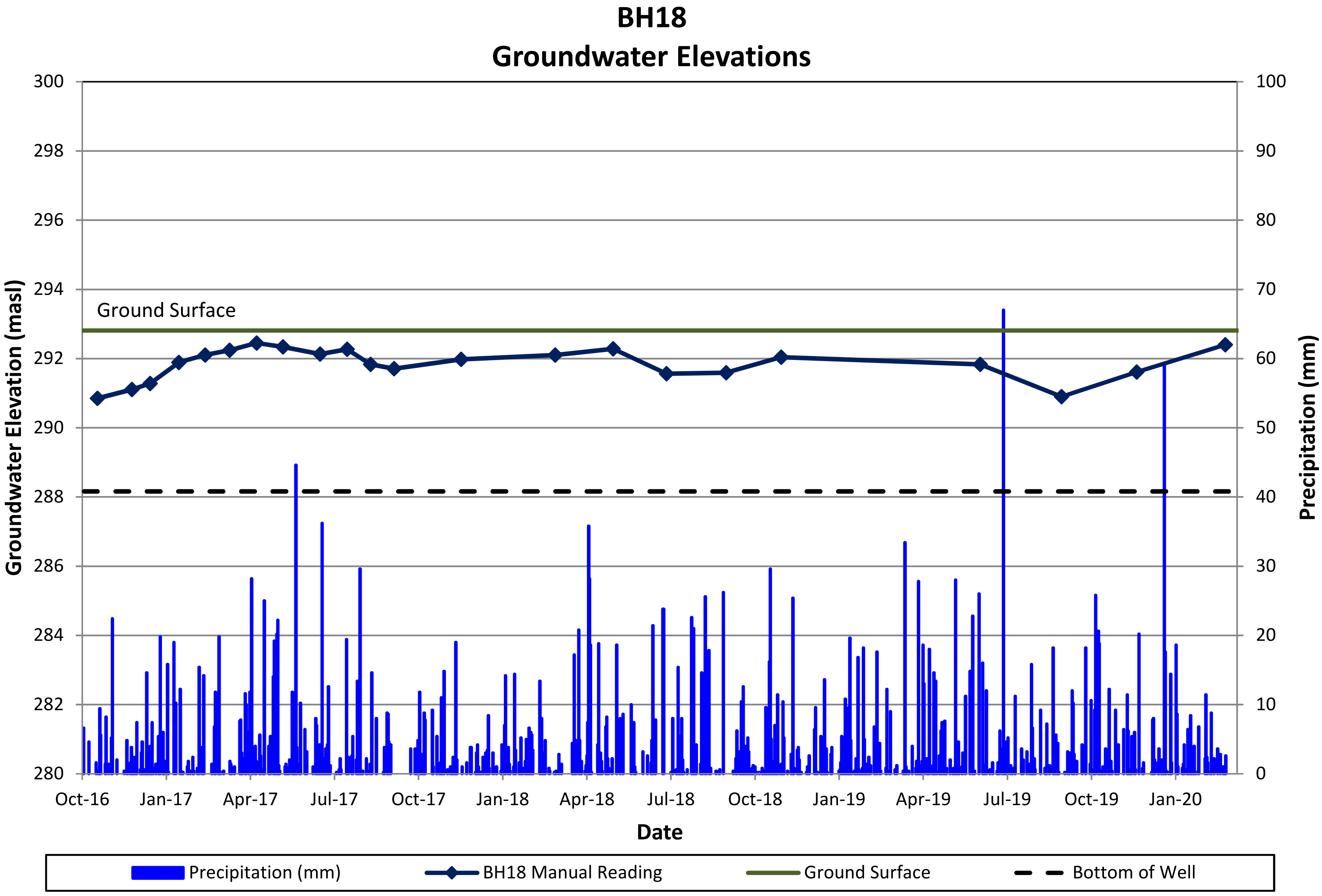
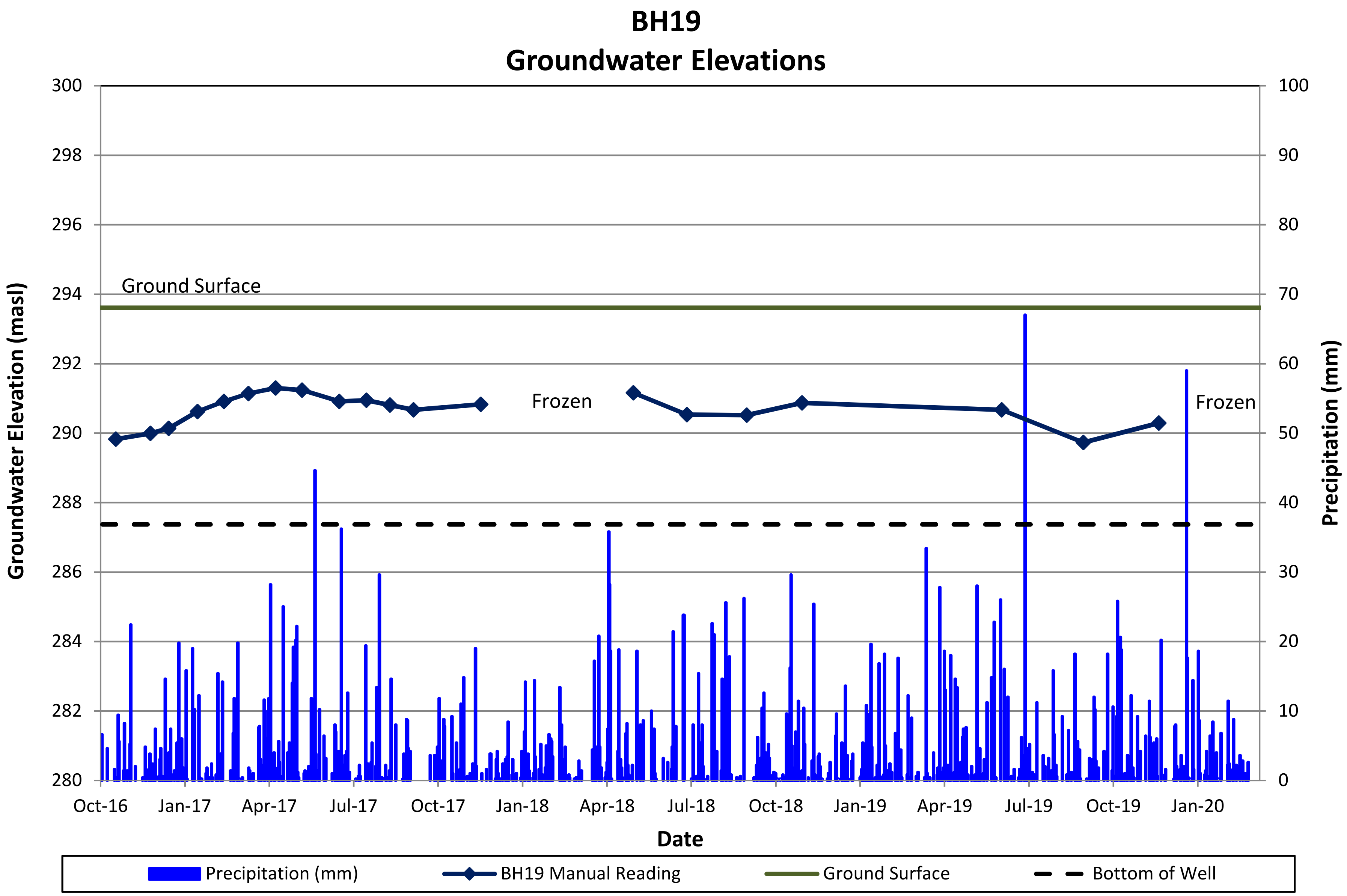
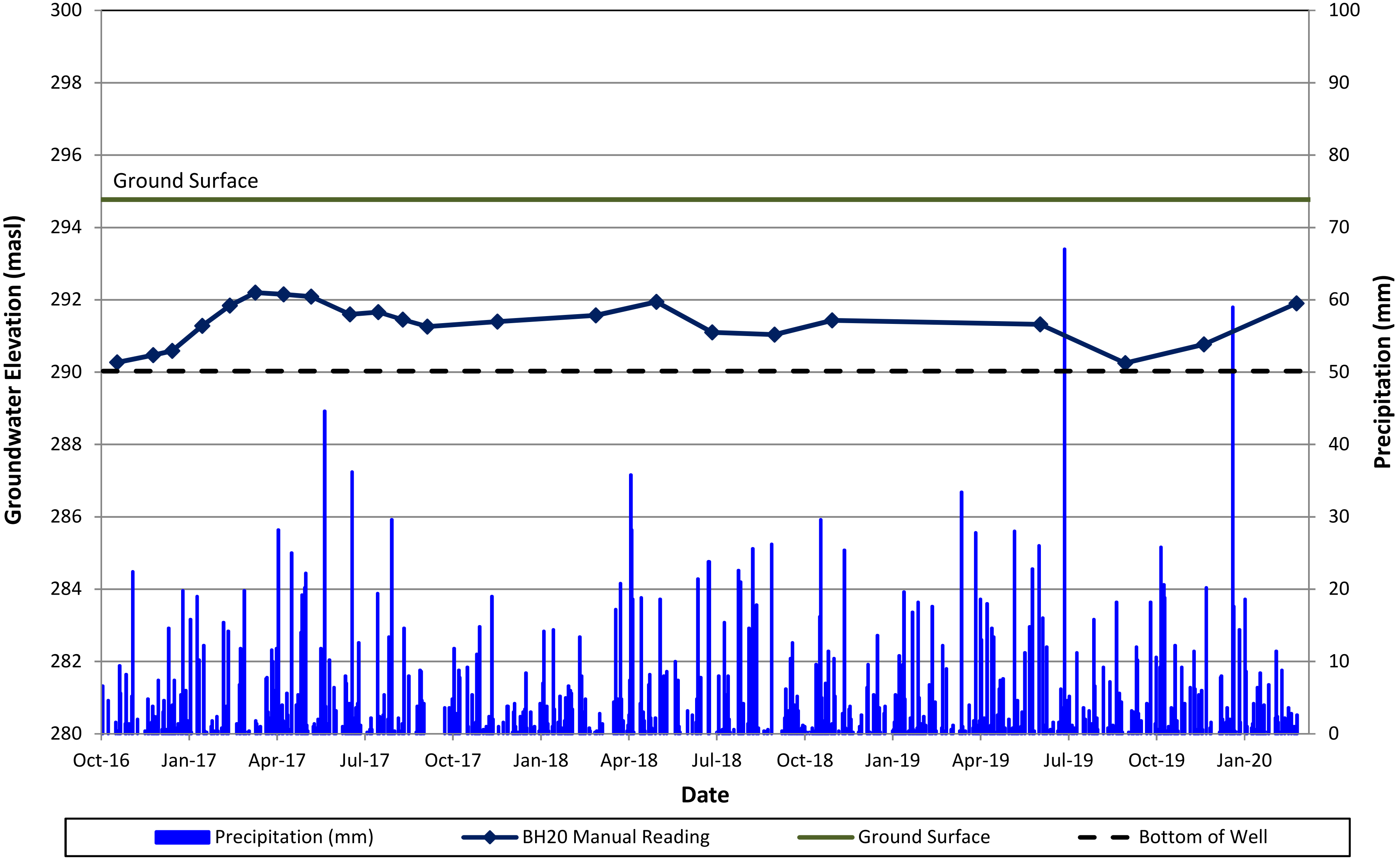
Figure D-3

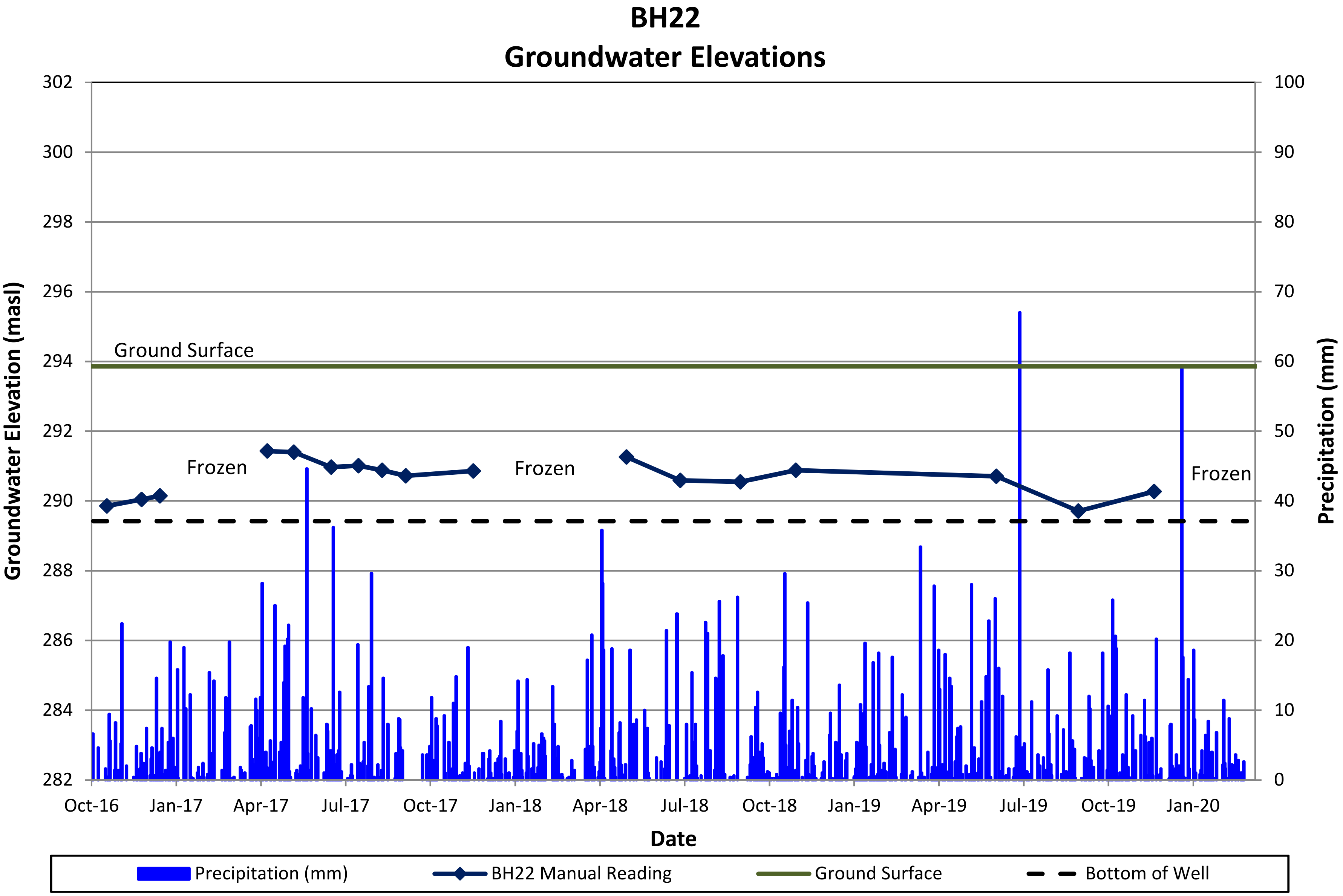

BH15
Groundwater Elevations
Ground Surface
Groundwater Elevation (masl)
Precipitation (mm)
302
300
298
296
294
292
290
288
286
284
282
100
90
80
70
60
50
40
30
20
10
0
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Apr-18
Jul-18
Oct-18
Jan-19
Apr-19
Jul-19
Oct-19
Jan-20
Date
Precipitation (mm)
BH15 Manual Reading
Ground Surface
Bottom of Well

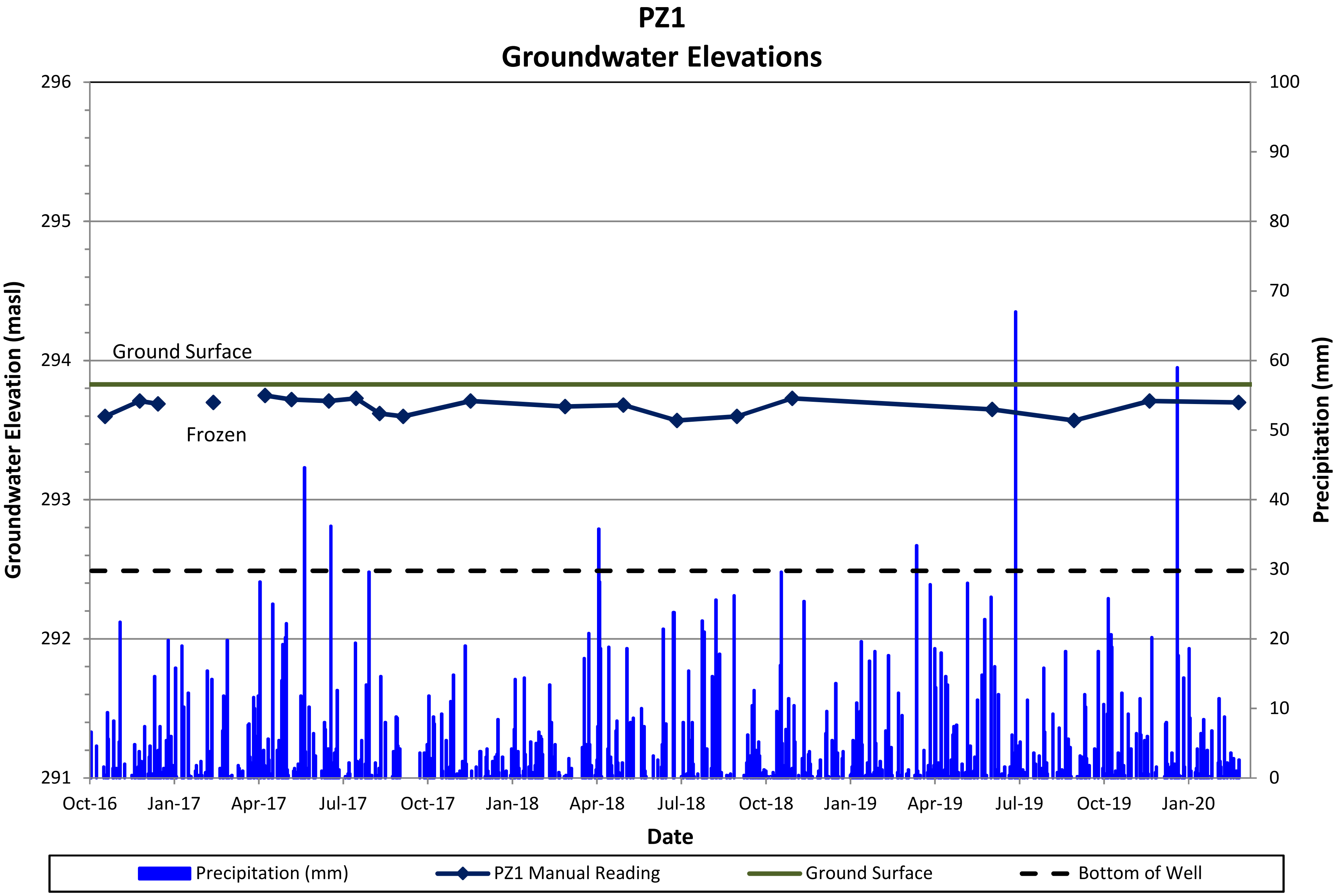

BH18
Groundwater Elevations
Ground Surface
Groundwater Elevation (masl)
Precipitation (mm)
300
298
296
294
292
290
288
286
284
282
280
100
90
80
70
60
50
40
30
20
10
0
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Apr-18
Jul-18
Oct-18
Jan-19
Apr-19
Jul-19
Oct-19
Jan-20
Date
Precipitation (mm)
BH18 Manual Reading
Ground Surface
Bottom of Well


BH19
Groundwater Elevations
Groundwater Elevation (masl)
300
298
296
294
292
290
288
286
284
282
280
Precipitation (mm)
100
90
80
70
60
50
40
30
20
10
0
Ground Surface
Frozen
Frozen
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Apr-18
Jul-18
Oct-18
Jan-19
Apr-19
Jul-19
Oct-19
Jan-20
Date
Precipitation (mm)
BH19 Manual Reading
Ground Surface
Bottom of Well

BH20
Groundwater Elevations

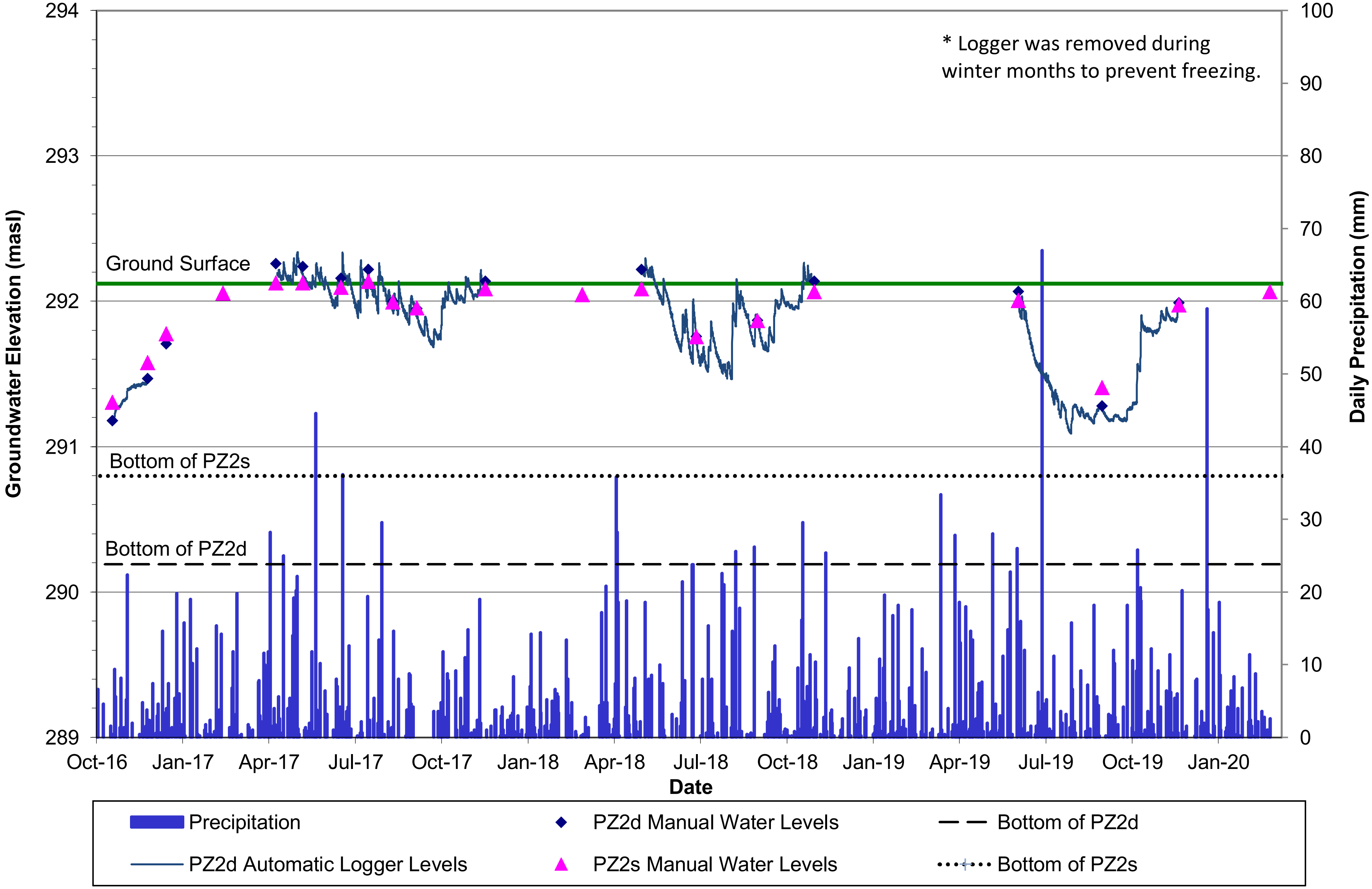



BH22
Groundwater Elevations
Groundwater Elevation (masl)
Precipitation (mm)
302
300
298
296
294
292
290
288
286
284
282
100
90
80
70
60
50
40
30
20
10
0
Ground Surface
Frozen
Frozen
Frozen
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Apr-18
Jul-18
Oct-18
Jan-19
Apr-19
Jul-19
Oct-19
Jan-20
Date
Precipitation (mm)
BH22 Manual Reading
Ground Surface
Bottom of Well



PZ1
Groundwater Elevations
Groundwater Elevation (masl)
296
295
294
293
292
291
Precipitation (mm)
100
90
80
70
60
50
40
30
20
10
0
Ground Surface
Frozen
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Apr-18
Jul-18
Oct-18
Jan-19
Apr-19
Jul-19
Oct-19
Jan-20
Date
Precipitation (mm)
PZ1 Manual Reading
Ground Surface
Bottom of Well

PZ2 s/d
Groundwater Elevations



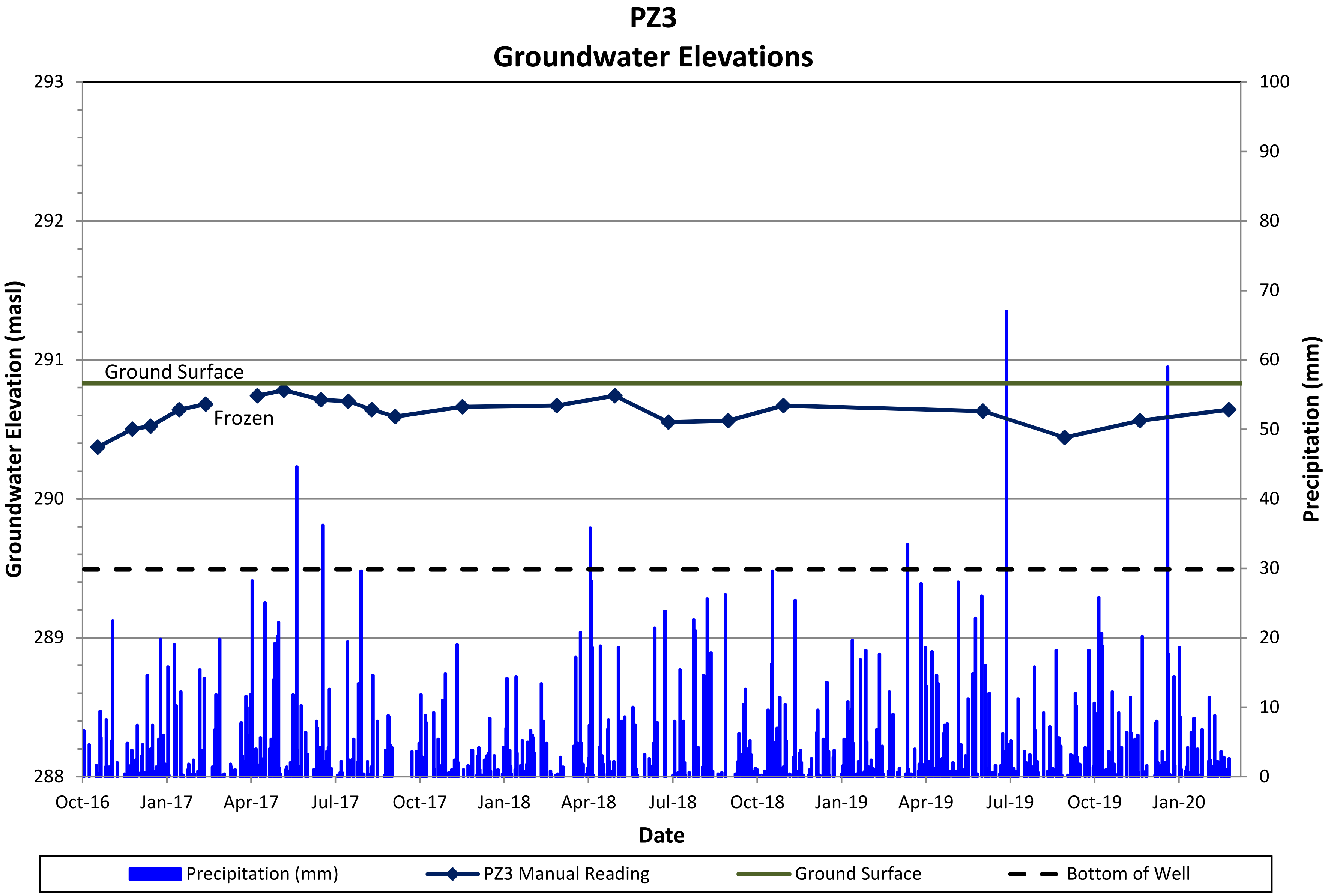


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Figure D-11

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Appendix E

Appendix E

Surface Water Monitoring

Table E-1
Surface Water Flow

Date	Days since rain:	Flow Rate (L/s)		
		SS1	SS2	SS3
18-Oct-16	1	0.5	1.6	<0.5
25-Nov-16	0	7.4	4.3	7.3
15-Dec-16	5	Partially Frozen	Frozen	Frozen and Snow Covered
16-Jan-17	3	Partially Frozen	Partially Frozen	Partially Frozen
14-Feb-17	2	Partially Frozen	Partially Frozen	Partially Frozen
13-Mar-17	5	Frozen	Frozen	Partially Frozen
12-Apr-17	1	2.8	6.6	8.2
11-May-17	4	2.6	2.6	10.4
21-Jun-17	1	0.9	4.1	7.4
21-Jul-17	1	4.3	3.9	8.8
16-Aug-17	1	0.6	<0.5	<0.5
11-Sep-17	4	1.0	1.2	<0.5
24-Nov-17	5	2.1	3.8	5.4
8-Mar-18	1	1.4	1.7	Frozen
11-May-18	1	3.3	2.7	5.9
9-Jul-18	3	0.9	0.1	0.6
13-Sep-18	3	1.2	<0.5	0.9
13-Nov-18	0	5.0	4.3	7.7
21-Jun-19	1	2.8	3.7	6.1
19-Sep-19	3	0.8	0.7	1.3
11-Dec-19	1	2.7	4.6	4.4
18-Mar-20	1	3.8	3.9	5.1

Note:
"<0.5" minimal flow not measurable with equipment (estimated)
"-" not measured

Appendix F

Water Quality

Appendix F

Table F-1
Groundwater Quality

Monitoring Well				**BH18**
Date Sampled				**15-Dec-16**
Parameter	**Unit**	**RDL**	**ODWQS**	
Electrical Conductivity	uS/cm	2		874
pH	pH Units	NA	(6.5-8.5)	8.00
Saturation pH				6.68
Langelier Index				1.32
Total Hardness (as CaCO3)	mg/L	0.5	(80-100)	**372**
Total Suspended Solids	mg/L	10		298000
Total Dissolved Solids	mg/L	20	500	462
Alkalinity (as CaCO3)	mg/L	5	(30-500)	408
Bicarbonate (as CaCO3)	mg/L	5		408
Carbonate (as CaCO3)	mg/L	5		<5
Hydroxide (as CaCO3)	mg/L	5		<5
Fluoride	mg/L	0.25	1.5	<0.25
Chloride	mg/L	0.50	250	36.1
Nitrate as N	mg/L	0.25	10.0	<0.25
Nitrite as N	mg/L	0.25	1.0	<0.25
Bromide	mg/L	0.25		<0.25
Sulphate	mg/L	0.50	500	18.6
Ortho Phosphate as P	mg/L	0.50		<0.50
Reactive Silica	mg/L	0.10		16.5
Ammonia as N	mg/L	0.02		<0.02
Total Phosphorus	mg/L	0.05		0.06
Total Organic Carbon	mg/L	0.5		3.4
Colour	TCU	5	5	<5
Turbidity	NTU	25	5	**31200**
Calcium	mg/L	0.10		113
Magnesium	mg/L	0.10		21.9
Sodium	mg/L	0.10	20 (200)	15.4
Potassium	mg/L	0.10		2.19
Aluminum	mg/L	0.004	0.1	0.055
Antimony	mg/L	0.003	0.006	<0.003
Arsenic	mg/L	0.003	0.025	<0.003
Barium	mg/L	0.002	1	0.086
Beryllium	mg/L	0.001		<0.001
Boron	mg/L	0.010	5	<0.010
Cadmium	mg/L	0.001	0.005	<0.001
Chromium	mg/L	0.003	0.05	<0.003
Cobalt	mg/L	0.001		0.001
Copper	mg/L	0.003	1	<0.003
Iron	mg/L	0.010	0.3	<0.010
Lead	mg/L	0.002	0.01	<0.002
Manganese	mg/L	0.002	0.05	**0.153**
Mercury	mg/L	0.0001	0.001	<0.0001
Molybdenum	mg/L	0.002		<0.002
Nickel	mg/L	0.003		<0.003
Selenium	mg/L	0.004	0.01	<0.004
Silver	mg/L	0.002		<0.002
Strontium	mg/L	0.005		0.409
Thallium	mg/L	0.006		<0.006
Tin	mg/L	0.002		<0.002
Titanium	mg/L	0.002		0.003
Tungsten	mg/L	0.010		<0.010
Uranium	mg/L	0.002	0.02	<0.002
Vanadium	mg/L	0.002		<0.002
Zinc	mg/L	0.005	5	0.006
Zirconium	mg/L	0.004		<0.004
% Difference/ Ion Balance	%	NA		7.86

ODWQS - Ontario Drinking Water Quality Standards
RDL - Reported Detection Limit

Table F-2
Surface Water Quality

Sample Location				**SS1**
Date Sampled				**15-Dec-16**
Parameter	**Unit**	**RDL**	**PWQS**	
Electrical Conductivity	uS/cm	2		614
pH	pH Units	NA	(6.5-8.5)	8.21
Saturation pH				7.08
Langelier Index				1.13
Total Hardness (as CaCO3)	mg/L	0.5		274
Total Dissolved Solids	mg/L	20		326
Alkalinity (as CaCO3)	mg/L	5		221
Bicarbonate (as CaCO3)	mg/L	5		221
Carbonate (as CaCO3)	mg/L	5		<5
Hydroxide (as CaCO3)	mg/L	5		<5
Fluoride	mg/L	0.05		<0.05
Chloride	mg/L	0.10		27.0
Nitrate as N	mg/L	0.05		<0.05
Nitrite as N	mg/L	0.05		<0.05
Bromide	mg/L	0.05		<0.05
Sulphate	mg/L	0.10		63.8
Ortho Phosphate as P	mg/L	0.10		<0.10
Reactive Silica	mg/L	0.05		14.6
Ammonia as N	mg/L	0.02		<0.02
Total Phosphorus	mg/L	0.01	0.03	<0.01
Total Organic Carbon	mg/L	0.5		4.0
Colour	TCU	5		13
Turbidity	NTU	0.5		<0.5
Calcium	mg/L	0.05		79.7
Magnesium	mg/L	0.05		18.2
Sodium	mg/L	0.05		18.8
Potassium	mg/L	0.05		1.38
Aluminum (dissolved)	mg/L	0.004	0.075	<0.004
Antimony	mg/L	0.003		<0.003
Arsenic	mg/L	0.003	1	<0.003
Barium	mg/L	0.002		0.071
Beryllium	mg/L	0.001		<0.001
Boron	mg/L	0.010	2	0.013
Cadmium	mg/L	0.0001	0.0002	<0.0001
Chromium	mg/L	0.003	0.009	<0.003
Cobalt	mg/L	0.0005		<0.0005
Copper	mg/L	0.002	0.005	<0.002
Iron	mg/L	0.01	0.3	<0.01
Lead	mg/L	0.001	0.001	<0.001
Manganese	mg/L	0.002		0.052
Dissolved Mercury	mg/L	0.0001	0.0002	<0.0001
Molybdenum	mg/L	0.002	0.04	<0.002
Nickel	mg/L	0.003	0.025	<0.003
Selenium	mg/L	0.004	0.01	<0.004
Silver	mg/L	0.0001		<0.0001
Strontium	mg/L	0.005		0.213
Thallium	mg/L	0.0003	0.0003	<0.0003
Tin	mg/L	0.002		<0.002
Titanium	mg/L	0.002		<0.002
Tungsten	mg/L	0.010		<0.010
Uranium	mg/L	0.002	0.005	<0.002
Vanadium	mg/L	0.002		<0.002
Zinc	mg/L	0.005	0.03	<0.005
Zirconium	mg/L	0.004		<0.004
Cation Sum	meq/L	NA		6.33
Anion Sum	meq/L			6.51
% Difference/ Ion Balance	%	NA		1.40

PWQS - Provincial Water Quality Standards
RDL - Reported Detection Limit

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Appendix G

Water Balance Calculations

WATER BALANCE CALCULATIONS
16114 Airport Road, Caldedon East
Shacca Caledon Holdings Inc.

PROJECT No.300039242.0000

TABLE G-1

Pre- and Post-Development Monthly Water Balance Components

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

Precipitation data from Albion Field Centre (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.00	-5.90	-1.40	6.10	12.40	17.30	19.90	19.10	14.30	8.10	2.10	-3.90	**6.8**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.35	3.96	6.55	8.10	7.61	4.91	2.08	0.27	0.00	**34.8**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	28.80	60.57	85.87	99.44	95.25	70.33	38.77	9.42	0.00	**488**
Adjusting Factor for U (Latitude 43° 55' N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	32	76	110	128	114	73	37	8	0	**579**
COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	60	50	50	67	76	76	82	77	75	68	82	58	**821**
Potential Evapotranspiration (PET)	0	0	0	32	76	110	128	114	73	37	8	0	**579**
P - PET	60	50	50	35	0	-34	-46	-37	2	31	74	58	**243**
Change in Soil Moisture Storage	0	0	0	0	0	-34	-40	0	2	31	42	0	**0**
Soil Moisture Storage max 75 mm	75	75	75	75	75	40	0	0	2	33	75	75	
Actual Evapotranspiration (AET)	0	0	0	32	76	110	122	77	73	37	8	0	**536**
Soil Moisture Deficit max 75 mm	0	0	0	0	0	35	75	75	73	42	0	0	
Water Surplus - available for infiltration or runoff	60	50	50	35	0	0	0	0	0	0	32	58	**286**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	36	30	30	21	0	0	0	0	0	0	19	35	**171**
Potential Direct Surface Water Runoff (independent of temperature)	24	20	20	14	0	0	0	0	0	0	13	23	**114**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	821	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	123	mm/year											
P-PE (surplus available for runoff from impervious areas)	698	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 soils	0.4	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - urban lawn/meadow	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.6**	

Latitude of site (or climate station) 43 ° N.

WATER BALANCE CALCULATIONS
16114 Airport Road, Caldedon East
Shacca Caledon Holdings Inc.

PROJECT No.300039242.0000

TABLE G-2

Pre- and Post-Development Monthly Water Balance Components

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

Precipitation data from Albion Field Centre (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.00	-5.90	-1.40	6.10	12.40	17.30	19.90	19.10	14.30	8.10	2.10	-3.90	**6.8**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.35	3.96	6.55	8.10	7.61	4.91	2.08	0.27	0.00	**34.8**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	28.80	60.57	85.87	99.44	95.25	70.33	38.77	9.42	0.00	**488**
Adjusting Factor for U (Latitude 43° 55' N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	32	76	110	128	114	73	37	8	0	**579**
COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	60	50	50	67	76	76	82	77	75	68	82	58	**821**
Potential Evapotranspiration (PET)	0	0	0	32	76	110	128	114	73	37	8	0	**579**
P - PET	60	50	50	35	0	-34	-46	-37	2	31	74	58	**243**
Change in Soil Moisture Storage	0	0	0	0	0	-34	-46	-37	2	31	74	11	**0**
Soil Moisture Storage max 300 mm	300	300	300	300	300	265	219	182	184	215	289	300	
Actual Evapotranspiration (AET)	0	0	0	32	76	110	128	114	73	37	8	0	**579**
Soil Moisture Deficit max 300 mm	0	0	0	0	0	35	81	118	116	85	11	0	
Water Surplus - available for infiltration or runoff	60	50	50	35	0	0	0	0	0	0	0	47	**243**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	54	45	45	31	0	0	0	0	0	0	0	42	**218**
Potential Direct Surface Water Runoff (independent of temperature)	6	5	5	3	0	0	0	0	0	0	0	5	**24**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	821	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	123	mm/year											
P-PE (surplus available for runoff from impervious areas)	698	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 - flat land	0.3	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - sandy loam soils	0.4	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - wooded lands	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.9**	

Latitude of site (or climate station) 43 ° N.

WATER BALANCE CALCULATIONS
16114 Airport Road, Caldedon East
Shacca Caledon Holdings Inc.

PROJECT No.300039242.0000

TABLE G-3

Pre and Post Development Water Balance Calculations (assuming no mitigation measures)

Catchment Area	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)
Exising Land Use*												
Grass and Meadow	15,216	0.00	0	0.698	0	15,216	0.114	1,739	0.171	2,609	1,739	2,609
Rural Residential	1,692	0.30	508	0.698	354	1,184	0.114	135	0.171	203	490	203
Wooded Lands	23,953	0.00	0	0.698	0	23,953	0.024	581	0.218	5,232	581	5,232
TOTAL PRE-DEVELOPMENT	**40,861**		**508**		**354**	**40,353**		**2,456**		**8,044**	**2,810**	**8,044**
Post-Development Land Use												
Residential	8,420	0.68	5,692	0.698	3,974	2,728	0.114	312	0.171	468	4,286	468
Commercial	5,550	0.68	3,757	0.698	2,623	1,793	0.114	205	0.171	307	2,828	307
Potential Park	1,037	0.00	0	0.698	0	1,037	0.114	119	0.171	178	119	178
Road Widening	1,000	0.00	0	0.698	0	1,000	0.114	114	0.171	171	114	171
Natural Heritage System and Buffer	24,854	0.00	0	0.698	0	24,854	0.024	603	0.218	5,429	603	5,429
TOTAL POST-DEVELOPMENT	**40,861**		**9,449**		**6,597**	**31,412**		**1,353**		**6,554**	**7,950**	**6,554**
% Change from Pre to Post											283	19
Effect of development (with no mitigation)											2.8 times increase in runoff	19% reduction in infiltration

* taken from mapping provided by Dillon Consulting

** figures from Tables G-1 and G-2

*** post development figures provided by Trafalgar Engineering

To balance pre- to post-,
the infiltration target (m^3/a)= **1,491** **m^3/a**

WATER BALANCE CALCULATIONS
16114 Airport Road, Caldedon East
Shacca Caledon Holdings Inc.

PROJECT No.300039242.0000

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TABLE G-4

Water Balance Mitigation Strategy
Direction of Roof Runoff to Pervious

	Roof Area Directed to Pervious (m^2)	Total Annual Precipitation (m)*	Runoff from Roofs (assuming 15% evaporation) (m^3/a)	% Infiltration over Pervious Area**	Potential Infiltration Volume (m^3/a)
Residential Roofs	2,933	0.821	2048	50%	1,024
Heritage House Roof	236	0.821	165	50%	82
				Total	1,106

* total average annual precipitation from Albion Field Center MOE climate station

** based on estimation in the LID SWM Planning and Design Guide (CVC & TRCA, 2010) for hydrologic groups A & B

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Appendix H

Dewatering Assessment

R.J. Burnside & Associates Limited 292 Speedvale Avenue West Unit 20 Guelph ON N1H 1C4 CANADA
telephone (519) 823-4995 **fax** (519) 836-5477 **web** www.rjburnside.com

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February 13, 2018

Via: Email

Ms. Ale Padron
Glen Schnarr & Associates Inc.
700 -10 Kingsbridge Garden Circle
Mississauga ON L5R 3K6

Dear Ms. Padron:

Re: Dewatering Impact Assessment
16114 Airport Road, East Caledon, Ontario
Project No.: 300039242.0000

1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) has been retained by Shacca Caledon Holdings Inc. to provide an assessment of the potential dewatering that would be required for servicing the proposed development at 16114 Airport Road in East Caledon, Ontario. This assessment has been based on data collected as part of a previous report titled "*Hydrogeological Impact Assessment for the 16114 Airport Road, East Caledon Ontario*" completed by Burnside and dated March 2017 and a letter titled "2017 Monitoring Update for *16114 Airport Road, East Caledon Ontario"* dated December 2017. The previous reports identified the presence of shallow groundwater across the subject property and that localized dewatering may be required during excavations for installation of municipal services and construction of basements. This assessment estimates the volumes of water that may be required and discusses potential impacts of dewatering activities.

In 2016 the Ministry of the Environment and Climate Change (MOECC) introduced new regulations that allow for construction related dewatering to proceed under the Environmental Activity Sector Registry (EASR) process if dewatering volumes are above 50,000 L/day but below 400,000 L/day. Takings above 400,000 L/day require a Category 3 Permit to Take Water (PTTW). A hydrogeological report is required to be completed for both the EASR and PTTW processes based on guidelines provided by the MOECC. This assessment may be used in support of an EASR/PTTW application in combination with the previously submitted Hydrogeological Impact Assessment report however a Monitoring and Mitigation Plan and Erosion and Sediment Control Plan will also be required at the time of application.

2.0 Hydrogeological Conditions

2.1 Groundwater Levels

Groundwater levels have been measured on the subject property as part of ongoing monitoring and in support of a hydrogeology assessment since October 2016 (Burnside, 2017). The monitoring locations are shown on Figure 1. The groundwater elevation data indicate that groundwater levels on the subject property range from 0.6 m below grade (mbg) to 4.5 mbg. Average seasonal variability in the wells is 1.7 m with water levels highest in the spring and lower throughout the summer and fall months. An upward gradient was observed at monitoring well nest BH3s/d. Groundwater elevations on the subject property during the seasonal high in 2017 ranged from 291 masl to 294 masl (Figure 2). Groundwater flow is interpreted to be towards the east and southeast (Figure 2).

2.2 Hydraulic Conductivity

Hydraulic conductivity is a measure of the ability of the soil to transmit groundwater. The surficial soils of the subject property are described as silty sand fill overlying deposits of sand, silty sand and silt. Based on grainsize analysis and single well response testing the hydraulic conductivity of the soils on the subject property is interpreted to be in the range of 10^{-6} to 10^{-7} m/sec (Burnside, 2017).

3.0 Dewatering Requirements

Installation of services will likely encounter shallow groundwater within the overburden. Since some of the excavations will be below the groundwater table, control of groundwater seepage into the open excavations may be required through the use of dewatering techniques. A review of grading and servicing plans (provided by Trafalger Engineering) indicates that a drawdown of the water table ranging between 2 m and 5 m may be required in some areas. In addition to dewatering for groundwater removal it may be necessary to remove accumulated surface water and direct precipitation collected in open excavations.

3.1 Groundwater Seepage

The amount of groundwater seepage into open excavations is controlled by the hydraulic conductivity of the sediments that make up the subsurface deposits, as well as the local hydraulic gradients. Conditions such as the degree of weathering and fracturing, as well as the amount of silt and sand or gravel and layering, may affect the overall effective hydraulic conductivity of the overburden deposits.

The extent of groundwater dewatering required in the excavations can be estimated using the following formulae as presented in “Groundwater Lowering in Construction – A Practical Guide to Dewatering, 2nd Edition” (Cashman & Preen, 2013).

The following equation is suitable for maintenance hole or short excavation lengths which groundwater infiltration is approximated as flow to an equivalent well:

$$Q = \pi K(H^2-h^2)/(\ln R_o/r_s)$$

The following equation is appropriate for long narrow trenches (pipe trenches):

$$Q = [\pi K(H^2-h^2)/(\ln R_o/r_s)] + 2[xK(H^2-h^2)/2L]$$

Where:

Q = Discharge (m^3/sec)
K = Hydraulic Conductivity (m/sec)
H = Initial water level relative to datum (m)
h = Final water level relative to the datum required for dewatering (m)
R_0 = Radius of influence of dewatering (m)
r_s = Equivalent radius of dewatering well (m)
π = 3.1416
x = length of trench (m)
L = distance from line source (m)

The surficial sediments on the subject property were observed to be variations of sand and silt with trace amounts of clay and gravel with hydraulic conductivity ranging from 10^{-6} to 10^{-7} m/sec. It has been assumed that excavations will encounter the highest yielding sediments during construction and hence the calculations were performed using the highest range for hydraulic conductivity applicable to the subject property (1.0×10^{-6} m/sec) to determine the maximum dewatering volume.

The dewatering calculations are presented in Table A-1 (for excavations with similar lengths and widths, radial flow) and in Table A-2 (for linear trench excavations) in Appendix A. Calculations have been completed for typical servicing trenches, for basements and for a deep manhole connection referred to as STC-4000. For trenches and basements that will occur across the development area, volumes have been calculated separately for the northwest portion of the site and the southeast portion of the subject property due to the difference in topography and groundwater elevations. When determining the maximum volumes for the subject property, the portion with the highest volume will be used.

3.2 Precipitation and Runoff

In the event of precipitation, water falling directly on the construction area will likely pool in excavation areas and basements created by site grading. In order for work to continue, the pooled water will need to be pumped out. The volume of water associated with these excavations has been estimated based on the rainfall over the subject property and an approximate size of the excavations. Runoff is developed based on a 50 mm rain storm event with all the water generated being pooled within the depression or excavation. This is a conservative estimate and was used to generate a typical runoff volume scenario. The calculated runoff volumes are provided in Table A-3, Appendix A.

3.3 Total Takings

The total required dewatering volumes for the subject lands is computed using both the groundwater seepage and the estimated surface water runoff (Table A-4, Appendix A). The total volumes provided below in Table 1 have been calculated using a conservative approach.

Table 1: Total Water Takings

	Volumes from Trench Excavations (L/day) per 100 m	**Volumes from STC-4000 Manhole (L/day)**	**Volumes from Basements (L/day) per 100 m^2**
Groundwater Seepage	150,000	12,000	11,000
Surface Water Runoff	30,600	1,800	7,200
Total	180,000	13,800	18,200

4.0 Impact Evaluation

4.1 Zone of Influence

The extent of the water table drawdown (i.e., Zone of Influence/Radius of Influence) that may occur when excavations are dewatered by pumping or gravity drainage has been approximated with an empirical relationship by Sichart and Kryieleis and presented in “Groundwater Lowering in Construction – A Practical Guide to Dewatering, 2nd Edition” (Cashman & Preen, 2013).

The radius of influence due to dewatering by pumping may be estimated from the following equation:

$$R_0 = 3000(H-h)K^{0.5}$$

Where:

K = Hydraulic conductivity (m/sec)
H = Existing height of the water table relative to datum (m)
h = Height of the water table after dewatering relative to datum (m)
R_0 = Lateral extent of drawdown/Radius of Influence/Zone of Influence (m)
r_s = Equivalent radius of well or system (m)

The literature indicates that the value of the constant 3,000 is applicable for situations when there is active pumping (as anticipated to occur in this case). When the radius of the well is not small compared to the radius of influence it is recommended to add the equivalent radius of the well resulting in the following equation:

$$R_0 = r_s + 3000(H-h)K^{0.5}$$

For plane flow cases such as linear trenches the distance of influence (L_o) can be estimated using the same empirical relationship with a different calibration factor:

$$L_0 = 1750(H-h)K^{0.5}$$

Where:

K = Hydraulic conductivity (m/sec)
H = Existing height of the water table relative to datum (m)
h = Height of the water table after dewatering relative to datum (m)
L_0 = Distance of influence/Zone of Influence (m)

Using these equations, the hydraulic conductivity of 10^{-6} m/sec and the required water table drawdown, the Zone of Influence for the dewatering sources has been calculated. The R_o (radius of influence) for basements and STC-4000 manhole is calculated in Table A-1, Appendix A. The L_o (distance of influence) for linear sources are calculated in Table A-2, Appendix A. The results are summarized below in Table 2.

Table 2: Zone of Influence

Source	Required Drawdown (m)	Zone of Influence (m)
Excavations (per 100 m x 4 m)	1.9 to 3.1	3 to 5
STC-4000 Manhole	4.8	16
Basements (per 100 m^2)	1.9 to 3.1	8 to 12

4.2 Water Well Interference Assessment

Most of the areas surrounding the subject property are municipally serviced however it is possible that there may be some properties that still rely on private wells as a water supply. A water well survey was conducted by Burnside as part of the 2017 study for the residential properties that back onto the subject property and there were no responses to this survey.

A review of MOECC water well records within 500 m of the subject property indicated that there are seven private water supply wells located in the vicinity of the subject property and four of them are screened in the surficial overburden aquifer (Table B-1, Appendix B). All of the wells are located outside of the anticipated Zone of Influence and therefore are not expected to be impacted by dewatering activities on the subject property (Figure 3).

The closest municipal supply well Caledon East Well 3, is located 700 southeast of the subject property (Figure 3) and is screened in the deep overburden at a depth of 47 m. It is anticipated that any drawdown associated with dewatering during construction will be very localized and restricted to areas in the immediate vicinity of sediments being dewatered. In addition, the expected short duration of dewatering will limit the area impacted. In this context, it is highly unlikely that the impact of dewatering will extend for any significant distances and will therefore not adversely impact the municipal water supply wells or potentially present domestic in the overburden.

4.3 Potential Surface Water Impacts

An Erosion and Sediment Control Plan will need to be designed for the subject lands that aims to protect surface water features from impacts due to dewatering activities. Depending on the proposed discharge locations, water quality of the discharge water may be required to ensure adequate sediment removal and that surface water features are not impacted.

Impacts to Boyce’s Creek and the adjacent provincially significant wetland, as a result of water table lowering, are not anticipated due to the limited Zone of Influence. Also, based on interpreted groundwater flow for the subject property, groundwater contribution to the wetland is limited to areas outside of the developable lands (Figure 2).

4.4 Potential for Settlement

It is recommended that an assessment of potential settlement as a result of dewatering activities be obtained from a geotechnical engineer.

4.5 Movement of Contaminants

Water quality sampling completed on the subject property as part of the hydrogeological assessment did not identify the presence of any contaminants of concern in the groundwater (Burnside, 2017). Due to the limited area of influence expected for dewatering in the area, it is not expected that any contaminants will be transported or moved during dewatering of the subject property. Designs of service trenches should include considerations for the installation of cut off walls to prevent the movement of groundwater along preferential pathways created by the service trenches.

5.0 Monitoring and Mitigation

Despite the anticipated limited impact on the groundwater and surface water resources of the area of the subject property, it is recommended that a monitoring program be put in place during the construction dewatering to record any impact as part of site due diligence. The monitoring program is recommended to ensure that unacceptable impacts to the local groundwater and surface water quality and quantity do not occur during the dewatering activities. The recommended monitoring program includes three stages as follows:

1. **Pre-dewatering monitoring –** to establish the baseline groundwater and surface water conditions prior to initiation of earthworks.
2. **Monitoring during dewatering –** to trigger any contingency actions required to prevent or mitigate impacts to the groundwater and surface water.
3. **Post-dewatering monitoring –** to confirm acceptable groundwater and surface conditions once dewatering is complete.

5.1 Pre-Dewatering

Pre-dewatering monitoring would be a continuation of the on-going groundwater and surface water monitoring on the subject property. Monitoring that has been occurring since October 2016 should provide an adequate baseline for pre-construction conditions.

5.2 During Dewatering

During dewatering groundwater monitoring should continue at piezometers within the wetland and groundwater wells outside of the area of construction. Monitoring locations equipped with automatic water level meters should continue to be downloaded to provide a detailed record of groundwater levels during construction activities. A Sediment and Erosion Control Plan and discharge water quality monitoring plan will need to be included in monitoring activities during dewatering.

5.3 Post-Dewatering

Following completion of the dewatering activities, monitoring of the piezometers and any remaining groundwater observation wells should continue until water levels in the wells have recovered and stabilized or at least for a period of three months.

6.0 Conclusions and Recommendations

Based on the analysis completed as part of this assessment, the following recommendations are provided:

- An application for an EASR will be required for construction dewatering on the subject property. A qualified professional should be retained to complete the registration.
- A monitoring program as outlined above should be established before commencement of dewatering activities at the subject property.
- A Sediment and Erosion Control Plan associated with dewatering should be completed as part of an application for EASR.
- EASR volumes should be registered as outlined in Table 1.
- In order to complete the EASR registration an Erosion and Sediment Control Plan should be developed by a qualified engineer.
- In order to complete the EASR registration an opinion on the potential for settlement should be obtained from a geotechnical consultant.
- All reports should be combined and retained on record in support of an EASR registration.

Yours truly,

R.J. Burnside & Associates Limited

Stephanie Charity

Stephanie Charity, P.Geo.
Hydrogeologist
SC:cl

Dwight Smikle, M.Sc., P.Geo.
Senior Hydrogeologist

Enclosure(s)

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Figures

LEGEND

▭	SUBJECT LANDS
—	WATERCOURSE
▬	APPROXIMATE AREA OF PROPOSED DEVELOPMENT
▲	SURFACE WATER MONITORING STATION
⊕	MONITORING WELL (TERRAPROBE, 2016)
●	PIEZOMETER

Sources:

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

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SHACCA CALEDON HOLDINGS INC.
CALEDON EAST, ONTARIO

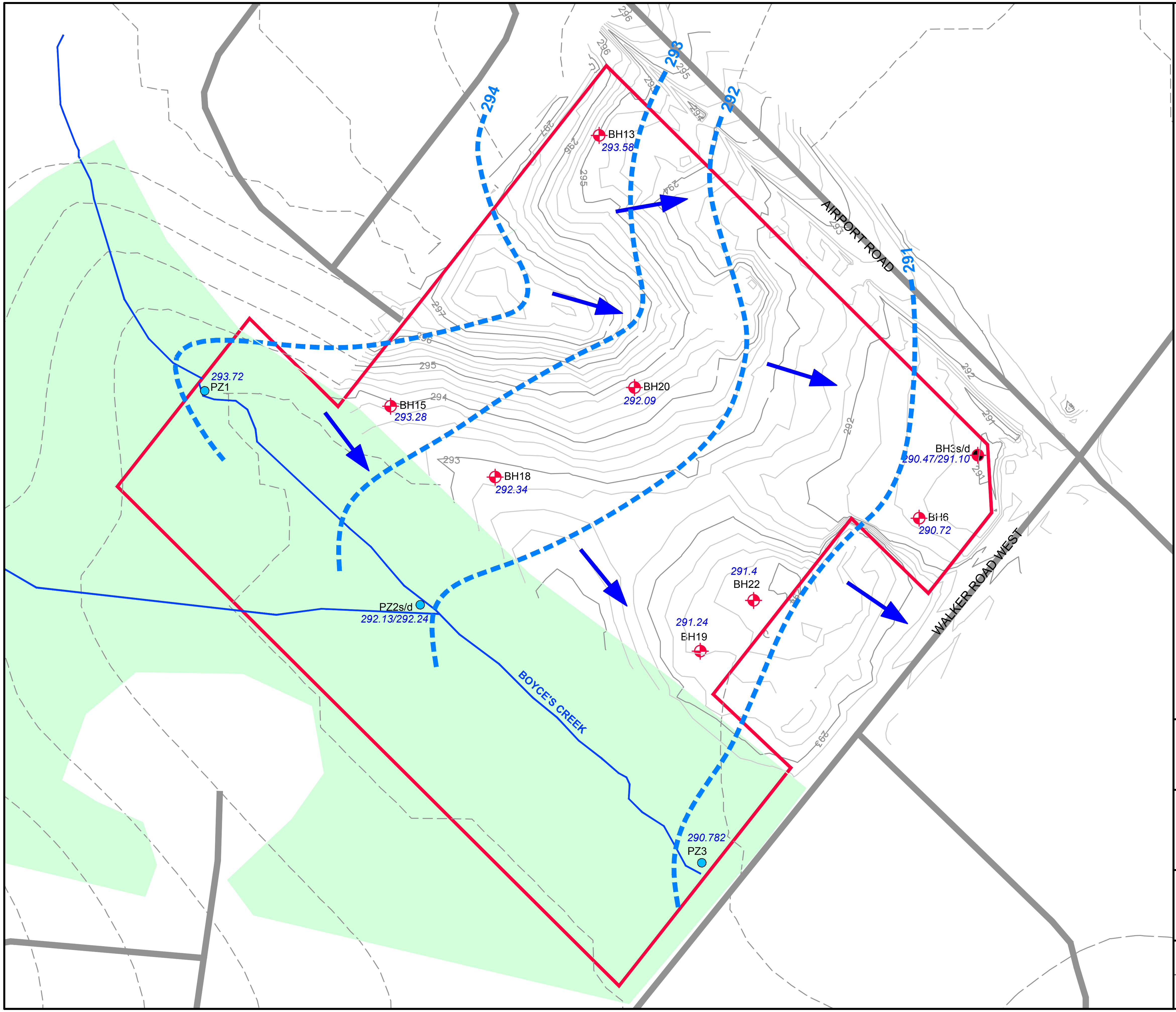
DEWATERING IMPACT ASSESSMENT

Figure Title

SITE PLAN

Drawn: SK
Checked: SC
Date: February 2018
Figure No.: 1
Scale: 1:1,250
Project No.: 300039242

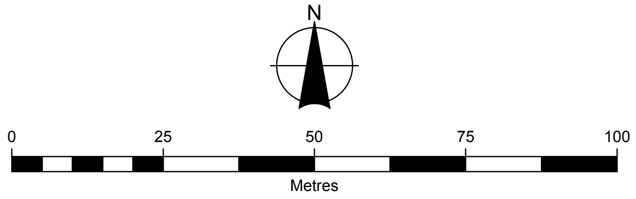
File Path: Nigel\Shared Work Areas\039242 Shacca\039242 Shacca DIA Site Plan.mxd



LEGEND

🟥	SUBJECT LANDS
—	WATERCOURSE
🟩	WOODED AREA
—	CONTOUR (0.5m intervals - masl)
- - -	CONTOUR (1m intervals)
⊕	MONITORING WELL (TERRAPROBE, 2016)
●	DRIVE POINT PIEZOMETER (RJB, 2016)
- - -	INTERPRETED GROUNDWATER CONTOUR (masl)
289.45	MEASURED WATER LEVEL (MAY 11 2017)
→	INTERPRETED GROUNDWATER FLOW DIRECTION

Sources:
1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Site contours provided by David B. Searles Surveying Ltd., July 21, 2016.
4. Regional contours created from 2002 Dem file, MNR.



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Client / Report

SHACCA CALEDON HOLDINGS INC.
CALEDON EAST, ONTARIO

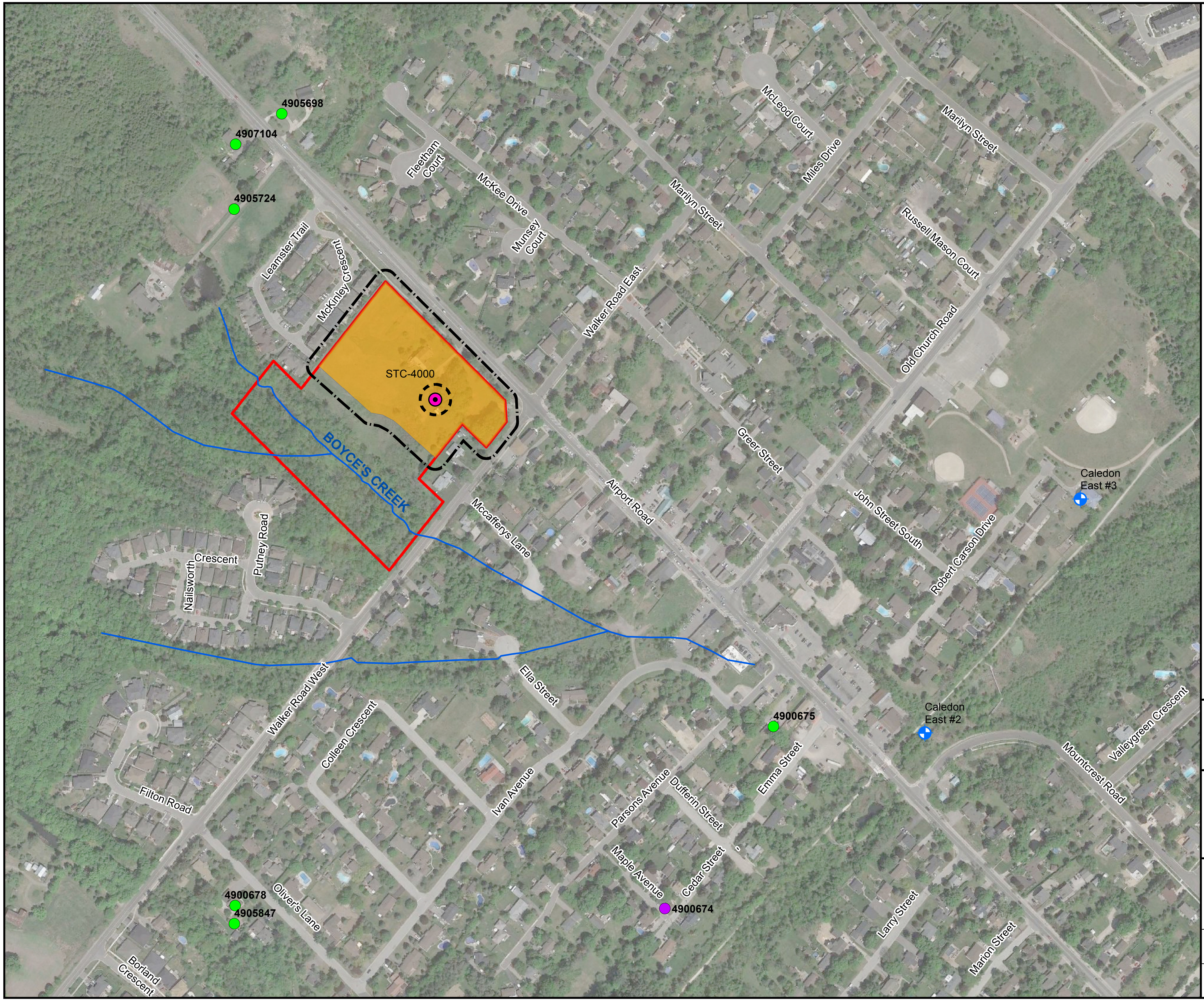
DEWATERING IMPACT ASSESSMENT

Figure Title

**INTERPRETED
GROUNDWATER FLOW**

Drawn	Checked	Date	Figure No.
SK	SC	February 2018	2
Scale		Project No.	
1:1,250		300039242	

File Name:Nigel\Shared Work Areas\039242 Shacca \ 039242 DIA Groundwater Flow.dwg Date Plotted: February 6, 2018 - 9:34 AM



LEGEND

🟥 SUBJECT LANDS
— WATERCOURSE
🟧 APPROXIMATE AREA OF PROPOSED DEVELOPMENT
▭ ZONE OF INFLUENCE AROUND DEVELOPMENT AREA
◉ PROPOSED STORM MANHOLE
▭ ZONE OF INFLUENCE AROUND STC-4000 (16m)
⊕ MUNICIPAL WELL

MOECC PRIVATE WATER SUPPLY WELLS WITHIN 500m

● BEDROCK
● OVERBURDEN

Satellite & Air Photo Source:
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SHACCA CALEDON HOLDINGS INC.
CALEDON EAST, ONTARIO

DEWATERING IMPACT ASSESSMENT

Figure Title

IMPACT ASSESSMENT

Drawn	Checked	Date	Figure No.
SK	SC	February 2018	3
Scale		Project No.	
1:4,000		300039242	

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Appendix A

Dewatering Calculations

Table A-1
Summary of Dewatering Estimates
Groundwater Seepage - Radial Flow

Source	Excavation Invert	Water	Dewatering		Datum	K	H	h	R_o	Width of	Length of	Equivalent	Q	Q
	m asl	Table masl	Level masl	Drawdown m	masl	m/sec	m	m	m	Excavation m	Excavation m	Radius (r_s) m	unconfined L/day	unconfined L/min
Basements - NW	290.90	293.00	289.90	3.10	285	1.00E-06	8	4.9	12	10	10	2.5	7,028	5
Basements - SE	290.60	291.50	289.60	1.90	278	1.00E-06	13.5	11.6	8	10	10	2.5	10,957	8
STC-4000 Manhole	287.20	291.00	286.20	4.80	278	1.00E-06	13	8.2	16	4	4	1.6	11,983	8

Notes:

m	metres
masl	metres above sea level
m/sec	metres per second

Dewatering level assumed to be 1 m below the base of the excavation to allow for bedding and conditions

Datum is based on average depth to underlying clay till (see X-sections in Hydrogeology Assessment Report, Burnside 2016)

Dewatering methods will be determined by the dewatering contractor retained to do the work.

Water table elevation based on groundwater contours for May 2017 (Burnside, 2017).

H is saturated thickness of aquifer before pumping [m];
h is saturated thickness of aquifer under pumping conditions [m];
R_0 is radius of pumping influence [m];
r_s is equivalent radius of pumping well [m];
x is length of excavation [m];
Q is pumping rate [m^3/s];
K is hydraulic conductivity [m/s];

The following equation is relevant in the case of radial flow towards the circular shafts:

Unconfined:

$$Q = \frac{\pi K\left(H^2 - h^2\right)}{\ln\left(\frac{R_0}{r_s}\right)}$$

Confined:
(asumed)

$$Q = \frac{\pi BK\ \left(H - h\right)}{\ln\left(\frac{R_0}{r_s}\right)}$$

Where:

$R_0 = 3000\ (H\text{-}h)\ K^{0.5} + r_s$

K = the hydraulic conductivity (m/sec
H = the existing height of the water table (m)
h = the height of the water table after dewatering (m
R_0 = the lateral extent of drawdown (m)

$r_s = \sqrt{}$ (width of excavtion x length of excavation) /π

Table A-2
Summary of Dewatering Estimates
Groundwater Seepage - Trenches

Source	Excavation Invert m asl	Water Table masl	Dewatering		Datum masl	K m/sec	H m	h m	R_o m	Width of Excavation m	Length of Trench m	Equivalent Radius (r_s) m	Distance to Line Source m	Q unconfined L/day	Q unconfined L/min
			Level masl	Drawdown m											
Trench Excavations - NW	290.90	293	289.90	3.10	285	1.00E-06	8	4.90	5	4	100	2.0	5	74,567	52
Trench Excavations - SE	290.60	291.5	289.60	1.90	278	1.00E-06	13.5	11.6	3	4	100	2.0	3	149,388	104

Notes:

m	metres
masl	metres above sea level
m/sec	metres per second

Dewatering level assumed to be 1 m below the base of the excavation to allow for bedding and conditions

Datum is based on average depth to underlying clay till (see X-sections in Hydrogeology Assessment Report, Burnside 2016)

Dewatering methods will be determined by the dewatering contractor retained to do the work.

Water table elevation based on groundwater contours for May 2017 (Burnside, 2017).

H is saturated thickness of aquifer before pumping [m];
h is saturated thickness of aquifer under pumping conditions [m];
R_0 is radius of pumping influence [m];
r_s is equivalent radius of pumping well [m]; (rs at end of excavation = 0.5 width of excavation)
x is length of trench [m] or excavation;
L is distance from line source [m]; assumed to be radius of influence
Q is pumping rate [m^3/s];
K is hydraulic conductivity [m/s];

$$\boxed{Q = \frac{\pi K\left(H^2 - h^2\right)}{\ln\left(\frac{R_0}{r_s}\right)} + 2\left[\frac{xK\left(H^2 - h^2\right)}{2L}\right]}$$

Where:

$R_0=1750(H-h)K^{0.5}$

K = the hydraulic conductivity (m/sec)
H = the existing height of the water table (m)
h = the height of the water table after dewatering (m)
R_0 = the lateral extent of drawdown (m)

r_s = half the width of excavation (m)

Table A-3

Summary of Dewatering Estimates
Surface Water Runoff Volumes

Source	Length of Excavation m	Width of Excavation m	Area of Excavation m^2	Total Area for Runoff m^2	Max Precipitation Event m	Estimated Runoff Volume m^3	Estimated Runoff Volume L
Trench Excavations	100	4.0	400	612	0.05	30.6	30,600
STC-4000 Manhole	4	4.0	16	36	0.05	1.8	1,800
Basements	10	10.0	100	144	0.05	7.2	7,200

Notes:
Total area for runoff assumes 2 meter buffer around width of excavation receiving runoff into excavation.

Table A-4
Summary of Dewatering Estimates
Total Volumes

Source	Unit	Groundwater Seepage	Runoff	Total
		L/day	L/day	L/day
Trench Excavations	per 100 m	149,388	30,600	179,988
STC-4000 Manhole	1	11,983	1,800	13,783
Basements	per 10 m x 10 m basement	10,957	7,200	18,157
Total		172,328	39,600	211,928

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Appendix B

MOECC Well Records

Table B-1: MOECC Water Supply Well Records within 500 m

MOECC Well ID	Well Use	Well Depth (m)	Aquifer	Year Drilled	Static Water Level (m)	Pumping Level (m)	Recommended Pump Depth (m)	Pumping Rate (GPM)	Top of Screen (m bgs)	Bottom of Screen (m bgs)
4905847	Supply Well	26.5	Overburden	1981	-	21.3	22.9	2.0	25.3	26.5
4900674	Supply Well	33.2	Bedrock	1949	11.9	-	-	-	-	-
4900678	Supply Well	6.1	Overburden	1967	2.7	5.2	5.5	2.0	-	-
4900675	Supply Well	48.8	Overburden	1954	21.9	36.9	0.0	2.0	-	-
4905724	Supply Well	26.2	Overburden	1980	3.7	18.3	22.9	6.0	25.3	26.2
4907104	Supply Well	12.8	Overburden	1989	5.5	10.4	11.6	10.0	-	-
4905698	Supply Well	18.3	Overburden	1978	6.1	6.1	-	5.0	-	-

Notes

"-" denotes data not available

Data summarized from MOECC Water Well Database.

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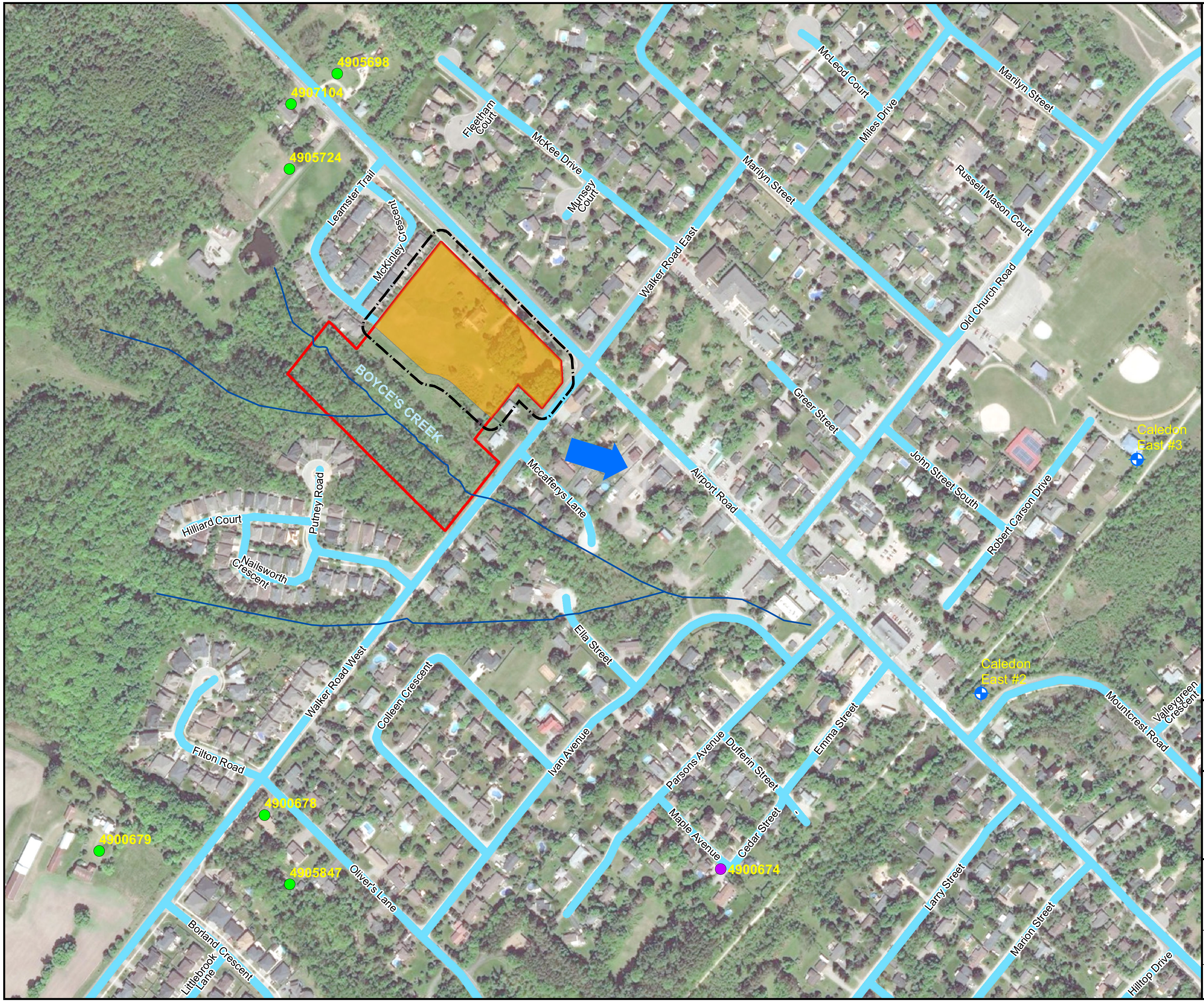
Appendix I

Water Well Survey



LEGEND

- ☐ SUBJECT LANDS
- — WATERCOURSE
- 🟧 APPROXIMATE AREA OF PROPOSED DEVELOPMENT
- ⬚ ZONE OF INFLUENCE AROUND DEVELOPMENT AREA
- ⊕ MUNICIPAL WELL

MECP PRIVATE WATER SUPPLY WELLS WITHIN 500m

- 🟣 BEDROCK
- 🟢 OVERBURDEN
- ▬ MUNICIPAL SERVICING
- ➡ INTERPRETED GROUNDWATER FLOW DIRECTION

Satellite & Air Photo Source:
Background satellite / air photo circa ??? obtained from Google Earth Professional.
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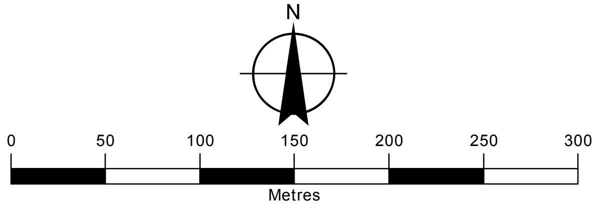

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Client

SHACCA CALEDON HOLDINGS INC.
CALEDON EAST, ONTARIO

HYDROGEOLOGICAL IMPACT ASSESSMENT

Figure Title

WATER WELL SURVEY

Drawn	Checked	Date	Figure No.
SK	SC	August 2018	I-1
Scale		Project No.	
1:4,000		300039242	

File Path: Nigel\Shared Work Areas\039242 Shacca\039242 Shacca HG Assessment Water Well Survey.mxd

Table I-1
Water Well Survey

Address	Municipal Servicing Available	Closest Water Well Record (Unconfirmed)	Distance to Site (m)	Survey Results
89 Walker Road West	Unknown	4900679	500	Left survey, no response
16216 Airport Road	Yes	4905724	160	Left survey, no response
16219 Airport Road	Yes	4905698	205	Left survey, no response
16218 Airport Road	Yes		180	Left survey, no response
16226 Airport Road	Yes	4907104	200	Left survey, no response
2 Oliver Lane	Yes	4900678	365	Left survey, no response, old dug well visible in side yard.
4 Oliver Lane	Yes	4905847	440	Owner confirmed that house is on city water. Not aware of any old well.
8 Cedar Street	Yes	4900674	475	Left survey, no response.

Door to door well survey was completed by Burnside on July 9, 2018.