Hydrogeological Assessment in Support of Draft Plan

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Barrie, Ontario

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1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) has been retained by ASA Development Inc. to complete a hydrogeological assessment of their lands located north of Lockhart Road and east of Yonge Street in the City of Barrie, Ontario (Figure 1). The lands are located at 989 Yonge Street and are within the Barrie Annexed Lands and the OPA 39 Hewitt's Secondary Plan Area (SPA) located on the southern boundary of the City of Barrie. In 2013, a Subwatershed Impact Study (SIS) for the Hewitt's SPA was completed for the Hewitt's Creek Landowners Group (Burnside, 2016). The Hewitt's Creek SPA includes lands bounded by Lockhart Road to the south, Sideroad 20 to the east, Mapleview Drive and Big Bay Point Road to the north (Figure 1). The current study is being completed in support of a draft plan application for the ASA Development Lands and for the purposes of this study, these lands are referred to as the subject lands.

1.1 Scope of Work

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

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

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

2. Review of the Ministry of the Environment, Conservation and Parks (MECP) water well records: The MECP maintains a database that provides geological records of water supply wells drilled in the province. A list of the available MECP water well records for local wells is provided in Appendix A and the well locations are plotted on Figure 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. These well data were compiled and mapped to characterize the local groundwater resources and assess potential impacts to the local private wells from development of the subject lands.

3. Install groundwater monitoring network: Groundwater monitoring locations were established to characterize the subsurface geology and observe the seasonal variations in the water table in both the shallow overburden on the subject lands. A total of 10 boreholes were drilled and completed as monitoring wells (5 cm

diameter) by McClymont and Rak Engineers Inc. (Geotechnical Engineers) to determine the local stratigraphy and site-specific soil and groundwater conditions of the subject lands. The locations of the monitoring wells are shown on Figure 2 and monitoring well construction details are provided on the borehole logs in Appendix B.

4. Hydraulic conductivity testing: Grainsize analyses were conducted as part of the geotechnical study conducted on the subject lands by McClymont and Rak Engineers Inc. The grainsize information is provided in Appendix C. To augment the grainsize information already collected and provide further insight into on-site hydraulic conductivity, Burnside will conduct single well response tests at up to three locations in the spring of 2020. In addition, permeameter tests are proposed to be completed at up to four locations on the subject lands.

5. Monitoring of groundwater levels: Monitoring has been completed to measure the depth to the water table and assess the groundwater flow conditions. Groundwater level monitoring was completed between December 2018 and May 2019 with measurements occurring on a monthly basis between June 2018 and May 2019. The groundwater monitoring data and hydrographs are provided in Appendix D.

6. Water quality review and testing: Water quality data collected in the area of the subject lands as part of the Subwatershed Impact Study (SIS) (Burnside, 2016) was reviewed as part of the current assessment. The water quality data is provided in Appendix E. To supplement the data from the SIS, additional data collection is proposed in the spring of 2020 from two monitoring wells located on the subject lands. The water quality samples will be submitted to a qualified laboratory for analyses of general water quality indicators (e.g., pH, hardness, and conductivity), basic ions (including chloride and nitrate) and selected metals to characterize the background water quality at the property.

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

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

2.0 Physical Setting

2.1 Topography and Drainage

The subject lands are located within the Lake Simcoe watershed and located within the Hewitt's Creek Subwatershed but are directly adjacent to the boundary with the Lovers Creek Subwatershed (Figure 3). The topography of the subject lands is generally flat to gently rolling. The height of the lands is located along the subwatershed divide between Lovers Creek and Hewitt's Creek at an elevation of 270 meters above sea level (masl). The lowest portion of the subject lands is located along the eastern property boundary at an elevation of approximately 264 masl. There are no watercourses on the subject lands.

2.2 Geology

The subject lands are located in the physiographic region known as the Peterborough Drumlin Field. The region is characterized as a rolling drumlinized till plain. The drumlins through the region are comprised of highly calcareous till (Chapman & Putnam, 1984).

The overburden was deposited as a series of advances and retreats of the Simcoe glacial ice lobe. This has resulted in drumlinized sheets of glacial till (Newmarket till), stratified glaciolacustrine deposits of sand and gravel, littoral-foreshore deposits and massive-well laminated deposits of sand and gravel. A review of the quaternary geology mapping for the area (OGS, 2003) indicates that the overburden sediments of the subject lands consist primarily of silty to sandy glacial till with an area of glaciofluvial ice contact stratified sediments of sand and gravel touching the west central portion of the boundary of the subject lands (Figure 4).

The bedrock underlying the subject lands is mapped as the Lindsay Formation of the Simcoe Group, which consists of limestone and shale (OGS, 2007).

2.3 Regional Hydrostratigraphy

The overburden deposits of the subject lands influence groundwater occurrence and flow. The overburden has been interpreted by regional studies such as the Tier 3 Water Balance (AquaResource, 2011) and Source Water Protection Assessment Report (LSRCA, 2012) to consist of alternating sequences of coarser-grained permeable areas (aquifers) and finer-grained less permeable areas (aquitards) of varying thicknesses. The basic hydrostratigraphic sequence that was modelled in the regional studies (AquaResource, 2011) consists of four main aquifer areas (A1-A4) and four main aquitards (C1 to C4) with a confining layer (UC) over the uppermost aquifer (A1).

A description of the interpreted regional hydrostratigraphic framework is provided below (LSRCA, 2012):

- Surficial Geology Layer – This layer represents coarse grained sediments in stream beds and at surface surficial geology areas that overly the UC. The thickness ranges from 0.1 m to 3 m.
- UC – Upper Confining Layer – Represents smaller areas of less permeable surficial material. The upper confining layer has been mapped as coarse-grained lacustrine deposits which are part of a regionally extensive sand plain (LSRCA, 2012). Regional studies such as the AquaResource (2011) report indicate that the confining layer (UC) is patchy in the area of the study area.
- A1 – Represents the uppermost aquifer. Frequently exists as a surficial unconfined aquifer and is stratigraphically equivalent to the Oak Ridges Moraine. It is generally associated with coarse grained glacial and interglacial sediments mapped as ice contact stratified drift. The majority of the local domestic wells are completed within this area. The upper aquifer A1 is reported to be present throughout the larger Barrie area, and has been interpreted to occur extensively in the study area.
- C1 – Upper aquitard; Described as varved clay and silt (LRSCA, 2012).
- A2 – Intermediate aquifer which is stratigraphically equivalent to areas within the Northern Till. The aquifer is generally described as being composed of sand with some clast rich portions (LRSCA, 2012). This area is used for the Innisfil Heights water supply.
- C2 – Intermediate aquitard.
- A3 – This area constitutes the main Barrie municipal aquifer and is the source of the Stroud water supply; it is stratigraphically equivalent to the Thorncliffe deposits in the Upland regions.
- C3 – Lower aquitard.
- A4 – Lower aquifer, thin and sometimes combined with A3 where C3 is thin or absent.
- C4 – Lower aquitard but may also represent weathered bedrock.

2.4 Local Stratigraphy

Boreholes were drilled at ten locations within the subject lands to install groundwater monitoring wells. The borehole logs are provided in Appendix B and locations shown on Figure 5. The boreholes indicated that the overburden is generally composed of sandy silt to silty sand with varying amounts of clay and gravel. Some occasional lenses of finer grained sediments (clay) and coarser grained sediments (sands) were encountered in some locations, however these lenses are interpreted to be discontinuous.

To illustrate the shallow hydrostratigraphic sequence of the subject lands, schematic geologic cross-sections have been prepared by Burnside (Figures 6 and 7) using the MECP well records (Appendix A) and the soils information collected during drilling of boreholes and monitoring wells (Appendix B). The locations of the cross-sections are illustrated on Figure 5 along with the locations of water wells and boreholes used in the construction of the cross-sections.

The cross-sections illustrate that the subject lands is underlain by a dominantly silty layer with a thickness of approximately 5 to 15 m. The silty layer overlies a sand layer that is 10 to 20 m thick and outcrops at the surface along the western boundary of the subject lands. The sand layer is interpreted to form the local aquifer where supply wells are completed to depths that are generally less than 20 m to 30 m below ground surface. The sand layer is underlain by a low permeability clay silt till (Figures 6 and 7).

2.5 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. Grainsize data and soil characteristics collected during a geotechnical investigation can be used to provide a general estimate of hydraulic conductivity. Single well response tests such as in situ bail-down or slug-testing methods are used in groundwater monitoring wells to assess in situ hydraulic conductivity of the soils represented across the screened interval of the well.

Grainsize data and soil characteristics were used to estimate soil hydraulic conductivity as part of the SIS (Burnside, 2016). The estimates obtained during the SIS using grainsize information indicate that the hydraulic conductivity of silty sand sediments within the Hewitt's Creek subwatershed vary between 5.6×10^{-4} cm/s to 4.8×10^{-6} cm/s. Single well response tests conducted during the SIS study indicates a range of hydraulic conductivity of between 1.4×10^{-4} cm/s and 4.8×10^{-5} cm/s. This range is considered to be moderate.

Based on the work previously completed and the similarity of the sediments encountered on the site to those encountered during the SIS, it is interpreted that hydraulic conductivity on the subject lands is of a similar range to that above.

As part of the geotechnical study completed by McClymont & Rak Engineers Inc, grainsize analysis was completed on three soil samples per borehole. The grainsize analysis curves are provided in Appendix C. It is proposed that single well response tests as well as permeameter testing be conducted on the subject lands in the summer of 2020 and these data will be used to confirm the above interpretation.

3.0 Hydrogeology

3.1 Local Groundwater Use

The City of Barrie obtains its water from a combination of groundwater and surface water based supplies. Municipal servicing is assumed to be available for lands within the municipal city boundary. All recently annexed lands within the Hewitt's Secondary Plan area, including the subject lands are previously serviced with individual water supply wells. Water well records for private supply wells are filed with the MECP and are available for review via the MECP online water well record database. A review of the online MECP water well records indicated that there are approximately 20 water well records within 500 m of the study area. Based on the well records and interpreted hydrostratigraphy, most of these wells are completed in the surficial (local) aquifer with depths ranging from 6 m to 64 m. The locations of the MECP water well records are shown on Figure 5.

The City of Barrie groundwater supply wells are located in deep aquifers (A3 and A4 in the regional hydrostratigraphy). There are no municipal water supply wells located close to the subject lands; the municipal water supply wells are located on the west and northern sides of the City and are approximately 7 km north of the subject lands. The Stroud municipal well is located approximately 1.3 km south of the subject lands. Our review of available source protection mapping indicates that the subject lands do not fall within any wellhead protection areas or intake protection zones.

3.2 Water Level Monitoring Results

Groundwater levels were monitored at the on-site monitoring wells between November 2017 and May 2019. Groundwater level data is provided in tables and hydrographs in Appendix D. Groundwater elevations are plotted with daily precipitation data obtained from a nearby climate station – Barrie-Oro (Climate Station ID# 6117700) – which is the closest station with daily precipitation values for monitoring period.

The groundwater monitoring data show the following (refer to Figure 5 for the monitoring locations and the data tables and hydrographs in Appendix D):

- Typically, in shallow wells in southern Ontario, a seasonal groundwater level pattern is apparent with highest levels occurring in the spring, declining throughout the

summer and early fall and then rising again in the late fall/early winter. The seasonal variation observed at the monitoring wells ranged between 1 m and 2 m.

- The groundwater table is interpreted to generally reflect the topography of the area. During the monitoring period, groundwater elevations in the monitoring wells ranged from 261.8 masl to 265.7 masl. Groundwater was shallowest at BH4 with seasonal high measured at approximately 1 m below ground surface (Figure D-4, Appendix D). Groundwater was also shallow at BH7 with seasonal high measured at approximately 1 m below ground surface (Figure D-7, Appendix D). The deepest groundwater levels were found at BH1, in the northwest corner of the subject lands where the seasonal high was measured to be approximately 5.5 m below ground surface (Figure D-1, Appendix D).

3.3 Interpreted Groundwater Flow Pattern

Groundwater flow within the shallow overburden (water table) is interpreted to be influenced by the surface topography with groundwater flow from the topographically higher areas towards topographically lower areas and surface water features. Groundwater elevation data (June 2018) obtained from the monitoring wells are shown on Figure 8, along with the interpreted groundwater elevation contours for the subject lands. The subject lands are located at a topographical high point for the surrounding lands. Arrows perpendicular to the groundwater elevation contours shown on Figure 8 illustrate the interpreted direction of the groundwater movement. Based on the groundwater contours completed for the subject lands, groundwater is interpreted to flow east from Yonge Street towards the St. Paul's Swamp.

3.4 Recharge and Discharge Conditions

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

The monitoring wells completed on the subject lands all indicate groundwater levels that are below grade and this is interpreted to indicate recharge conditions across the subject lands. It is noted however that groundwater at BH4 and BH7 are within 1 m of ground surface. These wells are adjacent to the St. Paul's Swamp which was interpreted to be supported by groundwater discharge as part of the SIS (Burnside, 2016).

3.5 Significant Groundwater Recharge Areas and Ecologically Significant Groundwater Recharge Areas

Significant Groundwater Recharge Areas (SGRAs) can be described as areas that can effectively move water from the surface through the unsaturated soil zone to replenish available groundwater resources (LSRCA, 2012). SGRAs were mapped by the Source Water Protection Assessment Report (LSRCA, 2012) as a requirement of the Clean Water Act, 2006 and based on guidance provided by the MECP. The delineation of these areas was completed using numerical models and analyses that included the evaluations of numerous factors including precipitation, temperature and other climate data along with land use, soil type, topography and vegetation to predict groundwater recharge, runoff and evapotranspiration. SGRAs represent areas where the annual recharge rate is greater than 115% of the average recharge of 164 mm/year across the Lake Simcoe watershed (or greater than the threshold recharge rate of 189 mm/year) (LSRCA, 2012). SGRAs within the subject lands are mapped in Figure 9.

Ecologically Significant Groundwater Recharge Areas (ESGRAs) were delineated for the Barrie Creek, Lovers Creek and Hewitt's Creek subwatersheds by Earthfx (2012) using the model developed by AquaResources for the Source Protection studies. ESGRAs were identified as areas of land that are assumed to support groundwater systems or environmentally sensitive features like lakes, cold water streams and wetlands (Earthfx, 2012). ESGRAs were delineated by identifying pathways in which recharge, if it occurred, would reach an ecologically significant feature. Ecologically significant features used for the delineation of the ESRGAs included headwater streams, cold water fisheries, wetlands, and brook trout and sculpin capture sites.

ESGRAs and SGRAs are not mutually exclusive. ESGRAs are determined based on the linkage between a recharge area and an ecologically sensitive area while SGRAs are located where high volumes of recharge are assumed to occur. The locations of mapped SGRAs and ESGRAs in the study area are shown in Figure 9.

As seen in Figure 9, a large portion of the subject lands are mapped as either SGRA or ESGRA. The soils encountered during drilling on the subject lands is generally consistent with the geological mapping and indicated the presence of silty to sandy glacial till with a moderate hydraulic conductivity. The moderate hydraulic conductivity of the more prevalent silty to sandy glacial till is interpreted to restrict the capacity of the soils to rapidly infiltrate water and hence the capacity of these recharge areas may in fact also be restricted.

3.6 Aquifer Vulnerability

Aquifer vulnerability refers to the susceptibility of the aquifer to potential contamination. Some degree of protection for groundwater quality from natural and human impacts is provided by the soil above the water table. The degree of protection is dependent upon

the depth to the water table (for unconfined aquifers) or the depth of the aquifer (for confined aquifers) and the type of soil above the water table or aquifer. As these two properties vary over any given area, the degree of protection or vulnerability of the groundwater to contamination also varies.

The aquifer vulnerability for aquifers serving municipal wells was mapped in the Lake Simcoe and Couchiching-Black River SPA Part 1 Approved Assessment Report, Lake Simcoe Region Conservation Authority, 2015. The approach used by the LSRCA to create a regional vulnerability map was the aquifer vulnerability index (AVI) method. Using water well records for the area to determine the soil types and depths to aquifer an AVI was calculated for each delineated aquifer to produce a map of regional groundwater vulnerability. Based on the AVI scores aquifers were divided into High Medium and Low vulnerability to contamination. The aquifer vulnerability mapping for the subject lands is provided in Figure 10 and shows that the entire property is mapped with a high vulnerability.

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. 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 local groundwater quality from infiltration in the urban areas is therefore expected to be limited.

4.0 Water Quality

4.1 Groundwater Quality

Water quality data was obtained from MW14 (located on the subject lands) as part of the SIS completed by Burnside in 2016. The water sample obtained was submitted to an accredited laboratory for analyses of general water quality indicators (e.g., pH, hardness, and conductivity), basic ions (including chloride and nitrate) and selected metals to characterize the background water quality. The groundwater testing results from the analytical laboratory are provided in Table E-1, Appendix E and discussed below.

- The sample exceeded the ODWQS for total hardness (100 mg/L) with a value of 557 mg/L. Hardness in groundwater is caused by dissolved calcium and magnesium and is typically related to the geologic material of the aquifer. Hardness is an aesthetic parameter as a drinking water will not be sourced from the local aquifer to service the proposed development hardness in groundwater is not a concern.

- Total Dissolved Solids (TDS) were detected in the sample at 2,010 mg/L which is above the ODWQS of 500 mg/L. The elevated TDS may be associated with high mineralization in water or high sediment load due to the presence of fine-grained

sediments suspended in water. As with hardness, there is no proposed use of groundwater within the proposed development and therefore the elevated TDS is not a concern. It is noted that along with the TDS, there are also elevated levels of electrical conductivity detected in the sample, this elevated electrical conductivity supports the interpretation of highly mineralized waters.

- The sample exceeded the ODWQS for turbidity (5 NTU) with a value of 8,780 NTU being reported. This high value is likely a result of high silt content in the sample.

- High levels of chloride (1,020 mg/L) and sodium (454 mg/L) are reported from MW14. These values both exceed the ODWQS and suggest that the groundwater at this location has been impacted by runoff from winter road maintenance along Yonge Street.

5.0 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 F.

5.1 Water Balance Components

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

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

Where:

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

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

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

Precipitation (P)

The long-term average annual precipitation for the area is 933 mm based on data from the Environment Canada Barrie WPCC (Station 6110557, 44°22'33.012" N, 79°41'23.010" W, elevation 221.0 masl) for the period between 1981 and 2010. The climate station is located 6 km northeast of the subject lands. Average monthly records of precipitation and temperature from this station have been used for the water balance calculations in this study (Appendix F).

Storage (S)

Although there are groundwater storage gains and losses on a short-term basis, the net change in groundwater storage on a long-term basis is assumed to be zero so this term is dropped from the equation.

Evapotranspiration (ET)

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

Water Surplus (R + I)

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

5.2 Approach and Methodology

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

A soil moisture storage capacity of 150 mm was used to represent the pre-development predominantly short to moderate-rooted vegetation in the fields and agricultural areas of the subject property (Table F-1, Appendix F). A soil moisture storage capacity of 75 mm was used to represent the post-development vegetation which will be dominantly urban lawn (Table F-2, Appendix F). Tables F-1 to F-2 in Appendix F detail the monthly potential evapotranspiration calculations accounting for latitude and climate, and then calculate the actual evapotranspiration and water surplus components of the water balance based on the monthly precipitation and soil moisture conditions.

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

5.3 Water Balance Component Values

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

Table 1: Water Balance Component Values

Water Balance Component	Agricultural Lands	Urban Lawn
Average Precipitation	933 mm/year	933 mm/year
Actual Evapotranspiration	593 mm/year	555 mm/year
Water Surplus	340 mm/year	378 mm/year
Infiltration	204 mm/year	246 mm/year
Runoff	136 mm/year	132 mm/year

5.4 Pre-Development Water Balance (Existing Conditions)

The pre-development water balance calculations are presented in Table F-3 in Appendix F. As summarized on Table F-3, the total area of the subject lands is about 11.2 ha. The water balance component values from Table F-1 and Table F-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 22,600 m^3/year (Table F-3, Appendix F).

5.5 Potential Urban 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 64% of precipitation in the study area). So, the net effect of the construction of impervious surfaces is that most of the precipitation that falls onto impervious surfaces becomes surplus water and direct runoff. The natural infiltration components (interflow and deep recharge) are reduced.

A water balance calculation of the potential water surplus for impervious areas is shown at the bottom of Table F-1 in Appendix F. There is an evaporation component from impervious surfaces and this is typically estimated to be between about 10% and 20% of the total precipitation. For the purposes of the calculations in this study, the evaporation has been estimated to be 15% of precipitation. The remaining 85% of the precipitation that falls on impervious surfaces is assumed to become runoff. Therefore, assuming an evaporation/loss from impervious surfaces of 15% of the precipitation, there is a potential water surplus from impervious areas of 793 mm/year.

It is noted that the proposed development will be serviced by municipal water supply and wastewater services. Therefore, there will be no impact on the water balance and local

groundwater or surface water quantity and quality conditions related to any on-site groundwater supply pumping or disposal of septic effluent.

5.6 Post-Development Water Balance with No Mitigation

To assess potential development impacts on infiltration, the post-development infiltration volumes have been calculated for the subject lands on Table F-3 in Appendix F. The land use areas and the associated percentage imperviousness were based on the current design layout.

The infiltration and runoff components for the post-development land uses have been calculated using the MECP SWM Planning and Design Manual (2003) methodology based on topography, soil type and land cover as shown on Table F-2 in Appendix F. In summary from these appendix tables, the average calculated post-development infiltration volume (without mitigation) is about 10,100 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 from 22,600 m^3/year to 10,100 m^3/year, i.e., a reduction of about 12,500 m^3/year or 55%. These calculations assume no low impact development (LID) measures for stormwater management are in place.

5.7 Recommended Mitigation Strategies for Infiltration

The water balance calculations suggest that, without mitigation, the subject lands will receive about 45% of the current amount of average annual groundwater infiltration after development. It is recommended to minimize the potential development impacts to infiltration through the use of 'low impact development' (LID) measures for stormwater management to ensure the post-development groundwater infiltration volume is maintained as close to the pre-development infiltration volume as possible.

6.0 Development Considerations

6.1 Construction Below the Water Table

Based on groundwater level data collected as part of this study water table on the subject lands ranges from 1 m to 7 m below ground surface.

The construction of buried services below the water table has the potential to capture and redirect groundwater flow through more permeable fill materials typically placed in the base of excavations. Groundwater may also infiltrate into joints in storm sewers and manholes. Over the long-term, these impacts can lower the groundwater table across the development area. To mitigate this effect, services to be installed below the water table should be constructed to prevent redirection of groundwater flow. This will involve

the use of anti-seepage collars or clay plugs surrounding the pipes to provide barriers to flow and prevent groundwater flow along granular bedding material and erosion of the backfill materials.

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

6.2 Local Groundwater Supply Wells

The area surrounding the subject lands is not currently serviced and residences are supplied by private wells. A water well survey has been completed on behalf of the Hewitt's Landowners Group to identify private water supply wells within 300 m of the Hewitt's SPA area (Burnside, 2019). The survey confirmed the location of private wells along Mapleview Drive, Yonge Street and Lockhart Road. Within 300 m of the subject lands, there were several shallow dug wells identified. A monitoring program for high risk wells (shallow wells) was commissioned by the Hewitt's Landowner Group in 2019. An impact contingency and mitigation plan for private well impacts has also been implemented (Burnside, 2019). The plan provides a mechanism for interference complaints to be addressed and for a temporary alternate water supply to be provided.

6.3 Well Decommissioning

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

7.0 References

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Ontario Ministry of the Environment, Conservation and Parks, Water Well Records.

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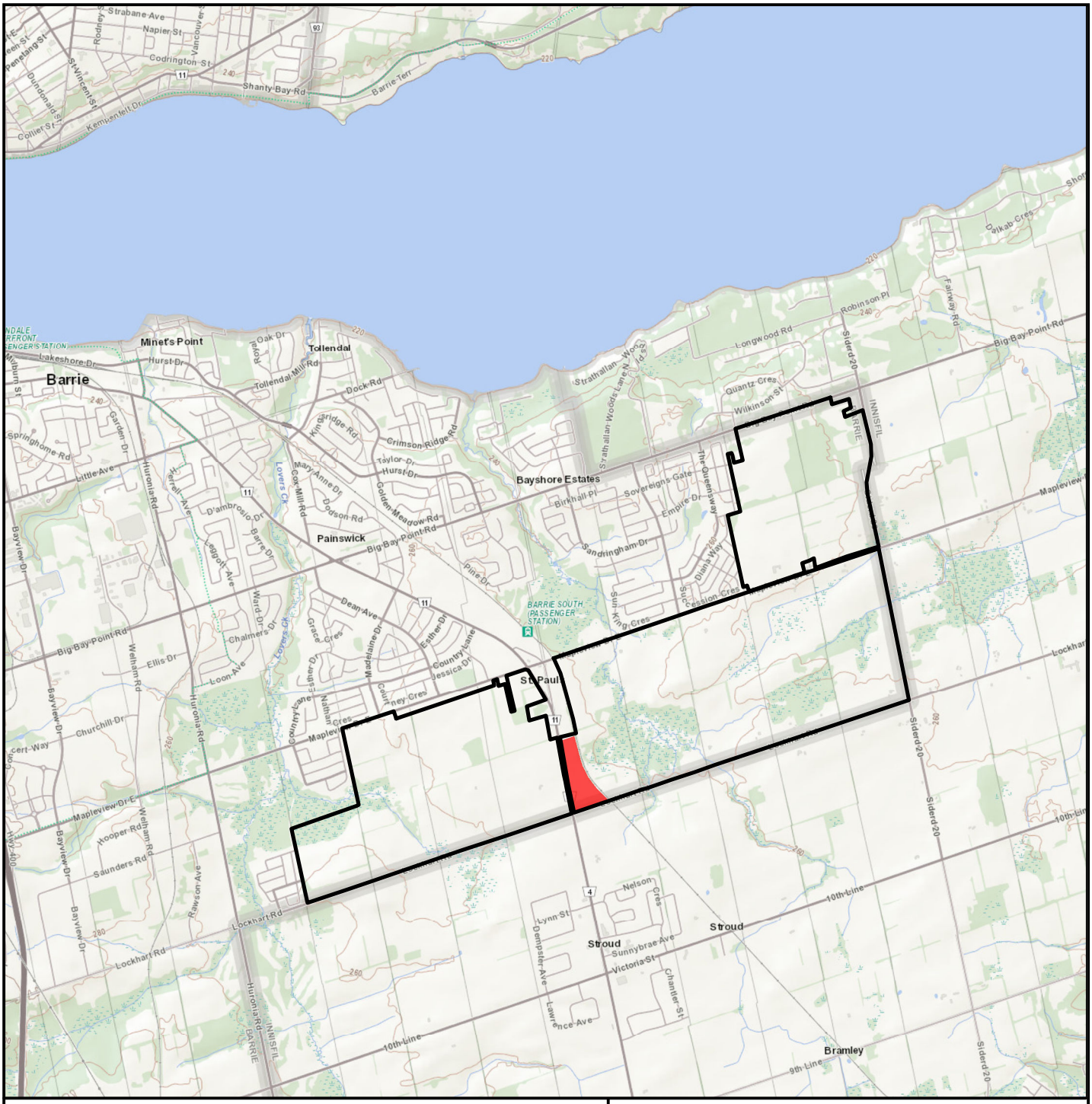
Figures



LEGEND

- HEWITT'S SECONDARY PLAN AREA
- SUBJECT LANDS

0 500 1,000 2,000 3,000 4,000

Meters

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ASA DEVELOPMENT INC.
BARRIE, ONTARIO

HYDROGEOLOGICAL ASSESSMENT

Figure Title:

SITE LOCATION

Drawn	Checked	Date	Figure No.
SK	DS	March 2020	1
Scale		Project No.	
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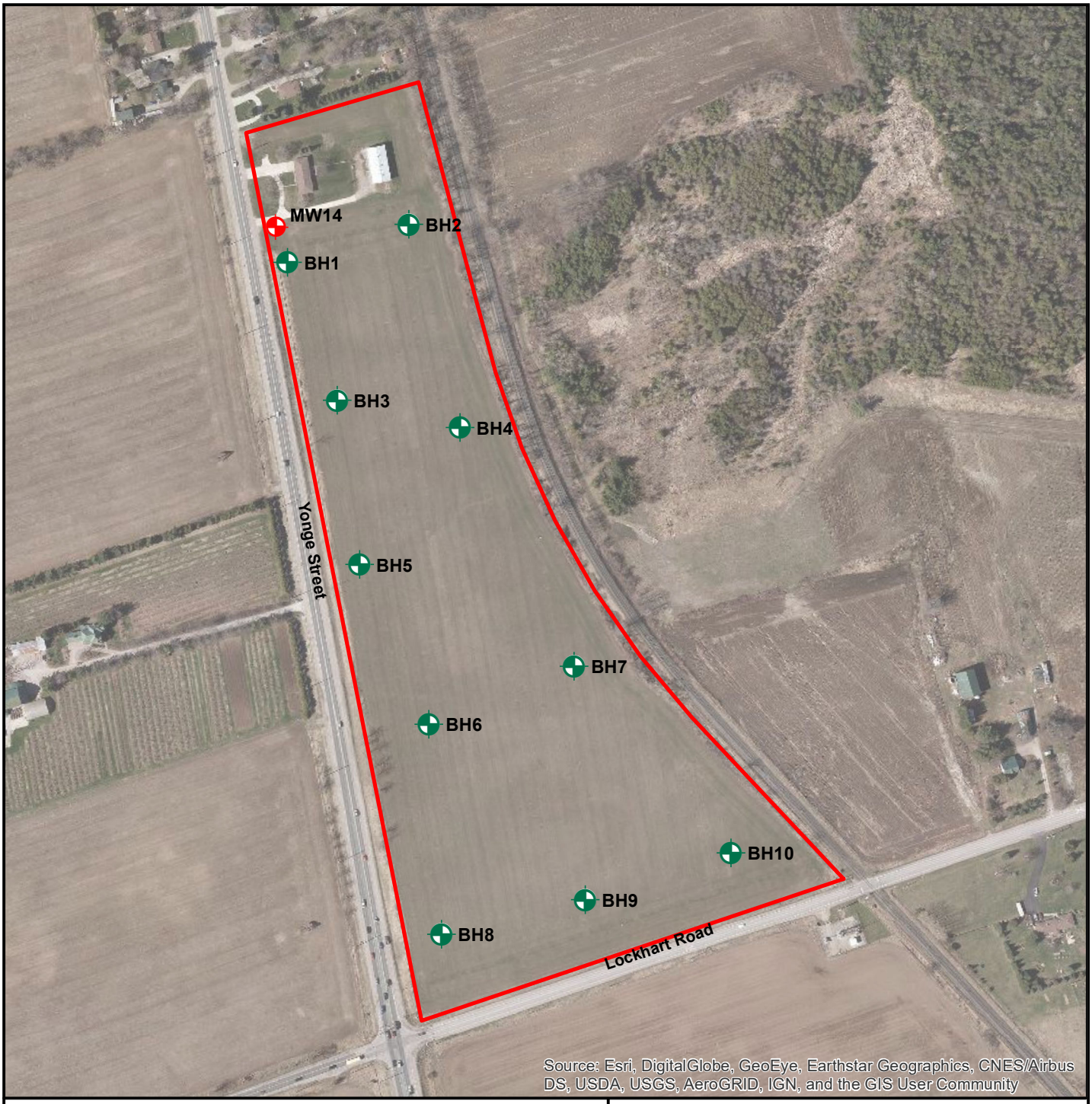

LEGEND

- SUBJECT LANDS
- MONITORING WELL (MCR, 2018)
- MONITORING WELL (RJB, 2014)

0 50 100 200 300

Meters

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Figure Title:

SITE PLAN

Drawn	Checked	Date	Figure No.
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Scale		Project No.	
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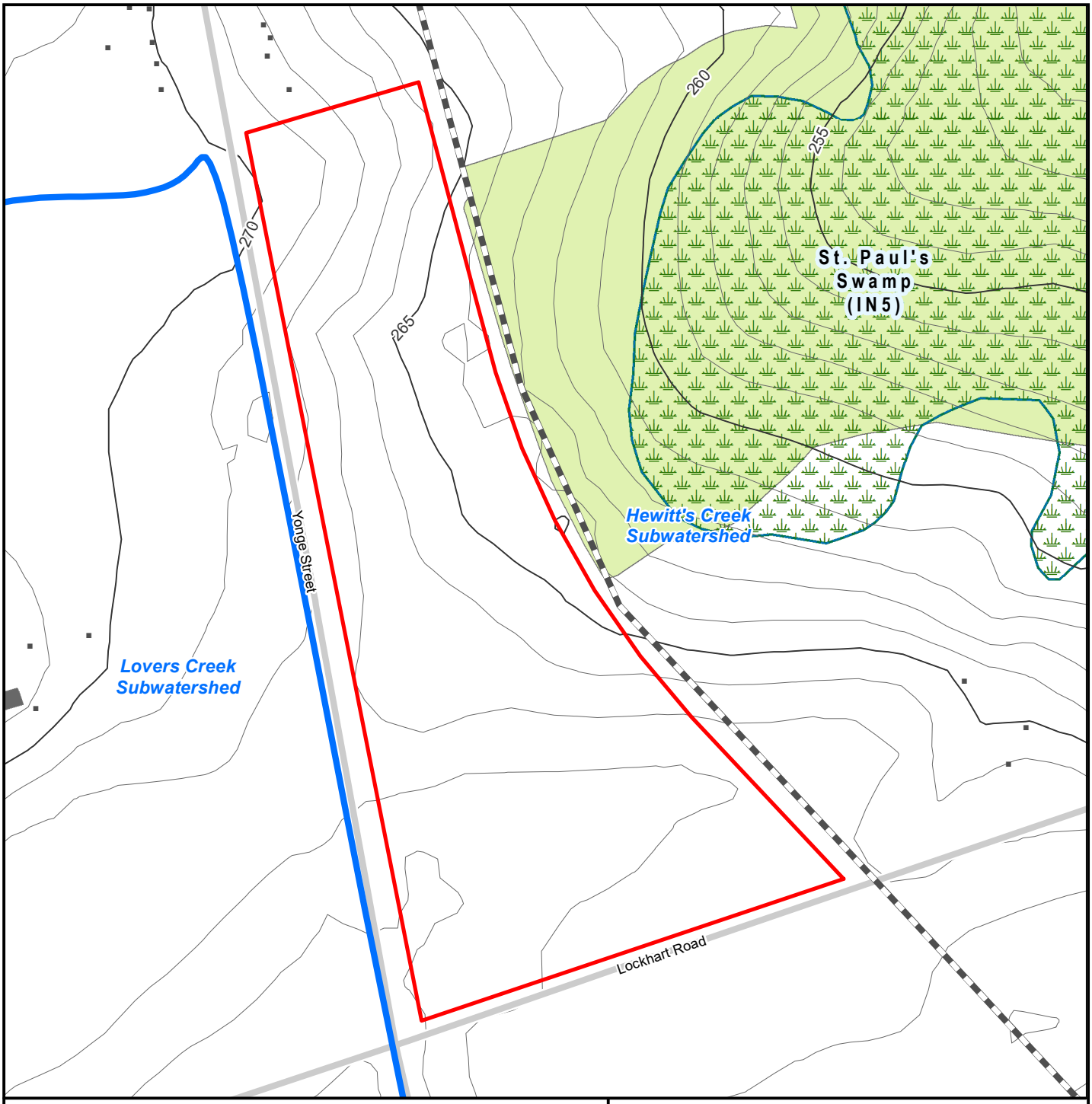

LEGEND

- SUBJECT LANDS
- SUBWATERSHED BOUNDARY
- WATERCOURSE
- PROVINCIALLY SIGNIFICANT WETLAND
- NATURAL HERITAGE SYSTEM (JONES, 2015)
- CONTOUR (5m intervals - masl)
- CONTOUR (1m intervals)
- RAILWAY
- ROADWAY
- BUILDING

0 50 100 200 300
Meters

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HYDROGEOLOGICAL ASSESSMENT

Figure Title:

TOPOGRAPHY AND DRAINAGE

Drawn	Checked	Date	Figure No.
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LEGEND

- SUBJECT LANDS
- CONTOUR (5m intervals - masl)
- CONTOUR (1m intervals)
- 5b: sandy silt to silty sand-textured till
- 6: sand and gravel, minor silt, clay and till
- 9c: sand, gravel, minor silt and clay
- RAILWAY
- ROADWAY

0 50 100 200 300
Meters

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Figure Title:

SURFICIAL GEOLOGY

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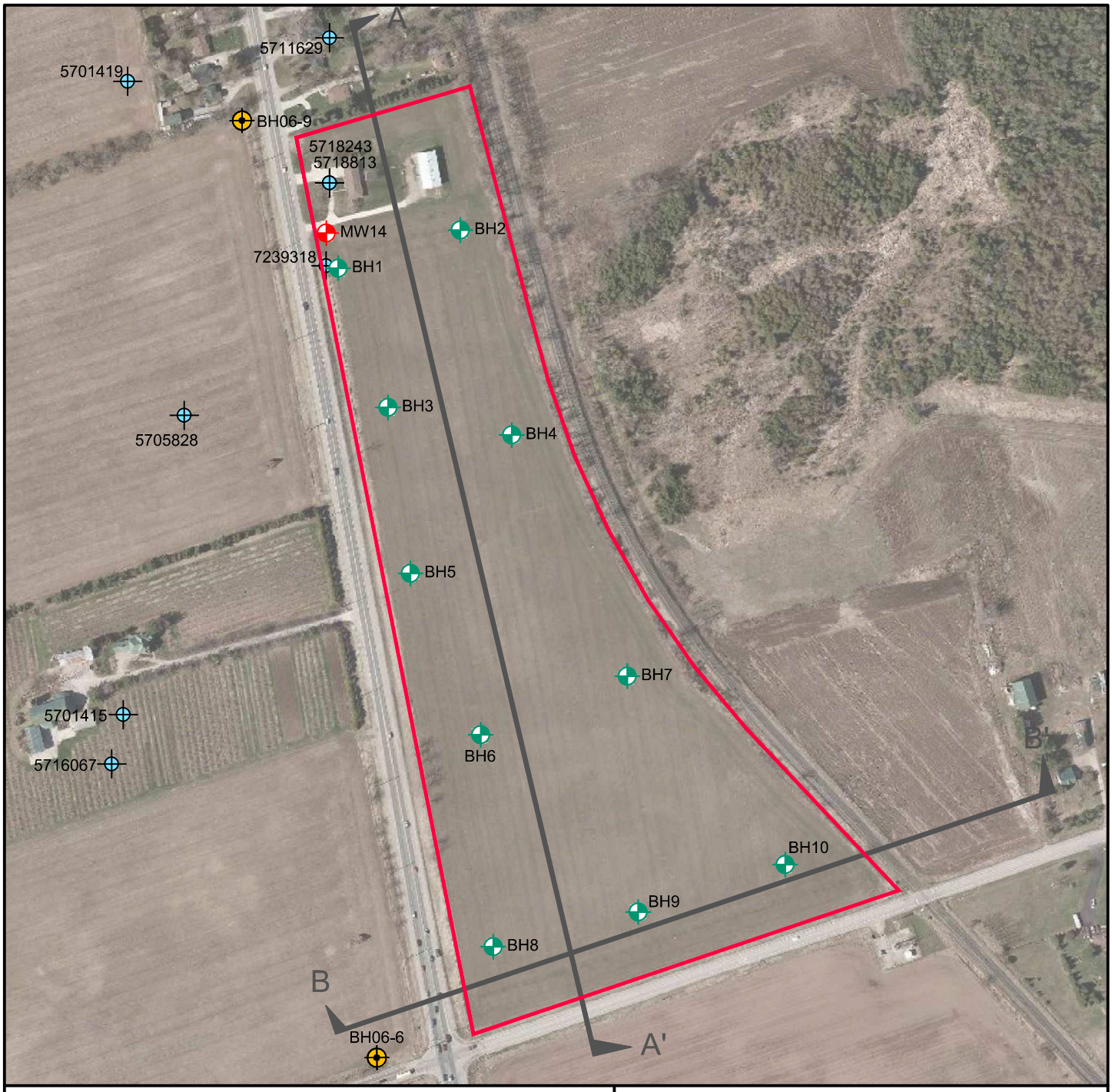

LEGEND

- SUBJECT LANDS
- MONITORING WELL (MCR, 2018)
- MONITORING WELL (RJB, 2014)
- MONITORING WELL (RJB, 2017)
- BOREHOLE (GOLDER, 2006)
- MECP WELL RECORD LOCATION
- A A' CROSS-SECTION LOCATION KEY

0 40 80 160 240 320
Metres

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BARRIE, ONTARIO

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Figure Title

BOREHOLE, WELL AND CROSS-SECTION LOCATIONS

Drawn	Checked	Date	Figure No.
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Scale		Project No.	
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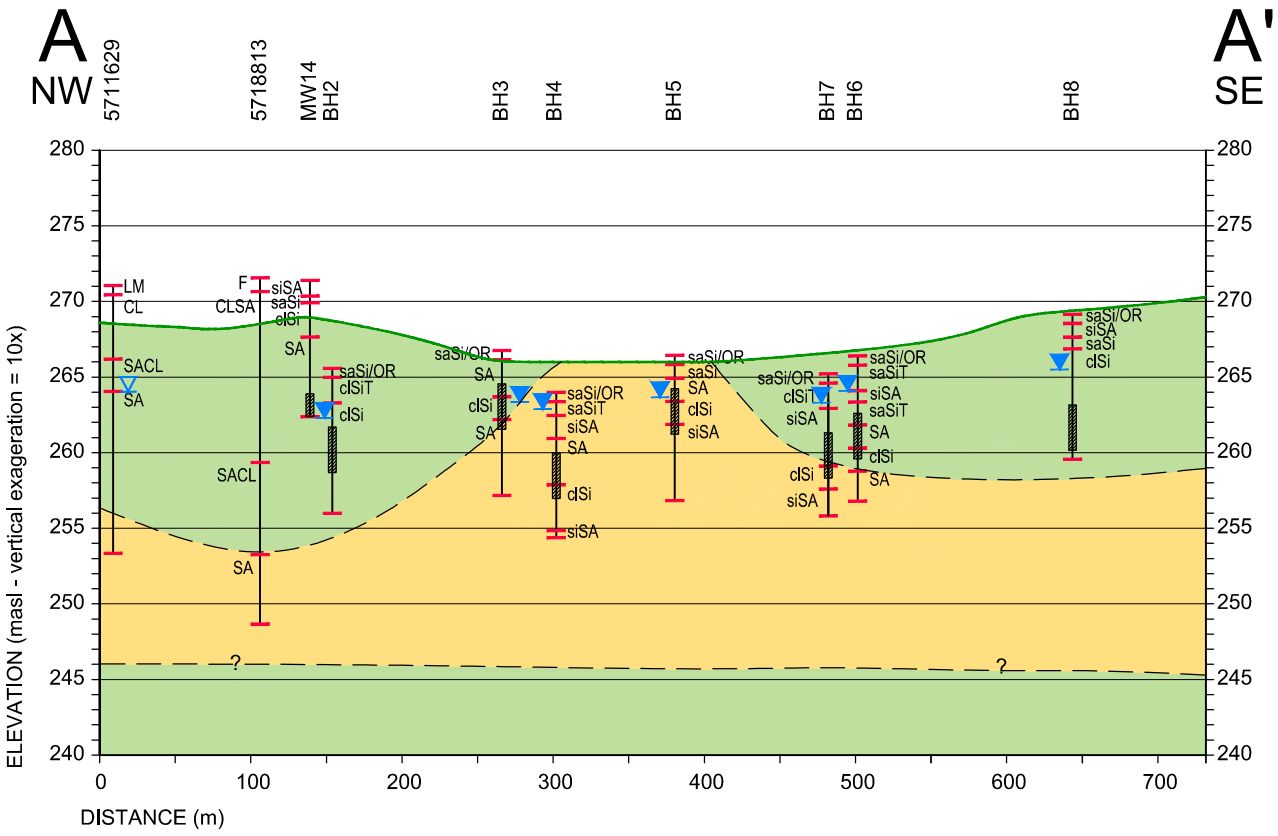

LEGEND

BH1 — WELL NUMBER / ID

EXISTING GROUND PROFILE

GEOLOGICAL CONTACT

MEASURED WATER LEVEL (JUNE 18, 2018)

STATIC WATER LEVEL (MECP WELL RECORD)

WELL SCREEN

------ INTERPRETED STRATIGRAPHY

SAND / SILT

SILT / CLAY / TILL

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

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Figure Title

INTERPRETED GEOLOGICAL CROSS-SECTION A-A'

Drawn	Checked	Date	Figure No.
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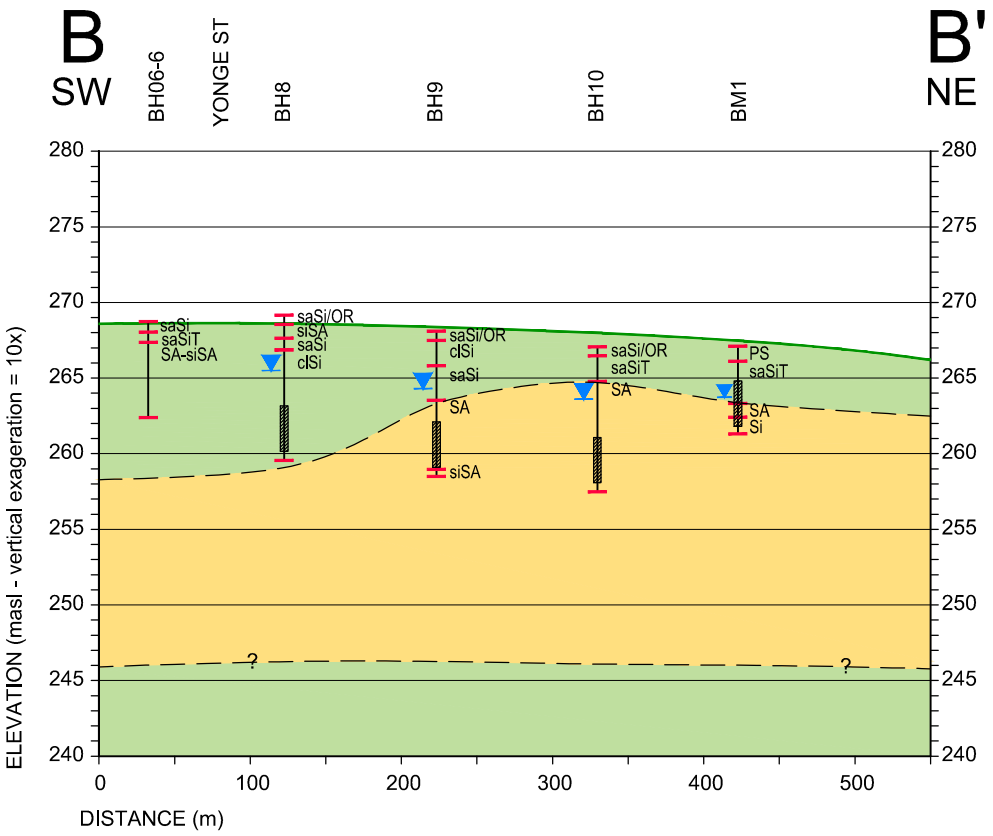

LEGEND

BH1 — WELL NUMBER / ID

EXISTING GROUND PROFILE

GEOLOGICAL CONTACT

MEASURED WATER LEVEL (JUNE 18, 2018)

STATIC WATER LEVEL (MECP WELL RECORD)

WELL SCREEN

------ INTERPRETED STRATIGRAPHY

SAND / SILT

SILT / CLAY / TILL

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

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HYDROGEOLOGICAL 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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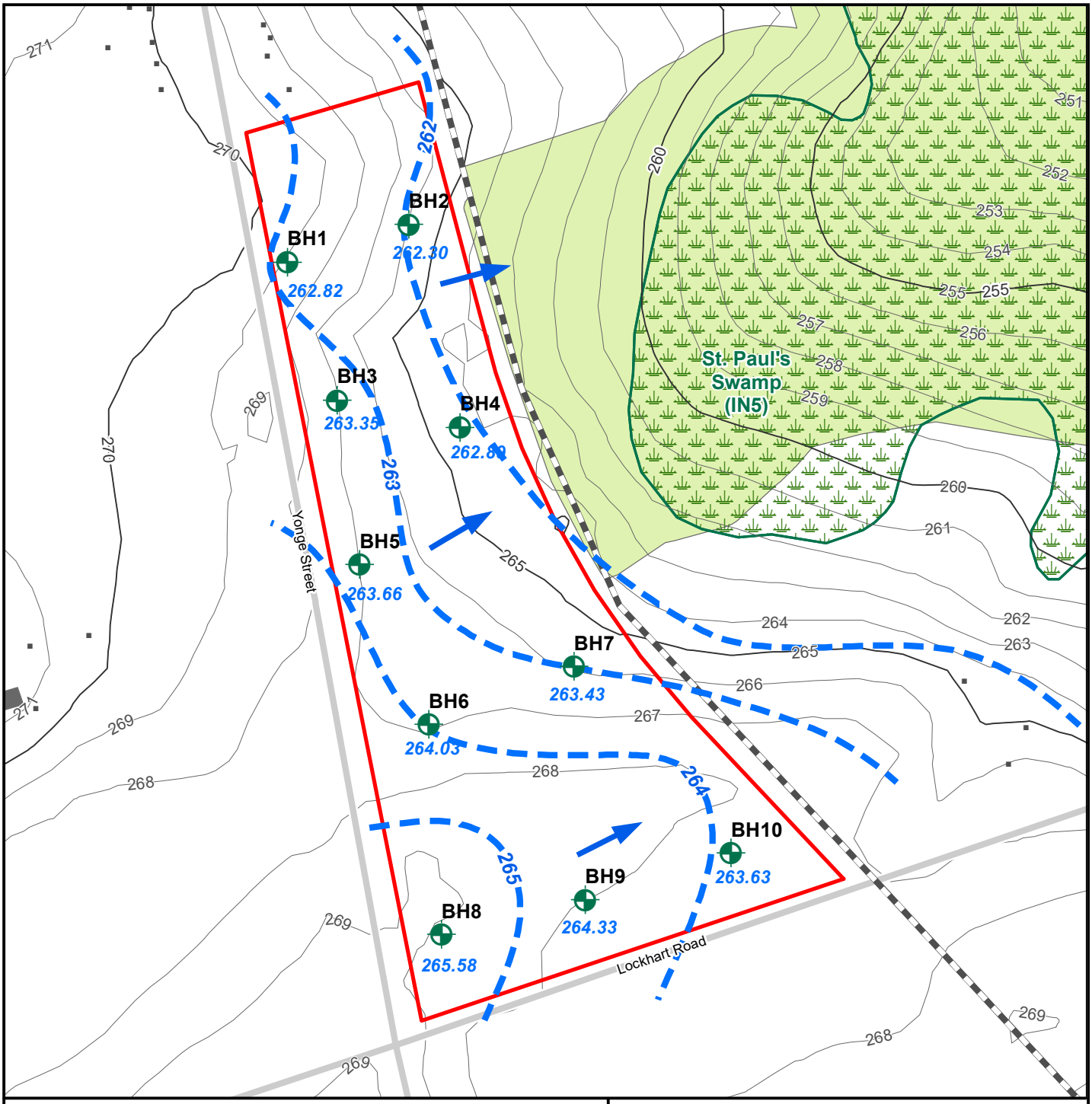

LEGEND

- SUBJECT LANDS
- WATERCOURSE
- CONTOUR (1m intervals)
- ROADWAY
- RAILWAY
- PROVINCIALLY SIGNIFICANT WETLAND
- NATURAL HERITAGE SYSTEM (JONES, 2015)
- MONITORING WELL (MCR, 2019)
- INTERPRETED GROUNDWATER CONTOUR (masl)
- 264.03 MEASURED WATER LEVEL (JUNE 18, 2018)
- INTERPRETED GROUNDWATER FLOW DIRECTION

0 50 100 200 300
Meters

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Figure Title:

INTERPRETED GROUNDWATER FLOW

Drawn	Checked	Date	Figure No.
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Scale		Project No.	
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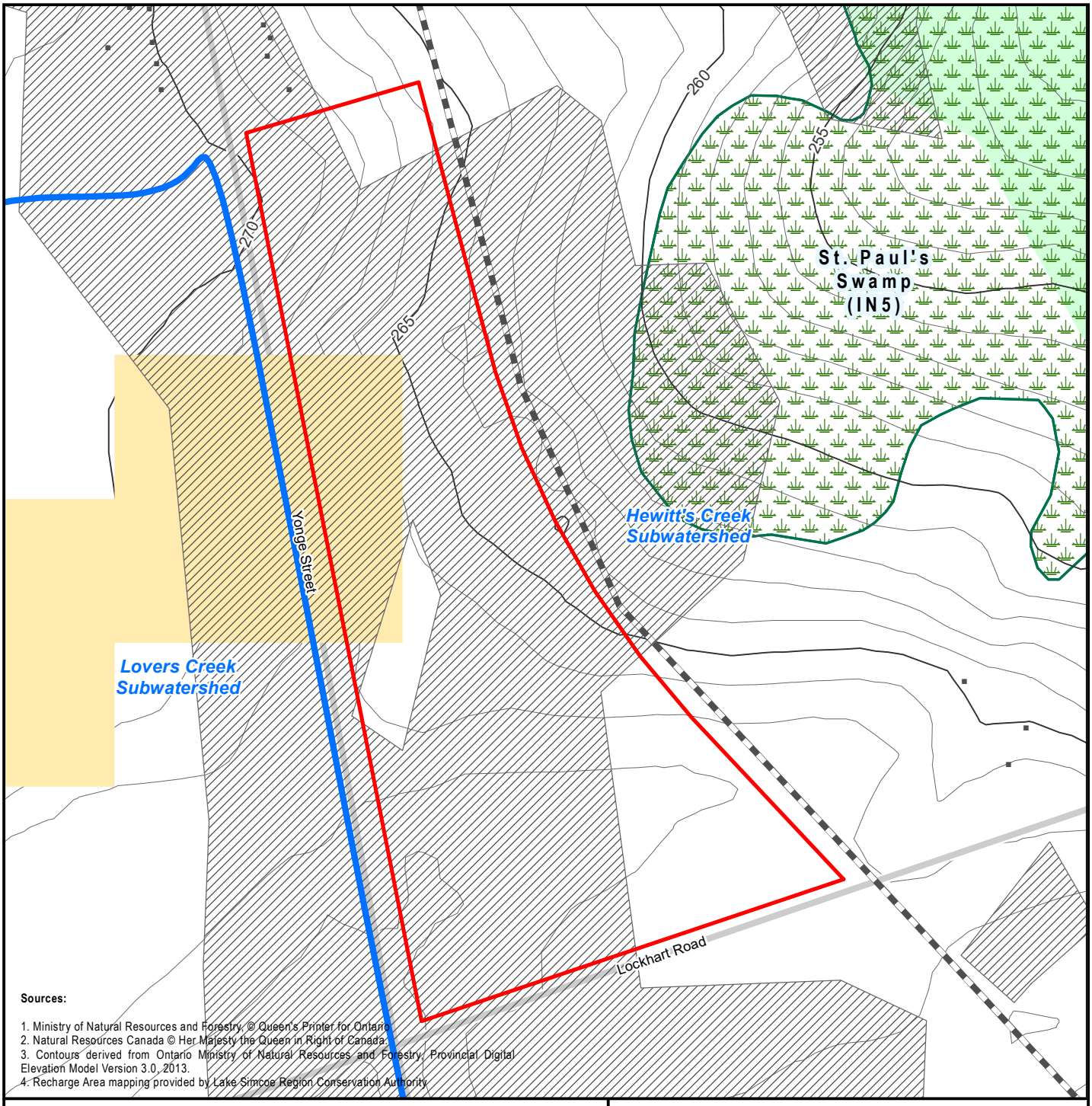

Sources:

1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario.
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Contours derived from Ontario Ministry of Natural Resources and Forestry, Provincial Digital Elevation Model Version 3.0, 2013.
4. Recharge Area mapping provided by Lake Simcoe Region Conservation Authority

LEGEND

- SUBJECT LANDS
- SUBWATERSHED BOUNDARY
- CONTOUR (5m intervals - masl)
- CONTOUR (1m intervals)
- ECOLOGICALLY SIGNIFICANT GROUNDWATER RECHARGE AREAS (ESGRA, LSRCA)
- SIGNIFICANT GROUNDWATER RECHARGE AREAS (SGRA, LSRCA)
- PROVINCIALLY SIGNIFICANT WETLAND
- WATERCOURSE
- WOODED AREA
- RAILWAY
- ROADWAY
- BUILDING

0 50 100 200 300
Meters

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BARRIE, ONTARIO

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Figure Title:

RECHARGE AREAS

Drawn	Checked	Date	Figure No.
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Scale		Project No.	
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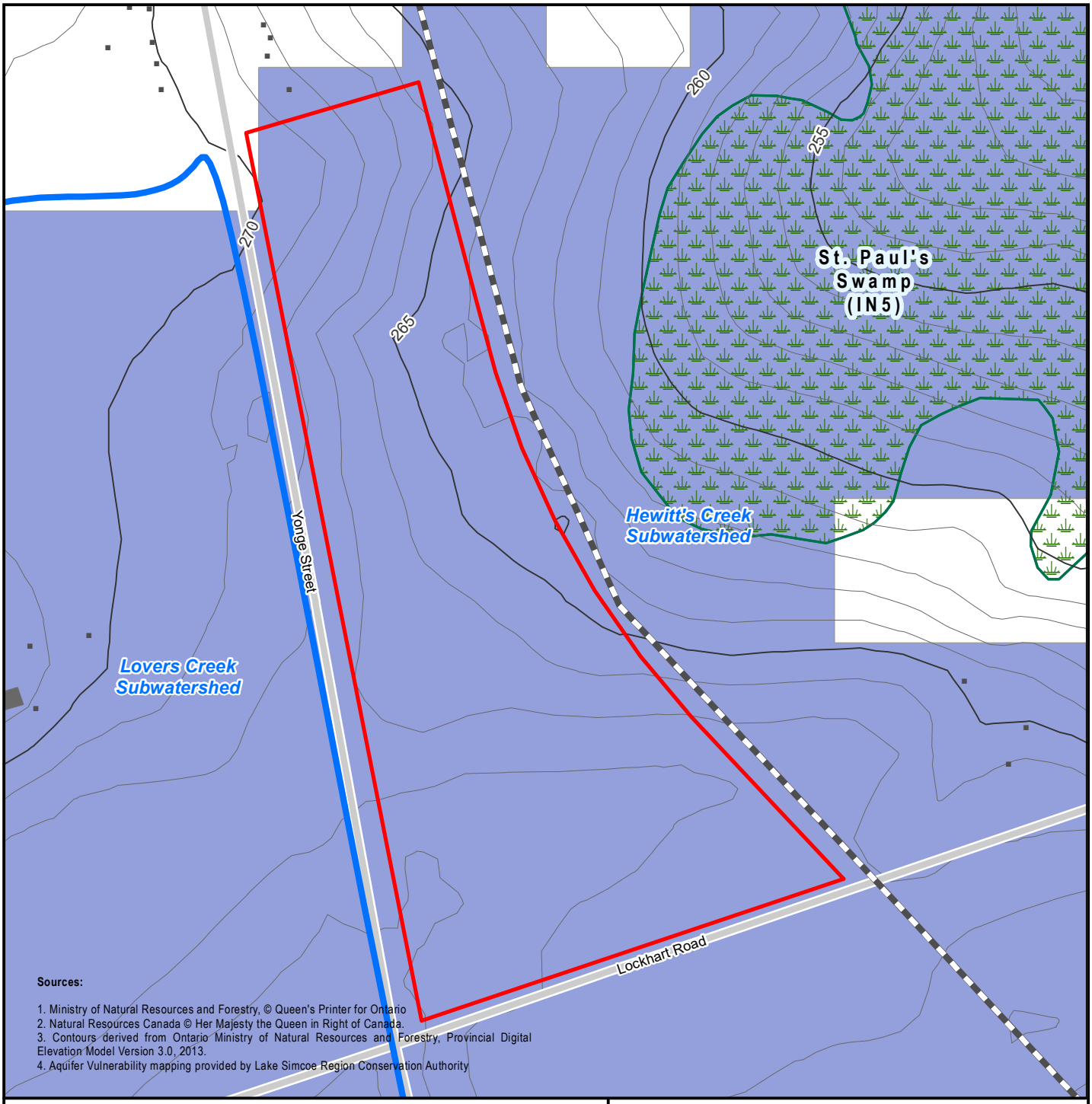

LEGEND

- SUBJECT LANDS
- SUBWATERSHED BOUNDARY
- CONTOUR (5m intervals - masl)
- CONTOUR (1m intervals)
- HIGH AQUIFER VULNERABILITY
- PROVINCIALLY SIGNIFICANT WETLAND
- WATERCOURSE
- RAILWAY
- ROADWAY
- BUILDING

0 50 100 200 300
Meters

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ASA DEVELOPMENT INC.
BARRIE, ONTARIO

HYDROGEOLOGICAL ASSESSMENT

Figure Title:

AQUIFER VULNERABILITY

Drawn	Checked	Date	Figure No.
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Scale		Project No.	
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Appendix A

MECP Water Well Records

Water Well Records

Friday, January 17, 2020
1:15:03 PM

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
INNISFIL TOWNSHIP	17 609712 4910766 W	2014/04 6809	2			TH	0022 5	7239318 (Z175927) A152307	BRWN CLAY SILT 0015 BRWN CSND 0028
INNISFIL TOWNSHIP	17 610469 4910446 W	2016/06 6946	2			MO	0010 10	7266354 (Z232470) A203374	BRWN SAND STNS WBRG 0020
INNISFIL TOWNSHIP CON 10 015	17 609732 4909940 W	1962/10 2514	6	FR 0054	35/57/5/1:0	ST DO	0057 3	5701273 ()	PRDG 0037 BRWN CLAY MSND GRVL 0054 MSND 0060
INNISFIL TOWNSHIP CON 10 016	17 609941 4909800 W	1963/01 2514	6	FR 0040	22/40/5/1:30	ST DO	0040 3	5701297 ()	PRDG 0022 MSND CLAY 0038 MSND 0043
INNISFIL TOWNSHIP CON 10 016	17 609914 4909873 W	1984/04 3203	5	FR 0022	8/40/10/1:0	DO	0051 3	5719231 ()	LOAM 0002 BRWN CLAY SAND 0022 BRWN SAND 0054
INNISFIL TOWNSHIP CON 11 015	17 609488 4911138 W	1959/10 1510	2	FR 0045	35/40/5/1:30	DO	0040 5	5701413 ()	CSND 0050
INNISFIL TOWNSHIP CON 11 015	17 609571 4911277 W	1963/01 4102	30	FR 0018	18//2/:	DO		5701477 ()	CSND 0025
INNISFIL TOWNSHIP CON 11 015	17 609614 4910663 W	1968/09 4608	30	FR 0025	26///:	DO		5705828 ()	BRWN CLAY STNS 0020 MSND 0036
INNISFIL TOWNSHIP CON 11 015	17 609572 4910457 W	1965/08 2514	6	FR 0043	30/52/3/2:30	ST DO	0052 3	5701415 ()	PRDG 0033 MSND CLAY 0043 MSND 0055 FSND 0058
INNISFIL TOWNSHIP CON 11 015	17 609564 4910423 W	1979/04 3203	6 5	FR 0060	30/75/2/6:10	DO	0080 3	5716067 ()	PRDG 0030 PRDR 0060 BRWN SAND CLAY 0064 GREY SAND CLAY LYRD 0083 GREY CLAY 0092
INNISFIL TOWNSHIP CON 11 015	17 609379 4910783 L	1999/03 2513	6	FR 0064	26/58/9/1:0	DO	0060 6	5734439 (195331)	LOAM 0001 YLLW SAND 0004 YLLW SILT 0018 YLLW SAND 0027 YLLW SAND SILT CLAY 0052 YLLW SAND 0064 YLLW CLAY 0064
INNISFIL TOWNSHIP CON 11 015	17 609372 4911182 W	1959/10 1510	2	FR 0045	35/40/5/2:0	DO	0040 5	5701412 ()	CSND 0050
INNISFIL TOWNSHIP CON 11 015	17 609376 4910783 L	2004/04 2513	6.28	FR 0085	36/55/2/1:0	DO	0086 6	5738721 (Z00199) A000103	BRWN SAND SILT STNS 0014 YLLW SAND 0062 BLUE SAND SILT CLAY 0085 GREY SAND SILT CMTD 0092
INNISFIL TOWNSHIP CON 11 015	17 609665 4911082 W	2008/01 2514	6.25	FR 0055	25/51/4/1:0	DO	0051 8	7102395 (Z54565) A048085	BLCK SAND GRVL LOAM 0001 GREY CLAY SAND LOOS 0049 GREY SAND PORS 0059
INNISFIL TOWNSHIP CON 11 015	17 609575 4910893 W	1967/01 4608	30	FR 0035	35//2/:	DO		5701419 ()	BRWN CLAY 0035 MSND 0050
INNISFIL TOWNSHIP CON 11 016	17 609623 4911154 W	1965/11 2514	6	FR 0043	24/43/4/2:0	DO	0043 3	5701420 ()	PRDG 0028 MSND CLAY 0035 BRWN MSND 0046 FSND 0049

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
INNISFIL TOWNSHIP CON 11 016	17 609694 4911024 W	1965/10 4102	30	FR 0026	26//6/:	DO		5701421 ()	BRWN CLAY 0012 CSND 0040
INNISFIL TOWNSHIP CON 11 016	17 609714 4910923 W	1974/10 3203	5	FR 0023	23/44/7/1:0	DO		5711629 ()	LOAM 0002 BRWN CLAY 0016 BRWN SAND CLAY 0023 GREY SAND 0058
INNISFIL TOWNSHIP CON 11 016	17 609714 4910823 W	1983/08 2514	6 5	FR 0060	27/70/6/1:30	DO	0071 4	5718813 ()	FILL 0003 BRWN CLAY SAND 0040 YLLW SAND CLAY GRVL 0060 GREY FSND VERY 0075
INNISFIL TOWNSHIP CON 11 016	17 609611 4911278 W	1997/05 5528	5 5	FR 0042	16/32/4/2:0	DO	0042 4	5732723 (155258)	LOAM 0001 BRWN SAND 0004 STNS GRVL 0005 BRWN SAND MGRD 0023 BRWN FSND 0049 BRWN SILT CLAY 0052
INNISFIL TOWNSHIP CON 11 016	17 609621 4911258 W	1997/06 5528	6 5	FR 0046	16/38/6/1:0	DO	0046 4	5732836 (155265)	BRWN SAND GRVL 0040 BRWN SAND 0050
INNISFIL TOWNSHIP CON 11 016	17 609971 4910979 L	1997/10 1851	6	FR 0044	17/48/4/1:0	DO	0044 6	5733085 (187561)	BLCK LOAM 0001 BRWN SAND 0004 GREY SAND 0010 BRWN SAND WBRG 0015 BRWN CLAY SLTY 0044 BRWN SAND WBRG 0050
INNISFIL TOWNSHIP CON 11 016	17 609686 4910964 W	2002/06 2513	7	FR 0067	23/59/8/1:0	DO	0062 5	5736948 (246396)	BLCK LOAM 0001 BRWN SILT SAND 0017 YLLW SAND 0060 GREY SAND VERY 0067
INNISFIL TOWNSHIP CON 11 016	17 609682 4911066 W	2016/04 1851	6.25	FR 0063	29/56/4/1:30	DO	0063 5	7261373 (Z164616) A063855	BRWN CLAY 0018 GREY CLAY SAND 0053 GREY SAND DRTY 0063 BRWN SAND 0068
INNISFIL TOWNSHIP CON 11 016	17 609714 4910823 W	1982/11 3660	5	FR 0058	21/45/6/2:0	DO	0062 3	5718243 ()	PRDG 0023 BRWN SILT 0058 GREY MSND 0065
INNISFIL TOWNSHIP CON 11 017	17 610514 4910523 W	1985/11 4816	6		10/20/5/2:0	DO	0040 4	5720335 ()	SAND 0004 GRVL 0006 BRWN SAND 0045 GREY CLAY 0045

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

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

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

1. Core Material and Descriptive terms

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

2. Core Color

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

3. Well Use

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

4. Water Detail

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

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix B

Borehole Logs

RECORD OF BOREHOLE 1

PROJECT : GE5243
LOCATION : 971 Yonge Street, Barrie, Ontario
STARTED : November 3, 2017
COMPLETED : November 3, 2017

MC CLYMONT & RAK ENGINEERS, INC.

SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	ORGANIC VAPOUR READINGS (ppm) ⊗ 100 200 300 400 / % LEL - (hexane) □ 20 40 60 80	SHEAR STRENGTH: Cu, KPa nat V - ✤ rem V - ● Q - ✖ U - ▲ 20 40 60 80 / WATER CONTENT, PERCENT wp w wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		268.70							
	POWER BORING / HOLLOW STEM AUGER	SANDY SILT with ORGANICS: trace of clay, gravel and rootlets, brown to black, moist, loose.			1	SS	4				Protective Metal Casing
				268.09 / 0.61							
		SANDY SILT TILL: trace of clay, gravel and stone fragments, brown, moist, compact to dense.			2	SS	14				
					3	SS	39				Bentonite
2					4	SS	39				
				265.65 / 3.05							
		SANDY SILT: trace of clay, brown, moist, very dense.			5	SS	58				5.33 m Long 50 mm ID PVC Riser
4											
				264.13 / 4.57							264.13
		SILTY SAND: trace of clay, brown, moist, very dense.			6	SS	83				Silica Sand
											263.37
6					7	SS	74				▽
											3.05 m Long 50 mm ID PVC Screen
				261.08 / 7.62							
		SAND: trace of silt, brown, moist to wet, very dense.			8	SS	89				
8											260.32
											Bentonite
					9	SS	>100				
				259.12 / 9.58							259.12
		End of Borehole									
10		Note: 1) Water level was not measured on completion of drilling. 2) Soil samples were screened using a RKI Eagle gas meter with methane response mode off. 3) Water level was measured at 6.50 m bgs on December 13, 2017.									

GROUNDWATER ELEVATIONS

▽ SHALLOW/SINGLE INSTALLATION
WATER LEVEL: 6.50 m bgs

▼ DEEP/DUAL INSTALLATION
WATER LEVEL:

LOGGED : OM
CHECKED : LM

MCR BOREHOLE LOG 5243.GPJ 2/14/18

RECORD OF BOREHOLE 2

PROJECT : GE5243
LOCATION : 971 Yonge Street, Barrie, Ontario
STARTED : November 3, 2017
COMPLETED : November 3, 2017

MC CLYMONT & RAK ENGINEERS, INC.

SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ORGANIC VAPOUR READINGS (ppm) ⊗ 100 200 300 400 / % LEL - (hexane) □ 20 40 60 80	SHEAR STRENGTH: Cu, KPa nat V - ✤ rem V - ● Q - ✖ U - ▲ 20 40 60 80 / WATER CONTENT, PERCENT wp w wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		265.69							
	POWER BORING / HOLLOW STEM AUGER	SANDY SILT with ORGANICS: trace of clay, gravel and rootlets, brown to black, moist, very loose.			1	SS	3	20 ⊗			Protective Metal Casing
				265.08 0.61							
		CLAYEY SILT TILL: some sand, trace of gravel and stone fragments, grey, moist, very stiff to hard.			2	SS	25	0 ⊗			Bentonite
2					3	SS	38	0 ⊗			
				263.40 2.29							3.81 m Long 50 mm ID PVC Riser
		CLAYEY SILT: sandy silt seams, brown, moist, hard.			4	SS	47	0 ⊗			262.64
		-moist to wet below 3.05 m depth.			5	SS	62	0 ⊗			Silica Sand
4											261.88 ▽
		-wet below 4.55 m depth.			6	SS	74	0 ⊗			
					7	SS	62	0 ⊗			3.05 m Long 50 mm ID PVC Screen
6											258.83
					8	SS	45	0 ⊗			Bentonite
8											
					9	SS	61	0 ⊗			256.09
				256.09 9.60							
		End of Borehole									
10		Note: 1) Water level was not measured on completion of drilling. 2) Soil samples were screened using a RKI Eagle gas meter with methane response mode off. 3) Water level was measured at 4.50 m bgs on November 9, 2017. 4) Water level was measured at 3.95 m bgs on December 13, 2017.									

GROUNDWATER ELEVATIONS

▽ SHALLOW/SINGLE INSTALLATION
WATER LEVEL: 3.95 m bgs

▼ DEEP/DUAL INSTALLATION
WATER LEVEL:

LOGGED : OM
CHECKED : LM

MCR BOREHOLE LOG 5243.GPJ 2/14/18

RECORD OF BOREHOLE 3

PROJECT : GE5243
LOCATION : 971 Yonge Street, Barrie, Ontario
STARTED : November 3, 2017
COMPLETED : November 3, 2017

MC CLYMONT & RAK ENGINEERS, INC.

SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ORGANIC VAPOUR READINGS (ppm) ⊗ / % LEL - (hexane) □	SHEAR STRENGTH: Cu, KPa (nat V - ✤, rem V - ●, Q - ✖, U - ▲) / WATER CONTENT, PERCENT (wp, w, wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		266.70							
	POWER BORING / HOLLOW STEM AUGER	SANDY SILT with ORGANICS: trace of clay, gravel and rootlets, brown to black, moist, very loose.			1	SS	3				Protective Metal Casing
				266.09 / 0.61							Bentonite
		SAND: some silt, trace of gravel, brown, moist, dense to very dense.			2	SS	30				2.29 m Long 50 mm ID PVC Riser
											265.18
					3	SS	47				Silica Sand
2											264.41
					4	SS	59				
				263.65 / 3.05							
		CLAYEY SILT: trace of sand, brown, wet, hard.			5	SS	35				
4											3.05 m Long 50 mm ID PVC Screen
				262.13 / 4.57							
		SAND: some silt, brown, moist to wet, very dense to dense.			6	SS	84				
											261.36
											Bentonite
6		-wet below 6.1 m depth.			7	SS	96				
					8	SS	49				
8											
					9	SS	>100				
				257.13 / 9.57							257.13
		End of Borehole									
10		Note: 1) Water level was not measured on completion of drilling. 2) Soil samples were screened using a RKI Eagle gas meter with methane response mode off. 3) Water level was measured at 4.08 m bgs on December 13, 2017.									

GROUNDWATER ELEVATIONS

▽ SHALLOW/SINGLE INSTALLATION
WATER LEVEL: 4.08 m bgs

▼ DEEP/DUAL INSTALLATION
WATER LEVEL:

LOGGED : OM
CHECKED : LM

MCR BOREHOLE LOG 5243.GPJ 2/14/18

RECORD OF BOREHOLE 4

PROJECT : GE5243
LOCATION : 971 Yonge Street, Barrie, Ontario
STARTED : November 2, 2017
COMPLETED : November 2, 2017

MC CLYMONT & RAK ENGINEERS, INC.

SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ORGANIC VAPOUR READINGS (ppm) ⊗ 100 200 300 400 / % LEL - (hexane) □ 20 40 60 80	SHEAR STRENGTH: Cu, KPa nat V - ✤ rem V - ● Q - ✖ U - ▲ 20 40 60 80 / WATER CONTENT, PERCENT wp w wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		264.01							
	POWER BORING / HOLLOW STEM AUGER	SANDY SILT with ORGANICS: trace of clay, gravel and rootlets, brown to black, moist, very loose.			1	SS	3	⊗ 15			Protective Metal Casing
				263.40 0.61							0.91 m Long 50 mm ID PVC Riser 263.10
		SANDY SILT TILL: trace of clay, gravel and stone fragments, brown, moist, compact.			2	SS	16	⊗ 20			Silica Sand
				262.49 1.52							
2		SILTY SAND: brown, wet, compact to dense.			3	SS	20	⊗ 0			▽
					4	SS	35	⊗ 0			3.05 m Long 50 mm ID PVC Screen
				260.96 3.05							
		SAND: some silt, brown, wet, dense to very dense.			5	SS	43	⊗ 0			260.05
4											Bentonite
					6	SS	58	⊗ 0			
6				257.91 6.10							
		CLAYEY SILT: silty sand seams, brown, wet, hard.			7	SS	97	⊗ 0			
					8	SS	68	⊗ 0			
8				254.87 9.14							
		SILTY SAND: brown, wet, very dense.			9	SS	72	⊗ 0			254.41
				254.41 9.60							
		End of Borehole									
10		Note: 1) Water level was not measured on completion of drilling. 2) Soil samples were screened using a RKI Eagle gas meter with methane response mode off. 3) Water level was measured at 2.20 m bgs on November 9, 2017. 4) Water level was measured at 1.80 m bgs on December 13, 2017.									

GROUNDWATER ELEVATIONS

▽ SHALLOW/SINGLE INSTALLATION
WATER LEVEL: 1.80 m bgs

▼ DEEP/DUAL INSTALLATION
WATER LEVEL:

LOGGED : OM
CHECKED : LM

MCR BOREHOLE LOG 5243.GPJ 2/14/18

RECORD OF BOREHOLE 5

PROJECT : GE5243
LOCATION : 971 Yonge Street, Barrie, Ontario
STARTED : November 6, 2017
COMPLETED : November 6, 2017

MC CLYMONT & RAK ENGINEERS, INC.

SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ORGANIC VAPOUR READINGS (ppm) ⊗ 100 200 300 400 / % LEL - (hexane) □ 20 40 60 80	SHEAR STRENGTH: Cu, KPa nat V - ✤ rem V - ● Q - ✖ U - ▲ 20 40 60 80 / WATER CONTENT, PERCENT wp w wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		266.42							
	POWER BORING / HOLLOW STEM AUGER	SANDY SILT with ORGANICS: trace of clay, gravel and rootlets, brown to black, moist, very loose.			1	SS	2	⊗ 0			Protective Metal Casing
				265.81							
		SANDY SILT: trace of clay and gravel, grey, moist, compact.		0.61	2	SS	26	⊗ 15			Bentonite 2.29 m Long 50 mm ID PVC Riser
				264.90							264.90
2		SAND: some silt, brown moist, dense to very dense.		1.52	3	SS	44	⊗ 0			Silica Sand
					4	SS	50	⊗ 0			264.13
				263.37							
		CLAYEY SILT: trace of sand, brown, wet, very stiff.		3.05	5	SS	20	⊗ 0			▽ 3.05 m Long 50 mm ID PVC Screen
4				261.85							
		SILTY SAND: sand seams, trace of clay, brown, moist to wet, very dense.		4.57	6	SS	67	⊗ 0			261.08 Bentonite
6					7	SS	94	⊗ 0			
					8	SS	93	⊗ 0			
8					9	SS	53	⊗ 0			256.85
				256.82							
		End of Borehole		9.60							
10		Note: 1) Water level was not measured on completion of drilling. 2) Soil samples were screened using a RKI Eagle gas meter with methane response mode off. 3) Water level was measured at 3.98 m bgs on November 9, 2017. 4) Water level was measured at 3.47 m bgs on December 13, 2017.									

GROUNDWATER ELEVATIONS

▽ SHALLOW/SINGLE INSTALLATION
WATER LEVEL: 3.47 m bgs

▼ DEEP/DUAL INSTALLATION
WATER LEVEL:

LOGGED : OM
CHECKED : LM

MCR BOREHOLE LOG 5243.GPJ 2/14/18

RECORD OF BOREHOLE 6

PROJECT : GE5243
LOCATION : 971 Yonge Street, Barrie, Ontario
STARTED : November 6, 2017
COMPLETED : November 6, 2017

MC CLYMONT & RAK ENGINEERS, INC.

SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ORGANIC VAPOUR READINGS (ppm) ⊗ 100 200 300 400 / % LEL - (hexane) □ 20 40 60 80	SHEAR STRENGTH: Cu, KPa nat V - ✤ rem V - ● Q - ✖ U - ▲ 20 40 60 80 / WATER CONTENT, PERCENT wp w wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		266.45							
	POWER BORING / HOLLOW STEM AUGER	SANDY SILT with ORGANICS: trace of clay gravel and rootlets, brown to black, moist, very loose.		265.84 0.61	1	SS	3				Protective Metal Casing
		SANDY SILT TILL: some clay, trace of gravel and stone fragments, brown, moist, loose to very dense. -trace of roots in the upper 150 mm.			2	SS	8				Bentonite
2		-trace of clay and sand seams below 1.5 m depth.			3	SS	52				3.66 m Long 50 mm ID PVC Riser
		SILTY SAND: trace of clay and stone fragments, brown, moist to wet, dense.		264.16 2.29	4	SS	46				
		SANDY SILT TILL: trace of clay and gravel, brown, wet, very dense.		263.40 3.05	5	SS	57				263.40 ▽ Silica Sand 262.79
4		SAND: some silt, brown, moist to wet, very dense.		261.88 4.57	6	SS	58				3.05 m Long 50 mm ID PVC Screen
6		CLAYEY SILT: trace of sand, brown, moist to wet, hard.		260.35 6.10	7	SS	36				259.74
		SAND: some silt, trace of clay and gravel, grey, wet, very dense.		258.83 7.62	8	SS	88				Bentonite
8					9	SS	77				256.85
		End of Borehole		256.85 9.60							
10		Note: 1) Water level was not measured on completion of drilling. 2) Soil samples were screened using a RKI Eagle gas meter with methane response mode off. 3) Water level was measured at 3.19 m bgs on December 13, 2017.									

GROUNDWATER ELEVATIONS

▽ SHALLOW/SINGLE INSTALLATION
WATER LEVEL: 3.19 m bgs

▼ DEEP/DUAL INSTALLATION
WATER LEVEL:

LOGGED : OM
CHECKED : LM

MCR BOREHOLE LOG 5243.GPJ 2/14/18

RECORD OF BOREHOLE 7

PROJECT : GE5243
LOCATION : 971 Yonge Street, Barrie, Ontario
STARTED : November 2, 2017
COMPLETED : November 2, 2017

MC CLYMONT & RAK ENGINEERS, INC.

SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ORGANIC VAPOUR READINGS (ppm) ⊗ 100 200 300 400 / % LEL - (hexane) □ 20 40 60 80	SHEAR STRENGTH: Cu, KPa nat V - ✤ rem V - ● Q - ✖ U - ▲ 20 40 60 80 / WATER CONTENT, PERCENT wp w wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		265.13							
	POWER BORING / HOLLOW STEM AUGER	SANDY SILT with ORGANICS: trace of clay, gravel and rootlets, brown to black, moist, very loose.			1	SS	3	0 ⊗			Protective Metal Casing
				264.52 0.61							
		CLAYEY SILT TILL: some sand, trace of gravel, silt seams, brown, moist to wet, stiff to very stiff.			2	SS	10	0 ⊗			Bentonite
2					3	SS	23	0 ⊗			3.81 m Long 50 mm ID PVC Riser
				262.84 2.29							
		SILTY SAND: trace of clay, brown, moist to wet, dense to very dense.. -trace of gravel in the upper 300 mm.			4	SS	40	5 ⊗			262.08
					5	SS	56	0 ⊗			Silica Sand
4											261.32
		-trace of gravel and wet below 4.55 m depth.			6	SS	54	0 ⊗			3.05 m Long 50 mm ID PVC Screen
				259.03 6.10							
6		CLAYEY SILT: trace of sand, brown, wet, hard.			7	SS	89	0 ⊗			258.27
				257.51 7.62							Bentonite
		SILTY SAND: trace of clay and gravel, brown, wet, very dense.			8	SS	97	0 ⊗			
8					9	SS	>100	0 ⊗			255.73
				255.73 9.40							
		End of Borehole									
10		Note: 1) Water level was not measured on completion of drilling. 2) Soil samples were screened using a RKI Eagle gas meter with methane response mode off. 3) Water level was measured at 2.43 m bgs on December 13, 2017.									

GROUNDWATER ELEVATIONS

▽ SHALLOW/SINGLE INSTALLATION
WATER LEVEL: 2.43 m bgs

▼ DEEP/DUAL INSTALLATION
WATER LEVEL:

LOGGED : OM
CHECKED : LM

MCR BOREHOLE LOG 5243.GPJ 2/14/18

RECORD OF BOREHOLE 8

PROJECT : GE5243
LOCATION : 971 Yonge Street, Barrie, Ontario
STARTED : November 1, 2017
COMPLETED : November 1, 2017

MC CLYMONT & RAK ENGINEERS, INC.

SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ORGANIC VAPOUR READINGS (ppm) ⊗ 100 200 300 400 / % LEL - (hexane) □ 20 40 60 80	SHEAR STRENGTH: Cu, KPa nat V - ✤ rem V - ● Q - ✖ U - ▲ 20 40 60 80 / WATER CONTENT, PERCENT wp w wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		269.18							
	POWER BORING / HOLLOW STEM AUGER	SANDY SILT with ORGANICS: trace of gravel, stone fragments and rootlets, brown to black, moist, very loose.			1	SS	3	10 ⊗			Protective Metal Casing
				268.57 0.61							
		SILTY SAND: trace of clay, gravel and stone fragments, brown, moist, dense.			2	SS	38	0 ⊗			
				267.66 1.52							
		SANDY SILT: brown, moist, compact.			3	SS	19	0 ⊗			Bentonite
2				266.89 2.29							
		CLAYEY SILT: trace of sand, brown, moist to wet, very stiff to hard.			4	SS	27	0 ⊗			
		-wet below 3.05 m depth.			5	SS	38	0 ⊗			▽ 6.10 m Long 50 mm ID PVC Riser
4					6	SS	96	0 ⊗			
											263.68 Silica Sand
6					7	SS	87	0 ⊗			263.08
											3.05 m Long 50 mm ID PVC Screen
					8	SS	>100	0 ⊗			
8											
					9	SS	68	0 ⊗			260.03
				259.58 9.60							
10		End of Borehole									

Note:
1) Water level was not measured on completion of drilling.
2) Soil samples were screened using a RKI Eagle gas meter with methane response mode off.
3) Water level was measured at 3.48 m bgs on December 13, 2017.

GROUNDWATER ELEVATIONS

▽ SHALLOW/SINGLE INSTALLATION
WATER LEVEL: 3.48 m bgs

▼ DEEP/DUAL INSTALLATION
WATER LEVEL:

LOGGED : OM
CHECKED : LM

MCR BOREHOLE LOG 5243.GPJ 2/14/18

RECORD OF BOREHOLE 9

PROJECT : GE5243
LOCATION : 971 Yonge Street, Barrie, Ontario
STARTED : November 1, 2017
COMPLETED : November 1, 2017

MC CLYMONT & RAK ENGINEERS, INC.

SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ORGANIC VAPOUR READINGS (ppm) ⊗ 100 200 300 400 / % LEL - (hexane) □ 20 40 60 80	SHEAR STRENGTH: Cu, KPa nat V - ✤ rem V - ● Q - ✖ U - ▲ 20 40 60 80 / WATER CONTENT, PERCENT wp w wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		268.12							
	POWER BORING / HOLLOW STEM AUGER	SANDY SILT with ORGANICS: trace of clay, gravel and rootlets, brown to black, moist, loose.			1	SS	4	5 ⊗			Protective Metal Casing
				267.51 0.61							
		CLAYEY SILT: trace of sand, brown, moist, stiff.			2	SS	11	0 ⊗			
		-moist to wet below 1.5 m depth.			3	SS	9	0 ⊗			Bentonite
2				265.83 2.29							
		SANDY SILT: fine sand seams, brown, moist to wet, compact to very dense.			4	SS	24	10 ⊗			
		-some clay and moist below 3.05 m depth.			5	SS	64	0 ⊗			6.10 m Long 50 mm ID PVC Riser
4				263.55 4.57							▽
		SAND: some coarse sand, trace of silt. brown, wet, very dense to dense.			6	SS	77	0 ⊗			
											262.62
											Silica Sand
6					7	SS	35	0 ⊗			262.02
											3.05 m Long 50 mm ID PVC Screen
8					8	SS	98	0 ⊗			
				258.98 9.14							258.97
		SILTY SAND: brown, wet, very dense.			9	SS	85	0 ⊗			
				258.52 9.60							
		End of Borehole									
10		Note: 1) Water level was not measured on completion of drilling. 2) Soil samples were screened using a RKI Eagle gas meter with methane response mode off. 3) Water level was measured at 4.44 m bgs on December 13, 2017.									

GROUNDWATER ELEVATIONS

▽ SHALLOW/SINGLE INSTALLATION
WATER LEVEL: 4.44 m bgs

▼ DEEP/DUAL INSTALLATION
WATER LEVEL:

LOGGED : OM
CHECKED : LM

MCR BOREHOLE LOG 5243.GPJ 2/14/18

RECORD OF BOREHOLE 10

PROJECT : GE5243
LOCATION : 971 Yonge Street, Barrie, Ontario
STARTED : November 2, 2017
COMPLETED : November 2, 2017

MC CLYMONT & RAK ENGINEERS, INC.

SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	ORGANIC VAPOUR READINGS (ppm) ⊗ 100 200 300 400 / % LEL - (hexane) □ 20 40 60 80	SHEAR STRENGTH: Cu, KPa nat V - ✤ rem V - ● Q - ✖ U - ▲ 20 40 60 80 / WATER CONTENT, PERCENT wp w wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		267.16							
	POWER BORING / HOLLOW STEM AUGER	SANDY SILT with ORGANICS: trace of clay, gravel and rootlets, brown to black, moist, very loose.			1	SS	3	⊗ 10			Protective Metal Casing
		SANDYSILT TILL: some clay, trace of gravel and stone fragments, brown, moist to wet, loose to compact,		266.55 / 0.61	2	SS	8	⊗ 0			
		-sand seams below 1.5 m depth.			3	SS	16	⊗ 15			Bentonite
2		SAND: trace of silt, brown, moist, dense to very dense.		264.87 / 2.29	4	SS	37	⊗ 0			
					5	SS	96	⊗ 0			6.10 m Long 50 mm ID PVC Riser
4		-some silt, trace of gravel and wet at 4.55 m depth.			6	SS	94	⊗ 0			▽
											261.66
											Silica Sand
6		-wet below 6.1 m depth.			7	SS	85	⊗ 0			261.06
					8	SS	82	⊗ 0			3.05 m Long 50 mm ID PVC Screen
8											
					9	SS	61	⊗ 0			258.01
		End of Borehole		257.56 / 9.60							
10		Note: 1) Water level was not measured on completion of drilling. 2) Soil samples were screened using a RKI Eagle gas meter with methane response mode off. 3) Water level was measured at 5.20 m bgs on November 9, 2017. 4) Water level was measured at 4.37 m bgs on December 13, 2017.									

GROUNDWATER ELEVATIONS

▽ SHALLOW/SINGLE INSTALLATION
WATER LEVEL: 4.37 m bgs

▼ DEEP/DUAL INSTALLATION
WATER LEVEL:

LOGGED : OM
CHECKED : LM

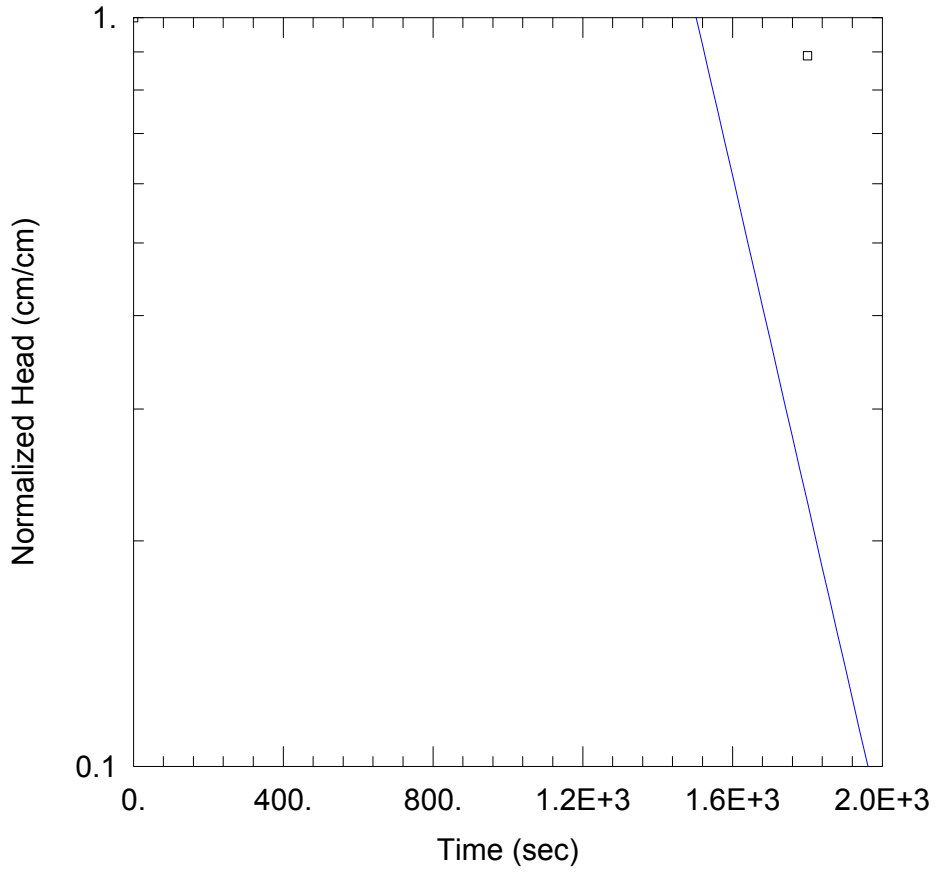
MCR BOREHOLE LOG 5243.GPJ 2/14/18

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix C

Hydraulic Conductivity Grainsize Analysis



HYDRAULIC CONDUCTIVITY TEST AT MW3 (SCREENED IN SILTY SAND)

PROJECT INFORMATION

Company: R.J Burnside
Client: Hewitt's Creek Landowners
Project: 300033110
Location: Barrie
Test Well: MW3
Test Date: October 22/ 2014

AQUIFER DATA

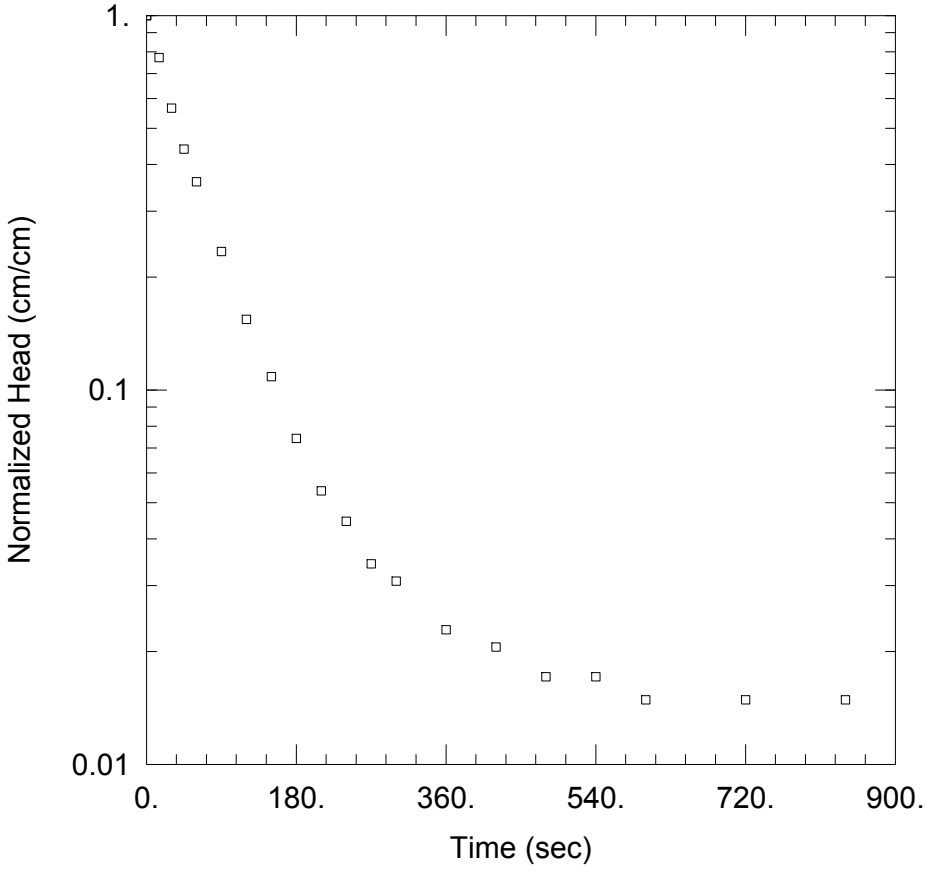
Saturated Thickness: 389.5 cm
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW3)

Initial Displacement: 58.5 cm
Total Well Penetration Depth: 389.5 cm
Casing Radius: 2.54 cm
Static Water Column Height: 389.5 cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0002939 cm/sec
y0 = 1.116E+5 cm



HYDRAULIC CONDUCTIVITY TEST AT MW5S (SCREENED IN SILTY SAND)

PROJECT INFORMATION

Company: R.J Burnside
Client: Hewitt's Creek Landowners
Project: 300033110
Location: Barrie
Test Well: MW5s
Test Date: October 21/ 2014

AQUIFER DATA

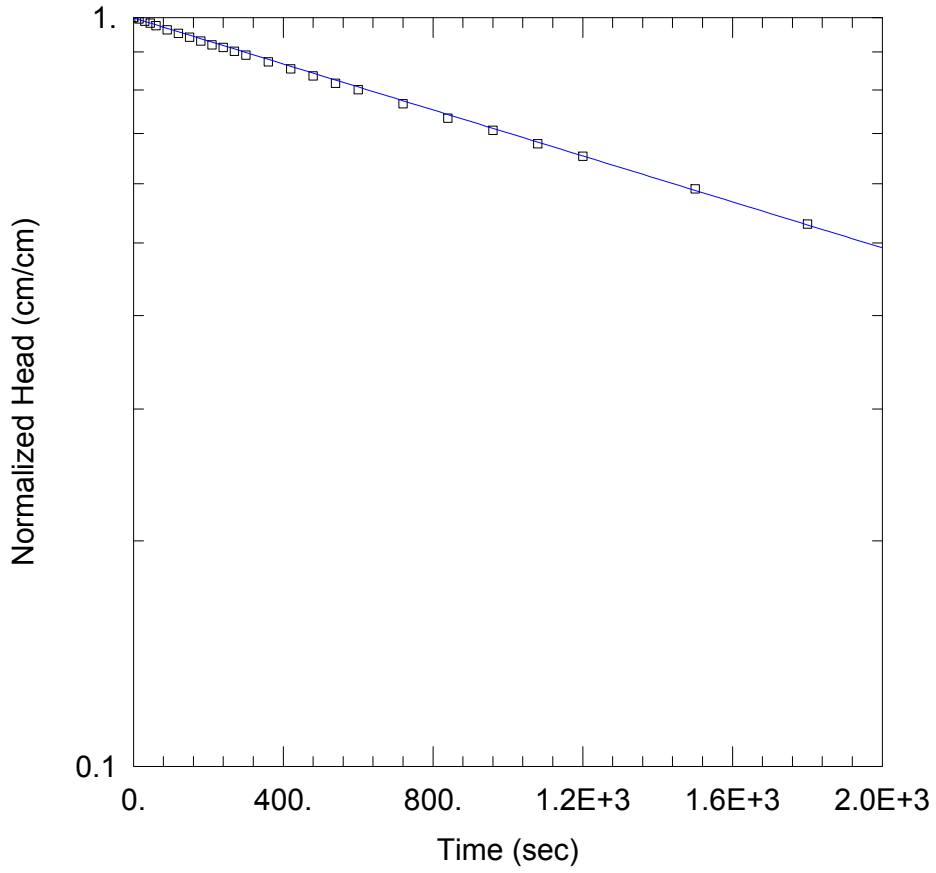
Saturated Thickness: 389.5 cm
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW5s)

Initial Displacement: 87.5 cm
Total Well Penetration Depth: 389.5 cm
Casing Radius: 2.54 cm
Static Water Column Height: 389.5 cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0002939 cm/sec
y0 = 1.116E+5 cm



HYDRAULIC CONDUCTIVITY TEST AT MW10S (SCREENED IN SILTY SAND)

PROJECT INFORMATION

Company: R.J Burnside
Client: Hewitt's Creek Landowners
Project: 300033110
Location: Barrie
Test Well: MW10s
Test Date: October 21/ 2014

AQUIFER DATA

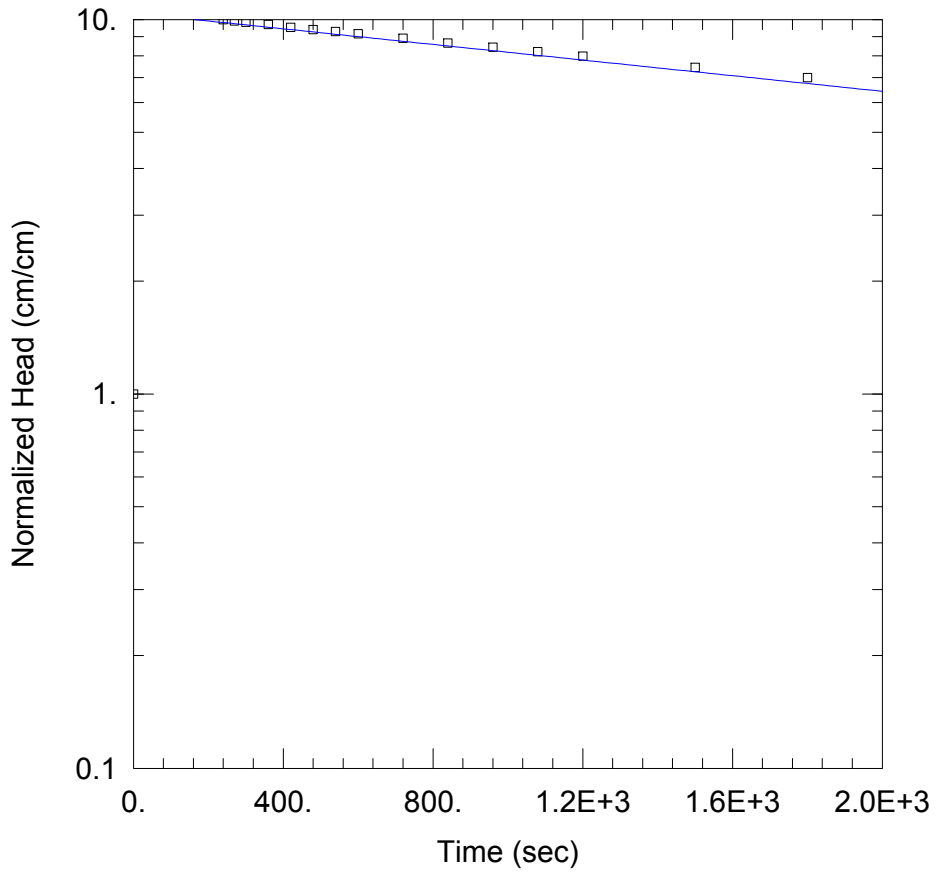
Saturated Thickness: 591. cm
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW10s)

Initial Displacement: 432. cm
Total Well Penetration Depth: 591. cm
Casing Radius: 2.54 cm
Static Water Column Height: 591. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.233E-5 cm/sec
y0 = 431.4 cm



HYDRAULIC CONDUCTIVITY TEST AT MW10D (SCREENED IN SILTY SAND)

PROJECT INFORMATION

Company: R.J Burnside
Client: Hewitt's Creek Landowners
Project: 300033110
Location: Barrie
Test Well: MW10d
Test Date: October 22/ 2014

AQUIFER DATA

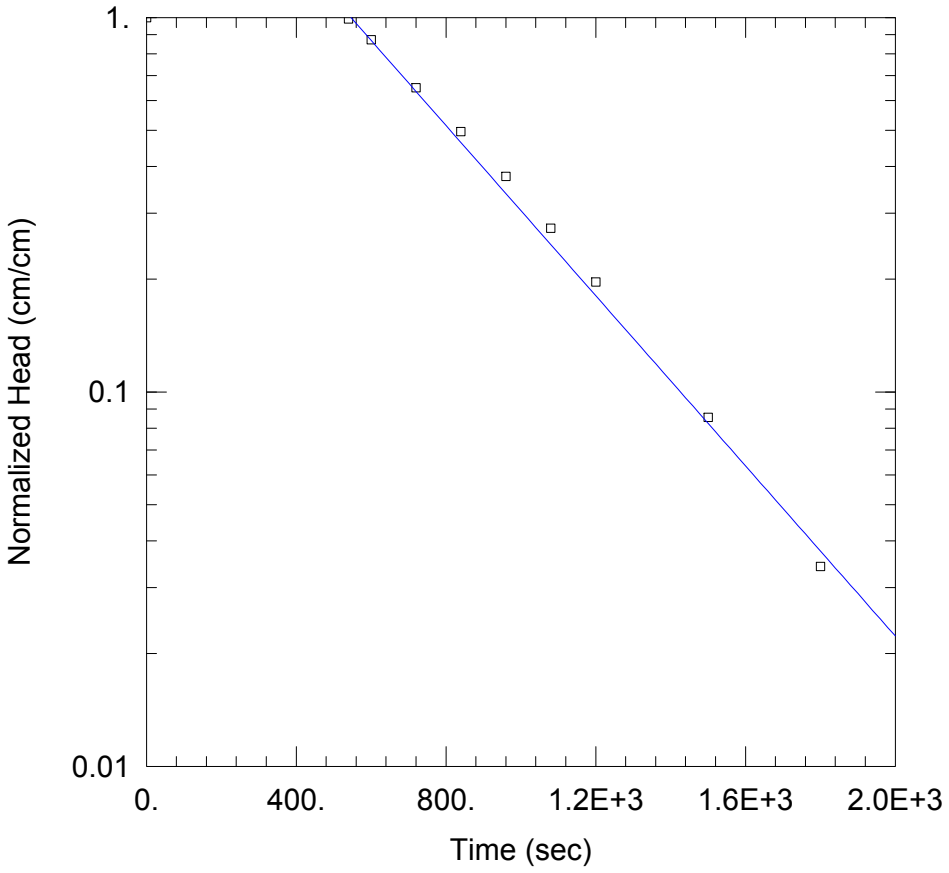
Saturated Thickness: 389.5 cm
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW10d)

Initial Displacement: 58.5 cm
Total Well Penetration Depth: 389.5 cm
Casing Radius: 2.54 cm
Static Water Column Height: 389.5 cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.405E-5 cm/sec
y0 = 608.2 cm



HYDRAULIC CONDUCTIVITY TEST AT MW13 (SCREENED IN SILTY SAND)

PROJECT INFORMATION

Company: R.J Burnside
Client: Hewitt's Creek Landowners
Project: 300033110
Location: Barrie
Test Well: MW13
Test Date: October 21/ 2014

AQUIFER DATA

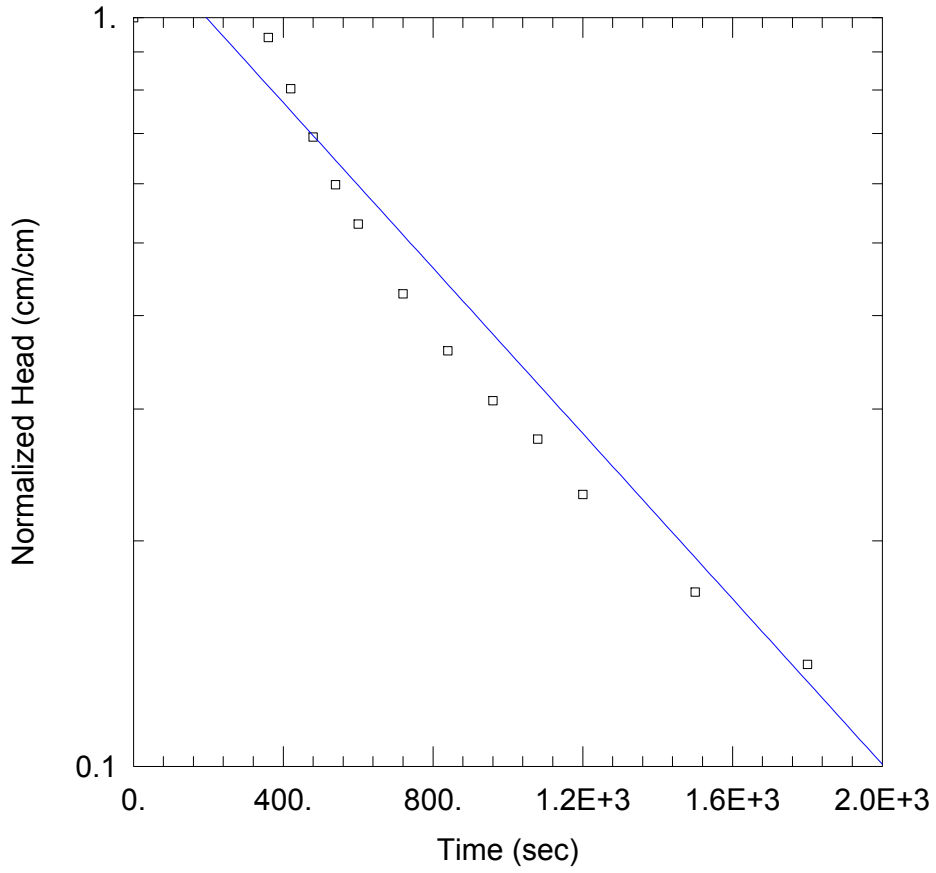
Saturated Thickness: 389.5 cm
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW13)

Initial Displacement: 58.5 cm
Total Well Penetration Depth: 389.5 cm
Casing Radius: 2.54 cm
Static Water Column Height: 389.5 cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0001531 cm/sec
y0 = 244.3 cm



HYDRAULIC CONDUCTIVITY TEST AT MW15 (SCREENED IN SILTY SAND)

PROJECT INFORMATION

Company: R.J Burnside
Client: Hewitt's Creek Landowners
Project: 300033110
Location: Barrie
Test Well: MW15
Test Date: October 22/ 2014

AQUIFER DATA

Saturated Thickness: 389.5 cm
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW15)

Initial Displacement: 58.5 cm
Total Well Penetration Depth: 389.5 cm
Casing Radius: 2.54 cm
Static Water Column Height: 389.5 cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 7.44E-5 cm/sec
y0 = 74.91 cm

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TEL: 905-470-0160 FAX: 905-475-6371

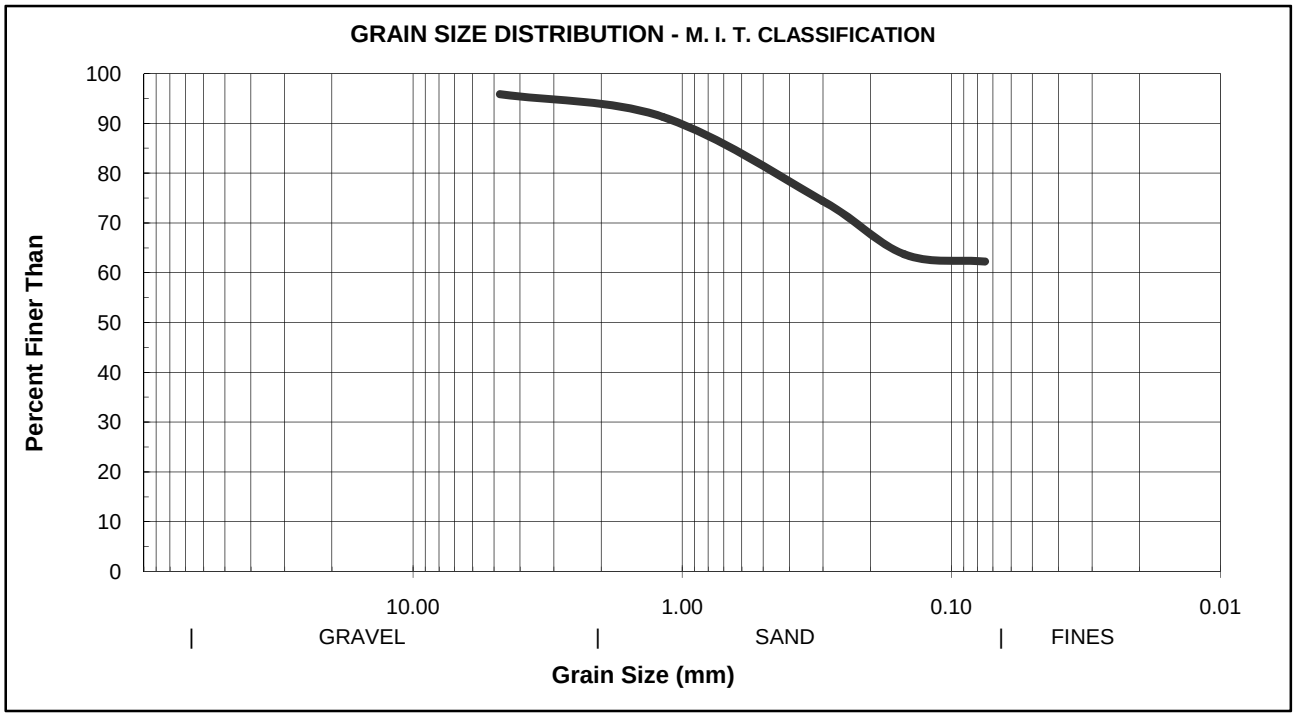
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/03/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-1 SS-3

Total weight of wet sample+container	300.1	Weight of wet sample+container(gm)	111
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	102.3
Weight of Wet sample(gm)	295.9	Weight of container(gm)	4.2
Weight of dry sample	271.8	Weight of dry sample(gm)	98.1
Moisture content	8.87	Weight of water(gm)	8.7
		Moisture content %	8.869

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	11.2	4.1	95.9	
16	1.2	23.6	8.7	91.3	
50	0.30	69.6	25.6	74.4	
100	0.150	98.7	36.3	63.7	
200	0.075	102.6	37.7	62.3	



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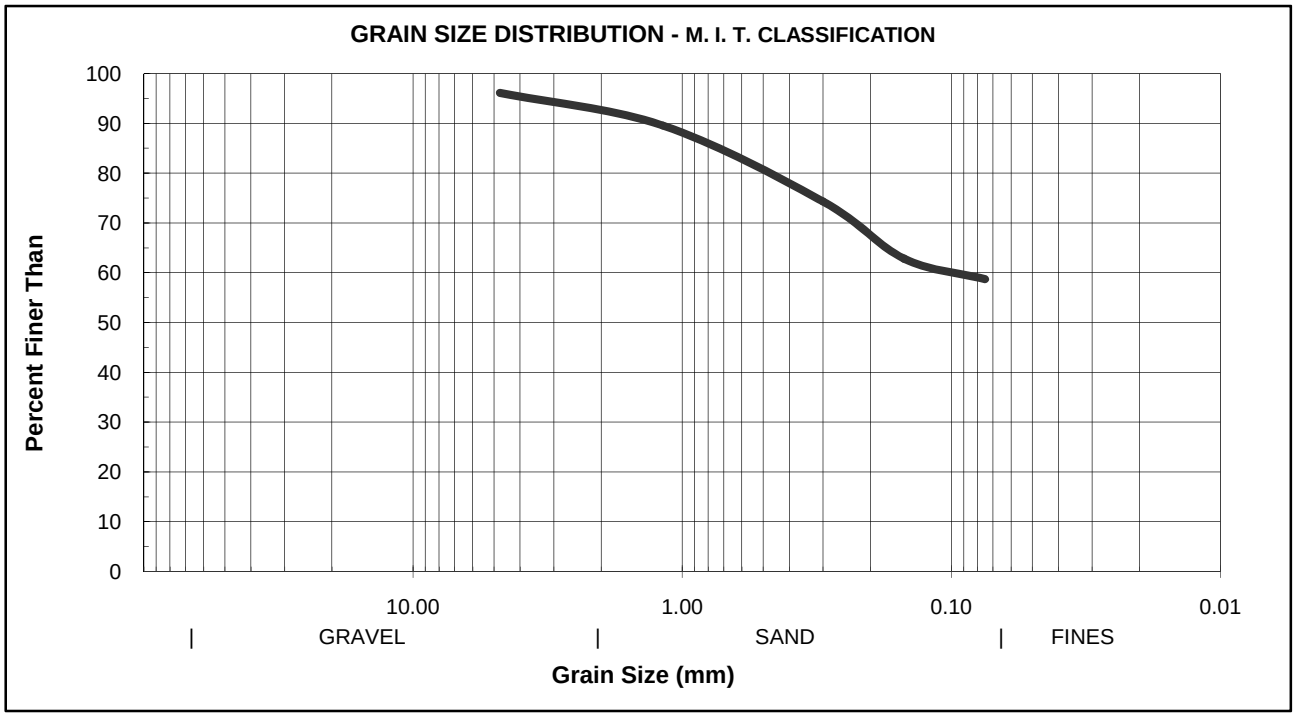
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/03/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-1 SS-5

Total weight of wet sample+container	301	Weight of wet sample+container(gm)	143.8
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	131.4
Weight of Wet sample(gm)	296.8	Weight of container(gm)	4.2
Weight of dry sample	270.4	Weight of dry sample(gm)	127.2
Moisture content	9.75	Weight of water(gm)	12.4
		Moisture content %	9.748

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	10.5	3.9	96.1	
16	1.2	28.2	10.4	89.6	
50	0.30	69.5	25.7	74.3	
100	0.150	100.5	37.2	62.8	
200	0.075	111.7	41.3	58.7	



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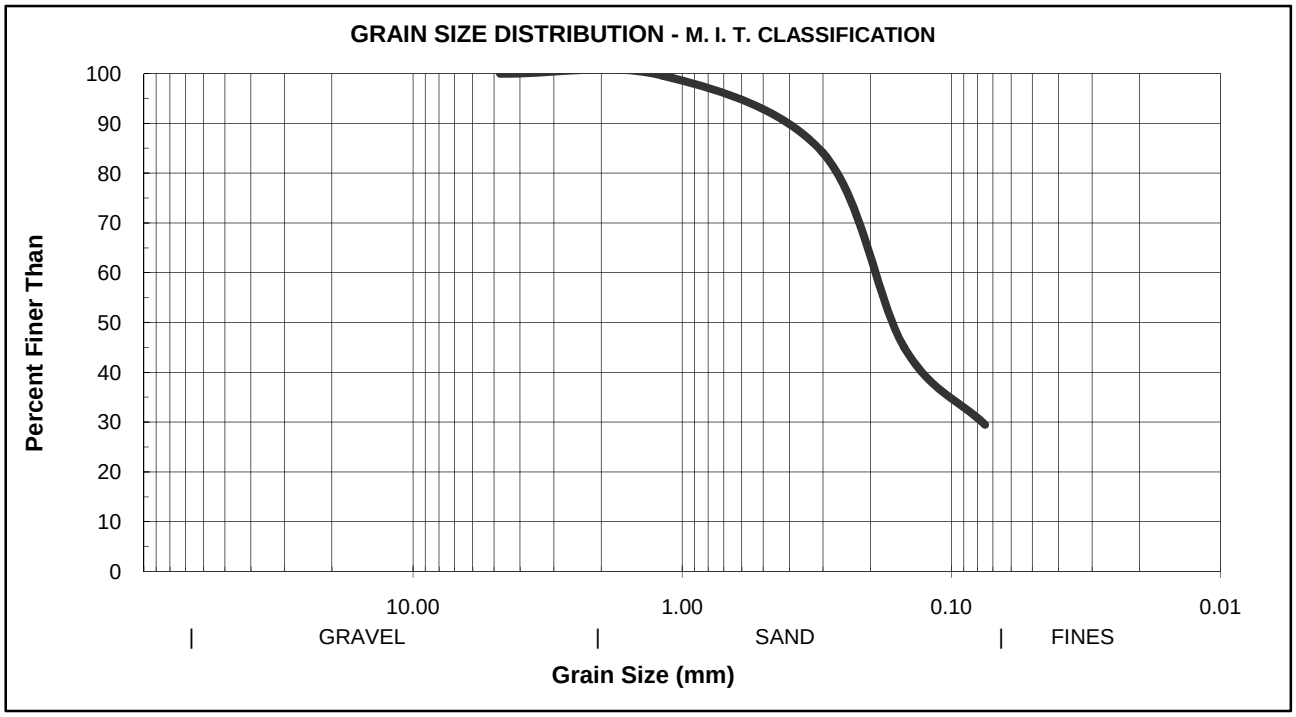
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/03/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-1 SS-6

Total weight of wet sample+container	291.6	Weight of wet sample+container(gm)	119.7
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	116.2
Weight of Wet sample(gm)	287.4	Weight of container(gm)	4.2
Weight of dry sample	278.7	Weight of dry sample(gm)	112
Moisture content	3.12	Weight of water(gm)	3.5
		Moisture content %	3.125

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	1.1	0.4	99.6	
50	0.30	44.4	15.9	84.1	
100	0.150	153.3	55.0	45.0	
200	0.075	196.6	70.5	29.5	



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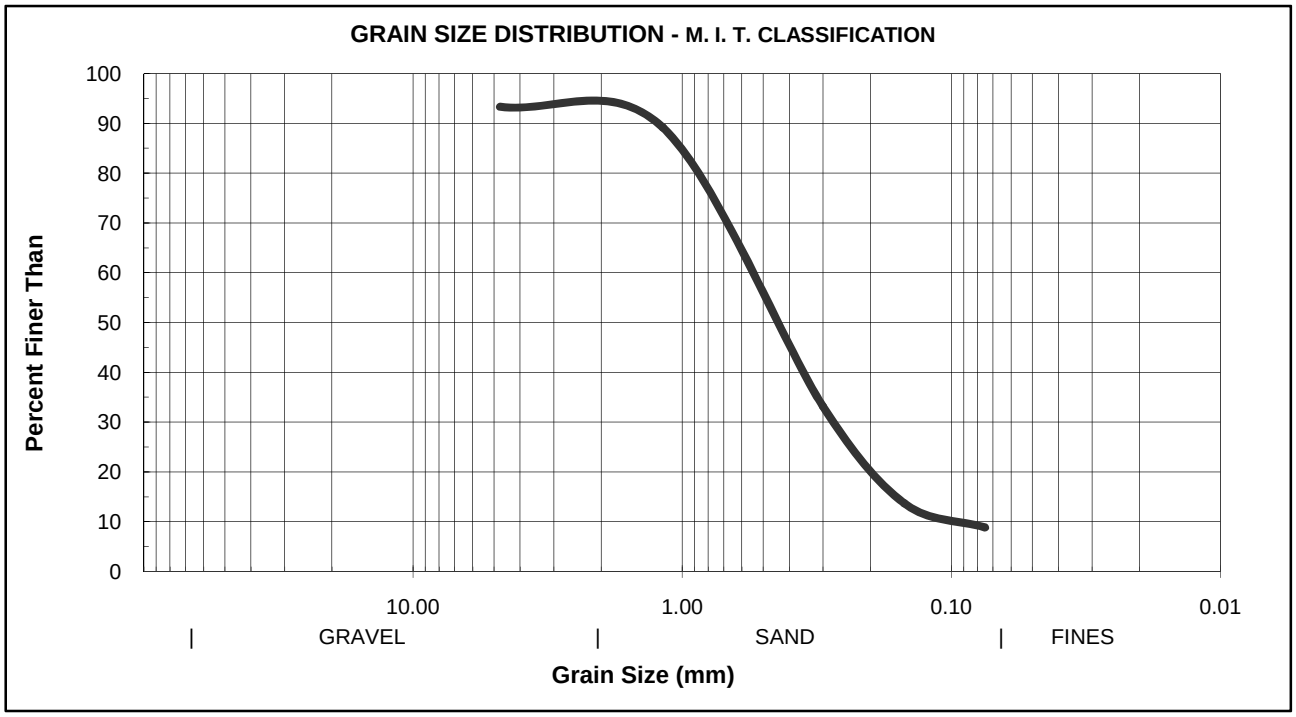
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/03/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-1 SS-8

Total weight of wet sample+container	302	Weight of wet sample+container(gm)	126
Weight of container(gm)	4.3	Weight of dry sample+container(gm)	109.5
Weight of Wet sample(gm)	297.7	Weight of container(gm)	4.3
Weight of dry sample	257.3	Weight of dry sample(gm)	105.2
Moisture content	15.7	Weight of water(gm)	16.5
		Moisture content %	15.68

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	17.2	6.7	93.3	
16	1.2	27.9	10.8	89.2	
50	0.30	172.0	66.8	33.2	
100	0.150	222.0	86.3	13.7	
200	0.075	234.7	91.2	8.8	



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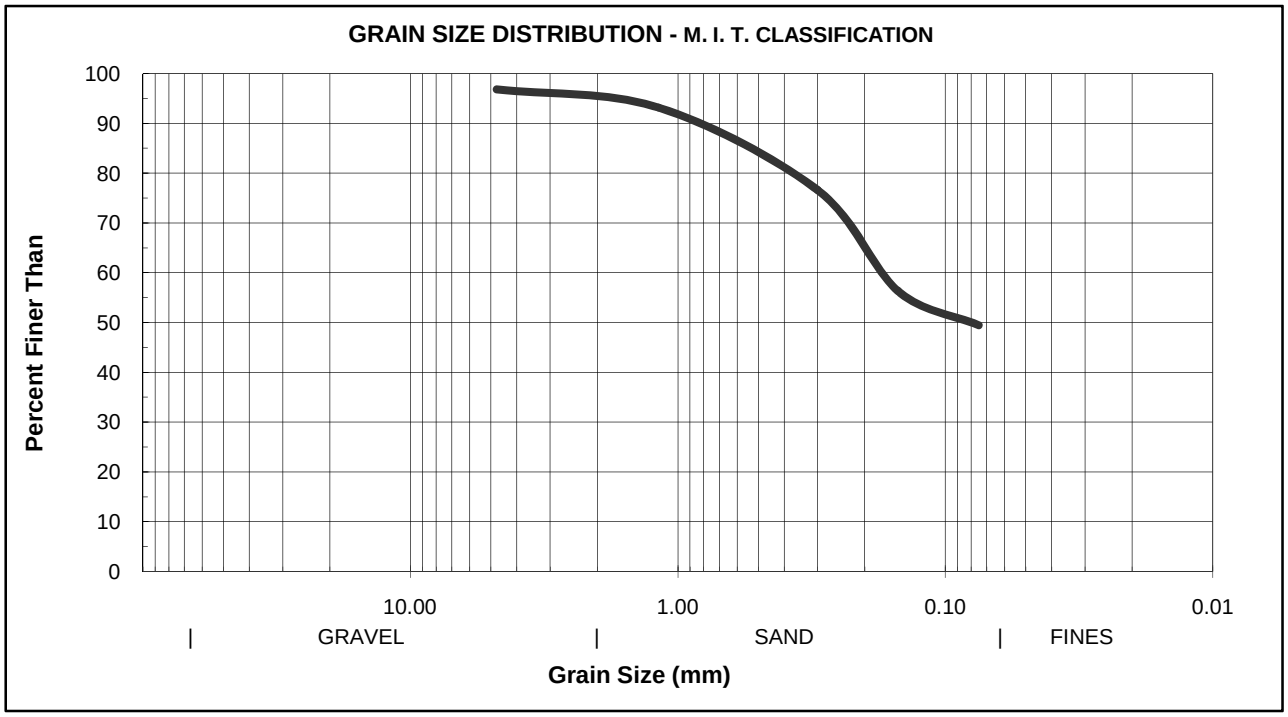
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/02/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-10 SS-3

Total weight of wet sample+container	240	Weight of wet sample+container(gm)	107
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	96.8
Weight of Wet sample(gm)	235.8	Weight of container(gm)	4.2
Weight of dry sample	212.4	Weight of dry sample(gm)	92.6
Moisture content	11.0	Weight of water(gm)	10.2
		Moisture content %	11.0

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	6.8	3.2	96.8	
16	1.2	14.5	6.8	93.2	
50	0.30	49.7	23.4	76.6	
100	0.150	92.7	43.6	56.4	
200	0.075	107.4	50.6	49.4	



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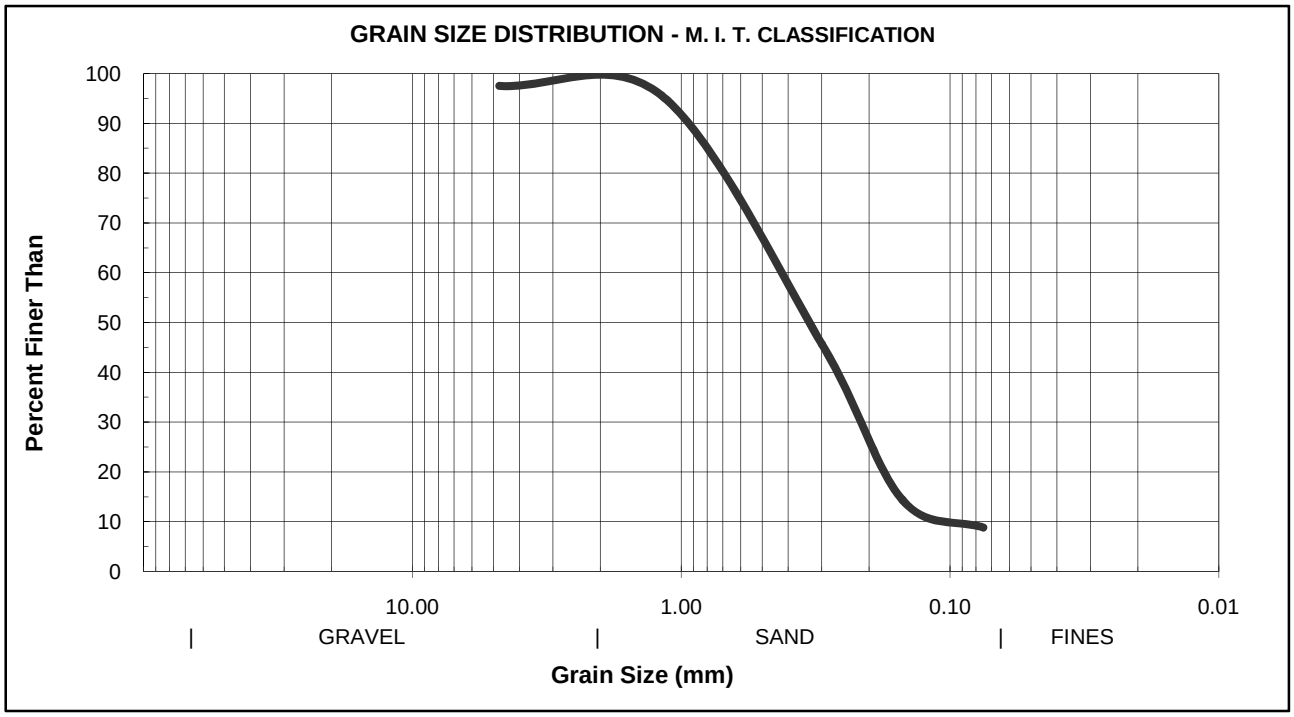
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/02/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-10 SS-4

Total weight of wet sample+container	250	Weight of wet sample+container(gm)	110
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	108.2
Weight of Wet sample(gm)	245.8	Weight of container(gm)	4.2
Weight of dry sample	241.6	Weight of dry sample(gm)	104
Moisture content	1.73	Weight of water(gm)	1.8
		Moisture content %	1.73

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	6.0	2.5	97.5	
16	1.2	10.8	4.5	95.5	
50	0.30	131.3	54.3	45.7	
100	0.150	207.0	85.7	14.3	
200	0.075	220.3	91.2	8.8	



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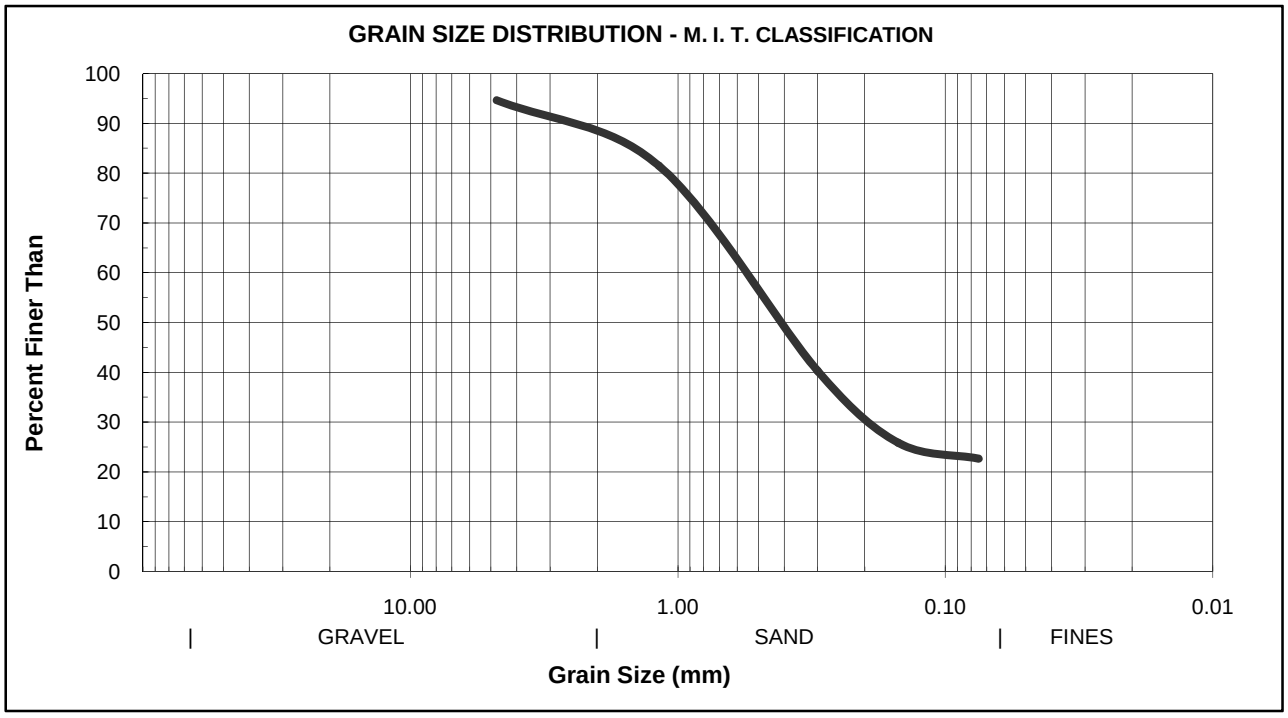
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/02/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-10 SS-6

Total weight of wet sample+container	250	Weight of wet sample+container(gm)	110
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	99.2
Weight of Wet sample(gm)	245.8	Weight of container(gm)	4.2
Weight of dry sample	220.7	Weight of dry sample(gm)	95
Moisture content	11.4	Weight of water(gm)	10.8
		Moisture content %	11.4

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	11.9	5.4	94.6	
16	1.2	40.8	18.5	81.5	
50	0.30	131.8	59.7	40.3	
100	0.150	163.6	74.1	25.9	
200	0.075	170.7	77.3	22.7	



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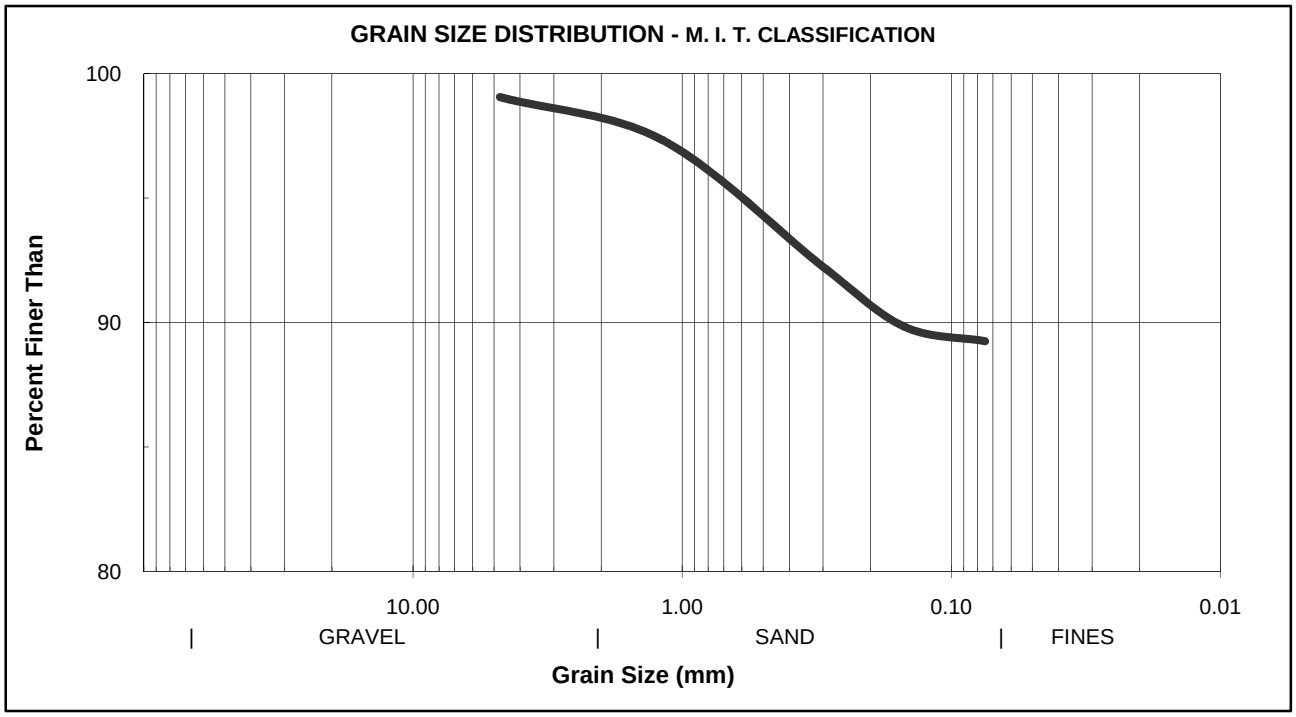
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/03/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-2 SS-3

Total weight of wet sample+container	293.2	Weight of wet sample+container(gm)	118.2
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	104.4
Weight of Wet sample(gm)	289	Weight of container(gm)	4.2
Weight of dry sample	254.0	Weight of dry sample(gm)	100.2
Moisture content	13.77	Weight of water(gm)	13.8
		Moisture content %	13.77

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	2.4	0.9	99.1	
16	1.2	6.8	2.7	97.3	
50	0.30	19.7	7.8	92.2	
100	0.150	25.8	10.2	89.8	
200	0.075	27.3	10.7	89.3	



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TEL: 905-470-0160 FAX: 905-475-6371

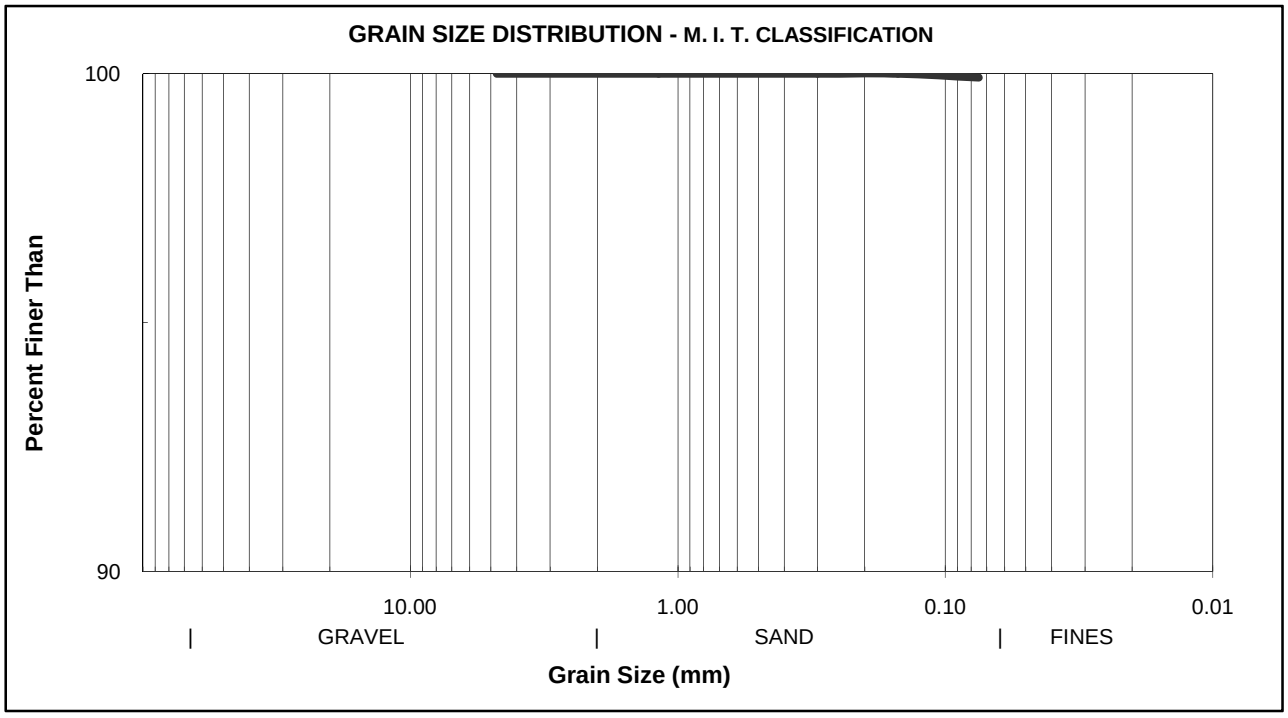
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/03/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-2 SS-5

Total weight of wet sample+container	302.6	Weight of wet sample+container(gm)	114
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	96.6
Weight of Wet sample(gm)	298.4	Weight of container(gm)	4.2
Weight of dry sample	251.8	Weight of dry sample(gm)	92.4
Moisture content	18.5	Weight of water(gm)	17.1
		Moisture content %	18.5

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	0.0	0.0	100.0	
50	0.30	0.0	0.0	100.0	
100	0.150	0.0	0.0	100.0	
200	0.075	0.2	0.1	99.9	



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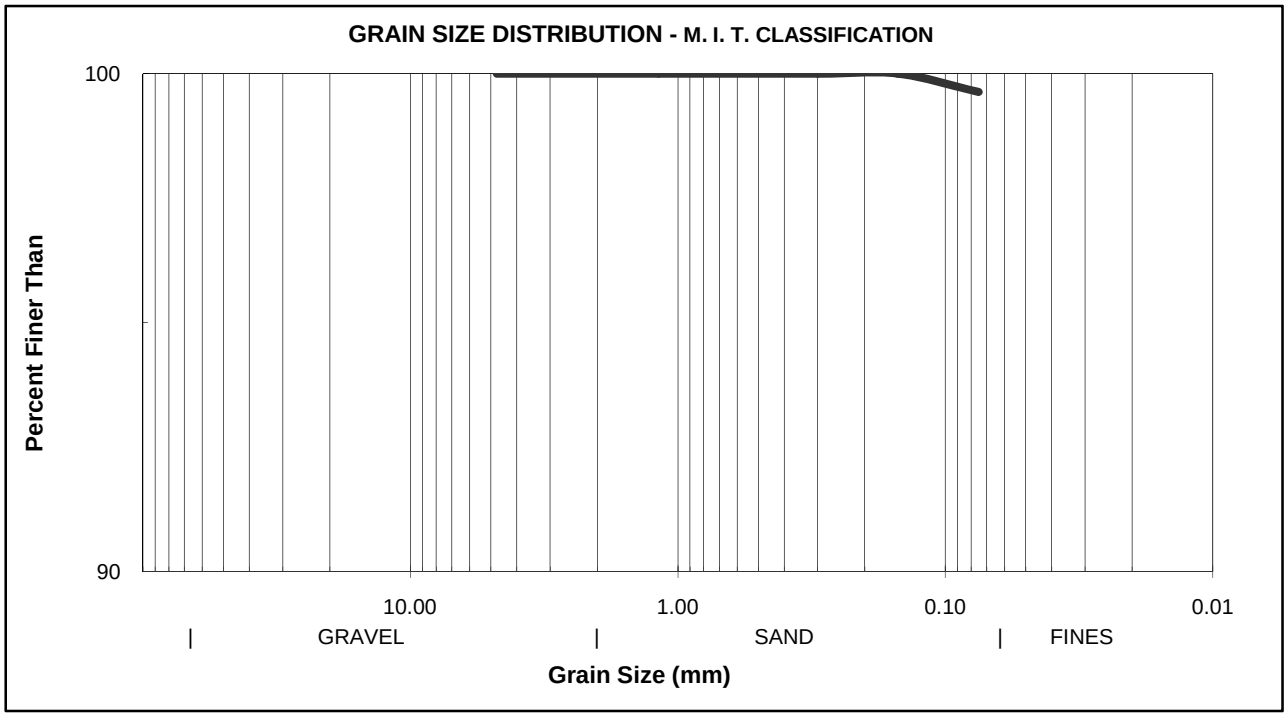
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/03/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-2 SS-6

Total weight of wet sample+container	297.2	Weight of wet sample+container(gm)	112
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	95.0
Weight of Wet sample(gm)	293	Weight of container(gm)	4.2
Weight of dry sample	245.9	Weight of dry sample(gm)	90.8
Moisture content	19.16	Weight of water(gm)	17.4
		Moisture content %	19.2

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	0.0	0.0	100.0	
50	0.30	0.0	0.0	100.0	
100	0.150	0.0	0.0	100.0	
200	0.075	0.9	0.4	99.6	



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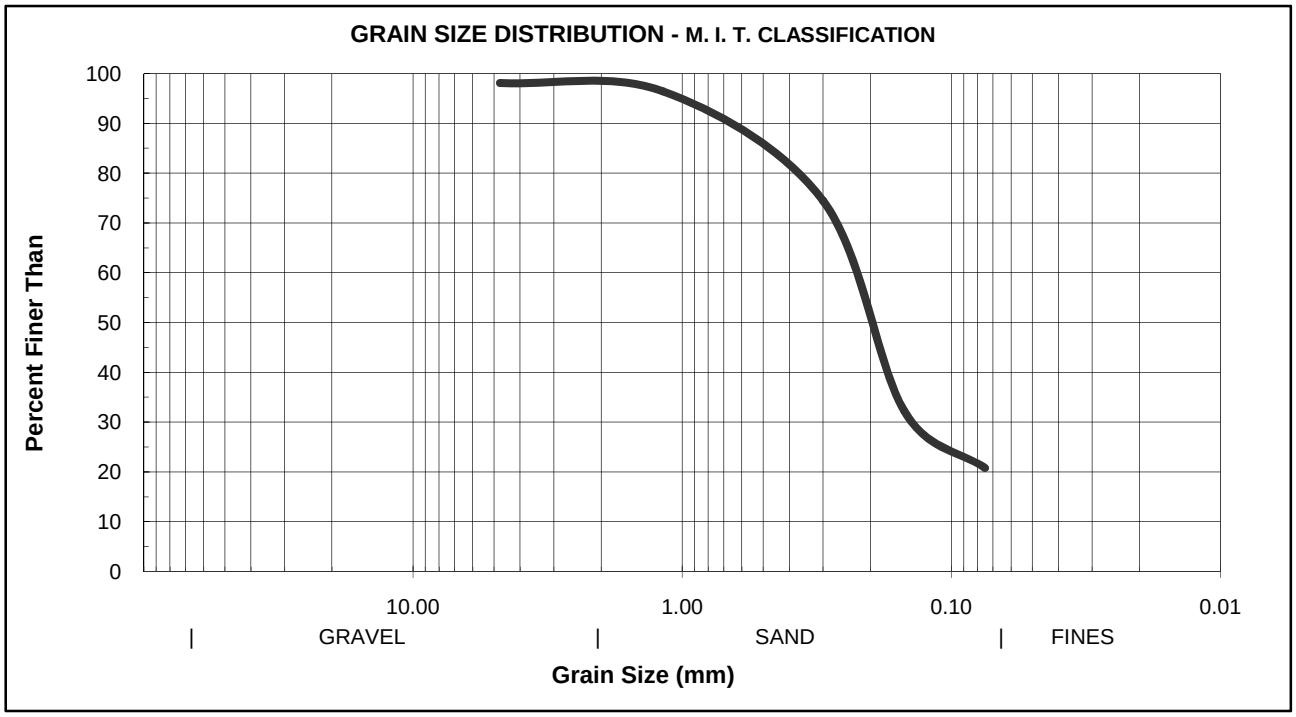
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/03/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-3 SS-3

Total weight of wet sample+container	301	Weight of wet sample+container(gm)	113.4
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	109.0
Weight of Wet sample(gm)	296.8	Weight of container(gm)	4.2
Weight of dry sample	284.8	Weight of dry sample(gm)	104.8
Moisture content	4.20	Weight of water(gm)	4.4
		Moisture content %	4.198

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	5.4	1.9	98.1	
16	1.2	10.2	3.6	96.4	
50	0.30	72.5	25.5	74.5	
100	0.150	192.9	67.7	32.3	
200	0.075	225.7	79.2	20.8	



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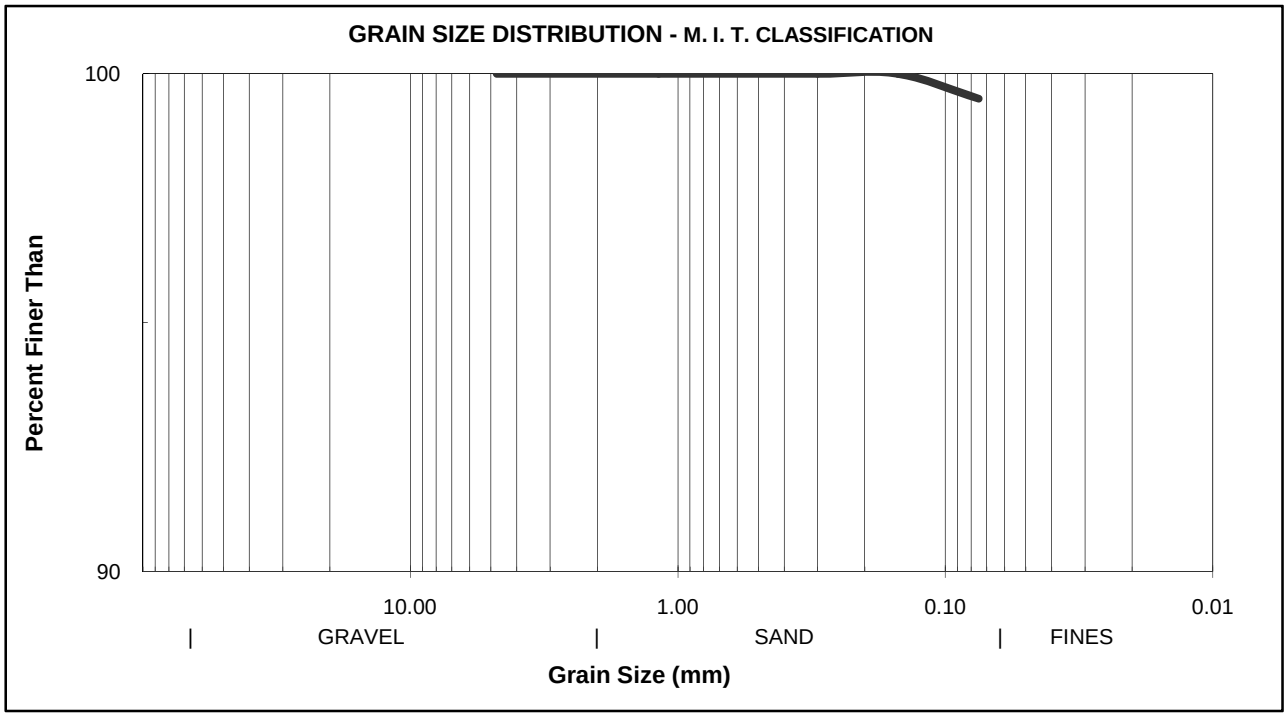
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/03/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-3 SS-5

Total weight of wet sample+container	294.5	Weight of wet sample+container(gm)	117
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	95.9
Weight of Wet sample(gm)	290.3	Weight of container(gm)	4.2
Weight of dry sample	236.6	Weight of dry sample(gm)	91.7
Moisture content	22.7	Weight of water(gm)	20.8
		Moisture content %	22.7

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	0.0	0.0	100.0	
50	0.30	0.0	0.0	100.0	
100	0.150	0.0	0.0	100.0	
200	0.075	1.2	0.5	99.5	



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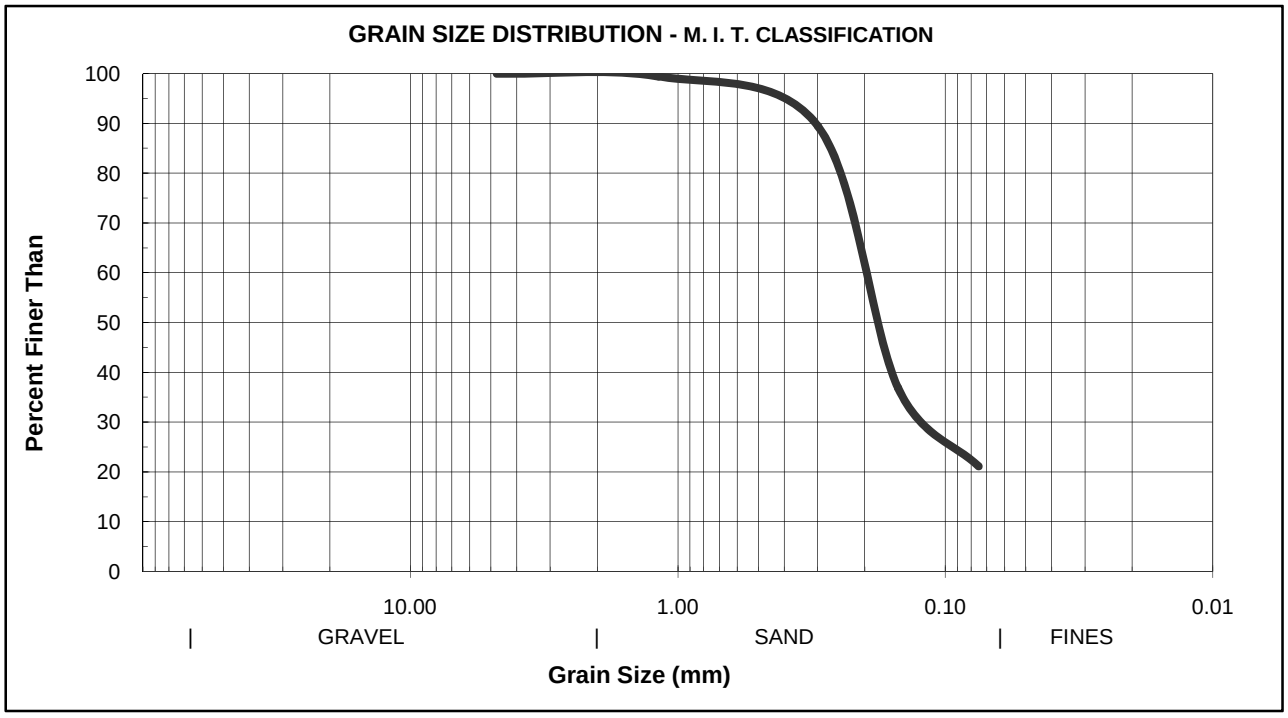
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/03/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-3 SS-6

Total weight of wet sample+container	306.6	Weight of wet sample+container(gm)	116
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	99.8
Weight of Wet sample(gm)	302.4	Weight of container(gm)	4.2
Weight of dry sample	259.5	Weight of dry sample(gm)	95.6
Moisture content	16.53	Weight of water(gm)	15.8
		Moisture content %	16.5

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	1.5	0.6	99.4	
50	0.30	27.3	10.5	89.5	
100	0.150	163.9	63.2	36.8	
200	0.075	204.8	78.9	21.1	



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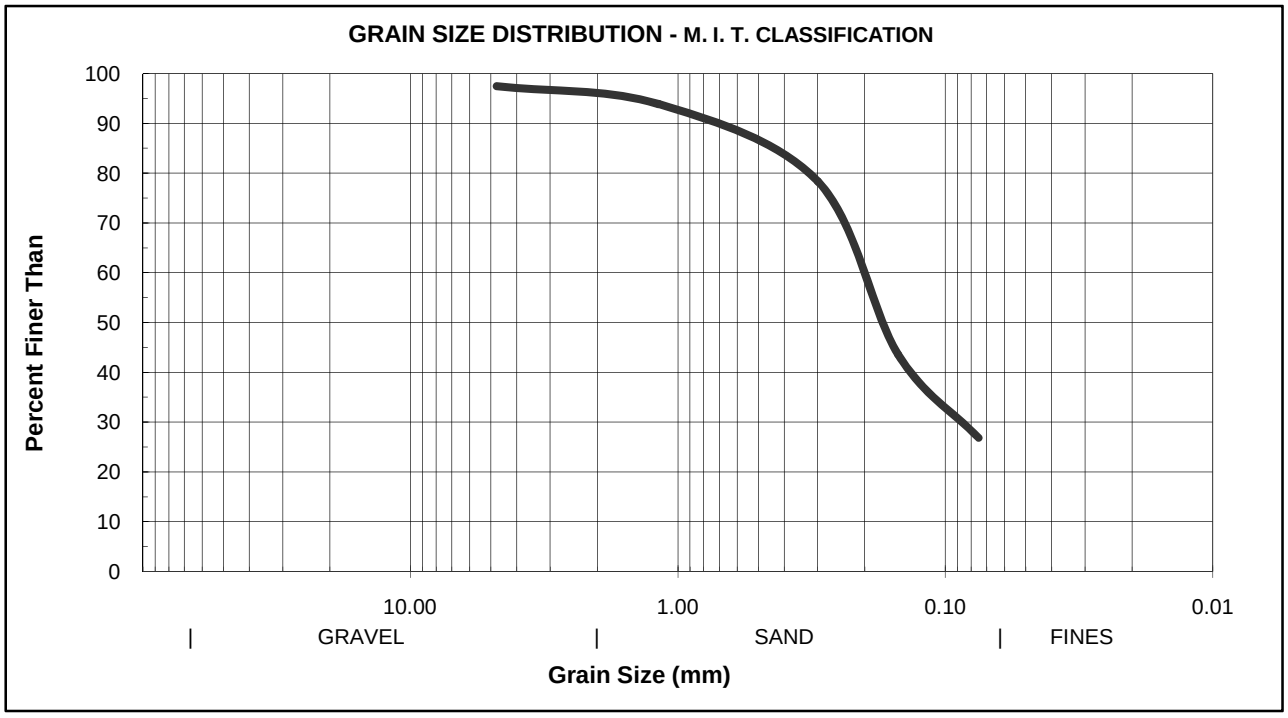
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/02/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-4 SS-3

Total weight of wet sample+container	178.9	Weight of wet sample+container(gm)	62.3
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	54.3
Weight of Wet sample(gm)	174.7	Weight of container(gm)	4.2
Weight of dry sample	150.6	Weight of dry sample(gm)	50.1
Moisture content	15.97	Weight of water(gm)	8
		Moisture content %	16

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	3.8	2.5	97.5	
16	1.2	9.2	6.1	93.9	
50	0.30	32.6	21.6	78.4	
100	0.150	85.0	56.4	43.6	
200	0.075	110.2	73.2	26.8	



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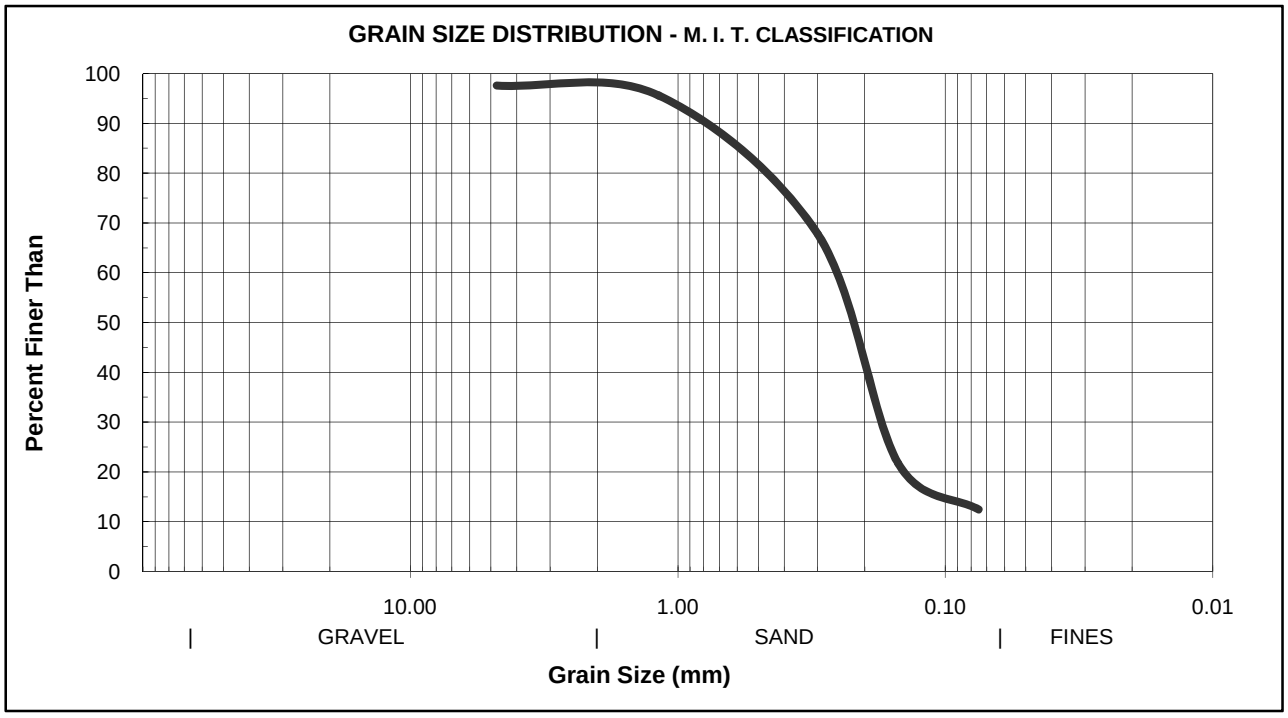
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/02/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-4 SS-5

Total weight of wet sample+container	300.4	Weight of wet sample+container(gm)	114
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	97.9
Weight of Wet sample(gm)	296.2	Weight of container(gm)	4.1
Weight of dry sample	253.7	Weight of dry sample(gm)	93.8
Moisture content	16.7	Weight of water(gm)	15.7
		Moisture content %	16.7

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	6.1	2.4	97.6	
16	1.2	11.2	4.4	95.6	
50	0.30	81.8	32.2	67.8	
100	0.150	198.5	78.2	21.8	
200	0.075	222.2	87.6	12.4	



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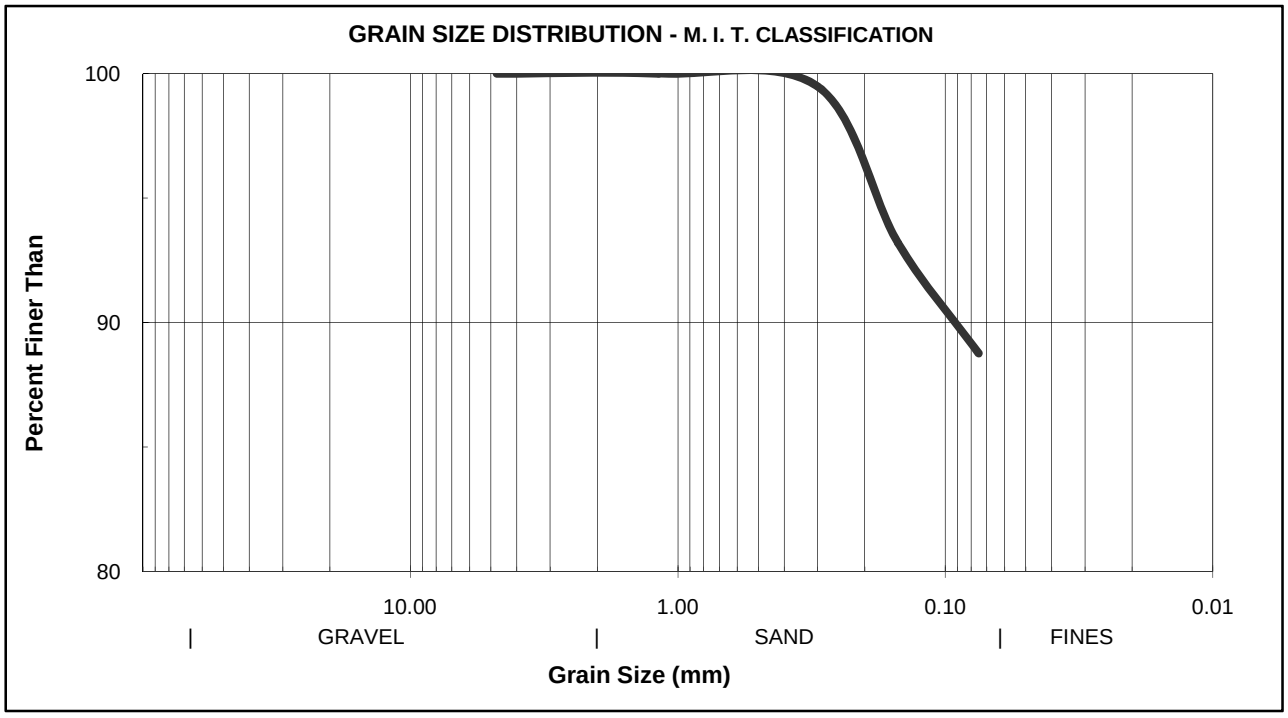
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/02/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-4 SS-7

Total weight of wet sample+container	252.1	Weight of wet sample+container(gm)	93
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	79.4
Weight of Wet sample(gm)	247.9	Weight of container(gm)	4.2
Weight of dry sample	209.9	Weight of dry sample(gm)	75.2
Moisture content	18.09	Weight of water(gm)	13.6
		Moisture content %	18.1

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	0.0	0.0	100.0	
50	0.30	1.1	0.5	99.5	
100	0.150	14.3	6.8	93.2	
200	0.075	23.6	11.2	88.8	



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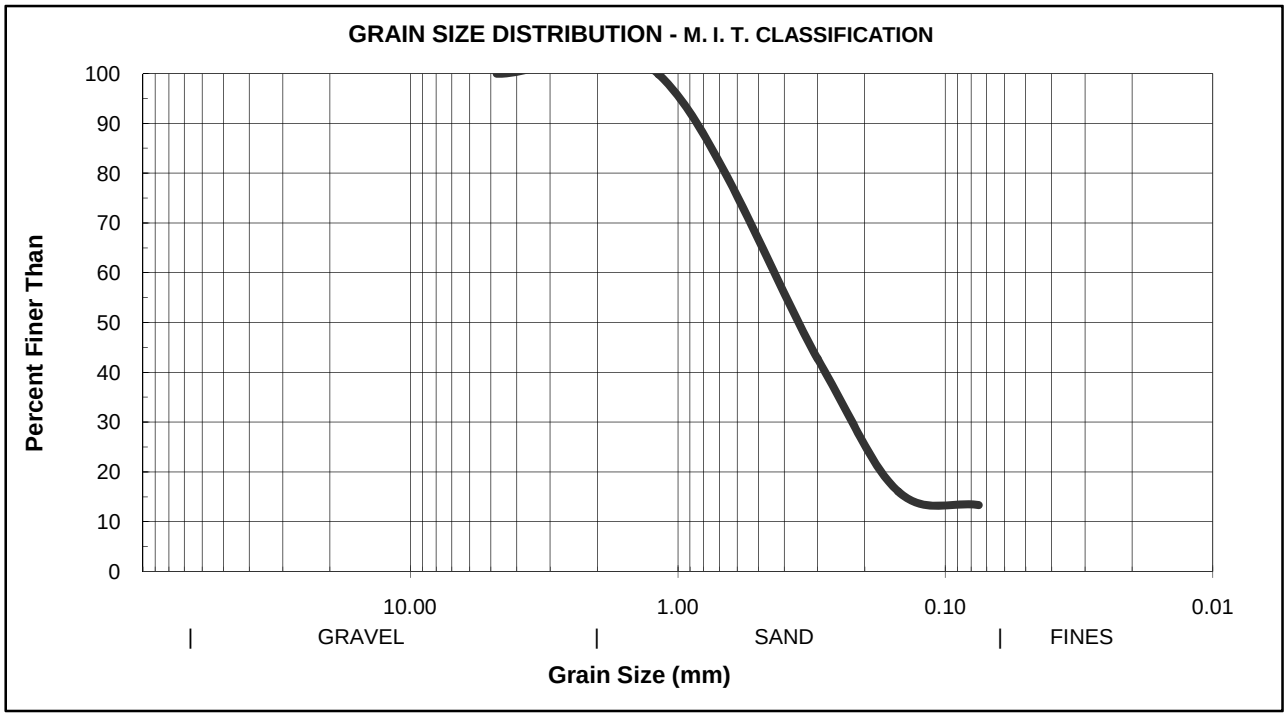
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/06/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-5 SS-3

Total weight of wet sample+container	80.7	Weight of wet sample+container(gm)	24.5
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	24.4
Weight of Wet sample(gm)	76.5	Weight of container(gm)	4.2
Weight of dry sample	76.1	Weight of dry sample(gm)	20.2
Moisture content	0.50	Weight of water(gm)	0.1
		Moisture content %	0.5

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	0.1	0.1	99.9	
50	0.30	43.6	57.3	42.7	
100	0.150	63.9	83.9	16.1	
200	0.075	66.0	86.7	13.3	



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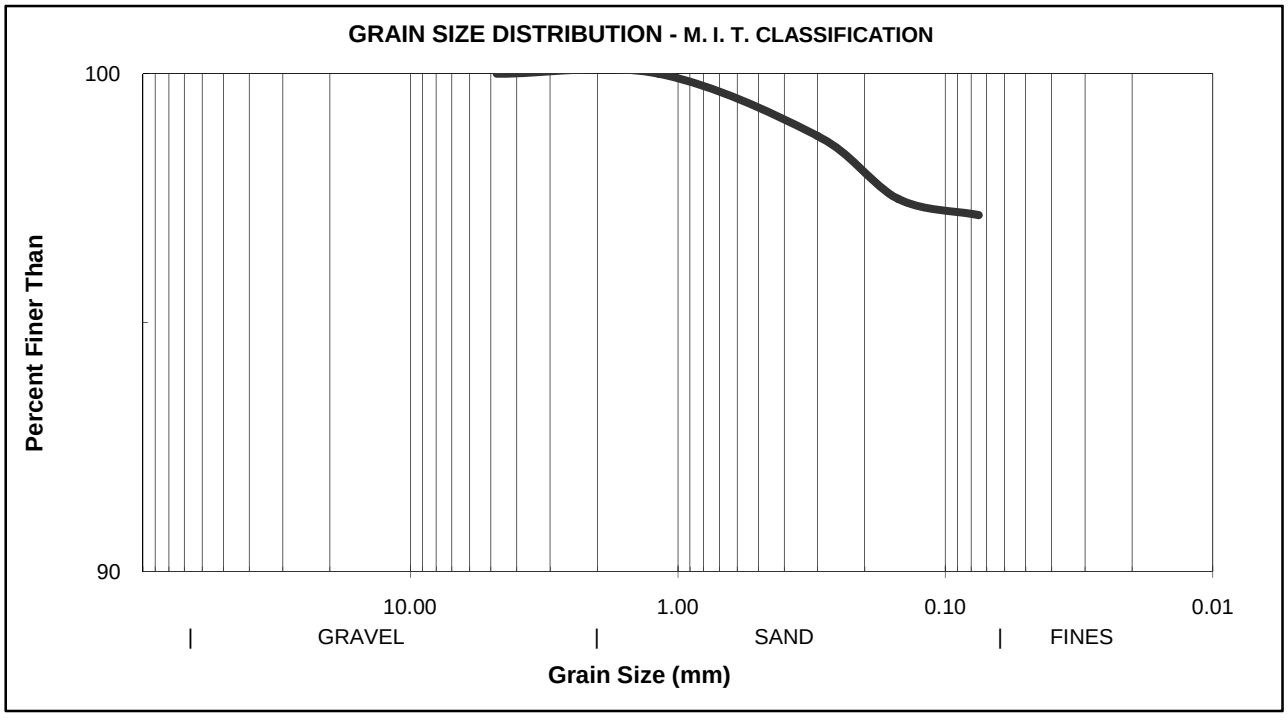
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/06/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-5 SS-5

Total weight of wet sample+container	224.5	Weight of wet sample+container(gm)	102
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	85.4
Weight of Wet sample(gm)	220.3	Weight of container(gm)	4.2
Weight of dry sample	182.9	Weight of dry sample(gm)	81.2
Moisture content	20.4	Weight of water(gm)	16.6
		Moisture content %	20.4

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	0.0	0.0	100.0	
50	0.30	2.3	1.3	98.7	
100	0.150	4.6	2.5	97.5	
200	0.075	5.2	2.8	97.2	



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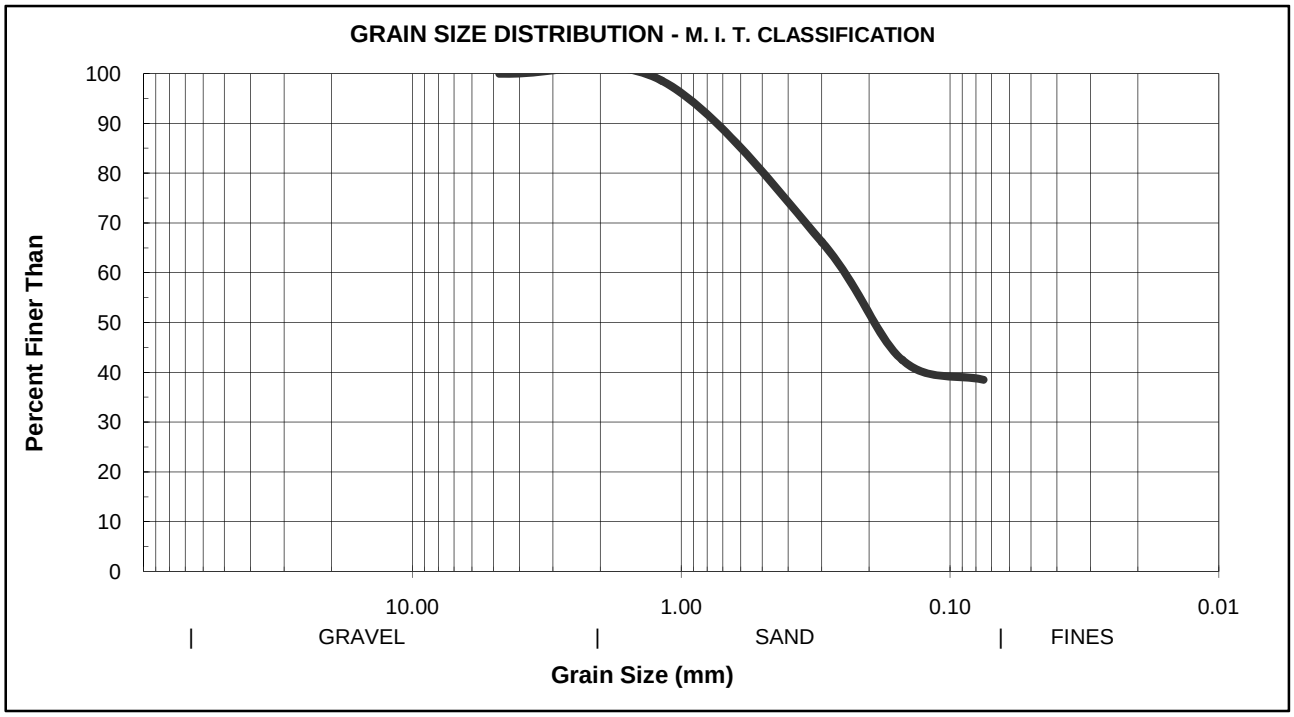
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/06/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-5 SS-6

Total weight of wet sample+container	240	Weight of wet sample+container(gm)	115
Weight of container(gm)	4.3	Weight of dry sample+container(gm)	100.8
Weight of Wet sample(gm)	235.7	Weight of container(gm)	4.4
Weight of dry sample	205.4	Weight of dry sample(gm)	96.4
Moisture content	14.73	Weight of water(gm)	14.2
		Moisture content %	14.7

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	2.9	1.4	98.6	
50	0.30	69.5	33.8	66.2	
100	0.150	118.3	57.6	42.4	
200	0.075	126.4	61.5	38.5	



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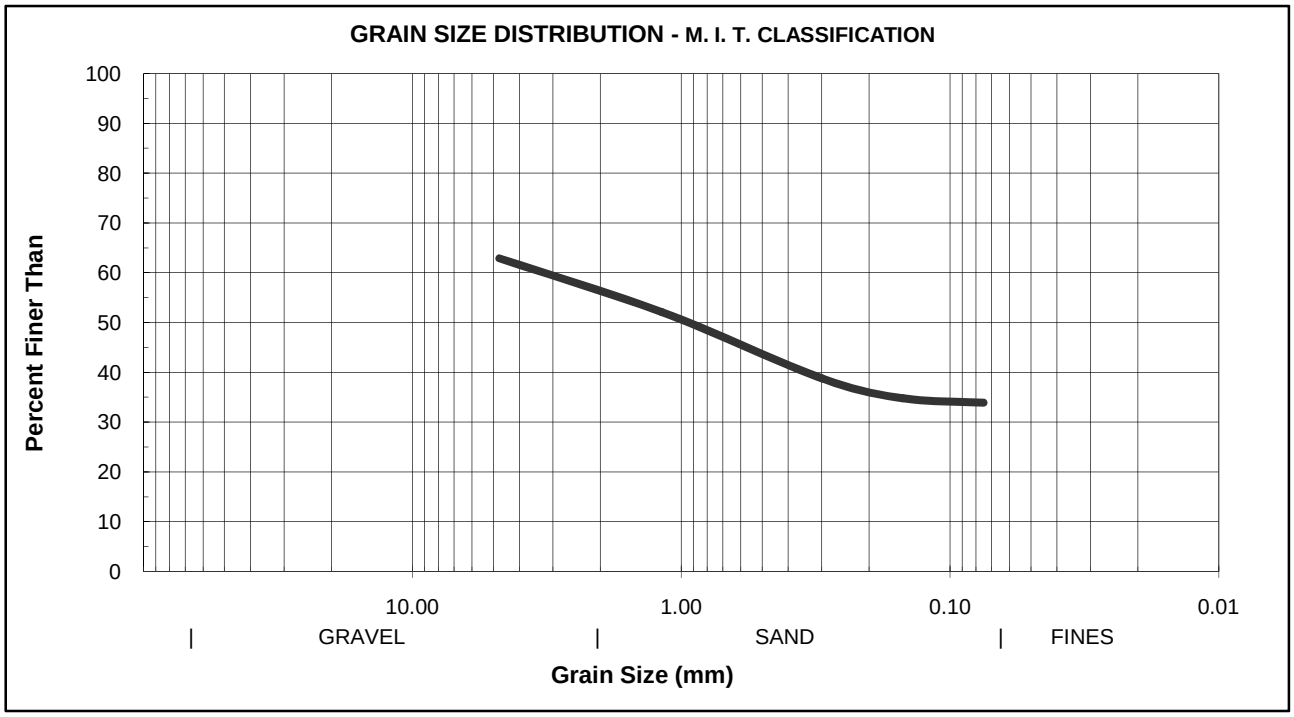
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/06/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-6 SS-3

Total weight of wet sample+container	259	Weight of wet sample+container(gm)	108
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	103.4
Weight of Wet sample(gm)	254.8	Weight of container(gm)	4.4
Weight of dry sample	243.5	Weight of dry sample(gm)	99
Moisture content	4.65	Weight of water(gm)	4.6
		Moisture content %	4.65

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	90.3	37.1	62.9	
16	1.2	116.6	47.9	52.1	
50	0.30	149.0	61.2	38.8	
100	0.150	158.7	65.2	34.8	
200	0.075	160.9	66.1	33.9	



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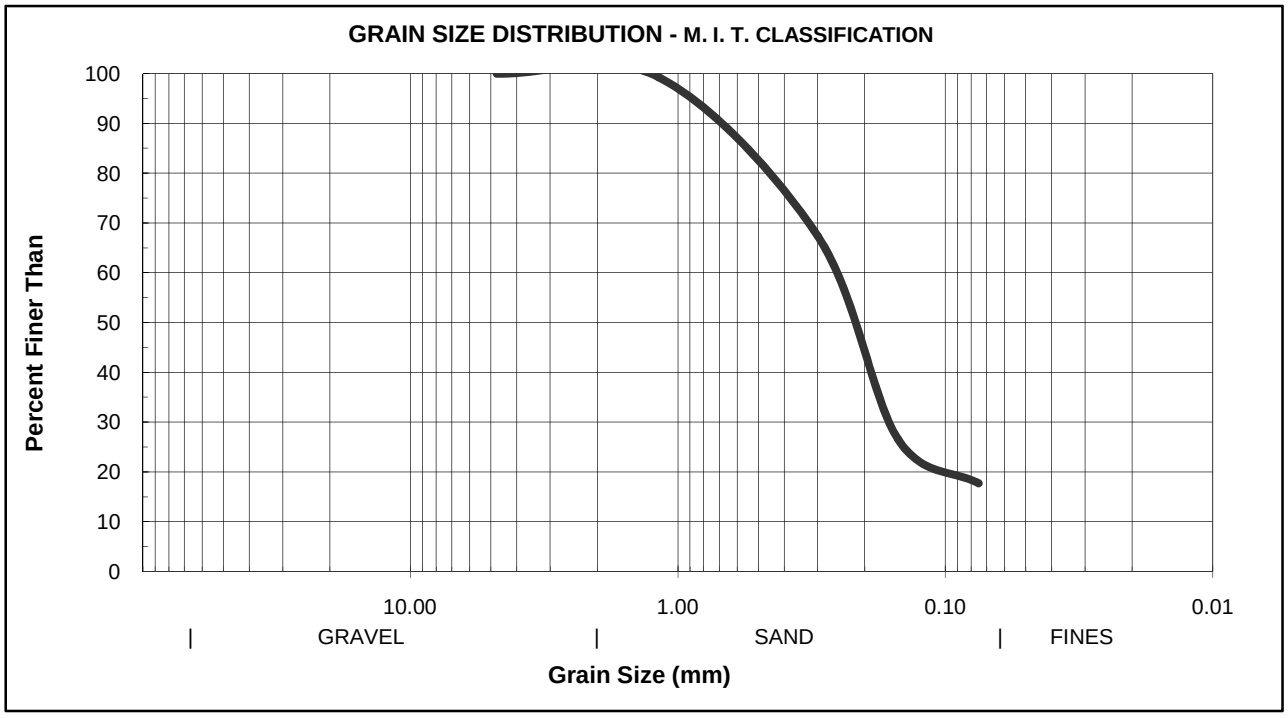
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/06/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-6 SS-6

Total weight of wet sample+container	218	Weight of wet sample+container(gm)	105
Weight of container(gm)	4.4	Weight of dry sample+container(gm)	90.6
Weight of Wet sample(gm)	213.6	Weight of container(gm)	4.2
Weight of dry sample	183.1	Weight of dry sample(gm)	86.4
Moisture content	16.7	Weight of water(gm)	14.4
		Moisture content %	16.7

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	1.3	0.7	99.3	
50	0.30	59.7	32.6	67.4	
100	0.150	134.5	73.5	26.5	
200	0.075	150.7	82.3	17.7	



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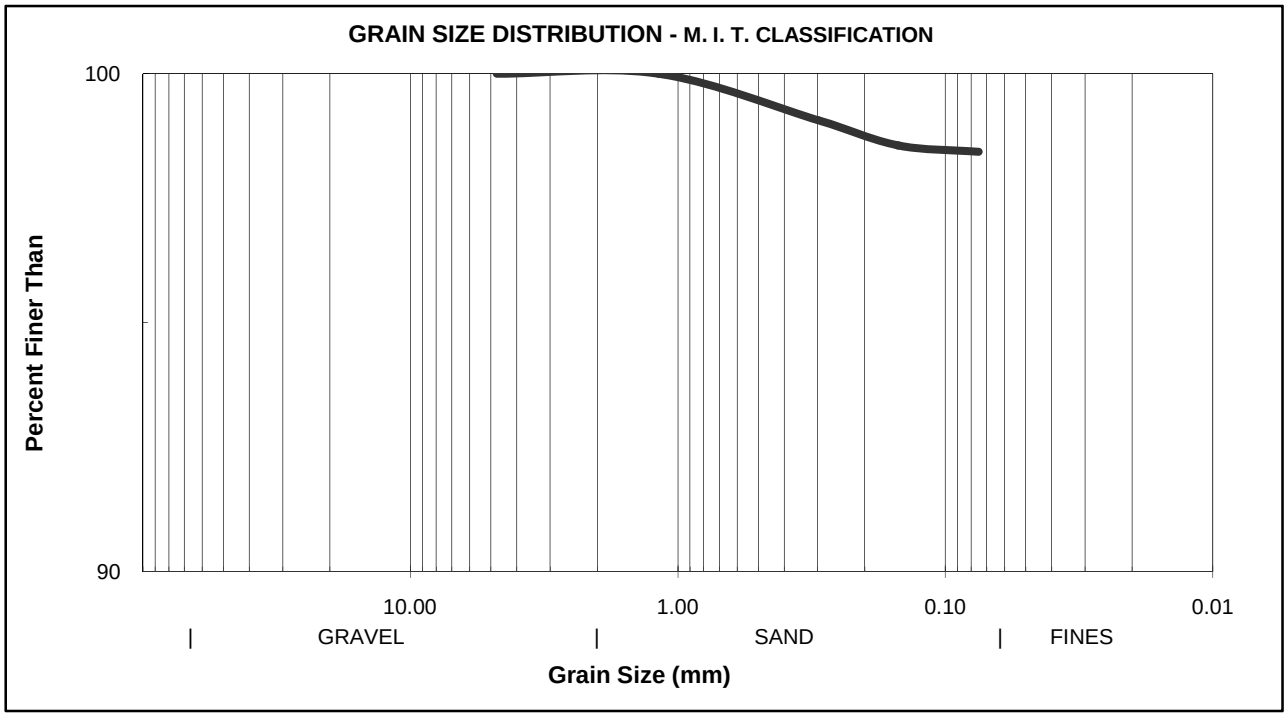
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/06/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-6 SS-7

Total weight of wet sample+container	280	Weight of wet sample+container(gm)	111
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	95.3
Weight of Wet sample(gm)	275.8	Weight of container(gm)	4.2
Weight of dry sample	235.3	Weight of dry sample(gm)	91.1
Moisture content	17.2	Weight of water(gm)	15.7
		Moisture content %	17.2

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	0.0	0.0	100.0	
50	0.30	2.2	0.9	99.1	
100	0.150	3.4	1.4	98.6	
200	0.075	3.7	1.6	98.4	



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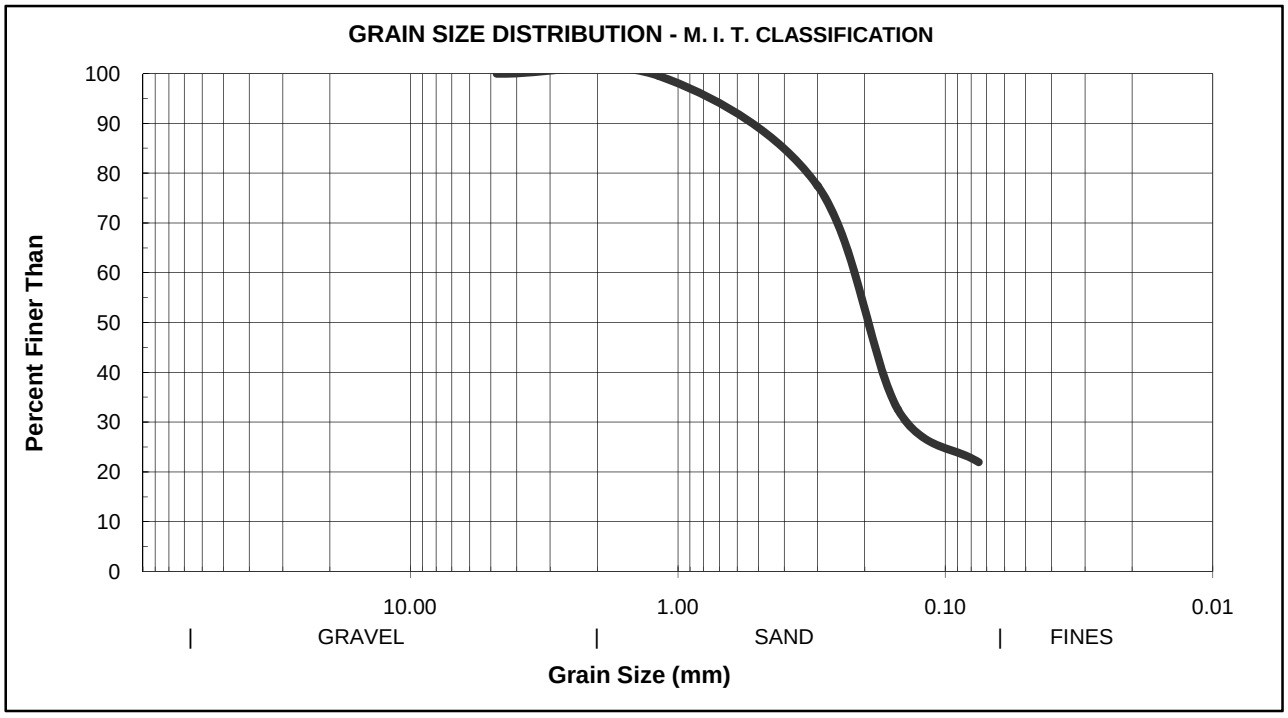
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/06/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-6 SS-8

Total weight of wet sample+container	240	Weight of wet sample+container(gm)	109
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	93.6
Weight of Wet sample(gm)	235.8	Weight of container(gm)	4.2
Weight of dry sample	201.2	Weight of dry sample(gm)	89.4
Moisture content	17.2	Weight of water(gm)	15.4
		Moisture content %	17.2

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.1	0.0	100.0	
16	1.2	1.0	0.5	99.5	
50	0.30	45.5	22.6	77.4	
100	0.150	135.8	67.5	32.5	
200	0.075	157.0	78.1	21.9	



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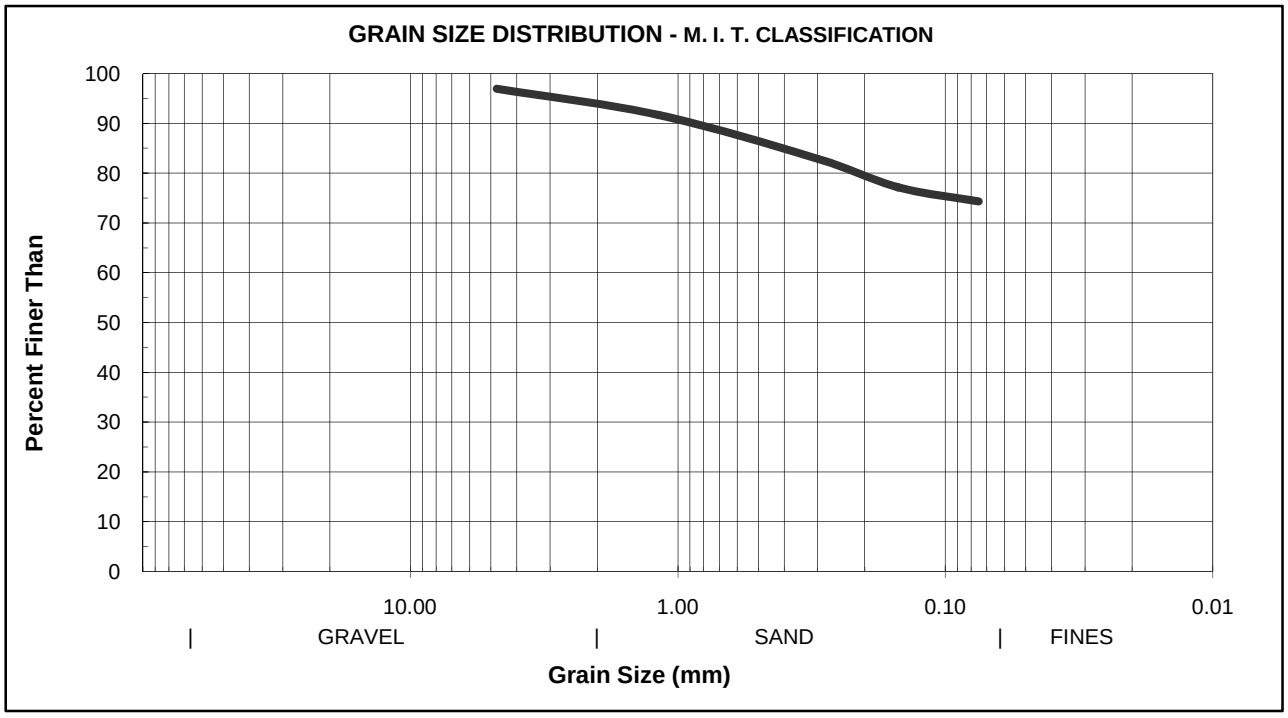
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/02/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-7 SS-3

Total weight of wet sample+container	250	Weight of wet sample+container(gm)	109
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	94.6
Weight of Wet sample(gm)	245.8	Weight of container(gm)	4.2
Weight of dry sample	212.0	Weight of dry sample(gm)	90.4
Moisture content	15.9	Weight of water(gm)	14.4
		Moisture content %	15.9

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	6.5	3.1	96.9	
16	1.2	17.6	8.3	91.7	
50	0.30	36.3	17.1	82.9	
100	0.150	48.4	22.8	77.2	
200	0.075	54.4	25.7	74.3	



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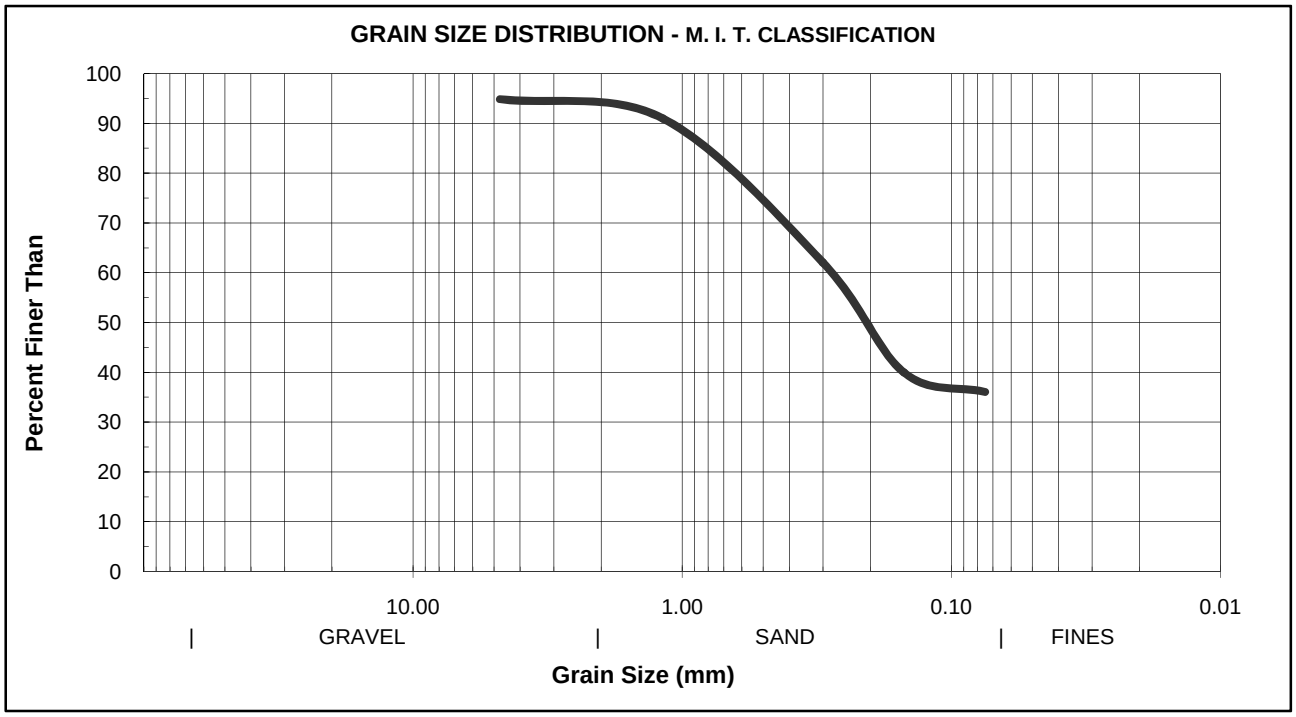
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/02/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-7 SS-4

Total weight of wet sample+container	248	Weight of wet sample+container(gm)	110
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	100.1
Weight of Wet sample(gm)	243.8	Weight of container(gm)	4.2
Weight of dry sample	221.0	Weight of dry sample(gm)	95.9
Moisture content	10.3	Weight of water(gm)	9.9
		Moisture content %	10.32

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	11.4	5.2	94.8	
16	1.2	20.0	9.1	90.9	
50	0.30	83.9	38.0	62.0	
100	0.150	132.8	60.1	39.9	
200	0.075	141.3	63.9	36.1	



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TEL: 905-470-0160 FAX: 905-475-6371

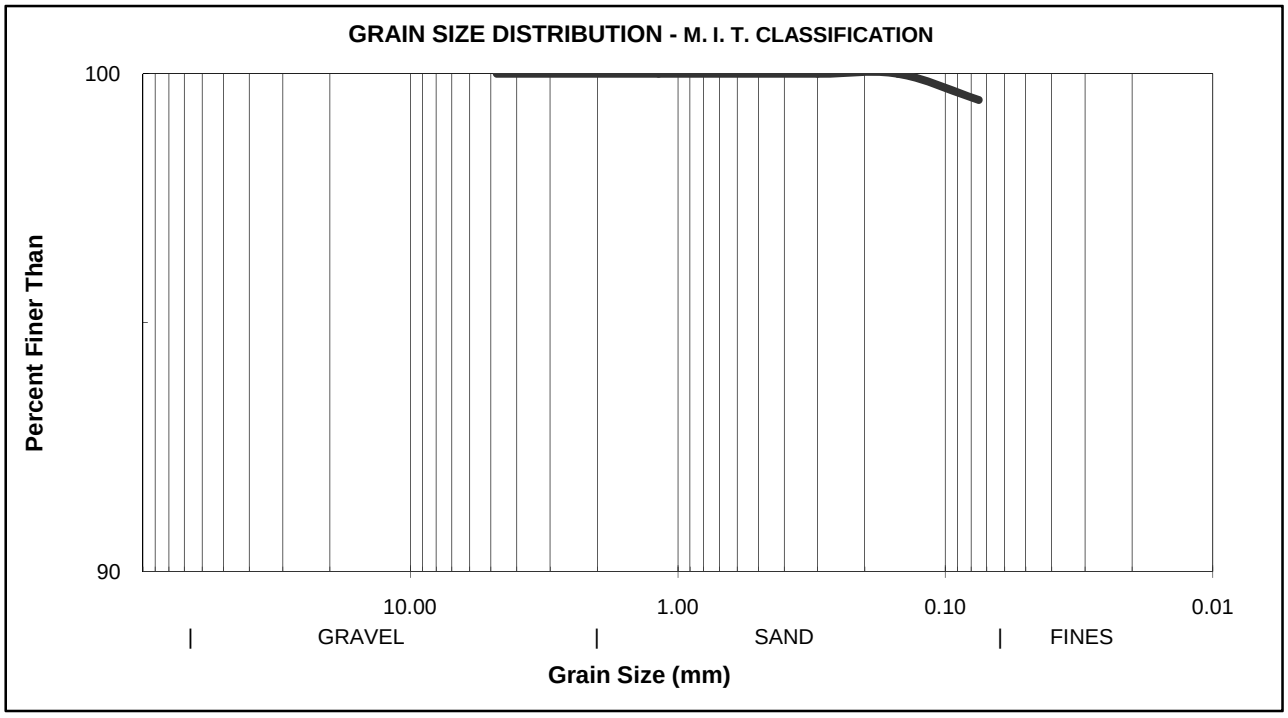
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/02/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-7 SS-7

Total weight of wet sample+container	249	Weight of wet sample+container(gm)	108
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	92.0
Weight of Wet sample(gm)	244.8	Weight of container(gm)	4.2
Weight of dry sample	207.1	Weight of dry sample(gm)	87.8
Moisture content	18.22	Weight of water(gm)	16
		Moisture content %	18.2

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	0.0	0.0	100.0	
50	0.30	0.0	0.0	100.0	
100	0.150	0.0	0.0	100.0	
200	0.075	1.1	0.5	99.5	



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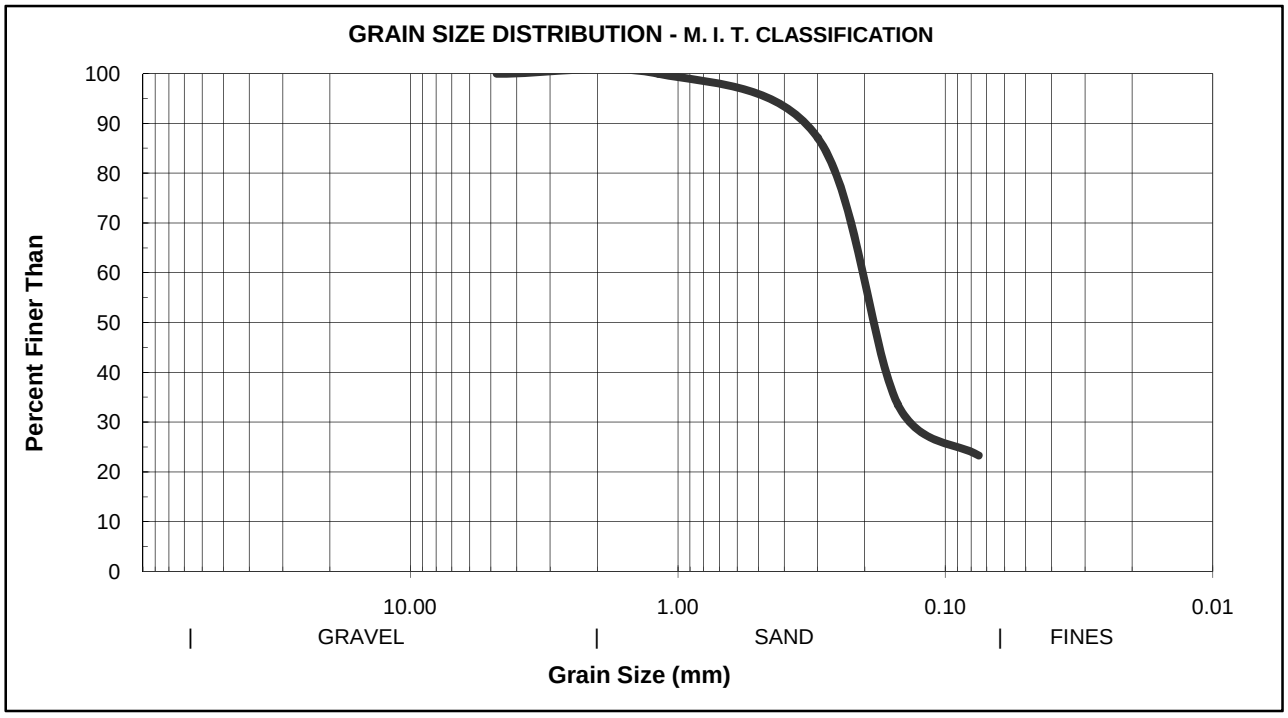
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/02/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-7 SS-8

Total weight of wet sample+container	245	Weight of wet sample+container(gm)	109
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	93.2
Weight of Wet sample(gm)	240.8	Weight of container(gm)	4.2
Weight of dry sample	204.5	Weight of dry sample(gm)	89
Moisture content	17.8	Weight of water(gm)	15.8
		Moisture content %	17.8

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	0.0	0.0	100.0	
50	0.30	26.4	12.9	87.1	
100	0.150	136.1	66.6	33.4	
200	0.075	156.9	76.7	23.3	



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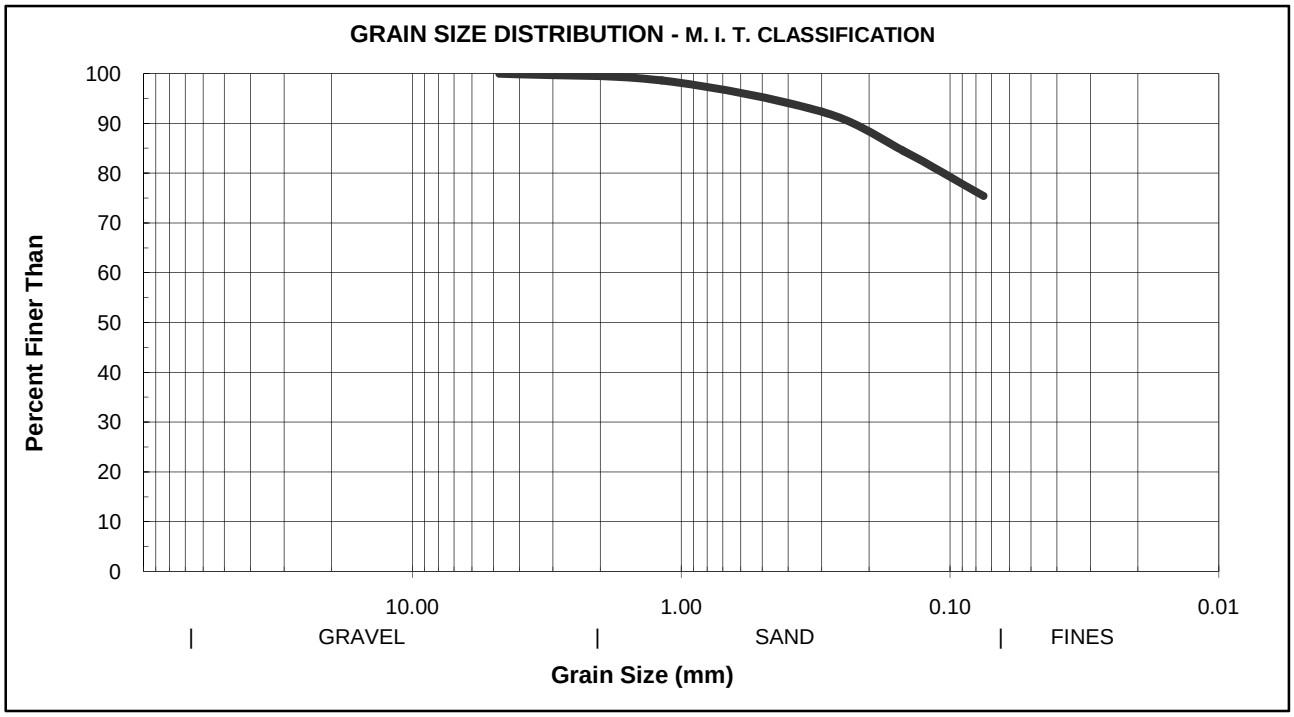
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/01/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-8 SS-3

Total weight of wet sample+container	250	Weight of wet sample+container(gm)	106
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	100.7
Weight of Wet sample(gm)	245.8	Weight of container(gm)	4.2
Weight of dry sample	233.0	Weight of dry sample(gm)	96.5
Moisture content	5.49	Weight of water(gm)	5.3
		Moisture content %	5.49

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	3.2	1.4	98.6	
50	0.30	17.9	7.7	92.3	
100	0.150	36.0	15.5	84.5	
200	0.075	57.3	24.6	75.4	



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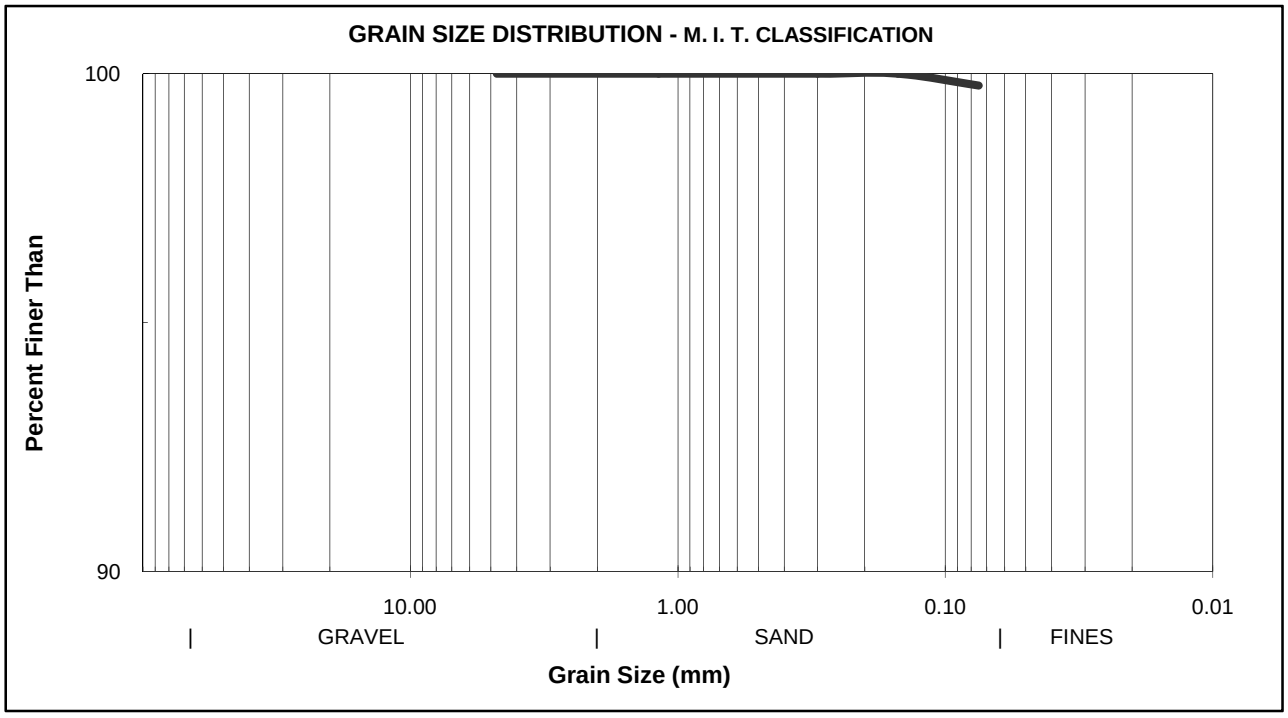
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/01/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-8 SS-4

Total weight of wet sample+container	250	Weight of wet sample+container(gm)	110
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	93.5
Weight of Wet sample(gm)	245.8	Weight of container(gm)	4.3
Weight of dry sample	207.4	Weight of dry sample(gm)	89.2
Moisture content	18.50	Weight of water(gm)	16.5
		Moisture content %	18.5

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	0.0	0.0	100.0	
50	0.30	0.0	0.0	100.0	
100	0.150	0.0	0.0	100.0	
200	0.075	0.5	0.2	99.8	



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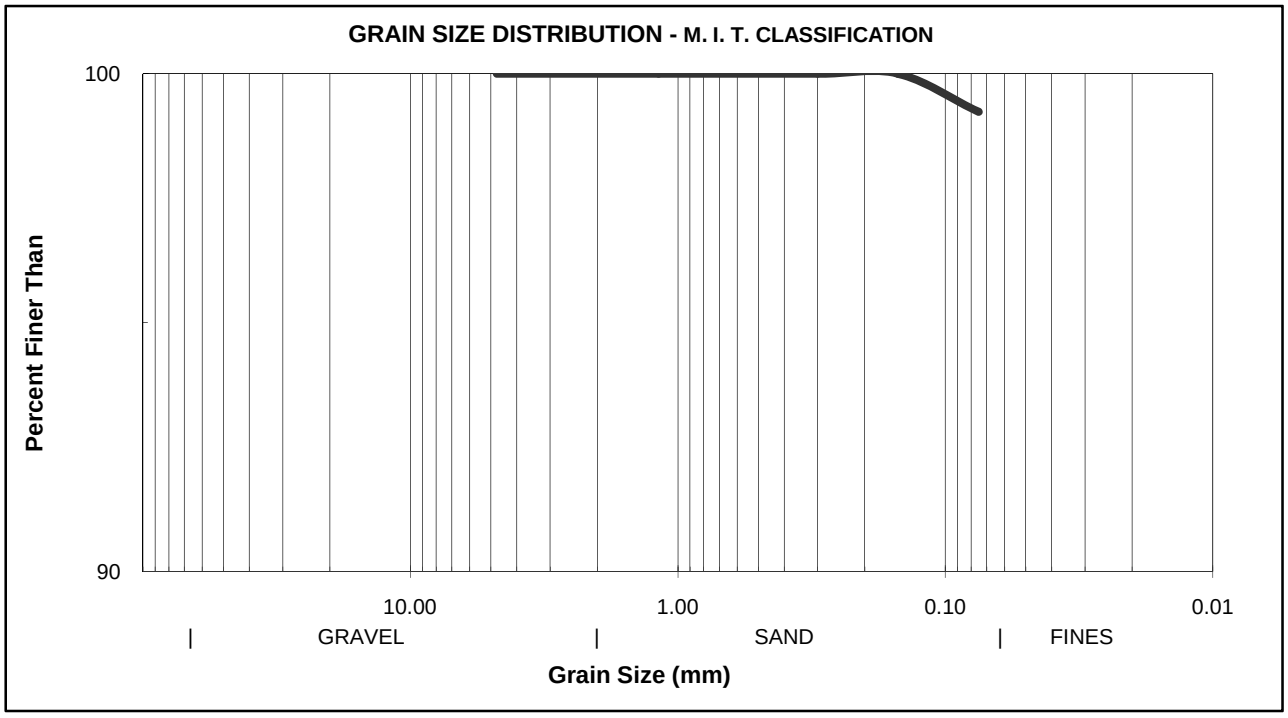
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/01/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-8 SS-7

Total weight of wet sample+container	250	Weight of wet sample+container(gm)	110
Weight of container(gm)	4.4	Weight of dry sample+container(gm)	93.8
Weight of Wet sample(gm)	245.6	Weight of container(gm)	4.4
Weight of dry sample	207.9	Weight of dry sample(gm)	89.4
Moisture content	18.12	Weight of water(gm)	16.2
		Moisture content %	18.1

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	0.0	0.0	100.0	
50	0.30	0.0	0.0	100.0	
100	0.150	0.0	0.0	100.0	
200	0.075	1.6	0.8	99.2	



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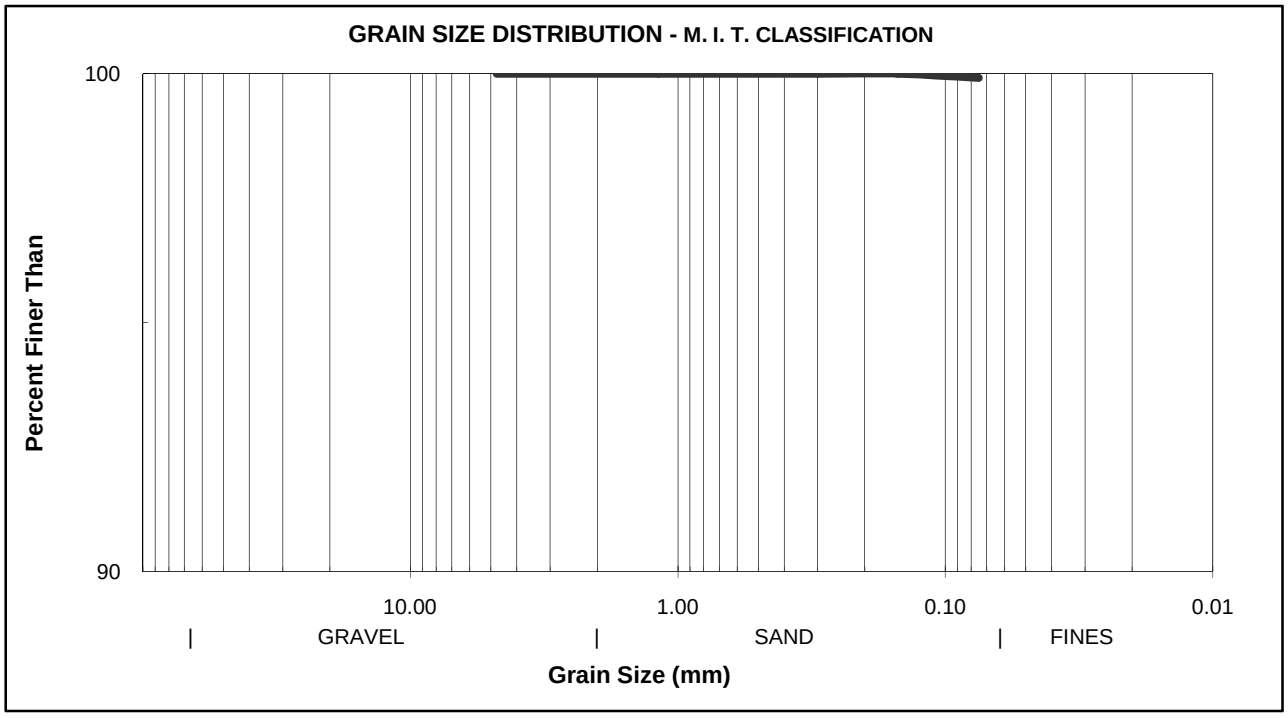
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/01/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-9 SS-3

Total weight of wet sample+container	270	Weight of wet sample+container(gm)	112
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	96.1
Weight of Wet sample(gm)	265.8	Weight of container(gm)	4.2
Weight of dry sample	226.6	Weight of dry sample(gm)	91.9
Moisture content	17.30	Weight of water(gm)	15.9
		Moisture content %	17.3

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	0.0	0.0	100.0	
50	0.30	0.0	0.0	100.0	
100	0.150	0.0	0.0	100.0	
200	0.075	0.2	0.1	99.9	



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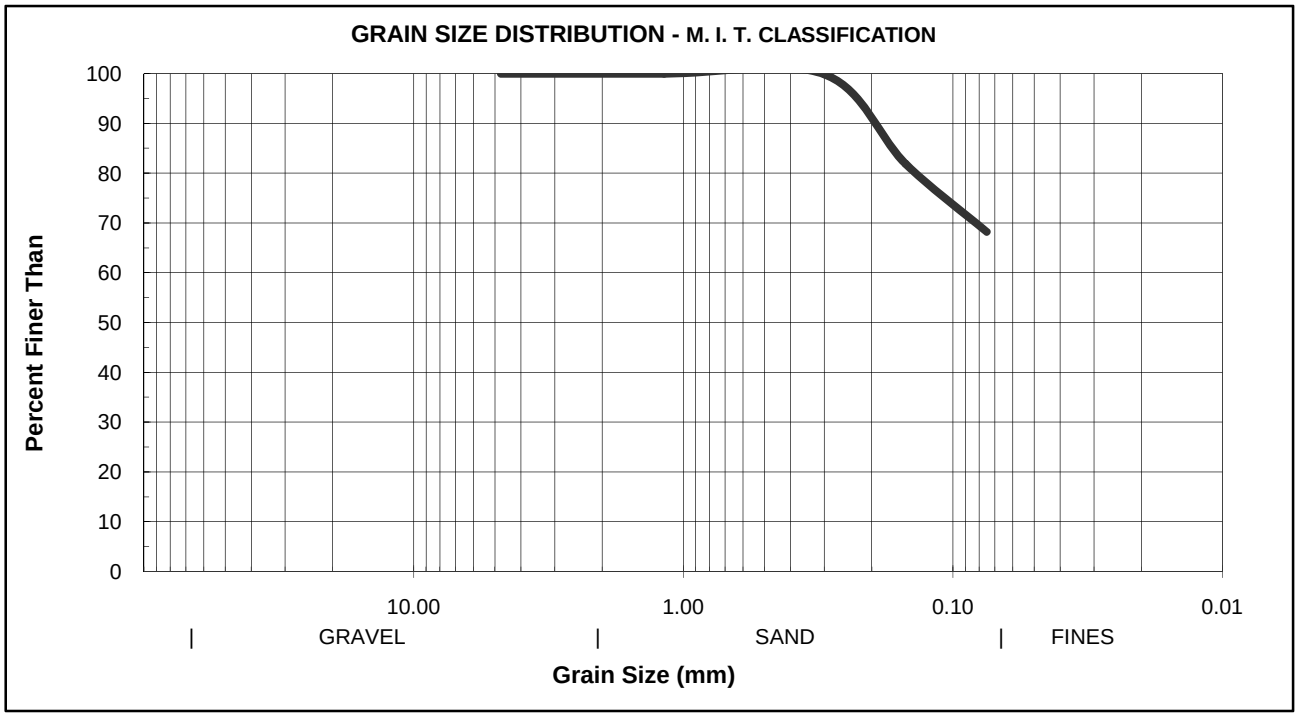
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/01/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-9 SS-5

Total weight of wet sample+container	240	Weight of wet sample+container(gm)	110
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	101.0
Weight of Wet sample(gm)	235.8	Weight of container(gm)	4.2
Weight of dry sample	215.7	Weight of dry sample(gm)	96.8
Moisture content	9.30	Weight of water(gm)	9
		Moisture content %	9.298

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	0.0	0.0	100.0	
16	1.2	0.0	0.0	100.0	
50	0.30	0.3	0.1	99.9	
100	0.150	39.0	18.1	81.9	
200	0.075	68.5	31.8	68.2	



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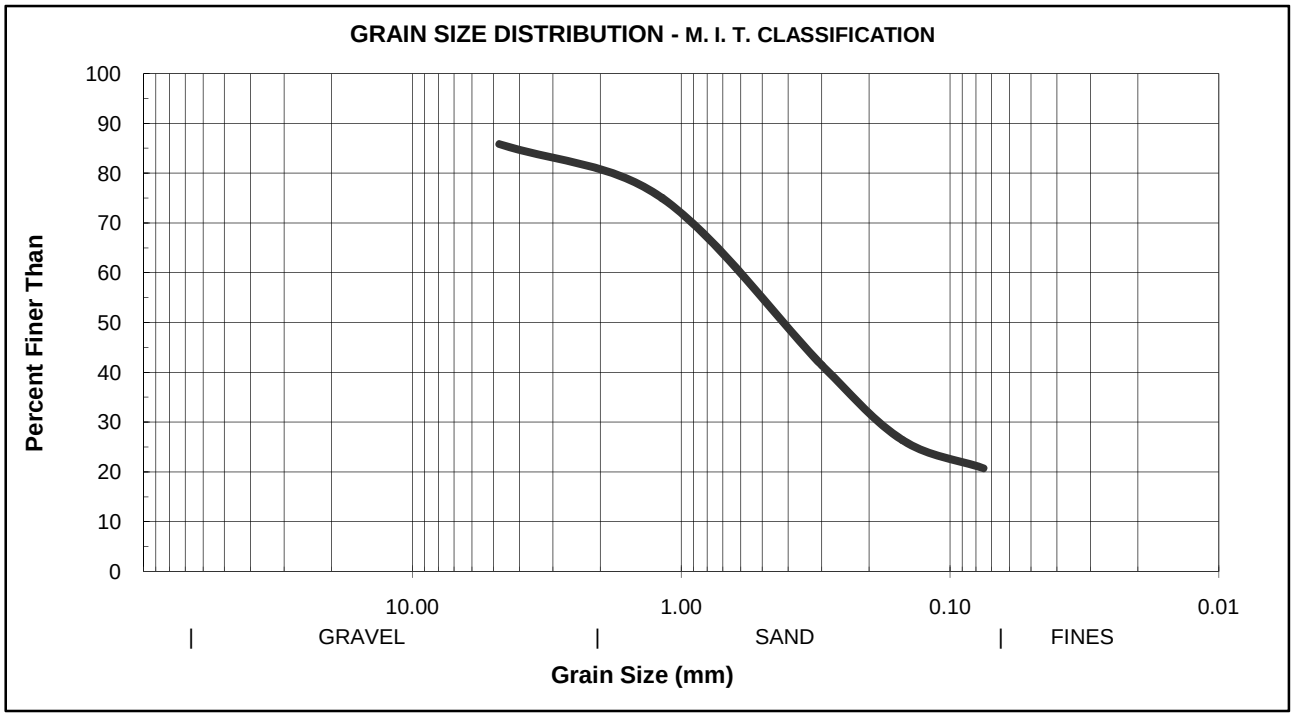
GRAIN SIZE ANALYSIS - MECHANICAL

Job No:	**GE5243**	Report No:	
Sample Type		Date Sampled:	11/01/017
Sampled by	OM	Date Tested:	12/15/017
Tested by	MA	Sample Location:	BH-9 SS-6

Total weight of wet sample+container	240	Weight of wet sample+container(gm)	112
Weight of container(gm)	4.2	Weight of dry sample+container(gm)	102.4
Weight of Wet sample(gm)	235.8	Weight of container(gm)	4.2
Weight of dry sample	214.8	Weight of dry sample(gm)	98.2
Moisture content	9.78	Weight of water(gm)	9.6
		Moisture content %	9.78

EXTRACTION/GRADATION TEST RESULTS

SIEVE		RETAINED		PERCENT PASSING	
#	SIZE mm	WEIGHT g	PERCENT %	SAMPLE %	SPECIFICATION %
4	4.8	30.4	14.2	85.8	
16	1.2	53.6	25.0	75.0	
50	0.30	125.8	58.6	41.4	
100	0.150	158.2	73.6	26.4	
200	0.075	170.3	79.3	20.7	



BURNSIDE

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Appendix D

Groundwater Level Data

Table D-1
Groundwater Elevations

	Well Depth (mbgl)	Ground Surface Elevation (masl)	9-Nov-2017		13-Dec-2017		18-Jun-2018		18-Jul-2018		20-Aug-2018		19-Sep-2018		19-Oct-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)	Water Level (mbgs)	Water Elevation (masl)
BH1	**8.38**	**268.70**	-	-	6.50	262.20	5.88	262.82	6.18	262.52	6.59	262.11	6.77	261.93	6.70	262.00
BH2	**6.86**	**265.69**	4.50	261.19	3.95	261.74	3.39	262.30	3.95	261.74	3.75	261.94	4.29	261.40	4.17	261.52
BH3	**5.34**	**266.70**	-	-	4.08	262.62	3.35	263.35	3.71	262.99	4.16	262.54	4.41	262.29	4.15	262.55
BH4	**3.96**	**264.01**	2.20	261.81	1.80	262.21	1.12	262.89	1.64	262.37	1.68	262.33	2.00	262.01	1.78	262.23
BH5	**5.34**	**266.42**	3.98	262.44	3.47	262.95	2.76	263.66	3.32	263.10	3.52	262.90	3.62	262.80	3.57	262.85
BH6	**6.71**	**266.45**	-	-	3.19	263.26	2.42	264.03	3.05	263.40	3.30	263.15	3.41	263.04	3.31	263.14
BH7	**6.86**	**265.13**	-	-	2.43	262.70	1.70	263.43	2.33	262.80	2.47	262.66	2.62	262.51	2.57	262.56
BH8	**9.15**	**269.18**	-	-	3.48	265.70	3.60	265.58	4.16	265.02	4.17	265.01	4.59	264.59	4.50	264.68
BH9	**9.15**	**268.12**	-	-	4.44	263.68	3.79	264.33	4.27	263.85	4.43	263.69	4.76	263.36	4.57	263.55
BH10	**6.84**	**267.16**	5.20	261.96	4.37	262.79	3.53	263.63	4.17	262.99	4.47	262.69	4.50	262.66	4.48	262.68

"-" denotes data unavailable

Table D-1
Groundwater Elevations

	Well Depth (mbgl)	Ground Surface Elevation (masl)	19-Nov-2018		19-Dec-2018		21-Jan-2019		19-Feb-2019		20-Mar-2019		29-Apr-2019		24-May-2019	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
BH1	**8.38**	**268.70**	6.89	261.81	6.56	262.14	6.47	262.23	6.54	262.16	6.57	262.13	6.46	262.24	6.18	262.52
BH2	**6.86**	**265.69**	4.23	261.46	3.92	261.77	3.66	262.03	4.00	261.69	3.90	261.79	3.69	262.00	3.58	262.11
BH3	**5.34**	**266.70**	4.06	262.64	3.92	262.78	3.79	262.91	3.97	262.73	3.27	263.43	3.74	262.96	3.56	263.14
BH4	**3.96**	**264.01**	1.83	262.18	1.53	262.48	2.17	261.84	1.64	262.37	1.36	262.65	1.21	262.80	1.25	262.76
BH5	**5.34**	**266.42**	3.51	262.91	3.35	263.07	3.29	263.13	3.39	263.03	3.31	263.11	3.04	263.38	2.93	263.49
BH6	**6.71**	**266.45**	3.21	263.24	3.03	263.42	3.00	263.45	3.12	263.33	3.06	263.39	2.66	263.79	2.61	263.84
BH7	**6.86**	**265.13**	2.70	262.43	2.26	262.87	2.23	262.90	2.34	262.79	2.20	262.93	1.88	263.25	1.86	263.27
BH8	**9.15**	**269.18**	4.49	264.69	4.28	264.90	4.24	264.94	4.37	264.81	4.41	264.77	4.11	265.07	3.90	265.28
BH9	**9.15**	**268.12**	4.50	263.62	4.24	263.88	4.20	263.92	4.33	263.79	4.43	263.69	4.19	263.93	3.90	264.22
BH10	**6.84**	**267.16**	4.38	262.78	4.16	263.00	4.09	263.07	4.16	263.00	4.14	263.02	3.86	263.30	3.41	263.75

"-" denotes data unavailable

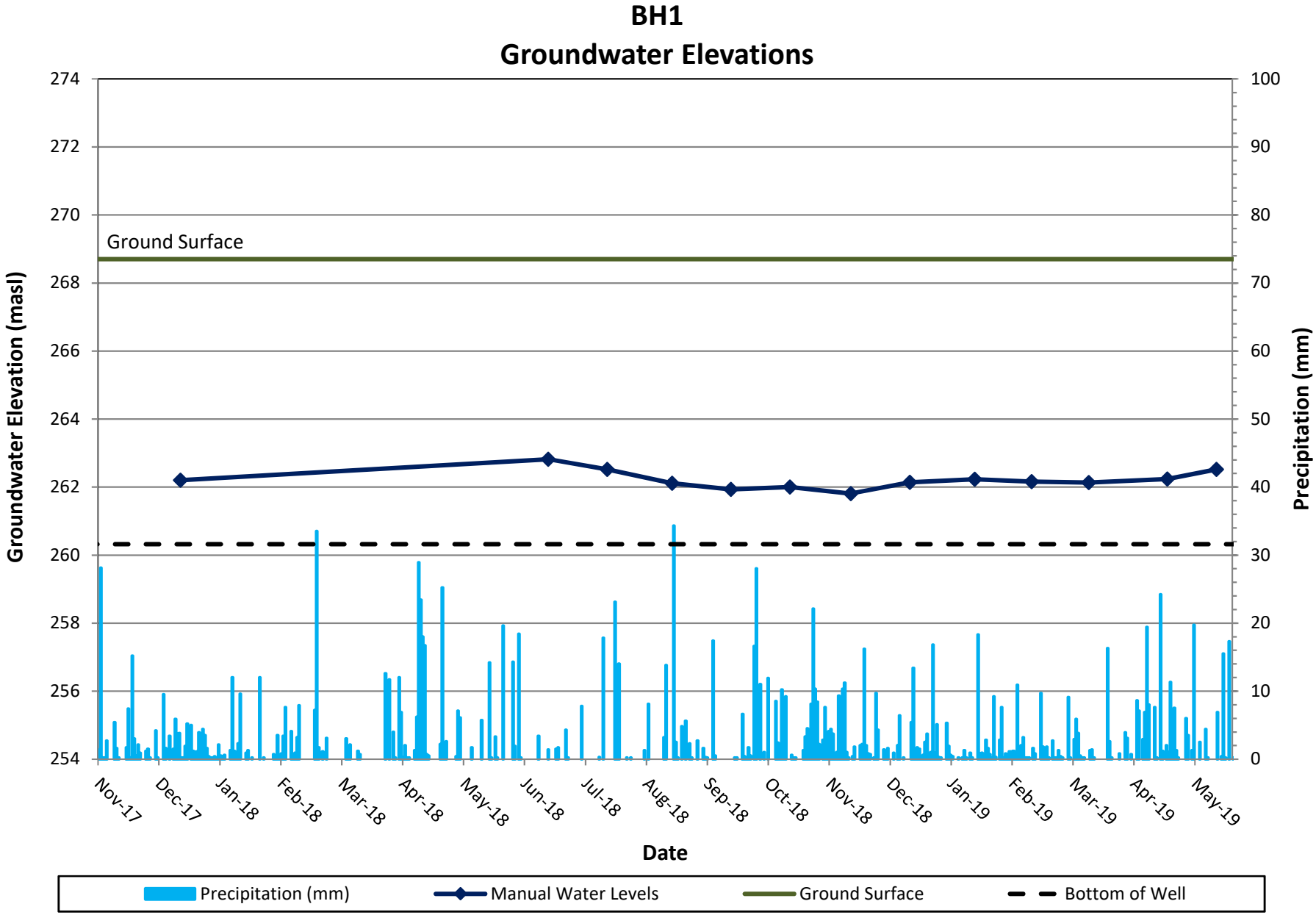

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Figure D-1

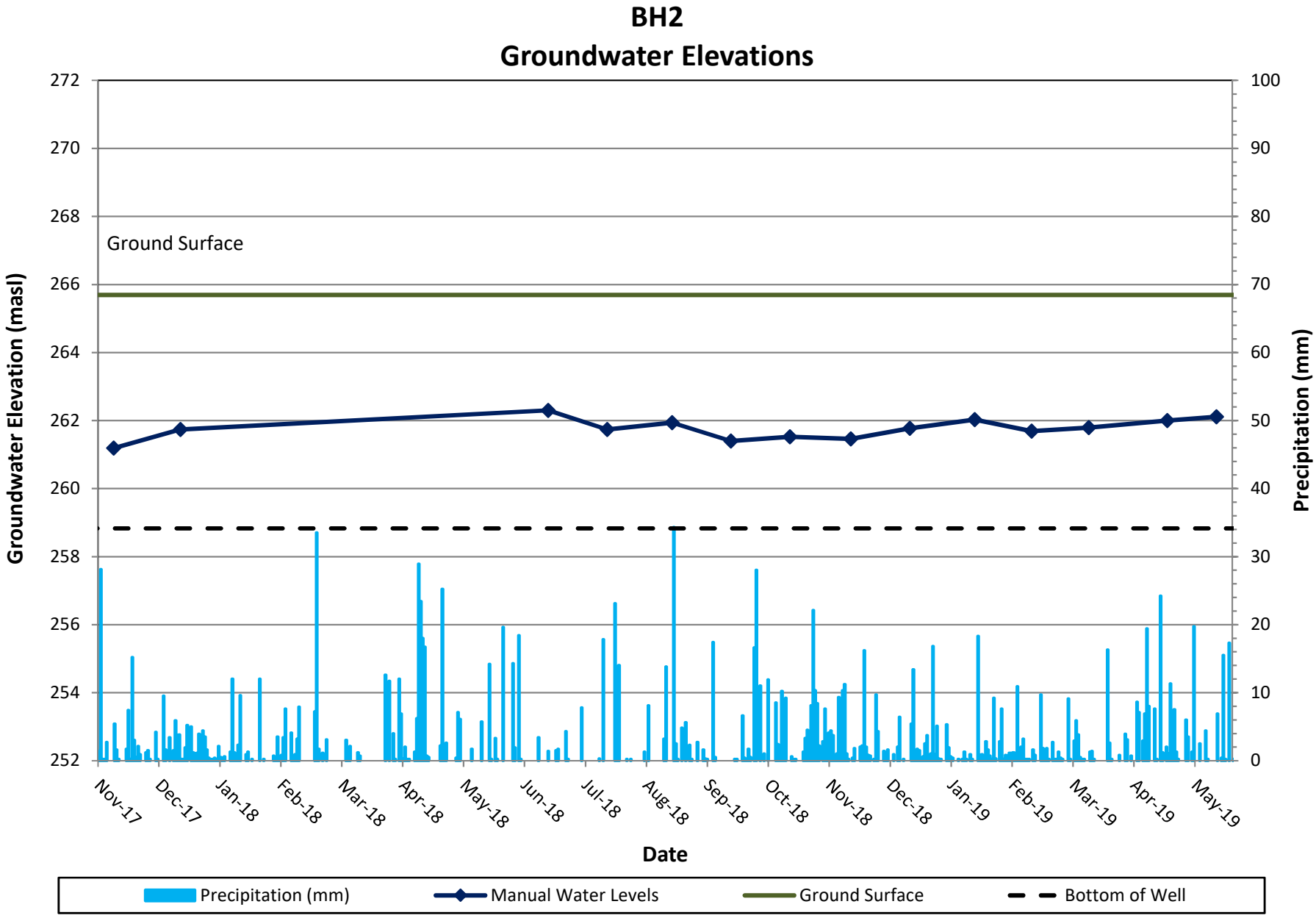

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Figure D-2

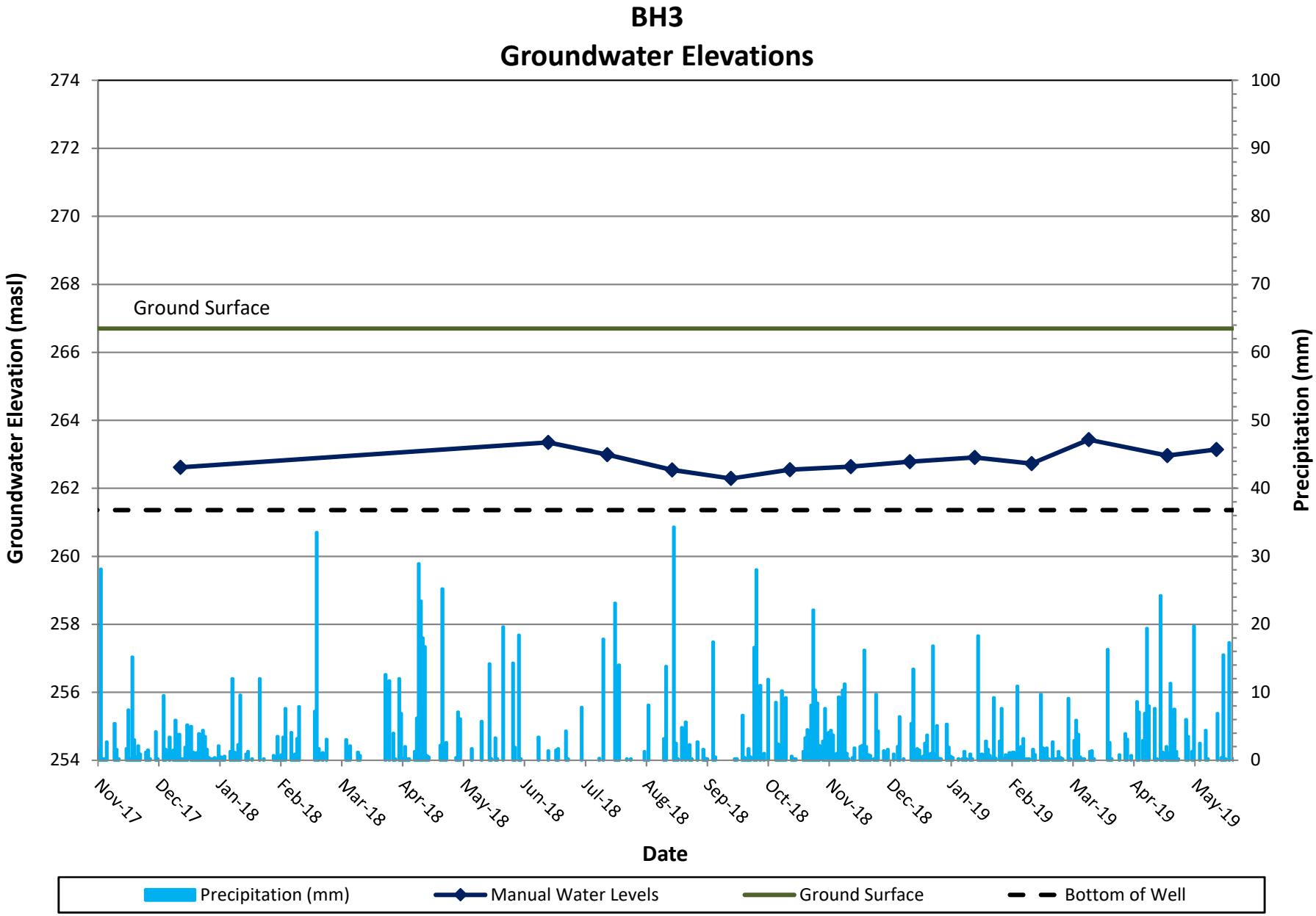

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Figure D-3

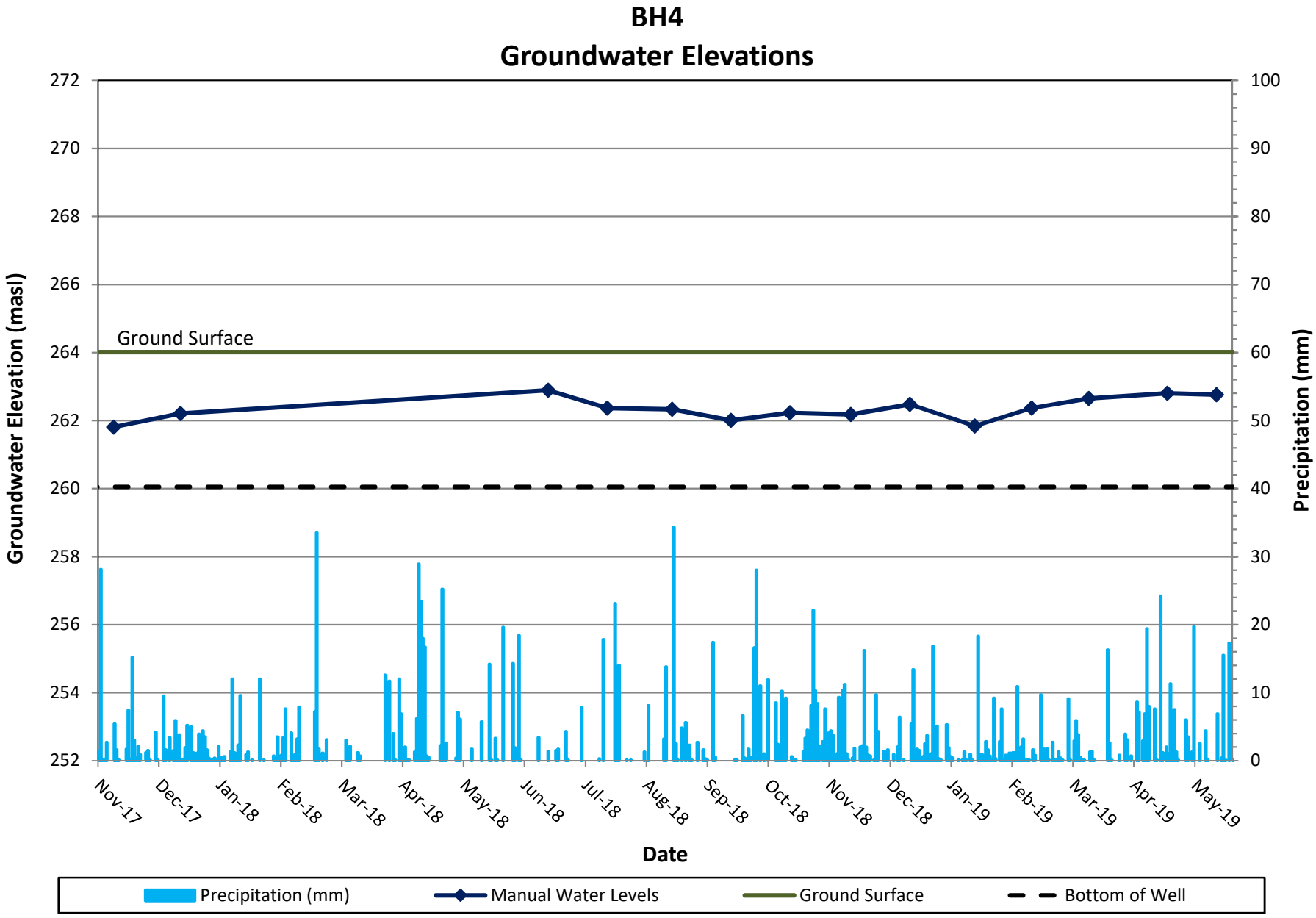

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Figure D-4

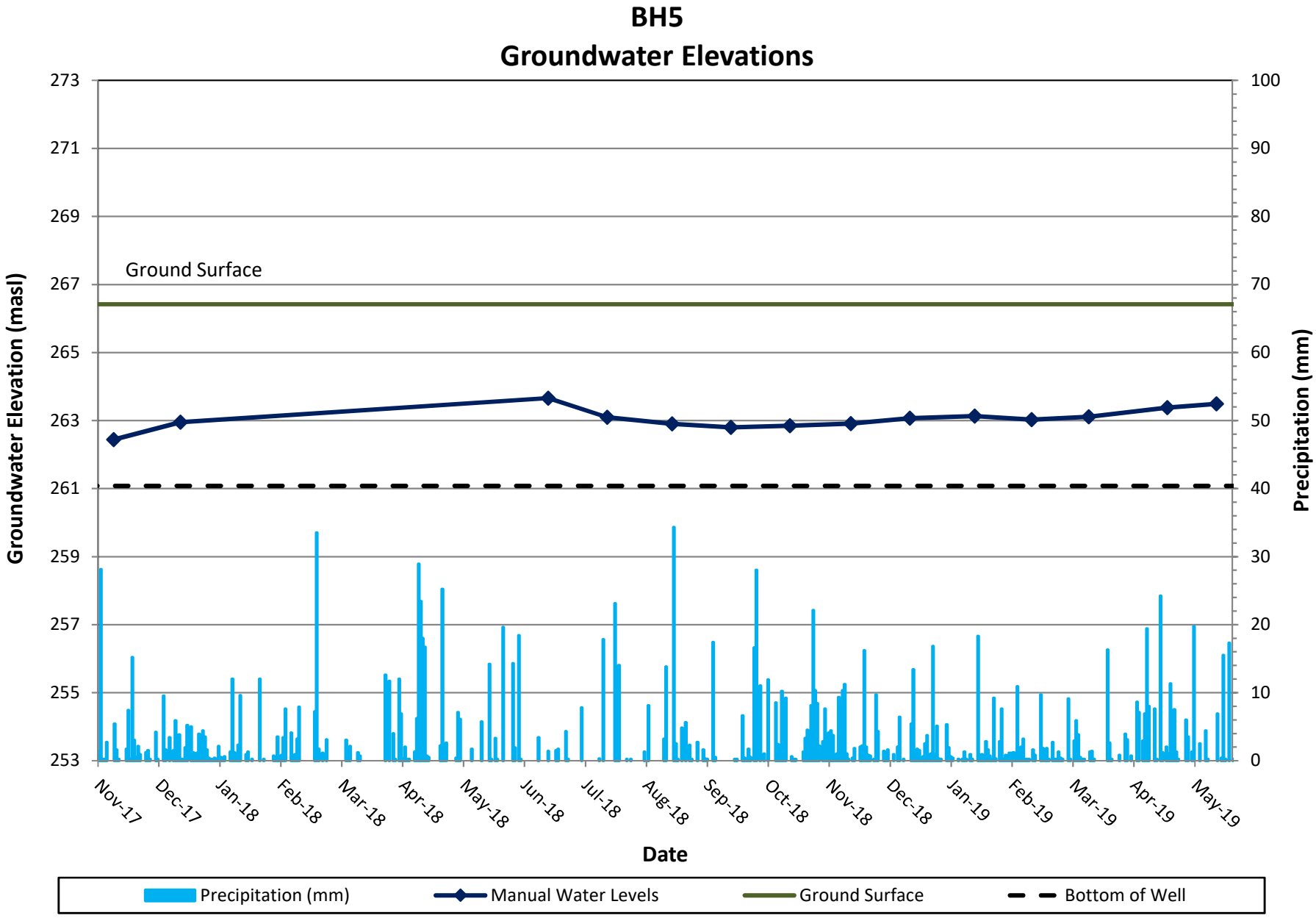

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Figure D-5

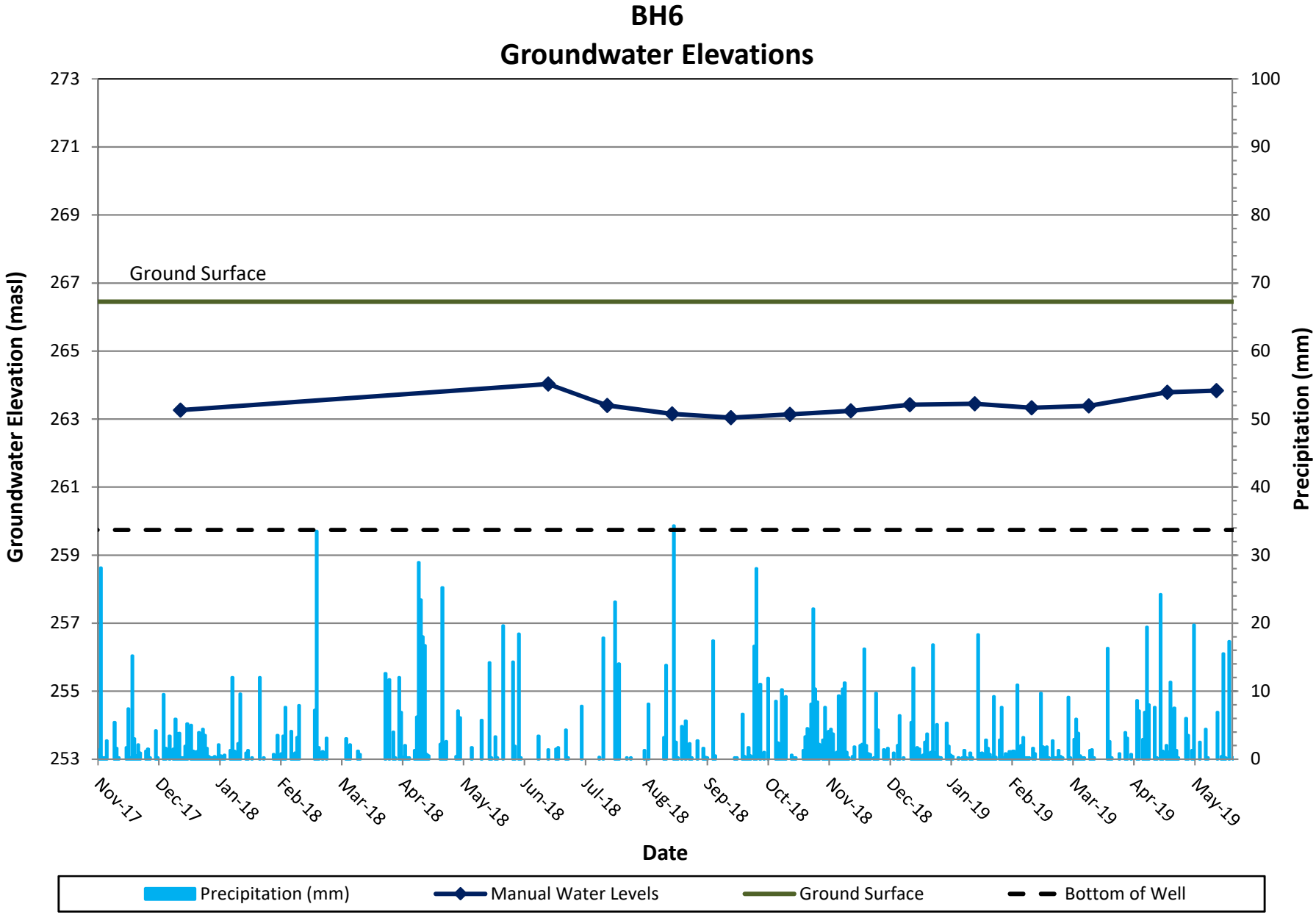

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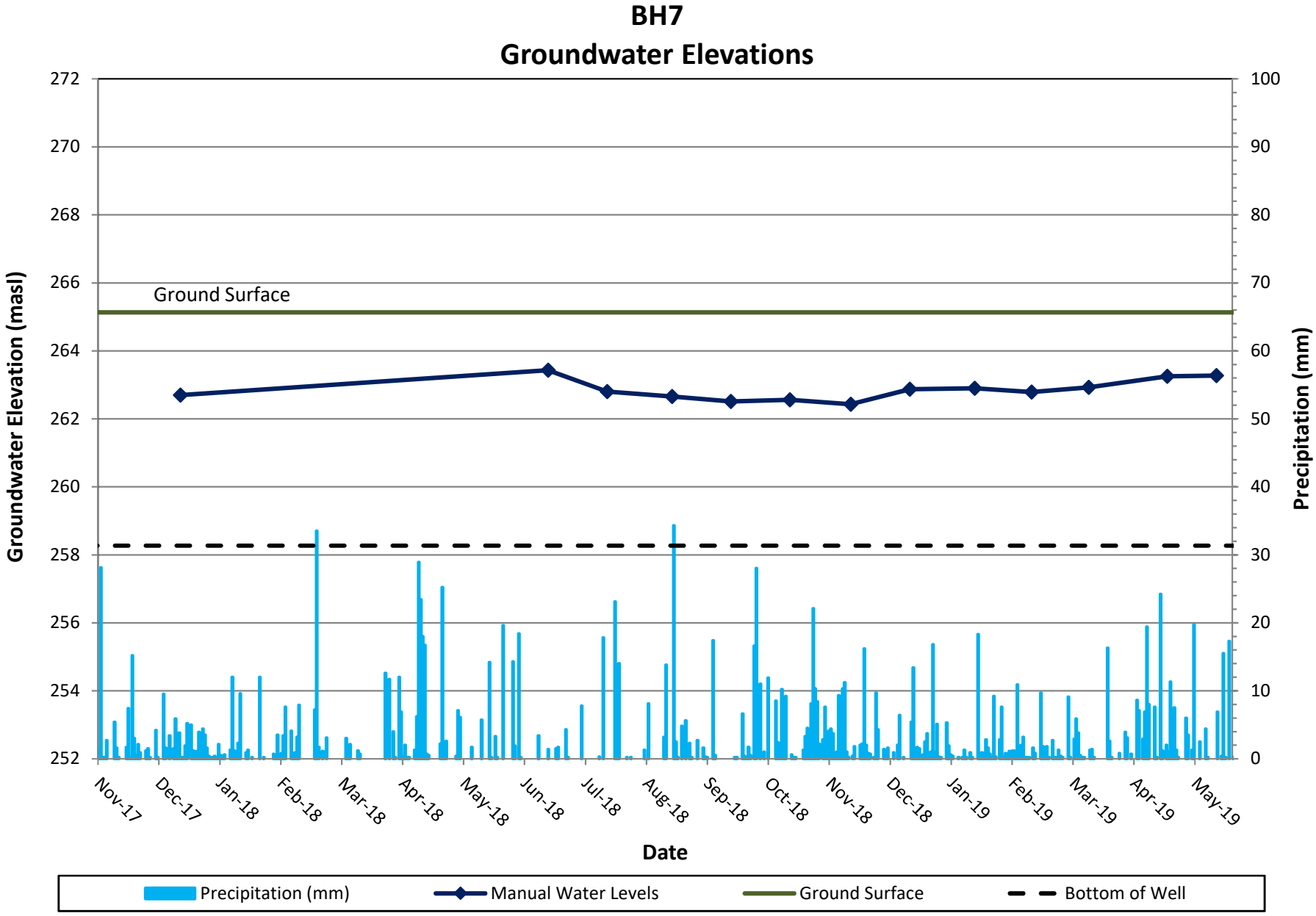
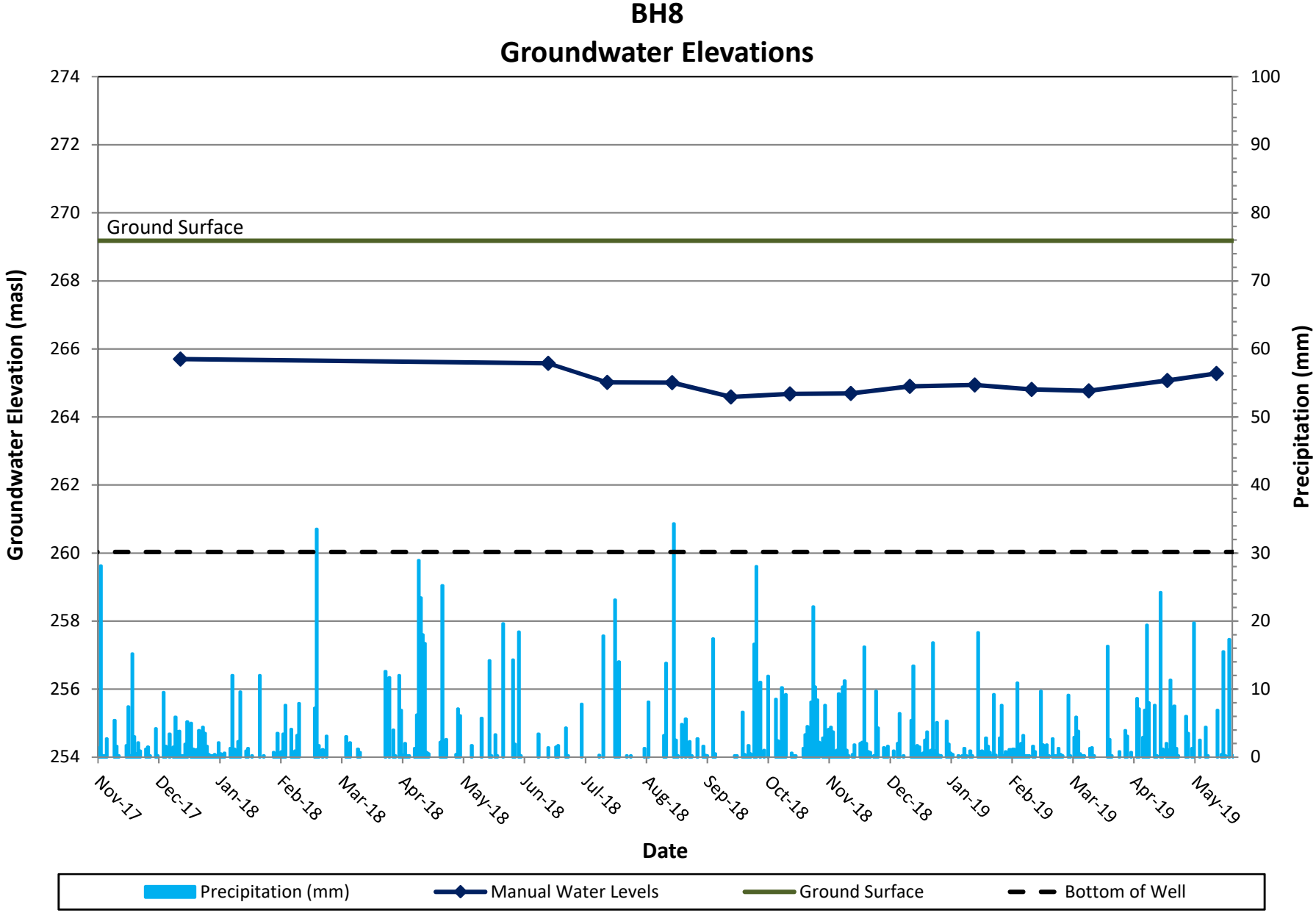
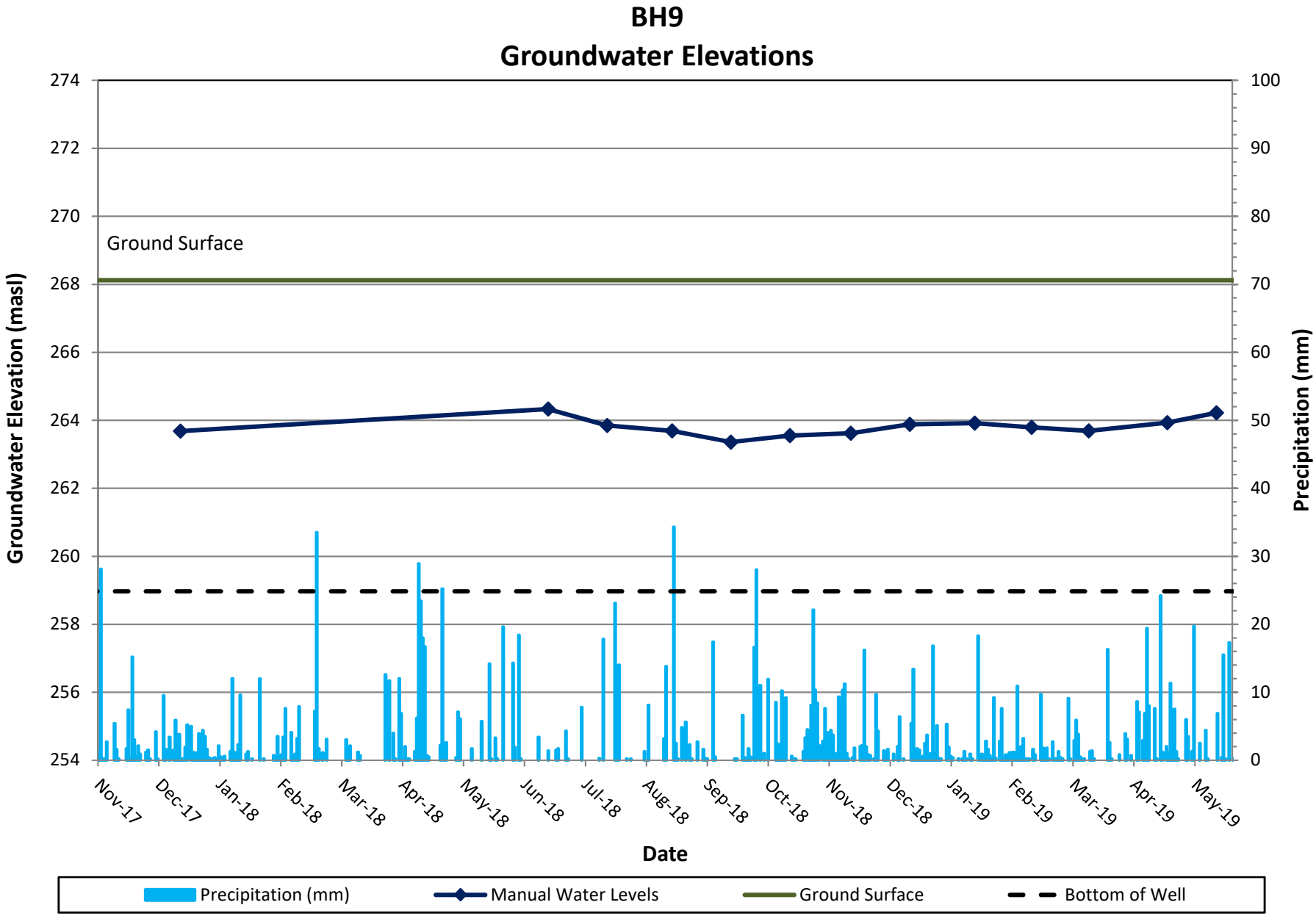
Figure D-6

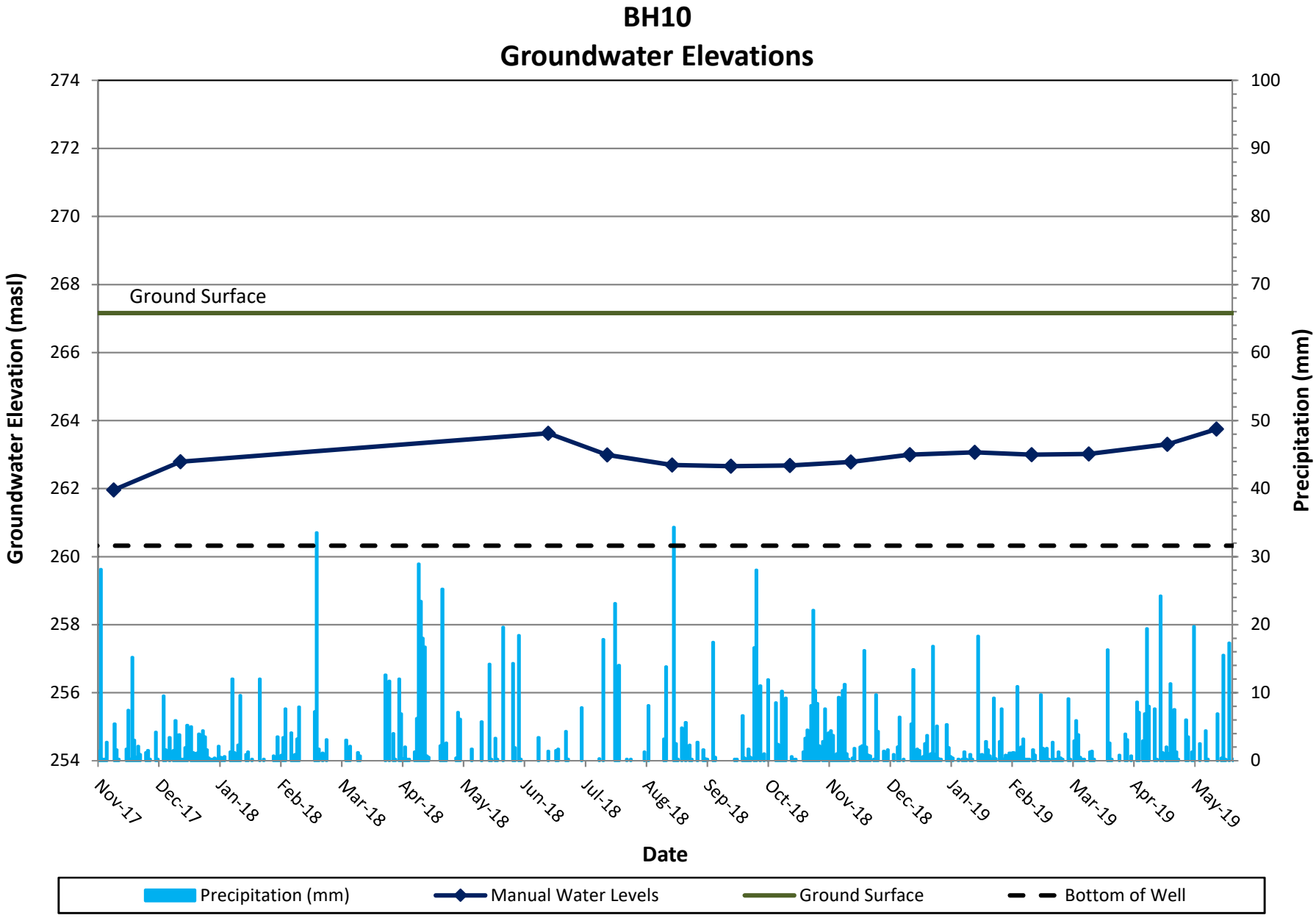

BH7
Groundwater Elevations
Groundwater Elevation (masl)
Precipitation (mm)
Ground Surface
272
270
268
266
264
262
260
258
256
254
252
100
90
80
70
60
50
40
30
20
10
0
Nov-17
Dec-17
Jan-18
Feb-18
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Date
Precipitation (mm)
Manual Water Levels
Ground Surface
Bottom of Well


BH8
Groundwater Elevations
Groundwater Elevation (masl)
Precipitation (mm)
Ground Surface
274
272
270
268
266
264
262
260
258
256
254
100
90
80
70
60
50
40
30
20
10
0
Nov-17
Dec-17
Jan-18
Feb-18
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Date
Precipitation (mm)
Manual Water Levels
Ground Surface
Bottom of Well



R.J. Burnside & Associates Limited
300050984

Figure D-9


BH10
Groundwater Elevations
Groundwater Elevation (masl)
Precipitation (mm)
Ground Surface
274
272
270
268
266
264
262
260
258
256
254
100
90
80
70
60
50
40
30
20
10
0
Nov-17
Dec-17
Jan-18
Feb-18
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Date
Precipitation (mm)
Manual Water Levels
Ground Surface
Bottom of Well

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Appendix E

Water Quality Data

Table E-1
Groundwater Quality
ASA Development Inc.

Observation Wells				MW14
Date				21-Oct-14
Parameter	**Unit**	**RDL**	**ODWQS**	
Electrical Conductivity	uS/cm	2		3940
pH	NA	NA	6.5-8.5	8.13
Saturation pH				6.69
Langlier Index				1.44
Total Hardness (as CaCO3)	mg/L	10	80-100	**557**
Total Dissolved Solids	mg/L	20	500	**2010**
Alkalinity (as CaCO3)	mg/L	5	30-500	293
Bicarbonate (as CaCO3)	mg/L	5		293
Carbonate (as CaCO3)	mg/L	5		<5
Hydroxide (as CaCO3)	mg/L	5		<5
Fluoride	mg/L	0.05		<1.0
Chloride	mg/L	0.10	250	**1020**
Nitrate as N	mg/L	0.05	10.0	1.6
Nitrite as N	mg/L	0.05	1.0	<1.0
Bromide	mg/L	0.05		<1.0
Sulphate	mg/L	0.10	500	26.1
Ortho phosphate as P	mg/L	0.10		<2.0
Reactive Silica	mg/L	0.05		11.5
Ammonia as N	mg/L	0.02		<0.02
Total Phosphorus	mg/L	0.05		1.19
Total Organic Carbon	mg/L	0.5		4
Colour	TCU	5	5	<5
Turbidity	NTU	0.5	5	**8780**
Calcium	mg/L	0.05		201
Magnesium	mg/L	0.05		13.4
Sodium	mg/L	0.05	20 (200)	**454**
Potassium	mg/L	0.05		1.82
Aluminum	mg/L	0.004	0.1	<0.004
Antimony	mg/L	0.006		<0.003
Arsenic	mg/L	0.003	0.025	<0.003
Barium	mg/L	0.002	1.0	0.153
Boron	mg/L	0.010	5.0	<0.001
Beryllium	mg/L	0.001		<0.010
Cadmium	mg/L	0.002	0.005	<0.002
Chromium	mg/L	0.003	0.05	0.004
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	<0.002
Mercury	mg/L	0.0001	0.001	<0.0001
Molybdenum	mg/L	0.002	0.04	<0.002
Nickel	mg/L	0.003	0.03	<0.003
Selenium	mg/L	0.004	0.01	<0.004
Silver	mg/L	0.002	0.00	<0.002
Strontium	mg/L	0.005		0.74
Thallium	mg/L	0.006	0.00	<0.006
Tin	mg/L	0.002	0.02	<0.002
Titanium	mg/L	0.002		<0.002
Tungsten	mg/L	0.010		<0.010
Uranium	mg/L	0.002	0.02	**<0.002**
Vanadium	mg/L	0.002	0.01	<0.002
Zinc	mg/L	0.005	5	0.006
Zirconium	mg/L	0.004		<0.004
% Difference/ Ion Balance	mg/L	0.1		6.6

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

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Appendix F

Water Balance Calculations

WATER BALANCE CALCULATIONS
ASA Development Inc.
989 Yonge Street
Barrie, ON
PROJECT No.300050984

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TABLE F-1

Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 150 mm (short to moderate rooted crops in sandy loam soils)

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

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	**6.9**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.19	3.91	6.90	8.66	7.97	5.44	2.31	0.39	0.00	**36.8**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	25.18	58.76	88.02	103.48	97.59	74.33	40.47	11.47	0.00	**499**
Adjusting Factor for U (Latitude 44° 22' N)	0.81	0.82	1.02	1.13	1.27	1.29	1.3	1.2	1.04	0.95	0.8	0.76	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
WATER BALANCE COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	83	62	58	62	82	85	77	90	94	78	89	74	**933**
Potential Evapotranspiration (PET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
P - PET	83	62	58	34	8	-29	-57	-27	17	39	80	74	**340**
Change in Soil Moisture Storage	0	0	0	0	0	-29	-57	-27	17	39	58	0	**0**
Soil Moisture Storage max 150 mm	150	150	150	150	150	121	64	37	53	92	150	150	
Actual Evapotranspiration (AET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
Soil Moisture Deficit max 150 mm	0	0	0	0	0	29	86	113	97	58	0	0	
Water Surplus - available for infiltration or runoff	83	62	58	34	8	0	0	0	0	0	22	74	**340**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	50	37	35	20	5	0	0	0	0	0	13	44	**204**
Potential Direct Surface Water Runoff (independent of temperature)	33	25	23	13	3	0	0	0	0	0	9	29	**136**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	933	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	140	mm/year											
P-PE (surplus available for runoff from impervious areas)	793	mm/year											

Assume January storage is 100% of Soil Moisture Storage

Soil Moisture Storage	150 mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003
*MOE SWM infiltration calculations		
topography - hilly	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - sandy loam	0.4	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - predominantly cultivated land	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.6**	
Latitude of site (or climate station)	44 ° N.	

WATER BALANCE CALCULATIONS
ASA Development Inc.
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TABLE F-2

Water Balance Components

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

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

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	**6.9**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.19	3.91	6.90	8.66	7.97	5.44	2.31	0.39	0.00	**36.8**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	25.18	58.76	88.02	103.48	97.59	74.33	40.47	11.47	0.00	**499**
Adjusting Factor for U (Latitude 44° 22' N)	0.81	0.82	1.02	1.13	1.27	1.29	1.3	1.2	1.04	0.95	0.8	0.76	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
WATER BALANCE COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	83	62	58	62	82	85	77	90	94	78	89	74	**933**
Potential Evapotranspiration (PET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
P - PET	83	62	58	34	8	-29	-57	-27	17	39	80	74	**340**
Change in Soil Moisture Storage	0	0	0	0	0	-29	-46	0	17	39	19	0	**0**
Soil Moisture Storage max 75 mm	75	75	75	75	75	46	0	0	17	56	75	75	
Actual Evapotranspiration (AET)	0	0	0	28	75	114	123	90	77	38	9	0	**555**
Soil Moisture Deficit max 75 mm	0	0	0	0	0	29	75	75	58	19	0	0	
Water Surplus - available for infiltration or runoff	83	62	58	34	8	0	0	0	0	0	60	74	**378**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	54	40	38	22	5	0	0	0	0	0	39	48	**246**
Potential Direct Surface Water Runoff (independent of temperature)	29	22	20	12	3	0	0	0	0	0	21	26	**132**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	933	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	140	mm/year											
P-PE (surplus available for runoff from impervious areas)	793	mm/year											

Assume January storage is 100% of Soil Moisture Storage
Soil Moisture Storage 75 mm <-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003

*MOE SWM infiltration calculations
topography - hilly 0.1 <-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - sandy loam 0.4 <-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - urban lawn 0.15 <-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor **0.65**

Latitude of site (or climate station) 44 ° N.

WATER BALANCE CALCULATIONS
ASA Development Inc.
989 Yonge Street
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TABLE F-3

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

Land Use Description	Approx. Land Area* (m^2)	Estimated Impervious Fraction for Land Use*	Estimated Impervious Area (m^2)	Runoff from Impervious Area** (m/a)	Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Runoff from Pervious Area** (m/a)	Runoff Volume from Pervious Area (m^3/a)	Infiltration from Pervious Area** (m/a)	Infiltration Volume from Pervious Area (m^3/a)	Total Runoff Volume (m^3/a)	Total Infiltration Volume (m^3/a)
Existing Land Use												
Rural Residential	9,980	0.25	2,495	0.793	1,978	7,485	0.132	990	0.246	1,839	2,969	1,839
Agricultural	102,030	0	0	0.793	0	102,030	0.136	13,864	0.204	20,797	13,864	20,797
TOTAL PRE-DEVELOPMENT	**112,010**		**2,495**		**1,978**	**109,515**		**14,855**		**22,636**	**16,833**	**22,636**
Post-Development Land Use (with no LID measures in place)												
Rural Residential	9,980	0.25	2,495	0.793	1,978	7,485	0.132	990	0.246	1,839	2,969	1,839
High Density Residential	73,460	0.80	58,768	0.793	46,601	14,692	0.132	1,944	0.246	3,610	48,545	3,610
Amenity Area/ Easement	7,400	0.50	3,700	0.793	2,934	3,700	0.132	490	0.246	909	3,423	909
Rail Buffer	13,270	0.00	0	0.793	0	13,270	0.132	1,756	0.246	3,260	1,756	3,260
Lockhart Road -ROW	7,900	0.75	5,925	0.793	4,698	1,975	0.132	261	0.246	485	4,960	485
TOTAL POST-DEVELOPMENT	**112,010**		**70,888**		**56,212**	**41,122**		**5,440**		**10,104**	**61,652**	**10,104**
										% Change from Pre to Post	366	55
										Effect of development (with no mitigation)	3.7 times increase in runoff	55% reduction of infiltration

* data provided by SCS Consulting Group (Nov, 2019)

** figures from Tables F-1 and F-2.

To balance pre- to post-,
the infiltration target (m^3/a)= **12,532**

Figure F-1
Pre-Development Monthly Site Water Balance