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A REPORT TO
BARA GROUP (RIVER OAK) INC.

HYDROGEOLOGICAL STUDY

PROPOSED MIXED-USE BUILDINGS WITH 1-LEVEL UNDERGROUND PARKING STRUCTURE

2163 AND 2169 SIXTH LINE

TOWN OF OAKVILLE

REFERENCE NO. 1909-W038

FEBRUARY 2020

DISTRIBUTION

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1.0 EXECUTIVE SUMMARY

Soil Engineers Ltd. has conducted a hydrogeological assessment for two proposed 6-storey mixed-use buildings, having a 1 level of underground parking structure, located at 2163 and 2169 Sixth Line, in the Town of Oakville.

The subject site located within the Physiographic Region of Southern Ontario known as the South Slope, on the Till Plains (Drumlinized) physiographic feature. Based on review of the surface geological map of Ontario, the subject site is situated Halton Till unit deposits, consisting, predominantly of silt to silty clay, high in calcium carbonate matrix content, considered as being clast poor. The Halton Till unit was deposited adjacent to a near shore beach environment during the last glaciation of Southern Ontario.

The subject site shows a gentle decline in elevation relief towards the east.

The subject site is located within the Sixteen Mile Creek Watershed. A wooded area is located north and east of the subject site. Additional wooded areas are also located approximately 300 m south of the subject site. These wooded areas are associated with the heavy system sixteen-mile creek. There are no other natural heritage features within, or in close proximity of the subject site. A small water body is located approximately 1,200 m northwest of the subject site just south of Dundas Street. There are no wetlands in or around the subject site.

The current study has disclosed that beneath a layer of asphaltic concrete and granular fill layer, the native soils underlying the subject site consists of silty clay till and shale bedrock, extending to termination depth of investigation at 9.1 meters below the prevailing ground surface.

The findings of this study confirm that the groundwater level elevations range from 140.91 to 143.6 masl.

The estimated hydraulic conductivity (K) for the saturated subsoil ranges from 2.1 x 10^{-7} to 9.1 x 10^{-9} m/sec for the overburden subsoil and weathered shales unit at the screened depth intervals for the monitoring wells constructed beneath the site.

The estimated construction dewatering flow rate for construction of the proposed 1 level underground parking structure is 213.1 L/day, by considering a 3x safety factor, the dewatering flow rate could reach an approximately daily maximum of 639.4 L/day. Since the estimated construction dewatering flow rates for the construction are not anticipated to exceed the MECP groundwater taking threshold limit; the applying for the Environmental Activity and Sector Registry (EASR) approval to facilitate the groundwater taking for a construction dewatering program for underground services and 1-level underground parking is not anticipated. However, a review of the Intensity Duration-Frequency Curve (IDF Curve) for the year 2010 for the subject site indicated that the 24 hour, 100 year return period rainfall depth for the area was recorded at 123.6 mm. Considering an approximate excavation area of 6,600 m^2 (length of 110 m and width of 60 m), the accumulated runoff volume could reach approximate to 815.76 m^3 /day (815,760 L/day). This potential volume accumulation within the developed footprint excavation exceeds the MECP threshold requirement of 50,000 L/day for requiring a groundwater taking approval.

The current construction dewatering flow rate estimation was based on the consideration for a 3.0 m depth for the proposed 1-level underground parking structure, and a 5.0 m depth for proposed underground services installation. As such, it is recommended that the dewatering needs estimation be updated if there are significant changes in the final designs from those considered for the assessment.

The zone of influence for temporary construction dewatering could reach a maximum of 2.5 m away from the conceptual dewatering array for installation of underground services. There are no water bodies, wetlands or watercourses located within the conceptual zone of influence for construction dewatering. Furthermore, Sixth Line could potentially be affected by ground settlement associated with the conceptual zone of influence for construction dewatering. It is recommended that a geotechnical engineer should be consulted to review potential ground settlement concerns prior to construction.

2.0 INTRODUCTION

2.1 Project Description

In accordance with the authorization from Mr. Khosrow Barati, President of Bara Group (River Oak) Inc., Soil Engineers Ltd. (SEL) has conducted a hydrogeological study for two proposed 6-storey mixed-use buildings, having 1 level of underground parking structure at 2163 and 2169 Sixth Line in the Town of Oakville. The location of the subject site is shown on Drawing No. 1.

The subject site is located in an existing developed area, where the surrounding land use includes; residential properties to the south, residential buildings to the west and wood lots to the north and northeast, along with residential properties to the southeast. The subject site itself is currently occupied by a single storey commercial building having an at grade paved parking lot.

This report summarizes the findings of the field study and the associated groundwater monitoring and hydraulic testing, and provides a description and characterization of the interpreted hydro-geo-stratigraphy for the site and surrounding area. The current study provides preliminary recommendations addressing construction dewatering needs prior to detailed design. Furthermore, the report provides a recommendation for any need to acquire an Environmental Activity and Sector Registry (EASR) approval, or a Permit-To-Take Water (PTTW) to facilitate groundwater taking for a construction dewatering program.

2.2 **Project Objectives**

The major objectives of this Hydrogeological Study Report are as follows:

1. Establishing the local hydrogeological setting for the site and local surrounding areas;
2. Interpretation of the shallow groundwater flow and runoff patterns;
3. Identify zones of higher groundwater yield as potential sources for any ongoing shallow groundwater seepage;
4. Characterizing the hydraulic conductivity (K) for the groundwater-bearing sub soil strata;
5. Preparing an interpreted hydrogeostratigraphic cross-section across the subject site;
6. Estimating any anticipated temporary dewatering flows that may be required to lower the water table to facilitate construction, or for any required long-term foundation drainage, following construction;
7. Estimating the anticipated zone of influence associated with any construction dewatering, if required;
8. Evaluating potential impacts from any construction dewatering to any nearby groundwater receptors within the anticipated zone of influence and to develop preliminary estimation for any dewatering flow rates that may be required to facilitate excavation and construction;
9. Providing comments regarding any need to file for an Environmental Activity and Sector Registry (EASR) approval, or to acquire a Permit-To-Take Water (PTTW) to facilitate a construction dewatering program.
10. Commenting on the feasibility of Low Impact Development Infrastructure at the completed development in support of future stormwater management planning.

2.3 Scope of Work

The scope of work for the Hydrogeological Study is summarized below:

1. Installation of four (4) monitoring wells within the site's development footprint;
2. Monitoring well development and groundwater level measurements at the four (4) installed monitoring wells to record the prevailing ground levels beneath the site;
3. Performance of Single Well Response Tests (SWRTs) at the monitoring wells to estimate the hydraulic conductivity (K) for the groundwater-bearing subsoil strata at the depths of the well screens;
4. Reviewing and plotting of Ministry of Environment, Conservation and Parks (MECP) water well records within 500 m of the proposed mixed-use development site;
5. Describing the geological and hydrogeological setting for the subject site and surrounding local area;
6. Review of the findings of the concurrent geotechnical study; review of any available engineering development plans and profiles for proposed underground services and for the proposed 1 level underground parking structure; assessing the preliminary dewatering needs and estimation of any anticipated dewatering flows to lower the groundwater levels for construction earth works, or for any anticipated long-term foundation drainage for the completed development;
7. Provide comments regarding any need to file for an Environmental Activity and Sector Registry (EASR) approval, or to acquire a Permit-To-Take Water (PTTW) to facilitate a construction dewatering program.

3.0 METHODOLOGY

3.1 Borehole Advancement and Monitoring Well Installation

Borehole drilling and monitoring well construction were conducted between October 3 and 11, 2019. The program consisted of the drilling of eight (8) boreholes (BH) and the installation of four (4) monitoring wells (MW), one within each of six (6) selected geotechnical boreholes at the time of drilling. The locations of the boreholes/monitoring wells are shown on Drawing No. 2.

Borehole drilling and monitoring well installation were completed by DBW Drilling, a licensed water well contractor, under the full-time supervision of a geotechnical technician from SEL, who also logged the soil strata encountered during borehole advancement and collected representative soil samples for soil classification. The boreholes were drilled using continuous flight power augers. Detailed descriptions of the encountered subsurface soil, bedrock and groundwater conditions are presented on the borehole and monitoring well logs, on the enclosed Figures 1 to 8, inclusive.

The monitoring wells were constructed using 50-mm diameter PVC riser pipes and screens, which were installed in each of the selected geotechnical boreholes in accordance with Ontario Regulation (O. Reg.) 903. All of the monitoring wells were provided with steel flush mount protective casings at the ground surface. The details of the monitoring well construction are provided on the enclosed Borehole Logs (Figures 1 to 8).

The UTM coordinates and ground surface elevations at the borehole/monitoring well locations, together with the monitoring well construction details, are provided on Table 3-1.

Table 3-1 - Monitoring Well Installation Details

Well ID	Installation Date	UTM Coordinates		Ground El. (masl)	Monitoring Well Depth (mbgs)	Screen Interval (mbgs)	Casing Diameter (mm)
		East (m)	North (m)				
BH/MW 1	October 3, 2019	603611	4813687	148.57	9.1	6.1-9.1	50
BH/MW 2	October 10, 2019	603647	4813706	148.65	9.1	6.1-9.1	50
BH/MW 7	October 7, 2019	603696	4813674	146.95	9.0	5.9-9.0	50
BH/MW 8	October 9, 2019	603723	4813648	146.94	9.1	6.1-9.1	50

Notes: mbgs -- metres below ground surface masl -- metres above sea level

3.2 Groundwater Monitoring

The monitoring wells were purged and developed on October 10, 2019, and the groundwater levels in the monitoring wells were measured, manually on October 21, 31 and on November 20, 2019.

3.3 Mapping of Ontario Water Well Records

SEL reviewed the MECP Water Well Records (WWRs) for registered wells located on the subject site and within 500 m of the site boundaries (study area). The records indicate that one (1) registered well is located within the study area related to the subsoil site. The well record location is shown on Drawing No. 3, and the WWRs reviewed for this study are listed in Appendix ‘A’.

3.4 Monitoring Well Development and Single Well Response Tests

BH/MWs 1, 2, 7 and 8, underwent development in preparation for single well response testing (SWRT) to estimate the hydraulic conductivity (K) for the subsoil strata at the depths of the well screens. Well development involved the purging and removal of several casing volumes of groundwater from each monitoring well to remove remnants of clay, silt and other debris introduced into the wells during construction, and to induce the flow of formation groundwater through the well screens, thereby improving the transmissivity of the subsoil strata formation at the well screen depths.

An SWRT is used to estimate the hydraulic conductivity (K) for the groundwater-bearing subsoil strata at the depths of the well screen. The K estimates provide an indication of the yield capacity for the groundwater-bearing subsoil strata and can be used to estimate the flow of groundwater through granular water-bearing subsoil strata.

The SWRT involves the placement of a slug of known volume into the well, below the water table, to displace the groundwater level upward. The rate at which the groundwater level recovers to static conditions (falling head) is tracked using either a data logger/pressure transducer, and/or manually using a water level tape. The rate at which the groundwater table recovers to static conditions is used to estimate the K value for the water-bearing strata formation at the well screen depth. BH/MWs 1, 2, 7 and 8, underwent SWRT on October 31, 209 with the results provided in Appendix 'B', and a summary of the findings provided in Table 6-2.

3.5 Review Summary of Concurrent Report

The following report, prepared by SEL was reviewed for the preparation of this hydrogeological study:

"A Report to Bara Group (River Oak) Inc. A Geotechnical Investigation for Proposed Mixed-Use Buildings'', Reference No. 1909-S038, November 2019.

4.0 REGIONAL AND LOCAL SETTING

4.1 Regional Geology

The subject site lies within the physiographic region of Southern Ontario known as the South Slope, on the Till Plains (Drumlinized) physiographic feature. The South slope exhibits an average width of 9.6 to 11.3 km, extending from the Niagara Escarpment to the

Trent River. It covers an area of approximately 2,400 square kilometers. The south slope is smoothed, faintly drumlinized, and is scarred at intervals by valleys and existing tributaries (Chapman and Putnam, 1984).

Reviewing the surface geological map of Ontario shows that the subject site is located on Halton. Till deposits, consisting, predominantly of silt to silty clay, high in calcium carbonate matrix content, which is considered as being clast poor. The Halton till was deposited adjacent to a near shore beach environment during the last glaciation Southern Ontario. Drawing No. 4, as reproduced from Ontario Geological Survey mapping, illustrates the quaternary surface soil geology for the subject site and surrounding areas. Drawing No. 4 also shows the areas, where bedrock outcrops were mapped at the ground surface.

Bedrock was contacted at depth elevations, ranging from 143.9 to 145.4 masl (i.e., between 2.3 mbgs and 3.3 mbgs) beneath the subject site. It consists of shale, limestone, dolostone and siltstone of the Queenston Formation which were deposited during the Upper Ordovician Epoch (Bedrock Geology of Ontario, 1993).

4.2 Physical Topography

A review of the topographic map for the site and surrounding area shows that there is a decline in elevation relief from the northwest to southeast. As such, it is anticipated that the surface runoff drains towards the southeast. Based on review of the topographic map for the area and from review of the ground surface elevations at the borehole and monitoring well locations, the subject site is relatively flat with a gentle decline in elevation relief towards the east. Drawing No. 5 shows the mapped topographical contours for the site and surrounding area.

4.3 Watershed Setting

The subject site is located within the Sixteen Mile Creek Watershed, which is shown on Drawing No. 6. Sixteen Mile Creek is a small, almost completely-urbanized water course, in which it's furthest headwaters originate with the farmlands south of Old Base Line Road. In spite of this fringe of rural roots, the watershed for Sixteen Mile Creek exists almost entirely within Oakville's city limits, where it covers largely urban and suburban landscapes. Much of its water flow originates from runoff derived largely from Oakville's own roads, parking lots, and housing roofs, yards and gardens (Oakvillegreen Conservation Association).

4.4 **Local Surface Water and Natural Features**

Tributaries of the Sixteen Mile Creek traverse areas that are approximately 75 m to the north and about 300 m to the south of the subject site, respectively. Associated wood lots are scattered around these tributaries. The records review also indicates that there is a body of water further away from the subject site, with the closest record being mapped, approximately 1200 m northwest of the subject site. There are no wet lands in or around the subject site. The locations of the site and the noted natural features are shown on Drawing No. 7.

5.0 **SOIL LITHOLOGY**

This study has disclosed that beneath a layers of topsoil and/or granular fill, and asphaltic concrete, the native soil and strata underlying the subject site consists of silty clay till and shale bedrock, extending to the termination depth of investigation at 9.1 meters below the prevailing ground surface. A Key Plan and the interpreted geological cross-sections along the delineated northwest-to-southeast transects are presented on Drawing Nos. 8-1 and 8-2.

5.1 **Topsoil** (BHs 3 and 6)

A layer of topsoil, approximately 8 to 13 cm thick, was observed at the ground surface at the above mentioned BHs locations.

5.2 **Pavement Structure**

5.2.1 **Asphaltic Concrete** (BHs 5 and BH/MWs 1, 2, 4, 7 and 8)

Asphalt concrete, 8 to 13 mm thick, was observed at the ground surface at the above mentioned BHs and BH/MWs locations.

5.2.2 **Granular Fill** (BHs 5 and BH/MWs 1, 2, 4, 7 and 8)

Granular fill, 20 to 50 mm thick, was observed below the asphaltic concrete layer at the above mentioned BHs and BH/MWs locations.

5.3 **Silty Clay Till** (All BHs and BH/MWs)

Silty clay till is a predominant subsoil unit encountered beneath the subject site, it was contacted at depths of between 0.05 to 3.3 mbgs at all of the BH/MWs locations. The thickness of the unit ranges from approximately 1.9 to 2.7 m. It is reddish brown in colour, and is firm to hard in consistency. It contains a trace of gravel, and occasional sand seams, layers, cobbles and boulders. The moisture content for the retrieved samples ranges from 9% to 19%, indicating moist to very moist conditions. The silty clay till unit extends to the top of bedrock at depths of 2.3 to 3.3 mbgs. The estimated permeability for this layer at the depths of where samples were recorded, is about 10^{-7} m/sec.

5.4 **Shale Bedrock** (All BH/MWs)

Shale bedrock was encountered at depths ranging from 2.3 to 8.1 mbgs, at the above mentioned BHs and BH/MWs locations. It is red in colour, it is weathered within its upper sections, becoming more compact and more sound with depth. It extends to the termination depth of investigation at 9.1 mbgs. The permeability of the underlying upper shale unit is anticipated to vary depending on the extent of fracturing, and presence of bedding planes.

5.5 **Low Impact Development (LID) Infrastructure**

A review of the borehole log sheets indicates that silty clay till is the predominated subsoil unit contacted beneath the subject site. Considering the low permeability for this thick subsoil unit; and the relatively shallow depth for the top of shale bedrock contacted within the boreholes, proposed Low Impact Development (LID) infrastructure could consider use of bioretention swales, the thickening topsoil within proposed landscape areas and use of permeable pavement within the driveway areas, to address future stormwater management planning for the developed site.

6.0 **GROUNDWATER STUDY**

6.1 **Review Summary of Concurrent Report**

A review of the findings from the concurrent geotechnical soil investigation report (SEL Reference No. 1909-W038) indicates that beneath a layer of top soil and asphaltic concrete layers, the native soils underlying the subject site consists of silty clay till, and shale bedrock which extends to maximum depth of the investigation at 9.1 m below the prevailing ground surface. to termination depth of depth of investigation at 9.1 mbgs.

6.2 **Review of Ontario Water Well Records**

The Ministry of Environment, Conservation and Parks (MECP) water well records (WWR's) for the subject site and for the properties within a 500 m radius of the boundaries of the subject site (study area) were reviewed.

The records indicate that one (1) well is located within the study area relative to the subject site. The location of this well recorded, based on the UTM coordinates provided by the records, is shown on Drawing No 3. A detailed summary of the MECP WWR's that were reviewed is provided in Appendix 'A'.

A review of the final status of the well record within the study area reveals that the one (1) well is listed as having an unknown status.

A review of the first status of the well shows that one (1) well is listed as having an unknown status. The records review indicates that there are no water well records within the subject site.

6.3 **Groundwater Monitoring**

The monitoring wells underwent development on October 31, 2019. The groundwater levels in the monitoring wells were measured on four (4) occasions, over the period extending from October 10 to November 20, 2019, to record the fluctuation of the groundwater table beneath the subject site. The groundwater levels and corresponding elevations are summarized in Table 6-1.

Table 6-1 - Water Level Measurements

Well ID		**October 10, 2019**	**October 21, 2019**	**October 31, 2019**	**Average**	**Fluctuation (m)***
BH/MW 1	mbgs	5.32	5.31	5.24	5.29	0.08
	masl	143.25	143.26	143.33	143.28	
BH/MW 2	mbgs	5.77	5.56	5.07	5.47	0.70
	masl	142.88	143.10	143.58	143.19	
BH/MW 7	mbgs	5.69	5.54	5.34	5.52	0.35
	masl	141.27	141.42	141.62	141.43	
BH/MW 8	mbgs	6.03	5.89	5.73	5.88	0.30
	masl	140.91	141.05	141.21	141.06	

Notes: mbgs -- metres below ground surface masl -- metres above sea level

As shown above, the groundwater levels at all the BH/MWs exhibited a consistent ascending trend throughout the monitoring period. The greatest fluctuated was observed at BH/MW 2, where the groundwater levels exhibited a 0.70 m difference in groundwater elevation over the monitoring period.

6.4 Shallow Groundwater Flow Pattern

The groundwater flow pattern for the shale bedrock beneath the site was interpreted from the average of groundwater levels measured at all BH/MWs, suggesting that it flows in a west to south-easterly direction. The interpreted groundwater flow patterns for the subject site are illustrated on Drawing No. 9.

6.5 Single Well Response Test Analysis

BH/MWs 1, 2, 7, and 8 underwent single well response tests (SWRTs) to estimate the hydraulic conductivity (K) for saturated aquifer subsoils at the depths of the well screens. The results of the SWRTs are presented in Appendix ‘B’, with a summary of the findings shown in Table 6-2.

Table 6-2 - Summary of SWRT Results

Well ID	Ground El. (masl)	Monitoring Well Depth (mbgs)	Borehole Depth (mbgs)	Screen Interval (mbgs)	Screened Soil Strata	Hydraulic Conductivity (K) (m/sec)
BH/MW 1	148.6	9.1	9.1	6.1-9.1	Shale Bedrock	2.1×10^{-7}
BH/MW 2	148.6	9.1	9.1	6.1-9.1	Shale Bedrock	2.2×10^{-8}
BH/MW 7	147.0	9.0	9.0	5.9-9.0	Shale Bedrock	7.1×10^{-9}
BH/MW 8	146.9	9.1	9.1	6.1-9.1	Shale Bedrock	9.1×10^{-9}

Notes: mbgs -- metres below ground surface masl -- metres above sea level

As shown above, the K estimates range from 2.1 x 10^{-7} to 9.1 x 10^{-9} m/sec for the weathered shale bedrock. The results of the SWRT provide an indication of the seepage yield capacity for the shallow groundwater-bearing bedrock strata at the depths of the screens. The above results suggest that the hydraulic conductivity for the groundwater-bearing subsoils shale bedrock at the depths of the well screens varies and is low to moderate, with correspondingly low to moderate anticipated groundwater seepage rates in open excavations below the prevailing groundwater table.

7.0 GROUNDWATER CONTROL DURING CONSTRUCTION

The estimated hydraulic conductivity (K) values suggest that groundwater seepage rates into open excavation below the groundwater table will be low to moderate. To provide safe, dry and stable conditions for earthworks excavations for the construction of the proposed underground parking structure, the groundwater table should be lowered in advance of, or during construction. Preliminary estimates for construction dewatering flows required to locally lower the groundwater table, based on the K test results, are discussed in the following sections.

7.1 Groundwater Construction Dewatering Rates

The proposed grading and development plans, showing the finished grade elevations for the development, and the invert elevations for the underground services and the 1-level underground parking structure were not available for our review at the time of this report preparation. As such, the average of the existing ground surface elevations, being at 147.5 masl as recorded at BHs and BH/MW's locations was considered as the finished grading elevation for this preliminary construction dewatering needs assessment. It should be noted that property reference plan, provided by RAW design, dated March 28, 2019 was reviewed for the current dewatering needs assessment. The construction dewatering flows were estimated and completed for the proposed 1 level underground parking structure and for the associated underground services, with the details presented as follows:

Preliminary Construction Dewatering Needs Estimation for Construction of the 1-Level Underground Parking Structure: Considering a ground surface elevation of 147.5 masl as the proposed grading elevation and assuming 3.0 ± m as the depth for the base of the proposed 1-level underground parking structure, a base elevation of 144.5 masl was considered for the construction dewatering needs assessment for the 1-level underground parking slab. To maintain a dry and safe excavation it is recommended that the groundwater table be lowered to an elevation of 143.5 masl, which is, about 1 m below the lowest estimated base elevation. The highest shallow groundwater levels were recorded at each BH/MW as measured over the monitoring period which ranged from El. 141.2 masl at BH/MW 8 to El. 143.6 masl at BH/MW 2. The subsoil profile consists of silty clay till and underlying weathered shale bedrock, extending to the maximum anticipated excavation depths. For the assessment, the entire site was considered as the proposed development footprint, which will be excavated for construction of the proposed 1-level underground parking structure. As such, a rectangular excavation, having the dimensions of about 60 m in width and 110 m in length was considered for this preliminary construction dewatering needs assessment. Considering the above-mentioned parameters, the estimated construction dewatering flow rates to facilitate excavation of the proposed 1-level underground parking structure could reach a daily rate of 213.1 L/day; by applying 3 x safety factor, it could reach a maximum rate of 639.4 L/day.

Since fractured/weathered shale bedrock was contacted at shallow depths beneath the subject site, where it is anticipated that accumulated runoff, generated from precipitation storm events should be considered for the construction dewatering needs estimation. There may be a need to remove temporary runoff accumulation within construction excavation and servicing trenches follow high storm events. A review of the Intensity Duration-Frequency Curve (IDF Curve) for the year 2010 for the subject site indicated that the 24-hour, 100 year return period rainfall depth for the area was recorded at 123.6 mm. Considering an approximate excavation area of 6,600 m^2 (length of 110 m and width of 60 m), the accumulated runoff volume could reach approximate to 815.76 m^3 /day (815,760 L/day). This potential volume accumulation within the developed footprint excavation exceeds the MECP threshold requirement of 50,000 L/day for requiring a groundwater taking approval and is over the 400,000 L/day limit for an EASR approval. However, if this volume does not need to be removed immediately and can be cleared over a series of days, it is anticipated that any required removal of any accumulated runoff volume can be accomplished without the need for an Permit-To-Take Water (PTTW).

Preliminary Construction Dewatering Estimation for Installation of Underground Services Alignments: The invert elevations for the installation of underground services were estimated based on the average of the existing ground surface elevations as determined at the BH/MWs locations, and by assuming 5.0± m depths for the underground servicing trench excavations. As such, an invert elevation of 142.5 masl was considered for this current construction dewatering needs assessment. To maintain a dry and safe conditions for excavation it is recommended that the ground water table be lowered to an elevation of 141.5 masl, which is, about 1.0 m below the estimated lowest considered underground services installation invert elevation. The highest shallow groundwater level within each BH/MW, as recorded during the monitoring period, ranges from elevations of 141.2 masl at BH/MW 8 to 143.6 masl at BH/MW 2. The estimated hydraulic conductivity (K) ranges from 2.1×10^{-7} m/sec to 9.1×10^{-9} m/sec. The subsoil profile consists of silty clay till and weathered shale bedrock, extending to the maximum anticipated excavation depth. It should be noted that a rectangular trench excavation, having dimensions of about 5.0 m in width and 50.0 m in length was considered for this preliminary construction dewatering needs assessment. Considering the above-mentioned parameters, the construction dewatering flow rate for installation of the proposed underground services could reach a daily rate of 12,544.7 L/day; by applying 3 x safety factor, it could reach a maximum rate of 37,634.0 L/day.

In accordance with the current policy of the Ministry of Environment, Conservation and Parks (MECP), where the dewatering flow rate is between 50,000 L/day and 4000,000 L/day, the approval for proposed groundwater taking for construction is by means of the filing an Environmental Activity and Sector Registry (EASR) with the MECP. Since the estimated dewatering flow rate is below 50,000 L/day, the registering for an approval for proposed groundwater-taking for construction is not required. Since the estimated construction dewatering flow rate for installation of the underground services is not anticipated to exceed 12,544.7 L/day, with a maximum daily flow rate of 37,634.0 L/day, being assessed, the applying for any approval for groundwater taking to facilitate a construction dewatering program is not anticipated in advance of proposed earth works and construction. An EASR approval could be considered to address any required rapid removal of accumulated runoff from within the excavations following a heavy storm events, should the pumping flows needs to facilitate any rapid volume removal of accumulated runoff exceed 50,000 liters per day.

It should be noted that base and invert elevations for the proposed underground structures, and underground services were not available for our review. As such, it is recommended that the dewatering needs estimation be updated should there be significant changes in development plans and proposed servicing depth elevations relative to our considered depths for this preliminary assessment.

7.2 **Groundwater Control Methodology**

Given that low to moderate groundwater seepage rates are anticipated into open excavations below the groundwater table, any construction dewatering can likely be controlled by occasional pumping from sumps when and where required during construction. Well points can be employed to lower the groundwater table if sump pit dewatering or other means cannot maintain stable soil conditions. The final design for any dewatering system will be the responsibility of the construction contractors retained for the development.

7.3 **Mitigation of Potential Impacts Associated with Dewatering**

The conceptual zone of influence for any construction dewatering could reach a maximum of 2.5 m away from the conceptual dewatering alignment around the excavation footprint and servicing trench areas. Based on the records review, there no natural heritage features located within the conceptual zone of influence for construction dewatering. Furthermore, based on the records review, there are no nearby water supply wells located within the conceptual zone of influence for construction dewatering.

Furthermore, there are adjacent residential structures and Sixth Line which may be located within the conceptual zone of influence for construction dewatering. It is recommended that the potential ground settlement concerns be assessed by a geotechnical engineer prior to proposed earthworks. Since the proposed development plans were not available for our review at the time of this report preparation, it is recommended that the dewatering assessment and zone of influence estimation be updated, along with an updated impact assessment to determine if a mitigation plan is required during construction, once finalized development plans become available for our review.

7.4 **Ground Settlement**

Sixth line and the residential structures may be located within the estimated conceptual zone of influence. It is recommended that potential ground settlement concerns associated with anticipated construction dewatering should be assessed by a geotechnical engineer prior to construction.

7.5 Groundwater Function of the Subject Site

The proposed development will consist of mixed-use buildings having an associated 1-level underground parking structure along with associated underground services and utilities. This study shows that the shallow groundwater table may be temporarily lowered in advance of, and during construction for the proposed underground parking structure and for the installation of the associated underground services. The subject site is located within an existing residential neighborhood. There are no records for any natural heritage features within the conceptual zone of influence for construction dewatering. However, there is a tributary of the Sixteen Mile Creek which traverses an area, approximately 75 m northeast of the subject site. Based on the measured shallow groundwater levels, the proposed 1-level underground parking structure is likely to be constructed below the shallow groundwater level. As such, it may be necessary to lower any perched shallow groundwater table temporarily during earthworks for construction. The construction site is underlain by low permeable subsoil and weathered shale in which the underground parking structure will be set within the shale bedrock unit. As such, any impacts form any temporary construction dewatering on the shallow groundwater function of the site are expected to be minor, with no long-term impacts being anticipated.

7.6 Low Impact Development Stormwater Management Infrastructure

The native surficial subsoil beneath the site consists mainly of silty clay till. The highest groundwater level lies at a depth of about 5.07 m below the prevailing ground surface. If the shallow soils remain unsaturated, LID infrastructure should be considered for the proposed development. Infiltration trenches, bioretention facilities and soak away pits along with green roof could be implemented to address future stormwater management planning for the proposed development. It is recommended that percolation rates for the surface soil and shallow subsoils be estimated using in-situ infiltration tests in support of any proposed LID infiltration infrastructure designs.

8.0 CONCLUSIONS

1. The subject is located within the Physiographic Region of Southern Ontario known as the South Slope, on the Till Plains (Drumlinized) Physiographic feature.
2. Based review of the surface geological map of Ontario, the subject site is underlain by the Halton Till unit, consisting predominantly of silt to silty clay matrix, high in matrix calcium carbonate, considering as being clast poor.
3. The subject site is located within the Sixteen-Mile Creek Watershed.

4. The subject site is located south of a Tributary of Sixteen Mile Creek. An associated wooded area is located north and east of the site subject site. Additional wooded areas are also located approximately about 300 m south of the subject site. A small water body is located approximately 1200 m northwest of the subject site. There are no wetlands in or around the subject site.
5. The subject site exhibits a gentle decline in elevation relief towards the east
6. This study has disclosed that beneath a layer of asphaltic concrete and granular fill, the native soils underlying the subject site consists of silty clay till and shale bedrock, extending to termination depth of investigation at 9.1 meters below the prevailing ground surface.
7. During the monitoring period, the measured groundwater level elevations range from 5.07 to 6.03 mbgs, or from EL. 140.91 to 143.6 masl.
8. Hydraulic conductivity (K) estimates, ranging from 2.1 x 10^{-7} to 9.1 x 10^{-9} m/sec were assessed for the weathered shale bedrock units at the screened depth intervals for the monitoring wells construction beneath the site.
9. The estimated construction dewatering flow rates could reach a daily rate of 213.1 L/day for construction of the proposed 1-level underground parking structure. By considering a 3x safety factor, the estimated dewatering flow rate could reach an approximately daily maximum of 639.4 L/day. For installation of the underground services the estimated construction dewatering flow rates could reach a daily rate of 12,544.7 L/day, by applying 3 x safety factor, it could reach a maximum rate of 37,634.0 L/day.
10. Since the estimated dewatering flow rate does not exceed the MECP groundwater taking threshold limit, the applying for Environmental Activity and Sector Registry (EASR) approval to facilitate the underground services installation and for construction of the 1-level underground parking structure is not anticipated. However, an EASR approval could be considered to address any requires rapid removal of accumulated runoff from within the excavations following a heavy storm events, should the pumping flows needed to facilitate its rapid removal exceed 50,000 litres per day. The current construction dewatering assessment was based on the consideration for a 3.0 m depth for proposed underground parking structure and 5.0 m depths for proposed underground servicing installation. As such, it is recommended that the construction dewatering needs estimation be updated if there is significant change in the final designs relative to the depths and dimensions considered for this assessment.
11. The conceptual zone of influence for construction dewatering could reach a maximum of 2.5 m away from the dewatering array considered around the construction footprint for the development. There are no water bodies, wetlands or watercourses located within the conceptual zone of influence for construction dewatering. Furthermore,

Sixth Line and associated infrastructure could potentially be affected by ground settlement associated with the Conceptual Zone of Influence for construction dewatering. As such, potential ground settlement concerns should be assessed by a geotechnical engineer, prior to proposed earth works.

Yours truly
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1267
Feb 12, 2020
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9.0 REFERENCES

1. The Physiography of Southern Ontario (Third Edition), L. J. Chapman and D. F. Putnam, 1984

2. Bedrock Geology of Ontario, 1993, Data set 6, Ministry of Northern Development.

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FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 542-2769

FIGURES 1 to 8

BOREHOLE LOGS

REFERENCE NO. 1909-W038

JOB NO.: 1909-W038

LOG OF BOREHOLE NO.: BH/MW 1

FIGURE NO.: 1

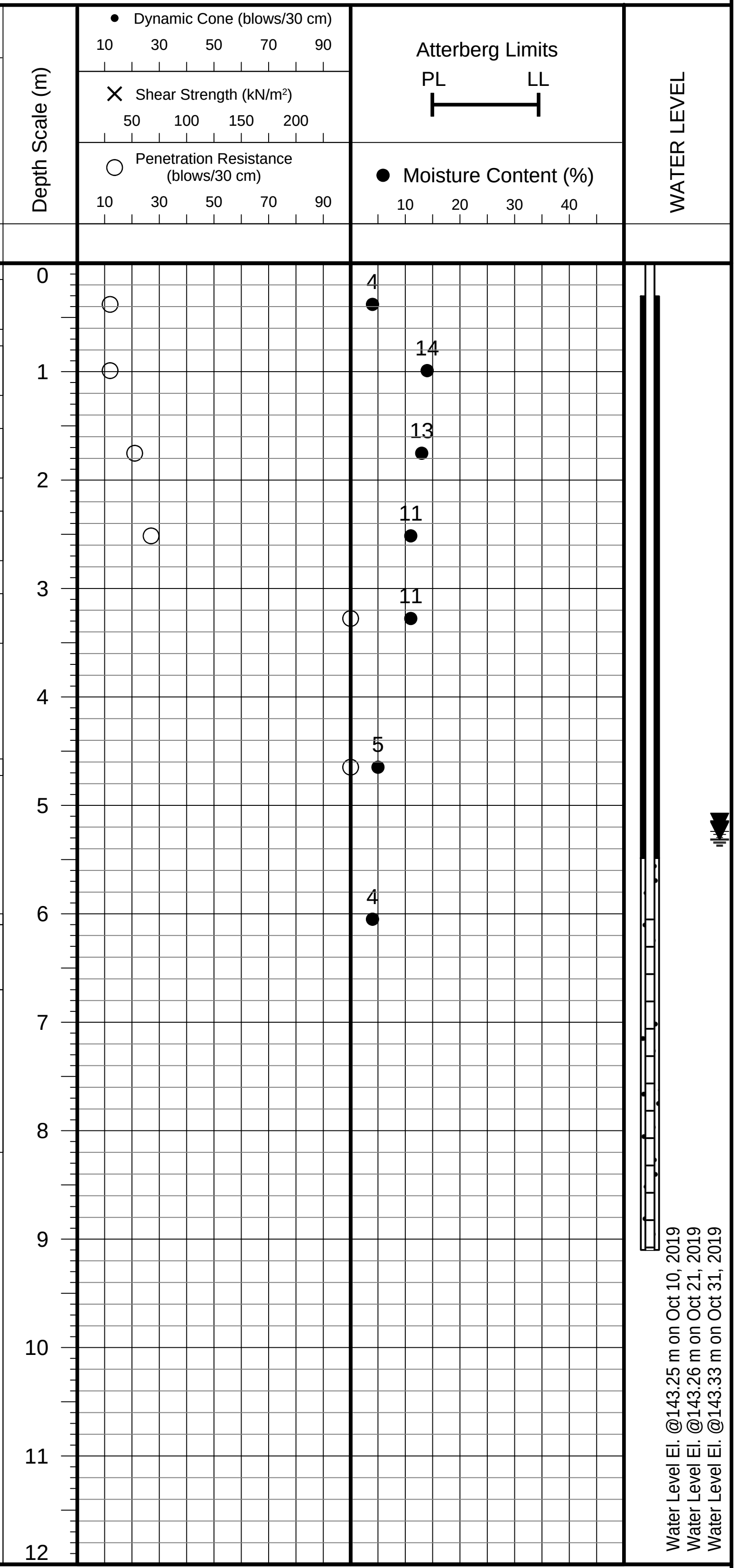
PROJECT DESCRIPTION: Proposed Mixed-Use Buildings

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 2163 and 2169 Sixth Line, Town of Oakville

DRILLING DATE: October 3, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
148.6	Pavement Surface			
0.0	**10 cm ASPHALT** **50 cm GRANULAR FILL**	1	DO	12
	Reddish brown, stiff to hard weathered **SILTY CLAY TILL** a trace of gravel occ. sand seams and layers, cobbles and boulders	2	DO	12
		3	DO	21
		4	DO	27
145.4 3.2	Reddish brown, hard **SHALE** stratified weathered to 6.5 m	5	DO	50/10
		6	DO	50/15
		7	AS	-
		8	RC RQD	58% 16%
		9	RC RQD	100% 50%
140.4 9.1	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 9.1 m 3.0 m screen from 6.1 to 9.1 m Sand backfill from 5.5 to 9.1 m Bentonite seal from 0.3 to 5.5 m Provided with a Flush Mount Casing			



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JOB NO.: 1909-W038

LOG OF BOREHOLE NO.: BH/MW 2

FIGURE NO.: 2

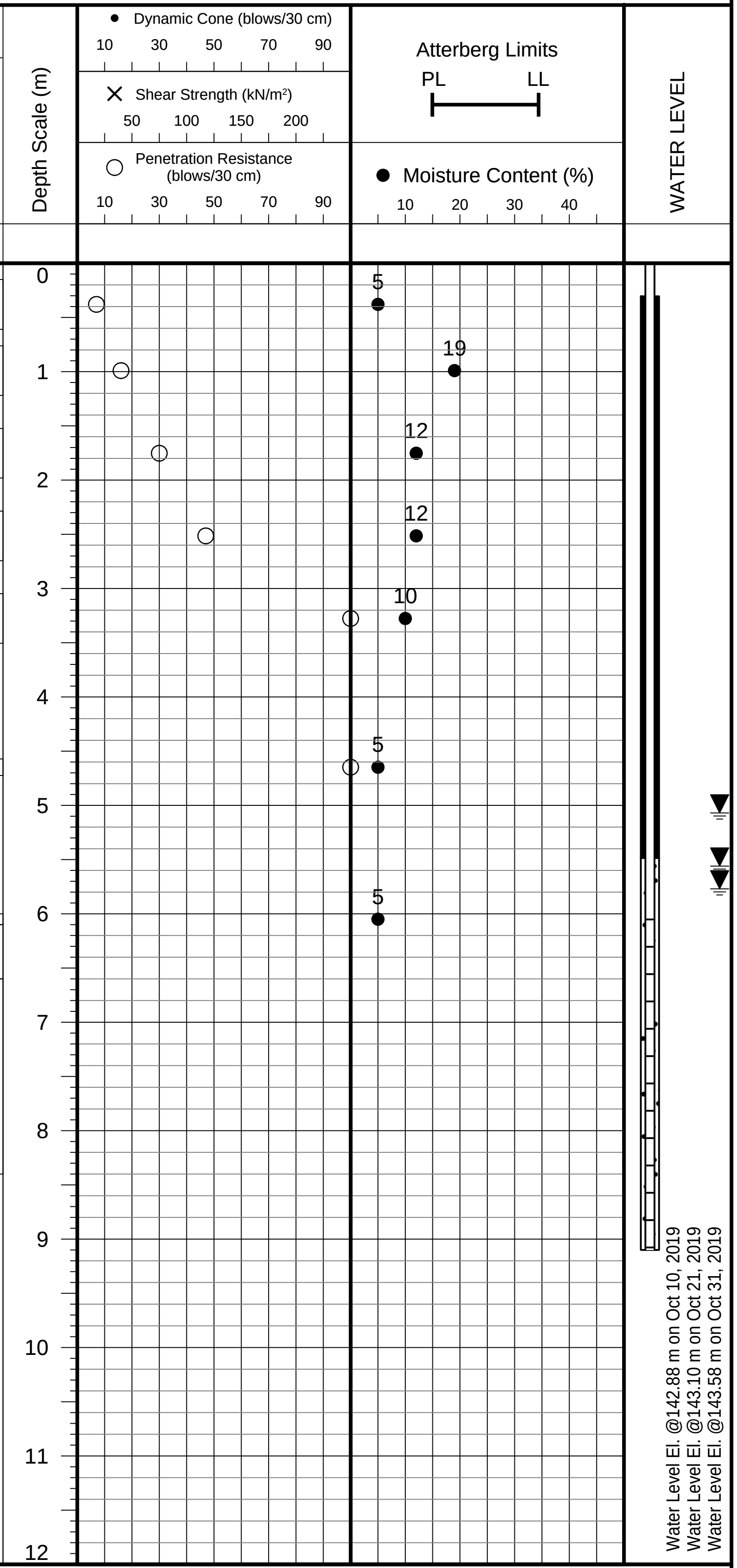
PROJECT DESCRIPTION: Proposed Mixed-Use Buildings

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 2163 and 2169 Sixth Line, Town of Oakville

DRILLING DATE: October 10, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
148.6	Pavement Surface			
0.0	**10 cm ASPHALT** **50 cm GRANULAR FILL**	1	DO	7
	Reddish brown, very stiff to hard **SILTY CLAY TILL** a trace of gravel occ. sand seams and layers, cobbles and boulders	2	DO	16
		3	DO	30
		4	DO	47
		5	DO	50/13
145.3 3.3	Reddish brown, hard **SHALE** stratified weathered to 6 m	6	AS	NP
		7	AS	-
		8	RC RQD	100% 70%
		9	RC RQD	98% 62%
140.2 9.1	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 9.1 m 3.0 m screen from 6.1 to 9.1 m Sand backfill from 5.5 to 9.1 m Bentonite seal from 0.3 to 5.5 m Provided with a Flush Mount Casing			



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Page: 1 of 1

JOB NO.: 1909-S038

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

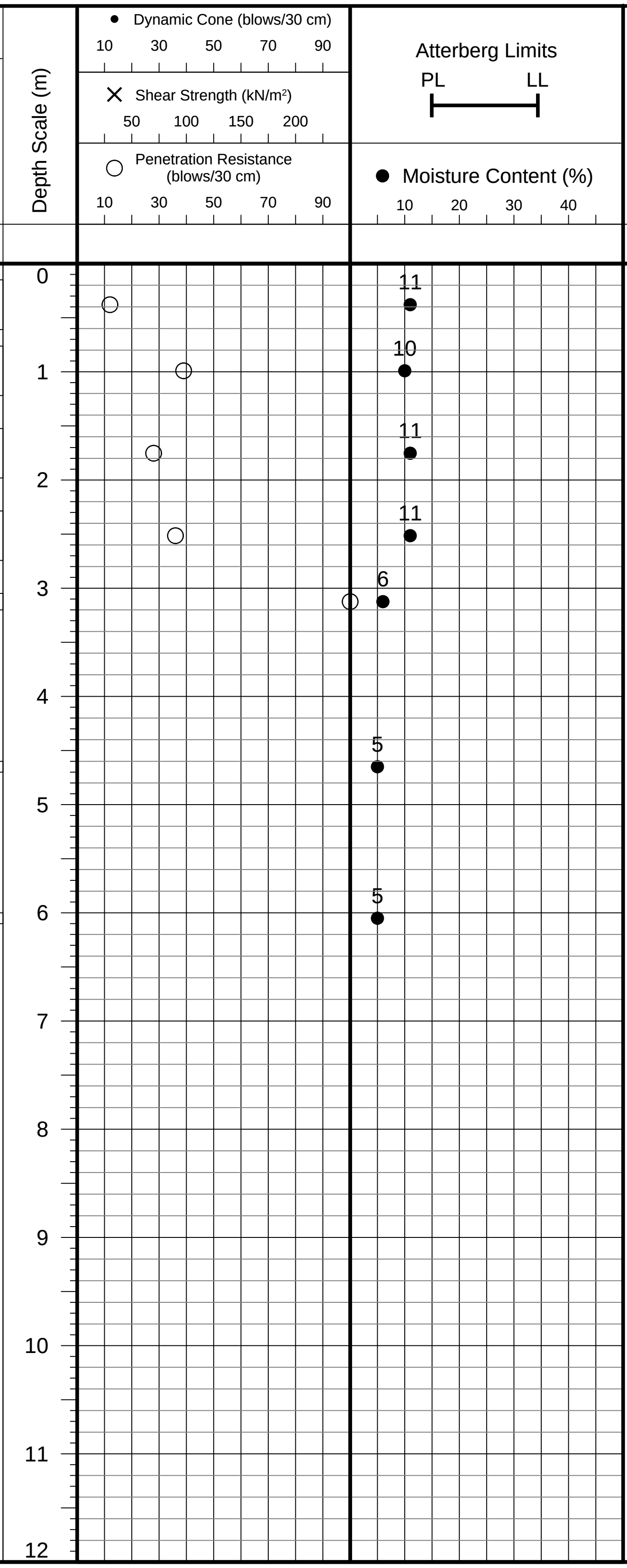
PROJECT DESCRIPTION: Proposed Mixed-Use Buildings

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 2163 and 2169 Sixth Line, Town of Oakville

DRILLING DATE: October 10, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	WATER LEVEL
147.5	Pavement Surface				
0.0	**8 cm TOPSOIL**				Dry on completion
	Reddish brown, stiff to hard weathered **SILTY CLAY TILL** a trace of gravel occ. sand seams and layers, cobbles and boulders	1	DO	12	
		2	DO	39	
		3	DO	28	
		4	DO	36	
144.5 3.0	Reddish brown, hard **SHALE** stratified, weathered occ. clay seams and limestone layers	5	DO	50/5	
		6	AS	-	
141.4 6.1	**END OF BOREHOLE**	7	AS	-	



JOB NO.: 1909-S038

LOG OF BOREHOLE NO.: BH/MW 4

FIGURE NO.: 4

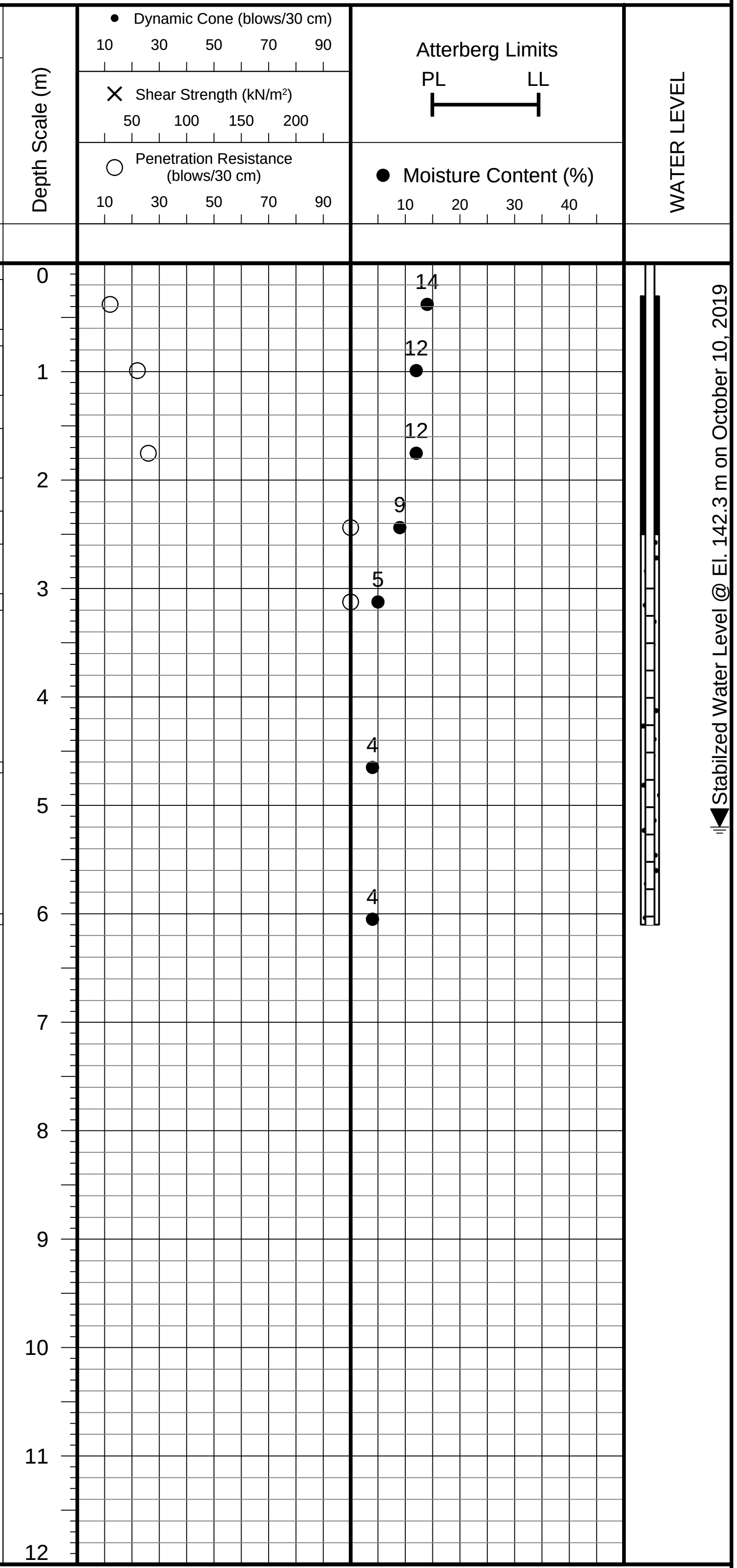
PROJECT DESCRIPTION: Proposed Mixed-Use Buildings

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 2163 and 2169 Sixth Line, Town of Oakville

DRILLING DATE: October 11, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
147.5	Pavement Surface			
0.0	**8 cm ASPHALT** **23 cm GRANULAR FILL**			
	weathered Reddish brown, stiff to very stiff **SILTY CLAY TILL** a trace of gravel occ. sand seams and layers, cobbles and boulders	1	DO	12
		2	DO	22
		3	DO	26
145.2 2.3	Reddish brown, hard **SHALE** stratified, weathered occ. clay seams and limestone layers	4	DO	50/10
		5	DO	50/15
		6	AS	-
		7	AS	-
141.4 6.1	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 6.1 m, 3.0 m screen from 3.1 to 6.1 m Sand backfill from 2.5 to 6.1 m Bentonite seal from 0.3 to 2.5 m Provided with a Flush Mount Casing			



Stabilized Water Level @ El. 142.3 m on October 10, 2019

JOB NO.: 1909-S038

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

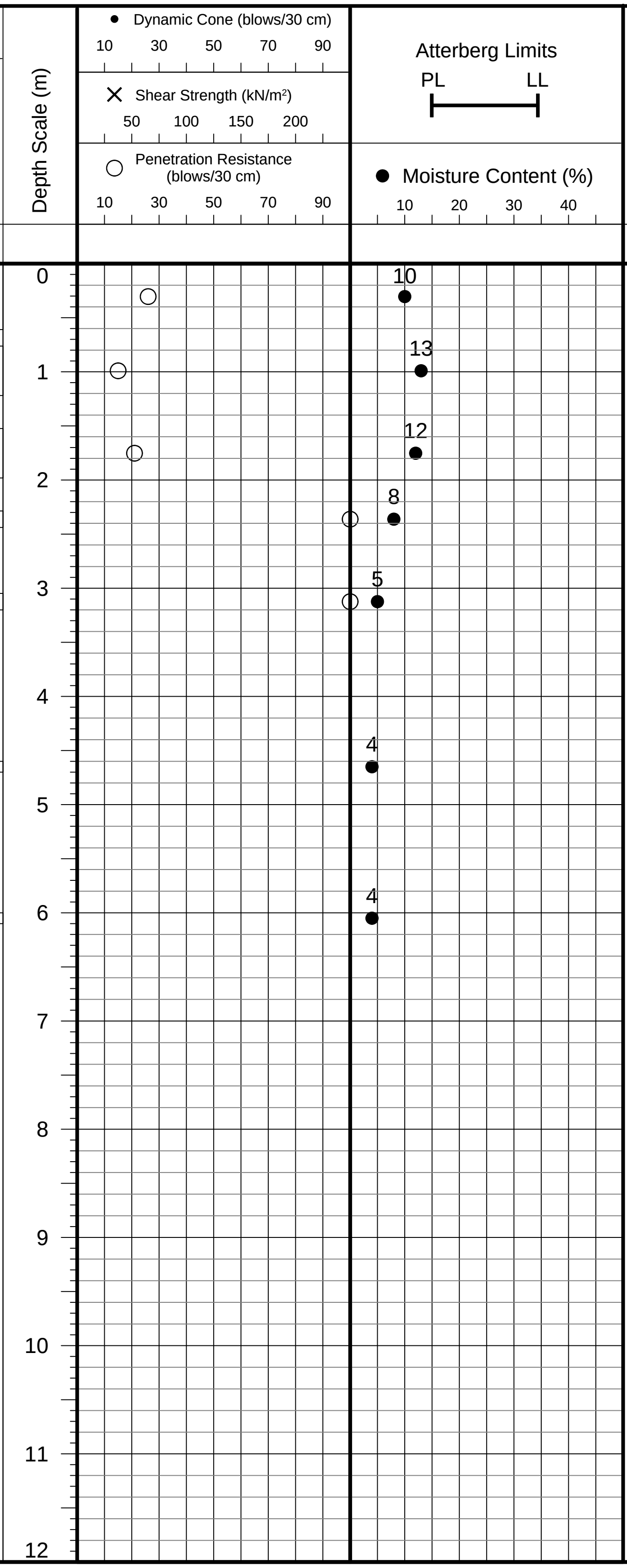
PROJECT DESCRIPTION: Proposed Mixed-Use Buildings

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 2163 and 2169 Sixth Line, Town of Oakville

DRILLING DATE: October 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Moisture Content (%)	WATER LEVEL
146.8	Pavement Surface					
0.0	**13 cm ASPHALT** **25 cm GRANULAR FILL**	1	DO	26	10	Dry on completion
	Reddish brown, stiff to very stiff **SILTY CLAY TILL** weathered a trace of gravel occ. sand seams and layers, cobbles and boulders	2	DO	15	13	
		3	DO	21	12	
144.5 2.3	Reddish brown, hard **SHALE** stratified, weathered occ. clay seams and limestone layers	4	DO	50/13	8	
		5	DO	50/5	5	
		6	AS	-	4	
		7	AS	-	4	
140.7 6.1	**END OF BOREHOLE**					



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JOB NO.: 1909-S038

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

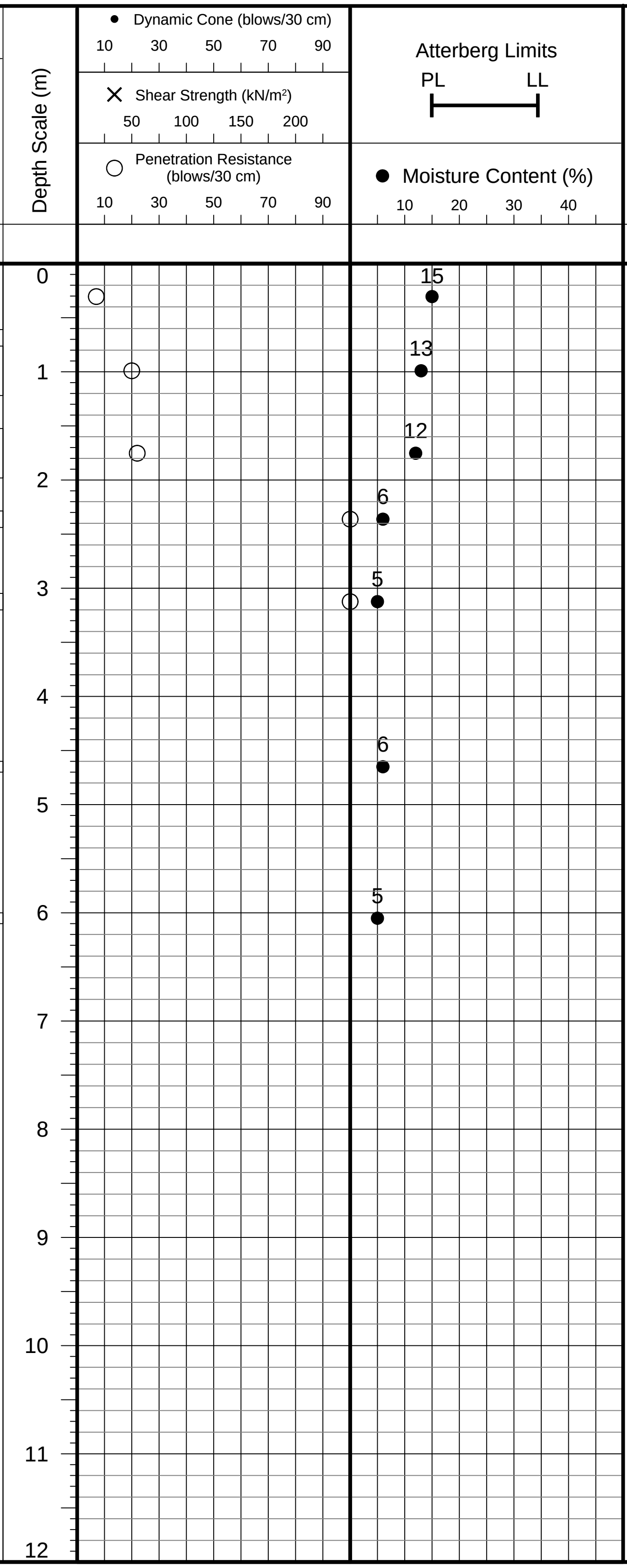
PROJECT DESCRIPTION: Proposed Mixed-Use Buildings

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 2163 and 2169 Sixth Line, Town of Oakville

DRILLING DATE: October 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
148.4	Pavement Surface			
0.0	**13 cm TOPSOIL**			
	Reddish brown, firm to very stiff weathered **SILTY CLAY TILL** a trace of gravel occ. sand seams and layers, cobbles and boulders	1	DO	7
		2	DO	20
		3	DO	22
146.1 2.3	Reddish brown, hard **SHALE** stratified, weathered occ. clay seams and limestone layers	4	DO	50/15
		5	DO	50/5
		6	AS	-
142.3 6.1	**END OF BOREHOLE**	7	AS	-



WATER LEVEL

Dry on completion

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JOB NO.: 1909-W038

LOG OF BOREHOLE NO.: BH/MW 7

FIGURE NO.: 7

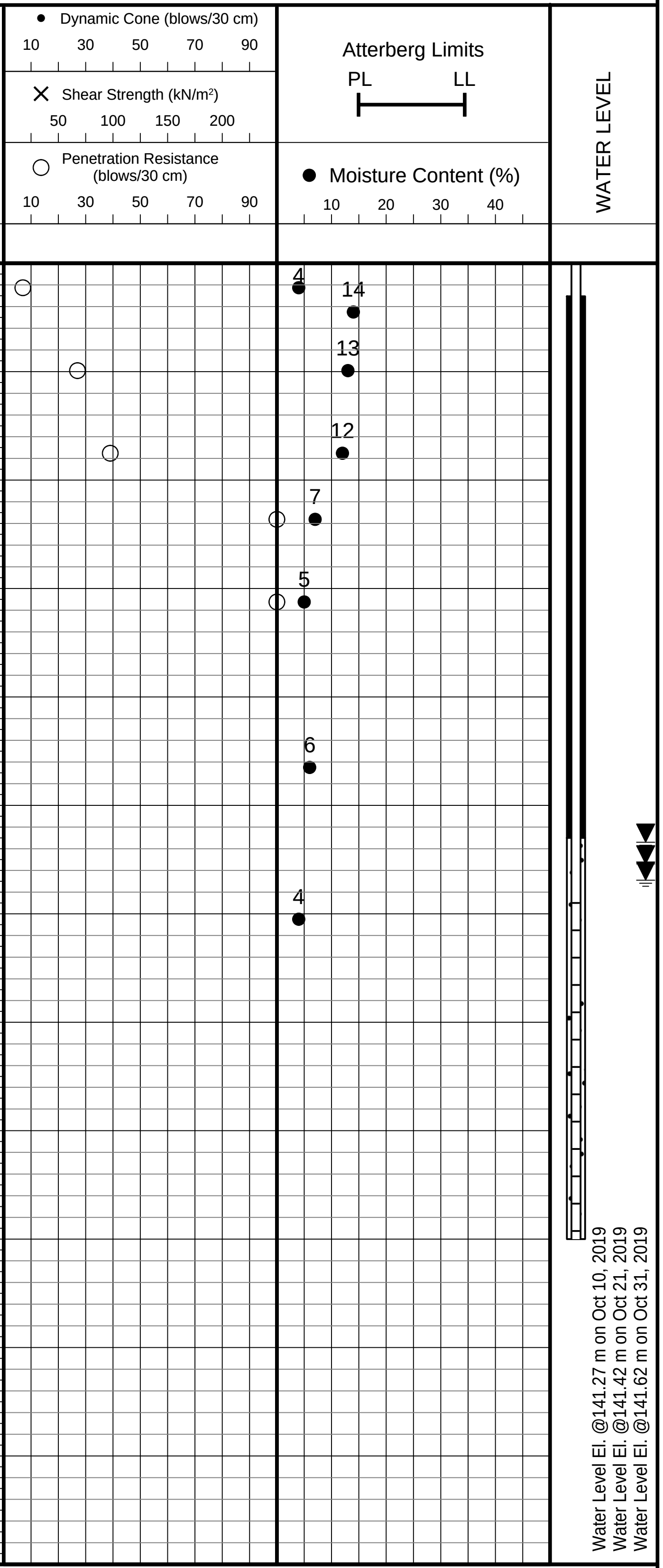
PROJECT DESCRIPTION: Proposed Mixed-Use Buildings

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 2163 and 2169 Sixth Line, Town of Oakville

DRILLING DATE: October 7, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)
147.0	Pavement Surface				
0.0	**8 cm ASPHALT** **20 cm GRANULAR FILL**	1A 1B	DO	7	0
	Reddish brown, very stiff to hard weathered **SILTY CLAY TILL** a trace of gravel occ. sand seams and layers, cobbles and boulders	2	DO	27	1
		3	DO	39	2
144.7 2.3	Reddish brown, hard **SHALE** stratified weathered to 6 m	4	DO	50/15	
		5	DO	50/13	3
		6	AS	-	4 5
		7	AS	-	6
		8	RC RQD	97% 73%	7
		9	RC RQD	100% 70%	8
138.9 9.0	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 9.0 m 3.0 m screen from 5.9 to 9.0 m Sand backfill from 5.3 to 9.0 m Bentonite seal from 0.3 to 5.3 m Provided with a Flush Mount Casing				9 10 11 12



Water Level El. @141.27 m on Oct 10, 2019
Water Level El. @141.42 m on Oct 21, 2019
Water Level El. @141.62 m on Oct 31, 2019

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Page: 1 of 1

JOB NO.: 1909-W038

LOG OF BOREHOLE NO.: BH/MW 8

FIGURE NO.: 8

PROJECT DESCRIPTION: Proposed Mixed-Use Buildings

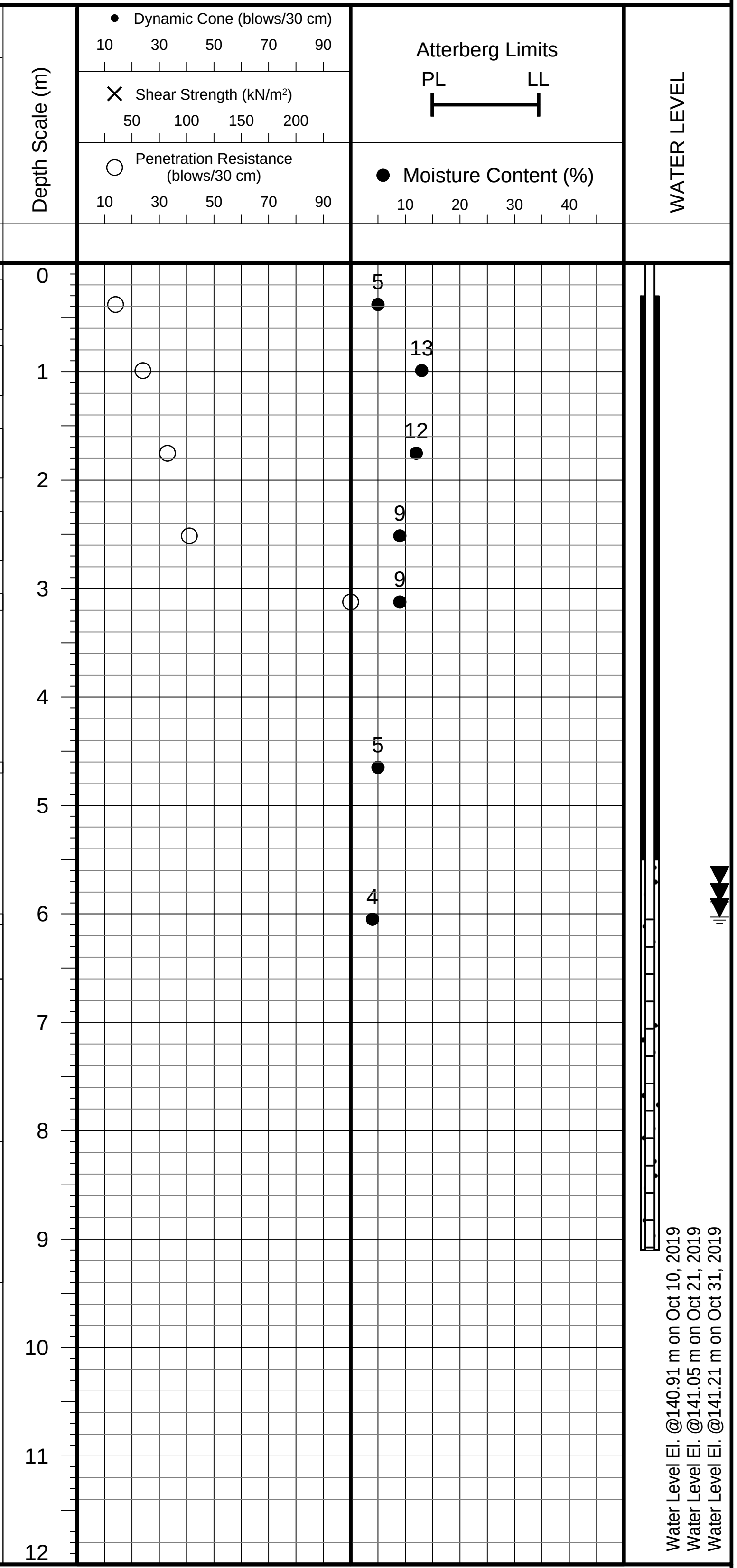
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 2163 and 2169 Sixth Line, Town of Oakville

DRILLING DATE: October 9, 2019

El. (m) Depth (m)	SOIL DESCRIPTION
146.9	Pavement Surface
0.0	**8 cm ASPHALT** **52 cm GRANULAR FILL**
	Reddish brown, very stiff to hard **SILTY CLAY TILL** a trace of gravel occ. sand seams and layers, cobbles and boulders
143.9 3.0	Reddish brown, hard **SHALE** stratified weathered to 5.5 m occ. clay seams and limestone layers
137.5 9.1	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 9.1 m 3.0 m screen from 6.1 to 9.1 m Sand backfill from 5.5 to 9.1 m Bentonite seal from 0.30 to 5.5 m Provided with a Flush Mount Casing

SAMPLES Number	Type	N-Value
1	DO	14
2	DO	24
3	DO	33
4	DO	41
5	DO	50/13
6	AS	-
7	AS	-
8	RC RQD	100% 70%
9	RC RQD	100% 81%
10	RC RQD	100% 88%



Water Level El. @140.91 m on Oct 10, 2019
Water Level El. @141.05 m on Oct 21, 2019
Water Level El. @141.21 m on Oct 31, 2019

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FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 542-2769

DRAWINGS 1 to 9

REFERENCE NO. 1909-W038

N

▭ Approximate Boundary of Subject Site

➤ Watercourse

━ Major Road

— Local Road

Soil Engineers Ltd.

Title: Site Location Plan

Project:

Hydrogeological Assessment
Proposed Mixed-Use Buildings
2163 and 2169 Sixth Line
Town of Oakville

Reference No. 1909-W038

Date: September 12, 2019

Scale:
0 30 60 120 180 240 300
Metres

Drawing No. 1

Source: Water Course, Ontario Ministry of Natural Resources and Forestry
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Source: Water Body, Ontario Ministry of Natural Resources and Forestry
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C:\GIS2019\1909-W038\

▭ Approximate Boundary of Subject Site

◉ Borehole

⊕ Borehole with Monitoring Well

→ Watercourse

━ Major Road

— Local Road

Soil Engineers Ltd.

Title: Borehole and Monitoring
Well Location Plan

Project:

Hydrogeological Assessment
Proposed Mixed-Use Buildings
2163 and 2169 Sixth Line
Town of Oakville

Reference No. 1909-W038

Date: November 21, 2019

Scale:
0 5 10 20 30 40 50
Metres

Drawing No. 2

Source: Ministry of Natural Resources and Forestry
©Queen's Printer for Ontario, 2019

Source: Water Course, Ontario Ministry of Natural Resources and Forestry
©Queen's Printer for Ontario

Source: Water Body, Ontario Ministry of Natural Resources and Forestry
©Queen's Printer for Ontario

🟥 Approximate Boundary of Subject Site

▭ 500 metres from Subject Site Boundary

● 1 Well Location from MECP Well Records (see Appendix 'A")

→ Watercourse

━ Major Road

— Local Road

Soil Engineers Ltd.

Title: MECP Well Location Plan

Project:

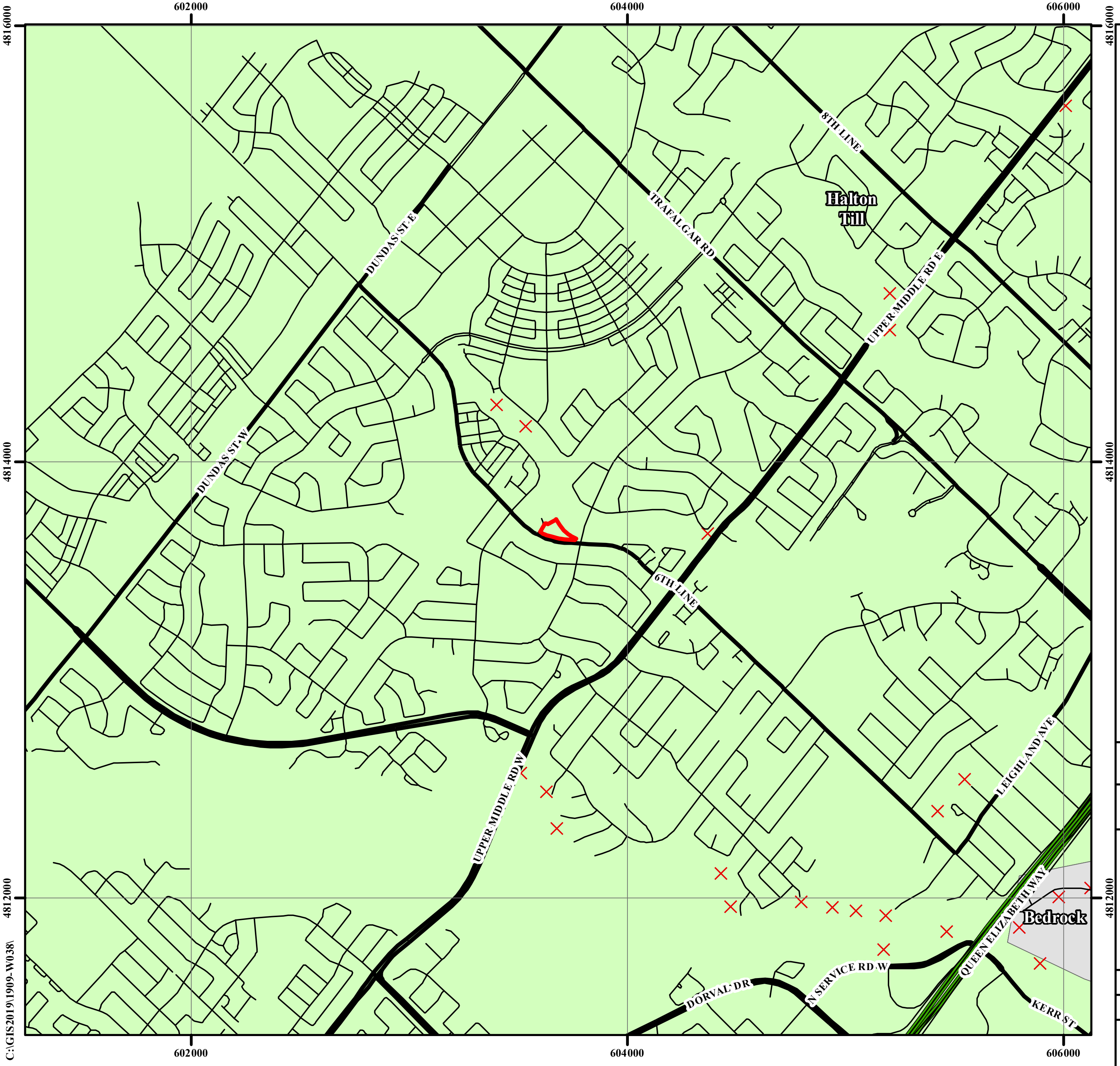
Hydrogeological Assessment
Proposed Mixed-Use Buildings
2163 and 2169 Sixth Line
Town of Oakville

Reference No. 1909-W038

Date: September 12, 2019

Scale:
0 30 60 120 180 240 300
Metres

Drawing No. 3



Source: Ontario Geological Survey, 1997,
Surface Geology of Ontario; Ontario Geological Survey,
Miscellaneous Released-Data 0014

N

🟥	Approximate Boundary of Subject Site
▨	Bedrock, undifferentiated igneous and metamorphic rock, or carbonate and clastic sedimentary rock, exposed at surface or covered by a discontinuous, thin layer of drift
🟩	Halton Till Material: predominantly silt to silty clay matrix, high in matrix carbonate content and clast poor
×	Outcrops
═	Expressway/Freeway
━	Major Road
─	Local Road

Soil Engineers Ltd.

Title: Quarternary and Surface
Geology Map

Project:

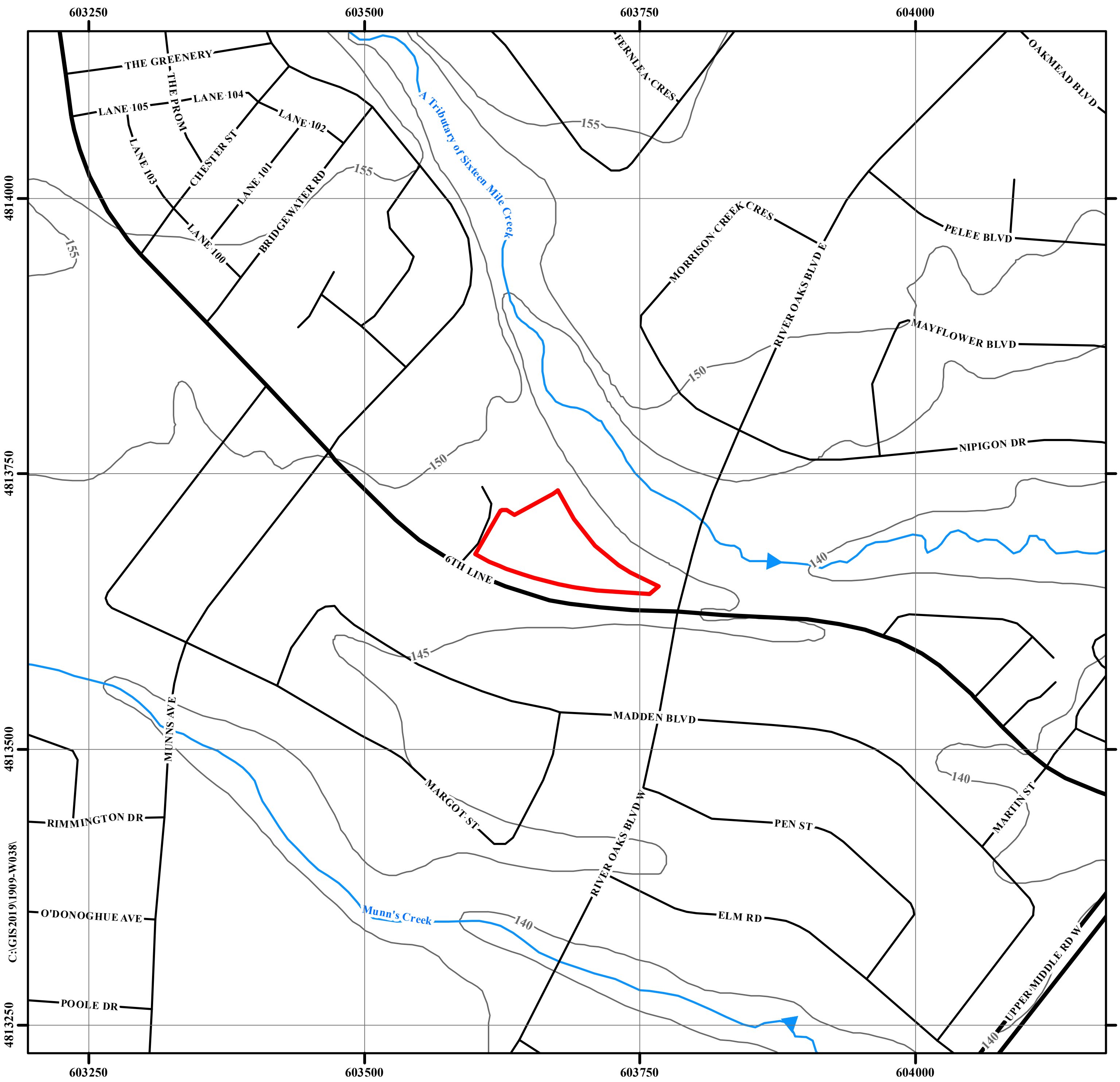
Hydrogeological Assessment
Proposed Mixed-Use Buildings
2163 and 2169 Sixth Line
Town of Oakville

Reference No. 1909-W038

Date: September 12, 2019

Scale:
0 125 250 500 750 1,000 1,250
Metres

Drawing No. 4



C:\GIS2019\1909-W038\

🟥 Approximate Boundary of Subject Site

Watercourse

Major Road

Local Road

—150— Topographic Contour (masl)

Soil Engineers Ltd.

Title: Topographic Map

Project:

Hydrogeological Assessment
Proposed Mixed-Use Buildings
2163 and 2169 Sixth Line
Town of Oakville

Reference No. 1909-W038

Date: September 12, 2019

Scale:

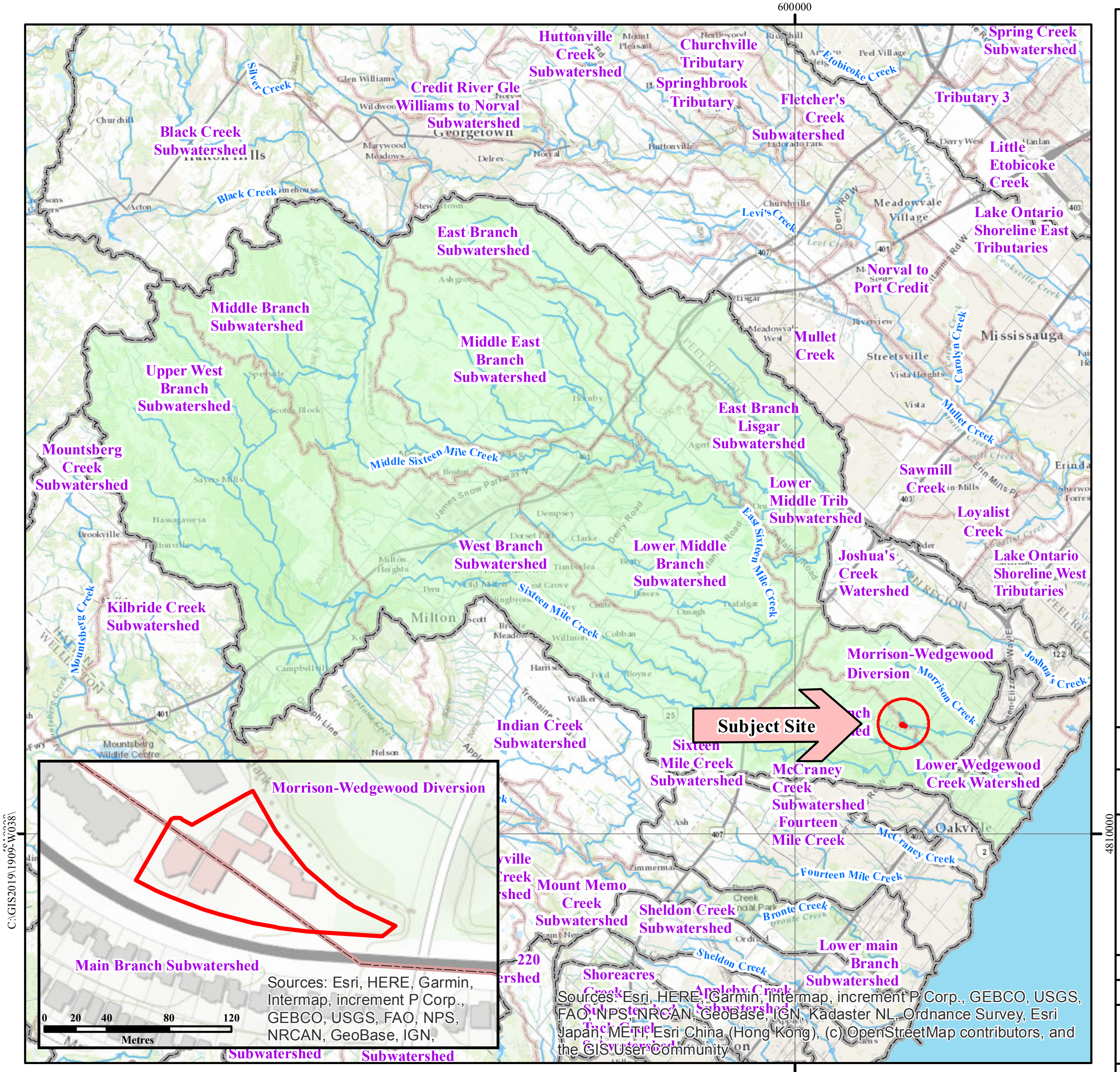
0 25 50 100 150 200 250
Metres

Drawing No. 5

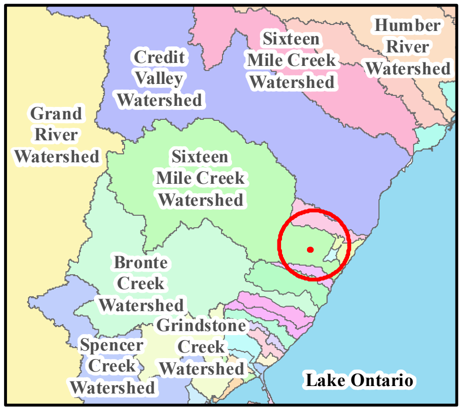
Source: Water Body, Ontario Ministry of Natural Resources and Forestry, 2015
©Queen's Printer for Ontario, 2015

Source: Contour, Ontario Ministry of Natural Resources and Forestry, 2015
©Queen's Printer for Ontario, 2015

Source: Water Course, Ontario Ministry of Natural Resources and Forestry, 2015
©Queen's Printer for Ontario, 2015



Watershed:



🟥	Approximate Boundary of the Subject Site
▭	Watershed Boundaries
🟦	Waterbody
—	Watercourse
—	Expressway/Major Road

Soil Engineers Ltd.

Title: Watershed and Subwatershed Map

Project:

Hydrogeological Assessment
Proposed Mixed-Use Buildings
2163 and 2169 Sixth Line
Town of Oakville

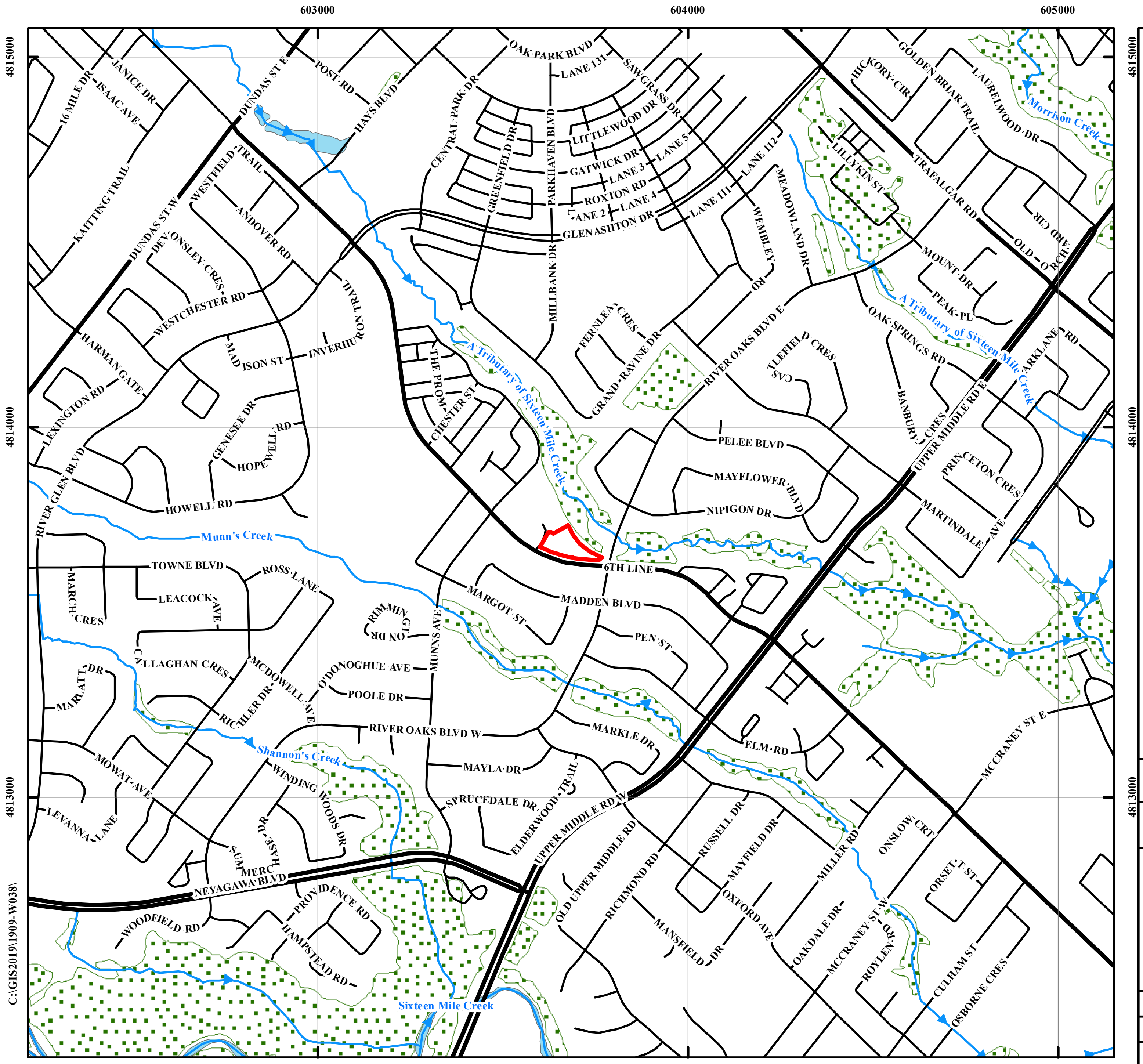
Reference No. 1909-W038

Date: September 12, 2019

Scale:
0 5,00010,000 20,000 30,000 40,000 50,000
Metres

Drawing No. 6

this mapping was produced by SEL and should be used for information purposes only.
Data sources used in its production are of varying quality and accuracy and all boundaries should be considered approximate.



▭ Approximate Boundary of Subject Site

▨ Wooded Area

🟦 Water Body

→ Watercourse

━ Major Road

— Local Road

Soil Engineers Ltd.

Title: Natural Features and Protection Area Plan

Project:

Hydrogeological Assessment
Proposed Mixed-Use Buildings
2163 and 2169 Sixth Line
Town of Oakville

Reference No. 1909-W038

Date: September 12, 2019

Scale:

0 75 150 300 450 600 750
Metres

Drawing No. 7

Contains information licensed under the Open Government Licence – Ontario, 2014 and 2015.
Includes information: Provincial Park, Conservation Reserve, Area of Natural and Scientific Interest, Wetland, Niagara Escarpment Protection Area, Oak Ridges Moraine Conservation and Wilderness Areas
Source: Ontario Ministry of Natural Resources and Forestry, 2015
©Queen's Printer for Ontario, 2015

Source:Water Course, Ontario Ministry of Natural Resources and Forestry, 2015
©Queen's Printer for Ontario, 2015
Source:Water Body, Ontario Ministry of Natural Resources and Forestry, 2015
©Queen's Printer for Ontario, 2015
OWES: Ontario Wetland Evaluatuion System

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

C:\GIS2019\1909-W038\

Source: Ministry of Natural Resources and Forestry
©Queen's Printer for Ontario, 2019

N

🟥	Approximate Boundary of Subject Site
●	Borehole
○	Borehole with Monitoring Well
→	Watercourse
—	Major Road
—	Local Road
A — A'	Cross-Section Direction
—150—	Topographic Contour (masl)

Soil Engineers Ltd.

Title: Cross-Section Key Plan

Project:

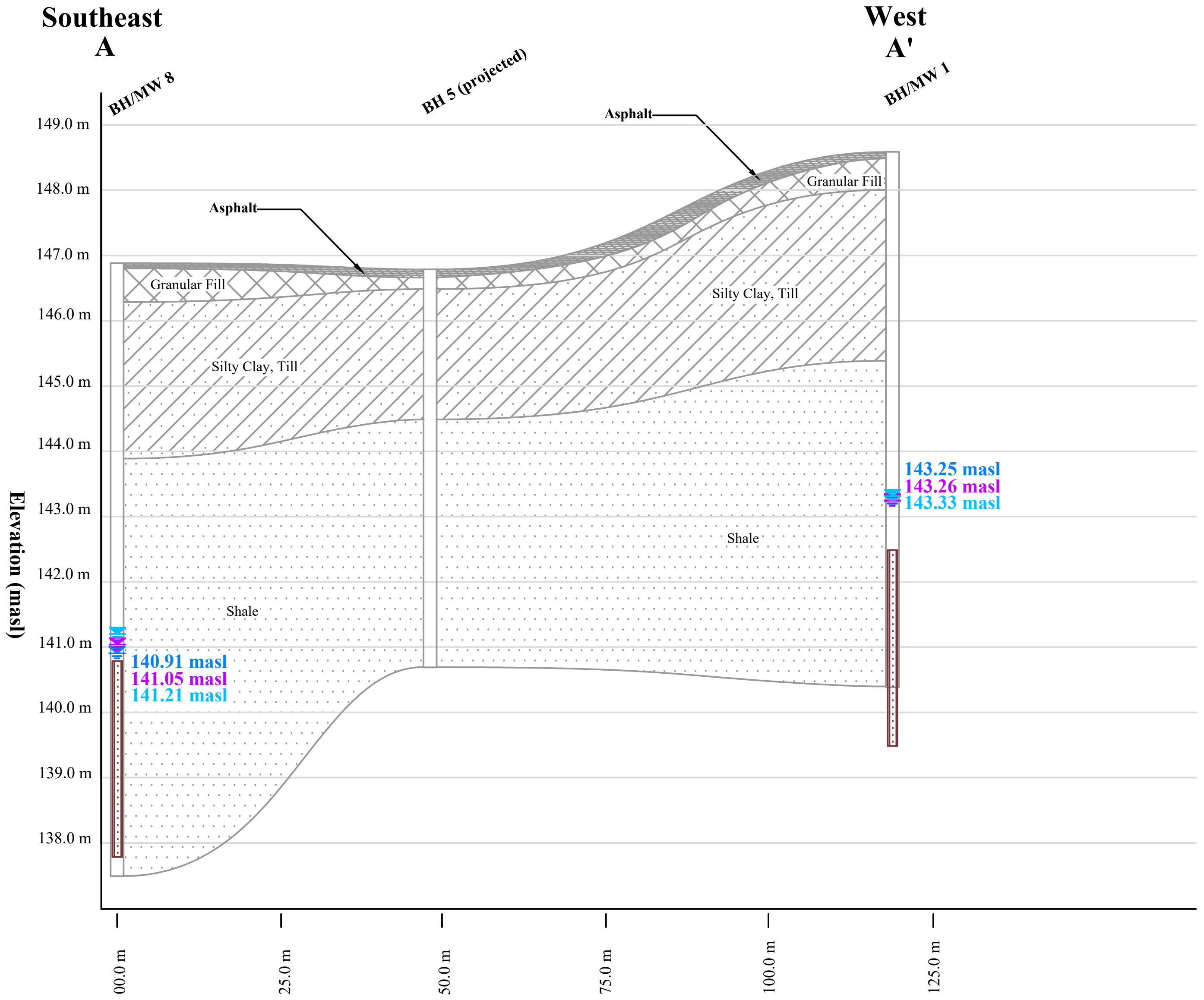
Hydrogeological Assessment
Proposed Mixed-Use Buildings
2163 and 2169 Sixth Line
Town of Oakville

Reference No. 1909-W038

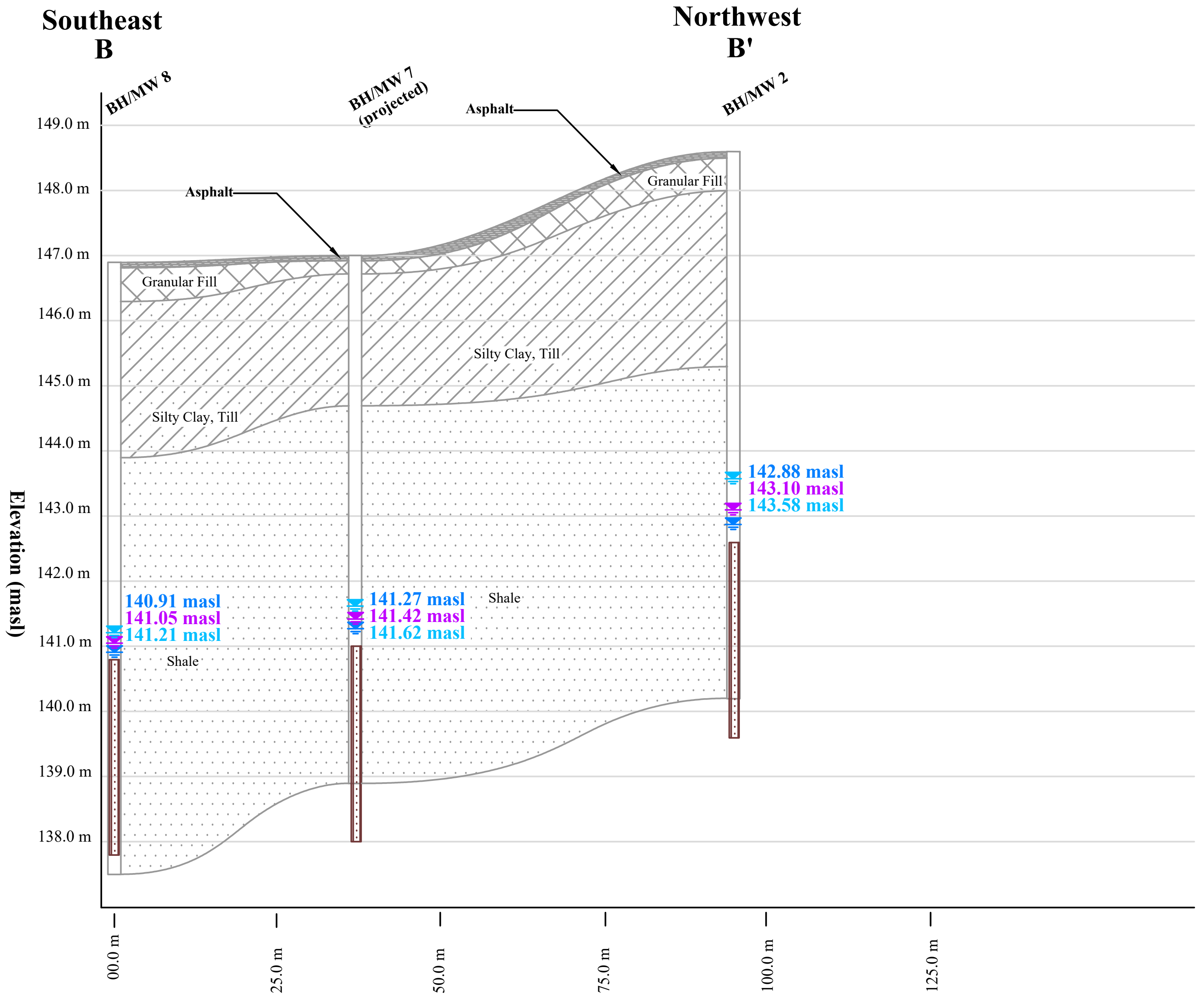
Date: January 10, 2020

Scale:
0 5 10 20 30 40 50
Metres

Drawing No. 8-1



Section A-A'



Section B-B'

▩ **Asphalt**

▦ **Granular Fill**

▨ **Silty Clay, Till**

░ **Shale**

▯ **3.0 m Screen**

▼ **Water Table on October 10, 2019**

▼ **Water Table on October 21, 2019**

▼ **Water Table on October 31, 2019**

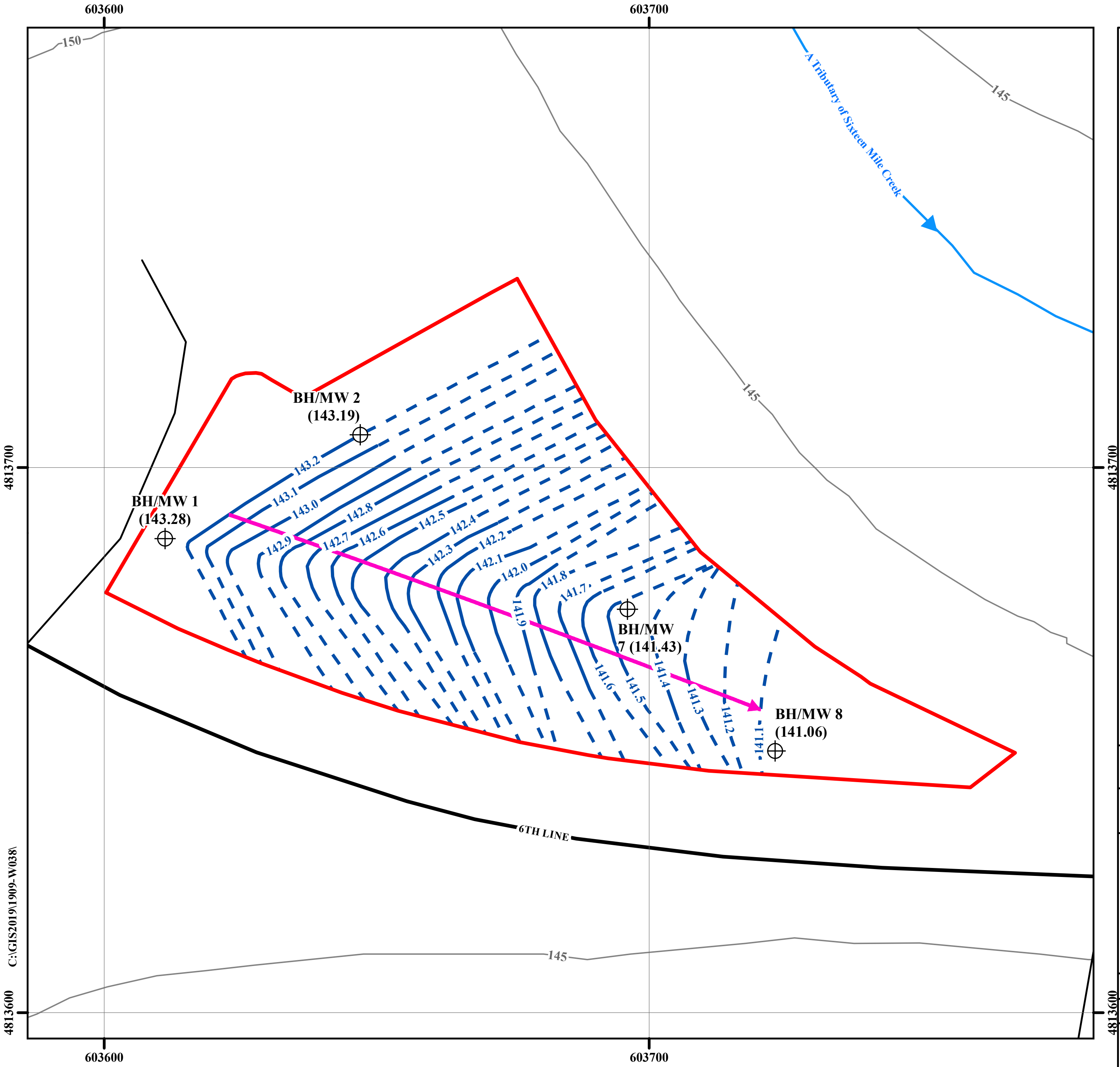
C:Projects/2019 Jobs/1903-W079

Soil Engineers Ltd.
CONSULTING SOIL, FOUNDATION & ENVIRONMENTAL ENGINEERS

Title: Geological Cross-Section (A-A' and B-B')

Project: Hydrogeological Assessment
Proposed Mixed-Use Buildings
Sixth Line, Town of Oakville

Reference No:	Date:	Scale: V	Scale: H	Drawing No.
1909-W038	January, 2020	1:100	1:2500	8-2



Source: Ministry of Natural Resources and Forestry
©Queen's Printer for Ontario, 2019

N

🟥 Approximate Boundary of Subject Site
⊕ Borehole with Monitoring Well
→ Interpreted Shallow Groundwater Flow Direction
— Interpreted Shallow Groundwater Level Elevation (masl)
- - Inferred Shallow Groundwater Level Elevation (masl)
→ Watercourse
— Major Road
— Local Road
—150— Topographic Contour (masl)
251.25 Average Shallow Groundwater Level Elevation (masl)

Soil Engineers Ltd.

Title: Shallow Groundwater
Flow Pattern Plan

Project:

Hydrogeological Assessment
Proposed Mixed-Use Buildings
2163 and 2169 Sixth Line
Town of Oakville

Reference No. 1909-W038

Date: January 10, 2020

Scale:
0 5 10 20 30 40 50
Metres

Drawing No. 9

APPENDIX ‘A’

MECP WATER WELL RECORDS SUMMARY

REFERENCE NO. 1909-W038

Ontario Water Well Records

WELL ID	MOECC WWR ID	Construction Method	Well Depth (m)**	Well Usage		Water Found (m)**	Static Water Level (m)**	Top of Screen Depth (m)**	Bottom of Screen Depth (m)**
				Final Status	First Use				
1	7188589	-	-	-	-	-	-	-	-

Notes:

*MECP WWID: Ministry of Environment, Conservation and Parks Water Well Records Identification

**metres below ground surface

APPENDIX ‘B’

SINGLE WELL RESPONSE TEST RESULTS

REFERENCE NO. 1909-W038

Falling Head Test (Slug Test)

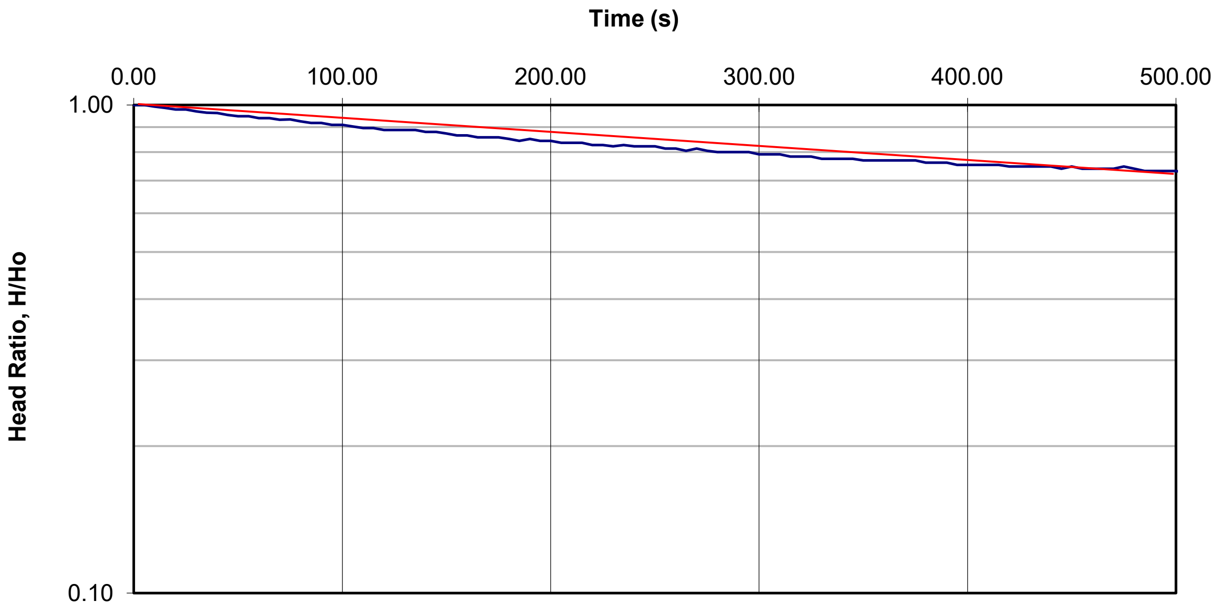
Test Date:		31-Oct-19	
Piezometer/Well No.:		BH/MW 1	
Ground level:		148.60	m
Screen top level:		142.50	m
Screen bottom level:		139.50	m
Test El. (at midpoint of screen):		141	m
Test depth (at midpoint of screen):		7.6	m
Screen length	L=	3.1	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.5	m
Initial water depth		5.24	m
Aquifer material:		**Shale Bedrock**	

Shape factor F= $\frac{2 \times 3.14 \times L}{\ln(L/R)}$ = 5.83401 m

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

$$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.00062395$$

K= **2.1E-05** cm/s
2.1E-07 m/s



Falling Head Test (Slug Test)

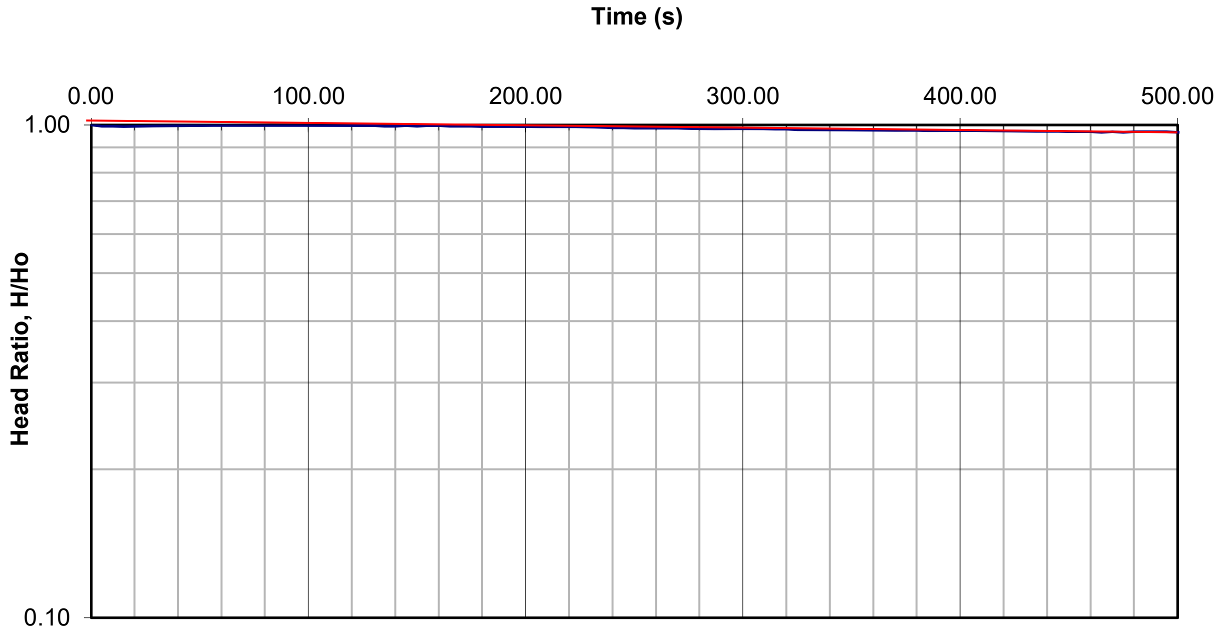
Test Date:		31-Oct-19	
Piezometer/Well No.:		BH/MW 3	
Ground level:		148.60	m
Screen top level:		142.50	m
Screen bottom level:		139.50	m
Test El. (at midpoint of screen):		141.00	m
Test depth (at midpoint of screen):		7.6	m
Screen length	L=	3.1	m
Diameter of undisturbed portion (	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-1.92	m
Initial water depth		5.07	m
Aquifer material:		**Shale Bedrock**	

Shape factor F= $\frac{2 \times 3.14 \times L}{\ln(L/R)}$ = 5.83401 m

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

$\frac{\ln(H1/H2)}{(t2 - t1)}$ = 6.6726E-05

K= **2.2E-06** cm/s
2.2E-08 m/s



Falling Head Test (Slug Test)

Test Date: 31-Oct-19
Piezometer/Well No.: BH/MW 7
Ground level: 147.00 m
Screen top level: 141.10 m
Screen bottom level: 138.00 m
Test El. (at midpoint of screen): 139.55 m
Test depth (at midpoint of screen): 7.45 m
Screen length L= 3.1 m

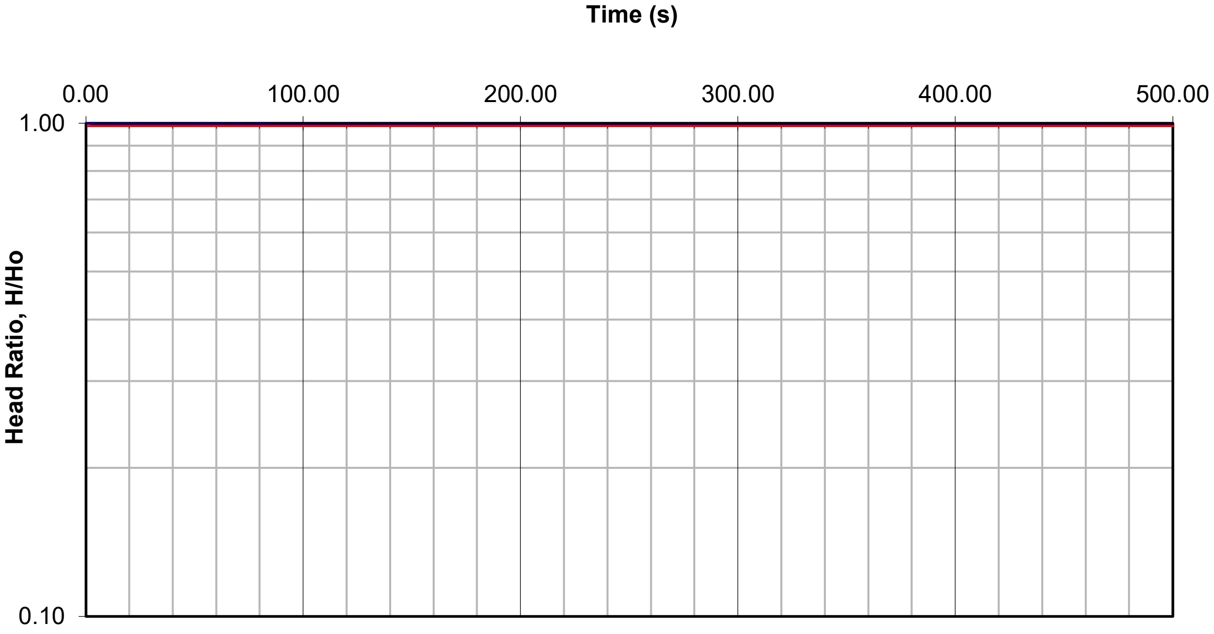
Diameter of undisturbed portion 2R= 0.22 m
Standpipe diameter 2r= 0.05 m
Initial unbalanced head Ho= -2.099 m
Initial water depth 5.34 m
Aquifer material: **Shale Bedrock**

Shape factor F= $$\frac{2 \times 3.14 \times L}{\ln(L/R)} = 5.83401 \text{ m}$$

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

$$\frac{\ln(H1/H2)}{(t2 - t1)} = 2.1073E-05$$

K= **7.1E-07** cm/s
7.1E-09 m/s



Falling Head Test (Slug Test)

Test Date:		31-Oct-19	
Piezometer/Well No.:		BH/MW 8	
Ground level:		146.90	m
Screen top level:		140.80	m
Screen bottom level:		137.90	m
Test El. (at midpoint of screen):		139.35	m
Test depth (at midpoint of screen):		7.55	m
Screen length	L=	3.1	m
Diameter of undisturbed portion (	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-2.453	m
Initial water depth		5.73	m
Aquifer material:		**Shale Bedrock**	

Shape factor $F= \frac{2 \times 3.14 \times L}{\ln(L/R)} = 5.83401$ m

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

$$\frac{\ln (H1/H2)}{(t2 - t1)} = 2.7088E-05$$

K= **9.1E-07** cm/s
9.1E-09 m/s